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Abstract

Background

The long-term monitoring of the plant cover of Doñana shrublands is part of a harmonised protocol for the Long-term Ecological Monitoring Program of Natural Resources and Processes targeting Terrestrial Vegetation. The general aim of this protocol is to monitor and assess the dynamics and trends of shrubland plant communities in Doñana. For shrublands, percent cover is recorded annually, starting in 2008, by the Doñana Long-Term Monitoring Team in one field sampling campaign per year during the flowering season (between March and May) across 21 permanent square plots (15 × 15 m). Permanent plots were located according to stratified random sampling according to the topographic gradient defining the main shrubland species dominance in the Doñana Biological Reserve. Cover is measured using the line intercept method in 3 transects inside the plots of 15 m length, oriented from east to west, and located at fixed points of 2.5, 7.5, and 12.5 metres on both sides of the plot. Using the line-intercept method, the coverage of each species per individual is measured with a measuring tape, recording its class age (adult or seedling) and canopy status (green or dry) as a living or dead specimen. The average plant height is recorded for every transect. This method enables the calculation of the total percent cover per species and plant density for transects and plots, as well as the total percent cover per class age and the total percent cover of dry and green canopies and bare soil. The annual species richness and diversity of vascular plants can also be calculated for every plot.

New information

This is the third published version of the standardised dataset of percent cover per woody plant species of Doñana long-term monitoring plots.

Keywords

Doñana Biological Reserve, line-intercept method, long-term ecological research, percent cover, sampling event, species coverage, terrestrial vegetation, unique scientific and technical infrastructure

Introduction

Shrublands are widely distributed plant communities in the Mediterranean basin. Shrubs are small-to-medium-sized perennial woody plants occupying vast areas in the Mediterranean region. Shrubland plant communities provide several ecosystem services (Riera et al. 2007). Shrub communities have been reduced in the last decades due to changes in land uses, wildfires, aridification, and global warming. Many research studies have focused on shrublands as a relevant indicator of climate and global changes (Gallego Fernández et al. 2004, Riera et al. 2007, Lloret et al. 2016, Pérez-Ramos et al. 2017, de la Riva et al. 2017). The long-term monitoring and research of these communities provides valuable information to assess spatial and temporal dynamics and understand the effects of severe disturbances (Pérez-Ramos et al. 2017).

Mediterranean-type shrubs widely dominate the vegetation in the terrestrial aeolian sands of Doñana National Park. A xerophytic shrub community dominates the drier and established sand dunes, mainly composed of Cistaceae and Lamiaceae species (*Halimium halimifolium* (L.) Willk., *H. commutatum* Pau, *Cistus libanotis* L., *Lavandula stoechas* L., and *Rosmarinus officinalis* L.). Low areas and depressions are usually closer to the water table and are dominated by heathland (*Erica scoparia*, *Calluna vulgaris*) protected by the Habitat Directive as Atlantic decalcified fixed dunes (Calluno-Ulicetea, [Habitat type 2150](#)). A transitional plant community has also been described between xerophytic shrubs and heathland as a mixed scrub of species from humid and xeric shrublands. Shrublands are an important representation along the protected area. Several factors are involved in the spatial distribution and the main boundaries of shrublands according to them, there are two main types of shrubs: xerophytic white shrubs and hygrophytic dark shrubs, but also transitions between both shrub types (Muñoz-Reinoso 2009). Doñana's shrublands have a high susceptibility due to their extreme ecological position, coping with extreme droughts, erosion, overgrazing, pests, wildfires, and human impacts such as conservation management for rabbits and Iberian Lynx, lowering of the water table, etc. Many of these plant communities are listed under the EU Habitat Directive and play a very relevant ecological role in stabilizing sand

dunes and providing shelter, food, and to the fauna of Doñana protected area. Long-term ecological research of Doñana shrublands based on a landscape-scale approach is providing very relevant insights on the biodiversity, functioning, services, and resilience of this emblematic ecosystem.

Project description

Title: Long-term monitoring of natural processes on the Singular Scientific-Technical Infrastructure Doñana Biological Reserve ([ICTS-RBD](#)) (ref.: 202030E286)

Personnel: Ricardo Díaz-Delgado, Mizar Torrijo-Salesa, Luis Alfonso Ramírez González, Antonio Alcaide, David Antonio Paz Sánchez, David Aragonés, Diego López, Olga Ceballos, Isidro Román Maudo, Alejandria Rojas, Juan Tenorio, Katrin Schmidt, Jose Ruíz-Martín, Javier Bustamante, Rocío Marquez-Ferrando

Study area description:

Doñana LTSER (Long-Term Socio-Ecological Research) Platform. Doñana Protected Area. Doñana National Park. Doñana Biological Reserve (RBD).

Design description: The Doñana Long-Term Monitoring Program has been carried out by ICTS-RBD (Unique Scientific and Technical Infrastructure of Doñana Biological Reserve) since 2004. Certain monitoring and survey activities already started in the 1980s, focusing on birds and endangered species such as the Iberian Lynx or the Imperial Eagle. The integrated program started in 2003, when it was extended and funded to monitor biodiversity and ecological processes targeting species, habitats, and populations, as well as ecosystem structure, function, and services. Long-term data systematically collected provides a baseline for decision-making and the assessment of management actions in order to minimize the impact of global change and local drivers. Results are annually reported to the Protected Area Managers and Practitioners and to the regional authorities as [technical reports](#) through open access reports.

Funding: National Parks Autonomous Agency (OAPN) between 2002–2007; Singular Scientific and Technical Infrastructures from the Spanish Science and Innovation Ministry (ICTS-MICINN); Ministry of Agriculture, Livestock, Fisheries, and Sustainable Development from the Regional Government of Andalusia (CAGPDES-JA) since 2007; and Doñana Biological Station from the Spanish National Research Council (EBD-CSIC) provide in-kind and direct funding to maintain the program. Finally, the project has also benefited from the eLTER Plus INFRAIA Research Project (Horizon 2020 EU Program, Agreement No. 871128), the eLTER H2020 INFRAIA project (Horizon 2020 EU Program, Agreement No. 654359), and the SUMHAL Research Project funded by FEDER actions [SUMHAL, LIFEWATCH-2019-09-CSIC-13, POPE 2014-2020] from the Ministerio de Ciencia, Innovación y Universidades.

Sampling methods

Description: The study area is located inside Doñana Protected Area in southwest Spain, where permanent plots spread across Doñana Biological Reserve (60 km²). The climate is Mediterranean sub-humid with Atlantic coast influence, resulting in wet mild winters and dry warm summers. The rainy season occurs between October and April, with a peak in December–January (average rainfall is about 550 mm). Doñana's four main ecosystems are monitored, including: temporary marshes, active sand dunes, Mediterranean shrublands and woodlands, and Doñana's shoreline of 30 km length. Under the vegetation topic, shrubland plant communities are monitored in 21 permanent plots sampled once per year during the peak flowering season, between March and May.

Sampling description: The long-term monitoring of Doñana shrublands started in 2008 by setting 21 permanent plots across the Doñana Biological Reserve. Each plot is sampled during one sampling campaign per year along the flowering season (between March and May). A total of 21 permanent square plots (15 × 15 m) were located according to stratified random sampling. Stratification was based on the 3 main types of shrub communities found on the stabilized sand dunes according to water table depth in summer: xerophytic white shrub > 4 m; transitions shrub > 1 m and < 4 m; higrophytic dark shrub < 1 m. Vascular plant cover is measured using the line intercept method across 3 transects per plot of 15 m length, oriented from East to West, and located at fixed points of 2.5, 7.5, and 12.5 metres on both sides of the plot. Using the line-intercept method, the contacts of each plant individual are recorded in a band strip of 50 cm along the measuring tape (Cummings and Smith 2000), together with the plant species, the class age, either adult (size class > 25 cm) or seedling (size class < 25 cm), the canopy status as a living or dead specimen, and the average canopy height per transect, visually estimated. According to the plant structure of the monitored vascular plant community, only one vertical stratum, the dominant and taller, is measured so that plants or seedlings in the understorey are disregarded, being those very infrequent. The method enables the calculation of the percent cover for each species across every transect and for the whole plot (as the summatory of the 3 transects), including total data per species on class age and percent of dry and green canopies, additionally to the percent cover of bare soil, plant species density, species richness, and plant species diversity. The maximum sampling time per plot was 75 minutes, being 40 minutes the average time, including stakes search and plot deployment. This permanent sampling is used as ground-truth for further landscape monitoring using different remote sensing data sources (satellite, airborne, and unmanned Aerial vehicle (UAV)), enabling the validation of shrubland mapping at larger scales (Jiménez and Díaz-Delgado 2015, Jiménez and Díaz-Delgado 2017).

Quality control: Taxonomic identification is assessed by different observers at the time in the field, using flowers and fruits to complement the correct identification. Plots are located with permanent stakes and coordinates collected with a D-GPS. Although more than 10 observers have participated in the sampling, 80% of the sampling was led by the

same observer. Data is digitally collected using mobile devices by means of a specifically designed [Cybertracker](#) sequence. This procedure guides the observer through a sequence of screens in a step-by-step way, some of them mandatory to prevent the loss of data. A map and a list of the plots, as well as a plant species list and observer names, are also available in the sequence for the observer. Unidentified plants in the field are later taxonomically identified. Contiguous individuals from the same species are recorded separately to improve plant density calculations. Data is transferred to a central [Cybertracker](#) database used for basic quality assessment, where the most frequent error (95%) corresponds to wrong tape measurements, which are corrected according to the previous record. Interannual plot percent cover comparisons are also used to assess consistency in plant species occurrences and relative abundance, although the plant cover dynamics of these plant communities are highly variable.

Step description: Along each plot, there are three different transects of 15 metres, on which a measuring tape is extended. The three transects are distributed at fixed distances from the Eastern side of the plot, the first one is 2.5 metres from the NE corner, the second one is 7.5 meters, and the last one is 12.5 metres. All the individuals intercepted by measuring tape are identified, and the tape distance of the initial and final contact points is recorded in order to calculate the total cover in the transect per species. Ancillary data on age class (adult or seedling: plant height under 25 cm) and canopy status (green or dry), which means the vitality of a living or dead specimen, is also recorded for each individual. The average plant height is recorded for every transect. The percent cover of each species is calculated per transect. Data is collected in the field using a CyberTracker-programmed sequence and downloaded as Excel or CSV-files.

Geographic coverage

Description: The 21 shrubland permanent plots included in this long-term monitoring are set across the Doñana Biological Reserve (RBD) (red line in Fig. 1). These plots are included in the Doñana LTSER Platform, which contains the Doñana Protected Area.

Coordinates: 36.983 and 37.031 Latitude; -6.548 and -6.463 Longitude.

Taxonomic coverage

Description: For the whole monitoring period, technicians have identified 34 different species, 8 generic identifications (i.e., genus), and a few individuals remain indeterminate. Taxons included 3 classes, 11 orders, and 16 different families of terrestrial plants (Table 1). The most abundant families are Cistaceae, Lamiaceae, Fabaceae, and Ericaceae, making up 93% of the total percent cover (including all years and transects) (Table 1).

Taxa included:

Rank	Scientific Name
kingdom	Plantae
phylum	Tracheophyta
class	Liliopsida
order	Asparagales
family	Asparagaceae
family	Asphodelaceae
order	Poales
family	Cyperaceae
class	Magnoliopsida
order	Asterales
family	Asteraceae
order	Caryophyllales
family	Caryophyllaceae
family	Plumbaginaceae
order	Ericales
family	Ericaceae
order	Fabales
family	Fabaceae
order	Lamiales
family	Lamiaceae
family	Oleaceae
order	Malvales
family	Cistaceae
family	Thymelaeaceae
order	Myrtales
family	Myrtaceae
order	Santalales
family	Santalaceae
class	Pinopsida
order	Pinales

family	Cupressaceae
family	Pinaceae

Traits coverage

Data coverage of traits

With the line-intercept method, the linear coverage intercepted with the measuring tape is measured, i.e., the initial and final contact of each individual. From raw data, we calculate plant percent cover for every plant species as the summatory linear distance covered by each species per transect divided by the total length of the transect (15 m). Additionally, plant canopy status (living or dead specimen; Fig. 2) and age class (adult or seedling: <25 cm; Fig. 3) for every individual are recorded, as well as the estimated average plant height per transect. These traits enhance the study of shrubland dynamics at plot (Figs 2, 3) and transect scales.

Temporal coverage

Notes: From 2008-04-08 to 2023-05-11

Usage licence

Usage licence: Other

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Data resources

Data package title: Long-term monitoring of woody plants of Doñana shrublands 2008-2023

Resource link: <https://www.gbif.org/dataset/deca479d-0832-4e4b-8c94-a09f32a80adb>; https://ipt.gbif.es/resource?r=covershrubland_icts-rbd

Alternative identifiers: <https://doi.org/10.15470/io6caz>

Number of data sets: 1

Data set name: Long-term monitoring of woody plants of Doñana shrublands 2008-2023

Data format: Darwin Core

Description: The dataset by Díaz-Delgado et al. (2024) contains three interconnected tables in text files: sampling events (Event core), occurrences (Occurrence extension), and extended Measurement or Fact extension (MoF) for the yearly percent cover of woody plant species of Doñana shrublands from 2008 to 2023 measured along 3 permanent transects located in 21 permanent square plots (15 × 15 m). The dataset also includes class age (adult or seedling) and plant canopy status (living or dead specimen).

Column label	Column description
id (Event core, Occurrence extension, MoF)	Identifier of the the sampling event
type (Event core)	The nature of a record
license (Event core)	License of dataset
institutionID (Event core)	An identifier for the institution having custody of the information referred to in the record
datasetID (Event core)	Identifier of the dataset including DOI
institutionCode (Event core)	The name (or acronym) in use by the institution having custody of the object(s) or information referred to in the record
datasetName (Event core)	Name of the published dataset
eventID (Event core, Occurrence extension, MoF)	An identifier for the set of information associated with a dwc:Event
parentEventID	An identifier for the broader dwc:Event that groups this and potentially other dwc:Events
samplingProtocol (Event core)	The references to the protocol used for the event
sampleSizeValue (Event core)	The numeric value for a measurement of the size of the sample in an event (length of the transect or the area of a plot)
sampleSizeUnit (Event core)	The unit of measurement of the size of the sample in an event
samplingEffort (Event core)	The amount of effort in minutes expended during the event
eventDate (Event core)	The date during which the event occurred
eventTime (Event core)	The time during which the event occurred
year (Event core)	The year during which the event occurred
month (Event core)	The month during which the event occurred
day (Event core)	The day during which the event occurred
habitat (Event core)	A category or description of the habitat in which the eventID occurred
locationID (Event core)	An identifier for the Location information
continent (Event core)	The name of the continent in which the location occurs

country (Event core)	The name of the country in which the location occurs
countryCode (Event core)	The standard code for the country in which the location occurs
stateProvince (Event core)	The name of the province in which the location occurs
county (Event core)	The name of the county in which the location occurs
municipality (Event core)	The name of the municipality in which the location occurs
locality (Event core)	The specific description of the transect in the plot
minimumElevationInMeters (Event core)	The lower altitude above sea level in meters
maximumElevationInMeters (Event core)	The higher altitude above sea level in meters
verbatimElevation (Event core)	The original altitude above sea level of the Location
locationRemarks (Event core)	Comments or notes about the location
decimalLatitude (Event core)	The geographic latitude (in decimal degrees) of the geographic center of the sampling plot
decimalLongitude (Event core)	The geographic longitude (in decimal degrees) of the geographic center of the sampling plot
geodeticDatum (Event core)	The geodetic datum upon which the geographic coordinates given in decimalLatitude and decimalLongitude is based
coordinateUncertaintyInMeters (Event core)	The horizontal distance (in meters) from the given dwc:decimalLatitude and dwc:decimalLongitude describing the smallest circle containing the whole of the dcterms:Location
modified (Occurrence extension)	Date of modification
language (Occurrence extension)	Language of dataset
collectionCode (Occurrence extension)	Code of the monitoring collection
basisOfRecord (Occurrence extension)	Method of species identification
dynamicProperties (Occurrence extension)	Additional measurements, facts, characteristics, or assertions about the record. In this case, the vitality, an indication of whether a plant was alive or dead at the time of observation
occurrenceID (Occurrence extension)	Identifier for the occurrence
recordedBy (Occurrence extension)	Names of observers responsible for recording the original occurrence
organismQuantity (Occurrence extension)	Value of the species percent cover per transect
organismQuantityType (Occurrence extension)	Type of measurement per occurrence (percent cover)
lifeStage (Occurrence extension)	Age class of the plant species (adult/seedling)

identifiedBy (Occurrence extension)	Name or names of the Observer/s identifying the taxon
scientificName (Occurrence extension)	Species scientific name
kingdom (Occurrence extension)	Kingdom of the species
phylum (Occurrence extension)	Taxonomic Phylum of the species
class (Occurrence extension)	Taxonomic Class of the species
order (Occurrence extension)	Taxonomic Order of the species
family (Occurrence extension)	Taxonomic Family of the species
genus (Occurrence extension)	Taxonomic Genus of the species
specificEpithet (Occurrence extension)	Taxonomic Epithet of the species
taxonRank (Occurrence extension)	Taxonomic Rank of the identification
scientificNameAuthorship (Occurrence extension)	Authorship of scientific name
measurementID (MoF)	Identifier for the measurementOrFact
measurementType (MoF)	The nature of the measurement
measurementValue (MoF)	The value of the measurement
measurementUnit (MoF)	The unit of the measurement value
measurementDeterminedDate (MoF)	The date on which the measurement was made
measurementDeterminedBy (MoF)	Names of observers who determined the value of the measurement
measurementMethod (MoF)	Description of the method used to determine the measurement

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Author contributions

Data collection: RDD, LARG, AA, DAPS, DA, DL, IRM, JR; data depuration: RDD, MTS; data standardisation: MTS, RMF; metadata redaction: RDD, MTS, RMF; datapaper redaction: RDD, MTS; project leader: RDD & JBD.

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Figure 1.

Geographic location of the 21 permanent plots (with their identification codes) surveyed on the dataset. All plots are located inside the Doñana Biological Reserve, RBD (red polygon). This protected area is in the southwestern part of the Iberian Peninsula, in the Huelva province (violet) of Andalusia.

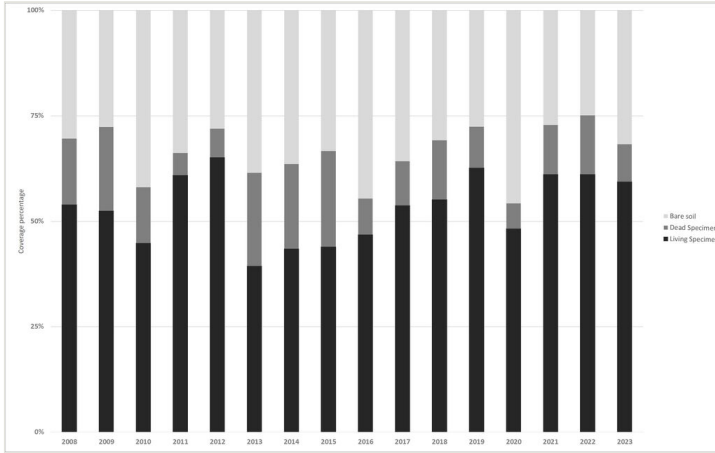


Figure 2.

Yearly total percent cover of woody shrub species according to canopy status (green/living specimens and dry/dead specimens) and bare soil.

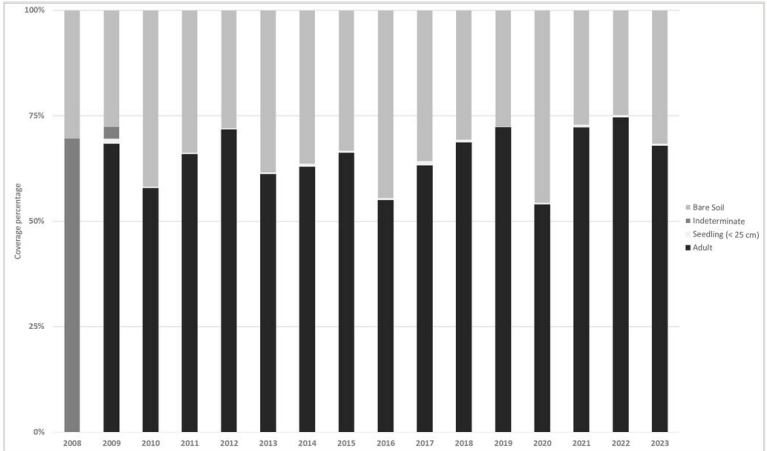


Figure 3.
 Yearly total percent cover of woody shrub species according to age class (adult or seedling) and of bare soil. Age class was not recorded in the 2008 sampling event.

Table 1.

Taxa are included in the dataset (class, order, and family). The percent cover for every family is calculated as the total plant cover from all sampling events.

Class	Order	Family	Representation (%)
Liliopsida	Asparagales	Asparagaceae	0.145
		Asphodelaceae	0.009
	Poales	Cyperaceae	0.003
Magnoliopsida	Asterales	Asteraceae	1.428
	Caryophyllales	Caryophyllaceae	0.004
		Plumbaginaceae	1.428
	Ericales	Ericaceae	9.057
	Fabales	Fabaceae	18.456
	Lamiales	Lamiaceae	28.246
		Oleaceae	0.479
	Malvales	Cistaceae	37.311
		Thymelaeaceae	0.029
	Myrtales	Myrtaceae	0.004
Santalales	Santalaceae	0.073	
Pinopsida	Pinales	Cupressaceae	0.943
		Pinaceae	1.911
Indeterminate		Indeterminate	0.472