Mark-Recapture activity

In class on Monday, we introduced the immense bat colony that lives under a bridge in Austin, Texas. One of the many questions we asked about the colony was seemingly quite simple: *how many bats live at this spot?*

It turns out that answering this question - or measuring population size in any other context - isn't a trivial task.

A relatively simple approach that ecologists have long used to generate *estimates* of population size is the Mark-recapture method. This approach takes place in a few steps:

1. Capture and mark (or tag) some number of individuals from the population whose size you are measuring.
2. Release the marked individuals back into the population, and allow them to 're-integrate' into the population.
3. After you are sure that the marked individuals have recovered (i.e. they are behaving exactly the same as they were behaving prior to your marking them), capture another population from the population.
4. This time, instead of marking any new individuals, simply record the total number of individuals you captured in Step 3, and the number of individuals that were marked.

You now have three pieces of information in hand, with which you can generate rigorous estimates of the true population size:

1. N_{Marked}: number of individuals marked in Step 1.
2. $N_{Captured}$: total number of individuals captured in Step 3.
3. $N_{Captured,\ Marked}$: number of marked individuals captured in Step 3

With these, you can estimate the total population size ($N_{\text{Total, Estimated}}$) as follows:

$$N_{\text{Total, Estimated}} = \frac{N_{Marked} * N_{Captured}}{N_{Captured,\ Marked}}$$

In-class activity

The above formula works well in theory, but there's lots of practical considerations that will affect the **quality** of our estimate – in other words, how close $N_{\text{Total, Estimated}}$ is to the true total population size.

This activity is designed to help you understand the factors that affect how close the estimated population size is to reality. You will complete this activity in groups of 3 people each.

1. Each group will be given three ziploc bags; each group member is responsible for one of these bags. Each of these three bags contain the same number of beans. (But note that the number of beans per bag will be different between different groups.)
2. Each of bag will be labelled with a letter - A, B, or C. Your letter determines how many beans you will mark (with a sharpie) in the first step:

Bag ID	Number of beans to mark
A	22
B	36
C	9

3. Return marked beans to the ziploc bag and shake it.
4. Rather than doing it just once, each student will repeat the "recapture" process 20 times, to get a *distribution of population size estimates estimates*. The number of beans to "recapture" in each draw is listed below:

Draw number	No. of beans to recapture
Sample 1	44
Sample 2	17
Sample 3	9
Sample 4	10
Sample 5	41
Sample 6	33
Sample 7	32
Sample 8	15
Sample 9	35
Sample 10	24

5. As you are *collecting* data, it is equally important that you *record* your process. To help collate data from all groups in the class, please make **one copy of this excel per group**, and fill it out all together: Link to data sheet.

   Note that you will have to apply some of your tech-skills to make a copy of this sheet into your University OneDrive account, and/or download it directly onto your computer.

6. Once you have filled out the sheet, share a copy with Dr. Kandlikar by uploading it to Moodle

7. The Excel sheet above is programmed to automatically calculate the mean and the standard error of the mean (SEM) from each of the 20 draws. Using these numbers, discuss the following within your group:

    1. Who (which group member ID - A,B, or C) had the "best" estimate of the true population size?
    2. How is the Standard Error of the Mean calculated, and what does it represent?

8. What does this activity tell you about uncertainty?

    Some questions you can ponder:

    1. What are the sources of uncertainty in our estimates or predictions of nature?
    2. Is it possible to eliminate these sources?
    3. If not, how can we best *reduce* the degree of our uncertainty?