Grade Level

- 6-8, with options for 9-12

Timeframe

- Two 45-minute class periods

Materials

- Student worksheets
- Color printouts of bolus photographs OR ability for students to work at computer screens or with projections of the photographs
- Lesson 2 Presentation

Key Words

- Bolus
- Gyre
- Marine debris
- Plastic pollution

WINGED AMBASSADORS

OCEAN LITERACY THROUGH THE EYES OF ALBATROSS

Lesson 4: Bolus Analysis

Activity Summary

Prior to leaving the nest, albatross chicks regurgitate a mass of indigestible material called a bolus. Boluses give us clues as to the types of food and trash eaten by albatross parents at sea. In this lesson, students will use professional photographs of boluses, donated by David Liittschwager, to perform a "virtual dissection" and analysis. They will compare the amounts of prey and non-prey items found in several boluses. They will consider the sources of these non-prey materials and create a model of a bolus, with which they can educate others.

Learning Objectives

Students will be able to:

- Explain that prior to fledging, albatross chicks regurgitate a mass of indigestible material called a bolus.
- This bolus provides a record of the items ingested by chicks.
- Note that nearly all albatross boluses include plastics.
- Calculate the percentage of prey and non-prey items found in boluses.
- Define the term "marine debris" and indicate its sources.
- Create a model of a bolus.

Outline

Engage – Albatross Chicks
Explore – Albatross Boluses
Explain – Class Data Comparisons
Elaborate – Marine Debris
Evaluate – Model Albatross Boluses

Background Information

Raising a chick is a very energy-intensive process for seabird parents. Adult albatross meet on breeding islands in the Northwestern Hawaiian Islands in late summer and fall. During that time, they engage in elaborate mating dances, and then they mate and produce an egg. Albatross pairs often mate for life. In a simple nest on the ground, the parents take turns incubating the egg for about two months, until the chick hatches. The chick remains on or near the nest for five to six months, depending on its parents to provide food from the ocean. The parents have been tracked flying thousands of miles in a matter of days to forage in productive ocean waters for food items like squid, fish eggs, and small fish near the sea surface. The parents produce energy-rich oil from their food, which they deliver in their stomach and regurgitate into the mouth of their chick back at the nest.

Back at the nest, chicks go from fluffy, soft plumage to more adult-like waterproof feathers. When the wind blows, they extend their long wings to exercise their breast muscles. By early summer, they are ready to go to sea for the first time, where they will remain for at least four years before returning to the colony to begin forming pair bonds. In preparation for leaving the nest (called fledging), chicks regurgitate a mass of undigested material collected in their stomach called a **bolus**. Boluses provide a record of the items ingested by the chick, including squid beaks, pumice, and fish bones that came from parents' foraging trips at sea.

Other animals have also evolved similar mechanisms to remove indigestible items from their stomachs. Owl pellets and cat fur balls are familiar examples. Unfortunately, nearly all boluses from Hawaiian albatrosses also include human-made trash such as fishing line and plastics. These floating items concentrate alongside albatross food items, and are scooped up and unintentionally fed to the chicks.

Ingesting trash can harm animals. In particular, scientists are beginning to learn more about how eating plastic can prevent healthy digestion, cause dehydration and increase pollutants in the animal's body. Seabird boluses are dissected to learn what they are eating and to study if the amount of plastic trash is increasing in the ocean. For this reason, albatross and other seabirds are ideal sentinels or bio-indicators of the health of the ocean because they travel across the ocean and sample marine debris along their journeys. By tracking their movements and dissecting their boluses, scientists are learning about albatross plastic ingestion.

What is a Gyre?

The albatross your students are studying inhabit the North Pacific. Their movements and foraging behavior are greatly influenced by the patterns of wind and water in this ocean basin. For example, large circular systems of ocean currents, called **gyres**, are the result of the wind's push on the surface of the ocean. The wind transports the water (and anything else floating on it or drifting in it) around the ocean, following a circular path.

Vocabulary

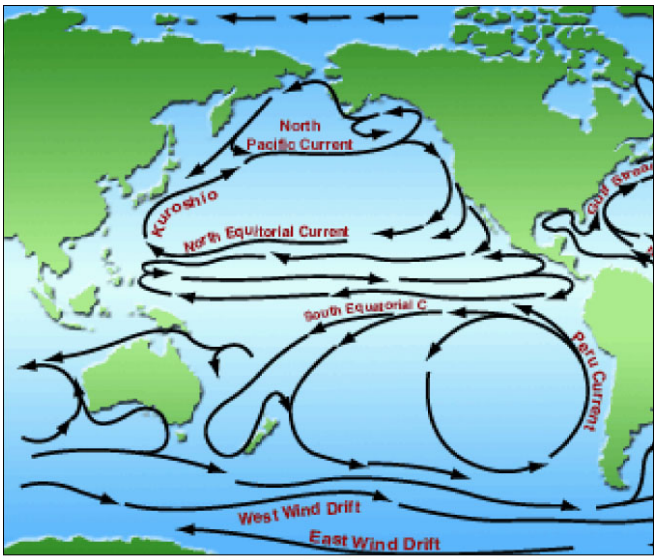
FLEDGLING – chick just about to leave (fledge) the nest

BOLUS – a mass of undigested material regurgitated by an albatross chick

MARINE DEBRIS – any persistent and solid material or item created by people and released (intentionally or unintentionally) into an ocean or large lake

CURRENTS – large masses of continuously moving ocean water (e.g., the California Current)

GYRE – a ring-like system of surface ocean currents driven by the wind. When water that is being pushed by the wind encounters a continent, the water flow turns to follow the coastline. This way, water travels around the gyre



Courtesy of Office of Naval Research

Figure of Surface Ocean Currents showing the major Pacific Ocean currents and gyres.

Misconception Note

This map is an *oversimplification* of the *average* ocean currents. There are numerous factors that affect the location, size, and strength of all of these features seasonally and annually. Depicting the dynamic nature of currents on a static map is very difficult.

As you can imagine, marine debris that enters the ocean will be carried by different surface ocean currents, depending on its origin. Scientists use computer models and wind data to predict where floating things (marine debris, floating fish eggs) will be transported by surface ocean currents. One example of a widely-used ocean current model is OSCURS (http://las.pfeg.noaa.gov/oscurs/).

When you and your students study the albatross boluses, you will also observe the movements of individual birds tracked by satellite. Think of the gyres pushing the sea surface (and floating plastics) along with their flow. Also, think about whether albatross routes seem to follow these ocean currents.

Preparation

- Color bolus photographs may be printed (four 8x11 pages per bolus), viewed on computer screens, or projected on a white board or wall paper. Each group of 2-4 students will need at least one photograph to analyze. Ideally, each group will compare one bolus from each species (Black-footed and Laysan albatross).
- If possible review background information on seabirds, and in particular albatross, from Lesson 1.

Learning Procedure

Engage (10 minutes)

Show students the Engage slides and videos.

Discuss what students are seeing, using the following discussion questions:

? Why do you think albatross adults perform a dance?

Accept all answers. Scientists believe that this courtship display is an important part of pair bonding.

? Why might albatross chicks regurgitate a bolus?

Accept all answers. Answers may include—to get rid of indigestible material, to prevent being weighed down as chicks fledge, etc.

Distribute student worksheets and direct students to read the first few paragraphs in the Engage section.

After students read the paragraphs, ask:

? What do you think you might find in a bolus?

Accept all answers as students may have no idea at this point. Possible answers may include:

- *Fish bones*
- *Stones*
- *Plastic*

? Scientists often collect and analyze boluses to examine their contents. Why do you think they do that?

Accept all answers. Possible answers may include:

- *To learn about the diet of albatross*
- *To find out what chicks are regurgitating prior to fledging*

? How might a stomach full of indigestible hard parts affect an animal? Or you?

Large amounts might cause dehydration, take up room for food, cut the stomach

Extension

Show the 5 minute video '360 Punches' of an albatross stomach being dissected on Kure Atoll (video provided for download or online viewing).

Explore

(35 minutes)

Explain to students that they are going to have the opportunity to analyze the contents of boluses through detailed photographs.

Show students the bolus photographs from the presentation and ask them to describe what they see. Note to students that the black, hook-shaped items are squid beaks. Squid use their beaks to break up prey much like teeth. These are not digestible, and therefore are a normal finding in a bolus.

Show students the close-up photograph of the squid beak. They should record a description on their worksheet.

Explain that students will be comparing the number of plastic, prey, and other items found in boluses. Divide students into groups of four. Create heterogeneous groupings if possible. Provide each group with 1-2 bolus photographs. Make the photographs available to students by printing them out (four 8 x 11 pages taped together make up one bolus), showing them on class computers, or projecting them on wall paper.

Each student should be responsible for ¼ of the bolus photograph (a quadrant) and will record his/her data in the data sheet. If time allows, have students count more than one quadrant to double check one another and improve the accuracy of the counts.

Discuss why plastic line is difficult to count using the same method. After the counts, students will measure the length and width (area) of the mass of line in their group's bolus and compare this with the total area of the items.

See Student Worksheets (Explore)

Each group will fill in a data table for their bolus(es) and calculate the percentage of plastic, prey, and other items. Two versions of the data table are provided and one for estimating the amount of plastic line.You may adapt these as needed for your class (editable version provided to download). As students count the items, encourage them to do the best they can. Explain that scientists often collect and analyze data in imperfect conditions.

Scientists also make assumptions and estimate measurements. To analyze how much line the birds ingested, help students understand the assumption that the flat 2D image is related to the 3D size (although not an exact measure).

Students will then answer the worksheet questions.

Differentiation:

1. Have advanced students devise other ways of categorizing the plastic items (e.g., by type of item, by color, by size). They should create and complete a new data table. Ask these students to share their findings during the class discussion in the Explain section.
2. Advanced students might also discuss how foam, line, or fragments may have different volumes and take up space in the bird's stomach differently.

Explain

(25 minutes)

Create a class table on the board and ask each group to add their data.

See Student Worksheet (Explain)

Direct students to calculate a class average of plastic, prey and other items and to complete the questions.

Discuss the answers to the worksheet questions as a class. Be sure to have student groups share items they identified.

Ask students:

? What were the most common non-prey items that you observed?
Plastic pieces and fishing line.

? Where are the chicks getting the plastics and fishing line?
The adult birds are picking up these items at sea, along with food. Albatross do not eat on land or the beach.

? Where are these items coming from?
Some plastics come from ships, but most are land-based and enter the ocean through drain pipes, rivers, and bays.

? Who is responsible for this pollution?
We all are!

? Are you surprised by the amount of plastic found in the boluses?
Allow students to share their ideas.

Discuss the presence of plastic line with students.

? Where does this line come from?
From humans—the line we see in boluses is mostly frayed and broken down fishing nets and ropes.

Explain to students that the nets and line may have been lost by accident, or intentionally released, e.g., when tangled or unusable.

Extension

Describe any obvious differences between Kure Atoll and Tern Island chick boluses. See four "advanced slides" presenting researcher results from the same boluses the students analyzed. Also look at the foraging tracks from both islands (available in Lesson 2).

Elaborate

(20 minutes)

Ask students whether they have ever heard of the "garbage patches" in the Pacific Ocean and other ocean basins. Explain that there are misconceptions about the garbage patches, and that you will clarify this information for them.

Using the presentation, introduce students to the idea of ocean gyres, the term marine debris and garbage concentrations at sea. Use this presentation to clarify these concepts.

On the map, assist students in identifying features, e.g., Alaska and Baja California, in

order to better understand the geography of what they are observing.

Ask students what they think are the sources of marine debris. Be aware that many students don't make the connection that most debris comes from land. If you will be doing the next lesson, explain that the class will be looking at litter on their school campus.

Show students the slide of satellite tracks of albatross movements, and ocean winds that create the large gyre systems in the North Pacific and the world.

Discuss:

? Do you know other animals that naturally throw up things they can't digest?
Examples include owl pellets, cat fur balls.

? Why don't humans produce boluses?
Our digestive systems are different from albatross. We do a good job of "passing" indigestible material. We usually do not put indigestible items such as large bones and seeds in our mouths.

On average, chicks are fed 25 grams of plastic in the 4 months before they fledge (on Kure Atoll, Oikonos-HPU data). If scaled to the size of a high school senior, that is the equivalent of 75 bottle caps inside your stomach – see Lesson 5 for activity.

Adult albatross also have the ability to regurgitate and may throw up undigested material at sea, where they spend the great majority of their time. At sea, however, this behavior is nearly impossible to observe.

? What if you ate plastic but couldn't throw it up or pass it?
Our systems might become very full of plastic, impeding our abilities to process real nutrients.

? How does this idea relate to seabirds?
Some bird species have no way (no adaptation) of getting rid of plastic in their systems. Therefore, the debris can interfere with their nutrition and digestion.

Extension

Plastics are known to contain and absorb toxic chemicals, threatening organisms that ingest them. The *Ecotoxicology of Marine Debris* is an extension of this lesson: http://bml.ucdavis.edu/education/cameos/resources/marine-debris/ecotoxicology/

Misconception Note

When people hear the term "garbage patch," they often picture large mats of floating plastic atop the ocean. While once popular in the media, this term is no longer encouraged to help change this misconception. Concentrations of garbage (microscopic plastics to large plastics) can be found on the ocean surface as well as in deeper waters. Concentrations of plastic are being found in mid depth waters where fish are ingesting it and on the ocean floor. Where wind and currents concentrate marine animals and plants, you will also find concentrations of human garbage.

See Student Worksheets (Elaborate)

Direct students to work with a partner to answer the questions about marine debris patches. Then, discuss their answers as a class.

Next, discuss the scale of the problem and the size of the ocean basins. As a class, determine that the best way to address the issue of marine debris is through *prevention* because clean up is so difficult. Discuss the value of cooperation, *laulima*, in protecting our ocean. This idea is the focus of the next lesson.

Extension

Students can practice graphing their results with Excel using the file Bolus Analysis.xls provided for download.

Learn the route of trash in the ocean using this online model based on real wind and current data: OSCURS:
http://las.pfeg.noaa.gov/oscurs/

Show students videos about marine debris such as the one at this link:
http://marinedebris.noaa.gov/videos

Evaluate (Homework)

See Student Worksheets (Evaluate)

For homework, assign the Evaluate task. Students can then display their boluses and placards around the classroom.

Resources

- More information about Ocean Currents:
  http://www.montereyinstitute.org/noaa/

  http://oceanservice.noaa.gov/education/lessons/ocean_motion.html

- Ocean Pollution video:
  http://www.montereyinstitute.org/noaa/

Credits and More Information

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We appreciate feedback, corrections and questions. Please email
WingedAmbassadors@oikonos.org

Free lessons and resources available at:

http://cordellbank.noaa/gov/education/teachers.html

http://oikonos.org/education

http://papahanaumokuakea.gov/education/wa.html

Education Standards

Ocean Literacy Principles

- 1g. 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.
- 1h. Although the ocean is large, it is finite and resources are limited.
- 6b. From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.
- 6c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.
- 6d. Much of the world's population lives in coastal areas.
- 6e. 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
- (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- 7f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.
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California

Grade 5:

- Life Science 2c: Students know the sequential steps of digestion and the roles of teeth and the mouth, esophagus, stomach, small intestine, large intestine, and colon in the function of the digestive system.
- Earth Science3a: Students know most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.
- Investigation and Experimentation 6b: Develop a testable question. Investigation and Experimentation 6g: Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.
- Investigation and Experimentation 6h: Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.
- Investigation and Experimentation 7b: Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data. Investigation and Experimentation 7d: Communicate the steps and results from an investigation in written reports and oral presentations.
- Investigation and Experimentation 7e: Recognize whether evidence is consistent with a proposed explanation.

Grade 7:

- Life Science 2b: Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
- Life Science 5b: Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire s
- Investigation and Experimentation 7 a: Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
- Investigation and Experimentation 7b: Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.

Grade 8:

- Investigation and Experimentation 9c: Evaluate the accuracy and reproducibility of data.

Education Standards

Hawai‘i

Grades 6-8:

Inquiry:

- Develop questions and hypotheses that can be answered through scientific investigations.
- Design and conduct scientific investigations to answer questions or to test hypotheses.
- Collect, organize, analyze and display data/information, using tools, equipment, and techniques that will help in data collection, analysis, and interpretation.
- Develop conclusions and explanations showing the relationship between evidence and results drawn.
- Communicate and defend scientific procedure used and conclusion and explanation drawn from evidence.
- Reflect and revise conclusion and explanation based on new evidence given from other valid points of view.

Values:

- Distinguish between facts and speculations/inferences.
- Evaluate all evidence that support or contradict the hypothesis.
- Ask questions to understand the multiple perspectives and interpretations of a problem, situation, or solution.
- Ask questions and explain findings and answers scientifically.

Safety:

- Apply school, classroom, laboratory, and field trip rules, as appropriate, to maintain a safe learning environment.
- Identify potentially unsafe conditions prior to the activity and explain how accidents can be prevented.

Nature of Inquiry:

- Identify good scientific explanations and justify their soundness based on evidence, logical and consistent arguments, and use of scientific principles, models, or theories.
- Give examples where scientists used mathematics and technology to gather, quantify, and analyze results of an investigation.
- Give examples of how science advances through legitimate questioning.
- Describe and exemplify the nature of scientific explanations.

Unity and Diversity:

- Compare and contrast the body structures of organisms that contribute to their ability to survive and reproduce.
-

Education Standards

Next Generation Science Standards (NGSS)

Standards

MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms
Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

ESS3.C: Human Impacts on Earth Systems
Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)

ESS2.CThe Roles of Water in Earth's Surface Processes.
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)

The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)

Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)

Science & Engineering Practices

4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

- Scale, Proportion, and Quantity

Education Standards

Common Core State Standards

English Language Arts

Reading:

CCSS.ELA-LITERACY.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

Writing:

CCSS.ELA-LITERACY.WHST.6-8.2
Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

CCSS.ELA-LITERACY.WHST.6-8.2.D
Use precise language and domain-specific vocabulary to inform about or explain the topic.

CCSS.ELA-LITERACY.WHST.6-8.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Mathematics

Math Practices:
CCSS.MATH.PRACTICE.MP6 Attend to precision.

6th Grade:
CCSS.MATH.CONTENT.6.RP.A.3
Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

CCSS.MATH.CONTENT.6.SP.B.5
Summarize numerical data sets in relation to their context.

CCSS.MATH.CONTENT.6.SP.B.5.A
Reporting the number of observations.

Lesson 4: Bolus Analysis

Name: _____ **Date:** _____

Engage

Read the following information:

Albatross parents are incredibly invested in raising their chicks. On the Northwestern Hawaiian Islands, adult albatross meet on breeding islands in the late summer and fall. They perform elaborate mating dances as they court and then produce an egg. The egg in laid in a nest on the ground. During this time, two parents take turns keeping the egg warm, allowing the chick inside to develop for two months.

Once the chick hatches, it stays on or near the nest for 5-6 months. During this time, the parents take turns flying thousands of miles to gather food for their chicks. Depending on the species, favorite food items include squid, fish eggs, and fish that they catch near the water's surface. Large albatross cannot dive underwater very far so most of their food comes from the sea surface. Chicks stay at the nest waiting for their meals.

As the chicks grow, they lose their fluffy, downy feathers and begin to look more like the adults. They begin testing their wings in the wind and are finally ready to take off to the sea and fend for themselves. Before they leave the nest, or **fledge**, the chicks regurgitate a mass of undigested material from their stomach. This mass is called a **bolus.**

Watch the video of a chick on Kure Atoll regurgitating a bolus.

Black-footed Albatross chick, almost fully grown, begging for food from its parent on Kure Atoll, Northwestern Hawaiian Islands.

Name: _____ Date: _____

Explore

Your teacher will give your group one or more photographs/projections of dissected albatross boluses. Answer the questions below to guide your analysis.

1. Carefully observe the photographs and describe a whole bolus. Describe what you observe.

   The bolus is mostly black and seems to be made up of chunks and strings. Its shape is irregular, but somewhat oval, and there are visible pieces of plastic and other items.

2. Observe the close-up photograph of the squid beak. Write a very detailed description of it.

   The squid beak is black and brown in color and appears smooth in texture. On one side, it has a "hook"; the other side is more jagged on the edges.

Name: _____ **Date:** _____

Next, you will analyze a bolus that a scientist has dissected.

3. Record the species and colony (where your dissected bolus was found) in the data table.
   BFAL = Black-footed Albatross
   LAAL = Laysan Albatross
   Kure = Kure Atoll Colony
   Tern = Tern Island Colony

4. Observe your dissected bolus carefully. Describe what you see.

   The bolus contains many different items. There are lots of squid beaks, but also fishing line, plastic, and other materials.

Sort and categorize your bolus and record your findings in the data tables.

Category descriptions:
Plastic Items:
Plastic Fragments – Rigid and hard complete or broken pieces in any shape (caps, broken bottles, toys)
Plastic Foams – Compressible and aerated plastic in any shape (packing foam, rubber)
Plastic Sheets – Flexible, flat and thin sheet of plastic (pieces of plastic bags or tarps)
Plastic Lines - Round single or multi-filament line or rope (unraveled fishing nets)

Prey Items – Hard parts from the food they eat
Squid Beaks – Hard upper and lower beaks of squid
Lenses – Hard eye lenses from fish and squid

Other Items (Non-plastic and Non-prey):
Seeds, Wood, Pumice, or other items that may float (not plastic)

5. a. Count the number of plastic items. Count by type (fragments, foam & rubber, and sheets) or combine all plastic as time allows. Analyze plastic line using a different method described below because it cannot be counted.

   b. Count the number of squid beaks and eye lenses. If this is difficult, devise a way to count in smaller sections or grids (quadrats).

   c. Count the number of "other" items that are not plastic or from an animal.

Name: _____ Date: _____

Colony: **Species:**				
	Plastic Items Fragments, Foam, Rubber, Sheets * use different method for line	**Prey Items** Beaks, Lens	**Other Items** Seeds, Pumice, Others	**Total**
	Count	Count	Count	Count
Partner or Quadrat Data A				
Partner or Quadrat Data B				
Partner or Quadrat Data C				
Partner or Quadrat Data D				
Total Count Entire Bolus				
% of Total				100%

Approximate Counts for the Boluses Given

Bird ID	Species	Colony	Plastic & Other	Prey Items
028	BFAL	Kure	~65	~225
359	LAAL	Tern	~65	~245
563	LAAL	Kure	~115	~260
289	BFAL	Tern	~95	~360

Name: _____ Date: _____

Colony:

Species:

	Plastic Items * use different method for plastic line			**Prey Items**		**Other Items**	**Total**
	Fragments	Foam, Rubber	Sheets	Squid Beaks	Eye Lenses	Seeds, Pumice, Other	
	Count	Count	Count		Count	Count	Count
Partner or Quadrat Data A							
Partner or Quadrat Data A							
Partner or Quadrat Data A							
Partner or Quadrat Data A							
Total Count Entire Bolus							
% of Total							100%

Name: _____ Date: _____

6. Plastic line is a difficult category to count. Estimate the amount of plastic line in your bolus by measuring the area (length x width). Area is related to volume in the bird's stomach.

Colony: **Species:**		
	Plastic Line Area (L x W)	**Total** Area (L x W)
Partner or Quadrat Data A		
Partner or Quadrat Data B		
Partner or Quadrat Data C		
Partner or Quadrat Data D		
Total Area of Flat, Sorted Bolus		
% of Total		100%

7. Are there any non-prey items that you can identify the source? If so, list them below:

Answers will vary and include streamers, rope, pen caps, bike reflector, fishing line.

Name: _____ **Date:** _____

Explain

8. Using the class data, calculate the percentage of prey vs. non-prey items in all of the boluses the class observed. Create a data table below in which you record your findings.

9. Using the class data, compare the area/size of plastic line in all the boluses.

Name: _____ **Date:** _____

10. Why do you think there are so many plastic items?

Albatross adults are picking up the items because the look like their natural food, or their natural food might be stuck to the plastic (fish eggs for example).

11. Where do you think the plastic items are coming from?

The items entered the ocean by flowing down a river, being blown out of a trash can, accidentally spilled from a big shipping vessel, or intentionally thrown into the ocean.

Elaborate

12. How would you explain what marine debris is, and where it comes from, to a 2nd grader?

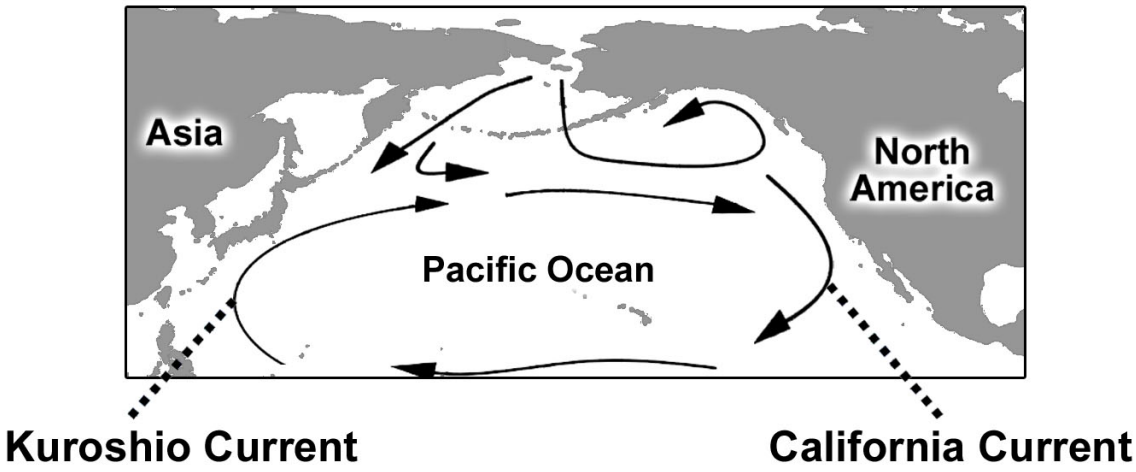
Answers will vary, but students should include information that marine debris comes from human activities and persists in marine and aquatic environments.

Name: _____ **Date:** _____

13. What are the major sources of marine debris and plastic?

Human activities on land and fishing activities at sea.

Observe the slides showing large-scale movement of water in the North Pacific. Large masses of continuously moving ocean water are known as **currents**. At the ocean's surface, winds drive these currents. In the North Pacific, these currents include the Kuroshio Current and the California Current, which are shown on the map below.



As you can see in this example, the ocean currents form several large circulations, **gyres**, around the North Pacific basin. The winds push the water, and everything floating in it, around the ocean in this circular path. The materials traveling around the ocean unfortunately include our trash.

14. How would you describe a gyre to a 2nd grader?

A gyre is a bunch of currents that form a circular pattern in an ocean. Currents are like rivers of water on the surface or deeper underwater.

Name: _____ **Date:** _____

15. How would you suggest addressing the marine debris problem? Use scientific evidence to support your suggestion.

Students should come up with their own suggestion, basing their idea on their understandings of watersheds, gyres, and.or the data that they collected from their boluses, e.g., types of plastic items.

16. In several scientific studies since 2008, biologists found that 100% of boluses thrown up by albatross chicks in the Northwestern Hawaiian Islands contained plastic trash and 52–66% of the bolus weight was plastic.

    a. How do these findings compare to your data? Use evidence from your data tables to support your comparison.

    b. How might eating and storing plastic inside the stomach affect a seabird chick?

If enough plastic is ingested, it can clog the digestive system or tear the stomach. Plastic takes up space for food and can result in malnutrition. Plastic contains contaminants the birds might absorb.

Name: _____ **Date:** _____

Evaluate

Based on the photograph analysis you did:

Using materials of your choice, build a creative model of an albatross bolus. This model should introduce your audience to the idea of albatross boluses and what they typically contain. Consider using materials from your school or home recycling bin.

Your model must include:

- A placard, similar to what you might see at a museum exhibit, which explains what your audience is looking at. The placard will describe:
    - what an albatross is and where they live
    - what an albatross bolus is
    - why scientists study albatross boluses
    - what albatross boluses contain
    - what marine debris is and why it is a problem
    - a key for others to interpret items in your model

- Be sure your placard is neat and organized, and uses appropriate vocabulary, spelling, and grammar

Name: _____ **Date:** _____