Large mammal density estimation: Applications and assumptions of two emerging techniques

Random Encounter and Staying Time & Spatial Count Models

JT Fisher, JM Burgar, M Dickie, AC Burton, R Serrouya
The importance of density estimation

Biodiversity Index

Steffan et al 2011
The importance of density estimation

Steffan et al 2011

(a) Biodiversity Index

(b) Human Pressure Index
Techniques to Estimate Density
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Spatial Capture Recapture (SCR/SECR)

Efford 2004

Photo credit: Franco Alo Photography
Techniques to Estimate Density

Spatial Capture Recapture (SCR/SECR)

- Uses individual markings

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Romairone et al 2018
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Random Encounter Models (REM)

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Rowcliffe et al 2008

Romairone et al 2018
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**Random Encounter Models (REM)**
- Assume trapping rate scales linearly with density

*Efford 2004*
*Rowcliffe et al. 2008*

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*Caravaggi et al. 2016*
Emerging techniques

Chandler and Royle 2013

Spatial Capture (SC)

Random Encounter & Staying Time (REST)

Nakashima et al 2018

Photo credit: Franco Alo Photography
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Spatial Capture (SC)

Random Encounter & Staying Time (REST)

\[ D = \frac{\sum (N \cdot T_F)}{A_F \cdot T_O} \]

Photo credit: Franco Alo Photography

Nakashima et al 2018
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Spatial Capture (SC)

Random Encounter & Staying Time (REST)

Nakashima et al 2018

\[ D = \frac{\sum (N \cdot T_F)}{A_F \cdot T_Q} \]
Objectives

- Compared density estimates from SC and REST models in NE Alberta
  - Model stability across years
  - Measures of precision
  - Comparison with density estimates from other sources
• Originally designed for REST
  • Random within clusters

How do density estimates from the two methods compare?
• Originally designed for REST
  • Random within clusters

• 25 cameras in 3 clusters each
  • 2017 and 2018

• How do density estimates from the two methods compare?
Results

- REST estimates show strong latitudinal variation, especially for deer.
- Moose and caribou have opposite patterns, generally consistent across years.
- SC shows consistent densities across latitudes, but yearly variation.

- Both have large CIs.
- REST tends to have more variable CIs.
Results

- REST estimates show strong latitudinal variation
  - Especially for deer

- Moose and caribou have opposite patterns
  - (generally) consistent across years

- SC shows consistent densities across latitudes, but yearly variation
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- Both have large CIs
  - REST tends to have more variable CIs
Results

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<table>
<thead>
<tr>
<th>Year</th>
<th>REST</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td><img src="image1" alt="Graph of REST estimates" /></td>
<td><img src="image2" alt="Graph of SC estimates" /></td>
</tr>
<tr>
<td>2018</td>
<td><img src="image3" alt="Graph of REST estimates" /></td>
<td><img src="image4" alt="Graph of SC estimates" /></td>
</tr>
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[Diagram showing results for different species and latitudes]
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Comparisons to alternate estimates

Aerial Surveys
- Burgar and Sztaba, 2015
- Chapman and Gilligan, 2013a
- Chapman and Gilligan, 2013b

DNA mark-recapture
- Government of Alberta
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“All models are wrong, but some models are useful”  Box (1976)
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Understanding assumptions is important
Assumptions

**Spatial Capture (SC)**
1. Density does not vary during sampling period
2. $\lambda_0$ and $\sigma$ were estimated for each year, but assumed constant across space
   - vary with movement, home range size, and habitat use

**Random Encounter & Staying Time (REST)**
1. Density does not vary during sampling period
2. Random sample of environment
   - Cameras placed randomly, but likely microhabitat selection
3. Perfect detection
   - Model of effective detection distance
4. Sample behavior randomly
   - Camera investigation likely inflates estimates
Other considerations

• Computation requirements
  • SC models can be computationally intensive

• Design assumptions
  • Random camera placement for REST vs high detection rates for SC
Conclusions

• Substantial divergence between SC and REST
  • Biological truth is unknown, making validation difficult

• Pragmatic approach for monitoring:
  • use both estimators where possible
  • consider the ecological plausibility of assumptions

• There is no silver bullet
  • How, and by how much, can we improve these estimates?
Acknowledgements

For more information about our projects, go to cmu.abmi.ca