Biology 370L

The Lincoln-Petersen Mark-Recapture Technique

by Eric Pauley

There are many techniques for estimating the sizes of natural populations. When a species is mobile, secretive, and/or difficult to catch, the **mark-recapture** (also called "capture-recapture") technique is often used.

In its simplest form, a mark-recapture study involves taking two samples from a population at different times. All the individuals in the first sample (S_1) are marked and released. After the marked animals have had time to mix with the population, a second sample (S_2) is taken, and the number of marked individuals (M) is determined. The size of the actual population (N) can be estimated using a formula developed by C. G. J. Petersen in 1896 and by F. C. Lincoln in 1930:

$$\frac{S_1}{N} = \frac{M}{S_2}$$

$$\text{or } N = S_1 S_2 / M$$

For example, suppose you capture and mark 500 animals (S_1) and release them. Then you come back later and capture 500 individuals again (S_2). However, only 250 of your second captures are marked (M). The true population size (N) could then be estimated as:

$$N = 500 * 500 / 250 = 1000$$

Alas, if only real life were this simple. This technique makes several assumptions:

1. You have captured a representative sample of the population.
2. At least some organisms will be re-captured.
3. The organisms mix randomly between sample dates.
4. Marks persist between sample dates.
5. Marked organisms have the same probability of re-capture as unmarked organisms. (i.e., marking has no effect on survival, growth, or reproduction)
6. Sampling effort is similar between dates.
7. You are dealing with a closed population.

Some of these assumptions are more important for some species and situations than for others.

In this lab, we will mark and (hopefully) recapture two different species in the salt marsh behind Waites Island: the marsh periwinkle (*Littoraria irrorata*) and the fiddler crab (*Uca* sp.). By comparing these two species, we can get an idea of the importance of some of these assumptions.

Using the data we collect, answer the questions on the third page.

Team members:______________________________________

SNAILS

Date: __________

Team #	Distance (m)	# Marked
	0	
1	5	
	10	
	15	
2	20	
	25	
	30	
3	35	
	40	
	45	
4	50	
	55	

Date: ________

# Marked	# Unmarked	Total

CRABS

Date: ___________

Team #	Distance (m)	# Marked
1	10	
2	20	
3	30	
4	40	

Date: ___________

# Marked	# Unmarked	Total

Mark-Recapture Lab

1. Based on your mark-recapture data, estimate the size of the snail and crab populations for the entire marsh. Show your work.

   Snails: ______________________ Crabs: ______________________

2. For snails only, you have another way to estimate population size (mean number per square meter). Use the aerial photograph supplied to estimate the area of the marsh in square meters (m^2). (The marsh is the dark strip with the diagonal white line of the causeway cutting across it). Then use the average number per square meter at the first count to estimate snail population size.

   Area of the marsh: ___________________ m^2
   (multiplied by the)
   Mean number of snails per m^2 : ___________________
   (equals the)
   Total number of snails in the marsh: ___________________

Type your answers to the following questions.

3. For snails, which estimate of abundance for the entire marsh is likely to be the most accurate? Why?

4. For snails, which of the assumptions on the first page are probably least valid? Why?

5. For crabs, which of the assumptions on the first page are probably least valid? Why?

Consider each of the seven assumptions of the mark-recapture method listed on the first page of your lab handout. How might violating each assumption affect your estimate of population size? Would violating the assumption make you overestimate the true number? Underestimate it? Would it make it impossible to make any estimate? For each assumption, imagine a specific scenario (think about an animal [**NOT A SNAIL OR CRAB**], how you would catch and mark it, and how the assumption might be violated). Write a short paragraph for each assumption explaining how your estimate of N would be affected. Include the specific scenario. Number your answers 6-11. For this individual lab (30 pts), turn in your typed answers to questions 1-11. You do NOT have to turn in a typical lab report containing Intro, Methods, Results, and Discussion.

Figuring out how violating an assumption affects population estimates will require some serious thinking - it may help you to think in terms of the formula:

$$N = S_1 S_2 / M$$

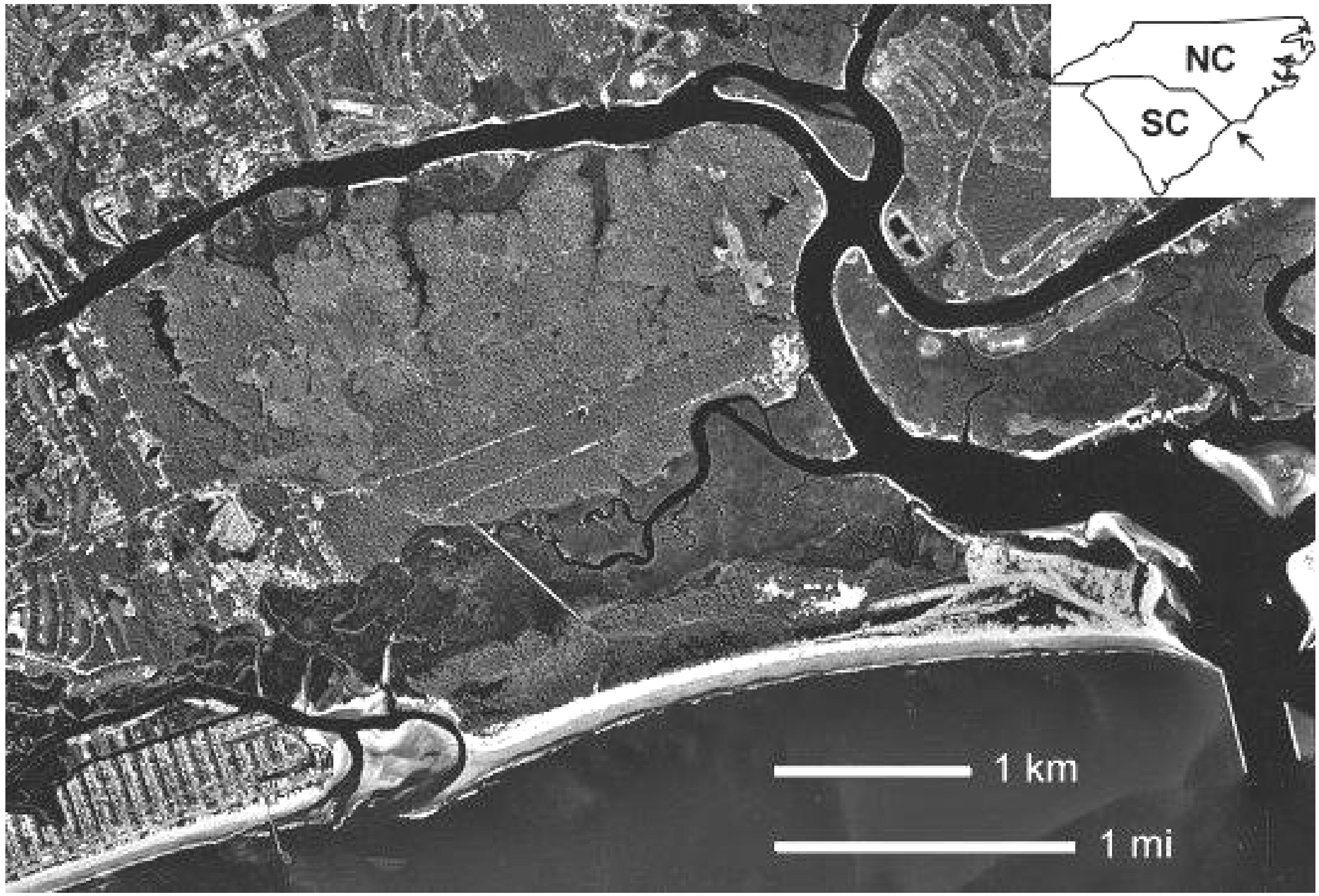
Would violating the assumption change S_1 , S_2 , or M? How would that affect N?

I'll do the first one for you:

Assumption 1: You have captured a representative sample of the population.

Violating this assumption could result in an underestimate of the true population. Let's say you wanted to estimate total population of the little green lizards (Carolina anoles, *Anolis carolinensis*) around the science building at CCU. You catch them in mesh traps and mark them with magic marker. But now also imagine that your capture method is good at capturing large males, but is poor at catching females and immatures (perhaps your traps have a coarse mesh that the smaller lizards can wriggle through). This means that the samples you capture will not be representative - females and immatures will be underrepresented. So you'll catch mostly males the first time, and you'll recapture mostly males (some marked), and you will be able to calculate an estimate of population size of males, but your estimate will be too small because it won't include the undetected females and immatures.

In terms of the formula N = S1 S2 / M, both S1 and S2 will be too small while M is not affected, so your calculated N will be too small.


NC
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