Capture-mark-recapture methods for abundance estimation

Same old equation:

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

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- n is the number of individuals detected
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Most methods differ in how they estimate p

Estimating p

- Set traps in a study area and mark each captured individual

Overview

Estimating p

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- Repeat the trapping on K occasions

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  - You will detect most of the population on the first occasion
  - Most of the captures on subsequent occasions will be recaptures
- And vice versa

$n = 5$ individuals captured over 3 sampling occasions

	Occasion 1	Occasion 2	Occasion 3
Animal 1	0	0	1
Animal 2	1	1	0
Animal 3	1	1	1
Animal 4	1	0	0
Animal 5	0	1	0

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These data tell us about p and hence N. Estimation is usually acheived using maximum likelihood methods.

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Later it was used by Lincoln (shown above) and Peterson to estimate fish and wildlife populations

- There are only 2 capture occasions

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- On the first, n_1 animals are captured and marked
- On the second, n_2 animals are captured and m_2 of them are recaptures

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And so...

$$\hat{N} = \frac{n_1 n_2}{m_2}$$

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- No births
- No deaths
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Lincoln-Peterson Assumptions

(1) Population closure
- No births
- No deaths
- No immigration or emigration

(2) All individuals are assumed to have the same capture probability

(3) No tag loss or mis-identification

Using more than 2 sampling occasions has many advantages, including the ability to account for:

- Temporal variation

K-SAMPLE CMR

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- Temporal variation
- Behavioral effects
  - Trap happiness
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- Individual heterogeneity
- Combinations of the above

Common models

Model	Description
M_0	The most basic model in which p and c are constant
M_t	p differs among sampling occasions and $p_t = c_t$.
M_b	Behavioral response model in which p and c differ. Can describe trap happiness or trap shiness.
M_{tb}	A combination of models M_t and M_b.

where

$p =$ capture probability

$p_t =$ capture probability on occasion t

$c =$ recapture probability

Suppose you remove individuals on each survey

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Eventually you should deplete the population

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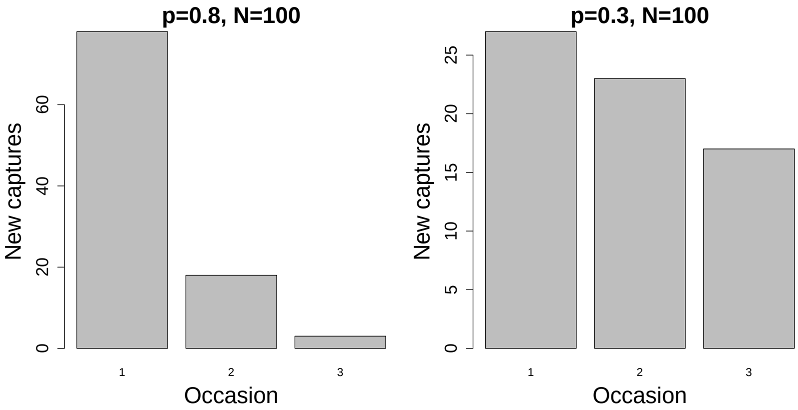
The number of captures you would expect on each occasion:

Occasion	Expected count
1	pN
2	$p(1-p)N$
3	$p(1-p)^2N$
4	$p(1-p)^3N$
$\vdots$	$\vdots$
K	$p(1-p)^{K-1}N$

The rate at which the population is depleted tells us about p.



Key points

- Capture-recapture methods use information about recapture rates to estimate capture probability and abundance
- More advanced methods can be used to estimate density and vital rates
- Modern field methods use camera traps or DNA sampling techniques to collect non-invasive capture-recapture data

Lingering questions

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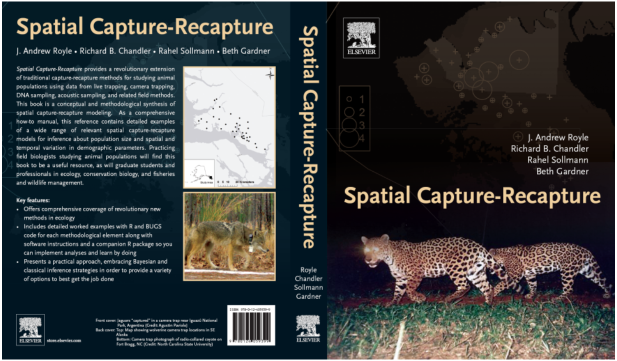

Read Chapter 11