English version of geosabina web page

INICIO - HOME

What is SABINA?

SABINA is a research group focused on the multidisciplinary integration of various disciplines such as spatial ecology, biostatistics, predictive modeling, botany, and forest management. The outcome of this integration includes conceptual, methodological, and applied contributions across different research fields such as biogeography, bioinformatics, conservation biology, ecology, the effects of climate change on biodiversity, macroecology, ecological restoration, and more. Currently, we are developing innovative ecological models by combining different methodologies (Bayesian statistics, graph theory, etc.) and data at various scales (hierarchical models), which can be applied to improve species distribution atlases, climate change vulnerability studies, ecological connectivity analyses, and to design ecological restoration and conservation plans.

Objectives A Wide Range of Geographic Information

One of the main objectives of SABINA is to disseminate the results of our research and make the generated data available to the scientific community, as well as to managers, government technicians, and the general public. To achieve this, we have developed a comprehensive geoportal that allows access to and exploration of the information from two of the projects we are currently carrying out. If you would like to learn more about the methodology used in each project, we invite you to visit the projects section on this website.

The geoportal offers a wide range of geographic information organized around the following projects:

- **Atlas of the Presence of Butterflies, Vascular Plants, and Iberian Bryophytes**, with a spatial resolution of 10 km. These files are available for download and allow spatial queries, providing a detailed view of the distribution of these species in the Iberian Peninsula.

- **Predictions of Potential Distribution** for birds, mammals, reptiles, amphibians, butterflies, vascular plants, and bryophytes, also with a spatial resolution of 10 km. These predictions are available for both the current climate scenario and four future climate scenarios, allowing analysis of potential changes in biodiversity distribution in response to climate change.

Additionally, biodiversity predictions are provided by taxonomic group, at a 10 km resolution, for the current period and for the four future climate scenarios considered in the project. These predictions offer valuable information on biological diversity patterns and their potential evolution in a climate change context.

The geoportal also provides **predictions of potential distribution for various Iberian forest species**, including trees and shrubs, at a more detailed spatial resolution of 250 meters. These predictions allow for special searches by region, which is particularly useful for identifying the most suitable species in the context of an ecological restoration plan. This enables managers and technicians to make informed decisions tailored to local conditions to promote the recovery and conservation of forest ecosystems.

Additionally, the project includes an **analysis of ecological connectivity for the Iberian Peninsula**. This analysis evaluates the spatial interactions between different areas and ecological corridors, providing valuable information for planning conservation and restoration measures that promote ecosystem connectivity.

In summary, our geoportal is a powerful and accessible tool for exploring the geographic information generated in the NEXTDIVE and Connect2Restore projects. We invite you to use this platform to access data, download available files, and perform spatial queries that can contribute to your research, environmental management, or general knowledge of biodiversity and the effects of climate change in the Iberian Peninsula.

INTEGRANTES Y COLABORADORES - PEOPLE

Already translated

LINKS DE INTERÉS - LINKS OF INTEREST

PROYECTOS - PROJECTS

NextDive

Towards a better understanding of global change by improving biodiversity data and predictions with tools derived from graph theory.

In the context of current global change, having high quality data on species occurrence is key not only for ecological understanding, but also for urgent issues such as determining the degree of threat to species and designing conservation and management strategies.

A first objective of the NextDive project is to improve and complete data from several available Iberian atlases (10 km resolution): flora, tetrapod and butterfly atlases, being the latter of special relevance given its relative incompletedness. Each atlas will be treated as a network of connections (presences) of species and cells, which will allow the use a powerful graph theory technique based on stochastic block modeling (SBM), widely used to calculate probabilities of connections and non-connections in all types of networks, but only recently used in ecology and never for this purpose.

This analysis will allow us to identify possible undetected and spurious presences that we will then check through: 1) field sampling (mainly with butterflies); 2) further searches in electronic repositories and literature; and 3) the collaboration of experts from the different groups studied.

A second objective is to generate reliable predictions of the potential effects of climate change on species and communities using optimized and updated ecological models. To this end, we will implement several innovations: 1) include new covariates (e.g., information on species interactions based on co-occurrence patterns); 2) new protocols to delimit regional species groups (e.g., using biogeographic regions); 3) include information on ecological niches (e.g., information on ecological niches of species and communities); 4) include information on species interactions based on co-occurrence patterns, using biogeographic regions); 3) including information on species ecological niches beyond the region under study (e.g., incorporating European-scale data on species distribution and environmental conditions); and 4) optimizing the modeling process itself (e.g., adopting multiscale approaches through hierarchical analyses).

We will also implement different validation tests of the results: 1) advanced statistics based on cross-validation; 2) modeling based on virtual species distribution data; and 3) comparison of model predictions with the presences found in new sampling and data searches (see above). This would be the first time that this last type of validation has been performed using full regional biotas.

Finally, a third objective is to use the previous results to predict possible effects of climate change through a vulnerability analysis and studies of current and future representativeness of species and diversity in Iberian protected areas.

In order to contribute to the development of future research, conservation and restoration initiatives, both the new data and predictions, and the modeling protocols (R packages) generated in the project, will be accessible through the SABINA research group website.

The project will be developed by a multidisciplinary team of nine researchers with expertise in botany, zoology, forestry, statistics, and spatial and predictive ecology.

NextDive (PID2021-124187NB-I00) is funded by the Spanish Ministry of Science and Innovation (Agencia Estatal de Investigación) and by “FEDER A way to do Europe”.

Connect2restore

Towards a national restoration plan taking into account connectivity and vulnerability to climate change.

Between 1939 and 1995, with the main objective of protecting the soil against erosion and preventing floods, more than 4 million hectares were afforested in Spain. However, the result was often conifer-dominated forests with low species diversity and high vulnerability to climate change. Replacing formations with mixed forests is therefore of utmost importance and would greatly benefit biodiversity and society.

The Connect2restore project contemplates a multidisciplinary approach to generate innovative tools applicable in ecological restoration. They are based on the pioneering combination of different aspects:

1) Improving predictions and assessments of vulnerability to climate change through outstanding innovations: 1.1) species distribution models (~500 woody and threatened plant species) combining three reliable techniques; 1.2) multi-scale hierarchical framework (Spain and Europe), which has proven to be more efficient than classical methods; 1.3) updated climate variables and future scenarios related to the recent IPCC 6th report; and 1.4) implementation of community-level modeling tools to predict potential species richness and composition.

2) Optimising the contribution of ecological connectivity analyses to forest restoration planning, identifying priority areas and corridors for restoration by considering: 2.1) the dynamic connectivity between the current and future distribution of different forest types; and 2.2) innovative ways of assessing information on riparian forests and ravines.

3) Integration of different organizations during the development of the project, e.g., the NGO for nature conservation WWF-Spain, the government of the Community of Madrid, and the Spanish Botanical Society, as well as a multidisciplinary team of botanists, ecologists, engineers, mathematicians and zoologists.

Our hypothesis is that these tools, which offer optimized plant biodiversity predictions (more realistic than the existing ones), applied to different scenarios of ecological connectivity and future climate change, will favor the design of efficient ecological restoration plans. Novel and dynamic restoration plans could be developed, compared to the current static ones, which do not consider future climate projections and connectivity analyses.

The main result will be a website with several applications for sustainable forest management, offering different multilayer maps revealing priority areas for restoration, and a selection of recommended woody plant species per pixel (~1 km2). The different stakeholders (European Union, regional and national administrations, NGOs, research centers, etc.) managing these forest ecosystems will be the main beneficiaries.

In the long term, if restoration plans are developed to generate more resilient forests, biodiversity and society (bioeconomy, recreation, climate regulation, human health, water and timber supply) will be the ultimate beneficiaries. The different approaches proposed here will not only potentially reduce costs, but also optimize the accuracy and appropriateness of the derived assessments. All these aspects fit perfectly with the definition of “nature-based solutions”, a priority for the European Union.

Connect2restore (TED2021-129589B-I00) is funded by the Spanish Ministry of Science and Innovation (Agencia Estatal de Investigación) and by “European Union NextGenerationEU/PRTR”.

PUBLICACIONES - PUBLICATIONS

NOTICIAS - NEWS

GEOPORTAL ESPAÑA/ECUADOR - GEOPORTAL SPAIN/ECUADOR

Features of the SABINA Geoportal for Spain

The **SABINA** **Geoportal** for Spain offers interactive tools to explore the current and future distributions of 100 tree species and 150 shrub species across peninsular Spain. The main features include:

1. Exploring and Downloading Potential Species Distributions: In the Models tab, users can view and download potential distribution maps for tree and shrub species, both for the present and for four future climate scenarios. These maps are derived from species distribution models (see the following sections for more details on the models and climate scenarios). The maps are available at a 1 km resolution, allowing detailed analysis of areas of interest. All distribution models can be downloaded in **GeoTIF format**, facilitating their integration into Geographic Information Systems (GIS). This is particularly useful for conservation, ecological restoration, or forest planning projects, as it allows for deeper data analysis and manipulation.

2. Identification of the Most Suitable Species: By clicking on any point on the map, the geoportal generates a list of the 10 most suitable tree species and the 10 most suitable shrub species for that area, according to our models. Additionally, each species in the list includes a link to a **detailed species sheet** with key information about its ecology, distribution, physiological traits, uses, and other characteristics. This tool is ideal for selecting species in restoration or reforestation plans.

3. Species Presence Atlas: In the Atlas tab, users can view and download presence data for all vascular plant species in Spain. These data are available at a resolution of 10 km UTM cells and can serve as a valuable reference for biodiversity studies and conservation planning. The atlas contains presence data for vascular plants in Spain, sourced from the **AFLIBER** database. Together with the Spanish Botanical Society, we are continuously updating this database through a chorology working group. When using the atlas, please cite it as follows: Ramos-Gutiérrez, I., Lima, H., Pajarón, S., Romero-Zarco, C., Sáez, L., Pataro, L., Molina-Venegas, R., Rodríguez, M.Á. & Moreno-Saiz, J.C. (2021) Atlas of the vascular flora of the Iberian Peninsula biodiversity hotspot (AFLIBER). Global Ecology and Biogeography, 30, 1951-1957.

4. Species sheet: In the Species Sheets tab, users can access a complete list of species for which distribution models have been generated. Each species has a detailed sheet that includes key information, such as its main functional traits, the habitat characteristics where it lives, its current distribution, primary uses, and other relevant additional observations.

Together, these features provide users with a powerful tool for planning and decision-making in conservation, ecological restoration, and forest management. This tool is also ideal for evaluating climate change impacts.

Species Distribution Models

The **SABINA Geoportal** offers species distribution models for woody species (trees and shrubs) in peninsular Spain, both for the current climate scenario and for four future climate scenarios. The resulting potential distribution maps are available at a 1 km resolution. There is a **toggle switch** that allows users to switch between tree models and shrub models. By sliding this switch, the list of species and the potential distributions specific to trees or shrubs are unlocked. In the following sections, you can find more detailed information about the methodology used to generate the tree and shrub models.

When using the models, please cite it using:

- Mateo, R.G., J. Morales-Barbero, A. Zarzo-Arias, H. Lima, V. Gómez Rubio & T. Goicolea. sabinaNSDM: an R package for spatially nested hierarchical species distribution modelling. (2024) Methods in Ecology and Evolution.
- Goicolea, T., A. Adde, O. Broennimann, J.I. García-Viñas, A. Gastón, M. José Aroca-Fernández, A. Guisan. & R.G. Mateo (2024) Spatially-nested hierarchical species distribution models to overcome niche truncation in national-scale studies. Ecography.

1. Tree Models

The distribution models for **tree species** have been developed using a spatially nested hierarchical approach (**NSDM**). These models combine large-scale global patterns with finer regional characteristics. The models were developed using the ***sabinaNSDM R package***, designed by our research team. Tutorials on how to use the package areavailable in the following links: to work with individual species or with multiple especies.

The models were trained with species data from various sources, such as the third Forest Spanish Inventory, GBIF, BIEN, and EUForest, using 25 environmental variables, including bioclimatic, edaphic, hydrological, and solar exposure characteristics (see table). More details on the species data and climatic variables used in these models can be found in the publication *Goicolea et al. (2024) Ecography*.

Consensus models were generated by combining three statistical algorithms: generalized linear models (GLM), gradient boosted machines (GBM), and random forests (RF). The specific methodology followed for the development of these models is available in supplementary material number 2 of *Mateo et al. (2024) in Methods in Ecology and Evolution*.

Table 1. Environmental variables

Variable	Tipo	Fuente
Bio1: Annual Mean Temperature	Bioclimatic	CHELSA
Bio2: Mean Diurnal Range	Bioclimatic	CHELSA
Bio3: Isothermality	Bioclimatic	CHELSA
Bio4: Temperature Seasonality	Bioclimatic	CHELSA
Bio5: Max Temperature of Warmest Month	Bioclimatic	CHELSA
Bio6: Min Temperature of Coldest Month	Bioclimatic	CHELSA
Bio7: Temperature Annual Range	Bioclimatic	CHELSA
Bio10: Mean Temperature of Warmest Quarter	Bioclimatic	CHELSA
Bio11: Mean Temperature of Coldest Quarter	Bioclimatic	CHELSA
Bio12: Annual Precipitation	Bioclimatic	CHELSA
Bio13: Precipitation of Wettest Month	Bioclimatic	CHELSA
Bio14: Precipitation of Driest Month	Bioclimatic	CHELSA
Bio15: Precipitation Seasonality	Bioclimatic	CHELSA
Bio16: Precipitation of Wettest Quarter	Bioclimatic	CHELSA
Bio17: Precipitation of Driest Quarter	Bioclimatic	CHELSA
soil pH at 0-5cm depth	Edaphic	Soilgrids
soil nitrogen content at 0-5cm depth	Edaphic	Soilgrids
soil sand content at 0-5cm depth	Edaphic	Soilgrids
soil organic carbon stock at 0-5cm depth	Edaphic	Soilgrids
Distance to rivers	Hidrologic	DEM
Accumulated flow	Hidrologic	DEM
Topographic index	Hidrologic	DEM
Annual solar radiation	Topoclimatic	DEM

2. Shrub Models

The distribution models for shrub species were calibrated at a European scale and projected exclusively in Spain, following the approach described in *Mateo et al. (2014)*. The species occurrence data used to train the models came from the **Forest** Forest Map of Spain, GBIF, and BIEN. The same environmental variables used in the tree models were applied here.

Consensus models were also generated using a combination of three statistical

algorithms: generalized linear models (GLM), gradient boosted machines (GBM), and random forests (RF).

Future Climate Scenarios

The species distribution models have been projected into four future climate scenarios, based on two socioeconomic pathways (optimistic and pessimistic) and two global circulation models (A and B) (see table). The two socioeconomic pathways are:

- **Optimistic**: Corresponds to the **SSP126** pathway (SSP1-RCP2.6), representing a sustainability scenario, with limited climate change due to strict greenhouse gas mitigation policies.
- **Pessimistic**: Corresponds to the **SSP585** pathway (SSP5-RCP8.5), assuming development driven by fossil fuels, with little to no effective climate policy, following a "business as usual" trend.

The two global circulation models used are:

- **A**: **IPSL-CM6A-LR** model (Institut Pierre Simon Laplace, France)
- **B**: **MRI-ESM2-0** model (Meteorological Research Institute, Japan)

Table 2. Climate Scenarios

Scenario name	Shared Socioeconomic Pathway (SSP)	Global Circulation Model
Optimistic A	SSP 126	IPSL-CM6A-LR
Optimistic B	SSP 126	MRI-ESM2-0
Pesimistic A	SSP 585	IPSL-CM6A-LR
Pesimistic B	SSP 585	MRI-ESM2-0

Nueva versión de INICIO en español:

¿Qué es SABINA?

Integración multidisciplinar

Sabina es un grupo de investigación enfocado en la integración multidisciplinar de diversas áreas, como la ecología espacial, la bioestadística, el modelado predictivo, la botánica y la gestión forestal. Su

principal línea de trabajo busca combinar estas disciplinas para abordar problemas complejos de manera integral. El resultado de esta integración son aportaciones conceptuales, metodológicas, y aplicadas en diferentes campos de investigación como biogeografía, bioinformática, biología de la conservación, ecología, efectos del cambio climático en la biodiversidad, macroecología, restauración ecológica, etc. En la actualidad estamos generando novedosos modelos ecológicos combinado diferentes metodologías (estadística Bayesiana, teoría de grafos, etc.) y datos a diferentes escalas (modelos jerárquicos), que podrán ser aplicados para mejorar atlas de distribución de especies, estudios de vulnerabilidad al cambio climático, análisis de conectividad ecológica, y diseñar planes de restauración ecológica y conservación.

Objetivos

Una amplia gama de información geográfica

Uno de los principales objetivos de **SABINA** es difundir los resultados de nuestras investigaciones y poner a disposición los datos generados, tanto para la comunidad científica como para gestores, técnicos de la administración y público en general. Con el fin de lograr esto, hemos desarrollado un completo geoportal que permite acceder y explorar la información de dos de los proyectos que actualmente estamos llevando a cabo. Si deseas conocer en detalle la metodología empleada en cada proyecto, te invitamos a consultar la sección de proyectos en esta página web.

El **geoportal** ofrece una amplia gama de información geográfica organizada en base a los siguientes objetos:

- **Predicciones de distribución potencial** para especies forestales a una resolución espacial de 1 km. Estas predicciones están disponibles tanto para el escenario climático actual como para **cuatro escenarios climáticos futuros**, lo que permite analizar posibles cambios en la distribución de la biodiversidad en respuesta al cambio climático.
- **Atlas de presencia de mariposas, plantas vasculares y briofitos ibéricos** con una resolución espacial de 10 km. Estos archivos están disponibles para su descarga y permiten realizar consultas espaciales, brindando una visión detallada de la distribución de estas especies en la Península Ibérica.

Adicionalmente, el geoportal pronto incluirá un **análisis de conectividad ecológica** para la Península Ibérica. Este análisis evalúa las interacciones espaciales entre diferentes áreas y corredores ecológicos, proporcionando información valiosa para la planificación de medidas de conservación y restauración que promuevan la conectividad de los ecosistemas.

En resumen, nuestro geoportal constituye una herramienta poderosa y accesible para explorar la información geográfica generada en los proyectos NEXTDIVE y Connect2Restore. Te invitamos a utilizar esta plataforma para acceder a los datos, descargar los archivos disponibles y realizar consultas espaciales que contribuyan a tu investigación, gestión ambiental o conocimiento general sobre la biodiversidad y los efectos del cambio climático en la Península Ibérica.