FISH 621 Laboratory #3: Removals and Ratios

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Instructions

The purpose of this lab is to:

- Quantify the reliability of approximate confidence intervals with examples from
  - Simple random sampling
  - Simple mark-recapture experiments
- Explore how we might generate simple spatial state fields describing the location of animals in space
- Implement our two-even removal estimator
- Explore change in ratio (CIR) estimators
- Calculate the Leslie depletion estimator

If you have a question during the lab, please un-mute yourself and ask, or type it into the chat box. There is a high likelihood that someone else has the same question. It is more fun if we all learn together in our distance-learning world.

I have posted the lecture slides to the ***Canvas site***, so you can reference this material as you work through the lab.

This and all other labs will be graded based on your attendance and participation.

Lab Contents

- **621_Lab 3_Removals and Radios.pdf** (this file)
- **621_Lab 3_ Removals and Radios.R** R script with exercises.

Exercise 2: Exploring Confidence Intervals

We have seen in lecture how we can calculate approximate 95% confidence intervals for predictions based on simple random sampling and our simple Petersen mark-recapture experiments.

But, we might like to prove to ourselves that a 95% CI means that among repeat experiments, 95/100 of these intervals for the estimates should encapsulate the true value. In this example we will do so based on our estimates of uncertainty from our estimator for simple random sampling, and for our abundance estimates from mark-recapture experiments without and with replacement.

Chapman Estimator

- Chapman (1951) recommended the alternative estimator
  - Called the "Chapman estimator"
    - $N^* = \frac{(n_1+1)(n_2+1)}{(m_2+1)} - 1$
- Using a Poisson approximation Chapman showed that
  - $var(N^*) \approx N^2\left(\frac{1}{\mu} + \frac{2}{\mu^2} + \frac{6}{\mu^3}\right)$ "Almost equal to"
  - But, in practice we use the variance estimator
    - $\widehat{var}(N^*) = v^* = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)}$

Exercise 3: Spatial State Models

In this week's lecture we spent quite a bit of time defining state and observation models for our model-based estimators. This is a foundation upon which we will build as we discuss more complex model structures in the coming weeks. As a starting point, we will explore how we can define a simple spatial state model for animal distribution as a function of the probability animals are distributed in some way across northings and eastings.

Exercise 4: Removal Estimator – Two Event

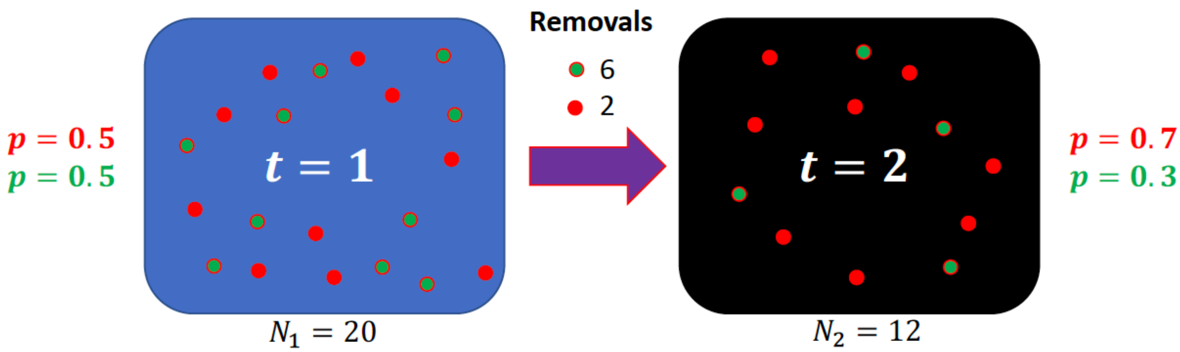
In this example we will explore how we can infer abundance assuming a constant observation probability p following a removal event.

Exercise 5: Change in Ratio Estimator

Change in Ratio estimators are useful under conditions where we:

- Have two discrete categories within our population (i.e. males/females, juveniles/adults, ect.)
- Have an estimate of ratio of the abundance in these categories at two time points
- And where we know the number of removals (or additions) to the population by category between the time points.

From this information we can calculate an estimate of abundance at either time point and for either category.



- Estimate of abundance at time $t = 1$
  - $\hat{N}_1 = \frac{R_x - R\hat{P}_2}{\hat{P}_1 - \hat{P}_2}$
    - $\hat{N}_2 = \hat{N}_1 - R$
- Estimate of type x at time $t = 1, t = 2$
  - $\hat{X}_1 = \hat{N}_1 \hat{P}_1$
    - $\hat{X}_2 = \hat{X}_1 - R_x$
- Estimate of type y at time $t = 1, t = 2$
  - $\hat{Y}_1 = \hat{N}_1 \hat{Q}_1$
    - $\hat{Y}_2 = \hat{Y}_1 - R_y$

Q_t is the probability of ***NOT BEING*** capture at time t

Leslie Depletion Estimator

- $\frac{C_t}{e_t} = qN_0 - qK_{t-1}$
  - Slope: q , Intercept: qN_0
- Process
  - Calculate CPUE $\frac{C_t}{e_t}$
  - Calculate K_t
  - Fit regression model
  - Extract intercept
    - Divide intercept by the slope (q)