Extension 8.2a of Activity 8.2 "You Are What You Eat":

"Are Seabirds What They Eat? Plastics and Seabirds"

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 undigestable 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

1. Power Point CD – Natural History of Black-footed Albatross
2. LCD projector/ or use .html version and load onto computers that have a web browser on them. You don't need to connect to internet, but presentation will use browser to play.
3. Color photos of contents of dissected bolus (PDFs on CD; 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) or Jennifer Stock (Jennifer.Stock@noaa.gov) 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

Activity 9.0 – 12.0: High School extensions for Activity 8.2a "Are Seabirds What They Eat? Plastics and Seabirds"

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

Extension of Results and Reflection:
Summarize results of the **Albatross Bolus Worksheet: Sorting for plastic by color and size** (adopted from Charles Moore, Agalita Marine Research Foundation and Bill Henry from University of California, Santa Cruz) 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).

ALBATROSS BOLUS PROTOCOL

(Courtesy: Charles Moore Algalita Marine Research Foundation & Bill Henry, UCSC)

1. The Albatross boluses are kept in the freezer. Remove one.

2. Each bolus has two worksheets, one for plastic type and one for plastic color. Fill in the top of each worksheet for that bolus.

3. Take pictures of bolus before it is sorted.

4. Sort into separate dishes: plastics, squid beaks, pumice, and other items that may have been part of the diet of the bird. All this will be weighed later. Check any rocks or larger items by floating them in seawater to see if they float. If they float they are pumice. Some non-floating rocks may also be found in the bolus, which the chicks may have picked up from the ground surrounding the nest. They will be covered with other condensed stomach contents. All stomach contents should be picked apart to find out what is in the condensed matter. Sort the plastic by type. The categories to be used are; identifiable objects, fragment, line, foam, pellets, and film.

5. Sieve each type of plastic for size class. The size classes are > 4.75 mm, 4.75 - 2.80 mm, 2.79 – 1.00 mm, and < 1.00 mm. Wash?

6. Any debris that may have come from the nest or surrounding area, that is not part of the bolus, is to be kept separate. This debris will be stored separately and not weighed, but needs to be identified and verified by the Quality Assurance Officer.

7. Have Quality Assurance Officer check the sorted bolus.

8. Take pictures of sorted bolus.

9. Record the count for each plastic type by size class and each non-plastic item type on the Worksheet: "Plastic by Type." One of the non-plastic item types will be squid beaks. Only record the number of squid beak tips, the squid beak debris weight will be added to the weight of the squid tips on the data sheet.

10. Weigh each plastic type by size class and each non-plastic item then record each weight on the Worksheet: "Plastic by Type."

11. Sort the plastic for each size class by color and record the count on the Worksheet: "Plastic by Color."

12. Each group of the sorted non-plastic items will be stored in whirlpak bags. Plastics will be kept in glass vials. Label each whirlpak bag with a fine tipped black felt maker with the following information.

    Albatross Bolus
    Island and Sample Number
    Date collected
    Item description (ex. Squid beaks)
    Count (number of items)
    Total weight of items

    Make sure there is a whirlpak bag for each non-plastic category on the data sheet. Place all whirlpak bags of each bolus into a larger bag labeled with the Island and Sample Number and number of bags it contains. **Place bolus back in freezer**.

13. Store each size class for each plastic type in a separate vial. Label each vial with the following information:

    Albatross Bolus
    Island and sample number
    Date collected
    Plastic – "type"
    Size class
    Count
    Weight

    Verify that there is vial for each size class for each plastic type.

14. Notify Quality Assurance Officer you are finished and would like to have your work verified.

Albatross Bolus Investigation Data Sheet

Investigators: *Date:*

BOLUS #: ***Species (if known):*** ***Location (if known):***

TOTAL NUMBER ITEMS IN BOLUS:		
NATURAL PREY ITEMS	Count	Percent of Total (Count/Total)*100
NON-NATURAL ITEMS		
RECOGNIZABLE WHOLE PLASTIC ITEMS (e.g.bottle caps)	Count	Percent of Total (Count/Total)*100
PLASTIC FRAGMENTS (group into size, shape, & color)	Count	Percent of Total (Count/Total)*100
Small (<10 mm)		
Medium (<20 mm, > 10mm)		
Large (>20 mm, <50 mm)		
Extra large (>50 mm)		
OTHER NON-NATURAL ITEMS e.g. fishing line	Count	Percent of Total (Count/Total)*100
TOTALS	Count	Percent of Total (Count/Total)*100
Natural items		
Non-natural items		
Comments & Notes		

Summary of Bolus Investigations: Percent Similarity Index (PSI)

Directions: 1) Calculate % numerical abundance (NA) for each item in a pair of boluses (% NA = count/total*100); 2) Calculate PSI by chosing smallest value (%) each item and enter value at right; sum to obtain overall PSI.

	Bolus #		Bolus #		PSI
	Count	% NA	Count	% NA	
Squid beaks					
Fishing line					
Whole plastic items e.g. bottle caps					
Extra large plastic fragments (>50 mm)					
Large plastic fragments (>20 mm and < 50 mm)					
Medium plastic fragments (<20 mm and >10 mm)					
Small plastic fragments (<10 mm)					
Other					
Total					

Comments:

Question: 1) How similar/dissimilar were the boluses? Explain

Summary & Conclusions:

NOTE: Total PSI values of 100 indicate 100% overlap; values of >80% can be considered similar

Summary of Bolus Investigations: Percent Similarity Index (PSI)

Directions: 1) Calculate % numerical abundance (NA) for each item in each bolus (% NA = count/total*100)

2) Calculate PSI by chosing smallest value (%) of each item and enter value at right; sum to obtain overall PSI.

DUMMY DATA

	Bolus #1		Bolus #2		PSI
	Count	% NA	Count	% NA	
Squid beaks		0		0	
Fishing line		0		0	
Whole plastic items e.g. bottle caps		0		0	
Extra large plastic fragments (>50 mm)		0		0	
Large plastic fragments (>20 mm and < 50 mm)		0		0	
Medium plastic fragments (<20 mm and >10 mm)		0		0	
Small plastic fragments (<10 mm)		0		0	
Other		0		0	
Total	127		145		0 **PSI**

PSI SUMMARY TABLE			
	#2	#3	#4
#1			
#2			
#3			

Comments:

Question: 1) How similar/dissimilar were the boluses? Explain

Summary & Conclusions:

NOTE: Total PSI values of 100 indicate 100% overlap; values of >80% can be considered similar

Summary of Bolus Investigations: Percent Similarity Index (PSI)

Directions: 1) Calculate % numerical abundance (NA) for each item in each bolus (% NA = count/total*100)

2) Calculate PSI by chosing smallest value (%) of each item and enter value at right; sum to obtain overall PSI.

DUMMY DATA

	Bolus #1		Bolus #2		PSI
	Count	% NA	Count	% NA	
Squid beaks	47	37.00787	63	43.44828	37
Fishing line	4	3.149606	3	2.068966	2
Whole plastic items e.g. bottle caps	2	1.574803	5	3.448276	1.5
Extra large plastic fragments (>50 mm)	0	0	0	0	0
Large plastic fragments (>20 mm and < 50 mm)	4	3.149606	6	4.137931	3.1
Medium plastic fragments (<20 mm and >10 mm)	5	3.937008	8	5.517241	3.9
Small plastic fragments (<10 mm)	62	48.8189	55	37.93103	37.9
Other	3	2.362205	4	2.758621	2.3
Total	127		145		**88** **PSI**

PSI SUMMARY TABLE			
	#2	#3	#4
#1	88		
#2			
#3			

Comments:

Question: 1) How similar/dissimilar were the boluses? Explain

Summary & Conclusions:

NOTE: Total PSI values of 100 indicate 100% overlap; values of >80% can be considered similar