Lesson 6: A Finch Argument

Introduction

You have completed several lessons to help you understand how the population of stickleback in Loberg Lake changed. In this lesson, you will have a chance to see if the ideas you have learned apply to another population of organisms.

Process and Procedure

1. The focus question for today's lesson is the unit central question that was introduced to you in Lesson 1: **"What causes populations of organisms to change over time?"** Reread your response to this question in Lesson 1. How would you answer this question now? In the space below, describe how your ideas have changed over the course of the last five lessons.

Studies of Galapagos Islands and Ground Finches on Daphne Major

2. Read the following to learn more about another population of organisms that has changed over time. Be prepared to use ideas from the reading about what changes occurred in this population of medium ground finches and explain what caused the changes.

Finches in the Galápagos Islands

For over 40 years beginning in 1973, Peter and Rosemary Grant conducted extensive studies of the living and nonliving components of the ecosystem on Daphne Major, a small island that is part of the Galápagos Islands. The Galápagos Islands are dry places, receiving on average 25 cm (10 in) of rainfall a year. But in 1977, the Galápagos Island of Daphne Major received nearly zero rainfall—only 24 mm, less than 1 inch. Using tweezers and nets, scientists on the island recorded how the number of seeds, insects, and cacti on the island declined sharply as organisms struggled to grow and survive without enough water. Later in 1983, the island experienced an El Nino effect and received 10 times more rain than normal. The scientists continued to study the environment through this period, gathering similar information about number of seeds, insects, and cacti. They found dense growth of vines that covered many cacti and provided habitat for insects.

The Grants caught, banded, and measured many species of finches. They counted their numbers and measured their mass, beak length, and mating habits. They tracked some individual finches throughout their lifetimes. For many individuals, they were able to determine if the individual mated or not each year.

Stop and Think

Why would scientists record the data listed? Why would they gather data over so many years?

There are many species of finches on the island. These finches vary in size from 10 to 20 cm, weigh between 8 and 38 grams, and are dull colored. A male attracts a female through song and they interact based on song and appearance. Together they raise a brood of chicks. Although different species of finches eat different foods, small, soft seeds are favored by several species of finches on the island, including the medium ground finch.

The population of medium ground finches changed dramatically while the Grants were studying Daphne Major. How did the population change and what caused the population to change? To answer these questions, you will examine different data sets and, using your knowledge of how populations change over time generate, and evaluate two possible scientific explanations.

Stop and Think

Thinking about the characteristics of ecosystems in general, why might the population of medium ground finches have changed so much?

Notes from video, The Beak of the Finch

3. To study the finch populations, scientists took a sample of birds from the area. This means that they caught, banded, and measured some of the birds in the area over a period of years. The question they were trying to answer was: What caused the population of medium ground finches on Daphne Major to change over time?

   With your team, choose the figures you will analyze and place a check mark in the first column of Table 1 for those you choose. Be prepared to justify why you selected some figures and did not select other figures.

   To analyze your assigned graph(s), follow the steps below.

   a. Identify changes, trends, or differences in your selected graphs or table.

   b. Write the words “What I see” or “WIS”. Then write a short comment to describe the change, trend, or difference that you noticed. Draw an arrow from each statement to the change, trend, or difference you wrote about. You should create one to three WIS statements for each of your chosen figures.

   c. Also record your WIS statement or statements in the third column of table 1.

   d. After you study each figure, go back and begin to add a “What it means” or WIM statement under each “What I see” or WIS statement. The WIM statement will help you interpret the change, trend, or difference you see. To help you write the WIM statements, use information from previous lessons, the reading about the Galápagos Islands, your chosen figures, and the video clip. Be prepared to share where you obtained your information (e.g., previous lessons, the reading, other figures, or video).

Table 1. Figures and Summary

Chosen	Figure number	What I see statement(s)	What it means statement(s)
	Figure 1: Population size of the medium ground finch between 1975 and 1978.		
	Figure 2: Survival rate of adult medium ground finches between 1976 and 1993.		
	Figure 3: Rainfall per year between 1973 and 2012		
	Figure 4: Survival rate of juvenile medium ground finches between 1976 and 1993		
	Figure 5: Number of large ground finch pairs by year 1983 through 2012.		
	Figure 6: Medium ground finch offspring beak depth in 1976		
	Figure 7: Medium ground finch offspring beak depth in 1978		
	Figure 8: Seed abundance on Daphne Major between 1975 and 1978		
	Figure 9: Seed size by year between 1976 and 1991		
	Figure 10: Sparrow beak depth of offspring, biological parents, and foster parents		

Figure 1: Population size of the medium ground finch between 1975 and 1978.

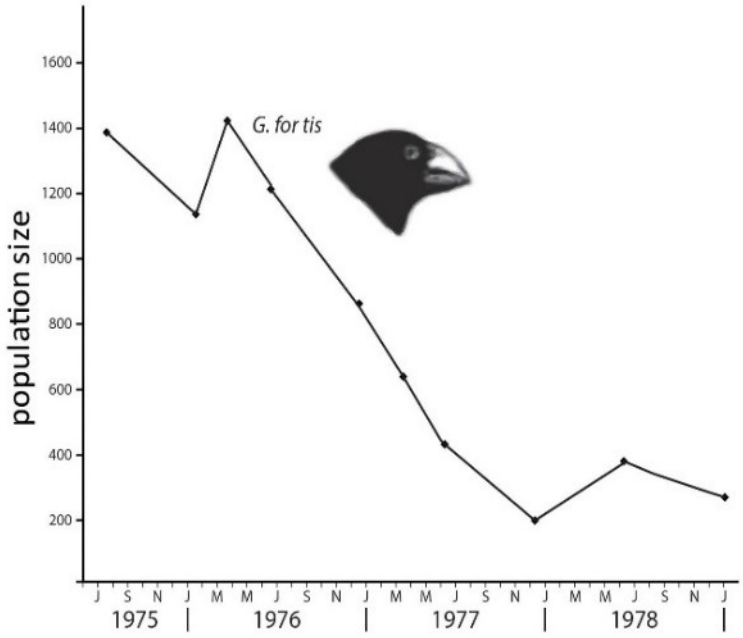

Figure 2: Survival rate of adult medium ground finches between 1976 and 1993.

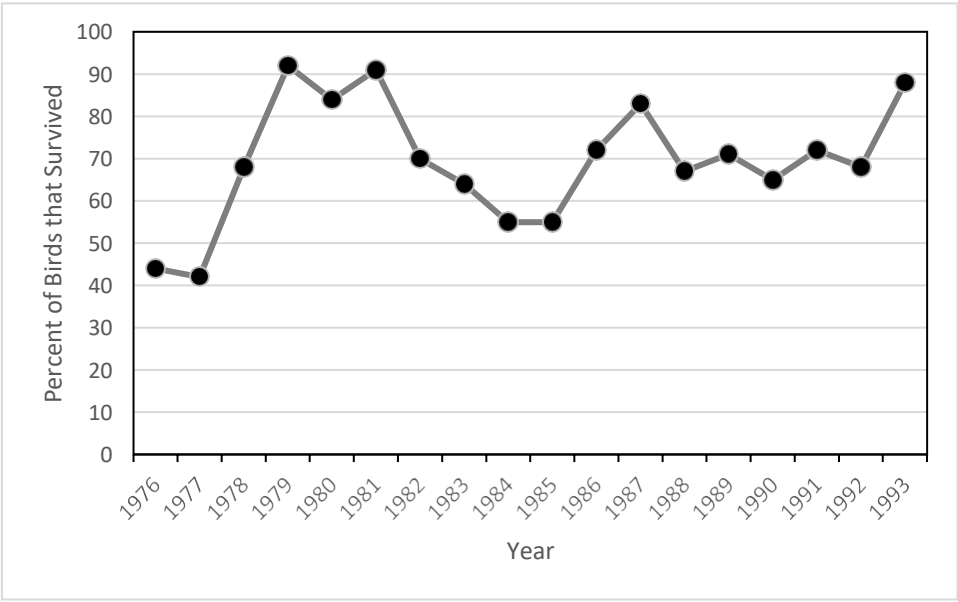

Figure 3. Rainfall and number of organisms by year 1976 through 1991.

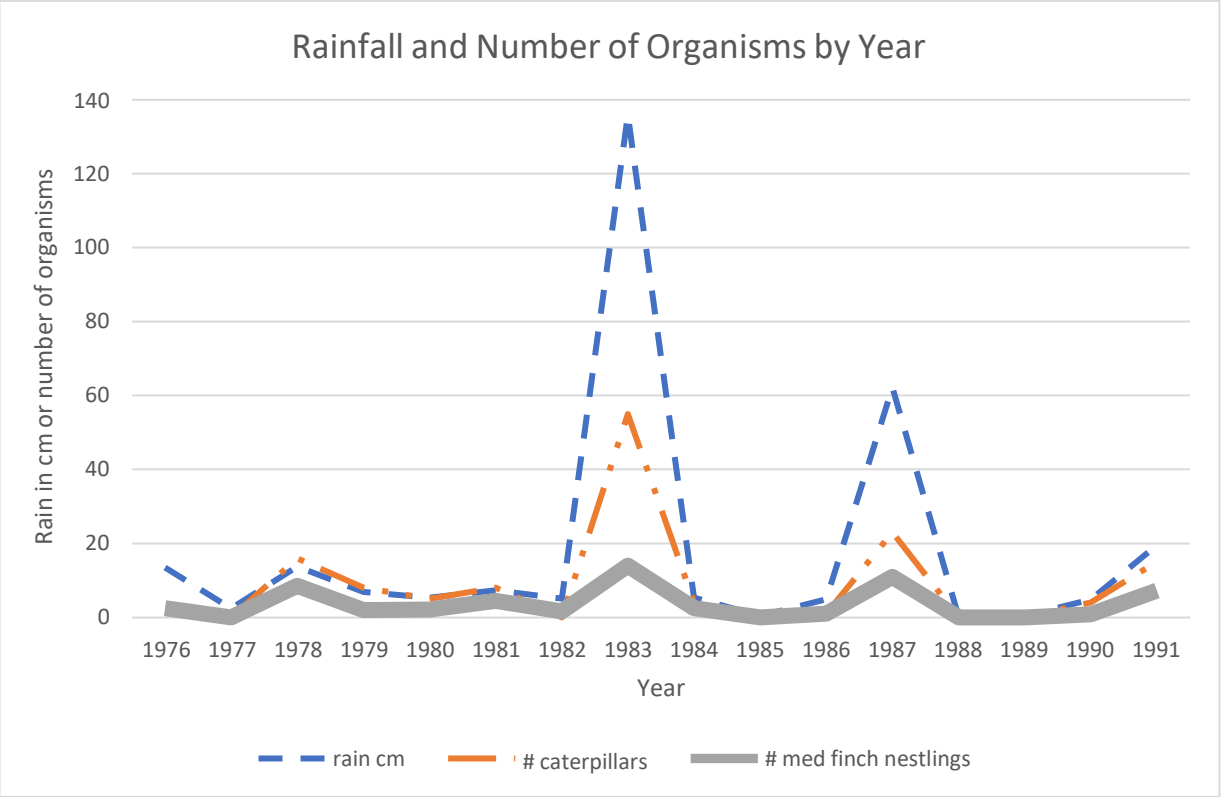

Figure 4: Survival rate of juvenile medium ground finches between 1976 and 1993. *Note that on this graph, the gaps in the line show that data were not collected in theyears where the line is not continuous.*

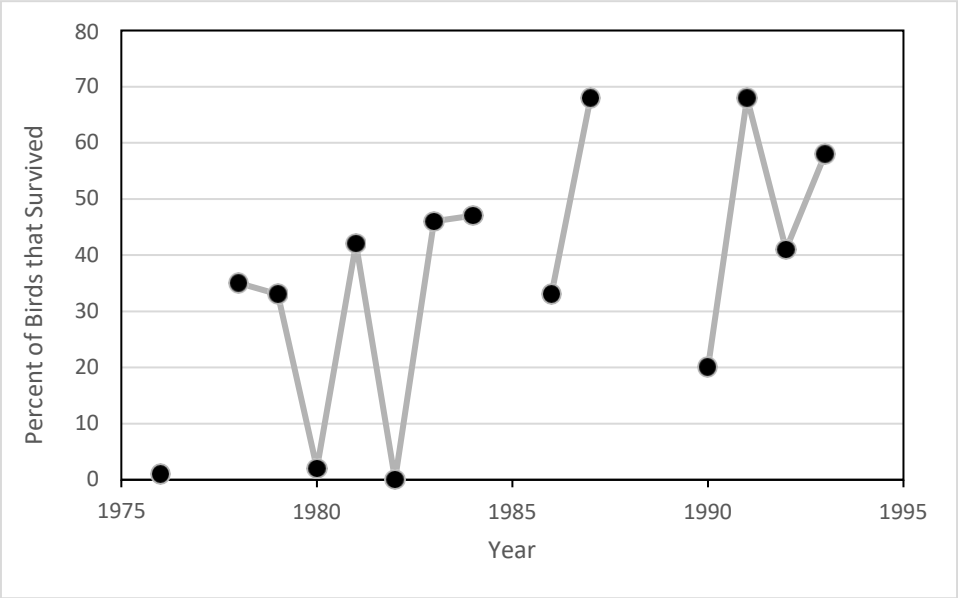

Figure 5: Number of large ground finch pairs by year 1983 through 2012.

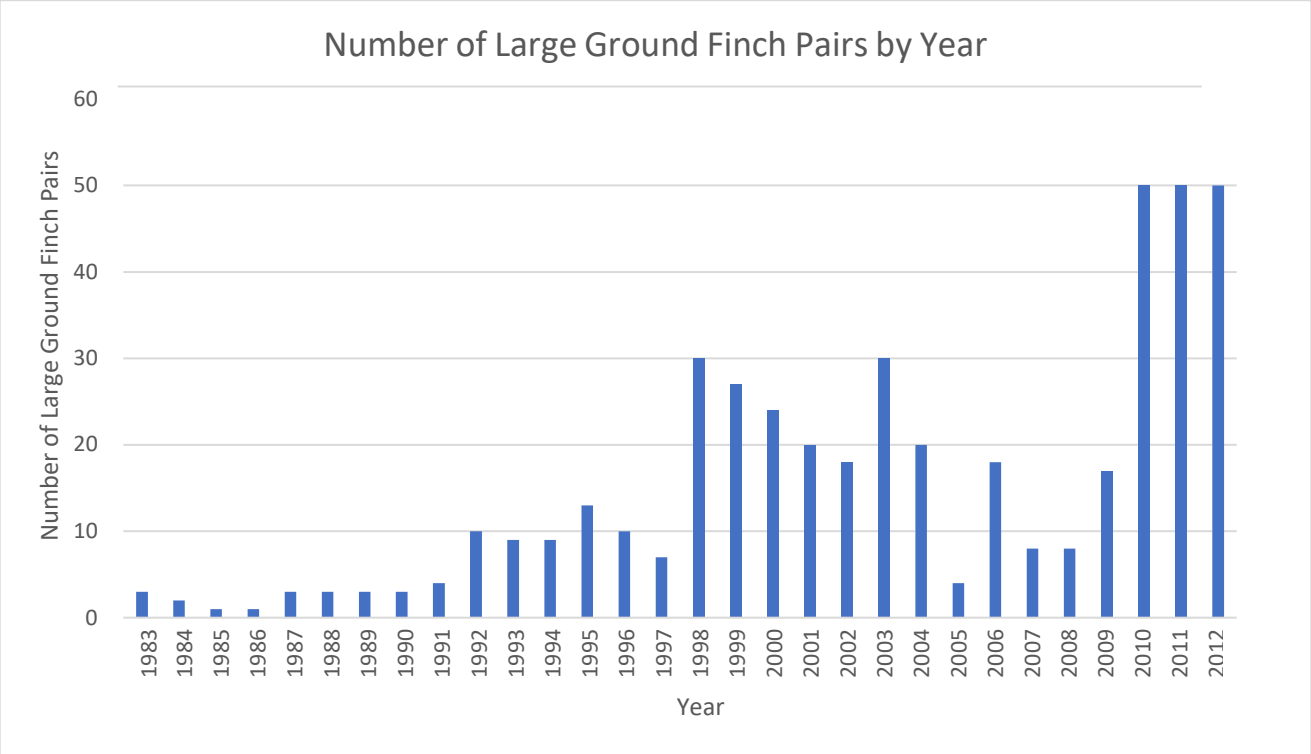

Figure 6: Medium ground finch offspring beak depth in 1976.

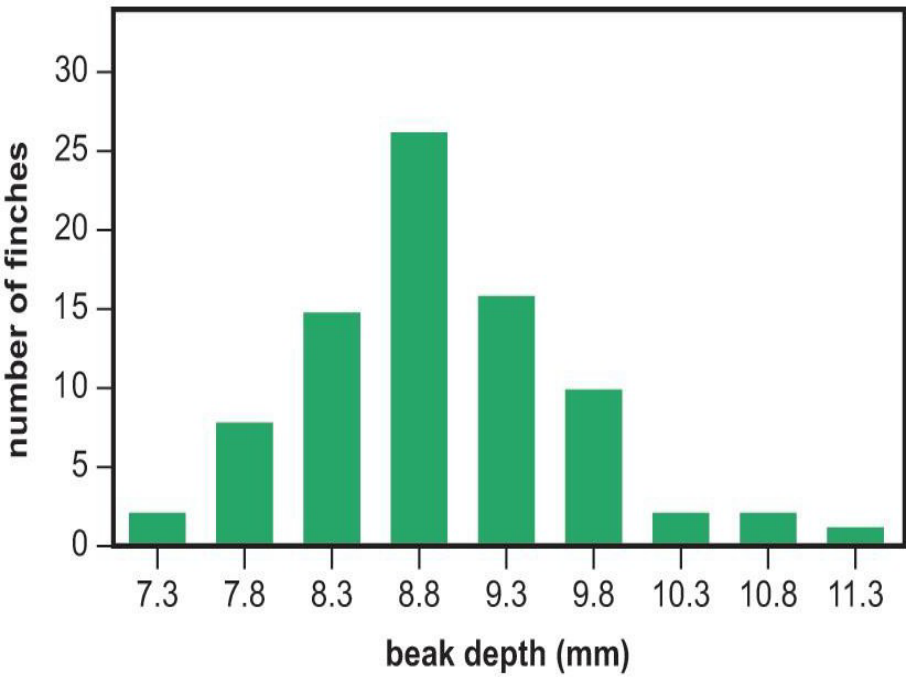

Figure 7: Medium ground finch offspring beak depth in 1978.

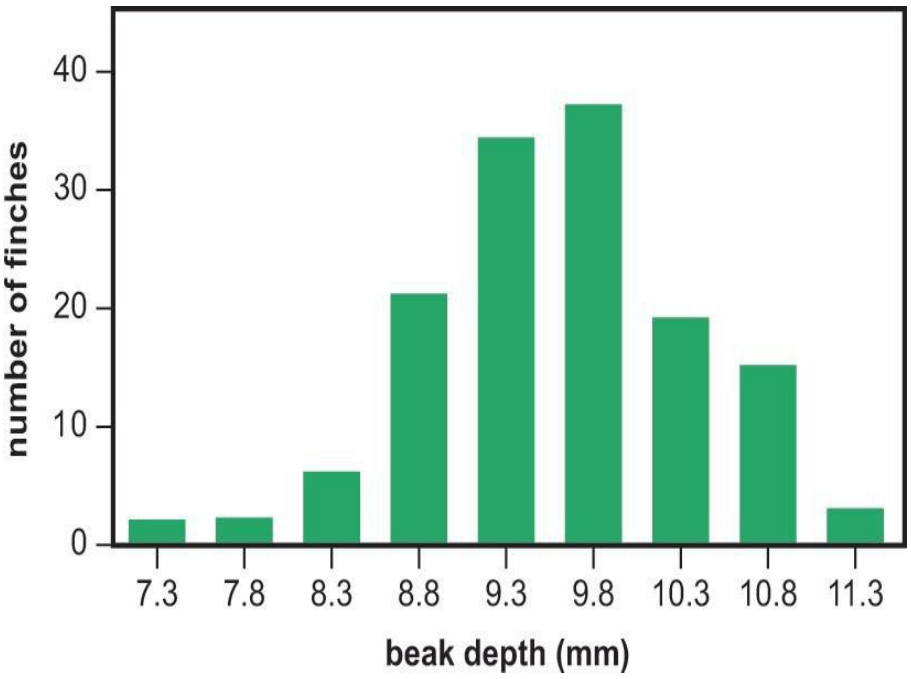

Figure 8: Seed abundance on Daphne Major between 1975 and 1978.

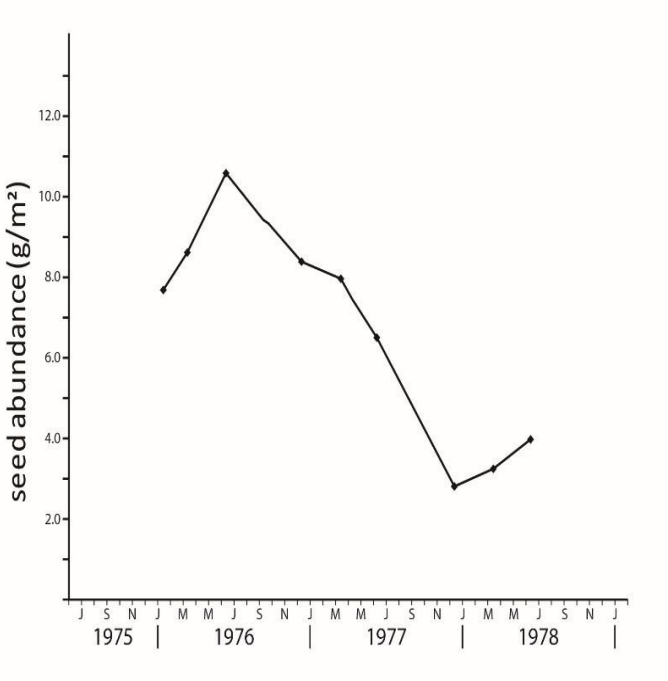

Figure 9: Number of large and small seeds per unit area by year 1976 through 1991.

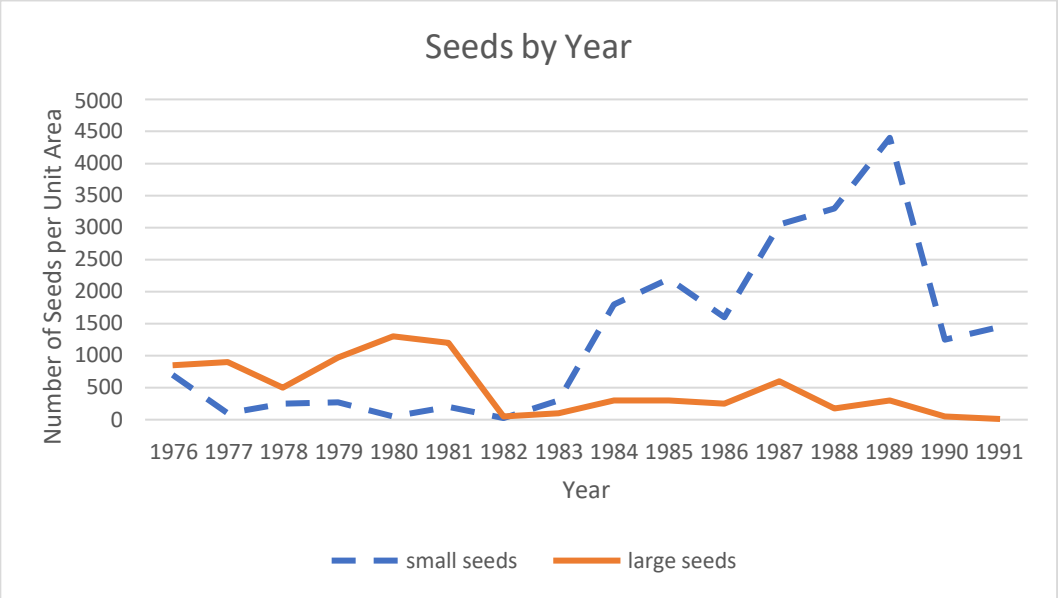

Figure 10: Sparrow beak depth of offspring, biological parents, and foster parents from sparrow egg switch experiment

	Foster parent/offspring (26 families)		Biological parent/offspring (23 families)	
Trait	**Slope**	**Standard Error**	**Slope**	**Standard Error**
Beak length	-0.06	0.43	0.37	0.19
Beak depth	-0.18	0.35	0.98	0.22
Beak width	-0.09	0.20	0.56	0.21

Sparrow egg switch experiment

Researchers in Canada wanted to know if traits in sparrows were determined primarily by genes or by the environment. To answer this question, they exchanged eggs from nests and looked to see if the offspring more closely resembled the biological parents or the foster parents.

The beak depth trait is of interest to us. To analyze the data, the researchers made graphs where the beak depth of the offspring was on the y axis and the beak depth of the parents was on the x axis. The data points were used to form a "best fit line."

The slope of the line is a measure of heritability. If beak depth is entirely determined by genes, the beak depth of offspring will be the same as that of the parents and the slope of the best fit line would be 1.0. If beak depth is entirely determined by the environment, there will be no correlation between the beak depth of the offspring and parents, and the slope of the best fit line would be 0.0. Slopes closer to 1.0 indicate genes influence the trait more strongly than the environment and slopes closer to 0.0 indicate the environment influences the trait more strongly than genes.

Reference

Smith, J.N.M. and Dhondt, A.A. (1980) Experimental Conformation of Heritable Morphological Variation in a Natural Population of Song Sparrows, *Evolution*, 34(6) pp. 1155-1158.

4. You and your team will develop a scientific argument using the information and evidence you've gathered so far to help you answer the question: What is the best explanation for why the medium ground finch population on Daphne Major changed over time?

   Developing a scientific argument involves alternative claims or full scientific explanations that answer a scientific question. Developing a scientific argument requires the evaluation of each alternative claim by analyzing the quality and relevance of the evidence and reasoning used to support the claim and determining how well each claim answers the questions. A scientific argument includes two main parts: 1) a complete explanation that answers the question and provides a critique of the evidence and 2) a rebuttal. A rebuttal provides justification for why the alternative claim, evidence, and/or reasoning is insufficient, irrelevant, or inaccurate.

   Your teacher will provide a partially completed argument. The handout will include the question to be answered and two alternative claims. You will:

   a. consider the scientific question you are investigating.

   b. consider two possible claims that answer the question.

   c. add evidence that supports each claim. The sources of evidence include the summary statements you recorded in table 1 for selected figures, the Galápagos Island reading, and/or the videoclip excerpted from the Beak of the Finch.

   d. critique the quality of the evidence.

5. Think about the analysis of each figure you completed in step 3. For each WIS statement, decide whether it supports (or is consistent with) claim A, claim B, or both and list it in the appropriate box on the tool. If a WIS statement doesn't support either claim, leave it out.

Claim A	**Claim B**
Drought conditions led to a change in food availability that gave medium ground finches with big beaks a survival and reproductive advantage.	Drought conditions caused medium ground finches to increase their beak size in order to adapt to a change in the food supply so they could better survive.
The evidence (WIS statement) that supports this claim is … ***Record your responses on the Argument Tool distributed by your teacher.***	**The evidence (WIS statement) that supports this claim is …** ***Record your responses on the Argument Tool distributed by your teacher.***
Critique Critique the quality and strength of the evidence that supports this claim. ***Record your responses on the Argument Tool distributed by your teacher.***	**Critique** Critique the quality and strength of the evidence that supports this claim. ***Record your responses on the Argument Tool distributed by your teacher.***

6. Work with members of your team and decide which claim, A or B, you think is best supported by evidence and scientific reasoning. Using the criteria listed below, write a scientific argument that includes:
in the Scientific Argument box,

   - the scientific question,
   - the claim that best answers the question,
   - relevant evidence and reasoning that supports your claim,
   - scientific reasoning that critiques

   the evidence, and in the Rebuttal box,

   - a rebuttal that refutes the other claim.

   Part of your team should write the scientific argument. The other part of your team should write the rebuttal. Once you have completed your argument, move on to step 7.

Part 1: Scientific Explanation and Critique of the Evidence ***Record your responses on the Argument Tool distributed by your teacher.***
Part 2: Rebuttal ***Record your responses on the Argument Tool distributed by your teacher.***

7. Scientists engage in argument to get feedback and refine their own ideas. One way this occurs is through presentations. A scientist will write a paper that makes a claim that is supported by evidence and reasoning. They will then share this paper with a group of interested scientists. Depending on their own ideas, individual scientists within the group may agree, disagree, or question the argument that is being presented.

   You will model aspects of this argumentation process in the next step. Check off each step as you complete it.

   a. Exchange your part of the Argument with other members of your team.

   b. Read your partner's part of the Argument.

   c. Ask questions to clarify your understanding of what your partners wrote.

   d. Provide feedback on sticky notes. Write at least two questions or pieces of feedback on your partner's part of the Argument. What you write should help your partners improve their argument. Place each sticky note on your partner's Argument Tool near the information that generated your question or feedback.

   e. Return the Argument Tool and sticky notes to your partner.

   f. Read through the sticky notes on your work. Decide if you agree with what is written. If you agree, revise your work in a different color. If you do not agree, write a statement on the back of the sticky note to explain why you are not taking the advice.

8. Submit to your teacher a completed argument tool with your team member's names on it.

9. During this unit, you used one primary crosscutting concept, cause and effect, to help you explain what causes populations of organisms to change over time. You have explained what caused changes in the stickleback fish population in Loberg Lake and what caused changes in medium ground finches on Daphne Major. How did thinking about "cause and effect" help you explain the changes (or not)?

10. How confident are you that you can answer this unit central question completely**, "What causes populations of organisms to change over time?"** Circle a number to show your confidence.

Not very confident 1 2 3 4 Very confident

11. How has your thinking changed, or not, about the causes for changes in a population over time? If your thinking changed, which activity was most influential and why?