Pinellas County Citizen Scientist
STEAM edition:

Use science, technology, engineering, arts and math to address the global waste problem

Text-only edition

Pinellas County Solid Waste
Tampa Bay Times Newspaper in Education

We're here! We're listening!

Pinellas County wants citizen scientist feedback. They care about your ideas and input and are ready to read your responses to the activities in this publication. Submit your ideas to Pinellas County at recycle@pinellascounty.org.

Citizen science

SciStarter defines "citizen science" as the "public involvement in inquiry and discovery of new scientific knowledge." There are four common features of citizen science practice:

- Anyone can participate
- Participants use the same protocol so data can be combined and be high quality
- Data can help scientists come to real-world conclusions
- A wide community of scientists and volunteers works together and shares data

"A citizen scientist is anyone who voluntarily contributes his or her time, effort and resources toward scientific research in collaboration with professional scientists or alone," defines SciStarter.

SciStarter is a collaboration of organizations that helps bring together citizen scientists around the world; the thousands of potential projects offered by researchers, organizations and companies; and the resources, products and services that enable citizens to pursue and enjoy these activities. For more information about SciStarter, go to scistarter.org.

Students as citizen scientists

As a student studying science, you can make a difference in your community and the community at large by becoming a citizen scientist. As the Public Broadcasting Service defines it, "Citizen Science happens when ordinary people study the world around them and send in the data they collect to scientists."

The demand for a strong workforce in the fields of science, technology, engineering and math (STEM) is growing. This need is recognized by academic, nonprofit and government institutions, yet there are some challenges in recruiting, training and retaining employees in these fields. One way educators and scientists have tried to overcome some of these challenges is by infusing creativity into the training of future scientists through the arts.

STEAM (Science, Technology, Engineering, Arts and Mathematics) programs incorporate hands-on learning opportunities that promote collaboration between different types of subjects. Incorporating visual as well as performing arts to the disciplines of science, technology, engineering and mathematics could serve as a benchmark for innovation.

Source: "STEAM: Using the Arts to Train Well-Rounded and Creative Scientists" by Verónica A. Segarra, Barbara Natalizio, Cibele V. Falkenberg, Stephanie Pulford and Raquell M. Holmes. Published in Journal of Microbiology & Biology Education.

Doing your part

The most important partner in the waste reduction chain is you! In citizen science, the public participates voluntarily in the scientific process, addressing real-world waste reduction that may include formulating research questions, conducting scientific experiments, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems.

Newspaper in Education

The Tampa Bay Times Newspaper in Education program (NIE) is proud to partner with Pinellas County to present this STEAM guide for citizen scientists.

The Times NIE program is a cooperative effort between schools and the Times Publishing Co. to encourage the use of newspapers in print and electronic form as educational resources — a living textbook. Our educational resources fall into the category of informational text, a specific type of nonfiction text. The primary purpose of informational text is to convey information about the natural or social world.

NIE serves educators, students and families by providing schools with class sets of the Pulitzer Prize-winning *Tampa Bay Times* plus award-winning original educational publications, teacher guides, lesson plans, educator workshops and many more resources — all at no cost to schools, teachers or families. In 2018-2019, NIE provided more than 1.4 million print copies and 11 million digital editions of the *Times* to area classrooms free of charge thanks to our generous subscribers and individual, corporate and foundation sponsors. NIE teaching materials cover a variety of subjects and are aligned to the Florida Standards.

The Times NIE program is a member of Florida Press Educational Services Inc. (FPES). FPES is a nonprofit 501(c)(3) organization of newspaper professionals that promotes literacy and critical thinking, particularly for young people. For more information, go to fpesnie.org.

For more information about the Times NIE program, visit tampabay.com/nie, call 727-893-8138 or email ordernie@ tampabay.com. Follow us on Twitter at twitter.com/TBTimesNIE. Like us on Facebook at facebook.com/TBTNIE.

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Credits

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Florida Standards: Reading the information in this publication and completing the activities correlates to the following Language Arts standards. LAFS.612.L.1.1; LAFS.612.L.1.2; LAFS.612.L.3.4; LAFS.612.L.3.6; LAFS.612.RI.1.1; LAFS.612.RI.1.2; LAFS.612.RI.1.3; LAFS.612.RI.2.4; LAFS.612.RI.2.5; LAFS.612.RI.2.6; LAFS.612.RI.3.7; LAFS.612.RST.1.1; LAFS.612. RST.1.2; LAFS.612.RST.1.3; LAFS.612.RST.2.4; LAFS.612.RST.2.5; LAFS.612.RST.3.7; LAFS.612.SL.1.1; LAFS.612.SL.1.2; LAFS.612. SL.1.3; LAFS.612.SL.2.4; LAFS.612.SL.2.5; LAFS.612.SL.2.6; LAFS.612.W.1.1; LAFS.612.W.1.2; LAFS.612.W.1.3; LAFS.612.W.2.4; LAFS.612.W.2.5; LAFS.612.W.2.6; LAFS.612.W.3.7; LAFS.612.W.3.8; LAFS.612.W.3.9; LAFS.612.W.4.10

Science and Arts standards are noted under each activity.

Educators: Share 100 words about how you used this resource in your classroom for a chance to win a $15 gift card! Visit tampabay.com/nie for details and to enter.

Your county

The mission of the Pinellas County Department of Solid Waste is to provide dependable, accessible and sustainable integrated solid waste management systems for the region in a collaborative manner, with visionary leadership to responsibly manage waste as a resource for the long term. The County does this by:

- inspiring conscious decision making and thoughtful consumption
- anticipating future needs to stay ahead of the curve
- balancing environmental, economic and social sustainability
- seeking regional cooperation and collaboration
- increasing operational capacity of the Solid Waste Disposal Complex

Where Pinellas County is today:

There is only one active landfill in Pinellas County; it is located adjacent to the Waste-to-Energy (WTE) facility. Both are managed by Pinellas County. The County uses its WTE facility to process most of the County's trash. The volume of trash is reduced by 90 percent, and the remaining ash is landfilled. The WTE facility can burn up to 3,150 tons of garbage per day. The maximum amount of trash that can be processed in the WTE facility each year is just over 1 million tons. In 2018, about 875,000 tons of garbage was processed through the WTE facility. Based on projected population growth and waste generation rates, the County anticipates the need to process at least 1.35 million tons per year by 2048. This is more than can be currently processed through the WTE facility, which means that more garbage will need to be landfilled. Given these constraints, the landfill is estimated to have less than 85 years left before it is full.

Where Pinellas County wants to be:

The goal is to place zero waste in our landfill.

Waste management hierarchy

The waste management hierarchy is the "order of priority of actions to be taken to reduce the amount of waste generated, and to improve overall waste management processes and programs." The waste management hierarchy ranks waste management strategies from most to least environmentally preferred.

Reduction is the first step on the list. The concept of reducing or eliminating waste before it is produced or used is essential to waste reduction. If there is less waste, then there is less waste that needs to be reused or recycled or that ends up in the trash.

The process of reducing waste begins with an examination of what you are using, and what it is used for.

Sources: Conserve Energy Future, Environmental Protection Agency

Zero waste goal

On average, each resident in Pinellas County generates approximately 12.16 pounds of waste per day. In 2017, this corresponded to more than 2.15 million tons of waste. Historically, the Pinellas County Department of Solid Waste has managed 55-60 percent of the total waste generated countywide at the Solid Waste Disposal Complex. In 2017, this totaled 1.2 million tons.

Recycling has eliminated almost 1.2 million tons from disposal. Continued recycling at this rate will see almost 1.4 million tons diverted from disposal by 2048. However, the key to reaching the zero waste goal is reduction.

Reaching the goal

To reach the goal of putting zero waste in the landfill, Pinellas County has a strategic plan to:

- minimize the amount of waste that is generated
- maximize how much is recycled
- manage what is left over

The implementation of the strategic plan is designed to position Pinellas County to sustainably manage waste effectively. With the strategies from these initiatives, the County will be able to continue to increase its recycling rate.

Call to action

As a resident of Pinellas County, you are part of the collaboration team. How can you help the County with the goal of putting zero waste in the landfill? Brainstorm some ideas with your class and family to come up with ideas to reduce waste. Submit your ideas to Pinellas County at recycle@pinellascounty.org.

Circular economy

A zero waste system is a cornerstone of a circular economy. As with cycles in nature, “circular economy” is a term for an industrial economy that produces neither waste nor pollution by design or intention. Materials circulate without being lost to the system, forming a closed loop. This approach is in contrast to the traditional linear economy, which has a "make, take, dispose of" model of production.

Citizen Scientist activity

THE PROBLEM:

In the past 40 years, the world's population has increased, and it continues to grow. We’re all dependent upon a limited number of natural resources for survival. As Eco-Cycle, one of the largest nonprofit recyclers in the U.S., notes, our present production system goes one way — from the earth to disposal.

- Natural resources are extracted from Earth.
- These resources are manufactured, sometimes through toxic and wasteful practices.
- The products are then distributed for sale, sometimes shipped long distances in the process.
- After the products are bought and used, they are often discarded and new products are purchased.

Source: Eco-Cycle

Points to ponder

- A zero waste system redesigns our systems and resource use – from product design to disposal.
- A zero waste system relies on empowering individuals to be educated and make smart choices.
- A zero waste system relies on reduction as the most important step in the waste management hierarchy.

The steps

1. **Identify the need:** Define and clarify the issues. Working in small groups, brainstorm the problem using the information presented. Create a chart listing what you know, what you need to know and what you hope to learn. Write down all your ideas – there are no bad ideas when brainstorming.
2. **Learn and study:** Research the background and issue. Research the problem and the points to ponder. Then, choose one of the issues you brainstormed to focus on. What specific part of this issue are you looking to solve?

Do the research

- Watch the video The Zero Waste Climate Solution at youtube.com/watch?time_continue=87&v=_E2u_LbboKE.
- Watch the video I Tried to Go Zero Waste for 7 Days at https://youtube/s9EhHQncTu8https://youtube/s9EhHQncTu8.
- Look for articles about this topic in the *Tampa Bay Times* and Pinellas County Recycle Guide (Go to tampabay.com/nie. Click on "Science" under the Curriculum tab.)
- Review the articles on the Eco-Cycle: Building Zero Waste Communities website at ecocycle.org/zerowaste.

3. **Collaborate:** With your group, brainstorm possible solutions and ideas to help solve the problem. Write down your ideas in outline, web or chart form.
4. **Draft:** Evaluate the alternatives and select the most promising solutions.
5. **Create:** On paper, write out your ideas in a comprehensive fashion. You can present your ideas in an infographic or graphic organizer.
6. **Share:** Present your ideas to the class and receive feedback that you will use for your final report.
7. **Report:** Finalize your ideas. Using the *Tampa Bay Times* articles you found in Step 2 as models, write an article addressing the problem and possible solutions. Send your article to recycle@pinellascounty.org.

Science Standards: SC.612.L.17.13; SC.612.L.17.14; SC.612.L.17.15; SC.612.L.17.17; SC.612.L.17.20; SC.612.N.1.1; SC.612.N.1.2; SC.612.N.1.3; SC.612.N.1.7; SC.612

In Pinellas County, our garbage is used to make electricity!

1. Garbage in Pinellas County is taken to the Solid Waste Disposal Complex, where 80 to 90 percent of it is burned as fuel in the County's Waste-to-Energy (WTE) facility. Pinellas County's WTE facility produces enough electricity to power 45,000 homes each day. The gas produced is cleaned by state-of-the-art pollution control systems.
2. Magnets are used to recover ferrous metals, such as iron and steel, from the ash. Electrical currents called eddy currents are used to recover nonferrous metals such as aluminum and copper. These metals are then sold for recycling.
3. The leftover ash, which takes up 90 percent less space than the original garbage, is landfilled for disposal.

How does Waste-to-Energy work?

1. Waste is burned, creating thermal energy (heat) and leaving only ash, metal, inert materials, glass and ceramics behind.
2. The heat converts water into steam within the steel-tube-lined walls of the boiler.
3. The rising steams turns the blades of a turbine-driven generator, converting the thermal energy into mechanical energy (energy of motion) and then into electrical energy (electricity).
4. Some of the electricity is used to power the WTE facility, and the rest is sold to Duke Energy for distribution to homes and businesses.
5. Ferrous (e.g., steel) and nonferrous (e.g., copper and aluminum) metals are recovered from the ash and sold for recycling.
6. The remaining ash is used for landfill cover.
7. The gas produced is cleaned using chemicals and filters, which neutralize and remove the contaminants. The emissions are closely monitored in real time by a Continuous Emissions Monitoring System (C.E.M.S.).

"Municipal solid waste (MSW) is used to produce energy at Waste-to-Energy facilities and at landfills in the United States. In 2016, 71 U.S. power plants generated about 14 billion kilowatt hours of electricity from burning about 30 million tons of combustible MSW. Burning waste also reduces the amount of material that would probably be buried in landfills. Burning MSW reduces the volume of waste by about 87 percent."

- U.S. Department of Energy

Citizen Scientist activity

THE FACT:

Waste-to-Energy facilities burn municipal solid waste (MSW), often called garbage or trash, to produce steam in a boiler that is used to generate electricity.

Investigate like a science detective

- Who created the design for Waste-to-Energy facilities? Is each design different?
- How is electricity produced by a WTE facility?
- What are the benefits of using this technology versus just landfilling?
- What can we recover from the garbage when we use this process?
- Where are the facilities located around the U.S.? Are they in rural or urban areas?
- When did they come into existence?
- Why are they being used?
- How are they being used?
- How is air pollution handled?

The steps

1. Working in small groups, brainstorm the questions and the information presented. Create a chart listing what you know, what you need to know and what you hope to learn. Write down all your ideas – there are no bad ideas when brainstorming.
2. Through the research, answer the questions. You can use the following sources to assist with your research:
   a. *Tampa Bay Times* newspaper
   b. Waste 360, waste360.com
   c. Environmental Protection Agency, epa.gov
   d. United States Department of Energy, eia.gov/energyexplained/?page=biomass_waste_to_energy#tab1
   e. Student Energy, studentenergy.org
   f. Confederation of European Waste-to-Energy Plants, cewep.eu/what-is-Waste-to-Energy
   g. Covanta, covanta.com/sustainability/energy-from-waste

Write like a science reporter

1. Using the information you learned with your group, write a newspaper article explaining Waste-to-Energy facilities to the general public. Use the articles in the news section of the *Tampa Bay Times* as models.
2. Next, using the information you learned, write an editorial, opinion article or letter to the editor explaining the pros or cons of having a Waste-to-Energy facility when trying to reach a zero-waste-to-landfill goal. Use the opinions, editorials and letters from the *Tampa Bay Times* as models.

Science Standards: SC.612.L.17.13; SC.612.L.17.14; SC.612.L.17.15; SC.612.L.17.17; SC.612.L.17.20; SC.612.N.1.1; SC.612.N.1.2; SC.612.N.1.3; 1 SC.612.N.1.7; SC.612.N.4.1; SC.612.N.4.2

"The most effective way to reduce waste is to not create it in the first place. Making a new product requires a lot of materials and energy – raw materials must be extracted from the earth, and the product must be fabricated then transported to wherever it will be sold. As a result, reduction and reuse are the most effective ways you can save natural resources, protect the environment and save money."

- Environmental Protection Agency

Benefits of reducing waste

- Prevents pollution by reducing the need to harvest new raw materials
- Saves energy
- Reduces greenhouse gas emissions that contribute to global climate change
- Helps sustain the environment for future generations
- Saves money
- Reduces the amount of waste that will need to be recycled or sent to disposal facilities
- Allows products to be used to their fullest extent

Source: Environmental Protection Agency

Eight simple ways to go zero waste

To reduce means to use less of something. Using less of something, such as packaging, will result in a smaller amount of waste. Source reduction entails reducing waste before something is purchased. You can help reduce waste by purchasing products that are not wasteful in their packaging or use.

A key factor of waste reduction is "conservation — using natural resources wisely, and using less than usual in order avoid waste," according to the National Institute of Environmental Health Sciences (NIEHS). Here are some suggestions offered by the Pinellas County Department of Solid Waste:

- Get a reusable water bottle. Enjoy your tap water and save money.
- Take your reusable coffee mug to your favorite coffee shop. Hand them your cup when ordering. This may take some courage, but it gets easier.
- Keep a "zero waste kit" with reusable cutlery, napkins and sealable containers.
- Replace cotton balls and makeup wipes with washable cotton pads.
- Find reusable shopping bags that you will remember to bring to the store.
- There are many options that can fold to fit in your pocket or purse.
- When buying produce, bring your own reusable mesh bag or use a 100 percent cotton pillow case.
- Bring your own straw. There are options that fold up in a case small enough to fit on your keychain.
- Don't forget to practice reuse. Many of these items can be purchased from the thrift store!

Source: National Institute of Environmental Health Sciences

Citizen Scientist activity

THE PROBLEM:

We live in a "make, take, dispose of" culture that thrives on convenience. Packaging – much of it single-use food wrapping and containers – has created a worldwide trash problem. What happens to all of those single-serve snack, water, juice and soda containers people no longer need? How can people reduce the amount of waste they produce?

Points to ponder

- What are some packaging options and alternative materials for packaging items to decrease waste?
- Rachelle Strauss of the United Kingdom's ZeroWasteWeek says, "We never actually throw anything 'away' – it's really just put somewhere else." How can we reduce the waste in the first place?
- Ordering food from restaurants or picking up a quick premade meal from the grocery store, fast food restaurant, sub shop or deli is convenient and quick. Are there ways to reduce packaging to eliminate waste when the food or drink is finished?
- How can we change packaging to make it more recyclable?

The steps

1. **Identify the need:** Define and clarify the issue you want to investigate. Working in small groups, brainstorm the problem and the information presented. Create a chart listing what you know, what you need to know and what you hope to learn. Write down all your ideas – there are no bad ideas when brainstorming.
2. **Learn and study:** Research the background and issue. Research the problem and the points to ponder. Come up with your own ideas based on your own experiences. Then, choose one of the issues you brainstormed to focus on. What specific part of this issue are you looking to solve? Use the following sources to assist with your research:

   a. *Tampa Bay Times* newspaper, paying special attention to the advertisements
   b. Pinellas County Recycle Guide – Go to tampabay.com/nie. Click on "Science" under the Curriculum tab.
   c. Pinellas County Solid Waste, pinellascounty.org/solidwaste/recycle
   d. Tampa Bay Recycles, tampabayrecycles.org
   e. Environmental Protection Agency, epa.gov
   f. National Institute of Environmental Health Sciences, kids.niehs.nih.gov/topics/reduce/reduce-waste
   g. nationalgeographic.com/environment/2019/06/you-eat-thousands-of-bits-of-plastic-every-year
   h. apps.npr.org/plastics-recycling

3. **Collaborate:** With your group, brainstorm possible solutions and ideas to help solve the problem. Write down your ideas in outline, web or chart form.

4. **Draft:** Evaluate the alternatives and select the most promising solutions.
5. **Create:** On paper, write out your ideas in a comprehensive fashion. Next, be creative. Present your ideas in a graphic organizer, blueprint, drawing, Sketch 3 dimensional rendering, cartoon or advertisement.
6. **Share:** Present your ideas to the class and receive feedback that you will use for your final report.
7. **Report:** Finalize your ideas. Using the *Tampa Bay Times* articles you found in Step 2 as models, write an article addressing the problem and possible solutions.

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“Wish-cycling is well-intentioned recycling that ends up creating more problems than solutions. While the intentions are good, these mistakes are costly and time-consuming – sometimes shutting down processing plants for hours at a time.”

- Florida Recycles

The contamination problem

A Materials Recovery Facility (MRF) is the hub of the recycling world. A Materials Recovery Facility processes recyclable materials to sell to manufacturers as raw materials to make new products.

Contaminating recyclables means polluting or damaging recyclable materials with nonrecyclable materials. This happens when people try to recycle items that can’t be recovered in single-stream residential recycling programs.

Items such as plastic bags, cords, wires and hoses jam and damage sorting equipment. These items are known as “tanglers” and can be very costly and dangerous.

To-go food containers, single-use plates and cutlery, and soiled paper products can’t be recovered and contaminate the clean, quality recyclables, which then become unusable.

Contamination increases recycling costs and degrades the quality of materials, reducing the ability of the materials to be recycled.

Source: Tampa Bay Recycles

How does recycling work?

In Pinellas County, only plastic bottles and jugs, metal cans, paper, cardboard, glass bottles and jars and cartons should be placed in a single bin for recycling. Recycling is a four-step process:

1. Assess if the item can be recycled by checking your recycling program rules.
2. Place the correct materials in your recycling containers.
3. The materials are sent to a Materials Recovery Facility where they are sorted, baled and sold to manufacturers who turn them into new products.
4. The new products made with recycled content are purchased by the consumer.

It takes all four steps for a material to truly be recycled!

Citizen Scientist activity

Material Recovery Facilities (MRFs) use a series of conveyers that carry recyclable materials over sorting screens or other mechanisms that divide the materials. According to *Encyclopaedia Britannica*, "As single-stream recycling becomes more common, more facilities are designed to accept and separate various types of recyclable materials. Automated systems can sort a number of materials simultaneously, such as paper, cardboard, aluminum, plastic and glass, using such tools as magnets and ultraviolet optical scanners. The mechanized process is augmented by workers who sort items by hand." Contamination often stops the process right in its tracks.

The Problem

As Recycle Across America notes, "Every day, the public throws millions of tons of garbage (food waste, diapers, plastic bags, wrappers, Styrofoam™, coffee cups, plastic straws, garden hoses, etc.) into recycling bins. That 'garbage' contaminates the good recyclables, hence the term "contamination.'"

Investigate and research like a scientist

- What is recycling?
- What is the science behind recycling?
- What items can be recycled in Pinellas County?
- What items cannot be recycled and why?
- Why do people put nonrecyclable items into recycle bins?
- What are the dangers of contaminating recycle bins with inappropriate items?

The steps

1. Working in small groups, brainstorm the questions. Create a chart listing what you know, what you need to know and what you hope to learn. Write down all your ideas before you begin the research.
2. Through the research, answer the questions and then think about the future. How can Pinellas County residents help make the MRF more effective by cleaning up their recycling?
3. How are recycling labels confusing? What is the importance of using standardized recycling labels? Use the following sources to assist you:
   a. recycleacrossamerica.org
   b. how2recycle.info
   c. tampabayrecycles.org
   d. pinellascounty.org/recycle

Plan like an engineer

Using the information you researched and discussed with your group, create a plan to improve on people's knowledge about recycling and the way they recycle in Pinellas County. Write out your plan in outline form and create a visual map to share with your class and Pinellas County. In your plan, include how you will not only increase clean recycling, but also decrease contamination in recycling bins and at the MRF. Create an advertising campaign to go along with your plan. Look in the *Tampa Bay Times* for effective advertisements, images and slogans. Use the ideas and images on the Recycle Across America page for ideas, as well. Brand your campaign for Pinellas County residents. Email your ideas to: recycle@pinellascounty.org.

Science Standards: SC.612.L.17.8; SC.612.L.17.11; SC.612.L.17.12; SC.612.L.17.13; SC.612.L.17.14; SC.612.L.17.15; SC.612.L.17.17; SC.612.L.17.20; SC.612.N.1.1; SC.612.N.1.2; SC.612.N.1.3; SC.612.N.1.7; SC.612.N.4.1; SC.612.N.4.2
Visual Arts Standards: VA.612.C.1.1; VA.612.C.1.2; VA.612.C.1.5; VA.612.C.1.7; VA.612.C.1.8; VA.612.F.1.2; VA.612.F.1.4; VA.612.F.2.4; VA.612.F.3.6; VA.612.F.3.8

"Versatile, pliable, durable, cheap to produce – and ubiquitous. Plastic is all of that. It is also both a life-saving miracle product and the scourge of the earth."

- Laura Parker, staff writer, National Geographic

Plastic overflow

Geologist Trevor Nance, Ph.D., writes, "Plastic, in the recent decades, has become a staple of convenience and a modern lifestyle. Several recent reports indicate the dire global situation associated with the world's plastic use. Two statistics jump out immediately: One, that globally, humans buy a million plastic bottles per minute. The second, 91 percent of all plastic is not recycled. On top of that, it is estimated that over half a trillion plastic bottles will be sold in 2020."

Here are some other interesting statistics:

- In 2015, Americans purchased about 346 bottles per person – 111 billion plastic beverage bottles in all.
- Some 18 billion pounds of plastic waste flows into the oceans every year from coastal regions.
- It is estimated that by 2050 the ocean will contain more plastic by weight than fish.

Sources: Forbes Media; Euromonitor International; Container Recycling Institute; University of Georgia; Ellen MacArthur Foundation

Plastic recycling rates

United States: 9 percent
China: 25 percent
European Union: 30 percent

Source: University of California, Santa Barbara

An overwhelming problem

Plastic pollution is a well-known problem in the world's oceans, but a new study of a remote group of islands has demonstrated how overwhelming the problem has become in some areas. A study published May 16, 2019, in the journal *Nature* reveals that the remote Cocos Keeling Islands in the Indian Ocean are "literally drowning in plastic," with an estimated 414 million items of plastic waste washed up on beaches.

The Cocos Island group is a remote territory of Australia in the Indian Ocean consisting of 27 islands. The scientists scanned more than two dozen beaches on seven islands. Of all the identifiable items, around 25 percent were disposable plastics, such as straws, bags and toothbrushes. Included in the plastic pollution were nearly one million shoes, such as flip-flops and sneakers, and more than 370,000 toothbrushes.

As disturbing as the numbers are, they may just be the "tip of the iceberg," according to the study's lead author, Jennifer Lavers. That's because 90 percent of the plastic found was buried in the sand, not just on the surface. That would indicate that surface surveys of beach pollution in the past may have significantly underestimated the amount of plastic pollution, she said. Plastic pollution is a problem for oceans all over the world.

Monitor the *Tampa Bay Times* for at least a week and find and closely read stories about ocean plastic pollution. Use what you read to write a short editorial outlining steps that nations of the world could take to address the problem. Use this information as part of the learning journal you are keeping to come up with ideas to reduce this and other plastic-related issues.

The plastic problem

Plastics deliver many benefits to the worldwide economy, but there also are quite a few drawbacks.

According to the Ellen MacArthur Foundation, 95 percent of plastic packaging material value is lost to the economy. That equates to $80-120 billion annually. Approximately 32 percent of plastic packaging escapes collection systems and winds up in oceans and clogs urban infrastructure. In addition, it is estimated that the cost of greenhouse gas emissions from its production is estimated at $40 billion annually.

As Trevor Nance writes, "The ever-growing demand for plastic is unlikely to be abated soon. Globally, we will have to manage the increasing risk of plastics in our environment and the harmful consequences that lie therein."

Sources: Ellen MacArthur Foundation; Forbes Media

Citizen Scientist activity

THE PROBLEM:

From individual sizes of chips and fruit cups to disposable diapers, razors, water bottles and juice bottles, plastic is convenient. In the form of straws, takeout food and beverage containers and covers, bags from the clothing or grocery store, plastic has become a way of life for many people. However, much of that plastic packaging winds up in oceans and clogs urban infrastructure. The cost of greenhouse gas emissions from plastic production grows annually.

Points to ponder

- How is plastic manufactured and what type of emissions are produced?
- Is there an alternative to plastic?
- Does plastic biodegrade? If so, how long does it take?
- Which types of plastics can be recycled?
- Which types of plastics can be reused?
- What is "upcycling"? Which types of plastics can be upcycled?
- What happens when plastic packaging enters oceans?
- How do plastics clog urban infrastructures, such as storm drains?

Check out some of these articles:

- The New Plastics Economy, the Ellen MacArthur Foundation, ellenmacarthurfoundation.org
- "Young sperm whale found dead in Sicily with stomach full of plastic," CNN News, cnn.com
- "The Strawless City: St. Pete bans plastic straws, Styrofoam," *Tampa Bay Times*
- Ocean Gyres Under Fire, University of Florida blogs
- "Mariana Trench: Deepest-ever sub dive finds plastic bag," BBC News, bbc.com
- nationalgeographic.com/environment/2019/06/you-eat-thousands-of-bits-ofplastic-every-year
- apps.npr.org/plastics-recycling

The steps

1. **Identify the need:** Define and clarify the issues. Working in small groups, brainstorm the problem and the information presented. Create a chart listing what you know, what you need to know and what you hope to learn. Write down all your ideas – there are no bad ideas when brainstorming.
2. **Learn and study:** Research the issues. Research the problem. Then, choose one of the issues you brainstormed to focus on. What specific part of this issue are you looking to solve? Which part of the issue is most important to you and your team of citizen scientists?
3. **Collaborate:** With your group, brainstorm possible solutions and ideas to help solve the problem. Write down your ideas in outline, web or chart form in a learning journal.

4. **Draft:** Evaluate the alternatives and select the most promising solutions.
5. **Create:** On paper, write out your ideas in a comprehensive fashion. You can present your ideas in an infographic or graphic organizer.
6. **Share**: Present your ideas to the class and receive feedback that you will use for your final report.
7. **Report:** Finalize your ideas. Write a final report addressing the problem and possible solutions based on your research.

Science Standards: SC.912.L.17.8; SC.912.L.17.11 SC.912.L.17.13; SC.912.L.17.14; SC.912.L.17.15; SC.912.L.17.17; SC.912.L.17.20; SC.912.N.1.1; SC.912.N.1.2; SC.912.N.1.3; SC.912.N.1.7; SC.912.N.4.1; SC.912.N.4.2

Why is recycling important?

Floridians threw away an estimated 3 million tons of paper in 2018. Recycling that paper could have saved:

- **51 million trees** – That's enough trees to cover an area over 20 times the size of Walt Disney World.
- **1.1 billion gallons of oil** – that's equal to the amount of oil that the state of Florida will use in the next 4.6 months.
- **21 billion gallons of water** – That's enough water to fill 30,000 Olympic-sized swimming pools.
- **12 billion kilowatts of energy** – That's almost enough energy to power all the homes in the Tampa Bay area for a year.

By using paper with recycled content, we can save even more!

Going beyond the text: Recycling is good for the economy

In addition to its environmental benefits, recycling plays an important part in the economy. Use the following sources to research the life cycle of paper, including manufacturing, consumer use, recycling and remanufacturing.

a. waste360.com/paper/green-bay-packaging-launches-100-recycledpaper-plant-using-mixed-papers
b. apnews.com/3d3d86a09b9647b795295e77355877db
c. nytimes.com/2019/03/22/business/cardboard.html
d. resource-recycling.com/recycling/2019/08/13/companies-planinvestments-in-us-recycled-paper-mills

Provide examples of the following:

1. Who purchases this material?
2. What is the value of this material?
3. What happens to the material next? What form does it take and where does it go?
4. What is the final end use of the material? Who is the buyer of the end product? Is it a consumer or a manufacturer?

Using the information you have learned, write a newspaper article about the economic and social impacts of recycling paper, including the creation of new jobs. Make sure you answer the basic journalism questions: Who, what, where, when, why and how.

Science Standards: SC.612.L.17.8; SC.612.L.17.11; SC.612.L.17.12; SC.612.L.17.13; SC.612.L.17.14; SC.612.L.17.15; SC.612.L.17.17; SC.612.L.17.20 SC.612.N.1.1; SC.612.N.1.2; SC.612.N.1.3; SC.612.N.1.7; SC.612.N.4.1; SC.612.N.4.2 **Visual Arts Standards**: VA.612.C.1.1; VA.612.C.1.2; VA.612.F.1.4; VA.612.F.3.4; VA.612.O.1.3; VA.612.S.1.5

Activity: Packaging

In this activity, you will keep a record of at least 20 household items purchased by your family over the course of one week. Create a table similar to that shown below. For each item, research and try to identify all the different types of packaging used and decide whether that packaging can be reused, reduced, recycled or composted, or if there is an alternative packaging or product that can be used.

An item may be placed in more than one type of packaging. For example, a six-pack of soft drink cans would include aluminum (the cans) and plastic packaging (the ring holder for the cans). A box of cereal would include paper (the box) and plastic packaging (the liner). A multipack of bar soap would include paper (each bar's wrapping) and plastic packaging (the outer wrap).

Be sure to make your classifications based upon the recyclables collected in your community. For example, if your area recycles only certain types of plastic, then only those types should be classified as recyclable.

Use the Federal Trade Commission's online resources to help you to classify your products: The Language of Recycling at consumer.ftc.gov/articles/0203-language-recycling and Shopping Green at consumer.ftc.gov/articles/0226-shopping-green.

At the end of one week, calculate the percentages of packaging that can be reused, reduced, recycled or composted or that can be more efficient. As a class, average the results to estimate the overall percentage of reusable, recyclable, nonrecyclable and compostable packaging and packaging made with recycled content purchased or used by the class.

For each product packaged in nonrecyclable packaging, identify some alternative products people could purchase to reduce the amount of nonrecyclable packaging used. For each product packaged in plastic packaging, identify some alternative products people could purchase to reduce their plastic consumption. For example, single-serving products packed in plastic, such as applesauce, can be purchased in large glass jars and packed in reusable containers for lunchboxes.

ITEM	REUSED	REDUCED	RECYCLABLE	COMPOSTABLE	ALTERNATIVE

Adapted from: "How Packaging & Purchasing Impact the Environment," *Action in the Classroom: An Introduction to Environmental Science for High School Students*, South Carolina Department of Health and Environmental Control's Office of Solid Waste Reduction and Recycling

Additional sources: *Encyclopaedia Britannica*; Environmental Protection Agency; "Plastics and Sustainability: A Valuation of Environmental Benefits, Costs and Opportunities for Continuous Improvement"; American Chemistry Council; "The cost of plastic packaging," *Chemical & Engineering News*; "Plastic Not-So-Fantastic: How the Versatile Material Harms the Environment and Human Health," *Scientific American*

What can I recycle?

Everything must be empty, dry and unbagged.

Metal – Only food and drink cans.

Glass – Only bottles and jars.

Plastic – Only bottles and jugs.

Paper and cardboard – Clean and dry. No food contact. No shredded paper.

Cartons – No straws.