Location uncertainty in azimuthal telemetry data and the spatial ecology of the threatened Gunnison sage-grouse

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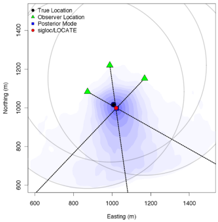
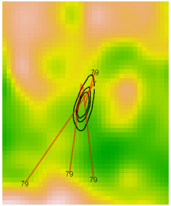
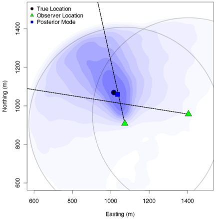
[1]*University of Rhode Island*, [2]*Colorado State University*, [3]*U.S. Geological Survey*, [4]*U.S. Fish and Wildlife Services*, [5]*Colorado Parks and Wildlife*, [6]*U.S. Department of Agriculture*







Outline

Motivation

- Gunnison sage-grouse
- Radio-telemetry location estimation

A New Model

- Azimuthal Telemetry Model (ATM)
- Simulation

Ecological Inference & Uncertainty

- Home-Range & Space-Use
- Resource Selection Functions
- Site Fidelity

Conclusion

MOTIVATION

Gunnison sage-grouse (*Centrocercus minimus*)

- Federally Threatened
- $<$ 5000 individuals
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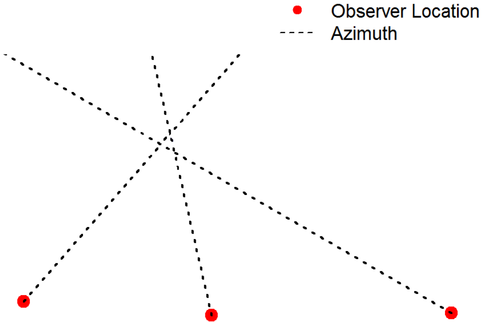
Colorado Study (2004 - 2010)

- 243 birds
- VHF (radio) tags on females
- One location every 1-3 days from May to September
- 2-12 azimuths per location
- $\approx$ 9000 locations

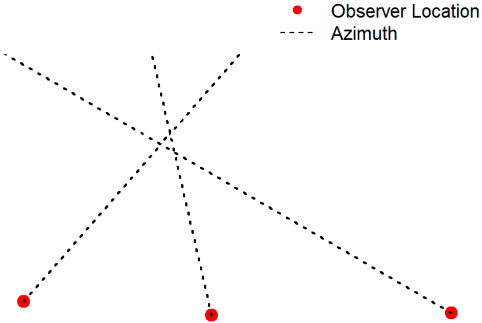
MOTIVATION



Motivation

Ecological Inference

- Describe location uncertainty
- Propagate location uncertainty into ecological models



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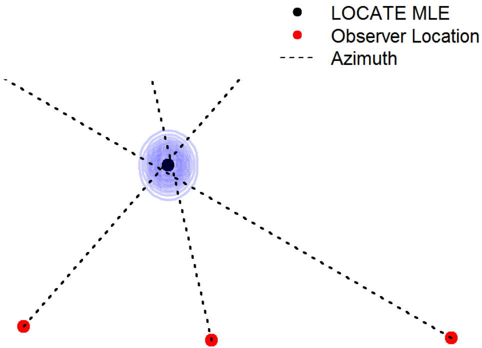
- Lenth 1981 MLE
- Software: LOCATE, LOAS, sigloc (R package)
- Elliptical uncertainty
- Poor coverage



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- Location uncertainty
  - ignored
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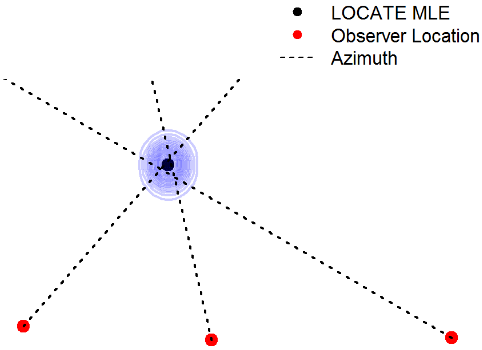
  - defines spatial scale
- Location estimates are dropped



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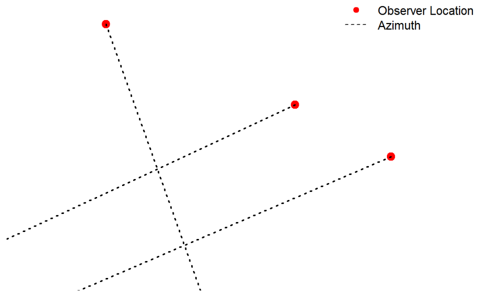

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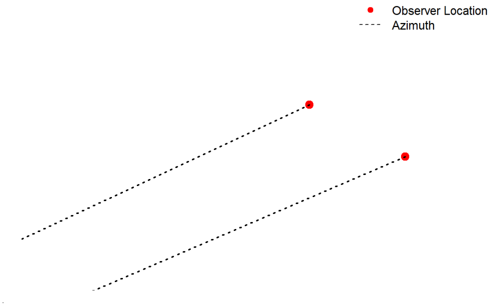

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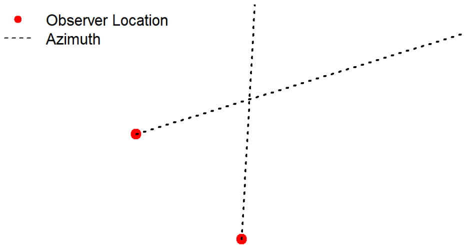

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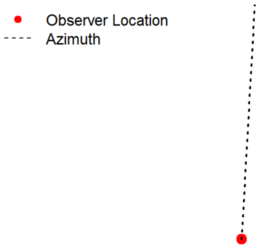

Motivation

Why develop new methods for radio-telemetry?

Radio-telemetry

- Historically, most animal spatial inference used radio-telemetry
- Radio-telemetry is still widely used
  - Relatively low cost
  - Miniaturization → can attach to small and volant species
  - Long battery life

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- i = day
- j =observation location

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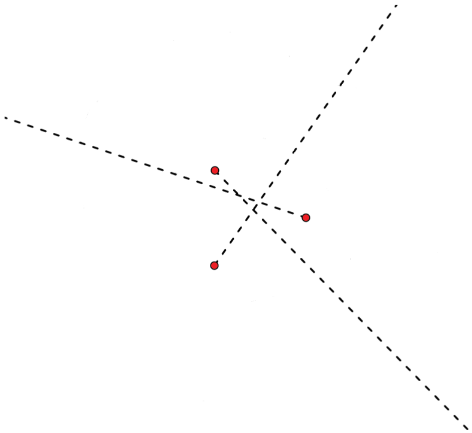
AZIMUTHAL TELEMETRY MODEL

We're going to take a Bayesian approach, which requires prior distributions for unknown parameters.



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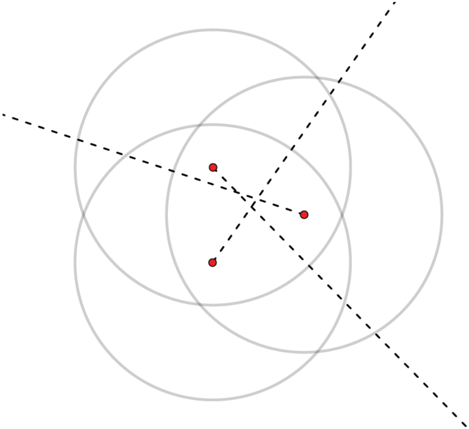

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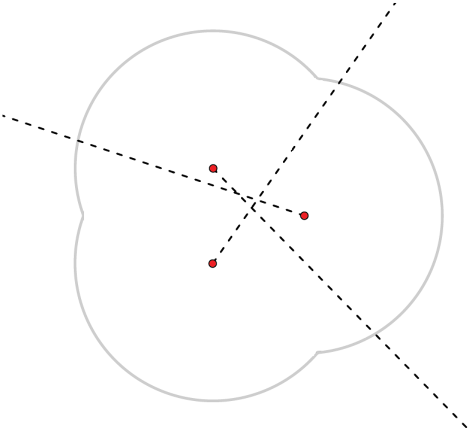

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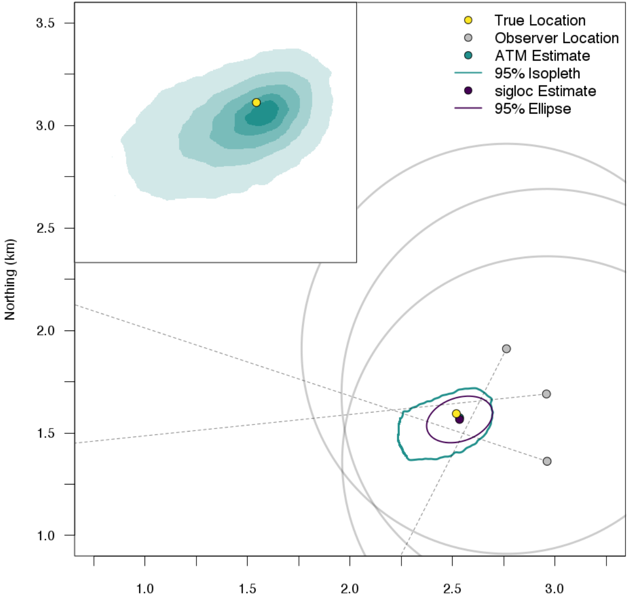

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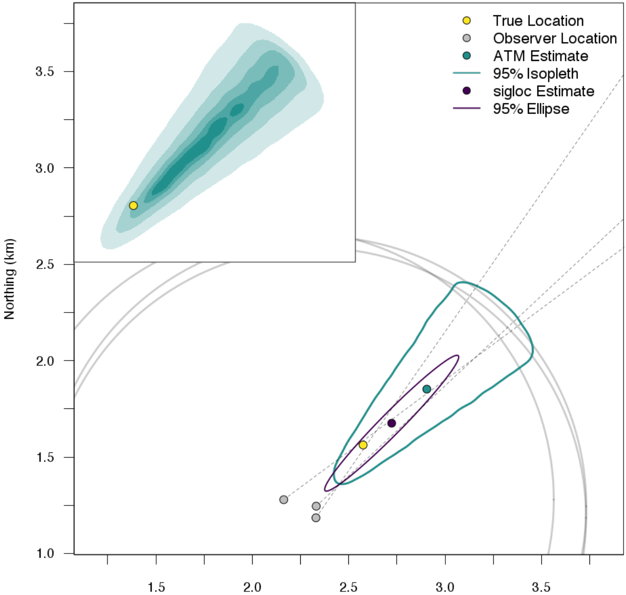

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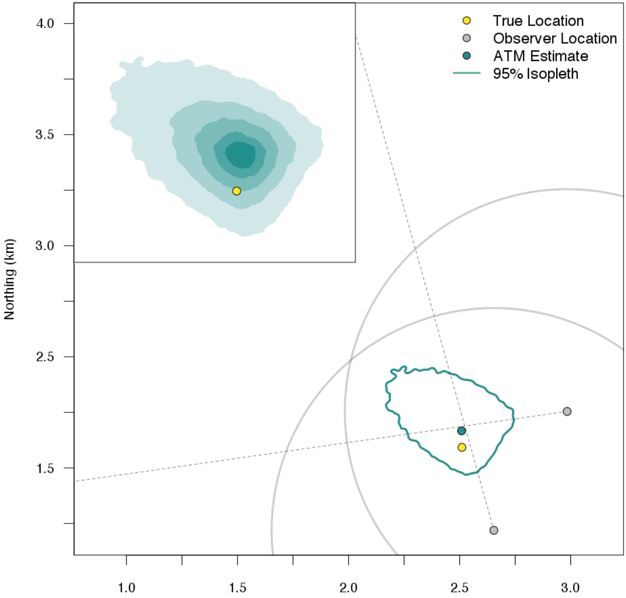

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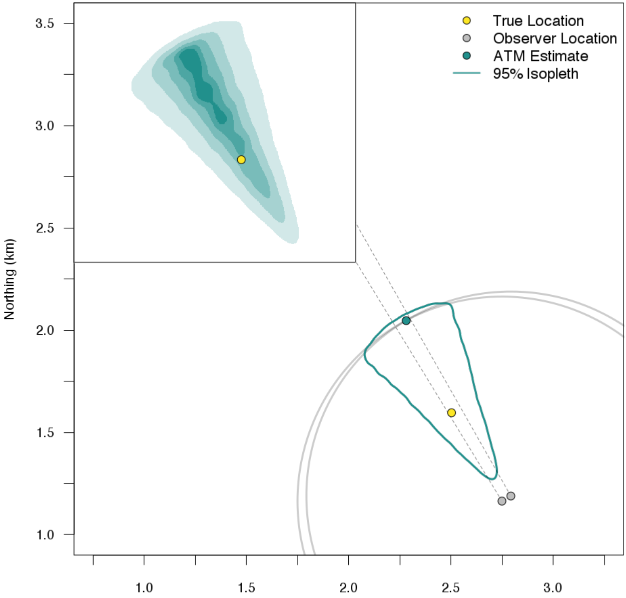

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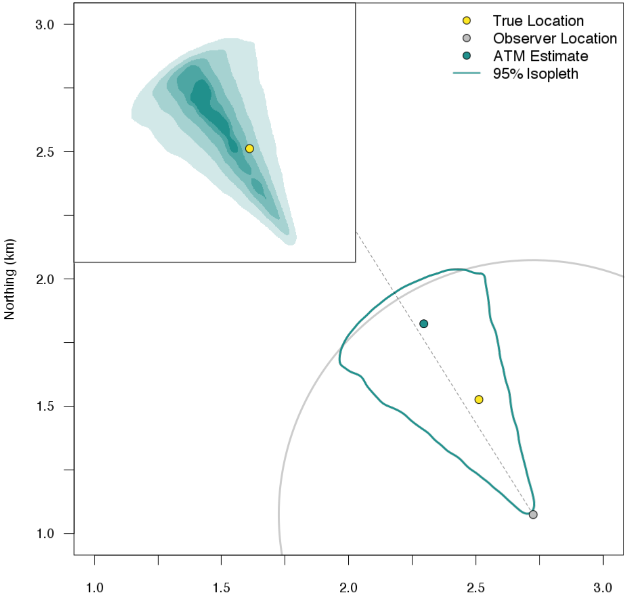

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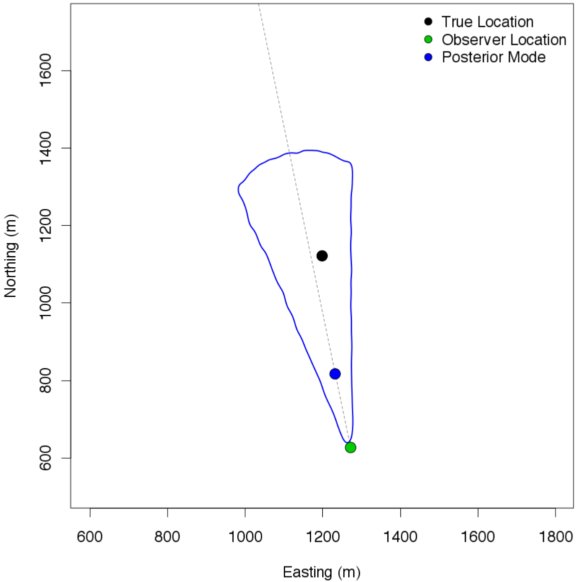
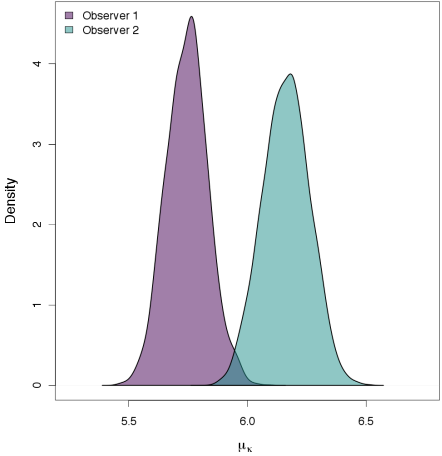
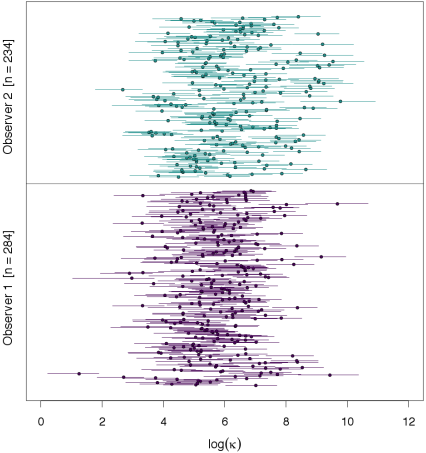


Azimuthal Telemetry Model

Observer Effect (Grouse Data)





Azimuthal Telemetry Model

Simulation

- Design: **Random**, **Encircle**, and **Road**
- Concentration Parameter (κ): **25**
- Num. Azimuths: **3**
- Num. of Simulations: **600**

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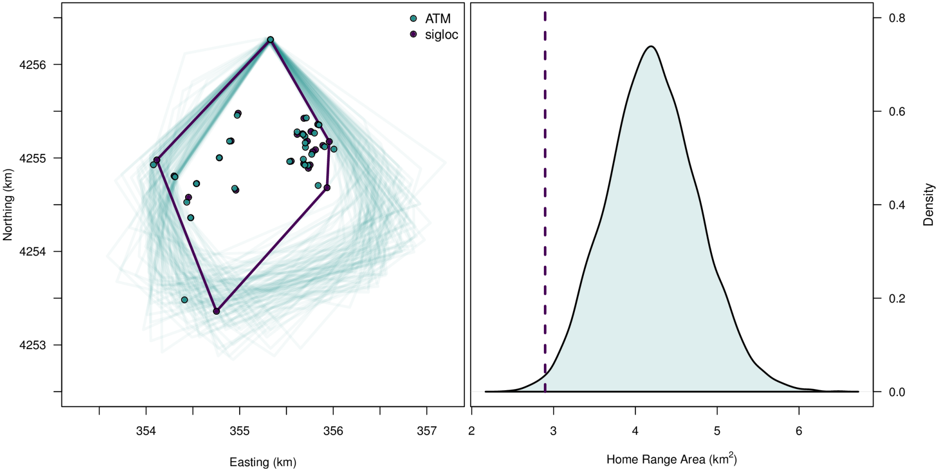
	Random		**Encircle**		**Road**	
	sigloc	ATM	sigloc	ATM	sigloc	ATM
n	439	600	581	600	409	600
Bias (m)	75	55	44	43	110	86
Coverage	0.33	0.92	0.33	0.92	0.30	0.90

Space Use Analysis

How does uncertainty about μ affect inference on sage-grouse space-use?

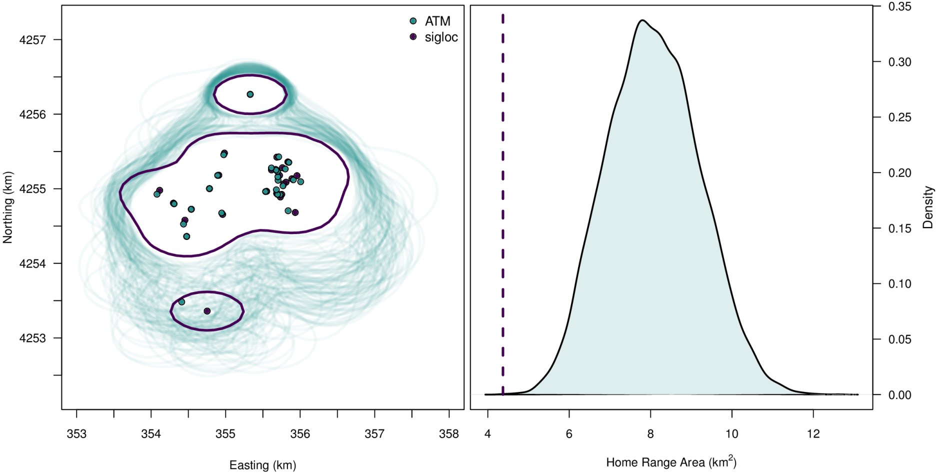
Space Use Analysis

Home-Range: Convex Hull

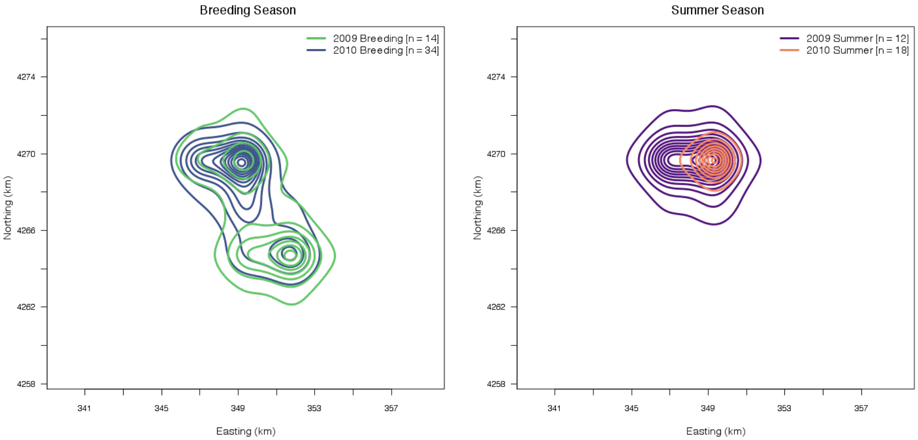


Space Use Analysis

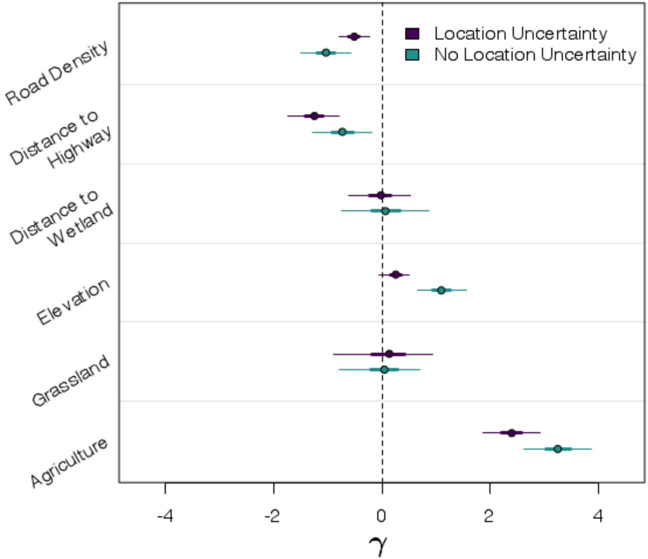
Home-Range: Non-Parametric Kernel



Site Fidelity

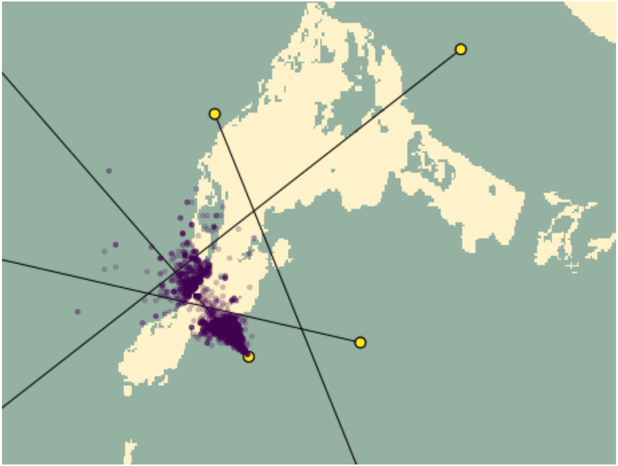


Resource Selection Function



Resource Selection Function

Hierarchical Learning via the ATM-RSF Model



Conclusion

Findings

- Flexible modeling of azimuthal uncertainty.
- Improved coverage of location with ATM.
- Hierarchical modeling provides straightforward propagation of uncertainty into ecology models.

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Developments

- Manuscript: Accounting for location uncertainty in azimuthal telemetry data improves ecological inference. Movement Ecology.
- R package: razimuth: https://github.com/cppeck/razimuth
- Site fidelity ecology of Gunnison sage-grouse

ACKNOWLEDGMENTS

- Researchers: M. Phillips, J. Wenum, N. Seward, and P. Street
- Research Technicians!
- Landowners throughout Gunnison County

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Colorado State University Fish, Wildlife, and Conservation Biology

Colorado Parks • Wildlife

The University of Rhode Island

USGS