

AGRISCIENCE EXERCISE

LIFE/EARTH CONCEPTS

- Key Concept: Environmental Resource Systems
- Sub-Concept: Population Dynamics
- Agricultural Context: Determining populations of insects, wildlife, fish, and other animals leads to sound decisions regarding their control, conservation, and effects of various programs, etc.
- Exercise: **Determining the Size of a Population Using the “Mark & Recapture” Method**
- Applied Principle(s): Population, Algebra
- Goals:
1. Calculate estimated total population using the “Mark and Recapture” formula.
 2. Test the accuracy of the Mark and Recapture method on a known population.
 3. Recognize limiting factors on a population.
- Preparation Time:
- Materials:
 - Calculator
 - Sample Population Kit*
 - Student Data Sheets (1 per student)(per group)
- References: Colverson, P. (Undated). Cornell Environmental Science Pilot Materials (ATP/2000). Ithaca, NY: Cornell University, Department of Education.
- Camp, W. G. and Donahue, R. L. (1994). Environmental Science. Albany NY: Delmar Publishers Inc.

Teacher Preparation:

* For each sample population kit, place 80 unmarked and 20 marked (blue marker) pennies into a box. Be sure that the box used is sealed, except for a slot through which the pennies may be removed and replaced. Students should not be able to see through the box, and should have no way of discriminating among which pennies are removed.



►Recounting and redistributing the pennies as necessary is strongly recommended between uses of the sample population kits, since some marked and unmarked items may become mixed up.

Procedures for Conducting the Activity:

1. Introduce students to the activity using the following problem situation, or a similar one that you have created:

You are a Game & Fish Commission agent. There have been increasing complaints about the number of raccoons in a particular community over the past two years. The animals are apparently becoming a nuisance, and residents want something done about the situation. You notice that the complaints logged in have come from a fairly large geographical area. You decide to investigate, but want to do so in an orderly manner. Misinformation could lead to unwanted consequences, such as the removal or eradication of too many animals. You want to get an accurate idea of just how many raccoons there actually are in the area, but you also have other duties to perform in your job. You call on an area biologist, who agrees to help determine the raccoon population. She suggests using the "Mark and Recapture" method.

2. Explain the "Mark and Recapture" method and formula to the class:
 - a. A sample number of animals in the desired population are captured.
 - b. Each animal in the sample is marked or tagged in some way. Insects can be marked with permanent ink; leg bands are used on birds; fin tags can be placed on fish; other animals can receive collars or ear tags.
 - c. Marked animals are released back into the normal population.
 - d. Later, a new sample is captured, and the number of marked and unmarked animals is recorded. (No new animals are marked.)
 - e. The following formula is used to estimate the total population:

$$\frac{\text{Total Estimated Population (TEP)}}{\text{Number Marked in Sample 1}} = \frac{\text{Total in Recapture}}{\text{Number Marked in Recapture}}$$

Example:

25 raccoons are initially captured, tagged, and released. A subsequent recapture yields 30 animals, of which 5 have tags.

$$\text{STEP 1: } \frac{\text{TEP}}{25} = \frac{30}{5}$$

STEP 2: $TEP \times 5 = 25 \times 30$

STEP 3: $TEP = \frac{25 \times 30}{5}$

STEP 4: $TEP = 150$ raccoons

- f. The more recaptures conducted, the more accurate the estimation of population size. Using the previous example:

In 4 subsequent recaptures, TEP's are 105, 174, 137, and 153.

Therefore, the average TEP $\frac{150 + 105 + 174 + 137 + 153}{5} = 144$

3. Divide the class into small groups of 3 students each.
4. Provide each group with a sample population kit, and data sheets.
5. Explain that their task is to determine the accuracy of the Mark and Recapture method, to find out how closely it can measure the actual size of a population. Each box contains a total of 100 pennies, representing an actual total population. Of these, 20 are marked, representing a sample of 20 animals initially captured, tagged, and released. Each group is to perform a series of 5 "recapture" situations. For each recapture, a sample of 15 to 30 pennies will be removed from the box by shaking them through the slot in the top. After the sample total and number marked are recorded, all will be returned to the box and mixed in before taking another sample.
6. Allow the students to complete the activity and discussion questions as directed on the data sheets, monitoring their progress as they work.
7. Once all groups have completed the exercise, discuss the answers to the discussion questions, especially noting the agricultural applications of the exercise.

AGRISCIENCE EXERCISE

Determining the Size of a Population Using the "Mark & Recapture" Method

STUDENT DATA SHEET

You are to test the accuracy of the "Mark and Recapture" technique, using the penny population in the box provided by your instructor. Since the total population is known, you will be able to determine how well this method works in estimating populations of real animals.

1. Assume that 20 pennies were originally caught, marked, and released back into their habitat (the box).
2. Perform 5 penny recaptures, completing the data chart as you go.
3. For each recapture, remove between 15 and 30 pennies from the box.
4. Be sure to replace all pennies and shake the box before the next recapture.

PENNY POPULATION ESTIMATE LOG

	A	B	C	D	E
	Total No. Recaptured	No. Marked in Recapture	¹ Total Est. Pop. (TEP)	² Average TEP	³ Percent Error
Recapture 1					
Recapture 2					
Recapture 3					
Recapture 4					
Recapture 5					

$${}^1\text{TEP} = \frac{20 \times \text{No. In Column A}}{\text{No. In Column B}}$$

$${}^2\text{Average} = \frac{\text{Total of TEP's}}{\text{No. of Recaptures}}$$

$${}^3\text{Percent Error} = \frac{\text{Ave. TEP} - 100}{100} \times 100$$

5. Complete the following questions. Be prepared to share your answers in a class discussion.
- a. What happened to your average TEP results (column D) as the number of recaptures increased? Why do you think this happened?

 - b. Why is it important to know the percent error when conducting an experiment?

 - c. What happened to your percent error (column E) as the number of recaptures increased? What factors affected this result?

 - d. Was your percent error high enough to discredit your population estimate? Why do you think so?

 - e. Do you think the Mark and Recapture method is an accurate way to estimate the total population of a species? Explain your answer.

 - f. Why would anyone choose the Mark and Recapture method over just capturing and counting the entire population?

 - g. At the beginning of class, your instructor gave you an example of how this technique can be used in real life. What is another scenario in which a population would need to be estimated? (Remember, populations of fish, insects, etc. can all be estimated with this method.)

Use the back of this sheet to record your answer.