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Evaluating European Conservation Areas and Proposal of New Zones of Conservation under the Habitats Directive. Application to Spanish Territories

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Abstract: The European Union (EU) ensures the conservation of biodiversity through the Natura 2000 Network, which establishes the classification and selection of protected areas at European level. Unfortunately, member countries cannot make the best zoning decisions for biodiversity conservation because there are no clear and uniform parameters to designate Natura 2000 sites. Due to this, it is convenient to evaluate the importance of the criteria for biodiversity conservation through a general assessment, which could establish relevant criteria that can be analysed through geostatistical methods combined in multicriteria analysis. This paper aims to consider biodiversity importance values taking into account land use, so that it is possible to develop a zoning proposal which verifies or corrects the suitability of the designated areas for the Natura 2000 Network in Castilla y León, Andalucía and Madrid (Spain). The choice of these regions allows us to compare areas with a high variability of population density, making possible to compare the potential protected areas with respect to the population living in each area. This assessment has been performed using basic and easily adaptable criteria of biodiversity conservation, so it could be applied in other European territories. In this way, clear and uniform parameters for zoning will be used, being possible to detect the best protected areas. One of the most important purposes of the Natura 2000 Network is to increase connectivity between territories; our work proposes new areas that could be linked to currently protected territories, to favour the achievement of this purpose of the Natura 2000 Network.

Keywords: Natura 2000; zoning; biodiversity; conservation; land use

1. Introduction

Protected areas are essential for biodiversity conservation [1], as a consequence several initiatives and agreements at national, European and international level have emerged to combat the loss of biodiversity recorded since the mid-twentieth century [2]. In the context of European integration, joint systems are becoming increasingly important in both social and ecological sense [3]. One of these initiatives at European level is the Natura 2000 Network, which is the largest conservation effort in Europe, created with the approval of the Habitats Directive [4,5], which also planned the incorporation to this network of some designated spaces under the Directive 79/409/EEC on the conservation of wild

birds (currently Directive 2009/147/EEC) [5]. Systematic conservation planning provides a structured, target-driven approach to ensure the long-term maintenance of biodiversity [6]. In order to achieve successful conservation strategies protected areas should be associated with local communities [7].

Ecological networks are based on landscape ecological principles and consist of core areas, corridor zones, buffer zones and, if needed, nature rehabilitation areas for the reestablishment of nature [8]. The Natura 2000 Network is based on the designation of a "coherent ecological network" of protected areas [9] under the basis of biological criteria, choosing on one hand places that contribute significantly to the maintenance of habitats and species of Community interest, and on the other hand more suitable spaces for the maintenance and recovery of all wild bird species depending on their needs for food or breeding areas.

Conflicts between the conservation of biodiversity and other human activities have been and continue to be of increasing concern in the European Union, often having important political, economic and environmental repercussions [10]. The Natura 2000 Network is the main instrument for nature conservation in the European Union, as it guarantees in the long term the survival of the most threatened species and habitats in Europe and halts the loss of biodiversity caused by the adverse impact of human activities [11].

Relatively homogeneous territories (named as biogeographic regions) compose the base to the designation of Sites of Community Interest (SCIs) within the scope of the Habitats Directive and Special Protection Areas for Birds (SPAs) of the Birds Directive (Figure 1). These biogeographic regions are intended to facilitate the identification process of places and the evaluation of proposals submitted by Member States by the European Commission [12].

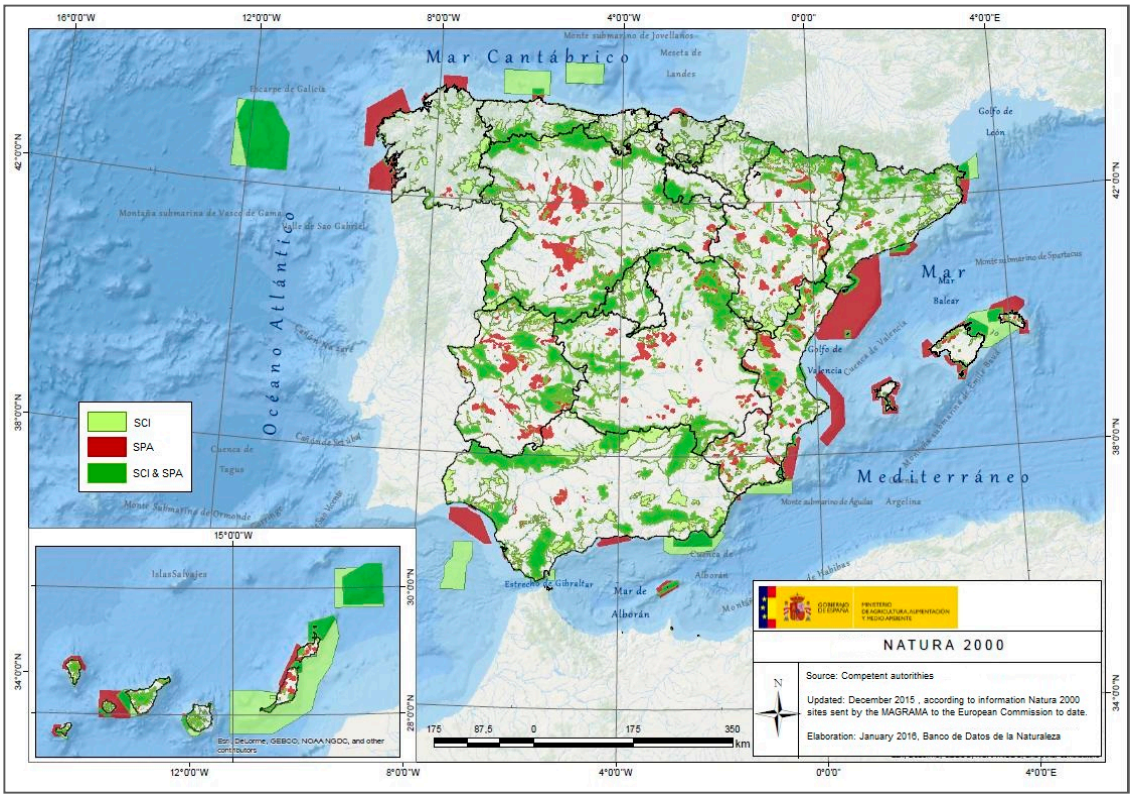

Figure 1. Sites of Community Interest (SCIs) and Special Protection Areas for Birds (SPAs) in Spain. Source: Ministry of Environment. Spain (2018).

The proper location of spaces to be protected is essential to achieve the conservation objectives suggested by the Natura 2000 Network. Regional conservation strategies go through the establishment of natural reserves [13–15]. The loss of biodiversity is combated with the establishment of biological

reserves in habitats [16,17]. Unfortunately, there are no clear and homogeneous criteria at European, national and regional level to guide the selection of these spaces.

At the international and national levels, some optimisation methods have been implemented. These initiatives try to select protected areas, which identify sets of natural reserves that maximize the representation of diversity [18–22]. Due to the importance of protected sites, determining their effectiveness in representing and maintaining biodiversity is a core issue in conservation biology [23]. An applied study has been developed in Crete (Greece) that examines the effectiveness of designated sites within the Natura 2000 Network as Special Conservation Areas (SACs) at the regional level, in terms of representativeness of plant biodiversity [24,25]. These studies have shown that the satisfactory representation of the biodiversity of the regional flora is not guaranteed by the presence of SACs included in the Natura 2000 Network, due to the lack of well-defined criteria in the process of designation of protected sites.

Connectivity is considered an essential part of the conservation of biodiversity. As a consequence, many connectivity studies have been developed through the last years. We can highlight the case of systematic evaluation of conservation to improve connectivity [26–30], and the lack of parameters and methods to select natural spaces together with non-explicit legislation which establishes the best way to preserve them. A clear assessment is needed which proposes the necessary measures to implement their protection.

The lack of parameters and methods to select natural spaces together with non-explicit legislation which establishes the best way to preserve natural spaces. It is needed a clear assessment which proposes the necessary measures to implement their protection [31].

Although several methods have been developed to select conservation sites for the protection of bird species, the European Commission has not presented formal criteria for the selection of these areas [32]. The European Court of Justice (ECJ) validated a series of ornithological criteria developed by Birdlife International, and on which the Important Bird Areas (IBA) method is based, which is one of the most worldwide recognised methods [32]. These criteria are globally threatened species, restricted-range species, groups of species linked to a habitat type (biome), concentrations of global importance, concentrations of European importance, species with unfavourable conservation status in Europe, species status favourable conservation more than 50% of the world population in Europe and areas of importance in the European Union for the species and subspecies of Annex I to the Birds Directive. A number of places with a high ornithological value can be obtained by the application of these criteria [33].

Since the main objective of ecological assessment is to provide criteria and information that can be used to identify conservation priorities [34], it is absolutely essential to define concrete criteria for the conservation of biodiversity in order to select protected sites [35]. Therefore, the process of decision-making in the conservation of nature is supported through an optimal selection of spaces to be protected [36,37].

It is necessary to emphasize that the definitions and requirements imposed by the Directive 92/43/EEC for the consideration of a habitat as of Community interest are carried out at European level, so it is understandable that there are discrepancies in the protection of certain habitats.

Due to the commented context, in order to improve management protection and conservation management at European level, it is absolutely necessary to define clear criteria that allow the Member States to optimally select protected areas [38]. The objective of this work is to verify the suitability of the current Natura 2000 sites in the studied regions, providing an optimal zoning proposal through a specific assessment of biodiversity. Finally, the aim is to unify the criteria for the assignment of protected areas in the Natura 2000 Network, creating a clear, uniform and applicable assessment for every country in the European Union.

2. Material and Methods

2.1. Study Area

The study area is focused in the regions of Castilla y León, Madrid and Andalucía, in Spain. Castilla y León has an approximate area of 94,222 km^2, being the biggest Spanish region and one of the largest in Europe; Madrid has 8030 km^2 and Andalucía has 87,268 km^2 (Figure 2). The region of Castilla y León, whose capital is Valladolid, is divided into 9 provinces with an estimated population of 2.5 million people. Madrid has a population of 6.5 million inhabitants and Andalucía 8.4 million divided into 8 provinces. Taking into account this data, we obtain a population density of 26.74 in Castilla y León, 809.11 in Madrid and 96.35 in Andalucía [39]. From this data it can be inferred that there are different population densities on these three regions: one low, another intermediate and the largest one in Spain.

Figure 2. Study Area: Regions of Castilla y León, Madrid and Andalucía, Spain.

With respect to the Natura 2000 sites of the study area, Castilla y León protects 25% of its surface under Natura 2000 Network, is Madrid ~40% and is Andalucía close to 30%, including maritime zones.

2.2. Methods

Based on the work of Velázquez [40], the goodness for the conservation of biodiversity in different regions has been evaluated. The methodology developed in this research has been adapted in order to be applied to different zones, very variable among them, which allows to assess the suitability of the current Natura 2000 areas in all the territories of the European Union.

As explained in the above section, the selected areas are the two largest regions in Spain, and the region with the largest urbanized territory with respect to its total area; thus, it will allow to be adapted to all types of territories. This general assessment includes the most updated data sources, so the results are closer to reality.

The importance of following this general assessment is that it allows evaluating the current protected areas making possible to incorporate new areas into the Natura 2000 network, the main objective of this study. Thanks to the combination of valuation and application of land uses, new protected sites can be defined quickly and easily.

The proposed assessment is based on three general phases (Figure 3). With this assessment we aim to achieve a proper evaluation of biodiversity within selected regions, allowing appropriate selection of protected sites (determined by certain criteria) which will improve biodiversity conservation by means of those protected sites [40].

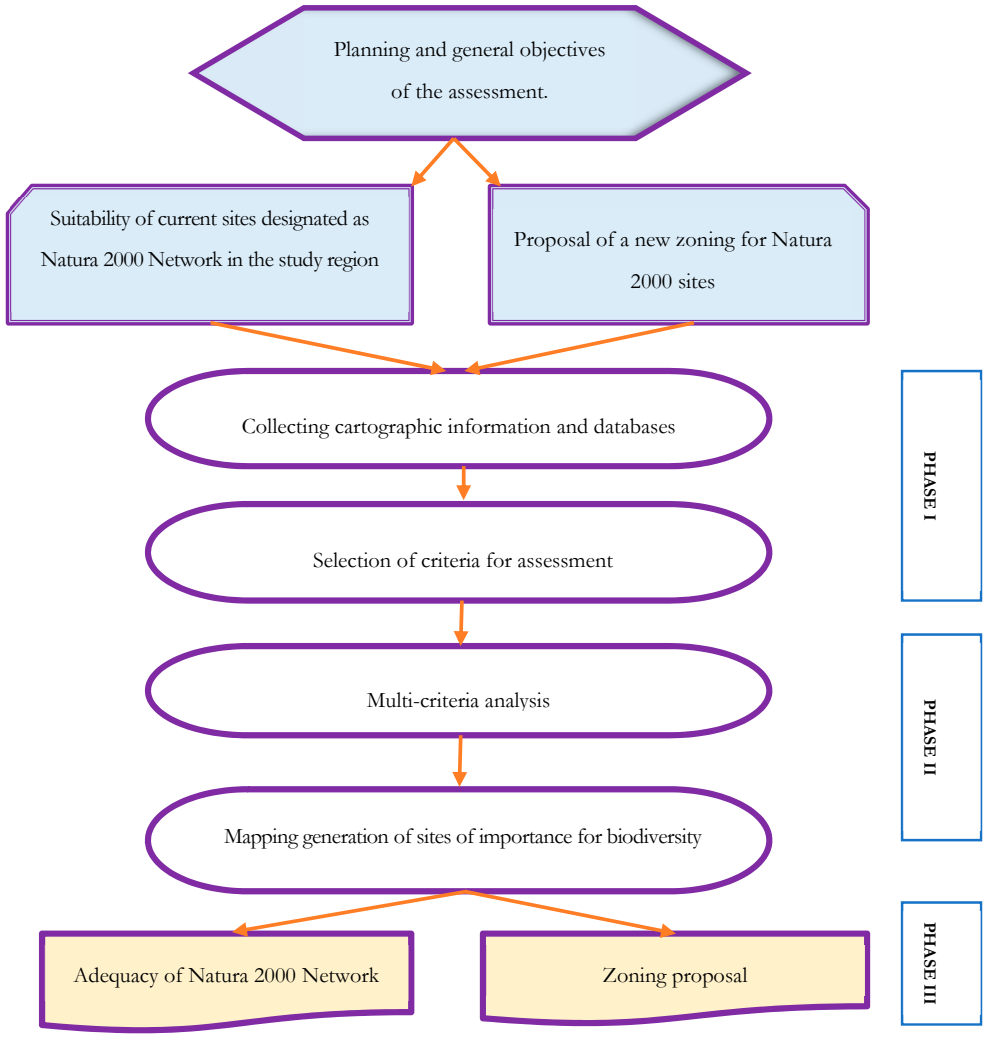

Figure 3. General assessment for the analysis of the adequacy of the Natura 2000 Network.

Through these criteria we will rate biodiversity, based in a defined scale whose final aim is to provide a qualified selection of protected places to include in Natura 2000 Network. The methodological phases are:

Phase I: Criteria selection and Information for the assessment.
Phase II: Analysis and study of areas of importance for biodiversity.
Phase III: Study of the adequacy of the current Natura 2000 network and new zoning proposal in the study area.

2.2.1. Phase I. Criteria Selection and Information for the Assessment

Protected Habitats listed in the Habitats Directive (Directive 92/43/EEC) [4] has been included for the analysis. The species included in Annex II were also used to analyse endangered species within

the study areas. Moreover, sites listed in the Bird Directive (Directive 79/409/EEC) [5] were included in this inventory. Corine Land Cover 2012 [41] and SIOSE Land Cover [42] provided information about the land use (excluding the artificial uses). National Biodiversity Inventory (NBI) was used to include information relating vertebrate species. A 10 ×10 km grid corresponding to the NBI grid has been used to relate all these variables.

The following databases were analysed to implement the proposed assessment, according to Figure 3 and Table 1.

- Protected habitats of the Habitats Directive: habitats from the Annex I of Habitats Directive were identified (habitats of community interest and priority habitats of community interest). Criteria 4a and 4b.
- Protected species of the Habitats Directive: protected species under Annex II of this Directive were discussed. Criteria 3b, 3c, 3d, 3e.
- Protected species of the Birds Directive: Directive 79/409/EEC on the conservation of wild birds [5]. The inventory of protected birds registered in Annex I was used. Criterion 3b.
- CORINE Land Cover 2012 (CLC 2012) [41] and SIOSE Land Cover [42] provide information on land use coverage at European and national level. Criterion 5. Land uses in artificial surfaces were excluded: Urban areas, industrial, commercial and transport, areas of mining, landfills and construction and nonagricultural artificial greenery areas, because they do not have a high value for conservation. CLC 2012 and SIOSE data recorded in agricultural areas were used: arable land, permanent crops, pastures and meadows and heterogeneous agricultural areas; forest areas with natural vegetation and open spaces: forests, shrubbery spaces and/or herbaceous, open spaces with little or no vegetation; wetlands: continental wetlands; and water surfaces: inland waters.
- National Biodiversity Inventory (NBI) [43]: All information classified as vertebrate's wildlife. The vertebrate groups were mammals, reptiles, fish, birds and amphibians; in the national inventory of biodiversity they are related to a grid of 10 km × 10 km, and they constitute very relevant criteria for determining species richness in the study area, determined by the presence of species in the grid. Criteria 1a, 1b, 1c, 1d, 1e and 1f.
- National Catalogue of Endangered Species (NCES) [44]: categories whose members face the threat of extinction: critically endangered (CR), endangered species (EN) and vulnerable species (VU) were considered. Criteria 2a, 2b, 2c, 2d, 2e and 2f.

Selection of Criteria for Assessment

In this phase we try to analyse main criteria to identify the most appropriate location for protection under Natura 2000 network according to its biodiversity value. The selected criteria were defined based on the indicators which allow biodiversity assessment of a site upon the information gathered.

The selected criteria and its description are displayed on Table 1.

2.2.2. Phase II. Analysis and Study of Areas of Importance for Biodiversity

The main objective of the second phase is to analyse and process the information through a multicriteria analysis, and to map the results obtained from it, generating a map of Value of Importance for Biodiversity (VIB).

Multicriteria analysis aims to set a VIB which would work as valid criteria to be considered for decision-making in biodiversity conservation. First, an assessment of each criterion by a group of experts has been carried out, which concludes with the generation of an ordinal scale, grading criteria in descending order (1 to 5) having 1 the lowest in biodiversity importance and 5 the highest. The experts were selected among those responsible for decision-making and academic staff in the selected regions, so they could boost their decision to objectively assess each criterion.

Table 1. Criteria and indicators for identifying suitable areas in Natura 2000 Network.

Criterion	Name	Indicator
1a	Amphibian fauna	Amphibians species in the 10 km × 10 km grid of NBI compared to the total amphibians (%).
1b	Birdlife	Birds species in the 10 km × 10 km grid of NBI compared to the total of birds (%).
1c	Mammals	Mammals species in the 10 km × 10 km grid of NBI compared to the total mammals (%).
1d	Fishes	Fishes species in the 10 km × 10 km grid of NBI compared to the total fishes (%).
1e	Reptiles	Reptiles species in the 10 km × 10 km grid of NBI compared to the total reptiles (%).
1f	Total Fauna	Presence of wildlife total of 10 km × 10 km grid of NBI compared to the total species; expressed in %.
2a	NCES Amphibian	Number of amphibian species included in the NCES as endangered species "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
2b	NCES Birdlife	Number of bird species including the endangered species NCES as "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
2c	NCES Mammals	Number of species of mammals included in the NCES as endangered species "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
2d	NCES Fish	Number of fish species including the endangered species NCES as "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
2e	NCES Reptiles	Number of species of reptiles included in the NCES as endangered species "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
2f	NCES Total	Number of Animals included in the NCES as endangered species "critically endangered" or "endangered and/or vulnerable" in the 10 km × 10 km grid of NBI.
3a	Amphibian Habitats Directive Annex II	Number of amphibians listed in Annex II of the Habitats Directive within the 10 km × 10 km grid of NBI.
3b	Birds Directive	Number of Birds listed in the Birds Directive within the 10 km × 10 km grid of NBI.
3c	Habitats Directive Annex II Mammals	Number of mammals listed in Annex II of the Habitats Directive within the 10 km × 10 km grid of NBI.
3d	Fish Habitats Directive Annex II	Number of fishes listed in Annex II of the Habitats Directive within the 10 km × 10 km grid of NBI.
3e	Habitats Directive Annex II Reptiles	Number of reptiles listed in Annex II of the Habitats Directive within the 10 km × 10 km grid of NBI.
4a	% Of habitats protected of Community priority interest	Area of habitats of priority community interest in relation to the surface of the 10 km × 10 km grid of NBI (%).
4b	% Protected Habitats of Community Interest	Area of habitats of community interest in relation to the surface of the 10 km × 10 km grid of NBI (%).
5	Shannon index	Shannon biodiversity index at the base of CLC 2012 and SIOSE with 10 km × 10 km grid of NBI.

The multicriteria analysis is used through the simple attribute utility theory method, called the Additive Model [45]. With this method, a utility function that represents the preferences of the decision-maker is constructed from utility functions for each attribute by means of Equation (1).

$$VIB = p_1u_1(x_{i1}) + p_2u_2(x_{i2}) + \ldots + p_nu_n(x_{in}) \quad (1)$$

where,

- p_n = weights
- u_n = subjective utilities;
- x_{ij} = actions that are under analysis.

This method is a straightforward system where the functions used can transform performance data of the alternatives concerning the criteria (objective/subjective–qualitative/quantitative) in a common dimensionless scale where the best alternative will be the one with the highest value function. This method intends to obtain a value for each surface's importance regarding the weighted grids for all the analysed variables.

Every expert has weighted each criterion, in order to generate a Value of Importance for Biodiversity (VIB) according to the selected criteria (Table 1). VIB is developed through a factor based of different importance; therefore, a certain gradation is given to each of them that will highlight some criteria for the final suitability of the set objective.

This assessment seeks to express the preferences of the experts on the set of criteria or attributes in terms of importance for biodiversity. It is a model of preferences aggregation based on individual criteria where global preferences are modelled. Given the weight of each criterion in the assessment, we proceeded to weight each criterion and determine the Value of Importance for Biodiversity (VIB), which is obtained as the sum of the weighted values.

Table 2 shows the weights obtained for each criterion, these weights are the average values of all scores awarded by each expert for each criterion.

Table 2. Weight obtained for each criterion.

Criterion	Name	Weight
1a	% Amphibian fauna	0.034
1b	% Birdlife	0.035
1c	% Wildlife mammals	0.036
1d	% Wildlife fish	0.032
1e	% Wildlife Reptiles	0.034
1f	% Total Fauna	0.042
2a	NCES Amphibian	0.035
2b	NCES Birdlife	0.035
2c	NCES Mammals	0.035
2d	NCES Fish	0.035
2e	NCES Reptiles	0.035
2f	NCES Total	0.05
3a	Amphibian Habitats Directive Annex II	0.033
3b	Birds Directive	0.036
3c	Habitats Directive Annex II Mammals	0.036
3d	Fish Habitats Directive Annex II	0.031
3e	Habitats Directive Annex II Reptiles	0.035
4a	% Of habitats protected of Community priority interest	0.115
4b	% Protected Habitats of Community Interest	0.095
5	Shannon index	0.181
Total		1

Creating a Map of Importance for Biodiversity

The goal is to generate a map where the locations with the highest VIB values are highlighted. This will be obtained by means of the VIB value obtained by the weighting of the proposed criteria, through the interpolation of the data with the least squared error. This step of the second phase is

achieved by assigning centroids to each of the 10 × 10 km grids of the NBI, which contain the values of importance for biodiversity. The centroids are the geometric centres of the figures, and allow us to perform an interpolation that generates new points, which allow us to perform a deeper analysis regarding the distribution of the VIB in the different areas of study. This interpolation will enable the generation of the maps. To do this, three interpolation methods have been compared to study which one best suits our needs better [46].

2.2.3. Phase III: Study of the Adequacy of the Current Natura 2000 Network and New Zoning Proposal in the Study Areas

Within this third phase, the main objective is to verify the suitability of the current Natura 2000 network in the three study regions with respect to the results of the second phase, and to develop strategies to improve the Natura 2000 network, proposing a new zoning based on the combination of VIB and land uses of the territories under study (CORINE and SIOSE Land covers).

Adequacy of the Natura 2000 Network

The analysis of the adequacy of the Natura 2000 network is carried out using the VIB of the study areas. For this, the maps of protected zones and the map of VIB are superimposed, which allows to obtain the VIB mean value of each SCIs and SPAs in Castilla y León, Andalucía and Madrid (Appendix A). This analysis will allow to know the current state of the SCIs and SPAs through the criteria defined in the second phase that originated the VIB, allowing to know the suitability of the current protected zones, in order to be able to present a new proposal of zoning for conservation.

Zoning Proposal

In order to develop the new Natura 2000 zoning, the areas with higher values of VIB are combined with the current land uses (CLC 2012 and SIOSE), erasing the urban-industrial covers, since they are not important for biodiversity conservation.

Quartiles of the VIB are determined, which allows a classification of the distribution of the VIB in each of the land use polygons in the areas of study. In this way, these polygons will be classified following a classification of 4 levels of protection, considering the criteria for the conservation of the biodiversity and the land uses suitable for that conservation.

3. Results and Discussion

3.1. Adaptation of the Natura 2000 Network

By weighting each criterion with the value obtained in Phase I, the value of biodiversity importance (VIB), which is achieved with the sum of the weighted values of all criteria grids was determined; these values are those that analyse the areas of greatest relevance to biodiversity conservation of the study area.

With the VIB obtained in the calculation of weighting of the criteria, a 10 km × 10 km grid of Andalucía, Castilla y León and Madrid regions with the VIB values is generated. In order to develop a clear and homogeneous assessment, we proceed to apply an interpolation method in which data is optimised, and where we obtain a more appropriate model to be adopted. In order to perform the interpolation process, we determined the centroids (points that measure the geometric centre of each grid); they have a VIB value that allows the interpolation method to distribute the values on the map and have a clearer outcome of the areas with the value of importance for biodiversity.

Given the VIB of each grid and having defined the centroids, we proceeded to determine the most appropriate method of interpolation to process values. Therefore, to define the optimal method that would make decisions based on the results, different interpolation models were proposed and a comparative analysis was performed in order to select the model that best fits the objective of this work. Two deterministic methods were used as interpolation models—inverse distance weighting (IDW) and the radial basis function—as well as the geostatistical method Kriging.

The choice of these three interpolators was based on the following considerations.

1. The IDW method uses the measured values surrounding the place of prediction, to predict a value for any other unsampled place, based on the assumption that things that are closer are more alike than those that are more separate; therefore, it is considered a suitable method because the values generated are close to reality.
2. The method of radial basis function uses five basic functions to process each value of the measured sample, thereby creating an accurate surface interpolation. It is also relevant to this case.
3. The Kriging geostatistical method is a method that estimates points by model histograms for data collection. It calculates the weights given to each reference point used in the assessment, and it is based on the premise that the spatial variation continues with the same pattern; thus, being an interpolation method for determining relevant values in different parts of the different areas.

The three methods provide pertinent information to develop a distribution map of values; however, Kriging was the selected method because of its lower value of mean square error compared with the other methods (7.1688). Kriging uses statistical models that allow a variety of output surfaces including predictions, standard errors of prediction, probability and quantiles.

With the defined interpolation method (kriging) a map called Map of value of importance for biodiversity (VIB) was created, which is overlapped with the map of Natura 2000 sites (see Figure 4). This map produces a comparison between the values of importance for biodiversity (generated previously with the multicriteria analysis) and the current allocation of protected Natura 2000 sites. This allows checking the suitability of the spaces according to the criteria defined in this work as relevant, also we can consider this as the first step to initiate a zoning proposal in which places with very high VIB are included and are not currently covered by the Natura 2000 Network.

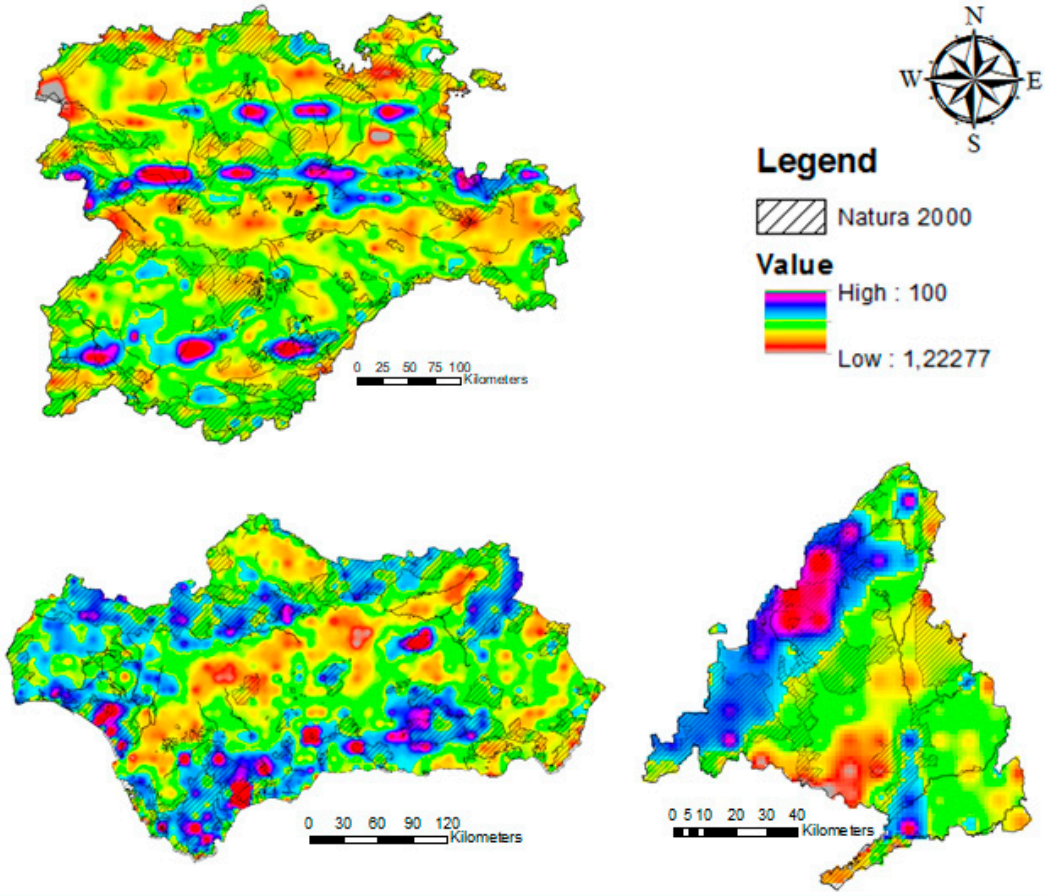

Figure 4. Map of Importance for Biodiversity (VIB).

3.2. Zoning Proposal

The zoning proposal expects to consider in a special way places with high VIB which are consistent with land use (CLC 2012 and SIOSE), in order to classify areas according to their biodiversity conservation importance, improving management mechanisms.

To develop this zoning proposal, we join the VIB map with database of land use CLC 2012, where the values are grouped into quartiles. In order to classify VIB into groups of importance, quartiles for these values were generated, which are associated with the polygons of the land uses base, and thus consider the importance of each space, which is at the same time consistent with land use, because a zoning proposal cannot be isolated from the territorial distribution of the study area.

After joining the VIB with land uses, we proceed to order the resulting polygons according to the code given in the nomenclature of the CLC 2012 and VIB, obtaining a first classification, grouped by VIB quartiles and land uses. This step allows us to gather information about the areas of the territory and to grant importance for biodiversity based on the most suitable land uses.

Having defined this classification, the degree of importance of each of the polygons is determined by its VIB. This allows us to set levels of protection (Table 3), which are grouped by the type of protection and where the level is determined by the different classifications of land use. By determining levels of protection, we can group zones according to their value, with the aim of making zoning proposals depending on the characteristics of importance for biodiversity in the study area. In addition, it must be said that levels are guidelines for determining various zoning proposals that can be very exclusive or flexible depending on the combination of zones and their respective valuation.

Table 3. Zoning levels.

Corine Code	Description (Corine Code/VIB)	Protection Classes	Protection Level			
			0	1	2	3
211	Non-irrigated arable land/VIB 4th quartile	1a1				X
211	Non-irrigated arable land/VIB 3rd quartile	2a1			X	X
211	Non-irrigated arable land/VIB 2nd quartile	3a1		X	X	X
211	Non-irrigated arable land/VIB 1st quartile	4a1	X	X	X	X
212	Permanently irrigated land/VIB 4th quartile	1a2				X
212	Permanently irrigated land/VIB 3rd quartile	2a2				X
212	Permanently irrigated land/VIB 2nd quartile	3a2		X	X	X
212	Permanently irrigated land/VIB 1st quartile	4a2	X	X	X	X
221	Vineyards/VIB 4th quartile	1a3				X
221	Vineyards/VIB 3rd quartile	2a3				X
221	Vineyards/VIB 2nd quartile	3a3		X	X	X
221	Vineyards/VIB 1st quartile	4a3	X	X	X	X
222	Fruit trees and berry plantations/VIB 4th quartile	1a4				X
222	Fruit trees and berry plantations/VIB 3rd quartile	2a4				X
222	Fruit trees and berry plantations/VIB 2nd quartile	3a4		X	X	X
222	Fruit trees and berry plantations/VIB 1st quartile	4a4	X	X	X	X
223	Olive groves/VIB 4th quartile	1a5				X
223	Olive groves/VIB 3rd quartile	2a5				X
223	Olive groves/VIB 2nd quartile	3a5		X	X	X
223	Olive groves/VIB 1st quartile	4a5	X	X	X	X
231	Pastures/VIB 4th quartile	1a6				X
231	Pastures/VIB 3rd quartile	2a6			X	X
231	Pastures/VIB 2nd quartile	3a6		X	X	X
231	Pastures/VIB 1st quartile	4a6	X	X	X	X
241	Annual crops associated with permanent crops/VIB 4th quartile	1a7				X
241	Annual crops associated with permanent crops/VIB 3rd quartile	2a7			X	X
241	Annual crops associated with permanent crops/VIB 2nd quartile	3a7		X	X	X
241	Annual crops associated with permanent crops/VIB 1st quartile	4a7	X	X	X	X
242	Complex cultivation patterns/VIB 4th quartile	1a8				X
242	Complex cultivation patterns/VIB 3rd quartile	2a8			X	X
242	Complex cultivation patterns/VIB 2nd quartile	3a8		X	X	X
242	Complex cultivation patterns/VIB 1st quartile	4a8	X	X	X	X

Table 3. *Cont.*

Corine Code	Description (Corine Code/VIB)	Protection Classes	Protection Level 0	1	2	3
243	Land principally occupied by agriculture, with significant areas of natural vegetation/VIB 4th quartile	1a9				X
243	Land principally occupied by agriculture, with significant areas of natural vegetation/VIB 3rd quartile	2a9			X	X
243	Land principally occupied by agriculture, with significant areas of natural vegetation/VIB 2nd quartile	3a9		X	X	X
243	Land principally occupied by agriculture, with significant areas of natural vegetation/VIB 1st quartile	4a9	X	X	X	X
244	Agro-forestry areas/VIB 4th quartile	1a10				X
244	Agro-forestry areas/VIB 3rd quartile	2a10			X	X
244	Agro-forestry areas/VIB 2nd quartile	3a10		X	X	X
244	Agro-forestry areas/VIB 1st quartile	4a10	X	X	X	X
311	Broad-leaved forest/VIB 4th quartile	1b1				X
311	Broad-leaved forest/VIB 3rd quartile	2b1			X	X
311	Broad-leaved forest/VIB 2nd quartile	3b1		X	X	X
311	Broad-leaved forest/VIB 1st quartile	4b1	X	X	X	X
312	Coniferous forest/VIB 4th quartile	1b2				X
312	Coniferous forest/VIB 3rd quartile	2b2			X	X
312	Coniferous forest/VIB 2nd quartile	3b2		X	X	X
312	Coniferous forest/VIB 1st quartile	4b2	X	X	X	X
313	Mixed forest/VIB 4th quartile	1b3				X
313	Mixed forest/VIB 3rd quartile	2b3			X	X
313	Mixed forest/VIB 2nd quartile	3b3		X	X	X
313	Mixed forest/VIB 1st quartile	4b3	X	X	X	X
321	Natural grasslands/VIB 4th quartile	1b4				X
321	Natural grasslands/VIB 3rd quartile	2b4			X	X
321	Natural grasslands/VIB 2nd quartile	3b4		X	X	X
321	Natural grasslands/VIB 1st quartile	4b4	X	X	X	X
322	Moors and heathland/VIB 4th quartile	1b5				X
322	Moors and heathland/VIB 3rd quartile	2b5				X
322	Moors and heathland/VIB 2nd quartile	3b5			X	X
322	Moors and heathland/VIB 1st quartile	4b5			X	X
323	Sclerophyllous vegetation/VIB 4th quartile	1b6				X
323	Sclerophyllous vegetation/VIB 3rd quartile	2b6			X	X
323	Sclerophyllous vegetation/VIB 2nd quartile	3b6		X	X	X
323	Sclerophyllous vegetation/VIB 1st quartile	4b6	X	X	X	X
324	Transitional woodland-shrub/VIB 4th quartile	1b7				X
324	Transitional woodland-shrub/VIB 3rd quartile	2b7				X
324	Transitional woodland-shrub/VIB 2nd quartile	3b7			X	X
324	Transitional woodland-shrub/VIB 1st quartile	4b7			X	X

Four levels of protection were defined (Table 3), which vary from 0 to 3, with level 0 as the most exclusive, because it determines the spaces with higher VIB (VIB first quartile), and level 3 the most flexible, because it considers more areas as spaces for biodiversity conservation with VIBs in the last quartile. Each of the levels of protection overlaps with the map of Natura 2000 and is presented as zoning proposal (Figures 5–7).

On the map, zoning proposals are interpolated by the level of importance. We can see that there are areas of great importance with very high VIB that are not currently listed as protected areas of Natura 2000, as well as some areas that are currently part of Natura 2000 network, not being classified with high VIB in the results obtained with the evaluated criteria in the assessment proposed in this work. However, each of the proposals has been based on biodiversity criteria and allows a clear view of the areas of greatest importance to the different regions in conservation and environmental protection terms, thus enabling developing management plans appropriate for each one of the SCIs, since there are clear and homogeneous classification criteria.

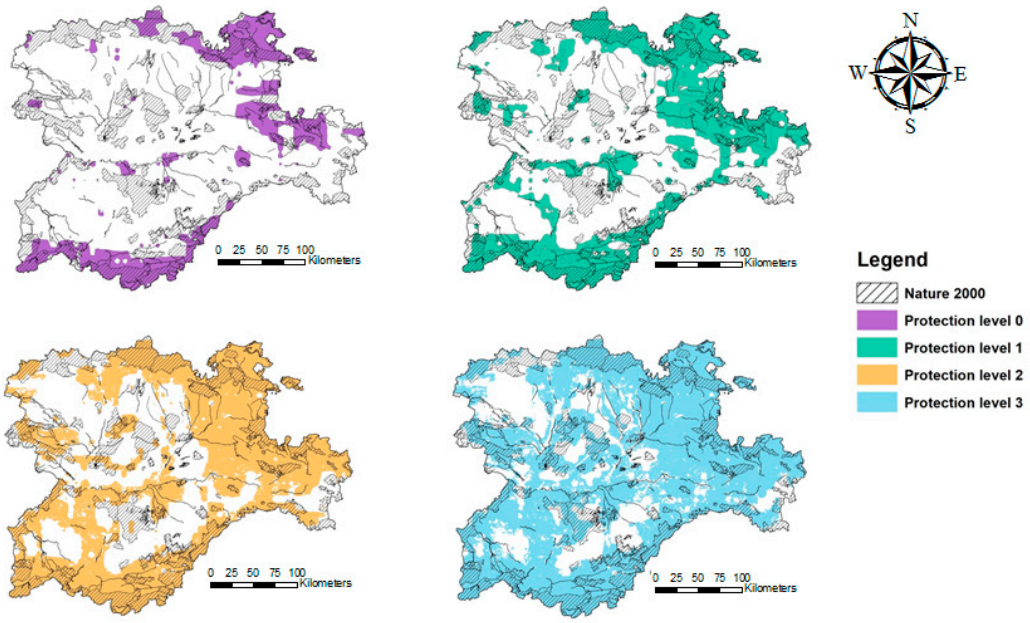

Figure 5. Map of proposed zoning levels of biodiversity conservation importance for Castilla y León region. Protection level 0 is the highest.

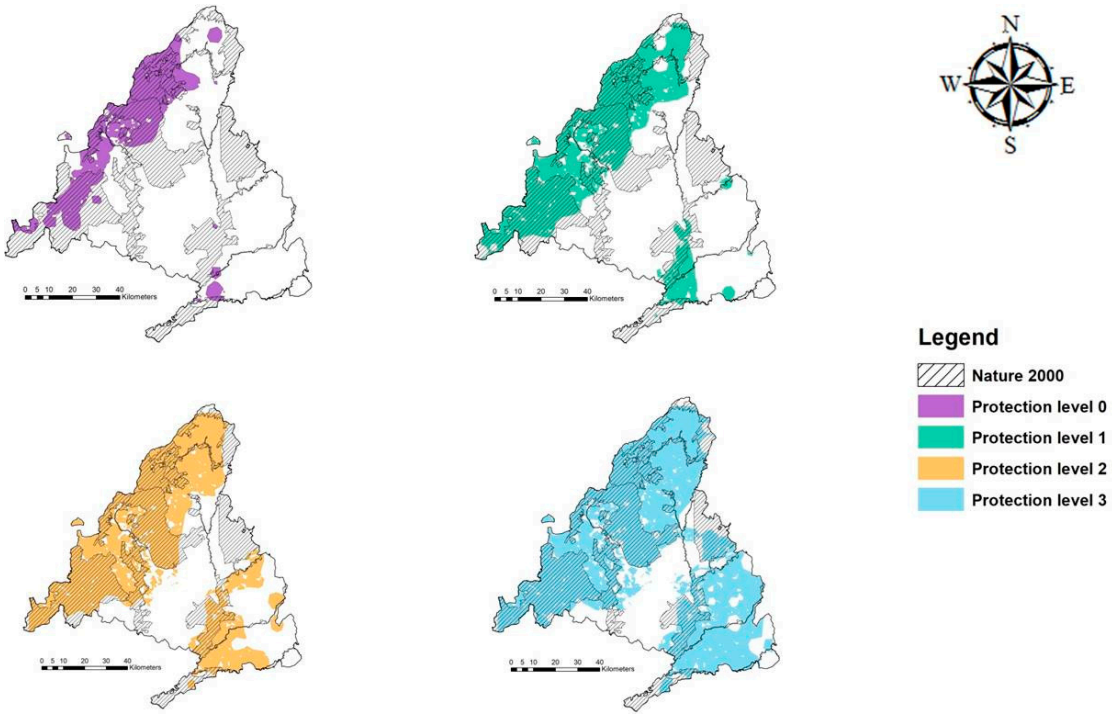

Figure 6. Map of proposed zoning levels of biodiversity conservation importance for Madrid region. Protection level 0 is the highest.

Table 4 and Figure 8 allows us to compare the Natura 2000 Network surface with the zoning proposal surface. According to the data, in Madrid, as well as in Castilla y León, the protected sites that are added are greater than the surface that is currently protected. Most notably, the new protected surface in Castilla y León is twice the current protected surface, so with the zoning proposal, this region would have three times the current protected area. The least significant change is in Andalucía with over 1,600,000 additional hectares.

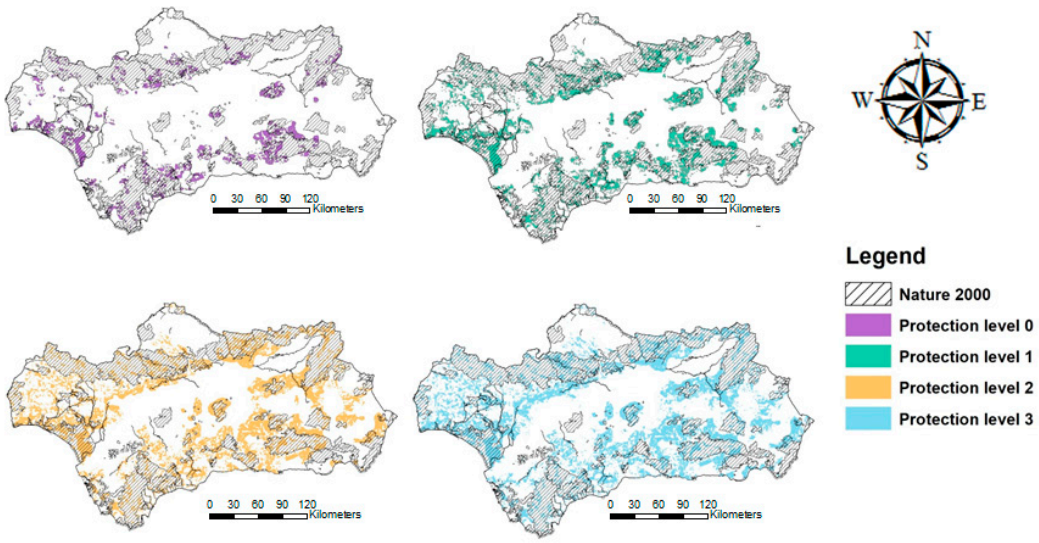

Figure 7. Map of proposed zoning levels of biodiversity conservation importance for Andalucía region. Protection level 0 is the highest.

Table 4. Current and new protected surface.

Region	Current Protected Area—Natura 2000 Network—(Ha) (1)	New Protected Area (Ha) (2)	(1)+(2) (Ha)	(2)/(1) (%)
Andalucía	2,573,200	1,649,600	4,222,800	64%
Castilla y León	2,341,400	4,867,600	7,209,000	208%
Madrid	316,613	341,510	658,123	108%
Total study area	5,231,213	6,858,710	12,089,923	131%

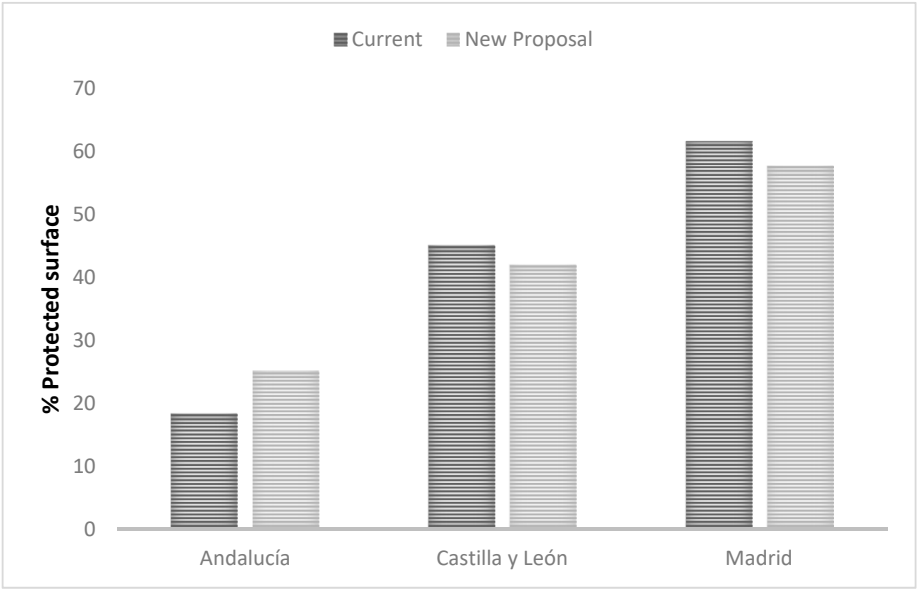

Figure 8. Current VIB vs. new proposal VIB.

Regarding the VIB index comparison between current and new area (Figure 8), for Castilla y León and Madrid, the new index is lower than the previous; however, in Andalucía the new zoning proposal has 6.8 points more than the Natura 2000 Network surface. Additionally, the lowest values on the index are in Andalucía, and the highest are in Madrid. However, it should be noted that the highest biodiversity index belongs to the areas with highest standard errors (Table 5).

Table 5. VIB statistics by region.

Current	**Mean**	**STD**	**Min**	**Max**
Andalucía	18.4	2.9	2.1	100.0
Castilla y León	45.0	4.7	5.9	98.3
Madrid	61.7	9.5	15.7	100.0
Proposal	**Mean**	**STD**	**Min**	**Max**
Andalucía	25.2	2.1	15.1	91.6
Castilla y León	41.9	3.2	5.7	100.0
Madrid	57.6	6.4	22.8	96.4

In order to check this assessment with the current protected areas, the average VIB value was calculated for all the Natura 2000 sites within the study areas. The results are presented in Annex I.

4. Conclusions

The lack of clear guidelines for the selection of protected areas has caused confusion and some errors in determining areas of importance for conservation or places of community interest in member countries of the European Union. However, there are different methodologies from various approaches for establishing optimal criteria of selection. The point of view of this study was the biodiversity conservation, so the results are based on obtaining areas with significantly high value for biodiversity conservation that from homogeneous and coherent criteria and can be analysed and applied in different member countries of the European Union and adopted as a unified assessment for the allocation of protected areas.

Once the multicriteria analysis in the study areas was developed, the suitability of the areas covered by the Natura 2000 Network could be checked. In this sense, we can conclude that the designation of protected areas in the study has a very high approximation to the results on the assessment of biodiversity criteria, therefore there is a zoning close to the optimum, but there are some places of great importance that are not covered and that could be designated as protected areas.

The results obtained in accordance with CLC2012 and SIOSE land cover databases allowed us to develop four zoning proposals considering areas with higher importance value in relation to land use. Some proposals can be adopted according to the level of restriction required or considered as relevant. Also it allows for appropriate management plans and they can be defined as special areas of conservation (SACs).

The proposed assessment is a first step in establishing criteria for zoning and is valuable as a support or justification at the time of decision-making regarding the conservation of biodiversity in specific locations. It is a flexible assessment which can add more criteria that provide a more specific outcome according to the needs of each member country of the European Union, and thus the proposed assessment has a unified method that avoids confusion and mistakes when determining which sites are of community interest and which require special treatment to ensure the conservation of biodiversity and to implement the Habitats and Birds Directives of the European Union.

The importance of the application of this assessment lies in proper land management which contributes to the sustainable development of member countries of the European Union by establishing areas for conservation in order to ensure the natural resources required. Also, it facilitates the compliance with the European politics in the environmental field.

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Appendix A. SCIs and SPAs VIB Values within Natura 2000 Sites in Andalucía, Castilla y León and Madrid Regions

Table A1. SCIs of Andalucía and mean VIB values.

SITE NAME	MEAN VIB
DOÑANA	28.853
MARISMAS DEL ODIEL	27.349
COMPLEJO ENDORREICO DE ESPERA	17.786
LAGUNA DE MEDINA	23.011
COMPLEJO ENDORREICO DE CHICLANA	26.403
COMPLEJO ENDORREICO DEL PUERTO DE STA. MARIA	26.701
COMPLEJO ENDOREICO DE PUERTO REAL	26.487
SIERRA DE GRAZALEMA	29.306
TORCAL DE ANTEQUERA	54.127
LAGUNA DE FUENTE DE PIEDRA	22.704
LAGUNAS DEL SUR DE CORDOBA	20.709
SIERRAS DE CAZORLA, SEGURA Y LAS VILLAS	25.550
SIERRA ALHAMILLA	16.821
CABO DE GATA-NIJAR	14.838
DESIERTO DE TABERNAS	14.312
PUNTA ENTINAS-SABINAR	12.710
LOS ALCORNOCALES	27.200
SIERRA DE HORNACHUELOS	25.659
SIERRA DE ARACENA Y PICOS DE AROCHE	25.844
SIERRA PELADA Y RIVERA DEL ASERRADOR	24.798
SIERRA NORTE	24.505
SIERRA MORENA	22.736
BAHIA DE CADIZ	21.246
ESTRECHO	19.790
SIERRAS DE ALCARAZ Y DE SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	31.226
ALBUFERA DE ADRA	16.064
KARST EN YESOS DE SORBAS	20.327
SIERRA MARIA - LOS VELEZ	21.734
SIERRA DEL OSO	15.963
SIERRA DE CABRERA-BEDAR	18.115
RAMBLAS DE GERGAL, TABERNAS Y SUR DE SIERRA ALHAMILLA	15.821
LA SERRETA DE CABO DE GATA	16.256
SIERRAS DE GADOR Y ENIX	15.618
SIERRA DEL ALTO DE ALMAGRO	20.333
SIERRAS ALMAGRERA, DE LOS PINOS Y EL AGUILON	14.809
CALARES DE SIERRA DE LOS FILABRES	21.317
ARTOS DE EL EJIDO	15.258
COLA DEL EMBALSE DE ARCOS	31.901
COLA DEL EMBALSE DE BORNOS	25.845
MARISMAS DEL RIO PALMONES	29.086
LA BREA Y MARISMAS DEL BARBATE	26.465
FONDOS MARINOS DE BAHIA DE CADIZ	19.269
LAGUNA DE LOS TOLLOS	14.082
SIERRA LIJAR	24.273
LAGUNA DE LAS CANTERAS Y EL TEJON	25.702
ACEBUCHALES DE LA CAMPIÑA SUR DE CADIZ	24.441
PINAR DE ROCHE	14.885
RIO GUADALETE	19.629
CUEVA DE LAS MESAS DE ALGAR	23.763
RIO DE LA JARA	21.427
CUEVAS DE LA MUJER Y DE LAS COLMENAS	28.300
SIERRA DE CARDEÑA Y MONTORO	22.230
SIERRA SUBBETICA	24.420
SIERRA DE SANTA EUFEMIA	21.625

Table A1. *Cont.*

SITE NAME	MEAN VIB
RIO GUADALMEZ	20.195
SUROESTE DE LA SIERRA DE CARDEÑA Y MONTORO	17.722
GUADALMELLATO	22.775
GUADIATO-BEMBEZAR	23.297
TRAMO INFERIOR DEL RIO GUADAJOZ	15.376
RIO ZUJAR	17.030
BARRANCOS DEL RIO RETORTILLO	31.481
RIO GUADALQUIVIR -TRAMO MEDIO	22.064
SIERRA DE BAZA	20.468
SIERRA DE CASTRIL	26.870
SIERRA DE HUETOR	27.161
SIERRA NEVADA	26.265
SIERRAS DEL NORDESTE	23.230
SIERRA DE ARANA	24.868
SIERRAS DEL CAMPANARIO Y LAS CABRAS	21.358
SIERRA DE LOJA	21.402
SIERRA NEVADA NOROESTE	26.695
SIERRA DE BAZA NORTE	22.473
SIERRA DE CASTELL DE FERRO	20.175
LA MALA	20.045
BARRANCOS DEL RIO DE AGUAS BLANCAS	30.851
LAGUNA DEL PORTIL	28.217
ENEBRALES DE PUNTA UMBRIA	18.295
ESTERO DE DOMINGO RUBIO	29.182
LAGUNAS DE PALOS Y LAS MADRES	27.324
MARISMAS DE ISLA CRISTINA	27.201
MARISMAS DEL RIO PIEDRAS Y FLECHA DEL ROMPIDO	20.934
PEÑAS DE AROCHE	24.056
DOÑANA NORTE Y OESTE	26.329
ANDEVALO OCCIDENTAL	21.573
DEHESA DEL ESTERO Y MONTES DE MOGUER	27.216
MARISMAS Y RIBERAS DEL TINTO	28.958
ISLA DE SAN BRUNO	28.506
MARISMA DE LAS CARBONERAS	33.370
RIO GUADIANA Y RIBERA DE CHANZA	19.700
BAJO GUADALQUIVIR	23.634
ARROYO DEL ALAMILLO	24.109
CORREDOR ECOLOGICO DEL RIO TINTO	21.003
DEHESA DE TORRECUADROS Y ARROYO DE PILAS	20.938
ESTUARIO DEL RIO PIEDRAS	23.446
ESTUARIO DEL RIO TINTO	27.834
LAGUNA HONDA	17.075
ALTO GUADALQUIVIR	18.059
CASCADA DE CIMBARRA	24.817
LAGUNA GRANDE	14.266
DESPEÑAPERROS	24.363
SIERRAS DE ANDUJAR	25.403
SIERRA MAGINA	38.914
CUENCAS DEL RUMBLAR, GUADALEN Y GUADALMENA	23.051
ESTRIBACIONES DE SIERRA MAGINA	30.230
TRAMO INFERIOR DEL RIO GUADALIMAR Y ALTO GUADALQUIVIR	16.671
RIO GUADIANA MENOR - TRAMO INFERIOR	19.676
RIO GUADALIMAR	16.343
RIO GUADIANA MENOR - TRAMO SUPERIOR	20.919
LAGUNA DE LA RATOSA	23.571
ACANTILADOS DE MARO-CERRO GORDO	22.763
DESFILADERO DE LOS GAITANES	26.938
LOS REALES DE SIERRA BERMEJA	75.455
SIERRA CRESTELLINA	34.366

Table A1. *Cont.*

SITE NAME	MEAN VIB
SIERRA DE LAS NIEVES	30.447
SIERRAS DE TEJEDA, ALMIJARA Y ALHAMA	27.774
SIERRAS DE ABDALAJIS Y LA ENCANTADA SUR	25.706
SIERRAS DE ALCAPARAIN Y AGUAS	27.038
SIERRAS BERMEJA Y REAL	45.963
SIERRA BLANCA	24.850
SIERRA DE CAMAROLOS	39.448
SIERRA DE MOLLINA	24.146
LAGUNAS DE CAMPILLOS	21.138
VALLE DEL RIO DEL GENAL	39.412
RIO VERDE	27.260
RIO FUENGIROLA	26.077
YESO III, HIGUERONES IX Y EL MARRUBIO	24.212
SIERRA BLANQUILLA	33.263
RIOS GUADALHORCE, FABALAS Y PEREILAS	26.878
COMPLEJO ENDORREICO DE UTRERA	14.277
COMPLEJO ENDORREICO LA LANTEJUELA	14.667
LAGUNA DEL GOSQUE	17.079
SIERRA DE ALANIS	22.855
CORREDOR ECOLOGICO DEL RIO GUADIAMAR	21.533
LAGUNA DE CORIPE	23.507
ARROYO DE SANTIAGO, SALADO DE MORON Y MATABUEYES/GARRAPATA	12.602
RIO CORBONES	18.880
MINAS EL GALAYO Y LA JABATA	29.421
RIO GUADAIRA	20.474
MINA EL ABREVADERO	30.180
VENTA DE LAS NAVAS	21.297

Table A2. SPAs of Andalucía and mean VIB values.

SITE NAME	MEAN VIB
DOÑANA	28.727
MARISMAS DEL ODIEL	27.478
COMPLEJO ENDORREICO DE ESPERA	17.761
LAGUNA DE MEDINA	23.011
COMPLEJO ENDORREICO DE CHICLANA	26.439
COMPLEJO ENDORREICO DEL PUERTO DE STA. MARIA	26.701
COMPLEJO ENDOREICO DE PUERTO REAL	26.242
SIERRA DE GRAZALEMA	29.310
TORCAL DE ANTEQUERA	55.905
LAGUNA DE FUENTE DE PIEDRA	22.799
LAGUNAS DEL SUR DE CORDOBA	20.995
SIERRAS DE CAZORLA, SEGURA Y LAS VILLAS	25.407
SIERRA ALHAMILLA	17.047
CABO DE GATA-NIJAR	14.958
DESIERTO DE TABERNAS	14.391
PUNTA ENTINAS-SABINAR	12.589
LOS ALCORNOCALES	27.181
SIERRA DE HORNACHUELOS	25.669
SIERRA DE ARACENA Y PICOS DE AROCHE	25.858
SIERRA PELADA Y RIVERA DEL ASERRADOR	24.940
SIERRA NORTE	24.519
BAHIA DE CADIZ	21.408
BRAZO DEL ESTE	16.433
EMBALSE DE CORDOBILLA	19.994
EMBALSE DE MALPASILLO	19.517
COMPLEJO ENDORREICO LEBRIJA-LAS CABEZAS	16.689

Table A2. *Cont.*

SITE NAME	MEAN VIB
PEÑON DE ZAFRAMAGON	25.215
ESTRECHO	19.611
ALBUFERA DE ADRA	16.148
KARST EN YESOS DE SORBAS	20.364
SIERRA MARIA - LOS VELEZ	21.713
COLA DEL EMBALSE DE ARCOS	31.901
COLA DEL EMBALSE DE BORNOS	25.584
MARISMAS DEL RIO PALMONES	29.086
LA BREÑA Y MARISMAS DEL BARBATE	26.333
LAGUNA DE LAS CANTERAS Y EL TEJON	25.702
SIERRA DE CARDEÑA Y MONTORO	22.286
SIERRA SUBBETICA	24.366
ALTO GUADIATO	16.555
SIERRA DE CASTRIL	26.740
SIERRA NEVADA	26.340
ESTERO DE DOMINGO RUBIO	29.138
MARISMAS DE ISLA CRISTINA	27.275
MARISMAS DEL RIO PIEDRAS Y FLECHA DEL ROMPIDO	21.274
PEÑAS DE AROCHE	24.144
ALTO GUADALQUIVIR	18.645
CASCADA DE CIMBARRA	25.065
DESPEÑAPERROS	24.398
SIERRAS DE ANDUJAR	25.388
SIERRA MAGINA	39.405
LAGUNA DE LA RATOSA	23.571
ACANTILADOS DE MARO-CERRO GORDO	22.763
DESFILADERO DE LOS GAITANES	27.073
LOS REALES DE SIERRA BERMEJA	76.190
SIERRA CRESTELLINA	35.112
SIERRA DE LAS NIEVES	30.445
SIERRAS DE TEJEDA, ALMIJARA Y ALHAMA	27.677
LAGUNAS DE CAMPILLOS	21.132
COMPLEJO ENDORREICO DE UTRERA	14.277
LAGUNA DEL GOSQUE	17.036
CAMPIÑAS DE SEVILLA	13.457
SIERRAS DE ALCARAZ Y DE SEGURA Y CAÑONES DEL SEGURA Y DEL MUNDO	24.630
SIERRA MORENA	22.837

Table A3. SCIs of Castilla y León and mean VIB values.

SITE NAME	MEAN VIB
PICOS DE EUROPA	51.719
HOCES DEL RÍO DURATÓN	42.199
VALLE DE IRUELAS	59.480
LAGUNAS DEL CANAL DE CASTILLA	35.512
ALTO SIL	31.172
SIERRA DE GREDOS	67.527
PINAR DE HOYOCASERO	55.051
SIERRA DE LA PARAMERA Y SERROTA	43.204
RIBERAS DEL RÍO ALBERCHE Y AFLUENTES	54.878
CAMPO AZÁLVARO-PINARES DE PEGUERINOS	55.172
ENCINARES DE LOS RÍOS ADAJA Y VOLTOYA	38.958
ENCINARES DE LA SIERRA DE ÁVILA	37.394
CERRO DE GUISANDO	57.404
PINARES DEL BAJO ALBERCHE	47.799
VALLE DEL TIETAR	66.315
OJO GUAREÑA	58.552

Table A3. *Cont.*

SITE NAME	MEAN VIB
MONTE SANTIAGO	58.444
MONTES OBARENES	58.991
BOSQUES DEL VALLE DE MENA	56.172
RIBERAS DEL ZADORRA	55.983
RIBERAS DEL AYUDA	54.202
RIBERAS DEL RÍO EBRO Y AFLUENTES	56.750
RIBERAS DEL RÍO NELA Y AFLUENTES	60.450
RIBERAS DEL RÍO RIAZA	37.959
RIBERAS DEL RÍO ARLANZA Y AFLUENTES	45.478
RIBERAS DEL RÍO ARLANZÓN Y AFLUENTES	47.094
RIBERAS DEL RÍO OCA Y AFLUENTES	48.532
RIBERAS DEL RÍO TIR N Y AFLUENTES	42.722
MONTES DE VALNERA	42.648
HOCES DEL ALTO EBRO Y RUDRÓN	58.835
EMBALSE DEL EBRO - MONTE HIJEDO	52.793
SABINARES DEL ARLANZA	51.585
SIERRA DE LA DEMANDA	47.588
HUMADA-PE A AMAYA	47.466
SIERRA DE LA TESLA-VALDIVIELSO	57.326
MONTES DE MIRANDA DE EBRO Y AMEYUGO	54.154
PICOS DE EUROPA EN CASTILLA Y LEÓN	48.341
SIERRA DE LOS ANCARES	41.409
VALLE DE SAN EMILIANO	31.888
HOCES DE VEGACERVERA	35.483
SIERRA DE LA ENCINA DE LA LASTRA	48.711
MONTAÑA CENTRAL DE LEEN	33.388
RIBERAS DEL RÍO ORBIGO Y AFLUENTES	33.523
RIBERAS DEL RÍO SIL Y AFLUENTES	39.595
RIBERAS DEL RÍO ESLA Y AFLUENTES	35.172
MONTES AQUILANOS Y SIERRA DE TELENO	31.253
REBOLLARES DEL CEA	29.699
LAGUNAS DE LOS OTEROS	34.990
OMAUA	23.476
LAS TUERCES	54.277
COVALAGUA	51.122
MONTES DEL CERRATO	29.402
RIBERAS DEL RRO CARRIUN Y AFLUENTES	31.959
RIBERAS DEL RIO PISUERGA Y AFLUENTES	34.902
MONTES TOROZOS Y PSRAMOS DE TORQUEMADA-ASTUDILLO	34.786
LAGUNA DE LA NAVA	36.849
EL REBOLLAR	53.660
RIBERAS DE LOS RAOS HUEBRA, YELTES, UCES Y AFLUENTES	35.614
RIBERAS DEL RSO TORMES Y AFLUENTES	46.816
ARRIBES DEL DUERO	39.626
CAMPO DE ARGAUEN	40.845
CAMPO DE AZABA	44.611
CANDELARIO	65.973
LAS BATUECAS-SIERRA DE FRANCIA	54.966
QUILAMAS	49.242
RIBERAS DEL RSO ALAGDN Y AFLUENTES	47.765
VALLE DEL CUERPO DE HOMBRE	53.777
RIBERAS DEL RRO AGUEDA	40.950
SIERRA DE AYLLON	40.374
SABINARES DE SOMOSIERRA	38.663
LAGUNAS DE COCA Y OLMEDO	43.756
LAGUNAS DE SANTA MARMA LA REAL DE NIEVA	26.397
RIBERAS DEL RÍO DURATAN	36.442
HOCES DEL RÍO RIAZA	53.153

Table A3. *Cont.*

SITE NAME	MEAN VIB
LAGUNAS DE CANTALEJO	31.265
SIERRA DE GUADARRAMA	80.347
VALLES DEL VOLTOYA Y EL ZORITA	37.155
SIERRA DE PRADALES	33.388
SABINARES SIERRA DE CABREJAS	48.355
ONCALA-VALTAJEROS	44.395
CIGUDOSA-SAN FELICES	45.772
SABINARES DE CIRIA-BOROBIA	28.759
SABINARES DEL JALAN	26.114
RIBERAS DEL RÍO DUERO Y AFLUENTES	44.740
SIERRAS DE URBIÓN Y CEBOLLERA	51.124
SIERRA DEL MONCAYO	45.815
PIRAMO DE LAYNA	35.209
CARAN DEL RÍO LOBOS	51.341
QUEJIGARES Y ENCINARES DE SIERRA DEL MADERO	42.114
QUEJIGARES DE GOMARA-NÁJIMA	25.563
ROBLEDALES DEL BERRAN	57.170
PINAR DE LOSANA	38.553
ENCINARES DE TIERMES	43.763
ENCINARES DE SIERRA DEL COSTANAZO	26.417
RIBERAS DEL RÍO CIDACOS Y AFLUENTES	46.760
ALTOS DE BARAHONA	36.659
RIBERAS DE CASTRONUAO	45.147
RIBERAS DEL RÍO CEA	38.718
RIBERAS DEL RÍO O CEGA	40.628
RIBERAS DEL RÍO ADAJA Y AFLUENTES	42.067
SALGREROS DE ALDEAMAYOR	49.404
EL CARRASCAL	39.167
HUMEDALES DE LOS ARENALES	30.778
SIERRA DE LA CULEBRA	38.135
TEJEDELO	40.655
QUEJIGARES DE LA TIERRA DEL VINO	39.903
RIBERAS DEL RÍO TERA Y AFLUENTES	41.110
RIBERAS DEL RÍO ALISTE Y AFLUENTES	25.189
CABONES DEL DUERO	33.345
LAGO DE SANABRIA Y ALREDEDORES	41.550
SIERRA DE LA CABRERA	35.953
RIBERAS DEL RÍO TUELA Y AFLUENTES	27.921
RIBERAS DEL RÍO MANZANAS Y AFLUENTES	28.331
CAMPO ALTO DE ALISTE	36.376
LAGUNAS DE TERA Y VIDRIALES	35.412
LAGUNAS Y PASTIZALES SALINOS DE VILLAFAFILA	36.953

Table A4. SPAs of Castilla y León and mean VIB values.

SITE NAME	MEAN VIB
ENCINARES DE LA SIERRA DE ÁVILA	36.050
CAMPO DE ARGAÑÁN	43.801
CAMPO DE AZABA	45.007
SIERRA DE GUADARRAMA	80.597
ENCINARES DE LOS RÍOS ADAJA Y VOLTOYA	38.558
CAMPO AZÁLVARO-PINARES DE PEGUERINOS	55.297
OTEROS-CEA	42.824
LA NAVA-CAMPOS NORTE	31.487
PENILLANURAS-CAMPOS SUR	28.499
PENILLANURAS-CAMPOS NORTE	33.254
EMBALSE DEL EBRO	54.427

Table A4. *Cont.*

SITE NAME	MEAN VIB
LAGUNAS DE VILLAFÁFILA	34.737
CAÑÓN DEL RÍO LOBOS	51.407
HOCES DEL RÍO DURATÓN	41.848
CERRO DE GUISANDO	57.552
PINARES DEL BAJO ALBERCHE	47.850
MONTES DE MIRANDA DE EBRO Y AMEYUGO	55.702
ALTOS DE BARAHONA	36.642
CANDELARIO	66.748
HOCES DEL RÍO RIAZA	53.084
FUENTES CARRIONAS Y FUENTE COBRE-MONTA	46.888
VALLE DEL TIETAR	66.602
SIERRA DE LOS ANCARES	41.218
ALTO SIL	31.154
VALLE DE SAN EMILIANO	31.745
PICOS DE EUROPA EN CASTILLA Y LEÓN	48.344
PICOS DE EUROPA	51.726
LAGUNAS DE CANTALEJO	31.791
MONTE SANTIAGO	58.763
SIERRA DEL MONCAYO	45.052
QUILAMAS	49.370
SIERRA DE URBIÓN	50.932
HOCES DEL ALTO EBRO Y RUDRAN	58.723
ARRIBES DEL DUERO	39.686
CAMINO DE SANTIAGO	29.984
RÍO AGUEDA	39.279
RÍO ALAGÓN	47.884
LAS BATUECAS-SIERRA DE FRANCIA	54.990
MONTES OBARENES	58.781
HUMADA-PEÑA AMAYA	47.759
SIERRA DE GREDOS	67.570
VALLE DE IRUELAS	59.485
SIERRA DE LA CABRERA	35.524
LAGO DE SANABRIA Y ALREDEDORES	42.774
MONTES AQUILANOS	31.861
SABINARES DEL ARLANZA	51.709
RIBERAS DE CASTRONUÑO	44.873
SIERRA DE LA DEMANDA	47.603
SIERRA DE LA TESLA-VALDIVIELSO	58.157
CAÑONES DEL DUERO	35.765
TIERRA DE CAMPIRAS	31.115
VALLES DEL VOLTOYA Y EL ZORITA	36.295
RIBERAS DEL PISUERGA	37.323
CIHUELA-DEZA	28.725
LA NAVA-RUEDA	34.178
CAMPO DE ALISTE	35.782
PARAMO LEONES	34.528
DEHESA DEL RÍO GAMO Y EL MARGAÑÁN	31.468
OMAGA	23.501
RIBERAS DE LOS RÍOS HUEBRA Y YELTES	35.751
CAMPOS DE ALBA	34.031
VALDEJAMUZ	31.263
TIERRA DEL PAN	33.509
LA NAVA-CAMPOS SUR	33.766
LLANURAS DEL GUARE	33.613
PÁRAMO DE LAYNA	34.305
OTEROS-CAMPOS	33.722
MONTEAGUDO DE LAS VICARBAS	31.210
ALTOS CAMPOS DE GÓMARA	29.682

Table A5. SCIs of Madrid and mean VIB values.

SITE NAME	MEAN VIB
SIERRA DE AYLLÓN	48.797
SIERRA DE GUADARRAMA	85.276
PINARES DEL BAJO ALBERCHE	69.649
CERRO DE GUISANDO	69.536
SIERRA DE SAN VICENTE Y VALLES DEL TIETAR Y ALBERCHE	63.157
YESARES DEL VALLE DEL TAJO	47.419
ESTEPAS SALINAS DE TOLEDO	50.661
CUENCAS DE LOS RÍOS JARAMA Y HENARES	46.560
CUENCA DEL RÍO LOZOYA Y SIERRA NORTE	69.607
CUENCA DEL RÍO GUADALIX	49.473
CUENCA DEL RÍO MANZANARES	66.803
CUENCA DEL RÍO GUADARRAMA	61.619
VEGAS, CUESTAS Y PÁRAMOS DEL SURESTE DE MADRID	52.677
CUENCAS DE LOS RÍOS ALBERCHE Y COFIO	65.729

Table A6. SPAs of Madrid and mean VIB values.

SITE NAME	MEAN VIB
SIERRA DE AYLLÓN	48.564
ESTEPAS CEREALISTAS DE LA CAMPIÑA	45.400
CARRIZALES Y SOTOS DEL JARAMA Y TAJO	38.819
SIERRA DE GUADARRAMA	84.149
ALTO LOZOYA	88.201
ESTEPAS CEREALISTAS DE LOS RÍOS JARAMA Y HENARES	46.142
CAMPO AZÁLVARO-PINARES DE PEGUERINOS	72.296
SOTO DE VIÑUELAS	48.596
PINARES DEL BAJO ALBERCHE	69.649
MONTE DE EL PARDO	56.206
ENCINARES DELOS RÍOS ALBERCHE Y COFIO	65.715
CORTADOS Y CANTILES DE LOS RÍOS JARAMA Y MANZANARES	55.288
CERRO DE GUISANDO	70.084
CARRIZALES Y SOTOS DE ARANJUEZ	46.312

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