Adaptations

Concepts

- Shorebirds, like other animals, are adapted in three ways to survive: physically, physiologically, and behaviorally.
- Shorebirds have many physical, or morphological, adaptations to help them walk, find food, hide, reproduce, and fly long distances during migration.
- Shorebirds are also adapted physiologically to their migrating lifestyle, particularly in their fat-loading abilities which enable them to store energy for long flights.
- Adaptations are naturally selected over a long period of time, and specialized animals like shorebirds cannot adapt overnight to damage or alteration of their habitat.

Activities

Build a Shorebird

(lower elementary)

Students will learn about the physical adaptations unique to shorebirds by dressing up a volunteer with bird "adaptations" that gradually transform him or her into a bird--and then into a shorebird. They will discover that shorebirds are a diverse group of birds designed to feed and nest in specific habitats. They will become familiar with some of the most common threats to shorebird survival.

What Can I Eat with This Beak?

(lower elementary, upper elementary/middle school)

Students collect a variety of simulated shorebird food items, using "tools" that represent four different shorebird beak designs. Then they determine which type of food their beak was designed to collect by sorting and identifying which food items they were most successful at catching.

Avian Olympics

(upper middle school/high school)

By competing in physical and math/science activities, students come to understand that shorebirds are incredibly adapted to long distance migration.

Build a Shorebird

Adapted from *Learn About Seabirds.* U.S. Fish and Wildlife Service.

Grade level: lower elementary
Duration: one 40 to 60-minute class period.
Skills: vocabulary, discussion, visualization, comparing similarities and differences
Subjects: science and history

Concepts:

- Shorebirds, like other animals, are adapted in three ways to survive: physically, physiologically, and behaviorally.
- Shorebirds have many physical, or morphological, adaptations to help them walk, find food, hide, reproduce, and to fly long distances during migration.
- Adaptations are naturally selected over a long period of time, and specialized animals like shorebirds cannot adapt overnight to habitat damage or alteration.

Vocabulary

- adaptation
- physical adaptation
- behavioral adaptation
- guano
- habitat
- market shooting
- habitat loss
- plumage
- down feathers
- contour feathers
- migration
- camouflage
- invertebrate

Overview

Students will learn about the physical adaptations unique to shorebirds by dressing up a volunteer with bird "adaptations" that gradually transform him or her into a bird-and then into a shorebird. They will discover that shorebirds are a diverse group of birds designed to feed and nest in specific habitats. They will become familiar with some of the most common threats to shorebird survival.

Objectives

After this activity, students will be able to:

- Define the term adaptation
- Describe three adaptations unique to birds
- Describe three adaptations unique to shorebirds
- Name the most significant threats shorebirds face today
- Name two other human related activities harmful to shorebirds

Materials

- Red, yellow, and blue student flash cards (provided in this activity)
- Down jacket or vest
- Pictures of down and contour feathers
- Two large paper bird wings
- Several drinking straws or toilet paper tubes
- Chicken bone
- Balloons
- Camouflage patterned hat, vest or cloth
- Large enough piece of blue felt or paper to stand on
- Spray bottle
- Scissors
- Duct tape
- Cardboard bill or tweezers tied on a string necklace
- Empty baby oil bottle
- M&Ms or gummy worms
- Popcorn
- String (20-40 feet)
- Black paper oil splashes
- Blue paper wetland
- 6-pack can rings or a net
- Clothespins

Optional

- Electric fan
- Rubber boots or waders

Introduction

Most shorebirds are uniquely *adapted* to living in open spaces that also provide an abundant source of *invertebrate* foods. Their adaptations are both *physical* (the way they are built) and *behavioral* (the way they act). This activity focuses on the physical adaptations of birds--and then specifically of shorebirds: their *down* and *contour feathers*, hollow bones, air sacs, long and pointed wings, *camouflage plumage*, long legs and toes, specialized bills, and oil glands.

Migration itself is considered an adaptation that enables shorebirds to take advantage of the abundant Arctic food resources in the spring and summer yet escape to more hospitable southern climates for the winter. Unfortunately, migration also exposes these birds to a wide variety of threats along the way. *Habitat loss*, oil contamination, disturbance, and trash are just a few examples.

For more information shorebird adaptations go the *Shorebird Primer*.

Activity Preparation

1. Gather the materials listed. Consider enlisting help from your students.
2. Assign your students or a parent volunteer to construct:

- one student-sized set of paper wings (to be cut and modified during the activity)
- one blue paper wetland to stand on
- one cardboard bill
- several black construction paper cut-outs of oil spills

3. Photocopy on cardstock and then cut out the activity flash cards (included here) in the colors shown below. There should be enough so that every student except the bird volunteer has at least one card. For large classes, students can share a card; on person reads the card the other attaches the adaptation to the "bird".

- General Bird Adaptation Cards - yellow
- Special Shorebird Adaptation Cards - blue
- Threats to Shorebird Cards - red

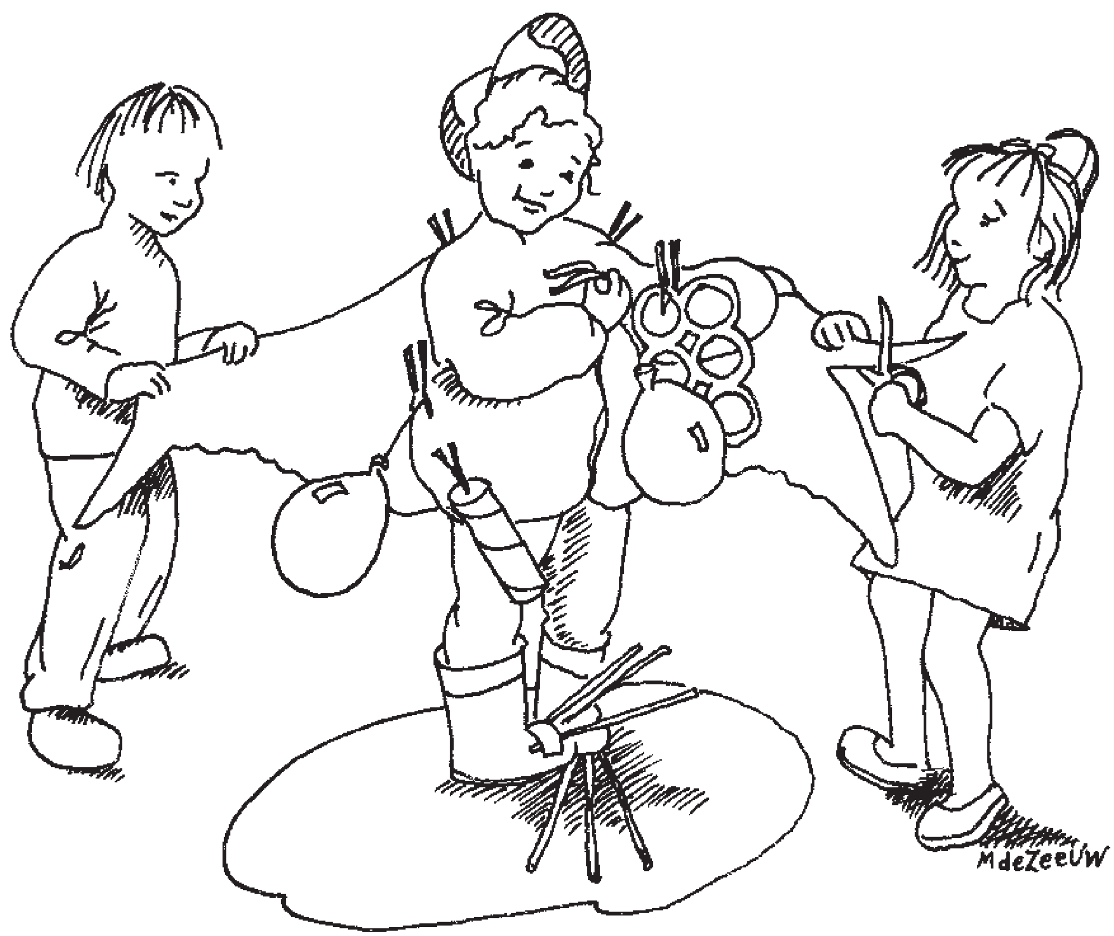
Procedure

1. Explain the term *adaptation* (a physical or behavioral characteristic that has evolved over time to help a species survive and reproduce in the environment where it lives). Tell the students that they will be exploring the world of shorebird adaptations by building a shorebird.

2. Ask for a volunteer. This person will be turned first into a bird, then into a shorebird, and finally into a Western Sandpiper. He or she will also be subjected to some threats a shorebird may face.

3. Distribute all the flash cards to the students. Tell them as you describe what is needed by the bird, they should look at their flash cards and raise there hand if they have the adaptation you are describing. They will place their adaptation on the "bird" using clothespins.

4. Begin to transform your volunteer into a bird with the *yellow flash cards*. Use the Teaching Notes 1-4 to guide the students through the activity. Repeat this process until all the yellow cards have been read and the adaptations added to the volunteer



Teacher Notes: General Bird Adaptations (Yellow Cards)

Adaptation	*Description*	*Material Needed*
1. Down Feathers Ask students to imagine they are birds in flight. How does it feel to be soaring above the earth? Is it cold? Is skin enough to insulate you up there? You will have had to adapt to temperature extremes. How? With feathers. **2. Contour Feathers** What sort of material is strong and flexible enough for the wings and tail to help you fly?	Feathers are a unique adaptation found only in birds. All birds have two kinds of feathers: 1) *Down feathers* — a kind of bird underwear — fluffy, under-feathers for insulation 2) *Contour feathers* — strong outer feathers for flight that are also the bird's clothes and coloration	Dress bird in *down jacket* and *bird wings*. Study *comparison pictures of down and contour feathers*.
3. Hollow Bones Ask students to think about how much they weigh. How much do you think a Bald Eagle weighs? It only weighs between 8–14 lbs. and has a 7–8 ft. wing span.	Hollow bones reduce weight. Most of the bird's weight is in the breast and wings (where the flight muscles are). Our bones are not hollow but instead are filled with marrow for red blood cell production. Birds have marrow only in their breast bone.	Attach *drinking straw* or *cardboard paper roll* to down jacket. Pass *chicken bone* around for the students to examine.
4. Air Sacs Ask a volunteer to stand up and become a crow by flapping his or her wings 20 times in 10 seconds. Does flapping like a bird make you breath faster than just walking? Yes!	Air sacs help birds take in enough oxygen for rigorous flight. Birds have lungs like we do, but that is not enough. Air sacs, like balloons, extend from the lungs, between and into hollow bones. During inhalation and exhalation, air flows through the lungs and the air sacs to maximize the absorption of oxygen.	Attach the *balloons* with clothespins to your volunteer. Each student with a yellow card places one balloon on the bird.

Teacher Notes: Special Shorebird Adaptations (Blue Flash Cards)

Adaptation	*Description*	*Material Needed*
5. Long, pointed Wings Think about the different shapes of bird wings. Why do penguins have short, stubby wings while an eagle has big, broad wings? Do you think that wing shape might be related to the bird's lifestyle?	Shorebirds migrate (fly long distances) between their habitat where they breed and the habitat where they winter. Long, pointed wings help shorebirds fly fast over such long distances. There wings also allow them to do aerial maneuvers to escape predators.	Use the *scissors* to shape the tip of the volunteer's paper wings so they look long and pointed.
6. Camouflage Plumage How can a small bird protect itself from larger predators? Would small shorebirds have much luck fighting with hawks on the beach or with foxes on the tundra?	Cryptic coloration, or camouflage, makes birds less conspicuous. Their brown, black and white plumage blends in well with their habitat--mudflats, beaches, or grassy tundra. Larger shorebirds, like avocets and oystercatchers, cannot hide as easily and therefore are not so camouflaged.	Place the *camouflage clothing* on the bird.
7. Long Legs Do you need long legs to sit in a tree, fly, or walk? How about running from the waves? What do humans use to walk and work in wet conditions?	Shorebirds seldom perch in trees but rather walk or roost on the ground. Many shorebirds walk on shorelines or mud to find food. Having long legs helps them wade through water or mud. (The length of the legs of a shorebird gives a clue to where it feeds.)	Place the *blue material* representing a wetland on the ground for the shorebird to walk on. Optional: Put the *rubber boots/ waders* on the bird.
8. Long Toes What are your toes for? Toes are for stability in walking.	Most shorebirds do not spend much time swimming. Therefore, they do not need webbed feet, just long toes for stability and walking.	Using duct tape, attach three long *drinking straws* to each toe of the bird.

5. Now, explain that the class is going to continue adding adaptations, this time with adaptations unique to shorebirds. Clarify to your students that shorebirds are birds of open spaces that fly long distances (migrate) to between their breeding and nonbreeding habitats.
6. Spray the volunteer lightly with the water spray bottle and have them stand on the blue felt or contruction paper. Our bird is now a wetland-loving shorebird.
7. Continue with using the Teaching Notes 5–11 to guide the class through the *blue flash cards*.

Teacher Notes: Special Shorebird Adaptations (Blue Flash Cards)

Adaptation	*Description*	*Material Needed*
9. Bills What do people use to feed themselves—(forks, straws, chopsticks, fingers, lips, teeth, etc.)? Do you use different things to help you eat different types of foods?	Bills, or beaks, are used for picking up food, nest construction, courtship, preening, and defense. Curlews probe deeply into the ground with their long, curved bills. Plovers and Surfbirds have short, stout bills to pick up prey they spot on the surface of sand or rocks. Sanderlings have tapering, tweezer-like bills to help them “stitch” the sand—(a rapid, repeated probing) to pull up worms and crustaceans right below the surface of the beach.	Attach a *cardboard bill* to the volunteer or tie *tweezers* on a string necklace around the neck of the “bird” to represent the shorebird’s bill. Place *gummy worms* in the mouth of the volunteer. These represent the segmented worms or the long, stretchy nemertean worms that some Sandpipers like to eat. You may also feed the bird *M&Ms* or other candy-coated treats, representing crunchy-coated invertebrates.
10. Oil Glands Pour oil (cooking or other colored oil) and water into a beaker and observe the separation. Does the oil get wet? What does “get wet” mean? “Wet” means saturated with water. Ask students how they keep dry in the rain. Is rain gear treated with any special coating? Yes!	The oil glands help keep shorebirds’ feathers waterproof. Feathers are kept clean and smooth by constant preening with oil from the oil gland found above the base of the tail. The oil is transferred to the plumage (feathers) with the bill or the back of the head.	Attach the *baby oil bottle* to the back of the down jacket. Ask the bird to try to preen!
11. Guano Imagine all the shorebird droppings left behind by the large migratory flocks of birds! Do you think there is any value to guano?	Guano from shorebirds, just as from other birds and bats, contributes to the chain of life. Tiny plants and animals use guano nutrients. They in turn become food for small fish, crustaceans, and other animals that shorebirds and even people eat.	Sprinkle the *popcorn* around the volunteer shorebird.

Congratulations your class has built a shorebird!

Teacher Notes: Threats To Shorebirds (Red Cards)

Threat	*Description*	*Material Needed*
12. Habitat Destruction Define the term *estuary* and *wetland*. Have you seen any shorebirds around your area? What kind of habitat is it? Is there any threat of it being destroyed? If there is not a local concentration of shorebirds, another well-known local animal can be substituted for the discussion.	Most shorebirds depend on habitat in three areas: breeding, nonbreeding, and migration stopover sites. Wetlands, estuaries in particular, are important stopover sites. They are also very attractive to humans as a source of water or home sites. Water is drained away or its course altered, and bridges, houses, and docks are built. Animals and plants that provide food and shelter for the shorebirds are destroyed.	Restrict the habitat available to the shorebird flock by penning it in with *desks* or by winding *string* around the student birds to tie them together. Now pass out *gummy worms* to all shorebirds that have habitat. What about everyone else? Can we make new habitat? How can we fix ruined habitat?
13. Oil Contamination	Oil spills kill shorebirds and destroy their habitat for many years.	Pin *oil splashes* on the volunteer shorebirds.
14. Disturbance How could disturbance harm a shorebird or flock of young birds? Can you think of some examples of disturbance? (planes, people coming too close to nesting shorebirds, Jet skis, pets)	If flocks are disturbed and cannot refuel with food at their traditional stopover points, they may not have another chance to find enough food for their long migrations.	Have the students make noise to simulate ATVs or motorcycles. Alternatively, turn on the *electric fan* and point it toward the flock to simulate a disturbance.
15. Trash Have you ever seen trash littering our wetlands? Where did it come from? Remember to put trash in cans, cut up plastic rings and long strings, and dispose of tangled fish line at home.	Plastic debris and other trash can be mistaken for food. Shorebirds can also get tangled in discarded fish line and six-pack can rings. Abandoned cars, appliances, and other trash items can leak poisons into wetlands.	Place netting or plastic six-pack rings somewhere on the sandpipers.

8. Now discuss the importance of shorebird scat (guano). Sprinkle the popcorn around the volunteer shorebird. Guano from shorebirds, just as from other birds and bats, contributes to the chain of life. Nutrients from guano area returned to the wetlands that the shorebird uses. The (elemental and molecular) nutrients in guano are made available for manufacture of food by tine plants and plankton. These "food makers" (photosynthesizers) become food in turn for small fish, invertebrates, and other animals. The food web is continued, and eventually includes the shorebirds and even humans. Every organism, and its activities, has a part in the chain of life on our planet.

9. Now turn the volunteer into a Western Sandpiper that is part of a huge flock. Western Sandpipers are very small Arctic-nesting shorebirds familiar to many people because of their huge migratory flocks. Select a few students to join the volunteer shorebird, perhaps holding hands to create a flock of Western Sandpipers. If you do not have Western Sandpipers in

your area (check the Shorebird Profile list in the Appendix), select another flocking shorebird, a Dunlin for example, to create a class flock. *Do not put students still holding red flashcards in the flock.*

10. Even with all these wonderful adaptations, life is not easy for a shorebird! In addition to the difficulties of migrating long distances over the ocean or in bad weather, shorebirds face many human-caused dangers. Market hunting has killed millions of shorebirds in the past. While it is illegal to kill and sell shorebirds today, other threats have grown significantly. Habitat loss is the biggest threat to shorebird survival today.

11. Now guide the students through the *red flash cards* that represent shorebirds threat. Explain to those students how to "carry out the threat" on the flock of students as directed in the Teacher Notes.

12. Wrap-up the activity using the question below.

What Makes a Bird a Bird?
Describe three unique adaptations of birds.
Feathers
Hollow Bones
Air Sacs

Describe three special adaptations of shorebirds.
Camouflage plumage
Long, pointed wings
Legs for walking, wading, and running
Bill for probing or picking

Why are shorebirds important?
Add diversity
Important part of food web, including prey for raptors and their guano fertilizes habitat

What is the most significant threat to shorebirds today?
Habitat alteration or loss

Name two other human-related activities that can be harmful to shorebirds.
Oil contamination (oil spills)
Trash
Disturbing birds from their nests, or while resting or feeding

Additional Activities

Build a Shorebird, Maya (activity sheet)
Have younger students complete the worksheet Build A Shorebird, Maya. Ask each student to write his or her own story about where Maya lives or develop the story together as a class. Ask them to color Maya so that she is well camouflaged for the habitat she lives in.

Comparing Wings
Have older students look for at least four different wing sizes and shapes found in birds of your area. Some examples might include pheasant, eagle, hummingbird, and tree swallow. Ask them to make drawings of the wing shapes they choose and compare the lifestyles, food habits, and habitat types of these birds.

Plumage Coloration
Have students work in small teams. Have each team select a shorebird from the Shorebird Coloring Pages in the Appendix. Make multiple copies of the coloring pages your students select. Using a bird field guide for reference, have them color a drawing for each of the birds' plumages (adult breeding, adult wintering, and juvenile). When everyone is done, compare the plumages of different species. Which have very different wintering and breeding plumages? Which are very similar? Do females always look like males?

Create Your Own "Super" Shorebird
Ask students to design their own shorebird to fit into the habitat of their choice. Explain to them that this bird does not have to resemble a real shorebird and that it does not have to live in a "natural" habitat. It does, however, have to be well adapted to its surroundings so it can find food, nest, and migrate. Instruct each student to write a brief bird biography that describes where it lives during the breeding and nonbreeding seasons, what it eats, and any special behaviors it has.

Build a Shorebird Student Activity Flash Cards Bird Adaptations

(Photocopy back-to-back on yellow cardstock.)

Bird Adaptation	Bird Adaptation
Down Feathers	*Contour Feathers*
Bird Adaptation	**Bird Adaptation**
Hollow Bones	*Air Sacs*

Build a Shorebird
Student Activity Flash Cards
Bird Adaptations

(Photocopy back-to-back on yellow cardstock.)

Bird Adaptation	Bird Adaptation
Strong outer feathers are used for flight. These are also the bird's clothes and coloration.	These are the fluffy under-feathers for insulation (the bird's underwear).
Bird Adaptation	**Bird Adaptation**
A lot of energy is needed to give birds energy to fly. Air sacs come from the lungs, between and into hollow bones. They help increase the amount of oxygen the bird can absorb.	These help a bird keep its weight low so it can fly.

Build a Shorebird Student Activity Cards Shorebird Adaptations

(Photocopy back-to-back on blue cardstock.)

Shorebird Adaptation	Shorebird Adaptation
Long Pointed Wings	Camouflage Plumage
Shorebird Adaptation	**Shorebird Adaptation**
Long Toes	Long Legs

Build a Shorebird Student Activity Cards Shorebird Adaptations

(Photocopy back-to-back on blue cardstock.)

Shorebird Adaptation	Shorebird Adaptation
Camouflage helps birds blend in with their surroundings so they are not easily seen.	Long, pointed wings are designed for long and fast flight.
Shorebird Adaptation	**Shorebird Adaptation**
Long legs help keep shorebirds dry as they wade through the mud and water looking for food.	Long toes help birds keep their balance while they walk on wet, slippery mud as they search for food.

Build a Shorebird Student Activity Cards Shorebird Adaptations

(Photocopy back-to-back on blue cardstock.)

Shorebird Adaptation	Shorebird Adaptation
Bill	Oil Gland
Shorebird Adaptation	**Shorebird Adaptation**
Guano	(blank)

Build a Shorebird Student Activity Cards Shorebird Adaptations

(Photocopy back-to-back on blue cardstock.)

Shorebird Adaptation	Shorebird Adaptation
The oil gland, found near the base of the tail, helps keep a shorebird's feathers waterproof.	Shorebirds use their bills for picking up food, building their nests, courtship, preening, and defense.
Shorebird Adaptation	**Shorebird Adaptation**
(blank)	Shorebird droppings, or guano, act like a fertilizer to the mudflats and waters where they feed

Build a Shorebird Student Activity Cards Shorebird Threats

(Photocopy back-to-back on red cardstock.)

Shorebird Threat	Shorebird Threat
Habitat Destruction	Oil Spill
Shorebird Threat	**Shorebird Threat**
Disturbance	Trash

Build a Shorebird Student Activity Cards Shorebird Threats

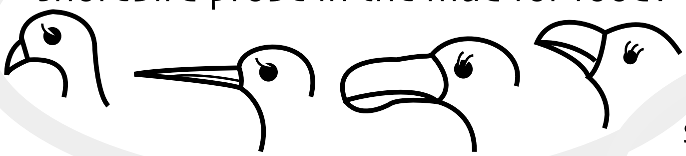
(Photocopy back-to-back on red cardstock.)

Shorebird Threat	Shorebird Threat
Oils spills can kill shorebirds and destroy their habitats.	Changing or developing wetlands can destroy the plants and animals that give shorebirds food and shelter.
Shorebird Threat	**Shorebird Threat**
Trash kills shorebirds. Some shorebirds confuse trash for food. They can get caught in fishing line, six-pack rings, and old fish netting.	Planes, boats, and people can scare shorebirds away from important feeding areas or chase them away from their nests.

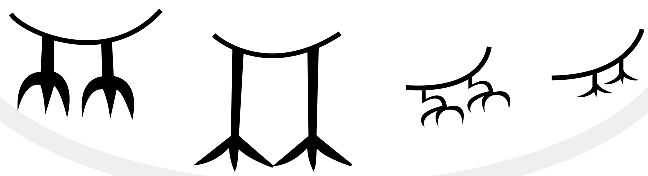
Add the beak, legs, feet and wings to

Build a Shorebird, Maya!

What **beak** would best help a shorebird probe in the mud for food?



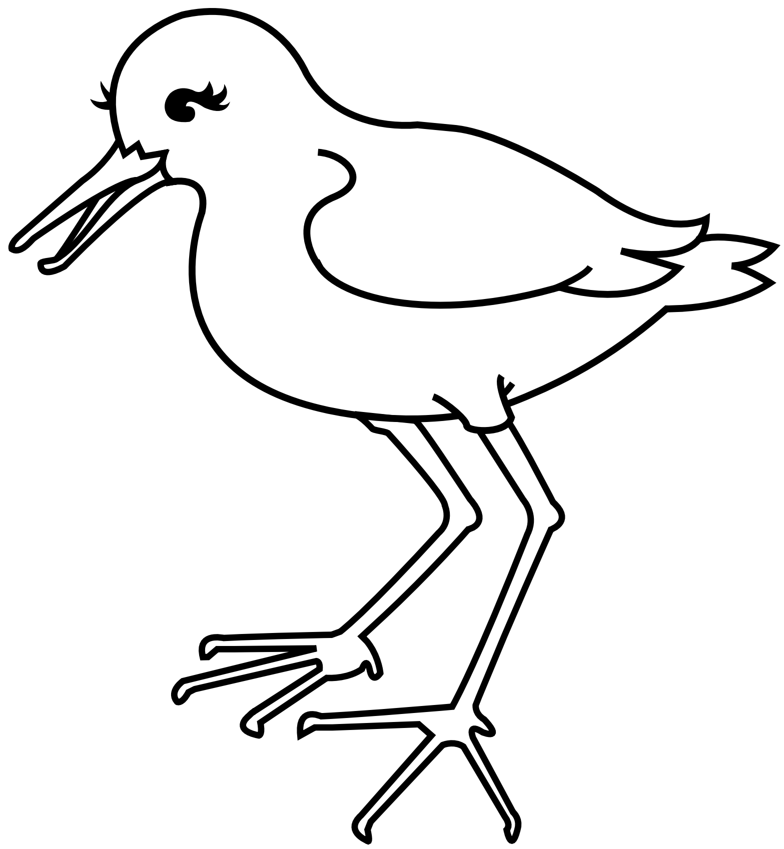
Which **legs** would best suit a shorebird for its wetland habitat?



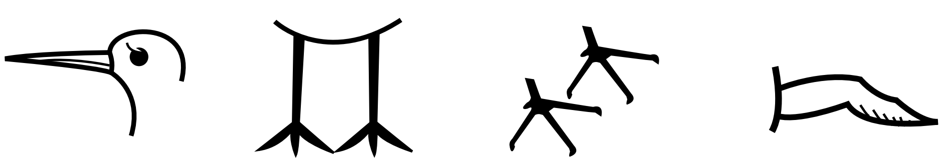
Which **feet** would best suit a shorebird for walking in its wetland habitat?

What type of **wings** help the shorebird fly long distance and escape quickly from predators?

Maya the Shorebird



Correct bird parts



What Can I Eat with This Beak?

Adapted from "Salt Marsh Manual: An Educator's Guide." San Francisco Bay National Wildlife Refuge.

Grade Level: lower elementary and upper elementary/middle school
Duration: one 40-minute class period.
Skills: comparison, evaluation, problem solving, discussion, vocabulary, visualization, and interpretation of data.
Subjects: science, math, language arts, and fine arts (additional activity)

Concepts:

- Shorebirds have many physical, or morphological, adaptations to help them walk, find food, hide, and reproduce in their habitat and to fly long distances during migration.

Vocabulary

- adaptation
- beak
- invertebrates
- coexist
- feeding success
- crustaceans

Overview

Students collect a variety of simulated shorebird food items, using "tools" that represent four different shorebird beak designs. Then they determine what type of food their beak was designed to collect by sorting and identifying which they were most successful at catching.

Objectives

After this activity, students will be able to:

- Describe how shorebird beaks are adapted for the foods they eat.
- Explain why many types of shorebirds may live in the same habitat at the same time.
- Match four common shorebirds to the foods they eat by looking at their beak design.

Materials (for a group of 30)

- *Shorebirds Across the Americas* poster (included in this education guide)
- Chalkboard/easel paper
- Beaks
  6 spoons
  6 pairs of scissors
  6 pairs of tweezers
  6 spring-type clothes pins
- Bird stomachs
  One paper cup per student
- Food items
  50 marbles (snails)
  100 toothpicks or cut pipe cleaners (worms)
  100 3/16" metal washers *(crustraceans)*
- One copy of the activity sheet *What Can I Eat with This Beak?*(included here) for each student.

Introduction

Mudflats are home to hundreds of different species of organisms that shorebirds eat. Most are *invertebrates*: worms, clams, snails, and crustaceans. Birds have different types of *bills* that allow them to eat different kinds of prey. Their bills are *adapted* to match their food types.

Many shorebirds have tweezer-like beaks. A bird with a "short tweezer" beak will take food near the surface of the mud while a "long tweezer" beak can reach animals that burrow deeper. Some birds like eagles and owls have tearing scissor-like beaks for ripping their food into bite-sized pieces. Other birds use their clothespin-like beaks to crush the hard covering of seeds. Chickadees and Pine Grosbeaks are two clothespin-beaked forest birds. The oystercatcher, a type of shorebird, has a beak that looks like a red clothespin for prying open mussels and chiseling limpets off rocks. Some birds have spoon-like beaks to scoop up small fish or strain plant material from the mud.

Since shorebirds eat different types of foods found in different places within a habitat, many different species can *coexist*. This is why you see many types of shorebirds feeding together in one area.

For additional information, read *Shorebirds Have Special Adaptations in Wetlands* found in the *Shorebird Primer*.

Procedure

1. Discuss with students the many different kinds of shorebird beak adaptations and how they relate to the foods that birds eat. What kinds of beaks have they seen? Show examples of beaks using the Shorebirds Across the Americas poster included in this education guide or your own pictures, study skins, masks, or puppets.

2. Hold up the beak "tools" one at a time and ask the students for examples of birds that have beaks similar to each "tool."

3. After the discussion, ask the class to imagine that they are a flock of shorebirds.

4. Have students count off in fours, with "ones" being spoon-beaks, "twos" being scissor-beaks, etc. Hand one "stomach" (paper cup) and one bird beak to each player.

5. Explain the rules:

   - Each shorebird (student) can only pick up food with its beak.

   - They have to drop the food into their stomachs (the paper cups).

   - Food may not be scooped or thrown into the stomach; the stomach must be held upright.

   - The teacher is a hawk that eats birds. Unruly behavior or violation of rules will result in the hawk capturing the

conspicuous bird and making it sit out for one round. (In reality, unusual behavior of a bird draws attention from a predator.)

6. Have students sit in a large circle (their habitat). Scatter one food type inside the circle and give the signal to start feeding. Feeding may occur only when a signal is given. One option is to simulate a normal feeding cycle. When the classroom lights are out, it is night and the birds are asleep. When the lights are on they can feed. Let them feed for a set time (up to two minutes). Turn off the lights as if the sun had set to signal when the birds should stop feeding.

7. Have similar beak-types get together and count the combined number of food items collected. Record the data for the entire class to see on one poster paper or the chalkboard as shown on the *Example Data Table*. Older students can record averages or graph beak efficiency (the number of items eaten for each beak type).

8. Repeat steps six and seven for each type of food.

9. To simulate a more natural feeding situation, mix all three food types together and let the "birds" gather food simultaneously. Record the data. The birds should first eat the food they can gather the easiest (as discovered in the earlier rounds), then switch to a secondary food item as it gets harder to gather their first choice.

10. Looking at the data table, discuss the following questions in class:

- Are some beaks better at getting a particular food item than other beaks? How does the feeding success (measured as number of items captured, or number of items per minute) change for each beak type as the food changes? Some birds eat food that lives in mud, some find food in water, and others eat plants. In which habitat does each of these beak types belong?
- Does having a different beak shape cause a bird to use it differently? Which beak types do shorebirds have? Which beak types do shorebirds not have? Why? Looking at the shorebird poster, can you find any other beak types besides the four studied in this activity?
- What other parts of the bird, besides its beak, are important to its feeding success (webbed or differently-shaped feet, length of neck, length of legs, etc.)? What differences do you detect in the feeding behavior of the birds when all food items are available at once? (Hint: More fighting or more relaxed and less fighting?)

11. Pass out a copy of the activity sheet What Can I Eat with This Beak? to each student. This activity sheet can also serve as an evaluation tool.

What Can I Eat with This Beak? Example Data Table

	Food Items			
Beak Type	*Worms*	*Snails*	*Crustaceans*	*All Food Types*
Tweezer				
Scissors				
Spoon				
Clothespin				

Additional Activities

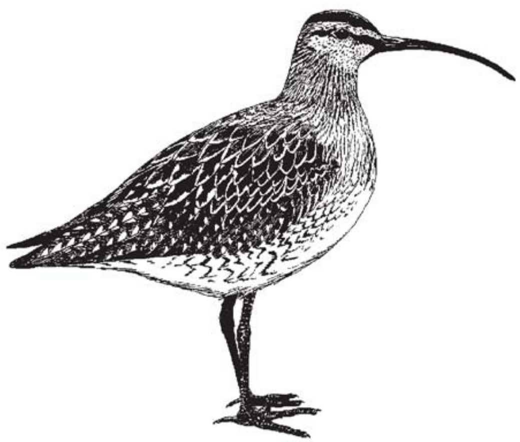
Cultural Connections
Have students research what people eat in one of the countries that shorebirds in their flyway migrate through.

Feeding Techniques
Have your students research different shorebird feeding techniques like probing, picking, crushing, and swirling. Give examples of local shorebird species that use these techniques to catch their food. Draw the bill shapes that go with each feeding technique.

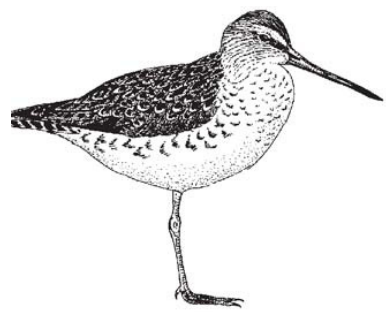
Create a Beak
Ask students to design their own shorebird beaks and then write an advertisement meant to "sell" the design to a shorebird. What could you eat with this beak? Where would you have to live? Are there any other adaptations required to use this design--for example, would you already need to have long legs or a long neck?

What Can I Eat With This Beak?

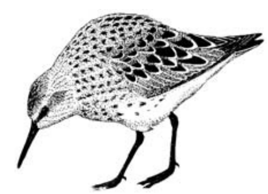
Activity Instructions:
In a wetland or on a beach food is everywhere.
Even though you cannot easily see it--shorebirds can!!!
Each shorebird species has a uniquely adapted beak to find its food.
Below is picture of a beach with food buried in the soil. Your task is to read the clues for each of the shorebirds species and choose which food item in the picture you think the bird is best adapted to eat.



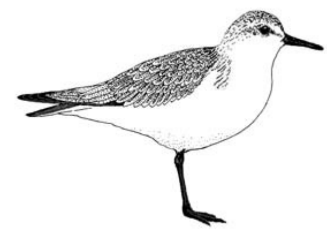
Whimbrel: I am a whimbrel. I use my down curved bill to probe very deeply into the mud for my food.



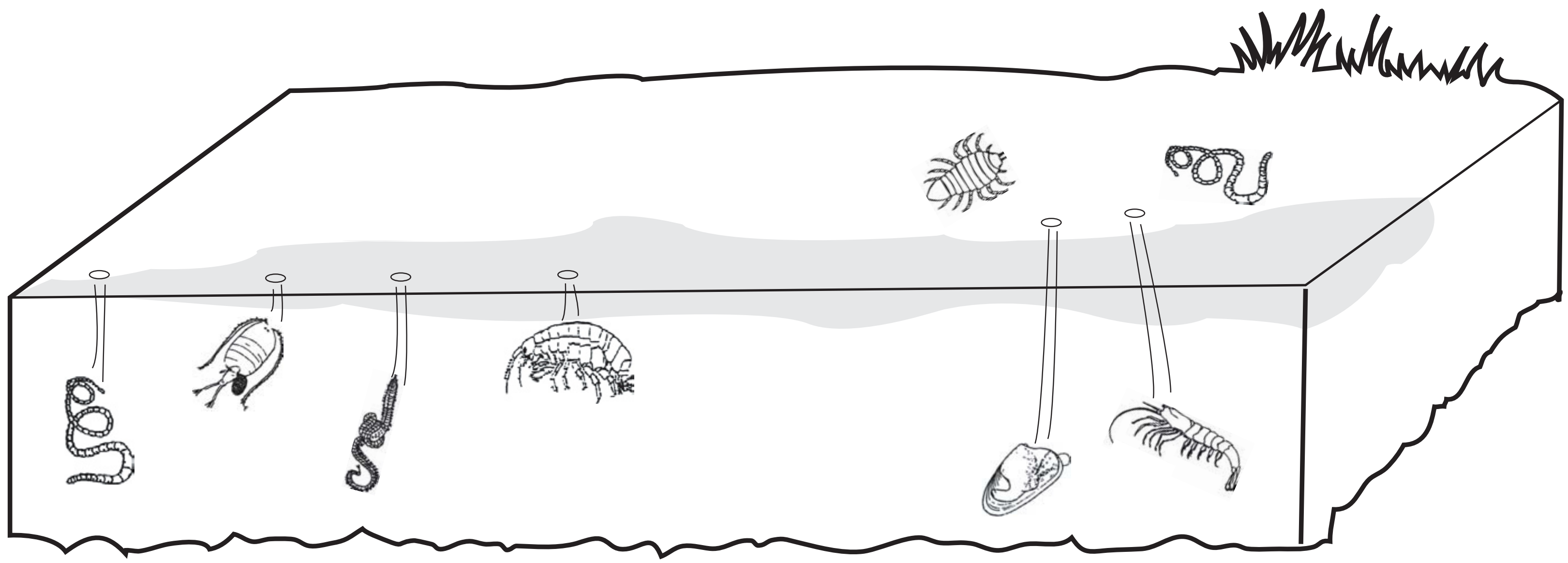
Long-billed dowitchers: The clue is in my name! I probe deeply in the mud for food.



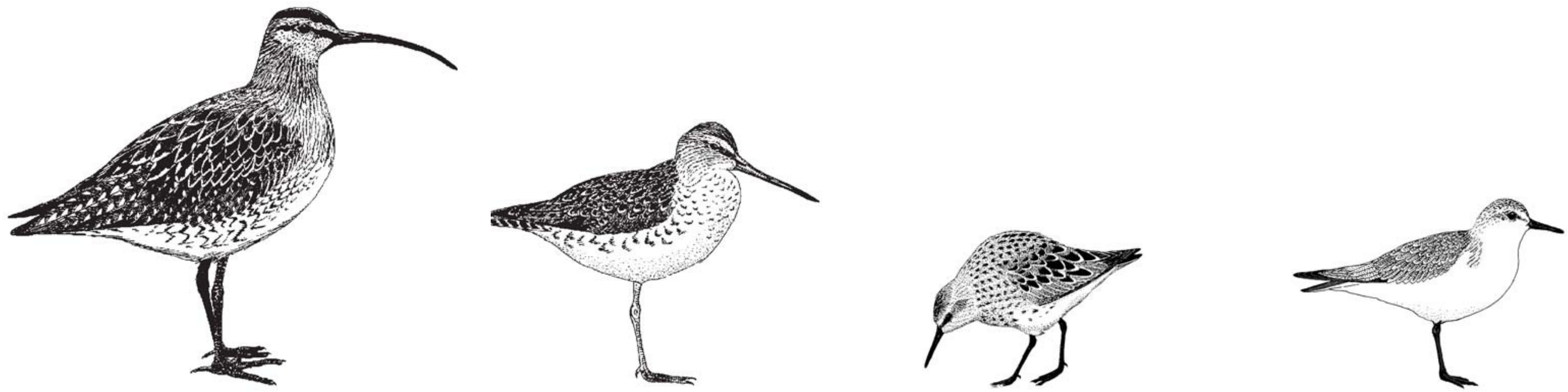
Western sandpipers: Some people think my beak looks like tweezers when i eat. I probe the mud near the surface.



Sanderling: I nab insects on the surfact of the soil with my beak.



What Can I Eat With This Beak? ANSWER SHEET



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Western sandpipers: Some people think my beak looks like tweezers when i eat. I probe the mud near the surface.

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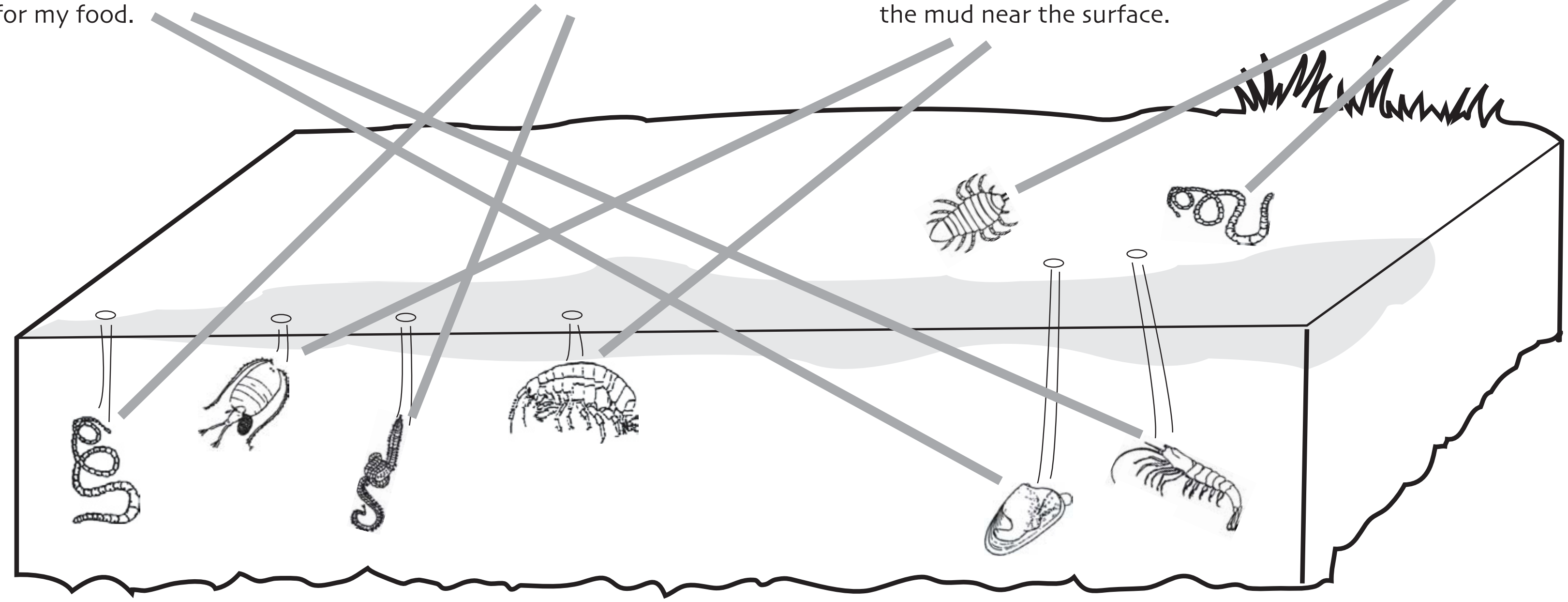

Avian Olympics

Adapted with permission from "One Bird-Two Habitats." Wisconsin Department of Natural Resources.

Grade Level: upper middle school/ high school
Duration: up to three 40-minute class periods
Skills: vocabulary, discussion, team building, comparison, and collection and interpretation of data
Subjects: science, math, and physical education

Concepts:
- Shorebirds, like other animals, are adapted in three ways to survive: physically, physiologically, and behaviorally.
- Shorebirds have many physical, or morphological, adaptations to help them walk, find food, hide, and reproduce in their habitat, and to fly long distances during migration.
- Shorebirds are also adapted physiologically to their migrating lifestyle, particularly in their fat-loading abilities which enable them to maintain energy for long flights.

Vocabulary
- migration
- fat-loading
- stopover site
- flyway

Overview
By competing in physical and math/ science activities, students come to understand that shorebirds are incredibly adapted to long distance migration.

Objectives
After this activity, students will be able to:
- Define the term migration.
- Explain why shorebirds migrate.
- Give three examples of adaptations that help shorebirds successfully migrate long distances.
- Give two common reasons why shorebirds might not survive a difficult migration.
- Explain the relationship between calories, fat, energy, and stopover sites.

Materials
- Triple-beam balance or other scale
- Clock with second hand visible to the entire room or one stop watch per group
- World map with kilometer scale
- Student worksheet and answer sheet
- Fifty meter track or running area

Introduction
Most shorebirds are uniquely *adapted* to living in open spaces (often wetlands) that also provide an abundant supply of invertebrate foods. Their adaptations are both physical (the way they are built) and behavioral (the way they act). This activity focuses on the physical adaptations of *fat-loading* and long-distance flight.

Migration itself is considered an adaptation that allows shorebirds to take advantage of the abundant Arctic food resources in the spring and summer, yet escape to warmer food-rich southern climates for the winter.

For more information about shorebird adaptations, read *Shorebird Adaptations* and *The Magnificent Shorebird Migration* found in the *Shorebird Primer*.

Activity Preparation
1. Photocopy one student worksheet for each student or each team of three to six students.
2. Have the student worksheet answers available for your reference during the activity.

Procedure
1. Divide the class into teams of three to six students to compete against each other in math skills, speed, and endurance. Ask each team to select a mascot migratory shorebird group, such as plovers, oystercatchers, sandpipers, curlews, turnstones, godwits, or phalaropes. The object of each team is to get the most possible points. You may wish to shorten or lengthen the lesson by awarding points only to certain answers or doing some of the calculations as a class.

2. Hand out a copy of the student worksheet to each group. Work through each problem as a class. Award the teams points. All the teams that get the right answer are automatically awarded one point; the first team to get the right answer gets two points.

3. Go outside to complete *Problem 3: Fast Travel* and *Problem 4: Wing-flapping.*

4. Provide a reward to the teams for most points, best effort, etc.

Additional Activities
Mechanics of Flight
Have students research the mechanics of flight. Compare the flight of birds to the flight of bats, insects, or airplanes. What are the differences between fixed and mobile wings? Why don't birds flying in a flock run into each other when they change directions?

Energy of Flight
Ask students to research the following questions: What kind of energy transfer is involved in flight? How do birds transfer chemical food energy into mechanical flight energy? What role does oxygen play in the trapping of the sun's energy (photosynthesis) and the release of energy (respiration) in animals? What role do hollow bones, bone marrow, and air sacs play in respiration?

Shorebird Types
Have students research the main shorebird types (plovers, sandpipers, etc.) and list their identifying characteristics.

Scientific Names
Practice learning the hierarchical structure (i.e., Kingdom, Phyla, Class, Order, Family, Genus, Species) of the animal kingdom and scientific (Latin) names by tracing one or two species of shorebirds through the hierarchy.

Local Shorebird Olympics
Ask your students to develop additional math problems that focus on the feats of local shorebirds.

- First assemble a list of your local shorebirds using field guides or a local bird list
- Divide the class into teams and assign each a local shorebird species from the list. Use the Shorebird Sister Schools Web site, the *Shorebird Profiles* found in the *Appendix*, and shorebird field guides and texts from your local library to find interesting facts.
- Assemble a new Avian Olympics Worksheet that highlights shorebird of your area.
- Repeat *Avian Olympics* using this new worksheet.

Avian Olympics Student Worksheet Answers

Problem 1—Weigh-in

The average middle school student weighs 100 pounds or 45 kilograms. How many grams are in 45 kilograms?

Answer: 45,000 grams

Compare that to the weight of the Western Sandpiper, about 25 grams (less than 1 ounce). Find an object in the classroom that you think weighs 25 grams. Weigh your object on a triple-beam balance.

How many Western Sandpipers (at 25 grams) would it take to equal the weight of an average middle school student (at 45 kilogram)?

Answer:
45,000 g x 25 g = 1800 Western Sandpipers

Problem 2—Eating Like a Bird (Fat-loading)

One quarter-pound hamburger and fries is an average-sized meal for a student. Two or three burgers would be a huge meal. What is the largest number of quarter-pound hamburgers any of the students has ever eaten in a single meal?

What percentage of the average weight of a middle school student is this? (Assume a quarter-pound hamburger = 114 grams.)

Example answer:
If 3 is the number of quarter-pound hamburgers eaten:
3 burgers x 114 g (burger weight) = 342 g
342 g ÷ 45,000 g (student weight) = 0.0076%, or less than 1%

Compare this with the Pacific Golden-Plover which gains enough fat to increase its body weight by almost 30% for its migration from Hawaii to Alaska. If an average student weighing 45 kilogram were going to increase his or her body weight by 30%, how much weight would he or she gain?

Answer: 45 kg (student weight) x .30 = 13.50 kg or 13,500g

How many quarter-pound hamburgers is this equal to?

Answer: 13,500 g x 114 g (hamburger wt) = 118 burgers

Problem 3—Fast Travel (outside activity)

With each team entering its fastest runner, have a 50-meter dash to determine how long it takes a student to sprint 50 meters.

How long would it take this runner to cover 1 kilometer?

Example answer: If a student runs 50 meters in 15 seconds,

$\frac{15 \text{ seconds}}{50 \text{ meters}} \times \frac{Y \text{ seconds}}{1000 \text{ meters}}$

$15{,}000 = 50X \quad \frac{15{,}000}{50} = Y \text{ seconds} = 300 \text{ seconds}$

300 seconds ÷ 60 minutes = 5 minutes to cover 1,000 meters

Use a map of the world to estimate the distance in kilometers from the school to Lima, Peru. Using these two measurements, calculate how long it would take the fastest runner on your team to get to Lima. Assume your runner could travel in a straight line without stopping.

Example answer:
60 minutes ÷ 5 min/km = 12 km/hour
7500 km ÷ 12 km/hour = 625 hours, or
625 hours ÷ 24 hours/day = 26 days

Discussion: Compare these results with Sanderlings, which are able to migrate 7500 kilometer (4650 miles) between Oregon and Peru in 230 hours--or about 10 days!

Avian Olympics Student Worksheet Answers

Problem 4—Wing-flapping (outside activity)

Have each team select a representative. Using a clock with a second hand, ask each team to determine the highest number of arm flaps possible in 10 seconds. Give a point to the group whose representative flapped the fastest (most times per 10 seconds).

Using the time from Problem 3--Fast Travel, how many arm flaps would it take a person to fly to Peru?

Example answer:
For 11 flaps in 10 seconds,

$\frac{11 \text{ flaps}}{10 \text{ seconds}}$ = 1.1 flaps per second

1.1 flaps x $\frac{60 \text{ seconds}}{1 \text{ minute}}$ x $\frac{60 \text{ minutes}}{1 \text{ hour}}$ x $\frac{24 \text{ hours}}{1 \text{ day}}$

= 95,040 flaps per day
1 day

95,040 flaps x 26 days = 2,471,040 flaps

Discussion: What assumptions were made to get this answer? What might affect the accuracy of our answer? We are comparing flaps (flying) with running time and comparing the abilities of two different students. We are assuming the same distance will be covered in the same amount of time in either way and that all students will perform at the same speed. In science, it is important not to "compare apples to oranges" and to be aware of all assumptions made.

Problem 5—Non-stop Travel

Which student can continue flapping his or her arms the longest?

Discussion: How does this feat compare with the American Golden-Plover which flies nonstop for 48 hours as it migrates from Nova Scotia to South America? The Pacific Golden-Plover and some curlews and tattlers fly nonstop for two to three days from Hawaii and other Pacific Islands to Alaska.

How far do you think the best classroom runner can run without stopping?

Discussion: How does this compare with some plovers, curlews and tattlers which fly non-stop from Hawaii and other Pacific Islands to Alaska, a distance of over 3500 miles? The little Western Sandpiper flies over 250 miles per day between stopover points along the Pacific Coast flyway to Alaska.

Problem 6—Long-distance Travel

Which team member has lived farthest from his or her current home? Using a map, determine how many kilometers away that is?

Discussion: How does this compare with Sanderlings that fly over 11,000 kilometer twice a year from their high-Arctic breeding grounds to nonbreeding grounds in Peru?

Problem 7—Fuel-Efficiency

Humans burn about 60 calories by running one kilometer. At this rate, how many calories would a student need to run from here to Peru?

Answer: Use a map to determine how many kilometers it is from your town to Lima, Peru. Multiply this number by 60 calories.

Example answer:
60 calories x 7500 km = 450,000 calories

If one gram of fat yields 9 calories of heat, how many kilograms of fat would this student need to eat before making the trip?

Example answer:
450,000 calories ÷ 9 calories/g = 50,000 g
50,000 g x 1,000 = 50 kg

Discussion: Compare this with the Pacific Golden-Plover, which can travel 3900 kilometers (2400 miles) in 48 continuous hours of flying, using fewer than 60 grams (2.1 oz) of body fat. Does this bird burn more calories per kilometer or few calories per kilometer than a student?

Avian Olympics
Student Worksheet

Directions
Answer the following questions one at a time. Do not proceed to the next question until your teacher tells you to. Show all your calculations (carrying your units through the calculations to see if your answer makes sense).

Problem 1 – Weigh-In
The average middle school student weighs 100 pounds or 45 kilogram. How many grams are there in 45 kilograms?

Compare the above weight to the weight of the Western Sandpiper, about 25 grams (less than one ounce.) Find several objects in the classroom that you think weigh 25 grams. Now weigh the objects and record which object comes closest.

How many Western Sandpipers (at 25 grams) would it take to equal the weight of an average middle school student (at 45 kilograms)?

Problem 2 – Eating Like a Bird (Fat-loading)
What is the largest number of quarter-pound hamburgers any person on your team has eaten in a single meal?

What percentage of the average weight of a middle school student is this? (Assume that a quarter-pound hamburger = 114 grams.)

If an average student weighing 45 kilograms were going to increase his or her body weight by 30%, how much weight would he or she need to gain?

How many quarter-pound hamburgers does this equal?

Problem 3 – Fast Travel
How long did it take the fastest student to sprint 50 meters?

Calculate how long it would take this runner to cover one kilometer.

Using a map of the world, estimate the distance in kilometers from your school to Lima, Peru.

Using your answer from above, calculate how long it would take the fastest student to sprint directly to Lima. (Assume he or she could run in a straight line without stopping.)

Avian Olympics Student Worksheet
Continued

Problem 4 – Wing-flapping
How many arm flaps can your group's representative do in ten seconds?

Using the time calculated in problem three, calculate how many arm flaps a student would make in a "flight" to Lima, Peru.

Problem 5 – Nonstop Travel
Which group member can continue flapping his or her arms the longest? How long?

How far do you think the best runner of middle school age can run without stopping?

How far do you think the average middle school student can run without stopping?

Problem 6 – Long-distance Travel

Which group member has lived the farthest away from his or her current home? How many kilometers away is that?

How does this compare with Sanderlings that fly over 11,000 kilometer twice a year from their high-Arctic breeding grounds to nonbreeding grounds in Peru?

Problem 7 – Fuel Efficiency
Humans burn about 60 calories by running one kilometer. At this rate, how many calories would you need to run from here to Peru?

If one gram of fat yields nine calories, how many kilograms of fat would you need to eat before making the trip?

How does this compare with the Golden-plover which can travel 3900 kilometers (2400 miles) in 48 continuous hours of flying using fewer than 60 grams (2.1 ounce) of body fat?