Detectability….

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Detectability

- *The probability that an individual in a particular habitat at a particular time will actually be observed*

(caught, seen, captured, detected, etc.)

Detectability

- If we sample tree frogs by listening for their calls and then catching them in a net and on the first day (cold and very windy) we collect 10 individuals, and then we go out the next week (warm and light rain) and we collect 50, has abundance increased 5x, or are conditions better for catching frogs?

Detectability

- This can lead to major sampling issues because of
  - Not all species or individuals were accounted for
  - Repeated counting of some individuals
  - Increased likelihood of capturing some species or individuals and not others

Detectability

- Count data is really commonly taken
- Intuitively it is simple
- Count data is often used as a measure of what is actually present
  - If it is there we assume that we find it and count it
  - Often times counts from sample units underrepresent the true number of organisms present
    - This results in systematic errors in sample-based estimates

Detectability

- Count statistics include: number of animals counted in an aerial survey, # from a line transect survey, number of animals caught in traps in a given night, etc.
- Counts represent some unknown fraction of the target population of animals of interest
- We must know what fraction of the population this count responds to understand what the number means

Detectability

$$E(C_i) = p_i N_i$$

- Here the expected count = the detectability p times the N in the sample unit *i*
- *1-p is the fraction of the population present that remains undetected*

Detectability

$$E(C_i) = p_i N_i$$

- Here the expected count = the detectability p times the N in the sample unit *i*
- What do we usually assume about this relationship?

Detectability - Perfect

- Perfect detectability: Individuals are completely detectable over time, space, etc.
- Sample count is identical to true N that is found in (i)
- Counts provide error-free comparisons across samples

$$E(C_i) = p_i N_i$$

$$p_i = p = 1$$

Detectability - Imperfect

- Less than complete, but constant detectability
- C_i is biased estimate of N_i by a factor of p_i
- If p_i can be estimated, then counts can be adjusted to provide unbiased estimates of abundance

$$E(C_i) = p_i N_i$$

$$p_i = p < 1$$

Detectability

- Counts represent biased estimates of N_i
- The bias is nonuniform over time adding variability and additional bias

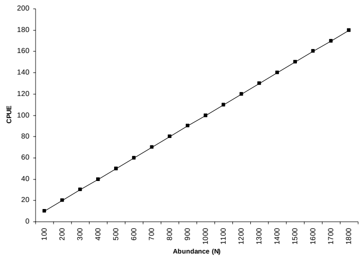
$$E(C_i) = p_i N_i$$

$$p_i < 1 \neq 1$$

Detectability issues are really common…

- Detectability most commonly varies over time and space
  - Diversity indicies (rare species sampling)
  - Line transect sampling
  - Point-counts
  - Mark-recapture
  - Habitat use
  - Availability
- Things aren't always what they seem….

Detectability issues are really common…



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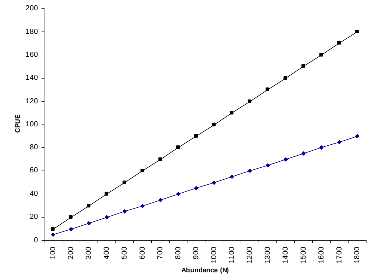

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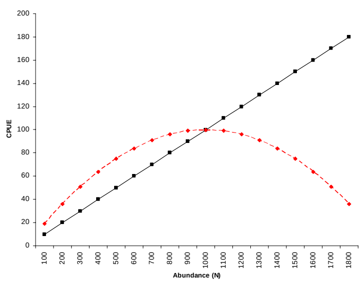

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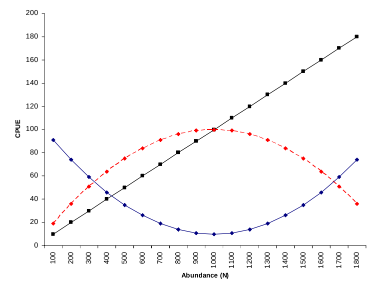

Detectability

- OK how can we estimate abundance?

$$E(C_i) = p_i N_i$$

Detectability

- Take the count, divide it by the detectability *or the probability of detection*

$$\frac{C}{p} = \hat{N}$$

Detectability

- Imagine a perfect world where we know the detectability
- We capture 100 mice in a night of trapping, and we know the detection probability is 0.25

$$\frac{C}{p} = \hat{N}$$

$$\frac{100}{0.25} = 400 = \hat{N}$$

Detectability

- We rarely (ever?) know the detectability and instead we must assume it (line transect) or estimate it from other data (usually mark-recapture).

$$\frac{C}{p} = \hat{N}$$

$$\frac{100}{0.25} = 400 = \hat{N}$$

Line transect

- Establish a series of lines of known length in the area of interest
- Lines can overlap (sample with replacement) or not overlap (sample without replacement)
- Biologist walks (swims, drives, flies) along each line and records what she sees

Line transect

- "Strip" transect biologist assumes detectability of 1 within a certain distance from the line
  - Widely used in reef studies to quantify fish, coral, and invertebrate abundance.
  - Vegetation studies to quantify number of species, density

Line transect

- "Strip" transect biologist assumes detectability of 1 within a certain distance from the line
  - Widely used in reef studies to quantify fish, coral, and invertebrate abundance.
  - Reasonable to assume detection of 1???

Line transect

- Surrogate studies (i.e. Jeff Laake stakes, wooden doves, John Witzig) generally show the detection probability is not 1 and usually much lower than would be reasonably guessed (0.6-0.8 terrestrial; 0.4-0.5 aquatic)
- *And these are done with surrogate species that don't swim off and don't hide!*

Line transect

- *Distance* type methods are a major improvement over strip transect as they attempt to incorporate detectability into the transect sample.
- The perpendicular distance from the line to the object is estimated or the actual distance and the angle to the individual from the line
  - *http://www.ruwpa.st-and.ac.uk/distance/*

Multi-pass or "depletion"

- Each time we walk down a path we are likely to see something new
  - Repeatedly sample an area and count number of species (of number of a species) measured in each sampling event

Multi-pass or "depletion"

- Example Meador et al. 2003 TAFS 132:39-46
- Assess efficacy of single-pass sampling in 10 river basins as part of standard monitoring program
- Species richness pass 1, 80.7-100% per basin based on at least seven samples per basin
- Individual sites ranged from 40-100%

Multi-pass or "depletion"

- Example Meador et al. 2003 TAFS 132:39-46
- Second sample yielded new species 50.3% of the time
- Inverse relationship between proportion of species captured on first event and stream size

Multi-pass or "depletion"

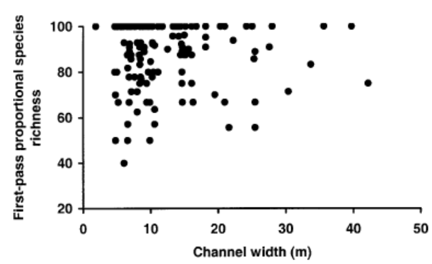

FIGURE 1.—Scatter plot of channel width (m) and proportional fish species richness of the first pass of backpack electrofishing (p_{r1}) based on National Water-Quality Assessment Program data (U.S. Geological Survey).

Mark-recapture

- Estimating detection probability is key in a mark-recapture study to estimate abundance, population trends, survival, diversity, occupancy, etc.
- General approach is to create a known population of animals by tagging and releasing these animals, and then try and recapture them

Mark-recapture

- Ratios of the marked:unmarked animals are then used to estimate capture probability
- *Intuitively simple, difficult to do!*
- Animals move about, tags are lost, animals leave the sampling site.
  - *Fish are particularly nasty creatures to work with*

Mark-recapture

- Example:
- Using Jolly-Seber type mark recapture models I estimated capture probabilities for flathead catfish to be 0.05 for a NC river.
- Capture probabilities for most fish populations are 0.1 or less

Mark-recapture

- Before you can check a fish for a tag you first have to catch the fish
  - I used radio-telemetry to evaluate my detectability estimates for flathead catfish
  - Sample, examine fish for tags
  - Then “virtually sample” and see how many radio tagged fish should have been caught
  - 67 chances to capture, 4 caught ~.06

Detectability

- Take home message
  - What you see might not be all that is there
  - Detectability can be a major source of uncertainty
  - Creative approaches often needed to estimate detectability in many situations
  - Key parameter to think about over the next few weeks of lecture and lab