Estimating Population Size

Introduction

The best way to measure the size of a population is to count all the individuals in that population. When determining the population sizes of trees or other relatively immobile organisms, this method is practical. If the organism is mobile, however, such as a fish, counting every individual would be difficult. Some individuals might be counted twice or not at all, since the experimenter would not know which fish had been counted and which had not.

Knowing the size of a population of animals is important in making environmental decisions that would affect the population, but estimating the size of wild populations is extremely difficult. In the case of ocean dwellers, such as whales, the task is especially challenging. Estimates of the number of minke whales, for example, have differed by as much as a factor of 10. Deciding whether to allow hunting of minke whales, based on population estimates that are too high, could lead to extinction of the species. On the other hand, basing a decision on an estimate that is too low could unnecessarily ban hunting of minkes by people that depend on whales for food. One method for estimating population size, the "line-transect survey", involves observing every animal seen while traveling in a straight line. Although traditionally used for counting land animals, the line-transect survey method has recently been applied to whales, providing more reliable data.

Another method often used to estimate population size is the "mark and capture" technique, in which scientists capture some animals from the population, mark them, and release them. At a later time, the scientists again capture animals from the same population and observe how many of them are marked. The method assumes that the ratio of the actual population to the sample size is the same as the ratio of the number of marked animals to the number marked in the recapture sample. Knowing three of the four values [recapture sample size (N_2), number originally marked (N_1), and number marked in the recapture sample (R)], scientists can calculate an estimate of the actual population size (P). This method of estimation is called the **Lincoln Index**.

$$P = (N_1 \times N_2) / R$$

P = total size of population
N_1 = size of first sample (the ones originally marked)
N_2 = size of second sample (the ones recaptured: some will be marked, some won't)
R = number of marked individuals recaptured in second sample

The Lincoln Index makes several assumptions that must be met if the estimate is to be accurate:
- The population of organisms must be closed, with no immigration or emigration.
- The time between samples must be very small compared to the life span of the organism being sampled.
- The marked organisms must mix completely with the rest of the population during the time between the two samples.

PROCEDURE
1) Answer the Pre-Lab questions on your answer sheet.
2) Select 50 marbles (or beans). If using one color of marbles, use the marker to draw a spot on 20 of the marbles. If using colored marbles, use 30 white and 20 colored.
3) Place all 50 marbles in the container and cover with the lid. Shake the container to mix them thoroughly. Take the lid off and without looking, withdraw 10 marbles. Count the number of marked marbles and record in the data table.
4) Put the 10 marbles back in the container and replace the lid. Shake the container again and withdraw a second set of marbles. Again, record the number of marked marbles in the sample in the data table. Continue in this manner until you have completed 10 trials.
5) Estimate the population size* for each trail by multiplying the number of marbles marked (20) by the number of marbles in both sample (20) and dividing the product by the number of marked marbles for that trial. The result is an estimation of population size. When you have done this for all 10 trials, find the average by adding the estimates and dividing by 10**.
6) Answer the conclusion questions.