Preparatory work for developing

GUIDANCE ON THE MAINTENANCE OF LANDSCAPE CONNECTIVITY FEATURES OF MAJOR IMPORTANCE FOR WILD FLORA AND FAUNA

Guidance on the implementation of Article 3 of the Birds Directive (79/409/EEC) and Article 10 of the Habitats Directive (92/43/EEC)

Report on the review of measures to promote connectivity

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1 INTRODUCTION

In the European Union, the Directive 79/409/EEC on the conservation of wild birds (Birds directive) and the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats directive) set out the legal basis for the establishment of a European Union network of protected areas under the banner of Natura 2000. The Directives contain provisions for the identification and designation of individual sites. In addition, they also contain specific provisions relating to the use of measures to promote connectivity between sites and overall coherence to form the Natura 2000 Network (See Section 2.1.1).

The importance of ecological connectivity has become increasingly recognised from the sub-national to the global level, with initiatives and policies being developed in most EU countries and within the Convention on Biological Diversity (CBD) Programme of Work on Protected Areas. This thrust in effort comes from the awareness that although the amount of protected areas has increased rapidly in the last fifty years, these areas will always remain in the minority (e.g. 18 per cent of terrestrial EU is covered by Natura 2000). Protected areas will remain 'core areas' that are vital for biodiversity conservation, but species survival and ecosystem functioning are reliant on interactions with the wider landscape.

The dependence of the wider landscape is exacerbated by the increasing threat being posed by climate change for which there is now a broad base of research showing the differing responses of species (Parmesan and Yohe 2003) and serious future impacts (Thuiller et al. 2005, Broennimann et al. 2006). The effects of climate change are likely to interact with those of fragmentation to present significant barriers to species trying to track changing ecological conditions. This means that one of the most pressing issues facing protected areas management and the Natura 2000 network is the promotion of connectivity and coherence within the wider land and seascape.

1.1 Aim of the review

This review examines practices in place at the Community level and in Member States (MS) that support the establishment of ecological networks and enhancement of ecological coherence and connectivity within ecosystems/landscapes (based on the Article 10 of habitats Directive). The review of the Member States' measures is based on a number of country case studies, including Belgium, Finland, Germany, Lithuania, the Netherlands, Slovakia, Spain and the UK. In addition, a short over view of international framework and measures will be provided.

The review forms a part of a broader study (ENV.B.2/ETU/2006/0042R) aiming to provide the European Commission with scientifically robust advice on how to guide the Member States in implementing connectivity and coherence related provisions of the Habitats and Birds directives.

The review looks into practises that a) specifically aim to enhance coherence and connectivity (e.g. ecological networks, ecological corridors, stepping stones etc.) and b) measures that do not seek to improve connectivity as such but may, in some instances, allow for the movement of species (e.g. provision of windbreaks, hedgerows, protected zones along water bodies to avoid nitrate deposition, and road and rail corridors).

Measures reviewed as a part of this review include, for example:

- legislative tools;
- policy instruments and their implementation;
- instruments for land-use planning and management;
- use of different incentives (e.g. agri-environment schemes) to improve the landscape/farmland connectivity.

The review is based on desk based research and interviews of relevant national experts. The finding of this review will be used in the context of the above mentioned study when developing guidance to the Member States (task 4 of the project).

2 REVIEW OF COMMUNITY MEASURES SUPPORTING CONNECTIVITY

2.1 Biodiversity and nature conservation

2.1.1 Habitats and Birds directives

The Habitats and Birds directives[1] form the main legal framework for protecting nature and biodiversity at the EU level. The overall aims of both directives are indicated in Box 1.1. In order to achieve their objectives both directives include two main types of action. Firstly the protection of important sites, these constitute Special Areas of Conservation (SACs) designated under Articles 4 and 5 of the Habitats directive (for habitats and species of Community interest) and Special Protection Areas (SPAs) designated under Article 4 of the Birds directive (for birds listed in Annex I of the directive and for migratory species). These are combined under Article 3 of the Habitats directive to form 'a coherent ecological network' referred to as the Natura 2000 network.

[1] Council Directive 92/43/EEC on the conservation of natural habitats of wild fauna and flora (the Habitats directive): http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/habitats_directive/index_en.htm

Council Directive 79/409/EEC on the conservation of wild birds (the Birds directive): http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/birds_directive/index_en.htm

Box 1.1. The aims of the EU Birds and Habitats directives

Birds directive

Article 1

1. This Directive relates to the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States to which the Treaty applies. It covers the protection, management and control of these species and lays down rules for their exploitation.

2. It shall apply to birds, their eggs, nests and habitats.

3. This Directive shall not apply to Greenland.

Article 2

Member States shall take the requisite measures to maintain the population of the species referred to in Article 1 at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.

Habitats directive

Article 2

1. The aim of this Directive shall be to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies.

2. Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest.

3. Measures taken pursuant to this Directive shall take account of economic, social and cultural requirements and regional and local characteristics.

The second type of actions are provisions for species protection that apply to the whole of each Member State's territory and concern the physical protection of listed species as well as their breeding sites and resting places.

Both directives include various connectivity conservation measures for protected areas and the wider environment. Firstly, connectivity measures are required to maintain or restore the coherence of the Natura 2000 network. In particular, paragraph 3 of Article 3 of the Habitats directive states that '*where they consider it necessary, Member States shall endeavour to improve the ecological coherence of Natura 2000 by maintaining, and where appropriate developing, features of the landscape which are of major importance for wild fauna and flora, as referred to in Article 10.*' In addition, Article 6.4 stipulates that if a plan or project with negative impacts on a site is to take place (due to 'imperative reasons of overriding public interest') the Member States are to take '*all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected*'.

The directives also include more general connectivity provisions that relate to land use planning and development policies. These are set out in the Article 10 of the Habitats directive and Article 3 of the Birds directive.

Article 10 of the Habitats directive

'Member States shall endeavour, where they consider it necessary, in their land-use planning and development policies and, in particular, with a view to improving the ecological coherence of the Natura 2000 network, to encourage the management of features of the landscape which are of major importance for wild fauna and flora. Such features are those which, by virtue of their linear and continuous structure (such as rivers with their banks or the traditional systems for marking field boundaries) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species.'

Article 3 of the Birds directive

'…Member States shall take the requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats for all the species of birds referred to in Article 1. 2. The preservation, maintenance and re-establishment of biotopes and habitats shall include […] (b) upkeep and management in accordance with the ecological needs of habitats inside and outside the protected zones…'

It is clear from the texts of the Habitats directive that the interpretation of 'coherence' is a key issue affecting the implementation of directives. When considering the ecological coherence of Natura 2000, it is important to note that the completed Natura 2000 network, defined by the Habitats directive as the sum of all areas designated for conservation under the Birds and Habitats directives (Article 3.1 of the Habitats directive), is a collection of individual protected sites (COM 2005)[2]. In order for these protected sites to actually form an ecologically coherent network then necessary functional connections amongst the sites and their surroundings must be maintained. Therefore management measures may need to go beyond the designated sites' boundaries and apply to the wider environment. Consequently, even though the Habitats directive's definition of a completed Natura 2000 network appears to be synonymous with a 'coherent ecological network' (see Article 3.1) it is important to distinguish between the established Natura 2000 network (i.e. all the protected areas) and establishing/maintaining overall ecological coherence of the Natura 2000 network (which includes the necessary functional connections amongst the designated sites). Further guidance on the interpretation of the overall coherence of the Natura 2000 network has been provided by the European Commission with respect to Article 6(4) of the Habitats directive[3].

It is important to note that Article 10 suggests that conservation of landscape features is of particular importance as a means of supporting the coherence of the Natura 2000 network. However, it also implies that such measures should also be taken elsewhere where necessary. Article 3 of the Birds directive clearly indicates that habitat

[2] Habitats directive Article 3.1: 'A coherent European ecological network of special areas of conservation shall be set up under the title Natura 2000. This network, composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.'

[3] Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC (http://ec.europa.eu/environment/nature/nature_conservation/eu_nature_legislation/specific_articles/art6/index_en.htm)

conservation and restoration measures should be taken inside and outside protected areas.

Enhancing the movement and existence of species outside the sites designated for their protection is also supported by the Articles 4.3 and 4.4 of the Birds directive. According to the Article 4.3 of the Birds directive, *'Member States shall send the Commission all relevant information so that it may take appropriate initiatives with a view to the coordination necessary to ensure that the areas provided […] form a coherent whole which meets the protection requirements of these species in the geographical sea and land area where this Directive applies.'* In addition, the Article 4.4 stipulates that *'[…] Outside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats.'*

A key issue to consider is when are connectivity measures deemed to be necessary. In this respect measures should be taken when they are necessary to achieve the overall objectives of the directives (Box 1.1). In the context of the Habitats directive, the primary objective of the directive is the maintenance or restoration, at favourable conservation status (FCS), of the natural habitats and species of wild fauna and flora of Community interest (see Article 2.2 and Annex 1 for FCS definition). A European Commission paper[4] considers that '*FCS can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well*'.

The Commission's paper also notes that '*Member States are expected to take all requisite measures to reach and maintain the objective of FCS*'. Therefore, in principle Article 10 measures, and other connectivity provisions, should be implemented whenever they are necessary to maintain or restore FCS of habitats or species of Community interest, (COM 2005). Furthermore, the Commission states that '*The concept of FCS is not limited to the Natura 2000 network. The definition of FCS for habitats and species in Article 1 indicates clearly that the overall situation of species and habitats needs to be assessed and monitored (see Article 11) in order to judge if it is favourable or not.*' It therefore follows from this that Members States should implement connectivity measures where these are required to maintain or restore FCS whether they contribute to the coherence of the Natura 2000 network or not.

The assessment of FCS in accordance with Article 17 of the Habitats Directive is complex and therefore guidelines for assessment, monitoring and reporting are being developed by the European Commission. These should be referred to and used as the basis for establishing whether connectivity measures are required in order to maintain and restore FCS. The requirement to maintain FCS, including its connectivity related obligations, does not apply directly to the Birds directive. However, there are somewhat analogous, though rather less specific, obligations to maintain populations under Article 2 of the directive (see Box 1.1). Therefore, as in the case of the Habitats directive, it can be interpreted that connectivity measures under Article 3 should be

[4] Assessment, monitoring and reporting of conservation status – Preparing the 2001-2007 report under Article 17 of the Habitats Directive (DocHab-04-03/03 rev.3) (http://circa.europa.eu/Public/irc/env/monnat/library?l=/reporting_framework/dochab-04-03-03/_EN_1.0_&a=d)

implemented whenever they are required to maintain populations in accordance with Article 2 of the directive.

In addition, it should be remembered that SPAs designated for conservation under the Birds directive form an integral part of the Natura 2000 network (e.g. Article 7 of the Habitats directive). Therefore, in practice the conservation objectives for these areas are often closely associated with the FCS concept (e.g. FCS is used for setting conservation objectives and undertaking surveillance in the designated sites).

In summary, the protection and restoration of important landscape features and other connectivity measures should be implemented if they are necessary to:

- support the coherence, including functional connections, of the Natura 2000 network;
- maintain or restore FCS in habitats and species of Community interest; or
- maintain or restore populations of birds in accordance with Article 2 of the Birds directive.

It is recognised that the implementation of connectivity measures may be constrained by the current lack of detailed knowledge of the ecological requirements of many species and habitats. Article 18 of the Habitats directive, therefore calls for research and exchange of information and specially states that '*Particular attention shall be paid to scientific work necessary for the implementation of Articles 4 and 10, and transboundary co-operative research between Member States shall be encouraged*'.

2.1.2 EU biodiversity policy 2010 and beyond

The need to promote the implementation of Articles 10 and 3 of the habitats and birds Directives has been acknowledged by the recently adopted **Commission Communication 'Halting the loss of biodiversity by 2010 – and beyond'** (COM 2006/216)[5]. The Communication also introduces a new EU biodiversity Action Plan for 2010 and beyond. This Action Plan places high priority on enhancing the coherence, connectivity and resilience of the protected areas network (e.g. both Natura and non-Natura areas) (Objective 1 of the Action Plan, see Box 2). The Commission's biodiversity Communication also recognises that in addition to 'structural tools', such as flyways, stepping stone and corridors, enhancing the coherence, connectivity and resilience of the Natura 2000 network involves 'enhancing the ability of the wider environmental matrix' (page 53 of the impact assessment, Annex to the Communication).

The Action Plan also includes a specific set of actions related to supporting biodiversity adaptation to climate change (Objective 9 of the Action Plan). The aim of these actions is to substantially reduce the damaging climate change impacts on biodiversity. One of the listed actions specifically addresses the coherence, connectivity and resilience of the Natura 2000 network (See Box 2).

[5] Halting the loss of biodiversity by 2010 – and beyond. Sustaining ecosystem services for human well–being (COM 2006/216)

The Council of the European Union endorsed the biodiversity Communication and related Action Plan in the Environment Council meeting on 18 December[6]. As regards the Natura 2000 network, the Council particularly emphasised strengthening the coherence, connectivity and resilience of the network. In this context, the importance of regional and local land-use planning, in particular the related responsibilities of the Member States, was stressed.

Box 2. Actions outlined in the biodiversity Action Plan related to the ecological coherence and connectivity of Natura 2000 (COM 2006/216)

OBJECTIVE 1: TO SAFEGUARD THE EU's MOST IMPORTANT HABITATS AND SPECIES.

TARGET (A1.2): Sufficiency, coherence, connectivity and resilience of the protected areas network in the EU substantially enhanced by 2010 and further enhanced by 2013

ACTION (A1.2.1): Carry out [in 2008, following next reports] scientific review of habitat types listed in annexes of nature directives, informed by 'shadow lists' of priority habitats; add to annexes any missing habitat types of Community interest, and ensure all habitat types of Community interest are sufficiently represented in the Natura 2000 network [by 2010].

ACTION (A1.2.2): Accelerate efforts to place other designated protected areas (non-Natura 2000) of national, regional and local biodiversity importance under effective conservation management [by 2010, 2012 in marine].

ACTION (A1.2.3): Assess [by 2008] and substantially strengthen [by 2010] coherence, connectivity and resilience of the protected areas network (Natura 2000 and non-Natura protected areas) by applying, as appropriate, tools which may include flyways, buffer zones, corridors and stepping stones (including as appropriate to neighbouring and other third countries), as well as actions in support of biodiversity in the wider environment (see also actions under objectives 2, 3 and 9).

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OBJECTIVE 9: TO SUPPORT BIODIVERSITY ADAPTATION TO CLIMATE CHANGE.

TARGET (A9.4): Resilience of EU biodiversity to climate change substantially strengthened by 2010.

ACTION (A9.4.2): Assess [by 2008], on the basis of available scientific evidence, and substantially strengthen [by 2010] coherence, connectivity and resilience of the protected areas network (Natura 2000 and non-Natura protected areas) in order to maintain favourable conservation status of species and habitats in the face of climate change by applying, as appropriate, tools which may include flyways, buffer zones, corridors and stepping stones (including as appropriate to neighbouring and third countries), as well as actions in support of biodiversity in the wider environment (cf action 1.2.3).

[6] Environment Council Conclusions, 18 December 2006 (http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/envir/92249.pdf)

2.1.3 The EU LIFE programme

The LIFE Programme to date

The EU LIFE programme (L'Instrument Financier pour l'Environnement) was introduced in 1992 and developed earlier Community nature conservation funding instruments). Its aim is to contribute to the implementation, development and enhancement of the Community's environmental policy and legislation as well as the integration of the environment into other EU policies. LIFE is open to all EU countries, some candidate countries (e.g. Romania before it joined the EU) and some third countries bordering the Mediterranean and the Baltic Sea.

The programme has been implemented in three phases, with 400 million Euros allocated for LIFE-I (1992-1995), approximately 450 million Euros allocated for LIFE-II (1996-1999), and a budget of 640 million Euro allocated for LIFE-III (2000-2004). LIFE III was extended in September 2004 for two-years (2005-2006) with a budget of 317 million Euro. The programme has therefore had the capacity to have had a significant impact on the management of protected areas in Europe. Indeed it has been the largest single funding source for nature conservation projects in the EU (other than on agricultural habitats, which have been funded by agri-environment measures, see Section 2.2 below). LIFE III is now closed for new projects (though many existing projects will continue for several years) and is to be replaced by a new instrument known as LIFE+ (see below).

From LIFE-II onwards the programme has addressed three thematic components: LIFE-Nature, LIFE-Environment and LIFE-Third countries (i.e. outside the EU). Of these **LIFE- Nature** is of most relevance to biodiversity conservation and increasing connectivity. This is because the specific objective of LIFE-Nature is to contribute to the implementation of the Birds and Habitats directives and in particular the establishment of the Natura 2000 network. LIFE-Nature projects have encompassed a wide variety of measures, including land purchase, restoration of degraded habitats (e.g. drain blocking and tree removal on bogs), habitat creation (e.g. reedbed establishment), establishment of sustainable land management systems (e.g. livestock grazing), control or elimination of alien or introduced species (e.g. Rhododendron or predators such as Brown Rats (*Rattus norvegicus*)) reintroductions of species (e.g. Golden Eagle (*Aquila chrysaetos*), awareness programmes and the provision of visitor facilities and interpretation materials. Projects typically last 3-5 years and most are relatively large with budgets of 1-5 million Euro. In total 2,751 LIFE projects were supported from 1992 to 2006 (970 LIFE-Nature, 1,552 LIFE-Environment and 229 LIFE-Third Countries projects).

A requirement of LIFE Nature projects (under Article 3 para 5 of the LIFE Regulation) is that projects in the European territory of the Member States must relate to:

1. a site proposed by a Member State under Article 4 of the Habitats directive as an SAC, or
2. a site classified as an SPA under Article 4 of the Birds directive as an SPA, or
3. a species in Annexes II or IV of the Habitats directive or in Annex I of the Birds directive.

This requirement has therefore constrained the potential for the LIFE-Nature programme to support some habitat connectivity projects. In particular, it is difficult to develop LIFE-Nature projects that aim to develop ecological networks by restoring or creating corridors or landscape features that are not likely to attain Natura 2000 quality. In some earlier LIFE-Nature projects this rule has been applied with some flexibility and projects have included habitat restoration measures that will take many years to develop habitats of Natura 2000 quality. In such cases the project has been approved on the basis of an assurance from the statutory conservation agency that all the land under the LIFE project will be designated as a Natura 2000 site as soon as it qualifies as such on habitat or species criteria. However, it appears that the rules on applying projects to Natura 2000 land quality have been more strictly followed and this has limited the application of the programme to increasing connectivity between sites.

The aim of **LIFE environment** projects is to contribute to the development of innovative techniques and methods by co-financing demonstration projects. LIFE environment projects do not therefore normally contribute directly to biodiversity conservation and enhanced habitat connectivity. However, some habitat connectivity and ecological network projects (such the Cheshire Econet project outlines below) have been carried out under this programme to avoid the Natura 2000 restrictions described above for LIFE-Nature projects.

Despite some of the limitations noted above many LIFE-Nature projects have helped to reverse fragmentation impacts and increase connectivity between Natura 2000 sites. In fact increasing connectivity is a primary aim of some projects. However, many more are likely to contribute to increasing connectivity as an indirect result of their actions. For example many habitat restoration projects may unknowingly reconnect populations of species by reversing habitat fragmentation impacts. Thus, although the European Commissions LIFE-Nature project database lists 51 projects that include ‘animal corridor’ as a key word identifier, it is likely that many more will contribute to increasing connectivity.

It is not therefore possible to identify all LIFE projects that have increased habitat connectivity or to describe the 51 listed projects in detail within this report. However, some examples of LIFE projects that have specifically aimed to develop ecological networks or have taken substantial actions to connect fragmented habitats or species populations is provided in Table 1 below.

Table 1. Examples of LIFE projects addressing habitat and species connectivity issues

Country / Project name and code	Overall Objective	Connectivity measures
Austria		
Conservation and management of the brown bear in Austria (LIFE02 NAT/A/008519)	Cross-border cooperation with Italy and in particular Slovenia, as the Austrian bear population is so small that its long-term survival depends on the migration of other bears from the Dinaric Alps.	Genetic tracing techniques to examine possible migration corridors and barriers against the background of genetic exchange between Alpine and Dinaric populations. Measures to facilitate necessary migrations.
River management of the central (inner) river Mur (LIFE03 NAT/A/000011)	Restoration and improvement of the characteristic river landscapes of the upper Mur valley in Styria.	Removal of obstacles to migrating fish, in particular the Danube salmon *Hucho hucho* and the Bullhead *Cottus gobio*.
Lafnitz - habitat cross-linking on an Alpine pannonical river (LIFE04 NAT/AT/000001)	This transboundary project targets the river Lafnitz over almost its entire length of 112 km, starting upstream in the Styrian mountains and continuing all the way down to the lowlands in Hungary. It follows the approach of the Water Framework Directive in adopting a holistic approach to its management over the whole catchment area.	Reconnection of isolated populations of fish, by removal of obstacles for migrating fish in the river course and the old side arms, interconnection of meanders and regeneratation of alluvial forests.
Bosnia Herzegovina and Croatia		
Protection of Biodiversity of the Sava River Basin Floodplains (LIFE06 TCY/INT/000246)	To protect and manage the unique landscape and biodiversity along the Sava River	Design of a coherent trans-boundary ecological network of core areas, buffer zones, and corridors.
Croatia		
Building-up the national ecological network as a part of the Pan-European Ecological network & the Natura 2000 network (LIFE02 TCY/CRO/012)	To contribute to the implementation of EU nature protection policy and legislation in Croatia.	Identification of areas that should become part of the NATURA 2000 and National Ecological networks. Development of the National Ecological Network as a coherent part of the Pan-European Ecological Network and the Regional Ecological Network by the Visegrad 4+2 countries
Denmark		
Consolidation of *Bombina bombina* in Denmark (LIFE99 NAT/DK/006454)	To enlarge the minute Danish population of Fire-bellied Toad (*Bombina bombina*) on 7 of the 8 sites to avoid inbreeding and other risks. To create an effective population of 500 individuals, or approximately 1,000 adult individuals.	Creation of large reserves in large-scale favourable terrestrial habitats.
Estonia & Finland		
Protection of *Triturus cristatus* in Eastern Baltic Region (LIFE04 NAT/EE/000070)	To ensure the long-term viability of the small and fragmented populations of the Great Crested Newt *Triturus cristatus* in Estonia and Finland, and its specific genetic traits.	Restoration and protection of a network of suitable habitats targeting 95-97per cent of the populations in the two countries. Around 240 small water bodies to be restored or created in Estonia and 28 in Finland. Hibernation habitats safeguarded by the restoration of surrounding semi-natural grasslands.
Finland		
Herb-Rich Forests, Forests of *Dencrocopos leucotus* and Western Taigas in North Karelia (LIFE00 NAT/FIN/007062)	To produce management and utilisation plans / restoration plans for 14 core sites of importance for White-backed Woodpecker (*Dendrocopos leucotus*) and Siberian Flying Squirrel (*Pteromys volans*) and carry out habitat management works to increase habitat quality for theses species.	The project includes the production of forest management guidelines for areas outside the Natura 2000 sites that are important feeding areas and ecological corridors for the squirrel and woodpecker.
Management of wetlands along the Gulf of Finland migratory flyway (LIFE03	Conservation of 12 sites along the Gulf of Finland flyway covering a total of 3850 ha, which are internationally	Establishment of a ecologically functional network of Natura 2000 wetland sites in favourable condition along the flyway. This, will be achieved

Country / Project name and code	Overall Objective	Connectivity measures
NAT/FIN/000039)	important wetlands for birds.	by a range of activities including the development of management plans for each area
Natural Forests and mires in the 'Green Belt' of Koillismaa and Kainuu (LIFE04 NAT/FI/000078)	Forest restoration by encouraging the development of natural features and processes.	The close proximity of the sites to the Russian border will enable them to act as stepping stones for species and habitats that are still abundant in Russia to recolonise areas in Finland once their habitats have been restored.
Germany		
Stabilization of the population of Beaver and Otter (LIFE96 NAT/D/003040)	To stabilise the Otter population and to support the Beaver's attempts to recolonize Lower Saxony.	Land purchase and habitat restoration (by natural regeneration and planting) along the river corridor (see below for further details).
Hungary		
Establishing the background of saving the Hungarian meadow viper (*Vipera ursinii rakosiensis*) from extinction (LIFE04 NAT/HU/000116)	To protect all sites harbouring Hungarian meadow vipers, to link isolated populations and to provide suitable habitat for hibernation.	Recreation of grassland habitats and forest clearance to create ecological corridors a safe environment in which to hibernate through winter, away from high ground-water levels.
Italy		
LIFE97 NAT/IT/004141 Conservation of wolf and bear in the new parks of Central Apennines	To carry out integrated emergency measures for bears and wolves throughout three national parks, to expand their populations both inside and outside the protected areas.	Identification of existing and potential ecological corridors for the dispersion of the species and measures to improve habitat quality. Management plans were prepared for identified ecological corridors.
Urgent actions for Bear in the SIC of the Sirente-Velino Regional Park (LIFE98 NAT/IT/005114)	Expansion of the Brown Bear (*Urso arctos*) population in the Sirente-Velino regional nature park, which is constrained by habitat fragmentation.	Measures to stabilize and broaden the range of sites suitable for the species, to contain its movements within these more secure areas, to reduce threats from poaching, disturbance and inadequate food resources.
Netherlands		
Connecting 3 pSCI around the Hoeksche Waard for Root Vole (LIFE06 NAT/NL/000079)	Conservation of important populations of the Root Vole (*Microtus oeconomus subsp. arenicola*) in three pSCIs (Haringvliet, Hollandsch Diep and Oude Maas), which are threatened by habitat loss and fragmentation and isolation.	Creation of 13.5 ha of stepping stone habitats link relatively isolated subpopulations
Portugal		
Recovery of Iberian Lynx habitat in Moura/Barrancos Site (LIFE06 NAT/P/000191)	The Project aims to restore and maintain key areas of Iberian Lynx (*Lynx pardinus*) habitat, and the connecting areas between them, through the promotion of long-term effective conservation management measures and awareness raising of the Lynx within the Moura/Barrancos Natura 2000 site.	Linkage of core areas of lynx habitat to allow the species to expand its habitat range.
United Kingdom		
A demonstration model which integrates environmental considerations in sustainable land use planning and management through the use of ecological networks (LIFE99 ENV/UK/000177)	The Life ECOnet Project offers a new approach to managing the landscape for people and wildlife, and improving the connections between surviving wildlife habitats. It identifies concentrations of habitats of high value for wildlife as well as areas that have the potential for the creation of new habitats and corridors for the movement of wildlife.	GIS, digital aerial photography and landscape ecology analysis of the landscapes of Cheshire, Abruzzo and Emilia-Romagna. Extensive discussions with all stakeholders to raise awareness and support for the concept of ecological networks. The network comprises existing nature reserves etc, incorporates existing rural and urban initiatives, and utilises available grants. Identification of opportunities for the creation of new habitats by 'green generators', such as quarries, derelict land and landfill sites. (see below for details)
Developing a strategic network of SPA reedbeds for	The project intends to expand the range of breeding sites and increase the	Habitat, enhancement and enlargement of existing Bittern sites and restoration/creation of reedbeds to

Country / Project name and code	Overall Objective	Connectivity measures
Botaurus stellaris (LIFE02 NAT/UK/008527)	number of areas suitable for dispersing young and over-wintering Bitterns (*Botaurus stellaris*). The long term aim is to establish a more extensive network of strategically located and self-sustaining sites across the UK.	create new sites for Bittern to link up isolatted populations and expand the species range.
Restoration of the mid Cornwall Moors for the *Euphydryas aurinia* (LIFE03 NAT/UK/000042)	Conservation of a metapopulation of Marsh Fritillary (*Euphydryas aurinia*) through the management of a minimum of 70 ha of suitable breeding habitat, to allow for the vagaries of local extinctions and (re)colonisations.	Habitat expansion and increased connectivity and quality of suitable breeding habitat by habitat management measures across the cSAC and at seven satellite sites. Reduction in habitat fragmentation by downgrading a trunk road which bisects the main site.
Urgent Conservation Management for Scottish Capercaillie (LIFE02 NAT/UK/008541)	Strategic coordinated conservation programme for the species across 8 SPAs and 37 additional key sites, which encompass the six main metapopulations identified in Scotland (hosting 60per cent of the total population), Its overall target will be to increase the population to 5000 birds by 2010.	Enhancement of existing populations through management actions focussing on the removal or marking of deer fences, the creation of suitable spaces and foraging sites within existing woodlands, increased predator control effort around key sites, the restructuring of woodlands and access control to reduce disturbance.

Of the projects listed above few appear to have explicitly aimed to develop ecological networks or connectivity measures in the wider environment. This is likely to be at least in part a result of the difficulties of developing projects on areas outside Natura 2000 sites. However, some have helped to develop ecological networks under the LIFE-third countries programme (e.g. Protection of Biodiversity of the Sava River Basin Floodplains).

Using LIFE to develop large scale ecological networks – the Life ECOnet project

Only one project, the Life ECOnet project, which was carried out under the LIFE-Environment programme, addressed the development of large scale ecological networks (see Box 3). The main objective of the demonstration project was to test the hypothesis that the integration of environmental issues in land use planning and management can be facilitated by the use of a holistic model that focuses on the realisation of regional ecological networks. It did this by investigating with local people in Cheshire (United Kingdom) and Abruzzo and Emilia-Romagna (Italy) the best ways of creating networks connecting areas for wildlife, and demonstrated how it is possible to use such networks to make land use planning and management more sustainable. It also used partners from Gelderland (Netherlands), who are pioneers in developing ecological networks, to advise the project.

Although the LIFE ECOnet project has now been completed further actions are being taken to create the proposed ecological networks. For example, three phases of implementation have been identified in Cheshire, with the first 2005-2010 phase targeting the mid-Cheshire Sandstone Ridge. To take this forward a feasibility study has been carried out of the Sandstone Ridge proposals. This found that the creation of the ecological network would have significant socio-economic benefits for the local and wider regional economies in terms of wealth generation, employment creation

and quality of life improvements (Evans, 2006). Cheshire County Council has therefore defined its vision for the project area, which is to '*create an interconnected network of woodlands, heathlands, peatlands and meadows that will provide benefits for people and wildlife.*' A number of costed projects have been identified to deliver the network, which will include the conservation and enhancement of 1,100 ha of new and enhanced habitats. The total cost of the first phase projects is £3 million. Some funding has been secured towards this, and further funding is being sought. Although it is early in the first phase, some progress had been made in practical actions by 2006, including acquisition of 5 ha of agricultural land and completion of some access improvements and habitat and landscape enhancements.

In conclusion, it appears that the LIFE ECOnet project and follow-on actions have been useful in targeting habitat expansion and restoration measures, whilst taking into account the socio-economic needs of the local population. However, it is evident that actual progress with delivering the network through habitat restoration etc is slow and much will depend on the availability of further funding. See http://www.lifeeconet.com/about.htm for details of the LIFE ECOnet project and www.cheshire.gov.uk/SREP for further information on the Sandstone Ridge component of the Cheshire ecological network.

Box 3. Life ECOnet project

The ECOnet had two guiding principles (Evans et al. 2006):

- that habitat expansion and restoration is ecologically informed and targeted to maximise ecological benefits; and
- that the creation of the ecological network is relevant to people's lives (socially and economically) and has the support and involvement of local communities, authorities and agencies.

It also aimed to:

- involve local people;
- contribute to sustainable development;
- re-connect the landscape;
- reduce conflicts between transport and wildlife;
- integrate policies for nature and land use;
- enable more objective land-use decision making;
- enhance targeting of land management schemes;
- provide a spatial framework for biodiversity initiatives; and
- support European Directives and initiatives.

The project was carreid out between 1999-2003 and involved five, equally important and co-dependent elements:

- Technical development of Geographical Information Systems (GIS) and the application of landscape ecology principles.
- Assessment and influence of land use policy and instruments.
- Demonstrations of integrated land management.
- Engagement with stakeholders.
- Dissemination of results.

For example, the following research was carried out to define a provisional ecological network for Cheshire (see Figure xx):

- Definition of Core Areas for Wildlife using GIS spatial analysis techniques of priority habitats, wildlife improvement areas and buffer zones (by Cheshire County Council). See Clarke and Booth (2000) for further details.
- Analysis using the ecological model LARCH on 15 animal species in five different key habitats to try and determine how animals use the Cheshire landscape (by Alterra, Wageningen).
- Development of a scenario for an ecological network in Cheshire, with recommendations for its design based on species requirements, competing land uses and stakeholder consultation (by Alterra, Wageningen).
- Development of a database and potential vegetation map of Cheshire based on the UK's National Vegetation Classification, National Soil Map, solid and drift geology, terrain and climate (by the University of Lancaster).

Using LIFE to increase connectivity between habitats and species populations

LIFE-nature projects have included a range of approaches and measures for increasing connectivity between habitats and species populations. The most common actions taken to connect populations appear to be:

- Increasing the size and productivity of source populations through habitat improvements and habitat expansion (e.g. for Capercaillie and Fire-bellied Toad).
- Reconnection and consolidation of fragmented habitats (e.g. for the Marsh Fritillary and Iberian Lynx).
- Creation / restoration of habitat patches as stepping stones (e.g. for |Bitterns and Great Crested Newts).
- Creation / restoration of linear corridors of habitat to allow for dispersal, migration and gene-flow between populations (e.g. for Brown Bears).
- Removal of dispersal and migration barriers (e.g. for fish).
- Protection and enhancement of migration staging posts (e.g. along the Gulf of Finland flyway).

It has not been possible to assess the outcome of these projects in this study. However, it is well known that the LIFE-Nature programme has had a high degree of success and a high proportion of projects have met or exceeded their initial objectives and conservation targets (European Commission 2003). Many LIFE projects have also been of a sufficient scale to have made a substantial impact on national populations of threatened species or habitat resources. Indeed, in some cases the LIFE programme has been the main measure used to reverse species and habitat declines.

For example, in the UK, two LIFE projects have been carried out on Bitterns, which together have resulted in a significant increase in the breeding population. The first LIFE-Nature project for the species (B4-3200/96/551: Urgent Action for the Bittern *B.stellaris* in the UK) was started in 1996 to address the species continued decline to an all time low of 11 males in 1997. Although the first project did much to help arrest the decline in Bittern numbers it was recognised that more and better habitat needed to be established to maintain a sustainable population in the long-term.

A second LIFE project was therefore started in 2002 (LIFE02NAT/UK/008527: Developing a strategic network of SPA reedbeds for *Botaurus stellaris*). This aimed to provide additional habitat, away from the core areas, to increase the species' range and to enable the dispersal of young birds from their natal reedbed. In addition, it aimed to create links with an isolated north-western outpost of breeding birds. To achieve this it included habitat restoration and creation actions at sites without Bitterns, and habitat enhancement and expansion at sites with Bitterns to increase productivity and thereby increase young colonisers.

The project finished in 2006 and managed to achieve or exceed its main habitat restoration and creation targets. Although it is too soon to assess the achievement of its long-term objectives there are encouraging results already. There has been successful breeding at one site and booming males were present at two other sites. Overall, the two LIFE projects have been the major contributor to the recent recovery of the UK Bittern population, which reached the UK's Species Action Plan target of 50 booming males by 2010 in 2004, well ahead of schedule (Figure 2). Although, the

number of booming males has since declined, the species recovery is still ahead of anticipated progress, and it is expected that the population will continue to expand as the newly created and restored habitats develop.

The second LIFE project provides a good example of how strategic measures can be taken to connect populations, and demonstrates the importance of basing connectivity measures on detailed and comprehensive research.

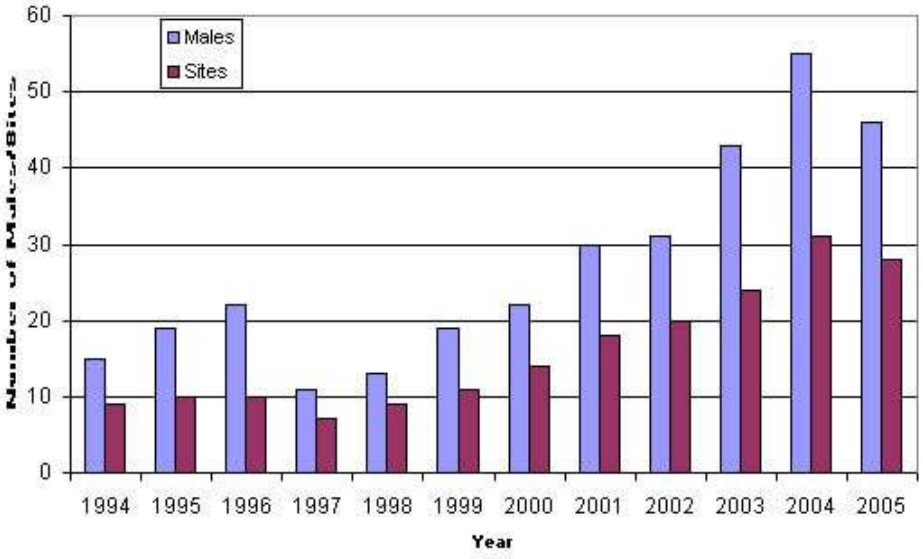

Figure 2. Booming male Bitterns and sites with male Bitterns in the UK (source www.rspb.org.uk)

Similar large scale projects have been carried out to link the isolated and fragmented populations of other species. Habitat fragmentation is a particular problem for many large carnivores as they require large foraging ranges. Thus several LIFE projects have aimed to link isolated populations of such species as Wolf (*Canus lupus*), European Lynx (*Lynx lynx*), Iberian Lynx and Brown Bear.

Many LIFE projects have also focussed on habitat restoration measures to reverse the general impacts of habitat fragmentation. Some of these have addressed rivers as intact river systems are often required to allow migration and dispersal of many important species. For example, several LIFE-Nature projects in Germany (e.g. LIFE96 NAT/D/003040), have actively restored floodplain habitats along the Elbe and its tributaries, the Havel and the Schalle, with the objective of establishing long biological corridors. These measures, designed to regenerate habitats along the river banks, have already had positive impacts on Otter (*Lutra lutra*) and Beaver (*Castor fiber*) populations (European Commission 2003).

In conclusion it is evident that, although the LIFE programme's overall impacts on connectivity cannot be quantified, the instrument has made important contributions to maintaining and increasing connectivity between habitats and species populations.

Community co-financing for environment in the future - LIFE+

Even though the LIFE programme has now closed to new applicants a new programme called 'LIFE+' has been developed and will carry out similar biodiversity conservation actions (amongst others). The agreement and implementation of the LIFE+ programme has been delayed, but it is anticipated that applications for projects will be invited in 2007.

Although the regulation for LIFE+ had yet to formally come into force at the time of writing this report (May 2007) the draft regulation had been approved by Parliament (http://ec.europa.eu/environment/life/funding/lifeplusdraft_en.pdf).

LIFE+ shall consist of three components: LIFE+ Nature and Biodiversity; LIFE+ Environment Policy and Governance; and LIFE+ Information and Communication. Of these LIFE+ Nature and Biodiversity provides the principal means of supporting connectivity conservation projects. However, connectivity measures could be taken under the other LIFE+ components (e.g. as forest measures under LIFE+ Policy and Governance).

The specific objectives of LIFE+ Nature and Biodiversity shall be:

(a) to contribute to the implementation of Community policy and legislation on nature and biodiversity, in particular the Habitats and Birds directives, including at local and regional level, and to support the further development and implementation of the Natura 2000 network, including coastal and marine habitats and species;

(b) to contribute to the consolidation of the knowledge base for the development, assessment, monitoring and evaluation of Community nature and biodiversity policy and legislation;

(c) to support the design and implementation of policy approaches and instruments for the monitoring and assessment of nature and biodiversity and the factors, pressures and responses that impact on them, in particular in relation to the achievement of the target of halting biodiversity loss within the Community by 2010 and the threat to nature and biodiversity posed by climate change;

(d) to provide support for better environmental governance by broadening stakeholder involvement, including that of NGOs, in consultations on, and the implementation of, nature and biodiversity policy and legislation.

LIFE+ has the potential to support a wide range of connectivity conservation measures (including land purchase), particularly with respect to objective a). Indeed, Annex 1 specifically lists 'site and species management and site planning, including the improvement of the ecological coherence of the Natura 2000 network', as one of the nature and biodiversity measures that are eligible for funding.

However, it should be noted that funding will not be provided for projects that can be supported by existing community funds, such as the ERDF, EAFRD and Cohesion Fund etc. Funding shall also only be provided for projects related to the

implementation of the Birds directive and Habitats directive that are best practice or demonstration projects.

Unlike the previous LIFE programme, LIFE+ has indicative annual national allocations and will allocate funding for action grants in accordance with its multi-annual strategic programme. It will also take into account national priorities for action identified by Member States from the Commission's multi-annual strategic programme. The priority areas of action listed in the multi-annual strategic programme for nature and biodiversity are:

- contributing to implementing Community policy and legislation on nature and biodiversity, in particular the Birds and Habitat directives, and promoting their integration with other policy areas;
- supporting the further development and implementation of the Natura 2000 network, including coastal and marine habitats and species;
- supporting the design and implementation of policy approaches and instruments for monitoring and assessing nature and biodiversity and the factors, pressures and responses that impact on them, in particular in relation to achieving the target of halting biodiversity loss within the Community by 2010; and
- improving knowledge of the impact of genetically modified organisms on ecosystems and biodiversity: risk assessment methodologies.

The scope of these actions is very broad and provides many opportunities for Member States to develop LIFE+ projects that aim to maintain and restore connectivity to reduce fragmentation and climate change impacts, on the Natura 2000 network and in the wider environment.

2.2 Agriculture

The management of agricultural habitats in the EU has a major impact on EU conservation measures for habitats and species, in particular the effectiveness of the Natura 2000 network and its connectivity. Although modern agriculture has many impacts on biodiversity (see below), there are many well-documented examples where low-input, traditional farming has been compatible with high biodiversity and may even sometimes have promoted it. Many of the most diverse wildlife habitats in Europe, for example, have long histories of agricultural management, but have shown dramatic declines in recent decades as production methods have changed and intensified. It is therefore possible for farming and biodiversity to co-exist. Indeed, agricultural systems managed in a sustainable manner can contribute to the maintenance of healthy ecosystems and support high biodiversity.

Furthermore, agricultural land makes up the vast majority of land outside protected areas in the majority of countries (with the exception of some predominantly forested northern EU countries). Therefore agricultural landscapes make up the majority of the wider environment and are the habitats (matrix) through which most species need to move if they are migrating or dispersing between protected areas and other high quality habitat patches. It is therefore clear that the quality of agricultural habitats and

their external impacts on other habitats is of profound importance in terms of maintaining and enhancing connectivity in the landscape.

2.2.1 Recent trends in agricultural habitats and species.

Despite the importance of conserving agricultural habitats and minimising agricultural impacts, agricultural systems have changed rapidly and extensively over the last few decades, resulting in widespread biodiversity impacts (Table 2).

Table 2. Observed biodiversity impacts from increasing agricultural intensity and area in Europe.

Impact category / source	**Examples of biodiversity impacts**
Direct (i.e. directly attributable to agriculture)	
Habitat loss (e.g. forest clearance or cultivation of grassland)	Loss of important habitat and associated species
Cultivation and mechanical farming operations	Destruction of ground nesting birds
Irrigation	Loss of dryland habitats (e.g. dry grssland and shrublands) and species
Drainage	Loss of wetland habitats and species
Use of artificial fertilisers	Decline in plant (and associated species) diversity due to dominance of species favoured by high nutrient conditions
Use of toxic pesticides / poisons	Declines in directly impacted species and reductions in food supplies for others
Use of modern commercial crop varieties	Fast growing dense crops out-compete native species, unsuitable for ground-nesting birds
Increases in pests and disease	Increased competition or predation pressures on native species
Introduction and spread of alien species	Increased competition or predation pressures on native species
High stocking density	Losses of grazing sensitive species, soil erosion and compaction.
Destruction of marginal habitats and increases in field size	Decline in habitat diversity
Disturbance of sensitive wildlife	Loss of species
Persecution of wildlife that damage crops	Loss or declines species
Indirect (i.e. resulting from other impacts that are directly attributable to agriculture)	
Increased water abstraction for irrigation	Loss or degradation of wetland habitats (especially in the Mediterranean)
Eutrophication of water bodies (from nutrient rich runoff and soil erosion)	Degradation of wetland habitats
Increase in fire risk	Habitat loss (permanent if severe) and population impacts of species
Atmospheric nitrogen pollution (from poultry and livestock)	Terrestrial eutrophication and loss of nutrient sensitive species
Secondary impacts (i.e. resulting from actions that are not an intrinsic part of the agriculture)	
Increased road and infrastructure development to supply agricultural areas	Further habitat loss from footprint and sourcing of building materials, disturbance, habitat fragmentation
Cumulative impacts (i.e. impacts that arise in combination with other landuse changes)	

Fragmentation of natural habitats from agriculture, roads, housing and forest plantations	Loss of species requiring large areas of continuous or accessible habitat

As a result of such changes much of Europe (particularly lowlands in the west) is now characterized by intensive agriculture that dominates much of the landscape. The driving force behind this intensification was new agricultural technology (machinery, agro-chemicals and plant breeding) combined with supportive agricultural policies, in particular the Common Agricultural Policy (CAP) in the EU. This led to not only to the loss of uncultivated semi-natural habitats, such as moorlands and wetlands, but also to profound changes in farming practices on existing agricultural land. Intensification resulted in farm and field amalgamation which involved loss of hedgerows, woodlands and other important ecological features. Farms also tended to specialise with a consequent decline in mixed farming. There were also marked switches in crop types and a substantial decrease in the area of unimproved pasture and hay meadows. On the remaining semi-natural grasslands, particularly in the uplands, CAP support policies and socio-economic, technological and structural changes to farming systems have led to increased stocking rates in many areas of Europe.

Intensification also resulted in a massive increase in the use and variety of agrochemicals (especially inorganic fertilisers, herbicides and pesticides) on farmland particularly on arable habitats. Pesticides had profound impacts on the populations of some raptors as a result of their toxicity, and they continue to have widespread indirect effects. Non-crop plants and invertebrates have declined massively as a result of their use (Aebischer 1991, Donald 1998), with almost inevitable, indirect impacts on birds (Campbell et al. 1997, Newton 2004). The biodiversity impacts of these agricultural changes have been well documented and have for example included major population declines in many farmland birds, across most of Europe (Donald et al. 2001, Tucker & Heath 1994).

2.2.2 Rural development policy and biodiversity conservation under agri-environment measures

Agri-environment measures (AEM) have been one of the most important mechanisms developed under the Common Agricultural Policy (CAP) to mitigate the impacts of agricultural intensification in the EU. The development of AEM started in 1985 under Council Regulation (EEC) No 797/85[7] and was further developed in 1991 by the Council Regulation (EEC) No 2328/91[8]. Under these Regulations MS were permitted to provide financial support for agricultural schemes which contributed towards the introduction or continued use of agricultural production practices, whilst being compatible with the requirements of conserving the natural habitat, and ensuring an adequate income for farmers. Initially uptake and implementation of these measures was quite limited.

[7] Council Regulation (EEC) No 797/85 on improving the efficiency of agricultural structures

[8] Council Regulation (EEC) No 2328/91 on improving the efficiency of agricultural structures

AEM were developed and implemented much further as a result of Regulation 2078/92 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside, known as the agri-environment Regulation. This Regulation aimed to '*encourage farmers to make undertakings regarding farming methods compatible with the requirements of environmental protection and maintenance of the countryside, and thereby to contribute to balancing the market; whereas the measures must compensate farmers for any income losses caused by reductions in output and/or increases in costs and for the part they play in improving the environment'*. With the agri-environment Regulation, the implementation of AEM became compulsory for the Member States but remained optional for farmers.

In 1999 Council Regulation on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) ((EC) No 1257/1999) was adopted. This Regulation established the first Community fund dedicated specifically to supporting the EU CAP. The regulation confirmed 'the essential role played by farmers as paid providers of environmental services that go beyond good farming practices and compliance with environmental legislation'. Taking into account national specificities, the implementation of AEM was part of the Member States' responsibility and had to be included in the corresponding Rural Development Programmes (RDR). In response to this and national priorities, a wide variety of measures have now been implemented.

In the Council Regulation on rural development for the period 2007-2013, i.e. the European Agricultural Fund for Rural Development (EAFRD) (1698/2005), AEM remain compulsory for Member States, which underlines their ongoing importance. In addition, according to the current Community co-financing arrangements a significant proportion of the costs of the management of the Natura 2000 network should come from existing Community funding instruments, including EAFRD (Miller, Kettunen & Torkler 2006). Therefore, the EAFRD Regulation is to provide an increasing number of possibilities for Natura 2000, including the option to use EAFRD fundingfor AEM and for other measures that enhance/support connectivity within the network/wider landscape scale. However, the programming of EAFRD funding gives Member States a lot of freedom to develop policies and measures according to their national and regional priorities. Consequently, the actual level and types of funding in support of Natura 2000 and ecological connectivity in individual countries will depend on decisions taken at a national level. For possibilities provided by EAFRD for Natura 2000, please see Table 5 in Section 2.3.1.

The cost and scale of AEM schemes has been significant, with some 24 billion euros being spent by the EU between 1992 and 2003 (Kleijn & Sutherland 2003). Clearly AEM has the potential to support the enhancement of ecological connectivity measures across a substantial proportion of the agricultural landscape, which is perhaps where it is most needed.

Generally two broad approaches have been taken to implementing AEM schemes:

- A 'broad and shallow' approach, offering relatively simple, low-cost management options over a very wide area.

- An 'narrow and deep' approach with more targeted, possibly higher maintenance, management options to fewer farmers.

Some countries have focussed on broad, or horizontal, measures whilst others have implemented narrower more targeted measures. Some, such as the UK started with targeted measures to defined areas, i.e. Environmentally Sensitive Areas (EAS), and then brought in measures that can be applied more widely under the Countryside Stewardship Scheme (CSS) and more recently the Entry Level Environmental Stewardship scheme, which is open to all farmers.

Agri-environment measures' benefits to biodiversity

In 2004 DG Agriculture launched an evaluation of AEM that have been implemented over the last 10 years under Regulations 2078/92 and 1257/99. The study was completed in 2005 (Oréade-Brèche 2005) and included an inventory and typology of MS measures, an assessment of implementation and evaluation in relation 16 criteria, which included biodiversity/ landscape impacts. A summary of the impacts on biodiversity is provided in Table 3 below. This suggests that the schemes have had a number of beneficial impacts on biodiversity, including the maintenance and restoration of habitats of high ecological value and increases in habitat / landscape diversity, which will enhance ecological connectivity.

Table 3. Synthesis of biodiversity impacts of AEM-related agricultural measures by type (Source: Oréade-Brèche 2005)

AEM by type of practice	**Most frequent beneficial biodiversity and connectivity related impacts identified during the evaluation**
Reduction of agricultural inputs	Plant and animal diversity increased or maintained
Creation or maintenance of ecological infrastructures with a habitat role (hedge, copse, small fields, grass strip/headland, etc.) or fallow field – set aside	Biologic diversity increased or maintained by creation or preservation of ecological infrastructures
	Creation of habitats for fauna and flora
	Effect on diversification and landscape structuring
Conservation of rare high nature value farmland habitats and endangered species	Diversity of plant and rare animals increased or maintained
	Habitats mostly maintained
Diversification of rotations, maintenance of grasslands, arable reversion to grassland and extensification	Plant and animal diversity increased or maintained particularly in prairies
	Creation and preservation of habitats
	Increase of diversity and quality of landscape
Continued farming in zones of agricultural decline (marginal zones, mountainous zones etc.)	Plant diversity sometimes improved
	Mostly preservation of habitats
	Restoration of landscape quality, diversity and opening
Cross-cutting programme including organic farming or Horizontal measures including organic farming	Plant and animal diversity mostly increased or maintained
	Increase of the diversity of habitats

However, the Oréade-Brèche synthesis does not appear to have been based on a critical analysis of the evidence of AEM impacts on biodiversity. Some caution should therefore be applied in assessing AEM results because some recent scientific papers have questioned their effectiveness {e.g. Kleijn, 2001, Berendse, 2004). In some cases concerns may have resulted from misconceptions, but a recent study by Kleijn et al. (2006) found that AEM in five European countries have performed poorly for a range of taxa that were considered either uncommon or listed in Red Data Books, whereas poor to moderate effects were reported across a range of more abundant and widespread taxa, including vascular plants, birds, bees, grasshoppers and crickets and spiders.

A European-wide AEM review concluded that there have been insufficient evaluation studies to allow a general assessment (Kleijn & Sutherland 2003). Nevertheless, Kleijn and Sutherland did find a number of studies that showed increases in target species as a result of AEM schemes. Of 19 bird studies providing results, four yielded positive increases in species richness or abundance, two gave negative results and 11 showed results in both directions. Of 20 arthropod studies, 11 yielded an increase in species richness or abundance and three showed mixed results but none showed a decrease. Of 14 plant studies, six showed increases in species richness or abundance and two showed decreases.

Some well monitored national schemes have shown a variety of biodiversity benefits, such as the ESA scheme and CSS in the UK (Reid & Grice 2001, Tucker 2003, Aebischer 2000). These included some major conservation successes such as for the Cirl Bunting (*Emberiza cirlus*) under CSS Special Projects (Peach, 2001). This was achieved through a partnership between governmental agencies and NGOs (RSPB) and landowners, and provides a convincing case for targeted implementation of agri-environment schemes that 'fit' well with existing farm practices and deliver conservation results (Evans et al. 2002). Part of this success was related to their practicality and attractive financial incentives and the projects also benefited from their ability to target resources to relatively small areas. Provision of advisers with specific conservation knowledge was also important in the success of the recovery programmes.

Overall it appears AEM schemes can provide biodiversity benefits, especially when they are appropriately targeted and designed. However, as noted by Whittingham (2007), performance may be limited by a number of factors, including:

- Application to small patches of land (which may not provide all of a species' ecological requirements or may be beyond the dispersal distance from uninhabited patches)
- Placement in inappropriate areas (e.g. where target species are absent or where ecological conditions are unsuitable)
- Application of generalised national habitat management measures, which are not always suited to local conditions

2.2.3 Specific agricultural measures supporting connectivity

Agri-environment measures

Although it has not been possible to directly assess the contributions that AEM has made to maintaining and increasing connectivity in farmland landscapes, it is possible to identify practical measures that have potential beneficial connectivity impacts. The actual impacts of such measures will however depend on their scale and spatial arrangements (Donald 2006, Whittingham 2007). Indeed Whittingham suggests that AEM schemes are more likely to increase biodiversity if a lower number of larger resource patches are provided, in contrast to current practice that promotes many small fragmented areas of environmental resource.

Set-aside

Set-aside was first introduced into the Common Agricultural Policy (CAP) as a voluntary measure in 1988. However, it only operated at a relatively small scale until it was included as part of the CAP arable reforms in 1992. Under the Arable Area Payment Scheme (AAPS) all farmers, other than those claiming payments on a small area, were required to enter a proportion of their land into set-aside. The primary objective of set-aside at this stage was to limit cereal production in order to stem the development of surplus production and reduce expenditure on intervention purchases and disposals. However studies of the environmental impact of set-aside suggested that there were environmental benefits arising from set-aside, and some of these may help to maintain biodiversity in the wider environment and enhance connectivity between protected areas and other habitats.

The Mid-Term Review of the CAP introduced the full decoupling of agricultural support payments and the Single Payment Scheme (SPS) providing farmers with a single payment in substitution for payments under most previous schemes. In order to be eligible for the payment, most farmers have to set aside a percentage of their arable land. Because land must be set aside from all arable land rather than from only cereals, oilseeds and protein (COP) crops, as under the AAPS, some farmers will have had to set land aside in 2005 that have never had to do so before and the spatial distribution of set-aside will have changed.

It was foreseen that any detrimental environmental impacts from set-aside reversion would be mitigated through an increase in AEM (see above) and the introduction of cross-compliance under the reformed CAP (see below).

Actual set-aside rules and implementation measures vary between MS. As an example, the set-aside is implemented ion the UK as follows:

- Land can be set aside either as a single plot or in a number of smaller plots or strips.
- Single areas must normally be no smaller than 0.1 hectares and at least 10 metres wide. However set-aside may be placed alongside watercourses, hedgerows,

woods and protected areas (Sites of Special Scientific Interest) in strips of between 6 to 10 metres and no smaller than 0.05 hectares.

- Set-aside strips along a boundary will normally be measured from the centre of that boundary.
- The 2 metre margin required for cross-compliance may be included in set-aside strips.
- Set-aside may be rotational or permanent.

As can be seen from this, set-aside can contribute to connectivity by maintaining habitat strips between habitat patches and along watercourses etc. Whole field set-aside may also create large habitat patches that can support species that would not otherwise be able to survive in intensive agricultural landscapes.

Cross-compliance measures

As part of the Agenda 2000 CAP reforms Member States were required (under the 'Horizontal Regulation' No 1259/1999) to take into account environmental and employment issues when giving grant aid to farmers. Member States had three options for fulfilling this obligation: giving support for agri-environmental commitments, fixing general mandatory environmental requirements (based on environmental legislation), and setting out specific environmental standards. Where farmers do not meet the stipulated environmental requirements, then payments may be reduced or withdrawn. Examples of environmental conditions are adherence to maximum stocking rates for cattle or sheep, compliance with specific conditions for the cultivation of sloping land, respect of maximum permitted volumes of fertilizers per hectare, and compliance with specific rules concerning the use of plant protection products.

However, the regulation was revised as part of the fundamental reform of the CAP in 2003, central to which was the introduction of a Single Payment (SP) to farmers, which is independent of production. As a result of this all farmers receiving direct payments are now subject to compulsory cross-compliance (according to Council Regulation No 1782/2003 and Commission Regulation No 796/2004). Farmers are now obliged to keep land for which they claim SP support in Good Agricultural and Environmental Condition (GAEC). These conditions are defined by Member States, and should include standards related to soil protection, maintenance of soil organic matter and soil structure, and maintenance of habitats and landscape, including the protection of permanent pasture. In addition, Member States must also ensure that there is no significant decrease in their total permanent pasture area, if necessary by prohibiting its conversion to arable land.

These cross-compliance measures therefore provide a minimum standard of environmental protection (which may be improved upon by AEM – see above). As some of these standards must include the maintenance of habitats and landscapes, then some basic connectivity features may receive some protection. The protection of permanent pasture may also be beneficial as such habitats can provide important

stepping stone and corridor habitats especially in arable dominated areas. However, it appears that in many cases Member States have based their GAEC requirements on existing policies and regulations and therefore the added value of cross-compliance may be limited. For example in the UK, key GAEC requirements for the protection of uncultivated habitats, protection of hedgerows, prevention of over-grazing and control of management burning practices are underpinned, by the EIA regulations, the Hedgerow Regulations (see Chapter 3) the Grazing Regulation and the Burning Regulation respectively.

2.3 Forestry

Issues related to forest policy within the EU fall under the full competence of the Member States. Therefore, EU's contribution in the area is mainly limited to supporting the implementation of sustainable forest management through common policies and strategies to be implemented jointly by the EU and the Member States.

The **European Union Forestry Strategy** was adopted in 1998 (COM(1998)649). During 2004, the European Commission carried out an extensive consultation with the Member States and stakeholders in order to evaluate the implementation success of the Forestry Strategy. The final Communication reporting on the implementation of the EU Forestry Strategy, including summarising the findings of the consultation, was published in March 2005 (COM(2005)84). One of the key recommendations was to develop an EU Action Plan for Sustainable Forest Management. The foreseen aim of the Action Plan was to provide a coherent framework for the implementation of forest-related actions and serve as an instrument of co-ordination between Community actions and the forest policies of the Member States.

In the annex to the Commission Communication on the implementation of EU Forestry Strategy (COM(2005)84) the European Environment Agency (EEA) noted that within the EU '*a tendency towards more uniform forest structures, reduction of variety in tree species and loss of biodiversity*'. According to the EEA '*the changes that forests underwent over the last few centuries have brought a great number of species to the verge of extinction in several European countries*'. Meeting the Gothenburg objective of halting the gradual loss of biodiversity by 2010, to which the EU Heads of State and Government made a commitment to in 2001, '*can be expected to remain a demanding task for some time in the forest sector*'.

The **EU Forest Action Plan** (COM(2006)30) was adopted on 15 June 2006. The Action Plan builds on the report on implementation of the EU Forestry Strategy and consequent conclusions by the Council[9]. The Action Plan focuses on four main objectives: 1) improving long-term competitiveness of the forest sector, 2) improving and protecting the forest environment, 3) contributing to the quality of life, and 4) fostering coordination and communication within the sector. The Action Plan

[9] Council Conclusions on an EU Forest Action Plan: http://ec.europa.eu/agriculture/fore/publi/2005_council_conclusions.pdf

introduces eighteen key actions that are to be implemented jointly between the Commission and the Member States during the period of five years (2007–2011). These include actions aimed at contributing towards achieving the biodiversity objectives for 2010 (and beyond) and enhancing the protection of EU forests.

The Action Plan does not address issues related to ecological coherence and connectivity as such. However, measures aimed at maintaining/improving connectivity can fall under the scope of several activities endorsed by the Action Plan. For example, the Action Plan supports restoration and afforestation initiatives with environmental/protective objectives and it also promotes the use of EAFRD for Natura 2000-forest measures. The Action Plan puts a lot of emphasis on monitoring forest ecosystems in the EU and, among other things, it proposes to initiate monitoring of forest fragmentation on biodiversity. In addition, the Action Plan strongly supports improving coordination and cooperation within the forestry sector. Improving coordination can further support and facilitate initiatives aimed at preventing fragmentation and/or improving connectivity. However, the concrete actions depend largely on the implementation of Community level provisions and recommendations at the national level.

The **EU Biodiversity Action Plan for 2010 and Beyond** (COM 2006/216) includes a number of actions aimed at supporting the conservation and sustainable use of biodiversity in the context of forest policy. For example, the Action Plan urges Member States to assess the effects of afforestation (and should the case arise deforestation) plans on biodiversity and, depending on the results, adjust the plans to avoid any negative biodiversity impacts (Action A2.1.15). In addition, the Action Plan emphasises the role of 'high nature value' forest areas and lists several actions to be taken jointly by the Commission and the Member States to address this issue (e.g. Actions A2.1.2., A2.1.3 and A2.1.7). For example, according to the Action Plan the high-nature-value forest areas threatened by the loss of biodiversity are to be identified by 2007. Furthermore, appropriate measures to maintain or restore the conservation status of these areas are to be implemented (2007 onwards) (Action A2.1.3).

2.3.1 Community support for forestry sector and forestry related agri-environment measures

The 1992 CAP reform introduced a set of accompanying measures for the agricultural sector. These measures included the Regulation 2080/92 on forest measures for agriculture (See also Section 2.2.2 above). This Regulation was aimed at improving forest resources, offering farmers alternatives to replace agricultural production, contributing to more environmentally sensitive countryside management and countering the greenhouse effect. Under the Regulation, payments were available for afforestation and forestry improvements with differentiated payments for broadleaves and conifers. Between 1992 and 1999, €1.5 billion were spent with 56.8 per cent of expenditure directed to broadleaves (excluding short rotation planting).

The 1999 Regulation for European Agricultural Guidance and Guarantee Fund (EAGGF) broadened support for the forest sector with a focus on multifunctional

forests (See also Section 2.2.2 above). As regards forestry, the Regulation was aimed at the development of forestry sector, extension of the woodland area and the maintenance and improvement of forest resources. During the EAGGF funding period (1999-2006) some Member States made forestry measures a much more significant part of their rural development plans and expenditure than others. Denmark, Ireland, Italy, Portugal, Spain and the UK all allocated more than the EU average of 9.7 per cent of the total rural development budget to forestry measures.

During the current 2007-2013 funding period the Member States have the possibility to use Community co-financing for forestry through the **European Agricultural Fund for Rural Development** (EAFRD) (Council Regulation (EC) No 1698/2005) (See also Section 2.2.2 above). EAFRD introduces some changes for the previous forest support. Overall, there is greater emphasis on investment and competitiveness in the private sector with reduced eligibility for public owners. Levels of support for plantations are lower than previously but agroforestry could, in future, receive support.

There are also opportunities for funding management actions for the Natura 2000 network under the EAFRD Regulation, including measures that can enhance/support connectivity within the network/wider landscape scale. However, the programming of EAFRD funding gives Member States a lot of freedom to develop policies and measures that suit their national and regional priorities. For example, it is not obligatory for the Member States to allocate any EAFRD funding for forestry related measures. Consequently, the actual level and types of funding in support of Natura 2000 and ecological connectivity in individual countries will depend on decisions taken at a national level. For possibilities provided by EAFRD for Natura 2000, please see Table 5.

The support provided in the context of EAFRD could have important implications for preventing forest fragmentation and supporting connectivity in forest systems. For example, targeted national EAFRD forestry measures could provide potential to connect forest habitats, particularly if uptake of measures in blocks of land or zones is encouraged. Furthermore, the EAFRD Regulation requires Member States to designate areas eligible for afforestation payments. These afforestation areas can contribute to restoration of forest habitats, including improving connectivity between forest habitats. However, careful consideration of biodiversity interest needs to be given in cases of afforestation as the biodiversity value of an area could decrease following afforestation, depending on what has been replaced.

In general, in order to prevent fragmentation and improve connectivity forest-environment annual payments (Article 47) and the linked grants (e.g. Articles 49 and 44) should be synchronised at the national level. In doing so, and in determining the remaining eligibility requirements for planting and management grants, the national EAFRD strategies and regional grant approval processes should identify the types and location of planting sites, geographical areas and types of planting (species, provenance, density, open spaces within woodland etc) which would best meet the biodiversity related targets in an area. These targets could include, for example, biodiversity action plans for woodland habitats and species, buffering and enhancing Natura 2000 sites, habitats used by Natura 2000 species, and woodland networks in the wider countryside.

Table 5. Examples on how the European Agricultural Fund for Rural Development (EAFRD) could support management of Natura 2000 areas in the context of agriculture and forestry, including enhancing connectivity within ecosystems / between individual sites. Table adopted from Miller, Kettunen & Torkler 2006, please see this document for more examples.

EAFRD Article	Description	Possible application in the context of Natura 2000
36(a)(i)	natural handicap payments to farmers in mountain areas	Payments could be used to support traditional extensive sustainable agricultural practice in areas where this is necessary for maintenance of valuable habitat - eg grazing of alpine meadows or open steppe.
36(a)(ii)	payments to farmers in areas with handicaps other than mountain areas	
36(a)(iii)	Natura 2000 payments and payments linked to Directive 2000/60/EC;	Many possible uses supporting maintenance of habitats (eg connectivity): eg phased mowing, restrictions on new drainage systems, requirements in relation to hedgerow management.
36(a)(iv)	agri-environment payments	There are many options open to Member States and agri-environment schemes can be designed to be adaptable to differing regional requirements. Fro example, agri-environment schemes could be targeted at agricultural land between key Natura 2000 sites in order to develop wildlife corridors linking important habitats.
36(a)(vi)	support for non-productive investments [agricultural land]	Temporary fencing for grazing management aimed to habitat maintenance, restricting public access or other agricultural activities; construction of stable for goats.
36(b)(i)	first afforestation of agricultural land	Could fund restoration of native forests where these have been lost; could link to other restoration projects to facilitate creation of a contiguous network of Natura 2000 sites.
36(b)(ii)	first establishment of agro-forestry systems on agricultural land	Could enable restoration of traditional agro-forestry systems such as Mediterranean dehesa/montado in areas where these have been lost.
36(b)(iii)	first afforestation of non-agricultural land	Could facilitate the restoration of native forests in areas where these have been cleared.
36(b)(iv)	Natura 2000 payments; [forests]	Restoring old growth forest: creation and management of large reserves (greater than 50ha) without any forest management.
36(b)(v)	forest-environment payments	Retention of dying / old trees in selectively logged forests, at a rate of 10per cent per hectare.; wide spacing between trees; mixing species to be planted.
36(b)(vi)	restoring forestry potential and introducing prevention actions;	Prevention actions could include planting of native tree habitats where these are fire-resistant.

36(b)(vii)	support for non-productive investments [forests]	Support establishment of small vegetated ponds in forest areas that could also contribute to increasing connectivity within the landscape.
52(b)(iii)	conservation and upgrading of the rural heritage	Restoration of local wetland habitats through modification of waterways and restorative planting.
63	Leader	Management of local habitats to facilitate objectives of local development plan eg cleaning of waterways to facilitate otter reintroductions as part of 'green waterways' campaign.

2.4 Inland water ecosystems – the Water Framework Directive (WFD)

The 'Directive establishing a framework for the Community action in the field of water policy' (2000/60/EC), i.e. the EU Water Framework Directive (WFD), sets up the basis for the protection of inland and coastal waters and groundwater resources in the EU. The Directive requires all inland and coastal water bodies to reach, as a minimum, 'good status' by 2015. This 'good status' comprises of aspects related to both ecological and chemical characteristics of the water body. In this context, the ecological status refers to the quality of the structure and functioning of aquatic ecosystems.

The goals of WFD are to be reached through the establishment of an integrated EU-wide river basin management structure within which environmental objectives for inland water bodies, including ecological targets, will be set. A key component of this structure is the development of river basin management plans (e.g. rivers, lakes, wetlands and coastal zones) that are to be finalised by the Member States by 2009.

The Water Framework Directive also takes fully into account the provisions of the Habitats directive and the river basin management plans are to Therefore, WFD has been seen to provide important support to the management and monitoring of Natura 2000 network in the future. The Directive does not contain any particular requirements for implementing the Habitats directive's provisions. However, the WFD definition of good ecological status includes aspects related to maintaining or restoring morphological characteristics and structure of inland water bodies, including preserving river continuity and securing natural migration of species.

The WFD framework for integrated management provides a good opportunity to enhance ecological coherence and connectivity of inland water ecosystems within the EU. As the implementation of the Directive is still at its early state it still remains to be seen how the Member States will include these aspects as integral part of their river basin management plans.

2.5 Coastal/marine environment and fisheries

EU coastal and marine systems are ecosystems fall under the influence of a number of Community legal and policy instruments[10]. The Common Fisheries Policy (CFP) is the main instrument controlling the EU fisheries sector and it also plays an important role in the overall management of EU coastal and marine systems. In addition, the proposed Marine Framework Directive is to establish a common maritime policy for the EU.

Preservation of coastal and marine ecosystems within the EU, including maintaining ecological coherence and connectivity, is mainly supported through the implementation of Community's biodiversity legislation and policy in the coastal/marine context. This includes the full implementation of the Birds and Habitats directives into all European marine areas under MS sovereignty and/or jurisdiction. The marine component of Natura 2000 network is to be fully implemented in the following maritime areas; internal waters, territorial sea, Exclusive Economic Zone (EEZ) and Continental Shelf. Significant progress have been made in the coastal and inshore areas, the challenge for MS in the coming years will be the full implementation of Natura 2000 network in the offshore environment (ZEE and Continental Shelf).

Preservation of coastal and marine ecosystems also includes the integration of the biodiversity related aspects into relevant sectoral policies. Traditionally, maintaining and/or enhancing ecological coherence and connectivity have not played a big role in EU coastal and marine context. However, the current/upcoming policies and initiatives provide a number of potential opportunities to address these issues.

2.5.1 Common Fisheries Policy

The Common Fisheries Policy is the framework for the management of EU and national fisheries. The basic Regulation (2371/2002) defines the general scope and objectives of the CFP as well as setting out in more detail specific objectives, management measures, access conditions and control and enforcement rules. The purpose of the CFP is to manage fisheries for both stock conservation and environmental purposes. In particular, as fisheries is a policy area of 'exclusive competence' of the EU, the management of fisheries beyond inshore waters (i.e. beyond 12 nautical miles), including spatial management, should be done through the CFP at an EU level.

As regards the protection of marine biodiversity, the basic CFP Regulation provides for the establishment of 'zones and/or periods in which fishing activities are prohibited or restricted including for the protection of spawning and nursery areas' (commonly called fisheries marine protected areas - fisheries MPAs) as well as

[10] Note: marine ecosystems fall outside the scope of this study. The marine and fisheries policies are, however, relevant in the context of coastal zones and is therefore included in this review

specific measures to reduce environmental impacts of fishing. The Regulation does not require the EU or Member States to develop the protected areas, but rather puts in place a legal framework through which they could be established. This CFP legal framework can be seen particularly important in situations where the EU Member States' legal competence is limited, i.e. when establishing MPAs beyond inshore waters.

The CFP does not set out any specific provisions for enhancing ecological coherence and connectivity within marine ecosystems, including connectivity between fisheries MPAs. The CFP Regulation does, however, provide a general opportunity to shift the emphasis of the fisheries policy from a narrow preoccupation with fish stock management to a more holistic or ecosystem based approach that includes sustainable use of both resources and the supporting marine ecosystems. In principle, this approach offers a possibility to address issues related to ecological coherence and connectivity within marine ecosystems. In practise, however, even though the application of the ecosystem based approach is slowly being adopted, these issues have not yet been adequately integrated into the planning and management of EU fisheries.

2.5.2 Proposed Marine Strategy Directive

On 24 October 2005 the Commission proposed a Marine Strategy Directive (COM (2005)505). It has the aim of achieving 'good environmental status' in the marine environment by 2021, at the latest. The proposed Directive is the central implementing element of the Thematic Strategy on the protection and Conservation of the Marine Environment that was adopted by the Commission at the same time (COM (2005)504). The overall objective of the Marine Thematic Strategy is 'to protect and restore Europe's oceans and seas and ensure that human activities are carried out in a sustainable manner so that current and future generations enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive'.

The proposed Directive recognises the commitments made under the CBD to create a global network of MPAs by 2012. Rather than creating new legal provisions or requirements for designating MPAs, the Directive supports the implementation of existing legislation, notably the Habitats directive, and designation of Natura 2000 sites. Nothing is added therefore to the existing Birds and Habitats directives obligations. While the proposed Directive is yet to go through the European Parliament and Council, if it is adopted in its current form it is not expected to add any impetus for MPA designation or management in marine areas.

The proposed Directive does not address issues related to ecological coherence and connectivity. These aspects can, however, be taken into consideration as a part of the integrated marine strategies required to be developed by the Member States.

2.5.3 Integrated Coastal Zone Management

MPAs, especially those in the coastal region, should arguably be implemented within the context of integrated coastal zone management (ICZM). That is, taking a holistic and long term perspective to managing the coastal environment. The only EU level policy relating to ICZM is a Recommendation (2002/413) of May 2002 adopted by the Council and the Parliament on the implementation of ICZM in Europe.

This recommends a strategic approach and principles that Member States should follow in undertaking national ICZM stocktaking and national ICZM strategies. It is important to note that such recommendations are non-binding, so it remains to be seen to what extent the Recommendation is implemented. One element of the strategic approach recommended is the 'protection of the coastal environment, based on an ecosystem approach' based on inter alia the 'use of a combination of instruments'. Beyond this however there is no reference to MPAs and ecological connectivity within coastal systems.

2.5.4 European Fisheries Fund (EFF)

The European Fisheries Fund is the main Community instrument for funding CFP in 2007-2013. According to the new EU funding approach for Natura 2000, EU co-financing for managing Natura 2000 sites will come from a mixture of existing funds, including the EFF, from 2007- 2013 rather than a single fund. This approach aims to ensure that the management of Natura 2000 sites will be carried out as an integral part of the wider land and marine management policies of the EU.

The EFF offers a number of possibilities for supporting the management of marine and freshwater Natura 2000 sites (Table 6). In this context, support can also be provided for enhancing connectivity between protected areas. In general, a number of Regulation's provisions can also help to maintain coherence and connectivity in marine and coastal areas by supporting non-damaging fishing and aquaculture methods.

The programming of EFF funding gives Member States a lot of freedom to develop policies and measures that suit their national and regional specific cities. Consequently, the actual level and types of funding in support of Natura 2000 and ecological connectivity in individual countries will depend on decisions taken at a national level. It is therefore important to ensure that these types of activities are included in Member States' priorities for EFF funding and so detailed in their national strategic plans and operational programmes.

Table 6. Examples on how European Fisheries Fund (EFF) could support management of coastal and marine Natura 2000 areas, including enhancing connectivity within ecosystems / between individual sites. For more examples please see Miller, Kettunen & Torkler 2006.

EFF Article	Description	Possible application in the context of Natura 2000
29(1)(c)	support for traditional aquaculture activities important for preserving and developing both the economic and social fabric and the environment	Support for maintenance of traditional fishponds which may represent important habitat, e.g. for migrating birds and/or amphibians and reptiles.
30(2)(a)	forms of aquaculture comprising protection and enhancement of the environment, natural resources, genetic diversity, and management of the landscape and traditional features of aquaculture zones	
30(2)(d)	sustainable aquaculture compatible with specific environmental constraints resulting from the designation of Natura 2000 areas in accordance with Directive 92/43/EEC	Incentives for maintaining water levels to suit migratory/breeding bird species.
37(a)	contribute sustainably to better management or conservation of resources;	Could be used to contribute to sustainable management of marine and freshwater species, e.g. enhancement of spawning grounds to improve stock numbers.
37(g)	develop, restructure or improve aquaculture sites;	Improvement of aquaculture sites by replanting of riverine vegetation e.g. reeds and rushes to create new habitat for invertebrates, small mammals and reptiles.
38(2)(a)	the construction or installation of static or moveable facilities intended to protect and develop aquatic fauna and flora	Installation of 'cages' in order to protect fragile benthic species and habitats (e.g. sea grass beds, sea fans).
38(2)(b)	the rehabilitation of inland waters, including spawning grounds and migration routes for migratory species,	
38 (2)(c)	the protection and enhancement of the environment in the framework of NATURA 2000 where its areas directly concern fishing activities, excluding operational costs.	Specific management actions affecting species that are commercially fished and also relevant to Natura - e.g. restoration of spawning grounds for salmon.
41 (2)(b)	Pilot projects: to enable tests to be carried out on management plans and fishing effort allocation plans, including, if necessary, the establishment of no-fishing zones, in order to evaluate the biological and financial consequences and experimental restocking	Establishment of no-fishing zones within Natura 2000 sites to allow monitoring of the effects of no fishing on habitats and species.

44(1)(c)	diversifying activities through the promotion of multiple employment for fishers through the creation of jobs outside the fisheries sector	Creation of jobs in species management (e.g. monitoring, protection and breeding of freshwater fish such as salmon and sturgeon).

2.6 Community support for regional development

The aim of the EU regional policy is to promote coherent development within the EU and reduce gaps between the wellbeing of different regions within the Community area. In practise, this policy area is responsible of coordinating the use of Community's Structural and Cohesion Funds (i.e. European Regional Development Fund (ERDF), European Social Fund (ESF) and the Cohesion Fund).

Traditionally, the Community's regional policy has paid only little attention to issues related to nature conservation and biodiversity. Furthermore, the initiatives supported by Structural and Cohesion Funds have frequently been criticised by having several negative effects on biodiversity (see for example WWF 2006). Promoting sustainable development has, however, improved the inclusion of environmental issues, including biodiversity, into EU regional policy.

As described earlier, the Community co-financing for managing Natura 2000 during the 2007-2013 period will come from a mixture of existing funds. This includes also the Structural and Cohesion Funds. This will also offer increased possibilities for supporting ecological coherence and connectivity in the context of regional development (Table 7). However, the actual level and types of funding available will depend on decisions taken at a national level.

Table 7. Examples on how European Regional Development Fund (ERDF) and the Cohesion Fund could support management of Natura 2000 areas, including enhancing connectivity within ecosystems / between individual sites. Table adapted and updated from Miller, Kettunen & Torkler 2006. Please see this source for more examples.

ERDF Article	Description	Possible application in the context of Natura 2000
4(4)	Environment, including investments connected with water supply and water and waste management; waste-water treatment and air quality; prevention, control and fight against desertification; integrated pollution prevention and control; aid to mitigate the effects of climate change; rehabilitation of the physical environment, including contaminated sites and land and brownfield redevelopment; promotion of biodiversity and nature protection, including investments in NATURA	Could fund one-off sediment removal and deepening from a river delta area to enable long-term habitat restoration.

	2000 sites; aid to SMEs to promote sustainable production patterns through the introduction of cost-effective environmental management systems and the adoption and use of pollution-prevention technologies	
4(5)	Prevention of risks, including development and implementation of plans to prevent and cope with natural and technological risks	Creating natural habitats patches though large-scale tree planting of native species that have low fire risk.
4(8) and 5(3)a	Transport investments	Where there is existing transport infrastructure (e.g. roads, rail corridors) improvements could be made to reduce its fragmentation effects (e.g. through addition of underpasses/overpasses).
5(2)a and 5(2)b	Environment and risk prevention, and specifically: stimulating investment for the rehabilitation of contaminated sites and land, and promoting the development of infrastructure linked to biodiversity and investments in Natura 2000 contributing to sustainable economic development and/or diversification of rural areas	Could fund one-off sediment removal and deepening from a river delta area to enable long-term habitat restoration.
6(1)b	Development of cross-border economic, social and environmental activities through joint strategies for sustainable territorial development: encouraging the protection and joint management of the natural and cultural resources, as well as the prevention of natural and technological risks.	Could fund cross-border initiatives that also support ecological connectivity within landscapes, including river-basin restoration including sediment removal, removal of large infrastructure such as dams.
6(2)b	Establishment and development of transnational cooperation: actions may include protection and management of river basins, coastal zones, marine resources, water services and wetlands; fire, drought and flood prevention; the promotion of maritime security and protection against natural and technological risks; and protection and enhancement of the natural heritage in support of socio-economic development and sustainable tourism, water management, with a clear trans-national dimension, including protection and management of river basins, coastal zones, marine resources, water services and wetlands.	
8	Sustainable urban development: strengthening economic growth, the rehabilitation of the physical environment, brownfield redevelopment, and the preservation and development of the natural and cultural heritage, the promotion of	Within urban areas, could support redevelopment of Natura sites to promote local use and community development.

	entrepreneurship, local employment and community development, and the provision of services to the population taking account of changing demographic structures.	
Cohesion Fund Article	**Description**	**Possible application in the context of Natura 2000**
2(b)	Environment within the priorities assigned to the Community environmental protection policy under the policy and action programme on the environment, in this context also including areas related to sustainable development which clearly present environmental benefits, namely energy efficiency and renewable energy and, in the transport sector outside the trans-European networks, rail, river and sea transport, intermodal transport systems and their interoperability, management of road, sea and air traffic, clean urban transport and public transport.	Construction of infrastructure for water treatment in order to improve water quality (and therefore habitat quality) at Natura 2000 sites.

2.7 Environmental impact assessments

Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are intended to be preventative mechanisms that avoid or pre-empt adverse environmental effects that might be associated with proposed programmes, developments or new activities. EIAs aim to identify, quantify and assess the potential impacts of individual projects (such as road, rail, port and large-scale industrial and residential construction or extraction projects). There have been long established EIA procedures in most EU countries, but these have been standardised to some extent with the EU Environmental Impact Assessment Directive (85/337/EEC, as amended by Directive 97/11/EC).

Comprehensive project EIAs typically involve the following key steps (Glasson et al. 1999):

1. Project screening
2. Scoping
3. Consideration of alternatives
4. Description of the project and environmental baseline
5. Identification and prediction of main impacts
6. Evaluation and assessment of impact significance
7. Recommendations for mitigation
8. Public consultation and participation
9. Production and review of an Environmental Impact Statement
10. Decision making
11. Post-decision monitoring, auditing and follow-up

Although this implies a linear process, EIA in practice is iterative, with feedback and interaction amongst the various stages. EIA is also more effective if it includes frequent public consultations and participation with key stakeholders throughout (not just at the end).

SEA is becoming increasingly important as a mechanism for ensuring that environmental and social concerns are integrated with the development planning process and also provides a mechanism for reducing uncertainty earlier in the planning process. This has been given added impetus through the EU SEA Directive (Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment), which became effective in July 2004. The SEA Directive has many references and requirements relating to the conservation of biodiversity and implementation of other EU nature conservation directives. For example, one of the criteria for determining whether or not a plan may have significant environmental effects is if it has 'effects on areas or landscapes which have a recognised national, Community or international protection status'.

If adverse environmental effects cannot be avoided, the EIA process generally triggers measures to reduce or control adverse effects on the environment ('mitigation') or to provide compensation (also known as 'offsets', see ten Kate *et al.* 2004) for unavoidable impacts.

One of the main constraints on SEAs and EIAs is that there is often limited information available on biodiversity and the effects of proposed projects to carry out comprehensive ecological evaluations or to undertake reliable assessments of potential impacts. As functional connectivity is particularly difficult to assess this is likely to be overlooked or over-simplified in impact assessment studies.

Despite some of the limitations associated with EIAs and SEAs, the processes provide many opportunities for maintaining and enhancing connectivity, where this is required, and for assisting with climate change adaptation. If carried out according to the best practice they can:

- Guide development programmes through SEA so that environmentally sensitive areas are avoided.
- Avoid fragmentation and other biodiversity impacts at the project level (through alternative projects, mitigation and if necessary project refusal).
- Provide connectivity and other biodiversity benefits through well designed project compensation (planning gain) measures (e.g. habitat restoration, which might contribute to the implementation of ecological networks).
- Improve understanding of connectivity impacts through research and post-project monitoring.

2.8 Climate change policy

Current EU climate change policy can be seen as a combination of several Community legislative instruments and policy papers related to climate change. In general, these include both overarching policy papers outlining the Community's

strategy and response to climate change, and specific initiatives addressing particular sectoral issues linked to climate change. In addition, the European Climate Change Programme (ECCPI and ECCPII) forms an integral part of the EU climate change policy. The ECCP is a Commission initiative, involving stakeholders from industry, Member State governments, non-governmental organisations (NGOs) and independent experts, aiming to develop measures and policy proposals to address climate change. The first ECCP was established in 2000 and it was later on followed by the launch of the second ECCP in 2005.

As regards biodiversity, the impacts of climate change on ecosystems and species, in particular the subsequent effects on human wellbeing, have been an important element in raising concerns over climate change in the EU. Nevertheless, the actual linkages between biodiversity and climate change have gained only little attention within the climate change policy itself. During recent years, however, issues related to adaptation to climate change have become increasingly addressed. Consequently, biodiversity has started to obtain a more prominent position in the discussions on EU climate change policy.

Adaptation is also one of the new focus areas of the second ECCP. A special working group on impacts and adaptation has been set up as part of ECCP II with a view to improve Europe's resilience (including the aspects of environmental, economic and social resilience) to climate change impacts and encourage the integration of adaptation into EU climate change policy. The process of this working group consists of a series of ten sectoral expert meetings looking at adaptation issues for different sectors, including biodiversity. The outcomes had of the expert meetings will feed into a Commission Green Paper on the EU's role in climate change adaptation. The Green Paper is envisaged to be launched in the context of a conference on adaptation to climate change, organised by the Commission in February 2007.

The experts meeting on biodiversity took place in May 2006[11]. Among other things, the experts meeting recommended that in order to address climate change biodiversity policies should encompass both the protected areas and the wider countryside. In addition, the experts highlighted that landscape scale connectivity and permeability should be improved.

3 SUMMARY OF NATIONAL MEASURES IN PLACE IN MEMBER STATES

This Chapter summarises the findings of eight Member State case studies carried out for this review. The country case studies aimed to identify existing national measures that support the establishment of ecological networks and enhancement of ecological coherence and connectivity within ecosystems/landscapes in Member States. The

[11] Outcomes of the ECCP II experts group meeting on biodiversity (May 2006): http://forum.europa.eu.int/Public/irc/env/eccp_2/library?l=/impacts_adaptation/biodiversity/biodiversity_finalminute/_EN_1.0_&a=d

following Member States were included in the review: Belgium, Finland, Germany, Lithuania, the Netherlands, Slovakia, Spain and the UK.

3.1. Legislative and policy measures

In general, the Habitats and Birds directives remain the main legal measures addressing ecological coherence and connectivity in Member States. However, only in a number of the reviewed Member States the national legislative instrument(s) transposing the Habitats and Birds directives include specific reference to ecological coherence and connectivity of national protected areas and/or Natura 2000 network (See Table 8 below). In some of the new Member States, such as Lithuania and Slovakia, issues related to connectivity were already addressed in the national legal instruments for nature conservation prior to the transposition of the EU directives. In Slovakia some provisions for the protection of landscape elements (e.g. riverbank vegetation, forests, peat bog, rivers and cliffs) have also been included in the national law on spatial and development landscape (50/1976 and its amendments).

The review also revealed some interesting examples on how national legal frameworks for agriculture and land-use planning can be used to enhance ecological coherence and connectivity within landscapes. For example, since 1997 hedgerows in the UK have been protected by the Hedgerows Regulations. The Regulations stipulate that it is against the law to remove or destroy certain hedgerows without permission from the local planning authority. Permission is required before removing hedges that are at least twenty metres in length unless they form part of the boundary of a dwelling. In general permission will not be given for the removal of hedges that are defined by the Regulations as being 'important', which includes hedges that are over thirty years old and of high historic or wildlife value. Although the Regulations are rather complex and have been subject to some criticism, it has been acknowledged that the legal protection of hedgerows contributes to maintaining ecological connectivity within UK agricultural landscapes.

In addition, in 1993 the Flemish Government in Belgium accepted legislation that prevents any further development (urbanisation, camping, tourism etc.) of all dune areas along the Flemish coast (so called 'Dune Decree'). The Decree includes all geomorphological landscape elements that can be classified as dunes (grasslands, meadows, forested areas, ruderal areas, decalcified fossil dunes, etc.). As an outcome, the Decree effectively stopped landowners from selling the dune areas allowing the government to start purchasing these areas for restoration. The restoration works (e.g. soil sanitation, dune restoration and species monitoring) can significantly contribute to the ecological connectivity of the Flemish coastal area. In addition to environmental protection, the provisions set out in the Dune Decree also aim to be compatible with the general socio-economic development of the area, e.g. supporting the restoration and maintenance of natural characteristics that attract tourism to the area.

To conclude, some potential examples in using legal instruments to maintain or enhance ecological connectivity in Member States exist. However, the number of these legislative measures remains limited. Additionally, the case studies also revealed that even when the ecological connectivity forms an integral part of the national legislation for nature conservation the practical implementation of

connectivity related measures still remains problematic. For example, the lack of funds and conflicts with other potential uses, such as forestry and agriculture, hindered addressing issues related to connectivity in practise.

As regards the national policy frameworks, it seems that in some of the Member States the aspects related to connectivity are gaining more prominent role in the context of national biodiversity and nature conservation policy. For example, this is the case in Finland where a number of recent biodiversity policy documents include specific reference to enhancing connectivity within the network of protected areas. However, it remains to be seen to what extent these policy level initiatives translate into practical actions. As regards climate change, the review concluded that with a few exceptions the national frameworks for climate change mitigation and adaptation do not directly address issues relating to ecological coherence and connectivity.

3.2. Establishing ecological networks and corridors

According to the review, processes of establishing ecological networks and/or corridors were taking place in the majority of reviewed Member States. However, the scale and level of implementation differed widely between Member States. In a number of countries, including Belgium (Flanders), Germany, Lithuania and the Netherlands, the establishment of country-wide ecological networks had been initiated. In some other Member States, e.g. Spain and Finland, examples on initiatives aimed at establishing ecological networks and corridors existed more at regional scale. Only in a number of Member States, e.g. Germany, Lithuania and Slovakia, the establishment of networks and/or corridors was also enshrined in national law. (See also Table 8 below).

Evaluating the implementation success of the ecological network/corridor initiatives remains difficult. It can be concluded, however, that the implementation process is often rather slow and the level of implementation varies both between and within the Member States. In a number of countries, such as Belgium (Flanders), Lithuania and the Netherlands, the implementation of the national networks seems to be either relatively advanced or well on its way. On the other hand, even in countries where the national legislation supports the establishment of ecological network(s) the existence and design of plans and strategies for the actual development of networks can vary widely (e.g. between different regions within the Member States). In addition, even where there are already full-coverage plans for ecological networks, these are not necessarily legally binding or in the process of being implemented.

3.3. Examples related to land-use planning

The review resulted in some interesting examples on using integrated approaches to land-use planning to address issues related to ecological connectivity. These examples are summarised below. More detailed information on the initiatives, e.g. their implementation, can be found in the country cases studies (Annex 1).

Since 2003, the Technical Office for Territorial Planning and Analysis of the Barcelona Provincial Council (Spain) has been carrying out a geographical information system (GIS) project (called SITxell) aimed at analysing the open areas of the Barcelona province. The SITxell provides a clear theoretical framework and practical tools that can be used to correct certain growth trends with potential negative impacts on the environment. It can also assist in managing conflicts between different land-uses and help at promoting management practice that ensure that the socio-economic development in open areas does not jeopardise the functioning of natural system. open areas; b) restore some important habitats (e.g. river systems); c) improve forest, cattle and agriculture practices; and d) make transport infrastructure more permeable for species. In addition, SITxell also identifies a number of key areas to be protected in order to maintain ecological connectivity in the region.

In Finland the ecological aspects of use and management of state-owned land are taken into consideration though landscape ecological planning (LEP). In principle, landscape ecological planning views an extensive forest area as a whole including managed forests, nature conservation areas, game areas and special areas for recreational use. Since 2000, landscape ecological plans have formed an integral part of planning and management of state-owned forests in Finland. Attempts have also been made to extend the application of LEP also to private land. Establishing ecological networks and improving connectivity play an integral role in LEP process. In 2001, the area under LEP included 181 000 hectares of land that had been designated as ecological corridors (including both patches of protected areas and 'pure' corridors).

3.4. Transport sector

In the context of land-use planning and management, the transport sector has a significant, and to a large extent negative, impact on landscape ecology within the EU. To some extent fragmentation of landscapes due to transport infrastructure can be avoided or mitigated by environmentally sensitive planning, at national, regional and local scales and by implementing specific measures that reduce the barrier effects of roads and railways etc. As regards the specific measures, artificial pathways (e.g. wildlife bridges and tunnels) and other measures to reduce collision risks can be used to improve 'the permeability' of transport networks. Such measures can reduce mortality rates and enable some species to cross roads and railways that would not otherwise be able to.

The review of the MS transport sector provided several examples aiming at enhancing ecological connectivity within landscapes. These initiatives included constructing artificial passages to enable the movement of species within national transport networks, using nature-oriented management of roadside and waterside verges and reconverting abandoned railway lines into infrastructure for non motorized transport (See Table 8 below).

Artificial passages and wildlife crossing (e.g. bridges and tunnels) are used in a number of the Member States. For example, artificial passages form an important element of the Dutch ecological network. Studies from Finland and the Netherlands

show that the artificial passages are actively used by animals. The effects of passages on population dynamics at local and regional level remain, however, unclear.

Of the reviewed Member States nature-oriented management of roadsides had been applied, for example, in Belgium (Flanders) and Finland. In both cases nature-friendly management of road side verges has been shown to contribute to the conservation of flora and fauna (e.g. insects) in the area. Consequently, the appropriate management of road- and watersides can also positively contribute to maintaining ecological connectivity within landscapes. In Flanders the road side management is also controlled through a Decree (Wegbechermenbesluit). The Decree stipulates that mowing of the verges can only take place after a certain date no herbicides or fertilisers should be used. The Decree is not always well implemented, but there are also several cases where the Decree is correctly used to protect nature.

In 1993 Spain initiated a national programme, called the Greenways Programme, which aimed to reconvert abandoned railway lines into infrastructure for non motorized transport, permitting use by walkers, cyclists and persons with reduced mobility. In addition to supporting environmentally friendly transport, tourism and leisure activities, the initiative also has benefits to wildlife conservation by creating corridors of habitat that are not intensively managed and that allow the spread of species. The outcomes of the Greenways Programme have been very positive. In 2005 more than EUR 60 million had been invested in converting some 1.500 kilometres of unused railway line into 45 green corridors. In addition, 350 km of new corridors has had been constructed.

Despite some of the observations mentioned above, and other evidence that wildlife bridges and tunnels are actively used by many of the species they were designed for, their efficacy in providing necessary functional connectivity and supporting broader ecosystem processes (e.g. in maintaining metapopulations or migrations) remain unclear (Clevenger & Wierzchowski 2006). Therefore, further studies are needed to clarify and improve the effectiveness of artificial passages in mitigating fragmentation impacts from roads and railways. The findings also indicate that artificial pathways, engineering designs, verge management and other similar mitigation measures should been seen as a second-best option to impact avoidance measures such as sensitive routing or project alternatives.

3.5. Measures related to agriculture

Several Member States have applied the European Community's agricultural policies, regulations and agri-environment schemes in ways that help to enhance biodiversity and ecological connectivity in agricultural and rural areas. For example, set-aside land has been used to provide breeding, feeding cover habitats for wildlife, in a number of Member States (e.g. in the context of this review in Germany and the UK). In addition, as the Section 2.2.2 (above) summarises, a variety of agri-environment measures, such as planting and restoring hedgerows, using buffer strips and field margins, and maintenance of certain habitat patches, that have been used to maintain, restore or create wildlife habitats. These measures have also directly contributed to improving the connectivity of the agricultural landscapes.

3.6. Public participation

As regards public participation, the review revealed some potential examples where public participation initiatives could contribute to maintaining and improving ecological coherence. In Belgium (Wallonia) an initiative for integrated river basin management (Contrat de Rivières) has been established to improve the involvement of stakeholders within given watershed areas, e.g. local politicians and administrators, different socio-economic groups, members of the education sector, farmers and fishermen, NGOs etc. In the context of the initiative, the stakeholders define an action plan (programme d'actions) that includes the common objectives for restoration, protection and valorisation of watershed's natural and hydrological resources. The Wallonian government co-finances the agreed restoration and other measures. The river basin action plans could provide a good opportunity to also secure and improve the ecological connectivity within individual river basins. However, it is not certain whether some of the actions plans have specifically addressed the issue.

Public participation is an integral part of a land-use planning related decision making processes in Finland. In this context, the Finnish Nature Conservation Association has initiated an initiative (Ruuhka-Suomi initiative) that aims to facilitate the participation of stakeholders in national/regional land-use planning, in particular from the perspective of protecting their natural environment. The project aims to support participation through providing advice and capacity building for stakeholders and facilitating information availability and communication. The initiative also actively follows national and regional developments (e.g. development regional master plans) providing comments to land-use plans with potential impacts of nature conservation and biodiversity. The Ruuhka-Suomi initiative has also contributed in raising public awareness in ecological networks and connectivity. Therefore, the initiative can also be seen as an potential example of using public participation methods as a tool to enhance ecological coherence and connectivity in land-use planning processes.

Table 8. Summary of existing Member State examples addressing ecological coherence and connectivity

Member State	Measure in place	Species/taxa concerned	Habitat type	Description/Comments
Legal measures				
Belgium (Flanders)	Dune Decree - legislation to prevent any further development of the dune areas along the coast	Dune/ coastal species, migrating/water birds	Dune habitats (e.g. grasslands, meadows, forested areas, ruderal areas, decalcified fossil dunes, etc.)	The Decree prevents fragmentation by effectively stopping landowners from selling the dune areas as nothing can be done with them. This allowed the government to start purchasing these areas for restoration.
Lithuania	The Law on Protected Areas (1993, amended 2001)	Not specified	Not specified	The Law on Protected Areas sets legal basis for the Nature Frame – an approach linking all country's protected areas with other ecologically valuable areas to form a

				landscape system of geoecological compensation zones.
Slovakia	Law on Spatial and Development Landscape (50/1976 with later amendments)	Not specified	Not specified	Act 50/1976 provides provisions for the protection of landscape elements such as riverbank vegetation, forests, peat bog, rivers and cliffs.
Slovakia	Act on Nature and Landscape Protection (No 543/2002)	Not specified	Not specified	The Act introduces the concept of 'biocorridors' as one of landscape elements essential to biodiversity conservation.
Establishing ecological networks and corridors				
Belgium	Vlaams Ecologisch Netwerk (Flemish Ecological network)	The most important and valuable nature areas, e.g. potential nature areas	Not specified	
Germany (Bavaria)	Ecological networks and special protection programmes for threatened species	Threatened species	Not specified	
Lithuania	Nature Frame – a country wide protected area network	Not specified	Not specified	See also legislative instruments above
The Netherlands	The National Ecological Network (EHS)	Not specified	Not specified	
Approaches to land-use planning				
Spain	SITxell project for integrated land-use planning	Not specified	Not specified	A land-use planning tool that integrates aspects related to environmental conservation into land-use planning.
Slovakia	Landscape ecological planning approach LANDET	Not specified	Not specified	
Finland	Landscape ecological planning (LEP) – an integrated approach to forest management planning, in which ecological goals are aligned with different forms of forest use.	Forest species	Forest habitats, however could be also applied to other habitats types	The approach has been applied in state-owned areas in Finland.
Agricultural policy and agri-environment measures				
Several Member States (e.g the UK/England)	Agri-environment schemes providing habitat connectivity benefits	Several species, including species associated	Agricultural habitats	

		with agricultural / forest ecosystems		
Several Member States (e.g. Germany and the UK)	Using set-aside land to enhance species protection, i.e. creating breeding, food and cover habitat for wildlife.	Several species, including species associated with agricultural / forest ecosystems	Agricultural habitats	
Transport				
Several Member states (e.g. Finland and Belgium)	Roadside verges/ transects	Butterflies, wasps and meadow flora	Roadside meadows/ grasslands	
Several Member States (e.g. Finland and the Netherlands)	Constructing artificial passages for species as part of road infrastructure development	Several species, particularly including mammals	Not specified	
Spain	Greenways Programme – a programme aimed at reconverting abandoned railway lines into infrastructure for non motorized transport.	Not specified	Roadside meadows/ grasslands	The initiative will also have benefits to wildlife conservation by creating corridors of habitat that are not in intensive agricultural management and allowing spread and colonisation of indigenous species.
Public participation				
Finland	Ruuhka Suomi – initiative	Not specified	Southern Finland, e.g. urban areas	An initiative aiming to facilitate the participation of stakeholders in national/regional land-use planning. Has also contributed in raising public awareness in ecological networks and connectivity
Belgium (Wallonia)	Integrated river basin management initiative (Contrat de Rivières)	Not specified	Different habitats located in river basins	An initiative that aims to support stakeholder participation and communication within watershed areas. The initiative could provide a good opportunity to also secure and improve the ecological connectivity within individual river basins.

4 REVIEW OF RELEVANT INTERNATIONAL EXAMPLES TO PROMOTE CONNECTIVITY

International initiatives to promote connectivity generally follow one of two models; either they are large trans-national initiatives that focus primarily on drawing together knowledge and expertise from different countries rather than focusing on implementation on the ground, or they are targeted field oriented initiatives that usually focus on a shared ecosystem or natural feature (e.g. river, wetland, or mountain), implementing specific actions over a given time period. Elsewhere in this report there are examples of local transboundary initiatives, thus this section will describe large trans-national examples of both awareness-raising political initiatives and ecosystem based initiatives. We also include relevant examples from other regions of the world.

There is a broad legal basis and mandate for both types of initiative established within global, European and national texts. Thus although EU Member States have a legal obligation to develop biodiversity conservation measures within their borders, they have also signed international commitments and multi-lateral environmental agreements (MEAs), which extend beyond the designation of sites for *in situ* conservation to the broader conservation of biodiversity within the wider landscapes or within sufficient natural surroundings to ensure long term survival. In this section we provide a summary of provisions to promote connectivity within the main international (global and European) binding MEAs.

4.1 Global Multi-Lateral Environmental Agreements (MEA)

The main relevant global MEA is the **Convention on Biological Diversity (CBD)**. Although the Convention text does not explicitly mention ecological coherence or the concept of ecological networks, many references are made to the need for the maintenance of viable populations in large enough areas inside and outside statutory protection (see Brusznik et al 2006 for details). The Programme of Work on Protected Areas, adopted in COP7, specifically addresses the need for ecological connectivity with a target that 'By 2015, all protected areas and protected area systems are integrated into the wider land- and seascape, and relevant sectors, by applying the ecosystem approach and taking into account ecological connectivity/ and the concept, where appropriate, of ecological networks.' Furthermore the use of the Ecosystem Approach as the Convention's guiding framework for implementation further strengthens the need for the integration of anthropogenic land use with ecological coherence through connectivity (Bennett 2004).

The **Ramsar Convention** explicitly mentions the need for an integrated approach to the conservation of wetlands and their sustainable use and takes as its basis integrated water resource or river basin management, which recognizes that numerous habitats and areas either impact on, or are affected by, water bodies. Therefore it is not possible to look solely at the water body itself. Furthermore the concept of zoning within larger sites or linking to buffer zones is also seen as important for the management of wetlands. The Conventions is also promoting the need for trans-

boundary Ramsar sites such as the **Cepkeliai-Kotra wetland complex** on the Lithuanian-Belarusian border.

The **Convention on the Conservation of Migratory Species** (CMS or Bonn Convention) provides a framework for a series of more specific taxonomic based agreements between relevant parties that aim to protect the network of habitats required by migrating species throughout their range. Examples of regional agreements include the EUROBATS agreements for the 45 European bat species, ACCOBAMS for marine cetaceans in the Mediterranean and Black Seas and ASCOBAMS for these species in the North and Baltic Seas. Further to these agreements are a series of Memoranda of Understanding and Action Plans for species or groups, e.g. the great bustard (*Otis tarda*) in Central Europe and the aquatic warbler (*Acrocephalus paludicola*).

4.2 European Agreements

At the pan-European level, the **Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention)** is a binding international legal instrument ratified by the Member States of the Council of Europe that provides an analogue to the Birds and Habitats Directives outside the EU. The Convention binds parties to the protection of habitats and species of European concern and promotes cooperation between countries for the protection of migratory species. One of the most important tools of the Bern Convention is the **Emerald Network**. Although very similar in aims and objectives to Natura 2000, there is an important distinction between the two – whereas Natura 2000 is legally binding through the transposition of the Habitats Directive into EU Member State national law, Emerald benefits only from 'soft' legal support through recommendations passed within the Bern Convention. Although the text of the Convention, which is strictly legally binding, does not mention Emerald, it does set out the need to protect habitats of species and endangered natural habitats. Currently the Emerald Network is in its first phase of implementation where pilot projects are underway to identify the most important sites. At the end of 2005, there were 27 pilot projects running, mostly in Central and Eastern Europe. This process should be complete by end of 2006. However the Emerald Network is primarily site based and does not focus on connectivity between sites or with the broader landscape.

The Council of Europe's **European Conference of Ministers responsible for Regional/ Spatial Planning (CEMAT)** aims to support sustainable spatial development across Europe. The guiding principles of CEMAT indicate that nature protection and ecological connectivity should be taken into account by spatial planning policy. Planners need also to identify the relevant components of ecological networks within their work. Although CEMAT considers the role of the spatial planning for rural communities and sustainable development, it has yet to consider in detail the integration of ecological coherence. The concept is, however, included in the Guiding Principles for Sustainable Spatial Planning adopted in 2000 (Bruszik et al 2006).

Other important MEAs that provide a basis for connectivity measures include the **Alpine and Carpathian Conventions.** Both the Conventions identify the need to harmonise nature conservation, support rural development and enhance ecological connectivity across their respective regions. The **Alpine Network of Protected Areas** was established by France as a contribution and implementation tool for the Alpine Convention in 1995. The network, with a permanent secretariat within the Alpine Convention, aims to act as a tool for international cooperation between protected areas for the implementation of the Convention. Activities include the organisation of workshops, sharing of experience, research and awareness-raising. The Alpine network has carried out a scoping study to identify 23 priority areas for an ecological network within the Alps and sees the implementation of the network as a long term goal.

In 2003, a joint work programme was developed for the **Helsinki (HELCOM) and OSPAR Conventions** which had the aim of ensuring 'that by 2010 there is an ecologically coherent network of well managed marine protected areas for the maritime areas of both HELCOM and OSPAR'. Feasibility studies are currently underway to identify the coherence of the current network and the major remaining gaps.

4.3 Examples of large trans-national awareness raising initiatives

The **Pan-European Ecological Network (PEEN)** provides the broadest ecological concept for continental Europe. Adopted in 1995 through the Pan-European Landscape and Biological Diversity Strategy (PEBLDS), PEEN aims to establish a 'physical network of core areas, linked by corridors and supported by buffer zones, thus facilitating the dispersal and migration of species' across Europe (PELBLDS Strategy text). In 2003, at the 5th Environment for Europe in Kiev, Ukraine, European Environment Ministers further endorsed this approach by establishing the targets of identifying PEEN in all pan-European states by 2006 and 'adequately conserving' all core areas by 2008 Brusnik et al 2006).

To date the mapping exercise to identify PEEN is almost complete, with Central, Eastern and South-Eastern Europe having maps (see Brusnik et al 2006). Western Europe is expected to be completed in early 2007. Core sites were based on a combination of maps of internationally recognised designated areas, maps of internationally acknowledged important species areas (e.g. Important Bird Areas) and maps of selected species distributions. Potential connecting areas or corridors were identified using forest areas and connective landscape features (e.g. mountains and rivers) for terrestrial ecosystems and species distribution data for marine ecosystems.

However how to meet the 2008 target of conserving all identified core sites and implementing PEEN on the ground is far more challenging. As such PEEN provides a pan-European perspective on the need for increased connectivity especially for migratory species. Implementation is necessarily through national and sub-national activities that are put in place to meet legal commitments. The principle goal of PEEN should be to raise awareness that when countries implement connectivity measures, they should consider not only the ability of species to move within their national borders but also across borders and within a whole species range context.

The **European Green Belt** provides a similar umbrella initiative for connectivity measures. Initiated by The World Conservation Union (IUCN), The Green Belt was established along the route of the former Iron Curtain as a mechanism to for the integration of rural development and nature conservation. One of the core elements of this approach has been to promote ecological coherence, but to date this has been through communication and awareness raising projects with rural communities.

4.4 Ecosystem based network examples

Transboundary or transnational initiatives that are based around specific ecosystems or natural features such as mountains and rivers tend to focus on practical implementation measures. Within Europe these are predominantly associated with mountain (e.g. Pyrenees, Alps, Carpathians) or river (Rhine, Danube) systems. Some have been established through MEAs between the affected countries and others have utilised transnational funding mechanisms. Most focus on regional sustainable development coupled with nature conservation and identify within their guiding principle or strategies that ecological coherence or connectivity is important. However with the exception of site based measures that contribute to the general quality of ecosystems involved, there are few examples of specifically implemented measures to support connectivity.

As part of the **Interreg IIIB Alpine Space Programme**, which ran from 2000-2006 contained 58 projects supporting sustainable development and long term cooperation for the Alpine region. Although several projects support nature conservation, with the possible exception of the Living Space Network, none identified within the 2006 project brochure addressed practical field based habitat or species connectivity measures. However there is scope for such actions within the 2007-2013 programme.

The **Cantabrian Mountain-Alps ecological corridor**, supported by the Spanish Fundacio Territori I Paysatge which is working on the implementation of a large, functional ecological network between the main mountain ranges in South-West Europe, connecting the Cantabrian Mountains, the Pyrenees, the French Massif Central and the Alps. This initiative is also to be extended to Central and Eastern Europe to ensure ecological connectivity between the Alps and the Apennines with the Balkan and Carpathian mountains;

The **Rhine 2020** is the current implementation programme of the International Commission for the Protection of the Rhine (ICPR), which was established by international treaty in 1950. The main targets of this 20 year plan are the continued restoration of the main stream as a backbone of the Rhine ecosystem and its main tributaries, their functioning of the Rhine as a habitat for migratory fish and the preservation and extension of areas of ecological importance along the Rhine and in the Rhine valley for autochthonous plant and animal species (ICPR 2001). Importantly the current programme considers ecological connectivity, floodplain development and flood defence as highly inter-connected and therefore has adopted an integrated approach.

The current plan is relatively new. However it is possible to view the success of the previous plan – the Rhine Action Programme (RAP) which was initiated in response to a major chemical spill into the Rhine in 1986. The RAP was launched in 1987 and aimed to rehabilitate the Rhine by 2000 (ICPR 2003). The results of this programme saw reductions in point source pollution into the Rhine either through waste water releases or accidental spills. Private companies using the Rhine implemented the ICPR Recommendations on the Prevention of Accidents and the Security of Industrial plants. Fish fauna was re-established in the river through habitat restoration and water quality measures.

Measures to improve habitat patch connectivity included the restoration of backwaters and tributaries of the Rhine, increases to the surface area of alluvial areas, reconnection of oxbow lakes and cut-off meanders. This also allows increased water retention in these areas as a measure for flood protection.

The Rhine Action Plan and the Salmon 2000 initiative saw the re-introduction of the salmon to the Rhine River through restoration of habitat features and reductions in pollution. However the survival of the salmon still relies on stocking of the river. The aim of the Rhine 2020 and Salmon 2020 plans is to establish self-sustaining populations of Salmon by 2020 (ICPR 2004).

However it should be remembered that the measures implemented for the Rhine are very expensive and require considerable investment from the countries bordering the river. These initiatives are based on a multi-lateral agreement between countries and require long term political and financial support.

River systems, as well as mountains, are naturally connecting structures that are easier to communicate socially and politically. For example it is relatively straightforward to explain that chemical spills upstream will have negative impacts downstream. This makes it easier to implement measures where the benefits can be identified for all the areas along the river. Thus although the activities for the Rhine have been highly successful, spawning similar initiatives for other rivers and providing much of the basis for the development of the Water Framework Directive in 2000, they are specialised to river ecosystems. Different approaches are needed when developing multi-national habitat connectivity initiatives.

4.5 Global examples

The ecological network concept was developed in Europe, primarily in Central and Eastern Europe with a background in spatial planning and land use. Other regions in the world such as North America, Central America and Australia have much larger areas of contiguous undisturbed habitat or wilderness, thus the concept of connectivity generally occurs on a large ecoregional scale and concentrates on their preservation (Bennett & Mulongoy 2006). Also most of these initiatives focus on the integration of sustainable development and nature conservation to promote greater connectivity.

The **WildCountry Initiative**, established by the Wilderness Society in Australia in 1997, focuses on a continental scale protection and restoration of the countries most

important ecological sites the connectivity between them. This approach is modelled on the **American Wildlands Project** launched in North America in 1992. The initiative provides an overall framework and scientific basis for actions at a regional level. The overall plan has reviewed the interactions between species, migration routes, fire regimes, hydro-ecological cycles, and projected impacts of climate change to identify core and restoration areas. Evaluations have been made of land use practices and areas identified that could be restored from agricultural production; these are mostly marginal areas where agriculture is no longer cost effective.

The initiative is currently being implemented through five separate regional landscape scale processes. A good example of this approach is the **Gondwanaland Link** which stretches for 1000 km's in Southwest Australia. Specific measures include the preservation of large intact areas of core habitat, the revegetation of degraded areas, land purchases, mixed production land use with restoration of native vegetation, and communications and awareness-raising with local communities and the private sector. As a result of these actions, the Gondwanaland Link as secured 5,600 ha of land for connectivity between protected areas.

Another group of large initiatives aim to create corridors for biodiversity to move across continental scale areas, usually framed around the movement of large carnivores. Examples of these approaches include, the **Meso-American Biological Corridor** In Central America, the **Yellowstone to Yukon** initiative and the **Bow Valley Wolf Corridor** in North America.

The **Meso-American Biological Corridor (MBC)** is a landscape corridor initiative that spans the southern states of Mexico and the Central American countries of Guatemala, El Salvador, Nicaragua, Belize, Honduras, Costa Rica and Panama. In total it covers almost 0.5 per cent of the world's terrestrial surface with virtually the whole area being designated a biodiversity hotspot. The region has been badly affected by civil conflict, over-exploitation of natural resources and natural disasters. The MBC was born out of the reconstruction process that took place in the region and started as a project to develop a corridor for the Florida panther through Mexico and Panama, called **Paseo Pantera**.

The MBC started via agreement between the countries concerning the long term aims and objectives. National Commissions were established in each country and in most cases implementation was delegated to regional authorities and local NGOs. As with the Australian example, measures have included land purchases, restoration, education and communication. Significant international donor support has been mobilised for the initiative. Examples of local level actions include the **Osa Biological Corridor** and **Path of the Tapir Biological Corridor** in Costa Rica.

The MBC is being implemented with varying degrees of success in different countries, as the level of involvement of the National Commissions differs. International donor funding originally foresaw a 10 year funding cycle and so will so end. The success of the initiative depends on continuation of such funding. Initially there was considerable criticism of Paseo Pantera and the MBC concerning the lack of local community involvement. Again different countries addressed this with varying success. Costa Rica for example has tried to implement measures through cooperation with local land owners and communities. One tool that has been implemented within

Costa Rica for the implementation of the MBC, is **Payments for Environmental Service (PES)**. Costa Rica was a global leader is adopting a Payments scheme that considered forests not just as a resource but as a provider of services. This approach which is also used in Europe such as Austria's Landscape Fund, the Swiss Ecological Compensation Programme), offers a possible mechanism for the implementation of connectivity features within semi-natural or privately owned landscapes.

The **Yellowstone to Yukon Initiative (Y2Y)** is a cooperation between over 170 organisations spanning the Yellowstone to Yukon ecoregion of the North Western United States and Canada. The ecoregion starts in Wyoming and stretches north for 3200 km's to the Yukon in North West Canada. The initiative aims to maintain landscape and biological diversity along the backbone of the Rocky Mountains and covers approximately 1.2 million km^2 of primarily tundra and coniferous forest (Merrill & Mattson 1998). The region is the only place in North America that is home to all the large mammals that were present before human impacts in the last two centuries started decimating their numbers. Within the region the initiative developed a coherent conservation plan, which aims to establish an ecological network for the region, containing core areas, corridors, and buffer zones within a matrix of multiple-use landscapes (Noss 1998). Currently there are 17 core areas and corridors identified within the region. As with other initiative Y2Y developed databases and GIS maps based on the ecological of the region and works with a wide range of stakeholders on conservation and education activities. The initiative works with local communities through an approach called **community stewardship** – which 'includes locally driven efforts to protect the ecological integrity of an area while striving to meet economic and social needs'. This approach is very similar to the community conserved area (CCA) approaches adopted in many developing countries.

4. CONCLUSIONS

At the **Community level**, the Habitats and Birds directives provide an undisputable legal basis for enhancing ecological coherence and connectivity as a part of the biodiversity and nature conservation in the EU. However, the implementation of directives' connectivity related provisions remains to be improved. Also, the two directives remain the only legal instruments that specifically address issues related to connectivity at the Community level. Consequently, it is evident that in addition to the legal provisions provided by the Habitats and Birds directives additional measures are needed to secure the maintenance of ecological connectivity within European landscapes, including between Natura 2000 areas.

The current Community framework for biodiversity and nature conservation puts an increasing emphasis on increasing connectivity between Natura 2000 sites and within the wider landscape. Aspects related to ecological coherence and connectivity can, in principle, also fall under the scope of several other Community policy sectors such as agriculture, forestry and rural development, fisheries, management of inland waters and regional development. However, none of these sectoral polices provide particular reference to maintaining/enhancing connectivity. Therefore, it can be concluded that issues are not adequately addressed within other relevant Community policy sectors at present. In particular, only a number of Member States had address ecological connectivity in the context of mitigation of and adaptation to climate change.

There is no specific Community funding instrument to aid the creation of networks and support the maintenance of ecological coherence and connectivity. However, the review revealed that measures aimed at enhancing connectivity between habitats and species have formed a part of several LIFE+ projects. On the other hand, only one LIFE project so far had specifically aimed at establishing broader ecological networks (the ECOnet project). The availability of LIFE funding has been mainly restricted to actual Natura 2000 sites. This has formed one of the main limiting factors in using LIFE funding to enhance ecological connectivity within Natura 2000 network in general, i.e. also outside the designated sites.

In addition to LIFE funding, several Community supported agriculture and rural development related measures, e.g. set-asides and agri-environment measures, have been used to improve the connectivity of agricultural systems. However, there seems to be a lack of concrete evidence on the actual impacts of the implemented agri-environment-measures on biodiversity. Therefore, there is a need to further analyse the real biodiversity benefits of these measures in the future, including their implications on enhancing connectivity within agricultural ecosystems.

The Community funding framework for 2007-2013 provides a number of opportunities to address issues related to ecological coherence and connectivity. In particular, since supporting the management of Natura 2000 network is to form an integral part of several Community funds, e.g. funds for agriculture and rural development, fisheries and regional development, there should be also more possibilities to address issues related to the connectivity of the network. For example, the European Fund for Agriculture and Rural Development (EAFRD) has potential to

build into agri-environment and forestry measures the possibility of non-horizontal targeted schemes that can focus on building ecological networks particularly based around Natura 2000 sites. It also seems that the upcoming LIFE+ funding would also be applicable for areas outside the designated areas. However, the actual possibilities supported by Community co-financing remain to be decided by individual Member States.

At **national level**, the review revealed a number of measures and initiatives aimed to address issues related to ecological connectivity within Member States. These included, for example, supporting the maintenance of connectivity as a part of the national legal framework for nature conservation, measures related to establishment of national/regional ecological networks, integrated approaches to land-use planning and management and enhancing connectivity within the agricultural and transport sectors. For example, in a number of countries the transport sector had been particularly proactive in taking concrete measures to address connectivity related issues.

In general, a number of the identified initiatives appeared, at least to a certain extent, to be able to enhance connectivity between habitats and species populations also in practise. It also seemed that issues related to connectivity had started to gain more prominence in Member States national policies, in particularly polices for biodiversity and nature conservation. On the other hand, although the legal basis for maintaining ecological connectivity was in place in a number of Member States the national level implementation of these existing provisions often appeared insufficient. There was also little evidence of horizontal legislative/policy frameworks being created to support the development of ecological corridors or networks at national level.

As regards the **international initiatives** to promote connectivity, two different categories of initiatives can be identified. Firstly, there are a number of large trans-national initiatives that focus primarily on drawing together knowledge and expertise from different countries rather than focusing on implementation on the ground. These include, for example, the programmes initiated in the context of CBD, the Ramsar Convention and the Council of Europe. The Pan-European Ecological Network (PEEN) can be considered as the main example of a large trans-national awareness raising initiatives at the European level. As such PEEN provides a pan-European perspective on the need for increased connectivity especially for migratory species. The implementation of PEEN is, however, necessarily through national and sub-national activities. Consequently, the main goal of PEEN should be to raise awareness that when countries implement connectivity measures, they should consider not only the ability of species to move within their national borders but also across borders and within a whole species range context.

Secondly, there exists a number of targeted field oriented initiatives that usually focus on a shared ecosystem or natural feature (e.g. river, wetland, or mountain). These initiatives are predominantly associated with mountain (e.g. Pyrenees, Alps, Carpathians) or river (Rhine, Danube) systems. According to the review, the Rhine 2020 programme can be regarded as an example of a successfully implemented initiative aiming to enhance connectivity at wider European scale. At global scale, North America, Central America and Australia have much larger areas of contiguous undisturbed habitat or wilderness. Thus, in comparison to Europe, the concept of connectivity in these regions generally occurs on a large ecoregional scale and

concentrates on their preservation (Bennett & Mulongoy 2006). Most of these non-European initiatives also focus on the integration of sustainable development and nature conservation to promote greater connectivity.

To conclude, both the Community and national legal/policy frameworks provide opportunities to address ecological coherence and connectivity within the EU. In addition, a number of national and regional examples, both at EU and international level, exist on how these issues can be addressed in practise. However, in can be concluded that the current framework of national and Community measures in place appears too inconsistent in adequately preventing further fragmentation of ecosystems and maintaining/enhancing connectivity. Therefore, further efforts are needed to secure the maintenance of ecological connectivity within European landscapes, including between Natura 2000 areas.

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ANNEX 1

COUNTRY CASE STUDY: Belgium

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INTRODUCTION

Belgium has a population of 10.511m people on an area of 32,545 km² (population density 344 people/km^2). It is separated into three federal regions: Flanders or the Flemish Region, Wallonia or the Walloon Region and the Brussels Capital Region. Environmental issues are managed at the regional level and so each one has developed different approaches to conservation of their natural resources.

The Belgian regions differ in their level of economic wealth, population density and therefore their impacts on their landscapes. Generally Flanders has a larger gross domestic product and a higher population density, leading to fewer natural spaces and a stronger emphasis placed upon actions to connect existing natural areas together. The Walloon Region with a lower GDP and a smaller population density also has some relatively large natural areas, primarily in the south east of the region. Thus less emphasis has been placed in this region on connectivity measures. The Brussels Capital region is entirely urbanised but has taken steps to connect its remaining green areas. There are a variety of legislative tools and initiatives within each region to support connectivity, however there are notable differences in the way these tools are implemented and enforced over time.

National and Provincial Legislative Framework

Before management of environmental concerns was devolved to the federal regions, the basis for nature conservation in Belgium was established by the 1973 Nature Conservation Law.. This was superseded in Flanders by the 1997 Nature Conservation Decree, which provides the basis for nature conservation and the establishment of Natura 2000 SPA's. This Decree includes references to ecological coherence and connectivity.

In the Walloon Region, the 1973 Federal Law still provides the legal basis for conservation, and is implemented through a series of legal regulations (Arrêté du Gouvernement), including those that provide for the establishment for Natura 2000. There is no strong legal basis for the establishment of ecological coherence in Wallonia. The Brussels region uses the 1973 Federal Law as its basis and established legislation in 2000 for the implementation of Natura 2000.

Transboundary cooperation

The regions have developed formal interregional as well as formal bilateral cooperations with neighbouring countries on the integrated management of transboundary ecosystems, such as river ecosystems and protected areas. The 'Plan de Base Ecologique et Paysager Transfrontalier' (PBEPT) Walloon Region-Luxembourg and the 'Grensoverschrijdend Ecologisch Basisplan' (GEB) Flemish Region-The Netherlands will allow to address more significant areas and to develop joint transboundary actions. The 'Three Countries Parc - Open space without borders' (Belgium-The Netherlands-Germany) aims to improve transboundary cooperation to maintain and strengthen the functioning of rural zones as well as to conserve open space in an urbanised environment.

Flanders

Flanders (total surface: 13,522 km²) is covered by about 250,000 ha of semi-natural ecosystems, 18% of the total surface area, primarily made up of forest (150,000 ha). The remaining areas are high nature value grassland (60.000 ha) and other semi-natural ecosystems (40.000 ha) (Dumortier et al 2006).

High nature value grasslands continue to decline primarily due to urban sprawl and pressures from agriculture (intensification and abandonment). Heathland, an important habitat, is also being lost. Grasslands and heath are primarily being succeeded by natural forest expansion and the declines in grass and heath birds and the expansion of forest species reflects this (Dumortier et al 2006). Currently the total area designated as Natura 2000 covers 163,000 ha (12 %) of Flanders.

Wallonia

In Wallonia (total surface: 16,844 km²) about 50 % is covered by agriculture and 30 % (545,000 ha) by forest, of which more than 50 % consists of monocultures, mainly of Norway Spruce (*Picea abies*). There are currently 240 sites making up the Natura 2000 network covering a total of 220,945 ha, approximately 16 % of the surface area (see Figure 3).

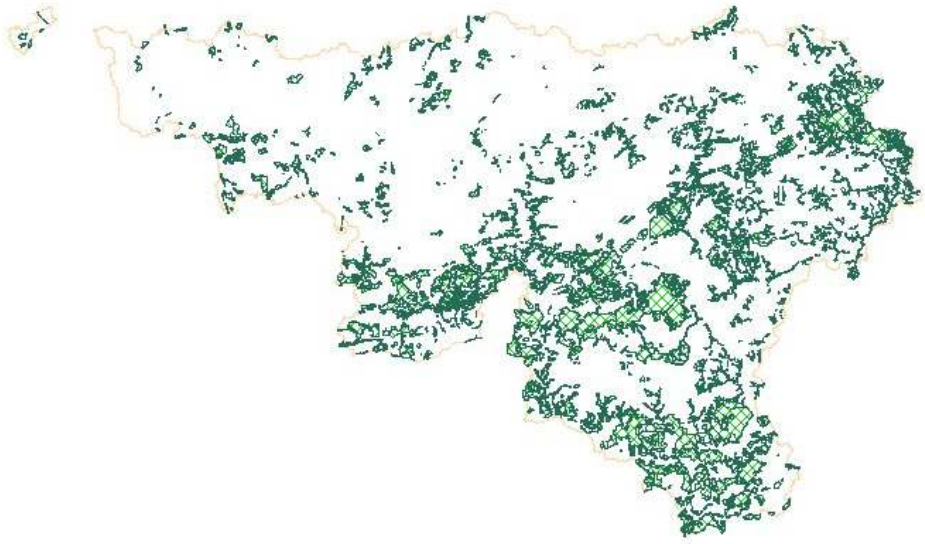


Figure 3: The Natura 2000 network in Wallonia.

Brussels Capital Region

Until now, the **Brussels Capital Region** has not developed a specific nature policy plan or biodiversity strategy plan, however, preservation of biodiversity is integrated in general policy. Brussels designated its Natura 2000 sites in 2002, which cover 2,320ha or 14% of the Region surface. Additionally about 240 ha or 1.5% of the Brussels Capital Region territory is designated as nature or forest reserve. It is likely that the Natura 2000 sites will subsequently be designated as nature reserves. The main programmes for conservation and also habitat connectivity are the Green and Blue Networks.

Within the spatial planning of Brussels, sites with high biological value have been added as a new category. This has extended protection from development to additional semi-natural areas that were not previously identified as either forest or parkland.

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS/ COHERENCE/ CONNECTIVITY

Connectivity measures are implemented separately within each of the federal regions. Generally Flanders is more advanced in the planning and implementation of such initiatives.

Verges with nature-oriented management

There is currently only one initiative that is common to all regions and this is the management of roadside verges. However this approach is implemented differently within each federal region. Within Flanders, the nature-oriented management of roadside verges is established by a legal decision (1984) and is the responsibility of the local and regional road and waterway managers. Currently some 998 km of roadside verges and 636 km of river and canal verges are now under nature-oriented management by the Flemish Government. Initial monitoring results confirm the effectiveness of these measures for vegetation conservation. Flanders possesses 17.000 km of regional roads and 20.000 km of river and canals. Although not all of them are bordered by semi-natural verges, there is still plenty of scope for further action. Many more verges are managed by local authorities. These authorities are actively encouraged to take measures towards more nature-oriented management.

In the Walloon Region, this roadside management is voluntary and established through contracts with local municipalities rather than legal regulations. Contracting municipalities establish management plans that govern the mowing and cutting back of verges. This form of management in both regions and through both forms of implementation (binding and non-binding) is identified as being successful and monitoring studies have identified the return of several rare species to verges.

Flanders

In Flanders there are two dominant ecological coherence structures. The first is called the Flemish Ecological Network (Vlaams Ecologisch Netwerk, VEN), composed of Large Nature Units (Grote Eenheden Natuur, GEN) and Potential Large Nature Units (Grote Eenheden Natuur in Ontwikkeling,GENO). The second is the so-called Integral Interweaving and Supportive Network (Integraal Verwevings- en Ondersteunend Netwerk IVON) and is composed of Nature 'Interwoven' Areas (Natuurverwevingsgebieden) and Nature Corridor Areas (Natuurverbindingsgebieden).

The basic concept of this integrated approach is that VEN provides the core biodiversity areas within the region, being based primarily on designated areas and that IVON identifies components of the landscape which mostly have primary functions other than nature conservation and/or elements that connect these core areas together. It to be remembered however that this spatial planning approach to the development of an ecological network is based primarily on an extremely detailed (one metre resolution) spatial planning map for the entire country. This map outlines the land use classes throughout the country and limits the ecological network sites (VEN) to pre-identified natural areas.

The Flemish Ecological Network (VEN)

The first selection of sites was adopted in 2002 and provides the most important and valuable nature and potential nature areas in Flanders. Areas were assigned based on detailed spatial planning analysis. The original targets foresaw the VEN to be 125,000 ha in size supported by IVON providing an additional 150,000 ha of connecting structures to be established by 2003. This has been postponed to 2007 and also in 2007 this target will not be reached.

By 2006 86,800 ha had been designated as part of VEN. As of 2006, only 840 ha (0.6 per cent of the target) of the IVON had been designated (2004), showing that implementation of the connecting structures is running significantly behind schedule.

Each identified area should receive a Nature Objectives Plan (to be completed by 2008) governing the management of the area. These plans are elaborated with participation of land-owners, farmers and local authorities. The first series of 5 Nature Objective Plans are in development since 2004. They treat a total area of 14.600 ha, which is 5% of the total plan area). Due to the complexity of the procedures and consultation processes the proposed dead-lines will not be reached.

In principle this approach of identifying core areas (VEN) and connecting structures (IVON) through an integrated spatial planning perspective offers a practical method to implement connectivity. It is based on the principle of identifying the primary functions of the areas involved. VEN areas must have nature conservation as their primary function; this could include nature-oriented recreation or limited

production (nature friendly forestry) as secondary functions. The IVON however utilises areas that are identified for use and production and states that a secondary function can be nature conservation. Examples of such areas include agri-environmental schemes and traditional connecting structures such as small rivers or hedgerows. In practice the process has experienced resistance and difficulties implementation..In the future the responsibility for developing initiatives in Nature Corridor Areas will be shifted more and more to the provincial and local authorities. The Flemish government can support them (financially).

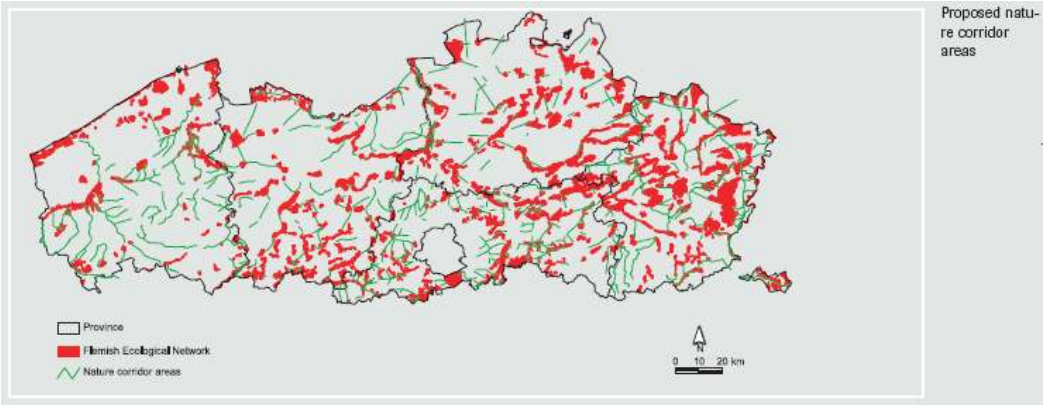


Figure 2: Proposed Flemish Ecological Network and Nature Corridor Areas in Flanders (Dumortier et al 2006)

Cross-Compliance measures in Flanders

The Nature Report of 2005 (Dumortier M et al, 2005, chapter 25) gives a summary of the implementation of Cross-Compliance measures in Flanders. About 635,000 ha (equivalent to 47% of Flanders) are officially registered as farmland. Four major types of agri-environmental schemes have been implemented in Flanders in order to promote biodiversity: field margins, fields with small landscape elements (pools and hedges), grasslands with meadow bird protection and grasslands with botanical management. By 2004, they covered an area of respectively 370, 6,565, 603 and 17 ha, reaching a total of 7,557 ha or 1.2 % of all officially registered farmland. For field margin and small landscape element schemes, the 2006 rural development planning targets of 250 and 5,000 ha have been met and exceeded ahead of time. Agri-environmental schemes for field margins now cover 0.5 % of riverbanks in agricultural use. The implementation of meadow bird protection and botanical management schemes progresses slowly and is behind schedule. The area under agri-environmental schemes for meadow bird protection covers approximately 3.5 % of the designated meadow bird protection areas. The effectiveness of meadow bird protection through agri-environmental schemes has been investigated, but the extent of the scheme was too limited to show any impact.

Since 2005 the total area of permanent pastures should be maintained at the level of 2003. However, this rule only protects the land-use of pastures. After 5 years, pastures may be converted into other crop, as long as there is an equivalent crop rotation to pasture on other fields. During this 5 year period, the pasture may be managed very intensively, with no or little ecological values for natural vegetations or fauna. Thus the protection of permanent pastures can protect the actual area but does not guarantee the ecological function of these pastures.

The Dune Decree (1993)

Another interesting network is provided by the Dune Decree. Coastal dunes are fragile habitat types, but are also under very high pressure from tourism and development.

In 1993, the Flemish Government accepted this legislation to prevent any further development (urbanisation, camping, tourism etc.) of all dune areas along the coast. This included all geomorphological landscape elements that can be classified as dunes (grasslands, meadows, forested areas, ruderal areas, decalcified fossil dunes, etc.). This Decree effectively stopped landowners from

selling these areas as nothing could be done with them – except restoring the nature value and hence allowed the government to start purchasing these areas for restoration.

This integrated coastal conservation policy strives for nature development compatible with the tourist, agricultural and general economic value of the district. Under the "Integrated Coastal Conservation Initiative" thorough soil sanitation works have been carried out and dunes restored in an abandoned military domain. At sea, the possibility of establishing a marine nature reserve will be tested. Populations of birds and marine mammals will be monitored, measures taken to rehabilitate stranded animals and patrol boats and aircraft deployed to carry out surveillance of water sporters and fisheries. On land, a naval base was demolished and works were carried out to restore a tidal marsh along the only estuary (river IJzer) on the Belgian coast.

Strategic sites in the dunes are being purchased (EC-LIFE Fund is used for a systematic acquisition policy) and where necessary cleared; management plans are being drawn up and scientific monitoring set in place. An important aspect includes negotiations with drinking water companies to see if water extraction from the dunes can be brought to more sustainable levels. Finally, in parallel, INTERREG funds will be used to construct a visitor interpretation centre. The outcome should be an integrated coastal management policy.

Two LIFE-Nature projects have been initiated to restore ecological corridors in this built area.

The River Scheldt corridor

The River Scheldt is an interesting example of trans-boundary ecological corridor. The Scheldt Estuary is unique in Europe as it is only of the very few rivers with a estuary that covers the hyaline, brackish and also the freshwater estuary. Protecting and connecting biotopes across this gradient is not easy as it is one of the most used waterways in Europe, a waterway which has been embanked and which is constantly re-profiled (dredging to allow large boats to reach the harbour of Antwerp).

Research has been carried out to (a) investigate the ecology of the estuary, (b) to assess the ecosystem services of the estuary and (c) to restore the estuary along its entire gradient. (controlled flood regime areas of over 500 ha)

Much of this work has been financed by the Flemish Government, by the EU (LIFE-nature) and has been done in collaboration with Dutch authorities.

Wallonia

The main tool for ecological connectivity in Wallonia has been the implementation of Natura 2000 which took place primarily in 2002. Currently the network encompasses about 220,000 ha, equalling 16% of the surface. Currently there is no coherent planning for ecological connectivity similar to that established within Flanders. However there are a number of small initiatives that can support greater connectivity between sites.

Contrat de Rivières

River Contracts are a tool to implement the Water Framework Directive. They aim to bring all the stakeholders together that are involved in a specific watershed area. A Programme of Actions is defined and agreed upon to restore, protect, and valorise the natural and hydrological resources of the watershed. Several groups can participate in these contracts: local politicians, the local administration, teachers, the socio-economic groups, and all the users (farmers, anglers, recreation, nature volunteers, NGOs). The Wallonian government co-finances the restoration and other measures. Several national and transboundary projects (both LIFE-Nature and Interreg have taken place within the framework of the River Contracts. For example the Semois-Semoy project (Interreg IIIA) focussed on the Semois-Semoy sub-catchment area. The project supported coherence between Action Plans implemented in

Belgium and France for the area, undertook habitat restoration activities and communications and awareness-raising actions. The Moules perlières LIFE-Nature project aimed to improve the habitats of the threatened pearl mussel (*Margaritifera margaritifera*) in three river basins. This required actions to improve water quality, develop conservation plans, and monitor populations.

Municipality nature development plans

Local municipalities can develop nature development plans to restore connect biotopes (hedges, ponds, small nature reserves) etc. These are local level actions usually implemented by NGOs or local organisations.

An example of a local level initiative is the "Clombers et Clochers" which aims to protect old buildings and bell towers for nesting and roosting species such as jackdaws, barn owls, bats, swifts etc). Local communes can receive financial support from the Wallonian ministry to undertake conservation measures for these buildings. There are now more than 3000 sites in 102 communes taking part in the initiative.

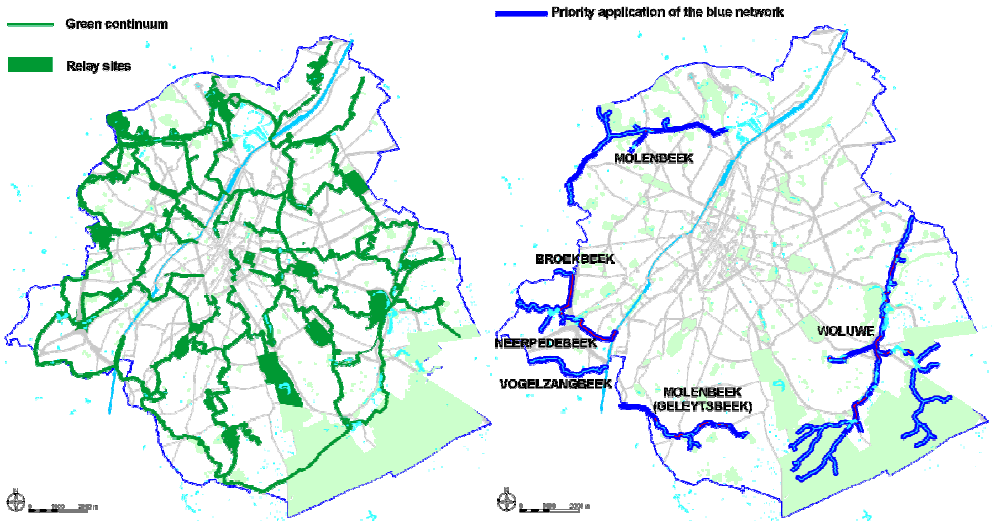
Brussels Capital Region

The Brussels Capital Region is dominated by the metropolitan area of the Brussels and is therefore constrained in the green spaces available for nature protection. However Brussels hosts one of the largest urban forests in Europe, the Foret de Soignes, and has taken steps to increase connectivity within the region.

A plan for an ecological green network was defined as an objective in the regional development plan of 2001, although no specific targets were described. The main tool for connectivity is provided by the Green and Blue networks. The Green Network aims to enhance the connectivity of green spaces and semi-natural areas in the urban environment, integrating scenic, esthetical, social, recreational and ecological functions of the green spaces and to develop of their interconnectivity by greenways and new green areas. This network does emphasise the ecological connectivity required to maintain biodiversity, but the focus remains on recreational and social aspects. Furthermore there are no binding regulations in place to support its implementation.

A similar approach is being implemented through the Blue network to connect the waterways of the region. purpose is to have an integrated, sustainable and ecologically-justified management of the open waterways in the Region. This requires active co-operation between the various sectors, in particular between the green spaces managers and the infrastructure department. Much attention is devoted to the increase of natural values and biodiversity in such a way that the public still has access to the areas concerned.

The Green Network and Blue Network of Brussels



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COUNTRY CASE STUDY: Finland

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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN FINLAND

Ecological characteristics of the country[12]

Finland is situated within the boreal coniferous forest natural vegetation zone, where the dominant tree species are Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*). There are also some deciduous woodlands, particularly in the south. Most of Finland's forests have been exploited for commercial forestry. Consequently, forestry activities have played a major role in shaping Finnish forests ecosystems and landscape throughout decades. At present, some 7.6 per cent of Finland´s forests are protected (as in 2002). About 4.1 of all the forestland is strictly protected, meaning that forestry cannot be practised. In addition to forests, Finland is also characterised by a vast number of inland water ecosystems that cover a tenth of the total area of the country.

Traditional rural biotopes in Finland include various types of meadowland, moorland, wooded pastures, and areas of woodland cleared for shifting cultivation. Due to drastic changes in farming practices, traditional rural biotopes have been disappearing so rapidly that their numbers are thought to have declined by more than 99 per cent over the last century. An inventory of cultural landscapes carried out across Finland during the period 1992-1998 recorded a total of 3,694 valuable traditional rural biotopes, with a total area of around 19,000 hectares, of which only about half is currently managed. The traditional rural biotopes are among the richest natural habitats in Finland, in terms of the diversity of their flora and fauna. Some 22 per cent (338) of the characteristic species of traditional rural biotopes are classified as threatened in Finland.

As regards species diversity, approximately 43,000 species of flora, fauna and fungi can be found in Finland. The Nature Conservation Act automatically protects all species of birds and mammals not specifically listed as game species or unprotected species in the Hunting Act. Some game animals are additionally protected under the Hunting Decree. The Nature Conservation Decree also protects 44 animal species from other species groups, as well as 131 vascular plants and 7 mosses. A total of 83 animal species and 46 plant species listed in Annexes II, IV and V of the EU Habitats Directive are found in Finland. In addition three plant genera are mentioned in Annex V. In Annex I of the EU Birds Directive 62 bird species are listed.

Finnish network of protected areas

Finnish protected areas network consists of three different types of statutory protected areas, including nature reserves, wilderness areas and hiking areas (Table 1, see also Chapter 3). Majority of these protected areas are established on state-owned land, however privately-owned sites further expand on the state-owned network.

Majority of Finnish protected areas (eg including almost all of the state-owned and many of the privately-owned areas) also belong to the national Natura 2000 network. The total area of the Natura 2000 Network in Finland is 49 000 km² (approximately 15 per cent of Finland's total surface area). Number of sites established under the Habitats and Birder directives is 1 715 and 467, respectively. As regards the ecological networks and connectivity, it can be seen that the implementation of Natura 2000 brought the concept of network idea to Finland.

Finland's nature conservation areas play an important role in preserving boreal biodiversity in Europe (eg habitats and species). In addition, the connectivity with in Finnish ecosystems contributes significantly to maintaining ecological coherence and connectivity within the Nordic countries.

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[12] Based on information from the Ministry of Environment (http://www.ymparisto.fi/default.asp?node=4071&lan=en)

Table 1. Number and size of protected areas in Finland (as in 1.1.2005). The number and size of national hiking areas established by law and recreational forests are also listed. (Finnish Forest and Park Service http://www.metsa.fi/page.asp?Section=2798&Item=4655)

Area Type	Number of Areas	Size of Area (sq. km)
National Parks	35	8,820
Strict Nature Reserves	19	1,536
Mire Reserves	173	4,539
Herb-rich Forest Reserves	53	13
Old-growth Forest Reserves	92	104
Seal Reserves	7	192
Other State-owned Protected Areas	63	476
ALL STATE-OWNED PROTECTED AREAS	**442**	**15,051**
Privately-owned Protected Areas	4,687	1,697
ALL PROTECTED AREAS	**5,129**	**17,377**
Wilderness Areas	12	14,904
COMBINED (protected areas & wilderness areas)	**5,141**	**32,281**
National Hiking Areas	7	355
Recreational Forests	99	1,644

Aspects related to fragmentation

According to experts' opinions fragmentation of landscapes and ecosystems is a moderate but growing problem in Finland. As elsewhere in Europe, fragmentation is mainly caused by development of infrastructure and transport networks (road and rail). In addition, forest areas are significantly influenced by a number of forestry activities, including construction of roads for logging purposes. Fragmentation has also occurred in inland water systems due to log driving and water level regulations.

Currently, the effects of fragmentation are the most prominent in the southern part of the country that is most heavily influenced by human activities (eg human settlement, regional development activities). However, the connectivity of natural and semi-natural landscapes is also negatively affected elsewhere. This is mainly due to forestry activities and increasing road networks needed to enable transport of people and good in a sparsely populated country like Finland. It has been estimated that, with the exception of North-Finland, natural areas are located approximately five kilometres from nearest road.

Fragmentation in Finland can also be seen to be caused by general degradation / change of natural habitats. For example, small amount of dead and rotten wood in forests creates problems for specialised groups of species. In addition, the increasing amount of threatened species and decreasing species populations make it more difficult to create viable and sustainable nature conservation networks. (Jappinen pers. com.)

Fragmentation can be seen as an important conservation issue in particularly in the southern part of Finland. Nature conservation areas in the South-Finland are very small and scattered. The surface area of protected sites in South-Finland is less that 2 per cent of the total size of the area. For example, the amount of traditional rural habitats, mires and many forest types in Southern Finland is already too limited. The protected areas are also to a large extent disconnected from each other.

According to the national experts, fragmentation has negatively affected the spread of following groups of species: flying squirrel and elk (moose) populations, number of old-growth forest species and mire habitats' daily butterflies in Southern Finland. For example, numbers of flying squirrels have declined severely in Finland in the past decades. The decline of the species has been attributed to habitat loss/degradation and fragmentation of forest areas (Hokkanen et al. 1982, Rassi et al. 2000). Public and game inquiries in the late 1970's indicated that the decline of the species has apparently been continuous since the 1950's (Hokkanen et al. 1982). This negative population trend was recently documented also in smaller, more intensively studied areas in Southern Finland (Anon. 2001). Fragmentation of forests has also led to decrease of number and size of populations of large forest fowl

species like capercaillie as well as of Siberian Jay in the Southern Finland. All the exemplified species are subjects to research and/or conservation actions.

RELEVANT NATIONAL FRAMEWORK

The framework for supporting ecological coherence and connectivity in Finland consists of several sectoral legal and policy instruments. The national sectors involved include biodiversity and nature conservation, agriculture and forestry, land-use planning and transport. This chapter provides a brief outline of the relevant legal and policy framework for promoting ecological coherence and connectivity in Finland. It also gives an overview on how aspects related to coherence and connectivity have currently been addressed within this framework.

Nature conservation and biodiversity

Issues related to nature conservation and biodiversity are governed by the Nature Conservation Act (1096/1996)[13]. The Act was drawn up in 1996 and one of its particular aims was to meet Finland's obligations derived from EU legislation, especially from the EU Bird and Habitats directives, and the international Convention on Biological Diversity (CBD). The special provisions relating to Natura 2000 network are outlined in paragraph 10 of the Act. The Nature Conservation Act is supplemented with Nature Conservation Decree (160/1997)[13]. The Degree provides more detailed provisions for species that receive protection under the Habitats directive. In addition, the protection of certain game species is conducted under the Hunting Act 65/1993 (i.e. species included in 5 § of Hunting Act)[14].

The priorities for nature conservation and biodiversity in Finland are outlined in national biodiversity strategies. The first national strategy for the period of 1997-2005 was developed in 1996 (National committee for biodiversity 1996). The biodiversity strategy for 2006-2016 is currently being finalised and it is envisaged to be adopted in the near future (Ministry for Environment 2006a). At the regional level, the priorities for nature conservation and biodiversity are included in regional environment centres' environmental programmes.

The Finnish protected areas network consists of three main categories of sites. Nature reserves (based on the Nature Conservation Act) are established on state-owned lands by law or by a government regulation or on privately-owned lands by the decision of Finland's environmental administration. Wilderness areas are established in accordance to the Wilderness Act (see below) on state lands in Lapland. National hiking areas are established in accordance to the Outdoor Recreation Act (606/1973)[15] on state land in different parts of Finland. The protected areas are managed according site-specific management plans. In addition, general principles of protected area management on state-owned land are provided by the national Forest and Park Service, i.e. Metsähallitus (2000a).

Nature conservation and biodiversity falls under the jurisdiction of Ministry of Environment. The implementation of nature conservation and biodiversity related legal provisions and policies is carried

[13] Finnish Nature Conservation Act and Degree (in Finnish):
http://www.finlex.fi/fi/laki/ajantasa/1996/19961096?search%5Btype%5D=pika&search%5Bpika%5D=luonnonsuojelulaki;
http://www.finlex.fi/fi/laki/ajantasa/1997/19970160?search%5Btype%5D=pika&search%5Bpika%5D=luonnonsuojeluasetus

[14] Finnish Hunting Act (in Finnish):
http://www.finlex.fi/fi/laki/ajantasa/1993/19930615?search%5Btype%5D=pika&search%5Bpika%5D=mets%C3%A4styslaki

[15] Finnish Outdoor Recreation Act (in Finnish): http://www.finlex.fi/fi/laki/smur/1973/19730606

out by regional environment centres, national Forest and Part Service (state-owned land) and municipal environmental administration. The general objectives of the Ministry of Environment are laid out in Ministry's work programme for 2007-2011 (Ministry of Environment 2005) and Ministry's strategy adopted in 2006 (Ministry of Environment 2006b).

As regards the adoption of habitats and species to **climate change** (e.g. issues related to fragmentation) has been addressed as a part of the national strategy for climate change adaptation published in 2005 (Ministry for Agriculture and Forestry 2005). These aspects have also been included in the 2006 Ministry of Environment's strategy adopted (Ministry of Environment 2006b). However, even though a majority of national policy documents address both ecological connectivity and climate change no specific connection is systematically made between these two aspects. Consequently, no particular evidence could be found to indicate that the current national framework would be adequate in addressing issues related to fragmentation and climate change.

Agriculture and forestry

Agriculture is an area of exclusive Community competence within the EU. Therefore, the Finnish legal and policy framework for agriculture is closely linked with the priorities outlined at the EU level. The Finnish agricultural sector is governed by a number of national legal and policy instruments covering different aspects of agricultural production, including financial support to the sector[16]. In the majority of the cases, these instruments are aimed at implementing the EU agricultural policy at national level.

The use of forests is controlled by the Forest Act (1093/1996) and the Forest Decree (1200/1996)[17]. In addition, the conservation and use of state-owned forests and wilderness areas located in Finnish Lapland is outlined in the Wilderness Act (1991/62)[18]. The National Forest Programme 2010 forms the current cornerstone and strategic foundation of the Finnish forest policy (Ministry of Agriculture and Environment 1999). At the regional level, regional forest programmes define the needs and objectives for the conservation and management of forests. The programmes are drafted in cooperation with other organisations in the region and they are revised at least every five years. Revisions for 2006-2010 were made in 2005.

Agriculture and forestry sectors are governed by the Ministry of Agriculture and Forestry. A number of government institutions and authorised municipal offices are responsible of implementing the different aspects of agriculture and forestry policy at regional and local level. For example, the state-owned land and water areas are administrated by state enterprise Metsahallitus whereas the regional agriculture and forestry centres guide the management of privately owned land under agricultural use and forestry. In addition, a number of environmental aspects of agriculture and forestry also fall within the scope of regional environmental centres (above).

Land-use planning

The most important legislation controlling land-use, spatial planning and construction in Finland is contained in the Land Use and Building Act (1999/132)[19]. The Act came into force in 2000 and its

[16] Finnish Ministry for Agriculture and Forestry - national legal frameworks for agriculture (in Finnish): http://www.mmm.fi/fi/index/etusivu/maatalous/lainsaadanto/kansallinenlainsaadanto.html

[17] Finnish Forest Act and Degree (in Finnish): http://www.finlex.fi/fi/laki/ajantasa/1996/19961093; http://www.finlex.fi/fi/laki/ajantasa/1996/19961200

[18] Finnish Wilderness Act (in Finnish): http://www.finlex.fi/fi/laki/ajantasa/1991/19910062

[19] Finnish Land Use and Building Act and Decree (in Finnish): http://www.finlex.fi/fi/laki/ajantasa/1999/19990132?search%5Btype%5D=pika&search%5Bpika%5D=maank%C3%A4ytt%C3%B6%20ja%20rakennus%20laki;

objective is to organise land-use and building to create the basis for high quality living environments and to promote ecologically, economically, socially and culturally sustainable developments. These general objectives are supplemented by more specific objectives relating to controls over land-use planning and construction. The Land Use and Building Act covers also national priorities and objectives for land-use (Article 22 of the Act). These objectives were outlined in further detail in related Finland's National Land Use Guidelines adopted by the Finnish Council of State in 2000 (Ministry of Environment 2000). More detailed regulations and controls on land-use and construction are included in the Land Use and Building Decree (1999/895)[19].

Land-use planning is administrated by the Ministry of Environment. However, the Finnish land-use planning system (as defined in the Land Use and Building Act) gives municipalities a high degree of autonomy in local land-use planning. In general, the land-use planning system has three levels of land-use plan. On the regional level, **regional land-use plans** are drawn up by 19 regional councils, which are made up of the representatives of local authorities. Land-use designations and planning reservations at regional scale are in line with the regional development strategies also drawn up by the regional councils. The regional plans must be approved by the Ministry of Environment. Municipal planning is guided by national land-use guidelines issued by the national government, and by regional land-use plans. The local authorities independently plan land-use on a local scale through **local master plans**, which define land-use patterns, and **local detailed plans**, controlling construction.

As regards public participation, the planning processes set out in the Land Use and Building Act have been designed to facilitate stakeholder participation. Therefore, individual citizens and non-governmental organisations are fully entitled to participate in planning processes, both at regional and local level.

Transport

The national transport sector is governed by a number of legal and policy instruments that cover aspects of road, rail and waterway transport. The development and maintenance of highways is currently controlled by the Highways Act (503/2005)[20] that became in force in 2006. This new Act covers the whole life cycle of highway networks, including aspects related to planning, (sustainable) development and maintenance. Similarly, the development and use of rail- and waterways is governed by Railway and Water Transport Acts (555/2006 and 1996/463 respectively)[21].

The transport related issues fall under the jurisdiction of the Ministry of Transport and Communications. At sectoral level the transport related issues are governed by national Road and Rail Administrations. The Ministry's long-term strategy 'Towards Intelligent and Sustainable Transport' describes the transport related targets at national level until 2025 (Ministry of Transport and Communications 2000). The environmental goals and actions, including related to biodiversity, are further defined in the 'Environmental Guidelines for the Transport Sector until 2010' (Ministry of Transport and Communications 2005). In addition, the Finnish Road Administration (Finnra) has its individual programme (until 2010) aiming to enhance the environmental aspects of the sector (Finnra 2006).

Other sectors

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http://www.finlex.fi/fi/laki/ajantasa/1999/19990895?search%5Btype%5D=pika&search%5Bpika%5D=maank%C3%A4ytt%C3%B6%20ja%20rakennus%20

[20] Finnish Highway Act (in Finnish): http://www.finlex.fi/fi/uutiset/?id=38

[21] Finnish Railway and Water Transport Acts (in Finnish):
http://www.finlex.fi/fi/laki/alkup/2006/20060555?search%5Btype%5D=pika&search%5Bpika%5D=rautatielaki;
http://www.finlex.fi/fi/laki/alkup/1996/19960463?search%5Btype%5D=pika&search%5Bpika%5D=vesiliikennelaki

In addition to the sectors above, a number of other legal instruments are relevant in the context of addressing fragmentation. The provisions of the Finnish Water Act (1961/264) and Land Extraction Act (1981/555)[22] prohibit development initiatives that cause significant negative changes to nature protection. In addition, the Environmental Impact Assessments Act (2005/200) provides general provisions for addressing effects of planned projects and initiatives for biodiversity and nature conservation. The above mentioned laws do not include specific reference to connectivity and fragmentation, however these issues can be considered under the general scope of these legislative instruments.

As regards the development of Finnish coastal zones, a national strategy for integrated coastal zone management was published in 2006 (Ministry of Environment 2006c). The strategy does not address issues related to ecological connectivity as such, however these issues can fall under the scope of the strategy (e.g. when adopting ecosystem approach on Finnish coastal areas).

Addressing ecological coherence and connectivity within the national legal and policy framework

The national legal framework for biodiversity and nature conservation outlined above does not particularly address issues related to ecological coherence and connectivity. The relevant provisions of the Habitats and Birds directives (ie Articles 10 and 3, respectively) have not been transposed in detail into national legislation (Nature Conservation Act). In the policy context, however, issues related to coherence and connectivity between protected areas have been taken into consideration, also in the context of climate change. These issues have been addressed in the relevant current policy documents such as the upcoming national biodiversity strategy for 2006-2016, national strategy for adaptation to climate change and Ministry of Environment's work programme for 2007-2011 and 2006 strategy. At the regional level, maintaining the coherence of ecological networks has been included as one of the priorities for Uusimaa, the most southern region in Finland (draft regional environmental programme, Uusimaa regional environment centre, 2006).

The national legal and policy framework for agriculture does not seem to provide any particular reference to promoting ecological coherence in Finland. However, support to the maintenance of diverse rural landscapes and management of Natura 2000 form an integral part of the suggested national strategy for rural development in 2007-2013[23] (Ministry for Agriculture and Forestry 2006). Aspects related to ecological coherence and connectivity can, therefore, clearly fall under the general scope of this strategy. As regards forestry, in state-owned forest areas the aspects related to biodiversity and nature conservation, including ecological coherence and connectivity, at planning level are taken into consideration by landscape ecological planning (LEP) (See Chapter 3). The management design of LEP is strongly supported by Environmental guidelines to Practical Forest Management of Metsähallitus (Finish Forest and Park Service 2005). However, even though conservation and sustainable use of biodiversity form an important part of the National Forest Programme for 2010 the programme itself does not provide any reference to maintaining connectivity within/between forest ecosystems.

As regards the land-use planning, promoting nature conservation and biodiversity is one of the statutory objectives of the Land Use and Building Act. Based on the Act's requirements, consideration of these aspects should also be included in regional and local land-use plans. The Act itself does not

[22] Finnish Water Act, Land Extraction Act and Environmental Impact Assessment Act (in Finnish):
http://www.finlex.fi/fi/laki/ajantasa/1961/19610264?search%5Btype%5D=pika&search%5Bpika%5D=vesilaki;
http://www.finlex.fi/fi/laki/ajantasa/1981/19810555?search%5Btype%5D=pika&search%5Bpika%5D=maa-aineslaki;
http://www.finlex.fi/fi/laki/ajantasa/2005/20050200?search%5Btype%5D=pika&search%5Bpika%5D=ymp%C3%A4rist%C3%B6vaikutusten%20arviointi

[23] National strategies are a requirement under the Regulation for the European Agricultural Fund for Rural Development - EAFRD (Council Regulation (EC) No 1698/2005)

address issues related to ecological coherence and connectivity. Nevertheless, maintaining connectivity between protected areas (when possible) is particularly mentioned as one of the objectives in the National Land Use Guidelines (Chapter 4.4 of the Guidelines). According to the guidelines ecological connectivity between protected areas should, if possible, be maintained. Additionally, fragmentation of uniform and ecologically/recreationally important areas should be avoided. In practise, however, the Finnish land-use planning sector has not been pro-active and successful in taking aspects related to ecological coherence and connectivity into consideration.

On the other hand, preventing fragmentation and maintaining ecological connectivity forms an integral element of the recent policies for national transport sector. Consequently, the environmental guidelines of both the Ministry of Transport and Communications and Finnish Road Administration support addressing ecological connectivity as a part of the development of transport networks.

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY

Legal measures and policy initiatives

As regards legal measures aimed to support connectivity, the Finnish Supreme Administrative Court has reached a number of decisions that support the protection of ecological networks for flying squirrel as a functional part of species' breeding and resting sites. These decisions refer to a number of specific local / regional cases, including local master plan for Tampere city, logging of Konikallio forest area in city of Forssa and construction of highway between cities of Turku and Helsinki (Decisions KHO:2002:78, KHO:2003:38, KHO:2003:98 respectively). The decisions include specific references to secure/maintain flying squirrel's movement pathways. According to national experts, these court decisions are the only current connectivity related legislative initiatives in Finland.

A number of national policy initiatives specifically consider and/or support the maintenance of connectivity between protected areas. These initiatives are outlined above in Chapter 2.3. More specific information on their ecological coherence and connectivity related provisions is provided in Table 2.

Table 2. Main relevant policy instruments in the context of ecological coherence and connectivity in Finland.

Policy instrument	**Provisions related to ecological connectivity / coherence**	**Scale of implementation**
Nature conservation and biodiversity		
National biodiversity strategy for 2006-2016 (draft to be adopted)	Ecological connectivity and coherence within the national protected area network (including Natura 2000) is to be enhanced, e.g. though management, restoration, landscape ecological planning, natural resources planning. This is also seen relevant in the context (of adoption to) climate change. Connectivity between forest protected areas is to be supported, including through forestry related agri-environment measures. Connectivity within agricultural landscape is to be secured by using relevant agri-environment measures.	National
National strategy for adaptation to climate change (2005)	Calls for support the connectivity between protected area networks in order to secure the adaptation of habitats, species and ecosystems to climate change. Notes also the role of commercial forests in maintaining biodiversity and serving as migration channels. In general, notes that the capacity of ecosystems and biotic communities to adapt to climate change can be promoted by maintaining and restoring traditional farmland habitats and by promoting the ability of ecosystems to function sustainably in accordance with their own regularities.	National

Ministry of Environment's work programme for 2007-2011	Support ecological resistance and resilience of national protected areas network. Support the implementation of provisions included in the national biodiversity strategy (see above).	National
Ministry of Environment's strategy (2006)	Support to coherent and representative protected areas network. Support the implementation of provisions included in the national biodiversity strategy (see above).	National
Regional environmental programme for 2020 – Uusimaa (draft to be adopted)	Aims to secure the connectivity / coherence of the Uusimaa ecological network of protected areas. One of the main focal points in is maintaining / reconstructing pathways for species.	Regional
Land-use planning		
National Land Use Guidelines	Guidelines state that land use should promote the preservation of biodiversity of valuable and sensitive natural areas. The preservation of ecological corridors between protection is to be promoted as far as possible.	National
Transport		
Ministry of Transport and Communications -Environmental Guidelines for the Transport Sector until 2010	Defined key measures include safeguarding animal migration routes through structural solutions. Attention is also given to the joint impacts of various measures (e.g. animal crossing bridges to safeguard both traffic safety and biodiversity) and links between biodiversity and climate change.	National
Finnish Road Administration (Finnra) environmental programme (until 2010)	Guidelines provide specific reference to supporting ecological connectivity in the context of road network development, e.g. though considering effects of fragmentation and developing corridors and pathways.	National

Approaches for land-use planning addressing ecological connectivity

Landscape ecological planning on state-owned land

Planning for state-owned lands, forests and waters is contained in the **natural resource plans**. These plans layout the general principles and goals of land use for the next ten years are defined. The goal is to reconcile the possibilities offered by natural resources with the needs of different parties to form an effective whole. Different forms of use of state-owned lands include nature conservation, forestry, recreation, ecotourism, real estate development and the sale of soil resources.

In the context of natural resource plans, the ecological aspects (e.g. aspect related to nature conservation and biodiversity, landscape ecology) are taken into consideration though **landscape ecological planning** (LEP). LEP is integrated approach to forest management planning, in which ecological goals are aligned with different forms of forest use, while bearing in mind the objectives of forestry in the area. The development of landscape ecological planning in Finland started as a cooperative project between Metsähallitus and the Finnish Environment Institute in 1994. The guidelines for LEP were published in 2000 (Kurvonen 2000). The practical planning method has taken shape in the course of pilot projects, which were started and implemented in areas administered by Metsähallitus in 1996 (i.e. state-owned forest areas). Since 2003 the first attempts to examine LEP in private owned forests has been carried out as a part of the Forest Biodiversity Programme for Southern Finland (METSO) (see below).

In principle, landscape ecological planning views an extensive forest area as a whole including managed forests, nature conservation areas, game areas and special areas for recreational use. The long-term objective of landscape ecological planning is to assure the survival of the area's native species as viable populations. Among other things, this requires the conservation of existing valuable habitats and ensuring that new ones can evolve. The planning also involves the effort to assure the conditions for the spread of various species. In this effort, the valuable habitats and ecological links in managed forests complement and enhance already existing nature conservation areas. Participation of relevant stakeholders play an important role in the LEP process.

Establishing ecological networks and improving connectivity play an integral role in LEP process. In 2001, the area under LEP included 181 000 hectares of land that had been designated as ecological corridors (including both patches of protected areas and 'pure' corridors). In principle, the corridors followed landscape's small waterways and wetlands. Approximately half of these LEP corridors had been established on forest land (spruce or pine) whereas the other half was located on land with little natural forest cover (e.g. bogs).

According to the evaluation of LEP programmes in 1996-2000, the main principles of planning ecological corridors within the LEP approach were sufficient. However, there was a lot of variation in terms of practical implementation of the approach, including the size of areas where the approach had been applied to. It was estimated that the established corridors might be inadequate, both in terms of habitat characteristics and size, in enabling the spread of certain species (e.g. old spruce forest species).

Since 2000, landscape ecological plans have formed an integral part of planning and management of state-owned forests in Finland. The LEP plans are implemented and updated as part of ongoing forest management practises.

Implementing landscape ecological planning on private land

As regards the application of LEP type of approaches outside the state-owned land, one of the main objectives of the governmental Forest Biodiversity Programme for Southern Finland (METSO) (2003-2006) was to enhance the establishment of protected area network in Southern-Finland[24]. In particular, METSO finances two important tools to improve the network of old-growth forests in Southern Finland. The tools are 1) restoration of nature values in the recently economically exploited forests in the protected areas, and 2) enhancement of voluntary conservation of nature values in the private forests in Southern Finland.

Supporting the existing network of protected areas was one of the main criteria in selecting areas for METSO programme (e.g. distance from existing conservation sites). Some of the pilot projects carried out in the context of METSO programme also included concrete incentives to improve the connectivity between privately owned protected areas. For example, the pilot project for Keski-Karjala area provided increased compensation to landowners that joint their efforts in establishing joint protected areas or small protected areas 'networks' in their land (Kolström et al 2006).

The final evaluation of METSO programme concluded that voluntary arrangements with landowners are a potential tool in improving conservation of biodiversity in densely populated South-Finland (Primmer & Keinonen 2006, Syrjänen et al 2006). However, the results indicated that more resources and additional tools would be needed to enhance the aspects of ecological coherence and connectivity through voluntary agreements.

Other existing initiatives and measures

Regional master plans

In general, regional master plans are a good possibility to take aspects related to ecological connectivity into consideration. These possibilities have already been taken up by some regions, for example some regional master plans include plans to study and define broad unified forest areas in the area (e.g. the planned regional plan for Uusimaa, to be adopted). Some regions (e.g. Keski-Suomi region) have also carried out preliminary studies for regional protected area networks. (T. Veistola, pers. com.)

[24] Forest Biodiversity Programme for Southern Finland (METSO) (in Finnish): http://wwwb.mmm.fi/metso/uudet_suojelun_keinot/yhteistoimintaverkosto/ajankohtaista.html

Initiatives related to transport

The Finnish transport sector, the Finnish Road Administration (Finnra) in particular, has been relatively proactive in taking issues related to biodiversity into consideration (e.g. Väre 2003). Consequently, a number of artificial passages (e.g. bridges and tunnels) have been constructed as a part of the road network.

Finnra has also been carrying out a number of assessments related to the use of artificial passages by animals and conservation of biodiversity in the context of road network maintenance. A 2002 study on the use of artificial passages in Pernaja European highway concluded that the built underpasses had been well adopted by animals and the related costs in road constructions have been justified (Vare 2002). According to the study, the underpasses have become a part of the territory for the local moose and they are also a part of the wandering route of moose. These constructions reduce habitat fragmentation at local and regional level of ecological network. The animal accidents have also reduced.

In addition, Finnra has assessed the role of roadside transects in maintaining biodiversity (Jantunen et al 2004). According to these studies, appropriately managed roadside transects can increase the abundance and diversity of several species, such as butterflies, wasps and meadow flora. It can be concluded, therefore, that these transects have a potential to enhance the connectivity between different habitats patches.

The Green Belt of Fennoscandia

The initiative 'Fennoscandian Green Belt' has been he brought forward by the intergovernmental body Finnish-Russian Working Group on Nature Conservation and its is supported by non-governmental organisations and some research organisations. The initiative roots back to the beginning of the 1990'ies. The idea is to conserve the ecological interface or the connectivity between Finland (now EU) and Russia boreal zone ecological network.

The Green Belt of Fennoscandia consists of already existing and planned protected areas along the Finnish-Russian border. It is not a continuous area but a network of unconnected areas. The Green Belt spans 1,000 km across the Finnish-Russian-Norwegian borders from the Gulf of Finland in the south to the Arctic Ocean in the north. This 20 to 30 km wide belt spans some of the last remaining old-growth boreal forests, harbouring about 50 percent of the endangered forest species in the area.

Developments related to establishing the Green Belt of Fennoscandia network are still taking place. In particular, Russia has been very proactive in seeking extra protection status, e.g. UN World Heritage nomination, for the area. Improving protection of the Green Belt has also been assisted by a number of projects carried out by Finnish Environment Centre and Forest and Park Services (e.g. Green Belt LIFE project). Given that the Green Belt initiative will become more concrete in the future, it can help to maintain and enhance ecological connectivity in the boreal zone of Fennoscandia.

Public Participation

Public participation is an integral part of a land-use planning related decision making processes in Finland. In this context, the Finnish Nature Conservation Association has initiated an initiative (Ruuhka-Suomi initiative) that aims to facilitate the participation of stakeholders in national / regional land-use planning, in particular from the perspective of protecting their natural environment[25]. The project aims to support participation through providing advice and capacity building for stakeholders and facilitating information availability and communication. The initiative also actively follows national and regional developments (e.g. development regional master plans) providing comments to land-use plans with potential impacts of nature conservation and biodiversity.

[25] Ruuhka-Suomi initiative (in Finnish): http://www.sll.fi/luontojaymparisto/maankaytto

The Ruuhka-Suomi initiative has also contributed in raising public awareness in ecological networks and connectivity. Therefore, the initiative can also seen as an potential example of using public participation methods as a tool to enhance ecological coherence and connectivity in land-use planning processes.

Potential / upcoming initiatives

During the recent decade, Finland has been interested in developing the application of ecosystem approach as a tool for planning and management. For example, application of this approach has been already supported in managing marine and coastal systems (Ministry of Environment 2006c). In addition, the LEP approach has been considered as a Finnish model for applying ecosystem approach in the context of state-owned forest ecosystems. METSO project has tried to further implement this approach in the context of areas owned by numerous private land owners. It seems that Finland will continue developing the application of ecosystem approach also in the future. This provides good opportunity to start systematically addressing issues related to ecological coherence and connectivity.

The national rural development strategy for 2007-2013 puts a strong emphasis on maintaining the diversity of agricultural landscapes for people and biodiversity. In addition, management of Natura 2000 network forms an integral part of the strategy. Therefore, national agri-environment measures will be increasingly focusing on improving landscape management for biodiversity. In this context, aspects related to connectivity could be specifically addressed. However, as throughout the EU, there is a need to ascertain the actual biodiversity benefits delivered by the schemes.

CONCLUSIONS

- Aspects related to ecological coherence and connectivity, both between protected areas and on wider landscape context, have not gained a lot of attention in Finland in the past. However, recent policy developments indicate attention given to these issues is increasing.
- Existing situation related to maintaining and enhancing ecological connectivity in Finland can be summarised as follows:
- Legal provisions for maintaining ecological connectivity are lacking. For example, Articles 10 and 3 of the Habitats and Birds directives has not been transposed into the Nature Conservation Act;
- Obligations to compensate for lost ecological connectivity in the context of land-use planning and development are inadequate/missing (e.g. building obligatory animal passes etc.);
- The recent and upcoming policies provide good support to maintaining and enhancing ecological coherence and connectivity. It now remains to be seen how effectively the current policies will be implemented. At sectoral level, the transport sector (i.e. the Finnish Road Administration) has already been notably proactive in addressing issues related to connectivity.
- A number of good measures / initiatives addressing connectivity related issues exist. For example, an integrated approach to landscape ecological planning (LEP) is systematically used to manage state–owned land, in particular forests ecosystems. This approach also integrates maintenance of connectivity within ecosystems. The transport sector also provides a number of good practical examples on addressing connectivity related issues, e.g. road side transects and artificial passages. However, the application of these measures should be broadened.
- There is a lack of funding to support enhancement of connectivity related measures and research. For example, Finland has decided not to use Community co-funding possibilities (European Agricultural and Rural Development Fund - EAFRD) for national forest sector;
- The main difficulty is how to implement connectivity related objectives in Southern Finland for the area is mostly owned by several private land-owners with small individual owning;
- Addressing ecological coherence in the context of climate change is still rather limited. For example, the national policy documents rather systematically address both ecological connectivity and climate change, however with the exception of the national strategy for adaptation to climate change no specific connection is made between these two aspects. No

particular evidence could be found to indicate that the current national framework would be adequate in addressing issues related to fragmentation and climate change.

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COUNTRY CASE STUDY: Germany

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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN GERMANY

Germany contains three biogeographic regions; most of the country is covered by the continental region, a smaller proportion of the Atlantic region in the North-West and a very small component of the Alpine region in the South. Germany lies at the centre of the European distribution of beech forests and contains 25% of the total beech forest area (BfN 2005).

The dominant forms of land cover in Germany are agricultural lands (53.5%) and forests (29.5%). In recent years there has been a slight decrease in the coverage of agricultural land and a small increase in forest area. Urban areas and transport infrastructure cover 11.3% of the territory and have grown steadily since 1993.

Agriculture

Compared to other EU countries, agriculture takes a relatively large share of the German landscape and is concentrated in the North and Western parts of the country. Intensification is increasing in the country as the number of smaller holdings is declining. Generally this has negative effects for connectivity measures. To try to counteract the negative effects of agricultural practices, the German Federal Nature Conservation Act (2002) contains seven agricultural best practices which include the measure to preserve and increase landscape elements that provide links between biotopes (see Box 1) . Furthermore the Federal Nature Conservation Act requires that the Länder must ensure that connectivity features remain in agricultural landscapes (Article 5 (3), see Box 2).

Organic farming has developed strongly in Germany, and now makes up 4.3% of the total agricultural area. These areas have been shown to contain increased biodiversity, increased species richness and abundance. Furthermore organic farms tend to provide more connective elements such as hedgerows and orchards. However BfN states that many conservation oriented farming management measures that could be carried out to improve landscape quality and connectivity are not, primarily due to a lack of financial support (BfN 2005). The Federal Ministry of Environment will continue to implement the reforms of the CAP which include more measures to support farmers to implement more nature oriented management practices.

Box 1: Criteria for Good Agricultural Practice

In addition to the requirements arising from provisions relating to agriculture and from Article 17 paragraph 2 of the Federal Act on the Conservation of Soils (*Bundes-Bodenschutzgesetz*), agriculture shall in particular comply with the principles of good agricultural practice outlined in the following:

- Land used for agriculture must be appropriately managed in accordance with the requirements of the site in question, and the sustained fertility of the soil and long-term usability of the land must be ensured.
- Any avoidable impairments of existing biotopes must not be incurred.
- The landscape components required for the interlinking of biotopes must be preserved and, where possible, increased.
- Animal husbandry must be in a balanced relationship to cropping; any adverse impacts on the environment are to be avoided.
- On erosion-prone slopes, in flood plains, at sites with elevated groundwater table and in boggy locations, farmers shall refrain from ploughing up grassland.
- The natural features of the land concerned (soil, water, fauna, flora) must not be impaired beyond the extent required to achieve a sustainable yield.
- Plot-specific recording and documentation of the use of fertilizers and plant protection agents in conformity with pertinent agricultural legislation is required.

Source: BMU, 2004
(www.bmu.de/files/pdfs/allgemein/application/pdf/bundnatschugesetz_neu060204.pdf)

Box 2: Article 5: Agriculture, Forestry and Fisheries

(3) The Federal Länder shall determine a regional minimum density for the continuous linear elements and the circumscribed spots required for the interlinking of biotopes (boundary landscape structures/ ecotones, especially hedgerows and baulks, and 'stepping-stone' biotopes), and will take appropriate measures (targets and items fixed under planning law, long-term arrangements, promotional and funding programmes or any other appropriate measures) if the density ascertained is falling short of this minimum and relevant structures and elements of the landscapes concerned need to be established.

Source: BMU 2002 www.bmu.de/files/pdfs/allgemein/application/pdf/bundnatschugesetz_neu060204.pdf

Forestry

Naturally deciduous forests would be the dominant land cover in Germany, but now occupy approximately 30% of the surface area. Forest area increases further south in the country. However the historical use of even-aged stands and coniferous species in plantations has meant that there is a great variation in the quality of forests and history of forest management in the different regions. For example 80% of the forest in Thuringia is classified as historic (i.e. used predominantly for forestry in last 200 years), whereas in Schleswig-Holstein only 43% of the forest has been used continuously for the past 200 years (BfN 2005). In terms of habitat quality the highest quality areas (i.e. in a near natural state) are found in montane areas. Generally there are few near natural forests remaining in Germany, and these mostly exist within protected areas. There is a need to increase the conservation based management of forests, and there was a good basis for this in that over 50% of the forests were in some form of public ownership. Recently in some Länder privatization of the formerly state-owned forestry administration has led to more economic pressure being placed on forests. For private forests it would be possible to introduce conservation measures into contractual management agreements, although in 2004, less that 4m EUR was used in this manner (Güthler et al 2004 in BfN 2004).

Habitat Fragmentation

The principle threats to German habitats are destruction and degradation caused by numerous activities but primarily by the conversion and intensification of land use. A study carried out in 1994 found that more than two thirds of all German habitat types are threatened (Riecken et al 1994 in BfN 2004). A revised edition of the Red Data Book of Biotopes will be available this spring (2007).

Habitats that are thought to be particularly threatened by effects from climate change due to their fragmentation include raised peat bogs and habitats of high mountains. Furthermore, the North Sea tidal flats and salt meadows in coastal proximity are threatened by area losses through erosion and increases in sea level. Among other effects, this would result in the loss of important over-wintering, resting and breeding areas for seabirds and waders.

Climate change

Studies in Germany estimate that climate change threatens 5-30% of all plant-and animal species and that the current level of habitat fragmentation is a significant barrier to species adaptation (Leuschner & Schipka 2004). Protected areas do not fulfill the requirements of protecting species responding to climate change. It is expected that the habitats of many of the animal-and plant species in Germany will move to the North and East in higher mountain areas or regions with a more beneficial moisture balance. BfN therefore identifies that the habitat networks must be established within Germany to provide opportunities for species to adapt to climate change and to reduce the blocking effect of roads, waterworks and intensive agriculture and forestry (BfN 2005).

Species

Germany has approximately 48,000 animal species and 28,000 plant species identified within its borders, this places it in the middle species richness in Europe. More than half the bird species, almost half of the mammals and freshwater fish and one third of the amphibians in Europe are found in Germany. There are however relatively few endemic species due to the geological history of the country. Similar threats as faced by habitats are the lead causes of declines in species. These include habitat loss and also the reduction in patch diversity.

Climate change is already showing impacts on species distributions in Germany, for example Mediterranean dragonfly, such as the scarlet darter Crocothemis erythraea have extended their range northwards and are increasingly commonly sighted in the country. There are fewer examples of range contractions which are predicted to occur. One example is the yellow-bellied toad, which is at the northern and north-eastern edge of its range and highly endangered. The original habitats of this species, such as parts of catchment areas close to rivers of hill and montane levels, have mostly been destroyed in Germany.

Natura 2000 in Germany

95 of the 238 habitats on Annex 1, and 152 of the 1040 species on Annex 2 of the Habitats Directive are found in Germany (BfN 2005). Currently (as of June 2006), Germany had 4,617 SCIs covering 53,294 km2. Germany also has a high representation of marine Natura 2000 sites. Responsibility for the implementation,management, monitoring and reporting of Natura 2000 sites is devolved to the Länder level, but BfN conducts scientific and technical coordination work. The level of implementation of the Habitats Directive varies between Länder, with some such as Saarland and Thuringia designating over 10% of their territory and others such as Lower Saxony and North Rhine/Wesphalia, designating just over 5%. Of the total amount of 53,294 km2 protected under the Habitats Directive, 20,085 km2 are marine areas, which means that Germany has the largest proportion of marine protected Natura 2000 sites in Europe.

Box 3: Criteria for the determination of suitable sites for the establishment of ecological networks pursuant to Article 3 of the Federal Nature Conservation Act (2002).

I Criteria for the determination of suitable sites for ecological networks:
• Typicalness of habitats/habitat complexes
• Completeness of habitat complexes
• Minimum size (specific for different types of habitat complexes)
• Fragmentation (unfragmented)
• Spatial location (importance as ecological corridor or stepping stone)
• Additional criterion: Presence of target species (regionalized system of target species)

II Criteria for the determination of site needs (deficits compared to conservation targets):
• Which of the habitats/habitat complexes are underrepresented?
• Are ecological network sites isolated or corridors interrupted?
• Which of the ecological network sites are under threat?

III Criteria for the determination of suitable development sites for ecological networks:
• Needs
• Abiotic and biotic potential
• Maximum degree of fragmentation
• Suitable spatial location
• Minimum size

Source: BfN (2004) after BURKHARDT et al. (2003), simplified

NATIONAL FRAMEWORK

Nature conservation legislation

Nature conservation within Germany is devolved to the Federal Länder which are responsible for implementing Federal legislation. The basis for German nature conservation activities is provided by the Federal Nature Conservation Act of 2002, which has the two main objectives:

- conservation of native species and their populations, including their habitats and biotic communities
- preservation, regeneration and development of sound functional, ecological relationships

For the first time, the Act stipulates the development of a national ecological network or network of interlinked biotopes (Biotopverbund, Article 3, see box 4), which comprises at least 10% of the country's territory. Legislation for the implementation of this network must be transposed into Länder legislation for implementation.

With regard to land use planning, nature conservation legislation states that all conditions and measures for nature conservation should be elaborated for the planning area and the regions have to regulate the prohibition of disturbance and harm to ecosystems. This means that the interests of nature conservation and landscape maintenance are integrated in land use planning. Furthermore, environmental assessment will play an important role in the monitoring of environmental effects of plans and programmes.

Box 4: Article 3 Network of Interlinked Biotopes (Biotopverbund)

(1) The Federal Laender shall establish a network of interlinked biotopes (Biotopverbund) covering at least 10% of the total area of each Federal Land. The establishment of the network of interlinked biotopes shall be performed by the Federal Laender on an interregional basis. To this end, the Federal Laender shall consult with each other.

(2) The network of interlinked biotopes is designed to safeguard on a lasting basis native fauna and flora species and their respective populations, as well as their habitats and biocoenoses, and to preserve, restore and develop functioning ecological interrelationships.

(3) The network of interlinked biotopes consists of core areas (Kernflächen), connecting areas (Verbindungsflächen) and connecting elements (Verbindungselemente). The network of interlinked biotopes includes:

1. designated 'national parks' (Nationalparke)
2. 'biotopes' (Biotope) protected under Article 30 of this Act
3. 'nature conservation areas' (Naturschutzgebiete), areas under Article 32 of this Act and 'biosphere reserves' (Biosphärenreservate), or parts of such areas
4. other areas and elements, including parts of 'landscape protection areas'(Landschaftsschutzgebiete) and 'nature parks' (Naturparke)

if they are suitable for reaching the aim laid down in paragraph 2 above.

(4) The required core areas, connecting areas and connecting elements shall be legally secured via the designation of appropriate areas pursuant to Article 22 paragraph 1, detailed planning in accordance with the provisions of planning law, long-term arrangements (contractual nature conservation) or other appropriate measures, so as to safeguard an interlinked network of biotopes on a lasting basis.

Source: Federal Nature Conservation Act (2002).
www.bmu.de/files/pdfs/allgemein/application/pdf/bundnatschugesetz_neu060204.pdf

Climate change policy

Germany remains at the forefront of climate protection and is certain to reach its Kyoto target of a 21 percent reduction in climate-damaging greenhouse gases by the year 2012 (Das Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2006). Germany is the first country in Europe having submitted its plans for the next emissions trading period between 2008 and 2012 to the European Commission. The key message from the decision of the Federal Cabinet on 28 June 2006 on the second "National Allocation Plan" (NAP II) for European emissions trading is to send a clear and strong signal for the continuation of a committed climate protection policy in Europe and to reject all attempts to delay the necessary decisions.

The German legislation on climate change protection states that definitions and models for project measures leading to forestation and reforestation in the framework of a mechanism for environmentally sustainable development, must also include the effect on biodiversity and natural ecosystems.

The relevant organizations within Germany working on habitat connectivity

National legislation on water resources management, nature conservation and landscape management is outlined at the federal level by the Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

The German Federal Agency for Nature Conservation (BfN) is a higher federal authority reporting to BMU and advises the Ministry on all issues relating to national and international nature conservation and landscape management, promotes nature conservation activities, supports research projects and acts as, among other things, the authority permitting the import and export of protected species of animals.

The responsibility for the implementation of nature conservation in Germany is devolved to the Länder level. This means that the development of the new legislation, such as the implemetantion of Natura 2000 had to be transposed into German federal law and then subsequently into the laws of the 16 Länder. The Länder are responsible for implementation and enforcement of Natura 2000, as well as for establishing the necessary monitoring and reporting regimes. The Federal Agency for Nature Conservation is assisting with scientific and technical coordination. Only marine implementation of the Habitats and Bird Directives in the EEZ falls exclusively into the responsibilities of the federal authorities. Also the The provisions of the Federal Nature Conservation Act on ecological networks had to be transposed into the state (Land) laws by April 1st 2005. Länder work with local authorities on issues such as building planning and landscape planning, the implementation of nature conservation and landscape management.

In May 2005, an international workshop on ecological networks and coherence according to article 10 of the Habitats Directive took place in Vilm, Germany in order to discuss the up to date implementation of aspects of coherence in EU Members States in the context of the implementation of the Habitats Directive or ecological networks. Besides requirements for additional measurements to increase coherence and possible approaches to implement theses were discussed from a scientific point of view. .

Conclusions

Germany is progressive with regard to ecological networks in terms of having set up a legal basis for their implementation. However, as implementation is the responsibility of the Länder, different methods and levels of implementation are applied, which provide a barrier to the development of a coherent ecological network across the whole of German territory. As a result, the scope of these provisions varies substantially as well as the current situation regarding the existence and design of plans and strategies for the development of ecological networks.

Even where there are already full-coverage plans for ecological networks, these are not necessarily legally binding or in the process of being implemented. In this regard, again, the situation varies substantially between individual Länder. For a long time, Schleswig-Holstein has been something of a forerunner in this field. Quantitative information on the current stock of sites for ecological networks in the individual Länder is not yet available.

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY

The National Ecological Network (Biotopverbund)

Most of the Länder have transposed the provisions on ecological networks from the Federal Act into their legal texts. In the following five states this has not yet happened: Hamburg, Mecklenburg-Vorpommern, Niedersachsen, Saarland and Sachsen. In Hamburg the process of legal implementation is ongoing. Seven of the 11 Länder that transposed the text have also included the reference “that the ecological network is to cover at least 10% (or more) of the surface area” (K. Ullrich pers. comm.). A complete (federate state level) planning for an ecological network in the mean time exists for most federate states with the exception of Bremen, Berlin, Hessen, Niedersachsen and Thüringen. However there is much less information available to determine what measures are being taken to implement these plans on the ground, and so an overview is not possible. This now remains the major next step that needs to be taken.

As implementation of the network occurs at the Länder level, there is no overall implementation nationally, beyond the provision of guidance. In a research and development project recently run by BfN, such an indicative map was produced (almost finished) showing core areas of national importance for an ecological network. An additional map shows spaces of varying connectivity that can be used as a help when searching for connective elements in practical planning processes. The source data for the project were provided by the Länder and included protected areas, Nature 2000 sites, results from habitat mappings and their plans for ecological networks.

Länder

North-Rhine/Westphalia (Nordrhein Westfalen)

Natura 2000 represents 8.2% of the state's territory and the sites are integrated into a state-wide ecological network. Activities that were implemented to establish coherence of designated sites included:

- alignment of state-wide biotope inventory;
- species mapping of target species;
- implementation and alignment of state-wide ecological network and special network planning for target species;
- site protection and management concepts;
- ecologically based financial support programs and local advice;
- implementation of "good agricultural and forestry practice";
- monitoring of implementation and efficiency of planning;
- consideration at regional/local town and country planning (impact regulation).

In North-Rhine/Westfalia there ia a clear link between Regional planning law and ecological networks. Planning law (ROG, implemented in LPIG 2005) calls for the necessities of ecological networks or habitat connectivity to be respected. Regional plans have to define and respect the priority areas for nature conservation. A complete scientific digital planning of habitat connectivity is existing by the Länder agency (LANUV). Their legal implementation via the regional planning is well advanced.

Schleswig-Holstein

The development of a protected areas and ecological network is the central and long-term strategy for protection of biodiversity. In the long-run scientifically at least 15% of the states territory should be integrated. (The Länder law currently prescribes 15 %, however in a new law proposal for April 2007 is it foreseen to reduce the percentage to 10%) The translation from the ecological network planning to reality follows the existing programme and the instruments of nature protection by for example by buying land, protected areas establishment, biodiversity protection programmes, agreements with the State Forest Service and a targeted establishment of buffer zones.

Sea Eagle protection and integrated coastal zone management

The project group for Sea Eagle protection consists of several nature conservation organizations (WWF, NABU, BUND, OAG), as well as the Hunting Association, Forest owners Association the Ministry for Environment and the Forest Agency Eutin. They follow the instructions of the State Schleswig-Holstein for the species protection project "Sea Eagle". The most important species protection measures are:

- Buying of old beech stands
- Reconstruction of former wetlands
- Developing protection zones around the nesting areas
- Maintaining the brood areas
- Agreement on forest economic and hunting measures in the protected zones with the forest employees, land owners and those who have a permission to hunt
- Targeted support to three public observation stations

For the North-sea, the goal of ecological quality for sea-bird populations has been taken on by the establishment of the network of protected areas, but the coherence and management still needs to be achieved. The Schleswig Holstein National park in the 'Watten Sea' and Bird protected area near Helgoland and in the North seas have been established for this purpose. In the national strategy for integrated coastal zones (Das Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2006), the dynamic development of coastal zones from an ecological, economic, social and cultural perspective is strived for. The protection and use of biological diversity should be balanced in a better

way. The German Coastal States have been involved in integrated coastal management and sustainable development of the coastal areas.

Schleswig-Holstein has developed a strategy with the framework concept of integrated coastal management, containing a network of initiatives and activities to improve dialogue with civil society. The coastal planning and improvement of management processes is strongly connected to the Interreg III-C project for Coastal Practice Network to network with scientific and legal experts. Furthermore, the involvement of the State in the Interreg III B project Baltcoast for transnational land use strategies in the offshore sector, is contributing to the development of transnational methods on steering the interests of use. Schleswig-Holstein has established cooperation with the Dutch and Danish regional bodies in the Watten region for protection and sustainable use at a regional level. Concrete ideas for projects are development of coastal forums, indicators and green tourism activities.

Bavaria (Bayern)

The main focus of measures is on the creation of an ecological network and special protection programmes for threatened species and habitats. The realisation of an ecological network began in 1986 –earlier than the EU legislation on Natura 2000. On the base of a specific concept (programme for the protection of species and habitats = ABSP) to date (January 2007) over 330 Ecological Network projects (called BayernNetz Natur) exist covering more than 25 % of the state area.

Species support programmes are targeted measures for maintaining the threatened species, which are developed throughout the State and consist of an analysis of populations and habitat structures and risk factors in order to determine protective measures. For the endemic and threatened plants in Bayern a special programme has been developed since 1991. In the framework of the projects by the State of Bayern, successful targeted measures for protection of these species were realised, based on detailed analysis of population trends, factors of influence and risks. The loss of species was stopped and increase in populations has been established for many types of plants. Beyond that there are special programmes for threatened animals with a similar structure than the programme for plants (e. g. for birds like *Ciconia ciconia*, all species of bats, amphibians like *Pelobates fuscus*, butterflies like Euphydryas maturna a.s.o.). Another approach is the protection of endangered habitats, e.g. mires, springs and floodplains or landscapes (e.g. the Alps) by special programmes.

In the meantime the EU legislation on Natura 2000 is integrated in the Bavarian ecological network as an additional concept and tool.

Further information:
http://www.bayern.de/lfu//natur/arten_und_biotopschutz/absp/index.html (concept)
http://www.stmugv.bayern.de/umwelt/naturschutz/baynetznatur/index.htm and http://www.pan-gmbh.com/absp/aindex.html and www.bayernnetznatur.de (in progress) (realisation of the ecological network)
http://www.bayern.de/lfu//natur/arten_und_biotopschutz/ahp/index.html (species protection programmes)
http://www.bayern.de/lfu//natur/arten_und_biotopschutz/moorentwicklungskonzept/index.html (example of a programme for the protection of a habitat)
http://www.stmugv.bayern.de/umwelt/naturschutz/lsn/de/index.htm (living space network for the Alps)

Rheinland-Pfalz

The planning of habitat connectivity is an ongoing activity in Rheinland-Pfalz. The regional planning projects are combined and will be integrated in a validated planning of system of habitat connectivity at the Länder level. Natura 2000 sites will mainly serve as important core areas, which will be supplemented by corridors and connecting links at Läner level.

Other specific initiatives

Apart from the Habitat Fallow Land and the Integrated Coastal Zone management projects mentioned above, another important initiative in Germany is the Green Belt.

The Green Belt is an initiative running along the former border between East and West Germany. The aim of the project is to protect important ecological sites along the border and to raise awareness for nature conservation and rural development. This initiative was initiated in Germany, but now it has been extended to the full route of the former Iron Curtain and has a Secretariat hosted by IUCN.

In Germany, a project was initiated to identify the areas of high natural importance along the Green Belt. The project identified that many areas of the Green Belt have not been developed and that there are a large number of important habitats present. Approximately 15 % of the area of the Green Belt has already been degraded or destroyed, and so the remaining areas in are in need of protection. A study identified 32 focal areas along the Green Belt, 21 one of which were identified as being of national importance and have been included as core areas for further activities within this initiative (Schlumprecht et al 2002).

CONCLUSIONS

Federally Germany has taken a strong position on the establishment of a national ecological network and the Federal Nature Conservation Act provides a strong basis for action. This legislation has been transposed into the laws of most Länder and plans have partly been drawn up. However as yet implementation on the ground is not coordinated and is yet to take off. Most connectivity measures are being implemented through separate projects. Nature Conservation policy also provides guidance and requirements for conservation actions within sectoral land use and spatial planning policies which also contribute to connectivity.

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COUNTRY CASE STUDY: Lithuania

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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN POLAND

Ecological characteristics

Lithuanian terrain is an alternation of lowlands with highlands, many scattered small lakes, fertile soil, Baltic coast with sandy, stony bottoms and shallow areas. Land use in 2001 was as follows: 39 per cent arable crops; 9per cent permanent crops; 6 per cent permanent pasture; 31 per cent forests and woodland; 15 per cent other (WWF 2004).

Lithuania, like the other Baltic States, is rich in species and habitats and the biodiversity is remarkably well preserved compared to other European countries. Several species that are threatened on a European scale are abundant (e.g. beaver, wolf, otter, black and white stork, corncrake, lesser spotted eagle, cranes, etc.). This preservation of habitats such as bogs, wooded meadows, wetlands and forests is due to relatively low human population density, a lack of economic development and retention of traditional land-use methods during the Soviet period and to long-term nature conservation traditions since the beginning of the 20th century.

Lithuania has an established system of protected areas with five National Parks (152,294 ha), four State Nature Reserves (23,805 ha), 30 Regional Parks (409,911 ha) and 54 Landscape Reserves (58,428 ha) WWF (2004).

Primary environmental problems in Lithuania are water quality, air quality, waste management, physical pollution, inappropriate land use and forest structure optimisation, depletion of landscape and biodiversity, insufficiency of protected areas.

Ecological changes

Lithuania has experienced some problems of fragmentation. For example, the Soviet period (1940-91) brought about changed land uses and landscapes. The principal trends were: a decline in natural grasslands and simplification and polarisation of landscape structure. During this period, the patchy mosaic type of landscape, characterised by small fields, grasslands and woodland, was replaced by extensive fields and forests. This resulted in loss of meadows, marshes and fens. Lithuania still has one of the largest portions of arable land compared to other European countries.

Recent political and economic changes have caused considerable changes to land use and landscapes. Intensive utilisation of forest resources has started as a result of more forest becoming privately owned. Land reform and the development of recreational activities have also increased pressure on rural areas. On the other hand, agricultural
development is declining resulting in decreased fertiliser and pesticide use but also leading to loss of valuable agro-habitats.

Natura 2000 sites

Natura 2000 sites	Number	Area (ha)	per cent of country area
SPAs	61	508,900	7.8
pSCIs	271	12,000	2
Total	332	No data[1]	No data

[1] some of the SPAs and pSCIs are overlapping, so no data on totals.
Source: IUCN (2005)

These sites were adopted by the Ministry of Environment in 2004 (WWF 2004), the State Service of Protected Areas is responsible for implementing protection and management of the Special Protected

Areas and Special Areas of Conservation. An IUCN assessment (2005) found that the percentage coverage of SPAs is more or less sufficient, the number of pSCIs appears to be high, but the percentage of country cover is low. The problem is that pSCIs were selected as small sites, mostly in areas which were already protected.

The Ministry of Environment tried to avoid designating large areas, with many landowners or users who would potentially be unsatisfied with Natura 2000 protection status. In many cases, it was only the least problematic areas which were designated (IUCN-EP 2005).

Designated SPAs are mostly in areas which are already protected, but the IUCN study found that there is not enough of them. There is a large number of nominated pSCIs, but the area covered is small and they usually lack buffer zones or protected corridors between each other.

RELEVANT NATIONAL FRAMEWORK

The protection of natural resources and co-ordination of land use planning in Lithuania is the primary responsibility of the Ministry of the Environment The main role of the Ministry of Environment is to conserve Lithuania's landscapes, natural ecosystems, natural features and biodiversity, protect forests, increase forest cover, and co-ordinate land use planning (Jongman & Kamphorst 2002).

Lithuanian cities and districts have environmental units or offices which, according to the Law on Environmental Protection for municipal institutions, implement environmental protection legislation (Jongman & Kamphorst 2002).

In 1984, in the national Integrated Nature Protection Scheme, the concept of a Lithuanian Nature Frame was raised and approved. This became the concept and approach for the conservation and protection of Lithuania's natural landscape. This concept has been adopted in national legislation and is integrated into the following four laws.

Law on Environment Protection (1992, amended 1996): the Ministry of Environment submits projects for the establishment of reserves, national parks and other protected areas to the Government of the Republic of Lithuania.

The Law on Protected Areas (1993, amended 2001) sets a legal background for all protected areas and the Nature Frame. The aim of the Law is to regulate social relations in connection with protected areas. According to the law, all protected areas of natural character and other ecological important and natural or semi-natural areas, which provide general landscape stability, shall be combined into a joint system of land management and ecological compensation zones by the Nature Frame.

Lithuania's system of protected areas consists of four general categories:
conservation areas (strict nature or culture areas, protected landscape objects, reserves)
preservation areas (protective zones of various purposes);
recuperation areas (sites where resources are protected/restored);
integration areas (national and regional parks as well as biosphere monitoring areas).

Categories 1 and 4 together are known by the name of 'particularly protected areas' and have the greatest significance in nature conservation. All the protected areas are combined in to the Nature Frame as a joint system of land management and ecological compensation zones.

The Law on Territorial Planning (1995) is the main legal instrument for establishing protected areas, the nature frame and ecological networks. It sets priorities for regulating and planning the purpose and use of land and for environmental and monument protection and developing a system of land and water use.

The Law on Forest (1994) sets a legal background for forest management, protection and use. It aims to protect forest in nature reserves and those classed as ecosystem protection forests as well as maintaining forests as buffer zones of protected areas.

Among other policy instruments, there are two documents which are most important for biodiversity protection: the National Environmental Strategy of Lithuania adopted by the Ministry of Environment in 1996 and the Lithuanian Biodiversity Strategy and Action Plan adopted by the Ministries of Environment and Agriculture in 1998. These two legal instruments provide a framework for environmental and biodiversity protection programmes in Lithuania.

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY

Nature Frame

Lithuania was one of the first European countries to develop the basic principles of ecological networks. The idea of Lithuania's Nature Frame was raised in the early 1980s with the preparation of the Integrated Nature Conservation Scheme in 1983. Since then the concept of a Nature Frame has become a universal concept for the conservation and protection of Lithuania's natural landscapes.

The Nature Frame links all protected areas with other ecologically valuable areas to form a landscape system of geoecological compensation zones. In this zone, land management is focused on forestry, recreation and nature conservation. The Nature Frame as a land management system consists of a network of areas of great geoecological significance. The main functions of the nature frame are:

to ensure that links between separate protected areas are protected;
to protect natural landscapes and natural recreation resources;
to neutralise the impact of economic activities in territories with intensive use;
to optimise the structure of anthropogenic landscapes by creating conditions for restoration of forests, and by regulating trends and intensity of agricultural activities and urban development.

The nature frame, as a land management system, is composed of three meta-functional subsystems:

geo-ecological watersheds, which are the territorial belts between different geosystems;
areas of inner stabilisation (areas of conservation and biodiversity significance), which fulfil functions of ecological compensation inside the separate geosystems;
migration corridors (linear territories like river beds, valleys, pit-grooves, etc.), which fulfil the functions of geodynamic exchange and biological information flow.

The Lithuanian Nature Frame connects areas with various purposes, e.g. strict nature reserves, managed reserves, national and regional parks, protection zones and protected sites of natural resources. The purpose is to ensure natural connectivity between the different categories of protected areas. The Nature Frame includes all natural and semi-natural ecosystems, covering about 60 per cent of the total Lithuanian territory.

This concept has been enshrined in the 1992 Law on Environmental Protection (as amended in 1996) and the 1993 Law on Protected Areas. However the present network of protected areas does not cover all species and ecosystems.

According to the Law on Protected Areas, an ecological network will form a part of the Lithuanian National Nature Frame, however at present, the network exists only on paper and is not defined on the ground. The Nature Frame is based on geographical criteria, rather than ecological elements and thus is not officially related to biodiversity conservation

Pan-European networks

The proposed Lithuanian ecological network is based on Council of Europe Emerald and European Union Natura 2000 networks, as well as the PEEN. As such, the main structural elements are the same as the pan-European networks with "core areas", ecological corridors, buffer zones and nature restoration areas. The proposed ecological network is composed of 82 core areas (29 of European

importance, 53 of national importance) totalling 976019.42 hectares. Other elements include 65280.75 hectares of buffer zones, 10797.90 hectares of stepping stone ecological corridors and near to 500000 hectares of ecological corridors.

Under the PEEN framework, a pilot ecological network was compiled at the county level in Klaipeda district and Neringa city. These local level projects aimed at involving members of the public in the ecological network planning process and making them more aware of the possibilities and options open to them for influencing their surrounding landscapes.

Nature Reserves

Protected areas in Lithuania cover more than 12 per cent of the territory. This network of protected areas consists of one Biosphere Strict Nature Reserve, three State Strict Nature Reserves, five National Parks, 30 Regional Parks, 254 State Nature Reserves, 410 Objects of Nature Heritage nearly 300 Municipality Reserves.

The Zuvintas Late is one of Lithuania's biggest lakes and oldest nature reserves. In 2002 the Lake and adjacent areas (Almalvas wetlands, fen meadows, drained peat lands and buffer zones) were designated as a Biosphere Reserve under Lithuanian legislation. This designation obliges the government to maintain and restore the biodiversity in the area. This involves restoring the drained wetlands, stopping degradation of the Zuvintas Lake and achieving favourable conservation status of the Natura 2000 habitats. A Dutch funded research project is currently being carried out at this reserve to produce a Management and Restoration Plan for the Dovine River Basin as a framework for coordinated planning and design of water management, river and wetland restoration and development of sustainable agriculture and fish breeding[26].

CONCLUSIONS

Compared with Western Europe, the natural preconditions for a well-functioning ecological network in the Baltic States are fairly good. The national biodiversity indicators are high in Lithuania because of diverse natural conditions and biodiversity has been remarkably well preserved due to low population density and inhibited economic growth during the Soviet period.

Lithuania has long-term traditions in classical nature conservation and has established an extensive protected areas system. However current changes to the economy and to land ownership require a rearrangement in terms of conservation principles and protected area systems.

The Nature Framework adopted by the Ministry of the Environment, does not allow for the formation of a coherent network of Natura 2000 sites protected by buffers and linked by corridors. Rather, the framework is based on physio-geographical and geomorphologic features, and so it is not particularly well-suited to biodiversity conservation or Natura 2000 (IUCN-EP 2005).

Although a theoretical ecological network exists, it is unclear as to whether this is in operation in practice. There are special protection areas and the concept of a 'Nature Frame' has been adopted into national legislation, however the ecological network side of this has not been officially adopted. There is very little information available on conservation programmes or programmes to enhance habitat connectivity within Lithuania. Also, there was no particular indication that the national framework would address ecological networks in connection with climate change.

26 http://www.wi.wur.nl/UK/services/Capacity+Development+at+Wageningen+UR/CDIC+Programme/All+projects/Project60

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COUNTRY CASE STUDY: Slovak Republic
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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN THE SLOVAK REPUBLIC

Ecological characteristics of the Slovak Republic

The Slovak Republic is a landlocked country bordering Austria, the Czech Republic, Hungary, Poland and the Ukraine. It has a highly diversified natural landscape, with the rugged Carpathian Mountains bordering the north and lowlands defining the south. The territory of Slovakia is thus divided into four provinces: the Western Carpathians, Eastern Carpathians, Western Pannonian Basin and Eastern Pannonian Basin. In total mountains account for more than 33 per cent of the total land area and are generally heavily forested or wooded. Of particular note are the High Tatras, with unique alpine and subalpine ecosystems, which are home to a number of endemic species. The Tatras National Park was the first national park in Slovakia, established in 1949.

Slovakia contains large areas of well preserved original forest, which account for around 41 per cent of the terrestrial area. The greatest use of land, however, is agriculture, accounting for around 49 per cent. 5 per cent are building areas, whilst only 2 per cent are waters (figures taken from WWF, 2004).

Most of the rivers within the Slovak Republic feed into the Black Sea as part of the Danube catchment. The exception to this is a small area to the east of the High Tatra Mountains, which belong to the Baltic Sea catchment.

Brief summary of the Natura 2000 network

As of June 2006, the Slovak Republic had designated 382 SCIs and 38 SPAs, a total area of 5.7km^2 and 12.3 km^2 or 11.9 per cent and 25.2 per cent of the terrestrial area of the country, respectively. Much of this area overlaps with areas that were already protected prior to Natura 2000 designation. According to NGOs, 'a substantial number of areas are missing from the list of proposed SCIs' (IUCN, 2005). In addition, Slovakia has not begun designation of SACs.

Stakeholder involvement in the designation process was good, as the Act on Nature and Landscape Protection (see section 0) places an obligation on the Ministry of Environment to involve owners, administrators, and tenants of lands nominated for protection under Natura 2000. In addition, the Ministry involved a consortium of institutions and organisations, including NGOs and educational facilities, to determine a list of sites.

Sites were chosen according to various scientific criteria but, according to a report by WWF (2004), Slovakia 'did not take coherence of the network into consideration while planning their sites'.

Recent ecological changes and causes of fragmentation

Probably the most significant change to the Slovakian landscape is a result of political, rather than environmental change. In the Soviet system, there was a network of public rural land that was state-owned. Following the shift to a market economy, much land was re-privatised. This reduced the potential for 'sustainable multi-purpose forestry practices' (Wilson 1999). In general agricultural land has expanded from a network of small fields interspersed with shrubs and forest to large agricultural areas.

Land has been further fragmented through the development of new road networks and greater urbanization of areas. Balancing measures such as hedgerows and road underpasses for animals are not a compulsory part of development projects; therefore efforts to ensure biodiversity connectivity is maintained are currently minimal.

More recently, a significant impact on one of Slovakia's protected areas was a strong windstorm which hit the Tatra National Park in November 2004. This destroyed over 100km^2 of forest, and began a series of debates regarding the fate of the damaged land. Environmentalists feared that pressure to exploit the area for tourism would result in the land being developed. However, in January 2006 the government agreed to allow the area to regenerate naturally.

Evidence of fragmentation impacts

A case study of the Trnava upland forest confirmed the relevance of fragmentation to Slovakia, recording a decrease by two thirds of the forested area since the 19th century, resulting in isolated patches of forest.

There is limited monitoring of species that are under threat, however the following groups are likely to be affected by fragmentation:

- Oak forests on uplands
- Riparian willow-poplar forests
- Large mammals
- Small ground mammals
- Amphibians

Generally, the diversity of species in Slovakia is declining. Of the total 3124 species of higher plants, 1135 are listed in the national Red List. Similarly, 244 of the 555 wild species of Vertebrata are endangered, including fish, amphibians, reptiles, birds and mammals. Three species of Slovak fauna and flora are listed in the IUCN Red Data Book, namely the Peregrine Falcon (*Falco peregrinus*), the golden drop of Turňa flower (*Onosma tornense*) and the evergreen shrub native to the Carpathian Mountains, Muran daphne (*Daphne arbuscula*).

Conclusions

Fragmentation of landscapes appears to be a growing issue in Slovakia, with pressure resulting from rapid development in the area. The total area designated under Natura 2000 is positive, although further work is still needed to ensure that all relevant habitats are included and that the sites form an ecologically coherent network.

Further monitoring is needed to assess the specific effects from fragmentation, although the number of declining species may indicate that steps need to be taken now to prevent further biodiversity loss.

RELEVANT NATIONAL FRAMEWORK

Legal and policy framework

Environmental obligations have been integrated into a number of Slovakian legislative items, including the constitution. Article 44 states the right of all citizens to 'a favourable environment' as well as 'a duty to protect and improve the environment'. Finally, it confirms the obligation of the State for 'the economical use of natural resources, an ecological balance and an effective environmental policy' (Slovak Republic Government Office, 1992).

Specific Laws Dealing with Biodiversity and Nature Conservation

Biodiversity and landscape fragmentation tend to be addressed under the term 'Ecological Stability'. A number of pieces of legislation are relevant, probably the most significant of which is the Act on Nature and Landscape Protection (No 287/1994). More recently, this was replaced by Act 543/2002 of

the same name, which entered into force on 1st January 2003. This transposed the Habitats and Birds directives into national legislation.

The Act launched the Slovakian system to address conservation and protected areas. This was called the 'Territorial System of Ecological Stability' (TSES), defined as 'an integrated structure interconnected to other ecosystems, their components and elements, which ensure a diversity of life conditions and forms in the landscape' (UNEP, 2000). This introduces the concept of 'biocorridors' as one of three landscape elements essential to biodiversity conservation.

Five categories of landscape protection are defined in the Act:

1. Basic level – general protection applied to the whole territory of Slovakia
2. Protected Landscape area, Protective Buffer Zone of National Park
3. National Park, Protective Buffer Zone of Protected Areas
4. Protected Area, Protective Buffer Zone of Nature Reserve, Protective Buffer Zone of Natural Monument
5. Nature Reserve, National Nature Reserve, Natural Monument, National Natural Monument

In addition to the Act on Nature and Landscape Protection, the National Biodiversity Strategy was approved by the Slovak government in 1997. This, together with the first Biodiversity Action Plan for 1998 to 2010, presented guiding principles in relation to the Convention on Biological Diversity, signed by the Slovak Republic in 1993.

Specific Laws Dealing with Landscape

Habitat fragmentation is also addressed in various laws related to landscape and development. For example, whilst the Act on Nature and Landscape Protection introduced TSES as a framework for designating levels of protection to landscape elements, the Law on Spatial and Development Landscape (50/1976 with later amendments) supports the practical implementation of protected sites. Meanwhile, the Law on the Acknowledgement of Environmental Influences (127/1994) provides a legal framework for environmental impact assessment.

An independent Act on Landscape Planning has been under development for a number of years with the intention of optimizing land use, although opposition from other sectors has delayed this.

Other Influencing Laws

In addition to laws that have a direct influence on biodiversity conservation, another law which can indirectly protect landscape is the Property Tax Law (106/1997). This allows owners of land that falls within the three highest categories of landscape protection (see section 0) and certain selected habitats can claim for property tax easement if these areas are not used commercially.

Methods and effectiveness of addressing ecological coherence in SR

Jongman *et al* (2004) describe the Slovakian approach to landscape connectivity as having a 'more pro-active character'. The inclusion of 'biocorridors' in national legislation indicates the country's commitment to addressing fragmentation issues in their land-use planning. Act 50/1976 provides provisions for the protection of landscape elements such as riverbank vegetation, forests, peat bog, rivers and cliffs. In addition, Environmentally Sensitive Area Schemes (ESAs) allow for the protection of linear features on farmland, such as tree lines and hedgerows, which may improve linear connectivity.

Ecological networks are therefore explicitly addressed in terms of legislation; however the system does not yet ensure the practical implementation of protected areas. WWF (2006) found that 'Slovakia did not take coherence of the network into consideration while planning their [Natura 2000] sites'. It is also argued that, whilst Article 10 of the Habitats directive is mentioned in Slovakian legislation the

meaning is actually different and, as such 'coherence is neither secured in legislation nor in practice' (IUCN, 2005). In addition, the revised Act on Spatial Planning may contradict ecosystem connectivity measures further due to misunderstanding between sectors.

Ecological Networks in connection with climate change

As yet, the national framework does not address ecological networks specifically in relation to climate change, and this is seen as a great challenge for Slovakia. However, the role of biocorridors is to facilitate species migration, dispersal and exchange of genetic information. Successful establishment of these elements may therefore mitigate against climate change effects.

National Governing bodies

The Ministry of Environment is responsible for landscape, spatial planning and environmental issues. It deals with national projects and issues obligatory regulations for Protected Landscape Areas (II), National Nature Reserves (V) and National Natural Monuments (V).

The Ministry of Land Use carries main responsibility for legislation on territorial planning. It carries the responsibility for the implementation of land amendment projects.

Additionally, the Ministry of Agriculture, Ministry of Construction and Regional Development and the Slovak National Commission on Biodiversity all have an influence on biodiversity and landscape fragmentation issues.

At a local and regional level, the Ministry of Environment is represented by regional and district administrations and municipalities. National Park and Landscape Protected Area Authorities also influence regional decision-making.

Finally the State Nature Conservancy of the Slovak Republic, established by the Ministry of Environment, is an expert organisation responsible for data collection, analysis and interpretation.

Decision-making processes

According to the Act on Nature and Landscape Protection, all relevant stakeholders must be involved in the designation of protected areas process. As such, the Ministry of Environment and Ministry of Land Use must solicit approval for TSES and land amendment projects, respectively. IUCN (2005) found that NGO and stakeholder participation in the Natura 2000 designation process was good, although due to political pressure from other Ministries, not all recommended SCI sites were finally designated.

Conclusions

The Slovak Republic has taken great steps to ensure landscape connectivity is included in national legislation and implemented at a regional level. However, as has been noted above, the practical implementation of measures is lacking and there is some debate over whether the Natura 2000 network of sites have been implemented with coherence as a primary goal.

There are no specific climate change activities related to biodiversity and habitat fragmentation, although it is likely that measures taken to ensure connectivity for migratory species and species dispersion will also provide mitigation measures in the face of a changing climate.

SPECIFIC INITIATIVES

As mentioned in section 0, The Act on Nature and Landscape Protection launched the Territorial System of Ecological Stability (TSES). This describes three landscape segments deemed necessary for conservation. These are termed 'biocentres', 'biocorridors' and 'interaction elements'.

- Biocentres represent an ecosystem or group of ecosystems, which provide a permanent habitat for reproduction, shelter and nourishment of organisms and their communities.
- Biocorridors are spatially interconnected sets of ecosystems which connect biocentres and enables dispersal and migration of species.
- Interaction elements are connected with the biocentres and biocorridors, but have been damaged or changed by man to some degree. They are supporting mechanisms.

As such, biocorridors are specific measures to address connectivity issues, whilst interaction elements may indirectly improve the movement of species.

Although part of a national framework, biocorridors and interaction elements are mostly defined as 'Protected Areas' under level IV of Protected Area Categories and, as such, are declared on a regional basis. It is therefore the responsibility of the municipalities and regional administrations to designate sites, whilst the Ministry of Land Use facilitates implementation.

Two projects, implemented as part of Slovakia's Biodiversity Action Plan, are quoted as case studies of these two approaches. These examples are summarised below.

The rural landscape of the **Bošáca valley** is made up primarily of arable land, which accounts for around 46 per cent of the area, followed by 16 per cent of meadows and pastures, and 14 per cent forest. A particular area of concern has been the abandonment of meadows and pastures, which has resulted in the progression of weeds and woody plant species in place of the previously rich variety of plant species, including orchids. To address this, a TSES of 17 biocentres and 17 biocorridors was proposed. Of the biocorridors, 2 were regional, 13 were existing local areas and 2 partially existed, with proposed extensions. The goals of the TSES were the maintenance of ecologically rich biotopes, enhancement of ecosystem function, proposal of missing natural elements, reduction of negative effects by technical measures. To improve connectivity, 100m of biocorridor was planted. Following this, the area is being monitored to observe any advancement of the planted trees, shrubs and plants.

The region of **Karlova Ves** is an urban area in Bratislava. As such, biodiversity is under constant threat from development, as well as isolation, air pollution and intensive recreation activities. The area contains some valuable natural habitats, including the forests of Devinska Kobyla and Sitina, small wetland areas, non-forest vegetation and areas of planted or cultivated shrub, tree and herbaceous greenery. In this region, TSES proposals were geared towards improving connectivity through engineering solutions, for example 'ecoducts', which would allow the migration of species such as small mammals, as well as providing areas for human recreational use.

CONCLUSIONS

The Slovakian provisions for biocorridors in the national framework of environmental protection are an effective way of ensuring connectivity issues are considered as an integral part of biodiversity conservation. Interaction elements provide an indirect method of addressing connectivity issues. In addition, there are provisions for the creation of landscape features, such as hedgerows, which may facilitate species migration and dispersal.

As such, the legislative framework in Slovakia is good. The implementation, however, is lacking due to lack of funds and conflict with other potential uses, for example forest harvesting and development of arable land. It is vital that a legal obligation is placed on land use planners to include biodiversity connectivity considerations in future developments. Conflicts between different interest groups, together with misunderstanding of terms and objectives, delay projects. In addition, the lack of a legal obligation to include connectivity measures in landscape planning means that there are fewer examples than may be desirable. This highlights a focus on 'protected areas' rather than better management of

the landscape as a whole. Therefore, it would be vital that a legal obligation is placed on land use planners to include biodiversity connectivity considerations in future developments.

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COUNTRY CASE STUDY: Spain
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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN SPAIN

Spanish network of protected areas

There are around 750 protected areas in Spain, many as a result of the fashion for their declaration in the 1990's. Despite their number and extent, many areas are poorly managed. In October 2004, 48 new national parks were earmarked for declaration over the coming years.

As regards the Natura 2000, the network of proposed Sites of Community Interest (candidate areas under Natura 2000) in Spain numbers 1,301, covering 11,334,710 ha which corresponds to 22.45 per cent of the member state territory[27]. Special Protection Areas proposed for birds numbers 416 sites covering 7, 836,617 ha and corresponding to 15.52 per cent of the territory. The EU Red Natura lists 1,206 sites which are to be protected as Zonas de Especial Conservación. These will cover around 110,00 km2 (22 per cent of Spain) of which 5,560 km2 will be marine sites.

Table 1. The surface area of national parks per provinces in Spain

National Park (Province/s)	Surface area (ha)	Declaration (year)
Picos de Europa (Asturias, Cantabria y León)	64,660	1918
Ordesa y Monte Perdido (Huesca)	15,608	1918
Teide (Santa Cruz de Tenerife)	18,990	1954
Caldera de Taburiente (Santa Cruz de Tenerife)	4,690	1954
Aigüestortes i Estany de Sant Maurici (Lleida)	14,119	1955
Doñana (Huelva)	54,252	1969
Tablas de Daimiel (Ciudad Real)	1,928	1973
Timanfaya (Las Palmas)	5,107	1974
Garajonay (Santa Cruz de Tenerife)	3,986	1981
Archipiélago de Cabrera (Palma de Mallorca)	10,020	1991
Cabañeros (Ciudad Real)	38,996	1995
Sierra Nevada (Granada y Almería)	86,208	1999
Islas Atlánticas (Pontevedra y A Coruña)	8,333	2002

Species conservation

There are 156 endangered species of fauna and flora in Spain. 90 per cent have currently (2004) no recovery plan, in contravention of the 1989 Nature Conversation Act. The number of endangered species has doubled since 1990. 108 are plants, 16 invertebrates, 1 amphibian, 4 reptiles, 4 fish, 17 birds and 6 mammals. In the last 100 years, at least 17 species of fauna and 24 species of plants have become extinct in Spain.

According to the Spanish Ministry of the Environment, since 1996 at least 1,000 animals have died a year from illegal poisoning. 44 per cent of these are protected species. The baits are often (59.6 per cent) put out by the owners of private game reserves to kill foxes and wolves, and so increase their rabbit and partridge populations. Between 1990 and 2003, a least 4 bears, 80 imperial eagles, 20 lammergeyers, 495 black vultures have been poisoned. The government believes that these figure are in reality much, much higher: BirdLife International claims that the Spanish population of the red kite has fallen by 50 per cent in 10 years because of poisoning.

[27] Spanish Environmental Ministry (Feb 2007): http://www.mma.es/portal/secciones/biodiversidad/rednatura2000/rednatura_espana/lic/lic.htm

Spain constitutes an enclave of interesting biodiversity within the European context, including the representation of various biogeographical regions from Alpine to Mediterranean habitats. The importance of the conservation of the flora and fauna in the country can be measured by looking at data that show there are 1,500 species of endemic flowers, and 41 endemic vertebrates, including some species which are in danger of extinction and highly sensitive to the fragmentation of their habitat such as the Iberian lynx (Lynx pardinus). Habitat loss, main threat for 'typically Spanish' animals - Spain's populations of Iberian lynx, European mink and capercaillie are down by more than 50 per cent since 1980 according to the 'Sustainability in Spain 2006' report, just out. All three species have lost much of their natural habitat but have also been directly persecuted by man until the middle of the last century (lynx due to their role as predators, mink for their fur and capercaillie as hunting trophies). Other iconic Spanish animals have fared better. Spanish Imperial eagle, Black vulture, Brown bear, lammergeyer, Great bustard and White-headed duck have all increased in numbers during the same period. But this is is due to the fact that they had become very rare and soon they too will suffer from habitat limitation,

Box 1. Information on flora and fauna in Spain

Fauna

- Spain has more birds, mammals and reptiles than any other EU country.
- Spain has the highest level of endemism in the EU. There are 40 endemic vertebrates. 12 of these are mammals.

Mammals

- Of the 118 species of mammal, 5 were introduced in the 20th century (American mink, marmot, muffloun, coypu). Several were introduced centuries ago (fallow deer, ginet, Egyptian mongoose, the latter two by the Arabs, probably as pets) and are are now considered as native. There are 85 native terrestrial mammals.
- Recent figures for 2004 suggest a slight recovery in the Cantabrian-Asturian population of bears, up from 75-80 to 120-130 individuals. 13-15 bears hang on in the Pyrenness. In 1900, there were an estimated 2000 bears left in Spain .
- Spain is one of the last remaining refuges of the European wolf. The population is slowly recovering from its 1970 low of 400-500 odd individuals with current (2003) figures estimated at 2,500, almost 30 per cent of European wolf numbers outside the ex-USSR. In early 2004, a wolf was detected in Northern Catalonia for first time in more than a century. It is thought to have made its way through France from the Italian Alps.
- The fox is probably the most common Spanish carnivore, its numbers estimated at 500,000-1,000,000 individuals.
- The otter is present in 42 of the 47 Spanish mainland provinces, and is absent from the islands. Population is thought to have fallen by 60 per cent between 1966 and 1985, though is now slowly recovering in many areas.
- The bucado (Capra pyrenaica pyrenaica) a sub-species of the Spanish mountain goat enjoys the doubtful distinction of being the first mammal to be become extinct in Europe in a 100 years, despite being protected since the early 20th century. The last one, a female, was killed by a falling tree.
- There are 27 species of bat. There are 11 species of shrew, 3 of which are endemic
- Around 500 whales, dolphins and porpoises beach on Spanish coasts a year. Fishing practices, gregarian instincts and currents are the main causes. Six whales beached as a result of the prestige disaster.
- In 2000 there were 160 lynxes in breeding age. In 2004 there are 100.

Birds

- Around 337 birds breed in Spain out of the total of 520 for Europe . More than 500 species are present at some time during the year. Officially (according to SEO) there are some 557 species listed for Spain (and rising). However, many of these are occasionals, vagrants or exotics
- Spain 's largest heronry with some 70 nests is a wild colony located in trees in Barcelona Zoo right in the centre of the city. German bird experts and the city council claim that the cliffs of Montjuic also in centre of Barcelona are home to Europe 's largest single concentration of kestrels.
- There are 56 species of reptiles. 11 are endemic to the Canaries
- There are 26 species of amphibians
- 68 species of continental fish live in Spanish rivers, 17 of which have been introduced.
- There are 227 species of butterflies.

Flora

- There are an estimated 8000 plant species in Spain , 2000 of which are endemic to the Iberian Peninsula and North Africa .
- Potentially, 95 per cent of Spain would be covered in some form of forest. 20-28 per cent of forest cover remains today. 50 per cent of this is pine forest.
- Some 105 species of autochthonous trees grow in Spain (nobody agrees on the exact figure). 44 of these are capable of forming true woods. 33 grow in the Canaries
- The most common tree in Spain is probably the holm oak (encina), estimated in 1995 at 682,881,000 specimens. However, despite these numbers many holm oak woods are made up of immature specimens.
- 50 per cent of the 2000 plants found in the Canaries are endemic.

RELEVANT NATIONAL FRAMEWORK

The most relevant legislative instruments in the context of ecological coherence and connectivity is the Law for the Conservation of the wild species and the flora and fauna, forestry and a Law modifying this (Law No. 4, 27 March 1989 and Law No. 41, 5 November 1997 respectively) In addition, in 1997 Spain adopted regulations 338/97 and 939/97 concerning trade in endangered wildlife (CITES).

There are no specific government policies in place to address the issue of ecological connectivity. The evidence is of regional or local authorities and NGO's developing or implementing such policies (see case studies below).

In 1998, Spain joined the Action COST 341 Habitat Fragmentation Due to Transportation Infrastructures, and a work program coordinated by the Ministry of Environment was set up. Within the framework of this initiative, intensive work has been carried out and includes:
The production of a database containing information on 250 references of publications and unpublished reports about the subject[28];
The production of an inventory which includes data on 140 measures: wildlife crossings and other measures applied to avoid fauna casualties.
A report on the state of the art in the country (currently in press) which compiles data about the extention of the problem, the measures which are applied, and the results of the monitoring programs[29].

But one of the most relevant aspects that has been carried out within the framework of the COST Action is the creation of the Working Group (WG): Fragmentation of Habitat Due to Transportation Infrastructures. This brings together technicians who are responsible for the administration of transport and environment in Spain and the 19 Autonomous Communities (regions with autonomous government). The aim of this group is to increase awareness and to exchange knowledge, and there are plans to carry out specific objectives in the future such as the editing of a Technical Normative for the construction of wildlife crossings. This will standardize technical criteria in order to make the fauna passages more effective and make sure that they comply with the function they are designed for. Another future objective is the translation and adaptation of the report COST 341. One of the most outstanding achievements of the group is the cooperation between transport and environmental professionals that has encouraged the reconciliation of different stances with the common objective that the planning, construction and maintenance of transport infrastructures increasingly integrates criteria of prevention of those impacts which affect biological diversity.

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY

There are some specific initiatives within Spain aimed at halting fragmentation and connecting habitat, including a workshop on developing mountain conservation corridors in the Catalonian Pyrenees, Green corridor development in the Guadiamar river Basin, Andalucia in response to the catastrophic mineral workings spill, the use of disused railways as ecological corridors and connecting green spaces on the urban fringes of Barcelona.

Mountain ecological networks

Mountains Conservation Corridor Workshop, Les Planes de Son (Catalonian Pyrenees) Spain, October, 2005 was organised by Fundació Territori Paisatge and this workshop has produced a Connectivity Conservation Management book. Mountain ranges form natural corridors in Spain and other evidence has been seen of plans being developed by the academic community and independent specialists to

[28] Included in the IENE database; see www.iene.info

[29] www.mma.es/conserv_nat/acciones/paisaje/paisaje.htm

maintain well managed habitat across these ranges. These plans are being prepared through concern over populations of alpine plants species of which there are endemic species and subspecies within mountains such as the Sierra de Guadarama and Sierra de Urbion.

Guadiamar green corridor

The river Guadiamar Basin is an important biogeographical corridor between the typical Central Spain vegetation (Sierra Morena) and the coastal Atlantic (dunes and marsh) across the Guadalquivir Valley. A great flora and communities diversity has been discovered, due to the belonging of the basin to five different biogeographical units, as well as a great richness of mediterranean landscapes, forests, shrubland and riverside and wetlands vegetation. The knowledge of the dynamism, progressive and regressive, of the vegetation is essential for developing any forestry restoring activity.

On 25 April 1998 the retaining Significant flooding occurred along the Guadiamar River and the spill threatened the nearby Doñana marshes — world famous as a World Heritage Site, a Ramsar Site, a Biosphere Reserve and an Important Bird Area. Fortunately the national park was not directly affected, but the aquatic fauna of the Guadiamar River were almost totally exterminated and sludge deposits of up to three metres thick were left along 40 kilometres of the watercourse. Soon after the disaster, the regional government of Andalusia approved a proposal to mitigate the impacts and restore the river ecosystem. A year later, in June 1999, the Strategy for the Guadiamar Green Corridor was established at a specially organized international seminar (Secretaría General Técnica, 2000). Interestingly, the goal of the strategy was not only to remedy the damage caused by the spill but also to restore the Guadiamar River as an ecological connection between the Sierra Morena mountains and ecosystems along the Atlantic coast. The Guadiamar Green Corridor will also form part of the Andalusian ecological network (RENPA), which is currently under development and aims to build the areas designated as EU Natura 2000 sites into an interconnected network (Vázquez, 2003).

The Guadiamar River is one of the few rivers in Andalusia that still retains its natural
Mediterranean regime of high winter and low summer flows. Serious fragmentation of the Guadiamar basin dates back many decades. However, the process has accelerated in recent years, primarily as a result of the increasing predominance of arable farming at the expense of old olive groves. An important consequence of this process was that the former intricate land-use matrix became transformed into a far simpler and homogeneous landscape. In addition, industrial and housing developments have caused serious fragmentation in the central and lower parts of the river basin.

Recreating the regional ecological function of the river basin requires both direct restoration of the areas directly affected by the spill and actions to increase connectivity at local and regional scales. Five specific measures are being undertaken with the aim of achieving these objectives.

The priority is to reconnect the northern part of the Green Corridor and the Sierra Morena mountains. Monitoring studies of small mammals show relatively limited movement in this area. Restoration works are directed mainly at reforestation and the replacement of eucalyptus stands with indigenous tree species.

The linking role of the smaller rivers is especially important in the central area of the basin. In addition, priority will be given to the headwaters of the Guadiamar River and the two western tributaries, the Alcarayón and the Agrio. Attention is also being given to the Tinto River to the west because of its important ecological relationship with the Guadiamar River.

Other parts of the project are restoring some of the drovers' roads. An extensive network of drovers' roads has existed in Spain for centuries, enabling livestock to be moved seasonally both north–south and between low- and high-lying ground. These tracks have come to provide an important semi-natural corridor function, particularly
with regard to the dispersal of herbaceous species.

Also important is the need to improve connectivity across the transport infrastructure, several roads and railways have created barriers to the movement of species, particularly the A49 motorway and the Seville-Huelva railway. The construction of ecoducts and other measures to increase their permeability to ecological flows is under consideration.

In halting fragmentation there is the need to restore or create 'stepping stones'. Many areas of land that are under public ownership or protected as part of the region's cultural heritage offer the potential to be developed as resting and feeding places. In order to support the formulation of effective measures, a special research programme was established as part of the action plan. This Green Corridor Research Programme (PICOVER) is multidisciplinary in structure and aims to apply the principles of the ecosystem approach through its four main themes: remedying and monitoring the contamination, the design of the Green Corridor, ecosystem restoration and integrating natural and human systems.

Much of the land directly affected by the spill, amounting to about 5,000 hectares,
was also taken into public ownership. Funding for developing the Guadiamar Green Corridor programme and implementing the various commitments and continuing action is proceeding.

Spanish Greenways Programme: Ecological re-use of railway lines

The aim of the Greenways Programme is to reconvert abandoned railway lines into infrastructure for non motorized transport, permitting use by walkers, cyclists and persons with reduced mobility. However this project will also have benefits to wildlife conservation by creating corridors of habitat that are not in intensive agricultural management and allowing spread and colonisation of indigenous species. Also, public control over this part of local heritage is thus preserved and it is reconverted into a useful resource for society, providing mobility, sport and open air leisure activities, respectful enjoyment of nature and peaceful civic coexistence.

Greenways are set up on railway infrastructure which have existed for decades and have now become integrated into the natural surroundings. Their reuse does not therefore affect the environment adversely, but rather it regenerates neglected spaces, especially those close to towns. This infrastructure allows environmentally educational activities to be carried out, particularly for young people, thereby promoting greater knowledge and awareness of nature.

The main objective of the Greenways Programme is to reuse disused former railway lines as non-motorized routes for cyclists, walkers and persons with reduced mobility, skaters, etc. Started in 1993, it affects more than 7,500 kilometres of disused railway lines distributed throughout Spain. Until the beginning of 2000, more than 29 million euros have been invested in creating 850 kilometres of Greenways.

Greenways are universally accessible routes, apt for the disabled, easily negotiated due to the gentle nature of the railway routes they run along and safe since motorized traffic is banned from using them. They are the product of preserving and rehabilitating a part of railway heritage which had become disused, as well as enabling new uses and activities to be developed which provide social and economic stimulus to the areas they pass through, thereby creating local employment. They promote ecological and active tourism, accessible to all people, with no distinctions made between social and economic level, age or physical capability.

In 1998, the European Greenways Association was formed to promote development of this 'good practise' which the Greenways are on a European level.

Regional, provincial and local governments have been participating more and more in implementing the Greenways Programme: they are responsible for drawing up Studies and Constructive Projects (generally with the help of the FFE) and putting availability of affected land together (by means of agreements with railway companies for transfer of rights to use, acquire or expropriate). They are responsible for management, maintenance and promotion of the Greenway when the works are end up. They increasingly are taking part in co-financing of work, together with the Ministry of the Environment. The Ministry of Employment and Social Affairs is getting deeply involved in the rehabilitation of old railway facilities to provide new eco-tourism services.

SITxell project for integrated land-use planning

In Spain, the use of non-building land forms an important element of territorial planning. It is also an essential starting point for formulating projects aimed at managing the open area systems in the country. In general, the current planning practises do not just aim at preserving individual non-building areas and area networks but rather proactively seek to manage the open areas in Spain in a more uniform and comprehensive manner.

Since 2003, the Technical Office for Territorial Planning and Analysis of the Barcelona Provincial Council has been carrying out a geographical information system (GIS) project (called SITxell) aimed at analysing the open areas of the Barcelona province. The purpose of the project is to plan the land-use on these areas and to identify the role they play in the overall natural areas system. The project is based on classical conceptual approaches for landscape planning (e.g. approaches introduced by Forman). In addition, a vast variety of geographical information regarding the attributes and values of the analysed open areas is taken into consideration. As an outcome, the project seeks to make specific proposals for the joint planning and management of the open areas in Barcelona province. The SITxell will also provide concrete data and criteria for the basis of local decision-making (e.g. analysis, diagnosis and systematisation of the ecological, landscape and socio-economic features of non building-land).

The SITxell provides a clear theoretical framework and practical tools that can be used to correct certain growth trends with potential negative impacts on the environment. It can also assist in managing conflicts between different land-uses and help at promoting management practice that ensure that the socio-economic development in open areas does not jeopardise the functioning of natural system. According to the current results, SITxell's proposes a) to strictly protect up to 70 per cent of existing open areas; b) restore some important habitats (e.g. river systems); c) improve forest, cattle and agriculture practices; and d) make transport infrastructure more permeable for species. In addition, SITxell also identifies a number of key areas to be protected in order to maintain ecological connectivity in the region.

The importance of the local government in defining territorial uses is gradually growing in Spain. SITxell provides the necessary territorial information for planning processes and it also provides general guidelines that help to improve connectivity between habitats.

CONCLUSIONS

The Pan-European Strategy for the Conservation of Biological Diversity identifies habitat fragmentation as the main cause of biodiversity loss in Europe. Fragmentation is also one of the main factors threatening the connectivity of Natura 2000 network. In Spain, the expansion of urban and agricultural spaces is the factor that has traditionally caused the fragmentation of the natural habitats. However, the development of transport networks that is becoming increasingly significant must be added to these previous factors within Spain for some critically endangered species, such as the Iberian Lynx. At present, the compatibility between the construction of new infrastructures and the conservation of biodiversity constitutes a challenge for those involved, since for the period 2000–2010 Spain expects to see the construction of around 6,000km of new transport infrastructures, the majority being motorways and high speed railways, which will add to the 700,000km of existing transportation network. In addition, it should be pointed out that this significant expansion of infrastructure networks will affect a highly sensitive landscape.

The mitigation of habitat fragmentation due to roads and railways is mainly developed during the process of environmental impact assessment (EIA), which analyses the effects of each project and designs measures destined to mitigate the environmental effects. In the near future and with a basis in a recently approved European Directive, the Strategic Impact Assessment (SIA) will also be applied which will evaluate the plans of infrastructures including several projects together as a whole.

The application of measures to facilitate wildlife crossings and to reduce mortality caused by traffic collisions has been developed throughout the last decade. The first fauna passages merely consisted of adapted culverts or places that combined the fauna passage with forestry roads or streams. However, these types of measures to mitigate habitat fragmentation are still not widely applied, and it is

necessary to increase the awareness of the technicians and decision makers involved and to encourage the dissemination of knowledge about the measures to mitigate the effects of habitat fragmentation.

In conclusion a majority of de-fragmentation projects improving ecological connectivity in Spain are in reaction to wildlife loss through expanding infrastructure or industrial pollution. Few have been designed from the outset in a strategic fashion to connect habitats. Consequently, adopting the Article 10 of the Habitats directive and plan measures for ecological networks to be implemented in collaboration with the PEEN framework should be the future priority of the Spanish federal and regional governments.

COUNTRY CASE STUDY: the Netherlands
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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN THE NETHERLANDS

Ecological characteristics of the Netherlands

The Netherlands is a small and very densely populated country, with 16 million people living in 34,000 km^2, at the mouth of the rivers Rhine, Maas and Scheldt. As over much of NW Europe, human activities have dramatically changed the landscapes and habitats that are present, such that little natural habitat remains. Now 64% of the land surface consists of agricultural land (including natural grasslands), 11% is urban and industrial, inland wetlands comprise 9%, whilst only 8% is forested (Corine Land Cover data 2000: http://dataservice.eea.europa.eu/dataservice/viewdata/viewpvt.asp). There are also extensive areas of coastal wetland.

The country has an extensive and complex coastline and much of the country is close to sea-level, a large proportion having been created by land reclamation schemes. Not surprisingly therefore, The Netherlands has a proportionally larger area of wetland habitats than most other countries in the EU, and a smaller area of terrestrial habitats. Characteristic wetland ecosystem types are estuaries (with extensive areas of mudflats and saltmarshes), inland lakes and marshes. Consequently the Netherlands hold internationally important populations of several species of wintering and migratory waterbird (Heath & Evans 2000).

Fragmentation and other threats to biodiversity

Natural and semi-natural habitats in the Netherlands suffered further losses and degradation over the second half of the last century. This has been driven by the country's high population density and associated increases urban areas, industrial activity and infrastructure developments, combined with agricultural intensification. For example, the built-up area has expanded by more than 20% over the last fifteen years (Milieu en Natuur Planbureau 2006). As a result, pressures on biodiversity in the Netherlands through habitat loss, changes in land use, environmental stress and habitat fragmentation is greater than the average across the EU.

These habitat and landuse changes have had major impacts on many species. For example, it is now considered that since 1950 nearly 500 of the more than 1,400 species of higher plants in the Netherlands have decreased in number, and more than 40 disappeared completely (http://netherlands.biodiv-chm.org). There have also been significant declines in many bird species, especially those associated with agricultural habitats (BirdLife International 2004a).

The EEA map of fragmentation resulting from urbanization, infrastructure and agriculture (EEA 1999) indicates that a significant proportion of the Netherlands has extreme or strong levels of fragmentation, particularly in the coastal areas. But some coastal areas and other parts of the country have minimal fragmentation. Overall The Netherlands appears to have much lower levels of fragmentation than nearby regions of Belgium and Germany, which may in part be due to recent polices on nature conservation and the creation of ecological networks (see below).

Despite ongoing pressures, some environmental improvements have occurred in recent years. Protected areas have expanded and as a result the area of natural habitat remained more or less the same between 1990 and 2000 (http://www.mnp.nl/en/publications/2005/NatureBalance2005). Furthermore about 50,000 ha of land was reclaimed for natural habitats and wildlife between 1990–2005, despite the expansion of housing and infrastructure (Milieu en Natuur Planbureau 2006). In some areas habitat quality has improved as a result of improved environmental conditions, a more favourable landscape structure and better land management. Successes have been achieved, for example in the river floodplains. As a result of these measures some groups of species are showing some recovery.

Nevertheless, some populations of birds, butterflies and reptiles that have specific habitat requirements have remained in decline since 1992 (Milieu en Natuur Planbureau 2006). Many habitats also remain in

unfavourable condition. It is therefore considered unlikely that the EU target of halting the loss of biodiversity by 2010 can be achieved in the Netherlands .

GENERAL NATIONAL FRAMEWORK

Nature conservation organisations

Since 1982 nature conservation has been the main responsibility of the Ministry of Agriculture and Fisheries, which subsequently became the Ministry of Agriculture, Nature Management and Fisheries and in 2003 the Ministry of Agriculture, Nature and Food Quality. Other ministries have responsibility for some aspects of nature conservation. The government is also supported by a number of research institutes, including the European Centre for Nature Conservation (http://www.ecnc.nl/index.html), The Netherlands Environmental Assessment Agency (http://www.mnp.nl/en/index.html), The National Reference Centre for Agriculture, Nature and Food Quality, and RIVM National Institute of Public Health and the Environment (http://www.rivm.nl/en).

The Netherlands also has a strong NGO conservation sector. Furthermore, these are continuing to grow, such that memberships of nature conservation organisations tripled between 1990 and 2005 and now more than 15% of all households are members (Milieu en Natuur Planbureau 2006). About 2.5 million households make donations for nature conservation and volunteers also help to manage natural areas.

Natuurmonumenten is the largest NGO nature conservation organisation with almost one million members (www.natuurmonumenten.nl). It owns about 70,000 ha of nature reserves and is responsible for the management of 85,000 ha of the natural heritage areas. Other major NGOs include Wereld Natuur Fonds (WWF Netherlands) (http://www.wnf.nl) and Netherlands Society for the Protection of Birds (Vogelbescherming Nederland, VBN), which is the BirdLife Partner in The Netherlands and has 125,000 members (http://www.vogelbescherming.nl/)

Legislation and protected areas

The Dutch government and people give a relatively high priority to nature conservation; perhaps as a result of the country's high population density and past losses of wildlife habitat. Dutch nature policy therefore aims to ensure that people can enjoy nature and that nature is preserved for future generations. To provide room for nature the government aims to protect existing nature and promote the development of new nature areas.

The Netherlands policy on nature conservation in its widest sense has been revised in a policy paper called "*Nature for people, People for nature*" (July 2000). This policy paper describes five different programmes and their respective goals for the coming years:

- International nature policy
- The ecological network of the Netherlands
- Wetland management
- Nature policy for rural areas, and
- Nature policy in urban areas.

The Netherlands' legislation in the field of nature conservation is laid down in the following acts (which incorporate previous acts, and are the responsibility of Ministry of Agriculture, Nature and Food Quality):

- The Flora and Fauna Act
- The Nature Conservation Act 1998

The Nature Conservation Act 1998 was amended on 1st October 2005, such that sites designated under the Wild Birds and Habitats Directives will be secured under Dutch law. A permit systems has also been implemented to ensure future projects which may affect Natura 2000 areas will be carefully evaluated. The Act also regulates the conservation of wetlands and nature monuments.

Measures to protect threatened (i.e. Red List) species have also been brought in under multi-year programme.

The Netherlands has developed a relatively comprehensive protected area network, which incorporates the following international and national designations (MANMF 2003):

- Ramsar Sites, in accordance with the Ramsar Convention (44 sites);
- World Heritage Sites in accordance with the World Heritage Convention;
- Natura 2000 Sites in accordance with the EU Bird Directive and Habitats Directive;
- Dutch "National Ecological Network" sites (see Section 3 below)
- State Nature Reserves (staatsnatuurmonumenten) and Protected Nature Reserves (beschermde natuurmonumenten) on basis of the Nature Conservation Act 1998 (most of which will be included in the Natura 2000 network);
- National Parks[30] (20 have been designated covering 120,000 ha);
- Protected Small-scaled Habitats (beschermde leefomgeving) on basis of the Flora and Fauna Act 1998;
- National Landscapes[31] (20 have been designated covering 20% of the country).

The Dutch contribution to the EU Natura 2000 network of protected areas consists mainly of large water bodies, marshes, dunes and areas of inland drift sand. As of December 2004, 141 Dutch sites have been included on the Atlantic list of Sites of Community Interest, covering about 750,000 ha. Eighty sites have been designated as SPAs under the Birds Directive, covering of over one-million ha[32]. This is a high proportion (over 90%) of the sites that are considered to be Important Birds Areas, and a much higher proportion than most other EU countries (BirdLife International 2004b).

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY

The National Ecological Network

The fragmentation and isolation of habitats as a result of intensive agriculture, urbanization and expanding infrastructure has been long recognised as a major threat to many habitats and their associated wildlife in the Netherlands. This has shaped Dutch nature policy, which centres on the creation of the National Ecological Network (NEN) (Ecologische Hoofdstructuur).

The NEN was launched by the Dutch government in its 1990 Nature Policy Plan and comprises systematically planned national network of protected areas. The proposed network will cover some 730,000 ha, which amounts to about 17.5% of the Dutch countryside. It will include all nature reserves/national parks and other important nature conservation sites (including all large wetlands and the Wadden Sea), forests, new nature areas (which will be set-aside for nature in the future) and some farmland areas, such as grasslands that are important for breeding waders and other birds.

A preliminary plan of the NEN was included in the national spatial policy document Structure Plan for the Rural Areas (Structuurschema groene ruimte; SGR-1). This included an indicative map of core areas, nature development areas and corridors. However, each of the twelve provinces of the Netherlands will determine the precise boundaries of the "Established Nature Areas" (bestaande natuurgebieden) and "Nature Development Areas" (natuurontwikkelingsgebieden). This will be done using 132 habitat and landscape types for which minimum aggregate totals areas have been fixed at a national levels (Bennett & Mulongoy 2006).

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30 http://www.nationaalpark.nl/engels.html

31 http://www.nationalelandschappen.nl/

32 Overlap is extensive between both categories: the total area covers 1.1 million hectares

The rationale for the NEN is similar to other physically defined ecological networks and assumes that connecting habitats will mitigate fragmentation impacts by enabling the exchange of individuals between habitat patches to form meta-populations. It is foreseen that connection zones would consist of interconnected natural elements and habitats (stepping stones and key areas), which would promote the exchange of one or more species. (Hootsmans & Kampf 2005 cited in Piper et al. 2006). Key area areas for connection would be where:

- the landscape in between the habitats is unsuitable: exchange is impeded by barriers or land use;
- the surface area requirements of the species are not met, even when new nature has been created;
- the species are hardly or not at all present in the planning area and the change of natural establishment from neighbouring populations is small; and
- essential elements of the species' habitat are isolated form one another and are difficult to access.

The development of the NEN is expected to be completed by 2018. It is primarily being funded by the government, and the NEN budget accounts for 1/3 of the annual nature conservation budget. Both public and private actors will be involved in the local management of the NEN. Thus, although land may be purchased by the government, farmers will often be invited to participate in its management, which will include nature conservation objectives. As a result, some farmers' organisations have been set up with the specific aim of maintaining nature and landscape or improving the environment in a certain region.

It is envisaged that when the NEN is fully completed, more than half of it will consist of large areas of connected nature areas (greater than 2,000 hectares in size). These 'new' landscape units will have been created by extending and linking up existing areas through land acquisition, landscape works and management of adjoining and intervening areas of land. When fully completed, about 20% of the NEN will consist of patchworks of nature fragments and habitats. For these patchworks to function as larger ecosystem units, their ecological condition will often have to be improved, which will present a considerable challenge in many areas.

Until recently good progress was made towards the completion of the NEN with the acquisition of land proceeding according to schedule (http://www.mnp.nl/en/publications/2005/NatureBalance2005). But progress has slowed and the Nature Balance 2006 report notes that additions to the NEEN have stalled in recent years, especially where landscape works are required to create or re-create wildlife habitats. Consequently, although more than halfway through the implementation period, almost three-quarters of the NEN has still to be completed. One reason for this is the slow progress being made with conservation management by private landowners. A few years ago the area target for subsidised conservation management by private landowners was raised considerably in order to improve the ecological conditions of the habitats within the NEN. But this resulted in reduced objectives for land acquisition. At the moment the available resources for nature and landscape policies do not match Dutch policy ambitions.

Another problem has been the short supply of land. In this situation a clear planning regime and political and administrative commitment is essential if the national objectives for nature and the landscape are to be met. The Environmental Assessment Agency also notes that the current decentralisation of decision-making on nature and landscape policies is putting a heavy burden on the shoulders of the provincial government.

The Wallonia-Luxembourg and Netherlands basic transboundary ecological and landscape plan

Another important ecological network initiative involving the Netherlands is the Wallonia-Luxembourg and Netherlands basic trans-boundary ecological and landscape plan. This is a tripartite governmental initiative between Belgium, Luxembourg and the Netherlands, which is being implemented by local authorities. It aims to apply the concepts developed in the Pan-European Biological and Landscape Diversity Strategy to this transboundary area. It also aims to develop a joint approach to transboundary environmental issues in Belgium, the Grand Duchy of Luxembourg and the Netherlands. By doing this it should provide scope for generating practical projects that can strengthen environmental relationships between the three partners. On this basis, two drafts are being prepared simultaneously, one involving the Flemish Region and the Netherlands, and the other involving the Walloon Region and the Grand Duchy of Luxembourg.

Limburg Robust Corridor (Schinveld to Mook)

The Limburg 'robust corridor' links a chain of habitats in southern Netherlands, on the eastern bank of the Maas/Meuse River close to the German border (Piper et al. 2006). The corridor contains hills and valleys with dry and wet forests, heathland, poor and rich pastures, hedges, arable fields and marshy valley grassland in the valleys. A significant proportion of the Limburg corridor has Natura 2000 status. Urban and rural settlements, roads and railways lines are also located in the corridor.

The objectives for the Robust Corridor project are to contribute to the spatial coherence of the Netherlands NEN) and to improve or establish connections between units of national and international biodiversity interest. It also aims to increase biodiversity resilience, by increasing the size of habitats and thereby the likely survival of vulnerable species.

Eventually the corridor should consist of approximately 1,975 ha of land, of which about 35% will be under stewardship agreements. However, establishment of the Limburg robust corridor is in its initial stages, with consultations taking place with various stakeholders and interest groups. Future decision-making related to the implementation of the corridor depends on a number of plans which are being developed and the availability of funds and the release of areas.

CONCLUSIONS

The Netherlands has recognised from an early stage that its habitats and many associated species have been substantially affected by habitat fragmentation. It has therefore attempted to slow and reverse these impacts through the development of its comprehensive national ecological network (combined with transboundaruy initiatives), which is now the principal component of the country's nature conservation policy.

The network includes a relatively high proportion of the country's land cover, of which a high proportion is under some form of protection. It also includes large areas that have been identified as nature restoration areas and/or connecting corridors etc. Although the NEN is an ambitious programme implementation of the network initially made good progress. However, progress has recently slowed and it is now proving difficult to obtain and manage land. The implications of this are not clear at the moment, but as with many other ecological network projects, it may prove to be difficult to achieve its objectives in practice.

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COUNTRY CASE STUDY: the UK (England)
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NATURE CONSERVATION AND FRAGMENTATION IMPACTS IN THE UNITED KINGDOM

The United Kingdom (UK) has recently undergone a process of devolution and, as a result, many environmental policies and regulations are carried out at a sub-national level and therefore differ between England, Northern Ireland, Scotland and Wales. This review therefore summarises policies, regulations and initiatives that have been taken at a UK level, but focuses on England in terms of sub-national impacts and initiatives because habitat fragmentation has been greatest in England. However, some leading initiatives to address habitat fragmentation networks have been taken in Scotland and Wales and these are therefore referred to where relevant.

Ecological characteristics of the UK

The UK's geographical position as a collection of temperate offshore islands on the north-eastern Atlantic edge of Europe, together with its diverse geology, geomorphology, soils and the results of past human management has created a rich variety of habitats for an island of its size (244,820 sq km). Species richness in some habitats is not as high as found in similar parts of continental Europe because of the effects of glaciation and subsequent isolation. Nevertheless, the UK has relatively diverse and characteristic assemblages of plants and animals.

Much of the UK has a high human population density and a long history of intensive land use. This has resulted in the loss of much of the UK's original natural broad-leaved forest cover and as a result many forest species have disappeared or become restricted to small areas, rather than occurring widely over the country. For example, all the larger carnivores and many other mammals have become extinct as a result of forest loss and hunting. However, species associated with open habitats extended their range as a result of agricultural and other human activities, until increases in the intensity of land use in the 20th century led to substantial declines in many species associated with semi-natural habitats.

In the UK approximately 7% of the land surface is urban and industrial, 66% consists of agricultural land (including natural grasslands), 14% is moorland and mires, 8% is forested, whilst inland wetlands comprise only 1% (Corine Land Cover data 2000: http://dataservice.eea.europa.eu/dataservice/viewdata/viewpvt.asp). The UK holds significant proportions of the European and biogeographical ranges of habitats such as estuaries, heaths, blanket bogs and raised bogs. Most of lowland England is dominated by farmland habitats (mainly arable agriculture in the east and grasslands in the west), villages, urban areas and woodlands, with small fragmented areas of semi-natural habitats such as heathlands, calcareous and acid grasslands, and wetlands. However, there are extensive upland areas, which are dominated by upland dwarf shrub heath (*Calluna* moorland) and extensive areas of blanket mire, though some areas have been planted with conifers.

As of 31st March 2006, 611 SACs had been designated in the UK, covering some 2,504,000 ha, of which 237 are wholly or partly in England covering 927,000 ha (www.jncc.gov.uk). A large proportion of SACs occur in upland areas (including moorland and mires) or along the coasts including important examples of sand dune, shingle, lagoon, saltmarsh, cliff and mudflat habitat.

Three habitat types can be highlighted as being of special importance for birds:
- Estuaries (for wintering and passage birds)
- Moorland and mire habitats
- Cliffs and other coastal habitats as breeding sites for seabirds

A significant proportion of these habitats have therefore been designated as SPAs. As of 21st September 2006, 252 SPAs had been designated in the UK, covering some 1,559,000 ha, of which 81 are wholly or partly in England covering 721,000 ha (www.jncc.gov.uk).

Fragmentation and other threats to biodiversity

Terrestrial wildlife habitats in the UK have been further reduced in extent and ecological condition over recent decades. These impacts have been particularly great in England (DEFRA 2002). A recent analysis by English Nature of the factors affecting lowland habitats (Townshend et al. 2004), indicated that the main threats to biodiversity in the lowlands has been agricultural intensification which has amongst other things led to substantial declines in farmland bird populations (Fuller et al. 1995; Gregory et al. 2004; Newton 2004; Siriwardena et al. 1998), water management, non-native invasive species, inappropriate management of woodlands, development, atmospheric pollution, climate change, recreation and deteriorating wildlife site quality and habitat fragmentation. Although upland habitats are less affected by agricultural improvements and developments etc, many habitats are in poor condition. The main pressures on upland wildlife in England are heavy livestock grazing (made worse by uncoordinated management of common land), inappropriate management of grouse moors, increased access and recreation, climate change and atmospheric pollution (Brown et al. 2001).

The EEA map of fragmentation resulting from urbanization, infrastructure and agriculture (EEA 1999) indicates that a large proportion of the UK has extreme or strong levels of fragmentation. However, this measure relates to physical fragmentation and may not accurately reflect functional connectivity between habitat patches. Nevertheless, it is clear that the most fragmented areas are mainly confined to England, especially in southern, central and north-east England.

There is some evidence that habitat fragmentation is having detrimental biodiversity impacts. An analysis of threats listed in the UK Habitat Actions Plans (produced under the UK Biodiversity Action Plan process – see below) found that fragmentation was the fourth most frequent threat and affected 17 habitats (Avery et al. 2001). Habitat fragmentation is a particular problem in lowland habitats, and has had a particularly severe impact on grasslands and heathlands, and the remnants of wildlife-rich habitat within highly developed urban areas (Townshend et al. 2004). Some woodlands, and especially the few remaining areas of semi-natural and ancient woodland, are also affected by isolation. Although this may be detrimental, some doubts have been raised over the actual impacts of woodland fragmentation (Rackham 2006). Furthermore, woodland cover has increased in recent years (Haines-Young et al. 2000) as a result of planting and natural regeneration of some areas. Consequently woodland habitat fragmentation is decreasing in most areas.

There is also some evidence from the UK's Countryside Survey 2000 (Haines-Young *et al*., 2000) that the overall stock of hedgerows has changed little in the UK since the 1980s. This is as a result of a marked reduction in removal rate as the rates of hedge planting has not changed. But, evidence from Countryside Survey does show a continued decline in the quality of hedgerow habitats that reduce their connectivity value, which may already be less than commonly appreciated (Davies & Pullin 2007).

Habitat fragmentation is less of a problem in the uplands, as large expanses of moorland and blanket mire remain. However, there are some problems where parcels of habitat have become isolated. This is a particular problem for some rare upland woodland habitats. Indeed, the lack of trees and woodland in the British uplands is an increasing matter of concern, and some large-scale schemes are now underway to try and restore upland native woodland.

In conclusion, it is clear that habitat fragmentation is widespread problem in the UK, and particularly in the lowlands of England. Consequently, despite some recent increases in forest cover, reversing the impacts of fragmentation is seen as a high conservation priority. For example, English Nature included the following in a recent list of 10 priority actions for lowland habitats (Townshend et al. 2004): "*Adapt to the impacts of climate change – Ensure that agriculture, forestry and development planning policies, and regional strategies, incorporate actions to reduce habitat fragmentation, so that species can respond better to the inevitable effects of climate change over the next 50 years"*.

In particular they recommend the following specific actions:

- Reconnect existing wildlife habitats, and restore hydrological connectivity through habitat creation.
- Increase size of existing habitats to reduce 'edge effects', and to allow species to survive catastrophic events.
- Improve the management of existing habitats, and carry out large-scale habitat restoration to increase the network of suitable areas within the landscape.

- Develop an integrated approach to habitat conservation which considers habitat mosaic and landscape context, rather than individual habitats.

GENERAL NATIONAL FRAMEWORK

Nature conservation organisations

Nature conservation in the UK is now primarily devolved with key policy decisions being made separately for England, Northern Ireland, Scotland and Wales. However, there are considerable consultations between the various country agencies involved, e.g. in relation to the delivery of EU directives and the UK Biodiversity Action Plan (UKBAP – see below). UK-wide coordination of some actions (such as protected area monitoring), plus international representation and advice is provided by the Joint Nature Conservation Committee (JNCC).

The Department for the Environment, Food and Rural Affairs (DEFRA) is responsible for the development of policies on the protection of the countryside and natural resources, amongst other sustainable development issues. Until recently, English Nature had the principal responsibility for coordinating and implementing nature conservation actions in England, though in cooperation with other partners such as the Rural Development Service (which administered agri-environment schemes) and the Environment Agency (which has environmental responsibilities for relating to rivers coasts and the use of water resources).

In October 2006, Natural England was formed by bringing together English Nature, the landscape, access and recreation elements of the Countryside Agency and the environmental land management functions of the Rural Development Service[33]. It aims to "*work for people, places and nature, to enhance biodiversity, landscapes and wildlife in rural, urban, coastal and marine areas; promoting access, recreation and public well-being, and contributing to the way natural resources are managed so that they can be enjoyed now and in the future*."

There are also several well established and large non-governmental nature conservation organisations in the UK. These include The National Trust (3.4 million members), The Royals Society for the Protection of Birds (RSPB: over 1-million members) and The Wildlife Trusts (670,000 members) and many others. Such organisations often campaign for improvements in nature conservation policies and legislation, but also increasingly work in partnership with the statutory sector (e.g. in the development of agri-environment schemes, research and monitoring). They also own and/or manage substantial areas as nature reserves (e.g. the RSPB has 182 nature reserves covering 126,846 ha).

Protected areas

The UK has a long established and extensive protected area system, which provides a major mechanism for protecting and managing important habitats. The principal national suite of sites providing statutory protection for flora, fauna, geological and physiographical features in the UK are Sites of Special Scientific Interest (SSSIs)[34]. SSSIs are designated under the Wildlife and Countryside Act 1981 as amended and their purpose in England and Wales is "*to safeguard, for present and future generations, the diversity and geographic range of habitats, species and geological and physiographical features, including the full range of natural and semi-natural ecosystems and of important geological and physiographical phenomena throughout England*" (DEFRA 2003). SSSI designations also underpin other national designations (such as National Nature Reserves) and the protection of all SACs, SPAs and Ramsar sites.

[33] Reports and publications produced by English Nature are referred to as English Nature reports rather than Natural England.

[34] Areas of Special Scientific Interest in Northern Ireland

There are over 4,000 Sites of Special Scientific Interest (SSSIs) in England, covering around 7% of the country's land. Over half of these are also of international importance and are designated as SACs, Ramsar sites and most SPAs.

Further non-statutory designations exist for Local Wildlife Sites (also known as County Wildlife Sites and Sites of Nature Conservation Interest) and Local Nature Reserves, which affords some protection through the planning system. The recognition of Wildlife Sites (by local authorities) complements the protection afforded by statutory sites (SSSIs), primarily by identifying other areas that have substantive wildlife interest and therefore merit some form of protection. They may also play an important role in protecting and enhancing the value of the SSSIs, by maintaining habitat patches in the wider landscape (i.e. functional mosaics of habitat). Some nature conservation benefits are also secured through National Parks and landscape designations, e.g. Areas of Outstanding Natural Beauty (AONBs), which aim to provide broader environmental protection measures for landscape and recreation purposes.

Most SSSIs (and other protected areas) are not strict nature reserves and are not managed specifically for nature conservation purposes. Instead, most are privately owned and are under some form of economic use, e.g. for grazing livestock, forestry, fishing, water storage, hunting and other forms of recreation.

SSSIs have principally been protected through the UK planning system and through agreements with owners. However, it became apparent in recent decades that a significant number of SSSIs, especially in lowland areas, were being degraded or destroyed despite their protected status (Marren 2002; Rowell 1991). In response to this, the UK revised and strengthened SSSI protection under the Countryside and Rights of Way Act 2000 (CROW Act). One of the key aims of the Government's revisions has been to emphasise the importance of positive management of SSSIs.

DEFRA has been set a Public Service Agreement (PSA) target to have at least 95% by area of England's SSSIs in Favourable Condition or Unfavourable Recovering Condition by 2010. The achievement of this PSA target has the potential to make a substantial contribution to the delivery of many UKBAP targets (see below). As of 1st January 2007, 73.95% of SSSI units by area where in Favourable Condition or Unfavourable Recovering Condition (www.english-nature.org.uk). The most frequent causes of unfavourable condition are overgrazing, burning and drainage (each affecting over 10% of SSSI units by area).

SSSIs in England do not have buffer areas but have been recently integrated into a wider defined ecological network - see Ecological Networks below (R. Catchpole pers comm.). Instead, the UK has used a range of wider countryside and landscape initiatives and designations, such as County Wildlife Sites, National Parks, Green Belts and agri-environment schemes (see below), to support the conservation of semi-natural habitats in the wider environment. However, English Nature recently noted that there is a growing awareness that SSSIs are becoming increasingly isolated from each other as land use intensifies. Unless the countryside around and between protected sites is amenable to wildlife, inbreeding and local extinction will lead to loss of species and general impoverishment within many of the protected sites (Townshend et al. 2004).

UK Biodiversity Strategy (UKBAP)

An important driver of nature conservation policy in the UK over the last decade has been the development and implementation of the UK Biodiversity Action Plan (UKBAP). This implements obligations under The Biodiversity Convention, which was ratified by the UK Government in June 1994. However, even before this, the Government had committed itself to producing a consultative national action plan, *Biodiversity: the UK action plan* (Anonymous 1994) based on the principles of the Biodiversity Convention. The overall goal of the plan is "*To conserve and enhance biodiversity within the UK and to contribute to the conservation of global biodiversity through all appropriate mechanisms*".

Following the publication of the UKBAP, the UK Steering Group was formed to develop a detailed programme of action to meet the plan objectives. The group published its conclusions and recommendations in 1995 in *Biodiversity: the UK Steering Group Report* (UKSG 1995a, b). The Government Response (Anonymous 1996) largely endorsed the UK Steering Group Report, and a

framework of groups, coordinated by the UK Biodiversity Group (UKBG), was established to drive the process forward. Four Country Groups (England, Northern Ireland, Scotland and Wales) were created to oversee implementation of the individual action plans, raise public awareness, encourage implementation at the local level and promote environmental education.

As part of the development of the UK BAP a series of 45 Habitat Actions Plans (HAPs) and 391 Species Action Plans (SAPs) have been produced for identified Priority Habitats and Priority Species (available at www.ukbap.org.uk). Implementation of these plans is now well underway and improvements in the status of many habitats and species has been noted; although there is still much to be done (DEFRA 2006a).

To take account of recent devolution within the UK country groups have been established to implement the UKBAP within England, Northern Ireland, Scotland, Wales. The England Biodiversity Strategy Group (EBSG) was formed and in 2002 published *Working with the grain of nature – a biodiversity strategy for England* (DEFRA 2002) known as the England Biodiversity Strategy (EBS). Although the EBS is a government strategy, it has been prepared in partnership with a wide range of public, voluntary and private sector stakeholders. The strategy outlines a number of actions that will be taken by government and its partners across all the main socio-economic sectors.

The UKBAP process has provided a number of opportunities for overcoming habitat fragmentation and the isolation of species' populations by identifying fragmentation threats and necessary measures to counter them within HAPs and SAPs. However, this approach has tended to be rather piecemeal, with habitat restoration and other actions for each Priority Habitat and Priority Species being developed in isolation. Explicit habitat connectivity targets have been rarely defined in SAPs.

This problem has been recognised to some extent in the EBS, which identified the loss, fragmentation and isolation of semi-natural habitats through agricultural intensification or development as a Priority Policy Issue. The EBS then identified a number of available tools and actions that can be used to deliver its desired outcome of "*preservation, management, restoration, creation and joining up of matrices of seminatural habitats in a way that will allow wildlife to thrive*". Similar actions are also identified for other related priority issues, such as loss of important farmland features (e.g. hedgerows and ponds) and the conservation of wider forest biodiversity at a landscape scale. The EBG also established an indicator to measure progress with maintaining and restoring hedgerows, lines of trees, walls, banks/grass and ponds in the farmland landscape (Indicator A5: Extent and condition of farmland habitat features in England).

The updated EBS (DEFRA 2006b) includes a climate change adaptation work programme, which cuts across all habitats and sectors. This includes an action by 2010 to "*Review experience and publish practical guidance on use of area-based and ecosystem approaches to land/sea management, including protected areas and ecological networks*."

SPECIFIC INITIATIVES SUPPORTING ECOLOGICAL NETWORKS, COHERENCE AND CONNECTIVITY[35]

Planning and development control

Spatial planning and development control regulations are important mechanisms that can reduce and mitigate fragmentation and other biodiversity impacts from proposed infrastructure, housing and industrial developments in the UK. These include the application of EU Directives relating to Strategic Environmental Assessment (SEA) e.g. for infrastructure programmes and Environmental Assessment (EIA) for significant development projects. These procedures take into account the need to protect statutory designated sites (e.g. SSSIs), and under the Habitats Regulations 1994 (which implement the Habitats directive) an Appropriate Assessment is required where a development may affect the integrity of a Natura 2000 site. Such assessments should include consideration of off-site impacts (i.e. outside the development footprint) which may affect protected areas. Fragmentation impacts, e.g. from road construction, on protected areas should also be considered.

[35] This section will focus on England as measures tend to be devolved to countries

Non-statutory sites such as Local Wildlife Sites also gain some protection through the planning system. Consideration of planning proposals should take into account National planning policy guidance on biodiversity and geological conservation in England, in *Planning Policy Statement 9* (PPS9, 2005). PPS9 indicates that there is a clear need to recognise and take account of important nature conservation sites (including sites of regional and local importance), species and features within the development planning process.

PPS9 also notes the value of habitat networks and promotes the development of plans. In particular it states that "*Local authorities should aim to maintain networks by avoiding or repairing the fragmentation and isolation of natural habitats through policies in plans. Such networks should be protected from development, and, where possible, strengthened by or integrated within it*."

Potential impacts on biodiversity in the wider environment are generally given lower levels of importance than within protected areas and may not be adequately considered. In some cases habitat conservation, including connectivity and fragmentation issues, may be indirectly addressed in the wider environment as a result of the consideration of the needs of legally protected species. For example, the Great Crested Newt (*Triturus cristatus*) is protected under the Habitats directive and in the UK by the Wildlife and Countryside Act. The habitats of these species (e.g. ponds) must therefore be protected, irrespective of their designation status, or adequately compensated for under a DEFRA license if the development must go ahead. Similarly, habitats may be protected for other protected species, such as Otters (*Lutra lutra*), Water Voles (*Arvicola terrestris*) and bats. But beyond such measures for protected species, consideration of connectivity across the wider environment largely depends on the quality of the environmental assessment report and local policies.

Wider biodiversity and connectivity issues may also be addressed in Regional Spatial Strategies (RSS) and Local Development Frameworks (by county, district and unitary authorities). Such Strategies and plans may include policies relating to connectivity (sometimes in relation to adaptation to climate change). For example, the RSS for the south east (http://www.southeast-ra.gov.uk/our_work/planning/sep/index.html) recommends climate change adaptation measures, which include "*ensuring that opportunities and options for sustainable flood management and migration of habitats and species are not foreclosed*".

Local plans within an RSS may in turn include connectivity measures. For example English Nature found the following connectivity measures in a review of two Structure Plans and 21 Local Plans in south-east England (Piper et al. 2006):

- creation and management of landscape features to act as 'stepping stones';
- green corridors;
- wildlife corridors and stepping stones;
- consolidation of ecological corridors/networks;
- restoration and enhancement of natural river and wetland elements.

Local plans may therefore take into account proposed ecological networks or wildlife corridors etc when making planning decisions. For example, wildlife corridors have been identified in spatial plans for North-West England, Bristol and London, and developments may be refused if they affect there ecological functions.

However, despite the existence of these mechanisms further development of planning approaches are required to maintain and increase connectivity (in the countryside and urban areas) and to adapt to the additional pressures of climate change. For example, Piper et al. (2006) state that action is needed to bring together approaches which will protect habitats and species, will protect their resilience to climate change and will also provide opportunities for the future. They recognise that landscapes need to be 'permeable' to wildlife and that this may involve matters beyond the powers of planners to address, so partnerships with a range of authorities, agencies and organisations are needed. They also suggest that specific spatial planning measures need to include the climate-proofing of spatial plans (both statutory and where possible non-statutory plans), the integration of plans, river basin management planning, risk assessment and ecosystem planning. Implementation at local and regional level will include opportunities mapping, site safeguard policies, partnership working, landscape frameworks, legal agreements and land market interventions.

Ecological networks

Until recently, no formal proposals had been produced for an ecological network for England that consists of core areas, buffer areas and corridors (although as described below, a pan-UK habitat network map is currently being developed). This appears to be, at least in part, due to a widespread scepticism amongst conservationists of the value of ecological corridors, and particularly linear corridors of physically connected habitat. This probably arises from a number of reviews of the evidence for the benefits of ecological corridors, including several studies commissioned by English Nature. These, and other reviews, have generally concluded that there is little evidence that corridors and linear features such as hedgerows significantly increase functional connectivity (Davies & Pullin 2007; Dawson 1994; Donald 2005; Donald & Evans 2006; Hobbs 1992; ITE 1994; Spellerberg & Gaywood 1993). Furthermore, this might be particularly the case in the UK, where many of the species that might benefit most from connections between protected areas, such as large carnivores, are absent. Therefore, there seems to be some support for the view that, in the absence of conclusive evidence of the functional benefits of corridors, the costs of establishing them need to be compared critically against the costs and potential benefits of alternative conservation approaches (Simberloff et al. 1992).

Furthermore, it is considered that many approaches for developing ecological networks, such as the Pan-European Ecological Network (PEEN), have focussed on physical connectivity rather than functional connectivity and have used methods that are not adequately supported by empirical evidence. Such approaches are thought to lack ecological realism.

Despite these reservations, there has been a recent increase in interest in ecological networks as a means of meeting statutory obligations under the Habitats directive (especially Article 10) PPS9 duties and commitments to the PEEN. Furthermore, climate change adaptation strategies are promoting increased connectivity amongst habitats and increased resilience within them, even though there are some reservations over the functionality of corridors etc for enabling species to move in response to climate change (ITE 1994). For example, English Nature's policy on climate change recognises the need to act in ways that respond in a dynamic manner to climate change, and has accordingly developed guidelines for climate change adaptation (cited in Piper *et al.* 2006). These guidelines give seven recommendations, which include "*Establish ecological networks maintaining linkages across landscapes by habitat restoration*".

As a result of these recent policy developments and obligations, Natural England and others have initiated further scientific studies and trials on the development of habitat networks and climate change adaptation strategies. In particular consideration has been given to using projected impacts of climate change on biodiversity from modelling studies such as the MONARCH project (Harrison et al. 2001) to inform the development of ecological networks. However, the issues are complex and impacts are difficult to predict with certainty (not least because climate impacts will interact with other future human induced habitat changes). It is therefore recognised that there is too much uncertainty in the models to enable the development of prescriptive and pro-active approaches to climate change adaptation. Natural England is currently looking at the role that habitat networks can play in climate change adaptation.

Work has also been undertaken to develop and test approaches for incorporating habitat conservation and enhancement priorities into RSSs and Local Development Frameworks (Catchpole 2006). Two approaches have been developed. The first approach sets broad objectives for strategic environmental enhancement using a landscape characterisation framework. It uses landscape description units, which allow environmental objectives to be set across entire regional land areas, not just for those areas rich in biodiversity. The approach is primarily based on mapping the density of UKBAP priority habitats (although cultural and historical information can also be incorporated). After validation by local stakeholders, a number of different environmental objectives are set for each category, which can guide appropriate actions for delivery of environmental gains.

The second approach produces habitat network maps that aim to indicate the degree of functional connectivity between existing patches of habitat by making an assumption about the relative cost to movement across different types of land cover (Catchpole 2006). This is intended to support operational delivery of habitat conservation and enhancement at finer scales.

The habitat network methodology has developed through collaborative work between the UK statutory conservation agencies and Forest Research, and has led to the application of a common approach to the definition of terrestrial ecological networks in the UK. The approach is based on 'least-cost' analysis (Adriaensen et al. 2003; Bunn et al. 2000) which uses the distribution of existing habitat patches in relation to intervening land cover and its permeability to species movement to identify areas where species movement may still be possible. The relative permeability of different land cover types has been determined by expert judgements of the relative movement cost for a 'generic focal species' (*sensu* Lambeck 1997) associated with four broad habitat types (in England): deciduous woodlands, heathlands, grasslands and mires, fens and bogs. The focal species represents the whole assemblage associated with each broad habitat type excluding species with very high or low capacities for dispersal.

The analysis uses habitat patch data derived from modified national habitat inventories and surrounding landuse (i.e. matrix) data were derived from remotely sensed (Landsat Thematic Mapper) land cover data (ITE 2000). Median movement cost estimates were then used to parameterise a 'least-cost' model using ArcMap 9.0 Spatial Analyst. In England the analysis was carried out at three different spatial scales which were determined through a systematic literature review of all UKBAP Priority Species and statutorily protected species.

The analysis produces what can be described as mapped 'movement envelopes' that indicate whether sites are part of a permeable cluster amongst which species movement might be possible, or whether they are isolated from other sites. The maps therefore enable users to identify which areas of landscape might enhance or inhibit the movement of individuals. Thus, where sites fall within a movement envelope they can be managed as part of a wider ecological network (e.g. with habitat management support from agri-environment schemes). Natural England state that this will be a particular priority when they occur in heterogeneous landscapes as this may contribute to the resilience of assemblages and thus help to deliver climate change adaptation at a local scale, which will be relevant to the greatest proportion of biodiversity (R. Catchpole, pers comm.).

Where habitat patches are not part of a functionally connected network, then other management options, such as habitat enhancement, increasing core area or increasing connectivity (e.g. through corridors or steeping stones) may need to be considered. However, it is envisaged that any action that seeks to increase functional connectivity will be the exception rather than the rule given the limited resources that are available for conservation actions. Natural England considers that any planned increase in connectivity would be subject to a risk assessment to evaluate the potential impacts of unintentionally spreading invasive non-native species, pests and diseases, and the loss of proven conservation programmes as well as the loss of locally adapted genotypes.

It has also been agreed that an assessment of functional connectivity using the 'least-cost' methodology will be used as a UKBAP connectivity indicator to monitor progress with the conservation and enhancement of habitat networks.

Some advantages of this 'least-cost' habitat network mapping approach are that it is ecologically meaningful (as it focuses on functional connectivity and takes into account the properties of the landscape), works at realistic scales, is transparent (with stated assumptions) and can be applied using readily available software and land-use data. It could also be relatively easily adapted to assess the location and extent of habitat networks in relation to particular species (e.g. a species of European Community importance) and the coherence of Natura 2000 sites with respect to such species. In such cases movement costs could be potentially refined using empirical data, such as from radio-telemetry or genetic studies (Epps et al. 2007). The statutory conservation agencies and a number of other partners intend to validate the approach through the use of carefully designed population genetic studies and an initial pilot project is already underway with partners from Natural England, Liverpool University and Forest Research (R. Catchpole, pers comm.).

The major limitation to the approach is that the movement costs are often deduced from expert opinion and are not well supported by meaningful empirical data (Epps et al. 2007). Movements costs are also highly simplified. For example, in England they do not consider the width of land-parcels connecting habitat patches (although this approach has been apllied in Wales), which may constrain movements if they are narrow and dominated by edge habitats. Nor did the analysis in England take into account barriers such as roads or major altitudinal variations (but these are limited). These factors therefore

need to be considered as part of the analysis and validation of the network maps. The method does not explicitly indicate where habitat networks are sufficiently large to be viable (and to hold minimum viable populations of key species). But the size of habitat networks can be deduced and the viability of populations assessed as a later and separate stage.

The 'least-cost' analysis approach to assessing functional connectivity has been used to produce an initial pan-UK ecological network, which will be finalised in September (R. Catchpole pers comm). This will follow the model of defining core areas, buffer areas and corridors, as included in the Pan-European Ecological Network (PEEN). Both Natural England and JNCC consider the pan-UK map should be used to substitute the UK component of the PEEN map produced by Alterra.

The map incorporates the results of habitat network analyses by the statutory conservation agencies and Forest Research. The England Habitat Network (as described above) has recently been completed and covers heathlands, grasslands, deciduous woodlands and mires/fens/bogs. The analysis for Northern Ireland has been completed in a similar manner to England through collaborative, cross-border working.

The analysis for Wales incorporates work on a Woodland Habitat Network (Watts et al. 2005a) and has now been completed by Forest Research on behalf of the CCW, for broadleaved woodlands, ancient semi-natural woodlands and unimproved grasslands as well as a selection of calcareous grasslands and marshy grasslands. This has been developed using the BEETLE (Biological and Environmental Evaluation Tools for Landscape Ecology) toolkit, which was developed to enable non-specialists to carry out least-cost analysis. This assesses functional connectivity using a similar 'least-cost' approach to that used in England. It uses a generic focal species approach, but in this case habitat area requirements are taken into account in the assessment (Watts et al. 2005a; Watts et al. 2005b).

The analysis for Scotland has now been completed by Forest Research on behalf of Forestry Commission Scotland and Scottish Natural Heritage for deciduous woodland, mixed woodland and heathland habitats. More detailed regional maps for mixed woodland and associated open habitats are due for completion in June 2007. These maps are also based on the BEETLE toolkit and build on a considerable amount of research into landscape ecology and habitat networks in Scotland (Fowler & Stiven 2003; Hampson & Peterken 1998; Peterken et al. 1995; Ratcliffe et al. 1998). Further information on the development of habitat networks in Scotland can be found at http://www.forestresearch.gov.uk/habitatnetworks.

No evaluation of freshwater or marine connectivity has been undertaken at the current time in the UK, although plans are present to look at the biological and physical continuity of rivers in England and Wales in the near future.

In addition to the work undertaken by the statutory conservation agencies a number of regional and local initiatives to define and develop ecological networks have been started by NGOs and wider partnerships (Table 2). However, these have been developed using different methods to those described above. Therefore, it is unclear to what extent these will be supported by the statutory conservation agencies and consequently their practical implementation, for example through the statutory planning system, may be limited.

Table 2. Examples of regional ecological network initiatives in England

Scheme / Objectives & description	**Methods**	**Progress**
Cheshire Ecological Network[A]		
This EU LIFE-Nature funded project aimed to offer a new approach to managing the landscape for people and wildlife, and improving the connections between surviving wildlife habitats. It identifies concentrations of habitats of high value for wildlife as well as	The network is based on an analysis of the viability of populations of 15 selected species using LARCH[1] (Landscape ecological Analysis and Rules for the Configuration of Habitats) and LARCH-SCAN (Spatial Cohesion Analysis of Networks) models[2]	The LIFE project has been completed and a draft ecological network identified for Cheshire. The first implementation phase (2005-2010) is underway, targeting the mid-Cheshire Sandstone Ridge. Projects have been identified to deliver the

areas that have the potential for the creation of new habitats and corridors for the movement of wildlife.	and an examination of potential scenarios[3]. Extensive discussions were held stakeholders to raise awareness and support for the concept of ecological networks.	network, which will include the conservation and enhancement of 1,100 ha of new and enhanced habitats. Some funding has been secured, but limited progress has been made with land purchase (5 ha) and enhancement.
An Indicative Ecological Network Map for Norfolk[B]		
The aim of the project has been to develop an indicative ecological network based on the general principles PEEN, which identifies core biodiversity areas, areas for the restoration/creation of habitats, identification of buffer areas and connectivity between areas.	The indicative maps for Norfolk are based on two approaches. The first approach analysed spatial data using GIS and was based on the methodology adopted in the East of England Biodiversity Mapping Project. The basic approach mapped SSSIs and County Wildlife Sites and BAP habitats and related these to the Level 2 (1:50 000) Landscape Description Units for Norfolk. The second approach was more qualitative with the indicative maps being based on a set of conservation priorities for a number of BAP habitats, agreed by practitioners in Norfolk, and then related to landscape or designated site boundaries.	A draft ecological network map and action plan has been produced (Land 2006). The draft map incorporates the findings of each ecological network approach .
A living landscape for the South East[C]		
A partnership of Wildlife Trusts in south-east England have produced an Ecological Network Map for the south-east that aims to rebuild the region's biodiversity. This supports a national initiative by the Wildlife Trusts to restore UK ecosystems[4].	The network map is primarily based on a map of existing ecological resources in each county, the identification of core areas (concentrations of UKBAP Priority Habitats and designated sites) and a mainly subjective assessment of the potential for physically connecting core areas (e.g. using solid maps to identify potential vegetation types.	The proposal map and report was produced in 2006 to stimulate discussion rather than practical actions at this stage.

Websites

A. See http://www.lifeeconet.com/about.htm for details of the LIFE ECOnet project and www.cheshire.gov.uk/SREP for further information on the Sandstone Ridge component of the Cheshire ecological network.

B. http://www.norfolkbiodiversity.org/

C. www.kentwildlifetrust.org.uk

References

1. Pouwels et al. (2002); 2. van der Sluis et al. (2003); 3. van Rooij et al. (2001); 4 The Wildlife Trusts (2006).

Habitat restoration / creation projects

The UK has developed a relatively ambitious programme of habitat restoration and creation. This has been primarily driven by the UKBAP, rather than proposed ecological networks and related connectivity initiatives. The primary aim of most schemes is therefore to increase the net resource of UKBAP Priority Habitats. Despite widespread support there is substantial concern over the limited progress made towards BAP targets for habitat restoration and expansion (DEFRA 2006b). While targets for cereal field margins and lowland calcareous grassland have been achieved through the support of agri-environment schemes (see below), progress is behind schedule for the majority of habitats, for a variety of reasons. The EBG therefore intends to place considerable emphasis on large scale habitat restoration over the next four years.

As noted above, most restoration targets and programmes have been developed in isolation and little consideration has been given to integrating restoration schemes and networks. Opportunities to locate habitat restoration projects such that they help increase habitat connectivity (e.g. as stepping stones) may therefore have been missed. However, this is now being addressed for some habitats. For example, Natural England, The Environment Agency and RSPB are developing a 50 year vision for wetlands (http://www.rspb.org.uk/policy/waterwetlands/news/vision.asp). This will help stimulate and guide wetland restoration projects and will include development of a GIS tool to help people seeking to create wetlands understand where and how they can make them most effective and a map showing priority areas for wetland restoration and creation. The results of the work on the England Habitat Network, as described above, have been incorporated into the project..

Some existing wetland restoration schemes have aimed to join fragmented blocks of habitat as part of a habitat expansion programme. For example, the Great Fen project in Cambridgeshire aims to restore and create over 3,000 ha of fenland habitats, which will link two very important but isolated National Nature Reserves: Holme Fen and WoodWalton Fen (http://www.greatfen.org.uk/). A similar scheme is being pursued at Wicken Fen, near Cambridge (http://www.wicken.org.uk/100y.htm).

Some other wetland creation projects have aimed to increase the functional connectivity of habitat networks for UKBAP Priority Species. For example, an RSPB led EU LIFE-Nature project (LIFE02NAT/UK/008527) was started in 2002, to develop a strategic network of SPA reedbeds for the Bittern (*Botaurus stellaris*) (http://www.bitterns.org.uk/). This aimed to provide additional habitat, away from the species' core areas, to increase its range and to enable the dispersal of young birds from their natal reedbeds. In addition, it aimed to create links with an isolated north-western outpost of breeding birds. To achieve this it included habitat restoration and creation actions at sites without Bitterns, and habitat enhancement and expansion at sites with Bitterns to increase productivity and thereby increase the number of potential young colonisers.

The project finished in 2006 and managed to achieve or exceed its main habitat restoration and creation targets. Although it is too soon to assess its impacts on Bitterns, there are encouraging results already. The project provides a good example of how strategic measures can be taken to connect isolated populations, and demonstrates the importance of basing connectivity measures on detailed and comprehensive research.

Forest restoration has also been driven by the UKBAP, the England Forest Strategy (Forestry Commission 1998) and most recently the launch of the Government's policy for Ancient and Native Woodland in England in 2005 (http://www.forestry.gov.uk/keepersoftime). One of the aims of the current policy is to improve the landscape context of woodland, and it lists the following strategic objectives:

- Create new native woodland to extend, link or complement existing woodland and other habitats.
- Create semi-natural habitats in locations where they will benefit species which use both woodland and non-woodland habitats.
- Reduce or buffer the impacts of intensive land uses and development which adjoin ancient or native woodland.
- Work towards creating landscapes that are 'ecologically functional'.
- Ensure the management and creation of ancient and/or native woodland conserves and enhances the natural beauty and character of landscapes.

These policy drivers have stimulated the development of several measures to support forest restoration and the restoration of other habitats on former commercial plantations. For example, good progress has been made on the restoration of non-heathland, with over 5000 hectares restored by 2006. Work started in 2002 on developing a new package of incentives for woodland management and creation as part of the England Woodland Grant Scheme (EWGS). In 2005 the full EWGS was launched with specific targeting of grants to improve condition, restore ancient woodland and expand native woodland.

Woodland protection and conservation has also been integrated into agri-environment schemes (see below). This included buffer strips, small-scale woodland creation and conservation of farmland trees.

There is also growing interest in the recreation of large areas of near-natural forest landscapes or 'wildwoods' (Garforth & Dudley 2003; Worrell et al. 2002). This is in part the result of new opportunities arising from socio-economic changes affecting agriculture and forestry, especially in the uplands. Such wildwoods would be extensive landscape mosaics dominated by native woodland (30-70%) but with other habitats, including agricultural land. The inspiration for such wildwoods comes from large, near-natural reserves re-created in continental Europe, in particular the Oostvaardersplassen (Wigbels 2001).

New wildwoods would be a contribution towards the development of new areas of wild land, referred to as "rewilding" or "wildlands" by some groups within the nature conservation movement (Taylor 2005). The key biodiversity benefit would be the creation of landscapes where natural ecological processes could regain importance.

The creation of large-scale wildlands would also be in accordance with requirements for biodiversity conservation in response to predicted climate changes (irrespective of what they might be), especially if such areas formed interlinked areas of habitat. To be effective each wildwood would have to be fairly compact in shape and cover thousands of hectares to allow natural dynamic processes to dominate. Another aim is to provide sufficient habitat for the re-introduction of viable populations of large herbivores and carnivores (such as the Eurasian Lynx *Lynx lynx*). Thus, there are significant constraints on where wildwoods can be developed.

Initially it is likely that new wildwoods will be restricted to the uplands where such conditions are likely to be found. Indeed English Nature has stated that there is scope for increasing native forest cover in the uplands, which could contribute to wildwood visions (Brown et al. 2001). In Scotland a number of small privately funded wildwood type projects have been initiated (Ashmole & Chalmers 2004; Watson Featherstone 2004), but progress in England has been slow and mainly restricted to within the National Parks (Worrell et al. 2002).

Agri-environment schemes in England

Agri-environment measures have provided an important mechanism for biodiversity conservation throughout the EU. In fact the UK has used its agri-environment schemes as the principal means of supporting conservation measures on farmland and most other semi-natural habitats other than closed-canopy forest. Consequently agri-environment schemes provide the only realistic mechanism for achieving biodiversity targets over a vast area of agricultural land (Vickery et al. 2004). They also help to maintain habitat connectivity within farmland landscapes, by maintaining and restoring patches of semi-natural habitat in the landscape. They also support the restoration and replanting of hedgerows, although there connectivity benefits may be limited (Davies & Pullin 2007). Furthermore, agri-environment schemes might bring significant environmental benefits to habitats other than farmland by restoring the agricultural matrix that separates them (Donald & Evans 2006).

The two agri-environment schemes that have provided habitat connectivity benefits in the UK have been the Environmentally Sensitive Areas (ESA) scheme and the Countryside Stewardship Scheme (CSS). The ESA scheme was introduced in 1987 and was designed to prevent loss of habitat and landscape features from intensification in targeted ESAs (i.e. areas of high biodiversity, landscape and historic value). CSS was initially launched as a pilot scheme in 1991 and is not restricted to specific areas, but does target habitats and landscapes of particular biodiversity, landscape and historic value. It also includes measures in more intensive farmland habitats. In both schemes agreements were offered to landowners under which annual revenue payments are provided for following prescribed management practices. The scheme also offered capital payments for a wide range of one-off works.

Practical measures included in ESAs and CSS that have helped to maintain and enhance small-scale habitat connectivity have included the following:

- Hedgerow planting/restoration
- Ditch management/restoration
- Pond and habitat creation/restoration
- Water level management
- Grass strip/margin creation in arable fields
- Uncropped margin creation in arable fields
- Reduced fertilizer /pesticide inputs in arable fields and margins
- Maintenance of winter stubbles
- Maintenance of summer fallows
- Creation of beetle-banks (rough grassland patches)

An evaluation of agri-environment schemes up to 2002 concluded that the schemes made a major contribution to environmental conservation in England (Tucker 2003). At that time agri-environment agreements covered some 847,000 ha of countryside in England (i.e. approximately 9% of rural agricultural and open grazed land) and undoubtedly had a significant impact on the environmental quality of the countryside.

The ESA scheme and CSS have subsequently been reviewed and reformed in response to the recent reforms to the CAP agreed in June 2003, though existing ESA and CSS agreements will continue until their expiry. This has led to the launch of Environmental Stewardship by DEFRA as part of its Rural Development Programme (http://www.defra.gov.uk/erdp/schemes/es/default.htm). This has the following three elements:

- Entry Level Stewardship (ELS) is a 'whole farm' scheme open to all farmers and land managers who farm their land conventionally. Acceptance is guaranteed provided that certain scheme requirements can be met.
- Organic Entry Level Stewardship (OELS) is a 'whole farm' scheme similar to the ELS, open to farmers who manage all or part of their land organically.
- Higher Level Stewardship (HLS), which will be combined with ELS or OELS options, aims to provide additional benefits particularly for UKBAP Priority Habitats and Priority Species, via a more intensive, but carefully targeted approach to habitat management.

Management options available for ELS and OELS that may maintain or enhance functional habitat connectivity at a small-scale include:

- Arable land (e.g. over-wintered stubbles, beetle banks)
- Boundary features (e.g. hedgerow management, stone wall maintenance, ditch management)
- Buffer strips (e.g. 2, 4, or 6 m buffer strips on cultivated land/rotational land; 2, 4, or 6 m buffer strips on intensive grassland/organic grassland)
- Encouraging a range of crop types (e.g. under sown spring cereals, wild bird seed mix/pollen and nectar seed mix in grassland areas)
- Maintenance of habitats on Less Favoured Area land (e.g. moorland and rough grazing, management of rush pastures)
- Lowland grassland outside the Less Favoured Area (e.g. taking field corners out of management, permanent grassland with low or very low inputs)
- Trees and woodland (e.g. protection of in-field trees, arable/ grassland or rotational grassland, management of woodland edges).

Uptake of ELS has been very high since its launch and nearly two-million hectares of agricultural land is currently being managed under the scheme. It is, however, too early to assess its effectiveness and efficiency in maintaining and enhancing habitat connectivity and other biodiversity attributes.

Management options available under HLS that may maintain or enhance functional habitat connectivity include:

- Arable land (e.g. flower-rich grass margins, fallow plots for ground-nesting birds such as lapwings)
- Grassland (e.g. maintenance and restoration of species-rich, semi-natural grassland, restoration of wet grassland for breeding waders and wildfowl)

- Maintenance of hedgerows of very high environmental value
- Inter-tidal and coastal (e.g. maintenance of sand dune systems, restoration of coastal saltmarsh)
- Lowland heath (e.g. restoration and maintenance of heathland)
- Moorland and upland rough grazing (e.g. restoration of moorland)
- Wetland (e.g. maintenance of ponds of high wildlife value, maintenance of reedbeds)
- Woodland, trees and scrub (e.g. restoration of woodland, retention of ancient trees in arable fields)

Current targeting of HLS favours conservation measures that aim to achieve favourable condition within SSSIs (which will include Natura 2000 sites). It is also likely that targeting will be used to help implement habitat restoration needs identified within the England Habitat Network.

Although the HLS has been launched there have been a number of problems which have slowed its implementation, including EU restrictions on modulation (now resolved), UK funding and IT problems within DEFRA.

Hedgerow regulation

A key measure that has been used to protect hedgerows in England and Wales has been the Hedgerows Regulations 1997. The Regulations stipulate that it is against the law to remove or destroy certain hedgerows without permission from the local planning authority. Permission is required before removing hedges that are at least twenty metres in length unless they form part of the boundary of a dwelling. In general permission will not be given for the removal of hedges that are defined by the Regulations as being 'important', which includes hedges that are over thirty years old and of high historic or wildlife value. Although the Regulations are rather complex and have been subject to some criticism, it has been acknowledged that the legal protection of hedgerows has helped to further reduce rates of hedgerow loss.

Recent monitoring of the extent and condition of farmland habitat features in England (EBS Indicator A5) showed that the loss of hedges and walls has halted (DEFRA 2006b), probably as a result of the combined effects of agri-environment measures and the Hedgerow Regulation. However, the long term condition and management of these features remains a concern. There is also little evidence that hedgerows actually provide any significant functional connectivity value (Davies & Pullin 2007).

CONCLUSIONS

The UK has a relatively extensive and effective protected area network, and recent initiatives have been taken to strengthen its protection and to improve ecological conditions at each site. This has been supported by the development of the UKBAP, which has helped to identify habitat and species conservation priorities, set conservation targets and extended conservation measures to the wider environment. The UKBAP has also broadened involvement in UK conservation and has helped to devolve planning to local levels.

Several UK policies and conservation mechanisms have helped to maintain and enhance connectivity between habitats. These have included planning regulations, UKBAP HAPs and SAPs, forestry policies and grants, and, of particular importance, agri-environment measures. However, there has been little strategic guidance or integration of these measures with respect to connectivity issues.

There is currently an increased interest in the development of ecological networks and connectivity measures in response to recent planning and climate change policy developments and obligations under the Habitats directive etc. Approaches have therefore been developed to set broad regional conservation objectives and utilise outputs from initiatives such as the England Habitat Network, which identify finer-scale opportunities for maintaining and enhancing functional connectivity, so that it can be incorporated into the planning process. A common approach to habitat network mapping has been agreed between the statutory UK conservation agencies, JNCC and DEFRA. It is anticipated that a pan-UK ecological network map will also be produced in 2007. However, there is no intention by Natural England to develop large-scale habitat restoration measures, especially in the most degraded and fragmented habitats as this is unlikely to be practical. Instead, the likely outcome will be a focus on maintaining the resilience of the largest networks and enhancing connectivity where this is practicable.

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