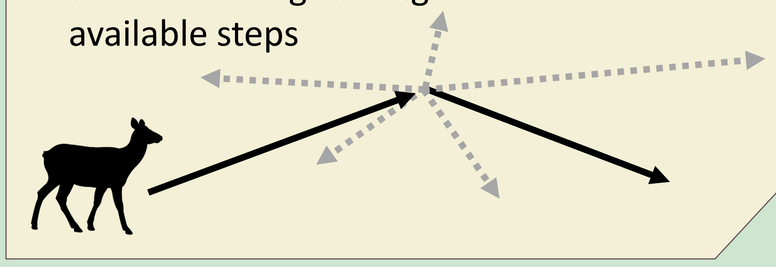
# A goodness-of-fit metric for integrated step-selection analyses

**Brian J. Smith**[1], Johannes Signer[2], John Fieberg[3], Tal Avgar[1]

[1]Department of Wildland Resources & Ecology Center, Utah State University, USA
[2]Faculty of Forest Sciences and Forest Ecology, University of Goettingen, Germany
[3]Department of Fisheries, Wildlife, Conservation Biology, University of Minnesota, USA

## What is iSSA?

- Parameterizes discrete-time biased correlated random walk (BCRW) [1]
- Habitat selection & movement processes
- Conditional logistic regression: used vs available steps



## The Problem

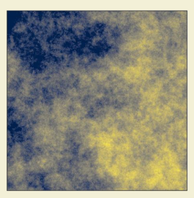
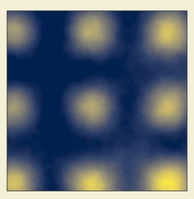
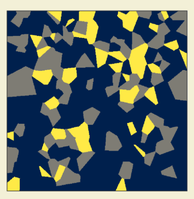
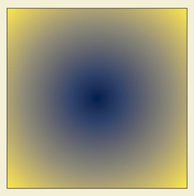
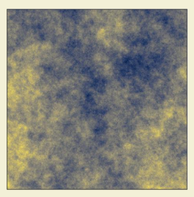
iSSA uses conditional logistic regression as a fitting "trick" to approximate the underlying model. Model evaluation should be based on the model of interest, not the conditional logistic regression.

## Approach

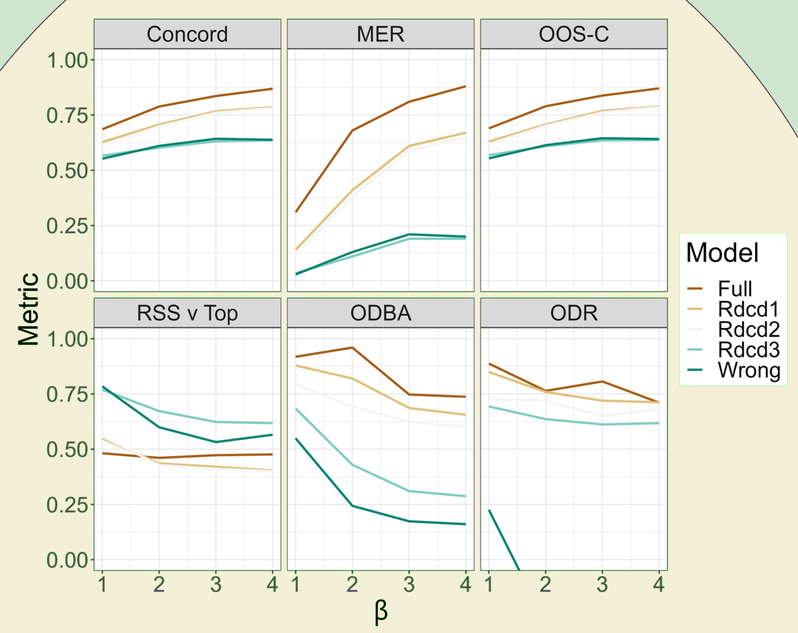
Use simulation to compare the performance of 3 different types of metrics under various selection strengths and model formulas:

1. Simulate habitat
2. Simulate movement data with 4 different selection strengths (β)
3. Fit iSSA with 5 different model formulas
4. Calculate fit metrics
5. Compare

## Simulated Habitat

| | | |
|---|---|---|
| Forage |  | + |
| Predator Density |  | − |
| Land Cover |  | +/− |
| Distance to Center |  | − |
| Sham |  | 0 |

## Results



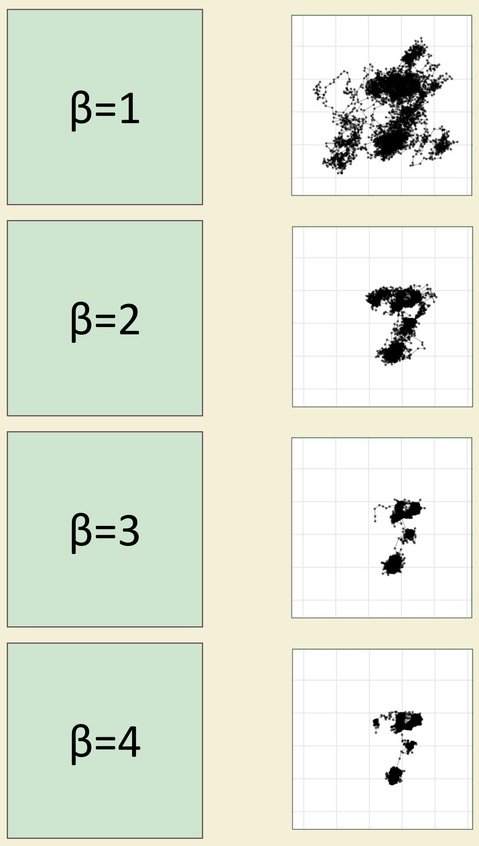

## Conclusions

All metrics *except* RSS v Top rank models in terms of correctness

Only the occurrence distribution metrics decrease with selection strength

OOS-C performs well and is relatively computationally efficient.

## Simulated Data




## Model Formulas

```
Full: ~ forage + pred + cover + dist_to_cent
Rdcd1: ~ forage + pred + dist_to_cent
Rdcd2: ~ forage + dist_to_cent
Rdcd3: ~ dist_to_cent
Wrong: ~ sham
```

## Metrics

Least Computational Intensity ← → Most Computational Intensity

### Conditional Logistic Regression Metrics

Typical metrics in the CLR literature

#### Concordance (Concord)

Generalization of ROC AUC to stratified models

#### Measure of Explained Randomness (MER)

Cox-Snell pseudo-$R^2$
N is total of only used steps

### Resampled Available Step Metrics

Numerically approximate redistribution kernel

#### Out-of-Sample Concordance (OOS-C)

Rank all steps in a stratum using fitted model risk prediction
Divide rank of used step by total steps per stratum
Take average across all strata

#### RSS vs Top Step (RSS v Top)

Calculate ratio of risk prediction for used step/top ranked step
How many times more likely the model is to select the top step over the used step

### Occurrence Distribution Metrics

Compare emergent distribution for observed vs simulated data

#### Bhattacharyya's Affinity (ODBA)

Calculate occurrence distribution for observed data [2]
Simulate tracks under fitted model and calculate occurrence distribution for simulated data [3]
Compare using BA [4]

#### Spearman's R (ODR)

Calculate occurrence distribution for observed data [2]
Simulate tracks under fitted model and calculate occurrence distribution for simulated data [3]
Compare using Spearman's R

## Acknowledgements

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UtahStateUniversity DEPARTMENT OF WILDLAND RESOURCES

UtahStateUniversity ECOLOGY CENTER

## More Information

GitHub Repo

https://github.com/bsmity13/iSSA_GoF

My Website

https://www.ecosmith.org

## Literature Cited

1. Avgar, T., Potts, J. R., Lewis, M. A. & Boyce, M. S. Integrated step selection analysis: bridging the gap between resource selection and animal movement. *Methods Ecol. Evol.* **7**, 619–630 (2016).
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4. Potts, J. R., Börger, L., Strickland, B. K. & Street, G. M. Assessing the predictive power of step selection functions: how social and environmental interactions affect animal space use. *Methods Ecol. Evol.* 1–39 (2022) doi:10.1111/2041-210x.13904.