

Lab 7.

Estimating Animal Population Sizes by Mark-Release-Recapture Methods

For most animals, direct counts of population size are impossible because the species are secretive, cryptic, or inaccessible. However, total population size can be estimated (with confidence limits) from a statistical analysis of a smaller sample that has been captured, marked, released and then recaptured at a later time.

A number of these “Mark-Release-Recapture” (MRR) methods are available at different levels of sophistication, and the choice of method should be matched to the ecology of the target species and the resources of the investigator. The simplest method, the Lincoln-Petersen method, involves a single marking and a single recapture.

The Lincoln-Petersen method

The method assumes the population is closed (no immigration or emigration, births or deaths between marking and recapture). The method also assumes that all members of the population are equally likely to be marked and recaptured, and that marked animals are randomly distributed in the population at the time of recapture.

A sample of individuals is captured, marked in a manner that does not affect survival, and then released back into the population. After a time period judged to be long enough to allow the marked animals to mix at random through the total population, a second sample is captured. The number of recaptured animals (i.e. marked animals) to first time captures in the second sample gives the Lincoln-Petersen estimate of total population size:

$$N = \frac{(n_1 + 1)(n_2 + 1)}{m_2 + 1} - 1$$

Where N is the Lincoln-Petersen estimate of the total population size, n₁ is the number of marked animals released into the population, n₂ is the total number of animals in the second sample, and m₂ is the number of marked animals in the second sample (i.e. recaptures).

The standard deviation of N is given by:

$$\text{St.dev} = \frac{(n_1 + 1)(n_2 + 1)(n_1 - m_2)(n_2 - m_2)}{(m_2 + 1)^2(m_2 + 2)}$$

The 95% confidence limits on any parameter are given by +/- 1.96 standard deviations around the parameter.

The Exercise.

At the beginning of lab, we will capture a sample of isopods from the isopod colony. Working in pairs, aim to capture 5-6 of the larger animals. Immobilize each isopod using paint brushes, and then use the fine tip of a tooth pick to apply a small dot of colored nail polish to the back of the animal.

Record the total number of marked animals (n_1) and return them to the colony.

After one hour, collect a sample of compost from the colony, separate the isopods, and count the total number of captures (n_2) and the number of captures carrying marks (m_2).

Using HALF the class data, calculate the Lincoln-Petersen estimate, its standard deviation and 95% confidence limits.

Repeat for the full class data set.

How does N, and especially the standard deviation and 95% confidence limits on N, vary with sample size?

As you have seen, if we know the sample sizes we can calculate the 95% confidence limits on N. It follows that if we desire specified confidence limits for a study, we can calculate the required sample size if we make an educated guess about the size of N.

Assume you are given the job of determining the size of the population of Coast Horned Lizards (a Threatened species in Southern California coastal sage scrub habitat). Your supervisor requires that your estimate be made with 95% confidence limits of +/- 15% or better, but also that you invest the smallest possible amount of manpower, time and money. You decide to use the Lincoln-Petersen method to minimize handling and disturbance of the animals. Your review of the literature reveals population densities in similar habitats that lead you to guess that your study area may contain roughly 800 animals.

In planning your MRR study, how large a sample size do you estimate that you will need?

