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**THE FUTURE OF ECOLOGICAL NETWORKS IN EUROPE
A DISCUSSION PAPER**

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Summary

Changes in the patterns of land use and management have impacted more than any other factor on the serious decline in richness and abundance of Europe's biodiversity. Issues include the intensification of agriculture and forestry and a consequent decline in traditional agricultural and forest management on which many habitats depend and, more recently, the large-scale abandonment of land. Further problems have been caused by the spread of urbanization and industrialization and the fragmentation of habitats by infrastructure. The associated improvement to drainage systems, the loss of wetlands and the modification of rivers and watercourses have created further impacts. There is also a growing pressure from public access to the countryside for the purposes of tourism, access and recreation. Finally, climate change and its impacts on biodiversity have gained much recent political, media and scientific interest.

The direct impact of these changes has been a reduction in the functioning and functionality of ecosystems. So, not only are they losing their value for wildlife and nature conservation, but they are also producing fewer of the essential elements on which many people, in rural areas in particular, have come to rely. These so called ecosystem 'goods and services' include basic items such as food, water, wood, building materials and fuel. At a more sophisticated level ecosystems can provide, for instance, natural waste management systems in the form of wetlands, which absorb and neutralize pollution and flood plain grasslands and woodlands that reduce the risk of flooding to towns and cities by alleviating the threat of extreme weather events (that appear to be one of the consequences of climate change).

It is understood that size, shape and connectivity are all factors that contribute to ecosystem functioning and functionality and, all over Europe, habitats and ecosystems are becoming smaller, more fragmented and their isolation from other areas is increasing. Habitat isolation and loss prevent natural species from reaching migration and dispersal destinations, forces them to live in habitats that may not be large enough for them to maintain viable populations, reduces or removes the potential for them to achieve genetic change, and prevents them from responding to the consequences and impacts of climate change (that is likely to force many species to migrate to new habitats). These issues affect terrestrial, aquatic and marine ecosystems.

A combination of scientific research and theory, and a realization that the protection and management of special sites on their own would not secure the long-term future for biodiversity, has therefore resulted in a gradual reconsideration of the strategic policy and practice of nature conservation. In essence ecological networks provide a framework for reversing the effects described above. Not only is it based on scientific theory and evidence, but it is also a highly effective concept in terms of its communicability. It has successfully bridged the science-policy interface and has been the basis of a paradigm shift in our consideration of nature protection and management in Europe.

Ecological networks from pan-European, other regional, national and local levels, therefore make a major contribution to the overall effort to protect, maintain and enhance biodiversity; the concept has gained significant political support over the last decade and a half. A platform now exists for: increased integration of ecological networks into the cross-sectoral policy agenda; research into their contribution to ecosystem services and mitigation and adaption for climate change; and an increase in the availability of information about practical delivery. This paper provides a brief overview of the ecological concepts, policy and research developments; it then covers a number of key areas and issues that may contribute to the future development and implementation of ecological networks in Europe.

The conclusion sets out some key points for discussion which are repeated here for ease of reference:

- It could be argued that green infrastructure is a natural evolution of the ecological networks concept. The relationship between ecological networks and green infrastructure (and the extent to which it builds on the concepts and legacy that it could inherit from the ecological networks

approach) therefore needs to be clearly articulated - including in relation to implementation, socio-economic aspects and stakeholder participation.

- The argument for maintaining, restoring and creating ecological networks in order to provide adaptation to climate change can be enhanced through linking it to green infrastructure.
- The synergies with the development of the wilderness debate should also be explored.
- Following the development of the PEEN the elaboration of national level networks is a pressing need and a high priority in the route to implementation. There is a clear need to develop the potential of national-regional ecological networks through funded programmes and projects.
- There is potential for biodiversity related initiatives such as ecological network implementation to provide a platform for civil society engagement and to build its capacity through applying a participative approach to the delivery of projects and programmes; project funding is increasingly being tied to the development of capacity in civil society (particularly in Eastern and South Eastern Europe). All of which provides an opportunity for biodiversity policy-makers and practitioners; but which also sets up a challenge to which they must now respond.
- Linking ecological networks to spatial planning at different geographical scales can be seen as a key to effective delivery in the future and could provide a useful framework within which values and specific ecosystem services could be attributed to aspects of the ecological network. However, in spite of the logic of this approach there are presently no instruments or guidance to drive this integration/ approach.
- CBD Conference of the Parties in Nagoya (Japan) in October 2010; and green infrastructure has emerged as a priority within the Communication from the European Commission (2011). These frameworks could be exploited.
- The current review of, for example, the EU Common Agricultural Policy presents an opportunity for new measures to be introduced that will benefit connectivity in agricultural landscapes.
- Resilient ecosystems are more resistant to IAS – thus the benefits of healthy ecological networks are significant particularly when poorly maintained or degraded networks can provide vehicles for the movement of IAS.

1. Background: the ecological networks concept

The concept of ecological networks is not new; the model has developed over the past 35-40 years (beginning in the 1970s and 1980s in countries where a strong land use planning tradition had created the institutional environment for allocating functions at the landscape scale) in the context of increasingly fragmented European landscapes. The concept is the translation of ecological knowledge on fragmentation processes in the landscapes of Europe and its consequences for populations of natural species.

Natural areas, whether protected or not, often represent isolated islands, of varying size but often too small, in the midst of intensive agriculture, built development or transport and energy infrastructure. Habitat isolation and loss prevent natural species from reaching migration and dispersal destinations, force them to live in habitats that may not be large enough for them to maintain viable populations, reduce or remove the potential for them to achieve genetic change, and prevent them from responding to the consequences and impacts of climate change (which is likely to force many species to migrate to new habitats).

Ecological networks' main goal was conserving biodiversity by maintaining and strengthening the integrity of ecological and environmental processes; and to counter the above effects by linking fragmented ecosystems with each other in order to promote exchange between populations of species and to enable the migration and spread of species. As a conservation approach, ecological networks are characterized by two generic objectives, namely (1) maintaining the functioning of ecosystems as a means of facilitating the conservation of species and habitats, and (2) promoting the sustainable use of natural resources in order to reduce the impacts of human activities on biodiversity and/or to increase the biodiversity value of man-managed landscapes (Bennett & Wit, 2001).

Ecological networks are based around the idea of core areas, ecological corridors, buffer zones and restoration areas. They are designed and managed in such a way as to preserve biological diversity and to maintain or restore ecosystem services through the interconnectivity of its physical elements within the landscape. They should also allow for the sustainable use of natural resources and the maintenance of existing social and institutional structures (loosely based on: UNEP, 2003). The ecological networks concept makes a major contribution to the overall effort to protect, maintain and enhance biodiversity; the concept has gained significant political support over the last decade and a half and has been accepted in many European countries.

All ecological networks share common conservation objectives and operational features, as well as a characteristic spatial architecture. This architecture is a derivation of spatial relationships and processes that are key to biodiversity conservation, particularly the distribution of local species populations, arrangement of habitats, geographical processes and human activities. Specific functions are allocated to different areas depending on their respective ecological value and natural-resource potential (Bennett, 2004). These functions are reflected in a coherent system of ecological network elements (Figure 1):

- **Core areas**, where the conservation of biodiversity takes primary importance, even if the area is not legally protected. The primary objective of core areas is to ensure the conservation of a representative array of characteristic habitats and species populations.
- **Corridors**, which serve to conserve vital ecological or environmental interactions by maintaining connectivity between the core areas where necessary. These linkages may be of three broad kinds:
 - *linear corridors* in the form of landscape elements such as hedges, shelterbelts, woods and rivers or infrastructure such as tunnels and ecoducts that allow species to traverse an obstacle;
 - ‘*stepping stones*’, that is, an array of small patches of habitat that individuals use during movement for shelter, feeding, resting and other ecological functions;
 - *landscape corridors* are various forms of interlinked landscape matrices, usually in the form of extensively managed landscapes, that retain sufficient natural elements to allow individuals to survive during movement between habitat patches
- **Buffer zones**, which insulate areas where biodiversity conservation is the primary objective from potentially damaging external influences, and particularly those caused by inappropriate forms of land use. This function therefore permits in principle a range of sustainable human activities.
- **Restoration areas** are those where the degraded functions of an ecosystem can be restored, especially in cases where habitat fragmentation disables normal functioning of ecosystems or endangers the local populations. These areas are important because they can improve ecologic connectivity and functionality of the system. This concept includes development or redevelopment of biodiversity values.
- **Sustainable use areas**, which may surround the network and where opportunities are exploited within the landscape mosaic for the sustainable use of natural resources together with the maintenance of most ecosystem services.

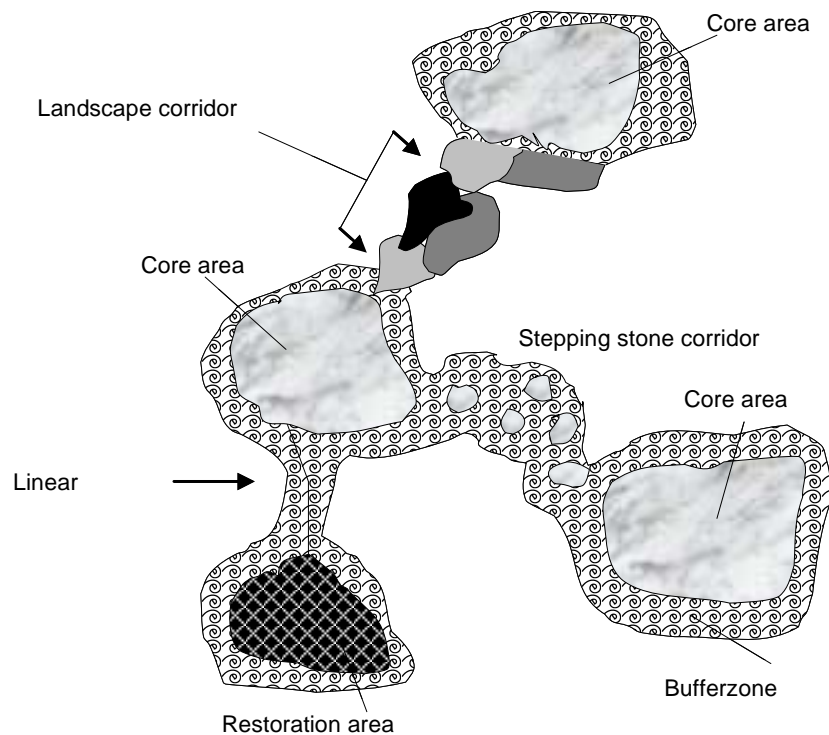


Figure 1: The ecological network model (Source: Bouwma *et al.*, 2002).

The ecological network model can be applied at various scales. Many ecological networks encompass a geographical region, such as a watershed, a mountain range or a biome, e.g. temperate broad-leaf forest. On the other hand, if it is a part of government policy or planning, it can be national, regional (e.g. county or province), or even transboundary between neighbouring countries. Thus, at present it is possible to find examples of the ecological network model being used as a strategic approach to biodiversity conservation at the supra-continental scale, all the way down to detailed conservation plans at the local (e.g. municipal) level.

2. Ecological networks in international frameworks and statute

The ‘Convention on the conservation of European wildlife and natural habitats’, better known as the ‘Bern Convention’, is a binding international legal instrument adopted by the Council of Europe in 1979 to foster the conservation and sustainable use of biological diversity in the European Continent. The Emerald Network is an ecological network set up by the Council of Europe as part of its work in the framework of the Bern Convention (CoE, 2009). This means that the Emerald Network is to be set up in each Contracting Party and observer state to the Bern Convention. In 2009, these included 27 EU member states, 20 other European countries, 4 African States and the European Community (CoE, 2010a). Article 4 of the Bern Convention is the most relevant article, as it states that Contracting Parties ‘shall take appropriate and necessary legislative and administrative measures to ensure the conservation of the habitats of the wild flora and fauna species, especially those specified in Appendices I and II, and the conservation of endangered natural habitats’ (CoE, 2010b).

The creation of the Emerald Network of areas of special conservation interest was agreed by the Standing Committee of the Bern Convention in 1989, through the adoption of Recommendation No. 16 (1989) on the Areas of Special Conservation Interest (ACSI). The Recommendation advocates Contracting Parties to take, either by legislation or otherwise, steps to designate areas of special conservation interest to ensure that necessary and appropriate conservation measures are taken for each area situated within their territory or under their responsibility (CoE, 2010d). All EU nature

conservation legislation therefore results from the obligations of the EU as contracting party to the Bern Convention and the consequent implementation of the 1979 EC Birds Directive and the 1992 EC Habitats Directive provided for the establishment of a representative system of legally protected areas throughout the EU, known as Natura 2000. These directives further strengthened existing protected site series at national level, or stimulated countries to define lists of protected sites (where they did not already exist).

In addition, at the third Ministerial Conference 'Environment for Europe' in 1995 Ministers of Environment of European countries launched the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) aiming to strengthen environment and biodiversity conservation policies in Europe. The Ministers called 'for the promotion of nature protection, both inside and outside protected areas, by implementing the European Ecological Network, a physical network of core areas and other appropriate measures, linked by corridors and supported by buffer zones, thus facilitating the dispersal and migration of species'. Thus, the setting up of a Pan-European Ecological Network (PEEN) covering Eurasia was one of the key steps taken under PEBLDS and it has been developed on the basis of national, regional and transregional ecological networks and initiatives throughout Europe (CoE, 2010a). In this context it was agreed that due to its political importance, its geographic extent and its biological and landscape diversity the Emerald Network, (together with Natura 2000 – see below), will constitute the main component of the PEEN (CoE, 2010c).

The concept of ecological networks is therefore implicit in a variety of international conventions (Ramsar convention, Bern Convention), European agreements (Habitats and Birds Directives) and related policy implementation (Natura 2000 and Emerald Networks). It has become operational in national and European strategies (Jongman *et al.*, 2004). Thus, the development of a European Ecological Network forms one of the priorities and activities of European nature conservation under the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) which was endorsed by 54 European countries in Sofia, in 1995. In PEBLDS, the aims of the Pan-European Ecological Network are to set out in order to ensure that (see also Rientjes and Roumelioti, 2003):

- A full range of ecosystems, habitats, species and landscapes of European importance are conserved;
- Habitats are large enough to guarantee key species a favourable conservation status;
- There are sufficient opportunities for dispersal and migration of species;
- Damaged parts of the key environmental systems are restored;
- The key environmental systems are buffered from threats.

At the moment of its endorsement, the Council of Europe (CoE) together with ECNC-European Centre for Nature Conservation received a political mandate to coordinate the establishment of the Pan-European Ecological Network (PEEN) and later, together, to lead on the Kyiv target on this issue.

The 2003 Kyiv Resolution on Biodiversity, endorsed at the Fifth 'Environment for Europe' Ministerial Conference, set 2006 as a target date for preparing indicative maps for all regions of Europe. It was envisaged that PEEN should be based on existing initiatives and European directives, its backbone being Natura 2000 (comprising Special Protection Areas under the Birds Directive and Special Areas of Conservation under the Habitats Directive) and the Emerald Network. Article 10 of the 1995 Habitats Directive, specifically relates to land-use planning, the development of policies and the exploration of possibilities for improving ecological coherence between sites designated under the directive, and provides further strong direction for EU Member States.

The Sixth Ministerial Conference "Environment for Europe" in Belgrade, Serbia (10-12 October 2007) represented a watershed for the development of a Pan-European Ecological Network. At the conference ministers received a report from the Council of Europe, Committee of Experts for the development of the Pan-European Ecological Network: "The Pan-European Ecological Network: taking stock" (Bonnin *et al.*, 2007) which provided information on the progress of work in the constitution of PEEN as a follow up to the previous Ministerial Conferences (mentioned above). As such (together with Jones-Walters, L. 2007; and Jongman, et al, 2011) it is a comprehensive digest of

available information; including an elaboration of progress in implementation, the history of the political process, the scientific and legal background and a reflection on the future for Ecological Network implementation in Europe.

Several initiatives, funded by both the EU and by EU/CoE Member States, have therefore sought to create spatial presentations of European Ecological Networks. Notable examples include: the indicative map of the PEEN for Central and Eastern Europe (Bouwma, Jongman & Butovsky, 2002), which covered 12 countries: Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Romania, Moldova, Ukraine, Belarus, and the European part of Russia; the indicative map of PEEN for South-Eastern Europe (Biro, Bouwma & Grobelnik, 2006) covering 9 countries: Slovenia, Croatia, Bosnia- Herzegovina, Serbia-Montenegro, Republic of Macedonia, Albania, Bulgaria, Greece and Turkey; and finally the draft PEEN map for Western Europe (Jongman, Bouwma & van Doorn, 2006). The only area not presently covered by either the PEEN map for Central and Eastern Europe or the map for South-Eastern Europe and Turkey lies between the Black Sea and the Caspian Sea (the Caucasus).

Ecological network maps and strategies have also been established at country level and around trans-boundary sites and site complexes. The Natura 2000 site network is now well developed across the European Union member states and the Emerald network constitution process is making progress at a pan-European level, particularly in the Western Balkans, Central and Eastern Europe, South Caucasus, as well as Norway and Switzerland. Together with other networks of protected sites that stem from international, national or regional arrangements, they provide the basis for planning and joint action. At a regional and local level many planning authorities have applied the principles of ecological connectivity to spatial planning and strategies. Often the latter have included a significant level of stakeholder and public involvement and participation in the planning process.

Driven by a strong political desire, in part at European level (through reforms to Common Agricultural Policy and related policy instruments, such as the Rural Development Policy) and within a number of Member States, there has been a movement of agricultural and forestry subsidy into support for sustainable, environmentally sensitive land management. Many Member States have implemented fiscal and financial instruments targeted at land managers in the agriculture and forestry sectors, which are explicitly underpinned by the idea that it is important to make physical connections between habitats and to provide corridors for the movement of species in the wider countryside around special sites. They therefore promote the management and creation of linear features such as hedgerows, dry-stone walls, shelterbelts and riparian and aquatic habitats and 'stepping stone' habitats such as woodlands, grasslands, ponds and lakes. Other sectors such as transport, business and industry have been engaged in the process through the provision of guidance such as 'codes of good practice'.

3. The future of Ecological networks in Europe

Clearly, a significant amount of progress has been made. There is a trend towards taking account of ecological connectivity in policy instruments at all levels. The EU Water Framework Directive is a very good example of this, and whilst the European Spatial Development Perspective (1999) is based on an economic approach, it does consider the integration of economy across sectors, with sustainable development as a guiding principle and concern. "The Guiding Principles for Sustainable Spatial Development of the European Continent" (2002) mentions in the context of its principles the need to reduce environmental damage and to enhance and protect natural resources and natural heritage; and so links social, cultural and environmental sectors. Along with a number of other existing and developing policy and funding frameworks, it recognises the importance of bringing economic and social requirements into harmony with ecological and cultural functions through long-term, large-scale and balanced spatial development.

The achievements to date clearly provide a strong platform for future action. However, it is clear that some momentum in the process of the development and implementation of ecological networks in Europe has been lost. The reasons for this include the current economic climate that

prevails in Europe, in which governments are more reluctant to prioritise fund environmental initiatives when economic and social issues still require urgent attention in relation to spending cuts. The former has focussed countries on their internal financial and fiscal requirements and drawn attention and support away from multilateral environmental agreements such as PEBLDS and, as a consequence, the PEEN process. The arrival of 2010 and, for some EU Member States, the achievement of targets such as ‘sufficiency’ in relation to Natura 2000 designation has further slowed progress and commitment.

In spite of this opportunities clearly exist for the further development and implementation of ecological networks. The following sections explore the potential of a number of key areas, namely: green infrastructure; national and regional ecological networks; stakeholder participation and building the capacity of civil society; spatial planning and sectoral integration; costs, benefits and ecosystem services: climate change; emerging policy and policy reform; and areas for research.

3.1 Green Infrastructure

Whilst the term Green Infrastructure has in the past been used to describe natural, connected habitat within urban areas it has recently been launched as a new concept that is now included within the European Commission's EU 2020 European biodiversity headline target and 2050 vision, aimed at halting and reversing the loss of biodiversity across the EU territory of the member states and a response to the Aichi targets signed at the CBDs COP 10 (EC, 2011) .

It is likely that a common definition of green infrastructure will be developed in due course; at present however it is articulated and is an ‘approach’ that calls for the protection and restoration of ecosystems in so far as possible to strengthen their resilience and sustain the key services that they provide; whilst also achieving conservation objectives and enabling Member States to adapt to climate change. In terms of a working definition the European habitats Forum, a member of the European Commission working group on green infrastructure, has come up with the following: *Green infrastructure is a strategically planned and delivered network of high-quality green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering a wide range of environmental and quality of life benefit local communities. Green infrastructure includes forests, rivers, coastal zones, parks, eco-corridors and other natural or semi-natural features which constitute key elements for the provision of ecosystem services.*

However it is finally interpreted, green infrastructure will clearly have some form of coherent ecological network at its core. It would therefore seem prudent to take into account the work that has been done at various geographical levels in order to define areas of existing and potential ecological connectivity. Below the level of ecological corridors that cross within and between countries, this includes the green and blue veining that makes up the patchwork quilt of traditionally managed multifunctional landscapes; and as such still remains at the heart of the description of ecological networks that is given above.

Perhaps the step that green infrastructure can take beyond what has already been achieved (with ecological networks) is to provide further context for informing the important decisions that need to be made in relation to the planning and management of the wider countryside outside of protected areas and other special sites. Thus, the consideration of issues such as ecosystem services, climate change adaptation and ecological resilience can be integrated within the new approach.

In many ways this would have been the desired future objective of any development of the ecological networks concept; and it could therefore be argued that green infrastructure is a natural evolution of ecological networks. Perhaps the key issue for debate is the extent to which it builds on the concepts and legacy that it could inherit from the ecological networks approach.

It is highly likely that, with or without green infrastructure, countries will continue to consider the development of national ecological networks particularly where they have large carnivores and herbivores and where the benefits of such an approach are clear.

3.2 National and Regional Ecological Networks

In June this year ECNC and the Macedonian Ecological Society (MES) presented the final results of the MAK-NEN project, concluding three years of work devoted to the development of a Macedonian Ecological Network (funded by the Dutch government). The presentation was held in Skopje and attended by numerous representatives of ministries, scientific and expert institutions representing sectors relevant to the implementation of the National Ecological Network in Macedonia, all of whom had been actively involved in the development of the final map.

Two of the main outputs of the project that were presented were the final MAK-NEN map, published in A1 format, and a Bear Corridor Management Plan. The Plan lists the 23 existing and potential bottlenecks for functioning of the ecological network identified on the map, elaborating the potential solutions and measures to be implemented by different stakeholders in order to ensure the full functionality of the network (Brajanoska *et al.*, 2009). It provides compelling and plausible evidence for the need to provide effective spatial planning at national level for threatened and other wildlife.

As a result of the three-year stakeholder involvement process, the discussion that followed the presentations showed that the participants have a high level of understanding, acceptance, ownership and support of the ecological network concept. This indicates that MAK-NEN has a bright future in Macedonia and, whilst the Macedonian ecological network is not the first national level network to be developed, it clearly should not be the last. It is pertinent to profile it here because it provides a recent example of best practice; not least because it includes a high level of stakeholder participation (see 3.3, below).

Following the development of the PEEN the elaboration of national level networks is a pressing need and a high priority in the route to implementation. However, national ecological networks are unlikely to function effectively unless they cross national boundaries. Again, there are a number of particularly good examples of cross boundary and regional ecological networks (e.g. within the framework of the Alpine convention and in the Dinaric Arc, etc). In the context of the Western Balkans, and the Macedonian ecological network, there is a clear need to develop the potential of national-regional ecological networks through funded programmes and projects.

3.3 Stakeholder participation and building the capacity of civil society

Consensus development through stakeholder participation is a promising trend that takes into account the interactive character of the communication process. Stakeholder participation already has a successful track record in assisting in the management of (for example) Integrated Coastal Zone Management, Invasive Alien Species and species protection issues. It now needs to be applied to the practical implementation of ecological networks (and almost certainly green infrastructure). Indeed, guidance already exists for the implementation of ecological networks through stakeholder participation (Jones-Walters *et al.* 2009) and in relation to local biodiversity action planning (Jones-Walters *et al.* 2010).

The greatest problem remains the ‘top down’ organisational paradigm. Participation is a daunting prospect for those who are used to making policy and then implementing it through legislation, regulation or the power that comes with owning land. They have difficulty in dealing with a range of people and organisations that may previously have been seen as the cause of the problem rather than the solution. However, where stakeholder participation may fail to convince, the principle and political rhetoric of ‘civil society’ may be more persuasive. Civil society is considered to be a necessary condition for ensuring lively, strong and participatory democracy. In addition to being a key to local involvement, participatory democracy also has to build collaboration among the institutions, professions and sectors that are capable of influencing the development of participation (Edwards, 2011).

There is clearly potential for biodiversity related initiatives such as ecological network implementation to provide a platform for civil society engagement and to build its capacity through applying a participative approach to the delivery of projects and programmes; particularly when such enterprises are associated with training in relevant skills (many of which are highly transferable). In this respect, it should also be noted that project funding is increasingly being tied to the development of capacity in civil society (particularly in Eastern and South Eastern Europe). All of which provides an opportunity for biodiversity policy-makers and practitioners; but which also sets up a challenge to which they must now respond.

3.4 Spatial planning and sectoral integration

There is significant scope to explore and further strengthen the integration of ecological networks and its related concepts into sectoral policy; for instance spatial planning and economic and infrastructure development. At the same time, the increasing and complimentary demand among economic actors and civil society for influence in shaping the spatial environment (referred to in 3.3 above) has led to greater stakeholder involvement in the decision-making processes.

The primary function of spatial planning is to guide and govern decisions about land use, such as the design and location of built and other development (as opposed to land management). As a spatial concept, maps presenting ecological networks are easily accommodated by spatial planners into their strategic documents. Perhaps the elaborated concept of green infrastructure, with its inclusion of ecosystem services and other aspects, will provide an added impetus to such an accommodation.

Modern spatial planning is now defined by stakeholder participation; and there is growing evidence that spatial planning and ecological network programmes in some European countries have come together to increasingly actively seek the involvement of a wide range of stakeholders (namely, municipalities, regional political authorities, developers, investors, environmental and other NGOs, public utilities, business, education, religious organisations and individual citizens).

Linking ecological networks to spatial planning at different geographical scales can therefore be seen as a key to effective delivery in the future. This is not only because of the obvious functional relationship between ecological networks and other forms of land use and infrastructure but also because delivering the concept through the vehicle of spatial planning is one of the main mechanisms for sectoral integration.

The link to 3.3 above in terms of skill sets, guidance and incentives is clear.

3.5 Costs, benefits and ecosystem services

The failure of society to place a value on nature has resulted in the degradation of ecosystems, a consequent reduction in ecosystem services and has contributed to a significant decline in biodiversity. The lack of comprehensive methodologies for providing economic valuation for biodiversity and ecosystem services, the results of which can be easily communicated to policy and decision-makers, has hampered efforts to protect, maintain and enhance habitats and species.

There has therefore been much recent activity around demonstrating the financial value of natural assets, biodiversity and the ecosystem services that they provide; evidenced, for example, by The Economics of Ecosystems and Biodiversity (TEEB) process and specifically their recommendations within the TEEB for policy-makers document (TEEB, 2011). Ecological networks and green veining provide a range of services. These include (for example) shelter and the reduction of erosion, pollination, adaptation to climate change, corridors for the movement of animals and to a lesser extent plants, recreational and cultural services.

It is certainly important to ensure that the full value of ecological networks is incorporated into policy appraisal and decision making mechanisms in order to increase the likelihood of the

sustainable use of natural resources and the protection of the natural environment. Such an approach could be applied to existing networks but also to the creation of new networks.

Spatial planning could provide a useful framework within which values and specific ecosystem services could be attributed to aspects of the ecological network (and to green infrastructure) as part of a further policy and decision-making layer of a map-based approach. There is presently no detailed guidance available on how this approach might be implemented.

3.6 Climate change

As is clear from the 2005 Millennium Ecosystem Assessment (MA, 2005), climate change is impacting more and more on biodiversity, both worldwide and in Europe. Scientific results into the possible impact on climate change increasingly provide evidence of considerable consequences for habitats and species. Species migrations, extinctions and changes in populations, range and seasonal and reproductive behaviour are among the responses that have been recorded, and these are likely to continue apace as climate continues to change in decades to come. Climate change is also poised to significantly alter the supply of European ecosystem services over the next century. While it may result in the enhancement of some ecosystem services, a large portion will be negatively affected through the impact of drought, reduced soil fertility, fire, and other climate change-driven factors.

From a biodiversity perspective in Europe, the climate change issue is highly relevant because (and particularly relevant to ecological networks):

- the range of some species will increase or decrease, and both aspects will have impacts on a variety of ecosystems;
- due to these range shifts some species will find themselves at the end of their ecological range (e.g. mountain summits), and they face extinction at national, European or sometimes even global levels; and
- some species that migrate or shift their range during and between the seasons are increasingly finding themselves restrained in their movement due to insurmountable barriers such as urban areas, major roads and other infrastructure and high intensity agricultural land.

For those that are now forced to move further due to climate change the removal or absence of animal and plant ‘highways’ becomes a major issue. Ecological networks will therefore play a significant role in providing adaptation to the impacts of climate change by allowing animals to migrate to areas where they can find favourable conditions. Where they do not exist it is highly desirable to increase the connectivity of habitats through the restoration and creation of new ecological networks. New habitat creation, such as the widespread planting of forests, hedgerows and shelterbelts, can act to sequester carbon and creates soils, substrate and vegetation with the potential to retain carbon.

Ecological networks can provide physical measures for combating the effects of extreme weather: for example, more shade for farm animals through flood relief and by providing a ‘natural sponge’ to hold water. With higher connectivity, the existing habitat is better able to fulfil an adaptation function. Green infrastructure in towns and cities can provide shade and many other functions as well as connecting wildlife areas and connecting people to wildlife. In addition, certain elements of ecological networks, in particular buffer zones, could provide important functions in terms of providing increased resilience and adaptive capacity for vulnerable protected areas and habitats. The vulnerability is a function of the character, magnitude, and the rate of climate variation to which the system is exposed, its sensitivity and its adaptive capacity (Natural England, 2011).

It is quite possible that the argument for maintaining, restoring and creating ecological networks in order to provide adaptation to climate change can be enhanced through linking it to green infrastructure (in the sense of 3.1 above).

3.7 Invasive Alien Species

Invasive alien species (IAS) are having an increased impact, not only for biodiversity where they can push out and displace native species, but for social and economic reasons as well. This is partly due to the effects of climate change and also due to human activity.

Alarmed by the lack of implementation of provision on introduction of alien species (and also about some misguided re-introductions), the Standing Committee to the Bern Convention decided in 1992 to create a specialised group of experts; originally called the “Group of Experts on the legal aspects on introduction and re-introduction of wildlife species” and now called the “Group of Experts on Invasive Alien Species”, it met for the first time in March 1993. The group collected and analysed different national laws dealing with invasive species and proposed work aimed at the harmonisation of national regulations on introduced species, particularly in the fields of definitions, territorial scope of regulation, listing of species whose introduction is undesirable, identification of authorities responsible for permits, conditions for issuing such permits and control involved. The group of experts meets every two years to check progress in implementation and propose new ideas (CoE, 2008).

During the early 2000’s the energy of the Group of Experts was largely devoted to the preparation and negotiation of a fundamental text to promote and guide European activities on Invasive Alien Species: the European Strategy on Invasive Alien Species. This strategy, which was prepared by Mr Piero Genovesi and Ms Clare Shine, was discussed at the 11th meeting of the Group, held in Horta (Azores, Portugal) in 2002 and was negotiated soon after the adoption, by the 6th Conference of the Parties of the Convention on Biological Diversity (decision VI/23 of April 2002) of *Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species*. The Strategy follows these guiding principles but goes further into the recommended actions. It promotes the development and implementation of co-ordinated measures and co-operative efforts throughout Europe to prevent or minimise adverse impacts of invasive alien species on Europe’s biodiversity, as well as their consequences for the economy and human health and well-being. The Group is currently working on the development of Guidelines on IAS in Protected Areas. The paper is not yet finalized, but will certainly be available in 2012.

There is a strong argument that resilient ecosystems are more resistant to IAS – thus the benefits of ecological networks referred to in 3.6 significant in relation to this issue. Equally ecological networks (particularly if they are poorly maintained or degraded) can provide vehicles for the movement of IAS. The issue here is to produce a balanced argument for maintaining landscape features, including ecological corridors, in good condition through effective and targeted management.

3.8 Wilderness

The arrival of wilderness as a policy issue, following the passing of a European Parliament resolution in 2009, has increased the profile of the issue and provided a challenge for policy makers and practitioners. There is a need for a policy-relevant definition that can guide decision making in relation to the protection and management of wilderness areas, including their exploitation for economic benefit, and for information and data about the extent of existing wilderness and wild areas and the opportunities for its recreation (Jones-Walters and Civic, 2010).

The links to ecological networks, not least because of the roles of large herbivores and carnivores in the wilderness issue, are clear. Planning for either ecological networks or wilderness should take in to consideration the needs of the other. The topicality of wilderness means that it is a potential opportunity to further the aims of the PEEN and regional and local ecological networks.

3.9 Emerging policy

The need to integrate the ecological network concept into the development of green infrastructure, which is emerging as a new and potentially influential policy instrument, has already been referred to in 3.1 above; similarly for spatial and other infrastructure planning. However, there is also a requirement for existing instruments (such as the EU Water Framework Directive) which offer the potential for strengthening ecological networks to be exploited to the full in their implementation. Furthermore the current review of, for example, the EU Common Agricultural Policy presents an opportunity for new measures to be introduced that will benefit connectivity in agricultural landscapes.

Again, the benefits of exploiting synergies with green infrastructure development are clear.

4. Conclusion and main points for discussion

The PEEN project was successful in reaching its goal to promote the idea of a pan-European vision of biodiversity conservation through a European ecological network (Jongman *et al*, 2011). Not only this, the translation of the PEEN principles into the development of national ecological networks has also made some progress. However, it is also clear that in the present economic situation countries are pursuing national priorities that are driven by social and economic factors, and that this is at the expense of the environment and international and cross boundary cooperation. European ecological corridors are not being developed and there is a clear issue around what institution or coordination mechanism should presently be responsible for driving this issue forwards.

Developing ecological connectivity is one of the recommendations of the CBD Conference of the Parties in Nagoya (Japan) in October 2010; and green infrastructure has emerged as a priority within the Communication from the European Commission (2011): *Our life insurance, our natural capital: an EU biodiversity strategy to 2020*. Perhaps a solution lies within the implementation of these instruments; however this means that the relationship between ecological networks and green infrastructure needs to be articulated; including in relation to implementation, socio-economic aspects and stakeholder participation. Linked to this, there is also a need to realise in practice the existing and recognized potential for spatial planning to act as a mechanism for cross sectoral integration, communication and delivery of ecological networks.

The contribution of ecological networks to the provision of ecosystem services and mitigation and adaptation in relation to the effects of climate change are important areas for research and subsequent articulation into policy. Climate and global change will affect the patterns of many ecological and other relationships in the landscape, potentially leading to a level of complexity that may prove intractable and difficult to resolve. Research on changing population patterns in relation to landscape permeability should be directed towards the provision of essential knowledge needed for the limitation and promotion of irreversible damage, adaptation and mitigation measures.

Codifying the economic benefits of ecological networks and making them explicit through interdisciplinary research and integrated long-term research on the social, economic and ecological mechanisms and maintain biodiversity and the ecological services it provides is also a clear necessity.

Further work can be carried out in relation to the full translation of the protected area networks into functional ecological networks, both at the level of policy and practice; in addition information about how to create actual ecological networks, particularly where this has involved stakeholder and public participation needs to be researched and made widely available. Knowledge transfer is needed as well as new knowledge especially in relation to the impact of changing environmental and land use conditions on species and habitats in the wider countryside.

Leadership has already been mentioned in the context of who has responsibility for ecological networks at European, regional, national and local levels. Linked to this is the issue of

communication; specifically to politicians and decision makers within key sectors (such as spatial planning, transport, industry, etc) but more widely to researchers, conservation practitioners and the interested public. Beyond this lies a requirement for active engagement with emerging policy agendas (which again requires a level of leadership and strategic direction).

Main points for discussion:

- It could be argued that green infrastructure is a natural evolution of the ecological networks concept. The relationship between ecological networks and green infrastructure (and the extent to which it builds on the concepts and legacy that it could inherit from the ecological networks approach) therefore needs to be clearly articulated - including in relation to implementation, socio-economic aspects and stakeholder participation.
- The argument for maintaining, restoring and creating ecological networks in order to provide adaptation to climate change can be enhanced through linking it to green infrastructure.
- The synergies with the development of the wilderness debate should also be explored.
- Following the development of the PEEN the elaboration of national level networks is a pressing need and a high priority in the route to implementation. There is a clear need to develop the potential of national-regional ecological networks through funded programmes and projects.
- There is potential for biodiversity related initiatives such as ecological network implementation to provide a platform for civil society engagement and to build its capacity through applying a participative approach to the delivery of projects and programmes; project funding is increasingly being tied to the development of capacity in civil society (particularly in Eastern and South Eastern Europe). All of which provides an opportunity for biodiversity policy-makers and practitioners; but which also sets up a challenge to which they must now respond.
- Linking ecological networks to spatial planning at different geographical scales can be seen as a key to effective delivery in the future and could provide a useful framework within which values and specific ecosystem services could be attributed to aspects of the ecological network. However, in spite of the logic of this approach there are presently no instruments or guidance to drive this integration/ approach.
- CBD Conference of the Parties in Nagoya (Japan) in October 2010; and green infrastructure has emerged as a priority within the Communication from the European Commission (2011). These frameworks could be exploited.
- The current review of, for example, the EU Common Agricultural Policy presents an opportunity for new measures to be introduced that will benefit connectivity in agricultural landscapes.
- Resilient ecosystems are more resistant to IAS – thus the benefits of healthy ecological networks are significant particularly when poorly maintained or degraded networks can provide vehicles for the movement of IAS.

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