



Waves, Wetlands, and Watersheds



Supplemental Activities for the California Coastal Commission Science Activity Guide (Version March 2010)

Created by
Carol A. Keiper, Oikonos Ecosystem Knowledge
Jennifer Stock, Cordell Bank National Marine Sanctuary

Activity 8.2a Extension of 8.2 “You Are What You Eat”

“Are Seabirds What They Eat? Plastics and Seabirds”

(Adapted from: “How do we know what albatrosses eat?” Oikonos - Ecosystem Knowledge & Cordell Bank National Marine Sanctuary)

Science skills

- Observing
- Identifying
- Analyzing
- Classifying
- Communicating

Concepts

- Seabirds mistake plastic for food and feed it to themselves and their chicks
- Albatross chicks regurgitate boluses, a compact mass of indigestible material
- Ingesting plastic can harm seabirds

California Science Content Standards

9. Investigation and Experimentation: Scientific progress is made by asking meaningful questions and conducting careful investigations.

9a. Plan and conduct a scientific investigation to test a hypothesis

9e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

Objectives

Students dissect a bolus (if available) or use bolus data sheets and photos included in this activity to identify, sort, classify, quantify, and summarize contents



Time to complete

One class period

Mode of instruction

Teacher directed group lab activity and work with data sheet, followed by presentation of results and class discussion

Materials - available to download at this link:

http://www.oikonos.org/projects/oceanstewardship_projects.htm#activities

1. Power Point CD – Natural History of Black-footed Albatross
2. LCD projector
3. Color photos of contents of dissected bolus use boluses if available)
4. “Albatross bolus Investigation Data Sheet”
5. Gloves, tweezers for sorting boluses, hand lenses, trays, rulers (metric is preferred), scale (digital, if available) and mounting boards and glue to mount contents of boluses (optional)

Preparation

Review Natural History of Black-footed albatross and Laysan albatross Power Point presentation, photocopy Bolus Investigation Data Sheet, photos of the contents of four boluses (or assemble boluses if available) one per student or group.

Outline**Before class**

1. Contact Carol Keiper (carol@oikonos.org) to investigate the possibility of getting boluses
2. Assemble dissecting trays, tweezers, gloves, mounting boards, glue (hot glue guns work well) if boluses are available
3. Prep for Power Point Natural History presentation; refer to script included in this packet
4. Photocopy Albatross Bolus Investigation Data Sheet, one per student or one per group of students
5. Color copy photos of boluses (included in this activity packet) or download and PDFs and laminate if possible
6. Refer to “Albatross Bolus Protocol” for additional information about handling and processing boluses

During class

7. Lead class discussion about how seabirds depend on the ocean for their food (even when they are raising a chick, they fly thousands of km in



- search of food for themselves and for their chick) and how they capture their prey (scavenging and dipping on the surface)
8. Discuss why some species are more susceptible to plastic ingestion than others and the importance of diet studies
 9. Refer to and review “Plastics and Their Uses” and the types of plastic that floats or sinks
 10. Discuss and list ideas of what they would expect to find inside the bolus, the regurgitated mass of indigestible materials
 11. Investigate contents of bolus and list, quantify, and summarize findings on Albatross Bolus Investigation Data Sheet

Background

Seabirds are birds that make their living on the open ocean; some are found near-shore and coastal, whereas others range far from the sight of land. They come to land to breed on remote islands and even when nesting they have to return to sea to find food for themselves and their chicks. This makes them completely dependent on finding their food in the ocean throughout their lives. An example of pelagic (open ocean) seabirds are the Black-footed albatross and Laysan albatross and are the focus of this lab activity. These birds are ocean wanderers that migrate thousands of miles throughout the North Pacific Ocean.

Seabirds are ecological indicators in marine ecosystems and diet studies can highlight shifts in prey types and changes in abundance and distribution of prey. Seabirds can also be used to quantify changes in threats caused by increased human use of coastal and open-ocean ecosystems (e.g. plastic pollution). The Black-footed albatross eat flying fish eggs, squid, crustaceans, fish, and pelagic barnacles and take their food by scavenging and dipping at the surface. Laysan albatross also eat squid and both species feed their chicks by regurgitating squid, flying fish eggs, and fish larva into the chick’s mouth. The chitinous beaks of squid resist digestion; undigested beaks, along with other undigestible items fed to chicks (e.g. plastic and fishing line) are retained in their stomach which chicks regurgitate as a compacted mass, the bolus. They regurgitate a bolus when they reach a certain age or size, usually just before they fledge (leave the nest site to venture out to sea). Unfortunately, if the chicks consume too many plastic items before they are able to regurgitate them, they become more vulnerable to starvation. (Note: cause of death is generally related to physiological stress due to blockage and satiation). By studying the contents of boluses, much information can be learned about seabird diets, however, we can also learn important information about human impacts on the pelagic, open ocean marine system, far from land.



Activity

1. Present the Power Point presentation on the Natural History of the Black-footed albatross to your class; highlight a) how these birds feed (dippers and surface feeders); b) what they feed on (flying fish eggs, squid, crustaceans and fish); c) feed their chicks by regurgitating food into the chick's mouth; d) chicks regurgitate a bolus when they reach a certain age or size, usually just before they leave the nest site; e) some parts of prey items are not digestible e.g. squid beaks
2. Conduct a class discussion on what types of threats these seabirds face (injury or death by drowning from longline fisheries and plastic ingestion)
3. Based on what they have just learned about albatrosses, their mode of feeding, their diet, and boluses, have students formulate hypotheses and predictions about the contents of a bolus
4. Divide class into small groups and distribute photos of boluses and bolus data sheet
5. Identify, count, and measure items in bolus photos; complete data sheet
6. If boluses are available, have students dissect, sort, and classify items by size and color. Measure and group items as follows: small (0-10 mm), medium (10-20 mm), large (20-50 mm), extra large (>50 mm), color and fishing line; complete bolus data sheet
7. Calculate the following: total number of items; total number of non-natural items; total number of plastic fragments and "user" plastic; total number of whole items e.g. bottle caps; enumerate items by color, size (see above), and shape; calculate proportions of each
8. Summarize by weight (if digital scale is available): weigh each bolus, natural, and unnatural items and calculate proportion of mass of plastic and unnatural items relative to each bolus

Results and reflection

1. Summarize results on data sheets and report findings and conclusions to the class
2. Create summary graph or chart of all bolus results e.g. graph proportion of natural vs. non-natural items; graph proportion of plastic; graph by color, size and shape
3. Compile all bolus data into a class graph and communicate results with other classes. What were some of the patterns of the plastic you observed in the bolus e.g. size, specific shape, colors, recognizable items? Was there any evidence of selective feeding e.g. did you find that only a particular kind of plastic had been ingested? What proportion of the bolus contained plastic items?
4. If boluses were used, mount on foam board and place in a display box and present results. NOTE: Bolus availability is extremely limited. Consider ways to reuse bolus as they may not be readily available.



Conclusions

Seabirds that feed on the surface of the ocean (dippers and scavengers), such as Black-footed albatross and Laysan albatross often mistake plastic pieces as food and also feed plastics to their chicks. Birds that feed by diving for their food also eat plastic, however, surface feeders eat more plastic than divers. Albatross chicks usually regurgitate a bolus right before they leave the nest and go to sea (fledge). Boluses contain indigestible natural (squid beaks) and un-natural (plastic) materials. If chicks are fed too much plastic they are likely to suffer from physiological stress from blockage and satiation (feeling so full) that can result in their death. Chicks can become so full and items can be so large that they are unable to regurgitate a bolus. Types of plastic include “user” plastic e.g. bottle caps, plastic toys, cigarette lighters, light sticks, fishing floats, and fishing line. We can think of seabirds as ocean barometers that can indicate the amount and extent of plastic pollution in our oceans.

Extensions and applications

1. Refer to plastics used in buoyancy experiments in **Activity 8.2** to conduct **Extension Lab Activity 8.2b: Plastic Investigations**
2. Research the life of an albatross

Adapted from: “Fishing for a Living: How do we know what Albatrosses eat?” developed by Cordell Bank National Marine Sanctuary and Oikonos-Ecosystem Knowledge

Further references on albatross:

Oikonos-Ecosystem Knowledge Black-footed albatross project
<http://www.oikonos.org/projects/albatross.htm>

Cordell Bank National Marine Sanctuary
<http://www.cordellbank.noaa.gov>

US Fish and Wildlife Service at Midway
<http://midway.fws.gov/>

Kinan, I. Occurrence of plastic debris and ingestion by Albatross at Kure Atoll, Northwestern Hawaiian Islands, Western Pacific Regional Fishery Management Council, Honolulu, Hawaii. Irene.Kinan@noaa.gov

Schreiber, E.A. & J. Burger eds. 2001. Biology of Marine Birds, CRC Marine Biology Series 2001

Safina, Carl. Eye of the Albatross. Henry Holt & Company New York



Extension Lab Activity 8.2b: Plastic Investigations

“What plastic items are albatross likely to eat?”

(Adapted from: “How do we know what albatrosses eat?” Oikonos - Ecosystem Knowledge & Cordell Bank National Marine Sanctuary)

Science skills

- Observing
- Classifying
- Predicting
- Communicating

Concepts

- Understand that seabirds that are surface feeders (albatross) are more likely to ingest plastic and feed it to their chicks
- Understand that birds with bigger beaks (albatrosses) eat larger prey and plastic (20-100mm)
- Scientists use Dichotomous keys as a tool for classifying things. Typically it is used to identify organisms.

California Science Content Standards

9. Investigation and Experimentation: Scientific progress is made by asking meaningful questions and conducting careful investigations.

Objectives

Students create and use a dichotomous key to determine if an albatross would ingest a particular piece of plastic. Students will measure objects and compare the characteristics of the assorted piles of plastic.

Time to complete

One class period

Mode of instruction

Teacher directed group lab activity and work with Dichotomous Key, followed by presentation of results and class discussion

Materials

1. Assorted plastic trash collected for Activity 8.2; assess the need to collect more; if necessary have students collect plastic trash from their neighborhoods, homes, and schools
2. Plastic Dichotomous Key Worksheet
3. Ruler to measure plastic



4. Plastic and Seabirds Power Point presentation

Preparation

Assemble all plastic that includes large/small, transparent/translucent, and assorted colors. Photocopy Plastic Dichotomous Worksheet. Read information about plastic and seabirds in the Plastic Power Point presentation. Optional: Select relevant (and appropriate to your particular class) information from the Power Point presentation to create a seabird and plastic information sheet to distribute to students.

Outline

Before class

Assemble all plastic e.g. bottle caps, Styrofoam, children's plastic toy parts, plastic fishing floats, toothbrushes, light sticks, and divide into piles to be distributed to each group of 4-5 students.

During class

1. Review concept of density and properties of objects in salt water
2. Review "Plastics and Their Uses" and the types of plastic that floats or sinks
3. Sort and categorize plastic into specific groups: size, shape, transparent/translucent, light, medium, or dark colors, bright (yellow/red) or dull (blue/green); industrial plastic (pellets) or user plastic, plastic fragments
4. Group objects that have similar characteristics and create sub-groups; start with most general and progress to increasingly more specific characteristics
5. Use Example Plastic Dichotomous Key from "Fishing for a Living: How do we know what albatrosses eat?" to create a Dichotomous Key

Background

Marine plastic pollution is one of the major threats to seabirds (and marine mammals, fish, sea turtles, and marine life that feeds on plankton). The increase in plastic production and "single-use" plastic has resulted in a corresponding rise in the amount of plastic debris in the oceans that is being ingested by seabirds. Seabirds mistake plastic for prey and eat bottle caps, plastic fragments, cigarette lighters, lightsticks, and pieces of children's toys. Seabirds most susceptible to plastic ingestion are surface feeders and scavengers, such as Albatross. Birds' beaks determine the size of the food they eat. Albatross eat flying fish eggs along with pumice that is often used as a floating item to which eggs are attached. Plastic items that range in size from ~2 – 20 cm and even as large as a toothbrush(!) are ingested; albatrosses also eat plastic wrappers.



Activity

1. Examine piles of plastic and plastic fragments; separate and group into categories based on similar characteristics; include size as a category and use ruler to measure
2. List characteristics; start with most general and progress to more specific
3. Create Plastic Dichotomous Key
4. Summarize results by using diagram/photo of actual size of albatross head and beak (see Plastics & Seabirds Power Point presentation slide # 8 & 9) and answering question “What items will an albatross most likely ingest and potentially cause harm? Assemble and label items likely to be ingested (several millimeters to ~20 cm) by an Laysan or Black-footed albatross

Results and reflection

1. Report findings and conclusions to the class
2. Create summary poster (use graphs/charts) of plastic items albatrosses are likely to ingest

Conclusions

Seabirds, specifically birds that feed on the surface of the ocean (dippers and scavengers), such as Black-footed albatross and Laysan albatross, often mistake plastic pieces as food and also feed plastics to their chicks. Types of plastic include single-use “user” plastic e.g. bottle caps, plastic toys, cigarette lighters, light sticks, industrial pellets known as nurdles and fishing floats. Seabirds such as the albatrosses also eat fishing line. We can think of seabirds as ocean barometers that can indicate the amount and extent of plastic pollution in our oceans.

Extensions and applications

Research the “life –expectancy” of plastic; determine why there are so many bottle caps and identify their source; determine if large pieces of plastic break up into smaller pieces. Use poster “Marine Debris Biodegradation Time Line” that can be purchased from Mote Marine Laboratory Sarasota, Florida 34236; 941-388-4441 or 1-800-691-MOTE.

Use activities and discussion questions for all grades in Activity CA3 Clean shorelines, Clean Oceans: Shoreline Cleanup p. 131 and Activity CA4 Preventing Pollution at the Source

Adapted from: “Fishing for a Living: How do we know what Albatrosses eat?” developed by Cordell Bank National Marine Sanctuary and Oikonos-Ecosystem Knowledge



Further references on Dichotomous Keys

<http://www.park.edu/bhoffman/courses/bi225/labs/Dichotomous%20Keys%202.htm>

Further references on ocean pollution: see p. 112 in Waves, Wetlands, and Watersheds

Activity 8.2c and High School

“Tracking Albatross and Tracking Trash”

(Adapted from Signals of Spring, Cordell Bank National Marine Sanctuary and Oikonos-Ecosystem Knowledge activities; and based on 2004-2005 research on the Black-footed albatross conducted by Oikonos-Ecosystem Knowledge, Duke University, Claremont Colleges, and USGS Western Ecological Research Center (<http://www.oikonos.org/projects/albatross.htm>)

Science skills

- Organizing
- Interpreting
- communicating

Concepts

- Black-footed albatross fly long distances to search for food
- Research is needed to answer questions about where they go because they are an endangered species
- Scientists use satellite telemetry to study their movement patterns
- During their journeys across the North Pacific they can encounter and eat plastic
- Black-footed albatross are an endangered species; one of the primary factors affecting their status is by-catch associated with longline fishing and potential impacts of plastic ingestion may further jeopardize the survival of this species
- Science plays a key role in providing important information for the conservation of the Black-footed albatross and other endangered and threatened species

California Science Content Standards

9e. Construct graphs from data

Objectives



- Students map locations of Black-footed albatross on a map of the North Pacific and determine overlap with the approximate location of the “eastern plastic garbage patch” documented by Agalita Marine Research Foundation (AMRF)
- Students understand the critical need for plastic pollution prevention

Time to complete: one class period

Mode of instruction: Teacher led mapping activity: Black-footed albatross satellite tracking location data (latitude and longitude), and mapping location of the approximate location of the “eastern garbage patch” on map of North Pacific Ocean

Materials: Map of North Pacific Ocean, Black-footed albatross location data (latitude and longitude), coordinates of the approximate location of the “Eastern Garbage Patch”, and Albatross Mapping Activity Summary Sheet

Preparation: photocopy maps and latitude/longitude data sheets for two albatross

Outline

Before class – photocopy maps and data sheets

During class

1. Lead class discussion about how scientists study seabirds that are far from land e.g. use of satellite telemetry
2. Help students locate and map location of tagging site at Cordell Bank National Marine Sanctuary
3. Demonstrate how to plot points of Latitude and Longitude on a map
4. Lead class to make predictions where they think Black-footed albatross would go after leaving the tagging location at Cordell Bank National Marine Sanctuary
5. Divide students into groups for mapping activity or have students work independently
6. Create an encircled point at each location and label each point with each day
7. Summarize mapping activity

Background

Build on lessons learned from **Activity 8.21 and 8.2b**. Advances in technology provide important tools to increase our understanding about ocean habitats and seabirds’ use of these habitats and can identify potential interactions with threats



far from land. Scientists use satellite telemetry to increase our understanding of long-distance ocean migrators. Satellite transmitters are placed on backs of albatross and Argos satellites (<http://www.argos-system.org/?nocache=0.20860023142883088>) that orbit our planet receive signals from tags (transmitters, <http://www.wildlifecomputers.com/Animals.aspx?ID=56>) and then relay this information to ground receiving stations that process the data. Research is needed on the Black-footed albatross because it is listed as endangered, largely due to by-catch from longline fisheries, but also other threats such as plastic ingestion. Science plays a key role in seabird conservation by providing resource managers the important information about biology, ecology, and movement patterns required for effective management and protection. Algalita Marine Research Foundation documented the location of the “eastern garbage patch” in the North Pacific Ocean. Data from the study on Black-footed albatross is included to complete the mapping activity.

Activity

1. Divide class into groups (or have students work independently)
2. Distribute map of North Pacific Ocean
3. Label National Marine Sanctuaries (NMS) as follows: along west coast from north to south label Olympic Coast NMS, Cordell Bank NMS, Gulf of the Farallones NMS, Monterey Bay NMS, Channel Islands NMS, Hawaiian Islands Humpback Whale NMS, and Northwestern Hawaiian Islands NMS (proposed)
4. Review how to map latitude/longitude
5. Label tagging location – Cordell Bank National Marine Sanctuary
6. Brainstorm with students: “As a scientist, what questions would you want to know the answers to?”
7. Map points of latitude/longitude of selected Black-footed albatross on North Pacific Ocean map; encircle points and label with the date for each bird
8. Use Albatross Mapping Activity Summary Sheet and calculate the following for each bird: total number days of tracking; average number of kilometers per day (#km/#days)
9. Map approximate location of “eastern garbage patch”
10. For each bird, determine total number days spent in garbage patch; proportion time spent in garbage patch (# days in patch/total # days)

Results and reflection

1. Determine which birds spent the greatest amount of time in the garbage patch and would thus be likely to encounter (and possibly ingest) plastic
2. Discuss patterns of tracklines and possible reasons of their occurrence in specific locations e.g. garbage zone



Conclusions

Humans are responsible for plastic marine debris that seabirds ingest. The continuing escalation of plastic marine debris warrants actions on many levels. At the local level, we can all do our part in preventing plastic debris from becoming part of the Pacific Ocean by being vigilant in keeping plastic from entering rivers and streams that flow into the ocean and that can then get transported around the planet via ocean currents.

Extensions and applications

1. Investigate why garbage accumulates in several regions in the Pacific:
<http://oceancurrents.rsmas.miami.edu/>;

http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_currents_2.html;

<http://marinedebris.noaa.gov/info/patch.html>;

<http://5gyres.org/>
2. Investigate plastic and marine debris: www.plasticdebris.org
3. Use the following website to measure how far the albatross traveled during different legs of its journey in miles or kilometers:
<http://jan.ucc.nau.edu/~cvm/latlongdist.html>

Adapted from: “Fishing for a Living: How do we know what Albatrosses eat?” developed by Cordell Bank National Marine Sanctuary and Oikonos-Ecosystem Knowledge

Further references:

1. Investigate longline fishing by-catch:
<http://bycatch.env.duke.edu/Collaborators/bycatch-bibliography>;

www.wpcouncil.org
2. Investigate Oikonos Black-footed albatross research:
<http://www.oikonos.org/projects/albatross.htm>
3. Investigate Algalita Marine Research Foundation:
<http://www.alguita.com/>, <http://www.algalita.org>



4. Learn more about Cordell Bank National Marine Sanctuary:
<http://www.cordellbank.noaa.gov>
5. Satellite telemetry:
<http://www.argos-system.org/?nocache=0.20860023142883088>
<http://www.wildlifecomputers.com/Animals.aspx?ID=56>
6. “Eye of the Albatross” by Carl Safina

Activity 9.0 – 12.0: High School extensions for Activity 8.2a and Extension 8.2 “You Are What You Eat”
See 8.2a for Science skills and concepts

California Science Content Standards

Ecology b: 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.

Follow 8.2a Objectives, Time to complete, Mode of instruction, Activity, and Results and Reflection

High School Extension of Activity: to investigate the contents of an albatross in greater detail, use **Bolus Investigation Datasheet: Sorting for plastic by color and size** (adopted from Charles Moore, Algalita Marine Research Foundation and Bill Henry from UCSC)

Extension of Results and Reflection:

Summarize results by using the **Percent Similarity Index (PSI)** summary data sheet to calculate a (PSI) for all boluses investigated (either photocopy images or boluses). This descriptive comparison can be used to determine overall how much the composition of boluses overlap or the degree of similarity (80% or greater can be considered to be similar).

Resources:

- 1) DVD and curriculum titled **Watershed Wonders** produced by the Algalita Marine Research Foundation 148 N Marina Drive, Long Beach, CA 90803.
<http://www.algalita.org/videos-educational.html#wonders>
- 2) Investigate detailed summary of numerous links on impacts of plastic
<http://www.mindfully.org/Plastic/plastic.htm>



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