How Should Scientists Study Plastic Micro-Debris in the Central North Pacific Gyre?

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INTRODUCTION:

Plastic litter is not uncommon on land, but there is a difference between common terrestrial and ocean based plastic debris. Plastic does not biodegrade. Plastic that makes its way to the ocean often finds itself floating for years in direct sunlight, which makes it brittle and easily broken into smaller pieces of plastic. Scientists are concerned that the plastic collecting in the gyre has the potential to negatively affect marine life, and ultimately humans.

The Central North Pacific Gyre is a region within the Pacific Ocean that circulates clockwise due to wind and the ocean currents that border it. The circulating motion draws floating objects toward its center. Biodegradable materials eventually decompose and return nutrients to the ocean. Plastic does not decompose and therefore continues to collect.

Although the presence of the plastic in the Central North Pacific Gyre was documented over ten years ago by Captain Charles Moore of the Algalita Marine Research Foundation, and plastic has been collected in plankton samples from within the California Current for over 35 years, there is relatively little known about the gyre or the plastic accumulating in it (Gilfillan et al., 2009).
Essential Questions (E.Q.):
• How do scientists conduct investigations and ask meaningful questions about the ocean?
• How do scientists describe and compare plastic collected in the gyre?
• What characteristics about the plastic in the gyre are still unknown and worth investigating further?

Materials: Scales for determining mass, metric rulers or meter sticks, Ziploc bags/grocery store bags for collecting and storing debris, plastic gloves for safety and hygiene, masking tape for creating labels.

Target Audience: Grades 9 - 12

Time/Duration: 3, 1 hour classes

Target Learning Objective(s)/Concept(s)/Desired Results:
Student will be able to:
• Conduct investigations and communicate findings that are meaningful.
• Analyze patterns (size, shape) and limitations with respect to categorizing and communication marine debris information.
• Understand and appreciate the process of collecting and analyzing micro-debris samples from the Southern California Current System through a classroom simulation.

Subject: Earth Science/Ecology/Marine Science/Environmental Science

Correlating National Science Standards:
National Science Standard 9-12
1. Science as Inquiry Standards
   - Understanding about scientific inquiry
5. Science and Technology Standards
   - Understanding about science and technology
6. Science in Personal and Social Perspectives
   - Science and technology in local, national, and global challenges
   - Environmental Quality

Correlating California State Standards:
INVESTIGATION AND EXPERIMENTATION
1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, students should develop their own questions and perform investigations. Students will:
   a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships and display data.
   l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
   m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

Correlating Ocean Literacy Standards:
7. The ocean is largely unexplored.
   A. Exploration leads to a better understanding of ocean systems.
   B4. The communication of accurate and timely information allows the public to make informed decisions that promote sustainability of the ocean.
In August of 2009, a group of marine biologists and volunteers from the Scripps Institution of Oceanography in La Jolla, California set out to collect data related to the amount and type of plastic marine debris present and its effects on marine life. The Scripps Environmental Accumulation of Plastic Expedition (SEAPLEX) members had approximately 20 days at sea to gather data. The edge of the Central North Pacific Gyre is located approximately 1,000 miles off the shore of California. SEAPLEX researchers had to travel four days just to reach it.

The plastic found in the gyre is predominantly pieces no bigger than a fingernail in size floating just beneath the surface of the water. It is difficult to collect, quantify and describe because the pieces are very dissimilar, they move with the currents and there is little understood about the origin of the plastic.

Scientists often have to use their best judgment when studying a new phenomenon, place or thing. It is similar to packing for a trip when you have little information about where you are going and what you will be doing there. Less than 5% of the ocean has been explored and therefore scientists that wish to study places like the Central North Pacific Gyre rely on their ability to design investigations and ask meaningful questions to start the process of understanding the gyre better.

Researchers develop their sampling plans based on previous sampling events and standards within the discipline. However, sampling and documenting plastic is a relatively new phenomenon in the gyre. Preparing for collection and determining the characteristics of priority to investigate are two very important parts of the research plan. In the case of the gyre, researchers had to use their best judgment to prepare for the trip, and used information they obtained to propose future trips.

There are also characteristics of the sample and environmental conditions that the researchers commonly document when they describe a sample. This helps other scientists and researchers to understand the data more completely. Ocean samples taken during the day may be remarkably different from samples taken at night. Weather conditions and seasonal changes are also important variables to consider when collecting or reviewing data. This is an important consideration when comparing samples collected over long periods of time.

The SEAPLEX crew collected the plastic utilizing similar techniques that are used in sampling plankton. They also collected larger plastic from the side of the boat using dip nets when possible. The researchers are currently processing hundreds of gyre samples and analyzing their data. However, the expedition generated new questions about the plastic floating in the ocean.

For more information go to the SEAPLEX home page and newsroom link http://sio.ucsd.edu/Expeditions/Seaplex/
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Day 1: Campus-based litter survey

A. Identify the sampling site: In groups of 4 or 5, you will be provided a map of your school campus with a portion of the campus designated as a sampling site.

B. Identify the characteristics of interest and the design collection standards: You will be responsible for determining the procedure for the collection of the debris. You should consider what will be documented and what environmental conditions are important to note/measure prior to the collection. You should design a chart for documenting the samples collected.

C. Collect data: You will be asked to collect debris from within their location for approximately 30 minutes.

D. Analyze Data: You should identify patterns and group the debris samples in order to quantify your results.

Day 2: Review current plastic debris practices

Researchers are studying the debris floating in the ocean, much like you, the students, are studying the debris found on your campus. You will be exposed to the rigor of data collection through a guided reading.


B. In groups, you will list the characteristics and measurements that author Lisa Gilfillan used to describe plastic micro-debris and what remarks she made regarding other published plastic micro-debris studies (Gilfillan et al., 2009).

**ABSTRACT:** What items and characteristics were the researchers focusing on?

Follow-up questions:
- What do each of those terms mean?
- Did any groups in the class consider measuring the area in which they were sampling?
- Why is it important to document this?

**INTRODUCTION:** Why is it important to research marine debris?

Follow up question:
- What did they want to determine?

**METHODS:** What were some of the environmental and collection-specific considerations the researcher had when reviewing archived data?

Follow up questions:
- Did any of the groups create and sample collecting protocol that was as rigorous as the one used by the researchers?
- Why is it necessary to be that detailed about the collection of the samples?
- How long did our class sample the campus?
- Would the results be different if we sampled for a longer amount of time?

**DISCUSSION: (Last two paragraphs)**
- What was the difference between plastic concentrations collected by Charles Moore before and after rain events?
- Would it be important to document weather conditions surrounding a sampling event?

Follow up question: In the seventh paragraph the researchers noted that they are unable to compare their data with the North Pacific Gyre. They also compare their results to other areas like the Bering Sea.
- Why is this important to do?
- What other studies do the researchers suggest would advance our understanding of presence of plastic in the marine ecosystems?
Day 3: Communicate findings

A. Communicate Findings: Student groups will present their findings to the class using charts and graphs.

B. Compare and contrast presentations: The entire class will compare and contrast the presentations. Include how the plastic debris was described and quantified. Collaborate with other students which presentations provided the most relevant and useful information about the survey.

C. Reflect on group work: Take some time to reflect on your pre-collection procedures and identify any concerns you may have with your samples (i.e. small pieces were over-looked, debris had broken down further since collection was done due to handling practices, environment was not noted well enough (landscaping, under lunch tables, near lunch quad, etc.).

D. Create a proposal for future research: With the knowledge you have gained from the first survey, students should write a proposal for future research. Proposal should be one page, double-spaced and include the following information:
   - Why is further research necessary?
   - How long should the survey take place?
   - What type of information will be gathered?
   - How will the data be collected and stored?