Hubbard Brook Research Foundation

Migratory Bird Math and Science Lessons

Ovenbird/Robert Royse

Lesson: Migration Math

One of the greatest feats in avian biology is the process by which many migratory songbirds, weighing barely a third of an ounce, can manage to find and consume enough calories to sustain a round-trip journey of over one thousand miles, from their breeding grounds to wintering grounds and back again. In addition to reinforcing basic math skills, this lesson is designed to give students a practical exercise in calculating the number of calories needed to sustain successful migration, and the amount of food needed to fuel the journey. The provided information on migratory flight distances comes from the Smithsonian Migratory Research Center's fact sheet *Neotropical Migratory Bird Basics.*

Summary	Students perform multiplication and division in the context of migration distances and caloric requirements of migratory birds.
Subject areas	Math
Skill level	Basic
Objectives	• Demonstrate conceptual understanding of mathematical operations. • Accurately solve problems involving single or multiple operations. • Gain understanding of and appreciation for the caloric intake and expenditure of migratory songbirds.
NH Mathematics Framework Standards	M(N&O)–6–3, M(N&O)–6–4, M(PRP)–8–1, M(CCR)–8–3
Time	Research time plus one 40-minute class period
Materials	Pencil Calculator, if teacher desires Introductory Slides.pdf Student Handout: *Migration Math (Version 1-Basic)* Student Handout: *Migration Math (Version 2-Advanced)* Optional: Migratory Birds in New Hampshire-Nicaragua
Assessment	Two versions of the student handout are provided. Version 1 tells students how to perform calculations, and Version 2 allows students to figure out how to do calculations on their own. No answer key is provided, since calculations are rather simple and will vary according to species of bird used for calculations.

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Note to Teachers

Background information

- This lesson focuses on Neotropical migratory birds that spend their summers breeding in New Hampshire. Each student will select or be assigned a bird from the Migratory Bird Flight Distances table at the end of this section. Students will use facts about these birds to perform calculations that will enable them to discover some amazing things about migration distances, flight lengths, caloric expenditure, and dietary requirements.

Optional: - If you would like to make this lesson interdisciplinary, you could have students choose a Neotropical migrant (from the list *Migratory Birds in New Hampshire–Nicaragua*) and research its migration pathway. An excellent resource for student research is the Cornell Lab of Ornithology's All About Birds website, found at http://www.allaboutbirds.org. Once at the site, click on Search Our Bird Guide or go directly to http://www.allaboutbirds.org/guide/search.

- Two versions of the student handout are included. While both supply conversion facts (i.e., 1 mile = 1.61 km), Version 1 tells students how to perform calculations, and Version 2 lets students figure out how to do calculations on their own.

- Please note this lesson uses assumed, not factual, information. For instance, Question 4 asks students to calculate the number of days it takes for their bird to migrate from its breeding ground to its wintering ground with the assumption that their bird travels 300 miles per day. While this number is a reasonable average, it doesn't give a realistic depiction of how long the migration actually takes. That's because the distance traveled per day depends not only on the species, but on other factors such as the season (the pace of migration is significantly faster in the spring than in the fall) and weather conditions. Plus, the pace of migration isn't the same each day over the course of a migration. It's only been within the past few years that researchers have been able to get a clear picture of how long it actually does take songbirds to migrate—the use of geolocators has made this possible. (For more information, read the article *Cracking the Mysteries of Bird Migration,* included in the lesson *Birds Fly from Here to Where?*)

After students have completed the Student Handout, you may wish to share the above with students along with the following two examples:

- For a bobolink that travels the average one-way distance of 5,900 miles: using the assumption of 300 miles/day, the bobolink takes 19.6 days to migrate one way. In reality, a recent study of bobolinks tracked using geolocators found that it took the birds in the study between 56 and 91 days to make their southward migration from Vermont to Argentina or Paraguay!

- For a wood thrush that travels the average one-way distance of 2,175 miles: using the assumption of 300 miles/day, it takes 7.25 days to cover the distance. In reality, the southward migration for a wood thrush tracked with a geolocator took 8 weeks to travel from Pennsylvania to Nicaragua, but only 14 days to make the return trip to Pennsylvania.

Introduce lesson to students:

Neotropical migratory birds are birds that breed north of the Tropic of Cancer (a line of latitude 23.4 degrees north of the equator) and winter in the tropics. Another way to phrase

Chestnut-sided Warbler/Robert Royse

this is: these birds spend our summer breeding in the US and Canada and then, during our winter, migrate to Mexico, Central America, South America or the Caribbean islands. There are over 200 species of birds that do this, and the distances that they travel vary.

Some, like the Black-capped Vireo, migrate relatively short distances. This bird breeds in Oklahoma and Texas, and migrates to Mexico—a *one-way distance* of 400 to 1,250 miles. Others, such as the Red Knot, breed in northern Canada and might migrate all the way to the tip of South America—a one-way distance that ranges between 1,500 and 10,000 miles! [1] (The *Introductory Slides*, included in Support Materials, contain images of these birds and may be displayed overhead.)

[1] from the Smithsonian Migratory Bird Center Fact Sheet "*Neotropical Migratory Bird Basics." (http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Fact_Sheets/default.cfm?fxsht=9)*

Migratory Bird Flight Distances

(This table is also included in *Introductory* Slides in Support Materials and may be projected overhead.)

Species	One-way migration distance (miles)	Breeding Range	Wintering Range
Northern Parula	300–3,000	southeastern Canada, eastern U.S.	Florida, West Indies, Mexico to Nicaragua
Wood Thrush	600–3,750	southeastern Canada, eastern U.S.	Mexico to Panama
Scarlet Tanager	600–4,350	southeastern Canada, eastern U.S.	northwestern South America
Blackpoll Warbler	2,500–5,000	Alaska, Canada, New England	northern South America
Purple Martin	600–6,000	southern Canada, U.S., Mexico	Brazil, Bolivia to northern Argentina
Cliff Swallow	1,250–6,800	Alaska, Canada, U.S., northern Mexico	southern Brazil, Bolivia to central Argentina
Common Nighthawk	2,500–6,800	most of Canada and U.S.	Colombia to central Argentina
Bobolink	5,000–6,800	southern Canada, northern U.S.	southern Brazil to northern Argentina

Table compiled with information found from the Smithsonian Migratory Bird Center factsheet "*Neotropical Migratory Bird Basics." (http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Fact_Sheets/default.cfm?fxsht=9*

Student Handout: Migration Math (Ver. 1 - Basic)

Name _____

Select the name of a migratory bird from the list that your teacher will show you.
Your teacher may ask you to show your calculations on a separate piece of paper and attach it to this one before turning it in.

1. What is the name of the species of Neotropical migratory bird you have chosen?

2. Note the range in distance that birds of your species travel during migration. Calculate the *average, round-trip* distance that this species travels from its summer breeding grounds to its wintering grounds and back again.

3. How many days does it take for your bird to migrate from its summer breeding ground to its wintering ground? Use the average, one-way distance as calculated in Question 2.
For this calculation, assume that your bird flies 300 miles/day (30 mph x 10 hours/day).
To calculate this: total miles ÷ 300 miles/day = number of days of migration
_____ miles ÷ 300 miles/day = _____ days

4. For how many total hours does your bird fly during its journey?
For this calculation, assume that your bird flies 10 hours/day.
To calculate this: number of days of migration x 10 hours/day = total hours flying
_____ days x 10 hours/day = _____ total hours

5. How many calories does your bird use during migration?
For this calculation, assume that your bird uses 4122 calories per hour when flying.
To calculate this: total hours flying x 4122 calories/hour = total calories used on migration

_____ hours x 4122 calories/hour = _____ calories

Did you know that the 110 Calories in that chocolate milk you just drank is actually 110,000 calories? When we talk about the number of Calories in the food we eat, we are actually talking about *kilocalories. One kilocalorie (or one Calorie)* actually equals *one thousand calories.* We write Calories with a capital "C" to abbreviate kilocalories when describing the amount of energy in the food we eat or work we do. This is done to make the numbers smaller since the amount of calories humans process is relatively large.

If we wanted to rewrite question 5 using Calories, we would say that *the average small bird uses 4.122 Calories per hour when flying.*

6. How much food does your bird need to eat during migration?
Let's assume that *1 caterpillar = 8.7 cal*
1 spider = 9.6 cal
I cup of berries = 75 cal
To calculate this:
Choose one type of food your bird typically eats from the list above.
total calories ÷ calories in your bird's food = total amount of that food your bird must eat on migration
_____ calories ÷ _____cal in bird's food
= _____ total amount of food your bird needs to eat

7. **Bonus:** It is more likely that birds obtain their daily caloric needs from a combination of the foods listed in question 6. Calculate the amount of food required if a bird obtains 40% of its calories from caterpillars, 25% of its calories from spiders, and 35% of its calories from berries. To calculate this:

A. Multiply the total calories by the percentage of each food type to get the number of calories from that food type.
Example:
Number of calories from caterpillars=
(Total calories) x 0.40 (percentage of calories from caterpillars)

B. Divide the number of calories from each food type by the number of calories each food type contains.
Example:
Number of caterpillars needed =
(number of calories from caterpillars) ÷ 8.7 calories (because 1 caterpillar = 8.7 calories).

C. Do this for spiders and berries as well.

8. Think about the total number of days and hours that it takes your bird to migrate, as well as the amount of food and calories that it must consume to fuel its journey. What is one question that you would like to ask a scientist, in order to understand how these birds accomplish such an incredible task?

Student Handout: Migration Math (Ver. 2 - Advanced)

Name _____

Select the name of a migratory bird from the list that your teacher will show you. Your teacher may ask you to show your calculations on a separate piece of paper and attach it to this one before turning it in.

1. What is the name of 'your' species of Neotropical migratory bird?

2. Note the range in distance that birds of your species travel during migration. Calculate the *average, round-trip* distance that this species travels from its summer breeding grounds to its wintering grounds and back again.

3. How many days does it take for your bird to migrate from its summer breeding ground to its wintering ground? Use the average, one-way distance as calculated in Question 2.
For this calculation, assume that your bird flies 300 miles/day (30 mph x 10 hours/day).

4. For how many total hours does your bird fly during its journey?
For this calculation, assume that your bird flies 10 hours/day.

5. How many calories does your bird use during migration?
For this calculation, assume that your bird uses 4122 calories per hour when flying.

Did you know that the 110 Calories in that chocolate milk you just drank is actually 110,000 calories? When we talk about the number of Calories in the food we eat, we are actually talking about *kilocalories. One kilocalorie (or one Calorie)* actually equals *one thousand calories.* We write Calories with a capital "C" to abbreviate kilocalories when describing the amount of energy in the food we eat or work we do. This is done to make the numbers smaller since the amount of calories humans process is relatively large.

If we wanted to rewrite question 5 using Calories, we would say that the *average small bird uses 4.122 Calories per hour when flying.*

6. How much food does your bird need to eat during migration?
Let's assume that *1 caterpillar = 8.7 cal*
1 spider = 9.6 cal
I cup of berries = 75 cal

7. **Bonus:** It is more likely that birds obtain their daily caloric needs from a combination of the foods listed in question 6. Calculate the amount of food required if a bird obtains 40% of its calories from caterpillars, 25% of its calories from spiders, and 35% of its calories from berries.

8. Think about the total number of days and hours that it takes your bird to migrate, as well as the amount of food and calories that it must consume to fuel its journey. What is one question that you would like to ask a scientist, in order to understand how these birds accomplish such an incredible task?

Examples of Neotropical migratory birds that breed in New Hampshire and winter in Nicaragua:

English	Spanish	Scientific name
Blue-winged Teal	Cerceta aliazul	*Anas discors*
Spotted Sandpiper	Andarrios maculado	*Actitis macularia*
Broad-winged Hawk	Gavilán aludo	*Buteo platypterus*
Ruby-throated Hummingbird	Estrellita pasajera	*Archilochus colubris*
Great-crested Flycatcher	Güis migrador	*Myiarchus crinitus*
Yellow-bellied Flycatcher	Mosquitero ventriamarillo	*Empidonax flaviventris*
Least Flycatcher	Mosquitero menudo	*Empidonax minimus*
Wood Thrush	Zorzal grande	*Hylocichla mustelina*
Gray Catbird	Maullador gris	*Dumetella carolinensis*
Magnolia Warbler	Reinita colifajeada	*Dendroica magnolia*
Tennessee Warbler	Reinita verduzca	*Vermivora peregrine*
Yellow Warbler	Reinita amarilla	*Dendroica petechia*
Chestnut-sided Warbler	Reinita flanquicastaña	*Dendroica pensylvanica*
Ovenbird	Reinita andarina	*Seiurus aurocapillus*
Black-throated Green Warbler	Reinita gorginegra	*Dendroica virens*
Black and White Warbler	Reinita rayada	*Mniotilta varia*
American Redstart	Candelita norteña	*Setophaga ruticilla*
Prothonotary Warbler	Manguito dorado	*Protonotaria citrea*
Northern Parula	Parula norteña	*Parula americana*
Common Yellowthroat	Enmascarado norteño	*Geothlypis trichas*
Philadelphia Vireo	Vireo canadiense	*Vireo philadelphicus*
Yellow-throated Vireo	Vireo pechiamarillo	*Vireo flavifrons*
Rose-breasted Grosbeak	Piquigrueso pechirrosado	*Pheucticus ludovicianus*
Indigo Bunting	Azulito norteño	*Passerina cyanea*