



Investigation 3

Show Me the Data

Before You Start



Time and Place

90 minutes, more if you explore eBird data

Indoors

MATERIALS NEEDED

Resource Pages

- “Graphs of Bird Data” handout
- “Graphing My Data” article
- “The ‘I Wonder’ Kid” handout

Journal Pages 7–11

Other Curriculum Components

- None

You Provide

- Graph paper
- Internet access

Getting Ready

- Copy the Reference Guide articles for each student.
- Make a color transparency or class handouts of “Graphs of Bird Data,” or prepare to project it for the class.

Goal

Students will use graphing techniques to visually represent data.

Learning Objectives

1. Students will be able to correctly identify and describe four kinds of graphs commonly used in science: pie charts, line graphs, scatter plots, and bar graphs.
2. Students will be able to draw an appropriate example of a pie chart, line graph, scatter plot, and bar graph to represent data.
3. Students will be able to explain how the four types of graphs are used to represent different kinds of information.

Lesson Outline

1. Introduce graphs.
2. Look at real world graph samples.
3. Discuss choosing the right kind of graph.
4. Generate class graphs.
5. Become an eBird data sleuth (optional).
6. Think on Your Own: complete another graph.

Conducting the Activity

1. Introduce graphs.

Remind the students that in Investigation 2, they saw examples of bar graphs in “Amy’s Scientific Report,” and different kinds of graphs in the “Answering Your Scientific Questions” article. Begin with a class discussion about how and why people use graphs.

Ask questions such as

- *Have you ever made a graph? Why do people make graphs?*
- *Can you name any types of graphs? (Make sure that bar, line, and pie/circle graphs have been mentioned.)*
- *Why do you think that information is often presented in graphs instead of just in lists or tables? (Graphs visually show relationships between variables.)*



Show Me the Data

2. Look at real world graph samples.

Display an overhead or give each student the “Graphs of Bird Data” handout (REFERENCE PAGE 16) that illustrates four kinds of graphs you will focus on: pie, line, scatter, and bar. Ask students to compare and contrast the graphs, focusing on how the data are presented and any differences they might notice between the kinds of data presented in each.

You may wish to create a Venn diagram to illustrate similarities and differences between pairs of graph types, and ask students to tell what they think the graphs show.

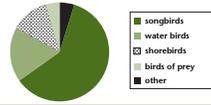
REFERENCE PAGE 16



Graphs of Bird Data

Pie Charts

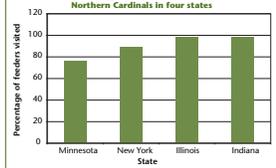
Types of birds we counted this month



Category	Color
songbirds	Dark Green
water birds	Light Green
shorebirds	White
birds of prey	Light Grey
other	Dark Grey

Bar Graphs

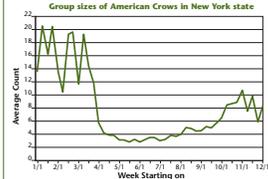
Percentage of feeders visited by Northern Cardinals in four states



State	Percentage of feeders visited
Minnesota	75
New York	85
Illinois	95
Indiana	95

Line Graphs

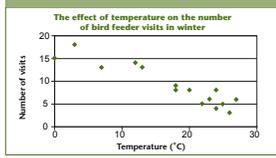
Group sizes of American Crows in New York state



Week Starting on	Average Count
1/1	18
1/15	15
1/29	12
2/12	10
2/26	8
3/12	7
3/26	6
4/9	5
4/23	4
5/7	3
5/21	3
6/4	3
6/18	3
7/2	3
7/16	3
7/30	3
8/13	3
8/27	3
9/10	3
9/24	3
10/8	3
10/22	3
11/5	3
11/19	3
12/3	3
12/17	3

Scatter Plots

The effect of temperature on the number of bird feeder visits in winter



Temperature (°C)	Number of visits
5	18
10	12
15	14
20	8
25	6
28	5
30	4



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Show Me the Data

3. Discuss choosing the right kind of graph.

Have students read “Graphing my Data” (REFERENCE GUIDE PAGES 17–21). Review the terms “Independent Variable” and “Dependent Variable” if necessary. Discuss ways that different types of graphs are better at illustrating different kinds of data. Make the following points by appropriately referencing the four “Graphs of Bird Data” graphs:

- Line graphs are especially helpful for showing how something changes over time.
- Scatter Plots are similar, and good for showing trends in data. They show how much one variable is affected by another.
- Bar graphs are used to compare two or more categories of things.
- Line, bar, and scatter plot graphs all have a dependent variable that is measured and plotted on the y-axis.
- Line graphs are preferred for showing changes over time because they better represent a continuum of data. Information presented in a bar graph is divided into categories.
- Pie charts show proportions and always add to 100%.

Students should record these ideas in the table on JOURNAL PAGE 7.

You may wish to discuss the “What Do You Think?” questions scattered throughout the article, or ask students to submit writ-

REFERENCE PAGE 17

Graphing My Data

BIRD Sleuth

You’ve probably heard the phrase, “A picture is worth a thousand words.” A well-made graph is worth a thousand words—it summarizes your data and might even make it easy to see any trends in your data! Graphing is all about showing people your data visually.

There are many kinds of graphs. Not every kind of graph will be best for your data. Deciding on what kind of graph to draw, and how to draw it, can require thought—which makes graphing a fun challenge! Here, you’ll learn about four kinds of graphs and when to use each kind.

Pie Charts

- When you can convert data to show percentages, you can use a pie chart.
- Remember that the pieces of a pie together make 100%.

Figure 1

WHAT DO YOU THINK? What is the most common kind of bird the students counted? What kind of bird was seen least often? Approximately what proportion of birds counted this month were water birds?

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JOURNAL PAGE 7

Name: _____
Date: _____

Show Me the Data

BIRD Sleuth Practice representing data using different types of graphs.

Types of Graphs

After a class discussion about graphs, fill in the reasons for using each type of graph.

Type of Graph	When to Use This Graph
Pie Chart	
Line Graph	
Scatter Plot	
Bar Graph	

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BirdSleuth: Investigating Evidence Investigator's Journal



Show Me the Data

ten responses as part of your assesment.

4. Generate class graphs.

Practice making a sample graph of each type with simple class-generated data (see samples below). Students should record a sample graph of each of the four kinds on **JOURNAL PAGES 8–10**.

Pie Chart

- Examples to graph: what proportion of students choose a given favorite sport, bird, or food? See the sample pie chart, Figure 1.
- Steps for making a pie chart:
 1. Collect the data and organize them in a table with column and row headings (see Table 1). Remember, pie charts are used to display percentages and the total of all categories always adds up to 100%.
 2. Calculate the proportions and circle degrees for each item in the table (for younger students, calculating circle degrees is not necessary; estimating and drawing the proportions will suffice).
 3. Draw a circle to represent a pie chart.
 4. Transfer the data to the graph by drawing segments in the chart. Distinguishing sections by color is the standard way to tell them apart.
 5. Decide on a title for the pie chart. The title should go at the top and summarize the variables studied.

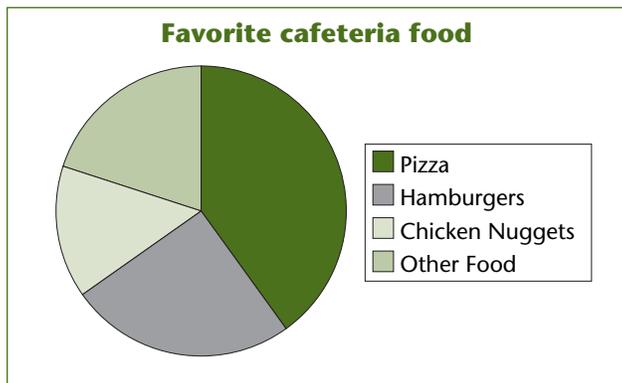


Figure 1: Sample pie chart

Favorite cafeteria food	Number of students	Percentage of students	Circle degrees (% x 360)
Pizza	8	40%	144
Hamburgers	5	25%	90
Chicken Nuggets	3	15%	54
Other	4	20%	72
Total	20	100%	360

Table 1: Table of favorite cafeteria foods

JOURNAL PAGE 8

Name: _____ Date: _____

Show me the Data

Fun with Graphs!

Follow along with your class to complete an example of a pie chart, line graph, scatter plot, and bar graph. For each graph remember to include:

- _____ Question you are trying to answer
- _____ Title for your graph
- _____ Labels for x and y axes (line, bar, and scatterplots)
- _____ Scale measurements for x and y axes (line and bar graphs, scatterplots)
- _____ Key or legend
- _____ Data table (optional)

1. Pie Chart

Question to graph _____

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Show Me the Data

6. Create a key to identify the sections of the pie chart.

Line Graph

- Examples to graph: a student's growth in height or weight since birth, the daily high temperature over the course of last week. See Figure 2 for an example.
- Steps for making a line graph:
 1. Collect the data and organize them in a table with column and row headings (see Table 2).
 2. Draw a right angle on the board to represent the graph axes.
 3. Label the x and y axes of the graph. Lay out the scales for each axis (for the example below: height in inches, 0–60, age in years, 1–10).
 4. Transfer the data to the graph by adding data points and drawing a line through them.
 5. Decide on a title for the graph. The



Figure 2: Sample of line graph

JOURNAL PAGE 9

Name: _____ Date: _____

Show Me the Data

2. Line Graph
Question to graph _____

3. Scatter Plot
Question to graph _____

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Kerry's height since age one	
Age (in years)	Height (in inches)
1	27
2	32
3	37
4	40
5	42
6	45
7	48
8	50
8	52
10	54

Table 2: Table of student's growth



Show Me the Data

title should go at the top and describe the relationship between the variables represented.

Scatter Plots

Scatter plots are best for showing whether two variables are correlated.

- Examples to graph: the number of hours that students spent studying for an exam versus the grade received (see Figure 3).
- Steps for making a line graph:
 1. Collect the data and organize them in a table with column and row headings (see Table 3).
 2. Draw the outline of a graph (a right angle) on the board to represent the graph axes.
 3. Label the x and y axes of the graph. Lay out the scales for each axis.
 4. Transfer the data to the graph by adding data points.
 5. You may choose to draw a best-fit line through the points if they seem to be correlated. (This has not been done in the sample, but it appears there is a positive correlation between time spent studying and test score.)

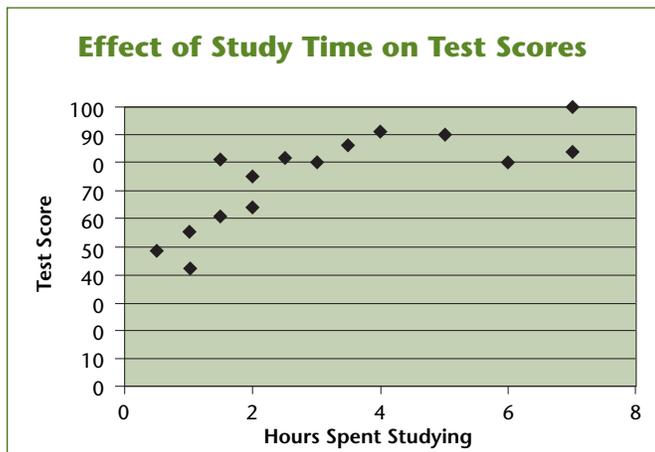


Figure 3: Sample scatter plot

Student	Hours spent studying	Test score
1	3	80
2	5	90
3	2	75
4	6	80
5	7	84
6	1	55
7	2	64
8	0.5	48
9	1	42
10	7	100
11	1.5	81
12	2.5	82
13	3.5	82
14	4	91
15	1.5	61

Table 3: Table of study time and associated test score



Show Me the Data

- Decide on a title for the graph. The title should go at the top and describe the relationship between the variables represented.

Bar Graph

- Examples to graph: which movies the students have recently watched, what pets they own, or which ice cream flavors are their favorites.
- Steps for making a bar graph:
 - Collect the data and organize them in a table with column and row headings (see table 4).
 - Draw a right angle on the board to represent the axes of the graph.
 - Label the x and y axes for the graph. Lay out the scales for the y-axis and the categories for the x-axis.
 - Transfer data to the graph by draw-

JOURNAL PAGE 10

Name: _____ Date: _____

Show Me the Data

4. Bar Graph
Question to graph _____

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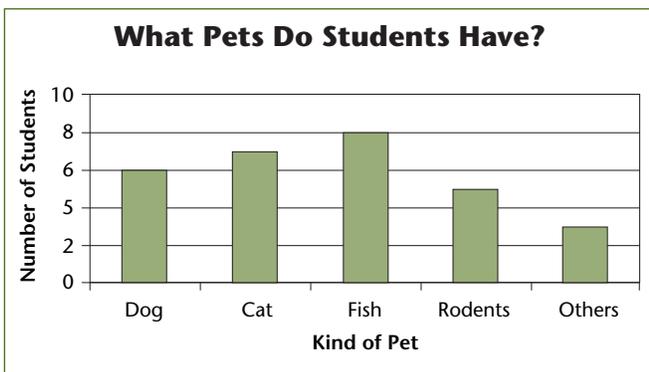


Figure 4: Sample bar graph

Kind of Pet	Number of Students who have at least one of this kind of Pet
Dog	6
Cat	7
Fish	8
Rodents	5
Others	3

Table 4: Pets owned by students



Show Me the Data

ing bars on the graph.

- Decide on a title for the graph. The title should go at the top and describe what the graph is about.

5. Become an eBird Data Sleuth (optional).

We encourage you to complete or begin **BIRD-SLEUTH: MOST WANTED BIRDS LESSON 6**, “Become an eBird Data Sleuth” with your students if you have not already done so. If you began the lesson, but did not complete either of the “Advanced Inquiry Options” (page 32 of that unit), consider doing that part at this time (see **TEACHER BACKGROUND** box this page, “Advanced Inquiry Options,” for information.)



(BirdSleuth: Most Wanted Birds may be ordered on the BirdSleuth web site.

Project “The ‘I Wonder’ Kid” overhead (**RESOURCE PAGE 22**—note that the students were previously introduced to this figure in the “Kinds of Questions” article on **RESOURCE PAGE 4**.) Emphasize the “Explore and Analyze Data” jumping in point on the diagram. To answer these kinds of questions, students will need to look at data that have already been collected. The Cornell Lab of Ornithology’s citizen science databases are a perfect resource. For example, eBird is full of data about the kinds and numbers of birds seen around the country, and can be used to answer many kinds of questions about bird distribution and abundance. eBird also easily generates graphs of that data. Consider visiting eBird at www.ebird.org to explore this resource.

If you’d like more support for using eBird, associated lessons can be found in two other BirdSleuth modules: BirdSleuth Most Wanted Birds and BirdSleuth: Exploring Bird Behavior (you may order these BirdSleuth modules at www.BirdSleuth.org.) Specifically, we encourage you to complete:

- BirdSleuth: Most Wanted Birds Lesson 6, “Become an eBird Data Sleuth,” particu-



Teacher Background ADVANCED INQUIRY OPTIONS

(Taken from Most Wanted Birds: “Become an eBird Data Sleuth”)

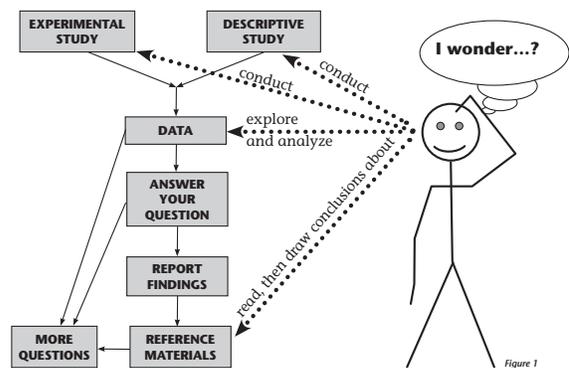
Open Inquiry

Give a copy of the “Questions to Investigate” handout (Resource Materials) to each student. Ask each pair of students to explore the question that interests them the most. You may wish to have students present what they have found either to the whole class, to another group, or in a written report.

Independent Inquiry

Have each student or pair of students develop a question that they think can be answered using the eBird database, then research the answers. You might specify that they examine either your classroom’s BirdSleuth eBird data (if you have collected enough), or all eBird data. Ask students to note any interesting findings as well as the answer to their question as they work. Students should share their findings with another group, with the entire class, or in a written report.

RESOURCE PAGE 22



Where will you jump into the process?

Depending on your question, you can enter the process of science at different stages. Look at the dotted arrows to see where this student scientist could jump into the scientific process. Some conduct their investigations through experimental or descriptive studies, some start by exploring and analyzing data from a database (like eBird, for example), and still others find answers by pulling together information they find in reference materials such as books or web sites.



Show Me the Data

larly the “Advanced Inquiry Options” (page 32 of that module, see Teacher Background box this page, “Advanced Inquiry Options,” for information.)

- BirdSleuth: Exploring Bird Behavior “Explore Corvid eBird Data” lesson (page 17 of that module).

These modules come complete with slide shows that can help you explore eBird.

6. Think on Your Own

Ask students to complete their own example graphs in groups, pairs, or individually, on **JOURNAL PAGE 11**. You may want them to do one of each type of graph, or specify type(s). They can use the data in their journals or data the class has collected during their BirdSleuth bird counts. Students should exchange their graphs with another group, pair, or student who can peer review their graph before submitting their revised graph to you for comment. Provide graph paper for the students.

In class, review and correct any common mistakes found in the graphs. You may wish to post exemplary examples of each type of graph.

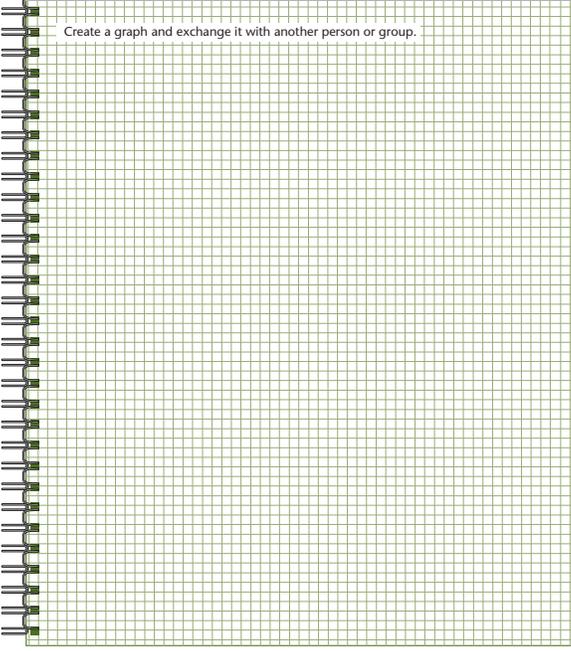
JOURNAL PAGE 11

Name: _____ Date: _____

Show Me the Data

Think on Your Own

_____ Create a graph and exchange it with another person or group.



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Thinking ahead to conducting independent research on your schoolyard...



Teacher Tip **JUMPING IN POINTS**

Questions that the students answer using the data you've collected on your schoolyard, questions that they answer using the eBird database, and questions they answer using literature and online resources are all possibilities for publication in the Classroom BirdScope student research magazine or BirdSleuth Reports webzine. In other words, each of these “jumping in points” is a great way to answer scientific questions, and each of these question types will be considered for publication.

Students will learn more about publishing their original research in Investigations 4 and 5.



Teacher Tip **HELPING STUDENTS INTERPRET DATA**

Consider the following questions to help students make sense of data:

- What patterns do you notice?
- What does the data “show”?
- What do you think the data mean? What can you conclude?
- How would you explain that?
- What generalizations do you think you can make based on your data/observations?

Show Me the Data

Notes Page



Name:

Date:



Show Me the Data

Practice representing data using different types of graphs.

Types of Graphs

After a class discussion about graphs, fill in the reasons for using each type of graph.

Type of Graph	When to Use This Graph
Pie Chart	
Line Graph	
Scatter Plot	
Bar Graph	



Name:

Date:

Show me the Data

Fun with Graphs!

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- _____ Key or legend
- _____ Data table (optional)

1. Pie Chart

Question to graph _____



Name: _____

Date: _____

Show Me the Data

2. Line Graph

Question to graph _____

3. Scatter Plot

Question to graph _____



Name:

Date:

Show Me the Data

4. Bar Graph

Question to graph _____



Name:

Date:

Show Me the Data

Think on Your Own

Create a graph and exchange it with another person or group.





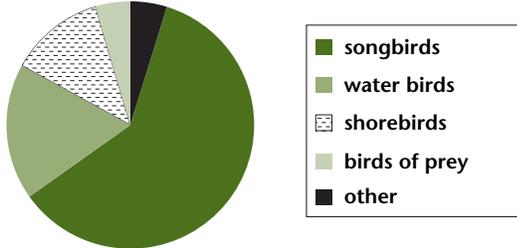
BIRD

Sleuth

Graphs of Bird Data

Pie Charts

Types of birds we counted this month



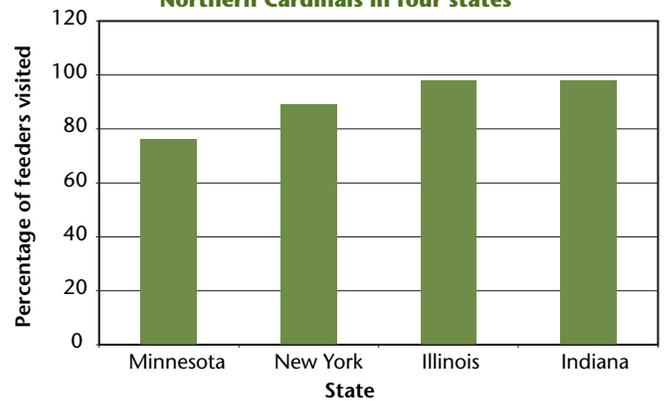
Line Graphs

Group sizes of American Crows in New York state



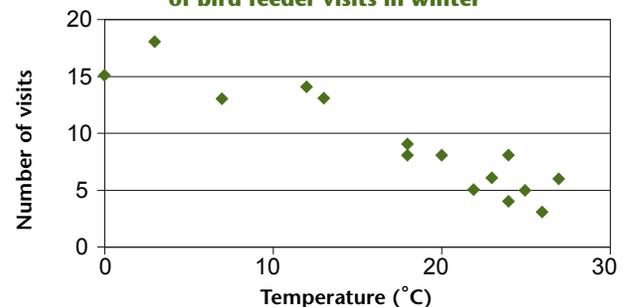
Bar Graphs

Percentage of feeders visited by Northern Cardinals in four states



Scatter Plots

The effect of temperature on the number of bird feeder visits in winter





BIRD

Sleuth

Graphing My Data

You've probably heard the phrase, "A picture is worth a thousand words." A well-made graph is worth a thousand words—it summarizes your data and might even make it easy to see any trends in your data! Graphing is all about showing people your data visually.

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Pie Charts

- When you can convert data to show percentages, you can use a pie chart.
- Remember that the pieces of a pie together make 100%.

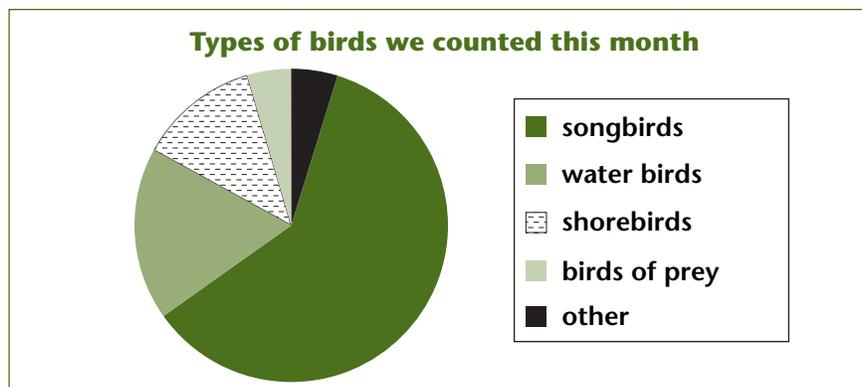


Figure 1



WHAT DO YOU THINK? *What is the most common kind of bird the students counted? What kind of bird was seen least often? Approximately what proportion of birds counted this month were water birds?*



Graphing My Data

Bar Graphs

- Use a bar graph when there is no connection from one data point to another (this is called categorical data). For example, a bar graph can be used to present data from different sites.

In the example in Figure 2, students wanted to know whether Northern Cardinals are seen at feeders more often in states where the cardinal is the state bird. They hypothesized that Northern Cardinals would be seen more in states like Illinois and Indiana, where the cardinal is the state bird, than in states that chose another bird as the state bird, like Minnesota and New York.

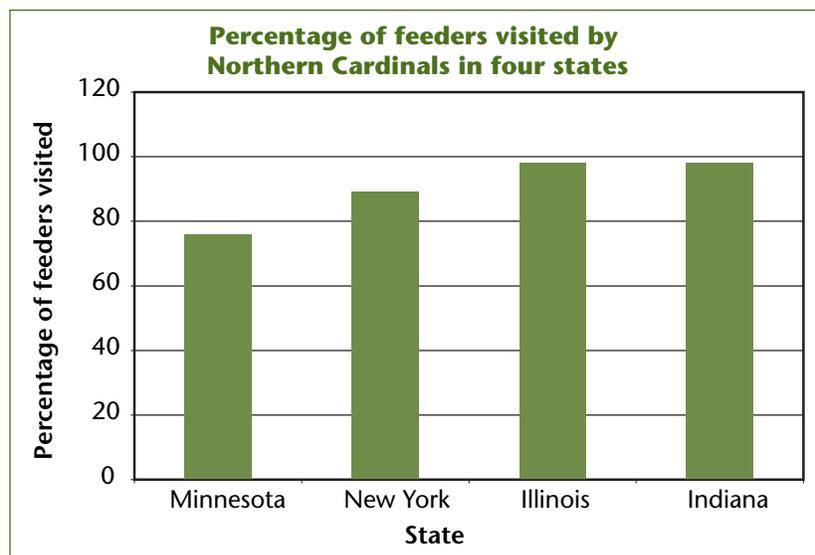


Figure 2: Percentage of feeders visited by Northern Cardinals in four states by Kelsey, Anna, Charlotte, and Hannah, 7th Grade, Minnehaha Academy, Minneapolis, MN, Mrs. Humason



WHAT DO YOU THINK? Was the girls' hypothesis right? Were Northern Cardinals reported more often in states that have Northern Cardinal as the state bird?

Graphing My Data

Line Graphs

- Line graphs are an excellent way to map Dependent and Independent Variables that are both quantitative (measured with numbers). Unlike a bar graph, the data are not grouped in categories.
- Line graphs are most useful for showing whether something changes over time.
- Draw a line through the data points when you have plotted them.

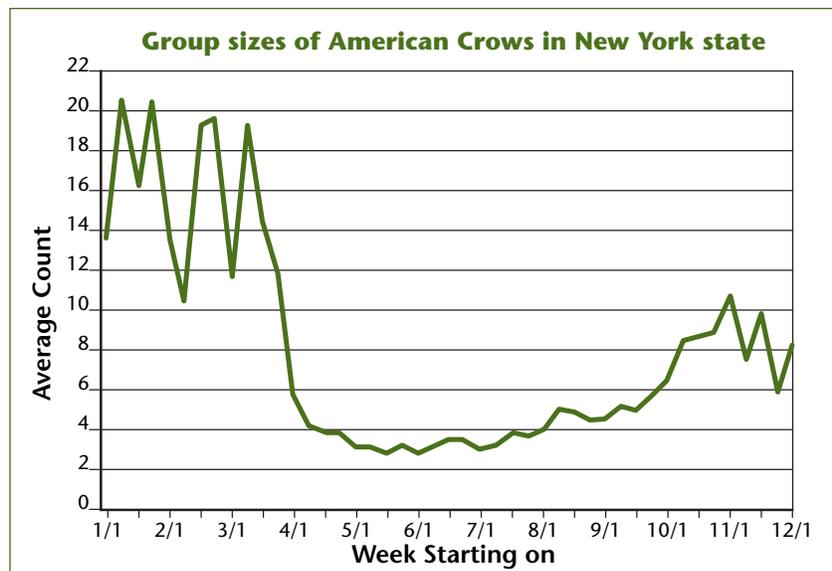


Figure 3: Group sizes of American Crows. From www.eBird.org



WHAT DO YOU THINK? *Does the group size of American Crows seem to change during the year in New York state?*



Graphing My Data

Scatter Plots

- Scatter plots show at a glance whether a relationship exists between the Dependent and Independent Variables.
- Scatter plots are like line graphs in that the Dependent and Independent Variables are both quantitative, but you don't draw a line through the data points.
- You may wish to draw a "line of best fit" between or near the points to show any correlation or relationship.

Examples

Imagine you wanted to determine whether the availability of food affects the weight of nestlings. You might imagine that the more insects a mother Eastern Bluebird brings to the nest in an hour, the heavier her fledglings will be when they leave the nest. The graph in Figure 4 shows a **positive correlation**; as one variable goes up, the other does too.

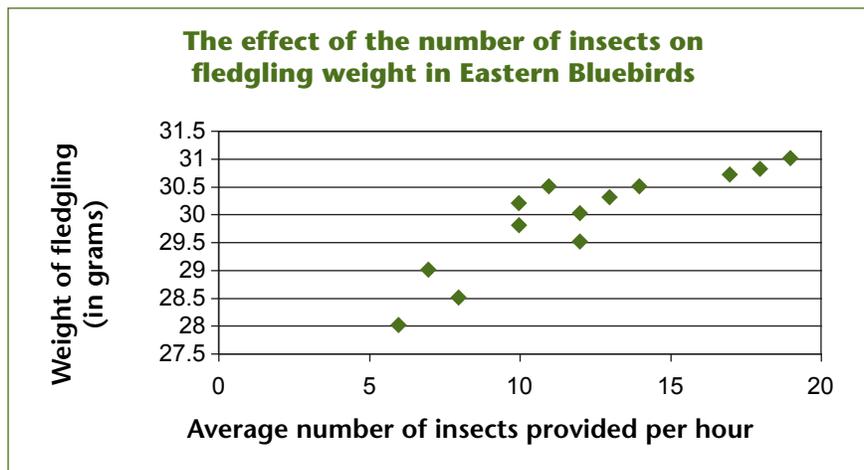


Figure 4: A scatter plot showing a positive correlation



WHAT DO YOU THINK? What is the range of weights of these Eastern Bluebird fledglings? In this sample, about how much does an average fledgling weigh?



Graphing My Data

Some researchers have found that when it is snowier or colder, birds visit feeders more (perhaps because they burn more energy staying warm, or perhaps when it is colder there is less food available besides seed at feeders, or both). If you graphed this relationship, you would find a **negative correlation**; as one variable goes up, the other goes down. See Figure 5.

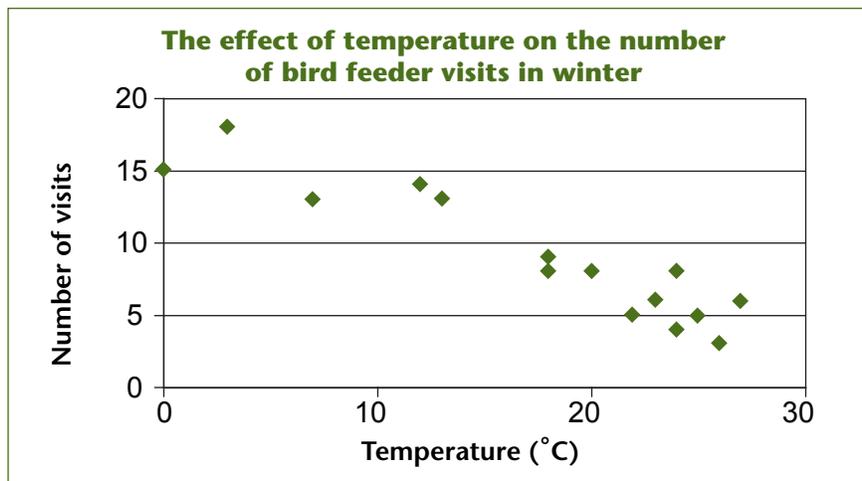


Figure 5: A scatter plot showing a negative correlation

Conclusion

After you summarize your data in graphs, you might notice a trend in the data, or you might find no trend at all. Either will help you draw conclusions about the evidence of data in your experiment or observational study, and show others what you found, too!



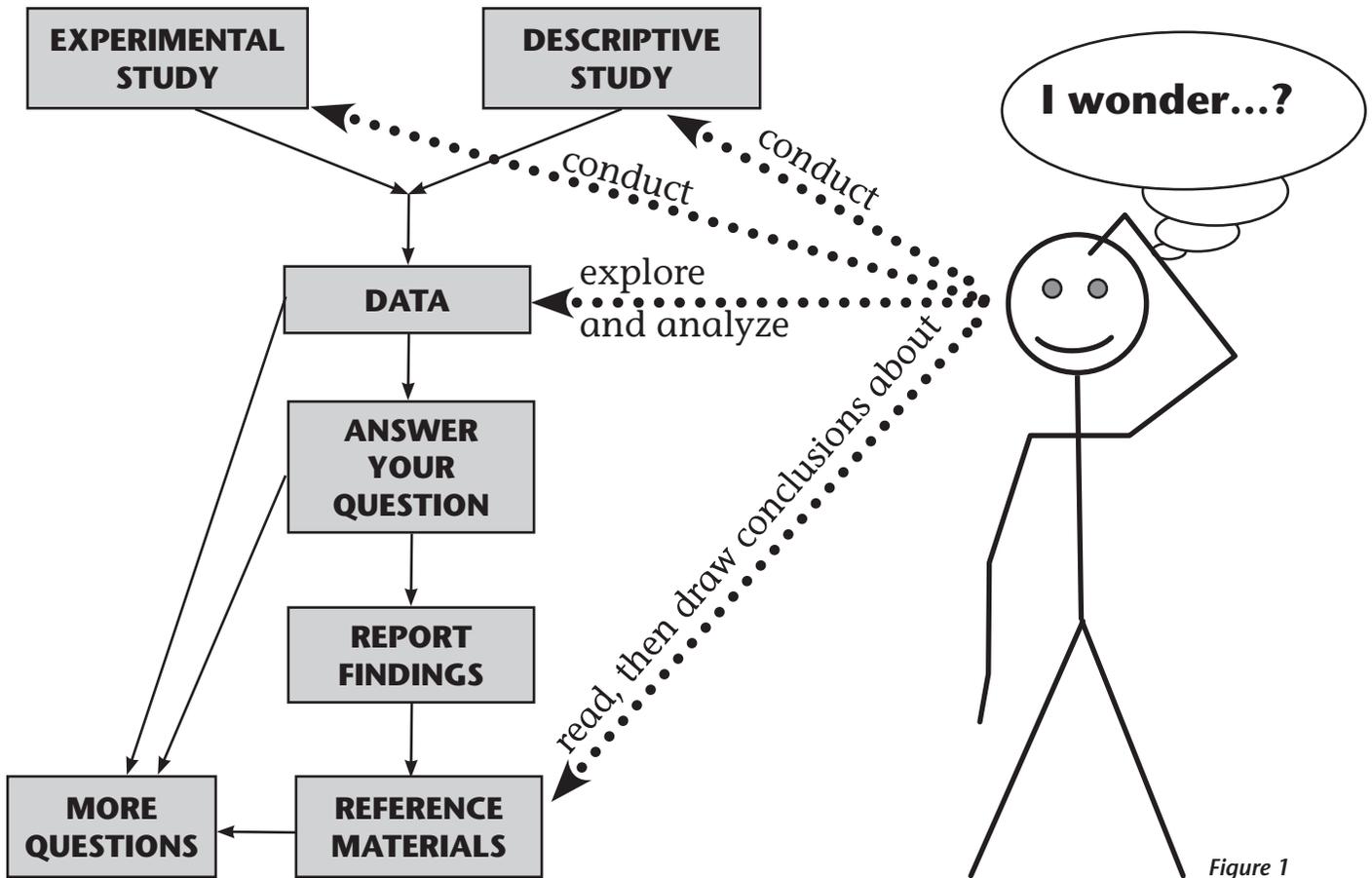


Figure 1

Where will you jump into the process?

Depending on your question, you can enter the process of science at different stages. Look at the dotted arrows to see where this student scientist could jump into the scientific process. Some conduct their investigations through **experimental** or **descriptive** studies, some start by **exploring and analyzing data** from a database (like eBird, for example), and still others find answers by **pulling together information** they find in reference materials such as books or web sites.

The Climate Challenge

This game is based on a traditional board game model, except it uses three separate boards to help teach participants about the effects that climate change may have on birds. The game requires players to assume the role of a bird, and then figure out how climate change is affecting their lives in their Food, Habitat, and Migration.

Materials:

- A printed copy (preferably laminated) of the game boards (three sheets follow these instructions).
- Some sort of bird figures or toy birds that participants can use to move across the game boards- plush birds will work, or even plain game pieces if you don't have any bird-related figures.
- A few sets of dice (you may want to enclose these separately in a small, clear plastic box so that they don't get lost; you will only need one at a time).
- A reward or prize of some sort for playing.

Optional Materials:

- Poster or chart to keep track of how many birds are successful in all three areas.

Putting It Together:

Attach the boards to a table with tape so that they are fixed in one spot. It doesn't matter what order you put the game boards in!!

Put game pieces/bird figures in the front (before the boards) and then the poster with results somewhere at the end.

Running the Game:

1. Have players choose a "bird" or game piece (choice doesn't affect game).
2. You can play individually, in teams, or competitively.
3. Have each player (or team) roll a single die and then move to the corresponding number of each of the boards.
4. Decide whether or not your bird was successful in each area.
5. Give players a prize no matter what!

Things to Remember:

Keep it positive- none of these birds are dying because of climate change (at least not during this game!) so keep it light.

This is just a gentle, kid-friendly introduction to climate change. If they want more (scientific) information, refer them to handouts or fact sheets you may have handy.

Hopefully most birds will see at least one change because of climate- if not, you can always play again!!

Food

1

There have been no effects from climate change here. You have plenty of your usual food!



2

The fish that you like to eat moved further away into colder water, but you were able to dive deeper than before and you still have enough food this year.



3

An early spring caused most of the insects to hatch early. There is not enough food for you this spring.



4

Since the ocean is warmer, your favorite fish (called a sandeel) moved to a cooler place to live, and is too far away for you to follow. There is no food for you!



5

There have been no effects from climate change here. You have plenty of your usual food!



6

The plants that you rely on for food bloomed and fell early because of a warmer spring. There is just barely enough food for you this year.



Habitat

1

2

3

Warmer weather led to a drought, which dried up the wetland where you normally go to breed. You will not be able to raise any chicks this year.



There have been no effects from climate change here. Your habitat remains the same and you will have lots of food for your healthy chicks this year.



The level of the sea is rising, and the salt marsh where you live is slowly flooding. Your habitat is changing, but you adapt and raise healthy baby birds this year.



4

There have been no effects from climate change here. Your habitat remains the same and you have lots of food and babies this year.



5

There have been more strong storms this year, and the coastline where you live is being washed away. You are not able to find a new habitat in time to breed or raise any chicks this year.



6

You are a chin-strap penguin, who likes open water. Melting pack ice in your habitat is good for you- you have more food and more chicks this year than before!



Migration

1

You leave your winter spot earlier than usual, but

2

You are a tree swallow, and you migrate and breed

3

There have been no effects of climate change

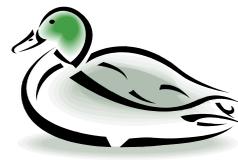
when you arrive at your nesting site you can still find enough food for your babies.



earlier than you used to. You are still able to find food to raise your young.



here. You will make your usual migration and have plenty of food to feed your young.



4

There have been no effects of climate change here. You will make your usual migration and have plenty of food to feed your young.



5

Since it doesn't get as cold in winter, you stop migrating south in the fall and stay in the same place year-round. There is still enough food for you and your young.



6

You migrate at the same time as last year, only to find that the insects you eat are already hatched and gone because the spring was so warm. You are too late for your food this year!

