



The “Umbrella Effect” of the Natura 2000 network

An assessment of species inside and outside the European Natura 2000 protected area network

Executive Summary

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Introduction/background/context

Natura 2000

Natura 2000 is a network of protected areas that now covers around 18% of the land surface of the European Union. These sites are designated under the Birds and Habitats Directives and the network includes both terrestrial and marine sites (Marine Protected Areas, MPAs). The ultimate goal of the two 'Nature Directives' is to ensure the long-term sustainability of more than 230 habitats and 1,500 species of animals and plants of 'Community Interest' and all bird species naturally occurring in the EU (Fig. 1). The ecological condition delivering such long-term sustainability is known as 'favourable conservation status' (FCS).

In May 2015 the Commission published the report *The State of Nature in the European Union* an evidence base which sets out the status of and trends for habitat types and species covered by the Birds and Habitats Directives for the period 2007-2012. The report, which is based on information reported by 27 Member States, provides a basis for formally judging the success of the nature directives in relation to their original goals.

Exploring the umbrella effect

The *State of Nature* report does not show the wider contribution of Natura 2000 to the conservation of species that are not listed in the annexes to the Directives. The need to understand this contribution is driven by a general inquiry into the effectiveness of the Nature Directives and the EU strategic target,

expressed within the Biodiversity Strategy to 2020, to "halt the deterioration of all species and habitats and achieve a significant and measurable improvement in their status...." It focusses in particular on the functionality of the Natura 2000 network in Europe as a key prerequisite for conserving biodiversity. In 2013 the European Commission therefore initiated a research project to assess the significance of the presumed "umbrella effect" of Natura 2000, related to its potential contribution in terms of halting and reversing the loss of species other than those for which the Natura 2000 sites have been set-up.

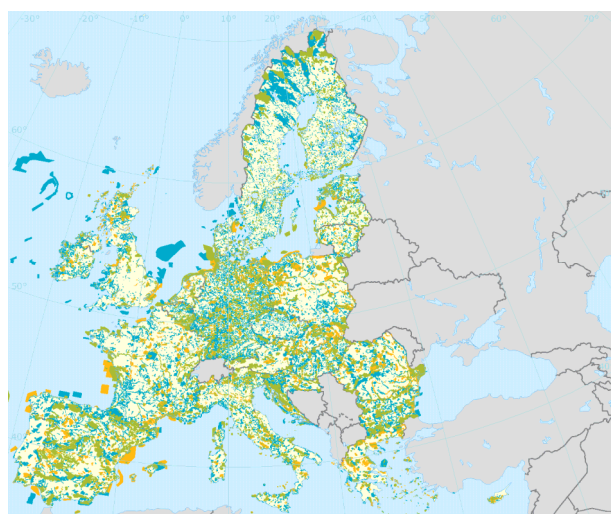


Figure 1 The Natura 2000 network for the EU-28, which comprises the areas of the Birds Directive (SPAs, orange) and Habitats Directive (pSCI, SCI, SAC, blue) or both (green) (EEA 2016).

Key research questions and approach

The research was focussed on terrestrial habitats and, in order to investigate the umbrella effect of Natura 2000, it addressed the general question of: "How much biodiversity is covered by Natura 2000?", further specified as follows:

- Which are, amongst the species regularly occurring within the European territory of the EU-28 Member States (common species), those that significantly benefit from the Natura 2000-related site conservation requirements under the EU Birds and Habitats Directive?
- What is e.g. in percentage of all species occurring in the wild in the EU, the share of EU species significantly benefitting from Natura 2000?
- How significant is this contribution of Natura 2000 in relation to the objective of halting and reversing biodiversity loss?

Key considerations were the spatial distribution, the geographical range¹ of species within the EU-28 countries², and the presence of species within Natura 2000 and outside the network. The presence can be expressed in the form of a simple figure or percentage of the distribution of a species within Natura 2000. Specific consideration was given to species which are not included in the annexes of either directive (i.e. species other than those for which areas were designated). However, in all cases the conservation

¹ 'Range' refers to the overall geographical envelope within the EU territory and 'distribution' is the spatial occurrence within the envelope.

² Some specific areas that do not form a coherent part of the EU territory were excluded because from biogeographical point of view they belong to a different zone or data was not available. These included the Macaronesian Islands, some Spanish enclaves on the African mainland and, for the birds, reptiles and amphibians, Cyprus.

value of species was assessed based on their position on Red Lists and status as endemics. The study was accompanied by a literature review that provided context in relation to the research questions.

The approach used existing data, for as many groups as possible and covered the terrestrial mammal, bird, reptile, amphibian, butterfly and plant species. The analysis is mostly based on GIS processing of species distribution data in relation to their presence within protected areas of the Natura 2000 network. Statistical distribution models were used as a cross-validation tool. Figure 2 shows the basic analytical framework used in the assessment.

The taxonomic groups differed in relation to the available data (some groups are recorded better than others), as well as within groups (some countries have better information than others), in some cases markedly. Available data may consist of atlas data or observation data³. Variation in data availability and quality among and within taxonomic groups critically determined the analytical approaches used.

The general approach for the analysis was based on habitat masking of 50 by 50 km data with CLC or GLC data (except for plants, see below). The robustness of the results provided by the general approach was validated by applying models at finer resolutions, and with a different approach. This was carried out first at 5 km by 5 km for the whole of Europe and for specific countries, with more detailed data, at the scale of 1 km by 1 km (Table 1).

Table 1 Scale levels for the different taxa for which the analysis was performed.

Taxa	50x50 km	5x5 km	2x2 km	1x1 km
Plants			x	
Mammals	x	x		
Birds	x	x		x
Reptiles and amphibians	x	x		x
Butterflies	x	x		

³ Available data can consist of atlas data or observation data: atlas data includes published data on presence and absence of a species based on comprehensive coverage or modelling, while observational data is here defined as records compiled from a range of databases, papers and reports. These are presence records associated with spatial information, often at high accuracy but absence data are generally missing.

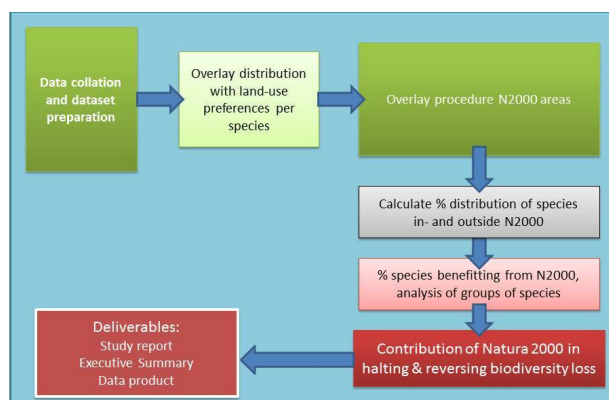


Figure 2 Analytical framework of the assessment.

In relation to the question of 'significant beneficial effect', 18% of Europe's land surface is Natura 2000. With a totally random distribution of species over the EU, on average 18% of their distributions would occur within Natura 2000. However, if the distribution of species is more than 18% in Natura 2000 (or less), this can provide the basis for considering if a benefit is being provided or whether some other effect may be being observed. 18% also provides an easily communicated baseline for judging the benefits provided by Natura 2000 to common species in the EU. For the results at country level the respective Natura 2000 coverage in each country was used as the baseline.

There is also a potential for sampling bias, particularly because species presence data are often collected on an opportunistic basis and there may be more collection of records within Natura 2000 sites (because of their accessibility, designation and the types of habitat found within them). A spatial bias correction technique was therefore applied; this allowed for a reduction of the error by predicting a high probability of presence where many presence data are available, and predicting low probability of presence where presence data are unavailable (but the species could be present).

Analysis

The questions posed by this study should ideally be answered based on empirical data on species occurrence inside Natura 2000. However these data are not available for all species and the entire territory of the EU-28. Given the species distribution data available, a robust approach was therefore developed to assess the importance of Natura 2000 areas for all species.



Figure 3 The Alpine ibex (*Capra ibex*) is considered Least Concern by the European Red List. Its distribution covers 0.4% of European territories and 38.4% of its distribution is protected by Natura 2000. (Photographer Nathan Ranc)

'Habitat masking' was carried out to estimate the fine-scale spatial distribution of available habitat within each 50×50 km cell occupied by a species. Species-specific habitat masks were made by assigning species to Corine Land Cover (CLC) habitats - Level 3 (CLC-3) or the Global Land Cover (GLC) map. The CLC-3 map is based on 2012 Remote Sensing data (Greece: 2006 data), and is available for the EU-territory with the exception of The Azores and Madeira. Geographical ranges for mammals were refined using habitat suitability models. Next an overlay was made between the species' 50×50 km distribution maps (Fig. 4A) and the CLC types,

resulting in maps showing apparently suitable CLC types within the species known range for the EU-28 (Fig. 4B). These 'masked' distribution maps were validated by experts. This validation revealed some limitations of the CLC map. As might be expected given the sometimes complex ecological requirements of species, the land cover types distinguished in Corine do not adequately differentiate among habitat types occupied and unoccupied for all species. In these cases, the Corine map seems too coarse and some important small land cover features are absent or underrepresented in the land cover data sets, for example streams, small rivers, small lakes, fens and open areas in forests. Habitat masked maps that were obviously unsuitable for these purposes were excluded from further analysis; for the breeding birds 44 species (identified in the data tables associated with the project technical report) were therefore excluded due to the unsuitability of the CLC information and 7 additional island endemic species were excluded because these regions were not covered by CLC.

The extent of a species' distribution in and outside Natura 2000 was then estimated based on combined atlas data and potentially suitable habitat, derived from CLC data (Fig. 4C).

Two approaches were then followed to model species distribution, the approach chosen was based on the available data and modelling results:

1. Based on the 50×50 km distribution data from the relevant taxonomic atlas. These were downscaled to 5×5 km cells using spatial regression modelling techniques, taking into account aspects such as soil and climate data, forest management, nitrogen and sulphur deposition and the CLC types, and GLC maps. This resulted in modelled species distribution maps at the 5x5 km scale.

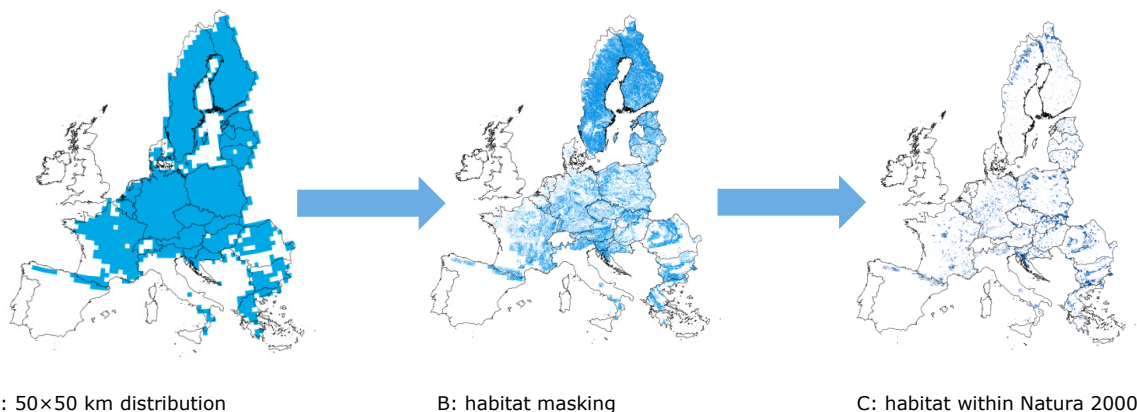


Figure 4 A: An example of the habitat masking process as applied to the Black Woodpecker (*Dryocopus martius*). The observed distribution of a species. B: after selection of suitable habitat based on CLC-3 or GLC the area is refined. C: after an intersection of habitat with the Natura 2000 map (EEA 2015) we derive at the distribution map of habitat in Natura 2000.



Figure 5 Countries for which detailed distribution modelling was done.

- Based on species observations available from different NGOs, data submitted to biodiversity web portals, count data from countries and EU Bird Directive reporting 2008–2012 10×10 km distribution maps (www.eea.eu) spatial models were built to produce distribution maps. As above, soil and climate data, forest management, nitrogen deposition and the CLC types and GLC maps were used to improve the models.

Detailed distribution atlas projects in individual European countries, with distribution data at relatively fine scale (e.g. 5×5 km or 10×10 km) were used specifically to ground-truth estimates of species coverage by the Natura 2000 network. Such data (empirical or modelled) was used to test broad-scale results for birds, mammals, reptiles and amphibians and butterflies.

The approach for the plants was different. To assess the importance of the Natura 2000 network for plant biodiversity in Europe the vegetation data stored in European Vegetation Archive (EVA) was used. The EVA database currently contains 1,122,134 vegetation plots, comprising 25,069,904 species recordings.



Figure 6 Yellow lady's slipper (*Cypripedium calceolus*).

The assessment was restricted to vascular plants which are better represented in the database than cryptogams. Altogether 779,635 vegetation plots are georeferenced and located in EU-28 countries, representing 395,499 unique locations. These unique locations in EU-28 countries have been assigned to 107,730 unique 2x2 km grid⁴ cells, of which 52,695 grid cells are located within Natura 2000 sites and 55,035 grid cells outside Natura 2000 sites.

The analysis was restricted to the rare and diagnostic plant species, which are those listed in European Red List of vascular plants of the IUCN, and a number of national Red Lists. Criteria for selecting national Red Lists of vascular plants in digital form, as well as the availability of sufficient well located plot data in the vegetation database at national levels. Species indicated as 'Least Concern' (LC) were excluded from the analysis, as were species from the Annex II list. The rule for LC species was applied to all Red lists including the IUCN list; for practical reasons it was a problem to include these species because of the scale of analysis that would have been required. The Annex II species were excluded as they have contributed to the designation of Natura 2000 sites. In general the Red Lists contain few Annex II species (with the exception of the IUCN European Red List of vascular plants). Even after having excluded LC and Annex II, 513 species remained for the analysis. Common species were treated in a separate analysis.

A list of around 500 European orchid species was also compiled on the basis of EVA and a list of species diagnostic for 40 Annex I habitat types, representing habitats which are in most cases widely distributed in Europe. Orchid species are selected because they capture the interest of many people, but also because these species often occur in vulnerable habitats.

Within each species group the number of species was counted in random selected grid cells, inside and outside Natura 2000 sites. Based on these random selections, the ratio was defined for the selected species inside and outside Natura 2000 sites. For the first two groups (Red List of European vascular plants and orchid species), the number of random selected grid cells was set to 5,000 inside and 5,000 outside Natura 2000 sites. For the analyses on national level the number of random selected grid cells was set to 500 (500 grid cells inside and 500 grid cells outside), since the selections were only performed on the country specific grid cells. Within each group, a grid cell was selected only once.

⁴ The grid size of 2x2km has been chosen because of the uncertainty of the location precision of the plots. With a grid size of 1x1 km too many plots would have been excluded.

Results

The combined results for the different animal groups are shown below. The plants are presented separately. Figure 7 shows that (based on the 18% baseline):

- All species groups benefit above what could be expected based on a random distribution – so that more than 18% of their distribution occurs in Natura 2000
- Species for which Natura 2000 areas were not specifically designated (non-annex species) do benefit from the Natura 2000 network
- The species of the annexes benefit more than the 'other' species; this is in particular the case for birds and butterflies, for reptiles and amphibians the difference is negligible.

To assess the extent to which species benefit from the Natura 2000 network it was determined whether the share of species distribution within Natura 2000 exceeded the share of Natura 2000 within a country (Fig. 8). The territory of Natura 2000 differs considerably between countries, from 8% in the UK to almost 38% in Slovenia. Figure 7 shows that the butterfly species have a particularly high presence within the Natura 2000 network, reflecting the fact that most habitats for butterfly species are found within the Natura 2000 network. In fact, relatively few butterfly populations and species still survive in the surrounding habitats due to the effects of intensive land use and farming practices, as has been widely reported in the literature. Mammal, amphibian and reptile species also show a larger presence within the Natura 2000 network. For bird species the patterns of species coverage by Natura 2000 are a close match to the share of Natura 2000 in the countries, except for Sweden which has a relatively high share, and Slovakia with a small share of birds in Natura 2000. Cyprus and Malta have relatively low shares of most faunal groups within Natura 2000.

The presence of threatened species (Red List species) in and outside Natura 2000 (Fig. 9) was compared.

- The analysis shows that for all species groups a relatively large share of Red List species occurs within the Natura 2000 network
- The threatened species benefit more than the not threatened species, with 35-40% found within Natura 2000
- Not evaluated species (i.e. species classified as 'data deficient' or 'not evaluated') have significantly lower presence in Natura 2000
- Threatened birds, reptiles and butterflies in particular benefit from Natura 2000 areas.

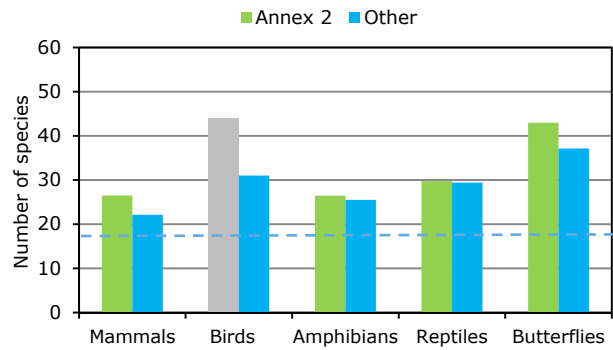


Figure 7 Average share of the occurrence of annex versus non-annex species occurring inside Natura 2000 areas in the EU-28 countries. Results are based on masking analysis. Note: bird species are Annex 1. Dotted line indicates the 18% baseline for Natura 2000.

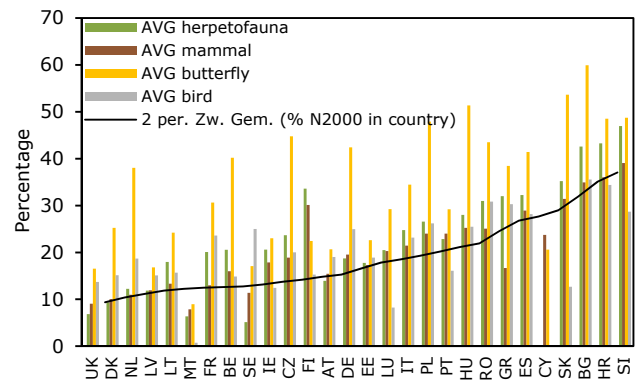


Figure 8 The average share of the occurrence of species inside Natura 2000 areas in the EU-28 countries for mammals, birds, reptiles and amphibians (collectively Herpetofauna – 'Herpeto' in the above) and butterflies.

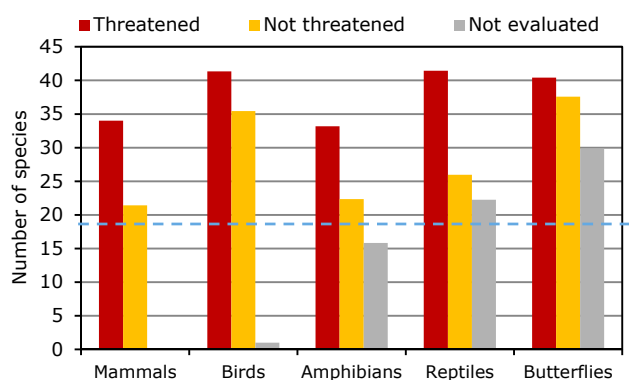


Figure 9 Average share of the occurrence of threatened, non-threatened and not evaluated species occurring inside Natura 2000 areas in the EU-28 countries based on the European Red Lists. Threatened=CR, EN and VU.

Bird endemism at species level in the EU is very low, perhaps due to their high mobility, and most endemics are found in the Macaronesian islands which were excluded from the analyses carried out

for this research. Birds are therefore not included in the results for endemic species (Fig. 10). For the other groups it was found that:

- The presence of endemic species was overall consistently higher in Natura 2000
- Endemic and non-endemic reptile species are evenly distributed with respect to Natura 2000
- Endemics and non-endemics of all species groups have a relatively large presence in Natura 2000 in relation to the 18% baseline.

Figure 11 shows an index of species presence within Natura 2000 areas. The calculation was based on the presence of species relative to the percentage of Natura 2000 coverage in a country. If species presence closely reflects the share of Natura 2000, the value will be 100; the value will exceed 100 for any country with higher species presence in Natura 2000. It also illustrates the relatively small share of species inside Natura 2000 in Cyprus, Malta and Greece.

The approach for plants differed due to the different resource base (EVA), which consists of a large dataset of observations. Although the data covers a large part of Europe, it is by no means comparable to systematically collected atlas data such as for the animal groups. Furthermore countries are not evenly represented in this database.

Overall plant Red List based analysis

Figure 12 clearly shows that Red List⁵ plant species and Orchid species are more likely to be found (more than 50%) in Natura 2000 sites than outside these sites. The group of Orchid species would probably show a greater difference between inside and outside Natura 2000 if the more common species such as *Listera ovata* and *Epipactis helleborine* had been excluded.

Plant hot spot analysis

Plant hotspots were calculated inside and outside Natura 2000 areas. A hotspot is defined as a 2x2 km grid cell with a minimum of 5 different Red List (or Orchid) species. The counting was performed on the basis of 2,500 unique random selected grid cells at European level, and 250 random selected grid cells at national levels. This procedure was repeated 500 times to obtain a statistically reliable result. The graphs below show that hot spots are more likely to be found inside than outside Natura 2000 sites (figs. 13 and 14). The differences between inside and outside Natura 2000 sites are less notable when the minimum number of 'hot-spot species' is set to a low

value, and more obvious when increasing the minimum number of species per grid cell.

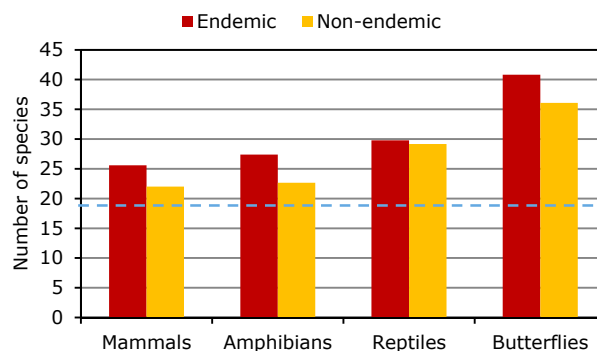


Figure 10 Average share of the occurrence of endemic versus non-endemic species occurring inside Natura 2000 areas in the EU-28 countries.

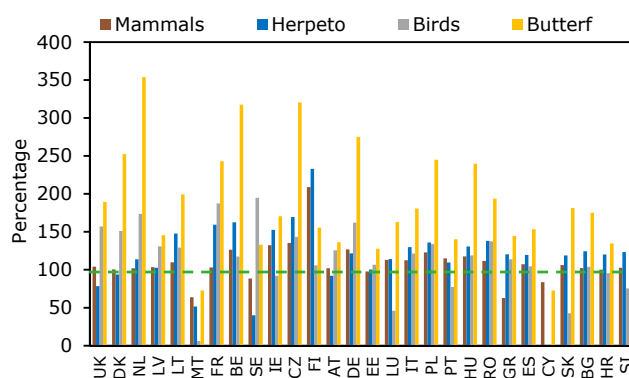


Figure 11 An index of species presence within Natura 2000 areas: calculated as species presence / proportion of Natura 2000 in a country. If species presence conforms with the proportion of Natura 2000, the value will be 100, for countries with higher species presence in Natura 2000, species groups will therefore exceed the value of 100.

Number of RL species in random selected grids

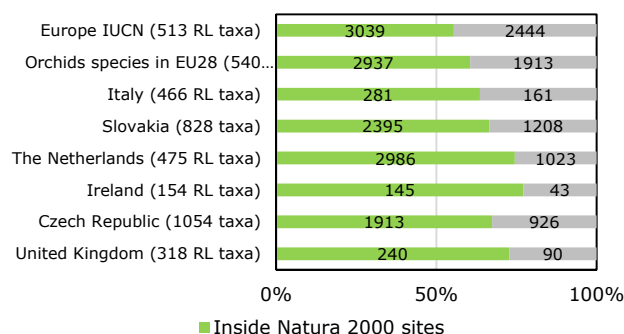


Figure 12 Number of Red List plant species in random selected grid cells in and outside Natura 2000 sites. Annex II species are excluded from the analysis.

⁵ The IUCN species cover 3 specific groups (aquatic plants, crop-wild relatives and species that are already covered by international policies) and are therefore not fully representative for overall biodiversity and may not be good indicators for this kind of analysis. However, the IUCN list does have an important status and was therefore included rather than omitted.

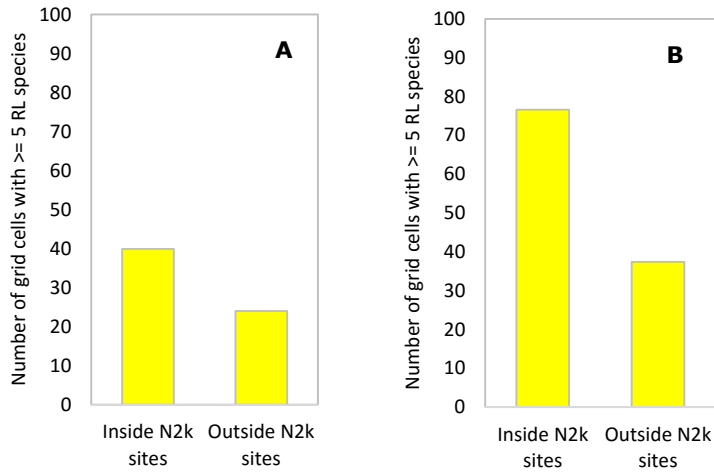


Figure 13 A: Hotspots European Red list species IUCN. B: Hotspots European orchid species. Based on 2500x2500 random sampled grids in- and outside Natura2000 sites.

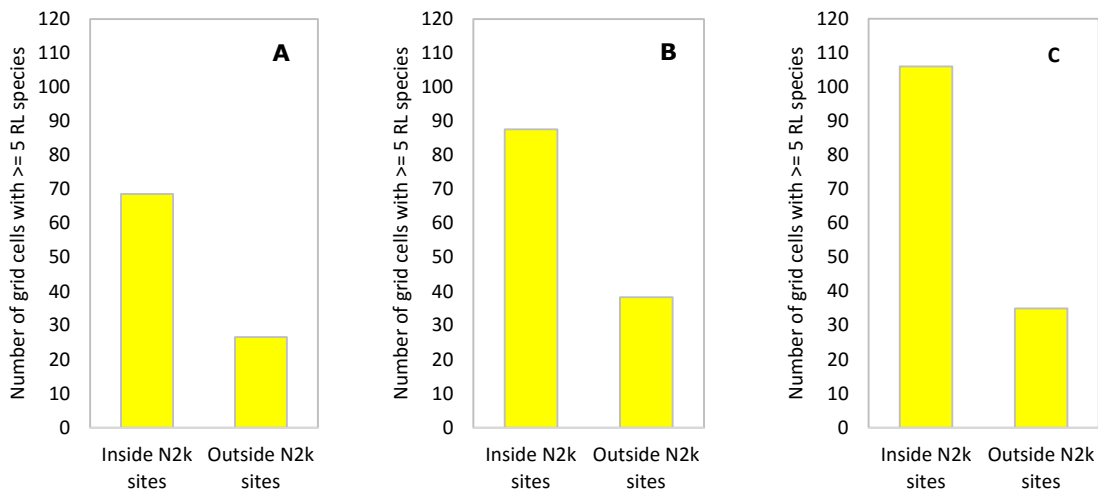


Figure 14 Hotspots in the Czech Republic (A), Slovakia (B) and the Netherlands (C). Based on 250x250 random sampled grids in- and outside Natura2000 sites.

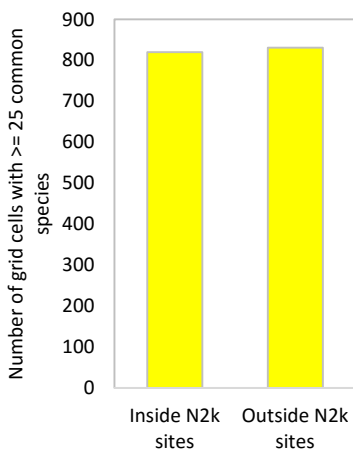


Figure 15 Common plants present inside and outside Natura2000. Based on 250x250 random sampled grids.



Figure 16 Intensive agriculture leaves little room for even common plant and animal species in particular butterflies. (Photographer Chris van Swaay)

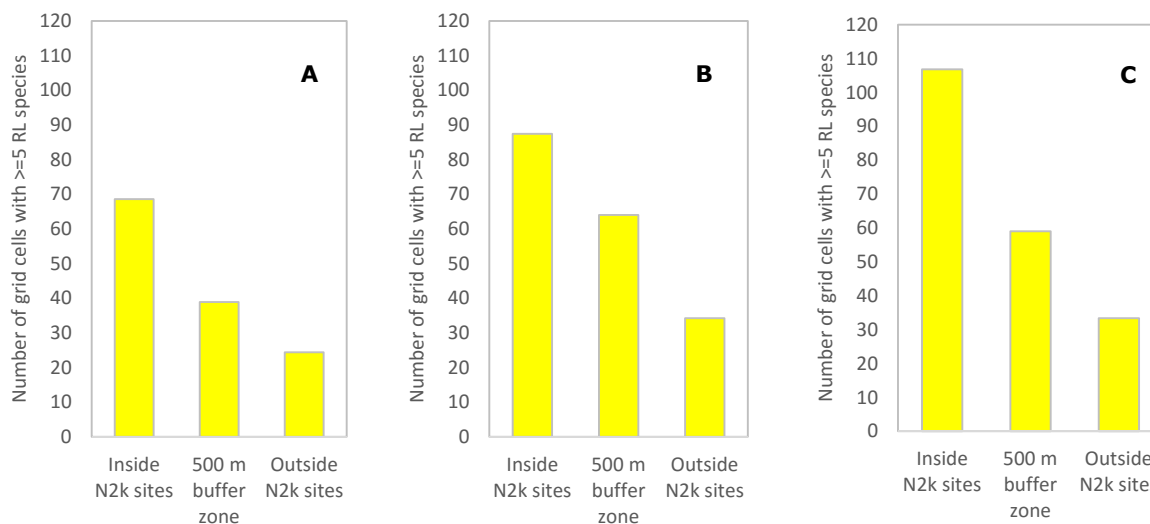


Figure 17 Hotspots in the Czech Republic (A) and Hotspots Slovakia (B) and The Netherlands (C). Based on 250x250 random sampled grids in Natura 2000 sites, in a 500 m buffer zone, and outside Natura 2000 sites.

Common Plant Species

We also examined the distribution of 300 of the most commonly occurring species in the database in relation to their occurrence inside and outside Natura 2000 sites (Fig. 15). For designation as a hotspot, the minimum number of the selected common species per grid cell (2x2 km) was set to 25. Figure 14 shows that even though there are slightly more grids that meet the criterion outside rather than inside Natura 2000 sites, common species are more or less equally distributed inside and outside Natura 2000 sites.

Buffer zone analysis

To gain insight into the plant biodiversity in the area immediately adjacent to the Natura 2000 sites, a buffer of 500 meters around all Natura 2000 sites was used in a further analysis. This was carried out for the Czech Republic, Slovakia and The Netherlands and the results are shown in Figure 17. The figures for the three countries show that the number of hotspots in the buffer zones was intermediate between the numbers inside and outside Natura 2000 sites. This means that, at least for the countries concerned, biodiversity just outside Natura 2000 sites may not be as important as the biodiversity inside the sites, but is still higher compared with areas further away from the sites. There can be various reasons for this, such as better site conditions, less environmental pressure, previous history of land use and management or the presence of nearby seed sources.

Biogeographical Regions

Figure 18 shows for all faunal species groups, the coverage of species in the Natura 2000 network in eight Biogeographical regions. The Black Sea and

Alpine regions are where the greatest percentage of species is present within Natura 2000. Species in the Atlantic and Boreal regions have the lowest percentage presence within Natura 2000, particularly for mammals, reptiles and amphibians; and for Boreal species four of the five groups fall below the baseline of 18%. This is partly a product of the relatively small numbers of species of some taxa in these regions; for example in the Boreal region only 2 species of reptile were considered (the adder *Vipera berus*, and the common lizard *Zootoca vivipara*) which are both common and have a wide distribution. Bird and butterfly species are consistently better represented within Natura 2000 in almost all biogeographical regions. For the butterflies this reflects the fact that their preferred habitats are nowadays found mainly within Natura 2000 sites.

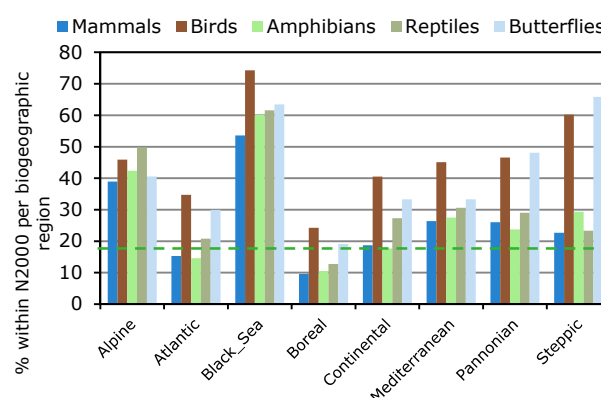


Figure 18 Presence of species in relation to the Biogeographical regions for all the animal species groups.

An analysis was also carried out for the presence of plant species hot spots within Natura 2000 in four biogeographical regions. The results show a greater

presence of Red list species (Fig. 19a) inside Natura 2000, which is a general trend for all regions but particularly Atlantic and Continental. Red list plant species hotspots have their highest presence in the Natura 2000 sites within the Continental biogeographical region, whilst in the Mediterranean their presence in Natura 2000 is comparatively low, but still with more hotspots inside than outside.

For Orchids, the Alpine biogeographical region is particularly important (Fig. 19b). In the Mediterranean region there are more orchid species outside Natura 2000 as a proportion of those inside Natura 2000, when compared to other regions. In general Orchid species require open areas that are not or less densely vegetated. In this region their specialised habitat requirements may occur more commonly outside Natura 2000.

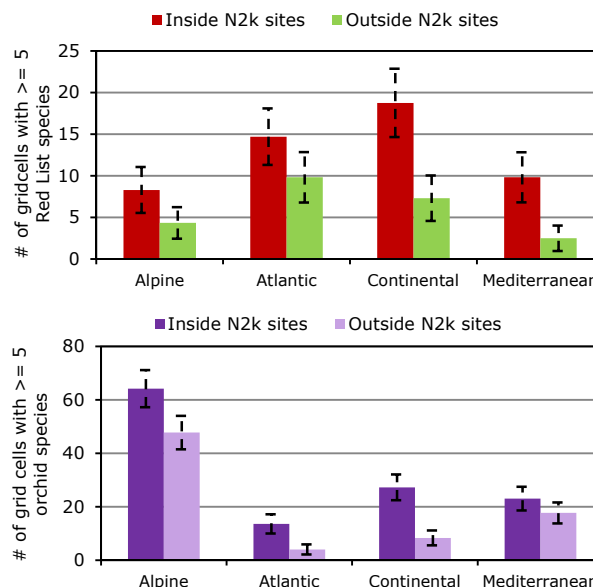


Figure 19 Number of hot spots of a) IUCN Red List species and b) Orchid species in relation to the Biogeographical regions.

Conclusions

General Conclusions

In summary for the animal groups:

- A greater number of common animal species and other 'non-Annex' animal species occur inside Natura 2000 than outside (in particular breeding birds and butterflies).
- Animal species for which Natura 2000 areas were not specifically designated (non-annex species) do, therefore, gain benefit from the Natura 2000 network.
- The species of the annexes benefit more (that is, generally occur more frequently within the Natura 2000 site boundaries) than the non-annex species; this is in particular the case for birds and butterflies, for amphibians and reptiles the difference is negligible.



Figure 20 Goldcrest (*Regulus regulus*) is a relatively tiny warbler characteristic of coniferous woodland whose widespread distribution is under-represented by the Natura 2000 network. (Photographer Jill Pakenham)

Overall the results show that all faunal species groups benefit more than might be expected based on the terrestrial coverage of Natura 2000. 18% of the land area of the Member States is covered by Natura 2000 sites and, if species were randomly distributed, then 18% of their distribution would be expected to fall within the Natura 2000 site boundaries. However, for every animal group, a greater proportion of the species that do not provide the reason for the designation of the sites (i.e. the common and other 'non-Annex' species) occur inside Natura 2000 than outside. Species for which Natura 2000 areas were not specifically designated do, therefore, gain benefit from the Natura 2000 network. In addition, Annex-listed species for which the Natura 2000 sites are designated also occur more frequently within the site boundaries⁶, in particular for birds and butterflies. Natura 2000 sites do not only therefore serve their purpose in protecting the Annex 1 (Birds Directive) and Annex 2 (Habitats Directive) species but also provide significant added value to non-Annex species. The reasons for this are evident in the results for the individual animal groups, in particular the birds and butterflies, as elaborated below.

⁶ A small number of Annex II species provide notable exceptions to this rule, listed and explored in more detail in the full technical report.

Birds

Table 2 lists the bird species that benefit most from Natura 2000, those showing more than twice the expected relative percentage distribution within Natura 2000.

Table 2 Bird species which benefit in particular from Natura 2000.

Species	Annex 1	EU Red List	Habitat
<i>Clangula hyemalis</i>		VU	coastal/marine
<i>Gypaetus barbatus</i>	x	VU	open natural habitat
<i>Falco rusticolus</i>	x	VU	open natural habitat
<i>Lagopus mutus</i>		VU	open natural habitat
<i>Charadrius morinellus</i>	x	LC	open natural habitat
<i>Calidris maritima</i>		NT	open natural habitat
<i>Limosa lapponica</i>	x	LC	marshlands/wetlands
<i>Stercorarius longicaudus</i>		LC	open natural habitat
<i>Larus genei</i>	x	LC	marshlands/wetlands
<i>Eremophila alpestris</i>		NT	open natural habitat
<i>Anthus cervinus</i>		NE	marshlands/wetlands
<i>Prunella collaris</i>		LC	open natural habitat
<i>Monticola saxatilis</i>		LC	open natural habitat
<i>Pyrhcorax graculus</i>		LC	open natural habitat
<i>Calcarius lapponicus</i>		NT	marshlands/wetlands
<i>Plectrophenax nivalis</i>		LC	open natural habitat

The species in table 2 are associated with habitats now found mostly in Natura 2000 sites (in particular mountainous areas and wetlands).

However, the converse is true for a number of other bird species that have a relatively limited percentage distribution within Natura 2000 areas. Using the 18% baseline, it can be seen in table 3 that a number of Annex 1 forest species are underrepresented. In many cases these are boreal species. This reflects the fact that large areas of boreal forest of sufficient quality to support these species occur outside Natura 2000 and further indicates that, with the exception of forest habitat, much of the 'better' habitat for birds is within Natura 2000 (for Annex and non-Annex species).

Species such as the Corncrake (*Crex crex*), Eurasian Skylark (*Alauda arvensis*), Northern Lapwing (*Vanellus vanellus*) and Common Quail (*Coturnix coturnix*) are characteristic of open country but also show a strong association with cultivated land, particularly crops, for breeding and foraging. Populations of these species are under-represented because this relatively intensively managed habitat is widespread over large parts of Europe but poorly covered by the Natura 2000 network. These species are still widespread but suffering significant declines from agricultural intensification (which reflects the fact that they are

Vulnerable – whereas the forest species are mainly Least Concern).



Figure 21 Skylark (*Alauda arvensis*) is a widespread species of farmland and cultivated land not well represented in Natura 2000. (Photographer Jill Pakenham)

Table 3 Bird species which are underrepresented in Natura 2000.

Species name	Annex 1	EU Red List	Habitat
<i>Circus cyaneus</i>	x	LC	semi-natural open+farmland
<i>Tetrastes bonasia</i>	x	LC	forest/shrub
<i>Tetrao urogallus</i>	x	LC	forest/shrub
<i>Coturnix coturnix</i>		LC	semi-natural open+farmland
<i>Crex crex</i>	x	LC	semi-natural open+farmland
<i>Haematopus ostralegus</i>		VU	semi-natural open+farmland
<i>Vanellus vanellus</i>		VU	semi-natural open+farmland
<i>Glaucidium passerinum</i>	x	LC	forest/shrub
<i>Strix uralensis</i>	x	LC	forest/shrub
<i>Strix nebulosa</i>	x	LC	forest/shrub
<i>Aegolius funereus</i>	x	LC	forest/shrub
<i>Alauda arvensis</i>		LC	semi-natural open+farmland
<i>Anthus pratensis</i>		VU	semi-natural open+farmland
<i>Locustella fluviatilis</i>		VU	marshlands/wetlands
<i>Sylvia communis</i>		LC	semi-natural open+farmland
<i>Phylloscopus trochilus</i>		LC	forest/shrub
<i>Regulus regulus</i>		NT	forest/shrub
<i>Nucifraga caryocatactes</i>		LC	forest/shrub
<i>Sturnus vulgaris</i>		LC	generalist

Further conclusions for birds are that:

- Species with smaller ranges and restricted distributions have better coverage in the Natura 2000 network compared to species with large ranges and wider distributions.

- Species associated with natural habitats (as opposed to semi-natural habitats), in particular mountainous areas, have better coverage/ over-representation in the Natura 2000 network.
- The countries having highest coverage of species' distribution in Natura 2000 are the 'set' of South and East European countries: Bulgaria, Croatia, Slovakia, Hungary, Slovenia, Romania, Greece and Spain.
- In general, species for which Natura 2000 sites have been designated (Annex I species) have a larger proportion of their distribution in the network than non-Annex I species.



Figure 22 Dotterel (*Charadrius morinellus*) is an arctic-alpine wader with a restricted European distribution, relatively well represented in the Natura 2000 network. (Photographer Edmund Fellowes)

Bird species of open natural habitats and coastal and marine habitats are best represented within the Natura 2000 sites. Forest-species are generally represented according the proportion of Natura 2000 sites. Bird species of farmland are relatively well represented in the Mediterranean area, but underrepresented in the Atlantic and continental part of Europe; this may be due to the fact that in western Europe large areas of farmland are designated for the protection of wintering birds and not so much for breeding birds. Unsurprisingly, generalist bird species are underrepresented in the Natura 2000-network because large parts of their ranges lie within intensively used areas such as cities.

Butterflies

The beneficial effects of the Natura 2000 network are also seen with butterflies. The more widespread a species is the greater likelihood that the proportion of its distribution inside Natura 2000 will reflect the proportion of the land-cover of Natura 2000. Non-Annex butterflies (more than any other animal group) occur more frequently inside Natura 2000 than outside. This is mainly because butterflies show a strong preference for specific CLC-3 level habitat types which are mainly now only found inside Natura 2000; outside they have been lost as

a result of a range of modern pressures and threats and competing land uses (such as agricultural intensification and urban sprawl).

The butterfly species which profit most from Natura 2000 are those species with a very limited distribution such as those on small islands, of which most (or even all) are inside Natura 2000. Remarkably all of the species that were considered occur in Natura 2000 (even if at a low percentage). Butterflies on Annex II of the Habitats Directive, for which Natura 2000 areas have to be designated, occur significantly more in Natura 2000 than other species. Threatened butterflies, both on the European and the EU-27 list, clearly benefit from Natura 2000 areas. Endemic species, that only occur in Europe or the EU-27 and for which we have a high responsibility, also occur more in Natura 2000 areas, this pattern more evident for butterflies than other species.



Figure 23 The scarce fritillary (*Euphydryas maturna*) is a species of woodlands. In most of Europe it is found in Natura 2000 areas. (Photographer Chris van Swaay)

For butterflies it can be further concluded that:

- In almost all countries butterflies are benefitting from Natura 2000.
- Threatened butterflies, either on the pan-European or on the EU-27 list, are benefitting from Natura 2000 areas.
- Endemic butterflies benefit from Natura 2000 areas.

The main reason for this is that key butterfly habitats occur more frequently in Natura 2000 sites than in surrounding urban and agricultural areas. Furthermore, in Eastern and Southern Europe where grasslands have been abandoned and turn into scrub and later secondary forest, all specialist butterfly species are lost. Active management of the butterfly habitats in Natura 2000 would be required to ensure long term survival of butterflies and these areas therefore provide an important tool for preserving Europe's butterfly diversity.



Figure 24 In Eastern and Southern Europe in particular grasslands become abandoned and turn into scrub and later secondary forest, losing all specialist butterfly species and thereby increasing the relative importance of Natura 2000. (Photographer Chris van Swaay)

Mammals

The mammals showed a similar but less strong pattern to the birds and butterflies with differences emerging for large mammals. The main conclusions are that:

- A majority of European mammal species benefit from Natura 2000.
- Large mammals are less likely to show an association with, or to derive an identifiable benefit from Natura 2000.



Figure 25 The Wild boar (*Sus scrofa*) is considered Least Concern by the European Red List. It covers 67.7% of the European territory and 18.9% of its distribution is protected by Natura 2000. (Photographer Nathan Ranc)

Large mammals often live at low densities and their territories can cover very large areas, that may include Natura 2000 but which will extend far into the wider countryside. They are therefore less likely to be closely associated with Natura 2000 using the approaches adopted in this study. Furthermore:

- Although Natura 2000 sites are not evenly distributed in EU-28, and some countries have relatively low percentages of coverage, some countries protect mammal species less than expected by the total number and area of sites.



Figure 26 The Iberian Lynx (*Lynx pardinus*) is considered Critically Endangered by the European Red List. It covers 1.8% of European territory and 45.3% of its distribution is protected by Natura 2000. (Photographer Nathan Ranc)

This is illustrated best by the results for Malta, Sweden and Cyprus. This outcome may however be indicative of mammal species distribution and behaviour and is not necessarily policy-related.

Amphibians and Reptiles

For the amphibians and reptiles it can be concluded that:

- A majority of European species benefit from Natura 2000.
- There is little difference in the level of protection by Natura 2000 between Annex II species and non-Annex II species.



Figure 27 The European green toad (*Bufo viridis*) is a species of toad found in many areas in mainland Europe, including steppes, mountainous areas, semi-deserts, and urban areas. (Photographer Fabrice Ottburg)

Four Annex II species had relatively restricted distributions and their Natura 2000 coverage was below the threshold of 18%. For three of the four Annex II species higher resolution data were available at the country level, revealing that these species are in fact probably well protected. Only one species, Italian Agile Frog (*Rana latastei*), had markedly lower coverage by Natura 2000 than the baseline of 18%. Furthermore:

- There was a clear north south gradient in the level of coverage by Natura 2000.

Reptiles and amphibians are not evenly distributed across European countries. Northern countries have fewer species, mainly common species that occur proportionately less in Natura 2000 because of their wide distribution. Southern countries have more species restricted in their distribution and which have higher coverage by Natura 2000 because their preferred key habitats tend to occur more frequently in Natura 2000. Finally:

- The assessment was less accurate for marsh turtles and cave salamanders

The marsh turtles and cave salamanders are typically difficult to assess. The major land cover types associated with marsh turtles (small wetlands and marshes) are underrepresented in the CLC map, leading to an underestimation of the distribution of their habitat. This causes higher estimations of their protection by Natura 2000. For cave salamanders of the genus *Speleomantes* detailed maps of the caves are not available at the level of Europe or even country (Italy, and a small part of France) where these species occur. However, in all cases these species were considered to be better covered by Natura 2000 than expected by chance.



Figure 28 The grass snake (*Natrix natrix*) is widespread in the European territory where it has several subspecies. (Photographer Fabrice Ottburg)

Plants

Based on the analyses of plant species distribution conclusions are that:

- Red list species and some other rare species occur significantly more often inside than outside Natura 2000 sites.
- None of the plant species considered in this study showed a strong preference for areas outside Natura 2000 sites

Natura 2000 sites are generally selected on habitat based criteria; hence qualifying habitats are generally rich in plant species, including rare species. In keeping with the results for the animal groups, it demonstrates that Natura 2000 is protecting the majority of the most diverse and species-rich habitats and that outside Natura 2000 there are fewer species of nature conservation interest. Nevertheless, most Red list species and

some other rare species do, to some extent, also occur outside Natura 2000 sites. From this it might be concluded that improved biodiversity cannot be attributed solely to the influence of the Natura 2000 network. Furthermore:

- Natura 2000 sites exert a strong 'buffer zone' effect.



Figure 29 Bee orchid (*Ophrys apifera*). (Photographer Fabrice Ottburg)

By extending the plant analysis beyond the boundaries of Natura 2000 sites to a 500 meter 'buffer zone' it was shown that, at least for the countries covered by this analysis, biodiversity in buffer zones (measured in terms of number of hotspots) is intermediate between the Natura 2000 sites and the area outside the buffer zone. The presence of Natura 2000 sites therefore seems to result in improvements in biodiversity around Natura 2000 as well as within – with implications for both policy and practice.

Areas for Future Research

The presence of a strong buffer zone effect around sites for plants suggests that, whilst future work could look at the implications of this and test it with other taxonomic groups, there are other issues related to the impact of the wider countryside connected to, but beyond Natura 2000. Green infrastructure has Natura 2000 and other protected areas at its heart and the approach and analysis that have been used here could be applied to questions about policy and practice in relation to connectivity through buffer zones, stepping stones and ecological corridors. This could be facilitated by the investigation and use of additional information on habitats and networks derived from Copernicus as well as other remote sensing data.

Furthermore the approaches used in this study could be applied to other drivers of biodiversity patterns such as climate change, for example modelling the impacts of temperature increase. Another policy issue of relevance, linked to the importance of high quality habitats for a range of species and which could be modelled, is that of land abandonment. This process

has already had a detrimental effect on butterflies, less so for large mammals and it could be valuable to assess its impact for other groups.

Finally, the role of taxa such as butterflies as indicators of the health of habitats and ecosystems within the Natura 2000 network might also be explored further as their sensitivity to both biotic and abiotic change could tell us much about species, in particular the huge array of other invertebrates, some with similar associations to habitats.

Concluding Remarks

The results confirm that Natura 2000 sites provide important additional value for a range of biodiversity and, among the taxonomic groups tested, butterflies and birds appear to benefit the most. The study also confirms that Natura 2000 sites are fulfilling their primary purpose of protecting the species in Annex I of the Birds Directive and Annex II of the Habitats Directive.

It is clear that the majority of species rich habitats in Europe are already in Natura 2000 sites. This emphasises the importance of policy and financial instruments and the associated management measures which are used to

continue to maintain and restore habitats in Natura 2000 sites to a condition that is favourable for all of their associated species. The exceptions to this include habitats in the Boreal region and some areas of traditionally managed agricultural land in Eastern and Southern Europe. Whilst this conclusion could be further investigated, the results of this study suggest that more forest and traditional agricultural land should be included within Natura 2000 or, at least, should be considered for sympathetic management.



Figure 30 The Hoge Venen (Hautes Fagnes, Hohes Venn) a Natura 2000 site on the Belgian-German border, a haven for Europe's wild plants and animals and a resource for the public to enjoy. (Photographer Lawrence Jones-Walters)

Colophon

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