FIELD PROJECT: WILDLIFE POPULATION ESTIMATION

To the lover of prescribed routine methods with the certainty of "safe" results the study of ecology is not to be recommended. –A.G. Tansley

For your Field Project you will conduct an actual population estimation of a wildlife population in the field. The purpose of this exercise is to give you an introduction to the methods used to estimate the abundance of populations.

Due Dates:

- **Project Proposal (20 pts) Friday March 6 by 5 PM on bCourses**
- **Final Paper (70 pts) Friday, April 17 by 5 PM on bCourses**

Picking a population:

The goal of this exercise is to *estimate* a wildlife population using a sampling method we have discussed in class and discussion. Therefore, you should choose a population upon which you *could not* conduct a complete or near complete census. For example, counting the number of spiders on your windowsill is a trivial exercise, whereas estimating the number of spiders in an urban park or the number of crayfish in Strawberry Creek would be perfectly appropriate for this assignment. Other examples of potential populations are the number of house sparrows in your neighborhood, snails in your backyard, banana slugs in Tilden Park, or squirrels on the Berkeley campus. In choosing your wildlife population to study, be *creative* but *realistic.*

Pick a **wildlife species** that you can:

- Identify with ease (i.e., make sure you know whether a bird species you choose exhibits sexual dimorphism where males are females of the same species look different so you don't misidentify them and count only individuals of one sex)

Pick a **sampling area** that you can:

- Define by setting boundaries (i.e., you can choose your "neighborhood," but set the extent of this area by cutting it off at certain streets)

Requirements:

- You **CANNOT** use people as a study organism
- You **CANNOT** capture, mark, or even touch any **vertebrate** wildlife species!
- You **CANNOT** use sampling methods that alter the distribution of your study organism (e.g., using lures, food baits, or call playback)

Estimating Population Size:

There are several methods available for estimating the size of a population (refer to lecture/section material and handout "**Methods for Approximating Populations**"). They fall into two main categories:

(1) mark-recapture sampling (invertebrates only for marking animals in this project); and

(2) plot/transect sampling (which includes quadrats, circular plots, strip transects, and distance transects; see lecture 8).

For **mark-recapture sampling**, you could estimate the number of garden snails in your backyard. This would entail capturing some snails, marking them with fingernail polish, releasing them, and then capturing some more at a later date (after allowing enough time to pass for mixing of the population) and determining how many are marked. (Note that while you may touch invertebrates, your marking method should not hurt the animal.)

For **plot/transect sampling**, suppose you want to estimate the number of Eastern fox squirrels on campus using **circular plots**. First, you could set up randomly located sampling stations and count the number of squirrels seen within a set radius at each station. Based on your findings, you could then extrapolate to get an estimate of how many squirrels there are on campus.

These are just two examples; you will need to select an experimental design—described in class or discussion—that is appropriate for your species. The more samples you collect or individuals you mark, the more accurate your estimate of the population size will be. This may take some time, so plan ahead.

Requirements for sample size:

1. Mark-recapture sampling
    a. Aim for 10 recaptured individuals for mark-recapture studies (which means you will need to mark many more than 10 individuals).
2. Plot/transect sampling
    a. You must have at least 5 total detections.
    b. You must have at least 10 sample locations
    c. You should sample at least 5% of the total area that you are extrapolating to (e.g., if the UCB campus is your study area, try to sample at least 5% of campus).
3. You are encouraged to sample more extensively than this if you think it would improve your population estimate.

Analyzing Results:

*See "***Methods for Approximating Populations"** for further guidelines on analysis. In your analysis, you will report your results using *summary statistics*. These include the mean population size, the standard deviation (SD), the standard error of the mean (SE), and your confidence interval (CI) for the population size with an associated degree of error. The ***mean*** is your estimate of the size of the population you sampled. The ***standard deviation*** tells you how variable your measurements are. The ***standard error of the mean*** tells you how variable your estimate of the mean is relative to the true mean population size. Finally the ***confidence interval*** is an interval that is likely to include the real population mean some proportion of the time. Typically, people present 95% confidence intervals (if you repeated your sampling effort 100 times, the interval would include the real population mean 95 times). For this class, we will continue that tradition, but you should note that this is not a magic number. **Note:** for **mark-recapture sampling** you will *only* report the mean and confidence intervals.

Required Analysis:

1. ***Plot/transect sampling (quadrats, circular plots, strip transects):*** **mean population size of your sample, SD, SE, confidence intervals, and *extrapolated total* population size**

2. ***Mark-recapture*****: population estimates and confidence intervals**

Project Proposal (20 points):

Due: Friday, March 6 at 5 PM on bCourses

In preparation for your final paper, you will write a project proposal. Scientists often have to write project proposals to ensure that they have fully thought through their experimental design and to express the broader implications of their research. In addition, the proposal will also offer the opportunity for your GSIs to assess the feasibility of your project and offer alternatives before you begin undertaking the study.

Required format:

1. Three sections: **Species Introduction & Justification**, **Proposed Methods,** and **Expected Results**
2. **Maximum 2 pages double-spaced** (12 point font); you will lose points for exceeding 2 pages.

Overview: (*see* **Proposal Grading Rubric** for additional guidance**)**

1. **Species Introduction & Justification:**
    a. Briefly introduce your species, including a few basic facts about its natural history (e.g., habitat selection, diet, ecological role).
    b. Explain why you selected this species (what makes it suitable for this project?)
    c. Relate why it might be important to wildlife ecology, management and/or conservation to estimate the population size of this species.

2. **Proposed Methods: (***see* **Sampling Designs** and **Methods for Approximating Populations** documents for additional guidance**)**
    You will use this section to explain how you plan to conduct your research.
    a. Describe the method you selected and why you selected it (i.e., mark-recapture vs. plot/transect sampling).
        i. Why is the method you chose the best method for the population you selected (think in terms of movement, detectability, etc.)?
    b. Describe where you will be conducting your study and what materials you will be using. In what type of habitat will you be?
        i. Will you be comparing populations in different habitats?
        ii. Include details about both the broad location (e.g., boundaries of Berkeley campus) and the habitat of your species at the finer scale (e.g., shallow pools of slow moving water in Strawberry Creek). No maps are required.
        iii. Explicitly convey the extent of your sampling area (remember you want to sample approximately 5% of the area if conducting plot/transect counts)

3. **Expected Results/Hypothesis:** This section should be 3-5 sentences about what you expect to find in your study and why. **You must include two citations (no more, no less) to support your expectations**. The best studies have interesting hypothesis (e.g., "I expect to find fewer than 500 squirrels on campus, a threshold suggested by Yudof et al. as critical to spread of disease.") You don't have to be correct; you just need to show you have put some thought into forming your project. This should involve a quick literature search to see how other people have attempted to estimate similar populations before.

Final Paper (70 points):

Due: Friday, April 17 at 5 PM on bCourses

Required format:

1. The Final Paper should be written up in the format of a standard scientific paper, as outlined below.
2. Each section (described below) should be *labeled* and should be written in *complete sentences*.
3. Length: **maximum of 5 pages, double-spaced**, 12 point font, *excluding* title page, references, and appendices.
4. All elements of the paper (title page, text, figures, references, appendices) must be combined in a single .doc, .docx or .pdf file and submitted via 'Assignments' -> 'Field Project'. Go to GSI office hours if you need help combining items into one document.

Required Sections in the Final Paper: (*see* "**final report grading form"** for the grading rubric for the final report)

1. **Title Page:**
    a. Include your name, date, and an interesting title for your study.

2. **Introduction:**
    a. Briefly describe the *goal* of the study (the information you are seeking to obtain).
    b. Briefly introduce the organism you are studying and its natural history.
    c. Identify your species by its scientific (i.e., Latin binomial) name, for example *Homo sapiens* for humans
        i. You can reduce the genus name to an initial, e.g. *H. sapiens*, after writing it out once in full.
        ii. If you are studying an invertebrate, try to identify it to species, but you may only be able to identify it to genus (or family), but that is perfectly acceptable.
    d. Include a *thesis sentence* stating the purpose of the paper and why it might be important to know the population size of your organism. Use background literature to make your introduction stronger.
    e. Include *at least* two references from the *primary literature* (scientific, peer-reviewed studies)
        i. The databases on the bioscience library website (http://www.lib.berkeley.edu/BIOS/biodbs.html) are a great place to search for articles—you will need to use a campus computer, or set up the Cal Library proxy on your home computer, to access these websites. Web of Science is particularly useful.
        ii. Make sure you choose appropriate references for both your species and your subject matter.
        iii. Remember to be *concise* and cite whatever literature you refer to in your text.
            1. In-text citations need to follow (author year) format—for example (Johnson 2003), and you must include a reference section at the end (see citation guidelines handout).

3. **Methods:** Make sure you demonstrate a thorough understanding of your chosen methods in this section. Be sure to justify your approach and chosen method as appropriate for your study organism/habitat/etc. There must be enough information so that a reader could duplicate your work.
    a. Description of the method used to count the population, including your method for determining random sampling locations.
    b. Time frame of your study (e.g., the dates you conducted your experiment, for how long you conducted each trial, times of day you conducted point counts, etc.)
    c. Materials or software used in these processes
    d. Description of the location of your experiment including map showing your sampling locations (or a map of the general study area for mark-recapture studies).
    e. Remember the sampling requirements:
        i. *Plot/transect sampling*
            1. You **must** have a *minimum* of 10 sample locations
            2. You **must** have a *minimum* of 5 detections of your study specimen.
            3. Sample *at least* 5% of the total area that you are extrapolating to.
        ii. *Mark-recapture*
            1. You should aim for at least 10 recaptures of invertebrates for mark-recapture studies (which means you will need to mark more than 10 individuals).
            2. You are encouraged to sample more extensively than this if you think it would improve your population estimate.
        iii. Be careful that you sample thoroughly within your chosen geographical area of inference.

4. **Results:** Graphs, data tables, etc. might be useful for summarizing results in an easy-to-read format, but do **not** substitute for a written results section. You are encouraged to include these visual aids as an appendix if you believe it strengthens your paper.
    a. Summarize the relevant data obtained in your experiment.
    b. Required analysis:
        i. *Plot/transect sampling:* mean population size of your sample, standard error, standard deviation, confidence intervals, and extrapolated total population size
        ii. *Mark-recapture:* population estimates and confidence intervals
    c. Include units on all estimates (e.g., 57 sparrows per acre, or 641 slugs/km^2 for density estimates).
        i. Use units consistently (e.g., metric units throughout)
    d. *Mark-recapture studies*: include a photograph of some of your marked individuals.
    e. Do *not* include your raw data (this goes in the Appendix).
    f. Do *not* discuss the *meaning* or *implications* of your results in this section (this goes into the discussion)

5. **Discussion:**
    a. Discuss and interpret the meaning of the results that you obtained, any problems encountered in your study, assumptions you may have violated, and any other interesting findings or phenomena (e.g., distribution patterns or strange absences of individuals).
    b. Discuss how far off you think your estimate of population size could be from the actual population size, and why your estimates may be accurate or biased.
    c. Discuss possible improvements to your methods that might yield more reliable results.
    d. Be sure to conclude with a few sentences that tie the whole paper together, including its significance and proposed future directions.

6. **References: (***Does not count towards your five page limit*)
    a. Format your references following the journal *Ecology* (We have included a sheet on bSpace with the required formatting guidelines)
        i. You will be graded on your formatting, as well as how appropriate your chosen references are.
    b. You MUST include at **least two primary literature references** (you have no limit in how many references you may use)
        i. A primary source is literature that comes from a peer reviewed journal, such as *Nature, Science, or Biological Conservation.*
        ii. This does **NOT** include: articles from newspapers or popular science magazines such as *Scientific American* or *Discovery*
        iii. You are welcome to include secondary sources as well (e.g. news articles, websites, textbooks), but only IN ADDITION to at least 2 primary sources.

7. **Appendix: (***Does not count towards your five page limit*) We will ***not*** accept hand-written data or calculations.
    a. Include your raw data
    b. Include calculations:
        i. In your calculations, you should carry the additional decimal places until the end, and then round down to the nearest individual. In general, your estimate should not have more significant figures than the data that it is based upon.
            1. In the write up, show your calculations to two digits after the decimal and round your final estimates to the appropriate significant digits
        ii. Show unit conversions
        iii. Show calculations for extrapolations (*plot/transect sampling only*)
            1. Follow the example (for banana slugs) in **Methods for Approximating Populations** document
            2. Make sure to use the appropriate formulas to calculate area for your sampling plots (what you sampled) and larger study area (what you are extrapolating to): rectangular/square plots (area = length * width), circular (area = π * $radius^2$)
        iv. Use consistent units (e.g., all metric)
        v. Make sure that your calculations are clear and concise, and the reader can easily follow your path to arriving at your final statistics.
        vi. We recommend that you type your calculations using Microsoft Equation Editor (in Microsoft Word 2010 select the Insert menu, then select Equation -> Insert New Equation).

Grading: Your grade on this assignment will depend on presentation, correct estimation procedures for the method used, and your adherence to the above guidelines. Novel, interesting study systems and creativity are encouraged, but feasibility is essential. The write-up is not intended to be overly long. Be as concise as possible, but edit for clarity and ask your favorite editors to read it for you. Make sure you proofread your report before you hand it in. Well-written work is important in science, particularly if you're trying to sway your audience to protect a threatened population! Accordingly, poorly written work will receive lower grades.

Consult a GSI on methods and study organism if you have questions!