

# KEEPING OUR COASTLINES CLEAN

A U.S. Virgin Islands  
Marine Debris Curriculum



# Introduction to the U.S. Virgin Islands Marine Debris Curriculum

Marine debris is a pervasive, global problem and one that is felt locally in the U.S. Virgin Islands (USVI). As part of a National Oceanic & Atmospheric Administration (NOAA) Marine Debris Program Prevention grant, "[Pride in Our Seas, Pride in Ourselves: Preventing Land-Based Sources of Marine Debris in the U.S. Virgin Islands through Educational Transformation and Community Engagement](#)" (NA16NOS9990133), we adapted, revised, and shared Oregon Sea Grant's [Marine Debris STEAMSS](#) (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum for the U.S. Virgin Islands, as well as adapted NOAA curricula from "[Turning the Tide on Trash](#)" and "[Talking Trash and Taking Action](#)." Eleven, USVI-specific, place-based lessons were adapted and included in the final curriculum. The finalized curriculum also includes 15 spotlights, which highlight USVI-specific marine debris research, local researchers, community-led prevention efforts (including Community Transfer Projects funded through this grant), and natural disaster impacts from marine debris, specifically Hurricanes Irma and Maria, which impacted the U.S. Virgin Islands community as two category 5 storms in September 2017, midway through the project. The curriculum includes original pictures and graphics created and contributed by the Project Team for the U.S. Virgin Islands.

The curriculum was co-created with the input of 61 educators from the USVI who participated in two NOAA- and Virgin Islands Established Program to Stimulate Competitive Research (VI EPSCoR)-funded Marine Debris Educators Workshops in 2016 and 2018. Additional input was gathered following in-class use and from teachers who participated in VI EPSCoR's Summer STEM Institutes for Teachers in 2017 and 2018, led by the Virgin Islands Institute for STEM Education Research & Practice (VI ISERP). Educators from eleven public schools and six private schools on St. Thomas and St. Croix participated in the Marine Debris Educators Workshops, along with the faculty, staff, and undergraduate and graduate students from the University of the Virgin Islands (UVI), the territorial STEM director, and individuals from the Virgin Islands Marine Advisory Service (VIMAS), VI EPSCoR, the Virgin Islands Department of Planning & Natural Resources Division of Coastal Zone Management (DPNR CZM), the Virgin Islands Waste Management Authority, the Virgin Islands Children's Museum, and the Youth Rehabilitation Center on St. Croix. Contributions from all of these individuals greatly enhanced this curriculum and highlighted the need for culturally-relevant, place-based curricula in USVI schools. For example, local educators shared the value of having a printed rather than electronic resource that highlighted local information, pictures, and resources (hence, the incorporation of the 15 spotlights included with the lesson plans).

This place-based curriculum uses local examples, which are important when teaching about ideas that are location dependent. For instance, when teaching about water flow, discussing how a snowpack melts in the spring and changes water flow only makes sense in places that receive snow. Using snow as an example in a place that never sees it, like the USVI, is asking learners to extrapolate without experience to fall back on. Instead, using a locally-relevant example, like the influences of hurricanes or the rainy season on water flow, is more appropriate and engaging. Additionally, culturally-relevant aspects of the curriculum are important for learners to make connections to the curriculum. This includes things like incorporating local vernacular and references to culturally-important places or events. For instance, in the USVI, ephemeral streams are locally called "ghuts." The modifications we made were to incorporate USVI ecological examples, integrate culturally-important places and events, utilize local vernacular, and include local images of people and places in USVI. We have provided links to additional resources and the original curriculum at the top of each lesson plan.



This project has successfully engaged the broader USVI community in marine debris education and prevention activities, and shared its goals and outcomes widely, many of which are highlighted in the 15 spotlights included in this curriculum, which were shared at the Sixth International Marine Debris Conference in San Diego, CA in March 2018. These highlights provide local examples of the work being done to understand, document, and prevent marine debris across the territory. This curriculum would not have been created without the support and input of the Virgin Islands community, Oregon Sea Grant, and funding from the NOAA Marine Debris Program and VI EPSCoR. We hope this curricula will be used and shared broadly to inspire coastal stewards of all ages, especially those of the next generation, to do what they can to prevent marine debris and to care for the coasts that we so treasure here in the U.S. Virgin Islands.

With many thanks,  
**The Project Leadership Team**

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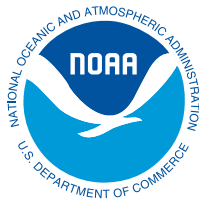
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# Marine Debris in the U.S. Virgin Islands: A Historical Perspective

## NOAA MARINE DEBRIS PROGRAM (MDP)

NOAA MDP has funded more than \$4.84 million in grants to USVI organizations, for marine debris removal, education, and prevention. To date, more than 377,500 lbs of marine debris has been removed from USVI shorelines.

## PLUS, COASTWEEKS!

VI Coastweeks has cleaned up beaches for 30+ years and removed more than 275,000 lbs of debris from USVI shorelines.

If you walked the length of coastline cleaned, you would have walked more than 508 miles! Since 1986, the effort has expanded to 82 beaches on St. Thomas, St. John, St. Croix and Water Island.



## THANK YOU VOLUNTEERS!

2.4 years or 21,000 collective hours. That's how much time volunteers have logged during coast-week clean-ups alone, and those make up only a fraction of the clean-ups that have happened in the USVI.

34 local and federal organizations and counting, have contributed to the efforts outlined here.

**PARTNERS** Virgin Islands Marine Advisory Service | The Ocean Conservancy | Coral Bay Yacht Club | Coral Bay Community Council | Grapetree Area Property Owners Association | Virgin Islands Department of Planning and Natural Resources | Virgin Islands Division of Coastal Zone Management | Virgin Islands Division of Fish and Wildlife | St. Croix Environmental Association | Boy Scouts of America, St. Croix | Coki Beach Dive Shop | Virgin Islands Conservation Society | Coral World Ocean Park | Virgin Islands National Parks | Friends of VI National Park Service | CRABBS Dive Club | Adventures in Diving Frederiksted | Blue Flag USVI | VI EcoSchools | Virgin Islands Waste Management Authority | US Environmental Protection Agency | The Environmental Finance Center at Syracuse University | The Virgin Islands Recycling Partnership | The National Fish and Wildlife Foundation | US Coast Guard | National Oceanic and Atmospheric Administration | US Army Corps of Engineers | Federal Emergency Management Agency | Ritz Carlton St. Thomas | Clean Sweep Frederiksted | CleanUP St. Croix | Get Trashed St. John | St. Croix Science & Conservation | Marine Rebuild Fund | 4Ocean | University of the Virgin Islands Center for Marine and Environmental Studies | Virgin Islands Established Program for Stimulating Competitive Research

## 1980 - 2000

The 1980s saw the first-reported marine debris clean-up organized by independent groups in the USVI. • Plus, the first annual Virgin Islands Coastweeks event kicked off and is the longest ongoing, data-collecting clean-ups on record in the territory.

**2001 - 2010** The Virgin Islands Waste Management Authority funds an analysis of USVI landfills to estimate solid wastes. • Coastweeks expands and new independent clean-up efforts are launched. • Special clean-ups are hosted following hurricane Marilyn.

## 2011 - 2020

The University of the Virgin Islands (UVI) collaborates with teachers to develop a marine debris curricula for the territory. • After hurricanes Irma and Maria in 2017, a Federal Emergency Management Agency-funded response (Emergency Support Function -10) removed large debris, like washed-up boats, and volunteers cleaned beaches and shorelines. • UVI conducts the first Great Mangrove Clean-up on St. Thomas. •

The NOAA Marine Debris Program funds a \$4.2 million USVI Department of Planning and Natural Resources removal grant of hurricane-generated debris. • New legislation geared toward reducing marine debris is instituted. •

Single-use plastic bags are banned, followed by a ban on plastic straws. • Led by UVI, the Marine Debris Action Plan is funded, along with an expansion of the Great Mangrove Clean-up to all three islands. • Additional efforts to address debris include VI Clean Coasts. NOAA MDP & stakeholders develop a Marine Debris Emergency Response Plan for the U.S. Virgin Islands.

# What's Next?

## The Marine Debris Action Plan

The USVI MDAP is a NOAA-funded effort led by the University of the Virgin Islands that provides a comprehensive framework for identifying objectives, strategies, and recommended actions to ensure that the USVI and its coasts, people and wildlife are free from the impacts of marine debris.

It is a living document that will be updated every five years. As the issues of marine debris change, so will this plan.







Participants in the 2016 Marine Debris Educators Workshop (Photo credit: Tucker Stone).



Participants in the 2nd Marine Debris Educators Workshop in March 2018 (Photo credit: Elisa Bryan).



U.S. Virgin Islands educators brainstorm improvements to the marine debris curriculum at the 2nd Marine Debris Educators Workshop in March 2018 (Photo credit: Kristin Wilson Grimes).





U.S. Virgin Islands educator, Ann Marie Gibbs, shares her Community Transfer Project experience in a panel at the 2018 Marine Debris Educators Workshop (Photo credit: Kristin Wilson Grimes).



Researchers and education and outreach professionals from the U.S. Virgin Islands presented at the Sixth International Marine Debris Conference in San Diego, CA in March 2018. From left: Danielle Lasseigne, Sennai Habtes, Howard Forbes, Jr., Kristina Edwards, Charles Grisafi (former NOAA Florida and Caribbean Regional Coordinator), and Kristin Willson Grimes (Photo credit: Nicole Rodi).



Fishing nets like this one, are a type of marine debris. The photo was taken in the St. Thomas East End Reserves, a marine protected area and NOAA priority watershed, on the east end of St. Thomas (Photo credit: Kristin Wilson Grimes).

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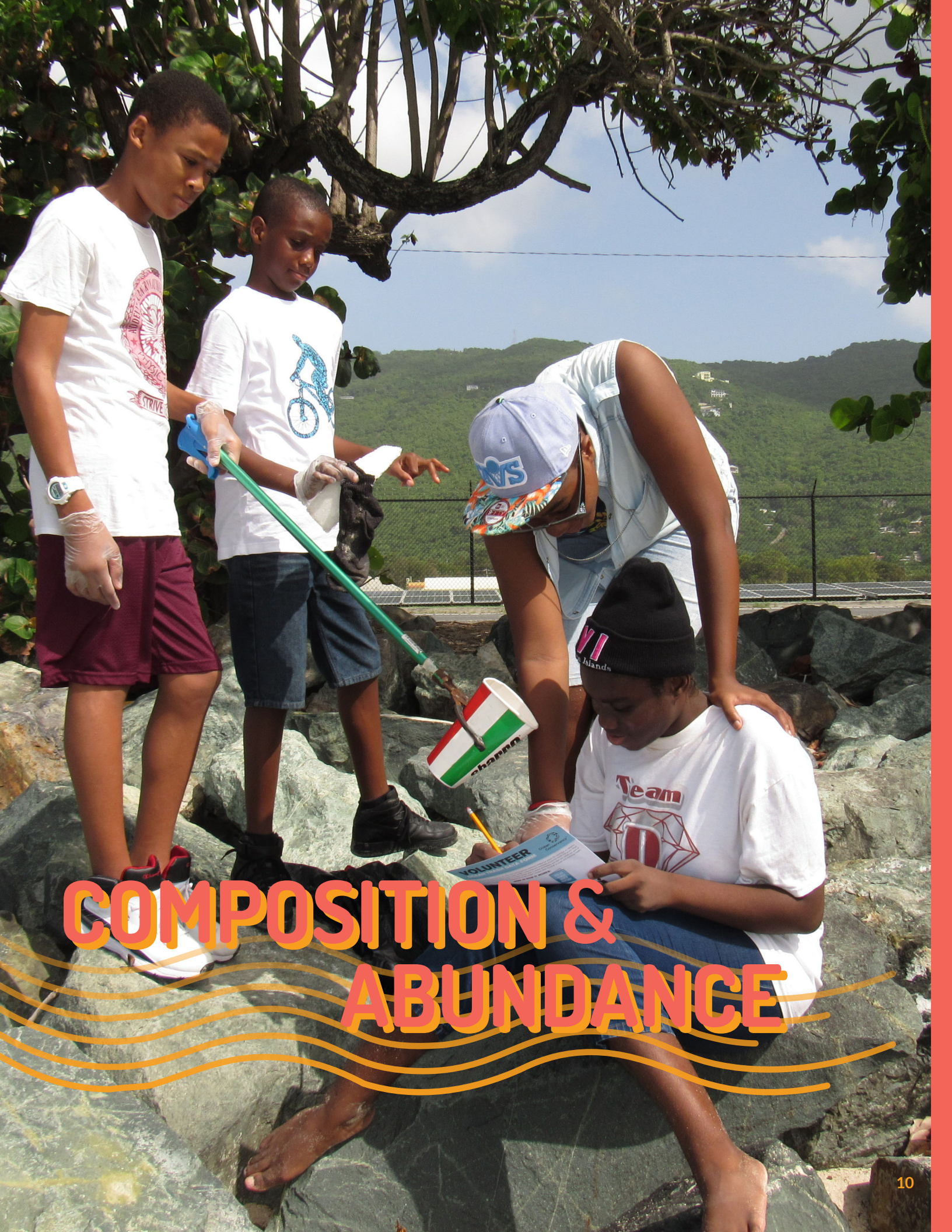
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# Links to the Next Generation Science Standards, Quick Reference Guide

Curricula by Sub-Section		Middle School						High School					Sci & Engineering Practices
		ESS 3-1	ESS 3-2	ESS 3-3	ESS 3-4	ETS 1-1	ETS 1-2	ESS 3-1	ESS 3-3	ESS 3-4	ETS 1-1	ETS 1-2	
Composition & Abundance	Beach Box Exploration			✓									✓
	Investigating Oceanic Garbage Patches			✓					✓				✓
	A Degrading Experience			✓					✓				✓
Sources & Transportation	Watershed Walk	✓		✓				✓					✓
	Sources of Microplastics: Microbeads			✓									✓
Impacts	Entanglement Problems			✓	✓				✓	✓			✓
	Natural Disasters and Marine Debris		✓	✓	✓			✓					✓
Solutions	Linked Beach-Ghut Clean Ups	✓		✓					✓				✓
	Mitigating Microplastics			✓					✓				✓
	Upcycling Plastic Bags					✓	✓				✓	✓	
	Making Connections Through Art			✓					✓				✓





# COMPOSITION & ABUNDANCE



# LESSON: Beach Box Exploration

The activities in this lesson were modified with permission from Oregon Sea Grant's "Creating and Using Beach Boxes" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/beach-boxes.pdf>).

**Grade Levels:** 5-8

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- Appendix F: Science & Engineering Practices

**Time:** Half day for beach cleanup (optional), one class period for in-class activity and discussion.

**Description & Objectives:** Utilizing field work and in-class activities, students will learn to identify, sort, and classify marine debris in the U.S. Virgin Islands. They will learn to identify and classify common marine debris through analyzing and/or collecting samples.

**Guiding Questions:**

- What is marine debris?
- Where is marine debris found?
- What physical traits do marine debris materials have in common?

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed that is then disposed of or abandoned in the marine environment.
- Marine debris exists both where we can easily see it (beaches, wrack lines on the beach) and cannot easily see it (gullies leading to the beaches or under the sand and the surface of the water).
- Marine debris is mostly plastic.
- Most marine debris comes from land-based sources (us!).

**Pre-Requisite Skills:** Students will need to understand the basics of what makes up different materials (e.g., plastics, natural materials) and the general idea of marine water movements (i.e., tidal activity, circulation).

**Teacher Preparation:** There are three options for completing this activity:

1. Students create beach boxes in class after attending a beach cleanup;
2. Students co-create beach boxes with their parents using common marine debris items found at home;
3. Teachers create the boxes for students. For classes unable to attend a cleanup prior to the lesson, fill a shoebox sized container with either decorative sand, small rocks or gravel, or dirt and a variety of debris materials that are found on territory beaches. Make enough beach boxes so groups of 3-5 students can explore each box.

**Materials Needed:**

- Classroom set of shoebox-sized containers with lids (plan for 3-5 students to one container)
- Gloves (each student needs at least one)
- Tweezers and magnifying lenses
- Marine debris (collected by students in options 1 & 2 or by teacher in option 3, prior to the lesson):
  - Items should be representative of the debris commonly found in the area (plastic bottles/packaging/caps, metal pieces/bottle caps, fishing line/rope, rubber, food packaging/wrappers/bags, cigarette butts, straws, misc. small plastic pieces)
- Natural products (collected by students in options 1 or 2 above, or by teacher prior to the lesson):
  - Items should be representative of the natural debris commonly found in the area (dried algae, shells, seeds, leaves, coconut husks, food waste, woody debris)
- Hand soap or hand sanitizer to be used after beach cleanup activity or after making the beach boxes
- Debris sorting worksheets and pencils (1 per group, at end of lesson instructions)
- Additional boxes, paper plates, or trays for sorting debris

**Teacher Instructions:** This activity is intended to be an engagement and introductory lesson to marine debris. As such, there is no formal worksheet associated with this activity. However, you should encourage your students to make notes about what types and how much marine debris they find and to record their observations about what they are seeing. This can be done on loose leaf paper or in a formal lab notebook. There are three options for completing this activity.

In-class discussion: Start by having an in-class discussion about what makes up marine debris.

- **Guiding Questions:** What do you think marine debris is? Do people in the Virgin Islands need to worry about this or not? Where can you find marine debris? What or who do you think creates marine debris in the Virgin Islands?

Create beach boxes (this can be done in 3 ways):

1. *Students create their own boxes at a beach cleanup.* Have the students attend a beach cleanup. While at the beach give a shoebox to each small group (3-5) of students and ask them to collect things they are seeing/finding on the beach. Additional directions:
  - a. Try to reduce the amount of sand collected. Have students shake off items before placing them in the bin.
  - b. Instruct students to collect both marine debris items and natural products representative of what's actually on the beach (see the "Materials Needed" list above for examples).
  - c. Safety check:
    - i. Give students gloves for handling debris and bring hand sanitizer/soap to clean up with afterwards
    - ii. Avoid dead things, sharp or hazardous objects (glass/metal), fishing hooks, and personal hygiene items.
2. *Students create their own boxes with their families at home.* Provide students with an empty shoe box or reusable container to take home. Together with their family, students add items to the box that they think are marine debris. Students can be given a few days to gather enough supplies.
3. *Teacher creates boxes for the students to use in class.* For classes unable to attend a cleanup prior to the lesson, fill a shoebox-sized container with either decorative sand, small rocks, gravel, or dirt and a variety of debris materials that are found on territory beaches. Make enough beach boxes for groups of 3-5 students to explore.

Beach box sorting: In the classroom, using gloves and additional boxes, plates, or trays, have each group sort debris from a beach box into two piles: human-made and natural materials. If boxes were acquired by the students, have the groups trade boxes so that they are not sorting their own materials. When sorting is done, have a discussion about their debris groupings.



An example of sorting boxes used where participants sorted marine debris (left) versus natural debris (natural) items (right) (Photo credit: Howard Forbes, Jr.).

An example of a beach box used at the STEAM Fair hosted by the Department of Education. This box contains sand on the bottom along with commonly found items during beach cleanups in the U.S. Virgin Islands (Photo credit: Howard Forbes, Jr.).



- **Guiding Questions:** What makes something human-made vs. natural? How can you tell when you find something which type of debris it is? What traits (evidence) did you use to decide this? Which piles seem to have more debris?

After sorting between human-made and natural materials, students sort the human-made materials by physical characteristics using the Marine Debris Sorting Worksheet. Ask them to record how many of each type they obtain.

- **Guiding Questions:** What characteristics/traits did you use to determine what made something marine debris? Did you detect any similarities or patterns in things in your box? Were you surprised to find objects in the box? How do you think your items got on the beach?

Teacher Notes:

- Some areas require special permission to walk through and collect data. If you are doing a beach cleanup, find out if the beach is in a protected area or if access is part of a private property. You may need to get special permits or permission to have cleanups in



- *Following the activity, materials can be responsibly discarded according to waste disposal guidelines, or they may be stored for repeated use of this activity with other classes or for another activity with the same class (See Lesson: Making Connections Through Art).*
- *For more information about marine debris researchers and trends in the U.S. Virgin Islands, please see Researcher Spotlight: Zola Roper, Masters of Marine & Environmental Science student, University of the Virgin Islands and Spotlight: Common Marine Debris Items in the U.S. Virgin Islands.*



U.S. Virgin Islands educators and University of the Virgin Islands Masters of Marine & Environmental Science alumni, Akacia Halliday, explore beach boxes with Howard Forbes, Jr. St. Thomas/St. John Coordinator for the Virgin Islands Marine Advisory Service, at the 2016 Marine Debris Educators Workshop (Photo credit: Kristin Wilson Grimes).



A variety of natural and marine debris items from Hassell Island (Photo credit: Kristin Wilson Grimes).



# Marine Debris Sorting Worksheet

Use this worksheet to sort your sample into the following eight categories.  
(Most appropriate for debris <2.5cm)

## Fragments



Pieces of hard plastic

## Pellets



Pre-production plastic pellets

## Foams



Polystyrene, insulation, etc.

## Films



Pieces of bags or wrappers

## Cigarette Parts



Cigarette butts and filters

## Filament



Fishing line, rope, synthetic cloth

## Glass



Glass fragments and shards

## Other



Rubber, metal, other debris

**How many object from each category did your sample contain?**

\_\_\_\_\_ Fragments

\_\_\_\_\_ Foams

\_\_\_\_\_ Pellets

\_\_\_\_\_ Films

\_\_\_\_\_ Filament

\_\_\_\_\_ Cigarette Parts

\_\_\_\_\_ Glass

\_\_\_\_\_ Other

# SPOTLIGHT

## Zola Roper, former Masters of Marine & Environmental Science student, University of the Virgin Islands

My name is Zola Roper. I was born and raised on the island of St. Thomas, U.S. Virgin Islands. My first years of schooling were spent at various public elementary, junior, and senior high schools and I went to the University of the Virgin Islands (UVI) for my undergraduate degree. Currently, I am a graduate student in the Master's of Marine & Environmental Science Program at UVI. The focus of my thesis research is marine debris, a pervasive and important local environmental issue, that hits close to home. My thesis examines spatial and temporal trends in a historical, territory-wide, citizen science-collected marine debris data set. This marine debris data set, amassed by the Virgin Islands Marine Advisory Service and Ocean Conservancy, spans over the past 30 years (1988-2016). You or your students, might have even helped to collect some of these data through the Coastweek Cleanups that happen every fall!

Previously, no one had completed a comprehensive analysis of these marine debris data. My research will answer important questions about U.S. Virgin Islands marine debris abundance, distribution, sources, and transport. More information about U.S. Virgin Islands marine debris patterns could lead to new and better solutions to this problem for the Territory, including changes to policy and human behaviors to prevent marine debris production.

In the Fall of 2019, I participated in a two-month internship with NOAA's Marine Debris Program (MDP) at NOAA headquarters in Silver Springs, MD, funded by the National Science Foundation. I was drawn to the MDP because their expertise would provide me with the opportunity to (1) augment my current academic research training with non-academic internship and training opportunities, and (2) allow me to pursue new activities centered around acquiring professional development experience that would help prepare me for multiple career pathways after graduation, such as potentially working for a federal agency.



Zola Roper, Graduate Student at the University of the Virgin Islands, participated in NOAA's Nancy Foster research cruise around the U.S. and British Virgin Islands in June 2018 (Photo credit: Vanessa McKauge).

During my two months, I participated in and led ongoing projects within MDP. The very first week of my internship I participated in the Marine Debris Operational Meeting located in Delaware, where I was able to meet the whole MDP team in person and learn about strategic planning and ongoing projects. Following the Operational Meeting, I dove into the Marine Debris Art Contest which included mailing out the 2020 art contest calendars and preparing congressional letters for Senators and Representatives with contest winners in their state. I also began preparing a marine debris dataset to be displayed on Science on a Sphere (SOS) which included summarizing various scientific studies, as well as having fun learning more about SOS itself. A large focus for the Communications Team is sharing the work of the MDP and its partners with the public through a variety of channels. For example, as part of this Team, I wrote a blog about the new updates to, and successes of, the Marine Debris Tracker App. During the last weeks of my internship, I took on the task of submitting weekly summaries of MDP team member activities to NOAA's Office of Response and Restoration. Finally, I had the unique chance to volunteer at the 2019 International Coastal Cleanup at Kingman Island, Washington D.C., learn about the Marine Debris Monitoring and Assessment Project protocols, and participate in interviews for the John A. Knauss Marine Policy Fellowship Program (<https://seagrant.noaa.gov/Knauss-Fellowship-Program>) placement week. This Fellowship matches highly qualified graduate students with "hosts" in the legislative and executive branch of government located in the Washington, D.C. area, for a one year paid fellowship.



As I reflect on my experience with MDP, I would like to highlight that my time as an intern was truly wonderful. I had the opportunity to learn and be involved with such an enthusiastic, collaborative, and supportive program under NOAA. It was exciting having the chance to network, not just with members of MDP, but also with other NOAA staff both in Silver Spring and other locations. Finally, it was amazing being able to participate in activities that are so important in the current marine efforts worldwide and right here, in the U.S. Virgin Islands.

For more information about some of the topics mentioned in Zola's spotlight, please visit the websites below:

- NOAA's marine debris art contest: <https://marinedebris.noaa.gov/outreach/artcontest.html>
- NOAA's science on a sphere: [https://sos.noaa.gov/What\\_is\\_SOS/](https://sos.noaa.gov/What_is_SOS/)
- Blog: Marine Debris Tracker App Reaches a Data Milestone: <https://blog.marinedebris.noaa.gov/marine-debris-tracker-app-reaches-data-milestone>
- Marine Debris Tracker App: <https://marinedebris.noaa.gov/partnerships/marine-debris-tracker>
- NOAA's Marine Debris Monitoring & Assessment Project: <https://marinedebris.noaa.gov/research/monitoring-toolbox>
- NOAA's John A. Knauss Marine Policy Fellowship Program: <https://seagrant.noaa.gov/Knauss-Fellowship-Program>



# SPOT LIGHT

## Common Marine Debris Items in the U.S. Virgin Islands

Recently, former University of the Virgin Islands Masters of Marine & Environmental Science student, Zola Roper, has examined more than 30 years of marine debris data collected by the U.S. Virgin Islands community during beach cleanup events associated with Virgin Islands Marine Advisory Service Coastweek events, which happen every fall. Data are for beaches on the islands of St. Thomas, St. John, and St. Croix, so they provide a good picture of marine debris trends across the territory.

What are the most abundant marine debris items we find along the territory's beaches? Well, when you look at the data from 2012-2016 (the years for which we have the most recent data), you find that the most abundant marine debris items are pretty much the same, year after year: beverage bottles (glass or plastic), bottle caps (metal or plastic) and food wrappers (See Figure 1). The bad news? We find A LOT of these items - thousands of them in any given year. The good news? Most marine debris globally, comes from land-based sources and the data for the U.S. Virgin Islands certainly supports that trend. That means we have a shot at reducing marine debris in the territory if we consume fewer single-use items (like plastic beverage bottles), and make sure that the waste we create gets disposed of properly in waste bins, rather than left on the beach, thrown out a car window, or tossed on the ground. This includes properly disposing of waste at important public cultural events like Carnival and the St. Croix St. Patrick's Day Parade. We can make a difference, if we all do our part!

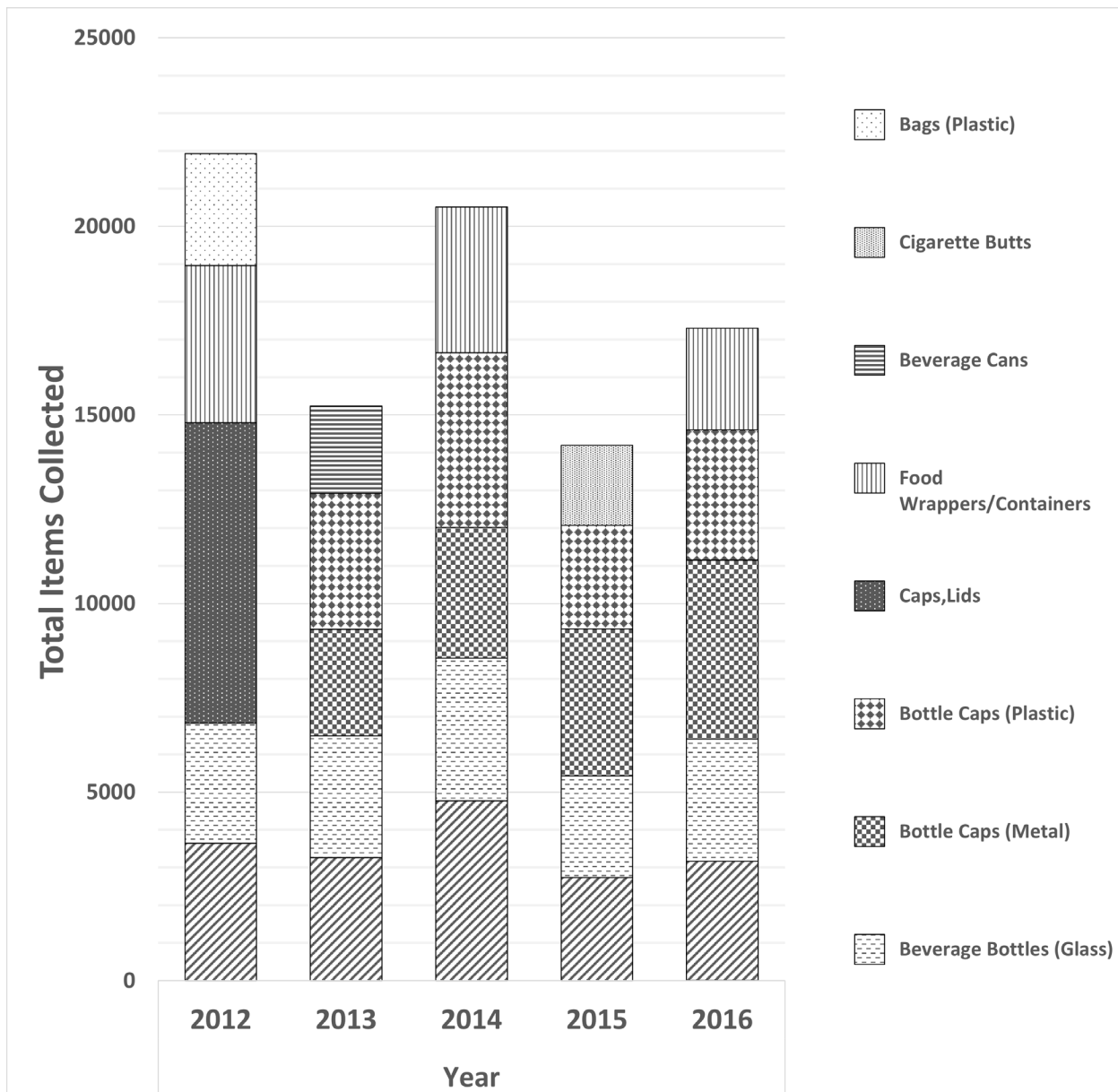


Metal bottle caps, like this one pictured at Magen's Bay on St. Thomas, are a commonly-found marine debris item on U.S. Virgin Islands beaches (Photo credit: Kristin Wilson Grimes).



Important cultural events like Carnival on all three islands and the St. Patrick's Day Parade on St. Croix (pictured), have the potential to produce marine debris, if trash items are not properly disposed of in waste bins (Photo credit: Kristin Wilson Grimes).





The total number of marine debris items collected from U.S. Virgin Islands beaches for the years 2012-2016. Only the top 5 items (by number) found in each year are included here, for simplicity (Figure courtesy of Zola Roper, data from the International Coastal Cleanups for the U.S. Virgin Islands).

# LESSON: Investigating Oceanic Garbage Patches

This lesson was modified with permission from Oregon Sea Grant's "Investigating the Great Pacific Garbage Patch" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum (<https://oregoncoaststem.oregonstate.edu/marine-debris-steamss/md-grades-9-12/composition-and-abundance>).

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Appendix F: Science & Engineering Practices

**Time:** 1-2 class periods

**Description & Objectives:** Students will learn about what happens to floating marine debris (surface, near surface, and in the water column) that doesn't get collected during beach cleanups. They will apply knowledge of oceanic water movement to understand why trash gets trapped in specific areas in the Atlantic and Pacific Oceans. Students will interpret maps published in news articles. This also tests students reading comprehension skills.

**Guiding Questions:**

- What is marine debris?
- Where is marine debris found?
- What physical traits do marine debris materials have in common?

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Marine debris exists both where we can easily see it (beaches and wrack lines on the beach) and cannot

easily see it (ghuts leading to the beaches, in the sand and on or under the surface of the water).

- Marine debris is mostly plastic.
- Most marine debris comes from land-based sources (us!).

**Pre-Requisite Skills:** Students will need to understand the basics regarding the chemical makeup of plastic and a basic understanding of ocean circulation.

**Teacher Preparation:**

- To prepare for this topic, it may be good to review a few articles about oceanic garbage patches and the NOAA Garbage Patches Fact Sheet (included).
- There has been some misinformation about oceanic garbage patches. Some individuals tend to over-hype the size of the patches. While sizable and not a natural part of the environment, you cannot see the patches from a satellite, nor are they the size of Texas, nor can you walk across them (particles are dispersed through the upper part of the water column).
- Additionally, it may be helpful to review basic ocean circulation. The Boundary Currents page of the NOAA National Ocean Service provides a great refresher on the forces that create Oceanic Gyres (included). However, the entire tutorial may be a useful resource for you if you wanted to cover currents in more detail in your classroom.
- Students will read a news article about plastics then answer a worksheet about it.

**Materials Needed:**

- NOAA Garbage Patches Fact Sheet (included at the end of this lesson)
- Oceanic Garbage Patch Worksheet (included at the end of this lesson)
- Computers for students to access this map, or color-printouts for them to reference: <https://bigblueorb.files.wordpress.com/2011/03/atlantic-trash-chart2.jpg>
- Transport of Coral Tree after Hurricanes - VI EPSCoR: <https://viepsscor.com/news/2017/12/22/coral-tree-found>
- Video Links
  - "Ocean Heroes: What is a Gyre?", One World One Ocean: <https://www.youtube.com/watch?v=h6i16Crl8ss>
  - "What's An Ocean Garbage Patch?", Discovery: <https://www.youtube.com/watch?v=J-gqJAsXiKQ>
  - "TRASH TALK: What is the Great Pacific Garbage Patch?", NOAA Marine Debris Program: <https://>



[marinedebris.noaa.gov/videos/trash-talk-what-great-pacific-garbage-patch-0](https://marinedebris.noaa.gov/videos/trash-talk-what-great-pacific-garbage-patch-0)

- “The Ocean Cleanup launches to the Great Pacific Garbage Patch”, CNET: <https://www.youtube.com/watch?v=nYC4Q-0wcAc>
- “How the oceans can clean themselves: Boyan Slat at TEDxDelft”, TEDx Talks: <https://youtu.be/ROW9F-c0klQ>. The Ocean Cleanup Project Founder Discussing Developing the Idea. This project was developed by an undergraduate student pictured in the TED talk above and can serve as an inspiration for students to pursue their ideas.

**Teacher Instructions:** This lesson will help engage students with understanding what happens to plastic marine debris that isn’t collected and reused, recycled, or disposed of properly.

**In class discussion/lesson:** Have a conversation with your students. Share the following information with them:

- There is a great deal of information and misinformation about how much marine debris exists in the open ocean and how it is distributed.
- There are oceanic garbage patches in both the North Pacific and North Atlantic Oceans that are being studied by scientists. Often, it is said that “The Pacific Garbage Patch is twice the size of Texas,” but scientists don’t actually know for certain how large it is, because it is constantly moving and the amount of marine debris is changing day by day.

Use videos:

- To introduce the idea of oceanic garbage patches: <https://www.youtube.com/watch?v=J-gqJAsXiKQ>
- To explore how water flows around the globe: <https://www.youtube.com/watch?v=h6i16Crl8ss>
- To understand how some microplastics move through the oceans: <https://marinedebris.noaa.gov/videos/trash-talk-what-great-pacific-garbage-patch-0>

After watching any of the videos, review (or teach) how water moves around the globe (earth movement and wind patterns contribute to the way water flows).

**Reading & worksheet (in class or as homework):** Provide students with the NOAA Garbage Patches Fact Sheet (<https://marinedebris.noaa.gov/fact-sheets/garbage-patches-fact-sheet>; also included at the end of this lesson) and have students read the article “Massive North Atlantic Garbage Patch Mapped” (<https://www.wired.com/2010/08/atlantic-plastic/>) and/or the “Garbage Patches” (<https://marinedebris.noaa.gov/info/patch.html>) informational page from the NOAA Marine Debris Program.

The links to these websites are available here:

- NOAA Garbage Patches Fact Sheet: <https://marinedebris.noaa.gov/fact-sheets/garbage-patches-fact-sheet>
- Massive North Atlantic Garbage Patch Mapped: <https://www.wired.com/2010/08/atlantic-plastic/>
- Garbage Patches: <https://marinedebris.noaa.gov/info/patch.html>

Then have the students complete a worksheet (note: there is a different worksheet for grades 9-12).

**Assignment follow-up:** After your students have completed the worksheet (either in-class or as homework) use these **guided questions** to have a discussion. You can summarize their answers on the blackboard/whiteboard.

- Why do you think some people may exaggerate the size or extent of the garbage patches? Lead them to think about how this can cause misconceptions about the problem of marine debris and what it looks like (for instance there are more microplastics, but people tend to focus more on macroplastics).
- Ask students to think about ways in which plastic or debris from the U.S. Virgin Islands could end up in the North Atlantic Garbage Patch. Do they think this is possible? How?

Invite students to read the short VI EPSCoR program blogpost on the transport of a coral nursery tree (made mostly from plastic) from the U.S. Virgin Islands to the Bahamas after Hurricanes Irma or Maria (<https://viepscor.com/news/2017/12/22/coral-tree-found>). Then, lead a discussion with them:

- **Guided questions:** Ask students to reflect on how this method of transport compares to those they just learned about. This is a good opportunity to lead a discussion on what the important forces are that concentrate marine debris in oceanic gyres (use information from the NOAA National Ocean Service Boundary Currents page to help inform your discussion ([https://oceanservice.noaa.gov/education/tutorial\\_currents/04currents3.html](https://oceanservice.noaa.gov/education/tutorial_currents/04currents3.html))).

Ask students to brainstorm ways to convey the problem of marine debris to others in ways that are both compelling, yet based on accurate information:

- Students could write up their own news story about marine debris for the school paper.
- Students could write a script for a radio station PSA about marine debris locally to be played on their school radio station or during the daily announcements.
- Students could create an infographic to hang somewhere in the school to educate other classes.

Another discussion option is to ask students to brainstorm ways to keep the ocean's gyres clean. You can either use the videos below to stimulate conversation in your class or use the videos to reinforce or contrast the suggestions made by students in your class.

- About The Ocean Cleanup Project: <https://www.youtube.com/watch?v=nYC4Q-0wcAc>
- The Ocean Cleanup Project Founder Discussing Developing the Idea: <https://youtu.be/ROW9F-c0klQ> This project was developed by an undergraduate student pictured in the TED talk above and can serve as an inspiration for students to pursue their ideas.

Additional activities for grades 9-12: Ask your students to research the issue further. Have students investigate the location and composition of the five ocean gyres. Then, lead them in a discussion using the following guided questions:

- Does water stay in its own gyre or does it move around the globe? How can they tell?
- What does this mean in terms of plastics found in the different gyres?
- Have them look up the differences in the size (surface area and depth) of the five different garbage patch gyres. How are the patches similar and different? Is there enough information to answer the question? What research needs to be done? (worksheet included)

Teacher Note:

For more information about plastics in local U.S. Virgin Islands waters, please see Spotlight: Plastics in the Water.



View of the coastal waters of St. Thomas from Hassel Island (Photo credit: Kristin Wilson Grimes).



## Oceanic Garbage Patch Worksheet

1. Where is the North Atlantic Garbage Patch in relation to the USVI (North, South, East or West)?

Go to the following web address to view a map of plastic collected in the Atlantic Ocean:

<https://bigblueorb.files.wordpress.com/2011/03/atlantic-trash-chart2.jpg>

Warmer colors on this map (red, orange and yellow) indicate where scientists have found high concentrations of plastic. The black-line contour indicates the boundary of the North Atlantic subtropical gyre: a part of the ocean bordered by strong currents that collectively flow clockwise. Most of the trash collected (83%) was found within the North Atlantic subtropical gyre. Within the gyre, water moves slowly (~2 cm/second).

Use the map image to answer the following questions.

2. If the distance between 20°N and 30°N is approximately 680 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? \_\_\_\_\_

a. How can you tell? \_\_\_\_\_

3. If the distance between 70°W and 60°W is approximately 650 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? \_\_\_\_\_

a. How can you tell? \_\_\_\_\_

4. Why is it important for the researchers mapping the North Atlantic Garbage Patch to collect data for multiple years? \_\_\_\_\_

5. What impacts do you think having a moving 'garbage patch' so close to the USVI means for marine life and people who need the marine environment to survive? \_\_\_\_\_

## Oceanic Garbage Patch Worksheet 9-12

1. Where is the North Atlantic Garbage Patch in relation to the USVI (North, South, East or West)?

Go to the following web address to view a map of plastic collected in the Atlantic Ocean:

<https://bigblueorb.files.wordpress.com/2011/03/atlantic-trash-chart2.jpg>

Warmer colors on this map (red, orange and yellow) indicate where scientists have found high concentrations of plastic. The black-line contour indicates the boundary of the North Atlantic subtropical gyre: a part of the ocean bordered by strong currents that collectively flow clockwise. Most of the trash collected (83%) was found within the North Atlantic subtropical gyre. Within the gyre, water moves slowly (~2 cm/second).

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3. If the distance between 70°W and 60°W is approximately 650 miles, how far is the densest part of the NA Garbage Patch from the USVI, approximately? \_\_\_\_\_
- a. How can you tell? \_\_\_\_\_
4. Think about what you've learned about water currents; can marine debris from the U.S. Virgin Islands end up in the North Atlantic Garbage Patch? Why or why not? \_\_\_\_\_
- a. What about the Pacific Garbage Patch? Why or Why not? \_\_\_\_\_
5. What impacts do you think having a moving 'garbage patch' so close to the USVI means for marine life and people who need the marine environment to survive? \_\_\_\_\_



6. How can the way marine debris is described sometimes lead to people developing misunderstandings about topics that are really important to marine communities?

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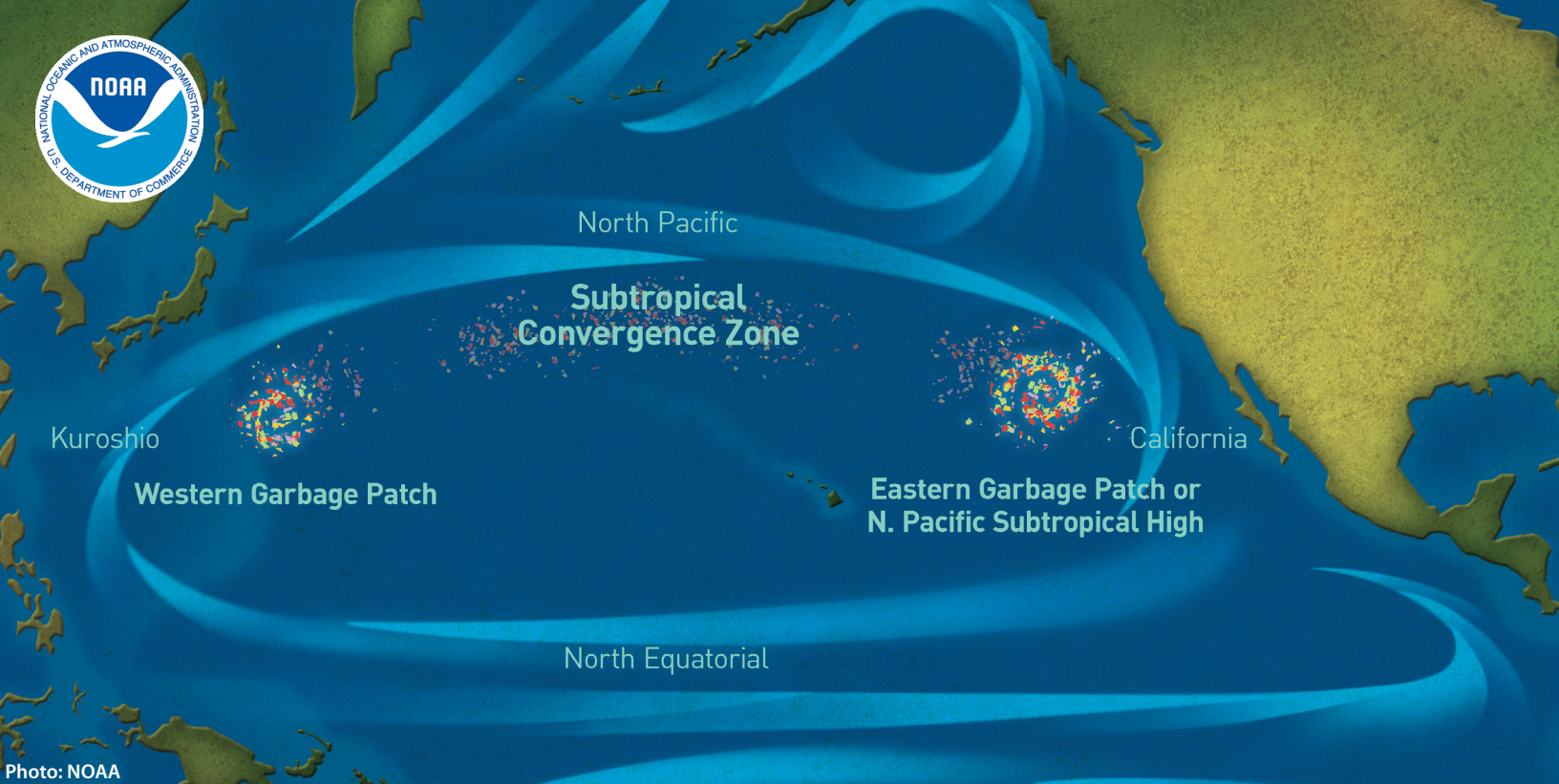
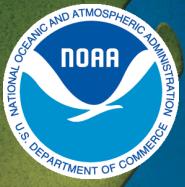


Photo: NOAA

# What are Garbage Patches?

The term 'garbage patch' is a misleading nickname for areas of the open ocean where man-made litter and debris accumulate. Although many believe that garbage patches are "islands of trash" that are visible from afar, these areas are actually made up of small plastic pieces, called microplastics, that are easily missed at first glance, or bundles of derelict fishing gear. This debris is always moving due to winds and currents, causing the garbage patches to constantly change size and shape. The items making up the garbage patches can be found from the surface all the way to the ocean floor.

Garbage patches are created from rotating ocean currents called gyres. These currents pull debris into a centralized location, forming 'patches' where marine debris accumulates. Although these patches exist around the world, the most well-known is the 'Great Pacific Garbage Patch,' located between California and Hawaii in the North Pacific Subtropical High.

## What are the impacts of garbage patches?

Large accumulations of marine debris can threaten wildlife through entanglement, ingestion, and ghost fishing, and can be a hazard to ocean vessels by clogging engines and propellers. More research is needed to fully understand the specific impacts of garbage patches on both humans and the environment.





## Why don't we just clean up the garbage patches?

Cleaning up marine debris found in the open ocean is not as simple as it may sound. The NOAA Marine Debris Program instead focuses on the prevention of marine debris, as well as removal from coastlines where debris is more accessible. Cleaning the open ocean would be challenging for several reasons:

**Things keep moving.** The areas where debris accumulates move and change throughout the year as wind and water currents shift.

**They're really big.** These accumulations of debris are usually very large and debris is unevenly distributed from the surface of the water all the way to the ocean floor.

**Most of the debris is tiny.** The garbage patches are composed mainly of microplastics, bits of plastic that are five millimeters or less in size. Because of their small size, microplastics can't be easily removed from the water column.

**It would cost a lot.** Collecting and transporting marine debris from the open ocean to shore for disposal could be very costly. Resources can go much farther when removal is focused along the coast.

## How YOU can help!

The best way to prevent large accumulations of debris from getting larger is to stop debris from entering the ocean in the first place.

### GET INVOLVED

and participate in local cleanups in your area.

### REMEMBER

that our land and sea are connected.

### DISPOSE OF WASTE PROPERLY

no matter where you are.

### REDUCE

the amount of waste you produce.

### REUSE

items when you can. Choose reusable items over disposable ones.

### RECYCLE

as much as possible! Bottles, cans, cell phones, ink cartridges, and many other items can be recycled.



# SPOTLIGHT

## Plastics in the Water

Much of our efforts towards removing marine debris are focused on the areas where we can directly see their impacts - like the coastline and the ocean surface. However, as plastic is becoming ever more present in our society, it is also becoming ever more present in the parts of the ocean that we don't see. In places like the North Atlantic or North Pacific Gyres, there are large amounts of plastic debris, much of it located below the surface as small pieces that are often invisible to the naked eye. These small pieces of plastics are called microplastics and they pose a significant problem to the organisms that we also cannot often see with the naked eye. These are part of a group of organisms called plankton which are a mix of plants, crustaceans, and fish among others, that live throughout the upper part of the ocean, and drift with currents as they are not large enough or strong enough to swim against them. They form the base of the food chain in the ocean; everything that feeds in the ocean in some way ingests either these organisms or something that has eaten them. Zooplankton, or the animals that fit into this category, are at risk of consuming microplastics as they are often the same size and shapes as the phytoplankton they eat. Plastics eaten by these organisms can eventually end up in the fish we eat.

Some of the more common types of zooplankton collected during the Brewers Bay Mare Nostrum Ecosystem Analysis Project zooplankton sampling. Because microplastics are similar to the size of the food that these animals eat, they can be confused as food and reduce the ability of these organisms to feed (Photo credit: Mara Duke).



The Neuston net used to collect zooplankton during the Brewers Bay Mare Nostrum Ecosystem Analysis Project sampling. Along with zooplankton, we often found microplastics, particularly plastic rope fibers and plastic fragments (Photo credit: Mara Duke).

As part of a one-year survey to understand the different types of zooplankton found in the waters surrounding Brewers Bay, University of the Virgin Islands (UVI) Masters in Marine and Environmental Science graduate student, Mara Duke, collected, preserved, counted, and identified the zooplankton in the upper 10 meters of the water column at 22 locations in Brewers Bay, St. Thomas, using a net towed behind a UVI research vessel. In addition to discovering patterns in different types of zooplankton and how the abundance of individual species were driven by seasonal differences in environmental variables, like temperature and salinity, she also often found a variety of microplastics in her samples. The most common types of microplastics she found were small plastic fibers and fragmented pieces of plastic. These likely originated from coastal debris, like single-use plastic bottles or straws which can degrade on shore and become brittle and break into much smaller pieces; or from polypropylene ropes, the bright yellow ropes commonly used in recreational boating, commonly called "polypro", that over time slowly break down and form small fibers floating in the ocean. The fibers may also have been the result of the synthetic clothing most of us wear. All of these materials are now common sights in the marine environment and are representative of how small choices we make can lead to large issues in the marine environment. Remember, even if we cannot see it, marine debris can impact all organisms in the ocean, big or small. Making the right choices in the products we use can help limit the amount of marine debris, especially plastics entering into our marine environment.





View of U.S. Virgin Islands coastal waters around St. John from Ram's Head (Photo credit: Kristin Wilson Grimes).



# LESSON: A Degrading Experience

This lesson is sourced from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience," (<https://marinedebris.noaa.gov/turning-tide-trash>). Most of the guiding questions in this lesson are taken directly from the NOAA lesson. The lesson has been modified to include locally-relevant examples.

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Appendix F: Science & Engineering Practices

**Time:** The duration of this lesson is approximately two months. This includes two, 40-minute class periods to introduce and set up the experiment, followed by a small amount of time (~10 min) each class to record data at several points over the subsequent two months.

**Description & Objectives:** In this activity, students will investigate how long it takes different types of debris to degrade and how weather and sunlight affect the breakdown rate. Students will learn how degradation rates impact how long debris persists in the environment. Students will learn the difference between human-made and natural materials.

**Guiding Questions:**

- What is marine debris?
- What physical traits do marine debris materials have in common?
- How do different physical processes affect the breakdown of human-made and natural materials?

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Marine debris is mostly plastic.

- Most marine debris comes from land-based sources (us!).
- Natural items and marine debris items degrade and break down over time, but at different rates, especially under different environmental conditions.

**Pre-Requisite Skills:** Students will need to understand the basics of what makes up human-made and natural products. Students will also need to understand the earth science cycles: water, nitrogen, carbon, etc., and how science is a process.

**Teacher Preparation:**

- Take care to clean/check trash for safety issues (i.e., sharp objects/materials and harmful chemicals).
- Part of this experiment takes place outside. Scout a location that will not encourage wildlife interference, such as a second floor balcony, nor one that will be interfered with by other people.

**Materials Needed:**

- Assorted pieces of trash in pairs. The following kinds of trash are recommended: two apple cores, two paper bags, two plastic bags, two candy wrappers, two plastic cups, two waxed-paper cups, two drink boxes and straws, two paper eggs cartons, two foam plastic egg cartons, two pages of newspaper, two foamed plastic packing peanuts, two starch packing peanuts, two six-pack rings, two steel cans, and two glass bottles.
- Two transparent containers covered with a net or screen (reduces windblown trash and discourages wildlife).
- Two pieces of rope or string, outdoor thermometer, and newspaper.
- Gloves, tongs, and additional cardboard and newspaper for removing and examining the trash pieces.
- Balance or scale to measure mass of each item, at beginning and end of experiment (optional).
- Optional - Create a model of one complete experimental set-up depending on how much guidance you want to give students.
- Data sheets (included at end of lesson) for inside and outside experiments.



**Teacher Instructions:** This is a long-term class science experiment.

In class discussion/lesson: Tell students they are starting a long-term class experiment to learn about trash degradation.

Talk with them about what degradation is, using the following guiding questions:

- What are the signs of degradation of different objects (changes in shape, color, and size)? How would you measure degradation (length, weight, color charts, etc.)? What abiotic (non-living) factors cause something to degrade? Guide students to think about the amount of sun, wind, rain, and heat to which the items are exposed and how those might impact degradation. What biotic factors cause something to degrade? Guide students to think about animals, insects and microorganisms that may eat or use organic materials.
- **Teacher Note:** *“The loss of an item’s ability to withstand being pulled apart also is an important sign of degradation, but this only should be evaluated at the end of the experiment so that the natural degradation process is not accelerated” (NOAA).*

Experimental set-up & data collection:

1. Have students fill both containers halfway with water. Make sure one of each type of trash is put in each container. As the students are building the containers, discuss why the experiment is being set up the way it is.
  - Depending on how you are having students measure degradation, you will want them to measure, weigh or otherwise assess the objects before putting them in the containers.
  - **Guiding questions:** Why are we putting the same type of item in each container? Would we be able to compare the things that affect degradation and persistence if we were comparing apples outside to oranges inside? Guide students into thinking about the importance of control variables in experimental design.
2. Cover one of the containers with a net or screen and secure with the rope or string. Label the container and put it outside in a sunny area where it won’t be disturbed by people or animals, but is also secure (e.g., think about the storms that occur in the territory and make sure the container is in a sheltered enough place that it will not blow away). Put the second container in the classroom in an undisturbed area with a sign cautioning other students and school employees that it is a school project.
3. On the data sheets (included at the end of this lesson) have a student record weather conditions (outdoor temperature, type, percent of cloud cover, and precipitation) each day. You may consider using the data sheets as class data stored on a clipboard near the indoor container.
  - If your school has a weather station from the Water Ambassadors Program or the Virgin Islands Water Resources Research Institute, use that station to record outside air temperature and precipitation.
  - If not, use a thermometer to measure outside air temperature and a rain gauge to measure precipitation. No rain gauge, no problem! Create a qualitative precipitation scale with your students: this could be as simple as, did it rain today or not? Or it could include multiple categories (e.g., no rain, light rain, heavy rain). It is up to you to decide how to measure this and how to measure can be a good discussion topic for students.
    - **Teacher Note:** *Add a second thermometer to measure inside air temperature. Add this variable to your data collection and analyses and compare to outside air temperatures when examining the final experimental results for added, interesting discussion.*
  - To measure cloud cover, you can use multiple options depending on the amount of time and resources available:
    - Use a weather website to determine how much sunlight was recorded on the island that day.
    - Build a cloud cover estimator (see: Measuring Cloud Cover) and have students estimate the percentage based on the number/amount of the quadrants covered.
      - Measuring Cloud Cover: [https://www.sserc.org.uk/wp-content/uploads/2012/04/Resource-2\\_2-Measuring-Cloud-Cover.pdf](https://www.sserc.org.uk/wp-content/uploads/2012/04/Resource-2_2-Measuring-Cloud-Cover.pdf)
  - **Teacher Note:** *You may need to continually refresh students about why we record data in metric not imperial measurements, why actual measurements are usually better than estimates, how both quantitative and qualitative data can be useful, etc.*
4. Every week (for a minimum of two months), have the class observe the changes in the trash items, both in the indoor and the outdoor containers. Have different students fill in the “Degradation Data” handouts every week.
  - **Teacher Note:** *You can use a camera to take weekly pictures of the containers as a record. If you do this, make sure you have a card with the date on it to remember when the photo was taken or re-name the digital image, appropriately. This is a good time to discuss with students about why you might want to take pictures when possible (e.g., reducing bias, possibility for quantifying change over time using image processing techniques).*

In class activity & discussion: what did they find?

1. At the end of the experiment, remove the contents from the two containers and spread over a tablecloth or newspaper. Make sure to have different sections for the inside and outside container. If you had students measure, weigh, or assess the trash at the beginning, make sure they measure, weigh, or assess the trash in the same way now.

2. As students are removing the items, have them compare the visible differences between the “indoor” and “outdoor” pieces of trash. Students should try to pull apart the trash to determine if there is a difference in strength between the “indoor” and “outdoor” pieces.
  - **Guiding questions:** Which pieces of trash have degraded? Does the location (outside or inside) affect if and how the trash was degraded? If so, how much? What types of trash (paper, plastic, food) were degradable? Which types were persistent? Do you think how an object degrades determines if it is found in the marine environment?

#### Assessment and evaluation:

- Have the students develop a hypothesis on whether the degradability of an object affects how marine debris develops.
  - UPSCALE: Have students make a prediction and design an experiment to test their hypothesis.
- Have students compare the Weather Watch data sheets and the Degradation Data sheets and answer the following questions (worksheets included):
  - Did the weather seem to affect the rate of degradation? How so? What weather conditions seemed to increase the degradation rates the most? Can you tell? How so?

#### Additional activities for grades 9-12:

- Begin the lesson with a field trip to the local landfill and/or locations that were damaged heavily by the 2017 Hurricanes Irma and Maria. Discuss the types of debris observed and the degradation process.
  - **Teacher Note:** Coordinate with the Virgin Islands Waste Management Authority to ensure safety on the field trip and to provide additional information about the landfill and waste management in the U.S. Virgin Islands.
- The experiment can also be conducted outside of class by individuals or groups of students, with the testing of additional variables that may influence degradation rates and the collection of additional data, such as mass (before and after). For example, students could bury debris items (in a controlled way) near their homes (to investigate what happens as debris is buried or composted in landfills), or agitate the items in water to simulate wave action.
- Have your students participate in a thought experiment:
  - Ask them to consider the landfill on their island. The landfills on St. Thomas and St. Croix are either slated to be closed in a few years or are already over capacity. Consider what you have learned about the degradation of materials and the landfill on your island to answer questions on the degrading experience thought experiment 9-12 worksheet (included at the end of this lesson).



Larger pieces of plastic, like these found along a remote shoreline of the East End Marine Park on St. Croix, can photodegrade and break down into smaller pieces over time (Photo credit: Kristin Wilson Grimes).



## **Degradation & Weather Worksheet**

Adapted from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience,"  
(<https://marinedebris.noaa.gov/turning-tide-trash>)

Compare the weather data and degradation data on your data sheets.

1. Make a line graph displaying the average weekly temperature and average weekly rainfall.

2. Make a note of the average weekly cloud cover.

3. Compare your graph to your degradation data from the box outside and inside.

a. Did the weather seem to affect the rate of degradation? How so? \_\_\_\_\_

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b. What weather conditions seemed to increase degradation the most? How can you tell?

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4. What types of debris persisted the longest? \_\_\_\_\_

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5. What types of debris degraded the quickest? \_\_\_\_\_

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6. What might these results mean for the marine life of the U.S. Virgin Islands? \_\_\_\_\_

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7. What are some things you can do to help prevent the types of debris that don't degrade from becoming marine debris in the U.S. Virgin Islands? \_\_\_\_\_

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## **Degrading Experience Thought Experiment 9-12**

Adapted from NOAA Marine Debris Program's Turning the Tide on Trash Curricula, lesson three "A Degrading Experience," (<https://marinedebris.noaa.gov/turning-tide-trash>)

You have just finished the degradation class experiment. Let's take what you learned a step further. The landfills on St. Thomas and St. Croix are either slated to be closed in a few years or are already over capacity. Consider what you have learned about degradation of materials and the landfill on your island to answer the following questions about marine debris in the U.S. Virgin Islands.

1. Based on what you know about how quickly (or slowly) different materials degrade, what do you think the landfill on your island is full of? Be as detailed as possible. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. What do you think the most persistent items are in the landfill? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. What were those materials originally used for? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. Did those items originate on or off-island? \_\_\_\_\_
5. Think about the location of the landfill, the watershed it is in, and the trash being thrown away. When people throw out a piece of debris that is resistant to degradation, what do you think happens to it? \_\_\_\_\_  
\_\_\_\_\_
6. Does it make it to the landfill? \_\_\_\_\_
7. If it does, do you think it stays there until it is completely degraded? \_\_\_\_\_  
\_\_\_\_\_
8. How long do you think it stays in the landfill? \_\_\_\_\_
9. Do you think it's possible for trash to fall/blow out of the landfill and eventually end up in the marine environment? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



10. What objects do you think persist the longest in the landfill? \_\_\_\_\_

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11. If the landfill is really close to the ocean, like on St. Thomas, what do you think happens to marine life and their habitat near that landfill? \_\_\_\_\_

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12. If the landfill is really close to several ghuts and small ponds, like on St. Croix, what do you think happens to those habitats near that landfill? \_\_\_\_\_

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13. There are several abiotic factors (like wind, rain, and heat, among others) that influence how long debris persists in the environment. For each of the following factors, describe how those factors may impact degradation of a debris item. Does it matter what the item is made of? What properties of the item make it more or less resistant to degradation?

a. Physical degradation (getting crushed, torn, etc.): \_\_\_\_\_

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b. Weather degradation (wind, rain, and heat): \_\_\_\_\_

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c. Photo degradation (sunlight): \_\_\_\_\_

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14. Which of the three degradation processes listed above has more of an impact in the U.S. Virgin Islands compared to another place, like Canada? \_\_\_\_\_

a. How so? \_\_\_\_\_

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15. Considering your answers to all the above questions, make a prediction about how the environment impacts the degradation of marine debris breakdown. \_\_\_\_\_

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LESSON THREE

**HANDOUT**

# Degradation Data – Outside

Month: \_\_\_\_\_

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

## Weather Watch - Week 1

Date	Temperature	Cloud Cover	Precipitation

## Weather Watch - Week 2

Date	Temperature	Cloud Cover	Precipitation



**HANDOUT**

**Degradation Data – Outside**

Month: \_\_\_\_\_

Item	Week 3	Week 4
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		

**Weather Watch - Week 3**

Date	Temperature	Cloud Cover	Precipitation

**Weather Watch - Week 4**

Date	Temperature	Cloud Cover	Precipitation

HANDOUT

# Degradation Data – Inside

Month: \_\_\_\_\_

Teachers: customize this handout based on the trash items you have in your experiment.

Item	Week 1	Week 2
Apple core		
Bag, paper		
Bag, plastic		
Candy wrapper		
Cup, Styrofoam		
Cup, waxed paper		
Drink box and straw		
Egg carton, paper		
Egg carton, foamed plastic		
Glass bottle		
Newspaper		
Packing peanut, foamed plastic		
Packing peanut, starch		
Six-pack holder		
Steel can		





# SOURCES & TRANSPORT



# LESSON: Watershed Walk

This activity was modified from the “Watershed Walk” lesson housed on the Northwest Aquatic and Marine Educators website (<https://www.pacname.org/ocep-watershed-walk-high-school/>), with permission from Oregon Sea Grant who is a co-author on the activity, along with the Oregon Coast Education Program (OCEP) Leadership team members.

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-1:
  - ESS3.A: Natural Resources - Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.
- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-1:
  - ESS3.A: Natural Resources - Resource availability has guided the development of human society.
  - ESS3.B: Natural Hazards - Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.
- Appendix F: Science & Engineering Practices

**Time:**

- 90 min prep
- 3 class periods: 1 class period – introductory presentation; 1 class period – field experience; 1 class period -- reflection.

**Description & Objectives:** These lessons are designed to be used after completing any of the Composition & Abundance lessons. Students will investigate and learn about nearby watersheds and about the ridge-to-reef concept. Students will use this knowledge to investigate how marine debris gets into and moves around the ocean. They will look for

evidence to determine the source (land or sea) of different types of marine debris.

**Guiding Questions:**

- Where does most marine debris come from in the U.S. Virgin Islands?
- How does marine debris get into the ocean?
- How are terrain, water systems, and marine debris connected?

**Key Ideas & Concepts:**

- Marine debris exists both where we can easily see it (beaches, wrack lines on the beach) and cannot easily see it (ghuts leading to the beaches or under sand and the surface of the water).
- Most marine debris comes from land-based sources (us!).
- Debris deposited by accident or on purpose, can travel downhill from waterways and through watersheds into the ocean.

**Pre-Requisite Skills:** Students will need to understand the basic concepts of marine debris, topography, watersheds, and the water cycle.

**Teacher Preparation:** Scout out an appropriate watershed to observe either on school property (ideal!) or nearby. As one of the goals of this activity is to provide experience with local watersheds that connect to local reefs, adequate time outdoors is helpful. The activity can be completed using Google Earth, if needed. Make a list of features of the chosen watershed (flat vs. steep, number of ghuts/human-made drainages, amount of natural vegetation, concrete/ asphalt or dirt surfaces). This works best in an area where students can see the whole watershed to answer some of the questions in the Watershed Worksheet, though this is not always possible. If needed, review general topographic and watershed concepts with your students. This can be done as separate lessons/class periods, if needed.

The United States Geological Survey has two introductory classroom activities that explain how to read and create topographic maps which may be helpful to review or complete with your students prior to this lesson. Those activities can be found here: <http://www.orange.wateratlas.usf.edu/upload/documents/HowToReadTopoPlusActivity.pdf> and <https://education.usgs.gov/lessons/toposaladtray.pdf>.

NOAA also has a great lesson which is available here: [https://oceanexplorer.noaa.gov/edu/lessonplans/ring\\_topographic\\_6\\_8.pdf](https://oceanexplorer.noaa.gov/edu/lessonplans/ring_topographic_6_8.pdf)

There is a mini-topography worksheet that can be used as part of this lesson plan, as well. This lesson can be



used with students to predict how topography might influence what, where, and how much trash might enter the ocean, becoming marine debris: <http://www.education.com/worksheet/article/topographic-map-matching/>

For more information about watersheds, visit: <https://oceanservice.noaa.gov/facts/watershed.html> then answer a worksheet about it.

#### Materials Needed:

- Computer/projector and internet access
- Video: NOAA Video “TRASH TALK: Where Does Marine Debris Come From” (<https://www.youtube.com/watch?v=FN9FF7VH4ig>)
- Watershed Walk Worksheet (at end of instructions)
- U.S. Virgin Islands Watershed Map (at end of instructions)
- Pencils, sturdy surface to write on (clipboards/notebooks), safety equipment (first aid kit, field trip paperwork, if leaving campus), camera (optional), art supplies (optional)
- Students: proper footwear/attire for outside exploration

#### Teacher Instructions:

Classroom introduction - explore the area around the school and define “watershed”: An engaging way to introduce this topic is to show students a mapping website that has topographical features on it, such as Google Earth. You can ask them to describe the area around their school using the map.

- **Guiding questions:** Where is the school in relation to mountains or steep terrain? Where are flat or low areas in the landscape that might flood with heavy rain? Where is the closest gully and/or drainage ditch? Follow the gully and/or drainage ditch - where does it lead to? Does it cross any streets or appear to go underground? Where does it meet the ocean?

After the class has described the area, this is a good time to define/describe what a watershed is and to review the water cycle, if this has not already been taught.

- According to NOAA, a watershed is “a land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays and oceans.”
- In the U.S. Virgin Islands, we don’t have snow, but we do have rain. Here and elsewhere, water flows from higher ground, like the hills and mountains, along low points in the landscape, like streams, gullies, and human-made channels, to areas of lower ground where it fills retaining ponds or empties into the ocean.
- Have the students relate the description of a watershed, local topography, and other landscape features (e.g., gullies, human-made channels, low areas) back to the previous discussion about the area around their school.
  - **Guiding questions:** Is our school part of a watershed? How can you tell? (Answer: Yes! Every place on land is part of a watershed which can vary in size and shape based on terrain. This is a great place to show and talk about the U.S. Virgin Islands Watershed Map (included), which depicts watershed boundaries, locations of some U.S. Virgin Islands schools, and gullies in relation to topographic features like hills, mountains, and drainages).

Watershed presentation: After the class has described their area and recognize that it is part of a watershed, you should begin your watershed presentation in preparation for the Watershed Walk. *Make sure students know they will be using this information to answer questions during their Watershed Walk.*

- Emphasize the role local terrain and landscape features have in moving water across the land. It will help students if you emphasize the effect of plants and dirt (which absorb water) versus concrete and metal (which tend to repel water, moving it elsewhere), in how water moves through the watershed. Where would you expect water to move more quickly, over the natural landscape (plants, dirt) or the human-made landscape (concrete/metal)? Answer: concrete/metal. What might this mean for trash in the watershed? How might it be expected to move across the landscape? Where might it aggregate (low spots in the landscape, like gullies, human-made drainages, and drainage ponds)? What other features in the landscape might affect the amount of trash in the watershed (e.g., presence and location of roadside dumpster bins, the landfill, areas with high human use)? Ultimately, where could all this trash end up? Answer: the ocean. Emphasize the ridge-to-reef concept. Debris higher in the landscape can travel downhill where it can be deposited into salt ponds, mangroves, beaches, and adjacent coral reefs and seagrass meadows, putting those habitats and the organisms that live there at risk.
- Next, show your students the NOAA video “TRASH TALK: Where Does Marine Debris Come From” (<https://www.youtube.com/watch?v=FN9FF7VH4ig>). The following discussion could be expanded to its own class period depending on time and interest.
  - **Guiding questions:** Think about the TRASH TALK video. In it, they talk about the many ways trash can find its way into the ocean, including land-based and ocean-based sources. Which do you think is most important in the U.S. Virgin Islands? Data from the territorial beach cleanups indicates that most marine debris found on U.S. Virgin Islands beaches comes from land-based sources - that means it comes from us! What’s the good news? If it comes from land-based sources, it means that we can prevent it. What do you think happens to trash, like a plastic bag, on a windy day? What about a water bottle on a slightly rainy day? On a really rainy

day? Ask students to think about how roadside dumpsters could impact the watershed (where does the trash enter the watershed and where could it end up? How might dumpster location matter? Or the number of dumpsters?). What do you think happens to the trash that blows or washes in from roadside dumpsters or is thrown into the ghuts on purpose? What about storm drains? Do those get flooded and overflow during the rainy season? Many ghuts are dry for part of the year. What happens to the trash that collects in them during the dry season when it comes to the rainy season? What about recycling? If the U.S. Virgin Islands had a wide-spread recycling program how might that impact how much trash ends up in the ocean? Ask students to think about how waste management practices (e.g., placement of roadside dumpsters, frequency of hauling) and personal behaviors (e.g., reducing the amount of garbage that they individually produce, reducing their use of single-use products like plastic beverage bottles or plastic cups, making smart choices to reduce packaging when making purchases, not littering, making sure their garbage ends up in a waste bin and not overflowing onto the ground, picking up after themselves at an event like a beach party) could reduce the amount of marine debris that ends up in our local waters. Emphasize the reduce, repurpose, reuse concepts rather than recycling, since no formal, widespread recycling program currently exists in the U.S. Virgin Islands. Have students consider U.S. Virgin Islands-specific marine debris issues not covered by the video (e.g., landfills that are at or near capacity, no landfill on St. John, cruise ship passengers that generate waste locally, prevalence of single-use water bottles (in schools and as fundraising items), shipping (>95% of our food is imported, most other household items are also imported), fishing (traps, lines, nets), storm impacts (e.g., abandoned and capsized boats).

**Field trip - Watershed Walk:** Make sure all students have a sturdy surface to write on, pencil, appropriate clothing (sneakers, especially if you are leaving campus) and the Watershed Walk worksheet (included). The students will travel to the selected watershed (on- or off-campus) and will be answering questions about what they are observing and how it relates to the information you provided in the watershed introduction and the water cycle. It is a good idea to plan 2-4 stopping points to help students connect the worksheet questions with a local area.

- **Guiding questions for each stop:** We are stopping to look at this area, what do you notice about it? Is it covered in human-made materials or is it natural (linking to previous activities to engage prior knowledge)? Why does the surface material matter, in terms of the water cycle? Does the rain run-off this area or get absorbed? What plants (if any) are growing here? How are these different from plants found on different areas of the school grounds? How might they impact the way water flows? What types of plants are going to stop small pieces of debris? What types of plants are going to stop large pieces of debris? Are there any types of debris that plants won't stop? What about the trash that's out here (if any) - what is likely to happen to it when it rains? Where might it end up?

**Watershed Worksheet (included) – modify based on number of stops during your walk:**

1. Look around the area. Where is the highest point in the watershed? If water falls or runs off the edge of that point, where does it go? Is there more than one high point in the area? What would happen to rain, if there are multiple high points in this area?
  - **Teacher Note:** This is a good time to review the water cycle – Ask them what happens to rain drops after they fall from the sky. Have them answer this question and questions 2-3 at each stop.
2. Are there any ghuts nearby? Can you see them easily, or are they hidden by plants or human-made structures? Can you tell if they are straight or curved?
  - **Teacher Note:** If there is a nearby ghut, take the students to it if possible. If a ghut or other natural water feature is too far away, take time to discuss what would happen if a ghut was running through the middle of the area you are in. Your students should make notes that ghuts tend to curve, while human-made ditches tend to be straight.
3. Keep a running list of the different types of surfaces you came across during your walk.
  - **Teacher Note:** Encourage students to notice the differences between dirt, grass, gravel, paved roads, parking lots, sidewalks, dirt roads, etc. The rest of the questions could be completed inside or as homework, depending on class time available, but are best answered while still outside.
4. What are some things you noticed on your walk that may negatively impact the water flow? Think about how watersheds hold and release water. Think about the quality of water moving through the area, did you see any trash?
  - **Teacher Note:** Encourage students to think about the water cycle again and how water moves through an area. This is a good time for talking about how different surfaces interact with water (added pollution, water getting absorbed or not, the effect of plants on water movement). Ask students to think about where the roads are built: Are they in a naturally flat area or hilly areas? Are they next to a drainage ditch? Are they built over a ghut or where a ghut used to be? All these things impact water flow and it is good to ask students to think about them while they are standing outside, looking at the environment around them.
5. Did you notice any storm drains? Did you see any that could get backed up when it rains? What happens to all the trash when the drains get backed up?
  - **Teacher Note:** Encourage students to think about human impacts on the environment with these questions. On St. Thomas – ask students to think about the storm drain in front of Banco Popular by Addelita Cancryn Junior High School. On St. Croix – ask students to think about either Gallows Bay or the bottom of King Cross St. in



*Christiansted. Also, ask students to note the differences around storm drains during dry times and right after a heavy rain. What do students remember seeing and smelling? Can they see and smell marine debris in those areas? Also, ask them to think about how water flows over concrete and metal (storm drains) versus dirt and plants (ghuts): is trash going to get caught in the storm drain or will it be easier for it to flow to the sea?*

6. What are some things you noticed on your walk that may positively impact the water flow? Think about how watersheds hold and release water.
  - **Teacher Note:** *This is an especially good time to ask students to observe and record the type of plant life in the area. Native plants are especially adapted to hold soil in place, preventing lots of water and dirt from flowing into the sea and filtering the water so there is not so much silt being dumped into the ocean. Have students look to see if they can observe a nearby salt pond or mangrove ecosystem or think about where these occur nearby. Salt ponds and mangroves are great at catching all sorts of materials before they enter the ocean. Ask students to try to think of things they can see on the walk that would be good for a salt pond or mangrove forest to catch and keep out of the sea.*
7. What are some of the ways that water flowing from high in the watershed down to the ocean below, impacts marine life?
  - **Teacher Note:** *This is a good time to have the students re-think about what happens when it rains, but this time have them focus not only on how water moves, but what it carries with it (oil, trash, dirt, other contaminants, etc.) and how those things can impact nearshore environments (mangroves, reefs, and seagrass meadows). Ask students to think about how impacts might be different in these different habitats. This is also a good time to make the distinction between pollutants (e.g., oil, heavy metals, other contaminants) and marine debris (which is defined as "any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes").*
8. Do these impacts change when there is a heavy rain or a light rain?
  - **Teacher Note:** *It would be good for students to make note of how the water flow changes during light and heavy rains and thus with rainy and dry seasons. Ask the students to think about areas they know are dry except for when it rains. If this is a site that you visit regularly and it experiences very different wet and dry conditions, consider taking pictures or video to share with your students so they can appreciate how different weather conditions affect the area and how that could impact how land-based sources of marine debris could enter the ocean.*
9. Do these impacts change during the different seasons of the year?
  - **Teacher Note:** *It would be good for students to make note of how the water flow changes during the rainy season compared to the dry season on the island. Ask them to think back to question 5 and to think about what those areas look like during the dry season and the rainy season. As in question 8, if this is a site that you can visit regularly, and it experiences very different conditions during rainy and dry seasons, consider taking photos or video to share with your students, to enrich this discussion.*

**In the classroom:** Reflect: Ask the students to share something they found interesting or something that surprised them, while on the Watershed Walk. Show students the map of the area around their school and show them the map of an area on a different island in the U.S. Virgin Islands.

- Have the students share some of the similarities and differences they can spot. Ask the students how the difference in elevations (topography) might change how the flow of trash, oil, and dirt move through the watershed. Have them think about how topography, natural landscape features (e.g., forests, salt ponds, mangroves, beaches) and human-made modifications to the landscape (e.g., roads, human-made drainages, locations of roadside dumpsters, locations of landfills) could influence what, where, and how much trash might enter the ocean, becoming marine debris.
  - **Teacher Note:** *Based on student answers, guide them toward the idea that more rain is needed to move larger, heavier objects. During light rain some trash will get stuck in the ghuts, while during heavier rain events, it is more likely that more trash will be flushed into the ocean. This could also be a time to explore inter-island differences in human populations across the U.S. Virgin Islands and how waste is managed differently on each of the islands.*
- Continued exploration: Ask the students to complete a neighborhood Watershed Walk around their home or on their walk home from school as additional homework. Ask them to share similarities and differences from what they observed during the in-class Watershed Walk.
- Links to other subject areas:
  - Link to language arts: Have the students write a short story from the perspective of a piece of litter that becomes marine debris. Have them consider its journey from ridge-to-reef and impacts to the local environment and local community.
  - Link to mathematics: Create simple math problems that have students predict transport of marine debris items under variable watershed, seasonal, and weather conditions (e.g., topography, slope, amount of rain, flow rates, etc.).

- Link to the arts: Have students draw a picture of their local watershed, the path a trash item might take through this landscape to the ocean to become marine debris, and the impacts to local environments and communities.

**Assessment and evaluation:** Ask students to draw and label a local watershed with the following traits: ghuts and where they meet the ocean, high/low areas, the types of surfaces (grasses, dirt, pavement), and have them incorporate the steps of the water cycle.

- Have students label/identify the features of the watershed that make marine debris more mobile.
- Have students predict which ghuts might have the most debris in them (students might predict that those ghuts running through or directly adjacent to roadside dumpsters, ghuts with easy road-side dumping access, and ghuts closer to large population centers, might have more debris than other ghuts).
  - Have students label different dumpster sites on a map and draw the possible debris transport pathways. As students complete additional marine debris lessons, and lessons about watersheds and the water cycle, they can add more ghuts and bays, and outline watersheds on the map. Additionally, students could identify where debris collects in their communities and map those areas as well. Students could then present this at the end of the year to different classes in their school or in different schools.
- Have students hypothesize how marine debris accumulation and movement would be different in this watershed under different weather events – rainy season versus dry season, before and after storm events.
  - What do you think happens to the trash on a windy day? On a lightly rainy day? A really rainy day? What do you think happens to the trash that blows off the road side dumpsters or is thrown into the ghuts on purpose? Where does the trash end up after a storm event? How might the volume of trash entering the ocean be different before and after a storm?

**Teacher Note:** For more information about how debris from land can become trapped in mangrove shorelines of the U.S. Virgin Islands, read *Spotlight: The Great Mangrove Cleanups*.



Roadside dumpster bins on St. Thomas. Trash that doesn't make it into the bins, has the potential to become marine debris (Photo credit: Kristin Wilson Grimes).





The generally steep terrain of the U.S. Virgin Islands means that land-based activities are connected to the ocean via the ridge-to-reef continuum. This view is looking east over Magen's Bay on St. Thomas (Photo credit: Kristin Wilson Grimes).

## Watershed Walk Worksheet

Modified from (Northwest Aquatic and Marine Educators, 2016), with permission from Oregon Sea Grant

1. Look around the area. Where is the highest point in the watershed? \_\_\_\_\_  
\_\_\_\_\_  
a. If water falls or runs off the edge of that point, where does it go? \_\_\_\_\_  
\_\_\_\_\_  
b. Is there more than one high point in the area? \_\_\_\_\_  
\_\_\_\_\_  
c. What would happen to the rain if there are multiple high points in this area?  
\_\_\_\_\_
  
2. Are there any ghuts nearby? \_\_\_\_\_  
a. Can you see them easily, or are they hidden by plants or human-made structures?  
\_\_\_\_\_  
b. Can you tell if they are straight or curved? \_\_\_\_\_  
\_\_\_\_\_
  
3. Keep a running list of the different types of surfaces you came across during your walk.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
4. Think about how watersheds hold and release water. What are some things you noticed on your walk that may negatively impact the water flow? \_\_\_\_\_  
\_\_\_\_\_  
a. Think about the quality of water moving through the area, did you see any trash?  
\_\_\_\_\_
  
5. Did you notice any storm drains? \_\_\_\_\_  
a. Did you see any that could get backed up when it rains? \_\_\_\_\_  
\_\_\_\_\_  
b. What happens to all the trash when the drains get backed up? \_\_\_\_\_  
\_\_\_\_\_
  
6. Think about how watersheds hold and release water. What are some things you noticed on your walk that may positively impact the water flow? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



7. What are some of the ways the water flowing from high in the watershed down to the ocean below, impacts marine life? \_\_\_\_\_

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8. How might these impacts change when there is a heavy rain or a light rain? \_\_\_\_\_

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9. How might these impacts change during the different seasons of the year?

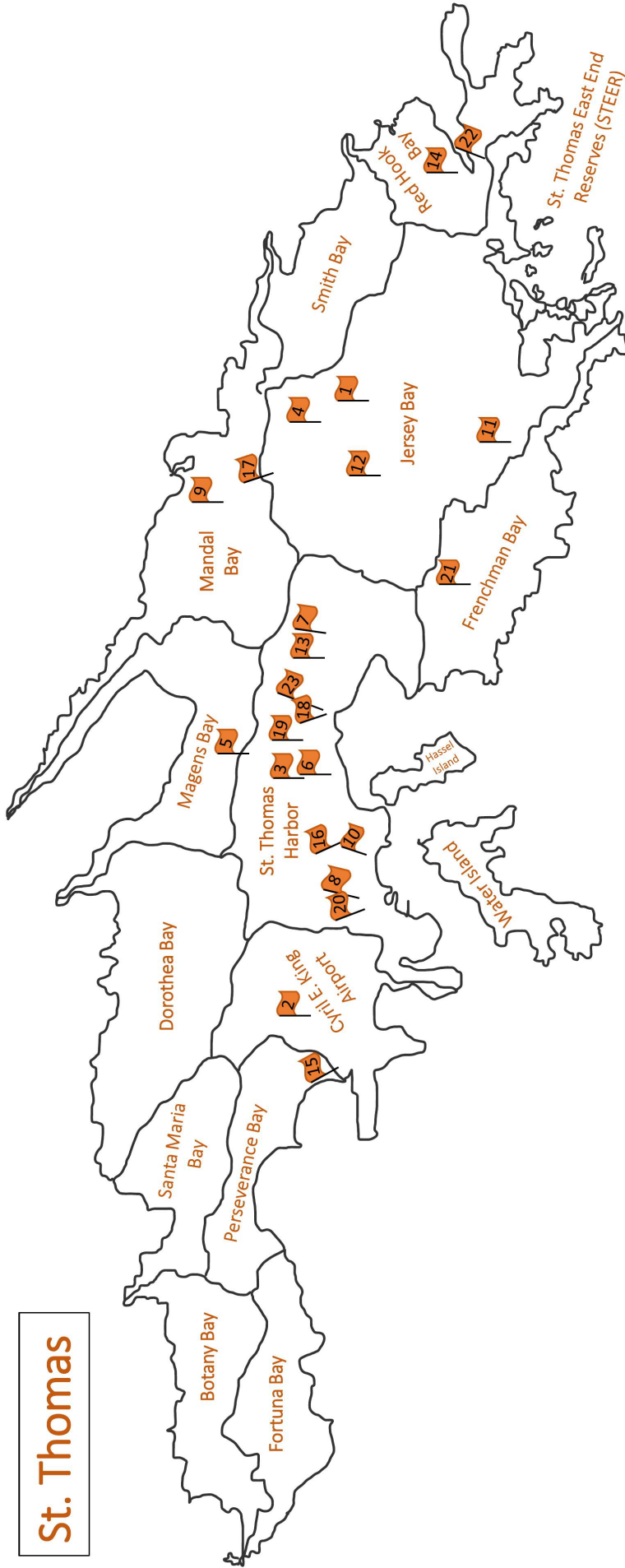
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Figure 2. A map of schools (public and private; elementary through senior high school) and watershed boundaries on St. Thomas (Figure courtesy of Allie Durdall).



St. Thomas Schools	
1. E. Benjamin Oliver Elementary School	16. Calvary Baptist School
2. Gladys A. Abraham Elementary School	17. Wesleyan Academy
3. Jane E. Tuitt Elementary School	18. Saints Peter & Paul Catholic School
4. Joseph Gomez Elementary School	19. All Saints Cathedral School
5. Joseph Sibilly Elementary School	20. Memorial Moravian School
6. Leonard Dober Elementary School	21. Antilles School
7. Lockhart Elementary School	22. Montessori School
8. Ulla F. Muller Elementary School	23. St. Thomas Seventh-day Adventist School
9. Yvonne E. Milliner-Bowsky Elementary School	
10. Addelita Cancryn Junior High School	
11. Bertha C. Boschulte Middle School	
12. Edith L. Williams Alternative Academy	
13. Charlotte Amaile High School	
14. Ivanna Eudora Kean High School	
15. University of the Virgin Islands-St. Thomas Campus	



Figure 3. A map of schools (public and private; elementary through senior high school) and watershed boundaries on St. John (Figure courtesy of Allie Durdal).

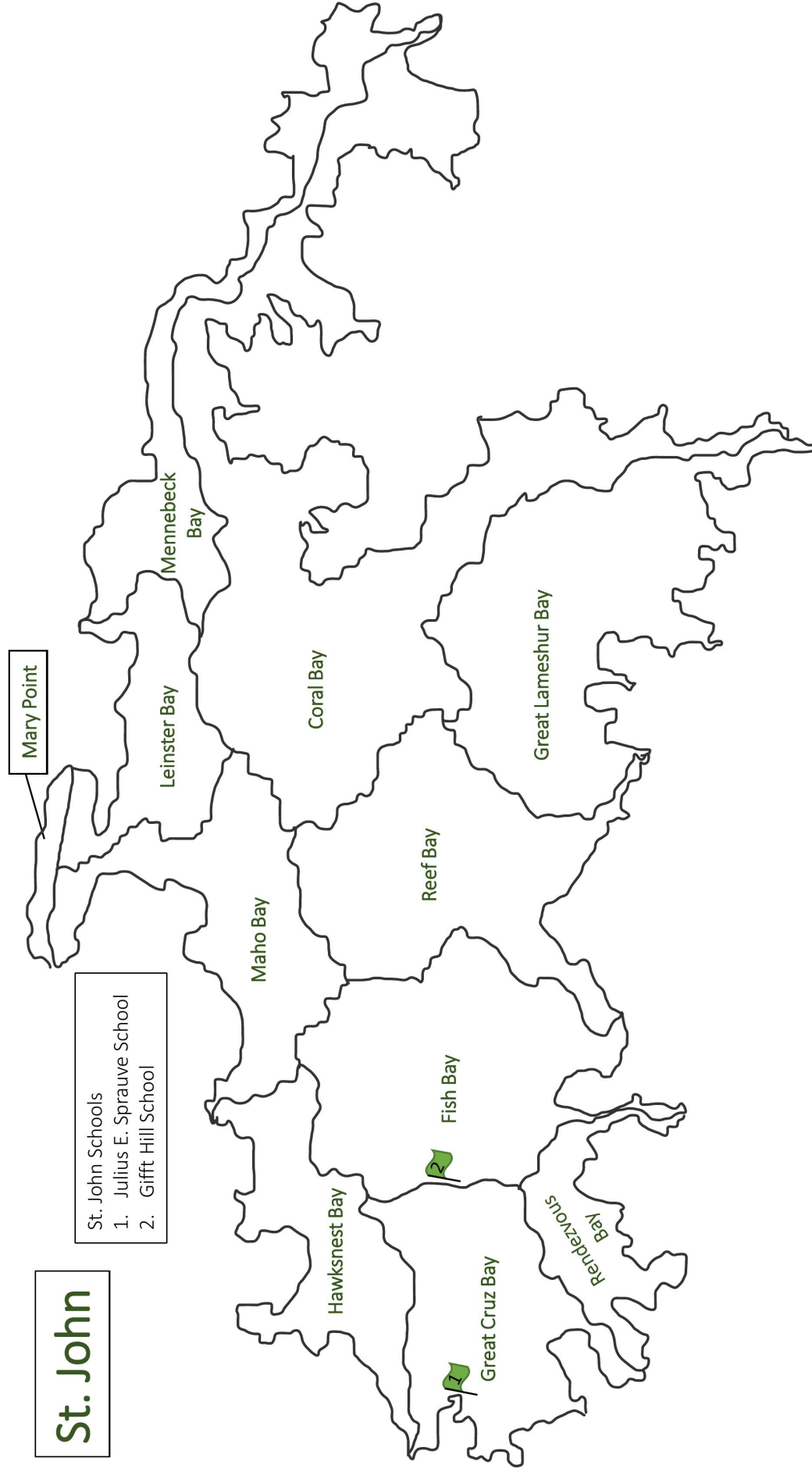
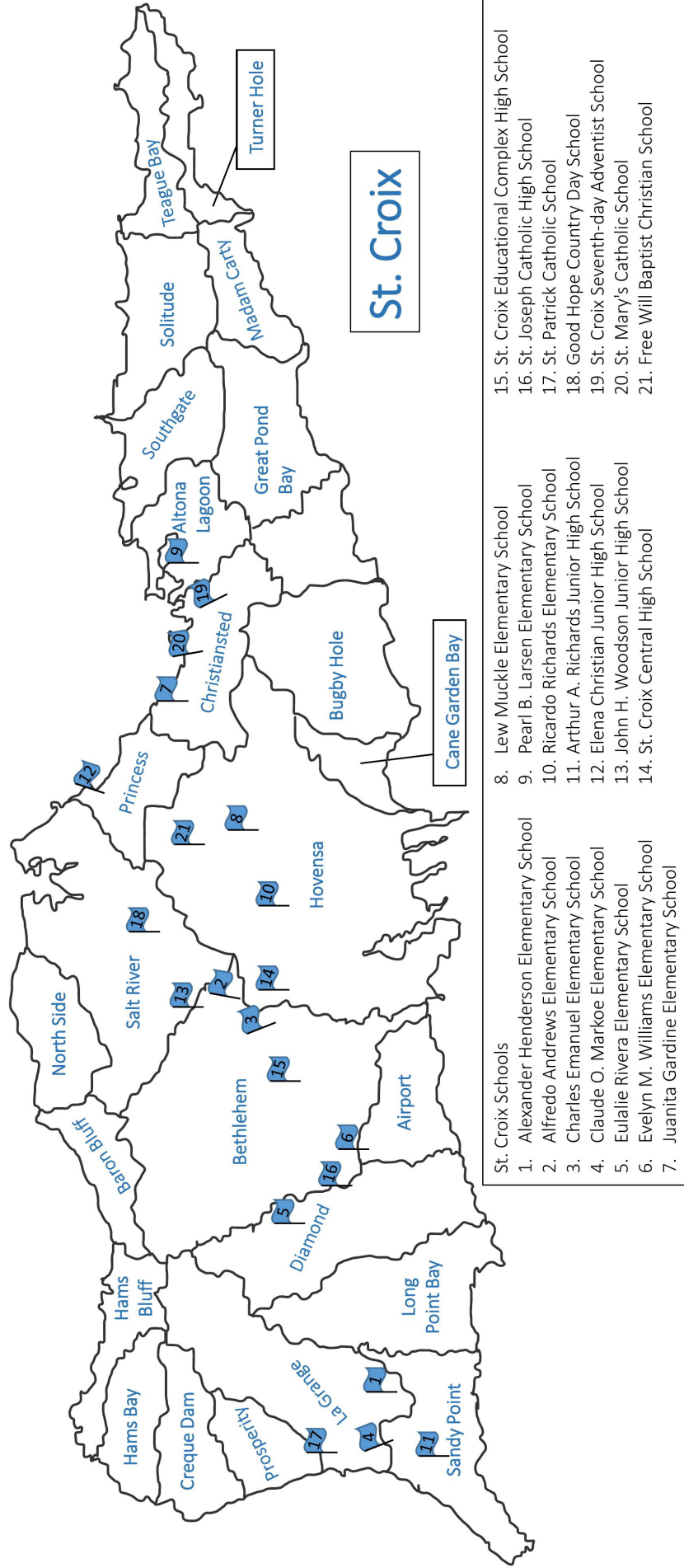


Figure 4. A map of schools (public and private; elementary through senior high school) and watershed boundaries on St. Croix (Figure courtesy of Allie Durdall).





# SPOTLIGHT

## The Great Mangrove Cleanups

Debris from our watersheds and the ocean ends up trapped in mangrove shorelines of the U.S. Virgin Islands. In recent years, efforts have focused on removing debris from these difficult to access shorelines. On April 21, 2018, 126 volunteers removed more than 3,000 lbs of marine debris during the Great Mangrove Cleanup, the first, large-scale community cleanup of mangrove shorelines in the St. Thomas East End Reserves (STEER), a marine protected area on the east end of St. Thomas, U.S. Virgin Islands (USVI).

These mangrove shorelines are difficult to get to, which makes them especially difficult to clean, and after the twin, Category 5 Hurricanes, Irma and Maria, hit the Territory in September 2017, these coastlines were chock full of marine debris. During the 2018 Great Mangrove Cleanup, the vast majority of marine debris we gathered came from land-based sources (90-95% of items) and most of the items, 65-70%, were plastic. These patterns are consistent with those observed globally. The single item we collected the most of was plastic beverage bottles – 1,765 of them! For such a small area of coastline, that's a lot. What this tells us, is if we want to reduce marine debris in the USVI, we should be thinking about what we are drinking out of, where we are disposing of trash, and where it might end up.

The USVI doesn't have widespread recycling programs, so items from the cleanup that could be reused were fenders, buoys, and pieces of wood. Metal was recycled for scrap and hard plastics (like all those plastic bottles) were recycled through the Virgin Islands Department of Planning & Natural Resources (DPNR) Division of Coastal Zone Management's recycling partnership with Terracycle, run by DPNR Education and Outreach Coordinator, Kristina Edwards.

Participating in the cleanup was a team from the University of the Virgin Islands (UVI) including members of the Center for Marine & Environmental Studies (CMES), Masters of Marine and Environmental Studies (MMES) students, and UVI undergraduates. Nearly 50 individuals from All Hands and Hearts, a volunteer organization assisting in hurricane recovery in the Territory, also participated in the



Marine debris items collected during the 2018 Great Mangrove Cleanup  
(Photo credit: Kristin Wilson Grimes)

cleanup, as did members of the Virgin Islands Established Program to Stimulate Competitive Research (VI-EPSCoR), the Virgin Islands Marine Advisory Service (VIMAS), Federal Emergency Management Agency, local government agencies (DPNR Division of Coastal Zone Management, DPNR Division of Environmental Enforcement, and the Virgin Islands Waste Management Authority), and other local non-profits (USVI Marine Rebuild Fund, Perfect Heart, Blue Flag, Camp Umoja, and the Environmental Association of St. Thomas, among others).

The cleanup was sponsored by the NOAA Marine Debris Program and Coral Reef Conservation Program, in partnership with VI-EPSCoR, VIMAS, UVI CMES, DPNR Division of Coastal Zone Management, USVI Marine Rebuild Fund, and three local businesses (Virgin Islands Ecotours, Pizza Pi, and Custom Builders).

"It was only by combining our efforts, that we were able to achieve such a big impact. It shows what we can accomplish when we work together. For as much as we were able to remove, there's a lot more to go," said Mr. Howard Forbes, Jr., Virgin Islands Marine Advisory Service St. Thomas/St. John Coordinator. VIMAS is University of Puerto Rico Sea Grant's extension arm in the U.S. Virgin Islands.





Volunteers from the 2018 Great Mangrove Cleanup, which removed marine debris from mangrove shorelines within the St. Thomas East End Reserves, a marine protected area on the east end of St. Thomas (Photo credit: Mark Grimes).

The Second Annual Great Mangrove Cleanup of the St. Thomas East End Reserves (STEER), took place Saturday, April 13, 2019, where 115 volunteers, ages 9-70, removed 1,786 pounds of debris from mangrove shorelines in kayak- and land-based cleanups of mangrove shorelines.

Students from UVI, Ivanna Eudora Kean High School, Charlotte Amalie High School, Bertha C. Boschulte Middle School, Ulla F. Muller Elementary School, Joseph Sibilly Elementary School, and home schools, participated in the cleanup, along with individuals from 13 other organizations.

Sponsors of the event included UVI CMESs, Virgin Islands DPNR, VIMAS, VI-EPSCoR, Virgin Islands EcoTours, St. Thomas Recovery Team, Pizza Pi, Yes! Waste Management, Virgin Islands Marine Rebuild Fund, and the NOAA Marine Debris Program and Coral Reef Conservation Program.



Community Engagement Specialist for Virgin Islands Established Program to Stimulate Competitive Research (EPSCoR), Jarvon Stout, with one of the more comical marine debris items found during the April 2018 Great Mangrove Cleanup, a toy sword (Photo credit: Howard Forbes, Jr).





Students from the Ulla F. Muller, helped to pick-up marine debris from vulnerable mangrove shorelines at the 2019 Great Mangrove Cleanup on St. Thomas (Photo credit: Kristin Wilson Grimes).

In 2019, the top 10 items collected at the 2019 Great Mangrove Cleanup were:

- 246 plastic beverage bottles
- 133 plastic pieces
- 114 other plastic bottles
- 113 plastic cups and plates
- 111 glass beverage bottles
- 109 construction materials
- 92 plastic grocery bags
- 89 other plastic bags
- 83 other plastic/foam packaging
- 82 beverage cans

Other weird finds included:

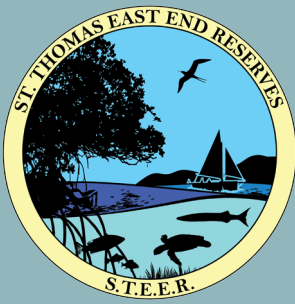
- 2 refrigerators
- 1 television
- 1 polaroid camera
- 11 tires
- 15 life jackets

"It was exciting to see so many people come out for this event, again this year. Working together we removed nearly 1,800 pounds of trash – that's a big impact! Like last year, the most common item we collected were plastic beverage bottles. What that tells me, is that plastic beverage bottles are a consistent marine debris problem for St. Thomas, so we should all be thinking more about what we are drinking out of, where we dispose of it, and where it may end up." – Dr. Kristin Grimes, Assistant Professor, Center for Marine & Environmental Studies, University of the Virgin Islands.



Volunteers at the 2019 Great Mangrove Cleanup on St. Thomas (Photo credit: Kristin Wilson Grimes).





# THE 2018 GREAT MANGROVE CLEAN-UP

Of The St. Thomas East End Reserves (STEER)

STEER contains one of the last remaining large mangrove forests on St. Thomas. Mangroves protect our shorelines and provide habitat for wildlife, like birds and fish.

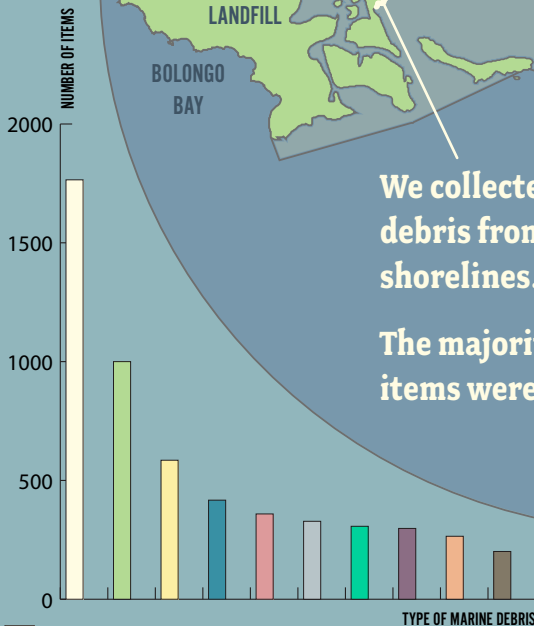
The location of STEER makes it vulnerable to marine debris and pollution. The Great Mangrove Clean-Up was the first ever large-scale, community clean-up of the Reserves.



We collected **1,349 lbs of debris** from nearshore areas. The vast majority of plastic items were plastic beverage bottles.

**ST. THOMAS**

We collected **1,672 lbs of debris** from wave-exposed shorelines. The majority of plastic items were plastic pieces.



- 1,765 plastic beverage containers
- 1,000 miscellaneous plastic pieces
- 585 random pieces of foam
- 417 aluminum beverage cans
- 359 other plastic bottles
- 328 plastic bags
- 307 glass bottles
- 289 pieces of rope
- 265 plastic cups
- 201 plastic food containers

**St. Thomas East End Reserves**

## WEIRD FINDS

11 snorkels



32 balls



55 shoes

**6,912 pieces of trash were collected**

**66% of items were plastic**

0 1000 2000 3000 4000 5000 6000 7000  
NUMBER OF ITEMS

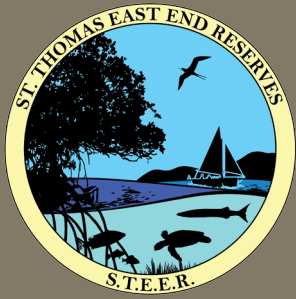
Approx 1.5 miles of shoreline cleaned by 126 volunteers ages 7 – 61.

**= 3,000 lbs**  
of marine debris collected and disposed of properly, repurposed or recycled (when able).

Tracey Saxby, IAN Image Library (ian.umces.edu/imagegallery/)







# THE 2019 GREAT MANGROVE CLEAN-UP

Of The St. Thomas East End Reserves (STEER)

STEER contains the largest remaining mangrove forest on St. Thomas!

— 246 Plastic Beverage Bottles

— 133 Plastic Pieces

— 114 Other Plastic Bottles

— 113 Plastic Cups & Plates

— 111 Glass Beverage Bottles

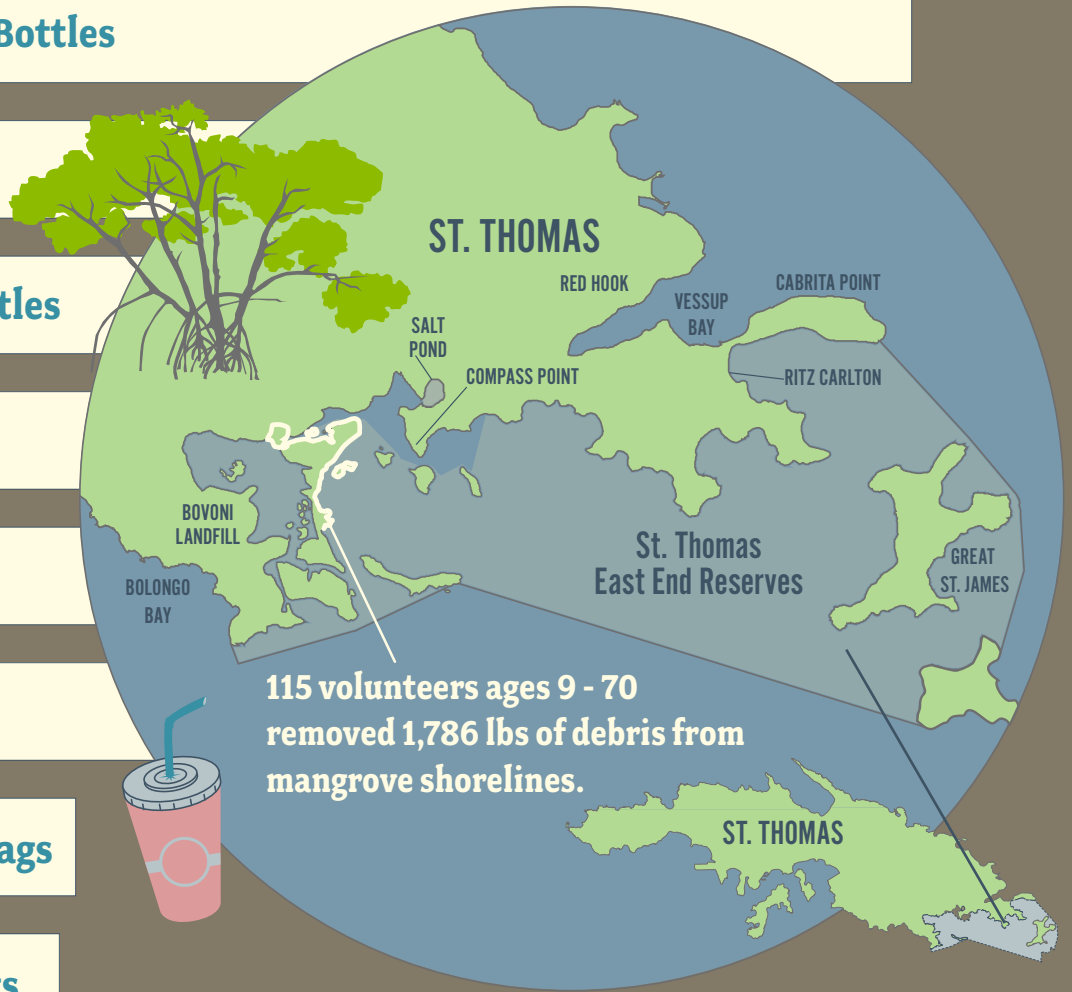
— 109 Construction Material Items

— 92 Plastic Grocery Bags

— 89 Other Plastic Bags

— 83 Other Plastic & Foam Packaging

— 82 Beverage Cans



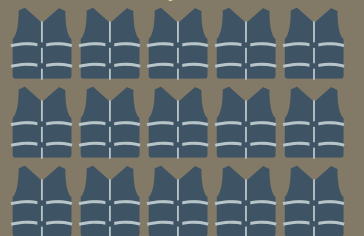
“...the data tell us we should all be thinking more about what we eat and drink out of, where we dispose of it, and where it may end up.”

Dr. Kristin Grimes, Assistant Professor,  
Center for Marine & Environmental Studies,  
University of the Virgin Islands

1 polaroid camera

## WEIRD FINDS

15 life jackets



2 refrigerators



1 television



11 tires



Tracey Saxby, IAN Image Library (ian.umces.edu/imagegallery/)

# ST. CROIX

US Virgin Islands

# THE 2020 GREAT MANGROVE CLEAN-UP

MANGROVE CLEAN-UP AREA

Salt River Bay is home to vital mangroves habitats

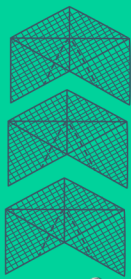
82 volunteers ages 4 – 71

880 lbs of marine debris removed!

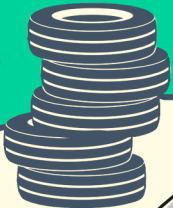
30% of all debris collected was beverage cans & bottles (glass & plastic)



3 crab traps



5 tires

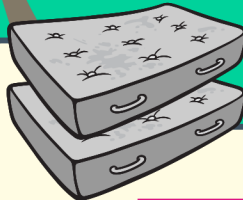


Weird Finds

1 pregnancy test



2 mattresses



1 DVD player

SALT RIVER BAY NATIONAL HISTORIC PARK AND ECOLOGICAL PRESERVE

1.8 miles of shoreline cleaned!

Thank You Sponsors!



Tracey Saxby, IAN Image Library (ian.umces.edu/imagelibrary/)



### How do the 2018 Great Mangrove Cleanup data compare to 2016 beach cleanup data?

We compared the top 10 marine debris items collected in the 2018 Great Mangrove Cleanup to the top 10 marine debris items collected through territory-wide beach cleanups for 2016 (the year for which we have the most recent data). Many of the top 10 marine debris items collected along mangrove shorelines were the same that are found in large numbers along territorial beaches (e.g., plastic pieces, glass beverage bottles, plastic beverage bottles, and beverage cans; see Table 1). But, if the density of the top 10 marine debris items collected per mile of mangrove shoreline cleaned are compared to totals from a historical analysis of all territorial beach cleanups from 2008-2016, similarly normalized by mile of beach cleaned, we find that marine debris densities are much greater along mangrove shorelines compared to beaches (Table 2).

These results show that all USVI coastlines are vulnerable to marine debris, but that mangrove shorelines may be especially susceptible, either because of, (1) their location relative to potential marine debris sources (in this case, Bovoni Landfill); (2) their ability to collect more marine debris or different types of debris at higher rates compared to USVI beaches (e.g., red mangrove root structures may trap floating marine debris especially well); or (3) the low frequency with which they are cleaned, compared to USVI beaches. More data from additional mangrove cleanups are needed to tell which of these reasons best explain our results.

Table 1. Top 10 marine debris items collected during the 2018 Great Mangrove Cleanup and all 2016 territorial beach cleanups. The number in parentheses is the total number of that item collected.

Ranking	2018 Great Mangrove Cleanup	2016 Territorial Beach Cleanups
1	plastic beverage bottles (1,765)	metal bottle caps (4,994)
2	plastic pieces (1,000)	plastic pieces (4,524)
3	foam pieces (585)	plastic bottle caps (3,765)
4	beverage cans (417)	glass beverage bottles (3,532)
5	other plastic bottles (359)	plastic beverage bottles (3,432)
6	plastic bags (328)	food wrappers (2,946)
7	glass beverage bottles (307)	cigarette butts (2,858)
8	rope pieces (289)	straws/stirrers (2,516)
9	plastic cups (265)	beverage cans (2,368)
10	plastic food containers (201)	glass pieces (1,816)

Table 2. The density of marine debris items collected per mile of shoreline, comparing territorial beach cleanup data from 2008-2016 to the 2018 Great Mangrove Cleanup data.


Marine Debris Item	2008-2016 territorial beach cleanups	2018 Great Mangrove Cleanup	Magnitude of difference
plastic beverage bottles	170	1,177	6.9x greater
plastic pieces	61	667	11x greater
foam pieces	814	390	half as small
beverage cans	114	278	2.4x greater
other plastic bottles	16	239	14.6x greater
plastic bags	136	219	1.6x greater
glass beverage bottles	155	205	almost no difference
rope pieces	29	193	7x greater
plastic cups	23	177	8x greater
plastic food containers	98	134	almost no difference

## How Do The Data Compare?

### 2016 Territory Beach Cleanups versus 2018 Great Mangrove Cleanup

Similar types of debris were found in the mangroves as on beaches, but a comparison of the density of debris items per mile suggest mangroves are particularly vulnerable. This may be because of:

- 1** the mangroves' location relative to potential marine debris sources (next to the Bovoni Landfill and populated areas).
- 2** the mangroves' ability to collect more marine debris or different types of debris at higher rates compared to USVI beaches (it appears mangrove root structures trap floating debris especially well).
- 3** the mangroves' structure, they aren't cleaned as frequently as USVI beaches (they are harder to get to than most beaches and many people believe they are dirty, smelly and hard to clean).




**These items were more abundant in the mangroves**

- 7 x more pieces of rope
- 6.9 x more plastic beverage bottles
- 14.6 x more misc. plastic bottles
- 8 x more plastic cups
- 11 x more random pieces of plastic

**The top five marine debris items collected**

2018 Great Mangrove Cleanup	2016 Territory Beach Cleanups
#1 Plastic Beverage Bottles	#1 Metal Bottle Caps
#2 Plastic Pieces	#2 Plastic Pieces
#3 Foam Pieces	#3 Plastic Bottle Caps
#4 Beverage Cans	#4 Glass Beverage Bottles
#5 Other Plastic Bottles	#5 Plastic Beverage Bottles



VIRGIN ISLANDS **EPSCor**

Tracey Saxby, IAN Image Library (ian.umces.edu/imagelibrary/)



Marine debris along a less-frequented shoreline in the East End Marine Park, a marine protected area on St. Croix. Most of the marine debris that can be seen is plastic (Photo credit: Kristin Wilson Grimes).



# LESSON: Sources of Microplastics: Microbeads

This lesson was modified with permission from Oregon Sea Grant's "Bags, Bottles and Beads: Sources of Microplastics" lesson from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum. ([https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/mitigating\\_microplastics\\_-\\_lesson\\_one.pdf](https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/mitigating_microplastics_-_lesson_one.pdf))

**Grade Levels:** 5-8

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- Appendix F: Science & Engineering Practices

**Time:** ~60 min (1-2 class periods depending on class length)

**Description & Objectives:** These lessons are designed to be used after completing any of the Composition & Abundance lessons. Students will learn what microplastics are, where they come from, and their effect on the environment.

**Guiding Questions:**

- Where does marine debris come from?
- How does marine debris get into the ocean?
- How do microplastics impact the marine environment?

**Key Ideas & Concepts:**

- Microplastics are any plastic marine debris that is less than 5 millimeters and bigger than 1 nanometer.
- Microplastics come from personal care products, laundry lint, or from larger plastics that have been broken up or photodegraded into very small pieces.
- Approximately 80% of marine debris originates on land (litter, trash blown into the street) and the rest comes from the ocean-based sources (lost fishing gear, abandoned boats, dumped trash).

**Pre-Requisite Skills:** Students will need to understand the basics of what plastics are and the general idea of marine water movements (i.e., tidal activity, circulation, waves).

**Teacher Preparation:**

- This is an in-class activity where students will complete an observation-action cycle where they make observations about microplastics in a jar, change the habitat in the jars (shaking) and make new observations. Students will then use their observations to make predictions and explanations about what happens to microplastics in the ocean.
- Pre-label the jars, label half "A" and half "B". Fill the "A" jars with ~1 tablespoon of soap containing a plastic exfoliant, and the "B" jars with ~1 tablespoon of soap containing a natural exfoliant. Don't tell the students which jar contains which exfoliant.

**Materials Needed:**

- 2 jars that seal for each group or pair
- Water (enough for each group to fill their jars halfway)
- Liquid soap/face wash with plastic microbead exfoliators (here is a link to products with and without microbeads by country: <http://beatthemicrobead.org/en/product-lists>)\*
- Liquid soap/face wash with natural (non-plastic) exfoliators
- Cleanup space
- Coffee filters
- Jar/bucket for microbead disposal (prevents escape to the sea)

**\*Teacher Note:**

- This original lesson was created pre-2015. The United States Microbead Free Waters Act of 2015 has now gone into effect which bans microbeads in personal care products; most "beads" in face washes and other products are now water-soluble, so it's unlikely products with exfoliating, plastic microbeads are still available. However:
  - The plastic from previously-used products is still in the ocean and microplastics are still a problem.
  - While personal care products with plastic microbeads are banned in the U.S., there are many places around the world where microbeads are still used in these and other products. Microplastics are truly a global issue, still.
- Consider completing the activity using just face wash with natural exfoliators.
  - Have students observe and draw the particles, and then explain that some soaps used to have plastic instead of the natural materials.

- Ask students to imagine those particles were plastic, to get an idea of the number of microbeads that might enter the ocean from one product.
- Emphasize that there are other sources of microplastics that enter waterways, including plastic fibers from clothing, and that microplastics are generated all over the world.

### Teacher Instructions:

#### Introduction & discussion:

1. Have your students look around and write down all the plastic products they can find (give students 10-15 seconds to look around the room and record what they see). Ask students to share some of the items they recorded.
2. Ask students to think about the amount of plastics in their lives and what happens to those plastics when we are done using them. Ask them to think about what products might have or once had “hidden” plastic in them (microbeads).
  - **Guiding questions** (written or verbal discussion): Do you think there are a lot of plastics in this classroom? Do you think you use a lot of plastics in your everyday life? How many of those plastics do you use only one time (e.g., 16 oz plastic water bottles, sandwich bags)? How many of those plastics do you use multiple times? What products do you think could have or once had “hidden” plastic (microbeads)?
3. After students have completed the discussion and recorded their initial thoughts about plastic usage, talk with them about how microplastics are made. Be sure to mention:
  - Microplastic definition: plastic debris less than 5 millimeter in size and greater than 1 nanometer.
  - Three general types of microplastics: fragments, fibers, and beads.
  - Microbeads and fibers can be manufactured intentionally, but fragments are the result of larger pieces of plastic degrading and breaking down into smaller pieces over time.
  - Plastic microbeads are intentionally manufactured (not anymore in the United States, but still in other parts of the world) and are often used in personal care products like face wash and toothpaste. These flow down drains that eventually lead to the ocean, and have largely unknown consequences on the marine environment.
  - After nine states banned the manufacture and sale of products with microbeads, Congress passed the Microbead-Free Waters Act of 2015, banning the manufacture and sales of personal care products with plastic microbeads starting in 2017 in the United States. Still, many other countries in the world continue to use microbeads in these types of products.
  - Because of this ban, personal care products with plastic microbeads were no longer manufactured beginning in 2017 in the United States. The plastic from previously-used products, however, is still in the ocean and microplastics are still a problem. Microbeads contribute a small part of the total microplastics in the ocean. Synthetic fibers from clothes, as well as the fragmentation of large plastic marine debris, are important and present sources of plastic. Also, while products with plastic microbeads are banned in the U.S., there are many places around the world where microbeads are still used. Microplastics in all their forms, are truly a global issue.
  - Discuss what products contain plastics that they may or may not think about containing plastic (here is a link to products with and without microbeads by country: <http://beatthemicrobead.org/en/product-lists>). This can be done as a conversation or as a presentation with associated worksheets.
    - **Guided questions:** What are plastics made of? Which products contain or used to contain microplastics? Where do most microplastics in the ocean come from? What products used to (in the United States) or still do (in some other countries in the world) contain microbeads? Many microplastics float, but some sink. What are the implications for each in terms of where you are likely to find them (water column, versus sea floor) and the plants and animals using those environments? What might that mean for coral reef environments surrounding the U.S. Virgin Islands?

#### Experiment:

After the discussion/presentation, challenge your students to use their science skills to figure out which jar, A or B has the plastic in it. Teacher Note: If purchasing products in the United States, neither should, but you can choose two products with visually different exfoliants (ex: those containing natural fragments like walnut shells vs. those containing manufactured exfoliants like microcrystalline wax beads).

- Step 1: Ask your students to observe the two jars of soap and record everything they can see and smell. Remind them to not taste or touch the soap.
- Step 2: Ask your students to carefully fill each jar, A and B, halfway with water and put the lid on the jar. After they have filled the jar, ask them to record what they see. Have the soaps changed?
- Step 3: Ask your students to record what happens when they shake the jar. Remind them again, if necessary, to not taste the liquid.
- Step 4: Ask your students to think about and answer the following questions. You can use the provided worksheet, included at the end of this lesson, if you want to assign this as in-class work or homework.



- Step 5: Have your students filter out the microplastics using the coffee filters and look at the left-over material. Ask them to imagine those particles as plastic, to get an idea of the number of microbeads that might enter the ocean from one product. Explain how up until 2017 many of these commonly used personal care products contained microplastics (now, most are water-soluble beads). Reinforce that many countries still use plastic microbeads in these types of products.
- Step 6: Lead your students in a guided reflection about the activity.
  - Guiding questions: Have your students think about how much laundry gets done in their family (how frequently a washing machine is used at home or at a laundromat). Ask them to think about the type of things that may accidentally go through the wash (small plastic pieces, pens, etc.). How can these things contribute to the microplastics in the waste water? What about the detergent itself? Have your students think about other types of products they may use, such as face wash. Do their face washes have scrubbing elements in them? What about their toothpaste? Do they think those products once likely contained plastic microbeads or were they more likely to contain natural substances, like salt or sugar (this will depend on personal choices at the household level)? Do they think that microplastics get filtered out of household waste or gray water before it enters the environment, or not? How do we know? What would you do to find out? Help lead the students to understanding that many microplastics are found in waste and gray water and may not be filtered out before ultimately entering the ocean. Animals may later ingest the microplastics.
    - Optional activity: An active field of scientific research is understanding the potential impacts of microplastics on organisms, particularly marine organisms that people eat whole, like shellfish (e.g., oysters, mussels, clams). Have your students research the impacts of microplastics on these types of marine organisms and share back to the class.

**Teacher Note:** For more information about microplastics in local waters, please see *Spotlight: Microplastics - Danielle Lasseigne*.



U.S. Virgin Islands educators and participants from the 2016 Marine Debris Workshop work through the “Sources of Microplastics: Microbeads” activity (Photo credits: Kristin Wilson Grimes).

## Watershed Walk Worksheet

Modified from Oregon Sea Grant's "Bags, Bottles and Beads: Sources of Microplastics" lesson from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum.

1. What was different about the two soaps before you shook them up? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. What was different about the two soaps after you shook them up? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. What do you think happens to the plastic in soap after someone uses it to wash their face or hands? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. What do you think happens to microplastics (microbeads, fragments, and fibers) when they enter the ocean?
  - a. Do they sink or do they float? \_\_\_\_\_  
\_\_\_\_\_
  - b. Do they get eaten by wildlife? \_\_\_\_\_  
\_\_\_\_\_
  - c. Do they dissolve or go away? \_\_\_\_\_  
\_\_\_\_\_
5. In 2015, President Obama signed the Microbead Free Waters Act, which says that no company can make or sell personal care products with microbeads in the United States.
  - a. How do you think this will affect the amount of microplastics going into the Caribbean Sea?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  - b. How do you think this act affects the amount of microplastics already in the Caribbean Sea?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



# SPOT LIGHT

## Microplastics by Danielle Lasseigne

Microplastics are plastic particles (fragments or fibers) that range in size from 1 nanometer to less than 5 millimeters. Microplastic fragments and fibers are often the result of larger pieces of plastic degrading and breaking down into smaller pieces over time. Danielle Lasseigne became interested in researching microplastic impacts on marine animals, especially corals, when she started the Marine and Environmental Science Master's Program at the University of the Virgin Islands (UVI) in 2015. However, to understand the impacts of microplastics on corals, we have to know how much is in the surrounding environment, and only a few studies have quantified microplastics in the U.S. Virgin Islands. Therefore, her Master's thesis focused on quantifying microplastics in different coastal environments around St. Thomas (beaches and nearshore waters). She hypothesized that microplastics would be more abundant in embayments with associated watersheds that contained roadside dumpster sites and higher human population densities (referred to as high human activity sites), compared to embayments with associated watersheds without roadside dumpster sites and lower human populations (referred to as low human activity sites).

To test her hypothesis, she collected the top 1-2 cm of sand from beaches around St. Thomas and surface water samples using a Manta Tow net that was pulled along the surface of the water by a boat. Samples were collected from Magen's Bay, Brewers Bay, Lindbergh Bay, and Bolongo Bay (all high human activity sites), and Hendricks Bay, Perseverance Bay, Sandy Bay, and Sprat Bay (all low human activity sites). These samples were then taken to the Environmental Analysis Lab at the University of the Virgin Islands to separate microplastics from each of the samples.

Danielle found that microplastics in beach sand were most abundant at Lindbergh, Brewers, and Magen's Bays (all high human activity sites), but not Bolongo Bay. This was a surprise as Bolongo Bay had been considered a high human activity site. Also surprising, were the high abundances found at Sprat Bay, which had been classified as a low human activity site. When Danielle examined her water samples, she discovered they mostly contained



Danielle Lasseigne, formerly a Research Analyst for the Center for Marine and Environmental Science at the University of the Virgin Islands, collecting beach sand from Sprat Bay (a low human activity site) to be processed for microplastics for her master's thesis at the University of the Virgin Islands Marine and Environmental Science Master's Program (Photo credit: John Cassell).

microfibers and that high human activity sites had more microplastics than low human activity sites with the exception of Magen's Bay, which more closely resembled the low human activity sites.

Danielle thinks that local activities have a lot to do with the patterns she observed. Beaches that have a lot of visitors and few waste receptacles (e.g., Lindbergh Bay), coastal bays located near sewage treatment facilities, and have fishing and boating activities (e.g., Bolongo Bay), tended to have more microplastics. Now that she knows where microplastics are most abundant, she and other researchers can look in those areas more closely to understand the likely sources for the microplastics, track their abundance over time, and study their impacts on animals in the environment.





# IMPACTS



# LESSON: Entanglement Problems

The activity in this lesson was modified with permission from Oregon Sea Grant's "Getting Out of a Bind" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum, which was originally developed by the Center for Marine Conservation and the California Coastal Commission for "Save Our Seas, A curriculum for Kindergarten through the Twelfth Grade." (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/oimb-gk12-marine-debris-2.pdf>). Some guiding questions and discussion are sourced from two additional activities, "All Tangled Up," found in 'Turning the Tide on Trash' (<https://marinedebris.noaa.gov/turning-tide-trash>) and "Entanglement" found in 'Talking Trash and Taking Action' (<https://marinedebris.noaa.gov/talking-trash-and-taking-action>).

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- MS-ESS3-4:
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- HS-ESS3-4:
  - ESS3.C: Human Impacts on Earth Systems - Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
  - ETS1.B: Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary)
- Appendix F: Science & Engineering Practices

**Time:** 15-30 min depending on how many students you have

**Description & Objectives:** The goal of this lesson is to demonstrate what happens to animals that get trapped by some kinds of marine debris. Students will experience similar effects to those that happen to animals that get trapped. This activity works well as an engagement activity.

**Guiding Questions:**

- What types of animals are affected by marine debris?
- How does marine debris like fishing line and plastic bags impact marine life?
- How does marine debris impact ecosystems?

**Key Ideas & Concepts:**

- Marine debris can cause marine organisms to become entangled, suffocate and/or starve.
- Marine animals have different appendages than people and they must use different methods to escape entanglement; sometimes they are unable to escape.

**Pre-Requisite Skills:** Students will need to understand the types of animals that live in or use the marine environment around the U.S. Virgin Islands. Students will also need to understand why those major types of marine animals are important to the ocean.

**Teacher Preparation:** This in-class activity works best in pairs or groups depending on the amount of time and resources available.

**Materials Needed:**

- A rubber band for each student.
- Optional materials: plastic bags, string, shoelace, dental floss

**Teacher Instructions:**

Introductory discussion: Have an in-class discussion about the different types of animals we have living in and using the marine environment around the U.S. Virgin Islands (e.g., sea turtles, whales, dolphins, fish, crabs, sea cucumbers, fish, jellyfish, sea birds).

- **Guiding questions:** What types of large animals live in or use U.S. Virgin Islands coastal waters? How are these large animals important to the ocean and to people? Animals living in and using the marine environment encounter different kinds of plastics. How do you think these animals might react to these plastics being in their environment? What are the different ways you think plastics can interact with and harm marine animals?

Activity instructions:

1. Show class a photo or short online video of an entangled animal.
  - (Suggested: [https://oceanoday.noaa.gov/trashtalk\\_impacts/](https://oceanoday.noaa.gov/trashtalk_impacts/); stop at 0:32 seconds)
2. Ask for a volunteer, putting a rubber band or any other rope-like material around the back of the student's hand. Make sure that both their thumb and pinky finger are 'caught' in the material.
3. Pass out additional entanglement materials for the class to try. Have each student pretend their hand and arm is a marine animal. Some could be a bird, others could be a fish or sea turtle. To demonstrate how hard it is for animals to escape, have students place the elbow of their 'trapped' hand into their 'free' hand so they are not tempted to use their free hand to untangle themselves. They should try to escape the entanglement material without using any of their 'free' body parts (teeth, face, etc). Let the students struggle to free themselves for a few moments without any help from their peers. Letting the frustration build will give them a better sense of what marine animals are experiencing.
4. While the students are struggling, ask them to describe their experiences.
  - **Guiding questions:** How hard is it to get out of the rubber band or other objects? Is your hand/arm tired? How do you think you would feel if you had been struggling for longer, like a few hours? If this was your mouth, would you be able to eat? How do you feel when you miss a meal? What would happen if it continued all day and you were constantly fighting to free yourself? Now imagine you are lying in the water after struggling to get free and a predator finds you, what do you do? Do you have enough energy to get away? What if your wings/fins are also entangled, can you get away? Think about how our hands and arms are different than the wings of birds and fins of turtles. Think about how our elbows and knees bend compared to how the limbs of birds, turtles, and fish move. Do you think these differences will affect how they get untangled from marine debris like plastic bags, fishing lines, fishing nets, and ropes?
5. At the end of the time limit, check in and see who has successfully untangled themselves. Remind the students that while they may have gotten free, many animals will not.

Follow-up: After completing the activity:

- Have students complete the worksheet (included at the end of this lesson).
- Have students brainstorm different ways to reduce the amount of entanglement debris in the U.S. Virgin Islands.
- Have students critique the activity and make a list of suggestions to improve the assignment.

Additional Activities for Grades 9-12:

- Have your students try this on a larger scale. Have students compare and contrast the limb shape and function of five different marine organisms. Ask them to write or draw what would happen if they got entangled in a plastic bag, fishing line, or fishing net and how these experiences would differ depending on organism and marine debris type.
- Have your students visit a younger grade and help them with this activity. Have them help teach the differences between humans and marine organisms, emphasizing the directional bend of joints are different and that people have opposable thumbs.
- Have your students visit their librarian to understand how to access scientific research on the issue of entanglement or have them do a web search to look up studies. Ask them to synthesize information from 2-4 studies to present back to the class. Consider assigning different types of animals to different groups of students. Discuss with them how there is a lot of information for some types of animals and less for others. Ask them to consider what this might mean for science and conservation. Based on what they learn, have them validate reasons for safe disposal of trash and how that will save local wildlife.
- Have students participate in real-life experiences that allow them to interact with wildlife and foster environmental stewardship (e.g., turtle watching, public turtle tagging events, beach cleanups).

**Teacher Note:** For more information about how local marine life can be impacted by marine debris, please see *Spotlight: Marine Debris Impacts to Sea Turtles in the U.S. Virgin Islands*.



## **Entanglement Worksheet**

As you complete this worksheet, think about the entanglement activity you participated in.

1. What was causing your hand to be entangled? \_\_\_\_\_

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2. Were you able to get untangled without any help, or without using your teeth, face, hand, or other body parts? \_\_\_\_\_

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3. What materials found on U.S. Virgin Islands beaches could the rubber band represent?

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4. When you were doing the activity with one rubber band, did it make your hand/arm tired?

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5. What made you tired? \_\_\_\_\_

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6. What do you think would happen if you had more than one rubber band on multiple fingers?

a. Would you get tired faster? \_\_\_\_\_

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b. Would you be able to get yourself free without help if you had multiple pieces entangling you?

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## **Entanglement Worksheet Grades 9-12**

As you complete this worksheet, think about the entanglement activity you participated in.

1. What was causing your hand to be entangled? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
2. Were you able to get untangled without any help, or without using your teeth, face, hand, or other body parts? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
3. What materials found on U.S. Virgin Islands beaches could the rubber band represent?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
4. When you were doing the activity with one rubber band, did it make your hand/arm tired?  
\_\_\_\_\_
  
5. What made you tired? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
6. What do you think would happen if you had more than one rubber band on multiple fingers?
  - a. Would you get tired faster? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
  - b. Would you be able to get yourself free without help if you had multiple pieces entangling you?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
7. What do you think would happen if a frigate bird or tern got entangled in fishing line or a discarded fishing net? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  
8. What about fish or sea turtles? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



9. What would happen to the marine animals that feed in the coral reef if discarded fishing nets get wrapped around the coral? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. What are other things that marine animals can get tangled in? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
11. Think about things that we use or buy, like plastic bags; how can marine life be impacted by those? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
12. What are some things that we can do to reduce the amount of marine debris that causes entanglements of and other harm to marine life here in the U.S. Virgin Islands?  
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\_\_\_\_\_
13. How would you increase awareness about the issues of entanglement of and harm to wildlife because of marine debris, here in the U.S. Virgin Islands community? Also, what kind of activities would you suggest to someone who wants to be involved in reducing instances of entanglement of or harm to wildlife?  
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# SPOT LIGHT

## Marine Debris Impacts to Sea Turtles in the U.S. Virgin Islands

Sea turtles are among some of the most charismatic marine animals and are also among the most vulnerable to the impacts of marine debris. Sea turtles can become very easily entangled in derelict fishing nets and other fishing gear, constricting movement and sometimes preventing the turtle from surfacing for air, resulting in eventual drowning and death. Here in the U.S. Virgin Islands (USVI), sea turtles are at risk of entanglement with fishing gear

and other marine debris items, including shipping pallets. For example, several years ago, a green sea turtle became lodged between the panels of a shipping pallet and had to be rescued. But entanglement is not the only marine debris problem that sea turtles face. Of particular concern, is the sheer abundance of single-use plastic bags in the oceans. Of the four sea turtle species present within the U.S. Virgin Islands (green, leatherback, hawksbill, and loggerhead), the hawksbills, greens, and leatherback sea turtles, are known to prey upon jellyfish, which unfortunately, look a lot like free-floating plastic bags. When a turtle mistakes a plastic bag for a jellyfish and consumes it, the turtle may suffocate if the bag becomes lodged in its airway. Even if the turtle can swallow the plastic bag, it can't digest it, which may lead the turtle to starve, another unfortunate outcome for these endangered species. Fortunately, recent bans on single-use plastic items, like plastic bags, within the USVI could mean hope for sea turtles within the territory and the wider Caribbean. "The reduction of plastics in the environment will reduce the tragic and needless death of endangered sea turtles from entanglement or ingesting plastic," says Dr. Paul Jobsis, sea turtle researcher and Director of the Center for Marine & Environmental Studies at the University of the Virgin Islands.



University of the Virgin Islands alumna of the Masters in Environmental Science Program, Scott Eanes, shows a student from the Addelita Cancryn Junior High School on St. Thomas, a sea turtle from Brewers Bay, captured as part of a research program examining sea turtle movement patterns (all work is conducted pursuant to a National Marine Fisheries Service permit #15809). In the U.S. Virgin Islands and elsewhere, these endangered species are vulnerable to marine debris (Photo credit: Howard Forbes, Jr.).



# LESSON: Natural Disasters and Marine Debris

This lesson was inspired by Oregon Sea Grant's "Tsunami Debris Species Risk: A Bio Blitz!" lesson (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/bioblitz-tsunami-debris-species-lesson-plan.pdf>) from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum, which was originally sourced from "Aquatic Invasions: A Curriculum for West Coast Aquatic Invasive Species Education" created for Oregon Sea Grant by Jennifer Lam, Tania Siemens, and Sam Chan. It is used with permission from Oregon Sea Grant.

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-2:
  - Natural Hazards - Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.
- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- MS-ESS3-4:
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-1:
  - ESS3.A: Natural Resources - Resource availability has guided the development of human society.
  - ESS3.B: Natural Hazards - Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.
- Appendix F: Science & Engineering Practices

**Time:** 40-60 min

**Description & Objectives:** The goal of this lesson is to

demonstrate what happens when natural disasters collide with inhabited areas. Students have the ability to interact with scientific models to learn about weather/natural disasters.

**Guiding Questions:**

- How does marine debris move in marine ecosystems?
- How do natural disasters change how marine debris moves in a system?

**Key Ideas & Concepts:**

- Natural disasters can create and move large pieces of marine debris.
- Marine debris can help spread invasive species.

**Pre-Requisite Skills:** Students will need to understand water currents and wind patterns during normal weather. Students will need to be able to make comparisons between data/images presented to them.

**Teacher Preparation:** This in-class activity works best in pairs or groups depending on the amount of time and resources available.

**Materials Needed:**

- Internet access needed for hurricane simulator (<http://scijinks.jpl.nasa.gov/hurricane-simulation/>)
- Fact sheet for *Halophila stipulacea*

**Teacher Instructions:**

**Introduction & background:** As a discussion, brief lecture, or presentation, go over the following points with your class:

1. Natural disasters & marine debris:
  - In 2017, the U.S. Virgin Islands were devastated by unprecedented back-to-back category 5 hurricanes, Irma and Maria. These natural disasters created a great deal of debris; in fact, Irma and Maria generated as much trash as the U.S. Virgin Islands usually do within an entire year. Hurricane winds and rains distributed much debris across the entire island (images included). Any debris that wasn't collected and properly disposed of, ended up staying in the environment, including the ocean. Hurricanes are one natural disaster that regularly impact the U.S. Virgin Islands.
  - Due to seismic activity, earthquakes and tsunami waves are also disasters that can threaten the

Caribbean region. Though the U.S. Virgin Islands have not experienced a major tsunami since 1867, anywhere there is an earthquake nearby or underwater, there is a potential for a tsunami. Tsunamis can be generated by other activities that add large amounts of energy to the ocean, including landslides that could be triggered by hurricanes, flooding, or earthquakes. Tsunamis move away from the origin point and carry with them marine species and marine debris. The farther away the origin point from land, the more variety of species and marine debris there will be when the wave does meet a land mass.

- **Teacher Note:** For more information about tsunamis, please visit: <https://www.tsunami.noaa.gov/>

## 2. Invasive marine species:

- Invasive species are organisms that have physical traits that enable them to reproduce quickly and when they are introduced from elsewhere, overtake native species and out compete them for resources. Once established, it is very hard to remove them.
- In the U.S. Virgin Islands, there is an invasive species of seagrass (*Halophila stipulacea*) that is easily spread by human activity (e.g., boating). Optional: you can share the fact sheet included at the end of this lesson.
  - **Teacher Note:** For more information about invasive species, please visit: <https://oceanservice.noaa.gov/facts/invasive.html>

## 3. Connecting the dots - natural disasters and invasive marine species:

- Compared to nearshore areas, the open ocean is less productive. If nearshore species are swept out to sea by a natural disaster, those species are



A fishing net and other marine debris items washed ashore following Hurricane Maria in the East End Marine Park, a marine protected area on St. Croix, in November 2017 (Photo credit: Kristin Wilson Grimes).

less likely to survive for long periods. However, sometimes the nearshore species can hitch a ride on human-made debris rafts. Natural disasters can move marine debris rafts that may transport invasive species to new locations.

- The invasive seagrass in the U.S. Virgin Islands, *Halophila stipulacea*, could get caught on marine debris that gets moved around during natural disasters.
- Understanding how ocean and wind currents move in relation to natural disasters can allow scientists to predict where marine debris rafts will arrive at new areas after a natural disaster. In addition to weather data, scientists can use the size of the marine debris raft to create a mathematical model to predict the location and time the marine debris raft will encounter near shore areas.
  - **Guiding questions:** Ask the students if they think debris moves in specific patterns or if it moves randomly. NOTE: If you have already completed the Lesson: Investigating Oceanic Garbage Patches, you can have students think back to how gyres work.

Derelict vessels resulting from Hurricanes Irma and Maria in the St. Thomas East End Reserves, a marine protected area and NOAA priority watershed on the east end of St. Thomas (Photo credits: Kristin Wilson Grimes).





- If you haven't completed the lesson "Investigating Oceanic Garbage Patches", you can introduce the idea of marine debris movement now. Use videos to introduce:
  - The idea of how water flows around the globe (Ocean Heroes: What is a Gyre? by One World One Ocean, <https://www.youtube.com/watch?v=h6i16CrI8ss>)
  - How microplastics and some macroplastics move through the oceans (TRASH TALK by NOAA <https://marinedebris.noaa.gov/videos/trash-talk-what-great-pacific-garbage-patch-0>)
- After watching any of the videos, review (or teach) how water moves around the globe (earth movement and wind patterns contribute to the way water flows, and hurricane formation).

#### In-class activity & assignment:

Have the students complete the SciJinks hurricane simulation, available here: <http://scijinks.jpl.nasa.gov/hurricane-simulation/>. Have students run the simulation for each season and answer the following questions (worksheet included at the end of this lesson): As the high pressure system moves closer to the islands: (1) How do wind patterns around the U.S. Virgin Islands change? (2) How does the temperature change (look in the low pressure system cloud to find the temperature)? Think about how marine debris moves in the Caribbean Sea and the Atlantic Ocean: (1) How do you think the changing wind patterns affect where marine debris goes? (2) If a hurricane were to move across the U.S. Virgin Islands, where might debris end up? Think about what you know about invasive species. If there is a lot of marine debris in the ocean, is it possible for an invasive seagrass to get moved from one area to another during a hurricane?

#### Additional Activities for Grades 9-12:

- Have your students do some additional research on *Halophila stipulacea*.
  - Ask them to research how the species lives and how it moves from place to place. Then, go back to the simulation and determine where *Halophila stipulacea* would move to if it were attached to large marine debris items after hurricanes in each season: spring, summer, fall, winter.
- Incorporate a field trip to a meteorological or coastal data station. A great resource is Ocean and Coastal Observing Virgin Islands (OCOVI; <http://www.ocovi.org>), a St. Thomas-based organization that supports the Caribbean Coastal Ocean Observing System (CARICOOS; <https://www.caricoos.org>).
- Analyze local marine debris data before and after major local hurricanes (e.g., Hurricanes Hugo, Marilyn, Irma, and Maria). Data are hosted on the Virgin Islands Marine Advisory Service (VIMAS) website (<https://www.uvi.edu/community/virgin-islands-marine-advisory-service/st-thomas/coast-weeks.aspx>). Pre- and post-data for Irma and Maria can be gained by contacting VIMAS (Mr. Howard Forbes, Jr.: [howard.forbes@uvi.edu](mailto:howard.forbes@uvi.edu)).
- Have your students research how hurricanes and tsunamis are created, grow, and dissipate. Then, have your students make a hypothesis about the types of marine debris generated by hurricanes versus tsunamis, make predictions on how the mode of transportation might impact what types of marine debris end up where, and how that might make a difference for the types of invasive species that get around on marine debris during those events.
- The topic of natural disasters offers rich opportunities for the discussion of how scientists, government, non-profit organizations, and residents work together to respond, recover, and rebuild.
  - **Guided questions:** Who is responsible for natural disaster response and debris removal? Is it the federal or territorial governments' responsibility or someone else? How did local organizations and residents contribute to response efforts after Irma and Maria? Information can be found in the U.S. Virgin Islands Hurricane Recovery and Resilience Task Force report (<https://www.usvihurricanetaskforce.org>) and through the St. Thomas Recovery Team (<https://strtvi.org>).

#### **Teacher Notes:**

- As a result of the 2017 hurricanes, talking with some students about natural disasters may unleash many emotions. Educators can review resources produced by the American Psychological Association (APA) related specifically to the mental health impacts of natural disasters. Local psychological resources, some of whom are available to do guest lectures, include Insight Psychological Services, LLC (<https://www.insightvi.com>), Beautiful Dreamers (<https://www.beautifuldreamers.org>), and the St. Thomas Recovery Team (<https://strtvi.org>). Suggested APA links include <https://www.apa.org/topics/disasters/> and <https://www.apa.org/helpcenter/recovering-disasters.aspx>.
- For more information about the impacts of natural disasters on marine debris production, please see Spotlight: Marine Debris and Natural Disasters, Removal of Abandoned and Derelict Vessels following Hurricanes Irma and Maria in the U.S. Virgin Islands

### Natural Disasters and Marine Debris Worksheet

You will be completing a simulation about hurricanes. Please record your data as you use the simulation and answer the following questions. Here is the link for the simulation: <http://scijinks.jpl.nasa.gov/hurricane-simulation/>.

1. Record wind and temperature patterns for hurricanes from each season:

Season	Temperature	Wind Movement
Spring		
Summer		
Winter		
Fall		

2. How do wind patterns around the U.S. Virgin Islands change as the high pressure system (the hurricane) moves closer to the islands? \_\_\_\_\_

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3. How does the temperature change (look in the low pressure system cloud to find the temperature) as the high pressure system (the hurricane) moves closer to the islands?

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For the next few questions, think about how marine debris moves in the Caribbean Sea and the Atlantic Ocean.

4. How do you think the changing wind patterns affect where marine debris ends up after a hurricane? \_\_\_\_\_

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5. If a hurricane were to move across the U.S. Virgin Islands, where might the debris end up?

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Think about what you know about the invasive species *Halophila stipulacea* and its impacts on marine life in the U.S. Virgin Islands.

6. If there is a lot of marine debris in the ocean, is it possible for the invasive seagrass to get moved from one area to another during a hurricane? \_\_\_\_\_

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7. What is one way that we can help stop the spread of *Halophila stipulacea*?

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### **Natural Disasters and Marine Debris Worksheet Grades 9-12**

You will be completing a simulation about hurricanes. Please record your data as you use the simulation and answer the following questions. Here is the link for the simulation: <http://scijinks.jpl.nasa.gov/hurricane-simulation/>.

1. Record wind and temperature patterns for hurricanes from each season:

Season	Temperature	Wind Movement
Spring		
Summer		
Winter		
Fall		

2. How do wind patterns around the U.S. Virgin Islands change as the high pressure system (the hurricane) moves closer to the islands? \_\_\_\_\_

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3. How does the temperature change (look in the low pressure system cloud to find the temperature) as the high pressure system (the hurricane) moves closer to the islands?

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For the next few questions, think about how marine debris moves in the Caribbean Sea and the Atlantic Ocean.

4. How do you think the changing wind patterns affect where marine debris ends up after a hurricane? \_\_\_\_\_

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5. If a hurricane were to move across the U.S. Virgin Islands, where might the debris end up?

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Think about what you know about the invasive species *Halophila stipulacea* and its impacts on marine life in the U.S. Virgin Islands.

6. If there is a lot of marine debris in the ocean, is it possible for the invasive seagrass to get moved from one area to another during a hurricane? \_\_\_\_\_

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7. What is one way that we can help stop the spread of *Halophila stipulacea*?

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8. Do some additional research on *Halophila stipulacea*. Research how the species lives and how it moves from place to place. Then go back to the simulation and determine where *Halophila stipulacea* would move to if it were attached to large marine debris after hurricanes in each season:

a. Spring:

b. Summer:

c. Fall:

d. Winter:

For the next few questions, think about how marine debris moves in the Caribbean Sea and the Atlantic Ocean.

9. How do you think the tsunami wave affects where marine debris ends up?

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10. If a tsunami were to move north, across the U.S. Virgin Islands, where would the debris end up?

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11. If it moved south? \_\_\_\_\_

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12. If it moved east? \_\_\_\_\_

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13. If it moved west? \_\_\_\_\_

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14. Think about what you know about the invasive species *Halophila stipulacea*. If there is a lot of marine debris in the ocean, is it possible for the invasive seagrass to get moved from one area to another during a tsunami?

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# When Seagrass INVADES

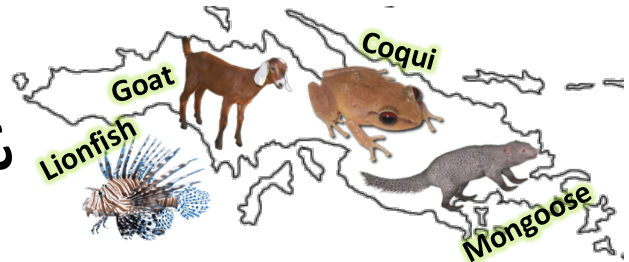
## Why are seagrass beds important?

- **They're a home** – They provide shelter to baby fish, snails, sea cucumbers, and crabs.
- **They're part of the food web** – They provide hunting grounds for other marine animals.
- **They're on your dinner plate** – Seagrasses support commercially-important seafood, like snapper, conch, and crabs.
- **They're something turtles love** – Turtles eat seagrass, tourists love turtles and our economy loves tourists!
- **They store carbon** – Seagrasses remove carbon dioxide from the atmosphere, helping to mitigate climate change.





## What is an invasive?

Invasive species are plants or animals that aren't native to the ecosystem, which can cause harm.

### Other St. Thomas Invaders



## What kinds of seagrass beds can you find in the USVI?

Native			Invasive
			
<b>Shoal Grass</b> <i>Halodule wrightii</i> 1-13 inches long thin, flat blades	<b>Turtle Grass</b> <i>Thalassia testudinum</i> 4-30 inches long wide, flat blades	<b>Manatee Grass</b> <i>Syringodium filiforme</i> 4-12 inches long round, thin blades	<b><i>Halophila stipulacea</i></b> 1-6 inches long short, paddle shaped blades

## What can you do to help slow the spread of *Halophila*?



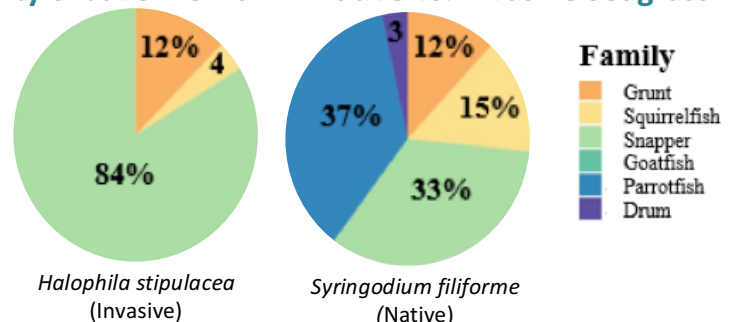
- Help us to increase awareness of this invasive species and the threats it poses!
- Use caution when boating to decrease its spread:
  - Use moorings and avoid anchoring, whenever possible
  - Turn off engines in shallow areas to decrease kicking up the seagrass

## What's so bad about *Halophila*?

Since its introduction to St Thomas in 2012, its presence has caused some problems:

- It outcompetes the native seagrasses and grows onto sand beds that stingrays and other species rely on for habitat
- It decreases the fitness of sea urchins that eat it
- It changes the food web (see below)

## Diversity of Juvenile Fish in Native vs. Invasive Seagrass



A healthier seagrass ecosystem contains more fish families.



**References:** Ocean Portal (2015) Smithsonian Institute. Retrieved from <http://ocean.si.edu/seagrass-and-seagrass-beds>  
 Willette, D. A., & Ambrose, R. F. (2009). The Distribution and Expansion of the Invasive Seagrass *Halophila stipulacea* in Dominica, We Indies, with a Preliminary Report from St. Lucia. *Aquatic Botany*, 91(3), 137-142. <http://doi.org/10.1016/j.aquabot.2009.04.001>  
 Seagrass images: Hs: F.T. Short, Hw: H.Hillewaert T: D. McShaffer SF: M. Davis, seagrass circle photo: Robert Zalog. Invasive photos: goat: longviewfarms.org, mongoose: z2downloadlibrary.wikia.com, lionfish: ww2.biol.sc.edu, coqui: themumble.wikia.com, STT map: www.maphill.com, megaphone: www.clipartbest.com. All other Symbols courtesy of the Integration and Application Network



# SPOT LIGHT

## Marine Debris and Natural Disasters: Removal of Abandoned and Derelict Vessels following Hurricanes Irma and Maria in the U.S. Virgin Islands

In September 2017, Hurricanes Irma and Maria made landfall in the U.S. Virgin Islands as Category 5 hurricanes, resulting in extensive damage to the territory and massive amounts of marine debris along its coastlines. These disasters triggered Presidential Disaster Declarations and a National Response Framework Emergency Support Function-10 (ESF-10) Mission Assignment (#4340DR-VI-USCG-06) by the Federal Emergency Management Agency (FEMA). The ESF-10 Mission Assignment included ~100 responders from the U.S. Virgin Islands Department of Planning and Natural Resources, the U.S. Coast Guard, the Environmental Protection Agency, the

National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, the U.S. Department of Agriculture, and several U.S. Coast Guard contractors. The ESF-10 Mission Assignment was tasked with two important responsibilities: (1) recovery and removal of pollution threats, and (2) physical removal of compromised vessels. From September 2017 to February 2018, 354 vessels were removed from St. Thomas, St. John, and St. Croix shorelines as part of the ESF-10 Mission Assignment. An additional 107 vessels were removed by owner, insurance, or another party, making the total number of vessels removed 461.

Why were some boats left behind? ESF-10 funding can only be used for boats determined to be damaged or sunk as a direct result of Hurricanes Irma and/or Maria. In addition, ESF-10 funding cannot be used for boats that (1) are on federal lands, and (2) have insurance that includes a salvage rider. The total number of vessels left in place totalled 18 across the U.S. Virgin Islands.

Unfortunately, just two years later in August 2019, Hurricane Dorian caught many boaters unprepared when it spun up as a Category 1 hurricane over the U.S. Virgin Islands, creating a number of new abandoned and derelict vessels that now must be removed. Removal is important as vessels may harm important coastal habitats like mangroves, seagrasses, and coral reefs.



A vessel capsized onto red mangroves in the St. Thomas East End Reserves (STEER), as a result of the 2017 hurricanes, Irma and Maria. STEER is a marine protected area and this area is a government-designated boat safety sanctuary area during storms (Photo credit: Kristin Wilson Grimes).





Old City Mangrove Lagoon, St. James, and Compass Point  
Marine Reserves and Wildlife Sanctuaries

# SOLUTIONS



# LESSON: Linked Beach-Ghut Cleanups

Some guided questions in this lesson were used with permission from Oregon Sea Grant's "Creating and Using "Beach Boxes" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/beach-boxes.pdf>). Other guided questions and activities in this lesson were adapted from NOAA's Turning the Tide on Trash curriculum (<https://marinedebris.noaa.gov/turning-tide-trash>). The Ocean Conservancy data sheets are included with permission.

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-1:
  - ESS3.A: Natural Resources - Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.
- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Appendix F: Science & Engineering Practices

**Time:** Half day for beach cleanup, half day for ghut cleanup, 1-2 class periods for in-class discussion.

**Description & Objectives:** Utilizing field work and in-class activities, students will learn to identify, sort and classify marine debris in the Virgin Islands.

**Guiding Questions:**

- What is marine debris?
- Where is marine debris found?
- Do the physical traits of marine marine debris affect how it gets from its point of origin to the beach?

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed that is then disposed of or abandoned in the marine environment.
- Marine debris is mostly plastic that people use.
- Marine debris is preventable as most of it comes from land-based sources.

**Pre-Requisite Skills:** Students will need to understand the basics of what makes up different materials (e.g., plastics, natural materials), the general idea of marine water movements (i.e., tidal activity, circulation), and the water cycle.

**Teacher Preparation:** Identify a beach that has a ghut that empties into it or very near to it. This can be done using a mapping application on your phone or computer. Make sure that both the beach and ghut are accessible for students and that you have permissions to clean both, if you want to do a linked cleanup.

**Materials Needed:**

- Cleaning materials for safely picking up and removing debris.
- Data sheets for recording marine debris data; we like the data sheets available through the Ocean Conservancy ([https://oceanconservancy.org/wp-content/uploads/2019/05/OC-DataCards\\_volunteerFINAL\\_ENG.pdf](https://oceanconservancy.org/wp-content/uploads/2019/05/OC-DataCards_volunteerFINAL_ENG.pdf)) for consistency with those that are used during U.S. Virgin Islands Coastweeks (beach cleanups) held each fall (also included at the end of this lesson).
- Clip boards and pencils.

**Teacher Instructions:**

**Introduction & background:** An engaging way to introduce this topic is to show students a mapping website that has topographical features on it (similar to Google Earth). You can ask them to describe the area around where they are going to do the beach and the ghut cleanup.

- **Guiding question:** Where are the beach and the ghut in relation to each other?

Next, have an in-class discussion about marine debris prior to attending the cleanup.

- **Guiding questions:** What do you think marine debris is? Do people in the Virgin Islands need to worry about it or not? Where can you find marine debris? What or who do you think creates the most marine debris in the Virgin Islands?



After the class has described the area, this is a good time to define/describe/review what a watershed is. The general definition of a watershed is an area of land that drains into a specific body of water. Have the students relate the description of a watershed back to the previous discussion about the area around where the cleanups are going to happen.

- **Guiding questions:** Is the area part of a watershed? How can you tell? What will happen to items that are improperly disposed of? Where will they eventually end up?

This is also a good time to remind students about the definition of marine debris.

- “Marine debris is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.”

#### Beach & ghut cleanup:

Organize your own or attend a linked beach-ghut cleanup and ask students to record the marine debris they collect. See the data card we like to use in the materials section of this lesson. Review with students, as needed, the difference between marine debris and natural debris items. You can emphasize that most marine debris is plastic and comes from land-based sources, globally. This is also true in the U.S. Virgin Islands. Most marine debris items on U.S. Virgin Islands beaches are plastics and either are disposed of on the beach itself or are disposed of elsewhere on land, then make their way to the beach.

- **Guiding questions:** What makes something human-made vs. natural? How can you tell when you find something, what it is? What traits (evidence) did you use to decide this? How might debris found in the ghut differ from what will be found on the beach? Do you notice if there are any protected areas or private property near the beach or ghut you are cleaning up? Do you think the type of property that an area of land is (e.g., private, public, or protected) affects the type of marine debris that is found there?

**Teacher Note:** *Some areas require special permission to walk through and collect data. If you are doing a linked beach-ghut cleanup, find out if it is a protected area or part of private property. You may need to get special permitting or permission to have cleanups in those areas.*

In-class activities and discussion: When you get back to the classroom:

1. Ask the students to share something they found interesting while cleaning up the beach and the ghut.
2. Show or reshoot the NOAA Video “TRASH TALK: Where Does Marine Debris Come From?” (<https://www.youtube.com/watch?v=FN9FF7VH4ig>).
3. Think about the video and their cleanup experience. Have students think about how trash moves across the landscape here in the U.S. Virgin Islands and how trash produced higher up in the watershed moves down through ghuts and storm drains to the ocean. Emphasize the ridge-to-reef connection.
4. Show them a map of the area they cleaned-up and show them the map of a similar area on a different island. Have the students share some similarities and differences they can spot between the two areas. Ask the students how differences in elevation may change how the flow of trash, oil, and dirt move through a watershed. How is topography similar or different in the two areas selected?
  - **Guiding questions:** What questions do you have about how marine debris may have arrived at your study site? Could the ghuts be part of the cause? Why or why not? What about storm drains? Why or why not? How is topography similar or different across the two areas? How might that influence marine debris found in both areas?

**Teacher Note:** *Emphasize the ridge-to-reef concept (the interconnected nature of the land and the sea in the U.S. Virgin Islands) and that activities we do on land impact nearshore and coastal environments.*

#### Assessment and evaluation:

- Have students complete the linked cleanup worksheet (included).
- Have students view online data (<http://www.marinedebris.engr.uga.edu/list/>) and compare the results of those areas to the areas your class cleaned-up. Also have them compare the U.S. Virgin Islands to other coastal areas (Florida, Oregon, Mexico, Australia). What are the similarities and differences between those places and the U.S. Virgin Islands?
- Alternative: Students could investigate the International Coastal Cleanup data (<https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/annual-data-release/>) and compare worldwide trends to the U.S. Virgin Islands. Have students hypothesize which areas might have more debris based on potential sources, pathways and regulations governing trash. Have students research regulations governing trash in the U.S. Virgin Islands and compare those to regulations in different parts of the world.

Additional activities for grades 9-12: Have students pick three different places around the world. Have them investigate and compare the top 10 types of marine debris found in those places, then research potential pathways (e.g., major rivers in those areas) that might connect land-based sources of debris to the ocean. Finally, have them research the regulations governing trash and those regions then report their findings to their classmates. Compare and contrast different regions from around the globe. Use International Coastal Cleanup data (<https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/annual-data-release/>).

**Teacher Notes:**

- Try to reduce the amount of debris generated by the cleanups, by using reusable sacks or buckets, rather than plastic garbage bags, and reusable gloves. If disposable gloves must be used, try to limit to one hand per student (dominant hand for picking up items).
- For more information about local efforts to reduce marine debris read *Spotlight: Virgin Islands Marine Advisory Service Coastweeks* and *Spotlight: Plastic Free July in the VI: The Summit on St. John*.
- For inspiring stories of local solutions to marine debris read the *Spotlight: Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands*, and the five associated spotlights.



Local students participate in beach cleanups at Brewers Bay Beach, St. Thomas as part of the annual Coastweeks activities that happen each fall in the U.S. Virgin Islands (Photo credit: Howard Forbes, Jr.).



Students and mentors from the 2019 Youth Ocean Explorers Program (run by the Virgin Islands Marine Advisory Service) conducting a beach cleanup, collecting data, and having fun at Brewers Bay Beach, St. Thomas (Photo credit: Howard Forbes, Jr.).



## Linked Beach-Ghut Cleanup Worksheet

1. Think about how we discard our trash. What types of trash are thrown away at the roadside dumpsters? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- a. What do you think happens to this trash on a really rainy day, or during the rainy season?  
\_\_\_\_\_  
\_\_\_\_\_
- b. What do you think happens when your trash falls out of the dumpster, or is left next to the dumpster rather than in it? \_\_\_\_\_  
\_\_\_\_\_
  
2. Think about the two different areas you cleaned-up, refer to your data cards if you need to refresh your memory.
- a. What were the most frequently collected items from the beach cleanup?  
\_\_\_\_\_  
\_\_\_\_\_
- b. What were the most frequently collected items from the ghut cleanup?  
\_\_\_\_\_  
\_\_\_\_\_
  
3. Think about the geography of the areas you cleaned up. Is the area around the beach open or secluded?
- a. Does the beach have a lot of plants nearby making a hidden/shaded area?  
\_\_\_\_\_
  
- b. Is the area around the ghut open or secluded? \_\_\_\_\_  
\_\_\_\_\_
  
- c. Does the ghut have a lot of plants nearby making it hidden? \_\_\_\_\_  
\_\_\_\_\_
  
4. Looking at your responses to question 3 above, how do you think the differences in the area (open vs. secluded) influence the type of trash that enters the ghuts and the beach? Why or why not?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



# VOLUNTEER

## OCEAN TRASH DATA FORM



Ocean and waterway trash ranks as one of the most serious pollution problems choking our planet. Far more than an eyesore, a rising tide of marine debris threatens human health, wildlife, communities and economies around the world. The ocean faces many challenges, but trash should not be one of them. Ocean trash is entirely preventable, and data you collect are part of the solution. The International Coastal Cleanup is the world's largest volunteer effort on behalf of ocean and waterway health.

### HERE IS HOW IT WORKS:



#### SITE INFORMATION:

Cleanup Site Name:

State or Province:  Zone or County:

Country:  Nearest Crossroad or Landmark:

#### NUMBER OF VOLUNTEERS WORKING ON THIS CARD:

adults children (under 12)

#### MOST UNUSUAL ITEM COLLECTED:

#### TYPE OF CLEANUP:

Land:  Underwater:  Watercraft:

#### DATE:

#### GO PAPERLESS!

Collect and record your data on **Clean Swell!**

Download the free app on your mobile device.



#### Please return this form to your area coordinator.

If you are unable to do so, please mail or email it to:

Ocean Conservancy  
Attn: International Coastal Cleanup  
1300 19th Street, NW, 8th Floor, Washington, DC 20036  
cleanup@oceanconservancy.org

Trash Free Seas: [www.oceanconservancy.org/cleanup](http://www.oceanconservancy.org/cleanup)  
Be a Green Boater: [www.oceanconservancy.org/do-your-part/green-boating](http://www.oceanconservancy.org/do-your-part/green-boating)  
Sponsors: [www.oceanconservancy.org/cleanupsponsors](http://www.oceanconservancy.org/cleanupsponsors)  
Clean Swell: [www.oceanconservancy.org/cleanswell](http://www.oceanconservancy.org/cleanswell)



# TRASH COLLECTED

**Citizen scientist:** Pick up all trash and record all items you find below. No matter how small the items, the data you collect are important for Trash Free Seas.<sup>®</sup>

**EXAMPLE:**

Plastic Bags:

||||| |||

TOTAL #

↓  
= 8

Please DO NOT use words or check marks. Only **numbers** are useful data.

**MOST LIKELY TO FIND ITEMS:**

TOTAL #  
↓

Cigarette Butts: =

Food Wrappers (candy, chips, etc.): =

Take Out/Away Containers (Plastic): =

Take Out/Away Containers (Foam): =

Bottle Caps (Plastic) =

Bottle Caps (Metal) =

Lids (Plastic) : =

Straws/Stirrers: =

Forks, Knives, Spoons: =

Beverage Bottles (Plastic): =

Beverage Bottles (Glass): =

Beverage Cans: =

Grocery Bags (Plastic): =

Other Plastic Bags: =

Paper Bags: =

Cups & Plates (Paper): =

Cups & Plates (Plastic): =

Cups & Plates (Foam): =

**FISHING GEAR:**

TOTAL #  
↓

Fishing Buoys, Pots & Traps: =

Fishing Net & Pieces: =

Fishing Line (1 yard/meter = 1 piece): =

Rope (1 yard/meter = 1 piece): =

**PACKAGING MATERIALS:**

TOTAL #  
↓

6-Pack Holders =

Other Plastic/Foam Packaging: =

Other Plastic Bottles (oil, bleach, etc.): =

Strapping Bands: =

Tobacco Packaging/Wrap: =

**OTHER TRASH:**

TOTAL #  
↓

Appliances (refrigerators, washers, etc.): =

Balloons: =

Cigar Tips: =

Cigarette Lighters: =

Construction Materials: =

Fireworks: =

Tires: =

**PERSONAL HYGIENE:**

TOTAL #  
↓

Condoms: =

Diapers: =

Syringes: =

Tampons/Tampon Applicators: =

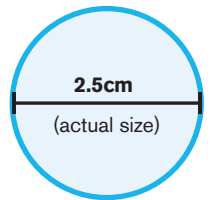
**TINY TRASH LESS THAN 2.5CM:**

TOTAL #  
↓

Foam Pieces =

Glass Pieces =

Plastic Pieces =



DEAD/INJURED ANIMAL	STATUS	ENTANGLED	TYPE OF ENTANGLEMENT ITEM
	Dead or Injured	Yes or No	

**ITEMS OF LOCAL CONCERN:**

1. 2. 3.

**CLEANUP SUMMARY (circle units)**

Number of Trash Bags Filled:  Weight of Trash Collected:  lbs/kg Distance Cleaned:  miles/km



# SPOTLIGHT

## Virgin Islands Marine Advisory Service Coastweeks

The Virgin Islands Marine Advisory Service (VIMAS) participates in The Ocean Conservancy's annual International Coastal Cleanup, locally known as Coastweeks, and has done so since 1990 throughout the U.S. Virgin Islands. VIMAS is part of the University of Puerto Rico's Sea Grant College Program and conducts marine outreach programs at the University of the Virgin Islands and in the broader U.S. Virgin Islands community. Coordinators Marcia Taylor and Howard Forbes, Jr., facilitate cleanup activities on St. Croix and St. Thomas/St. John, respectively. As coordinators, they understand the issue of marine debris and have coupled cleanup activities with classroom presentations, ensuring that students are first aware of the problem and then turn that knowledge into action to help address the issue. Every year hundreds of volunteers walk the beaches to pick up trash and record the types and number of items collected.



The St. Thomas Coordinator for the Virgin Islands Marine Advisory Service, Howard Forbes, Jr., and then Ivanna Eudora Kean High School para-professional teacher Marie Paul, working together to tally and remove debris collected at Lindberg Bay (Photo Credit: Jarvon Stout).

Taylor says about Coastweeks, "There is still plenty of trash on the beaches, and there is still a need to do cleanups, but there are also hundreds of people who now have an increased understanding of the problem and will likely work to keep trash off the beaches because of their participation in Coastweeks."

Through their efforts and those of all the volunteers, data collected have been provided to natural resource managers and to the local Legislature of the Virgin Islands to support data-driven policies that address marine debris at its source.

"It makes me proud to be involved in Coastweeks and to help push our territory forward towards cultivating a new generation of environmental stewards," said Forbes, Jr.

A group photo of participants at the Coastweeks kick-off cleanup at Brewers Bay in 2016 (Photo Credit: Jarvon Stout).





# SPOTLIGHT

## Plastic Free July in the VI: The Summit on St. John

In the Summer of 2017, Plastic Free St. John, the Island Green Living Association, and the Plastic Pollution Coalition, hosted their first Plastic Free Island Summit on the island of St. John. The summit brought together more than 100 individuals who attended meeting sessions or related awareness activities, revolving around impacts and solutions to plastic pollution, including marine debris. Fifteen presentations were made at seven different local venues. Collectively, more than 20 organizations,

The founder of the Bahamas Plastic Movement Kristal Ambrose collecting debris from a beach (Photo Credit: Jarvon Stout).



Youth Ocean Explorer students tallying marine debris collected during a beach cleanup event as part of the Plastic Free Island Summit events (Photo credit: Jarvon Stout).

businesses, and members of the U.S. Virgin Islands Legislature participated in the event. In addition to lectures, 14 local restaurants/establishments were recognized for pledging “No Plastic Straws in 2016,” as part of their commitment to reduce unnecessary disposable plastic across the island of St. John. Students from the Youth Ocean Explorers Summer Program based on St. Thomas were engaged in the summit by participating in educational activities led by Kristal Ambrose, Founder and Director of Bahamas Plastic Movement. This environmental non-profit engages youth in plastic pollution activism through research, education, citizen science, and policy change.

“It was such a pleasure to be a part of this movement as youth from all across the world gather to utilize creative approaches to tackle the issue of marine debris,” Ambrose said about the Summit.



# LESSON: Mitigating Microplastics

This lesson was inspired by Oregon Sea Grant’s “Mitigating Microplastics” lesson from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum. It is used with their permission (<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/mitigatingmicroplasticscurriculum.pdf>).

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- HS-ESS3-4:
  - ESS3.C: Human Impacts on Earth Systems - Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
  - ETS1.B: Developing Possible Solutions - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*secondary*)
- Appendix F: Science & Engineering Practices

**Time:** 60 min + implementation time

**Description & Objectives:** Use scientific data to craft a way to reduce microplastics. Students will talk about the costs and benefits of their solutions to the marine environment and the people who use it.

**Guiding Questions:**

- What are microplastics?
- How are microplastics made?
- What are ways we can reduce microplastics?

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Microplastics come from personal care products, laundry lint, or from larger plastics that degrade and break up into smaller pieces.
- Microplastics are any plastic marine debris that is less than 5 millimeters and larger than 1 nanometer.

**Pre-Requisite Skills:** Students will need to have an understanding of microplastics, what makes up plastics and some ideas about preventing marine debris.

**Teacher Preparation:**

- Inside 4-5 folders write the questions: What’s the problem with microplastics? Can we stop using plastic? Why or why not? Do you think plastics are good or bad? Why? How does plastic affect the ocean? Do you think we can clean up all the plastic in the ocean? Why or why not?
- Put students in groups of 2-4 (this may vary depending on the project). Make copies of Student Solutions Guide pages (included at the end of this lesson) for each group of students, and place each set in a folder for easier distribution. Make copies of “Designing Solutions to Microplastics: Graphic Organizer”, for each student (included at the end of this lesson).

**Materials Needed:**

- Notebooks
- Folders/large paper
- Markers/crayons/colored pencils
- Chart paper
- Folders with printed “Student Solutions Guide” and “Designing Solutions to Microplastics: Graphic Organizer” (1 for each student)

**Teacher Instructions:**

Define the problem:

1. Place the folders with questions open around the room.
2. Tell the students that there are five folders around the room with discussion questions. They are going to have a silent discussion (similar to a silent auction) about microplastics. Take a pencil and respond to the question on the folder. If someone else has already responded, write a response to that person or write a separate thought. Make sure to read everything before choosing how to respond.

3. Have your students circulate around the room, responding to the question or a comment made by another student. Give students 3-4 minutes at each question, depending on their pace.
  - **Teacher Note:** If you prefer students to discuss, each group can discuss aloud before writing on the folder.
4. Give students time to revisit their first station and read the responses, then debrief with the class.
  - **Guiding questions:** What surprised you? Is plastic in the ocean an easy problem to solve? What makes it easy or difficult? Why is it important to discuss issues like microplastics with people who have different opinions? How do you feel about this problem?

Group solution project design:

1. Next, give each group the “Student Solutions Guide” folders with existing projects and actions people have taken to reduce microplastics in the ocean. (Feel free to mix up the groups at this point).
2. Challenge the groups to develop a solution to the problem of microplastics. Remind students that every individual, no matter their age, is able to make a change in their environment, and your actions regarding plastics can contribute to or reduce the amount of microplastics in the environment.
3. In their groups, have the students review some solutions from the folders, and then come up with their own ideas to reduce microplastics. It is important that the solutions that the group develops are effective and that you are able to actually make this change (e.g., building a machine to clean up the gyre may not be feasible for this project). Teachers are encouraged to help students choose projects that are feasible but ambitious.
  - Students can use the “Designing Solutions to Microplastics: Graphic Organizer” (included at the end of this lesson) to guide their conversation about a feasible, actionable solution to microplastics.
  - Students should discuss each section of the graphic organizer, and each student writes the group’s thoughts in his or her notebook.
4. Have students create a presentation for their solution and explain it to the other groups.
  - **Teacher Notes:**
    - Presentations can be formal or informal, depending on the amount of time you have to spend on this lesson
    - Students can give feedback on each other’s ideas.
5. Optional extension: Have your students implement their ideas, or choose one idea to implement as a group! The solutions can be implemented within the classroom or community. This can be done in a variety of ways, depending on your school. The implementation phase gives students a sense of empowerment around the issue of microplastics, which can seem daunting. Building community, promoting awareness, and taking concrete actions help students think about their world differently.

Debrief: Have a discussion with your students when they are done sharing their project ideas.

- **Guided questions:** What are some challenges in designing a solution to microplastics? What were the challenges in implementing your solution? What was easy about it? What was challenging? Why do you think it’s important to think about issues like microplastics?

Additional activities for grades 9-12: Have your students research how microplastics are being replaced with natural alternatives or removed around the world. Have them determine if any of these methods are feasible in the U.S. Virgin Islands. If they are not currently feasible, have students research what would need to be done to make these methods a reality in the territory.

- Students can present their findings to their classmates and other classes. This could be a good project to team up with a class in a different content area. Have your marine science students work with chemistry and business students to determine what would need to be done to have the mitigation methods become a reality.

**Teacher Note:** For inspiring stories of local solutions to marine debris read the Spotlight: Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands, and the five associated spotlights.





## **Designing Solutions to Microplastics: Graphic Organizer**

Use the graphic organizer below to help you develop a possible solution to microplastics. Think about the plans costs and benefits as well as it's feasibility (if it's possible).

The Problem		
<i>What are microplastics?</i>	<i>How do microplastics get in the ocean?</i>	<i>What is the problem with microplastics?</i>
Our Solution		
<i>What solution did your group decide on?</i>	<i>What made you decide on this solution?</i>	
Evidence to Support our Solution		
<i>What evidence supports your solution?</i>	<i>What evidence does not support your solution?</i>	
Costs and Benefits		
<i>Costs of your solution:</i>	<i>Benefits of your solution:</i>	

## **Student Solutions Guide**

### **Glossary**

- Dilute – Less concentrated because water has been added to it
- Degradation – The process of objects breaking down; in the case of microplastics, by UV waves (photodegradation)
- Ecosystem – All the living organisms and non-living things in an environment
- Estuary – An area where freshwater and salt water mix
- Fragment – To break down into smaller pieces Impacts – The effects of something, either positive or negative
- Manta trawl – A net with floats and a bottle at the end to capture small particles at the surface of the ocean
- Marine Debris – Any trash or other solid material that ends up in the ocean or the Great Lakes without a purpose
- Microbes – Tiny organisms that live everywhere on Earth
- Microbeads – Tiny plastic particles added to many types of personal care products
- Microplastics – Plastic marine debris that is less than 5 mm
- Nurdles – Small, pre-manufacture plastic pellets
- Plastic – Manufactured long chains of hydrocarbons, often derived from natural gas or petroleum
- Polyethylene – The most common type of plastics, with a wide variety of uses, including packaging, shopping bags, and clothes
- Prey – An animal that is eaten for food
- Organism – A living animal, plant, or single-celled creature
- Sink – Where something ends up
- Surface Area – The area of the outermost layer of an object
- Toxin – Poisonous substance
- Weathering – Mechanical weathering is the process of breaking down materials into smaller piece



### Solution: Individual Actions

Recycling, placing waste in the proper place, and using reusable bags are all examples of actions people can take to reduce the amount of plastic entering rivers and the ocean. These are not the only possible actions!

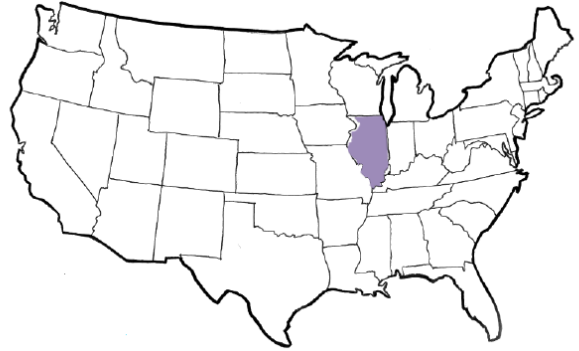
Things to think about:

- What other things can individuals do to reduce the amount of plastic entering the ocean?
- Will individual actions make a difference?
- What are you already doing to reduce the amount of plastic entering the ocean?
- How can you use individual actions to start bigger group actions?

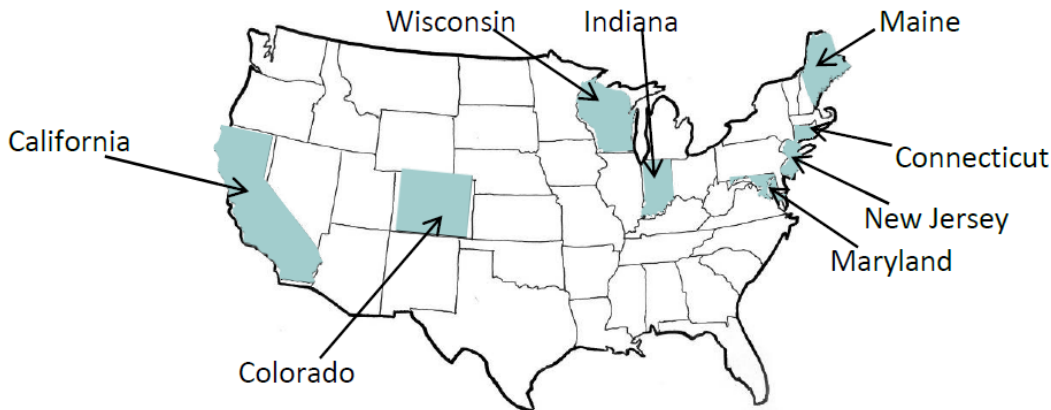
## Solution: Making Laws

A possible solution to microplastics is to make laws that stop companies from making and selling microplastics. If we don't use them, they won't go into the ocean, right?

In June 2014, Illinois was the first state to pass a law banning the manufacture and sale of microbeads in personal care products (face wash, soaps, etc.).



These states have also passed laws that restrict products with microplastics.



### President Obama Signs *Microbead-Free Waters Act of 2015*

December 28, 2015

Washington D.C. – A federal law was passed and signed by President Obama that bans the production and sale of personal care products with plastic microbeads. Some personal care products, such as toothpaste and face wash, have plastic microbeads that can go down the drain and into the ocean. Scientists are not sure how these small plastic beads affect the ocean environment. To stop more plastic from entering the ocean, Congress decided to ban personal care products with microbeads, starting in 2017. Nobody will be allowed to make or sell personal care products with microbeads anywhere in the United States.

Things to think about:

- How will this help the problem with microplastics?
- How can students help with this?
- Why is it important for many people to work together to stop microplastics from entering the ocean?



## Solution: Education

### *From the Field*



*Photo Credit: Marcus Eriksen*

*Name:* Marcus Eriksen

*Career:* Director of Research and Co-founder of 5 Gyres, an organization that works to end plastic pollution in the ocean. They study marine debris, educate people about the issue, and work with people making laws.

*Education:* PhD in science education from the University of Southern California

*Research:* Marine debris

*Notes:* In 2014, Marcus was part of a team that published a paper about the amount of plastic in the ocean. They estimated that there were more than 5 trillion pieces of plastic floating in our ocean! Marcus says a big part of his job is “myth-busting.” Many people think there is a big garbage patch floating in the ocean, but Marcus has said it’s more like “plastic smog.” As with air pollution, it’s a difficult task to clean up plastic in the ocean. That means that we will have to work together to come up with creative solutions to plastic marine debris. 5 Gyres works to stop marine debris through educating students, decision-makers, and people who can help reduce marine debris (that’s everyone!). Marcus feels that his job is rewarding, and that working to prevent marine debris is the right thing to do.

#### *Advice:*

1. Explore your core values to find what is important to you
2. Be part of a team
3. Commit to your cause

#### Things to think about:

- Why is it important to work as part of a team?
- How can you get people to understand microplastics?
- What is the most important thing people need to know about microplastics?

# LESSON: Upcycling Plastics

This activity was modified with permission from Oregon Sea Grant's "Upcycling" activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum

(<https://oregoncoaststem.oregonstate.edu/sites/oregoncoaststem.oregonstate.edu/files/MD/upcycling-lesson.pdf>)

which was inspired by Sara Wiener (<https://www.youtube.com/watch?v=sIHF1o9wvk0>).

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ETS1:
  - 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.
  - ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- HS-ETS1:
  - ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
  - ETS1-2. Design a solution to a complex real-world problem by breaking down into smaller, more manageable problems that can be solved through engineering.

**Time:** Prep: 1-2 hrs; Activity: 1-2 class periods

**Description & Objectives:** This lesson is designed to be used after completing any of the Composition & Abundance, Sources & Transport, and Impacts lessons. Students will reflect on how much plastic is part of their daily lives and explore creative ways to upcycle plastic bags and other thin, plastic materials into upcycled products to prevent them from potentially becoming marine debris.

**Guiding Questions:**

- How can people prevent marine debris from getting into the ocean?
- How can people get involved in marine debris solutions?

**Key Ideas & Concepts:**

- Personal behaviors can influence the amount of marine debris.
- Reducing, reusing, recycling, and upcycling can decrease the amount of marine debris.

**Pre-Requisite Skills:** Students will need to understand the basics of what plastics are and have basic sewing and mathematical skills.

**Teacher Preparation:**

- For this activity, many discarded, clean plastic bags or other thin plastic materials are needed. You or your

students will, potentially, need time to collect these materials. Consider assigning this as homework over a few class periods to make sure enough material is collected.

- This activity is appropriate for all ages, but younger students may need adult supervision.

**Materials Needed:**

- Many discarded, clean plastic bags and other thin plastic materials. Students should bring these in from home. For example:
  - Bread, tortilla, frozen vegetable bags
  - Discarded bubble wrap or plastic air pillows
  - Plastics with colors and pictures on them, like some dog and cat food bags, chip bags
- Plastics to AVOID: produce bags (too thin), most single-use grocery bags, plastics that still have another useful purpose (and don't need to be discarded yet!)
- Scissors
- Roll of parchment paper
- Irons
- Ironing boards
- Sewing machines or sewing materials (if desired)
- Accessory materials such as straps, snaps, buttons, dowels (optional)
- Glue guns (optional)

**Teacher Instructions:**

1. Start with a reflection with your students.
  - **Guiding questions:** How easy (or hard) was it to collect plastic bags and other thin plastic materials? Are all of the materials you collected actually plastic? Were you surprised by how many materials in your life are made of plastic? In 2016, U.S. Virgin Islands Bill No. 31-0379 restricted the use of plastic shopping bags in the territory. Maybe some of you remember times before and after this event. How do you think this action may have impacted the number of plastic bags in the territory and those potentially becoming marine debris? Does this bill mean there are no more plastic bags in the territory?
  - **Teacher Note:** *This is a good time to review what materials are and are not plastic to remind students how much plastic is in our daily lives, and to emphasize that the bill restricts plastic bag use but does not completely ban it.*



2. Next, lead your students in a discussion of what upcycling is. Upcycling is a way to repurpose discarded products or materials into a product of higher value or quality.
  - **Guiding questions:** What upcycling examples can you think of (e.g., yogurt container becoming a pot for a plant, making a plastic water bottle into a pencil container or a bird feeder)?
  - **Teacher Note:** *If there's time, have students complete a web search to explore the many creative ways people upcycle plastic materials. Consider having them complete their own upcycled project using other discarded plastic materials from their home for extra credit.*
3. Finally, create upcycled plastic panels, which students can craft into different, creative products (examples below).

#### Creating upcycled plastic panels:

First, demonstrate how to make flimsy plastic bags into strong plastic material:

1. Set up ironing and sewing stations around the room and assign an adult to staff each station at all times. Depending on the age of the students, the adult may do the actual ironing, or may supervise the student as he/she irons.
2. Place a large piece of parchment paper on the ironing board.
3. Obtain three newspaper bags (or similar) any layer them on top of each other on the parchment paper. This gives you six layers of plastic.
4. Cover the bags with another large sheet of parchment paper. Now all the plastic is between parchment paper. Important: the iron will only touch the parchment paper, not the plastic directly.
5. Apply a constantly-moving medium-hot iron to the top of the parchment paper to melt the plastic together. The plastic may shrink somewhat. If the plastic does not melt, increase the heat setting on the iron.

The result is a sturdy piece of plastic in the size of one of the original bags. This is the base plastic panel that the students can use to make their projects. Panels can be ironed together to make larger panels, or cut down to smaller sizes.

Next, demonstrate how to decorate the sturdy panels:

1. Obtain a sturdy panel and bring it to the workspace
2. Cut out colorful pieces of plastic materials and arrange them on top of the base panel as desired.
3. Cover the entire panel with a piece of clear plastic. This step is not always necessary, but this extra layer of clear plastic serves three functions:
  - a. It keeps the little pieces of plastic in place as you move your materials from your workspace to the ironing board,
  - b. Some colorful plastics are actually printed and smear when heated, and the extra plastic helps minimize that smearing and,
  - c. The extra layer of plastic adds strength to the material.
4. Bring the project to an ironing board and place it on top of a piece of large parchment paper.
5. Cover the project with another piece of large parchment paper. Now all the plastic is between parchment paper. Important: the iron should only touch the parchment paper, not the plastic directly.
6. Apply a constantly-moving medium-hot iron to the top of the parchment paper to melt the plastic directly.
7. Repeat as necessary if you want to add more decoration. You may not need more clear plastic (step #3) if you are only adding a few new details.
8. To keep the project flat, place the warm project from the ironing board between two flat boards to cool.

#### Make upcycled products:

Once the material has been decorated, it is ready to be engineered into an upcycled product. Depending on the age of the students, the time available, and the number of sewing materials (or optional sewing machines), projects can vary from very simple to very complicated.

- Simple project ideas:
  - Placemats, coasters: decorate a panel and cut out the desired shape with scissors
  - Class flags: each student can decorate a panel which can be sewn or glued onto a dowel, or strung onto a line.
- Intermediate projects:
  - Carnival or classroom decorations: following the class flags idea above, create banners, flags, or art to decorate your classroom or a carnival float.
  - Small bag: fold a panel in half and sew the edges to make a pouch. Provide straps that can be cut to length and sewn on each edge, or have the students make the straps out of strips of sturdy base material.
  - Card or coupon holder: see photos for construction ideas.



Examples of card or coupon holders created from upcycled plastic materials (Photo credit: Oregon Sea Grant).

- Advanced projects:

- Hanging art: Cut two large pieces of plastic in the shape of a chosen design (e.g., fish, whale, starfish, etc.), sew the edges together and stuff with plastic to give it three dimensions. Hang from the ceiling. Students may contribute decorated panels to make one large piece of art. Note: if you are using clear plastic to make the object, you will be able to see the stuffing inside.
- Shopping bag: Examine a reusable shopping bag to see how it is engineered and then create your own version by sewing your sturdy plastic panels together. Note: this can take a long time, especially if the student is not familiar with using a sewing machine.
- Costumes (for Carnival, Halloween, or other occasions): Combine panels together to create large pieces of plastic “fabric.” Examine the piece of clothing you are trying to create to see how it is engineered, or look up sewing patterns online. Using a sewing machine to sew together your plastic panels.



Examples of reusable bags created from upcycled plastic materials (Photo credit: Oregon Sea Grant).

Clean up and closing discussion:

Collect all the little pieces of unused plastic again at the end of the work session and save them for a future session. Display the upcycled projects in an “exhibit” for classmates to appreciate.

- **Guiding questions:** Did all plastics “behave” in the way that was expected when heated? What types of plastic worked best? Which did not work well? Categorize plastics according to the characteristics that make them ideal for these types of upcycling projects. Share your recommendations with other upcycling engineers.
- *Optional activity:* A few days after the project, talk to students again about the plastics they use around their homes.
  - Guiding questions: Are they looking at plastics differently now than before the project? Are they hesitating to throw out certain materials? Can we upcycle ALL the discarded plastics in our home? How else can we minimize discarded plastics? Discuss ways to reduce the use of single-use plastics.
- *Optional activity:* Have students compare and contrast the designs of their upcycled projects.
  - **Guiding questions:** Which design features provided added strength or functionality to the design? What design features were innovative? How does their design compare to others?



**Teacher Notes:**

- *Plan the activity in a well-ventilated large room. Because of the use of irons, this activity is ideal for family groups, older students or younger students who have several adult helpers that can be in charge of irons and optional sewing machines.*
- *Students may discover that different plastic materials have different qualities, and that not all plastics melt in the way they might expect. Some plastics shrink funny and distorted or get rough and bubbly. Experimentation is the best way to find materials that work best.*
- *This activity could be combined with the lesson “Making Connections Through Art.”*
- *For inspiring stories of local solutions to marine debris read the Spotlight: Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands, and the five associated spotlights.*



# LESSON: Making Connections Through Art

This activity was modified with permission from Oregon Sea Grant's "Making Connections Through Art" Activity from the Marine Debris STEAMSS (Science, Technology, Engineering, Art, Math, and Social Studies) curriculum (<https://oregoncoaststem.oregonstate.edu/marine-debris-steamss/md-grades-6-8/solutions>).

**Grade Levels:** 5-12

**Subject Areas:** Marine Biology: Debris Sources, Ecology

**NGSS Connections:**

- MS-ESS3-3:
  - Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
  - ESS3.C: Human Impacts on Earth Systems - Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
  - ESS3.C: Human Impacts on Earth Systems - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- HS-ESS3-3:
  - ESS3.C: Human Impacts on Earth Systems - The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Appendix F: Science & Engineering Practices

**Time:** Variable – depending on the projects explored.

**Description & Objectives:** This lesson is best done after completion of one lesson in each of the sections Composition & Abundance, Sources & Transportation, and Impacts. Students will take everything they have learned about marine debris to create, develop, and complete a project to share their knowledge.

**Key Ideas & Concepts:**

- Marine debris is any persistent solid material manufactured or processed and then disposed of or abandoned in the marine environment.
- Marine debris is mostly plastic.
- There are multiple ways to share/communicate information about marine debris prevention.

**Pre-Requisite Skills:** Ability to share thoughts and ideas in a coherent manner.

**Teacher Preparation:** The preparation will be different depending on the types of art projects you do with your students. It may be a good idea to divide your students into four groups and have each group tackle one aspect of marine debris (Composition & Abundance, Sources &

Transport, Impacts, or Solutions) and make an art project explaining that aspect and how people in the U.S. Virgin Islands can be part of the marine debris solution.

**Materials Needed:** Will vary based on the projects selected, but optimally some materials could be those collected during marine debris cleanup events.

**Teacher Instructions:** Have students think about the different activities you have done learning about marine debris. Think about the following:

- What is marine debris?
- How do you track and/or measure it?
- Where does it come from?
- How does it get from one area to another?
- What is the effect of marine debris on marine organisms and the people who use the marine environment?

Next, have students investigate the different ways you can communicate information to help people learn new topics. Guide students to learn the differences between sharing information through formal settings (e.g., classrooms, seminars, workshops) and informal settings (e.g., 'trashion' shows, large murals, hands-on activities at community events, short videos).

After students have thought about what information they want to share and how they want to share it, have students create marine debris educational materials for the community. Have students share their information as a public education effort linked with a local event (e.g., Carnival, Reef Fest, Agriculture and Food Fair).

- Consider connecting to previous lessons, like "Upcycling: Plastic Bags," or using objects collected from the "Linked Beach-Ghut Cleanups" for these projects.

Remind them to keep in mind the following:

- Be sure that your product is professional (i.e., neat, uses correct spelling and/or grammar, etc.) and make sure to include:
  - An attention to grammar
  - A specific action that you are asking your audience to do
  - Scientific reasons for taking action
  - Scientific data to support your idea



If the timing of these lessons align with the timing of the Annual NOAA Marine Debris Art Contest (October-November each year), and the art project selected fits the eligibility criteria, consider having your students submit to this contest. All students in grades K-8 from all U.S. states and territories are eligible to apply. This could be a fun activity and may result in national recognition for their creative work!

For more information about the Annual NOAA Marine Debris Art Contest, please visit: <https://marinedebris.noaa.gov/outreach/artcontest.html>

**Teacher Notes:**

- To find out more about local efforts to link marine debris and art, read the Spotlight: Turning Trash Into Treasure.
- For more creative art ideas, like how to make artistic masks from marine debris, please visit: <https://washedashore.org/iamdc/>.
- For inspiring stories of local solutions to marine debris read the Spotlight: Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands, and the five associated spotlights.

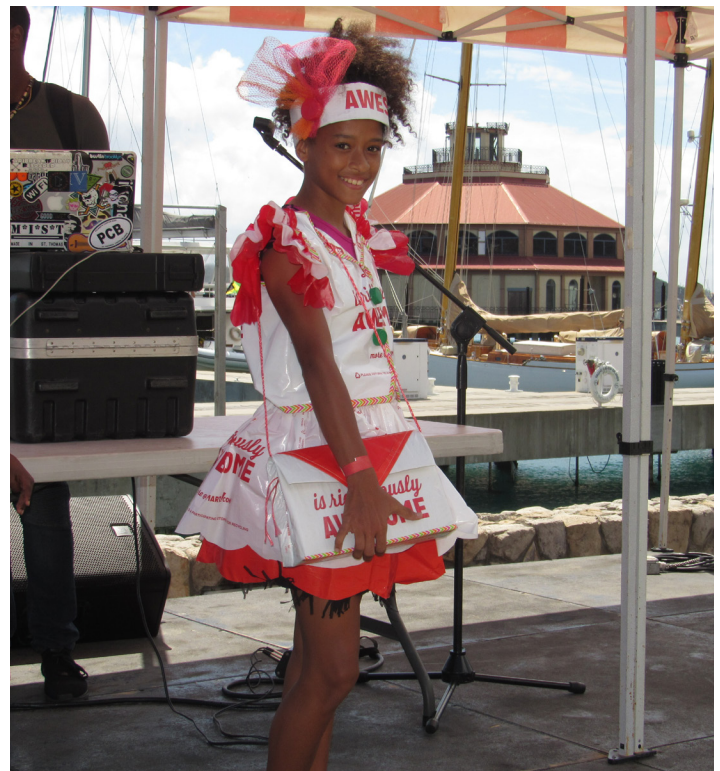


# SPOTLIGHT

## Turning Trash into Treasure

Upcycled art is quickly becoming a popular concept in the U.S. Virgin Islands. In recent years, community members and school groups have been reusing and repurposing trash and marine debris items, and transforming them into beautiful works of art. Many of these artworks are created for, and showcased in, Reef Fest's annual "Trashion Show." Reef Fest is a marine and environmental science-focused community outreach event that attracts thousands of people each year on the island of St. Thomas and is hosted by the Virgin Islands Marine Advisory

Students from the Lockhart Elementary School showcasing their costumes made from recycled materials at Reef Fest 2018 (Photo credit: Jarvon Stout).



Students from the Lockhart Elementary School showcasing their costumes made from recycled materials at Reef Fest 2018 (Photo credit: Jarvon Stout).

Service (VIMAS), Coral World Ocean Park, and the Virgin Islands Established Program to Stimulate Competitive Research (VI-EPSCoR). Every year, in preparation for the Trashion Show, local elementary, junior high, and high schools use debris they collect (particularly single-use waste items) and incorporate that debris into creative, colorful, and dynamic costumes that aim to send a message about the issue of marine debris in the territory. The photos that follow show recent Trashion Show entrees that were created for past Reef Fest events. The 2018 Reef Fest also provided an opportunity to showcase a series of upcycled art pieces that were made almost entirely from reclaimed plastic and metal bottle caps. Each piece depicted different scenes and wildlife commonly found in the U.S. Virgin Islands. Mr. Jarvon Stout, creator of these pieces and Community Engagement Specialist for VI-EPSCoR, says about them and about marine debris upcycled art more generally, "We can use art to engage the community on a variety of levels that we might not be able to do through other, more formal methods. If it makes them stop and think about marine debris, then it's done its job."





A sea turtle being decorated with plastic bottle caps and beverage cans (Photo credit: Jarvon Stout).



Metal bottle cap art on display at Reef Fest 2018. Also shown are jars filled with commonly found marine debris items in the U.S. Virgin Islands, such as straws, plastic utensils, and bottle caps (Photo credit: Jarvon Stout).

# SPOT LIGHT

## Community Transfer Projects: Turning New Knowledge into Action at the Local Level in the U.S. Virgin Islands

During 2016 and 2017 with funding from the National Oceanic and Atmospheric Administration's Marine Debris Program (Award #NA16NOS9990133), researchers and graduate students in the Masters of Marine & Environmental Science (MMES) Program at the University of the Virgin Islands (UVI) partnered with U.S. Virgin Islands middle and high school teachers and students, to explore creative ways to transfer marine debris information learned in the classroom to the broader community. The fundamental goal of these Community Transfer Projects was to reduce marine debris in the territory through activities that increased community awareness of marine debris impacts and promoted changes to individual behaviors. Ideas for the Community Transfer Projects were developed by USVI educators and used locally-important themes that identified with the culture and history of the U.S. Virgin Islands. Projects were supported by MMES graduate students and community partners.

In 2017, seven transfer projects engaged 10 UVI MMES students, 15 territorial educators, and 1,986 students from eight public and private schools on St. Thomas and St. Croix. Some of those projects are featured in the spotlights that follow.

“What was so exciting about these transfer projects, was that each worked on a locally-identified problem and a community-driven solution. Teachers identified the projects they wanted to work on with their students, while our Masters students, researchers at the University, and community partners played supporting roles to help the work happen. It is inspiring to see what these projects were able to achieve,” says Dr. Kristin Wilson Grimes, Research Assistant Professor of Watershed Ecology at the University of the Virgin Islands and project lead.



# SPOT LIGHT

## St. Croix Students Reduce Marine Debris Through SCUBA Diving

The AZ Academy, the St. Croix Educational Complex, and Cane Bay Dive Shop on St. Croix partnered with University of the Virgin Islands Masters of Marine & Environmental Science student, Carolyn Courtien, to train nine female high school students in open water SCUBA diving with funding from the NOAA Marine Debris Program.

The project was an extension of AZ Academy's After School Program, which regularly conducts beach cleanups, but felt that they were missing

marine debris in the water. The purpose of the "Diving for Debris" Community Transfer Project was to empower these students to take action to reduce underwater marine debris and to inspire them to educate their community, including other middle school students, about the sources of and solutions to marine debris. During the Spring of 2017, these nine students completed a 13-week SCUBA training program, which included lectures on marine conservation concepts, and the planning and execution of two public underwater cleanups at Divi Carina Bay and the Frederiksted Pier. These cleanups yielded a great deal of debris not usually seen in their beach cleanups. As part of the project, students were also able to tour the NOAA research vessel Nancy Foster, while docked at the Frederiksted Pier during the Coral Reef Ecosystems Research cruise in 2017. This program was unique, in that it provided specialized training to students that connected them with and provided the tools to clean up their local marine environment, and increased their exposure to careers working in the field of marine science.



Five students from the Diving for Debris Program preparing to collect marine debris under the Frederiksted Pier on St. Croix (Photo credit: Carolyn Courtien).

# SPOTLIGHT

## Making Outreach About Marine Debris More Accessible

Masters in Marine and Environmental Science (MMES) graduate students at the University of the Virgin Islands (UVI), Alex Gutting and Elizabeth Smith, had been looking for a way to involve elementary and middle school students in their efforts to educate the public in the U.S. Virgin Islands about the problem of marine debris and the actions individuals can take to reduce it. Through the “Pride in Our Seas, Pride in Ourselves” prevention grant from the NOAA Marine Debris Program awarded to UVI, Alex and Elizabeth were able to partner with Ms. Carol Wallace, an educator at Calvary Christian Academy (CCA), to join her in classrooms of grades 4-8 to teach about the problem of marine debris and how it affects ecosystem services provided by the ocean. This blossomed into television and radio appearances with Alex, Elizabeth, and students from CCA describing the benefits to the Virgin Islands community and the marine environment of making small changes in daily

habits that can lead to major reductions of waste going into the territory’s landfills, or being transported into the marine environment through inefficient waste management practices. Overall, nearly 1,000 members of the U.S. Virgin Islands community were reached by the “Outreach is Within Reach” Community Transfer Project events at the Tutu Park Mall and UVI’s “Afternoon on the Green.”

UVI MMES students Alex and Elizabeth indicated that the outcomes from the project that they were most proud of were the responses received from U.S. Virgin Islands residents who were unaware of the harm in using single-use plastics, and their commitment to making changes in their habits to avoid using these products in the future, as a result of their conversations with project participants. In addition, Alex and Elizabeth were also overwhelmed by the enthusiasm of the students in Ms. Wallace’s classes, the wonderful work they did repurposing marine debris into art, and serving as ambassadors in their own communities to reduce the amount of marine debris entering coastal waters of the U.S. Virgin Islands. Alex, Elizabeth, Ms. Wallace, and the students of CCA showed that sometimes it only takes a little more education, creativity, and outreach to truly make a difference in one’s community.



Above left: University of the Virgin Islands Masters of Marine & Environmental Science students, Alexandra Gutting and Elizabeth Smith, discuss the benefits of reusing materials to reduce marine debris, while providing participants with reusable drinking cups during an “Outreach is Within Reach” event at the Tutu Park Mall in St. Thomas (Photo credit: Carol Wallace). Above right: Calvary Christian Academy 6th grade student, Kayla Bellow, modelling a dress created with plastic waste, created by 8th grade student Yuanelis Baez (Photo credit: Carol Wallace).



# SPOTLIGHT

## Implementing Public High School-Based Marine Debris Research and Science Communication

The goal of this project was to educate Charlotte Amalie High School students about the harmful effects of marine debris through a research project that examined current and historical marine debris composition and abundance from beaches in a NOAA priority watershed on St. Thomas, in partnership with students from the University of the Virgin Islands (UVI) Masters in Marine and Environmental Science (MMES) Program. Through the project, high school students learned important scientific skills, such as conducting a research project, collecting and analyzing data, and communicating their research to peers and the wider community. Students presented their results at the Charlotte Amalie High School Science, Technology, Engineering, and Mathematics

(STEM) Fair and at the University of the Virgin Islands Spring 2017 Research Day, a special honor for high school students who do not usually present at this annual community event. Students received special permission to present because of the high quality of their work. Both of these symposia reached different communities of people in St. Thomas, extending the project impact.

“There were many benefits that emerged from this project. Students grew a greater appreciation for and awareness of how human activity on our beaches has such a great environmental impact on the wellness and condition of our beaches. Students saw that first hand when they tabulated the data. As a teacher, this project brought me back to the significance of doing scientific investigation for real world situations. It helped me to recognize how important it is,” said Mr. Vernon Callwood, a teacher from Charlotte Amalie High School, about the project.

“We both felt that we made a great connection with the students and Mr. Callwood, and it was exciting to see them all successfully put together a research project and present it at a college symposium. Overall, we are both happy to have helped the students complete this project as it was a rewarding experience for both of us. We are proud of them all for the hard work they put into their project and the advances they made in demonstrating their scientific knowledge,” said Amelie Jensen and Katharine Egan, UVI MMES students who worked on the project.



Students from Charlotte Amalie High School, a public high school on St. Thomas, participate in a beach cleanup at Lindbergh Bay. Data from the cleanup was compared to historical data collected through the International Coastal Cleanup (Photo credit: Amelie Jensen).





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Students from Charlotte Amalie High School present their results at University of the Virgin Islands Research Day in April 2017 with their teacher, Mr. Vernon Callwood (second from the right). University of the Virgin Islands provost, Dr. Camille McKayle (center), visits to learn about their results (Photo credit: Kristin Willson Grimes).



# SPOTLIGHT

## St. Croix Educational Complex Working to Reduce Marine Debris

Ms. Ann Marie Gibbs, teacher at the St. Croix Educational Complex, and Ms. Marcia Taylor, of the Virgin Islands Marine Advisory Service, worked with about 100 high school students from the St. Croix Educational Complex to increase awareness of the problem of plastic pollution. The purpose of the project was to increase awareness about the impacts of marine debris, especially single-use plastics, as well as take action to reduce it. Classroom presentations and coastal cleanups led to increased awareness

about the issue. These students then worked in groups to develop their own presentations on different aspects of marine debris and became marine debris ambassadors by giving those presentations to their school, younger students, and the community, reaching approximately 800 people. The students also promoted a pledge to stop using single-use water bottles within their school that was signed by 700 students.

Ms. Ann Marie Gibbs said that she was glad to be a part of this project and that “I want to teach my students that their actions impact the environment and that they must help to mitigate impacts. I believe my students now have a better appreciation of plastic pollution and will work to reduce it.”

Ms. Marcia Taylor said, “It was clear through the student presentations to their peers and younger students that they had become passionate about the issue of plastic pollution. I truly believe that this project will cause them to change their behaviors about using single-use plastics in the future.”



St. Croix Educational Complex students doing a coastal cleanup at Great Pond, St. Croix as part of the transfer project (Photo credit: Marcia Taylor).



# SPOTLIGHT

## U.S. Virgin Islands Public School Students Work with University of the Virgin Islands Masters of Marine & Environmental Science Students to Reduce Marine Debris

The “Keepin’ It Clean in 2017” was a U.S. Virgin Islands teacher-inspired project that paired University of the Virgin Islands (UVI) Masters in Marine & Environmental Science (MMES) students, territorial educators, and more than 1,275 4th-8th grade students from the Bertha C. Boschulte Middle School and Lockhart Elementary School, funded by a grant to UVI from the National Oceanic and Atmospheric Administration Marine Debris Program.

The goal of the program was to promote environmental stewardship and marine debris prevention through a home and school recycling program, with partners from the Virgin Islands Waste Management Authority (VIWMA) and Terracycle, a stateside company that recycles and upcycles materials into products that can be reused, like shoes and benches. Recycled items were shipped to the mainland because the U.S. Virgin Islands does not have a comprehensive recycling program. Cans were collected and recycled through an incentive program provided by VIWMA.

Together, students recycled over 2,500 plastic water bottles, 1,300 plastic bags, and 900 aluminum cans during the three-week program. “A project like this is unusual in public schools and we were so thrilled to partner with UVI to make this happen. The students took ownership and exerted great energy into the recycling project. It was refreshing to see them light up about this initiative to preserve the health and



Students from Lockhart Elementary School participate in the “Keepin’ It Clean in 2017” Community Transfer Project (Photo credit: Topaze Lake).

beauty of our island’s ecosystem,” said Ms. Juelis M. Hodge, Assistant Principal at Lockhart Elementary School and participating educator.

Through this project, students created educational posters and public service announcement videos to encourage their peers, teachers, and families to participate in the collection of recyclable materials and to promote the reduction of marine debris in the U.S. Virgin Islands.

“Making a difference starts with teaching the next generation. These kids will go home and share with their parents what they’re learning in school. It starts small, but it can lead to big changes,” says UVI MMES student, Vernita Smith, who participated in the project.

To thank students and teachers for helping to make a positive difference in the community, a ceremony was held to give participants reusable grocery tote bags, in addition to other reusable items donated by the Virgin Islands Experimental Program to Stimulate Competitive Research, so they could reduce their consumption of single-use plastics.

Like these students, you too can become part of the solution! Help your students to rethink, reuse, and reduce the plastic, single-use items in their lives. Empower them to see that small changes in our daily lives can lead to big changes for the U.S. Virgin Islands.



