**Population Ecology**

***Estimating Population Sizes***

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**Focus:** The students will learn to estimate population sizes and consider assumptions of mathematical models and their applicability to the ecology of an organism/population

**Overview:** This lesson centers around estimating population sizes, in particular different mark-recapture calculations and their associated assumptions. The students will complete a lesson in R to practice the basics of using R for calculations and to review mark-recapture equations. They will apply the methodology outlined in this swirl lesson to measuring the sizes of unknown populations.

**Learning objectives:**

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| 1. Complete a prelab reading to familiarize themselves with the goals of the lesson and the background ecological information of estimating population size |
| 1. Practice coding elements necessary to do basic calculation operations in R; building vectors, matrices, and number sequences; and conducting mark-recapture calculations in R |
| 1. Apply the methods and coding learned through swirl to their own mark-recapture of unknown in-lab populations |

**Lesson sequence:**

1. Prelab reading of in-class worksheet (Prepare before and use during lab)
2. Intro to Estimating Population Sizes (may be skipped if recently covered in class)
3. Swirl lesson
   1. Intro
   2. Basics\_of\_R
   3. Vectors
   4. Number\_Sequences
   5. Matrices
   6. Mark\_Recapture
4. Conduct mark-recapture experiments with mealworms
5. Use R to calculate and complete lab worksheet

**Pre-lesson activities:** Prelab reading relative to the basic elements of population estimation, if students need a refresher (it will help make sense of the mark-recapture calculations of the SWIRL lesson). This can be skipped if you have already (and recently) addressed this in your course. The goal is that students familiarize themselves with the general idea of mark-recapture and that they have code (and the associated rationale) to help them in collecting and comparing their own data.

**Post-lesson activities:** Students are to come to lab with their code saved to later run on their mark-recapture data collected lab. It is suggested that students submit their in-lab worksheets and commented code at the end of the lesson, but that the commented code from the swirl prelab be checked prior to beginning in-lab work. This is also an excellent lab for writing a Methods section; because the procedures are given in-depth, it forces the students to consider the important details which need to be provided in a Methods section, and what are simply procedural notes.

**Implementation notes:** This lesson was designed to be done prior to a 3-hr laboratory where students actively collect data and repeat the coding steps using their data. However, rather than a pre-lab activity, one could first collect the data in class and run the coding steps piecemeal or skipping straight to the section on mark-recapture. The lesson is subdivided into several subparts to facilitate students stopping and starting as they review the basics of how R works, so this lesson is ideal in the beginning of the semester as gentle introduction. Encourage students to go slowly and keep a document open in which to paste the code (and any notes) as they work; it will make generating their own R code easier later.

**Helpful References for Background and Suggested Lab Activities:**

Bailey, N. T. J. 1951. On estimating the size of mobile populations from recapture data. Biometrika 38: 293-306. Font, E. and E. Desfilis. 2003. Courtship, Mating, and Sex Pheromones in the Mealworm Beetle (*Tenebrio molitor*) in Exploring Animal Behavior in the Laboratory and the Field. eds. B.J Ploger and K. Yasukawa. Elsevier Science, USA. pp. 43-56.

Guerra, C., Reiner, R., Perkins, T., Lindsay, S., Midega, J., Brady, O., Barker, C., Reisen, W., Harrington, L., Takken, W., Kitron, U., Lloyd, A., Hay, S., Scott, T., & D. Smith. 2014. A global assembly of adult female mosquito mark-release-recapture data to inform the control of mosquito-bourne pathogens. Parasites & vectors 7:276.

Lincoln, F. C. 1930. Calculating waterfowl abundance on the basis of banding returns. U. S. D. A. Circ. 118: 1-4. Kingsolver, R.W. 2006. Ecology on Campus lab manual. Pearson Benjamin Cummings. USA.

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