Call for new unified criteria for registering species data on 2000 Natura network areas

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One-Sentence Summary: We advocate for new unified and realistic criteria for monitoring and reporting data on species from 2000 Natura areas that allows cross-border comparisons and conservation diagnosis.

The European Union's Birds and Habitat directives are intended to guarantee the persistence of species and natural habitats across Member States. To achieve this laudable aim, the Natura 2000 Network of protected areas was established in 1992. Since then, Member States are required to regularly monitor species and habitats and report findings to the European Commission. Monitoring data are stored in a freely accessible database that is updated as new data are reported. Natura 2000 is an invaluable example of a large-scale coordinated reserve network developed and operated to address major conservation issues. Despite these efforts, based on our analysis and on expert opinions by Natura 2000 executives from multiple Member States, we show that the Network is failing to adequately show advances in preserving biodiversity. The main contributing factor to this failure is Member States oftentimes not following reporting EU guidelines. We argue that relatively small changes regarding how data are collected and recorded could significantly boost their potential to help the Member States and the European Commission better monitor changes in biodiversity across the network and provide a valuable resource for managers and scientists across Europe. In particular, we advocate for new unified, realistic criteria to monitor and gather species data that could then be merged with information reported across Member States thus facilitating cross boundary comparisons and conservation actions.

Since the establishment of Natura 2000 Network of protected areas in 1992, European Member States are required to monitor species and habitats, both outside and inside the network. Monitoring inside data are reported annually by filling in a Standard Data Form (SDF), whereas the conservation status of species and habitats is reported every six years. Species to be monitored are those included in Annexes I and II in the Birds Directive (Council Directive 2009/147/EC), the ones included in Annexes II, IV and V in the Habitats Directive (Council Directive 92/43/EEC), and regular migratory species (e.g. the Greylag goose *Anser anser* or the Gadwall *Mareca strepera*). These monitoring data are then stored in a freely accessible database that is updated annually as new data are reported (*1*)

The Natura 2000 network constitutes a fundamental tool for the conservation of European biodiversity. However, an on-going debate exists regarding its effectiveness at maintaining viable populations, and on how to improve it (*2–6*). Of especial interest here is the utility of data gathered by Natura 2000 for the analysis or comparison of the conservation status of most populations and species. Despite the European Commission guidelines and the large amount of resources allocated to the Natura 2000 Network, data quality and availability appear to be a limitation. Indeed, information on many species are either lacking or incomplete (*7*, *8*). To evaluate the quality of the data across the network, we analyzed the 2020 Species Natura 2000 database (*1*)(see Appendix 1 for details). We detected that (1) data contain errors, and information on multiple species is entirely lacking or incomplete (e.g. > 50 % of missing population size data (Fig. S1, Table S1), (2) there are high heterogeneity across Member States in the quantity and quality of data, and even substantial variation between regions within countries (Figs. S1-S4, Appendix 1). These differences between states or regions are evident in terms of monitoring effort for the different taxonomic groups, data quality, or thoroughness in the quantity and quality of the data reported in each section of the SDF.

Some of the definitions in the SDF have been specifically criticized. For instance, among Natura 2000 managers, there is a general concern about the definition of "significant populations" regarding to the size and density of the population of the species present on the area in relation to the populations present within national territory (POPULATION category in the SDF). The European Commission criterion recommends that only those species barely observable at the site, for example a vagrant species, should be officially accepted as "non-significant". This aspect is problematical because conservation objectives and effective measures have to be set out or referred to in legally binding acts for all species with "significant" presence in each Natura 2000 area (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0484). Given that resources devoted to conservation are rather limited, and biodiversity is not uniformly distributed among countries, this criterion favors the occurrence of arbitrary decisions for the allocation of resources among countries and regions. By directly consulting with the Biodiversity Natura 2000 managers in each country, we confirmed that the use of expert opinion is widely used in many State Members for some or all the decision-making steps in the assessment of Natura 2000 populations, especially to determine the significance of populations (Appendix 2, Table S2). For instance, Spain or Germany, even if officially using the recommended European commission criterion, in practice are using expert opinion to determine the significance of populations, while the Netherlands explicitly use a particular quantitative criterion which is not the one recommended by Natura 2000 (Appendix 2, Table S2). The expert opinion used by the Member States to assess the significance of populations is quantitative, qualitative, or mixed, and may differ by species under the Birds and Habitats Directives (Appendix 2, Table S2). We argue that the use of expert opinion by most Member States is a source of heterogeneity in data monitoring that hinders the potential of the network.

The consequences of the disparities across Natura 2000 member states in the dedicated effort and allocation of resources, and in criteria used to identify significant populations are non-negligible. By assessing the distribution and population size in several species based on recorded data on Natura 2000, we demonstrate that these heterogeneities translate in an expensive dataset that do not allow for the objective assessment or comparison of the conservation status of species across Europe - the main goal of the very network. Indeed, the aforementioned disparities generate great inconsistencies in species *perceived* distribution among countries, likely consequences of boundary limits instead of true species distributions (Fig. 1, Appendix 3). For instance, the distribution of the common European turtle dove *Streptopelia turtur* from Natura 2000 dataset shows an unexpected, uneven distribution across Europe, including sharp border limits at both the national and regional levels (Fig. 1) (*9*). In many species, there were also marked differences in monitoring effort, with some countries or regions monitoring population size while others just indicating presence or absence of the species at a given location (Appendix 3).

The aims of the Bird and Habitat Directives to preserve biodiversity are important and widely supported (*7*). Much of the data collected across the Network's nodes are of high quality and potential usage. However, the overall utility of the species 2000 Network database is compromised by data errors, and especially lack of comparability across regions and countries. Data errors could be corrected via the appointment of data scientists to check existing data and

new data being uploaded. Yet, this task will not address the cause of inconsistency in data quality between and within countries. Part of the cause for this lack of consistency in data quality is the demands that the Directives impose on those who collect data, and the need to monitor large numbers of species, particularly in habitats with a high biodiversity.

We suggest the establishment of common guidelines to help readjust and unify monitoring protocols efforts among countries and regions that vary as a function of the species characteristics, such as generation time, and species conservation status and distribution. Similarly, use of e-DNA approaches (*10*), ecoacoustics (*11*), and camera traps (*12*), coupled with citizen science frameworks (*13*), such as Zooniverse (https://www.zooniverse.org/) or the European Butterfly Monitoring Scheme (eBMS; https://butterfly-monitoring.net/) could help monitor an unprecedented volume of species and populations. In addition, integrating independent biodiversity observations (*14*), data from other EU monitoring programs (i.e., Water and Marine Strategy Framework Directives) and incorporation of data collected by researchers based in universities, research institutes, and environmental consultancies could provide additional, useful data. In any case, reporting monitoring efforts and protocols would be key to account for differences between countries when assessing species population trends and distribution.

We also advocate the need of a revised definition of what is a 'significant' population. These new criteria should consider the species distribution and its conservation status, both at the local and the global scale, and in some cases, characteristics of the area (Fig. 2, S9). Moreover, species and populations conservation status should be determined in line with the species-specific life history (Fig. 2). Population trends of species with different life history strategies, i.e. different schedules of survival, development, and reproduction in a specie's life cycle, cannot be assessed in the same way and on the same time scale. Additionally, life history strategies determine the fragility, capacity to compensate, and finally the resilience of the species or populations facing different environmental changes (*15*).

We thus propose to slightly modify monitoring protocols and current criteria to determine population significance by considering species life history strategies, distribution and conservation status (Figs. 2, S9). We are not suggesting a major overhaul of the Directives but are instead proposing debate on how relatively small changes in guidelines could improve the utility of the huge data collected from the Natura 2000 network. Biodiversity continues to decline globally, the Natura 2000 network provides an invaluable resource in which to monitor and preserve the EU's biodiversity, but current practices could be markedly improved with relatively small tweaks to existing protocols.

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Acknowledgments: We are very grateful to all Natura 2000 managers, members of the 'Expert Group on Reporting' of both directives and the National Nature & Biodiversity contacts who provided information on their criteria to determine the "significance of populations". Data for the distribution map of the species *Streptopelia turtur* was kindly provided by BirdLife International, available at http://datazone.birdlife.org/species/requestdis. The illustrations of the species *Streptopelia turtur* and *Euphydryas aurinia* were kindly provided by Martí Franch.

Funding:

Spanish Ministry of Science and EU-FEDER funds (DEMORES, PID2021-124731NB-I00) (MG)

Tragsatec Group contract nº: 73576 (MG, JRJ, JU)

Author contributions:

Conceptualization: MG, TC, RSG, FC, FG

Formal Analysis: JRJ, MG

Investigation: JUD, MG, FG, JRJ

Funding acquisition: MG, FG

Writing – original draft: MG, TC

Writing – review & editing: All authors participated in the review and editing process of the manuscript.

Competing interests: Authors declare that they have no competing interests.

Data and materials availability: All data is available at the Natura 2000 database (http://www.eea.europa.eu/data-and-maps/data/natura-2000).

Supplementary Materials

Supplementary Text divided in Appendices: 1, 2, 3 and 4.

Figs. S1 to S9

Tables S1 to S3

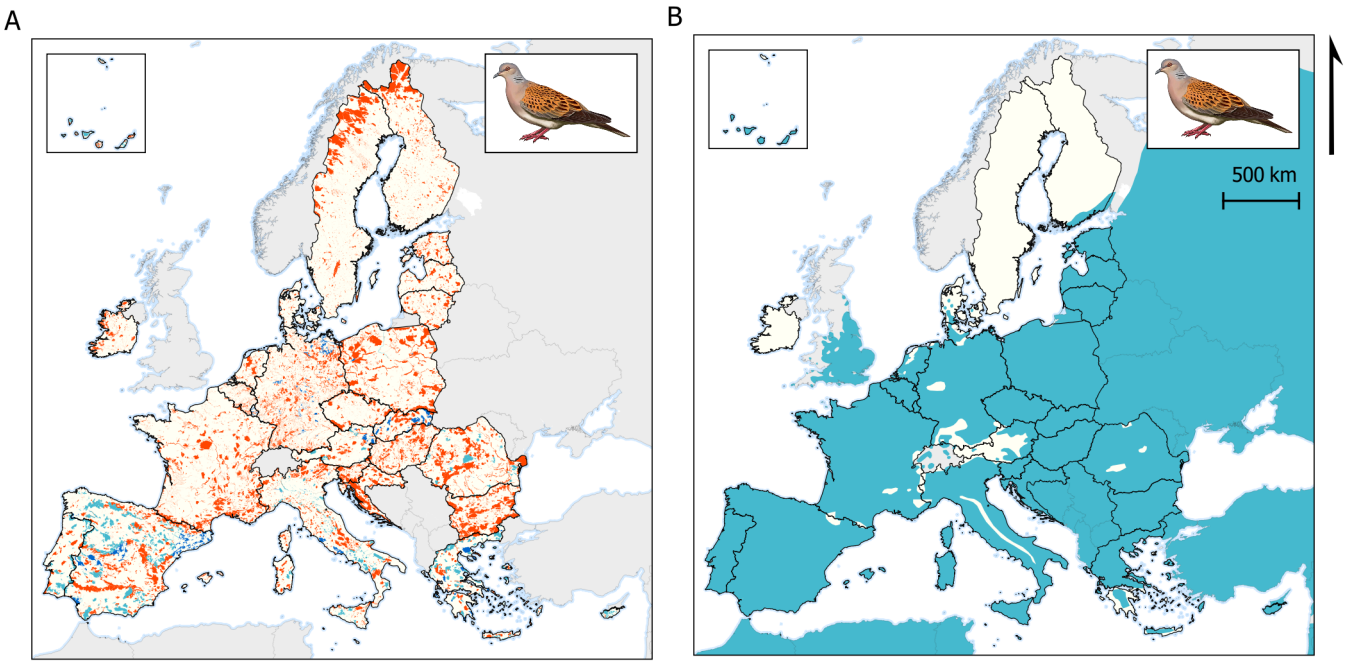

Fig. 1. Map of distribution of the European turtle dove *Streptopelia turtur* showcasing differences between the known distribution of the species and the one produced from Natura 2000 database. A) Occurrence and population size from the 2020 Natura 2000 database. Light blue: 2000 Natura areas with registered presence of the species but no information on population size; dark blue: 2000 Natura areas with registered presence of the species, also with information on population size; red: 2000 Natura areas with no registered presence of the species B) Distribution map of the species from data provided by BirdLife International (*9*).

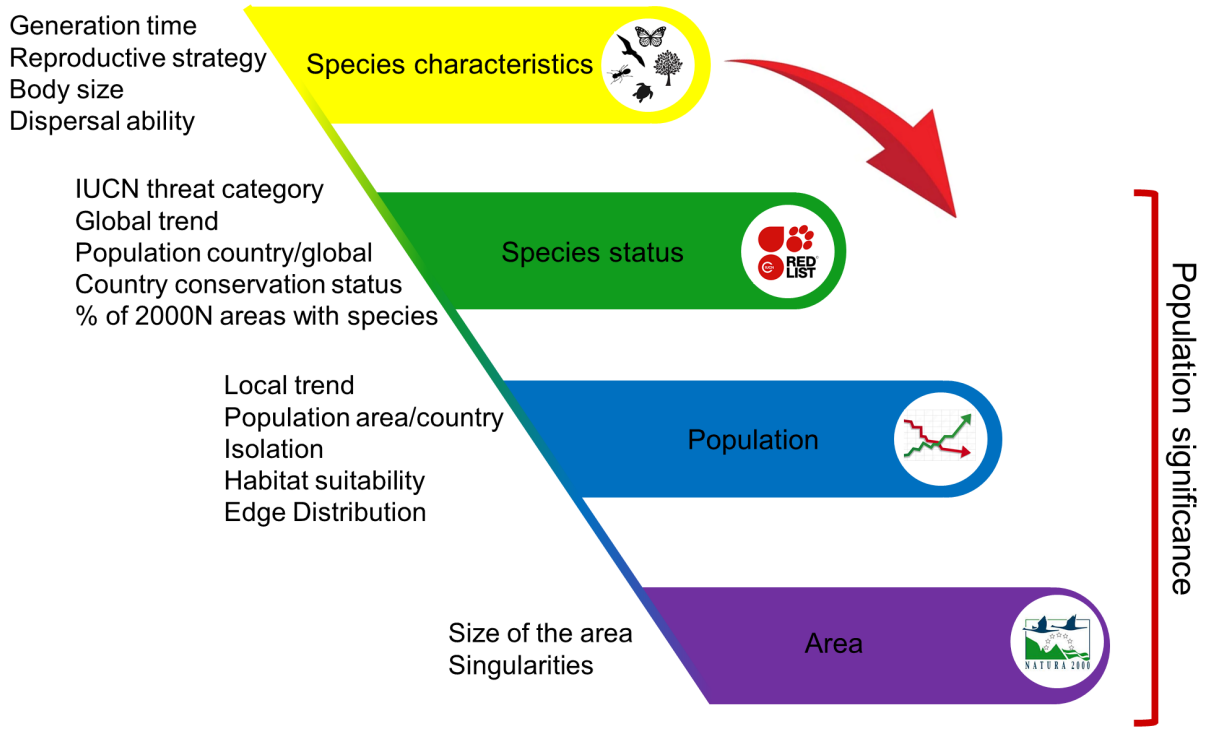

Fig. 2. Species, population and area characteristics to be considered when defining monitoring protocols and determining population significance criteria. Species-specific life history strategy should be considered when defining monitoring protocols and population conservation status. Population significance criteria should be based on Species status, and Population and Area characteristics, and criteria should be unified among countries to be useful for data comparisons across boundaries and for guiding conservation actions.

Supplementary Materials for

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The PDF file includes:

Supplementary Text, divided in 4 Appendices (1-4)
Figs. S1 to S9
Tables S1 to S3

Supplementary Text

In the Supplementary Text we first provide a description of the Natura 2000 SPECIES database (Appendix 1), then we provide a detailed description of the actual criteria used to determine the "significance of populations" by different State Members (Appendix 2); in the third appendix we show distribution maps of several species based on Nature 2000 database (Appendix 3). In the four and last appendix, we expand our vision about which factors should be considered to determine the significance of a population to help prioritizing resources in a realistic and unified way among countries (Appendix 4).

The data used for this study belong to the European Environment Agency (https://ec.europa.eu/environment/nature/natura2000/data). Specifically, we used:

- The vector layer Natura 2000 End 2020 – Shapefile (year 2020)
- The Natura 2000 database - Tabular data - SPECIES (year 2020)

All the analyses were done in software R (R Core Team 2021; https://www.r-project.org/) and QGIS (https://www.qgis.org/es/site/).

Appendix 1. Description of the Natura 2000 SPECIES database

Natura 2000 is the ecological network for the conservation of wild animal and plant species and natural habitats of Community importance within the Union. It consists of the sites classified under the Birds Directive first adopted in 1979 (Directive 2009/147/EC) and the Habitats Directive adopted in 1992 (Directive 92/43/EEC). Natura 2000 SPECIES database is generated from the compilation of the SPECIES data annually reported from all countries in the Standard Data Form (SDF) (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011D0484:EN:NOT). See the Official Journal of the European Union (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0484) for details on the SDF and instructions to fill information.

We analyzed here the Natura 2000 SPECIES database of 2020. This database contains 400177 records (i.e. populations), that correspond to more than 2900 different species and approximately 20990 Natura 2000 areas.

When analyzing the 2020 Natura 2000 SPECIES database we detected at least 0.5% erroneous values in 13 of the 18 variables of the SDF, either due to typological and completion errors, or erroneous missing values (Table S1). There is a mismatch between scientific names (SPECIESNAME) and species codes (SPECIESCODE), and scientific names are not standardized. There is a significant number of records (over 50%) that do not have population size values (LOWERBOUND and UPPERBOUND). In terms of population status (POPULATION_TYPE), more than 2% of records have typological errors and more than 2% erroneous missing values. ABUNDANCE_CATEGORY show a significant number of completion errors (≥15%) (Table S1).

Field in SDF	Content	Typological errors (%)	Completion errors (%)	Erroneous missing values (%)
COUNTRY_CODE	Country code	0	0	0
SITECODE	Natura 2000 site code	*	*	0
SPECIESNAME	Scientific name of the protected species	**	*	0
SPECIESCODE	Code the species listed in Article 4(1) and 4(2) of the bird directive 79/409/EEC and Annex II of Council Directive 92/43/EEC	<0.5	*	≥0.5
REF_SPGROUP	Species group from the reference ETC lookup species list	0	*	≥75
SPGROUP	Species group	0	*	<0.5
SENSITIVE	States if a species is sensitive or not for its publication	0	*	≥15
NONPRESENCEINSITE	Information about species that no longer exist on the site	0	*	≥25
POPULATION_TYPE	Population status for the species	≥2	*	≥2
LOWERBOUND/ UPPERBOUND	Limits for the species population size	0	<0.5	≥15
COUNTING_UNIT	Units of population	<0.5	≥2	<0.5
ABUNDANCE_CATEGORY	Species population abundance category	≥0.5	≥15	<0.5
DATAQUALITY	Assessment of the quality of data provided	≥2	≥2	<0.5
POPULATION	Size and density of the population of the species present on the site in relation to the populations present within national territory	<0.5	≥2	<0.5
CONSERVATION	Degree of conservation of the features of the habitat important for the species	≥2	≥0.5	<0.5
ISOLATION	Degree of isolation of the population present on the site in relation to the natural range of the species	≥0.5	≥0.5	<0.5
GLOBAL	Global assessment of the value of the site for conservation of the species concerned	≥2	≥0.5	<0.5
INTRODUCTION_CANDIDATE	Species referred to in Article 4 of Directive 2009/147/EC or species listed in Annex II to Directive 92/43/EEC considered as a candidate for introduction on the site	0	0	0

Table S1. Percentage of typological and completion errors in the 2020 SPECIES database from Natura 2000. "Content" explains the information recorded in the specific variable of the SDF column. * Unknown; ** Not quantified.

Of the 27 Member States of the European Union, Italy is the country with the highest number of records (106563), followed by Spain (70931), Germany (43619), France (39342) and Finland (16019) (fig S1). Most of the Natura 2000 Network areas have less than 100 registered populations, although there is great variability in the number of populations per site (with a minimum of 1 population to a maximum of 457). The SPECIES database contains species records of seven major taxonomic groups (Amphibians, Birds, Fish, Invertebrates, Mammals, Plants and Reptiles). There is great variability in the number of records of each group among Member States of the European Union (fig S2) and Birds are the taxonomic group with the highest number of records (301813).

We also detected high variability in the number of recorded populations per species. About 95% of the species have less than 1000 populations. Only a few species have more than 4000 recorded populations, such as *Lanius collurio*, with 4,745 records, or *Alcedo atthis*, with 4089. Species that motivated the declaration of Natura 2000 areas but are no longer present in these areas represent 1.2% of the data (4762 records). “Permanent” populations are the most abundant population status category (POPULATION_TYPE) (125958), followed by “breeding” populations (103157), and “concentrations” (97491) being the less abundant “wintering” populations (50506). About 45% of records had an assigned population size.

We identified a large amount of data deficient (DD) populations, being by far the most abundant category in data quality assessment (162298 records reported as DD or simply marked as NA). The proportion of DD and non-DD records is highly variable between Member States of the European Union, and represents: 1) more than 75% of the data in countries such as Cyprus, Italy, and Romania; 2) between 25 and 75% in Belgium, Croatia, the Czech Republic, Denmark, France, Germany, Greece, Latvia, Lithuania, Portugal, Slovenia, and Spain and 3) less than 25% in Austria, Bulgaria, Estonia, Finland, Hungary, Ireland, Luxembourg, Malta, the Netherlands, Poland, Slovakia, and Sweden (fig. 1). We must emphasize that the number of records reported by country is also very variable.

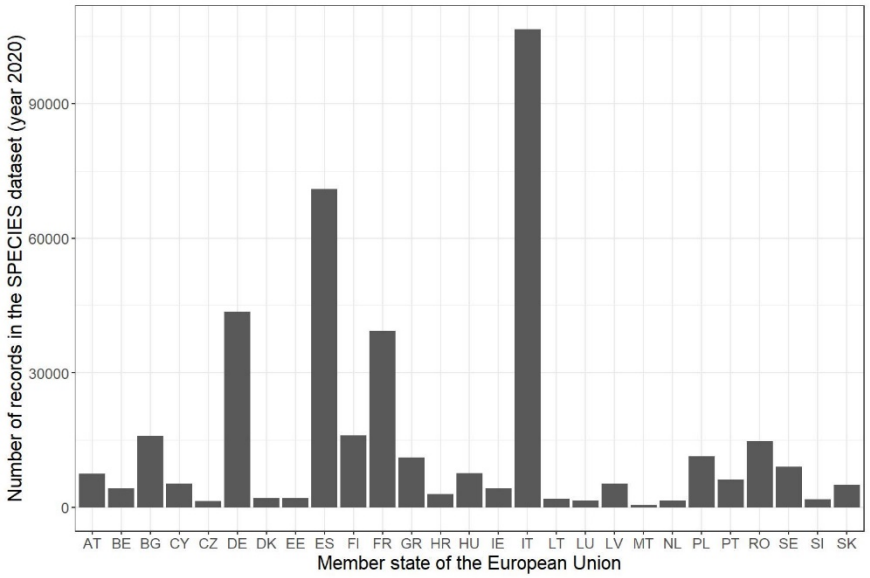


Fig. S1. Total number of populations registered at each Natura 2000 area by each EU State Member in 2020 database. EU state members are shown abbreviate in the X axis by alphabetical order (see table S3 for abbreviations).

Table S3. Members in the English name and in the SDF are

English Name	ISO code	English Name	ISO code
Austria	AT	Italy	IT
Belgium	BE	Latvia	LV
Bulgaria	BG	Lithuania	LT
Croatia	HR	Luxembourg	LU
Cyprus	CY	Malta	MT
Czech Republic	CZ	Netherlands	NL
Denmark	DK	Poland	PL
Estonia	EE	Portugal	PT
Finland	FI	Romania	RO
France	FR	Slovakia	SK
Germany	DE	Slovenia	SI
Greece	GR	Spain	ES
Hungary	HU	Sweden	SE
Ireland	IE		

Abbreviations of all State Natura 2000 Network. The also the ISO codes to be used shown.

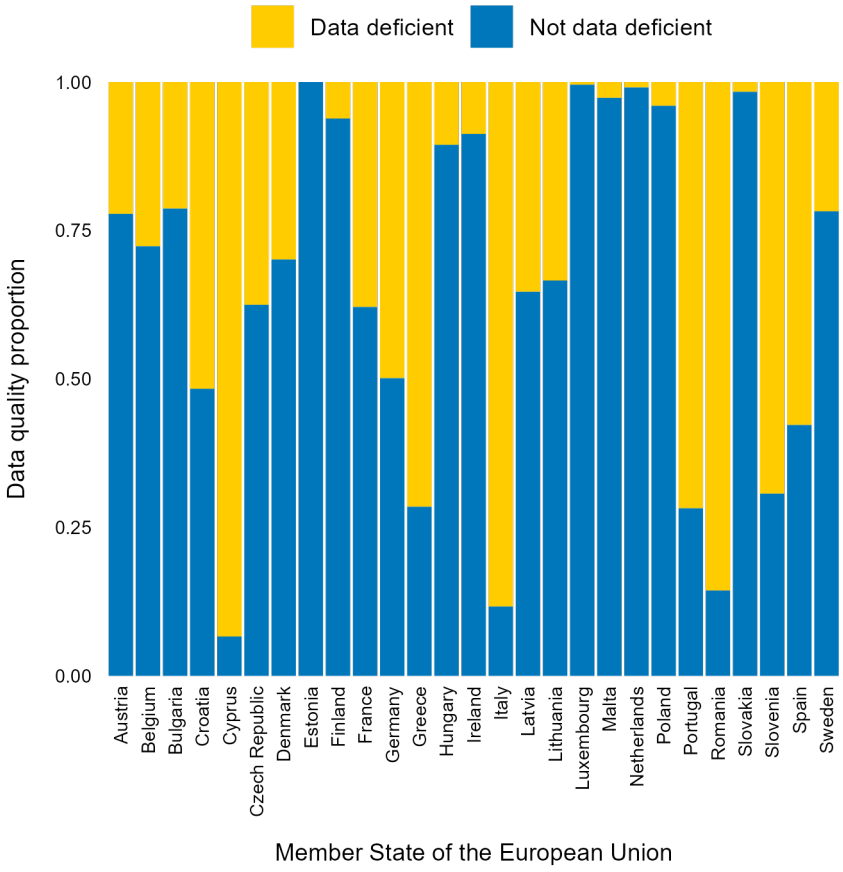


Fig. S2. Data quality in the 2020 Species Nature 2000 database is both highly heterogeneous among countries and overall low. Data Deficient (DD) include those records categorized as DD and those records without reporting data quality in the Standard Data Form (SDF). Non-DD category include all other records, categorized as "good", "moderate" or "poor data" in the DATA QUALITY category in the SDF.

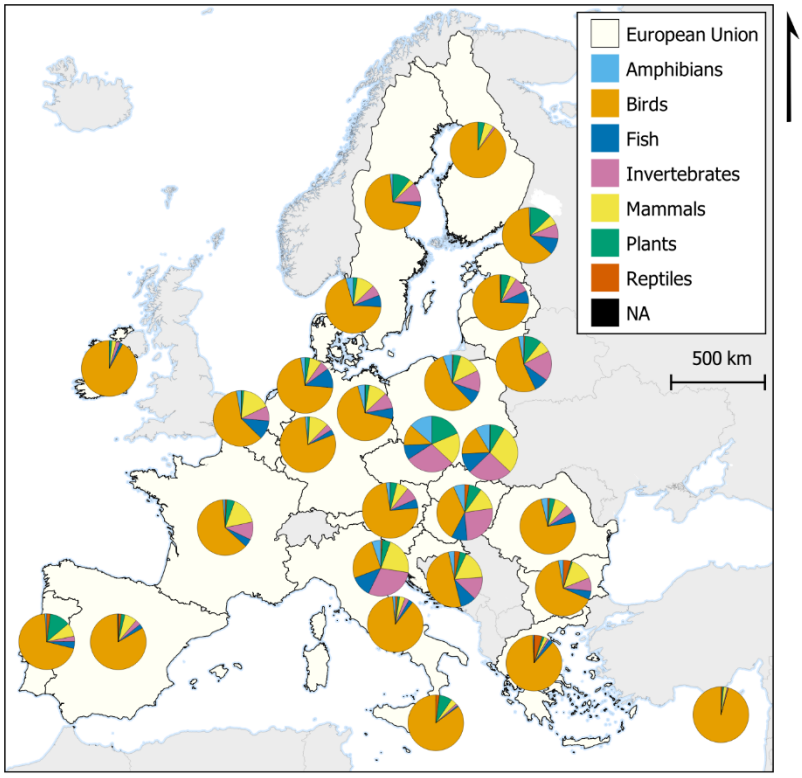


Fig. S3. Proportion of populations registered by taxonomic group at Natura 2000 areas in EU State Members. The proportion of populations registered by taxonomic group show that monitoring effort for the different taxonomic groups at Natura 2000 areas is heterogenous among countries.

Of special interest is the POPULATION category in the SDF. This category evaluates the relative size and density of the population in the Natura 2000 area with that of the national population. Populations should be assigned to different categories (A, B, C and D) depending on the ratio of the population size and the population size in the national territory. As proposed for criterion A(b), populations should be classified in relation to these percentages:

Significant A : $100\ \% \geq p > 15\ \%$,
Significant B : $15\ \% \geq p > 2\ \%$,
Significant C : $2\ \% \geq p > 0\ \%$.

In all areas where the species is observed, regardless the size of the population, the population should be considered **significant;** the population size will help to categorize the **significant** populations in A, B or C. Furthermore, all cases where a population of the species concerned is present on the area in question in a non-significant manner must be indicated. Only in those cases where a species is rarely observed on an area, for example a vagrant individual, the population could be categorized in a fourth category D, as a "**non-significant population**". In cases where the population is categorized as 'D: non-significant', no other indication is required for the other evaluation criteria. The European Commission criterion recommends that only those species barely observable at the area, should be officially accepted as "non-significant", but in practice many populations that are non-vagrant or rarely observed, are classified as "**non-significant**" based on particular criterion or expert opinion (fig. S3). This is highly relevant because conservation objectives and effective measures have to be set out or referred to in legally binding acts for only species and habitat types with "significant" presence in each Natura 2000 area.

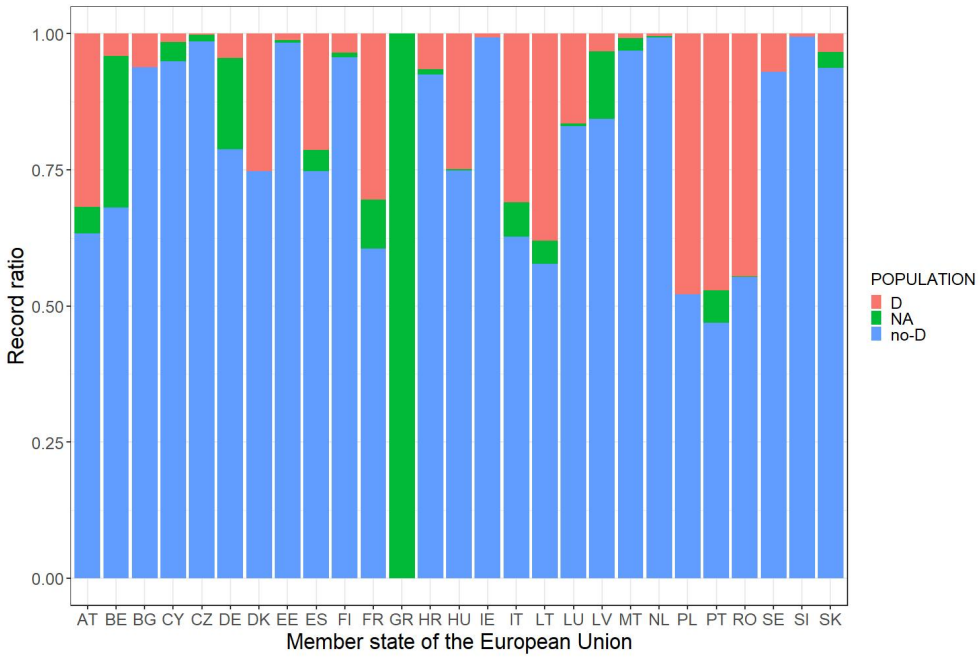


Fig. S4. Differences in the evaluation of populations significance by different EU State Members in 2020 database. D = populations categorized as non-significant. No-D= proportion of populations categorized as A, B or C (all of them significant). NA: no information about category of population. EU state member are shown abbreviate in the X axis by alphabetical order (see Table S3 for abbreviations).

Appendix 2. Actual criteria to determine the "significance of populations"

With the objective of knowing the criteria used in each of the Member States to determine the "significance of populations" in the SDF, during the months of October and November 2021, we contacted the different countries and regions within countries, when relevant. The first contact was made through the Spanish Ministry for the Ecological Transition and the Demographic Challenge, and we wrote to the members of the 'Expert Group on Reporting' of both directives. Through this approach we obtained three responses. A second round was then carried out through personal contact to The National Nature & Biodiversity contact points (NCPs) provided by the European Commission and to the contacts provided on the websites of the Natura 2000 of each country. With this approach we obtained most of the answers. We did a third round of contact and show them our gathered information to get some more answers and to check if they agree with our conclusions. The responses from the different Member States are shown below by country in Table S2.

Region	Country	Management of the areas falls on different regional bodies in the country?	The data reported to the SDFs have a proportion of DD / NA records >25% for the Data Quality variable?	Does the SM or region explicitly recommend other criteria to determine significant populations that the one recommended by the EC? *	Even if not officially, does the SM or region use other criteria to determine significant populations?	Is expert opinion used in some step of the decision-making process?	When expert opinion is used?
Burgenland	Austria (AT)	Yes	No	No	Yes	Yes	To decide if a population is not significant
Oberösterreich				No	Yes	Sometimes	To decide if a population is not significant
Tyrol				No	Yes	Yes	To decide if a population is not significant
Flanders	Belgium (BE)	Yes	No	No	Yes	Sometimes	To decide whether a population is not significant, what conservation measures to apply, and in what cases
Valonia			Yes	No	Yes	Unknown	Unknown
	Bulgaria (BG)*	Unknown	No	No	No	Yes	To decide if a population is not significant
	Croatia (HR)	NA	Yes	NA	NA	NA	NA
	Republic of Cyprus (CY)	NA	Yes	NA	NA	NA	NA
	Czech Republic (CZ)	Yes	Yes	No	Yes	Sometimes	Unknown
	Denmark (DK)	NA	Yes	NA	NA	NA	NA
	Estonia (EE)	NA	No	NA	NA	NA	NA

	Finland (FI)	No	No	Unknown	Yes	Yes	To decide if a population is not significant
	France (FR)	Unknown	Yes	No	No	Yes	To decide if a population is not significant
	Germany (DE)	Yes	Yes	No	Yes	Yes	To decide if a population is not significant
	Greece (EL/GR)	NA	Yes	NA	NA	NA	NA
	Hungary (HU)	Unknown	No	Yes	Yes	Yes	To apply exceptions; to decide if a population is not significant
	Ireland (IE)	NA	No	NA	NA	NA	NA
	Italy (IT)	NA	Yes	NA	NA	NA	NA
	Latvia (LV)	Unknown	Yes	No	Yes	Yes	To evaluate SDF data and critically review all other available data
	Lithuania (LT)	NA	Yes	NA	NA	NA	NA
	Luxembourg (LU)	NA	No	NA	NA	NA	NA
	Malta (MT)	Yes	No	Yes	Yes	Yes	Unknown
	Netherlands (NL)*	Unknown	No	Yes	Yes	Unknown	Unknown
	Poland (PL)*	Unknown	No	No	Yes	Sometimes	To apply exceptions (to decide if a population is not significant)
	Portugal (PT)	NA	Yes	NA	NA	NA	NA
	Romania (RO)	NA	Yes	NA	NA	NA	NA
	Slovakia (SK)*	No	No	No	Yes	Yes	To decide if a population is not significant
	Slovenia (SI)	Unknown	Yes	Yes	Yes	Yes	To decide if a population is not significant (especially when there is not enough field data)
	Spain (ES)	Yes	Yes	No	No	Yes	To decide if a population is not significant
	Sweden (SE)	Yes	No	No	Yes	Yes	To decide if a population is not significant

Table S2. Criteria for registering data in the SDF for different EU State Members (SM). The EU criteria for considering a population non-significant is: "a species is barely observable at the site, for example a vagrant species". Information comes from answers from EU Natura 2000 contacts from

each country. NA: means not available information. NA indicates that we could not get the information from that country. * These countries provided information on the management, decision-making and criteria used, however they did not answer on the third round to validate the table.

Appendix 3. Species occurrence and data on population size

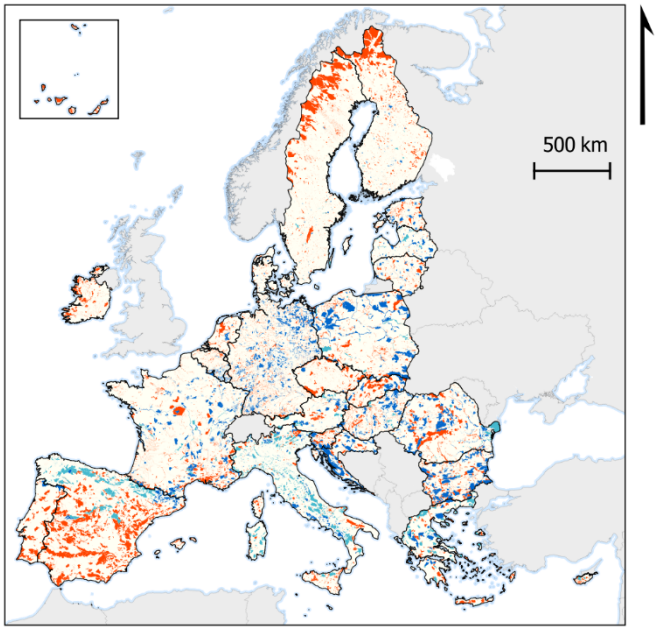
Based on the previous exploration of the SPECIES database, and with the objective to asses the consequences of the disparities in criteria and dedicated effort among countries, we mapped the occurrence and available data on population size of several species.

We first mapped the occurrence and data on population size of the most common and widely distributed terrestrial birds in Natura 2000: the European turtle dove *Streptopelia turtur* (fig.1), and the red-backed shrike *Lanius collurio*, the European nightjar *Caprimulgus europaeus*, the common cuckoo *Cuculus canorus*, the black kite *Milvus migrans*, and the common kingfisher *Alcedo atthis* (fig. S5). We found evidence that there is a heterogeneity in the sampling effort and/or in the data reported by the different Member States or even regions within countries. We observed a large number of areas without a registered presence of these species, even if they are distributed throughout the European geography (fig. S5).

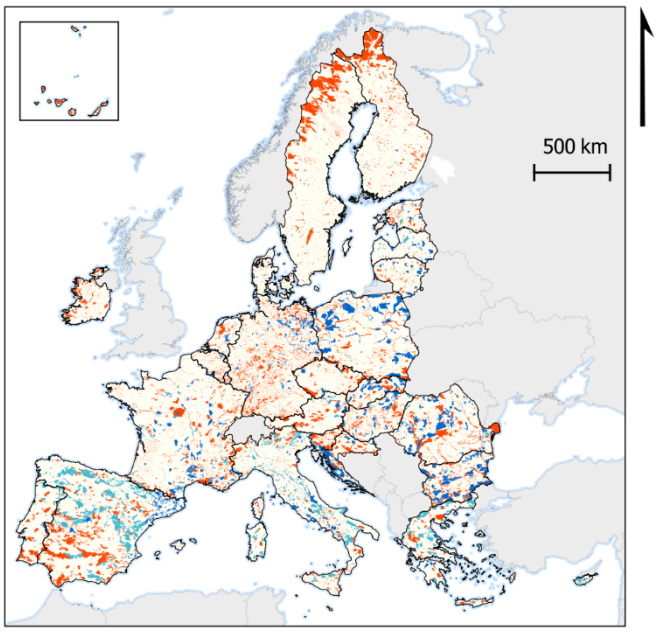
We also mapped the occurrence and population size of other common European species of other non-Bird groups based on recorded data on Natura 2000 areas. Specifically, we studied the distribution of two invertebrates, the Marsh Fritillary *Euphydryas aurinia* (fig S6) and the European stag beetle *Lucanus cervus* (fig S7); two amphibians, the great crested newt *Triturus cristatus* and the Yellow-bellied toad *Bombina variegata* (fig S8). We found many areas with registered presence of the species but no information on population size, while those with some information on populations size were eminently minorities, and, in many cases, aggregated nationally or regionally (e.g.: in Catalonia, Germany, and Bulgaria) (figs. S6-S8).

The consequences of the disparities in dedicated effort and allocation of resources across Nature 2000, and in criteria used to identify significant populations among countries are non-negligible and heterogeneities translate in a dataset that do not allow assessment or comparison of the conservation status of species.

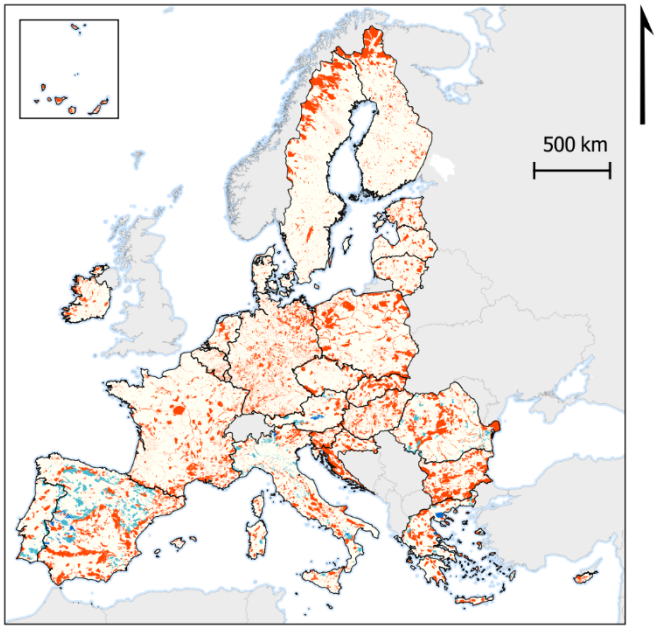
A)



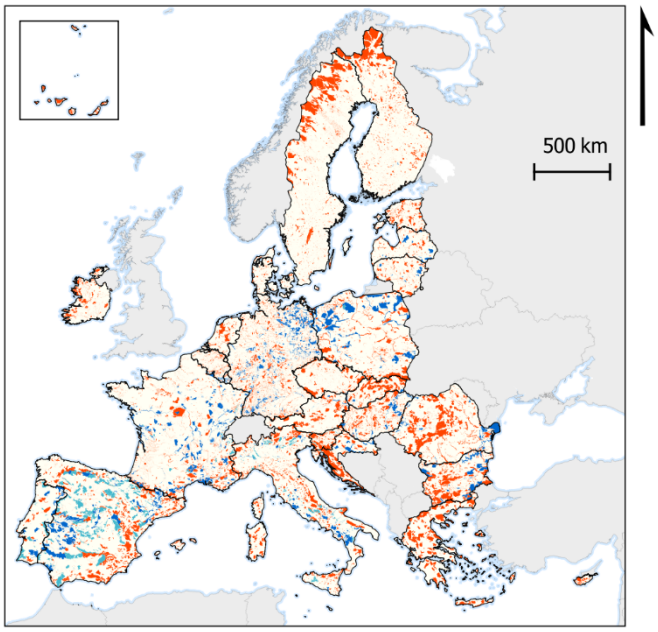
B)



C)



D)



E)

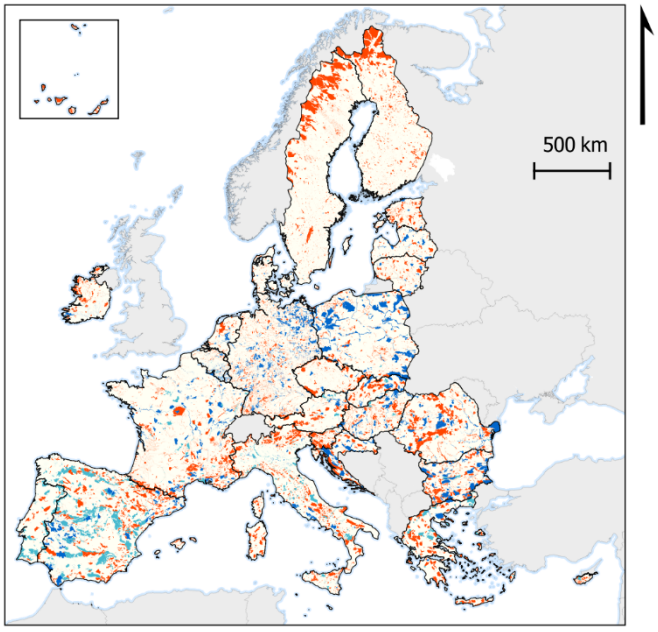


Fig. S5. The map of distribution of the most common and widely distributed European terrestrial birds in Natura 2000: (A) the red-backed shrike *Lanius collurio*, (B) the European nightjar *Caprimulgus europaeus*, (C) the common cuckoo *Cuculus canorus*, (D) the black kite *Milvus migrans*, and (E) the common kingfisher *Alcedo atthis*. In each figure, occurrence and population size from the 2020 version of the Natura 2000 global database are shown.

Light blue: 2000 Natura areas with registered presence of the species but no information on population size; dark blue: 2000 Natura areas with registered presence of the species, also with information on population size; red: 2000 Natura areas with no registered presence of the species. In some cases, national or regional frontiers are visible.

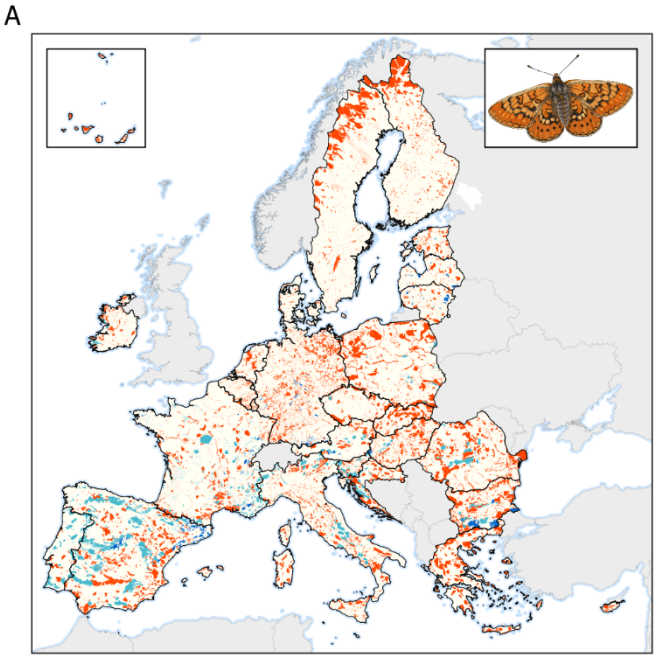


Fig. S6. Map of distribution of the butterfly Marsh Fritillary *Euphydryas aurinia*. We show in light blue: 2000 Natura areas with registered presence of the species but no information on population size; dark blue: 2000 Natura areas with registered presence of the species, also with information on population size; red: 2000 Natura areas with no registered presence of the species.

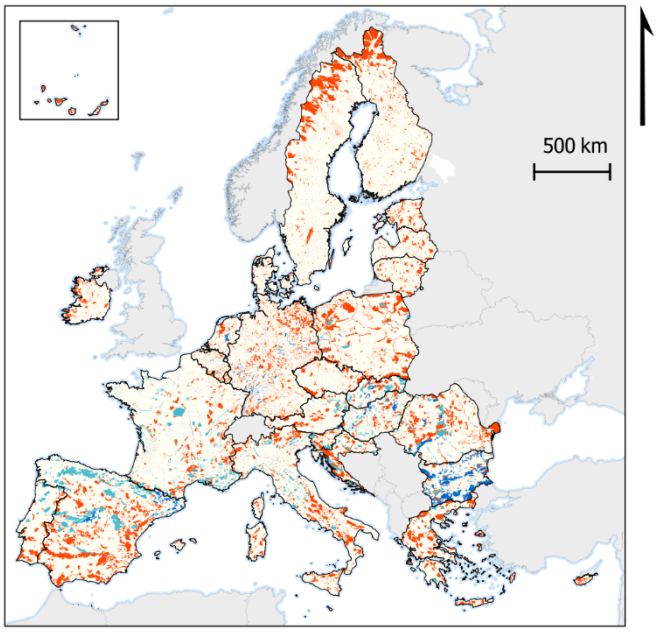
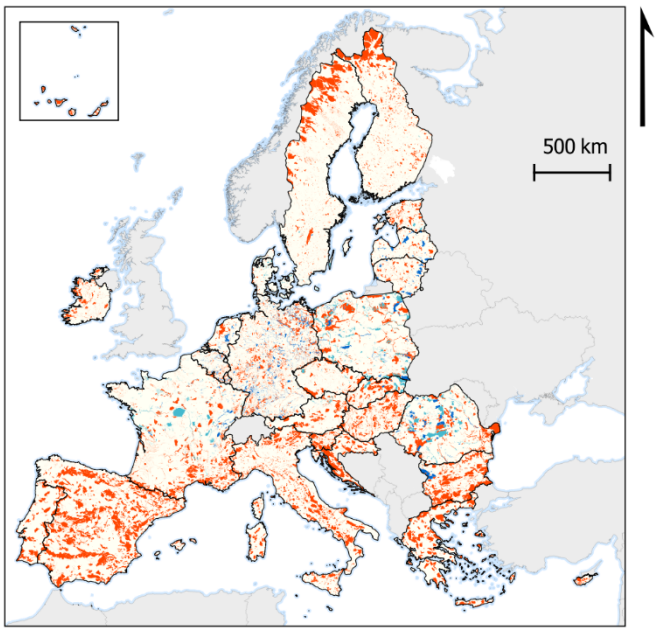


Fig. S7. **Occurrence and population size data available of one beetle *Lucanus cervus* in Natura 2000 Database**. We show in light blue: 2000 Natura areas with registered presence of the species but no information on population size; dark blue: 2000 Natura areas with registered presence of the species, also with information on population size; red: 2000 Natura areas with no registered presence of the species.

A)



B)

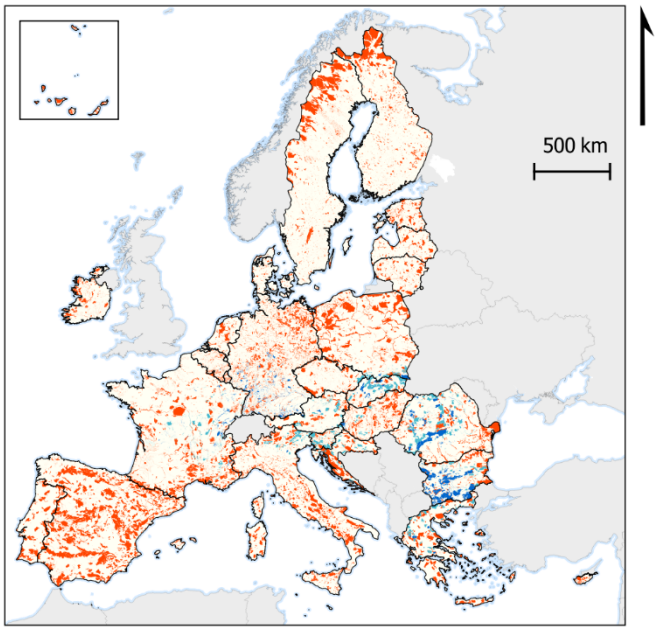


Figure S8. **Occurrence and population size data available of two amphibian species in Natura 2000 Database.** A) *Triturus cristatus* with 2313 populations in Natura 2000 and the category of threat Least Concern and B) *Bombina variegata*, with 1570 populations in Natura 2000 and the category of threat Least Concern. We show in light blue: 2000 Natura areas with registered presence of the species but no information on population size; dark blue: 2000

Natura areas with registered presence of the species, also with information on population size; red: 2000 Natura areas with no registered presence of the species.

Appendix 4. Suggestions for new unified criteria for determining population significance of the 2000 Natura populations

Based on the current criteria and the problems detected by Natura 2000 managers and this study, we provide some ideas to design the new criteria for determining population significance of the 2000 Natura populations. We propose to divide actual significant populations in three subcategories that would entail certain levels of prioritization in the allocation of resources and monitoring effort. We also suggest which factors should be considered to determine these levels of significance based on the species conservation concern, the global trend of the species and the population supported by the country or the area in relation to the global population or the country population, respectively.

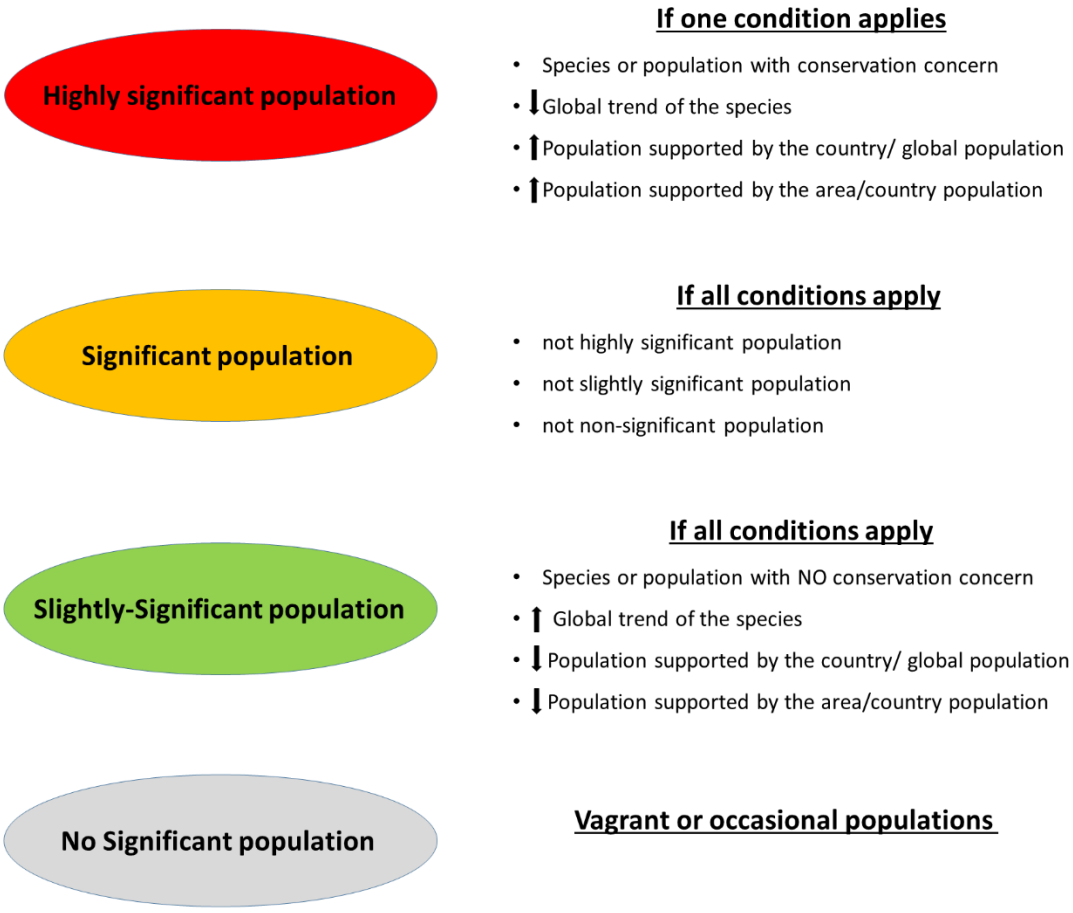


Figure S9. Possible subdivision of the "significant" category of population to prioritize resources in a unified manner among EU State Members.