

Activity: Do Christmas Bird Count data reflect trends associated with global change?

In her work, Dr. Terry Root found for the Eastern Phoebe “a striking association” between the average minimum temperature in January and the limit of bird’s northern range (Root and Schneider, 1993, p. 263). In this activity the class will investigate the temperature/range limit relationship.

Materials

- Paper and pencils
- Figures and graphs included in the activity

Earth Systems Understandings

This activity applies to ESUs #1 (aesthetics and value), #2 (stewardship), and #7 (careers and hobbies). Refer to the introduction of this book for a detailed explanation.

Scenario Reference

#2, Will Biological Diversity in the Great Lakes Region Suffer?

Answers

1. Local and yearly climatic variations allow the bird species' range to deviate around the isotherm. Therefore, a distributional range may deviate each year. The bird's range is a composite of a number of these yearly deviations.
2. Fragmentation of habitat is not highly variable from year to year, yet fluctuations of bird species over winter are extremely variable. Does this definitely indicate temperature as the main factor influencing bird distribution? **Maybe.**
3. As one proceeds from south to north, (1) the ambient air temperature gets colder, and (2) nights get longer. These factors have a great influence on species' and individuals' capacity to overwinter.

Figure 1. The distribution and abundance of the winter range of the Eastern Phoebe. The northern boundary lies very close to the -4°C isotherm of January minimum temperature (heavy solid line).

(Source: Root and Schneider, 1993.)

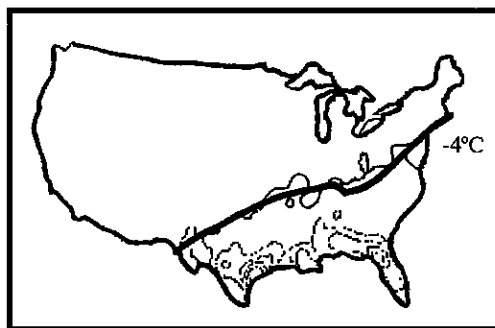
OBJECTIVES

When students complete this activity, they should be able to:

- understand how wildlife adapt to variations in the environment.
- relate environmental factors, such as temperature, to bird ranges.
- predict changes in the range of bird populations as a result of global climate change.

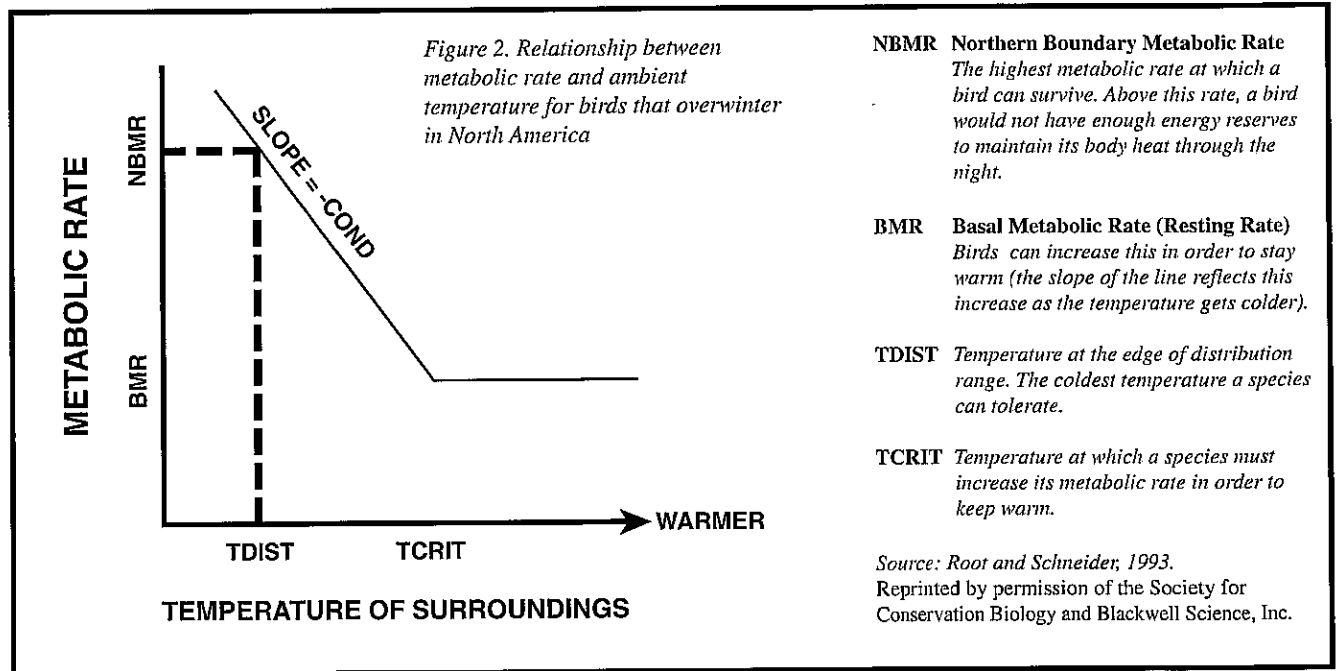
PROCEDURE

1. Figure 1 illustrates the influence of temperature on a species' range. Note that the range tends to fluctuate along the isotherm. Why does this fluctuation occur?
2. Is temperature the only factor driving the location of the northern boundary of the phoebe's range? Could variations in vegetation distribution be an influence?
3. Dr. Root decided to examine other temperature-dependent species belonging to the order of *passerines*, including juncos, sparrows, robins, cardinals, and many others. Passerines are generally small- or medium-sized perching songbirds. For the 51 species she selected, their northern range limits were associated with temperature. In fact, two dominant environmental factors were found to influence the winter lifestyle of birds the farther north they traveled. With your team of students, hypothesize what these factors were.



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From this information, Dr. Root constructed the following graph (Figure 2) to illustrate the relationship between the various parameters.



4. The Basal Metabolic Rate of the bird is the rate at which it is not performing any function except staying alive (e.g., it is asleep, not cold, not hot, not digesting food). The Northern Boundary Metabolic Rate is the bird's metabolic rate at the northern edge of its range. Figure 2 indicates that the bird's metabolic rate increases as the temperature drops below TCRIT. How would the metabolic rate of an individual in Florida compare to an individual in Michigan in the winter-time?
4. As a species moves farther away from the average temperature of its range toward the northern edge, its metabolic rate increases (slope of line). This is a result of shivering, which generates heat. The survival mechanism of shivering requires energy that the bird gets by burning body fat. The metabolic rate of an individual bird in Michigan would be higher than that of an individual in Florida where it is warmer.
5. By examining this information from several species, Dr. Root found that the NBMR tended to be an average of 2.5 times the BMR. This has become known as the 2.5 Rule.* But what controls this rule? Various environmental factors could have an influence. What happens to the winter environmental conditions as a bird travels from South to North?
5. Two main things happen as a bird travels north during the winter: the ambient temperature gets colder, and the nights get longer.
6. On a normal day, passerines accumulate body fat to about 11 percent of their total mass during each day. The following morning, little fat remains. Why?
6. To survive the low night temperatures, the bird must shiver. This action requires energy that is obtained from the bird's fat reserves.

* The 2.5 Rule was proposed by Jared Diamond in 1988 in an article in *Nature*.

7. Some factors could be ambient temperature, foraging time, type and availability of food source, and level of activity.
8. Alabama = 1 hour, Tennessee = 10, Indiana = 13 hours, Michigan = 3 hours. Students can practice their geography skills by locating each state on the map and noting the degrees change in latitude as one travels north to south. The class should consult library resources for additional information on winter conditions for each state.
9. While the cardinals in Alabama have the lowest number of hours of metabolism remaining, winter conditions in Alabama allow the birds to locate food easily. They still need to feed soon after waking, although weather conditions are unlikely to hamper their search.

In Tennessee and Indiana, winter storms can have a large impact on bird populations. Ice storms and freezing rain can prevent birds from finding food. However, with 14 hours of metabolism in reserve, cardinals should be able to withstand the worst of storms. In fact, present results suggest that some could go without food for up to 2 days before dying. However, additional research is required before this can be stated definitively.

Cardinals in Michigan have a difficult existence. Winters are harsh and long, with severe snow storms that may last many days. The Michigan birds only have 3 hours of metabolism remaining by morning. Therefore, immediately at dawn, Michigan cardinals must begin foraging if they are to survive.

Dr. Root concluded that the amount of fat lost over one night must fuel the mechanism for survival.

7. Accumulation of fat depends on various factors. What do you think are the most important of these? (Consider how people accumulate fat!)

To examine the issue of fat and its influence on bird distribution in winter, Dr. Root decided to sample cardinals on a north-south axis and determine if indeed birds in the northern latitudes did have less body fat in the morning. Figure 3 shows the results of this sampling on a south/north transect from Alabama, through Tennessee, Indiana, and Michigan. Estimates are for the amount of fat still present just after dawn.

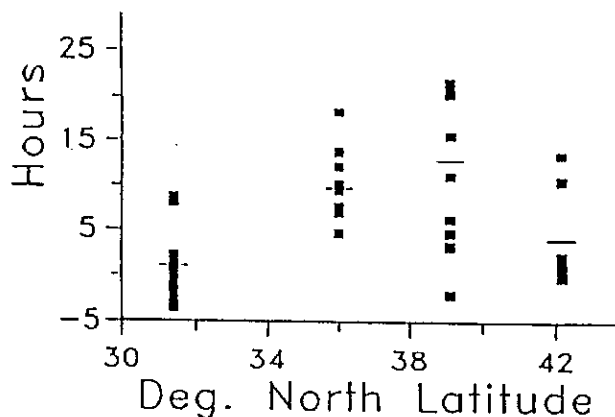


Figure 3. Hours of metabolism that can be fueled by body fat of Northern Cardinals sampled at different latitudes. Birds were sampled in the morning at each location. The average length of time the birds could survive indicated with a line (Source: Root, 1991). Reproduced from the book *Acta XIX Congressus Internationalis Ornithologica*, under the supervision of Henri Ouellet, 1991.

8. How many hours (mean) of metabolism after waking do the birds possess in body fat for each of the states? Have students locate the various states on a map. What type of weather conditions dominate these states in winter?
9. Consider climatic conditions and the hours of metabolism remaining for cardinals in the morning at each latitude.

Imagine what the cardinal's day is like. How can the climate conditions in winter affect the cardinals living in each state?

10. What impact could birdfeeders have on cardinals in each of these states?

It would seem from this information that foraging time (length of day) and ambient air temperature will both play a significant role in the survival and distributional patterns of birds.

11. From what we know of the possible changes that will accompany global warming, which of the two factors is likely to have the greater effect on the bird populations of North America? Examine the CBC of an area of the continent where climate may be similar to the type of climate predicted as a result of global warming for the area where your school is located. What kinds of birds can you expect to move into your area? What factors would determine whether they would survive there?
12. Consider the possible impacts of the last two winters on individual cardinals and other species and their populations.

REVIEW QUESTIONS

1. What factors influence the overwintering distribution of birds? How was the 2.5 Rule determined? How do birds stay warm and remain alive during the night when the temperature drops? What consequence does this force on the birds?
2. Would the birds in the 30°N latitude area have fewer or more hours of metabolism remaining in the morning in comparison to birds at 40°N?
3. Develop a concept map illustrating the Earth Systems interactions in this activity. Include all the Earth Subsystems and use connection lines and verbs to explain the interactions.
4. Scientists involved with global change use proxy data, such as the CBC, to try to predict future changes in population numbers and dynamics resulting from possible climatic alterations. From the evidence in this activity, do you think it is possible to use CBC data to predict the influence of possible climatic changes on bird populations and populations of other organisms? Write a paper describing your position on the use of such datasets to predict change.

10. These could have the greatest impact on survival of birds in Michigan. If a cardinal can get to a feeder in time, it should be able to replenish its fat reserves fairly quickly.

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CBC data can be obtained by contacting:
The National Audubon Society
700 Broadway
New York, NY 10003
Phone: 212/979-3000
Fax: 212/353-0508

The following can be purchased.
The National Audubon Society Field
Notes, CBC Issue. This contains results
of all previous Christmas Bird Counts.

For disks of CBC data or analysis of
population changes, contact:
National Biological Service
301/497-5819
HomePage:
<http://www.im.nbs.gov/im.html>

EXTENSIONS

Carbon Dioxide Information
Analysis Center
*Trends '93. A compendium of data
on global change.*

Regional temperature data can be
downloaded in the following manner:

```
ftp cdiac.esd.ornl.gov
Name: anonymous
Password: YOU@your e-mail address
Guest login ok, access restrictions apply.
ftp>cd/pub/trends93
ftp>dir
ftp>cd temp
ftp>get glakes721
ftp>quit
ftp>Goodbye
```

Precipitation Data from the
World Wide Web:
<http://www.ncdc.noaa.gov>
Click the Online Data Access Button
Choose Anonymous FTP Archive – U.S.
Monthly Precipitation for Cooperative
and NWS sites
Choose a reporting site within a state
With the cursor, highlight the data
Copy it to a word processing file.
Transfer data to a spreadsheet format,
parse the data and place the decimal
where appropriate.
The data are now ready to be graphed for
a particular month or season.

To request searches by state for tempera-
ture and precipitation data, contact the
National Climatic Data Center.
By e-mail: ORDERS@ncdc.noaa.gov

1. What happens to the birds that migrate South for the winter? Investigate a species that uses this mechanism to overcome falling temperature. What impact would habitat fragmentation have on such a species? (Read the *World Book Science Year 1994* article, "The Case of the Missing Songbirds," and the *Audubon* article, "Mystery of the Missing Migrants," for good discussions of this topic.)
2. We intuitively understand that weather and climate vary with latitude, but there are datasets that document such differences and perhaps hold a few surprises. Use the NCDC climate data (via Internet, e-mail, or CD-ROM) for winter in Michigan, Alabama, Tennessee, and Indiana. Graph relevant temperature and precipitation data to help understand what conditions birds must survive. Regional temperature data can also be downloaded from Trends '93, CDIAC's ftp, for example the Great Lakes, South Coastal Plain, and Eastern Prairies regions, pp. 717, 721, and 723. The National Climatic Data Center's homepage on the World Wide Web provides precipitation data by reporting site.
3. From your library or the local chapter of the Audubon Society, have students obtain the fourth issue of each year's *American Birds* for the last twenty years for the count location nearest your school. The students can create spreadsheets either manually or on computer for the location. Then they can graph trends either for an individual species or a group of species over that time period.

REFERENCES

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