**Title**

Authors

# Introduction

## Background (Large carnivores, conservation)

Large carnivores are currently recovering in human-dominated landscapes despite extermination efforts, habitat fragmentation and varying levels of human-induced mortality (i.e. via harvest or vehicle collisions). Reasons for these recoveries (favorable legislation, end of centuries of persecution), but some small populations remain critically endangered. Thus, there is critical to assess the potentially suitable habitat for the establishment and to facilitate management actions that help ensure their long-term viability and mitigate potential human-wildlife conflicts.

Regarding the expansion of populations of large predators increase, a greater understanding of recolonization potential is necessary for conservation. Species with big space requirements need conservation at large scales. Human-wildlife competition for space.

## Dispersal (The importance of dispersal for recovering populations)

The importance of predicting suitable habitats that support dispersal processes that enable demographic and genetic connectivity among wildlife populations.

This prediction is particularly crucial for small and isolated populations that are confined because of the expansion of humans and habitat degradation, and for which spatial expansion is therefore essential for their conservation.

## What factors affect dispersal?

Increasing urbanization and the expansion of exurban (i.e., formerly rural) areas can threaten the viability of animal populations. There is a large degree of infrastructure construction related to transport (road and rail), energy production (roads, windmills, hydropower schemes) and some types of recreational development (especially ski slopes). These linear features threaten to fragment habitat and reduce connectivity within and between large carnivore populations, increase mortality of carnivores, and increase human access to previously undisturbed habitats.

## Introduction of the case studies

Large carnivores are apex predators that play an important role in the regulation of ecological interactions and ecosystem health. Recolonizing large carnivores will probably have significant effects on Iberian Peninsula ecosystems.

Identifying core areas and potential corridors that link them is crucial for the long- term survival of carnivore populations. The particular situation of large carnivores in the Iberian Peninsula: the Iberian Lynx was on the verge of extinction less than two decades ago. Native brown bear (Ursus arctos) population of the Iberian Peninsula, which is also amongst the most severely threatened European populations

## Objectives

Understanding where populations of large carnivores may become re-established, through an assessment of habitat suitability and colonization barriers.

### Objective 1: estimate, and map habitat quality for two large carnivores, namely the Iberian Lynx and the Cantabrian brown bear in the Iberian Peninsula

### Objective 2: evaluate how dispersal limitation by natural and anthropogenic barriers might affect the large carnivore distribution

### Objective 3: Identify anthropogenic factors that are hindering potential dispersal for those species; simple prioritization

The goal of this study was to provide practical information based on dynamic modelling that could help to guide planning efforts concerned with the conservation of large carnivores and their habitat

# Methods

## Study region

Iberian Peninsula

## Study design

### Biodiversity data

Downloading, cleaning, rasterizing, thinning GBIF records

Generating background data

### Environmental data

Initial set of 34 variables

Downloading bioclimatic CHELSA variables, DEM topography layer,

Deriving spectral temporal metrics from remote sensing Landsat imagery

Transforming land cover data into fraction cover at larger scale

Resampling and standardization of predictors

Important variable selection with select07\_cv to deal with multicollinearity

## Analysis

### Species distribution models

ensemble of statistical and machine learning algorithms: GML, GAM, Bioclim, BRT, GP

equal weighting of absences and presences (GML, GAM)

iterative sampling for BRT and GP with equal sample size for presences and absences

threshold for binary predictions

model averaging for ensemble prediction

5-fold cross validation for model evaluation

### Dispersal models

Four scenario-based dispersal simulations for a 10-year time period

MIGCLIM

Input: Redlist data as initial distribution; (partly binarized) SDM prediction as habitat suitability

Species-specific dispersal settings

Exponential dispersal kernel based on average annual dispersal distance

Age of sexual maturity (simplicity of demographic information justified, because dispersal and population viability are extremely simplified too)

Scenarios

Different masks based on thresholds for artificial surface cover

Implementation as weak barriers

### Pseudo-prioritization

# Results

## Result of Objective 1

Species-specific evaluation of SDM algorithms and ensemble based on model performance measures and visual plausibility checks (overlay predictions and independent Redlist data)

Weighted mean ensemble as final model

Species-specific spatial habitat suitability patterns

## Result of Objective 2

Species-specific dispersal simulations for the four scenarios

## Result of Objective 3

Results of prioritization

# Discussion

## General advantage of coupling SDMs and dispersal

## Conservation implications for the bear

…

Bears are more sensitive/prone to human conflicts than lynx

## Conservation implications for the lynx

…

In Donana, artificial land cover fraction is comparably high, but lynx can survive through strong conservation efforts and reintroduction programme 🡪 important implications for planning local conservation in other areas

## Limitations

Coarse resolution: Need to distinguish between coarse resolution of population spread, and fine resolution of more recent movement studies. E.g., increasing human outdoor activities affect fine-scale movement patterns of bear, but the effects on dispersal and population spread are unknown

No information on prey availability/trophic interactions: Lynx consumption and therefore abundance is for more than 80% based on the presence of European Rabbit

Strongly simplifying dispersal assumptions: successful dispersal (=the establishment of a new population) actually summarizes the movement of at least one male and one female through the landscape, the mating, successful reproduction and survival of juveniles to adult age

## Conclusion