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

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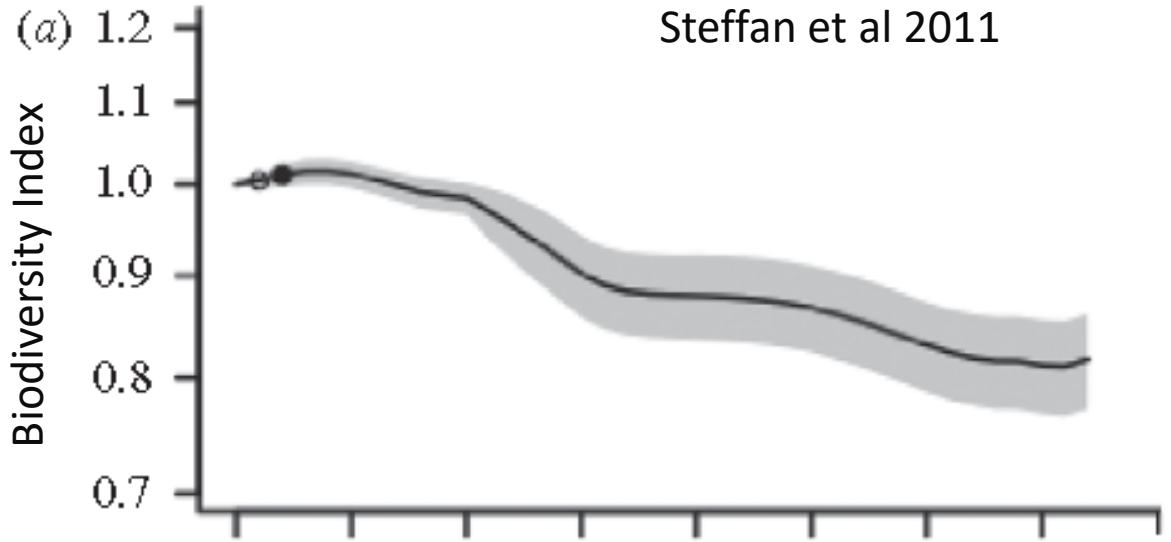
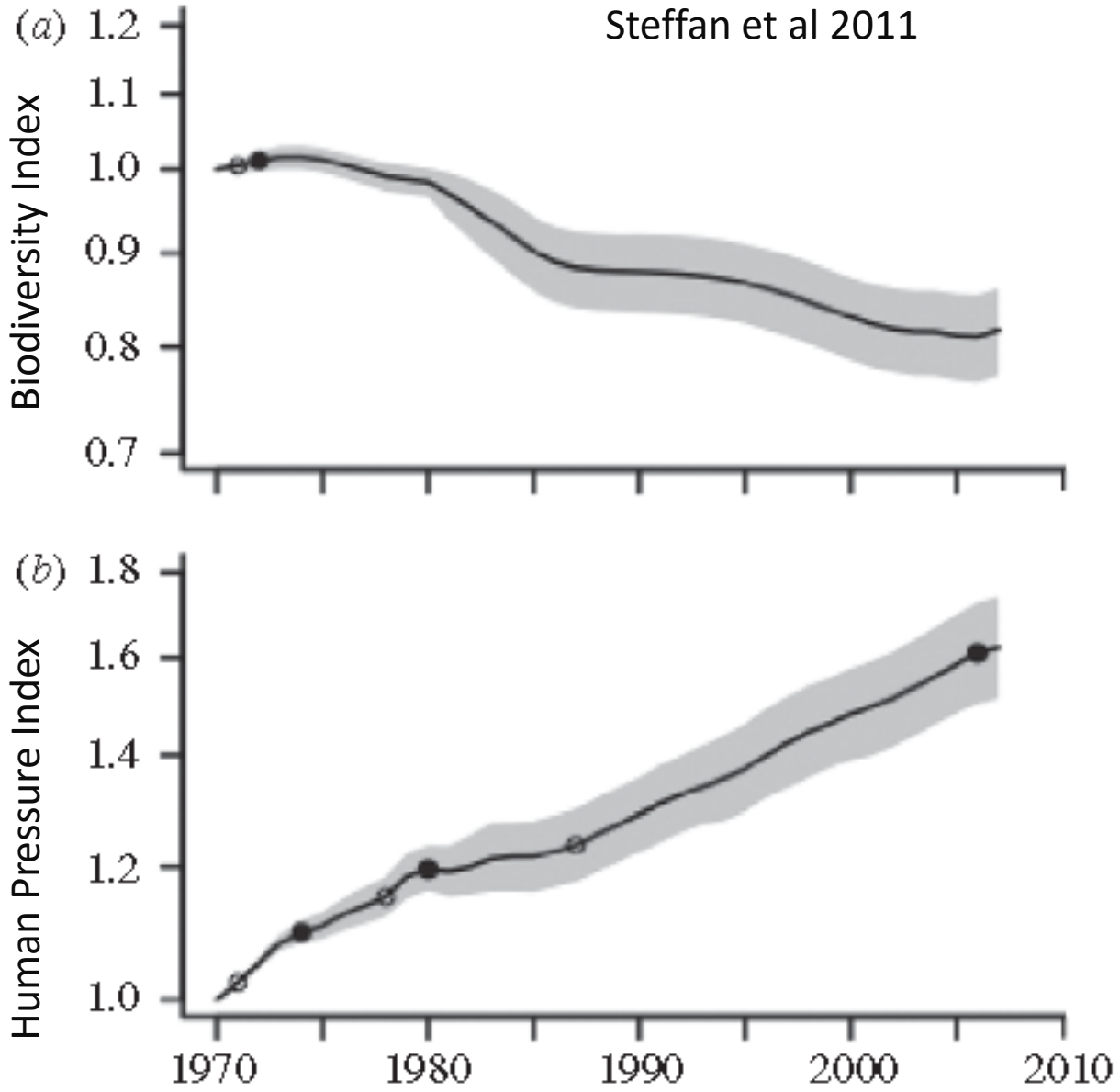
The importance of density estimation



Steffan et al 2011

The importance of density estimation

Steffan et al 2011



Techniques to Estimate Density

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Photo credit: Franco Alo Photography

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Efford 2004

Spatial Capture Recapture (SCR/SECR)

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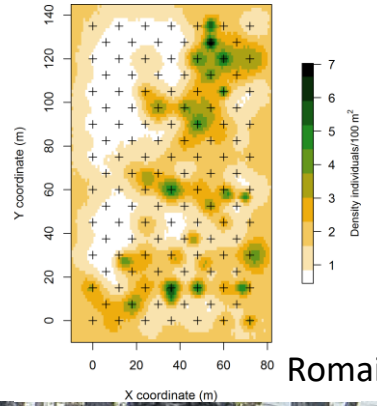
- Uses individual markings



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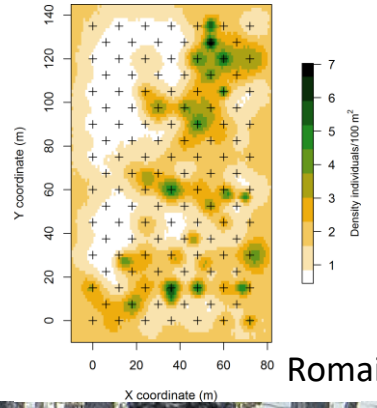

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Random Encounter Models (REM)

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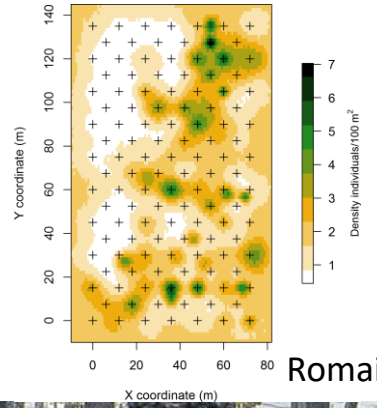

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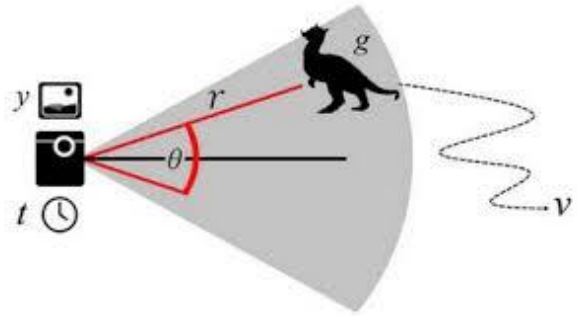

- Assume trapping rate scales linearly with density

Caravaggi et al 2016

Photo credit: Franco Alo Photography

Emerging techniques

Chandler and Royle 2013

Spatial Capture (SC)

Nakashima et al 2018

Random Encounter & Staying Time (REST)

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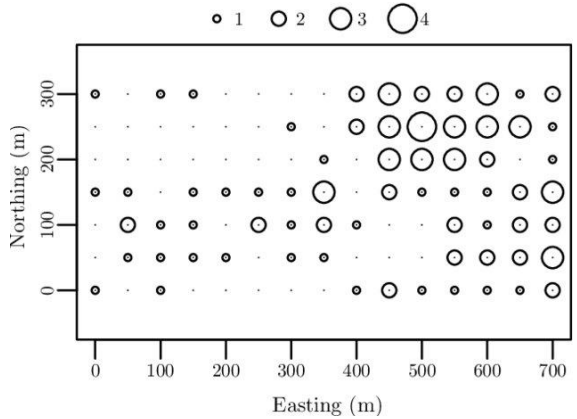

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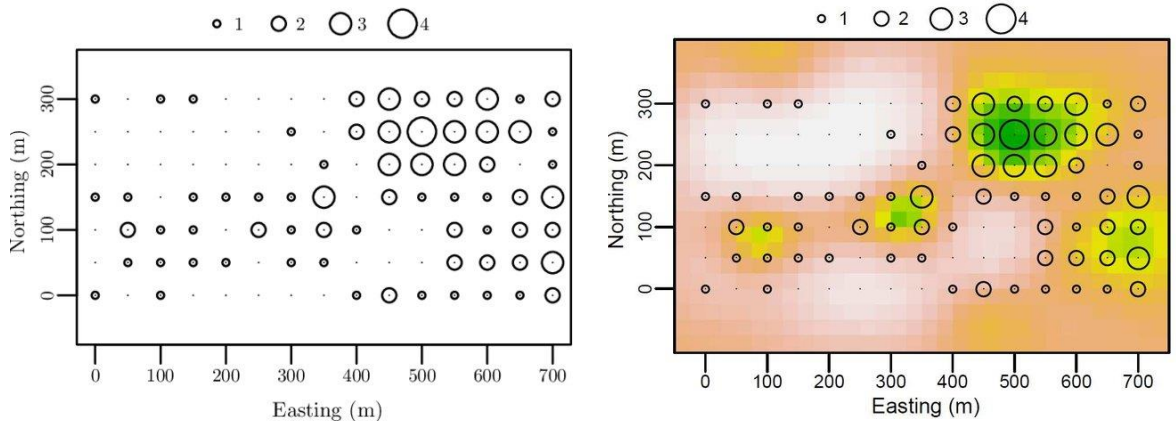

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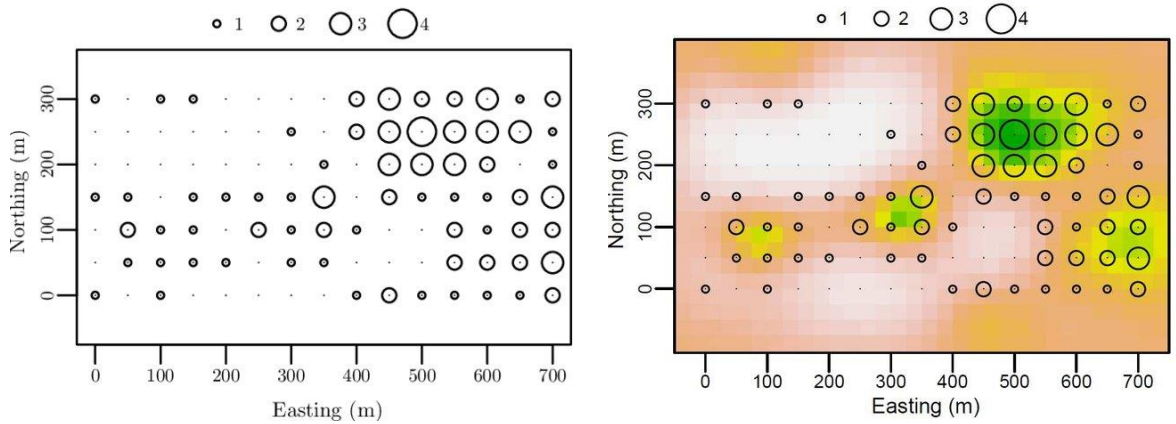

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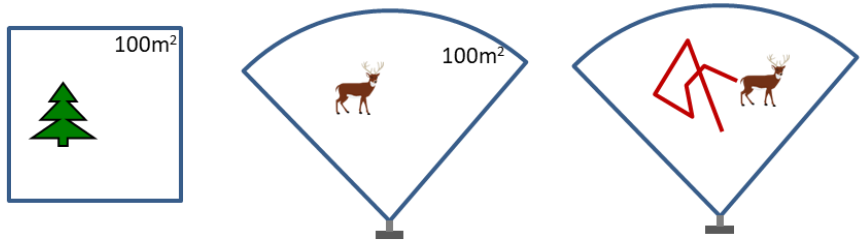

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Photo credit: Franco Alo Photography

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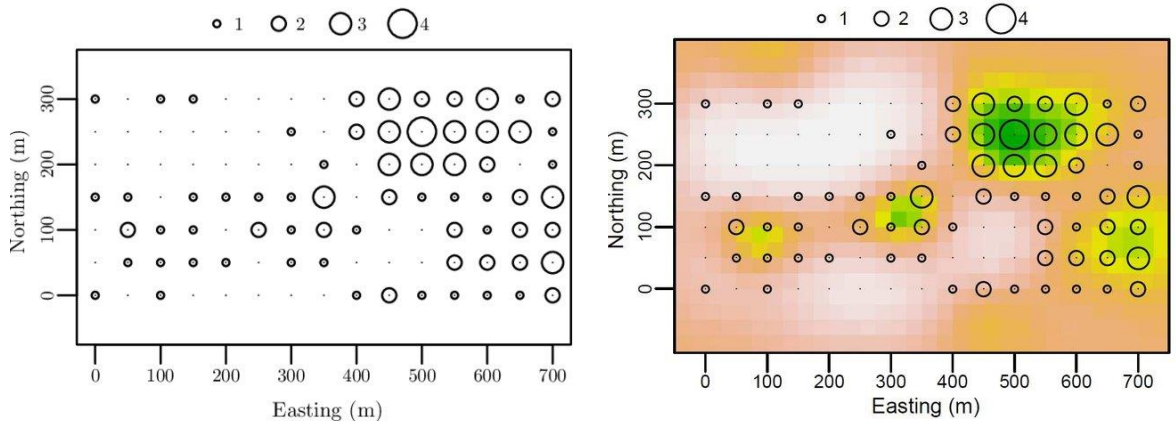

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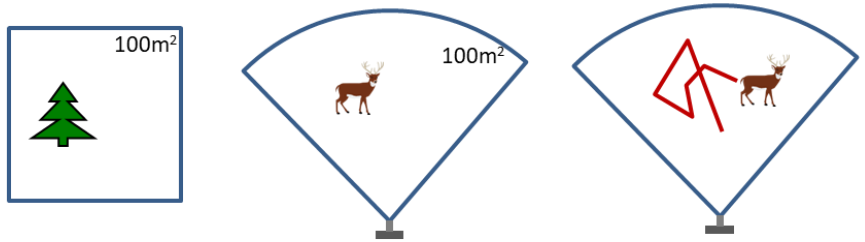

$$D = \frac{\sum(N \cdot T_F)}{A_F \cdot T_O}$$

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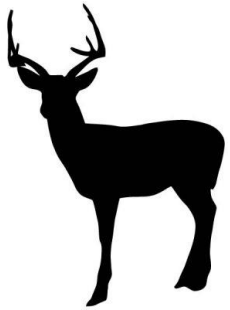
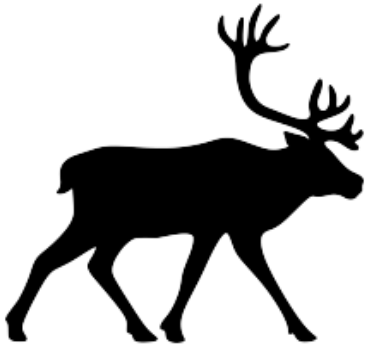
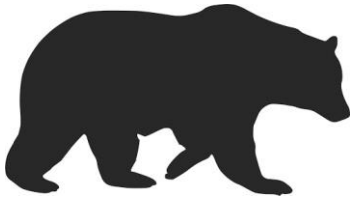
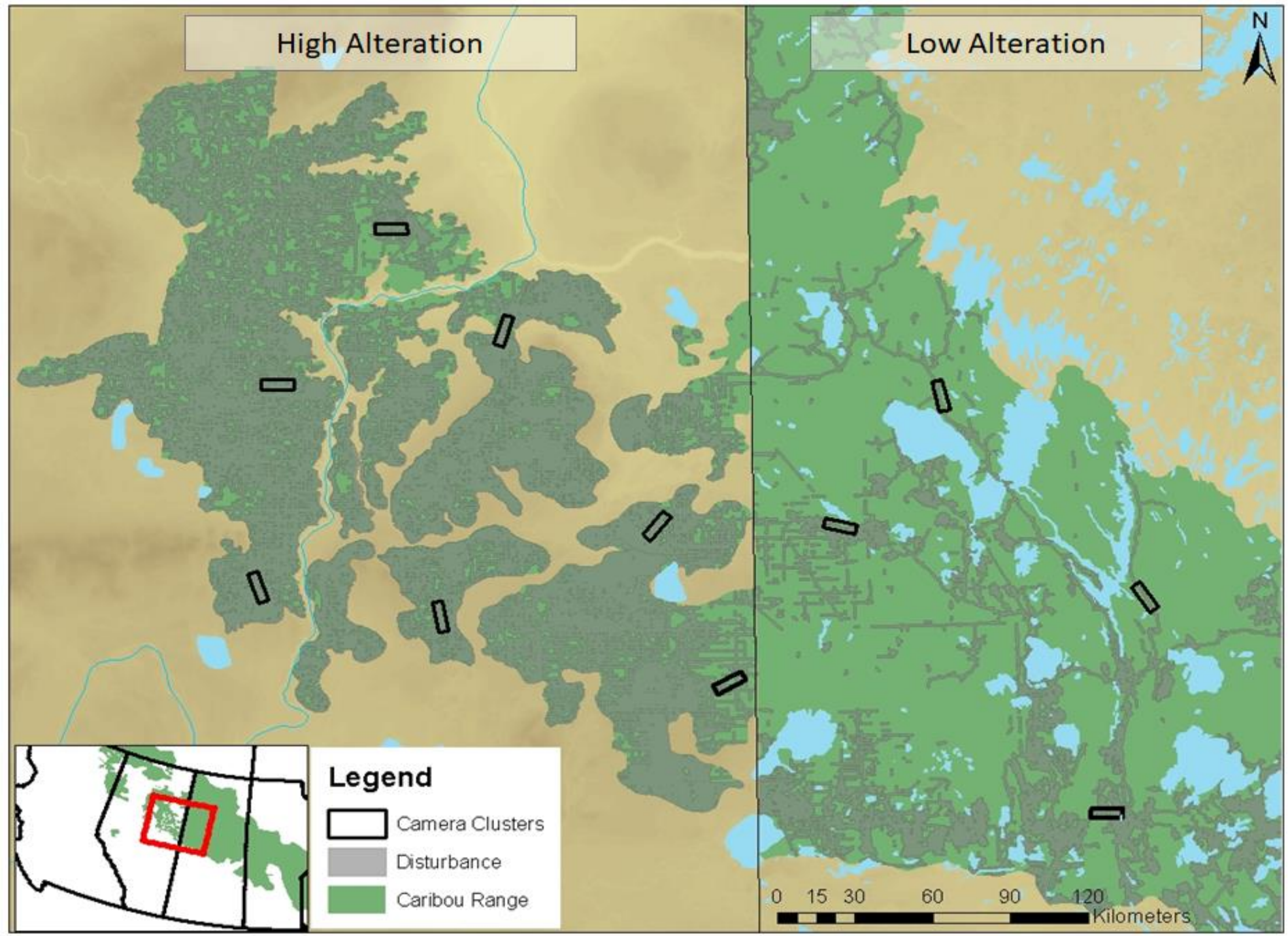
Objectives

- 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

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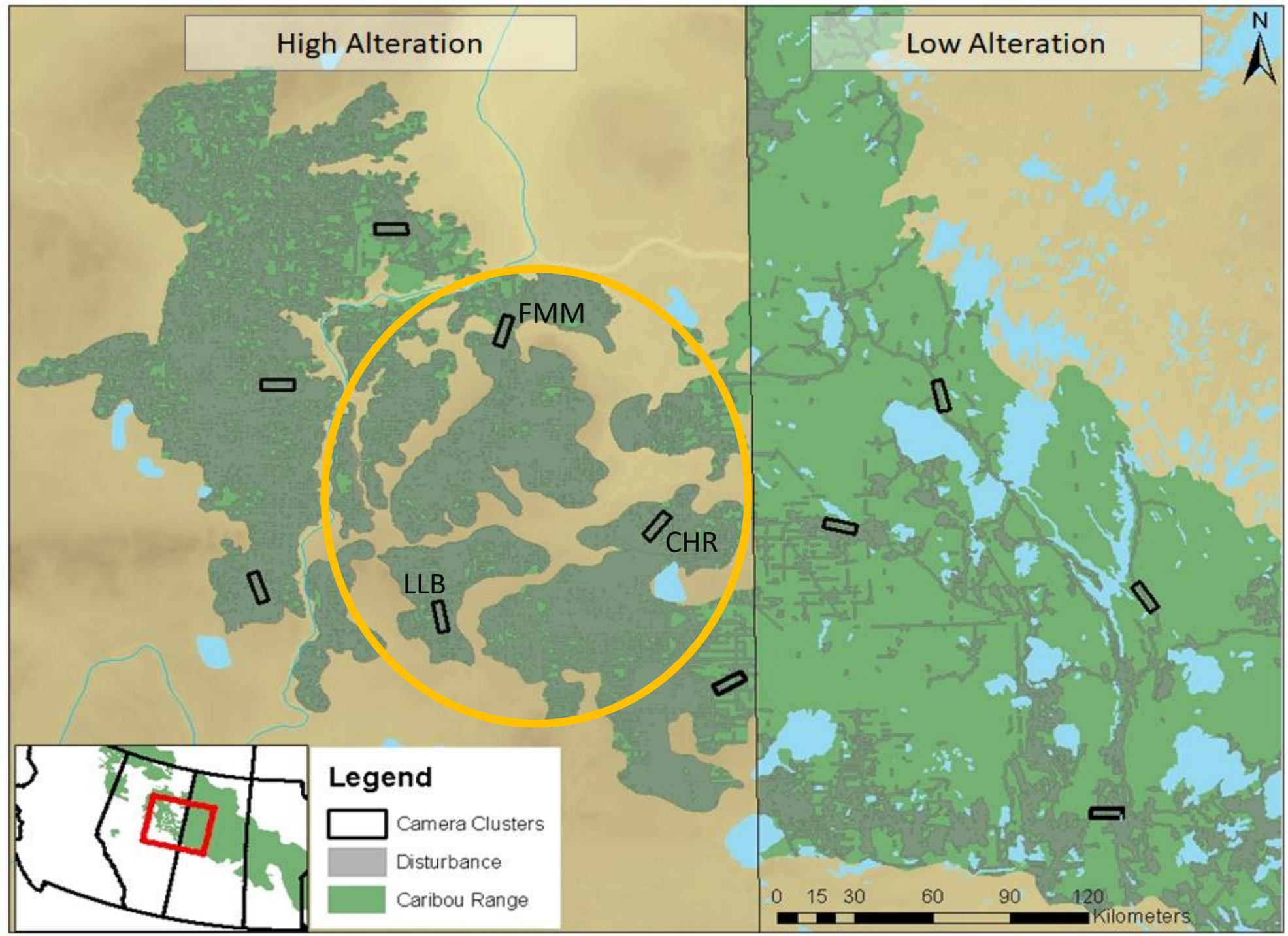

- Originally designed for REST
  - Random within clusters
- 25 cameras in 3 clusters each
  - 2017 and 2018
- How do density estimates from the two methods compare?

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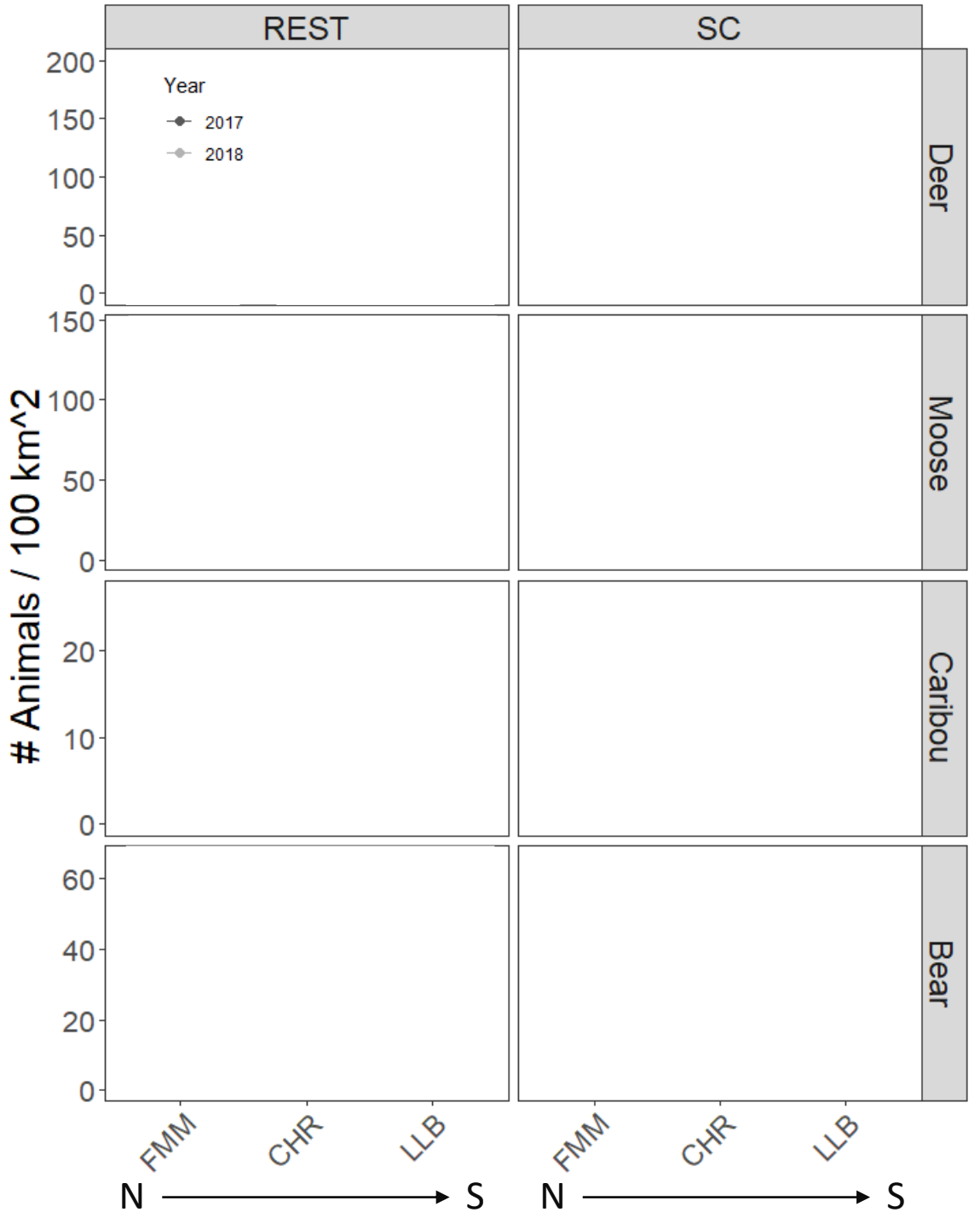
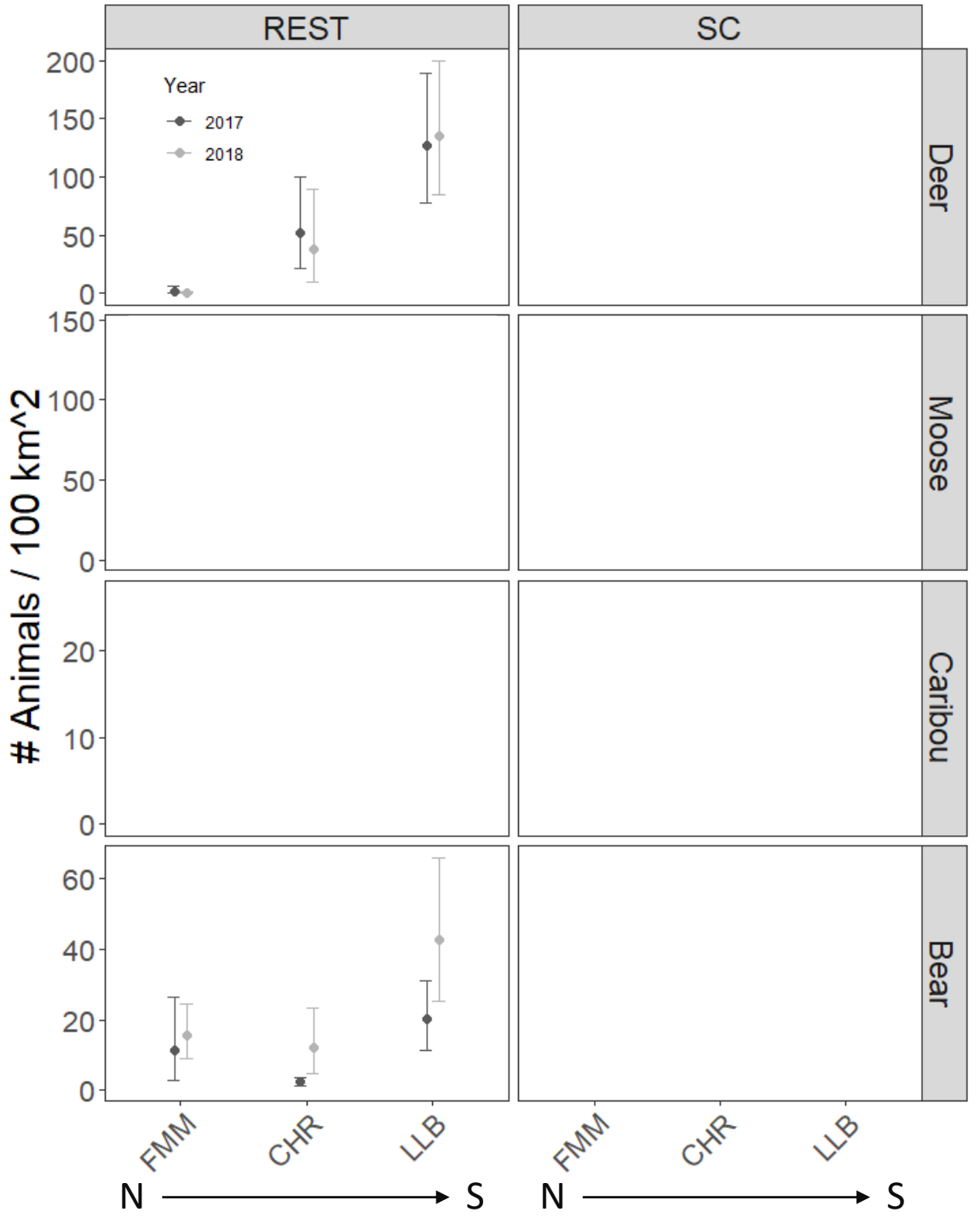
Results


REST
SC
Deer
Moose
Caribou
Bear
Year
2017
2018
Animals / 100 km^2
200
150
100
50
0
150
100
50
0
20
10
0
60
40
20
0
FMM
CHR
LLB
FMM
CHR
LLB
N
S
N
S

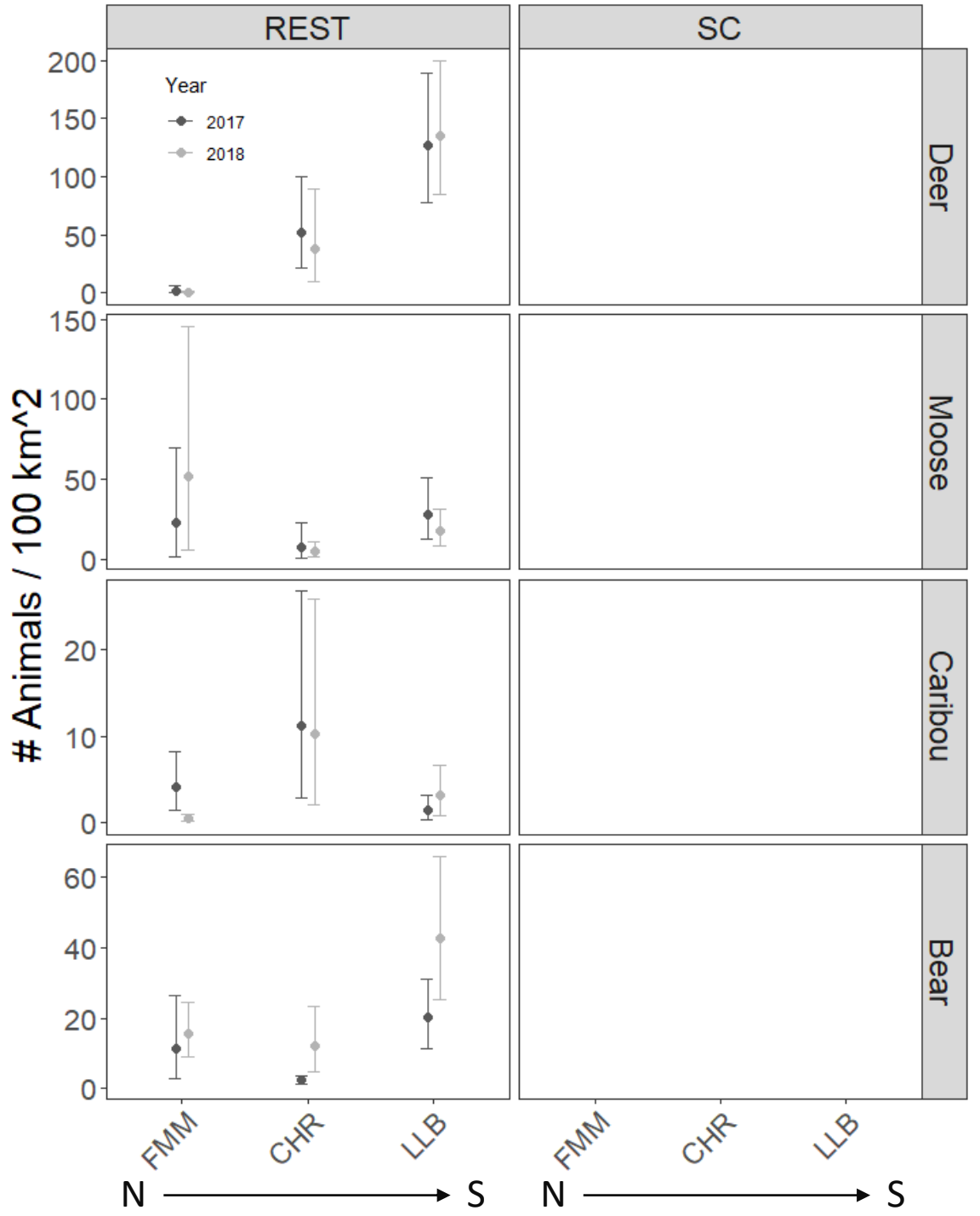
Results

- REST estimates show strong latitudinal variation
  - Especially for deer



Results

- REST estimates show strong latitudinal variation
  - Especially for deer
  - Moose and caribou have opposite patterns



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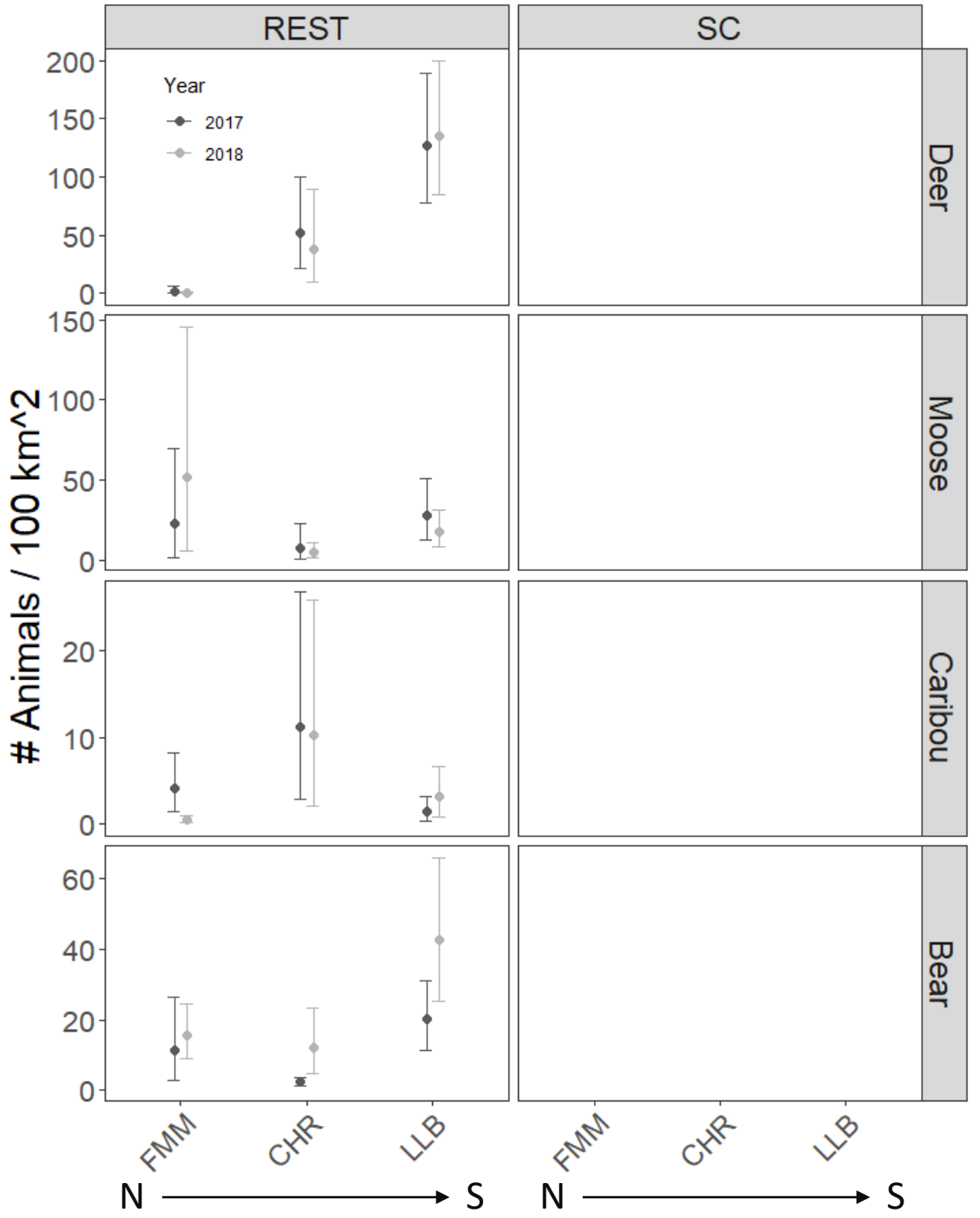
  - (generally) consistent across years



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- SC shows consistent densities across latitudes, but yearly variation
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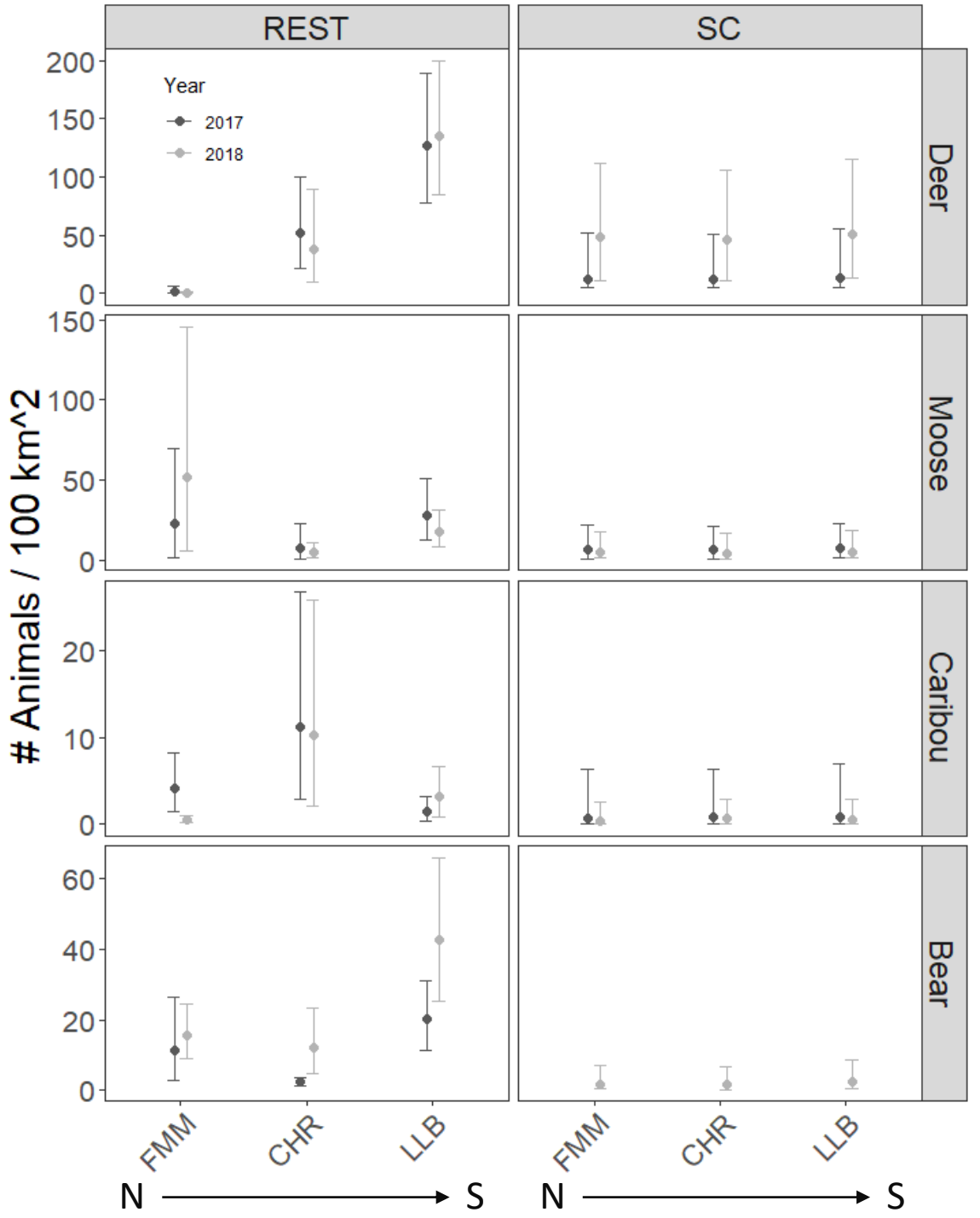
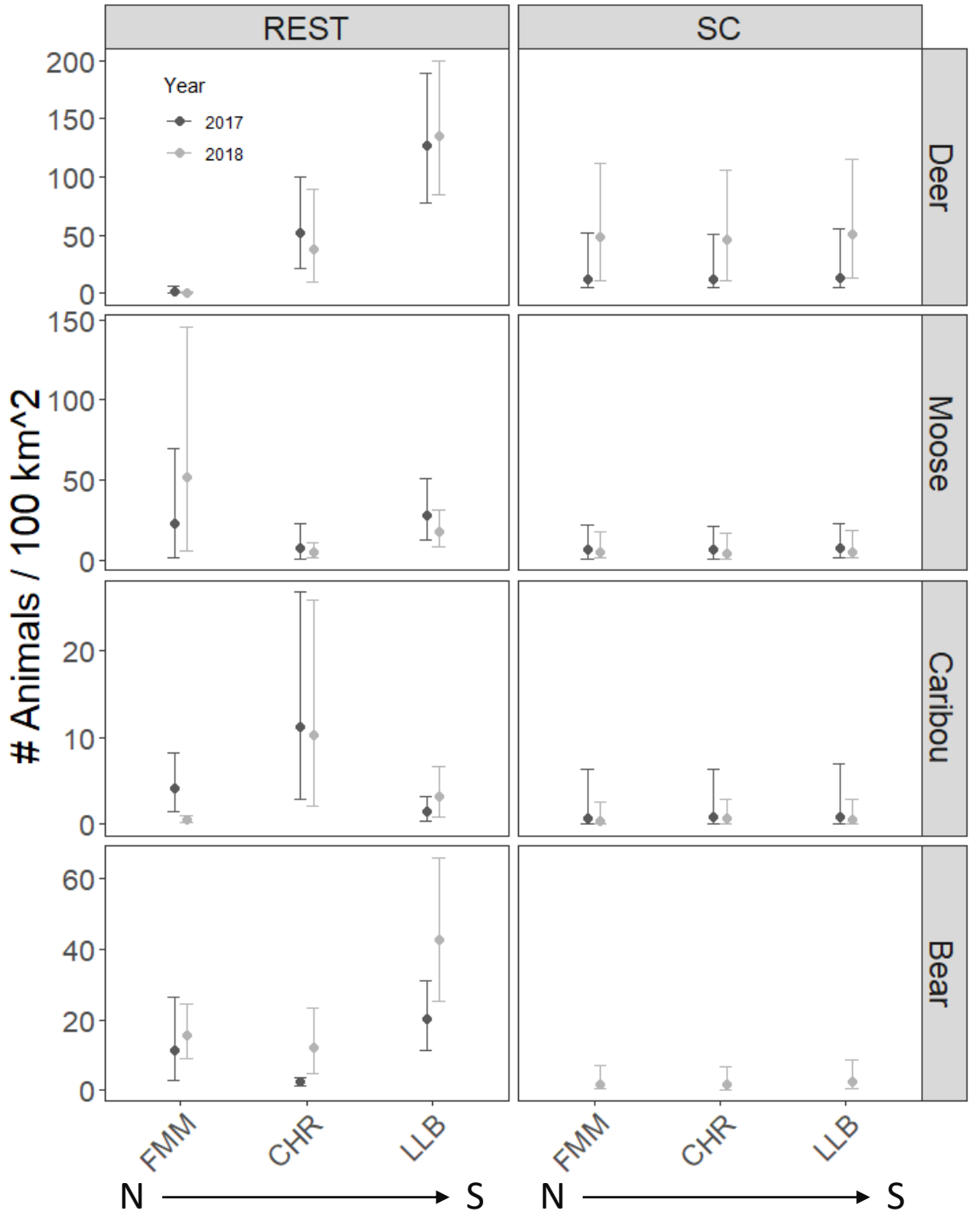


Results

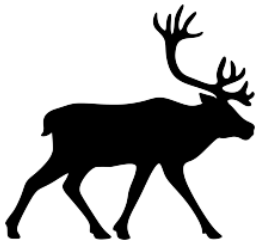
- REST estimates show strong latitudinal variation
  - Especially for deer
  - Moose and caribou have opposite patterns
  - (generally) consistent across years
- SC shows consistent densities across latitudes, but yearly variation
  - Especially for deer
- Both have large CIs
  - REST tends to have more variable CIs



Comparisons to alternate estimates

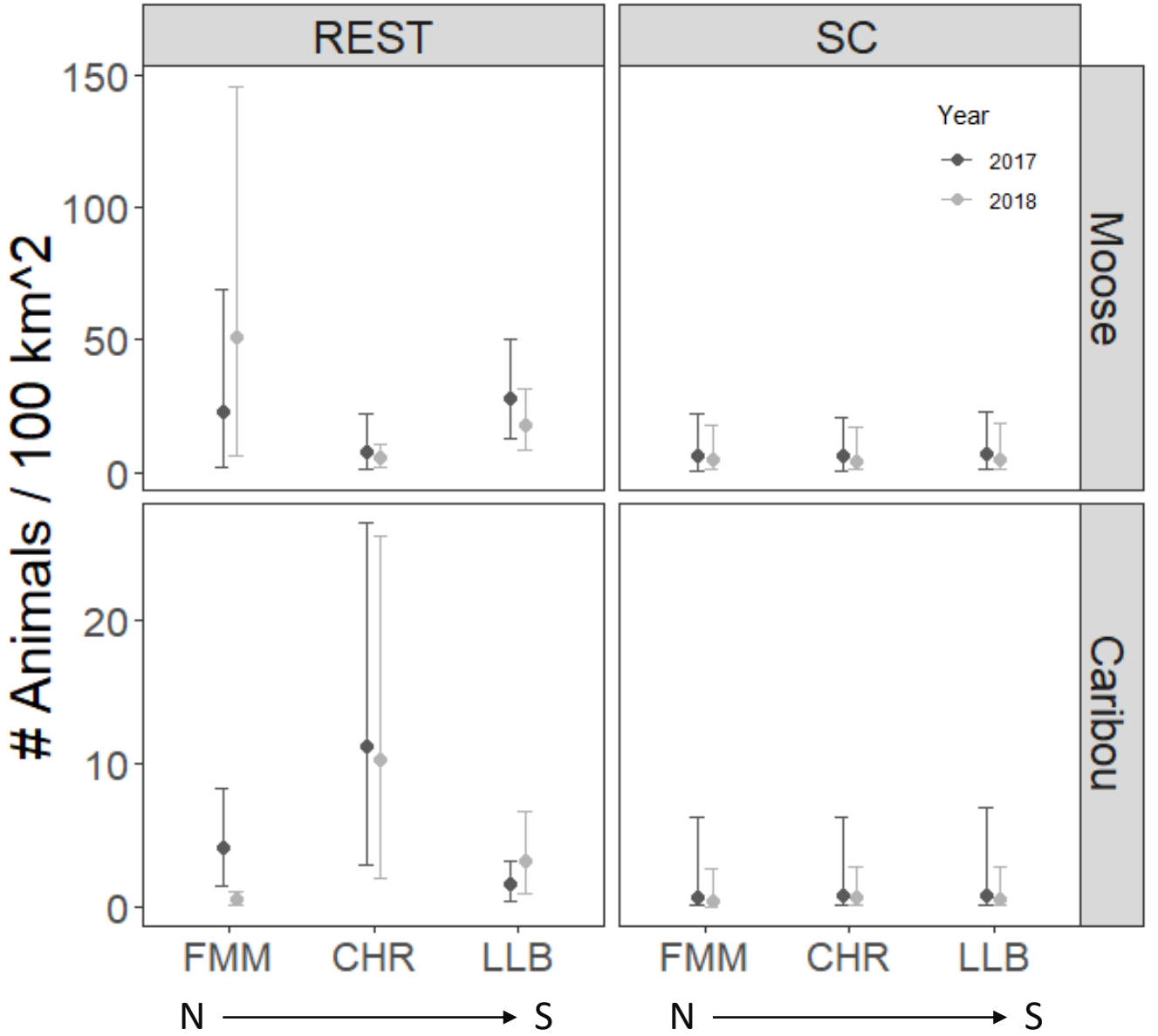
Aerial Surveys

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



DNA mark-recapture

- Government of Alberta



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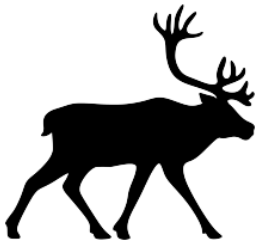

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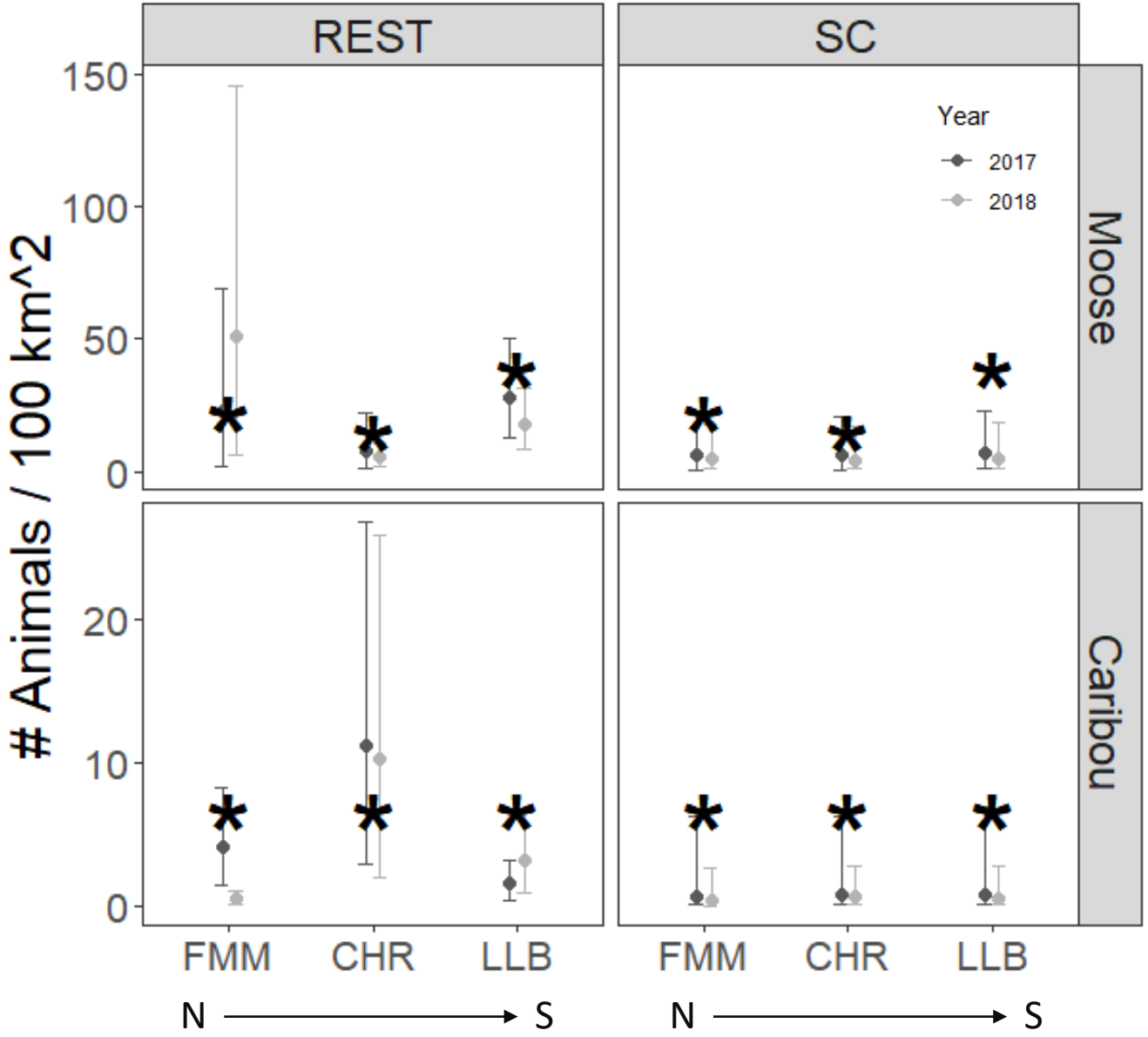

“All models are wrong, but some models are useful” Box (1976)

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Understanding assumptions is important

Assumptions

Spatial Capture (SC)

1. Density does not vary during sampling period
2. λ_0 and σ 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

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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

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Alberta Government

CMU CARIBOU MONITORING UNIT

RICC | Regional Industry Caribou Collaboration

UBC THE UNIVERSITY OF BRITISH COLUMBIA Faculty of Forestry

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