How environmental change affects animal movement

Quantitative
Ecology Lab
UBC Okanagan

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Why do animals move?

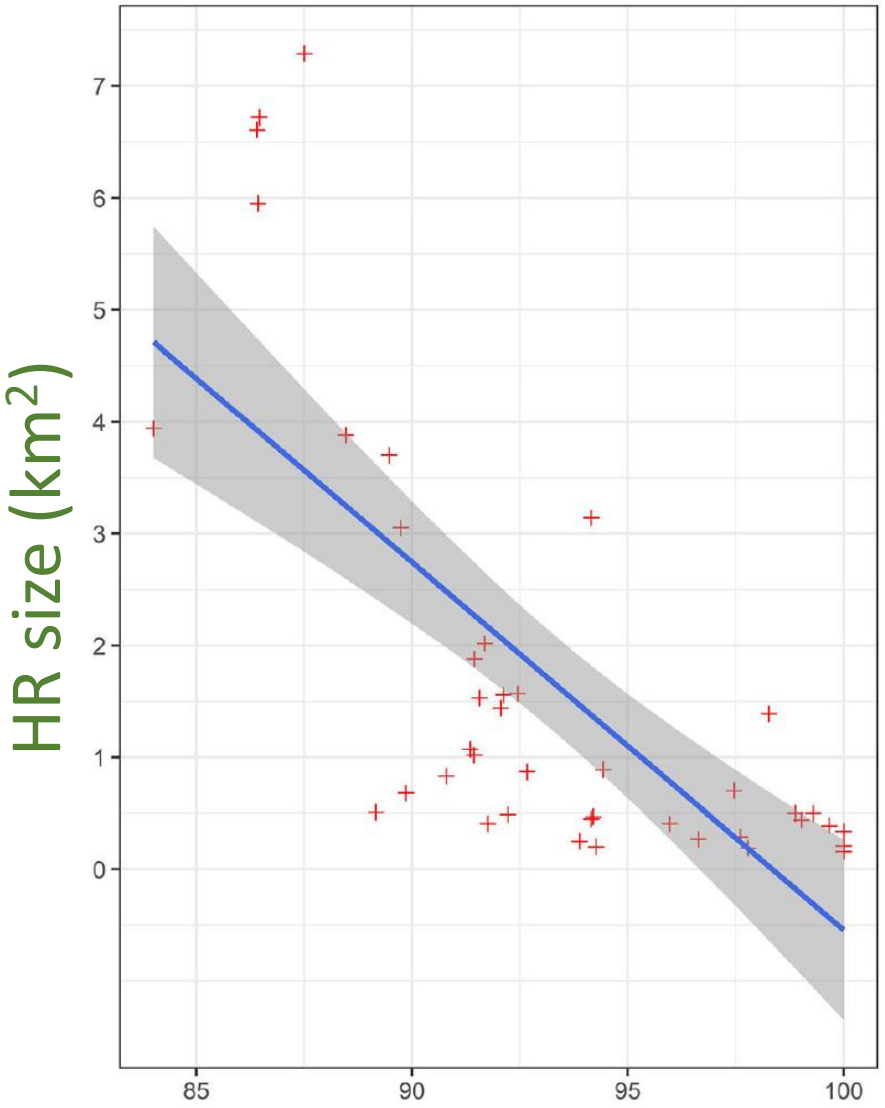
- Food/nutrients
- Water
- New den/nest
- Mate/group
- And many other reasons…

Mother elephant with offspring,
photo by Floodmfx, CC0, via Wikimedia Commons

Use **home range size** as a proxy for all needs

Resource abundance and HR

Resource abundance and HR: examples in literature



Red panda,
photo by Brunswyk, CC BY-SA 3.0,
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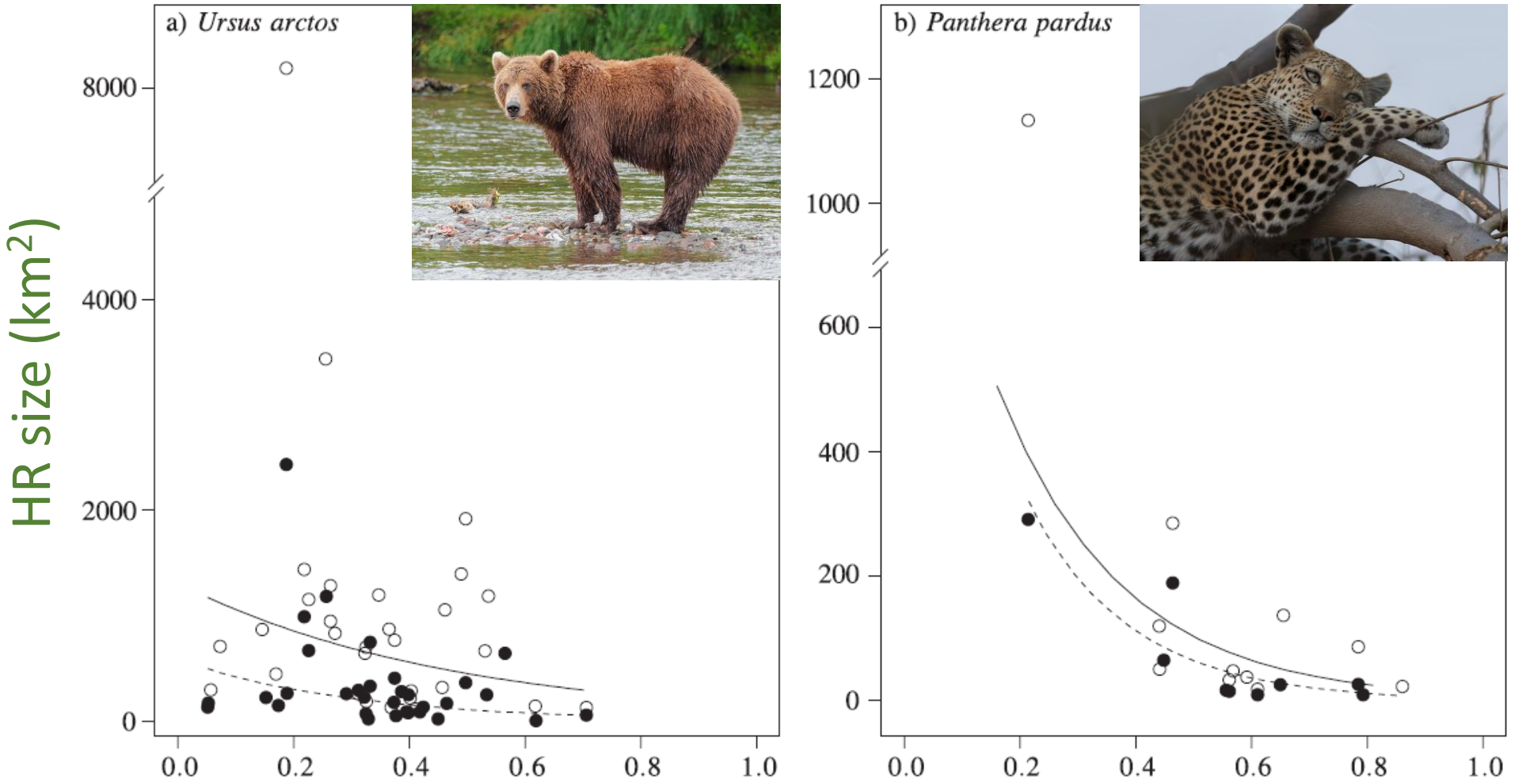
(Bista et al. 2022)

Resource abundance and HR: examples in literature

Brown bear, photo by Robert F. Tobler, CC BY-SA 4.0, via Wikimedia Commons

Leopard, photo by Gregory "Slobirdr" Smith, CC BY-SA 2.0, via Wikimedia Commons



(Nilsen et al. 2005)

Resource abundance and HR : an abundance of evidence

1. Bista, D., G. S. Baxter, N. J. Hudson, S. T. Lama, and P. J. Murray. 2022. Effect of disturbances and habitat fragmentation on an arboreal habitat specialist mammal using GPS telemetry: A case of the red panda. Landscape Ecology 37:795–809.
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6. Relyea, R. A., R. K. Lawrence, and S. Demarais. 2000. Home Range of Desert Mule Deer: Testing the Body-Size and Habitat-Productivity Hypotheses. The Journal of Wildlife Management 64:146.
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8. Williams-Guillen, K., C. McCann, J. C. Martinez Sanchez, and F. Koontz. 2006. Resource availability and habitat use by mantled howling monkeys in a Nicaraguan coffee plantation: Can agroforests serve as core habitat for a forest mammal? Animal Conservation 9:331–338.

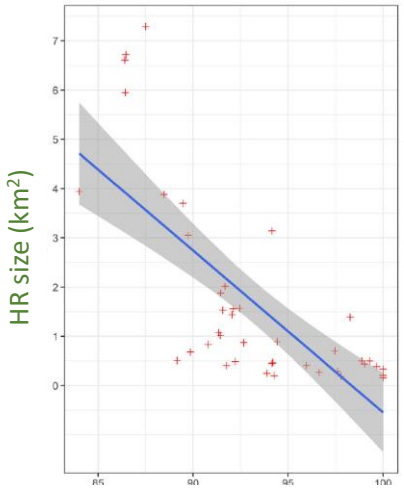
…

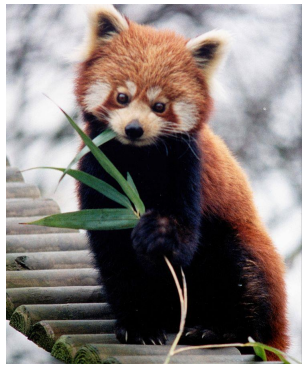
Resource abundance and HR : common issues

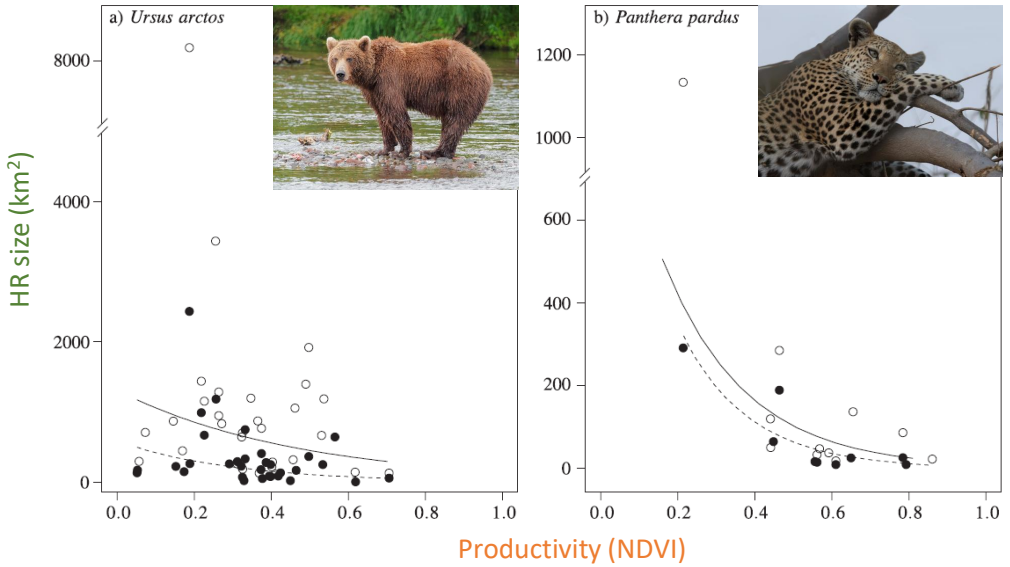
- Results reported as **new findings**

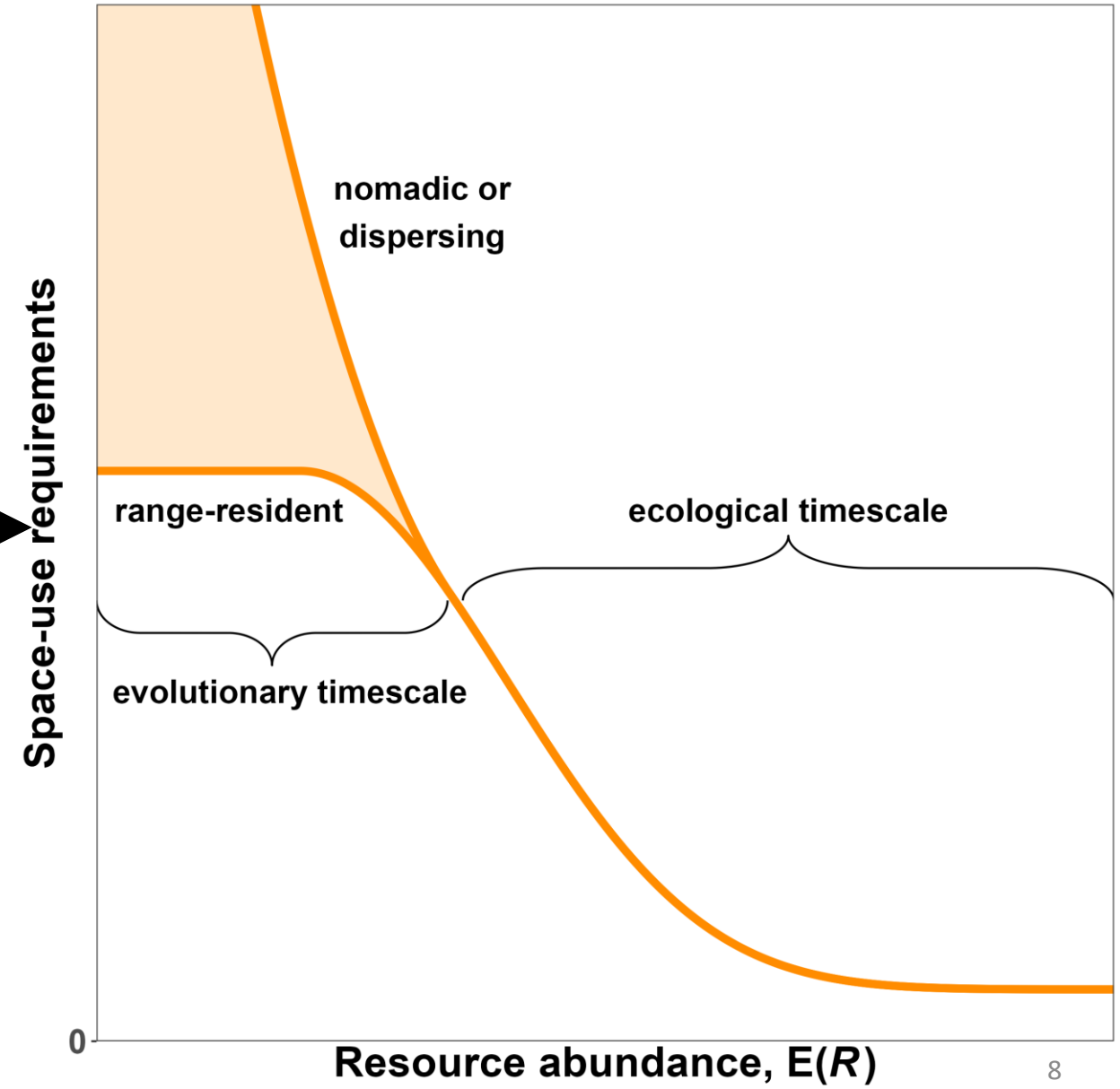
- No **unifying hypotheses**

Resource abundance and HR: hypothesis



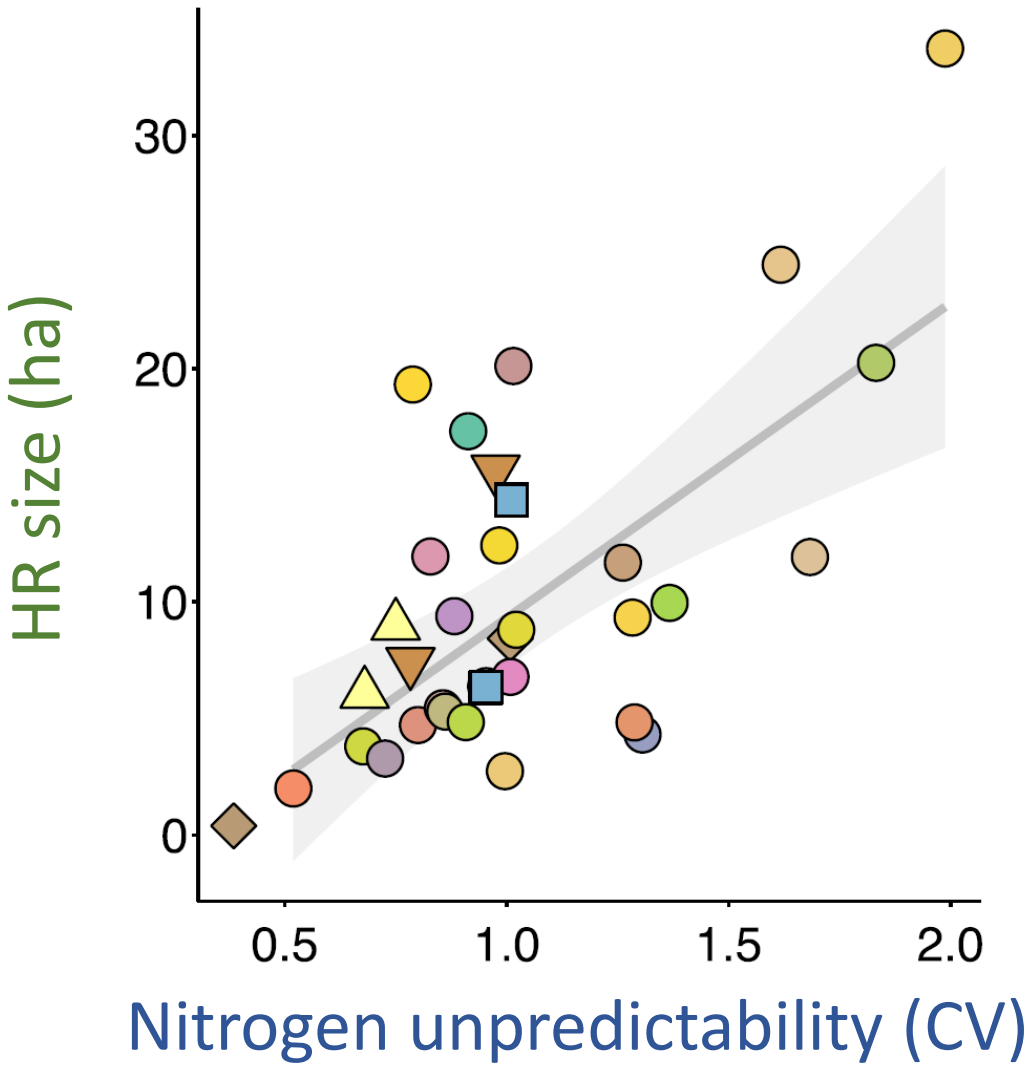






Resource unpredictability and HR

Resource unpredictability and HR: examples in literature



(Rizzuto et al. 2021)

Showshoe hares, photos by Walter Siegmund (top) and D. Gordon and E. Robertson (bottom), CC BY-SA 3.0, via Wikimedia Commons

Resource unpredictability and HR : current evidence

1. Herfindal, I., J. D. C. Linnell, J. Odden, E. B. Nilsen, and R. Andersen. 2005. Prey density, environmental productivity and home-range size in the Eurasian lynx (Lynx lynx). Journal of Zoology 265:63–71.
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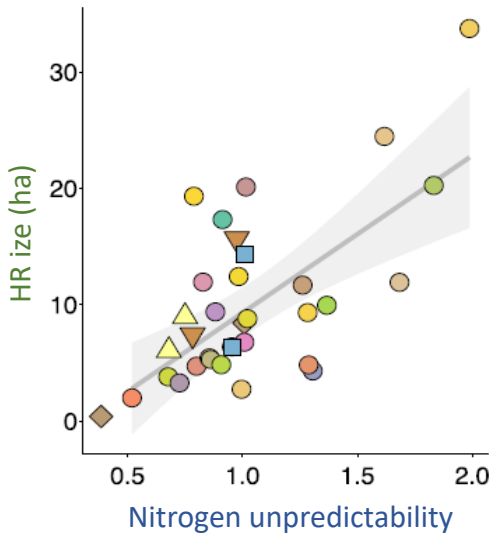
- Results reported as **new findings**

- No **unifying hypotheses**

Resource unpredictability and HR: a unifying framework



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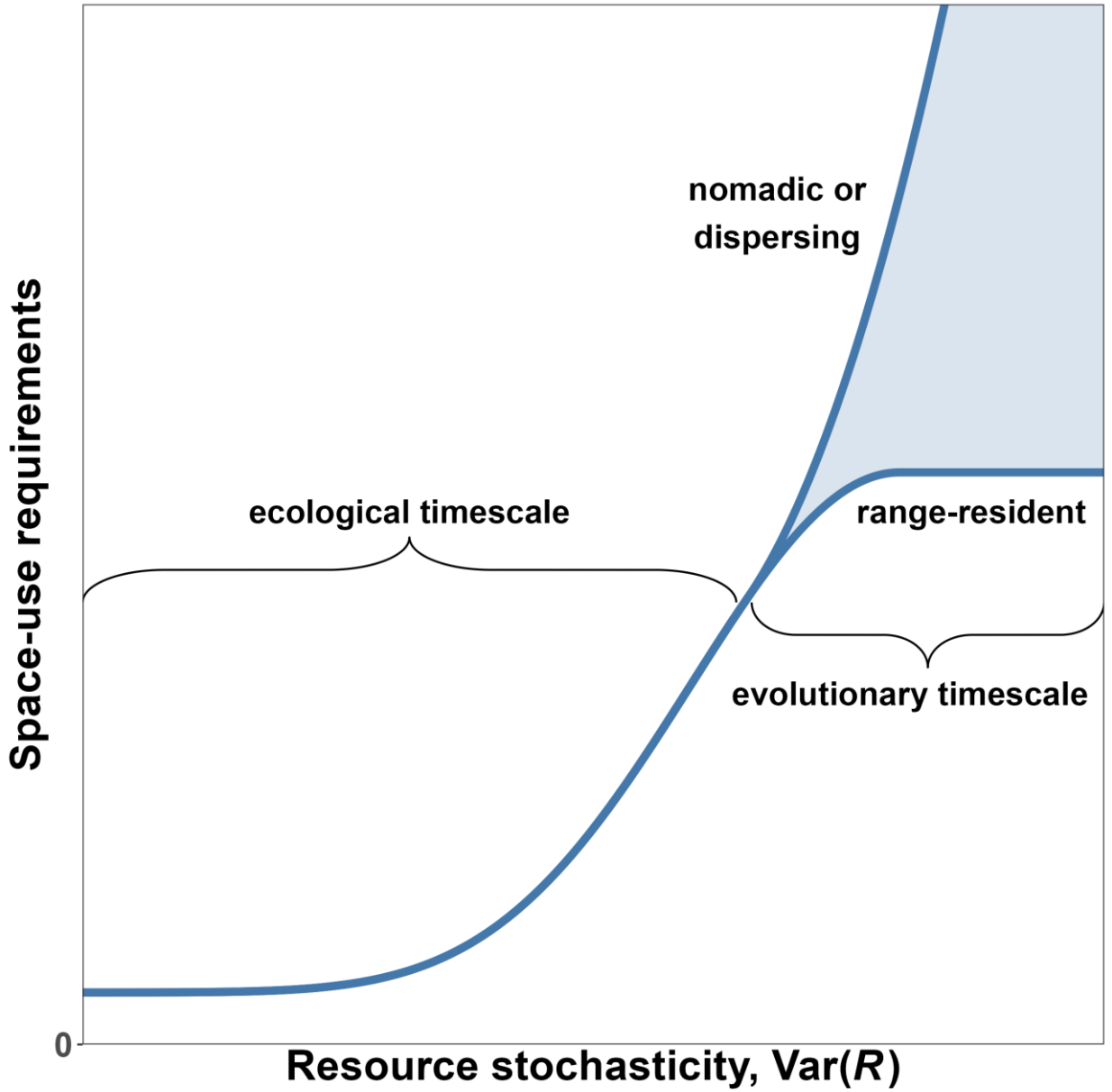
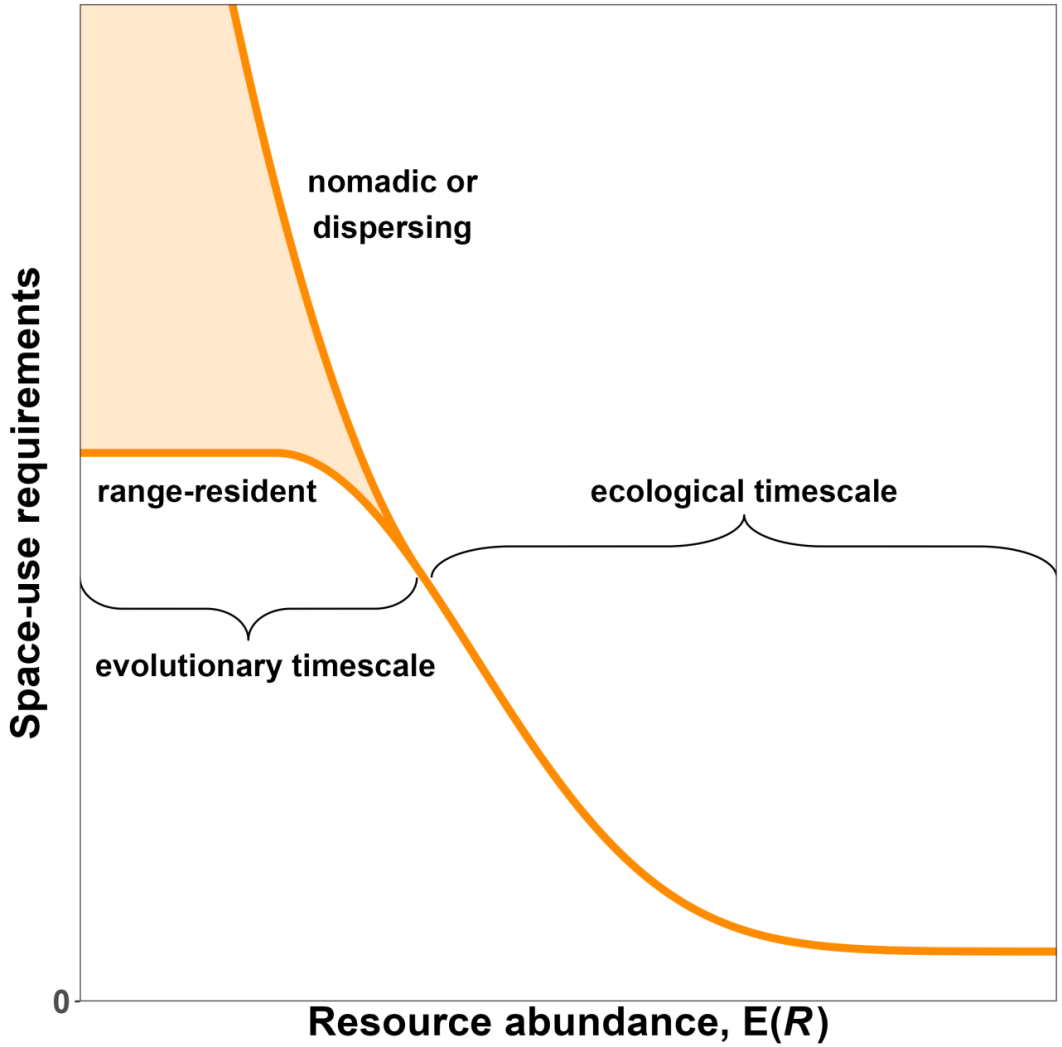
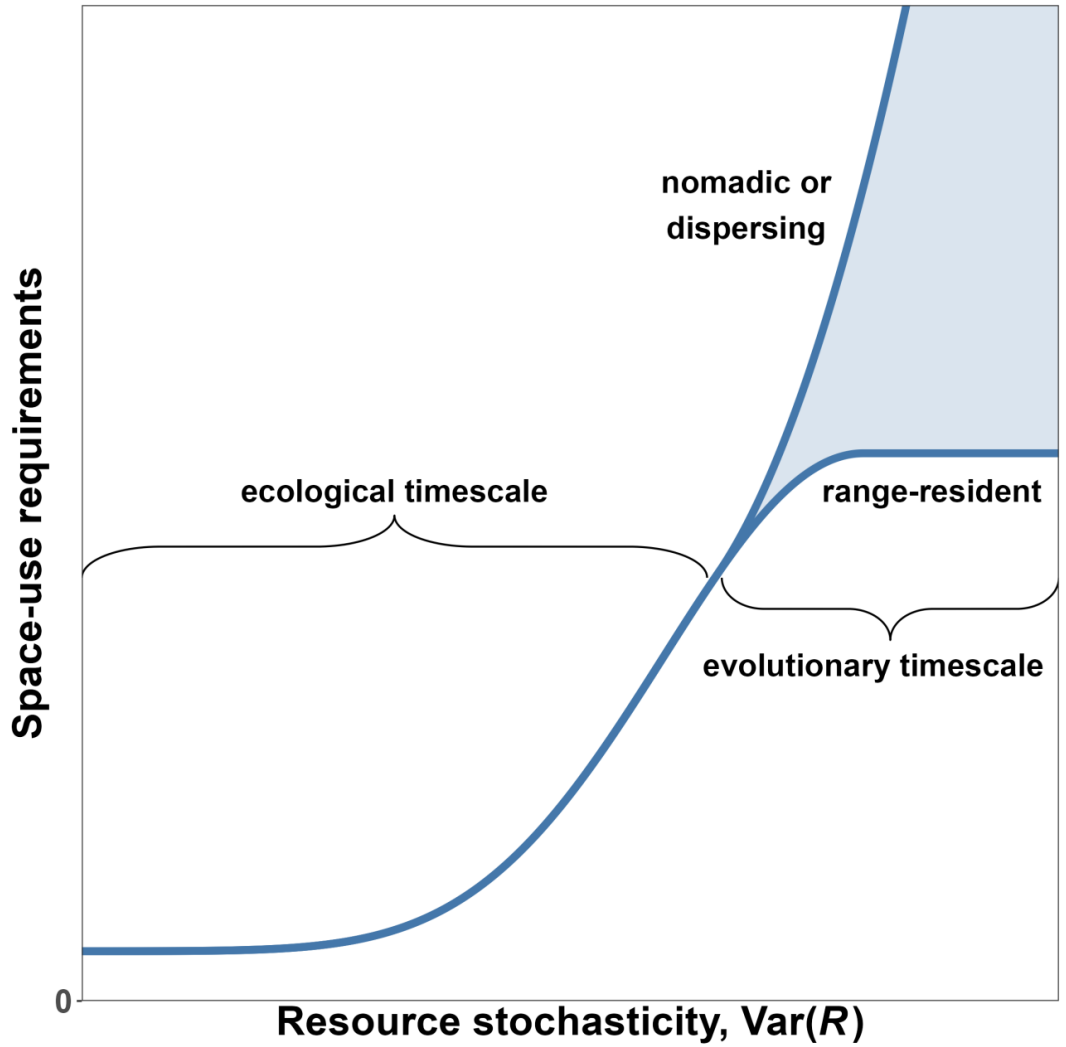
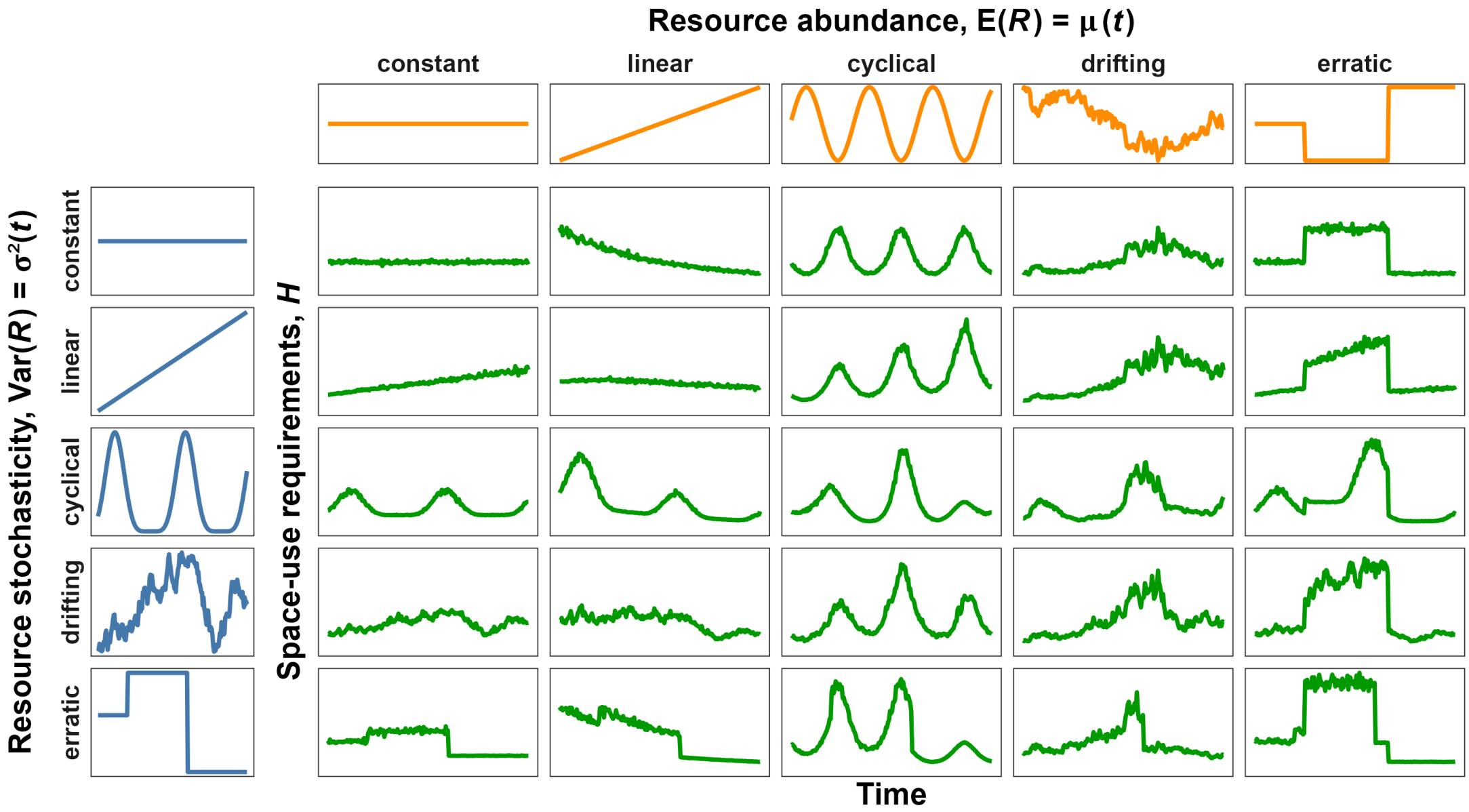


New generalized hypotheses

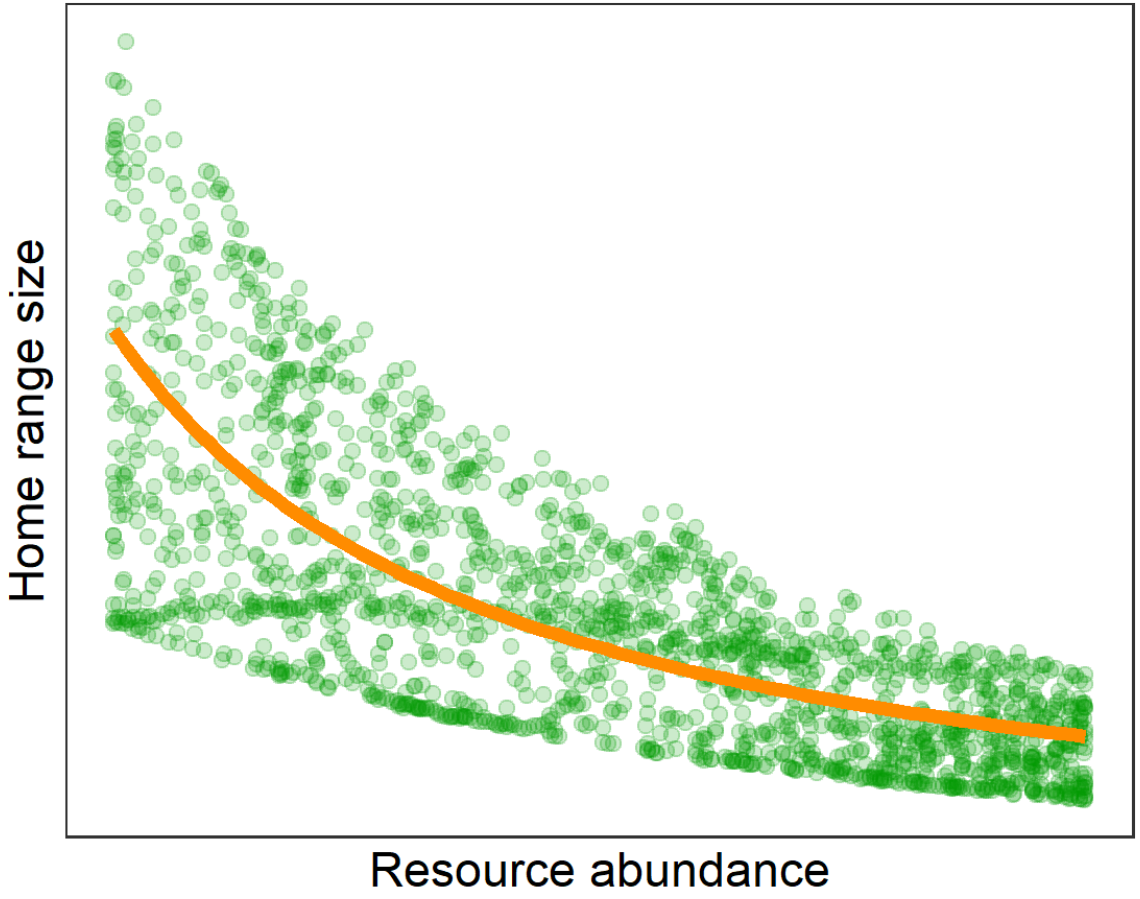


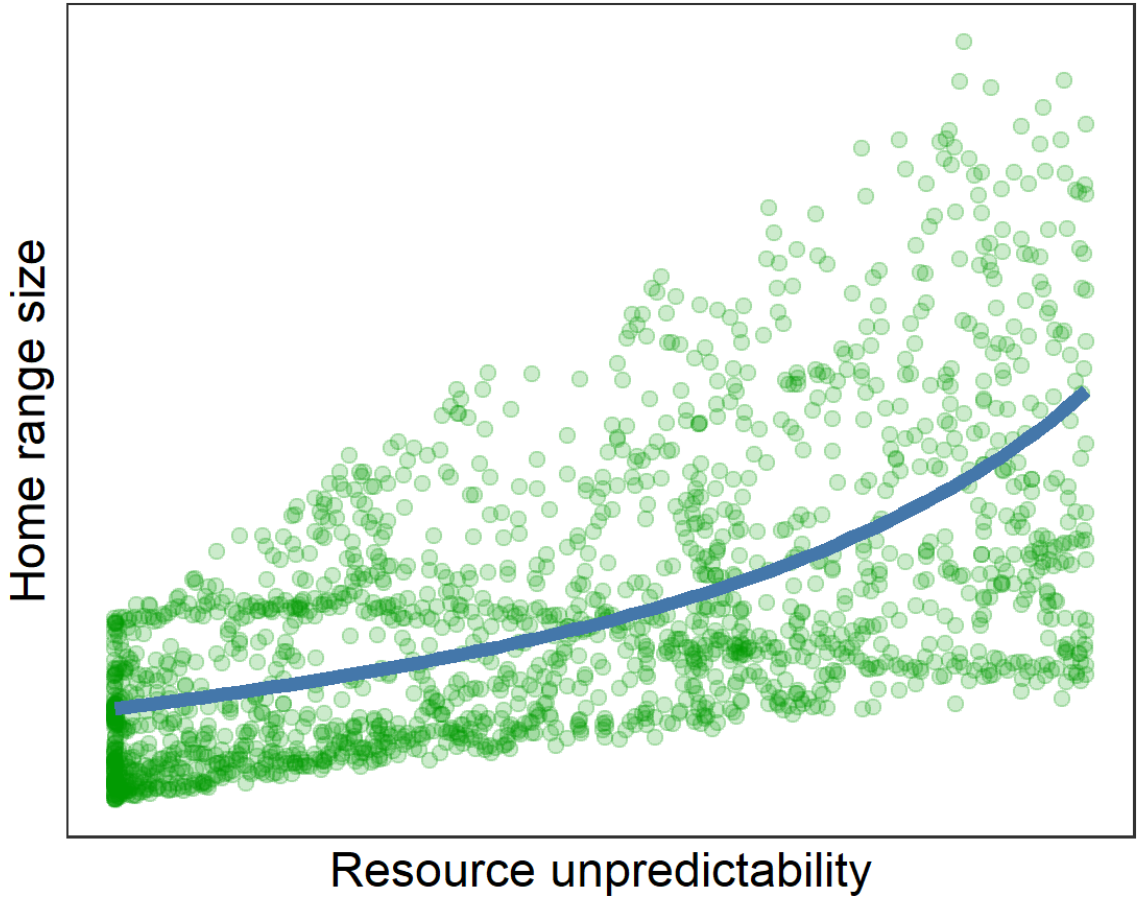


Chapter 1: Simulating the relationships

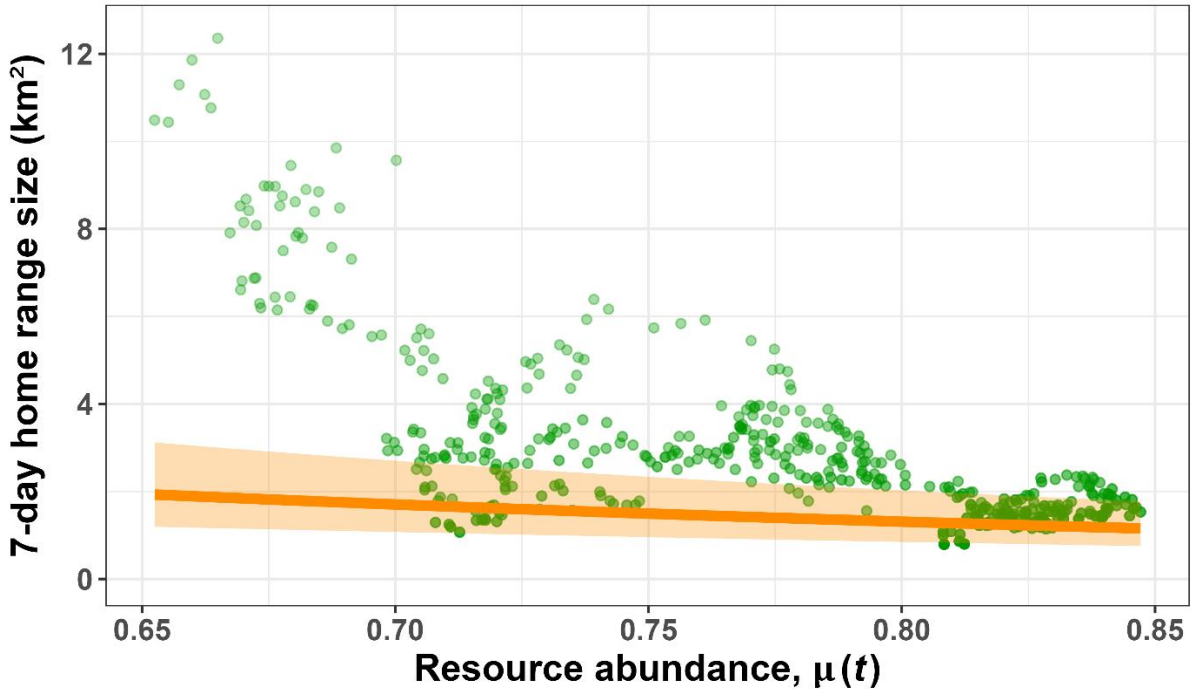


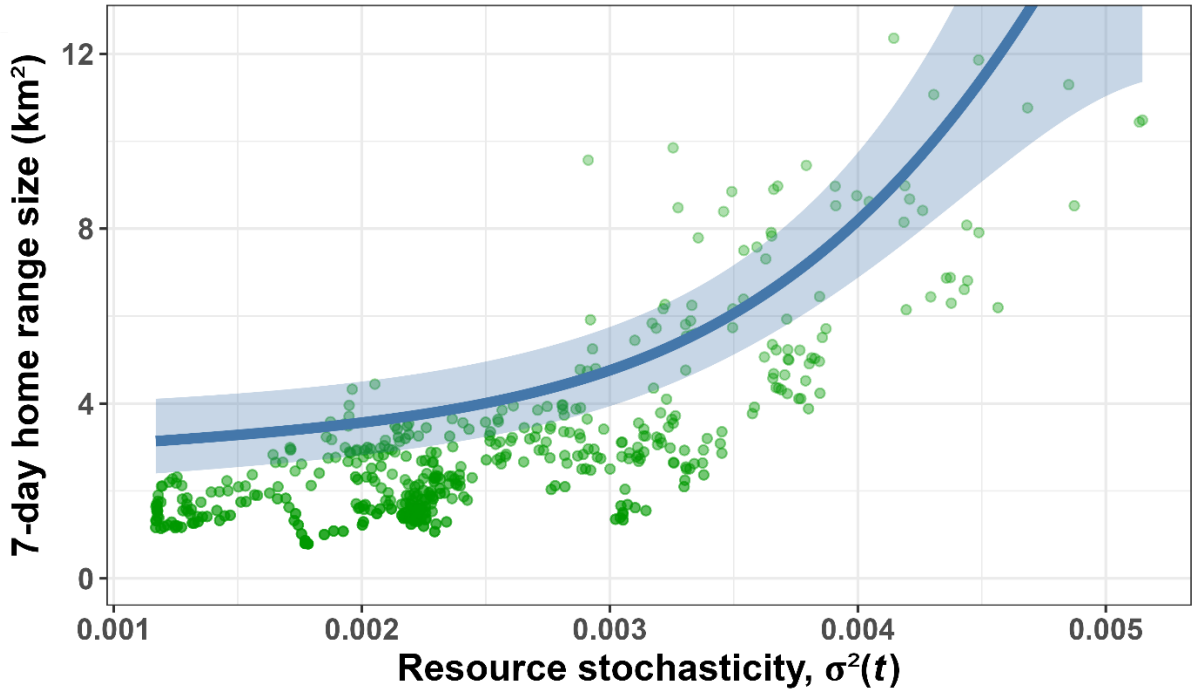
Chapter 1: Testing the hypotheses with simulated data





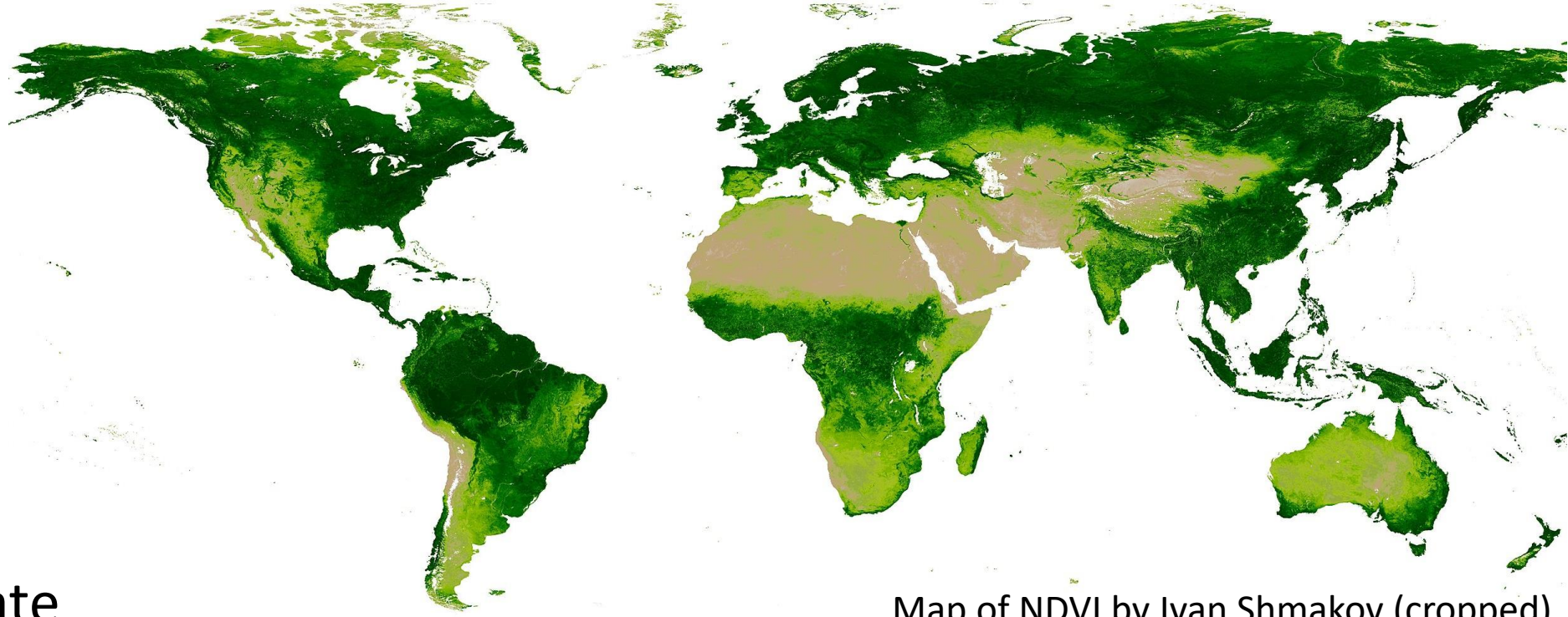
Chapter 1: Testing the hypotheses with real data





Preprint available at: https://www.biorxiv.org/content/10.1101/2023.11.03.565563v1

Chapter 2: Estimating abundance and unpredictability world-wide



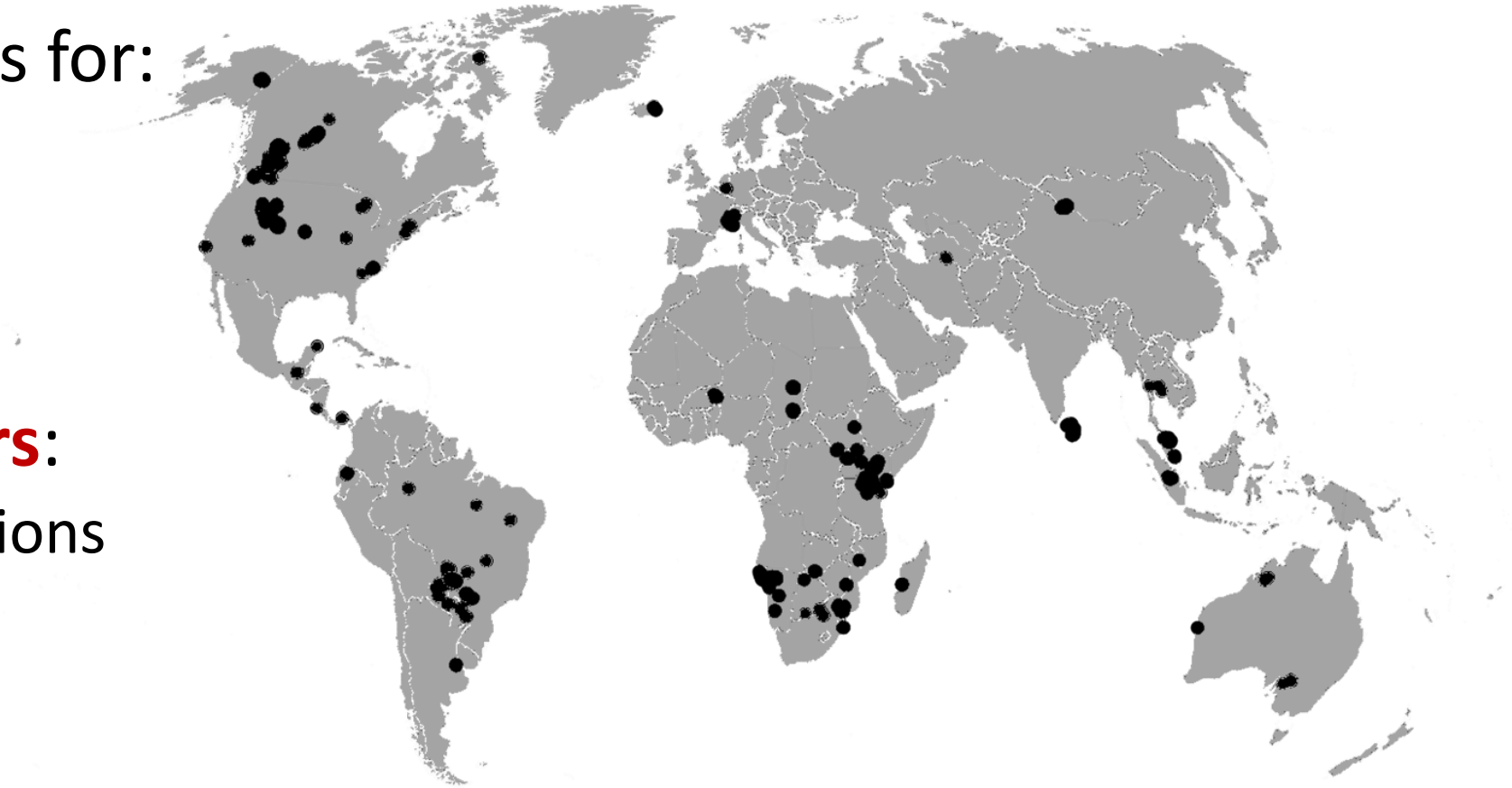
Map of NDVI by Ivan Shmakov (cropped)

NDVI:

- Productivity
- Seasonality
- Weather, climate
- Extreme events (burns, floods)
- Does not account for prey or competitors

AVHRR data: daily, 0.5-degree rasters since 1980s (>900 GB!)

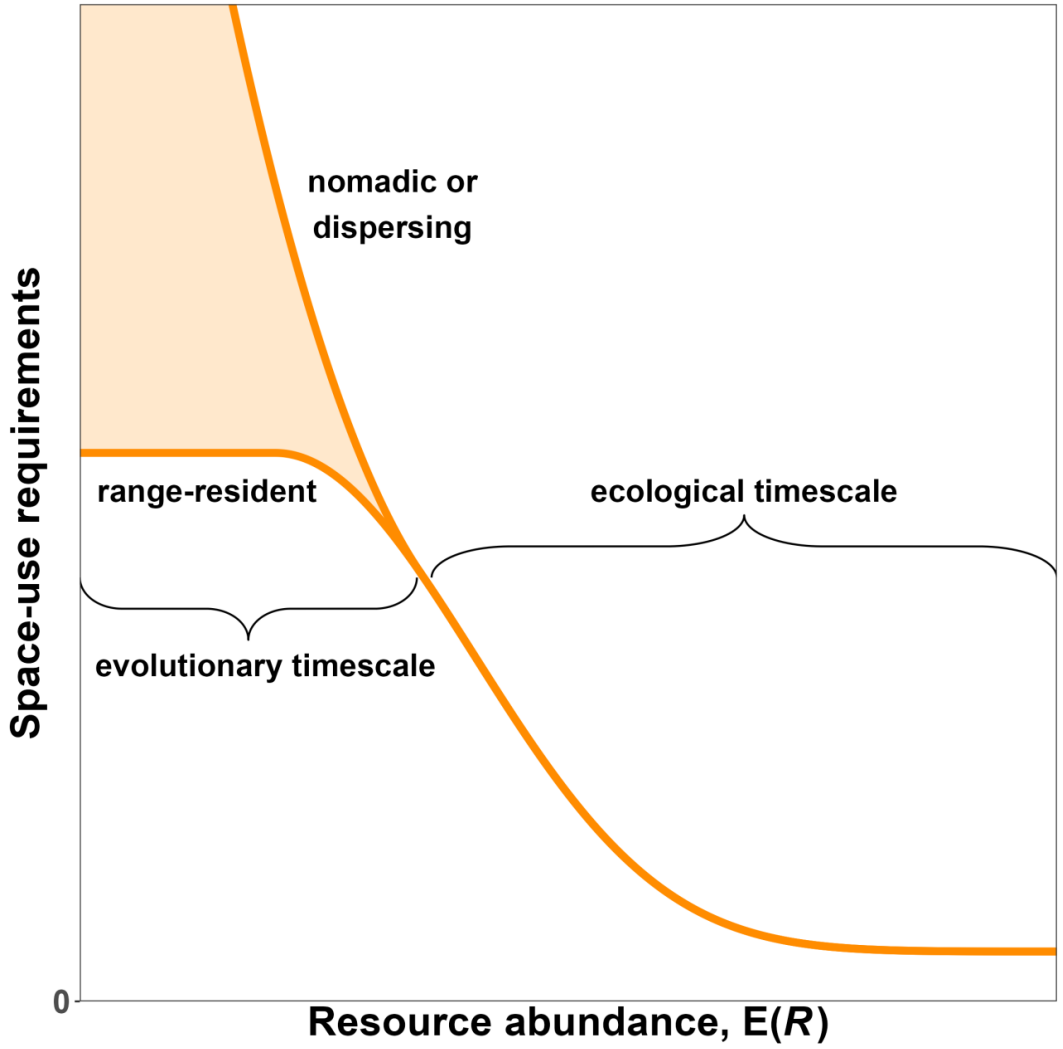
- Repeat HR analysis for:
  - 3,000+ animals
  - 85+ species

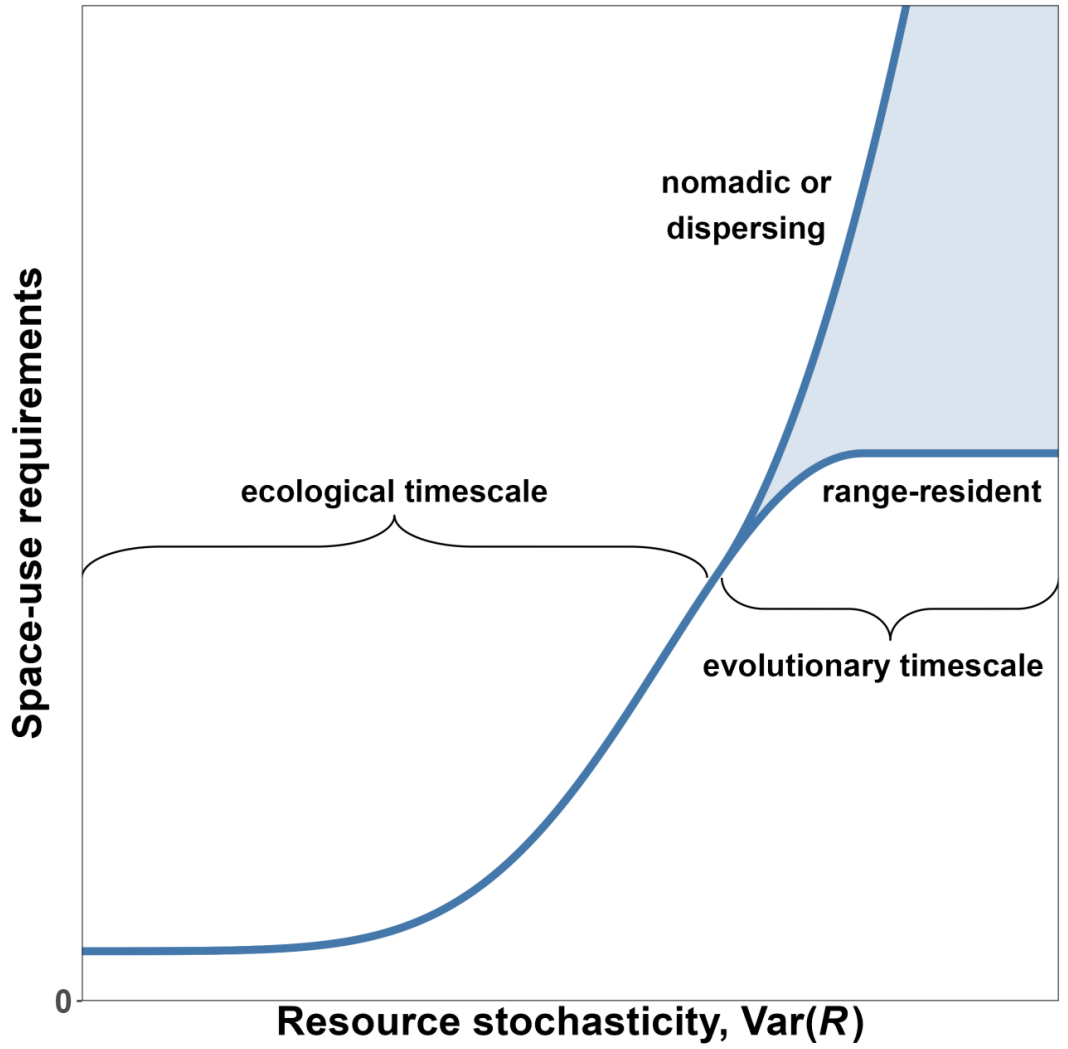


- Estimate **behaviors**:
  - Between populations
  - Between species

- Test for **common behavior**

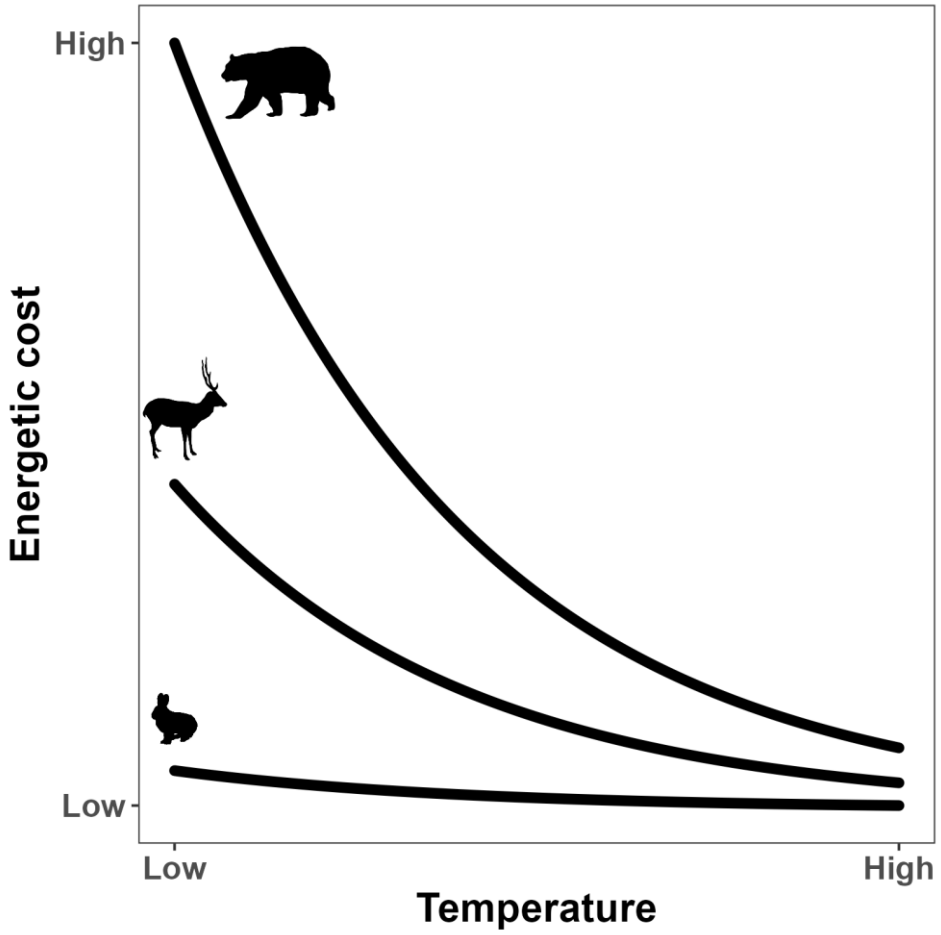
Generalizing relationships (with energetics scaling with mass)





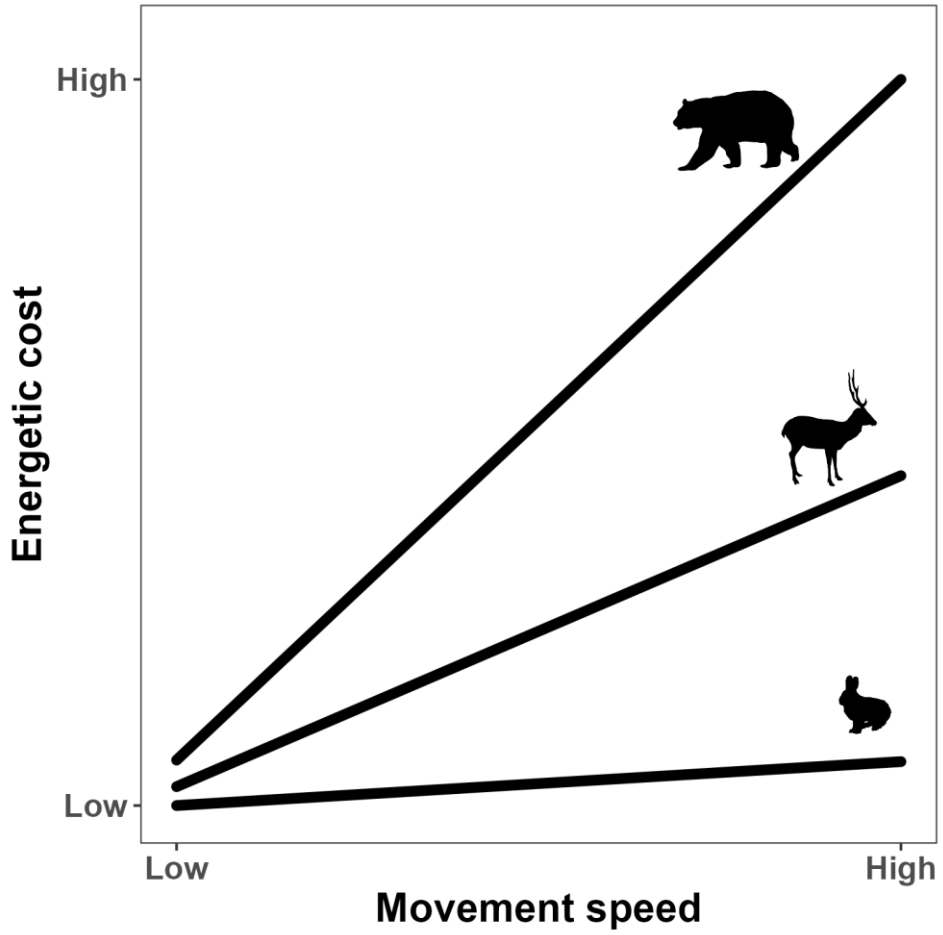
Energetic costs depends on temperature

$$I = I_0 M^{3/4} e^{-cT}$$



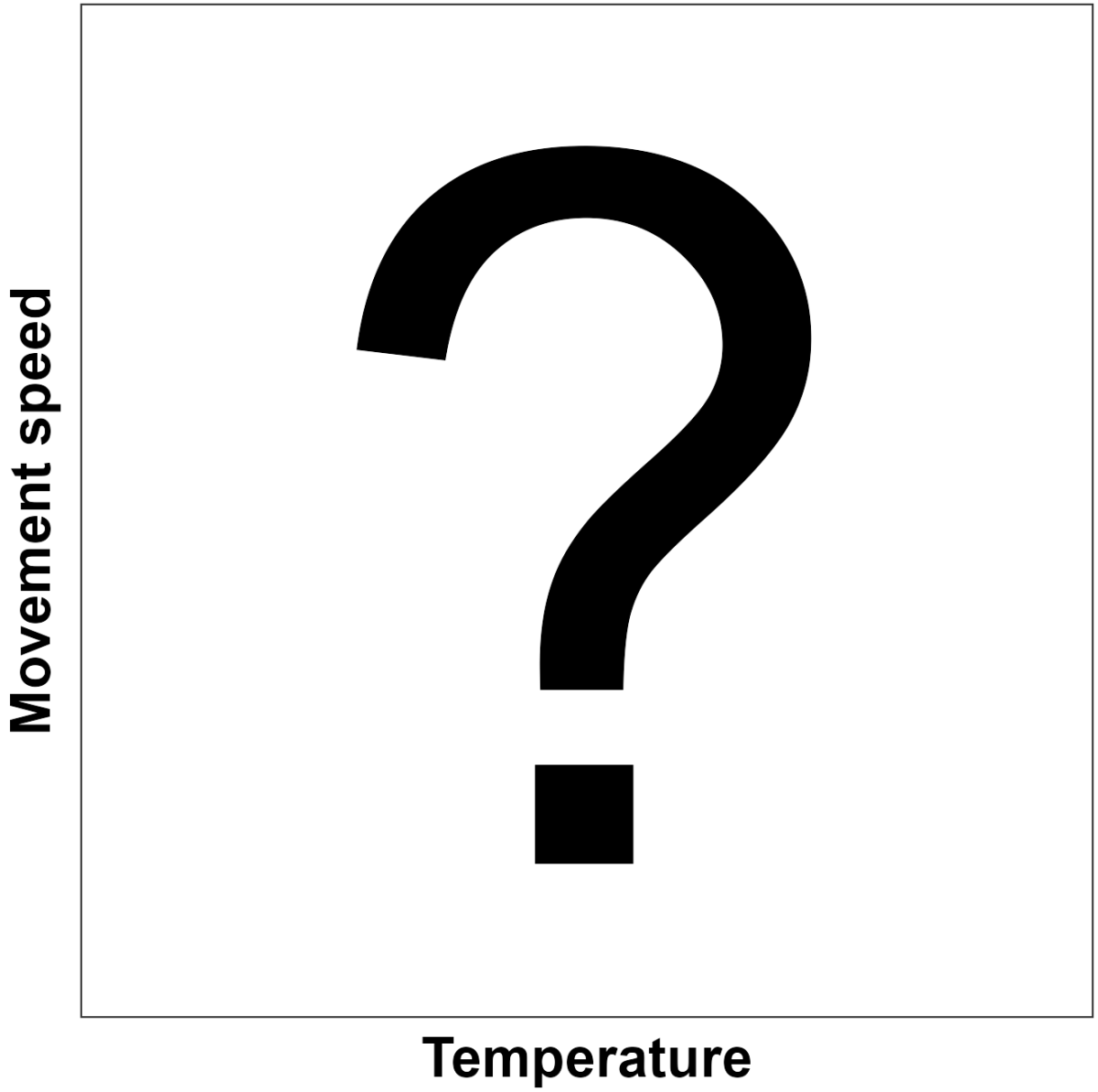
(Brown et al. 2004)

$$E = 10.7 M^{-0.684} v + 6.03 M^{-0.697}$$

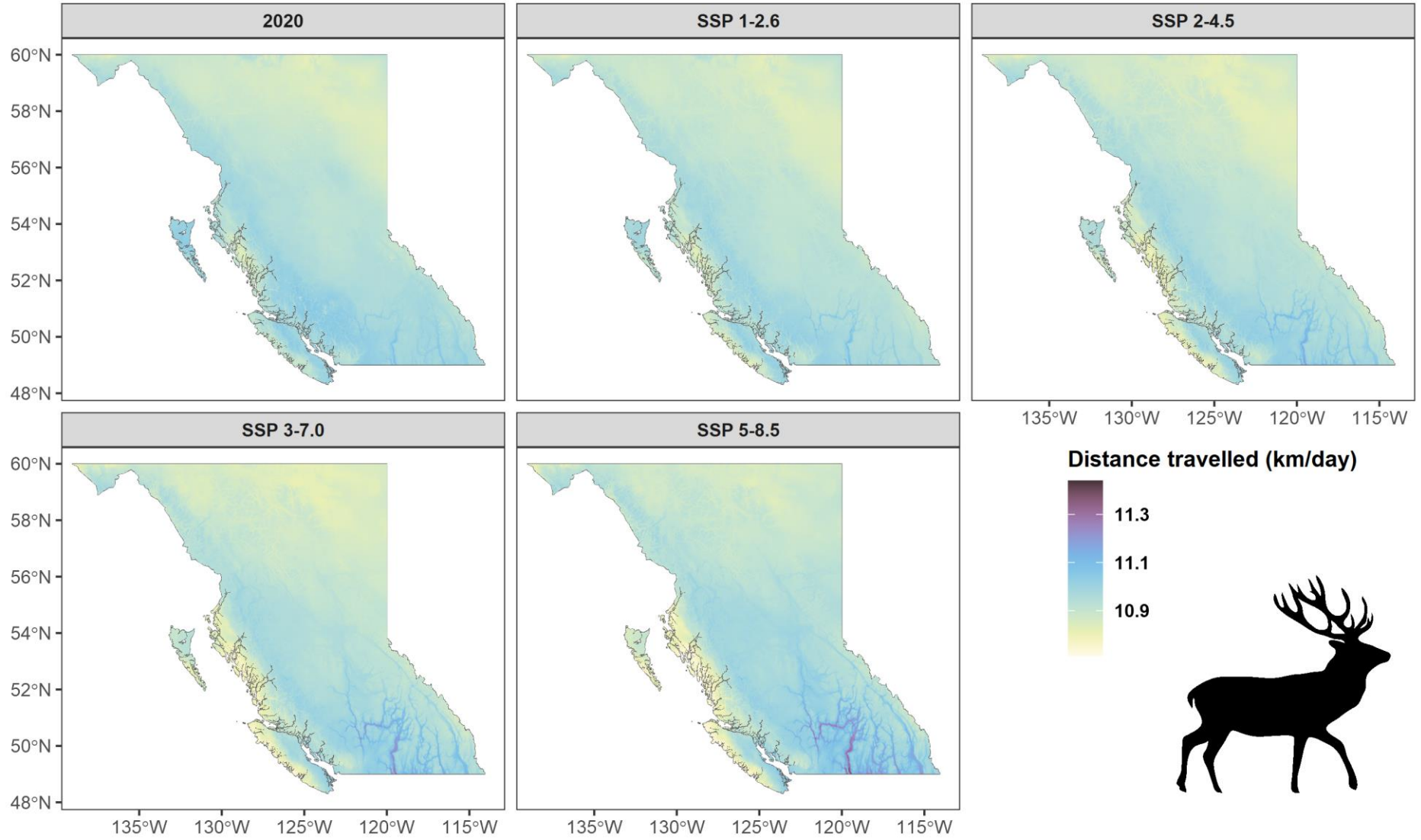


(Taylor et al. 1982)

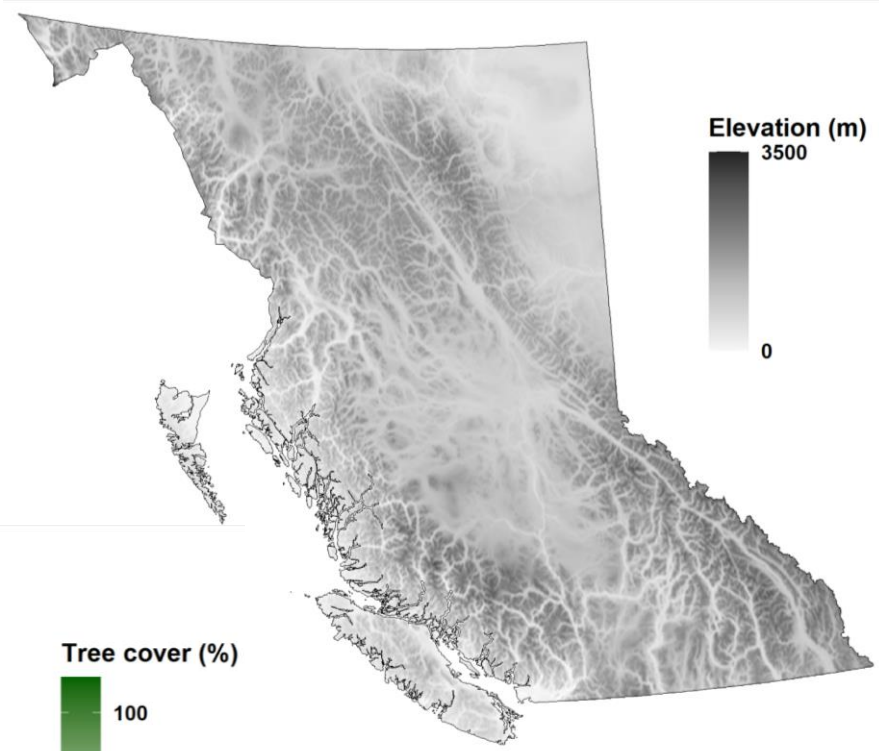
Chapter 4: Does movement depend on temperature?

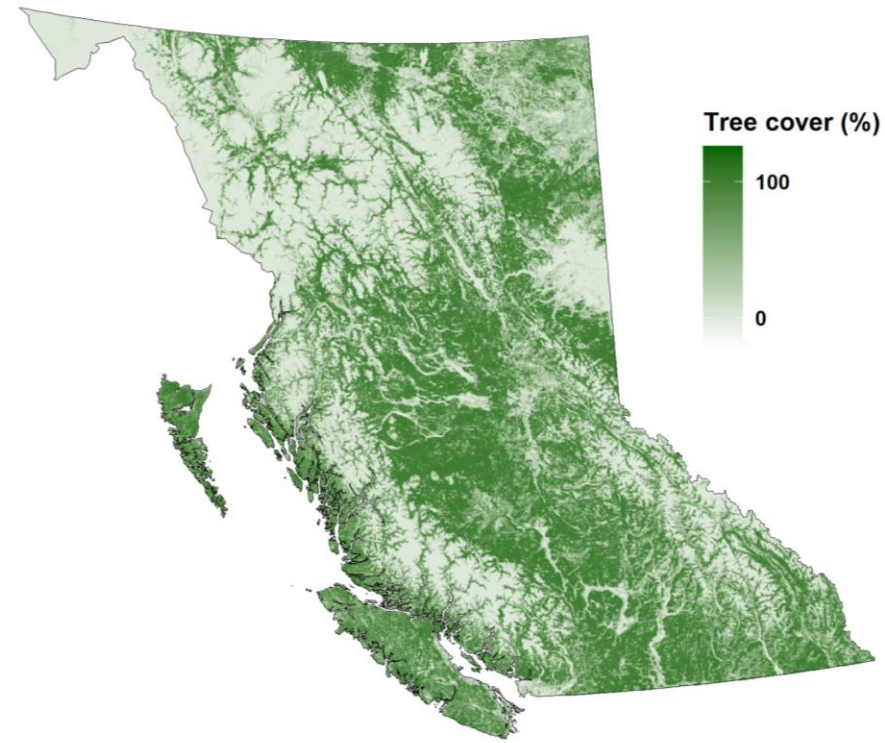


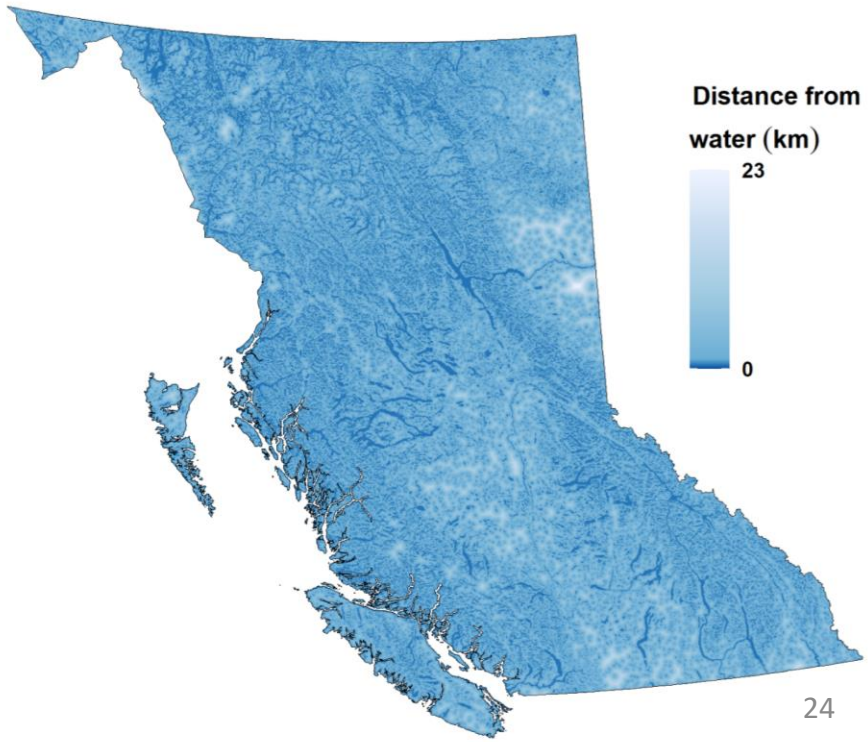
Predicting how elk will move in the future



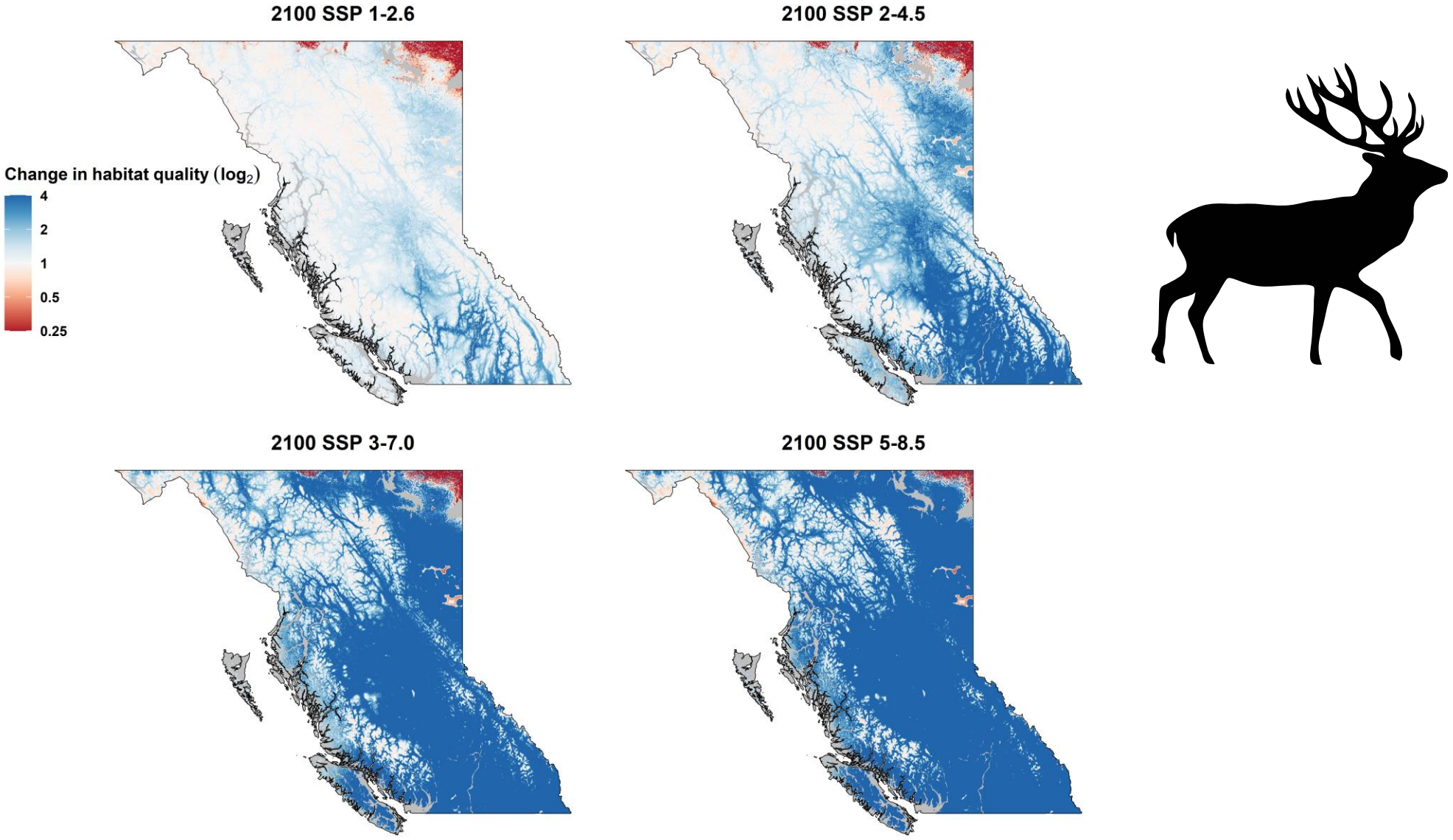
Assessing habitat selection



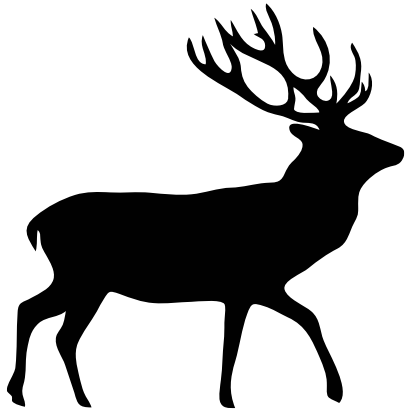


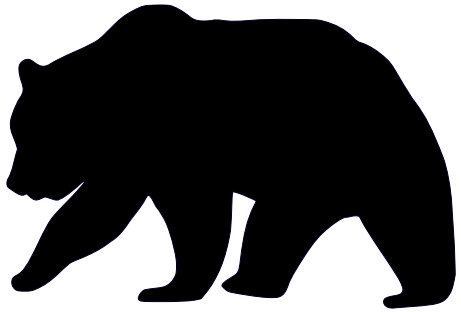


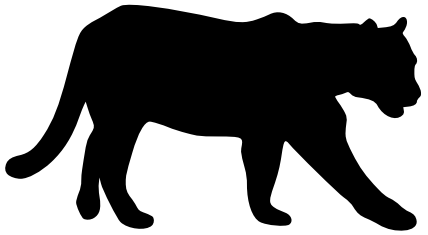
Elk habitat in 2100

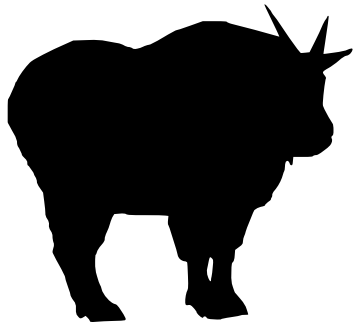


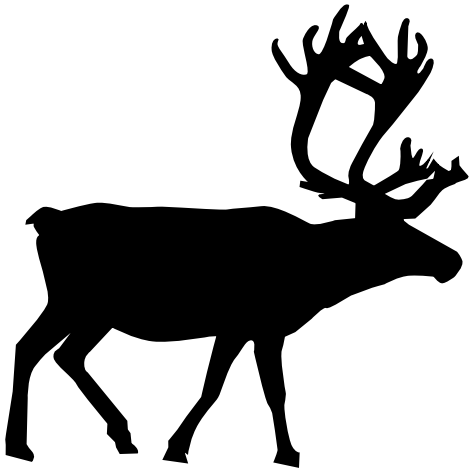
Chapter 4: How will climate change affect mammal movement in BC?

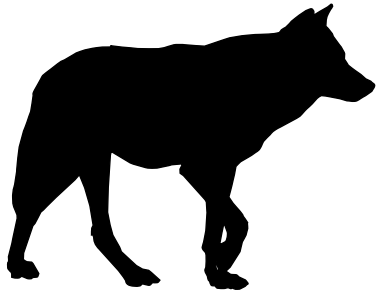


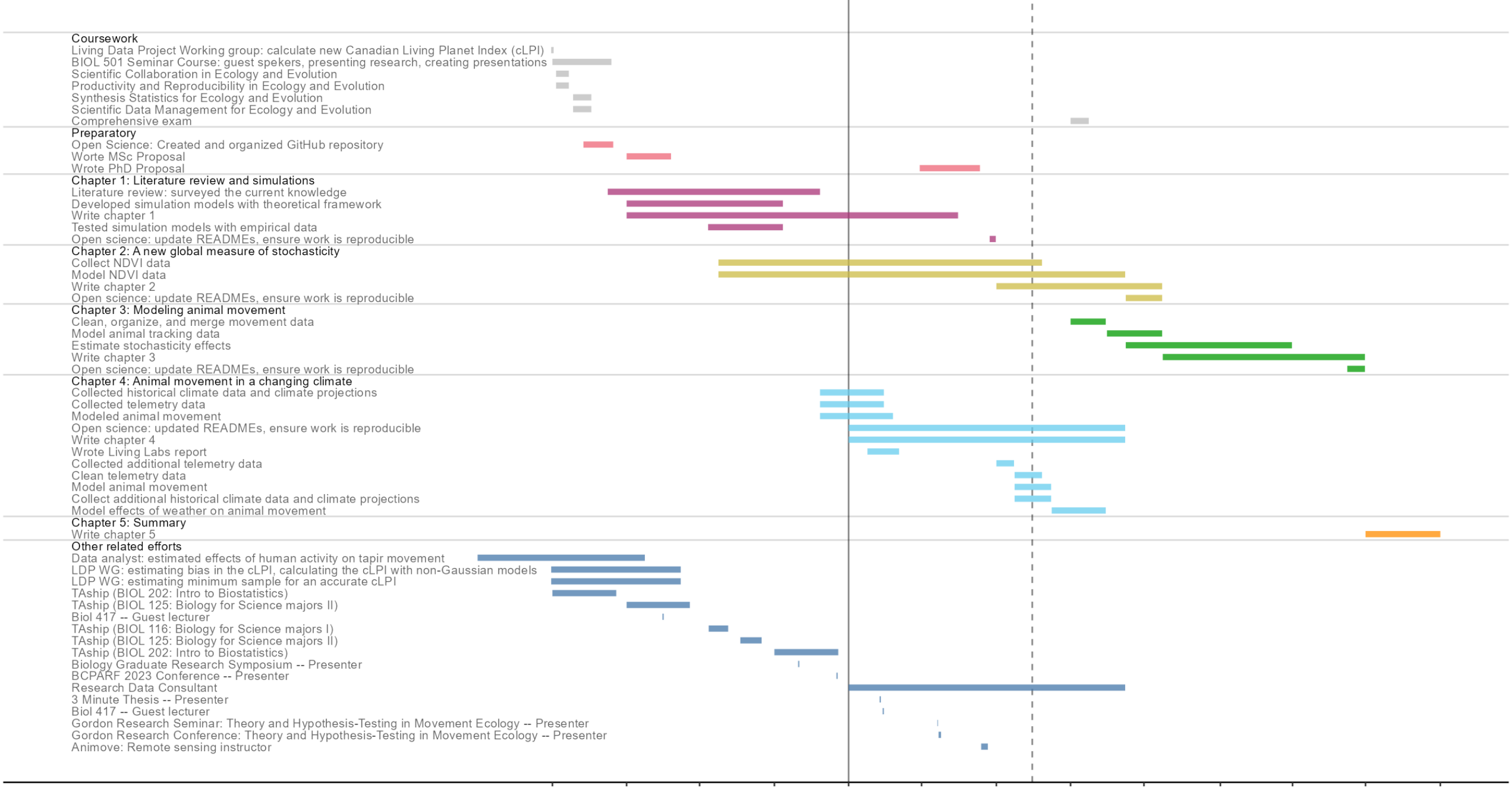











Coursework
Living Data Project Working group: calculate new Canadian Living Planet Index (cLPI)
BIOL 501 Seminar Course: guest spekers, presenting research, creating presentations
Scientific Collaboration in Ecology and Evolution
Productivity and Reproducibility in Ecology and Evolution
Synthesis Statistics for Ecology and Evolution
Scientific Data Management for Ecology and Evolution
Comprehensive exam
Preparatory
Open Science: Created and organized GitHub repository
Worte MSc Proposal
Wrote PhD Proposal
Chapter 1: Literature review and simulations
Literature review: surveyed the current knowledge
Developed simulation models with theoretical framework
Write chapter 1
Tested simulation models with empirical data
Open science: update READMEs, ensure work is reproducible
Chapter 2: A new global measure of stochasticity
Collect NDVI data
Model NDVI data
Write chapter 2
Open science: update READMEs, ensure work is reproducible
Chapter 3: Modeling animal movement
Clean, organize, and merge movement data
Model animal tracking data
Estimate stochasticity effects
Write chapter 3
Open science: update READMEs, ensure work is reproducible
Chapter 4: Animal movement in a changing climate
Collected historical climate data and climate projections
Collected telemetry data
Modeled animal movement
Open science: updated READMEs, ensure work is reproducible
Write chapter 4
Wrote Living Labs report
Collected additional telemetry data
Clean telemetry data
Model animal movement
Collect additional historical climate data and climate projections
Model effects of weather on animal movement
Chapter 5: Summary
Write chapter 5
Other related efforts
Data analyst: estimated effects of human activity on tapir movement
LDP WG: estimating bias in the cLPI, calculating the cLPI with non-Gaussian models
LDP WG: estimating minimum sample for an accurate cLPI
TAship (BIOL 202: Intro to Biostatistics)
TAship (BIOL 125: Biology for Science majors II)
Biol 417 -- Guest lecturer
TAship (BIOL 116: Biology for Science majors I)
TAship (BIOL 125: Biology for Science majors II)
TAship (BIOL 202: Intro to Biostatistics)
Biology Graduate Research Symposium -- Presenter
BCPARF 2023 Conference -- Presenter
Research Data Consultant
3 Minute Thesis -- Presenter
Biol 417 -- Guest lecturer
Gordon Research Seminar: Theory and Hypothesis-Testing in Movement Ecology -- Presenter
Gordon Research Conference: Theory and Hypothesis-Testing in Movement Ecology -- Presenter
Animove: Remote sensing instructor
Sep 2021
Jan 2022
May 2022
Sep 2022
Jan 2023
May 2023
Sep 2023
Jan 2024
May 2024
Sep 2024
Jan 2025
May 2025
Sep 2025

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References

- Bista, D., G. S. Baxter, N. J. Hudson, S. T. Lama, and P. J. Murray. 2022. Effect of disturbances and habitat fragmentation on an arboreal habitat specialist mammal using GPS telemetry: A case of the red panda. Landscape Ecology 37:795–809.
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