Clues from Albatross: Determining Ocean Health

Grade Level

5–8

Timeframe

Two 45-min. class periods

Materials

- Student handouts
- Color printouts of bolus photographs OR ability for students to work at computer screens or with projections of the photographs
- "Clues from Albatross" presentation

Key Words

Bolus, gyre, marine debris, plastic pollution

Standards

NGSS: MS-EES-3.C.
CCSS: W.6.10.
Ocean Literacy Principles: 1, 5, 6.
Details at end of lesson

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&

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A mōlī (Laysan albatross) parent checks on its chick. What can they tell us about our ocean? Photo: Dan Clark/USFWS

Activity Summary

Before 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 a bolus to perform a "virtual dissection" and analysis. They will compare the amounts of prey and non-prey items found in one kaʻupu (black-footed albatross) bolus. They will consider the sources of non-prey materials and create a plan to prevent plastic pollution, with which they can educate others.

Learning Objectives

Students will be able to:

- Explain orally and in writing that prior to fledging, albatross chicks regurgitate a bolus, which provides a record of the items ingested by chicks.
- Calculate the percentage of prey and non-prey items found in boluses and recognize that nearly all albatross boluses include plastics.
- Define the term "marine debris" and hypothesize about its sources. Create a plan for reducing plastic pollution and preventing plastic ingestion.
- Explain the importance of marine protected areas for safeguarding wildlife.

Background Information

Part of the most remote island chain in the world, Papahānaumokuākea Marine National Monument (pronunciation here) encompasses the Northwestern Hawaiian Islands, thousands of miles from the closest continents. The monument covers 582,578 square miles (1,508,870 square kilometers) of the Pacific Ocean and is dotted with ten islands and atolls and numerous small islets, which support an incredible diversity of coral, fish, birds and marine mammals, many of which are unique to the Hawaiian Island chain. The islands are a series of atolls, sandy islands formed around coral reefs. These atolls are critical breeding sites for millions of seabirds, including the world's largest albatross colony. Hōlanikū (Kure Atoll) is a seabird sanctuary managed by the State of Hawai'i in the monument that hosts thousands of albatrosses. Though relatively pristine, the monument is vulnerable to impacts from threats that are global in nature, including plastic and other marine debris.

Three Species of Albatross

Three species of albatross breed in the monument: ka'upu (black-footed), mōlī (Laysan) and the rare makalena (short-tailed albatross).

A ka'upu (black-footed albatross)
Photo: Eric VanderWerf/USFWS

Around October, Hawaiian albatrosses return from the open ocean to protected breeding colonies to find their mate and nest. Females lay a single egg, and chicks are incubated and fed by both parents. 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 regurgitate into the mouth of their chick back at the nest.

Fledging and Bolus Regurgitation

By early summer, chicks 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. 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.

Dangerous Trash

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, albatrosses 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.

A bolus regurgitated by an albatross chick: What clues does it contain? Photo: David Liittschwager

Importance of Ocean Currents and Wind

The albatrosses 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. Albatrosses do not nest off the West coast of the U.S., but many black-footed albatross travel there to feed throughout the year and are seen at marine sanctuaries such as Cordell Bank off of California.

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: https://oceanview.pfeg.noaa.gov/oscurs.

By monitoring items ingested by albatross and determining their origin, scientists can address how to best prevent marine debris and its impacts on wildlife.

Learn more:

"About Papahānaumokuākea Marine National Monument." National Marine Sanctuaries: https://www.papahanaumokuakea.gov/new-about

"Ka'upu." Hawai'i Department of Land and Natural Resources: https://dlnr.hawaii.gov/wildlife/birds/kaupu

"Marine Debris Program." NOAA: https://marinedebris.noaa.gov

"Wings of the Albatross" video. National Geographic Society (39:28): https://youtu.be/toJwBgjCZMI

Vocabulary	
Bolus	A mass of undigested material regurgitated by an albatross chick
Gyre	A rotating 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.
Fledgling	A chick just about to leave (fledge) the nest
Marine debris	Any persistent and solid material or item created by people and released (intentionally or unintentionally) into an ocean
Ocean currents	Large masses of continuously moving ocean water (e.g., the California Current)

Preparation

- Prepare to show the "Clues from Albatross" presentation.
- Print copies of the "Clues in Boluses" handout, one for each student.
- If students or student groups are using devices, they can use the "Interactive Bolus" tool: https://www.downloadwingedambassadors.org/bolus to record data online. Or, color bolus photographs may be printed (four 8.5 x 11" pages for one bolus), viewed on computers or projected on a large screen. Each group of 4 students (or less) will need at least one photograph (one section) to analyze.
- Review the background information above.
- Additional slides about albatross biology and adaptations, as well as other resources, are found on the Winged Ambassadors website: https://www.downloadwingedambassadors.org.

Procedure

Engage

- Open the "Clues from Albatross" presentation. Show students slide 2, a photo of a kaʻupu (black-footed albatross) and chick.
    - Ask: What do you know about albatrosses? Where do you think they might nest and feed?
    - Give students a minute to share their ideas with a partner and/or the class.
- Advance to slide 3, which shows Hōlanikū (Kure Atoll), a seabird sanctuary in the North Pacific basin. Explain this this remote island atoll is protected as one of the most important nesting sites for albatrosses and other seabirds.
- Advance to slide 4, which shows a map of national marine sanctuary locations, including Papahānaumokuākea Marine National Monument, where Hōlanikū (Kure Atoll) is located.
    - Tell students the map is of national marine sanctuary locations. Ask them if they have heard of marine sanctuaries. Share that they are areas of our ocean and Great Lakes where various habitats are protected and managed for the species that live there and natural resources.
    - Click through the animations on slide 4 to show blue arrows that represent albatross migration routes.
    - Ask: What do you think these blue arrows represent? Clarify that they represent albatross migration routes, if needed, and ask, "Why do you think these birds are flying between these areas?"
    - Show the remaining slides in the Engage section (slides 5–12) and draw from students' prior knowledge to discuss where albatrosses breed and nest, what they eat and where they have been found feeding.
        - At slide 12 ask: Where do you think a bolus comes from, and what might it contain?
        - Make sure they understand that a bolus is undigested matter that chicks regurgitate before they leave the nest and begin flying. It provides clues as to what parents and chicks are eating.

Explore

- Pass out the "Clues from Albatross" handout. Explain to students that they are going to have the opportunity to see what albatross adults and fledglings have been eating by analyzing the contents of a bolus through detailed photographs.
    - Ask: Do you know other animals that naturally regurgitate things they can't digest? (Answers can include owls and cats.)
- Advance to slide 14 (a bolus) and ask students to describe what they see.
- Advance to slide 16 to show students the close-up photograph of the squid beak and ask students to think about what it might be. Explain that they should record a description and/or illustration on their handout or in science notebooks.
    - Ask students to share their ideas of what it might be. Discuss how it is a squid beak and that squid use their beaks to break up prey much like teeth. These are not digestible, and therefore are a normally found in a bolus.
- Explain that students will be comparing the number of prey and non-prey items found in a bolus. Show slides 20–21 that describe how to categorize items.
- Divide students into heterogeneous group of 4 (or less).
- If students have their own devices, direct them to use the "Interactive Bolus" tool to record data online: https://www.downloadwingedambassadors.org/bolus. Demonstrate how to use the tool by clicking on an object and then measuring and categorizing it. Students can use the Bolus ID Guide using a link in the tool to help them identify objects.
    - Or, provide each group with 1–4 photographs of sections of a bolus. Make the photographs available to students by printing them out, showing them on class computers or projecting them. Ensure that all four sections of the bolus (upper left, upper right, lower left and lower right) are distributed so the entire bolus is analyzed.
- Ask students to follow instructions on the handout to complete the data tables and answer the questions.

Explain

- Create a class data table on the board.
    - Once students have finished their analysis, ask the groups to share their results with the class.
    - Ask the other groups if they recorded similar results for particular sections.
    - Compile class data so students can calculate the total % of prey and non-prey items in the bolus.
- Share the answer key for the bolus, which shows the counts made by scientists. Discuss the answers to the worksheet questions as a class. Be sure to have student groups share items they identified. Ask:
    - What were the most common non-prey items that you observed? Are you surprised by the amount of plastic in the bolus?

    - Where are the chicks getting the plastics and fishing line?
    - How does plastic ingestion affect albatross?
- Project the map of "Currents Where North Pacific Albatrosses Live" (slide 24) from the presentation.
    - Ask students to identify features, such as Alaska and California, so the class has a good understanding of the geography they are observing.
    - Ask students to think about where garbage might originate and what might cause it to wash up on Hōlanikū (Kure Atoll). Ask students to record their ideas on their handouts.
- Show the slides that relate to ocean currents and ocean winds that create the large gyre systems in the North Pacific and the world.
    - 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. 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.
        - Concentrations of garbage (microscopic plastics to large plastics) can be found on the ocean surface as well as in deeper waters, including the ocean floor.
    - Using the presentation, introduce students to the term marine debris and garbage concentrations at sea. Clarify these concepts.
    - 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. Ask:
        - Where are these plastic items coming from?
        - Who is responsible for this pollution?
- While students are still in their groups, ask them if they have ever been involved in litter cleanup events. Ask them to brainstorm ways they can prevent plastic pollution. Ask them to record ideas on their worksheets.
- Ask wrap-up questions:
    - Why is it important to collect data about the contents of boluses?
    - Why might it be important to have national marine sanctuaries?

Enrich/Extend

- Ask students to read "Plastics Cleanup Powerhouse" about National Geographic Explorer Rachael Zoe Miller (found at the end of the lesson). Ask them to create a list of interview questions to help them learn more about her background and work. Students can also read a short bio at https://explorer-directory.nationalgeographic.org/rachael-z-miller. They can learn about her organization Rozalia Project, funded by grants from NOAA and the National Geographic Society, at https://www.rozaliaproject.org.
- Ask students to design a service-learning or art project(s) to address the problem of litter and marine debris.
    - Find many suggestions in the "Marine Debris Toolkit": https://nmsmontereybay.blob.core.windows.net/montereybay-prod/media/educate/pdf/edu-webinar-marine-debris-monitoring-toolkit-for-teachers.pdf.
    - Complete the "Plastic, Plastic, Everywhere" lesson: https://nmsflowergarden.blob.core.windows.net/flowergarden-prod/media/archive/document_library/eddocs/plasticbaglesson.pdf.
    - National Geographic Society's Debris Tracker app allows anyone to contribute data on plastic pollution in their community: https://debristracker.org.
    - Ask students to create a simple graphic that educates the public, similar to this media campaign: https://www.papahanaumokuakea.gov/involved/busposter.html.
- Ask students to research the significance of albatrosses in native Hawaiian culture. One interesting document for more advanced students is "Nā Hulu Aloha — A Precious Remembering," National Park Service: http://npshistory.com/publications/noaa/papahanaumokuakea/psf-382-cody.pdf
- Tell students the story of Wisdom, a mōlī (Laysan albatross), that is the world's oldest known wild bird. Biologists first identified and banded Wisdom in 1956 after she laid an egg. As of 2023, she is at least 71 years old. Wisdom nests on Midway Atoll in the Papahānaumokuākea Marine National Monument.
    - Find more information about Wisdom: https://www.fws.gov/story/2022-12/wisdom-worlds-oldest-known-wild-bird-returns-midway-atoll

Evaluate

- Review student answers on their handouts and/or in science notebooks.
- Assess student participation in the bolus analysis activity and class discussion.
- Provide feedback on additional student projects.

Education Standards	
Next Generation Science Standards	Earth and Human Activity • MS-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. Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. Science and Engineering Practices: • Collecting, analyzing and interpreting data • Constructing Explanations and Designing Solutions • Using mathematical and computational thinking Crosscutting Concepts: • Cause and Effect • Scale, quantity and proportion
Common Core State Standards	Writing: W.6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. Speaking and Listening: SL.6.4 Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes.
Ocean Literacy Principles	1. Earth has one big ocean with many features. (c) 5. The ocean supports a great diversity of life and ecosystems. (d) 6. The ocean and humans are inextricably connected. (d, g)

Additional Resources

"Laysan Albatross Virtual Bolus Dissection." National Geographic Society. Includes videos and other resources: https://www.nationalgeographic.org/activity/laysan-albatross-virtual-bolus-dissection

"Mai Ka Pō Mai: Native Hawaiian Guidance Document for the Management of Papahānaumokuākea." Office of Hawaiian Affairs (OHA) and NOAA: https://www.oha.org/maikapomai
Mai Ka Pō Mai webinar: https://youtu.be/SriQ4tfSwHI

"Modern Explorer | Adventurous Albatross" video (4:75). National Geographic Society: https://education.nationalgeographic.org/resource/adventurous-albatross

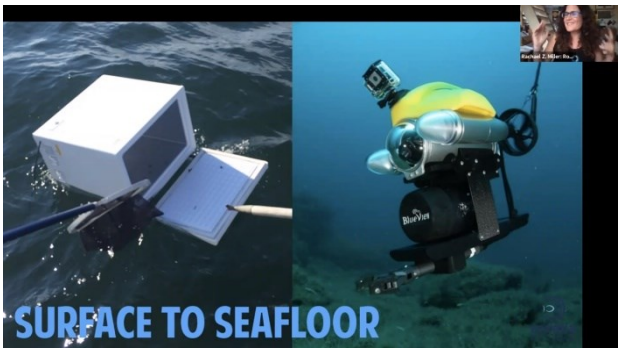
"Winged Ambassadors: Ocean Literacy Through the Eyes of Albatross." Complete curriculum: https://www.downloadwingedambassadors.org
NOAA webinar: https://sanctuaries.noaa.gov/education/teachers/winged-ambassador.html

Plastics Cleanup Powerhouse

Spotlight on Rachael Zoe Miller – Caring for Our Ocean

National Geographic Explorer Rachael Zoe Miller has trained Navy SEALs how to use underwater robots. She captains the sailing research vessel American Promise. And she co-invented the world's first plastic microfiber-catching laundry ball.

Miller has focused her career on protecting the ocean by addressing the problem of marine debris through cleanup and prevention efforts. She searches for marine debris from the surface to the seafloor. Her research starts in the ocean because, "Understanding the problem is the foundation before getting to solutions." Sensing, monitoring and modeling help Miller and her organization decide on the best clean-up strategies.



One of Miller's partners is Hector the Collector (right), an ROV used to search for and remove trash. https://youtu.be/Tw7Nct-XMSY

Miller and others discovered tiny plastic fibers from clothing were adding to ocean pollution. Microplastics are less than 5 mm in size: microbeads (found in body care products), glitter or broken off pieces. Synthetic fabrics also contribute to microplastic pollution. Researchers found that one fleece jacket could produce 81,317 pieces of microscopic fibers per wash! Fibers can block marine animals' digestive tracts. It has been found that 220+ marine species ingest plastic including cod, sea bass and oysters.

Rachael Zoe Miller: explorer, researcher, inventor
Photo: Adam Steckley/National Geographic Society

Miller said, "This microfiber problem screamed at us." One of her team's big goals was to, "Come up with a solution to see if we could stop this from happening." Rachael and her team invented a ball that goes in the washing machine and traps plastic fibers. Other scientists tested the ball and found it reduces production of microplastics by more than 30%.

Rachael is optimistic about reducing plastic in our ocean. "We recognize that the problem of ocean trash is one that is made by the collective "we." And we believe that the collective "we" can overcome it. The only way we're going to do this is with multiple solutions."

Miller has seen the power of collective efforts through her organization that is dedicated to removing plastic from waterways. Over the last 10 years, the project has removed more than a million pieces of trash from waterways and inspired over 45,000 people through direct programs. As she says, "Lots of little efforts to fix it, make a big positive impact."

For More Information

This lesson was adapted from lesson 4 of the "Winged Ambassadors" curriculum, courtesy of NOAA, Oikonos, and other partners. Find the original five lessons, additional information, and many more resources at https://www.downloadwingedambassadors.org.

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WINGED AMBASSADORS

OCEAN LITERACY THROUGH THE EYES OF ALBATROSS

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