Monitoring Piping Plovers in the Great Plains

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Preview

• International PIPL Census
• Important monitoring issues
• A specific proposal
International Census
Census methods

• 2 weeks in June
• All sites known to be occupied or contain habitat in last 5 years
• Count all adults exactly once

Census results

<table>
<thead>
<tr>
<th>Year</th>
<th>Observers</th>
<th>Sites visited</th>
<th>Sites occupied</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1121</td>
<td>0.38</td>
<td>3,469</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>351</td>
<td>0.39</td>
<td>3,286</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>414</td>
<td>0.41</td>
<td>2,953</td>
<td></td>
</tr>
</tbody>
</table>
**Census results**

- **Great Plains**
- **U.S.**
- **Canada**
  - 10%/yr

**Benefits of the census**

- Coverage of many ‘small’ sites
- Document distribution changes
- Habitat assessment
- Generating interest/participation
An identified need…

• to provide scientifically defensible estimates of PIPL abundance in the Great Plains
Monitoring issues

- Why monitor?
  - What is the larger context?
- What to monitor?
  - Objectives
- How to monitor?
  - Methods

Why?

- Is documentation enough?
- Is there a greater scientific or management framework?
  - Science: *a priori* hypotheses
  - Mgt.: state-dependent decisions
Objectives

• Define the population
• Select a state variable
  ▪ Abundance, Site occupancy (good)
  ▪ Status, Trend (not good)

Methods

• Detectability
  ▪ counts are usually incomplete
• Spatial sampling design
  ▪ inability to sample everywhere
  ▪ geographic variation
Detectability, $p$

- $N = C / p$
  - $N =$ abundance, $C =$ count
- Census, $N = C$
  - assumes $p = 1$
- Index, $N_2 / N_1 = C_2 / C_1$
  - assumes $E(p_1) = E(p_2)$

Dealing with variation in $p$

- Standardize
  - Identify & control sources of variation
- Model covariates
  - Identify & measure sources
- Estimate $p$
Estimating detectability

• Marking birds
  ▪ Individually
    • Good analysis methods available
    • Very difficult logistically
  ▪ Generically
    • Lincoln-Petersen estimator
    • Banding required before each survey

Estimating detectability

• Multiple-observers approaches
  ▪ Good balance between effectiveness and feasibility
• Distance sampling
• Removal modeling
Spatial sampling design

- Lots of options
  - stratified, systematic, cluster, dual-frame, adaptive
- Random selection
- Sampling where birds are not

A proposal for piping plovers in the Plains and Prairies
Objectives

• Population: entire population of adult piping plovers in the Great Plains and Prairie Canada
• To estimate abundance every 5 years in geographic units identified in the Recovery Plan

Methods

Detectability
Double-observer method

- Primary observer sees birds and tells secondary observer
- Secondary observer records birds seen by primary observer and additional birds (s)he sees

Double-observer method

- Visit several sites, switching primary, secondary roles
- $x_{i1} = \text{count by observer } i \text{ in primary role}$
- $x_{i2} = \text{count by observer } i \text{ in secondary role}$
Double-observer method

\[
\begin{align*}
E(x_{11}) &= Np_1 \\
E(x_{12}) &= N(1-p_2)p_1 \\
E(x_{21}) &= Np_2 \\
E(x_{22}) &= N(1-p_1)p_2
\end{align*}
\]

\[
\hat{\rho} = 1 - \frac{x_{12}x_{21}}{x_{22}x_{11}}
\]

Methods

Spatial sampling design
Sampling design

- Where to count plovers?
  - at all sites
- Where to estimate $p$?
  - at all sites
  - at a subset of sites

Stratified random sample

<table>
<thead>
<tr>
<th>Prop. of:</th>
<th>Sites</th>
<th>Plovers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small lakes</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Large lakes</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Rivers</td>
<td>0.30</td>
<td>0.15</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>0.05</td>
<td>0.20</td>
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**Estimation methods**

- Count plovers at all sites
- Estimate $p$ at a subset of sites
  - and mean $p$ by strata
- Estimate $N$ at all sites
- Calculate $N$ for the population

**Sample sizes**

- Estimate $p$ at 10-20% of sites
  - 100-200 sites
  - 2-6 estimates per stratum
- If mean $p$ within strata…
  - >0.8 with SE < 0.1…
### Hypothetical results

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>N</th>
<th>var(N)</th>
<th>SD(N)</th>
</tr>
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<tr>
<td>Site</td>
<td>8</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Population</td>
<td>3000</td>
<td>3750</td>
<td>1775</td>
<td>42</td>
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</table>

- **N\text{\textsubscript{2001}} = 3,750**
  - 95% CI: [3,672-3,837]
- 1% annual decline for 5 years…
  - **N\text{\textsubscript{2006}} = 3,566**
  - 95% CI: [3,491-3,649]
  - observed decline: -1.6%/year
Assumptions

• Inference method requiring the most assumptions that are least likely to be valid: naïve reliance on counts

Sampling for detectability

• Stratify for consistent $p$
  ▪ habitat
    • small lakes, large lakes, rivers
  ▪ ???
Double-observer method

• 2 people visit a series of sites
• They alternate being primary and secondary observers
• Allows flexible modeling of detection probabilities

Preview

• Define objective(s)
• Sampling issues
  ▪ Why not census?
• Analysis issues
  ▪ Power analysis
Monitoring objectives

- Estimate parameters for a demographic model
- Evaluate the effectiveness of management activities

Monitoring objectives

- Determine the status of a population
- Detect trends in abundance
  - provides insight into status
Define the population

• Spatial scale
  ▪ Piping plovers in the US Great Plains and Prairie Canada
  ▪ Where do movements occur?

• Temporal scale
  ▪ When do movements occur?

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Piping plover census

<table>
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<th>Year</th>
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<tr>
<td>1991</td>
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</tr>
<tr>
<td>1996</td>
<td>2500</td>
</tr>
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- **Great Plains**: 18%/yr
- **Lakes**
- **Rivers**

**Why census is inadequate**

- Census assumes every bird is counted (detection prob. = 1)
- Detection problems at 2 scales
  - Not all sites visited
  - Imperfect counting at each site
  - What if detection differs? by 0.15?
- Other methods are better
Spatiotemporal scales

• Evolutionary time: full mixing
• Annual: major redistributions
• Within a breeding season:
  ▪ stable during core time
  ▪ some inter-basin movement