Stations: Effects of Marine Debris on Ecosystems

Objectives:

Students will understand the three major effects of marine debris on ecosystems: entanglement, ingestion, and toxic pollution. They will connect their personal consumer choices with the effects of marine debris on the marine environment, and design and evaluate ways to mitigate the ecosystem effects of marine debris. They will construct marine debris art pieces to illustrate the effects of entanglement and ingestion.

Concept:

Marine debris has many effects on marine ecosystems. The three main effects are entanglement, ingestion, and toxic pollution. Because plastics persist in the ocean environment for so long, they can have numerous impacts on marine life. Larger pieces of plastics pose a threat as they may entangle marine mammal. Smaller pieces of plastic and those that have photodegraded after exposure to the sun are more likely to be ingested. The longer plastic is in the water, the more likely it is to leach chemicals or attract a biofilm filled with pollutants.

Materials:

- Science notebooks
- Pencils
- Handout: Estimated Life Span of Plastic
- Sample of photodegraded plastic from gyre
- Laptop/computer and projector or SmartBoard
- Entanglement Challenge Station:
  - Photos of entangled animals
  - Rubber Bands
  - Stopwatch
  - Entanglement Challenge Student Directions
  - Entanglement Challenge Set-up Instructions
- Fishing Line Tug of War Station:
  - Large clump of monofilament or many 2-5 foot strands of monofilament
  - 2 thick pieces of rope
  - Fishing Line Tug of War Student Directions
  - Fishing Line Tug of War Set-up Instructions
- Top of the Ocean Mat Sculpture Station:
  - Pieces of blue and green netting
  - Pieces of blue and green rope
  - Blue and turquoise plastic bottles
  - 16 gauge wire
  - Scissors
  - Top of the Ocean Mat Sculpture sample
  - Top of the Ocean Mat Sculpture Student Directions
  - Top of the Ocean Mat Sculpture Set-up Instructions
- Feeding Frenzy Station

(adapted from Learn About Seabirds Curriculum, US Fish & Wildlife Service)

  - Tarp or large piece of cloth
  - Spoons
  - 6 Fanny packs or grocery bags & twine
  - Popcorn
  - Foam packing materials or foam pieces from marine debris clean up
  - Feeding Frenzy Student Directions
  - Feeding Frenzy Set-up Instructions
- Albatross Bolus Investigations Station:
  - Albatross bolus sample specimen
  - Wide mouth (1.5 in)12 oz. plastic bottles
  - Small pieces of plastic commonly found locally as litter/marine debris (lighters, legos, bottle caps, etc.)
  - Tray or shoe box
  - Photos of dissected boluses
  - Photos of ingested plastics
  - Handout: Bolus Contents Data Sheet
  - Handout: Albatross - Case Study Background Information Sheet

Stations: Effects of Marine Debris *Continued*

- Albatross Bolus Investigations Student Directions
- Albatross Bolus Investigations Set-up Instructions

◎ Gyre Dangle Sculpture Station:

- Scissors
- Pieces of plastic marine debris (1-4 inches, Red, Orange, Yellow, Green, Blue, Violet & White)
- Pieces of blue rope from marine debris
- Fishing Line or 20 gauge wire
- Leather punch or drill
- Safety goggles
- Work gloves
- Gyre Dangle Sculpture sample
- Gyre Dangle Sculpture Student Directions
- Gyre Dangle Sculpture Set-up Instructions

Preparation:

Set up computer and projector or SmartBoard to show the "What's an Ocean Garbage Patch" video on youtube (http://www.youtube.com/watch?v=J-gqJAsXiKQ). This video on youtube sometime begins with advertisements, so play through these during your preparation.

Prepare the 6 stations for rotation. Each station includes instructions for set-up and directions for students.

You will need a variety of marine debris items for the two sculpture stations. If you will not be able to conduct a marine debris clean up prior to this lesson, contact CACS for assistance acquiring appropriate materials.

Drill or punch ¼ inch holes in the plastic pieces for the Gyre Dangle Sculpture – or ask a volunteer to do it.

Introduction:

Begin by showing the "What's an Ocean Garbage Patch" video on youtube (http://www.youtube.com/watch?v=J-gqJAsXiKQ). At the conclusion of the video, ask students to write their reaction in their science journal.

Ask students to write predictions of how long different plastic products persist in the marine environment. Pass out the handout with the timeline of how long plastics last in the environment.

Compare the timeline to the predictions students made. Discuss that plastics photodegrade rather than biodegrade. That is, as plastics are exposed to ultraviolet rays, the secondary bonds (plasticizers such as phthalates) between the polymer chains are changed, causing the plastic to become brittle and break into smaller and smaller pieces. Pass around the sample of photodegraded plastics.

This is different than biodegradation. Things that biodegrade are broken into smaller pieces by bacteria or other biological actions. Biodegradation returns the object to compounds found in nature, whereas photodegradation breaks plastics down to the synthetic polymers, but not natural molecular compounds.

Procedures & Activities:

Ask students to brainstorm how wildlife and ecosystems are affected by marine debris. Have students record their ideas in their science notebooks, and write all of their concerns on the board.

Stations: Effects of Marine Debris *Continued*

If they do not include entanglement, ingestion, or water pollution on the list, help them to add those concerns. Explain to students that all of these effects are important to consider and work to mitigate, but the three greatest concerns related to marine debris in marine ecosystems are entanglement, ingestion, and toxic pollution.

To learn more about these ecosystem effects, they will rotate through 6 stations:

- Entanglement Challenge
- Fishing Line Tug of War
- Top of the Ocean Mat Sculpture
- Feeding Frenzy
- Albatross Bolus Investigations
- Gyre Dangles Sculpture

Divide students into 6 groups and designate their starting stations.

Every 10-15 minutes, have students rotate to the next station. Tell students when there is 5 minutes left in each station so they have time to finish up their activities and science notebook responses.

Bring the groups back together. Lead a discussion about how students can affect these problems.

Talk about the CACS fishing line-recycling program as a great example of how potential entanglement items can be taken out of the environment. Also, the decreased occurrence of six-pack rings in marine debris is linked to consumer choices. Awareness that these products caused problems in the marine environment led to a significant reduction in the manufacturing of these harmful products.

Ask students to revisit their science notebooks and review the potential ecosystem effects of marine debris they wrote down at the beginning of the lesson.

Break students into small groups 2-5 people and have them work together to discuss potential ways to mitigate these effects. Encourage them to think not only of ways to clean up marine debris, but also ways to prevent certain types of marine debris (toxic, fishing line, etc.) from ever entering the ecosystem or ways to change the nature of marine debris (fishing line that breaks down more easily, etc.)

Have each group decide on their top two solutions and describe them in their science notebook.

Wrap-Up:

Come together as a class and have each group present their top two solutions. Discuss the pros and cons of each. Explain that every technology has both positive and negative effects, so the above all best thing they can do is reduce their use of single-use plastics such as plastic bottles, straws, utensils, take out containers, etc. The less plastic is thrown away, the less is available to make its way into the marine environment.

Extensions & Lesson Connections:

After working on the Gyre Dangles and Top of the Ocean Mat sculptures, students will likely want to finish the piece and share it with others. See the "Art Exhibit" Lesson for more information on finalizing the sculptures, writing artists' statements, and preparing the art for public display.

Stations: Effects of Marine Debris *Continued*

A great extension to the Bolus Sorting activities is to dissect an actual albatross bolus. CACS has a few boluses available to loan to teachers for this purpose. The Bolus Content Data Sheet from the sorting activity can be used for a dissection too. Contact CACS for more information about bolus dissection and to access a bolus for class use.

You can also extend the Bolus Sorting activities by having students sort debris before putting it into the mock albatross stomach. Provide students with a variety of large and small debris objects that potentially could be eaten by an albatross (bottle caps, foam, plastic toys) and things less likely to be eaten by an albatross (cans, bottles, glass, larger pieces of plastics debris). Before having students test the amount of plastic necessary to create a bolus that is too large to regurgitate, have students sort the debris in the following steps:

1) Place the items in a tub of water. Albatross are surface feeders, so will only eat things that float near the surface. Eliminate objects that sink.

2) Take items that did float and try to fit them through a 1.5-inch diameter PVC pipe. Items that can't fit through the PVC wouldn't fit into the esophagus of an albatross chick. Eliminate the objects that are too large.

3) Use only the remaining items as you place objects into the bottle.

Evaluation:

Review student science notebook entries, including data entries and reflections from the stations and their list of ways to mitigate the effects of marine debris on the ecosystem. Their list of ways to mitigate the effects of marine debris on the ecosystem should be evaluated for synthesis and application of the material learned. The other entries can be evaluated for completeness and effort.

Albatross Bolus Investigations Set Up Directions

1. Place small, common debris items in a tub at the station.

2. Set six bottles with lids at the station. They should be wide mouth (about 1.5 inches) and approximately 12 ounces in volume to represent the stomach of an albatross chick.

3. Place the sample bolus at the table for display only. Keep it in the plastic bag so pieces are not lost.

4. Make 1 copy of the Bolus Sorting Data Sheet for every student. Leave these data sheets at the station.

5. Make copies of the Albatross – A Case Study background information sheet for the students to read at the station.

6. Arrange the photos of ingested plastic at the station.

7. Place the four Dissected Bolus photos along with magnifying glasses at the station. For younger students, use zoomed in photos so the objects are larger.

Lesson adapted from *Winged Ambassadors Curriculum*, Oikonos Ecosystem Knowledge. Used with permission. These high resolution images were created by National Geographic photographer David Liittschwager and donated for educational use only. The boluses from Tern Island and Kure Atoll were provided by U.S. Fish and Wildlife Service and the State of Hawaii Department of Land and Natural Resources. The contents were prepped by Hawaii Pacific University and Oikonos as part of a research study on plastic ingestion by Pacific albatrosses breeding in Hawaii. This program was created by NOAA's Cordell Bank National Marine Sanctuary, Papahānaumokuākea Marine National Monument, and Oikonos Ecosystem Knowledge.

Albatross Bolus Investigations
Student Instructions

Model Stomach (activity #1)

1. Begin by reading the Albatross – A Case Study background information.

2. Choose a plastic bottle. This bottle will represent the stomach of an albatross chick. It is approximately the same size as an albatross stomach, and the mouth of the bottle is about as wide as an albatross throat.

3. Select 1-2 pieces of plastic debris from the tub and place them into your bottle. Close the "beak" by putting the bottle cap back on. Carefully shake the albatross stomach.

4. Open the beak, tip the stomach over, and see if the plastic pieces will empty out of the stomach like a bolus.

5. If the plastic comes out, put those pieces back in and add 2 more pieces. Close the beak. Shake the stomach. Open the beak. Empty the stomach.

6. Continue adding plastic until the bolus becomes so big that it gets stuck and cannot fit out of the throat.

7. Shake or poke inside of the stomach so you can remove the plastic pieces.

8. Count the number of plastic pieces and return them to the tub of marine debris. Place the empty bottle with lid back on the station table.

9. Answer the following questions in your science notebook:
   - How many pieces of plastic were in the mock bolus that was too big to be regurgitated?
   - What effects would a stomach full of plastic have on an albatross?

10. Move on to the Bolus Sorting activity.

Albatross Bolus Investigations
Student Instructions

Bolus Sorting (activity #2)

1. Take a moment to look closely at the sample bolus. Please do not touch it or take it out of the bag – it is fragile!

2. Look at the photos of plastic items found in birds. How do these photos make you feel?

3. Find a partner in your group and take a Bolus Contents data sheet.

4. With your partner, choose one of the photos of a dissected bolus to examine. Write the type of bird and breeding location at the top of your Bolus Contents data sheet.

5. Using a magnifying glass, examine the dissected bolus photo with your partner and record the items you see on your data sheet.

6. Answer these questions in your science notebook:
   - Were there more prey or non-prey items in the bolus?
   - What was the strangest non-prey item in the bolus?
   - Choose one non-prey item from the dissected bolus. Where do you think this debris originally came from? Have you used an object like this before?

7. If you have time left at this station, work with your partner to sort the contents of another bolus. Change one variable, so choose either a different species of albatross from the same island, or the same species of albatross at a different island.

Entanglement Challenge Set Up Directions

1. Arrange laminated photos of entangled animals at the station.

2. Place rubber bands and stop watch on the table.

3. Affix or place student directions sheet in an obvious place.

Entanglement Challenge
Student Instructions

Do This First: Photo Sorting

1. Take a look at the photos of entangled animals. As a group, sort them into categories based on the type of animal.

2. Answer these questions in your science notebook: What types of animals seem to be most affected by entanglement? Why do you think this is?

3. Sort the photos of entangled animals into categories based on the type of debris entangling the animal.

4. Answer this question in your science notebook: What types of debris seem to entangle animals most often?

Entanglement Challenge
Student Instructions

Now - Take the Entanglement Challenge

1. Put a rubber band around your pinky and forefinger over the back of your second and third fingers. Imagine you are a bird with plastic around your neck.

2. Put your other hand behind your back.

3. Start the stop watch.

4. Race the other people in your team to remove the rubber band only by wriggling your hand. You cannot use your other hand, body, or other people.

5. When you succeed in getting the rubber band of your hand, make note of the time on the stop watch.

6. Once everyone gets their rubber bands off, record in your science notebook how long it took to remove it and answer this question, "Why might it be difficult for marine animals to escape from marine debris once they are entangled?"

Feeding Frenzy Set Up Directions

1. Mix popcorn and foam pieces – you want about 3 pieces of popcorn for every piece of foam.

2. Spread the popcorn-foam mix onto the station table or a tarp or cloth on the floor.

3. Prepare 6 "stomach baggies." For each one, use a fanny pack or string a shopping bag onto a piece of twine that is long enough to be tied around a student's waist.

4. Set plastic spoons with stomach baggies next to the station.

5. Place a stopwatch and first page of student directions in a prominent place at the station.

6. Keep the second page of student directions with you: "Feeding Frenzy – Unknown Foam."

7. The students will come get this page from you once they have completed the first round.

Feeding Frenzy
Student Instructions - Page 1

1. At this station, imagine that you are seabirds that feed on small fish and zooplankton like crab and mollusk larvae.

2. Pick up a "stomach baggie" (fanny pack or bag on a string) and tie it around your waist. This is where you will put all your food.

3. Pick up a spoon with one hand. This will be your "mouth." You can only use this mouth to pick up food and transfer it into your stomach.

4. When every seabird is ready with their mouth and stomach, stand around the feeding area filled with popcorn. The popcorn represents small fish, a favorite food for seabirds.

5. One seabird must start the stopwatch, and then everyone has 1 minute to gather food.

6. Pick up food one piece at a time with your spoon-mouth and transfer it to your stomach.

7. You may not walk on the feeding area, but you can reach into it with your mouth.

8. At the end of one minute, everyone must stop.

9. Send one seabird from your group to get the next set of directions from the teacher.

Feeding Frenzy
Student Instructions - Page 2: Unknown Foam

1. Find a spot to carefully empty your stomach contents. Make sure they don't mix with anyone else's food.

2. Look closely at the things you ate. What do you notice?

3. Not all of what you gathered was food. Some is food: the popcorn plankton. But some is actually plastic pieces of marine debris foam.

4. Count how many pieces of foam you gathered as a seabird. Count how many pieces of popcorn plankton you gathered. Record this information in your science notebook.

5. Because foam can't be digested it accumulates in the stomachs of seabirds and fish. Place the pieces of foam you gathered back in your stomach baggie. Scatter the popcorn back in the feeding area.

6. Once all the seabirds are ready, set the stopwatch for 1 minute and feed again. After one minute, stop feeding.

7. Count up how much food and foam is in your stomach.

8. Answer these questions in your science notebook:
   - How much foam was in your stomach at the end of the second round?
   - How much food did you have in your stomach at the end of the second round?
   - How did this compare to the first round?
   - Was it hard for you to collect food once you knew that some of it was foam?
   - How would a real bird be affected by having foam in its stomach?

9. Scatter the foam and popcorn back in the feeding area and place your stomach baggies and spoons alongside.

RETURN THIS PAGE OF DIRECTIONS TO THE TEACHER WHEN YOU'RE DONE!

Fishing Line Tug of War Set Up Directions

1. Choose an appropriate location for the tug of war. Be aware of what is behind your participants to ensure safety, as their goal is to snap the line. This works best outside, if at all possible.

2. Check the tug of war rope from the kit. It should have one loop of rope tied to either end of a clump of monofilament fishing line. Check to make sure the connections between the rope and fishing line are strong.

3. Assign a parent volunteer or teacher to supervise the station, reminding that this is not a traditional tug-of-war, but that they are using cooperation and teamwork to break the line.

Fishing Line Tug of War
Student Instructions

1. Carefully pick up the fishing line tied to the rope.

2. Find an area near your station that is clear of large objects.

3. Have each person in your group choose a partner.

4. One at a time, have partners line up on opposite sides of the rope.

5. Have partners CAREFULLY but FIRMLY pull on the rope, trying to break the monofilament. You should cooperate with your partner.

6. Let each partner group try.

7. If no one succeeds in breaking the fishing line, split everyone in your station group into two teams and line up along the rope.

8. Teams need to pull in opposite directions to try to break the fishing line.

9. Save time to answer the following questions in your science notebook:

   • What would make it hard for an animal to disentangle itself from fishing line?

   • What are three ways entanglement can hurt an animal's ability to fill its basic survival needs?

Gyre Dangle Sculpture Set Up Directions

1. Use different colors of plastic marine debris that are no larger than the palm of a hand from a previous a marine debris clean up.

2. Use an awl, leather punch, or drill with a ¼ inch bit to create two small holes in each piece of plastic.

3. Hang the Gyre Dangle example from the ceiling or station table.

4. Set wire or string, wire cutters or scissors, tubs, and plastic debris on the table.

5. Post the following Artistic Criteria, if applicable to your class:

ARTISTIC CRITERIA TO POST:

1. Collect from the ocean beaches 1 – 4 inch sized plastic debris pieces that are three-dimensional and some that are recognizable objects.

2. Separate them by the rainbow colors of RED, ORANGE. YELLOW, GREEN, BLUE, PURPLE, AND WHITE.

3. Create strings of nicely balanced rainbow plastics that vary in length from 3 – 6 ft.

4. Look for a variety of textures, shapes and objects to create an interesting string of colors.

5. Use good craftsmanship by twisting the wires securely and neatly with no sharp points.

6. Attach the gyre dangle to the woven matted "Top of the Ocean" to create an evenly spaced yet random look that invites the viewer into the walkway.

Gyre Dangle Sculpture
Student Instructions

1. Separate the pieces of plastics by color in piles or clear containers. Be sure to follow the order of the rainbow, Red, Orange, Yellow, Green, Blue, Purple, and end with White.

2. While you are sorting the pieces, try to determine what they once might have been. Choose one piece and write about it in your science notebook:

- Does the item look new or old?
- Are there any clues of what it might have been used for?
- Are there any clues to the place or date of origin (labels, etc.)?

3. Use fishing line or thin wire (3-6 feet long) to tie a red piece of marine debris at the bottom of the dangle.

4. Attach the plastic pieces to the wire by color, with about 6 inches of Red at the bottom, followed by Orange – Yellow – Green – Blue – Purple and ending with White. Be sure to pass the wire through both holes in the plastic pieces.

5. Create a loop in the fishing line or wire so the dangle can be attached to the "Top of the Ocean" mat.

6. Carefully set your dangle aside. It will be added to the larger sculpture later.

Top of the Ocean Mat Sculpture Set Up Directions

1. Use blue, green, and turquoise marine debris from a previous clean up. You will need rope and netting. If you are located inland, yarn and strips of cloth can be used in lieu of rope, but you will still need some sort of netting. Contact CACS to request these materials if you did not pick up any during your clean up.

2. Place blue, green, and turquoise plastic bottles with the materials. As an example for the students, cut one in a spiral to form a long strip.

3. Hang the Top of the Ocean Sculpture example from the ceiling or station table.

4. Set wire cutters, scissors, tubs, wire, and plastic debris on the table.

5. Post the following Artistic Criteria, if applicable to your class:

ARTISTIC CRITERIA TO POST:

1. Create a multi-textured hammock-like weaving.

2. Create various lines that show movement and flowing, like water.

3. Use various analogous colors in blue to green hues.

4. Filling in negative spaces of the netting with woven and knotted rope and plastic bottle strips.

5. Use good craftsmanship by tying knots, twisting wire, and securing the edges.

6. Work collaboratively to have the final piece show unity and balance of color, texture, shape, and space.

Top of the Ocean Mat Sculpture
Student Instructions

1. Lay the netting out over a table and spread out around it as a group.

2. Separate thick rope into thinner strands. Put the rope in bins around the table so that everyone can reach. If any rope crumbles, throw it away in the trashcan. Rope that does this has photodegraded -- as plastic is exposed to sunlight, links between polymers in the plastic change and it becomes brittle, breaking into smaller and smaller pieces.

3. Cut bottles in a spiral from bottom to top, creating strips approximately ½ wide. Add these to the bins of materials you can use.

4. Tie one end of the rope to the net. If you are weaving a water bottle spiral, you can poke a hole in one end and tie it to the net with wire or string.

5. Weave the rope and plastic strips over and under the netting. Be sure to enter an adjacent square.

6. When you are finished, tie the rope onto the netting so it will stay in place. Poke a hole it the end of the spiral and tie it on with wire or string.

7. Work cooperatively with your group to create the top of the ocean mat.

8. Fill in the area as much as possible until it appears fairly solid and water like.