BIO_SOS

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Abstract	Eleven test sites in Europe (mainly in the Mediterranean) were selected for testing and ground verification of the methods to be developed in BIO_SOS. All sites are important areas for the conservation of biodiversity. Their landscape structure is analysed as well as the pressures and threats of each site, recognizing habitat loss and fragmentation to be of seminal importance. The analysis concludes with the identification of key biodiversity indicators that need to be monitored, and the definition of the spatial and temporal resolution of this monitoring.

Keywords	Landscape structure, classification schemes, pressures and threats, monitoring, resolution

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1. Executive summary

The BIO_SOS project aims to develop and validate a prototype system that provides a reliable long-term biodiversity monitoring service based upon high resolution (HR, 3 to 30 m) and very high (VHR, <3m) spatial resolution remote sensing data, and to embed monitoring information (changes) in innovative ecological modelling for Natura 2000 site management.

For practical application and method testing, eleven test sites throughout Europe were selected. Most sites are located in the Mediterranean countries of Italy (4), Greece (3) and Portugal (2) but two are located in the northern European countries of Wales (1) and the Netherlands (1)These sites are a diverse set of protected areas including wetlands, forests, grasslands and bogs. Site characteristics ranges from mountainous rough to flat coastal morphologies, from rangeland to human-dominated landscapes and land uses. The areas of these sites ranges from < 700 ha (Wales) to > 100,000 ha (Italy) and altitudes range from sea level to 1,545 m a.s.l. The wide array of different environmental characteristics of the selected sites has been selected to ensure system robustness. In this deliverable, we have compiled information on the landscape composition and land use of each site and present a short comparison. We have analysed the landscape composition of these sites according to two different classification schemes: Corine Land Cover/Land Use classification (CLC) and the Annex 1 habitat type classification.

Of all the level 3 CLC classes, only four are absent from our test sites. The commonest CLC class is natural grasslands (321) present in all but the Dutch site. The next most frequent classes found are forests (either broad-leaved 311, or coniferous 312), non-irrigated arable land (211) and land principally occupied by agriculture, with significant areas of natural vegetation (243).

The Annex 1 Habitats Directive classification scheme is more detailed than the CLC classification scheme regarding natural and semi-natural vegetation, but does not include human land uses, and thus leaves large parts of the landscape unexplored. Natural grasslands (CLC class 321) correspond to more than twenty habitat types and thus it is not surprising that no habitat type is present in more than four of our test sites, in comparison to the ten sites with natural grasslands. As a result, the correlation in the site diversity ranking according to the two schemes is relatively weak.

All of our test sites are important areas for biodiversity conservation and are simultaneously affected by one or more types of anthropogenic pressure or natural threats. By far the commonest type of human pressure is agriculture which, to a lesser or greater degree, is present in all test sites. The next commonest human pressures refer to water engineering, followed by forestry and tourism. Hunting and fishing is rarely reported as a major threat in the test sites. Most of these pressures imply spatial explicit effects on the landscape configuration (i.e., composition and structure) which are likely to affect processes relevant to species distribution at both landscape and local scales and which can be detected from remote sensing.

Analysis of landscape composition as well as human pressures and natural threats helped us identify a core of biodiversity indicators, whose monitoring would greatly benefit biodiversity conservation of these protected areas. More specifically, these key indicators will be related to the state and trend of: a) habitats of European interest, b) the abundance and distribution of indicator species, and c) fragmentation of natural and semi-natural areas. For the most efficient monitoring of such indicators, there is a need for high- to very high-resolution maps and detection of change that is

not currently available. Given the phenology of these habitat types, a multi-temporal analysis would greatly assist landscape classification accuracy. Since the test sites are part of the European ecological network Natura 2000, we suggest that monitoring should track changes in habitat loss and natural ecosystem fragmentation within intervals of 3-5 years, but certainly no longer than 6 years. The General Habitat Categories (GHCs) based on life forms were used for the definition and detection of spatial changes and, potentially, vegetation dynamic trends.

2. Introduction

BIO_SOS project

The main aim of the BIO_SOS project is the development of an operational ecological modelling system suitable for effective and timely multi-annual monitoring of Natura 2000 sites and their surrounding areas, which are exposed particularly to different and combined type of pressures. The project will:

1) Adopt and develop novel operational automatic high spatial resolution (HR), very high spatial resolution (VHR) and hyper-spectral resolution EO data pre-processing and understanding techniques for **land cover** (LC) map and **LC change** (LCC) map generation eligible for use in biodiversity monitoring. This is tantamount to saying that BIO_SOS is expected to provide improved operational core service products with respect to state-of-the-art satellite-based LC and LCC mapping systems.
2) Develop a modelling framework (scenario analysis) to combine EO and on-site *in situ* data to support the automatic provision of **biodiversity indicators** and provide a deeper understanding, assessment and prediction of the impacts that human induced pressures may have on biodiversity. This means BIO_SOS aims to develop and integrate new and existing models able to evaluate and predict trends in biodiversity issues. This will lead to the development of *new downstream services* production.

To achieve this, the BIO_SOS project will test the integration of existing and new automatic EO data processing techniques to enable better use of observations over different scales and link that with *in situ* information. For this purpose, the consortium identified eleven (11) test sites throughout Europe. These sites are mainly located in the Mediterranean countries of Italy (4), Greece (3) and Portugal (2) and in the northern European countries of the Netherlands (1) and Wales (1) All sites are known for their biodiversity conservation and therefore belong to the European Ecological Network Natura 2000. To distinguish these sites we assign BIO_SOS site codes presented in the following Table 1.

Table 1 The BIO_SOS test sites

BIO_SOS code	Natura 2000 code		Natura 2000 name
	SCIs /SACs	SPA	
IT1	IT9110008	IT9110039	Valloni e steppe pedegarganiche
IT2	IT9110005	IT9110038	Zone umide della Capitanata-Paludi presso il Golfo di Manfredonia
IT3	IT9120007	IT9120007	Murgia Alta
IT4	IT9150032	IT9150014	Le Cesine
GR1	GR2120001	GR2120005	Ekvoles Kalama
GR2	GR2120002	GR2120006	Elos Kalodiki
GR3	GR2120004		Stena Kalama
NL	NL9801023	NL3009017	Veluwe. Dutch case study concentrates on part N2K, namely Ginkelse and Ederheide, a heathland area and Weekeromse Zand an inland sand dune area
PT1	PTCON0021	PTZPE0037	Rios Sabor e Maçãs
PT2	PTCON0001	PTZPE0002	Peneda-Gerês
UK	UK0014791 UK0014790		Cors Fochno Cors Caron

BIO_SOS aims to develop an automatic system for the delivery of biodiversity information to users and managers. The main users of BIO_SOS are likely to be the local /regional managers of the Natura 2000 sites and the supervising national and/or regional authorities with responsibility for reporting to European Commission on the conservation status of species and habitats (Article 17 of the Habitats and Species Directive and Article 12 of the Birds Directive).

Habitat classification schemes in Europe

A great variety of concepts and definitions for habitats exist and these are reflected in the range of regional, national and European habitat classification schemes (Mücher 2009) with different habitat properties used as a basis for classification. The method of definition and classification of habitats influences how we can map and monitor them. The main European classifications are:

- CORINE Biotopes (CEC, 1991; Moss and Wyatt, 1994)
- The Palaearctic habitat classification (Devillers and Devillers – Terschuren, 1996)
- Annex I of the Habitats Directive (European Commission, 2007)
- The EUNIS habitat classification (Davies and Moss, 2002)
- The Phytosociological alliances of the European Vegetation Survey (Rodwell *et. al.*., 1995, 2002)
- The Natural Vegetation of Europe (Bohn *et. al.*., 2003; Bohn and Gollub, 2006)
- The recently established BioHab General Habitat Categories (Bunce *et. al.*., 2008, 2010).

The Natura 2000 habitats and EUNIS habitat classifications were both based on experience from the CORINE biotopes project and Palaearctic habitat classification (Mücher *et. al.*. 2004). These two classifications still differ in nomenclature, criteria and approach, which makes it difficult to link and compare them directly at a detailed level. Within European conservation agencies, one habitat classification is now central, namely the habitat type classification in Annex I of the Habitats Directive, whereas the EUNIS habitat classification is often used as a supplementary method. The definition, identification and characterisation of habitats depend on: a) our understanding of habitat units as spatial entities, and b) the classification of the spatial entities to be used for the identification and characterization of the habitat units as distinct from each other.

We suggest using the General Habitat Categories (GHCs) based on life forms for the definition and detection of spatial changes, as referred to also in the approved project proposal and, potentially, vegetation dynamic trends. Habitat maps can be obtained by interpreting land cover maps of sufficient detail with ancillary data, other EO derived products and by re-labelling and, where appropriate, by merging similar land cover classes, according to the 92/43 EEC Directive and to GHCs based on life forms as defined in the previous BioHab project [Bunce *et. al.*. 2008, 2010]. 154 GHCs are defined, with these derived from 16 easily identifiable Life-Forms and 18 Non Life Forms. The classification provides an easily repeatable system for use in the field that can be cross-related to other habitat classification schemes such as Habitat Directive Annex I and EUNIS. The GHCs can be easily identified on the ground, because they are based on life forms. They provide the lowest common denominator linking to other sources of data required for assessing biodiversity (e.g., phytosociology, birds and butterflies). They are also more easily discriminated using remote sensing methods as the system is based on life-forms that relate to habitat structure.

The GHC-approach therefore provides a powerful assessment tool for BIO_SOS,

providing the link between detailed site-based level measures and habitat assessments from remote sensing. In the BIO_SOS project, an effort will be made to improve the possibility of discriminating GHC from space, as earth observation presents the great potential for the proposed habitat monitoring system.

D2.2 – Objectives and content outline

In the frame of the WP2 entitled: User Requirements Completion, three tasks have been allocated. Task 2.2 is related to the Analysis of test area characteristics linked directly to this report of the deliverable D2.2: Site description. The objectives of this report compiled in the frame of D2.2 of the BIO_SOS project are as follows:

a) To provide a detailed description and analysis of the characteristics of each selected test site, in terms of data availability, habitat selection and habitat classification schemes, area extent, scale requirements, selection of biodiversity indicators, pressures and threats per site and per habitat,

b) To provide a synthesis of all data sets per country (IT, GR, NL, PT, UK, BR),

c) To provide comparisons between the sites and conclusions from D2.2 to be used as input to WP4, WP5, WP6, WP8.

The fulfilment of the mentioned objectives was carried out in cooperation with Partner 9 for Portugal, Partner 8 and Partner 1 (CNR-IGV) for Italian sites, Partner 2 for Greek sites, Partner 4 for the Dutch site, Partner 12 for Brazil sampling site, and Partner 11 for the Welsh site.

The content of the present report is structured as follows for each sampling site:

- Description and evaluation of main test site characteristics
- Habitat and species definition
- General Habitat Categories of interest
- Land cover classes of interest
- Definition of scale requirements
- Pressures and threaths
- Collection of pre-existing studies and information on test sites
- Biodiversity Indicator selection.

Parts of the present Report are also:

- Appendix 1. Summary tables for BIO_SOS sites.
- Appendix 2. Supplementary figures for BIO_SOS sites NL and IT1-4.
- Appendix 3. Acronym list.

Appendix 1, in particular is comprised of the following summary tables:

*Summary table 1*_BIO_SOS sites - Natura 2000 (N2K) type, i.e. SCI vs SPA, SCI/SPA spatial relation, Environmental Zones of Europe derived from the Environmental Stratification of Europe (Metzger et al 2005 and Jongman et al 2005)

*Summary table 2*_N2K – Annex I (Dir 92/43/EEC) habitat types represented in the BIO_SOS sites

*Summary table 3*_GHC – General Habitat Categories represented in the BIO_SOS sites according the EBONE D4.2 Rule based system for Annex I habitats (Bunce *et. al.*. 2010

*Summary table 4*_CLC – Corine Land Cover (level 3) classes represented in the BIO_SOS sites.

*Summary table 5*_OVERALL SUMMARY N2K– Annex I (Dir 92/43/EEC) habitat types (main entry) correspondence to GHC classification system and to the Corine Land Cover classification system. The correspondence to the EUNIS classification system is envisaged (task 6.1 of the BIO_SOS project)

*Summary table 6*_OVERALL SUMMARY GHC – GHC classification system (main entry) correspondence to Annex I (Dir 92/43/EEC) habitat types and to the Corine Land Cover classification system. The correspondence to the EUNIS classification system is envisaged (task 6.1 of the BIO_SOS project)

*Summary table 7*_Threats per site - Threat (pressures/impacts) categories and subcategories_according to Dimopoulos 2006, as adapted for the BIO_SOS project represented in the BIO_SOS sites.

*Summary table 8*_Threats cross tab - Threat (pressures/impacts) categories and subcategories_according to Dimopoulos 2006, as adapted for the BIO_SOS project represented in the BIO_SOS sites, in connection to GHC categories and Annex I habitat types, by site

*Summary table 9*_Threats NL - Threat (pressures/impacts) categories and subcategories_ for the Duch site

3. Test site characteristics

3.1 Partner 2: UOI Greece

The Greek Natura 2000 sites (test sites) are the following: GR1: EKVOLES KALAMA (Kalamas Delta) (GR2120001); GR2: ELOS KALODIKI (Kalodiki Fen) (GR2120002); GR3: STENA KALAMA (Kalamas Gorge) (GR2120004). All three sites are located in the prefecture of Thesprotia in the administrative region of Epirus (NW Greece) (Figures 1a and b).

a) b)

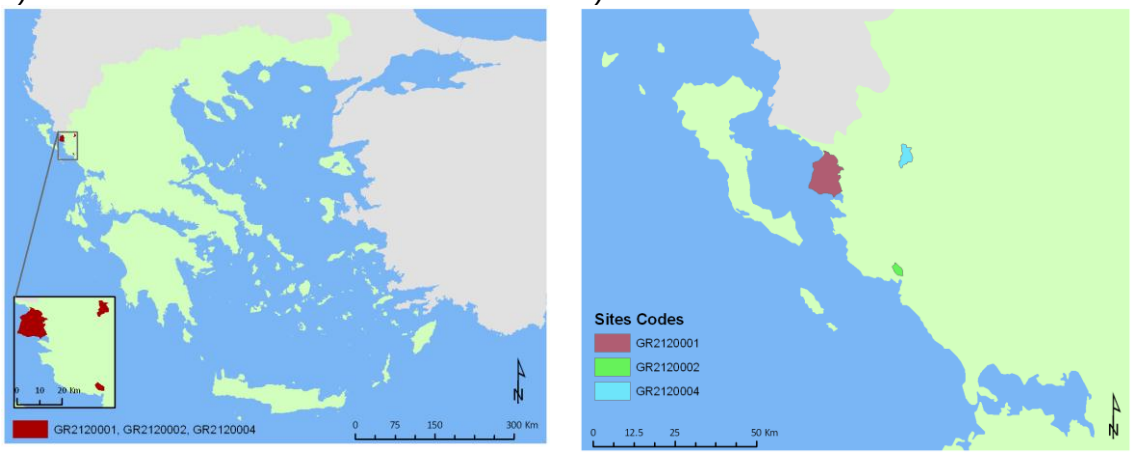


Figure 1 GR_a) The location of the Greek test sites and b) a close-up of the test site location.

3.1.1 GR1: Ekvoles Kalama GR2120001

General description

Site GR1 is the Kalamas River delta (Ekvoles Kalama) which is designated as an SCI (GR2120001) and has a surface area of 8481 ha. The riparian forest stands are ecologically important and are of high historic and aesthetic value. The Kalamas wetland is influenced by the topography and land cover of the surrounding hills. Reed and tamarisk thickets and halophytic plant communities are typical of the river estuaries and support a high diversity of plant species. The reed thickets are dominated by *Phragmites australis* and other species of the class *Phragmitetea.* The aquatic vegetation of the site is composed of plant communities that include *Lemnetea minoris*, *Ceratophylletea demersi* and *Potamogetonetea pectinati*. The zonal development of halophytic communities and wet meadows with *Juncus* sp. is very characteristic. Figures for land cover classes and habitat Tables are based on year 2000.

Habitat types (Dir 92/43/EEC) and species evaluation

According to the Habitats Directive, the River Kalamas includes 4 ha of the conservation priority habitat type 1150 (coastal lagoons). The site is of considerable ecological significance due to the diversity of the riparian forests (habitat types 92AO and 92DO). The most abundant natural habitat type is phrygana (*Sarcopoterium*

spinosum; 5420) followed by 1410 Mediterranean salt meadows (*Juncetalia maritime*; 1410) and Mediterranean and thermo-Atlantic halophilous scrubs *Arthrocnemetalia fruticosae* (1420). As far as their conservation status is concerned, we should point out that no habitat type is considered to be of excellent quality (Status A), but is rather good or average. This highlights the need to monitor the conditions of this site and to apply efficient management activities.

General Habitat Categories

A wide range of GHCs are present within the site, with these including coastal landscapes, habitat complexes, wetlands and other herbaceous vegetation categories that are notable features of the landscape. On the coast, estuaries and coastal lagoons, as well as habitat complexes with coastal dune systems (embryonic, shifting dunes) and river complexes (Mediterranean rivers with *Salix alba* and *Populus alba*) occur. Other herbaceous (HER) vegetation is associated to saline habitats with therophytic (THE) communities on mud and sand (*Salicornia* salt marshes), as well as Leafy Hemicryptophytic (LHE) vegetation on moist/saline habitats with Mediterranean salt meadows (*Juncetalia maritimi*) and annual vegetation of drift lines, as well as tall humid herb grasslands of the Molinio-Holoschoenion on moist/neutral soils. Other herbaceous (HER) vegetation is also associated to Mediterranean halophilous scrubs (Sarcocornietea fruticosi). On the calcareous mountain slopes Low Phanerophytic evergreen vegetation (LPH/EVR) includes thermo-Mediterranean scrubs with *Eurphorbia dendroides*. Tall Phanerophytic-evergreen vegetation (TPH/EVR) includes tall scrub riparian vegetation (2-5 m, cover > 30%) with *Tamarix* spp. Softwood forests of *Salix alba* and *Populus alba* are also present on seasonally wet soils assigned to the GHC of Forest Phanerophytes/Deciduous (FPH/DEC), as well as *Quercus macrolepis* forests on very dry soils assigned to the GHC of Forest Phanerophytes/Evergreen (FPH/EVR).

The GHCs potentially present within the study area, refer to the non Annex I (Dir. 92/43/EC) habitat type (72A0: Reed thickets). Within the next few months, this is expected to be attributed to one or more of the established system of GHCs supported by our research group after field work for appropriate documentation.

Agricultural areas are also present in the study site with the following three GHCs: cultivated herbaceous crop (CRO), cultivated woody crops (WOC) and most probably cultivated bare ground (SPA). Urban elements might be attributed to urban artificial (ART) and urban non-vegetated (NON).

Corine Land Cover classes

Figures for land cover classes are based on year 2000. Agricultural land that covers almost 62 % of the total area (Table 2), and is composed of permanently irrigated land (36.14 %) and complex cultivation patterns (14.33 %) (Table). The second largest class is forests and semi-natural areas (28 %) (Table 2), which is composed mainly of natural grasslands (12.19 %) and sclerophyllous vegetation (11.26 %) (Table 3). Wetlands and water bodies cover almost 10.05 % (Table 2) of the total area including salt marshes (6.74 %), coastal lagoons (1.01 %) and estuaries (2.31 %) (Table 3). Of the three Greek test sites, this site contains the highest amount of agricultural land.

Table 2 GR1_Corine level 1 land cover classes

Level 1	Name	Area (ha) in 2000	%
1	Artificial surfaces	12964.3	0.17%
2	Agricultural areas	4728216.2	61.77%
3	Forests and semi-natural areas	2143525.7	28.00%
4	Wetlands	516055.4	6.74%
5	Water bodies	253736.0	3.31%
	Total	7654497.5	100.00%

Table 3 GR1_Corine level 3 land cover classes

Level 3	Name	Area (ha) in 2000	%
112	Discontinuous urban fabric	12964.3	0.17%
212	Permanently irrigated land	2766544.9	36.14%
213	Rice fields	439990.7	5.75%
242	Complex cultivation patterns	1097020.7	14.33%
243	Land principally occupied by agriculture, with significant areas of natural vegetation	424659.9	5.55%
311	Broad-leaved forest	1263.6	0.02%
321	Natural grassland	932706.8	12.19%
323	Sclerophyllous vegetation	861764.6	11.26%
331	Beaches, dunes, and sand plains	347790.9	4.54%
421	Salt marshes	516055.4	6.74%
521	Coastal lagoons	77115.0	1.01%
522	Estuaries	176621.0	2.31%
	Total	7654497.5	100.00%

Definition of scale requirements

The site hosts vegetated, aquatic and bare land cover types. Previous habitat maps from the area were based on aerial photographs of high spatial resolution but updated land cover maps of this site should be extracted from very high resolution satellite images (i.e., grain less than 3 m). Aquatic land cover classes can be identified and delimited using imagery acquired at any time of the year. However, for the vegetated and agricultural land cover classes, multi-temporal satellite images because of transitions from winter (bare ground is more apparent) through spring (leaf flush when majority of plants are green) to summer (when many plant species have changed their leaves to more drought resistant forms). For detecting changes in the extent and shape of our habitat types, monitoring every six years is suggested with this following the Habitats Directive instructions.

Pressures and threats

Following the standard data forms of the Natura 2000 sites, a list of the human pressures and threats recorded inside and outside the Greek study site GR1 is given in Table 4. Water and soil pollution is observed in the Kalamas wetland which is attributed to many human activities (refuse disposal, unwise use of fertilizers and pesticides, etc.). Road construction on the hills has increased access for hunting and grazing. Many of the animal habitats in this site are very vulnerable because of a variety of human activities. Habitat alteration or destruction within the area is mainly a

intensive agriculture (with associated deforestation and pollution), grazing, embankments, sand extraction, stock farming, etc. Hunting is the most serious threat to the site's avifauna. Further details on other pressures and threats are included in Appendix 1, as well as the habitats on which their effects are thought to be more intense. Figures are based on year 2000.

Table 4 GR1_Main human pressures and threats recorded for GR1

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation	I	A	48	-
Fertilisation	I	B	48	-
Irrigation	I	B	40	-
Grazing	I	B	40	-
Grazing	O	A	80	
Animal breeding	I	B	3	-
Animal breeding	O	A	4	-
Burning	I	A	20	-
Fish and Shellfish Aquaculture	I	C	4	0
Hunting	I	A	90	-
Hunting	O	A	90	-
Continuous urbanisation	I	C	1	0
Water pollution	I	C	1	-
Water pollution	O	A	3	-
Soil pollution	I	C	48	-
Erosion	O	A	5	-
Eutrophication	I	C	1	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Concerning the 16 habitat types of GR1, 29 different threat subcategories have been adapted (see Appendix 1), eight of which are related to water engineering, management and consumption. Six are related to cultivation, agricultural activities and land use, six to tourism and recreational activities, four to forestry and forest use, four to construction works and mining activities, and one to invasive species.

Data availability

Available satellite images and other data available for the study site are listed in Table .

Table 5 GR1_Summary of the main data layers available for GR1 (Ekvoles Kalama GR2120001)

Source/Sensor	Data range
IKONOS multi and pan	2007-06-11
ASTER	2006-05-19
Landsat MSS, TM, ETM+ (USGS archive)	1984-2010 (Gap in 1991-1999)
Aerial photographs (scale 1:42000-1:3000)	1945, 1980, 1995

Biodiversity Indicator selection

For biodiversity and conservation status monitoring on the basis of biodiversity indicators, essential and sensitive elements of biodiversity should be measured and

translated into indicators. According to the EBONE and BIO_SOS Deliverable 2.1, the three main Biodiversity indicators relating to state and trend cover are:

(i) Extent and change of habitats of European interest in the context of a general habitat assessment
The challenge is to develop methods for "wall to wall" mapping and assessments of habitats that will be relevant to NATURA 2000 site habitats. This is currently achieved by a combination of two SEBI indicators "Habitats of European Interest" and "Ecosystem Coverage". As mentioned in D2.1, for the test areas other, more refined observation tools will be used to measure land cover changes (expansion, abandonment, concentration, local intensification and specialization). For BIO_SOS, the indicator concerning intensity of pressures and threats, as far as they are spatially explicit (e.g., land use and land use change), could be considered when developing specific studies. Agricultural land tends to be more and more expansive in the test areas, thus indicating it exerts the main intense pressure on natural habitats.

(ii) Abundance and distribution of selected plant species
Since decreases in a habitat's area would have a negative effect on the species dependent on that habitat, is the abundance and distribution of selected plant species is a particularly useful indicator for specialist species that are dependent on a restricted number of habitats. An assessment of changes in the extent and condition of the habitat on which selected species occur may provide a method of estimating indicators on a more broad scale within Natura 2000 sites. BIO_SOS will investigate the potential for using GHCs and its detection by RS tools as a surrogate measure of species diversity, using specific plant species and other taxonomic groups for which sufficient data are available from literature or previous projects, as well as changes in species richness.

(iii) Fragmentation of natural and semi-natural areas
This indicator shows changes in the average size of patches and semi natural areas. Work in BIO_SOS will investigate the derivation of landscape indicators at various spatial resolutions, but focus mainly on very high spatial resolution (VHR) data. This will focus on traditional spatial pattern indicators such as fragmentation and connectivity but also explore the potential for using more detailed information on habitats from GHCs.

Users

The Management Institution of Kalamas-Kalodiki is responsible for the conservation management of the concerned SCI sites in Greece and will be one of the main end users of our results. The management body administratively belongs to the Hellenic Ministry of the Environment, is closely linked to the regional services for the Environmental policy implementation and deals with conservation management of habitats, species and water resources.

Main indicator species

The summary of the main indicator species per habitat type for this site is given in the following table.

Table 6 GR1_Summary of the main indicator species per habitat type recorded for GR1

GHC Level 3	GHC Level 4	GHC Level 5	Indicators	ANNEX 1 CODE
				1020
				1050
1.1.4			*Ruppia maritima*	1130
1.1.3			*Phragmites australis*	1150
		5.2.2.9.1	*Cakile maritima*	1210
		5.2.1.1.1	*Salicornia europaea*	1310
		5.2.2.12.1	*Juncus maritimus*	1410
		6.2.2.3.2	*Sarcocornia fruticosa*	1420
		1.3.5.2.1	*Elymus farctus*	2110
		1.3.6.3.2	*Salix alba, Populus alba*	3280
		6.2.2.8.1	*Euphorbia dendroides*	5330
			not defined	5420
		6.6.2.3.3	*Quercus macrolepis*	9350
			not defined	72A0
		6.6.1.1.2	*Salix alba, Populus alba*	92A0
		6.6.2.3.1	*Tamarix* spp.	92D0

3.1.2 GR2: Elos Kalodiki GR2120002

General description

Site GR2 (GR2120002: Kalodiki Fen) is designated as an SCI and covers an area of 845 ha (Figures 1a and b). The Kalodiki Fen consists of two lakes (one large and one small) embedded in a topogenous mire or fen, located in a small basin created by a tectonic depression. The fen consists of two proximate peatlands which occupy an area of 195 ha, surrounded by hills of 550 m altitude. Kalodiki Fen is an inland, freshwater wetland belonging to the western chain of Greek wetlands. Eighteen vegetation types, of which nine are ranked as associations and nine as frame communities, have been recorded here. Kalodiki is a relatively heterogeneous wetland with small-scale variation. Its vegetation is characterised by a mosaic of well-developed swamp, mesotrophic and eutrophic freshwater and aquatic plant communities, all in various combinations of spatial arrangement. The diversity of the wetland vegetation types decreases in the following order (based on the number of distinguished communities): a) swamp and fen vegetation dominated by graminoids, sedges and forbs; b) communities of rooted, floating or submerged macrophytes in mesotrophic and eutrophic freshwaters; c) low herb communities of various habitats with wet-dry, or brackish-fresh conditions; d) communities of enriched margins of still or sluggish waters and damp disturbed places; e) tamarisk woodlands on soils inundated with fresh water. The ecological status of the whole ecosystem is strongly dependant on a small dam. Farmers frequently damage this dam in order to irrigate their crops and hence the dam is poorly maintained and often leaks. Eutrophication observed in the site is caused by erosion, agricultural activities and pollution. The wetland ecosystem is often disturbed by illegal activities such as hunting, rubbish dumping, and illegal cultivations within the wetland. Figures for land cover classes and Habitat Tables are based on year 2000.

Habitat types (Dir 92/43/EEC) and species evaluation

The Calcareous fens with *Cladium mariscus* (7210) are a priority habitat type according to the Habitats Directive. Even though they may cover only a small portion of this test site, this patch is of considerable ecological significance because of its rarity both at the national and European level. The site is covered mainly by Mediterranean type ecosystems such as phrygana (5420) and macchia vegetation (934A) that may be abundant nationally but are not so widespread at the European level. The habitat types present in this site are considered to be of good or average conservation status and thus monitoring is deemed necessary.

General Habitat Categories

The pattern of GHCs present within this inland wetland site is less diverse compared to the previous test site (GR1). The GHCs of this site include other herbaceous (HER) wetland vegetation with a) submerged hydrophytes (SHY) on wet eutrophic soils representing various plant communities on natural eutrophic lakes with Magnopotamion and Hydrocharition vegetation types, b) emergent hydrophytes (EHY) representing communities on calcareous fens with *Cladium mariscus*. Tall Phanerophytic-evergreen vegetation (TPH/EVR) includes tall scrub riparian vegetation (2-5 m, cover >30%) with *Tamarix* spp. Softwood forests of *Salix alba* and *Populus alba* are also present on seasonally wet soils assigned to the GHC of Forest Phanerophytes/Deciduous (FPH/DEC).

The GHCs potentially present within the study area are those listed as non Annex I

(Dir. 92/43/EC) habitat types (72A0: Reed thickets, 934A: Greek *Quercus coccifera* woods). With support from our research group, these are expected to be attributed to one or more of the established system of GHCs within the next few months after field work for appropriate documentation. Agricultural areas are also present in the study and include woody crops (WOC) and most probably cultivated bare ground (SPA). Urban elements might be attributed to urban artificial (ART) and urban non-vegetated (NON).

Corine Land Cover classes

The CLCs occuring include agricultural areas (30.74 %), forests and semi-natural areas (42.97 %) and wetlands (26.29 %) (Table 7). The agricultural areas are composed mainly of non-irrigated arable land (18.71 %), followed by land principally occupied by agriculture, with significant areas of natural vegetation (10.66 %) (Table 8). The forests and semi-natural areas are composed mainly of sclerophyllous vegetation (35.29 %) and natural grasslands (7.52 %). Finally, wetlands include only inland marshes (26.29 %). Among the three Greek test sites, the Kalodiki Fen is the most balanced in terms of the relative distribution of agricultural areas, forests and wetlands.

Table 7 GR2_Corine level 1 land cover classes

Level1	Name	Area (ha) in 2000	%
2	Agricultural areas	241866.3	30.74%
3	Forests and semi-natural areas	338079.1	42.97%
4	Wetlands	206831.0	26.29%
	Total	786776.4	100.00%

Table 8 GR2_Corine level 3 land cover classes

Level3	Name	Area (ha) in 2000	%
211	Non-irrigated arable land	147179.5	18.71%
242	Complex cultivation patterns	10778.3	1.37%
243	Land principally occupied by agriculture, with significant areas of natural vegetation	83908.6	10.66%
311	Broad-leaved forest	1223.7	0.16%
321	Natural grassland	59175.0	7.52%
323	Sclerophyllous vegetation	277680.4	35.29%
411	Inland marshes	206831.0	26.29%
	Total	786776.4	100.00%

Definition of scale requirements

The site hosts vegetated, aquatic and agricultural land cover types. Of major importance is the patch of calcareous fen that covers only a small area (<1 ha) and is of conservation priority. To accurately map this habitat type, and especially to detect any changes in its cover or possible fragmentation, from the use of very high resolution satellite images is advocated. As with the Kalamas River delta, imagery acquired at any time of year can be used for identifying the aquatic land cover classes but multi-temporal imagery will be needed to support classification of the vegetated and agricultural land cover classes. To detect change in the extent and geometric arrangement of the habitat types, monitoring every six years is recommended.

Pressures and threats

Following the standard data forms of the Natura 2000 sites, a list of the human pressures and threats recorded inside and outside the Greek study site GR2 is given in Table 9. The most important threat for site GR2 seems to be the restriction of the riparian forest because of expansion of agricultural land near the river banks. A reduction in grazing in the area would contribute to the development of the maquis vegetation and an improvement in its ecological condition. The site is moderately endangered by rare species collection for science. Figures are based on year 2000.

Table 9 GR2_Summary of the main human pressures and threats recorded for GR2

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation	I	B	25	-
Grazing	I	C	8	0
Hunting	I	C	5	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Concerning the 9 habitat types of GR2, 23 different threat subcategories have been adapted (see Appendix 1). Seven of these are related to water engineering, management and consumption, six are related to cultivation, agricultural activities and land use, two to tourism and recreational activities, four to forestry and forest use, three to construction works and mining activities, and one to invasive species. Further details on other pressures and threats are included in Appendix 1, as well as the habitats on which their effects are thought to be more intense.

Data availability

Available satellite images for the study site are listed in the following Table.

Table 10 GR2_Summary of main data layers available for GR2 (Elos Kalodiki GR2120002)

Source/Sensor	Data range
QUICKBIRD multi and pan	2006-07-26
ASTER	2006-05-19
Landsat MSS, TM, ETM+ (USGS archive)	1984-2010 (Gap in 1991-1999)

Biodiversity Indicator selection

As with the Kalamas River delta, similar biodiversity indicators will be considered.

Users

As with the Kalamas River delta, management is the responsibility of the Management Institution of Kalamas-Kalodiki.

Main indicator species

The summary of the main indicator species per habitat type for this site is given in the following table.

Table 11 GR2_Summary of the main indicator species per habitat type recorded for GR2

GHC Level 3	GHC Level 4	GHC Level 5	Indicators	ANNEX 1 CODE
				1020
				1050
		5.1.1.1.1		3150
				5420
		5.1.2.1.1	*Cladium mariscus*	7210
				72A0
		6.6.1.1.2	*Salix alba, Salix fragilis*	92A0
		6.6.2.3.1	*Tamarix* spp.	92D0
			Quercus coccifera	934A

3.1.3 GR3: Stena Kalama GR2120004

General description

The Kalamas River Gorge (Stena Kalama) is designated as a SCI (GR2120004) and has a surface area of 1867 ha (Figures 1 a and b). The vegetation of the slopes of Kalamas Gorge has good conservation status. The deciduous woodland found in this site consists of various tree species and the composition of the macchia vegetation is representative of this habitat type at these altitudes (c. 450m a.s.l.). The gorge's slopes are densely covered with mixed broadleaved deciduous and sclerophyllous vegetation with *Carpinus orientalis, Fraxinus ornus, Ulmus campestris Pistatus lentiscus, Quercus pubescens, Q. coccifera, Q. ilex* and *Phillyrea latifolia* occurring. The riparian forest with *Platanus orientalis, Salix alba, S. cinerea & Alnus glutinosa* occupies a zone of 10-30 m width. Finally, stands of *Scirpus holoschoenus* and *Carex* sp. grow along the river near the water. Figures for land cover classes and Habitat Tables are based on year 2000.

Habitat types (Dir 92/43/EEC) and species evaluation

This site includes the gorge around the River Kalamas. The main habitat types are riparian forests with *Platanus orientalis* (92C0) that cover a narrow strip of land parallel to the river bed. The *Salix alba* and *Populus alba* galleries (92A0) are also significant. Due to the steep slope of the gorge, other habitat types are also present in this narrow area including Mediterranean type ecosystems such as macchia and phrygana (5420). The conservation status of all the habitat types evaluated in this site is considered average or poor (conservation status C), thereby indicating a need for immediate site management. The condition of the site should also be closely monitored before it deteriorates.

General Habitat Categories

A wide range of GHCs are present within the site, including cliffs and screes, habitat complexes, other herbaceous, and tree and shrub vegetation categories. On the vegetated inland cliffs and calcareous rocky slopes, chasmophytic communities are present. River complexes (Mediterranean rivers with *Salix alba* and *Populus alba*) occur within the GHC of habitat complexes. Riverine forests of *Salix alba* and *Populus alba*, and *Platanus orientalis* woods are also present on seasonally wet and moist soils along the river, and these could be assigned to the GHC of Forest Phanerophytes/Deciduous (FPH/DEC), while the *Quercus trojana* woods occurring on dry calcareous slopes could be attributed to the same GHC (FPH/DEC).

The GHCs potentially present within the study area, refer to the non Annex I (Dir. 92/43/EC) habitat types of *Pteridium aquilinum* stands (5150), Garrigues of Eastern Mediterranean (5340) and Greek *Quercus coccifera* woods(934A). These are expected to be attributed to one or more of the established system of GHCs within the next few months, following field work and appropriate documentation by our research group. Agricultural areas present are cultivated herbaceous crop (CRO), cultivated woody crops (WOC) and most probably cultivated bare ground (SPA). Urban elements might be attributed to urban artificial (ART) and urban non-vegetated (NON).

Corine Land Cover classes

Agricultural areas are comparatively low (7.57 %) and the area is largely occupied by forests and semi-natural areas (92.43 %) (Table 12). The agricultural areas are composed only of land principally occupied by agriculture, with significant areas of natural vegetation (7.57 %) (Table 13). The forests and semi-natural areas are mainly composed of sclerophyllous vegetation (29.80 %), broad-leaved forests (23.40 %), fixed forests (16.85 %), coniferous forests (11.63%) and transitional woodland shrubs (8.72 %). Among the three Greek test sites, the Kalamas River Gorge is the most forested.

Table 12 GR3_Corine level 1 land cover classes

Level 1	Name	Area (ha) in 2000	%
2	Agricultural areas	137733.9	7.57%
3	Forests and semi-natural areas	1682561.1	92.43%
	Total	1820294.9	100.00%

Table 13 GR3_Corine level 3 land cover classes

Level 3	Name	Area (ha) in 2000	%
243	Land principally occupied by agriculture, with significant areas of natural vegetation	137733.9	7.57%
311	Broad-leaved forest	426005.0	23.40%
312	Coniferous forest	211635.9	11.63%
313	Mixed forest	306771.8	16.85%
321	Natural grassland	36983.3	2.03%
323	Sclerophyllous vegetation	542436.1	29.80%
324	Transitional woodland shrub	158728.9	8.72%
	Total	1820294.9	100.00%

Definition of scale requirements

The site hosts vegetated and aquatic land cover types. The riparian forests present are limited to narrow strips parallel to the river and, at points, their width is only a few meters. To accurately map this elongated shape of the habitat types, and especially to detect any changes in its cover, we suggest that these land cover classes should be extracted from very high-resolution satellite images (i.e., grain less than 1 m). For the riparian forests and other vegetation land cover classes, multi temporal satellite images are preferable as these allow changes in reflectance and derived products (e.g., vegetation indices) to be detected and used for mapping. Monitoring every six years is recommended.

Pressures and threats

Following the standard data forms of the Natura 2000 sites, a list of the human pressures and threats recorded inside and outside the Greek study site GR3 is given in Table 14. Grazing and arable farming largely influence the area and cause detrimental effects to many animal habitats (because of deforestation, uncontrolled water extraction, alterations in vegetation composition, pollution by the overuse of fertilizers and pesticides, river-bank erosion, etc.). Hunting and shooting are the main direct threats to the local fauna, especially migratory birds. Proposals for tourist

development of the area have also been made and this type of development will probably have serious impacts on the whole ecosystem. Figures are based on year 2000.

Table 14 GR3_Summary of the main human pressures and threats recorded for GR3

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation	I	A	4	-
Fertilisation	I	B	4	-
Grazing	I	A	78	-
Grazing	O	A		-
Animal breeding	I	B	1	-
Burning	I	A	40	-
Hunting	I	A	100	-
Hunting	O	A		-
Erosion	O	A		-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Concerning the habitat types of GR3, 21 different threat subcategories have been adapted (see Appendix 1). Seven of these are related to water engineering, management and consumption, three to cultivation, agricultural activities and land use, one to tourism and recreational activities, five to forestry and forest use, four to construction works and mining activities, and one to invasive species.

Data availability

Available satellite images for the study site are listed in Table 15.

Table 15 GR3_Summary of main data layers available for GR3 (Stena Kalama GR2120004)

Source/Sensor	Data range
ASTER	2006-05-19
ASTER	2004-09-11
Landsat MSS, TM, ETM+ (USGS archive)	1984-2010 (Gap in 1991-1999)

Biodiversity Indicator selection

As with the Kalamas River delta and Fen, similar Biodiversity indicators will be considered.

Users

As with the Kalamas River delta and Fen, management is the responsibility of the Management Institution of Kalamas-Kalodiki.

Main indicator species

For this site, Table 16 lists the main indicator species per habitat type.

Table 16 GR3_Summary of the main indicator species per habitat type recorded for GR3

GHC Level 3	GHC Level 4	GHC Level 5	Indicators	ANNEX 1 CODE
				1020
				1021
				1050
		1.3.6.3.2	*Salix alba, Populus alba*	3280
				5150
		6.2.2.8.2		5340
	1.2.2.1		*Potentilla caulescens*	8210
		6.6.1.8.8	*Quercus frainetto, Fagus sylvatica*	9280
		6.6.1.1.2	*Salix alba, Salix fragilis, Populus alba*	92A0
		6.6.1.6.8	*Platanus orientalis*	92C0
			Quercus coccifera	934A

3.2 Partner 4: Alterra Netherlands

3.2.1 NL: Ginkelse, Ederheide&WekeromseZand (NL9801023 + NL3009017)

General description

The Dutch study area for Bio-SOS is located within the Natura 2000 site, the Veluwe (site codes: NL9801023+ NL3009017) in the Province of Gelderland, and falls under the Habitat Directive as well as the Bird Directive. The Veluwe is the largest end moraine in the Netherlands; an undulating sandy landscape that was created during the penultimate glacial period, about 150,000 years ago. The final landscape of alternating sand dune areas, heathlands and dry forests was created by a long history of intensive land use (starting from Celtic fields in Iron Age). Drifting inland sand dunes caused by anthropogenic overexploitation were a serious threat and were battled around 1900 by massive forest plantations. Since then the sand dune area has severely diminished. However, the inland sand dunes of the Veluwe are still among the largest in Europe.

Although the entire Veluwe has a total surface area of 91.200 ha, the selected sites are much smaller. The heathland area Ginkelse and Ederheide covers an area of approximately 1000 ha in size and is known for its large area covered by *Calluna* heath vegetation. The main Annex Habitat types for this study area are4030 European dry heaths (4030), Dry sand heaths with *Calluna* and *Genista* (2310) and Inland dunes with open *Corynephorus* and *Agrostis* grasslands (2330). Ginkelse and Ederheide is managed by the Ministry of Defense. The Wekeromse Zand, an active inland sand dune area 3 km north of the Ginkelse & Ederheide, has a total area of approximately 500 ha and is managed by Geldersch Landschap. About 100 ha of this area is covered by open space with active inland sand dunes. The active inland sand dunes are of European importance. The main Annex Habitat types for of the Wekormse Zand are Dry sand heaths with *Calluna* and *Genista* (2310), Inland dunes with open *Corynephorus* and *Agrostis* grasslands (2330), Species-rich *Nardus* grasslands (6230), Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrub layer (9120) and Old acidophilous oak woods with *Quercus robur* on sandy plains (9190). The most important pressure to the biodiversity of the above-mentioned habitats is the nitrogen deposition caused by intensive agriculture in the region, which causes the growth of moss (*Campylopus introflexus*), grass (*Molinia caerulea*), and shrub (*Rubus fruticosus* spp.), and tree encroachment (*Pinus sylvestris* and *Betula pendula*). Specific pressures for Ginkelse & Ederheide are also caused by recreation. The conservation status of all Annex I habitat types (17 in total) of the Veluwe is bad (-) or really bad (--). The main management objectives are to obtain a good heathland structure, prevent encroachment and loss of sand dunes, avoid fragmentation and provide optimal environmental conditions for heath and sand dune fauna. Annex II habitat species observed in the site include amongst others: nightjar (*Caprimulgus europaeus*), Eurasian wryneck (*Jynx torquilla*), tawny pipit (*Anthus campestris*), stonechat (*Saxicola torquata*), wheatear (*Oenathe oenathe*) and the red-backed shrike (*Lanius collurio*).

Table 17 NL_Upper left and lower right coordinates of the study area (including bufferzone of 3 km)

Projection: WGS_1984_UTM_Zone_31N	
Upper left x,y co-ordinates (ULxy)	679500, 5780000
Lower right x,y co-ordinates (LRxy)	691500, 5764000

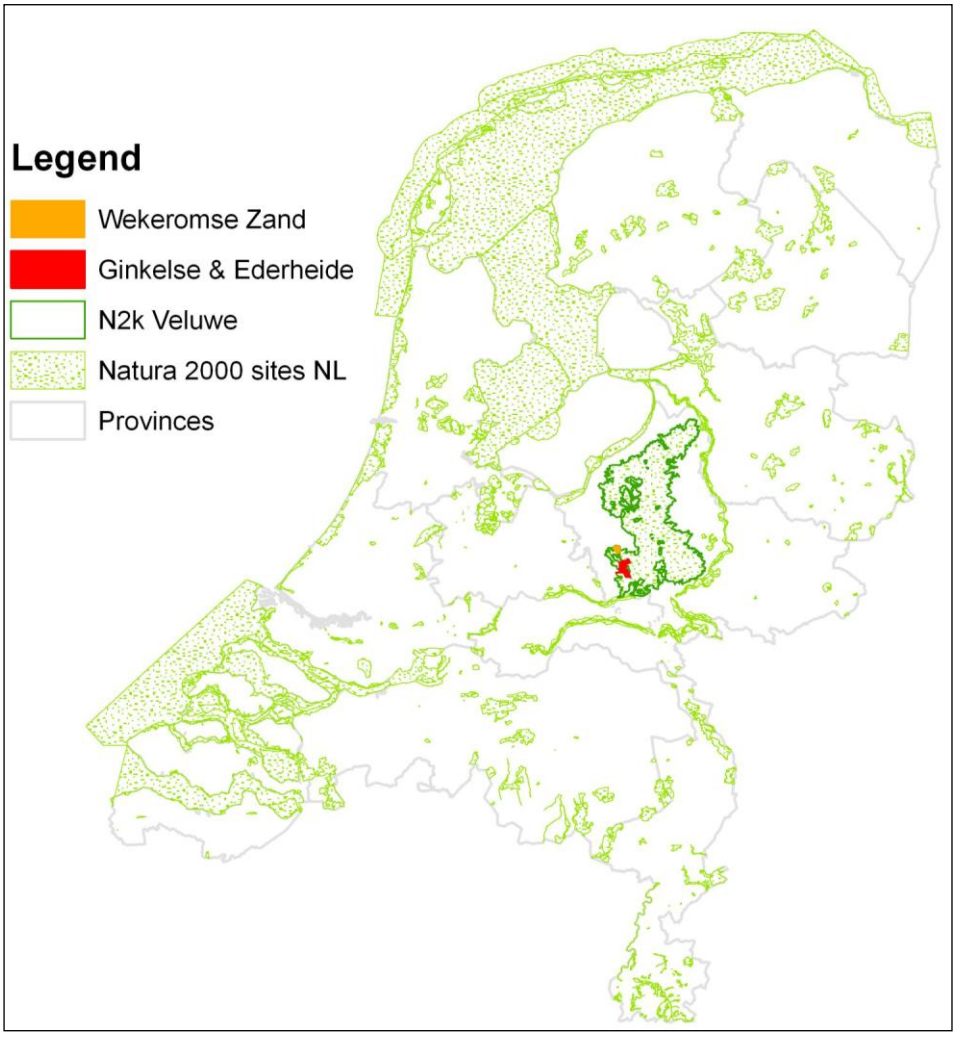


Figure 2 NL_Location of the Dutch study area Ginkelse - Ederheide & Wekeromse Zand within Natura 2000 Veluwe in the centre of the Netherlands

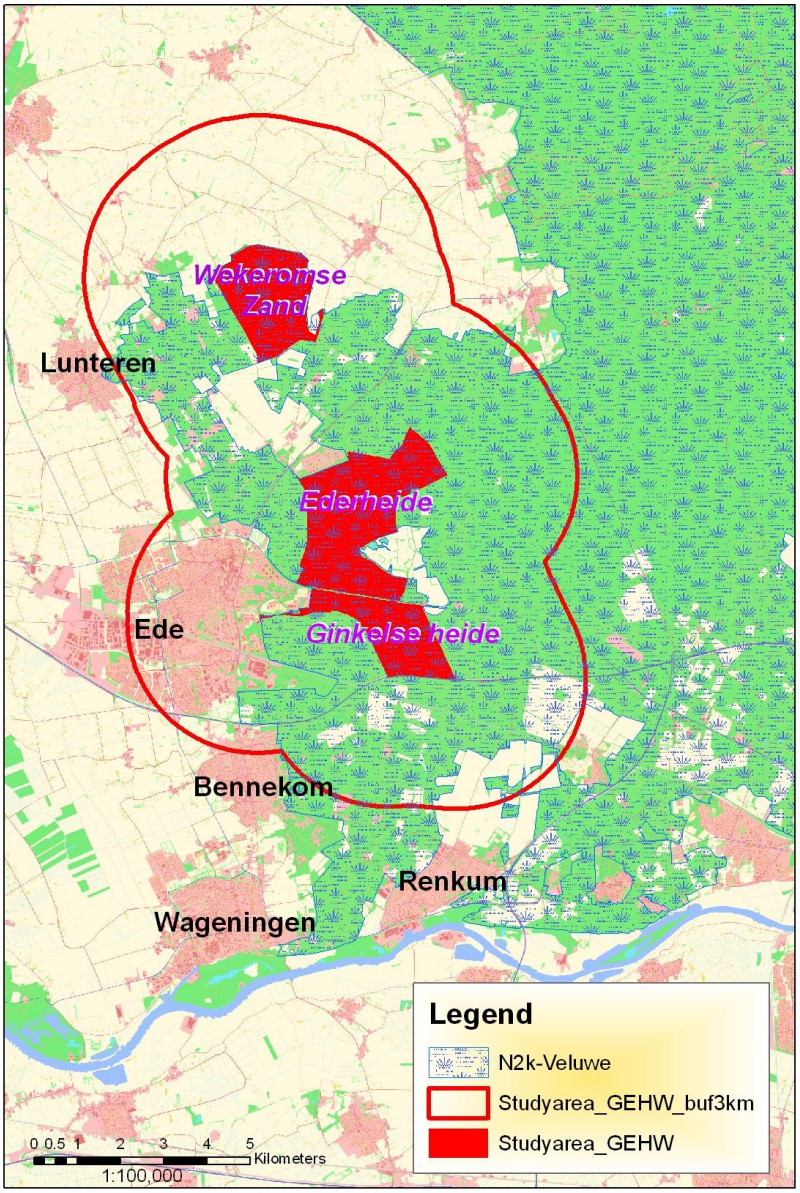


Figure 3 NL_Exact location of the Dutch study area Ginkelse - Ederheide & Wekeromse Zand with a bufferzone (redline) of 3 kilometres

Habitat types (Dir. 92/43/EEC) and species evaluation

Table 18 NL_list of habitat types

Habitats of main concern		2330	2310, 4030	6230*	9120, 9190
		Inland dunes with open *Corynephorus* and *Agrostis* grasslands	Dry sand heaths with *Calluna* and *Genista* (2310), Eur. dry heaths (4030)	Species-rich *Nardus* grasslands, on silicious substrates	Atlantic acidophilous beech forests with *Ilex* (9120), Old acidophil. oak woods with *Q. robur* on sandy plains (9190)
Spatially explicit pressures		Nitrogen deposition leading to moss encroachment (*Campylopus introflexus*), and so sand fixation. Tree encroachment (*Pinus sylvestris*)	Nitrogen deposition and local dog defecation leading to grass (*Molinia caerulea*), shrub (*Rubus fruticoses* spp.) and tree encroachment (*Pinus sylvestris* and *Betula pendula*).	Nitrogen deposition leading to grass encroachment and loss of lichens	
Conservation status		-- (v. low quality) C	-- (v. low quality) C	-- (v. low quality) C	- (low quality) B
Management target		Maintain range, improve area coverage and quality.	Maintain range, improve area coverage and quality.	Maintain range, improve area coverage and quality.	Improve area coverage and quality.
Management measures		Bring back wind dynamics to sand dunes by reducing forests and fixation by *Campylopus introflexus.* Tree-felling and ploughing	Reduce fragmentation, improve heathland structure, openness landscape, improve environmental conditions for fauna. Sod cutting, mowing, sheep herds	Try to improve quality?	Forest management to improve quality
CBD/SEBI indicators	Status and trends	Habitat coverage	Habitat coverage	Habitat coverage	Habitat coverage
	Ecosystem integrity	Habitat loss, fragmentation	Habitat loss, fragmentation	Habitat loss, fragmentation	Habitat loss, fragmentation
	Threats to biodiversity	Nitrogen deposition. Invasive taxon *Campylopus introflexus*	Nitrogen deposition. Encroachment	Nitrogen deposition. Encroachment	Nitrogen deposition. Encroachment
Phenology image acquisition		July & Winter	July & Winter	July	July & Winter
Ancillary point data		Bird nesting sites?	Bird nesting sites?	Bird nesting site?	Bird nesting sites?

General Habitat Categories

Table 19 NL_Annex I habitat types and GHCs

Annex I Habitat types (Natura 2000)			
Code	**Name**	**GHC**	**GHC description**
2310	Dry sand heaths with *Calluna* and *Genista*	6.3.2.1.3	GHC (BioHab): LPH/EVR + moist sands + expert knowledge + indicator species Env. Qualifier: 5.2 Distribution: ATN+CON+ATC Mapping rules: Many areas will be limited in extent and may be included into dune systems within the 25 ha unit. Examples need to be checked. May include inland dunes as well, so all dune systems in ATN + ATC, but probably so rare in CON as not to be included here. Indicators: *Calluna vulgaris, Genista anglica*
2330	Inland dunes with open *Corynephorus* and *Agrostis* grasslands	5.2.1.5.2	GHC (BioHab): CHE/THE + scrub below 30% + inland dunes + dry sandy soils + expert knowledge. Env. Qualifier: 7.3 Distribution: NEM+ATN+CON+ATC+PAN Mapping rules: Inland siliceous dunes. -may be mixed with 3210. Indicators: *Corynephorus canescens, Carex arenaria*
4030	European dry heaths	6.2.2.2.4, 6.3.2.1.5	GHC (BioHab): LPH/ EVR or SCH/ EVR + moist acid soils + wide range of conditions + better definition. Env. Qualifier: 5.2 Distribution: ALN+BOR+NEM+ATN+ALS+CON+ATC+PAN+LUS+MDM+MDN Mapping rules: ALN + BOR below 700m + NEM + CON + ATC + all ATN below 500m + ALS over 1500m + MDM over 1800m below 700m LUS below 800 m. Indicators: *Calluna vulgaris, Vaccinium myrtillis, Genista anglica, Erica cinerea*
6230	Species-rich *Nardus* grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	5.2.2.6.3, 5.2.2.7.2	GHC (BioHab): LHE/CHE + moist neutral / acidic soils + *Nardus* + wide range of species. If in BOR + in Scandinavia then refer to 6270 Env. Qualifier: 5.2+5.3 Distribution: ATN+ALS+CON+ATC+LUS+MDM+MDN Mapping rules: Making rules for this class is difficult because it depends on interpretation of the term “species rich”. There are two forms of this habitat, a lowland and upland type. More species rich grasslands with *Nardus* are rare in GB but rather common in continental Germany and at quite high elevations in the Alps and other high mountains. The comment in the text suggests that irreversibly degraded grasslands should be excluded which probably means many of those in GB. The rules below cover the whole range but mean that very different frequencies are likely to be involved. Mapping rules: Siliceous soils + rocks ALN + BOR below 700m + NEM + ATC all altitudes + ATN below 900 m + CON + ALS + LUS over 700m + MDM over 700m. Indicators: *Nardus stricta, Antennaria dioica, Arnica alpina, Gentiana spp., Campanula spp.*
9120	Atlantic acidophilous beech forests with *Ilex*	6.6.1.5.2	GHC (BioHab): FPH/DEC + *Fagus* usually over 70%+ *Ilex* and/or *Taxus* + most acid soils + local guidance. Env. Qualifier: 5.2 Distribution: CON+ATC Mapping rules: ATN southern classes only and within 100km of coast + ATC within 100km of coast + Acid brown soils + *Fagus*. Indicators: *Fagus sylvatica* over 70%, *Deschampsia flexuosa, Pteridium aquilinum, Vaccinium myrtillis*
9190	Old acidophilous oak woods with *Quercus robur* on sandy plains	6.6.1.5.2	GHC (BioHab): FPH/DEC *Quercus robur* + *Betula* 30-70 % + old forests + Acid moist podsols Env. Qualifier: 5.2 Distribution: NEM+ATN+CON+ATC+PAN+LUS Mapping rules: 100km from coast of Estonia to the Netherlands + Podsols + *Quercus robur / Betula*. Indicators: *Quercus robur, Betula* spp., *Deschampsia flexuosa*, *Pteridium aquilinum*

Table 20 NL_Overview fieldwork activities Eder Heide and Wekeromse zand April-July 2008

based on systematic point sampling during HABISTAT project (Alterra).

Ginkelse and Eder Heide			**Wekeromse Zand**		
Code	Description	Nr Samples	Code	Description	Nr Samples
Fcps	Forest coniferous	3	Fcps	Forest coniferous	2
Fd	Forest deciduous	1	Gpnd	Grassland permanent	4
Gpnd	Grassland semi-natural permanent	9	Hdca	Heathland dry *Calluna* adult	1
Hdca	Heathland dry *Calluna* adult	11	Hdcm	Heathland dry *Calluna* mixed	1
Hdcm	Heathland dry *Calluna* mixed	22	Sb--	Sand bare	3
Hdco	Heathland dry *Calluna* old	7	Sfg-	Sand fixated grasses	6
Hdcy	Heathland dry *Calluna* young	28	Sfgm	Sand fixated by grass and mosses	7
Hdey	Heathland dry *Erica* young	1	Sfmc	Sand fixated by moss *Campylopus*	2
Hgdd	Heathland grass encroached *Deschampsia*	9	Sfmp	Sand fixated by moss *Polytrichum*	8
Hgmd	Heatlland grass encroached *Molinia*	7	Wou-	Unvegetated oligotrophic water	1
Hsr-	Heathland shrub encroaches *Rubus*	1	**total**		36
Sb	Sand bare	2			
Sfgm	Sand fixated by grass and mosses	2			
total		104			

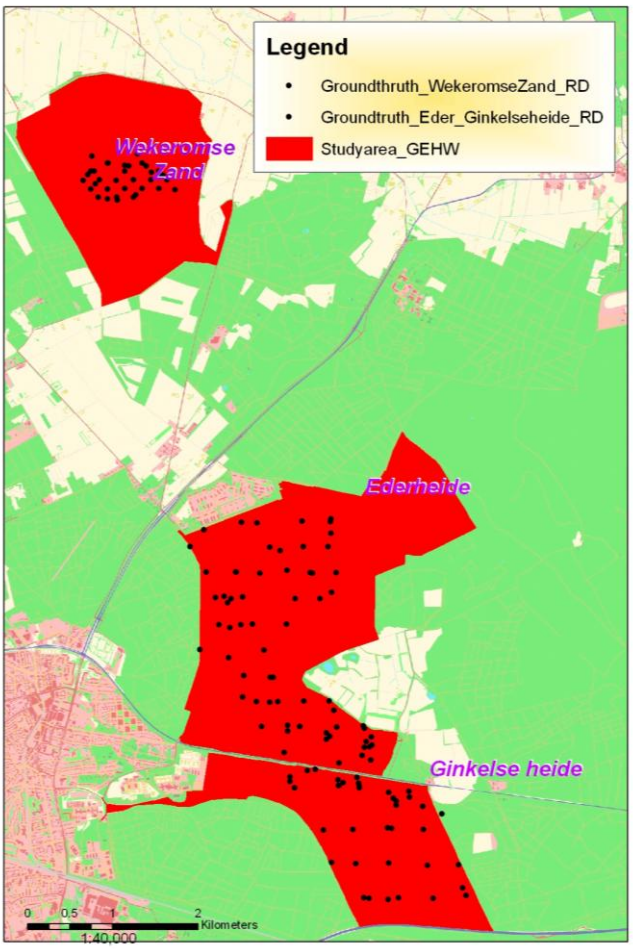


Figure 4 NL_Sampling points of 2008 fieldwork

Table 21 NL_General habitat categories or life forms encountered during fieldwork in the study site in 2008

GHC/life forms encountered		Species
SPV	Sparsely vegetated	Sand, Earth, Litter
CRY	Cryptogams	*Campylopus introflexus, Polytrichem piliferum*
CHE	Caespitose hemicryptophytes	*Molinia caerulea, Deschampsia flexuosa , Agrostis vinealis, Festuca* spp., *Corynephorus canescens, Carex pilulifera, Juncus squarrosus*
SCH	Shrubby chamaephytes (5-30 cm)	*Calluna vulgaris, Erica tetralix, Rubus fruticoses*
LPH	Low Phanerophytes (0.3-0.6 m)	*Calluna vulgaris, Rubus fruticosus*
MPH	Mid Phanerophytes (0.6 – 2m)	*Pinus sylvestris, Betula pendula*
TPH	Tall Phanerophytes (2-5 m)	*Pinus sylvestris, Betula pendula*
FPH	Forest Phanerophytes (> 5 m)	*Pinus sylvestris, Betula pendula*

Definition of scale requirements

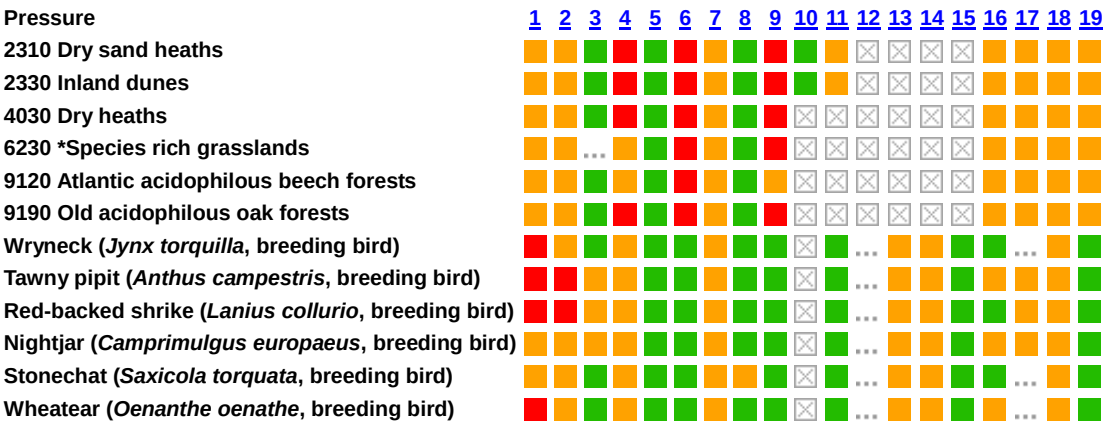
Analysis should preferably take place at a scale of 1: 5000. The minimum mapping unit should be around 400 m^2. For cartographic representation, a scale of 1:10.000 is the minimum. This scale is also used by the Ministry of Defense for cartographic representation.

The use of multi-temporal imagery is important for discrimination because of marked differences between species/communities at different times of year. Illustrations of the yearly profile of Normalised Difference Vegetation Index (NDVI) and end member spectra for a range of land uses and habitat categories are given in Appendix 2. However, to summarise, vegetation reaches its maximum biomass around July. Heather blossoms from mid-August to mid-September. Some grasses such as *Deschampsia flexuosa* remain green during winter time. All broadleaved forest is winter deciduous. Monitoring of the habitats of the Dutch study area would preferably be undertaken every 6-year s. However for management purposes a 3-year cycle would be optimal.

Pressures and threats

A summary of the pressures and threats is given below. Note that the estimates of the areas affected are uncertain but will be refined during the course of the BIO-SOS project.

Table 22 NL_Pressures and threats



Very sensitive Sensitive Not sensitive	1: Loss of area 2: Fragmentation 3: Acidification 4: Eutrophication 5: Reduced salt content in water 6: Salinization 7: Pollution 8: Desiccation 9: Increasing soil moisture 10: Changing speed of waterflow 11: Inundation regime 12: Soil disturbance 13: Noise disturbance 14: Light disturbance 15: Disturbance by vibration 16: Visual disturbance 17: Mechanical disturbance (e.g., military, recreation) 18: Disturbance population dynamics 19: Disturbance species composition (e.g., introduction)

Table 23 NL_Summary of the main human pressures and threats recorded for NL

Type of activity	In/out	Pressure intensity	% area	Influence
1. Land use change	O		5	+
2. Fragmentation	O		20	+
3. Acidification	I			-
4. Eutrophication	I		90	+
5. Reduced salt content in water				-
6. Salinization	I		80	+
7. Pollution	I		10	+
8. Desiccation				-
9. Increasing soil moisture	I		50	+
10. Changing speed of waterflow				-
11. Inundation regime				-
12. Soil disturbance	I		30	+
13. Noise disturbance	I		30	+
14. Light disturbance	I		10	+
15. Disturbance by vibration	I			-
16. Visual disturbance	O		20	+
17. Mechanical disturbance	I		15	+
18. Disturbance population dynamics	I			-
19. Disturbance species composition	I		10	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

A summary of the main datasets available for the Netherlands test sites are given in Table 24. Additional information can be found in Appendix 2, Figure A2.1 and Figure A2.2.

Table 24 NL_Summary of main data layers available for the NL case study site

Source/Sensor	Data range
Digital aerial photographs	1982*, 1989*, 1992*, 1995*, 2000, 2003, 2005, 2006, 2008
AHS-160 Hyperspectral imagery (2.4 m)	2007-10-07
CHRIS-PROBA (5 angles, 18 m)	2007-10-22
MODIS 16-day NDVI composites (250 m)	2001, 2003, 2006, 2008
Landsat (30 m)	1984-2010
National Land use databases – LGN (25 m)	LGN1 (1986), – LGN6 (2008)**
Historical Land use database - HGN (50 m)	1900 ****
Historical Land use database – HGN (50 m)	1960, 1970, 1980, 1990***
Digital topographic maps (1:10.000)	4 yearly update #
Soil database 1:50.000	years? ****
Dutch Elevation Model AHN-1 (1p /16m2) – precision:15 cm	2003
Dutch Elevation Model AHN-2 (10 p / m2) – precision: 5 cm	2010## (available soon)
Vegetation maps 1:10.000	1997, 2009*
Vegetation structure maps 1:10.000	2003, 2009*
Management database 1982 -2006 (based on AP interpretations	

* Only Ginkelse and Ederheide, ** € 0,10 / km^2, *** € 0,15 / km^2, **** € 0,30 / km^2, ## € 0,30 / ha, # € 500 euro / year

Biodiversity indicator selection

Indicators that are of interest for the Dutch case study (NL) are:

- SEBI indicator Habitats of European interest particularly in relation to the conservation status of heathland and inland sand dunes. For heathland, this is related to the structure (age) composition of heathland vegetation, which could be identified by using LiDAR, and grass encroachment by using hyperspectral and or very high resolution satellite imagery (Quickbird or Worldview-II). For inland dunes, indicators relate to the amount of open sand and the coverage by invasive moss *Campylopus introflexus*.
- CBD indicator Trends in the extent of selected biomes, ecosystems & habitats
- CBD indicator Invasive species (*Campylopus introflexus*)
- CBD indicator Sustainable use; N-balance (looking at moss, grass and shrub encroachment) and also changes in land use around Natura 2000 site (e.g., agricultural area).

Users

The Veluwe as a whole (Natura 2000 site NL9801023+ NL3009017) has many different owners, namely the Forestry Services (SBB), Foundation Natural Heritage (Natuurmonumenten), the Dutch royal family (Domeinen), the Ministry of Waterworks (Rijkswaterstaat), provincial landscape (Geldersch Landschap) and the Ministry of Defense (Defensie vastgoed). For the Dutch case study, only the Ministry of Defense (for the heathland area Ginkelse and Ederheide) and Geldersch Landschap (for the inland sand dune area of Wekeromse Zand) will be considered.

Main management objectives are to:

- Maintain the heath and sand dune vegetation in its optimal condition
- Prevent moss, grass, shrub and tree encroachment
- Prevent sand dune loss

- Avoid fragmentation
- Provide optimal environmental conditions for heath and sand dune fauna
- Promote natural dynamics (e.g., drifting sand dunes).

3.3 Partner 8 and Partner 1: UNIBA and CNR-IGV Italy

3.3.1 IT1: Valloni e steppe pedegarganiche IT9110008

General Description

The Gargano promontory (northern part of Apulia Region, SE Italy) rises steeply from the Tavoliere lowland up to a broad plateau with an altitude of over 900 m a.s.l. The substrate comprises carbonate platform and basin chert-carbonate rocks (upper Jurassic-Cretaceous). These are covered with thin alternating tracts of Neogene and Quaternary deposits. Gargano is one of the more intensely karstified areas in southern Italy with a high density of dolines. The landscape is typically low-relief karst but also presents high carbonate cliffs along narrow karstic canyons or near to the sea.

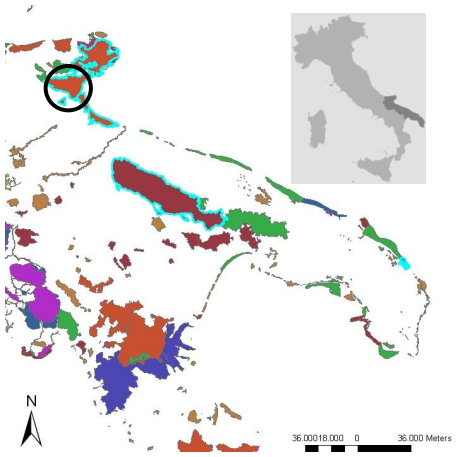


Figure 5 IT1_Location map of IT1 within the context of Natura 2000 sites and other protected areas

Valloni e steppe pedegarganiche (SCI; IT9110008 and SPA; IT9110039) is located on the south-facing slopes of the Promontory covering 29817 ha ranging from 5 to 644 m a.s.l. (Figure 5). Along this altitudinal gradient, the Macrobioclimate sensu Rivas-Martinez *et. al.*. (2004) varies from Mediterranean (at lower altitude) to Temperate. The bioclimate of San Giovanni Rotondo (575 m a.s.l.) is temperate with mesotemperate thermotype and subhumid ombrotype (Fanelli *et. al*. 2001).

The vegetation consists mainly of Mediterranean steppe grasslands dominated by *Stipa austroitalica*, *Festuca circummediterranea*, *Scorzonera villosa* and *Syderitis italica*, and is characterized by the presence of *Micromeria juliana* and *Cytisus decumbens*. This vegetation covers over 42 % of the area. The area is renowned for the presence of numerous *Orchid* species. Steppe environments have been used for livestock grazing and their unique floristic richness is considered the product of a long co-evolutionary process between man and nature. The disruption of this equilibrium (e.g., degradation, fragmentation, agriculture intensification/expansion) is considered a serious threat for steppe biodiversity.

The rupicoulous vegetation of Gargano is of enormous phytogeographycal importance because of the presence of several species whose main distribution areas lie on the opposite side of the Adriatic Sea. This vegetation type includes a few rare,

endemic or endangered plant species (e.g., *Campanula garganica*, *Lomelosia crenata* subsp. *dallaportae*, *Inula verbascifolia*, *Ephedra nebrodensis*). The communities occurring in the Gargano are mainly concentrated on the large fault planes that border the promontory.

Both the geographical location and the topographic variety, which is attributed to its karstic morphology and the presence of ravines (valloni), provide a rather heterogeneous landscape mosaic, composed of several vegetation types. Among these scrub formations, sometimes with *Euphorbia dendroides* and small woody patches (*Cyclamino hederifolii-Quercetum ilicis*; Biondi *et. al.*. 2004) occur.

The study site is located within the larger SPA "Promontorio del Gargano" (IT9110039) as well as the Gargano National Park. It also contains one of the largest Important Birds Areas in Italy, IBA230M "*Promontorio del Gargano e Zone umide della Capitanata*" together with site BIO_SOS site IT2 (IT9110005).

Habitat types (Dir 92/43/EEC) and species evaluation

According to the 92/43/EEC Directive, four habitat types are identified within the IT1 study site (Table 25).

Table 25 IT1_Habitat types (Annex I 92/43/EEC Directive)

Annex I code	Description
6220*	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea
62A0	Eastern sub-mediteranean dry grasslands (Scorzoneratalia villosae)
8210	Calcareous rocky slopes with chasmophytic vegetation
5330	Thermo-Mediterranean and pre-desert scrub

The dry grasslands were classified within the priority habitats "*Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea*" (6220*), that covers approximately 42 % of the site. Recently, grasslands of Gargano dominated by *Stipa austroitalica* (*Sideritido italicae-Stipetum austroitalicae*) were assigned to the alliance *Hippocrepido glaucae-Stipion asutroitalicae* of the *Scorzonero-Chrysopogonetalia* order (Fanelli *et. al.* 2001; Forte *et. al.* 2005). Consequently, the Italian Interpretation Manual of the Habitat Directive (Biondi and Blasi, 2009) ascribed this vegetation type to the category "*Eastern sub-Mediterranean dry grasslands (Scorzoneratalia villosae)*" (cod. 62A0). *Stipa austroitalica*, the dominant species, is a priority species according to Annex II of 92/43/EEC. The chasmophytic communities of Gargano (*Aubrieto italicae-Campanuletum garganicae*, *Centaureetum subtilis*, *Scabiosetum dallaportae* and *Pimpinello tragii-Inuletum verbascifoliae*) have been arranged within the trans-Adriatic order *Centaureo kartschianae-Campanuletalia pyramidalis* (Di Pietro and Wagensommer 2008). The rupicolous vegetation is included within the habitat "*Calcareous rocky slopes with chasmophytic vegetation*" (8210), and covers an estimated 25 % of the site. Scrub formations, with an estimated cover of only 6%, were included in the habitat type: "*Thermo-Mediterranean and pre-desert scrub*" (5330).

General Habitat Categories

General Habitat Categories (GHC) characterizing the study site and which uniquely correspond to Annex I Habitat types according the EBONE D4.2 Rule based system for Annex I habitats (Bunce *et. al.*. 2010) are reported in Table 26. There is no unique correspondence between Annex 1 5330 Habitat type and GHCs, therefore the GHCs potentially present are 6.2.2.8.1, 6.3.2.8.3 and 6.4.2.6.3, even though GHC 6.2.2.8.1 is the most likely to be present and is reported in Table 26.

Table 26 IT1_ Annex I Habitat types (Natura 2000)

Code	Name	GHC	GHC description
6220*	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	5.2.1.7.2	GHC (BioHab): CHE/THE + xeric + calcareous + critical species + expert knowledge. Env. Qualifier: 8.4 Distribution: ALS+PAN+LUS+MDM+MDN+MDS Mapping rules: Although included in grasslands the signal could be confused with fallow and sparsely vegetated depending on the proportion of bare ground. Calcareous soils. MDM below 800m + MDN below 1200m + MDS below 1600m. Indicators: ***Brachypodium distachyon,*** *Brachypodium retusum, Stipa spp.* **6220** Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*
62A0	Eastern sub-mediteranean dry grasslands (Scorzoneratalia villosae)	5.2.2.13.3	GHC (BioHab): LHE/CHE + xeric + indicators Env. Qualifier: 7.3 Distribution: PAN+MDN+MDS Mapping rules: East of Italy to the Balkans below 300m + PAN below 300m. Indicators: *Bromus erectus, Carex humilis* **62A0** Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)
8210	Calcareous rocky slopes with chasmophytic vegetation	1.2.2.1	GHC (BioHab): Inland cliff + limestone rocks + chasmophytes + LHE + CHE + LHE/CHE+SCH/EVR+ TER + possible HCH. Distribution: ALN+BOR+NEM+ATN+ALS+CON+ATC+PAN+LUS+MDM+MD+MDS Mapping rules: Calcareous + limestone rocks. Indicators: ***Potentilla caulescens,*** *Ramonda myconi (Pyrenees only), Cystopteris fragilis,* *Asplenium trichomanes, Asplenium viride, Woodsia glabella*. **8210** Calcareous rocky slopes with chasmophytic vegetation
5330	Thermo-Mediterranean and pre-desert scrub	6.2.2.8.1	GHC (BioHab): LPH/EVR+ xeric soils + indicators Env. Qualifier: 8.3+8.4 Distribution: MDS Mapping rules: MDS below 200m. southern classes only Indicators: *Euphorbia dendroides, Periploca laevigata,* ***Chamaerops humilis,*** *Genista* *spp.* **5330** Thermo-mediterranean and pre-desert scrub

Corine Land Cover classes

The Corine Land Cover classes (CLC) recorded in the study site and their respective cover percentages are listed in Table 27 in decreasing order of cover. Figures for land cover classes are based on a regional LC map (1:5000) from an ortophoto dated 2006.

Table 27 IT1_Corine Land Cover classes level 3

CLC3		Area %
211	Non-irrigated arable land	33.111
321	Natural grasslands	25.330
223	Olive groves	16.276
324	Transitional woodland shrub	9.602
323	Sclerophyllous vegetation	4.145
311	Broad-leaved forest	2.746
314	Grasslands with trees	1.436
121	Industrial or commercial units	1.308
332	Bare rocks	1.059
333	Sparsely vegetated areas	1.052
222	Fruit trees and berry plantations	0.762
131	Mineral extraction sites	0.712
122	Road and rail networks and associated land	0.690
212	Permanently irrigated land	0.306
241	Annual crops associated with permanent crops	0.217
	Other	0.663

The dominant landscape elements are non irrigated arable lands and natural grasslands and these collectively occupy 55 % of the area. Olive groves (16.3 %), which are widespread in the Gargano area, and sclerophyllous vegetation (4.1 %) also occur. Landscape elements of the other CLC classes (e.g., broad-leaved forests, along the dry valleys (“Valloni”) that cut the south-facing slopes of the promontory) are also present. The Corine Land Cover importance diversity curve is reported in Appendix 2, Figure A2.3.

Definition of scale requirements

Scale requirements for habitat mapping in terms of grain (sensor resolution) are both high and very high. Such resolutions are needed to obtain habitat maps at 1:5000 or lower (for within habitat patch monitoring) that can be aggregated for the entire site (1:10000 1:25000 without losing information).

The phenological peaks vary across the study area depending on altitude. For the dominant vegetation type (grasslands with *Stipa austroitalica* the peak of biomass is, on average, reached between April and May. The phanerophytic vegetation is comprised of both deciduous and evergreen communities because of the range of altitude. Consequently, a second period of satellite observation during winter months is needed to assist classification. Monitoring activities could be carried out every three years.

Pressures and threats

A summary of the main human pressures and threats recorded inside and outside the IT1 site is given in Table 28.

Table 28 IT1_Summary of the main human pressures and threats in IT1

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation, agricultural activities (Ploughing)	I	A	20	-
Cultivation, agricultural activities (Establishment of plantations)	I	A	30	-
Cultivation, agricultural activities (abandonment of grazing)	I	A	20	-
Cultivation, agricultural activities (excessive livestock numbers)	I	B	5	-
Cultivation, agricultural activities (fire impact)	O	A	10	
Forestry and forest use (Plantation of non-autochthonous woods)	I/O	B	5	-
Forestry and forest use (Forest wildfires)	I	B	5	-
Construction works and mining activities (Quarrying)	I	A	30	-
Construction works and mining activities (Wind and solar farms for alternative energy production)	I	A	5	-
Natural hazards (Occurrence isolated or at distribution boundaries)	I	A	60	-
Natural hazards Climatic impact (e.g.,, below-average precipitation for many years)	I	C	20	-
Poaching	I	B	50	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

A summary of remote sensing images already available at CNR for the IT1 site are listed in Table 29. A 2008 1:5000 land use image is already available and other ancillary data (e.g., vegetation map, animal species distribution, phytosociological releves) are currently being collected from different bodies.

Table 29 IT1_Remote sensing images already available for IT1

Source/Sensor	Data range	Source/Sensor	Data range
Landsat LTM	1986-05	Landsat TM 5	1998-08
Landsat TM 5	1986-10	Landsat TM 5	1999-06
Landsat TM 5	1986-08	Landsat ETM 7	1999-08
Landsat TM 5	1995-08	Landsat TM 5	1999-09
Landsat TM 5	1995-10	Landsat ETM 7	1999-10
Landsat TM 5	1996-09	Landsat TM 5	2000-01
Landsat TM 5	1996-11	Landsat ETM 7	2000-07
Landsat TM 5	1997-05	Landsat ETM 7	2000-08
Landsat TM 5	1997-09	Landsat ETM 7	2001-08
Landsat TM 5	1997-10	Landsat ETM 7	2003-05
Landsat TM 5	1998-06	Landsat TM 5	2004-04
Landsat TM 5	1998-07	Landsat TM 5	2004-08

Biodiversity indicator selection

Referring to the list of indicators included in BIO_SOS Deliverable 2.1, Biodiversity Indicators (sensu CDB and SEBI 2010) selected for monitoring the study site IT1 are:

- Habitat of European interest (presence and extent)
- Abundance and Distribution of Selected Species
- Fragmentation of natural and semi-natural areas

As far as the Abundance and Distribution of Selected Species indicator is concerned, a detailed checklist is being compiled with reference to animal species in order to select those species for which analytical data exist which are either regarded as priority species or are recognised of keystone importance in food webs.

Users

The main user for site IT1 is the Regional authority of Puglia, which is responsible for compliance with the Habitat and Bird Directives. They have already indicated their monitoring priorities in the SLA and keep in constant contact with the project with regard to focal species selection.

Main indicator species

The users have already indicated a few bird species (i.e. Lesser kestrel (*Falco naumanni)*, Lanner falcon (*Falco biarmicus feldeggi*), Egyptian vulture (*Neophron percnopterus*) and Eurasian eagle-owl (*Bubo bubo*)) negatively affected by pressures leading to habitat degradation and perturbation (*sensu* Art, 6, 92/43/EEC Directive) caused both by agriculture intensification/expansion and forest plantations at the expenses of natural habitats, as well as industrial expansion.

3.3.2 IT2: Zone umide della Capitanata-Paludi presso il Golfo di Manfredonia IT9110005

General description

The Zone umide della Capitanata-Paludi presso il Golfo di Manfredonia is located in the Northeastern part of the Puglia Region (Figure 6). This area falls within the boundaries of the Site of Community Interest (SCI; IT 9110005) Zone umide della Capitanata, of the Special Protection Area (SPA; IT9110038) Paludi presso il Golfo di Manfredonia and of the SPA Saline di Margherita di Savoia (IT911006). This site is partially enclosed within the Gargano National Park. The SCI and SPA have a surface area of 14.077 and 14.437 ha, respectively.

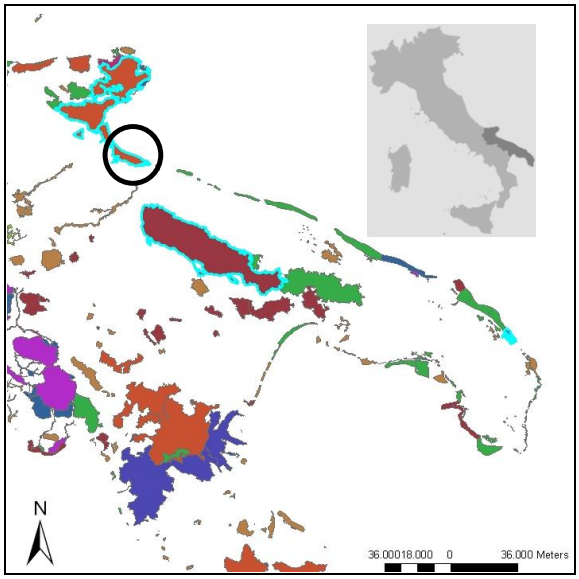


Figure 6 IT2_Location map of the IT2 study site within the context of Natura 2000 sites and other protected areas

As with the Valloni e steppe pedegarganiche (IT9110008), the Zone umide della Capitanata-Paludi presso il Golfo di Manfredonia is also classified as a Ramsar site and Important Bird Area (IBA 230M). It is one of the largest components of the Mediterranean wetland system, crucial to support several water bird species during annual migrations. A large part of the area is covered with active or partially abandoned cultivations. Agricultural areas occupy a wide area that was formerly (until the 1950s) covered by coastal lagoons and subsequently reclaimed for agricultural use. The perennial salt-marshes communities occurring are characterized by succulent chenopodiaceous dwarf shrubs, which are included in the *Sarcocornietea fruticosae*. Annual pioneer communities rich in glasswort and other small succulent plant species of salt marshes, usually appearing during the late summer-autumn period, are represented by the *Thero-Salicornietea*. Perennial halophytic sub-halophilous communities of salt marshes belong to the class *Juncetea maritimi*. These plant communities are characterized by *Juncus maritimus*, *Juncus acutus* and *Carex* sp. that grow in shallow waters with low salinity. Areas prone to waterlogging and with deep and muddy soils characterized by low salinity are colonized by subhalophylous *Phragmites australis* communities. *P. australis* forms almost

monophytic communities that are widely distributed in the area. This is an invasive species which spreads easily after cutting or fire.

Specific human pressures on fragile ecosystems are mainly caused by habitat destruction associated with crop area expansion, agricultural activities (diffuse pollution, water contamination, water withdrawal), hunting and poaching, alien species (fish farming), insect control (mosquitoes) and most recently by changes in the drainage regime which has caused water logging of sub-coastal *Salicornia* dominated habitats.

Habitat types (Dir 92/43/EEC) and species evaluation

According to the 92/43/EEC Directive, six habitat types are identified within the IT2 (Table 30).

Table 30 IT2_Habitat types (Annex I 92/43/EEC Directive)

Annex I code	Habitat
1150*	Coastal lagoons
1210	Annual vegetation of drift lines
1310	*Salicornia* and other annuals colonizing mud and sand
1410	Mediterranean salt meadow (*Juncetalia maritimi*)
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
1510*	Mediterranean salt steppes (*Limonietalia*)

The priority habitat types are coastal lagoons (1150*) and Mediterranean salt steppes (*Limonietalia*) (1510). For some natural or semi-natural vegetation types, such as the widespread communities dominated by *P. australis* , a habitat type cannot be associated (*sensu* dir 92/43/EEC). Other semi-natural or anthropogenic environments are pastures, uncultivated land, and arable land. Habitat types 1150*, 1310, 1420 and 1510* are threatened by existing agricultural practices whilst 1210 is at risk of a sharp decline because of coastal erosion.

General Habitat Categories

GHCs characterizing the study site and which uniquely correspond to Annex I Habitat types according the EBONE D4.2 Rule based system for Annex I habitats (Bunce *et. al.*. 2010) are reported in Table 31. There is no unique correspondence between Annex 1 1510 Habitat type and GHCs, therefore the GHCs potentially present are 5.2.2.12.2 and 6.2.2.5.1, even though the latter is the most likely to be present. The same is for the Annex 1 1420 Habitat type, which potentially correspond to the GHCs 6.2.2.3.2 and 6.3.2.2.1.

Table 31 IT2_ Annex I Habitat types (Natura 2000)

Code	Name	GHC	GHC description
1150*	Coastal lagoons	1.1.3	GHC (BioHab): AQU+TER+SHY+EHY+CHE+LHE/CHE. Mainly SHY with locally patches of EHY + brackish to salt water + highly saline + shallow water separated from sea in lagoons or ponds. Distribution: BOR+NEM+PAN+ATN+CON+ATC+LUS+MDN+MDS Mapping rules: Coastal lagoons in CLC which will miss small patches. Indicators: *Phragmites australis, Chara ssp., Potamogeton ssp., Ruppia spp.* 1150 Coastal lagoons
1210	Annual vegetation of drift lines	5.2.2.9.1	GHC (BioHab): LHE/CHE + saline soils + sand or gravel + linear coastal feature. Env. Qualifier: 5.5 Distribution: BOR+NEM+ATN+CON+ATC+LUS+MDN+MDS Mapping rules: Occur along coast but discontinuous and only probabilistic. Indicators: *Cakile maritima, Salsola kali, Glaucium flavum, Matthiola sinuata.* 1210 Annual vegetation of drift lines
1310	*Salicornia* and other annuals colonizing mud and sand	5.2.1.1.1	GHC (BioHab): THE + SPV/TER + mud + saline Env. Qualifier: 2.5 Distribution: ATN+ATC+CON+LUS+MDN+MDS Mapping rules: ATN+ATC+CON+LUS+MDN+MDS + 1km coastal mask + (bare mud if possible). Indicators: *Salicornia* spp*, Suaeda maritima, Sagina maritima, Sagina nodosa, Cochlearia danica.* 1310 *Salicornia* and other annuals colonising mud and sand
1410	Mediterranean salt meadow (*Juncetalia maritimi*)	5.2.2.12.1	GHC (BioHab): LHE/CHE + saline + SCH. Env. Qualifier: 6.5 Distribution: LUS+MDM+MDN+MDS Mapping rules: Coastal marsh < 1 km. Inland only possible on saline soils. Indicators: *Juncus maritimus, Artemisia caerulescens, Aster tripolium, Trifolium squamosum* 1410 Mediterranean salt meadows (*Juncetalia maritimi)*
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	6.2.2.3.2	GHC (BioHab): SCH/EVR or LPH/ EVR + saline soils + indicator species. Env. Qualifier: 5.5 Distribution: LUS + MDN + MDS Mapping rules: Mean high water mark + Saline mud. Indicators: *Sarcocornia fruticosa, Inula crithmoides, Sarcocornia perennis, Suaeda vera* 1420 Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
1510*	Mediterranean salt steppes (*Limonietalia*)	6.2.2.5.1	GHC (BioHab): SCH/EVR + LHE/CHE + dry saline soils Env. Qualifier: 6.5 Distribution: MDN + MDS Mapping rules: Impossible to map unless distribution of inland saline soils available Indicators: *Limonium* spp*., Lygeum spartum, Salicornia patula, Senecio auricula* 1510 Mediterranean salt steppes (*Limonietalia*)

Corine Land Cover classes

The Corine Land Cover classes (CLC) recorded in the study site and their respective cover percentages are listed in Table 32 in decreasing order of cover. Figures for land cover classes are based on a regional map (1:5000) from an ortophoto dated 2006.

The landscape of the study site is dominated by the Salines (422) which encompass 41 % of the total area, whereas non-irrigated arable lands and permanently irrigated land together occupy another 42 %. Other landcovers, some of which corresponding to habitat types, contribute the micro-heterogeneity of this landscape. Those with less than 1 % cover include beaches, dunes and sands (331), continuous and discontinous urban fabric (111/112), Vineyeards (221), road and rail networks (122), Olive groves (223), moors and heathlands (322), inland marche (411), construction sites (133), pastures (231) and other annual (241) and permanent crops (224) and complex cultivation patters (242) and agricultural land (243), dump sites (132) and bare rock (332), sport and leisure facilities (1142), schlerophyllous vegetation (323), water bodies (512), salt marshes (421), fruit trees and berry plantations (222), sparsely vegetated areas (333), green urban areas (141), port areas (123), grasslands with trees (141), coastal lagoons (521) and mixed forest (313).

Table 32 IT2_Corine Land Cover classes level3

CLC3	Area %
422 Salines	41.089
211 Non-irrigated arable land	27.32
212 Permanently irrigated land	15.252
321 Natural grassland	7.631
511 Water courses	2.219
121 Industrial or commercial units	0.752
Other	5.737

The Corine Land Cover importance diversity curve is reported in Appendix 2, Figure A2.4.

Definition of scale requirements

Scale requirements for habitat mapping in terms of grain (sensor resolution) are both high and very high, in order to obtain habitat maps at 1:5000 or lower (for within habitat patch monitoring) which can be aggregated (1:10000, 1:25000) without losing information for the entire extent likely to affect site functioning at ecosystem level. This almost coincides with the watersheds of the river system drained by the wetlands. Concerning phenology, all the plant communities show minimum biomass in winter. During the same period, the coastal lagoons show maximum flooding. Some of the plant communities show maximum biomass during the spring and others in late summer. Considering the habitat types (vegetation communities) in this site and their phenology, three periods of satellite observation could be January to February, April to May and August to September. Considering the heavy pressures on these coastal environments and their high sensitivity, a monitoring frequency of three years is suggested.

Pressures and threats

A summary of the main human pressures and threats recorded inside and outside the IT2 site is given in Table 33. Figures are based on a regional (1:5000) 2008 map.

Table 33 IT2_Summary of the main human pressures and threats

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation	I	A	40	-
Drainage, manipulation of ground-water level	I/O	B	20	-
Grazing	I	B	15	-
Animal husbandry	I/O	C	2	-
Poaching and illegal fishing	I	B	10	-
Continuous urbanisation	I/O	A	30	-
Water pollution	I/O	B	20	-
Soil pollution	I/O	B	10	-
Eutrophication	I/O	B	5	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

A summary of remote sense images already available at CNR for the IT2 site are listed in Table 34. A 2008 1:5000 land use image is also already available. The acquisition of other ancillary data (e.g., vegetation map, animal species distribution, phytosociological releves) from different bodies has already started.

Table 34 IT2_Remote sensing images already available for IT1

Source/Sensor	Data range	Source/Sensor	Data range
Landsat LTM	1986-05	Landsat ETM 7	2000-07
Landsat TM 5	1997-05	Landsat ETM 7	2000-08
Landsat TM 5	1997-10	Landsat TM 5	2001-04
Landsat TM 5	1998-07	Landsat ETM 7	2001-08
Landsat ETM 7	1999-08	Landsat TM 5	2004-08
Landsat TM 5	1999-09	IKONOS MS/Pan	2005-03
Landsat ETM 7	1999-10	IKONOS MS/Pan	2005-05
Landsat TM 5	2000-01	IKONOS MS/Pan	2006-01
		MIVIS	2009-05

Biodiversity indicator selection

Referring to the list of indicators included in BIO_SOS Deliverable 2.1, Biodiversity Indicators (sensu CDB and SEBI 2010) selected for monitoring the study site IT2 are

-Habitat of European interest (presence and extent)
-Abundance and Distribution of Selected Species
-Fragmentation of natural and semi-natural areas.

As far as the Abundance and Distribution of Selected Species indicator is concerned a detailed checklist is being compiled with reference to animal species in order to select those species for which analytical data exist which are either regarded as priority species or recognized of keystone importance in food webs.

Users

The main user for site IT2 is the Regional authority of Puglia., that is responsible with compliance to the Habitat and Bird Directives.

The users have already indicated their monitoring priorities in the SLA and keep in constant contact with the project with regard to focal species selection. They are mainly concerned with the degradation of priority habitat types Coastal lagoons (1150*), Mediterranean salt steppes (*Limonietalia*; 1510*), as well as both 1420-Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornietea fruticosi*) (1420) habitat types, all supporting several wintering water bird species.

3.3.3 IT3: Murgia Alta IT9120007

General description

Murgia Alta (SCI;IT9120007) lies in the north-western part of Murge hill, an oblong plateau in the centre of Puglia Region, stretching out NW-SE towards the nearby Basilicata Region (Figure 7).

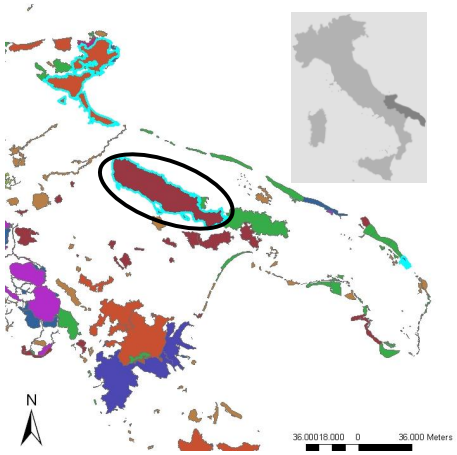


Figure 7 IT3_Location map of IT3 within the context of Natura 2000 sites and other protected areas

The site extends over 125,000 ha, ranging from 300 to 679 m a.s.l. The geological substrate is made up of a thick layer of Jurassic-Cretaceous carbonate sedimentary rocks, covered in alternate tracts by thin and discontinuous Plio-Pleistocene deposits. The site shows a typical karst landscape, slightly corrugated with dolinas, poljes and dry karst valleys (locally called lame), but sometimes is also abruptly interrupted with cliffs originating from tectonic events. According to the Rivas-Martinez (2004) classification, the macrobioclimate is Mediterranean with a pluviseasonal-oceanic Mediterranean bioclimate. The ombrotypes range from dry to sub-humid and the thermotype is meso-Mediterranean (Forte *et. al*. 2005).

The vegetation of the upper part of Murgia Alta consists mainly of wide expanses of Mediterranean steppe grasslands whose dominating species include *Stipa austroitalica, Festuca circummediterranea, Thymus spinulosus, Koeleria splendens* and *Asphodelus ramosus*, etc. In some tracts, the overall features of the steppe grassland appear closer to the garrigue and pseudo-garrigue because of the higher number of chamaephytes with fruticose and sub-fruticose habits. In other cases, scattered shrubs or trees determine physiognomic types of shrub-steppe or steppe-woodland (Bianco, 1962). Where the cliffs crop, *Aurinia saxatilis* subsp. *megalocarpa* and *Athamanta sicula* become dominant but this occurs rarely as marginal facies. Steppe grasslands are part of a traditional extensive grazing system and harbour a rich flora, with more than 1100 taxa (Bianco 1962). Several species, such as *Linaria dalmatica, Linum tommasinii* or *Ornithogalum adalgisae*, are of primary interest for conservation (Conti *et. al.*. 1997). Steppe grasslands of Murgia Alta also harbour numerous species of Orchidaceae and could be regarded as an important orchid site (Bianco 1981, Perrino *et. al.*. 2006). In the last decade, the most dramatic change of Murge landscape has been the transformation of the original rocky pastures into wheat fields, through stone clearing and crushing by modern technologies.

In the lower portion of Murgia Alta, the pastures are progressively replaced by olive groves, almond orchards and vineyards. Towards the south-east boundary of the site,

small remnant and degraded oak woods characterize the landscape (*Cyclamino hederifolii-Quercetum ilicis*; *Euphorbio apii-Quercetum trojanae*; *Stipo bromoidis-Quercetum dalechampii*; cf. Biondi *et. al.*. 2004).

The SCI/SPA Murgia Alta is partially enclosed in the Alta Murgia National Park and is also an Important Bird Area (IBA 135).

Habitat types (Dir 92/43/EEC) and species evaluation

According to the 92/43/EEC Directive, six habitat types are identified within the IT3 study site (Table 35).

Table 35 IT3_Habitat types (Annex I 92/43/EEC Directive)

Annex I code	Habitat type
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (important orchid sites)
6220*	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea
62A0	Eastern sub-Mediterranean dry grasslands (Scorzoneratalia villosae)
8210	Calcareous rocky slopes with chasmophytic vegetation”
91AA	Eastern white oak woods
9250	*Quercus trojana* woods

The dry grasslands were assigned to the priority habitats Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea (6220), with an estimated site cover of 20 %, and Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites) (6210), with an estimated cover of 27 %. Recently, grasslands dominated by *Stipa austroitalica* of the Murgia Alta (Acino suaveolentis-Stipetum austroitalicae) have been classified within the Scorzonero-Chrysopogonetalia order. Consequently, the Italian Interpretation Manual of the Habitat Directive included these grasslands within the Eastern sub-Mediterranean dry grasslands (Scorzoneratalia villosae) (62A0). This is not indicated among the “priority habitat”. However, *Stipa austroitalica* is included in Annex II of the 92/43/EEC Directive.

The chasmophytic communities of Murgia Alta (*Iberido carnosae-Athamantetum siculi*) have been recently assigned to the endemic alliance *Caro multiflori-Aurinion megalocarpae*, within the order *Asplenietalia glandulosi*. This vegetation type is included within the habitat “Calcareous rocky slopes with chasmophytic vegetation” (cod. 8210), with an estimated cover of 6 %. Woods dominated by *Quercus pubescens* (*Stipo bromoidis-Quercetum dalechampii*) were referred to the Eastern white oak woods habitat type (91AA) with an estimated cover of 15%. Woods dominated by *Quercus trojana* characterize the landscape of the southeastern part of the Murge ridge but they can also be found in the southern part of Murgia Alta (Teucrio siculi-Quercetum trojanae) even if in remnant and degraded patches. These woods are included in the habitat type “*Quercus trojana* woods” (9250), with an estimated cover of 5 %.

General Habitat Categories

General Habitat Categories (GHC) characterizing the study site and which uniquely correspond to Annex I Habitat types according the EBONE D4.2 Rule based system for Annex I habitats (Bunce *et. al.*. 2010) are reported in the following Table.

Table 36 IT3_ Annex I Habitat types (Natura 2000)

Code	Name	GHC	GHC description
6220*	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	5.2.1.7.2	GHC (BioHab): CHE/THE + xeric + calcareous + critical species + expert knowledge. Env. Qualifier: 8.4 Distribution: ALS+PAN+LUS+MDM+MDN+MDS Mapping rules: Although included in grasslands the signal could be confused with fallow and sparsely vegetated depending on the proportion of bare ground. Calcareous soils. MDM below 800m + MDN below 1200m + MDS below 1600m. Indicators: ***Brachypodium distachyon,*** *Brachypodium retusum, Stipa spp.* **6220** Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*
62A0	Eastern sub-mediteranean dry grasslands (Scorzoneratalia villosae)	5.2.2.13.3	GHC (BioHab): LHE/CHE + xeric + indicators Env. Qualifier: 7.3 Distribution: PAN+MDN+MDS Mapping rules: East of Italy to the Balkans below 300m + PAN below 300m. Indicators: *Bromus erectus, Carex humilis* **62A0** Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)
8210	Calcareous rocky slopes with chasmophytic vegetation	1.2.2.1	GHC (BioHab): Inland cliff + limestone rocks + chasmophytes + LHE + CHE + LHE/CHE+SCH/EVR+ TER + possible HCH. Distribution: ALN+BOR+NEM+ATN+ALS+CON+ATC+PAN+LUS+MDM+MD+MDS Mapping rules: Calcareous + limestone rocks. Indicators: ***Potentilla caulescens,*** *Ramonda myconi (Pyrenees only), Cystopteris fragilis,* *Asplenium trichomanes, Asplenium viride, Woodsia glabella*. **8210** Calcareous rocky slopes with chasmophytic vegetation
91AA	Eastern white oak woods	6.6.1.10.3	GHC (BioHab): FPH/DEC + *Quercus pubescens* over 30% + *Quercus virgiliana* + dry soils + expert knowledge Env. Qualifier: 7.3 Distribution: CON+MDN Mapping rules: CON 100 to 400m. + MDN over 300m. Southeast Balkans Indicators: ***Quercus pubescens, Quercus virgiliana****, Ostrya carpinifolia, Fraxinus* *ornus, Paeonia peregrina* **91AA** Eastern white oak woods
9250	*Quercus trojana* woods	6.6.1.8.7	GHC (BioHab): FPH/DEC + *Quercus trojana* over 70% + dry soils + expert local information. Env. Qualifier: 6.3 Distribution: MDN+MNS Mapping rules: MDS + presence of *Quercus trojana* only, maybe outliers in southern classes of MDN. Indicators: ***Quercus trojana,*** *Quercus pubescens, Quercus ilex* **9250** *Quercus trojana* woods

Corine Land Cover classes

The Corine Land Cover classes (CLC) recorded in the study site and their respective cover percentages are listed in Table 37 in decreasing order of cover. Moors and heathland (332), Vineyards (221), sparsely vegetated areas (333), road and rail networks and associated land (122), mineral extraction sites (131), annual crops associated with permanent crops (241), pastures (231), transitional woodland-shrub (324), sclerophyllous vegetation (323) and bare rocks (332). Figures are based on a regional LC (1:5000) map from an ortophoto dated 2006.

Table 37 IT3_Corine Land Cover classes level3

	CLC3	Area %
211	Non-irrigated arable land	48,424
321	Natural grasslands	23,779
223	Olive groves	5,872
311	Broad-leaved forest	5,633
314	Grasslands with trees	2,568
312	Coniferous forest	2,249
121	Industrial or commercial units	1,428
313	Mixed forest	1,262
111	Continuous urban fabric	1,125
222	Fruit trees and berry plantations	1,102
	Other	6.558

Natural grasslands and non-irrigated arable lands account for more than 70 % of the site. These two land uses characterize and dominate the Murgia Alta landscapes. Olive groves are of greater importance at lower altitudes towards the Adriatic coast. Broad-leaved forest refers mainly to *Quercus dalechampi* and *Q. virgiliana* woods; Coniferous forests are plantations of non-autochthonous pine and *Cupressus* species. The Corine Land Cover importance diversity curve is reported in Appendix 2, Figure A2.5.

Definition of scale requirements

Scale requirements for habitat mapping in terms of grain (sensor resolution) are both high and very high, in order to obtain habitat maps at 1:5000 or lower (for within habitat patch monitoring) which can be aggregated for the entire site (1:10000 1:25000 without loosing information). In IT3, the phenological peak of biomass of the grasslands with *Stipa austroitalica* (that is the dominant habitat type) reaches its maximum between April and May depending on the altitude. The phanerophitic vegetation of Murgia Alta includes, at least potentially (Biondi *et. al.*. 2004), woods dominated by *Quercus ilex* (evergreen) at lower altitude, by *Q. dalechampi* and *Q. virgiliana* (deciduous) on the Adriatic side, and by *Q. trojana* (semi-deciduous) in the south-eastern part of the site. Given this variability, a second period of satellite observations could be added during the winter months. Monitoring activities could be carried out every three years.

Pressures and threats

A summary of the main human pressures and threats recorded inside and outside the IT3 site is given in Table 38. Figures are based on a regional (1:5000) map from an ortophoto dated 2006.

Table 38 IT3_Summary of the main human pressures and threats recorded for IT3

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation, agricultural activities (Ploughing)	I	A	40	-
Cultivation, agricultural activities (Establishment of plantations)	I	B	10	-
Cultivation, agricultural activities (abandonment of grazing)	I	A	60	-
Cultivation, agricultural activities (excessive livestock numbers)	I	B	20	-
Cultivation, agricultural activities (fire impact)	I	A	60	-
Forestry and forest use (Plantation of non-autochthonous woods)	I/0	B	20	-
Forestry and forest use (Forest wildfires)	I	A	30	-
Construction works and mining activities (Quarrying)	I	C	10	-
Construction works and mining activities (Wind and solar farms for alternative energy production)	I	A	30	-
Natural hazards (Occurrence isolated or at distribution boundaries)	I	C	10	-
Natural hazards Climatic impact (e.g.,, below-average precipitation for many years)	I	C	20	-
Poaching	I	B	50	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

A summary of remote sensing images already available at CNR for the IT3 site are listed in Table 39. A 2008 1:5000 land use image is also already available. Acquisition of other ancillary data (e.g., vegetation map, animal species distribution, phytosociological releves) from different bodies has already started, including the studies for the Alta Murgia management plan (1998).

Table 39 IT3_Remote sensed images already available

Source/Sensor	Data range
Landsat TM 5	1998-03-07
Landsat ETM 7	1999-09-26
Landsat ETM 7	2001-01-02
Landsat ETM 7	2001-08-14
Landsat TM 5	2004-08-30
Landsat TM 5	2010-09-16

Biodiversity indicator selection

Referring to the list of indicators included in BIO_SOS Deliverable 2.1, Biodiversity Indicators (sensu CDB and SEBI 2010) selected for monitoring the study site IT1 are

-Habitat of European interest (presence and extent)
-Abundance and Distribution of Selected Species
-Fragmentation of natural and semi-natural areas.

As far as the Abundance and Distribution of Selected Species indicator is concerned a detailed checklist is being compiled with reference to animal species in order to select those species for which analytical data exist which are either regarded as priority species or are recognized of keystone importance in food webs.

Users

The main user for site IT3 is the Regional authority of Puglia, responsible for compliance to the Habitat and Bird Directives.

Main indicator species

The users have already indicated their monitoring priorities in the SLA and keep in constant contact with the project with regard to focal species selection. However they have already indicated a few bird species, i.e. lesser kestrel (*Falco naumanni*), Lanner falcon (*Falco biarmicus feldeggi*), negatively affected by pressures leading to habitat degradation and perturbation (sensu Art, 6, 92/43/EEC Directive) caused by agriculture intensification/expansion at the expense of natural habitats.

3.3.4 IT4: Le Cesine IT9150032

General description

Le Cesine is located on the Adriatic side of the SE Puglia region (Figure 8).

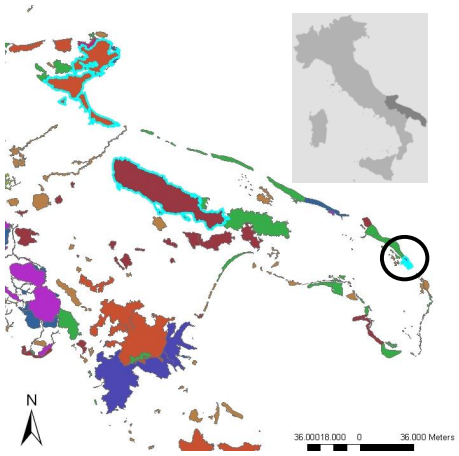


Figure 8 IT4_Location map of IT4within the context of Natura 2000 sites and other protected areas

Le Cesine is a SCI (SCI; IT9150032) with a surface area of 2148 ha and a SPA (SPA; IT9150014) with a surface area of 647 ha. Le Cesine is one of the oldest protected areas in Puglia, having been declared Ramsar site in 1977 and State Natural Reserve in 1980. The State Natural Reserve covers an area of 348 ha within the municipal district of Vernole (LE). The management body is WWF Italy. Le Cesine is also an Important Bird Area (IBA 146 and 146M).

This area is mainly composed by a complex of coastal lagoons where an intricate coenological pattern occurs. Several helophytic stands merged with stripes of halophilous and dry therophytic vegetation contribute to create very peculiar mosaics. In addition to the two larger water pools, there are also various channels, marshes, and humid grasslands. Among the helophytic vegetation types, *Cladium mariscus* communities (priority habitat 7210) are the largest. The woody vegetation is composed of *Pinus halepensis* and *Quercus ilex*, which are mixed with a matrix of Mediterranean maquis. The scrubby vegetation is characterized by garrigues with *Erica forskalii*. Near the sandbank *Juniperus macrocarpa* subsp. *macrocarpa* communities occur (priority habitat 2250).

Marine erosion has caused a progressive reduction of the sandbank separating the internal lagoons (coastal lagoons, priority habitat 1150) from the sea and determining a progressive increase in the salinity of the lagoon water, with a progressive spread of halophytic communities to the detriment of *Cladium mariscus* and *Juniperus oxycedrus* ssp. *macrocarpa* communities. Finally, the agricultural practices presently taking place both inside and outside the protected area are likely to lead to the disappearance of temporary ponds (priority habitat 3170). The protected area is prone to fire. In the summer of 2007, a wildfire spread across a large surface of the site, damaging the *Cladium mariscus* communities.

For the classification of plant communities we referred to the scheme proposed by Rivas-Martínez *et. al.*. (2001). For plant species nomenclature, we referred to the checklist of Conti *et. al.*. (2005).

Habitat types (Dir 92/43/EEC) and species evaluation

According to the 92/43/EEC Directive, fourtheen habitat types are identified within the IT4 study site (Table 40). Figures for habitat cover are based on a 2008 map (1 :5000) produced within an Interreg project.

Table 40 IT4_Habitat types (AnnexI 92/43/EEC Directive)

Annex I code	Habitat	Cover (%)
1120*	Posidonia beds (Posidonion oceanicae)	
1150*	Coastal lagoons	13.87
1210	Annual vegetation of drift lines	1.82
1310	*Salicornia* and other annuals colonizing mud and sand	0.20
1410	Mediterranean salt meadow (*Juncetalia maritimi*)	2.29
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	0.02
2110	Embryonic shifting dunes	1.38
2230	*Malcolmietalia* dune grasslands	0.06
2250*	Coastal dunes with *Juniperus* spp.	0.34
3170*	Mediterranean temporary ponds	0.17
5330	Thermo-Mediterranean and pre-desert scrub	9.5
5420	*Sarcopoterium spinosum* phryganas	7.95
7210*	Calcareous fens with *Cladium mariscus* and species of the *Carcion davallianae*	13.15
9320	*Olea and Ceratonia forests*	

The dominant habitat types are coastal lagoons (1150) and calcareous fens with *Cladium mariscus* and species of the *Carcion davallianae* (7210), both of which are priority habitats and cover 13.9 % and 13.2 % of the whole SIC surface area, respectively. Other priority habitats are Posidonia beds (Posidonion oceanicae; 1120*), Coastal dunes with *Juniperus* spp. (2250*) and Mediterranean temporary ponds (3170). It is not possible to associate a habitat type (sensu dir 92/43/EEC) to some of the natural or semi-natural vegetation types as they not belong to habitat types included in Annex I. Among the non-Annex habitats we should mention is *Phragmites australis* communities, a natural vegetation type largely widespread in humid areas. Other semi-natural or anthropogenic environments are pastures, uncultivated land, olive groves, arable land, reforestation with *Pinus* sp. pl. and *Eucalyptus* sp. pl. On the whole, the conservation status of the site habitat types is good. Nevertheless, habitat types 1150* and 7210* are threatened by salinity increase in water bodies. Habitat 2250* is at risk of a sharp decline due to coastal erosion. Habitat 3170* is threatened by agricultural practices.

General Habitat Categories

General Habitat Categories characterizing the study site and which uniquely correspond to Annex I habitat types are reported in Table 41.The general habitat classes that are potentially present in the area (due to the no unique correspondence between Annex 1 Habitat type and GHCs) are: 6.2.2.8.1 Thermo-Mediterranean and pre-desert scrub (5330); 6.2.2.9.1 Thermo-Mediterranean and pre-desert scrub (5330); 6.3.1.1.1 Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae (7210); 6.3.2.2.1 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosae, 1420); 6.3.2.6.3 Thermo-Mediterranean and pre-desert scrub (5330). In Table 41 the most reliable association is reported.
There is no correspondence in the *Sarcopoterium spinosum* phryganas (5420) Annex I habitat type in the EBONE D4.2 Rule based system for Annex I habitats.

Table 41 IT4_ Annex I Habitat types (Natura 2000)

Code	Name	GHC	GHC description
1120*	Posidonia beds (Posidonion oceanicae)	5.1.1.5.2	GHC (BioHab): SHY + saline water + over 30% Posidonia Env. Qualifier: 1.5 Distribution: MDM+MDN+MDS Mapping rules: Sea and ocean but with shallow coastlines only in the Mediterranean in MDN + MDS. Indicators: ***Posidonia oceanica*** **1120** *Posidonia* beds (*Posidonion oceanicae*)
1150*	Coastal lagoons	1.1.3	GHC (BioHab): AQU+TER+SHY+EHY+CHE+LHE/CHE. Mainly SHY with locally patches of EHY + brackish to salt water + highly saline + shallow water separated from sea in lagoons or ponds. Distribution: BOR+NEM+PAN+ATN+CON+ATC+LUS+MDN+MDS Mapping rules: Coastal lagoons in CLC which will miss small patches. Indicators: *Phragmites australis, Chara ssp., Potamogeton ssp., Ruppia spp.* 1150 Coastal lagoons
1210	Annual vegetation of drift lines	5.2.2.9.1	GHC (BioHab): LHE/CHE + saline soils + sand or gravel + linear coastal feature. Env. Qualifier: 5.5 Distribution: BOR+NEM+ATN+CON+ATC+LUS+MDN+MDS Mapping rules: Occur along coast but discontinuous and only probabilistic. Indicators: ***Cakile maritima****, Salsola kali, Glaucium flavum, Matthiola sinuata.* **1210** Annual vegetation of drift lines
1310	*Salicornia* and other annuals colonizing mud and sand	5.2.1.1.1	GHC (BioHab): THE + SPV/TER + mud + saline Env. Qualifier: 2.5 Distribution: ATN+ATC+CON+LUS+MDN+MDS Mapping rules: ATN+ATC+CON+LUS+MDN+MDS + 1km coastal mask + (bare mud if possible). Indicators: *Salicornia* spp*, Suaeda maritima, Sagina maritima, Sagina nodosa,* *Cochlearia danica.* 1310 *Salicornia* and other annuals colonising mud and sand
1410	Mediterranean salt meadow (*Juncetalia maritimi*)	5.2.2.12.1	GHC (BioHab): LHE/CHE + saline + SCH. Env. Qualifier: 6.5 Distribution: LUS+MDM+MDN+MDS Mapping rules: Coastal marsh < 1 km. Inland only possible on saline soils. Indicators: *Juncus maritimus, Artemisia caerulescens, Aster tripolium, Trifolium* *squamosum* 1410 Mediterranean salt meadows (*Juncetalia maritimi)*
1420	Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)	6.2.2.3.2	GHC (BioHab): SCH/EVR or LPH/ EVR + saline soils + indicator species. Env. Qualifier: 5.5 Distribution: LUS + MDN + MDS Mapping rules: Mean high water mark + Saline mud.

			Indicators: *Sarcocornia fruticosa, Inula crithmoides, Sarcocornia perennis, Suaeda vera* 1420 Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*)
2110	Embryonic shifting dunes	1.3.5.2.1	GHC (BioHab): TER (sand) +THE+CHE+ THE/CHE + LHE/CHE Distribution: BOR+NEM+ATN+CON+ATC+LUS+MDN+MDS Mapping rules: Coastal only. Indicators: ***Elymus farctus***, *Euphorbia peplis, Honkenya peploides* **2110** Embryonic shifting dunes
2230	*Malcolmietalia* dune grasslands	5.2.1.4.1	GHC (BioHab): LHE/THE + coastal dunes + local knowledge + indicator species. Env. Qualifier: 6.3 Distribution: MDN+MDS Mapping rules: Coastal only + sand dunes -only possible to indicate region. Indicators: ***Malcolmia lacera,*** *Anthyllis Hermosa, Lineria pedunculata* **2230** *Malcolmietalia* dune grasslands
2250*	Coastal dunes with *Juniperus* spp.	6.4.3.3.1	GHC (BioHab): MPH/CON + dry sandy soils + coastal dunes + Juniperus species Env. Qualifier: 6.3 Distribution: ATN+MDN+MDS Mapping rules: MDN + MDS but only Iberia + ATN (Jutland) + coastal mask of 500m + adjacent to dunes 331. Romeo also comments that it could also be within coniferous forest 312 but this is likely to be mostly 2270. Indicators: ***Juniperus turbinata spp. turbinata***, *Juniperus macrocarpa, Juniperus navicularis, Juniperus communis,* ***Juniperus oxycedrus*** **2250** Coastal dunes with *Juniperus* spp.
3170*	Mediterranean temporary ponds	5.2.1.3.1	GHC (BioHab): THE + GEO + THE/GEO + evidence of winter flooding + indicator species Env. Qualifier: 3.3 Distribution: LUS+MDM+MDN+MDS Mapping rules: MDM + MDN below 600m + MDS below 1000m + LUS Indicators: ***Juncus bufonius,*** *Serapias lingua, Graphalium uliginosum* **3170** Mediterranean temporary ponds
5330	Thermo-Mediterranean and pre-desert scrub	6.2.2.8.1	GHC (BioHab): LPH/EVR+ xeric soils + indicators Env. Qualifier: 8.3+8.4 Distribution: MDS Mapping rules: MDS below 200m. southern classes only Indicators: *Euphorbia dendroides, Periploca laevigata,* ***Chamaerops humilis,*** *Genista spp.* **5330** Thermo-mediterranean and pre-desert scrub
5420	*Sarcopoterium spinosum* phryganas	Not defined	Not defined
7210*	Calcareous fens with *Cladium mariscus* and species of the *Carcion davallianae*	5.1.2.1.1	GHC (BioHab): LPH/DEC + wet soil + dune slacks + indicator species Env. Qualifier: 2.3 Distribution: NEM+ATN+ALS+CON+ATC+PAN+LUS+MDM+MDN+MDS Mapping rules: Adjacent to water bodies but also wetlands – difficult to identify. Indicators: ***Cladium mariscus, Phragmites australis***, *Schoenus nigricans, Salix repens* **7210** Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
9320	*Olea and Ceratonia forests*	6.6.2.3.2	GHC (BioHab): FPH/EVR + 30-70 lea + 30-70 n% *Ceratonia* + xeric soils + indicator species. Env. Qualifier: 7.3 Distribution: MDN+MDS Mapping rules: MDS below 400m + distribution of *Olea* and *Ceratonia*. Indicators: ***Olea europaea ssp. sylvestris, Ceratonia siliqua,*** *Pistacia lentiscus, Myrtus communis* **9320** *Olea* and *Ceratonia* woods

Corine Land Cover classes

The Corine Land Cover classes (CLC) recorded in the study site and their respective cover percentages are listed in Table 42 in decreasing order of cover. The landscape of the Le Cesine site (IT4) is dominated by forest and scrub classes that cover almost half the total surface area. Besides conifer plantations, these also include sclerophyllous vegetation and maquis.Other CLCs with < 1 % cover include road and rail networks (122), land principally occupied by agriculture (243), transitional woodland scrub (324), water courses (511), industrial or commercial units (121), pastures (231), complex cultivation patterns (242), continuous/discontinuous urban fabric (111/112), construction sites (133) and bare rock (332). Figures for land cover classes are based on a 2008 dated map (1:5000) produced within an Interreg project.

Table 42 IT4_Corine Land Cover classes level3

CLC3	Area %
312 Coniferous forest	21.185
323 Sclerophyllous vegetation	14.863
521 Coastal lagoons	14.650
324 Transitional woodland shrub	13.652
211 Non-irrigated arable land	8.131
223 Olive groves	7.730
321 Natural grassland	7.718
421 Salt marshes	6.279
331 Beaches, dunes, and sand	2.382
Other	3.410

Among Corine Land Cover classes of semi-natural vegetation, coastal lagoons cover more than 14 % of the area and salt marshes, including different types of halophytic vegetation, covers about 6.2 % of the area. As for the cultivated areas, the most represented types are the Olive groves (7.7 %) and non-irrigated arable land (8 %). The Corine Land Cover importance diversity curve is reported in Appendix 2, Figure A2.6.

Definition of scale requirements

Scale requirements for habitat mapping in terms of grain (sensor resolution) are both very high, in order to obtain habitat maps at 1:5000 or lower (for within habitat patch monitoring) which can be aggregated (1:10000) without loosing information for the entire site extent. As for the phenology, the plant communities that are dominant in salt marshes (such as helophytic or scrubby halophytic communities) show all the minimum of biomass in the winter. In this same period, the coastal lagoons are in the maximum of flooding period. Some of the salt marshes plant communities show the maximum of biomass during the spring (especially some therophytic communities), but the vegetation types most widespread in salt marshes (such as *Sarcocornia* communities) show their maximum in late summer. Considering the habitat types in this site and their phenology, three period of satellite observation could be Jan-Feb; Apr-May; Aug-Sept. This period fit well also the woody vegetation (mainly evergreen).Considering the heavy pressures bearing on these coastal environments and their high sensibility, a monitoring frequency of three years is suggested.

Pressures and threats

A summary of the main human pressures and threats recorded inside and outside the IT4 site is given in Table 43. Figures are based on the Interreg map (1: 5000) dated 2008.

Table 43 IT4_Summary of the main human pressures and threats

Type of activity	In/out	Pressure intensity	% area	Influence
Cultivation	I/O	B	20	-
Ground water exploitation for irrigation	I/O	C	40	-
Grazing	O	B	40	-
Animal husbandry	O	C	3	-
Burning	I	B	50	-
Poaching	O	B	50	-
Continuous urbanisation	O	A	30	-
Water pollution	I/O	B	5	-
Soil pollution	O	C	10	-
Erosion	I	A	5	-
Eutrophication	I/O	C	2	-
Swimming and water sports activities and facilities	I/O	B	10	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

A summary of eemote sense images already available at CNR for the IT4 site are listed in Table 44. A 2008 1:5000 land use map is also already available. Acquisition of other ancillary data (e.g., vegetation map, animal species distribution, phytosociological releves) from different bodies has already started.

Table 44 IT4_Remote sense images already available

Source/Sensor	Data range
Landsat TM 5	1992-11
Landsat TM 5	2001-01
Landsat ETM 7	2001-08
Landsat TM 5	2004-05
Landsat TM 5	2004-08
QUICKBIRD multi and pan	2005-07
MIVIS	2009-05
QUICKBIRD multi and pan	2009-06
WORLDVIEW-2	2010-10
Source/Sensor	**Data range**
Habitat map (Info-Nat Interreg Project)	2007-2008
CLC map (Info-Nat Interreg Project)	2007-2008

Biodiversity indicator selection

.Referring to the list of indicators included in BIO_SOS Deliverable 2.1, Biodiversity Indicators (sensu CDB and SEBI 2010) selected for monitoring the study site IT2 are:

-Habitat of European interest (presence and extent)
-Abundance and Distribution of Selected Species
-Fragmentation of natural and semi-natural areas

As far as the Abundance and Distribution of Selected Species indicator is concerned a detailed checklist is being compiled with reference to animal species in order to select those species for which analytical data exist which are either regarded as priority species or are recognized of keystone importance in food webs.

Users

The main user for IT4 is the Regional authority of Puglia, in charge of compliance to the Habitats and Birds directives.

The users have already indicated their monitoring priorities in the SLA and keep in constant contact with the project with regard to focal species selection. They are mainly concerned with the degradation of priority habitat type *Coastal lagoons* (1150*), as well as of both Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*) (1420) habitat types, all supporting several wintering water bird species.

3.4 Partner 9: CIBIO/ICETA Portugal

3.4.1 PT1: Rios Sabor e Maçãs (PTZPE0037 and PTCON0021)

General description

"Rios Sabor e Maçãs" is a river system located in the northeast of mainland Portugal (Figure 9). The main river (Sabor) is a major tributary of the River Douro, and Maçãs is the main tributary of the River Sabor. The site has been designated both as an SCI (PTCON0021; surface area: 33482 ha) and an SPA (PTZPE0037; 50687 ha), with partially overlapping areas (Figure 8). Overall, this study site has a total surface area of 53009 ha.

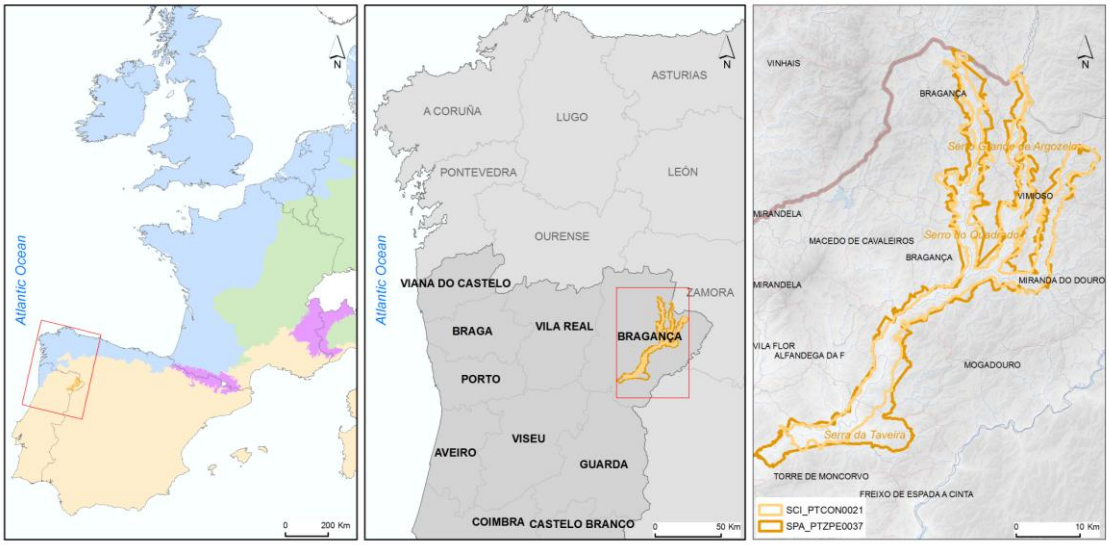


Figure 9 PT1_Geographic location and main toponyms of the "Rios Sabor e Maçãs" study site: in the European biogeographic context (left), in the NW-Iberian context (centre), and in the Northeast of Portugal (right)

The site is included in a Mediterranean valley system associated with Sabor River, where human settlement is millenial although with low population density. The landscape is dominated by the vigorous physiography of the valleys, which along with the peripheral positioning of the region favoured natural isolation and constrained land use and economic activities.

The highly seasonal and dry climatic conditions, reflected by the low annual values of precipitation (400-800 mm), and the predominant shallow soils (leptosols) induce severe water stress during the warm season. The shape and topography of the river basin and the annual rainfall distribution promotes torrential hydrological regimes and superficial erosion. The wilderness of the area and the spatial and temporal variability of environmental conditions and processes contribute to the existence of relevant local ecological values.

Dominant traditional land uses are husbandry and perennial agriculture (vineyards, olive and almond orchards). Cereal and other annual crops are cultivated in the surrounding plateau areas, and residual native forests are managed for cork, wood, timber, and as grazing areas included in agro-ecological systems. Traditional pasture has been decreasing, replaced by a concentration of livestock production in a

reduced number of intensive grazing and enclosed farmlands. Recent changes in the landscape, which resulted from partial abandonment of agriculture and of extensive husbandry, and afforestation with both native species (conversion of agricultural land) and exotic species (intensive forestry), are related to demographic decline, private land owners' absence, and increasing activities such as hunting and fishing.. Currently, a large hydroelectric dam is being constructed at the downriver end of the site, so profound transformations will occur in the main valley.

The site is managed by ICNB (as a Natura 2000 site), local authorities and hundreds of private land owners, who in many cases are absent or even unknown. The energy company in charge of the new dam will obviously become another important stakeholder.

Habitat types (Dir 92/43/EEC) and species evaluation

In this site, several forest types representing Annex I habitats are common on slopes (9330, 9340 and 9560*) and along river margins (91B0, 91E0* and 92A0). In rocky margins of the main rivers, the relict habitat 5110 occurs in mosaic with saxicolous grasslands (6160). In the courses and flood margins of temporary rivulets, wet grasslands (3280, 3290) and tall herb formations (6420) form dense mosaics. Most of the area is dominated by open scrublands (5210, 5330) in mosaic with annual and perennial dry grasslands of habitat 6220*. In steep slopes and vertical stone walls, saxicolous formations are common (8220). In the highest elevations, oak forests (9230), old chestnut groves (9260) and heaths (4030) can be found. This site hosts populations of more than 40 species listed in the Annexes of the Habitat and Bird Directives. Habitats and species associated with the main river valley will be severely affected by flooding once the hydroelectric dam is built. The identification of the main habitat types can be reported to habitat maps produced in 2005.

General Habitat Categories

Agricultural areas are dominated by perennial crops (WOC), including vineyards, olive groves and almond groves. Annual crops (CRO) also occur in the plateau areas around rural villages (ART) and include vegetable fields around houses (VEG). Forestry plantations are less common and include small stands of maritime pine (*Pinus pinaster*; FPH/CON), Mexican white cedar (*Cupressus lusitanica*; FPH/CON) and river red gum (*Eucalyptus camaldulensis*; FPH/EVR). Slope areas are dominated by woodlands and scrublands, including cork oak (*Quercus suber*; FPH/EVR) and holm oak (*Quercus ilex* subsp. *rotundifolia*; TPH/EVR) forests. Open scrublands are dominated by yellow retama (*Retama sphaerocarpa*; MPH/NLE), white Spanish broom (*Cytisus multiflorus*; MPH/NLE), or then by prickly juniper (*Juniperus oxycedrus*; TPH/CON). These scrublands occur in mosaics with annual (THE) and perennial pastures (CHE/LHE). The more dense low scrub formations are dominated by gum rockrose (*Cistus ladanifer*; MPH/EVR). In valleys, riparian forests (FPH/DEC) occur in mosaic with the threatened box (*Buxus sempervirens*) formations (TPH/EVR). Both habitat types will suffer great reduction in their extent after the construction of the hydroelectric dam (ART).

Corine Land Cover classes

The Corine Land Cover map (CLC2006) identifies 16 classes for this test site. Eight of these land cover classes belong to 'agricultural areas' (code 2 in level 1) and eight to forest and semi natural areas (code 3 in level 1). The main land cover classes (level 3) are transitional woodland-shrub (324), natural grasslands (321), moors and heathlands (322), occupying 21.2%, 15.3% and 14.8% of the total area, respectively (Table 45). A total of 432 polygon features are defined within PT1. The land cover

classes of transitional woodland-shrub (324), and land principally occupied by agriculture, with significant areas of natural vegetation (243) have the highest numbers of polygon features, with 98 and 70, respectively (Table 45).

Table 45 PT1_Corine Land Cover classes level3

CLC2006 classes level 3	Area (%)	Polygons
324 Transitional woodland-shrub	21.19	98
321 Natural grasslands	15.33	26
322 Moors and heathland	14.79	42
243 Land principally occupied by agriculture, with significant areas of natural vegetation	11.16	70
242 Complex cultivation patterns	7.72	37
223 Olive groves	7.47	31
211 Non-irrigated arable land	7.41	41
241 Annual crops associated with permanent crops	3.36	26
313 Mixed forest	3.08	21
312 Coniferous forest	2.74	12
311 Broad-leaved forest	2.72	16
222 Fruit trees and berry plantations	2.57	4
333 Sparsely vegetated areas	0.20	1
334 Burnt areas	0.14	3
231 Pastures	0.11	2
221 Vineyards	0.02	2

Regarding the transition of land cover between 1990 and 2006, it is possible to observe a shift between classes within the general category of forest and semi natural areas. In this context, there was an increase in 8% of transitional woodland shrub' (324) associated with a decrease of moors and heathland (322) and of natural grassland (321). Regardless, in the first decade of the period, an increase of 1.2% of coniferous forest (312) was observed representing a gain of 50%. A gradual decrease of non-irrigated arable land (211) in favour of land primarily occupied by agriculture was also observed, with significant areas of natural vegetation (243) and scrub and/or herbaceous vegetation associations (specifically, 322 moors and heathlands and 324 transitional woodland-shrub) was also observed. Further details are presented in Appendix 1.

Definition of scale requirements

Several processes will be assessed in this site, and the spatial and temporal resolutions will be variable according to the focal processes and changes in each situation. In general, focal habitat types will be associated to dominant land uses/land cover classes, and so should be assessable from high resolution imagery (10-30 m spatial resolution). Specific changes in point or linear habitats (e.g., seasonal ponds, lines of trees) will demand very-high resolution imagery (<10m spatial resolution, down to <1 m). Most processes to be evaluated are related to land use change and vegetation dynamics, and could therefore be monitored every 3-5 years, but specific responses could be assessed on a yearly basis. This is a rather seasonal area, so more than one image per year should be necessary to discriminate the several focal habitats.

Pressures and threats

Table 46 summarizes the main human pressures and threats on this test site. Only those with intensity A or B were included. Further details on other pressures and threats are included in Appendix 1, as well as the habitats on which their effects are thought to be more intense.

Table 46 PT1_Summary of the main human pressures and threats (those in intensity classes A and B) recorded for PT1 – Rios Sabor e Maçãs

Type of activity	In/out	Pressure intensity	% area	Influence
Construction of dams and reservoirs	I	A		-
Changes in forest structure by forestry or by abandonment of traditional forest-use	I/O	B		+
Plantation of non-autochthonous woods, e.g., poplars, eucalyptus	O	B		-
Poaching and illegal fishing	I/O	B		-
Succession due to grassland abandonment	I/O	B		+
Succession due to the abandonment of grazing	I/O	B		+
Water engineering and river straightening: prevention of riverine dynamics	I	B		-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

Table 47 summarizes the information on satellite and other relevant data on habitats, species and land cover that already exist for the test site.

Table 47 PT1_Summary of main data layers available for PT1– Rios Sabor e Maçãs (satellite imagery, habitat maps, land cover maps, species records)

Source/Sensor	Data range
Landsat5 TM scene 203/31	11-04-1990
Landsat5 TM scene 203/31	29-05-1996
Landsat5 TM scene 203/31	04-07-2003
Landsat5 TM scene 203/31	09-05-2006
Landsat5 TM scene 203/31	29-06-2007
Landsat5 TM scene 203/31	18-06-2009
Landsat7 ETM+ scene 203/31	01-07-1999
Landsat7 ETM+ scene 203/31	17-06-2000
Landsat7 ETM+ scene 203/31	20-06-2001
Habitats map	2005
Species records	2007-2010
Land Cover Map (COS90)	1990
Land Cover Map (COS00)	2000
Land Cover Map (COS06)	2006

Additionally, imagery from the MODIS sensor (2000-2010) are available: (i) MODIS Vegetation Indices 16-Day L3 Global 250m (Tile h17v04) data, with 250m of spatial resolution; (ii) MODIS Gross Primary Productivity 8-Day L4 Global 1km (Tile h17v04). Several thematic ancillary datasets are available for the site, namely climate, hydrography, geology, soils, socioeconomic and demographic data, agrarian censuses (farm structural survey data), forest surveys (national inventory), wildfires, and road network.

Biodiversity indicator selection

The main indicators will be related to the state and trend of: (i) habitats of European interest (extent and change), (ii) abundance and distribution of selected species, and (iii) fragmentation of natural and semi-natural areas. These indicators are valuable to address the effects of processes and drivers such as land use change (extensification, abandonment, concentration, local intensification and specialization) and fire regimes (and changes in those regimes).

Other indicators will be considered when developing specific studies. These include: (i) state and trends of ecosystem function (e.g., productivity, phenology), of landscape diversity and spatial structure and function, and of species diversity (e.g., species richness); (ii) intensity of pressures and threats e.g., land use and land use change, fire regimes; and (iii) response/adaptation (indicators related to e.g., land use planning, nature protection inside and outside protected areas, allocation of conservation resources/funding, and environmental compensatory measures).

Users

The main users and managers of this site are the National Agency for Nature Conservation (ICNB), hunters' associations, the energy production company, and land owners. ICNB is involved in the project as an End User.

3.4.2 PT2: Peneda-Gerês (PTZPE0002 and PTCON0001)

General description

"Peneda-Gerês" is a mountainous area located in the northwest corner of mainland Portugal (Figure 10), including a large part of the mountain ranges of Peneda, Soajo, Amarela, Gerês and Larouco. This site includes the only national park in the country (surface area: 69593ha) and it has been designated both as an SCI (PTCON0001; 88845 ha) and a SPA (PTZPE0002; 63438 ha). The limits are not entirely coincident but the national park is completely included in the SCI. Overall, this study site has a total surface area of 94480 ha.

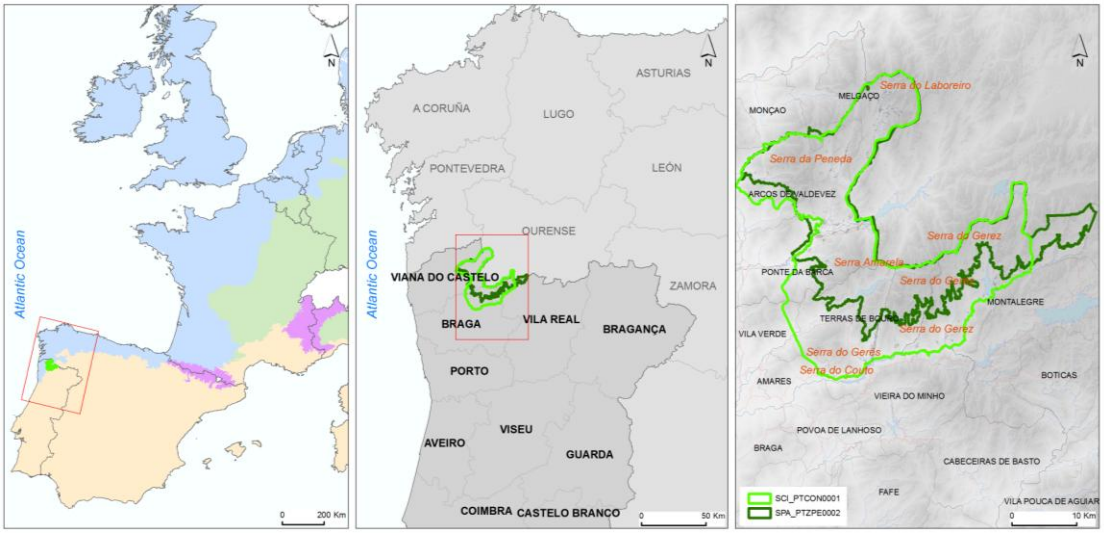


Figure 10 PT2_Geographic location and main toponyms of the "Peneda-Gerês" study site: in the European biogeographic context (left), in the NW-Iberian context (centre), and in the Northwest of Portugal (right)

The area presents a large altitude gradient (from 60 to 1545 m), with 63 % of its area at elevations above 800 m, and is located in a major bioclimatic transition, between the Atlantic and the Mediterranean biogeographic regions of Europe. The diverse geomorphologic and physiographic conditions, and a dense hydrographic network, further contribute to a rich ecological diversity. The dominant granite and shale geology determines a predominance of leptosols and regosols (> 90 %). Important areas of anthrosols have resulted from secular human adaptation to the steep slopes, where terraces and traditional farming systems have promoted water regulation and soil conservation practices.

Although the region has a long history of human settlement, its peripheral character contributes to a low population density, as well as to resident population loss and aging since the mid 20th century, as opposed to the urban sprawl occurring in local small centralities and increase of new agents and external land users. The dominant rural land uses are associated with annual and perennial crops (in valleys), forestry with native and exotic species in mid-altitude, and traditional agro-silvo-pastoral systems and wilderness land in higher elevation areas. Such traditional systems included seasonal internal migrations between valleys and high-elevation settlements, involved the regular use of fire as a land management tool and was associated with

agriculture, husbandry and management of native woodlands for wood and timber and as major land uses.

The external drivers and socio-economic internal dynamics (including a widespread demographic decline) determined the reduction of agricultural areas, with frequent and diverse transitions towards forest and semi-natural classes. Therefore, rural abandonment is extensively changing the landscape. Recent agro-environmental schemes aimed at buffering these trends have had limited success. More recently, windmill farms for energy production are being installed on mountain tops neighbouring the site.

In lowland areas, urban development, intensive forestry with exotic species, changes in fire regimes and installation of hydroelectric dams for energy production have been the most important processes and drivers of landscape change. In recent years, widespread invasion by alien plant species has become an important driver of biodiversity change, and it is spreading to higher elevations.

The area is managed by ICNB (the National Agency for Nature Conservation), but other agencies (e.g., the water resources agency and the national forestry agency) and local authorities also play important roles in specific areas. Hunting associations, common land associations, and hundreds of land owners are other relevant stakeholders.

Habitat types (Dir 92/43/EEC) and species evaluation

Mountain rural landscapes and grazing lands include extensive areas of Annex I habitats, namely native oak forests (9230), hay meadows (6510) and heath (4030). The two latter habitats are declining in favour of the former due to decreased husbandry and management of meadows. These species-rich landscapes also include frequent representations of priority habitats wet heath (4020*), acid grasslands (6230*) and riparian forests (91E0*), and populations of several plant and animal species listed in the Annexes of the Habitat and Bird Directives. Dry grasslands with dwarf chamaephytes (6160) and saxicolous habitats (8220, 8230) are particularly rich in endemic plant species. Mires and bogs are residual habitats (7140, 7150) in these landscapes but they are of high conservation value due to their extreme biogeographic location.

In lowland areas, oak forests are frequent on oligotrophic soils of slopes (9230) and on mesotrophic soils of valleys (9160). In gorges and along streams, laurel-leaved forests and scrublands (5230*) are also common. Together with riparian forests (91E0*), these are the most species-rich and ecologically significant habitats in lowlands. Heathlands (4030) and dwarf chamaephytic formations of rocky soils (8230) are common in areas subjected to wildfires. The identification of the main habitat types can be reported to habitat maps produced in 2007.

General Habitat Categories

In mountain landscapes, agro-pastoral activities mostly determine which GHCs are dominant in each area. Moors and heathlands (MPH/NLE, LPH/EVR) dominate in extensive grazing lands, which occupy large extensions in this site. These heathlands occur in mosaic with several types of pioneer grasslands dominated by annual (THE) or perennial (DCH/EVR) plant species. Broom (*Cytisus*) formations (TPH/NLE) are also common, replacing the previous vegetation in deeper soils along most successional pathways. Natural forests dominated by pedunculate oak (*Quercus robur*; FPH/DEC) and/or Pyrenean oak (*Quercus pyrenaica*; FPH/DEC) occur mainly in the valleys and steep slopes, along with birch (*Betula celtiberica*) and alder (*Alnus glutinosa*) riparian forests (FPH/DEC). The forestry plantations are well represented

and include stands of maritime pine (*Pinus pinaster*; FPH/CON), Scots pine (*Pinus sylvestris*; FPH/CON), Lawson's cypress (*Chamaecyparis lawsoniana*; FPH/CON) and Douglas fir (*Pseudotsuga menziesii*; FPH/CON). The Tasmanian blue gum (*Eucalyptus globulus*) stands (FPH/EVR) occur mainly in lowland areas, which are also affected by the presence of alien invasive woody plants such as the silver wattle (*Acacia dealbata*; TPH/EVR and FPH/EVR), threatening the native relict laurel (*Laurus nobilis*) thickets (TPH/CON and FPH/CON) and Portuguese laurel (*Prunus lusitanica*) formations (FPH/EVR). Agricultural areas are dominated by secondary grasslands and meadows (CHE/LHE), which are managed to feed cattle. Annual crops (CRO) and vegetable gardens around houses (VEG) occur in the more fertile soils.

Corine Land Cover classes

The Corine Land Cover map (CLC2006) identifies 18 classes for the test site: two land cover classes of artificial surfaces (code 1 in level 1), six classes of agricultural areas (code 2), nine classes of forest and semi natural areas (code 3), and one class of water bodies' (code 5). The main land cover classes in this test site are sparsely vegetated areas (333), bare rocks (332), and moors and heathlands (322), occupying 25.5 %, 16.8 % and 12.7 % of the total area respectively (table 48). The total number of polygon features in the test site is 557. The land cover classes transitional woodland-shrub (324), sparsely vegetated areas (333), and land principally occupied by agriculture, with significant areas of natural vegetation (243), have the highest numbers of polygon features, with 104, 65 and 56, respectively (Table 48).

Table 48 PT1_Corine Land Cover classes level3

CLC2006 classes level 3	Area (%)	Polygons
333 Sparsely vegetated areas	25.55	65
332 Bare rocks	16.82	11
322 Moors and heathland	12.71	53
324 Transitional woodland-shrub	10.55	104
321 Natural grasslands	9.10	54
313 Mixed forest	6.47	46
243 Land principally occupied by agriculture, with significant areas of natural vegetation	5.36	56
311 Broad-leaved forest	5.00	54
231 Pastures	2.49	44
312 Coniferous forest	1.63	19
512 Water bodies	1.41	7
241 Annual crops associated with permanent crops	1.08	18
211 Non-irrigated arable land	1.01	9
242 Complex cultivation patterns	0.71	13
112 Discontinuous urban fabric	0.05	1
334 Burnt areas	0.04	1
131 Mineral extraction sites	0.03	1
221 Vineyards	0.00	1

Comparing CLC data from 1990 and 2000, there was a generalized stability of land cover, while between 2000 and 2006 greater changes in land cover were observed,

particularly an increase of the class bare rock (332; 13.7 %) in detriment of the class sparsely vegetated areas (333). Further details are presented in Appendix 1.

Definition of scale requirements

Several processes will be assessed in this site, and the spatial and temporal resolutions will be variable according to the focal processes and changes in each situation. In general, focal habitat types will be associated to dominant land uses/land cover classes, and so should be assessable from high resolution imagery (10-30m spatial resolution). Specific changes in point or linear habitats (e.g., mires, lines of trees) will demand very-high resolution imagery (<10m spatial resolution, down to <1m). Most processes to be evaluated are related to land use change and vegetation dynamics, and could therefore be monitored every 3-5 years, but specific responses could be assessed on a yearly basis. This is a moderately seasonal area, so more than one image per year should be necessary to discriminate the several focal habitats.

Pressures and threats

Table 49 summarizes the main human pressures and threats on this test site. Only those with intensity A or B were included. Further details on other pressures and threats are included in the Appendix 1, as well as the habitats on which their effects are thought to be more intense.

Table 49 PT2_ A summary of the main human pressures and threats (those in intensity classes A and B) recorded for PT2 – Peneda-Gerês

Type of activity	In/out	Pressure intensity	% area	Influence
Forest wildfires	I/O	A		-
Invasive species	I/O	A		-
Construction of dams and reservoirs	I/O	B		-
Construction works and exploitation of springs	I/O	B		-
Damage by motocross and off-road vehicles	I/O	B		-
Drainage, manipulation of ground-water level	I/O	B		-
Gravel and sand extraction	I	B		-
Hunting	I/O	B		-
Intensive grazing (enclosures) and impact by excessive livestock numbers	I/O	B		-
Natural rarity	I/O	B		-
Occurrence isolated or at distribution boundaries	I	B		-
Pollution and eutrophication of inland and coastal surface waters	I/O	B		-
Structural degradation by fire impact	I/O	B		-
Wind and solar farms for alternative energy production	O	B		0

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Data availability

Table 50 summarizes the information about satellite and other relevant data that already exist for the test site.

Table 50 PT2_A summary of main data layers available for PT2 – Peneda-Gerês (satellite imagery, habitat maps, land cover maps, species records)

Source/Sensor	Data range
SPOT 5 scene 23-265 multi	07-08-2005
SPOT 5 scene 23-266 multi	17-06-2005
SPOT 5 scene 24-266 multi	06-05-2005
SPOT 5 scene 23-265 multi	14-10-2006
SPOT 5 scene 23-266 multi	21-08-2006
SPOT 5 scene 24-266 multi	28-10-2006
Landsat5 TM scene 204/31	26-08-1985
Landsat5 TM scene 204/31	31-01-1987
Landsat5 TM scene 204/31	04-05-1990
Landsat5 TM scene 204/31	05-06-1996
Landsat5 TM scene 204/31	13-07-2004
Landsat5 TM scene 204/31	30-04-2006
Landsat7 ETM scene 204/31	24-06-2000
Landsat7 ETM scene 204/31	19-02-2001
Landsat7 ETM scene 204/31	16-07-2002
Orthoimagery (RGB)	2002
Orthoimagery (RGB+NIR)	2004
Habitats map	2007
Species records	2000-2010
Land Cover Map (COS90)	1990
Land Cover Map (COS00)	2000
Land Cover Map (COS06)	2006
Land use change maps 90-00	(1990-2000)

Additionally, imagery from the MODIS sensor (2000-2010) is available: (i) MODIS Vegetation Indices 16-Day L3 Global 250m (Tile h17v04) data, with 250m of spatial resolution; (ii) MODIS Gross Primary Productivity 8-Day L4 Global 1km (Tile h17v04). Also, six SPOT 5 images (multispectral) for the period between 2002 and 2005 exist from previous projects and will eventually be available for use in the project upon specific protocols.

Several thematic ancillary datasets are available for the site, namely climate, hydrography, geology, soils, socioeconomic and demographic data, agrarian censuses (farm structural survey data), forest surveys (national inventory), wildfires, and road network.

Biodiversity indicator selection

The main indicators will be related to the state and trend of: (i) habitats of European interest (extent and change), (ii) abundance and distribution of selected species, and (iii) fragmentation of natural and semi-natural areas. These indicators are valuable to address the effects of processes and drivers such as land use change (extensification, abandonment, concentration, local intensification and specialization), fire regimes (and changes in those regimes), and invasion by alien species.

Other indicators will be considered when developing specific studies. These include: (i) state and trends of ecosystem function (e.g., productivity, phenology), of landscape diversity and spatial structure and function, and of species diversity (e.g., species richness); (ii) intensity of pressures and threats e.g., land use and land use change, fire regimes, and extent of invasion by alien species; and (iii) response/adaptation (indicators related to e.g., land use planning, nature protection inside and outside protected areas, allocation of conservation resources/funding, and agri-environmental schemes).

Users

The main users and managers of this site are the National Agency for Nature Conservation (ICNB), the water resources agency, the national forestry agency, local authorities, hunters' associations, common land associations, land owners, and tourists. ICNB is involved in the project as an End User.

3.5 Partner 11: ABERY

3.5.1 UK: (study site Cors Fochno/Borth Bog) Borth Bog, Wales

General description

Cors Fochno (Figure 11) is an estuarine mire complex containing the largest uncut area of lowland raised bog in the UK with an active peat forming dome of ~200 ha. The Natura 2000 site is located with the Dyfi catchment, which itself is a UNESCO Biosphere area. A wide range of habitats exist within the catchment (Figure 12), with those surrounding the bog including a 'drying' sandy estuary (Dyfi estuary) with mud and sand flats, sand dunes and saltmarshes; reed swamp, wet woodland, marshy grassland and improved/semi-improved grasslands grazed mainly by cattle and ponies. The estuary itself is part of a large marine Special Area of Conservation (SAC) called Penllyn a'r Sarnau and the estuary and bog together comprise the Dyfi-Cors Fochno RAMSAR site.

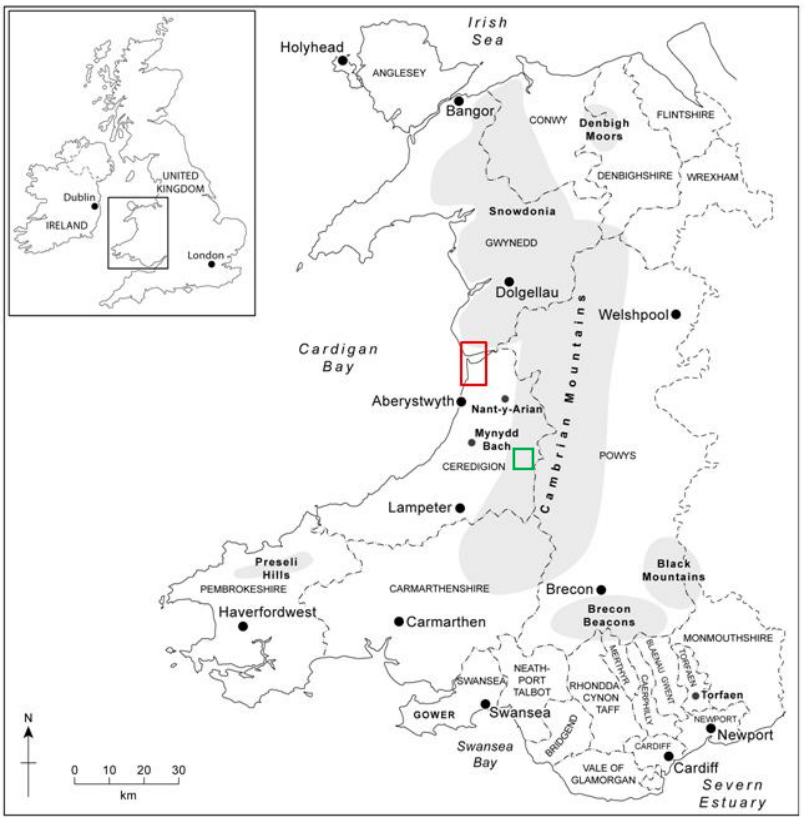


Figure 11 UK_Location map of Cors Fochno (red), Wales, UK. The location of Cors Caron (Tregaron Bog) is also highlighted (green)

The active bog dome supports a number of characteristic plant species, including *Sphagna* spp. (bog mosses), *Erica tetralix* (cross-leaved heath), *Andromeda polifolia* (bog rosemary), *Eriophorum angustifolium* (common cotton grass), *Calluna vulgaris* (heather) and *Rhynchospora alba* (white beak-sedge). *Myrica gale* (bog myrtle) and *Eriophorum vaginatum* (hare's tail cotton grass), *Narthecium ossifragum* (bog

asphodel) and *Drosera* (sundew) sp. are also locally abundant. Scarcer species include *Vaccinium oxycoccus* (cranberry), *Menyanthes trifolia* (bog bean) and *Rhynchospora fusca* (brown beak sedge). *Molinea caerulea* (purple moor grass) is abundant on the more disturbed sections of the bog and *Phragmites australis* (common reed), *Juncus maritimus* (sea rush) and *Schoenus nigricans* (black bog rush) occur on areas affected by former saline incursion.

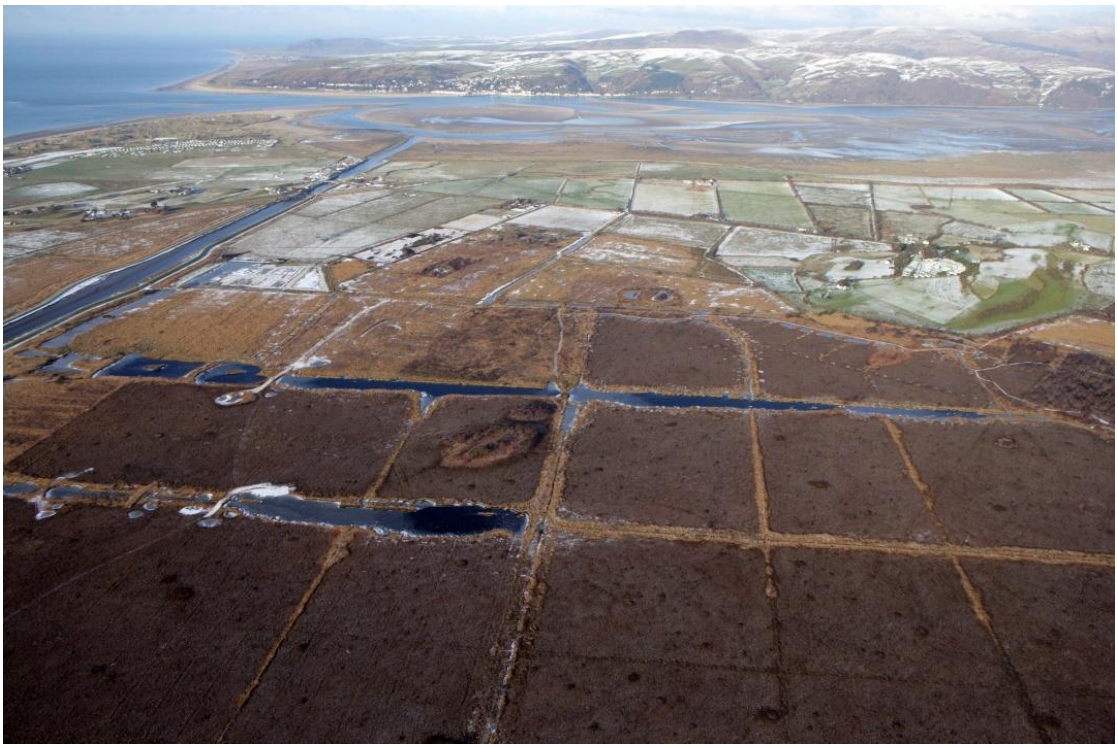


Figure 12 UK_Cor Fochno with the Dyfi Estuary and Ynyslas dune complex to the north and west (December, 2010)

Important features of the area in and around the bog include submerged fossil forest beds and the layers of peat and estuarine sediment provide an important palaeo-environmental and archaeological (last 7000 years) record of the area.

Cors Fochno, along with much of the estuary and dune area, is managed by the Countryside Council for Wales (CCW) as the Dyfi Nature Reserve. In addition to its designation as a SAC and RAMSAR site, Cors Fochno is also a 'core conservation zone' of the Dyfi Biosphere. The sand dunes and estuary are used extensively for recreation and the main bog area is surrounded by agricultural land. The main objectives for management are to:

- Restore active peat forming conditions, maximising peat growth and elevation
- Prevent deterioration of the peat archive (through drying and oxidation) and loss of carbon to the atmosphere.
- Restore areas of degraded mire by hydrological controls and appropriate grazing.
- Maintain or increase all rare and notable species populations.
- Enhance the landscape quality of the bog and surrounding ecosystems.
- Control encroachment of woody vegetation and prevent or reduce fire damage.

- Monitor important conservation features and environmental influences (e.g., aerial deposition).
- Maximise scientific research, education and access as far as compatible with the scientific features.

Habitat types (Dir 92/43/EEC) and species evaluation

The Annex I (Level 3) categories occurring within the Dyfi-Cors Fochno estuarine complex are listed in Table 51. These consist of non-vegetated areas occupying the coastal margins (1110, 1130 and 1140), colonising vegetation (1210, 1310), saltmarsh (1310, 1320, 1330 and 1410) and sand dune communities (2110, 2120, 2130, 2150 and 2190). The active raised bog vegetation (7110) is replaced by *Molinia*-dominated areas (6410) and bog woodland (91D0) at the margin. Large areas of degraded raised bog vegetation (7120), which are capable of natural regeneration, are also found and much is being actively restored. In the wider Dyfi catchment, a number of other Annex 1 categories are present (Table 52), including vegetated sea cliffs (1230), Oligotrophic to mesotrophic standing waters with associated vegetation (3130), natural dystrophic lakes and ponds (3160) and wet heaths (with *Erica tetralix* as a component) (4010). Non-Annex I categories exist (Table 53), including coniferous plantations, urban developments (e.g., caravan parks, infrastructure), *Pterdium aquilinum* stands and *Phragmites australis*.

Table 51 UK_Annex 1 Categories present within the Dyfi-Cors Fochno estuarine complex

Class	Description
1110	Sandbanks which are slightly covered by sea water all the time
1130	Estuaries
1140	Mudflats and sandflats not covered by seawater at low tide
1210	Annual vegetation of drift lines
1310	*Salicornia* and other annuals colonizing mud and sand
1320	Spartina swards (*Spartinion maritimae*)
1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
1410	Mediterranean salt meadows (*Juncetalia maritimi*)
2110	Embryonic shifting dunes
2120	Shifting dunes along the shoreline with *Ammophila arenaria* ("white dunes")
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")
2150	Atlantic decalcified fixed dunes (*Calluno-Ulicetea*)
2190	Humid dune slacks
6410	*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)
7110	Active raised bogs
7120	Degraded raised bogs still capable of natural regeneration
91D0	Bog woodland

Table 52 UK_Annex 1 Categories present within the wider Dyfi catchment

Class	Description
1230	Vegetated sea cliffs of the Atlantic Coasts
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoë* to *Nano juncetea*
3160	Natural dystrophic lakes and ponds
4010	Northern Atlantic wet heaths with *Erica tetralix*
7130	Blanket bogs (* if active bog)
91A0	Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles

Table 53 UK_Non-Annex 1 Categories present within the Dyfi catchment (including the area in and surrounding Cors Fochno)

Class	Description
1020	Cultivated land
1021	Anthropogenic vegetation
1050	Settlements
5150	*Pteridium aquilinum* stands
72A0	Reed thickets (*Phragmites australis*)

General Habitat Categories

A wide range of GHCs are present within the site. On the coast, non-vegetated categories include sand/mudflats (TID/SAN/EAR) and saltmarshes with therophytes (THE) and caespitose hemicryptophytes (CHE). Vegetated sea cliffs and beach and coastal dune systems are notable features of the landscape, with these including embryonic, shifting and fixed coastal dunes as well as humid dune slacks (LHE/CHE). Both active and degraded raised bogs, with cryptograms (CRY), CHE, shrubby chamaephytes (SCH) and low phanerophytes (LPH), form the main features of the area and, within the wider Dyfi catchment and uplands, blanket bog (1.3.4.2.1) occurs. Wet acid, neutral and saline wetlands occur, although the former two are not found within the Cors Fochno reserve area. Herbaceous vegetation is associated largely with waterlogged, wet and/or moist saline or acid areas. Bog woodlands (TPH/DEC) occur on the bog margins and other woodlands (primarily old sessile oak; DEC) are found within the Dyfi catchment. No other GHCs have so far been identified within the study area.

Corine Land Cover classes

The main Corine land cover classes associated with Cors Fochno relate to marine, estuarine and freshwater ecosystems, associated vegetated areas (i.e., sand dunes and saltmarshes) as well as woodlands and peat bogs (Table 54). The wider Dyfi catchment has a greater diversity of woodlands, moors and heaths, bare rock and sparsely vegetated areas (Table 55).

Table 54 UK_Corine Land Cover classes present within and in surrounding Cors Fochno

Class	Description		
324	Transitional woodland scrub	423	Intertidal flats
331	Beaches, dunes, sands	511	Water courses
412	Peat bogs	512	Water bodies
421	Salt marshes	522	Estuaries
321	Natural grassland	523	Sea and ocean

Table 55 UK_Corine Land Cover classes present, Dyfi catchment

Class	Description
311	Broad leaved forests
312	Coniferous forest
313	Mixed forest
322	Moors and heathland
332	Bare rocks
333	Sparsely vegetated areas

Definition of scale requirements

For the Cors Fochno site, multiple observations from both optical and radar remote sensing data are needed for mapping and monitoring purposes. Phenology is the key to discriminating habitats. Almost all vegetated habitats exhibit seasonal changes in, for example, leaf cover, productivity, moisture content and relative amounts of non-photosynthetic material, although some (e.g.,, broadleaved woodlands, bracken (*P. aquilinum*)) show greater seasonal ranges in such attributes than others (e.g.,, coniferous forests and heather (*C. vulgaris*)). To allow discrimination, seasonal imagery from at least the early spring (late March; before leaf flush) and mid summer (July; post leaf flush) is essential, although for some species groups (e.g., those associated with the active raised bogs), observations in early autumn (e.g., late September/early October) would benefit discrimination.

In monitoring the habitats, there is a need to separate seasonal changes and the short-term results of management activities from longer-term trends. To do this, a comprehensive time-series of optical and potential radar imagery is desirable. For Cors Fochno, the time-series of cloud-free Landsat sensor data extends back to the early 1970s and a preliminary comparison with data acquired in 2010 suggests significant changes across the landscape, with those associated with Cors Fochno reflecting the positive impact of past management.

A number of indicator species have been identified for Cors Fochno, including *Sphagnum pulchrum* and *S. cuspidatum*, *Phragmites australis* and *Spartina* and *Salicornia* sp. As well as indicator species, the distribution of microtopographical features (e.g.,, hummocks and hollows within the active raised bog) can also be used to indicate trends in the condition of habitats. A combination of multi-temporal very high resolution optical sensor (e.g., Worldview, Quickbird) from selected periods (e.g., early spring, mid summer and early autumn) at a frequency of every 3-5 years would provide capacity to monitor the distribution of these indicator species. These datasets should be integrated with available airborne LiDAR so that changes in distributions can be better linked with changes in microtopography. The inclusion of existing airborne multispectral (2002) and hyperspectral (2009) data for Cors Fochno would also assist in developing baseline maps of species/habitat types and conditions.

The inclusion of high frequency (X and C-band) and low (L-band) frequency Synthetic Aperture Radar (SAR) from spaceborne sensors is desirable, although the information content of these data has not been explored. These data are anticipated to provide information on differences in surface roughness and moisture content which may assist classification but also condition assessment. If interferometric data were available, there may potentially be used to quantify changes in the elevation of the active (including degraded) raised bog not only as a function of seasonal fluctuations in climatic variables (e.g., rainfall, temperature) but also hydrological regimes associated with management.

Pressures and threats

The main threats to the habitats associated with Cors Fochno are listed in Appendix 1 and in Table 56. Of primary concern is the active raised bog which is particularly vulnerable to changes in the hydrological regime caused by intentional drainage but also flooding and saline intrusion associated with storm surges and sea level rise. In particular, hand peat cutting carried out during the 18th, 19th and early 20th century and mainly around the margins of the dome as well as channelization and diversion of the River Leri have led to fragmentation of the bog and drainage subsidence. Subsequently, recent efforts by the Countryside Council for Wales (CCW) have focused on restoring the hydrological regime of the bog. Some flood events have occurred which has periodically swamped parts of the active bog and several predictions of flooding based on scenarios of rainfall and tidal regimes have been made. Such events may be exacerbated by climatic change.

Table 56 UK_Main human pressures and threats recorded for GR1

Type of activity	In/out	Pressure intensity	% area	Influence
Drainage/water engineering	I	B	60	-
Encroachment	I	B	10	-
Burning	I	B	10	-
Fertilisation	I	B	60	-
Waste dumping	O	C	1	-
Grazing	I	B	30	-/+
Grazing	O	A	70	-/+
Hunting	I	C	10	-
Urbanisation	I	C	2	-
Urbanisation	O	C	1	-
Recreation	I	C	10	-
Recreation	O	C	10	-
Gravel/sand extraction	O	C	10	-
Water pollution	I	C	10	-
Soil pollution	I	C	1	-
Eutrophication	I	C	10	-
Climate change	I/ O	C	100	-
Invasive species	I	B	15	-

Pressure intensity: A (high), B (medium), C (low); Influence: – (negative), 0 (null), + (positive)

Isolating habitats from those that naturally adjoin has also taken place over the years. For example, many areas drained were improved for agriculture and the transitions between the estuarine environment in the north and the shingle and dune ridge to the west have been severed by the road and rail networks and the channelization of the Leri. The major constructions took place in the first half of the 19th century.

Succession and encroachment (e.g.,, by woodland, *Molinia caerulea*) can potentially lead to a reduction in the area and function of the raised bog and control is largely

through grazing and active management. Invasive species, including Rhododendron also occur, and may lead to a depletion of native plant species. Much of the bog is surrounded by agricultural land and airborne (e.g.,, nitrogen) deposition or direct fertilisation may favour certain plant species (e.g., *Molinia*) at the detriment of others.

Data availability

A wide range of research data are available for the site, with this collected as part of a series of diverse and often interdisciplinary projects (Table 57).

Table 57 UK_Summary of main data layers available for Cor Fochno

Source/sensor	Data range
Aerial Photography	1972 and 1999
Daedalus Airborne Multispectral Scanner	
Ordnance Survey maps	SN68 and SN69
Historical scanned maps	1790, 1794, 1804 1837, 1875, 1928
Field plots/transects (11 permanent)	Ongoing
Digital Phase 1 habitat map	1970-1990
Digital habitat map (satellite-based)	2003-2006
Digital National Vegetation Classification (NVC) map	
Landsat MSS	1975
Landsat -4/5 TM and ETM+	1984 - Present
ASTER/IRS	2000 - Present
CASI L1b	2002
Airborne Thematic Mapper	2002
Hyperspectral and LiDAR	2009
NEXTMap Britain - topographic data	SN69

Biodiversity indicator selection

Referring to the list of indicators included in BIO_SOS Delevrable 2.1 the three main Biodiversity Indicators (sensu CBD and SEBI 2010) selected fo rmonitoring the study site UK are:

- Habitats of European interest (extent and change),
- Abundance and distribution of selected species,
- Fragmentation of natural and semi-natural areas.

Users

Whilst the active raised bog is largely preserved, a wide range of uses are made of the surrounding landscape, particularly for agriculture, forestry and recreation (see Appendix 1). The bog itself is the focus of a number of studies that are aiming to better understand how nitrogen pollution and changing climate will affect the biodiversity and ecosystem properties of peatlands (EU PEATBOG), the hydrology of raised bogs and implications for ecosystem restoration, various aspects of carbon cycling including methane emissions and dissolved organic carbon release. Research has also led to the development of a state-of-the-art hydrological model for raised bogs and advances in the remote sensing of plant communities (e.g.,, *Sphagnum*-dominated) and palaeo-ecology. Collectively, this work is leading to the development

of bio-indicators of risk for conservation managers and policy applications. A monograph for the site is currently being compiled which will include ecological and physical science.

Main indicator species

A number of biodiversity indicators have been identified for the diversity of habitats occurring within and surrounding Cors Fochno. Indicators of active bog include *Spaghum pulchrum*, *S. cuspidatum*, *S. papillosum* and *Drosera anglica* (greater sundew). *S. pulchrum* forms mainly in hollows whilst *Rhynchospora alba* (white beaked sedge), although scattered throughout the bog, often forms distinct patches in areas intermediate between the hollows and hummocks. This species often encroaches into pools which subsequently decline in area but can also indicate a recovery of the bog system if increasing at the expense of *Calluna* or *Myrica* species. Both species are useful indicators of the drier situation where hummocks prevail, and these dwarf shrubs often form dense stands. Towards the drained margins of the bog, *Eriophorum vaginatum* (hare's foot cotton grass) and *Scirpus cespitosus* (deer grass), and increase in dominance with drainage. Tussock-forming species such as these occur alongside *Myrica* and *Calluna* species.

Increased salinity is indicated by an increase in *Juncus maritimus* (sea rush) which is typically found on the upper saltmarsh and is often difficult to distinguish spectrally from *Juncus effuses*. The evolution of the creek system over time may also reflect artificial constraints on tidal flows and sedimentation within the saltmarsh system. The presence of *Juncus effuses* is indicative of fairly severe drainage disturbance. Saline inundation in the past is indicated by the presence of *Juncus maritimus* and *Phragmites australis* shows tolerance of a wide range of hydrochemical conditions, including brackish water around the bog margins.

The presence of *Molinea caerulea*, Betula (birch) and Salix (willow) species indicates stages in the drying out of the bog margins. *Molinea* is also tolerant to burning and a fluctuating water table, which tends to occur when the hydrology of the bog is affected by drainage. However, such impacts may be masked by those of management, as *Molinea* is often controlled by grazing.

Within the dune systems, the loss of embryo dunes is a concern as then there is no replacement for the morphologically older dunes. Within the dune systems, the loss of embryo dunes is a concern as then there is noreplacement for the morphologically older dunes. *Cakile maritima* (sea rocket) is the principal strandline colonist and indicator of embryo dunes, so a decline in this species may indicate a trend towards a less active system.

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3.5.2 UK: (study site Cors Caron/Tregaron Bog), Wales

General description

This sequence of peat domes at Cors Caron (also known as Tregaron Bog) developed on the floodplain of the Afon (River) Teifi in mid-Wales and covers an area of around 330 ha. Cors Caron now represents the most intact surviving example in the UK of a raised bog landscape (macrotope). The three main extant domes are hydrologically isolated by the River Teifi and associated surface drainage features, and all three have suffered extensive damage as a consequence of past drainage and peat-cutting. Plants characteristic of the active dome include *Sphagna* (bog moss) spp., *Erica tetralix* (cross-leaved heath), *Vaccinium oxycoccus* (cranberry), *Andromeda polifolia* (bog rosemary), *Menyanthes trifoliata* (bog bean), *Eriophorum angustifolium* (common cotton grass), *Calluna vulgaris* (heather) and *Rhynchospora alba* (white beak-sedge). *Eriophorum vaginatum* (Hare's tail cotton grass), *Narthecium ossifragum* (Bog asphodel) and *Drosera* (sundew) spp. are also locally abundant. *Molinia caerulea* (purple moor grass) is commonplace, particularly on the bog margins, and *Phragmites australis* (common reed) and *Phalaris arundinacea* (reed canary grass) occur along the river and fen margins. Habitats surrounding the bog include reed swamp, wet woodland, marshy grassland and improved/semi-improved grasslands. Cors Caron is currently managed by the Countryside Council for Wales (CCW) and is designated as a Special Area of Conservation (SAC), a Ramsar site and a Special Site of Scientific Interest (SSSI). The management objectives are similar to those in place for Cors Fochno.

Table 58 Annex 1 Categories present within the Dyfi-CorsFochno estuarine complex

Class	Description
7140	Transition mires and quaking bogs
7110	Active raised bogs
7120	Degraded raised bogs still capable of natural regeneration
91D0	Bog woodland
7150	Depressions on peat substrates of the *Rhynchosporion*

Table 59 Annex 1 Categories present within the wider Dyfi catchment

Class	Description
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoë* to *Nano juncetea*
3160	Natural dystrophic lakes and ponds
4010	Northern Atlantic wet heaths with *Erica tetralix*
7130	Blanket bogs
91A0	Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles
3260	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

Table 60 Non-Annex 1 Categories present within the Dyfi catchment (including the area in and surrounding Cors Fochno)

Class	Description
1020	Cultivated land
1021	Anthropogenic vegetation
1050	Settlements
5150	*Pteridium aquilinum* stands
72A0	Reed thickets (*Phragmites australis*)

General Habitat Categories

Active and degraded raised bogs but also transition mires and quaking bogs, with cryptograms (CRY), CHE, shrubby chamaephytes (SCH) and low phanerophytes (LPH), form the main features of Cors Caron and blanket bog (1.3.4.2.1) occurs in the wider Teifi catchment. Bog woodlands (TPH/DEC) occur on the bog margins as well as extensive tracts of *Molinia*-dominated marshy grasslands (5.2.2.2) and other woodlands (primarily old sessile oak; DEC) are found in the surrounding area. No other GHCs have so far been identified within the study area.

Corine Land Cover classes

The main Corine land cover classes associated with Cors Caron are listed in Table 61 and, within the wider Teifi catchment, a greater diversity of woodlands, heaths, moors, bare rock and sparsely vegetated areas exist (Table 60).

Table 61 Corine Land Cover classes present, Cors Caron

Class	Description		
324	Transitional woodland scrub	511	Water courses
412	Peat bogs	512	Water bodies

Table 62 Corine Land Cover classes present, Dyfi catchment

Class	Description
311	Broad leaved forests
312	Coniferous forest
313	Mixed forest
322	Moors and heathland
332	Bare rocks
333	Sparsely vegetated areas

Definition of scale requirements

The bog habitats within Cors Caron are similar to those at Cors Fochno and so the scale requirements are the same.

Pressures and threats

The main threats to the habitats associated with Cors Caron are listed in Appendix 1 and are similar to those at Cors Fochno in both type and area (with the exception of those relating to coastal alteration and sea level fluctuation. Of primary concern is the

active raised bog which is particularly vulnerable to changes in the hydrological regime caused by intentional drainage. Succession and encroachment (e.g.,, by woodland, Molinea caerulea) can potentially lead to a reduction in the area and function of the raised bog and control is largely through grazing and active management. Invasive species, including Rhododendron, also occur, and may lead to a depletion of native plant species. Much of the bog is surrounded by agricultural land and airborne (e.g.,, nitrogen) deposition or direct fertilisation may favour certain plant species (e.g., Molinia) at the detriment of others.

Data availability

Cors Caron is located in proximity to Cors Fochno and therefore much of the spaceborne remote sensing data and ancillary datasets available are similar. CASI and Airborne Thematic Mapper (ATM) data were acquired in 2001 but no other high resolution imagery (apart from aerial photography) have been obtained subsequently.

Biodiversity indicator selection

Biodiversity indicators are similar to Cors Fochno in that they include *S. papillosum*, *Drosera anglica* (greater sundew), *Eriophorum vaginatum* (hare's foot cotton grass) and *Scirpus cespitosus* (deer grass). However, *Spaghum cuspidatum* is more characteristic of this bog system. *Molinea caerulea*, *Betula* and *Salix* species are also indicative of encroachment and drying.

Users

Cors Caron is a reserve that attracts a reasonable number of visitors, with paths, boardwalks and hides. The area surrounding is used primarily for agriculture and forestry (primarily coniferous plantations).

3.6 Partner 12: IRD France

3.6.1 BR: Brazilian site in the Amazon

General description

The Brazilian study areas for BIO-SOS is located in the Western part of the Amazon basin and in the Para state of Brazil. The Brazilian test site is not Natura 2000 sites and there is no Corine Land Cover map or equivalent for this part of the world. Site Br is the Tapajos National Forest called Flona Tapajos. National Forest is part of the conservation categories defined by the Law 9,985 of 18 July 2000 of the Brazilian Federal Constitution that establishes the National System of Nature Conservation Areas (SNUC). The law stipulates the criteria and norms for the creation, implementation and management of Conservation Areas in Brazil. A Conservation Area is a territorial space with its environmental resources, including waters within its jurisdiction, with special natural characteristics, legally established by public authority for conservation objectives and with defined limits, under special administrative regime, where appropriate guarantees of protection are in place.

The SNUC separates Conservation Units into two groups: Strict Protection and Sustainable Use areas. The purpose of Strict Protection Areas is nature protection, and only indirect use of their natural resources is permitted, with the exceptions the law itself allows, while the purpose of Sustainable Use Areas is to harmonize nature conservation with the sustainable use of components of its natural resources. Part of this second group, National Forest (Floresta Nacional – Flona) is an area with forest cover of predominantly native species and whose objective and whose principal objective is sustainable multiple use of forest resources and scientific research, in particular methods for the sustainable exploitation of native forests. It is publicly owned and any private properties within the area are compulsorily acquired. Traditional populations inhabiting the area at the time of its creation are able to remain in accordance with the regulations and the management plan.

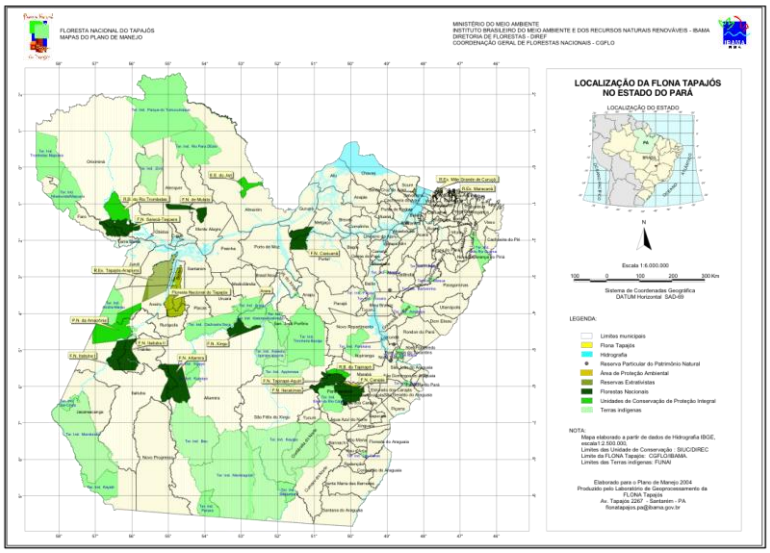

Figure 13 BR_Localization of the Tapajos National Forest in Brazil and in the Para State

The Tapajos National Forest is surrounded by the Tapajós river on its West border and by the Cuiabá-Santarém road (BR-163) on its East side. During the last years, this road has been famous to accelerate deforestation in this region of the Amazon.

The Flona Tapajos has an extension of 545.000 hectares and is mainly covered by dense evergreen forest.

General Habitat Categories

The main GHC of the Flona Tapajos is GPH (Mega phanerophytes) with EVR (Evergreen) phenological form. Agricultural areas are also present in the study site with the following three GHCs: cultivated herbaceous crop (CRO), cultivated woody crops (WOC) and cultivated bare ground (SPA). Urban elements are attributed to urban artificial (ART) and urban non-vegetated (NON).

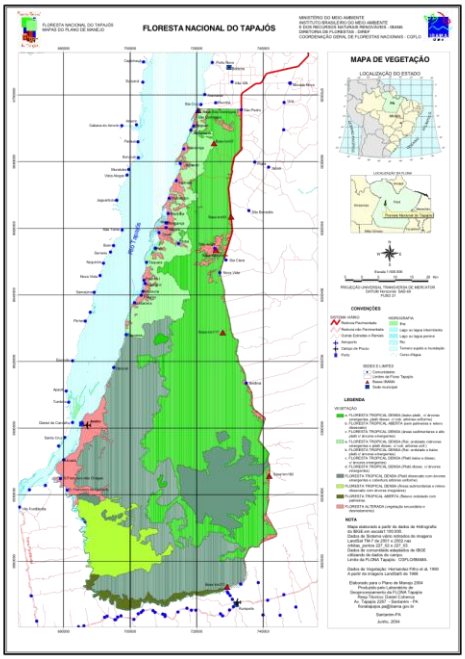

Figure 14 BR_Vegetation map of the Tapajos National Forest

Definition of scale requirements

For operational reason, the Amazon forest is generally monitored using high resolution images from Landsat type satellites at a resolution between 10 and 30 m on a yearly base. To detect new spot of deforestation, 250 m MODIS images are also useful every 15 days as well as radar data to detect deforestation during the rainy season.

Pressures and threats

Deforestation is the main threat of this conservation unit.

Data availability

Satellite images from Landsat, CBERS, IRS and SPOT are available for the study site. Limitation are strongly related to cloud cover.

Users

The Management Institution of the Tapajos National Forest is the Brazilian Institute of Forest Development.

4. Synthesis

The test sites of the BIO_SOS project are a diverse set of protected areas including wetlands, forests, grasslands and bogs. All of the protected areas are SCIs included in the Natura 2000 network because they host habitat types that are included in Annex 1 of the habitats directive (92/43 EEC). Furthermore, all areas are designated SPAs due to their diverse avifauna. All of the sites (with the exception of the smallest one) also include human activities, particularly those related to agriculture.

The surface area of the sites span from less than 700 ha (site UK) to more than 100,000 ha (site IT4). The test sites are located at altitudes from sea level (e.g., UK, GR1) up to 1545 m a.s.l. (PT2). Most of the sites belong to the Mediterranean biogeographic zone with the exception of sites UK and NL that belong to the Atlantic biogeographic zone. For the purposes of the BIO_SOS project we have compiled information on the land cover and land use of each site and we present a short comparison.

4.1 Corine Land Cover

Out of all the level 3 Corine Land Cover/Land Use classes only four are not present in any of our test sites. These are: 523 sea/ocean, 123 ports, 244 agro-forestry areas and 335 glaciers and perpetual snow. All of the other land cover classes are present in one or more sites. There are six more land cover classes present in only one site and three classes present in two sites. The land cover class that is present in all but the Dutch site is natural grasslands (321). The next most frequent classes present are forests (either broad-leaved 311, or coniferous 312), non-irrigated arable land (211) and land principally occupied by agriculture, with significant areas of natural vegetation (243).

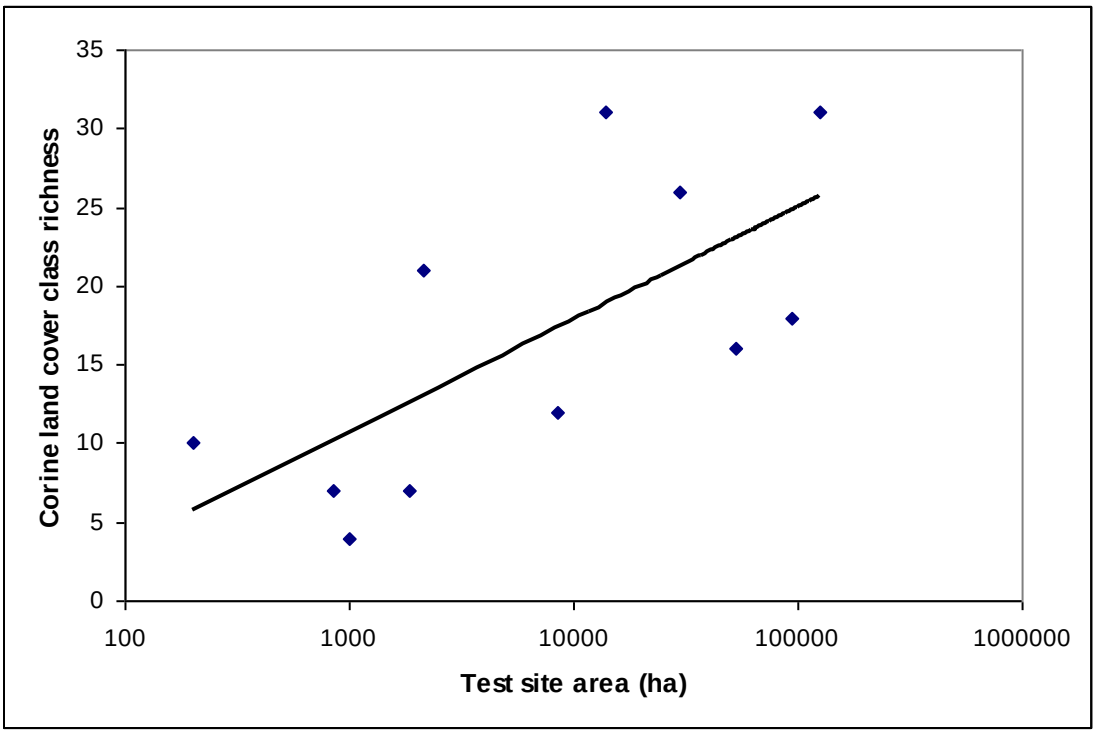

Figure 15 The relationship between the test site's area and its Corine Land Cover class richness. The fitted line represents the logarithmic model (R2=0.455; p=0.022)

As far as the sites are concerned, the sites with the greatest richness of CLC classes were IT2 and IT 3 (with 31 CLC classes each) followed by IT1 (26 classes) and IT 4 (21 classes). The site with the lowest richness of CLC classes was NL (with 4 CLC classes) followed by GR2 & GR3 (7 classes each). As this ranking indicates, site surface area is significantly correlated to the number of different land cover classes it includes (see Figure 15 above for the logarithmic model of the class richness area relationship R^2=0.455; p=0.022).

When comparing the composition of Corine land cover classes per site, we calculated the Jaccard Similarity Index for the pairwise comparison of all sites (Table 63). We found that no two sites had an identical composition. Overall the average score of the Jaccard similarity value was 0.278 and ranged between 0.067 and 0.781. The greatest similarity was observed between sites IT1 and IT3 (Jaccard similarity index was 0.781). The next most similar sites were PT1 and PT2 with Jaccard similarity 0.70. In general, the similarity among sites within a country was higher than among countries. The site with the lowest scores of the Jaccard similarity index was NL (maximum Jaccard value 0.19 with IT4) followed by UK (maximum Jaccard value 0.29 with GR1). This could be attributed to both the low number of land cover classes present in each site (4 in NL and 10 in UK), and to the fact that they are the only sites belonging to the Atlantic biogeographic zone, while all the others belong to the Mediterranean zone.

Table 63_ The values of the Jaccard similarity index for all pairwise comparisons among the BIO_SOS test sites. The Jaccard similarity index was calculated for the composition of Corine land cover classes in each site

	IT2	IT3	IT4	GR1	GR2	GR3	NL	PT1	PT2	UK
IT1	0.676	0.781	0.567	0.152	0.138	0.179	0.111	0.355	0.419	0.161
IT2		0.676	0.576	0.229	0.188	0.118	0.129	0.306	0.361	0.171
IT3			0.529	0.162	0.188	0.226	0.094	0.516	0.531	0.139
IT4				0.269	0.217	0.217	0.190	0.321	0.393	0.192
GR1					0.357	0.267	0.067	0.167	0.200	0.294
GR2						0.400	0.100	0.278	0.250	0.133
GR3							0.100	0.353	0.316	0.133
NL								0.176	0.158	0.077
PT1									0.700	0.130
PT2										0.167

The sites with the least represented CLC classes were IT3, GR1 and UK that each included two CLC classes not present in any other site. Furthermore, sites GR1 and UK were the only ones to have estuaries (522), while sites IT2 and IT3 were the only ones to have green urban areas (141), and sites IT2 and GR2 were the only ones to have inland marshes (411). It should be pointed out that no site had CLC classes composition totally different from any other, since they shared at least one common Corine land cover class.

4.2 Habitat types (Dir 92/43/EEC) and General Habitat Categories

The results of these two classification schemes will be presented jointly because they are identical. The main reason for this congruency is that the general habitat categories of the test sites have not been mapped in the field, but have been allocated in accordance with the habitats directive classification scheme. The general habitat categories are a fine scale classification scheme that needs very high resolution mapping, which will be undertaken for the test sites during the BIO_SOS project.

The habitat type classification scheme is more detailed than the Corine Land Cover/Land Use classification scheme, distinguishing significantly more classes of natural and semi-natural habitat types corresponding to a single CLC class. It is characteristic that natural grasslands (CLC class 321) correspond to more than twenty habitat types and thus it is not surprising that no habitat type is present in more than four of our test sites, in comparison to the ten sites with natural grasslands. There are four habitat types present in four sites each, namely annual vegetation of drift lines (1210), *Salicornia* and other annuals colonizing mud and sand (1310), thermo-Mediterranean and pre-desert scrub (5330) and *Salix alba* & *Populus alba* galleries (92A0). There are ten habitat types present in three test sites each, and 17 habitat types present in two sites each. Finally, there are a further 47 habitat types present in only one test site each. Overall in the eleven test sites there are 78 distinct habitat types.

All test sites include at least one habitat type included in Annex I of the habitats directive (92/43/EEC) and that is why they have been designated Sites of Community Interest (SCIs). In more detail our test sites host on average 11.5 habitat types, while the Annex I habitat type richness per site ranges between 4 and 24. The greatest richness of habitat types are present in the Portuguese sites (24 habitat types in PT1 and 22 in PT2) followed by the British site with 21 habitat types. On the other hand, the site with the least richness in habitat types is IT1 (with 4 habitat types) followed by IT3 and GR2 (with 5 habitat types), and then IT2, GR3 and NL (with 6 habitat types each). Further analysis showed that site richness in habitat types was not correlated with site area (R^2=0.025; p=0.64) or with the site richness of Corine Land Cover class richness (R^2=0.023; p=0.65). Consequently the ranking of sites according to their land cover class richness changes significantly. For example, site IT3 which hosts the widest range of Corine Land Cover classes (31) includes the lowest richness of Annex I habitat types (5). This is mainly due to the fact that the area covered by the Annex I habitat types is considerably smaller than the test sites area, and that several habitat types may correspond to the same CLC class. With the exception of the Italian sites where CLC richness is significantly greater than habitat type richness, in all other cases CLC richness is approximately equal to or less than habitat type richness.

When comparing the composition of habitat type composition per site, we calculated the Jaccard Similarity Index for the habitat type composition (Table 64). We found that no two sites had an identical composition. Overall, the average score of the Jaccard similarity value was 0.066 approximately equal to the minimum Jaccard similarity observed for the CLC classification scheme for the same sites. For the habitat type classification scheme, the Jaccard similarity index scores ranged between 0 and 0.50. In 28 of the 55 pairwise comparisons among the eleven test sites, we found no common habitat type. On the other hand, the greatest similarity (50% of the habitat types present in both sites) was observed between sites IT1 and IT3, as was the case for CLC. The second greatest Jaccard similarity score (0.33) were observed for the pairs IT2 vs GR1 and IT4 vs GR1. Finally, in this scheme it also appears that the comparisons among the sites of the same country are also more similar than the overall average.

Table 64 The values of the Jaccard similarity index for all pairwise comparisons among the BIO_SOS test sites. The Jaccard similarity index was calculated for the composition of habitat type classes present in each site

	IT2	IT3	IT4	GR1	GR2	GR3	NL	PT1	PT2	UK
IT1	0.000	0.500	0.059	0.059	0.125	0.000	0.000	0.077	0.000	0.000
IT2		0.000	0.250	0.333	0.000	0.000	0.000	0.000	0.000	0.080
IT3			0.000	0.000	0.111	0.100	0.000	0.036	0.000	0.000
IT4				0.333	0.000	0.111	0.000	0.056	0.000	0.129
GR1					0.188	0.176	0.000	0.118	0.000	0.129
GR2						0.100	0.000	0.115	0.000	0.000
GR3							0.000	0.034	0.000	0.000
NL								0.034	0.077	0.000
PT1									0.243	0.023
PT2										0.049

4.3 Comparison of CLC vs. Habitat types classification schemes

The two classification schemes (Corine Land Cover vs. habitat types) used here to compare the test sites are qualitatively different. Corine Land Cover/Land Use classification places an emphasis on human utilization of the landscape, while natural vegetation is coarsely classified in few vegetation types. Of the 46 classes used, 24 refer to artificial surfaces and agricultural land, while the remaining 22 classes cover natural and semi-natural vegetation, wetlands and water bodies. This scheme has also been applied consistently throughout Europe for producing land cover maps based on remote sensing data, and currently three such maps have been produced (the third is not yet completed).

The habitat type classification scheme, on the other hand, has been designed to assist in the conservation of the natural environment and thus it is more oriented towards natural habitat types. So far 229 land cover classes are identified. 178 of these classes are different types of forests and correspond to just 3 Corine land cover classes. On the other hand, in the European habitat type classification scheme there are no classes for artificial surfaces and agricultural land that form the bulk of the Corine classification scheme. Furthermore, this classification scheme has been applied only to areas of high conservation value that have been designated as part of the European Natura 2000 network of protected areas, and even in such sites there are portions unmapped due to the dominance of human dominated land cover / land use.

Besides the theoretical differences we compared the results of the two schemes for the test sites of the BIO_SOS project. The ranking of the sites according to their richness of the different land cover classes changed significantly (Spearman rank correlation R= -0.139; p=0.684). This might be due to the influence of the Italian sites that are among the richest in CLC classes and among the poorest in habitat types; which in term is a result of the fact that a large proportion of the site classified under Corine is not natural habitats and remains outside the habitat type classification.

Furthermore, this became apparent when we compared site richness with site area. In the case of the Corine classification, there was a significant correlation between

site area and land cover diversity (R^2=0.455; p=0.022), while no such correlation was apparent for the habitat type richness (R^2=0.025; p=0.64). This lack of diversity area relationship might be attributable to the fact that large portions of the sites area did not correspond to any habitat types.

Besides analysing the difference in richness of these schemes, we also analysed the differences in the sites composition of land cover classes. More specifically we estimated the matrix of pairwise Jaccard similarity values using the Corine scheme and the habitat type scheme. We compared the two matrices using the Mantel test. The comparison was significant (p=0.006) albeit relatively weak (correlation coefficient = 0.374). This finding indicates that the similarity in land cover composition was comparable in the two schemes.

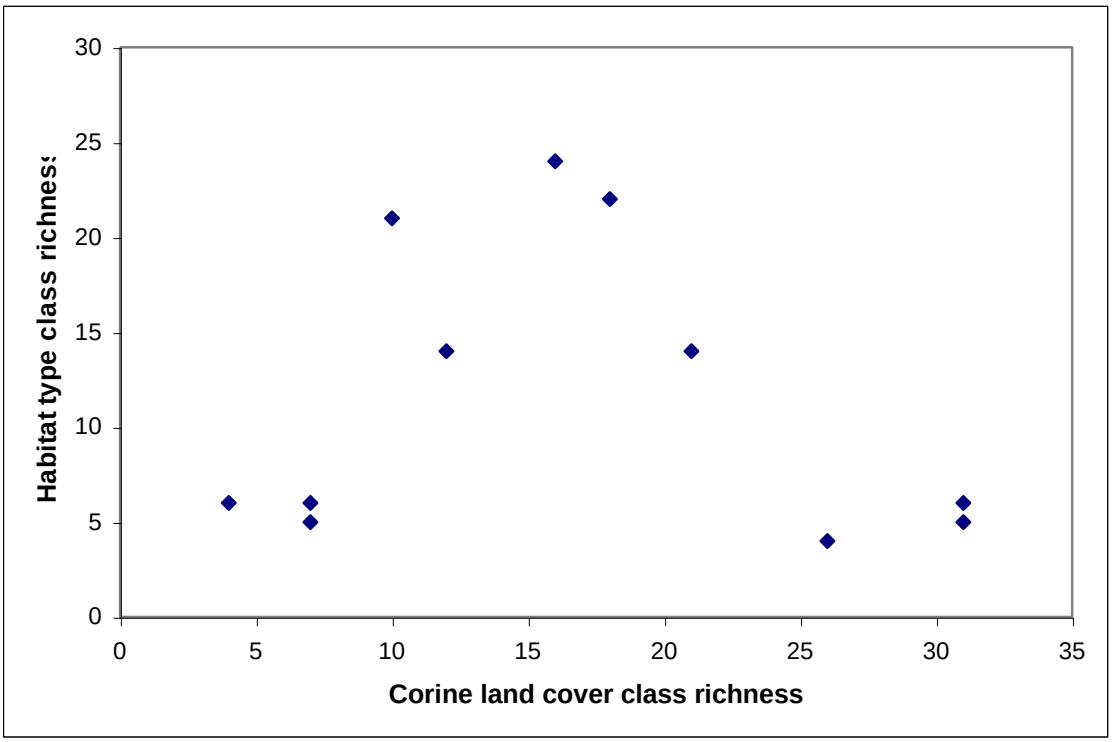

Figure 16 The relationship between the test site's richness in Corine Land Cover class and its habitat type richness

4.4 Pressures and threats

All the test sites are influenced by one or more types of anthropogenic pressure or natural threats. By far the commonest type of human activity that affects our test sites is agriculture that, in one way or another, is present in all test sites. Among them drainage and water manipulation along with structural degradation as a result of fires are the most common threats identified. The next commonest category of human activities refers to water engineering, management and consumption which affect almost all the test sites (the only exception being site NL). This was intuitively expected since many sites are wetlands. Among these activities, construction of dams, water engineering and river straightening for the prevention of riverine dynamics, and dumping of rubbish in water courses are the most common threats. The third commonest category is, perhaps surprisingly given the predominance of forest land cover classes, forestry and forest uses (eight sites). In this category, the most harmful activities refer to depletion of wood resources and plantation of non-

autochthonous tree species. The next commonest category is tourism (seven sites). Finally, the least frequently occurring human activities are hunting and fishing, which are perceived as a pressure in only three of the test sites, with this being severe in PT1 and PT2 but controlled in UK), as well as poaching (IT2). Not only anthropogenic, but natural hazards are also a recurring theme in the test sites (reported in eight sites). Among them invasive species are considered a major threat in all but the Italian sites.

Comparing among sites, we observed that the smallest of the sites (UK) is also affected by the greatest range of threats and pressures (only forestry is not a pressure), a fact that we contribute mainly to the fragile nature of the bog ecosystems. Next in line are the Greek sites that all are affected by almost all categories of pressures and threats except hunting and fishing, and with an emphasis on agricultural activities. The Portuguese sites follow, and finally the Italian and Dutch sites are the least affected.

To compare the similarity in the profiles of human activities among sites we calculated the Jaccard similarity index (Table 65). The results showed that no two sites had an identical profile and, in fact, two sites (PT1 and IT4) did not have any common pressures or threats. The greatest similarity was observed for sites IT1 and IT3 (0.67), followed by the pair GR1 – GR3 (0.63). Again sites within a country seemed more similar than the overall average (mean value of Jaccard similarity index 0.20).

Table 65 The values of the Jaccard similarity index for all pairwise comparisons among the BIO_SOS test sites. The Jaccard similarity index was calculated for the composition of threats and pressures reported in each site

	IT2	IT3	IT4	GR1	GR2	GR3	NL	PT1	PT2	UK
IT1	0.083	0.667	0.133	0.194	0.160	0.192	0.077	0.118	0.125	0.182
IT2		0.091	0.273	0.097	0.083	0.037	0.222	0.000	0.143	0.091
IT3			0.231	0.125	0.120	0.154	0.083	0.059	0.130	0.188
IT4				0.226	0.111	0.143	0.154	0.000	0.120	0.111
GR1					0.471	0.625	0.129	0.143	0.371	0.500
GR2						0.571	0.174	0.231	0.250	0.300
GR3							0.115	0.214	0.355	0.459
NL								0.133	0.136	0.156
PT1									0.250	0.273
PT2										0.471

Finally, trying to identify some of the environmental determinants of the pressures and threats, we found that site area was not correlated to the number of pressures and threats observed within the site (Spearman rank correlation coefficient –0.42; p=0.20). Also we found that the number of land cover types in a site was not correlated to the number of pressures observed in the site (for CLC Spearman rank correlation coefficient –0.49; p=0.12; for habitat types Spearman rank correlation coefficient 0.39; p=0.23). However, when comparing the similarity of sites according to their profiles of pressures and threats with that for their habitat types composition, Mantel test showed that the two matrices were significantly correlated (Correlation coefficient 0.42; p=0.002). Something that was not observed for CLC classes composition

(Mantel correlation coefficient 0.17; p=0.28). These results might imply that the profile of pressures and threats are more influenced by the natural habitat types, than by human land activities.

4.5 Definition of scale requirements

In all test sites the preceding analysis of their characteristics showed that for at least some features of the landscape with conservation interest there is a need for very high resolution maps and monitoring of change that is not currently available. Scale requirements for habitat mapping in terms of grain (sensor resolution) are both high and very high, in order to obtain habitat maps at 1:5000 or lower (for within habitat patch monitoring) which can be aggregated for the entire site (1:10000 or 1:25000 without loosing information). Furthermore, remote sensing observations from both optical and radar remote sensing data are desirable.

In terms of phenology, in all sites many if not most of the vegetated habitat types exhibit seasonal changes in, for example, productivity, moisture content and relative amounts of non-photosynthetic material. Especially in the Mediterranean biogeographic zone where most of the test sites are located, some habitat types (e.g.,, broadleaved woodlands) exhibit greater seasonal variation in such attributes than others (e.g.,, coniferous forests). To allow discrimination, seasonal imagery from at least the early spring (e.g., March; before leaf flush) and mid summer (e.g., late July; after leaf flush) is essential, although for some species groups (e.g., those associated with the active raised bogs), observations in early autumn (e.g., September or October) would benefit discrimination.

In almost all cases, the key biodiversity indicators identified are related to the state and trend of habitats of European interest, and fragmentation of natural and semi-natural areas. Therefore, most processes to be evaluated and monitored are related to land use change and vegetation dynamics, and could therefore be monitored every 3-5 years, but specific responses could be assessed on a yearly basis. Since all test sites belong to the European Natura 2000 network, it is suggested that they should be monitored at least every 6 years.

4.6 Biodiversity indicators

Despite the wide range of biodiversity indicators identified by CBD and by SEBI2010, consistently with the indicators selected for BIO_SOS (Deliverable 2.1, Tables 1, 2, 3), in almost all test sites of the BIO_SOS project there is a core of three key biodiversity indicators identified as appropriate and critical to monitor. More specifically, these key indicators will be related to the state and trend of: (i) habitats of European interest (extent and change), (ii) abundance and distribution of selected species, and (iii) fragmentation of natural and semi-natural areas.

These indicators are valuable to address the effects of processes and drivers such as land use change (e.g agricultural extensification or abandonment, urban sprawl, vegetation dynamics) and natural disturbance regimes (e.g., wildfires, floods). Even though the pressures and threats are not identical in all sites, and consequently all the processes and drivers are not applicable in all sites, the same key indicators seem to be effective in almost all cases.

On a secondary basis, other indicators will be considered in specific sites when developing specific studies. These include: (i) state and trends of ecosystem function (e.g., productivity, phenology), of landscape diversity and spatial structure and function, and of species diversity (e.g., species richness); (ii) intensity of pressures and threats e.g., land use and land use change, fire regimes; and (iii)

response/adaptation (indicators related to e.g., land use planning, nature protection inside and outside protected areas, allocation of conservation resources/funding, and environmental compensatory measures).

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Appendix 1: Summary tables for BIO_SOS sites

Appendix 1 includes the following summary Tables:

*Summary table 1*_BIO_SOS sites - Natura 2000 (N2K) type, i.e. SCI vs SPA, SCI/SPA spatial relation, Environmental Zones of Europe derived from the Environmental Stratification of Europe (Metzger et al 2005 and Jongman et al 2005).

*Summary table 2*_N2K – Annex I (Dir 92/43/EEC) habitat types represented in the BIO_SOS sites

*Summary table 3*_GHC – General Habitat Categories represented in the BIO_SOS sites according the EBONE D4.2 Rule based system for Annex I habitats (Bunce *et. al.*. 2010).

*Summary table 4*_CLC – Corine Land Cover (level 3) classes represented in the BIO_SOS sites.

*Summary table 5*_OVERALL SUMMARY N2K– Annex I (Dir 92/43/EEC) habitat types (main entry) correspondence to GHC classification system and to the Corine Land Cover classification system. The correspondence to the EUNIS classification system is envisaged (task 6.1 of the BIO_SOS project)

*Summary table 6*_OVERALL SUMMARY GHC – GHC classification system (main entry) correspondence to Annex I (Dir 92/43/EEC) habitat types and to the Corine Land Cover classification system. The correspondence to the EUNIS classification system is envisaged (task 6.1 of the BIO_SOS project)

*Summary table 7*_Threats per site - Threat (pressures/impacts) categories and subcategories_according to Dimopoulos 2006, as adapted for the BIO_SOS project represented in the BIO_SOS sites.

*Summary table 8*_Threats cross tab - Threat (pressures/impacts) categories and subcategories_according to Dimopoulos 2006, as adapted for the BIO_SOS project represented in the BIO_SOS sites, in connection to GHC categories and Annex I habitat types, by site

*Summary table 9*_Threats NL - Threat (pressures/impacts) categories and subcategories_for the Duch site

A copy of Appendix 1, file titled Summury_tables_for_BIO_SOS_sites.pdf ,

can be found at: http://www.biosos.wur.nl/UK/

Appendix 2: Supplementary figures for sites NL and IT1-4

Appendix 2

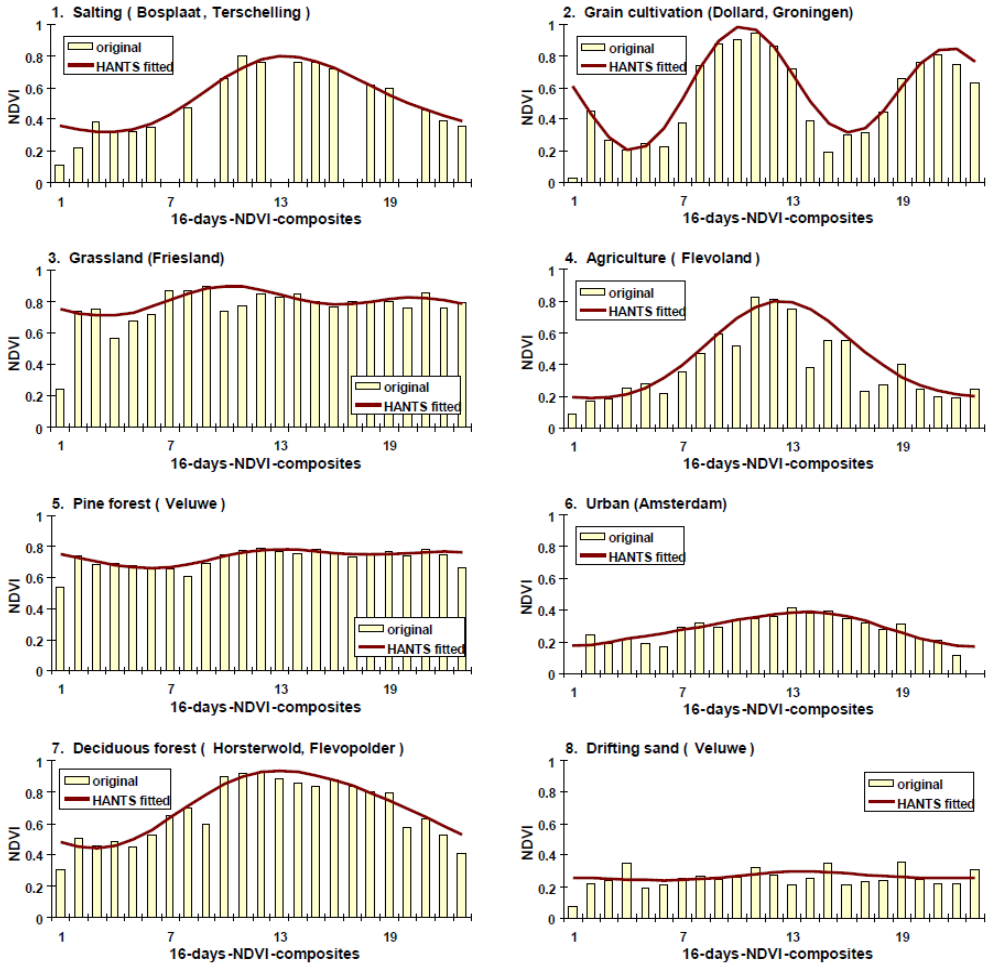

Figure A2.1 The yearly profile of the original NDVI values and the HANTS fitted curve for typical land use types in the Netherlands
Source: Alterra Report 2023 (Roerink & Danes, 2010)

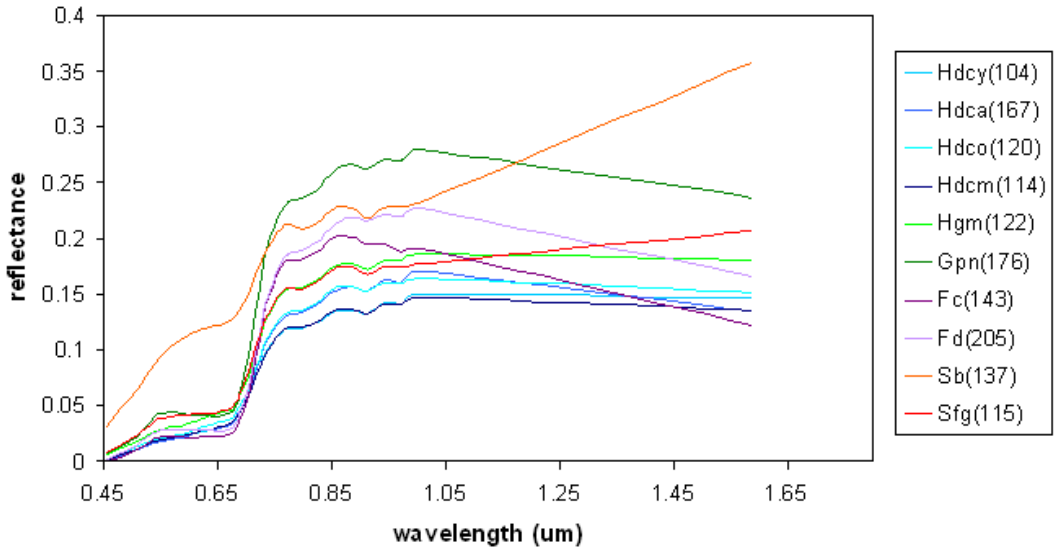

Figure A2.2 The AHS-160 based end-member spectra derived for the heath land habitat types present in the study area (NL)

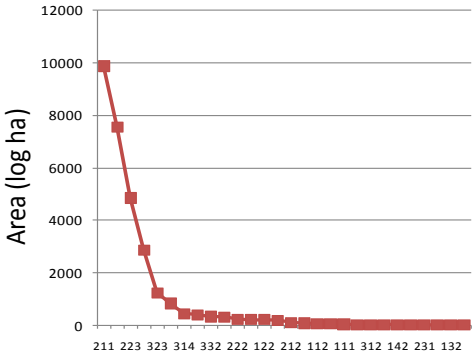

Figure A2.3 IT1 Corine Land Cover importance diversity curve

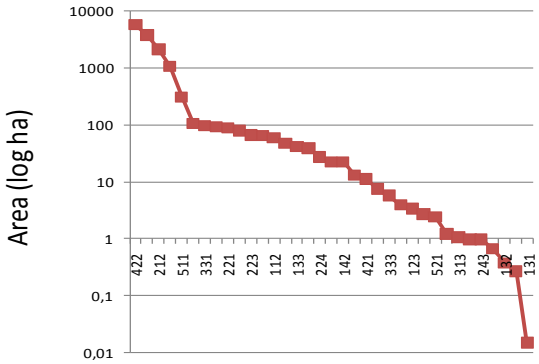

Figure A 2.4 IT2 Corine Land Cover importance diversity curve

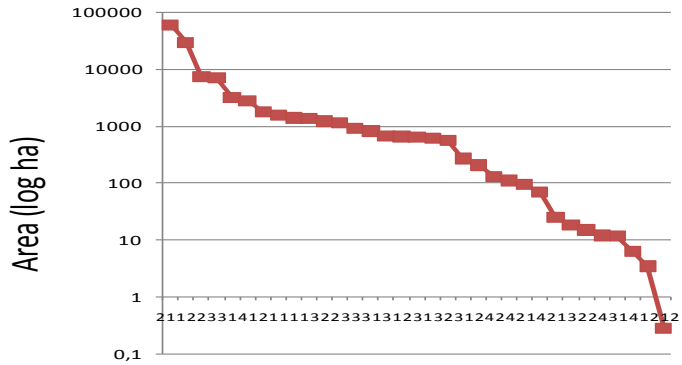

Figure A2.5 IT3 Corine Land Cover importance diversity curve

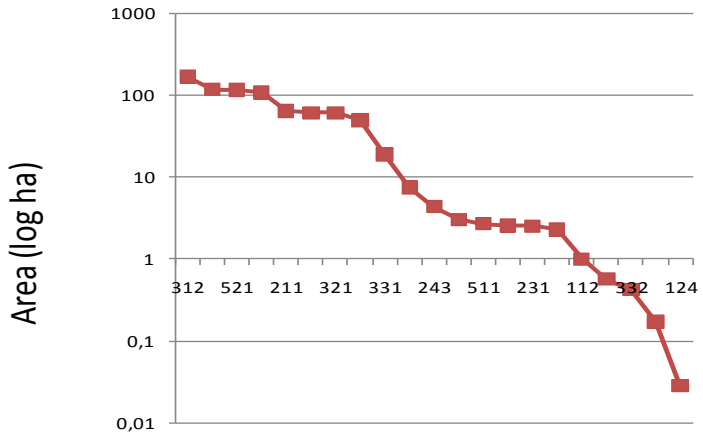

Figure A2.6 IT4 Corine Land Cover importance diversity curve

Appendix 3: Acronym list

CBD	Convention of Biological Diversity
CLC	CORINE Land Cover
EBONE	European Biodiversity Observation Network
EEA	European Environmental Agency
EO	Earth Observation
EUNIS	European Nature Information System
GHCs	General Habitat Categories
HR	High Spatial resolution (3-30m)
LC	Land Cover
LCC	Land Cover Change
MR	Medium spatial resolution (30-300m)
N2K	Natura 2000
RS imagery	Remote Sensed imagery
SEBI	Streamlining European 2010 Biodiversity Indicators
VHR	Very High spatial Resolution (<3m)