

Salamander Mark-Recapture using the Schnabel Method



Salamander Population Adaptation Research Collaboration Network

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I. Background:

SPARCnet (Salamander Population and Adaptation Research Collaboration Network) is a regional collaborative network designed to address scientific and educational objectives regarding the effects of climate change and land use on salamander populations. In 2013, SPARCnet started as a partnership between researchers at Penn State University and the USGS Northeast Amphibian and Research Monitoring Initiative (NEARMI) with the goal of creating a research and education network to understand terrestrial salamander population dynamics across multiple scales and the capacity for salamanders to respond to environmental change. The SPARCnet educational vision seeks to enhance understanding and appreciation for hidden biological diversity, increase scientific process literacy, and promote quantitative skills through biological sciences.

The growing network consists of over 20 research sites collecting mark-recapture data and 6 citizen science sites across the geographic range of red backed salamanders (*Plethodon cinereus*). In Spring 2018, SPARCnet sites had collected over 14,000 unique capture records of red backed salamanders.

The research network studies the population dynamics of this cryptic species by:

- 1) Creating a versatile, statistically and methodologically efficient research protocol that utilizes spatial capture-recapture models
- 2) Establishing a network of study partners that perform and coordinate observational and experimental studies with a common species

The core project uses mark-recapture methods in a study design of replicated plots.

II. Goals

This lab is design for SPARCnet members running a research or educational salamander mark-recapture plot. The specific aims of the activity are

- i. To learn and perform established field techniques for salamander mark-recapture surveys
- ii. To estimate the population size in an unmanipulated salamander population
- iii. To understand the utility of mark-recapture analyses in Ecology

During the lab, students visit the field site to score the third capture occasion of a single research plot. They record salamanders as recaptures or new individuals, but no marking or measuring is carried out. Thus, this lab does not count as a survey for the network unless the new salamanders are then marked by trained personnel. Students are provided with data from the previous two capture occasions of the same plot for their analysis.

III. External resources

Larsen, DR. 2014. Schnabel's Mark and Recapture. Natural Resource Biometrics.
<http://oak.snr.missouri.edu/nr3110/pdf/schnabel.pdf>

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Bailey, L. L., Simons, T. R., & Pollock, K. H. (2004). Spatial and temporal variation in detection probability of Plethodon salamanders using the robust capture–recapture design. *Journal of Wildlife Management*, 68(1), 14-24.

Mazerolle, M. J., Bailey, L. L., Kendall, W. L., Andrew Royle, J., Converse, S. J., & Nichols, J. D. (2007). Making great leaps forward: accounting for detectability in herpetological field studies. *Journal of Herpetology*, 41(4), 672-689.

Lab activity: Salamander mark-recapture using the Schnabel method

(Teacher Notes Included)

Step 1: Collect your field data following the SPARCnet protocol. Survey the plot systematically (e.g., boards A1 to A10). Lift a board and capture all salamanders on the surface below the board. Place individuals in a corresponding container for scoring their elastomer mark. Use the provided data sheet (Blank Field Data Sheet_Schnabel lab) to record the stage, color morph, and mark information for each salamander. Once the mark has been scored and verified by a second observer (or recorded as NEW), release the salamanders on the same surface and gently place the board back on top.

Step 2: Build a capture history matrix. First, enter the raw field data into a class Google Sheet. This should include all the information from the field data collection sheet. For students to translate this information into a capture history matrix, provide them with a spreadsheet that includes the codes for all salamanders marked on the plot (see Salamander Capture History Matrix example). They will then add capture location in the Survey 3 column for each individual they captured that was marked. Be sure to enter your data with the board number in the cell instead of just a “1” – this provides the spatial information! *Warning: It is likely that they will have read some codes wrong and this becomes a learning experience as they try to figure out which individual code most closely matches the one they read.*

Unmarked or NEW individuals should be listed at the bottom of the list as NEW-(Board Number)-(a,b,c if multiple new individuals under the same board).

Step 3: Summarize your capture numbers in a figure or table. Before conducting your mark-recapture analysis for population size, think about ways to summarize this capture information. Students could look at the whole capture data set over time, the composition of those captures, or just our results from today (for example, students could graph total capture numbers for each survey or the composition of red backed and unstriped individuals in each survey or the number of juveniles compared to adults captured in their survey). Have students think about the information you want to convey in your figure or table and the best way to visually represent that information. Always include a descriptive figure legend.

Step 4: Estimate the distance traveled by salamanders. If a salamander was recaptured, estimate the distance it traveled between capture occasions. The distance between each board is 1m. So, moving from A1 to A2 is recorded as the salamander traveling 1m from one occasion to the next. In the same way, moving from A2 to B2 is 1m of distance. If a salamander was captured all three capture occasions, take the average of the two distances traveled as your

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estimated distance traveled for that particular salamander. You can have your students graphically represent whether salamanders tended to move between boards (and how far) or stayed in the same location.

Step 5: To generate a population size estimate for your plot, have students summarize their capture history information into the following table (the =COUNTA function in Excel may be helpful). Some marked salamanders occur on the plot, but were not seen on the capture occasions that we are analyzing (*side note: ask your students about why these individuals weren't captured*). In addition to the new, unmarked individuals, only marked individuals that were captured on at least one of the three survey occasions should be included.

Survey (t)	C_t	R_t	U_t	M_t	$C_t M_t$
1		0			
2					
3					

Where;

t = survey occasion

C_t = total number of individuals caught on survey occasion t

R_t = number of marked individuals from previous surveys *in this data set* caught on survey occasion t (# of recaptures)

U_t = number of captured individuals on occasion t that were not captured on a previous survey occasion *in this data set* (which are then all marked and released so they can be identified in future surveys – we did not complete this step for survey 3, but still include the unmarked individuals in this column)

M_t = the cumulative number of marked individuals in the population at the start of the survey t

Step 5: Calculate the sum of the R_t column and the sum of the $C_t M_t$ column for use in the Schnabel equation (We use this handout: <http://oak.snr.missouri.edu/nr3110/pdf/schnabel.pdf>)

Analysis: Estimate the population size using the Schnabel equation:

Short Answer: Describe the assumptions required in your estimation of population size above and the likely violations of those assumptions. Suggest alternative study designs, sampling methods, or analysis method to account for those violations.

Suggested background reading: Mazerolle et al. (2007)