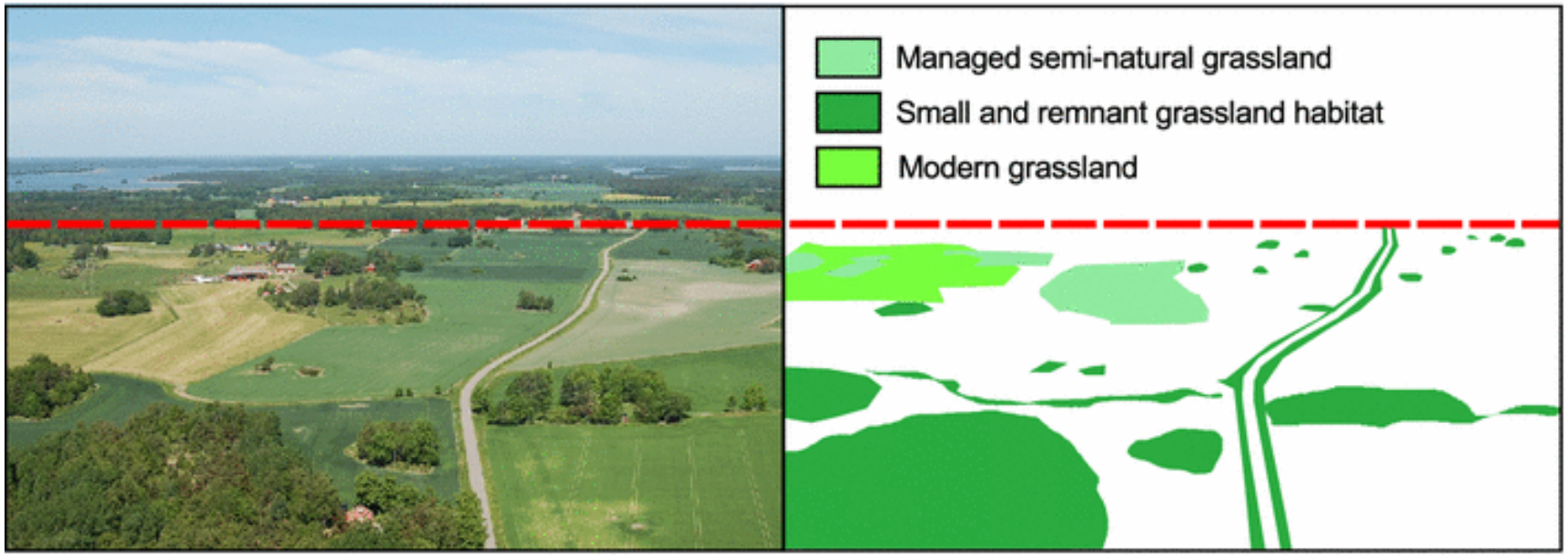
From individual movement to landscape and population connectivity

Bernardo Brandão Niebuhr
bernardo.brandao@nina.no

Animal Movement PhD-course, SLU
Ekenäs Herrgård
4-8 September, 2023

Landscape connectivity

- Structural connectivity
- Functional connectivity



Auffret et al. 2015

Landscape connectivity

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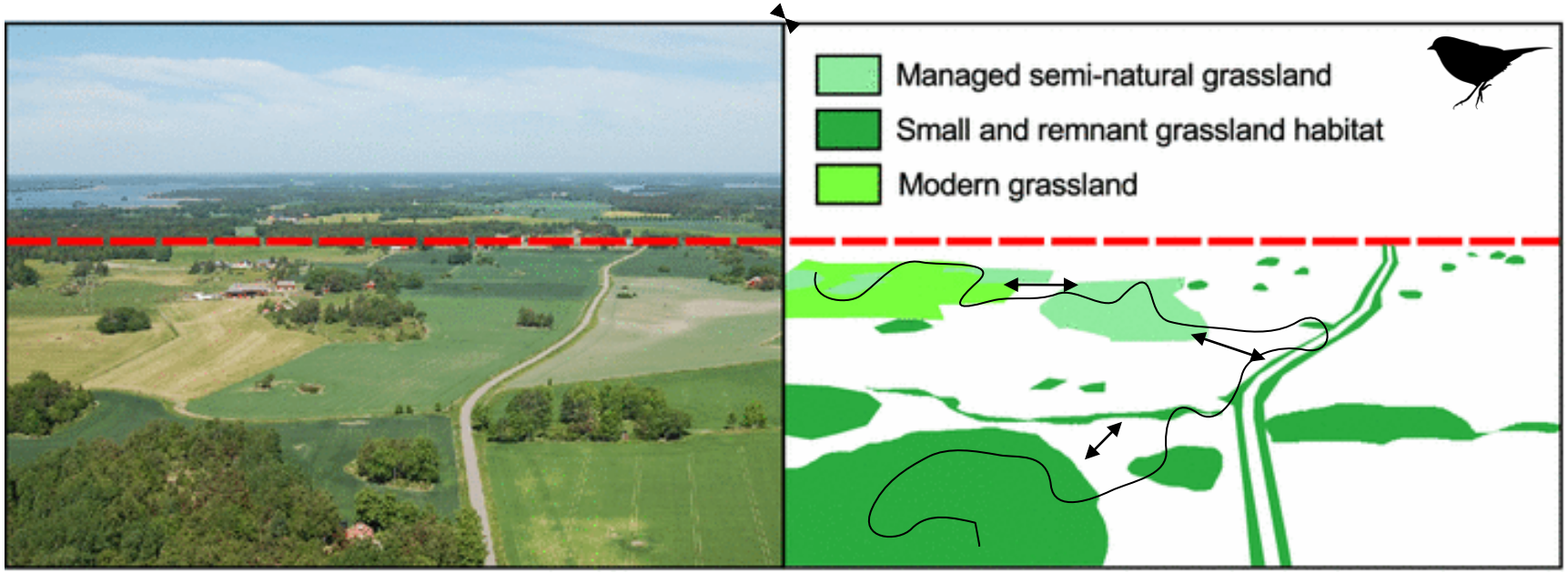
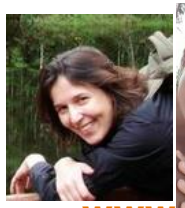


Auffret et al. 2015

Population dynamics

Movement ecology meets road ecology:
Landscape connectivity in face of an expanding road network




Bernardo Niebuhr, Fernando Ascensão,
Andreia Moraes, Brenda Alexandre, Assis,
Milene Alves-Eigenheer, Marcio de Morais-Jr,
Andreia Martins, Ademilson Oliveira, Elisamã Moraes,
Maria Lucia Lorini, Carlos Ramon Ruiz-Miranda,
Laurence Culot, Milton Cezar Ribeiro



Golden Lion Tamarins

Leontopithecus rosalia

- Callitrichidae
- Monogamic and cohesive groups
- Arboreal
- Forest dependance
- Endangered
- 30 years of continuous research

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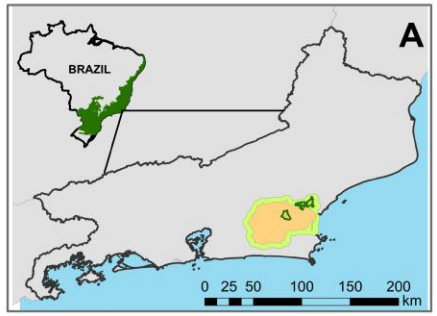
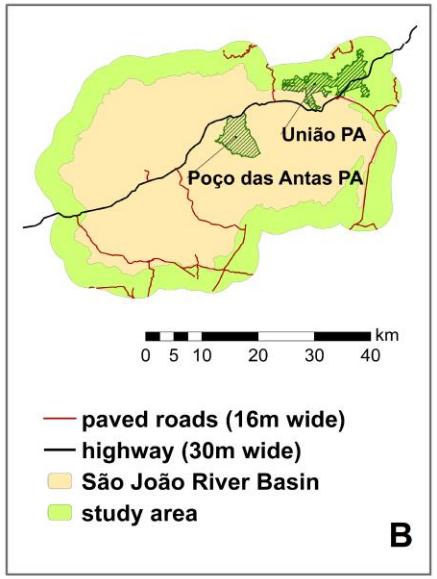
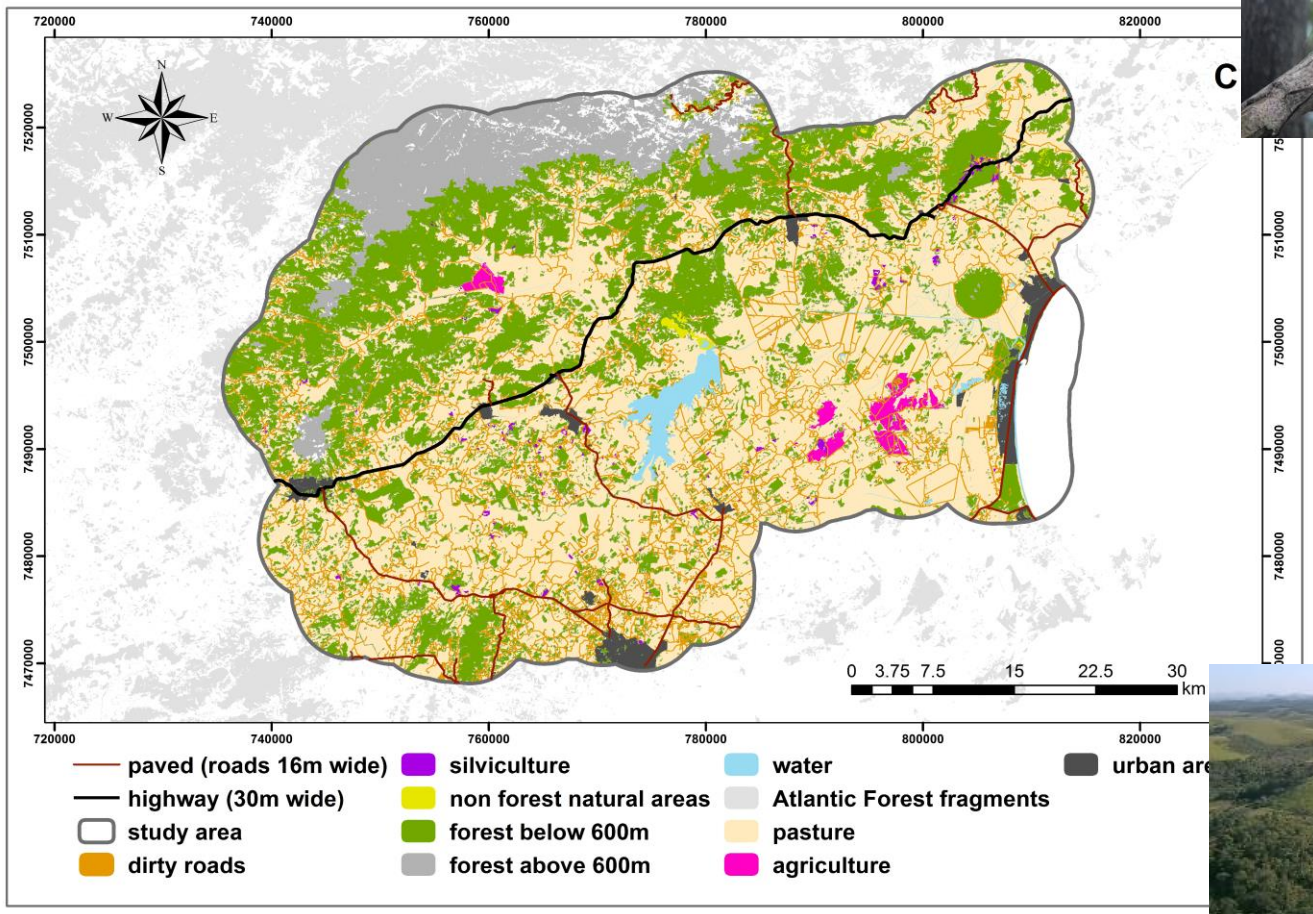
Golden Lion Tamarins

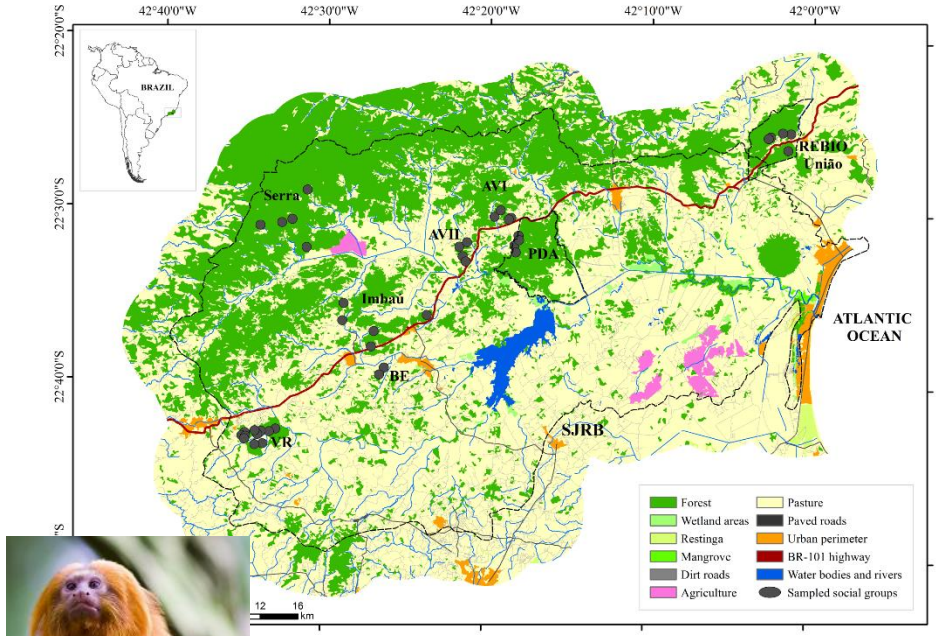
Leontopithecus rosalia

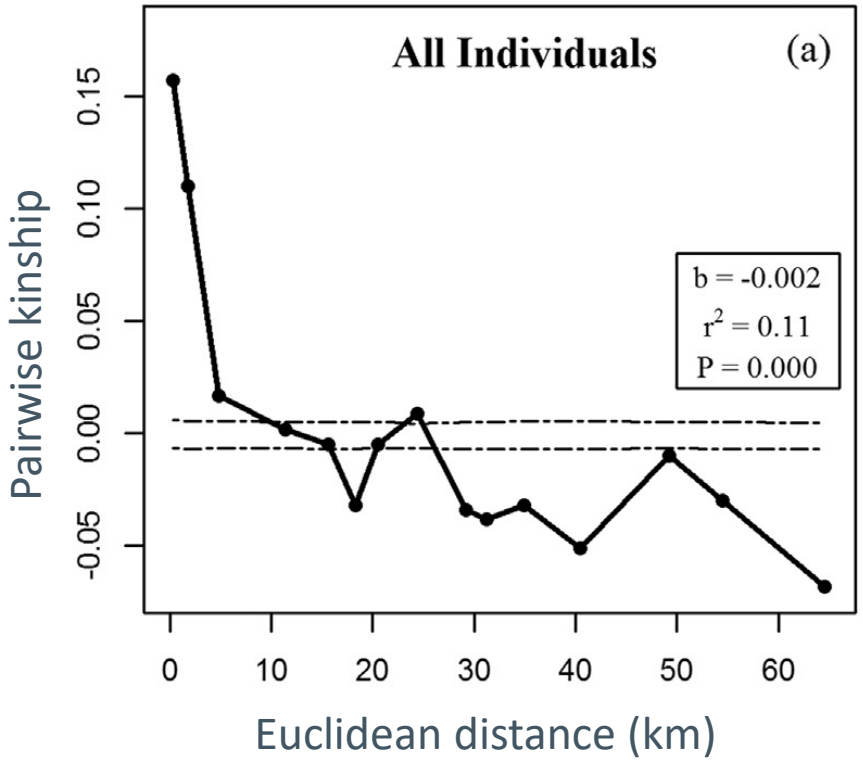






Movement meets roads





Moraes et al. 2018
Landscape genetics of GLT

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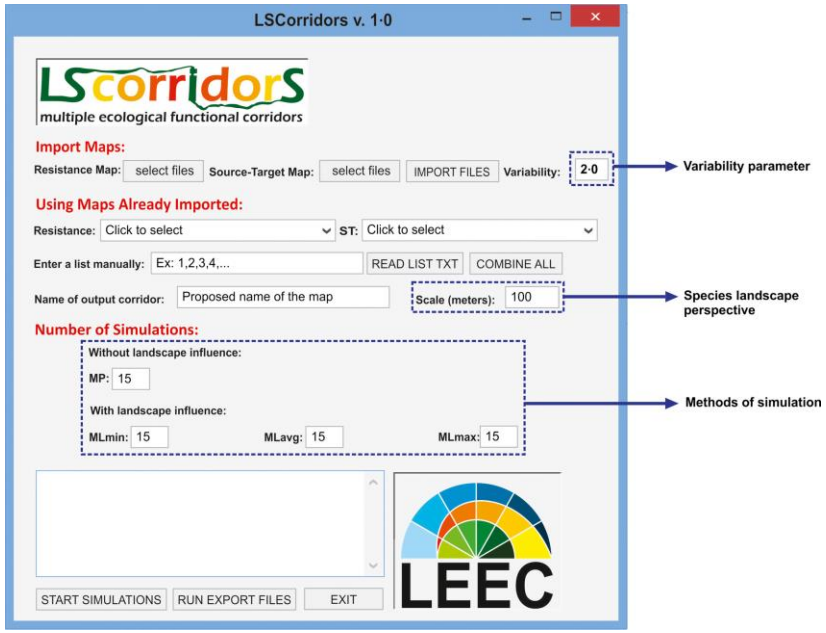
Methods in Ecology and Evolution

British Ecological Society

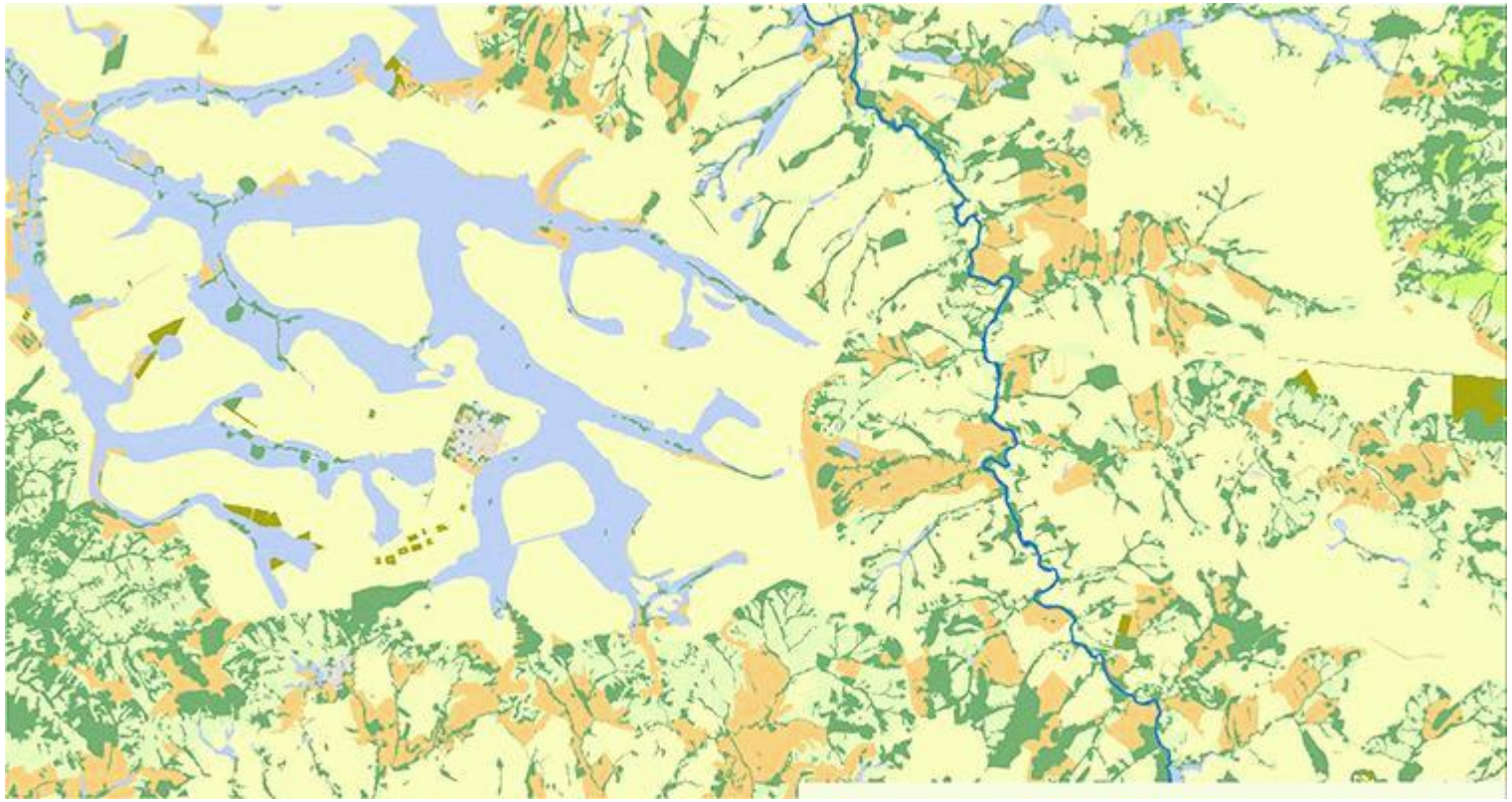
LScorridorS

multiple ecological functional corridors

Movement meets roads



Ribeiro et al. 2017



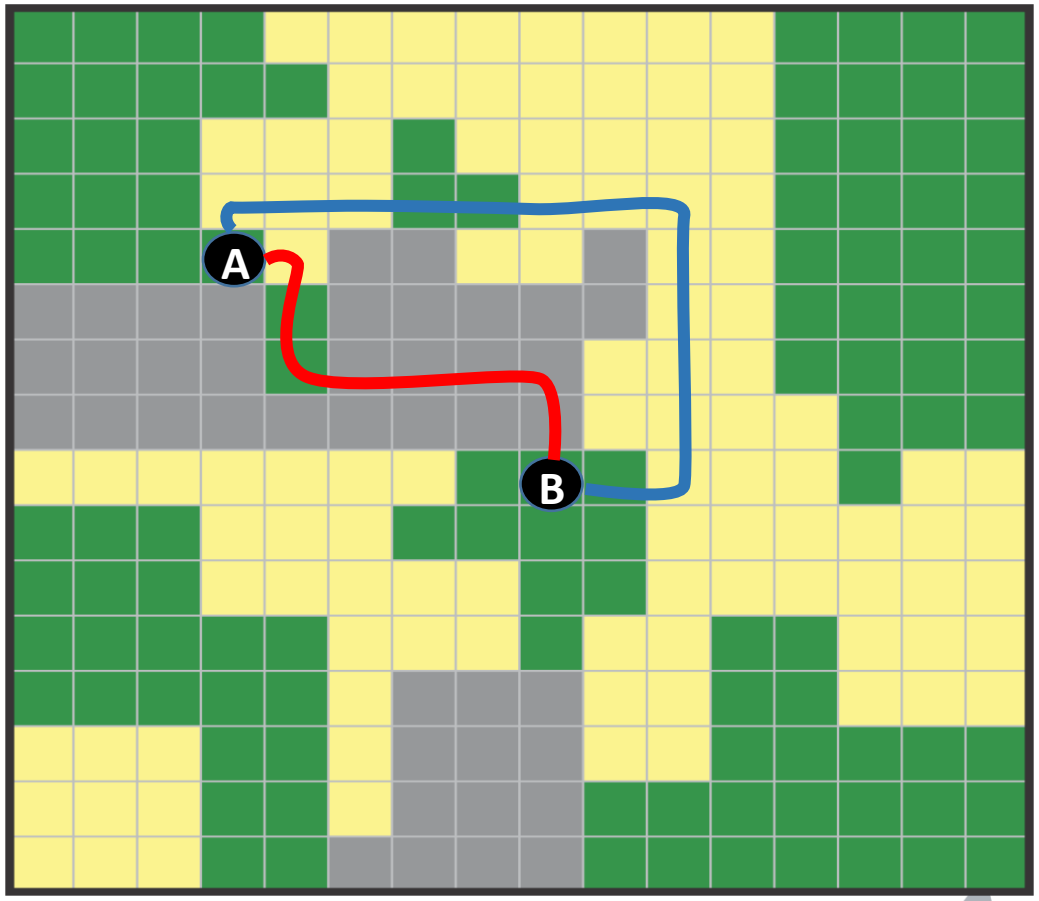
John Wesley Ribeiro, Juliana Silveira dos Santos, Pavel Dodonov, Bernardo Niebuhr, Felipe Martello, Milton Cezar Ribeiro

Legenda
Cana-de-açúcar
Reflorestamento
Vegetação nativa remanescente
Corpos d' água
Mancha urbana
Outros usos

Resistance map + **least-cost algorithm**

What is the ***shorter and less expensive route*** for a individual to goes from the patch A to B (Source-Target or ST)?

Land use	Resistance
Forest	1
Agriculture	30
Urban area	100



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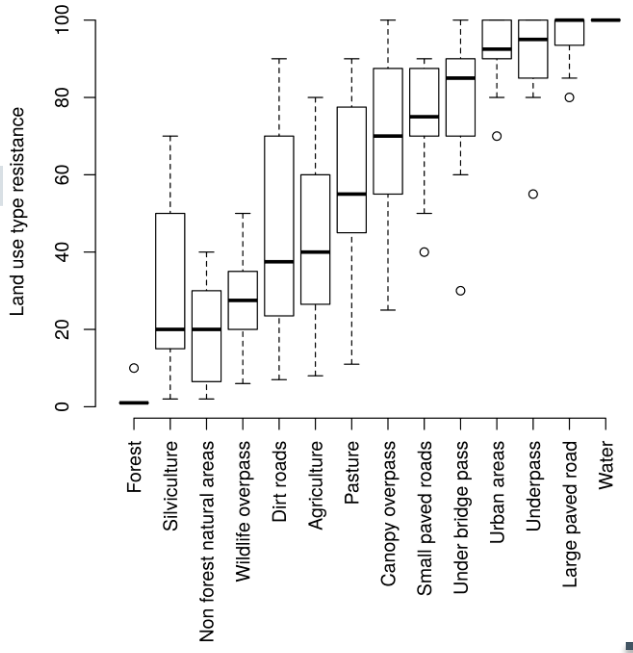
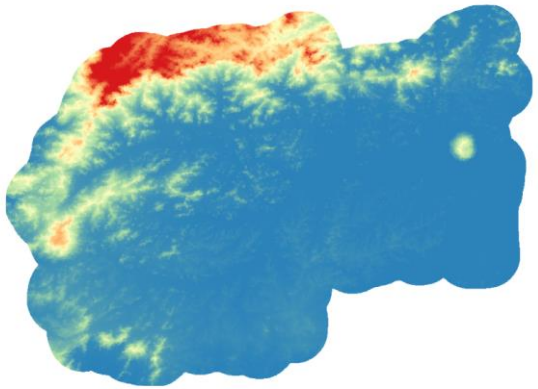
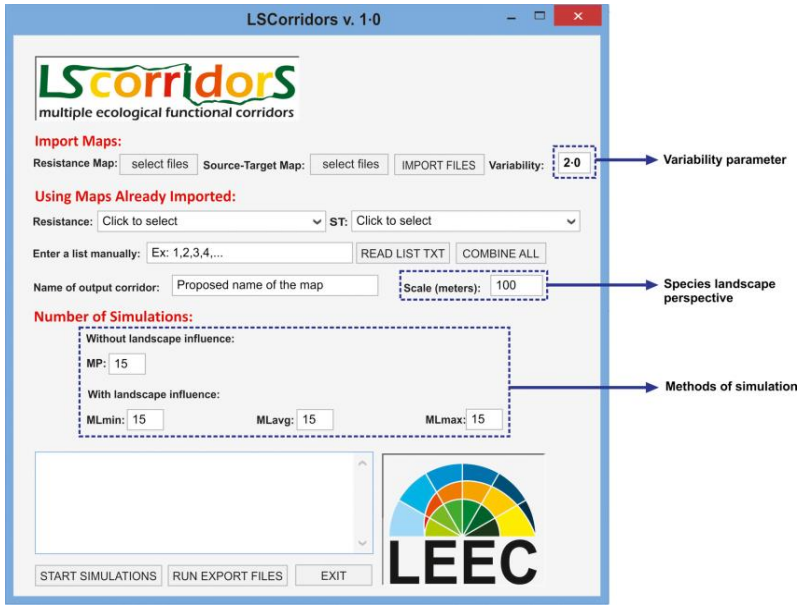
Expert knowledge



Elevation +





Movement meets roads

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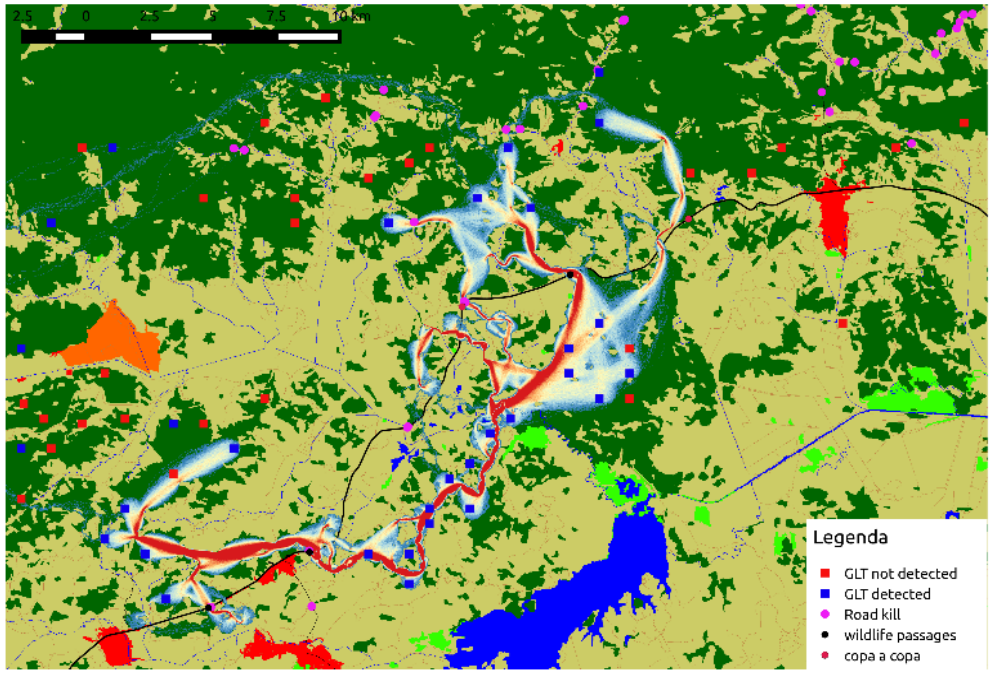

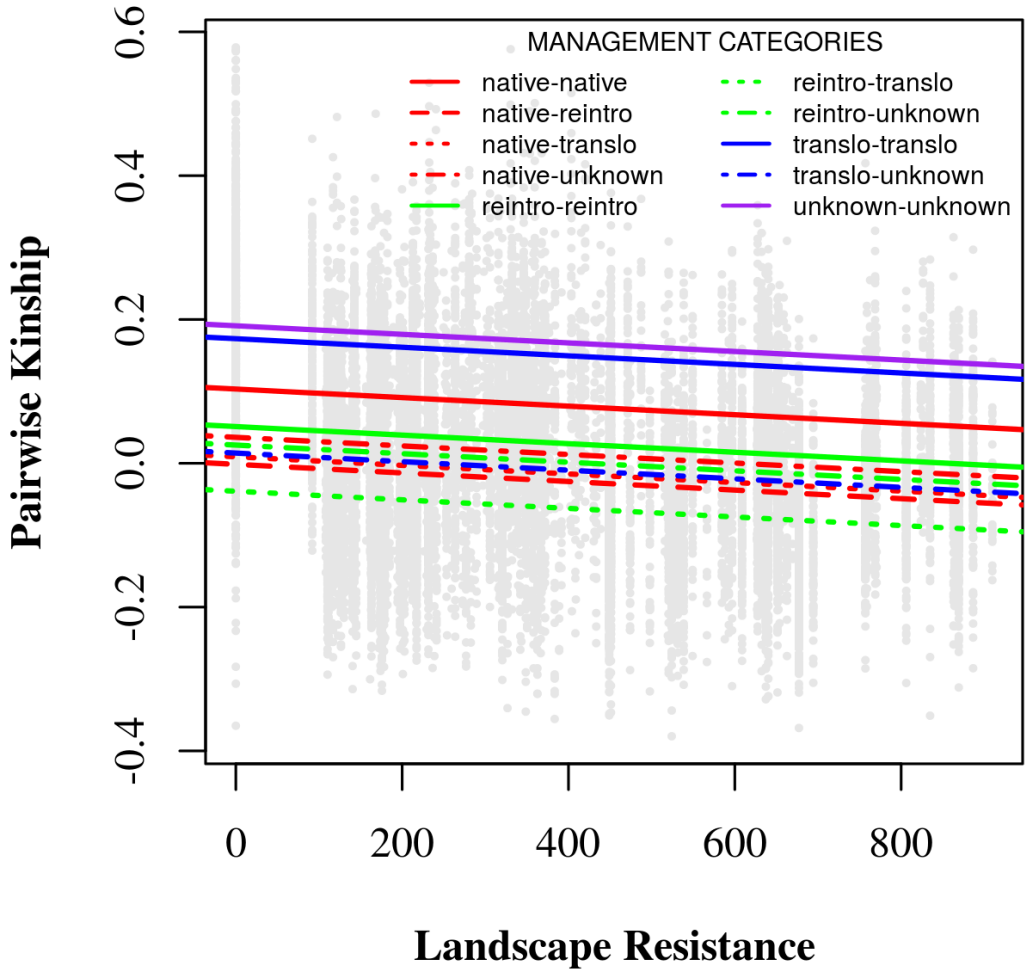

Moraes et al. 2018
Landscape genetics of GLT

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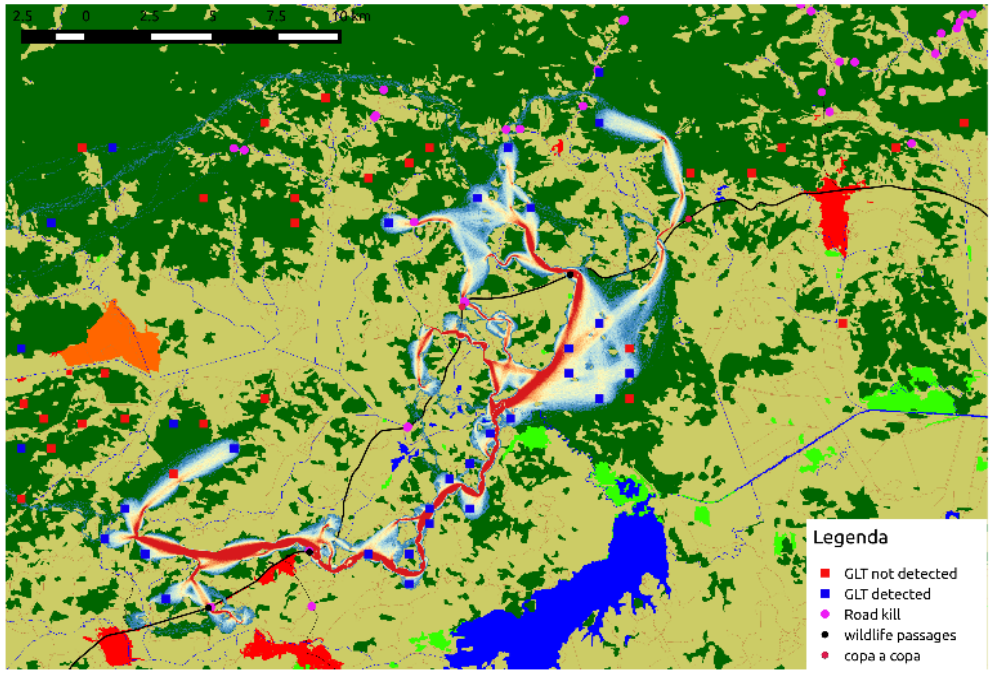
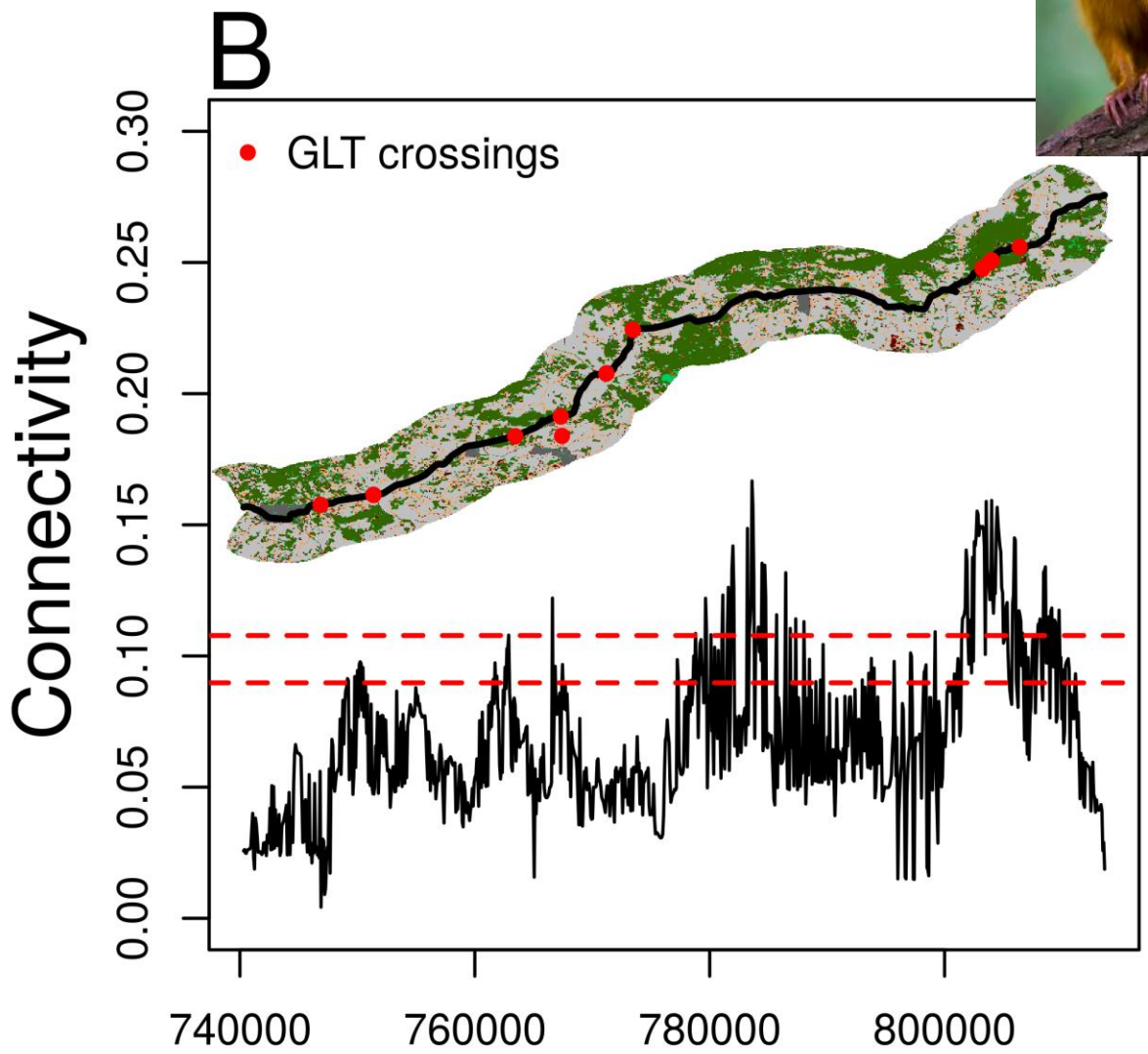
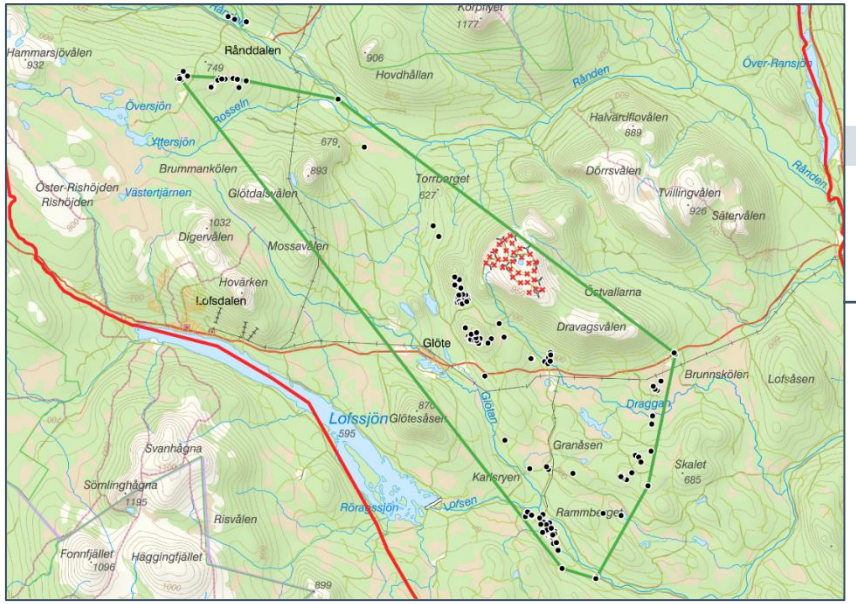


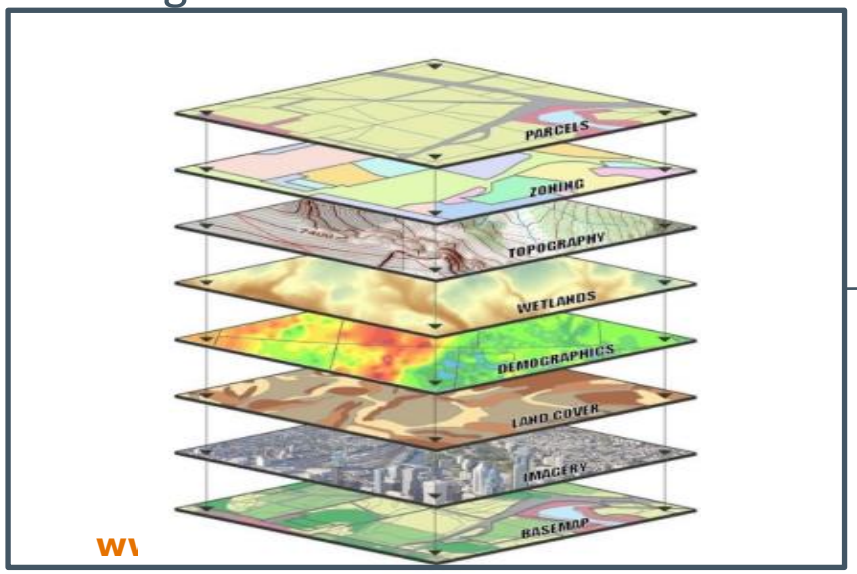


IA

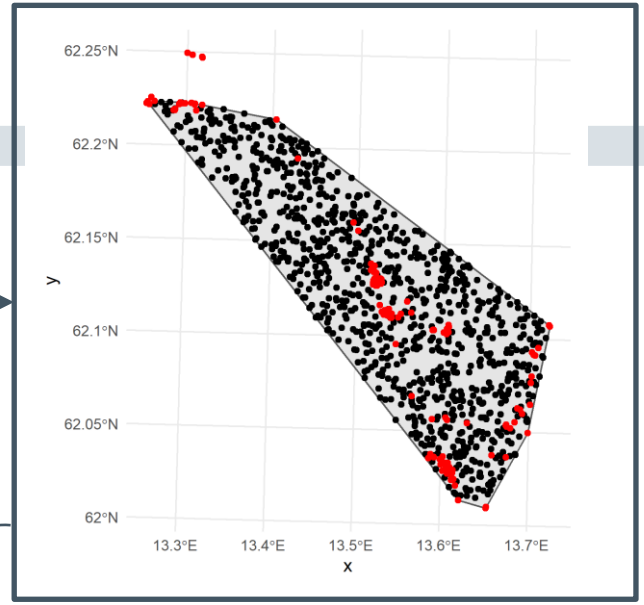
a. Animal movement (GPS) data



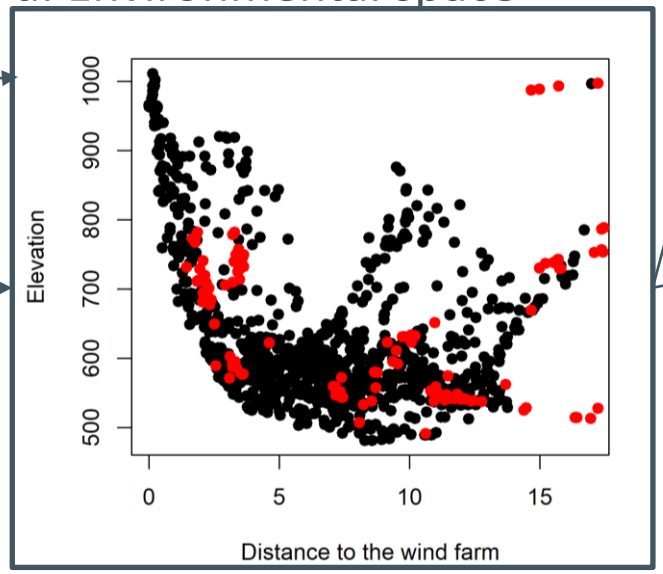
b. Background data



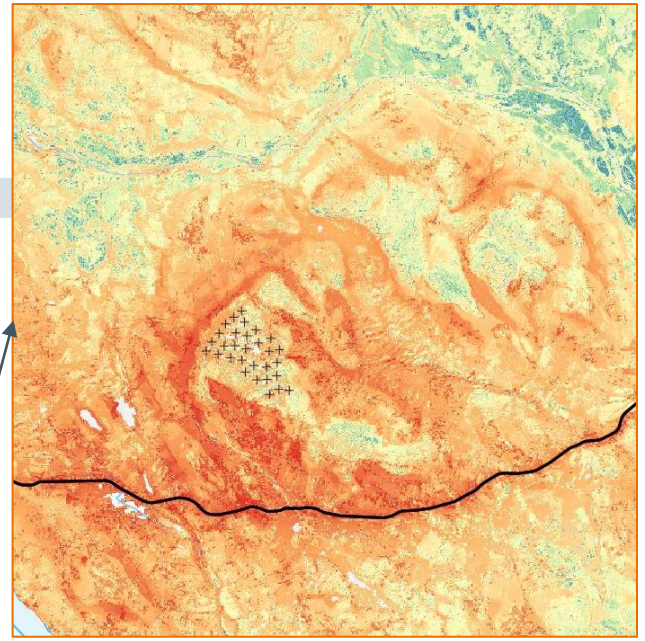
c. Use-availability design on geographical space

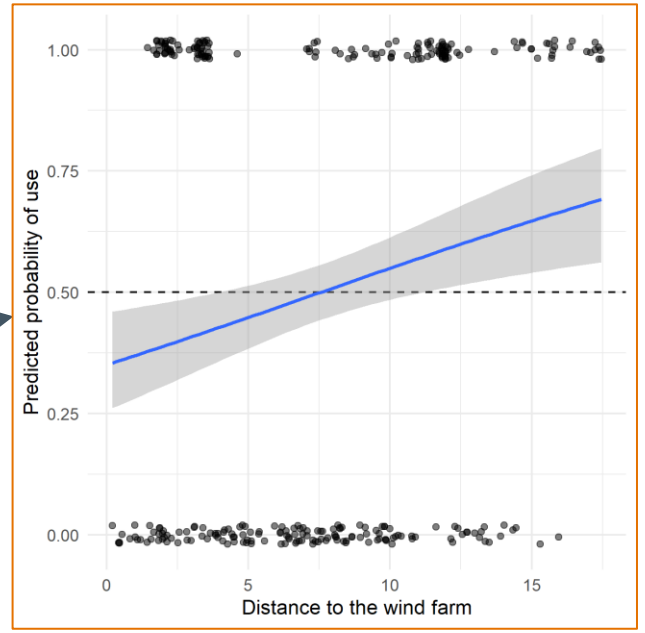


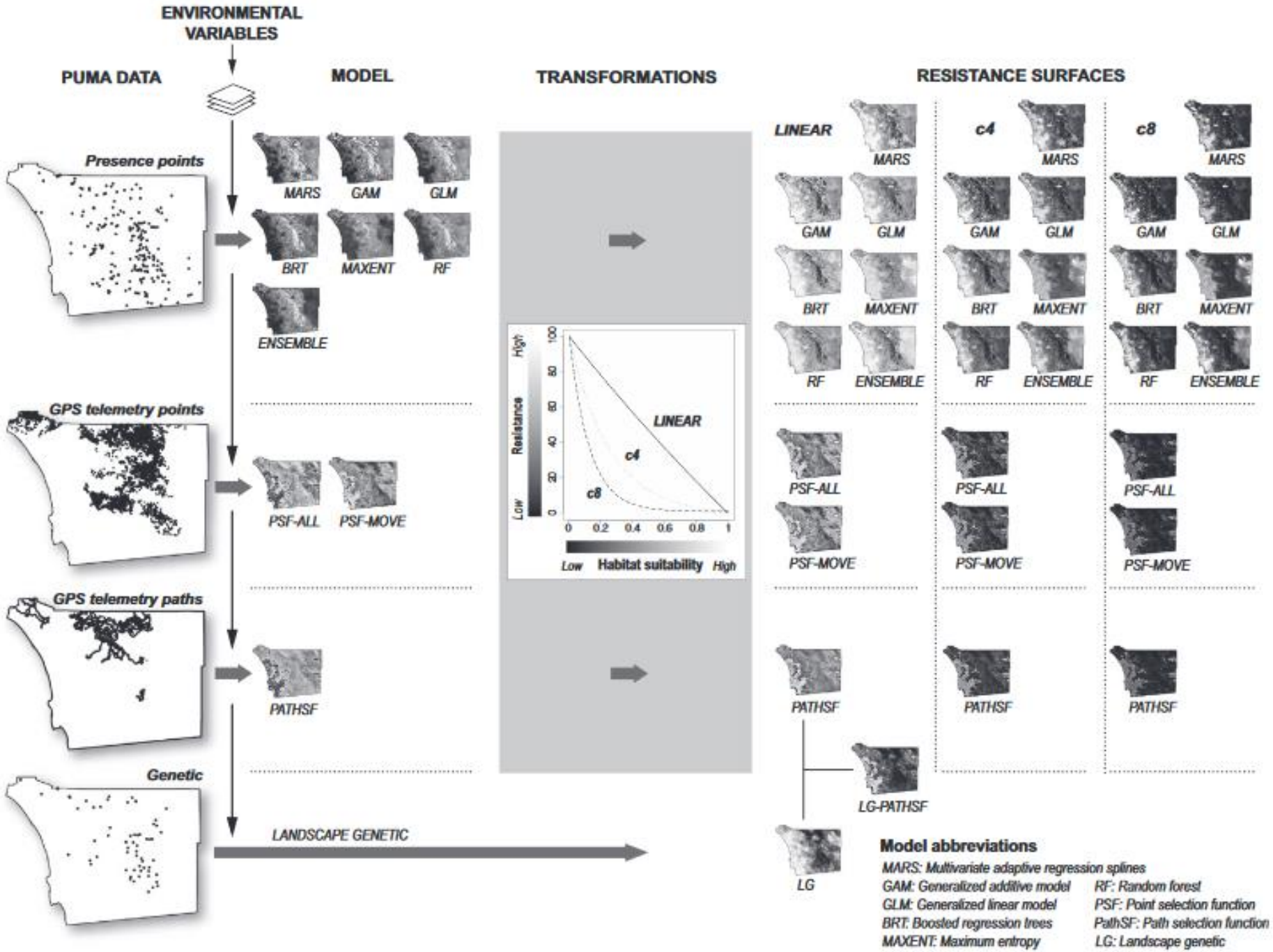
d. Environmental space



e. Predicted probability of use







Zeller et al. 2018

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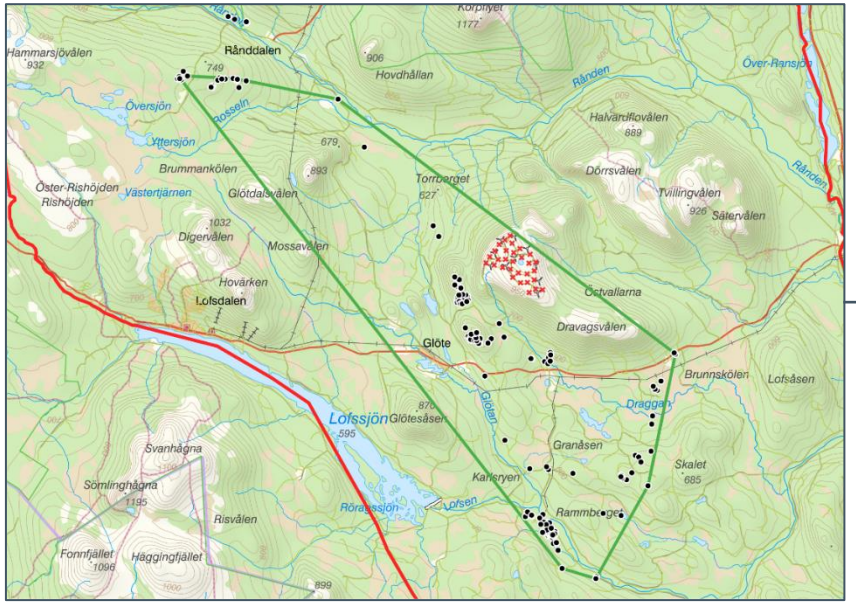

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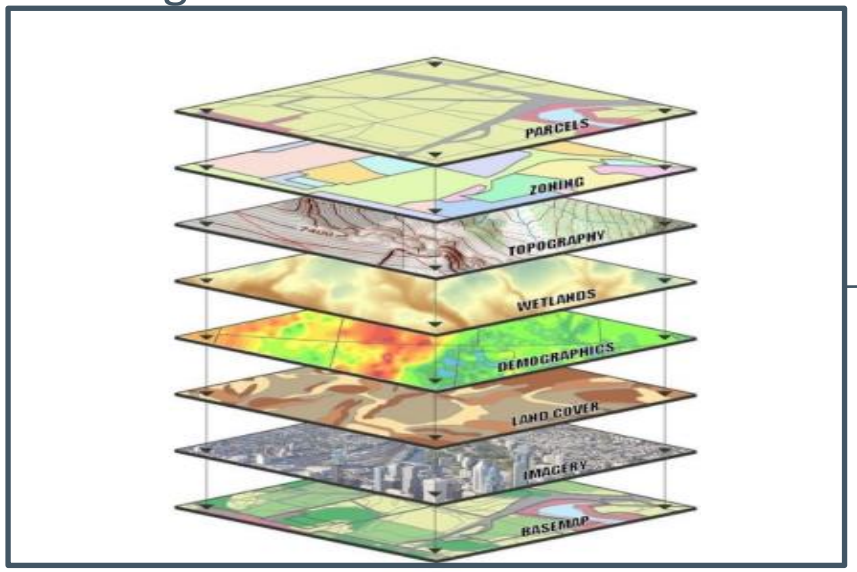

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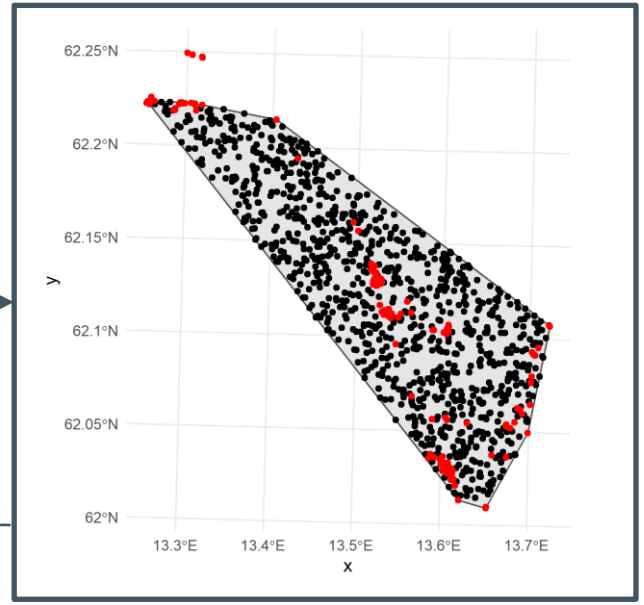

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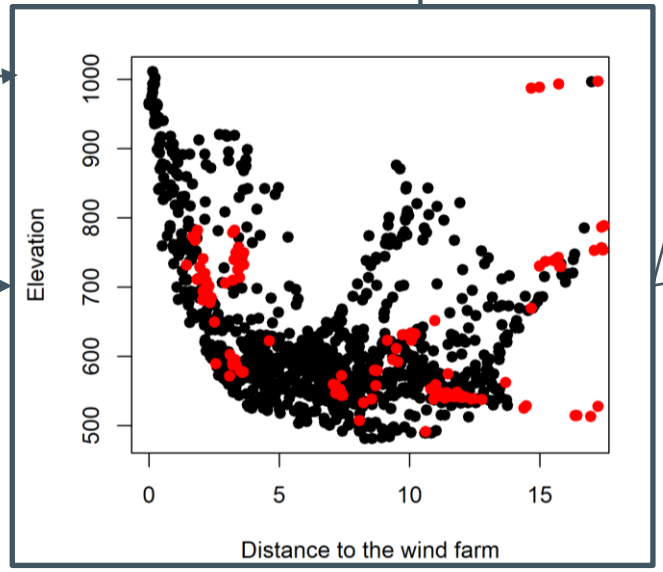

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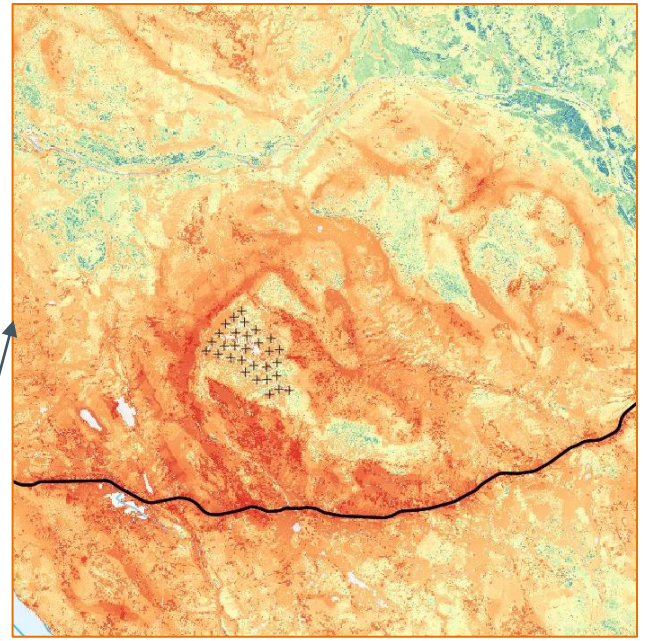

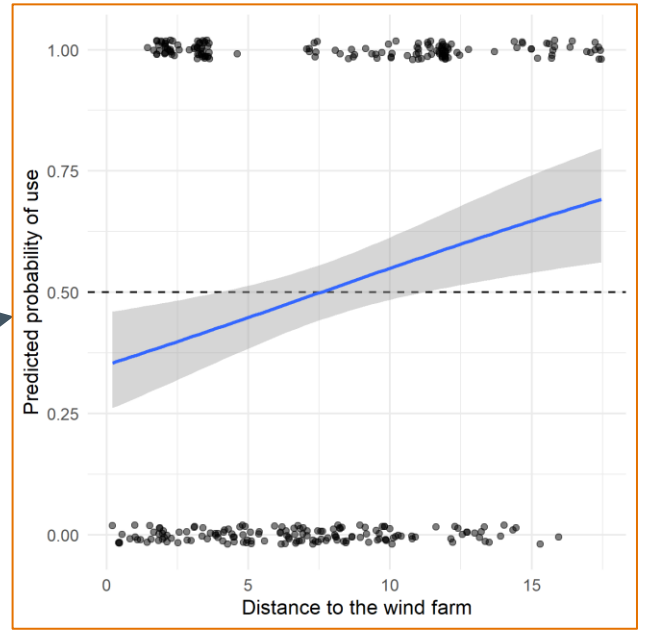

Habitat functionality: beyond Habitat suitability

PIXEL FOCUS (ENVIRONMENTAL SPACE)

DATA

Species	Habitat	Climate - weather	Land use & infrastructures	Biotic interactions
• Locations	• Vegetation	• T, precipitation	• Road, railway, forestry	• Competition
• Movements	• Topography	• Icing	• Renewable energy	• Predation
• Life history	• Trophic res..	• Extreme events...	• Tourism..	• Parasites..

HABITAT QUALITY

Panzacchi et al 2022
Van Moorter et al 2021
Van Moorter et al 2023a,b

Habitat functionality: beyond Habitat suitability

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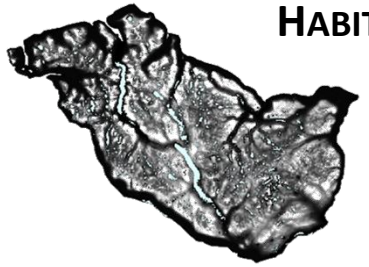
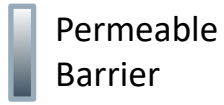
HABITAT QUALITY

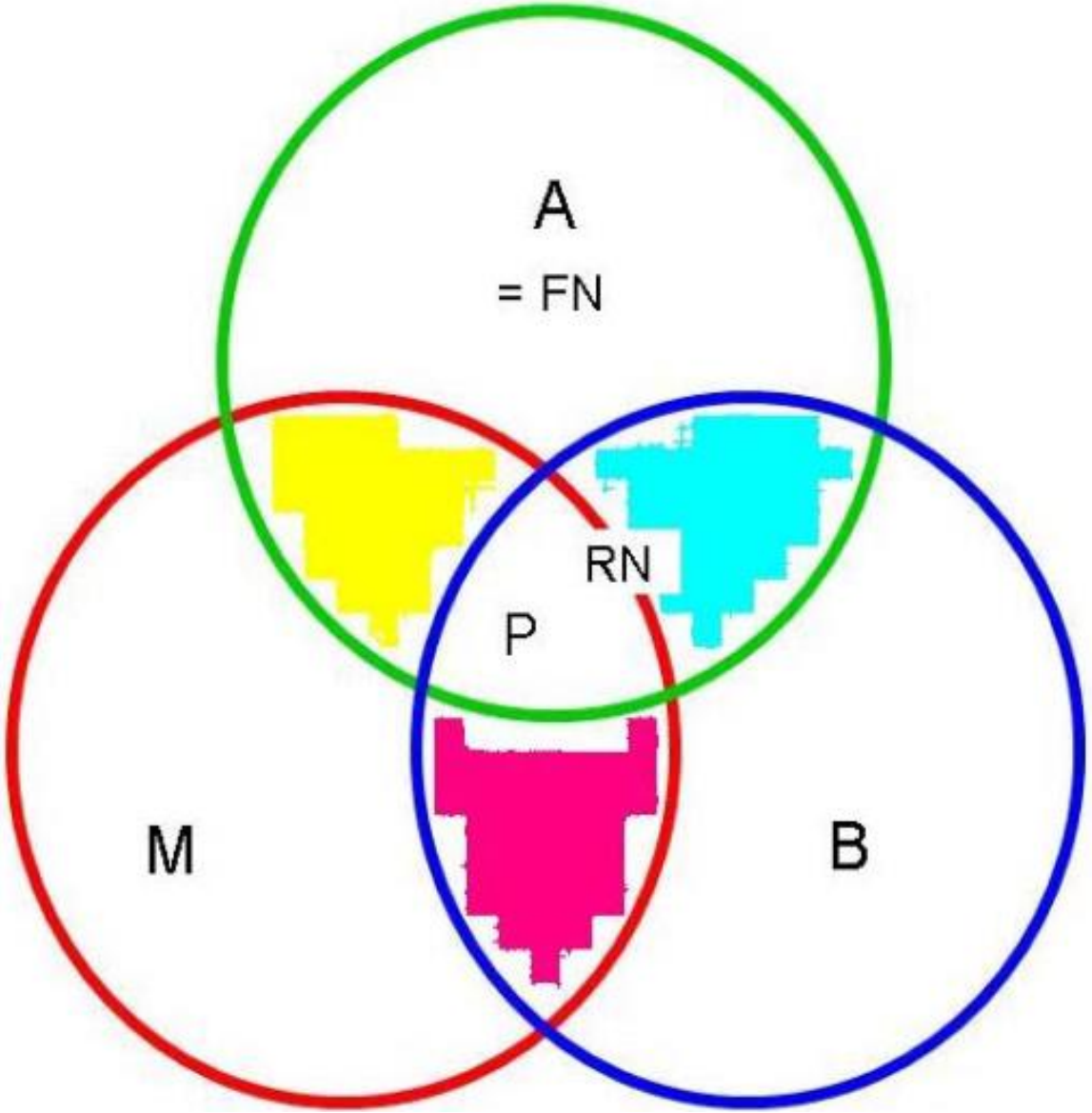
HABITAT PERMEABILITY



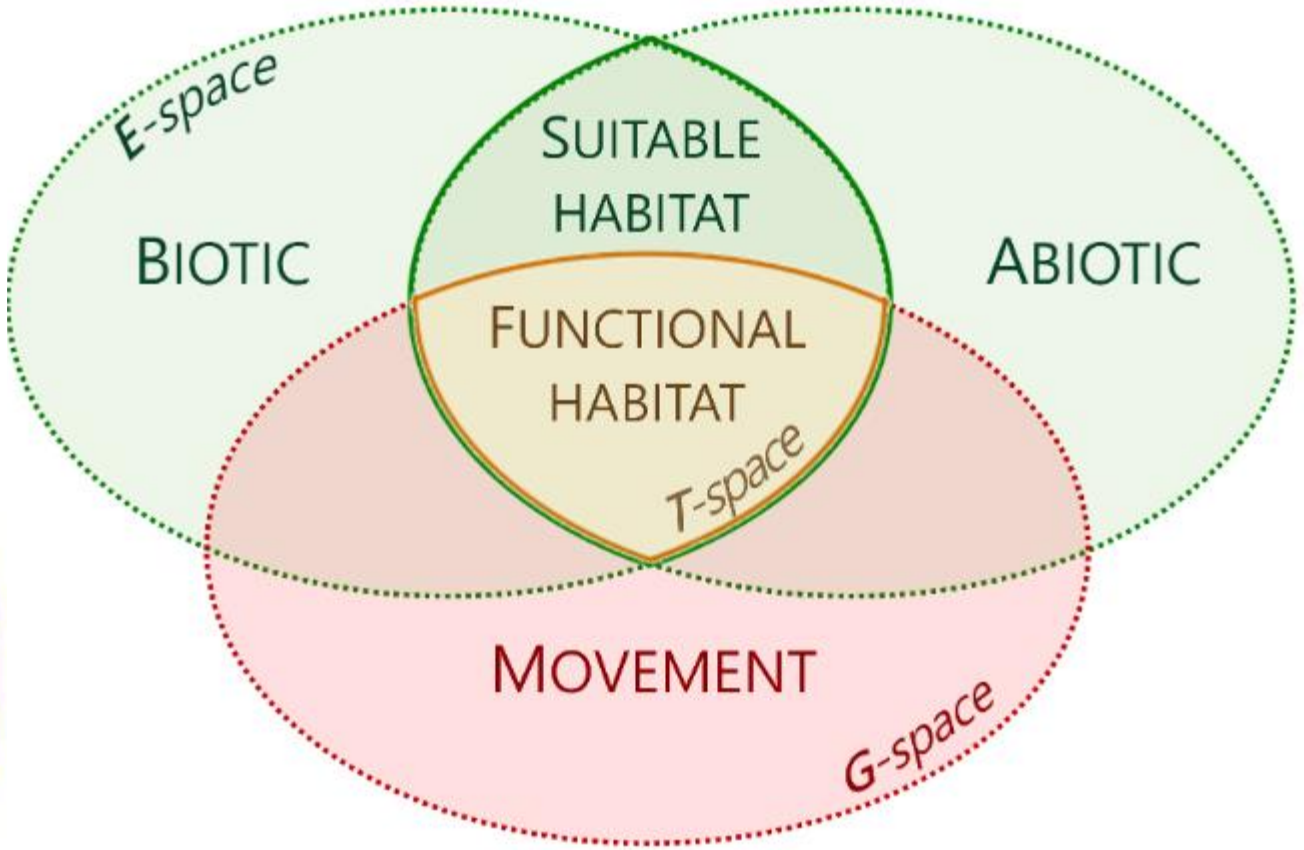


Panzacchi et al 2022
Van Moorter et al 2021
Van Moorter et al 2023a,b

Habitat functionality: beyond Habitat suitability



Soberón & Peterson 2005



Van Moorter et al 2023b

HABITAT FUNCTIONALITY: BEYOND HABITAT SUITABILITY

PIXEL FOCUS (ENVIRONMENTAL SPACE)

DATA

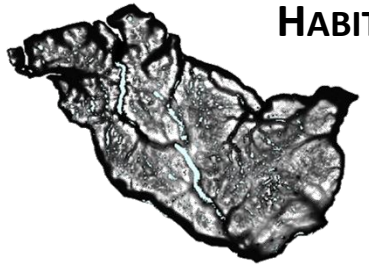
SPECIES	HABITAT	CLIMATE - WEATHER	LAND USE & INFRASTRUCTURES	BIOTIC INTERACTIONS
• Locations	• Vegetation	• T, precipitation	• Road, railway, forestry	• Competition
• Movements	• Topography	• Icing	• Renewable energy	• Predation
• Life history	• Trophic res..	• Extreme events...	• Tourism..	• Parasites..

HABITAT QUALITY

Preferred

Avoided

HABITAT PERMEABILITY

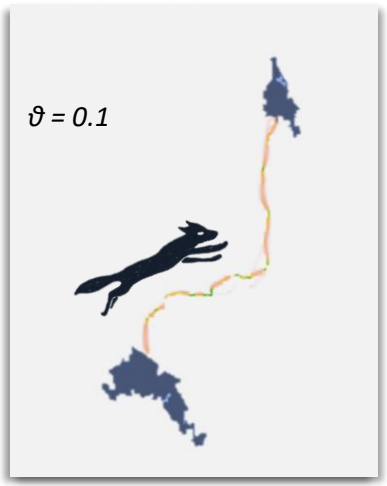


Permeable

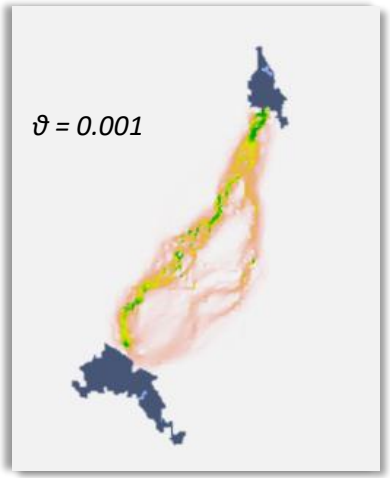
Barrier

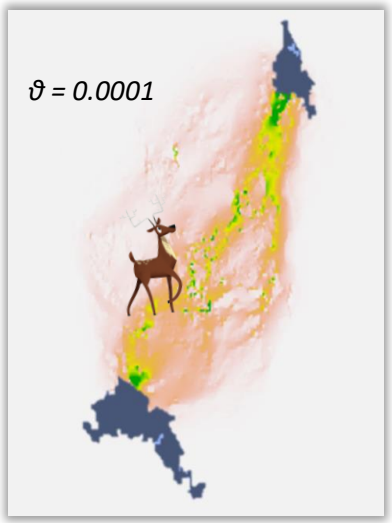
ConScape

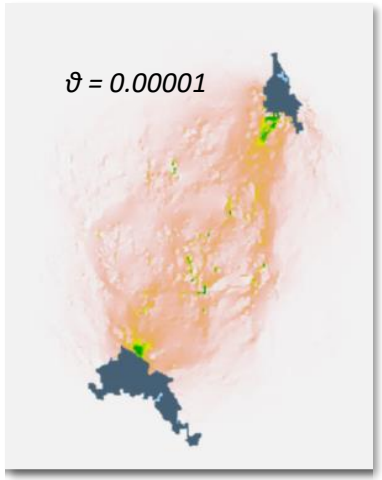
LEAST- COST PATH



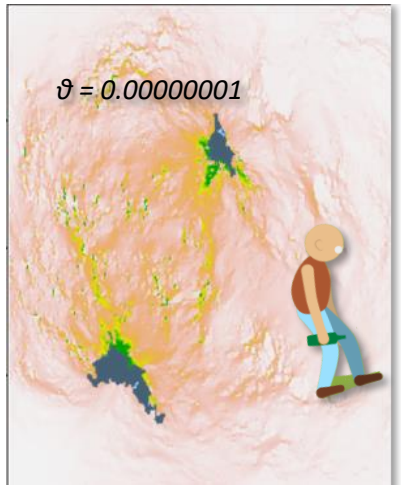
RANDOMIZED SHORTEST PATH







RANDOM WALK



Panzacchi et al 2022
Van Moorter et al 2021
Van Moorter et al 2023a,b

HABITAT FUNCTIONALITY: BEYOND HABITAT SUITABILITY

PIXEL FOCUS (ENVIRONMENTAL SPACE)

LANDSCAPE FOCUS (GEOGRAPHIC SPACE)

DATA

SPECIES	HABITAT	CLIMATE - WEATHER	LAND USE & INFRASTRUCTURES	BIOTIC INTERACTIONS
• Locations	• Vegetation	• T, precipitation	• Road, railway, forestry	• Competition
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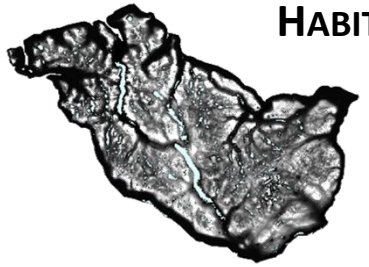
• Life history	• Trophic res..	• Extreme events...	• Tourism..	• Parasites..

HABITAT QUALITY

Preferred

Avoided

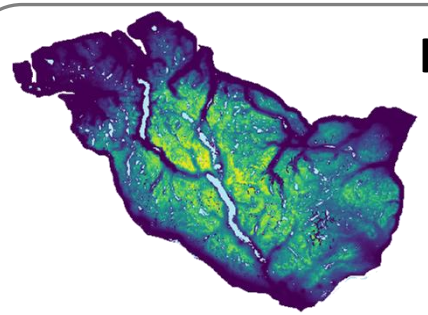
HABITAT PERMEABILITY



Permeable

Barrier

HABITAT FUNCTIONALITY



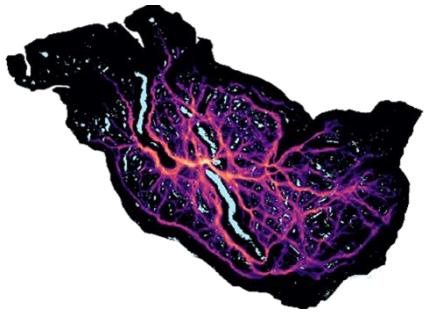
High (preferred and well connected)

Low (low quality &/or inaccessible)

MOVEMENT FLOW

High (movement hub, "traffic-jam")

Low

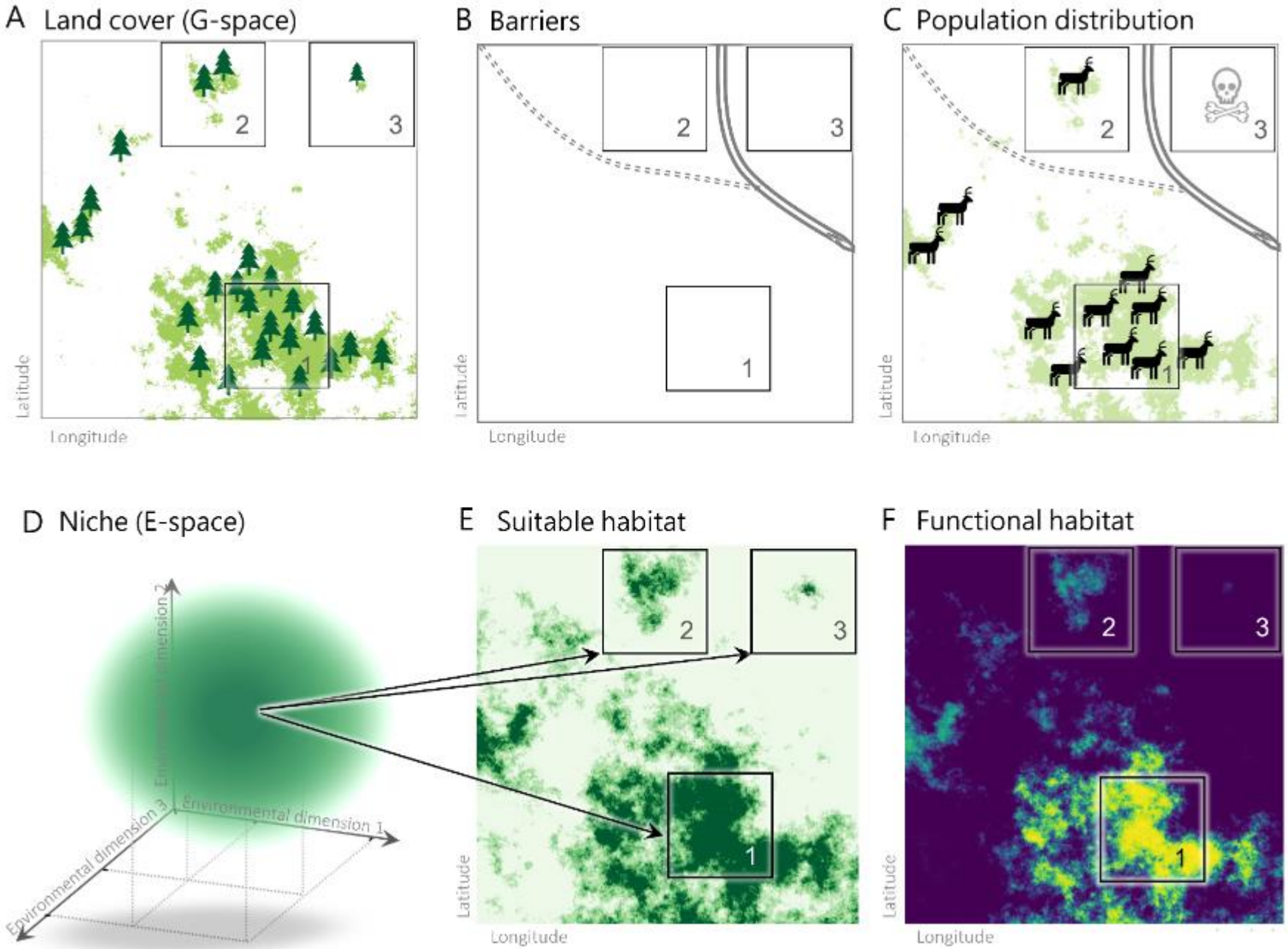


AID SUSTAINABLE LAND PLANNIG:

- *Scenario analyses:* quantify impact of changes in the landscape/climate
- Identify priority areas for conservation (zonation)

Panzacchi et al 2022
Van Moorter et al 2021
Van Moorter et al 2023a,b

Habitat functionality: beyond Habitat suitability



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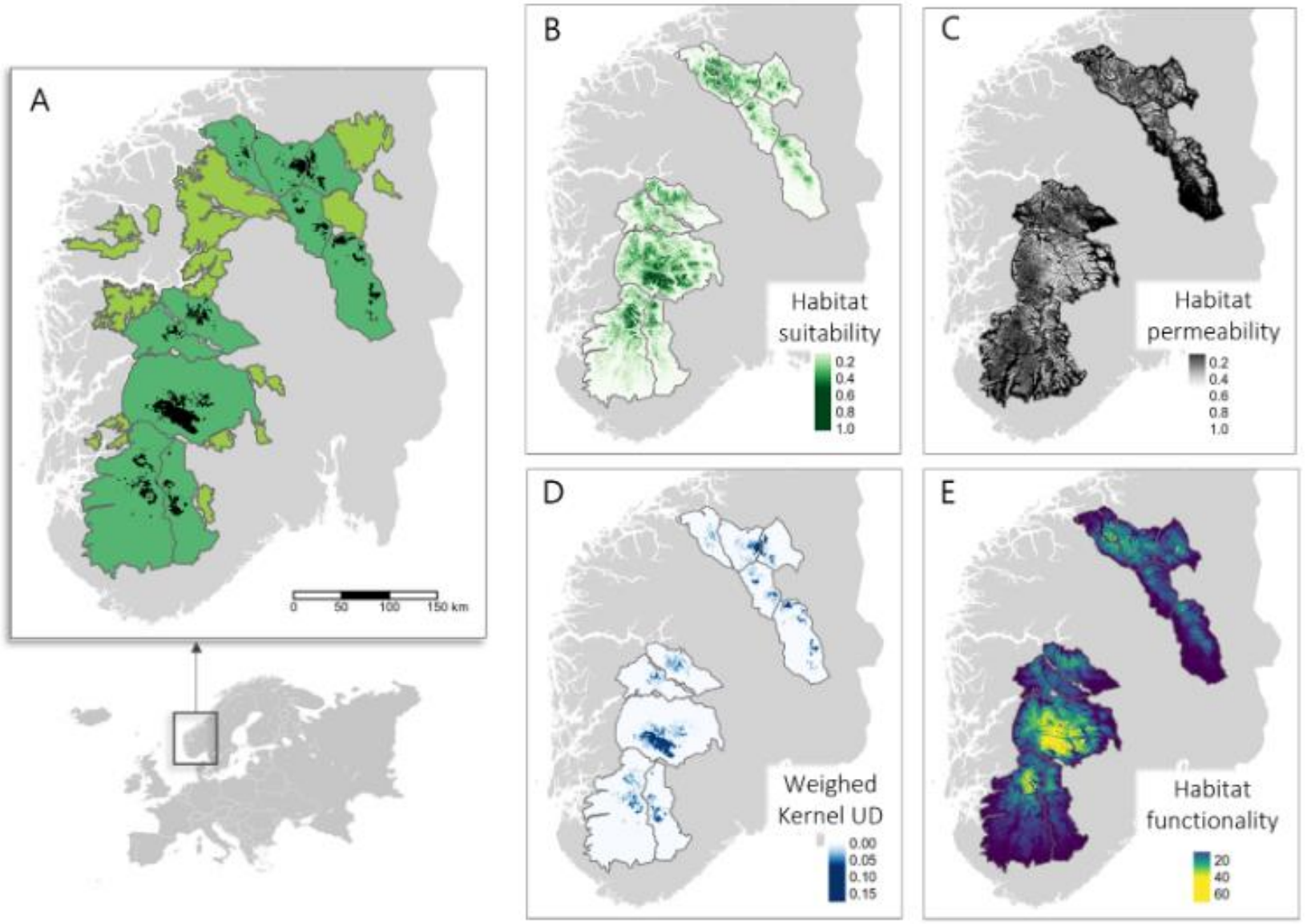

Van Moorter et al 2023b

Connectivity modeling tools

- R:
  - leastcostpath package
  - amt: `redistribution_kernel()` and `simulate_path()`
- GRASS GIS/Python: LSCorridors
- Julia:
  - Circuitscape
  - ConScape

Literature

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Bernardo Brandão Niebuhr
bernardo.brandao@nina.no

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