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Abstract

Background

The special area of conservation Montesinho/Nogueira (PTCON0002) is a key area for conserving biodiversity in the Iberian Peninsula. Covering an area of approximately 1081 km² in the northeast of Portugal mainland, the PTCON0002 is home to a wide range of biodiversity, including several endemic and endangered species, and priority habitats. Despite its ecological significance and importance for conservation, there is a lack of publicly available biodiversity data, which urges the need to create a comprehensive and up-to-date biodiversity dataset for the PTCON0002.

New information

To bridge the knowledge gap on biodiversity in PTCON0002, we undertook a thorough data collection process, such as species occurrence records and conservation status information at regional (Portugal) and European levels, from multiple sources. We collected and compiled this information for PTCON0002 resulting in a total of 31 871 records with 1 312 documented species. In addition, we developed an easy-to-navigate web-based geographic information system (Web GIS). In this article, we present an in-depth report on the process of compiling and preparing data, as well as the development and design of our Web GIS to increase awareness and enhance understanding of the importance of preserving biodiversity in PTCON0002.

Keywords

Biodiversity conservation, biodiversity dataset, conservation status, open science, occurrence records, species distributions, web GIS.

Introduction

Guaranteeing biodiversity conservation from local to global scale is a critical challenge that requires urgent attention. Nonetheless, biodiversity has been declining at an unprecedented rate in recent decades due to negative drivers working at various scales, such as human-related activities (e.g., deforestation, land-use change, habitat destruction, wildfires, and climate change) (Waldron et al. 2017). Biodiversity monitoring is essential to measure species conservation status and to plan evidence-based and impactful conservation actions (Jetz et al. 2019). According to recent studies, inadequate biodiversity monitoring has led to significant biases in our understanding of species distribution and abundance, particularly in under-studied taxa and ecosystems (Guerra et al. 2019, Johnston et al. 2023, Speed et al. 2018).

Accurate and up-to-date species occurrence records data are crucial for assessing and monitoring the condition of biodiversity (Jetz et al. 2019). There are multiple sources from which species occurrence data can be retrieved (Bloom et al. 2018). Citizen science platforms such as the Biodiversity Information Facility (GBIF; <https://www.gbif.org/>) and iNaturalist (<https://www.inaturalist.org/>) and historical collection data (Sillero et al. 2014) are commonly used. Nevertheless, the availability and accessibility of these records are often limited (e.g., no processing and integration in some citizens' reports), hampering the efforts to maintain up-to-date information on species diversity (Petersen et al. 2021, Sillero et al. 2018).

Web GIS provides an effective way to map and visualize species occurrence data (Asaad et al. 2019, Hancock et al. 2022) and make them accessible to a wider audience (Steiniger and Hay 2009). By utilizing these systems, conservationists and policymakers can easily identify areas of high biodiversity value, assess the effectiveness of conservation measures, and monitor changes in biodiversity over time (Arkhipova 2020, Frans et al. 2022, Hancock et al. 2022). This is particularly important for protected areas and conservation sites such as the special area of conservation Montesinho/Nogueira (PTCON0002), which is notable for its distinctive characteristics. Located in the north-east of Portugal mainland, is home to a diverse range of ecosystems, including forests, pastures, and mountainous terrain. PTCON0002 encapsulates unique supra and oromediterranean bioclimatic conditions making it a biodiversity hotspot, particularly for mammal species such as the Iberian wolf (*Canis lupus signatus*), roe deer (*Capreolus capreolus*), pine marten (*Martes martes*), and wildcat (*Felis silvestris*).

Herein, we aim to provide a comprehensive dataset of biodiversity data with high spatial resolution (1 km) and a Web GIS for monitoring biodiversity in the PTCON0002 in Portugal. The dataset contains a total of 31 871 species occurrence records from the mentioned area, documented between 2000 and 2022, covering five taxonomic groups: flora (vascular plants), amphibians, reptiles, birds, and mammals. Additionally, we developed a Web GIS to visualize the distribution of 1 312 individual species documented in the mentioned records.

General description

Purpose: The dataset was developed to provide detailed records of several species including vascular plants (flora), amphibians, reptiles, birds, and mammals, all with high spatial resolution of 1 km.

Additional information: The records were collected and assembled specifically for the PTCON0002 (see Fig. 1), which is a European Union's Natura 2000 site (<https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=PTCON0002/>). The data collection period spans from 2000 to 2022. All the species distribution maps are available through our Web GIS.

Sampling methods

Sampling description: We compiled biodiversity data from various sources spanning from 2000 to 2022 (see Table 1), eliminating nomenclature and coordinates errors from the datasets. We focused on five major taxonomic groups with the highest proportions of endangered species in PTCON0002: flora - vascular plants (42%), amphibians (41%), reptiles (21%), birds (13%), and mammals (27%) (IUCN (International Union for Conservation of Nature) 2022a). The species occurrence records were sorted according to their spatial resolution (<1 km, 1 km, 2 km, 10 km). We also included regional (Portugal) and European status in accordance with the International Union for Conservation of Nature (IUCN; <https://www.iucnredlist.org/>). We followed the most up-to-date taxonomy for each species (Bencatel et al. 2019, Speybroeck et al. 2020, Mathias et al. 2023, Sociedade Portuguesa de Botânica 2022, IUCN (International Union for Conservation of Nature) 2022b). Additionally, we selected records with at least 1 km spatial resolution. We wrote a script with R version 4.2.2. to plot distribution maps for each species (see Suppl. materials 1, 2). Then, we assessed each map to exclude any doubtful observations by cross-referencing species occurrence records with other databases/datasets and excluding records that do not occur in the region.

Overall, the present dataset consists of 31 871 species occurrence records, documenting 1 312 species in the region (see Table 2), compiled from different sources (Table 1). In addition to the species occurrence records, our dataset contains information on the current conservation status of each species at both the regional (Portugal) and European levels

(see Suppl. material 3), in accordance with the IUCN, and the source and spatial resolution of the records.

Hence, we developed a Web GIS with the R program to display individual species' distributions (see Suppl. material 2). We used several R packages, including "shiny" and "shinydashboard" packages (Chang and Ribeiro 2021, Chang et al. 2021), to connect the web user interface (UI) and the server through web widgets, and to enhance the UI performance, respectively. We additionally used the "leaflet" and "leaflet.extras" packages (Cheng et al. 2022, Karambelkar and Schloerke 2022) to create mobile-friendly interactive maps, and the "raster" and "terra" packages (Hijmans 2022a, Hijmans 2022b) to visualise the compiled biodiversity data and PTCON0002 bounds.

The Shiny app, which provides access to 1 312 individual species' distributions, is available in both Portuguese and English languages. It offers a user-friendly experience with quick 2-second access to individual species' distributions. While the app can support up to 50 users simultaneously, it may take up to 10 seconds to load. The app allows users to explore biodiversity data and environmental factors that influence species distributions within the PTCON0002 in a comprehensive and accessible way. Fig. 2 presents a glimpse of the individual species' distributions available for exploration on the Web GIS. The code and materials used in the app development can be found in the following GitHub repositories:

Link 1: <https://github.com/BravoAlpha2/WebGIS>

or

Link 2: <https://github.com/SpatialBioLab/MontObEO-WebGIS>

The app was originally designed for the MontObEO project - Montesinho biodiversity observatory: an Earth Observation tool for biodiversity conservation, founded by the Portuguese Foundation for Science and Technology (FCT: MTS/BRB/0091/2020), and it can be accessed through the MontObEO project website (<https://montobeo.wordpress.com/>). In addition, direct access to the app is available through the following URLs:

English (EN) version: https://montobeo.shinyapps.io/PTCON0002_WebGIS/

or

Portuguese (PT) version: https://montobeo.shinyapps.io/PTCON0002_WebSIG/

Geographic coverage

Description: The geographic range of the data covers the entire PTCON0002 with a spatial resolution of 1 km.

Coordinates: 41.618968° and 41.992493° Latitude; -7.285387° and -6.515783° Longitude (EPSG: 4326; WGS84 - World Geodetic System 1984).

Taxonomic coverage

Description: The PTCON0002 biodiversity dataset encompasses species occurrence records from five major taxonomic group (flora – vascular plants, amphibians, reptiles, birds, and mammals) with a total of 1 312 species (Table 2): flora (vascular plants) (n=1 086), amphibians (n=13), reptiles (n=19), birds (n=153) and mammals (n=41).

Temporal coverage

Notes: From 2000 to 2022.

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Species occurrence records of special area of conservation Montesinho/Nogueira.

Number of data sets: 1

Data set name: Species occurrence records of special area of conservation Montesinho/Nogueira.

Download URL: <https://doi.org/10.5281/zenodo.7657330>

Data format: Comma-separated values (.csv)

Description: The dataset contains biodiversity data for significant taxonomic groups (flora - vascular plants, amphibians, reptiles, birds, and mammals) in the special area of conservation Montesinho/Nogueira (Portugal). It covers the period from 2000 to 2022 and has a spatial resolution of 1 km or higher. Additionally, the dataset offers details on the conservation status of each species at both regional (Portugal) and European levels, as well as the sources of the records and their corresponding spatial resolution.

Column label	Column description
Taxonomic groups	Taxonomic groups in the dataset.
Genus	Genera of species in the dataset.

Species	Scientific name of the species in the dataset.
IUCN 2021 status for Europe	European status is in accordance with the International Union for Conservation of Nature (IUCN; https://www.iucnredlist.org/) 2021-3 version of the red list.
IUCN 2005 status for Portugal	Regional (Portugal) status of amphibians, reptiles, and birds in accordance with the 2005 version of the IUCN red list.
IUCN 2022-2023 status for Portugal	Regional (Portugal) status of flora and mammals in accordance with the 2022 and 2023 version of the IUCN red list of vascular plants and mammals, respectively.
Latitude	Latitude coordinates in EPSG: 4326 (WGS84 - World Geodetic System 1984)
Longitude	Longitude coordinates in EPSG: 4326 (WGS84 - World Geodetic System 1984)
Sources	Name of the source where the record was obtained.
Resolution	Code description – GPS indicates data with a spatial resolution higher than one-kilometre; 1 km refers to data with precisely one-kilometre spatial resolution.

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Author contributions

Data compilation and preparation: NG. Web GIS development: NG. Review and editing: all authors.

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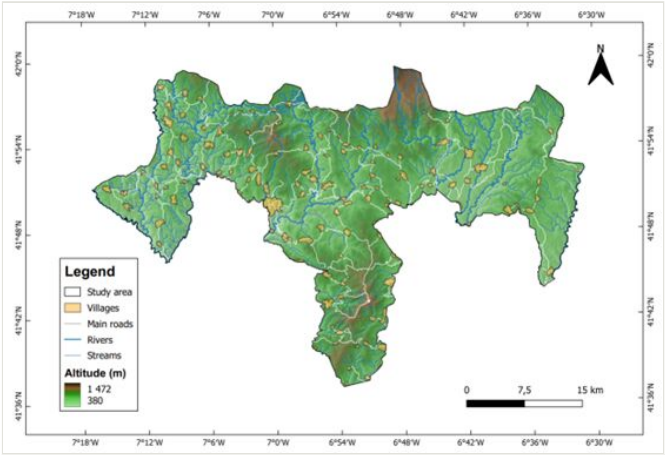


Figure 1.

Overview of the study area: Special area of conservation Montesinho/Nogueira (PTCON0002). Elevation for PTCON0002 from the digital model terrain of Portuguese Directorate General of the Territory (DGT; <https://www.dgterritorio.gov.pt/>).

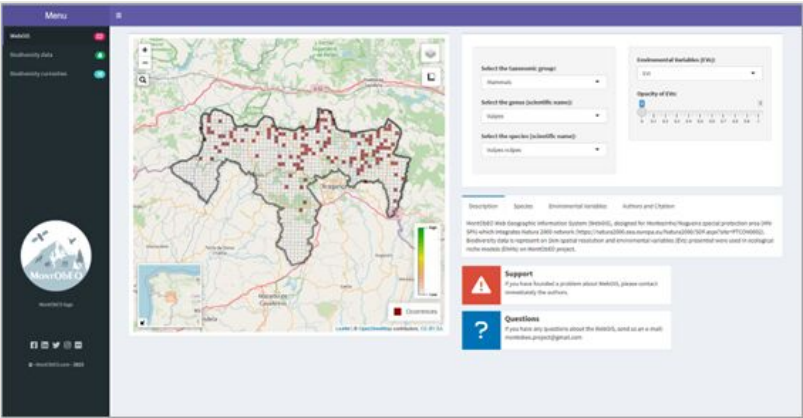


Figure 2.

View of the Shiny app (English version) comprehending the Web GIS of special area of conservation Montesinho/Nogueira (PTCON0002). The Shiny app contains other elements (“Biodiversity data”; “Biodiversity curiosities”) for users to explore more about the biodiversity in PTCON0002. The app was created for the MontObEO project - Montesinho biodiversity observatory: an Earth Observation tool for biodiversity conservation, founded by the Portuguese Foundation for Science and Technology (FCT: MTS/BRB/0091/2020).

Table 1.

Summary of the data sources used to compile the biodiversity data in the special area of conservation Montesinho/Nogueira (PTCON0002) indicating source link, number of occurrences records compiled, spatial resolution, and original timespan.

Sources	Link	Records	S
Atlas of amphibians and reptiles of Portugal	http://www2.icnf.pt/portal/pn/biodiversidade/patrin_atur/atlas-anfi-rept/	1 905	H a to
Field collection data	Not available	839	H th
Floradata	https://floradata.pt/	3 508	E k
Biodiversity.eu	https://biodiversidade.eu/	86	H a to
Global Biodiversity Information Facility (GBIF)	https://www.gbif.org/	8 459	H a to
EOD – Dataset eBird (GBIF dataset)	https://www.gbif.org/dataset/4fa7b334-ce0d-4e88-aaae-2e0c138d049e	7 958	H th
INaturalist	https://www.inaturalist.org/	906	H th
Portuguese Botanic Society	https://spbotanica.pt/	6 040	H th
ICNF's monitoring program	https://www.icnf.pt/	2 170	H th

Table 2.

Number of occurrence records and species documented in the special area of conservation Montesinho/Nogueira (PTCON0002) by taxonomic group.

Taxonomic group	Occurrence records	Species
Amphibians	1 841	13
Birds	16 224	153
Flora (vascular plants)	11 405	1 086
Mammals	1 439	41
Reptiles	962	19

Supplementary materials

Suppl. material 1: R script used to plot distribution maps for each species.

Authors: Nuno Garcia, João C. Campos, Daniel Silva, João Alírio, Lia Duarte, Salvador Arenas-Castro, Isabel Pôças, Armando Loureiro, Ana C. Teodoro, Neftalí Sillero

Data type: Script (.pdf)

[Download file](#) (47.88 kb)

Suppl. material 2: Species distribution maps.

Authors: Nuno Garcia, João C. Campos, Daniel Silva, João Alírio, Lia Duarte, Salvador Arenas-Castro, Isabel Pôças, Armando Loureiro, Ana C. Teodoro, Neftalí Sillero

Data type: Images (.pdf)

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Suppl. material 3: Summary of compiled biodiversity data.

Authors: Nuno Garcia, João C. Campos, Daniel Silva, João Alírio, Lia Duarte, Salvador Arenas-Castro, Isabel Pôças, Armando Loureiro, Ana C. Teodoro, Neftalí Sillero

Data type: Table (.pdf)

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