Discover Shorebirds

Educator Guide Curriculum Learning Resources

WHSRN
WESTERN HEMISPHERE
SHOREBIRD RESERVE NETWORK

Grades 3-8

ACKNOWLEDGMENTS

Many of the lessons and resources in this curriculum were adapted from Explore the World with Shorebirds! - Educator's Guide for the Shorebird Sister Schools Program, created by the United States Fish and Wildlife Service. These resources have educated students since 2004. We extend our gratitude to the many individuals and organizations who contributed to the production of that comprehensive curriculum. To learn more about this curriculum and for a full list of contributors visit: www.whsrn.org/outreach-resources/student-and-informal-education/

The development of this curriculum was possible thanks to the support of Environment and Climate Change Canada, US Forest Service–International Programs, and private donor and endowment funding to Manomet, Inc. Thank you to the Raincoast Education Society at the Tofino Wah-nah-jus Hilth-hoo-is Mudflats WHSRN site for their inspiration and contributions to this curriculum.

RECOMMENDED CITATION

WHSRN Executive Office. 2022. Discover Shorebirds: An Educator Guide - Lessons for Grades 3-8. Massachusetts, USA: Manomet, Inc. 119 pp. Available from https://whsrn.org/site-support/

Contributors: Marina Castellino, Laura Chamberlin, Clare Cunningham, Molly Jacobs, Benoit Laliberte, Vianey Ramirez, Emily Renaud, Madison Bolt, Kira deLeeuw, and Mark Maftei.

Design: Cheri Natalino

This project was undertaken with the financial support of:

Ce projet a été réalisé avec l'appui financier de:

Environment and Climate Change Canada

Environnement et Changement climatique Canada

Educator Guide

Discover Shorebirds

Lessons for Grades 3-8

Table of Contents

Educator Guide

Introduction

Shorebirds are amazing: their spectacular migrations are one of the longest on Earth. As the name suggests, they are found along shorelines, but they are uniquely adapted to a variety of habitats, and can be found from tundra in the Arctic to saline lakes in the desert. With funding from Environment and Climate Change Canada, the Executive Office for the Western Hemisphere Shorebird Reserve Network, Manomet, and Raincoast Education Society created this curriculum to highlight these unique flyers and their conservation needs.

This teacher's guide introduces each of the lessons and their activities in the curriculum and provides educational resources to help you and your students learn about shorebirds. With supplemental materials and real world examples, shorebirds will teach objectives in biology, habitat, migration, threats, ecosystem services, and stewardship.

Each lesson will begin with engaging, student-led, hands-on activities, followed by opportunities for synthesis and teacher guidance, additional rounds of hands-on learning to deepen the experience and allow students to apply their initial learning, and opportunities for assessment. Individual activities within the lesson are also structured this way to the extent possible. The online portal for the curriculum has all supplemental materials including printable worksheets, slideshows, and an interactive map. The online portal makes it easy to select and access materials for the lessons that are best for your class. Visit https://whsrn.org/discover-shorebirds/ to explore.

If your school or interpretive center is located near an important shorebird site, this curriculum can be a great resource for your students to connect to the importance of your local ecosystems. Stronger connections to sites will also promote and motivate children to engage in conservation and stewardship of the lands that surround them.

Alignment with Curricular Standards

The material included in this package was designed by consulting several different teaching standards identified for Grades 3-8 (ages 8-13) in Canada. Focus was given to the competencies and skills in British Columbia teaching standards (https://curriculum.gov.bc.ca/curriculum/science), however these objectives can be adapted for schools across the Western Hemisphere. Where possible curriculum includes elements that are related to additional priorities including math, enrichment, and traditional ecological knowledge.

Scalable: These lessons have been designed so that they are scalable and made relevant to younger or older students, depending on your needs.

Modular: Lessons complement one another but can also be offered as standalone units. Similarly, within lessons, activities complement one another but most can also be offered alone.

Know-Wonder-Learn Approach

The Know-Wonder-Learn (K-W-L) approach is used in most of the lessons. The K-W-L approach can be used to provide a structure for students' learning processes. It reinforces the idea that knowledge is accumulated, and empowers students to take ownership of their own learning process. During a K-W-L lesson, students begin by identifying things that they already know about a topic, and then things that they wonder about it. These are recorded in a chart, and the teacher then uses this information about prior knowledge and gaps in understanding to guide the rest of the lesson. At the end of the lesson, students return to the K-W-L chart to identify what they have learned about the topic, providing students with immediate positive feedback and the teacher with a way to evaluate the learning that took place.

Overview of Lessons

Key concepts: shorebirds, habitat, adaptation, camouflage, migration, tracking technologies, conservation, community stewardship

Lesson One: What is a shorebird?

1. Know-Wonder-Learn about Shorebirds
2. Hidden Eggs
3. What can I Eat with this Beak?
4. Fabulous Feet
5. Superfood for Shorebirds
6. Know-Wonder-Learn about Shorebirds, revisited

Students will use prior knowledge and observations of shorebirds and their habitats to construct explanations for how shorebird adaptations help them survive in their various habitats.

Students will analyze and interpret data on food availability in different habitats. Using this evidence students will prepare an argument for where particular shorebirds are likely to forage for food.

During these student-led, hands-on activities, students will explore shorebird adaptations and habitats. There is a strong focus on how the physical features of shorebirds (camouflage, bills, legs, feet) help them succeed in their habitats. Activities are designed for younger students, with suggested modifications for older students

Lesson Two: Migration Mania

1. Know-Wonder-Learn about Migration
2. Migration Headache
3. Shorebird Needs and Migration Map
4. Precarious Paths
5. Know-Wonder-Learn about Migration, revisited

Students will use prior knowledge and their experiences during a kinesthetic game to make predictions and construct explanations for why shorebirds migrate, and to identify what shorebirds might need during migration.

Students will identify patterns in the timing and geography of shorebird migrations, and use storytelling to communicate scientific information about migration to their peers.

This lesson will give students the opportunity to engage in interactive activities to learn about migration, expand on habitat needs, and introduce threats and conservation actions. Lesson three provides additional activities to discuss threats and actions to mitigate threats. Lesson four provides expanded learning opportunities for students with strong existing knowledge of migration.

Lesson Three: Making tracks with Shorebirds

1. Tracking with Satellite Transmitters
2. Resighting Flags
3. Motus Wildlife Tracking System
4. Design a Tracking Program

Students will investigate different technologies used to track shorebird migration, interpret and evaluate scientific datasets collected using those technologies, and identify the pros and cons of the different research methods.

Students will use prior knowledge of shorebird migration and their assessments of current tracking technologies to design a tracking plan for a selected species and share their plans with their classmates, clearly communicating their design rationale.

This activity introduces the science and technology behind several techniques used to better understand migration. Three types of technology will be reviewed and discussed through engaging activities. Students will discuss the advantages and disadvantages of each technology. The lesson culminates with students tasked to design their own tracking plan to answer questions about a selected species. This lesson is most appropriate for older students, with modifications possible for younger students.

Lesson Four: Shorebirds at Risk: Threats and Action

1. Know-Wonder-Learn about Threats to Shorebirds
2. Can't We Share?
3. What is WHSRN?
4. Protect your Site with your Voice
5. Know-Wonder-Learn about Threats, revisited

Students will use prior knowledge and their experience during a kinesthetic game to analyze how human behavior and environmental factors threaten shorebird habitats and then use these observations to make predictions about other potential threats facing shorebirds.

Students will utilize online resources and provide evidence from the WHSRN website to answer questions highlighting the importance and scope of WHSRN and its role in shorebird conservation.

Students will consider their own roles in shorebird conservation by examining the link between shorebird threats and human activity. Students will then advocate for a local shorebird species using artwork, poetry, press releases and other platforms to share their message with their peers.

Building off the introduction of threats and actions in Lesson Two, this lesson reviews what was learned about threats and expands on this knowledge with discussions about conservation action at important shorebird sites. The Western Hemisphere Shorebird Reserve Network will be introduced as one tool for conservation. Students will research a WHSRN site and use art to tell the story of their site. Activities have modifications for all ages.

Lesson Five: Understanding why Nature Matters

1. Know-Wonder-Learn about People and Natural Resources
2. The Ecosystem and You
3. Town Hall
4. Know-Wonder-Learn about People and Natural Resources

Students will explore local ecosystems and examine the relationships between living and non-living and natural and unnatural factors that they record in order to identify the different ecosystem services present.

Students will analyze different perspectives of environmental issues facing people and shorebirds and use prior knowledge of shorebirds, conservation and ecosystem services to develop an opinion on conservation action. Students will then communicate their stance on the issue in a debate format.

In Lesson Five, students will explore how they interact with natural resources by discussing the benefits that people receive from the environment. For younger students there is an observational activity that will open their eyes to the habitats near them. Older students will engage with each other in a role-playing scenario to better understand community perspectives in shorebird conservation.

Supplemental Material

Throughout the curriculum, icons will indicate where there are additional resources available. All resources are available online or to download individually. Activity Sheets for each lesson are also included after each lesson in the full curriculum.

Learning resources

Informational content for students and teachers for each lesson.

Activity sheets

Worksheets and materials needed to conduct the lessons.

Shorebird cards

Informational cards to help students learn the biology and ecology of shorebirds.

Slideshows

Photo slideshows that provide examples within the lessons.

Going Further

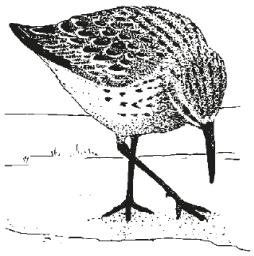
The learning resources included in this curriculum provide content to build a working familiarity with the concepts and information these lessons cover. Additionally, we stress the importance of identifying locally relevant material to support the lessons. To strengthen the connection to the lessons and to the site, consider a field trip to apply new knowledge to exploration of local shorebird habitats. WHSRN site partners often conduct educational activities or may have site-specific guidance or information.

Many of the lessons and resources in this curriculum are adapted from *Explore the World with Shorebirds! - Educator's Guide for the Shorebird Sister Schools Program* created by the United States Fish and Wildlife Service. These resources have educated students since 2004. In addition to the lessons found here, there are many more activities and resources available in the full curriculum: www.whsrn.org/outreach-resources/student-and-informal-education/

For more information or to connect with a WHSRN site visit www.whsrn.org or email whsrn@manomet.org.

LESSON 1

What is a Shorebird?



Learning Objectives

Students will use their own prior knowledge and observations of shorebirds and their habitats to construct explanations for how shorebird adaptations help them survive in their various habitats.

Students will analyze and interpret data on food availability in different habitats. Using this evidence, students will prepare an argument for where particular shorebirds are likely to forage for food.

Activity 1: Know-Wonder-Learn about Shorebirds

Time: 10-15 min

Provided: None

From your Classroom: Large paper, whiteboard, or chalkboard

Create a K-W-L chart on large paper or on the classroom whiteboard or chalkboard. Write 'Shorebirds' at the top.

Ask students "What do you **KNOW** about shorebirds?" Even if the term 'shorebird' is new to them, encourage them to draw on their prior knowledge of birds. Write their ideas down in the 'Know' section of the chart, OR give each student a sticky note and have them add what they know to the chart themselves.

Ask students "What do you **WONDER** about shorebirds?" If they are having trouble coming up with ideas, encourage them to wonder how shorebirds might be different from other birds they are familiar with. Record their questions in the 'Wonder' section of the chart using sticky notes or by writing them there yourself, then set it aside. Resist the temptation to answer their questions now - they will discover the answers themselves during the lesson! Return to the chart at the end of the lesson.

** This K-W-L brainstorm could also be done in a discussion format with the teacher writing down student ideas in the chart. Adapt terminology as needed for the age of students.*

Activity 2: Hidden Eggs

Time: 20-30 min | Student Level: Grades 3-5

Materials:

Provided: Egg Pattern (Activity Sheet 1.1), Pattern Backgrounds (Activity Sheet 1.2, available online), Habitat Backgrounds (Activity Sheet 1.3, available online), Eggs slideshow (Slideshow 1.1)

From your Classroom: Markers or crayons. If a color printer is not available to print the patterns, wrapping paper is an excellent substitute

Engage: How could you hide an egg in plain sight? Students brainstorm ideas; write on board.

Explore: Provide each student with Egg Pattern (Activity Sheet 1.1), a Pattern or Habitat Background (Activity Sheet 1.2 or 1.3), and markers or crayons. Students cut out their egg and tape it to the background, color it in to match the background so the egg cannot be seen, and add their camouflaged egg to a class display!

Optional

Provide students with a second egg and have them color it so it can be hidden in plain sight somewhere in the classroom, then hide it there secretly. Once they are all hidden, students see how many they can find!

Discuss: View the slideshow of actual shorebird eggs in natural habitats.

Small or large group discussion using the following prompts:

- What is camouflage for?

- Why do you think shorebird eggs are so well camouflaged?
- If an animal has well-camouflaged eggs, what does that tell us about its biology?
- Introduce the idea of an adaptation: a trait that helps an animal survive and reproduce in its habitat.

Activity 3: What can I Eat with this Beak?

*Adapted from *Explore the World with Shorebirds! - Educator's Guide for the Shorebird Sister Schools Program*

Time: 40 min | Student Level: Grades 3-5

Materials:

Provided: Shorebird Bills slideshow (Slideshow 1.2), Beaks Example Table (Activity Sheet 1.4), Beaks Worksheet (Activity Sheet 1.5), Beaks Answer Sheet (Activity Sheet 1.6)

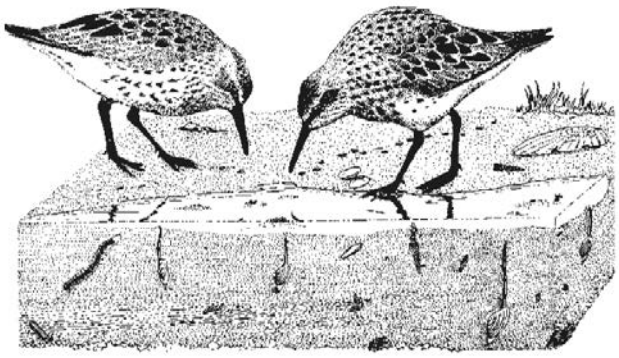
From your Classroom: 'Beak' tools (enough for each student to have one): spoons, scissors, tweezers (or chopsticks), spring-type clothespins. 'Food' items: 50 marbles (snails), 100 toothpicks or cut pipe cleaners (worms), 100 3/16" metal washers (crabs/ crustaceans)

Engage: Remind students what we learned about shorebirds just from looking at their eggs. What do the students think we can learn from their beaks?

Explore: Tell students that they are going to use simple tools to represent different types of beaks, and have students count off in fours. Each student gets a paper cup (stomach) and a 'beak' tool: 'ones' get a spoon, 'twos' get a pair of scissors, 'threes' get tweezers or chopsticks, and 'fours' get clothespins.

Explain the rules to students:

1. Each shorebird (student) can only pick up food with its beak
2. They have to drop food items into their stomach (the paper cup)
3. Food may not be scooped or thrown into the stomach; the stomach must be held upright.
4. The teacher is a hawk that eats birds. Unruly behavior or violation of the rules will result in the hawk capturing the unruly bird and making it sit out for the rest of the round (in reality, unusual behavior of a bird draws attention from a predator).



Conduct the activity:

1. Students sit in a large circle.
2. Scatter **one** food type throughout the circle.
3. Let students feed for a set time (up to 2 minutes). One option is to simulate a normal feeding cycle by using the classroom lights. When the classroom lights are out, it is night and the birds are asleep. When the lights are on, the sun has risen and they can feed. Turn off the lights again as the signal to stop feeding (sunset).
4. Students with similar beak types get together, and count the combined number of food items collected.
5. Record the class data in the Beaks Example Table (Activity Sheet 1.4) and/or on the board.
6. Repeat for each food type.
7. Run the simulation one final time with ALL food types included.
8. Provide students with the Beaks Worksheet (Activity Sheet 1.5) and have them fill it out.

Discuss: Encourage small or facilitate a large group discussion using the following prompts:

- Which beak type was the most successful for worms? The least successful? Discuss each food item in turn.
- Show the class the Shorebird Bills slideshow (Slideshow 1.2). Can the students identify real birds that have beaks similar to each of the tools we used? Do any of the birds have a beak that is not similar to one of the tools?
- Some birds eat food that lives in mud, some find food in the water, others pick things off the surface of the sand, etc. In which habitat do you think each of these beaks belongs?

- What happened when all the food types were available at the same time? What was your strategy? Did you experience more or less competition for the food?
- Would a real shorebird have a similar strategy?
- How are shorebird beaks examples of adaptations?

Activity 4: Fabulous Feet

Time: 40 min | Student Level: Grades 3-5

Materials:

Provided: Shorebird Cards, Fabulous Feet Worksheet (Activity Sheet 1.7), Shorebird Cards slideshow (Slideshow 1.5), Fabulous Feet slideshow (Slideshow 1.3)

From your Classroom: No materials needed

Engage: Remind students what we were able to learn about shorebirds from looking at eggs and beaks. Share the Fabulous Feet slideshow (Slideshow 1.3) which highlights shorebirds using their legs and feet in their habitats, noting differences. Ask students to brainstorm ideas for things that can be learned from looking at their legs and feet. Without discussing, record students' ideas so that they can be revisited later.

Explore:

1. Divide students into small groups and give each group a Shorebird Card. Make sure to include at least some long-legged birds such as the American Avocet and Lesser Yellowlegs, and some shorter-legged birds such as Killdeer and Semipalmated Sandpipers. American Oystercatchers are also a good choice for their thick, pink legs.
2. Students should read their Shorebird Card, then use the worksheet to brainstorm how the legs and feet might be adaptive. Questions for them to consider include:
   - What are the legs and feet used for?
   - Are they adapted for wading, swimming, walking on land, catching prey, or some other activity?
   - Do the legs and feet match the habitat?

Discuss: Students present their bird to the class (optional project trading card so all can see) and share their ideas about how the feet and legs are adaptive. Revisit the the Fabulous Feet slideshow (Slideshow 1.3) to discuss what the students learned.

Activity 5: Superfood for Shorebirds

Time: 40 min | Student Level: Grade 3-7

Materials:

Provided: Habitats slideshow (Slideshow 1.4), Superfood Habitat Worksheet (Activity Sheet 1.8), Superfood Data Table (Activity Sheet 1.9), Large Food Icons (Activity Sheet 1.10), Small Food Icons (Activity Sheet 1.11), Shorebird Cards

From your Classroom: A large paper for habitat drawing (e.g. butcher paper), markers or crayons, scissors, glue or tape.

Engage: Brainstorm list of habitats where shorebirds might be found, based on what they have learned so far. Show the Habitats slideshow (Slideshow 1.4).

Explore:

1. Assign students to small groups. Each group will be assigned a habitat to draw/diagram (sandy beach, salt marsh, mud flat, grassland, or saline lake) on a large piece of butcher paper.
2. Provide each group with a Superfood Habitat Worksheet (Activity Sheet 1.8) and Large Food Icons (Activity Sheet 1.10) that can be cut out.
3. Students should use the table on the Superfood Habitat Worksheet (Activity Sheet 1.8) to determine how many food icons of each type to glue or tape onto their habitat diagram.
4. Post the habitat drawings in different areas of the classroom.

   Note: this activity can also be done individually, with each student drawing their habitat on an 8.5x11 sheet of paper, using the Small Food Icons (Activity sheet 1.11).

   Modification for Grades 6-7: Provide each student with a copy of the Superfood for Shorebirds Data Table (Activity Sheet 1.9).

Assign each student one of the food items, and have the students make a graph showing how that food item varies across the habitats. All students assigned a particular food type can stand up together to present their graphs to the class or post with their habitat picture.

Discuss: Have each habitat team describe to the class why their habitat is a great habitat for shorebirds, what food it provides, and why it is unique.

Explore, Part II:

1. Each student selects a Shorebird Card at random, reads it, and becomes that bird!
2. Students get up from their seats and check out the habitat options based on what their shorebird needs, then pick one and go stand there - this is where they are going to forage for food today. Emphasize to students that there may be more than one good choice for their shorebird - but they need to be able to justify their choice with evidence. Make a list of which students/birds chose which habitats.

Discuss, Part II: Each student explains - in character as their shorebird - why this is a good habitat based on (1) adaptations (how is this habitat good for their bird based on its feet, legs, bill, etc.), and (2) the available food (what food does their bird eat)? For many birds there may be more than one good answer - the point is for the student to support their choice with evidence.

Activity 6: Know-Wonder-Learn about Shorebirds, *revisited*

Time: 15 min

Revisit the Know-Wonder-Learn chart created at the beginning of the lesson. Students should work in pairs to brainstorm things they have learned about shorebirds to add to the chart. Have them share by adding sticky notes, or by writing their responses onto the chart. Follow up on their 'wonder' items to see if we can now answer some of their questions.

Observe student presentations & discussions, and student contributions to the learn panel of the K-W-L chart to evaluate whether students have met the learning objectives.

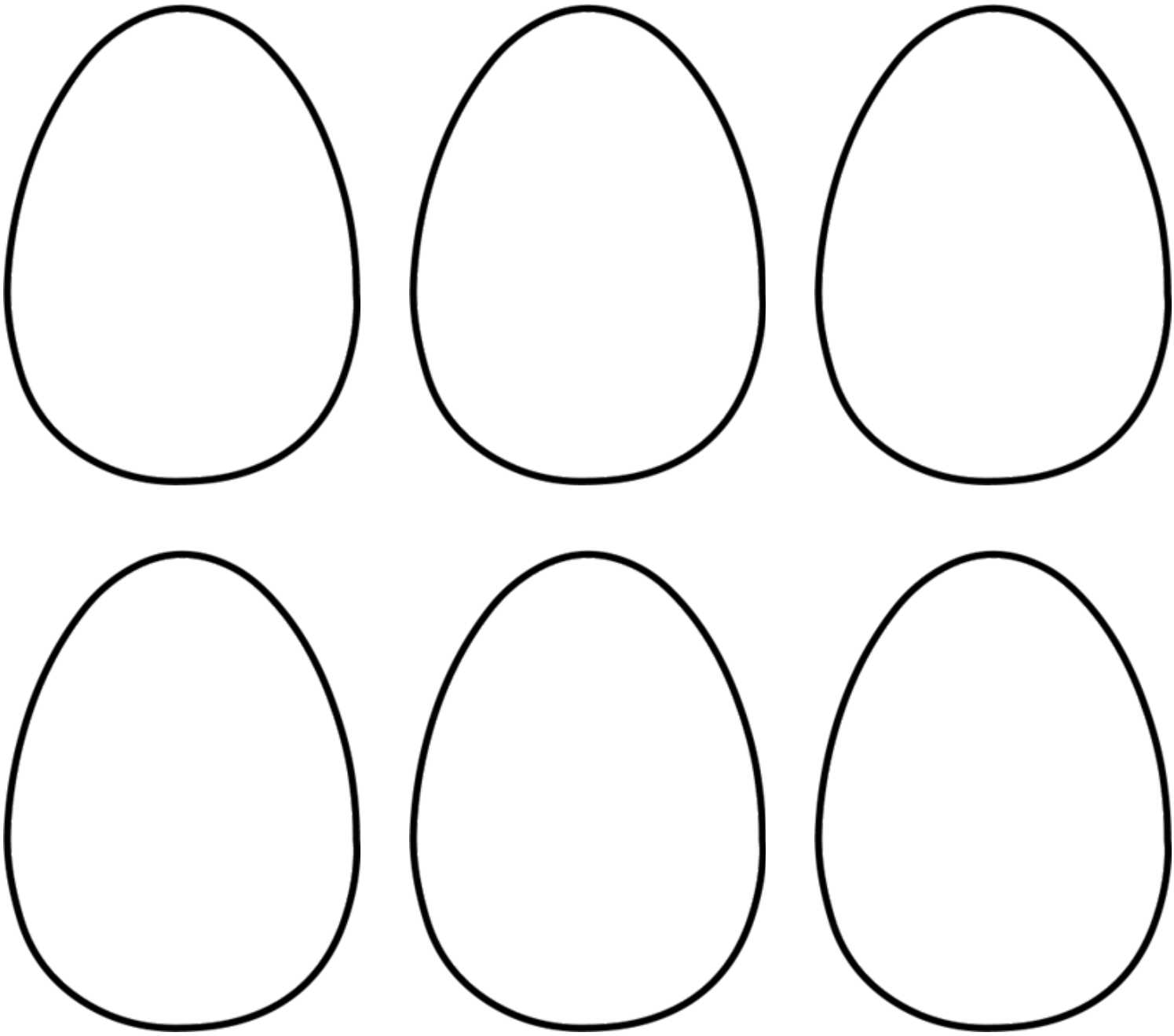
Things to look for:

- Are students identifying specific shorebird adaptations and explaining how those adaptations help the shorebirds in their habitats?
- Are students using scientific evidence (data on food availability) to make the case for why shorebirds might do better in one habitat than in another? Are they connecting this back to adaptations?
- Are students able to explain how resource availability might limit shorebird populations?

Cultural Connections: Reach out to local first nations/indigenous groups to learn stories and access traditional knowledge about shorebirds, their habitats, and their adaptations. Access resources such as the Ojibwe People's Dictionary to find indigenous names for birds and parts of birds. Other resources include Canadian Language Museum, First Voices, and Online Cree Dictionary. Please explore other resources that are most relevant in your area.

Notes

Egg Pattern: Activity Sheet 1.1



What Can I Eat with This Beak?

BEAK TYPE	FOOD ITEMS: Worms	Snails	Crustaceans	All Food Types
Tweezers				
Scissors				
Spoon				
Clothespin				

Beak Sheet Worksheet: Activity Page 1.5

What Can I Eat With This Beak?

Activity Instructions

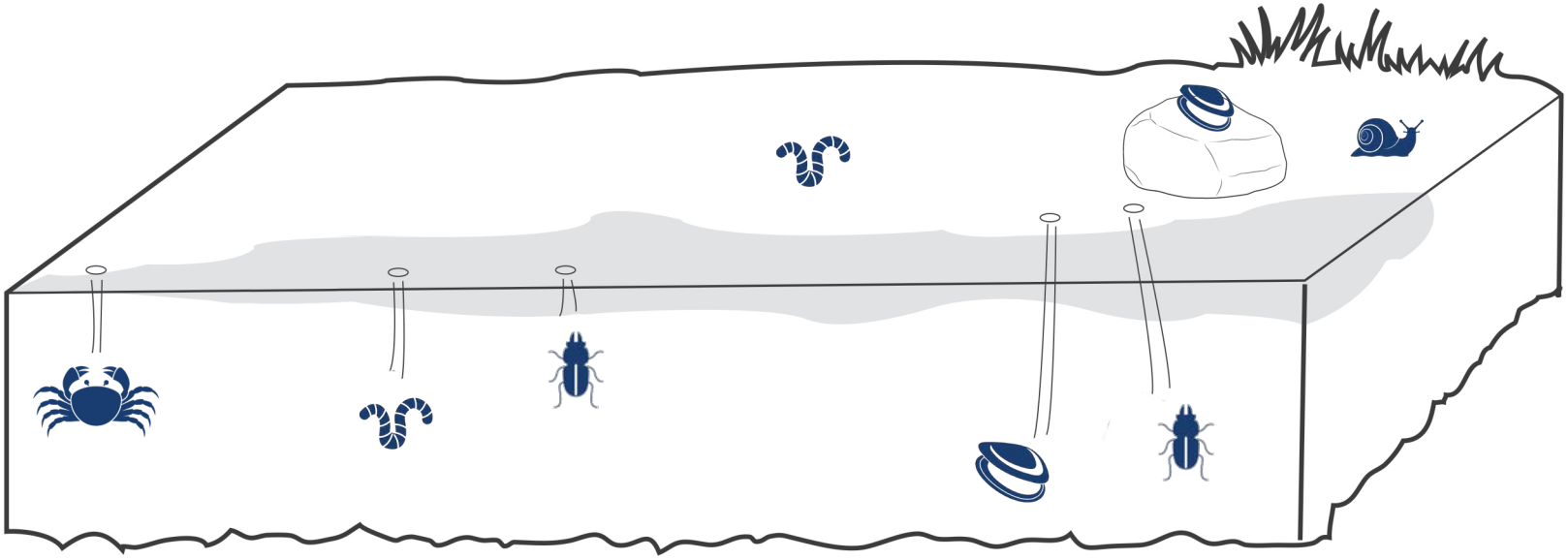
In a wetland or on a beach food is everywhere. Even though you cannot easily see it – shorebirds can!!! Each shorebird species has a uniquely adapted beak to find its food. Below is a picture of a beach with food buried in the soil. Your task is to read the clues for each of the shorebirds species and 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 deeply into the mud for my food.

Hudsonian Godwit: My bill is very long which means I can reach food in the mud that other shorebirds can't.

Semipalmated Sandpiper: Some people think my beak looks like tweezers when I eat. I probe the mud on and near the surface.

American Oystercatcher: My super strong bill helps me eat my favorite food oysters and other mollusks.



Beaks Activity: Activity Sheet 1.6 **ANSWER SHEET**

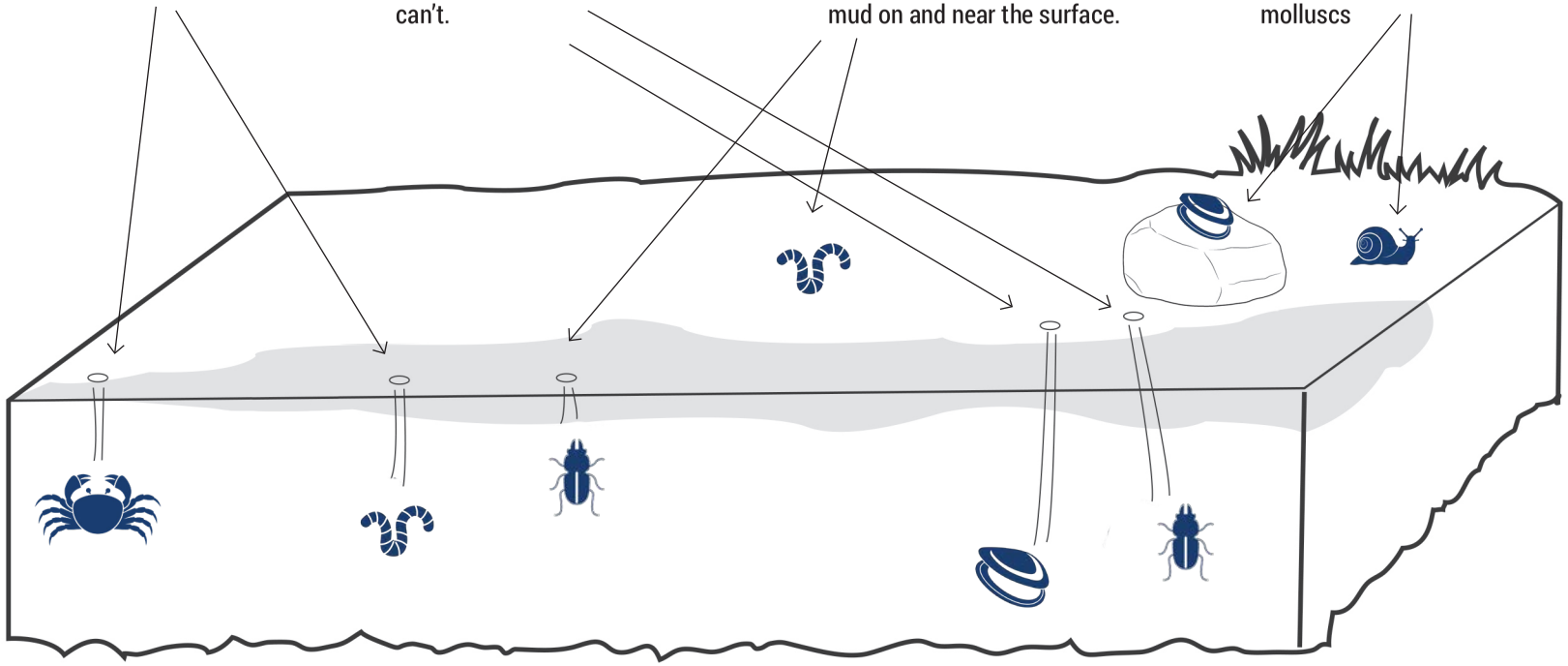
What Can I Eat With This Beak?

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

Hudsonian Godwit: My bill is very long which means I can reach food in the mud that other shorebirds can't.

Semipalmated Sandpipers: Some people think my beak looks like tweezers when I eat. I probe the mud on and near the surface.

American Oystercatcher: My super strong bill helps me eat my favorite food oysters and other molluscs



Student Name

Date

Shorebird Adaptations: Fabulous Feet

Name of Shorebird
(from Shorebird Card)

_____

Look at the Shorebird Card and examine the legs and feet of your shorebird. For each of the traits listed below, check the best answer(s).

Leg Length

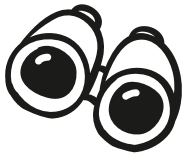
◯ Short ◯ Medium ◯ Long

Leg Color

◯ Dark ◯ Sandy

◯ Brightly colored ◯ Other

Foot shape



◯ Webbed ◯ Lobed

◯ Long toes ◯ Can't tell

Is there anything else you notice about the legs and feet of your shorebird?

_____

_____

_____

How do you think your shorebird uses its legs and feet?

_____

_____

_____

What would be an example of a good habitat for this shorebird, based on its legs and feet?

_____

_____

_____

What can legs and feet tell us about how a shorebird moves and eats?

_____

_____

_____

Salt Marsh Habitat

Salt marshes are coastal wetlands - lands that are sometimes flooded by salt water, and sometimes dry. Salt marshes have a very special type of soil known as peat - the thick peat layer acts like a sponge to hold water, so that even when the tide is out, salt marshes are never completely dry. Peat is also very good at absorbing water during floods - this is why salt marshes protect coastal lands during storms and very high tides. Salt marshes are also great filters- they improve water quality by removing pollution.

Salt marshes are important habitats! Salt marshes provide food and shelter to many animals, including shorebirds. They are full of many different types of food that shorebirds like to eat, including crabs, insects, snails, and fish.

Image credits: O. McCrosson, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

TYPE OF FOOD	NUMBER TO ADD TO SALT MARSH
Crabs	10
Horseshoe crab eggs	1
Insects	8
Snails	5
Worms	1
Clams & Oysters	3
Brine flies	3
Brine shrimp	5

Mud Flat Habitat

Mud flats are muddy areas that are covered in water at high tide, and exposed at low tide. Mud flats build up in protected areas, where very small sediment particles can settle out in the calm waters. Mud flats may seem barren, but they are full of life! Mud flats are home to many snails, worms, crabs and other invertebrates.

Mud flats are important habitats! Mudflats provide food and shelter to many animals, including shorebirds. They are the perfect location for some of the foods that shorebirds rely on like crabs, insects, snails, worms and clams and oysters.

Image credits: Paxson Woelber, CC BY 3.0 <https://creativecommons.org/licenses/by/3.0>, via Wikimedia Commons

TYPE OF FOOD	NUMBER TO ADD TO MUD FLAT
Crabs	3
Horseshoe crab eggs	0
Insects	5
Snails	7
Worms	8
Clams & Oysters	8
Brine flies	0
Brine shrimp	0

Grassland Habitat

Grasslands are large, flat areas dominated by grass with little annual rainfall. Depending on the amount of moisture and rainfall these habitats get, grasslands can be composed of tall grass or short grass. Grasslands are important to both humans and wildlife. Grasslands are home to an abundance of insects, worms and berries.

Grasslands are important habitats! Grasslands provide food and shelter to many animals, including shorebirds. They are loaded with food like insects, worms and berries.

Image credits: WherezJeff, CC BY-NC 2.0 <https://creativecommons.org/licenses/by-nc/2.0/>, via Flickr.

TYPE OF FOOD	NUMBER TO ADD TO GRASSLAND
Crabs	0
Horseshoe crab eggs	0
Insects	10
Snails	0
Worms	4
Clams & Oysters	0
Brine flies	0
Brine shrimp	0

Sandy Beach Habitat

Sandy beaches are sandy areas that are covered in water at high tide, and exposed at low tide. Sandy beaches are composed of fine, loose sediment that shifts with waves and wind creating a unique landscape of beaches and dunes. Sandy beaches are full of life as the ocean meets the land to create ideal habitats for clams, oysters, snails and crabs.

Sandy beaches are important habitats! Sandy beaches provide food and shelter to many animals, including shorebirds. They are full of many foods that shorebirds rely on like crabs, horseshoe crab eggs, snails, worms and clams and oysters.

Image credits: Sandra Richard, CC BY-NC 2.0 <https://creativecommons.org/licenses/by-nc/2.0/>, via Flickr.

TYPE OF FOOD	NUMBER TO ADD TO SANDY BEACH
Crabs	3
Horseshoe crab eggs	10
Insects	0
Snails	2
Worms	4
Clams & Oysters	2
Brine flies	0
Brine shrimp	0

Salt Lake Habitat

Salt lakes are inland, land-locked lakes that contain concentrations of salt. Salt lakes get their salinity from trapped minerals that dissolve in the lake over time. Salt lakes create unique habitats that allow the animals adapted to live in them to thrive. Salt lakes do not have a large variety of food for shorebirds, but they do have an incredible abundance of brine flies and brine shrimp, making them an important stopover site for migratory birds.

Salt lakes are important habitats! Salt lakes provide food and shelter to many animals, including shorebirds. They are home to only a couple of food sources like brine flies and brine shrimp, but they sure do have a lot of them!

Image credits: tom_stromer, CC BY-NC 2.0 <https://creativecommons.org/licenses/by-nc/2.0/>, via Flickr.

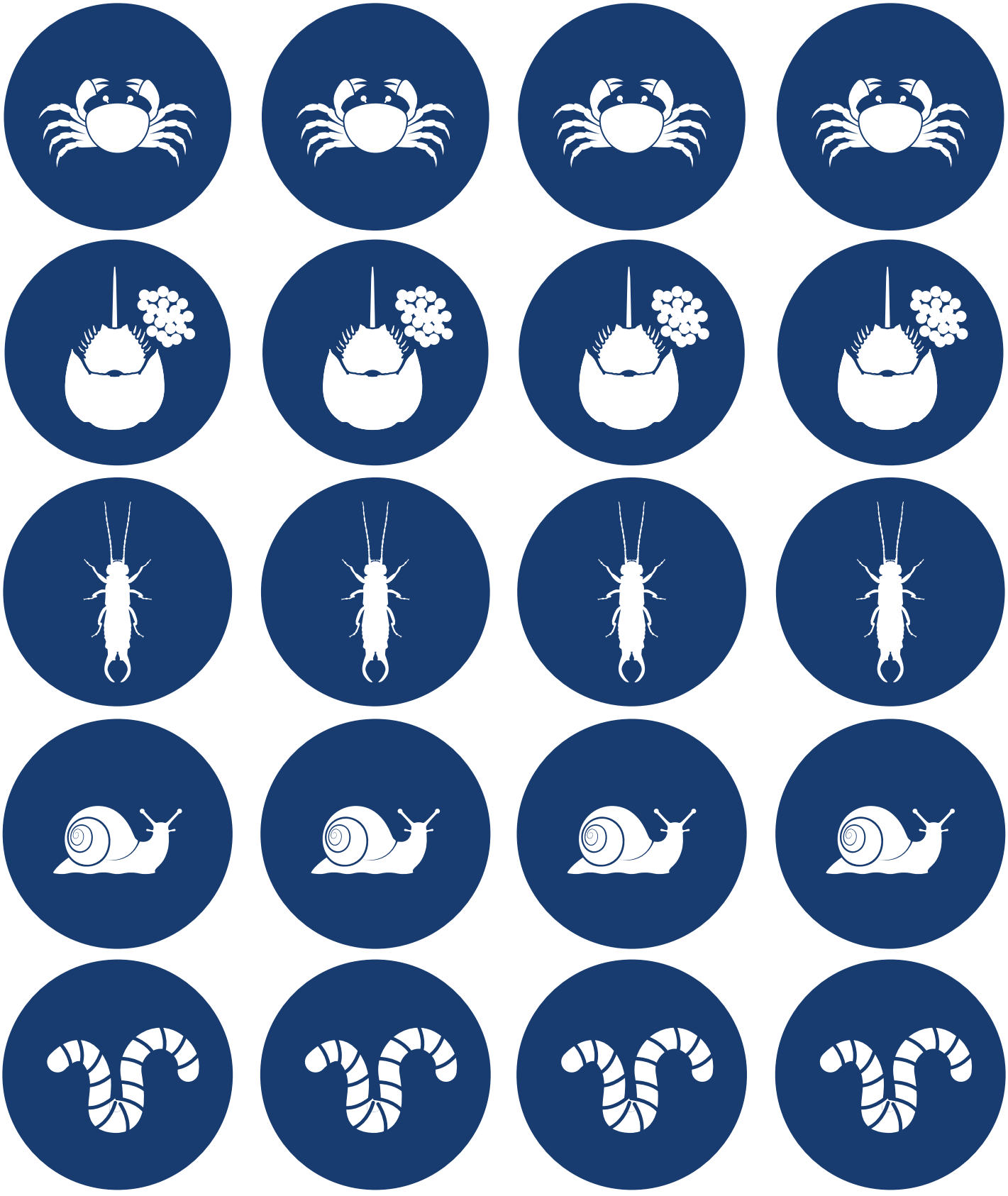
TYPE OF FOOD	NUMBER TO ADD TO SANDY BEACH
Crabs	0
Horseshoe crab eggs	0
Insects	0
Snails	0
Worms	0
Clams & Oysters	0
Brine flies	10
Brine shrimp	10

Super Food for Shorebirds: Graphing Activity

Find the type of shorebird food assigned by your teacher (or select one!). Make a column graph that shows how that food type varies between the habitats. Be sure to label your axes!

Type of Food	Habitat				
	Salt Marsh	Mud Flats	Grass-land	Sandy Beach	Salt Lake
Crabs	10	3	0	3	0
Horseshoe crab eggs	1	5	0	10	0
Insects	8	0	10	0	0
Snails	5	7	0	2	0
Worms	1	8	4	4	0
Clams & Oysters	3	8	0	2	0
Brine flies	3	0	0	0	10
Brine shrimp	5	0	0	0	10
Berries	7	0	7	0	0

Large Food Icons

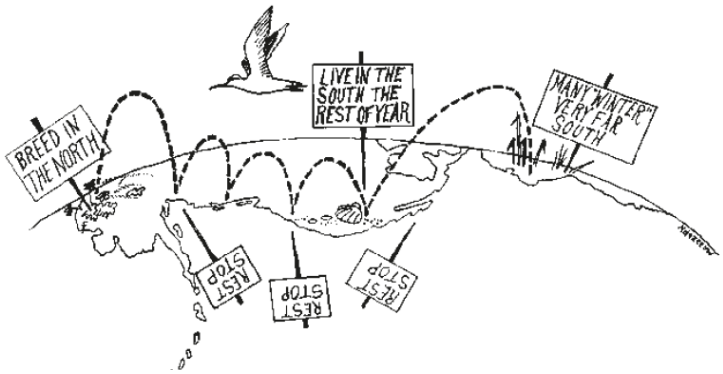


Large Food Icons

Small Food Icons

LESSON 2

Migration Mania



Learning Objectives

Students will use prior knowledge and their experiences during a kinesthetic game to make predictions and construct explanations for why shorebirds migrate, and to identify what shorebirds might need during migration.

Students will identify patterns in the timing and geography of shorebird migrations, and use storytelling to communicate scientific information about migration to their peers.

Activity 1: Know-Wonder-Learn about Migration

Time: 10-15 min

Materials:

Provided: none

From your Classroom: Large paper, whiteboard or chalkboard

Create a K-W-L chart on large paper or on the classroom whiteboard or chalkboard. Write 'Migration' at the top.

Ask students "What do you **KNOW** about migration?" Write their ideas in the 'Know' section of the chart, OR give each student a sticky note and have them add what they know to the chart themselves.

Ask students "What do you **WONDER** about migration?" Record their questions in the 'Wonder' section of the chart using sticky notes or by writing them there yourself, then set it aside. Return to the chart at the end of the lesson

** This K-W-L brainstorm could also be done in a discussion format with the teacher writing down student ideas in the chart. Adapt terminology as needed for the age of students.*

Activity 2: Migration Headache

*Adapted from *Explore the World with Shorebirds! - Educator's Guide for the Shorebird Sister Schools Program*

Time: 40 min | Student Level: Grades 3-8

Materials:

Provided: Migration Headache Habitat Scenario Cards (Activity Sheet 2.1) Migration Headache Diagram (Activity Sheet 2.2)

From your Classroom: Paper plates

Preparation: Select a large area to play - a field, gymnasium, hallway, or if necessary a classroom with desks and chairs moved out of the way. Place an equal number of 'bases' (paper plates) in each of three areas (See Migration Headache Diagram: Activity Sheet 2.2): 'Wintering Habitat' and 'Nesting Habitat' at either end of the space, and 'Stopover Habitat' in the middle. Each base should have a big X on one side drawn with marker - arrange the bases with the 'X' hidden to start. At the start of the activity, there should be enough bases in each habitat to accommodate all of your students if they stand two students per base. Shuffle the Migration Headache Habitat Scenario Cards (Activity Sheet 2.1).

Engage: Tell students that they are shorebirds! They have been eating and getting fat all winter, and now they are trying to migrate from the Wintering Habitat to the Nesting Habitat. The bases (paper plates) represent good shorebird habitat such as wetlands, beaches, or grasslands. Students should immediately go to the Wintering Habitat and find a safe habitat! This means they must stand with one foot on a base - no more than two students per base. All students should find a base at this point.

Explore:

1. Tell students they have a long way to migrate, so they will first have to stop and rest in a stopover site. Explain that any time they cannot find a base, their bird 'dies' and has to wait on the sidelines to rejoin the game as a fledgling. Tell them the time is now - they should fly to the stopover site and find a base to rest in! All students should find a base - explain that it's been a good year and there was no habitat loss in the stopover site.
2. Turn over 3-4 plates in the nesting habitat. Tell the students that there has been heavy rain that flooded many of the nest sites! When they migrate this time, some students will not be able to find a base and will be 'out'. Have these students line up to the side of the Nesting Ground so they can re-enter as fledglings when more habitat is available.
3. It's time now to head back to the wintering ground, but once again, they will need to find a safe stopover site. Draw a Migration Headache Habitat Scenario Card, read the prompt, and follow the directions to add or subtract bases (plates) from the stopover site. Have the 'fledgling' students line up on the side of the nesting habitat. On your mark, all students run to the stopover site and try to find a safe resting place (remember, only two students per base). Mobility impaired students can be accommodated with a head start, or by moving them to the next stage ahead of time. Students who do not find a base 'die' and must move to the sidelines - they'll get another chance to rejoin after the next round of nesting.
4. Draw another Migration Headache Habitat Scenario Card, read the prompt, and follow the directions to add or subtract bases from the wintering grounds. On your mark, students run to the wintering ground. Students who do not find a base must move to the sidelines.
5. Repeat step 4 to move from the wintering grounds back to the stopover site, then back to the nesting ground.
6. Once on the nesting ground, repeat step 3 to allow students on the sidelines to re-enter, then continue until you have gotten through all of the Migration Headache Habitat Scenario Cards. Depending on the order in which the Migration Headache Habitat Scenario Cards are drawn, it's possible that at some point all the bases in a particular location will be removed. For younger students, teachers may wish to manipulate so that this does not happen.

Discuss: In full class or small groups discuss why shorebirds migrate and what habitat requirements they have throughout their life cycle.

- Why do shorebirds migrate? Write down at least three reasons.
- What do shorebirds need during migration? Write down at least three needs.

Modification for younger students: brainstorm these as a large group and then draw pictures to represent the needs. For example, a student might draw a picture of a bird eating a crab or worm to represent that shorebirds need food along their migration route.

Activity 3: Shorebird Needs & Migration Map

Time: 50 min | Student Level: Grades 3-8

Materials:

Provided: Shorebird Cards, Western Hemisphere Map (Activity Sheet 2.3), Shorebird Migration Maps (Activity Sheet 2.4), Online map resource

From your Classroom: Pins and yarn (if using a printed map), sticky notes

Engage*: In full class or small group, discuss why shorebirds migrate and what habitat requirements they have throughout their life cycle.

- Why were the shorebirds migrating? Write down at least three reasons.
- What are three things shorebirds need during migration? Write these down as well.

Modification for younger students: Brainstorm these as a large group and then draw pictures to represent the needs. For example, a student might draw a picture of a bird eating a crab or worm to represent that shorebirds need food along their migration route.

**Duplicates the Discuss piece from Activity 2 - skip to Explore if you have already completed.*

Explore: Project or pin up the large format map of the Western Hemisphere.

1. Assign each group of students a Shorebird Card and Shorebird Migration Map.
2. Students should use markers or pins and yarn to add the Shorebird Migration Map of their shorebird to the map.

3. Tell students to write the migration reasons (from the 'Engage' step) on sticky notes and add them to the large map next to the nesting and wintering grounds. *Example: Students come up with "food" as a reason to migrate. Students could place a sticky note in the wintering ground that says "lots of food in winter", and one in the nesting ground that says "not enough food in winter". Other reasons might include temperature, predation risk, competition for nesting territories, daylight hours, etc.*
4. Next, have students use sticky notes or markers to add habitat needs along the migration route. *Example: Students might identify that birds need water along their route. They could add 'water' on a sticky note.*

Discuss: Each group of students presents their migration route to the class, explaining the migration needs and reasons for migration for their shorebird.

Activity 4: Precarious Paths

*Adapted from *Explore the World with Shorebirds! - Educator's Guide for the Shorebird Sister Schools Program*

Time: 15 min | Student Level: Grades 3-8

Materials:

Provided: Precarious Paths Cards (Activity Sheet 2.6 and 2.7), Flyways Map (Activity Sheet 2.5), Online map resource, Shorebird Migration Map (Activity Sheet 2.4), Shorebird Cards, Precarious Paths Teacher Key (Activity Sheet 2.9 and 2.10), Precarious Paths Dates (Activity Sheet 2.8)

From your Classroom: No supplies needed.

Engage: Divide students into small groups, give each group a Shorebird Card for one of the Precarious Paths species (Buff-Breasted Sandpiper, Ruddy Turnstone, Red Knot, or Western Sandpiper) and a Flyways Map (Activity Sheet 2.5). Students should work together to figure out the flyway that their shorebird uses, and highlight it on the map.

Explore:

1. Each group should get the set of Precarious Paths Cards (Activity Sheet 2.6 or 2.7) for their shorebird, shuffled into random order. Use the 'younger students' cards for grades 3-5, and the 'older students' cards for grades 6-8.
2. Students should work together to put the cards in order and assemble the migration story. Students should mark each location on their map with a Precarious Paths Dates (Activity Sheet 2.8).
3. Students use the cards to tell the migration story of their bird to the class, using the projected version of the Flyways Map (Activity Sheet 2.5) to indicate where each part of the story takes place.

Discuss: After students present their migration stories to the class discuss these prompts:

- How important is timing for migration? What would happen if a bird arrived at a destination too early or too late? Prompt students to come up with an example from one of the migration stories.
- **For older students:** How do you think climate change could affect migration timing?
- Is storytelling a good way to share scientific information? What are the pros and cons of using stories like these for learning?

Activity 5: Know-Wonder-Learn about Migration, *revisited*

Time: 15 min

Revisit the Know-Wonder-Learn chart created at the beginning of the lesson. Students should work in pairs to brainstorm things they have learned about migration to add to the chart. Have them share by adding sticky notes, or by writing their responses onto the chart. Follow up on their 'wonder' items to see if we can now answer some of their questions.

Cultural Connections: To highlight the role of storytelling in traditional ecological knowledge, stimulate storytelling around the importance of birds returning from migration, the significance of the seasons and changing weather. "A Year in the Life of a Red Knot" is a comic book that's been translated in 8 languages, including in Cree (3 dialects) and Innu. It tells the story of Rufus, a Red Knot traveling from the Canadian Arctic to the tip of South America and back and its adventures. Discussions can also include how the migratory birds are connected to the indigenous way of life in your region (e.g. egg, down and bird harvesting).

Habitat Scenario Cards

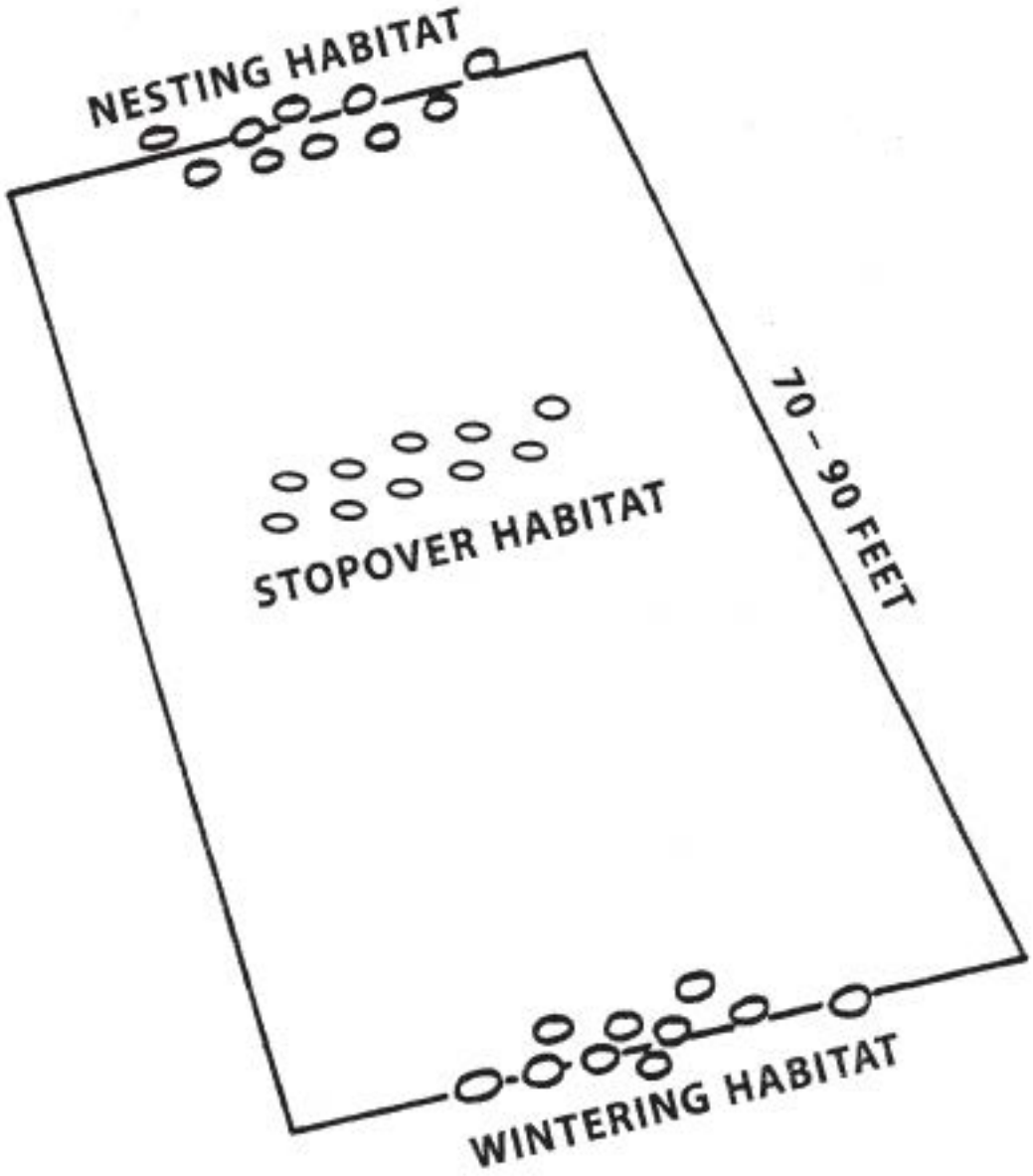
New housing developments are built on shorebird habitat *Remove 5 Plates*	**A wetland is drained** *Remove 5 Plates*
Grasslands and wetlands are converted to farmland *Remove 4 plates*	**The habitat is polluted** *Remove 3 Plates*
Drought Year: Less Rainfall than usual *Remove 3 Plates*	**People are getting too close and disturbing the shorebirds** *Remove 2 Plates*
Low food supply *Remove 1 Plate*	**Hunters illegally shoot some shorebirds** *Remove 1 Plate*

Habitat Scenario Cards

Grasslands and Wetlands are protected *Add 4 Plates*	**A local factory stops polluting the watershed, and water quality improves** *Add 4 Plates*
A wetland is restored so that shorebirds can now use it *Add 3 plates*	**People are educated about how to protect and conserve shorebirds** *Add 3 Plates*
Normal rainfall year *Add 2 Plates*	**Hunters are educated about shorebirds and follow local laws protecting them** *Add 1 Plate*
Farms managed to support crops, cattle, and shorebirds at the same time *Add 3 Plates*	*Make your own scenario.*

Diagram for Setup

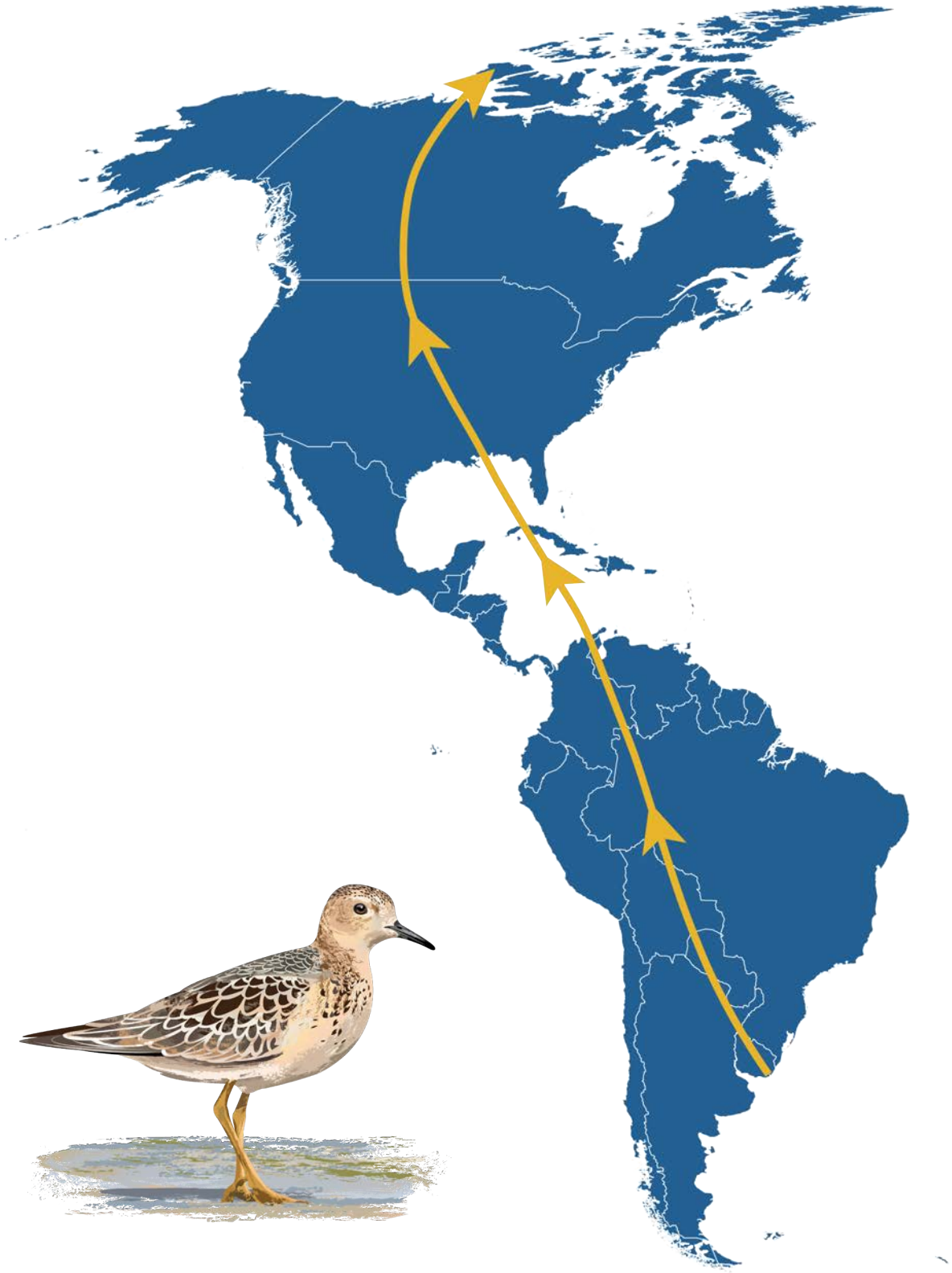
Select a large area to play - a field, gymnasium, hallway, or if necessary a classroom with desks and chairs moved out of the way. Place an equal number of 'bases' (paper plates) in each of three areas (*see diagram*): 'Wintering Habitat' and 'Nesting Habitat' are at either end of the space, and 'Stopover Habitat' in the middle. Each base should have a big X on one side drawn with marker - arrange the bases with the 'X' hidden to start. At the start of the activity, there should be enough bases in each habitat to accommodate all of your students if they stand two students per base.



Blank Hemisphere Map: Activity Sheet 2.3

Shorebird Migration Map: Activity Sheet 2.4 — American Avocet

Shorebird Migration Map: Activity Sheet 2.4 — Buff-breasted Sandpiper



Shorebird Migration Map: Activity Sheet 2.4 — Hudsonian Godwit

Shorebird Migration Map: Activity Sheet 2.4 — Killdeer

Shorebird Migration Map: Activity Sheet 2.4 — Lesser Yellowlegs

Shorebird Migration Map: Activity Sheet 2.4 — American Oystercatcher

Shorebird Migration Map: Activity Sheet 2.4 — Red Knot

Shorebird Migration Map: Activity Sheet 2.4 — Ruddy Turnstone

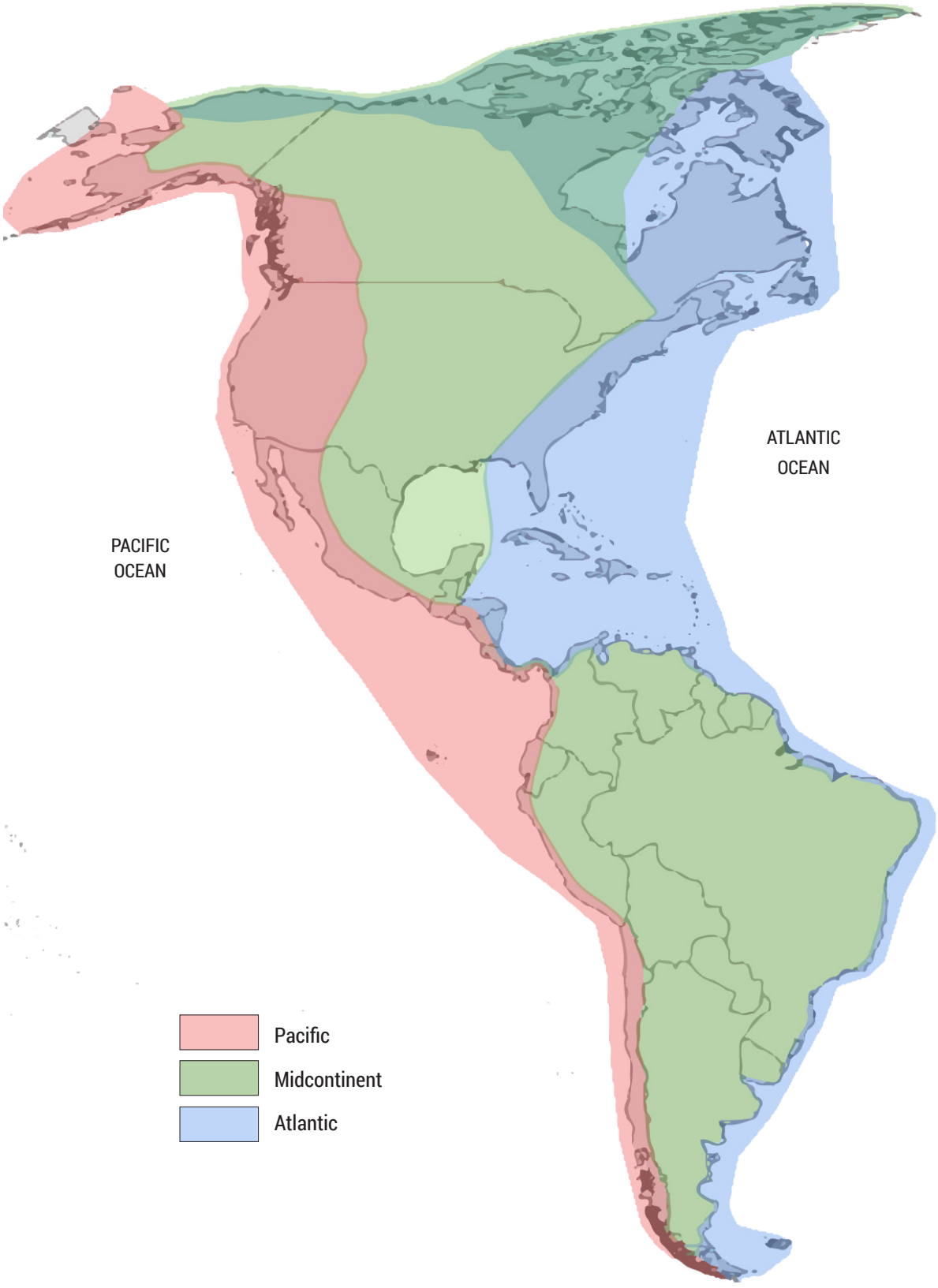
Shorebird Migration Map: Activity Sheet 2.4 — Semipalmated Sandpiper

Shorebird Migration Map: Activity Sheet 2.4 — Western Sandpiper

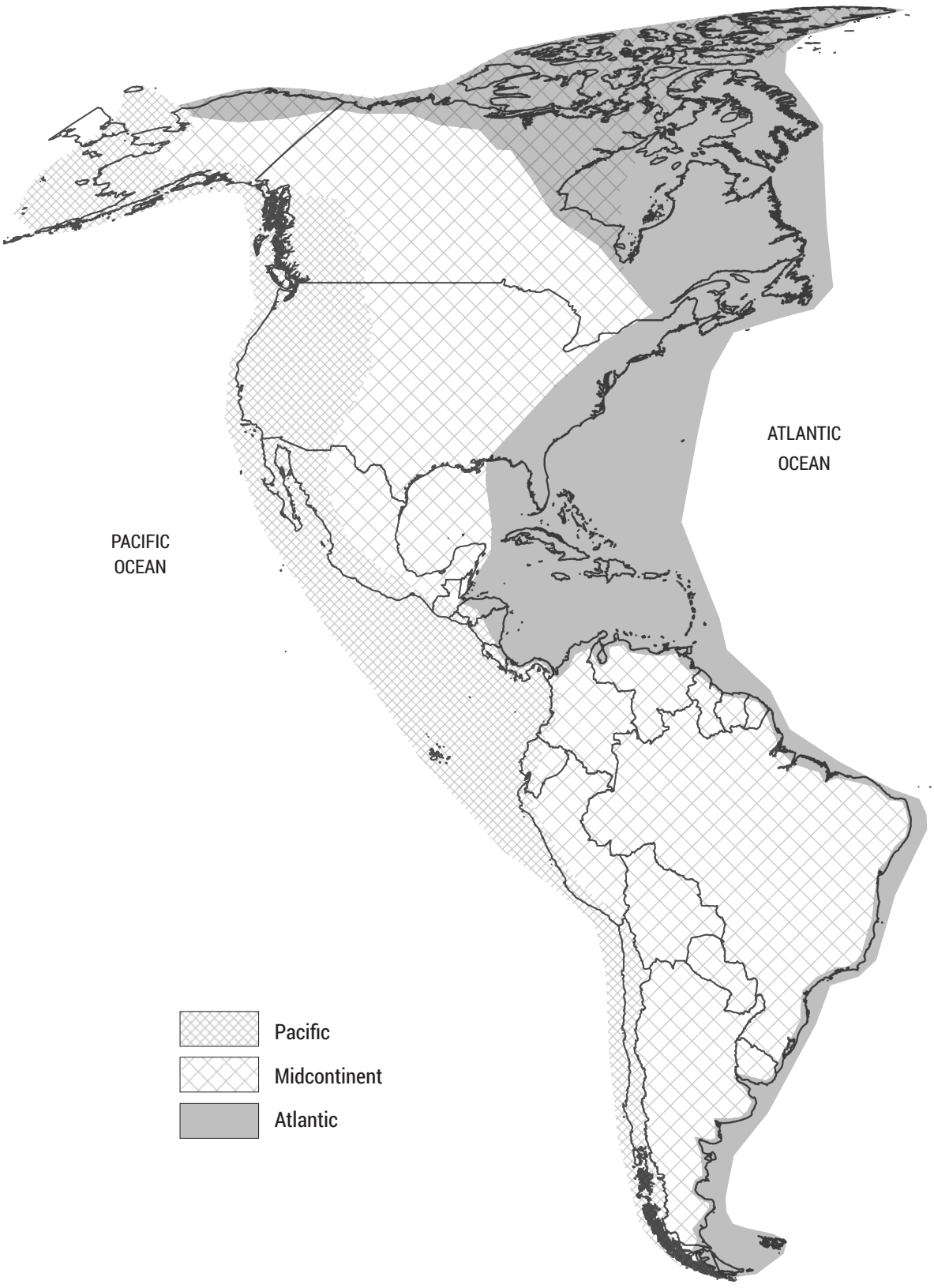
Shorebird Migration Map: Activity Sheet 2.4 — Whimbrel

Shorebird Migration Map: Activity Sheet 2.4 — Wilson's Phalarope

Flyways Map: Activity Sheet 2.5



Flyways: B&W Activity Sheet 2.5



Travel Notes: Red Knot

Red Knot	Red Knot
I'm on an island at the very southern tip of South America - in an area called Tierra del Fuego. I'm here with thousands of other red knots, and I spend most of the day on the shore gobbling up mussels from the mussel beds - they are delicious! When I'm not searching for food, I am resting and taking care of my feathers with other members of the flock!	I stopped on this beach halfway up the coast of Argentina to feed on the small ocean animals living in the mud and sand. I need to increase my body weight by 80 percent! I particularly love the small snails that are found here
Red Knot	**Red Knot**
Whew - that was a long flight! First I flew nonstop to the north coast of South America, and then I headed out across the ocean. I have now arrived on the sandy beaches and tidal flats of the Delaware Bay. There are about 15,000-30,000 of us here with tens of thousands of other shorebirds. We are all here for one reason: food! Horseshoe crab eggs galore! We eat and eat and eat…that is unless we are sleeping or trying to stay away from people and other animals.	I weigh so much that I don't think I can lift off the ground, even though I know it's time to head north. I move up the beach with the rest of the huge flock as the tide comes in, eating a few last horseshoe crab eggs as I go. Suddenly one bird takes off, and before I know it, we are all in the air! We fly north - we will not stop until we reach the arctic tundra.
Red Knot	**Red Knot**
As we fly over northern Canada, I see the tundra in springtime with its pools and hummocks of grass. I see an area that I like, and leave the flock and fly down to it. It is here that I will find my mate and we will spend the next six weeks establishing a nest, incubating the eggs, and raising our young.	Our babies have grown up and can feed themselves - they don't need me anymore! I leave them behind, and head to James Bay to eat clams on the mud flats. I will follow the west winds to the Atlantic coastline where I will spend the rest of the summer eating and slowly moving south. By September I'll be ready for a nonstop, four day flight over the ocean to South America! Eventually I'll end up where I started - in Tierra del Fuego at the southern tip of South America.

Travel Notes: Ruddy Turnstone

Ruddy Turnstone	Ruddy Turnstone
I have been working my way north for the past month or so, finding many sandy beaches and mud flats in Florida. I spend most of my time turning over stones and seaweed to look for and catch my favorite food – sand fleas! But I will eat anything I can scavenge, including dead animals and bits of food left over from other animals feeding.	I have stopped along the Delaware Bay to gorge myself on horseshoe crab eggs. I feed a little differently than the other shorebirds that join me – I dig up the eggs that are right under the surface, while they pick the eggs up off the surface. I guess in this way I am making more eggs available to everyone! This year, the horseshoe eggs seem harder to find.
Ruddy Turnstone	**Ruddy Turnstone**
I thought I ate enough horseshoe crab eggs so I could fly directly to my nesting grounds, but I guess I didn't gain as much weight as usual. I stop at Hudson Bay to feed among the rocks before continuing. I'm running late - I hope I will still have enough time to select a mate and nest.	I finally arrive in my nesting area! I see a good spot - a boulder to perch on while I call and watch for predators. Unfortunately the boulder is already taken by another Ruddy Turnstone, so I keep looking.
Ruddy Turnstone	**Ruddy Turnstone**
As much as I try, I can't find a good nesting site or a mate - they are all taken. I guess I arrived too late. I decide to leave the nesting area early and head south. Along the way I meet up with other Ruddy Turnstones that also didn't mate this year, and we form small flocks as we work our way down the Atlantic Ocean coastline. We stop at the Bay of Fundy in Nova Scotia and New Brunswick, and also further south in North Carolina and Georgia.	After spending some time on the beaches in Florida, we take off for South America! Our small flock finally arrives in northern Argentina, to the same beach where I started out last year. We will spend most of our time here eating, resting, and cleaning our feathers. I hope that next year I can make it back to the Arctic with plenty of energy and plenty of time to nest and find a mate.

Travel Notes: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
My friends and I are enjoying the shoreline of Argentina, which provides the perfect habitat for us to wade in shallow waters and fatten up on some of our favorite snacks like pillbugs, spiders, and snails. Yum! I'll soon have enough fat built up for my journey to the Arctic circle of Canada.	Whew! I made my way to the Central Plains region in Oklahoma. The short grass habitat is perfect for staying hidden and being able to find food. I'll stay here to rest and refuel on food for a couple of weeks before continuing my journey North to the Arctic Circle of Canada.
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
I've made it to Canada! All of my friends are arriving at the same time and the males have already started trying to impress us with their lekking. I am surrounded by courtship displays of male buff breasted sandpipers stretching out their wings and shaking their bodies. I wonder which display I will like best!	This morning I had a frightening experience! When I was searching for insects in the shallow water, a human grabbed me! The human put these funny-looking bands on my legs—a silver one, bright red and orange ones, and a white one with an end sticking out. These odd bands don't bother me when I walk or fly, but they sure do look funny. I wonder what they mean?
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
My eggs are hatching! The four eggs were laid 25 days ago, which means they are right on time. My chicks can't fly yet, but they are able to scurry around on the ground right away. Taking care of them is a big job - I had to incubate the eggs all by myself for almost a month. All of the male buff breasted sandpipers have already left our nesting grounds and are headed south for the winter.	I'm ready to leave my nesting grounds along with other successful females and our young! I'm flying with a small flock of 3 other birds who want to make this journey with me, but some others will fly back solo. I'll fly back along the same route I used to fly north.

Travel Notes: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
I take a break to feed at Padre Island in Texas until my small flock and I are ready to continue flying south. This seems to be an important resting stop for other migratory birds heading south as well!	We are back in Argentina! Many of us will stay here all winter long until it's time to head north and breed again. It seems like a lot of buff breasted sandpipers have already arrived, but I'm sure some of my friends won't be back until December. Very different than when we all arrive in Canada on the same day!

Travel Notes: Western Sandpiper

Western Sandpiper	Western Sandpiper
Huge flocks of us are forming here on the coast of Peru, getting ready for our long trip north to the nesting grounds. It's amazing having so many of us together at one time. We'd better hurry; we've got a long way to fly!	After stopping at several locations to feed, we've made it to the San Diego Bay National Wildlife Refuge in the United States. We'll rest and refuel in the mudflats before heading to our next stop-- San Francisco Bay.
Western Sandpiper	**Western Sandpiper**
After leaving Oregon Island National Wildlife Refuge, we stopped in the Fraser River Delta in British Columbia before heading to Alaska!	I bet there are one million of us here at Alaska's Copper River Delta. This is a wonderful place to stop along our way north. The endless mudflats give me a chance to probe the mud for tiny clams, worms, and sand fleas until I replace some of the body fat I used up getting here. I'm going to need that energy to make it all the way to western Alaska.
Western Sandpiper	**Western Sandpiper**
Looks like the male Western Sandpipers have beaten us here to the Yukon Delta National Wildlife Refuge. Well, that's OK. They've already selected nesting sites, so all I have to do is choose a mate and lay my eggs.	I'm so glad that my mate and I take turns incubating the eggs. That gives me a chance to feast on the large numbers of insects that are hatching now. I'd better watch out while I'm feeding. The Arctic fox is always looking to make a meal out of us shorebirds!

Travel Notes: Western Sandpiper

Western Sandpiper	Western Sandpiper
Here we go again! Those gulls are nasty predators and are after our chicks. Maybe I can distract them with the "broken wing act" while my mate leads our chicks to safety. Uh oh - looks like they've seen this trick before and aren't falling for it this time. That was a very narrow escape!	My babies have grown up and can feed themselves now, so it's time to leave them behind. I fly to Kachemak Bay in Alaska, then to Stikine River Delta in Canada. This is my favorite spot on my journey south because I can find so many clams here in the mudflats! After this, I will travel south along the coast line, stopping every couple hundred miles to rest and eat.
Western Sandpiper	**Western Sandpiper**
We have arrived on the coast of Mexico! This is a great place to rest. In fact, some Western Sandpipers will stay here all winter. I will make one more stop in Panama before continuing on to Peru.	I'm glad to be back in Peru for the winter. I need a rest! Every year the trip gets harder for me. There are so many people along the coast who disturb me when I try to rest and feed along the way. Sometimes the food has a strange, unfamiliar taste that makes me feel weak. Well, at least I can rest here for a few months and regain my strength.

Travel Notes: Red Knot

Red Knot	Red Knot
There are thousands of us feeding on the sandy beaches and mud flats at the southern tip of South America in Tierra del Fuego. I spend most of the day feeding in the mussel beds, devouring young mussels. When I'm not eating, I roost and preen with the rest of the flock.	I arrived on the central coast of Argentina to feed again on the invertebrates living in the mud of the immense tidal sand flat. I need to increase my body weight by 80 percent! I particularly love the small snails that are found here.
Red Knot	**Red Knot**
After a nonstop flight to the northern coast of South America, then across the ocean, I arrived on the sandy beaches and tidal flats of the Delaware Bay. There are about 15,000-30,000 of us here with tens of thousands of other shorebirds. We are all here for one reason: food! Horseshoe crab eggs galore! We eat and eat and eat…that is unless we are sleeping or trying to stay away from people and other animals.	I weigh so much that I don't think I can lift off the ground, but late in the afternoon, the incoming tide pushes me and the flock higher up on the beach. We all move away from the advancing water, moving as one. Someone jumps a certain way and we are all up in the air, flying north, knowing that we will not stop until we fly over Hudson Bay and reach the Arctic tundra.
Red Knot	**Red Knot**
As we fly over the northern Canadian tundra pools and hummocks of the Melville Peninsula, I leave the flock and fly down to a barren area scattered with vegetation. It is here that I will find my mate and we will spend the next six weeks establishing a nest, incubating the eggs, and raising our young.	Leaving our young behind, I make it to James Bay. This is my favorite spot on my southward migration. The tidal mud flats are full of clams! From here I will follow the west winds to the Atlantic coastline where I will feed almost constantly until late August. The best places to stop along the coast are national and state refuges, parks, and forests. By September I'll be ready for the nonstop, four day flight over the ocean to Suriname. I'll rest and feed before my final leg - a return flight to Tierra del Fuego, Argentina.

Travel Notes: Ruddy Turnstone

Ruddy Turnstone	Ruddy Turnstone
I have been working my way northward for the past month or so, finding many sandy beaches and mud flats in coastal south Florida. Much of my time is spent turning over stones and seaweed to look for and catch my preferred food – sand fleas! But I will eat anything I can scavenge, including dead animals and bits of food left over from other animals feeding.	I have stopped along the Delaware Bay to gorge myself on horseshoe crab eggs. I feed a little differently than the other shorebirds that join me – I dig up the eggs that are right under the surface, while they pick the eggs up off the surface. I guess in this way I am making more eggs available to everyone! This year, the horseshoe eggs seem harder to find.
Ruddy Turnstone	**Ruddy Turnstone**
I thought I ate enough horseshoe crab eggs so I could fly directly to my breeding grounds, but I guess I didn't gain as much weight as usual. I stop at Churchill, on the Hudson Bay to feed along the jetties before continuing. I hope I will still have enough time to select a mate and nest.	I finally arrive on the breeding grounds north of Hudson Bay and look for the location I have used in the past. The boulder on the tundra is an ideal place for me to perch and call and watch for predators. As I touch down, I am immediately assaulted by another Ruddy Turnstone, driving me away from the area.
Ruddy Turnstone	**Ruddy Turnstone**
As much as I try, I am unable to find a suitable nest site and available mate - I guess I arrived too late. Leaving the breeding grounds early, I head south. Along the way I meet up with other Ruddy Turnstones and we form small flocks as we work our way down the Atlantic coastline, stopping at the Bay of Fundy in Nova Scotia and New Brunswick, Pea Island National Wildlife Refuge in North Carolina, and Sapelo Island National Estuarine Reserve in Georgia.	After we depart from the national wildlife refuges and sanctuaries at the southern tip of Florida, our small flock arrives in northern Argentina. This is the same beach I started out at last season when I migrated north. We spend most of our time feeding and preening. I hope that next year I can make it back to the Arctic with plenty of energy and plenty of time to breed.

Travel Notes: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
My friends and I are enjoying the shoreline of Bahía de Samborombón in Argentina, which provides the perfect habitat for us to wade in shallow waters and fatten up on some of our favorite invertebrate snacks like pillbugs, spiders, and snails. Yum! I'll soon have enough fat built up for my journey to the Arctic circle of Canada.	Whew! I made my way to the Central Plains region in Oklahoma. The short grass habitat is perfect for staying hidden and being able to find food. I'll stay here to rest and refuel on food for a couple of weeks before continuing my journey North to the Arctic Circle of Canada.
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
I've made it to Canada! All of my friends are arriving at the same time and the males have already started trying to impress us with their lekking. I am surrounded by courtship displays of male buff breasted sandpipers stretching out their wings and shaking their bodies. I wonder which display I will find most impressive!	This morning I had a frightening experience! When I was searching for aquatic insects in the shallow water, a human grabbed me! The human put these funny-looking bands on my legs—a silver one, bright red and orange ones, and a white one with an end sticking out. These odd bands don't bother me when I walk or fly, but they sure do look funny. I wonder what they mean?
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
My eggs are hatching! The four eggs were laid 25 days ago, which means they are right on schedule and the chicks are almost immediately ready to leave the nest. I have been the only bird responsible for incubating these eggs since they were laid. All of the male buff breasted sandpipers have already left our breeding grounds and are headed south for the winter.	I'm ready to leave my breeding grounds along with other successful females and our young! I'm flying with a small flock of 3 other birds who want to make this journey with me, but some individuals are flying solo for the trip back. I'll most likely stop at the same spots on the way back to Argentina as I did during my journey north.

Travel Notes: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
I take a break to feed at Padre Island in Texas until my small flock and I are ready to continue flying southbound. This seems to be an important resting stop for other migratory birds heading south as well!	We are back at Bahía de Samborombón for another winter! Many of us will stay here all winter long until it's time to head north and breed again. It seems like a lot of buff breasted sandpipers have already arrived, but I'm sure some of my friends won't be back until December. Very different than when we all arrive in Canada on the same day!

Travel Notes: Western Sandpiper

Western Sandpiper	Western Sandpiper
Everyone's flocking up here on the coast of Peru, getting ready for our long trip north to the breeding grounds. It's amazing having so many of us together at one time. We'd better hurry; we've got a long way to fly!	After stopping at several locations to feed, we've made it to the San Diego Bay National Wildlife Refuge in the United States. We'll rest and refuel in the mudflats before heading to our next stop-- San Francisco Bay National Wildlife Refuge.
Western Sandpiper	**Western Sandpiper**
After leaving Oregon Island National Wildlife Refuge, we stopped in the Fraser River Delta in British Columbia before heading to the nutrient-rich Alaska coast!	I bet there are one million of us here at Alaska's Copper River Delta. This is a wonderful stopover site along our way north. The endless mudflats give me a chance to probe the mud for tiny clams, worms, and sand fleas until I replace some of the body fat I used up getting here. I'm going to need all that energy to make it all the way to western Alaska.
Western Sandpiper	**Western Sandpiper**
Looks like the males have beaten us here to the Yukon Delta National Wildlife Refuge. Well, that's O.K. They've already selected nesting sites, so all I have to do is choose a mate and lay my eggs.	I'm so glad that my mate and I take turns incubating the eggs. That gives me a chance to feast on the large numbers of insects that are hatching now. I'd better watch out while I'm feeding. The Arctic fox is always looking to make a meal out of us shorebirds!

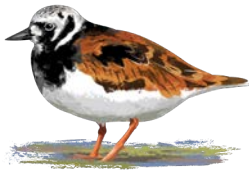
Travel Notes: Western Sandpiper

Western Sandpiper	Western Sandpiper
Here we go again! Those gulls are nasty predators and are after our chicks. Maybe I can distract them with the "broken wing act" while my mate leads our chicks to safety. Looks like they've seen this trick before and aren't falling for it this time. That was a very narrow escape!	Having left the young behind, I fly to Kachemak Bay at the Alaska Maritime National Wildlife Refuge, then to Stikine River Delta along the Canadian coast. This is my favorite spot on my southward migration because of the abundance of clams in the tidal mudflats. Then I will travel along the coast line, stopping every couple hundred miles. We take our time getting home.
Western Sandpiper	**Western Sandpiper**
We have arrived at Marismas Nacionales near Tepic, Mexico. This is a great place to rest. In fact, some Western Sandpipers will stay here all winter. I will continue to Peru with one stop in Panama before arriving.	I'm glad to be back in Peru for the winter. I need a rest! Every year the trip gets harder for me. There are so many people along the coast who disturb me when I try to rest and feed along the way. Sometimes the food has a strange, unfamiliar taste that makes me feel weak. Well, at least I can rest here for a few months and regain my strength.

Date Cards: Red Knot

Red Knot	Red Knot
 January 8	 March 14
Red Knot	**Red Knot**
 May 19	 May 31
Red Knot	**Red Knot**
 June 3	 July 18

Date Cards: Ruddy Turnstone

Ruddy Turnstone	Ruddy Turnstone
 April 10	 May 16
Ruddy Turnstone	**Ruddy Turnstone**
 June 3	 June 16
Ruddy Turnstone	**Ruddy Turnstone**
 July 8	 September 4

Date Cards: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
 March 16	 May 17
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
 June 4	 June 6
Buff-Breasted Sandpiper	**Buff-Breasted Sandpiper**
 July 9	 August 5

Date Cards: Buff-Breasted Sandpiper

Buff-Breasted Sandpiper	Buff-Breasted Sandpiper
 **October 12**	 **October 31**

Date Cards: Western Sandpiper

Western Sandpiper	Western Sandpiper
 **April 10**	 **April 20**
Western Sandpiper	**Western Sandpiper**
 **May 10**	 **May 20**
Western Sandpiper	**Western Sandpiper**
 **June 1**	 **June10**

Date Cards: Western Sandpiper

Western Sandpiper	Western Sandpiper
 **June 24**	 **July 18**
Western Sandpiper	**Western Sandpiper**
 **August 30**	 **September 15**

Teacher Key

Red Knot (Atlantic Flyway)

January 8
I'm on an island at the very southern tip of South America - in an area called Tierra del Fuego. I'm here with thousands of other red knots, and I spend most of the day on the shore gobbling up mussels from the mussel beds - they are delicious! The rest of the time I rest and take care of my feathers with the rest of the flock.

March 14
I stopped on this beach halfway up the coast of Argentina to feed on the small ocean animals living in the mud and sand. I need to increase my body weight by 80 percent! I particularly love the small snails that are found here.

May 19
Whew - that was a long flight! First I flew nonstop to the north coast of South America, and then I headed out across the ocean. I have now arrived on the sandy beaches and tidal flats of the Delaware Bay. There are about 50 to 100,000 of us here with tens of thousands of other shorebirds. We are all here for one reason: food! Horseshoe crab eggs galore! We eat and eat and eat…that is unless we are sleeping or trying to stay away from people and other animals.

May 31
I weigh so much that I don't think I can lift off the ground, even though I know it's time to head north. I move up the beach with the rest of the huge flock as the tide comes in, eating a few last horseshoe crab eggs as I go. Suddenly one bird takes off, and before I know it, we are all in the air! We fly north - we will not stop until we reach the arctic tundra.

June 3
As we fly over northern Canada, I see the tundra in springtime with its pools and hummocks of grass. I see an area that I like, and leave the flock and fly down to it. It is here that I will find my mate and we will spend the next six weeks establishing a nest, incubating the eggs, and raising our young.

July 18
Our babies have grown up and can feed themselves - they don't need me anymore! I leave them behind to fatten up some more, and head to James Bay. This is my favorite spot on my southward migration. The mud flats are full of clams! From here I will follow the west winds to the Atlantic coastline where I will spend the rest of the summer eating and slowly moving south. The best places to stop along the coast are national and state refuges, parks, and forests. By September I'll be ready for the nonstop, four day flight over the ocean to the north coast of South America. I'll rest and feed before my final flight - a return flight to Tierra del Fuego, on the southern tip of South America.

Teacher Key, continued

Ruddy Turnstone (Atlantic Flyway)

April 10
I have been working my way north for the past month or so, finding many sandy beaches and mud flats in Florida. I spend most of my time turning over stones and seaweed to look for and catch my favorite food – sand fleas! But I will eat anything I can scavenge, including dead animals and bits of food left over from other animals feeding.

May 16
I have stopped along the Delaware Bay to gorge myself on horseshoe crab eggs. I feed a little differently than the other shorebirds that join me – I dig up the eggs that are right under the surface, while they pick the eggs up off the surface. I guess in this way I am making more eggs available to everyone! This year, the horseshoe eggs seem harder to find.

June 3
I thought I ate enough horseshoe crab eggs so I could fly directly to my nesting grounds, but I guess I didn't gain as much weight as usual. I stop at Hudson Bay to feed among the rocks before continuing. I'm running late - I hope I will still have enough time to select a mate and nest.

June 16
I finally arrive in my nesting area! I see a good spot - a boulder to perch on while I call and watch for predators. Unfortunately the boulder is already taken by another Ruddy Turnstone, so I keep looking.

July 8
As much as I try, I can't find a good nesting site or a mate - they are all taken. I guess I arrived too late. I decide to leave the nesting area early and head south. Along the way I meet up with other Ruddy Turnstones that also didn't mate this year, and we form small flocks as we work our way down the Atlantic Ocean coastline. We stop at the Bay of Fundy in Nova Scotia and New Brunswick, and also further south in North Carolina and Georgia.

September 4
After spending some time on the beaches in Florida, we take off for South America! Our small flock finally arrives in northern Argentina, to the same beach where I started out last year. We will spend most of our time here eating, resting, and cleaning our feathers. I hope that next year I can make it back to the Arctic with plenty of energy and plenty of time to nest and find a mate.

Teacher Key, continued

Buff-Breasted Sandpiper (Central Flyway)

March 16
My friends and I are enjoying the shoreline of Argentina, which provides the perfect habitat for us to wade in shallow waters and fatten up on some of our favorite snacks like pillbugs, spiders, and snails. Yum! I'll soon have enough fat built up for my journey to the Arctic circle of Canada.

May 17
Whew! I made my way to the Central Plains region in Oklahoma. The short grass habitat is perfect for staying hidden and being able to find food. I'll stay here to rest and refuel on food for a couple of weeks before continuing my journey North to the Arctic Circle of Canada.

June 4
I've made it to Canada! All of my friends are arriving at the same time and the males have already started trying to impress us with their lekking. I am surrounded by courtship displays of male buff breasted sandpipers stretching out their wings and shaking their bodies. I wonder which display I will like best!

June 6
This morning I had a frightening experience! When I was searching for insects in the shallow water, a human grabbed me! The human put these funny-looking bands on my legs—a silver one, bright red and orange ones, and a white one with an end sticking out. These odd bands don't bother me when I walk or fly, but they sure do look funny. I wonder what they mean?

July 9
My eggs are hatching! The four eggs were laid 25 days ago, which means they are right on time. My chicks can't fly yet, but they are able to scurry around on the ground right away. Taking care of them is a big job - I had to incubate the eggs all by myself for almost a month. All of the male buff breasted sandpipers have already left our nesting grounds and are headed south for the winter.

August 5
I'm ready to leave my nesting grounds along with other successful females and our young! I'm flying with a small flock of 3 other birds who want to make this journey with me, but some others will fly back solo. I'll fly back along the same route I used to fly north.

October 12
I take a break to feed at Padre Island in Texas until my small flock and I are ready to continue flying south. This seems to be an important resting stop for other migratory birds heading south as well!

October 31
We are back in Argentina! Many of us will stay here all winter long until it's time to head north and breed again. It seems like a lot of buff breasted sandpipers have already arrived, but I'm sure some of my friends won't be back until December. Very different than when we all arrive in Canada on the same day!

Teacher Key, continued

Western Sandpiper (Pacific Flyway)

April 10
Huge flocks of us are forming here on the coast of Peru, getting ready for our long trip north to the nesting grounds. It's amazing having so many of us together at one time. We'd better hurry; we've got a long way to fly!

April 20
After stopping at several locations to feed, we've made it to the San Diego Bay National Wildlife Refuge in the United States. We'll rest and refuel in the mudflats before heading to our next stop-- San Francisco Bay.

May 10
After leaving Oregon Island National Wildlife Refuge, we stopped in the Fraser River Delta in British Columbia before heading to Alaska!

May 20
I bet there are one million of us here at Alaska's Copper River Delta. This is a wonderful place to stop along our way north. The endless mudflats give me a chance to probe the mud for tiny clams, worms, and sand fleas until I replace some of the body fat I used up getting here. I'm going to need that energy to make it all the way to western Alaska.

June 1
Looks like the males Western Sandpipers have beaten us here to the Yukon Delta National Wildlife Refuge. Well, that's OK. They've already selected nesting sites, so all I have to do is choose a mate and lay my eggs.

June 10
I'm so glad that my mate and I take turns incubating the eggs. That gives me a chance to feast on the large numbers of insects that are hatching now. I'd better watch out while I'm feeding. The Arctic fox is always looking to make a meal out of us shorebirds!

June 24
Here we go again! Those gulls are nasty predators and are after our chicks. Maybe I can distract them with the "broken wing act" while my mate leads our chicks to safety. Uh oh - looks like they've seen this trick before and aren't falling for it this time. That was a very narrow escape!

July 18
My babies have grown up and can feed themselves now, so it's time to leave them behind. I fly to Kachemak Bay in Alaska, then to Stikine River Delta in Canada. This is my favorite spot on my journey south because I can find so many clams here in the mudflats! After this, I will travel south along the coast line, stopping every couple hundred miles to rest and eat.

August 30
We have arrived on the coast of Mexico! This is a great place to rest. In fact, some Western Sandpipers will stay here all winter. I will make one more stop in Panama before continuing on to Peru.

September 15
I'm glad to be back in Peru for the winter. I need a rest! Every year the trip gets harder for me. There are so many people along the coast who disturb me when I try to rest and feed along the way. Sometimes the food has a strange, unfamiliar taste that makes me feel weak. Well, at least I can rest here for a few months and regain my strength.

Teacher Key

Red Knot (Atlantic Flyway)

January 8
There are thousands of us feeding on the sandy beaches and mud flats at the southern tip of South America in Tierra del Fuego. I spend most of the day feeding in the mussel beds, devouring young mussels. The rest of the time I roost and preen with the rest of the flock.

March 14
I arrived on the central coast of Argentina to feed again on the invertebrates living in the mud of the immense tidal sand flat. I need to increase my body weight by 80 percent! I particularly love the small snails that are found here.

May 19
After a nonstop flight to the northern coast of South America, then across the ocean, I arrived on the sandy beaches and tidal flats of the Delaware Bay. There are about 50 to 100,000 of us here with tens of thousands of other shorebirds. We are all here for one reason: food! Horseshoe crab eggs galore! We eat and eat and eat…that is unless we are sleeping or trying to stay away from people and other animals.

May 31
I weigh so much that I don't think I can lift off the ground, but late in the afternoon, the incoming tide pushes me and the flock higher up on the beach. We all move away from the advancing water, moving as one. Someone jumps a certain way and we are all up in the air, flying north, knowing that we will not stop until we fly over Hudson Bay and reach the Arctic tundra.

June 3
As we fly over the northern Canadian tundra pools and hummocks of the Melville Peninsula, I leave the flock and fly down to a barren area scattered with vegetation. It is here that I will find my mate and we will spend the next six weeks establishing a nest, incubating the eggs, and raising our young.

July 18
Leaving our young behind, I make it to James Bay. This is my favorite spot on my southward migration. The tidal mud flats are full of clams! From here I will follow the west winds to the Atlantic coastline where I will feed almost constantly until late August. The best places to stop along the coast are national and state refuges, parks, and forests. By September I'll be ready for the nonstop, four day flight over the ocean to Suriname. I'll rest and feed before my final leg - a return flight to Tierra del Fuego, Argentina.

Teacher Key, continued

Ruddy Turnstone (Atlantic Flyway)

April 10
I have been working my way northward for the past month or so, finding many sandy beaches and mud flats in coastal south Florida. Much of my time is spent turning over stones and seaweed to look for and catch my preferred food – sand fleas! But I will eat anything I can scavenge, including dead animals and bits of food left over from other animals feeding.

May 16
I have stopped along the Delaware Bay to gorge myself on horseshoe crab eggs. I feed a little differently than the other shorebirds that join me – I dig up the eggs that are right under the surface, while they pick the eggs up off the surface. I guess in this way I am making more eggs available to everyone! This year, the horseshoe eggs seem harder to find.

June 3
I thought I ate enough horseshoe crab eggs so I could fly directly to my breeding grounds, but I guess I didn't gain as much weight as usual. I stop at Churchill, on the Hudson Bay to feed along the jetties before continuing. I hope I will still have enough time to select a mate and nest.

June 16
I finally arrive on the breeding grounds north of Hudson Bay and look for the location I have used in the past. The boulder on the tundra is an ideal place for me to perch and call and watch for predators. As I touch down, I am immediately assaulted by another Ruddy Turnstone, driving me away from the area.

July 8
As much as I try, I am unable to find a suitable nest site and available mate - I guess I arrived too late. Leaving the breeding grounds early, I head south. Along the way I meet up with other Ruddy Turnstones and we form small flocks as we work our way down the Atlantic coastline, stopping at the Bay of Fundy in Nova Scotia and New Brunswick, Pea Island National Wildlife Refuge in North Carolina, and Sapelo Island National Estuarine Reserve in Georgia.

September 4
After we depart from the national wildlife refuges and sanctuaries at the southern tip of Florida, our small flock arrives in northern Argentina. This is the same beach I started out at last season when I migrated north. We spend most of our time feeding and preening. I hope that next year I can make it back to the Arctic with plenty of energy and plenty of time to breed.

Teacher Key, continued

Buff-Breasted Sandpiper (Central Flyway)

March 16
My friends and I are enjoying the shoreline of Bahía de Samborombón in Argentina, which provides the perfect habitat for us to wade in shallow waters and fatten up on some of our favorite invertebrate snacks like pillbugs, spiders, and snails. Yum! I'll soon have enough fat built up for my journey to the Arctic circle of Canada.

May 17
Whew! I made my way to the Central Plains region in Oklahoma. The short grass habitat is perfect for staying hidden and being able to find food. I'll stay here to rest and refuel on food for a couple of weeks before continuing my journey North to the Arctic Circle of Canada.

June 4
I've made it to Canada! All of my friends are arriving at the same time and the males have already started trying to impress us with their lekking. I am surrounded by courtship displays of male buff breasted sandpipers stretching out their wings and shaking their bodies. I wonder which display I will find most impressive!

June 6
This morning I had a frightening experience! When I was searching for aquatic insects in the shallow water, a human grabbed me! The human put these funny-looking bands on my legs—a silver one, bright red and orange ones, and a white one with an end sticking out. These odd bands don't bother me when I walk or fly, but they sure do look funny. I wonder what they mean?

July 9
My eggs are hatching! The four eggs were laid 25 days ago, which means they are right on schedule and the chicks are almost immediately ready to leave the nest. I have been the only bird responsible for incubating these eggs since they were laid. All of the male buff breasted sandpipers have already left our breeding grounds and are headed south for the winter.

August 5
I'm ready to leave my breeding grounds along with other successful females and our young! I'm flying with a small flock of 3 other birds who want to make this journey with me, but some individuals are flying solo for the trip back. I'll most likely stop at the same spots on the way back to Argentina as I did during my journey north.

October 12
I take a break to feed at Padre Island in Texas until my small flock and I are ready to continue flying southbound. This seems to be an important resting stop for other migratory birds heading south as well!

October 31
We are back at Bahía de Samborombón for another winter! Many of us will stay here all winter long until it's time to head north and breed again. It seems like a lot of buff breasted sandpipers have already arrived, but I'm sure some of my friends won't be back until December. Very different than when we all arrive in Canada on the same day!

Teacher Key, continued

Western Sandpiper (Pacific Flyway)

April 10
Everyone's flocking up here on the coast of Peru, getting ready for our long trip north to the breeding grounds. It's amazing having so many of us together at one time. We'd better hurry; we've got a long way to fly!

April 20
After stopping at several locations to feed, we've made it to the San Diego Bay National Wildlife Refuge in the United States. We'll rest and refuel in the mudflats before heading to our next stop-- San Francisco Bay National Wildlife Refuge.

May 10
After leaving Oregon Island National Wildlife Refuge, we stopped in the Fraser River Delta in British Columbia before heading to the nutrient-rich Alaska coast!

May 20
I bet there are one million of us here at Alaska's Copper River Delta. This is a wonderful stopover site along our way north. The endless mudflats give me a chance to probe the mud for tiny clams, worms, and sand fleas until I replace some of the body fat I used up getting here. I'm going to need all that energy to make it all the way to western Alaska.

June 1
Looks like the males have beaten us here to the Yukon Delta National Wildlife Refuge. Well, that's O.K. They've already selected nesting sites, so all I have to do is choose a mate and lay my eggs.

June 10
I'm so glad that my mate and I take turns incubating the eggs. That gives me a chance to feast on the large numbers of insects that are hatching now. I'd better watch out while I'm feeding. The Arctic fox is always looking to make a meal out of us shorebirds!

June 24
Here we go again! Those gulls are nasty predators and are after our chicks. Maybe I can distract them with the "broken wing act" while my mate leads our chicks to safety. Looks like they've seen this trick before and aren't falling for it this time. That was a very narrow escape!

July 18
Having left the young behind, I fly to Kachemak Bay at the Alaska Maritime National Wildlife Refuge, then to Stikine River Delta along the Canadian coast. This is my favorite spot on my southward migration because of the abundance of clams in the tidal mudflats. Then I will travel along the coast line, stopping every couple hundred miles. We take our time getting home.

August 30
We have arrived at Marismas Nacionales near Tepic, Mexico. This is a great place to rest. In fact, some Western Sandpipers will stay here all winter. I will continue to Peru with one stop in Panama before arriving.

LESSON 3

Making Tracks with Shorebirds

Learning Objectives

Students will investigate different technologies used to track shorebird migration, interpret and evaluate scientific datasets collected using those technologies, and identify the pros and cons of the different research methods.

Students will use prior knowledge of shorebird migration and their assessments of current tracking technologies to design a tracking plan for a selected species and share their plans with their classmates, clearly communicating their design rationale.

Activity 1: Tracking with Satellite Transmitters

Time: 30 min | Student Level: Grades 5-8

Materials:

Provided: Satellite Transmitters Worksheet (Activity Sheet 3.1)

From your Classroom: Internet, projector or individual tablets/computers

Engage: Share the *A Tale of Two Whimbrels* story map with students. Explain that this story map represents the migration of two Whimbrels that were tagged with a satellite transmitter to better understand the habitats they are using throughout the year. The team of biologists that tagged Salix and Sadlerochit traveled to the Arctic to capture six Whimbrels and attach satellite transmitters to track their annual migration.

Explore:

1. Students can read the story map on their own devices, review for homework, or it can be presented during class.
2. If desired, you can provide them with the discussion questions to consider while the story map is reviewed.

Discuss: Discuss as a class or have students complete the Satellite Transmitters Worksheet (Activity Sheet 3.1). If you are planning to do Activity 4, Design a Tracking Plan, be sure to emphasize advantages and disadvantages.

- What did you learn in this story?
- What challenges do the Whimbrels face on this migration?
- What did scientists learn with the results of this tracking study?
- What is the advantage of this type of tracking?
- What are the disadvantages of this tracking?
- Is there anything else you would like to learn about Whimbrel migration?

Activity 2: Resighting Flags

Time: 45 min | Student Level: Grades 5-8

Materials:

Provided: Banded Birds slideshow (Slideshow 3.1), Banded Birds Map (Activity Sheet 3.2), Data Collection Sheet (Activity Sheet 3.3), Banded Birds Worksheet (Activity Sheet 3.4)

From your Classroom: Bulletin board, pins, colored string, markers, white paper and colored paper with similar texture and weight, six boxes or buckets, large paper map of Western Hemisphere

Prepare for the activity:

1. Give each box a label: Arctic breeding site, Migration stopover at Delaware Bay, Migration stopover at Northern Brazil, Migration stopover at Lagoa do Peixe, Migration stopover, Bahia San Antonio, Argentina, Wintering site in Chile. These boxes will be the site.
2. Create six sets of 1.5"x 0.75" strips of white paper based on the chart below. Strips do not need to be precise in size or count. Place the strips in their respective boxes, based on the numbers in the chart below. It is recommended to try to get 60-75 strips of paper from one piece of paper.*
3. Create enough strips of color paper for each group of three to have six strips of paper, each set of six in a different color. The strips should be about the same size as the white paper, so that when eyes

are closed you cannot tell the difference between the white and colored.* Extra colored paper will be needed to test alternate trials.

4. Hang the large blank map on the bulletin board and mark the six sites as marked on the Banded Birds Map (Activity Sheet 3.2) so that pins can be used to mark bird locations. If a paper map is not available, project the Banded Birds Map (Activity Sheet 3.2) and mark with the paint tool on computer.
5. Distribute the sites around the room so that groups can easily move around the room.
6. If using pins or markers, make sure each bird/group has their own marker or pin color. Ideally the color of pins/markers would be the same color as the paper.

**Note: Students can help with this part of the preparation.*

Number of white paper strips for each box/bucket

Arctic	Delaware Bay	Northern Brazil	Lagoa do Peixe, Brazil	Argentina	Chile
130	10	50	25	25	75

Engage: Present the Banded Bird slideshow (Slideshow 3.1) to provide students with background information on how flags and bands are used to understand bird migration. Teaching guidance is included in the notes of the slideshow.

Explore:

7. Divide students into groups of three and explain to students that they are biologists and they have deployed their flags on Red Knots in the Atlantic Flyway.
8. Give each group six strips of the colored paper. These will be their flags. The students will create a flag 'id' to write on each flag. There should be five numbers or letters in any order, but they cannot form a word. The flag id will be the same for all of the flags in that group.
9. Have each group share their flag number with the rest of the class. Record the numbers on a whiteboard or other area that is visible to everyone. Assign each flag id a color (pin, marker, or on screen).
10. Explain that the white strips of paper in each box represent the difficulty of monitoring at that site, which is impacted by the density of birds at the site and the accessibility of the site.
    - The more strips of white paper in a box, the harder that site is to monitor.
    - The fewer pieces of white paper in a box, the easier that site is to monitor.
11. Provide students with background information about the monitoring difficulty at each 'site'.
    - **Arctic:** Very large area, difficult to access, and birds are only found in pairs over large territories. Monitoring is irregular.
    - **Delaware Bay:** Small area, easy to access, birds are densely concentrated at predictable locations and times. There are three long-term research projects which ensures that there are many biologists monitoring during the peak season.
    - **Northern Brazil:** Very large area, difficult to access, very little known about where birds are concentrated, but it is believed that there are many Red Knots along this coast. Monitoring is increasing here, but still infrequent.
    - **Lagoa do Peixe, Brazil:** Long, narrow beach that is mostly easy to access and find birds, but birds can be spread out along the coastline and can be time- consuming to monitor. Regular monitoring is conducted here.
    - **Bahia San Antonio, Argentina:** Preferred habitat at this site is well known and mostly easy to access. There can be significant human disturbance that prevents Red Knots from being able to use their preferred habitat. Regular monitoring is conducted here.
    - **Wintering site in Chile:** Red Knots will be at this site for the most time through the year and the areas were birds are concentrated are well-known, but it is very difficult to access in order to read flags. Typically aerial surveys are used for population counts, and flags cannot be read at that level.
12. Tell each biologist to distribute one flag at the different sites based on the chart above. Explain that each set of flags represents one bird's journey through the Atlantic Flyway.
13. Using the Data Collection Sheet (Activity Sheet 3.3), students will move between each site and randomly pull five pieces of paper, recording if it is white or if it is a flag. If it is a flag, have students record the id number of each flag pulled. The student pulling the paper should have their eyes closed or covered so they can't see the difference between the plain paper and flags.**
14. After each group pulls five pieces of paper, they will return them to the box for the next group.

15. After each group has completed all of the sites once (this represents one year of monitoring) have them come to the classroom map and record their flags based on the color-code created for their group at the beginning of the activity.
16. Reflect on how many flags were sighted and where.
    - Where did you see the most flags? Why?
    - Where did you see the least flags? Why?
    - What could be changed to increase the number of flags sighted?
        - Remind them that they cannot change the density of birds or the difficulty in monitoring as this is based on the natural system.
        - They can change:
            > How many flags are deployed: Each additional bird flagged = 6 new colored pieces of paper with a unique flag id.
            > How many people are monitoring at a site: Each additional person monitoring = additional pulls from each monitoring site box
17. Repeat by testing a few of the options that students suggest. Additional colored paper can be used to make new birds (use new flag ids). If more people are added to monitor you can pull more than five.

***It is likely that students will pull another group's flag. That is ok, in real life biologists see other scientists' flags frequently. They have a website bandedbirds.org to share these data with each other.*

Discuss: Discuss as a class or have students complete the Banded Birds Worksheet (Activity Sheet 3.4).If you are planning to do Activity 4, *Design a Tracking Plan*, be sure to emphasize advantages and disadvantages.

- Did you get a full migration route for any birds?
- Which modifications helped you see more flags? Why?
- What can scientists learn from a tracking study like this?
- How will they use that information?
- What is the advantage of this type of tracking?
- What are the disadvantages of this tracking?
- Is there anything else you would like to learn about using leg flags to track bird migration?

Activity 3: Motus Wildlife Tracking System

Time: 30 min | Student Level: Grades 5-8

Materials:

Provided: Motus Tracking Worksheet (Activity Sheet 3.5)

From your Classroom: Internet, projector or individual tablets/computers

Another technology that is used to understand migratory routes is the Motus Wildlife Tracking System (Motus). This tracking system consists of stations installed in a variety of habitats. Each station is composed of several antennae that can detect the movements of birds with tiny radio-transmitters attached to them. After antenna detects a bird with a transmitter, a computer on the tower records it and sends signals to a central database where users can access the data, seeing a list of all the stations where a particular bird has been detected. For more information on Motus, review the Learning Resources to better support the students.

Engage:

1. Give students 5-10 minutes to navigate the Motus Wildlife Tracking System website and look at the different stations around the world. Guidance for navigating the website is provided on the Motus Tracking Worksheet (Activity Sheet 3.5). The worksheet can be shared with students or projected on a screen while they are working.
2. Recommend to students that they explore the website looking at these specific data sets, including tracks of particular birds. There are many different species and projects in the database. Students should explore any that interest them, but they should also look at relevant shorebird maps by searching for projects under Explore Data > View Tracks and then indicating the project and/or species to search for.

Explore:

3. In pairs, have a student choose a shorebird from the Shorebird Cards to focus on.
4. Look at the migration maps of your shorebird on the Shorebird Superhighway online map have each group determine general areas where their species is at different times of the year.

Suggested Motus Projects to Review

Project	Species
Bahia Lomas Shorebirds	Red Knot
James Bay Shorebirds	Semipalmated Sandpiper
Monomoy - Steph Koch	Black-bellied Plover
Texas Gulf Coast Migratory Shorebirds	Red Knot, Sanderling
Brazil Non-breeding Shorebirds	Semipalmated Sandpiper
Semipalmated Sandpiper on the Bay of Fundy	Semipalmated Sandpiper
Nol - Wintering Shorebirds	Dunlin

5. Have students use the Motus website and interactive map to highlight some of the towers they think would pick up a signal from their species if tagged.
6. Now, have students choose a site where they would put up a new tower, i.e., a spot where there isn't one already and where it would be useful to get more data.
7. Students present their recommendations to the other students.

Discuss: Discuss as a class or have students complete the Motus Tracking Worksheet (Activity Sheet 3.5). If you are planning to do Activity 4, *Design a Tracking Plan*, be sure to emphasize advantages and disadvantages.

- How is this tracking method different from satellite tracking (Activity 1)?
- Why are these stations located where they are?
- What do you think impacts the decisions on where a station should go?
- Were the current sites in their region?
- Why do some of the tracks stop in North America even though we know these birds fly to South America?
- What are the advantages and disadvantages of this type of technology?

Activity 4: Design a Tracking Program

Time: 60 min | Student Level: Grades 5-8

Materials:

Provided: Tracking Program (Activity Sheet 3.6)

From your Classroom: writing materials, white board, smart board, or projector

Engage: Together as a class, brainstorm the pros and cons of each of the different tracking technologies (satellite transmitters, flags/bands, radio telemetry/motus) for 5 min, reflecting back on previous activities. Do not go into great detail, but make sure that students have a good understanding of each of the three types. The chart on the next page is included as a reminder for you.

Explore:

1. Split students into groups (numbers may vary based on class size and age group).
2. Distribute Tracking Program Worksheet (Activity Sheet 3.6).
3. Direct students to design a tracking plan. Groups can select one of the topics below or they can develop their own.

Pros and Cons of Tracking Technologies

	Flags and bands	Motus tracking	Satellite tracking
Pros	• Very inexpensive to deploy • Reliable, long lasting • Flags have been used for at least 20 years in some species so there is a large data set available	• Once the towers are in place, it is inexpensive to deploy • The towers can collect data from an infinite number of tags • Other species are also monitored with Motus radio transmitters	• Real-time results with precise location • Easy to use in difficult to access locations because it does not require monitoring or installation of additional equipment
Cons	• Numbers can fade and can become unreadable • Requires people to be present and monitoring regularly • Some of the locations are impossible to access for this type of monitoring	• Not enough towers in some of the important areas, particularly Midcontinent, Arctic, Boreal North America, and South America • Some towers need to have manual download • Towers can be destroyed by storms or vandals • Batteries are depleted after a year or two on transmitters	• Very expensive, can only deploy limited numbers • Heavy so can't be used on smaller birds • Technology is still evolving • Last for only a couple years • If one of the tags doesn't work or falls off it has a large impact on study

Topics:

- What other WHSRN sites is my local WHSRN site connected to based on the migration of species?
- Red Knots in the Atlantic Flyway have had extensive research done on their migration, but they also use the Midcontinent Flyway, where are the important places here?
- Where should we target a project that will work with ranchers on grassland management practices that are shorebird-friendly?
- How are shorebirds using the habitat at our WHSRN site during their stopovers?
- Where are the most important non-breeding locations for shorebirds in the Pacific Flyway?

4. Remind students of the Claim, Evidence, Reasoning framework or other similar framework that you use in your classroom.
   - Claim - What are the questions that they want to answer?
   - Evidence - What data do they need to collect?
   - Reasoning - How will the data help them answer their question?
5. Tell students they will have $15,000 to conduct a two-year study to answer their question(s). From the three different tracking techniques, students will select one technology for their tracking program. They should be prepared to explain why they selected the technique, potential drawbacks, how they will spend their funds, how they will collect and manage data, and then how they will use their results. The worksheet can be used to document the plan.
6. Once completed, each group will present their tracking plan.

Discuss: As a class, discuss the experience of designing a tracking program.

- What factors do you need to consider when designing the program?
- What are the other factors that you did not need to consider (ease of logistics, permitting for trapping birds, etc)?
- Would you choose a different technique if you wanted to study a different bird or migration path?
- Why is it important to understand the specific sites that shorebirds are using?

Expenses for each Tracking Technology

	Flags and bands*	Motus tracking*	Satellite tracking*
Flag or tag - Placed on bird	Flags: $2/flag	Radio Tags: $225/tag	Satellite tags: $1950/ tag
Registration of tag in network		$1500 for 20 tags (access to all tower data)	$80/tag
Equipment		$3400 for a new tower	
Staff for resighting flags	$1500/per site/year		

**All three technologies require the scientists to trap birds to put tags on them and to analyze data. For the purpose of this activity the cost is assumed to be the same for all three techniques and does not need to be included in the budget.*

Cultural Connections: Using technology to study bird migration is one way to understand where birds go, the timing of their migration, and what habitat is important. With their connection to land and stewardship, indigenous communities have other ways of understanding birds, habitat, and migration. Meet with local indigenous peoples to understand their traditional ecological knowledge on their shared space with shorebirds. How do they know when the birds will arrive? How long will they stay? Why are they important to the ecosystem?

Student Name

Satellite Transmitters Worksheet

1. What did you learn in this story?

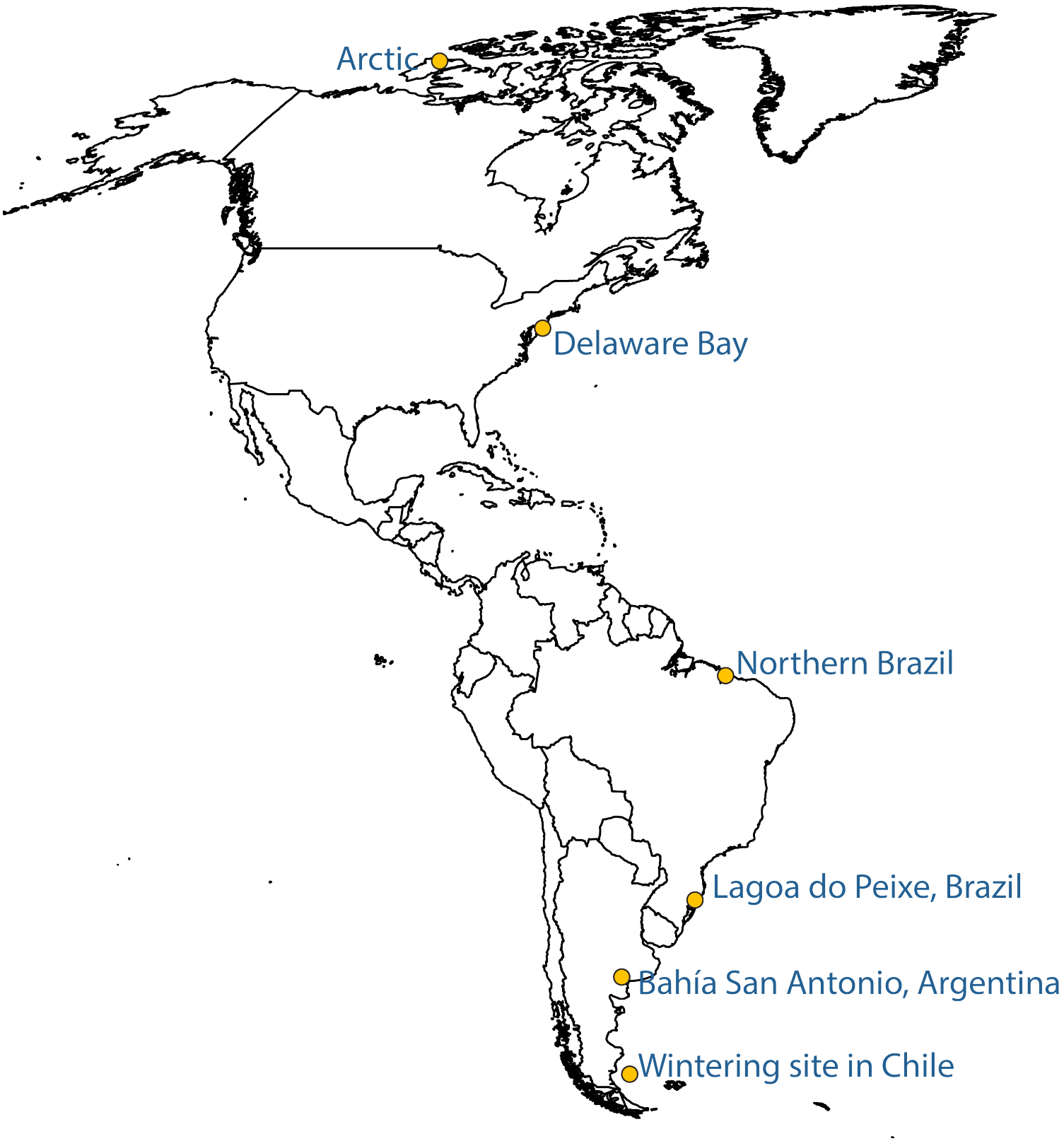
2. What challenges do the Whimbrels face on this migration?

3. What did scientists learn with the results of this tracking study?

4. What is the advantage of this type of tracking?

5. What are the disadvantages of this type of tracking?

Banded Birds Map: Activity Sheet 3.2



Group Members

Data Collection Sheet

First Flag ID:

Additional flag IDs:

	Arctic	Delaware Bay	Northern Brazil	Lagoa do Peixe	Bahia San Antonio	Chile	Modifications
First year							
Second year							
Third year							

Student Name

Banded Birds Worksheet

1. Which modifications helped you see more flags? Why?

2. How will scientists use that information?

3. What is the advantage of this type of tracking?

4. What are the disadvantages of this type of tracking?

5. Is there anything else you would like to learn about using leg flags to track bird migration?

Student Name

Motus Worksheet

Tips to Exploring the Motus website

1. Read about Motus on the About menu. Review other pages under this Menu to understand Motus and the network of partners.
2. On the map on the home page, zoom in and out to see where the Motus stations are located. Find the area where your school is located on the map and look for Motus stations nearby.
3. Go to the Explore Data menu to understand more about the projects, stations, and species monitored. Under Explore Data > View Tracks, search for different projects or species to see different migrations tracks.

1. Why are these stations located where they are?

2. What do you think impacts the decisions on where a station should go?

3. Why do some of the tracks stop in North America even though we know these birds fly to South America?

4. What is the advantage of this type of tracking?

5. What are the disadvantages of this type of tracking?

Tracking Program

$15,000 for a two year study. Costs of each technique:

	Flags and bands*	Motus tracking*	Satellite tracking*
Flag or tag - Placed on bird	Flags: $2/flag	Radio Tags: $225/tag	Satellite tags: $1950/tag
Registration of tag in network		$1500 for 20 tags (access to all tower data)	$80/tag
Equipment		$3400 for a new tower	
Staff for resighting flags	$1500/per site/year		

**All three technologies require the scientists to trap birds to put tags on them and to analyze data. For the purpose of this activity the cost is assumed to be the same for all three techniques and does not need to be included in the budget.*

State your research question.

What data do you need to collect to answer this question? *Include information about where the birds will need to be captured and tagged, where they need to be monitored, and where towers need to be installed if they don't already exist.*

How will the data you are collecting help to answer your question?

Tracking technology: _____

Create a budget to include how the funds will be spent between the two years.

LESSON 4

Shorebirds at Risk: Threats and Actions

Learning Objectives

Students will use prior knowledge and their experience during a kinesthetic game to analyze how human behavior and environmental factors threaten shorebird habitats and then use these observations to make predictions about other potential threats facing shorebirds.

Students will utilize online resources and provide evidence from the WHSRN website to answer questions highlighting the importance and scope of WHSRN and its role in shorebird conservation.

Students will consider their own roles in shorebird conservation by examining the link between shorebird threats and human activity. Students will then advocate for a local shorebird species using artwork, poetry, press releases and other platforms to share their message with their peers.

Activity 1: Know-Wonder-Learn about Threats to Shorebirds

Time: 10 min

Provided: None

From your Classroom: Large paper, whiteboard, or chalkboard

Create a K-W-L chart on large paper or on the classroom whiteboard or chalkboard. Write 'Threats to Shorebirds' at the top.

Ask students "What do you **KNOW** about threats to shorebirds?" Encourage them to draw on their existing knowledge from learning about threats in the migration lesson. Be sure that they include habitat loss and degradation, disturbance (e.g., on beaches and mudflats at stopover sites), and predation. They may write their ideas down in the 'Know' section of the chart, or give each student a sticky note and have them add what they know to the chart themselves.

Ask students "What do you **WONDER** about threats to shorebirds?" Record their questions in the 'Wonder' section of the chart using sticky notes or by writing them there yourself, then set it aside. Resist the temptation to answer their questions now - they will discover the answers themselves during the lesson! Return to the chart at the end of the lesson.

* This K-W-L brainstorm could also be done in a discussion format with the teacher writing down student ideas in the chart. Adapt terminology as needed for the age of students.

Activity 2: Can't We Share?

Time: 30 min | Student Level: Grades 3-6

Materials:

Provided: Habitat Card sheets (Activity Sheet 4.1), Environmental Events sheets (Activity Sheet 4.2), Environmental Stewardship sheets (Activity Sheet 4.3), Threats and Actions slideshows (Slideshow 4.1), Shorebird Cards

From your Classroom: 1 chair per student, speakers to play music, tape

Engage: Present the Threats and Actions slideshow (Slideshow 4.1) to provide students with background information on the threats that impact shorebirds and their habitat, as well as the actions to protect them. The habitats and shorebirds that will be represented in the next part of the activity will be reviewed. Teaching guidance is included in the notes of the slideshow.

Explore:

Prepare for the activity:

1. Select the music and arrange the chairs in two rows back to back, as in musical chairs.
2. Photocopy and cut the Habitat Cards (Activity Sheet 4.1) included in this activity.
3. Attach a habitat name to each chair, alternating the cards for equal distribution.
4. Print enough Shorebird Cards so that all students have one.
5. Photocopy and cut two copies of the Environmental

Events Cards (Activity Sheet 4.2) and Environmental Stewardship Cards (Activity Sheet 4.3). Add your own local events to the blank cards provided. Place the Environmental Event Cards in a box for random selection.

Conduct the activity:

1. Explain that each chair represents a specific shorebird habitat, such as marsh, mudflat, grassland, or stream corridor. Remind students that each habitat supplies the shorebirds that live there with their basic life needs.
2. Hand out the Shorebird Cards. Have the students read the cards and make sure they note the habitats that they use.
3. Tell the students to stand in front of a chair that represents one of their habitats and face the same direction, as if they were going to play musical chairs.

   Note: Students may question why some shorebird species are represented in more than one habitat type. Explain that most shorebirds breed in one habitat type (often Arctic tundra) but use another during migration and the nonbreeding season. For example, the Red Knot breeds in the Arctic tundra but uses coastal wetlands during migration and the nonbreeding season.
4. Start the music and tell the students to walk around the chairs slowly. When the music stops, each student should sit down in one of the chairs representing his or her habitat from the Shorebird Card. It's possible that even the first round students will not be able to find their habitat.
5. The teacher or a student chooses an "event" from the box, reads it aloud, and removes a chair that represents the affected habitat.
6. Continue the game, repeating steps 4 and 5 for each round. As students are eliminated from the game, they keep the environmental events that affected their habitats.
7. Play until there is one student left.
8. Spend a few minutes reflecting.
9. Now tell students that they are going to do the activity again, but in reverse. Explain that humans have an important responsibility to be good land stewards. Explain that land stewardship is taking care of the land so it is available for all species and future generations of people.
10. Using the Environmental Stewardship Cards, play the activity backwards by adding chairs in for each stewardship action. All students will start but with only one chair. With each card, a chair is added until all students have a seat again
11. Discuss how students can be good stewards of the land in their community--for example, putting trash in its proper receptacle, helping with conservation projects, etc.

Optional: *For older students, instead of using the Environmental Stewardship Cards to bring the chairs back in, students can be challenged to suggest a different action that would result in a positive outcome. To help them remember the events from the first round, read one Environmental Event Card out in each round until all chairs are back.*

Discuss: Discuss the following questions with the class:

- Ask students to share how events affected them in their habitats. What basic needs were shorebirds deprived of in these situations? What will they do now?
- When more than one person was trying to take the same chair, what happened? How is the same behavior reflected in nature?
- Which events were natural phenomena and which were the result of human behaviors?
- Which of these events can people do something about and which cannot be controlled?
- What can people do to correct natural disasters? What alternatives exist for the human "events" that hurt shorebirds and their habitat?

Activity 3: What is WHSRN?

Time: 20 min | Student Level: Grades 5-8

Materials:

From your Classroom: individual computers, internet

Engage: In small groups, provide students with a computer and a link to the Western Hemisphere Shorebird Reserve Network website: https://whsrn.org/

WHSRN Sites to Explore

Delta del Río Iscuandé	Delta del Estero Real	Delaware Bay
Bahía de Santa Maria	Laguna Madre	Grassland
Humedal Marino de Chamiza	Humboldt Bay Complex	Great Salt Lake
Río Gallegos Estuary	Bahía Blanca Estuary	Maryland -Virginia Barrier Islands
Desembocadura y Estuario del Río Maipo	Laguna de Rocha	Bay of Fundy
Barba Azul Nature Reserve	Laguna Mar Chiquita	Fraser Estuary
Ensenada de Pabellones	Piscina Artificales de ECUASAL	Tofino Wah-nah-jus Hilth-hoo-is Mudflats

Give students 10 minutes to explore the website and answer the following questions:

- What is WHSRN?
- Why does WHSRN exist and what is its goal?
- Who is involved in WHSRN?
- What is a WHSRN site and what does it do?

Discuss briefly questions as a class after 10 minutes and help students elaborate with the background from the Learning Resources section of the Educator Guide.

Explore: Working alone or in pairs, students will select a site from the chart above, read the site profile and other provided links, and prepare a presentation on that site. Presentations should include:

1. The important habitats and shorebirds, including information on species diversity, abundance, and timing of when shorebirds are at the site.
2. Threats to the site. Threats can include both natural and anthropogenic threats. Remind students that they should be specific - for example, using 'development' rather than simply 'habitat destruction' since habitat destruction occurs from many different types of threats.
3. The cause of the threats (e.g., increasing populations in coastal areas).
4. Current actions at the site to minimize or mitigate the threat.
5. One new action that could be implemented to minimize or mitigate the threat.

Optional

Students can also explore sites along the flyway that their site is linked to because of shared species. How could these sites collaborate to support conservation of their shared species.

Discuss: Students will share their presentation with the class and then reflect on all the presentations.

- What are the differences between the sites, and their threats and actions?
- What are the similarities between the sites, and their threats and actions?
- Are there certain habitats or shorebirds that are frequently impacted? What does this mean for their survival?

Activity 4: Protect your Site with your Voice

Time: 45-60 min | Student Level: Grades 3-8

Materials:

Provided: Project ideas

From your Classroom: Art supplies, audio-visual equipment, computers, editing software, or other materials as needed

Engage: Students should select a focal WHSRN site by completing the 'Explore' component of Activity 3 (What is WHSRN?). If they have not completed Activity 3, students will now need to select a site or all students will prepare something based on the local site. Tell students that they will tell the story of their selected WHSRN site (either a local site or the one researched in Activity 3) in an engaging and innovative way.

Explore:

1. Students can work individually or in small groups.
2. Students should think creatively about how they might have an impact on conservation and tell the story of their site with their words, art, or other creative expressions.
3. The creative projects should (1) tell the story of the site, (2) identify its most important threats, and (3) clearly explain an action that can be taken to address the threat. The action can be simple like leashing your dog on the beach or more complex like educating people about a new development proposed for shorebird habitat.
4. Allow time for students to brainstorm ideas, plan, and create their projects.

This activity has great flexibility to be adapted to the needs and abilities of your classroom. There is also potential for incorporating other learning objectives or enrichment classes like language, art, music, or library.

Younger students: Consider shared projects for younger students. For example, asking all students to write a poem or draw a picture. You may also want to outline the threat and action on the board in order to keep them focused.

Older students: Challenge older students to be creative and pursue their own unique ideas for sharing about shorebirds and their sites with the community. Older students can also give special consideration to a target audience and design projects based on the best way to engage that audience. For example, if they target their friends, maybe a social media video would be best. If they are targeting elected officials, a press release or town council meeting presentation may be more effective..

Project ideas

- Shorebird art exhibit for the local library
- Article for the school newspaper
- Poetry, music, theatre, dance
- Social media content
- Poster display for school hallway
- Youth artwork signs
- Puppet show skit
- Calendar
- Presentation and exchange with students at a different site

Discuss: Students should present their projects to the class, or potentially to broader audiences. After the activities have been presented or shared with class, school, or community, help students reflect on their experiences with this project - positive experiences, challenges, lessons learned, and outcomes.

Activity 5. Know-Wonder-Learn about Threats to Shorebirds, *Revisited*

Revisit the Know-Wonder-Learn chart created at the beginning of the lesson. Students should work in pairs to brainstorm things they have learned about threats to add to the chart in the 'Learn' section. Have them share by adding sticky notes, or by writing their responses onto the chart. Follow up on their 'wonder' items to see if we can now answer some of their questions.

Habitat Cards

Make enough copies so each chair has one, be sure there is an even mix of habitats.

Mudflats	**Sandy beaches**
Saline lakes	**Rocky coastal areas**
Saltmarsh	**Tundra**
Grasslands	**Agricultural fields**

Environmental Event Cards

A town has 300 acres of undeveloped grassland. It is replaced by a shopping mall and office complex.	A coastal community sells 50 miles of beachfront property to a local developer who builds homes, a strip mall, and a hotel complex.
An oil spill off the Atlantic Coast near Delaware Bay threatens migrating shorebirds that feed there.	An unusually heavy rainy season causes streams to flood lowland fields.
A hurricane blows away sand dunes where Snowy Plovers are nesting.	A drought threatens to dry out local freshwater wetlands.
Silt barrier fences are not installed at a new construction project. Rain carries loose soil into a nearby wetland.	Tanks of toxic chemicals buried in a field eventually leak into the soil of a nearby wetland.

Environmental Event Cards

A once restricted area of beach is opened up to public recreation. Personal watercraft vehicles (For example Jet Skis.) now scare away nesting and feeding shorebirds.	A farmer cuts hay in a field where shorebirds are nesting.
Agricultural chemicals are carried by runoff into a nearby wetland.	Because of habitat loss from disturbance, pollution, and development, migrating shorebirds have not been able to stop at their traditional stopover sites. They do not have enough energy to continue their migration to the Arctic to breed.
Create your own	Create your own
Create your own	Create your own

Environmental Stewardship

A town has 300 acres of undeveloped grassland. Of that, 200 acres will be used for a mall. The remaining 100 acres will be set aside as a preserve for local wildlife that includes an outdoor learning and research area.	A coastal community sells 50 miles of beachfront property to a local developer for building homes, a mall, and a hotel. The developer also plans to work with biologists to protect important beach habitat by landscaping with native plants.
A federal law is passed that requires all oil tankers to be double-hulled to help prevent hull punctures that result in oil spills.	Tanks of toxic chemicals buried in a field are removed by the Environmental Protection Agency. The company that buried the chemicals is paying to restore the land and the wetland.
Silt barrier fences are installed at a new construction project. The silt barrier stops rain from carrying loose soil into a nearby wetland.	Through water management projects, the local National Wildlife Refuge is able to provide water for the wetland so that shorebirds can use the habitat.
An unusually heavy rainy season causes streams to flood lowland fields. Shorebirds are able to find other nearby habitat to feed and rest.	Biologists plant native grasses to stabilize beach dunes, preventing them from blowing away. Though some natural damage still occurs from a hurricane, Snowy Plovers and the dunes survive.

Environmental Stewardship

A once restricted area of beach is opened up to public recreation. However, boats and skiers stay 200 feet away from the beach and use provided ramps for access.	When applying agricultural chemicals, a landowner follows the directions on the label to keep chemicals 100 feet away from wetlands. He also applies only during the recommended weather conditions. As a result, there are not pollutants in the wetland.
A farmer cuts hay in a field after the shorebirds finish nesting in mid-July.	Important stopover habitat is protected by national and state wildlife refuges and parks. Shorebirds have enough energy to complete their journey to the Arctic and breed successfully.
Create your own	Create your own
Create your own	Create your own

LESSON 5

Understanding why Nature Matters

Learning Objectives

Students will explore local ecosystems and examine the relationships between living and non-living and natural and unnatural factors that they record in order to identify the different ecosystem services present.

Students will analyze different perspectives of environmental issues facing people and shorebirds and use prior knowledge of shorebirds, conservation and ecosystem services to develop an opinion on conservation action. Students will then communicate their stance on the issue in a debate format.

Activity 1: Know-Wonder-Learn about People and Natural Resources

Time: 10-15 min

Provided: None

From your Classroom: Large paper, whiteboard, or chalkboard

Create a K-W-L chart on large paper or on the classroom whiteboard or chalkboard. Write 'People and Natural Resources' at the top.

Ask students "What do you **KNOW** about how people use natural resources?" Encourage them to draw on their existing knowledge about the value of ecosystems for people. Why is it important to them? Why might it be important to someone who is different from them? If needed, encourage them to think about drinking water, land for farming, energy, etc. Write their ideas down in the 'Know' section of the chart, OR give each student a sticky note and have them add what they know to the chart themselves.

Ask students "What do you **WONDER** about how people use natural resources?" If they are having trouble coming up with ideas, encourage them to wonder about those natural resources that both people and birds need, where are the overlaps? What is more important a bird's needs or people's needs? Record their questions in the 'Wonder' section of the chart using sticky notes or by writing them there yourself, then set it aside. Resist the temptation to answer their questions now - they will discover the answers themselves during the lesson! Return to the chart at the end of the lesson.

** This K-W-L brainstorm could also be done in a discussion format with the teacher writing down student ideas in the chart. Adapt terminology as needed for the age of students.*

Activity 2: Town Hall

Time: 45-60 min | Student Level: Grades 6-8

Materials:

Provided: Character Cards (Activity Sheet 5.1)

From your Classroom: whiteboard or projector to display problem description; Board or large paper for vote tally

Select one of the following problems for students to debate (choose one of the three)*:

1. At the Sandpiper Beach WHSRN site, there has been a proposal to close the entire beach to protect it for nesting American Oystercatchers. Sandpiper Beach will be completely closed to people between April 1 and July 30 each year. Tourism is an important part of the economy here with many people visiting to explore the beaches. They usually stay for multiple days, eat at restaurants, and buy souvenirs. This beach is ten miles long with multiple entry points staggered throughout the beach. The best habitat for nesting is clustered around three different sections of the beach.Should Sandpiper Beach be closed from April 1-July 30?
2. The Rainbow River WHSRN site is a delta where a river estuary flows into a large bay. The rocky coastline is under the influence of tides, so at low tides mudflats and small beaches are visible and accessible, making great habitat for shorebirds. There is a proposal to build a port that will provide many jobs for the local community, an area that is in great need of jobs. It will also add lots of boat and vehicle traffic to the area. There is research at another similar site that this type of facility can have water and sediment flow changes that have negative impacts on the invertebrate prey of several key shorebirds. Tourism is not common, but many

local residents like to enjoy the natural areas by hiking, kayaking, and bird watching. Should the port be built in this location?

3. The Pink Lake WHSRN site is a large saline lake that receives its inputs from several large rivers that drain nearby mountains as the snow melts. The surrounding area is semi-arid but highly populated. With limited access to groundwater, the majority of the freshwater coming down from the mountains is diverted for use for the communities including drinking water, household water, landscaping, ranching, and agriculture. As the suburban communities have expanded, the use of the freshwater water has increased and the lake level is getting lower and lower, impacting available habitat for shorebirds, waterfowl, and other wildlife. Should some water be left to flow to the lake?

**Note: For advanced students or a large class, more than one scenario can be used.*

Establish characters:

1. Divide students into groups of 3-4 or pairs. Students can also work individually. Younger students will find it especially useful to work in groups or pairs.
2. Provide each student or group with a Character Card (Activity Sheet 5.1). Each scenario has 6-7 essential characters, noted on the cards. If there are not enough students to cover all of the characters, be sure that at least all of the essential characters are included for a balanced representation.
3. Tell students to review their cards to understand their character's perspective. Characters represent the stakeholders at that site. In addition to the Character Cards, encourage students to use their own knowledge and experience to get into character as their stakeholder. If working in groups, give students time to discuss the character together.
4. Have students prepare their official opinion of the proposed action 1) continue, 2) be discontinued, or 3) a compromise created. Tell students that their opinion can be either an endorsement of the proposed action OR a practical rebuttal/compromise to the proposed action. Ask them to address the following questions in their opinion:
   - Why are the natural resources at this site important to you?
   - What will happen to your use of these natural resources if the project goes forward?
   - Do you agree with the proposal? Why or why not?
   - If you don't agree, what are possible alternative solutions?

Explain the town hall rules:

1. You will be the mayor and will be responsible for managing the debate, but will not have a vote. It is recemmended to provide basic ground roles for students: respect each other, no interrupting, stick to the permitted time, etc.
2. Each stakeholder will have two minutes to present their ideas, opinions, and potential solutions.
3. Rebuttals and further discussion can be allowed if time permits.
4. After the debate is completed, conduct a vote as a class (still in character as stakeholders) on the proposal. Students are permitted to change their opinion if the debate changed their opinions, however they should still be realistic to the needs of the character.
5. If the vote is in favor of a compromise, options for a compromise can be discussed

Discuss: After the vote is completed, discuss the results as a class. Discussion prompts to consider:

- What are the benefits for the natural resources that people use?
- What will happen to wildlife/shorebirds with this proposal?
- Will this solution work over the long term?
- Are any stakeholders losing completely with this proposal?
- In the real world, is each stakeholder 'vote' worth the same? Or will some stakeholders be able to influence leadership disproportionately?
- How was the indigenous community considered in this process?

Optional: *These are fictitious examples of WHSRN sites. However, they are based on situations at real sites. Challenge students to find sites with similar problems and write a proposal for a balanced compromise solution for that site. The proposal should include: key shorebirds, habitat at the site, land use, and key stakeholders and their perspectives. The WHSRN news section frequently highlights issues at sites and may be a good place to find real threats at sites.*

Activity 3: Know-Wonder-Learn about People and Natural Resources, *Revisited*

Revisit the Know-Wonder-Learn chart created at the beginning of the lesson. Students should work in pairs to brainstorm things they have about how people use natural resources to add to the chart. Have them share by adding sticky notes, or by writing their responses onto the chart. Follow up on their 'wonder' items to see if we can now answer some of their questions.

Character Cards

SCENARIO #1 *Disturbance on Coastal Beach*

Tourism Department for town: You work for the town promoting tourism for the area. One of the most popular places to go in the area is the beach itself, where people gather from all over every spring and summer to do fun activities, hold special events, or even just to relax. You work with the local businesses to create events and other activities to encourage visitors. But the beach is still the main attraction and the new proposal would stop all activity on the major beach area during this popular time, so the businesses will lose a great deal of business.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Owner of Sandpiper Hotel: Next to Sandpiper Beach, there is a large hotel that you have owned for many years. Hundreds of people visit the city to enjoy vacation time from May to July. Before the proposal to close the beach was made, you decided to spend a lot of money making your hotel bigger because the building sometimes did not have enough room. You are worried if Sandpiper Beach closes during this busy time, you will not make enough money to keep the hotel running.

SCENARIO #1 *Disturbance on Coastal Beach*

Horseback Riding Tours Company Owner: You are the owner of a horseback riding company that you recently founded with the help of some of your friends near Sandpiper Beach. You thought starting this new business would had great potential at this popular spring tourist spot. While you have several different trails in the area, your popular trail is down Sandpiper Beach so you are against the proposal.

SCENARIO #1 *Disturbance on Coastal Beach*

Birdwatching Guide: You work as a Birdwatching Guide for people visiting Sandpiper Beach. You have lived in the area for many years and know all about the best spots shorebirds visit, so people like hiring you to take them on trips to see the birds. You do not think that your Birdwatching business interferes with the birds in any way, but you also understand there could be other threats on the beach that need consideration.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Beach Tourist: Sandpiper Beach is a favorite annual vacation spot for you and your family. The great weather, fun activities, and wonderful beaches makes the area an ideal place to relax. The proposal for Sandpiper Beach however will close off the beach and will probably mean a number of the activities you would normally do during this season would not be available. You do not have the time to go to the beach during any other time of the year.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Sport Fisher: You are a sport fisher who lives nearby and you purchase a permit to drive on the beach and fish every year. You love seeing the birds when you are out there, sometimes they even come run around you while your fishing line is in the water. You understand why it is important to protect the shorebirds, but the proposal would also close off the area where you fish.

Character Cards, continued

SCENARIO #1 *Disturbance on Coastal Beach*

City Council Member #1: You are a long-time city council member who will be helping to make the final decision on the proposal to close Sandpiper Beach. The local wildlife has always been an important part of the city for you and many citizens in the area, so making sure the shorebirds have a safe place to rest during migration is a high priority. By protecting the shorebirds you feel that you are supporting the city, so you are in support of the proposal.

SCENARIO #1 *Disturbance on Coastal Beach*

City Council Member #2: You are a long-time city council member who has been asked to give their opinion on the proposal to close Sandpiper Beach. The beach area has always held unique importance to you and the people in the city, and it is important to the economic development of the region. You think that the proposal to close the beach does not support this goal, so you are against the proposal.

SCENARIO #1 *Disturbance on Coastal Beach*

Dog Owner: You are a local who lives in the Sandpiper Beach area who owns a big dog. Your dog loves the warm weather and is always full of energy, so you need to take the time to go outside to let him run off leash twice every day. Walking on the beach is a really convenient way to do this, but the proposal will mean you will have to travel to the other side of the city to another beach for daily exercise. Because of how difficult this could be on you, you are against the proposal.

SCENARIO #1 *Disturbance on Coastal Beach*

ATV Enthusiast: You are an ATV enthusiast who loves driving up and down Sandpiper Beach with your friends. The beach is so large that in the past you have been able to use specific areas to drive your ATVs. The proposal would entirely close the beach when the shorebirds arrive, even in the empty areas you feel that would not be a problem for you to use. Because of this, you are against the proposal.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Concerned Citizen: You are one of the locals who live near Sandpiper Beach with your family. Despite not knowing very much about shorebirds, you are someone who enjoys the outdoors and wants to do their best to protect wildlife, but you are not sure if closing the entire beach would be the right option yet. For now, you decide you are against the proposal.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Casual Birder: You are a member of the Sandpiper Beach Birders Group who loves going birdwatching for fun. Every spring, you travel down from your community to the Sandpiper Beach area to see the amazing birds that migrate each year with your birdwatcher friends. You think it is important that the shorebirds are protected so they can feed without disruption, but you also feel people like you should be allowed to enjoy their arrival in respectful ways. You think the best option for now is supporting the proposal.

Character Cards, continued

SCENARIO #1 *Disturbance on Coastal Beach*

Government Resource Agency Biologist: You work for a government natural resource agency as a biologist and it is your responsibility to protect habitat for wildlife. You help create strategies for protecting many different species in the region, and the shorebirds that migrate through Sandpiper Beach are some of the species you work with. The shorebirds are not only important to some of the locals in the Sandpiper Beach area, but also in the Arctic communities where they nest. You think supporting the proposal is the best option.

Essential character

SCENARIO #1 *Disturbance on Coastal Beach*

Environmental Advocate: You are an environmental advocate who lives in the Sandpiper Beach area. You participate in many different volunteer activities, raise awareness on local wildlife, and advocate for education and action on environmental issues. A part of that advocacy for you means protecting the shorebirds in the area, who use the beaches as a resting spot before returning to their nests. You are in support of closing the beaches.

Essential character

SCENARIO #2 *Development on Estuary*

Port Manager: You are a manager for the company that would like to build the new port on the bay. You are not from the area, but you have been offered the job of managing the development and eventual management of the facility. This is a great opportunity. You also know that this community does not have many other hiring opportunities, so you know how important it is for the community to have these new opportunities. You would like the proposal to go through.

Essential character

SCENARIO #2 *Development on Estuary*

Unemployed Worker #1: You are an experienced worker who lives in town but has not been able to find work for a while. In the past, there was an old factory in town you became a valuable employee for but it has since closed down. Because you want to use your job skills without moving to a new city, you would like the port to be built to provide job opportunities.

Essential character

SCENARIO #2 *Development on Estuary*

Unemployed Worker #2: You are an inexperienced young person who wants to start a career. The town you live in does not have very many opportunities for new workers, but you also do not have the money to move somewhere else. The factory would offer many jobs for many different skill levels, which could be a perfect starting point for you to get experience. Because of this, you are in support of building the factory.

Essential character

SCENARIO #2 *Development on Estuary*

Unemployed Worker #3: You are an older person who used to have a career, but recently became unemployed after your workplace closed down. Even though you are getting older, you still need to go to work so you can have an easy retirement in the near future. You do not have experience working at a port, but in your previous job you had lots of team management responsibilities and you think this will be useful here. You think it would be an ideal place to apply at and would like for it to be built.

Character Cards, continued

SCENARIO #2 *Development on Estuary*

Outdoor enthusiast: You are one of the locals who live in the town that enjoy the outdoors. You love to go for hikes, birdwatch, and relax in open spaces and you would like for natural areas to be protected in the town. The port that is proposed to be built has the potential to threaten shorebirds and other wildlife in the area through loss of habitat, pollution, and disturbance but you are not very sure how important shorebirds are or how much harm the port could do. You decide for now you are against the proposal.

Essential character

SCENARIO #2 *Development on Estuary*

Kayaker: You are a kayaker who loves to use the bay in this area of the community. Even though few from outside the region visit the town, there is a small but dedicated kayaking group. The company that started the proposal plans on building a large facility that will control the water flow near the facility, making it unsafe for kayaking. There is also likely to be increased ship traffic, which would make kayaking unpleasant and unsafe. Kayaking is very important to you and a number of other people in the town, so you are against the proposal.

Essential character

SCENARIO #2 *Development on Estuary*

Local Indigenous Community Member: You are a member of the local indigenous community that lives near where the company would like to build the port. Your community has hunting and fishing rights, including on the area of proposed development, so you can continue your traditional way of life. Because of the change in access, pollution, and disruption in quality of life, you are against building the factory.

Essential character

SCENARIO #2 *Development on Estuary*

Birder: You are a local birder who lives near the bay. Every year, many shorebirds from around North America gather in the bay for a few days before they continue traveling south for the winter. Not only do you love seeing these birds in your community, but you also want to make sure they are protected so they can travel safely every year. You are against building the port.

SCENARIO #2 *Development on Estuary*

Town Council Member #2: You are a long-time town council member who has been asked to give their opinion on the proposal to build a port in the community. Protecting the natural environment for the future is a high priority for you because you would like future generations to have a healthy community they can grow up in. Even though many in the community are looking for jobs, you do not want to accept the environmental problems the port has the potential to cause and are against the proposal.

SCENARIO #2 *Development on Estuary*

Government Resource Agency Biologist: You work for a government natural resource agency as a biologist and it is your responsibility to protect habitat for wildlife. You help create strategies for protecting many different species in the region, including shorebirds. You are concerned that the change in water flow will change prey availablity. The constant movement of ships is also concerning for the potential disruptions and increased wave action that it might cause. You are against the proposal.

Essential character

Character Cards, continued

SCENARIO #2 *Development on Estuary*

Environmental Advocate: You are an environmental advocate who lives in town and wants to protect the shorebirds. You participate in many different volunteer activities, raise awareness on local wildlife, and advocate for education and action on environment issues. You recently heard of the port proposal that could contribute to pollution in the area and threaten shorebirds. You would really love to help defend them, so you are against the proposal.

SCENARIO #2 *Development on Estuary*

Town Council Member #1: You are a long-time town council member who has been asked to give their opinion on the proposal to build a port in the community. A lack of job opportunities has been a pressing issue for many years and some citizens are struggling. Even though there is potential impacts to shorebirds, you do not want to wait longer for other options when one is already available that could help. You think it would be best for the community to build the port.

SCENARIO #2 *Saline lake*

Pink Lake Resident: You are a rural resident who lives near the saline lake shorebirds use for habitat. Less and less water has been available to the lake over time, and so more of the lake bed has been exposed and dried out. You have been living with dust storms for many years, but they have gotten worse as there is less water is in the lake. These dust storms can not only be annoying but can cause health problems like asthma, which is why you are in support allowing more water to reach the lake.

Essential character

SCENARIO #3

Local Indigenous Community Member: You are a member of the local indigenous community that lives near Pink Lake. Traditionally, you and your community will fish from the freshwater rivers upstream from the lake. While you do not own the land upstream you do have fishing rights so people could continue their way of life without interruption. Because continued access to the rivers and healthy wildlife is very important to you and your community, you are in support of protecting the flow of water.

Essential character

SCENARIO #3 *Saline lake*

Rancher: You are a rancher who lives by one of the freshwater rivers that drains into the Pink Lake. You have raised hundreds of cattle over your lifetime – just like your parents, your grandparents, and your grandparent's parents did before the big city even existed. To take care of your cattle, you need to use some of the river water to help grow fields of grass your cattle can graze on. Without using the river, not enough grass would grow for all of your cattle to feed on. Because of this, you are against using less river water.

Essential character

SCENARIO #3 *Saline lake*

City Council Member #1: You are a long-time city council member who has been asked to give their opinion on the proposal to protect Pink Lake by requiring more water to flow to the lake. You think that it is important that the city has plenty of water that can be used, but you also want to make sure that current practices do not lead to using more and more over time. To help the city be more sustainable with water use, you think it would be for the best to protect the shorebirds and require certain amounts of water to reach the lake.

Character Cards, continued

SCENARIO #3 *Saline lake*

City Council Member #2: You are a long-time city council member who has been asked to give their opinion on the proposal to protect the saltwater lake downstream. Even though you do not want to hurt the shorebirds if it can be avoided, you think that providing as much water as needed to communities should be the number one priority. You would not want the city to make decisions that could immediately put water availability at risk, so you think it would be best to continue using the same amount of water.

SCENARIO #3 *Saline lake*

Utilities Operator: As the city utilities operator, you are the person responsible for managing the water system that gives people clean running water in their homes, businesses, and schools. The river is really the only steady source of water for citizens, you are against requirements that would protect the lake. Using less river water could mean not as many people having access to clean water in the city, which is not an option for the community.

Essential character

SCENARIO #3 *Saline lake*

City Resident: You are one of the people who lives in the city and cares about wildlife. Recently, you heard that shorebirds use the lake when they migrate, but the high water use in the city means less is flowing into the lake for shorebirds to use. Since you live beside one of the largest rivers in a major city area, you are not worried about losing access to clean water if you need to use less. You would like others to use less water to protect the lake.

Essential character

SCENARIO #3 *Saline lake*

Environmental Group Organizer: You are an organizer behind the local environmental group in the city. You help put together petitions, protests, and other important events to convince people in the city to make decisions that protect wildlife. Shorebirds visit the lake every year to rest before traveling to their nests, and you would like to make sure they will always have this place available by recommending others use less water.

Essential character

SCENARIO #3 *Saline lake*

Farmer: As one of the farmers in the area, growing and selling crops to towns and cities is an important part of your job. Every year, you use the water that flows in from one of the rivers to help grow crops. Because the crops you grow need a lot of water, it would be hard for you to keep growing food if you ever needed to start using less. You are against using less water.

Essential character

SCENARIO #3 *Saline lake*

Rural Resident: You are a local who lives away from the city, but still uses the river for drinking water. You do not use very much of it for yourself, but having easy access to the river is still very important for you. If you had to use less water there would not be an easy way for you to get more if you ever needed it, so you are against using less to protect the lake.

Character Cards, continued

SCENARIO #3 *Saline lake* **Wildlife Researcher:** You are a researcher who lives in the area who studies shorebirds. A few years ago, you found that less shorebirds were coming to the lake during migration. If the communities in the area keep using more river water, it could become very difficult for the birds you study to migrate without this important resting spot. You are in support of requirements for more water to come to the lake to help protect the lake and shorebird habitat.	SCENARIO #3 *Saline lake* **Tourism Agency:** You are an employee at the local tourism agency for the city that specializes in places to visit in the area. One of the most popular spots tourists like to visit is Pink Lake, where visitors and photographers from all around the country like to go to see shorebirds before they travel to their nests. Ever since the lake level has been getting lower, so has the number of birds that visit the lake and the number of tourists that stop by to see them. Because the shorebirds are a big part of your business, you would like to help them by convincing others to use less water.
SCENARIO #3 *Saline lake*	SCENARIO #3 *Saline lake*
SCENARIO #3 *Saline lake*	SCENARIO #3 *Saline lake*

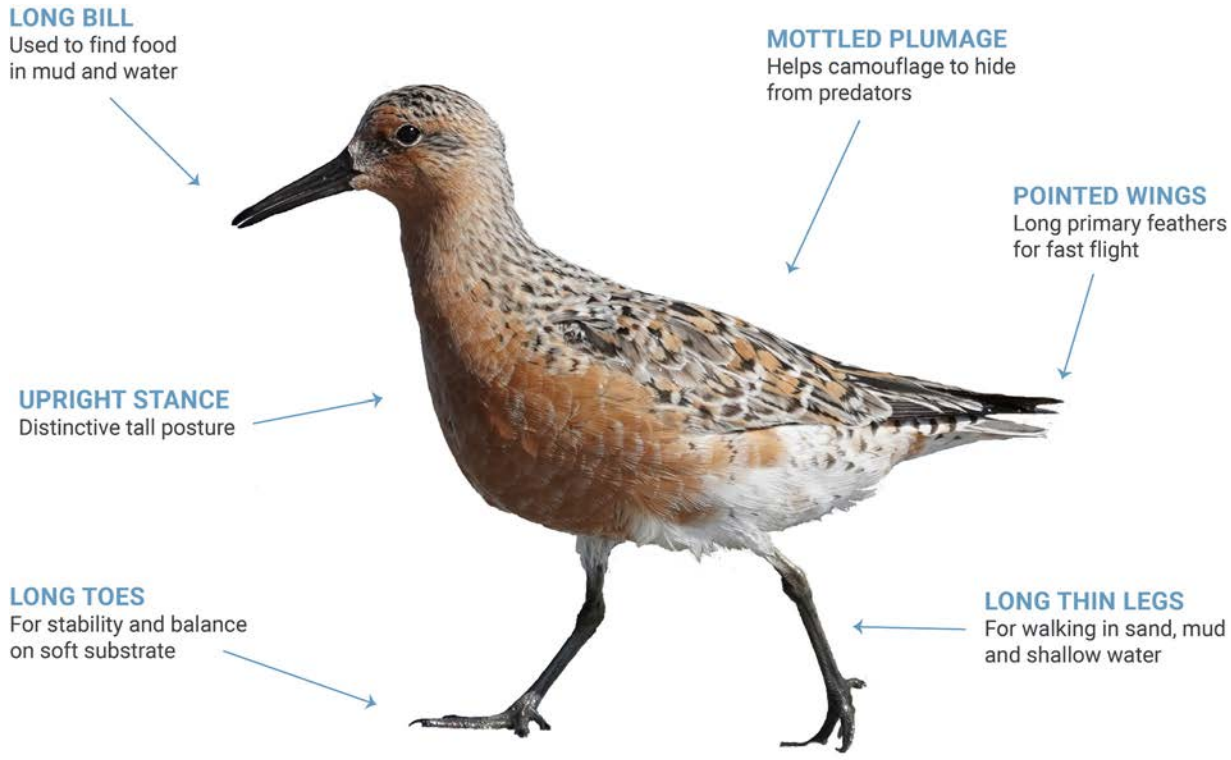
Lesson I: What is a Shorebird?

Shorebirds are a diverse group of birds in the order Charadriiformes, including sandpipers, plovers, avocets, oystercatchers, and phalaropes. There are approximately 220 recognized species of shorebirds in the world, 84 of which occur in the Americas for all or part of their lifecycle.

Most shorebirds are found near water, but several species prefer habitats far from shore. Shorebirds are found from intertidal mudflats, sandy beaches, and rocky coastlines to freshwater wetlands, grasslands, plowed fields and flooded agricultural lands. They feed mainly on mollusks, small crustaceans, marine worms, and insects. Shorebirds span a variety of sizes, bill shapes, and leg lengths, each species uniquely adapted to access their preferred foods in their specific habitats.

Shorebird traits:

- Long bill: Used to find food in mud and water
- Upright stance: Distinctive tall posture
- Long toes: For stability and balance on soft substrate
- Long, thin legs: For walking in sand, mud and shallow water
- Pointed wings: Long primary feathers for fast flight
- Mottled plumage: Helps camouflage to hide from predators



Adaptations

Adaptations are the *physical and behavioral traits* of an organism that make them better able to survive in an environment and, in turn, have more successful rates of reproduction. Physical traits are those that are part of an animal's body or plant's structure, whereas behavioral traits are actions or things that an organism does. Many times physical and behavioral traits are closely linked. Species with traits that make them better suited to their environments will be more likely to survive and pass their genes onto the next generation. Due to their unique life histories, shorebirds can be distinguished by adaptations that help them to survive in a variety of habitats, such as estuaries, mudflats, marshes, grasslands or tundras.

Eggs and Nesting

Shorebirds are typically *ground nesters*, making them very vulnerable to predation during breeding season. Because of this, many of the adaptations of shorebird eggs and nesting sites allow them to camouflage with their surroundings and incubate their eggs without being seen. When building nests, shorebirds tend to create shallow, saucer shaped structures that are inconspicuous at their nesting sites. In addition to having camouflaged nests, shorebird eggs are typically speckled to blend in with surrounding substrate and flora.

In most cases, shorebird eggs will also be shaped to have a point at one end. Although the exact reason behind this is not known, one theory is that this shape allows the eggs to fit together like a pinwheel in the nest. The advantage of this is that the eggs are more successfully incubated because more of each egg is covered by the incubating parent.

Beaks

All birds use their bills, or beaks for eating and have different traits that allow them to find food successfully depending on where they live. One of the most notable features of shorebirds are their long, slender beaks that are ideal for *probing* sand and mud for insects, clams, crustaceans, snails, worms and other invertebrates. Most shorebirds have beaks with similar shape and structure, but the varying lengths of shorebird beaks can be very telling as to where these birds find their food. Shorter bills are ideal for probing for animals living near the surface of the earth and longer bills are used to find animals buried deep within the ground.

Some shorebirds have unique adaptations for eating very specific types of food. For instance, Oystercatchers have large, chisel-like bills that are ideal for prying open mollusks. Surfbirds and species of plovers have very short, stout beaks that they use to forage for food on the surface of the beach.

Feet and Legs

Where water meets land often creates unstable and unpredictable substrate to navigate; however, this is something that shorebirds do not need to worry about due to their specialized legs and toes. Most shorebirds are equipped with long legs and long, pointy toes. These are ideal adaptations for walking and wading along the water's edge and preventing the birds from sinking into soft ground.

The long legs of shorebirds keep their bodies out of the water while they wade. Just as a shorebird's beak can tell us about where these birds find food when probing, the length of their legs can help to determine where they can be found along the water's edge. The longer a shorebird's legs, the more likely it is to be found wading deeper in the water searching for food. Equally as important for survival are the elongated toes of the shorebird. This special adaptation, which helps to distribute their weight over a larger surface area, is crucial for keeping individuals from sinking into the muddy, soft ground beneath them as they find food and wander through nesting grounds.

Additional Adaptations

Honing in on one aspect of an organism's life history exposes the unique adaptations that allow it to be successful in its environment. Focusing on shorebirds, many behaviors and physical characteristics can be linked to successful foraging, breeding, and overall survival. Some additional adaptations of shorebirds include:

Flocking: Many birds coming together in a large group or flock. Often seen when predators approach, flocking helps to reduce an individual's chance of being eaten. Even species that are known to be primarily solitary will join together with other shorebirds to escape potential threats.

Migration: This behavioral adaptation is thought to occur in order for birds to take advantage of the abundance of seasonal food sources in nesting grounds. For shorebirds, this often means flying from areas such as Mexico and South America to the United States and Canada in the spring and making the return journey in the fall.

Distraction Displays: Due to the nature of ground nesting, shorebirds can often be susceptible to predation. One way to protect their nests and chicks is to put on elaborate displays and lure predators away from their nests. An excellent example of this can be seen from Killdeer pretending to have broken wings. They will act as if they cannot fly and make a lot of noise to distract predators from a nearby nesting site. Once the predator gets close to the displaying Killdeer, it will quickly fly to safety.

Courtship Displays: There is often a lot of competition for males to attract females during the breeding season. Because of this, many elaborate courtship displays have evolved overtime in order to impress females and increase chances of breeding and passing on genes to the next generation. Some of these displays include excessive wing fluttering, tail cocking, nest scraping and singing.

Additional Resources:

All About Birds, Shorebirds list:

https://www.allaboutbirds.org/guide/browse/shape/Shorebirds

WHSRN About Shorebirds:

https://whsrn.org/about-shorebirds/

Explore the World of Shorebirds - Shorebird Adaptations:

https://migration.pwnet.org/pdf/Shorebird_Adaptations.pdf

Identifying Shorebirds in British Columbia:

https://bit.ly/identifyinbc

Hinterland Who's Who, Shorebirds:

https://www.hww.ca/en/wildlife/birds/shorebirds.html

Habitat

Shorebirds get their name from their tendency to be found by the shore, but they can be found anywhere from intertidal mudflats, sandy beaches, and rocky coastlines to freshwater wetlands, grasslands, plowed fields and flooded agricultural lands.

When thinking about the adaptations of shorebirds, it is crucial to consider how their characteristics increase survival and chances of successful reproduction in the habitat they are found in. Due to the nature of their landscapes, shorebird habitats have the potential to change dramatically in times of flooding, drought, excess evaporation, or the fluctuation of tides. In addition to these naturally occurring changes, there are many anthropogenic impacts on the composition of shore habitats including urbanization, agriculture, and managed water flow.

Willet eating a crab. *Photo: Maina Handmaker*

Why study shorebirds?

Because of their specific survival needs, shorebirds are excellent indicators of a healthy ecosystem. When indicator species populations are not doing well, are booming, or are staying relatively constant, researchers can learn a lot! A decline in shorebird populations is often indicative of less food availability, habitat loss or a number of other ecosystem disruptions.

Not only can shorebirds tell us a lot about the overall health of the habitats they rely on, but they also contribute to the health of these ecosystems by living there! Shorebirds are an important piece of the food chain. One unsuspecting way in which shorebirds contribute to their habitats is the production of guano, a.k.a. shorebird droppings! Guano is an excellent fertilizer for mudflats and other shore-like habitats. The high nutrient levels of guano also make it a substantial source of food for organisms at the base of the food chain like phytoplankton, small fish, and crustaceans!

Bahia de Todos Santos WHSRN Site in Mexico. *Photo: Laura Chamberlin*

Lesson Two: Migration Mania

What is Migration?

Each year, shorebirds travel thousands of miles from their overwintering grounds to their breeding grounds and back again. This long-distance journey, also known as migration, is timed perfectly to align with the availability of food resources around the world. Although scientists are always learning more about migration, it is thought that birds are taking advantage of the abundance of seasonal food sources in their nesting grounds. In order to have a successful migration, shorebirds must time their flights perfectly so that their stopover sites and nesting ground arrivals coincide with food availability. Due to the strenuous nature of the journey, any disruptions along the way could have devastating effects on migrating shorebird populations.

Migration Flyways

The western hemisphere is home to three major pathways that birds take to go from their wintering grounds to their breeding grounds. These pathways are known as flyways, or the routes that migratory birds follow during migration. Each year, thousands of birds follow these general paths resting at stopover sites along the way.

Pacific Flyway: Western coast of the Americas

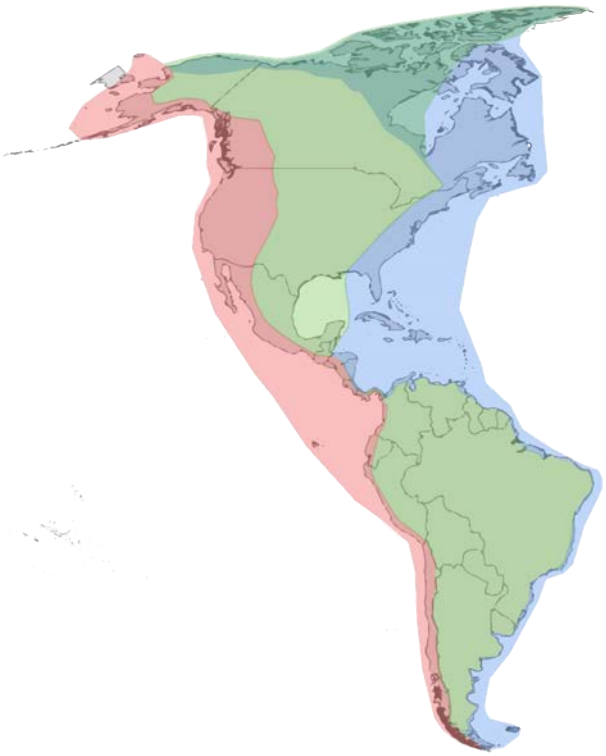
Atlantic Flyway: Eastern coast of the Americas

Midcontinental Flyway: Inland route through the Americas

Scientists are able to study the migration pathways of birds using technology such as radio telemetry and the observation of banded or flagged birds. By monitoring birds as they are migrating, researchers are able to make efforts to protect key habitats needed during shorebird migration.

Migration Timing

Compared to other birds, shorebird migration can take a long time. Some shorebirds will begin their migration to breeding grounds as early as February and won't return back to their overwintering grounds until October! There are many factors that influence migration timing including food availability or changes in weather patterns across the hemisphere. Early arrival to nesting grounds before it is warm enough could result in the water and ground still being frozen.



In the spring, there is a major rush for shorebirds to get to their breeding grounds, find a mate, and build a nest. An entire population of shorebirds will arrive within a few days of each other at their breeding grounds to ensure they are able to find mates. For shorebirds that breed and nest in the Arctic, there is only about a two month window that is suitable for finding mates, laying eggs and raising a family. After this two month period, the shorebirds are ready to head back to their overwintering grounds.

Fall migration is a much more leisurely journey for shorebirds, as they are not racing against the clock to find mates and set up nesting sites. Because of this, birds will head to their overwintering grounds in waves from anytime in late June through November. Typically, the first birds to leave nesting grounds are those that were not successful at raising chicks and shortly after successful breeders will follow.

Migration Needs

Migration is a long, energy expending journey that requires a lot of resources! If birds are not able to meet their needs, they may not be able to make it to their nesting grounds in time, which could result in an unsuccessful breeding season. The migration journey looks different for birds depending on which flyway route they travel by and the distance from their wintering grounds to their nesting grounds. Although many shorebirds nest in the Arctic, some will nest in areas further south.

Migratory shorebirds can be divided into three groups based on the length of their migrations.

Long-distance migrants: fly more than 8000 miles one way

Medium-distance migrants: fly 3500-7000 miles one way

Short-distance migrants: fly <3000 miles one way

To prepare for these flights, shorebirds must stock up on food at their overwintering grounds and increase their fat reserves so they have energy to fly. Some birds will gain more than half their weight in stored fat in preparation! Timing is critical when it comes to migration. Alignment of flight departures and arrivals at stopover sites to when resources are most abundant is critical for shorebirds to get the energy they need to continue their long journeys. *Stopover* sites are where migrating birds rest and refuel after the first leg of migration. This is imperative so that they are able to continue onward to their nesting grounds or overwintering grounds (depending on the time of year) without using all of their energy. Birds that are unable to meet their dietary needs during migration do not survive the journey.

Shorebirds are highly dependent on wetlands and estuaries as stopover sites that will provide them with safe resting grounds and an abundance of food while they prepare for the next leg of their journeys. Due to their specific needs, large numbers of shorebirds will congregate at the same stopover sites for several days or weeks. These habitats that are used by many shorebirds at the same time during migration are known as staging areas.

One crucial staging area in Canada is Shepody Bay in the Bay of Fundy. The bay's mixture of marshes and mudflats provides the perfect habitat for birds to stop during their long journeys. From mid-July to early September, over one million Semipalmated Sandpipers will visit this site!

Migration Threats

One of the greatest threats to migratory shorebirds is the loss of suitable habitat. By the time shorebirds make it to their stopover sites, which are typically the same locations each year, they do not have the energy to find alternative sites if the habitat no longer provides them with the protection and food they need to rest and refuel. Humans are one of the major causes of habitat loss for migrating shorebirds. Pollution, development, and agriculture expansion are just some of the anthropogenic influences that can cause devastating effects to the successfulness and survival of migrating shorebirds.

Additional Resources:

Explore the World of Shorebirds:

https://migration.pwnet.org/pdf/Flyways.pdf

Shorebird Flyways

www.shorebirdflyways.org

Pacific Flyway

www.pacificflywayshorebirds.org

Atlantic Flyway

www.atlanticflywayshorebirds.org

Migration Methods

Exactly how are shorebirds able to follow the same paths, stop at the same locations and find their nesting grounds successfully each year? Researchers are learning more about shorebird migration all the time and although their methods of navigation are not fully known, there are many theories as to how shorebirds are able to travel thousands of miles each year without getting lost. One theory is that shorebirds will use stars in the night sky to keep them on track. This is supported by observations of large flocks of shorebirds seemingly losing their way and becoming confused when they fly over metropolitan areas and areas of high light pollution. Another theory is that birds are guided by an internal magnetic compass that keeps them oriented and aligned with the earth's magnetic routes while in flight. Although this may sound surprising, the use of earth's magnetic fields for navigation is something that can also be seen in sea turtles and salmon as they are navigating long distances in the water!

Red Knot with Satellite Transmitter. *Photo: Arie Manchen*

Lesson Three: Making Tracks with Shorebirds

Shorebird Research and Technology

Discovering more about shorebirds through research

Scientists are still searching for answers to many questions about shorebirds. To understand the birds that live in a habitat, we can explore the area throughout the year and note the different species. With a good field guide, binoculars, and lots of practice, we could identify all of the species in an area. But how do we answer questions dealing with age, survivorship, mortality, or behavior? For conservation to be effective we need to understand their habitat needs.

Often, in order to focus management efforts, researchers need to know where a specific bird population is throughout the year. Individual shorebirds, because of their migratory patterns, are difficult to track throughout the year. There is often a need to link birds breeding in the Arctic with those migrating through Missouri and wintering in Argentina. Because of this need, ornithologists use several methods such as banding, radio and satellite telemetry, DNA testing, and stable isotope analysis.

Bird Banding

Bird Banding helps to answer many of these questions. Marking birds for study has been done for more than 100 years-ever since John James Audubon captured an Eastern Phoebe in the 1850s, wrapped a small piece of silver wire around its leg, and determined that the same bird returned the following year. Today, bird banding involves attaching a loose-fitting aluminum band

around the bird's leg that is coded ahead of time with a unique identification number. Often there is a series of colored bracelets and flags that represent the country where the bird was banded, the banding year, and perhaps the age of the bird.

There are several ways to capture birds for banding:

1. Researchers can stretch a fine net called a mist net across an area where birds are likely to fly. Once caught in the net, the bird is quickly and carefully untangled by the researcher, who bands it, collects data on the species such as age, weight, and sex, then releases it.
2. Chicks can be banded before they leave the nest. By banding birds in the year they hatch and recording their annual return, researchers can see how long they live and if they are being replaced by a sufficient number of young. Shorebirds, unlike other bird species, are tolerant of humans handling their chicks.
3. *Cannon netting* involves using an electrical charge to catapult a net into the air over feeding shorebirds. This method is usually used in coastal areas where many birds can be captured quickly.

Red Knot with flags and bands.
Photo: Arie Manchen

Because learning to handle birds properly requires special training, and to ensure that valuable information is not wasted or lost if birds are banded incorrectly, a special permit from the U.S. Fish and Wildlife Service is required for all bird banding in the United States. Trained biologists handle birds carefully and keep stress to the birds to a minimum, ensuring that they are rarely injured.

Many birds that have been banded disappear and die without the researchers knowing where, when, or why. If you find a dead bird with a band, please report it to the appropriate agency.

To Report a Color-Banded or Flagged Bird

If you and or your students are lucky enough to see a bird with a band this information can be reported at www.bandedbirds.org:

- Describe each band: type (metal, color band, flag); colors (as exactly as possible-light green, dark blue); and location on bird (left or right leg, upper or lower leg, above or below other bands).
- Report if you are unsure of any bands or if you did not see all parts of both legs clearly.
- Please also report species, location of sighting, date, and any other information about behavior or other birds.

Motus Wildlife Tracking

Motus Radio Telemetry: The Motus Wildlife Tracking System (Motus) is an international collaborative research network that uses coordinated automated radio telemetry to facilitate research and education on the ecology and conservation of migratory animals

Another technology that is used to understand migratory routes is the Motus Wildlife Tracking System (Motus). Motus is an international collaborative research network that uses coordinated automated radio telemetry to facilitate research and education on the ecology and conservation of migratory animals. This tracking system consists of stations installed in a variety of habitats. Each station is composed of several antennae that can detect the movements of birds with tiny radio-transmitters attached to them. After antenna detects a bird with a transmitter, a computer on the tower records it and sends signals to a central database where users can access the data, seeing a list of all the stations where a particular bird has been detected.

Motus is not just useful for understand migration at the flyway scale, but it can also help biologists understand the use of a particular site by tracking movements within the site. The automated recordings of Motus provide real time of data such as survival, and arrival and departure dates of marked birds. This all provides important data for the design of more effective conservation action plans at the site.

There are over 500 Motus stations installed throughout the Americas, stations are shared across the network and can be used for tracking the movements of a variety of wildlife, not just shorebirds. This tracking system has had extensive adoption by biologists across the Americas, but the presence of stations is still one of the limiting factors for the success of this tracking method. Motus stations will be needed in many more places to fully map the migration or use of a site by certain species.

Satellite Telemetry

Sometimes biologists will clip the feathers between a shorebird's shoulder blades and attach a small satellite transmitter with glue. The transmitter does not injure the bird and eventually falls off. The feathers will grow back without affecting the bird's ability to fly. This technique allows scientists to study shorebird behavior in real-time without the need for Motus radio towers. They can learn what habitat the birds are using, how long they stay there, where they fly to next, and much more. Satellite technology is more expensive then Motus tags and this type of transmitter can not be used on the smaller birds, but it is a reliable way to get location data in remote places.

Stable Isotopes

New technology is allowing biologists to isolate stable isotopes in shorebird feathers and to trace what location the bird was in when it grew those feathers during its molt. Stable isotopes are different forms of the same elements that have similar chemical properties but vary in their atomic mass due to differences in the number of neutrons. Isotopes vary by location, and can be linked to that region when analyzed in the tissue of an organism.

Carbon, nitrogen, and hydrogen are among the most useful for studying migratory connectivity since they are naturally abundant. Shorebirds consume prey in a particular location, if they are molting and growing new feathers the isotopes of that region will be incorporated into the tissue of the feather.

Additional Resources:

MOTUS Introduction:

https://www.youtube.com/watch?v=kqx85gL2Dek

Migratory Connectivity Project:

https://bit.ly/migratoryconnectivityproject

World Migratory Bird Day:

https://www.migratorybirdday.org/tracking-technologies/

People enjoying the beach with their dogs off leash can be a threat to shorebird habitat.

Lesson Four: Shorebirds at Risk: Threats and Action

Threats to Migrating Shorebirds

Shorebirds face almost insurmountable odds. Research shows a steep decline in the populations of several shorebird species, and it is suspected that many others have declining populations. What are the threats that affect migratory shorebirds each year? There are a variety of natural threats such as predators, weather, and disease. However, human-influenced changes are by far the most serious threats to shorebird survival today.

Vanishing habitat

Today, the primary threat to the survival of migratory birds is the disappearance and degradation of habitat. Many migrant shorebird populations are dependent on vital food and rest found at the same wetlands, estuaries, and grasslands year after year. In some circumstances, if one of these stopover locations is lost, shorebirds may not stop nearby even if an alternate site exists. Instead, they fly on to the next stop, perhaps hundreds of miles away, without resting or feeding. Many birds may not survive.

In many situations the habitat is still there, but it has been degraded to the point that it is no longer healthy and cannot support the wildlife as it did in its unspoiled state. Even if the habitat is not completely removed from the landscape, things such as disturbances from people, effects of nearby industry, and the increase of predators can make a habitat unhealthy for wildlife that depends on it. Urban sprawl and industry are reducing the availability of habitat. This type of development also reduces the quality

of neighboring conservation lands because nonnative species, chemical pollutants, and an increase in predators associated with humans (dogs, cats, raccoons, rats) can be introduced.

Agriculture and wetlands were historically drained or the water diverted for irrigation. Rivers have been dredged and diked for navigation and flood control. Prairies and wetlands were quickly replaced by agriculture. Our modern system of agriculture, called monoculture, uses a piece of land for a single type of crop which effectively eliminates habitat and species diversity. The use of pesticides to control weeds and insects on crop fields also is thought to have both direct and indirect effects on shorebirds. Food resources may be removed, causing the birds to starve. Chemicals may also accumulate within the birds' tissues, leading to deformities and poisoning. In places where agriculture and shorebirds attempt to coexist, eggs and young birds are often crushed by machinery.

Pollution hurts shorebirds and their invertebrate foods

Many types of pollution, including runoff and pesticides may all be affecting shorebirds and the insects and fish they feed on. An oil spill near coastal stopover areas, especially one timed with the peak of migration, would be a disaster to shorebirds. For example, Delaware Bay, a critical stopover site for over 600,000 migrating shorebirds, is also the second largest petrochemical port in the eastern United States. A major oil spill would coat the feathers of shorebirds, making it impossible for them to fly or stay warm and dry. Birds that try to clean themselves and accidentally ingest oil would be poisoned. An oil spill would also kill horseshoe crabs and their eggs, a critical food source for the shorebirds that pass through the area.

Human recreation can disturb wintering and feeding shorebirds

Migrating shorebird populations are also threatened by disturbances at their stopover sites. If the disturbance is intense enough, migrating shorebirds will continue migrating without stopping at all. Without adequate refueling, individuals may not have enough energy to reach their breeding grounds and/or breed successfully.

Popular recreation activities like riding off-road vehicles on barrier beaches sometimes leave deep tire tracks in the sand or mud, trapping newly hatched chicks. They also force birds into the air at a time that is critical for the birds to rest and feed. Operating jet skis and boats near shorebird wintering areas scares birds away.

Other types of recreation can also be a problem for shorebirds. Off-leash dog walking, kite flying, sunbathing, and surfing also chase birds from their choice feeding sites and cause them to use valuable energy in the process.

Shorebirds and hunting

Historically, flocks of migrating shorebirds were highly vulnerable to shooting. Market shooting was a common occurrence in the Nineteenth century. Market shooters took advantage of the need for fresh meat in the urbanizing eastern United States. Shorebirds could be easily and economically harvested because they concentrated in huge flocks at predictable migratory staging areas, could be decoyed into shooting range, and would return back for wounded flock mates. Most species of shorebirds were hunted throughout the 1800s, some to the point of extinction.

The Arctic-breeding Red Knot, which migrates in massive flocks northward across the United States, was severely affected by market hunters in the 1800s. The endangered Eskimo Curlew, called the "doughbird," was hunted for food and sport until it was likely driven to extinction. Even though regulations were passed to stop the killing of shorebirds, their low reproductive rate and highly social lifestyle has prevented their comeback.

Today in the United States, there are only two shorebird species (American Woodcock and Wilson's (common) Snipe) that have large enough populations to support a regulated harvest season. Subsistence egg gathering by native indigenous people in the Arctic is still a traditional practice that is allowed. Migrating shorebirds are still being hunted in many other countries today. Working with international, national, and regional communities is important to ensure that shorebirds are not overharvested.

Spread of exotic species

Nonnative or exotic species are being introduced into wetlands. Sometimes these introduced species seriously alter the structure of the wetland by competing with native plants and animals. As healthy wetland habitat shrinks, shorebirds lose the feeding and resting sites they rely on.

Resource management can conflicts with shorebirds

Many of our resource management strategies like mosquito-control programs, oyster-culture practices, and salt pond management can conflict with shorebird conservation. In places where agriculture and shorebirds attempt to coexist, eggs and young birds are often crushed by harvest machinery. As many as 400-600 birds were killed in a 10-day mowing season in the hay fields of the Silvies Floodplain in Oregon. Without grasses to hide in, the chicks that escaped the machinery were caught quickly by predators.

All along the Atlantic and Pacific coasts, entire beaches are raked daily or weekly to remove trash and tidal debris. This makes it impossible for Snowy Plovers or Piping Plovers to nest. Noisy and large, these machines can crush plover nests and chicks and scare the adults away. Beach raking also removes the kelp and driftwood that invertebrate foods live on.

Shorebirds and deadly diseases

Shorebirds are also susceptible to diseases. Most diseases are natural occurrences, but their effects on the bird population are dependent upon how many individuals are concentrated in the area at the time of the outbreak. Some of the diseases that may have a devastating effect on shorebirds include avian botulism.

Avian botulism outbreaks are common within the interior of North America during the summer and early fall when temperatures are warm and water conditions are low. A toxin is produced by a bacterium and is ingested by birds as they feed on invertebrates in infected waters. During late summer and fall, water resources are rare and migrating birds concentrate in the few areas where water does occur. Control of botulism outbreaks is difficult because there is still a lot to be learned about this disease. Land managers spend a lot of time and energy trying to avoid massive die-offs. Many critical shorebird staging areas are known to have botulism outbreaks. Several thousand shorebirds can be lost during severe outbreaks.

Predators out of balance

Shorebirds have only a few natural mammalian predators at their remote nesting grounds. Their cryptic coloration helps them hide from avian predators like falcons and jaegers. As Arctic nesting areas are developed, introduced predators may become an increased concern.

Shorebirds that nest, stop to rest and refuel, and winter on coastal beaches and mudflats near large population centers are vulnerable to predators. Many shorebird predators such as foxes, skunks, crows, gulls, rats, and raccoons are extremely successful at coexisting with people. Their population numbers have increased to the point that the delicate predator/prey relationship is out of balance. Normally, predators would not impact the shorebird population. However, shorebirds that are already at a disadvantage due to other human-related threats become vulnerable to these predators, including peoples' pets—dogs and cats! Even if not actively hunted by these predators, the energy used by shorebirds to move out of their way can jeopardize their health.

Wilson's Plover chick on a beach in Georgia, United States.

Photo: Abby Sterling

Sanderling running along the water's edge. *Photo: Abby Sterling*

Shorebird Conservation

Provides a hopeful future

- Over 38.7 million acres of shorebird habitat are part of the Western Hemisphere Shorebird Reserve Network (WHSRN). This voluntary network of over 430 organizations and agencies across the Americas is working together to protect and manage wetlands.
- The National Wildlife Refuge system, managed by the U.S. Fish and Wildlife Service, provides quality habitat for shorebird breeding, nesting, and wintering.
- Working with land managers and landowners, there are opportunities for management that benefits people and shorebirds.
- By managing habitat for shorebirds, numerous other species that depend on these ecosystems will benefit too.

Shorebird conservation is very challenging!

Land managers and biologists are faced with many tough questions that often have many possible answers, depending on an individual's perspective. Consider a private landowner who is trying to keep a family-owned ranching business alive. He or she will probably have different ideas and feelings about protecting shorebird habitat on land where his or her cattle grazes than a research biologist will. A community development committee elected to create jobs and attract tourist dollars into the community will probably have different coastal development priorities than a member of a bird-watching group.

Below are some of the difficult questions scientists must answer when promoting or defending shorebird conservation. Which of these questions do you think are easily answered?

How can we work to protect birds beyond our borders?
Perhaps one of the most significant conservation challenges is protecting species with long-distance migrations. The shorebirds that breed in North America migrate through or spend the nonbreeding season in at least 36 counties! Protecting shorebirds involves cooperation and agreement among many different countries. Cultural differences, gaps in scientific understanding, and varying conservation ethics can create challenges to cooperation among countries.

How can we increase our knowledge of shorebirds?
There is a need for more research and monitoring of many shorebird species. Biologists need more information on baseline population numbers, an inventory of habitats used by shorebirds, and the development of long-term monitoring programs. Existing data suggest that populations of many shorebird species are already declining.

How can we reverse past population declines?
Another significant conservation challenge is the low reproductive potential of shorebirds. The fact that most species lay a clutch of four or fewer eggs each season, with only very few species re-nesting, makes it difficult for biologists to reverse past population declines and increase shorebird numbers quickly.

How can we protect shorebirds from disasters?
The fact that shorebirds concentrate in such high numbers at migration stopover sites poses another challenge to biologists. Huge populations of shorebirds are vulnerable to any number of catastrophic environmental changes like weather events, oil spills, toxic chemical residues, habitat development, or human disturbances at many of these key sites.

How might climate change affect shorebirds?
Climate change is possibly the least studied threat to shorebirds across all the flyways. Scientists suspect that global warming could change water levels along the coast and eliminate important shorebird habitat. Warmer winters might change the migration patterns of shorebirds, causing some to winter further north, bypassing the more southern conservation lands specifically set aside for them.

How can we help private landowners save important habitat?
Much of the land used by shorebirds is privately owned. Several federal and most state natural resource agencies have programs to assist private landowners in managing wildlife and wildlife habitat on their property. These programs are limited in staff and funding.

How do we increase public understanding?
Many people do not see wetlands and grasslands as important. They are not aware of the benefits that wetlands and grasslands provide them. Therefore, they do not see a need to preserve or manage these unique and critical areas. Educators, students, biologists, and bird enthusiasts can work together through education and conservation projects to increase public understanding.

National and International Partnership Programs

Thankfully, an increasing number of individuals and countries are recognizing these conservation challenges and the threat of habitat destruction all over the world. Many federal, state, indigenous, and private groups have purchased and protected millions of acres for local and migratory wildlife. There is a worldwide effort to identify critical staging areas and then to protect them. More studies are conducted each year to answer questions about shorebird migration patterns, current population numbers, and habitat needs. Education programs are teaching people about the value of wetlands and grasslands for shorebirds and all the other species that depend on these vital ecosystems. The following is a description of several of these national and international partnership programs established to help protect shorebirds and their habitats.

The Western Hemisphere Shorebird Reserve Network: The Western Hemisphere Shorebird Reserve Network (WHSRN) brings together over 430 private and public organizations in seven countries working toward the conservation, restoration, and management of critical shorebird habitats throughout the Americas. Sites are recognized as significant to shorebirds when they fit one of three requirements: Regional Sites host at least 20,000 shorebirds; International Sites are used by at least 100,000 shorebirds; and Hemispheric Sites provide habitat to 500,000 or more shorebirds throughout the year. To date, WHSRN has over

114 wetland sites in 18 countries that are critical links in a shorebird migration chain. For more information contact www.whsrn.org.

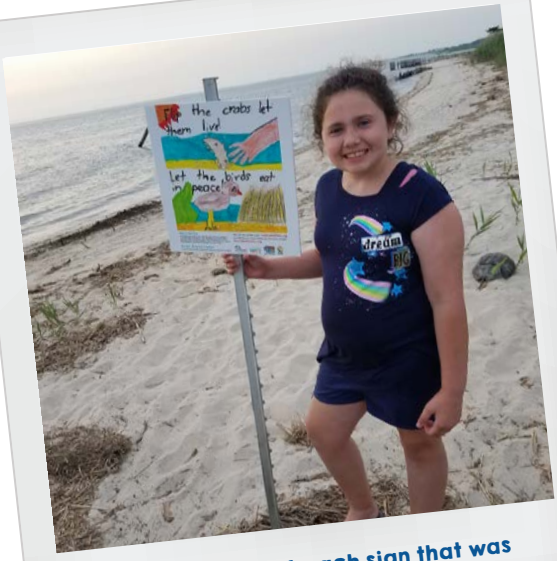
WHSRN works to:

- Build a strong international system of sites used by shorebirds throughout their migratory ranges.
- Develop science and management tools that expand the scope and pace of habitat conservation at each site within the Network.
- Establish local, regional and international recognition for sites, raising new public awareness and generating conservation funding opportunities.
- Serve as an international resource, convener and strategist for issues related to shorebird and habitat conservation.

The Ramsar Convention on Wetlands: This intergovernmental treaty signed in Ramsar, Iran, in 1971, was established to provide a framework for international cooperation for the conservation and wise use of wetlands and their resources. More than 170 countries from all regions of the world are now part of the convention. They meet every three years to discuss progress and wetland conservation. As part of membership, these countries agree to consider wetland conservation in their natural resource planning, promote wise use of wetlands in their countries, and establish nature reserves. They are also required to designate at least one site for inclusion on the "List of Wetlands of International Importance" based on criteria adopted under the convention. For more information go to http://www.ramsar.org.

The International Shorebird Survey (ISS): ISS is a volunteer program organized by Manomet. The purpose of the ISS is to collect information on shorebirds and the wetlands they use during migration. To date, more than 800 shorebird watchers have collected information from 1650 locations throughout the Western Hemisphere. Volunteers have added to our knowledge of migration routes, timing of peak migrations, trends in species declines, and locations of key stopover areas for shorebirds. The work of ISS volunteers has made it evident that many species of shorebirds are dependent on these critical sites, leading to the creation of WHSRN. To learn more about this important volunteer group, contact Manomet at www.manomet.org.

Whimbrels flying over the salt marsh at Monomoy National Wildlife Refuge WHSRN Site.
Photo: Alan Kneidel



Student with the beach sign that was created from her artwork.
Photo: Tami Kerr

You Can Help Shorebirds Too!

Learn about shorebirds.

The more you know about shorebirds, the more you will understand how you can help.

Never chase flocks of shorebirds.

Chasing shorebirds forces them to use up valuable energy and reduces the time they spend feeding and roosting.

Never let dogs chase shorebirds.

Choose to take your pets to an exercise area away from where shorebirds nest, rest, and feed. Always keep your pets on a leash.

Explain to others why it is so important not to disturb shorebirds.

Many people do not know that their actions hurt shorebirds. Share what you know with them so they can make better choices.

Become a shorebird observer.

Keep track of migrants coming through your local area. Help scientists identify critical staging areas for preservation. Submit your information to ebird.

Additional Resources:

Shorebird Threats and Status:

https://whsrn.org/about-shorebirds/shorebird-status/

Conservation Action and WHSRN:

https://whsrn.org/about-shorebirds/conservation-action/

Shorebird Monitoring:

https://whsrn.org/about-shorebirds/shorebird-monitoring/

Shorebird Resources:

https://whsrn.org/about-shorebirds/shorebird-resources/

Environment and Climate Change Canada:

https://www.youtube.com/watch?v=aB-AMDrQLzY

Children learn about the connection between horseshoe crabs and shorebirds at the Delaware Bay WHSRN Site. *Photo: John King*

Lesson Five: Understanding why Nature Matters

FOR YOUNGER STUDENTS:

Habitat: Valuable to People and Shorebirds

Wetlands are important habitats to people. They are a source of water for power, crop irrigation, transportation, drinking water, and recreation. More and more people are finding wetlands attractive home sites. Highway bridges span them, sewer plants are built near them, and ports are developed on them. Grasslands provide people with space and rich soil for farmers to raise cattle, horses, and crops like corn, soybeans, and sunflowers. They are also important places for people to enjoy nature, observe wildlife, hunt, or fish.

As these vital habitats shrink, shorebirds and countless other animals and plants lose the habitats they rely on. People will lose the benefits of clean water, flood control, fishing areas, and beauty that wetlands provide. We lose the rich soil, vast space, and diversity of life in grasslands. Is it possible that people and shorebirds can survive, possibly even thrive, together using these habitats? Yes, if we are dedicated to good land stewardship. The more we learn about these ecosystems and the intricate interactions among all the organisms living there, the better our chances of making good resource management decisions in the future!

FOR OLDER STUDENTS:

What is an ecosystem?

An ecosystem is a community of animals and plants interacting with one another and with their physical environment. Ecosystems include physical and chemical components, such as soils, water, and nutrients that support the organisms living within them. These organisms may range from large animals and plants to microscopic bacteria. Ecosystems include the interactions among all organisms in a given habitat. People are part of ecosystems. The health and wellbeing of human populations depends upon the services provided by ecosystems and their components - organisms, soil, water, and nutrients.

To try to understand the concept of ecosystem services, we need to put it in a context where a "system" can be described at different levels. A cell is one level, an organism is another. Organisms build up ecosystems that in turn create a biosphere consisting of a variety of ecosystems that interact with each other and exchange services. In each level, processes are developed that combine forces to create a working system at that particular level. All systems strive to evolve and stay alive. Each level also contributes so that the entire system in turn is a part and can develop. Everything is connected.

Healthy Ecosystems Benefit Human Well-being

Ecosystem services are the natural benefits that people derive from intact ecosystems. They are broken into four categories: Provisioning services are the products we obtain directly from the natural world. Regulating services are the natural services that allow nature to resist or fix temporary problems and also protect humans from some difficulties. Cultural services are the non-material benefits that make humans happy and give meaning to life. Supporting services are the fundamental processes to maintain basic ecological functions – all other ecosystem services rely on these supporting services.

Ecosystems provide "services" that:

- moderate weather extremes and their impacts
- disperse seeds
- mitigate drought and floods
- cycle and move nutrients
- protect stream and river channels and coastal shores from erosion
- detoxify and decompose wastes
- control agricultural pests
- maintain biodiversity
- generate and preserve soils and renew their fertility
- contribute to climate stability
- purify the air and water
- regulate disease carrying organisms
- pollinate crops and natural vegetation

A flock of Buff-breasted Sandpipers forages on grass grazed by cattle.
Photo: Daniel Alarcon

Why should we care about ecosystem services?

In our daily lives we use a variety of goods, services and experiences that nature offers us, and that we take for granted. Lots of living organisms' and their interactions provide us with an amazing and complex machinery of food, water, clean air, energy, clothing, housing and medicine, as well as cultural and aesthetic experiences. Everything that is vital for people to live.

Much of these vital factors are invisible to our eyes, and therefore relatively unknown and poorly appreciated, even though we are completely dependent on their existence and functioning. Biodiversity and the services that ecosystems provide are too poorly

protected in our society's physical and economic planning. If people are unaware of these benefits, they are unlikely to care about protecting them.

Threats to ecosystem services

Various human activities threaten and affect ecosystems in many ways. A few examples of these are:

- Development can cause landscape and ecosystem changes.
- Excessive resource extraction due to poverty or short-term gain, such as overfishing or logging, can upset the balance of an ecosystem.
- Pollution, both wastes and toxins in general, make it harder for organisms to survive.
-
- Invasion of non-native species due to human transfer between ecosystems can crowd out native species access to resources.
- Climate change stresses many ecosystems and makes them less effective.

Putting value on nature

Ecosystems and the services they provide have existed long before humans, but due to the over-exploitation of resources for human consumption, these ecosystem services are at risk. Unless we begin valuing ecosystems in a more conscious way, the benefits provided by ecosystem services will decline until they are no longer available. In order to continue benefiting from these services, humans must find ways to support the organisms living in these ecosystems and the relationships they have with their environment.

Because ecosystem services are considered public goods for which economists find it difficult to set realistic values, they are undervalued in decision-making processes. In modern society, ecosystems are often managed for the sole purpose of maximizing the benefits that can be sold in a market, such as food or timber. This has led to important ecosystem services being reduced or entire ecosystems being lost. Economic systems depend on social and ecological systems, and nature's full value is not easy to quantify.

The purpose of the valuation of ecosystem services is not to put price tags on nature so that someone can make money from them, it is so we can better understand how dependent we are on nature's complex functions and processes, and how expensive and difficult it would be to replace them. We can make better decisions about how we plan our societies and our lives, embracing wiser economic priorities.

Many people believe that natural resources are free, but this is not the case! With increased understand of ecosystem services such as air purification and pollination, decision-makers and landowners are able to incorporate these ecosystem services in management decisions, ensuring that all benefits are valued.

Additional Resources:

Ecosystem Services at WHSRN

https://whsrn.org/site-support/ecosystem-services/

Food and Agriculture Organization at the United States

https://bit.ly/faoprovisioning

Harte Research Institute

https://www.youtube.com/watch?v=EgzfsKHfAtw

Environmental Protection Agency:

https://www.epa.gov/eco-research/ecosystem-services

Human Welfare and Shorebird Conservation

https://bit.ly/humansandshorebirds

Shorebirds in working landscapes

https://bit.ly/workinglandscapes

Example of restoration in Nova Scotia, Canada

https://www.transcoastaladaptations.com/onslow-north-river

The Western Hemisphere Shorebird Reserve Network (WHSRN) is a science-based, partnership-driven, conservation initiative for protecting the ecological integrity of critical habitats for shorebirds throughout the Americas.

Administrative, technical, and communication services are provided by the WHSRN Executive Office, housed within Manomet's Flyways program.

You can learn more about migratory shorebirds in the Americas by visiting **www.whsrn.org.**

WHSRN
WESTERN HEMISPHERE SHOREBIRD RESERVE NETWORK

manomet

PO Box 1770
Manomet, MA 02345
manomet.org
whsrn.org