Navigating Underwater Hazards

What is hanging on to my rudder?

Module 17:

Grade Level

Middle School/ High School

Subject Areas

Sailing, Engineering, Environmental Science

Summary

Students take a closer look at the marine debris results they found in Module 6: Marine Debris. They examine the origin of their local debris and where it is headed. Students also explore water hazards created by debris. They look at international debris and local debris.

Duration

Preparation Time: 3 Hours
Lesson Time: 1 Week
Part I: Building Background Knowledge: 40 minutes
Part II: Sailors and Science: 2 Hours
Part III: Charting Water Hazards: 3 Hours
Part IV: Design Technology to Clean Up our Oceans.
Part V: Hack/ Modify Your ROV: 1 Hour

Skills

Gathering Information (observing and measuring), Course Charting, Arguing from Evidence, Calculating Time and Distance based on speed, Conversion

Sailing Skills

Course Charting, Plotting Coordinates of Marine Debris

Vocabulary

Storm Water Runoff, Degrade, Watershed, Chart, Longitude, Latitude, Trawl, Environmental Impact, Transpac, Mega Expedition

Standards

See the Standards Correlation Charts related to Common Core Standards and Next Generation Science Standards. US Sailing recommends working with your local schools to align the modules to their planning and standards objectives.

Objectives

Students will:

- Identify Sources of marine debris
- Predict path of marine debris considering storms, tides, wind, and currents
- Construct an explanation for a path of marine debris
- Design solutions (engineering) to reduce the amount of marine debris
- Ask questions and define problems about marine debris
- Engage in arguments from evidence about marine debris paths, origination, and impacts for sailors

Materials

- Flip chart paper
- Data recorded during a beach cleanup (paper data sheets or downloaded from the Marine Debris Tracker)
- Index cards
- Elevation map of sailing center
- Smart Phones or iPads
- Chart of local sailing waters
- Challenge Cards (student sheet 1) cut and laminate in advance
- TV or Smartboard to show TRASH TALK by NOAA http://marinedebris.noaa.gov/discover-issue/trash-talk.
- ROVS (1 per group)
- Computer/phones for research
- Perch Hack Materials – netting, chopsticks, tape, PVC, rubber bands, etc.

Career Connection

Coastal Engineers, ship pilots, captains (tugboat especially), researchers, scientists, activists, and conservationists are all careers that relate to marine debris and underwater hazards.

Procedure

Part I: Classroom: Building Background Knowledge

40 minutes

Place students in groups of 4 or 5. Give each group a blank piece of chart paper. Ask students, "In Module 6 we explored shoreline debris in our area. Look at the data we recorded during during our clean up. Together with your group use that data and create a list of the top 10 items we found during our clean up." Give students 4-5 minutes to make their group lists. Once they are finished ask students to discuss any debris they saw in the water while sailing and add that to their list (have they ever done a distance race or cruise?). Next, ask students what debris is found in our waters? Debris as big as a shipping container or as small as a bottle cap can be found floating in our waters. What debris can't we see that may be under the water? Maybe they saw some items at low tide or at low water levels. Ask them if they have ever had a piece of debris around their rudder while sailing. Remember to incorporate background knowledge on watersheds. Review Module 2 on buoyancy and discuss positive, neutral, and negative buoyancy.

Ask each group member to circle one piece of debris they are interested in learning more about (ghost traps, telephone poles, plastic bottles, straws, plastic bags). Use the Challenge Cards on Student Sheet 2 as well as any other items they select that may be more locally focused. We are going to research how that item may have arrived in our waters and where it could be heading. Have students write the item on an index card with their name on it.

As a group, have students watch TRASH TALK by NOAA http://marinedebris.noaa.gov/discover-issue/trash-talk. It is a 15 minute video about marine debris: where it comes from and why we should care. Review with students your local watershed, the route of storm water, and typical wind and current or tidal patterns that could affect marine debris in your area. Students are familiar with storms and have probably noticed how water flows into rivers and streams. Students probably do not think about where the storm water goes. Storm water affects everyone weather you live in a big city or in a small town or near a wetland.

Now, ask your students to write down the predicted source of the debris and where it may have traveled from to get to the shoreline or waters at your sailing center. Did it originate from people or from weather-related influence, such as flooding, rainwater, or high winds? On the back of the card or on a larger piece of paper, have students draw a map of the potential path of their piece of marine debris.

Sample: Plastic Bag- Started at the grocery store. It blew out of someone's car into the parking lot. When it rained it went into the storm drain. Then it floated into the river at the 34th street storm drain. It floated down the river and eventually rested by the sailing center docks. In the next storm, the currents took it out the inlet into the ocean.

Video Assessment - Have students share their stories with their groups. If time allows have students participate in a video assessment. Have the students answer the following prompts in a 1-2 minute video.

The debris I selected was _____. It could have come from _____ and travelled to or from _____ because of _____. Here is a map of the route it traveled_____. I learned _____ about _____.

In closing, remind students small steps lead to big results. According to NOAA's Marine Debris Program, Fighting the marine debris problem begins at home.

1. Try to cut back on the amount of trash you produce.
2. Opt for reusable items instead of single-use products, such as sandwich bags or plastic water bottles.
3. Recycle as much of your trash as you can.
4. Join local efforts to pick up trash and remember to collect data while you clean up!
5. Keep streets, sidewalks, parking lots, and storm drains free of trash—they can empty into our oceans and waterways.

Part II: Classroom: Sailors and Science

Roughly 8 million tons of plastic enters the ocean each year (Jambeck et al., 2015). Part of this accumulates in 5 areas where currents converge: the gyres. At least 5.25 trillion pieces of plastic are currently in the oceans (Eriksen et al., 2014), a third of which is concentrated in the infamous Great Pacific Garbage Patch (Cózar et al., 2014). This information can be found at: The Ocean Clean Up http://www.theoceancleanup.com/problem.html. According to the United Nations Environment Program, there are approximately 46,000 pieces of plastic floating on every square nautical mile of the world's oceans.

This plastic pollution has the potential to cause the following damage in the ages to come:

Environment: At least one million sea birds and one-hundred thousand marine mammals die each year due to plastic pollution (Laist, 1997). The survival of at least 100+ species (Gall et al., 2015), including the Hawaiian Monk Seal and Loggerhead Turtle, could be jeopardized by plastic debris (Derraik, 2002). Plastic pollution is furthermore a carrier of invasive species, threatening native ecosystems (Barnes, 2005).

Aquatic Invasive Species (AIS) love to latch themselves onto the hulls of boats, go for long rides across oceans, and take up new lives in foreign waters, where they are usually very unwelcome. The global spread of Asian carp, zebra mussels and thousands of other species that have hitched themselves around the world in just such a manner have proven themselves unwanted guests, impossible to disinvite. Scientists at Woods Hole Oceanographic Institution in Massachusetts have identified a variety

of microorganisms using floating plastic trash as rafts; a recent study found at least 1,000 different species of microbes attached to millimeter-sized scraps of plastic afloat in the North Atlantic.

Economy: Globally, plastic pollution causes at least US $13 billion of damage each year to industries including fishing, shipping, tourism and the cleaning of coastlines (UNEP 2014). The US West Coast spends approximately US $500 million each year to clean up their beaches. The costs of removing debris from a beach is, on average, US $1,500, and can get up to US $25,000 per ton (APEC 2009).

Heath: Toxic chemicals (including PCBs and DDTs) are adsorbed by the plastic, increasing the concentration a million times (Mato et al., 2001). After entering the food chain, these persistent organic pollutants bio-accumulate in the food chain, resulting in even higher concentration of pollutants inside of fish (Tanaka et al., 2013), including ones consumed by humans. Health effects linked to these chemicals are: cancer, malformation and impaired reproductive ability (Takada, oceanhealthindex.org).

The debris in the North Pacific has prompted The Ocean Cleanup, a major project based in the Netherlands, to pledge to help clean up the trash and debris. The Ocean Cleanup organized a major data collecting exercise called “The Mega Expedition”, where sailboats heading back to the mainland after the Transpac race proceeded along transit lanes aligned on lines of latitude and record what they see, as well as take samples.

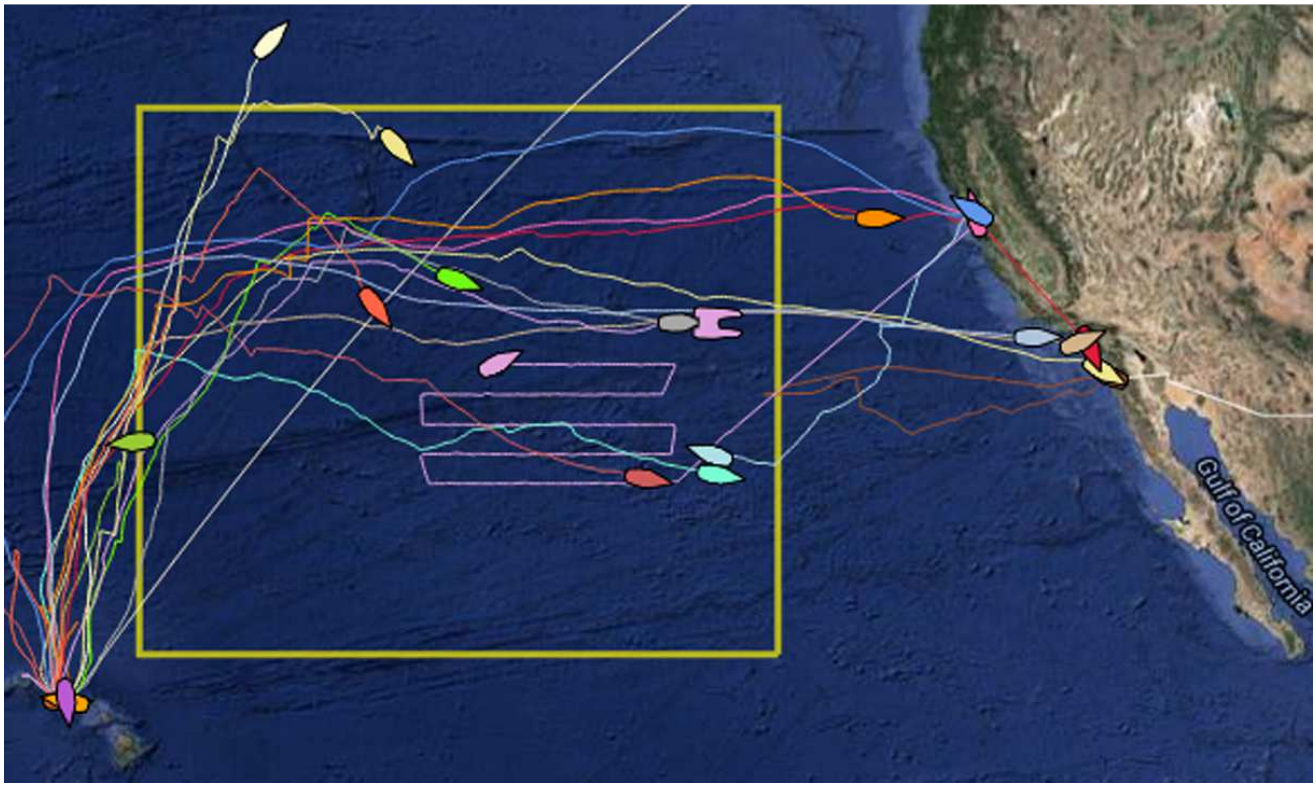
Approximately 30 vessels crossed the Great Pacific Garbage patch in parallel, taking part in the largest ocean research expedition in history. Sailing from Hawaii to Los Angeles, following the Transpac Race, the expedition covered 3,500,000 km2, collecting more measurements of plastic in three weeks than have been collected in the past 40 years combined.

About the Transpac: The Transpacific Yacht Race (Transpac) is an offshore yacht race starting off San Pedro, Los Angeles at the Pt. Fermin buoy, and ending off Diamond Head Lighthouse in Honolulu, a distance of around 2,225 nautical miles. Started in 1906, it is one of yachting's premier offshore races and attracts entrants from all over the world.

According to Scuttlebutt Sailing Magazine, in 2015, Wild Oats' Roy Disney, a veteran of 20 Transpacs said, "This race has been the trickiest ever. "The winds have been unbelievably fickle, but making the situation even more demanding now is this massive field of debris we've sailed into. We are seeing at least three bits of junk every minute - timber, fishing nets, plastic, poles that have broken away from commercial fishing nets; you name it, and it's probably here."

"It's so bad that we have a man stationed permanently on the foredeck to alert the helmsman of anything we might hit. That's our problem right now, but it will be even tougher when it's dark."

MEGA EXPEDITION - Project Map



The Ocean Cleanup is using the data to help design its floating boom apparatus that will help collect the trash for later disposal. For more information about this fascinating and ambitious project, visit the Ocean Cleanup website: theoceancleanup.com. Have students use Student Sheet 1.

Student Work:

1. Chart a course from LA to Diamond Head, HI (around 2,225 nautical miles)
2. How long would it take you to sail from LA to Diamond Head, HI in a 30ft cruising sailboat at an average speed of 5 knots? (1 knot is equal to 1 nautical mile per hour) Answer: *about 18 ½ days*
3. On average how long does it take to finish the Transpac Race?
   Answer: Morning Glory holds the race record, finishing the race in 6 days, 16 hours, 4 minutes, and 11 seconds to win in 2005
4. How many pieces of plastic do you think you could pick up on a Trawl from LA to Diamond Head? Why?
5. What methods of Data collection were utilized in the Mega Expedition?
   Surface Trawl, Arial Survey, Drag nets, and Sighting-
6. Challenge: Evaluate the pros and cons of The Ocean Clean Up's proposed technology.

Part III: Sailing – Charting Water Hazards

3 Hours +

During the 2013 Transpac, racers encountered a lot of debris (telephone poles, docks, parts of houses, etc). These items are most likely from the 2011 Tsunami that hit Japan. Below is chart with debris marked for other sailors on the course. As one boat said; “Be vigilant by day and pray at night”. Debris can be extremely hazardous to sailors; it can damage boats, possibly leading them to sink.

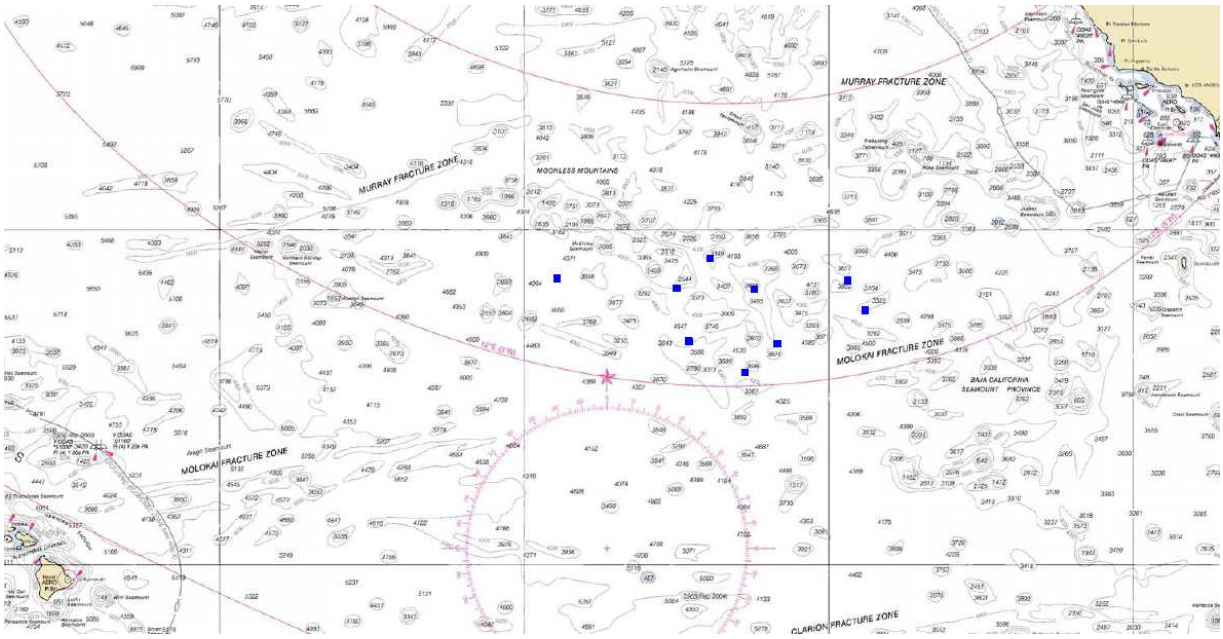


Figure 1 A: Chart showing Los Angeles, Ca to Diamond Head, Hawaii. The blue squares show large pieces of debris charted by sailors in the 2013 Transpac.

Take a distance sail and plot any marine debris, ghost traps, or hazards you may see. Mark them on your local navigational chart. If needed, alert the Coast Guard of any hazardous debris. After storms, all types of debris can be found in our waters. For example, after Hurricane Sandy, sunken boats, houses, and docks were found in local waterways.

Part IV (Classroom)

Design a new method to clean up underwater hazards and marine debris. Have students create a poster with a sketch, area of impact, and target materials to present to the class. Ask them to consider winds, currents, and buoyancy. Use the engineering by design process. (Student Sheet 2)

Part V (Classroom/Outdoor)

Hack your ROV - Divide the class into groups of 4-5 students. Give each student an ROV (Mate ROV in a bag or SeaPerch work well) and assorted hack materials along with one Challenge Card. (Student Sheet 2)

Student Sheet 1

Name: _____

In August 2015, around 30 vessels crossed the Great Pacific Garbage Patch in parallel, becoming the largest ocean research expedition ever. Sailing between Hawaii and Los Angeles, the expedition covered 3.5 million square kilometers and collected more data on oceanic plastic than has been collected in the past 40 years combined. *Chart can be found at: http://www.charts.noaa.gov/PDFs/530.pdf or http://www.charts.noaa.gov/OnLineViewer/530.shtml*

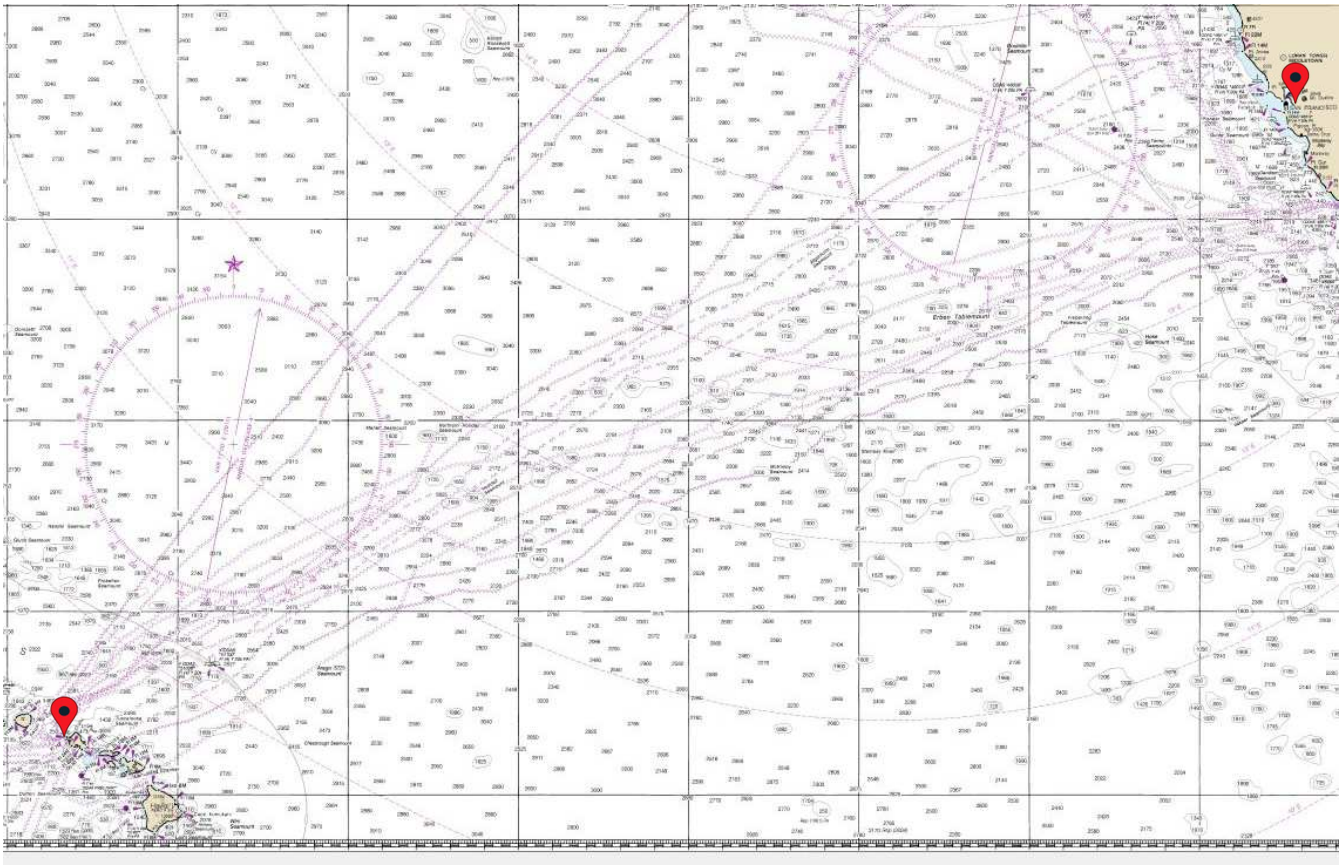


Figure 2: NOAA Chart 530 excerpt. Please note soundings are in fathoms. 1 Fathom is equal to 6 Feet.

1. Chart a rough course from LA to Diamond Head, HI

2. How long would it take you to sail from LA to Diamond Head, HI in a 30ft cruising sailboat at an average speed of 5 knots? (1 knot is equal to 1 nautical mile per hour)? _____

3. On average how long does it take sailors to finish the Transpac Race? _____

4. How many pieces of plastic do you think you could pick up on a Trawl from LA to Diamond Head? Why?

   _____

5. What methods of Data collection were utilized in the Mega Expedition?

6. Challenge: Evaluate the pros and cons of The Ocean Clean Up's proposed technology.

Note: Cut and laminate challenge cards for students. For Part I of the lesson, remove the CHALLENGE text.

Chesapeake Bay, MD - Derelict Fishing Equipment and Traps

Thousands of fishing traps are lost or abandoned each year in U.S. waters and become what are known as derelict traps, which continue to catch fish, crabs, and more surprising species such as turtles. These traps result in losses to habitat, fishery and the watermen who depend on the resources -- these losses are largely preventable, according to a newly published NOAA study.

Fisheries in the study include the Dungeness crab fishery in Alaska and Puget Sound; the blue crab fisheries in Maryland, Virginia, and North Carolina; the spiny lobster fishery in Florida; and the coral reef fish fishery in the U.S. Virgin Islands.

All seven fisheries contained derelict traps, with average numbers ranging from 5-47 traps per square kilometer. Between five and forty percent of all the derelict traps examined showed evidence of ghost fishing. When discarded, lost, or abandoned, fishing gear continues to fish and trap animals. The length of time a trap continued to ghost fish depended on the environmental conditions and trap design, but in every fishery, ghost fishing occurred longer than anticipated based on assumptions about gear degradation.

CHALLENGE: Hack your ROV to be able to remove derelict fishing equipment and traps in the Chesapeake Bay.

Providence, RI – Old Pilings

There are thousands of wood pilings, some sticking roughly 6 feet out of the water, and others submerged completely, in upper Narragansett Bay at the mouth of the Seekonk River. This debris is the product of development and the subsequent abandonment of properties as well as storms.

CHALLENGE: Hack your ROV to remove hazardous old pilings in East Providence Rhode Island.

Lake Champlain in Burlington, VT – Microbeads

Plastic microbeads used in personal care products such as facial scrubs and body washes are polluting our waterways. They wash down drains, slip through wastewater treatment plants and end up in our streams, rivers and lakes. Scientists found high concentrations of plastics in U.S. waterbodies, particularly the Great Lakes. In 2012 researchers found microbead densities of 466,000 pieces per square kilometer in a section of Lake Erie. Microbeads have also been found on Lake Champlain beaches in Vermont.

Microplastics are of particular concern because they have the potential to be ingested by a much wider range of organisms than large plastic debris, making them and the chemicals they carry bioavailable throughout the food chain.

- Some microbeads are the size of fish eggs. Larger fish and other aquatic organisms eat them, thinking they're food. This can result in reduced food consumption, stunted growth and possibly starvation. When plankton, mussels or fish fill up on plastic junk food they are likely to lose their appetite for healthier food.
- Plastics adsorb toxins such as PAHs, PCBs, and DDT, which can be passed up the food chain to fish, wildlife and ultimately, humans.

CHALLENGE: Hack your ROV to collect and remove micro plastics from water or sediment.

Chicago, IL - Plastic Bags in Lake Michigan

When the winds kick up in Chicago, people often see plastic bags take flight from where they lie discarded on the ground. They lift higher and higher until they disappear against the clouds or behind a high rise. Have you ever wondered where they land?

More often than we might expect, the answer is the Great Lakes. In other places, rain and urban runoff sweep those bags into storm water drains and out to sea, connecting the Great Lakes, and their trash, to the ocean.

CHALLENGE: Hack your ROV to collect plastic bags from our waterways, specifically in Chicago and the waters of Lake Michigan.

Boston, MA – Floating Debris from local tributaries

In Boston Harbor some of the most prominent marine debris items found are plastic beverage bottles and cigarette butts. The Boston Harbor Association's Marine Debris Prevention and Removal Program have been making Boston Harbor cleaner and more accessible for swimmers, boaters and marine life since 2000. They have removed more than 250 tons of floating debris from Boston Harbor since the program's inception. Each year from June through September, The Boston Harbor Association's on-water contractor, Boston Line & Service Co., removes floating debris from the Inner Harbor, Fort Point Channel, Chelsea Creek, and the Lower Mystic River. Floating wooden pilings that have come loose from the wharves are also removed.

CHALLENGE: Hack your ROV to collect floating beverage bottles from the harbor.

Northwestern Coastline Storm or Tsunami related debris – derelict vessels

After hurricanes, tsunamis, or other weather related events, many times vessels sink or drift free creating marine debris. The photo above is of a boat hull that washed ashore in Washington State from the Tsunami in Japan.

Marine debris items or significant accumulations potentially related to the tsunami can also be reported to DisasterDebris@noaa.gov (link sends e-mail) with as much information as possible (including its location, the date and time you found it, photos, and any relevant descriptions).

CHALLENGE: Hack your ROV to record photos, location, and other pertinent information about derelict vessels.