**Counting Mobile Populations**

**Question:**

“How do we quantify whether songbird species are declining in the U.S.?”

**Lab Overview:**

During our next field exercise we will be conducting a mark-recapture study of insect abundance in our Palouse River study area. We will use this data to estimate the population size within our study area. Estimations of animal abundance are important tools for both aquatic and terrestrial ecologists since many populations are mobile, occur over large areas, or are otherwise difficult to count in their entirety.

Songbirds in particular are a good example. In the 1950’s people began to notice that there seemed to be fewer songbirds in the U.S. But how do you turn a ‘gut feeling’ into data? How do you determine population size of birds that fly from Central America to Washington State each year? The US Fish and Wildlife service did just that and found that since the 1970’s Baltimore Orioles have declined 30%, wood thrushes 40% and golden winged warblers 46%! How did they come to these estimates and are they accurate?

In this lab we will model a similar technique to that used to quantify bird populations in order to understand the mark-recapture technique of estimating population size. Using our model we will work to understand the Lincoln-Petersen mark-recapture equation, a simple mark-recapture equation. In the process we will try to validate the technique (convince ourselves that it works the way we expect) under different conditions. We will also begin to explore some of the possible sources of error in our estimation using mark-recapture techniques.

**The Lincoln-Peterson Estimator**

The Lincoln-Peterson equation is a mathematical method for estimating a mobile population using the mark-recapture technique. It relies on the relationship between the number of marked animals to the total population, and the movement of individuals, to estimate the population size.

*Lincoln-Petersen Mark-Recapture Equation*

**

*P = estimate of entire population*

*C1 = # captured the first time (all are marked)*

*C2 = # captured the second time*

*M2 = # of marked individuals in second capture set*

**Materials**

* brown paper lunch sack
* macaroni noodles
* felt tipped pen

**Getting to know your model**

**1)** Each group should take a medium sized handful of macaroni and place it in their paper bag.

**2)** Have someone from the group count out 20 pieces of macaroni. Mark each of these pieces with the felt tipped marker using a method that can bee seen from all sides of the noodle.

**3)** Replace these marked noodles into the bag and shake it to mix all the noodles together.

**4)** Have another member of your group count out 20 noodles without looking in the bag.

**5)** Count the number of marked noodles and record them below.

**6)** How is each variable of the Lincoln-Peterson equation represented in the macaroni model we just worked through? What are their values?

*P =*

*C1 =*

*C2 =*

*M2 =*

**Getting to know your model (continued)**

**7)** Plug in the values you recorded from the model into the Lincoln-Petersen equation. What is your estimate of the “population size” of your bag of macaroni noodles? Repeat the procedure 5 times and average your estimates. Is this a better representation of the actual number of noodles in the bag?

**Procedure**

1) Break into groups of 2-3

2) Choose two variables from the Lincoln-Petersen equation to explore. List them below.

3) For each of your chosen variables what will happen to the accuracy of your estimate of the noodle ‘population’ if you increase that variable? If you decrease it? State each scenario as a hypothesis.

(Continued on next page)4) **!!Get rid of all the previously marked macaroni before you start this step!!** Conduct the procedure to estimate the number of noodles in the bag 5 times, setting one of the variables you picked either higher or lower than before. Record your estimates for each run and the average. Do this for the other variable as well. (Pick a value for each variable and hold it constant for 5 runs)

Variable #1

Circle the variable you are testing

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 |
| *C1* |  |  |  |  |  |
| *C2* |  |  |  |  |  |
| *M2* |  |  |  |  |  |
| *P* |  |  |  |  |  |

Average population estimate:

Variable #2

Circle the variable you are testing

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 |
| *C1* |  |  |  |  |  |
| *C2* |  |  |  |  |  |
| *M2* |  |  |  |  |  |
| *P* |  |  |  |  |  |

Average population estimate:

**Thinking Critically**

**Answer the following questions in the space provided or on an attached sheet. Use complete sentences, or paragraphs where appropriate.**

**1.1** Explain how the Lincoln-Petersen equation can be applied to estimating insect populations in our stream study area?

**1.2** What should our first step be?

**2.1** In general, biologists using the mark-recapture technique method assume that the mark or tag needs to be inconspicuous. Why might a more obvious mark affect your population estimate?

**2.2** What would constitute an obvious mark in our macaroni model?

**3)** Our model is a simplified way of understanding a technique performed in the wider world where all the factors cannot be controlled. Identify and discuss two factors that might affect our population estimate of Palouse River insects.

**4)** One assumption of the Lincoln-Petersen equation is that the study area is “closed”, i.e. – individuals cannot move in or out of the study area during the study. Is this true of songbirds? How would that affect the results? Would the population estimate be negatively or positively biased? Discuss.

**Extending Mark-Recapture to the Real World**

There are more advanced statistical tools for dealing with these and other problems in mark-recapture studies, however understanding the limitations of your model is an important part of being a scientist. Before and during our next field day be thinking of things that might affect our population estimate of insect populations and record them in your notes! Addressing these factors will be a part of our final work when we wrap up the field study.