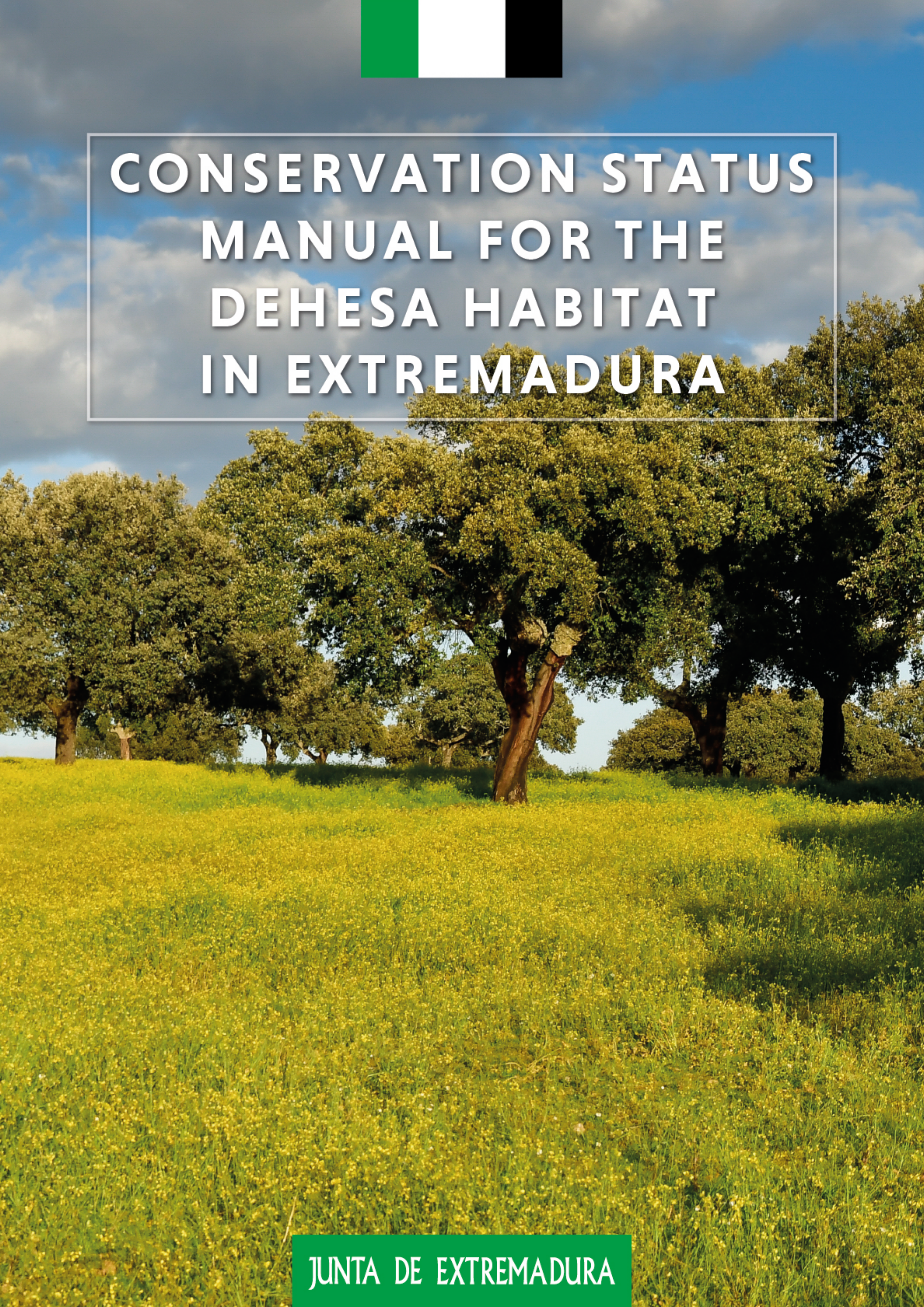
CONSERVATION STATUS MANUAL FOR THE DEHESA HABITAT IN EXTREMADURA



JUNTA DE EXTREMADURA

CONSERVATION STATUS MANUAL FOR THE DEHESA HABITAT IN EXTREMADURA

Habitat 6310 of Council Directive 92/43/EEC of 21 May, on the conservation of natural habitats and wild fauna and flora

Interreg España - Portugal
Fondo Europeo de Desarrollo Regional
Fundo Europeu de Desenvolvimento Regional
Unión Europea
União Europeia
PRODEHESA MONTADO
Proyecto de Cooperación Transfronteriza para la Valorización Integral de la Dehesa-Montado
JUNTA DE EXTREMADURA
Consejería para la Transición Ecológica y Sostenibilidad

INDEX

5 **PRESENTATION**

7 **PREFACE**

CH. 1 | LA DEHESA

9 Description, land and location

10 Uses and economic activities

11 Threats and opportunities

CH. 2 | THE DEHESA OF EXTREMADURA IN THE NATURA NETWORK

15 The Natura Network and Habitat 6310 Dehesas with Evergreen *Quercus* ssp.

17 The dehesa habitat 6310 in Extremadura and its environmental values

CH. 3 | CONSERVATION STATUS OF THE DEHESA HABITAT

21 Introduction

22 Materials and methods

- 22 Initial mapping
- 22 Field data
  - Fourth National Spanish Forest Inventory
  - Field data from the "ProDehesa-Montado" project
- 24 LiDAR data

26 Methodology

- 26 Selection of conservation status indicators
- 27 LiDAR estimation and modelling
- 28 Tree population structure
  - Tree population structure index at a pixel level
  - Tree population structure index at a tessera level
- 31 Shrub cover index
  - Shrub cover index at a pixel level
  - Shrub cover index at a tessera level
- 33 Conservation status methodology at a tessera level, combining the tree and shrub conservation statuses
- 33 Included vector data models related to the reproduction of protected species and the Natura 2000 Network
  - Inclusion percentage in the Natura Network
  - RAPEX zoning
  - Assignment of habitats that are favourable to the reproduction of protected species
  - Importance of inventoried species according to their protection category: Natural value (Nat. value)
  - Species diversity and habitat importance value (Total value)

36 Results

- 36 Conservation index based on tree population structure
- 37 Shrub cover index
- 39 Results at the tessera level of the combined conservation index for trees and shrubs

41 Analysis of results in relation to environmental values

- 41 Analysis of results at a habitat level in Extremadura
- 42 Analysis of results at the Natura 2000 Network level
- 43 Analysis of results from the RAPEX zoning
- 47 Analysis of results from the Favourable Habitat zoning
- 49 Analysis of results from the Natural Value zoning
- 52 Analysis of results from the Total Value zoning
- 56 Determination and characterisation of areas of High Natural Value
- 56 Distribution and characterisation of areas of High Natural Value

61 Conclusions





PRESENTATION

Possibly the best identity image of Extremadura and its natural wealth is the dehesa. This unique and singular ecosystem, which we feel is so much our own, arouses great interest, which is why attending to requests for information on its current situation helps to raise awareness of the need to guarantee its conservation and encourage its regeneration.

We are convinced that an in-depth knowledge of the dehesa and the dissemination of its values favours its survival. This Manual on the state of conservation of the dehesa habitat in Extremadura aims to enhance the value of this space, which is so important for our region, by providing precise analyses and an updated vision of its complex reality.

From the Department for Ecological Transition and Sustainability we conceptualize the dehesa as a natural treasure that is key to our objectives of preserving regional biodiversity and combating climate change, without forgetting its prominent economic and demographic component.

Preserving the dehesa means caring for and increasing its capacity as a sink for greenhouse gases, which is essential to combat and mitigate the harmful effects of climate change, which in turn, constitutes one of the main threats to this habitat.

The Extremadura Integrated Energy and Climate Plan 2021-2030 aims to achieve a climate neutral economy in our region by the end of this decade, and in this challenge the dehesa plays a key leading role as a carbon mitigator and as a reference system in the sustainable use of resources and in the reduction of emissions through the use of renewable energies.

We must be aware that the Iberian ecosystem of the dehesa and the montado is in a vulnerable situation, with a fragile ecological balance in the face of the climate crisis. For this reason, its analysis is essential in order to influence aspects such as research and innovation and thus be able to obtain answers and implement solutions to the negative consequences of the climate challenge already evident.

We agree that the dehesa is a natural environment of exceptional value that provides countless benefits and ecosystem services to Extremadura society, so we have to work together, institutions and landowners, to ensure its sustainability and turn it into an environmental and economic platform that provides opportunities and stimulates our development.

I would like to highlight the importance and potential of Spanish-Portuguese cross-border cooperation and I hope that this Manual will contribute to establish stronger and more fruitful links. In the field of the dehesa and montado, borders become blurred, the territory becomes a shared space and conservation a common cause.

Extremadura cannot be understood either economically, culturally or environmentally without the dehesa, which forms part of our memory, of our present as a region and also of a sustainable future to which it is necessarily linked. We are committed to its preservation, a task that will not be easy and will require great efforts to adapt to the scenarios that are expected. But the dehesa deserves it.

Olga García García
Councillor of the Department for Ecological Transition and Sustainability
Junta de Extremadura

◄ Dehesa in the SPAB of La Serena and Sierras Periféricas, at the tail end of the Zújar reservoir

PREFACE

The term **dehesa**, is defined in the Real Academia Española de la Lengua (Royal Spanish Academy of Language) as "land that is generally fenced and contains trees, commonly used as pasture", and it comes from the Latin word *'defensa'*, which means defence or fenced.

The most widespread dehesa usually coincides with wooded areas, with a well-developed pasture cover, which is accompanied by shrub species typical of vegetative successions of the Mediterranean ecosystem and whose vocation is mainly livestock, which configures the coverage of the various vegetable strata.

Specifically, this work is focused on the dehesa land described as a habitat with the code 6310, regulated by the Council Directive 92/43/EEC of 21 May, on the conservation of natural habitats and wild fauna and flora. We refer to this land as being made up of pasture and varied woodland, with evergreen species of the *Quercus* L. genus (from 5-75% of the tree density), predominantly holm oak and cork oak, in addition to a shrub layer of varied density, and with its primary use being for extensive livestock farming.

It is a unique ecosystem with a high diversity of flora and fauna species and a paradigm largely related to livestock management, but that can also be supplemented by agricultural, forestry and hunting uses, among others.

This manual forms part of the Cross-Border Cooperation Project for the Comprehensive Assessment of the Dehesa-Montado, PRODEHESA MONTADO, co-financed by the European Regional Development Fund (ERDF) and Cooperación Transfronteriza, the Interreg VA Spain-Portugal Cooperation Programme (POCTEP) 2014-2020.

The Regional Government of Extremadura, through the General Directorate for Sustainability from the Department for Ecological Transition and Sustainability, participates in the PRODEHESA MONTADO Project as a Beneficiary Partner and is responsible for a number of actions, including those detailed in "Action 2.- Assessment of the dehesa-montado habitat".

The aim of this publication is to make an approach to this ecosystem - by describing its most notable social, economic and environmental characteristics -, to frame the habitat in the whole of the Natura 2000 Network, to present the cartographic adjustments made in its distribution, as well as expose the assessment of its conservation status data and its relationship with the areas of highest natural value in the Autonomous Community.

It has been published in both English and Spanish, so it can reach a larger audience.

Finally, the back cover contains an illustrated map showing the distribution of this habitat, and there is also a QR code for downloading the map in a format that can be read by GIS.

◄ Panoramic photo of the dehesa in Extremadura

◄ Dehesa with Spanish lavender (*Lavandula stoechas*)

1 THE DEHESA

Description, land and location

The dehesa is an agroforestry system maintained and managed by humans, and it has a high level of biodiversity, meaning it is capable of generating highly sustainable agricultural and livestock activities.

In 1992, the European Union recognised the unique nature of this impressive vegetation area, through the Council Directive 92/43/EEC of 21 May, on the conservation of natural habitats and wild fauna and flora, cataloguing it as a natural habitat. It is more than 3.5 million hectares in size and is mainly concentrated in the south east of the Iberian peninsula. Two thirds of the land is located in Spain, where it is known as "dehesa", and another third is within Portugal, where they refer to it as "montado".

In Spain, the region with the largest proportion of dehesa land is Extremadura, with almost 1.5 million hectares, which makes up 35% of this autonomous community's territory.

The majority of current dehesa land originated from direct clearing of forests or the Monte de El Pardo (dense shrub and woodlands), for agriculture and grazing. Trees and shrubs were selectively removed on this land in order to increase the surface area for grazing and to enable livestock farming.

This process established a vegetation succession from Mediterranean forest to wooded pasture, with a varied level of tree cover and, to a lesser extent, shrub cover.

These processes for producing the dehesa land took place during the phases of the "agricultural conquest" over the period of 1750-1850, as well as more recently. As such, between 1900 and 1930, the so-called "agricultural conquest" led to what was known as the "golden age of the dehesa", where production became diversified and the dehesa land was increased by transforming large areas of Monte Pardo. It was during this period that

Holm oak and cork oak detail with the size of their fruits (acorns)

Vegetation succession

the term "dehesa" was first established, to identify woodland areas where the trees are distributed in a uniform manner, due to the way in which they were cleared. The identification and mapping of dehesas involves overlaying information on the ownership of the land, its preferred use, the presence of trees and the spatial layout of said trees (not their cover, which can vary significantly both between different estates and within each plot of land) (Díaz and Pulido, 2009).

Dehesas are usually located on poor-quality soil in Mediterranean climates with very dry summers. These constraints meant that fully ploughing the land exclusively for agricultural purposes was not profitable, except in areas that had been irrigated. Likewise, it has also proven difficult to entirely transform the land into pasture by removing all the trees, due to the low fertility of the soil. This has caused more value to be placed on the benefits provided by the trees (shade and the production of acorns for feeding livestock).

The key to the economic performance of dehesas is a uniform layout of trees, as this contributes towards the productivity of the pasture and the availability of fruit to feed the livestock (acorns).

This layout also considerably increases the conservation values of the dehesas, as it is responsible for the increased levels of local diversity maintained in the dehesas and their use by larger endangered species that breed or live in other kinds of habitat nearby, using the dehesas as a food source (grass, acorns, prey or carrion).

Uses and economic activities

Livestock is the most important use, in the form of extensive farming. This provides benefits to the health of the animals and to the conservation of the ecosystem and its resources, allowing various types of livestock to live alongside one another.

One of the most important species of livestock connected to this kind of ecosystem is the Iberian pig, which roams the estate freely to feed during the "montanera" months, the period when cork and holm oaks gradually drop their acorns. The appearance of the African swine fever virus in the 1960s was a major setback for this livestock population, which was entirely wiped out in Portugal. It made a strong comeback in Spain, along with the meat processing industry, curing companies in particular, which produce the products from Iberian pork: hams, paletas (ham shoulders), loins and other cured meat products. All of these products contribute towards the economic development of the rural population around the dehesa ecosystem.

Montanera pigs have historically been combined with flocks of Merino sheep, farmed for meat and wool. For centuries sheep were one of the key elements of transhumance, and the value of wool during the Middle Ages and the early centuries of the Modern Age was one of the triggering factors for the production of dehesa land. The fall of wool prices led to the breeding of cattle, which is today undergoing a notable increase, with indigenous breeds being crossed with others that provide more meat.

One final livestock species that is farmed is goats, although it is less common. Goats are adapted to browsing and also feed on shrubs, thus contributing to the conservation of the dehesa. Sheep and goats also sustain the dairy industry, with the development of companies that add to the economic wealth generated by this habitat.

Dehesas also provide highly sustainable forestry production. Tree pruning not only increases the production of acorns but also provides wood and charcoal, another important economic resource connected to this ecosystem.

Another very important forestry activity in the dehesa is the cork industry. This material is extracted from the outer bark of the cork oak. Its insulating properties and natural origin make it a highly demanded product within the wine industry, and increasingly so for construction as well. The key benefits of the cork industry are its high capacity for job creation and the fact that it is does not pollute the environment and its waste is recyclable, plus it also contributes towards conserving the dehesa habitat as the cork is harvested sustainably using non-invasive methods, with the bark regenerating spontaneously over a period of nine to fourteen years.

Threats and opportunities

The present and future of the dehesa are heavily dependent on the condition of the trees and the presence of a shrub layer. Excessive livestock farming will have a negative effect on the regeneration of trees and lead to the elimination of shrubs. The direction of the Common Agricultural Policy over recent decades has helped to exacerbate this problem, as it promotes the herbaceous layer over the tree layer, simplifying the system and classifying it strictly as either

Pigs feeding in the dehesa

Cork piled up in the dehesa in Extremadura

forestry or agricultural. The triple dimension of this agrosilvopastoral system requires a less simplistic approach, as, in practice, the direction of the agricultural policy has contributed towards the extension of grazing or agricultural land over woodlands and shrublands, and has led to an increase in the livestock population, particularly cattle.

The majority of trees in the dehesa today are old and there is a severe lack of younger trees. In order to support their regeneration and survival, holm oak and cork oak saplings need to be shielded by shrub species during the dry summer period, protecting them from livestock browsing at least during their first years of life. The presence of dispersing animals is also necessary to transport the acorns (zoochory) from the mother plants to areas with shrubs, where they will have a better chance of growing.

Another of the major problems today for these ecosystems is plant health. For the past 20 years, the disease commonly known as "seca" (dryness) has been responsible for major losses both in terms of tree density and numbers. There is currently a particular concern due to the proliferation of focal points and how far they are spreading. As an example to demonstrate the impact of seca on communities like Extremadura, 430 focal points were inventoried between 2003 and 2004, with an estimated annual mortality rate of 10-15%. Another 96 of these focal points were studied in 2008 and 2009, with an estimated annual mortality rate of 15-25%. In the Alto Alentejo and Baixo Alentejo regions of Portugal, the situation is similar to Extremadura and Andalusia, respectively, and in the Algarve the mass mortality of the trees has drastically altered the landscape[1]. The loss of holm oaks and cork oaks is generally related to factors that weaken the trees and predispose them to subsequent death. These weakening factors may be slight deviations in local weather, inappropriate pruning or corking, drastic alterations in the soil, or certain diseases, largely *Biscogniauxia mediterranea* and *Botryosphaeria* spp. Other potential causes of tree mortality are drought due to prolonged periods without rain, boreholes made by the *Cerambyx* sp., insect and root rot caused by the *Phytophthora cinnamomi* disease.

[1] Libro Verde de la Dehesa. F. Pulido and A. Picardo, 2010.

However, in response to the outcry from the scientific community and the managers of these spaces, in recent years the direction of the agricultural policies and rural development has begun to change, taking into consideration the protective role of the shrubs on the pasture, increasing the budget and carrying out more actions aimed at regenerating the dehesa.

This manual aims to contribute towards the continued study and characterisation of the dehesa, so that the data can be disseminated to help achieve a better understanding of this habitat and promote actions that guarantee its conservation.

Within this drive, it is also important to mention the various actions taken to increase the value of products produced in the dehesa, by obtaining quality certifications for its meat products. Furthermore, society has recently become more aware of the quality of products and concerned about their origin, leading to a rise in sub-products produced in the dehesa through extensive farming systems.

It is also important to highlight the social implication of the public on this ecosystem, not only from those that enjoy it temporarily in the form of tourism, an activity that has significantly increased, but also in relation to the community that lives in the surrounding area, which has now revealed its involvement in the conservation of this ecosystem.

The value and importance of the dehesa, or montado, in the conservation of species and protected areas has now been recognised by the scientific community, which has without a doubt contributed towards the characterisation and dissemination of data generated from the studies carried out within this field.

Deer specimens *(Cervus elaphus)*

◄ Bonelli's eagle *(Aquila fasciata)*

2

THE DEHESA OF EXTREMADURA IN THE NATURA NETWORK

The Natura Network and Habitat 6310 Dehesas with Evergreen *Quercus* ssp.

The Natura 2000 Network is a collection of natural areas in the European Union with a high ecological value.

The Natura 2000 Network was created as a result of the application of two Community Directives: Directive 2009/147/EC from the European Parliament and of the Council of 30 November 2009, on the conservation of wild birds, and Directive 92/43/EEC of the Council of 21 May, on the conservation of natural habitats and wild fauna and flora.

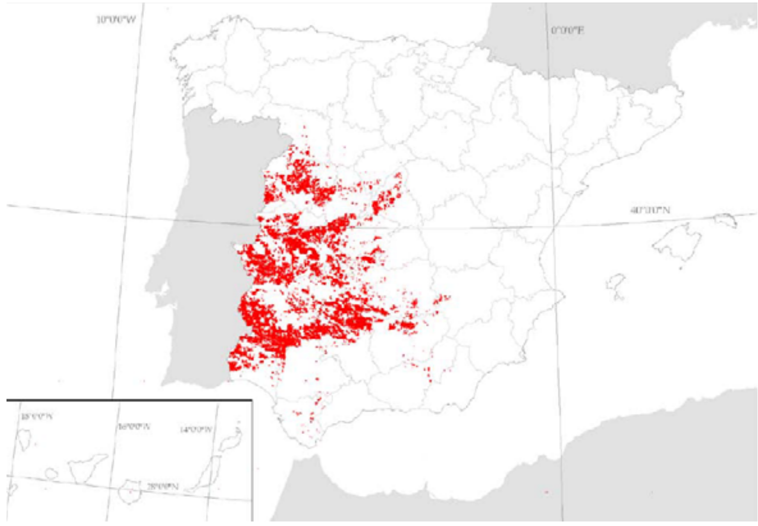
Body of water in the dehesa

Specifically, Directive 92/43/EEC establishes the protection of various types of habitats of community importance, due to their scarcity, uniqueness or the fact that they constitute the natural or semi-natural environments that are representative of the various European biogeographic regions. Annex I of the Directive lists more than 200 different types of habitat. This list includes the habitat related to the dehesa ecosystem, under the name "6310 Dehesas with Evergreen *Quercus* spp".

The definition of this type of habitat, according to the Interpretation Manual of European Union Habitats (EUR25, October 2003), is as follows:

"This landscape in the Iberian peninsula is characterised by wooded grasslands with a tree canopy of varied density made up of sclerophyllous oak trees, primarily *Q. ilex* spp. *ballota (Q. rotundifolia)* and, to a much lesser extent, *Q. suber, Q. ilex* spp. *ilex* and *Q. coccifera*, which is interspersed by small plots of dry crops and patches of low shrubs or woody shrubland. The sabanoid configuration of the trees and herbaceous grasslands, with patches that are cultivated or invaded by shrubs, are maintained using management practices for the purposes of providing vegetation for the extensive farming of cattle, sheep, goats and/or pigs, and also, as an alternative or in addition, for wild ungulates, such as deer *(Cervus elaphus)*, boars *(Sus scrofa)*, bucks *(Dama dama)* or roe deer *(Capreolus capreolus)* which are hunted. It is an important habitat for birds of prey, such as the endangered and endemic Iberian imperial eagle *(Aquila adalberti)*, and also for common cranes *(Grus grus)* and the endangered Iberian lynx *(Lynx pardinus)*".

If we are to assume that the entirety of the forest area is used for some form of livestock farming, and we exclude the forest area corresponding to pine and eucalyptus tree plantations, the estimated size of this habitat is approximately 2,248,000 ha in Spain and 869,000 ha in Portugal (data from 1992) (Díaz and Pulido, 2009).



Estimated distribution map for habitat 6310. Data from the Spanish Habitat Atlas, March 2005

The following types of dehesa habitat can be established.

I. Southern holm oak dehesas. Located in low areas of the meso and thermo-Mediterranean levels. These would be the typical dehesa plains in Extremadura, Andalusia and Castilla-La Mancha. Acorn production tends to vary in quantity from one year to the next, which enables the production of Iberian pigs of various levels of purity. There is also usually a higher density of trees that protect animals and grass from excessive insolation during the hottest months of the year. The trees are usually larger and there are less breadnuts.

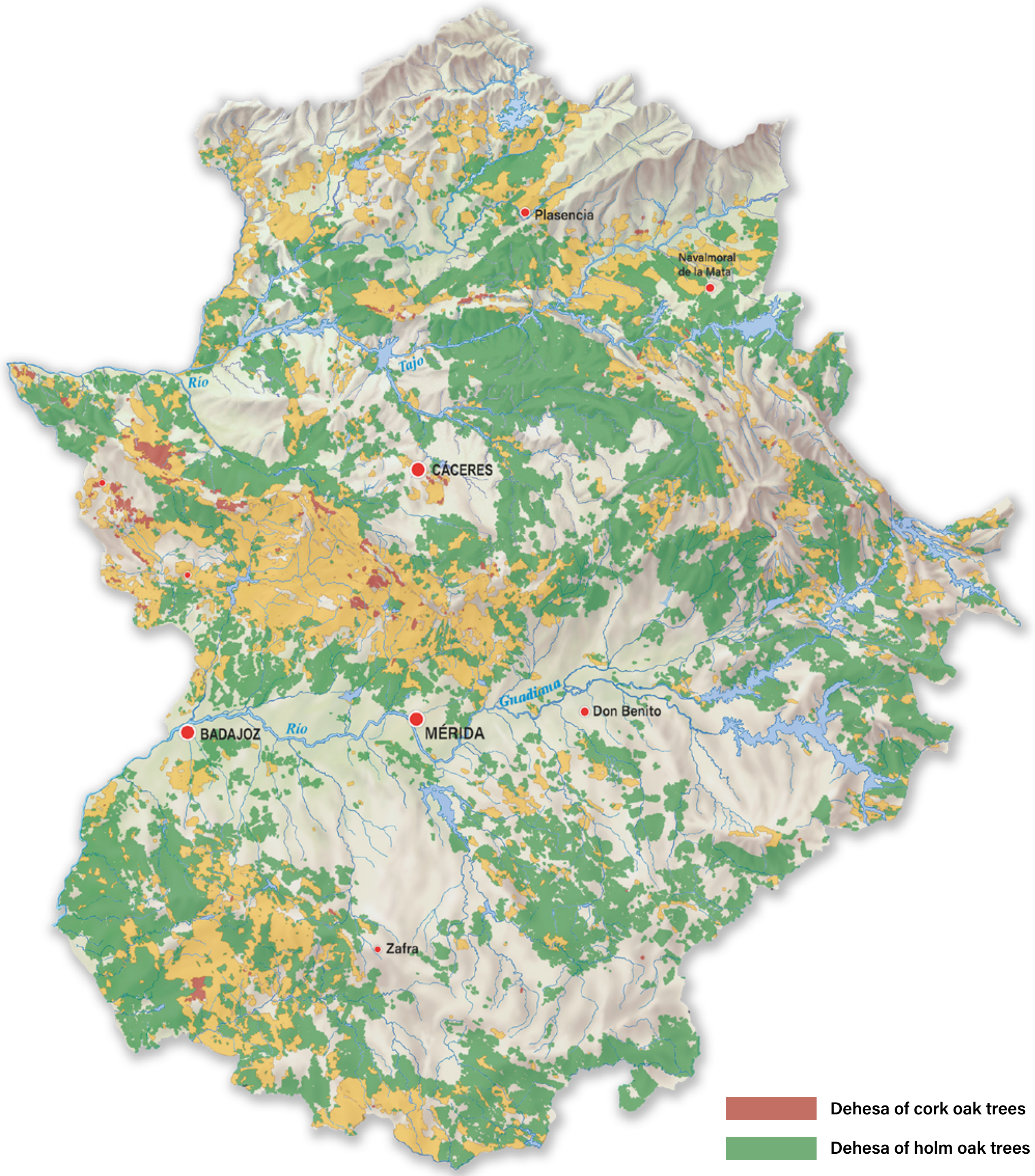
II. Northern holm oak dehesas. Located in low areas of the supra-Mediterranean level (dehesas typical of Castile and León). Acorn production is limited and irregular and there is more of a focus on the production of wood and the consumption of breadnuts for livestock, particularly in winter.

III. Cork tree dehesas and medium-height mountain dehesa landscapes. These types of dehesas are more commonly used for forestry purposes, particularly the extraction of cork, and also for hunting purposes (big game), so there is less of a focus on livestock farming. These would be the typical mountain dehesas, such as those in Sierra Morena, Sierra de San Pedro or Los Alcornocales.

The dehesa habitat 6310 in Extremadura and its environmental values

The total surface area of Habitat 6310, Dehesas with Evergreen *Quercus* spp in Extremadura, is made up of a tessellated surface area of 1,452,228.5 ha and a net habitat surface area of 1,428,918.5 ha (taking into account the % of habitat area in each tessera).

We therefore find a surface area of almost 1.5 million hectares, distributed as demonstrated in the map below:



Distribution map for Dehesas with Evergreen *Quercus* spp. in Extremadura, according to the primary species

In this anthropogenic landscape, human activity coexists alongside the ecosystem and is home to a wide range of flora and fauna. Spain makes up around 33% of the Natura 2000 Network, whose directives protect the majority of the species that live in this ecosystem.

In terms of the dehesa's importance as a breeding habitat for protected species, the data[2] are highly relevant: 23% of birds of prey and black storks in Extremadura breed in the dehesa; up to 76% of black vulture *(Aegypius monachus)* nests in Extremadura are built in the canopies of holm oak or cork oak trees, as are 42% of Iberian imperial eagle *(Aquila adalberti)* and black stork *(Ciconia nigra)*, nests, and this percentage goes up to 92% in the case of the black-shouldered kite *(Elanus caeruleus)*.

It is also used as a feeding area for many of the species that nest or shelter in the sierras and rocky areas surrounding the dehesa land. For example, scavenger birds, such as Egyptian vultures *(Neophron percnopterus)* and black and griffon vultures *(Gyps fulvus y Aegypius monachus)*, they feed mainly on the carrion of livestock raised in the dehesa (cows, pigs, sheep and goats), in addition to the carrion of large game, such as deer *(Cervus elaphus)* and boars *(Sus scrofa)*, which also feed in the dehesa. Another key example is the imperial eagle *(Aquila adalberti)* and endangered mammals like the Iberian lynx *(Lynx pardinus)*, whose main source of food is rabbit *(Oryctolagus cuniculus)*, which finds its perfect habitat within this ecosystem.

It is also important to note that the dehesa is the main winter destination for large populations of European cranes *(Grus grus)*, which come to this habitat to feed on acorns..

The fauna in the dehesa also includes a wide variety of invertebrates, which are essential to the trophic chain, as well as numerous different amphibian and reptile species.

Wild species in the dehesa

[2] Official data from the General Directorate for Sustainability, based on periodical censuses.

Specimens of cranes *(Grus grus)* in the dehesa

The fluvial channels are home to large populations of otters, whose prey includes the fish that are typically found in these rivers that are subject to low water levels, such as the Spanish minnowcarp *(Anaecypris hispanica)*, the *Squalius alburnoide*s, the Iberian nase *(Pseudochondrostoma polylepis)*, the barbel *(Luciobarbus bocagei)*, etc. The extensive network of "charcas", small reservoirs of water traditionally dug to provide water for livestock, form a specific habitat that is used by waders, waterfowl, herons and storks.

The local plant life, largely made up of annual grass, reaches diversity levels comparable to the most varied habitats throughout the world. This is due to the combination of species adapted to open and disturbed environments and forest species dependent on the shade of scattered trees.

The following chapter presents the results obtained from superimposing the dehesa habitat to the inventoried natural values of catalogued protected species.

◄ Bird's-eye view of a dehesa in Extremadura

3 CONSERVATION STATUS OF THE DEHESA HABITAT

Introduction

The purpose of this chapter is to present the methodology and results of the work carried out to assess the conservation status and suitability of the spatial data from the Natural Dehesa Habitat in Extremadura (Dehesas with Evergreen Quercus spp, under code 6310, in annex 1 of the Habitat Directive).

The definition of the conservation index for Dehesas with Evergreen Quercus spp. is described in the publication "Preliminary ecological bases for the conservation of natural habitats of community importance", edited by MAPAMA (Díaz and Pulido, 2009)[3]. The definition of an ecological indicator that approximates the categorisation of an ecosystem can be crucial when it comes to establishing conservation and management strategies. An ecological indicator may therefore be defined as a direct or indirect variable that approximates the conditions of the ecosystem. These conditions should be measurable and quantifiable so that comparative and qualifying criteria can be established. As in the publication from Díaz and Pulido (2009), which evaluates the conservation status of the dehesa systems based on their population structure (diversity of ages in tree species), species cover (density of shrub species) and early recruitment of saplings (density of regeneration).

Since the end of the 1980s, Habitat 6310, Dehesas with Evergreen *Quercus* spp., has been suffering from progressive deterioration, reduction and loss of distribution habitat as a result of various factors, both abiotic and biotic. Pressure from climate change, the replacement of traditional labour with more mechanical methods, overgrazing and the consequential loss of natural regeneration, insect infestations (*Cerambyx* sp.), diseases (*Phytophthora* sp), and changes in the use of land towards more profitable agricultural activities, are all factors that make it very important to develop an ecological indicator to assess the conservation status of the dehesa.

Quantifying this ecological indicator for small zones is relatively simple, although it requires prior inventory field work based on transects and circular plots. However, evaluating this conservational index at a regional level, as with the large surface area being evaluated in Extremadura, becomes more arduous, extensive and challenging with a limited timescale. However, there are tools that make it easier to obtain detailed information

[3] Díaz, Mario, & Pulido, Fernando (2009). 6310. Dehesas with EvergreenQuercus spp. In: *Preliminary ecological bases for the conservation of habitats of community importance in Spain*. Spanish Ministry of the Environment, Rural and Marine Affairs. Madrid.

of a surface area on a large scale, such as analysis using remote sensing systems like LiDAR (Light Detection and Ranging)[4].

LiDAR is an active system for obtaining data remotely through the use of an airborne sensor. The LiDAR data is obtained by recording the position of an object using a pulse of light (laser). By precisely measuring the time it takes for the portions of the pulse to return to the sensor, the system is able to calculate the distance between the sensor and the land surface and any objects on the surface. The difference in the reception times of the various pulse portions is what generates the returns. Repeating this pulse of light onto the surface being studied generates a high-definition point cloud, allowing information to be obtained about said surface.

In this study, the spatial distribution of the conservation index of the dehesas (habitat 6310) in Extremadura has been estimated based on the population structure index and the shrub cover index defined by Díaz and Pulido (2009), using the LiDAR data from the Spanish National Aerial Orthophotography Plan (PNOA) for 2010 (north and south Extremadura) and 2018 (south Extremadura), as well as field data from the Fourth Spanish National Forest Inventory (IFN IV) and our own data obtained in the field.

The importance of the natural assets in the dehesa habitat has also been calculated based on existing data from censuses and inventories of particular protected species.

Materials and methods

Initial mapping

The following activities were carried out to control the quality and improve the mapping provided by the Department for the Conservation of Nature and Protected Areas from the General Directorate for Sustainability.

1. Validation of the initial mapping using samples in the office. 900 points were chosen randomly and validated by photo interpretation, then interpreted as either dehesa or not dehesa. It was concluded that the vector map used was of excellent quality.
2. Adjustment of the outer limit of the Geographic Information System for Agricultural Plots in Extremadura.
3. Corrections based on inventory data.

Field data

Fourth National Spanish Forest Inventory

The data used in this project was from the IFN IV[6], specifically the data relating to the 814 plots distributed between the provinces of Cáceres and Badajoz, which fall within the limits established for habitat 6310, and where the main species are *Quercus ilex* or *Quercus suber* (Figura 1).

Measurement plots

Radius (m)	Dn
5*	[7'5 , 12'5)
10	[12'5 , 22'5)
15	[22'5 , 42'5)
25	≥ 42'5

* Regeneration is counted according to 4 categories in the 5 m radius

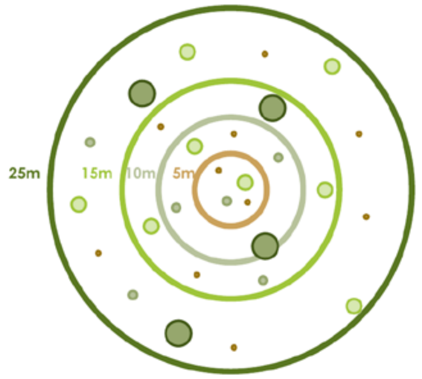


Figure 1. Description of the data collection in the IFN IV

[4] Dubayah, R. O., & Drake, J. B. (2000). Lidar remote sensing for forestry. *Journal of Forestry*, 98 (6), 44-46.

[5] Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E., & Wulder, M. A. (2014). Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment*, 148, 42-57. doi: https://doi.org/10.1016/j.rse.2014.02.015

[6] https://www.mapa.gob.es/es/desarrollo-rural/temas/politica-forestal/inventario-cartografia/inventario-forestal-nacional/default.aspx

Field data from the "ProDehesa-Montado" project

Photo 1. Measuring the diameter of tree canopies during the ProDehesa-Montado project inventory

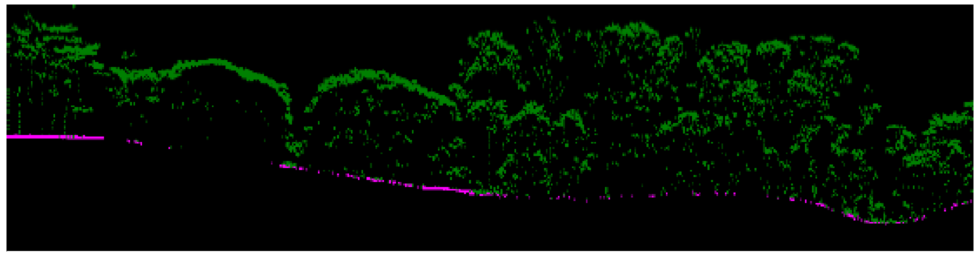
The inventory counted a total of 250 plots distributed among 39 different estates, which each containing 6-8 plots. This sample is considered to be ideal for validating the results of the habitat mapping at a tessera level, as it enables the situation of each estate to be assessed based on several different inventory plots.

The plots in this inventory were surveyed with a variable radius according to the thickness of the mass, so that at least 20 trees per circular plot with a maximum radius of 70 m were included (Photo 1). When estimating the regeneration density, the radius of the plot may vary between 10 and 50 metres, depending on the distance where the first regenerated tree is found. In any case, as with the IFN IV, the values are calculated by surface unit, so that they are comparable regardless of the size of the plot where they were measured (Figure 2).

Figure 2. Distribution of the inventory data used. Distribution of the plots from the IFN IV (black dots) and the plots established in the ProDehesa-Montado project inventory (red points), within the distribution of the habitat of community importance 6310. Dehesas with Evergreen *Quercus* spp. in Extremadura

LiDAR data

For profiling the population of the dehesa, we used variables from the point cloud provided by the Spanish National Aerial Orthophotography Plan[7] (PNOA). and from the combination of all the points, it has been possible estimate the height of the ground (MDE) and the height of the vegetation (MDV), with the latter being a reliable indicator of the height of existing vegetation cover (Figure 3).



Data profile view of a LIDAR Point Cloud. Compiled by authors

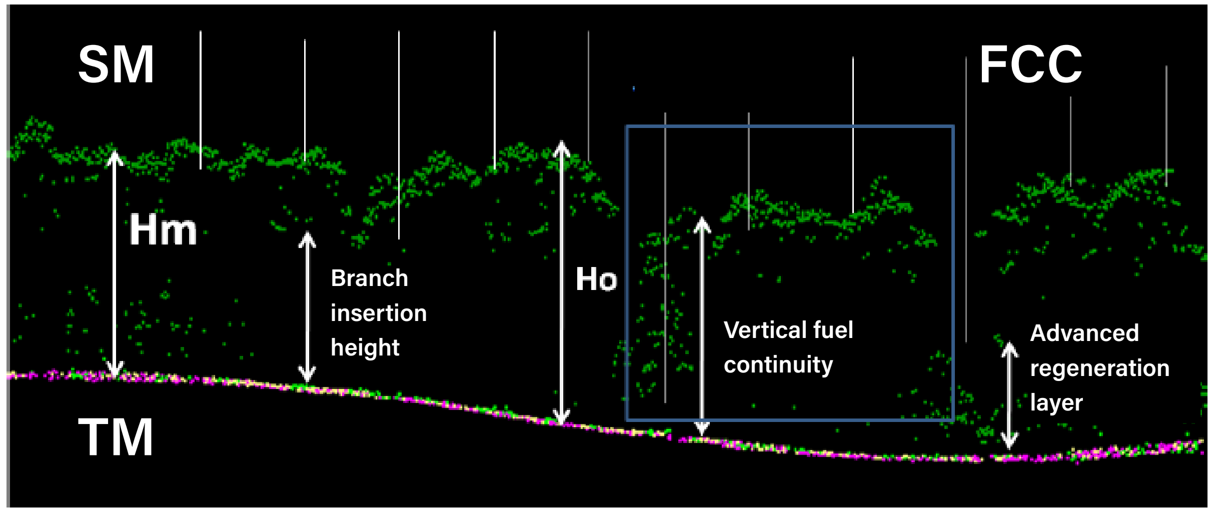
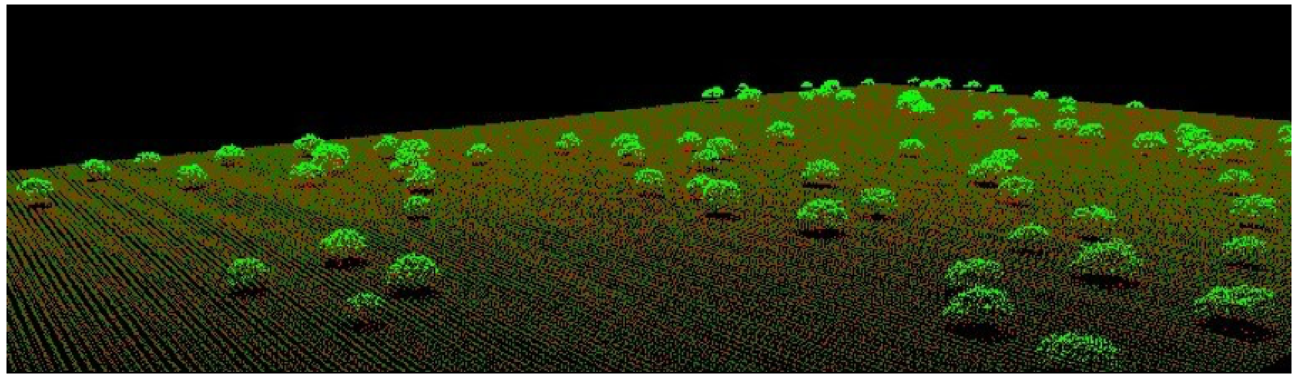


Figure 3. Graphic description of the dasometric variables related to the LiDAR point cloud.

The LiDAR data are obtained once the MDE and MDV have been estimated. These variables characterise the layout of the points within the point cloud in the vertical of a given surface. Such variables are correlated with the height of vegetation and the tree and shrub fractional canopy cover, making it possible to estimate the tree density, as well as the number and height of the trees.



[7] Spanish National Aerial Orthophotography Plan. https://pnoa.ign.es/

This LiDAR inventory was produced using mass methods, so that the relationships between the conservation indicators and the LiDAR data are established at a cell or pixel level, which in our case is 50x50 metres, in line with recommendations from other authors (Magnussen y Boudewyn, 1998[8]; Condes et al, 2013[9]) to analyse the LiDAR data. This will allow us to present the results with continuous "raster" variables, thus characterising the entire cover of habitat 6310 (Figure 4).

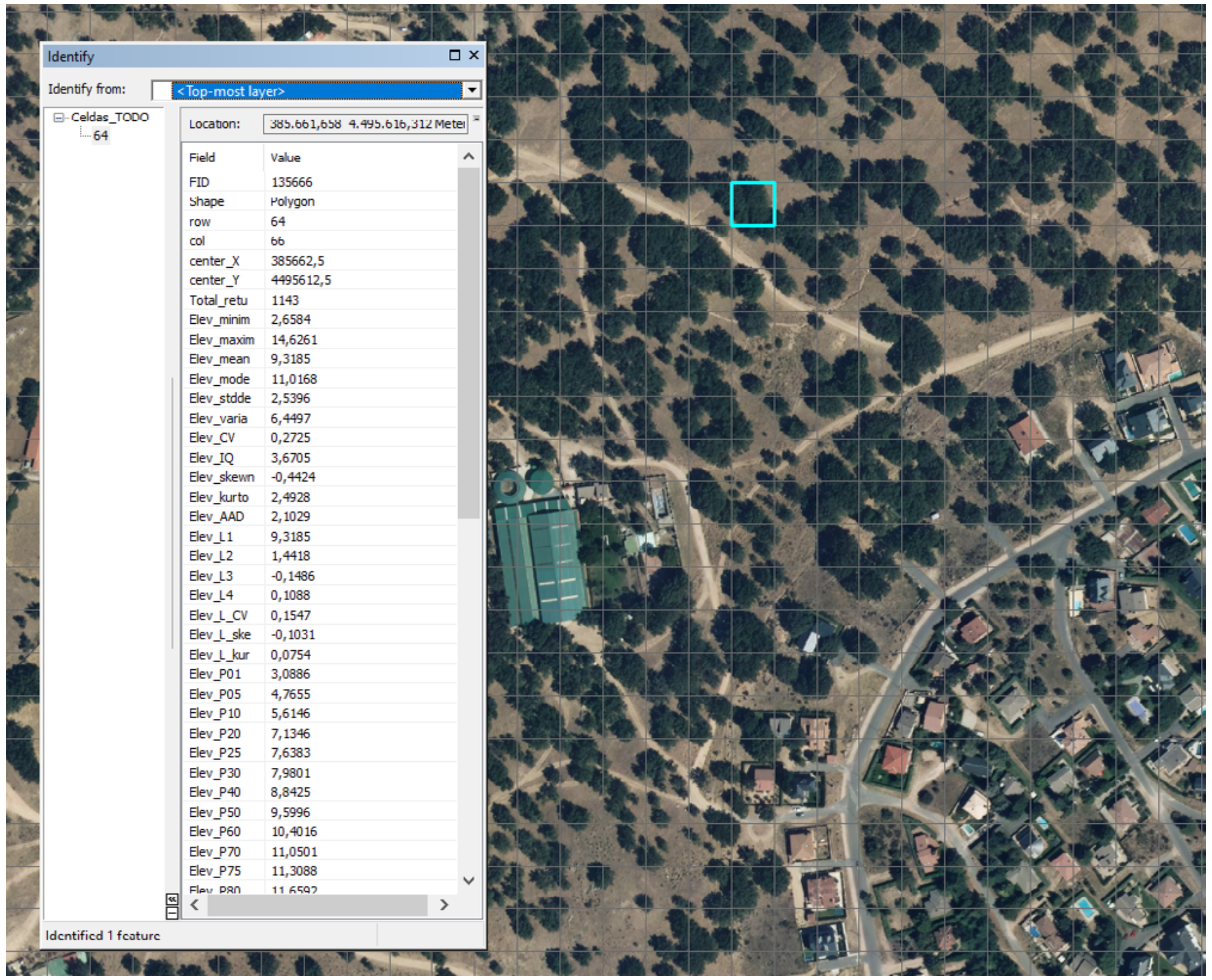


Figure 4. Example view of the values from the LiDAR data descriptors for the vegetation structure

The available LiDAR data are:

- LiDAR flight in 2010 with a resolution of 0.5 pulses/m², available for the whole of Extremadura.
- LiDAR flight in 2018 with a resolution of 1 pulse/m², available for the southern half of Extremadura (EXT-Sur).

[8] Magnussen, S.; Boudewyn, P.; 1998. Derivations of stand heights from airborne laser scanner data with canopy-based quantile estimators. *Canadian Journal of Forest Research* 28: 1016-1031

[9] Condés, S.; Fernandez-Landa, A.; Rodriguez, F.; 2013. Influence of the field inventory on sampling errors obtained in an inventory with LiDAR technology. 6th Spanish Forestry Congress. 6CFE01-432.

Methodology

Selection of conservation status indicators

The assessment of the conservation status for Dehesas with Evergreen *Quercus* spp., habitat of community importance 6310, is based on the publication "*Preliminary ecological bases for the conservation of natural habitats of community importance,* edited by MAPAMA" (Díaz y Pulido, 2009)[10].

The aforementioned publication identifies three indices that **must be applied, and are summarised below:**

1. **Tree population structure** (spatial distribution and size structure) at an estate scale and their variability in terms of the local use of the ground under the trees (farming, pasture, shrubs).
2. **Shrub cover by species**
3. **Early recruitment of saplings**

Of the three established conservation indices, both the tree population structure and the shrub cover by species are structural in nature, meaning that they relate to the height of the vegetation. The third — early recruitment of saplings — is functional in nature.

It is therefore considered that the two first indices — tree population structure and shrub cover — may be estimated based on LiDAR data, as they are related to the structure of the vegetation. The third index — early recruitment of saplings — refers to the number of saplings per year, which cannot be estimated using LiDAR data (Figure 5).

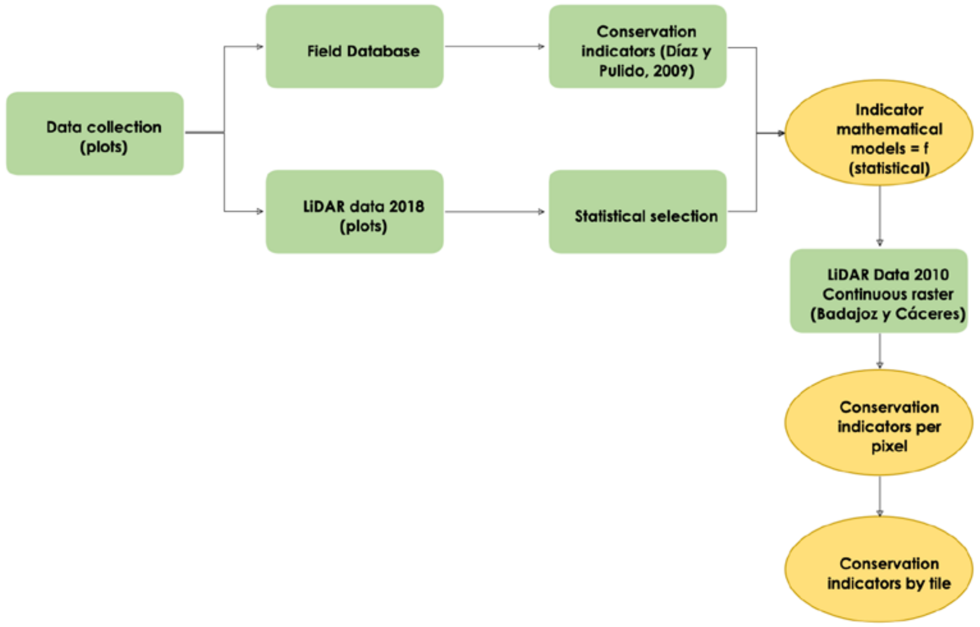


Figure 5. Workflow to obtain the conservation status indicator for habitat 6310 based on tree and shrub cover.

In any case, as established in the aforementioned literature, *the conservation status, in terms of structure and function, can only be estimated using variable number one (1) (tree size structure). Variables two (2) and three (3) indicate the probable trend in the short-medium term (negative if they are both unfavourable, and positive if both are favourable).*

[10] Díaz, Mario, & Pulido, Fernando (2009). 6310. Dehesas with Evergreen *Quercus* spp. In: Preliminary ecological bases for the conservation of habitats of community importance in Spain. Spanish Ministry of the Environment, Rural and Marine Affairs. Madrid.
Galicia González, Álvaro (2017). Assessment of the Conservation Status of Habitat 6310 (Dehesas with Evergreen *Quercus* spp.) in Andalusia, based on data from the Spanish National Forest Inventory. University thesis. ETSIMFMN. Universidad Politécnica de Madrid.

LiDAR estimation and modelling

The estimations of the conservation indices, both at a population structure and a shrub cover level, were completed using LiDAR modelling and data. Certain assumptions were made for this. When calculating the LiDAR data for estimating the tree population structure, we cut the height of the point cloud at 2 m from the ground. This allowed us to exclude from the data all the points below 2 m that may relate to shrubs or rocky outcrops (Photo 2).

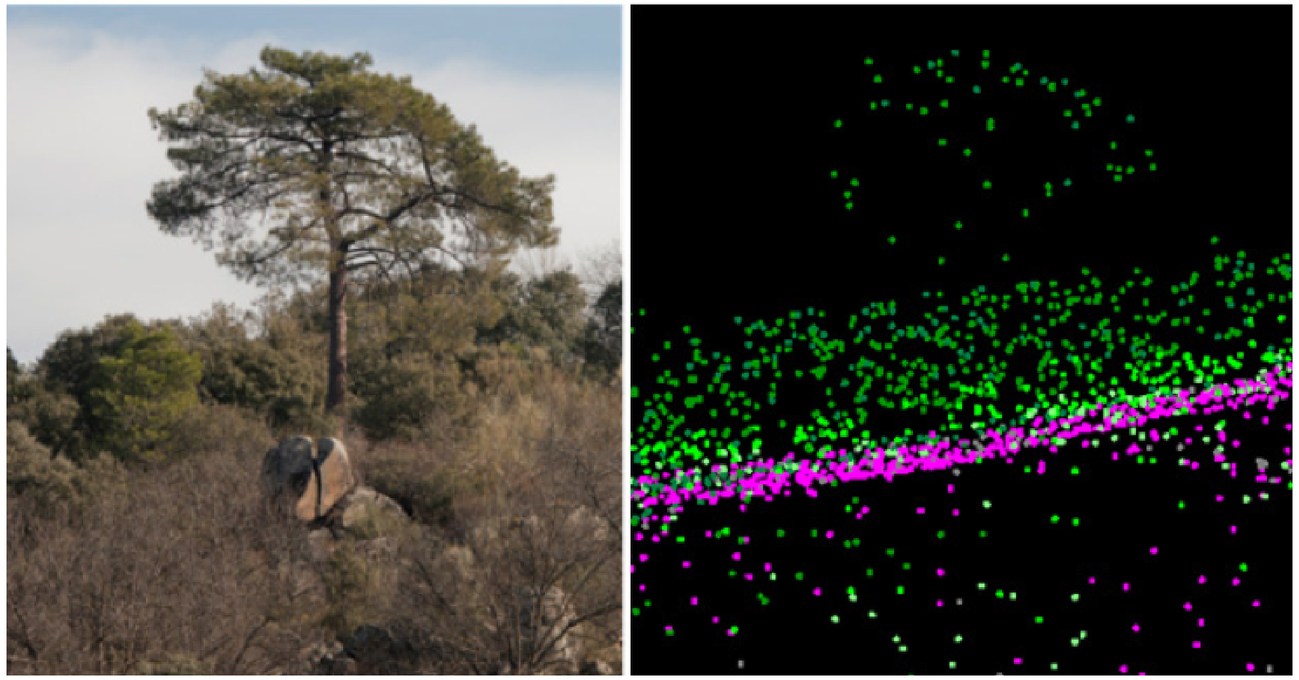


Photo 2. The vertical layers of vegetation can be segregated by making cuts in the point cloud

This field data were used to calculate the conservation indicators corresponding to each inventory plot, based on the available literature. These indicators were compared against the LiDAR data from the PNOA for each of the inventory plots, in order to obtain a relationship that would allow us to estimate the same for all the cover in habitat 6310 (Figure 6).

The relationship between the selected dasometric data and the LiDAR variables was estimated through modelling, using an algorithm developed with a Generalised Additive Model[11] (GAM). The GAM algorithm is a non-linear estimation that establishes the best calibration possible by adding non-linear predictions to each predictor used. The advantage of using this algorithm instead of other available alternatives is its flexibility when it comes to calibrating non-linear relationships, providing a smooth, reproducible and precise response.

To obtain the best date calibration possible between the LiDAR data and the inventories carried out, a model was developed with IFN IV (2016-2017) and LiDAR from 2018, which was subsequently extrapolated to the entire surface area of Extremadura with the LiDAR 2010 database.

The LiDAR data was selected using statistical procedures and expertise about the proposed problem, the required objectives and LiDAR data themselves.

[11] Hastie, T. and Tibshirani, R. (2014). Generalized Additive Models . In Wiley StatsRef: Statistics Reference Online (eds N. Balakrishnan, T. Colton, B. Everitt, W. Piegorsch, F. Ruggeri and J.L. Teugels). doi:10.1002/9781118445112.stat03141

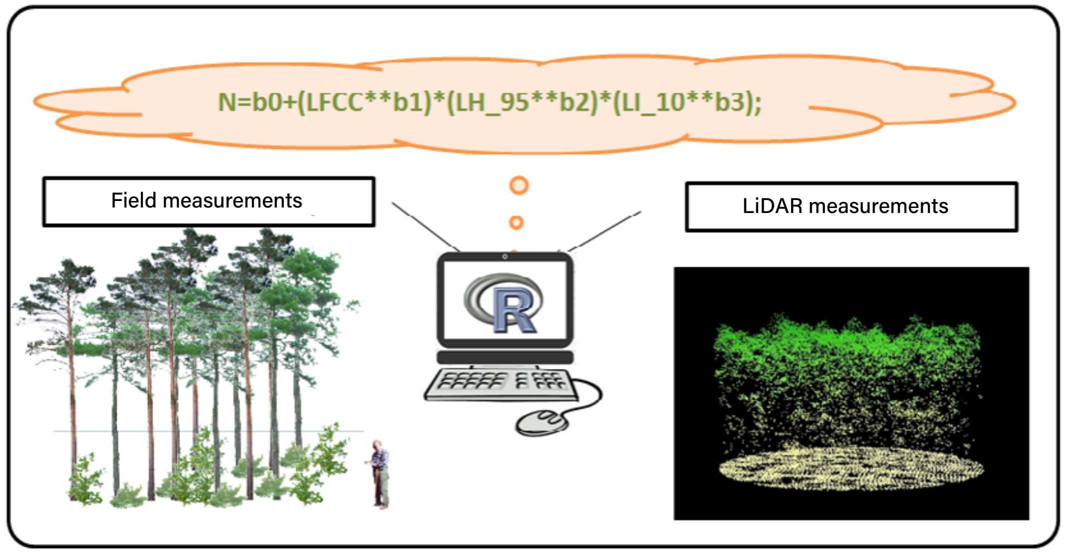


Figure 6. The models compare the data obtained in the field against the LiDAR data obtained from the point cloud corresponding to the same location

The LiDAR data used to build the statistical model that estimates the tree population structure was:

- "Elev strata (0.50 to 1.50) return proportion": return proportion between an elevation of 0.50 and 1.50 m.
- "Percentage first returns above 2.00": percentage of first returns above 2 metres
- "Elev P10": 10th percentile of elevation.
- "Elev P50": 50th percentile of elevation.
- "Elev P90": 90th percentile of elevation.▪ "Elev P50": percentil 50 de altura.

The shrub cover was estimated directly using LiDAR data without the need to build a regressive model, so the percentage values obtained in the selected LiDAR variables are directly attributed to levels of shrub cover. The LiDAR data were calculated by making a cut in the point cloud between 0.2 and 2 m above the ground, thus excluding the analysis of any returns under 0.2 m, which could relate to rocky outcrops, or returns above 2 m, which could correspond to the tree layer. The data used are:

- The percentage of all the returns (PRT_LiDAR)
- The percentage of the first returns (FCC_LiDAR)

Both the PRT_LiDAR and FCC_LiDAR sets of LiDAR data present percentage values from 0-100, which represent the percentage of returns (all returns, or just the first ones) that correspond to the cut from 0.2 to 2 metres and that, in both cases, is an approximation of the fractional canopy cover

Tree population structure

The objective of this index is to assess the conservation status of the tree cover in habitat 6310. The methodology proposed by Díaz and Pulido (2009) for estimating the conservation index based on the tree population structure consists of making random transects at a height of 20 m (10+10 m) and at varied lengths, including 50 trees of more than 5 cm in diameter at breast height[12] (DBH), classifying the results obtained according to the following:

[12] DBH: Diameter at Breast Height, also known as Regular diameter.

- Favourable (FV): regular distribution of trees and a proportion of young trees (DBH = 5-15 cm and mature) equal to or greater than that of the adult trees (DBH >15 cm and mature) in at least half of the sample (Photo 3).
- Unfavourable-inadequate (UI): regular distribution, with the proportion of mature trees being equal to or less than that of young trees in at least 10% of the sample.
- Unfavourable-bad (UB): irregular distribution, with the proportion of mature trees being greater than that of young trees throughout the sample (Photo 4).

Photo 3. Example of favourable categorisation (FV) of the tree population structure index where there are a greater number of young trees than adult trees

Photo 4. Example of unfavourable-bad categorisation (UB) of the tree population structure index where there are a greater number of adult trees than young trees

Considering that the trees classed as small have a DBH greater than 5 cm, in both the IFN IV and the ProDehesa-Montado Project, this was also the minimum measurement used by Díaz and Pulido (2009). In order to calculate the number of young trees, the total numbers of smaller and larger trees with a DAP of 15 cm were added together (Table 1).

Díaz and Pulido, 2009	IFN IV	ProDehesa-Montado Inventory
Young trees: Diameter 5-15 cm.	Larger trees with diameter < 15 cm + 0.5 x trees of regeneration category 4 (2.5-7.5 cm)	Larger trees with <15 cm + smaller trees (H> 2 m)
Adult trees: Diameter >15 cm	Larger trees with diameter >15 cm	Larger trees with diameter >15 cm

Table 1. Summary of factors considered when estimating the number of adult and young trees, as per Díaz and Pulido (2009), and how they correspond to the field data from the IFN IV and the ProDehesa-Montado inventory

Tree population structure index at a pixel level

The conservation index based on the tree population structure in the dehesas at a pixel level was determined on the basis of there being a greater number of young trees than adult trees. This was estimated using statistical techniques that compare the selected dasometric data against the LiDAR variables. The final estimation of the tree conservation index in habitat 6310 was completed in two stages. 1) A calculation was performed to determine the occurrence probability of young trees; and 2) a calculation was performed to determine the probability of there being a greater number of young trees than adult trees. Both sets of results were then combined and classified to estimate the tree conservation index at a pixel level. For the estimation of this index, the data from the IFN IV was used to generate the model, and the data from the ProDehesa-Montado inventory was used to validate it. Both sets of data were combined with the LiDAR data for each plot (Figure 7).

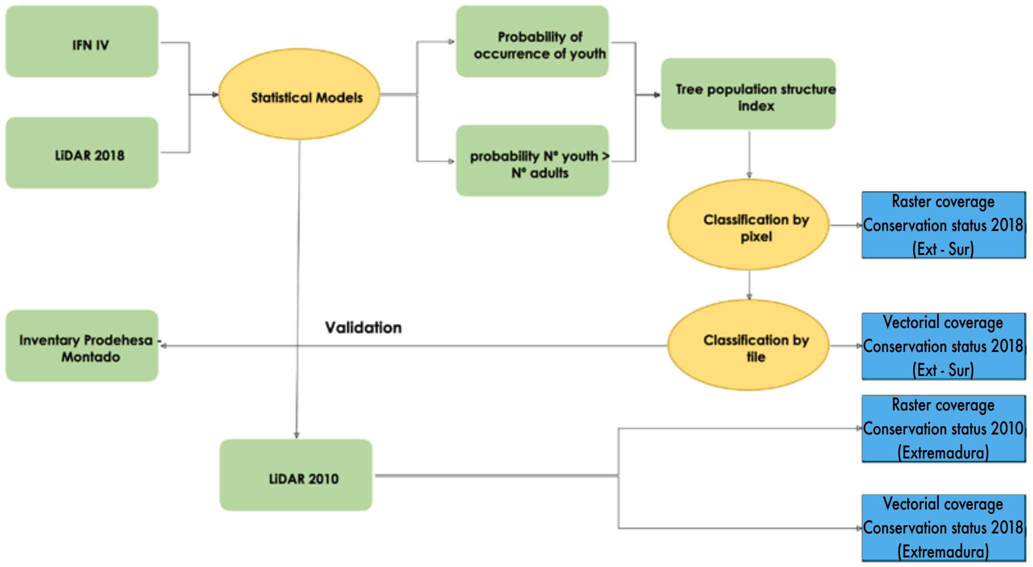


Figure 7. Workflow diagram demonstrating the process followed to obtain and validate the tree conservation index at both a pixel level and a tessera level for 2010 and 2018

The index obtained reflects the occurrence probability values of young trees over adult trees (p) for each pixel, with 0 being the lowest probability, and 1 being the maximum.

- When p>0.66, we can be very certain that the pixel has more young trees than adult trees, which is favourable according to the criteria defined by the literature.
- When p<0.33, we can be very sure that there are less young trees than adult trees.
- With an intermediate range of 0.33<p<0.66, the degree of uncertainty is very high

Tree population structure index at a tessera level

To define these criteria, the tesserae of the estates will be characterised based on the data corresponding to the inventory completed within the scope of the ProDehesa-Montado project.

Each group of plots corresponding to the same estate and tessera have been classified according to the criteria established by Díaz and Pulido (2009):

- Favourable (FV): regular distribution of trees and proportion of young trees (DBH = 5-15 cm and mature) equal to or greater than that of the adult trees (DBH >15 cm and mature) in at least half of the sample.
- Unfavourable-inadequate (UI): regular distribution with the proportion of mature trees being equal to or less than that of young trees in at least 10% of the sample.
- Unfavourable-bad (UB): irregular distribution with a greater proportion of mature trees than young trees throughout the sample.

The predictive model reflects the occurrence probability values for young trees over adult trees (p) that vary from 0 to 1 in each raster pixel:

- When p>0.66, we can be very certain that the pixel has more young trees than adult trees, which is favourable according to the criteria defined by the literature.
- When p<0.33, we can be very sure that there are less young trees than adult trees.
- With an intermediate range of 0.33<p<0.66, the degree of uncertainty is very high

When assigning values at a tessera level in habitat 6310, it was deemed appropriate to use criteria based on the frequency of tesserae with p<0.33 and tesserae with p>0.66. Unlike the average value, these criteria will not be affected by intermediate values (0.33<p<0.66) and it is expected that the degree of uncertainty in the results will be reduced.

Shrub cover index

The objective of this index is to assess the conservation status of the shrub cover in habitat 6310. The methodology proposed by Díaz and Pulido (2009) for quantifying this variable involved 10 circular measurements of a 5 m radius distributed uniformly across the transects, which were established for quantifying the tree conservation index through a visual estimation of the tree and shrub cover in the circles, separating the shrub cover by species.

However, the available field data related to shrub cover, both those from the IFN IV and those taken within the scope of the ProDehesa-Montado Project, do not provide reliable information, as none of them directly estimate the total shrub cover (Table 2).

Díaz and Pulido, 2009	IFN IV	ProDehesa-Montado Inventory
Total shrub FCC (%) in 10 circles of a 5 m radius distributed uniformly across the transects established for estimating the tree conservation index	FCC (%) of the species with the highest FCC (%) of all those present in the plot	Categorisation of the FCC (%) at a plot level based on the FCC (%) of each species present in the plot

Table 2. Summary of factors considered for estimating the cover of shrub species, as per Díaz and Pulido (2009), and how they correspond to the field data used

Shrub cover index at a pixel level

The shrub conservation index at a pixel level is developed based on the existing shrub cover estimated using percentages from the LiDAR data, so that the percentage values obtained in the selected LiDAR variables are directly attributed to the shrub cover percentages. The results were validated through correlation tests with the variables related to the shrub cover, provided by the data from the IFN IV (Figure 8).

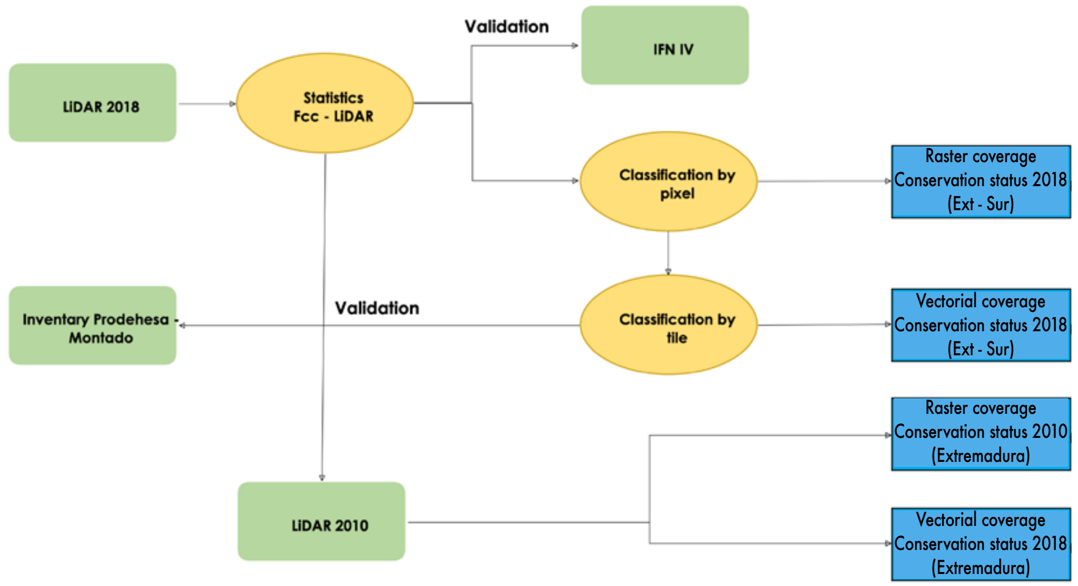


Figure 8. The workflow used to obtain the shrub conservation index based on LiDAR technology and the data from the IFN IV and ProDehesa-Montado inventories

Shrub cover index at a tessera level

For the categorical classification of the shrub conservation index at a tessera level (vector polygons) for the cover of habitat 6310, the methodology established by Díaz and Pulido (2009) was adapted by changing the transect concept to a pixel concept. In this way, the categorization described by Diaz and Pulido would be defined as follows:

- Favourable (FV): average shrub cover greater than 20% in the tessera, and cover greater than 50% in at least 1/3 of the tessera pixels.
    - Unfavourable-inadequate (UI): average cover less than 20% in the tessera, with at least one cover pixel greater than 50%.
    - Unfavourable-bad (UB): average cover less than 10% in the tessera and pixels with zero cover..

Conversation indices	Díaz and Pulido proposal (2009)	LiDAR estimation (description)	LiDar estimation (classification by pixel)	LiDar estimation (classification by tessera)
Tree population structure	Favourable (FV): regular distribution of trees and proportion of young trees (DBH = 5-15 cm and mature) equal to or greater than that of the adult trees (DBH >15 cm and mature) in at least half of the sample. Unfavourable-inadequate (UI): regular distribution, with the proportion of mature trees being equal to or less than that of young trees in at least 10% of the sample. Unfavourable-bad (UB): irregular distribution with a greater proportion of mature trees than young trees throughout the sample.	1) Estimation of the occurrence probability of young trees. 2) Estimation of the probability that the number of young trees will be greater than the number of adult trees. 3) Combination of both sets of results and classification to estimate the tree conservation index at a pixel level. 4) Extrapolation at a tessera level of habitat 6310.	When p>0.66, we can be very sure that the area has more young trees than adult trees. With an intermediate range of 0.33<p<0.66, the degree of uncertainty is very high When p<0.33, we can be very sure that there are less young trees than adult trees.	Favourable (FV): [pixels with p<0.33] < 50% or [pixels with p>0.66] > 10%. Unfavourable inadequate (UI): pixels with p<0.33] > 50% and [pixels with p>0.66] > 3%. Unfavourable bad: (UB): [pixels with p<0.33] > 50% and [pixels with p>0.66] < 3%.
Shrub cover by species	Favourable (FV): average shrub cover greater than 20%, and cover greater than 50% in at least 1/3 of transects. Unfavourable-inadequate (UI): average cover less than 20%, with at least one cover transect greater than 50%. Unfavourable-bad (UB): average cover less than 10% and transects with zero cover.	1) Direct estimation based on the fractional canopy cover obtained from the LiDAR point cloud, considering returns between 0.2 and 2 m. 2) Extrapolation at a tessera level of habitat 6310.	PTR_LiDAR = Shrub cover in the pixel.	Favourable (FV): average shrub cover greater than 20% in the tessera, and cover greater than 50% in at least 1/3 of the tessera pixels. Unfavourable-inadequate (UI): average cover less than 20% in the tessera, with at least one cover pixel greater than 50%. Unfavourable-bad (UB): average cover less than 10% in the tessera and pixels with zero cover.
Early recruitment of saplings	Not assessed			

Table 3. Relationship between the definition of tree and shrub conservation indices and their application at a pixel and a tessera level

Conservation status methodology at a tessera level, combining the tree and shrub conservation statuses

In order to determine the overall conservation status at a tessera level, combining both the tree and shrub conservation statuses, a corresponding matrix was developed that gave priority to the tree conservation status, and within the combination of categories, it was always the most favourable that was chosen. This produced the combined conservation status classification (Table 4).

Tree CS	Shrub CS	Habitat CS	Class
FV	N/A	Favourable	1
UI	FV	Favourable	2
UI	UI	Unfavourable inadequate	3
UI	UB	Unfavourable inadequate	4
UB	FV	Unfavourable inadequate	5
UB	UI	Unfavourable bad	6
UB	UB	Unfavourable bad	7

FV: Favourable, UI: Unfavourable inadequate, UB: Unfavourable bad

Table 4. Classification of the Conservation Status of Habitat 6310 based on both the tree and shrub conservation statuses

Included vector data models related to the reproduction of protected species and the Natura 2000 Network

We are looking for an overlap between the areas with higher natural values and the better conserved dehesas.

The intention was to analyse the dehesas within the Natura Network and the zoning of the dehesas within this Network, according to the protection grading established in its management instruments, and also to analyse the dehesa areas with a favourable habitat and the importance values for the species inventoried in each tessera.

The subsequent objective is to analyse the conservation status values (CS2010, CS2018) with the rest of the data included in the resulting mapping related to the reproduction of protected species and the Natura Network zoning:

- Inclusion percentage in the Natura Network.
- RAPEX zoning (Network of Protected Areas in Extremadura).
- Favourable habitat.
- Importance of the species (natural value).
- Species diversity and habitat importance value (total value).

The areas of high value will be selected from the statistical results of this interaction.

Inclusion percentage in the Natura Network

The field that displays this information is named "PorcentRN", which is assigned directly by superimposing layers. The RN2000 field shows the name of each area. Types of Natura Network areas: SPAB, SPA and SPA + SPAB (double designated spaces).

RAPEX zoning

The different zoning categories established in the management instruments of the spaces included in the Extremadura Protected Area Network have been unified. Since the zoning categories are different depending on the management instrument, they have been grouped according to their level of importance:

- Area of High Natural Value (AHNV), Area of Primary Importance (API), Reserve Area (RA)= 40
- Area of High Importance (AHI), Area of Limited Use (ALU), Area of Restricted Use (ARU), Area of Traditional Use (ATU) = 30
- Area of Importance (AI), Area of Compatible Use (ACU), Area of Common Use (ACOU), Area of Moderate Use (AMU): 20
- Area of Special Use (ASU), Area of General Use (AGU): 10
- Area of Traditional Settlements (ATS), Without Zoning (WZ): 5

Assignment of habitats that are favourable to the reproduction of protected species

For the parameter "Habitats that are favourable to the reproduction of protected species", the nesting species platforms in each of the tesserae of habitat 6310 were combined together. The result of this combination is included in the "HbFavEspec" field.

The calculation took into account the following bird species, as their nesting platforms were found within the tessera of habitat 6310. The inclusion percentages in the dehesa habitat are detailed below, in relation to the total population of species recorded in Extremadura.

67.9% Black kite	29.4% Black-winged kite	15.2% Bonelli's eagle
58.8% Red kite	28.3% Spanish imperial eagle	12.0% Egyptian vulture
58.3% Common buzzard	20.3% Eurasian eagle-owl	10.4% Black vulture
49.1% Short-toed snake eagle	17.7% Golden eagle	8.2% Peregrine falcon
46.9% Booted eagle	16.7% Eurasian sparrowhawk	3.7% Northern goshawk
45.6% Black stork	15.7% Griffon vulture	

The assessment also included information from the tesserae adjacent to those that contained breeding species.

The critical habitat area has been defined as a radius of 250 metres around each nesting platform.

As such, the criteria for determining the assessment of the tessera is established according to five categories, as follows:

- When the tessera is located within the critical habitat of the recorded species, and the nesting platform material comes from holm oak or cork oak trees, regardless of which species is occupying the tesserae, it is classified as excellent for species reproduction. Excellent reproduction = 4
- When the tessera is located within the critical habitat of the recorded species, and the nesting platform material is not from holm oak or cork oak trees, regardless of which species is occupying the tesserae, it is classified as good for species reproduction. Good reproduction = 3
- Tesserae that are located 250 metres from a tessera classified as excellent for species reproduction are themselves classified as being adjacent to a tessera that is excellent for reproduction. Excellent adjacent = 2
- Tesserae that are located 250 metres from a tessera classified as good for species reproduction are themselves classified as being adjacent to a tessera that is good for reproduction. Good adjacent = 1
- All other tesserae are classified as normal. Normal = 0

Importance of inventoried species according to their protection category: Natural value (Nat. value)

For the parameter "Importance of inventoried species according to their protection category", all the species in the Extremadura Biodiversity Atlas have been included[13], classified according to the protection category from the Extremadura Regional Catalogue for Endangered Species, with it being corrected should it not match with the protection category at a Spanish national level, in order to preserve the highest protection level. The result of this section is established in the field named "Nat Value", and is the result of the following formula:

NATVALUE = REVALUE + SHAVALUE + VUVALUE + SIVALUE

The data used to obtain this result came from the Biodiversity Atlas, related to the vertebrate taxa with distribution in the corresponding habitat 6310 tessera.

Depending on the assignment of the protection category for each taxon, we obtain a value based on the following criteria:

RE (Risk of Extinction): 20

SHA (Sensitive to habitat alteration):10

VU (Vulnerable):6

SI (Special Interest):4

The distribution data used for all the species was from the Regional Catalogue for Endangered Species of Extremadura, with the taxon presence being quantified as 1. This enabled the following segregated fields to be obtained, which were combined to provide the value "Importance of the inventoried species according to their protection category" **(NATVALUE).** This information was incorporated into the tessera in the following columns:

- **REVALUE:** represents the summation of the values calculated for the species in the Risk of Extinction category.
- **VLESPPR:** shows the calculation of nesting species.
- **SHAVALUE:** represents the summation of the values calculated for the species in the "Sensitive to habitat alteration" category in the regional catalogue.
- **VUVALUE:** represents the summation of the values calculated for the species in the "Vulnerable" category at a national level and in the regional catalogue.
- **SIVALUE:** represents the summation of the values calculated for the species in the "Special interest" category in the regional catalogue.

As such, **NATVALUE** represents the summation of the values calculated for the species included in the Atlas.

This calculation took into account 242 taxa, which are listed below according to their protection category:

- At risk of extinction: 12 species of fauna and 8 species of flora.
- Sensitive to habitat alteration: 35 species of fauna and 10 species of flora.
- Vulnerable: 32 species of fauna and 22 species of flora.
- Special Interest: 163 species of fauna and 67 species of flora.

[13] Official data from the General Directorate for Sustainability.

Species diversity and habitat importance value (Total value)

After analysing the results, we came to the conclusion that we needed to calculate another field that brings together the importance of habitat 6310 as a favourable habitat for the conservation of certain species, and the diversity of species that we know are at least present in said habitat.

However, the species inventory data have not been obtained with the same methodological criteria for all taxa or, in other words, for each taxon the information available is not of the same quality and precision in terms of number, status and specific location. For this reason, it has been chosen to prioritize those species of which we know their number and specific location, as well as their status in the dehesa habitat.

These species also act as an "umbrella" species, which means that they are an important species for conservation, as protecting them also indirectly protects the other species that make up the community in their habitat. We eventually chose to prioritise the bird species in a breeding status (nesting), applying a significant relative weight to them when classifying the tesserae.

Therefore, the result obtained in "favourable species habitat" is applied as a multiplier effect on the "importance of inventoried species" data, according to the following formula:

TOTAL VALUE =NAT VALUE *FAV HABITAT

Results

Conservation index based on tree population structure

The data and validation analysis of the conservation index based on the tree population structure is available via the following links:

VALIDATION OF RESULTS

VALIDATION OF RESULTS

http://extremambiente.juntaex.es/transicionecologica/servicios/cartografia

https://prodehesamontado.eu/en/results

Category	Nº of polygons	Surface area (ha)	% Surface
Tree conservation index with 2010 data			
Favourable	5.086	241.631,88	16,64%
Unfavourable-inadequate	1.139	101.776,29	7,01%
Unfavourable-bad	13.496	1.108.820,35	76,35%
Tree conservation index with 2018 data			
Favourable	2.514	148.398,82	22,45%
Unfavourable-inadequate	717	86.006,05	13,01%
Unfavourable-bad	4.554	426.517,73	64,53%
Tree conservation index with updated data			
Favourable	5.842	296.266,68	20,40%
Unfavourable-inadequate	1.295	128.844,90	8,87%
Unfavourable-bad	12.585	1.027.375,86	70,73%

Table 5. Classification of polygons according to the proposed criteria for the tree conservation index of habitat 6310, calculated with 2010 data for the whole of Extremadura, with 2018 data for the areas where data was available (southern area, practically overlapping with the province of Badajoz) and the updated data (2018 and 2010 in the areas where there was no data available from 2018)

The results were extrapolated to the entirety of the surface area of Extremadura using the cover occurrence probability of a greater number of young trees than adult trees, based on LiDAR from the PNOA of 2010.

In this case, the summary data was obtained for the tesserae and the affected land from the mapping of habitat 6310 for the whole of Extremadura, according to the conservation status (Table 5).

It is observed that in the vast majority of the polygons the tesseras are classified as inadequate or unfavorable - bad, which is representative of reality.

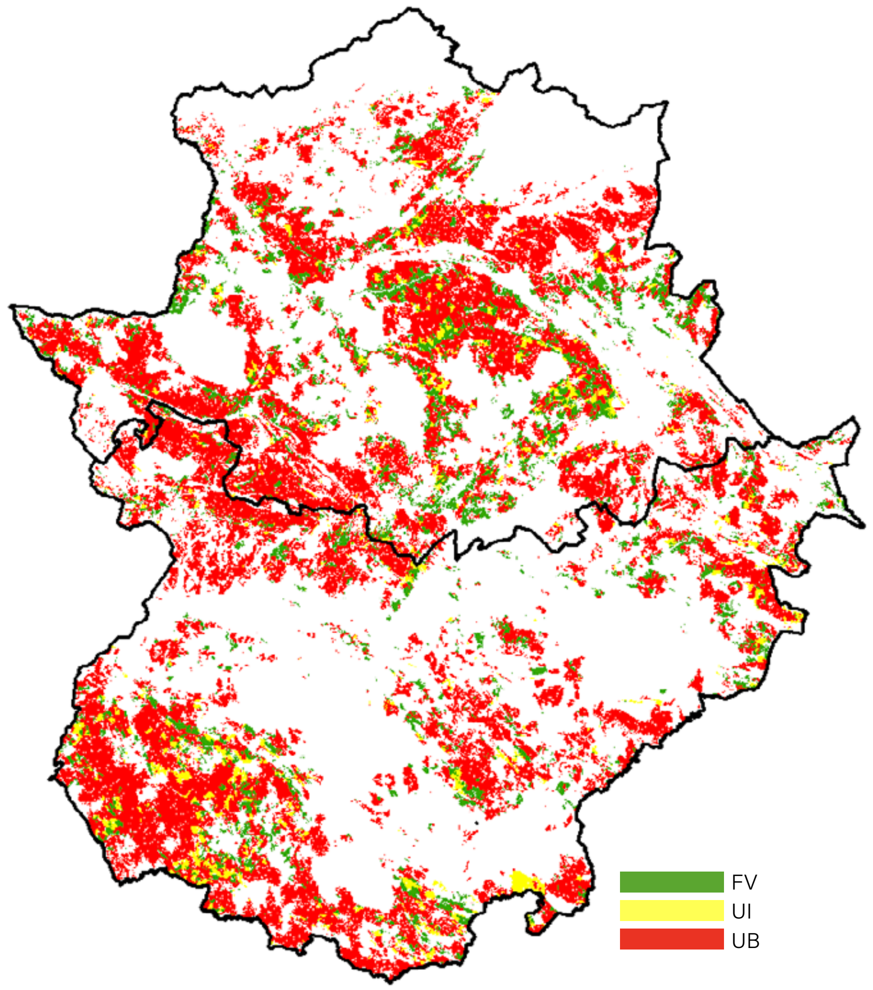


Figure 9. Distribution of the tree conservation index for habitat 6310 in 2010. FV: Favourable; UI: Unfavourable inadequate; and UB: Unfavourable bad

Shrub cover index

The data and validation analysis of the conservation index based on shrub cover is available via the following links:

VALIDATION OF RESULTS

VALIDATION OF RESULTS

http://extremambiente.juntaex.es/transicionecologica/servicios/cartografia

https://prodehesamontado.eu/en/results

The results obtained were validated at a tessera level with the inventory data obtained within the scope of the ProDehesa-montado project.

Category	Nº of polygons	Surface area (ha)	% Surface
Shrub conservation index with 2010 data			
Favourable	1.070	44.756,71	3,08%
Unfavourable-inadequate	2.795	121.681,65	8,38%
Unfavourable-bad	15.856	1.285.790,17	88,54%
Shrub conservation index with 2018 data			
Favourable	705	28.292,00	4,28%
Unfavourable-inadequate	1.309	70.464,78	10,66%
Unfavourable-bad	5.765	562.165,83	85,06%
Shrub conservation index with updated data			
Favourable	1.542	64.667,23	4,45%
Unfavourable-inadequate	3.252	152.760,22	10,52%
Unfavourable-bad	14.928	1.235.059,99	85,03%

Table 6. Classification of polygons according to the proposed criteria for the shrub conservation index of habitat 6310, calculated with 2010 data for the whole of Extremadura, with 2018 data for the areas where data was available (southern area, practically overlapping with the province of Badajoz) and the updated data (2018 and 2010 in the areas where there was no data available from 2018)

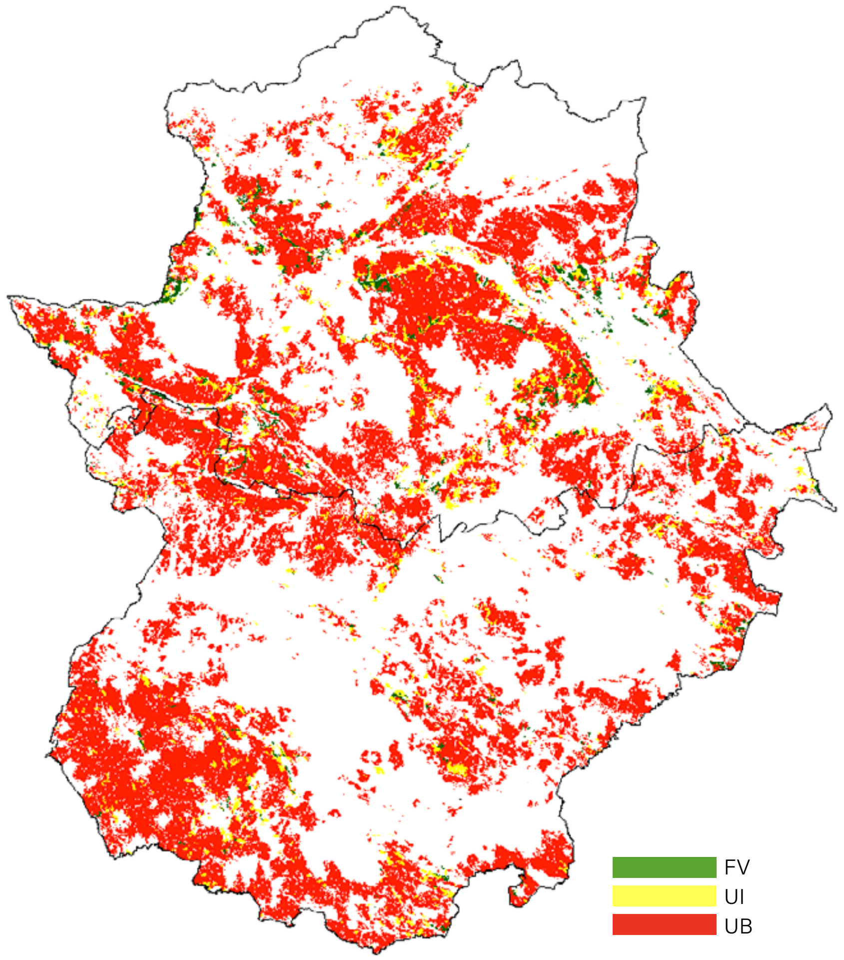


Figure 10. Distribution of the conservation index for the shrub cover in the dehesas in Extremadura, obtained for 2010. FV: Favourable; UI: Unfavourable inadequate; and UB: Unfavourable bad

As was the case with the results from the tree conservation index, it can be concluded that there are tesserae where the classification is unclear, between favourable (FV) and unfavourable bad (UB), and between unfavourable inadequate (UI) and unfavourable bad (UB), potentially due to anthropic actions related to clearing (visual check of orthophoto). Nevertheless, the data obtained are either good or excellent. The acceptable value for the overall accuracy of the classification may be due to the low number of tesserae used for the validation.

In this case, the summary data was obtained for the tesserae from the mapping of habitat 6310 for the whole of Extremadura for the conservation status of the tree cover (Table 6).

As can be seen, the tesseras in the vast majority of the polygons are classified as inadequate or unfavourable-bad, which is representative of reality.

Results at the tessera level of the combined conservation index for trees and shrubs

Both conservation statuses were combined in accordance with the described methodology to produce the following statistical summary of the tesseras in the mapping of habitat 6310 for the entirety of Extremadura with the combined conservation index for both trees and shrubs. We have taken into account the results obtained with the data from 2010, the calculation using the data from 2018 and the update that shows the most recent available data for the whole of Extremadura (essentially combining the results from the 2010 data in Cáceres with the data from 2018 in Badajoz, wherever they were available) (Table 7)

The final distribution of the conservation status for habitat 6310 in Extremadura with updated data can be seen in the following figure (Figure 11).

Category	Nº of polygons	Surface area (ha)	% Surface
Shrub conservation index with 2010 data			
Favourable	5.113	242.873,08	16,72%
Unfavourable-inadequate	1.186	102.366,27	7,05%
Unfavourable-bad	13.422	1.106.989,18	76,23%
Shrub conservation index with 2018 data			
Favourable	2.540	149.804,78	22,67%
Unfavourable-inadequate	770	87.125,66	13,18%
Unfavourable-bad	4.475	423.992,19	64,15%
Updated schrub conservation index (2018 and 2010)			
Favourable	5.892	298.879,67	20,58%
Unfavourable-inadequate	1.390	130.106,38	8,96%
Unfavourable-bad	4.476	1.023.242,47	70,46%

Table 7. Summary of the classification of polygons according to the proposed criteria for the tree and shrub conservation index of habitat 6310, calculated with the 2010 data for the whole of Extremadura, with the 2018 data for the areas where data was available (southern area, practically overlapping with the province of Badajoz) and the updated data (2018 and 2010 in the areas where there was no data from 2018)

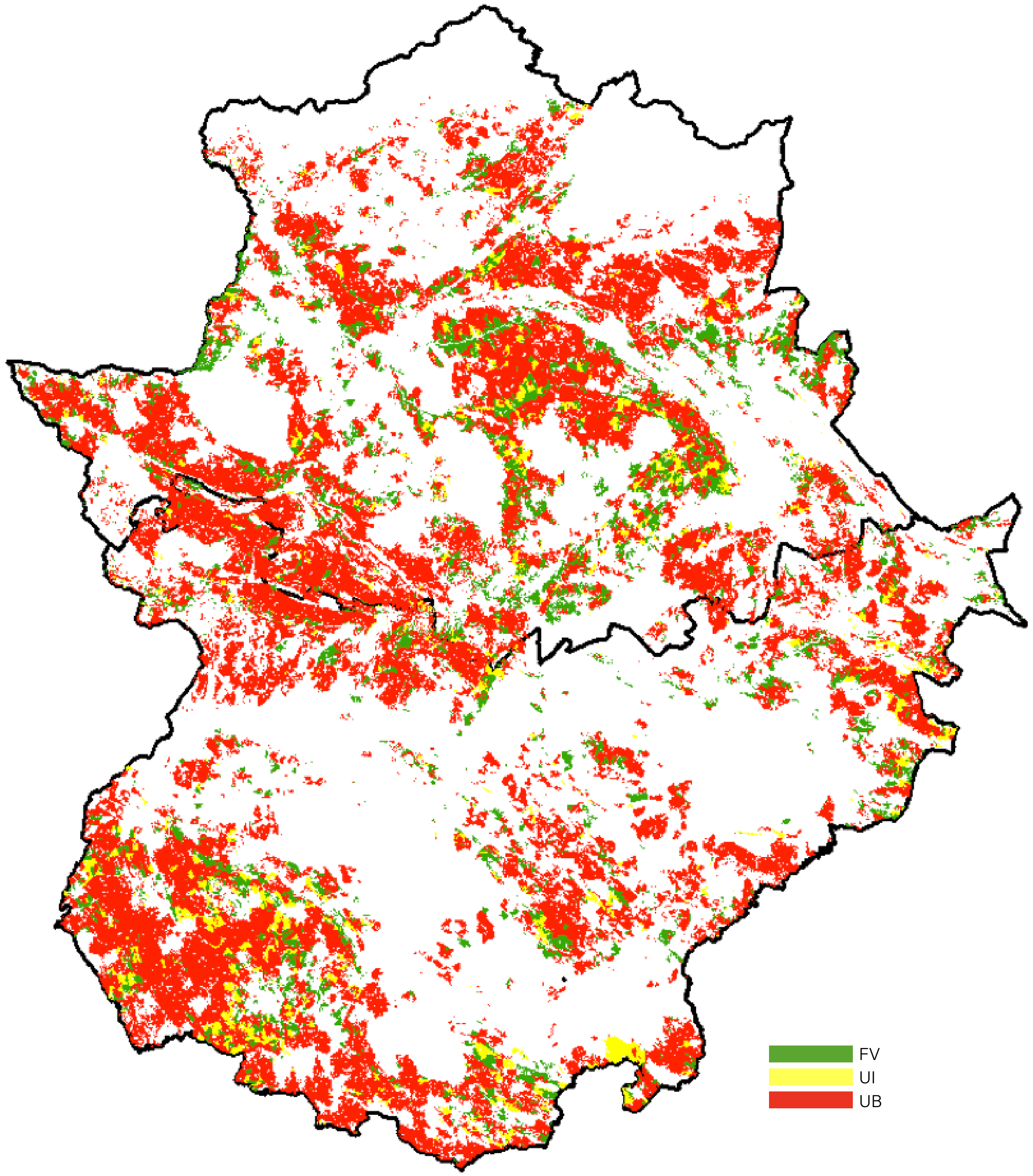


Figure 11. Distribution of the conservation index for habitat 6310 in Extremadura, obtained for 2010 as a combination of both the tree and shrub conservation statuses. FV: Favourable; UI: Unfavourable inadequate; and UB: Unfavourable bad.

Analysis of results in relation to environmental values

Analysis of results at a habitat level in Extremadura

Habitat 6310 is a very important part of Extremadura, as it makes up almost 35% of the autonomous community's total surface area. The percentage of surface area occupied by the habitat is similar for both Badajoz and Cáceres (Figure 12).

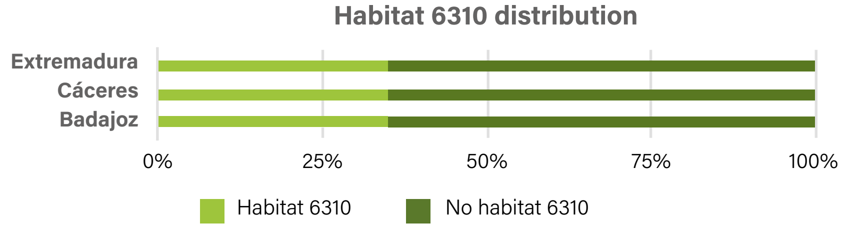


Figure 12. Percentage of the total surface area included in habitat 6310 for Extremadura, Cáceres and Badajoz

At a regional level, 17% of the surface area occupied by habitat 6310 was classified as a conservation status of "favourable" for the data from 2010 (CS_2010). However, the largest proportion fell within the conservation status of "bad", at 76%. The province of Cáceres had the largest surface area with a favourable conservation status in 2010, at 20%, as opposed to 14% in Badajoz (Figure 13).

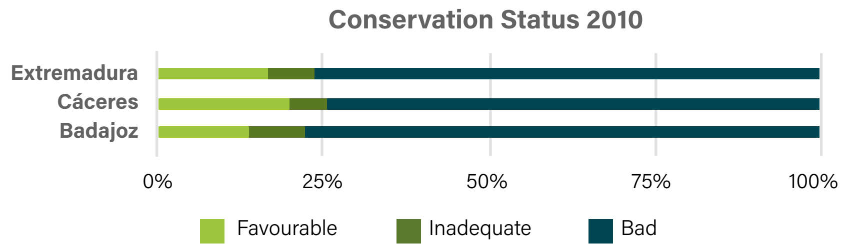


Figure 13. Distribution of the surface percentage within habitat 6310 in Extremadura, Cáceres and Badajoz classified according to the conservation status developed for 2010

For the year 2018, we only have information on the southern area of Extremadura, which is somewhat smaller than the province of Badajoz, where 23% of the surface area occupied by habitat 6310 is classified as a conservation status of "favourable" for the data from 2018 (CS_2018). However, the largest proportion is still within the conservation status of "bad", at 64% (Figure 14).

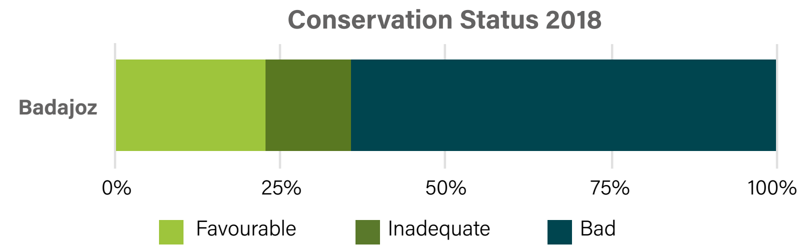


Figure 14. Distribution of the surface percentage within habitat 6310 in Badajoz classified according to the conservation status developed for 2018

Analysis of results at the Natura 2000 Network level

The distribution of the surface included in the Natura 2000 Network in Extremadura is presented below. (Figure 15).

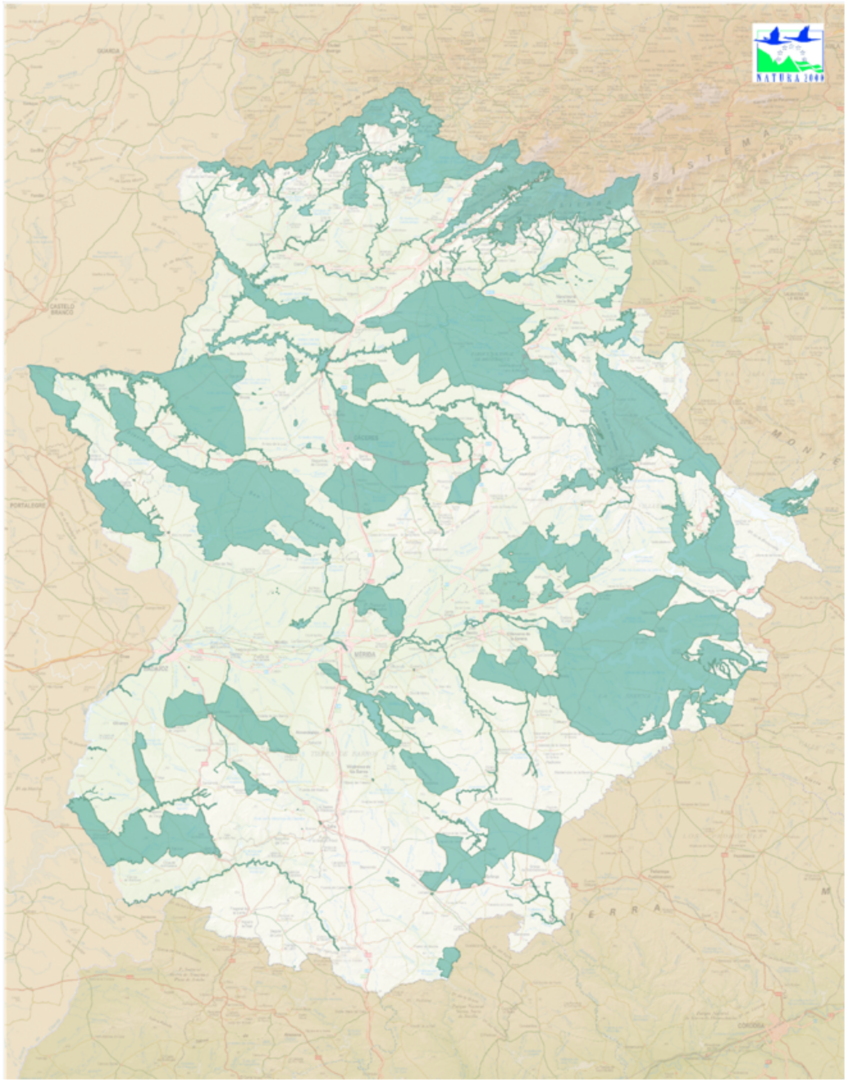


Figure 15. Distribution of the spaces that make up the Natura 2000 Network in Extremadura (SPAB and SPA)

At the Natura 2000 Network level, we found that the majority of the distribution of habitat 6310 fell outside of the spaces that make up the network (>90%). The "bad" conservation status makes up the majority of the total surface area of habitat 6310 and there were no significant differences observed between the dehesas inside and outside of the Natura Network.

The proportion of the total surface area in the Natura 2000 Network categorised as "favourable" is 17%, with 78% being categorised as "bad", meaning that around a fifth of the land included in the Natura 2000 Network was shown to be in the optimum conservation status in 2010.

The areas that make up the Natura 2000 Network are the Special Protection Areas (SPA) and the Special Protection Areas for Birds (SPAB), and both protection figures may also overlap (SPAB + SPA). The analysis carried out taking into account both protection figures shows that the SPAs contain the largest surface area classified as "favourable", followed by the SPABs and the areas where these figures overlap (Figure 15). However, in both cases, the largest surface area is that classified as "bad" (Figure 16).

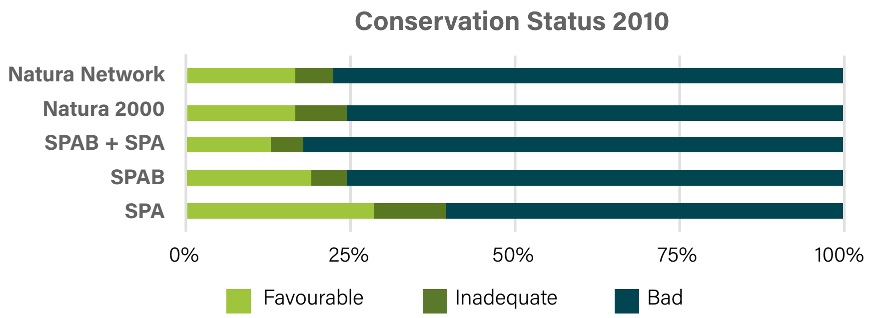


Figure 16. Distribution of the spaces that make up the Natura 2000 Network in Extremadura (SPAB and SPA)

By analysing the results obtained for the surface area included in the Natura 2000 Network with the data from 2018, we found that the proportion of the total surface area categorised as "favourable" is of 25% when compared to the habitat's surface area included in the Natura 2000 Network, with 63% being categorised as "bad". This means that around a quarter of the protected land included in the Natura 2000 Network was shown to be in the optimum conservation status in 2018 (at least for the southern area of Extremadura with available data).

Within the protection figures for the Natura 2000 Network (SPA, SPAB and SPAB + SPA), the analysis shows that the SPA areas contain the largest proportion of surface area categorised as "favourable", followed by the SPAB areas and the overlapping areas (Figure 17). However, in all cases, the largest surface area is that classified as "bad" (Figure 17). It is only in the SPA areas where the proportion categorised as a conservation status of "bad" is less than 50%

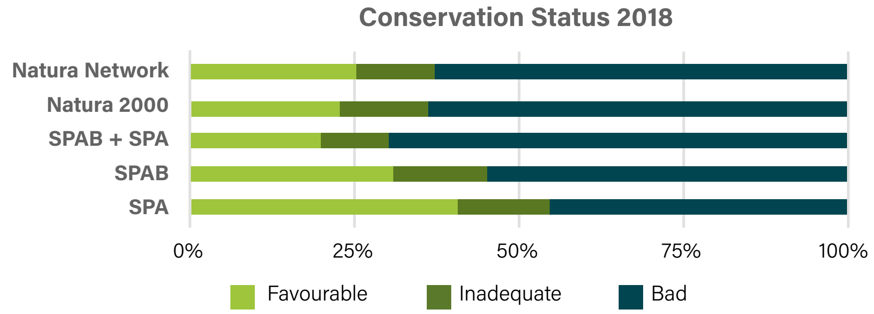


Figure 17. Distribution of the surface percentage within habitat 6310 included within the Natura 2000 Network, and the distribution of the conservation status with data obtained in 2018

Analysis of results from the RAPEX zoning

The areas that make up the Extremadura Network of Protected Areas (RAPEX) are zoned using their corresponding management plans. This has enabled fifteen protection areas to be established, grouped into five different classes: 1) Area of High Natural Value (AHNV), Area of Primary Importance (API), Reserve Area (RA); 2) Area of High Importance (AHI), Area of Limited Use (ALU), Area of Restricted Use (ARU), Area of Traditional Use (ATU); 3) Area of Importance (AI), Area of Compatible Use (ACU), Area of Common Use (ACOU), Area of Moderate Use (AMU); 4) Area of Special Use (ASU), Area of General Use (AGU); and 5) Area of Traditional Settlements (ATS), Without Zoning (WZ).

The largest proportion of surface area is found in classes 2 and 3, that is, in the following areas: Area of High Importance (AHI), Area of Limited Use (ALU), Area of Restricted Use (ARU), Area of Traditional Use (ATU), 3) Area of Importance (AI), Area of Compatible Use (ACU), Area of Common Use (ACOU)

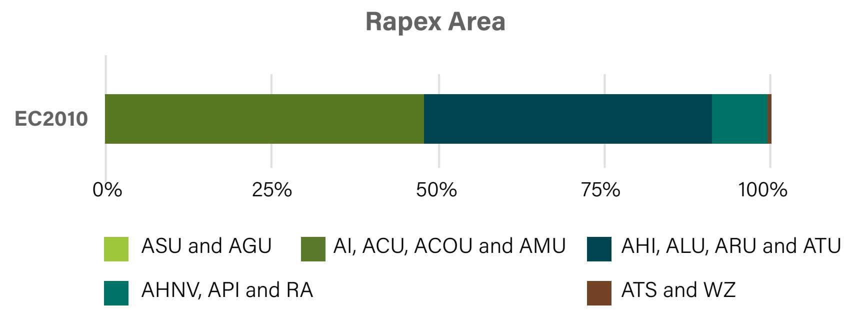


Figure 18. Distribution of the surface percentage within habitat 6310 and the Natura 2000 Network zoned for the RAPEX codification, with data obtained in 2010. AHNV: Area of High Natural Value; API: Area of Primary Importance; RA: Reserve Area; AHI: Area of High Importance; ALU: Area of Limited Use; ARU: Area of Restricted Use; ATU: Area of Traditional Use; AI: Area of Importance; ACU: Area of Compatible Use; ACOU: Area of Common Use; AMU: Area of Moderate Use; ASU: Area of Special Use; AGU: Area of General Use; ATS: Area of Traditional Settlements (ATS); and WZ: Without Zoning

and Area of Moderate Use (AMU), which occupy >90% of the surface area, while ~10% is occupied by class 4, Area of Special Use (ASU) and Area of General Use (AGU) (Figure 18).

Within these five classes, the highest proportions of land categorised as a "favourable" conservation status are found in class 1, Area of High Natural Value (AHNV), Area of Primary Importance (API), Reserve Area (RA), and also class 5. This is due to the fact that class 1 contains the areas with the highest protection and that class 5 has the largest surface area within the categorisation. (Figure 19).

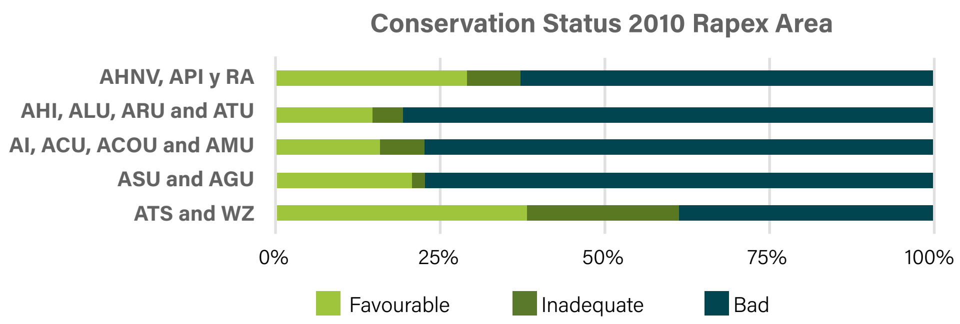


Figure 19. Distribution of the surface percentage of the conservation status within habitat 6310 and the Natura 2000 Network zoned for the RAPEX codification, with data obtained in 2010. AHNV: Area of High Natural Value; API: Area of Primary Importance; RA: Reserve Area; AHI: Area of High Importance; ALU: Area of Limited Use; ARU: Area of Restricted Use; ATU: Area of Traditional Use; AI: Area of Importance; ACU: Area of Compatible Use; ACOU: Area of Common Use; AMU: Area of Moderate Use; ASU: Area of Special Use; AGU: Area of General Use; ATS: Area of Traditional Settlements (ATS); and WZ: Without Zoning

The other categories and CS_2010 demonstrate an inversely increasing percentage of surface area categorised as "favourable", which is to say that the higher the percentage of surface area categorised as "favourable", the lower the protection category (Figure 19).

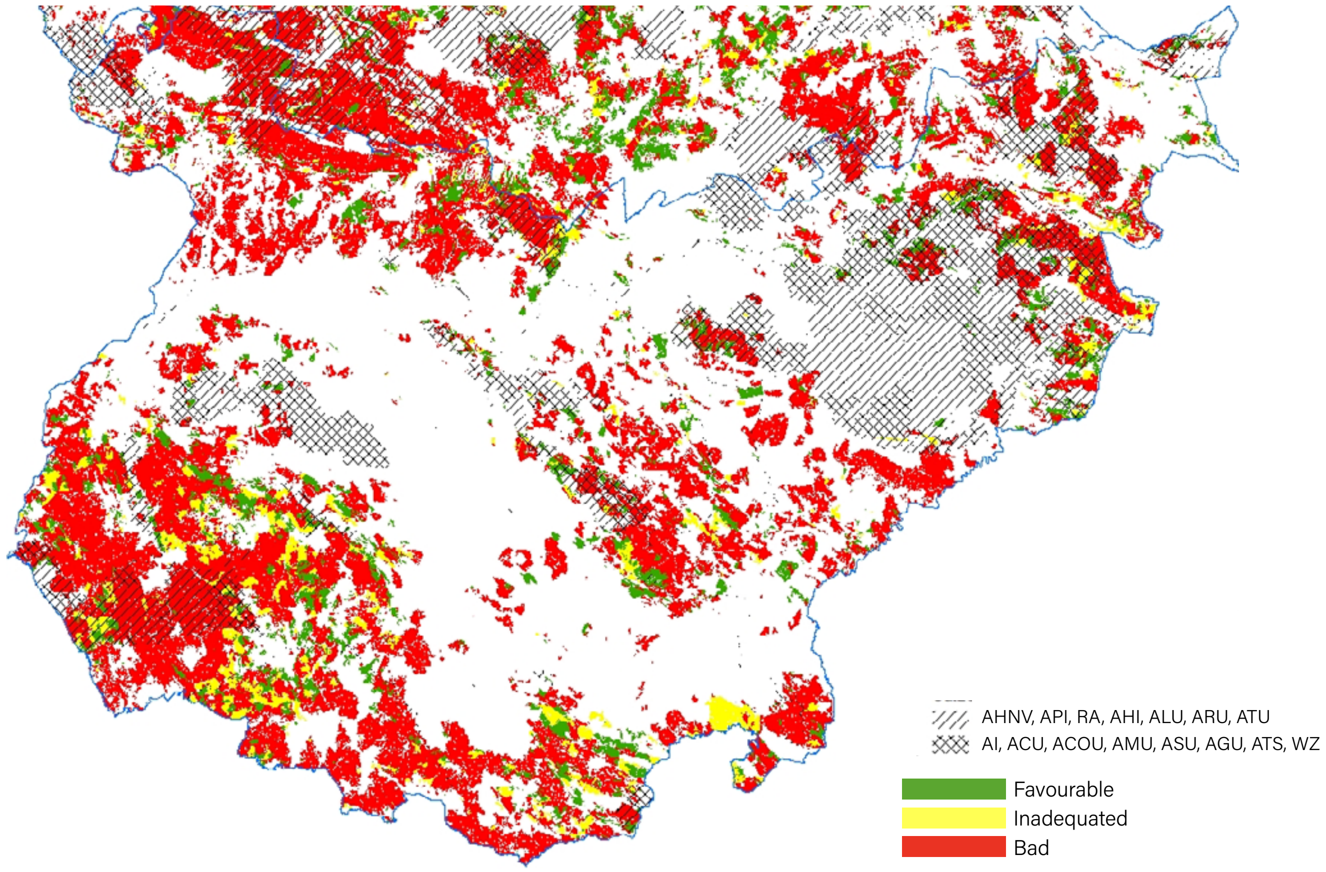


Figure 20. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2010. The shaded areas represent the land within the RAPEX area

The spatial distribution of the conservation status within the protected areas in Badajoz in 2010 (Figure 20) and Cáceres (Figura 21) show that within habitat 6310 the "bad" conservation status category is mostly made up of the larger tesserae, while the better conservation status categories are mostly made up of the smaller tesserae. It was also noted that the "bad" conservation status was the most prominent both within and outside of the RAPEX area (Figures 20-21).

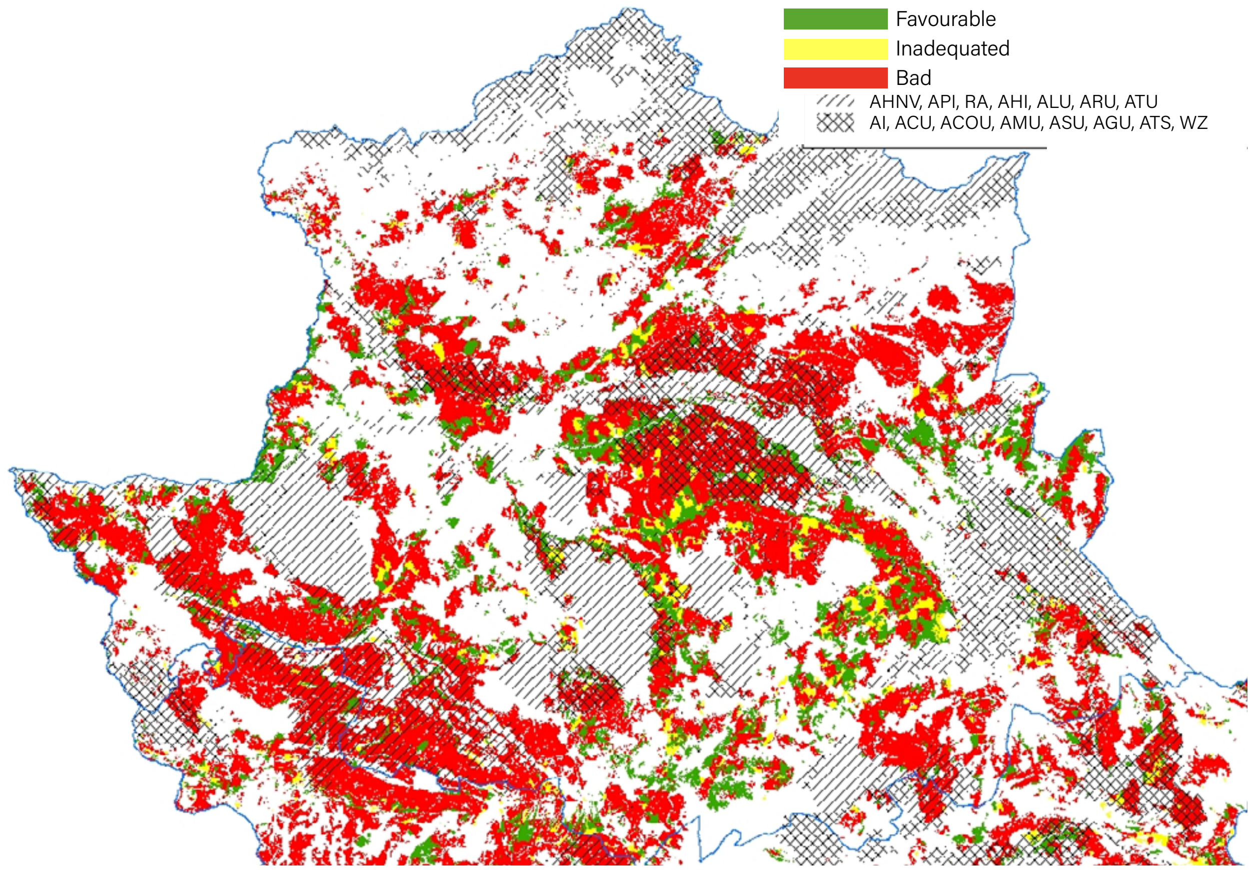


Figure 21. Spatial distribution of the Conservation Status of Habitat 6310 in Cáceres for 2010. The shaded areas represent the land within the RAPEX area

The 2018 study of the distribution of conservation statuses within the RAPEX zoning showed that the largest proportion of surface area was within classes 2 and 3. That is, within the following areas: Area of High Importance (AHI), Area of Limited Use (ALU), Area of Restricted Use (ARU), Area of Traditional Use (ATU), 3) Area of Importance (AI), Area of Compatible Use (ACU), Area of Common Use (ACOU) and Area of Moderate Use (AMU), which occupy >90% of the surface area, while ~10% is occupied by class 4, Area of Special Use (ASU) and Area of General Use (AGU) (Figure 22).

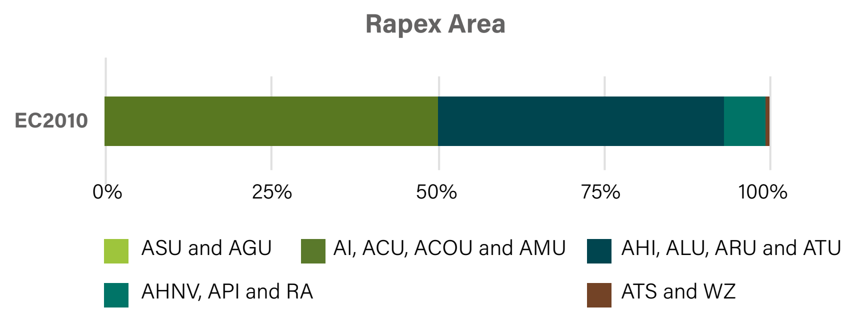


Figure 22. Distribution of the surface percentage within habitat 6310 and the Natura 2000 Network zoned for the RAPEX codification, with data obtained in 2018. AHNV: Area of High Natural Value; API: Area of Primary Importance; RA: Reserve Area; AHI: Area of High Importance; ALU: Area of Limited Use; ARU: Area of Restricted Use; ATU: Area of Traditional Use; AI: Area of Importance; ACU: Area of Compatible Use; ACOU: Area of Common Use; AMU: Area of Moderate Use; ASU: Area of Special Use; AGU: Area of General Use; ATS: Area of Traditional Settlements (ATS); and WZ: Without Zoning

Within these five classes, the highest proportions of land categorised as a "favourable" conservation status, as with 2010, are found in class 1, Area of High Natural Value (AHNV), Area of Primary Importance (API), Reserve Area (RA), and also class 5 (Figure 45).

In the other categories and CS_2018, the percentage of surface area categorised as "favourable" increases inversely in relation to an increased protection level (Figure 23).

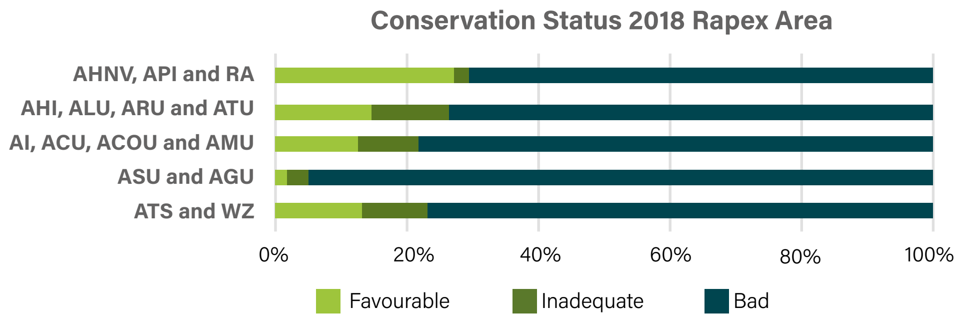


Figure 23. Distribution of the surface percentage of the conservation status within habitat 6310 and the Natura 2000 Network zoned for the RAPEX codification, with data obtained in 2018. AHNV: Area of High Natural Value; API: Area of Primary Importance; RA: Reserve Area; AHI: Area of High Importance; ALU: Area of Limited Use; ARU: Area of Restricted Use; ATU: Area of Traditional Use; AI: Area of Importance; ACU: Area of Compatible Use; ACOU: Area of Common Use; AMU: Area of Moderate Use; ASU: Area of Special Use; AGU: Area of General Use; ATS: Area of Traditional Settlements (ATS); and WZ: Without Zoning

The spatial distribution of the conservation status of habitat 6310, estimated for 2018, within the RAPEX areas, shows a random distribution between the various conservation status categories, so that, in order to find any relationship, we would have study other external factors unrelated to biodiversity (Figure 24).

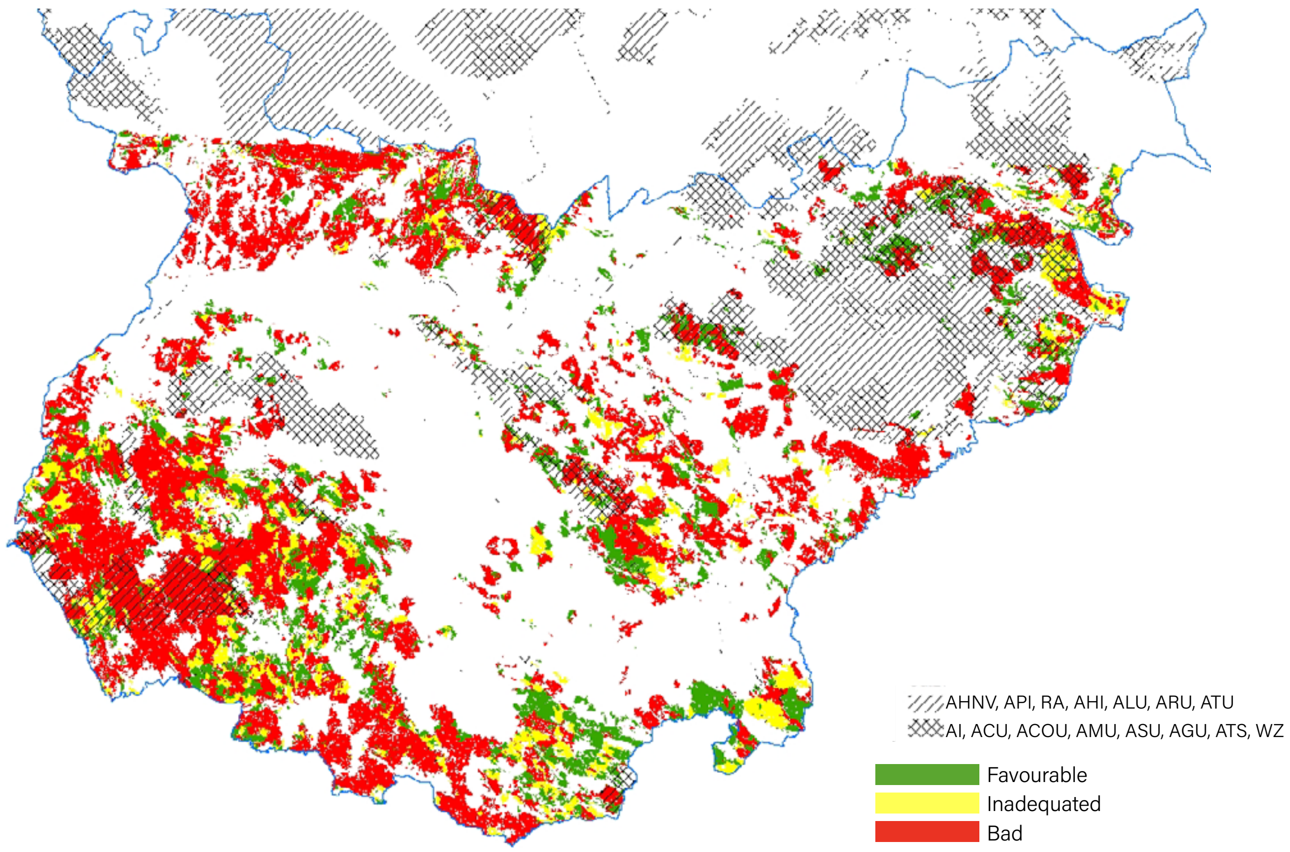


Figure 24. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2018. The shaded areas represent the land within the RAPEX area

Analysis of results from the Favourable Habitat zoning

Another zoning that was assessed was that of the habitat favourable for the reproduction of certain protected species. The largest surface area is occupied by the "normal" category (>60%), followed by the "excellent" and "excellent adjacent" reproduction areas (~30%), and the remaining 10% is made up of the "good" and "good adjacent" reproduction areas (figure 25). We observed that the largest proportion of surface area categorised as the "favourable" conservation status was classified as "good reproduction habitat" (Figure 25).

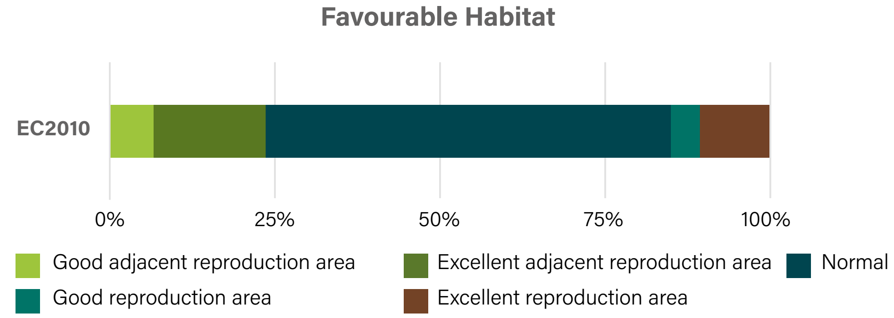


Figure 25. Distribution of the surface percentage of habitat 6310 zoned as a habitat favourable to species reproduction

The next category in terms of surface area categorised as a "favourable" conservation status is "good adjacent reproduction", "normal", "excellent reproduction" and "excellent adjacent reproduction". The "inadequate" conservation status category also follows a similar pattern (Figure 26). It is notable that the highest percentages of land categorised under the "bad" conservation status are found within the areas classified as "excellent reproduction" areas (Figure 26).

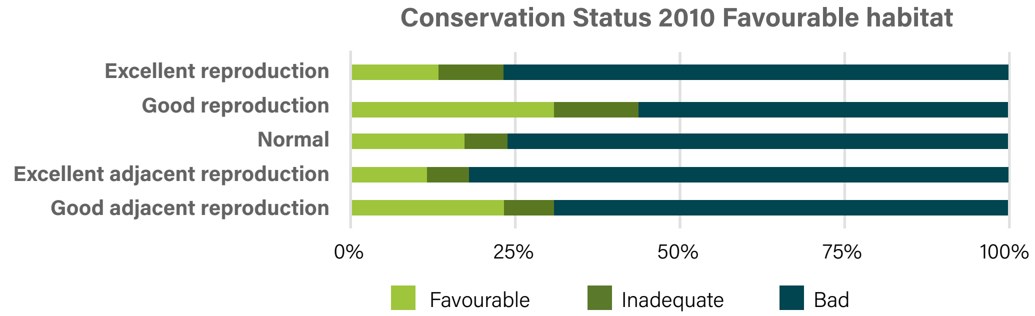


Figure 26. Distribution of the surface percentage of the conservation status within habitat 6310 and the Natura 2000 Network, zoned according to habitats favourable to species reproduction, with data obtained in 2010

The spatial distribution of the conservation status in the areas favourable to reproduction in Badajoz in 2010 (Figure 27) and in Cáceres (Figura 28) show that the majority of tesserae from habitat 6310 are those with the "bad" conservation status, particularly in "normal" reproduction areas. In addition, the "good" and "excellent" reproduction areas are largely made up of smaller tesserae.

In the zoning of habitats favourable for species reproduction in 2018, we observed that the largest proportion of land categorised under the "favourable" conservation status continued to be classified as "good reproduction habitat". The next category in terms of surface area categorised as a "favourable" conservation status is "excellent adjacent reproduction", "excellent reproduction", "normal", "good adjacent reproduction". The "inadequate" conservation status category also follows a similar pattern (Figure 29).

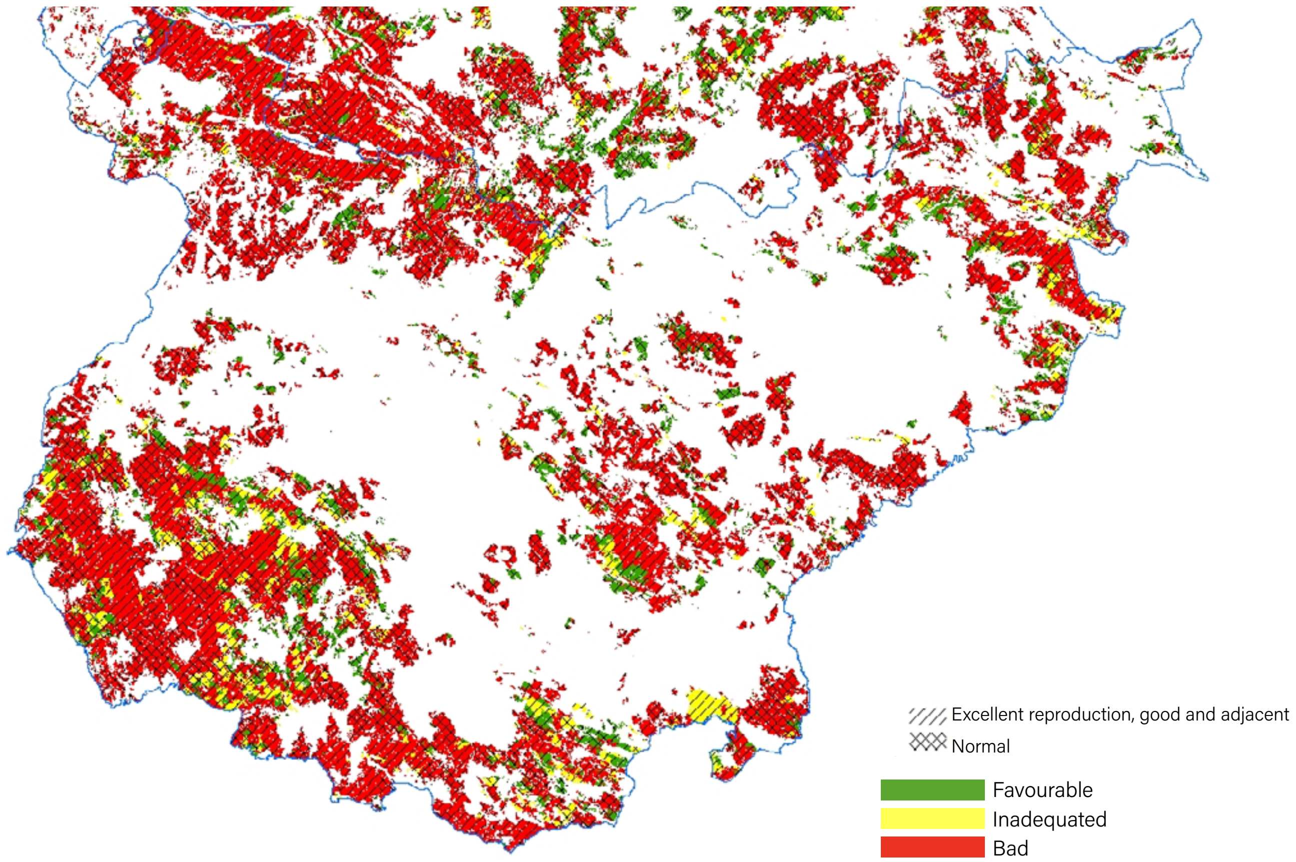


Figure 27. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2010. The shaded areas represent the areas that are favourable for reproduction

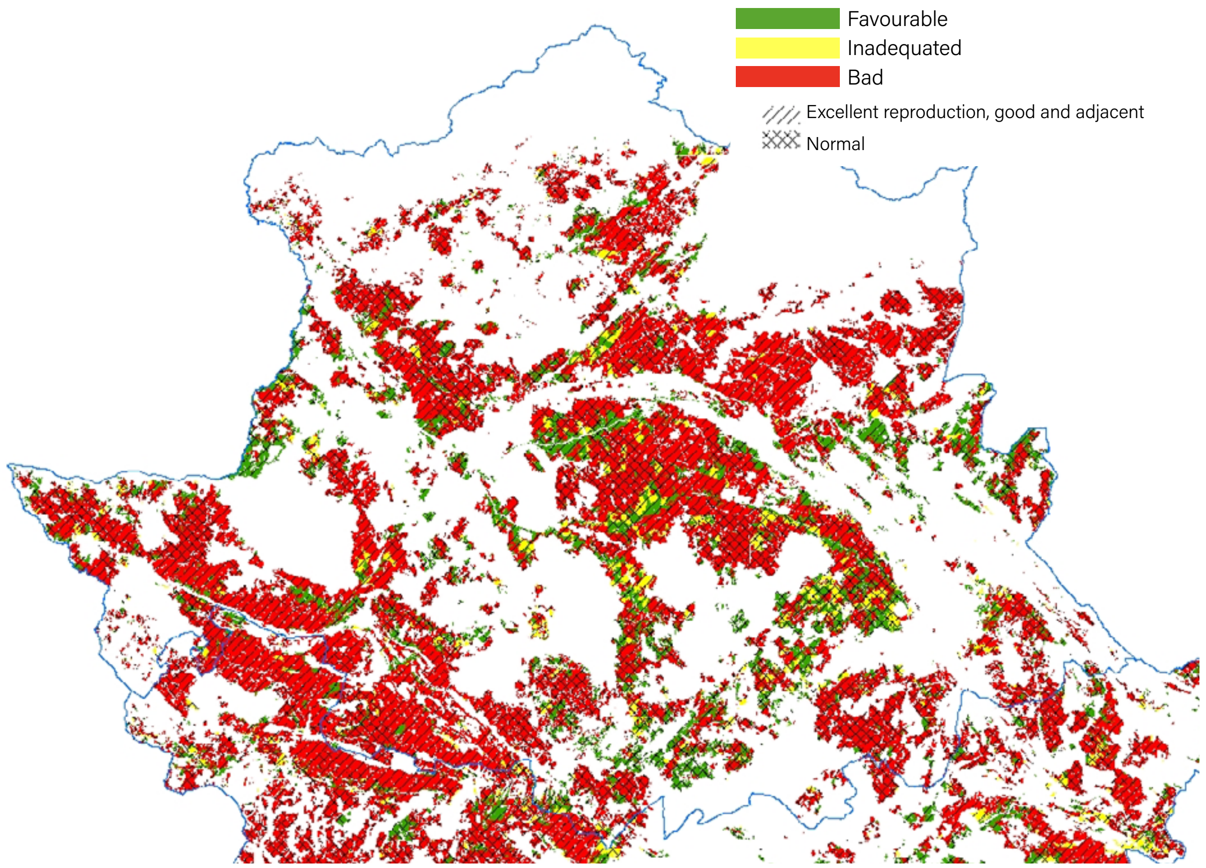


Figure 28. Spatial distribution of the Conservation Status of Habitat 6310 in Cáceres for 2010. The shaded areas represent the areas that are favourable for reproduction

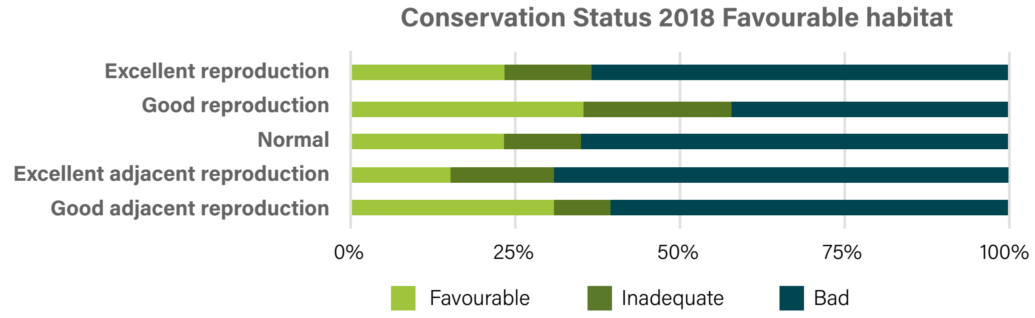


Figure 29. Distribution of the surface percentage of the conservation status within habitat 6310 and the Natura 2000 Network, zoned according to habitats favourable to species reproduction, with data obtained in 2018 for South Extremadura

As in the previous cases, the spatial distribution of the conservation status of habitat 6310 does not show a direct relationship with the areas categorised as good or excellent for species reproduction (Figure 30).

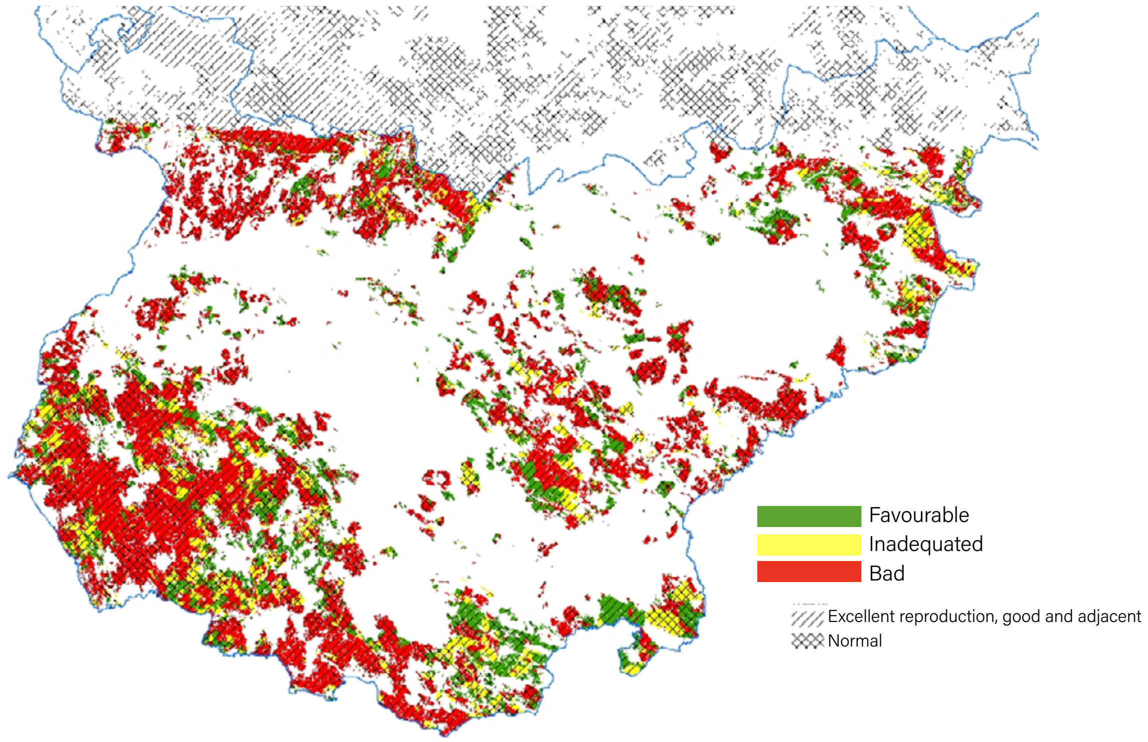


Figure 30. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2018. The shaded areas represent the areas that are favourable for reproduction

Analysis of results from the Natural Value zoning

The distribution of the "favourable" conservation status, in terms of natural value categories, is organised from highest to lowest as medium-low, high, medium-high and low, meaning that the best conserved areas of habitat 6310 are related to an area of high natural value. Furthermore, the largest percentage of areas categorised under the "bad" conservation status are found to be of low natural value. There is therefore a correlation between better conservation statuses and higher levels of natural value in habitat 6310 for 2010 (Figure 31).

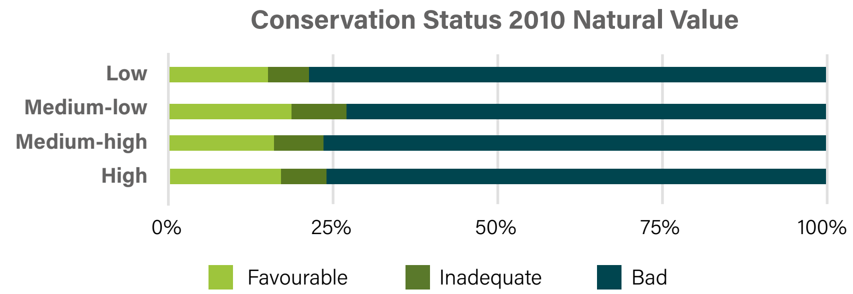


Figure 31. Distribution of the surface percentage within habitat 6310 classified according to the natural value and conservation status developed for 2010

As with the cases studied previously, the spatial distribution of the conservation status in habitat 6310 for 2010 within the areas of high natural value shows that the majority of the habitat is occupied by larger areas with poor conservation statuses and smaller areas with higher natural values (Figures 32-33).

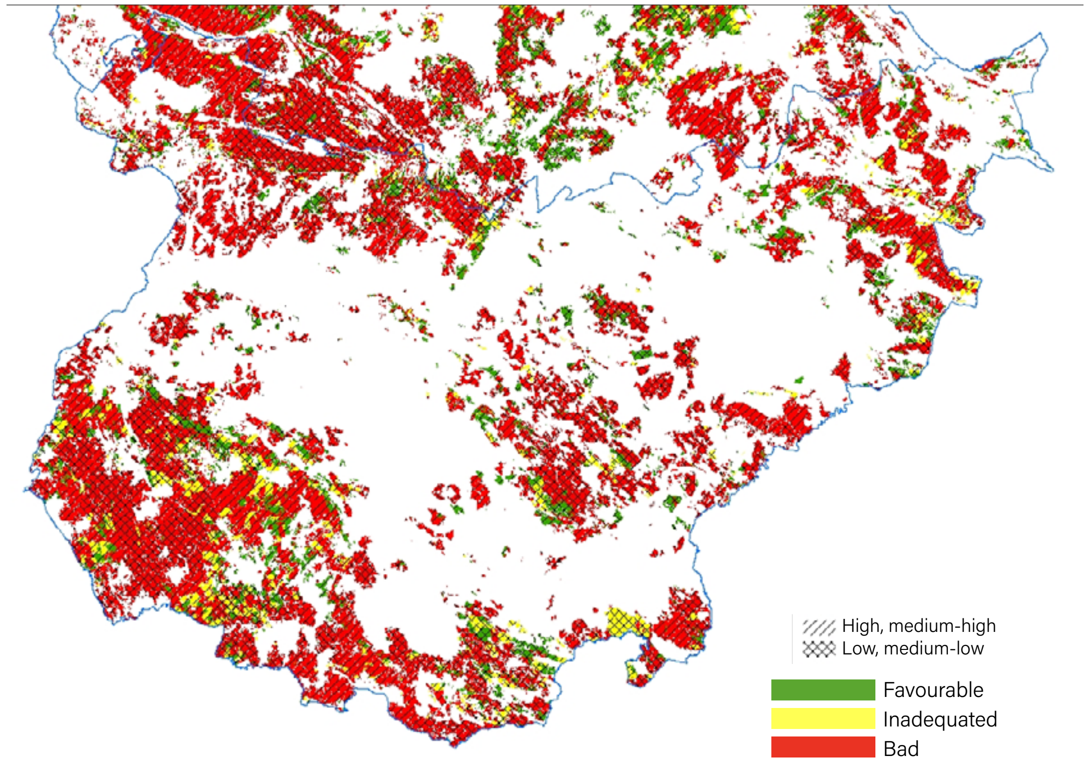


Figure 32. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2010. The shaded areas represent the land within the Natural Value areas

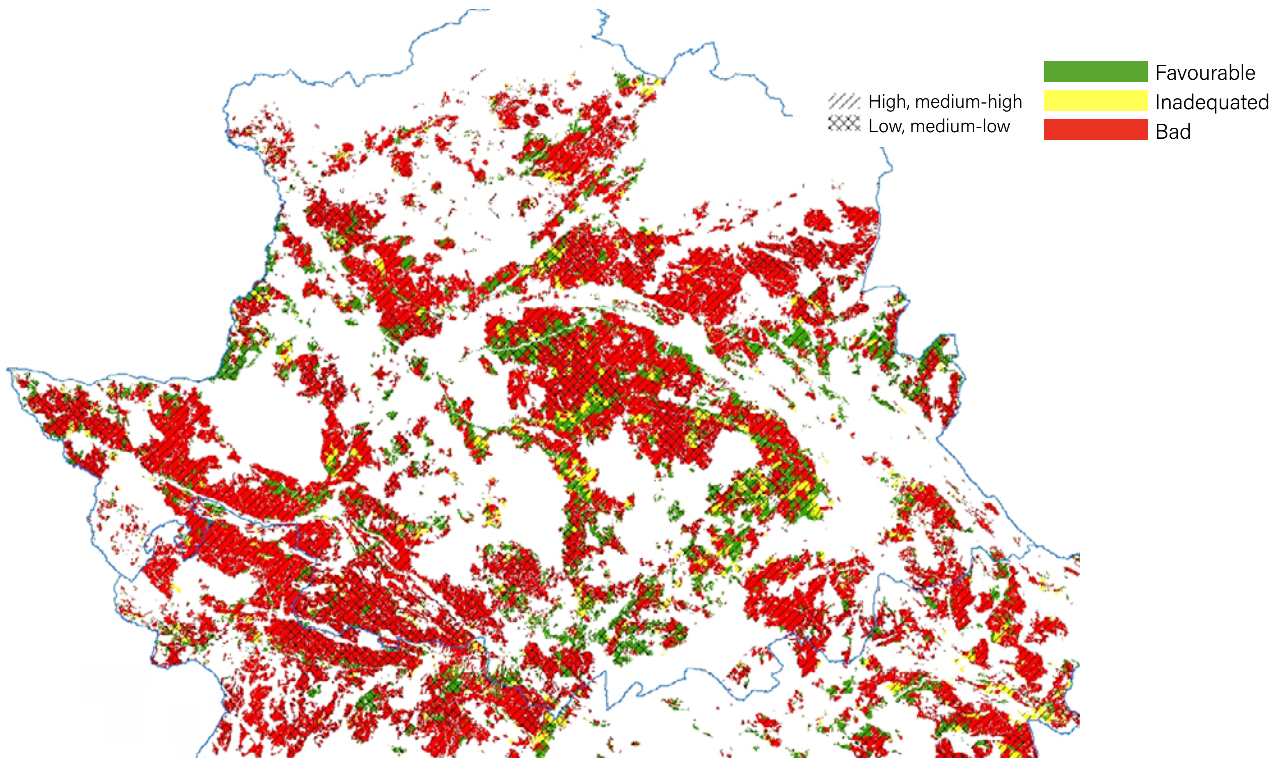


Figure 33. Spatial distribution of the Conservation Status of Habitat 6310 in Cáceres for 2010. The shaded areas represent the land within the Natural Value areas

The distribution of the "favourable" conservation status shows a higher proportion of land with high natural values, with the other three categories being distributed similarly to each other. Furthermore, the largest percentage of areas categorised under the "bad" conservation status are found to be of low natural value (Figure 34).

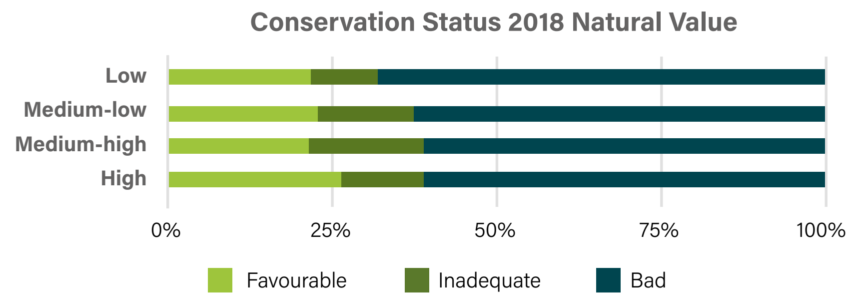


Figure 34. Distribution of the surface percentage within habitat 6310 classified according to the natural value and conservation status developed for 2018

The spatial distribution of the conservation status of habitat 6310, in relation to natural value categories, does not demonstrate any clear correlation in the estimation completed for 2018 (Figure 35).

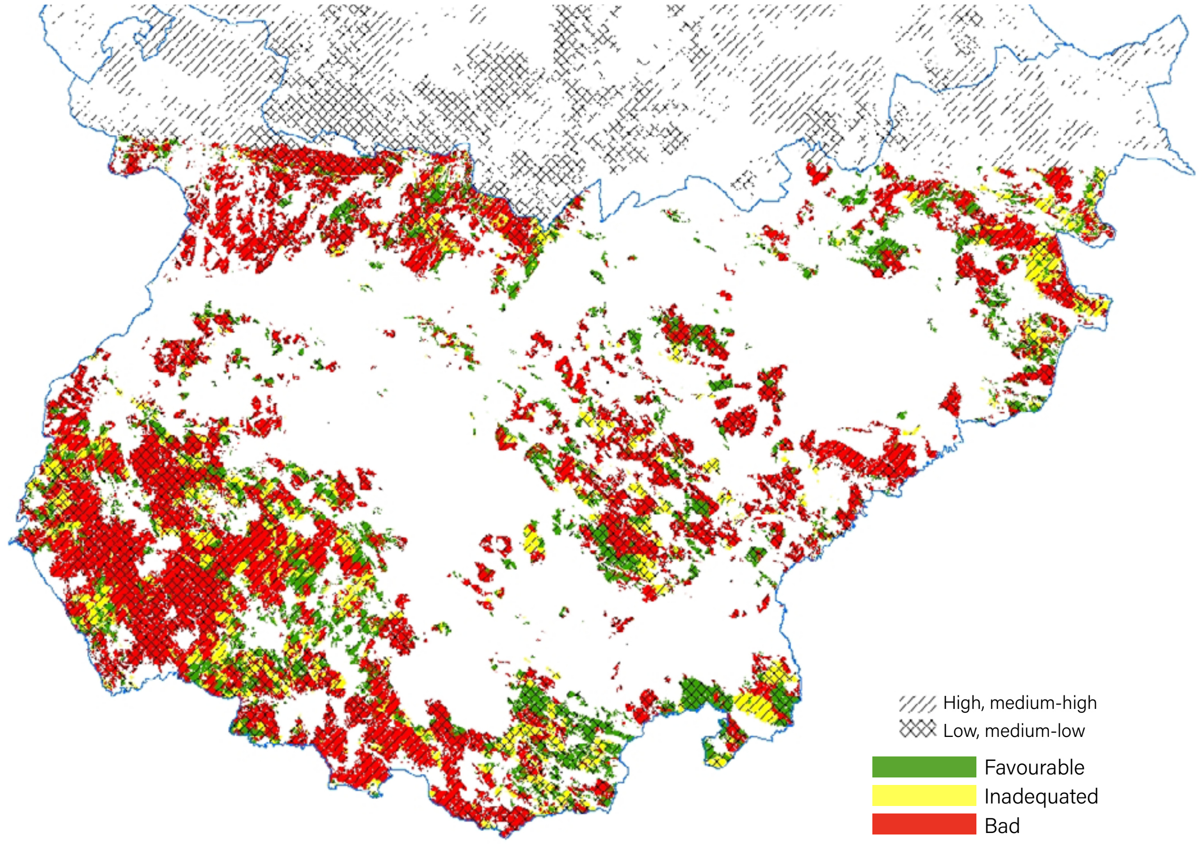


Figure 35. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2018. The shaded areas represent the land within the Natural Value areas

Analysis of results from the Total Value zoning

The conservation status of habitat 6310 in Extremadura, zoned according to total value, shows a positive correlation and higher percentages between "favourable" and "inadequate" areas with areas of high and medium-high total value, exceeding 30% of the total. However, the largest surface area is categorised with a conservation status of "bad" and a low total value (Figure 36).

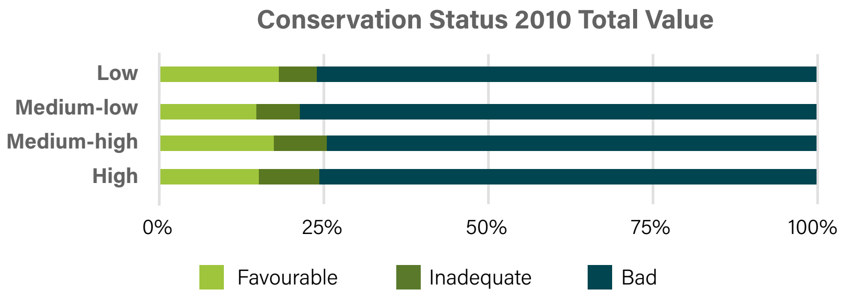


Figure 36. Distribution of the surface percentage within habitat 6310 classified according to the conservation status and total value developed for 2010

As with the cases studied previously, the spatial distribution of the conservation status of habitat 6310 for 2010 within the areas of high total value demonstrates the prevalence of larger areas with worse conservation statuses and smaller areas with higher total values, with the latter coinciding with sloped and thalweg areas (Figures 37-38).

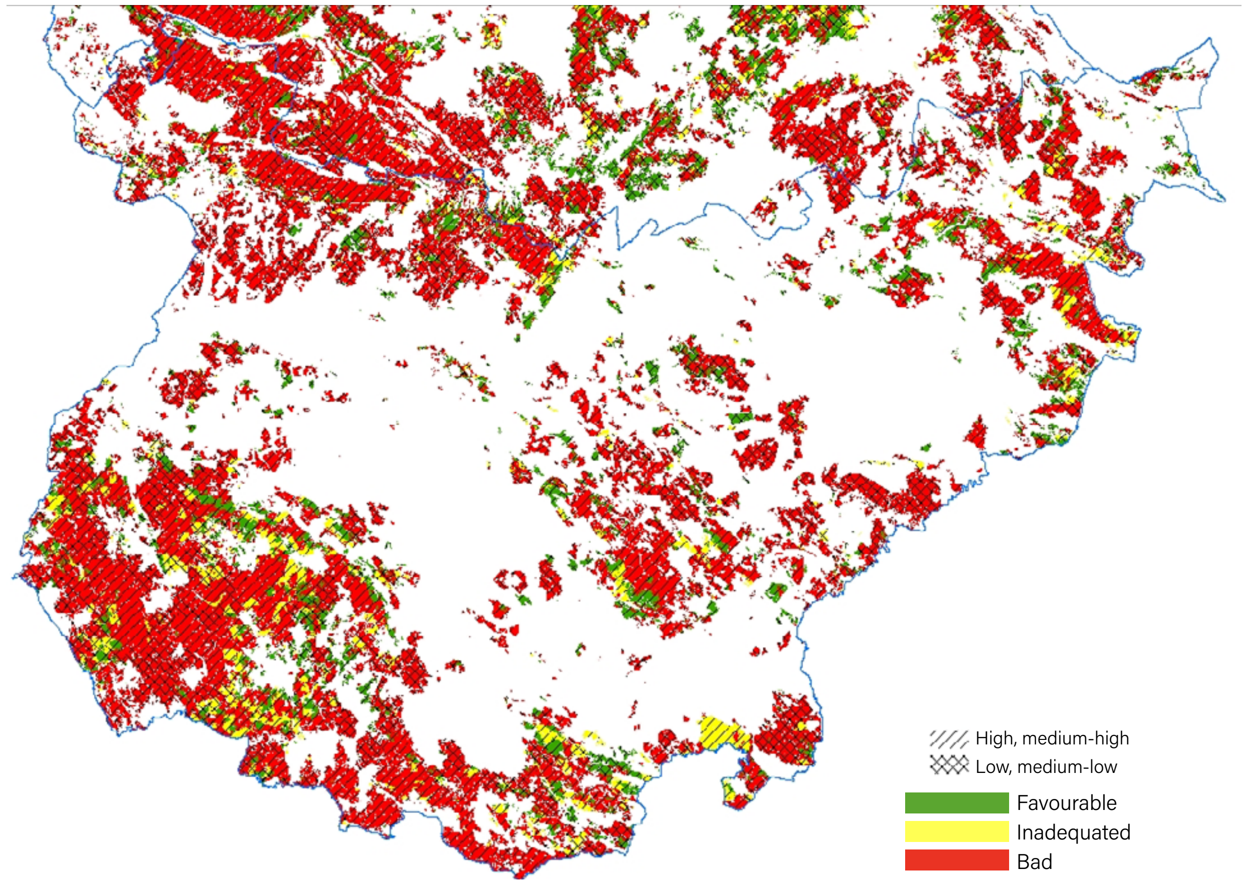


Figure 37. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2010. The shaded areas represent the land within the Total Value areas

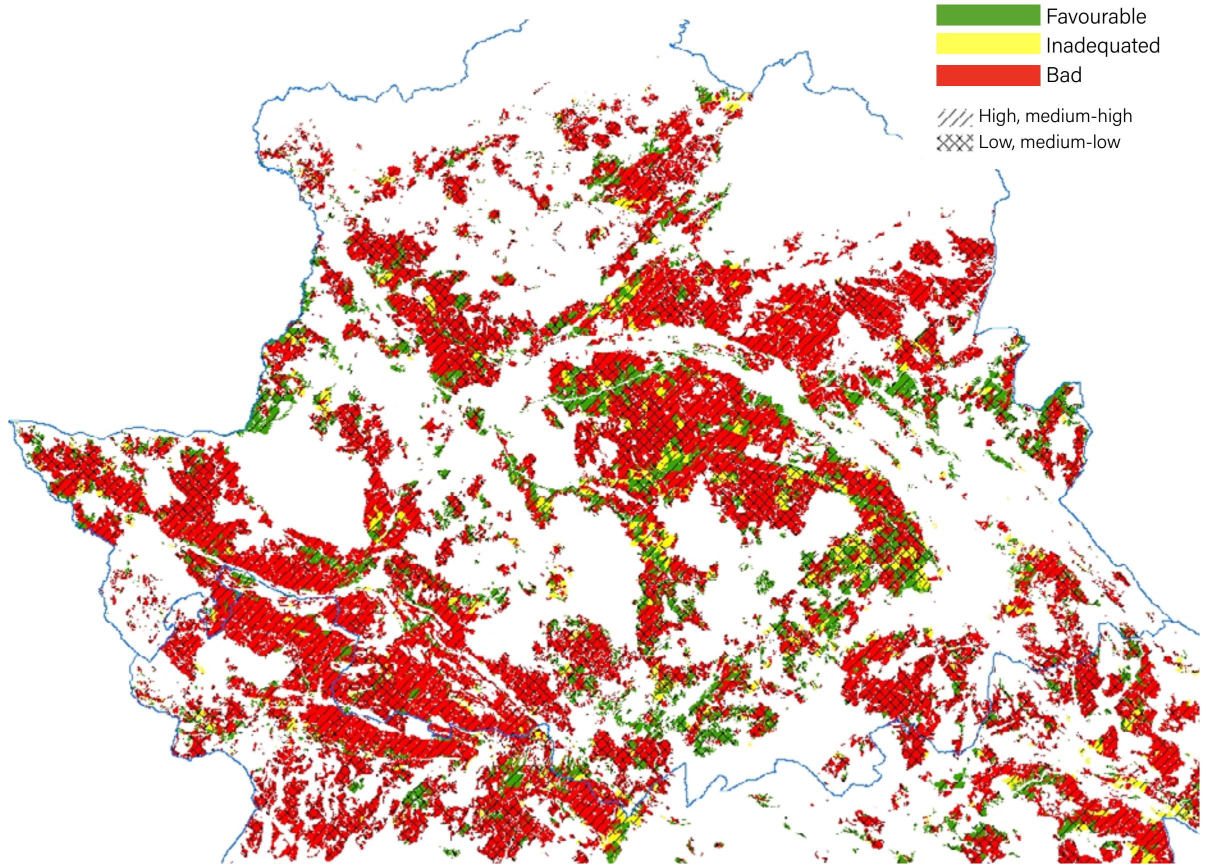


Figure 38. Spatial distribution of the Conservation Status of Habitat 6310 in Cáceres for 2010. The shaded areas represent the land within the Total Value areas

There is an overlap of the spaces that make up the RAPEX area with the conservation status of habitat 6310, along with the areas of high total value, but no clear pattern of distribution has been observed (Figures 39 y 40).

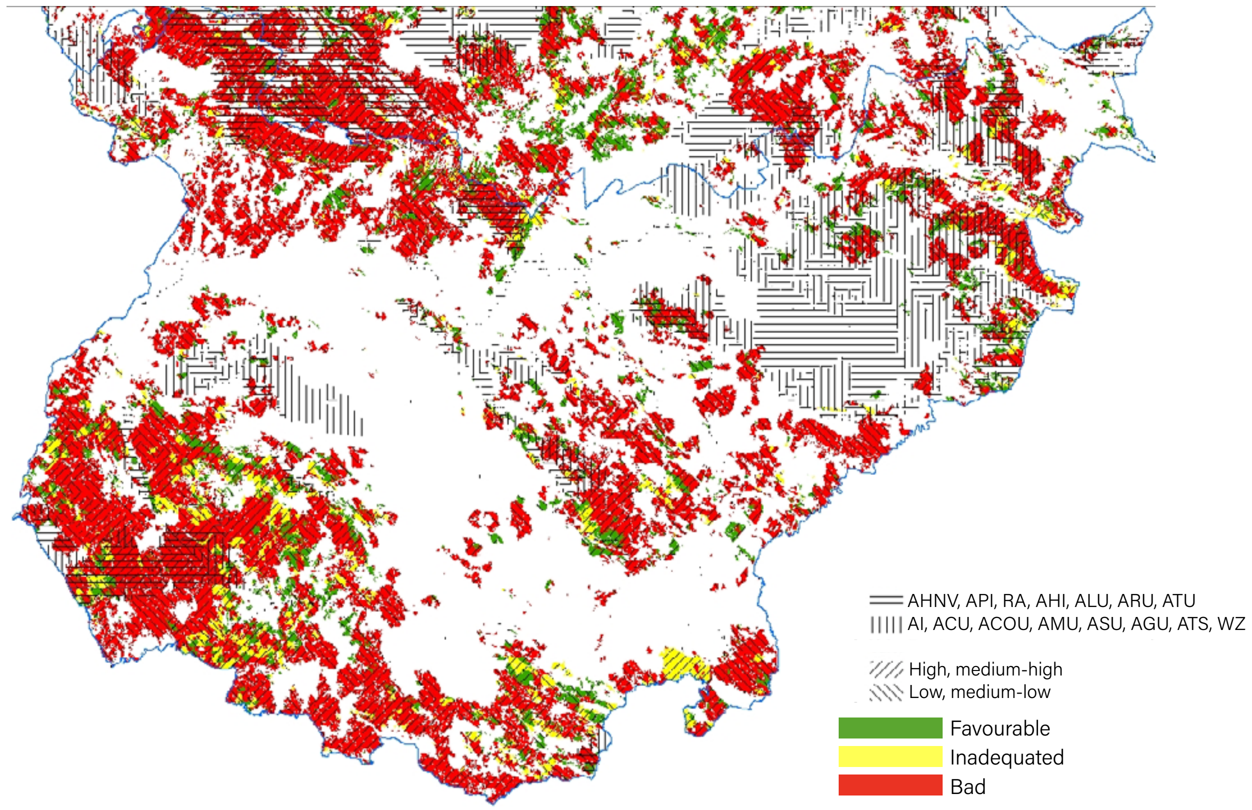


Figure 39. Spatial distribution of the Conservation Status of Habitat 6310 in Badajoz for 2010. The shaded areas represent the land within the Total Value areas

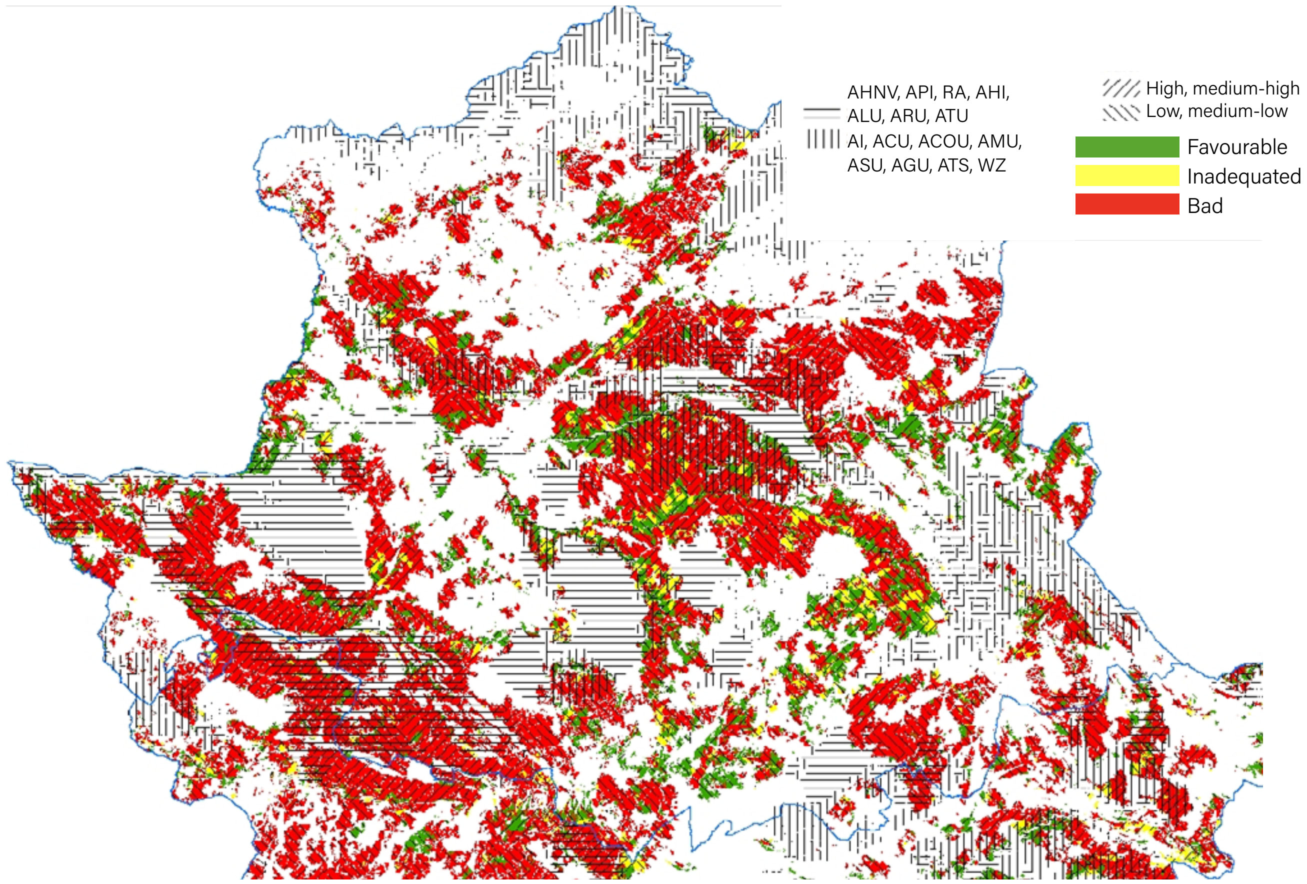


Figure 40. Spatial distribution of the conservation status of habitat 6310 in Badajoz for 2010. The shaded areas represent the land within the Total Value areas

The conservation status of habitat 6310 in Extremadura, zoned according to the total value, shows a positive correlation and higher percentages between "favourable" areas and with areas of low total value, exceeding 25% of the total. However, the areas with low and medium-low total value also occupy the largest surface area categorised as "bad" (Figure 41).

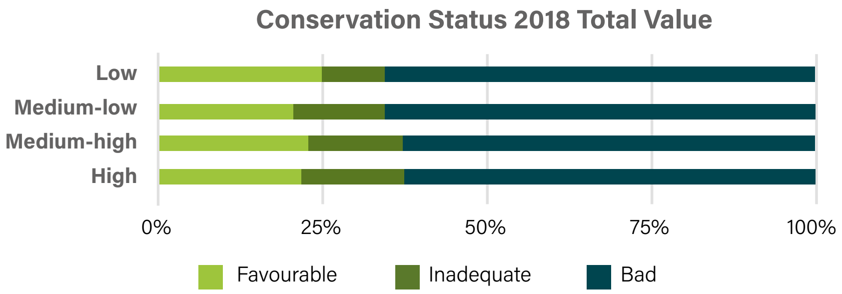


Figure 41. Distribution of the surface percentage within habitat 6310 classified according to the total value and conservation status developed for 2018

No evidence was found of a correlation between areas with a "favourable" conservation status in habitat 6310 and high total values (Figure 41), nor with the RAPEX areas and their zoning (Figures 42 y 43).

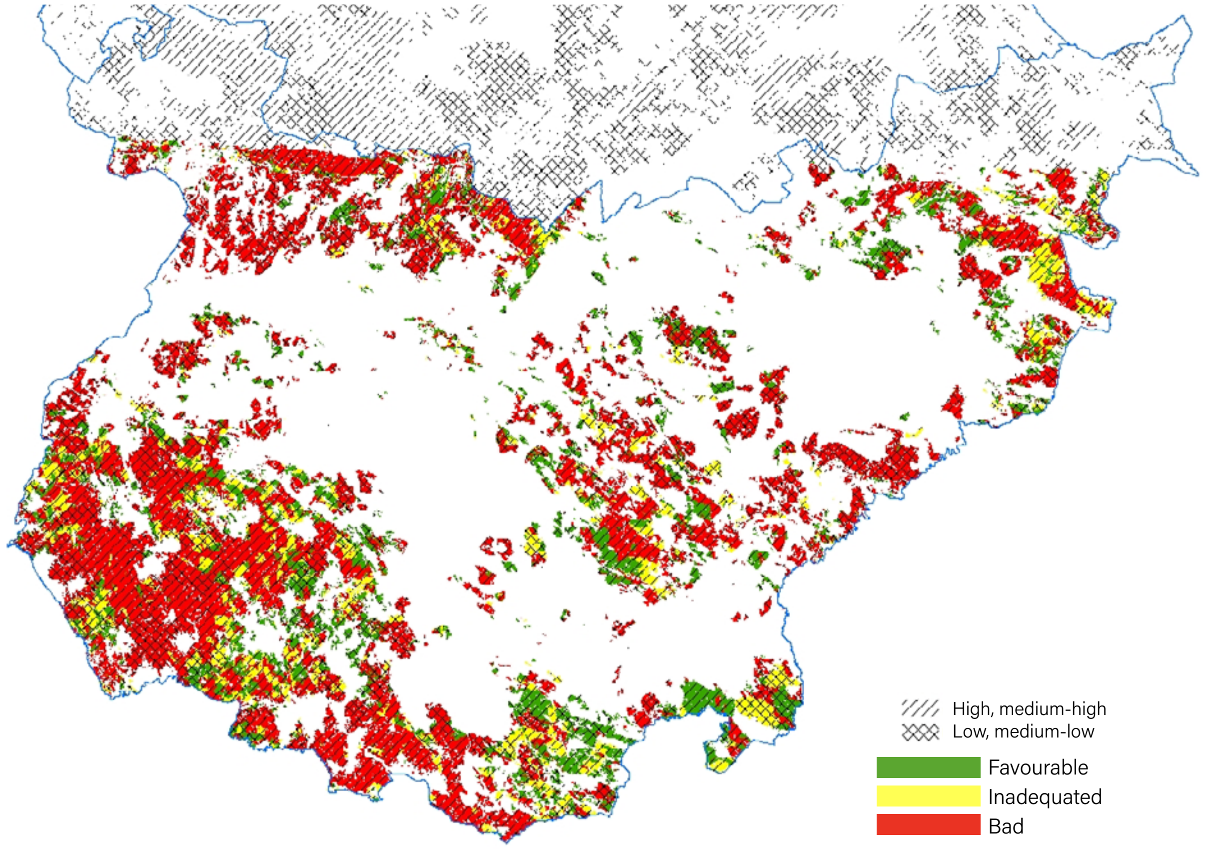


Figure 42. Spatial distribution of the conservation status of habitat 6310 in Badajoz for 2018. The shaded areas represent the land within the Total Value areas

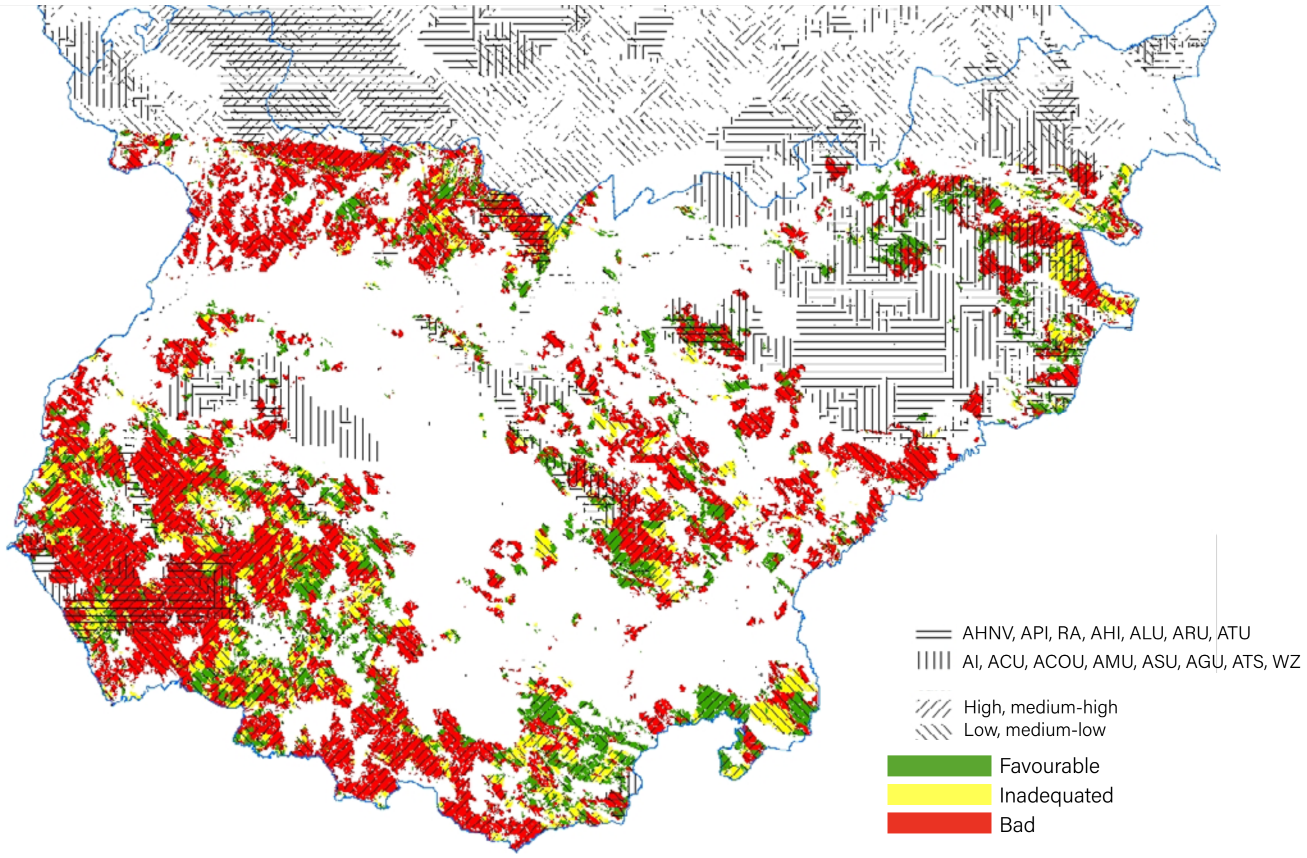


Figure 43. Spatial distribution of the conservation status of habitat 6310 in Badajoz for 2018. The shaded areas represent the land within the Total Value and RAPEX areas

Determination and characterisation of areas of High Natural Value

This section analyses the data of the dehesa land with the highest level of natural value, with the aim of determining the most biodiverse dehesas.

To determine the areas of high natural value, we considered those tesserae from habitat 6310 classified with a total value of ≥ 1,232, as this value occupies the 70th percentile of the distribution of total values of the sample studied, and occupies a surface area of 5.69% of the total of habitat 6310.

The provincial distribution (Figure 44) shows a higher percentage of areas of habitat 6310 classified as of High Natural Value in the province of Cáceres than in Badajoz.

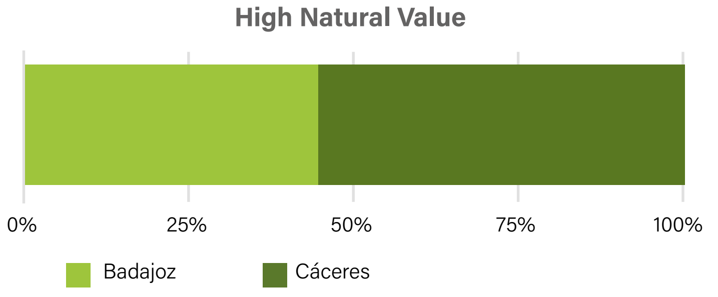


Figure 44. Percentage distribution of land within habitat 6310

Distribution and characterisation of areas of High Natural Value

The spatial distribution of areas categorised as of High Natural Value in habitat 6310 for 2010 shows a random distribution, with no specific pattern observed, only that the larger tesserae, or those with the largest number of adjacent tesserae, were in the "bad" conservation status (Figure 45).

As with the estimations carried out for 2010, the spatial distribution of areas categorised as of High Natural Value in habitat 6310 for 2018 shows a distribution with no apparent correlation with the defined conservation statuses, with the only observation being a decrease of larger tesserae or a larger number of adjacent tesserae categorised as the "bad" conservation status (Figure 46).

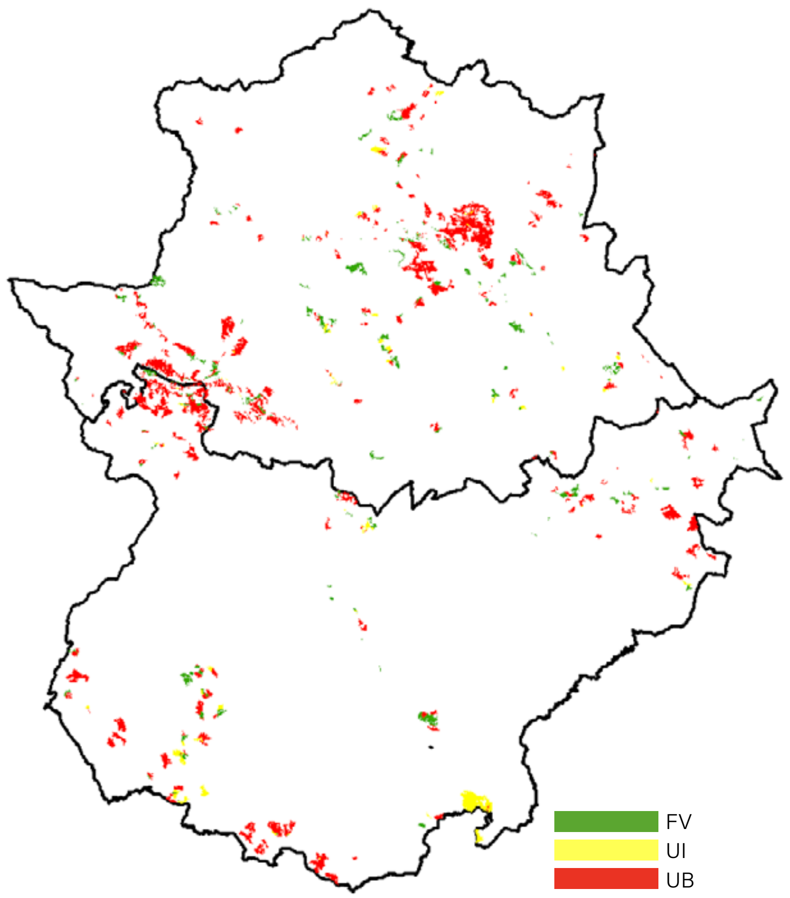


Figure 45. Spatial distribution of the areas categorised as of High Natural Value, classified according to the conservation status of habitat 6310 for 2010. FV: Favourable, UI: Unfavourable inadequate; and UB: Unfavourable bad

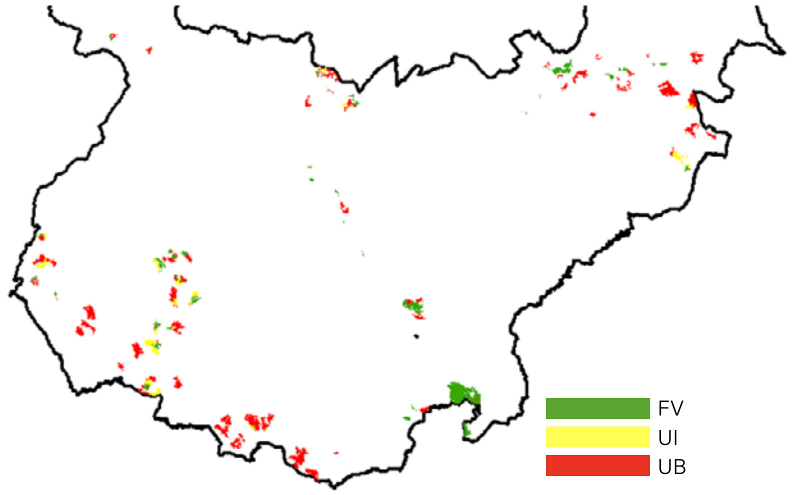


Figure 46. Spatial distribution of the areas categorised as of High Natural Value, classified according to the conservation status of habitat 6310 for 2018

The distribution of the two categories of estimated conservation status—trees and shrubs—shows that the tree cover has a higher proportion with a "favourable" conservation status than the shrub cover, with the total "favourable" proportion for both being approximately 20% (Figure 47). However, the largest proportion of land still fell within the "bad" conservation status.

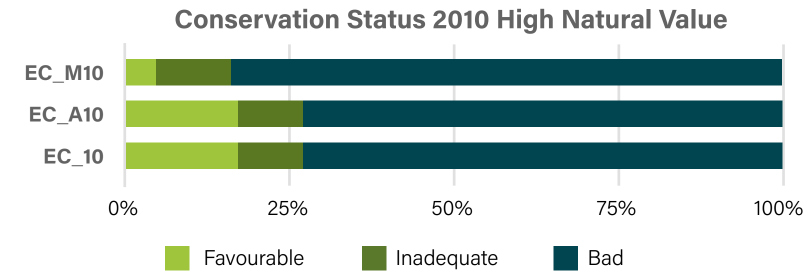


Figure 47. Distribution of the surface percentage within habitat 6310 categorised as High Natural Value and classified according to the estimated conservation status for 2010

In 2018, the predominant conservation status for the areas in habitat 6310 defined as of High Natural Value was the category of "bad". However, there are more areas categorised with the conservation status of "favourable" in the tree category of conservation than with the shrub category, resulting in an overall increase in the "favourable" conservation status over the two categories (Figure 48).

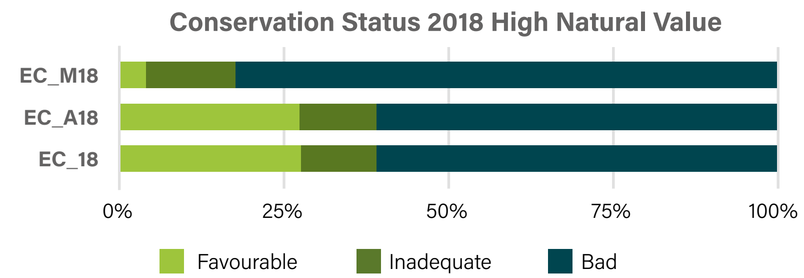


Figure 48. Distribution of the surface percentage within habitat 6310 classified according to the total value and conservation status developed for 2018

With regard to the distribution of the areas categorised as of High Natural Value in relation to the Natura 2000 Network, we observed that the largest areas with the "favourable" conservation status were outside of the limits of the Natura 2000 Network, while inside the Natura 2000 Network, we found (with 2010 data) that the largest areas with the "favourable" conservation status were located within the SPA areas, exceeding 20%, or >40% if we also consider the "inadequate" areas (Figure 49).

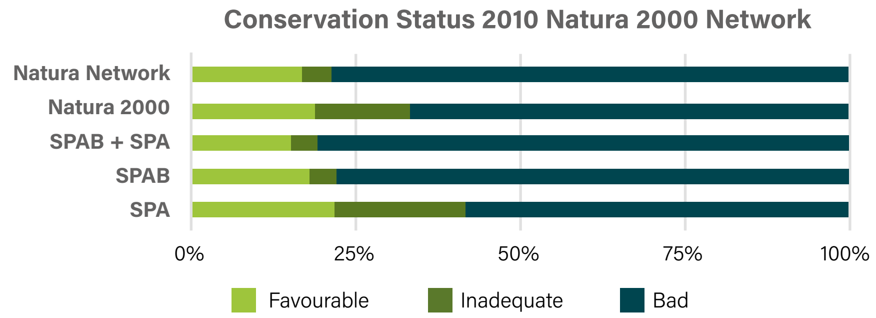


Figure 49. Distribution of the surface percentage within habitat 6310 categorised as High Natural Value and classified according to the estimated conservation status for 2010 in relation to the surface area occupied by the Natura 2000 Network

In terms of the protection figures for the Natura 2000 Network, there were also more habitat 6310 areas with the "favourable" conservation status within the SPA areas (2018 data), at >45%, and outside of the Natura 2000 Network (Figure 50).

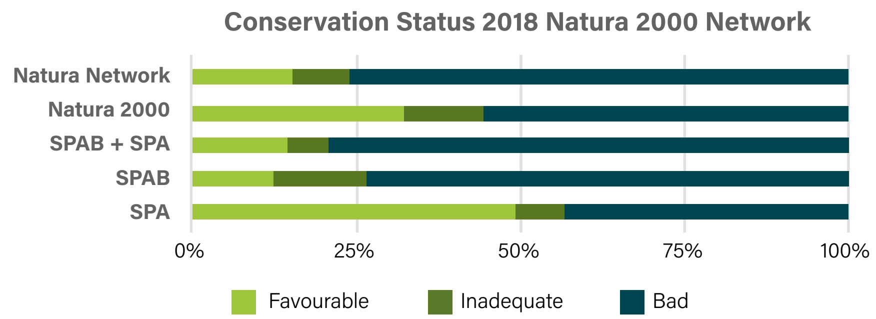


Figure 50. Distribution of the surface percentage within habitat 6310 classified according to the conservation status and Natura 2000 Network zoning developed for 2018

The habitat 6310 areas defined as of High Natural Value with a "favourable" conservation status mainly fall within the RAPEX zoning categories of Areas of High Natural Value, Areas of Primary Importance and Reserve Areas, at >30%, with these being the areas of greatest protection (Figure 51).

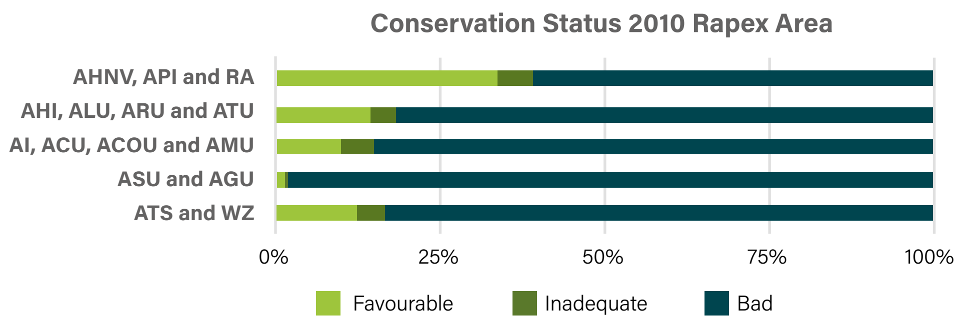


Figure 51. Distribution of the surface percentage within habitat 6310 categorised as High Natural Value and classified according to the estimated conservation status for 2010 in relation to the surface area occupied by the RAPEX zoning

In the 2018 data, within the RAPEX zoning categories, the other areas that stand out are those classified as Areas of High Natural Value, Areas of Primary Importance and Reserve Areas, with these being the areas of greatest protection (Figure 52), although the largest area remains that with a habitat 6310 conservation status categorised as "bad".

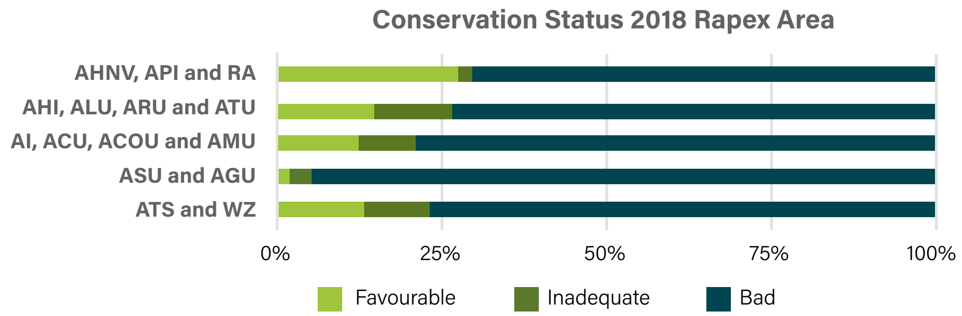


Figure 52. Distribution of the surface percentage within habitat 6310 classified according to the conservation status and RAPEX zoning developed for 2018

From the 2010 data, all of the selected habitat 6310 areas with a conservation status of "favourable" are located in the excellent or good areas, or adjacent, in terms of habitat favourable to species reproduction, with the good reproduction areas being predominant, with a surface area of >40% (Figure 52). All the tesserae in habitat 6310 with a "normal" classification in terms of habitat favourable to reproduction also have a "bad" conservation status (Figure 53).

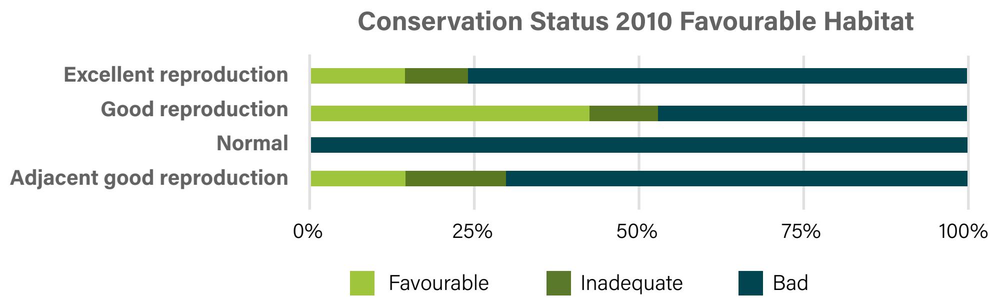


Figure 53. Distribution of the surface percentage within habitat 6310 categorised as High Natural Value and classified according to the estimated conservation status for 2010 in relation to the surface area occupied by the favourable reproduction habitat zoning

The areas defined as of High Natural Value are in habitat areas categorised as excellent or good, or adjacent, in terms of being favourable for species reproduction. The "favourable" conservation status is >20% in all reproduction areas, exceeding 70% in good reproduction areas (Figure 54), from 2018 data. The normal category for favourable habitat is not present in the surface area defined as of High Natural Value (total value ≥ 1,232).

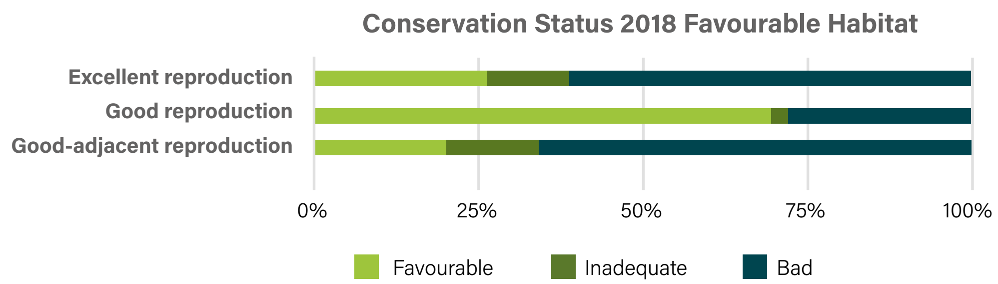


Figure 54. Distribution of the surface percentage within habitat 6310 classified according to the conservation status and favourable reproduction habitat developed for 2018

The habitat 6310 classified as of "High Natural Value" in 2010 is occupied by dehesas with a prevalence of adult trees (p0.33) and limited regeneration (low values of p0.66). They are dehesas with a limited tree fractional canopy cover (tree FCC), with a prevalence of pasture land, as the shrub fractional canopy cover of >50% (p0.55) is ~0% (Figure 55).

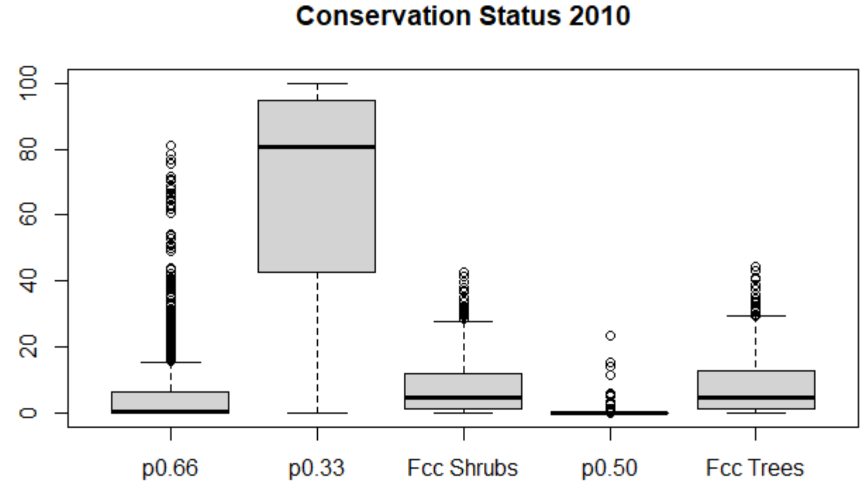


Figure 55. Distribution of the variables that characterise habitat 6310 classified as of High Natural Value for 2010

The dehesas in habitat 6310 categorised as areas of High Natural Value for 2018 demonstrate low regeneration values (p0.66), a prevalence of adult trees (p.033), an average tree fractional canopy cover of >30% (tree FCC), limited shrub cover (average shrub FCC <10%) and limited areas with a tree fractional canopy cover of >50% (p0.50), (Figure 56).

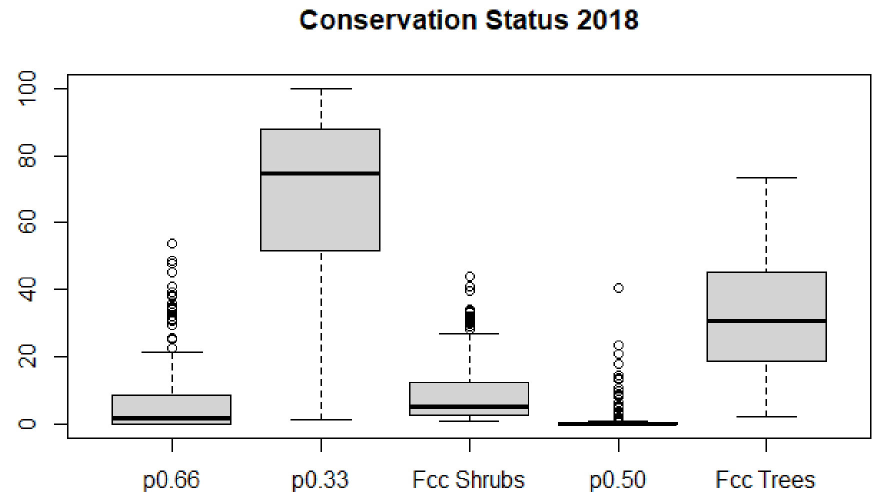


Figure 56. Distribution of the variables that characterise habitat 6310 classified as of High Natural Value for 2018

Conclusions

01

The conservation indices obtained for habitat 6310 in Extremadura demonstrate a prevalence of "unfavourable-bad" values (UB), both for the index based on tree population structure (more than 70% of the habitat land is UB with the updated data) and for that of shrub cover (more than 85% of the land is UB with the updated data). The combined conservation status index for tree and shrub cover, with the updated data, shows that 70.46% of the land in the dehesa habitat in Extremadura is classified as the "unfavourable-bad" conservation status (UB).

02

The quality indicators from the model developed to predict the conservation status of the habitat based on the tree population structure are either good or excellent.

03

The quality indicators from the model developed based on shrub cover are equally acceptable, although this prediction was underestimated as the cover values are lower than the observed data, under the accepted assumptions. Similarly, we observed that the conservation index classification for shrub cover at a tessera level also demonstrated conservative results, giving an unfavourable classification in many cases.

04

Based on the more recent data, only 20% of habitat 6310 in Extremadura falls within the "favourable" conservation status, with Cáceres containing a larger distribution of this categorisation than Badajoz.

05

Only a small percentage (<10%) of the total surface area of habitat 6310 is located within the Natura 2000 Network. Of the surface area that is included in the Natura 2000 Network, only 28% is classified with a "favourable" conservation status.

06

The majority of the habitat 6310 land categorised as favourable within the Natura 2000 Network is in those areas classified as Special Protection Areas (SPA), where the land categorised as "favourable" reaches a proportion of 34%.

In terms of the Special Protection Areas for Birds (SPAB), only 25% of the land in habitat 6310 falls within the "favourable" conservation status. Therefore, in all cases, the majority of habitat 6310 land located within the Natura 2000 Network is made up of areas classified with the "unfavourable-bad" conservation status, although the proportion of this classification is lower in the SPA areas than the SPAB areas.

07

The Areas of High Natural Value (AHNV), Areas of Primary Importance (API) and Reserve Areas (RA) all fall within the "favourable" conservation status, although they do not constitute a large proportion of the total surface area. However, the Areas of High Importance (AHI), Areas of Limited Use (ALU), Areas of Restricted Use (ARU), Areas of Traditional Use (ATU), Areas of Importance (AI), Areas of Compatible Use (ACU), Areas of Common Use (ACOU) and Areas of Moderate Use (AMU), which make up 90% of the total surface area, demonstrate a smaller surface area categorised as "favourable", at approximately 20%.

08

The good and good-adjacent reproduction areas have the largest surface area categorised as "favourable" (around 25%), and these categories occupy approximately 10% of the total area. On the other hand, the excellent and excellent-adjacent reproduction areas occupy approximately 30% of the total area, with around 20% of the surface area being categorised as "favourable".

09

No clear pattern has been found to determine the areas of High Natural Value in relation to the conservation status of habitat 6310, as areas were found within all three of the established conservation statuses. However, a high proportion of area defined as of High Natural Value with a "favourable" conservation status is located in maximum priority RAPEX areas, such as Areas of High Natural Value (AHNV), Areas of Primary Importance (API) and Reserve Areas (RA), and also coincide with excellent and good, and adjacent, reproduction habitat areas.

10

The dehesas categorised as of "High Natural Value" demonstrate low regeneration levels with a larger proportion of adult trees, low or medium fractional canopy cover values and limited or sparse shrub cover.

As a final conclusion regarding the conservation status of the dehesa habitat in Extremadura, the overall conservation status would be categorised as unfavourable, largely due to a lower proportion of young trees than adult trees, and, to a lesser extent, due to the low proportion of shrubs. However, the models do underestimate the presence of young trees and the shrub cover, so we estimate that the reality is actually more positive.

As for the distribution of this habitat within the Natura 2000 Network, it has a limited presence (10%) and the biodiversity results do not show a clear correlation between the more favourable conservation statuses and the areas with higher biodiversity or a greater number of species of high natural value.

However, this does not mean that the dehesa habitat is insignificant in terms of biodiversity or natural importance, as this habitat is often used as a feeding area and is used extensively by many different species. The majority of species in high protection categories often reproduce in areas near to the dehesas (rocky areas and sierras categorised as Mediterranean woodland habitats, under codes 9330 and 9340), as they depend on them for feeding.

Furthermore, the diversity of existing mosaics in the dehesa — where there are areas with agricultural land and low fractional canopy cover, areas with higher tree and shrub cover, areas used for livestock that have a larger tree layer and less shrubs, etc. — is what makes this ecosystem essential for the conservation of many different flora and fauna species, which depend on the dehesa and the montado for their survival.

www.prodehesamontado.eu

Edition: Junta de Extremadura | Consejería para la Transición Ecológica y Sostenibilidad

Design: Aísa Publicidad

Ilustrations: Antonio Grajera

Photographs:

CEFNA (Colectivo Extremeño de Fotógrafos de la Naturaleza)

Cover: Jesús Mateos Martín

Presentation: Domingo Rivera Dios

Preface: José Gordillo Caballero

Chapter 1: Eduardo Cubera Pereira

Page 11. José-Elías Rodríguez Vázquez

Page 12. José Gordillo Caballero

Page 13. Helios Dalmau Morago

Chapter 2. Helios Dalmau Morago

Page 15. Jesús Mateos Martín

Page 19. José-Elías Rodríguez Vázquez

Chapter 3. Helios Dalmau Morago

Interreg
España - Portugal

PRODEHESA MONTADO
Proyecto de Cooperación Transfronteriza para la Valorización Integral de la Dehesa-Montado

JUNTA DE EXTREMADURA
Consejería para la Transición Ecológica y Sostenibilidad