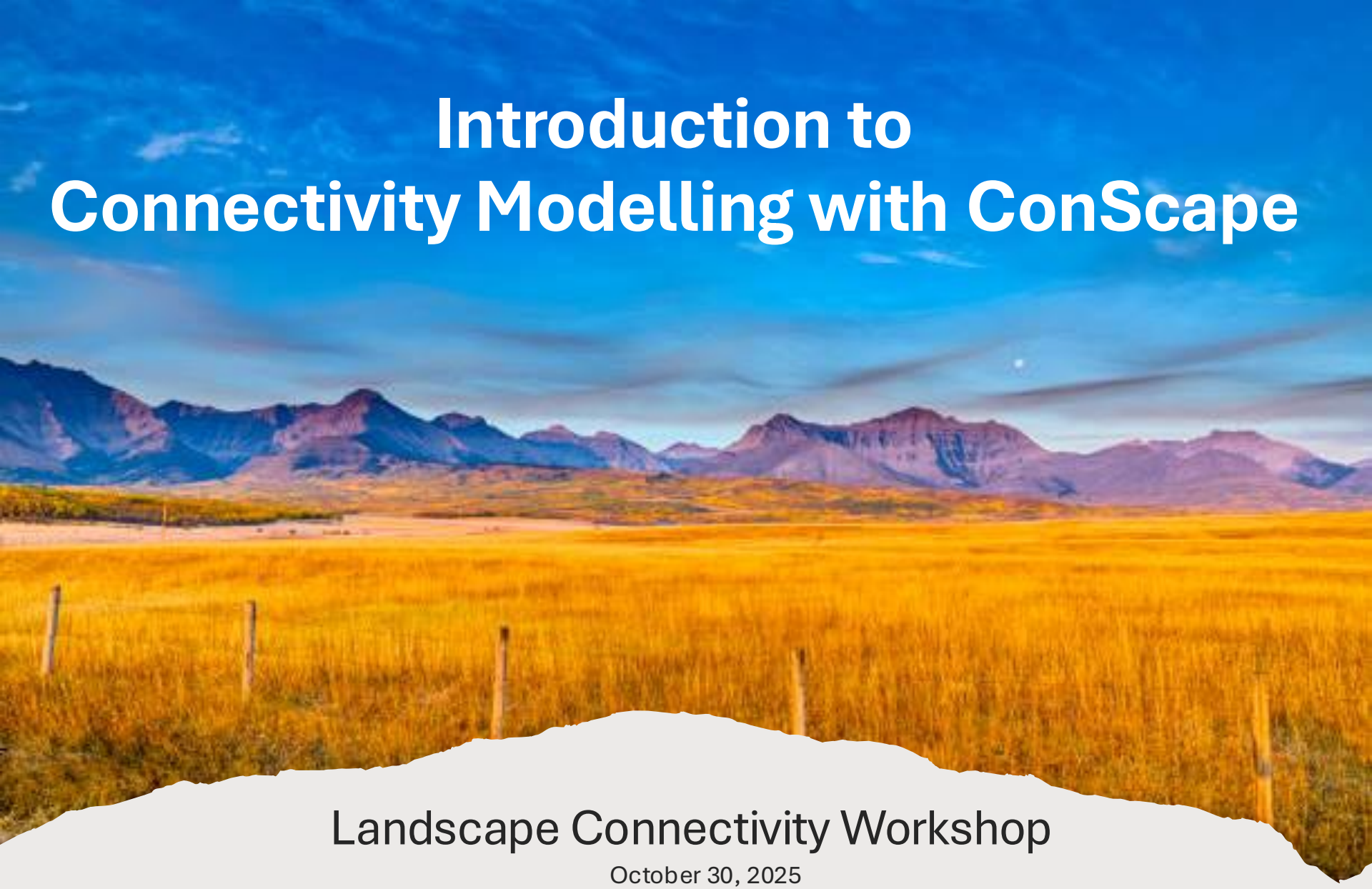


Introduction to Connectivity Modelling with ConScape

Landscape Connectivity Workshop

October 30, 2025

Celia Hein

University of Toronto

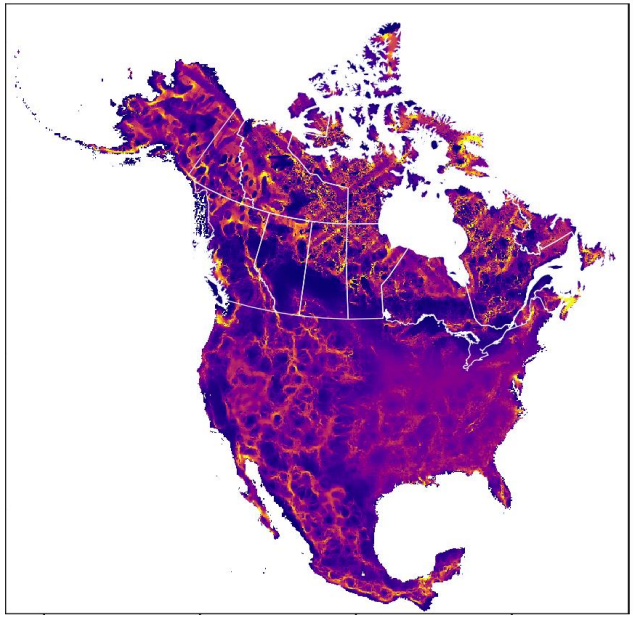
NSERC Alliance Grants

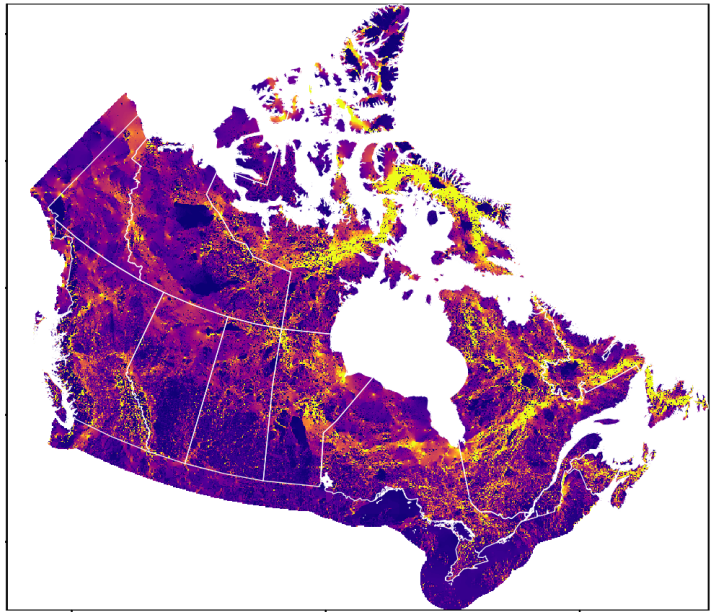
Current Density Models at Different Scales

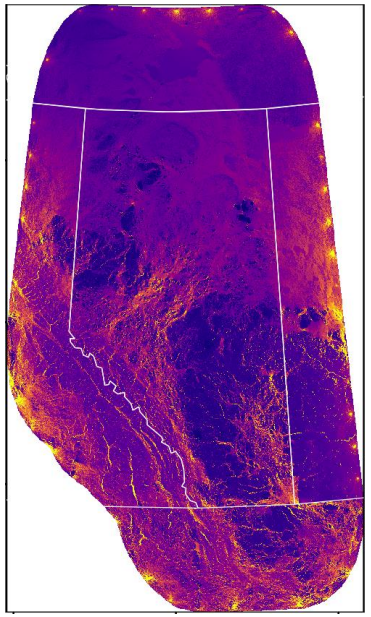
Belote et al. (2022), Landscape Ecology:
- North America
- 1 km resolution

Pither et al. (2023), PLOS One:
- Canada
- 300 m resolution

Marrec et al. (2020), Scientific Reports:
- Alberta
- 100 m resolution

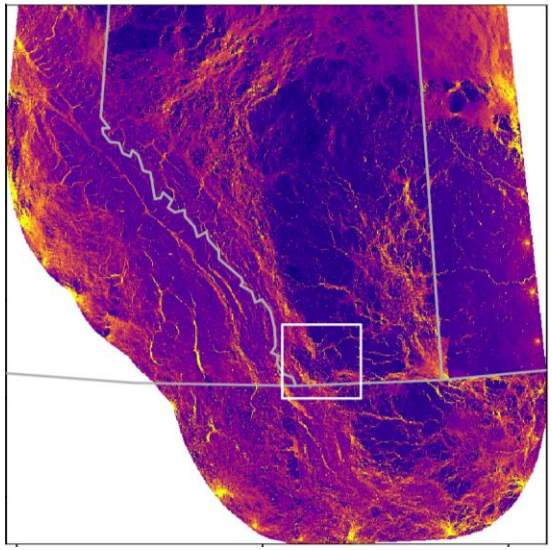




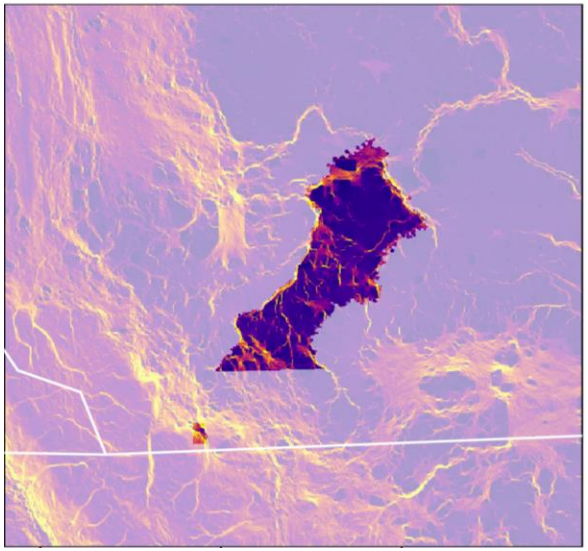


Local Connectivity Planning in a Regional Context

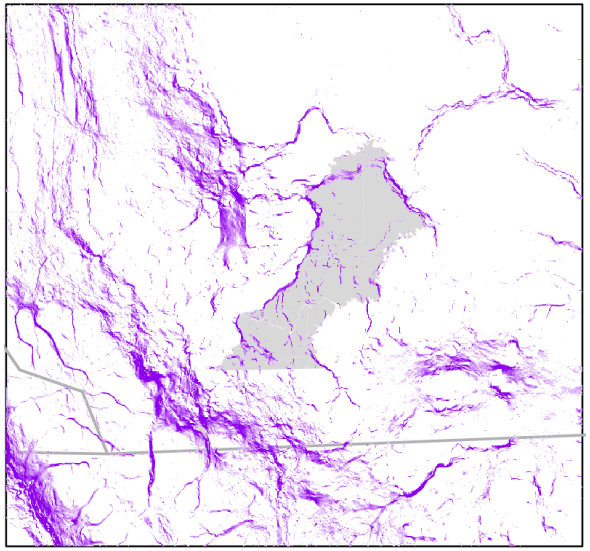
Study area in south Alberta



Kainai Reserves

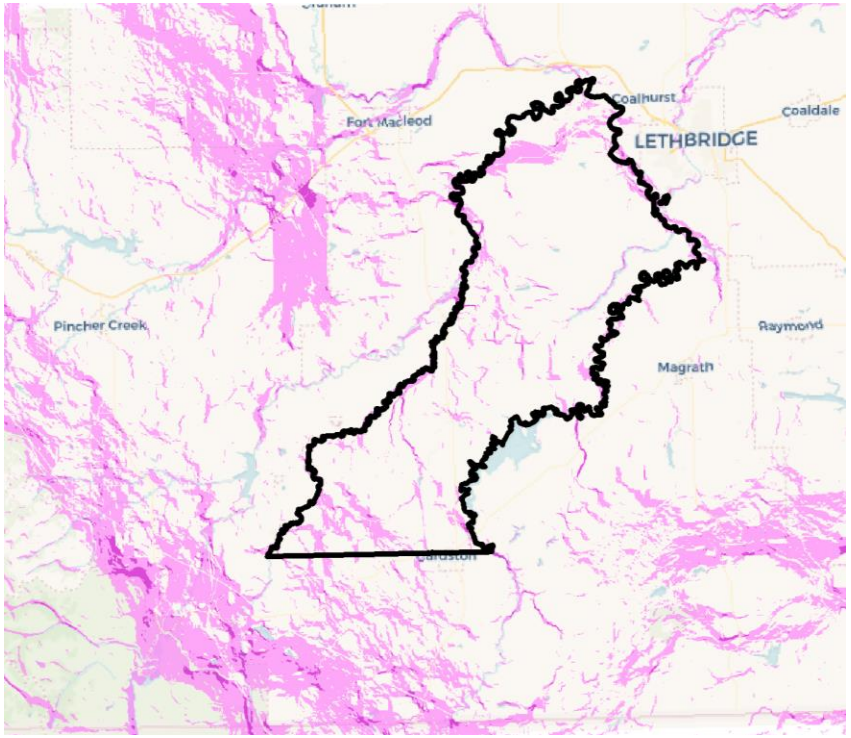


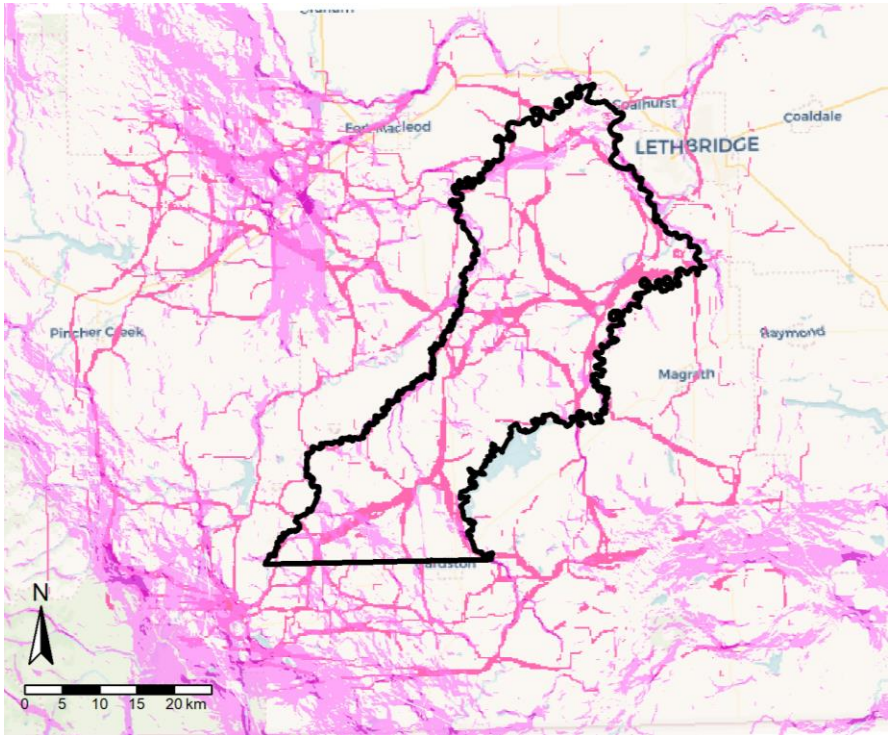
Ecological Flow Pathways



Local Connectivity Planning in a Regional Context

Regional Ecological Flow Pathways

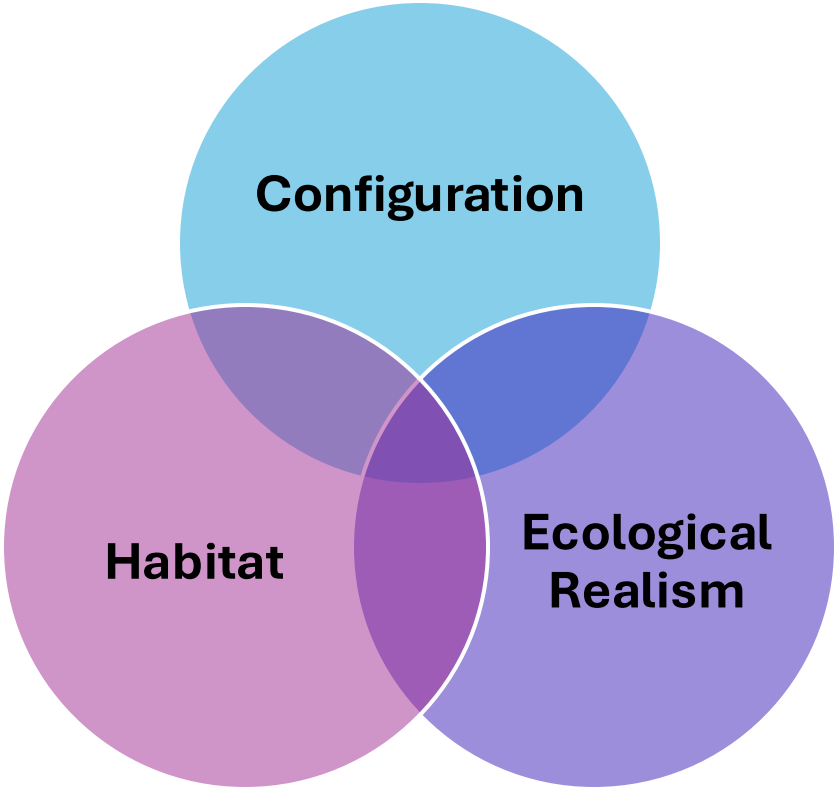




Why use ConScape?

Accelerating advances in landscape connectivity modelling with the ConScape library

Bram Van Moorter ✉, Ilkka Kivimäki, Andreas Noack, Robin Devooght, Manuela Panzacchi, Kimberly R. Hall, Pierre Leleux, Marco Saerens



Advantages of ConScape

- Multipurpose and flexible
- Computes paths between all possible pairs of pixels
- Path distribution is in between least-cost-path and random walk
- Paths are finite and related to dispersal
- Relatively easier to interpret for decision-making

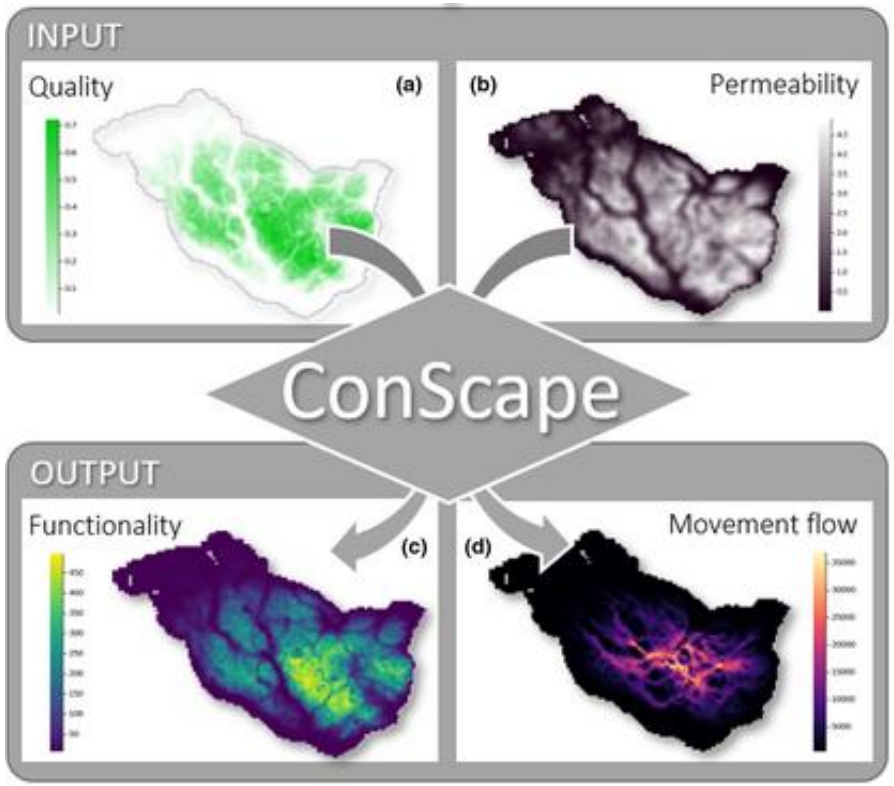
Integrates habitat quality, connectivity, dispersal

Van Moorter et al. (2023)

Flexible Input

Habitat-focus

Species-specific or agnostic



Permeability-focus

Resistance-based
Prob. Movement
Survivorship

Functionally connected habitat

Identify ecological pathways

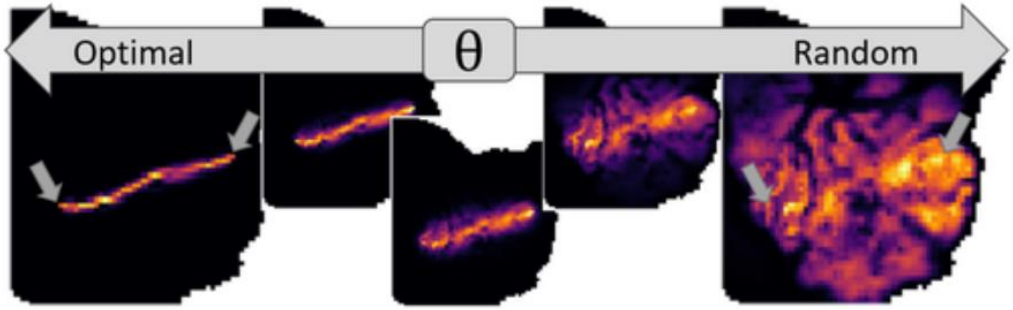
Advantages of ConScape: Movement Behavior

Path distribution is in between least-cost-path and random walk

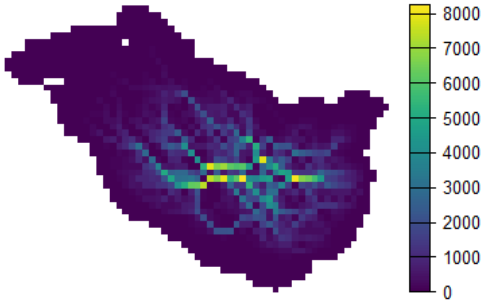
Between Two Points

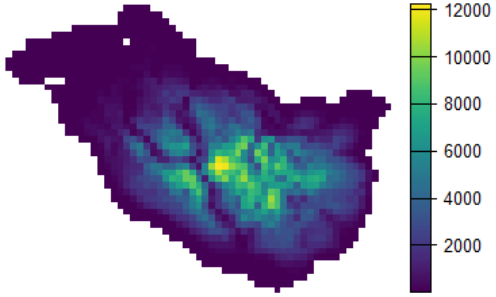
Optimal Least Cost Path

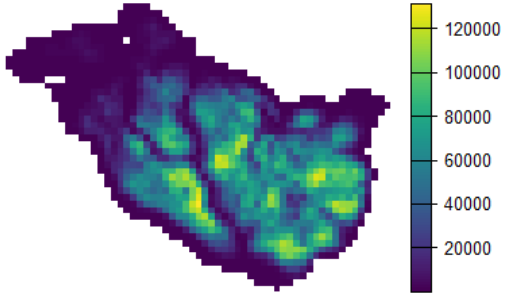
Random Walk



Entire Study Area







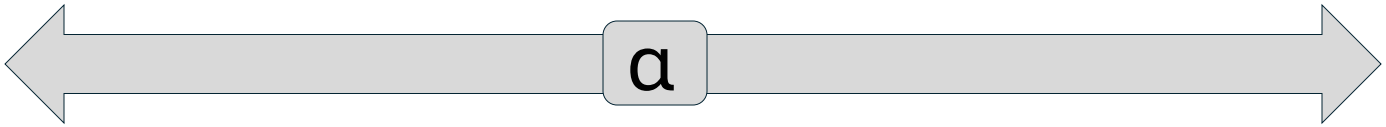
Van Moorter et al. (2023)

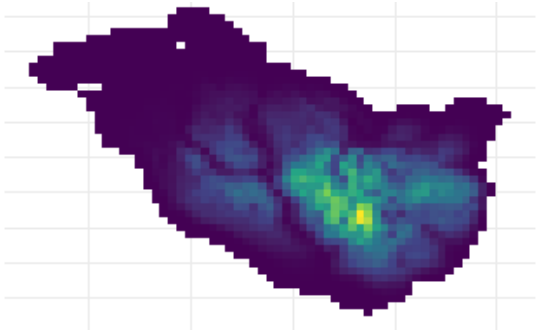
Advantages of ConScape: Dispersal Distance

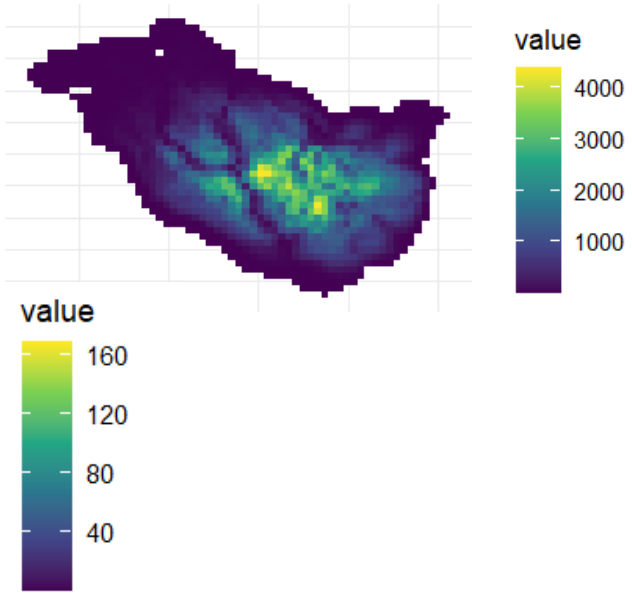
Paths are finite and related to dispersal

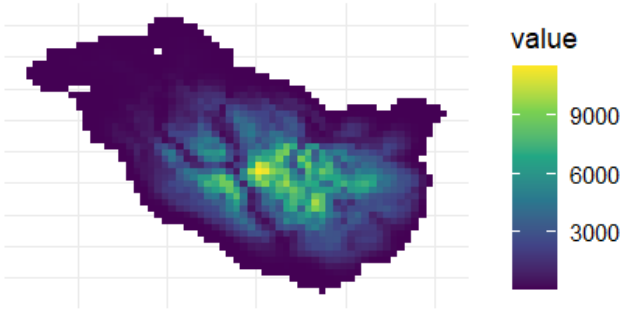
Low Dispersal

High Dispersal

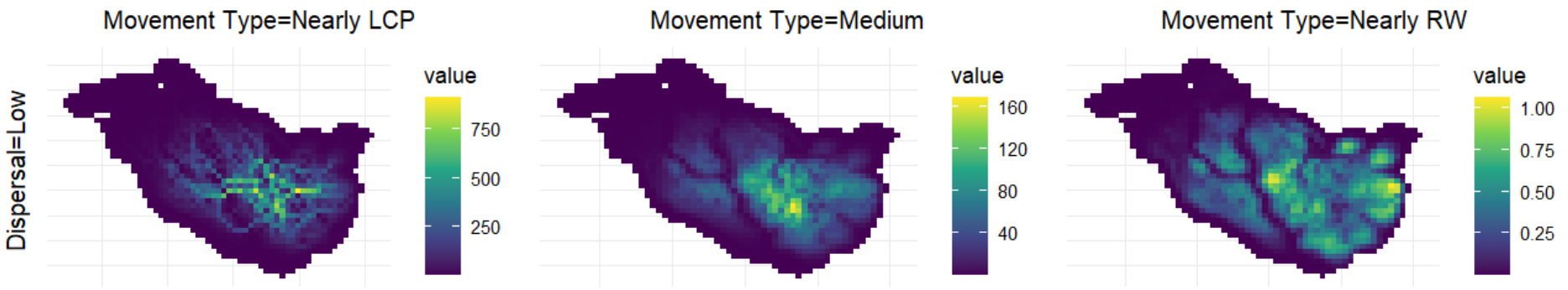




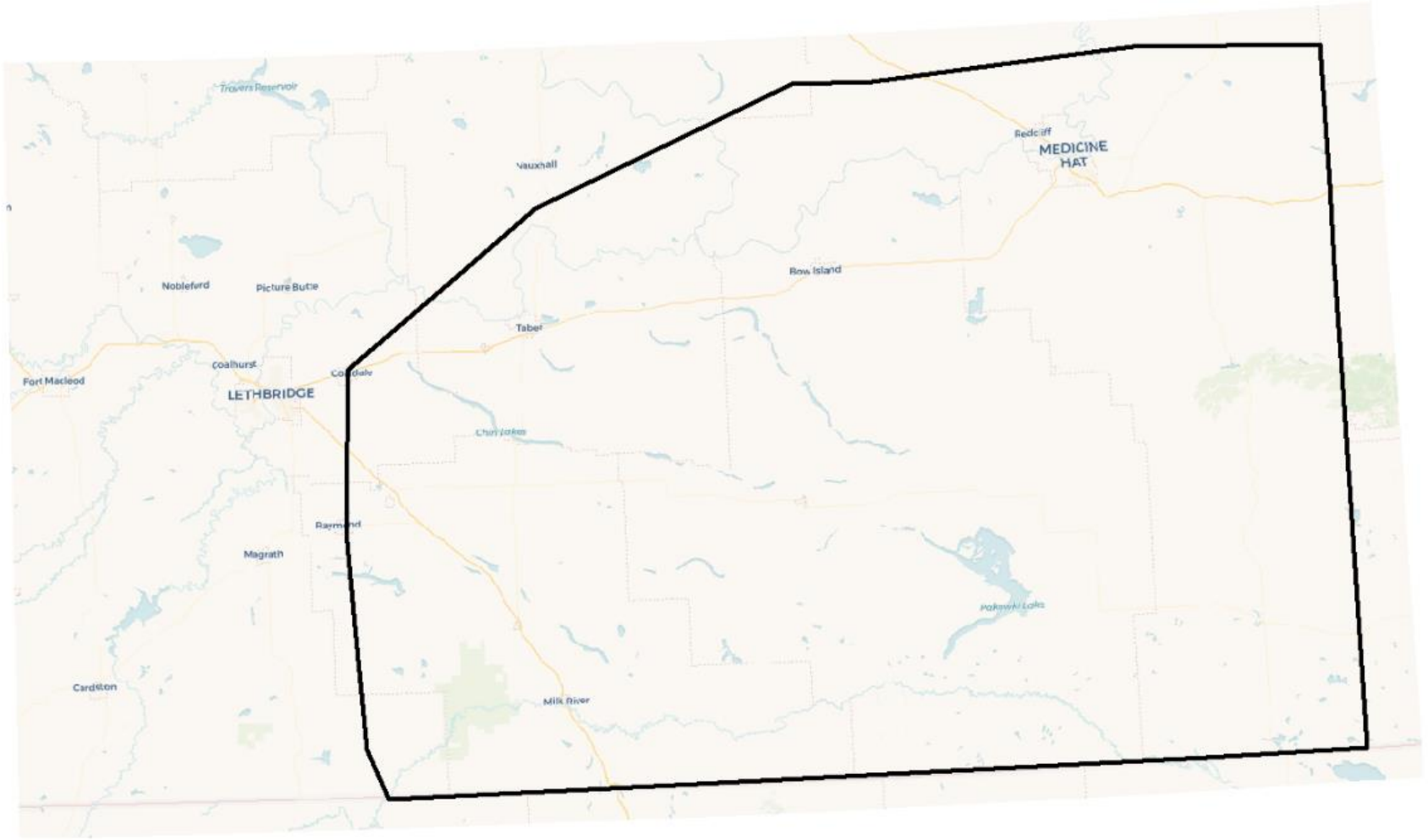




Some possible combinations of theta and alpha

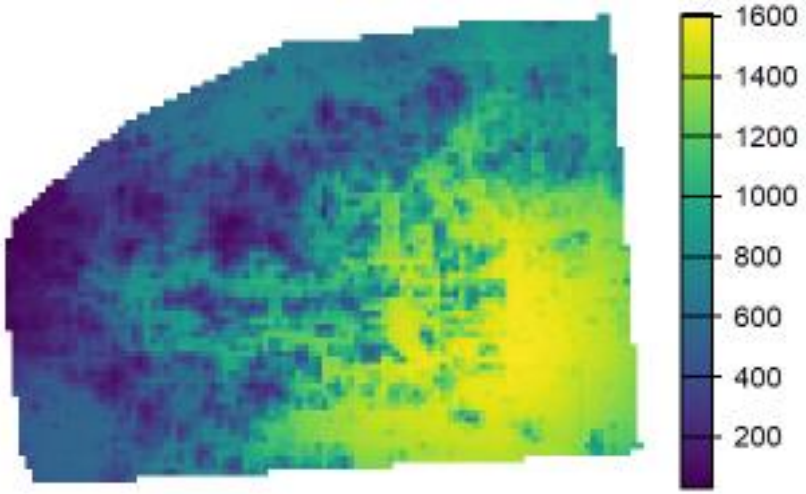


Southeast corner of Alberta

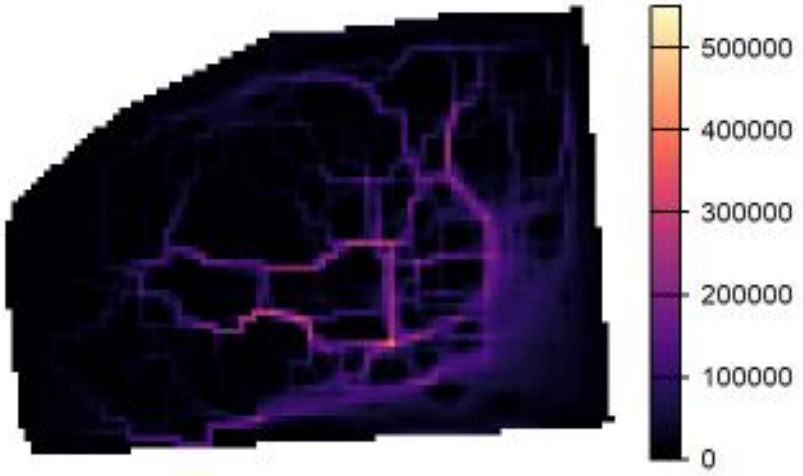


Functional Habitat and Movement Flow

Functional Habitat



Functional Habitat

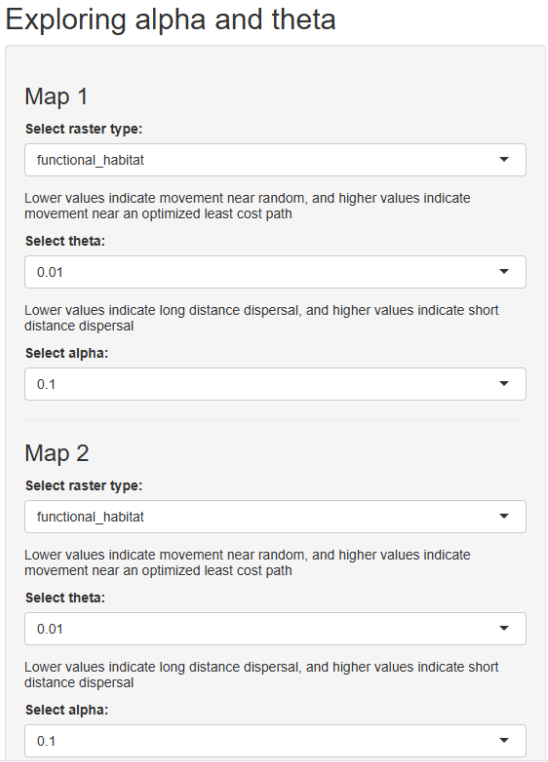


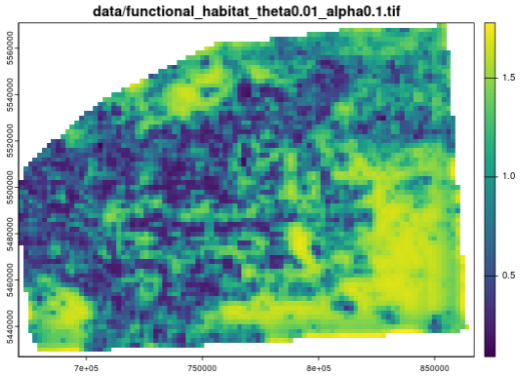
Resolution = 2km,
theta = 0.5,
alpha = 1/75

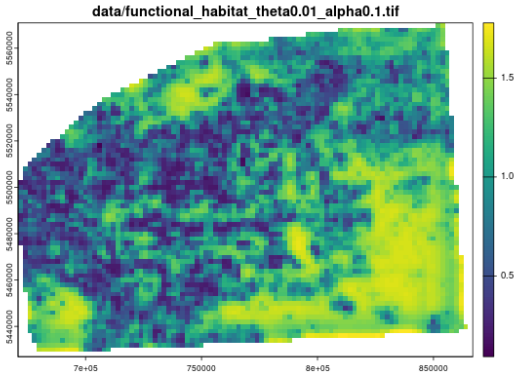
Exploring theta and alpha

Open link in browser:
https://019a0898-a296-35bf-47f4-119fc1ec6bf8.share.connect.posit.cloud/

Or launch directly from Rstudio
Open R project “WorkshopApp.Rproj”, open “app.R”, click “Run App” then “Open in browser”







Where to start

Explore and compare the extremes of the parameters for both functional habitat and movement flow.
Remember:
Low theta indicates more random movement
Low alpha indicates higher dispersal distances

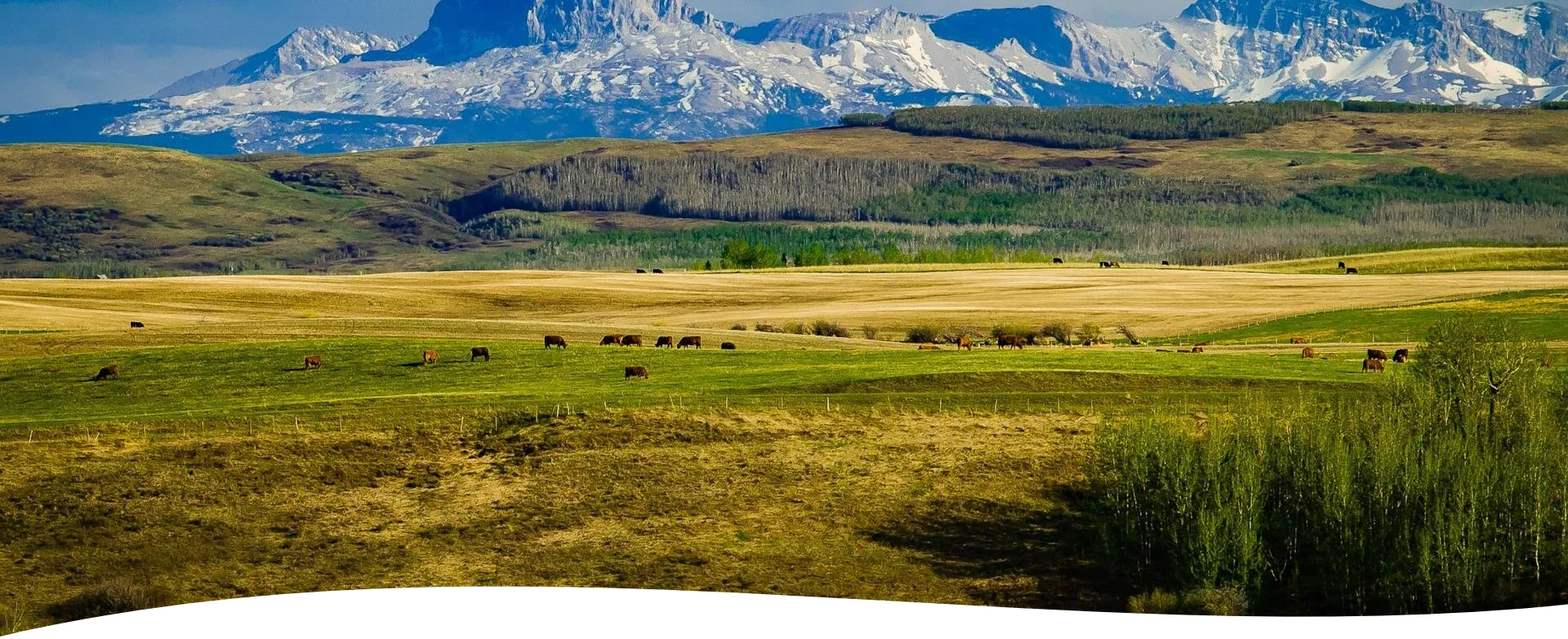
Example:

Most Restricted		**vs**	**Most Unrestricted**	
High theta	High alpha	vs	Low theta	Low alpha

What other extreme combinations can you find?

High theta	Low alpha
Low theta	High alpha

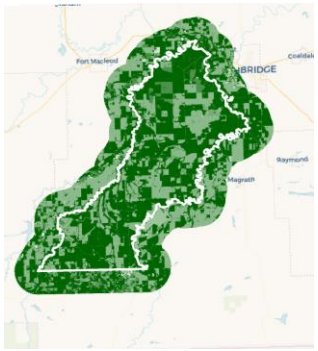
How do those compare to the most un/restricted?
How do the extremes compare to maps with more moderate values for theta and alpha?

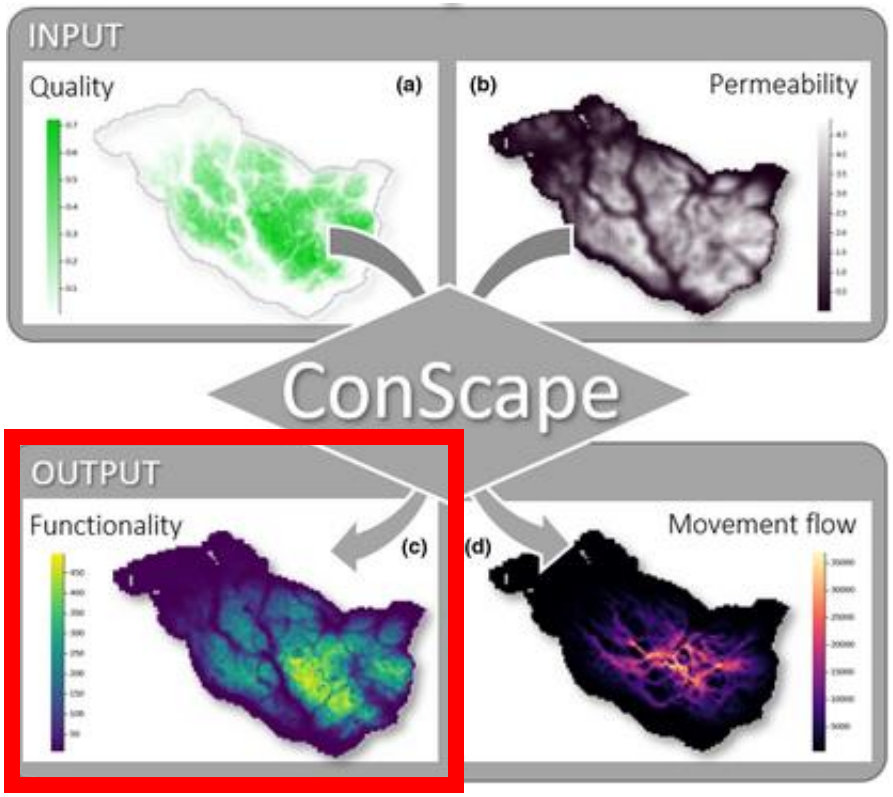


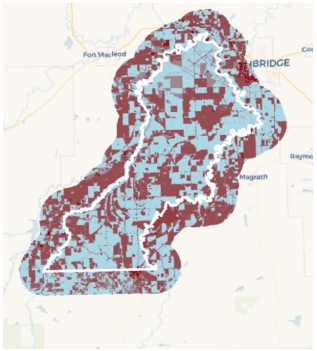
Please take some time to:

- Explore the app
- Discuss with peers
- Ask questions

Habitat Functionality







SSPF using habitat quality and resistance

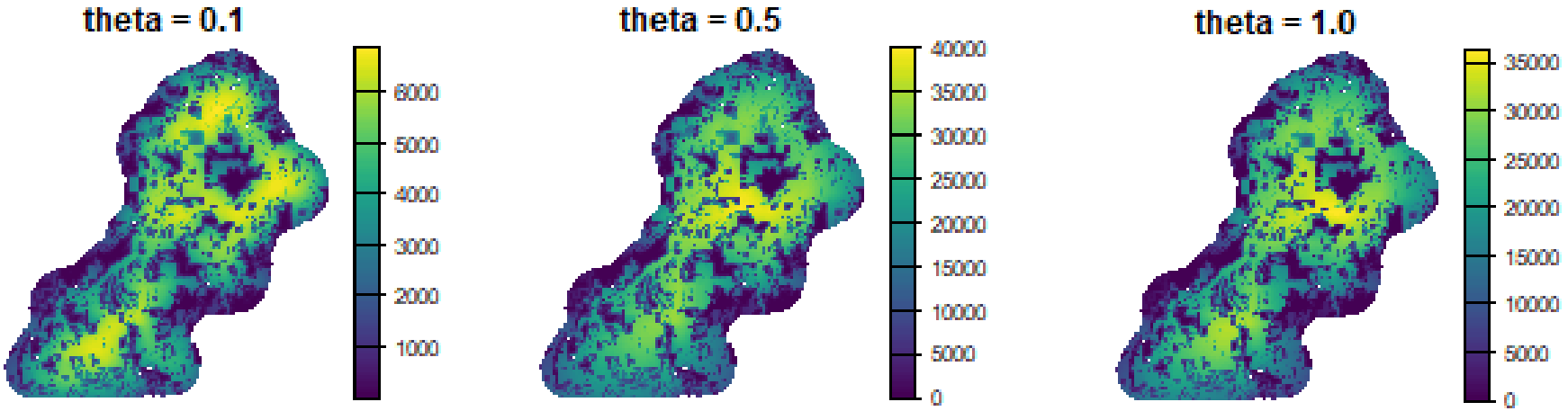
Eco distance matrix created using probability of RSP and the cost

Ecological distance scaled by physical proximity

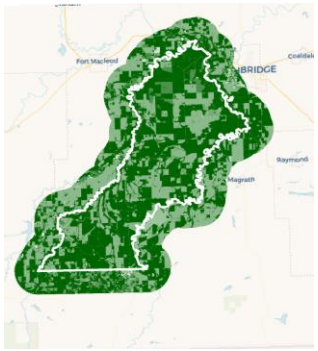
Habitat Functionality

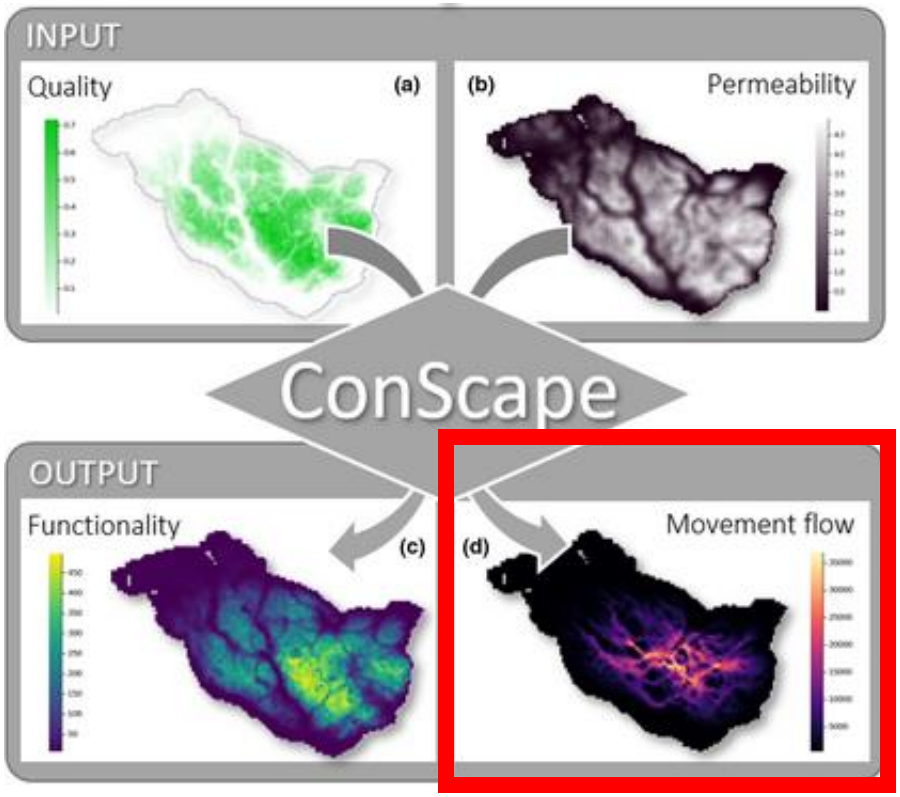
Functional Habitat :

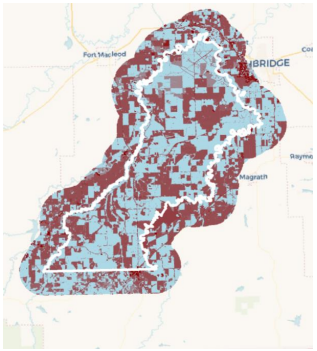
- Good quality habitat that is connected given for a given dispersal capability and random path distribution
  - A habitat quality threshold is not used, but rather quality is used a weight



Movement Flow: Dispersal Pathways







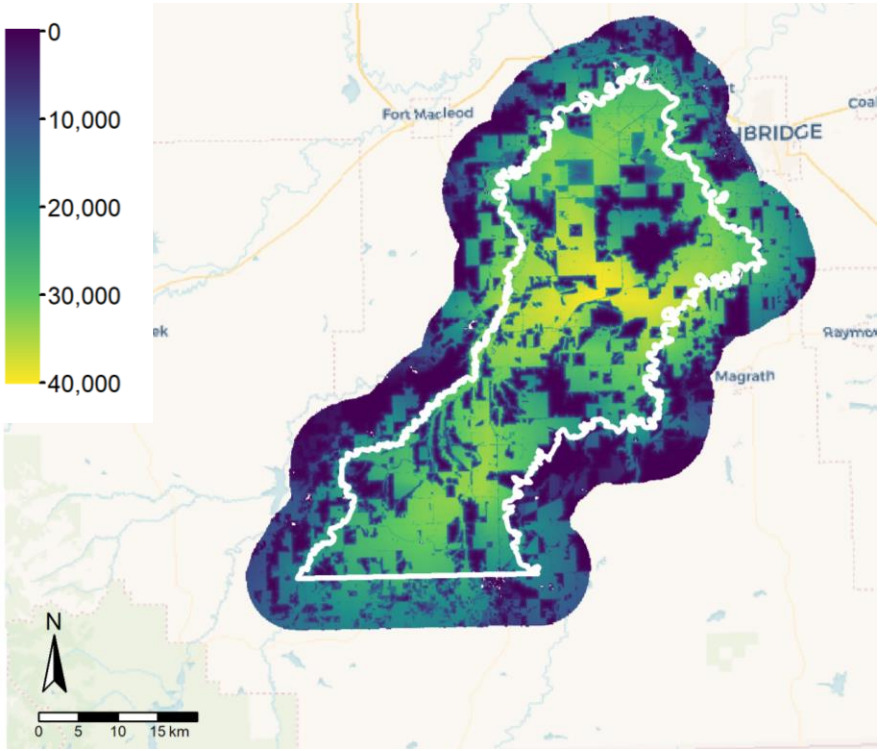
SSPF using habitat quality and resistance

Eco distance matrix created using probability of RSP and the cost

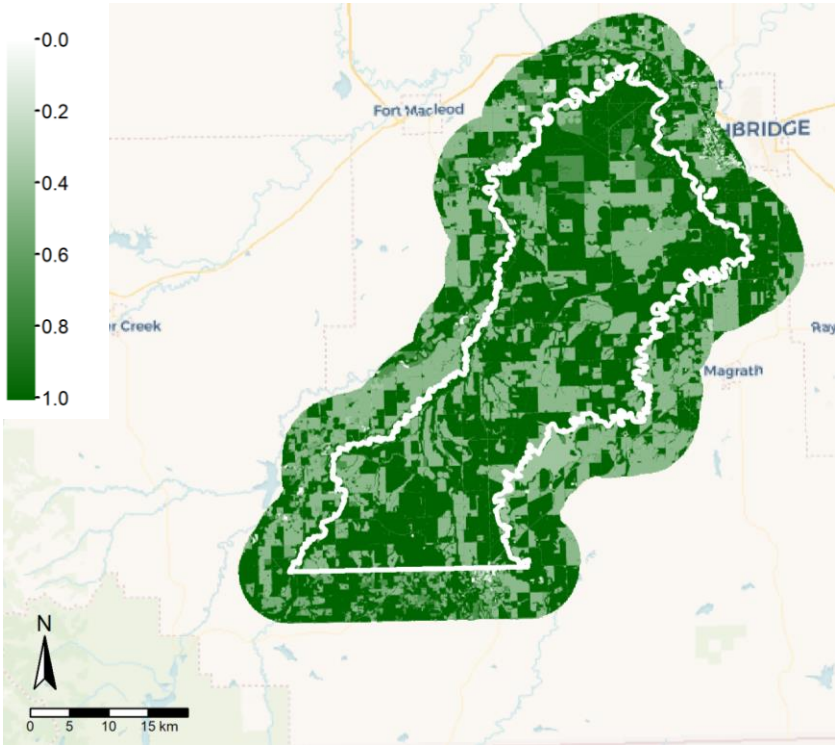
Weighted by the betweenness of habitat quality and geographical proximity

Habitat Functionality

Habitat Functionality



Habitat Quality (Naturalness)



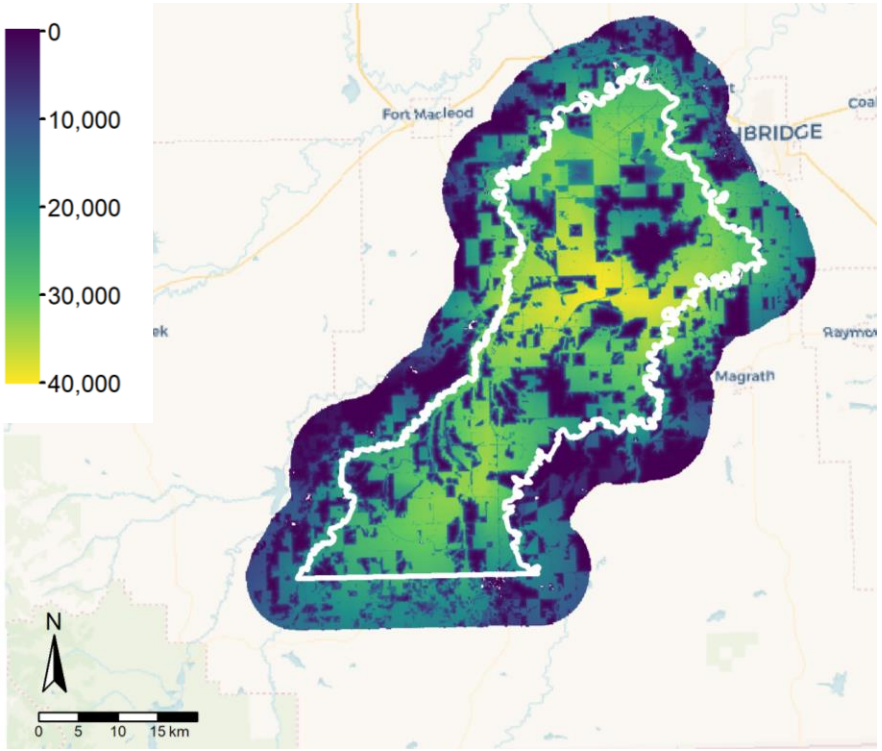
Theta = 0.5 (medium between LCP and CD)
Resolution = 100 m, Dispersal = 250 m

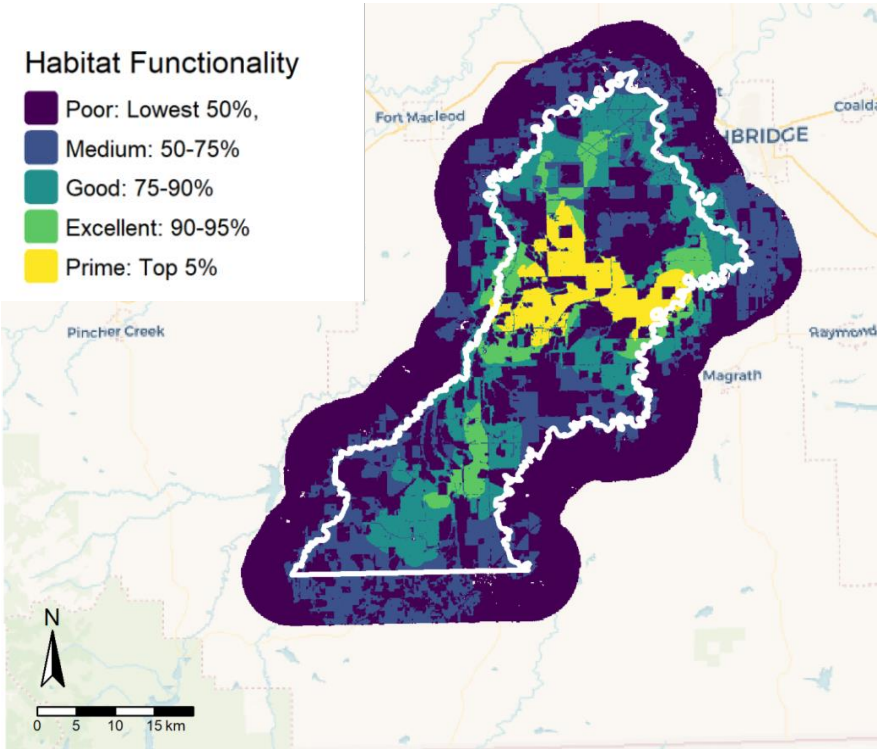
Habitat Proportion

30.7% Connected, 69.3% Unconnected

Functionally Connected Habitat: Thresholds

Habitat Functionality





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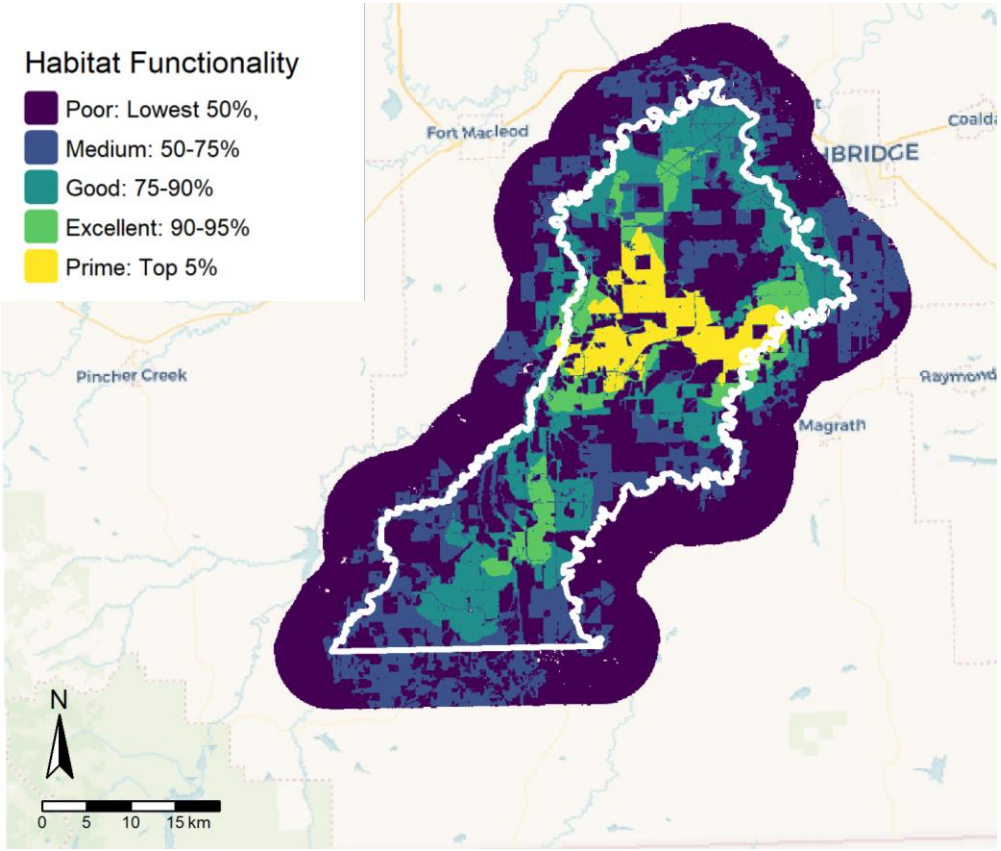
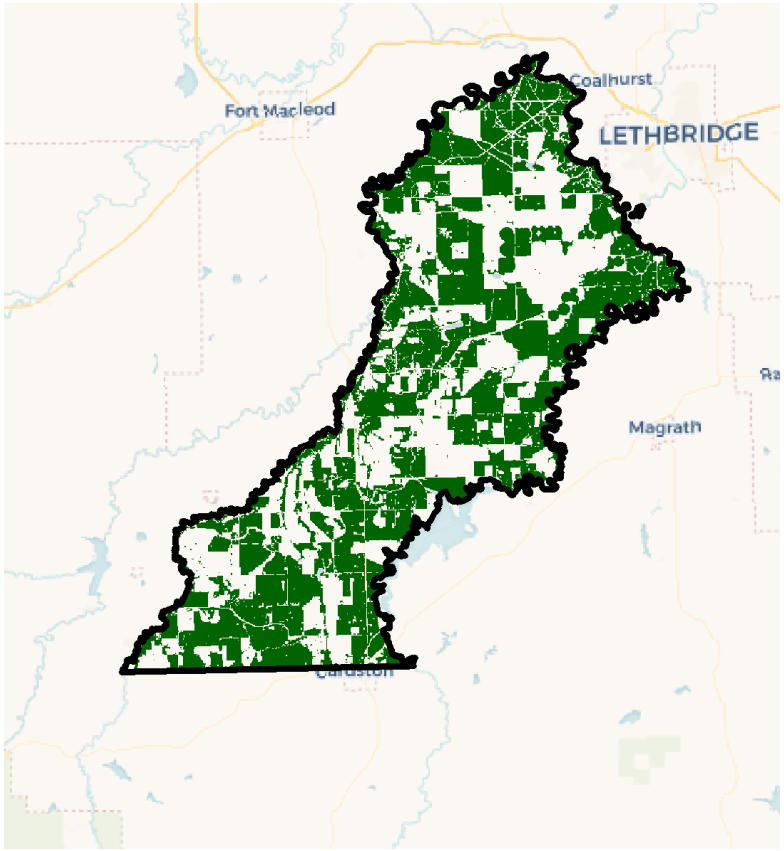
Habitat Functionality: Thresholds

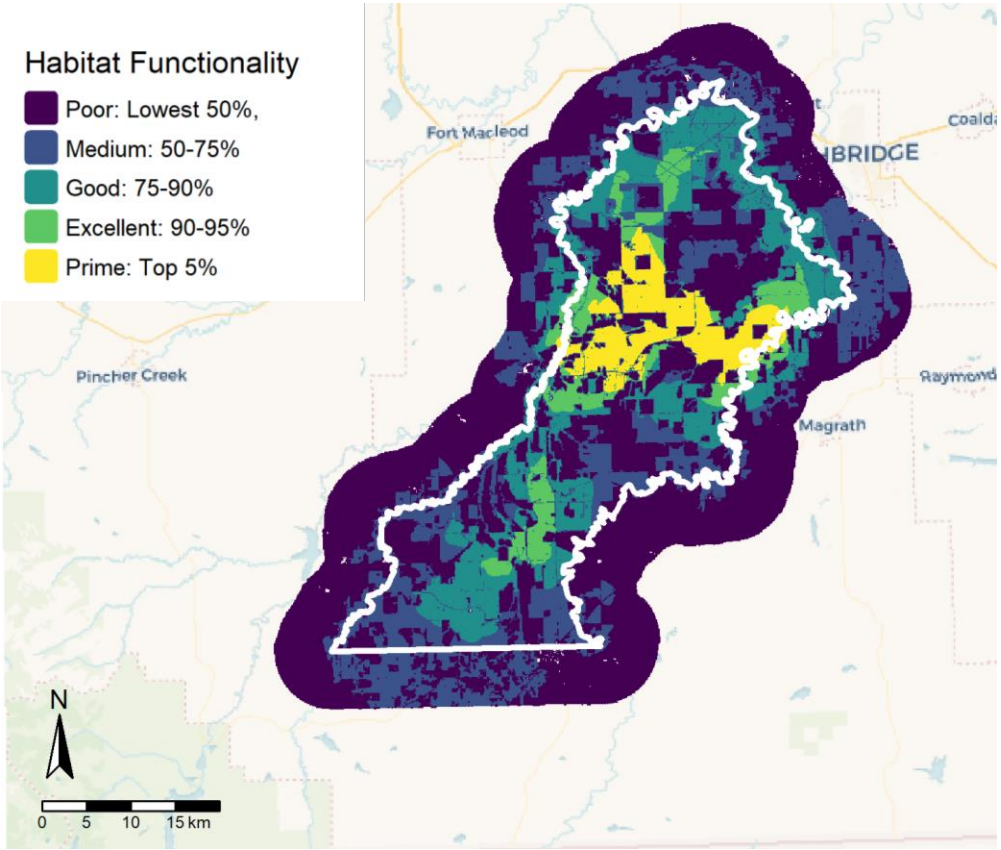


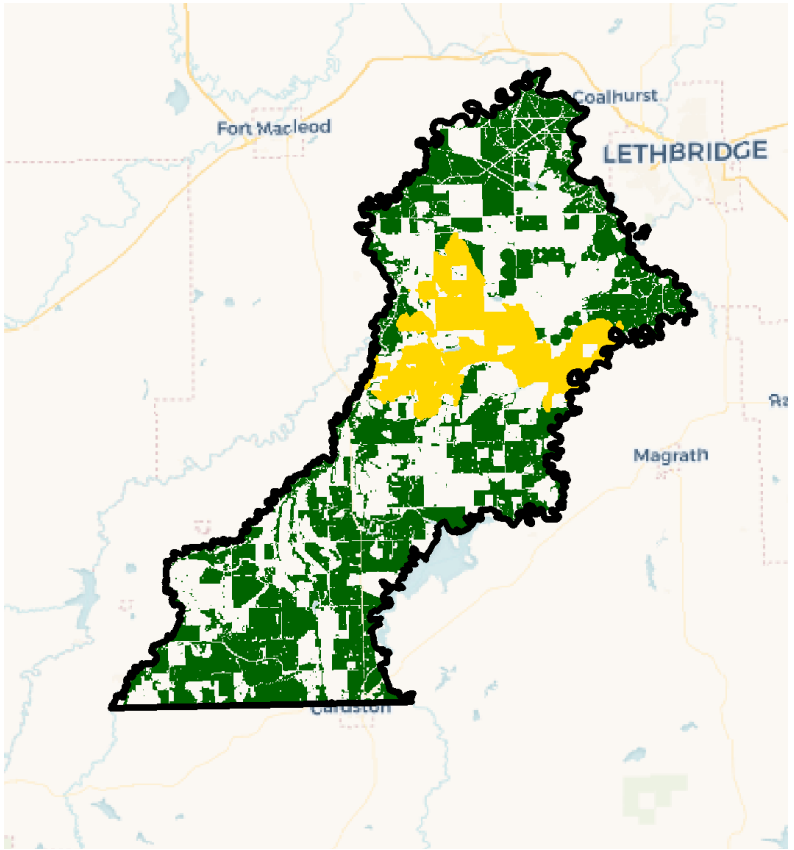
Natural Habitat: Quality = 1



Habitat Functionality: Thresholds

Natural Habitat: Quality = 1



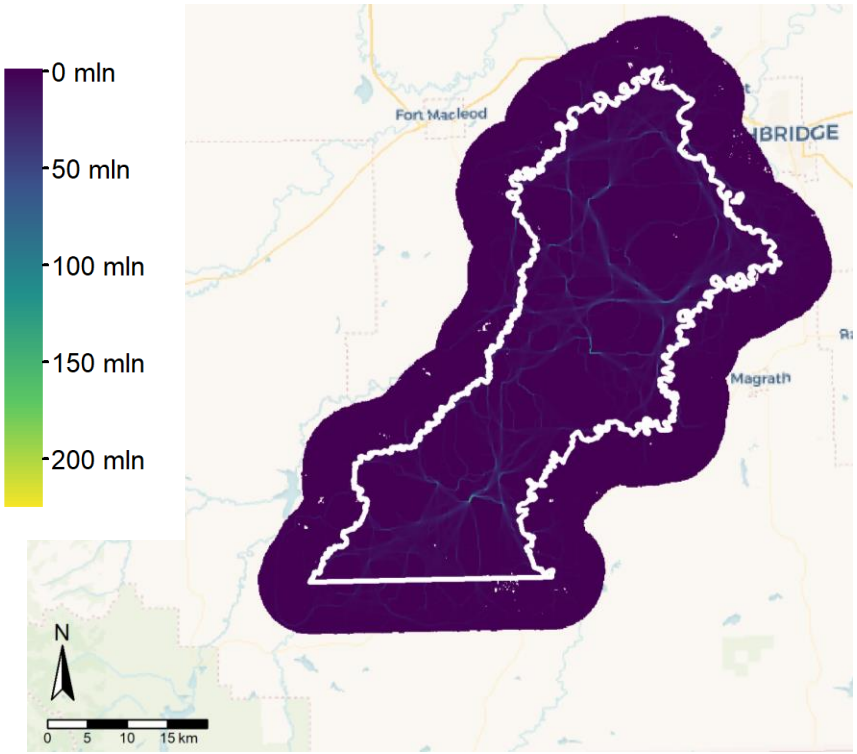


Main Objective #1: Where are important areas of habitat?

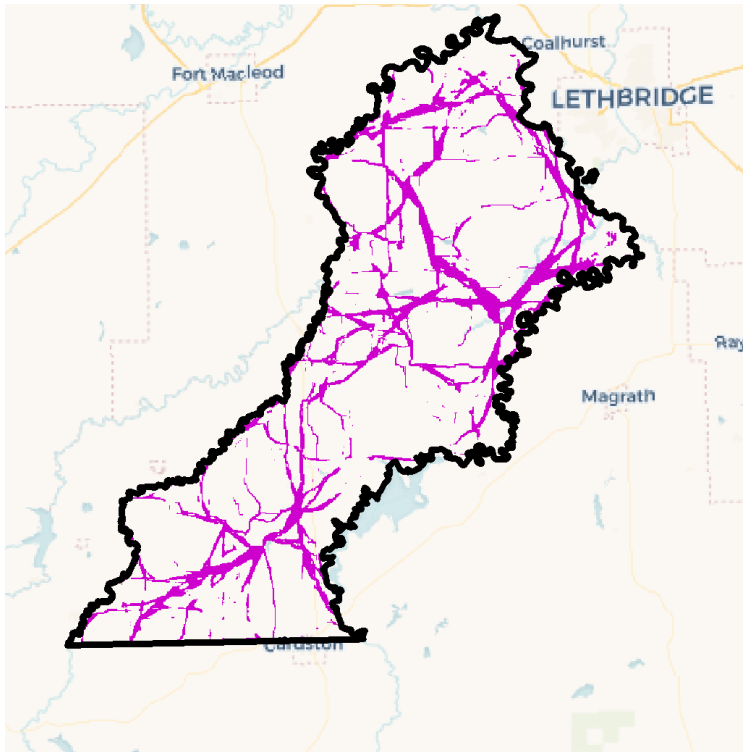
#2: Where are important ecological corridors?

Movement Flow: Dispersal Pathways

Movement Flow Pathways : Corridors



Top 90% of Movement Flow

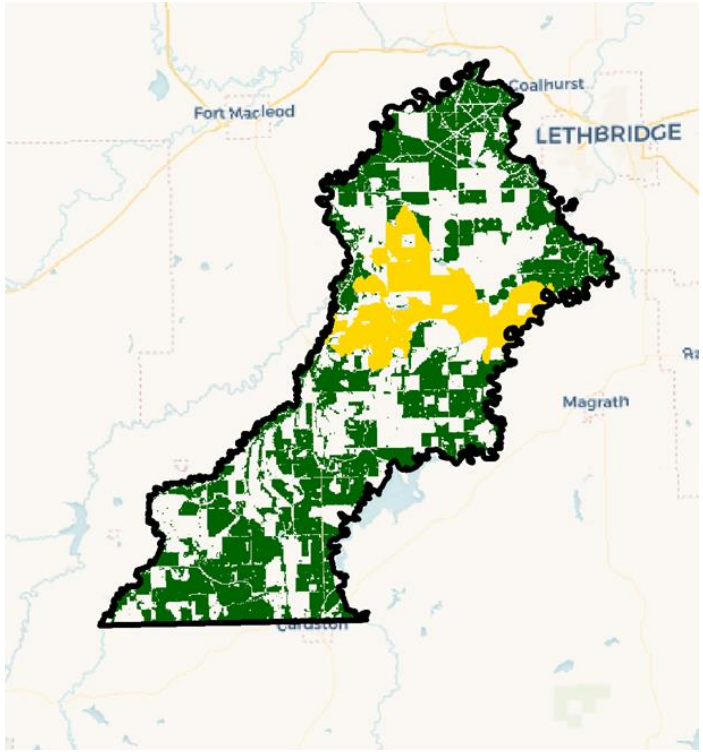


Theta = 0.5 (medium between LCP and CD), Dispersal = 250 m, Resolution = 100 m

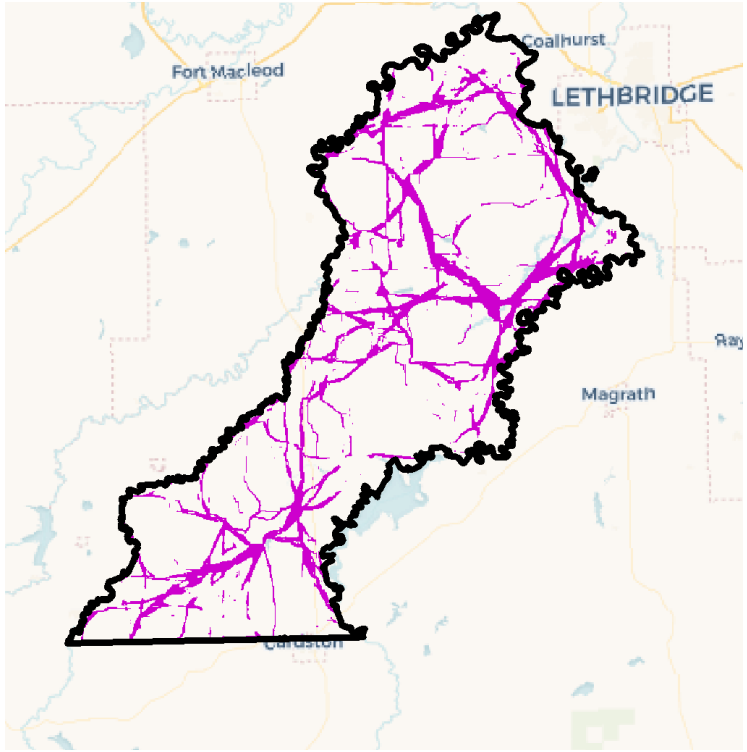
Main Objective #2: Where are important ecological corridors?

Putting it all together . . .

Natural & Prime Functional Habitat



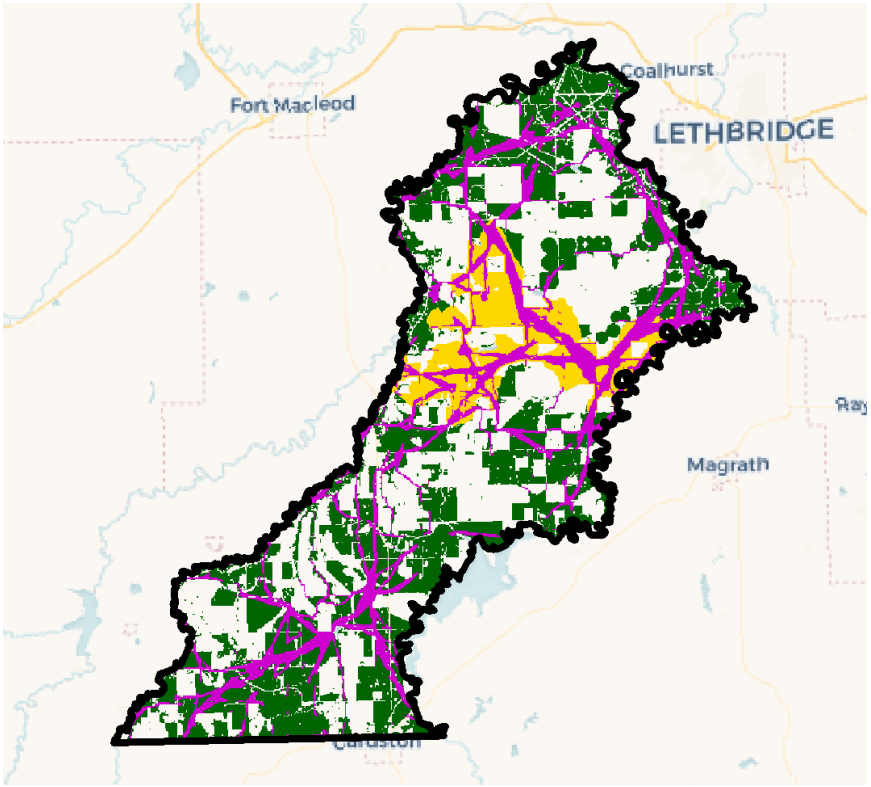
Top 90% of Movement Flow



High Value Landscapes: Case Study A

Main Objectives

1. Where are important areas of habitat?
2. Where are important ecological corridors?



We can:

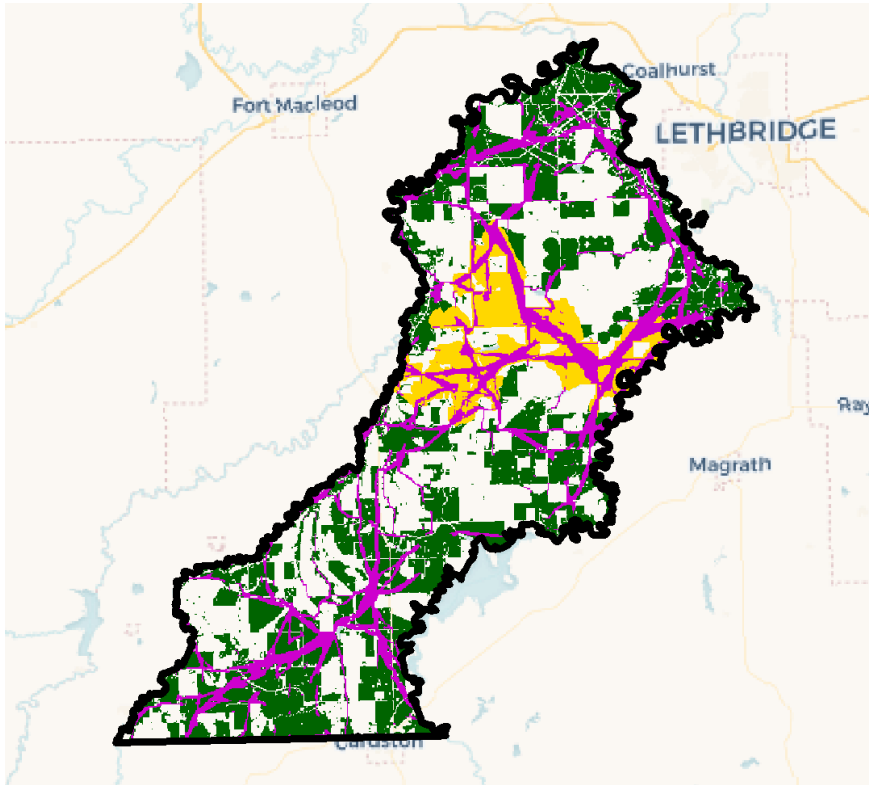
- Disentangle how different areas contribute to habitat area, quality, and function, as well as ecological flow

- Prioritize areas for conservation and restoration

High Value Landscapes: Case Study A

Main Objectives

1. Where are important areas of habitat?
2. Where are important ecological corridors?



We can:

- Disentangle how different areas contribute to habitat area, quality, and function, as well as ecological flow

- Prioritize areas for conservation and restoration

Deliverables

5	R / Julia vignette
6	Interactive tool
7	Video tutorial (?)
9	Ecological flow maps
10	Functional habitat maps
13	Grassland connectivity WS

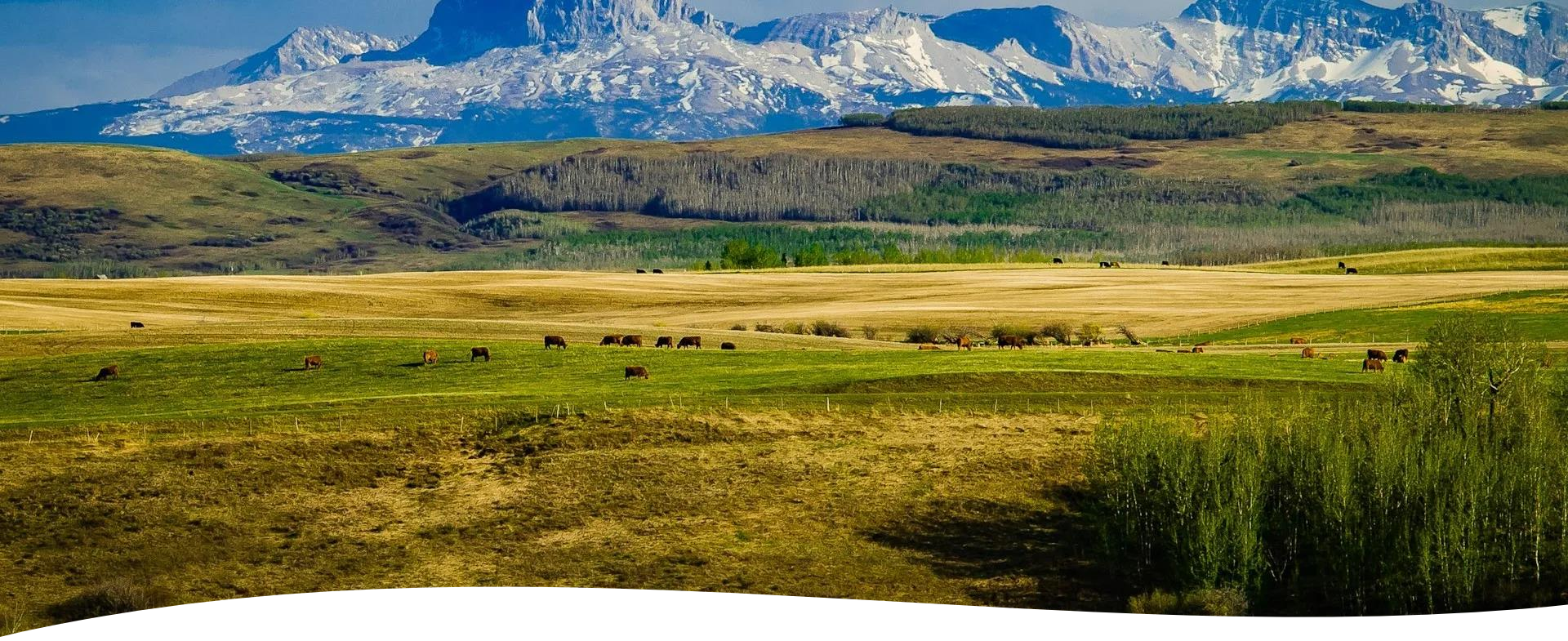
Next Steps: Scaling Up?

1. Expand Study Area Extent
2. Improve resolution

Hopefully possible in 1-2 months:

- Parallel computing with ConScape coming soon

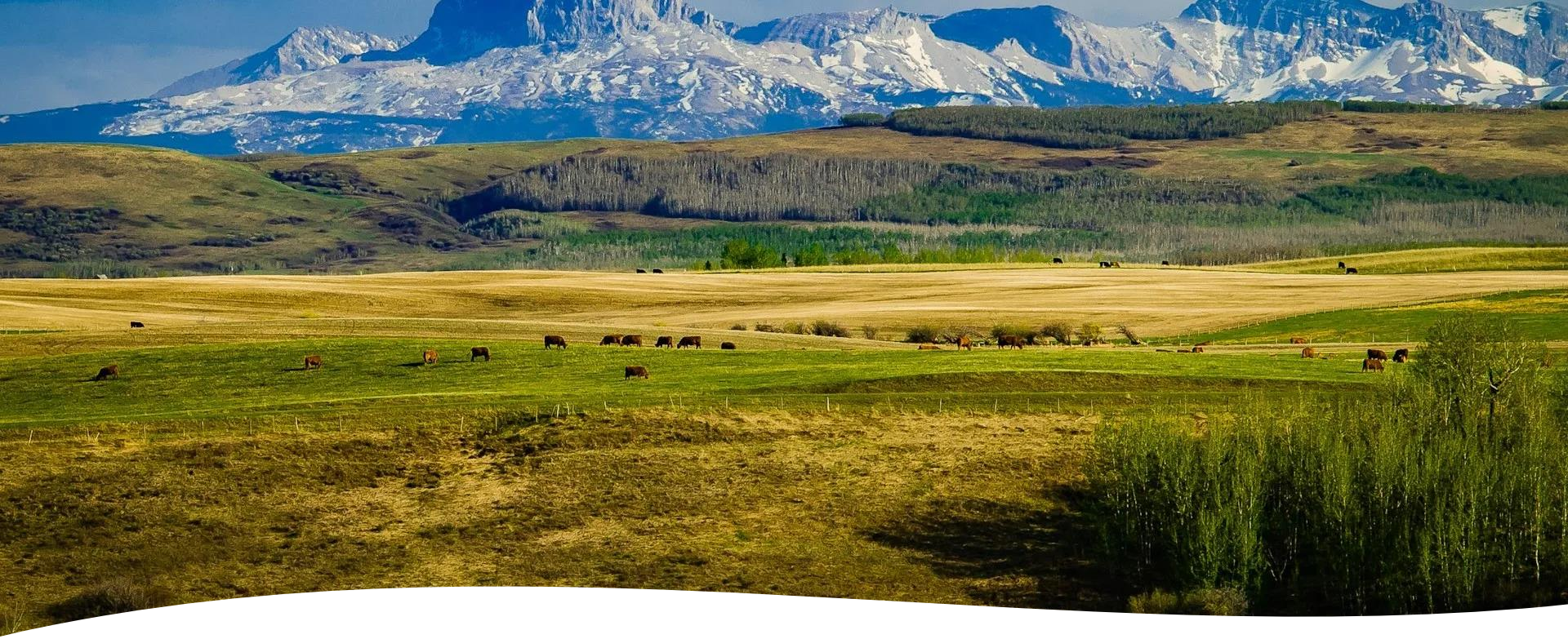
- Digital Research Alliance of Canada server maintenance finishing soon



Questions and Group Discussion

Overall, what would you like to see from the study?

- Which deliverables seem useful? Any we should add or remove?
- What habitat is the priority? Grassland/parkland data availability?
- Species agnostic vs species-specific?
- Geographical areas of interest?



Questions for Alvin

- Would you like any tweaks to this analysis?
  - Any changes to habitat quality/resistance input?
  - Theta, dispersal?
  - Validate with species data?

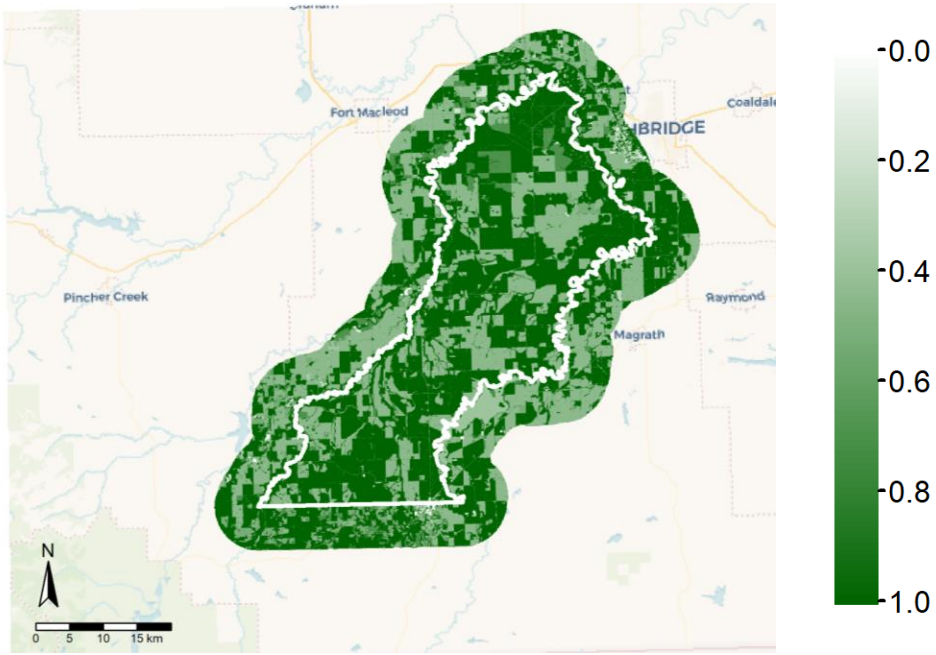
#OPENTOWORK

https://www.linkedin.com/in/celia-hein-851311b1/

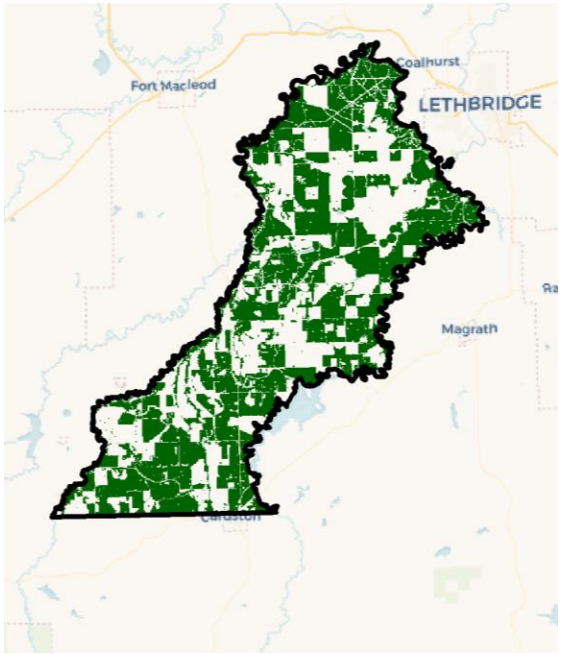
https://celiahein.github.io/

Kainai Reserve

Habitat Quality (Naturalness)



Natural Habitat: Quality = 1

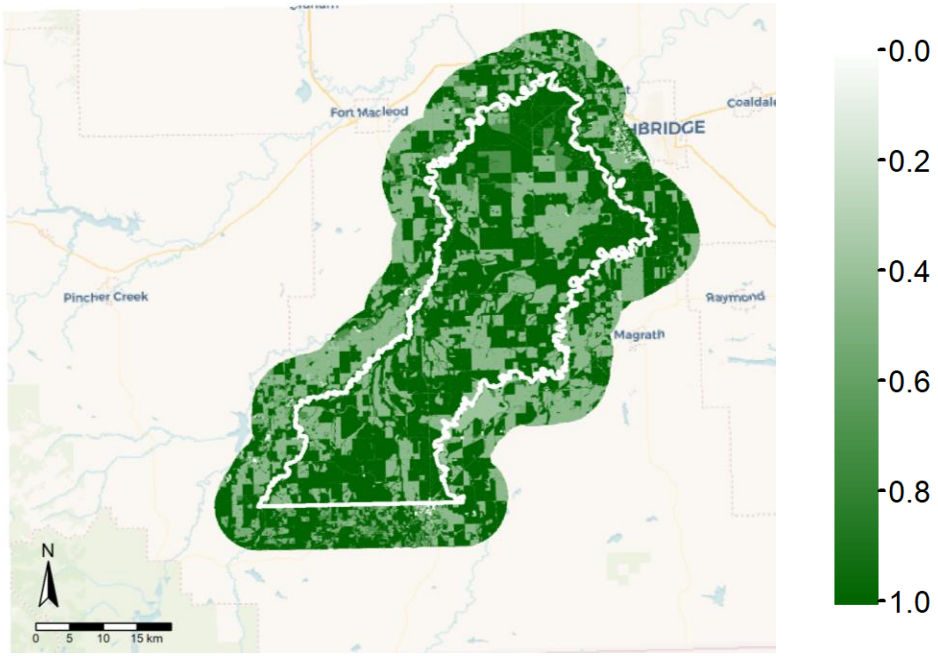


ABMI Human Footprint Inventory 2021

Main Objective #1: Where are important areas of habitat?

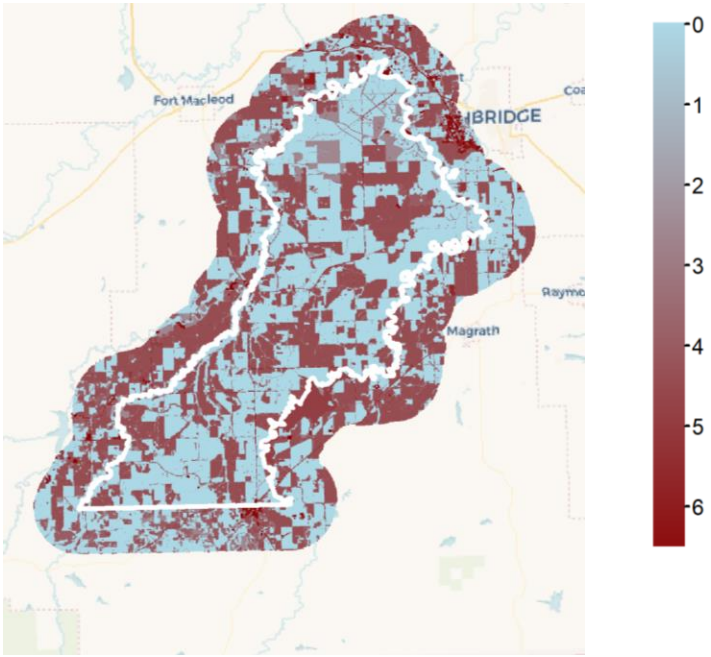
Kainai Reserve

Habitat Quality (Naturalness)



ABMI Human Footprint Inventory 2021

Resistance (log-scale)



Marrec et al. (2020) Resistance Values