center for microbial oceanography: research and education
C-MORE SCIENCE KITS

MARINE DEBRIS

Grade Level: This kit is appropriate for students in grades 8–12.

Standards: This kit is aligned with state science content standards for Hawaiʻi, California, and Oregon, as well as national Ocean Literacy Principles.

Overview: Marine debris is an environmental problem of global importance, enlisting the concern and action of scientists as well as the general public. This three-lesson kit focuses primarily on plastic marine debris. Students take part in activities that explore the impacts, geographical distribution by ocean currents, and implications of marine debris. Lessons 1 and 3 can each be completed in about 60 minutes, while lesson 2 may take up 2 class periods. Many of the activities are discrete and can be easily rearranged to fit various curricular objectives and time constraints. A pre- and post-unit survey is included.

Lesson 1: Biological Impacts
This first lesson begins with each student completing the **MARINE DEBRIS SURVEY** as a pre-unit survey. A short, narrated PowerPoint presentation introduces the issue of marine debris and its impacts. The majority of the class period is spent with students rotating among 6 activity stations, each one focusing on a different biological impact of marine debris. The class ends with a group reflection.

Lesson 2: Geographical Distribution
In the second lesson, a narrated PowerPoint presentation describes the distribution of marine debris and briefly introduces ocean currents. Students then work in pairs or small groups to examine the sources and dispersal of marine debris through a computer-based environmental forensics activity. Students track marine debris using an online ocean surface current model developed by NOAA researchers.

Lesson 3: Plastics and the Sea
In this culminating lesson, students watch a video documentary about C-MORE's 2008 research cruise focusing on the impact of plastics on our planet. Plastic production and use are introduced through the presentation of a narrated PowerPoint. In small groups, the students then engage in a discussion/worksheet activity addressing the diverse sizes of plastic debris and the impacts of those different sizes. Finally, students complete the **MARINE DEBRIS SURVEY** as a post-unit survey.

Suggestions for Curriculum Placement: These lessons can be used at the middle or end of the semester to help students synthesize a number of environmental, marine, biological, and physical science concepts. Skills such as forming and revising hypotheses, collecting and recording data, and using a computer-based model are taught through these lessons. The use of the online ocean surface current program to model the transport of marine debris in lesson 2 provides a means of incorporating technology into the science classroom. Also, use this lesson to introduce or revisit oceanographic concepts such as currents, winds, Coriolis Effect, etc.

Materials Included in This Kit:
(Paper materials contained in binder are shown in **BOLD CAPS,** additional copies are in Resource Folder)
Front Binder Materials
1. CD with *Albatross Necropsy* Video and narrated PowerPoint presentations (also contains electronic versions of binder materials)
2. DVD – *SUPER Cruise* by Lucy Marcus (used in Lesson 3)
3. C-MORE *Key Concepts in Microbial Oceanography* brochure
4. C-MORE *Microbial Oceanography: Resources For Teachers* brochure

Lesson 1: Biological Impacts

Materials are provided for 2 sets of 6 stations. We suggest 2-3 students per group.

5. **TEACHER GUIDE – Lesson 1: Biological Impacts**
6. **MARINE DEBRIS SURVEY**
7. **TEACHER ANSWER KEY to MARINE DEBRIS SURVEY**
8. **POWERPOINT SCRIPT – Lesson 1: Trash Talk: Biological Impacts of Marine Debris**
9. **STUDENT WORKSHEET – Lesson 1: Biological Impacts (2 pages front/back)**
10. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 1: Biological Impacts**
11. Bag of medium-sized purple Nitrile exam gloves
12. Bag of large-sized purple Nitrile exam gloves

For teacher use only, during the handling of boluses

13. Timer

Station 1

14. **PLACARD – Marine Debris Lesson 1, Station 1 Site for Attachment (2 in Resource Folder)**
15. **INSTRUCTIONS – Attachment Activity (2 in Resource Folder)**
16. **ARTICLE – *Marine Debris Gives Alien Species a Ride* (4 in Resource Folder)**
17. Pieces of marine debris with biofouling organisms (6)
18. Magnifying lenses (4)

Station 2

19. **PLACARD – Marine Debris Lesson 1, Station 2 Entanglement (2 in Resource Folder)**
20. **INSTRUCTIONS – Entanglement Activity (2 in Resource Folder)**
21. Rubber bands (10)

Station 3

22. **PLACARD – Marine Debris Lesson 1, Station 3 Entangled Animals (2 in Resource Folder)**
23. **IMAGES – Entangled Animals (2 sets in Resource Folder)**

Station 4

24. **PLACARD – Marine Debris Lesson 1, Station 4 Toxic Diet? (2 in Resource Folder)**
25. **ARTICLE – *Do Plastics Degrade in the Ocean?* (4 in Resource Folder)**
26. **ARTICLE – *Are Plastics Toxic in the Ocean?* (4 in Resource Folder)**

Station 5

27. **PLACARD – Marine Debris Lesson 1, Station 5 Albatross Necropsy Video (2 in Resource Folder)**

Station 6

28. **PLACARD – Marine Debris Lesson 1, Station 6 Albatross Bolus Dissection (2 in Resource Folder)**
29. **INSTRUCTIONS – Albatross Bolus Dissection (2 in Resource Folder)**
30. Intact bolus in resin (2)
31. Sorted bolus in resin and jars (2)
32. Dissected bolus for student lab (2)
33. Forceps (6)
34. Petri dishes (4)

Lesson 2: Geographical Distribution

This is a computer-based lesson, therefore we suggest 2–3 students per group.

35. **TEACHER GUIDE – Lesson 2: Geographical Distribution**
36. **POWERPOINT SCRIPT – Lesson 2: Carried Away! – Physical Dispersal of Marine Debris**
37. **POWERPOINT NOTES – Lesson 2: OSCURS Intro**
38. **INSTRUCTIONS for STUDENT WORKSHEET– Lesson 2: Environmental Forensics (15 in Resource Folder)**
39. **STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
40. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
41. **MAP 1: Countries Surrounding the Pacific Ocean (15 in Resource Folder)**
42. **MAP 2: Surface Currents in the North Pacific Ocean (15 in Resource Folder)**
43. **LANGUAGE GUIDE – Lesson 2: Environmental Forensics (6 in Resource Folder)**
44. Pieces of marine debris with language text and location cards (6)

Lesson 3: Plastics and the Sea

45. **TEACHER GUIDE – Lesson 3: Plastics and the Sea**
46. **POWERPOINT SCRIPT – Lesson 3: Plastics and People**
47. **STUDENT WORKSHEET – Lesson 3: VIDEO WORKSHEET – SUPER Cruise DVD**
48. **TEACHER ANSWER KEY to STUDENT WORKSHEET to Lesson 3: VIDEO WORKSHEET – SUPER Cruise DVD**
49. **STUDENT WORKSHEET – Lesson 3: PLASTICS AND THE SEA**
50. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 3: PLASTICS AND THE SEA**
51. **IMAGES – CLASS DISCUSSION ON PLASTIC SIZES (15 sets in Resource Folder)**

Extension Activities

52. Lesson 1 EXTENSIONS: Biological Impacts
52. **STUDENT WORKSHEET – Lesson 1: ALBATROSS BOLUS ACTIVITY**
53. Lesson 2 EXTENSIONS: Geographical Distribution
54. Lesson 3 EXTENSIONS: Plastics and the Sea
55. **STUDENT WORKSHEET – Lesson 3: Plastic Products: Are They Worth It?**
56. Color-coded MARINE DEBRIS SOLUTION CARDS for various sectors of society (science, citizens, business, and government) (18)

Other Materials:

53. **GLOSSARY**
54. **TEACHER EVALUATION**
55. **SUPPLY CHECKLIST**
56. Speakers

Materials Not Included in This Kit:

57. Computers
58. Projector
59. Paper towels

State Standards for Hawaiʻi, California and Oregon. The following standards and benchmarks can be addressed through this C-MORE science kit:

Hawaiʻi Content & Performance Standards (HCPS III):

Science Standard 1: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.

Grade 8 Benchmark for Science:
SC.8.1.1 Determine the link(s) between evidence and the conclusion(s) of an investigation.

Grades 9–12 Benchmarks for Physical Science, Biological Science, Earth & Space Science, Environmental Science and Marine Science:
SC.PS/BS/ES/ENV/MS.1.4 Determine the connection(s) among hypotheses, scientific evidence, and conclusions.
SC.PS/BS/ES/ENV/MS.1.7 Revise, as needed, conclusions and explanations based on new evidence.

Science Standard 2: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated.

Grade 8 Benchmark for Science:
SC.8.2.1 Describe significant relationships among society, science, and technology and how one impacts the other.

Grades 9–12 Benchmarks for Physical Science, Biological Science, Earth & Space Science, Environmental Science and Marine Science:
SC.PS/BS/ES/ENV/MS.2.1 Explain how scientific achievements and emerging technology have influenced society.
SC.PS/BS/ES/ENV/MS.2.2 Compare the risks and benefits of potential solutions to technological issues.
SC.ES.2.3 Explain the impact of humans on the Earth system.

Science Standard 3: ORGANISMS AND THE ENVIRONMENT: Understand the unity, diversity, and interrelationships of organisms, including their relationship to cycles of matter and energy in the environment.

Grades 9–12 Benchmarks for Physical Science, Biological Science, Earth & Space Science, Environmental Science, and Marine Science:
SC.MS.3.5 Describe how waves and currents move using physical principles.
SC.MS.3.7 Describe the relationship between fresh bodies of water, watersheds, and the ocean.

Science Standard 4: STRUCTURE AND FUNCTION IN ORGANISMS: Understand the interconnections of living systems.

Grades 9–12 Benchmark for Environmental Science:
SC.ENV.4.3 Explain how ecosystems respond to human activities.

Science Standard 5: DIVERSITY, GENETICS, AND EVOLUTION: Understand the interdependence between environmental systems and human societies.

Grades 9–12 Benchmarks for Environmental Science:
SC.ENV.5.1 Explain how economic and societal decisions affect global and local ecosystems.
SC.ENV.5.2 Assess the effect of human actions on an environmental system.
SC.ENV.5.3 Explain how population growth and natural resource consumption affect global sustainability.
SC.ENV.5.5 Compare the consumption of natural resources by different nations.
SC.ENV.5.6 Explain why recycling and conservation of resources are important.

Science Standard 6: NATURE OF MATTER AND ENERGY: Understand the interdependence of humans and the ocean.

Grades 9–12 Benchmarks for Marine Science:
SC.MS.6.4 Explain how human activities and development lead to marine pollution (*e.g.,* point sources, non-point sources).
SC.MS.6.5 Describe how urbanization has impacted the ocean.

Science Standard 8: EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents.

Grade 8 Benchmark for Science:
SC.8.8.4 Explain how the sun is the major source of energy influencing climate and weather on Earth.
SC.8.8.7 Describe the physical characteristics of oceans.

Grades 9–12 Benchmark for Physical Science, Biological Science, Earth & Space Science, Environmental Science, and Marine Science:
SC.ES.8.6 Describe how winds and ocean currents are produced on the Earth's surface.

Social Studies Standard 5: PARTICIPATION AND CITIZENSHIP: Understand roles, rights (personal, economic, political), and responsibilities of American citizens and exercise them in civic action.

Grade 9 Benchmarks for Participation in a Democracy:
SS.9PD.5.2 Investigate how citizens can monitor and advocate for a local, state, or national issue.
SS.9PD.5.5 Demonstrate the role of a citizen in civic action by selecting a problem, gathering information, proposing a solution, creating an action plan, and showing evidence of implementation.

Content Standards for California Public Schools:
Ecology
Grades 9–12 – Standard 6b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.

Investigation and Experimentation
Grades 9–12 – Standard 1a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
Grades 9–12 – Standard 1l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

Energy in the Earth System
Grades 9–12 – Standard 5a. Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.

State of Oregon Standards by Design:
Scientific Inquiry
8.3S.2 Organize, display, and analyze relevant data, construct an evidence-based explanation of the results of a scientific investigation, and communicate the conclusions, including possible sources of error. Suggest new investigations based on analysis of results.
8.3S.3 Explain how scientific explanations and theories evolve as new information becomes available.
H.3S.2 Design and conduct a controlled experiment, field study, or other investigation to make systematic observations about the natural world, including the collection of sufficient and appropriate data.
H.3S.5 Explain how technological problems and advances create a demand for new scientific knowledge and how new knowledge enables the creation of new technologies.

Engineering Design
8.4D.3 Explain how creating a new technology requires considering societal goals, costs, priorities, and trade-offs.
H.4D.5 Describe how new technologies enable new lines of scientific inquiry and are largely responsible for changes in how people live and work.
H.4D.6 Evaluate ways that ethics, public opinion, and government policy influence the work of engineers and scientists, and how the results of their work impact human society and the environment.

Interaction and Change
H.2L.2 Explain how ecosystems change in response to disturbances and interactions. Analyze the relationships among biotic and abiotic factors in ecosystems.
H.2E.4 Evaluate the impact of human activities on environmental quality and the sustainability of Earth systems. Describe how environmental factors influence resource management.

Ocean Literacy Principles. The following ocean literacy principles can be addressed through these lessons:

Ocean Literacy Principle 1: The Earth has one big ocean with many features.
c. Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.
g. The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.

Ocean Literacy Principle 6: The ocean and humans are inextricably interconnected.
e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

References:

NOAA Marine Debris Program. http://marinedebris.noaa.gov/

Environmental Protection Agency (EPA). http://www.epa.gov/owow/oceans/debris/moreinfo.html

Acknowledgements:

Special thanks to Michelle Hester, David Hyrenbach, Andrew Titmus and oikonos.org for the albatross boluses used in Lesson 1 of this kit. For additional lessons on albatrosses and marine debris, please check out http://www.downloadwingedambassadors.org/.

Boluses in this kit were regurgitated by Laysan albatross (Moli) and Black-footed (Ka'upu) albatross chicks hatched on Kure Atoll (State of Hawaiʻi Seabird Sanctuary; 28°25’N, 178°20’W) and Tern Island (Hawaiian Islands National Wildlife Refuge; 23°44’N, 166°8’W), within the Papahānaumokuākea Marine National Monument, Northwestern Hawaiian Islands during the 2009 and 2010 fledgling seasons. The boluses were analyzed to investigate plastic ingestion by K. David Hyrenbach and Andrew Titmus at Hawaiʻi Pacific University and Oikonos Ecosystem Knowledge under the auspices of a federal USFWS special purpose possession permit (MB180283-0) and a Papahānaumokuākea Marine National Monument research permit (NMNM-2009-034).

TEACHER GUIDE

Lesson 1: Biological Impacts

Time Required: 60 minutes.

Structure: Each student completes a **MARINE DEBRIS SURVEY** as a pre-unit survey. The post-unit survey will be given at the end of Lesson 3. A brief, narrated PowerPoint presentation introduces the issue of marine debris. The majority of the class period is spent with students working in small groups and rotating among six activity stations that focus on a different biological impact of marine debris. There are duplicates of each station, resulting in a total of twelve stations. The lesson ends with a group reflection.

Materials: (Paper materials contained in binder are shown in **BOLD CAPS**, additional copies are in resource folder)

Lesson 1: Biological Impacts

Materials are provided for 2 sets of 6 stations. We suggest 2-3 students per group.

1. **TEACHER GUIDE – Lesson 1: Biological Impacts**
2. **MARINE DEBRIS SURVEY**
3. **TEACHER ANSWER KEY to MARINE DEBRIS SURVEY**
4. **POWERPOINT SCRIPT – Lesson 1: Trash Talk: Biological Impacts of Marine Debris**
5. **STUDENT WORKSHEET – Lesson 1: Biological Impacts (2 pages front/back)**
6. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 1: Biological Impacts**
7. Bag of medium-sized purple Nitrile exam gloves
8. Bag of large-sized purple Nitrile exam gloves

$\Big\}$ For teacher use only, during the handling of boluses

9. Timer

Station 1

10. **PLACARD – Marine Debris Lesson 1, Station 1 Site for Attachment (2 in Resource Folder)**
11. **INSTRUCTIONS – Attachment Activity (2 in Resource Folder)**
12. **ARTICLE – *Marine Debris Gives Alien Species a Ride* (4 in Resource Folder)**
13. Pieces of marine debris with biofouling organisms (6)
14. Magnifying lenses (4)

Station 2

15. **PLACARD – Marine Debris Lesson 1, Station 2 Entanglement (2 in Resource Folder)**
16. **INSTRUCTIONS – Entanglement Activity (2 in Resource Folder)**
17. Rubber bands (10)

Station 3

18. **PLACARD – Marine Debris Lesson 1, Station 3 Entangled Animals (2 in Resource Folder)**
19. **IMAGES – Entangled Animals (2 sets in Resource Folder)**

Station 4

20. **PLACARD – Marine Debris Lesson 1, Station 4 Toxic Diet? (2 in Resource Folder)**
21. **ARTICLE – *Do Plastics Degrade in the Ocean?* (4 in Resource Folder)**
22. **ARTICLE – *Are Plastics Toxic in the Ocean?* (4 in Resource Folder)**

Station 5

23. **PLACARD – Marine Debris Lesson 1, Station 5 Albatross Necropsy Video (2 in Resource Folder)**

Station 6

24. **PLACARD – Marine Debris Lesson 1, Station 6 Albatross Bolus Dissection (2 in Resource Folder)**
25. **INSTRUCTIONS – Albatross Bolus Dissection (2 in Resource Folder)**
26. Intact bolus in resin (2)
27. Sorted bolus in resin and jars (2)
28. Dissected bolus for student lab (2)
29. Forceps (6)
30. Petri dishes (4)

Materials Not Included in this Kit, but Needed for Lesson 1:

31. Two computers with PowerPoint software and a CD drive
32. Projector
33. Paper towels

Advance Preparation:

1. Ensure this science kit contains duplicates of all six sets of materials. The printed materials for each station are located in the Resource Folder. The physical materials for each station are organized into labeled boxes.
2. Obtain materials that are not included in this kit but needed for Lesson 1 (see above list).
3. If possible, set up the twelve activity stations at the back or perimeter of the classroom so that you can start the lesson with the entire class before the students divide into groups.
4. Photocopy or print the **MARINE DEBRIS SURVEY** (one per student).
5. Photocopy or print the **STUDENT WORKSHEET – LESSON 1: BIOLOGICAL IMPACTS** (one per student).
6. Speakers are included in the kit for playing the narrated presentation. Refer to the laminated manual attached to the speaker storage case for set-up instructions.
7. Load the narrated PowerPoint presentation entitled *Lesson 1 – Trash talk – NARRATED* onto your computer by dragging the file from the CD onto your computer desktop. If you prefer to present the information yourself, load the non-narrated version. Also, drag the *Albatross Necropsy* video clip onto your desktop.
8. Eject the CD and return it to the binder.
9. Place the timer at the front of the classroom.
10. Set up six stations around your classroom. Materials are provided for 2 versions of each station, totaling 12 stations. Each station should have the materials listed below.

    <u>Station 1</u>
    a. Place **PLACARD (1)** and **INSTRUCTIONS – Attachment Activity (1)** at each station.
    b. Set out three items of marine debris with biofouling.
    c. Place two magnifying lenses at each station.
    d. Lay out copies of ***Marine Debris Gives Alien Species a Ride*** **(2)**.

    <u>Station 2</u>
    a. Place **PLACARD (1)** and **INSTRUCTIONS – Entanglement Activity (1)** at each station.
    b. Place 2-3 rubber bands at each station (1 per student in group).

    <u>Station 3</u>
    a. Place **PLACARD (1)** and **IMAGES STATION 3 – Entangled Animals (1 set)** at each station.

    <u>Station 4</u>
    a. Place **PLACARD (1)** – at each station.
    b. Lay out copies of ***Do Plastics Degrade in the Ocean?*** **(2)** at each station.
    c. Lay out copies of ***Are Plastics Toxic in the Ocean?*** **(2)** at each station.

    <u>Station 5</u>
    a. Place **PLACARD (1)** – at each station.
    b. Set up a computer at each station and copy the **Albatross Necropsy Video** file from the CD and load onto desktop.

    <u>Station 6</u>
    a. Place **PLACARD (1)** and **INSTRUCTIONS – Albatross Bolus Dissection (1)** at each station.
    b. Place (1) intact bolus in resin, (1) sorted bolus in resin and jars, and (1) dissected bolus for student lab at each station. *Note:* <u>*Boluses encased in resin are fragile, please handle with care.*</u>
    c. Place (2) forceps, (2) petri dishes, and a few paper towels at each station.
    Note: a quantitative worksheet is available with the extension activities (requires more time).

Instructional Procedures:

1. Inform the students that they are beginning a three-part study of marine debris. The unit starts with students completing a written survey to evaluate their knowledge about marine debris.
2. Distribute the **MARINE DEBRIS SURVEY** (one per student). Have students check the pre-survey box and answer the questions (allow 5–10 minutes). After lesson 3 is completed, the students will answer these same questions as a post-survey. A **TEACHER ANSWER KEY** is provided for your convenience.
3. Show the narrated PowerPoint presentation to introduce the issue of marine debris. If you prefer to present the information yourself using the non-narrated version of the PowerPoint presentation, a **POWERPOINT SCRIPT for Trash Talk: Biological Impacts of Marine Debris** is included as a guide. Please warn students that they may find some images in the PowerPoint and at the stations (3 & 5) disturbing.
4. Allow time for a brief class discussion after the slide show to clarify concepts in the PowerPoint. As time permits, have students share their own experiences with marine debris.
5. It's time to dive into learning about marine debris! Inform the students that they are now going to work in small groups to do activities at 6 stations around the room. (Explain there are twelve stations, but each of the six stations has a duplicate.) Each station teaches about a particular biological impact of marine debris and can take around 6-8 minutes, depending on the ability level of your students. Divide the students into groups and direct each group to a station. Use the provided timer to signal your desired rotation time.
6. At the end of the 6 rotations (~45min.), ask students to tidy up their last station.
7. In the remaining time before the end of class, lead a short group reflection on marine debris. First, summarize the major impacts to wildlife, for example:
   - attachment of harmful substances, such as:
     - toxins, leading to possible health problems
     - alien invasive species, leading to resource competition and/or habitat alteration
   - entanglement, leading to:
     - difficulty escaping predators or hunting for food
     - skin infections from cuts caused by marine debris, sometimes leading to death
   - ingestion of actual debris, leading to:
     - improper or inadequate nutrition, sometimes leading to death
     - injury of internal organs, sometimes leading to death

Clean-up:

1. Carefully place (2) sorted boluses for student lab back into their labeled containers. Gloves are provided. Forceps and Petri dishes go back into labeled Ziploc bag.
2. Rubber bands go back into labeled Ziploc bag.
3. Debris items and magnifying glasses go back into labeled container. Please be careful with fragile items.
4. Place placards, articles, images, and instructions back in their respective compartments in the Resource Folder.

References:

Activity 8.2A Extension of 8.2 "You Are What You Eat,"2008. http://www.oikonos.org/projects/oceanstewardship_projects.htm#activities

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Teuten, E., S. Rowland, R. Galloway, and R. Thompson, 2007. Potential for Plastics to Transport Hydrophobic Contaminants. *Environ. Sci. and Tech*. v. 41 (22), p. 7759-7764.

Image credits:

Station 1 Site for Attachment:

- Barnacles: http://www.sxc.hu/photo/172420
- Bryozoan: http://www.miljolare.no/virtue/img/2005/pages/029%20Bryozoa%2003.php
- Mussels: http://www.sxc.hu/photo/487332
- Vermetid snails: http://www.wildsingapore.com/wildfacts/glossary/tubehard.htm
- Tube worms: http://northislandexplorer.com/worms/redtubeworm.htm
- Coralline algae: http://www8.nos.noaa.gov/coris_glossary/index.aspx?letter=c
- Float with marine life: http://cmore.soest.hawaii.edu/cruises/super/marcus_blog.htm

Station 2 Entanglement:

- Hand: C-MORE
- Leatherback turtle: courtesy of Larry McKenna, http://www.saveourleatherbacks.org/

  Photographer's note – "This male young Leatherback Turtle (about 800 pounds where a mature adult can top 3,000 pounds) was impaled at sea by lines of the floats used to suspend the Asian LongLine "curtains of death" (1,000 hooks per boat strung throughout the Pacific to snare tuna and sword fishes). The Leatherbacks swim diagonally across the Pacific from nesting beaches in Indonesia to America west coast yearly to forage on jelly fish then return to mate and nest. The Leatherbacks are snared by the lines and hooks and left to drown. This one broke free and swam to a beach in Victoria, Australia to seek human help to live. Sadly with lots of fast volunteer help, including a farm family bringing their bed to the beach to transport the Leatherback to a hospital by their tractor, all efforts were just too late. The Leatherback was exhausted beyond recovery and gangrene had set deep in its shoulder and was badly infected."

Station 3 Entangled Animals:

- 1: Hawaiian monk seal, NOAA PIFSC http://celebrating200years.noaa.gov/magazine/debris/image2.html
- 2: Manatee, Kit Curtin, U.S. Geological Survey
- 3: Sea gull, David Cayless/Marine Photobank http://www.marinephotobank.org/secure/gallery-photo-grab-med.php?photo_id=6853

- 4: Coral, Keoki Stender, http://www.marinelifephotography.com/
- 5: Guillemot, Christine McGuiness http://www.birdguides.com/i/articles/001490/razor.jpg
- 6: Leatherback turtle, Larry McKenna http://www.saveourleatherbacks.org/
- 7: Manta ray, Dale Galvin/Marine Photobank http://www.marinephotobank.org/secure/gallery-photo.php?photo_id=6899
- 8: Fish, Beni Gomez/Marine Photobank http://www.marinephotobank.org/secure/gallery-photo.php?photo_id=6862
- 9: Fish, Martin Porta/Marine Photobank http://www.marinephotobank.org/secure/gallery-photo-grab-med.php?photo_id=7074
- 10: Dolphin, Randall Wells, Sarasota Dolphin Research Program www.sarasotadolphin.org
- 11: Heron, Tom Campbell http://www.tomcampbell.com/
- 12: Green turtle, NOAA http://www.noaanews.noaa.gov/stories2005/s2429.html
- 13: Sea urchin, Jeff Milisen, NOAA PIFSC
- 14: Humpback Whale http://hawaiihumpbackwhale.noaa.gov
- 15: Shark, Fiona Ayerst/Marine Photobank http://www.marinephotobank.org/secure/gallery-photo.php?gallery_id=16&photo_id=4615
- 16: Pelican, Phillip Colla http://www.oceanlight.com/spotlight.php?img=22571

Station 6 Albatross Bolus:

- (4) Bolus photos: C-MORE

Lesson 1: Overview

5-10 minutes:	I. Each student completes and turns in the **MARINE DEBRIS SURVEY**, pre-unit.
10 minutes:	II. A narrated PowerPoint presentation introduces the issue of marine debris, identifying what it is and why it's a problem, with an emphasis on its biological impacts.

~45 minutes: Students spend about 6-8 minutes at each of the 6 stations. You may need to allow for more time (an extra day) depending on the ability of your students. Students take **STUDENT WORKSHEET – Lesson 1: Biological Impacts** around with them to answer questions at each of the 6 stations.

	ACTIVITIES	MATERIALS TO SET UP
Station 1: SITE FOR ATTACHMENT	• Read article 1 • Observe marine debris items	• Placard • Instructions • Article 1 • Marine debris items • (2) Magnifying glasses
Station 2: ENTANGLEMENT	• Rubber band activity	• Placard • Instructions • Rubber bands (2-3)
Station 3: ENTANGLED ANIMALS	• Image matching	• Placard • Images (4 sheets)
Station 4: TOXIC DIET?	• Read article 4A • Read article 4B	• Placard • Article 4A (2) • Article 4B (2)
Station 5: ALBATROSS NECROPSY VIDEO	• Watch Necropsy video (on computer)	• Computer • Copy Necropsy video to computer
Station 6: ALBATROSS BOLUS DISSECTION	• Observe intact & sorted boluses • Dissect bolus	• Dissected bolus for student lab (1) • Intact bolus in resin (1) • Sorted bolus in resin and jars (1)

5–10 minutes: Clean up. Group reflection on marine debris, summarizing major impacts on wildlife (ingestion, entanglement, entrapment, toxicity, and introduction of alien invasive species).

MARINE DEBRIS SURVEY

Check one:
_______ Pre-survey
_______ Post-survey

Name: ____________________________

Period: ___________________________

Directions:
This survey is both a pre- and post- survey. Put a check mark at the top of this paper next to the survey you are doing (pre- or post- survey). Please answer each question to the best of your ability. Circle the most correct answer.

1. The following things were found on a beach. Which one is most likely to be marine debris?
   a. bird feather
   b. log
   c. bottle
   d. man-o-war jellyfish

2. Marine debris ________.
   a. is solid material
   b. includes items that were deliberately disposed of into the marine environment or the Great Lakes
   c. is persistent
   d. all of the above

3. Plastic _________________________.
   a. is found naturally in the environment
   b. does not break down into tiny microscopic pieces over time
   c. is found throughout the water column, from the surface to the ocean floor
   d. is not transported by ocean currents

4. On the line next to each description in Column A, place the number of the marine debris impact from column B that it best represents. Answers in Column B may only be used once.

Column A	Column B
_______a) Lost fishing net covering a coral reef	1. Aesthetic
_______b) Plastic in an albatross bolus	2. Alien species transport
_______c) Organisms living on a plastic bottle drifting across ocean	3. Health and Safety
_______d) Piles of marine debris visible from a scenic viewpoint	4. Entanglement
_______e) Broken glass on the beach	5. Ingestion

5. Major surface ocean currents are produced by ____________________________.
   a. differences in sun's energy
   b. wind blowing the water
   c. the Coriolis effect
   d. all of the above
   e. none of the above

TEACHER ANSWER KEY
MARINE DEBRIS SURVEY

Check one:
_______ Pre-survey
_______ Post-survey

Email kits@soest.hawaii.edu to request a completed teacher answer key. Please include your name, school, and grade(s) taught in your request. Mahalo!

Name: ______________________________

Period: ______________________________

Directions:
This survey is both a pre- and post- survey. Put a check mark at the top of this paper next to the survey you are doing (pre- or post- survey). Please answer each question to the best of your ability. Circle the most correct answer.

1. The following things were found on a beach. Which one is most likely to be marine debris? (SC.PS/BS/ES/ENV/MS.1.4, SC.ES.2.3, Standard 1l)
   a. bird feather
   b. log
   c. bottle
   d. man-o-war jellyfish

2. Marine debris ________. (SC.ES.2.3, SC.ENV.5.2, SC.ENV.5.6, SC.MS.6.4)
   a. is solid material
   b. includes items that were deliberately disposed of into the marine environment or the Great Lakes
   c. is persistent
   d. all of the above

3. Plastic ________________________. (SC.ES.2.3, SC.ENV.5.2, SC.MS.6.5)
   a. is found naturally in the environment
   b. does not break down into tiny microscopic pieces over time
   c. is found throughout the water column, from the surface to the ocean floor
   d. is not transported by ocean currents

4. On the line next to each description in Column A, place the number of the marine debris impact from column B that it best represents. Answers in Column B may only be used once. (SC.8.5.1, SC.ES.2.3, SC.ENV.5.6, Standard 1l, H.2L.2)

Column A

_______a) Lost fishing net covering a coral reef
_______b) Plastic in an albatross bolus
_______c) Organisms living on a plastic bottle drifting across ocean
_______d) Piles of marine debris visible from a scenic viewpoint
_______e) Broken glass on the beach

Column B

1. Aesthetic
2. Alien species transport
3. Health and Safety
4. Entanglement
5. Ingestion

5. Major surface ocean currents are produced by ____________________________. (SC.MS.3.5, SC.8.8.4, SC.8.8.7, SC.ES.8.6, Standard 5a, H.2L.2)
   a. differences in sun's energy
   b. wind blowing the water
   c. the Coriolis effect
   d. all of the above
   e. none of the above

Key to notation:
Hawai'i Content and Performance Standards
The relevant benchmarks for each question are shown in red in parentheses, and refer to *Hawai'i Content and Performance Standards* Version III.

LESSON 1 POWERPOINT SCRIPT

Lesson 1: Trash Talk – Biological Impacts of Marine Debris

Slide 1:
How would you like to lay out on a beach like this? (click) Is this location any better? (click) Feel like going for a swim? (click)

Slide 2:
Today we're going to talk about trash, specifically, trash in the ocean. Marine debris is a huge problem that has been talked about on TV and radio. So, let's dive right in. (click)

Slide 3:
Marine debris is defined as any persistent (click), solid material that has been manufactured or processed and has deliberately or accidentally been disposed of or abandoned in the marine environment or the Great Lakes. (click)

Slide 4:
Debris can enter the ocean by washing down a storm drain, (click) from trash in a river, from items left at the beach, or by falling off a ship (click). This isn't just a local problem, it's happening all over the United States, and even at your favorite beach. (click)

Slide 5:
Although you see marine debris piled up on a shoreline (click), marine debris is also floating in the open ocean as well as on the sea floor. Marine debris is everywhere! (click)

Slide 6:
Now let's look at some of the impacts of marine debris. It would be hard to imagine a pristine, beautiful beach covered in trash. (click) Simply stated, it's unattractive. (click) Hazardous debris items may also pose health risks and can cause serious injury to a person or an animal. (click) Debris that wraps around boat propellers can damage engines and even cause boats to lose control and crash. All of these impacts have an economic cost as well (click), from injuries and repairs to losses in tourism, dealing with marine debris costs money. (click) In addition to impacting humans, debris items can interfere with and obstruct animal habitat. (click)

Slide 7:
Look closely at the items washed up on the beaches (click). What does most of the visible debris appear to be made of? What you may notice is that most of these items are made up of only one type of material: (click) plastic. (click)

Slide 8:
You can imagine that almost everything we use in our lives, from shopping carts to soda cans could end up as marine debris, but now we're going to focus on items made of plastic (click) because plastic…is pesky. (click)
Unlike glass and aluminum, plastic is synthetic (click) and is not found naturally in nature. Most plastic is buoyant (click) and remains near the surface of the ocean where it is particularly attractive to organisms looking for a meal. Plastic also persists (click) for a long time in the environment because of its chemical composition. Most commonly used plastics don't ever fully decompose – they simply crumble into smaller and smaller pieces without ever going away. (click)

Slide 9:
Unfortunately, tiny plastics are being ingested by everything from larval fish to birds. For example, the Laysan Albatross live and raise their young in a remote (click), uninhabited part of the Pacific Ocean called the Northwestern Hawaiian Islands.

Adult albatross forage over thousands of miles of ocean to obtain food for themselves and their chicks. As part of the digestive process (click), albatross cough up a bolus that contains fish bones, squid beaks and other indigestible material such as pumice (click). An albatross bolus is similar to an owl pellet. By examining a bolus, we can tell what the bird ate. This bolus contained about 60 squid beaks, (click) but there were also just as many bits of plastic, along with a huge mess of fishing line. Researchers have found plastic in every single albatross bolus they have studied. (click) What might happen if the albatross is unable to cough up the fishing line or plastic in its stomach? (click)

Slide 10:
Unfortunately, not all albatross are lucky enough to be able to expel the plastic from their bodies. Large objects blocking a bird's throat can be deadly. The bodies of these two chicks were packed with plastic that was fed to them by their parents, who accidentally mistook floating plastic for food. A stomach full of plastic not only makes the chick feel full and stop begging for food, but birds can then die from starvation or physical damage from the plastic. (click)

Slide 11:
Once ingested, plastic may also provide a serving of toxic compounds. Some plastics are made from toxic chemicals, and toxins may accumulate, or build up, on plastics while floating in the ocean. While studies have shown that toxins attach to plastics in the ocean, no one knows if plastics eaten by an animal (click), like this fish, will cause the fish harm. If these toxins make their way up the food chain (click), they could eventually end up in the larger fish we all love to eat. (click) Scientists are still busy conducting research to find the answers to this potential problem. (click)

Slide 12:
Plastic can also entangle and trap wildlife, which interferes with an animal's range of movement, its ability to feed, reproduce or breathe. Many animals dive down to hundreds or even thousands of feet to hunt for food or escape from predators. Imagine being the leatherback turtle on the right diving 3000 feet down with a float strapped to you. This would be like trying (click) to dive to the bottom of the pool, with water wings on. (click)

Slide 13:
Finally, floating plastic provides a new habitat for organisms ranging from microscopic algae to crabs and barnacles. These floating hotels allow marine species to hitchhike a free ride to wherever the current carries it, even introducing alien species to new environments. In this cartoon, (click) the spaceship represents a piece of plastic in the ocean transporting an alien species to a new area. Once introduced into a new environment, the alien species may compete with native species for resources such as food and habitat. Eventually, they can dominate and wipe out other species that were once living there. (click) If marine organisms, like this crab or anemone, are transported to new environments by riding marine debris, they too can become alien invaders. (click)

Slide 14:
Let's review all the different impacts we just went over (click)
1. A beautiful beach covered in debris looks bad (click)
2. Hazardous debris items can cause injury or illness (click)
3. Clean-up efforts, and damages caused by marine debris can be very expensive (click)

Slide 15:
1. Organisms can mistake plastic debris for their natural prey (click)
2. Toxic compounds can attach to plastic and may leach into an organism when the plastic is ingested. (click)
3. Animals, like this Hawaiian monk seal, can get caught and trapped in items like fishing line, nets, 6-pack rings, and other pieces of trash. (click)
4. And finally, debris provides habitat for organisms and can transport invasive species into areas where they don't naturally occur. (click)

Name:___________________________ Period:_____________

STUDENT WORKSHEET

Lesson 1: Biological Impacts

Station 1: Site for Attachment

1) How many different types of organisms could you identify?

2) What do some alien species in this article use as transportation in the ocean? Why is this material favorable?

3) Why are these alien species harmful when they travel to new places?

4) Agriculture officials attempt to control the spread of invasive species by inspecting food before it travels from one location to another. Is there any way we can "inspect" like this in the ocean? How?

   If not, how can we prevent the spread of alien species?

Station 2: Entanglement (rubber band)

First, try the rubber band activity. Then try to complete the following questions with the rubber band on the hand you write with.

1) How do you think the entangled rope affected the turtle pictured on the Station 2 instruction sheet in each of the 3 following time periods…

   Immediately?

   1 *week* later?

   1 *year* later (if it survived)?

2) How would you feel if you had to wear the rubber band all day?

Station 3: Entangled Animals

1. Look at the **IMAGES – STATION 3: Entangled Animals**. For each numbered picture, write the name of the animal and the kind of marine debris you see in the data table below.

2. Here is a list of animals. Only one organism will be used twice. Bonus points if you can identify the specific type of bird or turtle.

bird – guillemot	coral	manta ray	sea urchin
bird – heron	dolphin	monk seal	shark
bird – pelican	fish	turtle – green	whale
bird – sea gull	manatee	turtle – leatherback	

3. Here is a list of marine debris. Items can be used more than once.

balloon ribbon	fishing net	plastic bag	rope
fishing line	glass jar	plastic ring	six-pack ring

PICTURE #	NAME OF ANIMAL	MARINE DEBRIS	HOW DID THIS DEBRIS GET INTO THE OCEAN?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Station 4: Toxic Diet?

Read articles 4A and 4B and answer these questions.

Article 4A

1) Why is it bad that some plastics are decomposing rapidly in the ocean?
2) What are some of the chemicals the article mentions and what impacts do they have?
3) What kinds of everyday items contain these types of toxic chemicals?

Article 4B

1) According to this article, how might plastics be harmful to life in the ocean?
2) What do scientists need to consider in the future before reaching a conclusion?

Station 5: Albatross Necropsy Video **WARNING: video contains graphic images**

Watch the entire video first, and then answer the questions below. You may watch it again if you need to.

1) How did this bird die?
2) What was it like inside the bird's stomach once they cut it open?
3) What were some common, everyday items found in the stomach?
4) How many pieces of plastic were found inside this bird?
5) How long was the longest piece?

Station 6: Albatross Bolus Dissection

Instructions: As albatross and other oceanic birds feed on their natural prey (albatross, for example, capture flying fish eggs and squid), they sometimes accidentally scoop up non-prey items. Food is digested, but indigestible items are regurgitated, or thrown up, in a "bolus." Examine the bolus and use the following data table to check off which items you see in it. Place a check mark ✓ in either the *present* or *absent* box after you go over each category.

NATURAL PREY ITEMS	present	absent
Squid beaks		
Other (describe)		
NATURAL NON-PREY ITEMS		
Plant material (e.g., sticks, leaves, seeds)		
Rocks (e.g., volcanic pumice)		
Other (describe)		
MAN-MADE ITEMS		
PLASTIC: identifiable objects; describe (e.g., bottle cap, lighter, etc.)		
PLASTIC: pieces, hard		
PLASTIC: pieces, soft (e.g. wrapper, film, Styrofoam)		
PLASTIC: pre-production pellets		
FISHING LINE		
ROPE		
GLASS		
METAL		
OTHER (describe)		
DATA ESTIMATION: Is most of the bolus made up of natural or man-made items?		

DATA INTERPRETATION: Of the items that you found in the bolus, which category would you predict takes the longest to degrade?

Of the items, which particular item were you surprised to find in the bolus?

Of the items, which individual item might have been the most "harmful" to the albatross?

TEACHER ANSWER KEY to STUDENT WORKSHEET

Lesson 1: Biological Impacts

Email kits@soest.hawaii.edu to request a completed teacher answer key. Please include your name, school, and grade(s) taught in your request. Mahalo!

Station 1: Site for Attachment

1) How many different types of organisms could you identify?

2) What do alien species in this article use as transportation in the ocean? Why is this material favorable?

3) Why are these alien species harmful when they travel to new places?

4) Agriculture officials attempt to control the spread of invasive species by inspecting food before it travels from one location to another. Is there any way we can "inspect" like this in the ocean? How?

   If not, how can we prevent the spread of alien species?

Station 2: Entanglement (rubber band)

First, try the rubber band activity. Then try to complete the following questions with the rubber band on the hand you write with.

1) How do you think the entangled rope affected the turtle pictured on the Station 2 instruction sheet in each of the 3 following time periods…

   Immediately?

   1 *week* later?

   1 *year* later (if it survived)?

2) How would you feel if you had to wear the rubber band all day?

Station 3: Entangled Animals

1. Look at the **IMAGES – STATION 3: Entangled Animals**. For each numbered picture, write the name of the animal and the kind of marine debris you see in the data table below.

2. Here is a list of animals. Only one organism will be used twice. Bonus points if you can identify the specific type of bird or turtle.

bird – guillemot	coral	manta ray	sea urchin
bird – heron	dolphin	monk seal	shark
bird – pelican	fish	turtle – green	whale
bird – sea gull	manatee	turtle – leatherback	

3. Here is a list of marine debris. Items can be used more than once.

balloon ribbon	fishing net	plastic bag	rope
fishing line	glass jar	plastic ring	six-pack ring

PICTURE #	NAME OF ANIMAL	MARINE DEBRIS	HOW DID THIS DEBRIS GET INTO THE OCEAN?
1			
2			
3			
4			
5			
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7			
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16			

Station 4: Toxic Diet?

Read articles 4A and 4B and answer these questions.

Article 4A

1) Why is it bad that some plastics are decomposing rapidly in the ocean?

2) What are some of the chemicals the article mentions and what impacts do they have?

3) What kinds of everyday items contain these types of toxic chemicals?

Article 4B

1) According to this article, how might plastics be harmful to life in the ocean?

2) What do scientists need to consider in the future before reaching a conclusion?

Station 5: Albatross Necropsy Video **WARNING: video contains graphic images**

Watch the entire video first, and then answer the questions below. You may watch it again if you need to.

1) How did this albatross chick die?

2) What was it like inside the bird's stomach once they cut it open?

3) What were some common, everyday items found in the stomach?

4) How many pieces of plastic were found inside this bird?

5) How long was the longest piece?

Station 6: Albatross Bolus Dissection

Instructions: As albatross and other oceanic birds feed on their natural prey (albatross for example capture flying fish eggs and squid), they sometimes accidentally scoop up non-prey items. Food is digested, but indigestible items are regurgitated, or thrown up, in a "bolus." Examine the bolus and use the following data table to check off which items you see in it. Place a check mark ✔ in either the *present* or *absent* box after you go over each category.

NATURAL PREY ITEMS	present	Absent
Squid beaks		
Other (describe)		
NATURAL NON-PREY ITEMS		
Plant material (e.g., sticks, leaves, seeds)		
Rocks (e.g., volcanic pumice)		
Other (describe)		
MAN-MADE ITEMS		
PLASTIC: identifiable objects; describe (e.g., bottle cap, lighter, etc.)		
PLASTIC: pieces, hard		
PLASTIC: pieces , soft (e.g. wrapper, film, Styrofoam)		
PLASTIC: pre-production pellets		
FISHING LINE		
ROPE		
GLASS		
METAL		
OTHER (describe)		
DATA ESTIMATION: Is most of the bolus made up of natural or man-made items?		

DATA INTERPRETATION: Of the items that you found in the bolus, which category would you predict takes the longest to degrade?

Of the items, which particular item were you surprised to find in the bolus?

Of the items…, which individual item might have been the most "harmful" to the albatross?

Marine Debris
Lesson 1, Station 1
Site for Attachment

INSTRUCTIONS – STATION 1: ATTACHMENT ACTIVITY

Lesson 1: Biological Impacts

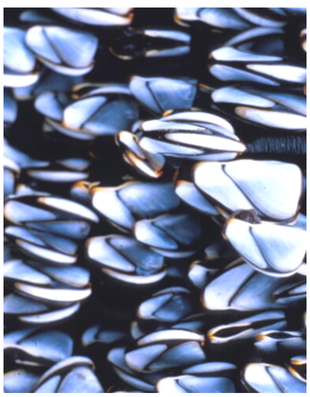
1

This station discusses the possible threat of organisms attaching to plastics in the ocean.

Instructions:

1. Read the article *Marine Debris Gives Alien Species a Ride*.
2. VERY CAREFULLY, use a magnifying glass to observe the abundance and diversity of organisms (skeletons). Try and identify them using the organism key below.
3. Answer questions for station 1 on your worksheet.

Use the following images to help identify the organisms that once lived on these items of debris.

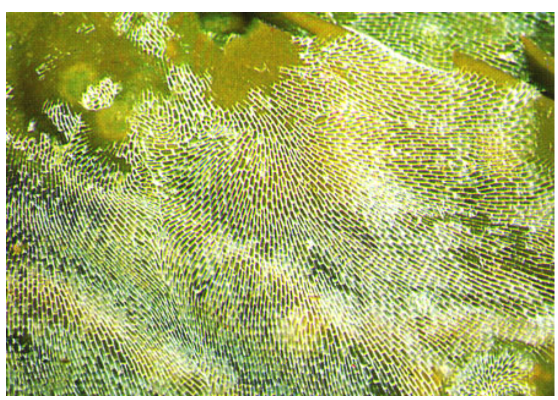

Gooseneck barnacles


Acorn barnacles


Tube worms


Vermetid snails


Mussels


Bryozoan colony


Crustose coralline algae

Marine Debris Gives Alien Species a Ride

1

The establishment of alien species in new environments is one of the greatest threats to native plants and animals. Alien or non-native species are organisms that are introduced outside of their natural range.

In new habitats, non-native plants and animals often lack natural enemies. This allows alien species to multiply and spread quickly.

Some alien species may be invasive, with the ability to spread disease, cause damage to the environment, the economy, our health and the way we live. Land plants and animal invaders are primarily spread by human activities, while marine organisms hitch rides on ships and floating debris.

A discarded float drifting across the pacific becomes a home for marine life.

Animals have made their home on materials floating in the ocean for millions of years. Wood, pumice (volcanic rock that floats), coconuts and other natural rafts have carried marine critters across oceans. With the introduction of plastic marine debris, marine organisms now have many more floating things to make a home on. Organisms ranging from dinoflagellate algae to iguanas have been seen floating on rubbish rafts, but most common are bryozoans, barnacles, worms, hydroids and mollusks.

British marine biologist David Barnes found that plastic debris was the single most abundant type of debris during a recent survey from the Arctic to the Antarctic. Because plastic debris is more durable than natural materials, plastic debris can transport marine hitchhikers to new places they could never before.

Because alien species are one of the greatest threats to biodiversity and marine species introductions are difficult to stop, marine debris should be considered a serious threat for transporting alien invaders.

This article is based on:

Barnes, D.K.A., 2002. Invasions by marine life on plastic debris. *Nature*. v. 416, p. 808-809.

Barnes, D.K.A., and Milner, P., 2005. Drifting plastic and its consequences for sessile organism dispersal in the Atlantic Ocean. *Marine Biology*. v. 146, p. 815-825.

Mayell, H., 2002. Ocean Litter Gives Alien Species an Easy Ride. *National Geographic News.* Retrieved October 2011. <http://news.nationalgeographic.com/news/2002/04/0429_020429_marinedebris.html >

Marine Debris
Lesson 1, Station 2
Entanglement

INSTRUCTIONS – STATION 2: ENTANGLEMENT ACTIVITY

Lesson 1: Biological Impacts

1. Try this experiment to demonstrate how an animal might feel when it gets entangled in marine debris:

   - Take one of the rubber bands and hook it over your pinky. Stretch the band over the back of your hand and hook the other end over your thumb.
   - Try to write your name on the worksheet somewhere using your pen or pencil.
   - Imagine you are a marine animal entangled in debris. Without anyone helping you or using any other part of your body, see if you can remove the rubber band.
   - Too easy? Try removing the rubber band without using your thumb!

2. Notice a rope attached to floating buoys is entangled in this leatherback turtle's neck and flippers. Now answer the questions for STATION 2: Entanglement (rubber band) on your worksheet.

HUMANS KILL WHERE NATURE DOES NOT (c) Larry McKenna, PhD

Marine Debris
Lesson 1, Station 3
Entangled Animals

IMAGES – STATION 3: ENTANGLED ANIMALS

Lesson 1: Biological Impacts

NOAA PIFSC

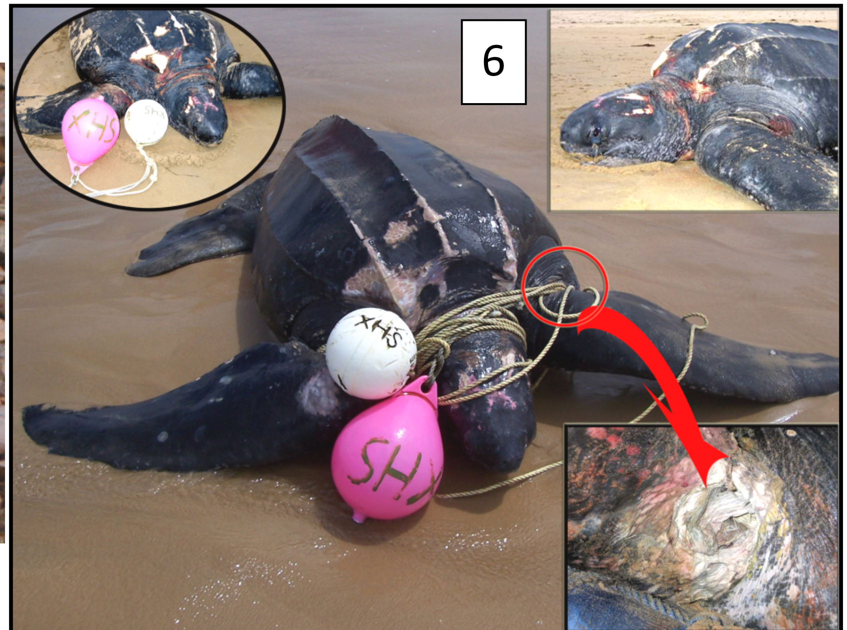
Kit Curtin - U.S. Geological Survey

David Cayless/Marine Photobank

Keoki Stender

5

6



Impaled by Circle Hook and Strangled by Long Line Floats.
Photos by David Donnelly & Laura Clark - Composited by Larry McKenna (c)

7

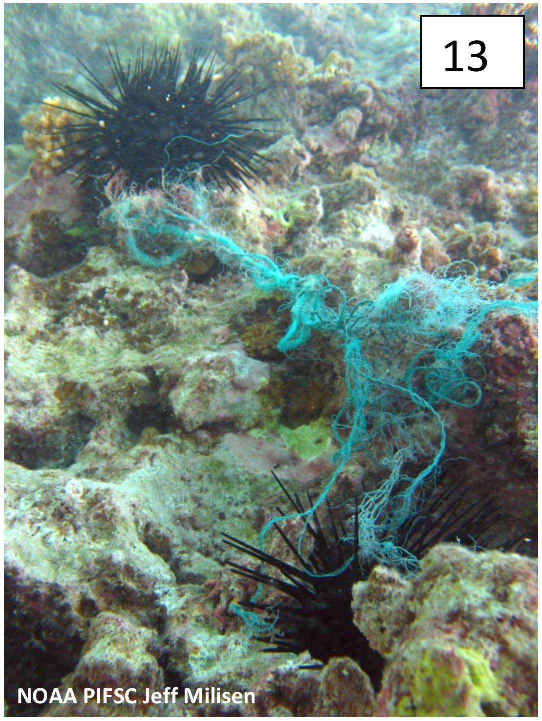
8

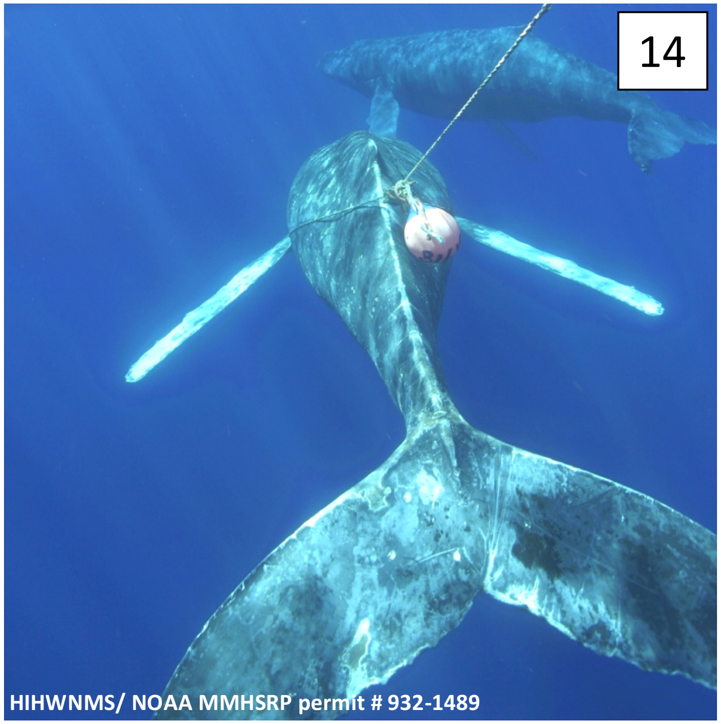

9
Martin Porta/Marine Photobank


10
Sarasota Dolphin Research Program


11
© Save Our Seas, Ltd./photo by Tom Campbell


12
NOAA


13
NOAA PIFSC Jeff Milisen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Marine Debris
Lesson 1, Station 4
Toxic Diet?

Do Plastics Degrade in the Ocean?

4A

Based on the NOAA Marine Debris Program "Plastic Marine Debris: What We Know" webpage August 2011 http://marinedebris.noaa.gov/info/plastic.html#acknow

What does it mean to degrade plastic?

Degradation here is defined as a process leading to deterioration of the physical properties of a plastic polymer (Bovey and Winslow, 1979). Physical properties include size, shape, texture, color, smell, density, etc.

Is this type of degradation the same as biodegrade?

No, biodegrade means that a substance is broken down into carbon dioxide, water and inorganic compounds by living organisms such as microbes. If plastics were to biodegrade, they would need to be broken down by organisms.

So do plastics degrade in the environment?

In general, yes, however there are many things to note (Singh and Sharma, 2008):

- There are MANY different types of plastic, and thus many different chemical compositions
- The rate of degradation depends on the chemical composition of the plastic and the environmental conditions
- Most commonly used plastics never go away; they just break down into smaller and smaller pieces. For plastics to go away, they would need to chemically break down completely into carbon dioxide, water, and small inorganic molecules (Andrady, 2003).

Degradation depends on:

- Density of the plastic – density determines whether the piece floats or sinks, plastics that sink get less sunlight
- Temperature of water – if the water is warmer there will likely be greater degradation
- Type of plastic – the structure of the plastic affects degradation
- Additives– extra chemicals included in the plastic to make it more durable (e.g., light stabilizers, hardeners, anti-oxidants)

Types of plastic degradation:

- Photodegradation: Most plastics photodegrade in the marine environment, breaking down into smaller and smaller pieces due to exposure to solar ultraviolet radiation. If underwater, plastic may not get direct sunlight exposure; therefore breakdown happens much more slowly in the aquatic environment.

- Thermal (thermo-) degradation: This type of degradation, caused by increased temperatures, leads mainly to the loss in extensibility (i.e., "stretchiness") of most plastics, except polystyrene.

- Biodegradation & bio-based plastics: There are some bio-based (e.g., corn, wheat, tapioca, algae) and biodegradable plastics in stores and in development. Biodegradable plastics are designed to be broken down by organisms that live in landfills and compost piles, not the ocean! While there are numerous microbes living in the ocean, none have been found to eat plastic yet. Also, there are also products that call themselves "biodegradable," but simply break down into smaller pieces faster, so be careful!

References:

Andrady, Anthony, 2003. *Plastics and the Environment*. New Jersey: John Wiley & Sons, Inc.

Bovey, F. and F. Winslow, 1979. *Macromolecules – an introduction to polymer science*. London: Academic Press. p. 423-430.

Singh, B. and N. Sharma, 2008. Mechanistic implications of plastic degradation. *Polymer Degradation and Stability*. v. 93 (3), p. 561-584.

Are Plastics Toxic in the Ocean? 4B

Plastic marine debris contains a slew of nasty chemicals [e.g. polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons, petroleum hydrocarbons, organochlorine pesticides (trichloroethane, hexachlorinated hexanes), polybrominated diphenylethers, alkylphenols, and bisphenol A] that are not only hard to pronounce, but are also contaminants. A contaminant is a substance not normally found in the environment, which, in high enough concentration, can cause problems for living things.

A team of scientists from Japan analyzed sand and seawater samples from 200 sites around the world and found chemicals derived from plastic in every sample. Some of the chemicals came from polystyrene, a common plastic used in disposable food containers, Styrofoam, DVD cases, and other things. Another one of the chemicals detected, Bisphenol A (BPA), is a chemical used in hard plastics and found in screwdriver handles, reusable water bottles as well as in the linings of cans. Some of these chemicals are carcinogens (cancer-causing) while others disrupt hormones.

Not only are plastics releasing contaminants into the water, they also attract toxic chemicals. PCB's (polychlorinated biphenyls) have been found on plastic debris in concentrations 100,000-1,000,000 times greater than in seawater concentrations.

Plastics are contaminants in the marine environment, and these contaminants are getting into marine organisms. For most species, the primary route of contaminant transfer is by eating plastics. Over 180 species of animals have been observed eating plastic debris, including birds, fish, turtles and mammals. Research indicates that contaminants can be transferred from ingested plastic to animals. Further research is needed to see if the intake of contaminates harms animals or if the contaminates are passed up the food web. Researchers need to consider the range of contaminant types, types of plastic, and environmental exposure effects.

Plastic marine debris is not only a physical threat to marine organisms, but is a chemical threat as well. Researchers are continuing investigations to determine if the chemical threats of marine debris can affect us humans.

This article is based on:

American Chemical Society, 2010. Hard plastics decompose in oceans, releasing endocrine disruptor BPA. *ScienceDaily*. Retrieved August 16, 2011. http://www.sciencedaily.com- /releases/2010/03/100323184607.htm

American Chemical Society,2009,. Plastics In Oceans Decompose, Release Hazardous Chemicals, Surprising New Study Says. *ScienceDaily*. Retrieved August 16,2011. http://www.sciencedaily.com- /releases/2009/08/090819234651.htm

Mato, Y., T. Isobe, H. Takada, H. Kanehiro, C. Ohtake, and T. Kaminuma. 2001. Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment. *Environ. Sci. Tech.* 35: 3p. 18-324.

Teuten, E. L., Saquing, L. M., Knappe, D.R.U., Barlaz, M. A., Jonsson, S., Björn, A., Rowland, S.J., Thompson, R.C., Galloway, T.S., Yamashita, R., Ochi, D., Watanuki, Y., Moore, C., Viet, P.H., Tana, T.S., Prudente, M., Boonyatumanond, R., Zakaria, M.P., Akkhavong, K., Ogata, Y., Hirai, H., Iwasa, S., Mizukawa, K., Hagino, Y., Imamura, A., Saha, M., and Takada, H., 2009. Transport and release of chemicals from plastics to the environment and to wildlife. *Phil. Trans. R. Soc. B* v. 364 (1526), p. 2027-2045.

Teuten, E., S. Rowland, R. Galloway, and R. Thompson, 2007. Potential for Plastics to Transport Hydrophobic Contaminants. *Environ. Sci. and Tech.* v. 41 (22), p. 7759-7764.

Marine Debris
Lesson 1, Station 5
Albatross Necropsy
Video

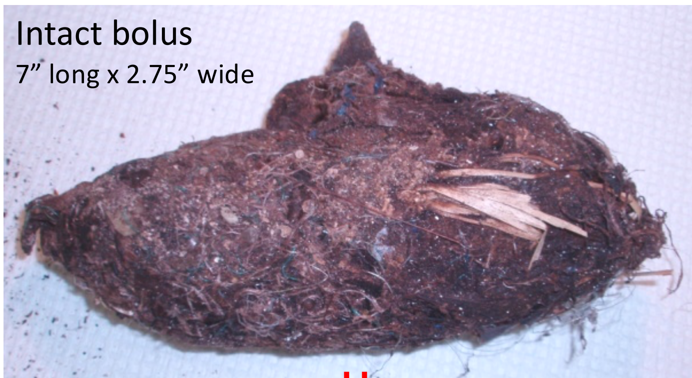
Marine Debris
Lesson 1, Station 6
Albatross Bolus
Dissection

INSTRUCTIONS – STATION 5: ALBATROSS BOLUS DISSECTION

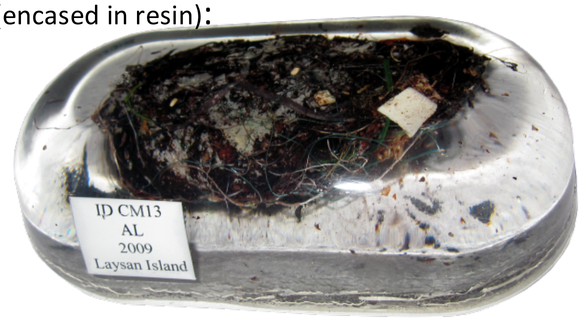
Lesson 1: Biological Impacts

Although Laysan albatross feed primarily on squid, they also eat fish, fish eggs, and crustaceans. Just before they fledge (fly for the first time), albatross chicks regurgitate a compacted mass of indigestible material called a *bolus*. Even though plastic is not a natural part of the birds' diet, every single albatross bolus found today contains plastic.

The intact, sorted, and dissected samples are actual albatross boluses from the Northwestern Hawaiian Islands, collected from Midway and Kure Atolls, and Tern Island. Follow the instructions below to determine how much plastic is present in an albatross bolus relative to other materials.


Intact bolus
7" long x 2.75" wide

Intact bolus
(encased in resin):



Dissected bolus:

Sorted bolus (Match ID numbers)
Jar = non-natural items; Resin = natural prey items

1. First, look at the **Intact Bolus** encased in resin. Notice the various man-made items mixed into the big mass.
2. Next, examine the **Sorted Bolus** to familiarize yourself with some of the common items you might find. Items with the same ID number are from the same bolus. The **Sorted Bolus** is displayed in two ways, plastics from the bolus are in a jar while natural items are fragile and encased in resin for protection.
3. Open the container labeled **Dissected Bolus** and empty its contents gently onto the paper towel.
4. These items came out of the stomach of a bird and are not clean. Using the forceps, gently move around the contents so you can see what kinds of items are present. If you need to handle the bolus contents, do not touch your face until after you have washed your hands.
5. On the last page of your worksheet, check off *present* or *absent* on the right-hand column as you go down the list.
6. Clean up your work area by returning all of the bolus contents into the container, and then wash your hands.
7. Answer the remaining questions on your worksheet.

TEACHER GUIDE

Lesson 2: Geographical Distribution

Time Required: 80–90 minutes of class time plus advanced preparation.

Structure: A brief, narrated PowerPoint presentation discusses the distribution of marine debris and introduces basic concepts in atmospheric and ocean circulations. The majority of the class period is spent with students working at computers in pairs or small groups to solve an environmental forensics problem. Students examine items of marine debris and use an online surface current model to determine their origin.

Materials:

This is a computer-based lesson, therefore we suggest 2–3 students per group.

1. **TEACHER GUIDE – Lesson 2: Geographical Distribution**
2. **POWERPOINT SCRIPT – Lesson 2: Carried Away! – Physical Dispersal of Marine Debris**
3. **POWERPOINT NOTES – Lesson 2: OSCURS Intro**
4. **INSTRUCTIONS for STUDENT WORKSHEET– Lesson 2: Environmental Forensics**
5. **STUDENT WORKSHEET – Lesson 2: Environmental Forensics (15 in Resource Folder)**
6. **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
7. **MAP 1: Countries Surrounding the Pacific Ocean (15 in Resource Folder)**
8. **MAP 2: Surface Currents in the North Pacific Ocean (15 in Resource Folder)**
9. **LANGUAGE GUIDE – Lesson 2: Environmental Forensics (6 in Resource Folder)**
10. Pieces of marine debris with language text and location cards (6)

Materials Not Included in this Kit, but Needed for Lesson 2:

11. Computers with high speed Internet access (*e.g.*, cable modem, DSL, broadband)
12. Projector

Advance Preparation: At least 30 minutes.

1. Speakers are included in the kit for playing the narrated presentation. Refer to the laminated manual attached to the speaker storage case for set-up instructions.
2. Load the PowerPoint presentations entitled **Lesson 2: Carried Away! – NARRATED** and **Lesson 2: OSCURS Intro** onto your computer by dragging the file from the Marine Debris Science Kit CD onto the desktop. If you prefer to present the information yourself, load the non-narrated version.
3. Eject the CD and return it to the binder.
4. Obtain enough computers with Internet access for your students to work in groups of 2–3.
5. The Ocean Surface Current Simulator (OSCURS) uses a large dataset and performs optimally with faster Internet connections.
6. OSCURS requires Java software, which can be downloaded for free at http://java.com/en/download/index.jsp.
7. OSCURS also requires familiarity with latitude and longitude. A fun, easy-to-understand animated video about the coordinate system is available at http://www.infoplease.com/p/brainpop/latitudeandlongitude.html. This video uses Adobe Flash Player, which you can download for free at http://get.adobe.com/flashplayer/.
8. Practice using the OSCURS Model to familiarize yourself with the process by following the instructions in the **POWERPOINT NOTES – Lesson 2: OSCURS Intro**. Run through the example in the PowerPoint script as well as the examples in the **STUDENT WORKSHEET – Lesson 2: Environmental Forensics**.
9. Run OSCURS with multiple computers simultaneously accessing the program to get a better estimate of the time required to complete the activity with your particular system.
10. Photocopy **STUDENT WORKSHEET – Lesson 2: Environmental Forensics** (one per student).

Instructional Procedures:

1. Show the PowerPoint presentations entitled **Lesson 2: Carried Away! – NARRATED** to introduce ocean circulation and the distribution of marine debris. If you prefer to present the information yourself, use the non-narrated version and the **POWERPOINT SCRIPT – Lesson 2: Carried Away! – Physical Dispersal of Marine Debris** as a guide.
2. Allow briefly for class discussion after the slide show to clarify concepts in the PowerPoint.
3. If your students are unfamiliar with the concepts of latitude and longitude, then play the short, animated video at http://www.infoplease.com/p/brainpop/latitudeandlongitude.html. Note: OSCURS requires east coordinates to run the program, therefore the west coordinates were converted to east coordinates, example 160^0W = 200^0E.
4. Give the PowerPoint presentation entitled **Lesson 2: OSCURS Intro** using the **POWERPOINT NOTES – Lesson 2: OSCURS Intro**. Model to students how to use the OSCURS Model by actually going through the program using the example provided.
5. Now for the investigation! Inform the students that they are going to work in small groups (2-3) to practice using the OSCURS model and take part in a forensic investigation focused on determining the starting coordinates of a marine debris item.
6. Distribute the **INSTRUCTIONS – Lesson 2: Environmental Forensics**, **STUDENT WORKSHEET – Lesson 2: Environmental Forensics**, **MAP 1: Countries Surrounding the Pacific Ocean** and **MAP 2: Surface Currents in the North Pacific Ocean** marine debris item among the class.
7. Instruct the students to complete the activity according to the **INSTRUCTIONS – Lesson 2: Environmental Forensics**. Let students know that the numbers on the instructions correspond to the numbers on the worksheet. When groups get to Part 2: Be a marine debris detective, give them a piece of marine debris tagged with a clue card and a **LANGUAGE GUIDE – Lesson 2: Environmental Forensics**.
8. There are only six pieces of debris with clue cards, so more than one group may end up studying a single item. The first groups finished with Part 1: Learn how to use the OSCURS model should be able to get the information they need and pass their debris to a group that works slower.

Lesson 2: Overview

10 minutes: Narrated PowerPoint presentation will introduce basic ocean circulation and distribution of marine debris.
10 minutes: Non-narrated PowerPoint presentation and online example to introduce the OSCURS Model.
60–70 minutes: Students work in pairs or small groups at computers with Internet access. There are six different pieces of marine debris, therefore two to three **groups** will analyze the same item of debris. Environmental Forensics Part 1: How to use the OSCURS Model • Practice using model with example coordinates and dates • Select your own coordinates and run model Environmental Forensics Part 2: Be a Debris Detective • Observe an item of marine debris • Identify the country of origin using **LANGUAGE GUIDE – Lesson 2: Environmental Forensics** • Use OSCURS model to generate debris tracks • Identify currents involved in debris transport using map of currents
5–10 minutes: At the end of the lesson, have groups that studied the same item of debris compare their results. Numbered questions on the **STUDENT WORKSHEET – Lesson 2: Environmental Forensics** may be assigned as homework. Otherwise, students submit their worksheets to the teacher.

LESSON 2 POWERPOINT SCRIPT

Lesson 2: Carried Away! – Physical Dispersal of Marine Debris

Slide 1:
Marine debris has many impacts on human health and safety, marine life, and economics. But how can trash from shore make it across oceans? Let's explore how marine debris can travel. (click)

Slide 2:
While most marine debris we see is washed up on beaches, (click) it can also be found floating in the middle of the ocean, and (click) on the bottom of the ocean as well. Where in the world can you find marine debris? (click)

Slide 3:
Practically everywhere! It is almost impossible to take a walk along a shoreline without finding some sort of trash. As this slide shows, marine debris has been found on every continent, even in Antarctica. Marine debris that washes up on beaches doesn't always come from the same county where it is found. Trash from the United States can be found washed up in Asia, (click) and debris from Asia has been found in the U.S (click). How does marine debris travel around the ocean so far from its source? (click)

Slide 4:
Through ocean currents. Currents are masses of water moving in the same direction. The magenta arrows on this map show the location and direction of major surface currents that transport water, and anything floating in the water, around the globe. How do currents form? (click)

Slide 5:
Ocean currents are driven by the sun's energy. The (click) sun's energy is more concentrated in the tropics, making it warmer. Because the earth is curved, (click) higher latitudes receive less energy and are cooler. The (click) differences in the sun's energy cause the Earth to heat differently. (click)

Slide 6:
The differential heating of the Earth causes air circulation. Direct sun rays at the equator (click) results in warmer air that becomes less dense, rises, and flows towards the poles. At the poles (click), the air is colder, denser (click) and sinks. The movement of air from the poles to the equator is felt as wind. This example shows how air would flow if the earth did not rotate.

Slide 7:
But the earth rotates once each day. The (click) earth's rotation not only gives us day and night, it also deflects the direction of moving objects that are not attached to land, including wind, currents and airplanes. In the northern hemisphere(click), the deflection is to the right. In the southern hemisphere (click), the deflection is to the left. (click) This deflection is called the Coriolis effect. Let's look at an example. (click)

Slide 8:
Imagine that you are going to take a plane (click) from New York City, to (click) Bogota, Colombia. If the earth did not rotate, the plane could just fly (click) straight to your destination. (click)

Slide 9:
Because the earth rotates, this is what would happen if the plane flew straight south (click). Here is the intended path (click) of the plane, but this (click) is the actual path the plane followed because of the Coriolis effect. As the plane was in the northern hemisphere, it moved toward the right of the intended path. Pilots adjust their course to make it to their destination. (click)

Slide 10:
The Coriolis effect influences the winds too, making the simple picture of air circulation, (click) a bit more interesting. For now, we are just going to focus on the prevailing winds in the northern hemisphere. In the mid latitudes (click), air flows

northwards and is deflected to the right creating the prevailing westerlies. In the tropics (click), air flows south and is deflected to the right resulting in the northeast trade winds. The westerlies and trade winds are known as the prevailing winds because they predominantly blow from the same direction. But what does the wind have to do with surface water currents? (click)

Slide 11:
Everything. The prevailing winds are what set up the surface currents. When the wind blows across the surface of the ocean it causes the water to move in the direction that the wind blows. But the ocean is also affected by the Coriolis effect, so in the northern hemisphere, (click) the actual movement of water is to the right of where the wind blows. The prevailing winds set up the major ocean currents. (click)

Slide 12:
Let's look at the major ocean currents again. Notice that the ocean tends to circulate in five areas (click). These circular current patterns are called gyres. (click)

Slide 13:
The gyres form between the continents as a result of the prevailing winds. The mid-latitude westerlies and tropical trade winds push the water to form a rotating gyre. (click)

Slide 14:
Several major currents make up the boundaries of a gyre. This map shows the major currents that make up the North Pacific Gyre. (click) How do the currents affect the movement of marine debris? (click)

Slide 15:
Scientists at the National Marine Fisheries Service in Seattle, WA developed a computer model called OSCURS to help answer this question. This model takes real data on surface ocean currents and allows you to see how a passive object floating in the ocean would be carried by these currents.

The scientists wanted to see how debris released from both sides of the Pacific would be dispersed by surface currents, so they chose 8 points along Japan, which are shown as (click) red circles, and 11 points along the U.S. and Canada, which are shown as (click) blue squares. These points represent the places where marine debris were released. Scientists then used the model to simulate how the debris would travel in 20 years. (click)

Slide 16:
After 6 months, the simulated debris quickly moved along the west coast of the U.S. and out from the coast of Japan. (click) After a year, some debris had already made it halfway across the pacific. (click) And 3 years later, the debris spread and spread. (click) …all over the Pacific Ocean. (click)

Slide 17:
After 20 years, most of the Japanese trash (click) is in the Eastern Pacific, and the U.S. trash is dispersed throughout the North Pacific, but concentrated in the Western Pacific. (click)

Slide 18:
Let's review what we have covered so far.

1. Marine debris is found throughout the world. (click)
2. The equator receives more heat than the poles. Winds are produced when this heat rises and moves towards the poles, while cold air at the poles sinks and moves towards the equator. (click)
3. Wind pushes on the surface of the ocean and creates currents. (click)
4. The rotation of the Earth causes the winds and currents to bend. (click)
5. Surface currents transport passive objects like marine debris all over the ocean in a short period of time. (click)

Slide 19:
Computer simulations are helpful in studying the path of marine debris. The OSCURS model has been updated and is accessible online for you to track marine debris.

POWERPOINT NOTES

Lesson 2: How to use OSCURS

There is no narrated version of this PowerPoint. Use the following notes to go over the PowerPoint – Lesson 2: How to use OSCURS to introduce the computer model to your students. Following the presentation, lead your students through an example of how to use the model using the directions provided.

<u>Slide 1</u>: How to use the OSCURS Model

- OSCURS stands for Ocean Surface CURrent Simulator
- Program estimates how ocean currents cause floating debris to move around the North Pacific Ocean
- Uses data to generate model tracks, online version can only predict paths up to today, not into future

<u>Slide 2</u>: Information OSCURS needs to simulate debris movement (click)

- the date of when that item was lost (click)
- the date of when the item was collected (click)
- and the estimated position (latitude/longitude) of where the item entered the ocean

<u>Slide 3</u>: Latitude and longitude review

- Picture on left shows Earth divided in north and south degrees (click)
- Picture on the right shows Earth divided east to west, also in degrees (click)
- (Click) Which shows lines on latitude?
- Lines of latitude divide the Earth north and south (click)
- Lines of longitude divide the Earth east and west (click)

<u>Slide 4:</u> Review of coordinates

- The equator is 0° latitude and the Prime meridian is 0° longitude
- Any point on Earth can be represented by a coordinate point, where lines of latitude and longitude cross. Example: 15°N by 60°W is a coordinate point. (click)
- To find 15°N by 60°W, go north 15° (click), then to 60° west (click)
    - To get a specific location divide degrees into minutes and seconds or use decimal degrees
- OSCURS wants all coordinates to be North and East
    - For our example, 15°N by 60°W is equal to 15°N by 300°**E**. (click)
    - This is like going the other way around the world. (click)

<u>Slide 5</u>: OSCUR model output

- Red line shows the output of an object that started in Hawaiʻi
- Why does the path curve around the pacific?
- Overlay simulated path on an ocean current map (click)
- Point out land (brown), ocean (light blue) and currents (blue arrows)
    - Note the different currents have names
    - Currents form circular gyre around the North Pacific
- For model example, debris started in Hawaiʻi (click)
    - Traveled with the currents (click)
- You can get a general idea of how debris will travel based on the currents
    - OSCUR model uses data to give more detail

Slide 6: Example scenario

- Surfing with your best friend “Waggles” at Waikiki Beach, Hawai‘i on Christmas day 2006
- You let him borrow your board, and a huge wave comes in without warning (click)
  - Board is taken out to sea and lost
  - But you wrote your name and number on board, and hope someone will find it
- Three years later, the Coast Guard calls
  - Found a lost fisherman in the Northwest Hawaiian Islands clinging to your board
  - How did you board get way out there?
- Use the OSCURS model!

Slide 7: Information needed for OSCURS model

- Where the surfboard was lost (click)
  - Waikiki Beach, coordinates 21.27°N by 202.17°E
- When the surfboard was lost (click)
  - Christmas day, December 25, 2006
- When the surfboard was found
  - Three years later, December 25, 2009
- This is all that is needed to be entered into OSCURS

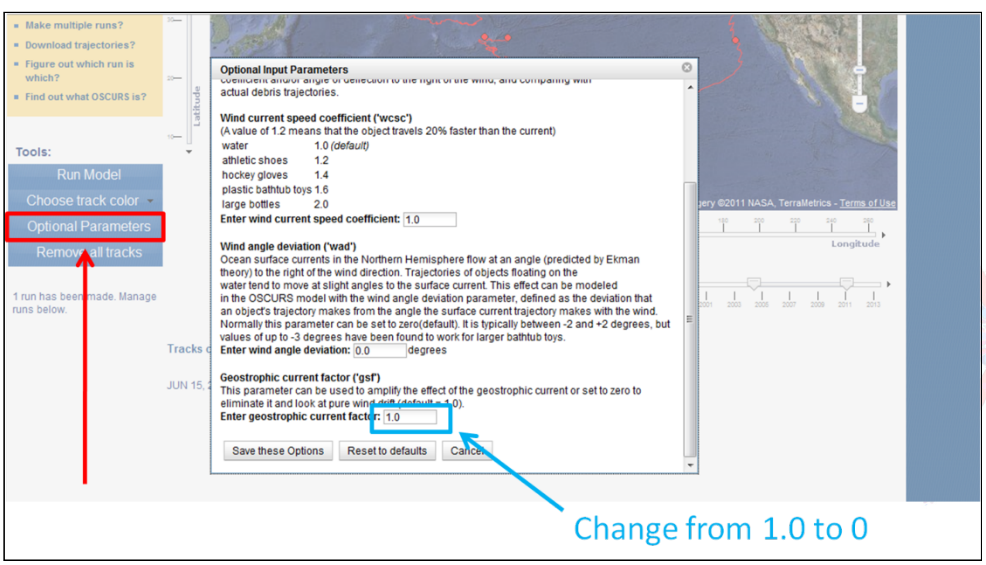
Slide 8: Click on link to go to the OSCURS website and model how to use OSCURS with the Waggles example scenario. Use the information below as a guide.

How to use OSCURS Model Guide

1. On a computer connected to the Internet, go to http://oceanview.pfeg.noaa.gov/oscurs/.
2. Scroll down and click on the link that says **Optional Parameters**, found on the left side of the screen.
   a. In the pop-up box, set the model parameters to the following values:

      Wind Current Speed Coefficient: 1.0
      Wind Angle Deviation: 0.0
      Geostrophic Current Factor: 0.0

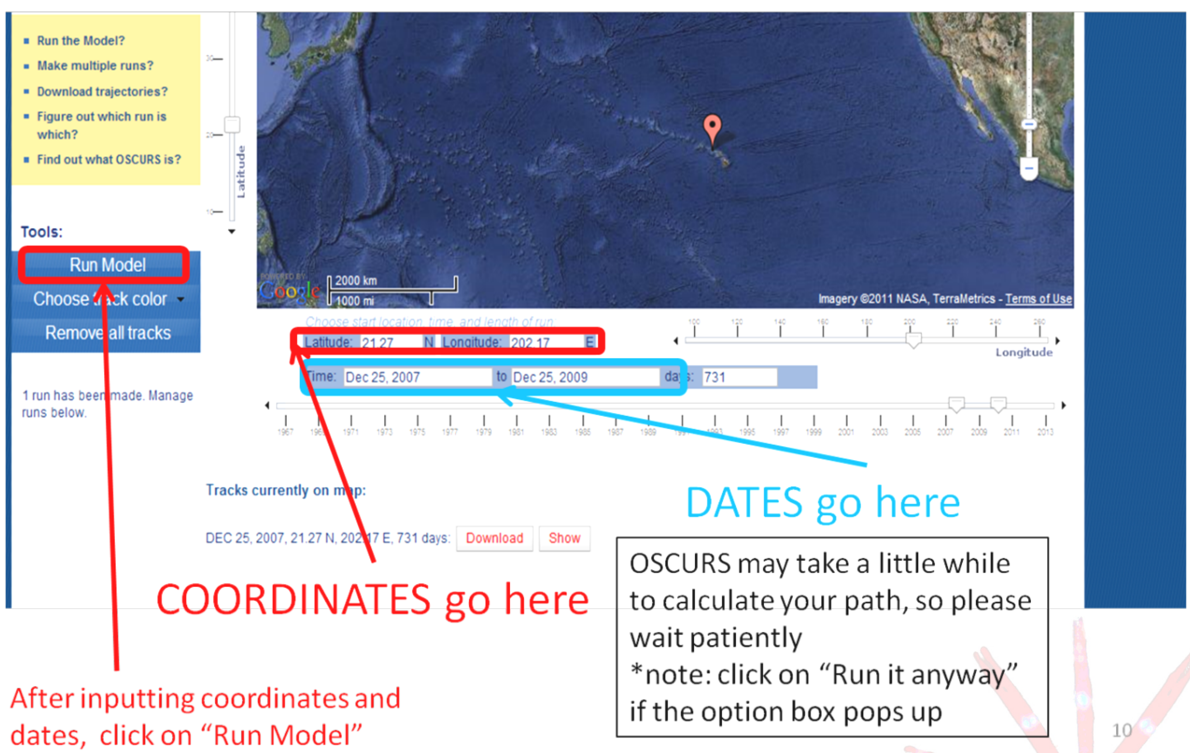
   Once you have changed the numbers, click **Save these Options**.



3. Enter your starting coordinates.
    a. Click on the latitude box, delete the contents and enter your latitude: **21.27**
    b. Click on the longitude box and enter your longitude: **202.17**

    Note: Check to make sure the marker moves to the desired starting location. In this example it should be over Hawai'i. You can also check the current location of the marker by clicking on the marker.
4. Enter the start date.
    a. Click on the starting date box next to where it says "Time." Enter: **Dec 25, 2006**
    b. Use the calendar to select the starting date.

        To change month, click on arrows. To change year, click on the year to the left or right until the year you need is in the center. Then click on the calendar day to select the date.
    c. You can also type in the date in using this format Month (first 3 letters - Dec) Day (two digit - 25), year (four digit – 2006).
5. Enter the end date. **Dec 25, 2009**
    a. Click on the end date box to the right of where it says "to"
    b. Enter the ending date using one of the methods above. Enter: **Dec 25, 2009**
6. Click on **Run Model**. If a box pops up that asks, "Are you sure?" Click on **Run it anyway.**



7. To get a closer look at the path, zoom in or out with the scroll bar (+,-) on the right of the map. You can move the map by clicking and dragging
8. The dots on the tracks indicate the first day of the year, as well as the end location. You can click on the dot to get the position.
9. To run multiple models on the same map, change the color of the lines by clicking on the **Choose Track Color,** then select a new color.

INSTRUCTIONS FOR STUDENT WORKSHEET

Lesson 2: Environmental Forensics

Part 1: Learn how to use the OSCURS model

1. Use the OSCURS model to predict the path marine debris traveled from 4 starting locations in the Pacific between Jan 01, 2004 and Jan 01, 2009.
   a. Go to the OSCURS model website by typing in http://oceanview.pfeg.noaa.gov/oscurs/.
   b. Scroll down and click on the link that says **Optional Parameters**, found on the left side of the screen.
   c. In the pop-up box, set the model parameters to the following values:

      Wind Current Speed Coefficient: 1.0

      Wind Angle Deviation: 0.0

      Geostrophic Current Factor: 0.0

   Once you have changed the numbers, click **Save these Options**.
   d. Enter your starting coordinates.
      i. Click on the latitude box, delete the contents and enter the latitude. For California, enter **35.27**
      ii. Click on the longitude box and enter the longitude. For California, enter **236.32**
   e. Enter the start date.
      i. Click on the starting date box next to where it says "Time"
      ii. Use the calendar to select the starting date. For California select **Jan 01, 2004**
      To change month, click on arrows. To change year, click on the year to the left or right until the year you need is in the center. Then click on the calendar day to select the date.
      iii. You can also type in the date using this format Month (first 3 letters - Jan) Day (two digit - 01), year (four digit – 2004). For California, enter **Jan 01, 2004**
   f. Enter the end date.
      i. Click on the end date box to the right of where it says "to"
      ii. Enter the ending date using one of the methods above. For California, enter **Jan 01, 2009**
   g. Click on **Run Model**. If a box pops up that asks, "Are you sure?" Click on **Run it anyway.**
   h. To get a closer look at the path, zoom in or out with the scroll bar (+,-) on the right side of the map. You can move your view of the map by clicking and dragging it.
   i. To run multiple models on the same map, change the color of the lines by clicking on **Choose Track Color.** Select a new color and repeat steps for Hawaiʻi, Japan, Russia, and My Point.
   j. Draw each path on your worksheet with an arrow showing which direction the debris traveled.
2. Answer question 2 on your worksheet.
3. Now drag the balloon to a location in the ocean where you would like to run a path. Use the same time period, Jan 01, 2004 to Jan 01, 2009.

Part 2: Be a marine debris detective

4. Now you are going to use the OSCURS model to figure out where pieces of marine debris originated from.
   a. Get a piece of marine debris with a clue card from your teacher.
   b. Examine the debris and record the information you know (clues) in #4 on your worksheet.
5. Use the clues on the debris to help you figure out the country and city your object originated from.
   a. Use the **LANGUAGE GUIDE – Lesson 2: Environmental Forensics** sheet to find out the language on the debris.

b. Once you have figured out the language, decide what country your marine debris item originated from.
c. Figure out whether your debris came from LAND or SEA, and use one of the tables below to hypothesize the two closest cities to where your debris may have originated from.
d. Based on your hypothesized country of origin, use the current map to determine what currents your debris traveled along.

Sources of debris entry from LAND			
Country of Origin	**Nearby city**	**Latitude (°N)**	**Longitude (°E*)**
Russia	Palana	56.93°N	156.15°E
Russia	Petropavlovsk	51.53°N	158.91°E
Vietnam	Da Nang	16.16°N	109.50°E
Vietnam	Ho Chi Minh City	10.17°N	109.03°E
Mexico	Puerto Vallarta	22.11°N	253.98°E
Mexico	Guerrero Negro	28.04°N	244.66°E
United States	Honolulu	21.28°N	202.15°E
United States	Kona	20.08°N	203.95°E
United States	San Francisco	38.82°N	234.84°E
United States	San Diego	33.54°N	242.12°E
China	Shanghai	30.55°N	124.06°E
China	Guangzhou	20.89°N	114.17°E
Korea	Jeju	33.45°N	125.84°E
Korea	Kimch'aek	39.64°N	128.78°E

Sources of debris entry from SEA			
Country of Origin	**Port of origin**	**Latitude (°N)**	**Longitude (°E*)**
Philippines	Roxas City	11.98°N	123.13°E
Philippines	Manila	18.88°N	120.65°E
Korea	Jeju	33.45°N	125.84°E
Korea	Kimch'aek	39.64°N	128.78°E
Japan	Shibushi	30.29°N	133.70°E
Japan	Tomakomai	40.98°N	145.55°E
United States	Dutch Harbor	54.16°N	183.87°E
United States	Los Angeles	33.93°N	238.01°E

6. State your hypothesis of where your debris originated and how it traveled to the location it was found. (e.g. The "DEBRIS" originated in "COUNTRY", near "CITY" on "DATE" and followed the "CURRENTS".
7. Draw your hypothesized route on the HYPOTHESIS map.
8. Use the OSCURS model to test your hypothesis.
   a. Remove all tracks from the model by clicking **Remove all Tracks**.
   b. Enter the city's coordinates you think your debris originated from into the OSCURS model.
   c. Change the time of the model to match the date your item was lost and the date it was found. Record this data on your worksheet.
   d. Run the OSCURS model. Click on the final point of your path; do the final coordinates match the place where your item was found? If not, change the track color and rerun the model with a different city's coordinates.
9. Record your conclusions of where the debris originated and what currents the debris traveled.
10. Answer question.
11. Answer question.

Name: ___________________________________ Period: ____________________

STUDENT WORKSHEET

Lesson 2: Environmental Forensics

Part 1: Learn how to use the OSCURS model

1. Use the OSCURS website to simulate how marine debris traveled between **Jan 01, 2004 to Jan 01, 2009**. For the 4 sets of coordinates below, run each path in a different color but keep the dates the same. Draw each path on the map with an arrow showing which direction the debris traveled.

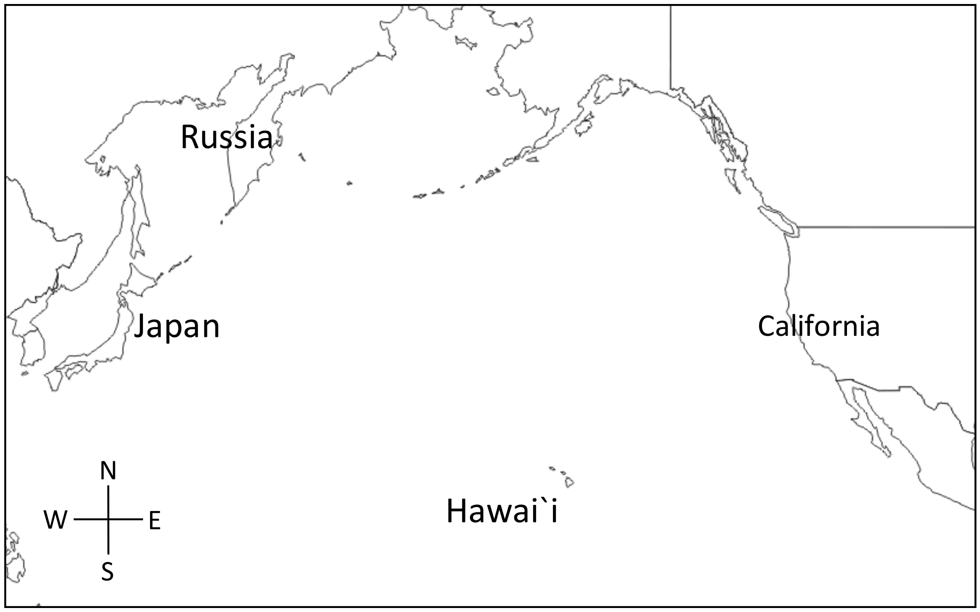
California
35.27°N x 236.32°E

Hawai`i
22.13°N x 199.67°E

Japan
41.77°N x 149.41°E

Russia
53.24°N x 161.70°E

My Point
__________N x __________E



2. How do the model paths compare with the currents in the Pacific Ocean?

3. Now drag the balloon to a location in the ocean where you would like to run a path. Label it My Point and draw the path on your map.

Part 2: Be a marine debris detective: figure out the country and city your object originated from

4. What We Know:

   Item Description:____

   Where Item Found: Latitude:______________________ Longitude:______________________

   Date Item Lost:______________________ Date Item Found:______________________

   Event that made your item into marine debris:______________________________

   The source of the debris was from LAND / SEA. (circle one)

5. What We Need to Find Out:

   Language on Item:______________________ Country of Origin:______________________

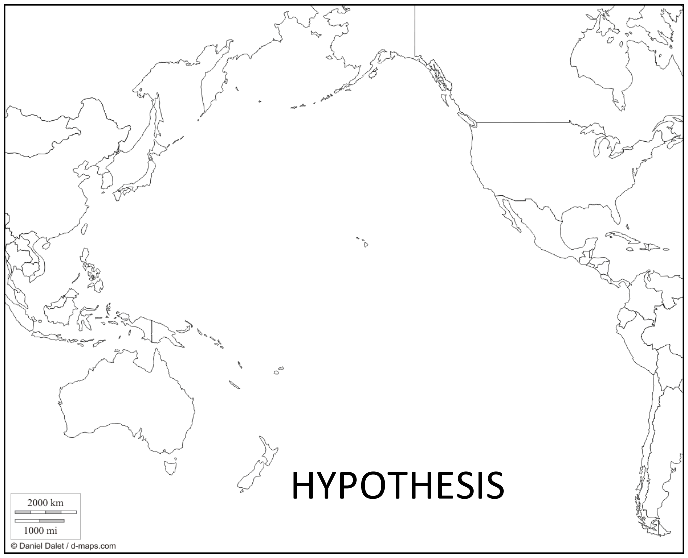
   Possible City 1:______________________ Possible City 2: ______________________

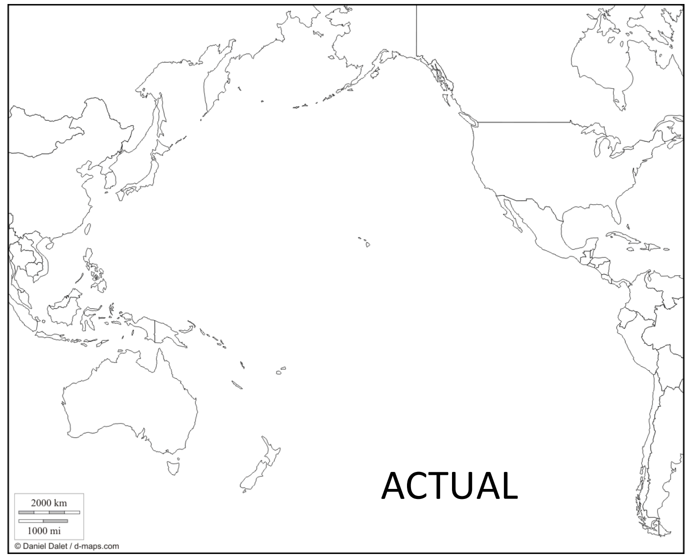
   Possible currents the debris followed:______________________________

6. State the hypothesis you are going to test with the OSCURS model:

Predicting the path

7. On the HYPOTHESIS map below, locate the country in your hypothesis and label it on the map. Draw a small star ☆ on the coast of that country. On that same map, draw a predicted path of your hypothesis above. Begin at the star and end at where your debris was found.





8. Run the OSCURS model based on where you think your item originated from. Record the data you need to enter in the model, below. Click on the final point of your path, do the final coordinates match the place where your item was found? If not, you need to revise your hypothesis and test another set of coordinates from your country of origin.

Time: (date lost) ____________________ to (date found)_________________________

1st attempt: Latitude_________________ Longitude ____________ Did it work?____________

2nd attempt: Latitude________________ Longitude ____________ Did it work?____________

9. Where did your debris originate from? ____

Draw the path your debris followed on the ACTUAL map above.

Which currents were involved? ____

10. Identify a point on the line where you think your item was after one year. Using the scale at the bottom left of your OSCURS map on the computer, estimate how far your debris traveled in 1 year?

11. Marine debris tends to accumulate, or build up, more in the North Pacific Gyre area (on your ocean current map). Why is that?

TEACHER ANSWER KEY to STUDENT WORKSHEET

Lesson 2: Environmental Forensics

Part 1: Learn how to use the OSCURS model

1. Use the OSCURS website to simulate how marine debris traveled between **Jan 01, 2004 to Jan 01, 2009**. For the 4 sets of coordinates below, run each path in a different color but keep the dates the same. Draw each path on the map with an arrow showing which direction the debris traveled.

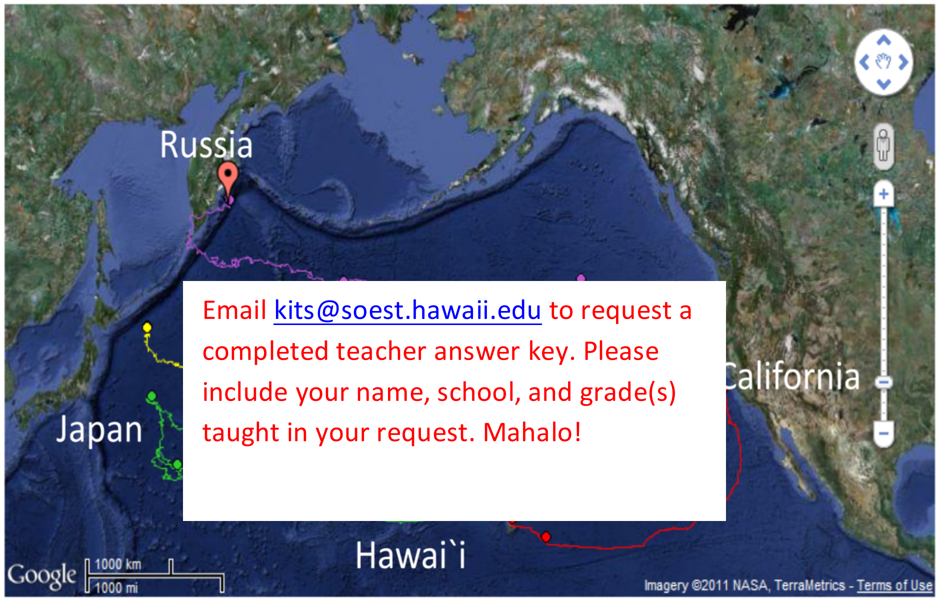
California (in RED)
35.27°N x 236.32°E

Hawai`i (in GREEN)
22.13°N x 199.67°E

Japan (in YELLOW)
41.77°N x 149.41°E

Russia (in PURPLE)
53.24°N x 161.70°E

My Point
___________ N x ___________ E



Email kits@soest.hawaii.edu to request a completed teacher answer key. Please include your name, school, and grade(s) taught in your request. Mahalo!

2. How do the model paths compare with the currents in the Pacific Ocean?

3. Now drag the balloon to a location in the ocean where you would like to run a path. Label it My Point and draw the path on your map.

Part 2: Be a marine debris detective: figure out the country and city your object originated from

4. What We Know:

Item Description:____

Where Item Found: Latitude:________________________ Longitude:____________________

Date Item Lost:_______________________ Date Item Found:_______________________

Event that made your item into marine debris:________________________________

The source of the debris was from LAND / SEA. (circle one)

5. What We Need to Find Out:

Language on Item:_____________________ Country of Origin:_______________________

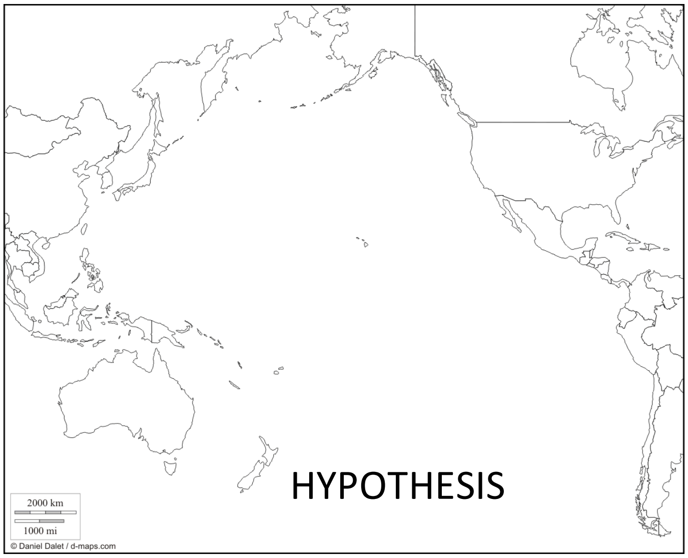
Possible City 1:_______________________ Possible City 2: _______________________

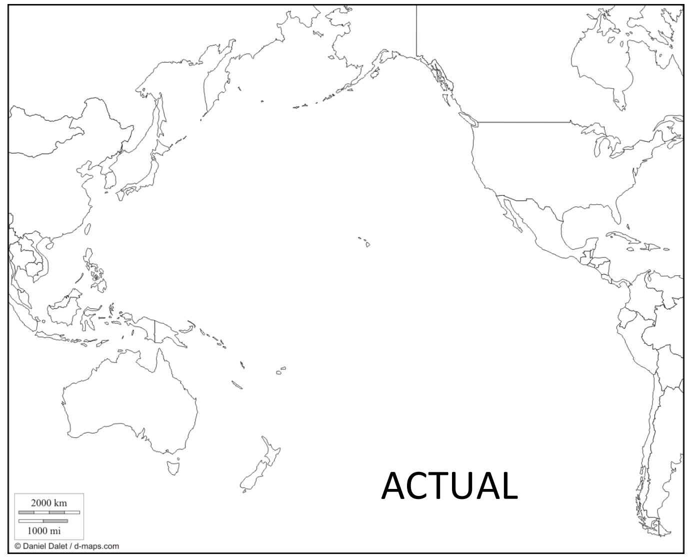
Possible currents the debris followed:_______________________________________

6. State the hypothesis you are going to test with the OSCURS model:

Predicting the path

7. On the HYPOTHESIS map below, locate the country in your hypothesis and label it on the map. Draw a small star ☆ on the coast of that country. On that same map, draw a predicted path of your hypothesis above. Begin at the star and end at where your debris was found.





8. Run the OSCURS model based on where you think your item originated from. Record the data you need to enter in the model, below. Click on the final point of your path, do the final coordinates match the place where your item was found? If not, you need to revise your hypothesis and test another set of coordinates from your country of origin.

Time: (date lost) ____________________ to (date found)________________________

1st attempt: Latitude_________________ Longitude ____________ Did it work?____________

2nd attempt: Latitude________________ Longitude ____________ Did it work?____________

9. Where did your debris originate from?
Draw the path your debris followed on the ACTUAL map above.
Which currents were involved? ____

10. Identify a point on the line where you think your item was after one year. Using the scale at the bottom left of your OSCURS map on the computer, estimate how far your debris traveled in 1 year?

11. Marine debris tends to accumulate, or build up, more in the North Pacific Gyre area (on your ocean current map). Why is that?

Pages 54 – 59 are the answer key for Lesson 2: Environmental Forensics and have been removed from the web version. Email kits@soest.hawaii.edu to request a completed teacher answer key or complete lesson plans including answer key. Please include name, school, and grade(s) taught in your response.

Mahalo!

A fishing vessel encountered a storm on Halloween 2005 and lost many items overboard, including this one.

Found: near Midway Island by a C-MORE research vessel on October 31, 2009

Location: Latitude: 27.3° N Longitude: 190.09° E

1

center for microbial oceanography: research and education
C-MORE linking genomes to biomes

Heavy rains overflowed a river and carried this item straight to the ocean on September 15, 2003.

Found: coast of Oregon on

Date: April 15, 2007 at

Location: Latitude: 42.86° N Longitude: 235.21° E

2

center for microbial oceanography: research and education
C-MORE linking genomes to biomes

A group of friends carelessly allowed this item to wash into the ocean during their picnic on a hot, tropical day at the beach on May 31, 2005.

Found: near Midway Island by a C-MORE research ship

Date: May 31, 2008

Location: Latitude: 33.57° N Longitude: 172.30° E

3

center for microbial oceanography: research and education
C-MORE linking genomes to biomes

A winter storm in the eastern Pacific brought strong winds, causing trash from land to end up in the ocean. This item was blown out to sea on January 1, 2007.

Found: northern coast of the Big Island (Hawaii)

Date: February 7, 2008

Location: Latitude: 20.12° N Longitude: 204.53° E

4

center for microbial oceanography: research and education
C-MORE *linking genomes to biomes*

A cargo ship runs into a storm on U.S. Independence Day, 2003 and loses some containers full of brand new products, including this item.

Found: 800mi. NE of Hawaii by C-MORE ship

Date: September 1, 2008

Location: Latitude: 25.95° N Longitude: 212.02° E.

5

center for microbial oceanography: research and education
C-MORE *linking genomes to biomes*

This piece of trash from a Christmas parade made its way into the ocean on Christmas day, 2004.

Found: northern Philippines

Date: December 25, 2009

Location: Latitude: 19.46° N Longitude: 119.85° E.

6

center for microbial oceanography: research and education
C-MORE *linking genomes to biomes*

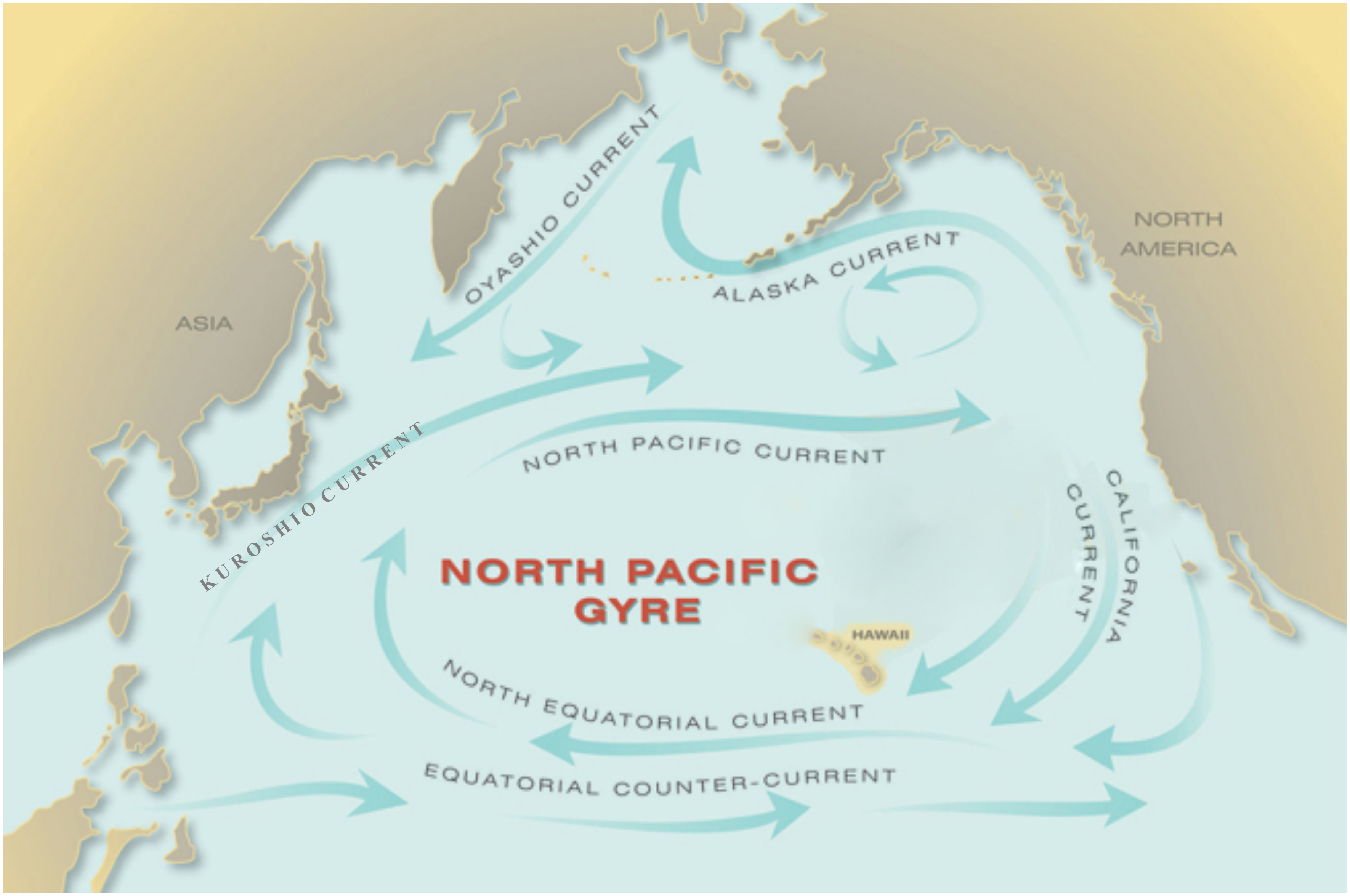
MAP 1: COUNTRIES SURROUNDING THE PACIFIC OCEAN

Lesson 2: Geographical Distribution

Cities noted in Lesson 2 are included on this map.

MAP 2: SURFACE CURRENTS IN THE NORTH PACIFIC OCEAN

Lesson 2: Geographical Distribution



LANGUAGE GUIDE – ENVIRONMENTAL FORENSICS

Lesson 2: Geographical Distribution

To the best of your ability, match the language printed on the marine debris item with the text shown in one of the images below. The country where that language is spoken is listed below the image.

Russia

Philippines

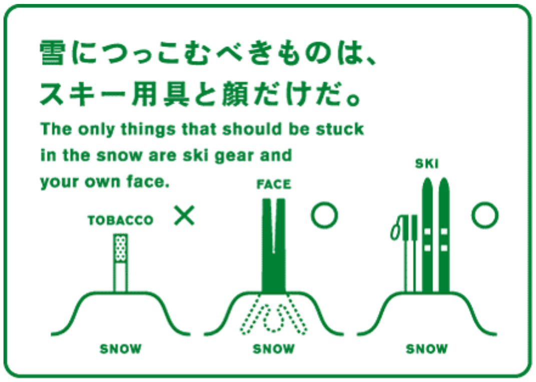
Mexico

Vietnam

China

Hint: Korean characters often include circular shapes and short straight lines!

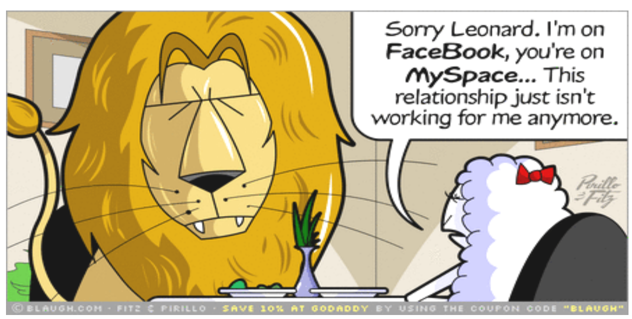
Korea



Japan
(with some English translation)

Hint: Many Japanese characters are simplified, whereas all Chinese characters are pictorial.

***i.e.*, compare the Japanese characters for bread “パン” with the Chinese ones “面包. ”**



United States

TEACHER GUIDE
Lesson 3: Plastics and the Sea

Time Required: 50–60 minutes.

Structure: In this lesson, students watch a video documentary about C-MORE's 2008 research cruise focusing on the impact of plastics on our planet. Plastic production and use are introduced through the presentation of a narrated PowerPoint. In small groups, the students then engage in a discussion/worksheet activity addressing the diverse sizes of plastic debris and the impacts of those different sizes. Finally, students complete the **MARINE DEBRIS SURVEY** as a post-unit survey.

Materials:

1. **TEACHER GUIDE – Lesson 3: Plastics and the Sea**
2. **POWERPOINT SCRIPT – Lesson 3: Plastics and People**
3. **VIDEO WORKSHEET – Lesson 3: SUPER Cruise DVD (in binder)**
4. **TEACHER ANSWER KEY to VIDEO WORKSHEET – Lesson 3: SUPER Cruise DVD**
5. **STUDENT WORKSHEET: MARINE DEBRIS GREAT AND SMALL – Lesson 3: Plastics and the Sea**
6. **TEACHER ANSWER KEY to STUDENT WORKSHEET: MARINE DEBRIS GREAT AND SMALL – Lesson 3: PLASTICS AND THE SEA**
7. **IMAGES – MARINE DEBRIS GREAT AND SMALL (15 sets in Resource Folder)**
8. **MARINE DEBRIS SURVEY**
9. **TEACHER ANSWER KEY to MARINE DEBRIS SURVEY**

} provided in Lesson 1

Materials Not Included in the Kit but Needed for Lesson 3:

10. Computer with PowerPoint software and a CD drive
11. TV or computer with DVD player
12. Projector

Advance Preparation:

1. Ensure that this science kit contains all materials for Lesson 3.
2. Obtain materials that are not included in this kit but are needed for lesson 1 (see above list).
3. Photocopy or print **VIDEO WORKSHEET – Lesson 3: SUPER Cruise DVD** (one per student).
4. Photocopy or print **STUDENT WORKSHEET: MARINE DEBRIS GREAT AND SMALL – Lesson 3: PLASTICS AND THE SEA** (one per student).
5. Photocopy or print the **MARINE DEBRIS SURVEY** (one per student) provided in Lesson 1.
6. Speakers are included in the kit for playing the narrated presentation. Refer to the laminated manual attached to the speaker storage case for set-up instructions.
7. Load the narrated PowerPoint presentation entitled **Lesson 3: Plastics and People – NARRATED** onto your computer by dragging the file from the Marine Debris Science Kit CD onto the desktop. If you prefer to present the information yourself, load the non-narrated version.
8. Eject the CD and return it to the binder.

Instructional Procedures:

1. Video presentation (20–30 minutes)

    Explain to students that part of the solution to the marine debris problem is knowing the extent of marine debris in the ocean. In August 2008, the Center for Microbial Oceanography: Research and Education (C-MORE) sent a team of scientists aboard a research cruise to investigate the North Pacific Gyre and created a video documentary highlighting the trip. Review some of the main points and then have students complete the worksheet.

2. PowerPoint presentation (10 minutes)

   Play narrated version of **Lesson 3 – Plastics and People**. If you prefer to present the information yourself using the non-narrated version of the PowerPoint presentation, a **POWERPOINT SCRIPT** is included as a guide.

3. Small group discussion on plastic sizes (15-20 minutes)
   a. Group students in pairs or small groups.
   b. Pass out one copy of **STUDENT WORKSHEET: MARINE DEBRIS GREAT AND SMALL** to each student.
   c. For each group, pass out a set of **IMAGES – MARINE DEBRIS GREAT AND SMALL**.
   d. Students can either complete worksheet by the end of class or as homework.
   e. Summarize the main points of the discussion gained from lessons 1 & 2
      - Tiny plastics can be ingested by animals (i.e., small fish, birds), transport alien species, and are difficult to clean up
      - Small plastics can be ingested by animals, transport alien species, and are difficult to clean up
      - Medium plastics can be ingested by animals, transport alien species, entangle some animals, cause injury to humans on the beach, looks bad, and have economic impacts.
      - Large plastics can entangle animals and boat props, cause injury to humans on the beach, looks bad, has economic impacts, and provides a large surface for transporting alien species
      - Plastics of all sizes may leach toxic chemicals into the ocean water
      - Large pieces of plastic break down into smaller and smaller pieces over time

Assessment & Clean-up:

1. Pass out the **MARINE DEBRIS SURVEY** (one per student). Have students check the post-survey box and answer the questions (allow 5 minutes). A **TEACHER ANSWER KEY** is provided for your convenience (see Lesson 1).
2. As the students are completing their surveys, we would be grateful if you would complete the **TEACHER EVALUATION** in this kit. All comments, corrections, and suggestions are very welcome. If you prefer, you can complete the evaluation online (http://www.surveymonkey.com/s/CMORE-kit-evaluation).
3. Return all printed materials to the binder or resource folder.
4. Re-pack the kit for return to C-MORE. Double check that all the items are included by completing the **SUPPLY CHECKLIST**. Please make a note of missing, broken, or damaged items so that they can be replaced. Please pack the kit so that the materials are stored as they were when you received them.

References:

International Coastal Cleanup. http://www.oceanconservancy.org/site/PageServer?pagename=icc_home

Pocket Guide to Marine Debris.
http://www.oceanconservancy.org/site/DocServer/Pocket_Guide_English.pdf?docID=3501

Lesson 3: Overview

20-30 minutes	Students watch SUPER – a video documentary by Lucy Marcus about the C-MORE research conducted on the North Pacific Gyre. Students then complete a video worksheet**.** An answer key is provided which includes the time stamp (minutes: seconds) for each answer if you wish to repeat some parts.
5-10 minutes	PowerPoint Presentation: Play narrated version of **Lesson 3 – Plastics and People**
15-20 minutes	Group discussion on plastic sizes. In pairs or small groups, students complete a worksheet after viewing a set of pictures, each showing different sized plastics. They will also discuss how the different-sized plastics impact many different organisms in the ocean in different ways.
5-10 minutes:	Each student completes and turns in the **MARINE DEBRIS SURVEY**, post-unit.

LESSON 3 POWERPOINT SCRIPT

Lesson 3: Plastics and People

Slide 1:
Let's now take a closer look at the relationship between plastics and people. (click)

Slide 2:
Plastics are synthetic or man-made, and most plastic products start off as these tiny pellets. (click) In factories, the pellets are melted and poured into molds where they then cool down and become what we know as hard plastic. Many different plastic products start off in a factory like this. (click) Unfortunately, some these same plastic products end up floating around our oceans or washed up on beaches. (click)

Slide 3:
Interestingly, plastic marine debris was never really abundant up until recently. So where did all of this trash come from? Ecologically speaking, plastic is a relatively new player in the system. The first commercial plastic product was created in 1862, and was used to make a variety of products such as combs, knife handles, and plaques. (click)
Since then, the production and diversity of plastics has grown (click) and grown (click). (click) Now, almost everything we use has a plastic component (click).

Slide 4:
Companies have now found ways to make plastic more durable than before. Newer products are advertised as (click) "heavy duty" or "super strong" to convince consumers that they will not break apart so easily. What potential danger does this pose if these items make their way into the ocean? Extra heavy duty on land also means extra heavy duty in water. (click)

Slide 5:
Because disposable products are cheap and convenient, there has been a steady increase in our production of plastic products and plastic trash. This chart compares how much plastic waste is generated to how much we actually end up recycling. (click)

The red line on the graph shows how much plastic is thrown away. However, (click) notice how little actually gets recycled and reused. The red line shows how the amount of plastic trash thrown away has been increasing since 1960. In 2009, 30 million tons of plastics were just thrown away, equivalent to about 300,000 whales!

Because we recycle and reuse so little of what we have produced, the vast majority of all the plastic that has ever been made is probably still existing in the environment! (click)

Slide 6:
Why did the amount of plastic trash increase? During the 1950's, popular media articles reported that disposable products would save us time. This picture is from an article in LIFE Magazine, suggesting that housewives would be more efficient if they didn't have to wash and put away dishes. This quickly led to the mentality that waste saves time. (click)

Slide 7:
Not only are we producing more plastic, the supply of plastic is also growing to accommodate our ever-growing population, which is expected to reach 9 billion people by 2040. More people means more natural resources are required to support all those people. (click)

Slide 8:
Remember these tiny resin pellets? One of the main ingredients in making these pellets is crude oil (click). As the price of crude oil rises, the cost of things like (click) gasoline for our cars also rises. Since plastic products require crude oil in the production phase, the price for plastic products also increases. (click)

Slide 9:
Although oil *is* expensive, the real culprit is consumption. The United States only makes up 4.5% of the total world population, but we consume 24% (click) of all the oil that is being produced on the planet! (click) That's the same amount as the total consumption of all 32 countries that make up Europe and Eurasia, combined! Consider this: if everyone on Earth consumed as much as America, we would need FOUR planet Earths to support ourselves. (click)

Slide 10:
Let's take plastic bags as an example. Every year, (click) we use 1.2 trillion bags worldwide.
(click) This translates into more than 1 million bags used per minute. The next time you see plastic bags at a grocery store, consider that a plastic bag is only used for an average of (click) 12 minutes before it is thrown away. What happens after their 12 minutes of use? (click)

A handful of these bags end up in the stomachs of sea turtles, every species of which is listed as threatened or endangered. (click)

Slide 11:
But there are economic costs as well. (click)
We use 12 million barrels of oil to make plastic bags for the U.S. each year. (click) If oil is ~$100/barrel, then it costs $1.2 billion/year for fuel for plastic bags alone. In addition, even the cleanup of plastic costs money. Before taking action on plastic bag use, San Francisco (click) spent $8.5 million each year just to clean up plastic bags. Does it seem worth it?

Luckily, San Francisco started a movement to ban plastic bags that has now spread to Boston, Portland, OR, Phoenix, and other cities in the United States. Internationally, Ireland, China, Bangladesh, Rwanda and Australia have been leaders in passing nationwide bans or taxes on free, single-use plastic bags. (click)

Slide 13:
In Hawaii, two islands have already taken measures to ban plastic bags to prevent them from entering our ocean. Do you know which islands? (click) Maui and Kauai began enforcing a plastic bag ban in 2011. Imagine if you went to your local supermarket and saw no plastic bags to carry your groceries home. Bans greatly impact society, but marine debris is such a widespread problem that it will take all of our efforts to make a noticeable difference. (click)

Slide 14:
Movements such as a plastic bag bans aim to reduce marine debris on a larger scale. But now, we're going to consider what happens to some other everyday plastic products that get lost or abandoned in the ocean over time. Much of the plastic debris in the ocean were once household items probably familiar to us. Since they break down into smaller and smaller pieces, plastic marine debris can range in size from a microscopic fragment to a refrigerator. Can you recognize anything in this picture? Perhaps some of this came from tossing a plastic bottle on the beach, or maybe even losing a plastic bag in strong winds. (click)

Consider the dangers of tiny plastics ingested by seabirds and other larval fish. How about the ropes entangling a marine mammal? Or perhaps a floating buoy transporting alien species to a new territory? While life in our ocean continues to battle for survival, all of these hazardous plastic items originated from people. It is *our* responsibility to be more aware of our daily actions.

Name:____________________________________ Period:_______________

VIDEO WORKSHEET
Lesson 3: SUPER Cruise DVD

1. What was the path taken by the C-MORE ship and which ocean did it cross?

2. What did the scientists want to find out on this cruise?

3. Name at least 2 positive things marine microbes do for our planet?

4. How do scientists collect and study plankton and tiny plastics?

5. Why might microbes be important in the clean up plastics?

6. How do plastic pieces provide a new, unintentional, habitat for marine organisms?

7. What happens to big pieces of plastic in the ocean?

8. Why are the really tiny pieces of plastic dangerous to animals?

9. What do freshwater streams and rivers have to do with marine debris?

10. What kinds of things can you do to make a positive impact?

TEACHER ANSWER KEY to VIDEO WORKSHEET

Lesson 3: SUPER Cruise DVD

Email kits@soest.hawaii.edu to request a completed teacher answer key. Please include your name, school, and grade(s) taught in your request. Mahalo!

1. What was the path taken by the C-MORE ship and which ocean did it cross?

2. What did the scientists want to find out on this cruise?

3. Name at least 2 positive things marine microbes do for our planet?

4. How do scientists collect and study plankton and tiny plastics?

5. Why might microbes be important in the clean-up of plastics?

6. How do plastic pieces provide a new, unintentional, habitat for marine organisms?

7. What happens to big pieces of plastic in the ocean?

8. Why are the really tiny pieces of plastic dangerous to animals?

9. What do freshwater streams and rivers have to do with marine debris?

10. What kinds of things can you do to make a positive impact?

Name:____________________________________ Period:______________

STUDENT WORKSHEET: MARINE DEBRIS GREAT AND SMALL

Lesson 3: Plastics and the Sea

1. What were the first things you noticed about the photos? (What colors? How big were they? Estimated #?)

2. Classify the photos into different categories based on size. Give each category a name and size range.

   A: _____________________________ B: _____________________________

   C: _____________________________ D: _____________________________

3. Which size category do you think has been in the ocean the longest? Why?

4. From your labeled categories above, discuss which one you think poses the greatest danger to the marine environment. Think about all that you know about marine debris (i.e., entanglement, ingestion, toxins, transport of invasive species, injury, economic costs).

   Our group selected the category: __________________________________

   Why did you choose this?

   What were some good arguments to support the other categories?

   Is any *one* category really *right* or *wrong*? Why?

5. Can you identify anything you see in the category you chose (if they're broken fragments, what kind of objects do you think they came from)? List them below.

   1.) ____________________________ 4.) ____________________________

   2.) ____________________________ 5.) ____________________________

   3.) ____________________________ 6.) ____________________________

6. Think of 3 items you use daily that have the greatest chance of becoming marine debris? What makes you think that? List and support your choices below.

Item	**Reason**
1.) __________________	____
2.) __________________	____
3.) __________________	____

7. Marine debris is a global problem, and there are billions of people living on our planet. What kinds of small changes can you make in your everyday life to prevent and reduce marine debris?

 Name:____________________________________ Period:_______________

TEACHER ANSWER KEY: MARINE DEBRIS GREAT AND SMALL

Lesson 3: Plastics and the Sea

Email kits@soest.hawaii.edu to request a completed teacher answer key. Please include your name, school, and grade(s) taught in your request. Mahalo!

1. What were the first things you noticed about the photos? (What colors? How big were they? Estimated #?)

2. Classify the photos into different categories based on size. Give each category a name and size range.

   A: _____________________________ B: _____________________________

   C: _____________________________ D: _____________________________

3. Which size category do you think has been in the ocean the longest? Why?

4. From your labeled categories above, discuss which one you think poses the greatest danger to the marine environment. Think about everything you've learned about marine debris so far (i.e., entanglement, ingestion, toxins, transport of invasive species).

   Our group selected the category: __________________________________

   Why did you choose this?

   What were some good arguments to support the other categories?

   Is any *one* category really *right* or *wrong*? Why?

5. Can you identify anything you see in the category you chose (if they're broken fragments, what kind of objects do you think they came from)? List them below.

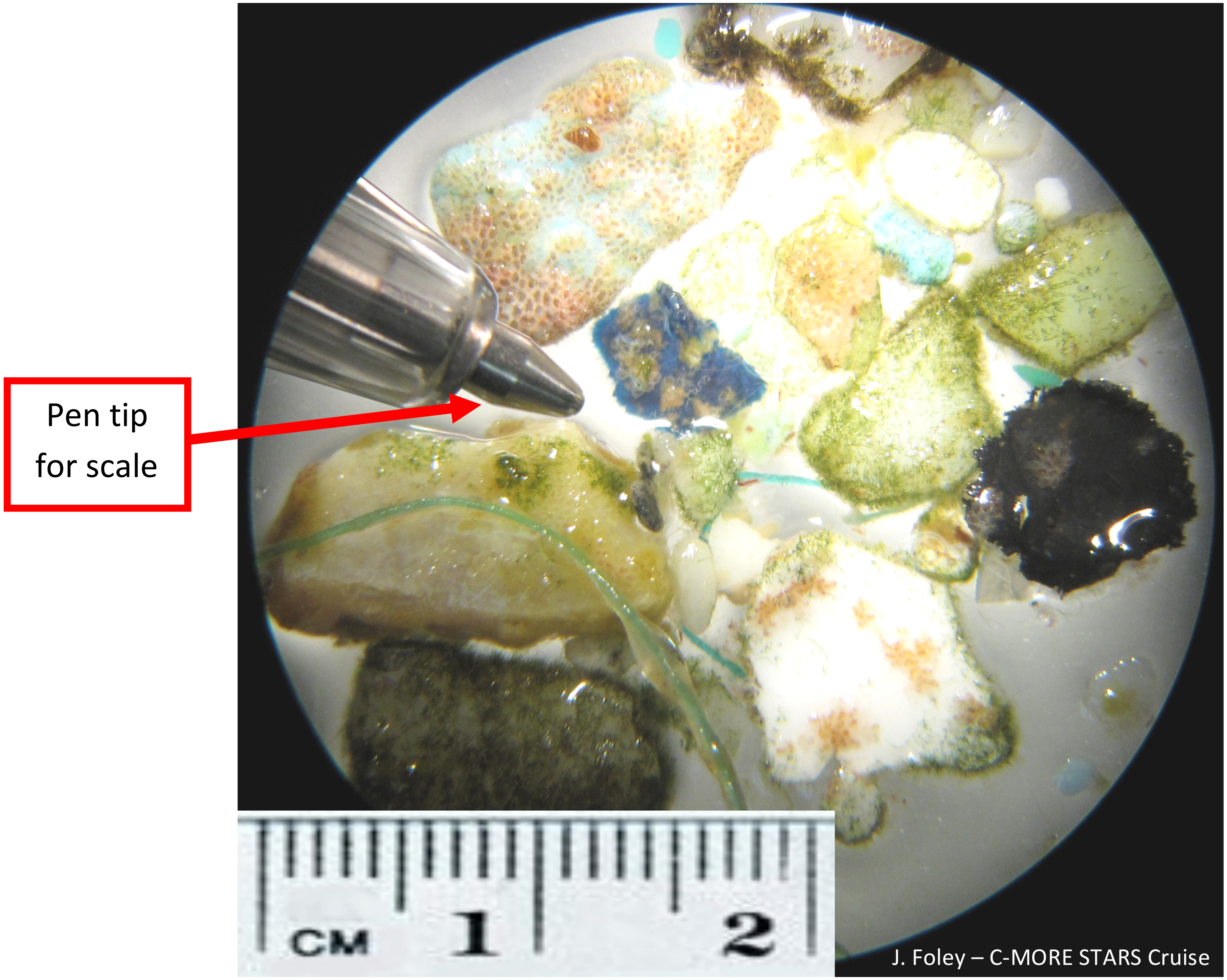
6. Think of 3 items you use daily that have the greatest chance of becoming marine debris? What makes you think that? List and support your choices below.

7. Marine debris is a global problem, and there are billions of people living on our planet. What kinds of small changes can you make in your everyday life to prevent and reduce marine debris?

A

Penny for scale

B



IMAGES – MARINE DEBRIS GREAT AND SMALL

Lesson 3: Plastics and the Sea

D


Marine debris is everyone's problem.
R. Kagami – C-MORE


R. Kagami – C-MORE


J. Milisen NOAA PIFSC

Extension Activities

Lesson 1 EXTENSIONS: Biological Impacts

Albatross Bolus Dissection (for Lesson 1, Station 6)
A more extensive bolus dissection worksheet is included on the next page. In contrast to the present/absent checklist style, students manually count and tally the items they encounter while investigating the dissected bolus at **Station 6, Albatross Bolus Dissection**. They then analyze and interpret their data similar to the version in the **STUDENT WORKSHEET – Lesson 1: Biological Impacts**. Since this worksheet uses quantitative data, students can also analyze percentages to make more detailed comparisons. Keep in mind there are only 2 boluses for dissection in the kit, so plan accordingly as this worksheet takes more time to complete.

Biological Impacts Skit

a. Explain to students that they will perform a skit in groups of 3–5 demonstrating how an ordinary product eventually becomes marine debris, and how that debris item might affect marine animals. They will pick one item from around the classroom and share a story of how it became marine debris. Students can play whichever role they choose, as long as there is a
   - Manufacturer or distributor of the product (i.e., supermarket giving out plastic bags)
   - Source of entry into the ocean (i.e., trash on the road eventually taking the sewer to the sea)
   - Animal(s) involved (turtle entangled and cannot hunt for food)

b. Students can use props or arts/crafts available in the classroom

c. After each group performs in front of the class, have the class audience suggest ways to change parts of the story so the final outcome is not an entangled animal.

STUDENT WORKSHEET – ALBATROSS BOLUS ACTIVITY

Lesson 1: Biological Impacts

Name: ______________________________

Period: ______________________________

Driving question: How much of the bolus consists of plastic items?	
Investigators:	
Hypothesis:	
NATURAL PREY ITEMS	NUMBER
Squid beaks	a)
NON-NATURAL PREY ITEMS	NUMBER
Whole plastic items (such as toothbrushes, lighters, etc.)	b)
Plastic fragments (such as wrappers, film, Styrofoam, etc.)	c)
Wood or other vegetation	d)
Pieces of rope	e)
Metal	f)
Rocks/pumice	g)
FISHING LINE - CIRCLE ONE OF THE FOLLOWING:	
Absent / Present in low abundance / Makes up ~1/2 of the bolus contents / Makes up most of the bolus contents	
	TOTAL NUMBER
Subtotal of natural prey items (a)	
Subtotal of plastic items (b+c)	
GRAND TOTAL of contents (sum of a through g)	

DATA ANALYSIS:
What percentage of the total bolus items consist of natural prey items? ___________
What percentage of the total bolus items consist of plastic? ____________

DATA INTERPRETATION: Of the items that you found in the bolus, which would you predict takes the longest to degrade?

CONCLUSION: Compare your data with your hypothesis. Do your data generally support your hypothesis?

Lesson 2 EXTENSIONS: Geographical Distribution

Additional Marine Debris Tracking using OSCURS

a. On March 11, 2011 a devastating earthquake and tsunami struck Japan washing entire towns into the sea. Have your students use OSCURS to predict where the debris is today.
b. Have your students conduct some background research on the tsunami as well as find locations to use as a starting location.
c. Data to enter into OSCURS:
   Starting Date: Mar 11, 2011 Ending Date: Today
   Location: Off east coast of Japan (around 38°N x 142°E)
d. Have students try different starting locations around the impacted area to see how the trajectory changes.
e. Have the students vary the Wind Current Speed Coefficient (range 1-2) under Optional Parameters to see how the size of the object can change the trajectory.
f. Researchers at the University of Hawai'i used a different model to predict where the debris would travel http://iprc.soest.hawaii.edu/news/press_releases/2011/maximenko_tsunami_debris.pdf and http://www.hawaii.edu/newsatuh/2011/04/tsunami-debris. How do the results of the OSCURS model compare with the UH model?
g. Discuss the tsunami and its lasting impacts.

Simulating ocean currents

a. This lesson will help students understand how the ocean currents move in a circular motion, and how those currents form a gyre. A tray or pan is set up, filled with water and floating "debris" (grass or anything that floats).
b. Students work in pairs and blow through straws over the water's surface in opposite and parallel directions to create a gyre effect in the middle of the tray or pan.
c. Have students reflect on what happened to the grass after they both blew (created wind) in opposite directions.
d. For additional instruction, introduce land masses (i.e., rocks) in the pan and have students hypothesize what the grass might do differently when they blow on the surface again.

Lesson 3 EXTENSIONS: Plastics and the Sea

Plastic products: Are they worth it?

a. Pass out one copy of **STUDENT WORKSHEET – Plastic Products: Are They Worth It?** to each student. A teacher answer key is not provided because there are no correct answers (this is an opinion survey).
b. Call upon students to name an item on the list that they think is a good use of plastic, why they think it is, and if they could think of an alternative material to use to make the item. Also have students share an item on the list that they think is a bad use of plastic, why they think it is, and if they could think of an alternative material to use to make the item.

Brainstorming solutions

a. Summarize some of what's been learned over the past few days about the problem of marine debris.
    - It harms wildlife in many ways.
    - Plastic is a durable chemical that takes a long time to break down in the marine environment.
    - There's been an increase over time in the amount of plastic and in numbers of plastic users.
    - Ocean currents distribute marine debris far from their source.
    - Many products are now made out of plastics, when they weren't before.
b. Now that we know there's a problem and we know some of the impacts, let's move forward. Knowing that a problem exists is the first step to solving that problem! In separate areas, write these four categories on the board:
    - government (*e.g.*, city, county, state, federal, international)
    - business (*e.g.*, fishermen, grocery stores)
    - scientific research (*e.g.*, oceanographers, microbiologists)
    - citizens (all of us! – through our schools, daily lives, clubs)

    Have the class brainstorm ideas about how different parts of society could work toward a solution. You may wish to use one of the following brainstorming methods:
    - Method #1 – Ask students to share their ideas. Give positive feedback and excitement. Help the students clarify their ideas, and write their ideas on the board under the appropriate category.
    - Method #2 – If students are having a hard time thinking of possible solutions, tell them that it *is* hard! This is a real environmental problem, and world leaders are having a hard time coming to grips with it, so of course students will too. Use the **SOLUTION CARDS** to help generate some ideas. Here are some ways of using the **SOLUTION CARDS:**
        - Keep the **SOLUTION CARDS** in your own hand, and use them to give hints to students to come up with their own ideas.
        - Shuffle the **SOLUTION CARDS** and randomly give them out to students. Let them ponder the idea on their card, and then ask students to raise their hands to share ideas.
        - Organize students into groups of four and hand out one set of **SOLUTION CARDS** to each group. Have each student take a card and read and discuss their card with their group.
c. Although this brainstorming session could go on longer, try to restrict this portion of the lesson to less than ten minutes. The goal is to have students understand that while the marine debris problem is huge, it is being addressed and can be solved.

Political action

a. You may decide as a class to take political action to express your concern about the issue of marine debris. One important way to take such action is to communicate directly with government officials.
b. Find out the name and address of the government official you'd like to contact by going to the "Contact Elected Officials" website of the US government, http://www.usa.gov/Contact/Elected.shtml, which has both federal and state links.
c. Hand out one index card to each student.
d. Explain that their assignment is to write a short message to a government official you have selected. Each student's message should explain what marine debris is, one way in which it is a problem, and one solution to the problem.
e. Tell the students that their cards will be graded.

Name: ____________________________ Period: ______________________

STUDENT WORKSHEET – Plastic Products: Are They Worth It?
Lesson 3: Plastics and the Sea

Ever since plastics were invented, they've been used in more and more products. The purpose of this survey is to think about how plastic is used. For each item below, check if you think it's a good or bad use of plastic, then name an alternative material that could be used to make that product.

PLASTIC PRODUCT	GOOD	BAD	ALTERNATIVE MATERIAL
1. Contact lens			
2. Velcro ®			
3. Toothbrush			
4. Grocery bag			
5. Chapstick® tube			
6. Food wrap			
7. Silly Putty ®			
8. Child car seat			
9. Water bottle			
10. Surfboard			
11. Mylar ® balloon			
12. Measuring cup			
13. Band-aid ®			
14. "Rubber" slippers			
15. Six-pack ring			
16. Compact disc (CD)			
17. Drinking straw			
18. Styrofoam cup			
19. Disposable utensils			
20. Pen			
21. Ziploc bag			
22. Pencil case			
23. Computer			
24. Ruler			

GLOSSARY

albatross — A large seabird that has webbed feet and long slender wings. Albatrosses are excellent gliders

alien species — A foreign species introduced to a new area. Alien species often negatively affect the new area, either economically or environmentally

benthic — Relating to the bottom of a sea or lake or to the organisms that live there

biodegradable — Capable of being broken down by living things (such as **microorganisms**); able to decay or rot

biodiversity — Various species of plants and animals in an environment

bolus — (bowl-us); A mass of indigestible items thrown up by an animal

carcinogen — A substance that causes cancer

decompose — To break down, decay or rot

dissection — To expose and separate parts of an animal for examination

distribute — To spread out

ecosystem — A complex community of organisms and its interaction with their environment

entangle — To wrap or twist together, to become knotted

fledge — The life stage when a young bird can first fly away from its nest

fouling	The attachment of plants, animals, and microorganisms to hard objects in the ocean or other (biofouling) bodies of water
hydrophobic organic toxins	Poisonous carbon-containing compounds that don't mix with water
indigenous	Originating from a particular region or area. Example: The ohiʻa tree is indigenous to Hawaiʻi
leaching	To dissolve out by the action of a percolating liquid
manatee	(man-uh-tee); A large marine mammal about the size of a seal or sea lion, sometimes known as a sea cow
marine debris	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
microorganism	A living thing that is too small to be seen by the naked human eye.
necropsy	An autopsy performed on an animal
OSCURS	**O**cean **S**urface **CUR**rent **S**imulator; an ocean circulation computer model.
PCBs (polychlorinated biphenyls)	A class of organic compounds that are toxic and have been classified as a persistent organic pollutant
persistent organic pollutants	Chemical substances that persist in the environment, build up and transfer through the food web, and pose a risk of causing negative effects to human health and the environment.
pumice	A porous or spongy form of volcanic glass, used as an abrasive

TEACHER EVALUATION

http://www.surveymonkey.com/s/CMORE-kit-evaluation

1. Please circle the C-MORE science kit used:

   Marine Debris **Ocean Acidification** **Plankton**

   Marine Mystery **Ocean Conveyor Belt** **Random Sampling**

   Nautical Knots and Maritime Careers

2. I borrowed this science kit from_____________________________________.

3. Please rate how strongly you agree or disagree with each of the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Online kit reservation was easy.	1	2	3	4	5
Picking up this science kit was difficult.	1	2	3	4	5
This science kit was easy to use.	1	2	3	4	5
The Teacher Guide was difficult to follow.	1	2	3	4	5
My students enjoyed using this science kit.	1	2	3	4	5
I would not borrow this science kit in the future.	1	2	3	4	5
I will borrow other C-MORE science kits.	1	2	3	4	5

   Comments:

4. Are the time estimates given for each lesson reasonable? If not, please explain.

5. How did you use this science kit? (Example: in a 6th grade public school classroom to introduce a unit on…)

6. Did you use the entire science kit? If you omitted any lessons or activities, please list which ones and explain why you skipped them.

7. Were your students involved and interested in the science kit activities?

8. Please suggest two things that could be improved.

9. Any other comments?

10. Please tell us about your students. As we are committed to serving underrepresented populations, please estimate the number of your students in the following categories:

School (optional): ___________________________

___ **Total number of students**

___ African American
___ Filipino
___ Hispanic
___ Native American
___ Native Hawaiian or Pacific Islander
___ Other (please specify)

Grade(s) kit was used with:________________

___ Learning disabled
___ Eligible for free or reduced lunch
___ Neither parent attended college
___ Physically disabled

11. Please fill out the following information if you would like to be notified of other C-MORE programs (workshops, GEMS grants, teachers aboard research ships, etc).

Name_______________________________

City/Town____________________________

State________________________________

Zip_______

Email Address________________________

Thank you for your feedback.

SUPPLY CHECKLIST

Marine Debris

Use the boxes to check off each item as you reassemble this kit.

Note: This checklist is three pages.

Contents of Binder:

- ☐ Front pocket
    - ☐ CD (contains *Albatross Necropsy* Video, PowerPoints, and electronic versions of everything in binder)
    - ☐ DVD – SUPER cruise by Lucy Marcus
    - ☐ C-MORE *Key Concepts in Microbial Oceanography brochure*
    - ☐ C-MORE *Microbial Oceanography : Resources for Teachers brochure*
- ☐ Front Materials
    - ☐ **Marine Debris** (provides a general overview & standards addressed)
- ☐ Lesson 1 Tab
    - ☐ **TEACHER GUIDE – Lesson 1: Biological Impacts**
    - ☐ **MARINE DEBRIS SURVEY**
    - ☐ **TEACHER ANSWER KEY to MARINE DEBRIS SURVEY**
    - ☐ **POWERPOINT SCRIPT – Lesson 1: Trash Talk: Biological Impacts of Marine Debris**
    - ☐ **STUDENT WORKSHEET – Lesson 1: Biological Impacts (2 pages front/back)**
    - ☐ **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 1: Biological Impacts**

    Station 1
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 1 Site for Attachment**
    - ☐ **INSTRUCTIONS – Attachment Activity**
    - ☐ **ARTICLE – *Marine Debris Gives Alien Species a Ride***

    Station 2
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 2 Entanglement**
    - ☐ **INSTRUCTIONS – Entanglement Activity**

    Station 3
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 3 Entangled Animals**
    - ☐ **IMAGES – Entangled Animals**

    Station 4
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 4 Toxic Diet?**
    - ☐ **ARTICLE – *Do Plastics Degrade in the Ocean?***
    - ☐ **ARTICLE – *Are Plastics Toxic in the Ocean?***

    Station 5
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 5 Albatross Necropsy Video**

    Station 6
    - ☐ **PLACARD – Marine Debris Lesson 1, Station 6 Albatross Bolus Dissection**
    - ☐ **INSTRUCTIONS – Albatross Bolus Dissection**
- ☐ Lesson 2 Tab
    - ☐ **TEACHER GUIDE – Lesson 2: Geographical Distribution**
    - ☐ **POWERPOINT SCRIPT – Lesson 2: Carried Away! – Physical Dispersal of Marine Debris**
    - ☐ **POWERPOINT NOTES – Lesson 2: OSCURS Intro**
    - ☐ **INSTRUCTIONS for STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
    - ☐ **STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
    - ☐ **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 2: Environmental Forensics**
    - ☐ **MAP 1: Countries Surrounding the Pacific Ocean**
    - ☐ **MAP 2: Surface Currents in the North Pacific Ocean**
    - ☐ **LANGUAGE GUIDE – Lesson 2: Environmental Forensics**
- ☐ Lesson 3 Tab
    - ☐ **TEACHER GUIDE – Lesson 3: Plastics and the Sea**

- ☐ **POWERPOINT SCRIPT – Lesson 3: Plastics and People**
- ☐ **STUDENT WORKSHEET – Lesson 3: VIDEO WORKSHEET – SUPER Cruise DVD**
- ☐ **TEACHER ANSWER KEY to STUDENT WORKSHEET to Lesson 3: VIDEO WORKSHEET – SUPER Cruise DVD**
- ☐ **STUDENT WORKSHEET – Lesson 3: PLASTICS AND THE SEA**
- ☐ **TEACHER ANSWER KEY to STUDENT WORKSHEET – Lesson 3: PLASTICS AND THE SEA**
- ☐ **IMAGES – CLASS DISCUSSION ON PLASTIC SIZES**

☐ Extensions Tab
- ☐ Lesson 1 EXTENSIONS: Biological Impacts
- ☐ **STUDENT WORKSHEET – Lesson 1: ALBATROSS BOLUS ACTIVITY**
- ☐ Lesson 2 EXTENSIONS: Geographical Distribution
- ☐ Lesson 3 EXTENSIONS: Plastics and the Sea
- ☐ **STUDENT WORKSHEET – Lesson 3: Plastic Products: Are They Worth It?**
- ☐ Color-coded **MARINE DEBRIS SOLUTION CARDS** for various sectors of society (science, citizens, business, and government) (18)

☐ Glossary Tab
- ☐ **GLOSSARY**

☐ Teacher Evaluation Tab
- ☐ <u>Completed</u> **TEACHER EVALUATION**

☐ Supply Checklist Tab
- ☐ <u>Completed</u> **SUPPLY CHECKLIST**

<u>Contents of Resource Folder:</u>

☐ Lesson 1, Station 1 Tab

60. **PLACARD – Marine Debris Lesson 1, Station 1 Site for Attachment (2)**
61. **INSTRUCTIONS – Attachment Activity (2)**
62. **ARTICLE – *Marine Debris Gives Alien Species a Ride*. (4)**

☐ Lesson 1, Station 2 Tab
- ☐ **PLACARD – Marine Debris Lesson 1, Station 2 Entanglement (2)**
- ☐ **INSTRUCTIONS – Entanglement Activity (2)**

☐ Lesson 1, Station 3 Tab
- ☐ **PLACARD – Marine Debris Lesson 1, Station 3 Entangled Animals (2)**
- ☐ **IMAGES – Entangled Animals (2 sets)**

☐ Lesson 1, Station 4 Tab
- ☐ **PLACARD – Marine Debris Lesson 1, Station 4 Toxic Diet? (2)**
- ☐ **ARTICLE – *Do Plastics Degrade in the Ocean?* (4)**
- ☐ **ARTICLE – *Are Plastics Toxic in the Ocean?* (4)**

☐ Lesson 1, Station 5 Tab
- ☐ **PLACARD – Marine Debris Lesson 1, Station 5 Albatross Necropsy Video (2)**

☐ Lesson 1, Station 6 Tab
- ☐ **PLACARD – Marine Debris Lesson 1, Station 6 Albatross Bolus Dissection(2)**
- ☐ **INSTRUCTIONS – Albatross Bolus Dissection (2)**

☐ Lesson 2, Instructions Tab
- ☐ **INSTRUCTIONS for STUDENT WORKSHEET – Lesson 2: Environmental Forensics (15)**

☐ Lesson 2, Map 1 Tab
- ☐ **MAP 1: Countries Surrounding the Pacific Ocean (15)**

☐ Lesson 2, Map 2 Tab
- ☐ **MAP -2: Surface Currents in the North Pacific Ocean (15)**

☐ Lesson 2, Language Guide Tab
- ☐ **LANGUAGE GUIDE – Lesson 2: Environmental Forensics (6)**

☐ Lesson 3 Tab
- ☐ **IMAGES – CLASS DISCUSSION ON PLASTIC SIZES (15)**

Lesson 1, Station 1 Box:

- ☐ Pieces of debris with biofouling (6)
- ☐ Magnifying lenses (4)

Lesson 1, Stations 2 and 6 Box:

- ☐ Timer
- ☐ Rubber bands (10)
- ☐ Sorted albatross bolus in resin and jars (2)
  Note: One sorted bolus consists of 1 resin block and 1 jar containing plastic found in bolus (match ID numbers).
- ☐ Dissected albatross boluses (2)
- ☐ Forceps (6)
- ☐ Petri dishes (4)

Lesson 2 Box:

- ☐ Pieces debris with clue cards (6)

Other Supplies:

- ☐ Intact bolus encased in resin (2)
- ☐ Speakers
- ☐ Medium Nitrile gloves – 1 bag
- ☐ Large Nitrile gloves – 1 bag