Investigation 1.2

A Sample Census — Wildlife on the Move

Objectives:

- Estimate the size of a population of mobile animals using the mark–return–recapture method.
- Compare true census and sample census methods of determining population size.

Background Information:

A **population** refers to the total number of individuals of a single species that live in a designated region at a given time. For example, the population of bison within Yellowstone National Park is about 3,000. The population of humans on planet Earth is approximately 6 billion.

Population density refers to the number of individuals of a species that live in each unit area of habitat at a given time. The habitat is divided into appropriate units such as acres or hectares, square miles or square kilometers. For example, the population density of white-tailed deer in Forest County is 29 deer per square mile.

A **census** is a count of a population. The method chosen depends upon the mobility and size of the population and the accuracy required. A **true census** is an actual count of all of the individuals of a species in a given area. Every ten years, census takers record the number of people living in the United States. Although it provides the most accurate data, it is often impossible to take a true census. This method can only be used if the individuals are large and immobile or slow-moving.

A **sample census** is an estimate of the population. A sample census may be used to determine the population density of almost any plant or animal when an actual count is not possible. The **estimated population** is calculated by multiplying the average population density by the total area of the habitat. For example—if the area of Forest County is 675 square miles and the census estimate is 29 white-tailed deer per square mile, the estimated population of white-tailed deer in Forest County is:

Estimated Population Density X Area of Habitat = Estimated Population

29 white-tailed deer/square mile X 675 square miles = 19,575 white-tailed deer

Animals are usually harder to count than plants because they move and are more difficult to see. Wildlife biologists or ecologists often use the **mark–return–recapture method** to estimate the population density of animals. Animals are trapped and marked in some way, and then they are released. The traps are set again and the animals that are caught are checked for the identifying marks.

The estimated population is determined by using the following formula:

$$P = \frac{T_F T_L}{M}$$

P = estimated population
T_F = total animals captured in first trapping
T_L = total animals captured in a later trapping
M = recaptured animals that are marked

The advantage of the mark–return–recapture method is that it allows an estimate of a population to be made when a direct count is impossible. But the method is not always reliable. Marked animals may be more easily spotted by a predator. Some animals may avoid the trap after being trapped the first time. In other cases, the animals may be attracted to the trap by the presence of food.

Charlie and Libby Schwartz were wildlife biologists, who worked for the Missouri Department of Conservation for many years. For more than 20 years, they used the mark-return-recapture method to estimate the population of the three-toed box turtle. They marked the turtles by filing identifying notches in the edge of the top shell, and they trained their labrador retrievers to find and retrieve the turtles.

Questions for Discussion:

Before beginning this investigation, answer the following questions in your laboratory notebook:

1. Define the following terms:

   census — sample census
   population — true census
   population density

2. As a wildlife manager, you are hired to take a census of the following organisms. Indicate whether you would use a true census or a sample census and justify your choice:

   Bison in the Badlands National Park
   White oak trees in the city park
   Codling moths in an orchard
   Field mice on a farm

3. After taking the census of bison in the Badlands National Park, the wildlife managers know that there are 500 bison in the park. What additional information do the scientists need in order to determine the population density?

4. Wildife biologists use the mark-return-recapture method to estimate the population of rabbits. Twenty rabbits are captured and marked. Two weeks later, 12 rabbits are recaptured. Of these twelve, only 5 are marked. What is the estimated population? Be sure to show your work.

5. What is the advantage of the mark–return–recapture method? Why isn't this method always reliable?

6. How did Charlie and Libby Schwartz "trap" the three-toed box turtles in their study?

7. Make a copy of the chart below:

Trapping	Animals Trapped	Marked Animals (M)	Estimated Population (P)
1st	$T_F = 20$		
2nd	$T_L = 16$		
3rd	$T_L = 19$		
4th	$T_L = 17$		
5th	$T_L = 20$		
6th	$T_L = 14$		
7th	$T_L = 18$		
8th	$T_L = 19$		
9th	$T_L = 20$		
10th	$T_L = 15$		
11th	$T_L = 17$		
12th	$T_L = 12$		

A Sample Census:
using the Mark–Return–Recapture Method

Materials: (per group)

paper lunch bag
permanent marker
paper towel
popcorn kernels

Safety precautions: Be sure to pick up any popcorn kernels dropped on the floor as they might cause someone to fall. Follow all safety rules when working in the laboratory.

Procedure:

1. The preferred habitat of the species *Cornus poppi* is a paper lunch bag. Your task is to estimate the population of *Cornus poppi* in its habitat, using the mark–return–recapture method.
2. Traps are set, and 20 animals are captured. To simulate this trapping, remove 20 animals by taking one popcorn kernel (animal) at a time from the paper bag.
3. Place the popcorn kernels (captured animals) on a paper towel and mark with a permanent marker. Allow the ink to dry completely before you return the animals to their habitat. [Put the kernels back in the lunch bag and shake.]
4. Twenty traps are set to recapture the animals. When the traps are checked, only 16 of the traps contain animals. Four traps are empty. To simulate this trapping, remove 16 animals (corn kernels) from the lunch bag. [Remove the animals one at a time without looking.]
5. Check each of the animals for markings. Record the number of animals that are marked in the chart in your notebook. Return all of the animals to their habitat. [Put the kernels back in the lunch bag and shake.]
6. The traps are reset. When the traps are checked, animals are found in 19 of the traps. To simulate this trapping, remove 19 animals (corn kernels) from the lunch bag. [Remove the animals one at a time without looking.]
7. Check each of the animals for markings. Record the number of animals that are marked on your chart, and return the animals to their habitat. [Put the kernels back in the lunch bag and shake.]
8. The traps are set again and again. Refer to the "animals trapped" column of the data chart to determine how many animals are caught each time the traps are set. Simulate each trapping by removing the correct number of animals (corn kernels) from the lunch bag without looking. Check each animal for markings. Record the data and return the animals to their habitat and shake.
9. Using the formula given in the background information, calculate the estimated population for each trapping.

Remember that $\mathbf{T_F}$ is the number of animals marked in the first trapping. This number is 20. For the second trapping $\mathbf{T_L}$ is 16. The number of kernels marked is **M**. If none of the animals caught in the trapping were marked (M = 0), the calculation cannot be made. Calculate the estimated population for each trapping.
P=(20x16)/M Population = (habitat area) Density

Analysis:

Write the answers to these questions in your laboratory notebook:

1. What are the smallest and largest population estimates?
2. Calculate the average population estimate.
3. Count the total number of kernels in the bag. What is the actual population of *Cornus poppi*? Is this a true census or a sample census?
4. Do you think that the mark–return–recapture method is an accurate way to estimate the population? Justify your opinion.
5. What changes might you make in the procedure to increase the accuracy of the sample census?
6. Would the results be more accurate or less accurate if all of the kernels were removed at the same time instead of one at a time? Explain.
7. Biologists think that the presence of bats is an indicator of a healthy environment. You have been hired to take a census of bats in your county. Design a procedure for a census that would provide a good estimate of a bat population.