INTRODUCTION

This activity focuses on the medium ground finch (*Geospiza fortis*), a bird species that lives on the Galápagos Islands in the Pacific. Individual medium ground finches have some differences in their physical characteristics, even if they are part of the same species. In this activity, you will explore the importance of these differences. You will also practice skills, such as displaying and interpreting data and supporting claims with evidence, that are essential to your success in science and in your professional life beyond school.

MATERIALS

- “Group Data Table” handout
- box with substrate
- rice and beans
- tweezers and pliers
- cups
- timer (can use phone or watch)
- measuring spoons and cups or a scale

PART 1: Introduction to the Phenomenon

Begin by making some observations about the images in Figure 1 below. First, observe the two individual medium ground finches (A, B). Then, observe some of the seeds that these finches eat (C, D, E). Finally, observe the environment in which finches live and search for seeds (F).

![Figure 1](image)

**Figure 1.** Two different medium ground finches (A, B). Seeds that finches eat from the genuses *Euphorbia* (C), *Sida* (D), and *Tribulus* (E). Plants and rocks on an island in the Galápagos where finches live (F).

1. What do you notice? Record your observations about the images in the following table.
2. Based on your observations, make a prediction about how different individuals of this species might interact with these different seeds.

PART 2: Discussion of the Model

The environment on the Galápagos Islands has changed over time. To explore how this affected the finches on the islands, you will now model the environmental changes. Your model will use the following materials: a box with substrate, rice, beans, tweezers, and pliers. These materials represent the finches, the seeds, and their environment.

3. In small groups, discuss what each material represents based on your observations of Figure 1. In the table below, list which image in Figure 1 (A, B, C, D, E, or F) you think is represented by each material.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Image Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box with substrate</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td></td>
</tr>
<tr>
<td>Tweezers</td>
<td></td>
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<tr>
<td>Pliers</td>
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</table>

4. How could you use the materials in this model to represent the interactions between finches and seeds in the Galápagos?

5. What might be some limitations of this model? In other words, what is not included in this model that is part of the phenomenon you observed in Part 1?

PART 3: Preparing and Practicing with the Model

Next, you’ll practice modeling how finches with different beaks eat different types of seeds. Take a few “seeds” of each type (rice and beans) and try picking them up with each tool (tweezers and pliers).

- To “eat” a small seed (represented by rice), just **pick it up with your tool**.
- To “eat” a large seed (represented by beans), **pick it up and crush it with your tool**. This models how finches must crack open large seeds, which usually have tough shells, to get to the nutritious parts inside.

Prepare the environment for the model by putting the substrate on the bottom of your box. (This may already have been done by your instructor.) Put some seeds in the substrate and try picking them up with the tools.
6. As you interact with the different parts of the model, make careful observations.
   a. Observe the beaks (represented by the tweezers and pliers). How well does each beak pick up each type of seed? How well does each beak crush the larger seeds?

   b. Observe the seeds (represented by rice and beans). How easily can each type of seed be picked up? How easily can the larger seeds be crushed?

   c. Observe the environment (represented by the box with the substrate at the bottom). How does the substrate affect how easy it is to find and pick up seeds?

7. Based on your observations, make a prediction about each beak’s ability to get food under the three environmental conditions (A, B, C) listed below.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Small beak (tweezers)</th>
<th>Large beak (pliers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Both small and large seeds are available.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B: Only large seeds are available.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C: Only small seeds are available.</td>
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</tbody>
</table>

In the next three parts of this activity, you’ll test your predictions by modeling Conditions A, B, and C.

PART 4: Modeling Condition A
You will now model Condition A: Both small and large seeds are available. This is the condition that finches on the Galápagos Islands experienced before 1977.

Read the following steps carefully before starting.

**Step 1:** Watch the short film *The Beak of the Finch* from the start to 7:20. This film clip will provide some context for what you are about to do.

**Step 2:** Pick two members of your group to be “finches.” The remaining members will be “observers.”
- Finches will use a tool (tweezers or pliers) to “eat” as many seeds as possible under a time limit.
- Observers will add seeds to the environment, oversee and time the feeding trials, and count “eaten” seeds. Observers will also make sure that large seeds, if any, are crushed and counted correctly.

**Step 3:** Each finch should choose one tool (tweezers or pliers) and take two empty cups. The observers should sprinkle 2/3 cup (120 g) of large seeds (beans) and 3 tbsp (36 g) of small seeds (rice) into the box with the substrate.

**Step 4:** Run your first trial for 30 seconds.
- Observers should start the trial with the timer.
- Before time is up, finches should pick up as many seeds as possible and place them in their cups. Place small and large seeds in separate cups. Remember that large seeds must be crushed!
- Observers should count each large seed as it is crushed. Small seeds can be counted at the end.
- After 30 seconds, observers should end the trial and count the small seeds collected by each finch.

**Step 5:** Record your results in the “Group Data Table” handout under “Condition A.”
- For this first trial, record your results under “Trial 1.”
• The “Small” beak column is for the total number of seeds (of any size) collected by the tweezers. The “Large” beak column is for the total number of seeds (of any size) collected by the pliers.

Step 6: Empty the cups. Do not put any more seeds in the box. This models the limited supply of seeds available in a season.

Step 7: Repeat Steps 4–6 to run at least four trials total, or as directed by your instructor.

• For each trial, record your results in the “Group Data Table” handout in the row for that trial.
• Let someone else in the group be a finch each time. If someone is a finch more than once, they should use a different tool the second time.

Step 8: After your final trial, add up the number of seeds collected by each beak over all the trials. Record these numbers in the “Total” row of the “Group Data Table” handout.

Step 9: Remove all seeds from your box. Answer the questions below before moving on to Part 5 (Condition B).

8. Write a claim to answer this question: What does this model tell you about the medium ground finch’s ability to find food on the Galápagos Islands before 1977?

9. What is the evidence for this claim? Cite specific evidence from the data you collected.

10. How does your evidence support this claim? Explain your reasoning without simply restating your evidence.

11. Based on what you observed in your model and in the film clip from the start of Part 4, how would you expect this finch population to change (if at all) over the next generation or two? To support your explanation, cite evidence from the model and the film clip.

PART 5: Modeling Condition B
You’ll now model Condition B: Only large seeds are available. This is the condition that finches on the Galápagos Islands experienced from 1977–1983.

Read the following steps carefully before starting.
Step 1: Watch the film *The Beak of the Finch* from 7:20 to 10:01.

Step 2: Pick two members of your group to be “finches.” The remaining members will be “observers.”

Step 3: Each finch should choose one tool (tweezers or pliers) and take one empty cup. The observers should sprinkle **1/3 cup (60 g) of large seeds (beans)** into the box with the substrate.

Step 4: Run your first trial for **30 seconds**.
   - Observers should start the trial with the timer.
   - Before time is up, finches should pick up **and crush** as many large seeds as possible. Place the crushed remains in a cup.
   - Observers should count each large seed as it is crushed and end the trial after 30 seconds.

Step 5: Record your results in the “**Group Data Table**” handout under “**Condition B**.”

Step 6: Follow the same **Steps 6–9** as in Condition A. Answer the questions below before moving on to Part 6 (Condition C).

12. Write a **claim** to answer this question: How did food resources for finches change when the environment changed from **1977–1983**?

13. What is the **evidence** for this claim? Cite specific evidence from the data you collected, including how the model represents what happened in the film clip.

14. How does your evidence support your claim? Explain your **reasoning** without simply restating your evidence.

15. How would you expect this finch population to change (if at all) over the next generation or two? To support your explanation, cite evidence from the model and the film clip from the start of Part 5.

**PART 6: Modeling Condition C**

You’ll now model Condition C: Only small seeds are available. This is the condition that finches on the Galápagos Islands experienced after 1983.

Read the following steps carefully before starting.

Step 1: Watch the film *The Beak of the Finch* from 10:02 to 11:23.

Step 2: Pick two members of your group to be “finches.” The remaining members will be “observers.”

Step 3: Each finch should choose one tool (tweezers or pliers) and take one empty cup. The observers should sprinkle **1.5 tbsp (18 g) of small seeds (rice)** into the box with the substrate.

Step 4: Run your first trial for **30 seconds**.
   - Observers should start the trial with the timer.
   - Before time is up, finches should pick up as many small seeds as possible and put them in their cups.
   - After 30 seconds, observers should end the trial and count the small seeds collected by each finch.

Step 5: Record your results in the “**Group Data Table**” handout under “**Condition C**.”

Step 6: Follow the same **Steps 6–9** as in Condition A. Answer the questions below before moving on to Part 7.
16. Write a **claim** to answer this question: How did food resources for finches change when the environment changed after 1983?

17. What is the **evidence** for this claim? Cite specific evidence from the data you collected.

18. How does your evidence support this claim? Explain your **reasoning** without simply restating your evidence.

19. How would you expect this finch population to change (if at all) over the next generation or two? To support your explanation, cite evidence from the model and the film clip from the start of Part 6.

**PART 7: After the Experiment**

You’ll now use your data to determine which finches would have survived after 1977 based on how much food they collected. The mean number of seeds that each finch collected during Condition A is its **free-feeding amount**: the amount of food that the finch must eat to be full. Assume that for a finch to survive, it needs to eat at least 80% of its free-feeding amount on average, which we’ll call the **80% limit**.

Read the following steps carefully before starting.

**Step 1:** Using your group’s data table, calculate the mean (average) number of seeds collected by each beak type under each condition. Record the results in the “**Mean**” row of your “Group Data Table” handout.

**Step 2:** Using your mean for the **small** beak under Condition A, calculate the 80% limit for finches with small beaks. **Record your answer in the “80% limit” row** for the small beak under Condition A.

**Step 3:** Using your mean for the **large** beak under Condition A, calculate the 80% limit for finches with large beaks. **Record your answer in the “80% limit” row** for the large beak under Condition A.

**Step 4:** Compare the 80% limits with the mean number of seeds that your finches collected in Conditions B and C. If this mean is larger than or equal to the 80% limit, the finch survived. If this mean is smaller than the 80% limit, the finch died. **Mark the finches that died with a cross in the “80% limit” row.**

Answer the following questions based on your results.

20. Did any of your finches die in Conditions B or C?

21. List which finches died under each condition.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Finches that died (small beak or large beak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B: Only large seeds are available.</td>
<td></td>
</tr>
<tr>
<td>C: Only small seeds are available.</td>
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</table>
PART 8: Making Sense of the Phenomenon — Variations within Populations

Answer the following questions based on what you learned from your model investigation and the film.

22. Was there any difference in the abilities of the two beaks to pick up small seeds? If so, what features made one beak more successful than the other?

23. Was there any difference in the abilities of the two beaks to pick up and crush large seeds? If so, what features made one beak more successful than the other?

24. As shown in the film, what caused the average beak size in the finch population to change over time? Be as specific as possible about the different aspects that could have led to these changes.

25. How did this model help you figure out how the finch population changed over time?

26. Consider the selective pressures that could have led to the average beak size of the finch population changing over time. Create a diagram to explain this change in the finch population over generations.
   - Keep in mind that these finches typically live less than 12 years and can produce offspring in their first two years.
   - Use the data from your model investigation and the film to support the interactions that you believe happened on the Galápagos Islands.
   - Be sure to label your components and their interactions in your diagram.