Occupancy modeling for wild ungulates from camera traps at National scale

Sonia Illanas[1], Joaquín Vicente[1], Pelayo Acevedo[1], Elise Zipkin[2]

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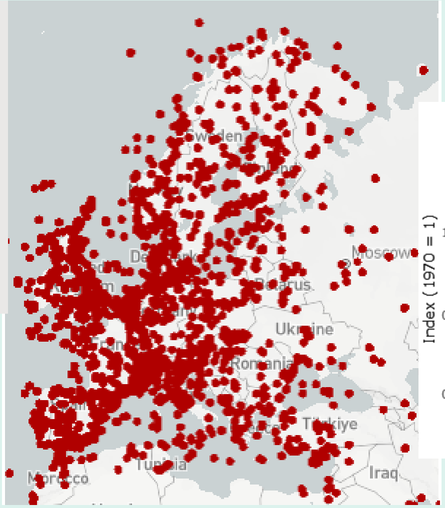
PONTEVEDRA
2-6th JUNE
2025
III SIBECOL & XVII AEET MEETING
Another science is possible
Diversity, degrowth, and sustainability in ecological research

Quantify distribution and abundance of wildlife

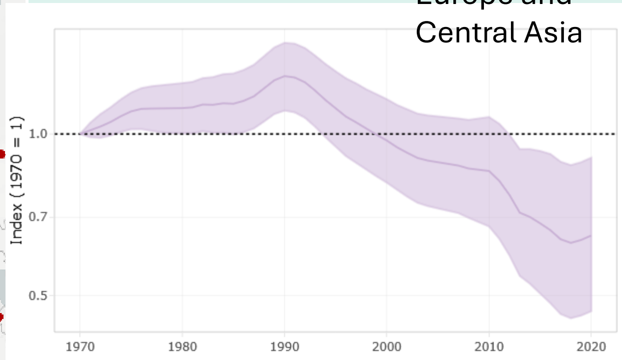
Living Planet Index

4615 populations

619 freshwater & terrestrial species



35% nature loss in Europe and Central Asia



LPI (2024) www.livingplanetindex.org/

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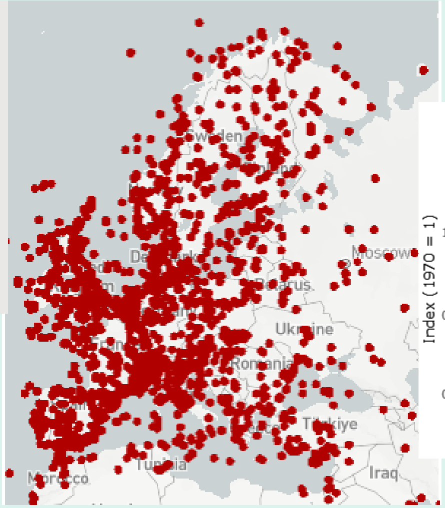

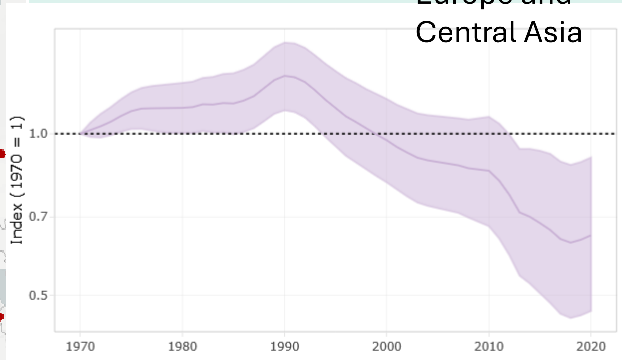

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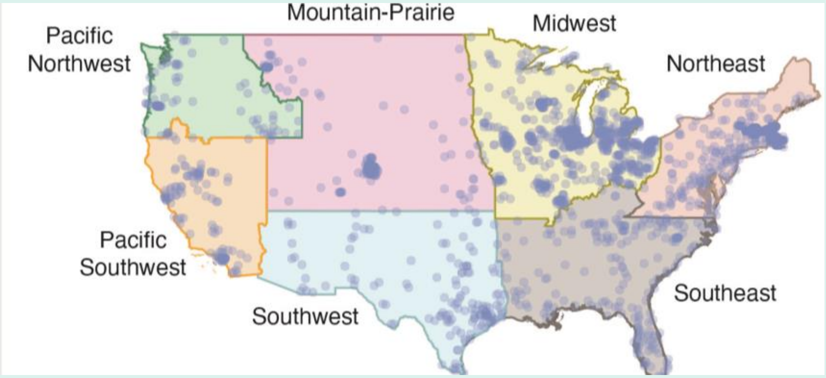
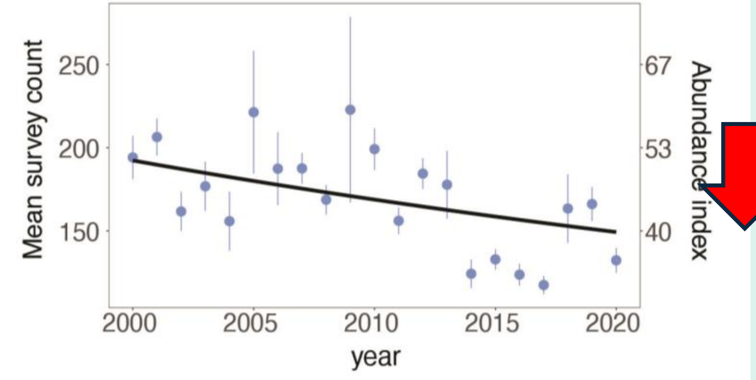
Rapid butterfly decline across the United States during the 21st century

12.6 million individual butterflies counted

76,957 surveys analyzed

35 monitoring programs





22% decrease in total number of butterflies from 2000-2020

Fig. 1. (A). The transparent blue points on the map show the 2478 unique survey locations. **(B)** The black line shows our estimated abundance index derived from a fitted generalized additive model of total annual butterfly abundance.

Edwards et al. (2025) Science 387,1090-1094.

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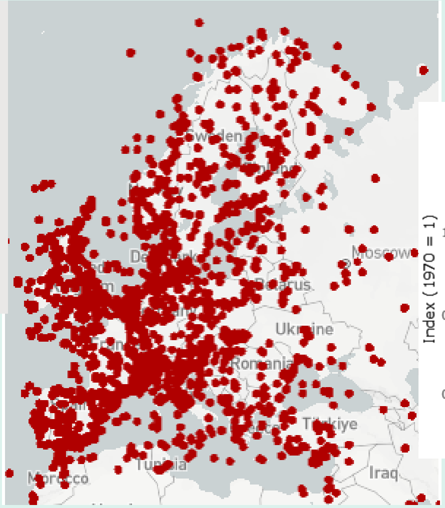

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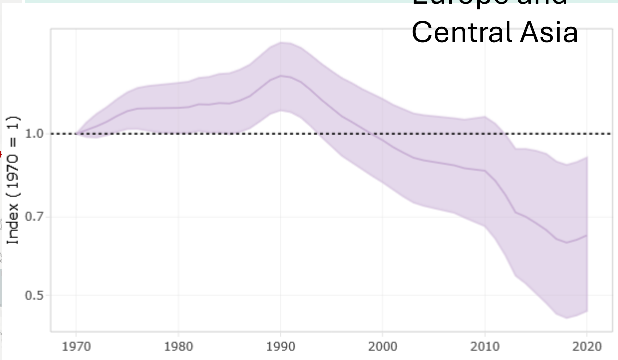

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EUROPABON

Valdez et al., (2023). Ecography, 2023: e06604

Lack of available data for detecting global biodiversity trends!

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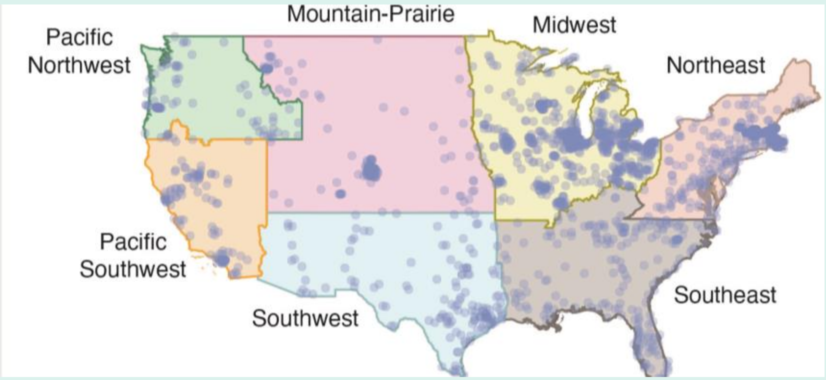

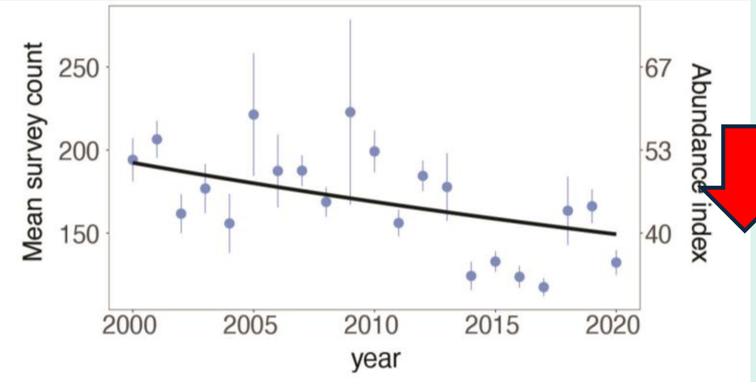

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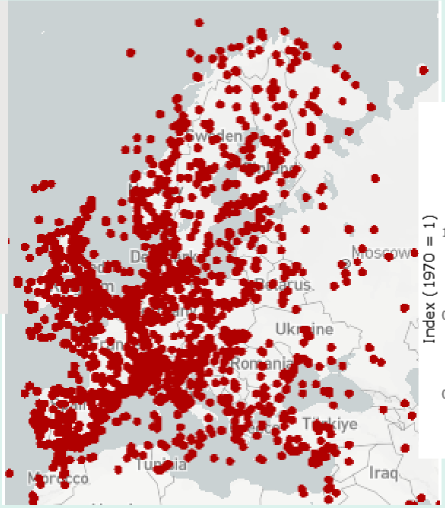

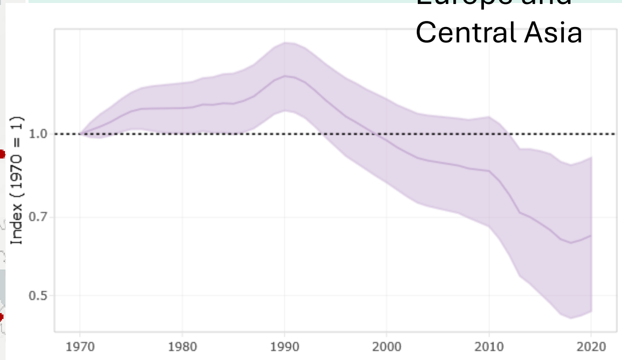

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ENETWILD ONE HEALTH AND WILDLIFE

How was the data generated?

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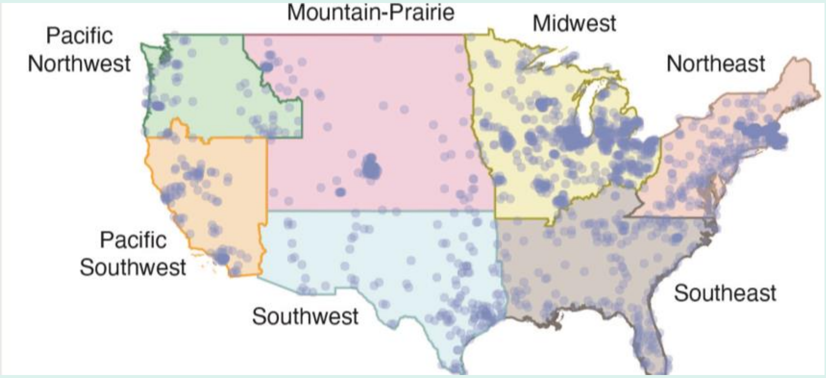

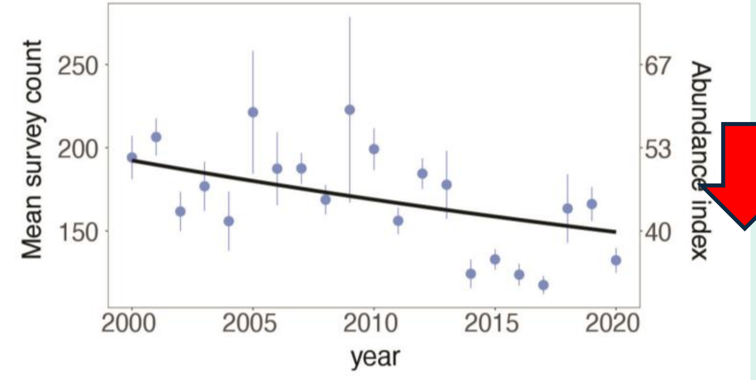

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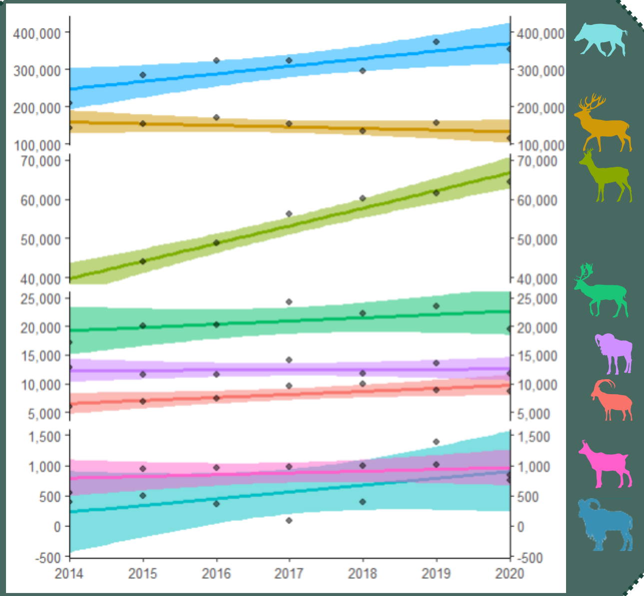

Number of animals hunted
2014-2020

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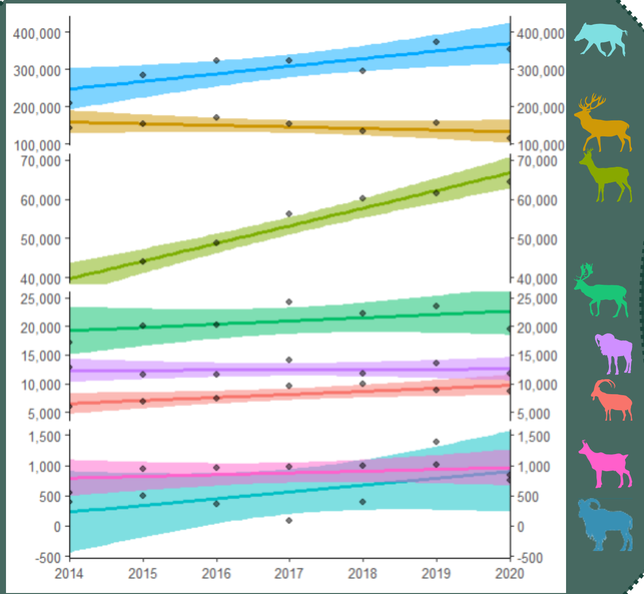

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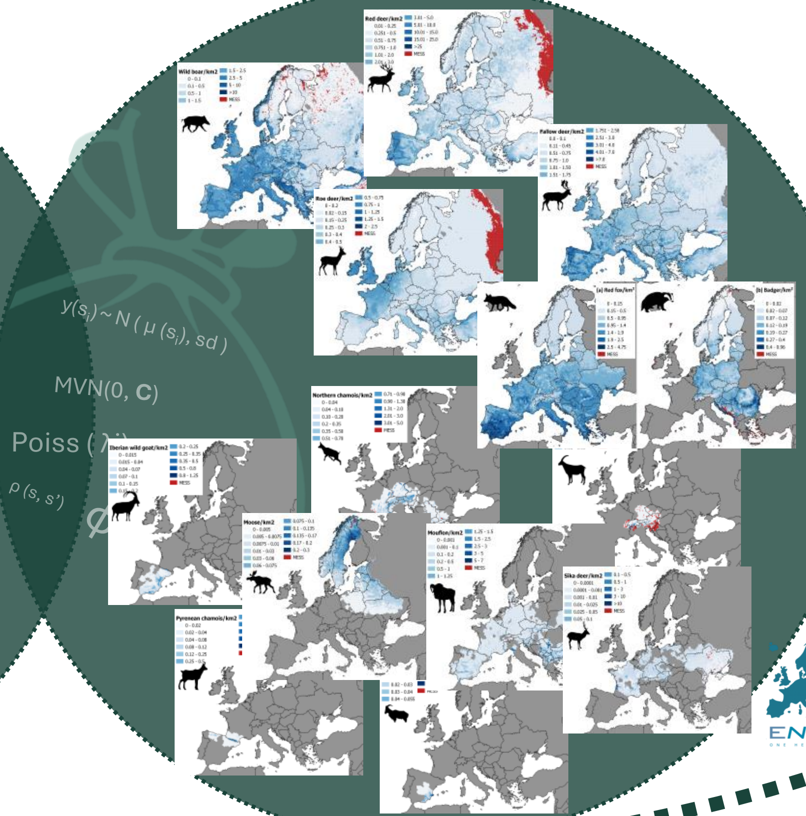

Data is **essential.**

ENETWILD

Wildlife monitoring at large scales

To improve population monitoring in Spain (and Europe), a network of observatories were established since 2021.

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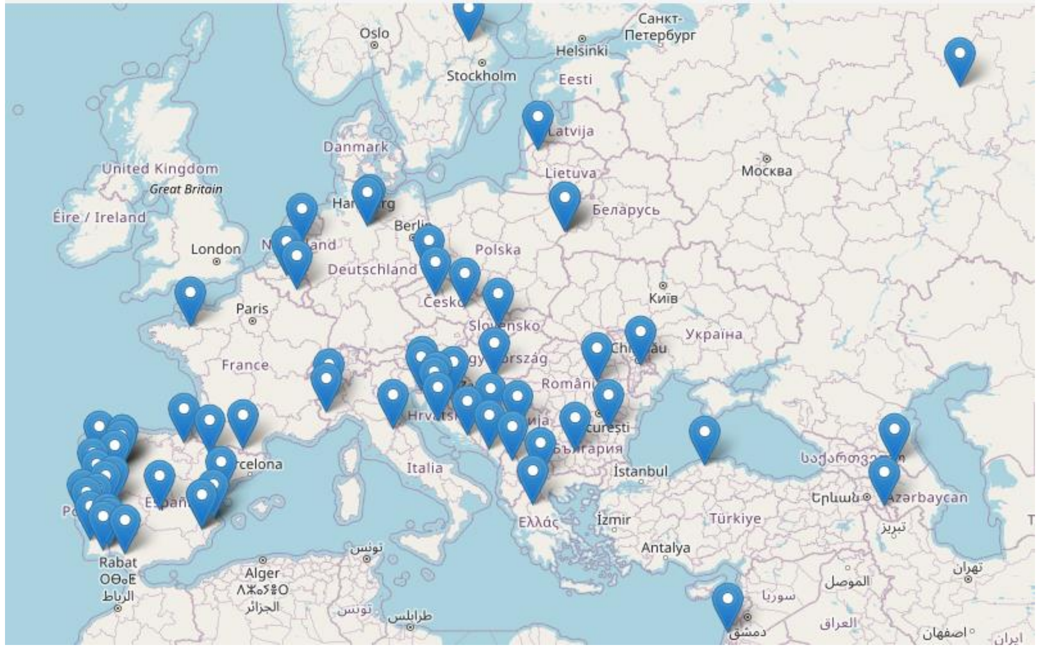

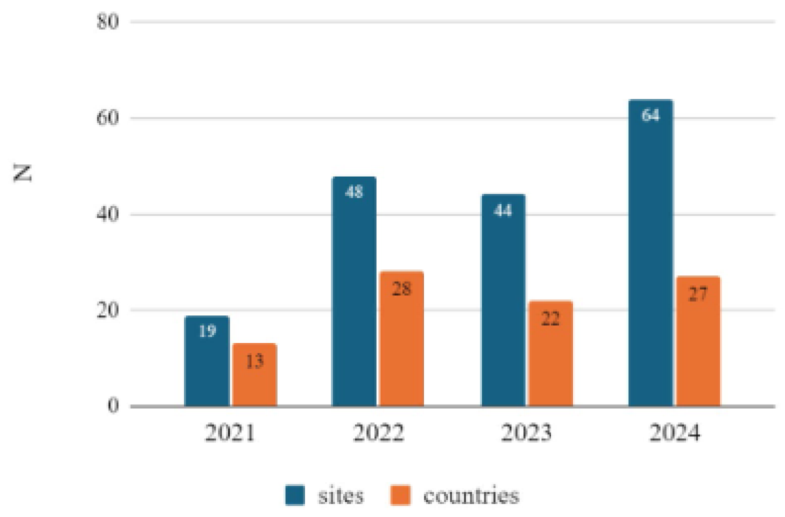

Figure 22. Number of observation sites and countries covered by the EOW

european observatory of wildlife

Contact us if you'd like to be part of the observatory network!

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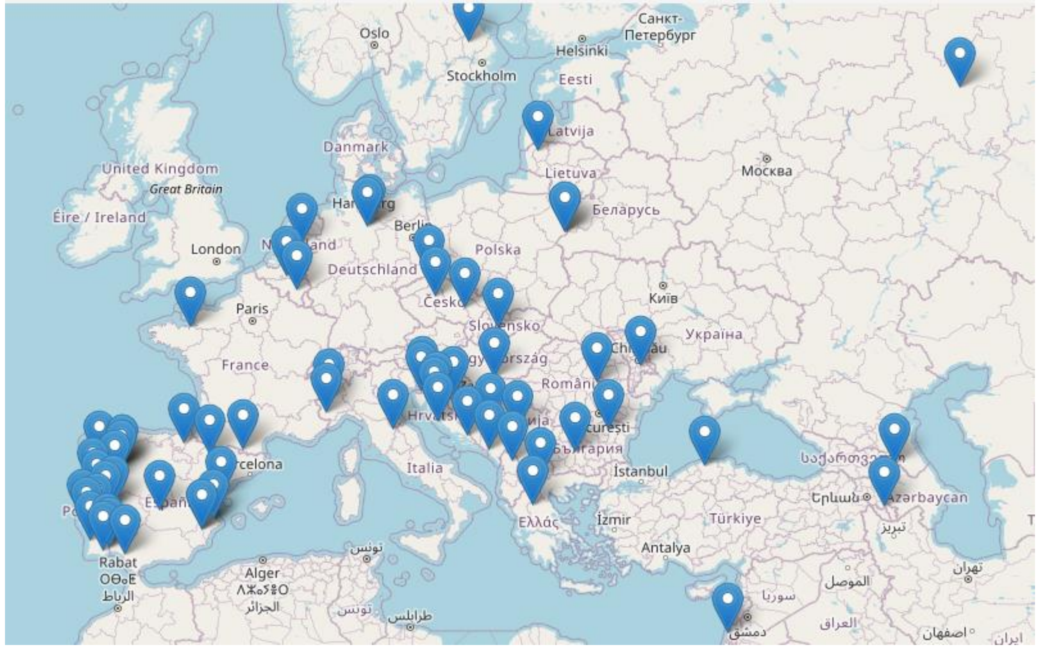

EXTERNAL SCIENTIFIC REPORT

ENETWILD

APPROVED: 22 June 2021

doi:10.2903/sp.efsa.2021.EN-6771

Data generated by camera trapping in at least 15 areas in Europe including East and South Europe: Report of the field activities - first semester 2021

ENETWILD-consortium[1]

External Scientific Report

APPROVED: 18 October 2024
doi: 10.2903/sp.efsa.2024.EN-9084

Generating wildlife density data across Europe in the framework of the European Observatory of Wildlife (EOW)

ENETWILD-consortium[1], Guerrasio T, Carniato D, Acevedo P, Apollonio M, Arakelyan M, Arnon A, Beatham S, Belova O, Berde L, Berdión O, Blanco-Aguiar JA, Bleier N, Burgui Oltra JM, Bužan E , Carvalho J, Casaer J, Del Frate M, Dijkhuis L, Duniš L, Ertürk A, Dal Mas M, Ferroglio E, Forti A, Gačić D, Gavashelishvili A, Hillström L, Jenječić M, Ježek M, Keuling O, Licoppe A, Liefting Y, Martinez-Carrasco C, Olano I, Palencia P, Plis K, Podgorski T, Pokorny B, Rowcliffe M, Santos J, Smith GC, Sola de la Torre J, Šprem N, Stoyanov S, Zanet S, Vicente J, and Scandura M

ıe EOW

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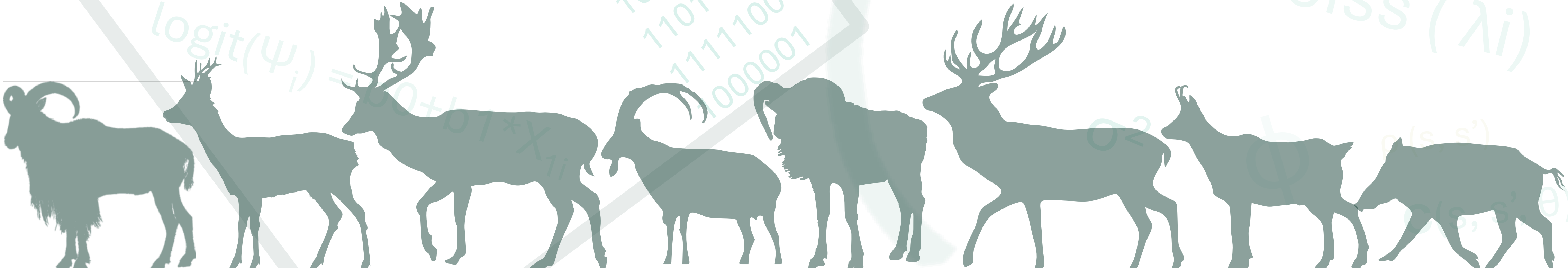
Occupancy patterns at National scale

1. The aim of this work is to **model occupancy** of **wild ungulates** at **national level** using a **camera trap** network.

2. **Compare** if the **spatial predictions** are **equivalent** to the patterns shown by **hunting yields statistics**.



Camera trap sampling

30 locations

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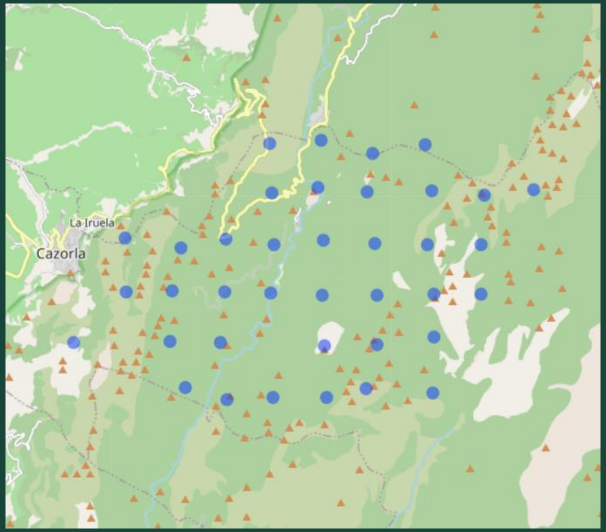
Regular grid

(Random origin)
715 CT



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Temporal serie

Oct2023 –Jul2024

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Sampling occasion: week

Avoid temporal correlation

Detected (1) / No detected (0)

Goldstein et al. (2024), MEE 15, 1177-1191

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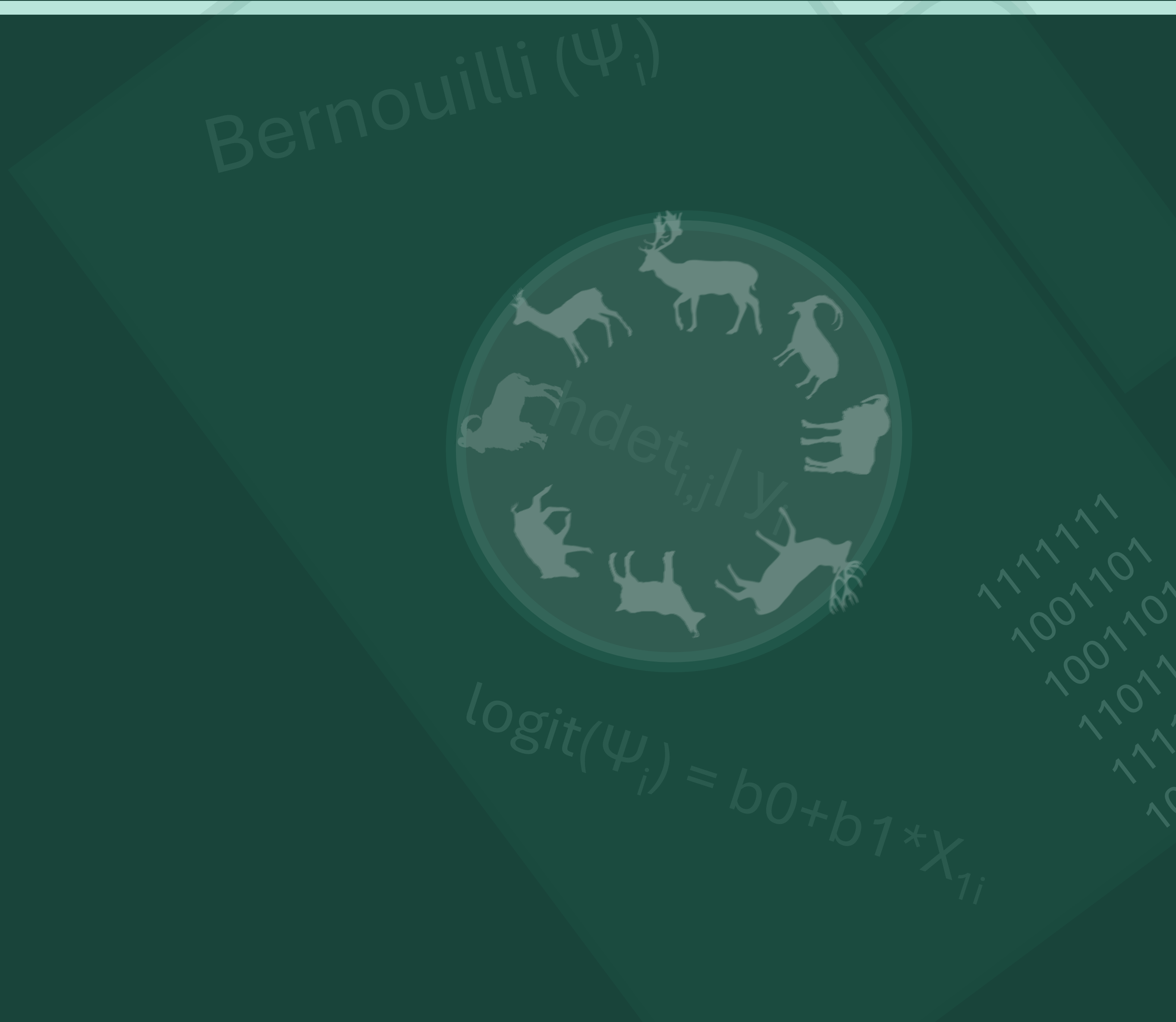
Agouti: Image identification
AI deepFaune v6.2



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SINGLE SPECIES OCCUPANCY MODEL (SSOM)

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Single Species Occupancy Models

Occupancy Model

Detectability Model

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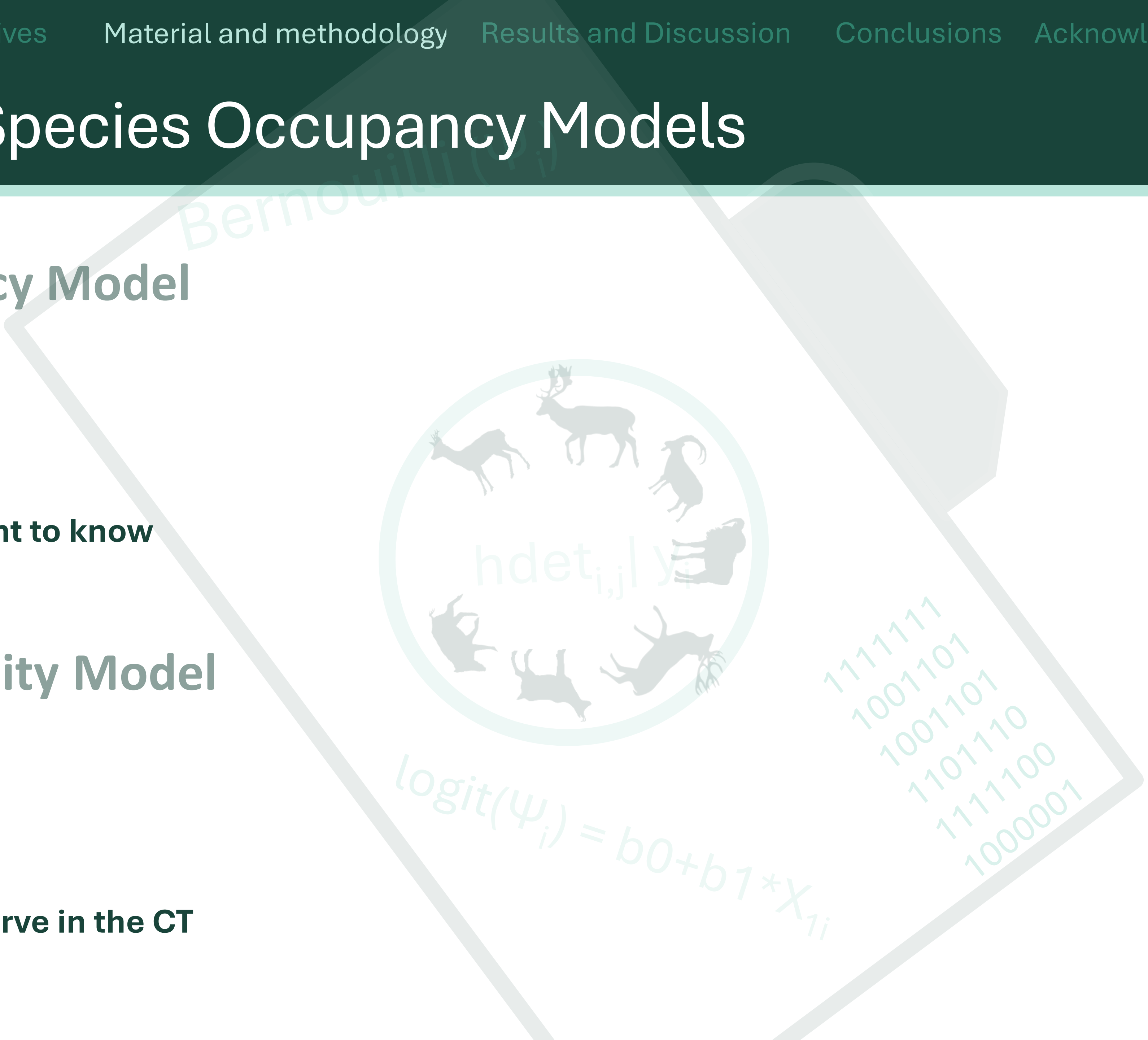
Single Species Occupancy Models



Occupancy Model

What we want to know

Detectability Model

What we observe in the CT

Single Species Occupancy Models

Occupancy Model

$Z_i \sim \text{Bernouilli}\ (\Psi_i)$

$\text{logit}\ (\Psi_i) = \boldsymbol{\beta} * \mathbf{X}_i$

What we want to know

Detectability Model

$(y_{i,j} | Z_i) \sim \text{Bernouilli}\ (Z_i * p_{i,j}\ )$

$\text{logit}(p_{i,j}) = \alpha 0 + \alpha 1 * X1_i + \alpha 2 * X2_{i,\ j}$

What we observe in the CT

i: site, where?

j: occassion, when?

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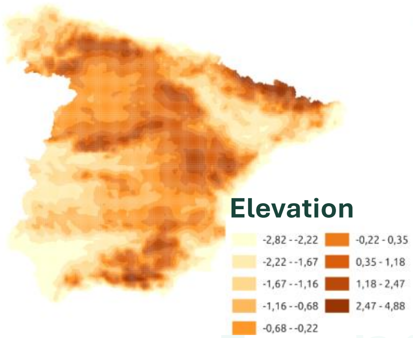

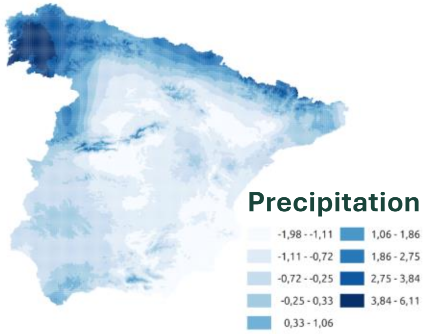

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Random effect

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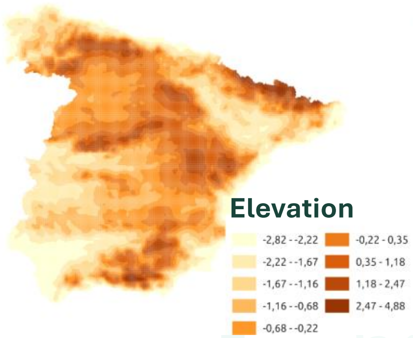

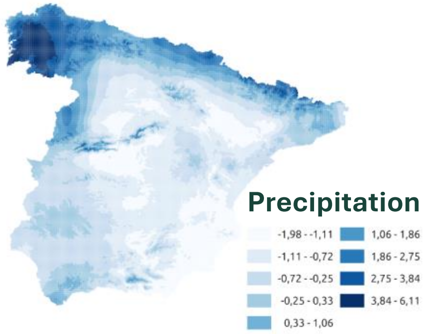

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What we observe in the CT

i: site, where?

j: occassion, when?

Model parameters

- Priors: $\alpha, \beta \sim N\ (0, 1)$
- Inits: $\alpha, \beta \sim N\ (0, 1)$

- **MCMC**
  - n.iter = 10000
  - n.burning =2500
  - n.chains = 3
  - n.thin = 1

- **Convergence**
  - Traceplots,
  - Rhat,
  - ESS

v1.3.0

v4.5.0

SSOM – HY comparison

We predicted SSOM into a 2 km x 2 km grid and compared to hunting yields statistics of Spain at province level.

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∑HY

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Is there a correlation pattern?

Scatterplot

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∑ Occupancy probability

∑HY

1 Is there a correlation pattern?

Scatterplot

2 Are the relationships similar?

Correlation of occupancy probabilities HY between species

Correlation plot

corrplot v0,95

Mantel test

ape v5,8-1

Species detected & SSOM predictions

Identification ~60 sp.

~40 birds sp.
3 lagomorphs sp.;
2 rodents sp.;
8 Artiodactyla sp.(order);
9 Carnivora sp. (order)

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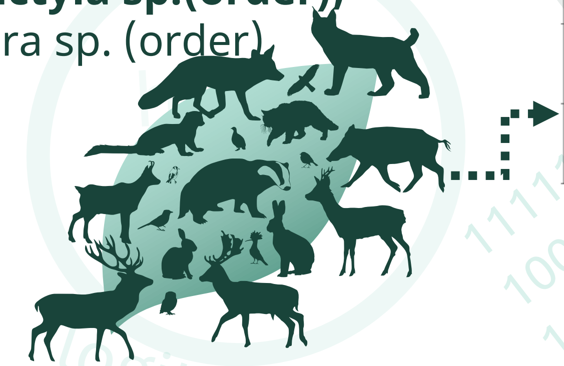

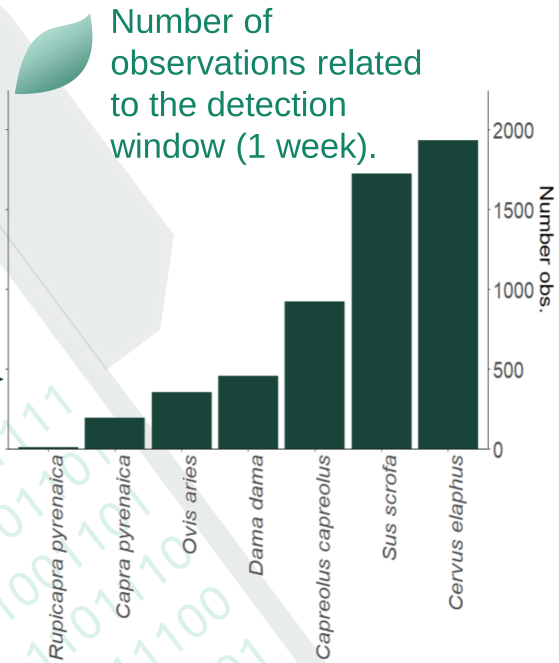

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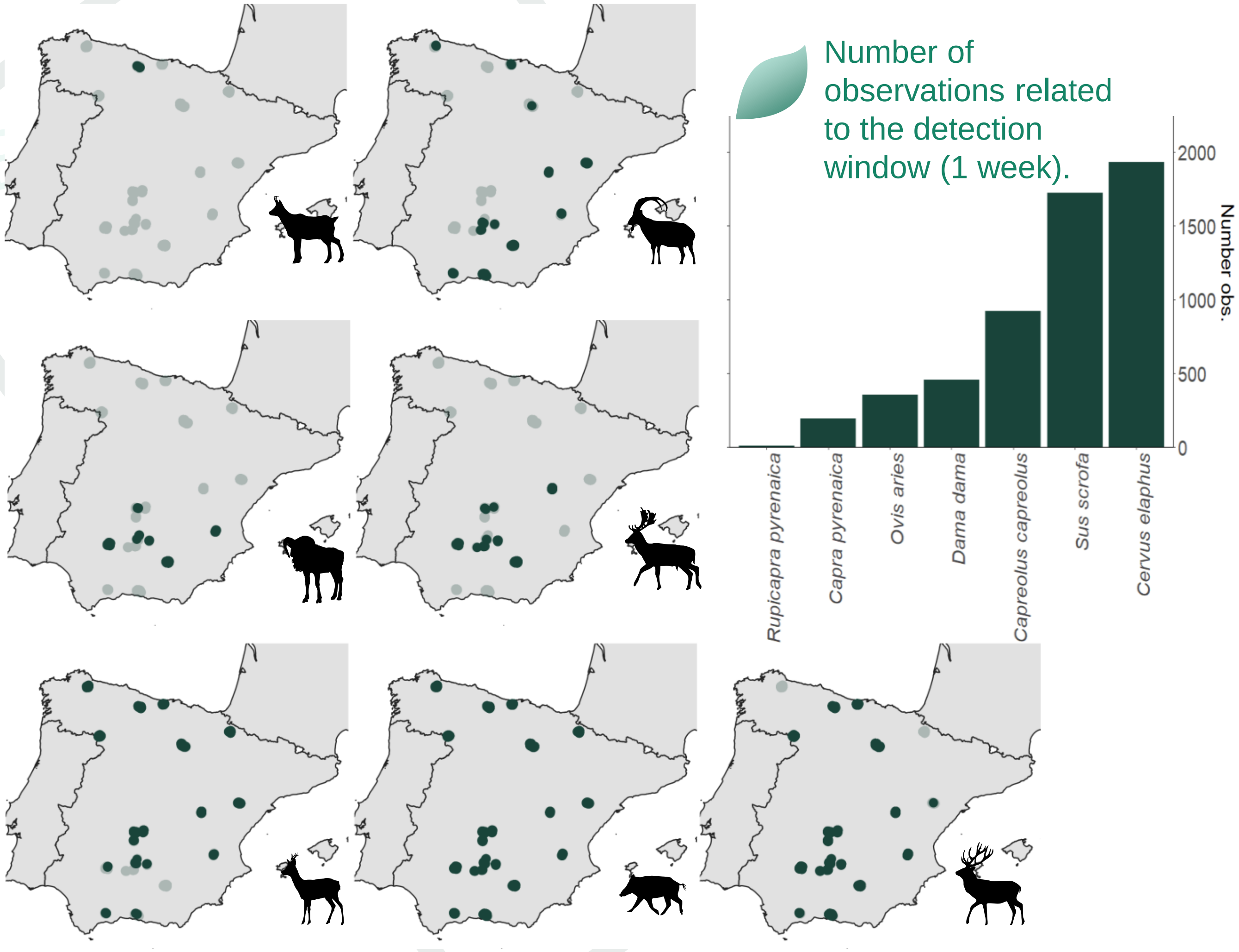

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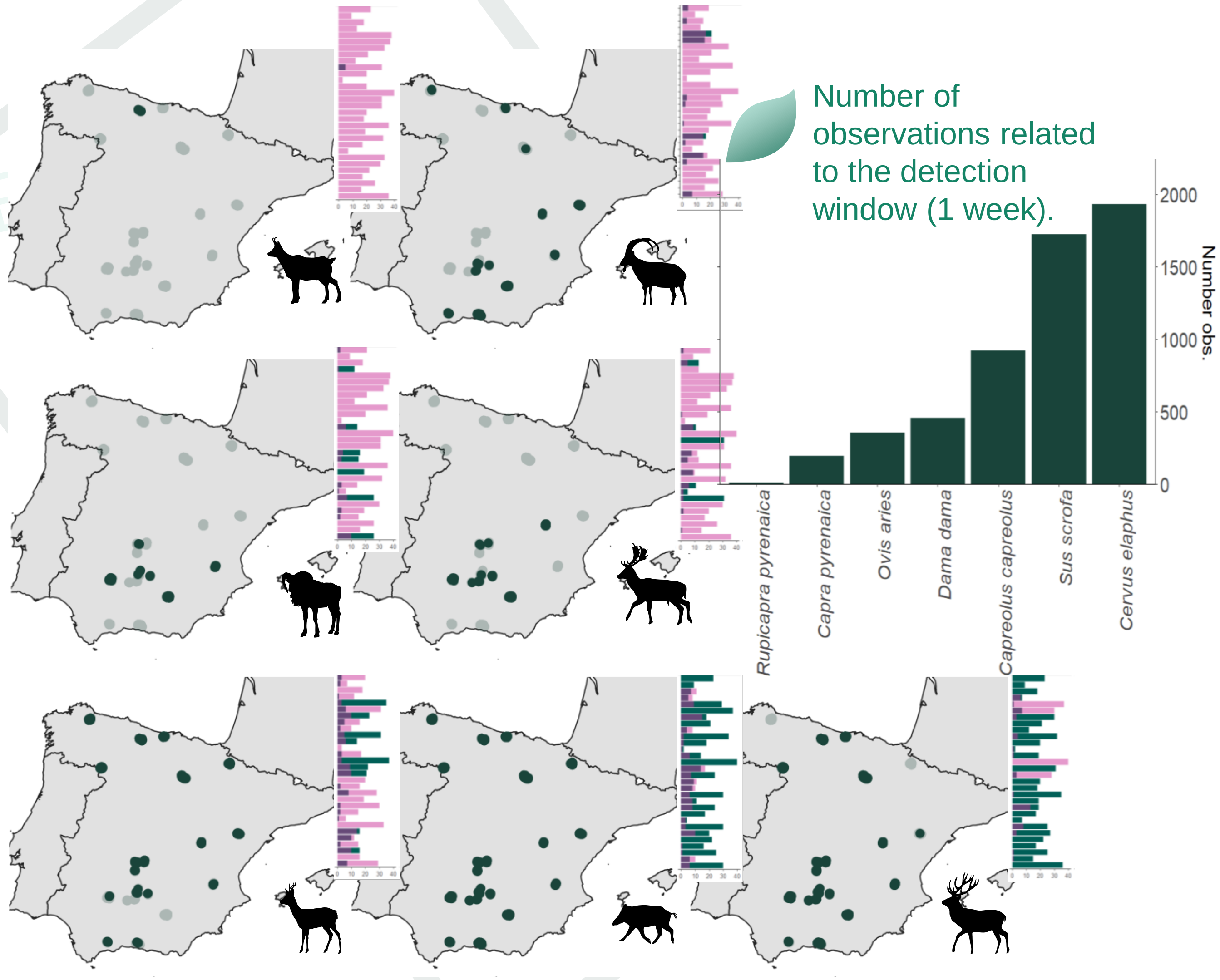
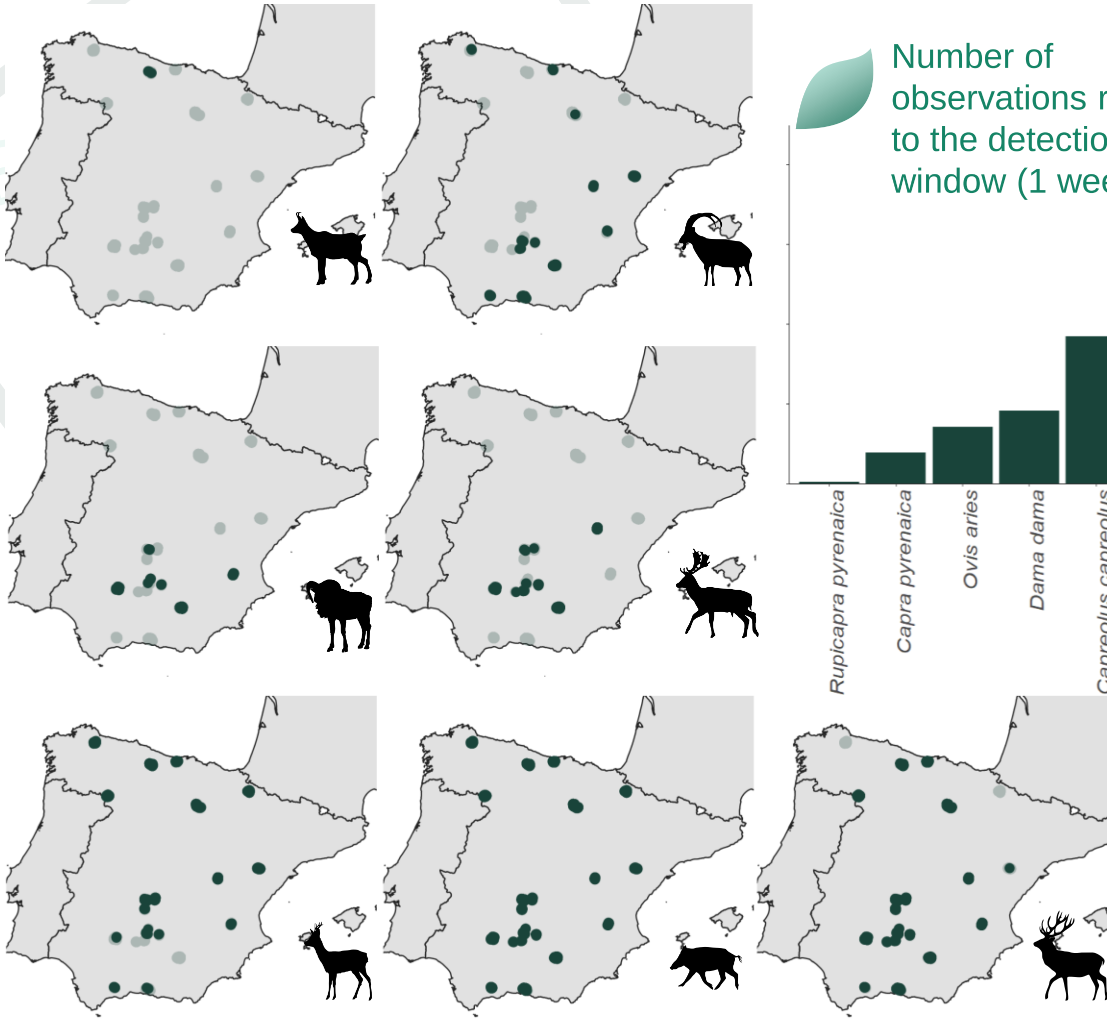
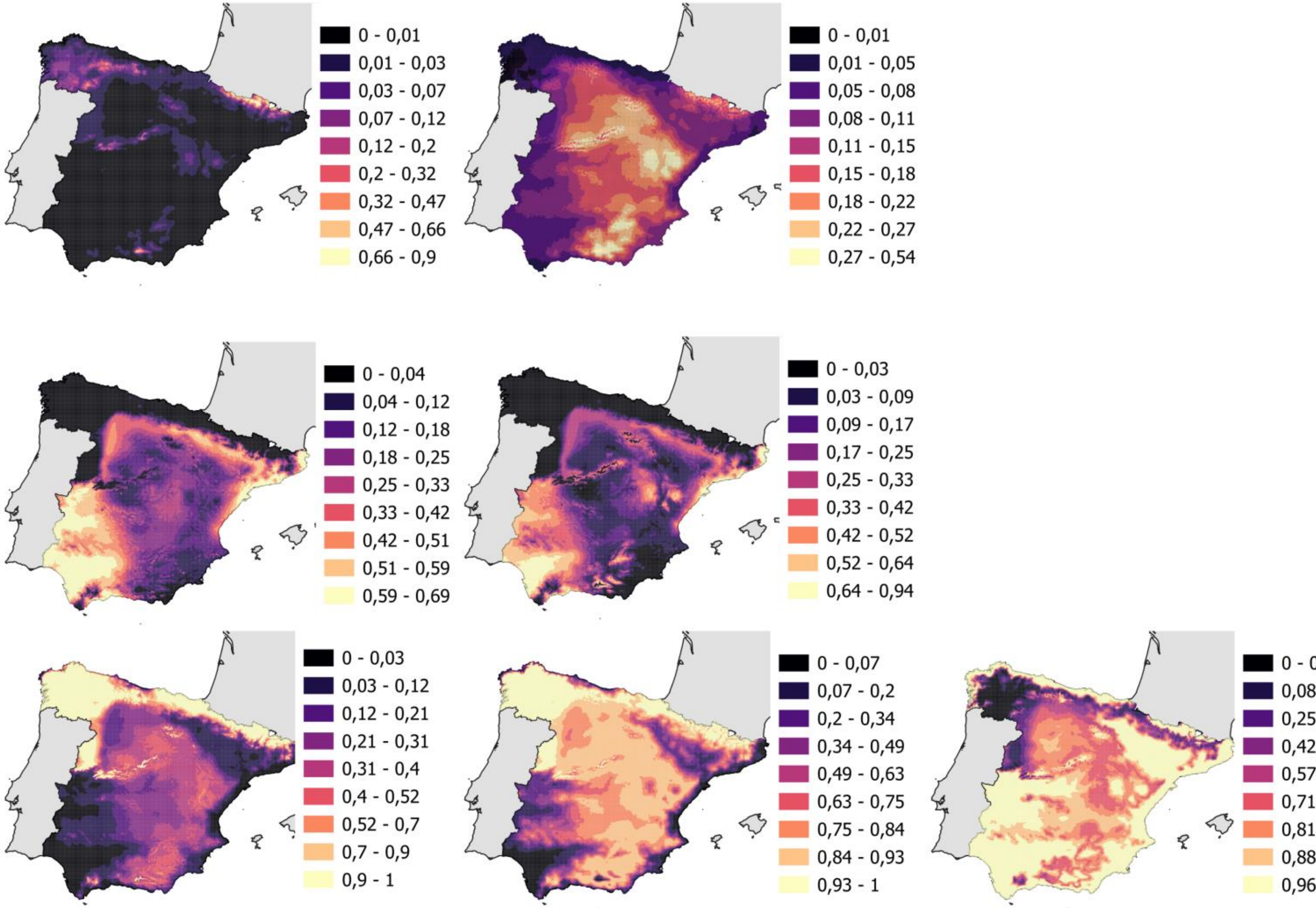


Number of observations related to the detection window (1 week).

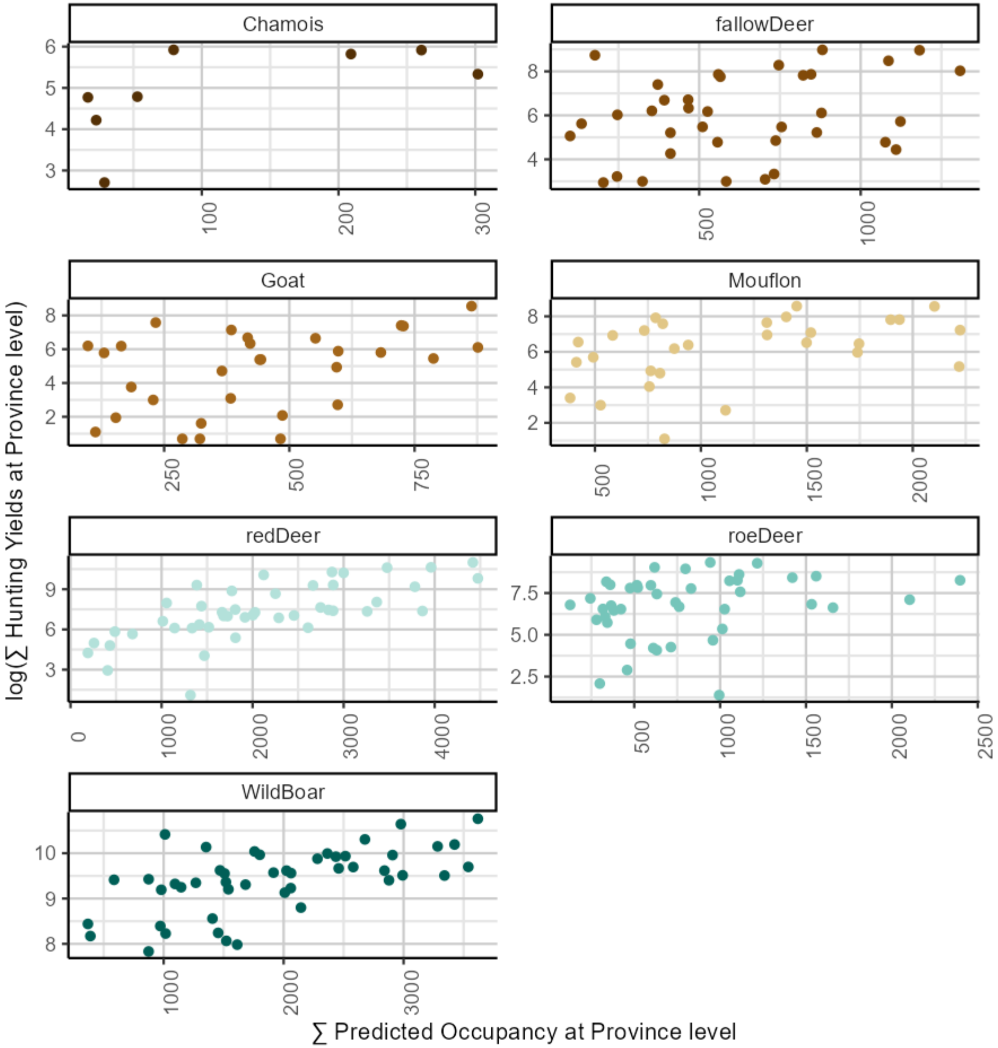
Species detected & SSOM predictions



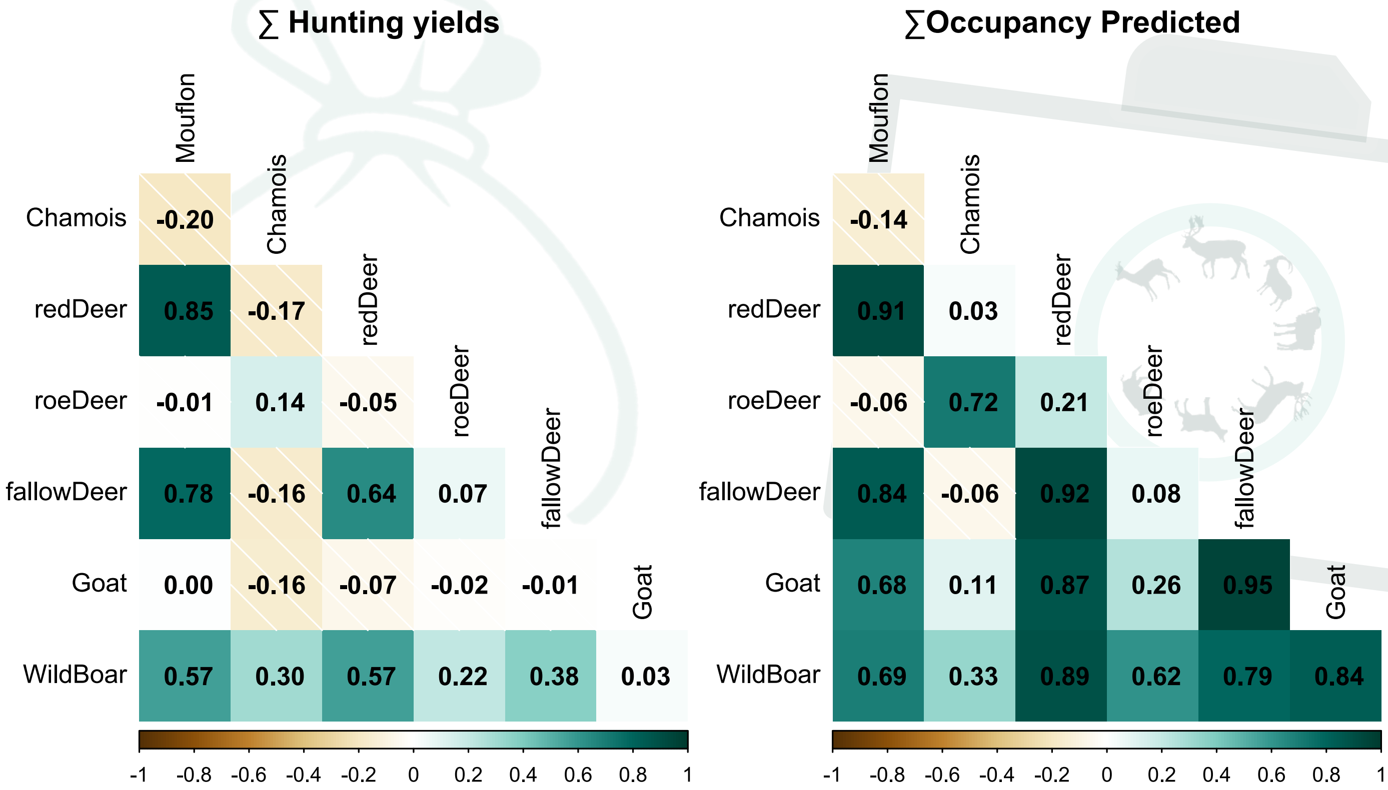


SSOM comparison with HY

1 Scatterplots



2 Correlation plot



∑ Hunting yields

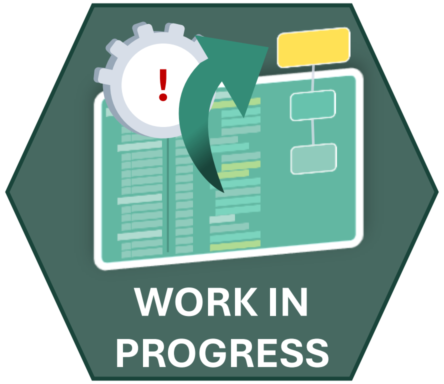
	Mouflon	Chamois	redDeer	roeDeer	fallowDeer	Goat
Chamois	-0.20					
redDeer	0.85	-0.17				
roeDeer	-0.01	0.14	-0.05			
fallowDeer	0.78	-0.16	0.64	0.07		
Goat	0.00	-0.16	-0.07	-0.02	-0.01	
WildBoar	0.57	0.30	0.57	0.22	0.38	0.03

∑Occupancy Predicted

	Mouflon	Chamois	redDeer	roeDeer	fallowDeer	Goat
Chamois	-0.14					
redDeer	0.91	0.03				
roeDeer	-0.06	0.72	0.21			
fallowDeer	0.84	-0.06	0.92	0.08		
Goat	0.68	0.11	0.87	0.26	0.95	
WildBoar	0.69	0.33	0.89	0.62	0.79	0.84

Mantel test p-value=0.005

Yet a lot more to do!



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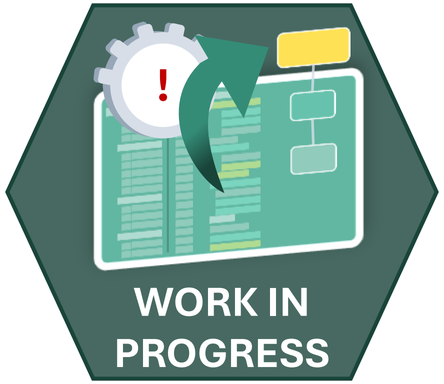
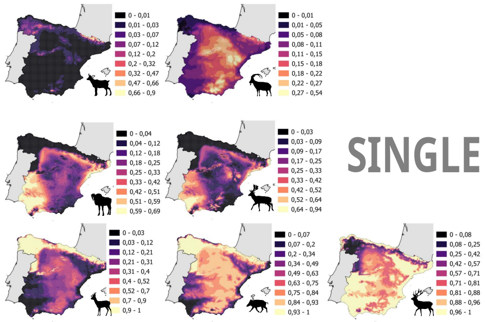
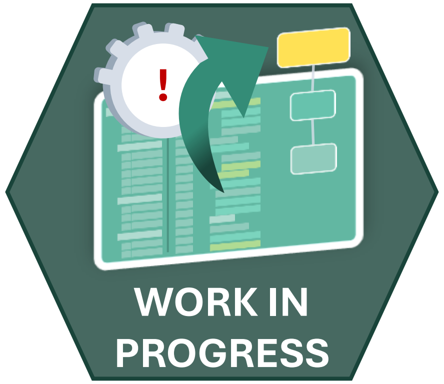
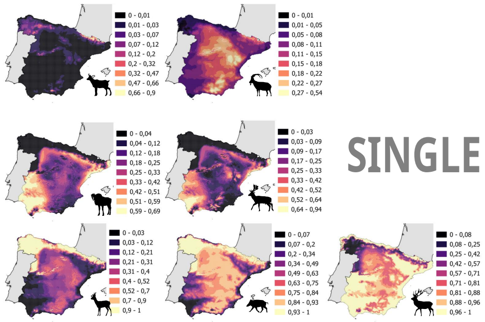




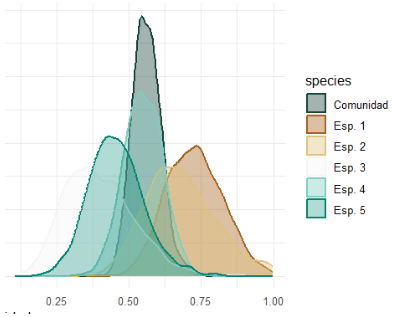
SINGLE SPECIES OCCUPANCY MODELS (SSOM)

Yet a lot more to do!



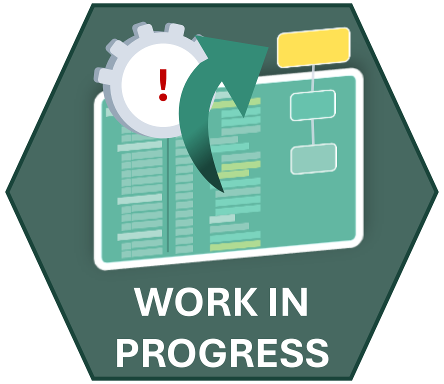


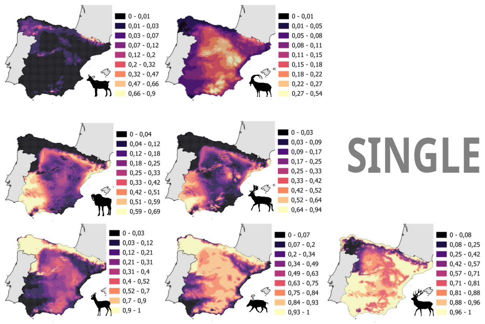
SINGLE SPECIES OCCUPANCY MODELS (SSOM)



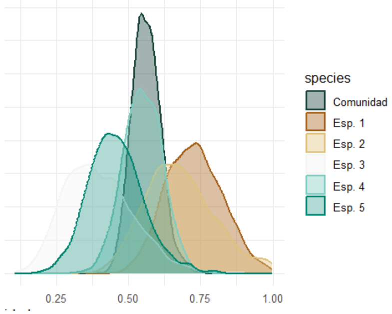
MULTISPECIES OCCUPANCY MODEL (MSOM)

Yet a lot more to do!





SINGLE SPECIES OCCUPANCY MODELS (SSOM)



MULTISPECIES OCCUPANCY MODEL (MSOM)

DATA INTEGRATION OF CAMERA TRAPS AND HUNTING YIELDS

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Many thanks for keeping attention!

Comments, doubts, suggestions?

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