Using connectivity modelling for applied conservation in the Kainai Reserve

Landscape Connectivity Workshop

October 30, 2025

Celia Hein & Alvin First Rider

Project Context

NSERC Alliance Grant: Bridging the gap between academic research and its application

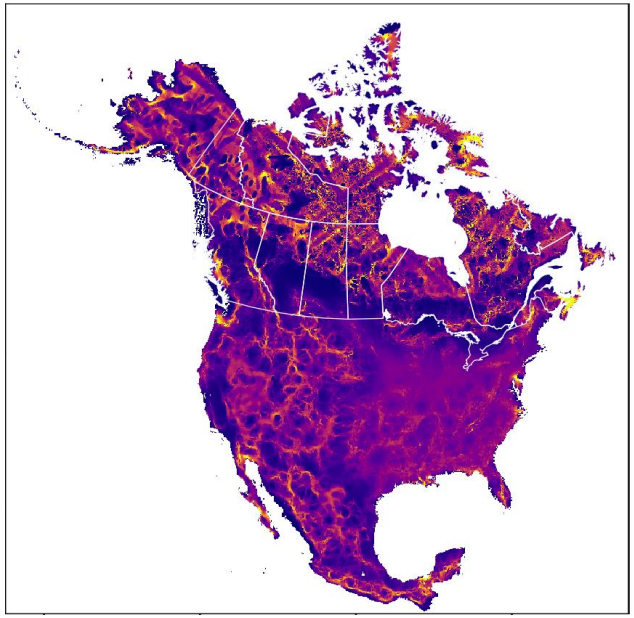
Goal: Use connectivity modelling for applied conservation at smaller scales and facilitate coordination between scales

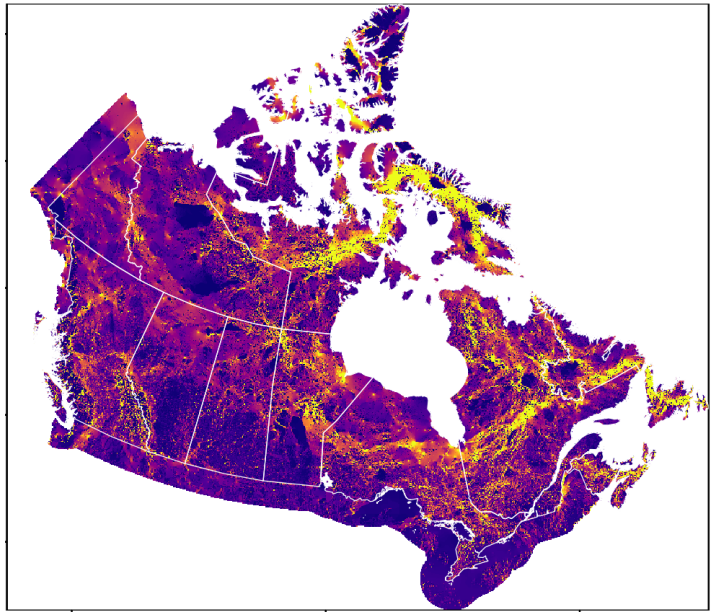
Current Density Models at Different Scales

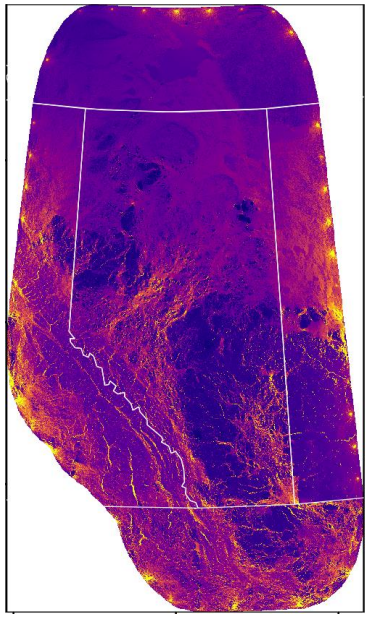
Belote et al. (2022), Landscape Ecology:
- North America
- 1 km resolution

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

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

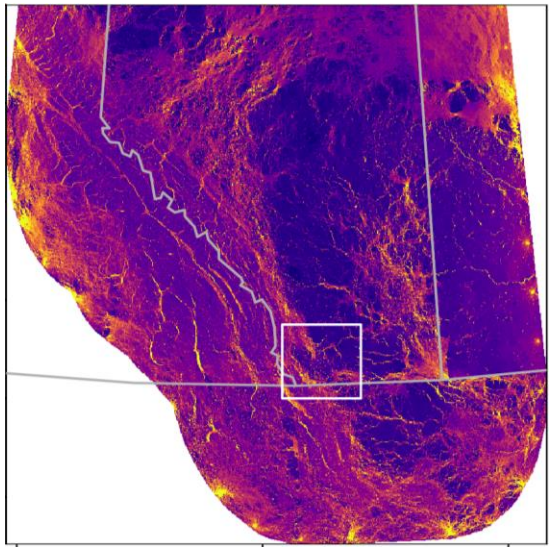




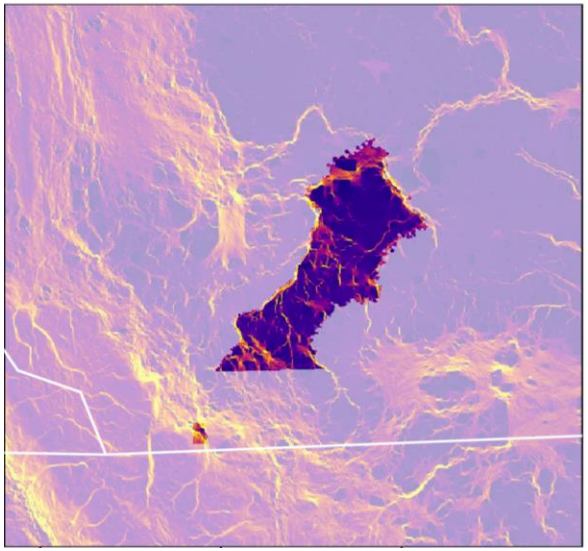


Local Connectivity Planning in a Regional Context

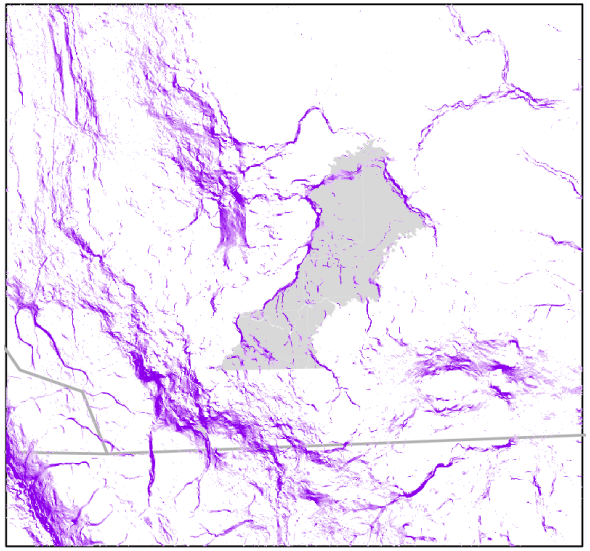
Study area in south Alberta



Kainai Reserves



Ecological Flow Pathways



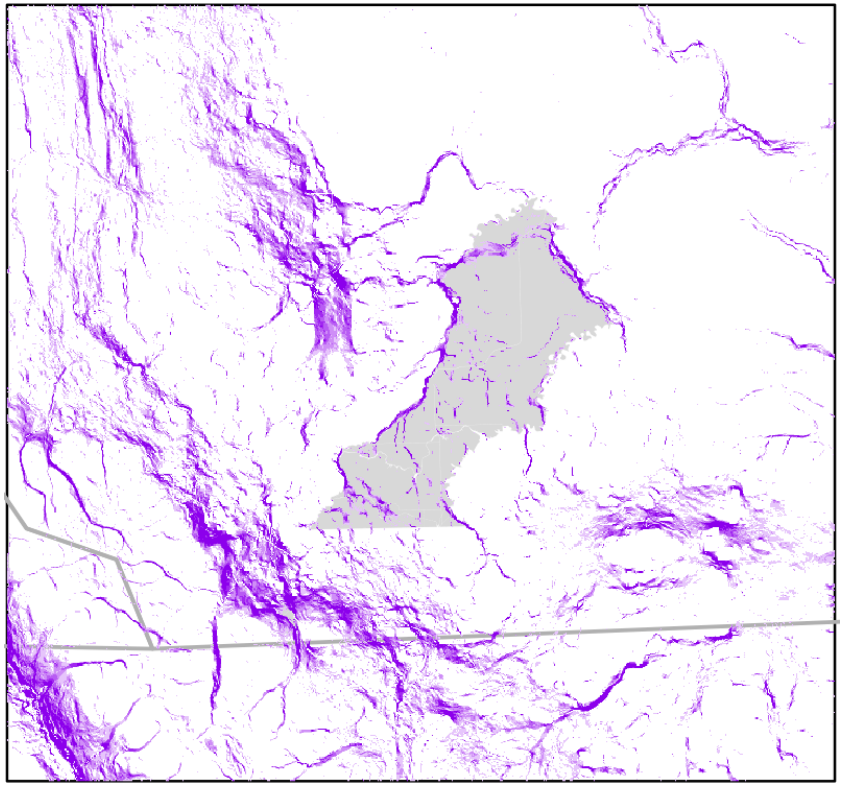
Main Objectives: Within Kainai Reserve

1. Where are important areas of habitat?

2. Where are important ecological pathways?

3. Identify high-priority areas for conservation and restoration

Ecological Flow Pathways



ConScape

Blends “Conefor” and “CircuitScape” style approaches

Van Moorter et al. (2023)

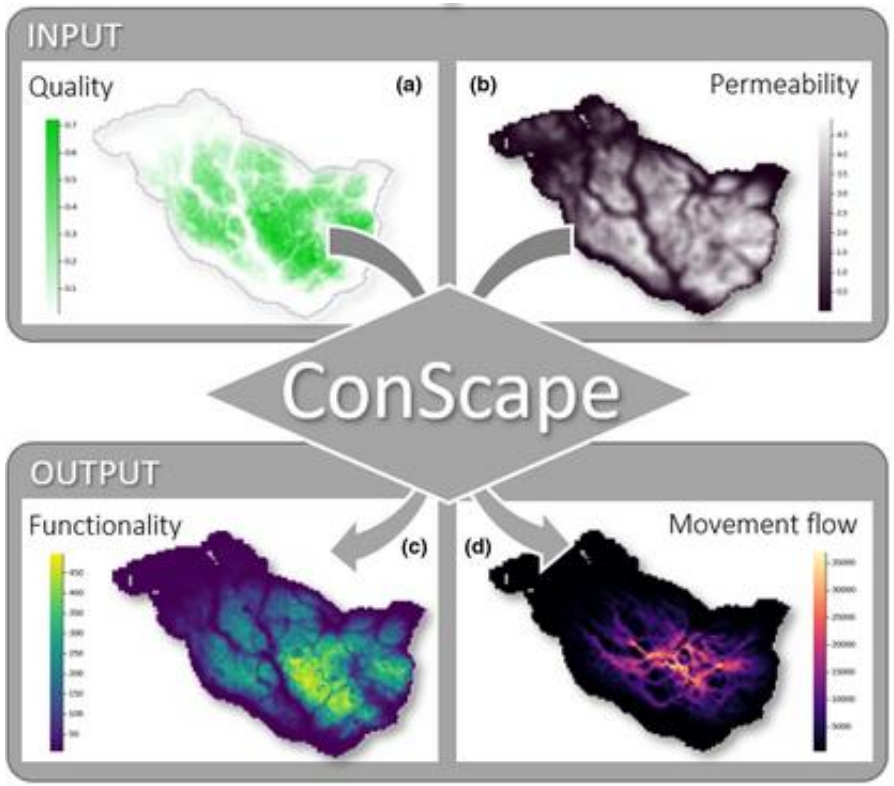
Integrates habitat quality, connectivity, dispersal

Van Moorter et al. (2023)

Flexible Input

Habitat-focus

Species-agnostic



Permeability-focus

Resistance-based

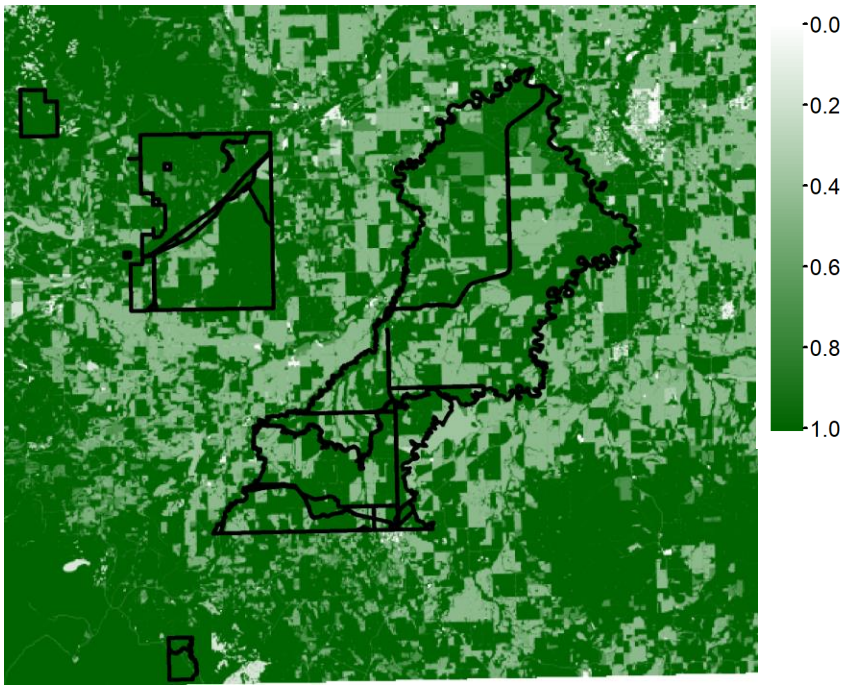
Functionally connected habitat

Identify important ecological pathways

1. Where are important areas of habitat?
2. Where are ecologically potential corridors?

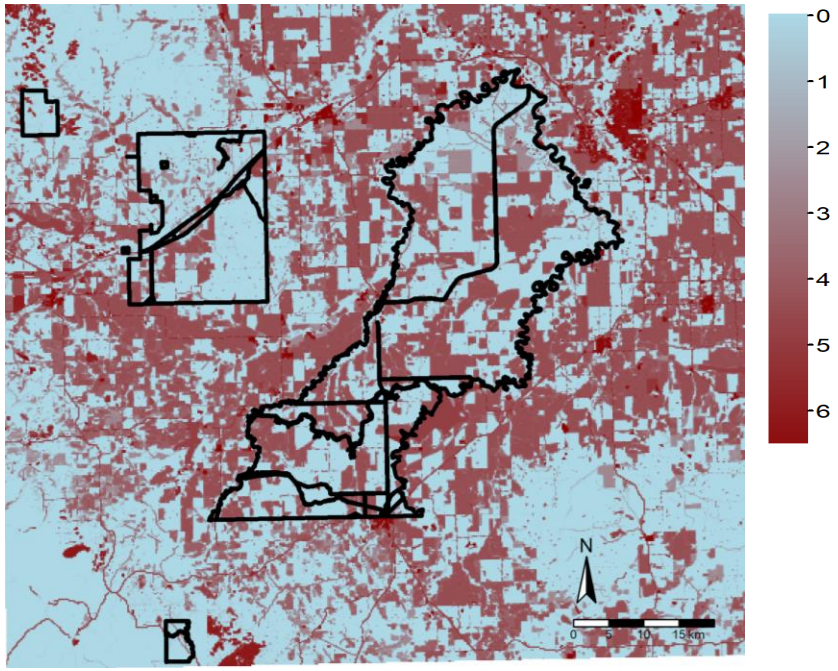
Kainai Reserve- Study Area and Inputs

Habitat Quality (Naturalness)



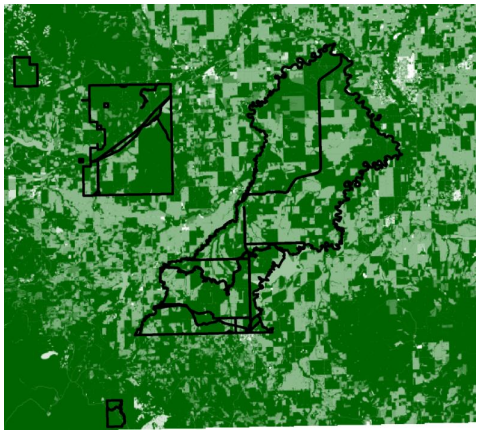
ABMI Human Footprint Inventory 2021

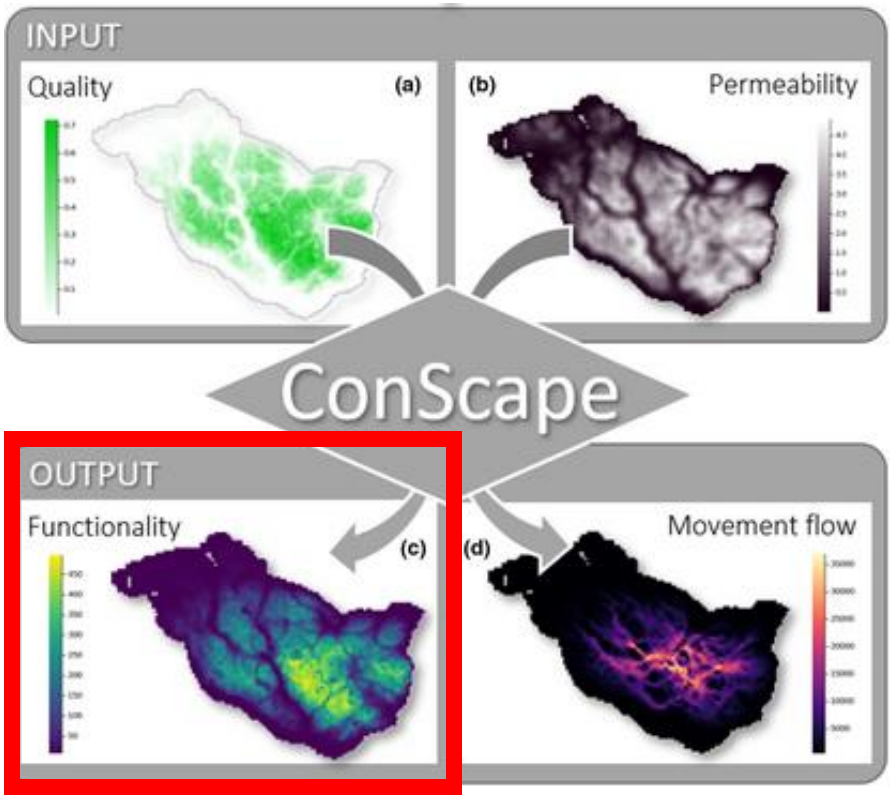
Resistance (log-scale)

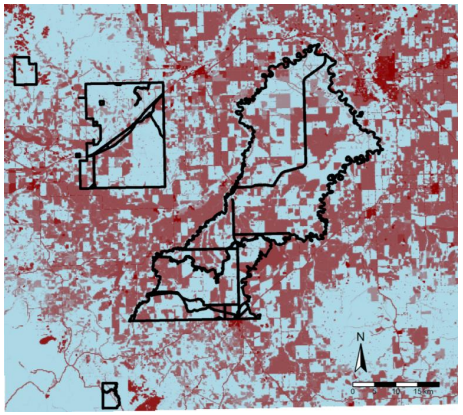


Marrec et al. (2020) Resistance Values

Habitat Functionality







Habitat Functionality

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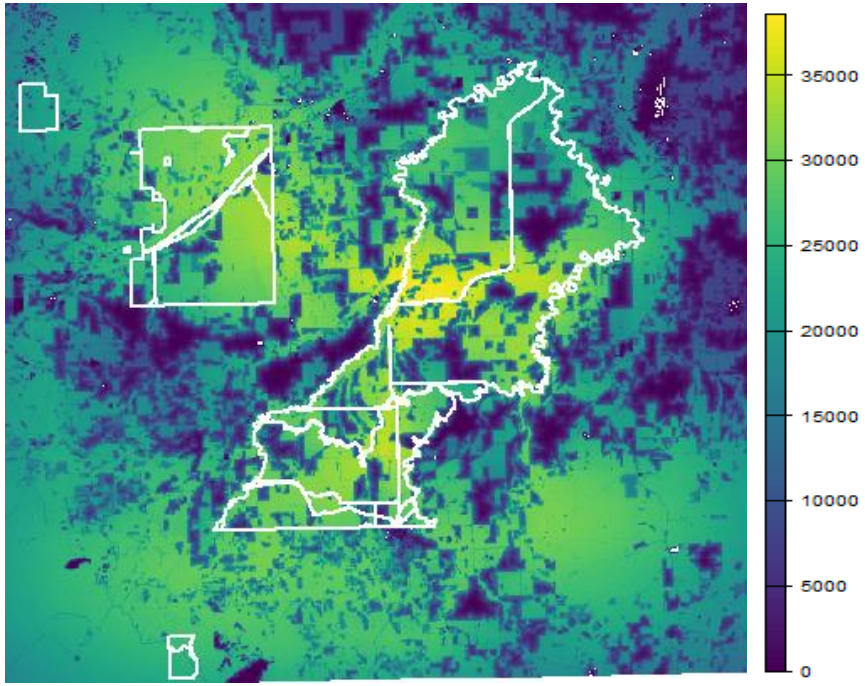
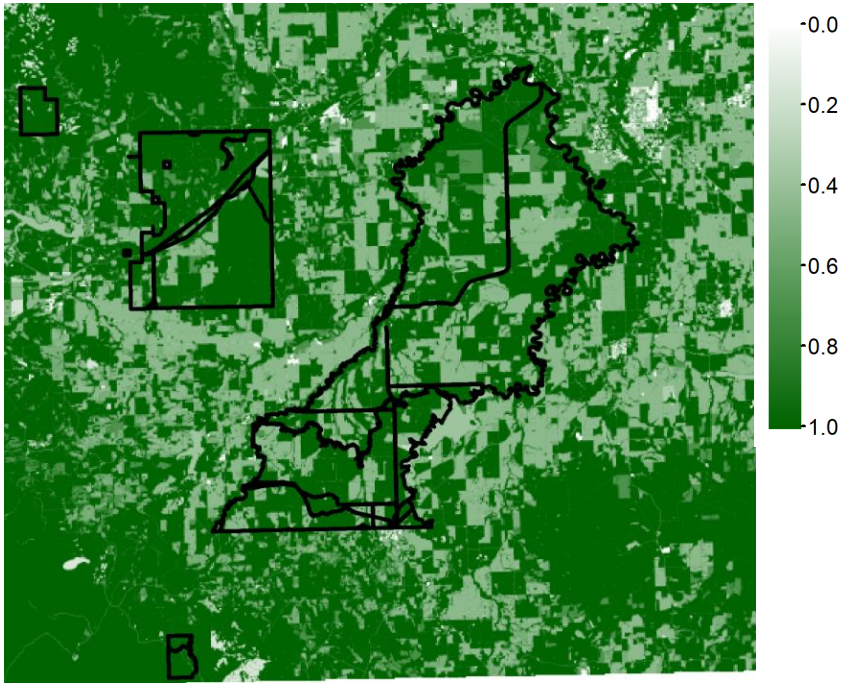


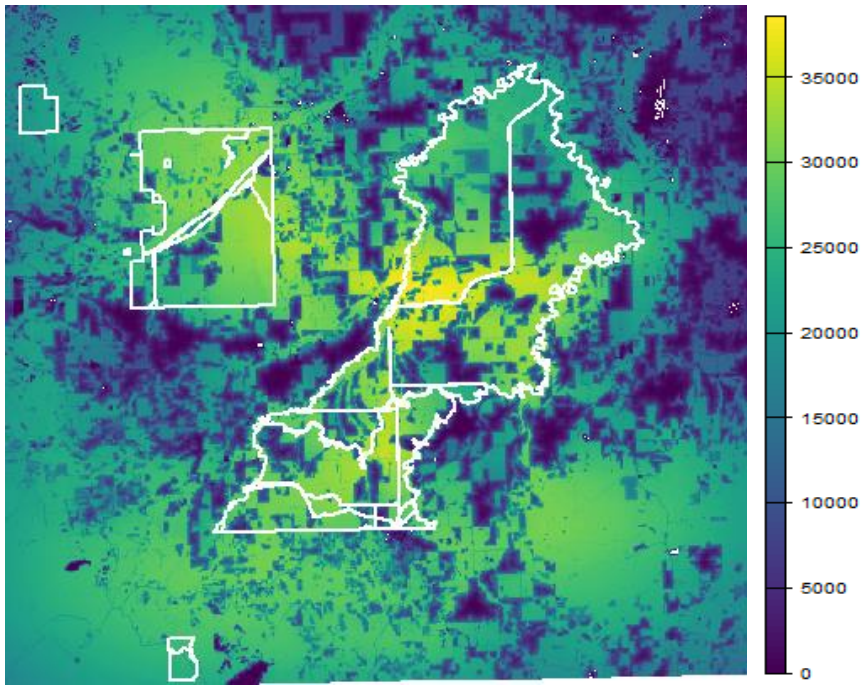
Habitat Quality (Naturalness)



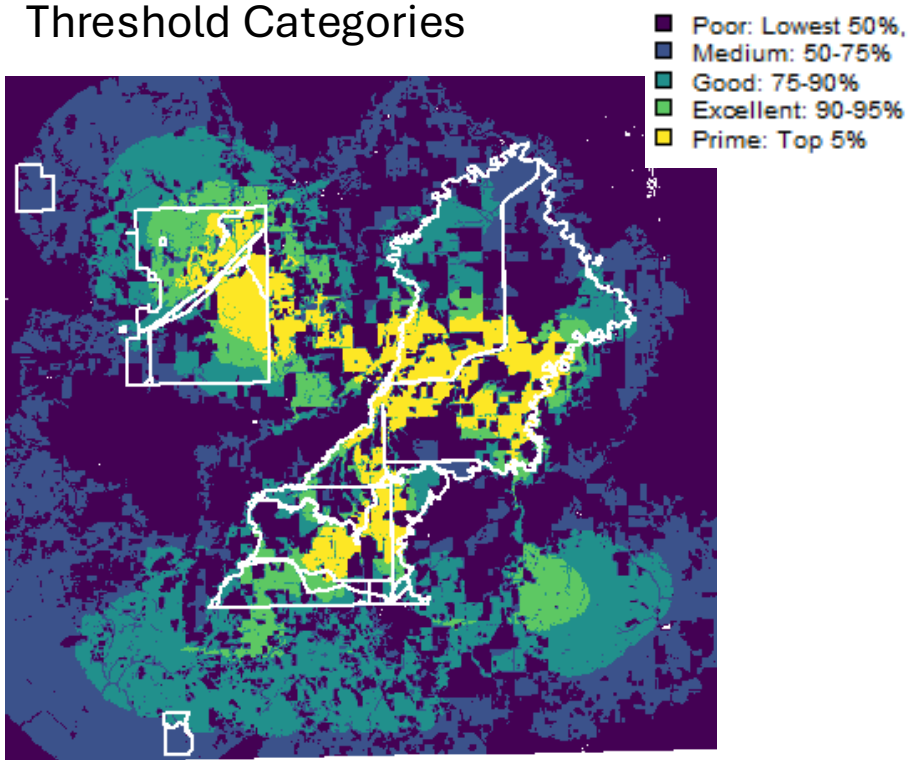
Habitat functionality is a pixel value weighted by how well connected the pixel is and the habitat quality.

Functionally Connected Habitat: Thresholds

Habitat Functionality



Threshold Categories



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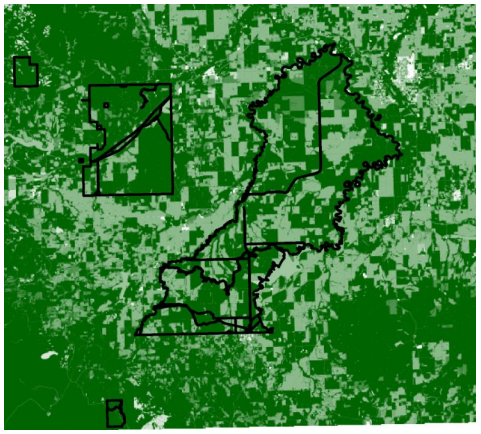
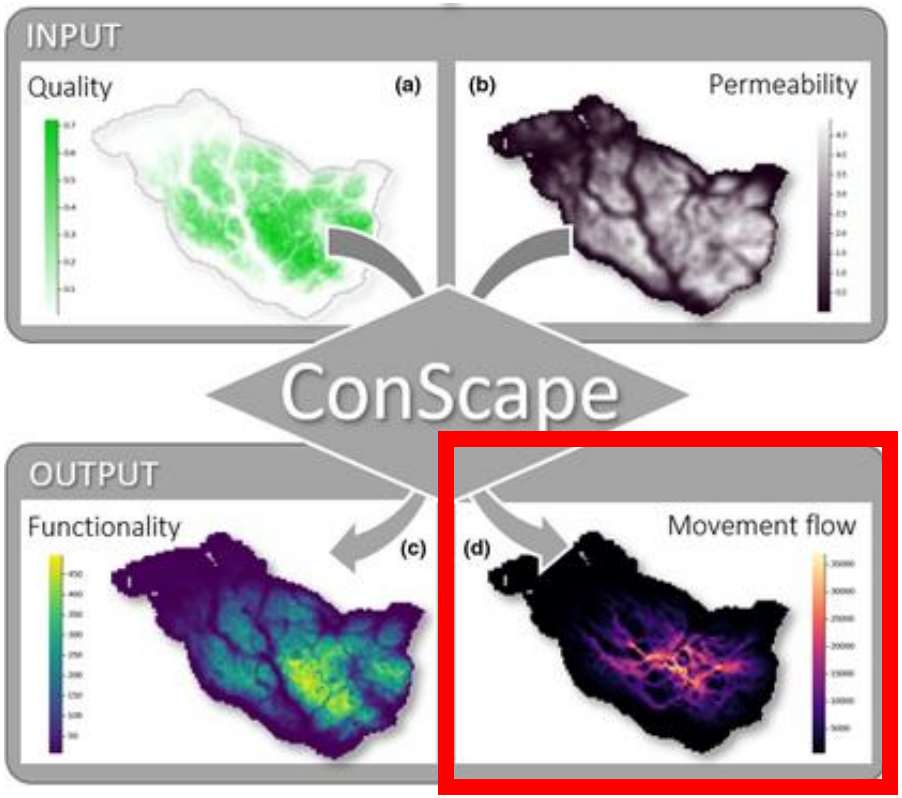
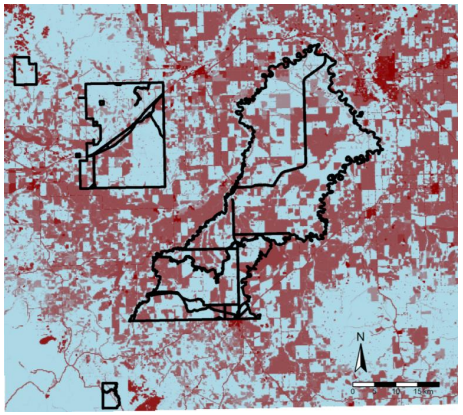
Movement Flow: Dispersal Pathways

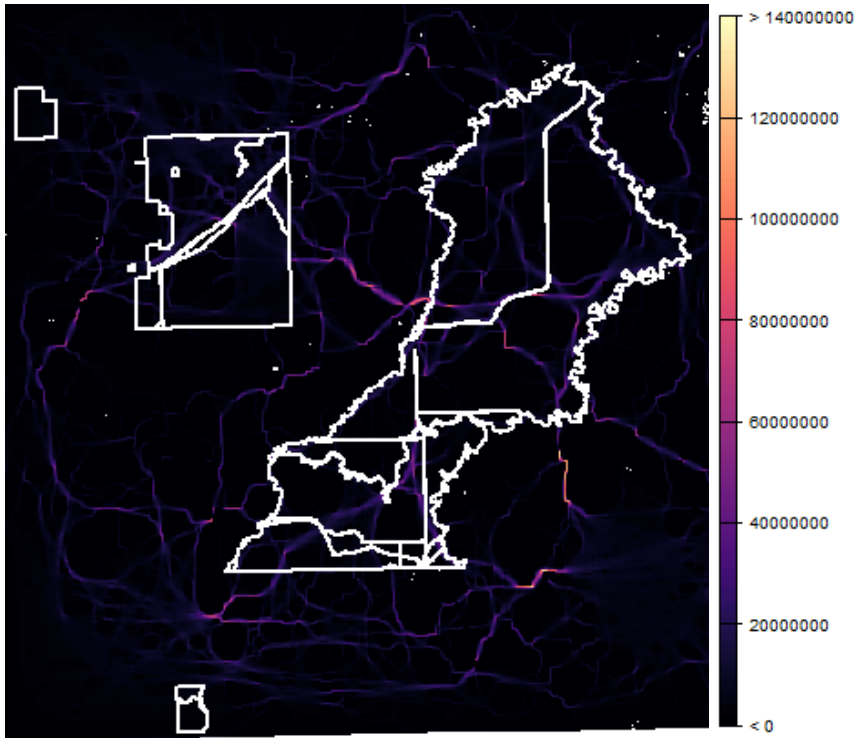




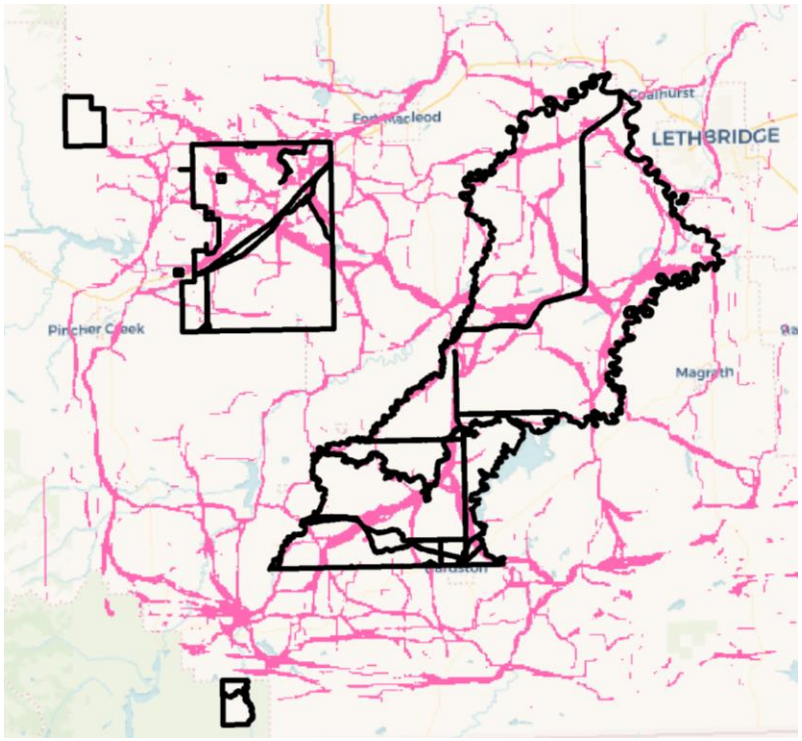


Movement Flow: Dispersal Pathways

Movement Flow Pathways : Corridors

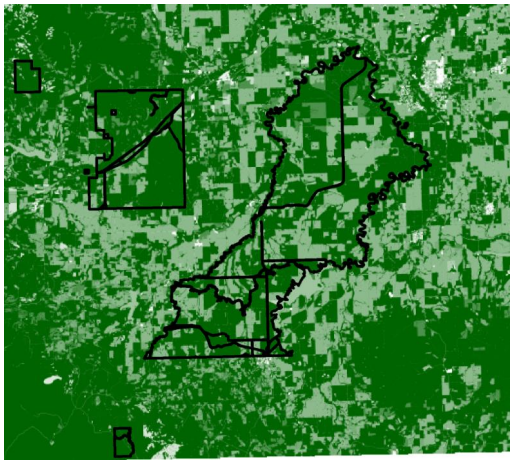


Top 10% of Movement Flow

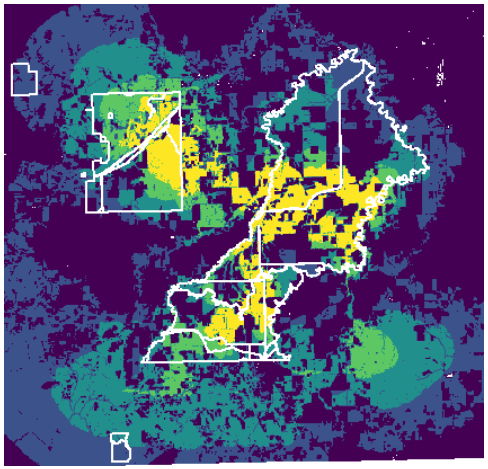


Local Habitat and Connectivity Mapping

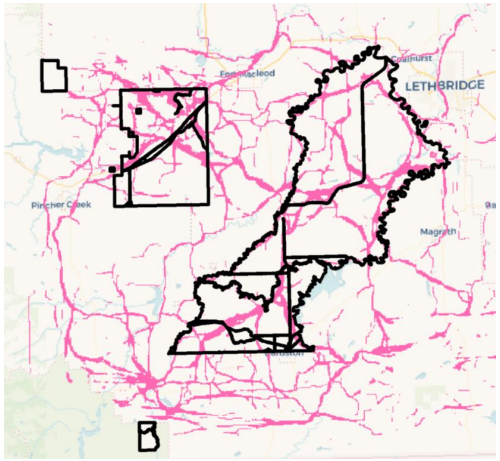
Habitat Quality (Naturalness)



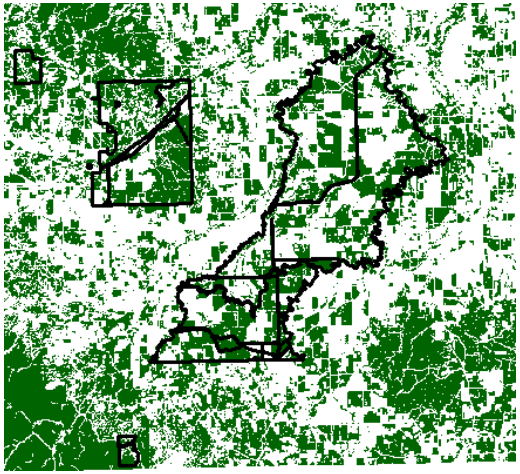
Functionally Connected Habitat



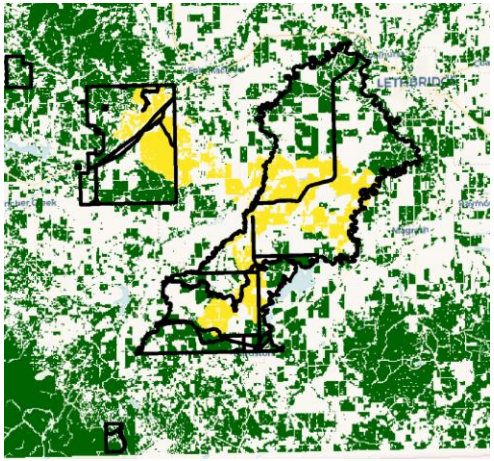
Top 10% of Movement Flow (Potential Corridors)



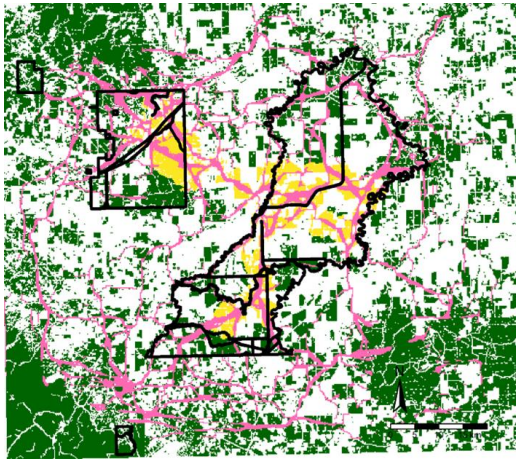
Natural only



Natural & Top Connected

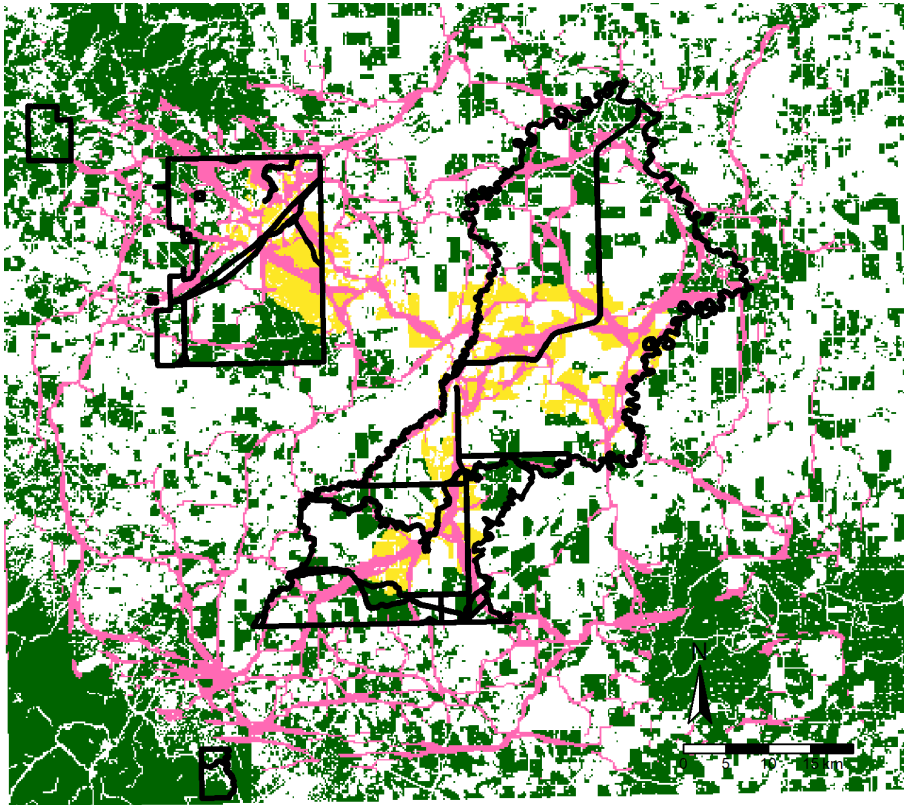


High Priority Areas



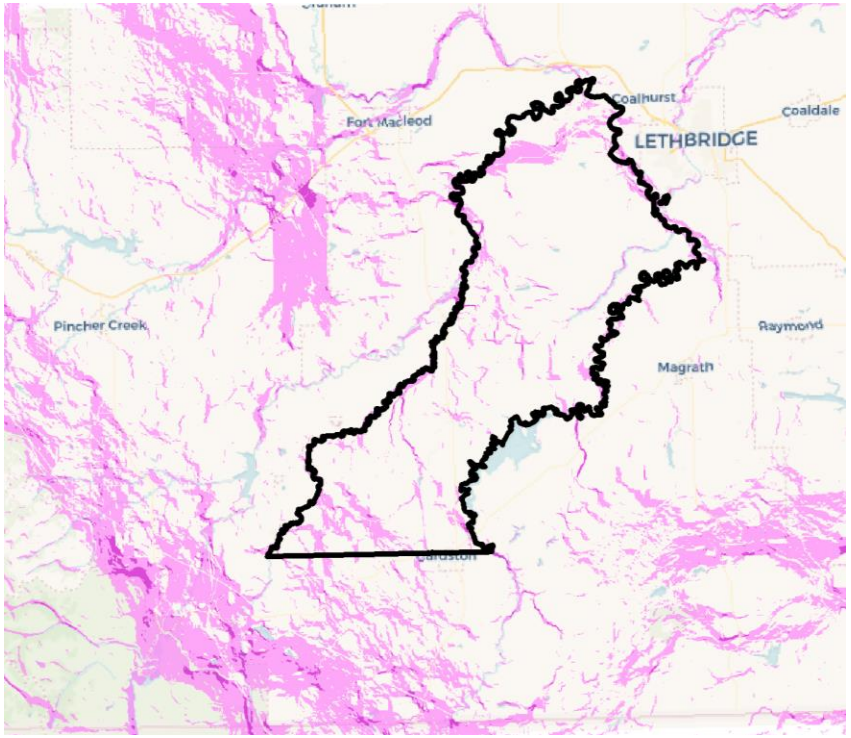
Identify priority areas for conservation

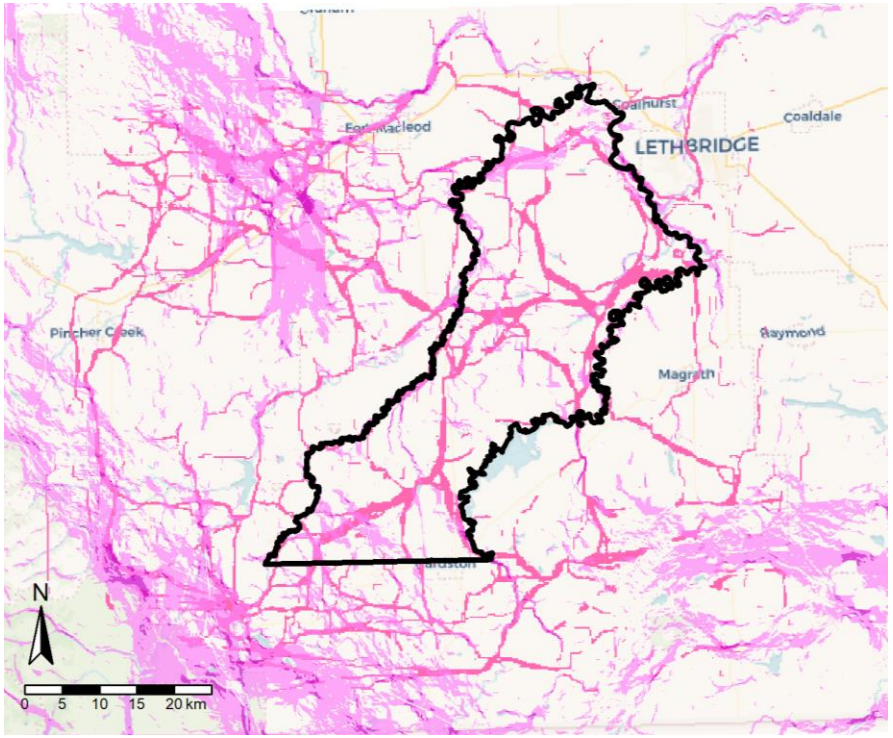
We can disentangle how different areas contribute to habitat area, quality, and function, as well as movement flow pathways



Local Connectivity Planning in a Regional Context

Regional Ecological Flow Pathways



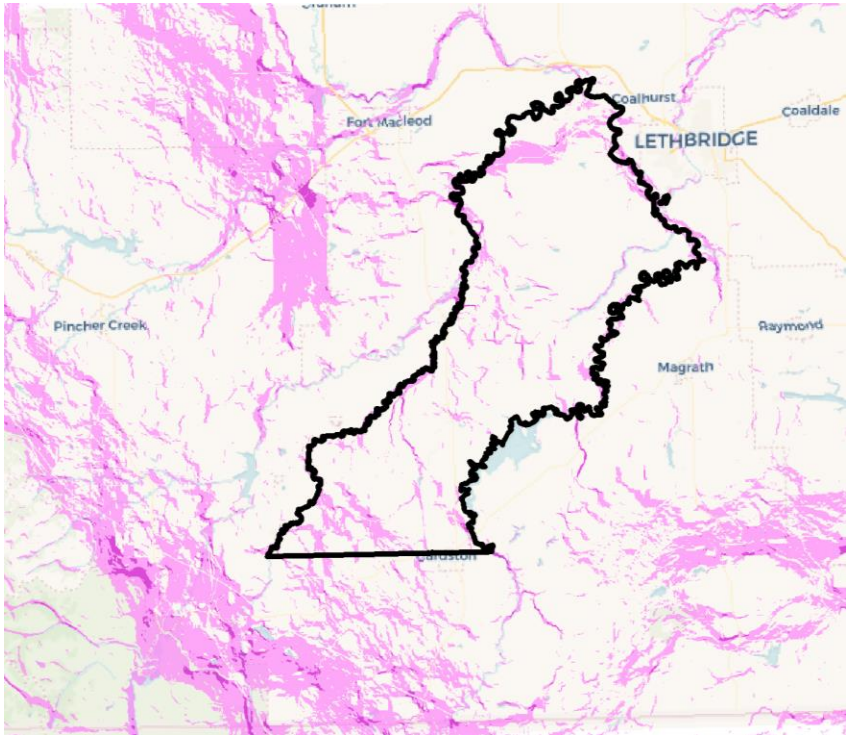


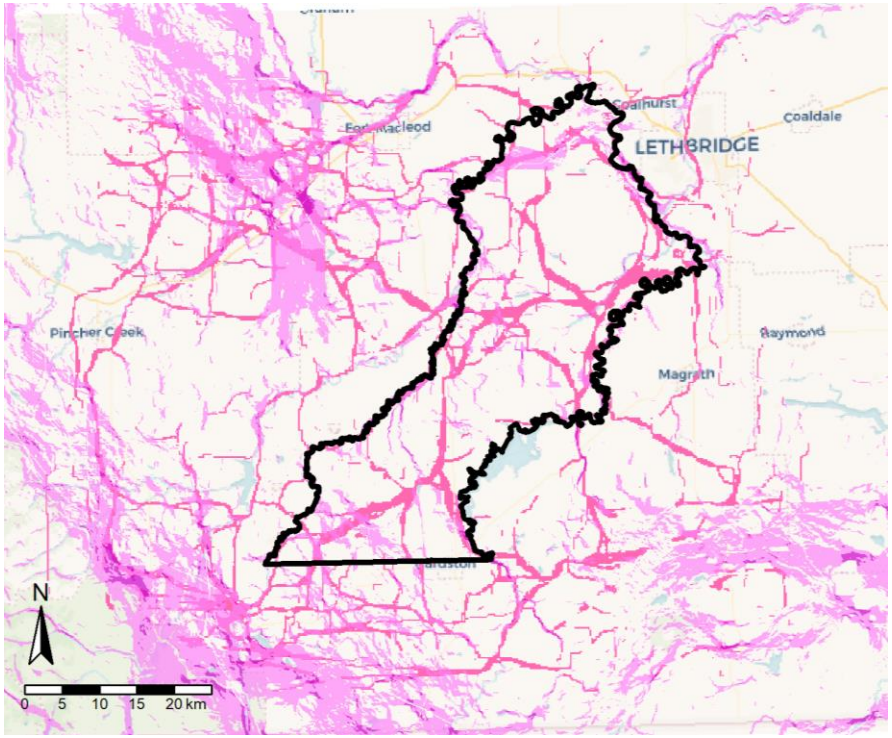
We can:

- Identify and prioritize conservation of pathways into and out of Kainai Reserve
- Potentially coordinate pathway conservation with the surrounding areas

Next Steps

Regional Ecological Flow Pathways

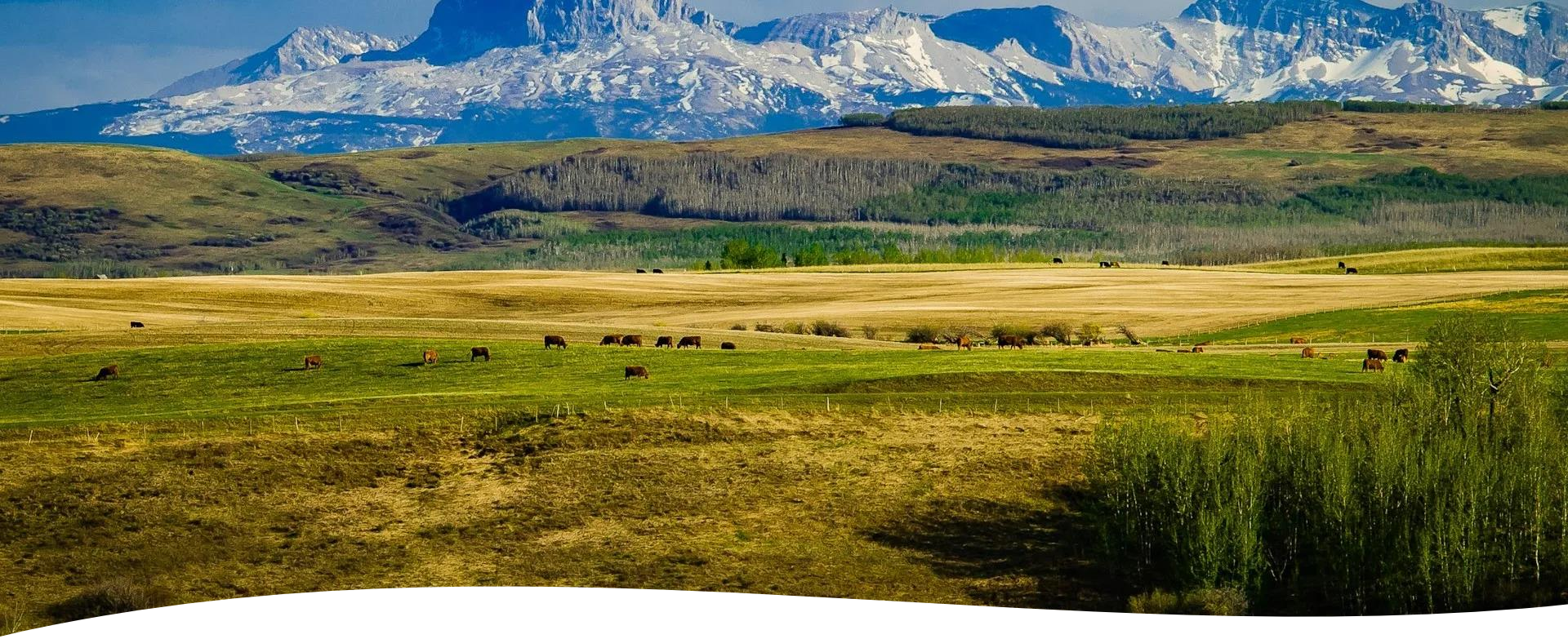




Reduce boundary effects and resolution

Conduct analysis for a range of dispersal distances

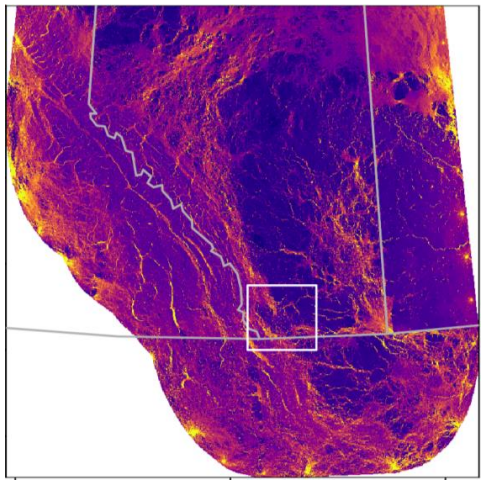

Thank you for listening



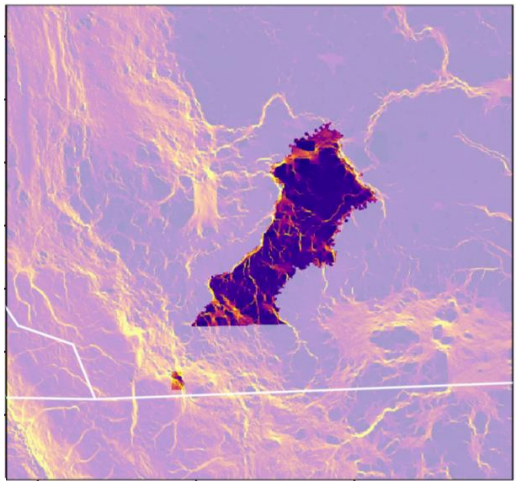
Questions?

Local Connectivity Planning in a Regional Context

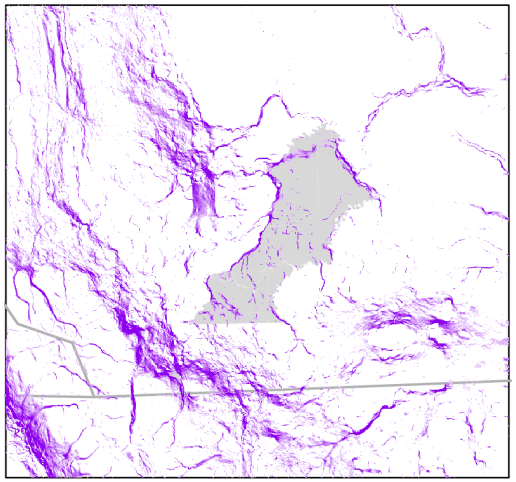
Study area in S Alberta



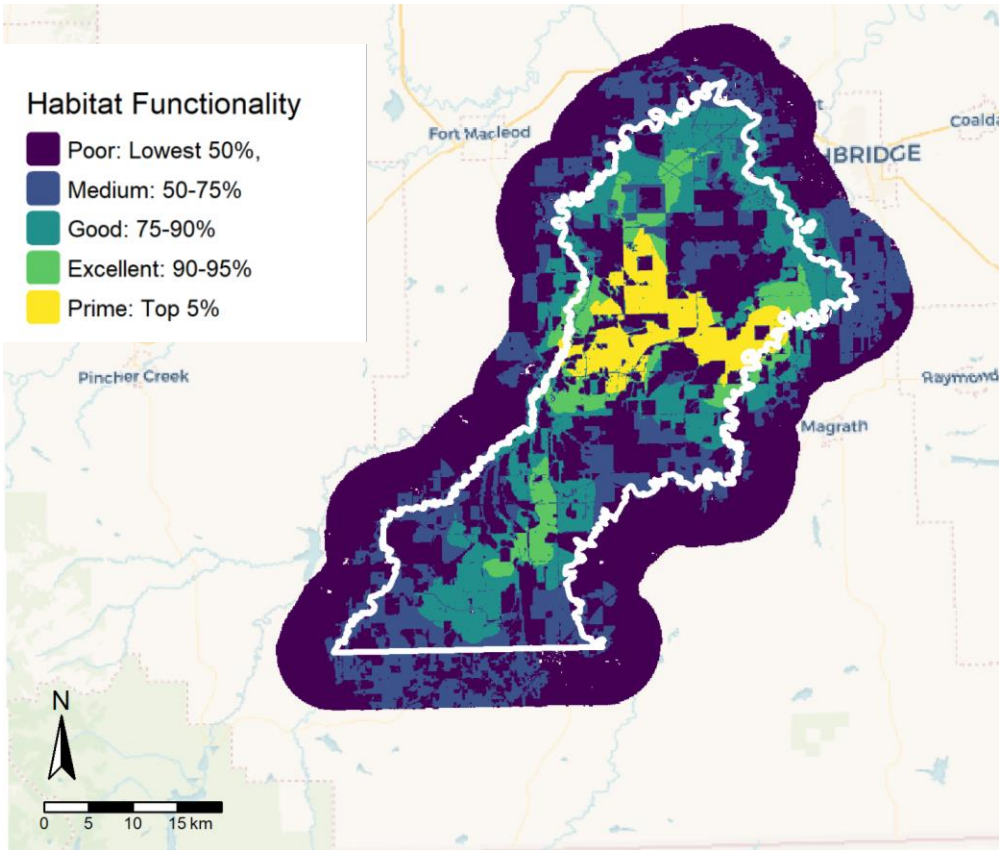
Kainai Reserves



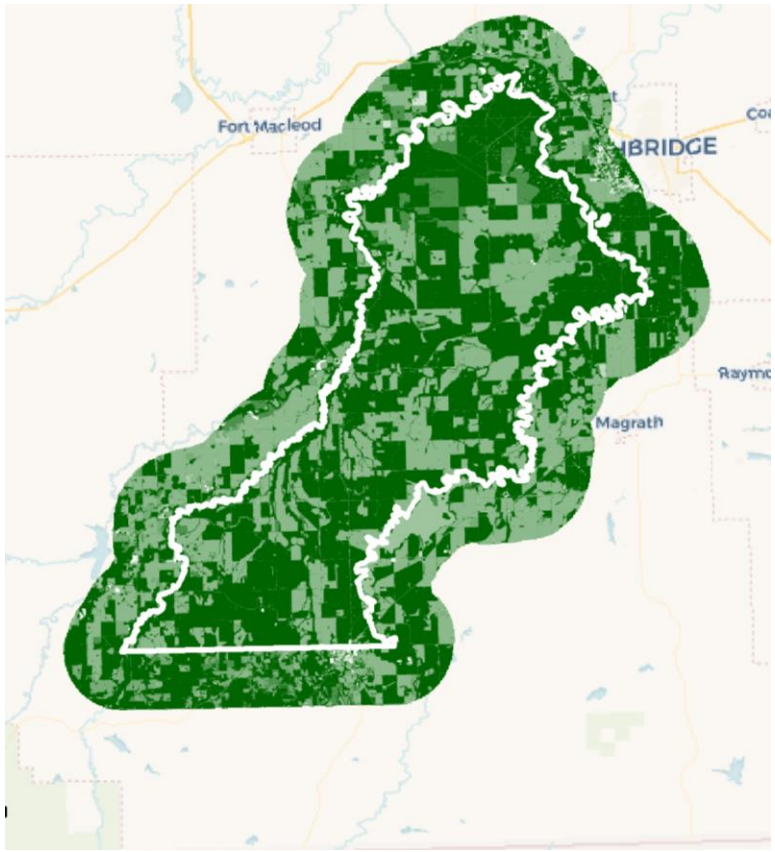
Ecological Flow Pathways



Functionally Connected Habitat: Thresholds



Habitat Quality (Naturalness)

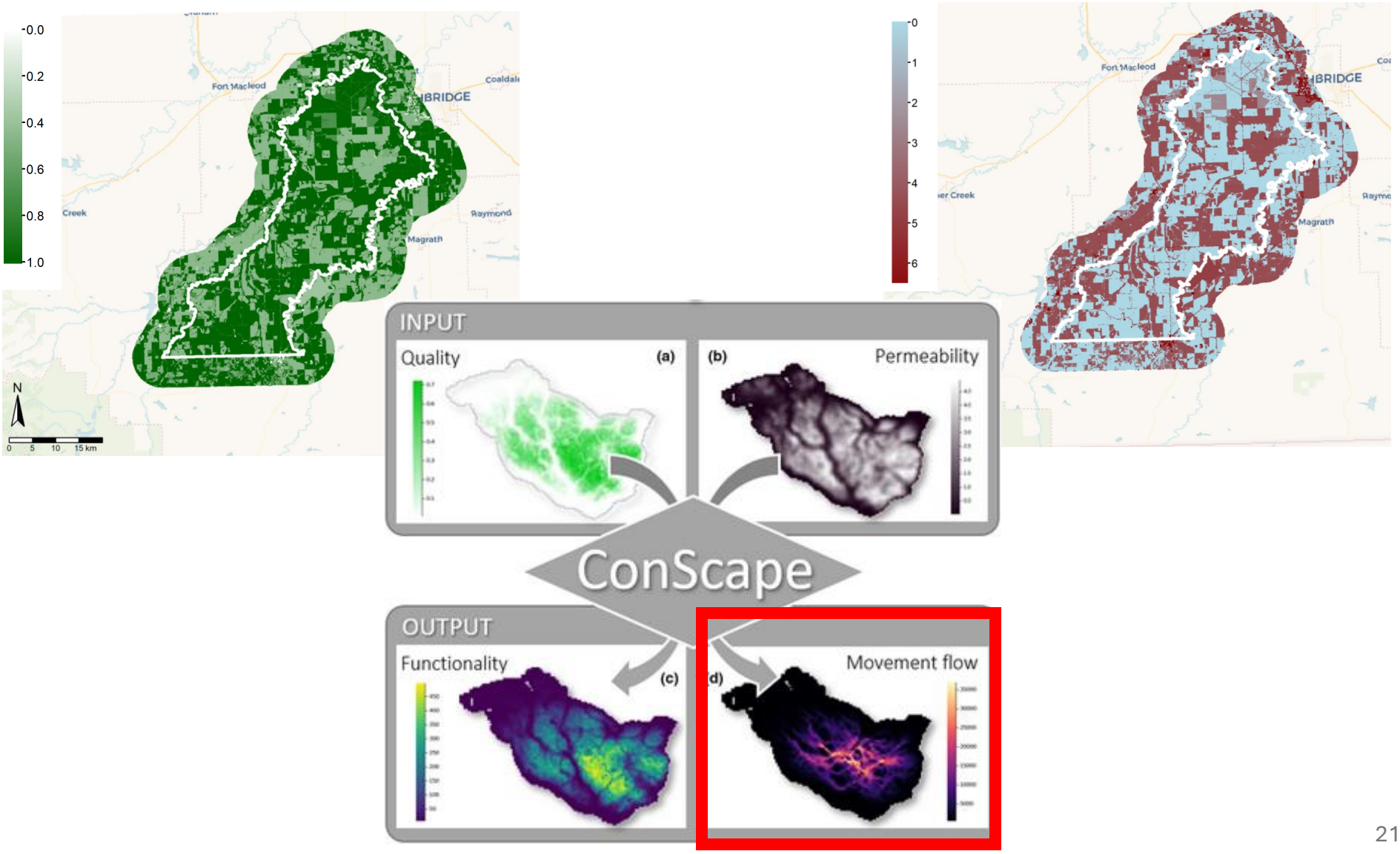


Theta = 0.5 (medium between LCP and RW)
Resolution = 100 m, Dispersal = 250 m

Habitat Proportion

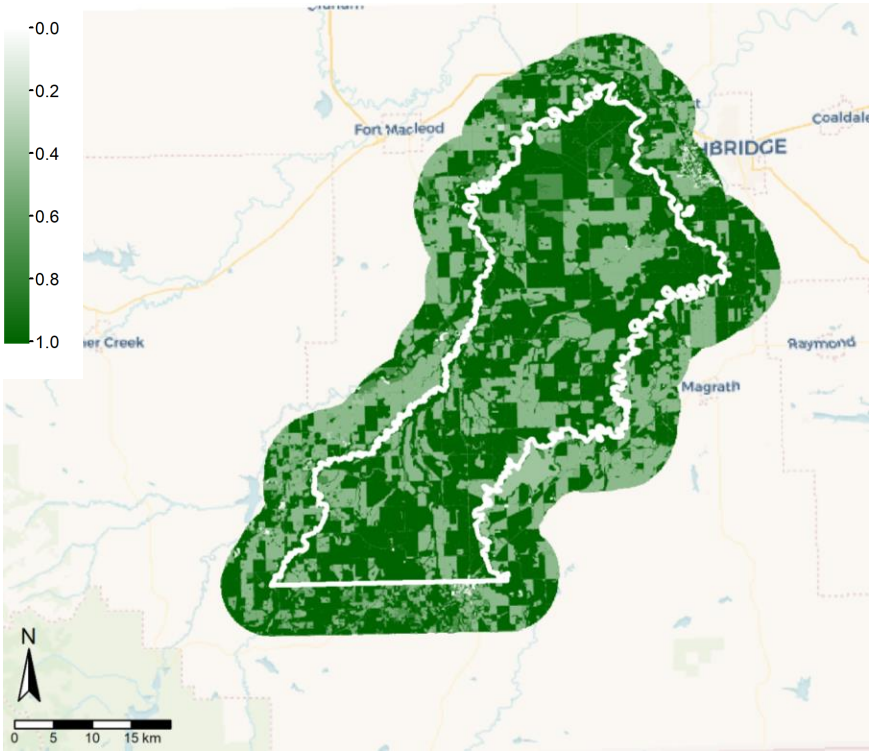
30.7% Connected, 69.3% Unconnected

Modelling Movement Flow



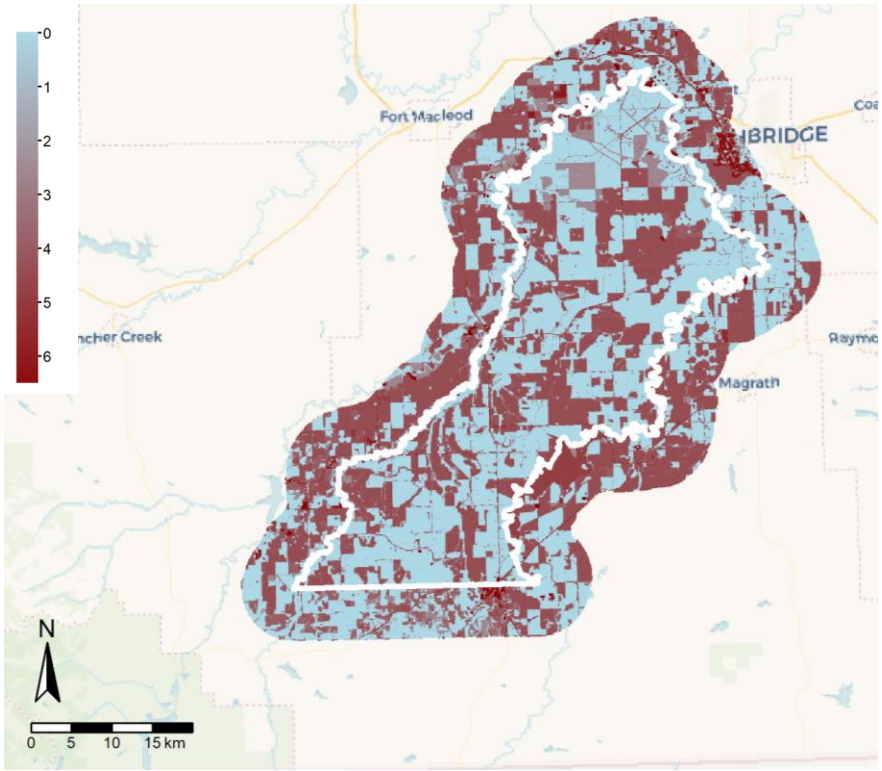
1: Where are important areas of habitat?

Habitat Quality (Naturalness)



Made by "reversing" the ABMI Human Footprint Inventory 2021

Resistance (log-scale)



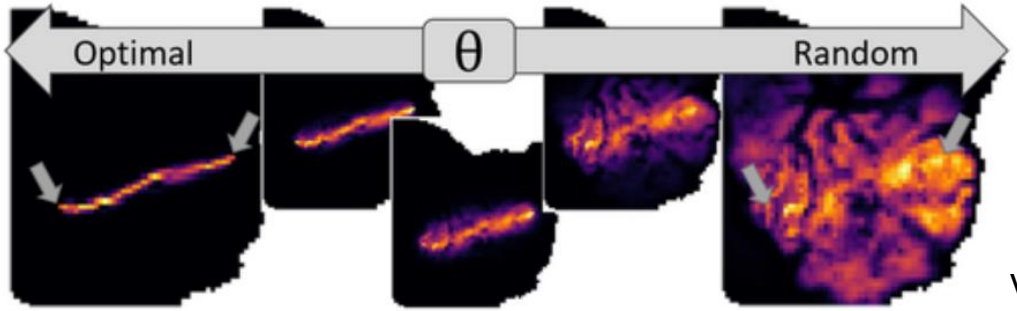
Made by applying resistance values from Marrec et al. (2020)

Advantages of ConScape: Movement Behavior

Between Two Points

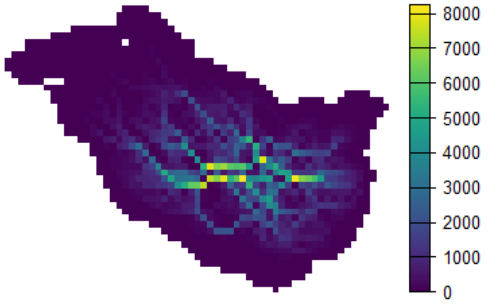
Optimal Least Cost Path

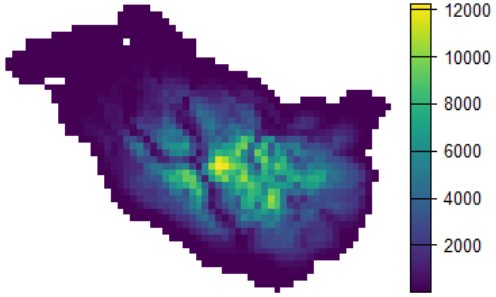
Random Walk

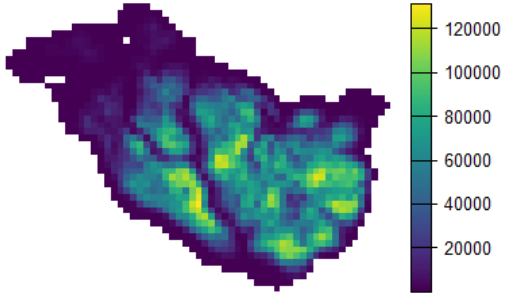


Van Moorter et al. (2023)

Entire Study Area

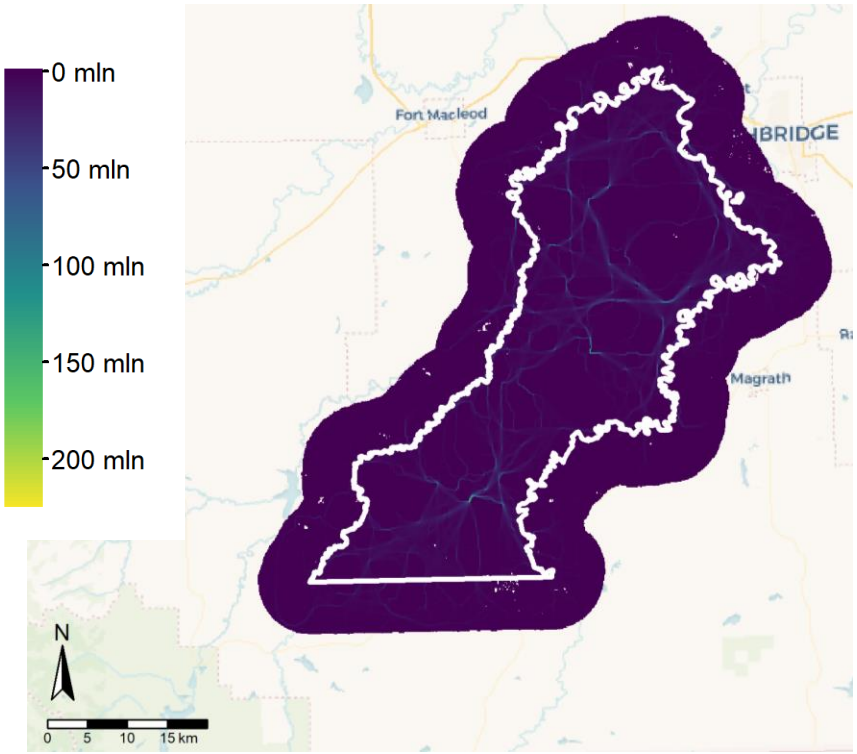




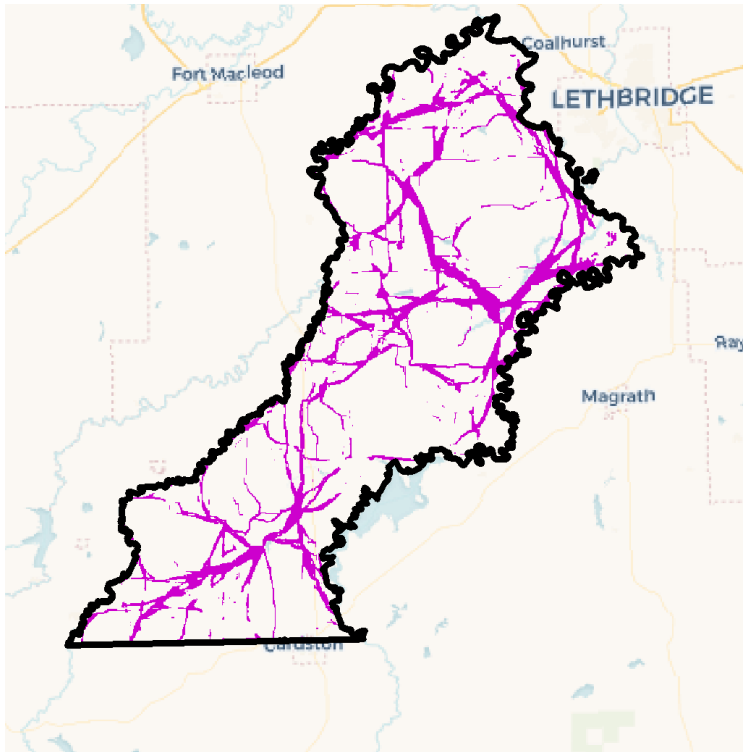


Movement Flow: Dispersal Pathways

Movement Flow Pathways



Top 10% of Movement Flow



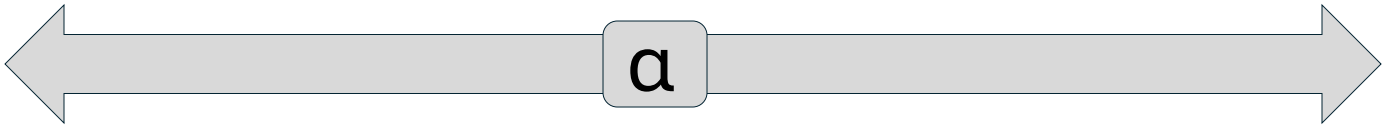
Theta = 0.5 (medium between LCP and CD), Dispersal = 250 m, Resolution = 100 m

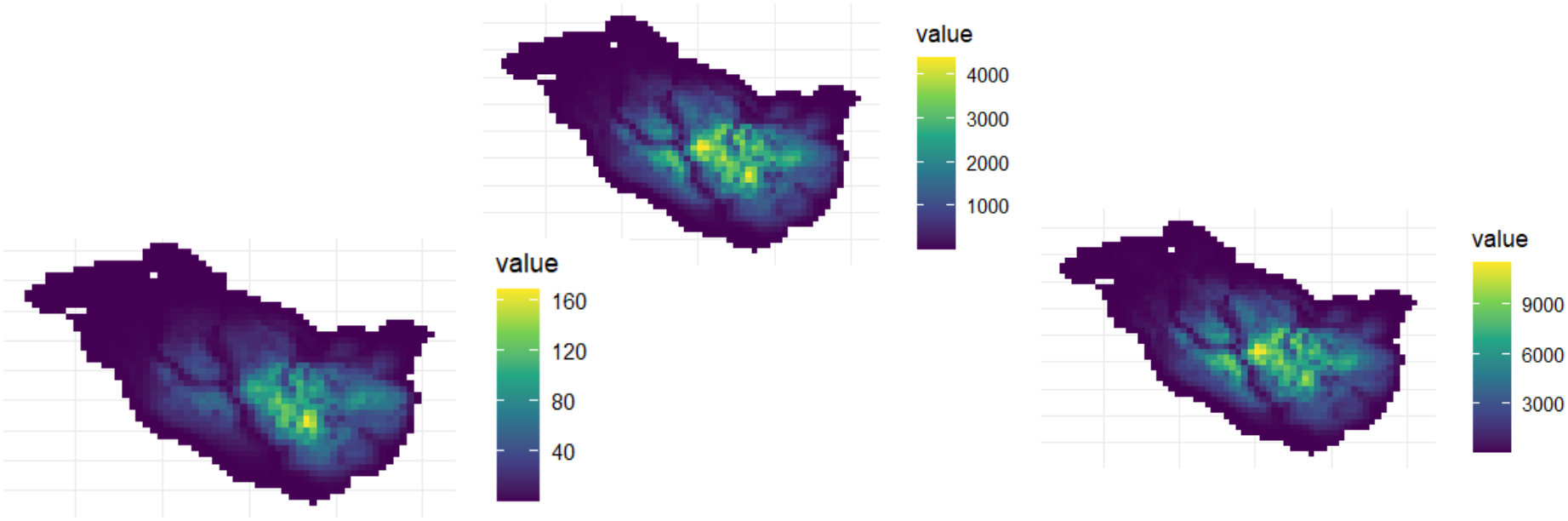
Main Objective #2: Where are important ecological corridors?

Advantages of ConScape: Dispersal Distance

Low Dispersal

High Dispersal





#OPENTOWORK

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

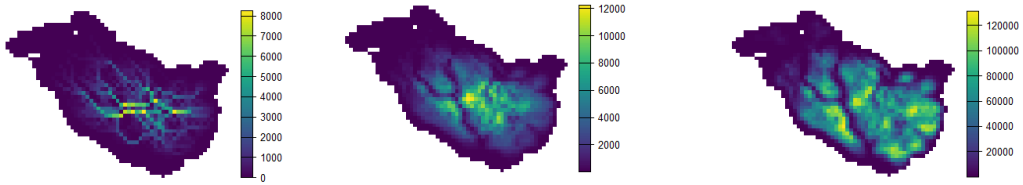
https://celiahein.github.io/

Integrates habitat quality, connectivity, and dispersal

Van Moorter et al. (2023)

Least cost path

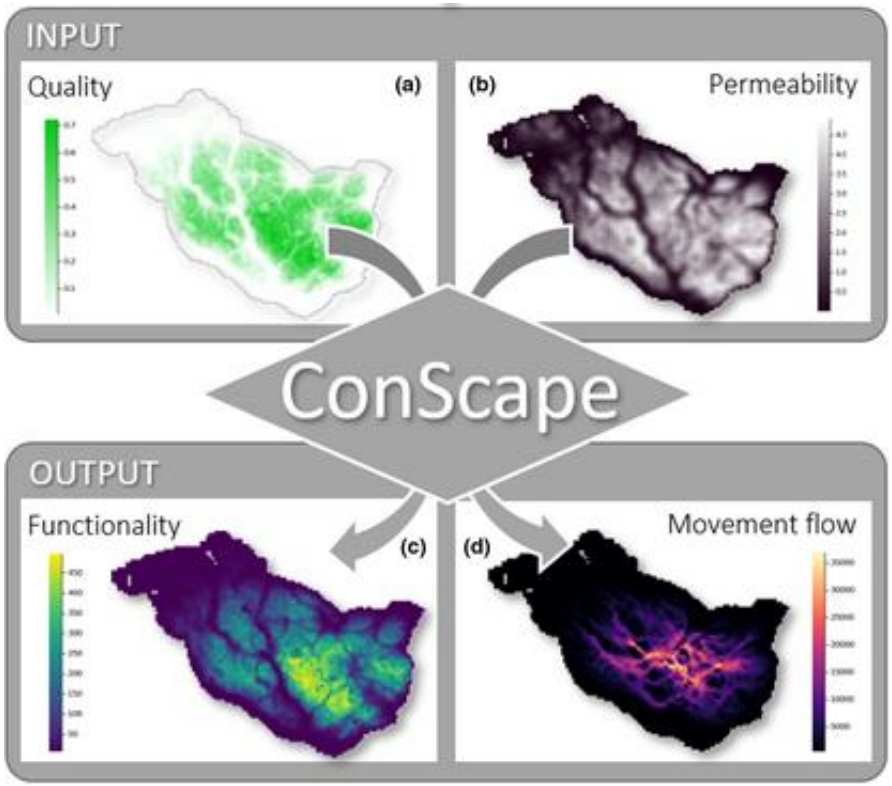
Random walk



Low dispersal

High dispersal

Flexible Input

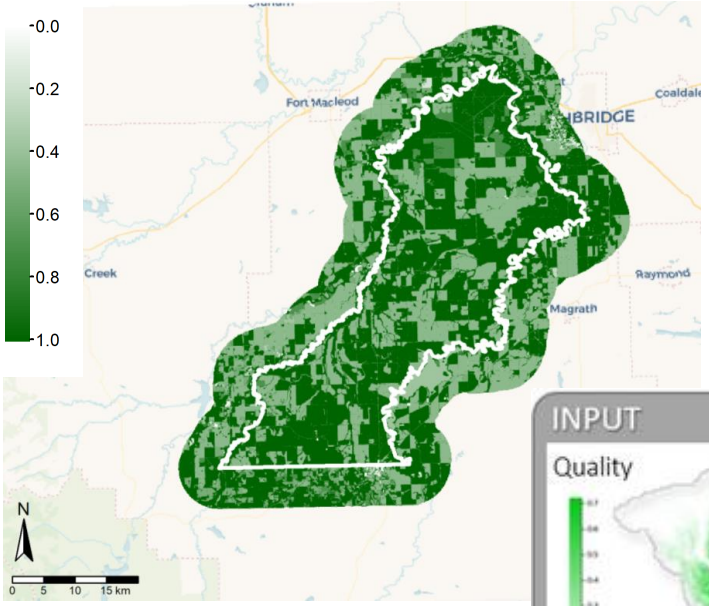


1. Where are important areas of habitat?

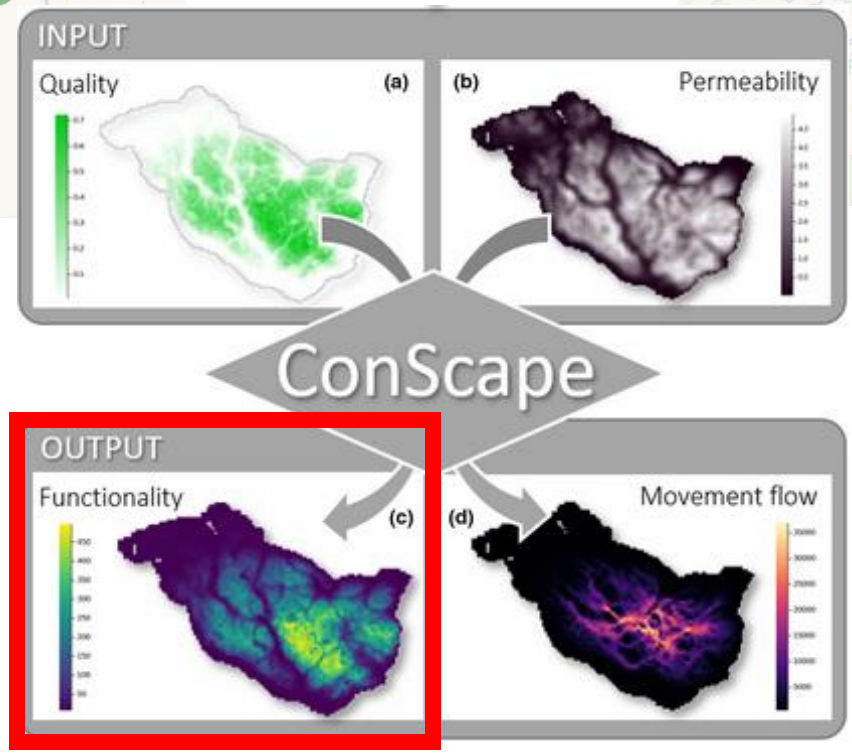
2. Where are ecologically important corridors?

Creating Input Maps

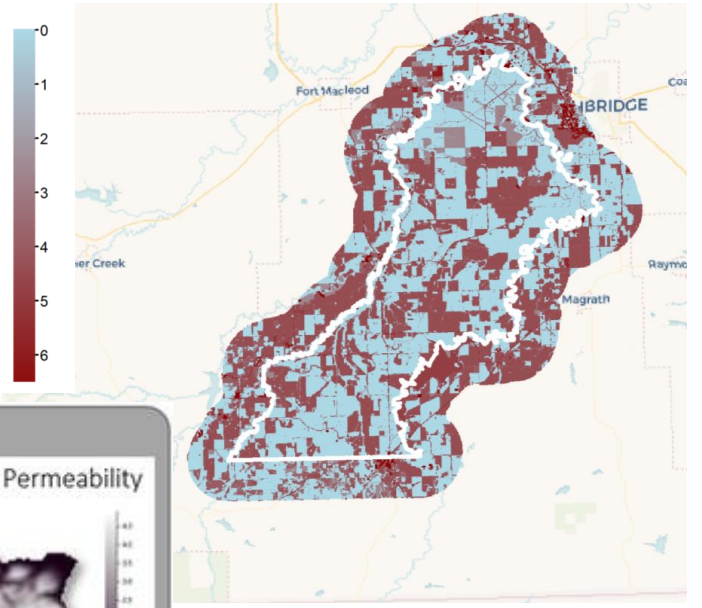
Habitat Quality (Naturalness)



Made by "reversing" the ABMI Human Footprint Inventory 2021



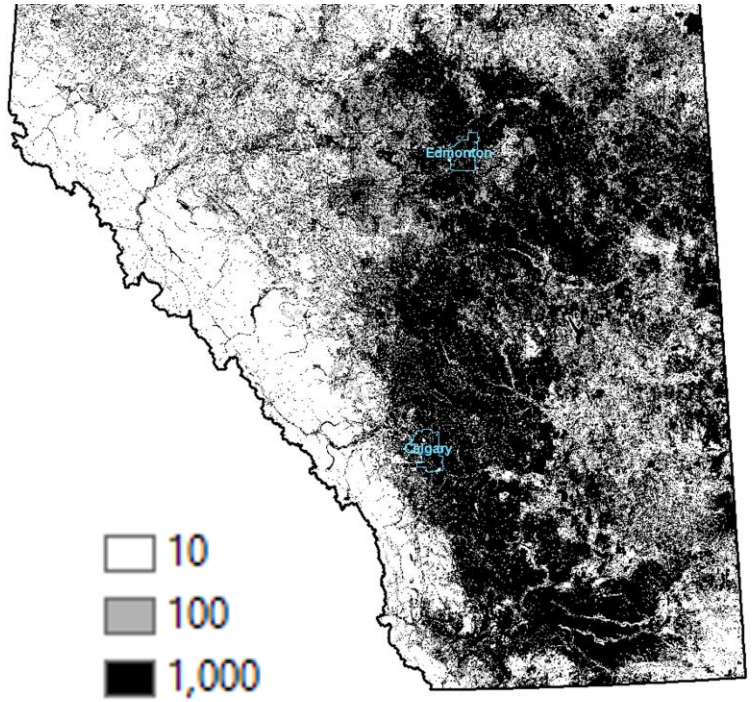
Resistance (log-scale)



Made by applying resistance values from Marrec et al. (2020)

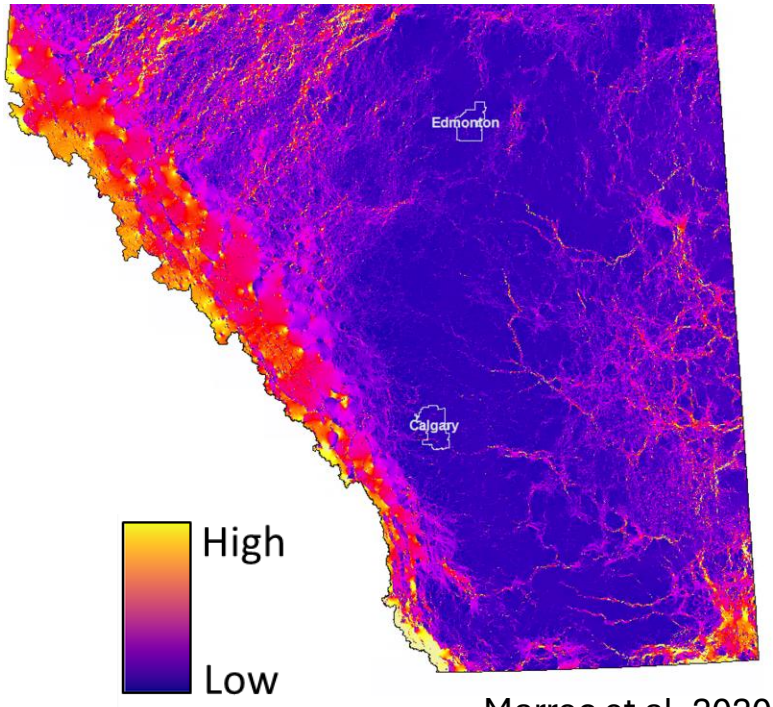
Research Context

Resistance



Bowman & Cordes 2015

Ecological Flow (Current Density)

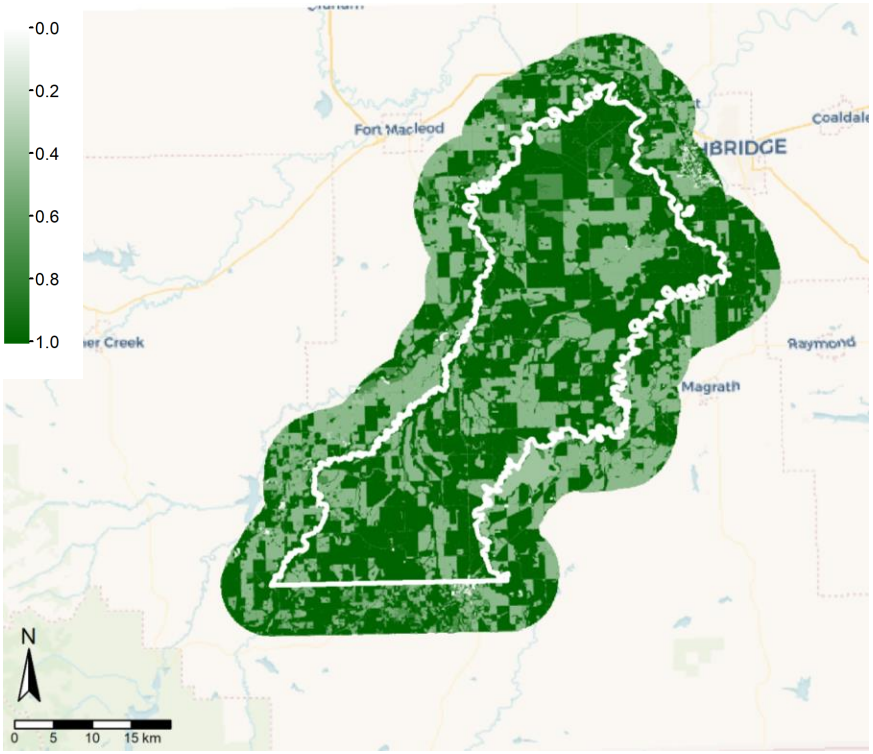


Marrec et al. 2020

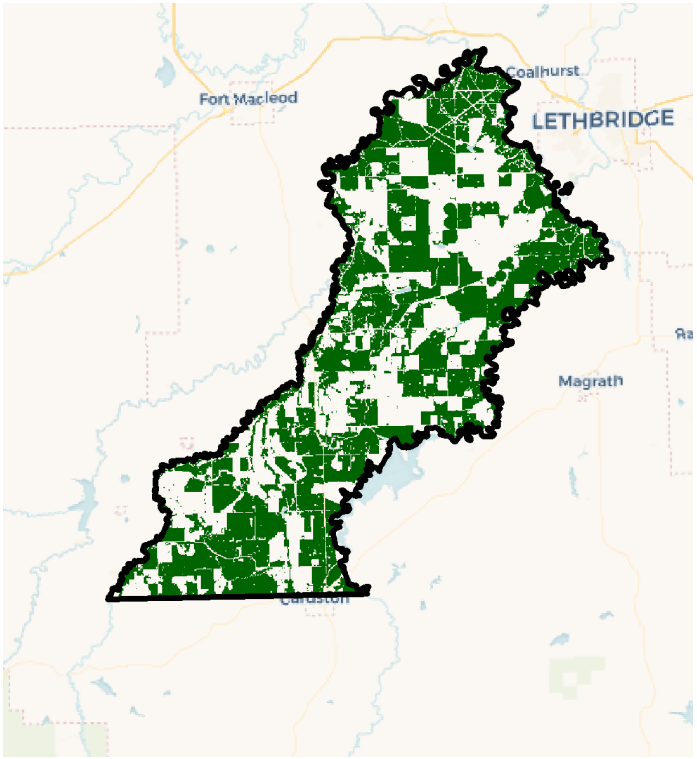
- Provincial scale
- Assumes random movement and infinite dispersal
- Identifies main ecological pathways **between** sub-regions
- Maybe less relevant for smaller-scale management **within** sub-regions

1: Where are important areas of habitat?

Habitat Quality (Naturalness)



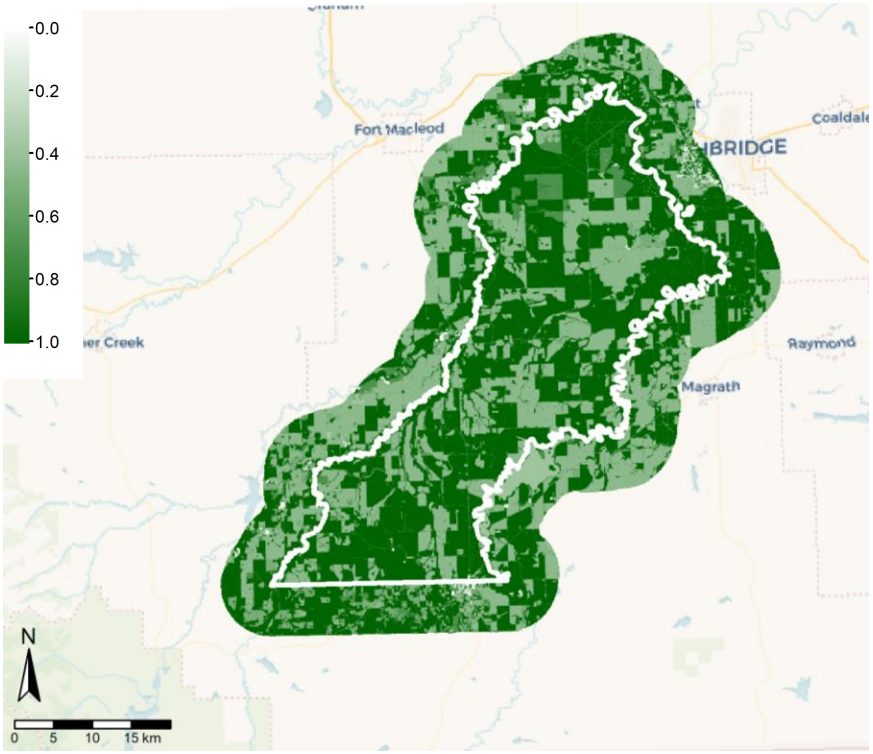
Habitat Quality (Natural only)



Made by “reversing” the ABMI Human Footprint Inventory 2021

1: Where are important areas of habitat?

Habitat Quality (Naturalness)



Made by “reversing” the ABMI Human Footprint Inventory 2021

ConScape

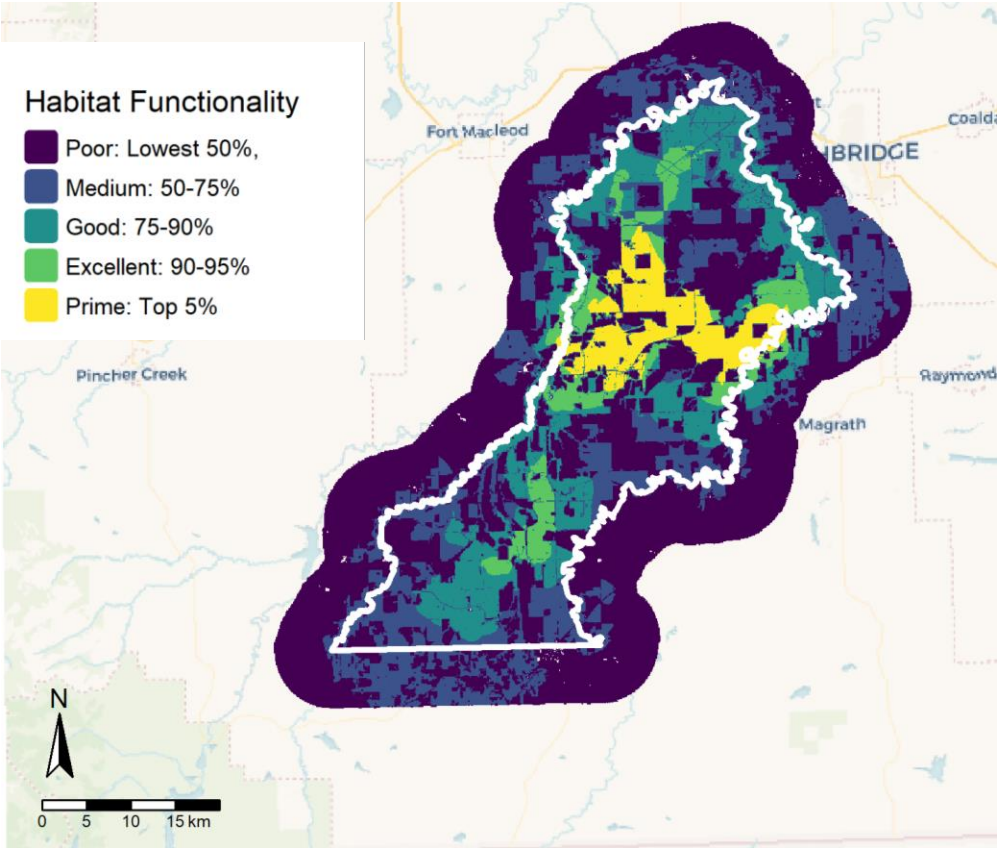
Van Moorter et al. (2023)

Blends “Conefor” and “CircuitScape” style approaches

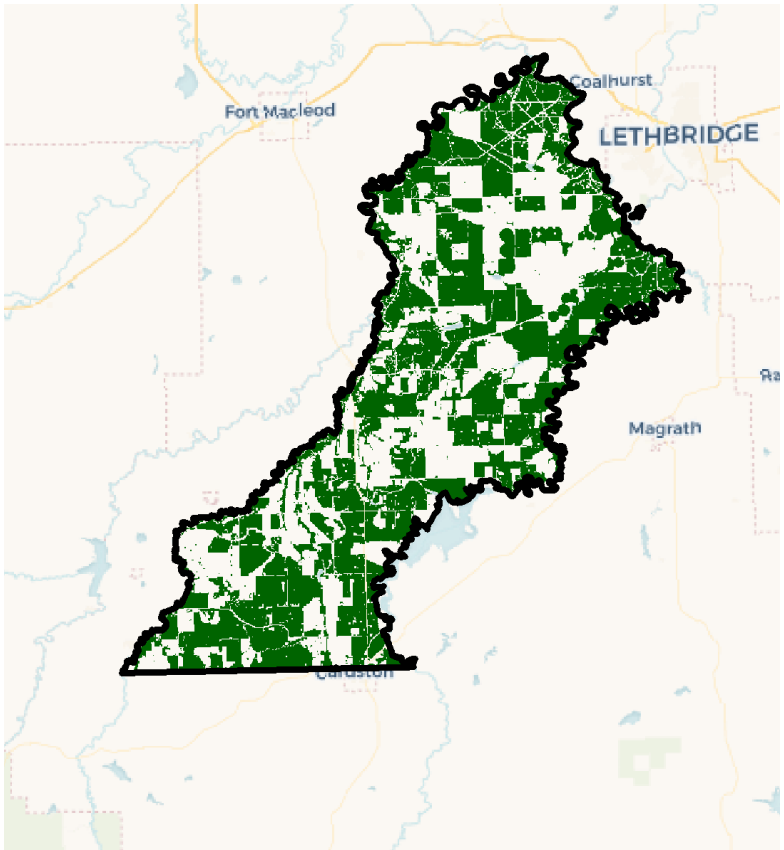
Path distribution is in between least-cost-path and random walk

Computes paths between all pairs of pixels, while considering dispersal

Functionally Connected Habitat: Thresholds



Habitat Quality (Natural only)



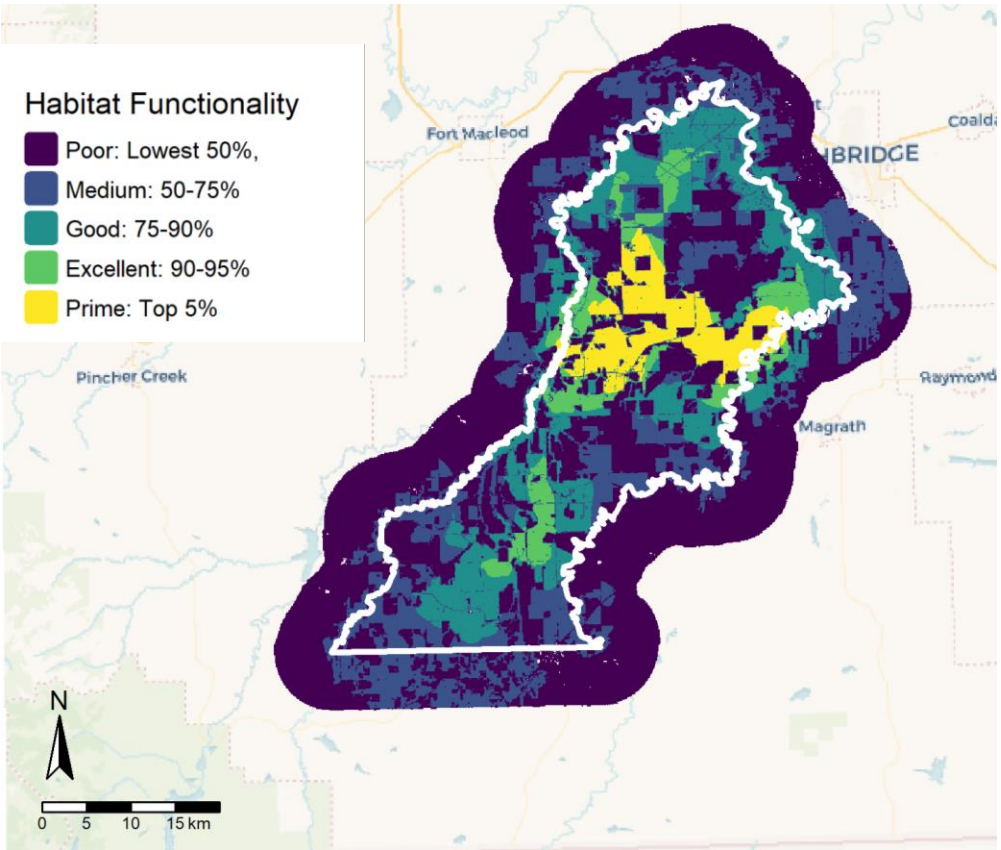
Resolution = 100 m, Dispersal = 250 m

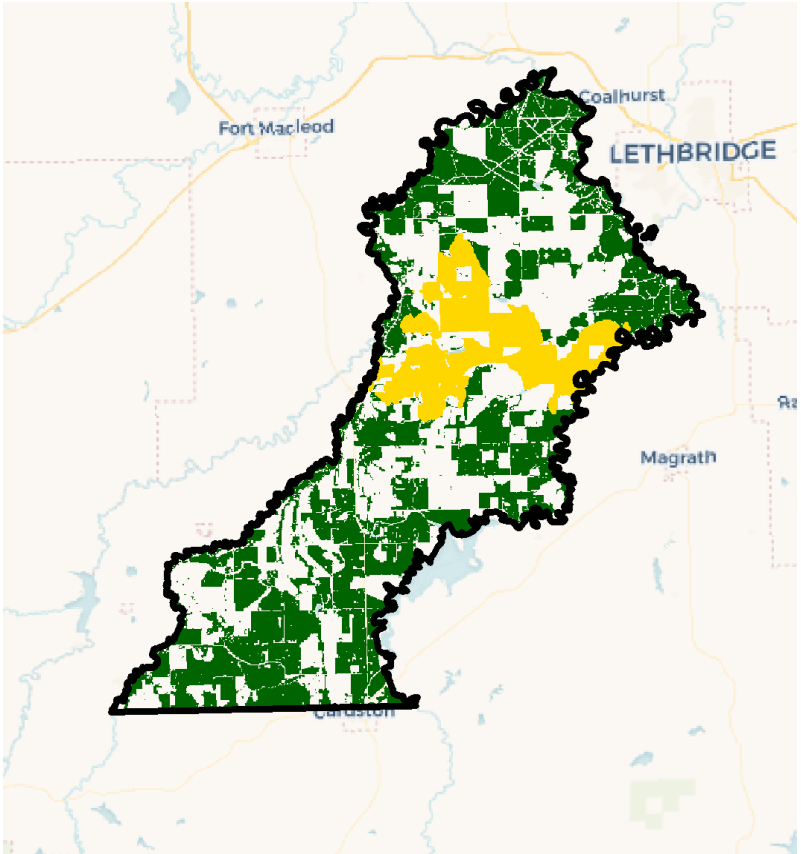
Habitat Proportion

31% Connected, 69% Unconnected

Functionally Connected Habitat: Thresholds

Natural & Prime Functional Habitat



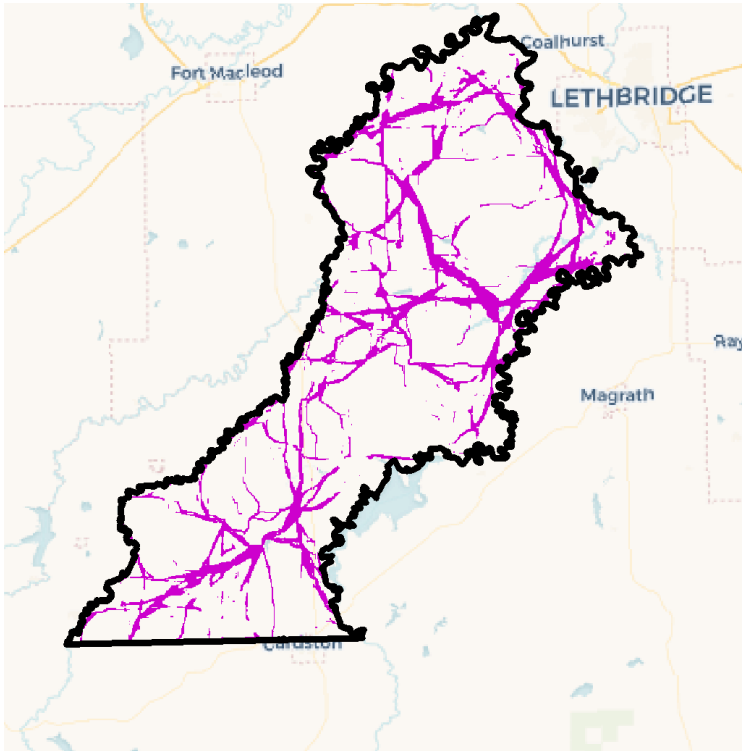


Main Objective #1: Where are important areas of habitat?

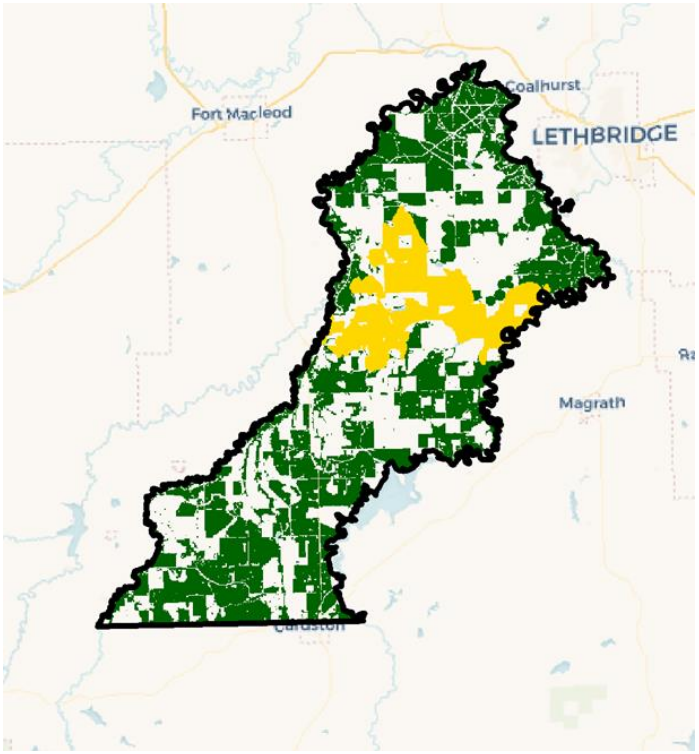
#2: Where are important ecological corridors?

2: Where are important ecological pathways?

Top 10% of Movement Flow

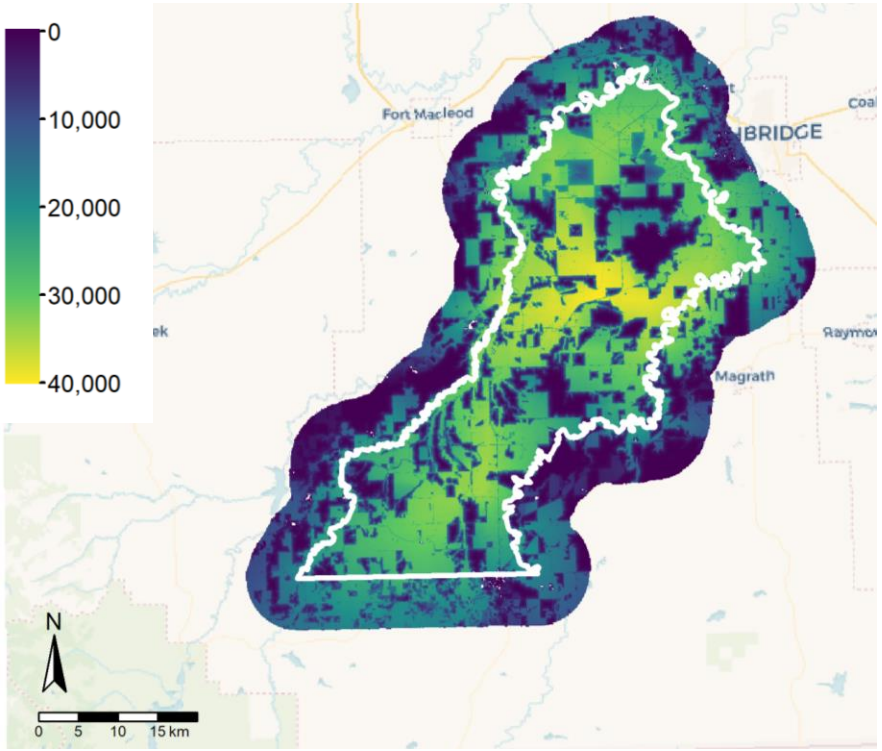


Natural & Prime Functional Habitat

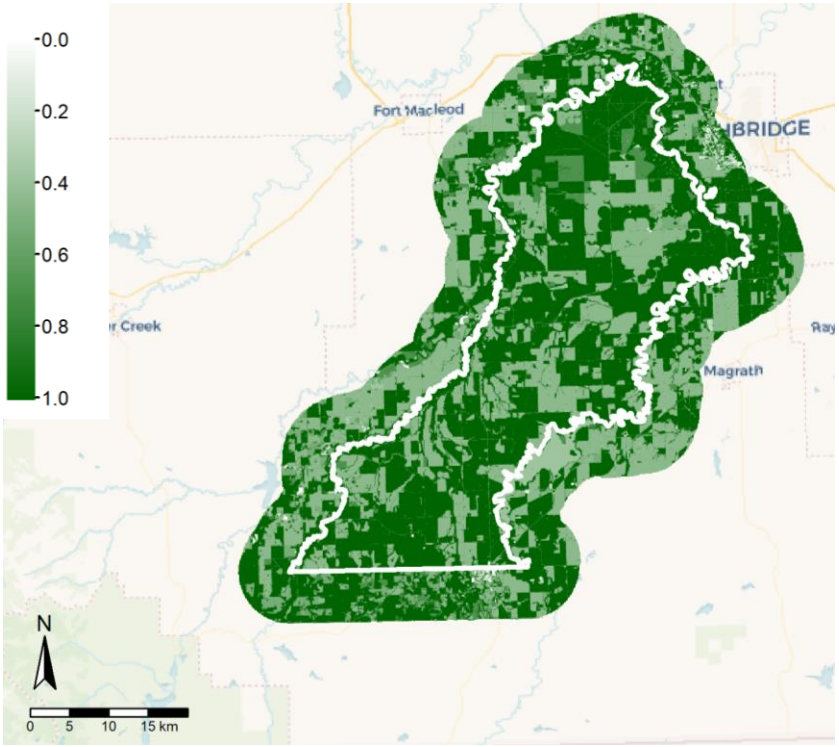


Habitat Functionality

Habitat Functionality



Habitat Quality (Naturalness)



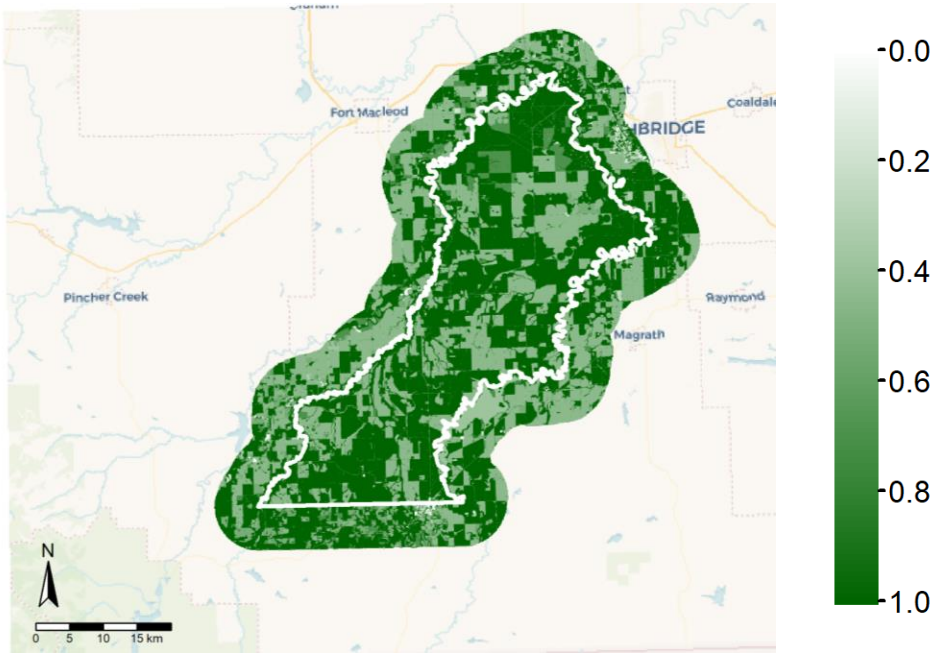
Theta = 0.5 (medium between LCP and CD)
Resolution = 100 m, Dispersal = 250 m

Habitat Proportion

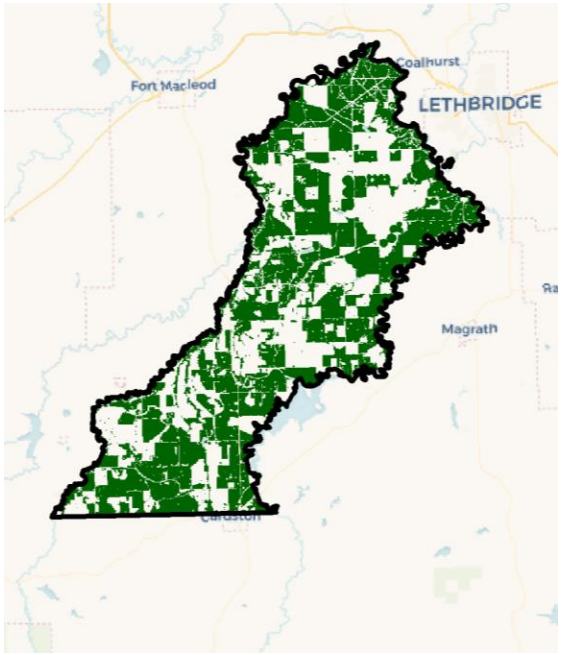
30.7% Connected, 69.3% Unconnected

Kainai Reserve

Habitat Quality (Naturalness)



Natural Habitat: Quality = 1

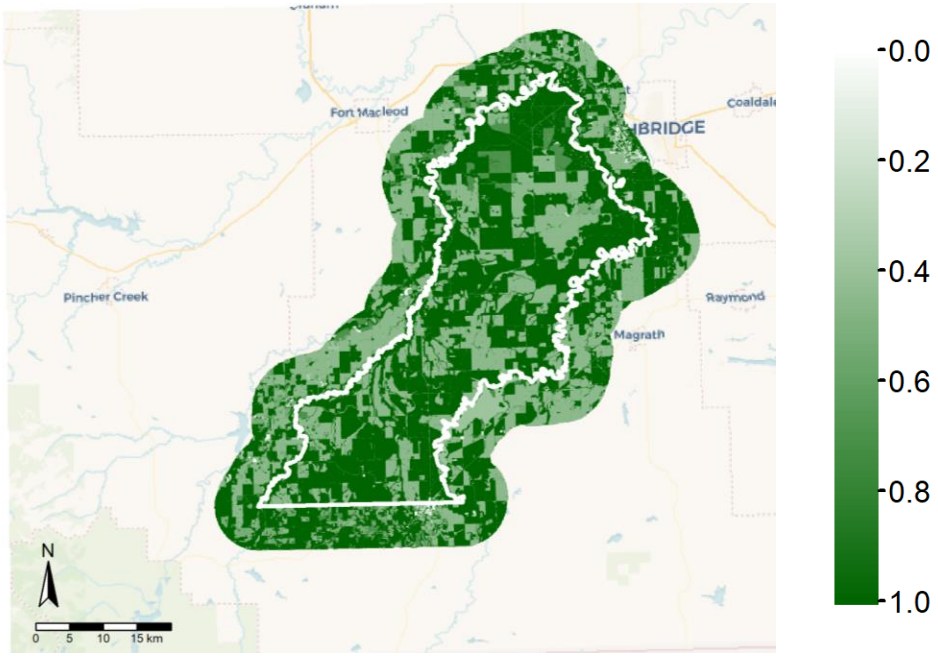


ABMI Human Footprint Inventory 2021

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

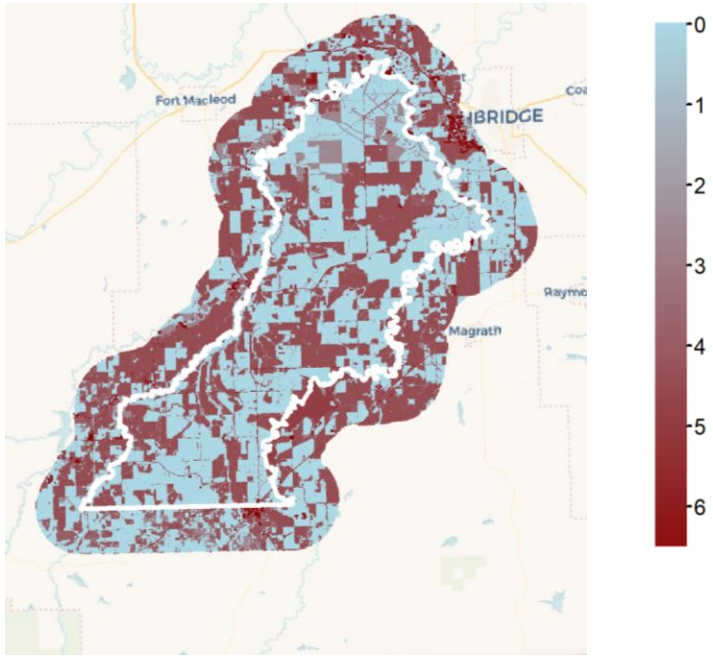
Kainai Reserve

Habitat Quality (Naturalness)



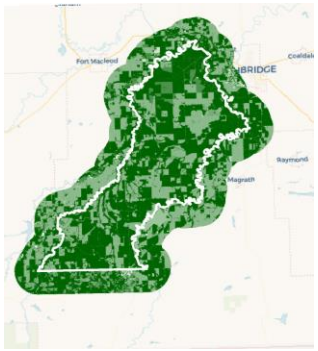
ABMI Human Footprint Inventory 2021

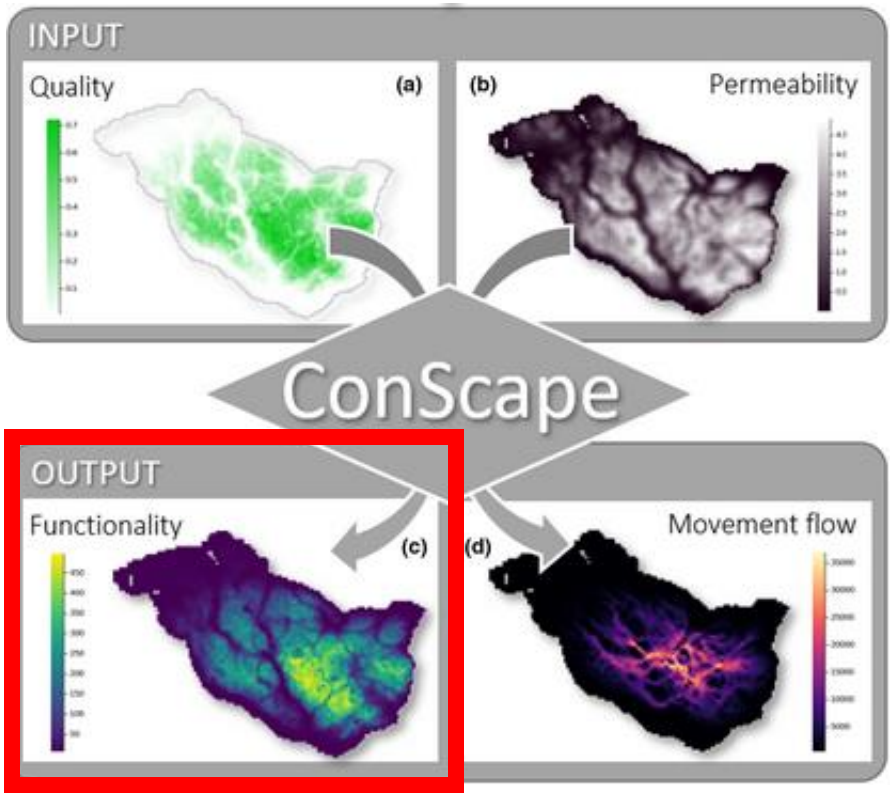
Resistance (log-scale)

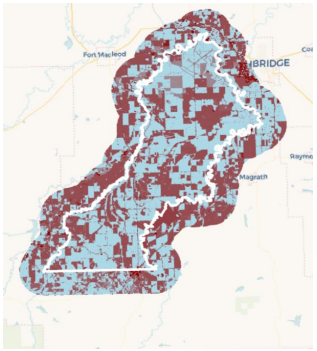


Marrec et al. (2020) Resistance Values

Habitat Functionality







SSPF using habitat quality and resistance

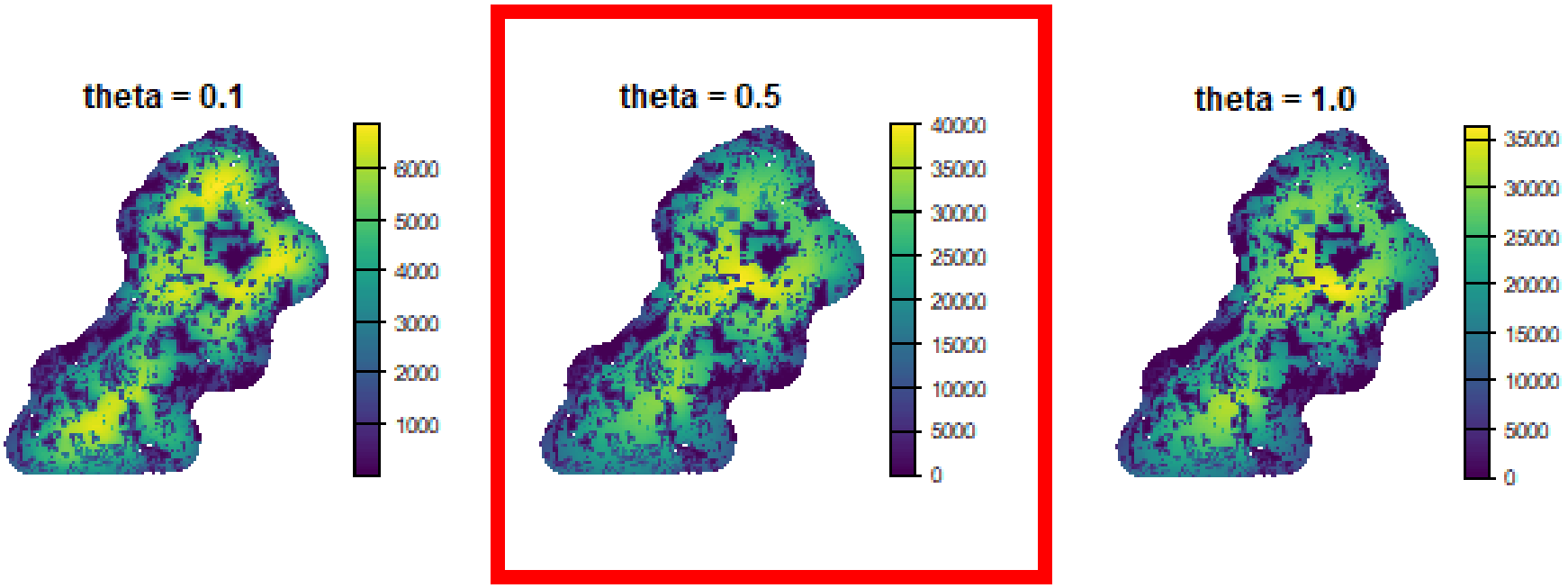
Eco distance matrix created using probability of RSP and the cost

Ecological distance scaled using geographic distance

Habitat Functionality

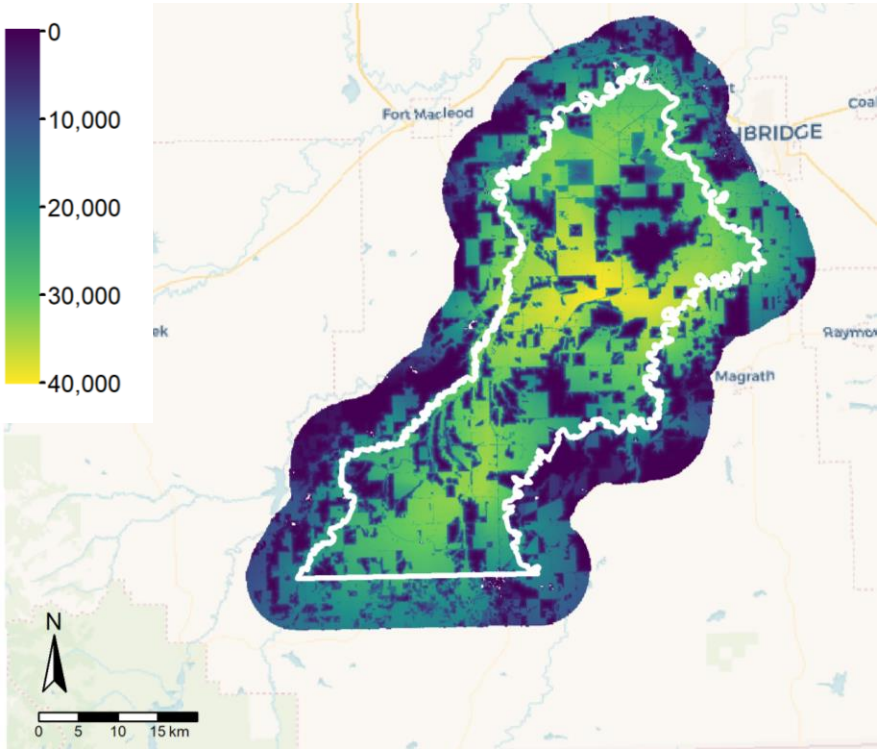
Functional Habitat :

- 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

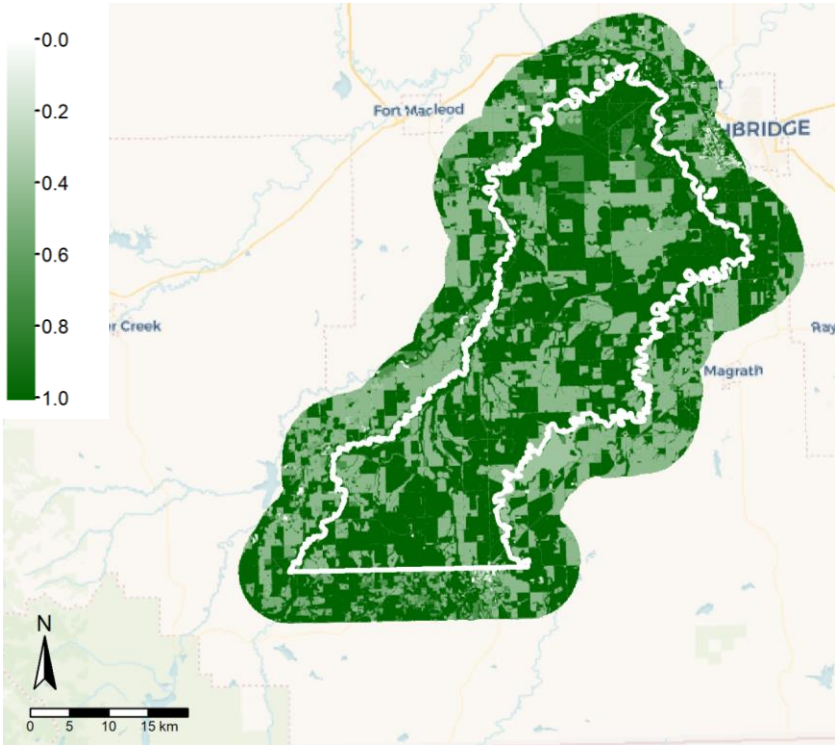


Habitat Functionality

Habitat Functionality



Habitat Quality (Naturalness)



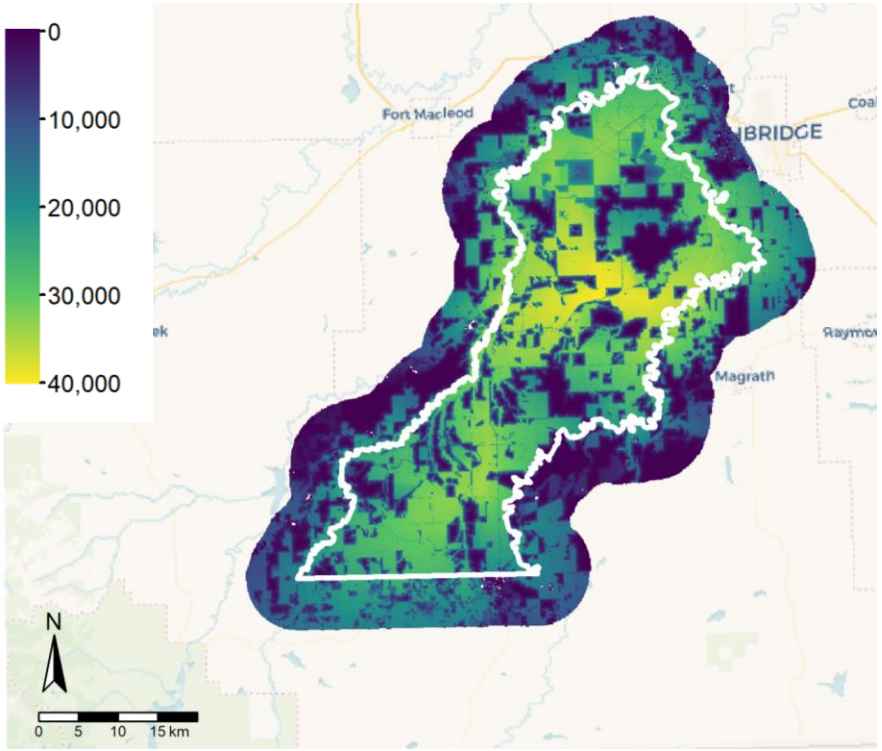
Theta = 0.5 (medium between LCP and CD)
Resolution = 100 m, Dispersal = 250 m

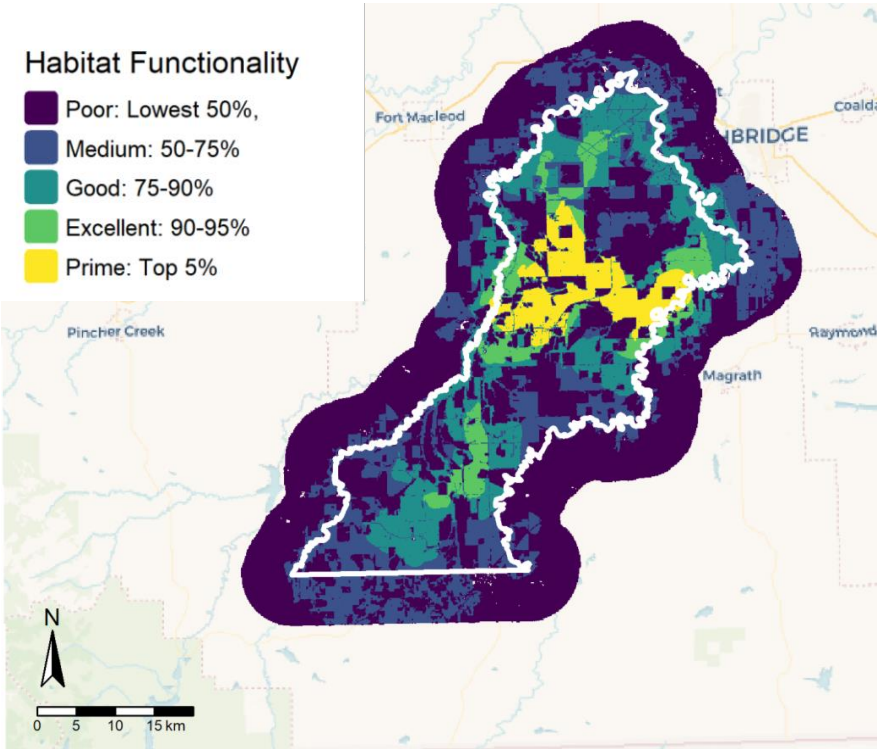
Habitat Proportion

30.7% Connected, 69.3% Unconnected

Functionally Connected Habitat: Thresholds

Habitat Functionality



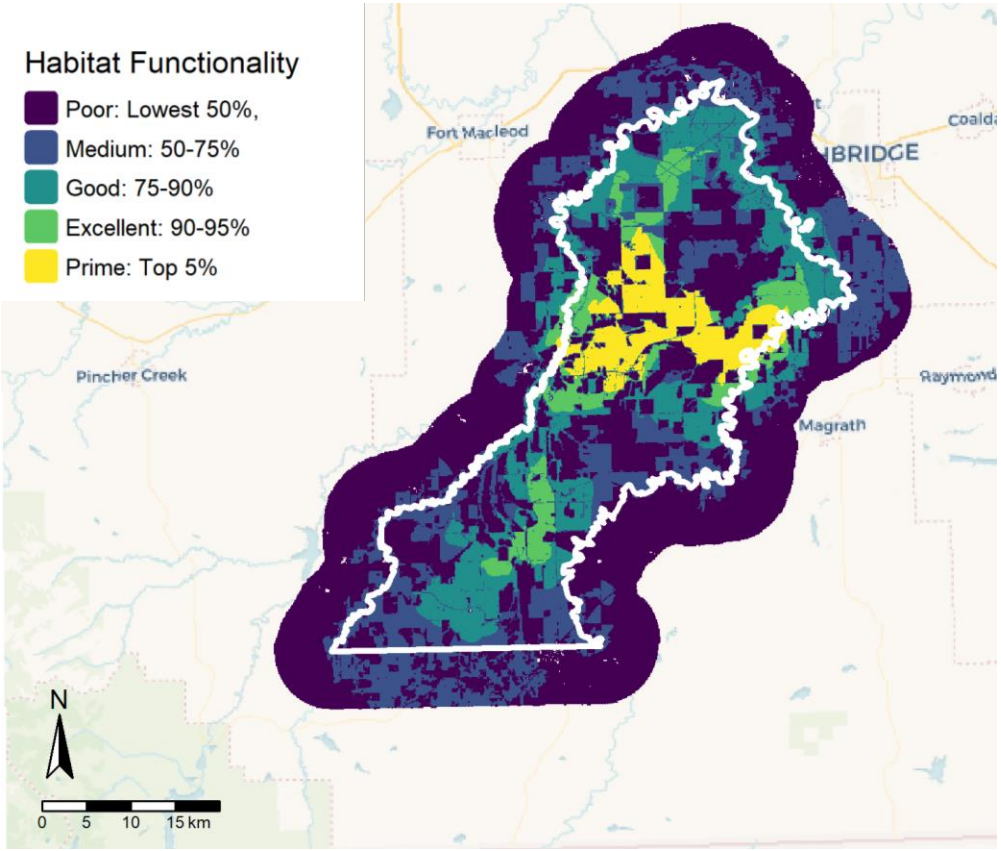


Theta = 0.5 (medium between LCP and CD)
Dispersal = 250 m, Resolution = 100 m

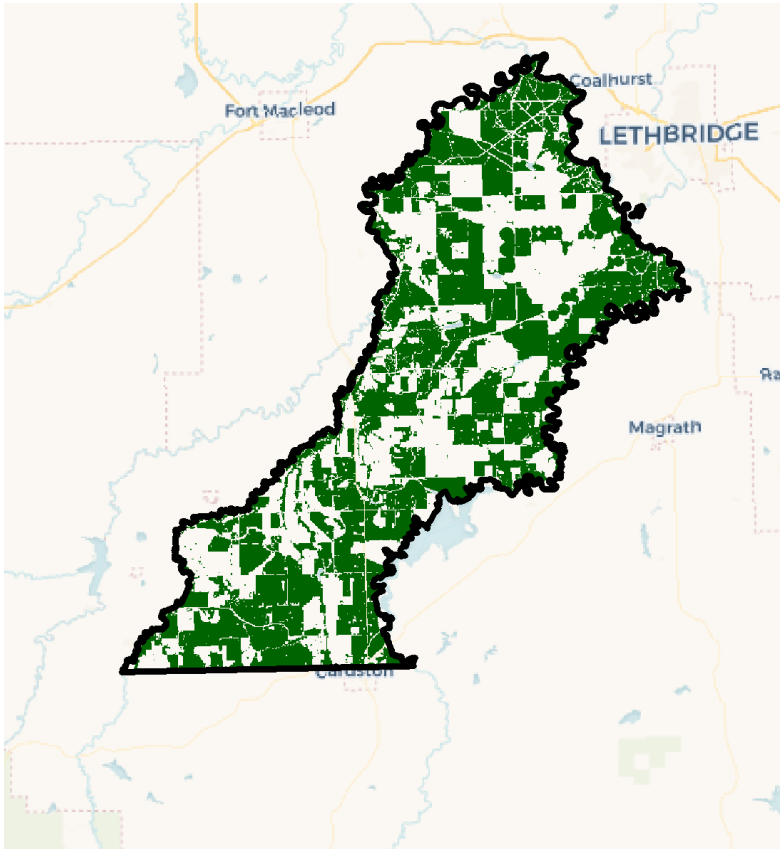
Habitat Proportion

30.7% Connected, 69.3% Unconnected

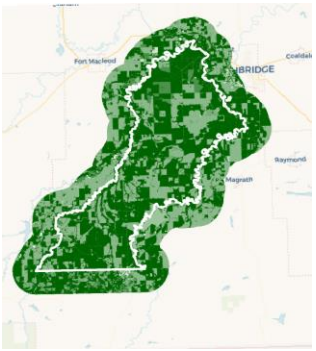
Habitat Functionality: Thresholds

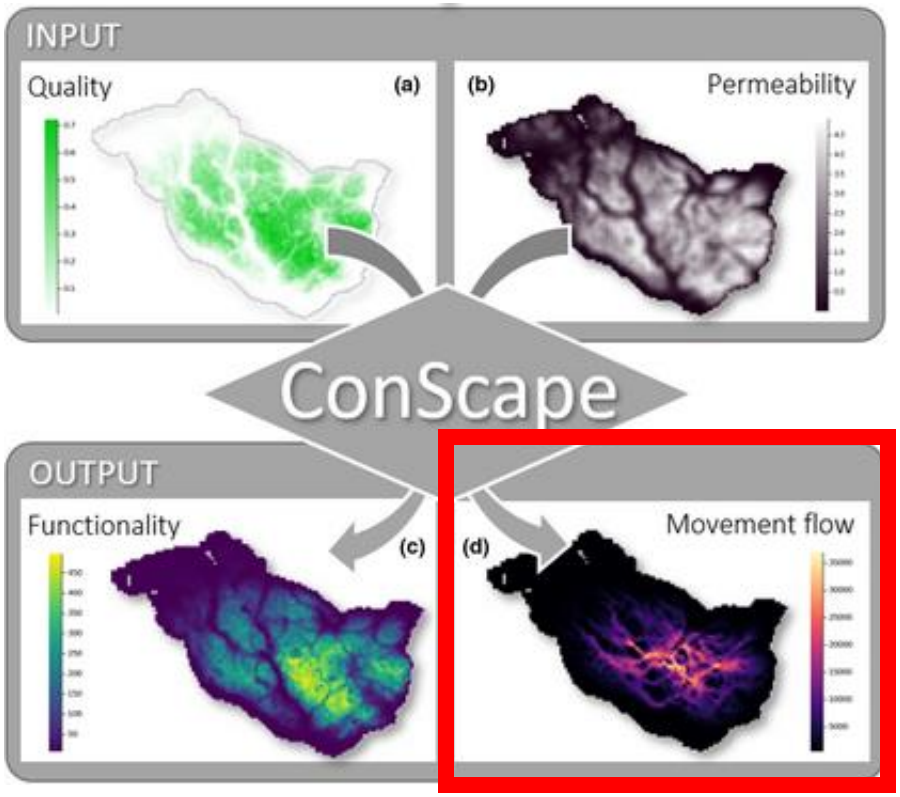


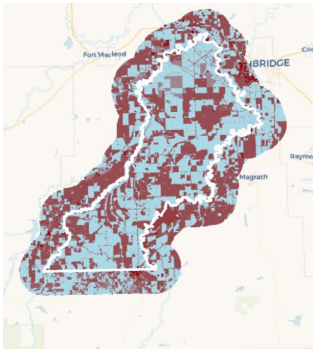
Natural Habitat: Quality = 1



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