DEEP SEA DEBRIS | EDUCATOR

Links to Next Generations Science Standards |

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Links to Common Core Standards |

CCSS.ELA-LITERACY.WHST.6-8.9: Draw evidence from informational texts to support analysis reflection, and research.

CCSS.Math 3.MD Measurement and Data 3: Represent and interpret data.

S T E M

Pacing | 1-3 class periods

Background Needed | Graphing and data analysis skills

Assessment | Rubric provided

Materials/Resources |

- Student worksheets
- Devices with online access
- Calculators
- Graph paper (optional)
- Colored pencils (optional)

Overview

This module will introduce students to the topic of marine debris and degradation rates of various materials. Students will analyze an authentic data set as documented by *Nautilus* science team members during a Southern California Expedition (Summer 2015). Students will categorize the percent of trash found on various dives and summarize how this relates to the big picture of marine pollution world-wide. Students will demonstrate their understanding of this topic by describing how they could take action within their town/school/community to help reduce pollution's impact on the oceans.

Objectives & Learning Outcomes

- Students will calculate percentages and represent a dataset in graph or table form.
- Students will summarize key findings and implications from an authentic deep sea pollution observation dataset and dive track maps.
- Students will explore material degradation to understand how pollution impacts marine ecosystems.
- Students will document an idea for how they can help their town, school or community reduce its impact on marine pollution.

Define the following terms:

Students will be able to understand and use the following vocabulary:

Marine debris

- ✓ Persistent, manufactured, processed or solid material that's disposed of in the marine and coastal environment.

Point pollution

- ✓ Comes from a single identifiable source such as a pipe, ditch, ship, or factory smokestack

Set The Stage!

Have some assorted materials on display when students enter the classroom such as a plastic bag, 6 pack soda plastic ring, dish soap or laundry detergent, health & cosmetics products. Ask students to think about how these items impact the world's oceans. Students can work in groups with laptops and have 10 minutes to research some information. Groups can then report out about what they learned or were surprised by and have a class discussion.

Non-point pollution

- ✓ Comes from many different sources and can result from processes such as land runoff, precipitation, and seepage.

Run-off

- ✓ The draining away of water or materials carried in it from the surface of an area of land, building or other structure.

Primary microplastics

- ✓ Plastic particles that are manufactured to be microscopic. Commonly found in cosmetics such as facial cleansers as exfoliators, and air blasting cleaning technology such as used for removing rust and paint from machinery.

Secondary microplastics

- ✓ Microscopic plastic fragments broken down from larger plastic debris both on land and at sea. Breakdown caused by various physical, biological and chemical processes that reduce the structural integrity of the material.

Biodegradation

- ✓ Process by which bacteria and microorganisms such as fungi break down organic matter into water, carbon dioxide and/or methane, and energy.

Photodegradation

- ✓ Process by which a material is altered by exposure to photons, especially those found in the wavelengths of the sun's rays.

Activity/Tasks

Students will:

- read the introduction and define vocabulary terms to get better acquainted with current topics in marine pollution,
- calculate percentages of various trash found during several Nautilus dives off the coast of Southern California,
- visually represent data in graph or table form,
- analyze trends and key points within the provided data and maps,
- complete discussion questions,
- come up with an action plan to reduce pollution's impact.

Student Data

Encourage students to come up with their own categories for their charts or graphs and to think about how to best visually represent the data. They can use graph paper or a computer program such as Microsoft Excel to complete this task.

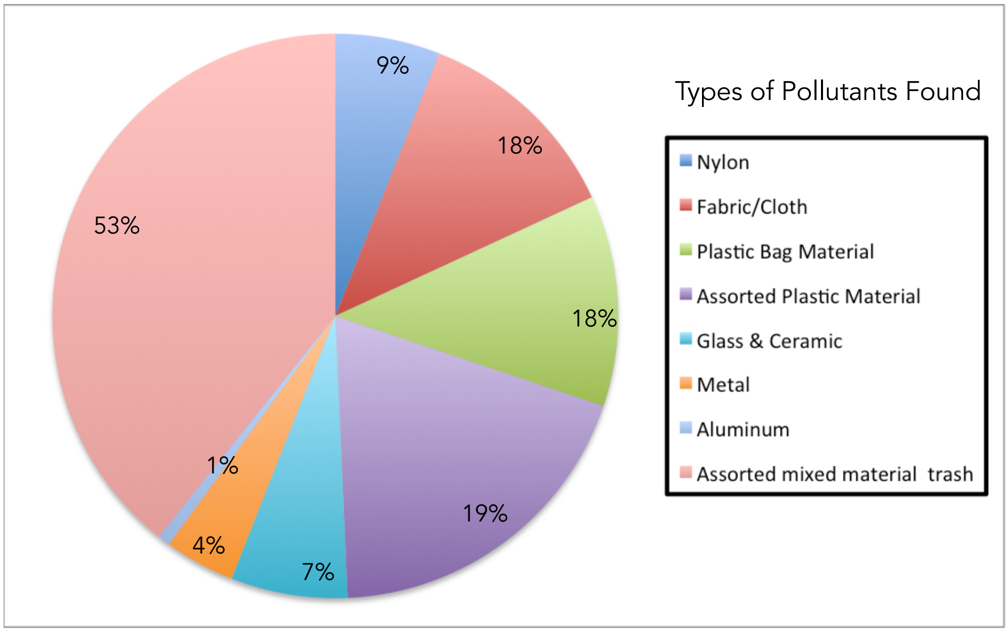
Extensions & Adaptations

Introductory |
Have students choose one type of pollutant and trace its path from their home/town/school to a marine ecosystem. They could complete some research to get an estimated timeline of travel for their material to potential aquatic habitats.

Advanced |
Have students research various types of plastics, the processes by which they degrade in the environment, and/or the effect this has on the planet. Students could be assigned or choose a sub-topic to present to the class in more depth. Students can start with the following sites to learn more:

- https://marinedebris.noaa.gov/sites/default/files/Gen_Plastic-hi_9-20-11_0.pdf
- http://science.howstuffworks.com/science-vs-myth/everyday-myths/how-long-does-it-take-for-plastics-to-biodegrade.htm
- http://plastic-pollution.org

Here is an example of a pie chart created in Excel:



Student Analysis

- ✓ Students should be able to note that all of this trash was found within a small geographical area of the seafloor off the California Coast. There were approximately 151 pieces of trash *observable* on the seafloor surface at various locations and depths ranging from 400 to 1028 meters. Students could correlate this data with the fact that this was a small section of seafloor observed; there are millions of pieces of garbage on the seafloor in other geographical locations, in addition to being buried beneath the sediment and floating in the open water. Also, it can be difficult to get a true estimate of the types of trash because of poor visibility/sediment coverage at those depths.

Group Discussion Questions

Key Points:

- ✓ Materials such as cloth, paper and thin plastic tend to have quicker decomposition rates as compared to thicker plastic materials, metals and glass if all variables are kept the same.
- ✓ The problem does not go away after some materials like plastics break down in the environment due to the release of toxic chemicals. These toxins along with micro plastics can cause a great deal of harm to organisms and the planet.
- ✓ Temperature, pressure and amount of sunlight can all affect the rate at which materials break down. Since oceans tend to have increased pressure, decreased temperatures and sunlight, materials tend to break down much more slowly as compared to land.

DEEP SEA DEBRIS | STUDENT

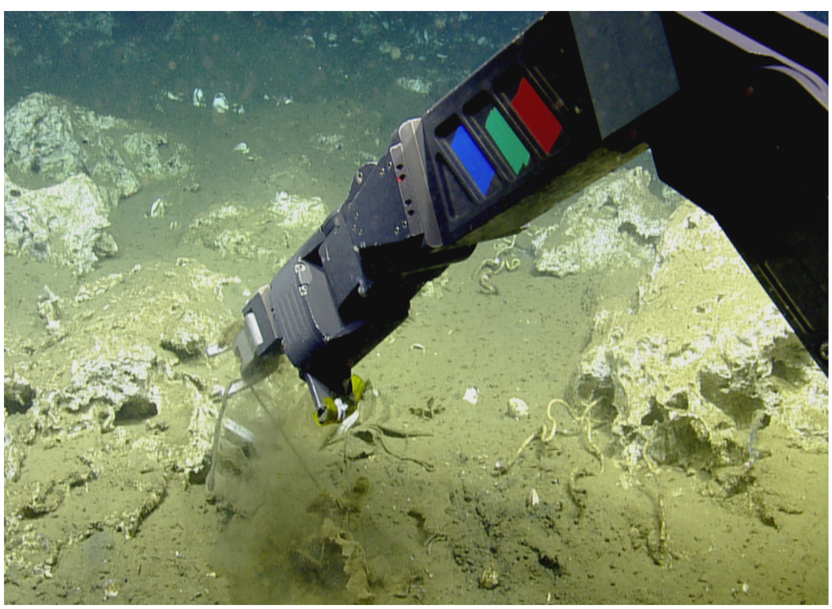
Learning Goals

- Learn to identify sources of global marine pollution.
- Calculate frequency percentages of trash types found in the Nautilus Exploration Program data log.
- Explore material degradation to understand pollution impacts on marine ecosystems.
- Demonstrate understanding of the topic by proposing one solution for reducing impact of marine debris.

Introduction | Humans release about 8 million tons of plastic trash into the ocean each year- that's five plastic trash bags full of plastic for every foot of shoreline in the world! Plastic is not the only form of man-made ocean trash; assorted metal, textiles, glass and wood also fall under the category of marine debris. Much of this trash washes back on beaches, some sinks, some is eaten mistakenly by animals, but each year more enters the ocean to impact the marine habitat. Evidence of human pollution has been found across all ocean depths with trash often greeting *Nautilus'* Remote Operated Vehicles (ROVs) in otherwise unexplored regions of the seafloor.

About 80% of marine debris comes from land-based sources through littering, groundwater runoff or extreme natural events. Trash washes down storm drains, streams or rivers and is carried by the wind into the ocean. There is always an ecosystem downstream for pollution. Whether you live inland or along the beach, your lifestyle plays a role in impacting the ocean's health. Trash can often be mistaken as food and consumed by marine life. Top level predators including humans can be poisoned by eating contaminated seafood.

Some trash breaks down (degrades) completely, but many materials are manufactured to be resilient and not break down. Materials break down more quickly on land than underwater as they are exposed to more sunlight (photodegradation), oxygen for microbes (biodegradation) and physical forces like wind and rain.



ROV - Remotely Operated Vehicle- *Hercules* had its manipulator arm hooked by discarded line at 1,025 meters off the coast of Southern California. Entanglement hazards like this are a top concern for ROV pilots.

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Helpful Resources

NatGeo: Great Pacific Garbage Patch
http://nautl.us/294JeJ5

UNEP: Biodegradable Plastics
http://nautl.us/295SJZj

NOAA Marine Debris Program
http://nautl.us/2986b1X

NatGeo: True Harm of Microplastics
http://nautl.us/296Rw5P

How Long Until It's Gone Brainstorm

Check your answers and learn about more materials' decomposition rates:
http://nautl.us/292L0Pp

This module focuses on marine debris that sunk to the ocean floor. You will analyze the trash data log from several ROV dives during a Southern California *Nautilus* expedition looking for patterns and conclusions. You will then work in a small group to present one solution for how your school or community can reduce its impact on ocean pollution.

Vocabulary |

1. Marine debris

2. Point pollution

3. Non-point pollution

3. Run-off

4. Microplastics

6. Biodegradation

7. Photodegradation

How Long Until It's Gone Brainstorm |

Match the marine debris materials with the estimated amount of time it takes for them to decompose in the marine environment. Some answers will be used more than once.

1. Glass bottle	a. 6 weeks
2. Foam buoy	b. 2 months
3. Apple core	c. 3 months
4. Styrofoam cup	d. 2-5 months
5. Tin can	e. 6 months
6. Wax milk carton	f. 10-20 years
7. Plastic bottle	g. 50 years
8. Plastic grocery bag	h. 200 years
9. Disposable diaper	i. 400 years
10. Aluminum can	j. 450 years
11. Plastic 6-ring drink holder	k. undetermined
12. Photodegradable 6-ring drink holder	
13. Cotton shirt	
14. Newspaper	

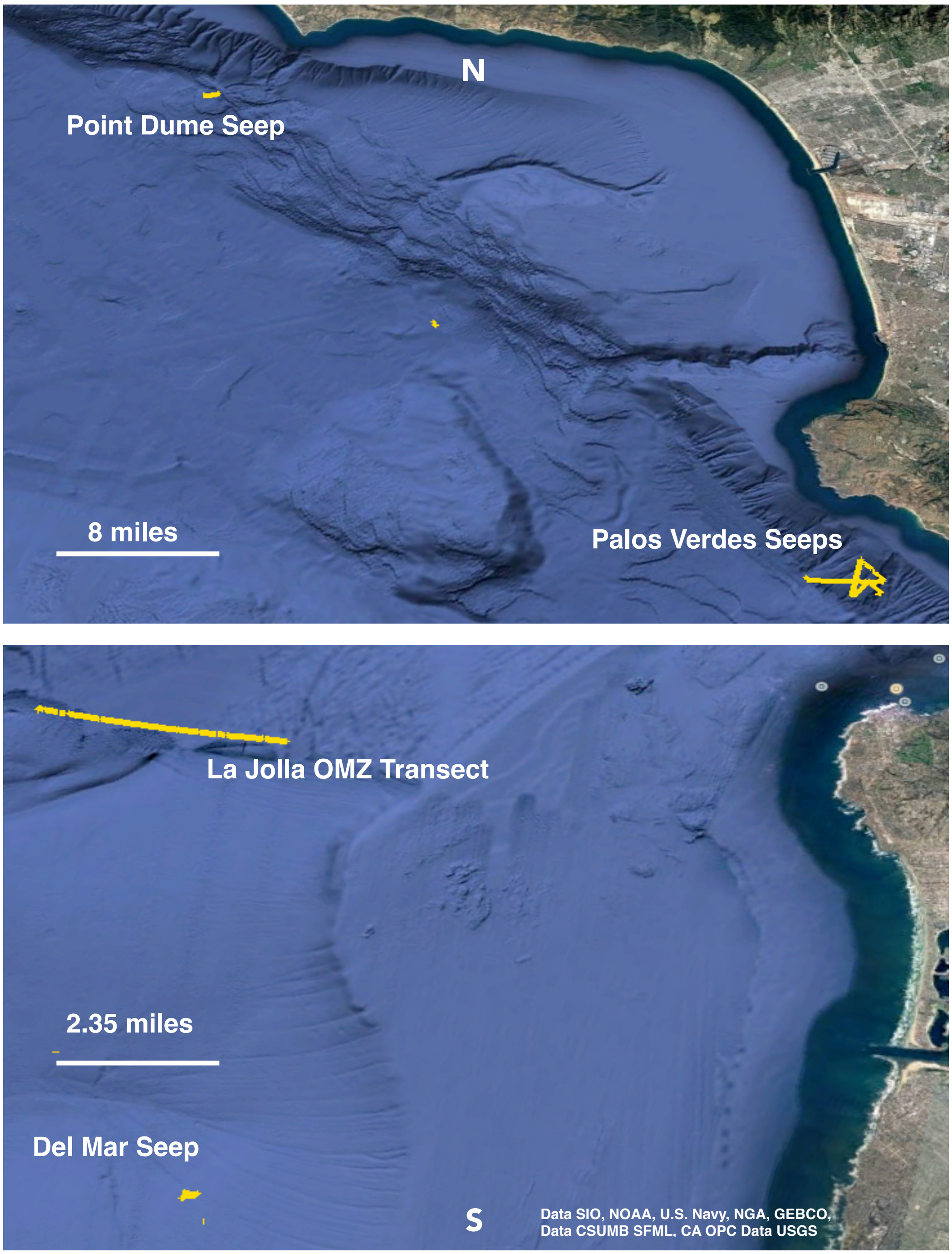
Data log of seafloor trash during a 2015 Southern California *Nautilus* expedition.

	Depth (m)	Data Log Description
July 28, 2015 Del Mar Seep	1027.2	5 pieces of nylon balloon
	1023.3	8 pieces of fabric, 1 plastic 6-pack soda ring, 17 scattered plastic bag pieces
	1020.9	3 pieces of rubber cable
	1028.1	12 assorted plastic pieces
	1028.4	5 pieces of torn canvas
	1028.3	1 plastic bag
	1028.8	1 piece nylon rope
	1024.8	1 aluminum soda can
	1023.8	Mixed assorted trash - 12 pieces visible
	1023.7	Mixed assorted trash - 7 pieces visible
	1024.0	12 pieces plastic debris
	1024.9	1 glass bottle
	1027.3	3 pieces of fabric string, 2 pieces fabric
	1026.7	1 plastic spoon
	1027.0	1 metal wire
	1021.7	1 aluminum can
	1021.2	1 rubber cord, 3 pieces plastic debris
	1022.9	9 pieces broken glass/ceramic
	1022.4	1 rubber-coated cable wire
	1024.8	1 rubber cord, assorted trash - 15 pieces visible
August 1, 2015 La Jolla Oxygen Minimum Zone Transect	684.1	1 piece nylon line, 5 metal stakes
	668.8	7 pieces assorted metal & plastic
	439.9	1 piece of nylon fishing line
August 5, 2015 Palos Verdes Seeps	503.8	1 piece nylon line, assorted pile of trash
	406.8	1 piece of metal equipment
August 7, 2015 Point Dume Seep	727.7	10 pieces assorted plastic trash

<u>*Nautilus* Dive Tracks (Base map by GoogleEarth)</u>

The trash data log was collected during four ROV dives offshore of Southern California. Examine the maps below to see where these dives took place. How do you think seafloor structure affects marine debris distribution? Click on this link (http://nautl.us/29qaKnk) to learn more about the scientific goals of each dive.

W



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<u>Data representation:</u> Create a graph or chart to display a summary of the different types of trash found during the ROV dives. You'll need to determine how to classify the trash from the marine debris data log.

Step 1: Determine how many categories and which categories will be represented.
Step 2: Divide the marine debris data log into your determined categories.
Step 3: Use this formula to calculate percentages of trash within each category.

$$\frac{\textit{Amount or number of trash items}}{\textit{Total number or amount}} \times 100 = \textit{Percent}$$

Step 4: Create a summary chart or graph using graph paper or a computer. Label each category and title the graph.

<u>Analysis:</u> Write a paragraph in the space below summarizing the findings from the pollution dataset and maps provided. What key points stand out in the data?

Partner/Group Discussion Questions:

1. Which of the logged trash types would break down most quickly? Most slowly? What other types of trash would you expect to find on the seafloor?

2. What environmental factors could contribute to the rate of which these various materials break down? Why would the ocean slow down trash degradation compared to land?

Taking Action: Come up with one idea that you could implement within your school/community to help spread awareness about marine pollution or to reduce the impact of pollution within your community. Document a brief plan of the steps you would take to accomplish this.

Use the resources below to learn more about action steps to clean up marine debris.

- City of Chicago Plastic Bag Ban — http://nautl.us/29ayLip
- Marine Debris Impact on Sealife — http://nautl.us/2970y24
- Plastic alternatives- Algae Water Bottles? — http://nautl.us/29sYZuC
- 5 Gyres Institute — http://www.5gyres.org
- Ikea Adopts Mushroom-Based Packing Material — http://nautl.us/296Q6sd
- Plastic-Eating Bacteria? (CNN) — http://nautl.us/298kDVo

DEEP SEA DEBRIS | ASSESSMENT

STEM Project & Task Rubric

OBJECTIVE	CRITERIA			
	4 Exemplary	3 Commended	2 Emerging	1 Developing
Knowledge & Understanding |	Student consistently, correctly and thoroughly answers all questions. Uses an abundance of relevant vocabulary and is able to explain relationships within the content using examples. Can apply the content to other topics or real life.	Student is able to consistently answer most questions correctly. Uses an adequate amount of relevant vocabulary. Can explain relationships within the content and can apply content to other topics or real life.	Student is able to answer some questions correctly. Uses some relevant vocabulary. Student does not elaborate on relationships within the content or make connections between the content and real life.	Student is able to answer a few questions correctly. Inconsistently uses relevant vocabulary. Student does not elaborate on relationships within the content or make connections between the content and real life.
Content Organization, Methodology & Analysis |	Student effectively organizes complex ideas, concepts, and information to make important connections and distinctions. This may include detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses.	Student is able to organize ideas, concepts, and information to make connections and distinctions. This may include mostly detailed, labeled and thorough procedures, data tables, graphs, diagrams and/or analyses.	Student attempts to organize ideas, concepts and information to make some connections and distinctions. Student is able to provide basic procedures, data tables, graphs, diagrams and/or analyses.	Student has difficulty organizing ideas, concepts and information to make connections and distinctions. Student is unable to provide basic procedures, data tables, graphs, diagrams and/or analyses.
Self-Directed Learner |	Student is actively engaged in the learning process; consistently contributes to class discussions and asks clarifying questions. Seeks out and shares additional resources with the class or teacher. Advocates for his/her learning needs.	Student is engaged in the learning process. Often contributes to class discussions and asks clarifying questions. Advocates for his/her learning needs.	Student is inconsistently engaged in the learning process. Sometimes contributes to class discussions or asks clarifying questions. Inconsistently advocates for his/her learning needs.	Student is weakly engaged in the learning process. Rarely contributes to class discussions or asks clarifying questions. Rarely advocates for his/her learning needs.
Technological Tools |	Use of digital resources is always appropriate for the task. Willing to learn and use technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is appropriate for the task. Willing to use technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is sometimes appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message.	Use of digital resources is rarely appropriate for the task. Inconsistent use of technology for inclusion of charts, graphs, pictures, etc. to amplify the message.
Collaboration Skills |	Consistently works effectively and respectfully with a diverse group of learners. Actively checks with others for understanding and how he or she may be of help. Student listens when others speak and incorporates or builds off of the ideas of others.	Works effectively and respectfully with a diverse group of learners. Checks with others for understanding and how he or she may be of help. Student listens when others speak.	Sometimes works effectively and respectfully with a diverse group of learners. Sometimes checks with others for understanding and how he or she may be of help. Student listens when others speak.	Has difficulty working effectively and respectfully with a diverse group of learners. Rarely checks with others for understanding and how he or she may be of help. Student may talk over other students or does not listen when others speak.
Total Score: ____________	**Comments:**			

How Large is Nautilus Nation?

Tracking the reach of Ocean Exploration Trust's education programs is essential in ensuring we are funded to continue making discoveries and inspiring the next generation of explorers.

Name: **My Community (City, State):**

Email Address:

School's Name:

Instruction date: **Grade level instructed:**

Subject area:

My education space is a...

- ❏ Classroom
- ❏ After school program / Club meeting
- ❏ Fair / Festival / Event
- ❏ Museum / Science Center
- ❏ Other. Tell us more:

Who did you engage in your teaching?

Students

Community Members

Select all the OET materials you used in your instruction:

- ❏ STEM Learning Modules. Which ones? ____________________
- ❏ Digital Resource Library materials. Which ones? ____________________
- ❏ Nautilus Live website: photo albums ❏ highlight videos ❏ live stream
- ❏ Meet the Team STEM mentor profiles
- ❏ Facebook (NautilusLive) ❏ Twitter (@EVNautilus) ❏ Instagram (@nautiluslive)
- ❏ Other. Tell us more: ____________________

____

What made working with OET resources valuable to your instruction (select all that apply)?

- ❏ Hands-on activities ❏ STEM career connections
- ❏ Easy to use lessons ❏ Standards-based lessons
- ❏ Website resource access ❏ Real world application of curricula topics
- ❏ Excitement of cutting-edge discoveries / Unfamiliarity of deep ocean
- ❏ Another reason. Tell us more: ____________________

____

Using OET resources increased my confidence in teaching my science, technology, engineering, or math subjects.	❏ Yes	❏ No
OET provided me with helpful and relevant teaching resources.	❏ Yes	❏ No
Using OET resources increased my awareness of STEM careers.	❏ Yes	❏ No
If yes, how so? How can we improve?		

Please scan this document or snap a picture of it with your phone. Email the feedback or questions to education@oet.org. You can also submit feedback online: http://nautl.us/2cp3PNu

Thank You For All You Do!