TRAWLING THROUGH THE FIVE GYRES: A MICROPLASTIC RESEARCH STUDY

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Grade Level
6th Grade

Subject area
Life & Environmental Science

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Title Trawling Through the 5 Gyres: A Microplastic Research Study

Focus: Students will help collect data about the types of microplastics in the 5 main gyres of the oceans, and learn how our habits of using single-use plastics can affect this pollution.

G**rade Level**: 6th Grade

VA Science Standards

6.1 The student will demonstrate an understanding of scientific and engineering practices by

c) interpreting, analyzing, and evaluating data

- organize data sets to reveal patterns that suggest relationships
- construct, analyze, and interpret graphical displays of data
- compare and contrast data collected by different groups and discuss similarities and differences in findings
- use data to evaluate and refine design solutions

6.9 The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment. Key ideas include

a) natural resources are important to protect and maintain;
b) renewable and nonrenewable resources can be managed;
c) major health and safety issues are associated with air and water quality;
d) major health and safety issues are related to different forms of energy;
e) preventive measures can protect land-use and reduce environmental hazards; and

there are cost/benefit tradeoffs in conservation policies.

Learning Objectives:

- ✓ Students will count items found in a research trawl, and graph the count results.
- ✓ Students will compare and contrast their results to the results from other groups in the class
- ✓ Students will distinguish between primary and secondary microplastics
- ✓ Students will identify what single-use plastics are
- ✓ Students will create a plan of action to reduce their use of single-use plastics (*optional*)

Time Required: 45 minutes – 90 minutes

The lesson and activity should take 45 minutes. An additional 45-minute challenge activity is included, which could be modified and assigned as a take-home project, completed in another class period or skipped entirely.

Key words, vocabulary:

Ocean Gyre: areas where the ocean currents move in a circular pattern, leading to an area of calm water in the middle

Microplastic: pieces of plastic less than 5 mm in size

Primary Microplastic: microplastics that were always under 5mm in size (e.g. plastic bead)

Secondary Microplastic: microplastics that formed from the break-down of large pieces of plastic

Manta Trawl Net: a type of net that is pulled behind a research vessel, used for collecting plastic debris. Scientists keep track of the distance covered and speed while trawling in order to calculate the volume of water that went through a manta net.

Nurdle: a small piece of plastic made by the manufacturer, and sent to companies to use in their plastic molds for products

Single-use plastic: a plastic that is not intended to be reused multiple times, but rather meant to be thrown away after one or a few uses

Background Information:

Plastic pollution is a major problem in the worlds oceans. It is estimated that 10 – 28 billion pounds of trash entered the oceans in 2010 alone (Jambeck et al., 2015). This plastic is mostly microplastics, or plastic bits smaller than 5mm (Cozar et al., 2014). The main reason for this plastic pollution is not actually litter on the beaches or on the ocean, this pollution is mostly from ineffective waste management (Jambeck et al., 2015). In other words, plastic doesn't make it to the landfill, but instead gets into our waterways leading to the oceans. To keep track of this plastic and understand the problem, scientists have used manta net tows throughout areas of high plastic concentrations (such as the North

Pacific Gyre aka the 'Great Pacific Garbage Patch'). This research has shown that the most debris is in the North Pacific, followed by the Indian, North Atlantic, South Pacific and South Atlantic (Eriksen et al., 2014). This is a product of the pollution in the countries surrounding those ocean gyres. In particular, pollution and waste management is very poor in Asian countries, leading to the high debris in the Indian and Pacific oceans (Jambeck et al. 2015). Although the Indian gyre is physically the smallest, it still accumulates the second most debris because of poor waste management and very dense populations in the surrounding countries. Students will analyze different gyres, and find different amounts of pollution in each gyre according to this trend. They will be asked why they think this is, and you should help them reach the conclusion that it's a product of: 1. How populated the land around that ocean is and 2. How well those populations manage their waste (i.e. how much they pollute). Research still isn't clear on what types of plastic dominate different gyres. Remind students that this research project would help contribute to that knowledge gap!

Scientists have also found that the majority of microplastics come from single-use plastic waste, that has broken down into microplastics over time. In order to help with this problem, scientists suggest 'turning off the tap'. This is based on the overflowing tub analogy - if your tub is overflowing you aren't going to bucket out the water, you are going to turn off the faucet! We cannot fix the problem by simply removing plastic from the oceans. Instead, decreasing our use of single-use plastics is the most effective way to help reduce the marine debris problem. During this activity, students should gain an understanding of the marine debris problem and the contribution that secondary microplastics make, and the additional 'challenge' activity will help them see how they can make changes in their daily life.

Student handouts and other materials needed:

- ☐ Student Worksheet
- ☐ PowerPoint
- ☐ Data sheet (useful for personal modification of tables in worksheet)

Materials & supplies:

The materials for this activity is 5 complete 'nets' with microplastics. This lesson is designed so that teachers may use one of two approaches to build these nets: sustainable/reuse (aka use products you already have or recycled) or purchasing new supplies (using beads and mesh you buy from the store). Either approach will work well! The supplies for each approach are listed below, but the instructions for setup are the same regardless of your approach.

**The option for a sustainability approach is included so that teachers may choose to set an example of 'reusing and recycling' for the students, and so that teachers may have the option to make this a free activity.

Purchasing new supplies:

- ☐ 5 pieces of mesh or fabric to be the 'trawl net' cut in an approximately 6 in x 6 in square
- ☐ Rope or string to tie together the trawl net opening
- ☐ 7 bead colors, corresponding to each of the plastic types in the net
    - The most you'll need of one color is 144
- ☐ Label for each gyre (North Pacific, South Pacific, North Atlantic, South Atlantic, Indian)
- ☐ *Optional with challenge activity:* poster boards (5) and markers

OR

Sustainable/re-use supplies:

- ☐ 5 pieces of mesh or fabric to be the 'trawl net' cut in an approximately 6 in x 6 in square (e.g. old cut-up t-shirt works well)
- ☐ Rope or string to tie together the trawl net opening
- ☐ 7 types of plastics you can cut up around the house or trash, cut into small pieces (less than 5 mm). Examples:
    - Old zip-lock bag or saran wrap
    - Cut-up folder, plastic wrap from food, etc.
    - Cut-up soda or water bottle
    - Pieces of fishing line
    - Broken up Styrofoam coffee cup
- ☐ Label for each gyre (North Pacific, South Pacific, North Atlantic, South Atlantic, Indian)
- ☐ *Optional with challenge activity:* poster boards (5) and markers

Set-up:

Each mesh bag should be filled with the different 7 types of plastic, according to the chart on the next page. You will fill in the debris color/type column depending on what approach you choose to take when gathering your supplies. Examples can be found in the supply list, or the Sample ID table in the corresponding excel sheet. When you've counted and sorted all debris according to each gyre, place them on your fabric/mesh 'net', tie it up so that the debris won't fall out, and label according to each gyre type.

To make it more realistic to the actual oceans, all gyres have the appropriate total of plastic according to research. The proportion of each type of plastic is also accounted for, according to preliminary research.

BUT scientists are still learning about what plastics are most common and where, and the student project is 'helping' to answer that question. For example, we know that there is a low abundance of nurdles and microbeads relative to secondary microplastics, therefore, those counts are relatively low. We also know that polypropylene is the most common debris found in all the oceans, so that is very high.

		Count per Gyre					
Debris Color/Type	Type of Plastic	North Pacific	Indian Ocean	North Atlantic	South Pacific	South Atlantic	TOTAL
	Plastic Film	11	10	9	12	6	48
	Polystyrene	25	19	17	15	14	90
	Polypropylene Plastic	35	33	30	23	23	144
	Rubber	15	13	10	8	8	54
	Nurdle	10	8	5	2	1	26
	Nylon Thread	14	10	9	6	4	43
	Microbead	10	7	5	4	4	30
	TOTAL	120	100	85	70	60	435

Procedure:

Gathering of lab materials – 15-30 minutes

Setup of each gyre's net – 30 minutes

Introduction (slides 1-9) – 10 minutes

Individual group work (worksheet through question 1) – 10 minutes

Sharing results with class (and slide 10) – 10 minutes

Finish worksheet (worksheet questions 2-3, slides 11 and 12) – 10 minutes

Wrap-up as a class and cleanup (slide 13) – 5 minutes

Challenge activity – 45 minutes (or at home)

Assessment:

Teachers should assess the students activity results based on their worksheet (below) and participation with the group and presenting to the class. For the follow-up activity, students should be evaluated based on their poster.

References:

Cozar, A., Echevarria, F., Gonzalez-Gordillo, J.I., Irigoien, X., Ubeda, B., Hernandez-Leon, S., Palma, A.T., Navarro, S., Garcia-de-Lomas, J., Ruiz, A., Fernandez-de-Puelles, M.L., Duarte, C.M., 2014. Plastic debris in the open ocean. Proc. Natl. Acad. Sci. 111, 10239–10244. doi:10.1073/pnas.1314705111

Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryan, P.G., Reisser, J., 2014. Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. PLoS One 9, 1–15. doi:10.1371/journal.pone.0111913

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R., Law, K.L., 2015. Plastic waste inputs from land into ocean. Science (80-.). 347, 768–771. doi:10.1126/science.1260352

Trawling Through the 5 Gyres: A Microplastic Research Study KEY

REVIEW SLIDES 1 – 8 WITH THE STUDENTS AS BACKGROUND.

Introduction

Marine Scientists across the world need the help of citizen scientists, like you! Scientists have observed plastic floating in the oceans, but they need to learn more about this plastic to help law-makers decide how to manage the problem. To help these scientists, you will be collecting data on microplastics collected from the 5 main ocean gyres.

Ocean gyres are areas where the ocean currents move in a circular pattern, leading to an area of calm water in the middle. Plastic pieces from all over the world are carried by the currents and accumulate in these gyres. The majority of these plastics are Microplastics! Microplastics are pieces of plastic less than 5 mm in size. They can be primary microplastics, which are microplastics that were always small (like a plastic bead), or secondary microplastics, which are microplastics that came from a large piece of plastic (like a small piece of a broken Styrofoam cup). To observe these microplastics, scientists have used a manta trawl net. This net is pulled behind a research vessel, collecting all the plastic debris.

Your task: Your team of scientists is charged with sorting and counting the microplastics collected in a trawl net from one of the 5 major ocean gyres.

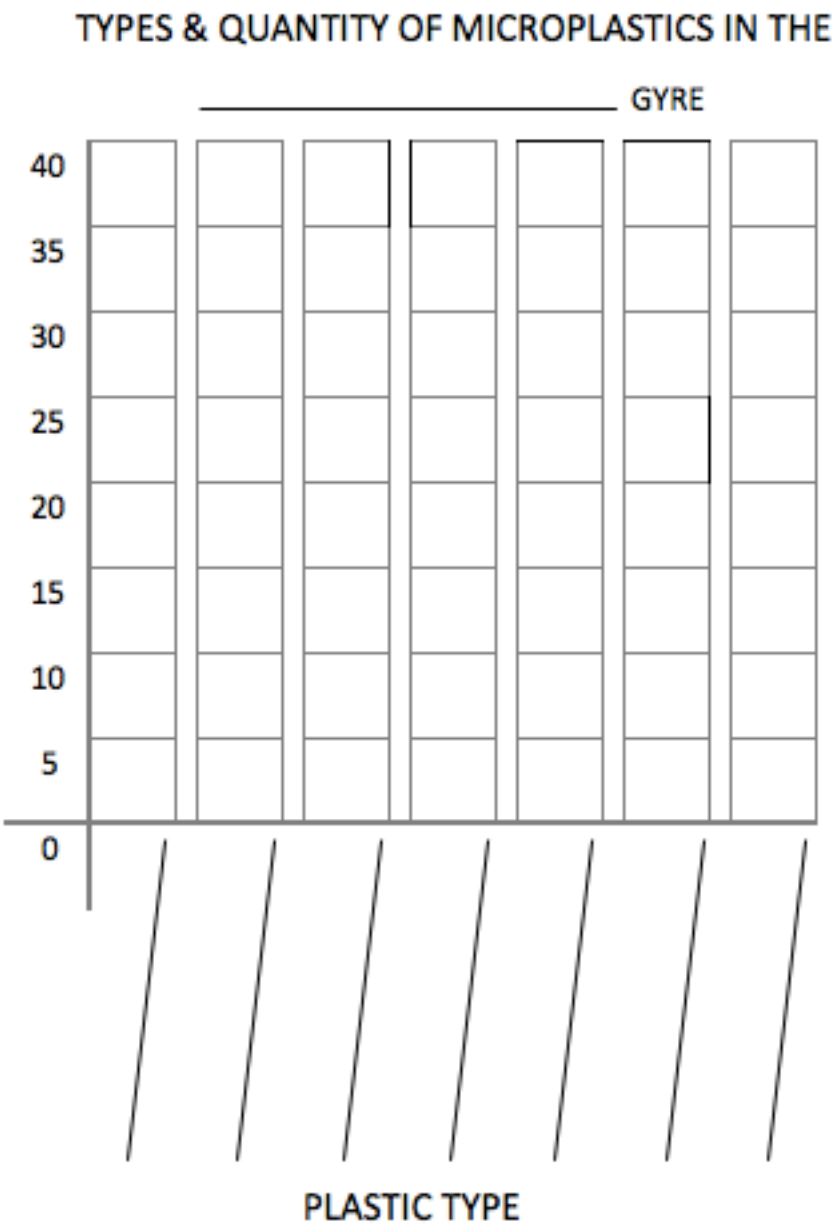
Instructions

- Open your trawl net and sort the microplastics by color/type
- Identify each type of debris, using the Plastic ID table below
- Count each type of plastic, and record the number in the Plastic ID table below
- Record the counts using the plastic ID table
- Graph the results of the plastic type and the quantity of each on the graph
- Assess the data and decide on action plans by following the questions provided

PLASTIC ID TABLE		
Debris Color/type	Type of Plastic	Item Count
Fill in depending on your supply approach.	Plastic Film	
	Polystyrene	
	Polypropylene Plastic	
	Rubber	
	Nurdle	
	Nylon Thread	
	Microbead	

GRAPHING THE DATA

Fill in the X axis with the different types of plastic you found. Using the scale on the Y axis, fill in the bars to create a bar graph illustrating the distribution of microplastics in your gyre.



STUDENTS SHOULD FILL THE GYRE THEY STUDIED IN THE TITLE, AND THE LABELS FOR THE "TYPE OF PLASIC" ON THE X AXIS. STUDENTS SHOULD FILL IN THE BARS DEPENDING ON HOW MUCH PLASTIC THEY FOUND, UP TO THE LEVEL ON THE Y AXIS. IF YOU HAVE A PAPER PROJECTOR, YOU CAN DISPLAY THIS ON THE PROJECTOR DURING THE STUDENT PRESENTATIONS.

THINK ABOUT THE DATA

Now that you've collected the data, it is time to interpret the results. Work as a group to answer the following questions.

1. Describe the microplastics found in your ocean gyre. What plastic is most abundant? What is least abundant?

THIS SHOULD BE A DESCRIPTION OF WHAT THEY FOUND IN THEIR GYRE, TO HELP THEM WHEN THEY PRESENT TO THE CLASS WHAT THEY FOUND IN THE GYRE.

2. Share your data as a group with your classmates. How does your gyre compare to the other four gyres?

YOU CAN ENCOURAGE STUDENTS TO TAKE NOTES ON WHAT THE OTHER GROUPS FOUND IN THEIR GYRES IN THIS PLACE, AND THEN USE 1-3 SUMMARY SENTENCES TO COMPARE THEIR GYRE TO OTHERS.

3. Look at the information provided that shows what types of plastic products lead to the microplastics in your ocean gyre. Are your microplastics mostly primary or secondary microplastics? What other trends do you notice about the most common products that lead to microplastics?

HERE, YOU ARE HOPING THAT STUDNETS MAKE THE CONNECTION THAT:

1. MOST OF THE PLASTICS ARE SECONDARY PLASTICS, AND
2. MOST OF THE PLASTICS ARE FROM SINGLE-USE PRODUCTS

HAVE THE "WHAT MAKES THE MICROPLASTICS" SLIDE ON THE BOARD WHILE THEY'RE WOKRING ON THIS PART. ALTERNATIVELY, YOU CAN PRINT THAT SLIDE FOR EACH GROUP TO HELP THEM UNDERSTAND THE SOURCES OF THEIR MICROPLASTICS.

THIS WILL LEAD THEM INTO THE CHALLENGE ACTIVITY, IF YOU CHOOSE TO DO THAT. IF NOT, THIS COULD EASILY BE COMPLETED ON ANOTHER DAY OR BE USED AS HOMEWORK.

CHALLENGE!

Now that you've helped scientists analyze data about the microplastics in the oceans, you've probably noticed that most of these microplastics come from single-use plastic. Policy makers are working to set up laws that will help reduce the waste. In the meantime, you want to take action to do your part in reducing marine debris.

Working as a group...

- ✓ Brainstorm some single use plastics that you all use daily. Pick out one that you think you use the most.
- ✓ Estimate how many of that item your group throws away each week.
- ✓ Generate an action plan for how you can reduce your use of that single-use plastic.
    - For example, you can bring a reusable fork to the cafeteria to lower your use of disposable cutlery! Keep it simple.
- ✓ Design a poster explaining why you chose that single-use plastic and your plan to reduce your waste.
- ✓ When your group is done with your poster, present your action plan to your class.
- ✓ Take your estimate of that plastic your group uses each week, and multiply that number by 5 to estimate for the whole class. Write that number on the board.
- ✓ When every group is done, add all of the class single-use plastic estimates together.

Got your number? It's pretty big, right?! *Imagine, each week your class could save that much single-use plastic simply by adopting the action plans you've made*.

Don't see the connection between your trash and marine debris? Science has shown that most marine debris *doesn't* come from people littering on the beach. It actually comes from waste that was thrown in the trash but didn't make it to the landfill due to mismanaged waste. So even if you throw your trash away, it may still make it to the ocean... If we make decisions to lower our use of single-use plastics, we can lower the amount of marine debris *and* show companies that we want solutions for the single-use plastic problem!

It may seem like a daunting task, but you don't have to remove all single-use plastic from your life. *Remember: no one can do everything, but everyone can do something.*

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Black	Rubber	
Red	Nurdle	
Yellow	Nylon Thread	
White	Microbead	

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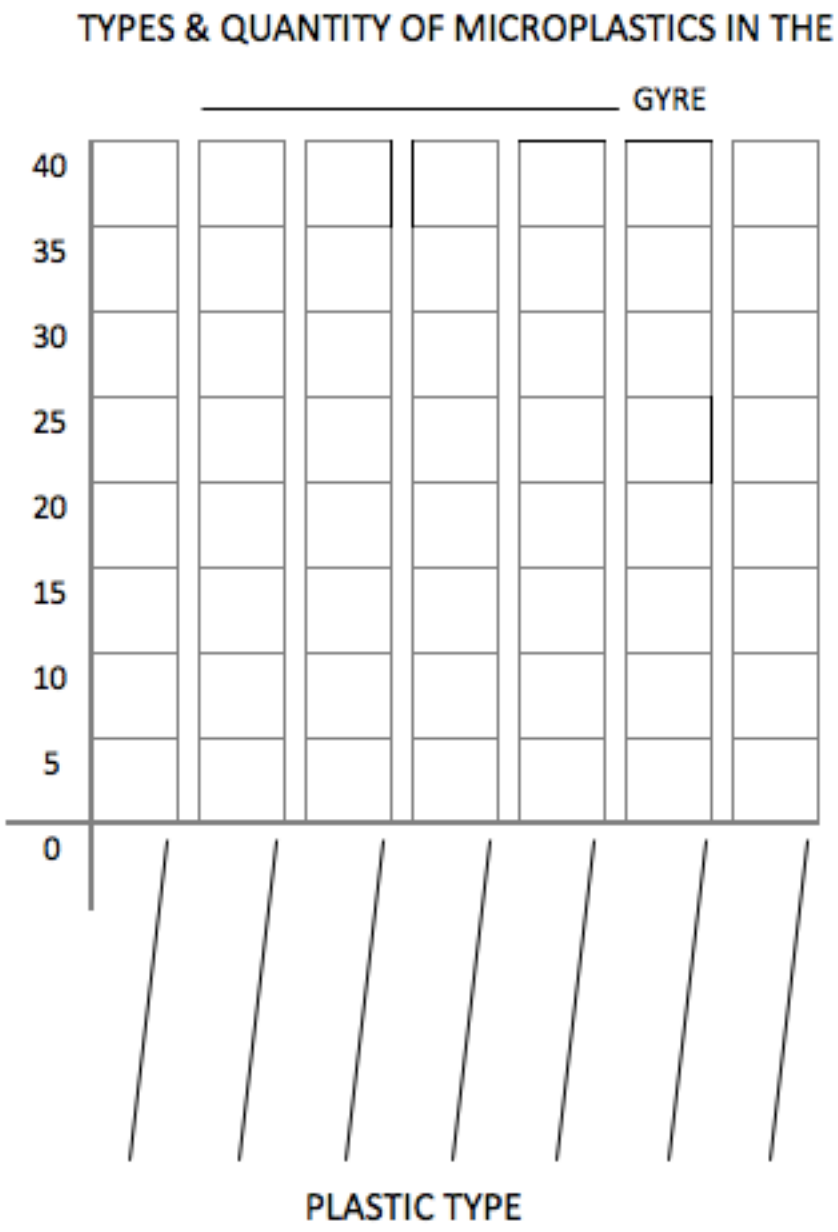

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