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Conservation on the blink: deficient technical reports threaten conservation in the Natura 2000 network

Fulgencio Lisón[1]*, Adison Altamirano[1], Richard Field[2] and Gareth Jones[3]

[1]Laboratorio de Ecología del Paisaje Forestal, Departamento de Ciencias Forestales, Universidad de La Frontera, P.D. Box 45-D, Temuco, Chile.

[2]School of Geography, University of Nottingham, Nottingham NG7 2RD, United Kingdom.

[3]School of Biological Sciences, University of Bristol, 24 Tyndall Avenue, BS8 1TQ Bristol, United Kingdom.

*Corresponding author: e-mail: fulgencio.lison@ufrontera.cl; Phone: +56 45 2591043; Fax: +56 45 2325634

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Abstract

Globally, laws define both where protected areas are and their level of protection. Usually, the legal protection is not absolute and alternative land-uses can be implemented if perceived gains outweigh conservation losses. Technical reports, describing the importance of each protected area, are therefore crucial for decision-making, impact assessments, mitigation policies and management plans, and thus effective conservation. While much research has focused on protected areas themselves, including the biodiversity they contain and the impact of illegal activities, almost no research has evaluated the adequacy of the technical reports. Given high levels of data availability, the European Natura 2000 network (N2000) might be expected to represent best practice. Here we compare known bat presences with records from Standard Data Forms (SDFs) of Spanish N2000 Special Areas of Conservation (SAC); the Habitats Directive protects all European bat species. Across 1206 SACs, we found far fewer bat species listed in the SDFs than are known to occur in the SACs they represent, for both Annex II and particularly Annex IV bat species. These findings have serious conservation implications, including that decisions are systematically biased against conservation outcomes: if SDFs greatly underestimate the conservation value of their SACs, development of the land (or sea) is much more likely to be permitted. Incorporating known species presences into the SDFs of SACs is low in cost and straightforward, and can potentially achieve tremendous conservation benefits for minimal outlay; it should therefore be a top conservation priority globally, and conservation scientists should urgently engage with government agencies, accordingly.

Keywords: Chiroptera, Habitats Directive 92/43/EEC, Management policies, Spain, Special Areas of Conservation.

1. Introduction

Despite protected areas now covering 15.4% of the world's land surface (UNEP-WCMC, 2016), global biodiversity continues to decline more than 20 years after the United Nations Convention of Biological Diversity (Butchart et al., 2010). The extent to which reserves fulfil their role of protecting biodiversity depends on how well they meet two objectives (Margules and Pressey, 2000). The first is representativeness, a long-established goal referring to the need for reserves to represent, or sample, the full variety of biodiversity. This is addressed mainly in the original designation of areas as protected, and has been much researched (for example, using gap analyses and metrics of irreplaceability; Kukkala and Moilanen, 2013; Le Saout et al., 2013; Kukkala et al., 2016). The second objective is persistence: reserves, once established, should promote the long-term survival of the species and other elements of biodiversity they contain by maintaining natural processes and viable populations (Margules and Pressey, 2000) - increasingly important because of ongoing climate change that could undermine conservation efforts (Araújo et al., 2011; D'Amen et al., 2011; de Koning et al., 2014). An integral part of biodiversity conservation is ensuring the ongoing protection of reserves in the face of competing demands for the use of that land (or sea), such as development for housing, agriculture or extraction industries. In most cases, the legislation protecting any given reserve allows alternative uses of the area if the benefits are considered to outweigh the costs to a sufficient degree (Lee et al., 2007). Evaluating the conservation costs usually involves considering the likely impacts on the species known to be present in the reserve – as listed in official documentation associated with each reserve. However, this official documentation may not include all species known to occur within the reserve, and no research that we are aware of has examined this. Here we evaluate the extent to which official documentation reflects the bat species known to be present in Natura 2000 protected areas throughout Spain.

In Europe, the Natura 2000 network of protected areas (N2000) has become the mainstay of current conservation policies (Gaston et al., 2008). N2000 is based on two European Directives: (i) the Birds Directive (Official Journal of the European Union, 2009), which provides a list of birds for which the member states are required to designate Special Protection Areas (SPAs); and (ii) the Habitats Directive (Council Directive, 1992), which aims to protect specific animals (other than birds), plants and habitats, for which each member state is required to designate Special Areas of Conservation (SACs). Together, SPAs and SACs form the N2000 network.

In the case of SACs, the presence of a species in a particular annex of the Habitats Directive can be used as a proxy for conservation interest. The species of highest conservation interest tend to be those appearing in Annex II and Annex IV of the Habitats Directive. Annex II species are defined as "*animal or plant species of community interest whose conservation requires the designation of SAC sites*" (Council Directive, 1992). For Annex IV species "*a strict protection regime must be applied across their entire natural range within the EU, both within and outside Natura 2000 sites*" (Council Directive, 1992). The Habitats Directive recognizes caves as Priority Habitat (Code 8310) and many SAC sites were designated specifically for bats, and to include caves. For each SAC site, there is a Standard Data Form (SDF; Official Journal of the European Union, 2011), which defines its characteristics, location, size and the species present, for which it was designated. These SDFs are the basis for developing future management and recovery plans for these species. They are also crucial for decision-making because they are consulted to make Environmental Impact Assessments, for decisions on the development of infrastructures and urban areas, and to prioritise allocation of public funds for agriculture and forestry.

A number of studies have evaluated the effectiveness of the N2000 network in representing particular taxonomic groups, including plants (Chiarucci et al., 2008; Kallimanis et al., 2014), invertebrates (Abellán et al., 2007; Sánchez-Fernández et al., 2008) and various vertebrate groups (Abellán and Sánchez-Fernández, 2015; Albuquerque et al., 2013; Lisón et al., 2015b; Maiorano et al., 2015). Some have examined species of conservation concern in different taxonomic groups, for example species included in Annex II of the Habitats Directive (Gruber et al., 2012; Lisón et al., 2013) or threatened species (Trochet and Schmeller, 2013). However, there are no studies, to our knowledge, that investigate whether the SDFs are accurate in their documentation of the biodiversity present in the SAC sites they support, or whether this accuracy differs between threat categories for the species according to their status in the Habitats Directive's annexes.

Bats are an appropriate group to explore these questions because all European bat species are included in either Annex II or Annex IV of the Habitats Directive. European bats form a relatively homogeneous group of mammals, with similar ecological requirements (Dietz et al., 2009; Jones et al., 2009). Bats are also threatened (Jones et al., 2009), with most species' populations decreasing in recent decades (Dietz et al., 2009). In some European countries, however, an increase in the range and size of bat populations has been observed and attributed to application of specific management measures (Haysom et al., 2013). Because of their position in food webs, bats are very important species for the maintenance of ecosystem functions such as suppression of insect pests, pollination, seed dispersal, and nutrient cycling through their guano in terrestrial, aquatic and cave ecosystems. (Civantos et al., 2012; Jones et al., 2009; Kunz et al., 2011). As well as providing such valuable ecosystem services for humans (e. g. suppression of pests in agricultural landscapes, pollination of crops), bats serve as bioindicator and sentinel species (Boyles et al., 2011; Jones et al., 2009; Kunz et al., 2011; Lisón et al., 2015a). Nevertheless, rather few studies have specifically examined the relationship between bat distributions and the N2000 network (Lisón et al., 2013, 2015b; Maiorano et al., 2015; Zehetmair et al., 2015).

Spain represents approximately 18% of the surface of N2000 within the EU, with more protected land surface area in N2000 than any other country (European Commission, 2010). With 31 bat species, the Iberian Peninsula contains a high proportion of European bat biodiversity (approximately 80% of European bat species; Dietz et al., 2009; Palomo et al., 2007). Using data on bat species' distributions from mainland Spain and the Balearic Islands, we test the accuracy of data documented in SDFs for each SAC site, with respect to the bat biodiversity contained within these protected areas. We do this by comparing the species listed in the SDFs with the known distributions of European bat species. We also test for differences in this accuracy of the SDFs between Annex II and Annex IV species. Finally, we discuss the implications of the deficiencies we find for achieving the N2000 aims, and for conservation more generally.

2. Materials and methods

Our dataset for bat occurrences in mainland Spain and the Balearic Islands was based initially on distribution maps published in the Atlas and Red Book of Spanish terrestrial mammals (Palomo et al., 2007), with a resolution of 10 x 10 km UTM cells. Given the large home ranges of most bats and the fact that SACs frequently contain bat roosts, it is reasonable to attribute species' presences to SACs based on this distribution information. We added to the dataset 3708 new records at the same resolution from our own field sampling, and from a comprehensive compilation of recent literature (see Appendix A). This information was generated by bat experts using different methodologies (roost searching, acoustic surveys and trapping), minimizing the risk of bias in species detection (Flaquer et al., 2007), and providing important information even for rare species. The size of the spatial units used is appropriate given that the home-range of bats usually spans several kilometres (Dietz et al., 2009; Rainho and Palmeirim, 2011) and the roosts of most of the bats are in SACs (Lisón et al., 2013; Rainho and Palmeirim, 2013). We used this dataset to determine which bat species are present in each Spanish terrestrial SAC, according to the best available information. We refer to this as the 'known presences' of bat species in SACs.

We used data for 29 of the 31 species present in the study area. We did not include *Myotis nattereri/escalerai*, because these cryptic species have only recently been separated and their distributions are not yet well known (Palomo et al., 2007). For the sibling species *Eptesicus serotinus* and *E. isabellinus*, we considered the distribution of the latter to be confined to Andalusia and Murcia in south-southeast Iberia (Lisón et al., 2015b), while the former is distributed throughout the rest of the Iberian Peninsula, although there may be a contact zone (Santos et al., 2014). Eleven out of the 29 species in our dataset are listed in Annex II of the Habitats Directive and the other 18 are listed in Annex IV (see Appendices B and C).

In Spain, Autonomous Communities (AACCs or 'regions') are responsible for designating the SACs, so we aggregated data at the AACC level for analysis and display purposes. After determining which bat species are present in which SACs, according to our distribution dataset (known presences), we calculated the number of SACs in each region that contain at least one Annex II bat species, and the number that contain at least one Annex IV bat species (Appendix C).

In parallel, we analysed the Standard Data Form (SDF) for each SAC (Spanish Government, 2013), which were updated in 2013. We recorded which bat species are officially documented as being present in each Spanish terrestrial SAC, according to its SDF. We refer to this as the 'official presences' of bat species in SACs. Using this parallel dataset, we again calculated the number of SACs in each region that contain at least one Annex II bat species, and the number that contain at least one Annex IV bat species (Appendix B).

For each region, we divided the number of SACs that have official presences of Annex II or Annex IV bat species by the number of SACs in the region, to determine the percentage of SACs containing these target species. We refer to this as the 'official percentage of SACs' with Annex II or with Annex IV species. Then we repeated the process using known presences instead of official presences, to produce the 'known percentage of SACs' with Annex II or with Annex IV bat species. For each Annex type separately, we used a Wilcoxon test to determine whether there were significant differences between the official and actual percentages of SACs with species in that Annex. All analyses were performed using R software (R Core Team 2014), including the *Rcmdr* package.

Some SACs are underground roosts and their designation as SACs was exclusively due to the presence of bats. We refer to these SACs as 'exclusive', to indicate the centrality of bats to their protected status. These sites are usually very small because only the entrance to the roost (cave, mine or tunnel) has been protected, but we highlight their importance since they have been protected specifically for their bat communities. Usually, the information contained in the SDFs is based on a regional atlas compiled by regional experts. However, it is difficult to know when surveys were done, what the survey effort was (and thus how complete the species list is likely to be for any particular SAC) or the aims of the surveys, because this information is normally not published and not available.

3. Results

We analysed a total of 1206 SDFs for SAC sites in Spain (excluding the Canary Islands). According to this official documentation, 481 SACs (39.9%) have Annex II species and 123 (10.2%) have Annex IV species (Table 1). These numbers are much lower than when we recalculate them using known presences: 944 SACs (78.3 %) contain Annex II species and 953 (79.0 %) contain Annex IV species. Eighty-one SACs (6.7 %) were designated exclusively for bats (Table 1); five regions had no SACs of this type, while the highest amount was 17 of the 84 (20.2%) SACs in Comunidad Valenciana being of this type. All regions (AACCs) had Annex II species in the technical reports for at least some of their SACs; proportions ranged from 16.9% (30 out of 178) of the SACs in Andalucía containing at least one Annex II species to 100% for La Rioja (all six) and Madrid (all seven). Again, these numbers are much higher when using known presences instead of official presences (Table 1). For Annex IV bat species, six regions did not report the presence of any of these species in their SDFs for any of their SACs, while the highest percentage was Madrid, in which six of the seven (86%) of the SACs contained Annex IV species. Once again, the numbers were much higher for known presences than for official presences (Table 1).

Considering each species separately, the number and percentage of SACs in each region that contain individual Annex II and Annex IV bat species are shown in Appendix B (official presences) and Appendix C (known presences). Across all species and regions, we found that the percentage of SACs with Annex II bat species officially present was significantly lower than for known presences (Wilcoxon test, w = 215, P <0.001; Figure 1A). We found the same for Annex IV bat species (Wilcoxon test, w = 242, P <0.001; Figure 1B). Also, the percentage of SACs with Annex II bat species officially present was significantly higher than that for Annex IV bat species (Wilcoxon test, w = 233, P <0.001; Figure 1), but the percentage of known presences did not differ significantly between the two annexes (Wilcoxon test, w = 170, P = 0.119).

Similarly, when we analysed regions separately we found significant underrepresentation of Annex II bat species in the SDFs (Figure 2A): there were always higher levels of known presence than official presence for these species. Importantly, there was much more marked underrepresentation of the presence of Annex IV species in the SDFs (Figure 2B).

4. Discussion

We have shown that the Standard Data Forms for Special Areas of Conservation in Spain seriously under-represent the occurrences and diversity of protected bat species known to be present in those SACs. This deficiency is particularly large for the Annex IV species. While the scientific community has carefully studied the effectiveness of the Natura 2000 network in terms of whether the SACs and SPAs contain various taxonomic groups and their habitats (e.g. Abellán and Sánchez-Fernández, 2015; Lisón et al., 2013, 2015b; Maiorano et al., 2015; Sánchez-Fernández et al., 2008), very little attention has been paid to whether the SDFs supporting these protected areas accurately represent the biodiversity known to be within them. This issue is very important because the SDFs underpin management and conservation plans, and are central to the practical implementation of sustainable development (Popescu et al., 2014): conservation planning should be established in accordance with actual biodiversity patterns (Pressey et al., 2003; Jeanmougin et al., 2016). Further, the SDFs are the defining documents used in decision-making by governments regarding territorial planning, land use, future infrastructure development, Environmental Impact Assessment, N2000 connectivity, public funds for agroforestry and mitigating policies (Mazaris et al., 2013; Romano and Zullo, 2015; Stone et al., 2013). The SDFs can be used to indicate conservation needs in N2000 sites, and they are keystone documents for achieving the N2000 conservation aims (Hochkirch et al., 2013; Kati et al., 2015) and Aichi Targets (Convention on Biological Diversity, 2010).

Some studies have questioned the effectiveness of the N2000 network in protecting bat species (Lisón et al., 2013; Zehetmair et al., 2015) and whether the Annex II bat species act as ‘umbrella species’ representing the remaining bat species (Lisón et al., 2015b), although some Annex IV species are threatened or rare (Palomo et al., 2007). Our results add a new dimension to a growing body of research that identifies shortcomings in conservation policies with respect to biological knowledge (Rodhouse et al., 2016). Also, they highlight the importance of improving communication between ecologists and managers, as well as the need to implement open communication channels that will help make protected-area management more effective. Part of a new emphasis on better data in official documentation for protected areas can be the involvement of the public in gathering such data (citizen science; see e.g. Bonney et al., 2009; Silvertown, 2009; Barlow et al., 2015;Newson et al., 2015).

Our quantification of the very large under-representation of bat in the SDFs of Special Areas of Conservation is partly based on the assumption that distribution data at 10 km x 10 km resolution indicate the presence or absence of species in SACs within those grid squares. This is potentially problematic for two main reasons. First, some of the distribution data may reflect historic presences but the species may now be absent from the grid square. Second, species do not completely fill the landscape, so presence within a grid square does not necessarily mean presence in a SAC within the grid square. However, given what we know about bat ecology and movement capacity (Dietz et al., 2009; Rainho and Palmeirim, 2013) and the habitats contained within SACs, we consider it likely that most bat species appearing in areas surrounding SACs use those sites for roosting or feeding, or that the SACs contain important habitat for them in some other respect (Lisón et al., 2013, 2015b; Rainho and

Palmeirim, 2013). Further, part of our dataset was from recent field surveys. Certainly it is inconceivable that the massive under-representation of known occurrences that we found in the SDFs is entirely due to artefacts of the methods. Instead, the great differences found in almost all the bat species between the official and known occurrences show that there are serious deficiencies in the application of Natura 2000, especially for Annex IV bat species, even though most of these species are easily detected by ultrasound surveys (Flaquer et al., 2007) and many have quite a wide distribution (Appendix C; Palomo et al., 2007).

The under-reporting of species in the SDFs could also be due in part to those reports being written several years ago (Lisón et al., 2015b; Palomo et al., 2007), when there was less information about bat distributions in some regions. However, SDFs were updated in 2013 after the last report made during the period between 2007 and 2012 under art. 17 of the Habitats Directive. At this time, the Atlas of Mammals of Spain was revised and contained considerable information on bat distributions. Therefore, the necessary information was available and this problem could be solved simply by updating the dataset (see Appendices). There may also be a lack of political will to ensure that the reports are up to date, and greater willingness would strengthen the protection of species offered by N2000 (Rojas-Briales, 2000; Orlikowska et al., 2016).

We cannot reject the possibility that our results represent an issue restricted to Spain, though we consider it highly unlikely. Given the seriousness of the implications of our findings, similar studies in other countries and with different taxa should be undertaken as a matter of urgency. Further, the Spanish situation in itself is of international interest because of the high importance of Spain within the N2000 network, and its high biodiversity within the European context.

Member States are not specifically required to list the Annex IV species present in the Natura 2000 sites (Official Journal of the European Union, 2011). This does not explain under-representation as a general phenomenon because Annex II species are also significantly under-represented in the official documentation. However, it is almost certainly one reason why the under-representation is much more extreme for Annex IV than Annex II species. Given the need to conserve Annex IV species, many of which are threatened, our results thus highlight the lack of requirement to list Annex IV species in

SDFs as a major problem with the Habitats Directive; it would be interesting to explore why this requirement is missing from the legislation.

Certainly, the under-representation of protected species in the SDFs biases the outcomes and associated decision-making of N2000 against conservation objectives, and favours developers and other parties that may oppose conservation goals (Apostolopoulou and Pantis, 2009; Margules and Pressey, 2000). Thus it is very likely to negatively affect conservation and the aims of N2000. But these aims are very important. For one thing, some Annex IV bat species are rare, and often endemic and cryptic, and therefore could face high levels of threat (see national Red List in Palomo et al., 2007 and regional Red List in Lisón et al., 2011). Further, bats have important roles in ecosystem structure and function (Boyles et al., 2011; Jones et al., 2009; Kunz et al., 2011) to ignore their presence in the SDFs will hinder the development of strong conservation plans to guarantee the integrity and coherence of the N2000 network (Orlikowska et al., 2016).

5. Conclusions

The considerable deficit of occurrence information for species of conservation importance in the SDFs of protected areas is a serious concern, undermining the effectiveness of conservation networks such as Natura 2000. The technical reports are the keystone to management and conservation plans and decision-making within protected areas. There is an urgent need to update them with much more complete information about which species are in which protected conservation sites, and also to open up communication channels between conservation scientists and the managers of protected areas: incorporating citizen science would enhance this. Better knowledge of the biodiversity of protected areas, and their conservation status, will aid decision-making at all levels.

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Table 1: Number of Special Areas of Conservation (SACs) containing Annex II and Annex IV bat species in each Autonomous Community (AACC) of Spain. 'Abbrev.' is the abbreviation used for each AACC in Figure 2 and in the supplementary online material. 'No. of SACs' is the number of SACs in each AACC, and 'Exclusive' is the number of these that were designated exclusively for bats. The other columns contain the number of SACs in each region that have Annex II or Annex IV bat species according to the Standard Data Forms (official presences) or known presences. Numbers in parentheses are percentages of the total number of SACs in the AACC.

			Official presences		Known presences		
AACC	Abbrev.	No. of SACs	Annex II	Annex IV	Annex II	Annex IV	Exclusive
Andalucía	And	178	30 (16.9%)	3 (1.7%)	118 (66.3%)	87 (48.9%)	3 (8.4%)
Aragón	Ara	156	69 (44.2%)	29 (18.6%)	106 (67.9%)	119 (76.3%)	12 (7.7%)
Asturias	Ast	49	19 (38.8%)	0 (0.0%)	44 (89.6%)	44 (89.6%)	1 (2.0%)
Baleares	Bal	111	29 (26.1%)	5 (4.5%)	68 (61.3%)	79 (71.2%)	8 (7.2%)
Cantabria	Can	21	10 (47.6%)	0 (0.0%)	20 (95.2%)	19 (90.5%)	2 (9.5%)
Castilla León	Cle	122	70 (57.4%)	0 (0.0%)	110 (90.2%)	118 (96.7%)	3 (2.5%)
Castilla La Mancha	Cma	74	19 (25.7%)	0 (0.0%)	55 (74.3%)	56 (75.7%)	5 (6.8%)
Cataluña	Cat	111	81 (73.0%)	0 (0.0%)	105 (94.6%)	99 (89.2%)	2 (1.8%)
Extremadura	Ext	88	34 (38.6%)	17 (19.3%)	69 (78.4%)	87 (98.9%)	14 (15.9%)
Galicia	Gal	58	11 (19.0%)	0 (0.0%)	48 (82.8%)	44 (75.9%)	0 (0.0%)
Madrid	Mad	7	7 (100.0%)	6 (85.7%)	7 (100.0%)	7 (100.0%)	0 (0.0%)
Región de Murcia	Mur	47	28 (59.6%)	31 (66.0%)	38 (80.9%)	38 (80.9%)	2 (4.3%)
Navarra	Nav	42	16 (38.1%)	9 (21.4%)	35 (83.3%)	42 (100.0%)	0 (0.0%)
La Rioja	Rio	6	6 (100.0%)	4 (66.7%)	6 (100.0%)	6 (100.0%)	0 (0.0%)
Comunidad Valenciana	Val	84	37 (44.0%)	9 (10.7%)	63 (75.0%)	56 (66.7%)	17 (20.2%)
País Vasco	Vas	52	15 (28.8%)	10 (19.2%)	52 (100.0%)	52 (100.0%)	0 (0.0%)
Total		1206	481 (39.9%)	123 (10.2%)	944 (78.3%)	953 (79.0%)	81 (6.7%)

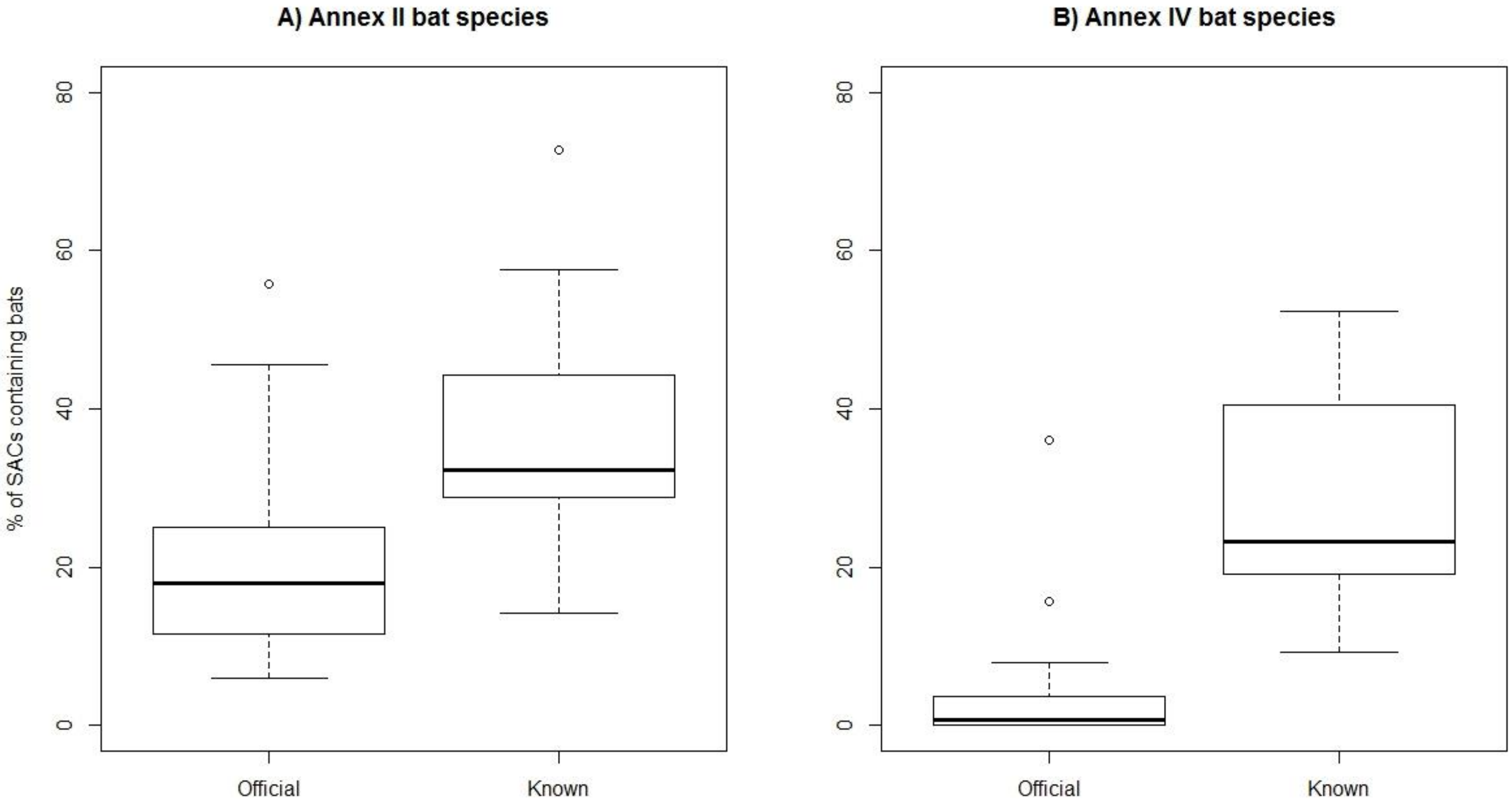
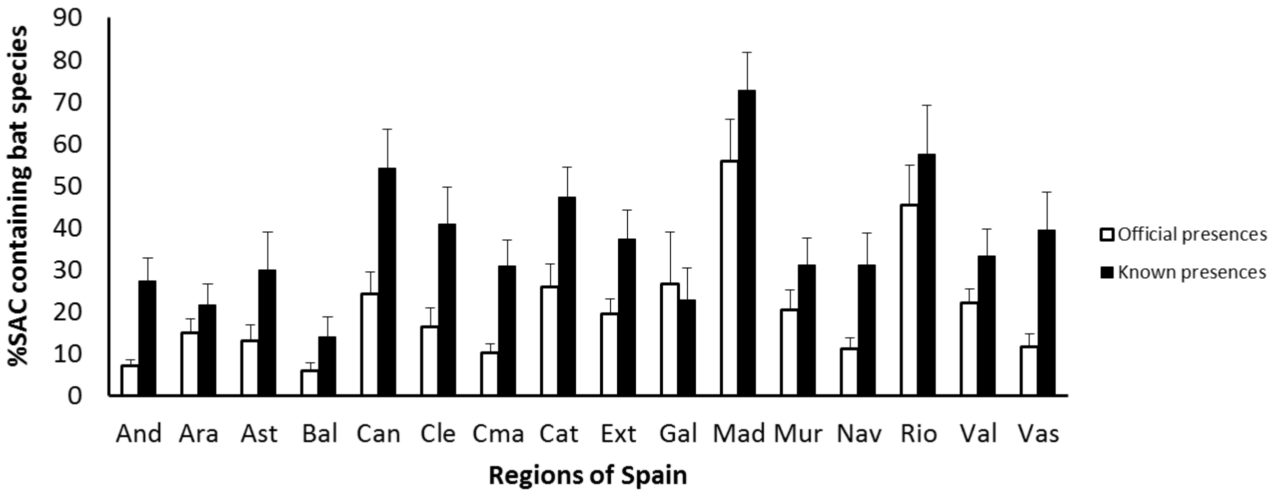


Figure 1: Boxplots representing the variation across regions (Autonomous Communities) in the percentage of Special Areas of Conservation that contain at least one Annex II (A) or Annex IV (B) bat species. Each percentage value (vertical axis, labeled "% SACs containing bats") refers to one region.

(A) Annex II



(B) Annex IV

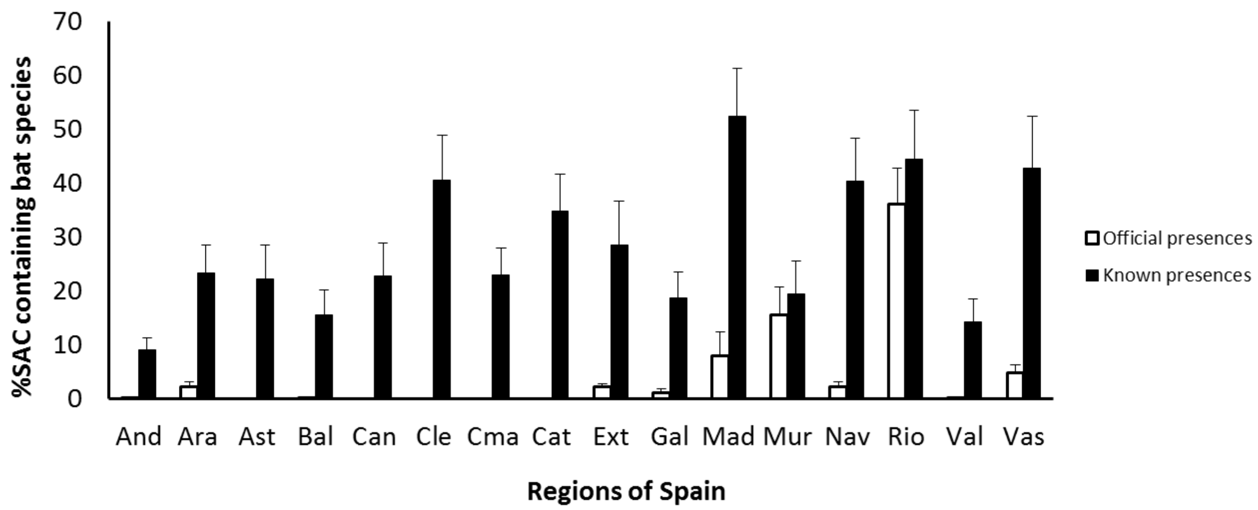


Figure 2: Under-representation of bat species in the Standard Data Forms (SDFs) supporting Special Areas of Conservation (SACs; 'Official' – white bars), as judged by known occurrences ('Known' – black bars). For each region (Autonomous Community; abbreviations explained in Table 1), the mean percentage across all the species is shown (error bars are one standard error of the mean), where each percentage is the number of SACs in the region that contain the species, expressed as a percentage of the total number of SACs in the region. Annex II (A) and Annex IV (B) bat species.

Appendix A: List of bibliographic references used to complete the database of bat distributions and known occurrences in Special Areas of Conservation in Spain.

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Appendix B: Official presences of each bat species in Special Areas of Conservation (SACs) in each Autonomous Community (AACC) in Spain. The values shown are percentages: in each case, the percentage of all the SACs in the AACC that are occupied by the species, according to the Standard Data Forms of the SACs. Abbreviations of AACCs are explained in Table 1; those of species are explained in the footnote below.

	Sp	And	Ara	Ast	Bal	Can	Cle	Cma	Cat	Ext	Gal	Mad	Mur	Nav	Rio	Val	Vas
Annex II	Bbar	0.6	19.9	18.4	0.9	14.3	9.0	2.7	9.9	4.5	6.9	42.9	0.0	16.7	33.3	6.0	7.7
	Mbec	1.1	0.0	0.0	0.0	14.3	3.3	4.1	1.8	9.1	1.7	0.0	0.0	4.8	33.3	3.6	3.8
	Mbly	7.9	6.4	0.0	0.0	23.8	8.2	4.1	24.3	14.8	1.7	71.4	19.1	7.1	33.3	31.0	1.9
	Mcap	0.6	1.9	0.0	10.8	0.0	0.0	0.0	20.7	0.0	0.0	0.0	27.7	0.0	0.0	23.8	0.0
	Mema	2.8	16.0	10.2	0.9	14.3	9.8	9.5	29.7	13.6	3.4	42.9	8.5	14.3	66.7	11.9	15.4
	Mmyo	11.2	18.6	6.1	18.0	42.9	32.8	10.8	17.1	31.8	69.0	85.7	34.0	14.3	33.3	28.6	15.4
	Msch	14.0	18.6	22.4	17.1	38.1	29.	20.3	41.4	31.8	5.2	71.4	40.4	19.0	50.0	33.3	23.1
	Reur	10.7	19.9	22.4	0.0	47.6	9.8	13.5	38.7	21.6	5.2	85.7	14.9	4.8	83.3	32.1	11.5
	Rfer	12.9	28.8	32.7	7.2	47.6	41.0	21.6	55.9	35.2	98.3	100.0	44.7	23.8	66.7	36.9	26.9
	Rhip	7.9	34.0	30.6	5.4	19.0	36.9	14.9	44.1	20.5	100.0	57.1	25.5	19.0	100.0	19.0	23.1
	Rmeh	7.9	0.0	0.0	4.5	4.8	0.0	10.8	2.7	31.8	1.7	57.1	10.6	0.0	0.0	16.7	0.0
Annex IV	Eser	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	1.1	3.4	0.0	0.0	0.0	66.7	0.0	9.6
	Eisa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.1	0.0	0.0	0.0	0.0
	Hsav	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	2.1	0.0	66.7	0.0	0.0
	Malc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0

Mdau	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	8.5	0.0	66.7	1.2	7.7
Mmys	0.0	12.2	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	33.3	0.0	1.9
Nlas	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	2.1	7.1	33.3	0.0	0.0
Nlei	0.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	16.7	50.0	0.0	13.5
Nnoc	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	1.9
Paur	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	12.1	0.0	0.0	7.1	50.0	1.2	15.4
Paus	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	1.7	42.9	25.5	2.4	66.7	2.4	13.5
Pmac	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0
Pnat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0
Pkuh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	14.3	36.2	0.0	50.0	0.0	7.7
Ppip	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4	5.2	71.4	57.4	0.0	50.0	0.0	11.5
Ppyg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	53.2	0.0	0.0	0.0	0.0
Tten	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	1.1	0.0	14.3	42.6	2.4	66.7	0.0	5.8
Vmur	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species abbreviations: Bbar: *Barbastella barbastellus*; Mbec: *Myotis bechsteinii*; Mbly: *Myotis blythii*; Mcap: *Myotis capaccinii*; Mema: *Myotis emarginatus*; Mmyo: *Myotis myotis*; Msch: *Miniopterus schreibersii*; Reur: *Rhinolophus euryale*; Rfer: *Rhinolophus ferrumequinum*; Rhip: *Rhinolophus hipposideros*; Rmeh: *Rhinolophus mehelyi*; Eser: *Eptesicus serotinus*; Eisa: *Eptesicus isabellinus*; Hsav: *Hypsugo savii*; Malc: *Myotis alcathoe*; Mdau: *Myotis daubentonii*; Mmys: *Myotis mystacinus*; Nlas: *Nysctalus lasiopterus*; Nlei: *Nyctalus leisleri*; Nnoc: *Nyctalus noctula*; Paur: *Plecotus auritus*; Paus: *Plecotus austriacus*; Pmac: *Plecotus macrobullaris*; Pnat: *Pipistrellus nathusii*; Pkuh: *Pipistrellus kuhlii*; Ppip: *Pipistrellus pipistrellus*; Ppyg: *Pipistrellus pygmaeus*; Tten: *Tadarida teniotis*; Vmur: *Vespertilio murinus*.

Appendix C: Known presences of each bat species in Special Areas of Conservation (SACs) in each Autonomous Community (AACC) in Spain. The values shown are percentages: in each case, the percentage of all the SACs in the AACC that are occupied by the species, according to the best available information on bat distributions. Abbreviations of AACCs are explained in Table 1; those of species are explained in the footnote below.

	Sp	And	Ara	Ast	Bal	Can	Cle	Cma	Cat	Ext	Gal	Mad	Mur	Nav	Rio	Val	Vas
Annex II	Bbar	3.9	26.3	34.7	1.8	38.1	50.0	6.8	42.3	8.0	29.3	42.9	0.0	40.5	50.0	6.0	38.5
	Mbec	6.7	1.3	0.0	0.0	19.0	10.7	10.8	13.5	21.6	10.3	57.1	0.0	4.8	50.0	0.0	15.4
	Mbly	25.8	7.7	6.1	0.0	42.9	26.2	17.6	42.3	33.0	1.7	85.7	31.9	16.7	66.7	22.6	11.5
	Mcap	2.8	3.8	0.0	15.3	0.0	0.0	2.7	39.6	0.0	0.0	0.0	34.0	0.0	0.0	29.8	0.0
	Mema	17.4	29.5	18.4	0.0	33.3	27.9	32.4	58.6	22.7	22.4	71.4	29.8	42.9	66.7	22.6	44.2
	Mmyo	40.4	28.2	18.4	27.9	90.5	70.5	43.2	44.1	62.5	24.1	100.0	36.2	40.5	16.7	45.2	50.0
	Msch	47.8	24.4	53.1	24.3	85.7	64.8	45.9	64.0	62.5	12.1	100.0	57.4	33.3	100.0	58.3	75.0
	Reur	34.8	22.4	42.9	0.0	66.7	39.3	37.8	52.3	39.8	15.5	85.7	17.0	23.8	83.3	50.0	44.2
	Rfer	55.1	44.2	71.4	28.8	95.2	75.4	66.2	82.9	70.5	58.6	100.0	66.0	69.0	100.0	70.2	78.8
	Rhip	37.1	50.0	83.7	45.0	76.2	79.5	55.4	76.6	36.4	77.6	85.7	48.9	71.4	100.0	34.5	76.9
	Rmeh	29.8	0.0	2.0	11.7	47.6	6.6	20.3	5.4	52.3	0.0	71.4	21.3	0.0	0.0	26.2	0.0
Annex IV	Eser	0.0	42.3	51.0	18.9	42.9	68.9	27.0	57.7	51.1	50.0	85.7	0.0	76.2	83.3	29.8	98.1
	Eisa	23.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	5.7	0.0	0.0	63.8	0.0	0.0	2.4	0.0
	Hsav	12.4	48.7	16.3	28.8	9.5	47.5	36.5	62.2	13.6	10.3	100.0	8.5	45.2	66.7	25.0	19.2
	Malc	0.0	0.0	0.0	0.0	0.0	0.8	0.0	7.2	0.0	3.4	0.0	0.0	14.3	16.7	0.0	0.0

Mdau	18.5	32.7	59.2	0.0	38.1	80.3	41.9	51.4	29.5	41.0	85.7	17.0	78.6	50.0	10.7	76.9
Mmys	1.1	9.6	12.2	0.0	19.0	22.1	6.8	9.0	6.8	10.3	42.9	0.0	23.8	16.7	0.0	30.8
Nlas	9.0	12.2	6.1	0.0	0.0	23.0	10.8	2.7	6.8	5.2	57.1	0.0	14.3	16.7	0.0	0.0
Nlei	11.2	26.9	12.2	34.2	23.8	44.3	27.0	45.0	28.4	25.9	57.1	0.0	76.2	66.7	2.4	86.5
Nnoc	0.6	0.0	2.0	0.0	9.5	6.6	1.4	0.0	2.3	0.0	14.3	0.0	4.8	16.7	0.0	3.8
Paur	0.0	25.6	26.5	0.0	38.1	47.5	12.2	34.2	8.0	37.9	57.1	0.0	31.0	16.7	1.2	57.7
Paus	13.5	40.4	10.2	22.5	19.0	74.6	44.6	55.0	33.0	46.6	85.7	46.8	47.6	83.3	22.6	42.3
Pmacc	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pnat	0.0	0.0	0.0	1.8	0.0	0.8	50.0	17.1	1.1	0.0	14.3	2.1	14.3	0.0	1.2	15.4
Pkuh	15.2	52.6	4.1	46.8	14.3	52.5	0.0	72.1	43.2	1.7	85.7	48.9	81.0	83.3	26.2	96.2
Ppip	22.5	64.7	73.5	56.8	81.0	95.9	54.1	69.4	97.7	63.8	85.7	59.6	100.0	100.0	48.8	100.0
Ppyg	23.0	10.9	71.4	22.5	81.0	94.3	47.3	72.1	97.7	15.5	85.7	53.2	40.5	100.0	47.6	100.0
Tten	15.2	46.2	55.1	46.8	33.3	72.1	48.6	67.6	88.6	24.1	85.7	51.1	78.6	83.3	39.3	42.3
Vmur	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Species abbreviations: Bbar: *Barbastella barbastellus*; Mbec: *Myotis bechsteinii*; Mbly: *Myotis blythii*; Mcap: *Myotis capaccinii*; Mema: *Myotis emarginatus*; Mmyo: *Myotis myotis*; Msch: *Miniopterus schreibersii*; Reur: *Rhinolophus euryale*; Rfer: *Rhinolophus ferrumequinum*; Rhip: *Rhinolophus hipposideros*; Rmeh: *Rhinolophus mehelyi*; Eser: *Eptesicus serotinus*; Eisa: *Eptesicus isabellinus*; Hsav: *Hypsugo savii*; Malc: *Myotis alcathoe*; Mdau: *Myotis daubentonii*; Mmys: *Myotis mystacinus*; Nlas: *Nysctalus lasiopterus*; Nlei: *Nyctalus leisleri*; Nnoc: *Nyctalus noctula*; Paur: *Plecotus auritus*; Paus: *Plecotus austriacus*; Pmac: *Plecotus macrobullaris*; Pnat: *Pipistrellus nathusii*; Pkuh: *Pipistrellus kuhlii*; Ppip: *Pipistrellus pipistrellus*; Ppyg: *Pipistrellus pygmaeus*; Tten: *Tadarida teniotis*; Vmur: *Vespertilio murinus*.