



ACTIVITY 8

Modeling a Method

INVESTIGATION

Estimating the population size
of the Azores bullfinches was
key to its conservation.





8: MODELING A METHOD

GUIDING QUESTION

How can you revise a model for estimating population size?

INTRODUCTION

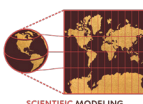
The Azores bullfinch, a small bird found in a limited range in the Azores archipelago, an autonomous region of Portugal in the mid-Atlantic Ocean, lives in high-altitude forests and shrubland. In 2000, it was declared endangered. By 2016, its population had increased significantly, and it is now classified as “vulnerable,” which is a lower risk of extinction. Successful conservation efforts have included monitoring the size of the population through **mark and recapture**—a method of estimating population size by catching as many organisms as possible during a certain period, marking and releasing them, then returning at another time to repeat the process, and this time recording how many newly captured organisms were marked as having been captured before.

Mark and recapture is one common method scientists use to estimate population size. Counting all individuals in a population is the most accurate way to determine its size. Since this is often not possible, scientists usually estimate the total population based on a smaller measured number. In this activity, you will model the method of mark and recapture for estimating populations.



Mark and recapture is used to estimate the population of different aquatic species. It is used in both closed systems (such as lakes and ponds) and open systems (such as rivers and oceans).

CONCEPTUAL TOOLS



MATERIALS LIST

FOR EACH PAIR OF STUDENTS

- BAG OF PLASTIC DISKS
- TIMER
- MASKING TAPE
- CALCULATOR

FOR EACH STUDENT

- STUDENT SHEET 8.1
"Mark and Recapture"

PROCEDURE

- 1 With your partner, obtain a bag of disks, a timer, and some masking tape. You will model the method of mark and recapture for estimating the size of a population. In this model, the bag represents a forest, and each disk in the bag represents a bird in the forest.
- 2 Have one person "capture birds" by reaching into the bag and taking out a disk—one at a time—while the other person times that person for 15 seconds. In the box for Day 1 on Student Sheet 8.1, "Mark and Recapture," record the number of birds caught.
- 3 Mark each bird with a small piece of masking tape and return it to the forest by returning the marked disks to the bag.
- 4 Shake the bag for 20 seconds to simulate the passage of time. This allows the marked birds to mix back in with the rest of the population.
- 5 Switch roles and "capture birds" for Day 2. Have one person reach into the bag and take out a disk—one at a time—while the other person times them for 15 seconds. Count and record both the total number of birds and the number of marked birds you caught on Day 2 in the boxes for Day 2 on the student sheet.

- 6 Use the proportion of marked birds you caught on Day 2 to estimate the total size of the bird population, as shown in the following equation. Calculate and record your population estimate on the student sheet.

$$\text{estimated population size} = \frac{\left(\text{Number of birds caught on Day 1} \right) \times \left(\text{Number of birds caught on Day 2} \right)}{\text{Number of marked birds caught on Day 2}}$$

- 7 Your teacher will tell you the total number of disks in the bag. Compare your estimate to that number.
- 8 The bag and disks are a physical model of how the method of mark and recapture works in the real world. As a group, discuss the following aspects of the model.

HINT: Think about how the model does or does not represent the real-world system.

- What assumptions were made about how well this physical model represented the real-world method of mark and recapture? (How might the model not represent the method of mark and recapture correctly?)
- What were the limitations of the model? (What could it not explain or predict?)



Counting the total number of individuals in a population of birds in flight is difficult.

- 9 Based on your discussion from Step 8, revise your model by modifying the procedure. Record your planned changes to the model and an explanation for the changes on the student sheet.
- 10 Test your revised model by repeating the procedure with your changes. Calculate and record your population estimate from the revised model on the student sheet.
- 11 Evaluate changes to the model by comparing your first population estimate with your second. With your partner, discuss which estimate you think is more accurate and why.
- 12 Share the changes you made to your model and your population estimates with the class. Compare the range of population estimates and discuss which changes to the model resulted in more accurate estimates.

BUILD UNDERSTANDING

- ① In this activity, you modeled the method of mark and recapture for estimating populations.
 - a What are two assumptions of the model of mark and recapture?
 - b Select one assumption and explain how it would affect the population estimate if the assumption was false.
- ② Imagine a city uses a model to predict the number of seagulls on the main public beach to better plan for trash management. The model included 2 factors: the number of tourists and the time of year. The model predicted an average of 200 seagulls per day in July. Local researchers then used data from the method of mark and recapture from 3 days in July to estimate that the average number of seagulls per day in July was 350 seagulls.
 - a Why are the two estimates different, and which is likely to be more accurate? Explain your reasoning.
 - b Describe two specific ways the city could revise their model to improve its accuracy by adding specific real-world factors that were initially left out.



Seagulls find many sources of food near shoreline piers.

- ③ Imagine you are studying a forest ecosystem in which a nonnative bird species has recently been seen. Which estimation method would be most useful in addressing each of the following scientific questions? Explain your reasoning.

Question A: What is the population size of this newly introduced bird species?

Question B: You observe that the nonnative bird species nests only in mature oak trees. How many mature oak trees are there in this area?

CONNECTIONS TO EVERYDAY LIFE

- ④ Imagine you built a simple model on your phone to help you get to school on time. Your model predicts the exact time you need to leave your home to arrive at school on time. In your model, you include the time you woke up and the total time it took you to get to school yesterday. After the first week, you realize that you are still arriving at school after the bell rings. Suggest two specific ways you could revise your model to make it more accurate.

KEY SCIENTIFIC TERM

mark and recapture