

Field Sampling/Ecology

Regents Biology

Name _____

Per _____ Date _____

Lab # _____ “Estimating the Size of a Motile Population”



Introduction

A **population** is all the individuals of a single species that live in a specific area at the same time. It is important to know if a certain population is increasing or decreasing, because changes in one population can cause changes in other populations. **Ecologists** may use this information about population changes to determine if a species is endangered, to set hunting limits, to monitor invasive species, or to evaluate the health of an ecosystem.

Measuring the size of a population can be difficult, especially if it is **motile** (able to move from place to place) since many individuals can avoid being captured. Wildlife biologists developed the **capture-recapture method (CRM)** to determine the size of motile animal populations. This method has been successfully used for decades to accurately determine many animal populations including monarch butterflies, gypsy moths, rabbits, deer, and polar bears (just to name a few!). **Epidemiologists** (scientists who study how and why diseases occur in populations) also use this method to track various diseases, including HIV and multiple sclerosis (MS), in human populations.

The capture-recapture method involves two visits to the study area. On the first visit, scientists capture and mark as many members of a population as possible in a specific area over a certain amount of time. Depending on the species, organisms can be marked using tags, bands, hair dye, ear notches, or paint. The organisms are then released back into their environment. Some time later, the same area is visited a second time and organisms (both marked and unmarked) are captured again in the same manner. The population is calculated based on the following idea:

The % of marked organisms recaptured on the second visit should be the same as the % of the total population marked on the first visit.

Scientists must make **three assumptions** when using this method:

- 1) An organism that has been captured, marked, and released will behave normally. It will be neither more nor less likely to be recaptured because it is marked.
- 2) All organisms will have sufficient time between the first and the second capture period to allow them to randomly mix within a broad area.
- 3) There are no organisms entering or leaving the area (it is a closed population).

Although population sizes can often be estimated fairly accurately using this method, in most cases the actual (true) population size can never be determined because it is usually impossible to capture all individuals of a motile population.

Purpose

To estimate the size of a grasshopper population using the capture-recapture method.

Materials

nail polish storage container (Ziploc bag) calculator pen or pencil

Procedure

Day 1

1. Your class will be assigned to a defined area in which to capture grasshoppers. Each group of 4 will record the number of grasshoppers captured, marked, and recaptured by the group. This data will be compiled as class data.
2. Define Roles:
 Recorder: _____
 Collectors: _____, _____, _____
3. When your teacher tells you to start, capture as many grasshoppers as possible (not crickets!). Place the hoppers in the Ziploc bag. The recorder should tally the number of hoppers collected in the space below. (*Note: you may be asked to record your data on a separate green sheet and transfer them to this handout later*)

Table 1 – Day 1 Tally (group)

| | <i>marked grasshoppers (P)</i> |
|-------|--------------------------------|
| Tally | |
| Total | |

4. After 10 minutes, your teacher will tell you to stop. At this time, carefully remove each grasshopper from the bag (one at a time) and place a small spot of nail polish on its back (thorax). **Be careful not to hurt the grasshoppers.** Release each hopper after it has been marked.

Caution: Stand back while releasing marked hoppers so you don't get wet polish on your clothes!

Day 2

5. The next day, return to the same location. When your teacher tells you to start, collect as many marked and unmarked grasshoppers as possible, placing them in the Ziploc bag as you catch them. The recorder should tally both marked and unmarked grasshoppers in **Table 2** below (*or on the green sheet*).

Table 2 – Day 2 Tally (group)

| | <i>Marked grasshoppers recaptured (M)</i> | <i>Unmarked grasshoppers captured</i> | <i>Total grasshoppers collected (X)</i> |
|-------|---|---------------------------------------|---|
| Tally | | | You do not need to tally, just add up total and write below |
| Total | | | |

6. After 10 minutes, your teacher will tell you to stop collecting.

7. The recorder will determine the following three totals:

P = the number of grasshoppers captured and marked on **Day 1**

M = the number of **marked** grasshoppers captured **Day 2**

X = the **total** number of grasshoppers (**marked and unmarked**) captured **Day 2**

8. All group members should copy the recorder's field data onto their own handouts (Tables 1 and 2).

9. Record your group data (values for P, M, and X) in **Table 3** below.

Table 3 – Combined Group and Class Data

| P (# hoppers captured & marked Day 1) | | M (# marked hoppers recaptured Day 2) | | X (total # hoppers captured Day 2) | |
|---|------------|---|------------|--|------------|
| Group Data | Class Data | Group Data | Class Data | Group Data | Class Data |
| | | | | | |

10. The recorders will report the group data to the class, and class data will be determined. Write the class data in **Table 3** above.

11. Using the formula below, calculate the total grasshopper population in the study area (solve for N). Do the calculation twice: once for your group data and once for the class data. Record your calculations and answers in **Table 4** below (be sure to show all work).

$$\frac{P}{N} = \frac{M}{X}$$

Table 4 – Calculation of Population Size (N)

| Population size (N) based on group data: | Population size (N) based on class data: |
|--|--|
| $N = \frac{(P)(X)}{M} = \left(\frac{\quad}{\quad} \right) \left(\frac{\quad}{\quad} \right) =$ | $N = \frac{(P)(X)}{M} = \left(\frac{\quad}{\quad} \right) \left(\frac{\quad}{\quad} \right) =$ |

Discussion and Conclusion (please answer the following questions in the spaces provided)

1. What is a population? _____

2. Why is it important to know if a population is increasing or decreasing?

3. How do ecologists use information about population changes?

4. Why is it more difficult to measure the size of a motile population?

5. a) What do epidemiologists do?

b) Why do epidemiologists use this method?

6. What three assumptions must be made when using the capture-recapture method (CRM) to determine the size of a motile population?

7. a) How did the value of N based on your group data compare with the value of N based on class data (ex. pretty close, very different, higher, lower)?

b) Which data (group or class) probably gives a more accurate estimate for N? _____

Why? _____

8. What are some factors that would make the marked grasshoppers more likely to be captured than the unmarked grasshoppers?

9. What are some factors that would make the marked grasshoppers less likely to be captured than the unmarked grasshoppers?

10. Why can the actual (true) population size never be determined in most cases?