Space for species: towards a cohesive Natura 2000 network

Biodiversity is considered as one of the most important natural resources, providing foods, medicines and fibers to people, as well as spiritual values and enjoyment. Biodiversity also controls and prevents outbreaks of pests in crops and timber plantations. By that, biodiversity represents an important, but difficult to quantify economic value. Last but not least, biodiversity is an important component of ecological resilience, the potential of ecological systems to recover from disturbance. Biodiversity is the machinery of ecosystem functioning.

In this light, the world wide concern about the decline of biodiversity is understandable. This decrease is mainly caused by the loss, fragmentation and deterioration of natural and semi-natural habitats due to human activities all around the world. The urgency of this process was recognized at the United Nations world conference in Rio de Janeiro in 1992, and implemented in the Convention of Biodiversity (CBD). The EU Head of States committed themselves to stop the decline of biodiversity by 2010. The main current EU-policy is the Natura 2000 network of protected areas, as part of the Habitat and Bird directives. Member states are currently involved in the designation of protected areas, based on the current distribution and occurrence of target species and habitat types. This portfolio of protected areas is an important first step towards a Europe-wide conservation network.

It is scientifically recognized that ecological networks can be an effective spatial strategy for conservation of biodiversity, in particular in a world which is predominantly used by humans, either for food or timber production, or for housing, drinking water production, infrastructure and industries. The network concept is supported by the metapopulation theory, which is a spin off of the island biogeography theory of MacArthur and Wilson. It is very appropriate to describe what happens in fragmented populations, which are restricted to and dependent on the small patches of (semi)-natural ecosystems, embedded in human used land. The theory predicts that the small local populations which are not viable by themselves can persist in a network of small populations. In such a network, called a metapopulation, the local populations support each other by exchange of individuals or seeds. As a result, local loss of populations can be replenished by immigrants who colonize deserted patches and settle new populations. If the rates of these two processes, local extinction and recolonization, are in balance, the species can be sustainable at the regional scale. The other condition for sustainability is that the network is large enough to prevent stochastic extinction of all local populations in one year. Hence, in ecological networks, the local risk of extinction is spread over the regional level: while the individual ecosystem patches can't offer sustainable conditions, the whole network might.

So far the theory, but what about the real world? In the Netherlands and in

Bittern (roerdomp)

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The Natura 2000 protected sites showing no or little coherency

Nature Policy Plan 2000 shows an ecological network which consist of the large ecological patches connected by robust ecological corridors

other regions where human land use is a dominant driver of spatial development, many populations of species can be found which show the characteristics of metapopulations. For example, the bittern, a large marsh heron, uses the fresh water marshes across the whole River Rhine delta as one single network. This means that all marshes in the Netherlands are interdependent as far as the future of this species is concerned. The heron occurs in pretty large local populations in the Oostvaardersplassen and in the large marshland complexes in the northwest of the Province of Overijssel and adjacent parts of Friesland. Such major cornerstones of the Dutch Delta landscape are always inhabited by bitterns. On the contrary, smaller and more remote marsh areas, for example in Brabant and Gelderland, are often unoccupied for a couple of years, and then might show new establishing local populations. For the much smaller sedge warbler, a song bird species of the same marsh habitat, similar processes were observed on a regional scale. The densities of the populations of this species vary a lot due to dry periods in the African wintering areas. During such dry weather spells, the number of breeding pairs of this species in the Dutch delta decreases considerably, even more so in regions with a high degree of habitat fragmentation. This shows that fragmentation causes populations to be more vulnerable to large scale variations in weather conditions, which is the case under the climate change weather regime. Similar patterns were observed all over the world at a variety of spatial scales for example for mammals, reptiles, amphibians, butterflies, locusts, and plants. These obser-vations, which are supported by experimental studies with simulated models of metapopulation systems, learn that biodiversity conservation on the long term requires a careful consideration of the spatial distribution of ecosystems across regions. The effectiveness of conservation networks therefore depends on the amount and spatial configuration of habitats. This brings ecology into the domains of spatial planning and design.

The European conservation strategy will only be effective if the portfolio of Natura 2000 protected sites will be an ecologically cohesive network. It will only be ecologically sustainable if the exchange of individuals between sites takes place at a high enough rate, compared to the rate of local extinctions. There are two arguments for this statement. First, many Natura 2000 areas are too small to ensure sustainability for all target species on their own. Secondly, even for species which find large enough areas in many Natura 2000 sites, a cohesive network is still of value. Climate change is predicted to shift suitable climate zones across geographic scales, and species will have to respond by expanding northward, while vanishing in the southern parts of their range. This can only happen if individuals are able to "jump" from site to site, and establish new populations in sites that became suitable due to warmer winters or hotter summers. Hence, appropriate connectivity is an essential feature of landscapes to allow populations to adapt to shifting climate zones. What is appropriate depends on the density of networks units, their size and quality, and it also depends on the rate of climate change. The faster the rise of temperature, the faster the response of species must be, and the better the cohesion of the network ecosystems.

Is this awareness commonly found among European policy makers? Not at all. The implementation of the Natura 2000 network so far is only focused at the designation of protected areas. There is no analysis, and hence no insight, as to whether the network will be able to function as a cohesive ecosystem network. Many countries still are unaware of this principle, and are even reluctant to take further steps into the implementation of the European nature network. Article 10 of the Habitat directive urges

countries to ensure sufficient cohesion by developing the landscape between the protected sites and making it sufficient permeable, by removing barriers, stimulating corridors zones and green veining of the agricultural landscape. This article is only recently brought into discussion at the EU-level.

How could the Natura 2000 portfolio become an ecologically coherent network? On the way to ecological sustainability, three crucial steps have to be taken:
- Define the problem: find out where in the European landscape the spatial cohesion needs to be improved, and explain why (defining the location of bottlenecks and their causes).
- Define the set of possible solutions. Solutions must be implemented in the regional context, which may be widely different among regions across Europe. There are many ways to improve the cohesion of the landscape (other than legal protection). So it is important to link the ecological effectiveness of potential solutions to the type of bottleneck. This leads to a set of potential strategies to develop spatial cohesion in the European Ecological Network.
- Implement spatial cohesion strategies into the spatial planning policy at the regional and local level. Design solutions that fit into the regional socio-economic context. Planning and design rules for ecological networks should be available for regional planning authorities and stakeholder groups.


Sedge warbler (rietzanger)

Planning ecological networks is a learning process with many actors at different levels of spatial scale. Fifteen years of scientific research in The Netherlands, with applications elsewhere in Europe, provided a broad expertise which can be of use to other countries (see literature list). For example, there is software to evaluate the sustainability of ecological networks for target species, which has been applied to screen the Dutch part of the Natura 2000 network. The input of these models varies for different parts of Europe, but the assessment software is applicable everywhere. Dutch design handbooks for ecological corridors and ecological networks can be adapted for application elsewhere in Europe. However, scientific knowledge developed in one country is not always simply transferable to other geographic regions: adaptations for different ecological conditions are necessary. Also, the application methods need to be improved in dialogue with the ever varying regional political and spatial context.

Making the Natura 2000 network ecologically cohesive requires the mobilization of all available knowledge on landscape ecology, spatial planning and organizing public support. It also requires that at the EU level the regional planning and design activities are coordinated. And it is urgent. The first impacts of climate change are already measurable in a changing distribution of species.

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