Bird Beaks

NOAA Office of Education
Oil Spill Workshop
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Created by
Stephanie Serra, Joan Turner, Tina Miller-Way
Discovery Hall Programs
Dauphin Island Sea Lab
Bird Beaks

Grade level

K-12 (can be adapted for all ages by selective inclusion of research on the natural history of specific bird species found in the area, by inclusion of extra detail on physiological effects and by exploring the impacts of changes in reproduction on population sizes)

Time Required

50 min

I. Course of Study

Alabama Course of Study (ALCOS)

Kindergarten, Life Science, Content Standard 6
   Compare size, shape, structure, and basic needs of living things.

1st Grade, Life Science, Content Standard 4
   Describe survival traits of living things, including color, shape, size, texture, and covering.

2nd Grade, Life Science, Content Standard 6
   Identify characteristics of animals, including behavior, size, and body covering.

3rd Grade, Life Science, Content Standard 13
   Describe ways to sustain natural resources, including recycling, reusing, conserving, and protecting the environment.

4th Grade, Life Science, Content Standard 5
   Describing behaviors and body structures that help animals survive in particular habitats.

4th Grade, Life Science, Content Standard 6
   Classify animals as vertebrates or invertebrates and as endotherms or ectotherms.

5th Grade, Physical Science, Content Standard 4
   Describing alternatives to the use of fossil fuels Examples: solar energy, geothermal energy, windmill, hydroelectric power, biomass.

5th Grade, Life Science, Content Standard 9
   Describe the relationship of populations within a habitat to various communities and ecosystems.

7th Grade, Life Science, Content Standard 1
   Describe characteristics common to living things, including growth and development, reproduction, cellular organization, use of energy, exchange of gases, and response to the environment.

9th – 12th Grade, Biology Core, Content Standard 11
   Classify animals according to type of skeletal structure, method of fertilization and reproduction, body symmetry, body coverings, and locomotion.

9th – 12th Grade, Biology Core, Content Standard 12
   Describe protective adaptations of animals, including mimicry, camouflage, beak type, migration, and hibernation.

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9th – 12th Grade, Biology Core, Content Standard 14
Trace biogeochemical cycles through the environment, including water, carbon, oxygen, and nitrogen. Relating natural disasters, climate changes, nonnative species, and human activity to the dynamic equilibrium of ecosystems.

9th – 12th Grade, Biology Core, Content Standard 16
Identify density-dependent and density-independent limiting factors that affect populations in an ecosystem.

9th – 12th Grade, Aquascience, Content Standard 6
Describe adaptations that allow organisms to exist in specific aquatic environments.

9th – 12th Grade, Aquascience, Content Standard 7
Describe processes and environmental characteristics that affect growth rates of aquatic animals.

9th – 12th Grade, Environmental Science Elective Core, Content Standard 1
Identify the influence of human population, technology, and cultural and industrial changes on the environment.

9th – 12th Grade, Environmental Science Elective Core, Content Standard 2
Evaluate various fossil fuels for their effectiveness as energy resources.

9th – 12th Grade, Environmental Science Elective Core, Content Standard 12
Identify positive and negative effects of human activities on biodiversity.

9th – 12th Grade, Marine Science Elective Core, Content Standard 7
Identify patterns and interrelationships among producers, consumers, scavengers, and decomposers in a marine ecosystem.

9th – 12th Grade, Marine Science Elective Core, Content Standard 11
Describe positive and negative effects of human influence on marine environments.

9th – 12th Grade, Zoology Elective Core, Content Standard 7
Explain how species adapt to changing environments to enhance survival and reproductive success, including changes in structure, behavior, or physiology.

9th – 12th Grade, Zoology Elective Core, Content Standard 8
Identifying causative factors of decreasing population size.

National Science Education Standards:

Life Science E.C.1 Characteristics of Organisms
Life Science M.C.5 Diversity and adaptations of organisms
Life Science H.C.6 Behavior of organisms

Ocean Literacy Standards

Essential Principle 5 The ocean supports a great diversity of life and ecosystems.
Essential Principle 6 The ocean and humans are inextricably interconnected.
II. Concepts

The *Deepwater Horizon* oil spill flowed unstopped for three months in 2010. The spill began April 20, 2010, after an explosion that killed 11 men and injured 17 others. On July 15, 2010, and after several attempts, the well was capped and the leak stopped. The relief well was permanently sealed on September 19 and the well declared sealed. Estimates indicate that a total of 4.9 million barrels of crude oil were released. This volume consisted of both sweet Louisiana crude oil (a lighter weight oil) and natural gas. Beaches from Louisiana to Florida reported oil on shore. Because of the dynamic environment of a sandy shoreline, some of the oil was covered by layers of sand before it was cleaned up. One can still find oil buried on some beaches along the Gulf Coast.

The oil rig that blew up and resulted in the *Deepwater Horizon* event was located approximately 50 miles southeast of the Mississippi Delta (28° 44.20′ N and longitude 88° 23.23′ W), just beyond the edge of the continental shelf of the Gulf of Mexico. The Gulf of Mexico is home to many species of plants and animals that were affected by this spill. Initially the media focused on the spill’s impact on birds, likely because of the relative availability to and emotional impact of photos of oiled birds. According to US Fish and Wildlife a total of 3,046 birds were collected alive, 6,147 birds were collected dead, and 1,252 were successfully released during the clean-up of the *Deepwater Horizon* oil spill.

The birds most easily seen by the public visiting Gulf coast beaches are shorebirds. Shorebirds show a wide and fascinating variety of beak shapes and lengths. The shape of a bird’s beak can tell us about what and how it eats (the study of this relationship is referred to as *functional morphology*, or more simply by the adage – forms follows function). There are many species of shorebirds that feed by probing their beaks into sand and mudflats. The length of the beak generally indicates the depth of sand or mud from which that species feeds. A bird with a very short beak like the *semipalmated plover* (pictured below) found on Dauphin Island beaches will pick small crustaceans off the surface of the sand. *Sanderlings* or *red knots* (pictured below), which are common on Dauphin Island during migration, have slightly longer beaks and feed by probing the sand or mud for small animals living just below the sand’s surface. The *whimbrel* and *short-billed dowitcher* (pictured below) found on Dauphin Island feed by probing their long beaks deeper into the sand, catching worms, clams and crustaceans. Even longer billed species such as the *black necked stilt* and *avocet* (pictured below) which are occasional visitors to our beaches, have amazingly long beaks that they use to probe deeply into the sand or mud.

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Thus, if we were to diagram these shorebird species and the depth at which they feed, it might look something like the figure below.

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Researchers have investigated the effects of oil spills on birds found around aquatic habitats. During an oil spill, feathers absorb oil, become matted, and lose their insulating ability and water repellency. Without these critical functions, the birds cannot fly, they cannot regulate their temperature (recall that birds are endothermic or warm-blooded animals) and they have lost their natural waterproofing. The birds experience hypothermia and spend abnormal amounts of time preening (cleaning their feathers). Unless rescued, oiled birds typically die from hypothermia, starvation and drowning.

Birds preen to keep their feathers clean and functional. During preening, the birds ingest anything coating the feathers, including oil. Researchers have documented at least three effects of ingested oil on birds, both short-term and long-term effects. First, the reproductive ability of the bird is compromised. Embryos are very sensitive to oil that contaminates the shell: amounts as small as 1-10 uL, can cause death to the embryo. This occurs not because the embryo suffocates, but because the oil is toxic. Additionally, birds are less fertile as energy is diverted from reproduction to dealing with the stress. Over a longer period of time, these effects will result in decreases in population size, fewer birds. The DDT-pelican story dramatically illustrates this effect. Secondly,
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birds are ingesting toxic compounds. Recall that oil is a mixture of many different compounds, some of which are toxic. Ingestion of toxic compounds causes gastrointestinal irritation and hemorrage as well as impaired kidney and liver function. Necopsies of birds from oil spills have shown enlarged kidneys and shrinking of associated tissues. The metabolic stress casued by this ingestion results in decreased immune function and makes the bird more susceptible to other infections. Aspergillis, a fungal disease common in birds, has been found to be responsible for some mortality that occurs even after birds have been rescued and cleaned. Lastly, oil ingestion has been shown to damage red blood cells. What do red blood cells do again? Hemolytic anemia, a condition that happens when there are not enough red blood cells circulating to supply the oxygen needs of the animal, has been found to occur days and weeks after oil ingestion.

Now think about what happens to beaches during an oil spill. Tidelines on sandy beaches are very dynamic; sand is constantly being picked up and moved around by the wave energy. Over several tidal cycles or after a storm event, shells, drfitwood, beach wrack and even human trash can get covered by layers of sand and become ‘invisible’ at the surface. The same is true for oil that washes in on the beach. The photographs below show layers of oil from the Deepwater Horizon event, buried below the surface of an otherwise ‘clean’ looking beach. These pictures are from research done by Dr. Markus Huettel at Florida State University and Dr. Joel Kostka from Georgia Institute of Technology. You can learn more about their research at http://myweb.fsu.edu/mhuettel/Projects/NSF_Oil.html.

III. Behavioral Objectives

The student will be able to:
Discuss human-environment interactions.
Describe the external anatomy and functional morphology of birds.
Explore the impact of buried oil on shorebird feeding.
Explain the impact of the Deepwater Horizon oil spill on birds.

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IV. Materials
- container (a large pan or individual cups based on class size)
- sifted sand, moistened
- molasses
- clear drinking straws
- ruler
- Sharpie
- scissors

V. Teaching/Learning Procedures/Instructional Procedures
- Prior to teaching this lesson: create your “beaches” by layering the sand and molasses in cups. Each cup can be a different “beach”. Layer the “oil” at different depths of the cups (some shallow, some deeper). You may even want to have a clean “beach.” Beaches need to be at least 3 in. deep.
- LABEL your beaches with a name or number to represent different beaches in the area (needed for data sheet)
- Cut straws to specific beak lengths of each bird species. The “beak” sizes are estimates and not the actual lengths of each species. Leave an extra inch on the straw for a “hand-hold”. Mark the measurement line on the straw with a Sharpie.
  - 0.5 in. represents the Plover
  - 2 in. represents the Red Knot and the Sanderling
  - 2.5 in. represents the Short-billed Dowitcher and the Whimbrel
  - 3 in. represents the Avocet and the Black-necked Stilt
- Discuss the Deepwater Horizon Oil Spill in the Gulf of Mexico. Show a map of the area affected. Ask students which animals were affected and how they were affected. Focus the students on the topic of birds.
- Discuss the shorebird species that feed by probing beaks in the sand. Use the pictures of the birds in the concepts section of this lesson.
- Give students 5 beaks of the same bird species and the data sheet.
- Have students insert the beak into the “beach” up to the measurement line. With a finger on top of the straw’s upper opening, remove the straw from the “beach”. Upon removal the student will be able to see “oil” through the clear straw.
- Use the ruler to determine the depth of “oil.” Have students record this data on the data sheet.
- Have students visit 5 different “beaches” and record data from each beach.
- The data at the end can be combined to create a report for clean/oiled beaches and population counts of birds affected/unaffecte.
- Describe the number of ingestion ‘events’ for each species relative to its beak length. Are some species more likely to ingest oil than others? Which one(s)?
- Discuss the impact of ingested oil on bird survivorship and reproduction rates relative to the number of ingestion ‘events’. Explore the implications of these sublethal effects on population size.

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VI. Resource Materials

Articles about birds:

http://www.dcnr.state.al.us/watchable-wildlife/what/birds/shorebirds/

http://www.weeksbay.org/photo_gallery/shorebirds/shorebirds.htm


Information about oil ingestion on feathers and bird survival and reproduction:
*The toxicity of petroleum oils to birds.* Leighton, F.A. Environmental Reviews, 1993, 1:(2) 92-103, 10.1139/a93-008.


http://www.owcn.org/about-oiled-wildlife/effects-of-oil-on-wildlife

http://oils.gpa.unep.org/facts/wildlife.htm

VII. Lab Activity (data sheet)

1. Measure your bird beak (straw) using the ruler above. Record your measurement in inches and centimeters. ___________ in ____________ cm

   Circle your category of birds listed below.
   - 0.5 in. represents the Plover
   - 2 in. represents the Red Knot and the Sanderling
   - 2.5 in. represents the Short-billed Dowitcher and the Whimbrel
   - 3 in. represents the Avocet and the Black-necked Stilt

2. Beach code __________
   Poke the beak into the beach. Use the ruler above and measure the depth of the oil in centimeters. ________________

3. Beach code __________
   Poke the beak into the beach. Use the ruler above and measure the depth of the oil in centimeters. ________________

4. Beach code __________
   Poke the beak into the beach. Use the ruler above and measure the depth of the oil in centimeters. ________________

5. Beach code __________
   Poke the beak into the beach. Use the ruler above and measure the depth of the oil in centimeters. ________________

6. Beach code __________
   Poke the beak into the beach. Use the ruler above and measure the depth of the oil in centimeters. ________________

7. Out of 5, how many of your bird species ingested oil? ____________________________
8. Of the entire bird community (4 species), how many of your bird species ingested oil?

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9. Describe the number of ingestion ‘events’ for each species relative to its beak length. Are some species more likely to ingest oil than others? Which one(s)? Explain.

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10. Imagine that each ‘beak’ represents 100 individuals. What effects would oil ingestion have on population size of the different shorebird species? Would some species be more affected than others?

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