



Biases in conservation: A regional analysis of Spanish vertebrates

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ABSTRACT

Apart from being the main cause of biodiversity loss, humans are also essential for sustainability and biological conservation. Regulations for the conservation of threatened species are key to respond to this challenge. Here we evaluate the efficacy of mandatory regulations in Spain, a decentralized country, for the effective protection of threatened terrestrial vertebrates. We studied the association between the number of both “vulnerable” and “endangered” species on regional lists of threatened species and approved management plans for such species (mandatory) with ecological (e.g. percentage of forest and agricultural areas), social (e.g. environmental awareness and GPD per capita) and geographical (e.g. total and protected areas) variables on the regional scale. Our results showed that an approved management plan is available for only 20% of threatened terrestrial vertebrates and there were important taxonomical and regional biases. Higher protection levels appeared in regions with higher percentages of protected area, more citizens’ environmental awareness, lower GPD per capita and shorter regional lists. Herpetofauna has fewer approved management plans than mammals or birds. Our results highlight the importance of integrating the perspective, knowledge and practices of all stakeholders (Academia, governments and society) to effectively apply environmental regulations.

1. Introduction

One of the major challenges that today’s society faces is mitigating the biodiversity loss curve (Ceballos et al., 2015; Ceballos et al., 2017; Mace et al., 2018; Ripple et al., 2019; WWF, 2020) as it threatens the essential ecosystem services provided for humanity (Díaz et al., 2006), harming both human well-being and ecosystem functioning (Mace et al., 2005; Tilman et al., 2014). Global changes, such as habitat loss and fragmentation, soil erosion, water scarcity, development disparities or global warming (Schellnhuber et al., 1997), are the main threats for biodiversity conservation (Bellard et al., 2014). Despite humans being the main cause of biodiversity loss, they are also key to find strategies for sustainable development and effective conservation policies. For example, Hoffmann et al. (2015) calculated that without conservation measures, at least 148 ungulates species would increase the endangered status worldwide, and Bolam et al. (2020) estimated that bird and mammals extinction rates would have been 2.9–4.2-fold higher without conservation policies. However, conservation policies are generally driven by taxonomical and geographical biases (Lawler et al., 2006; Díaz

et al., 2018). Albeit it helps to protect some species, it can undermine the overall biodiversity conservation goal (Di Marco et al., 2017; Christie et al., 2020a).

Conservation actions focus on a small charismatic group of animals, mainly motivated by species’ popularity rather than their threat status (Díaz et al., 2018) or research activity (Troudet et al., 2017). Previous studies demonstrate that humans tend to lavishly pay more attention to vertebrates (Restani & Marzluff, 2002), especially mammals and birds (Titley et al., 2017), and to species that are phylogenetically close to humans or esthetically attractive like Cetaceans (Martín-Forés et al., 2013). Beliefs in and myths about harmfulness herpetofauna (Ceríaco, 2012; Rueda Núñez, 2014), or conflicts between humans and large carnivores like wolves and bears (Kleiven et al., 2004; Margalida et al., 2011) or scavengers (Morales-Reyes et al., 2018), hinder effective conservation policies. Taxonomical biases are also found in research as the number of studied species is not proportional to the number of species found in nature. For example, although there are more amphibian species than mammals, scientific research encompasses 10-fold more mammal species than amphibians (Clark & May 2002). Rosenthal et al.

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Table 1
Main European, state and regional regulations for wildlife protection in Spain.

Europe	Council Directive 92/43/EEC, of May 21, 1992 (Habitats Directive) Directive 2009/147/EC on the conservation of wild birds	
Spain	Law 42/2007, of December 13, on Natural Heritage and Biodiversity (Appendix A)	Spanish List of Threatened Species ("Vulnerable" and "Endangered")
Regions	Regional Laws for nature and biodiversity (Appendix A)	Regional Lists of Threatened Species (Vulnerable, Endangered and Others)

Table 2
Number of species on the Spanish List of Threatened Species and percentage of species considered "Vulnerable" and "Endangered" (Ministerio para la Transición Ecológica, 2020).

Taxonomical group	Number of threatened species	Percentage of "Vulnerable" species	Percentage of "Endangered" species
Spain	52	60%	40%
Spain	35	80%	20%
Spain	15	47%	53%
Spain	8	75%	25%
Spain	110	65%	35%

(2017) demonstrated that endothermic vertebrates are extremely over-represented in scientific publications, and Dos Santos et al. (2020) showed that scientific capacity of countries within species' range,

Table 3
Number of threatened species, "Vulnerable" species (VU), "Endangered" species (EN), species with approved management plans (also expressed as a percentage) and Index of Adjustment to the List (IAL). Regions are ordered from top to bottom from the highest to the lowest IAL.

Region	Number of Threatened species	Vulnerable	% VU with approved management plans	Endangered	% EN with approved management plans	IAL
Asturias	6	4	100	2	100	1.00
La Rioja	22	17	29	5	80	0.63
Balearics	36	22	45	14	71	0.63
Andalusia	45	27	26	18	78	0.60
Murcia	20	14	0	6	67	0.44
Canaries	14	6	0	8	63	0.42
Valencian Comm.	51	39	15	12	50	0.38
Extremadura	41	29	0	12	50	0.33
Castilla - La Mancha	82	70	1	12	42	0.28
Basque Country	43	26	12	17	35	0.27
Navarre	33	17	24	16	19	0.20
Cantabria	23	19	0	4	25	0.17
Aragón	28	21	5	7	14	0.11
Galicia	65	48	2	17	12	0.09
Madrid	33	22	0	11	9	0.06
Mean	36.13	25.40	17.30	10.73	47.62	0.38
SD	19.68	16.67	26.81	5.16	28.38	0.26

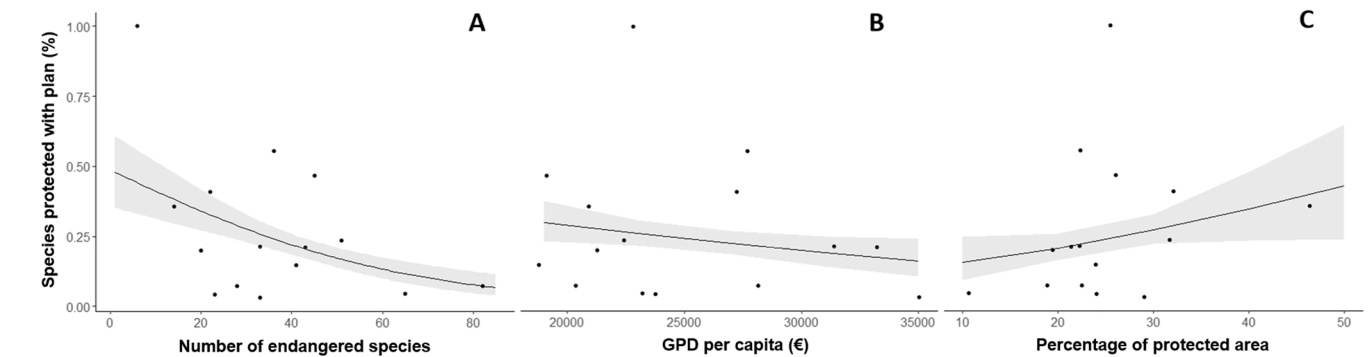


Fig. 1. Relations between the percentage of species protected with a management plan and: A) number of threatened species; B) GPD per capita; C) percentage of protected areas. These variables are included in the binomial GLM models, which have the 92% of the model averaging weight. The gray zone around the line represents the 95% confidence interval.

Table 4
Model averaging results for the ecological, social and geographical variables used in the binomial GLMs. Two goodness-of-fit metrics were used: lower "AIC (Akaike's information Criterion)" indicates a more parsimonious model, and a higher "Weight" denotes a model's better fit compared to the other tested models.

Model	Degrees of freedom	AIC	Weight
1-3	3	133.47	0.47
1-4	3	134.55	0.27
1	2	135.33	0.18
1-2	3	138.18	0.04
4	2	139.64	0.02
3-4	3	142.38	0.01
2-4	3	142.48	0.01
2	2	149.51	0.00
2-3	3	149.58	0.00
5	2	152.78	0.00
3	2	156.31	0.00
6	2	156.61	0.00

1 = Number of protected species, 2 = environmental awareness, 3 = GPD per capita, 4 = Percentage of protected area, 5 = Percentage of forest area, 6 = Percentage of agricultural area, 7 = ha of protected area.

followed by body mass and years since taxonomical description, explain conservation research efforts. In addition to these predictors, the presence of species in man-made habitats also can explain the conservation-related research effort (Silva et al., 2020). Besides taxonomical biases, species conservation and research efforts are also

Table 5

Number of threatened species (VU and EN) for the different taxonomical groups and Regions and percentage of those with approved management plans.

Region	Mammals	% with plan	Birds	% with plan	Reptiles	% with plan	Amphibians	% with plan	Total	% with plan
Asturias	1	100	3	100	0	0	2	100	6	100
La Rioja	12	16.7	10	70	0	0	0	0	22	41
Balearics	13	38.5	20	35	1	100	2	50	36	38.9
Andalusia	12	8.3	29	69	3	0	1	0	45	46.7
Murcia	4	25	15	6.7	1	0	0	0	20	10
Canaries	1	0	10	20	3	100	0	0	14	41.7
Valencian C.	12	16.7	35	28.6	2	0	2	0	51	23.5
Extremadura	12	41.7	25	4	1	0	3	0	41	14.6
Castilla - La Mancha	20	5	58	8.6	3	0	1	0	82	7.3
Basque C.	16	18.8	20	25	3	0	4	25	43	20.9
Navarre	10	30	23	17.4	0	0	0	0	33	21.2
Cantabria	12	8.3	9	0	0	0	2	0	23	4.4
Aragón	9	0	17	11.8	2	0	0	0	28	7.1
Galicia	15	0	30	6.7	13	7.7	7	0	65	4.6
Madrid	12	0	12	8.3	5	0	4	0	33	3
Total	161	15.5	316	22.2	37	13.5	28	14.3	542	19.2

Table 6

Average of years (standard deviation is shown) taken to approve management plans for threatened species since they appear on the Regional List.

Region	Years taken to approve management plans (\pm SD)
Asturias	10.17 \pm 4.5
La Rioja	16 \pm 0
Balearics	2.21 \pm 1.4
Andalusia	7.95 \pm 1.9
Murcia	21 \pm 0
Canaries	2 \pm 3.1
Valencian C.	15.17 \pm 5.8
Extremadura	11.67 \pm 4.1
Castilla - La Mancha	6.33 \pm 6.1
Basque Country	11.56 \pm 5.9
Navarre	1.43 \pm 0.8
Cantabria	0 \pm 0
Aragón	12 \pm 5.7
Galicia	6.33 \pm 0.6
Madrid	18 \pm 0
Mean	9.45 \pm 6.45

subject to strong geographical biases. For example, some ecosystems from the northern hemisphere like temperate forests dominate the scientific literature (Lawler et al., 2006). Di Marco et al. (2017) found that around 40% of biological conservation studies are carried out in the USA, Australia and the UK, but only 10% in Africa and 6% in Southeast Asia. Due to taxonomic biases in scientific research, conservation policies and societal preferences are closely related issues, as we explained in the previous examples, governments decisions and social interest can largely define which animal groups are studied the most.

Here we used threatened status and conservation policies of terrestrial vertebrates in Spain to analyze taxonomical and geographical conservation biases. In this study, we quantitatively analyzed the national and regional lists of threatened species, and the management plans for terrestrial vertebrates, in Spain to evaluate the factors associated with fulfilling conservation policies, and to find potential geographical and taxonomical biases. Although conservation actions in Spain have substantially increased in the last few decades (Morillo & Gómez-Campo, 2000), a complete review of the conservation status of its threatened vertebrate species, and its adjustment to existing regulations, is lacking. We hypothesize that (1) the compliance with conservation regulations in Spain varies between regions, due to their ecological, social, and geographic differences. In this sense, higher percentage of threatened species under a management plans are found in regions with a higher Gross Domestic Product (GDP) per capita, because it is presumed that they have more technical and administrative capacity to develop the conservation policies; higher percentage of protected area and forest area, where conservation policies have

traditionally been focused on; and more environmental awareness, being citizen pressure one of the major drivers that lead to political action. On the contrary, lower percentage of threatened species under a management plan are found in regions with high number of threatened species in their lists and higher percentage of agricultural area; (2) endotherm species, like mammals and birds, have higher rates of approved management plans than herpetofauna, due to most of reptiles and amphibians are generally less popular species

2. Materials and methods

This research was conducted in Spain, which includes 17 Regions known as “Autonomous Communities” (15 insular regions and 2 island regions; map in Appendix D). The wildlife conservation regulation of Spain, as a decentralized country, includes three levels: European directives, national laws and regional normative (Table 1, Appendix A). Each region must approve its own regional list of threatened species with at least two categories: “Endangered”, which includes taxa or populations whose survival is unlikely if the causal factors of the current situation continue to act; “Vulnerable”, taxa or populations at risk of moving to the previous category in the immediate future if the adverse factors that act on them are not corrected. They must include the species already listed on the National List that are present in their territory. They can also include more species or increase the degree of certain species’ threat according to scientific reports. Furthermore, each region has to develop a Conservation Plan for the threatened taxa or populations included in the “Vulnerable” category within a maximum 5-year period, and a Recovery Plan for the taxa or populations included in the “Endangered” category within a maximum 3-year period (Appendix A). The conservation measures contemplated in both these Conservation and Recovery management plans aim to recover populations of target species by reducing threats, and protecting or improving both current and potential habitats. In addition, these management plans seek to encourage research, dissemination, awareness and the involvement of society in conservation actions.

We used data on state and regional regulations of terrestrial vertebrates (mammals, birds, reptiles, amphibians). National law correspond to Law 42/2007, of December 13, on Natural Heritage and Biodiversity, and Royal Decree-Law 139/2011, of February 4, about the Spanish List of Threatened Species, as well as all its modifications. We also included data from regional normative on the management of biodiversity, and those regulations with a modified regional list of threatened species (Appendix A) and the management plans of every species (Appendix B). We considered any regulations approved before 2020.

For all 17 Regions, we obtained the number of threatened species categorized as “Vulnerable” and “Endangered”, the year that each species was included on the list and the year of publication of its

management plan (if applicable). The approval of the management plan, however, do not imply the start up of the same, being only the first step of a long administrative process which also could induce a failure in the effectiveness of them. Nevertheless, we chose the approval date to be as precise and equal between regions as possible. This information was broken down into taxonomical groups. We produced an Index of Adjustment to each Region's list (Eq. (1)), which synthesizes the adjustment of each regional administration to national law; that is, how many of its threatened species have an approved management plan. We considered two rates: EN_r and VU_r ; that is, the ratio of the species cataloged as "Endangered" or "Vulnerable" with an approved plan, respectively, to the total threatened species. Therefore, this index is a weighted mean that attaches twice the importance to "Endangered" species as we consider them a priority to "Vulnerable". The rates and the index included values between 0 (not adjusted) and 1 (fully adjusted).

$$\frac{2*EN_r + VU_r}{3} \quad (1)$$

We used binomial generalized linear models (GLM) to determine the association between the level of protection of threatened terrestrial vertebrates in each Region (i.e., percentage of species with a management plan) with the ecological, social and geographical variables of the Regions under study (Table C3). The ecological variables included the percentage of agricultural area (Ministerio de Agricultura Alimentación y Medio Ambiente, 2013), the percentage of forest area (Ministerio de Agricultura Pesca y Alimentación, 2016) and the number of protected species in each Region. The geographical variables included the area (ha) and the protected area (ha) of each Region (Ministerio de Agricultura, Pesca y Alimentación, 2017), as well as the percentage of protected area to the Region's total area. The social variables included the Region's GDP per capita (Datosmacro, 2019) and its environmental awareness. Environmental awareness was measured based on the responses to a national survey (yes/no), which calculated the percentage of people who stated being very interested in the environment (Instituto Nacional de Estadística, 2008). We also performed model averaging to select the best fitted model to the variables tested in the GLM (Dormann et al., 2018).

In order to check whether there were significant differences in the number of protected species among the different considered taxonomical groups (mammals, birds, reptiles, amphibians), we performed a Chi-square test for all pairs of groups. All the statistical analyses were carried out with R, version 3.6.3 (R Core Team, 2020). Model averaging was performed using *MuMIn* R package.

3. Results

3.1. Geographical analysis of the protection level

The Spanish List of Threatened Species includes 110 species of terrestrial vertebrates (Table 2). The range of the number of species included on the list per Region varies from 6 to 82 (Table 3). On average, each Region has 36.1 ± 19.7 species on its list: 25.4 ± 16.7 species classified as "Vulnerable" (VU) within a range from 4 to 70 species, and 10.73 ± 5.2 cataloged as "Endangered" (EN) from 2 to 18 species (Table 3). Two Regions (Castilla y León and Catalonia) do not have an approved list of threatened species (they were excluded from the analysis).

Of the total listed species, 20% have an approved management plan (17% of the "Vulnerable" species and 48% of the "Endangered species"). Significant differences were found in the number of approved management plans between conservation status ($\alpha = 0.05$, $P = 0.005$). The mean of the Index of Adjustment to the list was 0.38 ± 0.26 , within a range from 0.06 to 1 (Table 3).

The general average for the approval of the management plans in the different Regions is 9.5 ± 6.5 years. No significant differences were found in the time taken to approve management plans ($t = 0.45$, $df = 24$,

$P = 0.66$) between the "Endangered" (9.13 ± 6.87 years) and "Vulnerable" species (10.29 ± 6.05 years). Only four regions indicated the average values of periods of time according to legal requirements (Table 6 and Table C1).

A negative association was observed between compliance with regulations and the number of threatened species plus GPD per capita, as was a positive association with the percentage of protected area and environmental awareness (Fig. 1). No significant association was noted for the other tested variables with compliance to regulations. Model averaging included four models, which encompassed 96% of the weight: number of protected species and GPD per capita (47%); number of protected species and percentage of protected areas (27%); number of protected species (18%) and number of protected species; and environmental awareness (4%) (Table 4).

3.2. Taxonomical analysis of the protection level

Birds were the taxonomical group with the highest percentage of threatened species covered by a management plan (22%), followed by mammals (16%), amphibians (14%) and lastly reptiles (13%) (Table 5). There were significant differences among all pairs of groups ($P < 0.01$).

For those species with a management plan, the taxonomical group that took the shortest time to have a management plan were reptiles (4.1 ± 1.8 years, $n = 5$), followed by amphibians (6.3 ± 5.1 years, $n = 4$), mammals (8.0 ± 6.9 years, $n = 25$) and birds (10.6 ± 6.3 years, $n = 70$) (Table 6 and Table C2).

4. Discussion

Here we used data from Spanish conservation regulations to analyze potential geographical and taxonomical biases in the conservation of threatened terrestrial vertebrates in Spain. We found that the mandatory regulations for the conservation of wildlife species in Spain are complied with only by 20% of the species, which highlights generalized under-protection of terrestrial vertebrates. Moreover, delays in the applications for management plans were found, which represented were exceeded the application period described in laws by more than 2-fold for "Vulnerable" species and 3-fold for "Endangered" species. We also found regional differences due to ecological, geographical and social factors, as well as taxonomical biases.

Before discussing differences between taxa and regions, it is important to understand that the approval date of a management plan (the data we used in our work) is only a first step of the project cycle, which means that a management plan could have been approved but do not have an effective operational implementation. The management plans could fail after their approval if they are drafted by experts who do not know the correct project management approach (Battisti, 2018), they do not involve local agencies and citizens (Battisti et al., 2020), or periodical inspections are not carried out.

4.1. Regional biases

Not all Spanish regions protected their fauna equally. There was a wide variability between different regions, with some protecting every threatened species and some that almost did not develop management plans for any of them. Furthermore, two Regions (Catalonia and Castilla y León) have no approved regional lists. The Regions with extensively threatened species lists tend to cover a lower percentage of them using a management plan, probably due to budgetary, technical and administrative limitations. The application of joint management plans for a group of similar species, which are affected by the same threats, or plans to protect specific habitats could be useful in the event of resource scarcity for regions with longer lists, like steppe birds management plans (Junta de Andalucía, 2011).

Although we hypothesized that regions with higher economic capacity (higher GPD per capita) would provide larger budgets for

conservation policies, we found that the number of threatened species with management plan tended to decrease GDP per capita rose. Therefore, the wealthiest regions are also the most urban and industrialized ones (Cámara de Comercio de España, 2018) and attach less importance to nature (Battisti & Zocchi, 2018; Esteban Curiel, 2000; Mayer, Frantz, Bruhman-Senecal, & Dolliver, 2009), which indirectly implies that less social pressure is placed on species protection. However, the opposite phenomenon can emerge in some regions (e.g. increasing ecotourism from developed countries).

The percentages of protected areas in Regions were the other main variable that can explain compliance with regulations, followed by environmental awareness. Both showed a positive relation to the number of species with a management plan, which highlights the importance of protection measures and environmental awareness. More economical resources and research efforts are allocated to protected areas than to non-protected territories (West et al., 2006). Hence there is more knowledge about the species inhabiting them and more elements to draw up management plans. Moreover, many protected areas are of outstanding cultural, tourist and historic interest (Wray et al., 2010) with, thus, more interest in protecting their species can be expected of many stakeholders, such as local inhabitants, NGOs, regional politicians and researchers (Ament et al., 2016; Garibaldi & Turner, 2004). Environmental awareness varies widely among different Spanish Regions (Esteban Curiel, 2002; Instituto Nacional de Estadística, 2008), and the positive relation between environmental awareness and the proportion of species with a management plan makes it difficult to identify the causality of this relation. On the one hand, high rates of environmental awareness in Regions can pressurize governments to develop conservation measures or, on the contrary, conservation plans encourage dissemination actions to raise society's awareness, and these actions may increase environmental awareness. Moreover, the Regions with more protected areas lead to better environmental education and promote wildlife tourism, which also increases environmental awareness. In this sense, conservation education, the first step to get a greater environmental awareness (Jacobson et al., 2015), could also explain the regional biases in the management plans.

4.2. Taxonomical biases

Consistently with previous studies (Christie et al., 2020a; Christie et al., 2020b; Junker et al., 2020), our results indicated differences in conservation efforts between taxonomical groups. Birds, followed by mammals, obtain higher percentages of approved management plans than herpetofauna (Restani & Marzluff, 2002; Titley et al., 2017). These differences could be explained by managements plans being drawn up for less popular species, like most reptiles and amphibians, being prioritized less. On the one hand, mammals and birds, phylogenetically close to humans, are naturally more attractive to us (Martín-Forés et al., 2013; Titley et al., 2017). Additionally, there are many unfounded beliefs in and myths about herpetofauna in many regions, which have traditionally been considered harmful to local populations (Ceriaco, 2012; Pollard, Thaman, Brodie, & Morrison, 2015; Rueda Núñez, 2014; Uyeda et al., 2016). Due to this social rejection to reptiles and amphibians, they could face serious difficulties to be officially protected, even when they could be more threatened by extinction than popular species (Davies et al., 2019).

Moreover, a taxonomical bias in species research can influence conservation policies because conservation problems are identified earlier in the most studied taxonomical groups, and more knowledge and tools are available for their conservation (Burgman, 2004; Hutchings, 2004; Martín-López et al., 2009). Donaldson et al. (2018), using data for over 10,000 species, found that certain taxa were the focus of the most of the published papers, whilst other threatened species barely received research attention. They concluded that "while greater research on threatened species alone cannot ensure their protection, understanding taxonomic bias may be helpful to address knowledge

gaps in order to identify research directions and inform policy."

4.3. Long delays in approving management plans

Our results show a major delays in drawing up and enforcing conservation measures and huge differences among Spanish Regions. Spanish National Law specifies that a Conservation Plan must be applied for "Vulnerable" species within a maximum 5-year period, and a Recovery Plan for "Endangered" species within a maximum 3-year period. However, the reality lies far from these requirements as management plans take around 10 years to be approved (when considering only the species with an approved plan, less than 30% of the total threatened species). The delay in performing conservation measures and actions could affect species preservation, especially that of endangered species that are close to extinction (Essl et al., 2015). In the current global change context, timing conservation actions is crucial, particularly for those species that are vulnerable to climate change (Naujokaitis-Lewis et al., 2018). Furthermore, early approval of management plans is more economically efficient and improves biodiversity recovery (Fuller et al., 2007). Given the administrative, social and economic peculiarities of the different countries, worldwide comparative studies related to delays in conservation policies are complex to be performed, but we consider not just occasional and local studies are necessary, but official and systematic informs, driven by countries governments and supranational organizations, guaranteeing compliance with the regulations and the established times.

4.4. Reducing biases in species conservation

Some highlights and general recommendations to reduce conservation biases can be deduced from our results. On the one hand, as several social, ecological and geographical variables are related to complying with environmental regulations, integration among Academia, governments and society is essential for their application (Armitage et al., 2007; Felt et al. 2007; Future Earth, 2014; Carmen et al., 2015). Academia provides systematic literature and measurable information to set up environmental policies (Heink et al., 2015; Dicks et al., 2016). Governments must apply and create the necessary regulations to protect threatened species. Society can pressurize governments so that regulations are drafted and subsequently applied. Finally, the local working groups and environmental volunteers could improve the actual implementation of management plans. Therefore, the ultimate reason of the wildlife underprotection in Spain and in so many other countries could be lack of political commitment and barely any social claim to protect biodiversity (Mehring et al., 2016).

Moreover, given the biodiversity crisis and the taxonomical and regional biases of threatened species in Spain, we consider that greater national coordination is necessary, along with enough budgetary allocations for researchers and technicians to cover all the taxonomical groups, and to make regular evaluations of both lists of threatened species and management plans. Effective biodiversity protection would ultimately result in a direct and indirect increase in ecosystem services, which could be considered mid- and long-term investments.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Regulations used to obtain the results

National Law – Ley 42/2007.

We present the main information below:

Article 58.

- (1) On the List of Wild Species in the Special Protection Regime, the Spanish List of Threatened Species will include, when there is technical or scientific information advising, the taxa or populations of threatened biodiversity by including them in some of the following categories:
 - (a) “Endangered”: taxa or populations whose survival is unlikely if the causal factors of their current situation continue.
 - (b) “Vulnerable”: taxa or populations at risk of moving to the previous category in the immediate future if the adverse factors that act on them are not corrected.
- (2) The listing, discontinuation or change of category of a taxon or population on the Spanish List of Threatened Species will be carried out by the Ministry of the Environment at the proposal of the State Commission for Natural Heritage and Biodiversity, by the initiative of Autonomous Communities or the Ministry itself, whenever there is technical or scientific information that advises it.

Any citizen or organization may request the initiation of the inclusion, change of category or exclusion procedure by accompanying the corresponding application with the scientific argument for the proposed measure.

- (3) The Autonomous Communities, in their respective territories, can produce catalogs of threatened species by establishing, in addition to the categories listed in this article, other specific ones by determining the prohibitions and supplementary actions that are considered necessary for their preservation.
- (4) The Autonomous Communities may, wherever appropriate, increase the degree of protection of the species in the Spanish Catalog of Threatened Species in their own catalogs by including them in a higher threat category.

Article 59. Effects of inclusion on the Spanish Catalog of Threatened Species.

- (1) Regarding the Spanish Catalog of Threatened Species:
 - (a) The inclusion of a taxon or population in the “Endangered” category will entail, within a maximum 3-year period, adopting a recovery plan that includes the most appropriate measures for fulfilling the objectives and, wherever appropriate, the designation of critical areas. In critical areas, and in areas of the potential reintroduction or expansion of these taxa or populations defined as such in the recovery plans, conservation measures and management instruments, specific to these areas or integrated into other plans, will be established to prevent the negative effects on the species that have motivated the designation of these areas.
 - (b) The inclusion of a taxon or population in the “vulnerable” category will entail, within a maximum 5-year period, adopting a conservation plan that includes the most appropriate measures for fulfilling the pursued objectives.
 - (c) For those taxa or populations that share the same conservation problems or similar geographical areas, plans to simultaneously cover several taxa or populations may be developed.

- (d) For the species or populations that live exclusively, or a high proportion of them, in protected natural areas, the Natura 2000 Network or areas protected by international instruments, plans may be integrated into the corresponding planning and management figures for those spaces.
- (2) The Autonomous Communities will prepare and approve conservation and recovery plans for threatened terrestrial species.

Regional Laws.

Andalusia.

- Ley 8/2003 de 28 de octubre, de la flora y la fauna silvestres. <http://www.boe.es/buscar/pdf/2003/BOE-A-2003-21941-consolidado.pdf>
- Decreto 23/2012 por el que se regula la conservación y el uso sostenible de la flora y fauna silvestres y sus hábitats. <https://www.juntadeandalucia.es/boja/2012/60/6>

Aragón.

- Ley 6/1998, de 19 de mayo, de Espacios Naturales Protegidos de Aragón. <https://www.boe.es/eli/es-ar/1/1998/05/19/6/dof/spa/pdf>
- Decreto 181/2005, de 6 de septiembre, modifica parcialmente el Decreto 49/1995, por el que se regula el Catálogo de Especies Amenazadas de Aragón. <http://www.boa.aragon.es/cgi-bin/EOA/BRSCGI?CMD=VEROBJ&MLKOB=81734540202>

Asturias.

- Decreto 32/1990, de 8 de marzo, de creación del Catálogo Regional de Especies Amenazadas de Fauna Vertebrada <https://www.asturias.es/bopa/disposiciones/repositorio/LEGISLACION19/66/1/ODBA03D3EA8045018A797944BD9081EE.pdf>

Balearics.

- Decreto 75/2005, de 8 de julio, por el cual se crea el Catálogo Balear de Especies Amenazadas y de Especial Protección, las Áreas Biológicas Críticas y el Consejo Asesor de Flora y Fauna de las Islas Baleares. http://www.caib.es/sites/puntinformacioambiental/es/n/decreto_752005_de_8_de_julio_por_el_cual_se_crea_el_catalogo_balear_de_especies_amenazadas_y_de_especial_proteccion_las_areas_biologicas_criticas_y_el_consejo_asesor_de_fauna_y_flora_de_las_islas_baleares-54301/
- Resolución del consejero de Medio Ambiente, de 7 de septiembre de 2013, de inclusión y cambio de categoría de diversas especies en el Catálogo Balear de Especies Amenazadas y de Especial Protección. <https://www.conservacionvegetal.org/wp-content/uploads/legislaciones/122/2013%20adición%20catalogo%20protegidas%20Balears.pdf>

Canaries.

- Ley 4/2010, de 4 de junio, del Catálogo Canario de Especies Protegidas. <https://www.boe.es/buscar/doc.php?id=BOE-A-2010-9772>

Cantabria.

- Ley 3/1992, de 18 de marzo, de Protección de los Animales. <http://www.boe.es/buscar/pdf/1992/BOE-A-1992-11685-consolidado.pdf>
- Decreto 120/2008, de 8 de diciembre, por el que se regula el Catálogo Regional de Especies Amenazadas de Cantabria. <https://boc.cantabria.es/boces/verAnuncioAction.do?idAnuBlob=143779>

Castilla-La Mancha.

- Ley 9/1999, de 26 de mayo, de Conservación de la Naturaleza. <http://www.boe.es/buscar/pdf/1999/BOE-A-1999-16378-consolidado.pdf>
- Decreto 33/1998, de 5 de mayo, Catálogo Regional de Especies Amenazadas. <https://docm.jccm.es/portaldocm/verDisposicionAntigua.do?ruta=1998/05/15&idDisposicion=123061563212731534>
- Decreto 200/2001, de 6 de noviembre, modificación Catálogo Regional de Especies Amenazadas. <https://global.economistjurist.es/BDI/legislacion/legislaciongeneral/emergentelegislacion.php?id=35442>

Castilla y León.

- Decreto 63/2007, de 14 de junio, por el que se crean el Catálogo de Flora Protegida de Castilla y León y la figura de protección denominada Microrreserva de Flora. https://noticias.juridicas.com/base_datos/CCAA/cl-d63-2007.html

Catalonia.

- Ley 3/1998, de 4 de marzo, de Protección de Animales. <http://www.boe.es/eli/es-ct/1/1988/03/04/3>
- Orden de 10 de abril de 1997, por la que se amplía la relación de especies protegidas de Cataluña. <https://www.tuslances.com/galeria/Orden%2017%20de%20junio%20de%201999%20Especies%20objeto%20de%20caza%20Cataluña.pdf>

Madrid.

- Ley 2/1991, de 14 de febrero, para la Protección y Regulación de la Fauna y Flora Silvestres de la Comunidad de Madrid. <https://www.boe.es/eli/es-md/1/1991/02/14/2>
- Decreto 18/1992, de 26 de marzo, aprobación del Catálogo Regional de Especies Amenazadas de Fauna y Flora Silvestres y creación de la categoría de Árboles Singulares. http://www.madrid.org/wleg_pub/secure/normativas/contenidoNormativa.jsf?opcion=VerHtml&nmnorma=1165&cdestado=P#no-back-button

Valencian Community.

- Decreto 265/1994, de 20 de diciembre, del Gobierno valenciano, por el que se crea y regula el Catálogo Valenciano de Especies Amenazadas de Fauna y se establecen categorías y normas de protección de la fauna. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj5hOLLirPwAhUNxYUKHSF3AKIQFjABegQIBBAD&url=http%3A%2F%2Fwww.fedme.es%2Fdownload.php%3Fdoc%3Dhttp%3A%2F%2Fwww.fedme.es%2Fsalaprensa%2Fupfiles%2F111_F_es.pdf%26name%3DValencia-Catalogo-Especies-Amenazadas-de-Fauna.pdf&usg=AOvVaw01KuyXYFqdw1gBQLzFqwSa

Extremadura.

- Ley 8/1998, de 26 de junio, de Conservación de la Naturaleza y Espacios Naturales de Extremadura. <https://www.boe.es/eli/es-ex/1/1998/06/26/8>
- Decreto 37/2001, de 6 de marzo, Creación Catálogo Regional de Especies. <http://doe.juntaex.es/pdfs/doe/2001/300o/01040040.pdf>
- Decreto 78 /2018, de 5 de junio, por el que se modifica el Decreto 37/2001, de 6 de marzo, por el que se regula el Catálogo Regional de

Especies Amenazadas de Extremadura <http://doe.gobex.es/pdfs/doe/2018/1120o/18040091.pdf>

Galicia.

- Ley 9/2001, de 21 de agosto, de Conservación de la Naturaleza <http://www.boe.es/buscar/pdf/2001/BOE-A-2001-17999-consolidado.pdf>
- Decreto 88/2007, de 19 de abril, por el que se regula el Catálogo Gallego de Especies Amenazadas. https://www.xunta.gal/dog/Publicados/2007/20070509/Anuncio12742_es.html

La Rioja.

- Ley 5/1995, de 22 de marzo, de Protección de los Animales de La Rioja. <https://www.boe.es/eli/es-ri/1/1995/03/22/5>
- Decreto 59/1998, de 9 de octubre, por el que se crea y regula el Catálogo Regional de Especies Amenazadas de la Flora y Fauna Silvestre de La Rioja. https://ias1.larioja.org/boletin/boletin/bor_mostrar_anuncio.jsp?referencia=558639-1-HTML-166255-X

Navarre.

- Ley Foral 2/1993, de 5 de marzo, de protección y gestión de la fauna silvestre y sus hábitats. <http://www.lexnavarra.navarra.es/detalle.asp?r=2671>
- Ley Foral 18/2002, de 13 de junio, modificación Ley Foral 2/1993, de 5 de marzo, de protección y gestión de la fauna silvestre y sus hábitats <https://www.boe.es/eli/es-nc/lf/2002/06/13/18>

Basque Country

- Ley 6/1993, de 29 de octubre, de Protección de los Animales. <http://www.boe.es/eli/es-pv/1/1993/10/29/6>
- Ley 16/1994, de 30 de junio, de Conservación de la Naturaleza del País Vasco. <https://www.euskadi.eus/bopv2/datos/1994/07/9402695a.pdf>
- Decreto 167/1996, de 9 de julio, de Regulación del Catálogo Vasco de Especies Amenazadas de la Fauna y Flora Silvestre y Marina. http://www.habe.euskadi.eus/s23-edukiak/es/contenidos/decreto/bopv199603481/es_def/index.shtml
- Orden de 8 de julio de 1997, por la que se incluyen en el Catálogo Vasco de Especies Amenazadas de la Fauna y Flora Silvestre y Marina, nuevas especies, subespecies y poblaciones de vertebrados. http://www.legegunea.euskadi.eus/webleg00-confich/es/contenidos/orden/bopv199703965/es_def/index.shtml
- Ley 1/2010, de 11 de marzo, de modificación de la Ley 16/1994, de 30 de junio, de Conservación de la Naturaleza del País Vasco. <http://www.boe.es/eli/es-pv/1/2010/03/11/1>

Murcia.

- Ley 7/1995, de 21 de abril, de la “Fauna Silvestre, Caza y pesca Fluvial”, actualmente nombrada como “Ley de la Fauna Silvestre de la Región de Murcia”. <https://www.boe.es/eli/es-mc/1/1995/04/21/7>
- Ley 10/2002, de 12 de noviembre, de modificación de la Ley 7/1995, de 21 de abril, normas reguladoras de la fauna silvestre, caza y pesca fluvial. <https://www.iberley.es/legislacion/ley-10-2002-12-noviembre-modificacion-ley-7-1995-21-abril-fauna-silvestre-caza-pesca-fluvial-386857>

Appendix B. Index of the state and regional web pages that include norms on biodiversity protection and/or the List of threatened species consulted

- Ministerio para la Transición Ecológica del Gobierno de España: <https://www.miteco.gob.es/es/biodiversidad/temas/default.aspx>
- ANDALUSIA. Junta de Andalucía - Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible: <http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.7e1cf46ddf59bb227a9ebe205510e1ca/?vgnextoid=a23f3e9f6127c410VgnVCM1000001325e50aRCRD&vgnnextchannel=91aac879a47c410VgnVCM1000001325e50aRCRD>
- ARAGÓN. Gobierno de Aragón. <https://www.aragon.es/-/catalogo-de-especies-amenazadas-en-aragon>
- ASTURIAS. Gobierno del Principado de Asturias – Red Ambiental de Asturias: <http://movil.asturias.es/portal/site/medioambiente/menuitem.4691a4f57147e2c2553cbf10a6108a0c/?vgnextoid=aeebe84e8fa0c110VgnVCM1000006a01a8c0RCRD&i18n.http.lang=es>
- BALEARICS. Consejería de Medio Ambiente y Territorio - Servicio de Protección de Especies: https://www.caib.es/sites/proteccionespecies/es/catalogo_balear_de_especies-6864/
- CANARIES. Gobierno de Canarias – Consejería de Transición Ecológica, Lucha contra el Cambio Climático y Planificación Territorial: https://www.gobiernodecanarias.org/medioambiente/temas/informacion-ambiental/catalogo_especies_amenazadas/
- CANTABRIA. Gobierno de Cantabria - Consejería de Desarrollo Rural, Ganadería, Pesca y Biodiversidad: https://www.cantabria.es/c/document_library/get_file?uuid=3bd137d1-7063-408f-9f58-ab2b814b78f9&groupId=16835
- CASTILLA-LA MANCHA. Junta de Comunidades de Castilla-La Mancha - Consejería de Agricultura, Agua y Desarrollo Rural: <https://docm.jccm.es/portaldocm/codigoLegislativo.do?idDescriptorLeNg=147>
- CASTILLA Y LEÓN. Junta de Castilla y León – Medio Ambiente de Castilla y León: <https://medioambiente.jcyl.es/web/jcyl/MedioAmbiente/es/Plantilla100DetalleFeed/1246988359553/Normativa/1175259764817/Redaccion>
- CATALONIA. Generalitat de Catalunya – Departamento de Territorio y Sostenibilidad: http://mediambient.gencat.cat/es/05_ambits_da_ctuacio/patrimoni_natural/fauna-autoctona-prottegida/
- EXTREMADURA. Junta de Extremadura – Consejería de Medio Ambiente y Rural, Políticas Agrarias y Territorio: http://extremambiente.juntaex.es/index.php?option=com_content&view=article&id=1353&Itemid=165
- GALICIA. Xunta de Galicia – Consellería de Medio Ambiente, Territorio e Vivenda: https://cmatv.xunta.gal/seccion-organizacion/c/DX_Conservacion_Natureza?content=Direccion_Xeral_Conservacion_Natureza/Biodiversidade/seccion.html&sub=Especies_ameazadas/
- LA RIOJA. Gobierno de La Rioja – Medio Ambiente: <https://www.larioja.org/medio-ambiente/es/biodiversidad/catalogos-especies-amenazadas>
- MADRID. Gobierno de la Comunidad de Madrid – Flora, fauna y especies protegidas: <https://www.comunidad.madrid/servicios/urbanismo-medio-ambiente/flora-fauna-especies-prottegidas>
- NAVARRE. Gobierno de Navarra – Medio Ambiente: https://www.navarra.es/home_es/Temas/Medio+Ambiente/Patrimonio+natural/Conservacion+de+especies.htm

- BASQUE COUNTRY. Gobierno vasco – Medio Ambiente: <https://www.euskadi.eus/gobierno-vasco/diversidad-biologica-geologica/>
- MURCIA. Gobierno de Murcia – Murcia Natural: <http://www.murcianatural.carm.es/web/guest/fauna3>
- VALENCIAN COMMUNITY. Generalitat Valenciana - Conselleria de Agricultura, Desarrollo Rural, Emergencia Climática y Transición Ecológica: <http://www.bdb.gva.es/es/lista-por-estados-legales-de-especies>

Appendix C. Complementary figures and tables

See Tables C1–C3.

Table C1

Average years taken to approve the management plans for threatened species in each Region since they appeared on the regional list, broken down into threatened categories.

Region	Vulnerable (years)	Endangered (years)
Asturias	11.75	7
La Rioja	16	16
Balearics	2.3	2
Andalusia	8.14	7.86
Murcia	21	21
Canaries	–	2
Valencian C.	11	19.33
Extremadura	–	11.67
Castilla - La Mancha	5	6.6
Basque Country	13	10.83
Navarre	2	0.67
Cantabria	–	0
Aragón	16	8
Galicia	7	6
Madrid	–	18
Mean	10.29	9.13
SD	6.05	6.87

Table C2

Average number of years taken to approve of the management plans for threatened species since their appeared on the Regional List, broken down into taxonomical groups.

Region	Mammals (years)	Birds (years)	Reptiles (years)	Amphibians (years)
Asturias	1	12	–	12
La Rioja	16	16	–	–
Balearics	1.4	2.57	4	2
Andalusia	8	7.95	–	–
Murcia	21	21	–	–
Canaries	–	1.5	2.33	–
Valencian C.	12	15.8	–	–
Extremadura	11.2	14	–	–
Castilla - La Mancha	5	6.6	–	–
Basque Country	10.67	13.4	–	5
Navarre	1.66	1.25	–	–
Cantabria	0	–	–	–
Aragón	–	12	–	–
Galicia	–	6.5	6	–
Madrid	–	18	–	–
Mean	7.99	10.61	4.11	6.33
SD	6.87	6.31	1.84	5.13

Table C3

Regional values of the ecological, geographical and social variables included in the analyses. Mean and SD (standard deviation) are estimated for all the Regions.

Region	Number of threatened species	Area (ha)	Protected area (ha)	Percentage of protected area (%)	Percentage of forest area (ha)	Percentage of agricultural area (ha)	GPD per capita – 2018 (€)	Environmental awareness (%)
Asturias	6	1,060,300	270,153	25	43	2	22,789	77.2
La Rioja	22	504,500	161,707	26	35	31	27,225	76.5
Balearics	36	499,200	111,315	19	37	32	27,682	69.8
Andalusia	45	8,726,800	2,274,474	46	33	39	19,107	80.7
Murcia	20	1,131,300	219,751	22	27	37	21,269	72.3
Canaries	14	744,700	345,001	29	19	8	20,892	88
Valencian C.	51	2,325,500	736,971	19	32	28	22,426	75.6
Extremadura	41	4,163,500	996,357	24	46	27	18,769	55.5
C - La Mancha	82	7,946,300	1,501,778	19	35	46	20,363	65
Basque	43	723,400	154,691	21	56	10	33,223	81.2
Country								
Navarre	33	1,039,100	231,162	22	42	33	31,389	67.1
Cantabria	23	532,100	127,762	24	40	2	23,757	78.7
Aragón	28	4,772,000	1,074,366	23	33	37	28,151	79.4
Galicia	65	2,957,500	313,968	11	49	13	23,183	69
Madrid	33	802,200	232,714	29	33	29	35,041	81.8
Mean	36	2,528,560	583,478	25	37	25	25,017	74.5
SD	19	2,720,951	628,902	8	9	14	5165	8.2

Appendix D. Map of Spanish Regions or Autonomous Communities

See Table D1.

Table D1

Map of the Spanish Regions or Autonomous Communities.



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