Effects of switching to a two-wire hair sampling system for capture-mark-recapture analysis

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Outline
• Capture-Mark-Recapture basics and assumptions
• Non-invasive sampling
• Previous research
• Study area
• Methods
• Results
• Research implication and future directions

Capture-Mark-Recapture (CMR)

Lincoln – Peterson Model:
\[ \hat{N} = \frac{n_1}{\hat{p}} \]
\[ \hat{p} = \frac{m_2}{n_2} \]

- \( n_1 \) = # of animals captured in capture occasion 1
- \( n_2 \) = # of animals captured in capture occasion 2
- \( m_2 \) = # of marked animals captured in capture occasion 2
- \( p \) = capture probability
Capture-Mark-Recapture (CMR)

\[ \hat{N} = \frac{n_1}{\hat{p}} \]
\[ \hat{p} = \frac{m_2}{n_2} \]

\[ n_1 \]
\[ n_2 \]
Capture-Mark-Recapture (CMR)

\[ \hat{N} = \frac{n_1}{\hat{p}} \quad \hat{p} = \frac{m_2}{n_2} \]

\[ \hat{N} = \frac{3}{0.5} = 6 \quad \hat{p} = \frac{2}{4} = 0.5 \]

Assumptions (Otis et al. 1978):
1. Population is closed
2. Marks are not lost
3. Marks are correctly identified
4. All individuals have an equal probability of capture and that probability does not change

- **Time** – Capture probabilities vary over time
- **Behavioral** – Capture probabilities change due to a behavioral response from being captured (e.g., “trap-happy” or “trap-shy”)
- **Heterogeneity** – Capture probabilities differ by individual (e.g., females with cubs vs. females without)

- **Huggins (1991)** – Use of individual covariates
  - Weight, age, or capture frequency
- **Pledger (2000)** – Mixture Models
  - 2 proportions \( \pi \) of the population with different capture probabilities
  - Hard to catch \( \pi \) vs. Easy to catch \( (1-\pi) \)
Capture-Mark-Recapture with Heterogeneity Mixtures

Lincoln – Peterson Model:
\[ \hat{N} = \frac{n_1}{\hat{p}} \quad \hat{p} = \frac{m_2}{n_2} \]

Capture Probabilities Using Pledger’s Mixture Models:
\[ \hat{p} = \pi_L \cdot p_L + \pi_H \cdot p_H \]
Capture-Mark-Recapture with Heterogeneity Mixtures

\[ \hat{p} = \pi_L \cdot p_L + \pi_H \cdot p_H \]
\[ \hat{N} = \frac{n_1}{\hat{p}} \]
\[ \hat{p} = \frac{m_2}{n_2} \]

- \( n_1 = 3 \)
- \( n_2 = 4 \)
- \( m_2 = 3 \)
- \( \pi_L \) = proportion of individuals with a low capture probability
- \( \pi_H \) = proportion of individuals with a high capture probability

\[ \hat{p} = 0.675 \cdot \frac{1}{4} + 0.325 \cdot \frac{3}{4} \]
\[ \hat{p} = 0.437 \]
\[ \hat{N} = \frac{3}{\hat{p}} \]
\[ \hat{N} = \frac{3}{0.437} = 6.3 \]
Capture-Mark-Recapture with Heterogeneity Mixtures

\[
\hat{p} = 0.675 \times \frac{1}{4} + 0.325 \times \frac{3}{4} = 0.437 \\
\hat{p} = 0.437 \\
\hat{N} = \frac{3}{\hat{p}} \\
\hat{N} = \frac{3}{0.437} = 6.3
\]

\[
\hat{p} = \frac{3}{4} = 0.75 \\
\hat{N} = \frac{3}{\hat{p}} \\
\hat{N} = \frac{3}{0.75} = 4
\]

Capture-Mark-Recapture (CMR)

- Capture Probabilities
  - Heterogeneity – “Bane of CMR’s existence”
  - Hard to measure
  - Minimize or quantify it as much as possible to get reliable population estimates (Petit & Valiere 2006)
  - Biased \( p \)
    - High \( \rightarrow \) Underestimate \( N \)
    - Low \( \rightarrow \) Overestimate \( N \)
  - Want \( p \) as high as possible (>0.20)
    - Reduces chance that heterogeneity will go undetected
    - Can be low due to trap bias or trapping effort

Non-invasive sampling

- Uses DNA as marker
  - Collection of hair, feces, or feathers
- No physical handling of the animal
  - Goal to reduce negative (“trap-shyness”) behavioral biases after first capture
- Increase sampling area and effectiveness
  - Can cover a larger area and increase the number of “traps” in the study area
**Study Area:**
Upper Atchafalaya River Basin

**Sampling Methods**

- Study began in 2007
- 4 hair sites per home range
- Grid 1.6 km²
- Strands of barbed-wire were stretched across 3-4 corner trees
- Sites were baited and scent lure was hung

- Sites were checked every 7 days for 8 weeks
- Hair was collected if >5 guard hairs or >20 under-fur hairs.
- Samples were sent to Wildlife Genetics International for analysis.
- WGI sub-sampled criteria: 25 samples/week

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Bait gone with no hair

Low numbers of males captured

Methods

Set between 40-60cm

Bottom wire: 35-40cm

2010-2012:

Change in Methods

2007-2009 (Lowe 2011):

2010-2011:

0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

2007-2009

2010-2011

26M:44F
OR 1:2

39M:47F
OR 1:1.2

Males

Females

2007-2009

2010-2011

7/11/09 8:18 AM
60 Sec

7/21/11 9:19 AM
60 Sec
Overall Question:
How does the addition of a second wire affect the estimates of population parameters?

Hypothesis:
Proportion of hard to catch males (πL) will decrease in year 4 of sampling due to the addition of a second wire.

Methods: Data Analysis
- Data from 2007-2010 (2011 excluded)
- Program MARK (White and Burnham 1999)
  - Closed capture with heterogeneity
  - Constant (\( \pi \))
  - Group effects (g)
  - Time dependent (t)
  - One vs. Two wire (Wire)
  - One vs. Two wire for Males (Wire Male)
- AIC for Model Selection
### Model Set

<table>
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<tr>
<th>Model</th>
<th>AICc</th>
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#### β (wire), β (wire male), and β (g + wire) did not differ from zero.

### Research Implications & Future Directions

- **No over-whelming results**
- **Needs more data**
  - Comparing 3 years vs. 1 year of data
  - Increase sub-sample size
  - 2012 data
- **Continue with 2-wire system**
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