USING SPATIALLY VARYING COEFFICIENTS (SVC) FOR GAME SPECIES ABUNDANCE MODELS' AT LARGE SCALE

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INTRODUCTION

The use of correlative models for explaining or predicting the spatial patterns of abundance of species can be challenging, because predictors can vary regionally or locally their effect.

Different solutions have been proposed for considering possible variations as adjusting only **one model** using **region as** an **explicative categorical predictor** (**REG**) or adjusting **one independent model per each homogeneous region** (**IND**).

More recently, tools capable of parameterizing the variation of the **effect of predictors through the space** (spatially varying coefficients; **SVC**) have been implemented.

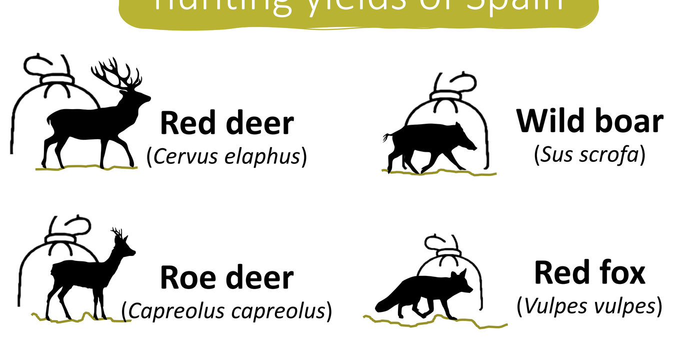
This work aims to explore three different modeling methodologies (REG, IND, and SVC) for four game species and comparing their predictions results in mainland Spain.

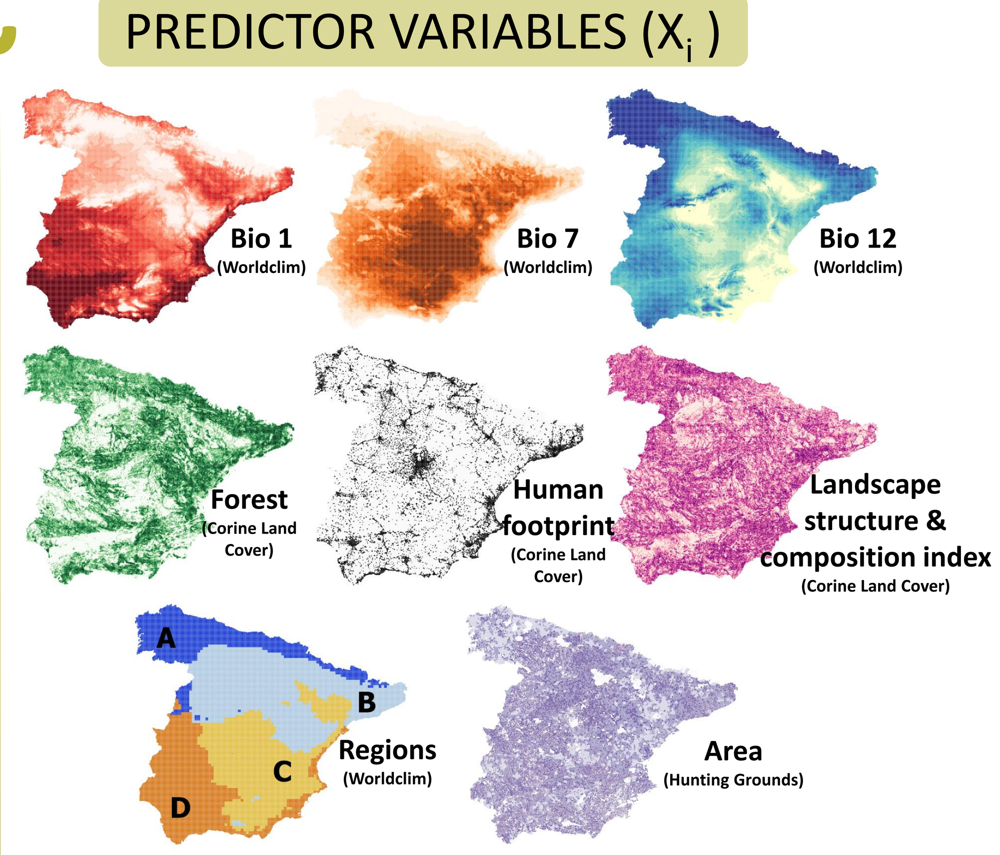
MATERIALS AND METHODOLOGY

RESPONSE VARIABLE (y_i) ~ PREDICTOR VARIABLES (X_i)

2014/2015
2021/2022

Maximum hunting yields of Spain





MODELING

spAbundance

batch.length=1000
n.batch=50
n.chains=3
n.burn=10000
n.thin=10

Doser et al. (2024)

STATIONARY

REG

$$y_i \sim Poiss(\lambda_i)$$

$$\log(\lambda_i) = \boldsymbol{\beta_1} * \mathbf{X1}_i + \boldsymbol{\beta}_{Reg} * \mathbf{X}_{Reg}$$

IND

$$y_{i\,RegA} \sim Poiss(\lambda_{i\,A})$$
$$y_{i\,RegB} \sim Poiss(\lambda_{i\,B})$$
$$y_{i\,RegC} \sim Poiss(\lambda_{i\,C})$$
$$y_{i\,RegD} \sim Poiss(\lambda_{i\,D})$$
$$\log(\lambda_{i\,A}) = \boldsymbol{\beta_A} * \mathbf{X}_i$$
$$\log(\lambda_{i\,B}) = \boldsymbol{\beta_B} * \mathbf{X}_i$$
$$\log(\lambda_{i\,C}) = \boldsymbol{\beta_C} * \mathbf{X}_i$$
$$\log(\lambda_{i\,D}) = \boldsymbol{\beta_D} * \mathbf{X}_i$$

NONSTATIONARY

SVC

$$y(s_i) \sim N(\mu(s_i), sd)$$

Random Spatial Effects — Fixed effects

$$\boldsymbol{\mu}(s_i) = \boxed{\mathbf{w(s_i)}} * \boxed{\boldsymbol{\beta} * \mathbf{X}_{(si)}}$$

$w(s_i)$ modeled through

Gaussian Process,

$w(s_i) \sim MVN(0, \mathbf{C})$

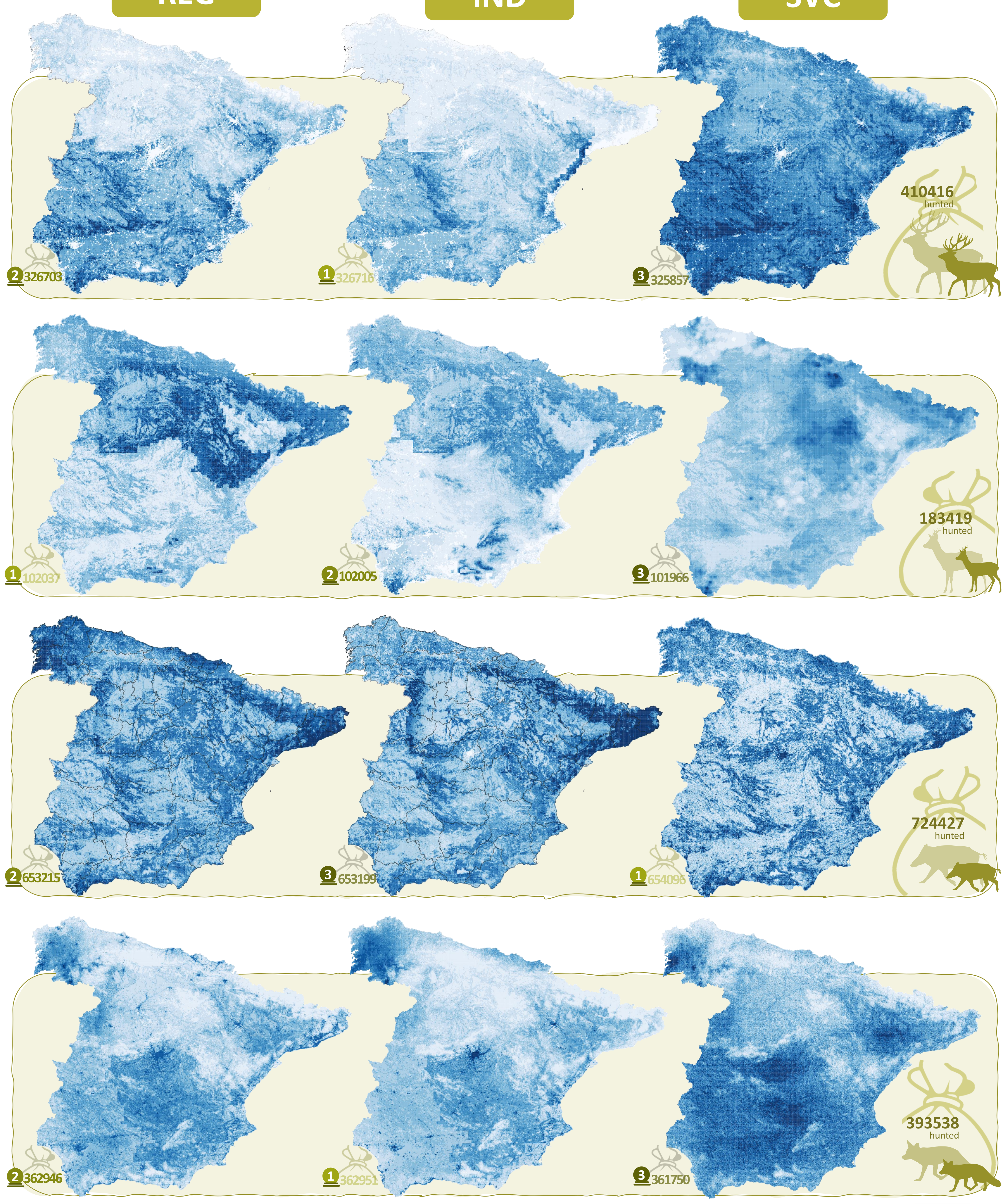
$\mathbf{C}(s, s', \theta)$

If a function f(exp covariance),

θ are the parameters of the function (σ^2, ϕ)

$$\rho(s, s') = \sigma^2 * \exp(-\phi * dEuc)$$

RESULTS



CONCLUSIONS

MORE RESULTS!

1. Regarding broad scale spatial patterns of species abundance:
   - **Spatial patterns** showed **concordance** with the **known distribution** of each species (high correlation (r) among predictions and observed data).
   - The tested methodologies seem to have equivalents patterns ($\bar{r}_{REG\text{-}SVC}$: 0,988; $\bar{r}_{IND\text{-}SVC}$: 0,977; $\bar{r}_{IND\text{-}REG}$: 0,985).
   - **IND** and **REG** models showed **sharp changes** among regions, which are avoided with **SVC** models.
2. Regarding reliability in predicted numbers:
   - **REG** predicts numbers better than others when abundance patterns are similarly influenced by the environment, as for the roe deer.
   - **IND** allows to add in the model regional heterogeneity, as those related to hunting management. For species with large differences in management among regions, like red deer and red fox, this method achieved higher performance
   - **SVC** is a **good alternative** for **modelling abundance of species with a wide geographic range and under very different environmental conditions. This is the case of** the wild boar in Europe, and it was also shown with this species in Spain

FOOD FOR THOUGHT!

Hunting species data:

- Red deer is an intensively managed game species, bringing this fact variability in the data, while roe deer follows a homogeneous management which abundance distribution responds to a more natural processes. Red fox and wild boar are widely distributed species in Spain, but the first one has a regional hunting interest while the second one maintains it through all the territory.
- The **homogeneity/heterogeneity in hunting effort** through the Spanish territory depends on the game species and can be playing an **important role when modeling** hunting yields under the different approaches.
- **SVC** modeling tends to over adjust to the data: **caution is advised when modeling low quality data** (GiGo principle: garbage in, garbage out). Non expected abundance patterns could warn about data problems.

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