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**Background**

Traveling Through Trash: Coastal Migratory Animal Encounters with Marine Debris (3T) is a project focused on anthropogenic land-based litter as a source of marine debris found in coastal waters through which species of migratory marine animals travel. The 3T project highlights the detrimental impacts marine debris can have on migrating animals. Several of these migratory species are particularly popular with school children, especially sea turtles, dolphins and whales. Research by Cheng and Moore (2010) shows that by cultivating empathy, students better engage in environmental issues. It is our belief that children will more readily engage in marine debris prevention if they understand that it can hurt one of these popular charismatic species.

The coastal waters of North Carolina lie along a major migration corridor for marine species. Many marine species migrate along the coast, including the critically endangered North Atlantic right whale and several species of threatened sea turtles. Encounters between these species and marine debris found in coastal waters causes injury or mortality as a result of ingestion or entanglement. As much as 80% of marine debris has been estimated to originate from land-based litter. According to the Keep America Beautiful organization (2009) younger people are more likely to litter than older people, with those aged 19 and below more likely to litter than any other age group. Because of this every effort must be made to educate youth to encourage them to stop littering, whether intentional or not. To effect such a change in behavior, youth will have to care about the problem of litter and marine debris. One way that the 3T project hopes to change behaviors associated with littering is to educate school children about migratory species that spend time in the coastal waters off of the North Carolina coast and get them to empathize with the organisms and care about the impacts that marine debris has on them. To achieve this, the 3T project created a life-size inflatable right whale classroom to take to classrooms in rural, coastal North Carolina counties. Classes of up to 30 children can attend 3T educational programs inside of the whale. The programs utilize a STEM curriculum developed specifically for the 3T project.


The Whale Classroom

The whale is 56 feet long by 15 feet wide and 11 feet high.

Project Goals & Objectives:

The primary long-term goal of the 3T project is to increase student self-awareness of how their own lifestyle choices and behaviors contribute to the creation of land-based litter that can become marine debris, and to encourage students to take actions to prevent this from happening. To achieve this long-term goal, the project strives to meet the following six objectives:

1. Increase student understanding of how land-based litter enters a watershed, travels to the coast and becomes marine debris
2. Increase student awareness of where marine debris is found in the Atlantic Ocean
3. Increase student awareness of migratory species that travel along our coastal waters and the purposes behind their migrations (feeding, mating, calving, etc.)
4. Increase student understanding of the impacts that marine debris (in the form of land-based litter) can have on migratory species through ingestion and entanglement
5. Increase student awareness of the actions youth can take to prevent marine debris
6. Increase student sense of responsibility/stewardship for the ocean
The following lesson plans were created to help meet each of the project objectives. These lesson plans along with instructions and tips for implementation can be found in this manual.

- What is Marine Debris? – Objective 1
- Mapping Migration – Objective 2 & 3
- Ocean Gyres and Debris Collection – Objective 2
- Passing through the Perilous Plastic Ocean – 3 & 4
- Comparative Feeding Strategy of Whales – Objective 3 & 4
- Biomagnification of Plastic Pieces in the Marine Food Chain – Objective 2 & 4
- How’d That Litter Get There? Stomach Dissection Simulation – Objective 1 & 4
- Extremes of Entanglement – Objective 4 & 5
- Biomechanical Prosthetics for Marine Organisms – Objective 4 & 6
- iRefuz – a tracking app for not generating litter – Objective 5 & 6

**Supporting Materials**

In developing this curriculum the 3T project team consulted materials provided on the NOAA Marine Debris Program website:  [https://marinedebris.noaa.gov/educational-materials](https://marinedebris.noaa.gov/educational-materials)

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<td>Animal Entanglement</td>
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<td>How Harmful is it?</td>
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In addition, the team reviewed other educational materials, including those previously developed by MarineQuest, in an attempt to come up with some new activities and lessons.
Introduction: What is Marine Debris?

Ask the students, “Has anyone ever heard of marine debris before?” Let them think about it and raise their hands. Next, ask them, “Does anyone know what marine debris is?” Allow the students to think about it for a moment and make some guesses.

For elementary school students, it might be helpful to break the words down for them. Start by asking what they think about when they hear the word, “marine.” Most of the time, the students will say water, ocean, fish or other animals, etc.... you want them to associate marine with the sea or ocean. Next, ask them what they think “debris” means. This one is a little harder, so you can explain debris as just a fancy word for trash. Now ask the students to put the 2 words (marine and debris) together... “Ocean trash,” or trash in the ocean is what we mean when we say “marine debris.”

Now that the students know that marine debris is trash in the ocean, ask them to give you some examples.

To help jog their brains a little more, ask them to think about the things they throw away everyday either at home or at school. If the students give an answer that isn’t marine debris (ex. Soap from washing a car, oil spill), tell them that it’s good that they brought it up, but it’s technically not marine debris and you’ll tell them why when you go over the definition. Try and get the students to give you a range of different materials that marine debris could be (i.e. plastic, glass, paper, cardboard, Styrofoam, etc.).

Now go into the technical definition of marine debris: Marine debris is 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. For younger audiences, focus on the following key words/phrases: man-made, solid, ends up in ocean or Great Lakes on accident or on purpose.

Instead of just reciting this definition, break down the definition in bullet points and ask these questions, referring back to the examples they just gave you:

- What state of matter were all of those examples?
  Marine debris has to be a solid, CANNOT be a liquid or gas.

- How were all of those examples/items made? And who makes them?
  Marine debris is all man-made (has been manufactured/processed by humans in some way).

- How long do you think those solid, man-made items are going to last in the environment once they reach the ocean?
Marine debris is persistent in the environment. (It’s a good idea to explain what persistent means to the elementary school students—you can say that persistent just means that it’s going to last in the environment for a very, very long time maybe even forever).

- Now review these 3 main characteristics of marine debris with the students. Have them name all 3 (if they can) back to you.
- Then ask the students how does all this trash get into the ocean? (Save the specific ways - wind, rivers, littering, etc. - for the canvas activity). Ask them if trash gets into the ocean on purpose (intentionally or directly) and/or by accident (unintentionally or indirectly)?

Now transition to the canvas activity.

**Materials and Kits:**
The Introduction to Marine Debris kit includes:
Large Community Canvas dropcloth on which a community has been drawn/painted and labelled. Suggestions include road, farm, river, shopping area, landfill, factory/industrial park, residential neighborhood, school, church, etc.

Multiple pieces of cleaned human trash. Suggestion for sites and trash include:
- School/cafeteria small milk carton/ Mylar juice pouch
- Fast food restaurant Styrofoam container
- Coffee shop paper cup
- Garage oil tube or bottle
• Grocery store   plastic bag
• Gym or sports field   plastic water bottle
• Landfill/dump   large black garbage bag
• Church   funeral bouquet ribbon
• House   Birthday balloon/ lightbulb
• Construction site   piece of wood/ hard insulation
• Farm   mesh feed bag
• Factory   metal can
• Road   cigarette/ piece of tire
• Beach/coast   plastic beach ball/ suntan lotion tube

**Marine Debris Matching board games (trifold boards):**
These were created by posting background information onto small trifold boards. On the left is general background information on marine debris and how it decomposes. On the right is statistics/data related to the Top Ten Marine Debris Items. Students use the middle of the board to match marine debris items with decomposition time cards.

([www.oceanconservancy.org/our-work/international-coastal-cleanup/top-10-items-found-1.html](http://www.oceanconservancy.org/our-work/international-coastal-cleanup/top-10-items-found-1.html))
For elementary age students:

Once you have completed explaining the characteristics of marine debris, have pairs of students select a piece of the cleaned trash. Once the students have all selected their marine debris item, ask if any of them have an item they have never seen before or are unfamiliar with. Majority of the marine debris items are common trash items that the students should be familiar with. If some of the students don’t know what item they have, start by explaining those items first as a group. Discuss what the item is, what it is used for, and how it can be an issue once it reaches the ocean. Pick a few more items to go over as a group—try to only talk about 3-4 items to stay in your time limit.

Focus the students’ attention on the canvas (they’ve already seen it or walked past it as they were entering the room for the program). Explain that the canvas is a map with different community sites/locations labeled on it. Invite them to walk around the canvas, study the different sites, think about their marine debris item (whatever item they are holding in their hands) and decide where they think that item came from on the map before it reached the ocean. (Depending on how you make your map, you may want students to take off shoes).

The students must pick a location on the map where they think their trash came from. Explain that it’s not where the item was made, but more of where were they using that. Once everyone has circled the map ask the class to freeze where they are and face the canvas. Have them sit on the site/location on the canvas where their item originated from or was used. Remind the students to walk slowly and carefully so no one slips and falls. Also no pushing or shoving of any kind.

Some students might mention that they think their item can come from more than one place. Explain to them that that’s not wrong, but just to pick one location. Some students might try to sit in the ocean, but remind them that this is before their trash reached the ocean.

Now that the class is sitting in locations according to their marine debris item, there are a couple of ways you can explain the different ways our trash gets transported from land into the ocean:

1. If you do not have a lot of time left, do not go into too much detail and explain every location. Instead, point out that all of them are sitting according to where their trash came from and that no one is sitting in the ocean because you’re talking about before it reached the ocean. Then ask the students, “If you’re not in the ocean, then that means you are all on what?” Sometime this takes a second to process and they might start shouting out the specific location they’re sitting at, but you want them to understand that they are all sitting on land. Then emphasize that most of the marine debris (trash in our ocean) come from somewhere on land. Then ask the students, “So how is all this trash on land making its way into the ocean?” You want
the students to come up with: humans littering (a direct/intentional way), wind blowing (an indirect/unintentional way), and rivers (an indirect/unintentional way). These are the main ways trash gets transported from land into the ocean.

The students may mention other ways trash can reach the ocean, like other animals. Just help them to understand that wind and rivers are the most important ways.

It is also important to mention that with rivers, anything that is littered or falls into the river, whether by accident or on purpose, means that it’ll wash down the river all the way into the ocean. So ask them, “Where do all rivers lead?” It also might be helpful to point out the mouth of the river on the canvas.

2. If you have more time to spare, use the locations as a guide and ask for a volunteer at some or each location. Ask that student to tell the group what item they had and make up a story of how they think that item could’ve reached the ocean. As you go through the rest of the locations, a lot of the students will say the wind blew it there or someone littered, and they may not mention the river. So, ask them if there’s another body of water on the map that their trash can blow into or someone can litter into besides all the way to the ocean. Then wrap up, and list the 3 main ways trash gets transported from land into the ocean (littering, wind, and rivers).

Now that the students understand how trash gets into the ocean, ask the students, “Raise your hand if you live on the coast?” A lot of them may not raise their hands. Explain to the class that all of their hands should be raised because they all live on the coast. Explain that even if they cannot see the ocean or walk/bike to the beach, they are still part of the coast. Explain that the coast is anywhere from right at the beach up to 100 miles inland.

It’s helpful to stand at the beach/coastline on the canvas, then walk to the back, off of the canvas to represent 100 miles inland. It’s also helpful to explain that 100 miles is equivalent to driving for 2 hours straight, non-stop, directly away from the ocean. Then ask the students, “How long does it take you to get to the beach?” A lot of them will answer less than 2 hours to prove your point.

Explain that since they live on the coast, they have a huge responsibility about how they dispose their trash since they’re so close to the ocean. This will then lead to inland, non-coastal communities. Ask the class, “How about the people in rest of the country that don’t live on the coast, that are 400 or even 600 miles away from the nearest ocean? (Just pick any larger number than 100 miles as an example). Maybe even ask, “What about people who live in the middle of the country?” Does their trash matter? Can their trash make its way to the ocean?” The students should understand that yes, it is still possible. There answers should reflect the 3 main ways (littering, wind and rivers). Explain that it just might take longer for their trash to reach the ocean since they’re further from the coast.
For middle schools:
Transition to the tri-fold boards activity.
Have the students break into 8 groups of 3-4 and provide each group with a tri-fold game board. Explain that they are to read the information on the sides, either out loud taking turns or quietly to themselves, then match the cards inside the Ziploc bag. Explain that half of the cards have a picture of a marine debris item on it and the other half of the cards have a decomposition timeline. All they need to do is match the marine debris item with how long they think it’s going to take for that item to break down in the environment/ocean. Allow the groups to work on this activity for ~10 minutes. Once all the groups are finished, go over the answers all together and have the students move their cards around as needed.

Next ask the students, “What can account for the various decomposition rates for the different marine debris items?” They should be able to conclude that it is mainly due to the different materials the items are made from. After discussing this, point out that some of the items have a broad decomposition range. Use the plastic bag as an example. Ask them, “How is it possible for the same plastic bag to break down in 200 years or 1,000 years?” They might get stuck on this and give you some incorrect answers. If so, backtrack and ask them, “How does plastic break down in the ocean?” Direct them to the information on the trifold board that explains how plastic breaks down via a process called “photodegradation.” Ask the students what they think photodegradation means. If they are struggling, break the word down and ask them, “What does “photo” refer to (you can reference photosynthesis) and what does it mean for something to “degrade?” You should end up with the definition of “breaking down via sunlight.” Go back to the plastic bag example. Ask the class, “How long is it going to take for a plastic bag that is floating at the surface of the ocean to break down?” Somewhere closer to 200 years since it is exposed to the sun the most. Then ask, “So where is a plastic bag that takes 1,000 years going to be in the water column?” Somewhere towards the bottom of the ocean/seafloor. If necessary, remind them that the deeper into the ocean, the less light is available.

Ocean Literacy Principles Met by Activity:
Principle #6
Mapping Migration

Mapping of Marine Migratory Species’ Routes
Time to complete lesson: 35-40 minutes

General Lesson Overview:
In this lesson, students will learn about the North Atlantic Right and Gray Whale migrations.

Background Information:

Many large whales migrate long distances during the year. Whales, just like birds, migrate from north to south in the Northern Hemisphere. Below, you will find descriptions of the migratory patterns of two species of large whales – the North Atlantic right whale (Atlantic) and the gray whale (Pacific).

North Atlantic Right Whale (*Eubalaena glacialis*)
During the **summer**, North Atlantic (NA) right whales use the cold waters from Cape Cod to Nova Scotia (Canada) for mating and feeding. NA right whales feed on zooplankton, including copepods, euphausiids, and cyprids. Right whales are able to filter out the copepods from the seawater, consuming more than a ton of the tiny creatures in a single day. Right whales need that much food to build up the blubber layer that keeps them warm in the frigid Atlantic waters. They also draw on their blubber when food is scarce and, for females, when meeting the extra demands of breeding and nursing.

Each **fall**, pregnant females travel south to the warm coastal waters off of the Southeast Atlantic Coast. It is not known where most males and non-calving females go during this fall/winter time period, as they are rarely seen.
In the **winter** months, calving females give birth and nurse their young in the Southeast Atlantic (Florida to North Carolina). The area of the Atlantic Ocean just off the border of North Carolina and Virginia is a documented Right whale calving grounds.

In the **spring**, mothers and calves make the long journey north back to their feeding grounds. Large aggregations of NA right whales can be found in the Great South Channel (east of Cape Cod) and in Massachusetts Bay as they travel north to their summer feeding grounds.

**Gray Whale (Eschrichtius robustus)**

During the **summer** and **fall**, gray whales feed in the Bering, Chukchi, and Beaufort Seas. Gray whales are bottom feeders, and use their baleen to sift invertebrates (amphipods, ghost shrimp, and crab larvae) from the soft sediments. They also feed on herring eggs and larvae in eelgrass beds. They build up their blubber in preparation of their migration south. Their migration begins in the **fall**, led southward by pregnant females. Males, non-calving adult females, and juveniles soon follow, although some juveniles don’t reach the summer grounds before turning around and heading back north.

In the **winter**, mothers give birth and nurse their babies in the shallow waters in the lagoons of the Baja Peninsula. Mating occurs along the coast of Baja and the mainland of Mexico.

In the **spring**, all whales leave their nursing and breeding grounds (including newly pregnant females) and migrate north to Alaska.

**Materials and Kits:**

Mapping of Marine Migratory Species’ Routes Classroom Kit includes:
- 8 Magnetic Whiteboards with Map of North America (use a permanent marker to trace the outline of North America on dry erase board; include latitude/longitude lines)
- Magnets (pictures provided) – eight of each (print images on cardstock and attach to peel and stick ceramic disk magnets). You will need 120 magnets to create 8 sets. For older students you will need assorted magnetic pegs/pushpins (14 for each group)

- o Right whales
  o Baby right whales
  o Gray whales
  o Baby gray whales
  o Sun
  o Snowflake
  o Krill photo
  o Pacific
  o Atlantic
  o Star
  o Plastic bag
  o Net with fish
  o Water bottle
  o Yellow arrows
  o Blue arrows
Instructions:

1. What is it called when animals move from one place to another?
   a. Migration

2. Why might animals migrate?
   a. Temperature/water temperature (too cold or warm)
   b. Food availability
   c. Reproduction/ nursery grounds for babies

3. Do whales migrate? Where? What other animals migrate (focus on marine mammals)?
   a. Turtles
   b. Birds
   c. Sharks
   d. North Atlantic Right Whales
   e. Blue whale
   f. Gray whale
   g. Humpback whale
   h. Dolphins

4. Explain blubber stores, feeding, calving, nursing, and the nutritional cycle of a general migrating whale.

5. Show the students the map. What is this a map of? Confirm that we will be focusing on the coast we live on and the west coast. Ask students which oceans we are looking at. Have them place the Pacific magnet, Atlantic magnet, and star magnet (your current location).

6. Have students hypothesize the migration of the whales based on what we know so far. Ask where they think each whale would be in the summer and winter. Have them discuss, while making their maps, how they think the whales would be impacted by marine debris as they migrate.

7. Break the students into groups.
   a. For younger students, have them place the sun where they think the whales are during the summer. Have them then place the snowflake where they think the whales are during the winter. Have them place the krill where they think the animals feed. Place the marine debris items where they think they would be found. Finally, have them move the whale and baby whale on the board as it would swim on the coast.
   OR
   Have the students place the blue arrow magnet along the coast pointing SOUTH, the route of both whales from NORTH to SOUTH (from summer to winter). Then have them place the yellow arrow magnet along the coast pointing NORTH, the route of both whales form SOUTH to NORTH (winter to summer). They can then place the sun, snowflake, krill, marine debris, and whale magnets in the appropriate places.

   b. For older students, ask them to use the latitude and longitude markings on the map to track the “sightings” in the following table using the assorted magnetic peg/pushpin map magnets:
<table>
<thead>
<tr>
<th>Sighting date</th>
<th>Area</th>
<th>Lat/Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2003</td>
<td>Great South Channel</td>
<td>40N, -70W</td>
</tr>
<tr>
<td>August 2003</td>
<td>Bay of Fundy</td>
<td>45N, -65W</td>
</tr>
<tr>
<td>December 2003</td>
<td>Georgia</td>
<td>31N, -80W</td>
</tr>
<tr>
<td>January 2004</td>
<td>Florida</td>
<td>30N, -80W</td>
</tr>
<tr>
<td>June 2004</td>
<td>Great South Channel</td>
<td>40N, -70W</td>
</tr>
<tr>
<td>August 2004</td>
<td>Maine</td>
<td>45N, -67W</td>
</tr>
<tr>
<td>July 2005</td>
<td>Maine</td>
<td>43N, -70W</td>
</tr>
<tr>
<td>August 2005</td>
<td>Massachusetts Bay</td>
<td>42N, -71W</td>
</tr>
<tr>
<td>November 2006</td>
<td>Maine</td>
<td>43N, -70W</td>
</tr>
<tr>
<td>December 2006</td>
<td>Florida</td>
<td>30N, -80W</td>
</tr>
<tr>
<td>January 2007</td>
<td>Florida</td>
<td>29N, -80W</td>
</tr>
<tr>
<td>February 2007</td>
<td>Georgia</td>
<td>31N, -80W</td>
</tr>
<tr>
<td>March 2007</td>
<td>Florida</td>
<td>30N, -80W</td>
</tr>
<tr>
<td>August 2007</td>
<td>Bay of Fundy</td>
<td>44N, -65W</td>
</tr>
</tbody>
</table>

Discuss why this female didn’t repeat the pattern of going north to south every year (the calving interval for right whales is 3-5 years i.e. only one calf per 3-5 years).

8. **Once done with the maps, bring the group back together to discuss what they have created.**
   a. Go over the direction the arrows should be going in.
   b. How are these whales being impacted by marine debris as they migrate?
      i. **NA Right Whales**
         1. NA right whales swim very close to shore, and often encounter many types of marine debris.
         2. Entanglement issues in fishing gear or discarded/ghost nets
            a. Acute entanglement – drowning
            b. Chronic entanglement – long-term entanglement that affects ability to swim, eat, reproduce. Includes entanglement around the rostrum.
         3. Plastic ingestion while feeding in the summer/fall
            a. Can choke the animals
            b. Can make them sick
      ii. **Gray Whales**
          1. Gray whales usually travel within 2.5 miles of the shore along 5,000-7,000 miles of coastline to make their migration. This is one of the few whale migrations that can be seen from shore.
          2. Gray whales eat by sifting through the sediment, where marine debris can settle. Plastic, rubber, rope, duct tape, fabric, and even golf balls have been found in the stomach of gray whales.
**Tips for success / extra info:**
When making magnet pieces, DO NOT LAMINATE as glue will not stick to the plastic. Print pieces out on cardstock, tape (with packaging/masking tape) on one side, then apply to sticky side of magnet; if you cannot find self-stick magnets that work, use cool glue gun type of glue to secure the magnet to back side tape.

Photos from:
http://www.nmfs.noaa.gov/pr/images/cetaceans/graywhale-merrillgosho_noaa.jpg

**Pictures for Magnets**
Pacific

Atlantic
Ocean Gyres and Marine Debris Collection

Time to complete lesson: 20-25 minutes

General Lesson Overview:
Students will learn how ocean gyres form, and how they concentrate marine debris.

Background Information:
A gyre, in oceanography, is any large system of rotating ocean currents, particularly those involved with large wind movements. To a large extent, horizontal movement of ocean surface waters mirrors the long-term average planetary circulation of the atmosphere. Three surface wind belts encircle each hemisphere: trade winds (equator to 30 degrees latitude), westerlies (30 to 60 degrees), and polar easterlies (60 to 90 degrees). The westerlies of middle latitudes and the trade winds of the tropics drive the most prominent features of ocean surface motion, large-scale roughly circular current systems elongated in the east-west direction known as gyres. Subtropical gyres are centered near 30 degrees latitude in the North and South Atlantic, the North and South Pacific, and the Indian Ocean. Gyres in the Northern and Southern Hemispheres are similar except that they rotate in opposite directions because the Coriolis Effect acts in opposite directions in the two hemispheres. Ocean gyres, composed of surface currents, are caused by the Coriolis Effect. The Coriolis Effect helps explain the curvature and paths of winds in the atmosphere. Because the Earth is larger at the Equator than it is at the poles, the Earth rotates faster at the Equator than it does at the poles (i.e. a point on the Equator has farther to travel in a day). As the earth spins, the apparent deflection and bending of the winds (towards the right in the Northern Hemisphere, and the left in the Southern Hemisphere) is the Coriolis Effect. Viewed from above, subtropical gyres rotate in a clockwise direction in the Northern Hemisphere but in a counterclockwise direction in the Southern Hemisphere.  

http://nationalgeographic.org/encyclopedia/ocean-gyre/

Some additional information of Coriolis Effect and formation of gyres can be found at:
- Good review of wind belts for instructors

- http://www.youtube.com/watch?v=mi6F1PdXUPM
In 1992, a crate of ~29,000 plastic bathtub toy animals left Hong Kong, China bound for Tacoma, WA, USA. In route, the crate was washed overboard! Thousands of Floatee toys including yellow rubber ducks, blue turtles, green frogs and red beavers were released into the Subpolar Gyre, a current that circulates counterclockwise around the North Pacific Ocean. Because the toys were branded with the text “The First Years” oceanographers and citizen scientists were able to track their dispersion and identify them when they washed up on beaches. About 2/3 of the toys headed south, eventually washing up on beaches in Indonesia, Australia and the western shore of South America. The other 1/3 were caught in the Subpolar Gyre and over the years have been found on the beaches of Alaska and Japan. Using computers and ocean data along with the locations recorded for each Floatee found, scientists believe that the remaining toys will enter the Arctic Ocean, and head to the North Pole.

Materials and Kits:

3T Ocean Gyres and Debris Collection Kit Includes: (this is for 4 stations; 1 will do for demo)
- 8 magnetic stir plates
- 4 plastic under bed storage bins (16” x 24”, 28 qt. size)
- 8 magnetic stir bars
- Small plastic/rubber ducks (we used baby shower decorations; make sure they are water tight)
- Homemade confetti (collected from hole punch machine - paper, cardstock and plastic chads)/pieces of marine debris
- Blank ocean map on which students can draw gyres
- Inflatable globe

**Instructions:**

1. Read *Ducky* by Eve Bunting (K-5 appropriate) or “Using flotsam to study ocean currents” by Curtis Ebesmeyer at [http://oceanmotion.org/html/gatheringdata/flotsam.htm](http://oceanmotion.org/html/gatheringdata/flotsam.htm)
2. Discuss ocean gyres. What is a gyre? What makes a gyre? Where are gyres located?
a. Use an inflatable globe as a reference when discussing gyres.
b. Hand out map with the gyres shown on it.
c. Be sure to review the Coriolis Effect for middle school groups (see references)

3. Demo the ocean gyres.
   a. Have the students hypothesize how the gyres should appear in the tubs.
   b. Set tub on two stir plates
   c. Fill tub with water (approximately 3 – 4 inches; test to make sure stir bars spin)
   d. Place the magnetic stir bars in the tub of water on top of the stir plates. Slowly turn on the stir plates to a medium-low rate (Note: because the stir plates only spin in one direction, they will not be able to show the difference in gyre rotation in different hemispheres).
   e. Allow the gyres to form (if necessary, increase the speed)
   f. Once their gyres are established, ask students to hypothesize what is going to happen to the marine debris that they will add (Will it all sink? Float? All get caught in the gyre?)
   g. Have students draw their predictions on the blank map.
   h. Add small plastic/rubber ducks. Do they travel similarly to those in the story?
4. Further exploration of gyres.
   a. What happens to marine debris when it enters the gyres? Where does it end up? Emphasize that trash is located in every part of the ocean – may be concentrated in gyres but is also by the coast, and at the bottom and top and throughout the water column. (Did paper, cardstock and plastic chads distribute at different levels within the water column? If so, why?)
   b. Discuss ocean garbage patches. Is the one in the Pacific the only one? No. They’re at the center of every gyre! Why?
   c. Hypothesize how we can clean up the marine debris in our ocean gyres. Have the students come up with a few ideas, and discuss pros and cons of each.

Tips for success / extra info:
- Recommended story books: Ducky by Eve Bunting; 10 Little Rubber Ducks by Eric Carle
- Flotsametrics and the Floating World: How One Man’s Obsession with Runaway Sneakers and Rubber Ducks Revolutionized Ocean Science by Curtis Ebbesmeyer and Eric Scigliano
- http://www.windows2universe.org/teacher_resources/ocean_education/currents_main.html Ducks in the Flow

Ocean Literacy Principles Met by Activity:
- Principle #1
- Principle #3
- Principle #5
- Principle #6
- Principle #7
Passing Through the Perilous Plastic Ocean
(Time to complete lesson: 20 minutes for one round of game)

General Lesson Overview:
Students will learn about the hazards of marine debris on migratory marine populations by completing this fun simulation game.

Background Information:

Ingestion
Seabirds, sea turtles, fish, and marine mammals often ingest marine debris that they mistake for food. Ingesting marine debris can seriously harm marine life. For example, whales and sea turtles often mistake plastic bags for squid, and birds often mistake plastic pellets for fish eggs. Animals can also eat marine debris while feeding on natural food.

Ingestion can lead to starvation or malnutrition when the marine debris collects in the animal's stomach causing the animal to feel full. Starvation also occurs when ingested marine debris in the animal's system prevents vital nutrients from being absorbed. Internal injuries and infections may also result from ingestion. Some marine debris, especially some plastics, contains toxic substances that can cause death or reproductive failure in fish, shellfish, or any marine life. In fact, some plastic particles have even been determined to contain certain chemicals up to one million times the amount found in the water alone.

Entanglement
Marine life can become entangled in marine debris causing serious injury or death. Entanglement can lead to suffocation, starvation, drowning, increased vulnerability to predators, or other injury. Marine debris can constrict an entangled animal's movement which results in exhaustion or development of an infection from deep wounds caused by tightening material.

Right Whale Migration
North Atlantic right whales inhabit the Atlantic Ocean, particularly between 20° and 60° latitude. For much of the year, their distribution is strongly correlated to the distribution of their prey. During the summer, North Atlantic right whales feed at higher latitudes (north) near New England, the Bay of Fundy, and Scotian Shelf. During winter, right whales occur in lower latitudes (south) and coastal waters where calving takes place. However, the whereabouts of much of the population during winter remains unknown.
Goals

This game simulates the negative effects that plastic trash can have on the feeding and survival of marine animals. Through several rounds of play, students collect colored beads that represent the food of marine animals. In the first round, the players determine the number of calories their animals need to stay alive. In following rounds, the players are physically hindered in some way from gather food normally.

Materials:
Globe
Stuffed right whale toy
Laminated game cards for each round of migration (see masters at end of lesson)
Pictures of various migratory species displaying impacts of marine debris

Instructions:

1. Before playing, set the course, including the Northern and Southern boundaries and compass rose in middle. Put the Round 1 (in Northern waters), Round 2 (in the middle of the simulation), and Round 3 (in Northern waters) game cards in their appropriate spots. Follow the following game instructions – see rest of lesson plan for more detail.

| **Round 1** | 1. Students pick up one card  
| 2. Students sit  
| 3. Discuss how right whales eat  
| 4. Take cards from students  
| 5. Students migrate to south and sit |
| **Round 2** | 1. Discuss what they’re doing in southern waters  
| 2. Students stand, pick up one card from middle of field  
| 3. Students sit in northern waters (some in middle – they died)  
| 4. Discuss what happened  
| 5. Take cards from students, tell them to remember their handicap and use it in Round 3 |
| **Round 3** | 1. Discuss where the students are in their migration  
| 2. Students pick up one card, using handicap if applicable  
| 3. Students migrate to the south and sit if they don’t die OR sit down in their spot if they die  
| 4. Discuss what happened |
2. Introduce the concept of migration. What are some kinds of animals that migrate on our coast? Why? Where? When? Ask about marine organisms if none were mentioned by students.

3. What are some obstacles/dangers of long migrations?

4. Introduce marine debris as one of the perils animals encounter during long migrations. Discuss what marine debris is, and ask the students for some examples of marine debris items.

5. While there are many types of migratory animals on our coast, today all students will be a North Atlantic right whale. Introduce them to the North Atlantic right whale and remind them that Watson the Whale is a North Atlantic right whale.

6. Our migration begins in the waters surrounding Maine and Nova Scotia. Show students on the globe where this is.

7. Round 1
   a. Bring students to the section designated as the northern waters. When the instructor says begin, students will do their best right whale impressions as they search for food (find one Round 1 game card). Each card is the same with a picture of zooplankton and a statement that says that ‘Right Whales eat as much as 2600 pounds of these animals each day’.
   b. Have the students sit in place, and begin a discussion about how right whale eat these zooplankton using baleen. This is the summer and the time when these animals are feeding and gaining energy in preparation for their migration to the southern waters of the Atlantic coast. Ask what would happen if they were unable to eat this amount each day (would not have enough energy, might get sick, would not be able to make long journey south, etc.).
   c. Collect Round 1 game cards.
   d. Have students stand up and do their best Right Whale impression as they migrate down to the southern waters, then sit down when they arrive.

8. Round 2: Round 2 cards will have different entanglement scenarios with outcomes: must hop on 1 foot, cover mouth with both hands, must keep hands behind back, travel 10 steps and sit down, etc.
   a. Students should be sitting in southern waters. Show students on the globe where they are. Ask why they think right whales spend the cooler months in the south. Discuss that pregnant right whales give birth in these southern waters.
   b. When the instructor says go, the students will migrate to the ‘North’. Each student must pick up one Round 2 game card. They will read their card and follow the instructions as they continue their journey.
   c. Have students sit down in northern waters when they arrive (some might be sitting in the middle – they had a card where they were entangled and died). Have different students explain what happened to them during the migration and discuss. Note that some students may have died and will be sitting to represent this.
d. Collect student’s cards before beginning the next round – make sure to tell them to remember their handicap from this round, as they will use it in the next round! For example, if they had to keep their hands behind their back to migrate, they need to also do this during Round 3.

9. Round 3:
   a. Ask students where they are in their yearly migration: back in the North to feed during the summer months.
   b. Students will follow the same directions from Round 1, but this time some students may be ‘handicapped’ from their encounter with marine debris in the previous round.
   c. When the instructor says go, students will do their best right whale impression as they search for one Round 3 game cards to simulate feeding. Some cards will have Zooplankton while others will have marine debris and associated impacts. If students die, they will sit down where they picked up their card. Students that survive will migrate to the South and sit down.

10. Discuss the outcomes of the simulation. Review why these whales migrate. How were whales impacted by marine debris? Was it harder to get to and ‘catch’ your food after you were entangled? Show large pictures of entanglement and stomach contents if available.

**Ocean Literacy Principles Met by Activity:**
- Principle #1
- Principle #5
- Principle #6

**Game Cards:** you will need to print the cards, fold in half and laminate. One side will indicate the round being played and the other side indicate the information/situation to be used by the player. You will also need to make 2 large signs, Northern Waters and Southern Waters. You will need approximately 40 round 1 cards, 42 round 2 cards and 46 round 3 cards.
Round 1

A North Atlantic right whale eats 2600 pounds of these tiny krill and copepods each day!
You swam into an abandoned fishing net and it wrapped around your mouth. You must cover your mouth with both hands and you can no longer eat!

Marine debris wrapped around your pectoral fin. You must keep your hands together behind your back for the rest of your journey!

Your got caught in marine debris and cannot free yourself! Take 10 steps forward and sit down. You drowned.
Round 2

You swam into an abandoned fishing net and it wrapped around your fluke! It is hard for you to swim and from now on you must hop on one foot.

Round 2

Your got caught in marine debris. Walk around in circles for 10 seconds as you try to free yourself.

You are tired and hurt, but you keep swimming to the North!

Round 3

You found nutritious krill and copepods!
Round 3

You swallowed a plastic bag when searching for food. Your stomach feels full and you stop eating. Take 10 steps and sit down. You starved to death.

Round 3

You accidently swallow a broken DVD case. You begin to feel sick and no longer eat. Take 10 steps and sit down. You died from internal injuries.

Round 3

You found krill and copepods, but they are full of plastic! You feel very sick and can’t swim well. Crawl to find the rest of your food.
Comparative Feeding Strategy of Whales

Time to complete lesson: 20-25 minutes

General Lesson Overview:
In this lesson, students will compare two different types of whale feeding: baleen and toothed whale.

Background Information:
Cetaceans (whales, dolphins, and porpoises) are classified into two suborders based on several factors, including their feeding adaptations: the baleen whales (suborder Mysticeti) and the toothed whales (suborder Odontoceti). *Ceti* refers to the Latin word for whale, while *Mysti* translates to mustache and *Odont* refers to teeth.

Baleen whales have two blowholes and are generally larger. Toothed whales have one blowhole and are usually smaller (the only toothed whale longer than 13 meters is the sperm whale). However, the most obvious difference between the two suborders is their feeding strategy.

http://ocean.si.edu/sites/default/files/styles/750x/public/photos/M.Weinrich_WCNE_135_3573cropped_0.jpg?itok=jwmOMc2s

Baleen whales

Baleen whales, including right whales, blue whales, humpback whales, gray whales, etc., have baleen plates in the gums along each side of the upper jaw. These plates are triangular and arranged like teeth in a comb. The inner edge is frayed, allowing the fringes to form a dense mat inside of the mouth. Baleen is made out of keratin, the same substance that human hair and fingernails are composed of. This allows the baleen to grow for the life of the animal,
wearing down when it gets too long. Baleen whales, some of the largest animals to ever live on earth, use their baleen to strain food from the water, eating some of the smallest, most abundant life in the ocean: plankton. Some baleen whales also eat small schooling fishes and crustaceans such as krill, copepods, and either swimming with their mouths open, or opening their mouths suddenly and taking in large quantities of water. The water is forced back out past the baleen, where their prey is trapped, and when the water is gone, the whale swallows its meal.

Toothed Whales

Toothed whales, including dolphins, beaked whales, sperm whales, etc., have hard, often conical-shaped teeth. Toothed whales hunt their prey with echolocation. Echolocation is a navigation system used to detect objects in the water. The whale sends out sound waves from its nasal passage, through its melon, and out to its environment. The sound bounces back, or “echoes” off of the objects, then returns to the whale through its lower jaw. The lower jaw links to the ear and the whale then gets a clear “sound-picture” of the size, shape, and location of the object. When they locate their prey, they capture it, using suction, their teeth, or both. The prey items preferred by toothed whales vary by species, but most eat fish, squid, crabs, or other mammals. Once they capture their prey, it is swallowed whole.


Materials and Kits:

Review skeleton images for baleen whale (Right Whale) and compare with skeleton of a toothed whale (Orca).
Comparative Feeding Strategy of Whales kit - Includes:

- Laminated diagrams of whale skeletons
- Plastic tubs with green dots pattern on bottom – phytoplankton
- Hair pick combs – baleen whales
- Large hair jaw clips – toothed whales
- Fake squid (available in fishing lure supplies)
- Krill - chads from hole punch machine (paper, cardstock, plastic sheets)
- Small pieces of marine debris (i.e. straws, coffee stirrers, balloons, plastic bag pieces, bottle caps, fishing line)
- Water
Instructions:
1. Fill plastic tubs with water.
2. Introduce the two types of feeding adaptations of whales – baleen vs. teeth.
   a. Ask the students if they know anything about these two types.
3. Introduce the activity and ask what the materials symbolize.
4. Add the squid and hole punch chads, explaining what they symbolize.
5. Have the students run hair clips (toothed whales) through the water to see what they catch.
   a. They should catch squid. They may also catch some chads, but not a lot.
6. Have the kids then run combs (baleen whales) through the water to see what they catch. Make sure students are combing through the water only and not trying to scoop with the combs. The combs should be held so that the teeth are pointing straight down, and keeping them in that same orientation the students move them through the water. Remind them that they need to act and feed the same way a real baleen whale would, and they do not scoop with their mouths. They also should not try to stab the food.
   a. They should catch a substantial number of chads.
7. Now add in the pieces of marine debris, telling students to pay special attention to see if they can catch the debris while they are feeding. Which whales were able to catch the debris? Were they still able to catch any food with the debris in the tub?
8. Discuss why it is important that the two types of whales eat different food sources.
9. Did the students “eat” any pieces of debris? What happens to these pieces of debris? Can you see how a whale might accidentally ingest plastics (gulp feeding, mistaking for
squid or fish while using echolocation, etc.)? What do the debris pieces do to the whale? Why is this bad?

a. Marine debris can be ingested by both baleen and toothed whales. Baleen whales might eat it while they are feeding (this includes smaller pieces within their prey items and in the water column). Baleen whales can ingest large pieces of plastic as well. Toothed whales use echolocation when feeding. If you’re not using your eyesight, can you see how a plastic bag floating in the water column could look like a squid?

b. Marine debris can build up in the stomachs of whales, making them sick and preventing them from eating nutritional food. Large pieces of plastic are not passable by whales. These plastics can build up, even to the point where they are in the stomach and esophagus of the whale. Whales can also choke on plastic. Chronic entanglements around the rostrum and mouth of the whale can prevent it from feeding. Whales who have eaten or are entangled in plastic often times end up starving. Lastly, plastics are also toxic and can adsorb toxins, which can build up in the blubber layer and internal organs of the whale, causing long-term health issues.

Tips for success / extra info:

How a DVD Case Killed a Whale by Isabelle Groc for National Geographic

Ocean Literacy Principles Met by Activity:

- Principle #5
- Principle #6
Biomagnification of Plastic Pieces in Marine Food Chain

Time to complete lesson: Depends on class size and level of math skills – 45-60 minutes

**General Lesson Overview:**

In this lesson, students will learn about the concept of biomagnification, and how plastic concentrates in marine organisms as you move up the food chain.

**Background Information:**

Marine debris can impact the marine environment in many ways. Marine debris is defined by NOAA 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’. Many marine animals ingest marine debris, usually plastic, as they are feeding. These animals may mistake the plastic as food, or they may accidentally eat it as they are feeding. Even zooplankton have been found to ingest plastic. This is often possible because larger pieces of plastic have photodegraded. Photodegradation is the process by which plastic is broken down via sunlight. As organisms at higher trophic levels begin feeding on zooplankton that have ingested plastic, these plastics will begin to accumulate in higher level organisms. Biomagnification is the process by which pollutants, such as plastic, concentrate as they move higher up in the food chain (to higher trophic levels).


**Materials and Kits:**

Biomagnification of Plastic Pieces in the Marine Food Chain Kit includes:

- Plastic beads (small and large green, small clear, small red)
- 35 Ziploc bags (4 sizes) with photos of marine organisms (provided)
- 2 dozen wax pencils
• Laminated data assessment sheets
• 8 calculators
• Calculator instructions

Instructions:
1. Introduce the topic of food chains by asking the students if they can describe a simple food chain. Some discussion points are:
   a. What is the base of the food chain?
      i. In the marine environment, the base of the food chain is phytoplankton.
   b. How do organisms at the base of the food chain get their food?
      i. By photosynthesis.
2. Discuss how marine debris can enter the food chain and the consequences of this.
   a. Does plastic look like food to marine organisms?
   b. Can you always see plastic in the ocean?
   c. Do marine organisms eat plastic?
   d. Is plastic good for the marine organisms? Is eating plastic the same as eating food?
3. If the base of the food chain is affected by plastic, this can in turn affect many organisms as the plastic is accumulated in the food chain.
4. Explain the activity to the students. This game simulates the following food chain.

   Phytoplankton → Copepods (Zooplankton) → Small fish (Atlantic Menhaden) → Large fish (Weakfish) → Bottlenose dolphin

5. Tell the students that they will be conducting a feeding activity to learn about the food chain!
6. Give each child a “stomach” (Ziploc bags with animal on it).
   a. Depending on how many students you have, you can divide bags up accordingly (see following table), but there should only be one or two apex predators; the majority of students will be zooplankton.

<table>
<thead>
<tr>
<th># of students</th>
<th># zooplankton</th>
<th># small fish</th>
<th># large fish</th>
<th># apex predator</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>11</td>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>14</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>30</td>
<td>15</td>
<td>9</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>35</td>
<td>16</td>
<td>10</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

7. Pour the plastic beads (which represent food, toxins and debris out – select an area of clear space on carpet, bare floor, parking lot, etc. Set boundaries to this space so the students do not run everywhere.
   a. Explain to the students that you will be starting from the bottom of the food chain. So ask them, “What might zooplankton eat?”
8. Allow the copepods to feed first from the ocean of beads for about 20-30 seconds. Make sure that the students are using one hand to pick up the beads and the other
hand to hold their bag/stomach. They cannot scoop or sweep the beads into their bags. Have the students use only their thumb, pointer, and middle fingers to pick up the beads (sort of simulating a claw).

9. When their “stomachs” are full, have students seal their bags shut. Then allow the next organism (the Menhaden) to feed on the copepods for about 20-30 seconds. To do this, they play a game of SILENT tag. When the copepod is tagged, it must freeze and give its stomach (bag with beads) to the predator, then sit down. The small fish then puts the copepods’ “stomach” in its own bag/”stomach” and continues to feed until time is called (up to the instructor). Make sure the students just hand their sealed bag to the predator that ate them—DO NOT EMPTY THE CONTENTS INTO THE NEW/BIGGER BAG. Just put the sealed bag full of beads into the bigger bag.

   a. Remind the students:
      i. No running! Only fast walking allowed.
      ii. No shoving! Only a gentle tag allowed.
      iii. Silent tag! If you talk, you’re out! (this is up to the teacher)

10. Repeat the “feeding” with each successive level of the food chain, each round lasting about 20-30 seconds. However, you will notice that it takes less time to feed each level because there will be fewer food sources.

11. Once the students have all “fed” work as a group to draw their food chain, starting from the dolphin and working all the way down to the copepods (see example food chain diagram below). You can either start drawing this food chain diagram on the board or on a large sheet of paper. Have the dolphin(s) hold their “stomach(s)” and take out the bags inside (these are the Weakfish (large fish) the dolphins ate). As they take the Weakfish bags out, have them hand the bags back to the students that were the Weakfish. Add these Weakfish to the food chain diagram, respectively to which dolphin ate them. Continue this for the next trophic levels. Have the Weakfish open their “stomachs,” hand those bags back to the students who were the Menhaden, and add them to the food chain diagram. Lastly, have the Menhaden hand back the copepods their bags, and add the copepods to the food chain diagram.

![Example of single food chain (one apex predator)](image-url)
Example of double food chain (demonstrates use of multiple apex predators)

12. Now that the class has created their food chain(s) from top to bottom, they will now work from bottom to top to figure out how much food (phytoplankton), plastic, and toxins ended up in the apex predator (dolphin) by counting the beads. Have the students work together to empty out the copepods’ “stomachs.”

Step 1: Sort the beads, making sure to keep them separate according to each copepod
- There are 4 types of beads: large green, small green, red, and clear; however, the students may not notice at first that there are different sizes of the green beads. Let the students figure this out on their own, since each type of bead will represent something different in the end.
- Ask the students if there is any other way the beads can be sorted other than color to have them notice that there are two different sized of the green beads.

Step 2: Count how many of each type of bead was consumed by the copepod

Step 3: Record the amounts of different beads on the data sheets provided

Step 4: Find how many of the beads ended up in the next higher trophic level, the Menhaden.
- To do this, have the students work together to add up the amounts of different types of beads found in the copepods, according to how many copepods that Menhaden had eaten, and record that on their data sheet.
- For example, if the Menhaden had eaten 3 copepods, then the students should add up all the amounts of large green, small green, red, and clear beads to find the total amount of each bead that ended up in the Menhaden. If the Menhaden only ate one copepod, then they do not need to add any beads together and should keep that same number counted for the copepod “stomach.”

Step 5: Find how many beads ended up in the next higher trophic level, the Weakfish.
- Have the students work together to add up the amount of different beads that were found in the Menhaden, according to how many Menhaden each Weakfish had eaten, and record these amounts on the data sheet.

Step 6: Find how many beads ended up in the next higher trophic level, the Dolphin.
- Have the students add up the amount of different beads in the Weakfish, according to how many Weakfish each dolphin had eaten, and record these amounts on the data sheet.
13. Discuss what each type of bead might represent.
Large green beads = plastic, small green beads = phytoplankton, red beads = phytoplankton, clear beads = toxins associated with plastic.

14. Now, discuss with the students what consequences eating plastic and toxins have on marine organisms and the marine food chain as a whole
   a. K-2 → have them sort the green beads into big and small, explain that large beads are plastic and the consequences of this
   b. 3-5 → have them sort the green beads and write down on their data sheet how many of each type of bead they have, discuss. If the animal ate 20 large green beads, they are dead. If they ate 10 large green beads, they are sick. The clear beads represent the toxins associated with plastic, so if they ate any of those, they are sick. If they ate any of the small green or red, they are okay – that is good food.
   c. 6-8 → after sorting, have them write down on their data sheet how many of each type each organism had eaten. You can also have the students calculate the amount of plastic they consumed as a percent of their total consumption. If the animal ate 10% large green beads, they are dead. If they ate 5% large green beads, they are sick. If they ate any percentage of clear beads, have them add it to their percent of large beads – if it is over 10%, they are dead. The small green and red beads are okay.
      i. \[ \frac{\text{# of plastic beads}}{\text{# of “food” beads}} \times 100 \]

15. Discuss how the organisms at the bottom of the food chain consume the phytoplankton, plastics, and toxins, yet the animals at the top of the food chain also eat those things because their prey items do. In fact, the animals at the top of the food chain have the most toxins, because they are eating thousands upon thousands of the small things at the bottom of the food chain. With each food chain level, toxins increase.

**Background information from:**
An Educator’s Guide to Marine Debris (NAMEPA) (http://www.namepa.net/education/)
Turning the Tide on Trash (NOAA) (https://marinedebris.noaa.gov/turning-tide-trash)
Bigelow Labs Toxic and Harmful Algal Blooms educational activities:
https://www.bigelow.org/archive/edhab/

**Ocean Literacy Principles Met by Activity:**
Principle #2
Principle #3
Principle #4
Principle #5
Principle #6
Copepods are one of the most dominant members of the zooplankton, and are the major food source for many seabirds, small fish, and baleen whales. In addition to playing an important role in the marine food web as primary consumers, copepods contribute greatly to the proportion of secondary production in the ocean.

Marine debris has a major impact on copepods and other zooplankton primarily through their interaction with microplastics. Microplastics are plastic pieces that are smaller than 5 mm. Ingestion of these microplastics causes obstructions to feeding appendages, blocks the digestive tract, and introduces toxins to the organism.
Small fish (Atlantic menhaden)

The Atlantic menhaden is a commercially and ecologically important species in the Atlantic waters of the United States. The menhaden is a filter-feeder, consuming plankton by rapidly swimming to capture and filter water. Menhaden are schooling fish and act as important prey items for large predators, including seabirds, large fish, and marine mammals.

Menhaden are very oily, so humans catch and process them for fish oil and livestock feed.

Since menhaden are filter-feeders, ingestion of microplastics (plastic pieces smaller than 5 mm) is common. Microplastics have been found in the digestive tract of larval menhaden, where they cause intestinal blockage and introduce toxins to the animal. Menhaden are an important indicator species for estuaries – if they are sick, it means that the estuary is sick!
Large fish (Weakfish)

Weakfish are a large, abundant fish that are found in the Atlantic Ocean from Florida to Canada. Weakfish are important ecologically, but are also important to recreational fisheries on the East Coast of the United States. Weakfish undergo seasonal migrations, leaving nearshore waters and heading south towards warm waters during autumn. Weakfish gather in estuaries and bays nearshore in the spring and summer to spawn.

Weakfish feed on a variety of animals, including crustaceans, mollusks, and worms, but the single most important item of their diet is the Atlantic menhaden.

Weakfish can ingest marine debris by mistake when hunting. In addition, the hooks of anglers easily damage the entire mouth of this fish (this is where it gets the name “weakfish”), and this can be true for lost and discarded fishing gear as well. Marine debris also introduces toxins to the digestive tract of weakfish.
Bottlenose dolphins are commonly found off the Atlantic coast. Bottlenose dolphins are opportunistic feeders, eating many types of fish and squid. To find their prey, dolphins use echolocation, which is like a built-in sonar device in which dolphins send and receive sound beams to identify their prey items (and also navigate). In North Carolina, bottlenose dolphins feed upon sound-producing fish, such as the weakfish. To find these sound-producing fish, dolphins use passive listening to listen for their prey instead of echolocating to find them. Depending on the area, bottlenose dolphin individuals and groups may be year-round residents, seasonal residents, or transients. It is thought that seasonal residents and transient dolphins often migrate south to warmer temperatures and higher fish populations.

Bottlenose dolphins and other marine mammals are intensely impacted by marine debris. Bottlenose dolphins can become entangled in marine debris, including lost or discarded fishing nets or line. Entanglements can cause short term (drowning) or chronic (difficulty swimming, eating, and breathing) issues for marine mammals. Dolphins can also ingest marine debris by mistake. A plastic bag floating in the water column might look a lot like a squid to an echolocating marine mammal! This not only obstructs the digestive tract of these animals and makes them unable to absorb nutrients or eat further, but they are adversely affected by toxins adsorbed to plastic particles. Marine mammals are at particular risk for toxin absorption because their body is surrounded by a fatty, insulating layer of blubber that sequesters and concentrates the toxins. High levels of PCBs have been linked to reproductive failure and suppressed immune response in bottlenose dolphins.
**Calculator Instructions**

How to calculate percent plastic from total beads consumed:

\[
\frac{\text{# of beads in category}}{\text{# of beads total}} \times 100
\]

1. Type # of beads in category.
2. Press the \( \div \) button.
3. Type # of beads total.
4. Press the \( = \) button.
5. You will get a decimal.
6. Press the \( \times \) button.
7. Type 100.
8. Press the \( = \) button.

That number is the % plastic found in the stomach out of all food consumed.

Plankton distributed on floor with “stomachs” from different trophic levels of food chain.
Tables for Counting

Print out these tables and students can use them to keep track of the number of beads they have.

<table>
<thead>
<tr>
<th>Category:</th>
<th># large green</th>
<th># small green</th>
<th># clear</th>
<th># red</th>
<th># beads total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dolphin (Apex Predator)</strong></td>
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<tr>
<td><strong>Weakfish (Large Fish)</strong></td>
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<tr>
<td><strong>Atlantic Menhaden (Small Fish)</strong></td>
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<tr>
<td><strong>Copepod (Zooplankton)</strong></td>
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</tbody>
</table>
**General Lesson Overview:**
In this lesson, students will learn about the impact of marine debris on sea turtles by simulating a sea turtle stomach dissection.

**Background Information:**
The North Carolina Coast is home to many different species of sea turtle. Of the seven global species of sea turtle, five are known to make the waters of NC their home – the Loggerhead, Green, Leatherback, Kemp’s Ridley, and Hawksbill. These turtles migrate through and find their prey items in NC waters, and the Loggerhead and Green (and occasionally/rarely the Leatherback and Kemp’s Ridley) nest on NC beaches.

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**Coastal Shallow Water Benthic Feeding Zone(s)**
- Immature Turtles
- Adults
- Age at first breeding about 20-50 years.

**Breeding Migration**
- Adult males and females

**Open Ocean Surface Feeding Zone**
- ‘the last year(s)’

**Return to Feeding Areas**
- Breeding Migration at 2-3 year intervals

**Mating**
- Occurs offshore to nesting beaches

**Nesting Beach**
- Several clutches of eggs are laid

---

*Image credit: Commonwealth of Australia / GBRMPA*
Each turtle eats a different array of food items, but there is one item that they all partake in – marine debris. This is especially true for turtles such as the Leatherback, which feeds almost exclusively on jellyfish – and they often mistake a floating plastic bag for their prey. Turtles can also become entangled in marine debris, contributing to short- and long-term problems that negatively impact their health.

A sea turtle stranded on one of our beaches and later died. Scientists are looking for our help to determine why. They conducted a necropsy during which they removed the stomach contents of the turtle. The scientists have asked us to analyze the stomach contents to learn what we can about the sea turtle and what might have caused it to strand and die. They want us to pay particular attention to any signs of marine debris.

**Materials and Kits:**

**THIS KIT REQUIRES PREPARATION AT LEAST TWO HOURS BEFORE SCHEDULED ACTIVITY.**

Stomach Dissection Simulation Kit, Includes:

- Quart-size plastic storage tubs (sealable) with various marine debris and food items
  - Marine debris examples:
    - Balloons
    - Plastic grocery bags
    - Straws
    - Styrofoam peanuts
    - Bubble wrap
    - Net
    - Fishing line filament
    - 6-pack plastic ring holders
  - Food examples:
    - Jellyfish
    - Squid
    - Crabs
    - Dehydrated seaweed
    - Sea urchin
    - Shrimp
    - Clams

- Metal dissection trays with silicone lining
- Dissection tweezers
- Marine debris
- Natural food items – green lettuce/leafy veggie, rice noodles for jellyfish, sardines, squid, pieces of natural sponge, small clam shells, crab shell (or use figurines of small fish/squid/crabs)
- Sugar free gelatin (use orange and green colors, or clear gelatin)
- Canned cat food – fish variety
- Eye drop of ammonia (masks the Jello smell and provides an odor of decomposition)
- Gloves
- Small dish tubs for rinsing contents
- Containers to store rinsed stomach contents after dissection
- Glue
- Tablespoon
- Green and/or orange food coloring

**Instructions:**

1. Make gelatin mixture night before. To make mixture, combine 1 pack of Jello mix with 1 cup hot water then 2 cups cold water. Add 2 tablespoons of glue to mixture to make mixture more viscous. Add 1 drop of ammonia to mask smell of Jello and add 1-2 drops of green/orange food coloring. You can also add a spoonful of the canned cat food to give a more fishy smell and some texture. Note: this activity requires one Jello mixture per dissection set up (accommodates up to 4 students). If you are going to have 5 “dissections,” then make up 5 Jello packs worth of the “stomach” mixture in one large container (will be distributed into 5 containers).

2. Gather marine debris and food items, lump them together into a wadded ball, and place in the plastic storage tub. Pour in two cups of diluted Jello, immersing trash completely in the Jello. Tightly seal the container and place in the refrigerator for at least two hours or overnight.

3. Add gelatin mixture to containers with food and marine debris and leave in refrigerator overnight. Take containers out of refrigerator at least 1 hour before lesson. Gather marine debris and food items, lump them together into a wadded ball, and place in the plastic storage tub. Pour in two cups of diluted jello, immersing trash completely in the gelatin mixture. Tightly seal the container and place in the refrigerator for at least two hours or overnight.

4. On the day of the activity, discuss if the students think we have sea turtles on the coast of North Carolina. Explain that sea turtles in migrate through our coastal waters as they are feeding (use map at [http://www.seaturtle.org/tracking/maps/project/517.gif](http://www.seaturtle.org/tracking/maps/project/517.gif)).

5. Discuss what turtles typically eat and tell the students to be on the lookout for typical prey items in the stomach of the turtles.
   a. Loggerhead – carnivorous, feed on benthic shellfish, horseshoe crabs
   b. Green – young turtles eat worms, grasses, algae, and crustaceans; adult turtles eat sea grass and algae and are strictly herbivorous
   c. Kemp’s Ridley – crabs, shellfish, shrimp, fish, squid, sea urchins, jellyfish
   d. Leatherback – almost exclusively eat jellyfish
   e. Hawksbill – love to eat sponges, but also eat mollusks, algae, crustaceans, sea urchins, fish, jellyfish

6. Note that there are 2 options for how to implement this lesson:
   a. Split class into 5 groups. Each group will get a specific species of sea turtle and have to identify what species they have based on their dissection (containers should be coded on bottom so teacher can confirm the identification)
   b. Split the class into more than 5 groups (the lesson can accommodate up to 8) and just look at the different marine debris items found in each sea turtle stomach.
7. Provide students with gloves, a dissection tray, a pair of dissection tweezers for each pair of students, rinsing stations (small tubs filled with water for rinsing the debris and food items removed from the stomach contents during their dissection, 1 storage tub, and 1 container of simulated stomach contents per group/dissection tray. Have kids open the container of simulated stomach contents and gently pour out into the dissection tray. Students will use tweezers to remove and sort the contents. Use the rinsing station to clean dissection materials that need identification. Determine which items are food and which are marine debris. Within groups (4 is the maximum number of students recommended for this activity), 2 students can pick through the stomach contents, while 1 rinses and 1 records data. Encourage students to switch jobs during the dissection.

8. Analyze the contents from the simulated turtle stomachs. Can students conclude/identify which species of sea turtle provided the stomach contents they dissected? Hypothesize how items could have contributed to the demise of the sea turtle (internal and external).

Create labels for each of the 5 containers using this information:

**Specimen 1**
Found at Site D
Washed up on beach
Had fishing net wrapped around front right fin
Storm a few days before stranding

**Specimen 2**
Found at Site A
Washed up on beach
Had a large cut in shell from boat strike
Other smaller minor cuts/markings on shell

**Specimen 3**
Found at Site B
Washed up in intertidal zone on beach
Discolored shell and skin
Some white patches on shell

**Specimen 4**
Found at Site E
Washed up on beach
Had long fishing line wrapped around neck, around left fin, then underneath shell to back flippers
Seaweed stuck in fishing line too
Specimen 5
Found at Site C
Washed up on beach
Looked healthy, no serious cuts or anything attached
Stormed day before stranding

Tips for success / extra info:
Add leafy greens, such as lettuce and parsley, to the green turtle’s container to show more of their diet.


Ocean Literacy Principles Met by Activity:
- Principle #5
- Principle #6
Extremes of Entanglement

Time to complete lesson: Demonstration – 10-15 minutes

General Lesson Overview:
In this lesson, students will learn about the dangers of entanglement to marine organisms by testing how much weight it takes to break a plastic six-pack ring, plastic bag, fishing line, and netted produce bag.

Background Information:

Entanglement of marine species in marine debris is a problem that has been shown to affect at least 200 species. The most commonly entangled groups of animals are pinnipeds (seals) and sea turtles, but marine mammals, fish, and invertebrates can also become entangled. Entanglement can cause decreased swimming ability, disruption in feeding, life-threatening injuries, and death.

Pinnipeds generally become entangled around the head and appendages in net fragments, monofilament line, packing straps, rope, and rubber products.

Young sea turtles tend to seek shelter under floating objects to avoid predation, a behavior that makes them particularly vulnerable to entanglement if the marine debris they are hiding under has loops and openings that could catch on appendages. Sea turtles of all ages become entangled in fishing gear, burlap bags, six pack rings, onion bags, packing straps, steel cables, plastic bags, rubber gloves, and other marine debris.

In the United States, 44 of the 138 species of sea birds have been reported to become entangled in marine debris. Diving seabirds are susceptible to entanglement in nets while
pursuing fish underwater. Sea birds may also gather synthetic material to build their nests, where their chicks may become entangled in those materials when in the nest.

Entanglement events have been documented for at least 60% of the baleen whale species and 8% of the toothed whale species. Baleen whales are most likely to become entangled in fishing gear, while toothed whales become entangled in both fishing gear and other forms of marine debris such as rope, packing straps, rubber gaskets, and even Frisbees.

According to a novel study by Arthur et al. 2015, the breaking strengths of commercial fishing lines known to entangle whales can exceed the estimated maximal force output of the whales they entangle. This suggests that large whales may be unable to break the extremely strong fishing line used today. For example, a 32 foot long North Atlantic Right Whale is able to produce a maximal force of 14.6 kilonewtons (~3,300 lbf [pound-force]), but the breaking strength of some single commercial fishing lines is as high as 40 kilonewtons (~9,000 lbf) (Arthur et al. 2015).

Whales are most likely to be seen with rope or netting wrapped around their flukes, pectoral flippers, or mouth. Entangled whales usually do not die immediately (unless they drown), but instead suffer for an average of six months before succumbing to infection caused by ropes cutting into tissue and bone.

There are 2 options of doing this lesson:

- Teachers can do this lesson as a demonstration

**Materials and Kits:**
- 1 Bucket
- 1 Luggage scale
- 1 S-hook
- 1-pound weights
  (socks filled with pea gravel) about 30
- Marine debris items:
  6-pack ring, plastic bag, fishing line, netted produce bag

**Instructions:**

1. Introduce students to entanglement.
   What is entanglement?
2. Who gets entangled in marine debris?
   a. Fish
   b. Invertebrates
   c. Sea turtles
   d. Marine mammals (dolphins, whales, porpoises, seals, sea lions, etc.)
   e. Sea birds
3. What kind of harm does entanglement cause to these animals? Explain that one of the most common items for marine animals to become entangled in is six-pack rings (plastic that holds six-packs of soda together). These rings are made of
plastic and are very strong. Many species become entangled in these and often cannot shed them.

4. Determine how strong the six-pack rings can be. Ask for student volunteer. Give them gloves to wear to protect their hands. Let them hold onto a ring in the six-pack and then try to lift them off the floor. This usually gets their attention!

5. Attach the luggage scale to the six-pack ring, then the bucket to the marine debris item via the s-hook. Teacher can hold the entire apparatus from the handle on the luggage scale or use any existing pole or bar (such as in a closet) to hang the apparatus.

6. Ask for a volunteer or hand each student a one-pound weight (sock filled with pea gravel)

7. Ask the students for their hypothesis: How many pounds of force will it take to break the marine debris item?

8. Have the student(s) drop their weight into the bucket (carefully and lightly), and count as a group, to see how many pounds it takes to break the plastic six-pack ring. BE CAREFUL – the bucket will drop suddenly! Make sure that the students are always clear of the bucket (place soft landing pad on floor under bucket).

- Teachers can split the class up into multiple groups to do the activity independently. Since only 30 1-pound weights are provided in the kit, you can use water, sand, or any other “standard weights” found around the classroom. Turn the luggage scales on and they will show how much weight is added.

- Teachers can set up stations that utilize different types of entanglement materials such as plastic grocery bag, fishing line and netting and allow students to rotate through stations. Students will compare the weight needed to break or tear the different type of debris.

Note: student can compare the weights by graphing data; but this isn’t precise because each filament is made of different materials and they have different diameters.

**Tips for success / extra info:**
- 2014 NOAA Marine Debris Program Report on Entanglement

**Ocean Literacy Principles Met by Activity:**
- Principle #1
- Principle #5
- Principle #6
**Biomechanical Prosthetics**

*Time to complete lesson: Lab lesson – 30-40 minutes*

**General Lesson Overview:**
In this lesson, students will observe some of the more extreme impacts of entanglement to marine organisms by designing and testing a model prosthetic.

**Background Information:**

**Entanglement** of marine species in marine debris is a problem that has been shown to affect at least 200 species. The most commonly entangled groups of animals are pinnipeds (seals) and sea turtles, but marine mammals, fish, and invertebrates can also become entangled. One of the most famous marine organisms to suffer from the impacts of entanglement is Winter the bottle nose dolphin whose story has been documented in children’s literature and a Disney movie. At only three months old, Winter was found stranded in Mosquito Lagoon, near Cape Canaveral, Florida, having become entangled in a crab trap line which cut off circulation to her tail flukes. After disentanglement, she was transported to CMA for treatment of her extensive injuries. However, despite exhaustive efforts to promote healing, her tail deteriorated and could not be saved. Winter is missing her entire tail fluke and joint. Tail flukes are the powerhouse of the dolphin and are attached to the peduncle, the muscular part of the dolphin. To swim naturally, a dolphin moves the peduncle up and down and the tail flukes propel the dolphin forward. Attaching a prosthetic tail with a complete fluke and joint onto a dolphin had never been done before. Over the course of several months, Winter learned the correct body position to be fitted for a stretchy, plastic sleeve, very like those used in human prosthetics. Without her prosthetic, Winter compensates for the absence of flukes by utilizing her entire body to propel herself forward, moving side-to-side like a shark. The prosthetic is a cue or "discriminative stimulus", encouraging her to swim in a normal up-and-down fashion, working all muscles that surround the peduncle while still maintaining her ability to swim comfortably when the prosthetic is off.

Allison a green sea turtle survived a predator attack in 2005 with only one remaining flipper. For years, Allison could only swim in circles but in 2009, a Sea Turtle Inc. intern designed a prosthetic device to help Allison swim. It was the first successful sea turtle prosthetic in the
world. Since then, it has gone through several revisions, each one improving on the last. The latest is made of carbon fiber.

In this lesson, students will investigate how the loss of a limb impacts a sea turtle and a dolphin’s ability to swim by:

- observing mechanical pool toys that have been modified to have removable flippers and fins as they move in water
- designing and engineering simple prosthetic replacements for the missing limbs and observing how the toys swim with them on

**Materials and Kits:**

Marine Animal Prosthetic Kit Includes:

- battery operated pool toys in shape of sea turtle and dolphin with moveable appendages (modify so that flippers/fluke are removable and re-attachable)
- extra batteries
- small head screw driver
- narrow, long plastic tub at least 10 inches deep
- laminated Tracking sheets and wax pencils
- materials for creating prosthetic
  - plastic from a gallon milk jug
  - sheets of pressed foam
  - metal cut from an aluminum can
  - old swimmy fins
  - coat hanger (cut small pieces to make pegs for prosthetic)

**Tracking sheets can be made from Plexiglas sheet cut to cover surface of the tub; or by using a roll of clear laminate to create a sheet to cover the tub. Plastic wrap does not work**

**Instructions:**

1. When students are assembled around the tub, turn on the sea turtle and allow it to swim the length of the tub. Students should trace path of the swimming turtle on their tracking sheets.
2. Repeat step 1 but remove one of the back flippers.
3. Repeat step 1 but remove both of the back flippers.
4. Repeat step 1 but remove one of the front flippers.
5. Repeat step 1 but remove one of the front flippers and one back flipper on the same side.
6. Repeat step 1 but remove one of the front flippers and one back flipper on opposite side.
7. Repeat step 1 but remove one of the front flippers and both of the rear flippers.
8. Have students analyze the paths they tracked/traced and explain how the removal of the flippers impacted the turtles motion.
9. Turn on the dolphin and allow it to swim the length of the tub. Students trace the path.
10. Remove the fluke and put the dolphin back in the tub; trace the path and explain how the fluke removal impacted the dolphin’s motion.
11. Set pool toys on a towel to drain (later you will need to carefully open the battery compartment and dry it out. BE VERY CAREFUL NOT TO STRIP THE SMALL SCREWS THAT HOLD LID IN PLACE).
12. Have students work in small groups to design a prosthetic flipper or fluke for one of the toys. Use the engineering cycle to encourage thoughtful design.
13. Attach the groups prosthetic designs to a peg created by cutting a piece of hanger wire
14. Repeat step 1 or 9 but replace a flipper or the fluke with the prosthetic. Trace the path of motion and compare to the intact turtle or dolphin. If it doesn’t match, study the other tracks from steps 2-8 or 10 and see if there is a match.
15. Have students critique all the prosthetics and decide on which one worked best.

Ocean Literacy Principles Met by Activity:
- Principle #1
- Principle #5
- Principle #6

Tips for success / extra info:

If you have access to a 3D printer, students can use it to design and print working prosthetics.
http://www.seewinter.com/winter
http://www.seaturtleinc.org/rehabilitation/allison/
Allison isn’t the only sea turtle to receive a prosthetic. Yu Chan is a loggerhead sea turtle found entangled in fishing nets in Japan in 2008. While entangled, she had been attacked by a shark and lost half of her forelimb and part of another due to her injuries. Because she still had a stump in place, Japan’s largest prosthetic company worked with the Sea Turtle Association to develop prosthetic flippers for Yu-Chan. The prototype flippers, which are made from polypropylene and stainless steel, were eventually replace with a pair of rubber flippers that attach to her body via a cloth body suit that slips over her head and wraps around her shell.


Winter isn’t the only dolphin to wear a prosthetic. Fuji a dolphin in Japan contracted an infection that caused her to lose much of her tail fin. The tire company Bridgestone helped to manufacture a rubber prosthetic that clamped on to her residual tail. Fuji was so adept at swimming with her prosthetic tail that she starred in the aquariums dolphin shows even using her artificial tail to jump out of the water!

The iRefuz App was developed to help users become mindful of the choices they make before generating trash. As part of the assessment plan for the 3T project, the app was developed for student use. The objective behind the app was to get users (in our case, students in grades 3-8) to record actions that involved their *choice not to generate* a particular kind of trash that could someday become marine debris. For example, a child might tell their parent that they do not want balloons as part of their birthday celebration as these are a particularly harmful form of marine debris. We conducted a survey and identified 23 types of trash that are associated with marine debris and that can be generated by students in the grade levels we served (note – adults can generate this trash also). We also included an “other” option. These items of trash were used to build categories into the iRefuz app.
Students utilizing the app scroll through the list of categories and select the item they are choosing not to use, thusly not creating trash. Then they can leave a comment about the item or their decision not to use it, if they want, before hitting submit.

The app is basically a counter that we are able to use to determine which items of trash youth are most able to not generate. The app can be downloaded for free from:


We learned two important lessons in developing this app. The first involves the type of trash our participants were most able to not generate. Users most often chose not to generate trash from candy/snack wrappers, aluminum cans, straws, balloons and plastic water bottles – in that order.

The second lesson we learned was more important. Teachers who used the app in their classroom reported that students did not understand the concept behind the app. The students got more gratification from first generating the trash and then recycling it, than they did in not generating trash in the first place. Non-action (not generating trash) was not as meaningful to them as the action recycling required.

To combat this, we worked with a local Girl Scouts troop to create promotional posters that could be placed in the schools. If you are interested in printing these posters, please contact project staff at MarineQuest@uncw.edu and we can send you the digital files.
iRefuz to use Plastic Bags!

How Can You Help?

Download the iReuz app
Select an item you choose not to use and then enter your refusal
As the number of your refusals increase, the amount of marine debris will decrease!

Did You Know? Marine organisms like sea turtles confuse plastic bags for jellyfish and ingest them. Every year humans use 1 trillion plastic bags and many end up in our oceans.

www.un cw.edu/marinequest/travelingthroughtrash
iRefuz to use Plastic Water Bottles!

How Can You Help?

Download the iReuz app

Select an item you choose not to use and then enter your refusal

As the number of your refusals increase, the amount of marine debris will decrease!

Did You Know? Americans throw away more than 35 billion plastic water bottles every year and many end up in our ocean where they degrade and leach chemicals into the sea.

www.uncw.edu/marinequest/travelingthroughtrash
**iRefuz to use Straws!**

**Did You Know?** In the U.S., we use 500 million straws a day! That is enough straw waste to wrap the circumference of the earth 2.5 times. Sea animals can choke on straws.

www.uncw.edu/marinequest/travelingthroughtrash

**How Can You Help?**

Download the iReuz app

Select an item you choose not to use and then enter your refusal

As the number of your refusals increase, the amount of marine debris will decrease!
iRefuz to use Ziploc Bags!

How Can You Help?
Download the iReuz app
Select an item you choose not to use and then enter your refusal

As the number of your refusals increase, the amount of marine debris will decrease!

Did You Know? Marine organisms like sea turtles confuse plastic bags for jellyfish and ingest them. Every year humans use 1 trillion plastic bags and many end up in our oceans.

www.uncw.edu/marinequest/travelingthroughtrash
iRefuz Upcycling Activities

In support of the iRefuz app we created a webpage that teachers and students can use to explore other ways to deal with potential items of trash. The same items that appear in the app are represented in a grid format on the webpage. When a student clicks on a grid item they are linked to a page full of upcycling activities. The following is an example of the types of activities available to teach about upcycling plastic bottle caps. To access the webpage and lots of other fun upcycling activities, please visit:

http://www.uncw.edu/marinequest/TravelingThroughTrash.html

UNCW MarineQuest
Traveling Through Trash
NOAA Marine Debris Prevention Through Education

Plastic Bottle Caps
Instead of generating bottle caps, try a reusable bottle and a Soda Stream system

Crafts

Make a cool little capsule to store tiny things with the tops of bottles
For more information, click here.

Do you like to sew? Store your pins with these nifty bottle cap pin cushion rings
For more information, click here.

Annoyed that plastic bags are hard to open and close? Make a refillable bottle cap bag
For more information, click here.

Have eco-friendly fun with this bottle cap tic-tac-toe game
For more information, click here.

If a link is broken, please report to casec@uncw.edu
Acknowledgments

The 3T project was supported by a matching grant from NOAA’s office of Marine Debris Prevention through Education. Grant NA15NOS4630150 supported work that took place from 09/01/2015 through 11/30/2016. During the course of this work, project staff traveled 8,524 miles throughout coastal North and South Carolina to serve 10,381 students in 74 different schools.

Where has #WatsonTheWhale Been?

During the 2015-2016 school year the 3T project traveled over 8,500 miles and served more than 10,300 students in coastal North and South Carolina.

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