From individual movement to landscape and population connectivity

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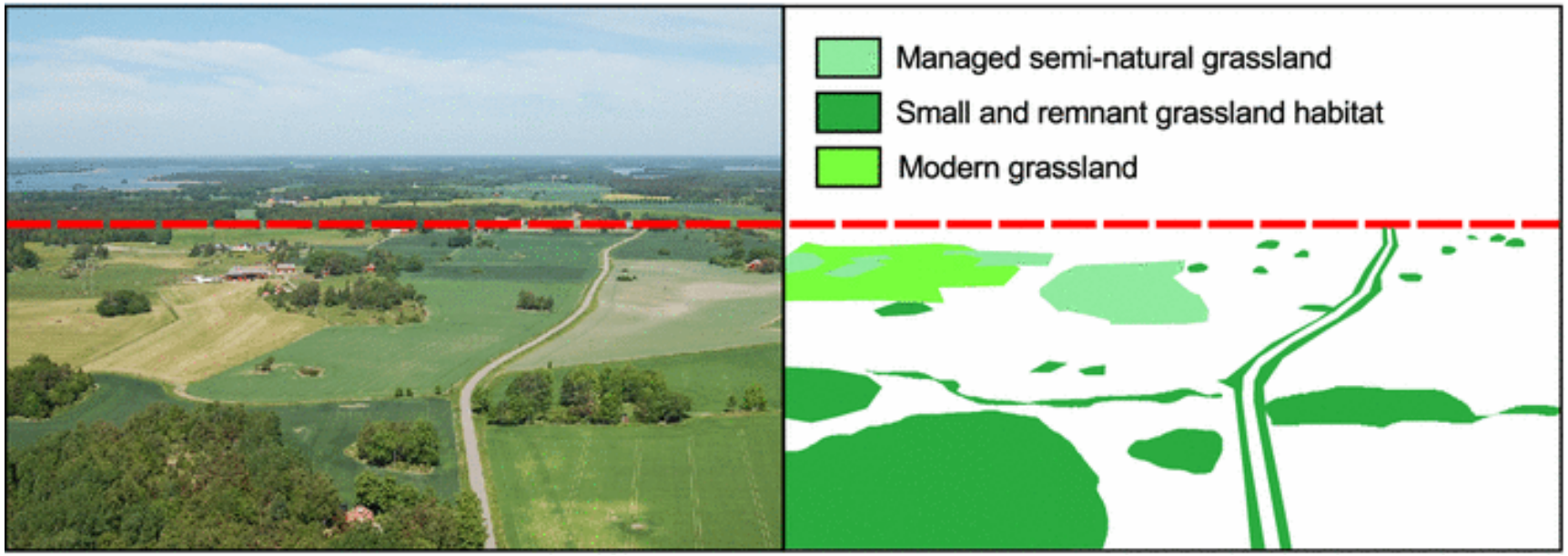
Animal Movement PhD-course, SLU
Ekenäs Herrgård
4-8 September, 2023

Landscape connectivity

- Structural connectivity
- Functional connectivity



Auffret et al. 2015

Landscape connectivity

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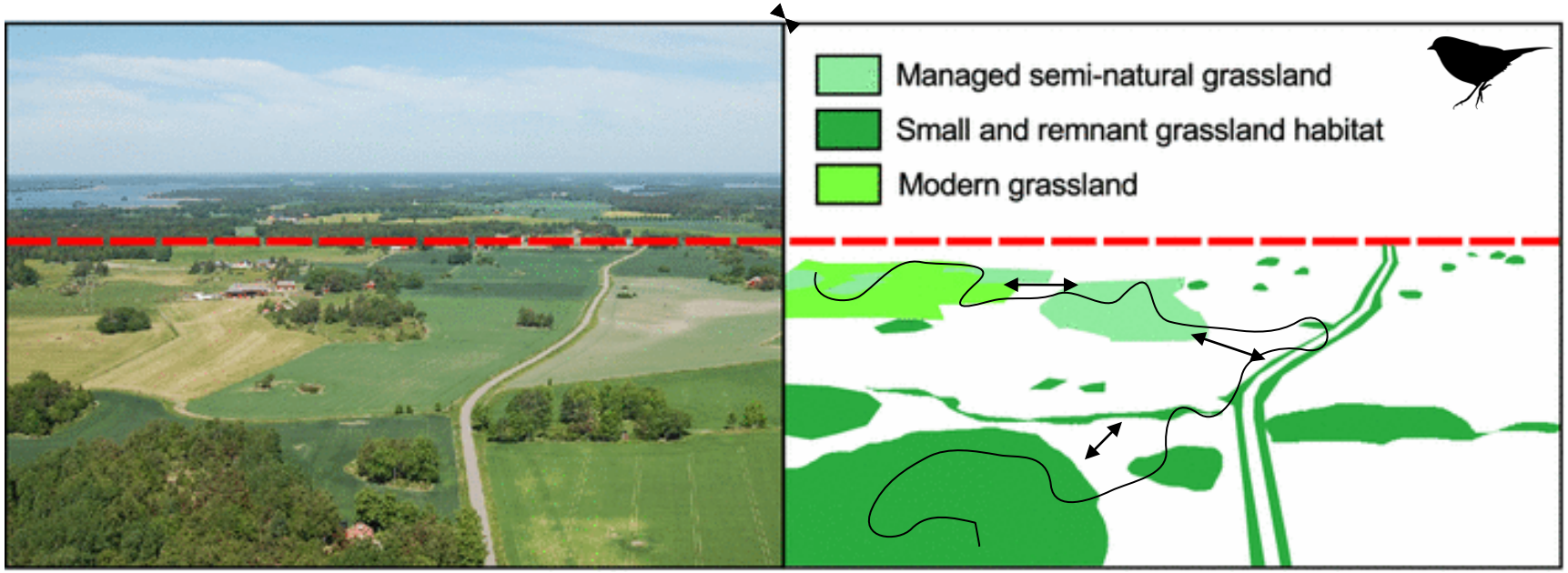
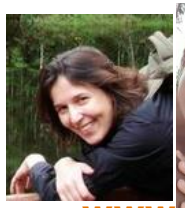


Auffret et al. 2015

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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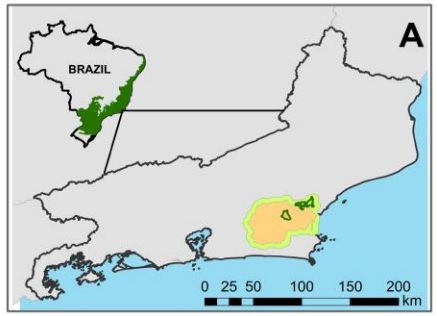
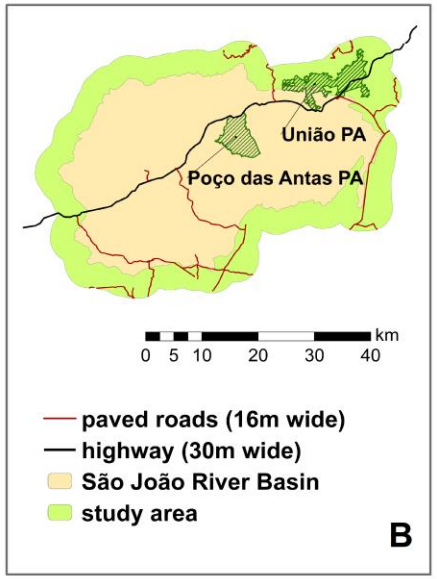
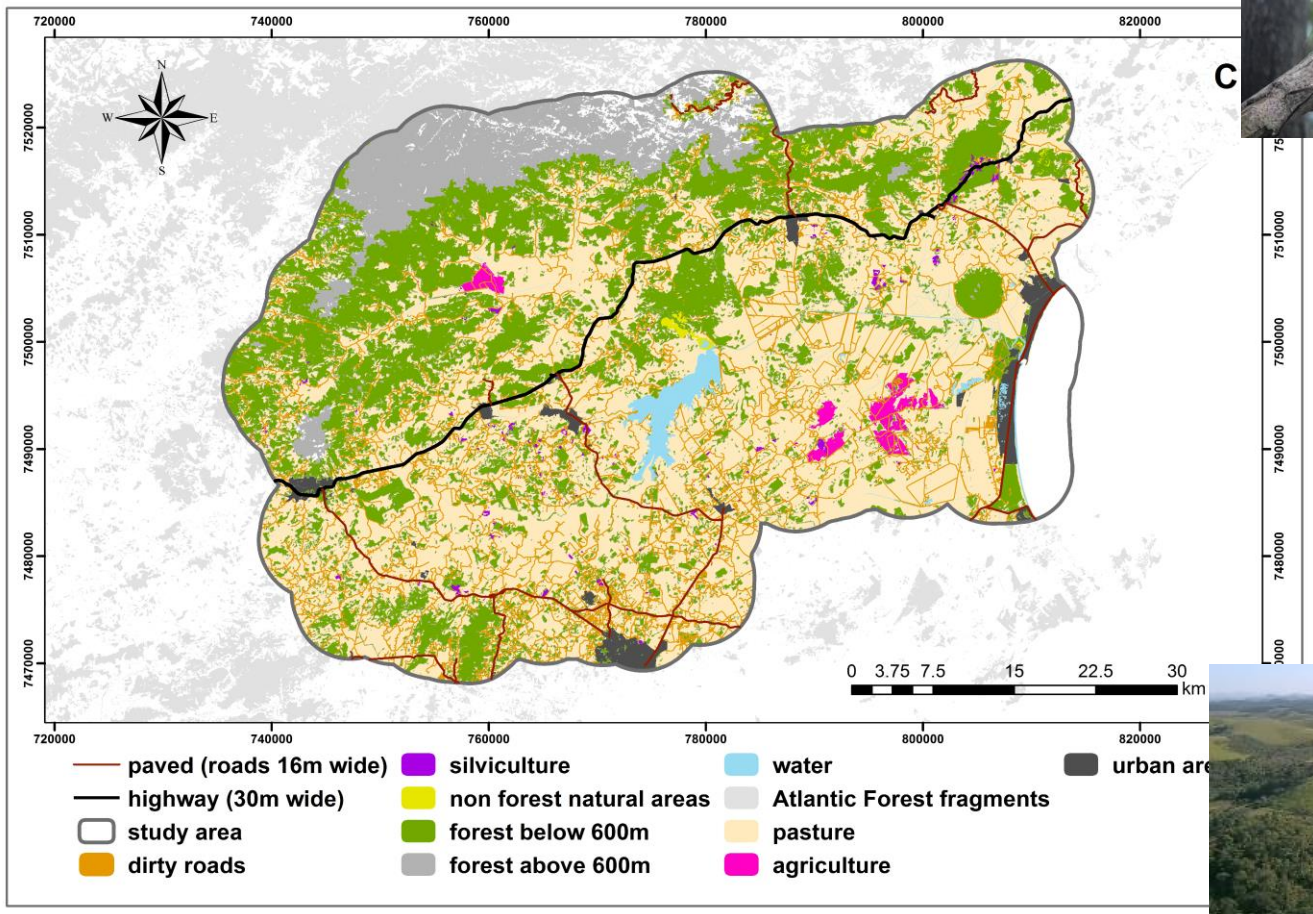
Golden Lion Tamarins

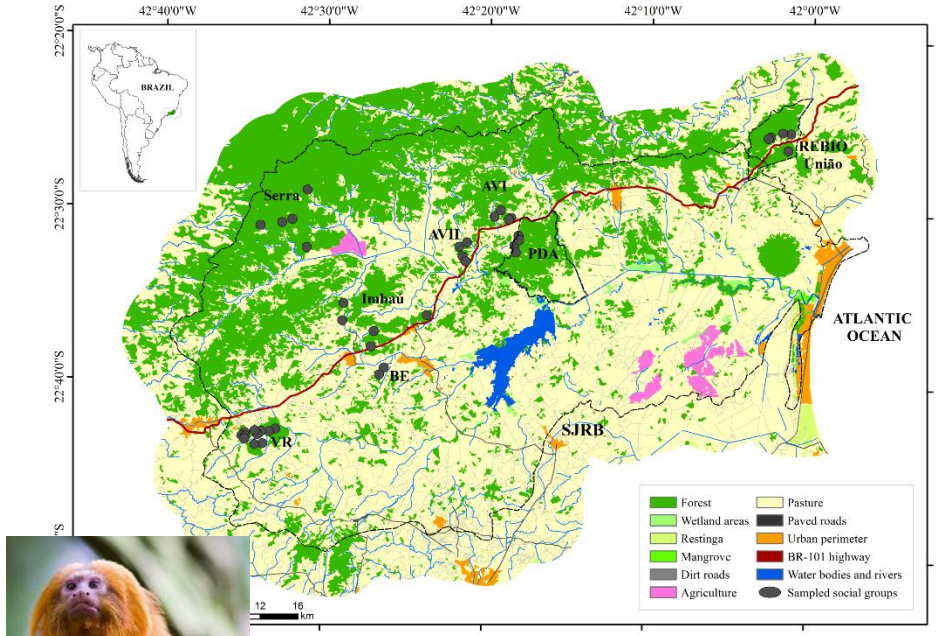
Leontopithecus rosalia

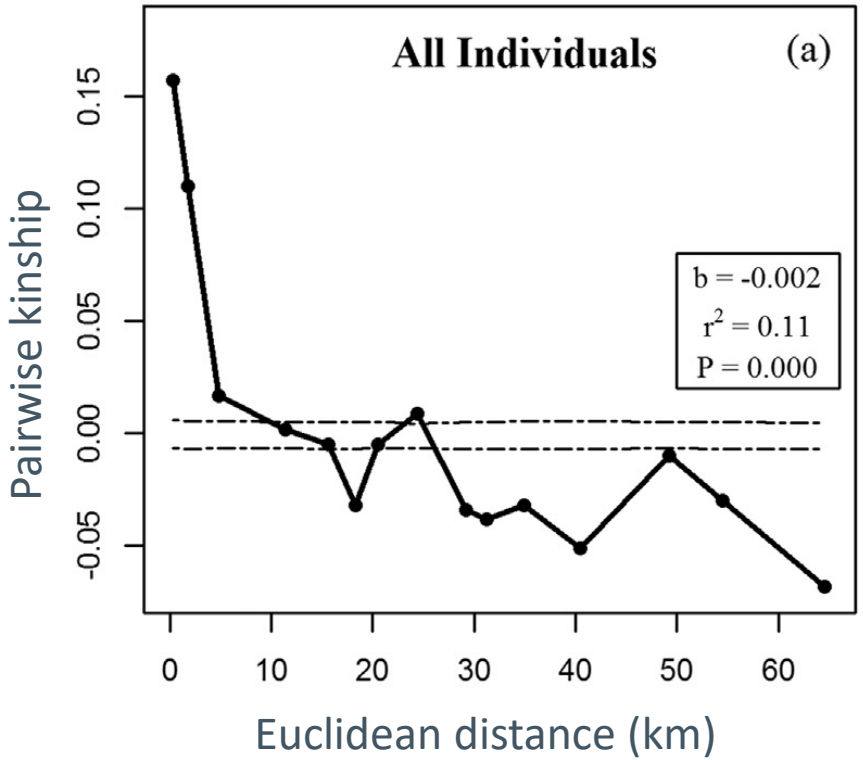






Movement meets roads





Moraes et al. 2018
Landscape genetics of GLT

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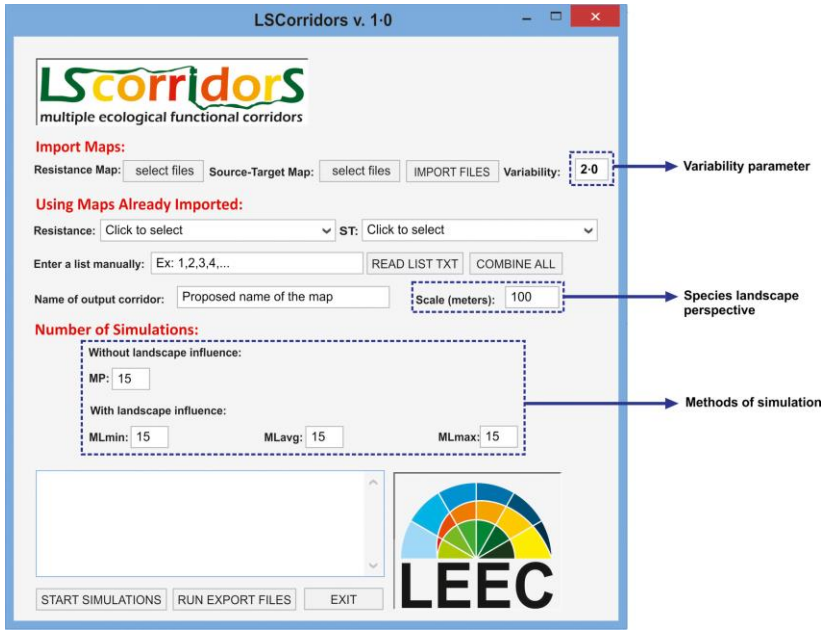
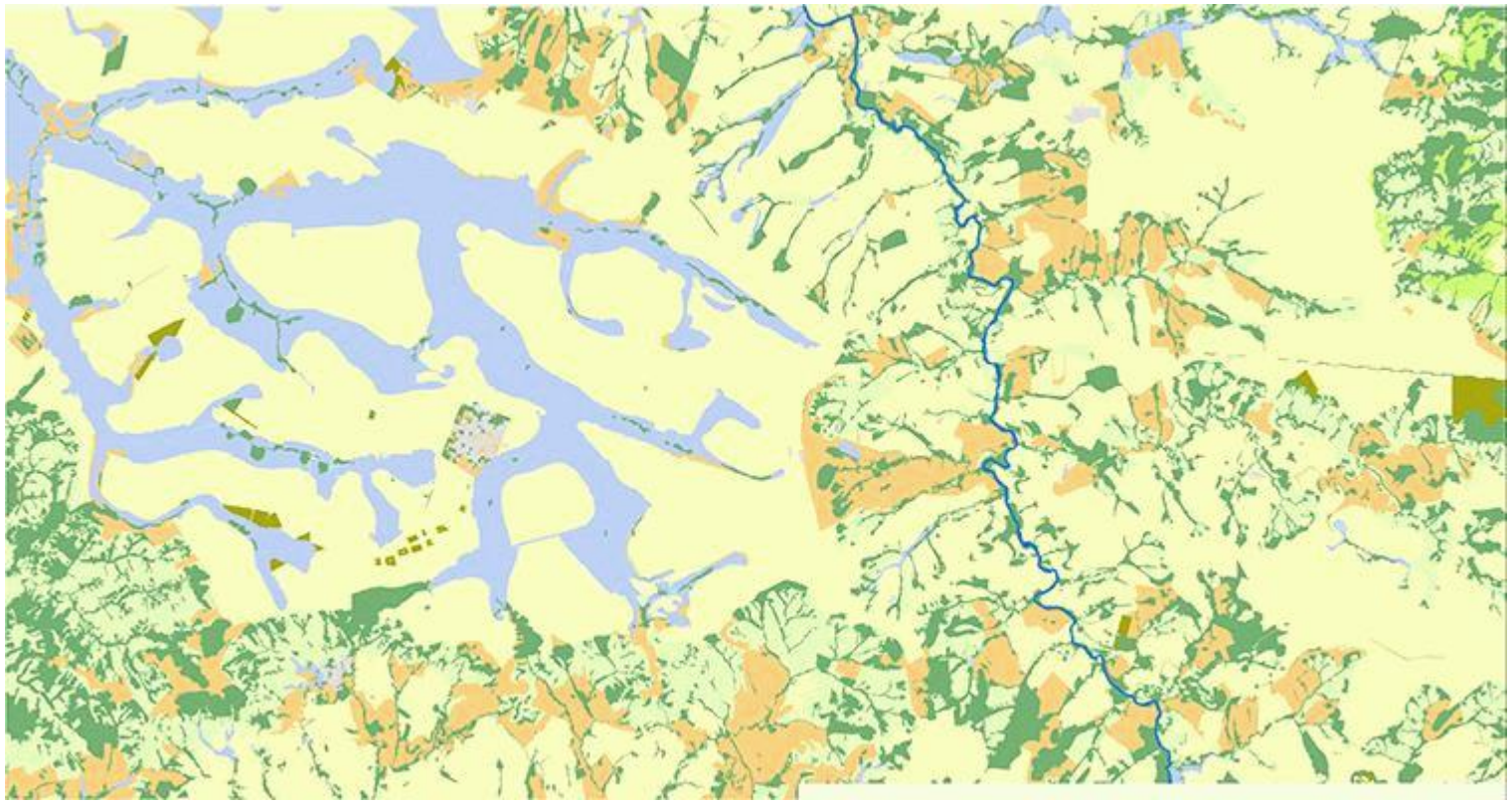
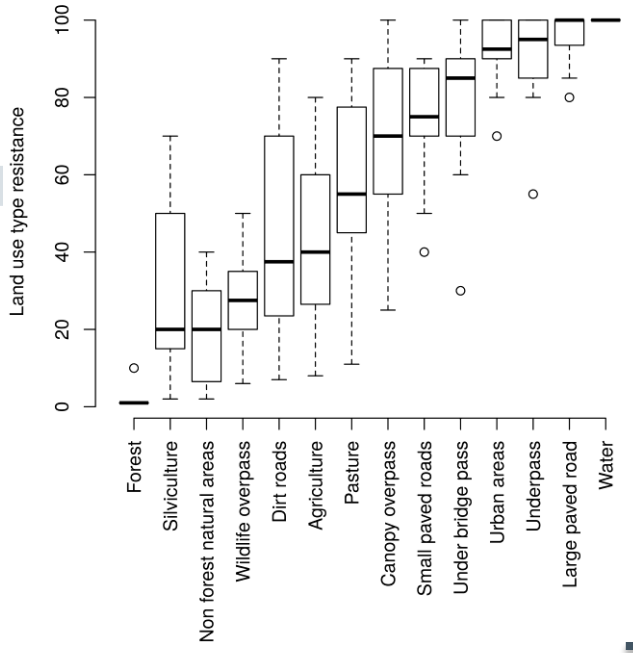
Movement meets roads



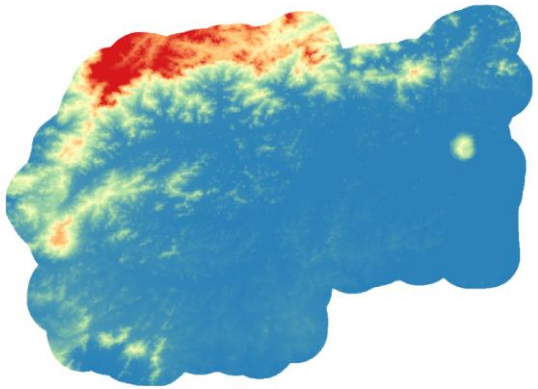
Ribeiro et al. 2017

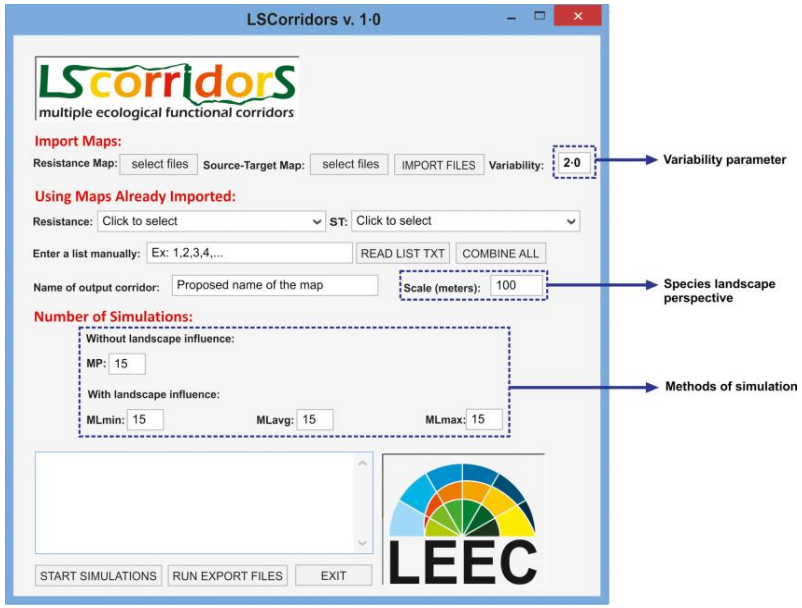


Expert knowledge



Elevation +





Movement meets roads

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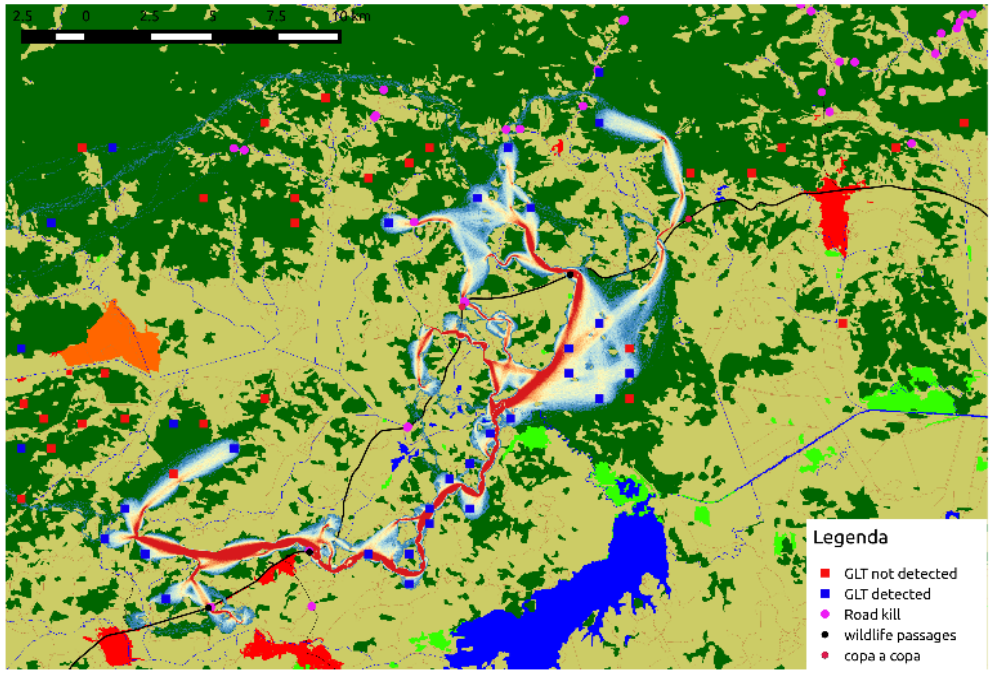
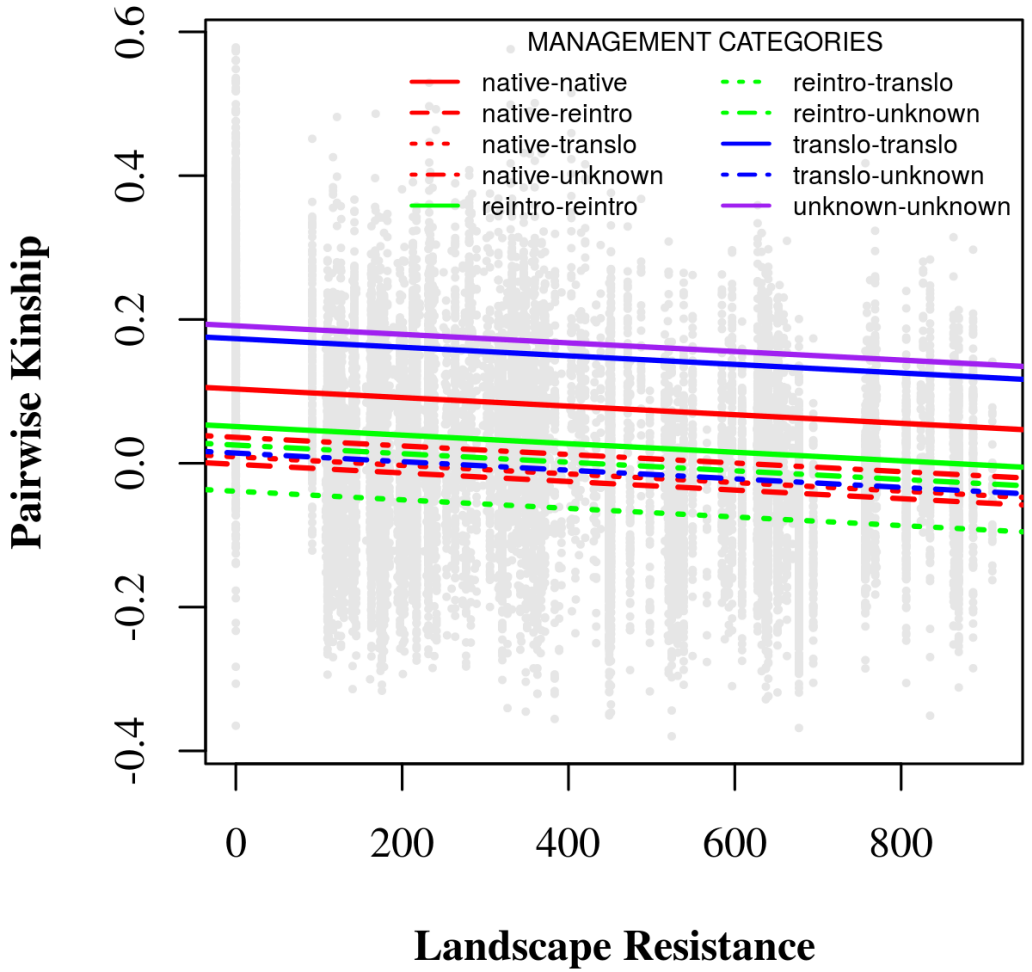
Movement meets roads





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Landscape genetics of GLT

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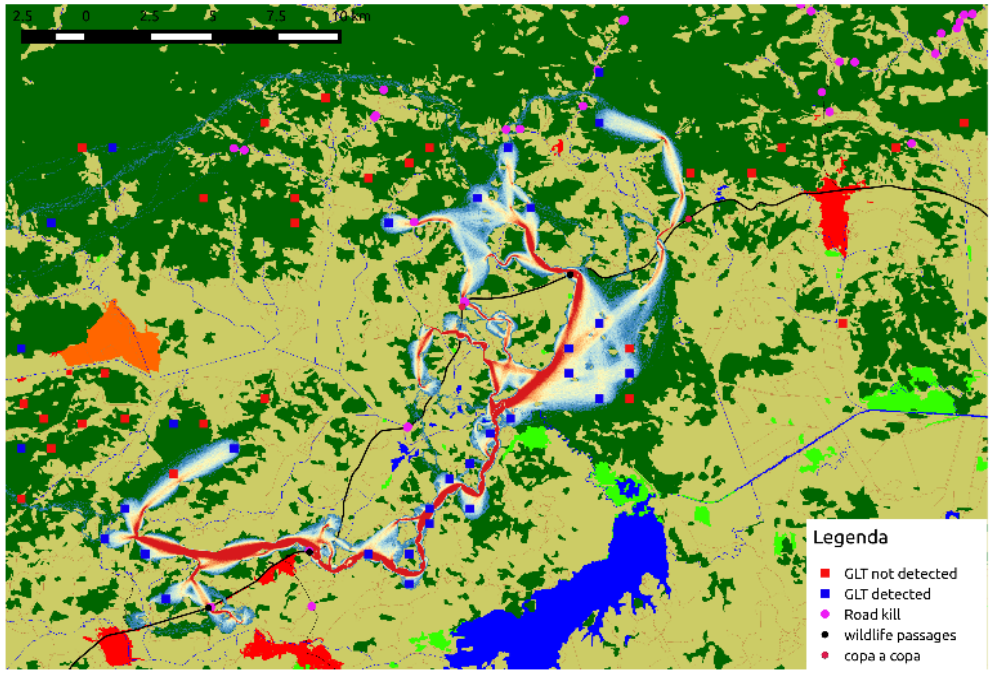
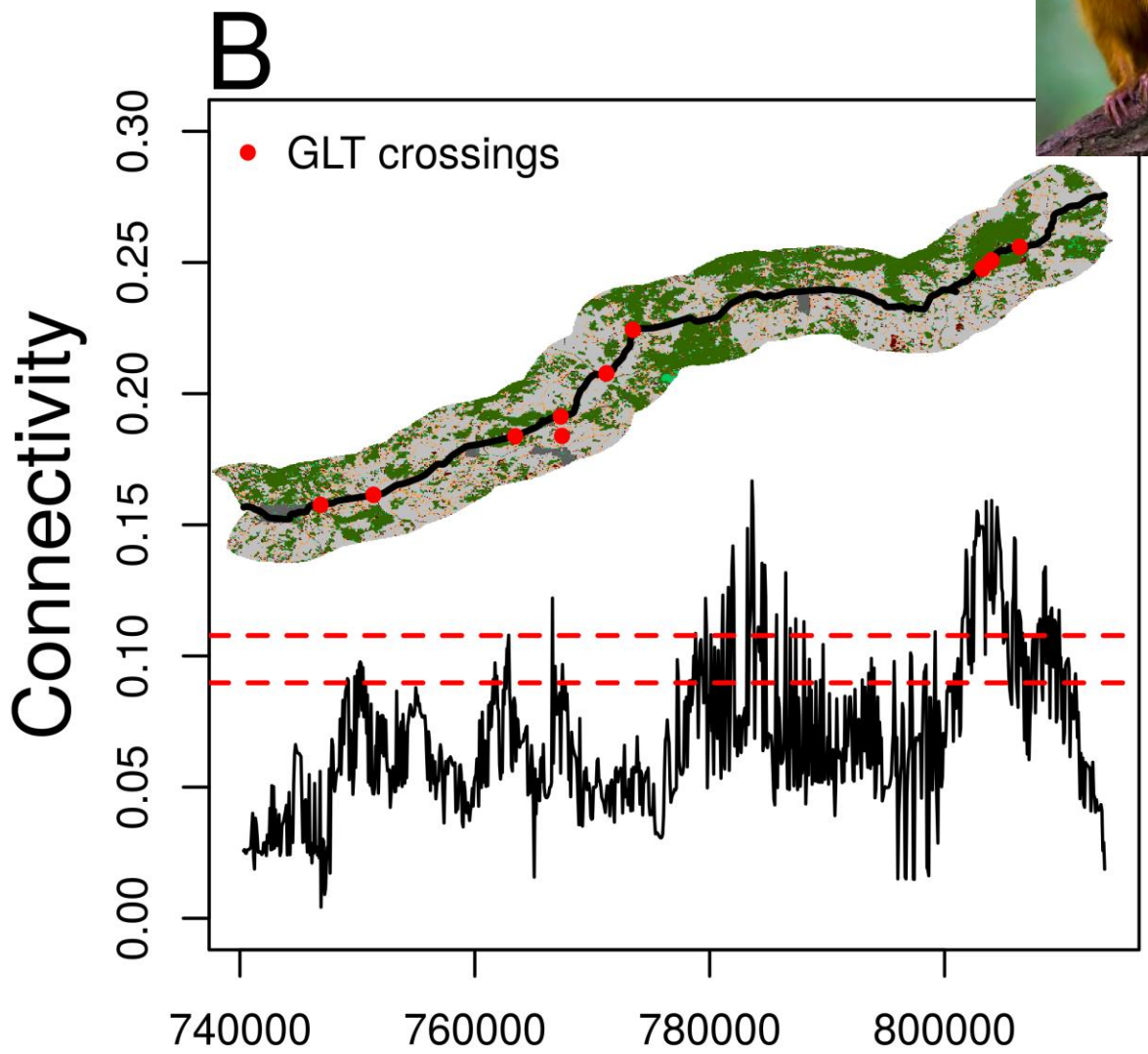
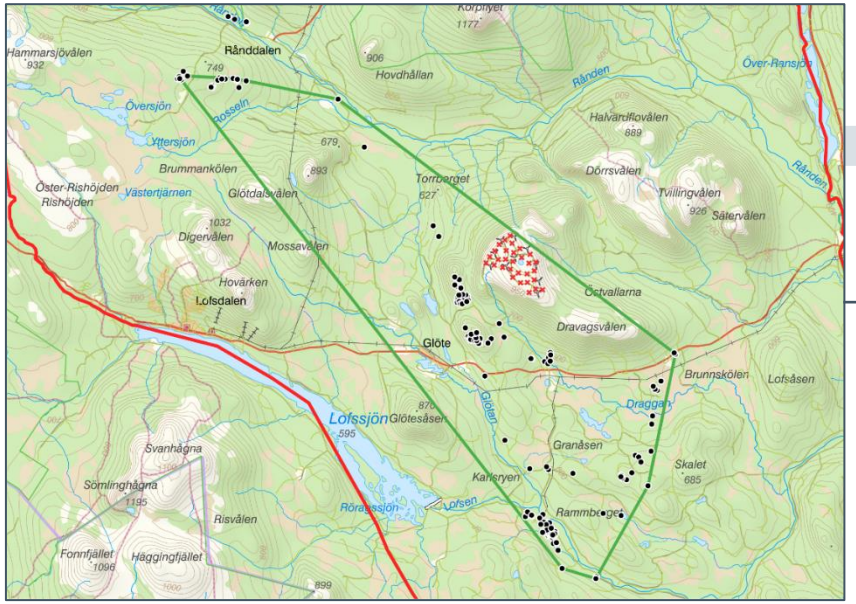


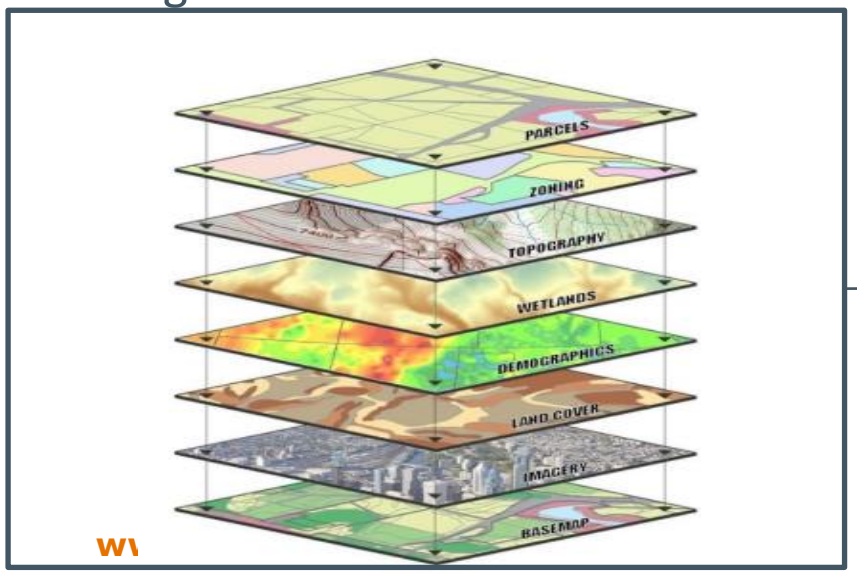


IA

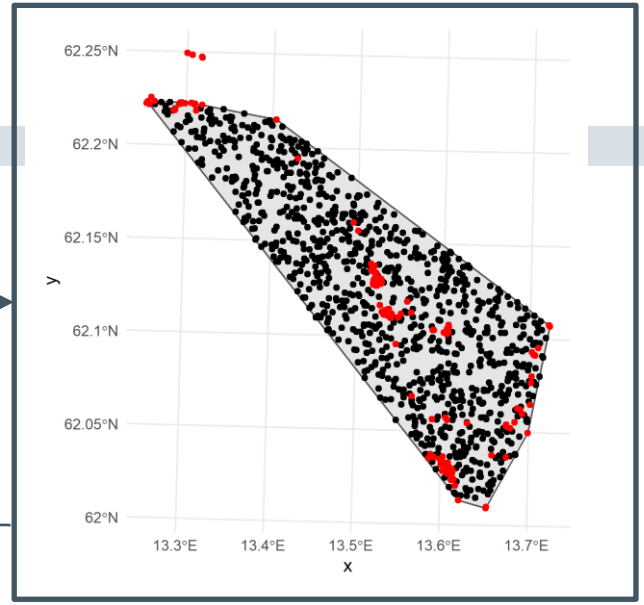
a. Animal movement (GPS) data



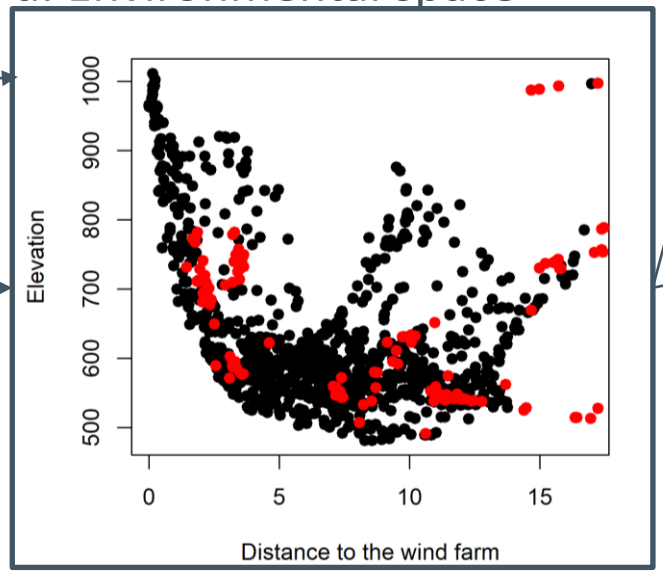
b. Background data



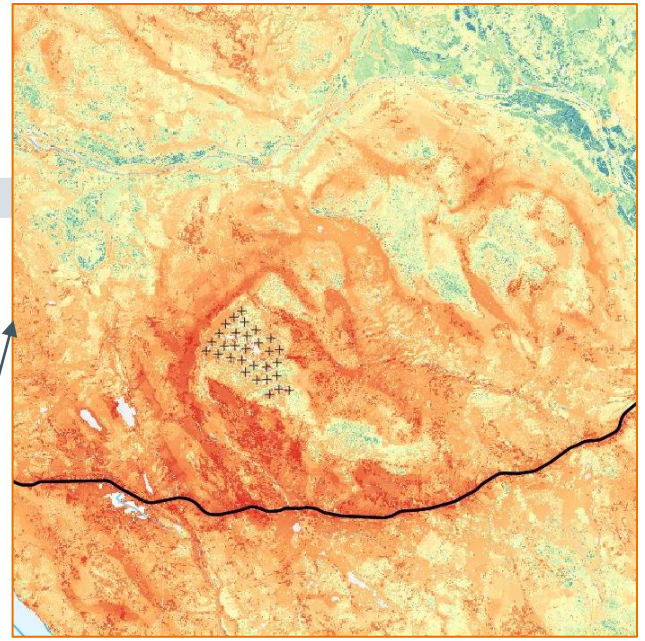
c. Use-availability design on geographical space

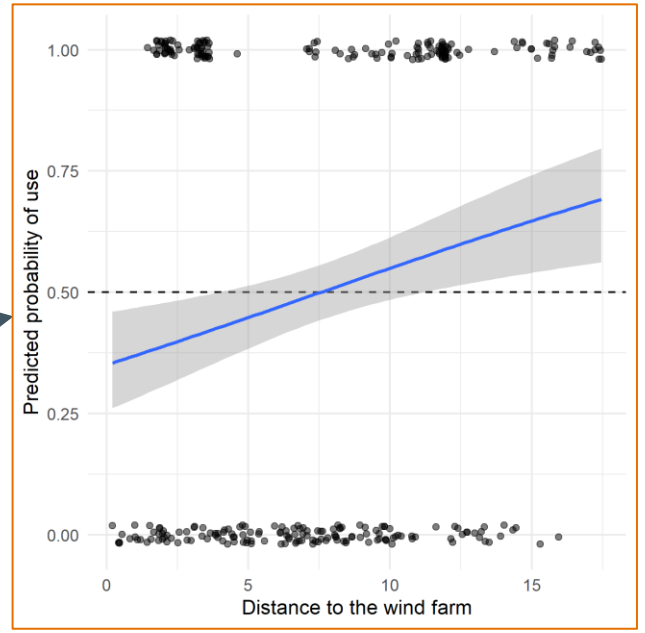


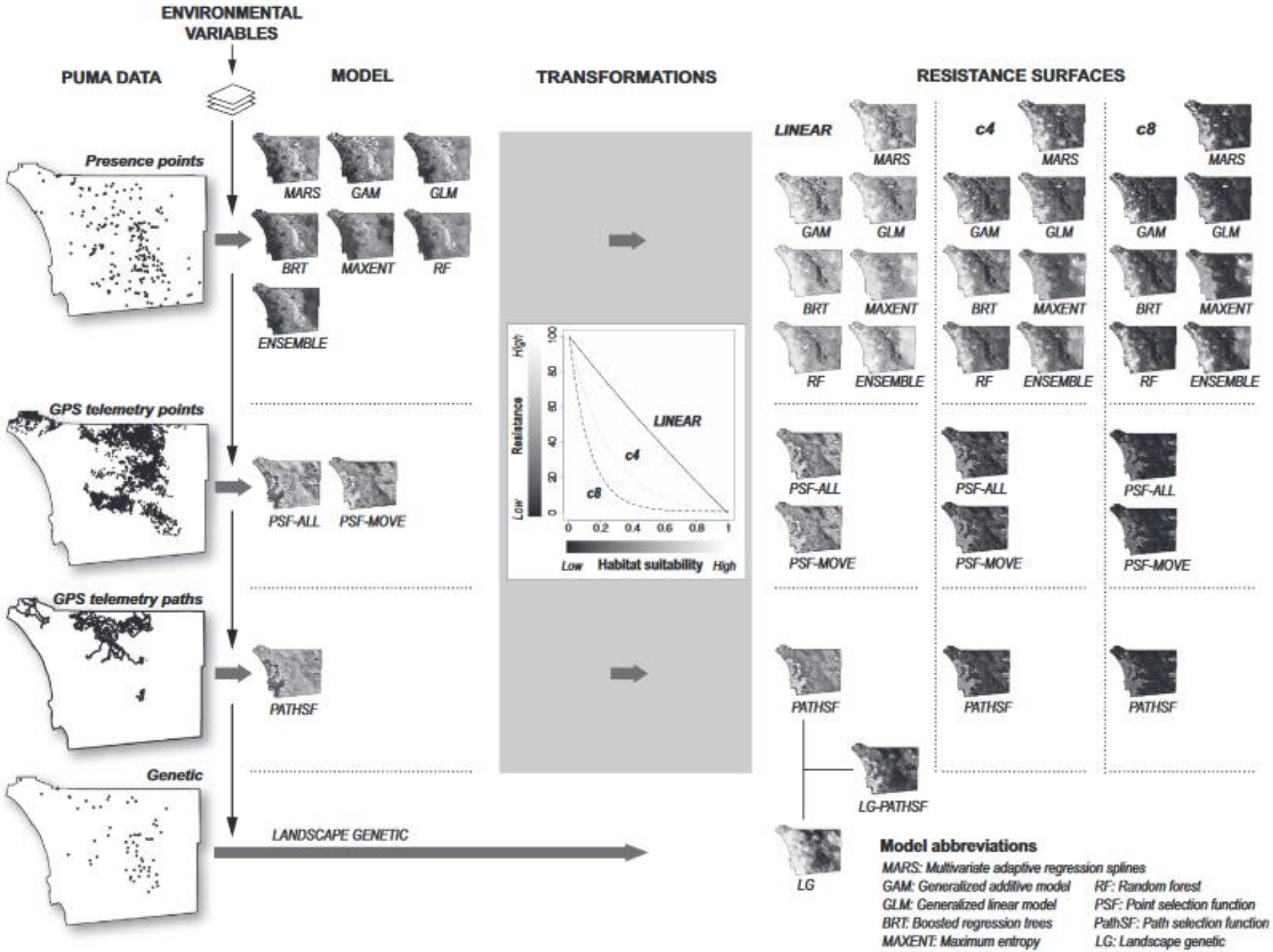
d. Environmental space



e. Predicted probability of use







Zeller et al. 2018

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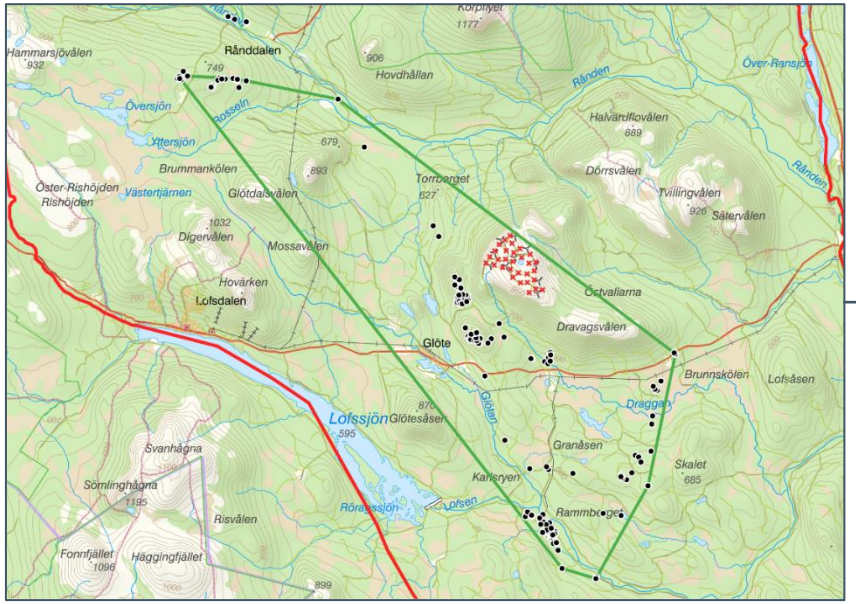

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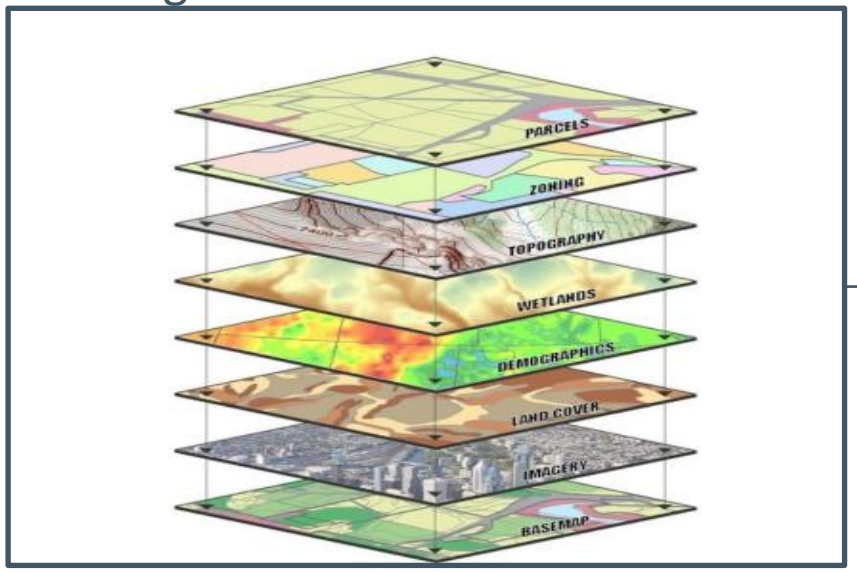

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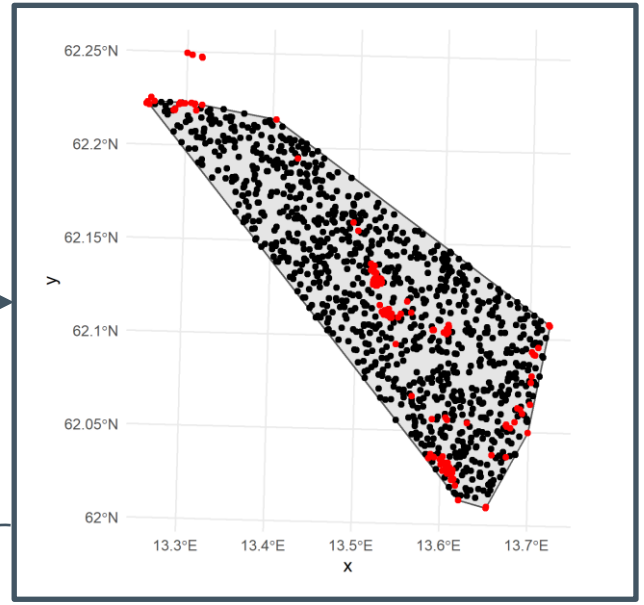

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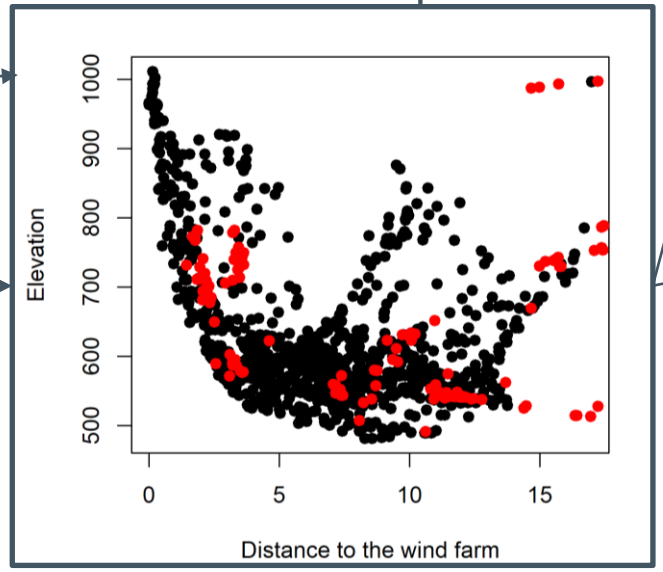

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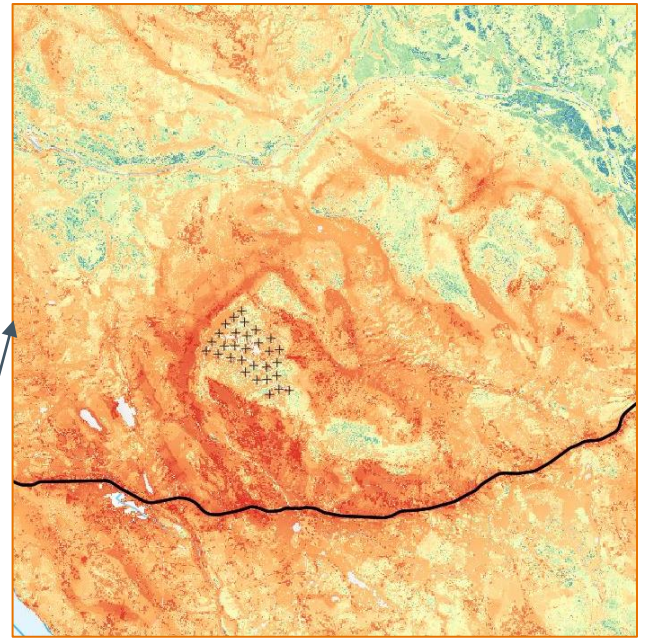

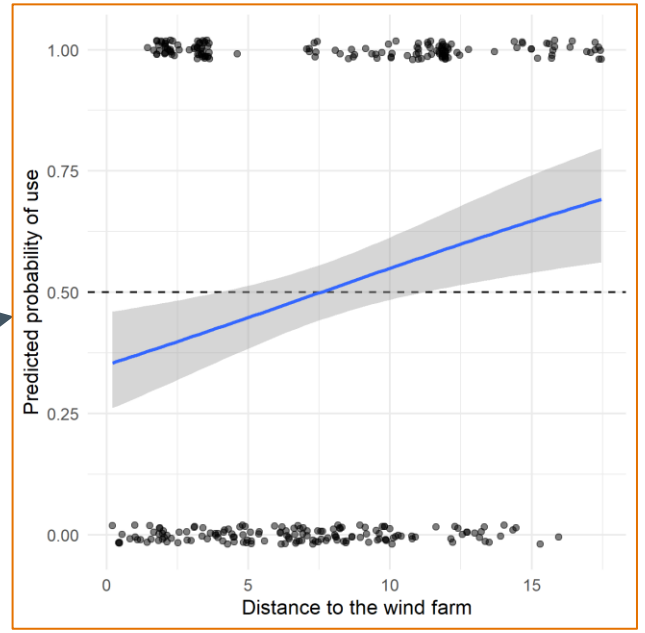

Habitat functionality: beyond Habitat suitability

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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(ENVIRONMENTAL SPACE)

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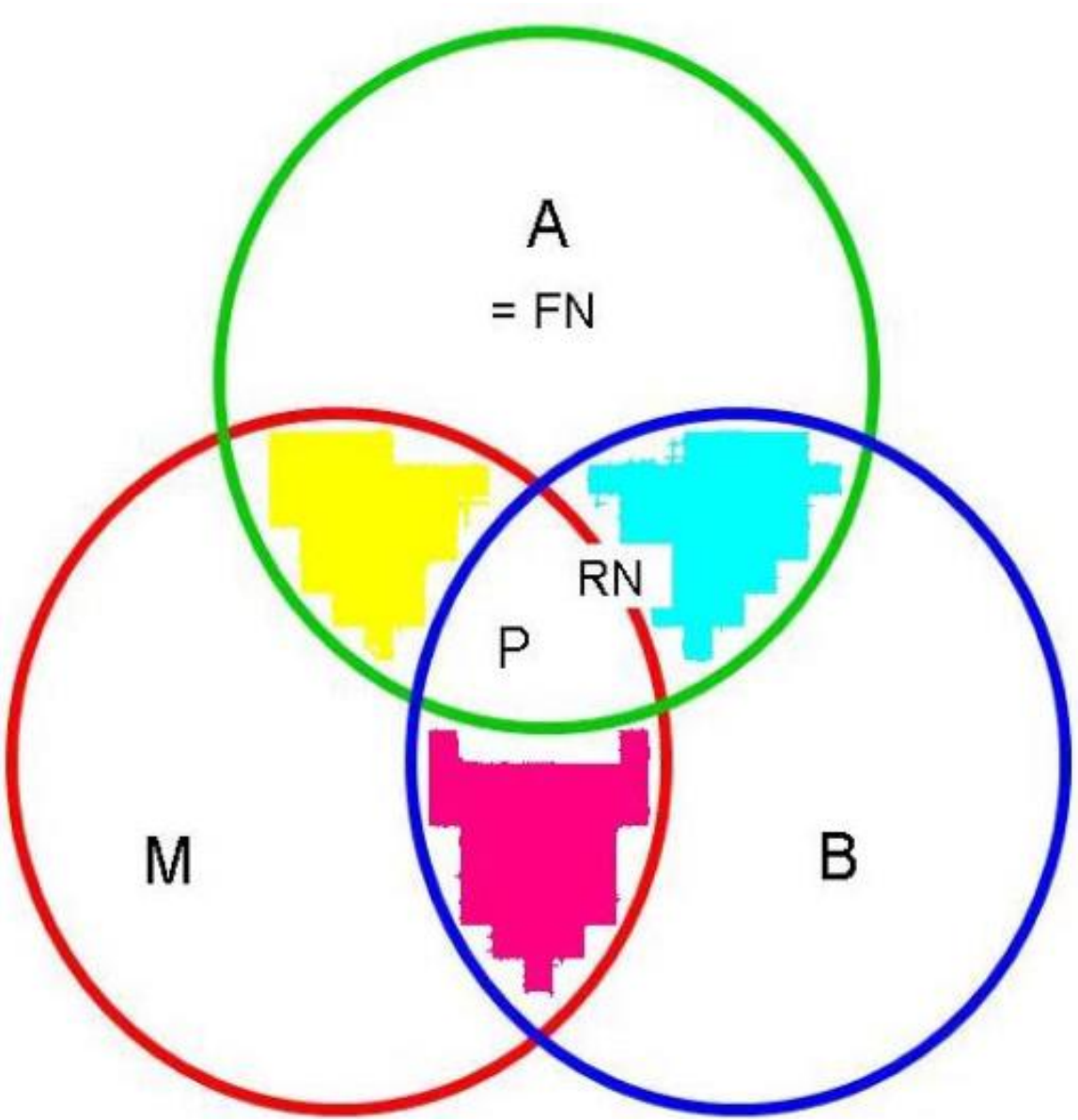
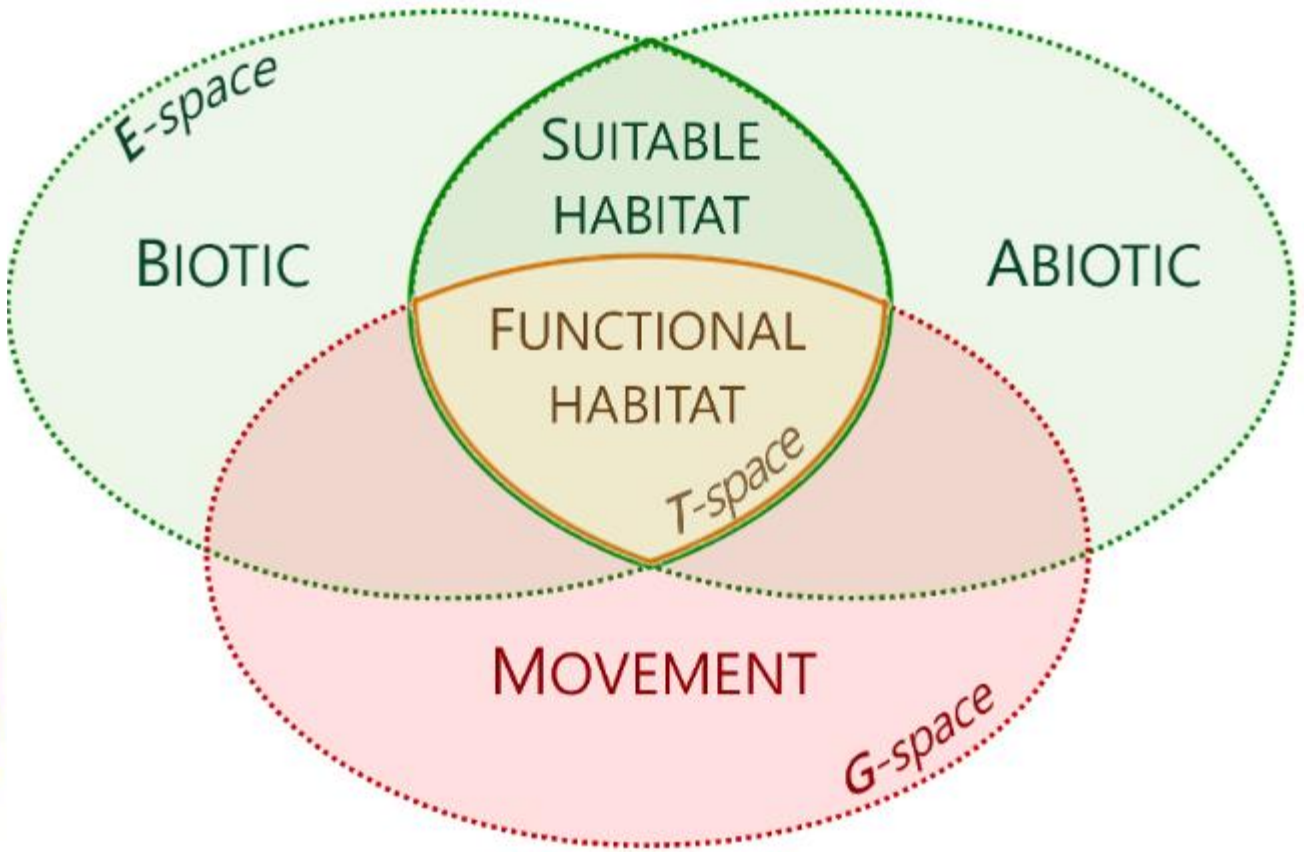
HABITAT QUALITY

HABITAT PERMEABILITY

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

Habitat functionality: beyond Habitat suitability





Van Moorter et al 2023b

HABITAT FUNCTIONALITY: BEYOND HABITAT SUITABILITY

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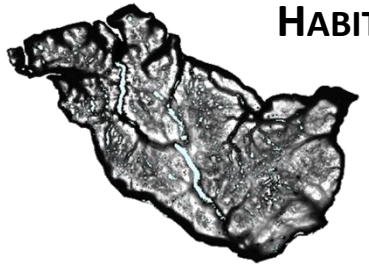
HABITAT QUALITY

Preferred

Avoided

HABITAT PERMEABILITY

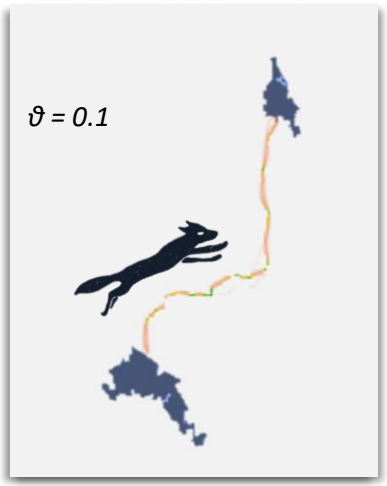


Permeable

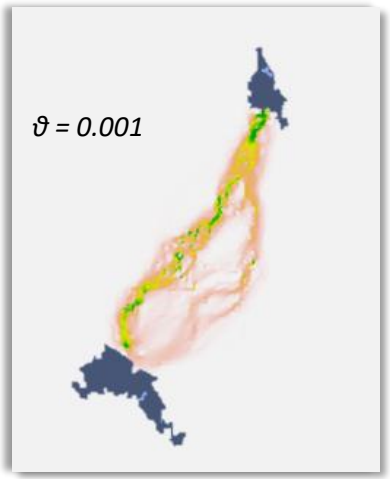
Barrier

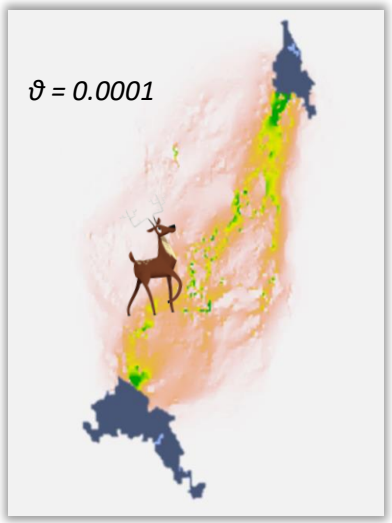
ConScape

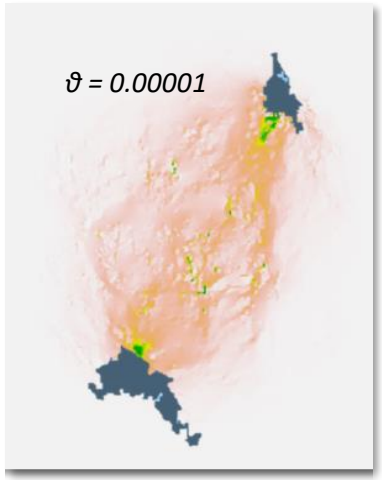
LEAST- COST PATH



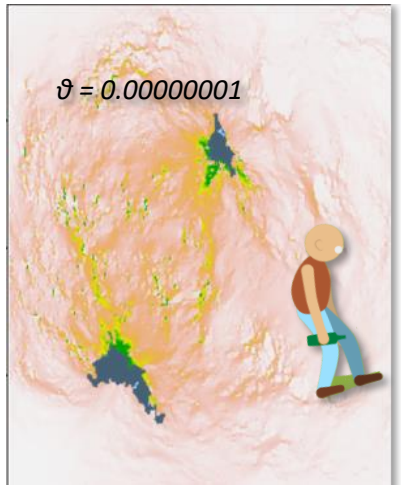
RANDOMIZED SHORTEST PATH







RANDOM WALK



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

HABITAT FUNCTIONALITY: BEYOND HABITAT SUITABILITY

DATA

SPECIES	HABITAT	CLIMATE - WEATHER	LAND USE & INFRASTRUCTURES	BIOTIC INTERACTIONS
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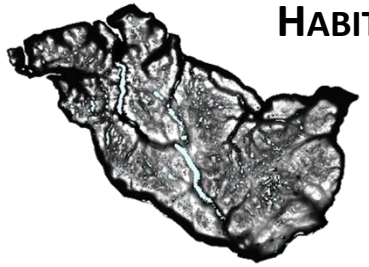
PIXEL FOCUS (ENVIRONMENTAL SPACE)

HABITAT QUALITY

Preferred

Avoided

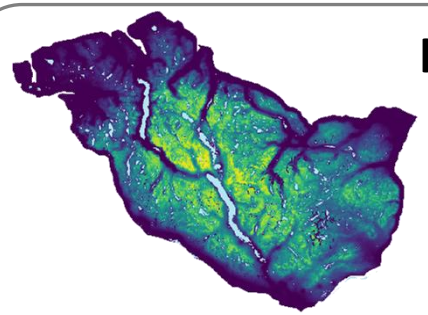
HABITAT PERMEABILITY



Permeable

Barrier

LANDSCAPE FOCUS (GEOGRAPHIC SPACE)



HABITAT FUNCTIONALITY

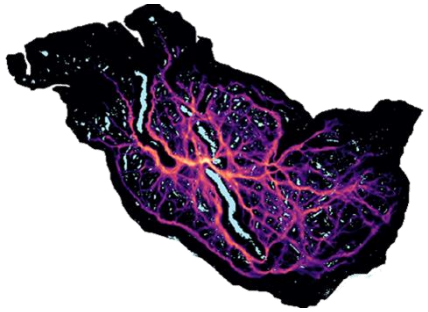
High (preferred and well connected)

Low (low quality &/or inaccessible)

MOVEMENT FLOW

High (movement hub, "traffic-jam")

Low

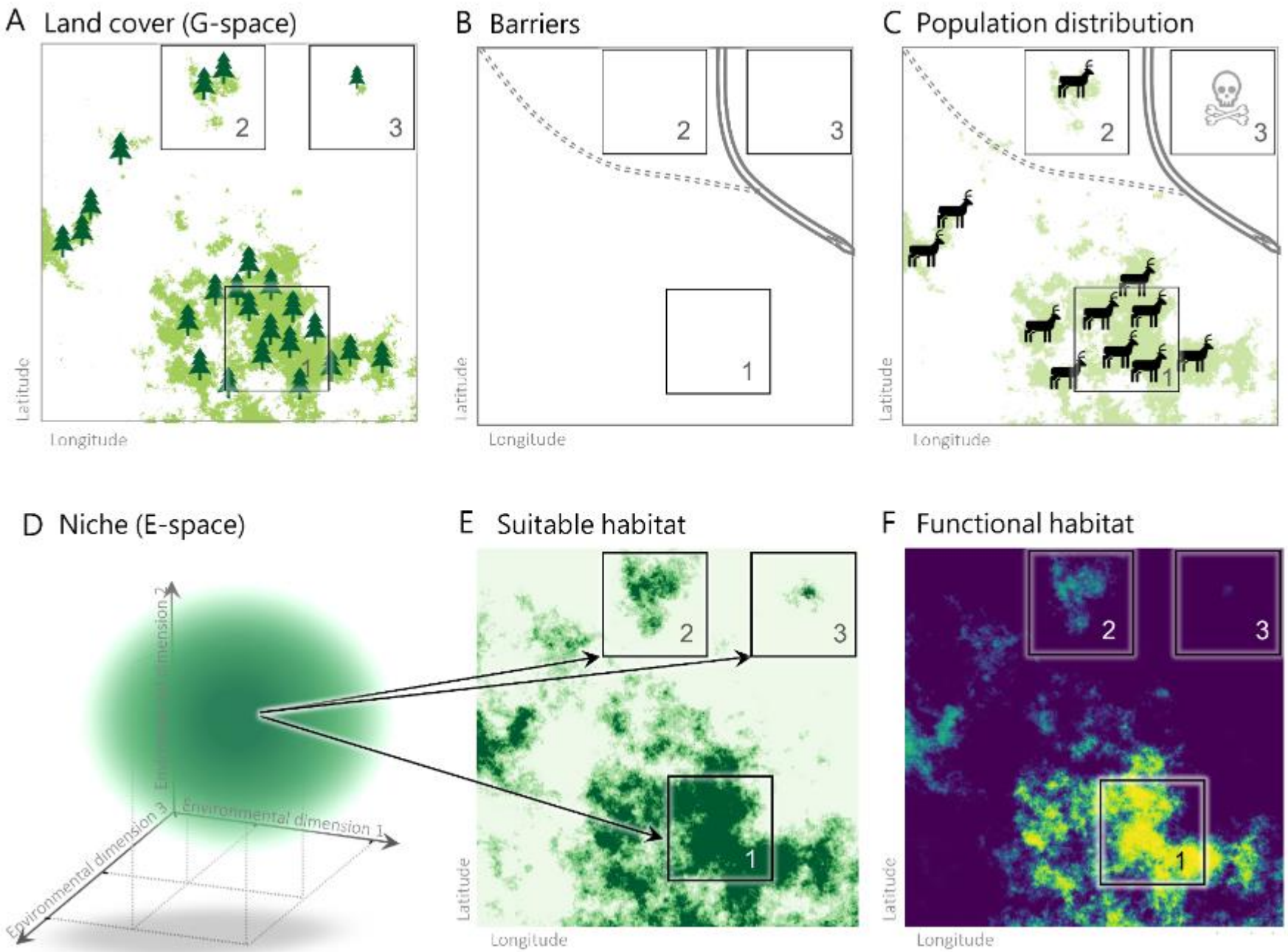


AID SUSTAINABLE LAND PLANNIG:

- *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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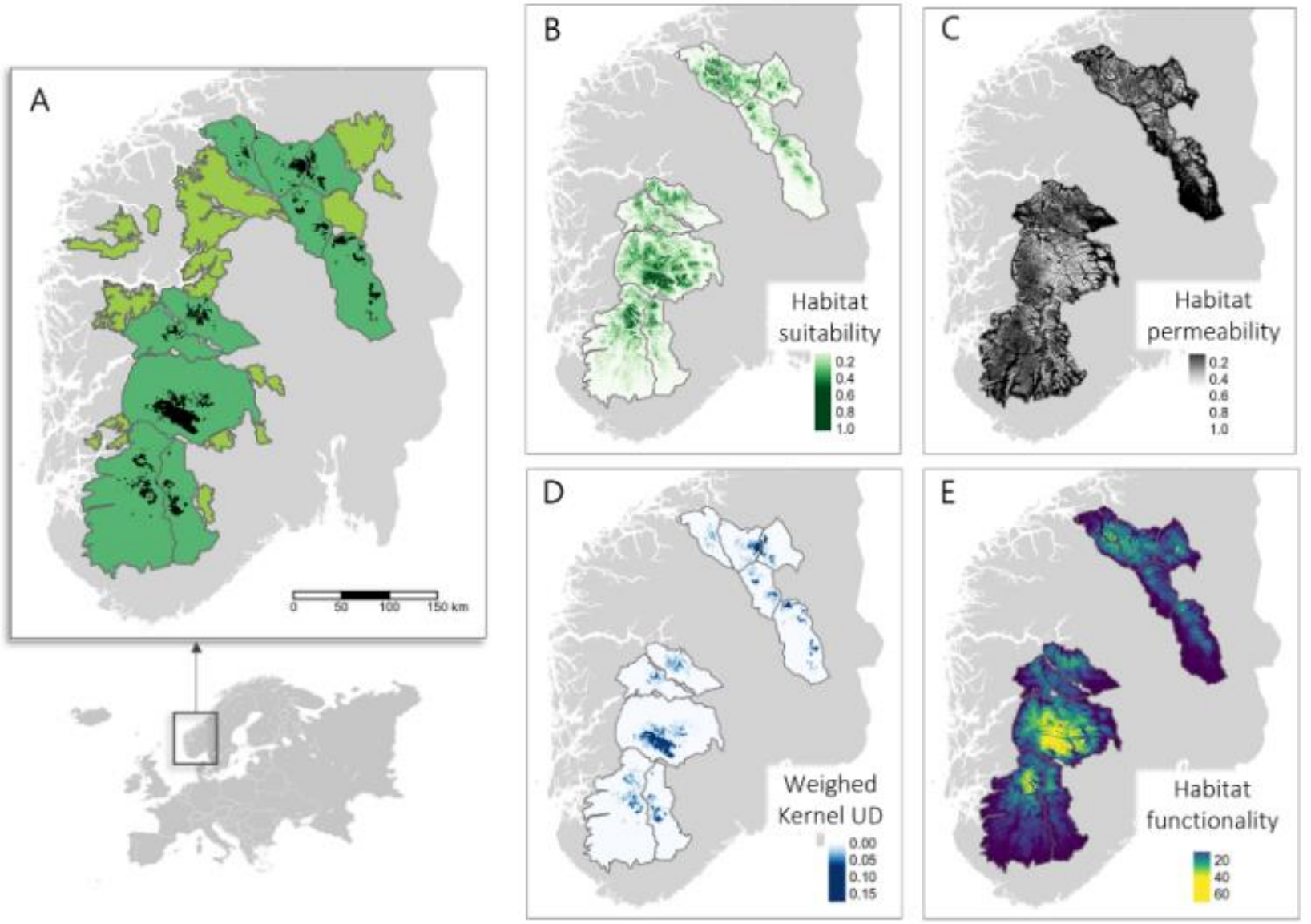

Van Moorter et al 2023b

Connectivity modeling tools

- R: leastcostpath package
- GRASS GIS/Python: LSCorridors
- Julia:
  - Circuitscape
  - ConScape

Literature

- Moraes, A. M., Ruiz-Miranda, C. R., Galetti Jr., P. M., Niebuhr, B. B., Alexandre, B. R., Muylaert, R. L., Grativol, A. D., Ribeiro, J. W., Ferreira, A. N., & Ribeiro, M. C. (2018). Landscape resistance influences effective dispersal of endangered golden lion tamarins within the Atlantic Forest. Biological Conservation, 224, 178–187. https://doi.org/10.1016/j.biocon.2018.05.023
- Zeller, K. A., Jennings, M. K., Vickers, T. W., Ernest, H. B., Cushman, S. A., & Boyce, W. M. (2018). Are all data types and connectivity models created equal? Validating common connectivity approaches with dispersal data. *Diversity and Distributions*, *24*(7), 868–879. https://doi.org/10.1111/ddi.12742
- Van Moorter, B., Kivimäki, I., Panzacchi, M., & Saerens, M. (2021). Defining and quantifying effective connectivity of landscapes for species' movements. Ecography, 44(6), 870–884. https://doi.org/10.1111/ecog.05351
- Van Moorter, B., Kivimäki, I., Noack, A., Devooght, R., Panzacchi, M., Hall, K. R., Leleux, P., & Saerens, M. (2023). Accelerating advances in landscape connectivity modelling with the ConScape library. Methods in Ecology and Evolution, 14(1), 133–145. https://doi.org/10.1111/2041-210X.13850
- Van Moorter, B., Kivimäki, I., Panzacchi, M., Saura, S., Brandão Niebuhr, B., Strand, O., & Saerens, M. (2023). Habitat functionality: Integrating environmental and geographic space in niche modeling for conservation planning. Ecology, n/a(n/a), e4105. https://doi.org/10.1002/ecy.4105

Cooperation and expertise for a sustainable future

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