



Hubbard Brook Research Foundation

Migratory Bird Math and Science Lessons



Blackpoll Warbler/Donna Dewhurst

Lesson: Birds Fly from Here to Where?

Migration occurs primarily as a means for birds to exploit the richest sources of food and it is one of the most important aspects of their life cycle. The purpose of this lesson is for students to become familiar with Neotropical migratory birds and the methods researchers use to study their migration. Why do they migrate? To where do they migrate, and what are these habitats like? Do all of the migratory birds in New England migrate to the same areas and along the same pathways? How are researchers able to learn about the timing of migration and location of migratory pathways? Students will explore the reason for migration, be introduced to habitat characteristics in the tropics, sketch examples of migratory pathways, and identify the methods that researchers use to study migration.

As a follow-up to this lesson, you may wish to devote some time to discuss some of the fascinating means by which birds manage to fly from one part of the hemisphere to the other. This process happens with astounding accuracy and fidelity. Information on the mechanisms birds use for navigation as well as adaptations for dealing with the physical demands of migration can be found in the supplemental fact sheets written by the Smithsonian Migratory Bird Center:

[Neotropical Migratory Bird Basics](#)

[Have Wings, Will Travel: Avian Adaptations to Migration](#)

We gratefully acknowledge the Smithsonian Migratory Bird Center (SMBC) for their assistance with this lesson. The mapping exercise included here has been modified and adapted from the SMBC [Bridging the Americas](#) program.

Summary	In this three-part lesson, students will consider temperate and tropical habitats, map migratory ranges of birds, and read a short article to become familiar with the research methods used to study the migrations of birds.
Subject areas	Life science, biology, environmental science
Skill level	Basic
Objectives	<ul style="list-style-type: none"> Define what is meant by <i>Neotropical migratory bird</i>. Explain why Neotropical migratory birds migrate. Identify some locations that these birds migrate to, and list some characteristics of these habits. Describe research methods used to learn about the movement and timing of migration patterns of birds.
NH Science Framework Standards	S:SPS3:8:1.2, S:SPS3:11:2.8, S:SPS4:8:6.3, S:LS3:8:1.1, S:LS5:11:1.1, S:LS5:11:3.1
Time	One to two 40-minute class periods, depending on whether reading and questions are done in class or for homework. (Part I: 15 minutes; Part II: 20 minutes; Part III: time will vary, may be given as a homework assignment.)
Materials	<ul style="list-style-type: none"> ▶ Habitat-Tropical or Temperate.pdf ▶ Erasable markers for color-coding birds' migration ranges on whiteboard at front of class; a different color for each bird. ▶ Colored pencils (4 different colors for each student). ▶ Color copies of the range maps for the four birds; copies can be shared within groups. Maps can be found online (All About Birds) or on the following documents: <ul style="list-style-type: none"> • American Redstart All About Birds.pdf • Bicknell's Thrush All About Birds.pdf • Blackpoll Warbler All About Birds.pdf • Black-throated Blue Warbler All About Birds.pdf ▶ Student Handout - Birds fly From Here to Where? ▶ Student Reading - Cracking the Mysteries of Bird Migration ▶ Student Handout - Cracking the Mysteries of Bird Migration
Assessment	Two student handouts with answer keys are included.

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Note to Teachers

Introduce lesson to students:

This lesson should be introduced with the following question: Why do birds migrate? Why expend an enormous amount of energy to make a risky journey twice each year? Allow students to brainstorm ideas, and then help them to realize that the reason birds migrate is to find optimal food. The most nutritious, calorie-rich food is found in the temperate zone during our summer months, and is essential for birds while laying eggs and raising young. In winter months food is scarce in the temperate zone so birds must travel to the tropics to meet their nutritional and caloric needs.

Part I

What's it like in the Neotropics? Students are familiar with how the forests in New England look in the summer, but probably less familiar with the tropical habitats that 'our' migratory birds occupy during our winter. Students will view various habitat images and try to categorize each as either temperate or tropical habitat.

1. Distribute copies of the Procedure and *Birds Fly from Here to Where?* Student Handout to all students.
2. The entire class will view the slideshow "[Habitat: Tropical or Temperate?](#)" Students will talk as a class to determine whether the image belongs to the tropics or temperate region of our hemisphere.
3. The slide show is designed so that after students have made their guess the answer will be displayed with the image.

4. As students view the slides, lead a discussion to encourage students to think about the significance of the differences seen between tropical and temperate habitats. Possible questions to ask include: How does vegetation relate to food sources? Do the two habitats vary with the seasons? If so, how?

Part II

Each fall, all Neotropical migratory birds fly from their breeding habitat to their non-breeding habitat, but do they all chose the same route? Where, exactly do they go?

1. Project a large map of North and South America onto a white board at front of class. A blank copy can be found at <http://www.eduplace.com/ss/maps/pdf/americas.pdf>.
2. Help students to locate and mark the Tropic of Cancer on their maps (on their Student Handouts). Explain the significance of the line: *The Tropic of Cancer is a line of latitude 23.4 degrees north of the equator which marks the northern extent of the tropics.*
3. Discuss with students: the definition of 'Neotropical migratory bird.' *Neotropical migratory birds are species of birds in the Western Hemisphere that breed north of the Tropic of Cancer and then winter in the tropics.*
4. Divide students into four groups: each group will focus on one of four bird species: Bicknell's Thrush, Blackpoll Warbler, Black-throated Blue Warbler, or American Redstart.
5. Distribute copies of the four birds' species descriptions to the groups. The descriptions come from the [All About Birds](#) website, but



Black-throated Blue Warbler/Robert Royse

PDFs of these web pages are included so that it is not necessary for students to have internet access to complete the lesson. If students do have access, teachers may wish to have students work directly from the [bird guide search page](#) from the *All About Birds* site.

- Permission to create PDFs from the *All About Birds* website has been generously granted by the [Cornell University Lab of Ornithology](#), a world leader in the study, appreciation, and conservation of birds. The *All About Birds* website is an excellent, free resource for students, teachers and anyone wishing to know more about birds and bird watching.

6. Students should follow the instructions given on the Procedure handout.

Part III

How are the migratory routes of these different bird species known? How do scientists study bird migration?

1. Ask students this question and allow them to brainstorm answers.
2. Assign the reading [Cracking the Mysteries of Bird Migration](#). After reading, students should answer questions that accompany the article on the Student Handout *Cracking the Mysteries of Bird Migration*.
3. Recommended: After students have read the article, trace the Godwit's flight on a large map to illustrate the flight as described in the article.



Student Procedure

Part I

1. View the slideshow *Habitat: Tropical or Temperate?* As a class, you will try to decide whether each habitat shown is from the tropical or temperate region of the western hemisphere.
2. Complete Questions 1 and 2 on the Student Handout *Birds Fly From Here to Where?*

Part II

3. Use the map on your Student Handout *Birds Fly From Here to Where?* As a class, locate the Tropic of Cancer and draw this line on your map in the appropriate place.
4. Your class will divide into four groups.
5. Your group will be given the name of a species of Neotropical migratory bird to research. Obtain copies of this bird's species description from your teacher. Alternatively, go to the Cornell University Lab of Ornithology's All About Birds (<http://www.allaboutbirds.org/guide/search>) website and search for the species description of that bird.
6. Locate the range map that is included in the species description. Notice the location of its summer (breeding) ground, winter (non-breeding) ground and its migratory pathway. Draw these locations on your map with colored pencils, using a separate color for each one.
7. At the bottom of the map, create a legend to indicate what each color describes.
8. Label at least one of the countries to which your bird migrates.
9. A representative from your group should describe the range of your bird to the entire class and use an erasable marker to mark its breeding ground, non-breeding ground, and migratory pathway on the large map projected at the front of the room. This person should also provide the name of one Central or South American country to which your bird migrates.
10. Listen to your classmates closely, because you will need this all of this information to answer Questions 3–6 on the Student Handout.

Part III

11. Read the article *Cracking the Mysteries of Bird Migration*.
12. After reading, answer the questions on the Student Handout *Cracking the Mysteries of Bird Migration*.

Fact Sheet on American Redstart - page 1 of 3

http://www.allaboutbirds.org/guide/american_redstart/id

If you have internet access we recommend you view the American Redstart fact sheet online.

The screenshot shows the Cornell Lab of Ornithology's 'All About Birds' website. The page is titled 'American Redstart' and features a navigation menu with options like 'Bird Guide', 'Birding Basics', 'Living Bird', and 'Get Involved'. The main content area includes the scientific name *Setophaga ruticilla*, its IUCN conservation status of 'Least Concern', and a description: 'A boldly patterned warbler of second growth woods, the American Redstart frequently flashes its orange and black wings and tail to flush insect prey from foliage.' There are also sections for 'At a Glance' with icons for Habitat (Forest), Food (Insects), Feeding (Tree), Behavior (Foliage Gleaner), and Conservation (Least Concern), as well as 'Cool Facts' and 'Measurements'.

The Cornell Lab of Ornithology
All About Birds WINNER THE 2010 WEBBY AWARDS

Search in: Website Bird Guide

American Redstart
Setophaga ruticilla ORDER: PASSERIFORMES FAMILY: PARULIDAE
IUCN Conservation Status: Least Concern

Similar Species Related Species Go to: American Redstart

A boldly patterned warbler of second growth woods, the American Redstart frequently flashes its orange and black wings and tail to flush insect prey from foliage.

Identification Life History Sound Video Visit Birds of North America for more on this species

At a Glance Range Map

Habitat: Forest Food: Insects Feeding: Tree Behavior: Foliage Gleaner Conservation: LC Least Concern


Cool Facts

- The American Redstart is not particularly closely related to the Painted Redstart and the other redstart warblers of the Neotropics. They all are similarly patterned and forage in similar ways, flashing their tails and wings to startle insect prey. In other parts of the world other unrelated species of birds look and act similarly, such as the fantails of Australia and southeastern Asia.

Measurements


Both Sexes
Length: 4.3-5.1 in / 11-13 cm
Wingspan: 6.3-7.5 in / 16-19 cm
Weight: 0.2-0.3 oz / 6-9 g

Fact Sheet on American Redstart - page 2 of 3



• A young male American Redstart resembles a female in plumage until its second fall. Males in the gray and yellow yearling plumage will try to hold territories and attract mates, singing vigorously. Some succeed in breeding in this plumage, but most do not breed successfully until they are two years old.


• The male American Redstart occasionally is polygynous, having two mates at the same time. Unlike many other polygynous species of birds that have two females nesting in the same territory, the redstart holds two separate territories up to 500 m (1,640 ft) apart. The male starts to attract a second female after the first has completed her clutch and is incubating the eggs.



Other Names

- Petit du Feu, Paruline Ramboyaute (French)
- Candelita, Pavito migratorio (Spanish)

American Redstart
Setophaga ruticilla




LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology
Range data by NatureServe

[View dynamic map of eBird sightings](#)


Habitat



Moist second growth deciduous forest, with abundant shrubs.

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Food




Insects, some small fruits.

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Nesting

Nest Description
Nest a tightly woven open cup fitted into branches or fork in tree or shrub. Made of grasses, bark strips, hair, leaves, twigs, or mosses, glued together with spider silk.

Nest Placement




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Nesting Facts

Clutch Size
1-5 eggs

Egg Description
Creamy white with dark speckles around large end.

Condition at Hatching
Helpless with tufts of down.




Round Robin

A blog from the Cornell Lab of Ornithology

Fact Sheet on American Redstart - page 3 of 3

Behavior




Moves rapidly while foraging. Flashes wings and tail to flush insect prey. Frequent flycatching.

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Conservation

status via IUCN: Declines seen in some areas, but still widespread and abundant.



Least Concern

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Credits

- Sherry, T. W., and R. T. Holmes, 1997. American Redstart (*Setophaga ruticilla*). In The Birds of North America, No. 277 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

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[All About Birds](#) [Bird Guide](#) [American Redstart](#)

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Fact Sheet on Bicknell's Thrush - page 1 of 2

http://www.allaboutbirds.org/guide/Bicknells_Thrush/id

If you have internet access we recommend you view the Bicknell's Thrush fact sheet online.

The screenshot shows the Cornell Lab of Ornithology's 'All About Birds' website page for Bicknell's Thrush. The page features a navigation bar with options like 'Bird Guide', 'Birding Basics', 'Living Bird', and 'Get Involved'. The main content area includes a title 'Bicknell's Thrush', its scientific name *Catharus bicknelli*, and its IUCN Conservation Status: Vulnerable. A photograph of the bird is shown on the left, and a text block on the right states: 'Only recently considered a separate species from the Gray-cheeked Thrush, the Bicknell's Thrush has one of the most restricted breeding and wintering ranges of any North American bird.' Below this, there are tabs for 'Identification', 'Life History', 'Sound', and 'Video'. A 'Range Map' section shows the bird's distribution in North America, with a legend indicating 'Year Round', 'Summer (breeding)', 'Winter (non-breeding)', and 'Migration' ranges. The 'Cool Facts' section highlights its unusual mating system and territorial behavior. The 'Habitat' section notes its preference for montane fir and spruce forests.

The Cornell Lab of Ornithology
All About Birds 15,659 people like this. Be the first of your friends.

Search in: Website Bird Guide

Bicknell's Thrush
Catharus bicknelli | ORDER: PASSERIFORMES | FAMILY: TURCIDAE
IUCN Conservation Status: Vulnerable

Similar Species Related Species Go to: Bicknell's Thrush

Only recently considered a separate species from the Gray-cheeked Thrush, the Bicknell's Thrush has one of the most restricted breeding and wintering ranges of any North American bird.

Identification Life History Sound Video Visit Birds of North America for more on this species

At a Glance

- Habitat: Forest
- Food: Insects
- Nesting: Shrub
- Behavior: Ground Forager
- Conservation: Vulnerable (VU)

Cool Facts

- Bicknell's Thrush has an unusual mating system. Both males and females mate with different partners. Each nest has young from different males, and males may have young in several nests. More than one male feeds at most nests.
- Males do not hold strict territories, and several different males may sing from the same area within one hour.

Habitat

- Breeds in montane fir and spruce forests, usually associated with recently disturbed areas.
- Winters in broadleaf montane forests.

Measurements

Both Sexes

Length
6.3-6.7 in
16-17 cm

Weight
0.9-1.1 oz
26-30 g

Other Names

- Grive de Bicknell (French)
- Zorzal migratorio, Tordo de Bicknell (Spanish)

Range Map

Bicknell's Thrush
Catharus bicknelli

LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration


Map by Cornell Lab of Ornithology
Range data by NatureServe

View dynamic map of eBird sightings

Fact Sheet on Bicknell's Thrush - page 2 of 2

Forest [Back to Top](#)

Food


 Insects and other arthropods, fruit.

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Nesting

Nest Description
Open cup of twigs and moss in small tree.

Nest Placement


 Shrub

Nesting Facts

- Clutch Size**
3-4 eggs.
- Egg Description**
Bluish green with light brown speckling.
- Condition at Hatching**
Naked and helpless.

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Behavior

 Ground Forager

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Conservation

status via IUCN Population data are difficult to gather, but because of the small range and restricted habitat, it is considered a high conservation priority. Listed on the Audubon Watchlist.

 Vulnerable

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Credits

- Rimmer, C. C., K. P. McFarland, W. G. Ellison, and J. E. Goetz. Bicknell's Thrush (*Catharus bicknelli*). In *The Birds of North America*, No. 592 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

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Fact Sheet on Blackpoll Warbler - page 1 of 3

http://www.allaboutbirds.org/guide/Blackpoll_Warbler/id

If you have internet access we recommend you view the Blackpoll Warbler fact sheet online.

The screenshot shows the Cornell Lab of Ornithology's 'All About Birds' website. The page is for the Blackpoll Warbler (*Dendroica striata*). It features a navigation bar with 'Bird Guide', 'Birding Basics', 'Living Bird', and 'Get Involved'. The main content area includes the species name, IUCN status (Least Concern), a description of its migration, and a photo of the bird. A 'NestWatch' advertisement is also present. Below the main content are tabs for 'Identification', 'Life History', 'Sound', and 'Video'. The 'At a Glance' section includes icons for Habitat (Forest), Food (Insects), Feeding (Tree), Behavior (Foliage Gleaner), and Conservation (Least Concern). The 'Cool Facts' section lists two interesting facts about the bird's song and migration. The 'Measurements' section provides data for both sexes, including length, wingspan, and weight.

Blackpoll Warbler
Dendroica striata | ORDER: PASSERIFORMES | FAMILY: PARULIDAE
IUCN Conservation Status: Least Concern

One of the most common birds of the northern boreal forest, the Blackpoll Warbler flies all the way to South America to spend the winter.

At a Glance

- Habitat: Forest
- Food: Insects
- Feeding: Tree
- Behavior: Foliage Gleaner
- Conservation: LC (Least Concern)

Cool Facts

- The song of the male Blackpoll Warbler is one of the highest-pitched of all birds.
- Part of the fall migratory route of the Blackpoll Warbler is over the Atlantic Ocean from the northeastern United States to Puerto Rico, the Lesser Antilles, or northern South America. This route averages 3,000 km (1,864 mi) over water, requiring a potentially nonstop flight of up to 88 hours. To accomplish this flight, the Blackpoll Warbler nearly doubles its body

Measurements

Both Sexes

Length	5.5 in 14 cm
Wingspan	3.3–5.1 in 21–23 cm
Weight	0.4–0.5 oz 12–13 g

Fact Sheet on Blackpoll Warbler - page 2 of 3

mass and takes advantage of a shift in prevailing wind direction to direct it to its destination.

Other Names

- Paruline rayée (French)
- Chipe gorda negra (Spanish)

Habitat



Forest

Breeds in boreal coniferous forest (primarily spruce) and woodland, mixed coniferous-deciduous second growth, tall shrubs, and alder thickets; in migration and winter found in a variety of forest, woodland, scrub and brushy habitats.

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Food



Insects

Insects and spiders, fruit during migration.

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Nesting

Nest Description

Open cup of twigs and lichens, lined with grasses, fine plant fibers, and feathers. In small tree.

Nest Placement



Tree

Nesting Facts

Clutch Size
3-5 eggs

Egg Description
White, buff, or pale green with brown spots all over and purplish blotches around the larger end.

Condition at Hatching
Helpless.

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Behavior



Foliage Gleaner

Prey usually gleaned from foliage or twigs.

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Blackpoll Warbler

Dendroica striata



LEGEND
 ■ Year Round
 ■ Summer (breeding)
 ■ Winter (non-breeding)
 ■ Migration

Map by Cornell Lab of Ornithology
 Range data by NatureServe

[View dynamic map of eBird sightings](#)

Project FeederWatch

Embrace the winter. Count feeder birds for science!



Fact Sheet on Blackpoll Warbler - page 3 of 3

Conservation
status via IUCN: Common and widespread. Some declines have been noted, but more data are needed.

LC
Least Concern

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Credits

- Hunt, P. D., and B. C. Eliason. 1999. Blackpoll Warbler (*Dendroica striata*). In *The Birds of North America*, No. 431 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

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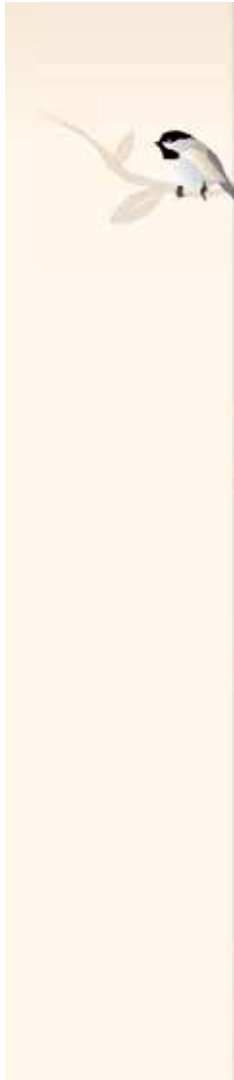
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http://www.allaboutbirds.org/guide/Black-throated_Blue_Warbler/id

If you have internet access we recommend you view the Black-throated Blue Warbler fact sheet online.

The screenshot shows the Cornell Lab of Ornithology's 'All About Birds' website. The page is for the Black-throated Blue Warbler (*Dendroica caerulescens*). It features a navigation bar with 'Bird Guide', 'Birding Basics', 'Living Bird', and 'Get Involved'. The main content area includes a photo of the bird, a description of its habitat and migration, and a 'Project FeederWatch' advertisement. Below the main content are tabs for 'Identification', 'Life History', 'Sound', and 'Video'. A 'Range Map' is also visible. The 'At a Glance' section provides icons for Habitat (Forest), Food (Insects), Feeding (Shrub), Behavior (Foliage Gleaner), and Conservation (Least Concern). A 'Measurements' section lists: Both Sexes, Length 4.3-5.1 in (11-13 cm), Wingspan 6.7-7.9 in (17-20 cm), and Weight 0.3-0.4 oz.

Fact Sheet on Black-throated Blue Warbler - page 2 of 3



Cool Facts

- The sexes of the Black-throated Blue Warbler look so different that they were originally described as two different species.
- On the wintering grounds the sexes use slightly different habitats. The male is most common in forest at lower to mid-elevations, while the female uses shrubbier habitat at higher elevations.

8-12 g

Other Names

- Paruline bleue à gorge noire (French)
- Reinta azul negra (Spanish)

Habitat



Forest

- Breeds in mature deciduous and mixed coniferous-deciduous woodlands with a thick understory, often in hilly or mountainous terrain.
- Winters in dense tropical forests.
- On migration, found in variety of habitats, including forest, forest edges, parks, and gardens.

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Food

Insects and some small fruits.



Insects

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Nesting

Nest Description

Nest an open cup of strips of bark, held together with spider web and saliva. Places in fork of low shrub.

Nest Placement



Shrub

Nesting Facts

Clutch Size
2-5 eggs

Egg Description
Creamy white with dark speckles concentrated at the large end.

Condition at Hatching
Helpless with tufts of down.

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Behavior

Black-throated Blue Warbler *Dendroica cyanescens*



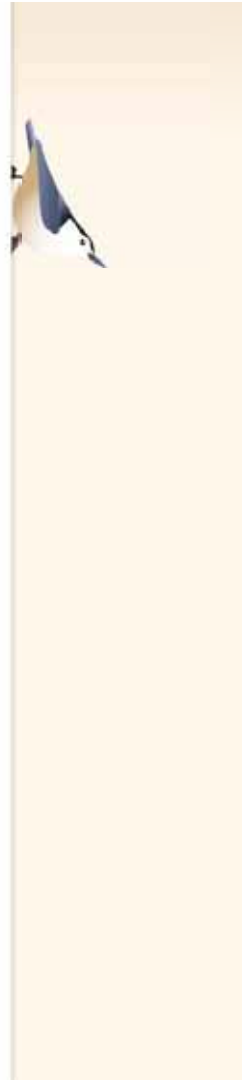
LEGEND

- Year Round
- Summer (breeding)
- Winter (non-breeding)
- Migration

Map by Cornell Lab of Ornithology
Range data by NatureServe

[View dynamic map of eBird sightings](#)

NestWatch
Combine **fun** backyard discoveries with **real science!**





Foliage Gleaner

Forages mostly in lower to mid-levels of forest, taking insects mostly from the underside of leaves.

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Conservation

status via IUCN



Least Concern

Probably decreased markedly with destruction of eastern forests in 17th and 18th centuries. With the beginning of abandonment of farms in New England in the late 19th and 20th centuries, populations rebounded. Currently populations seem stable.

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Credits

- Holmes, R. T. 1994. Black-throated Blue Warbler (*Dendroica caerulescens*). In *The Birds of North America*, No. 87 (A. Poole, and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

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Student Handout

Birds Fly From Here to Where?

Name _____

Part I

1. Describe or draw at least three differences, as observed from the habitat slideshow, between the breeding and non-breeding habitats of migratory birds.

2. Why do birds migrate?

Part II

3. What is one *similarity* between the range of your bird and that of one of the other birds described by your classmates? Your answer should include the names of both birds.

4. What is one *difference* between the range of your bird and that of one of the other birds described by your classmates? Your answer should include the names of both birds.

5. What is a *Neotropical* migratory bird? (Define the meaning of “Neotropical migratory bird.”)

6. How might deforestation in the Dominican Republic affect an American Redstart that breeds in New Hampshire?

Americas



Outline Maps

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Student Reading

Cracking the Mysteries of Bird Migration

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On March 17, 2007, the Bar-tailed Godwit known to science as E7 spread her wings and took flight, leaving the northern shores of New Zealand behind her. For the next eight days and nights she flew non-stop, 10,000 kilometers (about 6,200 miles) northwards to the coast of China's Yellow Sea. Five weeks later, after a brief break for refueling, E7 continued on her way. She headed east, and then took a sharp left turn in the featureless mid-Pacific, before arriving six days later at her breeding ground in Alaska. By late August, she was off again, this time on a non-stop journey of nearly 12,000 kilometers (about 7500 miles)—the longest continuous bird flight on record—that ended just 13 kilometers (about 8 miles) from where she had started.

1 Until recently, the idea that we could chart a small bird's migration in such detail was unthinkable. Now, however, biologists are developing tracking technologies that are leading to a revolution in their understanding of migration. Suddenly they have the power to answer questions they could barely guess at before. They are beginning to learn not just where the birds are going, but also the timetables of their migratory flights and their airspeeds and energy costs. These new techniques are also helping to explain the biology that underpins the uncanny navigational abilities of migratory birds.

The new-found opportunities have biologists brimming with anticipation. "Every new instrument you put out is a major breakthrough," says Martin Wikelski from the Max Planck Institute for Ornithology in Radolfzell, Germany. "I think we're entering a new, data-rich realm of animal movement. It's a very exciting time."

2 The old tracking techniques were crude and not very effective. For a century or so, biologists put **numbered metal bands on the legs** of migrating birds, then waited to see where they turned up. This helped to sketch the outlines of migration routes, but revealed next to nothing about where individual birds stop to rest and refuel along the way.

3 Then, in the 1960s, William Cochran of the Illinois Natural History Survey in Champaign, began mounting **home-made radio transmitters** on birds. Using hand-held antennas he would track their migratory flights, chasing them by car or—when budgets allowed—by light aircraft. The technique is still used today because it is quite cheap and the tiny transmitters are light enough to mount on even relatively small birds, but the work involved in following them is hard and the hours punishing, especially when tracking songbirds, which migrate at night.

"You sit out there starting at sunset," says Wikelski. "You've filled up the gas tank. You've got your food. You've got your sleeping bag. You've cancelled all your appointments for the next day... And you wait for the bird to take off. Then you race with the bird, try to catch up with it, and after 500 miles, you have to recapture it [to remove the transmitter] and drive back again. You're

up for 35 hours—and then you have to capture another bird, because you only have a short season.”

④ The pay-off for all those sleepless nights has been a more intimate snapshot of migration than leg bands ever allowed. This, for example, is how Cochran and Wikelski discovered that Swainson’s thrushes often fly all night, but will cut their flight short if they hit a cold front. Radio transmitters also revealed that these thrushes are sensitive to wind speed, and stay put on nights when it exceeds about 10 kilometers (about 6 miles) per hour. By adding a **heart-rate sensor**, Wikelski and his colleague Melissa Bowlin found that the birds’ hearts beat faster on windy nights, showing they have to work harder to go the same distance—even with a tailwind. This may be because higher winds cause turbulence that buffets the small birds. Indeed, this may be the reason most small birds choose to migrate at night, when turbulence tends to be lower, says Bowlin, who is now at the University of Montana in Missoula.

Not surprisingly, the rigors of chasing birds by car—and the many failed nights when a bird chooses a course not well served by roads—have meant that very few researchers have taken on the challenge. And, of course, such an approach will not work for birds that migrate over water, such as Godwits. No wonder the new tracking devices are causing such excitement.

In-flight transmission

⑤ The Godwit study, for example, highlights the benefits of **satellite tracking**. E7 was one of 24 Godwits to have a transmitter surgically implanted in its abdominal cavity. This sends out regular beeps that are picked up by a satellite and relayed to researchers on the ground. The global coverage has made it possible to log the Godwits’ entire migration itinerary, and

has also revealed that their travel plans are extremely precise, with one primary site at each of their three major stops. These ‘stopover sites’ are extremely important because they provide migrating birds with a place to rest and refuel. “No other stopover sites are showing up, and that has got us concerned,” says Robert Gill from the US Geological Survey’s Alaska Science Center in Anchorage, who heads the tracking program. Although these sites are all protected, Godwit numbers have already dwindled to just a few thousand birds, and any damage to any of the sites could be catastrophic to the species, he says.

For all their ease of use, though, satellite tags are not perfect. The transmitters draw a lot of power and their batteries are heavy: the smallest tags available today weigh about 10 grams, which rules out satellite tracking for any birds smaller than about half a kilogram—about the size of a pigeon. What’s more, the batteries only last a few months—even though they are set to transmit just a few hours a day to save power—so it’s rare that researchers can track a single bird through its full migratory cycle, let alone for several years running.

⑥ Other researchers are experimenting with ways of improving tracking technologies. One idea is to fit birds with **miniature cell phones** so that they can be tracked using the existing network of communication towers. Another approach that already shows promise is to fit birds with tiny, light and long-lasting devices called **geolocators** that do nothing more than sense and record the time of sunrise and sunset each day. Once geolocators have been recovered from their subjects and their stored data downloaded, researchers can calculate a position fix for each day, determining latitude from day length and longitude from the sunrise time.



American Redstart/Robert Royse

Unlike satellite tags, geolocators can be used on very small birds and so have offered the first opportunity to track the complete migration of Sooty Shearwaters, small seabirds that spend most of the year roaming the Pacific away from their breeding grounds in New Zealand. Each spring huge flocks of Shearwaters turn up in the northern hemisphere, proving the birds must cover vast distances—but little else. “We knew this migration existed, but we didn’t know if the same birds made that migration in a single season, which directions they chose to go, or the routes they followed,” says Scott Shaffer at the University of California in Santa Cruz. “Just within the last couple of years, we’ve really been able to answer these questions.”

7 It turns out that the Shearwaters make a huge figure-eight across the Pacific, flying eastward from New Zealand and then north for a stopover off the coast of either California, Alaska or Japan, before finally heading south again. The whole journey lasts more than six months and covers an average of 64,000 kilometers (about 40,000 miles)—the longest known migration of any animal.

The technologies developed in the past decade have led to gigantic leaps in our understanding of bird migration. Heart-rate sensors, mini cell phones, satellite tracking and geolocators have all contributed important details about the journeys that migratory birds take. Because these animals range over very large areas, they are uniquely sensitive to changes all around the globe. Therefore researchers believe that it is valuable to study migration because noticing changes to migratory patterns could provide an early-warning system for climate change and other major ecological shake-ups. As we continue to study migratory birds, patterns of change may be revealed that would not be obvious from a study conducted in just one location.

4. Explain one of the things that this technology enabled him to learn about the Swainson's Thrush.

5. What technology has been used to map the Godwit's migration, and what did scientists learn from this that will help people to protect the Godwits?

6. How do geolocator tags work, and what is their advantage over satellite tags?

7. Cite one amazing fact that geolocators have enabled scientists to learn about the migration of Sooty Shearwaters.

8. Songbirds are of interest to many people and there is widespread support for their conservation. How can the information learned from bird migration research be used to aid in conservation efforts?

Answer Key - Part I

Birds Fly From Here to Where?

Part I

1. Describe or draw at least three differences, as observed from the habitat slideshow, between the breeding and non-breeding habitats of migratory birds.

Answers will vary.

2. Why do birds migrate?

Birds migrate to find the most nutritious and caloric food.

Part II

3. What is one *similarity* between the range of your bird and that of one of the other birds described by your classmates? Your answer should include the names of both birds.

Answers will vary.

4. What is one *difference* between the range of your bird and that of one of the other birds described by your classmates? Your answer should include the names of both birds.

Answers will vary.

5. What is a *Neotropical* migratory bird? (Define the meaning of “Neotropical migratory bird.”)

Neotropical migratory birds are species of birds in the Western Hemisphere that breed north of the Tropic of Cancer and then winter in the tropics.

6. How might deforestation in the Dominican Republic affect an American Redstart that breeds in New Hampshire?

By this point in the lesson, students should have observed the range maps to learn that the Dominican Republic is one of the places in which the American Redstart lives during the non-breeding season. The alteration or destruction of its non-breeding habitat has many possible ramifications: less food, less cover from predators, less suitable habitat in general. The health of a bird in the non-breeding season has a huge effect on the condition of the bird as it migrates back to its breeding grounds. Even if it survives migration, it may not arrive with enough energy to successfully reproduce (defend territories, attract mates, build nests, lay eggs, raise young, etc.) Among avian ecologists, this concept is known as “connectivity:” conditions and habitat quality in one part of a bird’s yearly cycle greatly affect the health of the bird during other parts of the cycle.

Answer Key - Part II

Cracking the Mysteries of Bird Migration

1. In addition to learning where birds go, what else are scientists learning from new tracking technologies?

Airspeeds, energy costs and timetables of flight

2. Why is bird banding not an ideal technique for studying bird migration?

Answers will vary, but students should realize that the chances of recapturing the same individual once it has migrated to another hemisphere are extremely slim.

3. Describe the technology and methods that William Cochran used to study the movement of birds.

Radio transmitters

4. Explain one of the things that this technology enabled him to learn about the Swainson's Thrush.

Answers will vary: Swainson's Thrushes fly all night, will cut flight short if they encounter a cold front, won't fly if wind speed is greater than 10 km per hour, etc.

5. What technology has been used to map the Godwit's migration, and what did scientists learn from this that will help people to protect the Godwits?

Satellite tracking with surgically implanted transmitters. The Godwits have only one place to rest and refuel at each of their three stopover sites. If something happens to one of these places (e.g., if habitat is destroyed), the godwits most likely won't be able to complete their migration and their population will dwindle.

6. How do geolocator tags work, and what is their advantage over satellite tags?

Geolocator tags record light intensity. Because the sun rises at different times at different longitudes, and because the length of day varies with latitude, these light records can be used to figure out the approximate location of a bird fitted with one of these tags. They weigh much less than satellite tags and thus can be used on smaller, lighter birds.

7. Cite one amazing fact that geolocators have enabled scientists to learn about the migration of Sooty Shearwaters.

Answers will vary: the Sooty Shearwater's journey lasts over 6 months and covers 64,000 km (about 40,000 miles); they pass quickly through the tropics and spend most of their time in the temperate latitudes where food is abundant.

8. Songbirds are of interest to many people and there is widespread support for their conservation. How can the information learned from bird migration research be used to aid in conservation efforts?

Answers will vary, but should reference the technologies described in the article: i.e., if geolocators are used to determine the migration route and stopover sites of the Bicknell's Thrush, people can devote efforts to be sure that these sites remain protected and suitable for this bird.