BIO FAX!

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Catalog No. FB1439

Publication No. 10265

Estimating Populations

Student Activity Kit

Introduction

The size of an animal population becomes newsworthy when it becomes very large (too many rats in one place) or very small (on the verge of extinction). How do biologists monitor the size of wild animal populations?

Ecological Concepts

- Mark/recapture technique
- Random sampling
- Population size estimating

Background

If a species behaves in such a way that it can be easily counted, then accurate monitoring of its population size and density is easily accomplished. For most species, however, actual counting of all individuals is not possible. Biologists have developed numerous sampling techniques for estimating the size of populations. The specific method employed is usually determined by the behavior and habitat of the species in question. Information on mice, for example, may be collected because they are easily trapped. Direct information about wolves, on the other hand, may be hard to secure and might be determined indirectly by collecting their scat.

The key to most population estimates is the use of random sampling procedures. Once random samples are secured, mathematical and statistical techniques are utilized to project the population estimate.

This laboratory activity will illustrate one method often used in the field. It is often referred to as the *mark/recapture method.* Using this method organisms are randomly trapped, tagged, and released back into the area where they were trapped. After a period of time, traps are set again. The number of trapped animals from the second trapping are divided into two groups, those tagged and those not tagged. The ratio of tagged animals compared to the total trapped population is used to formulate a ratio that is then used to project the total population size. The assumption of this technique is that the actual total population is reflected in the same proportion as the trapped population during the recapture. Of course, this technique would only be considered sound with organisms that are easily trapped, tagged, and redistributed evenly back into the original population.

Materials

Container (600-mL beaker, jar, bowl or shoe box)
Plastic beads, blue, 200–300
Plastic beads, yellow, 25–50
Population Worksheet

Safety Precautions

This laboratory is considered nonhazardous. Please follow standard laboratory guidelines.

Experiment Overview

The goal of this study is to accurately estimate the size of the "Blue" population in the container.

Procedure

1. Secure a container containing the "Blue" population. Do not count. *Tip:* This container should be holding approximately 200 blue beads.
2. Remove a small handful (25–30) of the Blues from the container. Count the number of Blues removed. This number represents the initial number of trapped Blues. Record this number on the Population Worksheet (A). Set these Blues aside for the remainder of the laboratory.

3. Obtain an equal number of "Yellow" beads to equal the number of the Blue removed (trapped). For example, if 25 Blues were drawn from the original container, obtain 25 Yellow beads.
4. Place these Yellows into the original population container the handful of Blue beads was removed from. These Yellows will represent the initial trapped Blues and we will assume they have been tagged Yellow. The population container is now holding approximately 175 Blue beads and 25 Yellow beads.
5. Disperse the Yellows back into the population randomly. Do this by shaking the population container vigorously for about one minute.
6. Without looking, retrap a small handful of organisms from the population container. Count the number of tagged organisms (Yellows) and the number of non-tagged organisms (Blues). Record these numbers as Trial 1 on the Population Worksheet.
7. Replace all the organisms from Trial 1 back into the population container. Shake the population container vigorously again for about one minute.
8. Repeat the sampling technique as in step 6 and record the counts of tagged and untagged organisms as Trial 2 on the worksheet.
9. Repeat these same sampling procedures for a total of 20 trials, recording the results on the worksheet.
10. Determine the total number of tagged and untagged organisms for all of the trials. Record these numbers on the worksheet.
11. Complete parts 3–6 on the worksheet.

Teacher's Notes

Estimating Populations

Materials Included in Kit

Plastic beads, blue, 3000

Plastic beads, yellow, 750

Population Worksheet (copy master)

Additional Materials Needed (for each lab group)

Container (600-mL beaker, jar, bowl or shoe box)

Pre-Lab Preparation

1. Secure appropriate containers to hold the beads during the lab. The containers should have a large enough opening at the top to allow student hands to reach in to secure a *small* handful of beads. A 500–600 mL plastic beaker works well, although other jars or bowls can be used.
2. Divide the beads equally among the containers to be used for each lab group's population. The number in each container will vary (do not count) and will depend upon the number of working groups you set up. If the Blue beads are divided into 15 groups, there will be about 200 beads in each container. If fewer containers are used, the population sizes can be greater.
3. Make a copy of the Population Worksheet for each student.

Safety Precautions

This laboratory is considered nonhazardous. Please follow all standard laboratory safety precautions.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. All items from this kit can be saved and used many times.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard C: Life Science, population and ecosystems
Content Standards: Grades 9–12
Content Standard C: Life Science, behavior of organisms

Tips

- Enough materials are provided in this kit for 30 students working in pairs, or for 15 groups of students. All materials are reusable. The laboratory can reasonably be completed in one 50-minute class period.
- With a little research you are likely to find state or local biologists that do random sampling of populations with some regularity. Field trips and/or guest speakers can help to make this simulation laboratory activity take on real-life meaning.
- Be sure students do the sampling in an "eyes-closed" and random fashion. If they do it systematically, they will get excellent population predictions. If the containers are not good for shaking, have students stir the population beads for one minute.

Teacher's Notes *continued*

Sample Data

1. Number of Blue in initial trapping: *25* (A)

2.

Trial #	# of Tagged (yellow)	# Not Tagged (blue)
1	*0*	*15*
2	*0*	*10*
3	*1*	*15*
4	*2*	*17*
5	*0*	*16*
6	*1*	*13*
7	*3*	*14*
8	*0*	*11*
9	*1*	*6*
10	*1*	*12*
11	*2*	*17*
12	*3*	*15*
13	*3*	*11*
14	*4*	*12*
15	*3*	*11*
16	*1*	*17*
17	*0*	*20*
18	*4*	*14*
19	*1*	*11*
20	*2*	*17*
Total	*32*	*274*
Average/Trial	*1.6* (B)	*13.7* (C)

Teacher's Notes *continued*

3. Calculate the percent of the average number of tagged organisms in the samples:

$$\bar{S} = \frac{B}{B+C} \times 100\% = \frac{1.6}{15.3} = 10.5$$

4. If the actual population is a reflection of the tagged/untagged ratio, then the following should be true:

$$\frac{\text{(A) \# originally tagged}}{\text{(P) Total Population}} = \text{average percent } (\bar{S})$$

Solving algebraically for P yields:

$$P = \frac{(A)}{\bar{S}} = \frac{25}{.105} = 238$$

Calculate the estimated total population (P): *238*

5. Count the actual population in the population container (tagged and untagged organisms). *250*
6. How close was your estimate to the actual population? Calculate the percentage deviation from the actual.

$$\frac{12}{250} = 4.8\%$$

7. How could the experiment be improved to decrease the percentage of deviation from the actual?

   Take more samples, larger samples, shake more evenly, use a sampling device, etc.

8. What errors may be present when biologists actually go into the wild to monitor wild animal populations?

   Many unforeseen factors can affect the size of a population. Food, death, predators, etc. Accept a variety of logical answers.

9. What animals would you think this mark/recapture technique would work well for? Why?

   Easily-trapped, small animals would be especially well suited. Since their recapture rate would be high enough to assure a good sample size.

10. What animals would you think this mark/recapture technique would not work well for? Why?

    Very wary animals that are difficult to trap.