# An ecological network in the Alps – new space for nature

## Overview on changing nature conservation practices in the Alps

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## Abstract

Among all known causes for the decrease of biodiversity in Europe, the fragmentation of habitats and landscape caused by infrastructures and intensive land use can be identified as the most important factor. To prevent the so caused loss of biodiversity it is necessary to conserve or restore the connectivity between ecosystems. This demands a rethinking of the traditional nature protection policy. Nature protection cannot be confined only to protected areas anymore. On the contrary areas needed for functional ecological processes require consideration from the beginning in the planning and organisation of the landscape. This paper provides an overview on the current developments in the Alps.

**Keywords:** biodiversity, ecological connectivity, fragmentation, landscape planning

## 1 Ecological networks, a new approach for nature protection

### 1.1 Threats to species and landscapes

The destruction of natural habitats associated with the fragmentation of the living spaces of flora and fauna can be identified nowadays as one of the most important factors causing the decrease in the diversity of species in Europe and therefore also in the Alps (Berthoud 2004). These phenomena are triggered by a growing urbanisation, the increasing number of infrastructures (roads, rails, energy transport) and pollution (soil, water), and the excessive exploitation of natural resources. They are particularly pronounced in mountain regions because of the specific characteristics of these areas and call therefore for adapted actions.

After one century of protection of those natural areas considered as valuable from a scientific, aesthetic or cultural point of view, a century aiming at the conservation of endangered species (Plassmann 2002), it became clear that these protected "natural islands" can not sufficiently preserve biodiversity themselves. Habitat fragmentation, isolation and the loss of ecological continuity result in a diversity loss inside and outside the protected areas.

From the sixties onwards, nature protection policies have been oriented more and more towards the preservation of ecological values of landscapes and semi-natural habitats. In the following decades new theories and approaches of landscape ecology, conservation biology and ecosystem sciences (the theory of island biogeogra-

phy (Mac Arthur & Wilson 1967), metapopulation theory (Levins 1969), sources and sinks concept (Pulliam 1988), and the new paradigm of non-equilibrium (McDonnel 1997) have opened new perspectives concerning the most efficient manner to protect nature and biodiversity and are at the origin of the concept of ecological networks (Bonnin 2007).

## 1.2 The concept of "ecological networks"

The concept of ecological networks was basically formulated as a response to the habitat fragmentation process. Only large natural areas connected to each other offer optimal living conditions to species with landscape-scale habitat giving them the possibility to satisfy their needs: to move, to eat, to rest and to reproduce themselves. When the space available becomes too small or when the connections between habitat patches are interrupted, the internal function of the system is disturbed:

- Migrating animals may be unable to move to those areas where they would normally stay part of the year;
- Natural populations and communities may be unable to move across the landscape in response to changing environmental conditions, especially to climate change;
- Genetic exchanges between different local populations may be prevented;
- A patch of habitat in which a species has become locally extinct cannot easily be re-colonised by other local populations of the same species (Convention on Biodiversity 2005).

The concept of ecological networks described by Bennett (2004) allocates specific functions to different parts of the landscape according to their ecological value and their potential in natural resources. An ecological network is therefore composed of the following components: core areas, connection elements (corridors, stepping stones) and buffer zones embedded in a landscape matrix (figure 1).

Core areas are areas of great natural value representing the living spaces of flora and fauna. Their size depends on the individual needs in space of each species. In these areas the conservation of the environmental conditions adapted to the needs of the species has priority. In fact, these areas will often be areas protected by law such as biotopes, natural reserves, or national parks, even if this is not necessarily the case.

Connection element, i.e. physical elements of the landscape that ensure the ecological connectivity and coherence, link these core areas. . Corridors are functional connections between ecosystems or different habitats of a species, allowing its dispersion or migration. Stepping stones are small islands with characteristics similar to those of the habitats that offer shelter to the species and diminish the distances between the core areas. Connection elements can be for example hedges, river banks, green strips along the roads or rails or isolated structures like stone heaps or isolated trees.

The matrix is the dominant element of the landscape in which the other components of the ecological network lay. In an agrarian landscape for instance, the agrar-

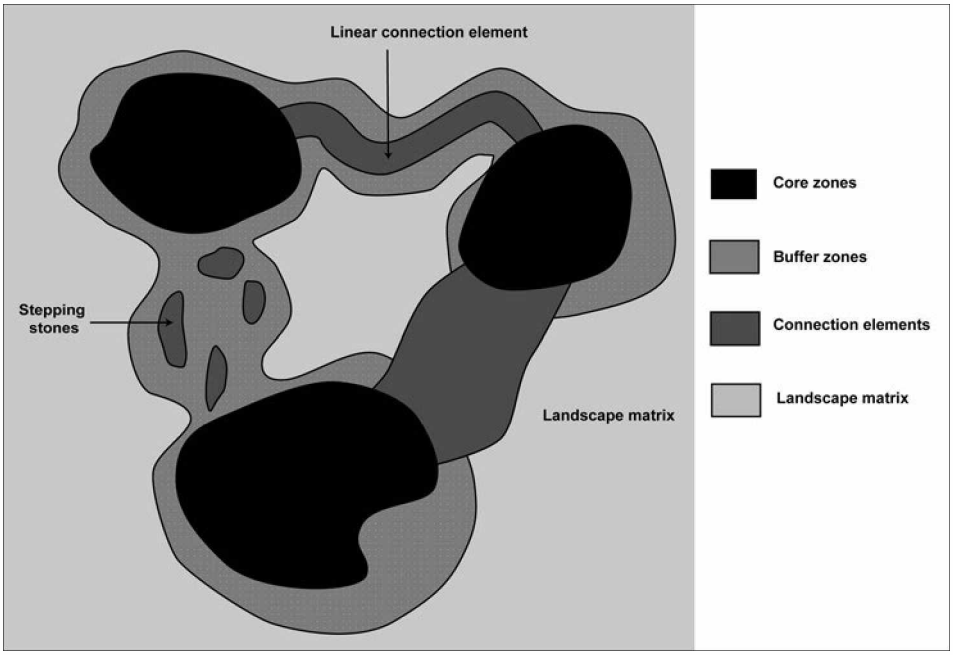


*Figure 1: Components of an ecological network (ALPARC 2004).*

ian matrix is the total of the parcel devoted to agriculture. The consideration of this matrix is important to avoid the recreation of an artificial isolation of this network dedicated to nature in relation to the neighbouring spaces, which would themselves be dominated by human activities. Nature protection measures have to adapt to the space as a whole and not only to some zones.

## 1.3 Ecological networks as complex functional systems

Concretely, ecological corridors are linear landscape elements that allow the dispersion of animal or vegetal species between two habitats inside a more or less hostile environment, i.e. the matrix: a hedge between two coppices, a river between two wetlands or even a pass between two valleys. These corridors play an important role for the biological exchanges between different populations. Nevertheless these corridors are not necessarily the same, depending on the species or species association that are considered: the structural elements used as corridors by large herbivores are not used in the same way by micro mammals or insects. Depending on their capacity of movement and the habitats characteristics (for example the degree of humidity for amphibians) the species use corridors of different characteristics. The same corridor can represent a habitat for certain species but an insurmountable barrier for others: a large river for example. A given geographic situation, therefore, has not necessarily the same value for each species; the concept of corridors has a more functional dimension than a structural one.

# 2 Mountain regions

The application of the ecological network concept is of particular importance in mountain areas. Compared to lowland areas, they are more intensively affected by the phenomena responsible for the decline of biodiversity.

## 2.1 Areas with very specific characteristics

Mountains are characterised by slopes. The organisation of the landscape is therefore very specific for wildlife as well as for people due to the opposition between valley and summits. Contrary to lowland regions where landscape planning meets only few important natural obstacles, the development of human activities in mountain areas has to concentrate in the valleys. The essential part of urbanisation, intensive agriculture, industry and the big transport infrastructures are concentrated in the valley bottoms, completely invading them sometimes. This can be observed in densely populated regions around the big metropolitan areas such as Grenoble in France (biggest metropolitan area in the Alps), but also in more isolated valleys sometime falsely considered as 'wilder', such as the Maurienne valley where all infrastructure (highway, rails, roads, a highly canalised river, electricity networks) as well as industries are concentrated in a small valley bottom. The higher regions are not always in a better position: the development of large tourism infrastructures is responsible for important landscape changes in these regions too (big complexes of buildings in ski areas, ski slopes, ski lifts and connections between different ski areas, access roads).

Beside these infrastructures intensive agriculture contribute to the standardisation of the landscape, making it comparable to the landscape of the large agrarian regions in the lowlands. These large undiversified cultures associated with the use of pesticides and fertilisers do not attract wildlife to these regions. In the Adige valley in north Italy for example, a region well-known for its intensive fruit production, some populations of red deer are completely cut off from some of their seasonal habitats.

## 2.2 Human activity, source of biodiversity

Nevertheless some human activities are on the contrary beneficial for biodiversity. Many landscapes are directly related to the traditional mountain agriculture that created semi-natural habitats of great biological value such as meadows or hedge row landscapes. Today's challenge is the maintainance of adapted human activities in high altitude while limiting or restricting certain activities in the valleys (urbanisation, intensification).

Beside the mentioned human influences, however, nature is responsible for the complex organisation of mountain: the altitudinal belts and local conditions (exposition, geology) engender diversified living conditions to which the different species are specifically adapted. Furthermore, natural barriers existing in large number in mountain areas (big water bodies, high mountains, glaciers) contribute to the

biological diversity (endemic species) that ecological networks will in any case modify or override.

Contrarily to species of high altitude those of the lower levels need even more possibilities to move in valleys and between different valley sides. Nowadays, of the 25 % protected area of the Alps (GIS of ALPARC 2007) the major part is located in altitude. The lower zones suffer therefore from lacking protection of habitats. Thus ecological networks are of particular importance to these zones.

Finally, in addition to all these factors climate change has to be taken into account to which mountain regions are particularly sensitive (Beniston 2005). In this context the ecological network earns its whole importance: it has to give the species the possibility to move more easily so that they can adapt themselves to the inevitable modifications of their habitat.

# 3 Planning ecological networks

## 3.1 A coherent landscape planning project

This new concept of nature protection requires application to urbanised and exploited areas, encompassing more than the areas originally reserved for nature. This approach will not stay without impacts onto the present practices of soil use and landscape planning.

The potential conflicts between ecological objectives (biological connectivity) and the aims of land use have to be taken into account when it comes to plan landscape development in mountain areas.

Today, different initiatives exist to create ecological networks within the Alpine arc, for example in Switzerland, Germany or France (ALPARC 2004). The application of the concept of ecological networks differs between these initiatives. The configuration of the networks depends on the social, political, geographic or biogeographic context.

One of the fundamental questions rising from the conception of ecological networks is the one of the most appropriate scale. There are initiatives at national level (ex. the Swiss National Ecological Network REN (Berthoud & Righetti 2004)), at regional (Region Rhône-Alpes or the Isère departement (Berthoud 2001)) or even more local level (for example in the Bavarian Alps (Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen 1999)). All these initiatives work at levels appropriate for their territory. This leads from a cartography at a 1:100,000 scale to actions planned at the level of single land parcels. It can be assumed that all planning levels have their importance if the appropriate objectives are associated to each working scale. The cartographic representation of an ecological network at regional level offers a global vision of the most important ecological connections in a defined area whereas the local planning will offer the possibility to define appropriated measures to concretely create the ecological network on the ground and to adapt the measures to the precise local conditions.

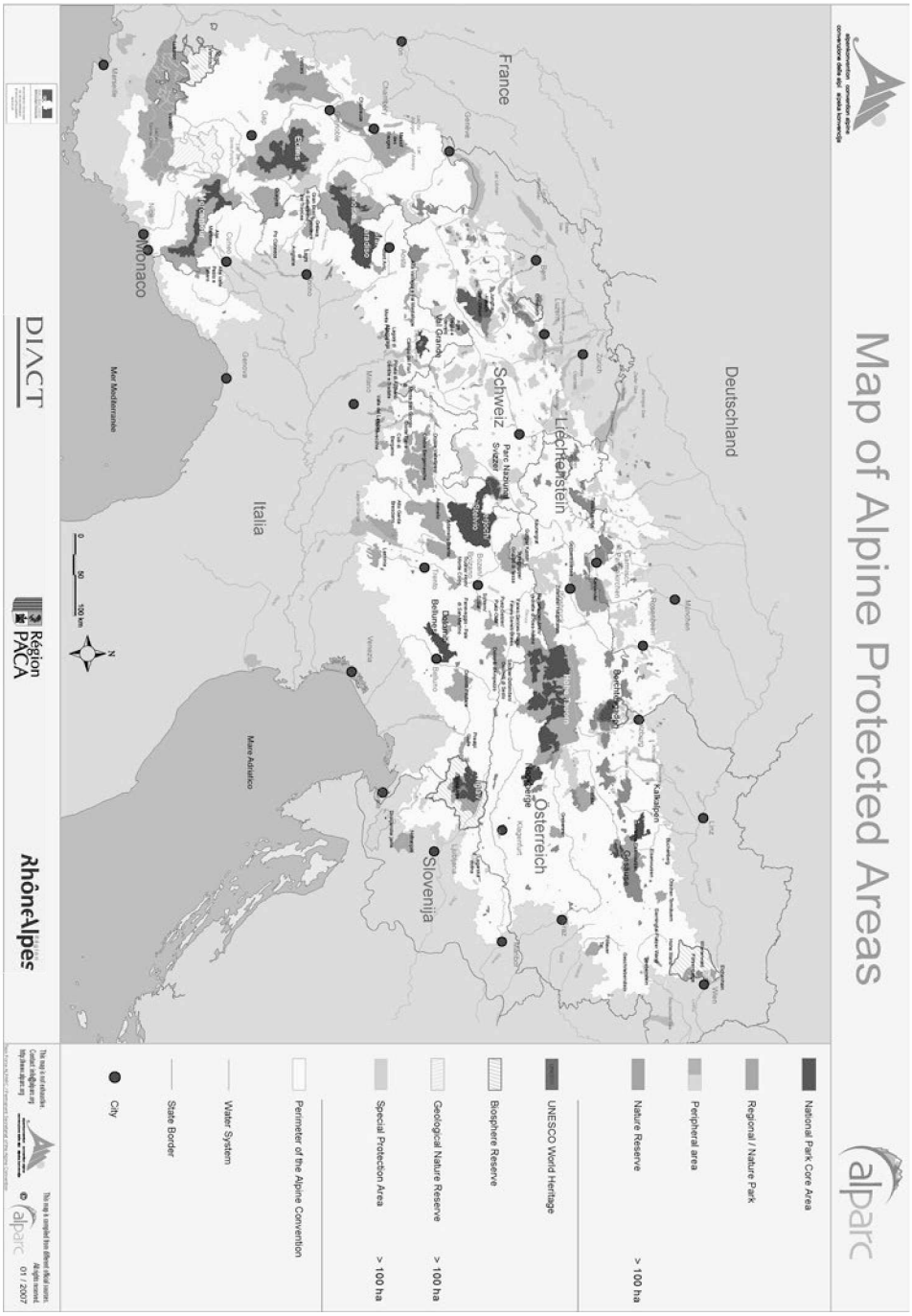


*Figure 2: Large protected areas in the Alps (GIS ALPARC 2007).*

In the French region Isère for example, the local administration is actively implementing a regional ecological network called *Réseau écologique du department de l'Isère – REDI* since 2001. They are currently leading different actions in the Grésivaudan valley such as the restoration or recreation of various wildlife corridors. An open participatory process and the early and strong involvement of different stakeholders (farmers, hunters, landscape planners, highway company…) have led to a very dynamic process with a strong local identification.

To apply the concept of ecological connectivity to a territory as a whole, the aspects of connectivity have to be systematically taken into account in all planning documents. This is the only way to represent the ecological functionality of a landscape in a coherent manner and to prevent from having to resort to measures of restoration of destroyed connectivity. Considering the connectivity aspects in the planning documents has to lead to a coherent planning scheme for a defined region, which in turn will allow the planning and implementation of coherent and complementary actions in all activity sectors (agriculture, urbanism, transport).

Based on such coherent schema these aspects could be considered as early as possible in all important development projects. Indeed, it cannot be forgotten that ecological networks do not only have positive effects for flora and fauna but also for humans, particularly in mountain areas (Alsace Region 2004). These are:

- Conservation of a diversified and interesting landscape with determining effects on local economy (tourism) and for the local population (preserving green spaces between settlements, preservation of the local identity);
- Water management (water quality and limitation of flood risks);
- Soil preservation (protection against erosion and landslides);
- Air purity (air decontamination, fixation of pollution by vegetation, temperature regulation);
- Agriculture, forests and hunting (protection of cultures and cattle, resistance of forests, refuges for game);
- Economy (valorisation of products, tourism and leisure); and
- Pedagogic and scientific interest;
- Natural hazard reduction (avalanches, floods, fires, invasive species…).

Nevertheless, projects improving ecological connectivity can also entail negative effects such as problems with invasive plants. As the effects of ecological networks are only measurable over large temporal scale, it is difficult to define quantitative objectives for ecological networks which are also difficult to evaluate, so far no project has been evaluated on its success (in ensuring connectivity and increasing biodiversity conservation). Therefore it is currently difficult to provide tangible scientific prove to support this concept, even if different local initiatives (for example in the frame of the Eco-Quality directive in Switzerland) have shown positive results (in the Intyamon valley or the Val-de-Ruz) (Lugon 2002).

## 3.2 Communication and participation

Every actor, public or private is responsible for the impact of his activity on the ecological network at the level of his territory. The communication aspect with relevant actors in the region (politicians, communities, farmers, nature protection societies) is therefore of great importance to the success of every ecological network project. In mountain areas this also means taking into consideration the specific actors of these regions (associations, institutions) to develop a joint project widely accepted, understood and supported.

In the region of the national park Kalkalpen in Austria the managers of the national parks Nördliche Kalkalpen and Eisenwurzen are working on a project to create a regional ecological network. This initiative aims at the early integration of the local stakeholders and public services in the project (mayors and politicians, land owners, tourism actors, NGOs) systematically trying to win their participation in and approval of the different steps of the project.

## 3.3 International cooperation

Protected areas are the principal instrument of biodiversity protection in Europe. In view of the described problematic, the protection objectives should be redefined to counter them or to adapt efficiently to the situation. Today it is recognised that the connectivity between the protected areas must be developed, e.g. by creating ecological networks or fighting against the fragmentation of habitats.

It is also in this aim that four Alpine-wide network organisations are aiming to create an ecological continuum across the entire Alps. To this end, ALPARC (Alpine Network of Protected Areas), CIPRA (International Commission for the Protection of the Alps), ISCAR (International Scientific Committee on Research in the Alps) and the WWF's European Alpine Programme lead a large-scale project. Initial activities of this project include compiling a catalogue of measures, selecting pilot regions for the exemplary implementation of those measures, and identifying all connections of relevance to an Alpine-wide ecological network. In the frame of this project first concrete ecological projects and initiatives should be started by 2009 all over the Alpine arc.

The creation of ecological networks is explicitly cited in numerous conventions, legislations and directives (Convention on biodiversity, Habitat and Bird directive, Alpine Convention, various national laws on nature protection such as in Switzerland or Germany). Considering the size of the home range of different species (the large carnivores for instance) and the great distances travelled by some migrating species, exceeding by far the surfaces of the large protected areas, the importance of creating ecological networks appears even more clearly. It becomes even more obvious that networks at this scale can only be developed through a tight cooperation between the different states. Besides, various border areas exist, which are important for wildlife and where cooperation is necessary, for example the French Italian border or the Julian Alps between Italy, Austria and Slovenia.

The principal mountain ranges of Europe are all located in border regions and extend over several countries, as it is the case for the Alps, the Pyrenees or also the Carpathians. To develop coherent projects of ecological network within the boundaries of these mountain regions but also between them, international cooperation is extremely important. Facing phenomena such as climatic change or the decline of biodiversity, the topic of ecological networks will be one of the great future challenges to rethink and reorganise the mountain areas.

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