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**Report on a prioritised list of habitats and  
emblematic species in the framework of Action 12  
of the Nature Action Plan**

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With text contributions of: Walter van Wingerden (stag beetle), Geert Groot-Bruinderink (Eurasian lynx), and Chris van Swaay (Large copper).

# 1 Habitats, Species and connectivity

## 1.1 Introduction

This study presents illustrative habitats and species in need of spatial connectivity, in support of EU-transboundary protected areas management and in line with Green Infrastructure. Based on sound scientific principles a selection of species and habitats should be made that are of relevance for conservation, require improved spatial connectivity, that function as ‘flagship species’ (Simberloff, 1998), and can be illustrative for a conservation approach. Moreover, it is requested that the examples show how Green Infrastructure can contribute to ecosystem services, in line with MAES (Maes et al., 2014).

In ‘Our life insurance, our natural capital: an EU biodiversity strategy to 2020’ the European Commission has set itself ambitious targets. Target 2 of the EU-Biodiversity Strategy is:

By 2020, ecosystems and their services are maintained and enhanced by establishing Green Infrastructure and restoring at least 15 % of degraded ecosystems.

Action 6b of the EU Biodiversity Strategy to 2020 concerns the development of a Green Infrastructure Strategy. The EU-wide strategy on Green infrastructure (GI) was adopted in 2013 and promotes investments to ensure that natural areas remain connected together, to restore the health of ecosystems and allow species to thrive across their entire natural habitat so that nature keeps on delivering its many benefits. GI is defined as:

*Green Infrastructure is strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings (European Commission, 2013).*

The underlying principle of Green Infrastructure is that the same spatial area can frequently perform multiple functions if its ecosystem is in a healthy state, resulting in win-win or ‘small loss-big gain’ solutions. An example of a multifunctional Green Infrastructure is the Gardens of Turia in Valencia, Spain (Province of Flevoland, 2014). After a particularly severe flood in 1957, the city administration decided to divert the river around the city and to convert the eight kilometre long old river bed into a public park, combining housing, recreational activities and tourism with the sustenance of healthy air and a habitat for animals. Green Infrastructure consists of a wide variety of environmental features which operate on different levels, from small elements such as green walls to healthy and fully functioning ecosystems.

## 1.2 Aim of the study

As shown in the above definition, GI can provide multiple benefits, a wide range of ecosystem services. The aim of this study is to provide Member States with examples for habitat restoration and reconnection of areas through Green Infrastructure, with multiple benefits for the environment. We follow hereby the pre-selection on species of relevance for GI (Condé et al., 2017). The examples which are elaborated in this study can serve as example for Member States to build further on, projects can be developed along similar lines for other species. The examples should provide arguments to convince planners or politicians to engage in Green Infrastructure development, based on the multiple benefits in the form of ecosystem services. Finally, examples will increase the understanding and support from stakeholders and the general public.

## 2 Methods

### 2.1 Introduction

The work consists of a first quick analysis of the habitats based on different criteria, after which a few habitats will be described in more detail (depending on time available). For species such a quick scan has already been (Condé et al., 2017) and therefore on the basis of this analysis we will describe some species in more detail.

### 2.2 Selection of habitat types

#### 2.2.1 *Priority habitats*

A prioritization of habitats was prepared in the Biogeographical Process for most of the biogeographical regions (Table 2.1). For most regions there were some 20 habitats, only for the Continental a much larger number of priority habitats was selected, for various reasons. These priority habitats have been publicized in the pre-scoping documents for the seminars. The habitats on this list in an unfavourable – bad conservation status in all regions have been assessed for their need for spatial connectivity. This list will be the starting point for selection of habitats for further review.

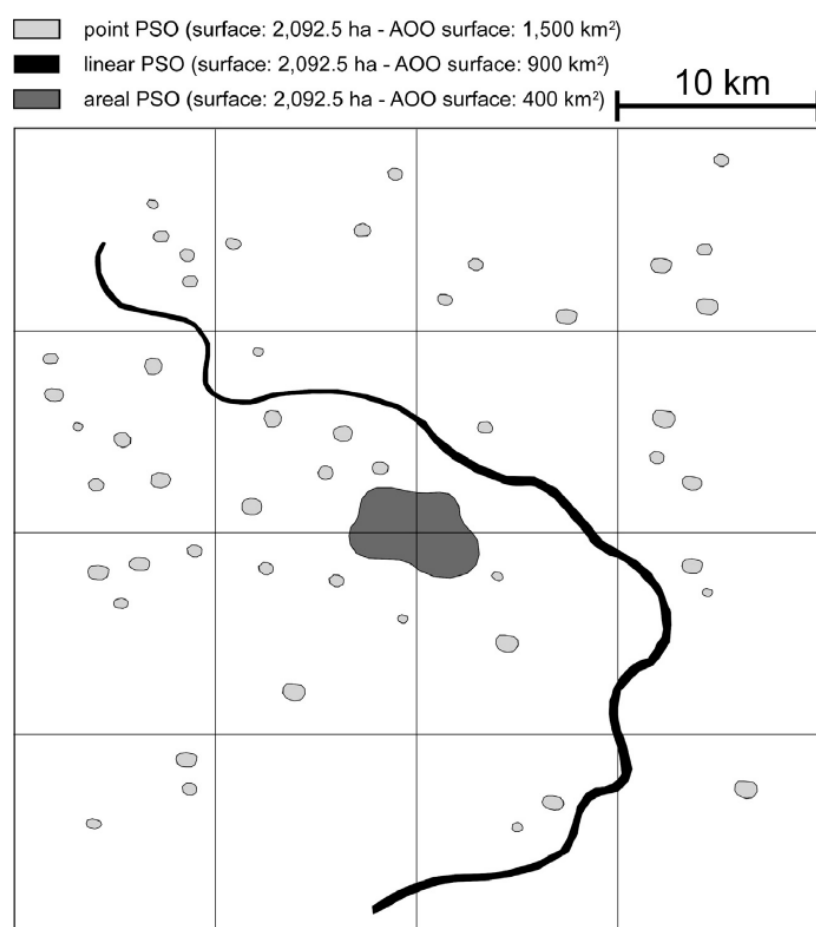
Additional criteria have been applied to further prioritize between the large number of habitats of interest. The criteria applied are the 1) landscape configuration 2) biological vulnerability 3) abiotic vulnerability of habitat and 4) the restoration capacity. These criteria are further described in the paragraphs below.

**Table 2.1: Priority habitats for the different biogeographical regions**

Biogeographical region	Number of priority habitats for discussion	Reference
<b>Boreal</b>	18, including: 6 grasslands, 5 mires & bogs, 5 forests, 1 coastal, 1 freshwater	<a href="#">Pre-scoping document for the Boreal region</a> , 2011
<b>Atlantic</b>	20, including: 6 grasslands, 3 mires & bogs, 1 forest, 2 heathlands and scrubs, 4 coastal, 4 freshwater	<a href="#">Pre-scoping document for the Atlantic region</a> , 2012
<b>Alpine</b>	22 including: 6 grasslands, 3 mires & bogs, 7 forests, 6 freshwater	<a href="#">Revised pre-scoping document for the Alpine region</a> , 2012
<b>Mediterranean</b>	23 including: 3 grasslands, 4 forests, 1 heathlands and scrubs, 13 coastal or marine, 2 freshwater	<a href="#">Pre-scoping document for the Mediterranean region</a> , 2013
<b>Continental/ Pannonian/ Steppic/ Black Sea</b>	59 including: 18 grasslands, 7 mires & bogs, 14 forests, 4 heathlands & scrubs, 9 coastal, 6 freshwater, 1 rocky	<a href="#">Pre-scoping document for the Continental/Pannonian/Steppic/ Black sea regions</a> , 2014
<b>Macaronesian</b>	No discussion has taken place yet between ES and PT for this region	<a href="#">Unofficial list</a> , 2018

## 2.2.2 Landscape configuration vulnerability/ pattern of habitat types.

Our environment is spatially structured, and habitats own some intrinsic, ecologically based and scale-dependent spatial features, which give rise to different types of pattern of spatial occupancy. Depending on the spatial configuration, the habitats might have a different need for connectivity: the vulnerability and/or the need for connectivity is higher for some habitat types than others. We identify three main patterns of habitat types: areal, linear and point pattern<sup>1</sup> which were considered as crucial features in explaining rareness of habitats (Gigante, Foggi, Venanzoni, Viciani, & Buffa, 2016). This pattern of habitat is a tool to discriminate among broad categories of plant community-based habitat types. Habitats with linear and point distribution, often naturally small in size and dispersed, are more susceptible to biased evaluation of their actual distribution and consequently of their threat status. Linear habitat types and point habitat types are due to their small size more vulnerable too. Some point habitat types are 'naturally fragmented', such as petrifying springs with tufa formation. We determine in this study to this spatial vulnerability on the basis of expert knowledge and –where possible- literature.



**Figure 2.1:** The configuration of habitat types, like the linear habitat types, will also define suitability for measures to improve spatial connectivity. Three classes have been defined: point, linear, and areal habitats (Gigante et al. 2016)

<sup>1</sup> Areal habitat types: with an extended distribution; e.g. broadleaved temperate forests, natural and semi-natural grassland formations; linear: with a distribution in strips, where length is much greater than width, like riparian and water-dependant formations, coastal plant communities; point: with a naturally scattered spatial distribution, e.g. vegetation of temporary ponds.

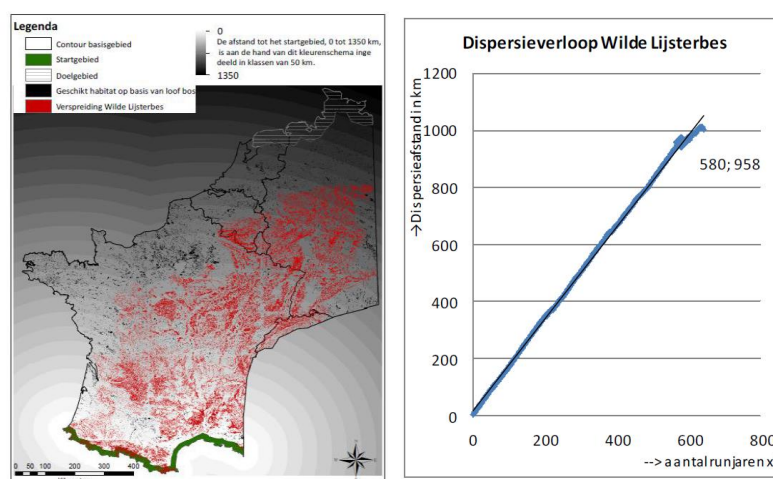
### 2.2.3 Biological vulnerability of habitats

The need for connectivity of habitats is based on the specific species depending on the habitat. Some isolated habitats like moors and heathers may have (mostly) species with a very limited dispersal range (Van der Sluis, 2000), whereas species e.g. from riverine habitats have a much larger range (Foppen, Geilen, & Van der Sluis, 1999; Van der Sluis, Romanowski, Bouwma, & Matuszkiewicz, 2007).

One study assessing the species-habitat interaction in relation to mobility of species within European ecological networks involved the quantitative modelling of species of Natura 2000 habitats for (mostly) the Atlantic and Continental Biogeographical region (Vos, 2013). The model DIMO was used to model representative species from heathers, moors and dune associations, forests, and natural grasslands. DIMO is a plant dispersal model that shows how plant species may move across regions when growing conditions change, for example, due to climate change. It can be used for analysis of spatial connectivity and for land use planning. DIMO simulates plant dispersal in time, given (abiotic) suitability and species-specific characteristics. As a result it gives the potential plant species distribution e.g. due to habitat changes. The maximum dispersal distance was calculated in the European landscape, from the South of France northwards for some 50 species.

The description of habitats in the interpretation manual of the European Union describes also species which are dependent on a specific habitat type (DG-Env, 2013). In the evaluation of priority habitats has been assessed if specific fauna species are mentioned.

**Figure 2.2 Dispersal map and Dispersal graph for *Sorbus aucuparia*, a fictive example for forest habitats, based on Dimo modelling (Vos, 2013). The graph shows modelling result for Rowan (*Sorbus aucuparia*), dependent on animal dispersal, with a potential dispersal of 958 km**



Source: Vos 2013.

### 2.2.4 Abiotic vulnerability of habitats

Besides the landscape configuration and biological vulnerability, also the abiotic vulnerability of habitats plays a role when prioritizing habitats with regard to the need for connectivity. The abiotic requirements of specific habitats will define the sensitivity for fragmentation and hence the need for connectivity. Important abiotic conditions are the vulnerability for desiccation, and climate change impacting on habitats.

### **Vulnerability for desiccation**

In particular the relation with groundwater might determine the vulnerability for fragmentation. A typology could be:

1. independent from ground water;
2. habitats dependant on groundwater;
3. habitats dependant on local seepage and perched water table;

For each habitat type an estimate could be made of the type of habitat, which group it belongs to.

### **Vulnerability to climate change**

It has been argued that climate change requires a connected network of habitats in order to ensure the movement of species due to climate change (Heller & Zavaleta, 2009; Verboom et al., 2010). An assessment has been prepared on the vulnerability of habitats to climate change (EU, 2012). The assessment uses three vulnerability levels:

1. low vulnerability
2. moderate vulnerability
3. high vulnerability

### ***2.2.5 Restoration or regeneration capacity of habitat***

For some habitat types improvement of spatial connectivity is almost impossible due to specific abiotic conditions or the long recovery time, other habitat types might be more suitable for eco-engineering or other measures to restore or expand habitat. Linear habitat types may be more suitable for improved spatial connectivity. Linear may be habitats related to coastal areas (cliffs, mudflats, dunes), to rivers (running water, floodplains) or rocky slopes (calcareous rocky slopes), forests depending on water et cetera (Gigante et al., 2016).

A specific assessment of restoration capacity, expressing the ability of ecosystems, habitats or plant communities, to be restored to ecological integrity, with grades from 'none', through 'poor' and 'limited' to 'good' has also sometimes been used, like in Bulgaria, (Biserkov ed.)<sup>2</sup>, Germany (Riecken, 2006). In the marine environment, where there are limited options for active intervention, regeneration ability, is the more commonly used terminology. The Wadden Sea Red List categorised this as 'impossible', 'hardly possible' (more than 150 years), 'difficult' (15-150 years) and 'conditionally possible' (under 15 years under favourable conditions although certain typical species might need longer) (von Nordheim et al. 1996, in Rodwell, Janssen, Gubbay, & Schaminée, 2013).

For the Netherlands a study was done listing measures for habitat restoration, as well as the effectiveness of measures (Smits et al). This however is not available for the remainder of Europe, and will therefore not cover all priority habitats; also, effectiveness of restoration measures are likely to differ, depending on the location. Based on expert judgement as well as indications provided in the red list of habitat types (European Union, 2016) an indication of the restoration capacity of various habitat types has been prepared.

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<sup>2</sup> <http://e-coddb.bas.bg/rdb/en/vol3>



## 2.3 Selection of species

A selection has been made of species in need of spatial connectivity that can benefit from Green Infrastructure projects. In 2017 a database with details on the connectivity needs for these species and a list of transboundary species was made. From the list a further selection has been made on the following criteria:

- It should be an emblematic species. Emblematic species or flagship species are illustrative to convey a message of the necessity of GI. The focus is on terrestrial species, which includes also freshwater habitats; marine habitats are for practical reasons excluded. No single definition of emblematic species is available so this will be based on an expert judgement combined with an internet search.
- The species should depend on migration and/ or dispersal over a longer distance (three different classes were distinguished).
- The selected species should be novel, go further than more known examples as the Brown Bear or Red deer (Groot Bruinderink, Van Der Sluis, Lammertsma, Opdam, & Pouwels, 2003), although it can be built on existing work.
- Overall the examples should reflect variation in species groups
- Examples should show vulnerable species
- Selected species are examples for a variety of pressures (e.g. climate change, fragmentation, intensification of land use, land abandonment)

In particular for mammal species an assessment by species was done; the common name was included in the table, a note was made on the need for landscape connectivity, and whether a species was pre-selected or not (Table.2). From the original list of 111 species, 8 were collected as possible priority species. Most species are central-western European species, although there is also a typical alpine species (Alpine chamois) and two Eastern European species (Steppe polecat, Romanian hamster).

**Table 2.2: Source table for mammal species for selection**

Species Name	Name	Selection?	Need Connec	0-40 kr	41-60 kr	> 60 kr	Communiti	Migratic
<i>Alopex lagopus</i>	Arctic fox	n	few countries	y		y	y	y?
<i>Barbastella barbastellus</i>	Wester barbastelle	n	short range	y	y		y	y
<i>Bison bonasus</i>	European bison	n	one country	y		y	n	n
<i>Canis aureus</i>	Golden jackal	n	natural expan	y		y	n?	n
<i>Canis lupus</i>	Wolf	n	problem anim	y		y	y	n?
<i>Capra ibex</i>	Alpine ibex	n	one country	y	y		y	n?
<i>Capra pyrenaica</i>	Iberian wild goat	n	one country	y	y		n	n
<i>Castor fiber</i>	Beaver	n	problem anim	y		y	y?	n?
<i>Cricetus cricetus</i>	European hamster	n	short range	y	y		y	n
<i>Dryomys nitedula</i>	Forest dormouse	n	short range	y	y		n	n
<i>Eptesicus nilssonii</i>	Northern bat	n	no corridors	y		y	y	n
<i>Eptesicus serotinus</i>	Serotine bat	n	short range	y	y	?	y	y
<i>Felis silvestris</i>	Wild cat	y	LARCH modell	y		y	y	n
<i>Galemys pyrenaicus</i>	Pyrenean desman	n	one country	y	y		n	n
<i>Genetta genetta</i>	Common genet	n	introduced	y	y		y	n
<i>Gulo gulo</i>	Wolverine	n	Sweden-Finlar	y		y	n?	n?
<i>Herpestes ichneumon</i>	Egyptian mongoose	n	one country	y	y		n	n
<i>Hypsigos savii</i>	Savii's pipistrelle	n	unknown	y		y	n	?
<i>Lepus timidus</i>	Mountain hare	n	short range	y	y		n	y
<i>Lutra lutra</i>	Eurasian otter	y	most of Europ	y		y	y	n
<i>Lynx lynx</i>	Eurasian lynx	y	most of Europ	y		y	y	y
<i>Lynx pardinus</i>	Iberian lynx	n	one country	y		y	y	y
<i>Marmota marmota latirostris</i>	Tatra marmot	n	endemic subs	y?	y?		n	n
<i>Martes martes</i>	European pine mart	y	LARCH modell	y	?	?	y	n?
<i>Mesocricetus newtoni</i>	Romanian hamster	y	two countries	y	y		n	n

## 2.4 Mapping Ecosystem Services

An analytical framework for mapping and assessing the condition of ecosystems in relation to the services these ecosystems provide has been developed by DG Environment based on key indicators with the feedback of some Member States. The major results were published in MAES Reports (Christine Estreguil et al., 2018; Maes J et al., 2016; Maes et al., 2018). The CICES classification of Ecosystem Services was used (Version 5.1, EEA).

Ecosystem services do not occur independently, they often occur in bundles. Ecosystem services may be prevalent in some Biogeographical Regions, and less so in other; a graph is included in Annex I which demonstrates this link. Also certain habitats tend to have a particular correlation with services, which is also shown in Annex 1 (Ziv et al., 2018). This is obvious for e.g. grasslands that may be correlated with grazing. In Annex 1 an overview of these correlations is given; this has been guiding in the selection of Ecosystem services from the extensive list from CICES.








**Table 2.3: Selected ecosystem services and their relevant indicators/proxies**

ES Section	Group Ecosystem Services	Indicator/Proxy
<b>Provisioning</b>	Cultivated crops (CC)	Percentage of crop production
	Reared Animals (LSU)	Livestock
	Wild animals and their output (WI)	Yield, catch per effort
	Materials from timber (MT)	Presence of forest and agroforest land
	Plant-based resources (PR)	Enhanced Vegetation Index (EVI)
<b>Regulating and Maintenance</b>	Erosion protection (EP)	Soil Erosion Prevention (SEP)
	Climate regulation (CR)	Below and Above-ground carbon storage
	Flood Protection (FP)	Area of wetlands, coastal protection
	Pollination and seed dispersal (PS)	Pollination potential
	Maintenance of Nursery Populations and Habitats (NS)	Shannon Diversity Index (SHDI)
<b>Cultural</b>	Outdoor Recreation (RC)	Recreation potential (natural habitat)
	Residential (RE)	Area build-up
	Inspiration (IN)	Extent of protected area

## 2.5 Available data

The basis for the species and habitats selection forms already collected data, a list of transboundary species (transboundary, across at least two Member States), and distribution information (countries), which have been extracted from the Art. 17 2007-2012 spatial dataset for species listed in the Habitats Directive.

Based on this dataset of transboundary species, experts from UBA and ILE SAS have compiled a database with details on the connectivity needs for these species. This contains an indication of the need for corridors, dispersal distance and type of corridors. The type of corridors relates to migration, commuting or dispersal corridors (Van der Sluis, Bloemmen, & Bouwma, 2004).

Shape \ Function	Dispersal	Migration	Commuting
			
linear corridor 	Atlantic salmon Sea lamprey	Atlantic salmon Sea lamprey	
linear corridor with attached nodes 	Stag beetle Large copper Yellow-Legged- Dragonfly		Large copper
stepping stones 	Lynx Yellow-Legged- Dragonfly	Brent goose Eurasian crane Yellow-Legged- Dragonfly	
landscape mosaic 	Brown bear Large copper	Brown bear	Brown bear

**Figure 2.3: Shape and functions of corridors for different example species (Van der Sluis et al., 2004)**

Further, specific studies have been done for evaluation of approaches to migration corridors (Leibenath, Blum, & Stutzriemer, 2010; Opermanis, MacSharry, Aunins, & Sipkova, 2012; Opermanis, MacSharry, Evans, & Sipkova, 2013; Strnad et al., 2013).

Some studies have been done for specific ecosystem types, such as forests (Christine Estreguil, Caudullo, & San-Miguel-Ayanz, 2013). Also studies on (Pan) European networks and studies on landscape connectivity are used to expand the dataset (Biro, Bouwma, & Grobelnik, 2006; Bloemmen, Van der Sluis, & Bouwma, 2004; Bouwma, Foppen, & Opstal, 2004; Bouwma, Jongman, & Butovsky, 2002; Bouwma, Van der Sluis, & Soukop, 2013; Van der Sluis, Jongman, Bouwma, & Wascher, 2012).

## 3 Results

### 3.1 Habitat selection

We developed four distinct criteria to assess the need for connectivity, being landscape configuration, biological vulnerability, abiotic vulnerability: climate change and changes in hydrology. Further we assessed also the restoration capacity. Of the 104 selected priority habitats (Table 2.12.1) 30 were reviewed based on their unfavourable conservation status (U2). Below first the results are presented and discussed for each criterion, and next on the basis of a combined assessment of the four criteria we prioritized vulnerability for fragmentation, rated on a three point scale (high, medium, low).

#### Landscape configuration

The majority of the reviewed habitats (12 out of 30) have a landscape configuration belonging to the area type, as described in par. 2.2.2. Nine of the reviewed habitat types have a linear configuration. Based on the MAES classification habitat types with a linear configuration are mostly grasslands that occur along rivers or coastlines (see Table 3.1).

#### Biological vulnerability

Table 3.1 shows that only a few habitat types are biologically vulnerable, using the suggested method. Most of the priority habitats are not specifically mentioned in conjunction with fauna species: in most cases only plant species are mentioned, and more general groups like 'invertebrate species'. Therefore, although this criterion is logical from an ecological point of view, the habitat manual description of associated species provides limited insights into biological vulnerability of the habitats.

The database linking species with the MAES ecosystems types has been produced but it cannot provide the information at the habitat level.

#### Abiotic vulnerability

Table 3.1 Table shows that the abiotic vulnerability for climate change is moderate for 15 habitat types and high for 5. Abiotic vulnerability due to changes in hydrology are estimated as moderate for 8 habitat types and high for 8 habitat types. With regard to the MAES classification habitat types with a high abiotic vulnerability are mostly wetlands and to a lesser extent grasslands that occur along rivers or coastlines (see Table 3.1 Table).

#### Restoration capacity of Habitat

Many of the habitats are 'difficult' with regard to restoration opportunities (12), whereas most are 'conditionally possible' (18), which might mean a restoration period under 15 years under favourable conditions.

#### Overall assessment

Table 3.2 shows the results based on a ranking exercise using the four criteria. For each of the criteria a numerical score is given (indicated in the heading of the table). The need for connectivity is a simple summation of the ranking criteria for all factors, which means that the lowest calculated value would be 4, highest would be 13. Therefore, we assume a high need for connectivity with a score of 11 or more, a moderate need for connectivity is a score between 8-10, and a score below 8 means a low need for connectivity.

Based on the ranking only one habitat type ranks high on all four criteria, being 1630\*, *Boreal Baltic coastal meadows*. The habitat scores high due to its linear landscape configuration, its' biological vulnerability based on associated bird species, its sensitivity for climate change and dependence on groundwater. Another 8 habitat types score *moderate need for connectivity*.

We used the MAES classification to further analyse the results. The four habitat types with a linear configuration are grasslands that occur along rivers or coastlines (Table 3.1). Some 2 habitat types belonging to sparsely vegetated area and one is belonging to the wetland group.

**Table 3.1: Selection of the Priority habitats for biogeographical regions with unfavourable conservation status, with an indication of the vulnerability (number of habitats)**

	Point	area	linear	no info		Total
Landscape configuration vulnerability	9	12	9			30
	no animals	insects	mammals	birds	no info	
Biological vulnerability	25	1	0	3	1	30
	Low	moderate	high	unknown		
Abiotic vulnerability (climate change)	9	15	5	1		30
Abiotic vulnerability (changes in hydrology)	13	8	8	1		30

**Table 3.2: Ranking of the 30 habitat types based on the four criteria.** The need for connectivity is indicated in column 8. High need for connectivity= score > 11, moderate need for connectivity score between 8-10, low need for connectivity < 8

Habitat type	Priority BGR	Conservation Status	Landscape configuration vulnerability 3= linear, 2= areal 1= point	Biological vulnerability, Based on Interpret manual: 1: no animals, plants; 2: insects and plants; 3: mammals; 4: birds	Abiotic vulnerability (climate change) based on Bouwma et al 2012. 3=High, 2=moderate, 1=low	Abiotic vulnerability (changes in hydrology) 3= Seepage/ flooding, 2= groundwater dependant 3= not groundwater dependant	Need for connectivity	Potential for restoration	Maes classification
1630* Boreal Baltic coastal meadows	Bor	U2	3	4	3	2	12	3	grasslands
3230 - Alpine rivers and their ligneous vegetation with <i>Myricaria germanica</i>	Alp	U2	3	1	3	3	10	2	River slakes
2190 - Humid dune slacks	Atl, Med, Con	U2	3	1	2	3	9	3	wetlands
2110 - Embryonic shifting dunes	Med, Con	U2	3	1	3	1	8	2	sparsely vegetated areas
6210* Semi-natural dry grasslands and scrubland facies on calcareous substrates ( <i>Festuco-Brometalia</i> ) (* important orchid sites)	Atl, Bor, Alp, Con	U2	1	4	2	1	8	3	grasslands
6230* Species-rich <i>Nardus</i> grasslands, on silicious substrates in mountain areas (and sub-mountain areas in Continental Europe)	Alp, Con	U2	1	4	2	1	8	3	grasslands
6440 - Alluvial meadows of river valleys of the <i>Cnidion dubii</i>	Con	U2	3	1	1	3	8	2	grasslands
6450 - Northern boreal alluvial meadows	Bor,	U2	3	1	1	3	8	2	grasslands
7240 Alpine pioneer	Alp	U2	2	2	2	2	8	2	sparsely vegetated areas
1340* - Inland salt meadows	Alp, Atl, Con	U2	1	1	2	3	7	3	grasslands
2120 - Shifting dunes along the shoreline with <i>Ammophila arenaria</i> ("white dunes")	Med	U2	3	1	2	1	7	2	sparsely vegetated areas
2130* Fixed coastal dunes with herbaceous vegetation ("grey dunes")	Atl, Con	U2	3	1	2	1	7	2	grasslands
6410 - <i>Molinia</i> meadows on calcareous, peaty or clayey-silt-laden soils ( <i>Molinion caeruleae</i> )	Atl, Alp, Con	U2	2	1	2	2	7	2	grasslands
7120 - Degraded raised bogs still capable of natural regeneration	Bor, Con	U2	1	-	3	3	7	3	wetlands
7150 - Depressions on peat substrates of the <i>Rhynchosporion</i>	Con	U2	1	1	2	3	7	3	wetlands
7320 Palsa mires	Alp	U2	1	1	3	2	7	3	wetlands
9080 - Fennoscandian deciduous swamp woods	Alp, Bor	U2	3	1	1	2	7	3	Woodland forest

Habitat type	Priority BGR	Conservation Status	Landscape configuration vulnerability 3= linear, 2= areal 1 = point	Biological vulnerability: Based on Interpret manual: 1: no animals, plants; 2: insects and plants; 3: mammals; 4: birds	Abiotic vulnerability (climate change) based on Bouwma et al 2012. 3=High, 2=moderate, 1=low	Abiotic vulnerability (changes in hydrology) 3= Seepage/ Flooding, 2= groundwater dependant 3= not groundwater dependant	Need for connectivity	Potential for restoration	Maes classification
3140 Fixed dunes Empetrum	Atl	U2	2	1	2	1	6	2	Heathland shrubs
3150 Fixed dunes Calluna	Atl	U2	2	1	2	1	6	2	Heathland shrubs
4030 - European dry heaths	Con	U2	2	1	2	1	6	3	Heathland shrubs
6120 - Xeric and calcareous grasslands	Con	U2	2	1	2	1	6	2	grasslands
6270* Fennoscandian lowland species-rich dry to mesic grasslands	Alp, Bor	U2	2	1	2	1	6	3	grasslands
7160 - Fennoscandian mineral-rich springs and spring fens	Bor,-	U2	1	1	1	3	6	3	wetlands
9050 - Fennoscandian herb-rich forests with Picea abies	Bor,	U2	2	1	1	2	6	3	Woodland forest
9060 - Coniferous forests on, or connected to glaciofluvial eskers	Bor,	U2	2	1	2	1	6	3	Woodland forest
9180* Tilio-Acerion forests of slopes, screes and ravines	Alp, Con	U2/ U1	2	1	1	2	6	3	Woodland forest
1530 - Pannonic salt steppes and salt marshes	Con	U2	2	1	unknown	2	5	3	grasslands
9070 - Fennoscandian wooded pastures	Bor,	U2	2	1	1	1	5	3	grasslands
2330 - Inland dunes with open Corynephorus and Agrostis grasslands	Con	U2	1	1	1	1	4	2	grasslands
6530* Fennoscandian wooded meadows	Bor,	U2	1	1	1	unknown	3	3	grasslands

## 3.2 Species selection

The selection of species was done through a quick scan of mammals, reptiles, amphibians, fish, arthropods-beetles, and arthropods-butterflies. The selection was done based on the prepared tables of species (Condé et al., 2017), and provided data on connectivity requirements, as well as own data on species mobility. In particular species which were modelled for the development of ecological networks, indicated in the tables with 'LARCH<sup>3</sup> modelling', which assumes better knowledge of spatial movements of a species.

<sup>3</sup> LARCH (Landscape Analysis and Rules for Configuration of Habitat) is a landscape ecological model to assess species' habitat and viability of populations.

## Mammals

In total 73 mammal species have been listed for consideration. The choice of mammals was restricted to non-marine mammals. Also the bats were excluded, since generally not enough is known on their use of corridors and the dispersal distance. Based on the remaining list a selection has been made of species with larger dispersal requirements, which are also appealing to the wider public (emblematic species). This results in the following preliminary selection of mammal species (Table 3.3). A species like the European beaver has been excluded due to its controversial image, or resistance it may cause in particular with farmers, hunters and water authorities.

**Table 3.3: Pre-selection of mammal species**

Species Name	Name	Selection	Notes
<b>Felis silvestris</b>	Wild cat	y	LARCH modelling
<b>Lutra lutra</b>	Eurasian otter	y	most of Europe; range 50 km
<b>Lynx lynx</b>	Eurasian lynx	y	most of Europe
<b>Martes martes</b>	European pine marten	y	LARCH modelling
<b>Mesocricetus newtoni</b>	Romanian hamster	y	two countries, short range?
<b>Mustela eversmanii</b>	Steppe polecat	y	LARCH modelling Ukraine
<b>Mustela putorius</b>	Western polecat	y	

## Reptiles

The Reptiles list includes 52 species. Also this group contains marine species, like turtles. A large number are snakes, which are considered less appreciated by a majority of the people, and therefore not meeting the requirement of being an emblematic species.

Further, a large number of reptile species (including snakes) have a very limited range (often less than 2 km), transboundary corridors are therefore not essential. This results in a small selection of Reptile species which could be considered. Of the identified species, the pond turtle and Green lizard can be attractive as example species, however, considering the home range they are not so well suited (Table 3.4).

**Table 3.4 : Pre-selection of reptile species**

Species Name	Name	Selection	Notes
<b>Algyroides nigropunctatus</b>	blue-throated keeled lizard	y	
<b>Emys orbicularis</b>	European pond turtle	y	Moves upto 2 km
<b>Lacerta viridis</b>	Green lizard	y	LARCH modelling Italy; dispersal upto 200 m
<b>Ophisaurus apodus</b>	European glass lizard	y	LARCH modelling Israel; movement upto 200 m



## Fishes

In total 64 fish species were listed in the table. Half of these are either marine species or do not need specific landscape connectivity or corridors. For quite a few species no data is available on migration. Two more well-known and charismatic species are the Atlantic Salmon and the River Lamprey, both of which are known to be vulnerable for fragmentation (dams) and have high demands towards water quality. The sturgeon which occurs in the Danube river basin could in principle be of interest, also considering the conservation measures that have been taken (Table 3.5Table).

Many more species are listed, but they are often less known, and for that reason less attractive.

**Table 3.5: Pre-selection of fish species**

Species Name	Name	Selection	Notes
<b>Lampetra fluviatilis</b>	European river lamprey	y	
<b>Salmo salar</b>	Atlantic Salmon	y	
<b>Huso huso</b>	European sturgeon	y	

## Amphibians

A large majority of the 36 amphibian species have a very limited range and dispersal distance. One of the few exceptions is the European tree frog. This species can move at least 10 km. The species is found in small-scaled, mostly agricultural landscapes; *Hyla meridionalis*, the Mediterranean tree frog has similar characteristics but is more restricted to ponds, and less mobile (Table 3.6Table). Other species with a slightly larger range are the Green toad, which is attractive to see, and the Agile frog. Still their range is limited, they might be less emblematic, and few conservation projects for these species will exceed the local scale.

**Table 3.6: Pre-selection of amphibian species**

Species Name	Name	Selection	Notes
<b>Hyla arborea</b>	European tree frog	y	Dispersal distances up to 12 km, pioneer species
<b>Bufo viridis</b>	Green toad	y	More 2 km
<b>Rana dalmatina</b>	Agile frog	y	More 2 km

## Arthropods

Some 19 of the 31 arthropod beetle species are flying. Non-flying species have such a limited range, that they are of little interest at the scale of this study. Of these, only 12 are likely to be dependent on landscape connectivity.

A large number is habitat specialist, e.g. saproxylic species which depend very much on old growth forest and presence of snags and dead wood, such as the Stag beetle or Capricorn beetle. These species are not typically dependent on connectivity, limiting factor is more the absence of habitat or not effective habitat management. For this reason, only Stag beetle is included here which is appreciated by the public and which may have a larger dispersal range (Table 3.7).

**Table 3.7: Pre-selection of beetle species**

Species Name	Name	Selection	Notes
<i>Lucanus cervus</i>	Stag beetle	y	Dispersal distances up to 7 km

Of the dragonflies and butterflies finally, there are some 55 species selected. Of these, 25 are dependent on dispersal. For butterflies dispersal is often unknown or very limited, whereas dragonflies often may disperse over larger distances. This results in a selection of four dragonfly species, and one butterfly species (Table 3.8).

**Table 3.8: Pre-selection of dragonfly and butterfly species**

Species Name	Name	Selection	Notes
<i>Leucorrhinia caudalis</i>	Lilypad Whiteface	y	Dispersal distances up to 98 km
<i>Leucorrhinia pectoralis</i>	Yellow-spotted Whitefaced999	y	Dispersal up to 27 km
<i>Lycaena dispar</i>	Large copper	y	LARCH modelling; upto 5 km
<i>Ophiogomphus cecilia</i>	Green snaketail	y	LARCH modelling; Dispersal up to 10 km
<i>Oxygastra curtisii</i>	Orange-spotted emerald	Y	Up to 10 km

### 3.3 Associated Ecosystem Services with restoration measures

Based on measures for defragmentation, and development of Green Infrastructure, the provision of Ecosystem Services may change. Selected ecosystem services for this assessment are related to Provisioning services, Regulating and Maintenance services, and Cultural services.

Although this selection might be challenged to be subjective, the selected services are relevant in the wider European context and commonly used in other studies, and selected services may change as a result of landscape changes or measures for GI (Bürgi, Silbernagel, Wu, & Kienast, 2015; Vallés-Planells, Galiana, & Van Eetvelde, 2014). To estimate how the service provision changes as a result of measures to improve connectivity through GI, a semi-quantitative approach is followed based on the analysis of land cover change (Table 3.9) (Van der Sluis et al., in press).

The results are related to the examples described in Chapter 4 below.

**Table 3.9: Quantitative assessment of change in landscape service provision in study areas: + increase, ++ : strong increase, - decrease, -- strong decrease, ° negligible**

Service Provision \ Example study	Boreal Baltic Meadows (H1630)	Alpine Rivers (H3230)	Eurasian lynx	Stag beetle	Sturgeon	Large copper
Cultivated crops (CC)	°	°	-	°	°	°
Reared Animals (LSU)	++	+	-	°	°	°
Wild animals and their output (WI)	+	°	-	°	++	+

Materials from timber (MT)	◦	◦	++	-	◦	◦
Plant-based resources (PR)	++	◦	+	◦	◦	++
Erosion protection (EP)	++	++	+	◦	++	◦
Climate regulation (CR)	+	◦	++	++	◦	++
Flood Protection (FP)	++	++	+	◦	++	++
Pollination and seed dispersal	++	+	+	+	+	+
Maintenance of Nursery Populations and Habitats (NS)	++	++	++	++	++	++
Outdoor Recreation (RC)	+	++	++	+	++	++
Residential (RE)	+	◦	◦	◦	◦	◦
Inspiration (IN)	++	++	++	++	++	+

## 4 Example descriptions

### 4.1.1 (1630\*) Boreal Baltic coastal meadows

#### Ecology and distribution

The 'Boreal Baltic coastal meadows' are characterized by low growing plant communities. They occur in the geolittoral zone and are sometimes interspersed with salt patches. Characteristically the vegetation occurs in distinct zones, with saline vegetation closest to the sea. The salinity is low since tide hardly exists, but they can be affected by land upheaval.

The habitat is widespread along the Baltic coast of Estonia, Finland and Sweden, rare in Latvia and absent from Lithuania. Estonia reported the largest habitat area. Of the approximately 190 km<sup>2</sup> of this habitat in the Boreal region, about 78 % is included in Natura 2000 sites.

Land use in this zone consisted historically mostly of grazing and mowing, which resulted in a gradual expansion of the habitat, keeping the vegetation low and open and rich in vascular plants. The flora is very rich, e.g. in Estonia a total of 390 plants species have been found on coastal meadows, which is 26% of all Estonian species. More than 20 protected species grow on coastal meadows, including many orchids: *Dactylorhiza ruthei*, Frog orchid, Fen orchid, Baltic orchid, Blood-red dactylorhiza, Early marsh orchid, Musk orchid, Marsh helleborine, Early-purple orchid, Common spotted orchid, Military orchid, Fly orchid and Fragrant orchid. Other decorative species in coastal meadows are: *Gladiolus imbricatus*, *Armeria maritima*, *Tetragonolobus maritimus*, large pink *Dianthus superbus* and Red kidney vetch (*Guidelines for Coastal Meadow Management. Guidance for Estonian Environmental Board land conservation specialists and land managers*, 2011).

Important bird species depending on this habitat type and adjoining lagoons (Habitat 1150) is Birds Directive Annex I species Eurasian bittern (*Botaurus stellaris*), and several Annex II species, including black-tailed godwit (*Limosa limosa*), Common redshank (*Tringa totanus*), Mute swan (*Cygnus olor*), Eurasian coot (*Fulica atra*), Northern lapwing (*Vanellus vanellus*) and Common snipe (*Gallinago gallinago*). Also the Dunlin (*Calidris alpina schinzii*), Ruff (*Philomachus pugnax*) and other meadow wader species breed, and grassland passerine community is present. A large number of waders of different species, as well as migrating geese and other waterfowl are present during passing migration (Rüsiņa, Auniņš, & Spunģis, 2017). In moister areas, large sedge tussocks are preserved, which are important for birds. This also indicates that the scale of the area and variety of habitats defines the completeness of bird assemblages (Rüsiņa et al., 2017).

Coastal meadows are valuable habitats for a large diversity of invertebrate species, in particular nectar feeding species and grassland species associated with animal excrement. One of the few endemic insects found in Estonia, *Aeschna osiliensis*, is specifically associated with coastal meadows and other coastal habitats. Seaweed mounds and salinas are home to an unconventional community of predatory beetles. Shallow water bodies that appear in coastal meadows provide habitat for the rare large white-faced darter (*Leucorrhinia pectoralis*). In coastal meadows there are various dragonflies and species of *homoptera*, *auchenorrhyncha* and *heteroptera*. Areas with a long standing grazing tradition feature sods generated by ant species of *Lasius* and *Myrmica*.

#### Conservation status

The conservation status of this habitat type is unfavourable-bad, based on the assessment in all Member States except Estonia which reported unfavourable-inadequate. The range is favourable in all countries, but other parameters are poor or bad for most of the region. In Sweden the bad situation is stable.

## Problem

Inappropriate land use, particularly the abandonment of agricultural management (grazing and mowing) represents the major pressure to this habitat type. Abandonment of traditional management results in encroachment, which causes a decline in bird populations: grasslands smaller than 10 ha, will hold no waders and the passerine community may be incomplete. Pressures with less intensity are recreation, sport and water pollution. Finland informed that dredging/ removal of limnic sediments and dumping and depositing of dredged deposits is a threat.

## Proposed measures for GI

Appropriate management is the main proposed measure for maintenance of grasslands. Other proposed measures include establishment of protected areas and improvement of legislation. The 'Natureship project (2009–2013)', financed by the EU Central Baltic Interreg IV A Programme 2007–2013 and national funding providers. The project has two focus areas: "Water protection and coastal planning" and "Biodiversity and cultural landscapes". The project activities target coastal areas in Finland, Sweden and Estonia. A total of eleven organisations have been involved in project implementation. Lead partner is the Centre for Economic Development, Transport and the Environment in Southwest Finland, with other partners from Finland such as Metsähallitus, the University of Turku, municipalities, from Estonia Environmental Board of Estonia and University of Tartu, and from Sweden the County of Gotland and Norrtälje Nature Conservation Foundation.

The goal of the project is to increase cooperation in habitat management and water protection in the Central Baltic operating area. The most important objectives of the Natureship project are promoting interdisciplinary coastal planning following the principles of sustainable development. The aim of integrated coastal planning is to find solutions that will benefit all users of the area over the long term, taking natural values into account. It aims at finding best cost-efficient methods for water protection and biodiversity and rating ecosystem services.

The project has promoted conservation cooperation between these areas and the exchange of experiences on habitat and species management. Ecosystem service thinking plays a role in the planning and implementation of management measures. The project aims at finding win-win solutions that benefit all: nature, water protection, local farmers and entrepreneurs, as well as inhabitants. Special emphasis is placed on Natura 2000 areas.

To proceed in reaching the objective of multiple-use planning, an optimal network of harvested reed beds and coastal meadows is being designed in the project for areas where reed beds are growing heavily.



**Photo 4.1 Coastal meadows, Lihula Vala N2000 site, Estonia**



Photo: © Theo van der Sluis

## **Assessment of Ecosystem Services**

Ecosystem services related to the proposed measures, as described above, are discussed in par. 2.4 and presented in Table 3.9.

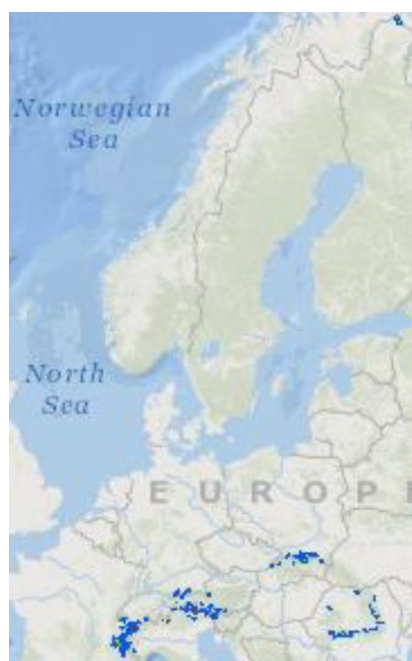
The Boreal Baltic coastal meadows are maintained through livestock herds which as part of agro-ecosystems have different outputs, reared animals and their resources, hay and possible other wildlife. ES include the supply of nutrition and other renewable natural resources as well as occurrence of natural ecosystem processes, maintenance of water resources and circulation of nutrients. The meadow ecosystem can protect the coast against erosion, floods, and do some climate regulation, but the meadows also maintain pollinator populations and livestock will facilitate seed dispersal. Ecosystem services also include recreational use of nature and the experiences obtained there, as well as residential services, and inspirational services.

### 4.1.2 (3230) Alpine rivers and their ligneous vegetation with *Myricaria germanica*

#### Ecology and distribution

The habitat of Alpine rivers holds plant communities of low shrubby pioneers invading the herbaceous formations on gravel deposits rich in fine silt, of mountain and northern boreal streams with an alpine, summer-high flow regime. These deposits are usually dynamic, often being destroyed and recreated in floods. German tamarisk *Myricaria germanica* and Willow species *Salix spp.* are characteristic species of the '*Salici-Myricarietum*'.

The Habitat type is typical for the Alpine biogeographical region, and most of the habitat is found in the Alps and Carpathians; an isolated occurrence is reported from northern Finland. The habitat usually occurs in small patches, the overall habitat area is quite small as well. In Germany, Poland, and Slovenia the entire national habitat area is located in Natura 2000 sites; in Austria and Finland a large part of the national habitat area is located in Natura 2000 sites (note that the 2017 Seminar document did not include Croatia at the time, so its habitats are not included in its figures).



#### Conservation status

The overall conservation status of this habitat type in the Alpine biogeographical region is unfavourable-bad (and deteriorating). There has been no change in conservation status since 2001–2006.

#### Problem

The habitat has become rare due to river engineering. All countries reported a broad range of pressures, the most important being sand and gravel extraction, canalisation, water deviation, modification of hydrographic functioning, and modification of structures on inland water courses (e.g. small hydropower projects and weirs). Other important pressures are vegetation succession, waste disposal, water pollution, invasive non-native species, removal of sediments, flooding modifications, lack of flooding, surface water abstraction, and construction of dykes and embankments.

## **Proposed measures for GI**

A larger project looking at the River Basin as a whole, is the DRAVA LIFE – Integrated River Management (LIFE14 NAT/HR/000115), a Croatian project with involvement of WWF-Austria. The project foresees three transnational conservation actions, which involve stimulation of more natural river dynamics, decrease of human impact, increase inter-sectoral river management and cross-border cooperation along the Drava River.

## **Assessment of Ecosystem Services**

Ecosystem services related to the proposed measures, as described above, are discussed in par. 2.4 and presented in Table 3.9. The Alpine river habitat is restored through reversal of engineering works, removal of dams etc. This has limited potential for provisioning services, much more for regulating services like erosion protection, flood protection and maintenance of nursery populations and habitats (in particular fish species). Some cultural services are related to Outdoor recreation, as well as inspiration.

### **4.1.3 Eurasian lynx (*Lynx lynx*)**

#### **Ecology and distribution**

The Eurasian lynx (*Lynx lynx*) used to occur throughout Europe, but currently the European distribution is associated with a rather scattered pattern of large continuous forest regions. Important core areas are: East Poland, the Carpathians, the Alps and the Jura Mountains. The species occurs in many Biogeographical regions: Boreal, Alpine, Continental, Pannonian, and a small part of the Mediterranean region.

The Czech Sumava and German Bavarian Forest hold recently established populations. In some Western European regions the species has been reintroduced very recently. The home-range size within these regions varies according to the season, prey-density, sex and age. Dense populations are mainly found where prey availability of roe deer and chamois is high. Human activity and intensive land use is tolerated as long as there is enough vegetation cover.

#### **Conservation status**

The Eurasian lynx is protected under the Bern Convention (appendix III), EU Habitats Directive (appendix II and IV, for some Eastern European countries annex V), CITES (Appendix II) and IUCN Red list (Least Concern status). The species seems stable throughout most of its territory (Adamec et al., 2012)

#### **Problem**

The habitat of the lynx has mostly a patchy distribution; suitable habitat is often destroyed by deforestation and agriculture. As a result, most smaller populations have limited genetic variation or are even inbred. Other problems are related to persecution, low acceptance due to conflict with hunters and shepherds, and vehicle collision.

The landscape is fragmented for the Lynx: potential suitable habitat is badly connected with core areas and peripheral areas are especially badly connected with already occupied areas. The latter is problematic for the species, because relatively small populations of the Eurasian lynx may easily become extinct as a result of environmental stochasticity (random fluctuations), such as prey availability, poaching (nowadays), hunting (in the past) or road kills.



## Proposed measures for GI

To strengthen the European lynx population it is essential to improve the connectivity of the landscape, the peripheral areas where small populations face the threat of extinction. Recent Lynx observations in Northern Belgium, the southern parts of the Netherlands and the Dutch Veluwe indicate the potential for colonisation of small isolated areas. Spontaneous recolonisation of potential habitat (forest) may be facilitated by incorporating corridors with stepping stones into the ecological network for the Lynx.

With the LARCH model<sup>4</sup> the potential habitat and the connectivity of the landscape were evaluated for the Eurasian lynx. The analysis confirmed that the potential habitat has a patchy distribution. The most effective corridors comprise the area between Northeastern and North-western Poland, the area from Western Poland, the corridor south of Berlin, towards the Harz area and the area between South-eastern Belgium and the French-Swiss Vosges and Jura area.

Transboundary migration occurs in almost all countries in central and Eastern Europe (e.g. Hungary, Bulgaria, Romania, Czech republic, Greece, Baltic states). There are specific proposed measures, as described above, that aim at improving the landscape connectivity:

- Life Lynx (<https://www.lifelynx.eu/>), a consortium of mostly Slovenian partners, with Croatia and Italy
- the INTERREG project 3Lynx (<https://www.interreg-central.eu/Content.Node/3Lynx.html>).
- LIFE Luchs Pfälzerwald - Reintroduction of lynxes (*Lynx lynx carpathicus*) in the Palatinate Forest Biosphere Reserve (LIFE13 NAT/DE/000755) (<https://snu.rlp.de/de/projekte/luchs/>)

LIFE Lynx project's primary objective is rescuing the Dinaric-SE Alpine lynx population from extinction and to preserve it in the long term. The Dinaric-SE Alpine lynx population went extinct at the beginning of 20<sup>th</sup> century due to hunting and persecution, habitat loss and lack of prey species. It was successfully reintroduced in 1973 by translocating animals from the Carpathians and Slovenia. The animals spread, but after a few decades the population started declining, mainly due to genetic deterioration.

Currently, the population is small, isolated, and extremely inbred. It urgently needs reinforcement by introducing additional, healthy animals from another population. The Dinaric-SE Alpine population is now reinforced with lynx from population in the Carpathians. This work is done in close cooperation with stakeholders to ensure broad public acceptance of lynx conservation. Scientific information is incorporated into management plans and other strategic documents. Improved population connectivity for lynx will improve natural gene flow of lynx within this population. Such a metapopulation will help reduce negative impacts of habitat fragmentation and will reverse genetic deterioration across entire Dinaric-SE Alpine population.

The INTERREG 3Lynx project has set itself quite a different aim: to integrate lynx monitoring, conservation and management into a common strategy on transnational level. The project does so, by improving lynx conservation capacities of responsible stakeholders through experience, data and tool sharing and by implementing a harmonised lynx monitoring at population level. The project is also an instrument to achieve active involvement of key stakeholders (hunters and foresters) into

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<sup>4</sup> LARCH (Landscape Analysis and Rules for Configuration of Habitat) is a landscape ecological model to assess species' habitat and viability of populations.

lynx conservation issues. These are only a small sample of projects, many more initiatives have been listed in (Christine Estreguil et al., 2018).

The LIFE Pfälzerwald program's main aim is to re-establish a lynx population in the Palatinate Forest, the transboundary biosphere reserve Pfälzerwald/Vosges du Nord. This is achieved through a reintroduction programme involving the release of 20 lynx, (10 coming from Switzerland and 10 from Slovakia). This should result in a reproducing population of lynx in Rheinland Pfalz. The project is also monitoring lynx, it aims to increase public acceptance, cooperation with stakeholders (it is all on public land) and improved spatial connectivity<sup>5</sup>.

**Photo 4.2 Eurasian lynx**



Photo: © Peter xxx

### **Assessment of Ecosystem Services**

Ecosystem services related to the proposed measures, as described above, are discussed in par. 2.4 and presented in the Table 3.9. Ecosystem services related to interventions for the Eurasian lynx are mostly related to forest habitats that are promoted. The European lynx is very much dependent on extensive and continuous forest habitats. This demands the conversion from cropland to forest, that may reduce some of the provisioning services such as crop and livestock. The development of Green Infrastructure for the Lynx will however also benefit a range of mammals such as Red deer, Roe deer, Wolf, Brown bear, Badger, Wild cat and Pine marten. The increased cultural services include outdoor recreation services as well as inspirational services.

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<sup>5</sup> see: <https://snu.rlp.de/de/projekte/luchs/wiederansiedlung/massnahmen-zur-wiederansiedlung/> (in German)



**Figure 4.1:** Eurasian lynx (*Lynx lynx*) distribution in Europe 2006 - 2011. Dark cells: permanent occurrence, Grey cells: sporadic occurrence. Red borders mark countries for which information was available (Adamec et al., 2012)

#### 4.1.4 Stag beetle (*Lucanus cervus*)

##### Ecology and distribution

The Stag beetle (*Lucanus cervus*) is one of the largest insect species in Europe. The larval development in dead wood takes five till eight years. Although females are able to fly and need to do so in order to search for stumps for mating and laying eggs, they tend to stay in the neighbourhood of the stump they emerged from. A wide range of woods are used, especially oak, but also ash, elm, sycamore, lime, hornbeam, apple, cherry and even some garden tree varieties. Chances for colonisation of new habitats are therefore limited.

The Stag beetle is common only in Northern and Central Spain and Northern Italy and is rather stable. In France the short-term trend is stable, although the long-term trend is unknown<sup>6</sup>. In South-eastern England its populations are surviving well in several core areas<sup>7</sup>.

Distribution patterns have been shrinking since 1900 in the remaining countries, leaving only small isolated populations.

##### Conservation status

The Stag beetle is listed in appendix III of the Bern convention and in appendix II of the EU Habitats Directive. In many European countries the European Stag beetle also occurs on the national Red-lists, but it does not occur on the IUCN Red-list since the species is not endangered on a global scale.

##### Problem

The main risks for the Stag beetle is its vulnerability -due to its long life cycle which requires large stumps in an undisturbed environment- and the relatively small dispersal range of the females. It appears that the main condition for survival and gradual dispersal forms a rather dense network of undisturbed patches with old large stumps of deciduous trees and sap trees for adult feeding as well.

At the landscape level the beetle is affected by the disappearance and fragmentation of old deciduous forests, leading to smaller and more isolated habitat patches. As a result, the distribution of the beetle is scattered (Figure 4.2). Dispersal distances are reportedly up to 3 km (Rink & Sinsch, 2007).

At the local level, forestry activities also minimize the remaining suitable habitat because they consist of the removal and disturbance of large pieces of dead wood from the forests and the cutting of deciduous trees for forest regeneration purposes. Consequently only small stumps are left behind which are too small for proper larval development of the beetle. In addition the use of herbicides and insecticides threatens the beetle.

The decline and fragmentation of habitat of the Stag beetle also affects other saproxylic (woodboring) insects; Figure 4.2 shows the distribution of forests containing habitats of 200 endangered species of woodboring invertebrates compiled by the Invertebrate Consultants' Group of the CDSN-committee (Speight, 1989). Countries for which such habitats are presented are: Norway, Sweden, Finland, Denmark, Germany, Switzerland, England and Belgium. For France data

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<sup>6</sup> [http://cdr.eionet.europa.eu/Converters/run\\_conversion?file=/fr/eu/art17/envubhesg/FR\\_species\\_reports.xml&conv=354&source=remote#1083ATL](http://cdr.eionet.europa.eu/Converters/run_conversion?file=/fr/eu/art17/envubhesg/FR_species_reports.xml&conv=354&source=remote#1083ATL)

<sup>7</sup> see: [https://ptes.org/wp-content/uploads/2018/06/SoBSB\\_2018.pdf](https://ptes.org/wp-content/uploads/2018/06/SoBSB_2018.pdf)

was only partly available and no forests were considered appropriate for listing in Ireland and the Netherlands.

Some forests are of respectable size, but others are as little as 40 ha. The greater part lies within mountainous parts of the continent. The distribution pattern shown on the map clearly demonstrates that forests being important for saproxylics are either isolated relicts in unforested regions or – although embedded in large woodland regions – isolated from similar forests.

### **Proposed measures for GI**

To create more breeding possibilities for the Stag beetle old and moribund deciduous trees as well as large stumps of these trees are required. At the local level connectivity can be enhanced by the introduction of natural and artificial breeding facilities, such as dead wood pyramids, loggeries and large wooden boxes filled with wood chips and sawdust. The location of these breeding habitats should be based on the core areas already present. The corridors connecting the breeding places should be of the 'nodal type' with nodes every 2 km.

At the landscape level connectivity can be enhanced with the maintenance of ancient woods, conservation of forest remnants, hedgerows and old deciduous trees. The exchange of individuals between isolated patches of old deciduous woodland can be facilitated with plant schemes for deciduous trees in the vicinity of forest remnants, single trees, open areas and coniferous woodland. These corridors should be constructed away from roads, as Stag beetles are very vulnerable to traffic.

Little evidence is found of larger, transboundary projects aiming at the Stag beetle: the project LIFE for insects - Conservation of selected Natura 2000 insect species in transboundary area (CZ-SK) of Western Carpathian Mts. LIFE16 NAT/CZ/000731 is focused at the regional scale, and partly at meadows for butterflies. The LIFE description notes however: *the most threatened habitats in Central Europe is open-canopy middle forests home to valuable Habitats Directive-listed species such as the stag beetle (Lucanus cervus) or clouded Apollo (Parnassius Mnemosyne) butterfly. With the disappearance of traditional coppicing of woodlands and forest grazing (and changes in forestry practices and legislation), the best way to support this habitat is through the restoration of open-canopy forests.*

In South Sweden a life project aims at restoring saproxylic beetle species (LIFE15 NAT/SE/000772). One of the project aims is to: *Initiate the creation of decaying wood habitats which in the longer term can bridge gaps in space and time for the Annex I habitats (9070, 6530\*, 9160, 9020 and 9190) and Annex II species Osmoderma eremita, Cerambyx cerdo, Lucanus cervus and Anthrenochernes stellae within the Natura 2000 sites.*

One of the methods used is 'veteranisation' of trees: a method to create old tree structures in younger trees, carried out using a chainsaw by arborists. The veteranisation methods aim to mimic effects on trees due to naturally occurring disturbances like storm felling, lightning, browsing animals and woodpeckers. It increases the number of available dead-wood-habitats for threatened species, as e. g. hollow trees, trees with partially dead trunks, and sap flows. So far no results have been reported at <http://lifebridgingthegap.se>

### **Assessment of Ecosystem Services**

Ecosystem services related to the proposed measures, as described above, are discussed in par. 2.4 and presented in Table 3.9Table. The Stag beetle is exemplary for the strongly declining group of large wood boring (saproxylic) beetles, such as the black tinder fungus beetle. If ancient woods are maintained then ancient woodland indicator plants will also benefit. These old forests have limited provisioning services, and may in fact require reduced timber harvesting. The regulation services may be high though, in particular climate regulation, pollinator functions and seed dispersal and



maintenance of nursery populations and habitats. The habitat finally may facilitate some recreational services, as well as inspirational services.

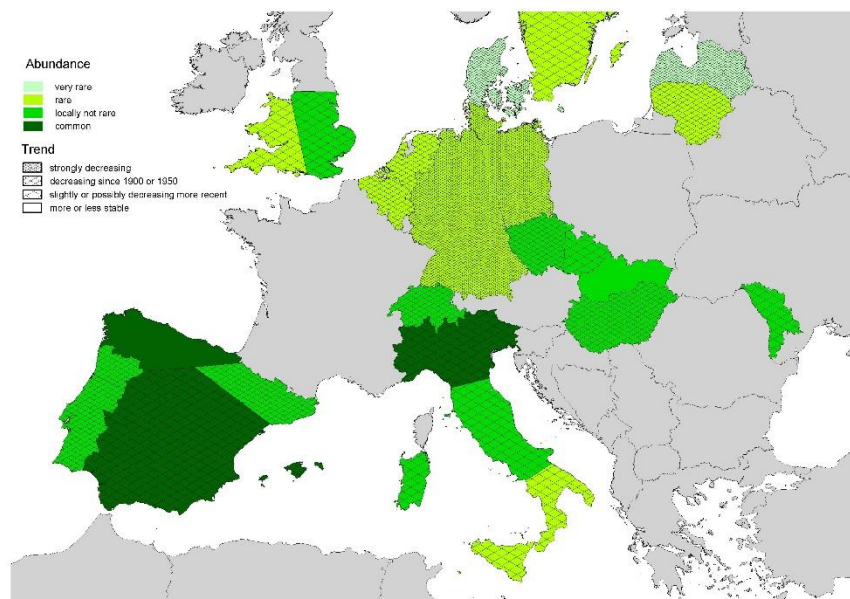


Figure 4.2: Distribution of countries with old-growth forests and populations of Stag beetle

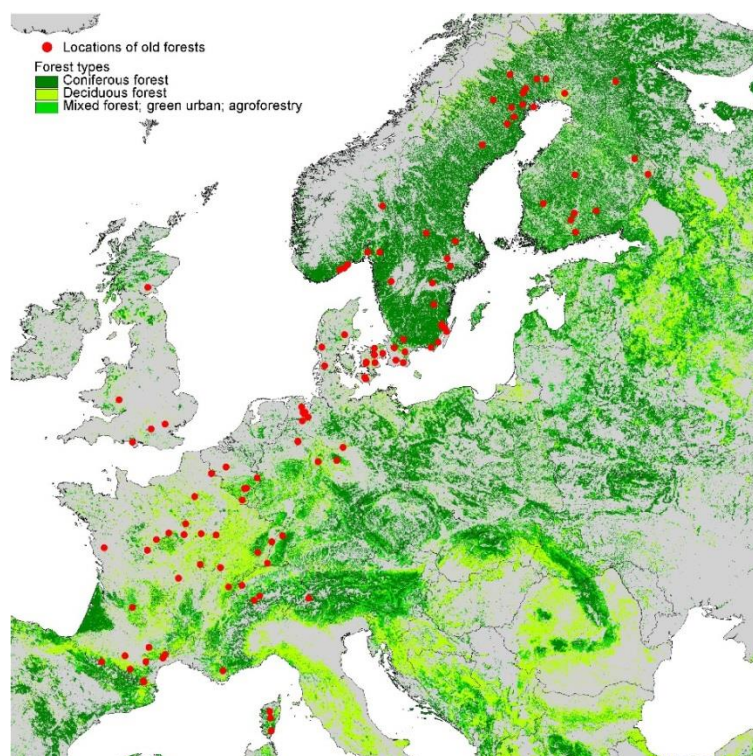


Figure 4.3: Presence of old forests, and forest types in NW-Europe (Speight, 1989)

#### 4.1.5 European sturgeon/Beluga (*Huso Huso*)

##### Ecology and distribution

The Beluga or European sturgeon (*Huso huso*) is endemic to the Ponto-Caspian Sea region that includes the Caspian Sea (the largest inland body of water in the world) as well as the Sea of Azov

and the Black Sea. The current native wild distribution within the EU is restricted to the Black Sea (in the Danube only), but it does occur in the Caspian sea and Volga as well. As it is a long-lived species (has a long life expectancy), individuals can still be caught in areas where their spawning sites have been cut off. The beluga have reached 100 years of age and more than 1,000 kg weight. The last wild population in the Black Sea basin migrates up the Danube river. All other Black Sea stocks are almost extirpated due to overfishing and impoundment of spawning rivers.

### **Conservation status**

The European sturgeon is critically endangered, following the IUCN criteria and included in the EU Habitats Directive Annex V, the Bern Convention Annex II & III. Based on catch data, and number of recorded spawning individuals it is estimated that the species have seen a wild native population decline of over 90% in the past three generations (a minimum of 60 years) and overfishing for meat and caviar may cause global extinction of the remaining natural wild populations. Stocks of sturgeons are dramatically decreasing, particularly in Eurasia; the world sturgeon catch was nearly 28,000 tons in 1982 and less than 2,000 tons by 1999 (Billard & Lecointre, 2000).

### **Problem**

The decline of Sturgeon resulted from overfishing and environmental degradation such as: accumulation of pollutants in sediments, damming of rivers, and restricting water flows, which become unfavourable to migration and reproduction.

### **Proposed measures for GI**

In the immediate future, survival can only depend on stocking and effective fisheries management and combating illegal fishing. Range states are also encouraged to provide protection to the species spawning and feeding grounds. Protective measures include fishing regulation, habitat restoration, juvenile stocking, and the CITES listing of all sturgeon products including caviar.

In future sturgeon farming may resolve some pressure on the wild populations (due to illegal fishing), presently farming yields more than 2,000 t per year (equivalent to wild sturgeon landings) and about 15 t of caviar. This artificial production may contribute to a reduction of fishing pressure and lead to the rehabilitation of wild stocks.

One of the approaches is the MEASURES project developed under the INTERREG Danube Transnational program: Managing and restoring aquatic Ecological corridors for migratory fish species in the danUbe RivEr baSin<sup>8</sup>. MEASURES aims to create ecological corridors by identifying key habitats and initiating protection measures along the Danube and its main tributaries. The sturgeons and other migratory fish species act as flagship species in support of these goals. A combination of measurements is required to restore the landscape connectivity for the European sturgeon. These measurements comprise the bypassing of obstructions such as dams, weirs and culverts, the restoration of spawning areas by restoration of the morphology of rivers and streams, and in some cases young fish have been reintroduced in tributaries of big rivers.

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<sup>8</sup> <http://www.interreg-danube.eu/approved-projects/measures>

The corridor required for migration and dispersal is of the 'linear type'. A coordinated approach is required though, the connectivity may be a major problem, for Sturgeon to reach its spawning areas a chain of measures is required.

### **Assessment of Ecosystem Services**

Ecosystem services related to the proposed measures, as described above, are discussed in par. 2.4 and presented in the Table 3.9. The sturgeon populations can be restored through reversal of engineering works, removal of dams etc. This has some potential for provisioning services, in particular for fisheries. More important are the regulating services like erosion protection, flood protection and maintenance of nursery populations and habitats. The habitat finally may facilitate some recreational services (fishing), as well as large inspirational services.

### **4.1.6 Large copper (*Lycaena dispar*)**

#### **Ecology and distribution**

The Large copper (*Lycaena dispar*) usually occurs in natural marsh vegetation along water courses, rivers and marshes, but may also be found in unimproved, semi-natural grasslands. The male defends his territory, whilst the female wanders over large wetlands looking for a male or –after mating- for a plant to deposit eggs. The females are quite mobile and can colonise relatively quickly suitable habitats up to a distance of ten km. This means that the butterfly functions very well in mosaics of habitat patches. The Large copper has declined significantly in Western Europe, whereas Eastern European populations are mostly stable. At the northern limit of its range in Estonia and more recently in Finland, the butterfly is expanding, probably caused by global warming in the last decades.

#### **Conservation status**

The Large copper is listed on appendix II of the Bern Convention and on appendix II and IV of the EU Habitats Directive. The butterfly is listed as 'at Lower Risk, Nearly threatened species' on the IUCN Red-list.

#### **Problem**

The biggest threat to the Large copper is the fragmentation of its habitat, which are the large marshes and natural, humid grasslands. Intensification of agriculture in North-western Europe has resulted in drainage and reduction in size of these habitats. In Eastern Germany and Poland, large viable populations still exist, but unfavourable changes in agricultural practice could take place following the accession of these countries to the European Union.

The accession of the new member states to the European Union causes agricultural intensification in these countries. This leads to the fragmentation of the wetlands in Central Poland.

By means of a LARCH analysis potential habitat of the Large copper was identified and compared with the actual distribution pattern of the species (Figure 4.4). In many areas (1, 2, 3) large core populations exist whereas in other regions populations are smaller, but still well connected (4, 5). In areas such as North-western Germany (6) however the wetlands are too small, scattered and isolated. Although the ecology differs slightly for this species, the model also predicts reasonably well the potential distribution of the Large copper in the Netherlands. In reality this subspecies is restricted to the Dutch regions of North-west Overijssel and Southern Friesland.



## Proposed measures for GI

To increase the connectivity for the Large copper two types of corridors are required.

Firstly corridors connecting different networks and secondly corridors which link smaller local populations within a particular network. The landscape matrix is very important for the development of such network corridors, but also linear corridors with attached nodes are needed to link the smaller local populations. This is illustrated in Figure 4.4.

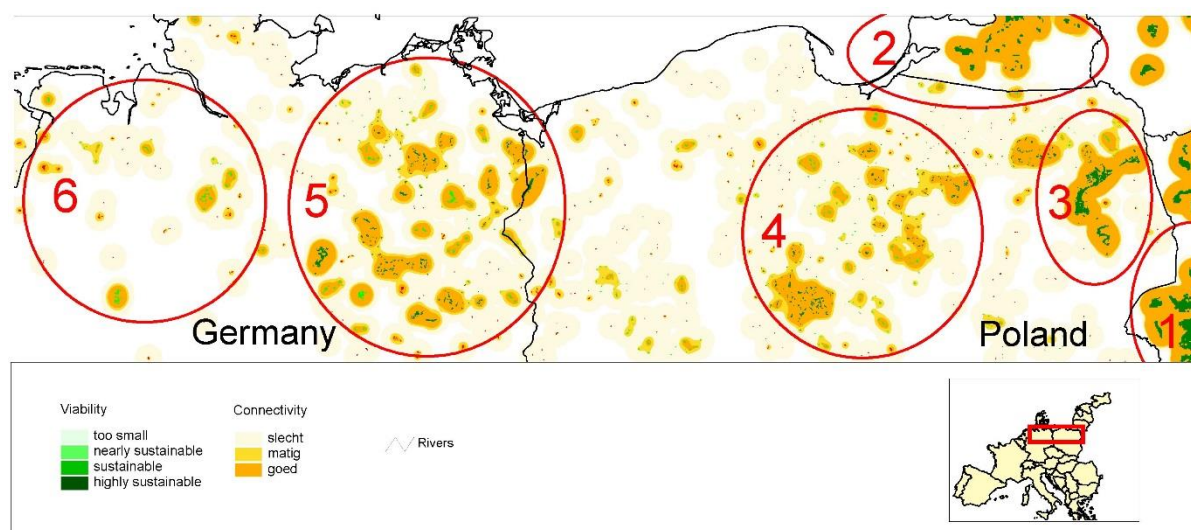
In the North-western part of Germany wetlands are small and isolated. This means that the Large copper population occurring in the Netherlands is isolated from populations in Eastern Germany. Only a large scale creation of wetlands could be a solution to this problem.

It is important that existing wetlands with *Lycaena dispar* populations are maintained and the area is connected to the Biebrza valley and Kaliningrad.

## Assessment of Ecosystem Services

The Large copper is an umbrella species for many other wetland insects. But also other species of large wetlands, such as the Otter and many birds will profit from action taken to favour this butterfly.

The habitat for the large copper is much related to large wetlands and meadow systems, which should be restored. This has limited potential for provisioning services, some wild animals, but much more important are plant –based resources, the reed which is used for various purposes, roofing, and for biomass, pellets etc (Van der Sluis et al., 2013). These wetlands have also important regulating services, in particular climate regulation, flood protection and maintenance of nursery populations and habitats (in particular fish species). The areas also form important recreation areas for hikers, canoers, fisherman or hunters. Also inspirational services are associated with large wetland areas (Table 3.9).



**Figure 4.4: Ecological core areas for the Large Copper**

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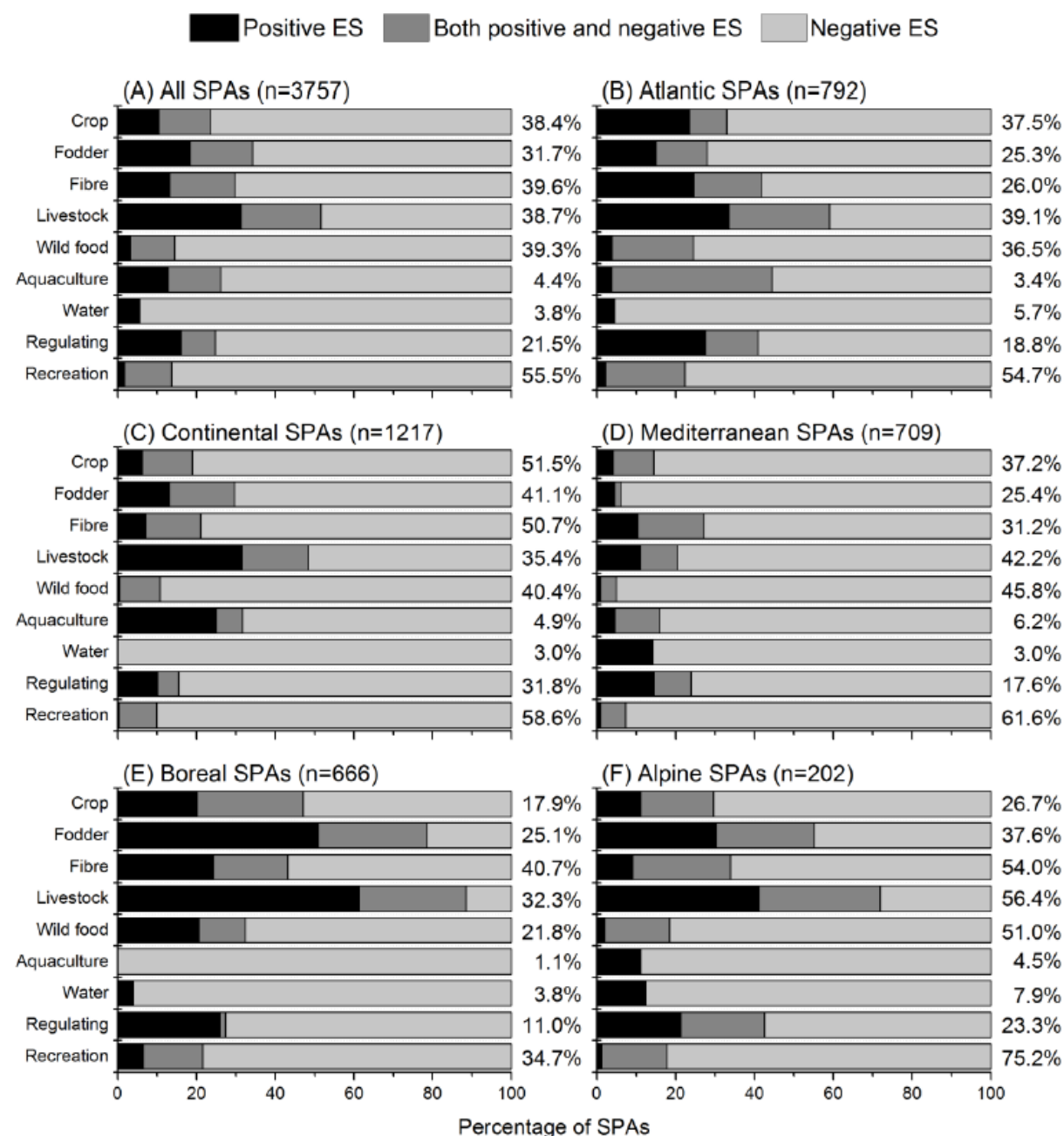
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# Annex 1 Prevalence of habitat types containing each ecosystem service

Correlation of Ecosystem Services ES with Special Protection Areas SPAs in specific Biogeographical Regions (Ziv et al., 2018)



Ecosystem service are categorised as positive (darkest colour), both (middle colour), and negative (lightest colour). Colours indicate broad habitat classes: blue = marine/aquatic, turquoise = grass/heath, brown = agricultural, green = forest, purple = other (Ziv et al., 2018).

