Hubbard Brook Research Foundation

Migratory Bird Math and Science Lessons

Least Flycatcher/Robert Royse

Lesson: Hunt and Peck

Neotropical migratory birds make use of a variety of foods throughout their life cycle, yet every year they migrate to the temperate forests of New England to feed on insects. They risk the long journey because during summer months, the food in the temperate forests is more caloric, nutrient rich, and abundant than that in the tropics. In order to learn the types and amount of insects available to birds during the summer, avian scientists at the Hubbard Brook Experimental Forest (HBEF) walk along imaginary fixed lines—called transects—through the forest and survey the insects found along these lines. Since it is impossible to sample every square meter of an area as large as the HBEF, transects serve as a representative subset of habitat. Scientists then use statistics to extrapolate what they've measured along transects to estimate bird or insect abundance for the whole forest.

Summary	The purpose of this lesson is to: a) teach students that birds migrate to find food; b) introduce the transect as a key research method that is used to collect data in an efficient manner; and c) build awareness and understanding for the reasons that scientists want to collect these data. Students will use a basic arthropod identification guide to collect data along a simulated transect, represent these data graphically, and then analyze the results.
Subject areas	Life science, biology, environmental science
Skill level	Average
Objectives	• Explain why Neotropical migratory birds migrate. • Identify reasons why scientists study the types and quantities of food available to birds. • Describe a transect and its value as a research method. • Collect data using a simulated transect. • Represent data in a graph. • Analyze and evaluate data by answering discussion questions.
NH Science Framework Standards	S:SPS1:8:3.2, S:SPS1:11:3.3, S:SPS1:12:3.3, S:SPS1:8:4.1, S:SPS1:11:4.1, S:SPS3:8:1.2
Time	One 45-minute class period plus homework
Materials (per group)	• Student Procedure: *Data Collection* • 1m x 1m piece of green cloth/material • One sheet of Arthropod Images • Arthropod ID Guide (one set of 10 cards) • Scissors • Envelope • 1m length of yarn • 2 popsicle sticks
Materials (per student)	• Student procedure: Data analysis • Graphing software or graph paper and ruler • Hunt and Peck Data Table • Student Handout: Hunt and Peck Analysis and Discussion Questions Optional: • Paper and Pencil Graphing Instructions • Excel Graphing Instructions for Macs and PCs • Introduction to Migratory Birds.pdf • Methods of Bird Research.pdf
Assessment	Student Handouts with answer keys included. To eliminate photocopying, display data table and/or analysis questions on overhead; students can copy data table and record responses in lab books.

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Note to Teachers

Background information on transects

Transects are imaginary lines across a study area along which researchers walk to count and record occurrences of an object being studied. They are used when variation is expected across a study area, and are particularly useful when a complete survey is not practical. The nature of transects (long, narrow lines) allows a researcher to maximize the amount of area covered for the effort.

There are several different kinds of transects that are used for ecological field studies. Three basic types are:

Line-intercept: Researchers follow a line across an area and record the number of times, or in some cases the length of, the line as it intercepts the object being studied. This type of transect is typically used to sample plants and other immobile objects. For example, one might sample canopy gaps in a forest by looking up as a line is walked, and recording the length of the line that crosses openings in the forest canopy. The length of line in gaps divided by the total line length provides an estimate of the proportion of forest in gaps.

Line transect (aka strip census): Researchers walk a line through an area of study and record the individuals observed from (not necessarily intercepted by) that line. It is commonly used for sampling animal populations. For example, Hubbard Brook researchers use a type of line transect to census birds. They walk lines a fixed distance apart, stopping periodically to listen, observe, and record the number of birds detected.

Belt transect: Belt transects are long and very narrow plots: a line of fixed width (i.e., 1 meter wide) is established and all organisms of interest within this area are counted. It is commonly used to study change along a gradient. For example, researchers interested in how vegetation changes according to elevation might set up belt transects at various elevations along a gradient, with each transect running along a line of constant elevation. *Although your students will not study change along a gradient, they will use this type of transect to survey arthropods. It is not exactly the way that Hubbard Brook scientists survey arthropods, but it is the easiest to communicate and practice in the classroom.*

Introduce lesson to students:

1. Why do birds migrate? Why expend an enormous amount of energy to make a risky journey twice each year? Allow student 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 which are laying eggs and raising young. In winter months food is scarce in the temperate zone so birds must travel to the tropical zone to meet their nutritional and caloric needs. If desired, the slideshow Introduction to Neotropical Migratory Birds may be shown to further explain the importance of food as the reason for migration.

2. Why do scientists want to know about the food that birds eat? Food plays a huge part in the lives of birds and has a major influence over the locations where birds choose to live. Scientists at the Hubbard Brook Experimental Forest have studied the types and quantity of

food available to birds to answer questions such as: Why have certain species of birds declined over time while others have increased? Why are more young birds fledged in some years than others?

3. How would you determine the availability and types of food that Neotropical birds eat? Let students brainstorm for a few minutes. Acknowledge their ideas in the context of how practical/realistic/feasible these ideas are. How much time and human resources would it take to carry out these ideas?

4. Explain the use of transects in ecosystem studies. (See above.) If desired, the slideshow Methods of Bird Research may be shown to illustrate different types of transects.

5. Explain:

a. When birds are breeding in the summer months of New England, they eat a lot of spiders and insects—particularly caterpillars, which are rich in nutrients and calories. Insects and spiders are called arthropods and are part of the Phylum Arthropoda. (If time allows, show the Arthropod ID Guide as a slideshow to illustrate examples.)

b. For this activity, students will need to classify 40 individual arthropods, mostly to Order.

i. Introduce students to the idea of *taxonomy* and *classification*. *Taxonomy* is basically is a method of classifying living things, or putting living things into categories, using a *hierarchical order.*

Analogy: Let's classify where you live! Ask one student where he/she lives and write his/her example on the board:

Planet
  Continent
    Country
      State
        County
          Town
            Street
              House number

Note that with each step "down" the hierarchy, we get more and more specific, more descriptive about where that student lives. This example can be done again, with a different student's address, to illustrate that the first 6 or 7 "steps" are the same.

ii. The teacher may wish to also show the following example of human classification:

Kingdom - Animalia
  Phylum - Chordata
    Class - Mammalia
      Order - Primates
        Family - Hominidae
          Genus - Homo
            Species: Homo sapiens

Post Activity

Graphing

Instructions for creating graphs with Excel (on a Mac or PC) or with pencil-and-paper are included within this lesson.

Analysis and discussion

After students have graphed their data, show students the master graph. It is included as a slide in Support Materials for easy viewing. (It is also included on the *Data Table and Graph* answer key). Students will need to reference this graph to answer questions on the *Analysis and Discussion* student handout. Students will also need to examine the graphs of other groups.

Student Procedure

Data Collection

1. If you are using a lab book, copy the data sheet below into your book. If not, use the data table provided by your teacher.

Taxonomic group	Number of individuals
Class Arachnida	
Class Insecta, order Opiliones	
Class Insecta, order Coleoptera	
Class Insecta, order Hemiptera, suborder Heteroptera	
Class Insecta, order Hemiptera, suborder Homoptera	
Class Insecta, order Neuroptera	
Class Insecta, order Lepidoptera	

2. Each group should obtain one sheet of *Arthropod Images*, a few pairs of scissors, and an envelope. Members of the group should carefully cut out the images and place in the envelope.

3. Each group should obtain at least one set of the *Arthropod ID Guide*, 2 popsicle sticks, a pre-cut length of yarn, and a piece of green cloth.

4. One member of the group should equally distribute the arthropods to the all members. (For example, if there are 5 people in your team, give each person 8 arthropods.)

5. The green cloth represents a research area in a forest. Place each arthropod somewhere on this "research site." You can scatter them at random, but make sure all the images are facing up.

6. When all teams are ready, switch places with another team by walking over to their "research site." Be careful not to disturb any of the pieces of cloth. Your team will set up and use a *belt transect* to collect data at this research site.

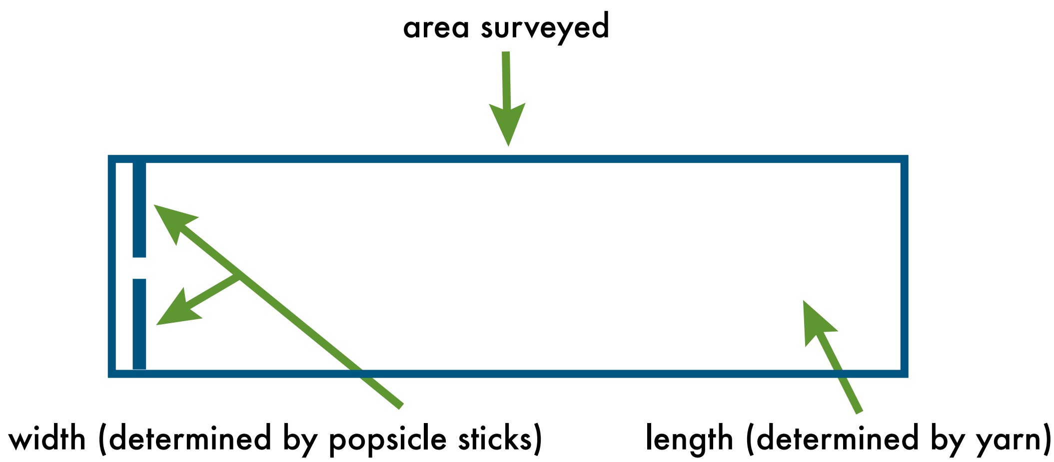
7. With your team, discuss the best place so set up the transect, so that the data you gather is *representative* of the entire area. *Representative* means that the area you sample is similar to most of the area within your study site. Because you are using green cloth that is uniform in color, your "research site" has no variation. However, observe the distribution of the arthropods on the cloth. This observation should help you decide where to run the transect.

8. Once you've reached an agreement, use the yarn to "run" the transect. The yarn should stretch in a straight line over the cloth. Use a piece of tape on each end to secure the yarn.

9. Place the two popsicle sticks on either side of the transect, so that both are in a line together.

10. Starting at one end of the transect, move the popsicle sticks along the yarn and pick up all of the arthropods that lie within this area.

11. By the time you've reached the end of the transect, you should have collected all of the organisms within a popsicle stick's length above and below the transect. This area is called a *belt transect,* which is a long, rectangular plot. The area within this plot is determined by the length of the yarn and width of the popsicle sticks.



12. Use the arthropod ID guide to identify the taxonomic group to which each organism belongs. Write down the name of each taxonomic group on your data sheet, and use a tally to keep track of the number of individuals in each group.

Student Procedure

Data Analysis

1. Create a bar graph to represent the data.

   a. If using Excel or other software, enter your data into a spreadsheet. Using the order (or suborder) names only, use the following as an example:

	A	B
1	**Taxonomic Group**	**Number of Individuals**
2	Arachnida	
3	Opiliones	
4	Coleoptera	
5	Heteroptera	
6	Homoptera	
7	Neuroptera	
8	Lepidoptera	

   b. Make the graph.

2. Analyze your data by using the graph to answer the analysis questions on the *Hunt and Peck Analysis and Discussion* student handout.

Student Handout I

Hunt and Peck Data Table

Name ______________________________________

Taxonomic Group	Number of individuals
Class Arachnida	
Class Insecta, order Opiliones	
Class Insecta, order Coleoptera	
Class Insecta, order Hemiptera, suborder Heteroptera	
Class Insecta, order Hemiptera, suborder Homoptera	
Class Insecta, order Neuroptera	
Class Insecta, order Lepidoptera	

Student Handout II

Name ________________________________

Hunt and Peck Analysis and Discussion Questions

1. According to your data, which taxonomic group had the greatest number of individuals? The least?

2. Compare your results with that of the other teams. Did all of the teams find that the same taxonomic group had the most organisms in it?

3. Look at the “master graph” and notice the height of the bars for each taxonomic group.

a. How does the “master data” compare to yours? Are your data representative of the “master data”?

b. If not, give one reason to explain why this might be.

4. Imagine you are the first person to ever sample a certain forest for insects. You can run as many transects as you need to, but do not want to run any more than are necessary. How would you go about deciding when to stop? What would you look for when comparing data from each transect?

5. Recall that scientists at the Hubbard Brook Experimental Forest study the types and quantities of food available to birds to help them understand why the population sizes of different species of birds change over time. Do you think that collecting data on arthropods for one season would give scientists enough data to answer these questions? Explain your answer.

6. The Black-capped Chickadee is a year-round resident in New England—it does not migrate. Though it eats mostly arthropods during its breeding season, during the winter half of its diet is composed of seed and berries. In contrast, the American Redstart is a Neotropical migratory bird that relies on eating arthropods year-round, in both its breeding and wintering grounds. Hypothesize why the American Redstart migrates while the Black-capped Chickadee does not.

Arthropod Images

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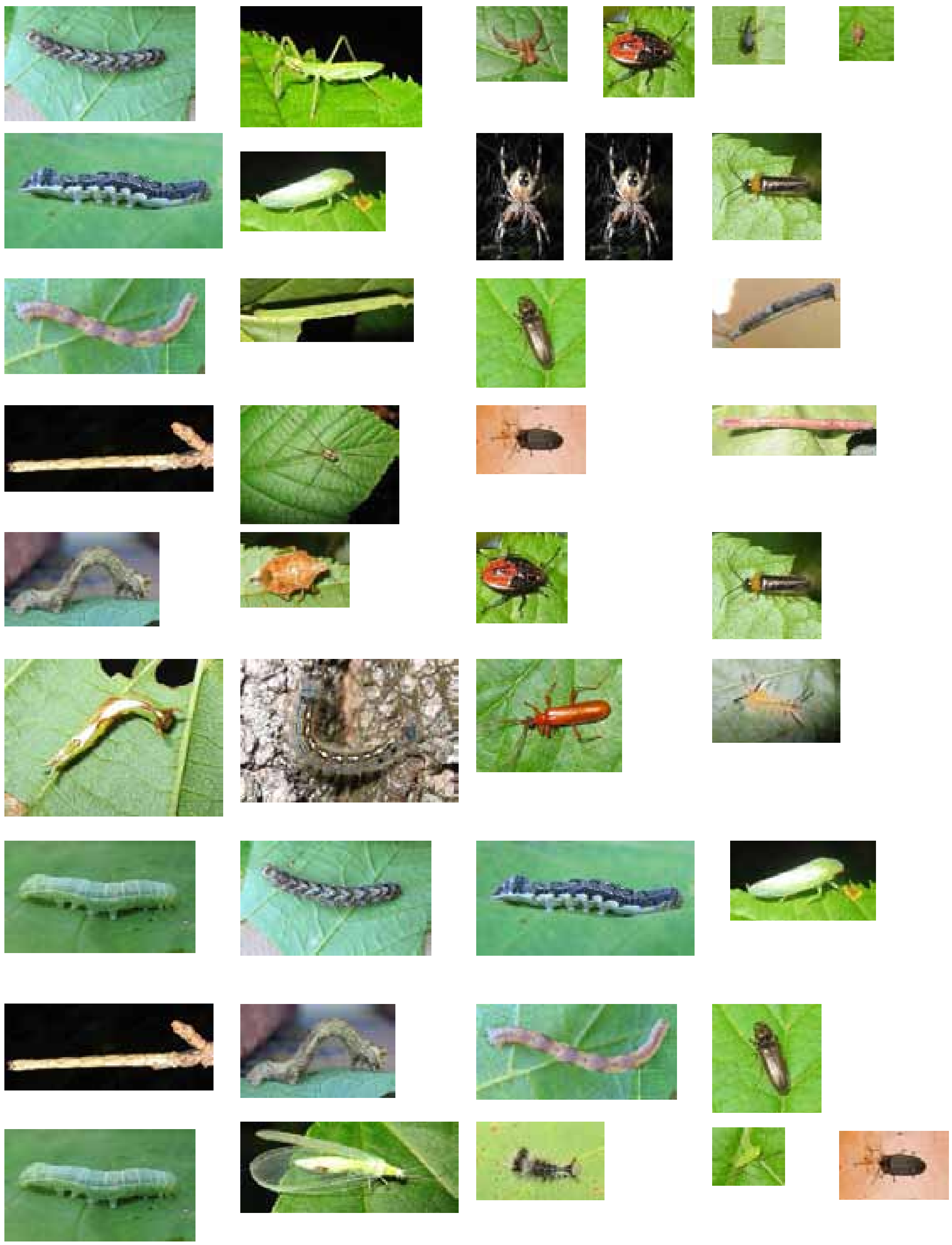
Hunt and Peck: Arthropod Images
Carefully cut out the images and place in your group's envelope.

Images courtesy of Scott Schwenk, University of Vermont. Images shown are not actual size, but are to scale relative to one another.



Phylum Arthropoda

Class Insecta

Order Lepidoptera – moths and butterflies

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

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Phylum Arthropoda
Class Arachnida
Order Araneae -spiders

Phylum Arthropoda
Class Arachnida
Order Opiliones- daddy long-legs

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

Phylum Arthropoda

Class Insecta

Order Coleoptera – beetles

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

Phylum Arthropoda
Class Insecta
Order Coleoptera – beetles

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

Phylum Arthropoda
Class Insecta
Order Hemiptera
Suborder Heteroptera – true bugs

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

Phylum Arthropoda

Class Insecta

Order Hemiptera

Suborder Homoptera – leafhoppers, aphids, cicadas & relatives

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

Phylum Arthropoda

Class Insecta

Order Neuroptera – lacewings

Adapted from W. Scott Schwenk , University of Vermont, for Hubbard Brook Research Foundation

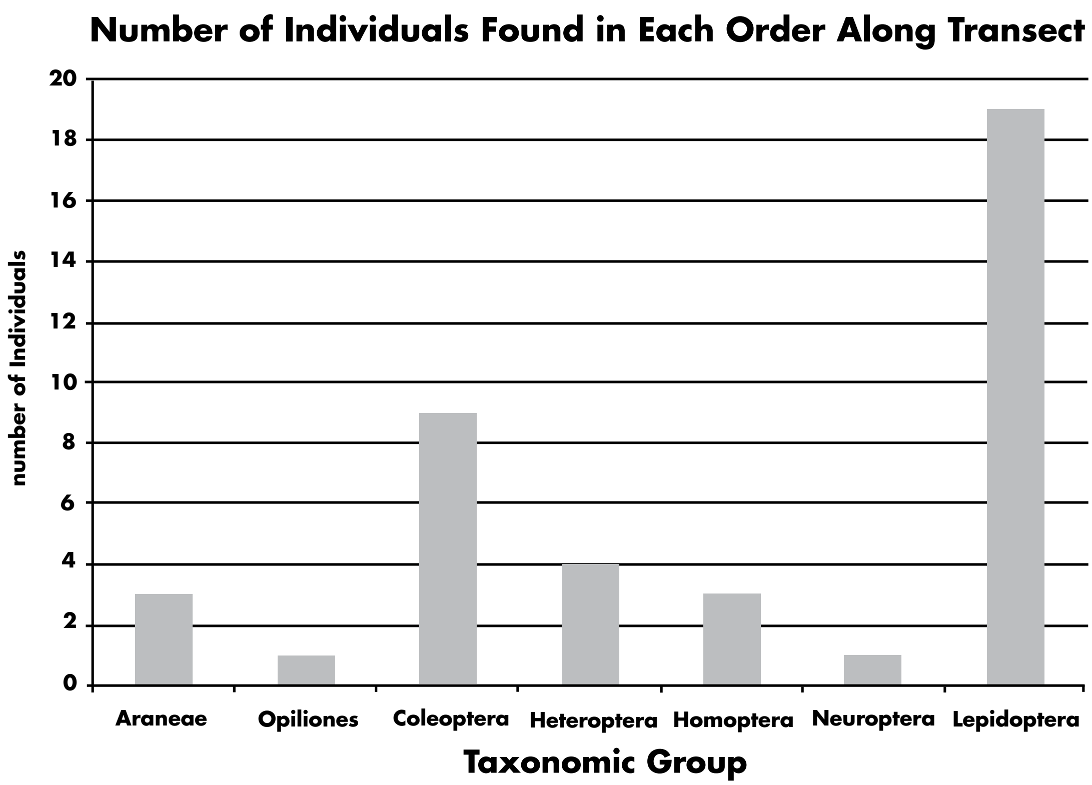
Answer Key

Hunt and Peck Data Table and Graph

Master Data Table of all arthropods given to each group

Taxonomic Group	Number of individuals
Class Arachnida, order Araneae	3
Class Arachnida, order Opiliones	1
Class Insecta, order Coleoptera	9
Class Insecta, order Hemiptera, suborder Heteroptera	4
Class Insecta, order Hemiptera, suborder Homoptera	3
Class Insecta, oorder Neuroptera	1
Class Insecta, order Lepidoptera	19
Total number of Arthropods	40

Graph created with data from the Master Data Table



Answer Key

Hunt and Peck Analysis and Discussion Questions

1. According to your data, which taxonomic group had the greatest number of individuals? The least?
Answers will vary.

2. Compare your results with that of the other teams. Did all of the teams find that the same taxonomic group had the most organisms in it?
Answers will vary. Most likely, the order Lepidoptera will contain the greatest number of individuals.

3. Look at the "master graph" and notice the height of the bars for each taxonomic group.

c. How does the "master data" compare to yours? Are your data representative of the "master data"?
Answers will vary. Student data is representative of the master data if the proportions of individuals in various orders match that of the master data.

d. If not, give one reason to explain why this might be.
Answers will vary but should have something to do with the distribution of arthropods (i.e., if the students clumped individual arthropods together instead of spreading evenly over the cloth, they would probably get results that do not match that of the master data).

4. Imagine you are the first person to ever sample a certain forest for insects. You can run as many transects as you need to, but do not want to run any more than are necessary. How would you go about deciding when to stop? What would you look for when comparing data from each transect?
You would stop when the data collected from the transects gave similar results; i.e.: when no new orders were identified, when the proportion of individuals in each order matched that of other transects. If transects continued to give different data (i.e.: a types of orders or abundances of individuals in each order), then you would want to keep running transects and collecting data.

5. Recall that scientists at the Hubbard Brook Experimental Forest study the types and quantities of food available to birds to help them understand why the population sizes of different species of birds change over time. Do you think that collecting data on arthropods for one season would give scientists enough data to answer these questions? Explain your answer.
Data collected from one season would not be enough, because population sizes of all organisms vary from year to year, depending on many things: climate, food available, predators, etc. The arthropods eaten by birds also need to eat, and insects, especially when in larval form, are very dependent on temperature and moisture. The results that researchers get from one season's worth of data collection might be very different from results from another year. Getting an idea of what happens to arthropod populations over time helps researchers to understand the effects of food availability on bird populations over time.

6. The Black-capped Chickadee is a year-round resident in New England—it does not migrate. Though it eats mostly arthropods during its breeding season, during the winter half of its diet is composed of seed and berries. In contrast, the American Redstart is a Neotropical migratory bird that relies on eating arthropods year-round, in both its breeding and wintering grounds. Hypothesize why the American Redstart migrates while the Black-capped Chickadee does not.

The number of arthropods available during the winter is very low compared to the summer. There is not enough to sustain an American Redstart through the long, cold winter months, so it must migrate in search of food. Because the Chickadee has a varied diet, it can sustain itself with the seeds and berries available here in the winter. There are a variety of ways in which students can state the above in hypotheses.

Paper and pencil graphing instructions

1. Determine the type of graph that should be made with the kind of data you have. In this case, a bar or column graph is most appropriate, because the data is in categories.

2. Determine the independent variable and dependent variables. The independent variable is the variable that the scientist changes or predetermines; in this case, Taxonomic Group.

3. Label the axes. When making a graph the Y axis represents the dependent variable and the X axis represents the independent variable.

4. Make sure the axes are labeled with appropriate units. Axes should be labeled so that it is easy to understand what variables are represented on the graph.

5. Give the graph a clear title that explains what the whole graph represents.

6. Decide what type of graph is most appropriate to use with your data (line graph, bar graph, etc.) and plot your data on the graph.

Graphing Instructions for Excel with Mac and PC Computers

The directions for making graphs using Excel (version 2008) on a Mac are as follows:

a. Highlight the data you wish to graph. Include the column headings.
b. Under Insert in the toolbar, select Chart.
c. A horizontal ribbon appears under the main toolbar. At the top of this ribbon are 12 small ovals with the main graph types (bar, bubble, column, scatter, etc). Choose the type of graph you wish to make.
d. Subtype choices sometimes appear: select the most appropriate choice.
e. The graph is produced as you soon as graph subtype has been selected. Check to see if things are making sense.
f. To edit things like the title, use the right-hand sidebar, called the "Formatting Palette." Inside this palette are the "Chart Options." The chart title, x-axis, and y-axis labels all appear in one drop down menu near the top of the Chart Options section, under the label "Titles."
g. You can choose to either imbed your graph in the current sheet or to place it in a separate sheet. You have to click on the chart and then press control and click at the same time. Now select "Move Chart." A dialog box appears asking if you want it inside an existing sheet or if you want the chart to occupy a new sheet all by itself.

The directions for making the graphs using Excel (version 2007) on a PC are as follows:

a. Highlight the data you wish to graph. Include the column headings as you highlight.
b. Under Insert in the toolbar go to Charts.
c. Choose the type of graph you wish to make. Subtype choices sometimes appear: select the most appropriate choice.
d. The graph is produced as you soon as graph subtype has been selected. Check to see if things are making sense.
e. To label chart title, x-axis and y-axis, go to Chart Layouts and click "Layout 1." Now you can insert the titles by clicking in the area that you want to insert and typing the title.
f. By default, the graph background should be set to white, but to save printer ink, be certain of this before printing. If background is not white, click in chart area, right click, and choose "Format Chart Area." You will see a toolbar: click on the 'paint bucket' icon and choose white.
g. Be sure to click on the chart before you print, or you will end up printing the chart with the spreadsheet of data in the background.