Less Plastic Guide

A curriculum for students K-12 with hands-on science programs
and activities about the impacts of plastic
correlated to Next Generation Science Standards (NGSS)

Elementary school students sample the Cold River for microplastics in 2021.

Researched, written and published by Green Mountain Conservation Group

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Welcome Educators

Are you interested in providing meaningful, experiential education opportunities for your students to explore their local environment? Do you want students to cultivate connections to their surroundings and real world issues through scientific investigation, as well as develop creative and critical thinking, problem solving, communication, and media literacy skills? This Less Plastic Guide will do just that!

Students will take an approach to learning science that encompasses discovery and problem solving to explore and learn about their local watershed. They will learn about plastic pollution as a local and global environmental issue, investigate their surroundings for microplastics, reflect on their own plastic use, and learn how they can make a difference through community science and their own actions. All of this correlates to Next Generation Science Standards. This Less Plastic Guide includes a curriculum for students K-12, with 10 science lessons in addition to many educational videos, online activities, and extensions that can be used to reinforce lessons and allow for remote learning and homeschooling opportunities.

This Guide takes an interdisciplinary approach, incorporating science, culture, art, engineering and mathematics. The incorporation of diverse teaching techniques within the lessons also makes the material more accessible to a variety of learning abilities. As part of their discovery process, students will explore a research question, conduct investigations, collect evidence, use the evidence to describe their findings, and communicate their findings to an audience.

Questions that guide watershed discovery:

- How does plastic get into the environment? What are its impacts?
- How can I sample for microplastics in my local environment?
- How can I impact the system of streams, rivers, and watersheds that sustain me?

"You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make." – **Jane Goodall**

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Acknowledgments

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- Lauren Moreira and Blair Folts for their vision and collaboration that brought the "More Clay, Less Plastic" movement in Italy to the Ossipee Watershed

GMCG's AmeriCorps members use the manta trawl to sample for microplastics in Ossipee Lake in 2021.

Tara Schroeder, Education Coordinator
Green Mountain Conservation Group, October, 2021

Introduction

Green Mountain Conservation Group's (GMCG) Less Plastic Initiative began in 2016 in conjunction with *'More Clay Less Plastic - Change in your hand'*, a movement from Italy that promotes the use of ceramics instead of plastic. The pottery collection traveled to nine shows around Italy and culminated in Venice, the "Water City." Gathering at Vinaria Restaurant in Venice and Kingswood Regional High School in Wolfeboro, the participants used video conferencing to share in a conversation around their message. The movie "Bag It" was shown at the high school and inspired students to raise funds to replace their Styrofoam lunch trays with reusable ones. The initiative has grown to include more local schools and a Less Plastic Challenge in April of 2019 in which youth from schools across the watershed in New Hampshire and Maine were challenged to upcycle plastic pellet bags. Following these initial events, GMCG was awarded grants by the Dorr Foundation and NH Conservation Moose Plate Grant Fund to expand the Less Plastic Initiative in 2021-2023 to include microplastics research and education in the Ossipee Watershed as well as the creation of this Less Plastic Guide.

While plastic pollution is a well-known problem, much of the attention and research to date has focused on plastics found in marine environments. People living far from coastal communities do not often see the impact of their plastic use, and not surprisingly, there is a lack of information on microplastics in freshwater ecosystems. During the summer 2019 launch of a new cyanobacteria monitoring initiative on the Ossipee Lake system, GMCG noted that many of the samples collected showed a surprising amount of plastic contamination. These small bits of plastic, or microplastics, were visible under a microscope and came in a large assortment of colors, sizes, and shapes. Microplastics end up in water supplies where they can be taken up by lower order organisms like plankton and fish, extending up through to apex organisms such as humans. While it is still unclear what effect plastic consumption has on humans, there is concern that microplastics contain and transmit toxic chemicals upon ingestion according to Dr. Ramakrishnan Nara. A study from the University of Newcastle in Australia suggests that, on average, people consume five grams of plastic each week, or a credit card's worth of plastic (Nara 2018).

Over the last few years, GMCG has designed less plastic programs to be more hands-on and science-based, with microplastics investigations of single use water bottle samples, bioplastic making and upcycled t-shirt bag-making activities. Programs have had success inspiring students to change habits around plastic, for example, by using reusable water bottles and shopping bags, and even brought about a movement in one high school to use reusable trays instead of single use Styrofoam trays. However, change did not always last and some students were throwing away the reusable trays out of habit so the school returned to Styrofoam trays. Student feedback was that these programs need to happen at a younger age, before the throw-away culture is ingrained, thus instilling better habits and curbing plastic use early on. For these reasons, GMCG further developed and expanded the Less Plastic Initiative program to elementary schools and created the Less Plastic Guide.

The Less Plastic Guide includes lesson plans and projects for grades K-12 to be used by educators in the Ossipee Watershed and beyond. The purpose of the Less Plastic Guide is to provide science-based programs to educate youth about the issue of plastic in the environment with the intent that the students' own research about plastics will inform decision-making around plastic use and create lasting changes in behavior, thereby reducing plastic pollution. Students will take on the role of citizen or community scientists collecting and sharing important data with their community. Educating youth to be environmental stewards is vital to the local environment and our health and wellbeing. This project will initiate long-term economical, sustainable, and community-oriented programs that can be replicated for years to come and serve as a model for other communities.

GMCG has always been a local leader in water quality monitoring, and constantly looks to extend our efforts to protect natural resources and educate the citizens of the Ossipee Watershed community regarding any new threats. The Less Plastic Guide is another way the organization can promote "healthy water, healthy communities" and provide a science-based educational curriculum to promote local investigations of this global issue. It is our hope that through an understanding of their resources, youth will also understand the role they can play as future community leaders.

Founded in 1997, GMCG is a community-based, charitable organization dedicated to the protection and conservation of natural resources in the Ossipee Watershed in central Carroll County including the towns of Eaton, Effingham, Freedom, Madison, Ossipee, Sandwich, and Tamworth, as well as Maine's Sacopee Valley. All of GMCG's youth education programs are provided free of cost.

Healthy Water, Healthy Communities

Reference:

Nara R. *Microplastic Contamination of the Food Supply Chain.* Food Safety Magazine, December 2018/January 2019

Tools for Success: How to Use the Less Plastic Guide

This guide is a resource for educators to help teach students about plastics in the environment in their local watershed. The activities in this guide are designed for students from kindergarten through high school. There are eight lesson plans and many educational videos to go along with these lesson plans. Each lesson contains objectives, key concepts, science vocabulary, activities, and extensions connected to the Next Generation Science Standards. Students will have the opportunity to use scientific equipment, sampling protocols, and analysis to investigate their local environment for microplastics. In the back of the guide, there is a glossary of terms and an appendix with additional teaching tools and resources.

The Guide includes lessons for younger students, with stories about plastic that can be paired with a game, activity, or plastic craft to learn about plastic in the environment, its impacts on wildlife, and how we can reuse plastic to prevent it from entering the environment. Many activities can also be readily adapted for older students, and GMCG has successfully piloted these lessons for K-8. Each activity has some background information, as well as additional resources such as videos, handouts, and references that are offered to enhance learning. Extension activities are provided to expand upon what is learned through the activity, with research, presentations, crafts and other exercises. GMCG is available to lead any of these programs at schools in the Ossipee and greater Saco River Watershed, and has more in-depth programming available on plastics if teachers are interested.

Since GMCG hosts AmeriCorps members each year who have helped develop and pilot this program, we track our education metrics. If you use any of this content, we would appreciate it if you could fill out the Google Form below. This information is important for our grant tracking, grant applications and will help us continue to host AmeriCorps members in the future. Thank you!

Google Form for Feedback:
www.docs.google.com/forms/d/e/1FAIpQLScWUdk7jYU3NyT_PCCGRRZ55AR0et4WclLoNlekwaWyPBlPSg/viewform

Modeling a Watershed & Non-point Source Pollution

Grade levels: K – 12th

Subject Areas: Earth Systems; Earth & Human Activity; Ecosystems: Interactions, Energy & Dynamics; Earth's Place in the Universe; Engineering Design

Duration: Videos 5-12 minutes; Experiment Set Up 5-10 minutes; Model Demonstration 10-15 minutes

Preparation: 10 minutes

Setting: Classroom or home

Next Generation Science Standards: K-ESS2-2; K-ESS3-1; K-ESS3-3; K-2-ETS1-1; K-2-ETS1-2; K-2-ETS1-3; 2-ESS1-1; 2-ESS2-1; 2-ESS2-2; 4-ESS2-2; 4-ESS3-2; 5-ESS2-1; 5-ESS3-1; 3-5-ETS1-1; 3-5-ETS1-2; 3-5-ETS1-3; MS-LS2-5; MS-ESS2-4; MS-ESS3-3; MS-ESS3-4; MS-ETS1-1; MS-ETS1-2; MS-ETS1-3; HS-LS2-7; HS-ESS3-4; HS-ETS1-1; HS-ETS1-2; HS-ETS1-3.

Materials:
AV equipment for video
1-2 spray bottles/misters
Tray
Variety of cups or newspaper
Thin plastic sheet
Food coloring

Background: A watershed is a region of land within which water flows into a specified body (drainage basin), such as a river, lake, sea, or ocean. The runoff comes from precipitation or melting snow. Students will create a watershed model in this exercise and explore various types of pollution. Students will demonstrate how water moves from high to low elevation within a watershed, and understand the concepts of point source and non-point source pollution, and how pollutants such as microplastics can get into the environment.

Point source pollution originates from a specific place such as an oil refinery or a paper mill. Non-point source pollution, on the other hand, is contaminated runoff originating from an indefinite or undefined place, often a variety of places (e.g., farms, city streets and parking lots, yards and landscaping, construction sites, and logging operations). The soot, dust, oil, animal wastes, litter, sand, salt, pesticides and other chemicals that constitute non-point source pollution often come from everyday activities such as fertilizing lawns, walking pets, changing motor oil, and driving. With each rainfall, pollutants from these activities are washed from lawns and streets into surface waters, groundwater, or storm drains that often lead directly to nearby bodies of water such as streams, rivers, and oceans.

Younger students will explore various ways pollution moves through the model and why it is important not to pollute. Older students can manipulate the watershed model and engineer technologies that prevent contaminants from spreading throughout the watershed, called Best Management Practices (BMPs).

Objectives: Students will understand that watersheds are interconnected systems, and that land use activities in one location can impact water resources downstream. Students will explore different types of non-point source pollution and their movement through a watershed, as well as mitigation strategies.

Key Concepts: water cycle, watersheds, scientific inquiry, waste management, non-point source pollution, point source pollution, storm water runoff, Best Management Practices (BMPs), potential source of contamination

Vocabulary: water cycle, watershed, pollution, contaminant, point source pollution, non-point source pollution, potential source of contamination, microplastics, storm water runoff, Best Management Practices (BMPs)

Procedure:

1. Preview videos to introduce the concepts of the water cycle and how water flows in a watershed: "Water Cycle Song for Kids" (2:01 minutes, Lampofilm). This fun, educational song about the water cycle is great for students grades K-6, they get to sing, learn and remember the 4 stages of the water cycle. www.youtube.com/watch?v=7ldMebGj4cU

"We All Live in a Watershed" music video (2:45 minutes, Water Rocks! Production) for younger students grades K-3 to learn about the concept of a watershed. www.youtube.com/watch?v=3ZP0B8PsuNU

GMCG's "What is a Watershed?" (7:40 minutes) for older students grades 4-12, and for teachers to understand how to create the watershed model. https://www.youtube.com/watch?v=uszd1Ccwtjo. This watershed simulator website can also be used to show where water flows in your students' watershed: https://river-runner-global.samlearner.com/

2. Gather the needed materials:
   a. Tray to collect water during the experiment
   b. Variety of cups or other items (bunched up newspapers and rocks will work, too) of differing heights to create varied elevations
   c. Spray bottles/misters
   d. Thin plastic sheet; a plastic bag cut to an appropriate size works well
   e. Food coloring of any color
   f. Map of your local watershed and watershed boundaries (for older students)

3. Assemble your watershed.
   a. Fill the container with a little bit of dirt at the bottom.
   b. Arrange the cups on the tray to create topography.
   c. Place the plastic sheet over the cups, creating a land surface with high and low elevations. Older students might use the watershed map to create a more

realistic representation of their local watershed, labeling local rivers, lakes, ponds, mountains, and potential sources of contamination across the landscape.

4. Experiment: where does the water and pollution go?
   a. Spray water across the entire landscape to simulate precipitation. Students can also help with creating rain. Observe where the water accumulates and how it gets there.
   b. Dry the landscape and add a drop of food coloring to the landscape. This simulates a source of pollution or "potential contamination source" in the environment. Pollutants could be salt from the roads, nutrients from erosion or fertilizers on a farm, chemicals from pesticides or herbicides, or microplastics from air pollution/landfills/wastewater. Different colors can represent different types of non-point source pollution.
   c. Repeat step a.) and observe where the water flows in the environment.
   d. Wrap up and conclusion: Discuss with students where the pollution ended up. Some questions to ask include: Would they would want to live in this watershed? What impacts could this pollution have on the environment? On people? How can we prevent our watershed from becoming polluted? What types of pollution could be problems in our watershed? How do we know whether or not they are a problem?

Extension Activities:

K-4 Extension Activities:

-Draw your watershed model, including different types of pollution. Older students can record their observations of what happens when precipitation falls on their model, how water flows downhill, and what happened when pollutants entered their watershed.
-Act out the water cycle and what happened in your watershed model, perhaps to the "Water Cycle Song for Kids" and "We All Live in a Watershed" music videos, with students acting out the rain and different types of pollution moving through the watershed. Perform your reenactment in front of others.

5-12 Extension Activities:

-After completing the "What is a Watershed" demonstration, discuss ways to reduce pollution in a watershed. Students can then learn about and engineer different types of Best Management Practices or BMPs for the model (see Appendix A for examples of BMPs).

- Gather materials that can be used to create a waste management system. These materials can be tailored to what you have on hand, but can include popsicle sticks, cotton balls, toothpicks, aluminum foil, recycled items, etc.
- Students may work in groups to design a device to place in the watershed model to prevent the spread of pollution during a rain event. All groups should have access to the same fixed number of materials to engineer their device.
- After 20-40 minutes (tailor to the amount of time available), test the devices by placing them in the watershed model, adding the food coloring, and then adding

the precipitation. Alternately, devices can be placed after the pollution is added depending on the designed function of the device.

- Observe the spread of pollution using the containment device. Make note of any changes from the unprotected pollution.
- Debrief with students. Some questions to consider include: What designs were particularly effective? Were any designs 100% effective? Do you think that real world pollution containment systems (i.e., landfills, storage tanks, etc.) are 100% effective at preventing pollution from entering the environment? How will increased population impact natural systems such as watersheds? Evaluate feasibility of BMPs based on their potential cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

More activities, articles and information about non-point source pollution can be found at: www.epa.gov/nutrientpollution/what-you-can-do-your-classroom

Next Generation Science Standards:

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
K-ESS3-1. Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.
K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.
K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate howthe shape of an object helps it function as needed to solve a given problem.
K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
4-ESS3-2. Generate and compare multiple solutions to reduce the impacts ofnatural Earth processes on humans.
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differencesamong several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
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.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Simulated Washing Machine:
How do plastics get into the environment?

Grade levels: K – 12th

Subject Areas: Earth & Human Activity; Ecosystems: Interactions, Energy & Dynamics; Engineering Design

Duration: 1 hour

Preparation: 15-20 minutes

Setting: Classroom or home

Next Generation Science Standards: K-ESS3-3; K-2-ETS1-1; 5-ESS3-1; MS-ESS3-3; MS-ESS3-4; HS-LS2-7; HS-ESS3-1; HS-ETS1-1.

Materials:
Fleece or polyester clothing item made from plastics
Container large enough to "wash" clothing item
Gridded filters & hand filter
Microscope and laptop, phone or iPad with software
Prepared slides of tap water, bottled water, deionized water, distilled water

Background: Plastics have been found virtually everywhere in our environment, from Antarctica to the Arctic Circle, and from the top of Mount Everest to the Mariana Trench, one of the deepest spots in the ocean. But how did plastics get there?

People have been using synthetic plastic for more than 150 years; it is cheap, flexible and durable, and it can be fashioned into everything from toys to car parts. The problem is that because plastics are synthetic, there are no well-established mechanisms to degrade plastics in nature. Therefore, they can remain in the environment for extended periods of time, some taking centuries to deteriorate. While they cannot be chemically altered, plastics can be physically broken down into smaller and smaller pieces called microplastics. Microplastic are pieces of plastic that are smaller than 5mm. There are three main types of microplastics: microbeads; microfilaments, and microfibers. In this activity, students will simulate a washing machine and explore a variety of water samples to observe/compare results by viewing and counting microplastics under microscopes.

Objectives: Students will understand what microplastics are and how they can be released into the environment. Students will observe microplastics from a variety of water samples to analyze for microplastics and compare the results. Students will get a basic understanding of how to use a microscope.

Key Concepts: scientific inquiry, synthetic, pollution, decomposition, biodegradation, photodegradation

Vocabulary: watershed, ecosystem, non-point source pollution, surface water, groundwater, microplastics, single use plastics, distilled water, deionized water, tap water, biodegradation, photodegradation, microfilament, microfiber, microbead

Procedure:

1. Set up multiple microscope stations. More microscope stations with a variety of prepared slides will be necessary for larger groups. Set up the stations with prepared slides of samples as follows (either pre-prepare with or without students using a hand or vacuum filter if available, or borrow prepared slides from GMCG):
   a) Tap water
   b) Bottled water
   c) Distilled water
   d) Deionized water
   e) Snow
   f) Surface water body (lake, river, stream or pond)
   g) Simulated washing machine

2. Simulated washing machine instructions:
As a guaranteed way to find microplastics in a sample, bring a container large enough to "wash" a fleece or polyester piece of clothing. Follow these steps:
   a. Submerge the clothing in a container filled with water.
   b. Agitate the clothing in the container. Students can take turns pretending to "wash" the clothing.
   c. Scoop some water out and vacuum filter or hand filter onto a gridded filter paper. The wash water will have microplastics fibers in it of varying colors. Students should be able to see it in the solution, as well as on the gridded filter.
   d. View filter under the microscope to see the microfibers.

3. If there's time, have the students count and record the number of microplastics/and or the types, colors, etc. they find in each sample at each station. Microplastics can be identified and distinguished from organic material and other substances by a few distinguishing characteristics: they are <5mm; have no cellular or organic structures visible such as cell walls; the material is equally thick throughout its entire length; and the color should be homogenous (Hidalgo-Ruz et al., 2012). See next page for types of microplastics and examples from various sources as viewed under a microscope.

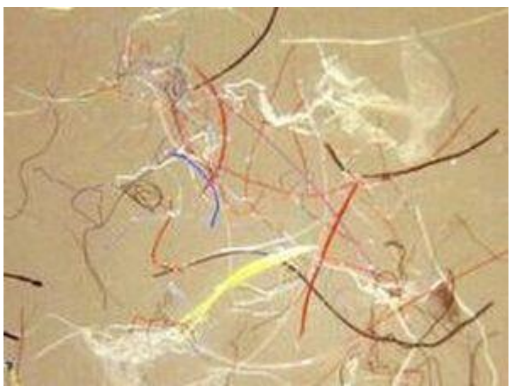
4. After viewing the samples at all of the stations, discuss the results. Which samples had the most microplastics? Which had the least? What types of microplastics did you see? How do these microplastics get into air and water (ie. through dryer vent/lint, waste water/septic systems/incineration/biodegradation/photodegradation when thrown away). Why do people use plastics in the first place? How can we reduce the plastics we use and what gets into the environment? How do plastics affect the

environment? How do plastics affect you?

Types of microplastics:

1.)

2.)



3.)

Examples of microplastics:
1.) microfragments
2.) microfibers
3.) microbeads

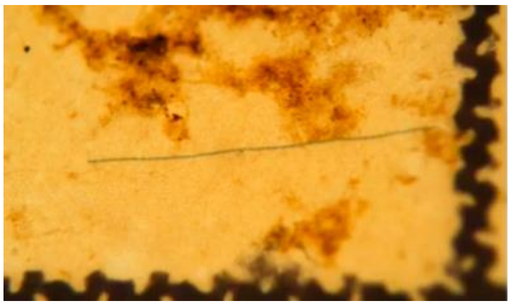
Photos: 1.) Microplastic fragments from the western North Atlantic, collected using a towed plankton net. (Photo: Giora Proskurowski, Sea Education Association (SEA) www.marinetechnologynews.com/news/ocean-micro-plastics-harmful-513260). 2.) Fibers were the primary source of microparticles found in Bay Area wastewater. (Sherri Mason/SUNY Fredonia)www.kqed.org/science/882103/microfibers-how-the-tiny-threads-in-our-clothes-are-polluting-the-bay. 3.) Microbeads-plastic-particles/MN Pollution Control Agency/Wikimediacommons/CCBY-NC2.0 www.thenewsminute.com/article/still-rubbing-plastic-face-how-check-if-your-cosmetic-product-has-microbeads-104711.

More examples of microplastics:

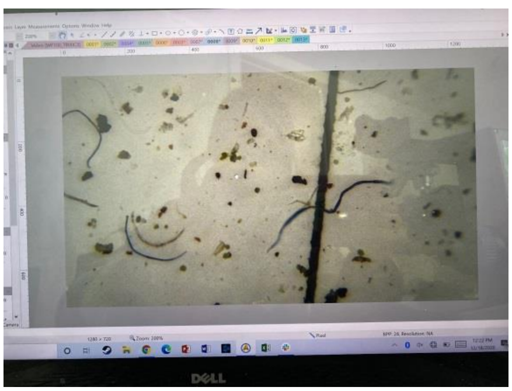
1.)

Examples of microplastics found in:
1.) a single use plastic water bottle;
2.) a fresh water lake;
3.) fresh snow.
Photos: GMCG staff

2.)



3.)



Extensions:

- Collect water samples from groundwater and surface water sources in your community (ie. well water at home or school, a spring, river, stream, lake, or pond) to analyze for microplastics. Older students can compare results in a graph or chart.
- Analyze water samples for microplastics from a variety of liquid products packaged in single use plastic bottles and/or clothing produces made from plastic. Older students can compare results in a graph or chart.
- Older students can research where microplastics have been found in the environment and create a map to display results.
- Older students can research studies on microplastics in tap water versus bottled water. Report findings to the class.

- Older students can research and analyze potential solutions to microplastics in the environment and design, evaluate and refine their own solutions to microplastics in the environment, either by creating alternatives to plastics or creating a device that will remove microplastics from the environment. Report findings and inventions to the class.
- Check the labels and tags of the clothing that the students are wearing. Is anyone in the group wearing clothing entirely free of plastic? They can work with a partner, checking each other's labels, if this is more comfortable.

Plastic free = cotton, linen, wool, hemp, rayon/viscose, modal, and Tencel;
Plastic = polyester, nylon, acrylic

Side note: Conventional cotton is responsible for around 25% of the world's pesticide use and enormous amounts of water. (www.goodonyou.eco/what-to-do-about-microfibres/)

What can we do?

- Shop at second-hand and consignment stores
- Choose organic cotton and TENCEL
- Wash less often and use a shorter "eco" cycle
- Use liquid detergent (less friction = less fiber release)
- Spot clean any fluffy, "fleecy" garments that you can to reduce machine washing (machine washing creates the most microfibers)

Next Generation Science Standards:

K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

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

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

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.

References:

Hidalgo-Ruz, V., Gutow, L., Thompson, R. C., & Thiel, M. (2012). Microplastics in the marine environment: A review of the methods used for identification and quantification. Environmental Science & Technology, 46(6), 3060–3075. http://doi.org/10.1021/es2031505

Fish Sticks: Plastics & the Food Web

Grade levels: K – 8th

Subject Areas: Earth & Human Activity; From Molecules to Organisms; Energy; Ecosystems: Interactions, Energy & Dynamics

Duration: Video 10:29 minutes and/or films 30-60 minutes and/or GMCG previsit 30 minutes; Activity Set Up 5-10 minutes; Game & debriefing 15 minutes

Preparation: 5-10 minutes

Setting: Outdoor or indoor space with room to move/run

Next Generation Science Standards: K-LS1-1; K-ESS3-1; K-ESS3-3; 5-PS3-1; 5-ESS3-1; MS-LS1-6; MS-LS2-1; MS-LS2-3; MS-LS2-4.

Materials:
AV equipment for video and/or film
Colored popsicle sticks
Spinner similar to Twister

Background: In this game, students will learn about the issues plastics and microplastics cause for fish and other living things. Plastic persists in the environment - it can take decades to a century to thousands of years for plastic to break down in nature, releasing toxic chemicals over time that can contaminate groundwater, soil, and be ingested by humans and wildlife. Animals cannot tell the difference between plastics and food. Plastics can become trapped inside their stomachs making them feel full while not giving them nutrition. More than 260 species of invertebrates, fish, turtles, sea birds and mammals are reported to ingest or become entangled in plastic debris, resulting in impaired movement, feeding, reduced reproductive success, lacerations, ulcers and death (Alabi, 2019).

About 8 million tons of plastic enters the ocean each year. The Great Pacific Garbage Patch (PGP) is a spot where the water swirls in a circle called a gyre which keeps the plastics and trash caught there. It has a lot of large plastics like fishing nets, but also has a lot of microplastics making it a plastic soup that is difficult to clean up. Plastic fragments in the PGP have been found to outnumber plankton 60 to 1, and it is estimated that the patch contains nearly 80,000 tons of plastic, or the equivalent to 500 jumbo jets in weight (The Ocean Cleanup, 2021).

According to the Environmental Protection Agency, outside of the small amount of plastics incinerated, every bit of plastic ever manufactured still exists today and is compounding by increasing global production. Every piece of plastic ever used is most likely still here somewhere. A report from the Ellen MacArthur Foundation, in partnership with the World Economic Forum (Mathuros, 2016) predicts that by 2050 plastic in the oceans will outweigh fish.

Objectives: Students will experience a simulation of the food web and understand the impacts of plastic debris on the feeding activities and health of aquatic animals. Students will consider the effects of microplastics from an animal’s perspective, and understand how plastics in the food web can impact human health as well.

Key Concepts: gyres, food chains, food webs, bioaccumulation, biomagnification, photodegradation, biodegradation, effects of plastics on aquatic life

Vocabulary: bioacculmulation, gyres, plankton, Great Pacific Garbage Patch, photodegradation, biodegradation, persistent organic pollutants

Procedure:

1. Preview the GMCG plastic informational video (GMCG Plastic Informational Video: www.youtube.com/watch?v=fCmV65qLOIA 10:29 minutes). Other options can include viewing the short film, "Smog of the Sea": Smog of the Sea film (30.19 minutes): www.vimeo.com/181069340, showing of the film "Bag It", "A Plastic Ocean", or another film relating to plastics in the environment (See Appendix H for a list of recommended films). GMCG can present the pre-visit slide show to the students virtually or in person.
2. Following the film, have the students participate in one of GMCG's Kahoot quizzes, also in Appendix H.
3. Review what all animals need to survive (food, water, shelter, space) as well as the food chain, with some examples from an aquatic ecosystem.
4. Either indoors or outdoors, spread colored popsicle sticks out in a wide area.
5. Explain the rules to a group of students. The activity can work with anywhere from 3 students or more.

   Rules:

   a. Students need 6-8 sticks to survive (vary this number depending on participants' age and ability. For example, younger students can be required to collect less sticks).
   b. Students can only grab 2 sticks at a time
   c. After each round have a student spin the color wheel to determine which color of sticks have microplastics. The microplastic color stick is subtracted from your total for the round. Additionally, if a student picked up a microplastic, he/she is inhibited in the next round as follows (as an animal that ingests microplastics might be with impaired movement, feeding, reproductive success, etc.):

      a. Have to hop with two feet
      b. Can only pick up one stick at a time
      c. Can only hop on one leg
      d. Double elimination: After the first time not reaching the stick cut off (6-8 sticks) you are starving; after the second round, you have starved and are out of the game.

6. Continue playing and adding inhibitions until there is a winner.
7. Wrap-up discussion can include questions like:

   - Could you tell which sticks were food or plastic each round? This is the same for animals. Plastic bags can look like jellyfish to a sea turtle, and microplastics can look like plankton to fish.
   - How difficult was it to survive when you began to eat plastics?
   - In nature, what does eating plastics do to animals?

- What are some ways we can reduce the amount of plastic that gets into the environment?
- What are some ways we can reduce the amount of plastic that gets into the environment? Be sure learners are aware that doing laundry releases a huge amount of microplastics. "Synthetic materials used in clothing & textiles such as polyester, acrylic, and nylon represent about 60% of the clothing material worldwide. Every time we do our laundry, an average of 9 million microfibers are released…" (Ocean Clean Wash, 2022)

What can we do?

- Shop at second-hand and consignment stores
- Choose organic cotton and TENCEL
- Wash less often and use a shorter "eco" cycle
- Use liquid detergent (less friction = less fiber release)
- Spot clean any fluffy, "fleecy" garments that you can to reduce machine washing (machine washing creates the most microfibers)

Extensions:

K-2 Extension Activities:

- Read or share GMCG's video of the story: "Tammy Turtle: A Tale of Saving Sea Turtles": Children's Book Reading (8:29 minutes): In this video, GMCG's Education and Outreach Assistant EB Brandt reads the story of Tammy Turtle. This story highlights the lifecycle of a turtle and the dangers of plastic waste entering the ocean and being consumed by wildlife. www.youtube.com/watch?v=QKpXHEkr6vE

5-12 Extension Activities:

- Review current scientific research on microplastics in animals and food webs and its impacts. Present findings to the class.
- Investigate the impacts of microplastics on human health. Present findings to the class. Here is one article that could be discussed with students: www.theguardian.com/environment/2021/dec/08/microplastics-damage-human-cells-study-plastic?fbclid=IwAR1azuUmx94ypHTnjs2HKgf_gXZa6iExyScEktXBMbbDEwP06wePTZFaKVY
- Research Boylan Slat's invention for cleaning up the PGP. Slat founded The Ocean Cleanup at the age of 18 in his hometown of Delft, the Netherlands. Present findings to the class.

References:

What is microfibers pollution and why is it bad? (2021, July 5). Retrieved January 12, 2022, from http://www.oceancleanwash.org/the-issue/

Next Generation Science Standards:

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1. Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.

K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

References:

The Great Pacific Garbage Patch • The Ocean Cleanup. (2022, January 17). Retrieved December 17, 2021, from https://theoceancleanup.com/great-pacific-garbage-patch/

Mathuros, F. (2016, January 19). More plastic than fish in the ocean by 2050: Report offers blueprint for change. Retrieved January 13, 2022, from https://www.weforum.org/press/2016/01/more-plastic-than-fish-in-the-ocean-by-2050-report-offers-blueprint-for-change

OA, A. Public and environmental health effects of Plastic Wastes Disposal: A Review. Retrieved December 17, 2021, from http://www.clinmedjournals.org/articles/ijtra/international-journal-of-toxicology-and-risk-assessment-ijtra-5-021.php?jid=ijtra

The Four R's and Recycling

Grade levels: K – 5th

Subject Areas: Earth & Human Activity; Matter & Its Interactions

Duration: Game set up: 5 minutes, Game play: 10 minutes

Preparation: 5 minutes

Setting: Classroom or other group setting

Next Generation Science Standards: K-ESS3-1, K-ESS3-3; 2-PS1-1, 2-PS1-2

Materials:
Plastic packaging items with resin IDs 1-7
9 bins or boxes
Colored tape
Additional plastic items for extension activities

Background:
Recycling is a beneficial way to reduce the amount of raw materials that need to be extracted from the earth, and reduce the amount of waste we send to landfills. Recycling plastic, however, is a scientifically and economically complicated process.

Each type of plastic is made out of a specific polymer, and it can only be combined with other plastics of the same polymer when it is recycled. The number within the recycling triangle on a piece of plastic tells us about what kind of plastic it is, and is called the "resin ID code". Appendix G provides some examples of the kinds of items are made from each type of plastic. This symbol does not, unfortunately, guarantee that the item can be recycled.

Most municipal waste recycling facilities are only able to recycle plastics labeled with a 1, 2, or 5. These plastics, however, degrade in quality when they are recycled. Therefore, they can only be recycled a couple of times, unlike metal and glass which can be recycled many times over. Items must be clean, and not contaminated with food residue or mixed with non-recyclable materials to be recycled. Single-use plastics, like straws, bags, and take out containers, are items that are designed to be used only once and then thrown away. These items are often challenging to recycle, and are thus thrown away. The average single-use plastic item is used for less than 10 minutes but will be here long after our grandkids. When considered together, these result in a large amount of plastic waste being sent to a landfill or incinerator.

Since China stopped taking plastics to recycle from the United States in 2018, only 8- 9% of all plastic is recycled. Recycling statistics estimate that there will be 12 billion metric tons of plastic in landfills by 2050. Every year, the United States alone burns or buries in landfills 32 million tons of plastic, impacting the health, wealth, and well-being of many nearby communities. If plastic production and use grow as currently planned, by 2030 greenhouse gas emissions from plastic production could reach 1.34 gigatons per year, equivalent to the emissions released by more than 295 new 500-megawatt coal-fired power plants. Incineration is not a solution to this problem, nor can we recycle our way out of this mess (Lindwall, 2020).

Some organizations and individuals have begun to adopt a different approach to tackle our waste issue other than the original three R's. The concept of a fourth "R" of "rethink" "refuse" or "review", is another way to consider what we purchase in the first place to prevent the creation of plastic waste. "Rethink Reuse Recycle Refuse" can also be a helpful mantra that rhymes for students to remember.

Objectives: Students will learn to sort plastics into the seven categories and understand that not all plastics are recycled. Students will be informed and empowered on ways to reduce, reuse and recycle.

Key Concepts: recycling, single-use plastic (SUP), waste management, citizen action, research, inquiry

Vocabulary: polymer, recycling, resin, single-use plastic (SUP)

Procedure:
1. Begin by asking the students questions about waste and recycling. Prompt thinking about the life of single-use plastic from its creation, through its short functional life to its long afterlife. Some example questions are listed below:
    a. What do people throw away?
    b. Can pollution come from the trash that you throw away?
    c. What are some effects of pollution on humans, animals, and the environment?
    d. What are the three R's? Why are they listed in the order "reduce, reuse, recycle"?
    e. What are single-use disposable items?
    f. What non-renewable resources are being used to create these items?
    g. Where does your plastic bag go after you bring your groceries home?
    h. Where does your plastic water bottle go after you hydrate?
    i. Where does the packaging go after you open your new electronic item?

2. To begin setting up the recycling game, place seven bins corresponding to the seven categories of plastics in an open area

3. Have two additional bins containing the plastic materials 6-10 feet away from the other seven bins. One bin should contain plastics that can be differentiated from the other so that each team's plastic can be counted separately (i.e. putting a piece of colored tape on the plastics in one bin).

4. Explain the rules of the game. They are as follows:
   a. One player from each team will pick up a single plastic item from their designated bin. Players can only pick up one plastic item at a time!
   b. Players must identify the plastic and run it to the correct bin one at a time, in a relay race format.
   c. Once the first team member has sorted the plastic, they return to their team bin and then the next team member takes their turn.
   d. This continues until every student has gone at least once and the round is over.
   e. After the round, count the plastics to determine the winning team.
   f. The game ends after a predetermined amount of time (such as 1 minute) and the team with the most correctly recycled materials is the winner.

5. The duration of each round should be adjusted based on the number of participants. The round should end when each student has at least had one turn, but before they run out of materials to sort. Generally, a 1 to 2-minute round is long enough for up to eight players.

6. For the second round of the game, follow your local recycling rules. Plastics that cannot be recycled locally should be placed in a "trash bin" to illustrate waste. If your local area accepts all plastics, or no plastics, collect #1, #2, and #5 plastics, and "throw away" the others, since these are the most likely to be recycled once they are collected.
   a. Conway collects #1, #2, #3, #5, and #7, no black plastics
   b. Effingham collects #1, #2, and #5, but no plastic bags
   c. All towns in Maine collect all numbers of hard plastic, but no plastic bags or Styrofoam.
   d. Sandwich, Freedom, and Madison collect all numbers of hard plastic, but no plastic bags or Styrofoam
   e. Ossipee collects #1 and #2 plastics
   f. Tamworth does not collect plastic for recycling

Extensions:

K-2 Extension Activities:

- Story: "Tammy Turtle: A Tale of Saving Sea Turtles": Children's Book Reading (8:29 minutes): In this video, GMCG's Education and Outreach Assistant EB Brandt reads the story of Tammy Turtle. This story highlights the lifecycle of a turtle and the dangers of plastic waste entering the ocean and being consumed by wildlife. www.youtube.com/watch?v=QKpXHEkr6vE
- Story: "One Plastic Bag": Children's Book Reading (9:26 minutes): GMCG's Education and Outreach Assistant EB Brandt reads "One Plastic Bag" that describes the true story of women in Gambia up-cycling plastic bags into

sellable items. www.youtube.com/watch?v=baoIqlNKCVo

- Upcycling is a way to reuse plastic materials that would otherwise be thrown away, giving them a second life. The following activities are craft projects centered around this principle.
  - Upcycled T-shirt Bag Making (7:33 minutes): In this video GMCG Education Coordinator Tara Schroeder goes over how to upcycle your old T-shirts into reusable bags. Perfect for replacing single use bags and a reusing old material, this craft is thrifty and will help the environment. www.youtube.com/watch?v=BgTyhW-x6FM
  - Plastic Pom Pom Ornament Making (9:16 minutes): This is a fun craft where kids learn how to make a fluffy plastic pom-pom. These can become ornaments, decorations, or toys. www.youtube.com/watch?v=TqhnjKcJuFw
  - Plastic Bottle Planter: Kids can turn extra plastic bottles or jugs into planters to plant new cuttings, flowers, or seeds and watch them grow. Make a face on the jug and grow grass hair and give your friend a haircut every now and again (Appendix F).
  - Plastic Bag Wreath Great for the holiday season, this easy craft will allow kids to turn single use plastic bags into a festive wreath (Appendix G).
- Students can test their knowledge of what is and is not recyclable by playing GMCG's Recycling Game: www.scratch.mit.edu/projects/484091722
- Students can research their own waste production by filling out the school and home audits and accompanying worksheets in Appendices C and D. Add some math and calculate how much plastic waste is produced daily, weekly, monthly and yearly at home or at school with the tally sheet in Appendix E.
- Take a field trip to a waste management facility to see what is recycled and how it is recycled. Before the trip, brainstorm questions to ask, such as: Where does the waste go now and where it might go in the future? How much is spent on dealing with waste each year? How much is spent or gained by recycling? How does the town pay for these services? Have students journal about their experience.
- Older students can explore the different types of plastics and their properties, such as rigidity, pliability, and different uses. Page 8 of the publication "Identification of Polymers" (Katz, 1998) has a chart of types of polymers/resins and their uses: www.yumpu.com/en/document/read/40542559/polymer-identification
- Create a public service announcement or PSA at school or for your community (poster, announcement, podcast) about the 4 R's and why people should follow them.

Next Generation Science Standards:

K-ESS3-1: Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.

K-ESS3-3: Communicate solutions that will reduce the impact of humans of the lands, water, air, and/or other living things in the local environment.

2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2: Analyze data obtained from testing different materials to determine which materials have the properties that are the best suited for an intended purpose.

References:

Katz, D. (1998). Polymer identification. Retrieved December 17, 2021, from http://www.yumpu.com/en/document/read/40542559/polymer-identification

Lindwall, C. (2021, April 20). Single-use plastics 101. Retrieved December 17, 2021, from https://www.nrdc.org/stories/single-use-plastics-101

Microplastics Sampling & Analysis for Rivers & Streams

[1]

Grade levels: 4^{th} – 12^{th}

Subject Areas: Earth & Human Activity; Engineering Design

Duration: Video 10:29 minutes; Slide show 20-30 minutes; Sampling 60 minutes plus travel; Results 60 minutes

Preparation: 60 minutes

Setting: Classroom or home, and a local river or stream

Next Generation Science Standards: 5-ESS3-1; MS-ESS3-3; MS-ESS3-4; HS-ETS1-1.

Materials:
Previsit:
AV equipment for video and slide show
Examples of plastic items

In the field sampling:
Plankton net(s)
Glass jars
Labeling tape
Permanent marker
First aid kit
Cooler for samples

Post Visit:
Filters & hand filter
Microscope and laptop, phone or iPad with software
Prepared slides

Background: This program was successfully integrated into the Volunteer Biological Assessment Program (VBAP) for Ossipee Watershed schools in 2021. Students sampled local streams and rivers for macroinvertebrates and gathered water quality data to assess the health of the ecosystem. Information about microplastics in the environment was added to the pre-visit, field day and post visit for this program so that students can further investigate microplastics as a type of pollution in their local environment. This program can also be used as a stand-alone program, apart from VBAP.

Students sample Cold River for microplastics in 2021.
(Photo credit: Steve Watson, Sandwich Central School)

Objectives: Students will understand what plastic is, how it gets into the environment, and its impacts. Students will sample and assess a local water body for microplastic pollution, and present their results to an audience.

Key Concepts: watershed, plastics, microplastics, pollution, food web, bioaccumulation, biomagnification, scientific inquiry

Vocabulary: watershed, ecosystem, non-point source pollution, surface water, synthetic, fossil fuels, monomers, polymers, microplastics, single use plastics, petrochemicals, food web, bioaccumulation, biomagnification, plankton, photodegradation

Procedure:

In-classroom Pre-visit:

1. Present the pre-visit slide show to the students (Appendix B) and/or the GMCG plastic informational video (GMCG Plastic Informational Video: www.youtube.com/watch?v=fCmV65qLOIA (10:29 minutes). The purpose of this slide show is to give the students background knowledge of plastic and microplastics prior to sampling their local river or stream for microplastics. GMCG is able to do a previsit for local schools, if desired.

2. Show some examples of different types of plastics. You could have students investigate their lunch, survey the classroom, or dissect the trash or recycling one day to see what you find.

Extension Activities:

- Students can take GMCG's Kahoot Quiz on plastics to find out how much they know and learn some facts about plastic: www.create.kahoot.it/share/gmcg-less-plastic-initiative/9e7d5b53-c3f4-4924-ad1b-0a0a665bcd06
- Students can view a plastic-themed film such as "Bag It"; "Straws"; or "A Plastic Ocean" and follow up with a Kahoot Quiz by GMCG to learn more about plastic and its impacts. Please see Appendix H for details and links to quizzes.

Sampling a Local River or Stream:

Microplastics Sampling Protocol

1. Screw a collection container into the nozzle at the end of the net.
2. Place the net in the water so that it flows through the opening and the ring is fully submerged.
3. Secure the net by pushing a stake through the metal ring into the bottom of the river or stream.
4. Leave the net in the water for 5 minutes. A second net can be left undisturbed in the current for one hour. (This second sample is the one that can be analyzed at GMCG using Nile Red solution.)
5. Retrieve the net by lifting the ring to allow water, sediment, and any other matter to drain into the collection container.
6. Unscrew the sample collection container and transfer the water sample to a clean collection container.
7. Label your samples with the tape and marker to include water body name, date, time, sample number (1-5) and school name.
8. Repeat the process with small groups of students until you have 5 samples.

**Samples can remain in a cooler for as long as necessary prior to analyzing.*

In-classroom Post Visit:

***** A short presentation can be provided by GMCG to share the results of the sampling if it time allows (Appendix B).

1. Filter 100 mL of each sample through a Buchner funnel with a 0.45 μm filter.
2. After filtering, transfer the filter paper to a glass plate for observation.
3. Students can examine the samples in the classroom using a white light microscope as follows:
    a. Set up microscopes and connect with computers or iPads.
    b. Set up slides of stream samples for students to view under microscopes and investigate for microplastics.
    c. Students can count how many microplastics they see in each sample and compare the results.
    d. GMCG also has prepared slides of microplastics from tap water, single use plastic water bottles, washing machines, among others, for students to view under the microscopes.

4. Discuss the meaning of the results with the students. The discussion will answer the following guiding questions: Are there microplastics in our local stream or river? How might they have gotten into the stream or river? How could they impact the food web? How could they impact me? How will an increase in human population impact natural resources?
5. For the second sample that is analyzed at GMCG, 1-2 mL of 10μg Nile Red solution is added to the sample and then examined using a microscope equipped with blue light and an orange filter. Under these lighting conditions, nonpolar particles (i.e. plastic) treated with Nile Red will appear fluorescent.

Presentation:

The students and the teacher will work together to create a presentation to share with an audience. One option is to create a PowerPoint of the results. The results can include graphs of the data, maps showing the location of the sampling site and watershed, and pictures of the students doing the sampling and analysis. It can also include information on what the data means.

Extension Activities:

- Microplastics in Bottled Water vs. Tap Water video (4:45 minutes): In this video, microplastics are examined under a microscope from filtered water samples of tap water, bottled water, and lake water. The tap water and bottled water samples were compared for the abundance of microplastic fragments in each. The bottled water sample was determined to have a greater frequency of microplastic fragments, likely coming from the bottle itself, the manufacturing process, or the bottle cap leeching into the water. The tap water sample had less, but still contained microplastic samples. As a comparison, lake water was examined and microplastics were found in that sample as well. This quick observational study goes to show that microplastics are being found in almost any environment at this point in time, and this information

is backed up by scientific studies. A few scientific studies are linked in the video at the end for additional reading and resources. This video is designed to show what a microplastic fragment might look like under a microscope, and talk about the fact that drinking bottled water will likely lead to more microplastic consumption, and add additional waste into the environment.
www.youtube.com/watch?v=hT_4ZMuvZj4

- Students can ask a question about plastics in the environment and conduct their own research to present and report back to the class.
- Design a method for monitoring microplastics in your local environment.
- Students can complete a plastic audit at school of their lunchbox to monitor (Appendix C)
- Students can complete a plastic audit for their home (Appendix D)
- Students can make a poster or share in their school announcements about what they learned to serve as a public service announcement about the importance of reducing plastic use.
- Students can participate in a "Less Plastic Challenge" or host one school-wide. See Appendix J for an example.

Next Generation Science Standards:

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4. Construct an argument supported by evidence for how increase in human population and per-capita consumption of natural resources impact Earth's systems.
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.

Landfill in a Bottle Experiment

"Let's look for ways for us to create less trash…there is no away."
~ Jeb Berrier, "Bag It" filmmaker

Grade levels: 4th – 12th

Subject Areas: Earth's Systems; Earth & Human Activity; Ecosystems: Interactions, Energy & Dynamics; Engineering Design

Duration: Video 6:59 minutes; Experiment Set Up 15-30 minutes; Experiment can take from 1 month to 1 year, or longer if desired

Preparation: 30 minutes

Setting: Classroom or home

Next Generation Science Standards: 4-ESS3-2; 5-LS2-1; 5-ESS2-1; 5-ESS3-1; MS-LS2-3; MS-ESS3-4; HS-LS2-7; HS-ETS1-1; HS-ETS1-2; HS-ETS1-3.

Materials:
AV equipment for video
Bottle or container with wide top, such as soda bottles
Dirt/soil from backyard
Spray bottle/mister
4-5 different trash items (plastic, paper, organic, etc.)

Background: More info: The Environmental Protection Agency estimates that the average American produces about 5 pounds of trash per day or 1,642 pounds of trash each year. Our waste has steadily increased over the last decades, reaching 292.4 million tons in 2018, compared to 88.1 million tons in 1960. Where does it all go? A lot of our trash ends up being buried in a landfill. The United States has over 3,000 active landfills and 10,000 closed landfills. While our waste needs to go somewhere, there are many concerns about the environmental impacts of landfills, from the emission of methane gas which accelerates climate change, to the leaching of harmful chemicals into groundwater. Landfill capacity in the U.S. is reaching its peak and landfills may run out of space within the next few decades. In 2018, U.S. landfills received 27 million tons of plastic, making up 18.5% of all municipal solid waste.

The following experiment explores the science of biodegradation and the ability of soil microorganisms to break down materials in the natural environment. It also explores what our world's waste management system looks like. Many items are biodegradable, which means soil microbes can break them down in the environment and use the materials in them for other purposes in the ecosystem. Other products such as plastics are not biodegradable and will remain in the environment for hundreds to thousands of years when thrown away. These plastics have been causing huge problems in the ocean and have found their way into almost every ecosystem in the form of microplastics. This experiment is a miniature version of what a landfill should look like and it should be evident how these different materials either degrade or do not degrade over time.

Objectives: Students will understand how landfills work, how certain materials break down or persist over time, the impacts of waste on the environment, and how they can reduce their own waste. Students will observe, describe, and interpret how trash impacts their daily lives and the environment surrounding them. Students will analyze and apply an understanding of how to influence a change in their environment regarding trash.

Key Concepts: decomposition, biodegradation, scientific inquiry, waste management, conservation, pollution

Vocabulary: biodegradation, microorganisms, decomposition, microplastics, organic, conservation, methane, greenhouse gas, leachate, landfill, aquifer, single-use plastic, landfill, plastic, composting

Procedure:

1. Preview Video: Landfill in a Bottle Experiment (6:59 minutes): www.youtube.com/watch?v=EC2aUiemeM8
2. Gather the needed materials:
    a. Bottle or container with a wide enough top. Soda bottles work great for this, but make sure to cut off the neck so that you have a wide opening at the top
    b. Dirt/soil from backyard. Gather enough to fill the bottle about ½ - ¾ full. Bagged dirt may note work for this experiment as it may have been sterilized and thus will not contain microbes.
    c. Spray bottle/mister
    d. 4-5 different "trash materials." Make sure these materials are made up of different substances. You want something plastic, something made out of paper, something like an apple core or banana peel. The goal is to see how well these different materials will degrade in the soil.
3. Fill the container with a little bit of dirt at the bottom
4. Start burying the "trash materials" in layers in the bottle, adding some dirt on top of each item that is buried
5. Once all materials are buried, pour any leftover dirt on top of the pile that is already in the bottle.
6. Monitor this bottle by keeping it in a sunlit area and misting the soil on top as often as is necessary so that it stays moist.

Extension Activities:

- Provide the students with a bag of various trash items made from different substances (different plastics, organics, metal, cotton, leather, etc.). Have them create a timeline for when these substances are likely to fully decompose, and discuss the results.
- Students can visit their local landfill to understand where their waste and recycling goes, and map their waste and recycling if it goes to a landfill or facility that is farther away. If your school has students from many different towns, mapping where waste

and recycling goes could be interesting. How is the environment protected from waste at the facility? Draw a diagram of how the Earth's systems interact at the landfill.

- Students can investigate the economics of their town's waste management system and learn how much waste disposal costs their community, how much their town recoups from recycling, and calculate what a reduction in various types of waste might save their towns. Create PSAs for your community about the value of reducing waste, including plastic. Design and evaluate potential solutions.
- Discuss with students the idea of composting. How does it work? What are the benefits? What are the challenges? Does anyone compost at home? How might this impact our landfills? How might this benefit our environment? Consider if a composting bin at school is feasible, especially if your school has gardens.

Next Generation Science Standards:

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
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.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

References:

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Vasarhelyi, K. (2021, April 15). The hidden damage of landfills. Retrieved December 19, 2021, from http://www.colorado.edu/ecenter/2021/04/15/hidden-damage-landfills

Baby Legs: DIY Plankton Nets for Microplastics Sampling

Grade levels: 4th – 12th

Subject Areas: Engineering Design; Earth & Human Activity; Ecosystems: Interactions, Energy, and Dynamics

Duration: 30 minutes film; 2 hours design & build; Sampling 60 minutes plus travel; Results 60 minutes

Preparation: 30 minutes

Setting: Classroom or home, any surface water body(ies)

Next Generation Science Standards: **3-5-ETS1-1; 3-5-ETS1-2; 3-5-ETS1-3; MS-ESS3-3; MS-ETS1-1; MS-ETS1-2; MS-ETS1-3; MS-ETS1-4; HS-LS2-7.**

Materials:
Large container (ie. coffee container, gallon water jug, food container)
Nylon leggings
Rope
Scissors
Screw driver
Plumbing clamps (optional)
Glass jars for samples

Background: Microplastics are defined as anything less than 5mm in size, and end up in surface waters where they can be taken up by organisms like plankton and fish. Humans can also ingest microplastics from the environment. Scientists use plankton nets and a larger device called a Manta trawl to sample for plankton and microplastics in the ocean and in fresh water bodies like Ossipee Lake. These devices are designed to collect plankton and microplastics located in the water column. By towing across measured distances and for a specific amount of time, scientists can quantify how much plastic is floating along the surface of the water.

GMCG samples for microplastics in Ossipee Lake, 2021.

In this activity, students will design, create and test their own plankton net called "baby legs" to sample local fresh waterbodies for microplastics.

Objectives: Students will collaborate to design, build and use a plankton net to sample microplastics within local waterbodies, observe and measure microplastic pieces per sample, assess and compare results and observe trends regarding amount of microplastic and location of sampling.

Key Concepts: scientific inquiry, engineering, sampling protocols

Vocabulary: watershed, ecosystem, non-point source pollution, surface water, microplastics, petrochemicals, food web, bioaccumulation, biomagnification, plankton, photodegradation

Procedure:

1. Watch the short film, "Smog of the Sea": Smog of the Sea film (30.19 minutes): www.vimeo.com/181069340
Trailer: www.thesmogofthesea.com/watch-film

2. Construct a plankton net with the students, such as "baby legs" below, or have them come up with their own invention using the following guidelines:

a. Design and sketch a device to collect microplastics in surface waters.
b. The design may have the following features: net mouth; mesh; collection bottle; buoyancy at the mouth.
c. Present your design to others and gather feedback.
d. Build your plankton net.

Baby Legs Plankton Net Design Instructions:

1. Gather your materials. The main container (baby body) that the rest of the components will be attached to can be a coffee container, gallon water jug, other food containers. Something that floats is ideal.

Photo: Baby legs trawling device for microplastics sampling (Source: www.publiclab.org/wiki/babylegs).

e. If needed, pre-cut containers to form a cylinder with a large hole on the top and bottom.

f. Construct the baby legs belt. This is the component that attaches the nylon leggings to the baby body. Some examples of materials to use include: paracord; rope; or plumbing clamps.

g. Attach the nylon leggings to the main container using the belt. Tights or pantyhose may be used. Ex knot: Stretch rope around baby body, cross each end over one another 2-3 times to create 2-3 "X's" (like the first step in tying shoes), then stretch the ends back around the baby body, and tie a (square) reef knot. www.animatedknots.com/square-knot.

h. Punch/drill three holes in the side of the baby body. Then insert three pieces of rope from the outside to the inside for each hole and tie a half hitch (to prevent the rope from pulling through).

i. Attach a casting rope to the container which can be used to pull the baby legs behind a person or a boat in a lake or pond to collect samples. Another option is to attach the casting rope to a stake which can be placed within a stream or river for sample collection.

j. Connect the three pieces of rope to your casting rope.

k. If needed, water bottles can be attached to the sides of the with zip ties to assist in stabilizing the apparatus.

3. Prepare to sample a local water body. Plan which local water body(ies) to sample and how, possibly following the sampling protocol from the previous lesson, “Microplastics Sampling & Analysis for Rivers & Streams”, or have the students do some research and come up with their own. Have the students make some predictions: What types of natural plants/materials do you think the plankton net will collect? What types of man-made materials do you think the plankton net will collect? What size plastic pieces do you predict will be caught in the plankton net?

4. Test the apparatus, collect samples, and make some observations. Which design worked best and why? What would you do differently next time?

5. Follow sample filtering guidelines from “Microplastics Sampling & Analysis for Rivers & Streams”. Observe findings under the microscopes as described, and compare and contrast results.

Extension Activities:

- Map the locations and results from sampling. Which waterbodies had microplastics? What other materials were found? How might you design a sampling program for your watershed in the future?
- Have students research other microplastics studies. How and where are they being conducted? What are the findings?
- Brainstorm possible solutions to remove microplastics from the environment.
- Present the results to another class, the school, or the greater community.

Next Generation Science Standards:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Bioplastic & Alternatives to Plastic

Grade levels: 4th – 12th

Subject Areas: Matter & Its Interactions; Engineering Design; Earth & Human Activity; Ecosystems: Interactions, Energy & Dynamics

Duration: 17 minutes videos; 30 minutes activity; 24-48 hours for ornaments to harden

Preparation: 15 minutes

Setting: Classroom or home

Next Generation Science Standards: 3-5-ETS1-1; 3-5-ETS1-2; 3-5-ETS1-3; 4-ESS3-2; 3-5-ETS1-1; 3-5-ETS1-2; 3-5-ETS1-3; **MS-PS1-1; MS-PS1-2; MS-PS1-3; HS-PS1-5; HS-LS2-7.**

Materials:
Whole milk
Acidic liquid (vinegar or lemon juice)
Stovetop and pot or microwave
Coffee filters (and optional strainer if you have one)
Parchment paper to lay out the casein plastic after dried
Cookie cutters (optional)

Photo source: *https://www.questrmg.com/2019/08/09/bioplastics-solution-problem/*

Background: Not all plastics are human made. There are naturally occurring plastics, like the rubber tree which people used 3,500 years ago. However, the majority of plastics used today are synthetic, or human-made, and derived from petroleum or natural gas. Bioplastics are plastic materials produced from renewable biomass sources, such as cellulose, vegetable fats and oils, corn starch, potato starch, straw, hemp, weeds, woodchips, sawdust, or recycled food waste. Sugar-based bioplastics can biodegrade under normal conditions for composting. Bioplastics can be a more environmentally friendly and sustainable alternative to synthetic plastics since they require less fossil fuels during production in comparison to other types of plastic, reducing energy consumption and the emission of greenhouse gases.

This experiment involves isolating casein, which is a milk component, and can be done at home or in the classroom with some simple ingredients. It covers an array of science topics that include precipitation reactions and polymers in chemistry, plastic waste and usage, pH, and solutes and solvents. Casein can be used as a form of plastic and will biodegrade in the environment, with uses being traced back to ancient times up until the end of the 1800's.

Objectives: Students will explore alternatives to synthetic plastic in this activity and consider the implications of using synthetic plastics versus bioplastics on the environment. Students will create their own bioplastic and fashion it into an ornament or other decoration or figurine.

Key Concepts: synthetic, biodegradation, sustainability, climate change

Vocabulary: synthetic, monomer, polymer, bioplastic, pH, reactant, biodegradation

Procedure:

1. Explain what plastic is and how it is made. You can have the students preview the GMCG plastic informational video: www.youtube.com/watch?v=fCmV65qLOIA (10:29 minutes).

Background: The term plastic is broader than what we usually think. Plastics do not have to be entirely human made; there are naturally occurring plastics as well. Plastics are made of polymers which are chains of monomer molecules. Polymers = many parts and monomers = one part. If molecules were paperclips, one single paperclip would be a monomer. If you were to then link a bunch of paperclips together you've made a polymer. Plastic polymers are stable, meaning the material is fairly durable, but they are also moldable under heat and pressure which makes them a valuable material. They are used to manufacture everything from baby bottles to car parts. We make these plastics out of oil and gas which are fossil fuels. This is important to remember because these are non-renewable resources that pollute the environment.

Here is how synthetic plastic is made:

- We extract oil and gas from the earth and transport it to refineries to produce ethane and propane.
- Ethane and propane are sent to a cracking plant where they are "cracked" or broken down into smaller molecules.

A catalyst is then mixed in to link the molecules together (like the paperclips) into polymers called resins. The resins are melted, cooled, and chopped into nurdles, small pellets to be used to make other plastic shapes.Watch this video that describes the process of making plastic in more detail: http://www.youtube.com/watch?v=C7EwPX7312k.

2. Describe what bioplastics are and provide some examples. Preview GMCG's Bioplastic Ornament Making video (5:58 minutes): www.youtube.com/watch?v=xBurWWQrQuw.

3. Gather the ingredients and supplies needed to make bioplastic ornaments, and follow the instructions below.

Bioplastic Ornament Making and Science Instructions

Combining vinegar with milk as the reactants in a precipitation reaction will cause the two main ingredients of milk - whey and casein - to separate from each other. Here, the acidic nature of vinegar causes this precipitation reaction by lowering the pH of the liquid mixture as a whole. The casein that was mostly soluble in milk is now insoluble in a low pH environment and quickly precipitates out of solution as the solid substance. Each casein molecule is a monomer and chains of casein molecules are called polymers. Polymers are a primary ingredient in what makes up plastic products that are so readily available in the world today.

1. Gather the needed materials:
    a. Whole milk
    b. Acidic liquid (vinegar or lemon juice)
    c. Stovetop and pot or microwave
    d. Coffee filters (and optional strainer if you have one)
    e. Parchment paper to lay out the casein plastic after dried
    f. Cookie cutters (optional)
2. Heat up the whole milk in a pot or the microwave. The milk should be warm but not boiling. If using the stovetop, heat until you see steam coming from the milk
    a. Add food coloring to milk before step three if you would like colorful casein.
3. Take the milk off the heat and add vinegar a little bit at a time stirring it in until you start to see the solids forming.
4. Stir for 30 seconds to1 minute
5. Drain the mixture through coffee filters and strainer in a sink.
6. After liquid is drained, carefully pick up coffee filter that has the casein in it, and wring it out so that the casein dries
7. Set casein out onto parchment paper and knead it a little bit to form a more solidified dough like substance
8. Shape the casein however you like! Some ideas include using cookie cutters to make shapes, shaping it into a cube for a dice, etc.
9. Let sit for 24-48 hours so that it hardens.

Extensions:
- Draw a diagram of the atomic composition of different types of plastics.
- Make predictions about the substances in the experiment before and after the chemical reaction. What happens to the molecules when the temperature changes? When the pH changes? Why?
- Students can investigate bioplastics in use around the world and compare. Which solutions are most viable based on materials, cost, feasibility for our part of the world? Present your findings to the class.
- Design your own bioplastic solution to replicate an item that is currently made from synthetic plastic. Compare and contrast students' designs and assess potential for solving the problem.

Next Generation Science Standards:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.
MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

Glossary of Terms

Aquifer: A layer of permeable rock, sand, or gravel that contains water beneath the Earth's surface.

Best Management Practices (BMPs): Methods that have been determined to be the most effective and practical means of preventing or reducing non-point source pollution to help achieve water quality goals. BMPS include both measures to prevent pollution and measures to mitigate pollution.

Bioaccumulation: The gradual accumulation of substances, such as pesticides or other chemicals, within an organism. Bioaccumulation occurs when an organism absorbs a substance at a rate faster that it can excrete it.

Biodegradation: The breakdown of organic matter by microorganisms, such as bacteria and fungi.

Biomagnification: The increase in concentration of a toxin, such as pesticides, in the tissues of organisms at successively higher levels in a food chain. (Also known as **bioamplification** or **biological magnification**).

Bioplastics: Plastic materials produced from renewable biomass sources, such as vegetable fats and oils, corn starch, straw, woodchips, sawdust, or recycled food waste. In contrast, common plastics, such as fossil-fuel plastics (also called petro-based polymers) are derived from petroleum or natural gas.

Catalyst: A substance that increases the rate of a chemical reaction without being permanently chemically altered during the reaction.

Ecosystem: All the organisms in a biological community and the physical environment with which they interact (also known as an **ecological system**).

Fossil fuel: A hydrocarbon-containing material formed underground from the remains of dead plants and animals that humans extract and burn to release energy for use. The main fossil fuels are coal, petroleum and natural gas, which humans extract through mining and drilling.

Groundwater: The water present beneath Earth's surface in rock and soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water.

Gyre: A system of rotating currents. Plastic trash accumulates in these areas, especially in the oceans.

Inorganic: A material that is not derived from living material or organic (carbon-containing) materials.

Microorganism: An organism of microscopic size, which may exist in its single-celled form or as a colony of cells (also known as a **microbe**).

Microplastics: Fragments of any type of plastic less than 5mm in length. They cause pollution by entering natural ecosystems from a variety of sources, including cosmetics, clothing, and industrial processes.

Molecule: A group of atoms held together by chemical bonds. A single molecule cannot be divided into parts without changing the chemical composition.

Monomer: A molecule that can react together with other identical molecules to form a larger chain or three-dimensional network, called a polymer, in a process called polymerization.
Non-point source pollution: Contamination of water or air that does not originate from a single discrete source. This type of pollution is often the cumulative effect of small amounts of contaminants gathered from a large area.
Nurdle: A small plastic pellet that is used as the base material in the manufacturing of plastic products.
Organic: A material that is derived from living or carbon-containing materials.
Persistent organic pollutants; Organic pollutants that are resistant to environmental degradation through chemical, biological or photolytic processes. These chemicals are toxic, and adversely affect human health (also known as **forever chemicals**).
Photodegradation: The alteration and eventual breakdown of materials by light (photons).
Plankton: The diverse collection of organisms found in water that are unable to propel themselves against a current. They provide a crucial source of food for many small and large aquatic organisms.
Polymer: A material consisting of very large molecules (macromolecules) composed of many repeating subunits called monomers.
Recycling: The process of converting waste materials into new materials and objects.
Refinery: A facility which processes a material to convert it into a product of value.
Resin: A substance of plant or synthetic origin that can be converted into a polymer.
Sediment: A naturally occurring material broken down through weathering and erosion, which can be transported by wind, water, ice, or gravity. Sediment can consist of rocks and minerals, and remains of plants and animals.
Single-use plastic: Products made of plastic that are designed to be used only once, or for a short period of time before being thrown away.
Surface water: Water located on top of the Earth's surface, including rivers, lakes and streams.
Synthetic: A material made through chemical synthesis, rather than natural processes.
Upcycling: The process of transforming by-products, waste materials, useless, or unwanted products into new products of greater quality, adding artistic value or environmental value (also known as **creative reuse**).
Watershed: A region of land within which water flows down into a specified body (drainage basin), such as a river, lake, sea, or ocean.

Appendix A. Stormwater Management BMPs:

Best management practices (BMPs) are strategies used to reduce runoff into waterways. This runoff carries non-point source pollution from its source and deposits it into waterways, which can impair the water quality of these waterways. By filtering the water through a natural substrate before it reaches the water body, some of the pollutants can be removed, thus protecting the water quality. Some examples are provided below. For more information, visit: https://www.epa.gov/soakuptherain or https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/2020-01/wd-08-20b.pdf

Raingarden: A sunken, flat-bottomed garden that sues soil and plants to capture, absorb and treat stormwater. It helps to reduce stormwater runoff and recharge groundwater.

Image: https://extension.unh.edu/resource/rain-gardens-design-and-installation

Rain Barrel: A container that captures rainwater from your roof to temporarily store it for use later. It helps to reduce runoff.

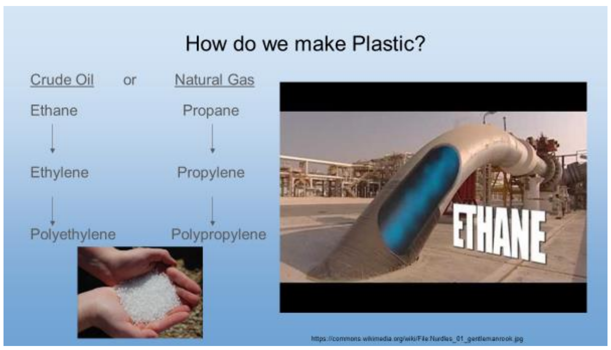
Image: https://www.des.nh.gov/blog/manage-stormwater-soak-rain

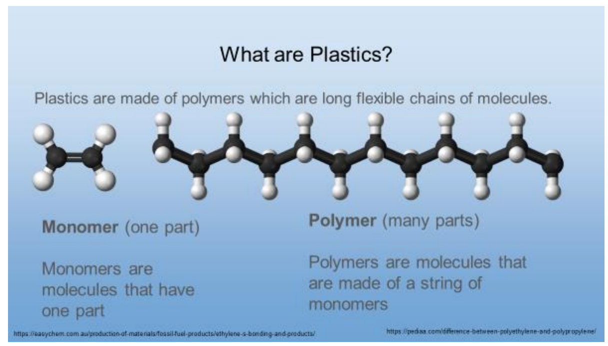
Vegetated Buffer: An area along a water body that stabilizes the shoreline and provides wildlife habitat and shade. Buffers help slow down and clean stormwater runoff.

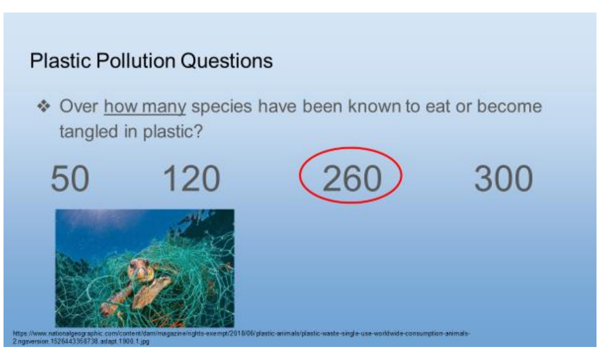
Image: http://cwsec-sc.org/maintain-vegetation-plant-trees-buffers

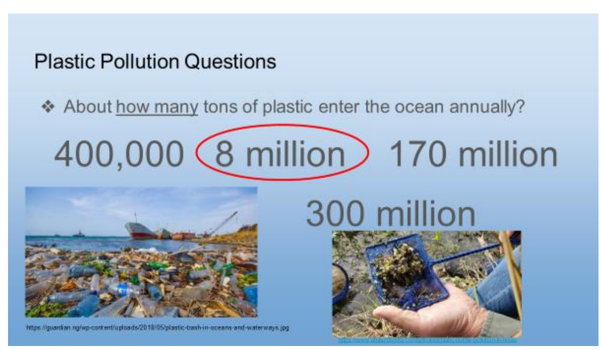
Appendix B: GMCG Slide Shows:

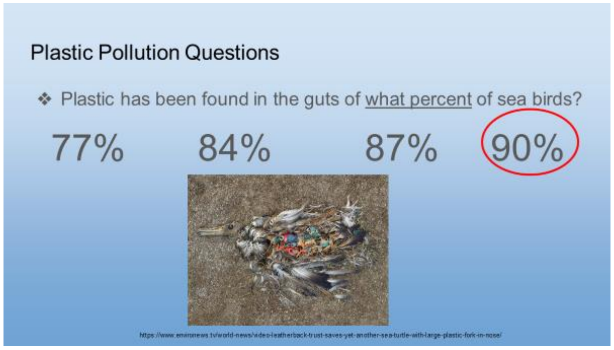
Pre-visit Presentation:

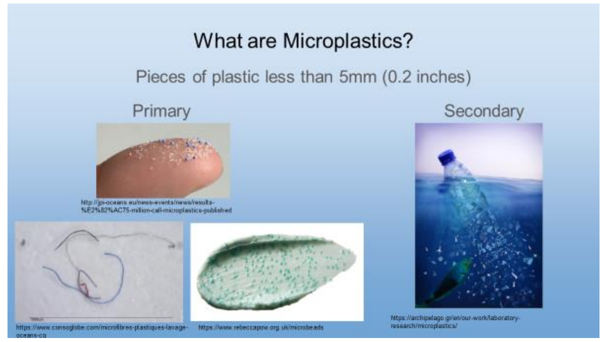


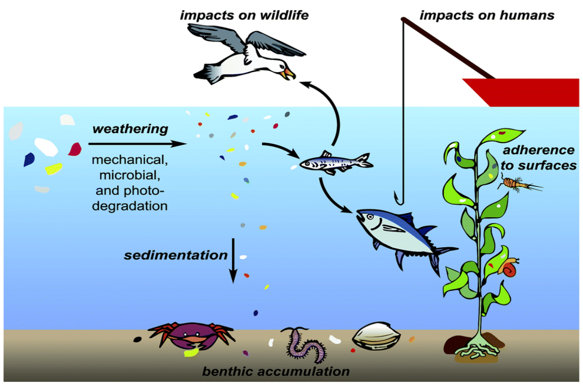


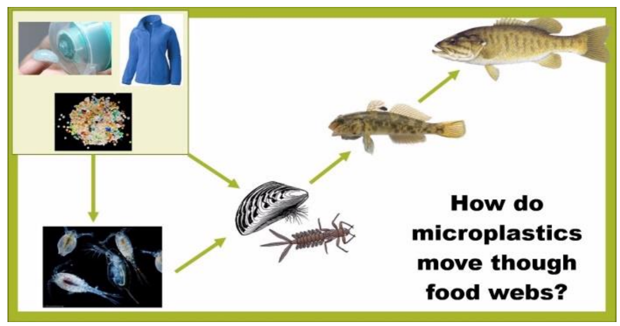


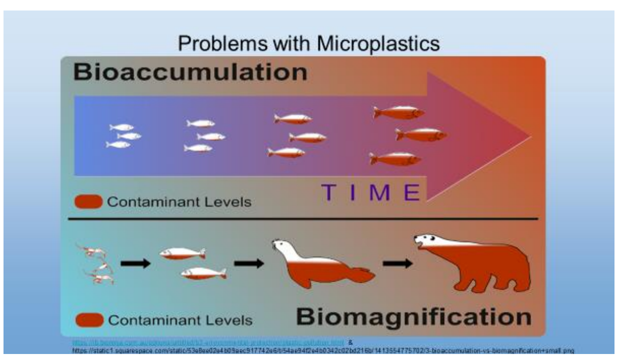



Plastic Pollution Questions
❖ Plastic has been found in the guts of what percent of sea birds?
77%
84%
87%
90%


What are Microplastics?
Pieces of plastic less than 5mm (0.2 inches)
Primary
Secondary

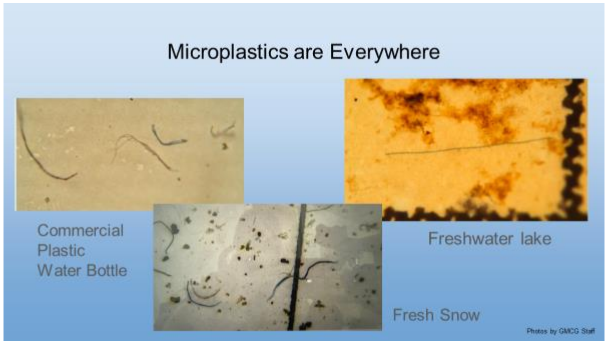

impacts on wildlife
impacts on humans
weathering
mechanical, microbial, and photo-degradation
adherence to surfaces
sedimentation
benthic accumulation

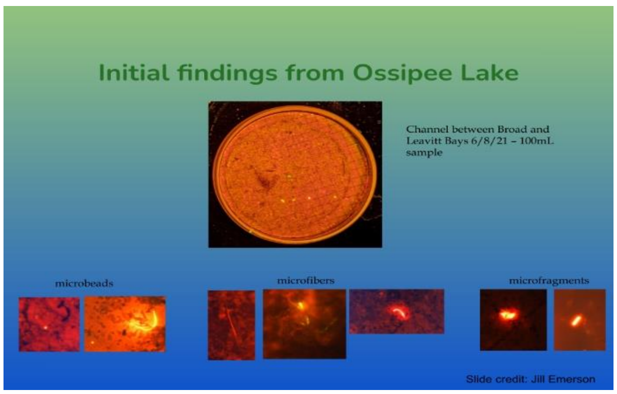

How do microplastics move though food webs?

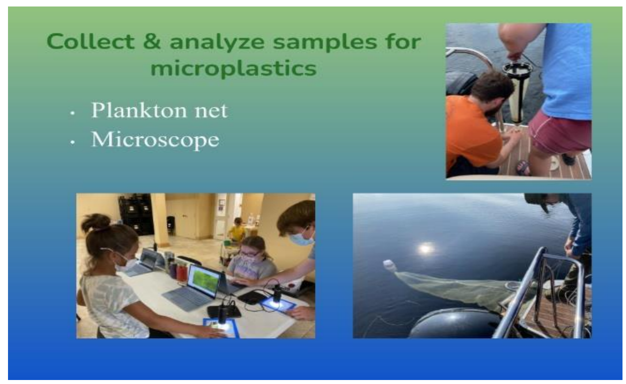

Problems with Microplastics
Bioaccumulation
Contaminant Levels
TIME
Contaminant Levels
Biomagnification

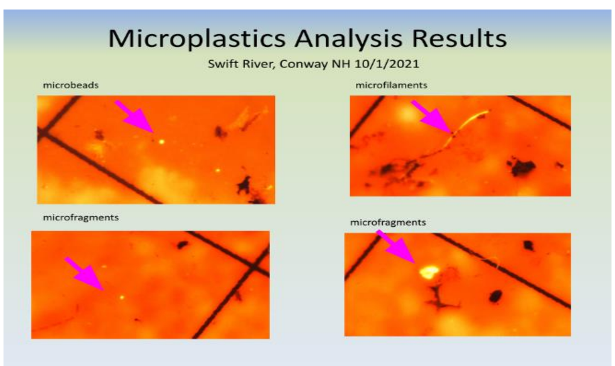

Ingesting Microplastics
A Study from the University of Newcastle says that we ingest 5 grams of plastic each week.
- We don't know yet how ingesting plastic will impact humans
- Some studies show impacts to smaller marine animals
It took you approximately
1 WEEK
to eat this credit card

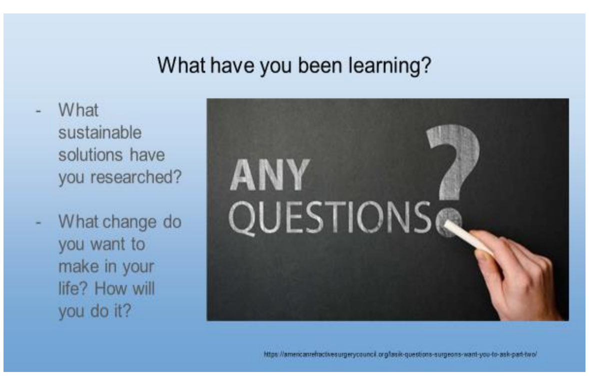
Post Visit Presentation:











Appendix C: Lunchbox Plastic Audit at School:

Introduction:

- Have a discussion with your students about food packaging.

Activity:

- Explain the Lunchbox Dissection Activity. Students will go through their lunchbox and use the worksheet to record what items are there and how much packaging they have. If students do not have a lunch box you can ask them to pick 5-10 food or snack items they commonly eat to record. The goal is to get students thinking about what types of packaging are used and how we can reduce the amount of plastic waste.
- During this activity it could be helpful to have your local recycling information available so students know what can and can't be recycled near them. Most areas take plastic 1, 2, and 5 but some grocery stores will take plastic bags back or have a plastic bottle redemption center where you can get 5-10 cents back per bottle.

Wrap Up:

- After everyone has completed their dissection ask them to share.
    - How many points did they get?
    - What were some of their solutions?
    - What types of packaging are recyclable and what isn't?
    - What types of food had more packaging? Why?

Worksheet/Point Tally Sheet

Food item	How many layers of packaging? +1 each	Can you think of alternative packaging? -1	Is the container reusable? -1	Is the container recyclable? -1

Total Points:______________________

Appendix D. Plastic Audit for Home:

A plastic audit of your entire home can be really overwhelming. Plastic is everywhere and in so many forms. We have become used to co-existing with it. We recommend you start with a single room such as the kitchen. This will make the project more manageable and you will be more likely to succeed!

1. **Make a list of single use vs. reusable plastic for that room.** If you choose the kitchen, begin by going through cupboards, drawers, your fridge and freezer. Dividing your plastic into single use vs reusable is helpful because you should focus on removing the single use plastics from your routine first. To differentiate, consider if the item was intended to be reused. You can (and should!) reuse plastic bags but they were not designed to be reused so consider them single use. You can use the worksheet below.
2. **Identify items in your single use plastic list that you can easily change.** Do you use Ziploc bags regularly? Do some items come in excess packaging or single use servings? Do you have disposable plastic silverware? Make note of these items.
3. **Do some research.** Look up/brainstorm potential alternatives to items on your single use plastic list. Is there a store that sells food in bulk such as nuts or spices? Can you buy peanut butter that comes in a glass jar instead of plastic? For some items such as yogurts, you may look into buying in bulk instead of single serving sizes which will reduce your plastic. You can also consider not purchasing certain items if they only come in plastic.
4. **Invest in things that will help you maintain a low plastic lifestyle.** Do you own reusable shopping bags? Could you save glass jars to put loose snacks in after buying them in bulk? If you put the structures in place to make it easy to not use plastic, you will keep it up!
5. **Challenge others and tackle a new room!** Talk about your experiment with friends and family. Would they want to try it? The more brains working on it the more ideas you'll come up with! Now that you have experience, expand your audit to more rooms!

How to fill out the worksheet

1. As you go through the room you are auditing, write down items in either the single use plastic or reusable plastic categories.
2. Once you have made your list, go through it and place a check next to any of the single use plastic items you think you can easily replace or do without.
3. On the next piece of paper, write out each item and your plan. What will you replace it with? Do you know where to get the replacement? Will you simply stop getting it?

Replace	Single Use Plastic	Reusable Plastic

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Item:____

Plan:____

Goals

Do you have any goals to use less plastic? If so, record them here!

Appendix E: Plastic Recycling Audit Using the 4 R's for the Home or Classroom:

*How many of each item do you use per day as an individual? As a class? As a family? Add items not listed in the last few rows.
*Multiply to find how much you use per month, then year.
*Can you get by without this item or use an alternative? Can you reduce how much of it you use? Can you reuse it? Is it recyclable?
*Graph the data for yourself, your family or your class.

Material	**# of items/ day**	**# of items/ week**	**# of items/ month**	**# of items/ year**	**Rethink**	**Reduce**	**Reuse**	**Recycle**
Plastic water bottle								
Plastic soda or juice bottle								
SUP plastic bags								
SUP cutlery (forks, knives, spoons)								
SUP cups								
Laundry detergent								
Fruit container								
Vegetable container								
Snack container								

Have a discussion with students about how we can reduce our collective plastic footprint. Here are some ideas to consider:

1. When practical, buy in bulk, and buy local so that the items do not need to be shipped and handled as much, and therefore may require less packaging. Products packaged in bulk produce less waste and may cost less, too. Farmers markets can be a great way to avoid plastic packaging.

2. Choose reusable or recyclable packages. Familiarize yourself with your local recycling program. Purchase products that come in packages that can be recycled at your town's facility.

3. Avoid single-use plastic whenever possible. For example, use a reusable water bottle. Instead of using single-use plastic bags at the grocery store, bring your own reusable bag.

Other ideas?

Additional Resources:

www.plasticisrubbish.com/welcome/ This blog has a search bar that allows you to search for a plastic free alternative! It also has a ton of information on plastic in general.

www.businessinsider.com/household-plastic-alternatives-eco-friendly-2018-8 This has a lot of options to help keep plastic out of the kitchen and enforce plastic-free habits

https://learn.eartheasy.com/guides/the-best-eco-friendly-alternatives-for-the-plastic-in-your-life This site goes through great alternatives for common plastic all through the house.

www.litterless.com/wheretoshop This website highlights stores in every state that have bulk options, though with Covid, use it as a reference.

www.trashplastic.com/kitchen This has lots of non-plastic options though it is from the UK

Appendix F: Plastic Bottle Planter Instructions:

Ages: Adult assistance under the age of 9 and possibly older depending on the complexity of your decorations

Materials:
Plastic water bottle
A plate or old lid for the base of the planter
An exacto knife or a way to cut plastic
Soil
Flowers, plants, or seeds to pot (herbs for the kitchen would be great!)
Decorations of any kind, examples include paint, string, googly eyes, pom poms, construction paper, paper mache, markers, etc. glue

Steps:
1. Cut your bottle in half and discard the top half
2. Poke four holes into the base of the water bottle so water can drain out
3. Decorate your bottle however you want!
4. Fill the bottle with soil
5. Plant your flowers or seeds and put in a sunny spot. Don't forget to water them!

Appendix G: Plastic Bag Wreath Instructions:

Ages: Adult help for children under 9 with the whole project, help with wire cutting for children under 12 if making a smaller wreath

Materials:
A number of plastic bags, depending on how large your wreath will be
A wire coat hanger or other wire
A wire cutter
Scissors
Assorted decorations if desired

Steps:

1. If making a smaller wreath, cut the bottom of the wire coat hanger off and shape into a circle, twisting the two ends together and roughly forming a hook if desired. If making a larger wreath, simply bend the wire coat hanger or other wire into a circular shape. Set aside the wire.
2. Take your plastic bag and cut the bottom and the top handles off, then roll or fold the bag so the two holes are on the top and the bottom and cut in 1 inch increments to create 1 inch wide strips.
3. Cut your inch wide strips to be 5 inches long (or a different length if desired) you will need many of these to complete your wreath
4. Get your wire and begin to tie the strips onto it using the first half of an overhand knot or the beginning of tying your shoes.
5. Continue to tie on the plastic strips and push them together until you can't fit any more on. This will make your wreath look full
6. Add any additional decorations you want such as buttons or bows. Hang to display!



Appendix H: Films about Plastic & Kahoot Quizzes:

(Films can be streamed on Vimeo, Amazon Prime, Netflix, or other software, in addition they are available to borrow from the GMCG library and may be available at your local library)

"STRAWS": STRAWS is a documentary film that charts the history of straws and continues to present day issues that surround our current culture's obsession of single use conveniences. Used once and tossed, billions of non-recyclable plastic straws are used annually winding up in landfills, littering streets and finding their way to oceans. The Ocean Conservancy ranks straws as the number five most common item collected at beach cleanups behind bottle caps, wrappers, and cigarette butts. A viral video of a sea turtle with a plastic straw in its nose has now sparked anti-plastic straw campaigns globally and inspired sustainable alternatives. Actor/Director Tim Robbins narrates a humorous history of straws, and Director Linda Booker interviews marine researchers, artists, citizen activists, and business owners in California, Costa Rica and North Carolina about how it's possible to make a sea of change, one straw at a time.
Trailer: www.strawsfilm.com/home
Kahoot Quiz: www.create.kahoot.it/share/straws/7512e5a3-dcb0-4363-b30d-37feabdb7036

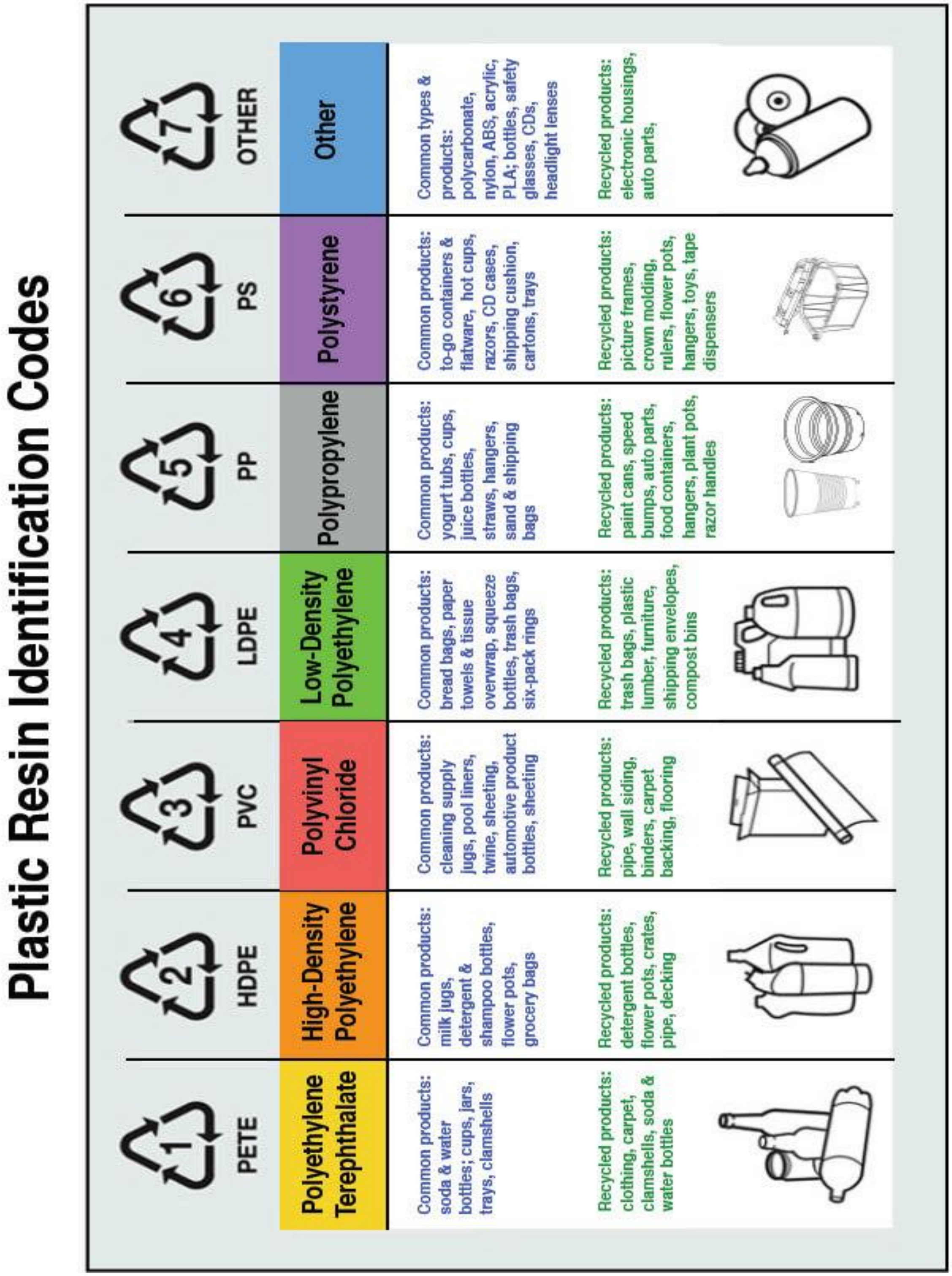
"A Plastic Ocean": A Plastic Ocean begins when journalist Craig Leeson, searching for the elusive blue whale, discovers plastic waste in what should be pristine ocean. In this adventure documentary, Craig teams up with free diver Tanya Streeter and an international team of scientists and researchers, and they travel to twenty locations around the world over the next four years to explore the fragile state of our oceans, uncover alarming truths about plastic pollution, and reveal working solutions that can be put into immediate effect.
Trailer: www.aplasticocean.movie/
Kahoot Quiz: www.create.kahoot.it/share/plastic-ocean-kahoot/ac631838-b3c4-4028-86b3-228c97135be6

"Bag It!": An average guy makes a resolution to stop using plastic bags at the grocery store. Little does he know that this simple decision will change his life completely. He comes to the conclusion that our consumptive use of plastic has finally caught up to us, and looks at what we can do about it. Today. Right now.
Trailer: www.newday.com/film/bag-it
Kahoot Quiz: https://create.kahoot.it/share/bag-it/209aa6e5-f055-4191-bc55-c45bd1bc0f30

Other films:
Films and Videos about Plastic Pollution & Plastic-Free Living:
www.myplasticfreelife.com/films-and-videos-about-plastic-pollution-plastic-free-living/

“Plastic China”: A 2016 Chinese documentary film depicting the lives of two families who make their living recycling plastic waste imported from developed countries. The film premiered at the International Documentary Film Festival Amsterdam in November 2016, and was shown at the 2017 Sundance Film Festival (Source: www.wikipedia.com)
www.cnex.tw/plasticchina

Appendix I: Recycling Codes Explained:



Source: www.thesmarthuman.com/dr-aly-cohen-discusses-data-on-everyday-chemicals-and-emf-exposure-at-western-connecticut-state-universitys-institute-for-holistic-health-studies/

Appendix J: Less Plastic Challenge Example:

LESS PLASTIC CHALLENGE

Will you take on the challenge of up-cycling single-use plastics?

What: Transform single-use plastics into something new!

Where: Submit your name, town, and a photo of your project with a written or video explanation to education2@gmcg.org

When: Submissions will be accepted through April 15th. Winners will be announced on Earth Day (April 22nd)

For more submission information visit gmcg.org

GREEN MOUNTAIN CONSERVATION GROUP

About 50% of plastic products are single-use plastics that we use for 10 minutes or less on average, but persist in the environment for hundreds of years. These plastics pollute our environment, kill wildlife, and harm human health. It is up to us to find creative solutions to reduce plastic waste.

1 $50

2 $25

3 $25

Winners will also receive a gift basket from:

TRUEARTH

2019 winner: sleeping bag for the homeless

Funding provided by the Dorr Foundation and NH Conservation Moose Plate Grant Fund

Appendix K: Resources for Taking Action:

Resources for plastic-reduction in schools:
www.plasticpollutioncoalition.org/guides-schools/ http://www.postlandfill.org/wp-content/uploads/2015/12/Plastic-Free-Manual-12.2.15.pdf
https://www.greenschoolsalliance.org/program/campaigns/stop-plastics
www.onemoregeneration.org/educational-program-info/
GMCG Less Plastic Initiative Poster: https://www.gmcg.org/wp-content/uploads/2019/06/Copy-of-Copy-of-Less-Plastic-Poster.pdf

Resources for participating in other community science projects about plastics:
Helpful websites where you can learn about plastic pollution, host a zero waste event, lobby for single use bans in your community, participate in citizen science such as with

-National Geographic's "Debris Tracker" app where information you contribute can help researchers develop data-driven solutions to plastic pollution threats. By collecting data about litter wherever you see it, from the ocean to your backyard, you can contribute to critical scientific research. Help scientists and researchers better understand the bigger picture of the plastic pollution crisis, from global trends to impacts on local communities. To get started, all you need to do is download the free Marine Debris Tracker mobile application, also called Debris Tracker, on your smart device. www.nationalgeographic.org/education/programs/debris-tracker/

-Brand Audit Citizen Science Initiative: Your community can also use the data to help drive positive changes locally. Break Free From Plastic's brand audits is a citizen science initiative that involves counting and documenting the brands found on plastic waste collected at a cleanup to help identify the companies responsible for plastic pollution. Learn about corporate campaigning - from tea companies to Coca Cola to find alternatives to plastic packaging.
www.breakfreefromplastic.org/brandaudittoolkit/

Other resources:
-Plastic Pollution Coalition: Plastic Pollution Coalition is a growing global alliance of more than 1,200 organizations, businesses, and thought leaders in 75 countries working toward a world free of plastic pollution and its toxic impact on humans, animals, waterways, the ocean, and the environment. www.plasticpollutioncoalition.org/
-The Surfrider Foundation: The Surfrider Foundation is dedicated to the protection and enjoyment of the world's ocean, waves and beaches, for all people, through a powerful activist network. One of their areas of focus is reducing the impact of plastics in the marine environment. www.surfrider.org/
Contact your representatives to advocate for less plastic legislation.
-Find your NH US representatives: www.house.gov/representatives/find-your-representative
-NH house representatives:
http://www.gencourt.state.nh.us/house/members/default.aspx
-Find your NH US senators: www.senate.gov/states/NH/intro.htm