Estimating Population Size

**STANDARD COURSE OF STUDY CORRELATIONS:**

**Biology, Secondary Grades, Goal 5:** The learner will develop an understanding of the ecological relationships among organisms.

5.01 Investigate and analyze the interrelationships among organisms, populations, communities and ecosystems, including techniques of field ecology; abiotic and biotic factors; and carrying capacity.

**Science, Grade 6, Goal 7:** The learner will conduct investigations and use technologies and information systems to build an understanding of population dynamics.

**Math, Grade 7, Goal 1:** The learner will understand and compute with rational numbers.

1.01 Develop and use ratios, proportions, and percents to solve problems.

1.02 Develop fluency in addition, subtraction, multiplication, and division of rational numbers.
   a. Analyze computational strategies.
   b. Describe the effect of operations on size.
   c. Estimate the results of computations.
   d. Judge the reasonableness of solutions.

1.03 Develop flexibility in solving problems by selecting strategies and using mental computation, estimation, calculators or computers, and paper and pencil.

**INTRODUCTION TO LESSON:** Students will simulate the capture-mark-recapture technique of population size estimation, which is the method often used for counting mobile organisms. Students will discover some of the ways that population size can be estimated and will explore how estimating population sizes helps scientists gauge the health of the environment.

**BACKGROUND FOR TEACHER:** The video contains a few references to the methods used to assess the health of the marsh environment. These methods involve capturing and counting populations, simulated in this lesson. There are other ways to estimate population size. (See Additional Resources for links to information about other sampling methods.) The choice of method depends upon the type of environment and the type of organisms involved.

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**engage**

Show Chapters 1–3 of the video. Have students work in groups to discuss why it is important to estimate population sizes and how they might determine the population sizes of some of the organisms mentioned in the video. Ask them to focus on one type of fish, one type of shellfish, one plant and one bird. (Alternatively, you could assign one of the marsh organisms to each group and ask them to brainstorm ways to track the population sizes over several seasons.) Have groups present their proposals. Also, have students identify any questions that arose as they were trying to decide how best to estimate population sizes.

**explore**

Have students complete the bean counting activity. If you’re teaching multiple classes using different color beans, let the students know. That way, they can appreciate that more than one research group is studying the same population.

**explain**

Have each group explain how they estimated the size of their bean populations and which sampling technique was the most accurate. Then have students in
Estimating Population Size

BEYOND THE CLASSROOM

If you have a varied ecological environment around your school, have students do some real population sampling, choosing the most appropriate method.

Additional Resources:

A nice overview of various sampling techniques can be downloaded at http://bio.fiu.edu/pcb3043l/lab_manual/lab_1.pdf.

For a comprehensive view of quantitative population ecology (great as teacher background), visit http://www.ento.vt.edu/~sharov/PopEcol/.

Quadrat sampling is a good method for forested areas. The Web site http://www.eco-online.qld.edu.au/novascotia/resources/quadrats.html explains how to set up a quadrat study.


Teacher’s Notes:

...
Population Sampling
The Great Beanie Body Count

Purpose: To simulate sampling techniques used to estimate population sizes.

PROCEDURE – FIXED SAMPLE SIZE:
1. Take 50 beans from the population bag (the bag represents the environment).
2. Draw a small line on each bean.
3. Place the marked beans back in the bag.
4. Mix the beans well.
5. Take out 20 beans randomly without looking into the bag.
6. Count the marked beans and record the total in the chart (Trial 1).
7. Place the 20 beans back in the bag and remix.
8. Repeat steps 5, 6 and 7 two more times (Trials 2 and 3).

PROCEDURE – RANDOM SAMPLE SIZE:
9. Remove a handful of beans from the bag.
10. Count the marked beans and the total number of beans; record both numbers in the chart (Trial 4).
11. Return all beans back to the bag and remix.
12. Repeat steps 9, 10 and 11 two more times.
13. Complete the calculations and record in the chart (Trials 5 and 6).
14. Count all of the beans in the bag and record the total in the column “Actual number of beans in bag.”
### Estimating Population Size

#### Trials

<table>
<thead>
<tr>
<th>Trials</th>
<th>Number of beans with marks</th>
<th>Total number of beans in handful(s)</th>
<th>Calculation of total number of beans in bag</th>
<th>Actual number of beans in bag</th>
<th>Percent error</th>
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</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td>20</td>
<td></td>
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<tr>
<td>(10 beans)</td>
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<td>Trial 2</td>
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<td>(10 beans)</td>
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<td>Trial 3</td>
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<td>20</td>
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<tr>
<td>(10 beans)</td>
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<tr>
<td>Average of Trials 1-3</td>
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<td>60 ÷ 3 = 20</td>
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<tr>
<td>Trial 4</td>
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<tr>
<td>(1 handful)</td>
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<td>Trial 5</td>
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<tr>
<td>(1 handful)</td>
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<td>Trial 6</td>
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<tr>
<td>(1 handful)</td>
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<tr>
<td>Average of Trials 4-6</td>
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Note: When you calculate the average, use the average number of beans per trial and the average number of beans per handful. In other words, don’t simply average your previous calculations.

#### CALCULATIONS:

**A. Average:**
- Average number of marked beans (Trials 1-3): Add up all marked beans for Trials 1-3 and divide that number by 3.
- Average number of marked beans (Trials 4-6): Add up all marked beans for Trials 4-6 and divide that number by 3.
- Average total number of beans (Trials 4-6): Add up all the beans that were removed from the bag for Trials 4-6 and divide that number by 3.

**B. Calculated Total Number of Beans in Bag:**

\[
\text{Total Beans in Bag} = \frac{\text{Total beans in Trial}}{50 \text{ marked beans}} \div \text{# of marked beans}
\]

**C. Percent Error:**

\[
\text{Percent Error} = \frac{\text{Calculated value} - \text{Actual value}}{\text{Calculated value}} \times 100 = \% \text{ error}
\]

#### ANALYSIS QUESTIONS:

1. Which of your calculated averages came closest to the actual total bean population size?
2. What is the relationship between sample size and the accuracy of your calculated population size?
3. Assuming that there is no way to count every individual in a population, what do your results suggest about the best methods for sampling populations?
4. Periodically, you shook the bag to thoroughly mix in the marked beans. What was this supposed to represent about real populations?
5. In what ways do real populations differ from our bean population?
6. In what ways are real populations similar to our bean population?
7. What factors might affect the sizes of the following populations of coastal North Carolina species?
   - Flounder:
   - Pelicans:
   - Clams:
   - Marsh Grass: