Estimating Pest Population Size:
The Capture, Mark, and Recapture Method

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Background:
A variety of methods must be employed when attempting to estimate populations of insect or other pests. One method, used by entomologists and wildlife biologists, is the capture, mark and recapture method. The capture, mark, and recapture method is an alternative sampling method that is particularly useful with mobile or far-ranging species. One of the more familiar uses of this method is the monitoring of Pennsylvania white-tailed deer and black bear populations. After black bears are captured, ear tags or gum tattoos are applied and the bears are examined later at hunter check stations.

When used in conjunction with other population sampling techniques, the mark and recapture method can be a powerful tool for monitoring insect and other pest populations.

Introduction:
The capture, mark and recapture method for estimating population size can be summarized by the following formula:

$$P = \frac{N_1 \times N_2}{M}$$

where:

N_1 = number of individuals marked initially

N_2 = number of individuals in second or recapture sample

M = number of *marked* individuals in second or recapture sample

P = population estimate

Learning Objectives:
1. Understand how the capture, mark and recapture method is used to estimate pest, pest predator , or wildlife populations.
2. Estimate the population of a pest species using the mark and recapture method.
3. Analyze and list factors that can effect the accuracy and precision of a population estimate.
4. List advantages and disadvantages of the mark and recapture as a method for estimating insect pest population size.

Materials Needed:
Objects representing pests, pest population
Markers or tape to tag or mark objects
Calculator

Timeline: One hour

Note to Instructors:
- to save time, mark objects in advance.
- the number 75 for both the N_1 and N_2 samples was chosen for convenience and to save time; these can be any number and do not have to be the same.
- to add realism, use names and profiles of actual pests; a similar activity may also be conducted in the field.

Procedure:

1. Divide into teams of 3-4 individuals. Obtain objects representing a pest population from your instructor.

2. Record your team or pest name in Table 2 and on the board (e.g. black beans = black bean *beetles*, white beans = grubs, toothpicks = endangered population of *walking sticks*).

3. Capture and mark 75 individuals (N_1) from the original pest population.

4. Return the marked individuals to the original population. Consider that in a real setting, there would be a time interval between your first sample and your second sample. Individuals would disperse and mix during that time.

5. Capture another 75 individuals (N_2) from the original population. Count and record the number of marked individuals (M) obtained in the second sample. Record this number in Table 1.

6. Calculate a population size estimate (P) using the mark and recapture formula provided in the introduction. Record in data table.

7. Repeat steps 2.-5. two more times.

8. Calculate an average or mean population estimate, the deviation from the observed mean, and the average deviation. Record in Table 1.

9. Record your team's population estimate (mean or average) and average deviation in Table 2 (and on the board).

10. Compare each team's estimate to the actual population total (which your instructor will provide). Which team was the most *accurate* (i.e. came closest to the actual population number)?

11. Compare average deviations. Which team's deviation was the smallest or the most *precise* (had the highest *precision*)?

Table 1.

Trial	N_1	N_2	M	P	deviation from observed mean
1					
2					
3					
				Mean/Avg.=	Avg. dev. =

Table 2.

Team	N_1	Pop. Estimate Average +/- avg. deviation	Actual Population Total

Analysis and Discussion:

1. Fifty lacewings are captured and marked. One week later, 40 lacewings are recaptured. Twenty of these are marked. What is the estimated population of lacewings?

2. What are some of the advantages and disadvantages of the capture, mark, and recapture method? What are some factors that might make this method unreliable?

3. What is the difference between accuracy and precision?

Resources / References:

Enger, E. D. and B. F. Smith. 1997. *Field and Laboratory Activities in Environmental Science*, 6th ed. Wm. C. Brown, Dubuque, IA.

Environmental Science: Ecology and Human Impact, Laboratory Manual. 1995. Addison-Wesley, Menlo Park, CA.

www.accessexcellence.com/AE/AEC/AEF/1995/nevin_grasshopper.html (grasshopper mark and recapture)
www.sitesalive.com/tg/ml/private/mltgmark.htm
www.learner.org/jnorth/tm/monarch/EstimateMRR.html
oikos.villanova.edu/course/~3255/labs/markrecapture/handout.html