Czech University of Life Sciences
Faculty of Environmental Sciences

Nature Conservation

Spatial pattern of bird diversity and community metrics in two protected areas of Northern Spain

Diploma Thesis

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DIPLOMA THESIS ASSIGNMENT

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Thesis title

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Objectives of thesis

The aim of this thesis is to assess the spatial pattern of avian diversity within two protected areas of Northern Spain, characterized by a similar land use composition, comparing the relative effectiveness of each area protecting different components of bird diversity.

Methodology

The study area included two Important Bird Areas (IBA's), Tierra de Campos (42º09'N 5º12'W) and Tierra de Campiñas (41º09'N 5º09'W), which are located in Castilla y Leon administrative area in north-western Spain.

Areas were divided in 10 km x 10 km squares (Figure 6) and birds were surveyed by means of point counts within each squares.

Landscape metrics and avian diversity metrics were estimated for each spatial unit. Were calculated different community metrics as the taxonomic diversity, functional diversity and evolutionary uniqueness in each bird assemblage. Three independent FD measures were used; each of them represents one of the three key components of functional diversity: Functional Richness (FRic) is the amount of functional space occupied by species; Functional Evenness (FEve) measures regularity of abundance distribution along functional space; Functional Divergence (FDiv) measures how far high species abundances are from the center of the functional space.

In this study, Mantel test were used to test for spatial congruence / mismatch between each diversity metric in both protected areas of Spain. For testing normality of data, from both protected areas, a Shapiro-Wilk normality test was used. A parametric test, Student's t test, and a non-parametric test, Wilcox test, were used for comparing different biodiversity metrics in two studied areas.

The proposed extent of the thesis

50

Keywords

Avian diversity; phylogenetic diversity; functional diversity; Natura2000; protected area

Recommended information sources

Albuquerque, F.S., Assunção-Albuquerque, M.J.T., Cayuela, L., Zamora, R., Benito, B.M., 2013. European Bird distribution is “well” represented by Special Protected Areas: Mission accomplished? Biol. Conserv. 159, 45–50. doi:10.1016/j.biocon.2012.10.012

De Albuquerque, F.S., Gregory, A., 2017. The geography of hotspots of rarity-weighted richness of birds and their coverage by Natura 2000. PLoS One 12, e0174179. doi:10.1371/journal.pone.0174179

Devictor, V., Mouillot, D., Meynard, C.N., Jiguet, F., Thuiller, W., Mouquet, N., 2010. Spatial mismatch and congruence between taxonomic, phylogenetic and functional diversity: the need for integrative conservation strategies in a changing world. Ecol. Lett. 13, 1030–1040. doi:10.1111/j.1461-0248.2010.01493.x

Kukkala, A.S., Arponen, A., Maiorano, L., Moilanen, A., Thuiller, W., Toivonen, T., Zupan, L., Brotons, L., Cabeza, M., 2016. Matches and mismatches between national and EU-wide priorities: Examining the Natura 2000 network in vertebrate species conservation. Biol. Conserv. 198, 193–201. doi:10.1016/j.biocon.2016.04.016

Morelli, F., Benedetti, Y., Perna, P., Santolini, R., 2018. Associations among taxonomic diversity, functional diversity and evolutionary distinctiveness vary among environments. Ecol. Indic. 88, 8–16. doi:10.1016/j.ecolind.2018.01.022

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Prague on 09. 04. 2018

Declaration

I hereby declare that the work presented in this thesis is, to the best of my knowledge, original work, except as cited in the text. The research was completed under the direction of Federico Morelli, PhD.

Prague, 2018 Kristina Floigl

Acknowledgment

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Abstract

Aim Since there is a worldwide decline in biodiversity, there is a need to calculate biodiversity metrics in order to better understand which areas should be in focus of protection. By calculating avian diversity metrics, our study aimed to test spatial mismatch between avian diversity within protected areas and which metrics should be in the focus of protection in future conservation plans.

Study area This research presents spatial pattern of bird diversity and community metrics in two protected areas, Tierra de Campos and Tierra de Campiñas, in Spain. Data was collected by ornithologists from SEO, BirdLife International partner in Spain, from middle of April till the end of July during 2012.

Methods For the purpose of the bird survey and data analysis both protected areas were divided into 10x10 kilometres squares, and each spatial unit was surveyed by mean of sample sites, where birds were recorded by point counts. Spatial analyses of the studied areas was performed in ArcGIS and tested by using spatially explicit tests (Mantel test) to explore significant correlations among avian diversity metrics.

Results In 84 sample squares 172 bird species were recorded. Spatial analyses showed that both studied areas are characterized by large coverage of arable land. Results from the research showed bird communities with higher mean evolutionary distinctiveness in the protected area Tierra de Campiñas, and values of higher community evolutionary distinctiveness were found in the forested areas than in areas with arable lands. The results of Mantel test showed only three significant correlations between diversity metrics: bird species richness and community evolutionary distinctiveness; bird species richness and functional richness; functional richness and community evolutionary distinctiveness.

Main conclusions Our study supports the hypothesis that there is mismatch between different avian diversity metrics and then conservationists should take into consideration all of them when assessing the level of protection offered by a protected area. Findings of our study provide valuable information for future conservation plans.

Keywords: *Avian diversity; phylogenetic diversity; functional diversity; Natura2000, protected area*

Abstrakt

Cíl studie Vzhledem k celosvětovému úbytku biodiverzity byli poslední dobou ochránci přírody nuceni sáhnout k výpočtům metriky biodiverzity, aby lépe porozumněli, které oblasti mají být předmětem ochrany. Tato studie se zaměřuje na použitý rozdílných metod na výpočet ptačí diverzity na několika chráněných územích a použití výsledků těchto výpočtů v budoucích plánech ochrany přírody.

Zájmové oblasti Tato výzkumná metoda prezentuje prostorový vzor metriky ptačí diverzity a ptačích společenství na dvou chráněných územích, Tierra de Campos a Tierra de Campiñas, ve Španělsku. Sběr dat byl proveden ornitology z SEO, BirdLife International partner ze Španělska, z druhé poloviny dubna do konce července 2012.

Metoda Pro datovou analýzu byla plocha obou území rozdělena na čtverce o rozloze 10x10 kilometrů, kde každý z těchto čtverců byl analyzován za pomocí metody výběrového průměru, při sčítání ptactva. Prostorová analýza a grafické výstupy byly zpracovány v softwaru ArcGIS. Mantelův test byl proveden v softwaru Rstudio pro zjištění podstatných korelací mezi metrikami ptačí diverzity.

Výsledky V 84 zájmových oblastech bylo zaznamenáno 172 ptačích druhů. Prostorová analýza ukázala, že pro obě území je charakteristická zemědělská půda. Výsledky zkoumání ukázaly, že komunitní vývojová různorodost je vyšší v zalesněných oblastech než v oblastech se zemědělskou půdou. Výsledky Mantelova testu ukazují pouze na tři významné korelace mezi diverzitou: bohatosti ptačích druhů a komunitní evoluční různorodosti; bohatosti ptačích druhů a funkční bohatosti; funkční bohatosti a komunitní evoluční různorodosti.

Závěr Výsledky studie poskytují cenné informace pro budoucí plány ochrany území. Tato studie podporuje hypotézu, kde dochází k rozdílným výsledkům při použití různých metod pro výpočet ptačí diverzity. Ochránci přírody by měli vycházet z kombinace všech těchto výsledků při posuzování chráněného území.

Klíčová slova: *Ptačí diverzita, phylogenická diverzita, funkční diverzita, Natura2000, chráněné území*

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1. Introduction

This section includes introduction and importance of this study.

In the world where human activities are present in most parts, remain only small patches without anthropocentric disturbance such as protected areas (PA). The protected areas networks are a fundamental key as refuges for endangered species and their habitats. Roles of protected areas vary depending in their management strategies, nevertheless all PA share the same aim: To protect biodiversity.

In order to protect biodiversity, conservationists need to assess the state of the same through suitable indices or metrics. In that sense, in this study we calculated some of these metrics on bird assemblages and used them to compare two protected areas in Spain. One studied area is Tierra de Campos which is an Important Bird Area (IBA) and the other studied area is Tierra de Campiñas which is a Natura2000 site under protection of Habitat Directive (Zisenis 2017). This study highlighted the relevance to consider species traits and other components of biodiversity for a better understanding of avian diversity on conservation strategies.

2. Aims of Diploma Thesis

The aim of this thesis was to assess the spatial pattern of avian diversity within two protected areas of Northern Spain, characterized by a similar land use composition. Additionally, comparing the relative effectiveness of each area protecting different components of bird diversity.

3. Literature Review

In this section is information that was obtained during the review of significant literature for the study. Information about biodiversity, different versions of protected areas worldwide and within European Union, and tools used in ecology for measuring biodiversity.

3.1 Biodiversity and its threats

Biodiversity, by the United Nations Convention on Biological Diversity, is defined as 'Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (www.cbd.int). Another worldwide accepted definition of biodiversity is 'biodiversity is the variety of life on Earth at all its levels, from genes to ecosystems, and the ecological and evolutionary processes that sustain it' (Mouchet et al. 2010 in Gaston 1996).

Threats to biodiversity mostly have anthropogenic character; threats that are globally affecting biodiversity are global warming, population growth and resource consumption, habitat loss and invasive species (www.cbd.int). In Europe, the biggest threat to biodiversity is intensification of agriculture, such as creation of monocultures and use of pesticides (ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics). In Spain most of the land-use is agricultural crops, covering over 60% of IBAs. Therefore agriculture has one of the highest impacts on bird species and their breeding sites; around 14% of Spanish IBAs is under threat of agricultural intensification.

The agriculture is a dominant form of land use on the world's terrestrial surface, accounting for more than 40% of land use coverage (Balmford et al., 2005; Lomba et al., 2014). In Europe, agricultural landscapes are artificial mosaics of different land use types, and represent one of the most common habitat. But during the last few decades the agricultural landscapes have been subject to a rapid and large-scale change, caused mainly by the intensification and mechanization of agricultural activities (Chamberlain et al., 2000; Donald et al., 2006, 2001; Geiger et al., 2010; Sanderson et al., 2013; Stoate et al., 2009).

The intensification of farming systems can be explained at two different spatial scales: local scale -e.g. increased use of agrochemicals or pesticides (Geiger et al., 2010) and landscape scale -e.g. destruction of semi-natural and marginal habitats (Benton et al., 2003). By agricultural intensification many components of the landscape as marginal and unproductive elements of farmland (shrubs, isolated trees, and uncultivated patches) are removed. These marginal and unproductive elements of farmland landscapes can be considered key habitats for many birds, for nesting, feeding and refuge (Ceresa et al., 2012; Morelli, 2013; Perkins et al., 2002), as well as providing ecological corridors (Bennett et al., 2006; Reijnen et al., 2008) and to increase and maintain the plant communities diversity (Wierzcholska et al., 2008).

In Spain, the intensified irrigation of crops causes the loss of endangered steppes which are important habitats for example the case of *Otis tarda*, a species listed on *Annex I* of Birds Directive. A threat to bird diversity that is widely spread in Spain is also hunting, which is present in more than 40% of IBAs. Apart from hunting, illegal robbing of eggs and chicks is affecting most of raptor species, for example *Falco peregrinus* (Viada, 2000) which is also listed on *Annex I* of Birds Directive.

3.2 Hotspots of biodiversity

There are several different ways of protecting nature and conserving its ecosystem, such as identifying hotspots of species richness, endemism and areas with species taxonomically unique for the hotspot. One of the approaches that is common worldwide for conservationists is to identify areas with high species endemism and habitat loss, these areas are known as hotspots of biodiversity (Myers et al. 2000). To this day list of global biodiversity hotspots contains 35 areas (Sloan et al. 2014), which have been identified by Myers in a paper published in 2000 and later it was revised by Mittermeier et al. (2004) and Sloan et al. (2014). Criterion to make the list of biodiversity hotspots are (i) area has to include at least 1,500 vascular endemic plants and (ii) have 30% or less than its original vegetation cover (Myers et al. 2000). These strict criteria have been used till today to add more areas to the list of hotspots (Sloan et al. 2014).

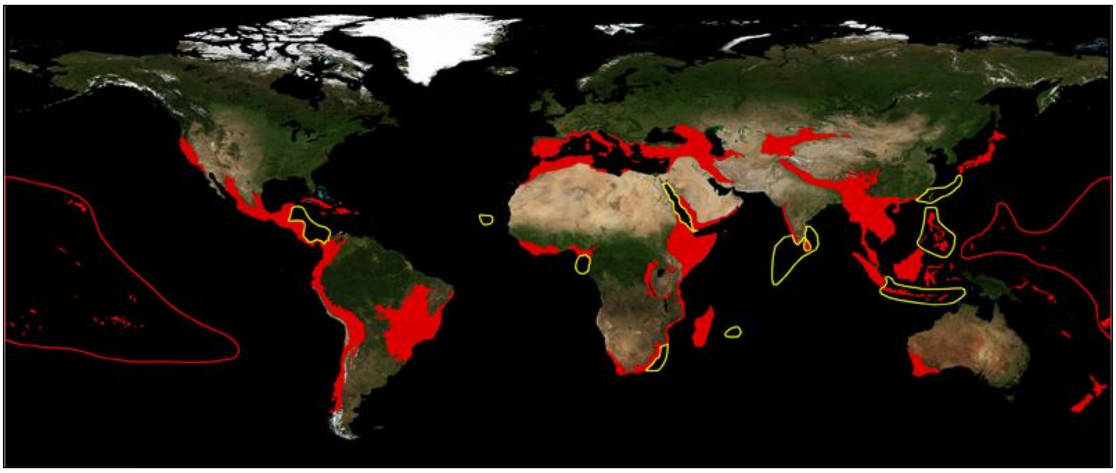

Figure 1 Biodiversity hotspots in the World by Mittermeier. Earth's biodiversity hotspots are shown on this world map. Red shows terrestrial hotspots; yellow shows marine hotspots. (Global landcover map © ESA – MEDIAS France/Postel, http://www.hotspots-e-atlas.eu/)

Mediterranean Basin was added to the list by Mittermeier et al. (1998) as it is a habitat to 4.3% of all plants and 0.9% of all vertebrate species. As Spanish flora consists of 7,500 species and 6,000 of these species are characteristic for Mediterranean climate, most part of Spain is covered by the biodiversity hotspot (Mittermeier et al. 2004).

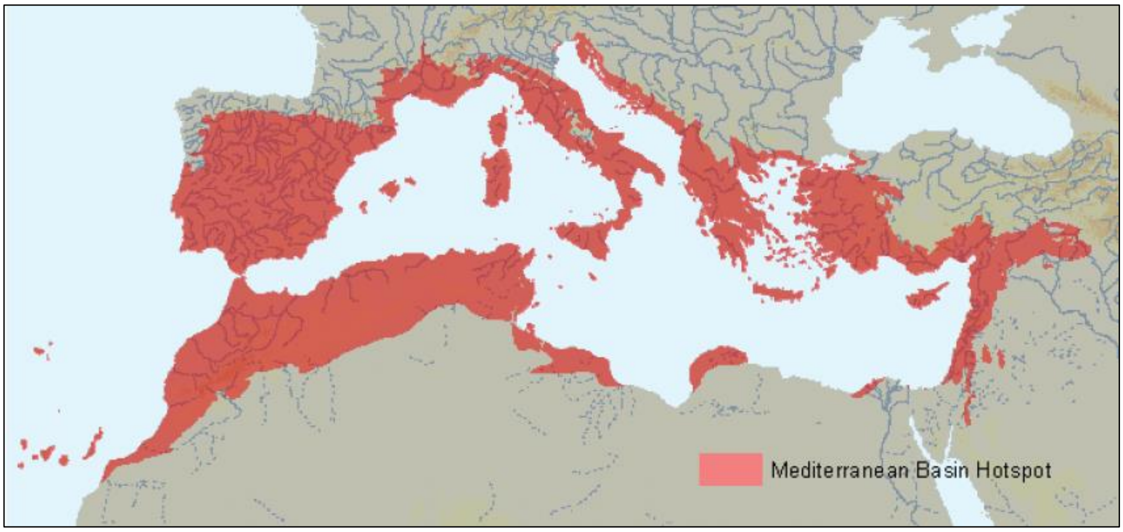

Figure 2 Mediterranean Basin Hotspot of biodiversity (http://www.iucn.org).

3.3 Conservation strategies

A clear definition of protected areas has been given by International Union for Conservation of Nature (IUCN) in 2008. which states that "A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values” (https://www.iucn.org/). Various conservation strategies and categories of protected areas have been proposed by scientists from different backgrounds, depending on their area of interest. There are six categories of protected areas defined by the IUCN. Defined according to the extent of human intervention, management and allowed tourism. From category of Strict Nature Reserves with the lowest level of human intervention, in order to preserve ecosystems, to category of Protected Areas with sustainable use of natural resources where the local community is dependent on the resources from these areas.

In the past decade scientists are proposing an idea of using protected areas as refugia to species from land use change, climate change and global warming. Therefore new management techniques for protected areas have been proposed under climate change (Rannow et al. 2014). This strategy, using protected areas to mitigate climate change caused by human activities was tested by Gaüzère et al. (2016) in France. In the research scientists were tracking changes in bird communities and their population, linked to variations in the climate, within protected areas. Results that they obtained proved that protected areas can help breeding birds as refugia. Another, newly published, research testing similar hypothesis worked in USA. Researchers came to a conclusion that composition of bird species in national parks changed during the years due to environmental changes. Additionally, they propose to managers different strategies. Their prepositions are either to invest into resisting, containing these changes in national parks or actively make ecological changes toward adapting to new conditions (Wu et al. 2018).

Definition of protected areas by the IUCN is only a general framework which has a purpose to help conservationists develop conservation strategies and management on a worldwide, regional and national level (Dudley 2008). A concept, on a worldwide level that has been proposed in the beginning of the ‘90s, called “biodiversity hotspot” recognizes areas with high level of endemism and overall species richness (Myers et al. 2000). Another example of an international conservation strategy, but focusing only on wetlands, is the Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar Convention was signed in 1971 in Ramsar, Iran, and is also known as the Convention on Wetlands. The Convention represents an international treaty between, so far, 169 countries which signed it; there are over 2,000 Ramsar Sites worldwide (Mauerhofer et al. 2015). In order for a wetland to be listed as a Ramsar site it has to be regularly visited by more than 20,000 birds. This criterion indicates the importance of wetlands for bird species as migratory routes and feeding areas (https://www.ramsar.org/, Dauda et al. 2017).

On the other hand, a conservation strategy developed and accepted only within the European Union is Natura 2000 Network of Protected Areas (Ostermann 1998, Maiorano et al. 2007, Rosso et al. 2017).

3.4 Protected Areas Network and Natura2000

Global biodiversity loss is at central focus of United Nations Convention on Biological Diversity (1992), but little has been done to achieve the set goals (Waldron et al. 2017). There are three main goals set by the Convention: 'the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources' (European Environment Agency 2009). The Convention defines biodiversity as a hierarchical notion, with three main organizational levels: genetic, species and ecosystem diversity. Ecosystem diversity is recognized as a composition of species that share habitat, their relationship with both biotic and abiotic factors as well as physical conditions around them (Bonn and Gaston 2005). Thus it is important that landscape and environment are also recognized as conservation priorities.

Biodiversity in Europe is characterized as rich in different biogeographic regions, but these biogeographic regions are threatened by anthropogenic influence (European Environment Agency 2004). Europe’s biodiversity is continuously declining, as recent data has show that 60% of species assessments and 70% of habitats assessments had a less than desirable conservation status (www.eea.europa.eu). The Ecological Network Natura 2000 is protecting both habitats types and species, which makes it different from previous conservation strategies that mainly focused on the protection of species. The protected sites that are included within Natura 2000 are designated according to two directives, which are Bird Directive accepted in 1979 and the most important in Europe, Habitat Directive from 1992. Bird Directive covers specific bird’s habitats as Special Protected Areas (SPAs), as for Habitat Directive it refers to protecting habitats as Special Areas for Conservation (SPCs) (Grodzinska-Jurczak and Cent 2011, Grodziska-Jurczak et al. 2012). Currently Natura 2000 is covering 18% of European continent by protecting 27,312 sites (www.ec.europa.eu).

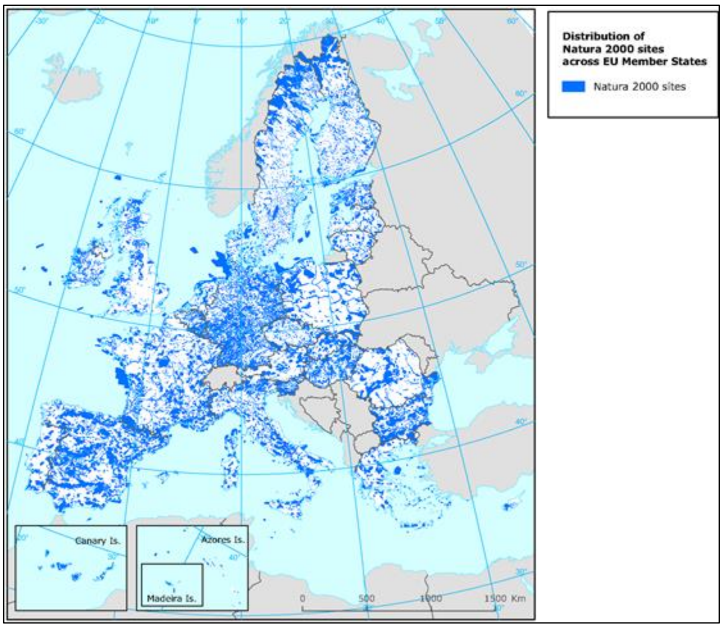

Figure 3 Distribution of Natura 2000 sites across European Union (www.eea.europa.eu).

The Important Bird Areas (IBAs) programme started officially in 1987 within the world's first international conservation organisation - International Council for Birds Preservation found in 1922 in London. Later on this organisation became BirdLife International. The IBAs programme works to develop a global network of protected areas for birds, on EU level these areas are SPAs. The main goal of this programme is identification and classification of areas according to their importance for birds, data collection and filling of databases and taking specific measures of protection. There are more than 10.000 of IBA within 200 countries. The future plan of programme is to identify around 15.000 IBAs within an international network with a purpose to protect birds and their habitats worldwide (www.birdlife.org). There are four criteria for IBAs and they are (i) globally threatened species, (ii) restricted-range species, (iii) biome-restricted species, or (iv) significant single- or mixed-species congregations. These areas are regarded as areas which, if threatened, would significantly affect species of concern (O'Dea et al. 2006).

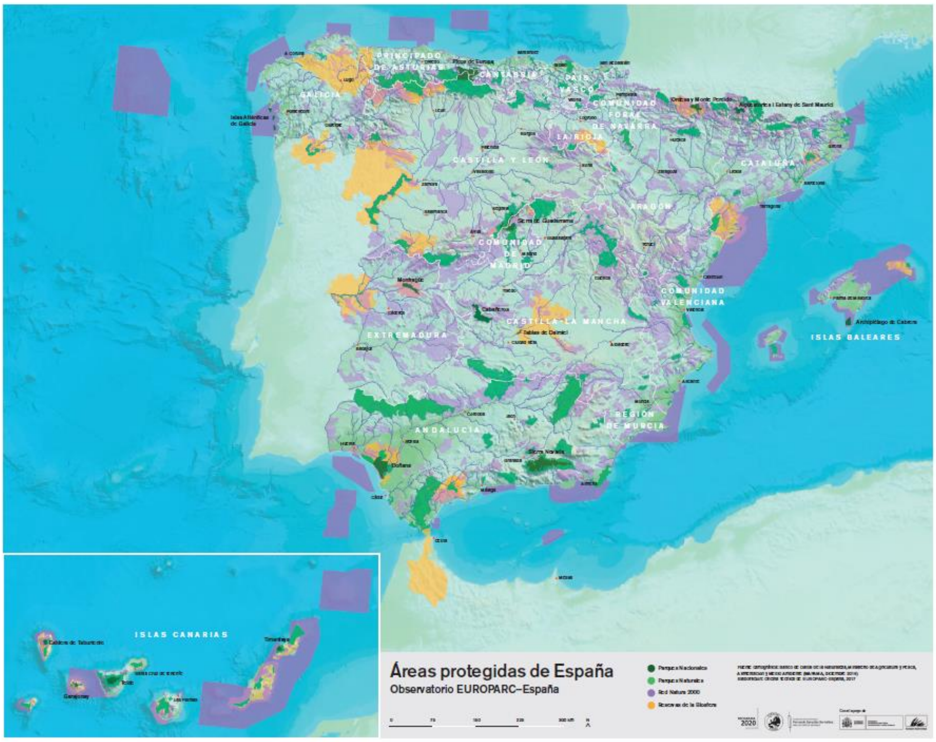

Figure 4 Protected areas in Spain (Banco de Datos de la Naturaleza, Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (MAPAMA, diciembre 2016))

The Spanish Ornithological Society (SEO in Spanish), which a BirdLife partner since 1954, is responsible for IBA programme their main goals remain conservation of birds and their habitats, connecting on an international level with other organizations and obtaining field data (www.birdlife.org). Currently, more than 45% of IBAs in Spain are under national protection areas, but in only around 15% of IBAs is most of the area protected (Viada, 2000). SEO designed more than 450 IBAs in Spain which cover the area of more than 22 thousands of hectares (datazone.birdlife.org/country/spain).

3.5 Importance of farmlands for avian diversity

Agricultural land represents a large portion of European total terrestrial area thus it is one of the most abundant habitats in Europe and 50% of all European species are dependent on this habitat (Zakkak et al. 2015). Farmlands are of breeding and wintering importance for 120 bird Species of European Conservation Concern. The data collected from the Pan-European Common Bird Monitoring Scheme (ebcc.info/pecbm.html) showed that populations of farmland bird species declined in almost 50% since the 1980's. Therefore, it is important to look into the main factors affecting the population decline in farmland bird species across Europe. As it was explained earlier in the text, there are various factors which can influence the population of farmland birds (Boatman et al. 2004, Butler et al. 2010).

3.6 How to measure biodiversity?

Biodiversity, as defined above, is very complex and multidimensional concept which makes it difficult for conservationists to measure it, but it is necessary in order to protect it. Measuring biodiversity has been around since researchers had a need for giving units to biodiversity in order to study it. There are different groups of biodiversity measures; taxonomic diversity (TD), functional diversity (FD) and phylogenetic diversity (PD) (Purvis and Hector 2000, Mouchet et al. 2010).

Taxonomic diversity measures, such as species richness, is proposing that all species and individuals are equal in ecosystem, thus it does not look at functional and evolutionary differences between species in a community (Devictor et al. 2010). Nevertheless, species richness is at focus when calculating TD because it shows the presence of species in a community (Lee and Martin 2017).

Functional diversity is being more recognized as an important biodiversity metric by conservationists. A widely accepted definition that has been proposed by Tilman (2001) states that functional diversity includes components of biodiversity which influence ecosystem functioning. Many definitions of FD have been proposed and most of them are considering living organisms as a functional part of the environment. Since it is connected to the functioning of ecosystem, FD is considered the most important biodiversity measurement as it is the most effective one (Laureto et al. 2015). A very well graphical representation of FD metrics was made by Carmona et al. 2016 (See Figure 5). As an addition to FD, a functional diversity index has been proposed by Zoltan (2005), where he states “this index has been proposed based on the quadratic entropy of Rao that incorporates both the relative abundances of species and a measure of the pairwise functional differences between species”. RaoQ index is presented as a useful tool in research of Ricotta and Moretti (2011), for considering different aspects of functional composition and diversity. Phylogenetic diversity refers to differences in phenotypes, genetic characteristics and behavior between species that belong to different evolutionary lineages. These metrics are getting more attention as complementary metric to species richness, since conservationists consider that loss of evolutionary diversity plays a great role in global extinction rates. Evolutionary distinctiveness (ED) is an important tool used in identifying species and communities which have higher values in terms of evolutionary heritage (Pollock et al. 2015, Pellens and Grandcolas 2016, Tucker et al. 2017).

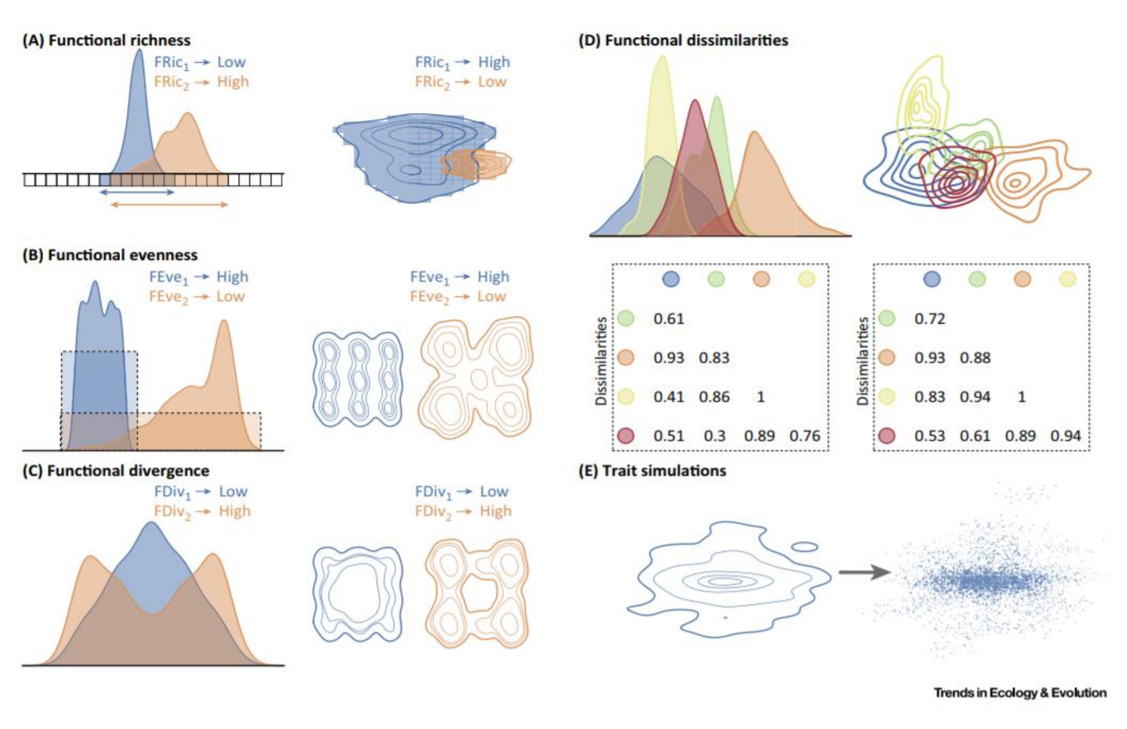

Figure 5 Several Existing Approaches Can Be Incorporated into the Trait Probability Density (TPD) Framework. Functional richness (FRic; A) is the amount of functional volume occupied by a TPD, which can be estimated as the sum of the hypervolumes (or range in the single-trait case) of the cells where TPD is greater than 0, and is therefore independent of species abundances. Functional evenness (FEve; B) is an indicator of evenness in the distribution of abundance within occupied functional trait space. Communities where all trait values have a similar probability should have high FEve values, and vice versa. FEve can be estimated as the overlap between the TPD of the considered unit and an imaginary trait distribution occupying the same functional volume with uniform probabilities throughout. Functional divergence (FDiv; C) is an indicator of the distribution of abundances within the functional trait volume. Communities where the most abundant trait values are near the extremes of the functional volume should have high FDiv, and vice versa. The abundance-weighted distance to the center of gravity of the TPD proposed in [14] can be used as an indicator of FDiv, using calculations based on the relative abundance of individual cells within the TPD instead of on species average trait values and species abundances. Dissimilarity between units (D) can be calculated from overlap between their TPD functions. Finally (E), TPD functions can be used to randomly draw trait values consistent with those present in a given unit (e.g., population, community, and region) (Carmona et al. 2016).

4. Methodology

In this section is description of the study area and data collection. All the equations for calculations of biodiversity and land use metrics. Also spatial and statistical analyses that were performed during the study.

4.1 Characteristics of the study area

The study area (8400 km^2) has included two Important Bird Areas (IBA’s), Tierra de Campos (42º09’N 5º12’W) and Tierra de Campiñas (41º09’N 5º09’W), which are located in Castilla y Leon administrative area in north-western Spain.

Figure 6 Tierra de Campos (Photo: Angel de los Rios) and Tierra de Campiñas (Photo: http://territorionatural.blogspot.cz/2014/02/grullas-avutardas-y-perdices-en-la.html)

One of the study areas, Tierra de Campiñas, is a Special Protected Area (SPA) since 2000, as a part of Natura 2000 network of protected areas (PA). The landscape is characterized mostly by large open spaces with dry-land cereal crops (See Figure 6). Other parts of landscape consist of pine forests, species *Pinus pinea* and *Pinus pinaster*, and *Quercus* rotundifolia. Types of vegetation that also exist in this area, in smaller amount, are dry grasslands and scrublands (http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=ES0000204).

Figure 7 Location of Tierra de Campos (1) and Tierra de Campiñas (2) in Spain (Credit: Angel Vaca Lorenzo).

Mediterranean bioregion is characterized by Mediterranean Temperate climate, where summers are usually warm and dry, while winters are cool with rainfalls (Kottek et al. 2006). Mediterranean Basin is recognized as a hotspot of biodiversity, and it stretches along the cost of Mediterranean Sea. The territory of the hotspot covers most part of Spanish terrestrial area. The main reason for recognizing this area as one of the 34 biodiversity hotspots is a high level of plant endemism and the lowest proportion (less than 5%) of vegetation conserved in its natural form. In Mediterranean Basin the most dominant vegetation are Mediterranean forests, woodlands and shrubs (Mittermeier et al. 2004).

Agriculture presents the most dominant land-use in Spanish IBA's (over 60%) (Viada, 2000). The composition of land-use in the two study areas consists mostly of agricultural area (93%), forest and semi natural area (5.7%), artificial surfaces (1.12%) and water bodies and wetlands which together cover less than 1% of the land. For more detailed land-use composition in each protected area look at Table 1. Agricultural fields are important for overall species diversity since 50% of all European species depend on this habitat (Zakkak et al. 2015). Farmlands in Europe are important as breeding and wintering areas for 120 bird species of European Conservation Concern (Donald et al. 2002 in Tucker and Heath 1994). These habitats are important as breeding and conservation areas for species from *Annex I* list of Bird Directive, such as *Otis tarda*, *Tetrax tetrax* and *Falco naumanni* (Alonso and Alonso 1996, Viada 2000).

4.2 Field work

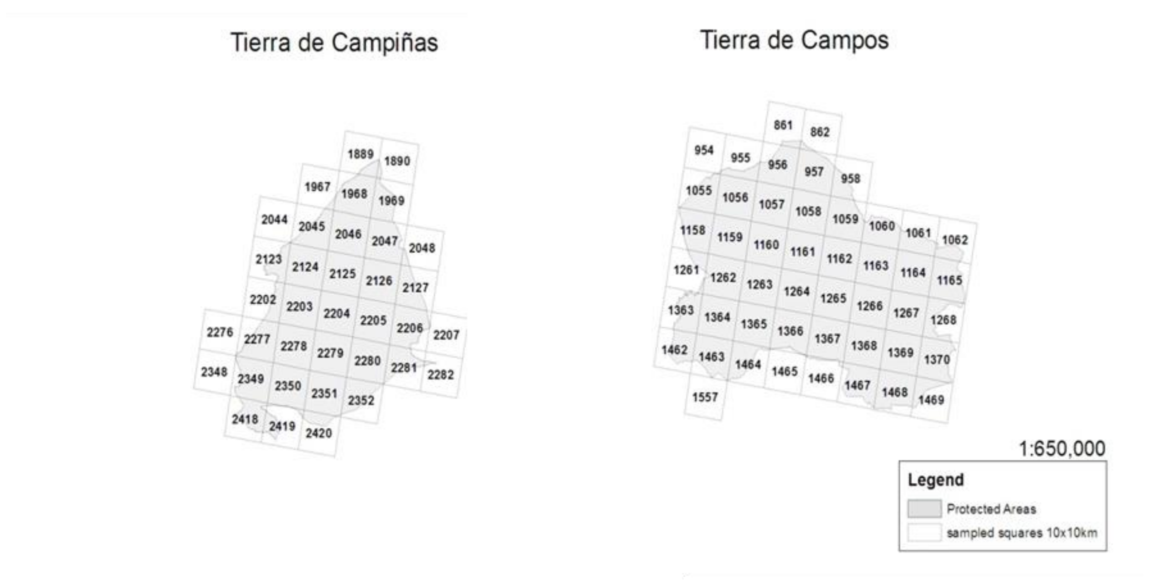

Figure 8 Studied areas Tierra de Campiñas and Tierra de Campos.

Group of ornithologists conducted the survey of birds between mid-April and the end of July during 2012. Areas were divided in 10 x 10 km squares (Figure 8) and birds were surveyed by means of point counts within the 10 km x 10 km squares. Experts visited each point count at least one time, between 6 and 10 a.m., only under good weather conditions. Birds that were detected visually and acoustically within a 100-m radius around the observer were recorded. Owls and other nocturnal species were ruled out the study. Inside each square bird counts were summed and presented as bird communities (SEO/BirdLife 2013).

4.3 Spatial analyses

For spatial analyses, bird point count data from both PAs were entered into ArcGIS 10.4.1. Layer of squares 10 x 10 km was intersected with the layer of land cover downloaded from CORINE Land Cover. CORINE Land Cover (CLC) was used to derive land use types in the squares of research areas. Categories for land-use are divided in five main classes (forest and semi natural areas, water bodies, artificial surfaces, agricultural areas and water bodies). Main classes are divided into two more levels that go into more detailed explanation of the land use. For this particular research second level of division was used for categories, although not all of them were present in the study area. This level consists of 15 different categories, although 2 from these categories are not present in the study area (marine waters and maritime wetlands).

Categories that were present in the study area are shown in the table1. Within each square of the researched areas dominant land use was calculated. CORINE is a national geo-referenced land-cover database, based on satellite digital images for all of Europe (Bossard et al. 2000).

Table 1. Areas (km^2) and percentage of each land use type derived from the CLC in the study areas.

CLC categories	**Tierra de Campos (km2)**	**Percentage (%)**	**Tierra de Campiñas (km2)**	**Percentage (%)**
Arable land	4376.43	91.2	3140.88	87.2
Artificial, non-agricultural vegetated areas	0.27	0.006	0.54	0.015
Forests	109.2	2.3	180.96	5.03
Heterogeneous agricultural areas	139.25	3	61.31	1.7
Industrial, commercial and transport units	12.11	0.25	12.09	0.33
Inland waters	0.91	0.02	9.63	0.3
Inland wetlands	3.87	0.08	0	0
Mine, dump and construction sites	1.54	0.03	2.15	0.06
Open spaces with little or no vegetation	0.84	0.02	0.32	0.009
Pastures	21.08	0.44	27.47	0.8
Permanent crops	12.17	0.25	33.5	0.9
Scrub and/or herbaceous vegetation	88.07	1.8	99.51	2.8
Urban fabric	34.23	0.7	31.63	0.9
Grand Total	*4800*	*100*	*3600*	*100*

4.4 Landscape metrics and diversity indices

Landscape metrics are indices of landscape structure, made primarily for categorical maps. Landscape metrics are used to describe heterogeneity, composition and spatial arrangement of landscape (Walz 2011). These metrics are defined as: algorithms that quantify specific spatial characteristics of patches, classes of patches, or entire landscape mosaics. There are two categories of landscape metrics: the ones that quantify composition of the map without referring to spatial attributes and the ones that quantify the spatial configuration of the map (Ramezani 2012). In this study, edge density and edge density weighted were calculated in order to get better insight into the spatial characteristics of the landscape. Edge density (EDG) is total length of all edge structures in landscape per hectare (Xiao et al. 2016). Additionally, edge density weighted was calculated, which differs from edge density in having the number of different land use types which are present in each square. Both edge density and edge density weighted were calculated for each 10x10 km^2 square. Shannon Diversity Index (SHDI) is the most used index in landscape ecology when studying land use diversity.

This index is used to represent compositional structure of the landscape. With this index abundance and variety of different land use types within landscape can be calculated (Ramezani 2012, Bibi and Ali 2013). The formulas how metrics and index were calculated are shown in the Table 2 (http://www.umass.edu).

Table 2. Formulas and abbreviations for calculation of landscape metrics and diversity index

Landscape metrics	**Formula**	**Abbreviations**
Edge density (EDG)	EDG= E/A	E- Total length of edge in the landscape (m). A- Total landscape area (m2).
Edge density weighted (EDGW)	EDGW= EDG*LU/A	EDG- Edge density. LU- number of different land use types in each square. A- Total landscape area in square meters (m2).
Shannon Diversity Index (SHDI)	$H' = -[\sum Pi*\ln Pi]$	H´ - Diversity Index. Pi- proportion of each land use in the sample. lnPi - natural logarithm of this proportion

The landscape metrics are often associated with the species diversity in a given area. For instance, many studies demonstrated the strong correlation between landscape heterogeneity and the avian diversity in different types of environments (Morelli et al. 2013, 2018b).

4.5 Calculation of taxonomic diversity, functional diversity and evolutionary uniqueness in bird communities

Species richness is commonly used to study the diversity-habitat heterogeneity relationship (Lee and Martin 2017). In this study, taxonomic diversity was measured by bird species richness (BSR). Bird species richness was given as the number of recorded bird species in each square of the study area.

Functional diversity (FD) was calculated for the avian communities within each square of the study area. This study used avian niche traits from Pearman et al. (2014) for calculating functional diversity indices. These calculations were based on traits related to feeding and breeding ecology, considering this information appropriate for characterizing bird communities. The trait table consists of 73 variables that describe the each bird species niche, including variables across 1) body mass (g), 2) food types (13 variables), 3) behavior used for acquiring food (9 variables), 4) substrate from which food is taken (9 variables), 5) time of day that the species forages (3 variables), 6) foraging habitats (20 variables), and 7) nesting habitats (18 variables) (Pearman et al., 2014). Body mass is in grams and the rest of variables are binomial (scored as either 0 or 1). Multidimensional functional diversity indices were proposed in order to avoid issues with strong positive correlation between the most used functional diversity indices and species richness in sample sites (Villéger et al. 2008).

There are three independent FD measures; each of them represents one of the three key components of functional diversity:

- Functional Richness (FRic) is the amount of functional space occupied by species;
- Functional Evenness (FEve) measures regularity of abundance distribution along functional space;
- Functional Divergence (FDiv) measures how far high species abundances are from the center of the functional space.

Table 3. Formulas for calculating components of functional diversity.

Index	**Formula**
Functional Richness (FRic)	Quickhull algorithm
Functional Divergence (FDiv)	$FDiv = \frac{\Delta d + \overline{dG}}{\Delta \lvert d \rvert + dG}$
Functional Evenness (FEve)	$FEve = \frac{\sum_{j=1}^{S-1} min\left(PEWj\,\frac{1}{S-1}\right) - \frac{1}{S-1}}{1 - \frac{1}{S-1}}$

These independent functional diversity measures are used to describe the relationship between ecosystem functioning, functional diversity and environment, and to represent the distribution of taxa in functional species (Mouchet *et al.*, 2010). In this study, the functional diversity indices (FRic, FEve, FDiv) were calculated using the ‘FD’ package (Laliberté et al. 2015). Additionally, multivariate index of FD Rao’s quadratic entropy (RaoQ) was calculated.

For exploring phylogenetic diversity, Evolutionary Distinctiveness (ED) a measure how isolated a species is in a phylogenetic tree and it is used as a measure of species uniqueness (Morelli et al. 2016, Tucker et al. 2017). From species present in the community the sum of the branch lengths was used in order to estimate the phylogenetic diversity. Calculation of ED is done by dividing the total phylogenetic diversity of a clade amongst its members. It is achieved by applying a value to each branch equal to its length divided by the number of species subtending the branch (Isaac *et al.*, 2007; “www.edgeofexistence.org” 2015). By using the ED score for each bird species in a sampling site (sampling square), community evolutionary distinctiveness (CED) was estimated as the average ED considering all species from the sampling site (Morelli et al. 2016).

4.6 Statistical analyses

The differences of mean values of functional diversity, evolutionary distinctiveness and species richness metrics between both protected areas were explored graphically by means of boxplots. Subsequently, we assessed simple linear regression plots in order to explore the potential associations between bird species richness and edge density weighted, as well as functional diversity and edge density weighted.

For testing normality of data, from both protected areas, a Shapiro- Wilk normality test was used. A parametric test, Student’s t test, and a non-parametric test, Wilcox test, were used between data for comparing different biodiversity metrics in two studied areas (Crawley 2007).

Mantel test was used for analysing spatial autocorrelation of data. This test checks for correlation between two distance matrices, one derived from ecological distance matrix and the other one from geographical distance between squares, which were used as sampling sites (http://qiime.org/tutorials/distance_matrix_comparison.html) (Diniz-Filho et al. 2013). In this study, Mantel test was used to test for spatial mismatch between each diversity metrics in both protected areas of Spain. In that case, the Mantel test can be considered as a spatially explicit test of correlation (Legendre and Fortin 2010). For testing significance, Monte Carlo permutations with 999 randomizations were used (https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Randomise/Theory).

All statistical tests were performed with R software (R Development Core Team 2017).

5. Results

In this section results obtained during the study are presented. Data collected during the fieldwork, results of spatial and statistical analyses. Also results of landscape and biodiversity metrics that were calculated and graphically shown by using ArcGIS maps.

5.1 Bird species with highest ED scores

During the fieldwork ornithologists recorded a total of 172 species from 84 different sites (10 x 10 km squares) in Tierra de Campos and Tierra de Campiñas (see the table in the Annexes section). Species with five highest evolutionary distinctiveness score are provided in the table below. Recorded species with the highest ED score was the Eurasian hoopoe (*Upupa epops*), although the most interesting to discuss due to their conservation concern is the Great bustard (*Otis tarda*).

Table 4. Bird species with highest evolutionary distinctiveness (ED) scores.

Species	**ED score**
Upupa epops	35.58134
Ixobrychus minutus	23.25809
Regulus ignicapilla	22.84292
Otis tarda	22.72517
Tachybaptus ruficollis	22.22395

Bird species with the highest ED score was the Eurasian Hoopoe (*Upupa epops*); it is categorized as least concern (LC) according to the IUCN Red List Criteria (http://www.iucnredlist.org).

Figure 9 The Eurasian Hoopoe (*Upupa epops*) in Adana, Turkey (Photo: Zeynel Cebeci).

The Eurasian Hoopoe is a migratory species typical for open habitat such as pastures, agricultural fields and orchards. Preferred landscape for them consists of patches of vegetation and bare soil, for easier foraging for food (Hildebrandt and Schaub 2017). The species is a secondary cavity-nesting, which means that it uses holes in trees made by some other species, holes in walls, cliffs etc. Species is insectivorous and mostly feeds on insects that are considered as pests in forestry, such as pine processionary caterpillar (*Thaumetopoea pityocampa*), that is a threat to pines in Southern Europe (Battisti et al. 2000). From egocentric point of view, the Hoopoe's importance is reflected in its diet. This consists mostly of insects that are considered as pests by farmers and foresters. Although the species is not recognized as threatened there are still some threats to it, which researchers are pointing out. Threats such as hunting, due to interesting color pattern and feathers, and loss of preferred habitats led to species decline in Europe (Bötsch et al. 2012). Conservationists are suggesting habitat management measures, such as preserving open landscapes with patchy vegetation and avoiding use of modern agricultural technologies. Additionally, enforcement of hunting law could be beneficial for species population increase. During the fieldwork conducted for this study, Hoopoe was present in 83 from 84 sampling squares. Which is an indicator that in both studied areas, the dominant land use are agricultural fields. Sample square where species was absent is characterized by industrial and urban area, which indicates that species is sensitive to presence of humans and prefers open habitats.

Species with the second highest ED score was Little Bittern (*Ixobrychus minutus*), which was recorded only in 1 sampling square in the protected area Tierra de Campiñas. It is categorized as least concern (LC) according to the IUCN Red List Criteria. Little Bittern is listed on Annex I of the EU Birds Directive, Annex II of the Bern Convention and Annex II of the Convention on Migratory Species (http://www.iucnredlist.org).

Figure 10 The Little Bittern (*Ixobrychus minutus*) (Photo: Marek Szczepanek).

Little Bittern feeds on fish from rivers and small lakes, mostly it occurs in wetlands, on trees next to rivers and water marshes. As other species, which are dependent on water bodies, it is threatened by water pollution, habitat destruction and fish overexploitation (http://www.iucnredlist.org). Conservationists propose some measures for increasing population trend on the European level, such as: reducing water pollution and managing reeds and marshes.

The third place on the ED score was the Common Firecrest (*Regulus ignicapilla*) which is a typical migratory forest bird species. Current population trend is stable for this species according to IUCN expert's estimation. In Mediterranean region its preferred habitat are oak forest (*Quercus ilex* and *Quercus suber*). Firecrest is listed on the Bern Convention Appendix II (http://www.iucnredlist.org).

Figure 11 The Common Firecrest (*Regulus ignicapilla*) (Photo: D. Carlos I - Caldas da Rainha).

Species with one of the highest ED score recorded in both studied areas was the great bustard (*Otis tarda*); it's categorized as vulnerable (VU) according to the IUCN Red List Criteria (http://www.iucnredlist.org).

Figure 12 The Great bustard (*Otis tarda*) in Hungary (Photo: Andrej Chudý).

It is considered as one of the heaviest flying bird species, as males reach up to 15 kilos while females are much smaller and weight only 4-5 kilos. This makes them the most sexually dimorphic bird species (Alonso 2015). Certain conservation measures have been proposed by the European Union in order to protect the species, since it's threatened by human activities. Species is very sensitive to presence of human activities and artificial surfaces, therefor recommended measures are to prevent disturbances in breeding sites, introduce more winter cereals and intensify grazing (Birds Directive, Annex I 2009). Spanish populations recovered due to two important conservation measures: habitat management and mortality reduction of adult males (Alonso 2015).

And last but not least, Little Grebe (*Tachybaptus ruficollis*) which is a migratory wetland bird. Species inhabits wetlands with shallow waters rich with plants and invertebrates. Conservationists are suggesting wetland management for supporting nesting of this species.

Figure 13 The Little Grebe (*Tachybaptus ruficollis*) in Osaka, Japan (Photo: Laitche).

5.2 Land use composition

Tierra de Campos was divided into 48 squares, whereas Tierra de Campiñas into 36 squares (Figure 6). After performing spatial analyses in ArcGIS, obtained results showed that land use of both Tierra de Campos and Tierra de Campiñas are characterized by arable land, 91.2% and 87.2% respectively (Table1 and Figure 14).

The fact that in both of our study areas dominant land use is arable land, indicates the similar bird composition in both areas. When comparing list of recorded species with the list from Farmland Species of European Conservation Concern (Annex 11: Farmland Species of European Conservation Concern, IEEP 2007), 63 out of 119 bird species from the list were present in our sample. Out of 63 bird species 14 were recorded in more than 80 square sites.

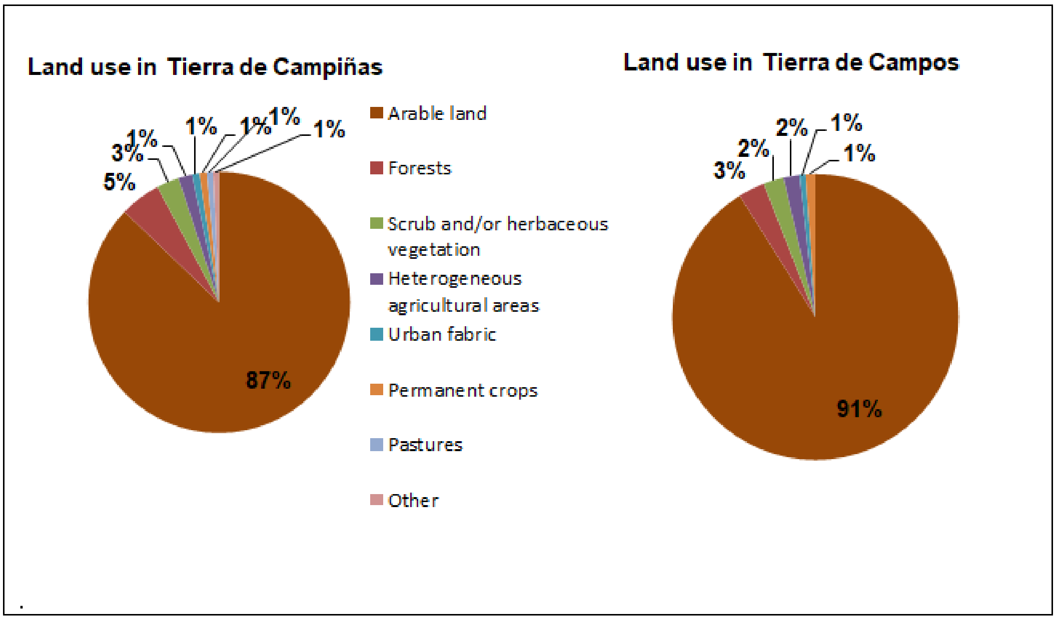

Figure 14 Pie charts of land use in studied areas, Tierra de Campiñas and Tierra de Campos.

5.3 Landscape metrics and biodiversity metrics

As landscape metrics, edge density (EDG) and edge density weighted (EDGW) were calculated for each sample square in the studied areas. Results are shown by using ArcGIS maps. In Tierra de Campiñas calculated EDG values were lower than in Tierra de Campos (Figure 15).

Taxonomical, functional and evolutionary diversity metrics were calculated for each sample square in studied areas. Results are shown by using ArcGIS maps. Recorded bird species richness (BSR) was the highest in Tierra de Campos with the value of 117, whereas the lowest value of BSR was 51 (Figure 16). As for evolutionary uniqueness, community evolutionary distinctiveness (CED) it's values were higher in Tierra de Campiñas which is interesting to discuss since the dominant land use, agricultural land, is characteristic for both studied areas (Figure 17). RaoQ index was higher in Tierra de Campiñas, whereas in Tierra de Campos it had somewhat lower values (Figure 18). Functional divergence (FDiv) and functional richness (FRic) had the highest values in Tierra de Campos, whereas functional evenness (FEve) had the highest values in Tierra de Campiñas (Figure 19).

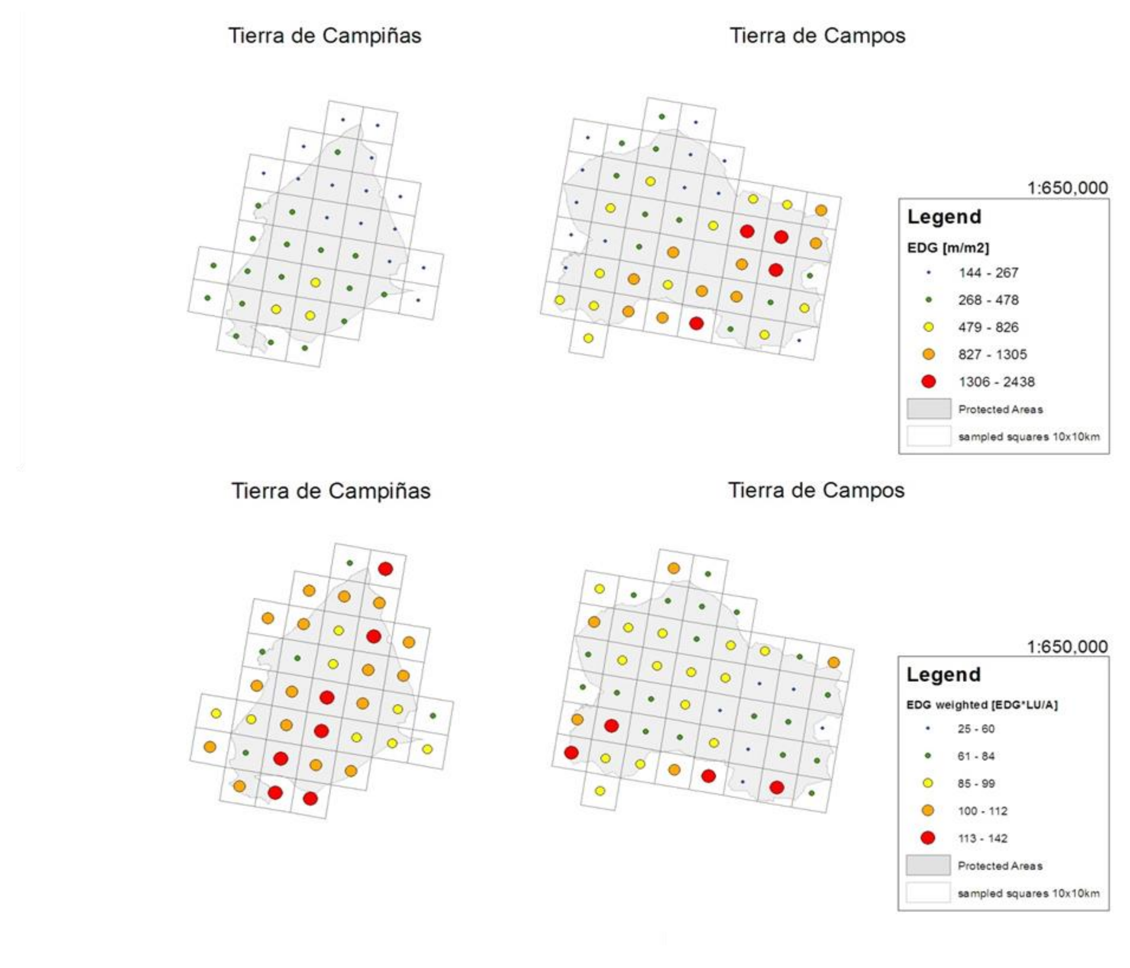

Figure 15 Edge density (EDG) and edge density weighted (EDGW) calculated for each sample squares.

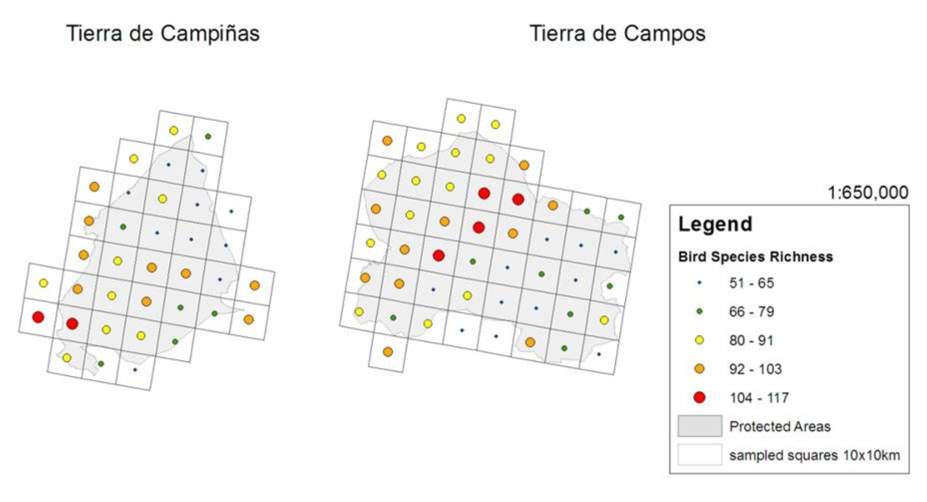

Figure 16 Bird species richness calculated for each sample squares.

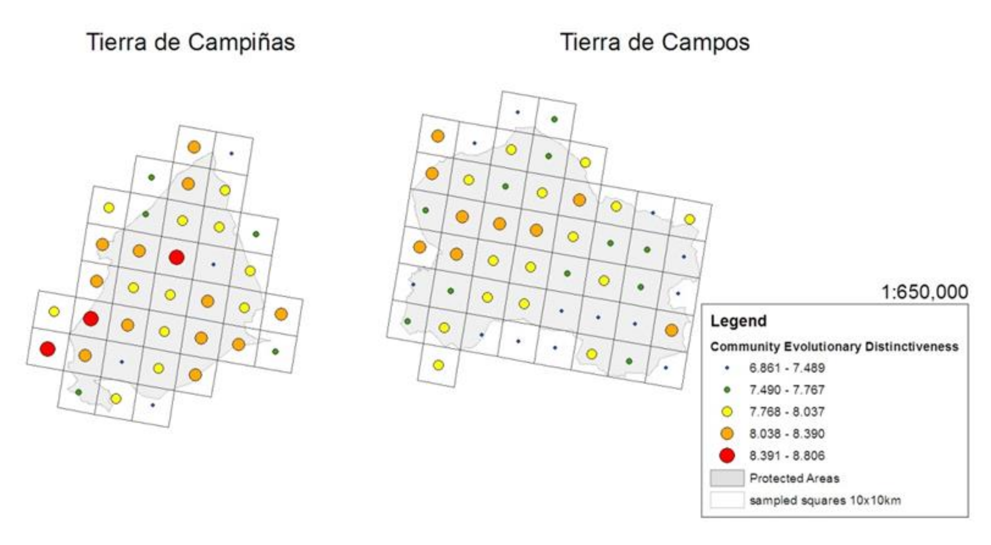

Figure 17 Community evolutionary distinctiveness calculated for each sample squares.

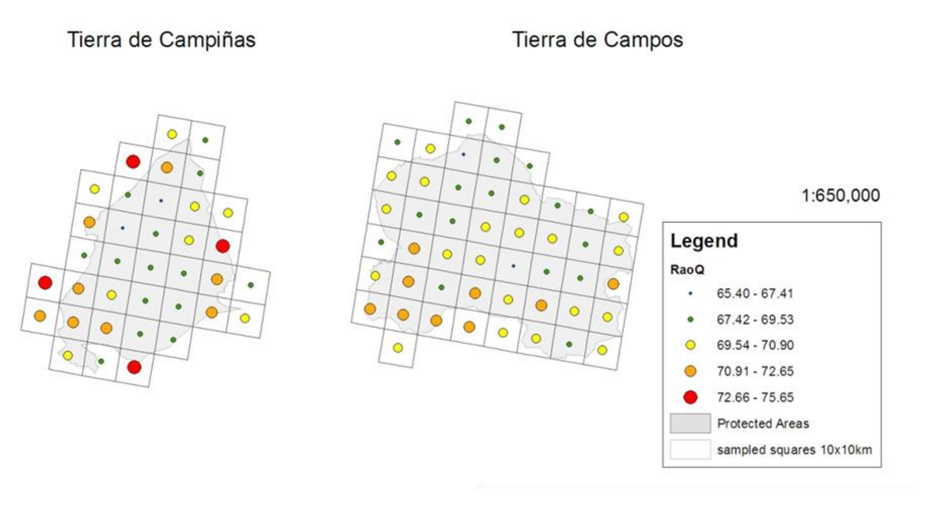

Figure 18 RaoQ index calculated for each sample squares.

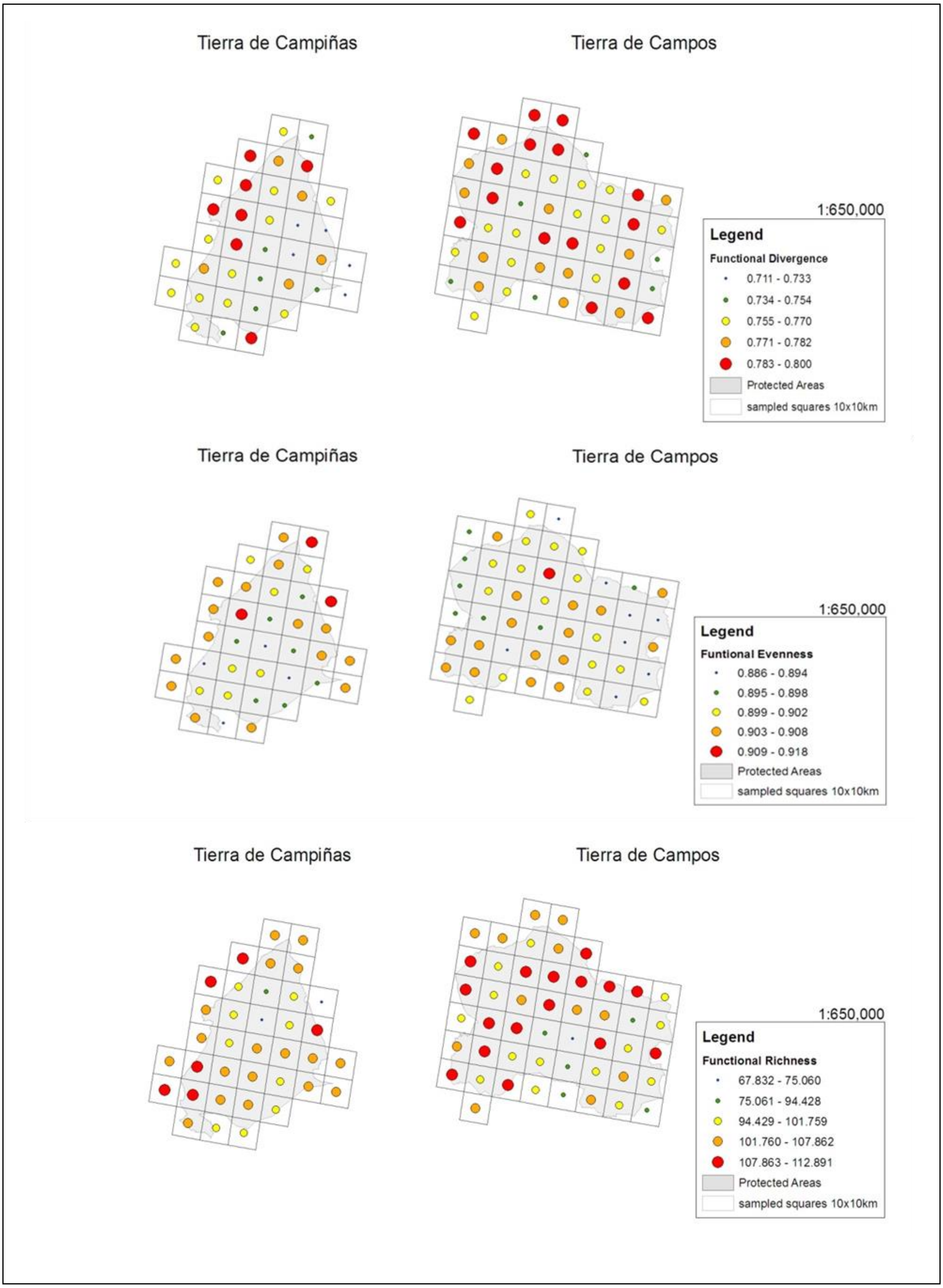

Figure 19 Functional diversity metrics – Functional divergence, functional evenness and functional richness calculated for each sample squares.

5.4 Diversity and community metrics in both protected areas

After performing Shapiro-Wilk normality test obtained results for Tierra de Campos showed that it's not possible to reject the hypothesis that the sample comes from a population which has a normal distribution (p-value= 0.4175, *P* = 0.05). However, in Tierra de Campiñas sample did not come from a population with a normal distribution (p-value= 0.04263, *P* = 0.05). Because of presence of both normal and non-normal data distribution, both parametric and non-parametric tests were used.

5.4.1 *Comparing avian diversity metrics between the two Spanish PA's*

Both studied areas were rather similar in terms of BSR, RaoQ, FDis, FEve and FRic (respectively: p-value= 0.5159, p-value= 0.8187, p-value= 0.6891, p-value= 0.1718, p-value= 0.4824, *P* = 0.05). However, results obtained showed that main differences were related to levels of CED and FDiv. CED showed statistically significant differences between both Spanish protected areas, with higher values of CED in Tierra de Campiñas than in Tierra de Campos (p-value= 0.001601, *P* = 0.05). FDiv as well, showed statistically significant differences between both Spanish protected areas, with higher values of FDiv in Tierra de Campos than in Tierra de Campiñas (p-value= 0.009525, *P* = 0.05) (Figure 20).

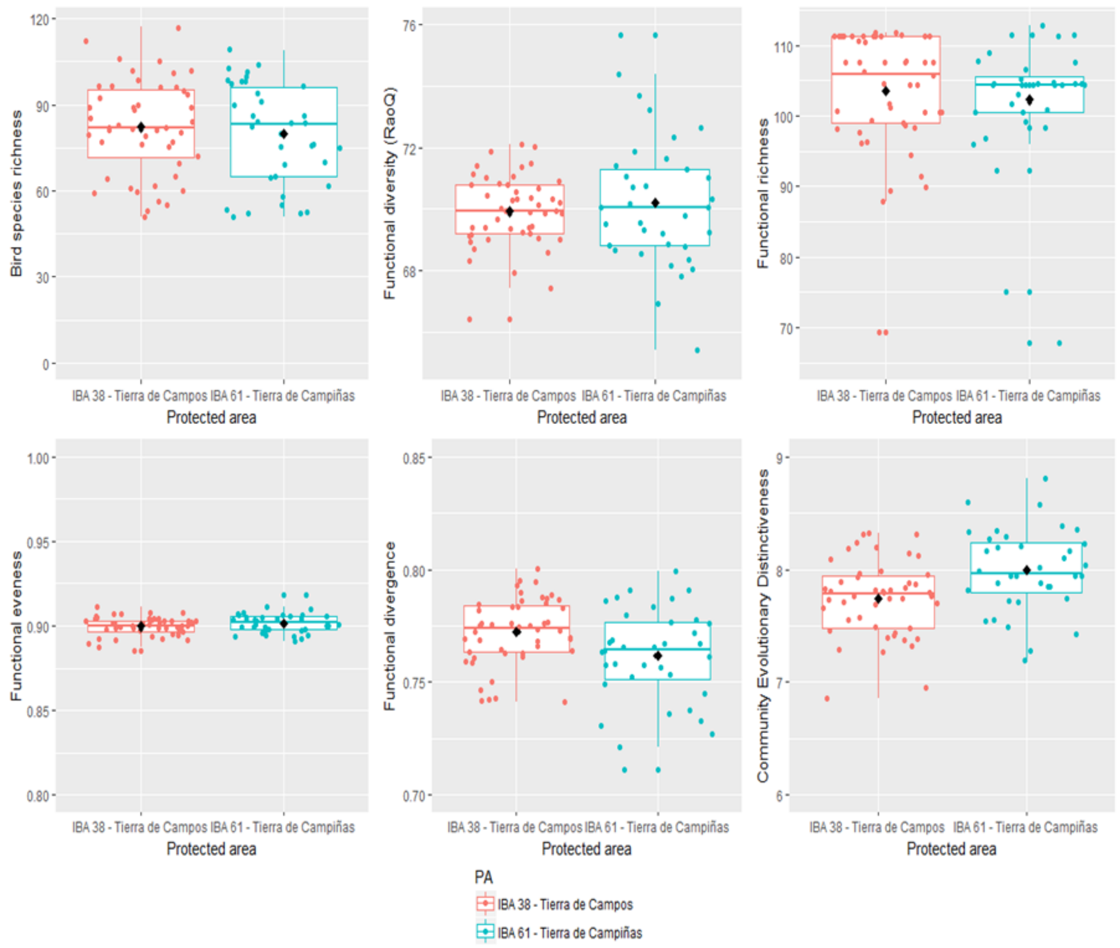

Figure 20 Comparison of taxonomical (BSR), functional (RaoQ, FRic, FEve, FDiv) and evolutionary (CED) diversity metrics between Tierra de Campos and Tierra de Campiñas. The ggplots show the median (lines in the middle of rectangles) and extreme values.

5.4.2 *Spatial analyses among diversity and community metrics*

Results obtained from Mantel test showed statistically significant correlation between bird species richness and edge density; bird species richness and community evolutionary distinctiveness; bird species richness and functional richness; functional richness and community evolutionary distinctiveness (Table 5). The other avian diversity and community metrics were not significantly spatially structured (Table 5).

Table 5. Results obtained from Mantel test, comparison of spatial distribution for different biodiversity metrics and between BSR and EDG.

	r_M	p-value
BSR/EDG	**0.1766792**	**0.0008**
BSR/CED	**0.2215445**	**0.0001**
BSR/RaoQ	-0.03144226	0.7344
BSR/FRic	**0.291698**	**0.0001**
BSR/FDiv	0.01356061	0.3626
BSR/FEve	0.04580006	0.1547
RaoQ/CED	0.00207548	0.4393
RaoQ/FDiv	0.06850483	0.1392
RaoQ/FEve	0.01146565	0.3767
RaoQ/FRic	0.09469621	0.1114
FRic/FEve	0.1134102	0.0686
FRic/FDiv	-0.07256486	0.9016
FRic/CED	**0.1532702**	**0.0242**
FEve/FDiv	-0.02883286	0.671
FEve/CED	-0.01505388	0.5783
FDiv/CED	0.01051114	0.398

EDG – Edge density; BSR**-** Bird species richness; CED- Community evolutionary distinctiveness; FRic- Functional richness; FDiv- Functional divergence; FEve- functional evenness; RaoQ- functional diversity index

r_M- correlation coefficient

Number of permutations: 9999

6. Discussion

In this section is the significance of our study and discussion of the main results that were obtained during the fieldwork.

6.1 Importance of a multi-facet approach on biodiversity

This study explored the differences in diversity and community metrics between the two protected areas focused: a Natura2000 site and a IBA site. These differences in overall metrics and in spatial distribution of each variable show that there is no unique pattern when it comes to conservation and protection of nature. Here we prove that different metrics, which represent different community traits, are complementary but not uniformly distributed in space. Then, depending the focus of protection, conservationists should take into account all biodiversity facets. Taxonomical, functional and evolutionary diversity are complementary and all are relevant for better understanding communities' composition, and should be all taken into account when proposing future conservation plans.

6.2 Spatial distribution of avian diversity

Although one should expect higher bird species richness in the core area of the PA where the level of protection is the highest (Albuquerque et al. 2013), our study showed opposite results for one protected area. In this particular case species richness was higher on the edge in the SPA Tierra de Campiñas, which is a Natura 2000 site protected under the Habitat Directive. However, this was not the case in Tierra de Campos which is not categorized as a SPA under the Habitat Directive. In Tierra de Campos the area hotspot of BSR was in the core area and lower values were present on the edges. This can be explained by the buffer effect, which implies that in the core area species are protected from environmental effects outside the borders of the PA. These environmental pressures associated to the border areas of the protected areas could be natural (e.g. presence of invasive species) or human-made (e.g. hunting). In this case species are more abundant in the core area where there is less risk of environmental pressure.

After comparing CED in both PAs, a significant difference in values was noticed. Even though land use composition in both PAs is somewhat similar and both are characterized by arable land. Community evolutionary distinctiveness was higher in the SPA Tierra de Campiñas, which probably can be explained by the fact that in this area percentage of forest is a little bit higher than in Tierra de Campos (respectively 5% and 3%). When looking at land use composition in sampled squares, the highest CED values were in the squares with the highest ratio of forests. Since it is hypothesized that forests are more complex, heterogeneous and older habitats than arable land they support higher CED and bird species characterized by high ED scores (Morelli et al. 2018). Our study supports this hypothesis and indicates that species present in these communities are more evolutionary unique. The main importance on the protection of bird communities characterized by high evolutionary uniqueness is because they're threatened by numerous factors. In arable lands, which is dominant in our study, evolutionary distinct species are threatened by agriculture intensification and expansion of monocultures (Frishkoff et al. 2014). Therefore it is important for protected areas to focus on species with high ED scores and conserve evolutionary distinct communities. To summarize, phylogenetic diversity is important because high evolutionary distinctiveness supports more stable communities (Cadotte and Jonathan Davies 2010, Cadotte et al. 2012).

Both FRic and FDiv had somewhat high values in both PAs, although in Tierra de Campos FRic was higher. These higher values indicate higher number of occupied niche spaces in this area. In Tierra de Campiñas FRic was higher on the edges as well as BSR, which suggests that these metrics are spatially correlated. Some studies already confirmed this association between both variables (see Villéger et al. 2008). This was confirmed by Mantel test.

Mantel test was used also for testing spatially explicit correlation between different biodiversity metrics. Obtained results, presented in the table 5, show that only three metrics were significantly spatially correlated. Similar spatial pattern was for BSR and CED; BSR and FRic; FRic and CED. All these metrics showed a positive spatial correlation ($\mathbf{r_M} > 0$, p-value< 0.005). By comparing BSR with EDG with Mantel test, it is visible that they are positively correlated. In the sample squares where one metric is higher the other metric follows the trend. I hypothesize that this phenomenon happens because where landscape heterogeneity is higher there will be more available niches for species, therefore higher species richness (Kisel et al. 2011).

6.3 Bird species important for conservation

As previously mentioned, the Great bustard is present in both of the studied areas. According to data from European Commission, in Castilla y León (the administrative area of our study areas) is the single largest population of great bustards in Spain and in the European Union (Birds Directive, Annex I 2009). Our study supports the fact that *O. tarda* is relatively abundant in these areas of Spain, since it was recorded in 72 out of 84 sites during the fieldwork. The Great bustard was recorded in Tierra de Campos which is defined as an IBA. This record could be used as an argument to increase the level of protection of the area. Conservationists claim that appropriate habitat management for the Great bustard also promotes better conditions for species characteristic for arable lands, such as *Miliaria calandra*, *Anthus campestris* and *Melanocorypha calandra* (Birds Directive, Annex I 2009).

7. Conclusions

In this section are summarized overall significant results from this study and suggested focus for future studies.

Protecting species listed in our study is critical both for scientists and farmers, due to their high influence on ecosystems functioning surrounding them. Therefore, management of arable lands in a supporting way of species like the Eurasian Hoopoe, which feeds on farmland pests, is contributing to both farmers and the ecosystem. On the other hand, the Great bustard is valuable for conservationists as it can serve as an umbrella species, since it is on the Annex I of Birds Directive.

Concept of umbrella species has been introduced in conservation planning and it refers to one species being protected while a number of naturally co-occurring species benefits from it. Umbrella species can be used in conservation management for both protecting a habitat and community of species (Caro and O'Doherty 1999, Breckheimer et al. 2014). Abundance of Great bustard in our studied areas can serve as an argument for future protection of Tierra de Campos.

In conclusion, our study supports the hypothesis that different avian diversity components (taxonomical, functional and phylogenetic diversity) should be considered when protecting species and their habitat. Focusing on only one diversity component is not enough to understand the complexity of a concept like biodiversity. The functional diversity can take into account the differences associated to species' functional traits, while the evolutionary distinctiveness describe the evolutionary history or uniqueness of the species assemblage. All these components are important when assessing a community, with conservation purposes.

In future research, focus of the study should consider environmental factors as well. Such as climate change during some time period, since it is speculated that PAs are refugia for species during the global warming.

8. References

Albuquerque FS, Assunção-Albuquerque MJT, Cayuela L, et al (2013) European Bird distribution is “ well” represented by Special Protected Areas: Mission accomplished? Biol Conserv 159:45–50 . doi: 10.1016/j.biocon.2012.10.012

Alonso JC (2015) The Great Bustard: Past, Present and Future of a Globally Threatened Species. Ornis Hungarica 22:1–13 . doi: 10.2478/orhu-2014-0014

Alonso JC, Alonso JA (1996) The great bustard Otis tarda in Spain: Present status, recent trends and an evaluation of earlier censuses. Biol Conserv 77:79–86 . doi: 10.1016/0006-3207(95)00137-9

Alonso JC, Martín CA, Palacín C, et al (2003) Distribution, size and recent trends of the Great Bustard Otis tarda population in Madrid region, Spain. Ardeola 50:21–29 . doi: 10.1016/S0006-3207(02)00188-X

Annex 11 : Farmland Species of European Conservation Concern (IEEP 2007)

Balmford, A., Bennun, L., Brink, B., Cooper, D., Côté, I.M., Crane, P., Dobson, A., Dudley, N., Dutton, I., Green, R.E., Gregory, R.D., Harrison, J., Kennedy, E.T., Kremen, C., Leader-williams, N., Lovejoy, T.E., Mace, G., May, R., Mayaux, P., Morling, P., Phillips, J., Redford, K., Taylor, H., Rodríguez, J.P., Sanjayan, M., Schei, P.J., Jaarsveld, A.S. Van, Walther, B.A., 2005. The Convention on Biological Diversity’s 2010 target. Himal. J. Sci. 3, 43–45.

Battisti, A; Bernardi, M.; Ghiraldo, C. (2000) Predation by the hoopoe (*Upupa epops*) on pupae of *Thaumetopoea pityocampa* and the likely influence on other natural enemies. *Biocontrol*. 45: 311–323. doi:10.1023/A:1009992321465

Bennett, A.F., Radford, J.Q., Haslem, A., 2006. Properties of land mosaics: Implications for nature conservation in agricultural environments. Biol. Conserv. 133, 250–264. doi:10.1016/j.biocon.2006.06.008

Benton, T.G., Vickery, J., Wilson, J.D., 2003. Farmland biodiversity: is habitat heterogeneity the key? Trends Ecol. Evol. 18, 182–188. doi:10.1016/S0169-5347(03)00011-9

Bibi F, Ali Z (2013) Measurement of diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary, Pakistan. J Anim Plant Sci 23:469–474

Biodiversity from A-Z www.biodiversitya-z.org

Birds Directive Annex I (2009) Great Bustard Otis tarda. 1–9

BirdLife International www.birdlife.org

BirdLife International Data Zone http://datazone.birdlife.org/country/spain

Boatman ND, Brickle NW, Hart JD, et al (2004) Evidence for the indirect effects of pesticides on farmland birds. Ibis (Lond 1859) 146:131–143. doi: 10.1111/j.1474-919X.2004.00347.x

Bonn A, Gaston KJ (2005) Capturing biodiversity: selecting priority areas for conservation using different criteria. Biodivers Conserv 14:1083–1100 . doi: 10.1007/s10531-004-8410-6

Bossard M, Feranec J, Othael J (2000) CORINE land cover technical guide – Addendum. European Environment Agency Technical Report 40. Copenhagen

Bötsch Y, Arlettaz R, Schaub M (2012) Breeding dispersal of Eurasian Hoopoes (*Upupa epops*) within and between years in relation to reproductive success, sex, and age. Auk 129:283–295 . doi: 10.1525/auk.2012.11079

Butler SJ, Boccaccio L, Gregory RD, et al (2010) Quantifying the impact of land-use change to European farmland bird populations. Agric Ecosyst Environ 137:348–357. doi: 10.1016/j.agee.2010.03.005

Cadotte M, Dinnage R, Tilman D (2012) Phylogenetic diversity promotes ecosytem stability. Ecology 93:S223–S233. doi: 10.1890/11-0426.1

Cadotte MW, Jonathan Davies T (2010) Rarest of the rare: Advances in combining evolutionary distinctiveness and scarcity to inform conservation at biogeographical scales. Divers Distrib 16:376–385. doi: 10.1111/j.1472-4642.2010.00650.x

Carmona CP, de Bello F, Mason NWH, Lepš J (2016) Traits Without Borders: Integrating Functional Diversity Across Scales. Trends Ecol Evol 31:382–394. doi: 10.1016/j.tree.2016.02.003

Caro TM, O'Doherty G (1999) On the use of surrogate species in conservation biology. Conserv Biol 13:805–814. doi: 10.1046/j.1523-1739.1999.98338.x

Ceresa, F., Bogliani, G., Pedrini, P., Brambilla, M., 2012. The importance of key marginal habitat features for birds in farmland: an assessment of habitat preferences of Redbacked Shrikes Lanius collurio in the Italian Alps. Bird Study 59, 327–334. doi:10.1080/00063657.2012.676623

Chamberlain DE, Fuller RJ, Bunce RGH, et al (2000) Changes in the abundance of farmland birds in relation to the timing of agricultural intensification in England and Wales. J Appl Ecol 37:771–788. doi: 10.1046/j.1365-2664.2000.00548.x

Chao A, Chiu C-H, Jost L (2016) Phylogenetic Diversity Measures and Their Decomposition: A Framework Based on Hill Numbers. Pp. 141-173 in R. Pellens, P. Grandcolas (eds.), Biodiversity Conservation and Phylogenetic Systematics, Topics in Biodiversity and Conservation 14. doi: 10.1007/978-3-319-22461-9_8

Crawley MJ (2007) The R Book

Dauda TO, Baksh MH, Shahrul AMS (2017) Birds' species diversity measurement of Uchali Wetland (Ramsar site) Pakistan. J Asia-Pacific Biodivers 10:167–174 . doi: 10.1016/j.japb.2016.06.011

Devictor V, Mouillot D, Meynard C, et al (2010) Spatial mismatch and congruence between taxonomic, phylogenetic and functional diversity: The need for integrative conservation strategies in a changing world. Ecol Lett 13:1030–1040 . doi: 10.1111/j.1461-0248.2010.01493.x

Diniz-Filho JAF, Soares TN, Lima JS, et al (2013) Mantel test in population genetics. Genet Mol Biol 36:475–485 . doi: 10.1590/S1415-47572013000400002

Donald, P.F., Green, R.E., Heath, M.F., 2001. Agricultural intensification and the collapse of Europe's farmland bird populations. Proc. R. Soc. London B - Biol. Sci. 268, 25–9. doi:10.1098/rspb.2000.1325

Donald PF, Pisano G, Rayment MD, Pain DJ (2002) The common agricultural policy, EU enlargement and the conservation of Europe's farmland birds. Agric Ecosyst Environ 89:167–182 . doi: 10.1016/S0167-8809(01)00244-4

Donald, P.F., Sanderson, F.J., Burfield, I.J., Van Bommel, F.P.J., 2006. Further evidence of continent-wide impacts of agricultural intensification on European farmland birds, 1990–2000. Agric. Ecosyst. Environ. 116, 189–196. doi:10.1016/j.agee.2006.02.007

Dudley N (2008) Guidelines for applying protected area management categories

EDGE of Existence (2015) www.edgeofexistence.org

European Commission www.ec.europa.eu

European Environment Agency www.eea.europa.eu

European Environment Agency (2009) Progress towards the European 2010 biodiversity target

European Environment Agency (2004) The state of biological diversity in the European Union. Stakeholders' Conf Biodivers EU - Sustain Life, Sustain Livelyhoods, Gd Hotel Malahide, Irel 1–30

Eurostat Statistics Explained www.ec.europa.eu/eurostat/statistics-explained/index.php/Farm_structure_statistics

Frishkoff LO, Karp DS, M'Gonigle LK, et al (2014) Loss of avian phylogenetic diversity in neotropical agricutural systems. Science (80-) 345:1343–1346. doi: 10.7910/DVN/26910

FSL- https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Randomise/Theory

Gaüzère P, Jiguet F, Devictor V (2016) Can protected areas mitigate the impacts of climate change on bird's species and communities? Divers Distrib 22:625–637. doi: 10.1111/ddi.12426

Geiger, F., Bengtsson, J., Berendse, F., Weisser, W.W., Emmerson, M., Morales, M.B., Ceryngier, P., Liira, J., Tscharntke, T., Winqvist, C., Eggers, S., Bommarco, R., Pärt, T., Bretagnolle, V., Plantegenest, M., Clement, L.W., Dennis, C., Palmer, C., Oñate, J.J., Guerrero, I., Hawro, V., Aavik, T., Thies, C., Flohre, A., Hänke, S., Fischer, C., Goedhart, P.W., Inchausti, P., 2010. Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland. Basic Appl. Ecol. 11, 97–105. doi:10.1016/j.baae.2009.12.001

Grodzinska-Jurczak M, Cent J (2011) Expansion of nature conservation areas: Problems with natura 2000 implementation in Poland? Environ Manage 47:11–27 . doi: 10.1007/s00267-010-9583-2

Grodziska-Jurczak M, Strzelecka M, Kamal S, Gutowsk J (2012) Effectiveness of Nature Conservation - A Case of Natura 2000 Sites in Poland. In: Protected Area Management. InTech

Hildebrandt B, Schaub M (2017) The effects of hatching asynchrony on growth and mortality patterns in Eurasian Hoopoe *Upupa epops* nestlings. Ibis (Lond 1859) 145–157 . doi: 10.1111/ibi.12529

International Union for Conservation of Nature (IUCN) https://www.iucn.org/

IUCN Red List http://www.iucnredlist.org

Isaac NJB, Turvey ST, Collen B, et al (2007) Mammals on the EDGE: conservation priorities based on threat and phylogeny. PLoS One 2:e296 . doi: 10.1371/journal.pone.0000296

Kisel, Y., McInnes, L., Toomey, N.H., Orme, C.D.L., 2011. How diversification rates and diversity limits combine to create large-scale species-area relationships. Philos. Trans. R. Soc. London B - Biol. Sci. 366, 2514–2525. doi:10.1098/rstb.2011.0022

Kottek M, Grieser J, Beck C, et al (2006) World map of the Köppen-Geiger climate classification updated. Meteorol Zeitschrift 15:259–263 . doi: 10.1127/0941-2948/2006/0130

Laliberté E, Legendre P, Shipley B (2015) Measuring functional diversity (FD) from multiple traits, and other tools for functional ecology: R package version 1.0-12

Laureto LMO, Cianciaruso MV, Samia DSM (2015) Functional diversity: An overview of its history and applicability. Nat e Conserv 13:112–116 . doi: 10.1016/j.ncon.2015.11.001

Lee M-B, Martin JA (2017) Avian Species and Functional Diversity in Agricultural Landscapes: Does Landscape Heterogeneity Matter? PLoS One 12:e0170540 . doi: 10.1371/journal.pone.0170540

Legendre, P., Fortin, M.-J., 2010. Comparison of the Mantel test and alternative approaches for detecting complex multivariate relationships in the spatial analysis of genetic data. Mol. Ecol. Resour. 10, 831–844. doi:10.1111/j.1755-0998.2010.02866.x

Lomba, A., Guerra, C., Alonso, J., Honrado, J.P., Jongman, R.H.G., McCracken, D., 2014. Mapping and monitoring High Nature Value farmlands: Challenges in European landscapes. J. Environ. Manage. 143, 140–150. doi:10.1016/j.jenvman.2014.04.029

Maiorano L, Falcucci A, Garton EO, Boitani L (2007) Contribution of the Natura 2000 Network to Biodiversity Conservation in Italy. Conserv Biol 21:1433–1444 . doi: 10.1111/j.1523-1739.2007.00831.x

Mason NWH, Mouillot D, Lee WG, Wilson JB (2005) Functional richness, functional and functional evenness divergence: the primary of functional components diversity. Oikos 111:112–118 . doi: 10.1111/j.0030-1299.2005.13886.x

Mauerhofer V, Kim RE, Stevens C (2015) When implementation works: A comparison of Ramsar Convention implementation in different continents. Environ Sci Policy 51:95–105 . doi: 10.1016/j.envsci.2015.03.016

Mittermeier RA, van Dijk PP, Rhodin AGJ, Nash SD (2004) Hotspots Revisited: Earth's Biologically Richest and Most Endangered Ecoregions. Chelonian Conserv Biol 14:200 . doi: 10.2744/ccab-14-01-2-10.1

Morelli, F., 2013. Relative importance of marginal vegetation (shrubs, hedgerows, isolated trees) surrogate of HNV farmland for bird species distribution in Central Italy. Ecol. Eng. 57, 261–266. doi:10.1016/j.ecoleng.2013.04.043

Morelli F, Benedetti Y, Ibáñez-Álamo JD, et al (2016) Evidence of evolutionary homogenization of bird communities in urban environments across Europe. Glob Ecol Biogeogr 25:1284–1293 . doi: 10.1111/geb.12486

Morelli F, Benedetti Y, Perna P, Santolini R (2018) Associations among taxonomic diversity, functional diversity and evolutionary distinctiveness vary among environments. Ecol Indic 88:8–16 . doi: 10.1016/j.ecolind.2018.01.022

Morelli, F., Pruscini, F., Santolini, R., Perna, P., Benedetti, Y., Sisti, D., (2013) Landscape heterogeneity metrics as indicators of bird diversity: Determining the optimal spatial scales in different landscapes. Ecol. Indic. 34, 372–379. doi:10.1016/j.ecolind.2013.05.021

Morelli, F., Benedetti, Y., Šímová, P., (2018) Landscape metrics as indicators of avian diversity and community measures. Ecol. Indic. 90, 132–141. doi:10.1016/j.ecolind.2018.03.011

Mouchet MA, Villéger S, Mason NWH, Mouillot D (2010) Functional diversity measures: An overview of their redundancy and their ability to discriminate community assembly rules. Funct Ecol 24:867–876 . doi: 10.1111/j.1365-2435.2010.01695.x. In: Gaston, K.J. (1996) Biodiversity: A Biology of Numbers and Difference.Black- well Science,Oxford.

Myers N, Mittermeier RA, Mittermeier CG, et al (2000) Biodiversity hotspots for conservation priorities. Nature 403:853–858 . doi: 10.1038/35002501

Nagy S, Nagy K, Szép T (2009) Potential Impact of EU Accession on Common Farmland Bird Populations in Hungary. Source Acta Ornithol ACTA Ornithol 44:37–44 . doi: 10.3161/000164509X464867

Natura 2000 Data Form http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=ES0000204

O'Dea N, Araújo MB, Whittaker RJ (2006) How well do Important Bird Areas represent species and minimize conservation conflict in the tropical Andes? Divers Distrib 12:205–214 . doi: 10.1111/j.1366-9516.2006.00235.x

Ostermann OP (1998) The need for management of nature conservation sites designated under Natura 2000. J Appl Ecol 35:968–973 . doi: 10.1111/j.1365-2664.1998.tb00016.x

Palacín C, Alonso JC (2008) An updated estimate of the world status and population trends of the great bustard Otis tarda. Ardeola 55:13–25 . doi: 10.5122/cbirds.2010.0007

Pan-European Common Bird Monitoring Scheme ebcc.info/pecbm.html

Pearman PB, Lavergne S, Roquet C, et al (2014) Phylogenetic patterns of climatic, habitat and trophic niches in a European avian assemblage. Glob Ecol Biogeogr 23:414–424 . doi: 10.1111/geb.12127

Pellens R, Grandcolas P (2016) Biodiversity Conservation and Phylogenetic Systematics

Perkins, A.J., Whittingham, M.J., Morris, A.J., Bradbury, R.B., 2002. Use of field margins by foraging yellowhammers Emberiza citrinella. Agric. Ecosyst. Environ. 93, 413–420.

Pollock LJ, Rosauer DF, Thornhill AH, et al (2015) Phylogenetic diversity meets conservation policy: small areas are key to preserving eucalypt lineages. Philos Trans R Soc B Biol Sci 370:20140007–20140007 . doi: 10.1098/rstb.2014.0007

Purvis A, Hector A (2000) Getting the measure of biodiversity. Nat Insight Biodiverstiy 405:vol 405 no. 6783 . doi: 10.1038/35012221

R Development Core Team (2017) R: A language and environment for statistical computing

Ramezani H (2012) A Note on the Normalized Definition of Shannon's Diversity Index in Landscape Pattern Analysis. Environ Nat Resour Res 2:54–60 . doi: 10.5539/enrr.v2n4p54

Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat https://www.ramsar.org/

Rannow, S., Wilke C., Gies M., Neubert M. Pp. 291-303 in S. Rannow and M. Neubert (eds.), Managing Protected Areas in Central and Eastern Europe Under Climate Change, Advances in Global Change Research 58. doi: 10.1007/978-94-007-7960-0_20

Reijnen, R., Foppen, R., Braak, C. Ter, Thissen, J., 2008. The Effects of Car Traffic on Breeding Bird Populations in Woodland . III . Reduction of Density in Relation to the Proximity of Main Roads. J. Appl. Ecol. 32, 187–202.

Ricotta, C., Moretti, M., 2011. CWM and Rao's quadratic diversity: A unified framework for functional ecology. Oecologia 167, 181–188. doi:10.1007/s00442-011-1965-5

Rosso A, Aragón P, Acevedo F, et al (2017) Effectiveness of the Natura 2000 network in protecting Iberian endemic fauna. Anim Conserv. doi: 10.1111/acv.12387

Sanderson, F.J., Kucharz, M., Jobda, M., Donald, P.F., 2013. Impacts of agricultural intensification and abandonment on farmland birds in Poland following EU accession. Agric. Ecosyst. Environ. 168, 16–24. doi:10.1016/j.agee.2013.01.015

Sloan S, Jenkins CN, Joppa LN, et al (2014) Remaining natural vegetation in the global biodiversity hotspots. Biol Conserv 177:12–24 . doi: 10.1016/j.biocon.2014.05.027

Stoate, C., Báldi, A., Beja, P., Boatman, N.D., Herzon, I., van Doorn, A., de Snoo, G.R., Rakosy, L., Ramwell, C., 2009. Ecological impacts of early 21st century agricultural change in Europe – A review. J. Environ. Manage. 91, 22–46. doi:10.1016/j.jenvman.2009.07.005

Tilman, D. (2001) Functional Diversity. Encyclopedia of Biodiversity, 3, 109-120. doi.org/10.1006/rwbd.1999.0154

Tucker CM, Cadotte MW, Carvalho SB, et al (2017) A guide to phylogenetic metrics for conservation, community ecology and macroecology. Biol Rev Camb Philos Soc 92:698–715 . doi: 10.1111/brv.12252

UMass http://www.umass.edu

United Nations Convention on Biological Diversity www.cbd.int

Viada, C. (2000) Spain (Including the Canary Islands). Pp. 515-649 in M. F. Heath and M.I. Evans, eds. *Important Bird Areas in Europe: Priority sites for conservation*. 2: Southern Europe. Cambridge, UK: BirdLife International (BirdLife Conservation Series No. 8).

Villéger S, Mason NWH, Mouillot D (2008) New multidimensional functional diversity indices for a multifaceted framework in functional ecology. Ecology 89:2290–2301 . doi: 10.1890/07-1206.1

Waldron A, Miller DC, Redding D, et al (2017) Reductions in global biodiversity loss predicted from conservation spending. Nature 551:364–367 . doi: 10.1038/nature24295

Walz U (2011) Landscape structure, landscape metrics and biodiversity. Living Rev Landsc Res 5: . doi: 10.12942/lrlr-2011-3

Wierzcholska, S., Dajdok, Z., Wuczynski, A., 2008. Do bryophytes reflect the diversity of vascular plants and birds in marginal habitats ? Scripra Fac. Rerum Nat. Univ. Ostrav. 186, 194–200.

Wu JX, Wilsey CB, Taylor L, Schuurman GW (2018) Projected avifaunal responses to climate change across the U.S. National Park System. PLoS One 13:e0190557. doi: 10.1371/journal.pone.0190557

Xiao R, Wang G, Zhang Q, Zhang Z (2016) Multi-scale analysis of relationship between landscape pattern and urban river water quality in different seasons. Sci Rep 6:1–10 . doi: 10.1038/srep25250

Zakkak S, Radovic A, Nikolov SC, et al (2015) Assessing the effect of agricultural land abandonment on bird communities in southern-eastern Europe. J Environ Manage 164:171–179 . doi: 10.1016/j.jenvman.2015.09.005

Zisenis M (2017) Is the Natura 2000 network of the European Union the key land use policy tool for preserving Europe’s biodiversity heritage? Land use policy 69:408–416. doi: 10.1016/j.landusepol.2017.09.045

Zoltan, B.-D., 2005. Rao’ s quadratic entropy as a measure of functional diversity based on multiple traits. J. Veg. Sci. 16, 533–540. doi:10.1658/1100-9233(2005)16[533:RQEAAM]2.0.CO;2

9. Annexes

Annex nr. 1:

Table 6. Bird species survey

Species	Number of cases
Alectoris rufa	84
Carduelis cannabina	84
Corvus corone	84
Coturnix coturnix	84
Falco tinnunculus	84
Galerida cristata	84
Miliaria calandra	84
Passer montanus	84
Apus apus	83
Carduelis carduelis	83
Circus pygargus	83
Columba palumbus	83
Hirundo rustica	83
Melanocorypha calandra	83
Milvus migrans	83
Passer domesticus	83
Phoenicurus ochruros	83
Sturnus unicolor	83
Upupa epops	83
Columba livia	82
Alauda arvensis	81
Oenanthe oenanthe	81
Calandrella brachydactyla	79
Pica pica	79
Serinus serinus	79
Streptopelia turtur	79
Picus viridis	78
Anas platyrhynchos	77
Athene noctua	77
Buteo buteo	77
Tyto alba	77
Carduelis chloris	76
Ciconia ciconia	76
Motacilla flava	76
Petronia petronia	76
Corvus monedula	75
Corvus corax	74
Luscinia megarhynchos	74
Gallinula chloropus	72
Otis tarda	72
Turdus merula	72
Fringilla coelebs	71
Anthus campestris	70

Oriolus oriolus	69
Parus major	69
Falco naumanni	67
Motacilla alba	66
Cuculus canorus	65
Burhinus oedicnemus	64
Hippolais polyglotta	63
Lullula arborea	63
Merops apiaster	63
Pterocles orientalis	63
Cettia cetti	62
Parus caeruleus	61
Acrocephalus scirpaceus	60
Lanius meridionalis	59
Tetrax tetrax	59
Lanius senator	58
Cisticola juncidis	57
Emberiza cirlus	56
Falco subbuteo	56
Asio otus	54
Sylvia cantillans	54
Certhia brachydactyla	53
Sylvia atricapilla	51
Troglodytes troglodytes	51
Dendrocopos major	50
Sylvia communis	48
Acrocephalus arundinaceus	46
Hieraaetus pennatus	46
Riparia riparia	46
Circus aeruginosus	45
Phylloscopus bonelli	45
Erithacus rubecula	42
Fulica atra	42
Otus scops	41
Streptopelia decaocto	40
Caprimulgus europaeus	39
Galerida theklae	36
Rallus aquaticus	35
Circus cyaneus	34
Sylvia borin	34
Tachybaptus ruficollis	34
Aegithalos caudatus	33
Clamator glandarius	33
Milvus milvus	33
Vanellus vanellus	33
Falco peregrinus	31
Columba oenas	30
Strix aluco	30

Charadrius dubius	29
Anthus trivialis	28
Remiz pendulinus	28
Turdus viscivorus	28
Accipiter gentilis	25
Ardea cinerea	24
Sylvia undata	24
Pterocles alchata	23
Phylloscopus ibericus	22
Actitis hypoleucos	21
Asio flammeus	21
Muscicapa striata	20
Oenanthe hispanica	20
Accipiter nisus	19
Ficedula hypoleuca	19
Phylloscopus collybita	19
Emberiza hortulana	18
Himantopus himantopus	18
Jynx torquilla	18
Saxicola rubetra	18
Alcedo atthis	15
Coccothraustes coccothraustes	14
Elanus caeruleus	13
Motacilla cinerea	13
Tringa totanus	13
Turdus philomelos	13
Coracias garrulus	12
Parus ater	12
Sylvia hortensis	12
Phoenicurus phoenicurus	10
Regulus ignicapilla	10
Sylvia conspicillata	10
Caprimulgus ruficollis	9
Circaetus gallicus	7
Emberiza cia	7
Garrulus glandarius	7
Nycticorax nycticorax	7
Anas strepera	5
Ardea purpurea	5
Passer hispaniolensis	5
Podiceps cristatus	5
Chlidonias hybrida	4
Corvus frugilegus	4
Parus cristatus	4
Podiceps nigricollis	4
Recurvirostra avosetta	4
Anas clypeata	3
Charadrius alexandrinus	3

Dendrocopos minor	3
Hirundo daurica	3
Lanius collurio	3
Anas querquedula	2
Bubulcus ibis	2
Chlidonias niger	2
Emberiza schoeniclus	2
Glareola pratincola	2
Larus ridibundus	2
Neophron percnopterus	2
Porzana porzana	2
Prunella modularis	2
Sitta europaea	2
Sterna albifrons	2
Sylvia melanocephala	2
Aquila chrysaetos	1
Ardeola ralloides	1
Bubo bubo	1
Chersophilus duponti	1
Coturnix japonica	1
Egretta garzetta	1
Gallinago gallinago	1
Gyps fulvus	1
Hippolais pallida	1
Ixobrychus minutus	1
Limosa limosa	1
Locustella luscinioides	1
Monticola saxatilis	1
Monticola solitarius	1
Panurus biarmicus	1
Porzana pusilla	1
Pyrrhocorax pyrrhocorax	1