Towards ecological connectivity in the Alps

The ECONNECT Project Synopsis

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Imprint

Editors: *Füreder Leopold, Kastlunger Claudia*

Authors: *Füreder Leopold, Abderhalden Angelika, Abderhalden Walter, Angelini Paolo, Badura Marianne, Bou-Vinals Andrea, Church Jon Marco, Haller Ruedi, Heinrichs Anne-Katrin, Kastlunger Claudia, Kreiner Daniel, Künzl Michaela, Lainer Ferdinand, Parodi Paolo, Plassmann Guido, Poscia Valerio, Randier Céline, Renner Kathrin, Sedy Katrin, Ullrich-Schneider Aurelia, Waldner Thomas, Walzer Chris, Weinländer Martin*

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Preface

The ECONNECT project, implemented to stimulate significant interest for the protection, improvement and development of ecological connectivity throughout the Alpine range, brought up some very clear results why ecological connectivity is not available in the Alpine region. ECONNECT was launched in order to promote model implementation of ecological networks in several pilot regions. With the support of tools and fundamentals provided by the Ecological Continuum Initiative, the pilot regions have been working to show how ecological connectivity can be improved in the specific case at the local level and beyond protected areas. ECONNECT also provided additional support in the form of pan-Alpine data bases and analyses of physical and legal barriers to the migration of animals and plants being effective both in the terrestrial as well as in the aquatic ecosystems, respectively. ECONNECT demonstrated in a very lively way at several workshops, conferences and other activities, how the exchange of knowledge is promoted, both among the actors and with other mountain regions.

While society appears to appreciate the value of protected areas (e.g. sanctuary, recreation) and generally accepts the importance of biodiversity and the associated ecosystem services, there is little understanding of the dynamic needs of our environment and occurring organisms. It appears prudent to raise awareness of the limitations of a static protected area approach to Alpine environmental protection in the face of rapid regime changes.

ECONNECT defined many activities and produced several important results for typical Alpine terrestrial and aquatic species both at Alpine-wide and regional/local level. Nevertheless, these efforts will need to be further deepened, in particular considering further activities at various spatial levels (within and beyond the Alps) and a deeper scientific knowledge about the relevance of connectivity for issues like ecosystem services, distribution of non-native species, pests and disease and climate change.

Biodiversity and ecosystem services provide important values to society and economy. Ecosystem services generate much economic value, although commonly the general population is not aware about this. Likewise, ecological connectivity represents an indispensable value for society and the economy, because it plays a central role in ecosystem functioning. When the connectivity between habitats is lost, these habitats gradually degrade and biodiversity levels within them (and associated ecosystem services) decline.

Hence, ecological connectivity is a determining factor for the survival, migration and adaptation potential of all plant and animal species present in a given habitat and – by extension – a determining factor for the preservation of ecosystem services.

1. INTRODUCTION

Füreder L., Heinrichs A.K., Ullrich-Schneider A., Waldner T., Walzer C.

Background and Rationale

Human impact on natural ecosystems is the primary reason of the current mass extinction of species (MILLENIUM ECOSYSTEM ASSESSMENT 2005) and one of the greatest concerns for biodiversity conservation. Through human activities in our today's landscapes the original and natural ecosystems have often been reduced to small, isolated patches. In Europe 78 % of natural areas are smaller than 1 km² (GASTON et al. 2008). As a consequence, habitats and distribution/ home ranges of many species have been extensively diminished, degraded, and fragmented, causing a serious threat for their survival. Along with the structural impairments, the functionality of these ecological systems is often seriously threatened (SALA et al. 2000). Since about 100 years protected areas are designated in order to conserve a representative sample of the natural and the cultural heritage of all countries. Now maintenance and restoration of some sort of "connectivity" among ecosystem elements and processes are regarded as the most obvious answer to counteract the negative impacts of fragmentation and of the relatively small sizes of remaining patches (CROOKS & SANJAYAN 2006).

Habitat degradation and fragmentation not only reduce the overall size of natural habitats but also lead to landscape “patchiness”, that is, the isolation of natural areas into distinct habitat “islands” that prevent essential ecological processes from taking place. The integrity and functioning of ecosystems, including the conservation of biodiversity and provision of ecosystem services, largely depend on the existence of an ecological continuum. Ideally, an ecological continuum without fragmentation in the landscape would consist of a rich variety of interconnected natural habitats hosting a rich variety of species.

Modern governments are challenged to manage increasing demands for a growing variety of land use activities. In parallel with the effort to install and manage protected areas, the need to conserve the connectivity of natural lands around and between the protected areas became evident.

In combination, the effects of climate change, human population density and growth, economic growth etc. can have severe effects on static protected (core) areas; especially if they lack ecological connectivity. Thus, an increasing need for measures compensating this lack of connectivity was obvious. The goal of such measures is an improved permeability and defragmentation of the entire territory via an active and adaptive management throughout all sectors (social, administrational and political). Isolated protected areas are vulnerable to multiple threats and are not always able to protect all of their biological values. So over the last years the consensus emerged that biodiversity conservation required large-scale interconnected natural landscapes with embedded and interconnected protected areas.

Why connectivity matters

- *Human society depends on a healthy natural environment: if the environment is not treated and managed with precaution, vital systems could fail!*
- *Migration and dispersal are vital for species, in particular for ensuring their adaption potential. Therefore areas need to be connected and kept free of barriers.*
- *In order to ensure the survival of populations in the case of habitat loss and fragmentation, connections are very important, because then the species can compensate by moving away. Otherwise local or total extinction is possible (this situation is even worse, if climate change is added to the scenario).*
- *The loss of ecological connectivity is equivalent with the reduction or loss of ecosystem services.*
- *The natural ability for resilience of ecosystems is impaired by connectivity loss, causing human disturbances to be more severe.*

Generally, there is a lack in the awareness of the importance of ecological connectivity and the benefits it brings for economy and society among decision makers, stakeholders and the public. While land-use planning traditionally has made an effort to balance a variety of land uses and distributing them across the landscape to avoid conflicts and minimize environmental impacts, the conservation of biological connectivity now must be added to land-use planning imperatives (WORBOYS et al. 2010).

The Alpine Arc is one of the most biodiversity-rich (Millennium Ecosystem Assessment – Mountain systems – document 293) and at the same time, in its permanent settlement areas, one of the most densely populated regions in Europe. In this human dominated landscape, the natural environment is subject to multiple pressures driven by economic activity, including transportation, tourism, agriculture and economic development and urbanization. All of these pressures ultimately result in habitat destruction and fragmentation so land-use-management outside protected areas is very important for conservation (POLASKY et al. 2005). The sole concentration on protected areas neglects the overall matrix in which these areas are enclosed and what happens outside often affects the inside considerably (DAFONSECA et al. 2005).

The PLATFORM ECOLOGICAL NETWORK of the Alpine Convention

The Alpine Convention is an international treaty according to international law concluded between Austria, Switzerland, Germany, France, Italy, Liechtenstein, Monaco, Slovenia, and the European Community. The Convention aims to ensure the holistic and sustainable development of the entire Alpine region. The area of application comprises some 190,000 square kilometers. 13.6 million people live in the Alps.

The PLATFORM ECOLOGICAL NETWORK …

- *Has been established by the Alpine Convention in 2007.*
- *Aims at creating an alpine cross-boundary spatial network of protected areas and connecting elements with the support of experts, policy makers and other relevant groups (see article 12 of the Nature Conservation Protocol of the Alpine Convention).*
- *Facilitates sharing, comparing and revising of crucial information on measures and methodologies between the different alpine countries and it provides an important link between policy makers, the scientific community and practitioners.*
- *Allows an efficient cooperation with other sectors.*

Holding and reducing habitat fragmentation in the Alpine Arc is essential for achieving effective biodiversity conservation, in compliance with a number of international and regional conventions and agreements, including *inter alia* the Alpine Convention, the Convention on Biological Diversity and the European Union Habitats Directive of which the NATURA 2000 network is a central pillar. It is also in line with targets set out in the new EU 2020 biodiversity strategy.

As biodiversity is threatened by changing land use, urbanisation, fragmentation and manmade barriers, ecological networks covering the whole Alpine mountain range are an important contribution to achieve those international commitments. The Alpine space, the land covered by the Alpine Arc, consists of several states and provinces with their different languages, grown and unique traditions and ways to look at problems. The result is a confusing amount of methods in conservation and related spatial aspects. Some Alpine wide networks considered it necessary to establish a coordinated transnational approach to harmonize all these methods (geographical data, common terminology). In 2002, major Alpine non-governmental organisations (i.e. ALPARC, CIPRA, ISCAR and the WWF European Alpine Programme) joined together and introduced a new approach on Alpine-wide conservation. In 2007, the Ecological Continuum Initiative, a follow up, made it possible to take these ideas a step further by using the features of all these organisations to lay the ground for creating or restoring the ecological connectivity between all areas that are important for Alpine-wide conservation. The Ecological Continuum Initiative has been financed by the Swiss MAVA Foundation for Nature and was the cornerstone of several follow-up projects - one of them is ECONNECT.

The CONCEPT of CONNECTIVITY

The concept of connectivity is based on biological science. Natural connectivity for species in the landscape has a structural component, which relates to the spatial arrangement of habitat or other elements in the landscape, and it has a functional (or behavioral) component, which relates the behavioral responses of individuals, species or ecological processes to the physical structure of the landscape (CROOKS & SANJAYAN 2006). WORBOYS (2010) recognized and refined four types of connectivity:

- *Landscape connectivity – is a human view of the connectedness of patterns of vegetation cover within a landscape.*
- *Habitat connectivity – is the connectedness between patches of habitats, which are suitable for a particular species.*
- *Ecological connectivity – is the connectedness of ecological processes across many scales and includes processes relating to trophic relationships, disturbance processes and hydro-ecological flows.*
- *Evolutionary process connectivity – identifies that natural evolutionary processes, including genetic differentiation and evolutionary diversification of populations, need suitable habitat on a large scale and connectivity to permit gene flow and range expansion – ultimately, evolutionary processes require the movement of species over long distances.*

The ECONNECT Project

The ECONNECT project was designed to improve the understanding of the concept of ecological connectivity and to enhance such connectivity across the Alpine range. The project pursued a holistic approach by involving administrative bodies, scientific institutions and a multitude of stakeholders across national borders. The project, which was carried out under the Alpine Space Programme of the EU, had a total budget of €3,198,240, of which the European Regional Development Fund (ERDF) contributed €2,285,120. The project ran from September 2008 to November 2011.

Sixteen partners from six Alpine countries collaborated in the project:

- AUSTRIA: University of Veterinary Medicine, Vienna – Research Institute of Wildlife Ecology (lead partner); Hohe Tauern National Park; Environment Agency Austria; Gesäuse National Park; University of Innsbruck – Institute of Ecology
- GERMANY: National Park Berchtesgaden
- FRANCE: CEMAGREF; Council of Departement of Isère
- ITALY: Alpi Marittime Natural Park; Autonomous Region Valle d'Aosta; European Academy of Bolzano (EURAC); Ministry for the Environment; WWF Italy
- LIECHTENSTEIN: CIPRA International
- SWITZERLAND: Swiss National Park
- INTERNATIONAL: The Task Force Protected Areas / Permanent Secretariat of the Alpine Convention coordinating ALPARC
- OBSERVERS: Federal Agency for Nature Conservation, BfN (DE), International Scientific Committee for Alpine Research ISCAR (CH); Nature Park Logarska Dolina (SLO), Biosfera Val Müstair (CH)

Chris Walzer, lead partner of the project

Paolo Angelini, Leopold Füreder, Guido Plassmann, Kathrin Renner, Katrin Sedy and Aurelia Ullrich-Schneider, work package leaders

Kristina Bauch, Anne Sophie Croyal, Luca Giraudo, Ruedi Haller, Anne Katrin Heinrichs, Daniel Kreiner, Michaela Künzl, Ferdinand Lainer, Cristiano Sedda, Pilot Regions

The ECONNECT Vision

ECONNECT envisions an enduringly restored and maintained ecological continuum, consisting of interconnected landscapes, across the Alpine Arc region, where biodiversity will be conserved for future generations and the resilience of ecological processes will be enhanced.

This assumes that:

1) Larger tracts of interconnected and permeable landscapes in undisturbed and human-dominated landscapes maintain more biodiversity than fragmented landscapes, which enables regeneration and renewal to occur after ecological disruption. Following disruption, smaller less diverse ecosystems may suddenly shift from desired to less desired states and their capacity to generate total economic value may decrease.

2) Functioning ecological processes are the foundation for the adequate provision of ecosystem services.

This implies that:

3) Active adaptive management and governance of resilience must not be limited to individual elements of an ecological network (corridors, core zones), but must necessarily be applied to the entire territory (matrix) and across all sectors of society, while enabling non-exclusive, multi-functional spaces for sustainable economic and recreational activities Alpine communities.

4) In the face of marked global anthropogenic change and applying the precautionary principle, policy makers are urged to initiate wide-reaching decision making processes and implement any needed policy changes on a legal /institutional level to sustain desired ecosystem states and transform degraded ecosystems into fundamentally new and more desirable configurations.

The ECONNECT Aims

The ECONNECT project aimed at the protection of biodiversity and the enhancement of ecological connectivity across the Alpine range through an integrated and multidisciplinary approach. Particular attention was given to biodiversity rich regions to establish and increase the links between them and even towards other neighbouring ecoregions like the Mediterranean or the Carpathians.

The project has involved international umbrella organizations linked to the Alpine Convention, scientific institutions and local implementation partners. All these entities have joined forces to demonstrate the need for connectivity across the Alps as well as to explore the best options for coordinated action and the development of innovative tools to promote ecological connectivity.

The ECONNECT work packages and their responsibilities are found in the Appendix.

2. THE PILOT REGION APPROACH

Haller R., Heinrichs A.K., Kreiner D., Lainer F., Plassmann G.

In the past, conservation efforts focused on maximizing biodiversity in protected areas (BRUDVIG et al. 2009) and these areas were chosen to include most of the territories' biodiversity, their natural and cultural heritage. Considering the resource needs of the worlds growing population, it is unlikely that enough land can be directly protected to facilitate the needs of all species and communities (MAWDLEY et al. 2009). Given that the number of threatened species is steadily rising and protecting land only represents a static approach, the concept of protected areas is insufficient. Within ECONNECT a Pilot Region Concept was defined as this kind of implementation was considered to be more dynamic and to include modern ideas of conservation connectivity. The integration of areas around and between protected areas which may comprise high biodiversity habitats and/or functioning connectivity elements is an essential tool to achieve ecological connectivity between Alpine landscapes.

The definition and selection of the ECONNECT Pilot Regions followed a step-by-step procedure, based on prior definitions of quality criteria in order to represent a significant variety of situations, natural conditions and ecological challenges of territories in the Alpine Arc. This proceeding intended to achieve the development and test of concrete implementation strategies and measures in order to improve ecological connectivity. The seven regions selected are quite different concerning their features and framework conditions, but all of them participated in a common methodological approach. Although common, it was intended to allow a sufficient flexibility to make ECONNECT more concrete on the ground and to launch a very detailed planning process with an intense involvement of stakeholders and landowners.

In ECONNECT, the term „Pilot region“ can mean three different things: (a) a spatial background for a territory which is relevant for the protected area within the Pilot Region (b) a region or side presenting a more or less functional ecosystem allowing ecological processes and (c) in general a region relevant for ecological connectivity of the Alpine Arc.

In almost all cases the protected area managing authorities, e.g. the National Park administrations, have been acting as the coordinating and moderating institutions within ECONNECT. This approach is based on the consideration that usually protected areas in the Pilot Regions have various distinguished links and interactions with the surrounding areas and relevant regional actors.

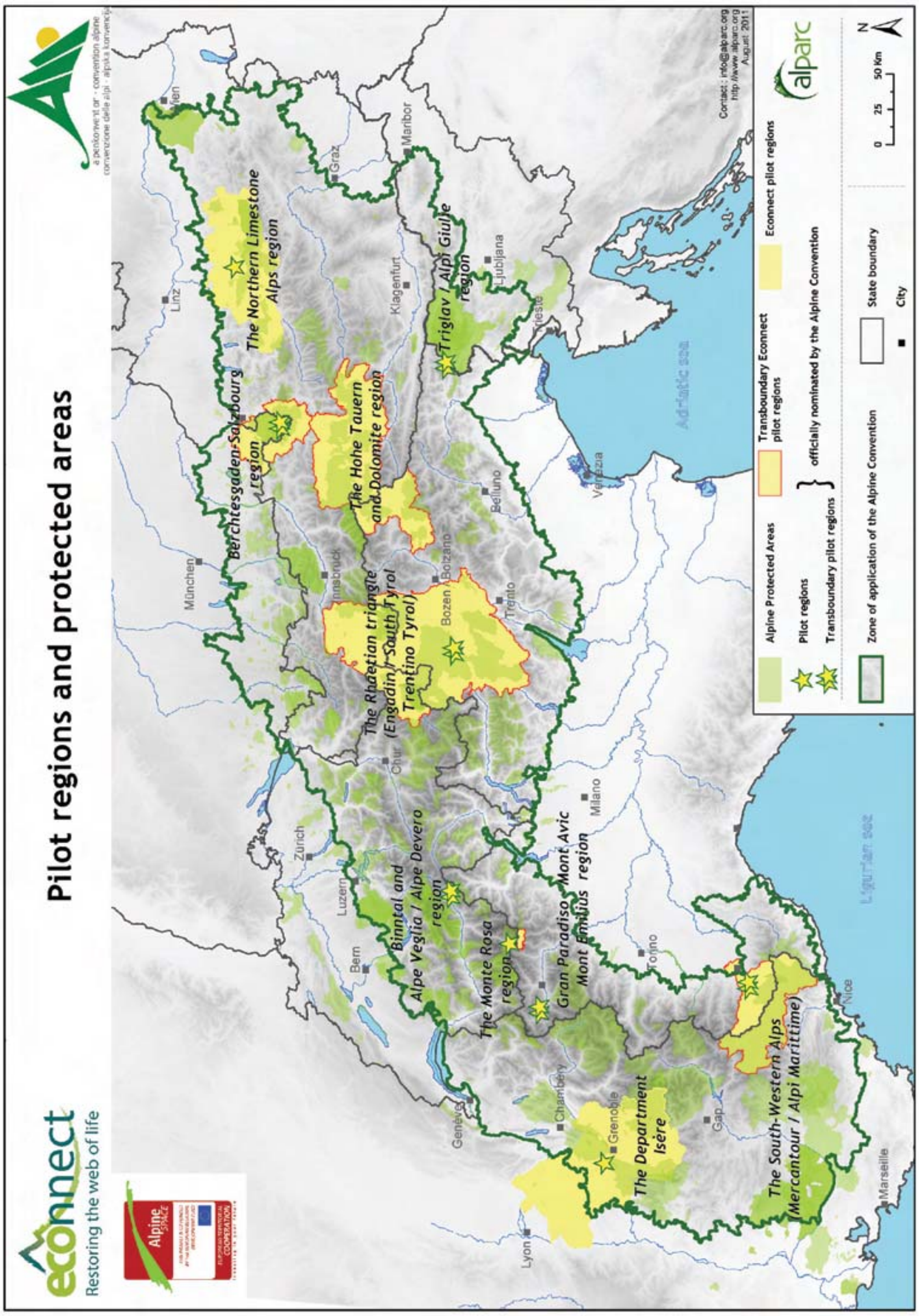
The Pilot Region Concept was shown to be a sound way to bring cooperation and coordination between private and public actors forward. Beyond supporting local implementations of individual conservation arrangements, a network was built where measures, management plans and projects between the cooperation partners were coordinated. As a holistic approach it pays attention to other policy sectors like spatial development, economic activities and infrastructure. Ecological connectivity doesn't stop at administrative borders, nor does it exist in protected areas only: the Pilot Region Concept takes this knowledge into account. Pilot regions allow the analysis of entire landscapes – the matrix of the territory as the research object by collaboratively using existing structures and data in these regions.

In order to define concrete implementation measures an extensive planning process has been realized, which includes detailed habitat mapping, landscape modelling and the identification of the landscapes' potential of connectivity, to link important habitats and to ensure migration possibilities for particular species. Moreover, an intense dialogue with stakeholders and/or landowners has been carried out. Generally speaking, the whole process of ECONNECT aims at the realisation of a continuum of habitats ("ecological continuum"), on the base of a permeable landscape matrix, and at reducing the fragmentation of the space, especially in those areas where a high degree of conflicts of use can be presumed.

As a result of the common planning process, concrete measures to enhance ecological connectivity have been chosen by every Pilot Region, thus showing that it is possible to improve ecological connectivity by targeted measures on the ground. At the same time the results of the planning process will be a key element for further physical planning of the territory making sure that spaces not yet fragmented and important for migration of species and special habitats will be conserved.

In the appendix is an overview of all the Pilot regions and the measures taken there.

Map 1 (next page) The Alps according to the Alpine Convention with the ECONNECT pilot regions, including protected areas. Protected area managers need an official legitimisation to intervene in areas outside their territory as facilitators and partners of a process, based on stakeholder involvement, leading to an alpine ecological continuum. *With courtesy of ALPARC, Guido Plassmann & Stéphane Morel (2011)*


Pilot regions and protected areas
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The Northern Limestone Alps region
Berchtesgaden-Salzburg region
The Hohe Tauern and Dolomite region
The Rhaetian triangle (Engadin / South Tyrol / Trentino Tyrol)
Triglav / Alpi Giulie region
Binntal and Alpe Veglia / Alpe Devero region
The Monte Rosa region
Gran Paradiso - Mont Avic Mont Emilius region
The Department Isère
The South-Western Alps (Mercantour / Alpi Marittime)
Adriatic sea
Ligurian sea
Alpine Protected Areas
Pilot regions
Transboundary pilot regions
officially nominated by the Alpine Convention
Transboundary Econnect pilot regions
Econnect pilot regions
Zone of application of the Alpine Convention
State boundary
City
alparc
0 25 50 Km
N

The Transboundary Area Berchtesgaden – Salzburg

The transboundary region Berchtesgaden-Salzburg comprises parts of the Free State of Bavaria (Germany) as well as the Federal State Salzburg (Austria). Based on the three large protected areas National Park Berchtesgaden, Biosphere Reserve Berchtesgadener Land, and Nature Park Weissbach, a close cross-border cooperation in the field of ecological connectivity is supported in the region.

The entire pilot region is characterized by a diverse mosaic of different habitat types. Next to pristine alpine habitats in their natural dynamics elements of traditional cultural landscapes can be found: natural forests, extensive grasslands and mountain pastures show a broad spectrum of rare animal and plant species. Human utilisation is concentrated in the valleys and in the northern part of the pilot region, which represents the connection to the Alpine foothills. Here urban areas, infrastructure elements, and intensive forms of land use lead to the disconnection of functional relations in the landscape.

The French Department Isère

The Departement Isère lies in the French region of the Rhône-Alps. The region is characterized by the outer Alps' densely populated valleys but also rich diversity of habitats from high mountains to alluvial forests. Especially in the valleys there is a need for action to avoid the development of a continuous settlement belt from Valence to Geneva. The valleys are important migration routes for the entire Alpine region, especially for migratory birds. Furthermore they play an important role for local migration of selected species in between the numerous mountains and the large protected areas in this region (National Park Les Ecrins, Natural Parks Vercors, Chartreuse, Bauges).

The Department Isère works on ecological networking since 1996. In 2001 a map of the ecological networks of the department was produced. Since then several activities have been carried out to improve the deplacements of the fauna inside the networks previously identified. The department is now launching a European project on a large scale (70km) to protect the connectivity between the three massifs: Chartreuse, Vercors and Belledonne, e.g. green bridges and tunnels, speed limits on important road sections, public relations, and consideration during the planning processes. It also aims to integrate its action into a wider alpine frame. Experiences gained in the department and outcomes achieved through previous projects have been shared with other pilot regions.

The Northern Limestone Alps


HOLLINGER Andreas © Nationalpark Gesäuse

The Pilot Region "Northern Limestone Alps" is shaped by its common history of the cultural area "Eisenwurzen" and its more than 800 years of utilization. It covers the north eastern part of the range from the Alpine Rhine to the Viennese basin. It touches three federal states as well as more than 25 protected areas with more than 200,000 ha. The region is characterised by vast areas with a low settlement density and a low degree of fragmentation, a large share of forest (>80 %), a densely structured cultural landscape and rich biodiversity (especially endemic species as it was a refuge in the ice ages). The region is also important as a connection with other alpine parts as well as with the neighbouring Carpathian Mountains. The most important natural habitat types in terms of ecosystem services are beech-fir-spruce forests and springs as drinking water supplies. During a first workshop in October 2006, a common initiative for building an ecological network was founded by the protected areas of the region. The three main partners Gesäuse National Park (Styria), Kalkalpen, National Park (Upper Austria) and Wilderness Dürrenstein (Lower Austria) took the lead and formed a consortium for connectivity in the pilot region. After three additional information events, interviews of approx. 150 stakeholders were carried out and led to the implementation of four working groups (forest, water, pastures and extensive grassland, communication). Their outcome was integrated in the interregional project idea "VEuER" (VErnetzen und ERleben). Projects for the white-backed woodpecker, the Ural owl and western capercaillie were initiated. Several publicity events were planned for 2012.

The Rhaetian Triangle (Engadin, South Tyrol, Trentino, Tyrol)

The pilot region "The Rhaetian Triangle", situated in the Austrian-Italian-Swiss borderland, represents a wide range of southern and central Alpine habitats, from dry meadows to small relics of primarily riverine systems, as well as a whole spectrum from lower based broad-leaved forest to higher located different coniferous forest types. Two areas are particularly important in this region: The first one extends from the Po-Plains along the Adige-valley over the central Alps to the Inn-Valley (Engadin in Switzerland and the upper Inn Valley in Austria). The highest point of the area is the Ortler with 3,905 meters above sea level. The lowest passage over the central Alps, the Reschenpass (1,504 meters above sea level), is also part of this Pilot Region and very important for connectivity. Here, migration paths from the east and south are present and mostly determined by geographic/topographic characteristics. Networks are of particular importance in the densely populated and intensively used Adige valley (fruit growing). The second important area is situated between the existing protected areas like the Swiss National Park and the National Park Stilfserjoch, the Biosphere Val Müstair, the Natural Park Kaunergrat, Adamello and Adamello Brenta as well as parts of the South Tyrolean Natural Parks. In this area a more administrative and legal aspect is envisioned, aimed at developing a connection between the existing protected areas. The first workshop with participants from all involved countries and from different affected sectors (agriculture, forestry, spatial planning, nature conservation, etc.) took place in October 2008. The ecological network shall be promoted by strong international cooperation and by the coordination of different sectors.

The “Hohe Tauern” Region

The “Hohe Tauern” region is the roof of Austria with its highest mountain, the Grossglockner (3,798 m above see level) and more than 300 peaks over 3,000 meters. Ten percent of its area is still covered by glaciers. The most important habitats in this Pilot region are layers of mountainous to Alpine vegetation from the valleys to the peaks. In this region the South Tyrolean Natural Parks (Rieserferner-Ahrn, Fanes-Sennes-Prags, Drei Zinnen, Puez-Geisler) in Italy as well as the National Park Hohe Tauern build the largest cohesive protected network area in the Alps. Therefore this region is central for the alpine arc and an important intersection between the northern Alps and the southeast foothills in Slovenia which are particularly important for large birds of prey. This area also represents the transition from the greater areas of the dolomites to the "Hohen Tauern".

The Southwestern Alps – Mercantour/Alpi Marittime

This Pilot region "Southwestern Alps – Mercantour/Alpi Marittime" is located at the southwest end of the alpine arc in the French region Provence-Alpes-Côte-d'Azur and the Italian region Liguria and Piedmont. The Natural Park Alpi-Marittime on the Italian side (created in 1995 spreading over the three valleys Gesso, Stura and Vermenagna) and the National Park Mercantour on the French side together form one geographical unit. They share a border for over 35 km and together they create a protected area of over 100,000 ha. Both regions are also close to each other culturally, so that one may refer to it as a single local unit. Therefore the transboundary cooperation in this region has a longstanding tradition and in the near future the area could become the first example of an European park according to the EGTC (see chapter 2.1). The area plays an important role as a connection to the other Italian mountain ranges (Apennines) and is world famous for its botanic wealth (2,600 species).

Pilot Region "Monte Rosa"

This pilot region is situated in the Italian-Swiss borderland, in the north-east of Valle d'Aosta. It corresponds to the Site of Community Importance and Special Protection Area "Ambienti glaciali del Gruppo del Monte Rosa". This site covers the entire Valle d'Aosta side of Monte Rosa with the heads of the valleys of Ayas and Gressoney and the areas of the ridge between the basins of Valtournenche, Breuil and Cime Bianche. The site hosts the priority habitat "Limestone pavements" and several biotopes of particular vegetation interest. The mean altitude level of the area is 3,350 meters above sea level with a minimum of 2,000 meters and a maximum of 4,531 meters above see level. The area is an important migration path for the populations of ibex between Switzerland, Piedmont and Valle d'Aosta and will be studied in order to maintain and improve ecological connectivity in the area.

The motivation and challenges in the Pilot regions are related to different aspects of the terrestrial, aquatic and aerial continuum of habitats and species. In the transboundary region of Berchtesgaden-Salzburg and in the Monte Rosa region, for example, the economic perspective of biodiversity, the contribution of connectivity to the region's touristic attractiveness and the impacts of tourism on connectivity, respectively, have been reviewed. This topic automatically guarantees the involvement and interaction with a wide range of stakeholders.

In other Pilot regions, like the Eastern part of the Northern Limestone Alps, trends like depopulation, land abandonment and reforestation are important facts for the present and future status of connectivity. At present, intensification of tourism, forestry and farming or hydroelectric power plants are the main reasons for biodiversity loss, causing fragmentation and isolation.

High mountain ranges, like the "Hohe Tauern" and Dolomite region, need a strong interaction with their surrounding territories in order to enable species migration and habitat development, also in view of climate change impacts. Another problem in the Alps is the densely populated valleys, like in the French Department Isère, which prevent species from migration. Both in the French Department Isère as well as in the Rhaetian Triangle, which serves as main migration area for European brown bear or lynx, one of the main challenges was the integration of connectivity issues in the land use planning at regional and local level. Moreover, it has been very important to raise awareness for the problems of terrestrial, aerial and aquatic connectivity on a local and regional level by using also the transboundary and transnational work and vision of ECONNECT.

ECONNECT Implementation Recommendations for Pilot Regions

Künzl M., Badura M., Heinrichs A.K., Plassmann G., Haller R., Walzer C.

Protected areas are a key element of ecological networks due to their spatial role in the network and their potentially catalytic function for the initiation and support of the process to maintain and restore ecological connectivity. Protected area administrations not only have valuable interdisciplinary competences and know-how regarding several aspects which are essential for the process, like communication skills and specific ecological knowledge of the region. Moreover, according to several international and European agreements and guidelines, they are obliged to ensure the spatial and functional integration of the protected area(s) into its surroundings (e.g. Natura 2000). Protected area administrations have successfully taken on the role of co-ordinators in the process of analysing and improving ecological connectivity at the level of the pilot regions serving as a model for the implementation process on the ground. Their particular needs, competences and leadership functions have been previously described in the 'Policy Recommendations' of the ECONNECT project (FÜREDER et al. 2011).

The expanse of protected areas is generally too limited to allow for fully functional ecosystems at a scale large enough to conserve biodiversity. Alpine parks and nature reserves alone are too small to protect Alpine biodiversity, especially in times of climate change where increased migration of fauna and flora is essential for the survival of whole groups of species. Migration needs horizontally and vertically interconnected habitats with as little fragmentation as possible (FÜREDER et al. 2011). It must be assumed that patches of undisturbed habitats should be as large as possible in order to attain ecosystem functions that are more resilient in the face of anthropogenic threats, e.g. pollution, invasive species, extractive and unsustainable uses, etc. To respond to these threats protected areas have to be actively managed and cross-sectoral landscape-level approaches are needed.

During implementation of the ECONNECT project, seven pilot regions under the leadership of protected area administrations applied a common methodology to elaborate and realize various concrete measures and to establish spatial linkages in order to improve ecological connectivity in their region (a list of measures is provided in the Appendix). The experiences and lessons learnt from this process were summarized in the Implementation Recommendations of ECONNECT (KÜNZL et al. 2011).

The Implementation Recommendations aim at supporting protected area administrations and experts working towards nature conservation at a regional level (Table 1).

Table 1 The ECONNECT Implementation Recommendations addressed (KÜNZL et al. 2011):

Title	Problem / Question	Approach
1) The Pilot Region Approach – a successful governance model and 'future lab' for enhanced ecological connectivity in the Alps.	Ecological connectivity needs comprehensive concepts and practical implementation activities. Necessarily, these must be co-ordinated in order to achieve tangible results.	Protected area administrations are starting points for the development of successful governance models of connectivity at regional level due to their interdisciplinary competences and know-how.
2) Pilot regions contribute towards maintaining and improving priority areas for connectivity in the Alps.	Priority areas for ecological connectivity require both conservation and preventive measures to maintain or improve their value.	The JECAMI tool enables the pilot regions to identify their role and the potential for connectivity in the Alps and at a regional level.
3) It is essential to develop a suitable mix of analysis methods to define and implement ecological connectivity in the pilot regions.	The basis of ecological connectivity requires the analysis of landscape elements (structural) and species needs (functional) in order to develop comprehensive results.	ECONNECT identified the landscape approach as basis for ecological connectivity. Species serve as indicators for landscape functions and support detailed analysis steps as well as the evaluation of measures at local level. Additionally, they are valuable for communication purposes.
4) Connectivity measures must be based on a common regional focus.	In pilot regions specific regional conditions, local knowledge, needs and constraints must be considered and integrated to achieve a maximum impact for ecological connectivity.	Embedded in an Alps wide context and common methodological approach, all actors at pilot region level contribute to get a clear picture on the existing framework conditions for connectivity in order to find adequate solutions for its specific regional context.
5) Cross-sectoral cooperation is a pre-condition for maximizing ecological connectivity and nature conservation in the Alps.	Impacts on biodiversity and connectivity are manifold, often resulting from activities of spatial relevance of different economic sectors. This calls for interaction and co-operation with the respective impact sources.	Pro-active efforts to analyze and counteract risks for biodiversity and connectivity must be tackled by joining forces with other relevant sectors – the instruments are territorial and include in particular spatial planning.
6) Pilot regions should communicate their knowledge on legal frameworks conditions and constraints in order to facilitate efficient progress towards ecological connectivity.	Existing legal instruments may be useful to achieve connectivity goals.	The existing national rules and regulations concerning connectivity need to be carefully analysed. Their potential for enhancing connectivity must be discussed and proposals have to be made as to necessary improvements and modifications.

Note: Implementation recommendations are not prioritized.

3. CONNECTIVITY CONSERVATION – HINDERED BY A VARIETY OF BARRIERS

Kastlunger C., Füreder L.

Connectivity conservation plays an important role in biodiversity conservation but the underlying science of connectivity ecology has only recently come into its own (CHESTER & HILTY 2010). Ecological connectivity can be defined as the extent (spatial and temporal) to which a species or population can move among landscape elements in a mosaic of habitats (HILTY et al. 2006). Not only the landscape itself may feature obstacles and barriers hindering the distribution and migration of organisms, also various other barriers may interfere with the implementation of connectivity. ECONNECT identified potential barriers becoming effective in different phases of implementation and at various levels.

In this respect, a barrier may be anything, either natural or manmade, that keeps something from passing through or preventing a process moving on. According to the Oxford Dictionary it means for example,

- a fence or other obstacle that prevents movement or access
- a circumstance or obstacle that keeps people or things apart or prevents communication or progress.

ECONNECT had a closer look on legal, social, data and ecological barriers in the Alpine space because all these barriers hinder connectivity and therefore conservation.

Ecosystems, but also protected areas, often cross political and jurisdictional boundaries. So in many cases a protected area is a patchwork quilt of federal, state, corporate, municipal, private and other types of land (CORTNER et al. 1998). A significant challenge is to design institutions and cooperative approaches to cut through these legal barriers (CORTNER et al. 1998).

BROOK et al. (2003) had a look on landowners' responses to conservation activities on their land. They found out that many landowners considered surveying of species on their land as a great risk, because they feared rules and regulations on how they are allowed to use their holdings in the future. Many of them did not trust the government or conservation organizations. So for successful nature protection it is important to solve fears like that, to break down social barriers for example by advancing communication between all the sides. In European planning processes public participation has existed for a very long time (PATEL et al. 2007) so it seemed obvious to involve stakeholders into the process of the ECONNECT project. Conservation planning can never be treated like an isolated vacuum, it is only possible if economic and political factors are considered (POLASKY et al. 2005).

Ecological barriers separate suitable habitats as they are not acceptable as living space, so they hinder the spread of a species for example through climatic (temperature) or physical (fence) hindrance (ALLABY 1999). Barriers also lead to fragmentation of habitats (BHATTACHARYA et al. 2003) and populations can get isolated because barriers cut trough their habitat (BANARESCU 1990). In order to gain specific knowledge about existing barriers in the Alps, the habitats for several target species were assessed by literature review and experts knowledge. This information served as a basis for the subsequent modelling procedure.

Legal Barriers

Angelini P., Church, J.M., Parodi P., Poscia V., Randier C.

A supporting legal framework is an essential prerequisite for the establishment of an ecological continuum throughout the Alps. The Alps consist of eight different countries, each of which has its own legal framework. Moreover, the individual countries may have federal states or provinces with specific regulations. In the framework of ECONNECT a working group provided an overview of the different legislations in force at various governance levels that potentially affect ecological connectivity. ECONNECT analyzed the impediments for the establishment of functioning ecological networks among protected alpine areas in order to preserve biodiversity for the region.

The National Assessments

The legal situation with regard to protected areas was assessed in Austria, France, Germany, Italy, Slovenia and Switzerland and published in a series of six national assessments. The survey of the legal provisions was carried out by EURAC under the coordination of the Italian Ministry for the Environment, whilst CIPRA France produced the study on French protected areas. The survey was aimed at the "identification of the legal situation of Alpine protected areas". A first step was to take into account the different overall organization of the Alpine member states. Then the studies examined the national legislative framework concerning nature protection and spatial planning and after that the existing legislation at national and regional level. Existing experiences in trans-boundary cooperation were integrated into the national assessment, as well as the introduction of the European Grouping on Territorial Cooperation in each state.

The Comparative Outlook

The transboundary character of the legal situation for ecological networks was further assessed by four comparative outlooks which were produced by the Italian Ministry for the Environment and the EURAC with the aim of generating a "comparison of the legal situations of protected areas". The four comparative outlooks were produced for the neighbouring states Italy/France, Switzerland/Italy, Austria/Germany and Italy/Austria. The studies examined the legal situation of protected areas in each couple of adjacent Alpine states with the overall goal of identifying the obstacles to ecological connectivity and the best tools to establish and/or maintain ecological corridors and networks. Additionally further comparisons between Italy, Switzerland and France were made possible due to contributions of the Region Val d'Aosta and the Alpi Marittime Natural Park. Furthermore the global dimension was taken into account consulting the United Nations Environmental Program and the Food and Agriculture Organization of the United Nations.

The European Grouping of Territorial Cooperation

In neighbouring protected areas of adjacent Alpine member states some areas enjoy national park status, whereas others may be nature parks, Natura 2000 sites or protected landscapes and therewith the legal status and the legal provisions can differ widely. In order to provide a legal tool for overcoming such legal obstacles the option of adopting the European Grouping of Territorial Cooperation (EGTC) was analyzed for its feasibility and was assessed in relation to actual cases. In the cases of the parks of Alpi Marittime, Mercantour, Berchtesgaden, Monte Rosa, Hohe Tauern and the Rhaetian Triangle the opportunity to implement the EGTC or other legal tools in each of these regions was evaluated. These cases analysis together with the analysis of the EGTC itself and the EGTC model are complementary to the above mentioned comparative outlooks at national scale.

The EGTC was designed as a legal tool on a European scale to facilitate and enhance cooperation at interregional and international level that reach across borders. A very new feature of the tool is that it can assume legally binding character, which enables regional and local authorities and other public bodies from different member states to join together in a cooperation grouping obtaining legal personality. The partners of the cooperation grouping can be the member states themselves, regional or local authorities, associations or any other public body. These public authorities from different member states can team up and deliver joint services after getting the agreement of participation from their respective countries, and do not require the prior signing of an international agreement and ratification by national parliament. The participants in a EGTC first agree on the location of the official EGTC headquarters, which determines the applicable law for the interpretation and application for the whole agreement. Furthermore the convention of the EGTC specifies the list of members, a definite area of actions, a concrete list of objectives, the time of duration for the actions and a common mission statement[1].

The analysis of the EGTC conducted by ANGELINI & CHURCH (2009) briefly summarizes the strengths, weaknesses, opportunities and trends present in this legal tool. The document states that the most important points of strength of the tool. First of all its broad thematic applicability and the enhanced legal status the EGTC entices providing a legal framework on trans-border cooperation. Moreover it allows a broader participation that would not otherwise be possible. In this sense the EGTC provides the institutional framework of certain activities which have been initiated within INTERREG programmes. The main weakness are considered in the analysis, are the restrictions imposed by the tool itself under the regulation of Article 7, namely that the EGTC can only be initiated if at least two EU member states participate and that the participating institutions/ organizations have to agree on their respective state organ.

1 http://ec.europa.eu/regional_policy/information/legislation/index_en.cfm

ANGELINI & CHURCH (2009) see the opportunities of the EGTC tool in the possibility of representing a transnational platform and the possibility for the tool of satisfying the need for transboundary cooperation which biodiversity preservation requires.

ARTICLE 7 of the EGTC (European Grouping of the Territorial Cooperation)

- *The EGTC may be given the ability to act on behalf of its members*
- *In any case, it shall act within the confines of the tasks given. It is not authorised to exercise powers conferred by public law to safeguard general interests of the State: police, regulatory powers, justice, foreign policy*
- *Its action is limited to cooperation in the cohesion field*
- *One member may be empowered to execute the EGTC's tasks*

Awareness and Legal Tools

In the framework of the ECONNECT project the work towards awareness was addressed by workshops that were opened to lawyers, policy makers, managers of protected areas and other relevant stakeholders. The first transnational workshop in Domodossola (Italy) was organized on April the 27th 2009. The title of the workshop was "The legal framework of protected areas in each Alpine State" and aimed at identifying the legal situation of protected areas in the Alpine states, with an emphasis on trans-boundary issues such as Natura 2000 and the creation of an Alpine ecological network.

On May, the 6th of 2010 CIPRA France organized a second workshop with the title "Legal barriers and possibilities for the implementation of ecological corridors in the Alps" in Grenoble (France). During the workshop some surveys on natural areas represented important inputs. Moreover legal instruments that help ecological connectivity and experiences from similar programs like the DIVA Corridors Programme were also presented. Around forty specialists assessed the capacity of currently available legal tools to cope with the new challenges of ecological connectivity in the Alps[2].

On September, the 9th of 2010 the final conference on legal barriers took place in Aosta (Italy). The conference was organized by the Italian Ministry for the Environment and the Val d'Aosta region with technical support from EURAC. The first conference on "Ecological connectivity and mountain agriculture: existing instruments and a vision for the future" and the results of the *Legal Barriers Work Package*, were presented to a broad public. Furthermore the comparative outlooks, an EGTC model and a study produced by the Val d'Aosta region about the power of regions with a strong focus on the Italo-Swiss scenario were presented.

[2] Workshop proceedings and a synthesis for decision-makers can be found on: http://www.econnectproject.eu/cms/?q=download_area/en#Seminaronlegalbarriers-May2010

MAJOR CONCLUSIONS on LEGAL BARRIERS

- *The frameworks for nature protection of the different countries reflect their different traditions and administrational competencies. Federal States such as Austria, Germany and Switzerland with their regional competences (Länder and Kantone) have a different approach than unity states like France, Italy and Slovenia.*
- *The European Grouping of Territorial Cooperation presents an important opportunity for transboundary cooperation. Specifically for the cooperation between protected areas in different states, with the possibility of an institutionalization.*
- *The park managers need political support and official legitimisation to participate actively and as an initiator organisation within the process of interconnecting the protected alpine areas and for actions outside protected borders.*
- *Ecological connectivity must be the central focus of a holistic spatial planning approach. The planning process must be integrated across all sectors such as agriculture, tourism, industry, transport and environmental conservation. Ecological connectivity must be included in the spatial planning instruments of the local, regional and national management and governance authorities.*
- *Landscape protection in the sense of preserving ecological connectivity is an important instrument for the fulfilment of international commitments like the Habitats Directive, the Birds Directive and also the Convention on Biodiversity*
- *Awareness of the connectivity topic in the society is low. Valorisation systems for ecological connectivity should be developed/adopted to visualize its importance and to give policy marks communicable tools*

From left to right: *Santa Tutino*, Autonomous Region of Valle d'Aosta, Head of Services in Protected Areas; *Giuseppe Isabellon*, Agriculture and Natural Resources Councillor of the Autonomous Region of Valle d'Aosta; *Augusto Rollandin*, President of the Autonomous Region of Valle d'Aosta; *Paolo Angelini*, Italian Ministry for the Environment, Italian National Focal Point for the Alpine Convention.

Social Barriers – Get To Know Your Stakeholders!

Haller R., Heinrichs A.K., Kreiner D., Lainer F., Ullrich-Schneider A.

How to Involve People

Participative approaches have proven to be a useful tool for overcoming the increasingly complex task of organizing a multilevel-process like establishing an ecological network. In such a participative approach the preparation phase is very important. Clarification of following topics is part of this phase: (a) ensure the essential resources (time, money, logistics), (b) clarify the goals, (c) analyze the situation and check for available instruments and (d) gain awareness about boundaries, existing barriers and conflicts between people. This approach gains advantage from strong guidance, effective leadership and dynamic project planning and management. Locally adapted solutions have shown to be more adequate. Furthermore a good information management is important: be sure to have enough background knowledge when meeting stakeholders, integrate local knowledge and expertise and provide a sound ecological planning. Key-stakeholders that are influential and trustworthy should be engaged from an early stage on. To facilitate the communication visualization

LIST to SUCCESS –Workshop "Sharing knowledge for the implementation of an ecological continuum within and beyond the Alps", Grenoble, November 4th – 6th 2009 (ULLRICH 2009)

- *Every participant must know why he/she is involved (validation, information etc.)*
- *Arrange creative campaigns to involve people and increase motivation (e.g. photo competition)*
- *Bring people together with the same motivation and mobilization towards the problem*
- *Have a very competent and qualified person leading the process as a „neutral project manager"*
- *Have „same words in your head"*
- *Composition of groups balanced according to comfort/culture*
- *Carry out (time) efficient processes: precise questions, quick feedback*
- *Be attentive, listen – visible from your response (e.g. what he/she said is in your map)*
- *Arrange field trips to see situations in situ directly*
- *Define clear goals!*
- *Define and agree on „the rules of the game" so that everybody knows them*
- *Have the time for the project*
- *Relations of the persons present in the room*
- *Find time for 1-1/face-to-face communication – don't rely on group participation only*
- *Find easy reachable locations*
- *Powerful friends*
- *Have a neutral, happy mediator/facilitator, somebody who is not identified with anybody*
- *Involve stakeholders with positive experience of other projects*

tools, maps, good stories, flagship species, field trips or logos have shown to be useful. Best communication is creative, professional and flexible. A so called "List to Success" was put together which gives an overview of important questions/topics regarding stakeholder involvement.

Actions Need Actors

In ECONNECT all pilot regions made a harmonized and major effort to involve relevant stakeholders (including nature conservation authorities, forest, water and agriculture administrations, road office, NGOs, spatial planners, landowners, farmers, fishermen and hunters associations, churches, etc.) from the very beginning. The objective was to build up long lasting partnerships and to boost win-win-situations between the partners.

To achieve this, different approaches were used in the different pilot regions: (a) active involvement of stakeholders by information events and meetings and by carrying out an ongoing formalized dialogue (e.g. by a Steering Group at regional level), (b) standardized interviews with stakeholders and active integration in the common development of implementation measures and future activities and projects (e.g. by workshops) and (c) taking over the role of a coordinating and moderating body in the region, with the objective of enhancing ecological connectivity at all administrative levels, including the municipal level.

Stakeholder meeting in the Nationalpark Gesäuse, Pilot region Northern Limestone Alps

The following four case-studies of stakeholder involvement are exemplary for the Pilot regions (some more are presented on the following pages):

Pilot Region “Rhaetian Triangle”

The example of the Rombach riverine system shows that ecological connectivity needs international collaboration and the involvement and engagement of local stakeholders. While in Switzerland a lot has been done to restore the ecological value of the river the Italian neighbours plan to canalize the water for hydropower use. This could interrupt the connectivity of the riverine system and truncate the upper basin from the lower part toward the Etsch valley.

Fortunately, a local environmental conservation group expressed its opposition against the plan to tube the Rombach in Taufers - Tubre in Italy. Together with the political party responsible in the ECONNECT pilot region Inn–Etsch, this local group identified a set of actions and measures to impede the hydropower project or at least mitigate its impact. These actions include public discussions, raising awareness of local politicians or actions at the river for a wider public to show the uniqueness of the river in this area. The highlight was an international day of biodiversity 2011. Over 120 experts from Switzerland, Italy and Austria searched for 24 hours for all occurring species. In a concerted action 1850 different species were identified.

ECONNECT ended in November 2011, but the definitive decisions and projected implementations had neither been fully carried out nor completed at that time. It is therefore important to support further actions to keep pressure high on local stakeholders. Long term actions - financially supported - are important, if we want to achieve the ecological connectivity on aquatic systems in the Alps.

Pilot Region “Northern Limestone Alps”

As the main driving forces of the project the protected area managers of the pilot region defined the main stakeholders. All identified stakeholders were invited to information events and workshops in the pilot region “Northern Limestone Alps” (see figure 1). People of all three federal provinces participating in the project attended those events, representing protected areas, local governments with different departments, landowners, foresters, hunters and many more. At least 180 stakeholders were participating in the process during the last three years. 150 stakeholders expressed their thoughts in personal interviews. The main results are summarized in a database, and include project ideas, methods and measures, which can contribute to the creation of ecological networks in the region. Four working groups have been set up to deal with the main topics: “Communication”, “Rivers and riverine Landscapes”, “Natural forests” and “Meadows & Pastures”. Their common outcome was integrated in a connectivity project called “VEuER”.

Pilot Region “Berchtesgaden-Salzburg”

To involve the stakeholders a variety of different tools were established in the pilot region. They concentrated on different key aspects like responsibility, expertise and information:

Responsibility: a regional steering committee was established, which guaranteed the coordination among actors, was available for support and content related questions and had the responsibility to make strategic decisions.

Expertise: an expert workshop with representatives of local authorities (forestry, agriculture, water management etc.) was held. In addition several expert interviews were carried out. The goal was to establish a common methodology for the pilot region based on the approached proposed by the Continuum Initiative.

Information: various resources were used to distribute information like public lectures, a homepage and the involvement of local stakeholders and partners during the whole planning and implementation process (e.g. special information events).

To sensitize the staff of the national park to topics like ecological connectivity an internal competition on the topic “Unknown Biodiversity” was started in the “Year of Biodiversity” in 2010.


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Pilot region "Hohe Tauern"

In this pilot region all important stakeholders were involved: from landowners to different economic sectors like agriculture, forestry, hunting, fishing, water management, nature conservation, science, as well as different responsible authorities, NGOs, and many more. The National Park as the main animator of the process applied the same philosophy as during the creation of the national park: actively involving and motivating the stakeholders for contributions to the planning process of ecological connectivity in the region.

Examples of KNOWLEDGE TRANSFER & AWARENESS RAISING

One important component of the ECONNECT project was to communicate connectivity to a wider audience. To do this, different activities were carried out, for example:

- ***"Clicks beyond the borders":*** *a photo contest started on May, the 22nd of 2010, the "Biodiversity day". The aim was to take pictures that illustrate the overcoming of barriers in the Alps. Amateurs and professionals uploaded over 100 photos they have taken on FLICKR. A panel of experts evaluated the pictures and the best 12 were shown in the final conference of ECONNECT in September 2011 in Berchtesgaden.*
  As a side project a short film about two wolves - "Romeo and Juliet" - was done, showing the difficulties of these two to get to each other.
- ***"The Wall"****, created by the "Ecological Continuum Initiative" is a colourful installation visualizing the barriers many animals encounter in their movements. On October the 20th of 2010 six different walls blocked the ways of pedestrians in Zurich (CH), Vienna (A), Munich (D), Ljubljana (SI), Milan (I) and Lyon (F). The walls can be borrowed for further events in order to raise awareness on the problem of habitat fragmentation.*
- ***"The ECONNECT newsletter"*** *started in March 2009. Everyone interested was able to subscribe for the newsletter at the ECONNECT project homepage and then got all the important information concerning everything going on in and around ECONNECT.*
- *International and national* ***"Conferences & Workshops"*** *were held within the frame of ECONNECT addressing topics like "legal frameworks of protected areas", "ecological networks in the Alps", "sharing connectivity knowledge", and many more.*

"Regulation of Touristic Flows" (Monte Rosa)

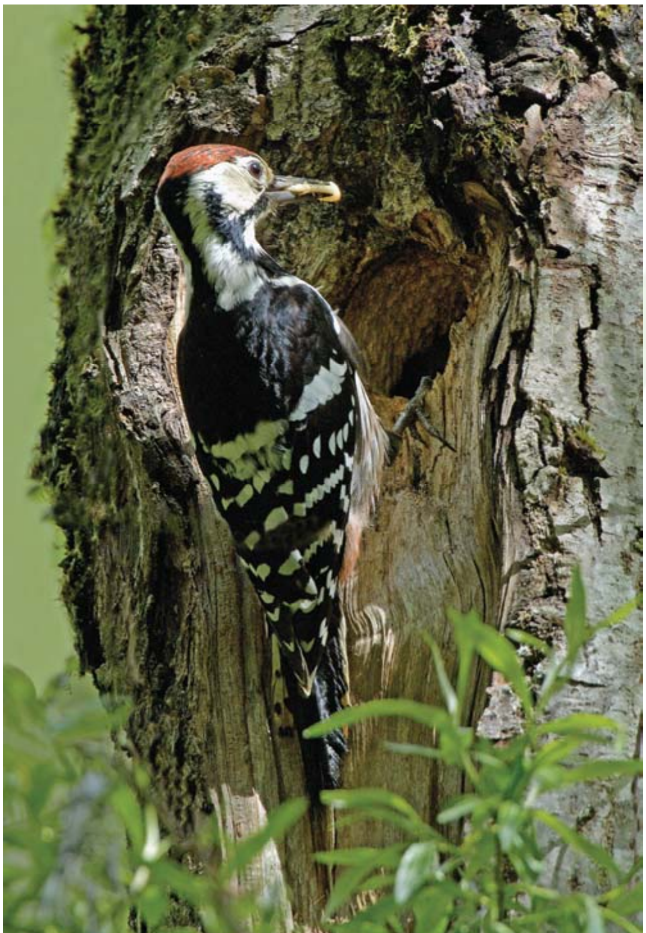
The pilot region is an important habitat for Galliformes like the Rock Ptarmigan (*Lagopus mutus*). To shelter their core areas and areas of potential presence, the elaboration of maps that regulate touristic flows is crucial.

"Ski & Biodiversity" (Southwestern Alps)

This project concentrates on the impact of skiing and logging cables on Tetraonidae (especially the black grouse *Tetrao tetrix*). Cables were identified, mapped and visualization tools were established in areas with high bird density to avoid collisions. By planning the position of wind generators the collisions of birds with their blades are also minimized.

"White-backed woodpecker"
(Northern Limestone Region)

Dendrocopus leucotos is a characteristic species of the region and one of the rarest woodpeckers in Central Europe. It depends on semi-natural to natural old forests with sufficient dead wood and feeds mainly on wood-boring beetles, their larvae other insects, nuts, seeds and berries. The white-backed woodpecker is an indicator of suitable habitats. Many other species like various birds, bats and small mammals depend on the woodpeckers breeding borrows, so the implementation of measures for the woodpecker has a positive effect on lots of endangered species. Together with help of the main landowners (ÖBF - Austrian State Forest, Styrian Federal Forests, Federal Forests of Vienna) a habitat model for the whole pilot region was calculated. The results of the modelling were then verified in field excursions and a common agreement "on how to go on" was achieved: creating a matrix of sufficient deadwood, common monitoring and so on.


MAREK Herfried © Nationalpark Gesäuse

Measures for another bird, the **"Ural owl"** (*Strix uralensis*), were taken by the wilderness area "Wildnisgebiet Dürrenstein" together with other main landowners: at least 10 nesting boxes were installed, one at every suitable habitat which were defined in common excursion.

Genetic analyses of neighbouring populations of the **western capercaillie** (*Tetrao urogallus*) should lead to a better understanding of "turnover" and so to an adapted management.

"**Dry meadows**" (The Rhaetian Triangle)

As action plans for dry-meadows in all three countries (Austria, Italy, Switzerland) exist, the aim of the project is the harmonizing of those by mapping (protection, cultivation), the exchange of experience, and the collaboration with the network project Via Claudia Augusta (Austria) and the collection of spatial data.

"**Extensively utilized grasslands**" (Transboundary Area Berchtesgaden–Salzburg)

Focal species (butterflies, dragonflies) and priority areas within the region are defined. An analysis and recommendations for financial support of traditionally cultivated grasslands are made and best practices (innovative financial measures, testing of Austrian instruments) are developed. Also contractual measures to ensure the long term protection of elements of the ecological network are found.

"**Develop an Eco-Game!**" (The Rhaetian Triangle)

This project is a collaboration with the "Zürcher Hochschule der Künste" (University of Arts Zürich) to develop a game concentrating on ecological topics.

"**Contractual measures for motorway & railway underpass & integration of corridors in land planning**" (Departement Isère)

All three projects focus on the transport sector, policy and authorities with the aim to increase the connectivity in the densely populated valleys. This is done for example with the construction of underpasses to guarantee the fauna (especially amphibians) a safe way underneath the road, the motor- and the railway. To consider migration in future projects, contractual measures with the municipalities are made.

"**Aerial, Aquatic & Terrestrial Connectivity**" (Southwestern Alps)

To improve the terrestrial connectivity the migration routes and presence of ungulates and small and large carnivores were studied. Priority areas, necessary planning instruments and structures were defined. Incidence sites where impact is likely and the correlation with fauna distribution were checked. The aquatic connectivity focused on the Gesso River from its source to its confluence into the Stura. Following topics were investigated: hydro balance, water catchments, electric power stations, flora and fauna situation (especially bullhead and crayfish), GPS localization and cataloguing of all physical barriers and drainage points with the aim to do a document defining all appropriate measures to deal with these topics. For "Aerial Connectivity" see "Ski & Biodiversity".

“**Revitalisation of the Saletbach**” (Transboundary Area Berchtesgaden–Salzburg)

With the revitalisation of the Saletbach, the ecological quality of a human influenced river was improved by supporting natural dynamics and restoring the natural connections between aquatic and terrestrial habitats. Restoration measures included also the river channel, which was degraded by human activity before.

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The Saletbach is the natural connection between the Lake Obersee and the Lake Königssee. Before its regulation and disconnection caused by a power plant, a natural exchange between the two lakes was possible. One of the benefits for the ecosystem is the expected increase of reproduction opportunities for the trout of the Lake Königssee, which will support the development of a viable fish population. Additionally, a study on connectivity within a larger spatial context is focusing especially on the functional integration of protected areas into their surroundings. The implementation of the revitalisation of the river linking the both lakes was only possible with the commitment and support of several stakeholders and partners, who have been involved in the process from the beginning.

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Data Barriers – Mind The Gap!

Renner K.

Data Collection and Availability

Geographic data covering the Alpine Convention area was used to carry out the alpine-wide modelling of barriers and connectivity.

Parts of the data were available from online geo-portals; other datasets were sourced and licensed from official European data providers. Specific data was provided by official and/or widely accepted sources like the European Environment Agency (EEA), the European Commission DG Environment and the European Commission Joint Research Centre (JRC). Data that was not available for free was purchased from sources like Eurogeographics. The Teleatlas dataset was used as the key information on barriers as it represents the most comprehensive and detailed road network available.

As the quality of the data was very different, it was decided that the alpine-wide data-level was not always sufficient, especially regarding water features. To gain better accuracy for the analysis of the aquatic connectivity, EURAC purchased national (Switzerland, Slovenia) and in some cases regional data sets. For the analysis at Pilot area level, geographic data was collected for every region within the Pilot areas; initially according to general requirements, later on according to the needs of the common regional methodology to calculate the Continuum Suitability Index (CSI – see chapter 4.1). There was a big difference regarding time and money that had to be invested in data acquisition depending on region and type of data. For example in some Austrian regions land use and elevation data could only be purchased at high costs (also due to the vast area the detailed data had to cover) and so the data licenses were a considerable expense to the project. Another time consuming process was identifying the suitable data sets in each region (different administrative systems, data delivery schemes, languages, etc.), establishing contact with the appropriate public authority department, ordering the data according to regional mechanisms, preparing license and sublicense documents, manage various license and sublicense documents and data users, check and adapt differing data sets to the requirements of the projects methodology and finally the numerous data sets.

ECONNECT collected data on an Alpine-wide and on a Pilot-region level.

- *Restricted data: the EURAC made contracts with the data owners*
- *Free Data: available on the GeoPortal, that was made for ECONNECT*

Alpine wide data was collected at a national or supra-national level at a scale between 1:100,000 and 1:500,000. This kind of resolution fits the needs of the terrestrial modelling aiming for a resolution of 1 km. However, for aquatic analyses data with a better resolution was required (scales varied significantly between a forest cover dataset of a rather high spatial resolution of 25 m and a river network dataset at a scale of 1:500,000). Parts of this gap could be closed by using national river network data (Switzerland, Slovenia) and regional data sets for the rest of the Alps.

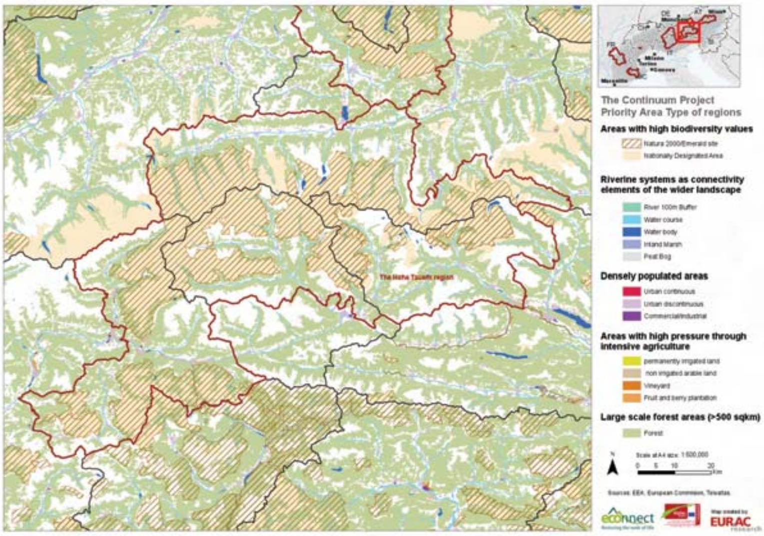
The question of scale was a crucial and interesting one in the ECONNECT project where ecological connectivity is implemented at a local scale but is studied for a large area as the Alps. No matter how accurately measured geographic data is, it is always only a model of the real world. There are clear differences in the level of detail of the geographic data used in this study regarding thematic and spatial resolution. This difference in accuracy has a significant impact on the analysis results. Because the best data available for the alpine-wide analysis was not always economic (time, cost) other data had to be used. Ecological barriers are effective at a local scale. A barrier can be very small on the ground, e.g. a fence or weir, and still have an effect on alpine-wide permeability, for example on long distance migration. But these small dimensioned features are not included in a dataset with a resolution of 1:100,000 or if they are included there are likely to have thematic inaccuracies in a continuum suitability index which is calculated by combining 10 different indicators and which makes it possible to measure and compare the suitability of different areas. These indices range from land use, population density, topography but also include measures about land use planning. How closely the results of the modelling are matching actual circumstances could be shown by the validation of WP5 results of barriers and corridors.

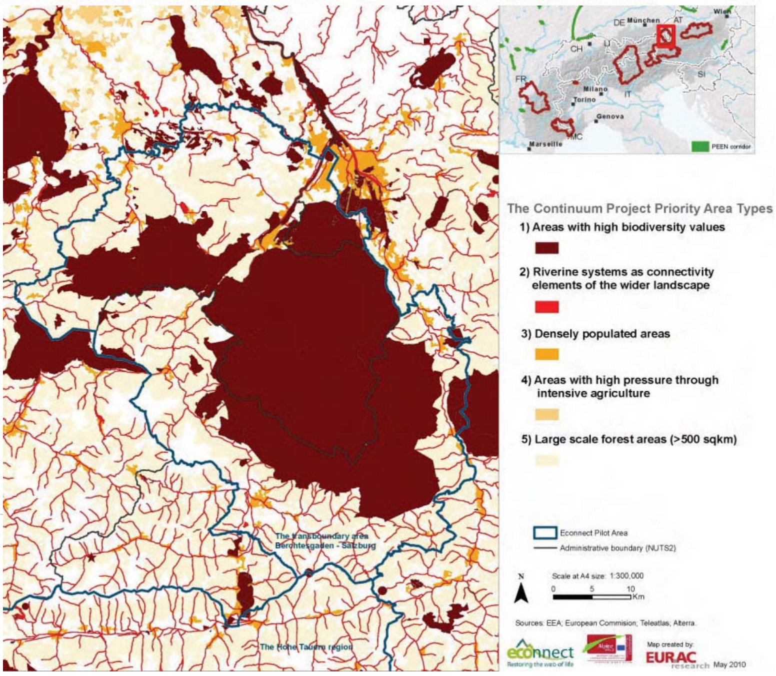
The quality of the data varied from region to region. Some very specific datasets were not available for all regions or could not be acquired due to unreasonable high costs. This was especially the case in some Austrian regions, where land use and elevation data had to be purchased from the "Bundesamt für Eich- und Vermessungswesen (BEV)" or the Federal Agency for Meteorology and Survey since no difference between commercial or research use of the data were made. On the contrary, as a best practise example, all data and metadata for the Italian region of Lombardia was available freely and easily on the internet.

![econnect — Restoring the web of life]

Priority Area Types according to the definition of "The Continuum Project"

In the framework of the Continuum Project the main areas the project should focus on, were ranked by experts on ecological connectivity in the Alps. The results were seven priority area types ranked according to their importance. There is a preference for improving the connectivity mainly in areas with high biodiversity, riverine systems, urbanised areas and in areas of interest for the Pan European Ecological Network (PEEN) (SCHEURER et al. 2008). The seven priority area types were mapped for each ECONNECT pilot area as exemplary shown in these figures.



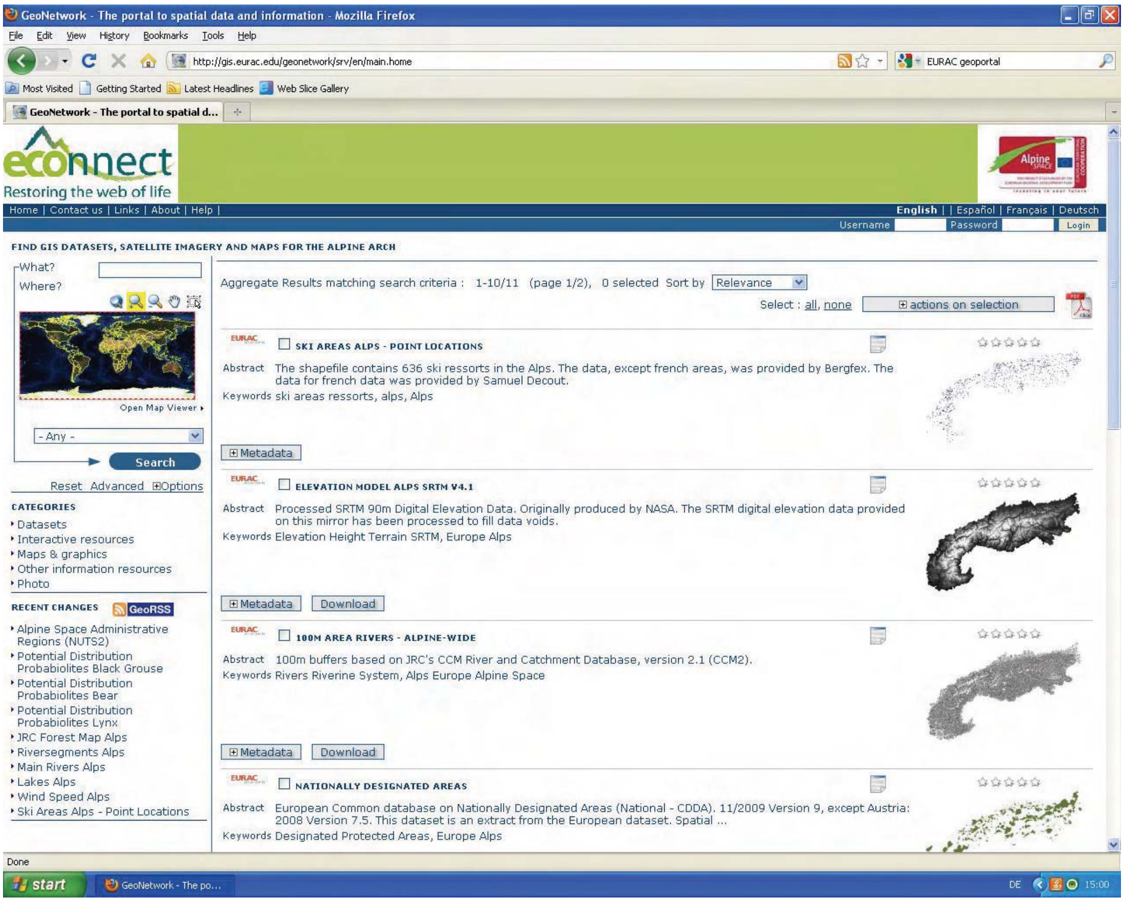


Maps of priority areas in the Pilot Region "Hohe Tauern" (above) and priority area types ranked according to expert opinions (below)

GeoPortal

In order to store and share the data of several project partners in a systematic and easy way, an online geospatial catalogue was set up, the so called GeoPortal (see screenshot). With a username and password every project partner was able to add metadata for datasets, to upload files containing data and to confer user-rights for the data available for download.

All data sets remained in one central place and could be accessed from anywhere in the world. It was the intend that all data in the GeoPortal should remain available for other alpine-wide projects.



Screenshot of the ECONNECT GeoPortal

Ecological Barriers

The Terrestrial Perspective

Sedy K.

Analysis of species habitat needs

First, a harmonized methodology for the modelling of several species habitats and corridors in the whole Alps was developed, which allowed the visualization of barriers (ECONNECT Berchtesgaden Workshop 2009, ECONNECT Grenoble Workshop 2009).

The statistical learning method MaxEnt (PHILLIPS & DUDIK 2008, FRANKLIN 2010) is a suitable modelling approach for the distribution of the selected species. It was given preference among other methods as it was successfully applied to conservation biology in the past (PEARSON et al. 2006, YOST et al. 2008). It calculates the maximum entropy distribution and is able to handle presence only data and small sample sizes (WISZ et al., 2008; BALDWIN 2009, ELITH et al., 2006).

ECONNECT's TERRESTRIAL AND AQUATIC TARGET SPECIES:

- *Black grouse (*Tetrao tetrix*)*
- *Brown bear (*Ursus arctos*)*
- *European bullhead (*Cottus gobio*)*
- *European otter (*Lutra lutra*)*
- *Eurasian lynx (*Lynx lynx*)*
- *Gray wolf (*Canis lupus*)*
- *Griffon vulture (*Gyps vulvus*)*
- *Red deer (*Cervus elaphus*)*

Table 2: ECONNECT modeling approaches for target species

Species	Habitat distribution	MSPA	Specific barriers
Black grouse	Maximum entropy distribution (MaxEnt), PHILLIPS 2008	GUIDOS (VOGT et al. 2007)	Ski resorts
Brown bear	Logistic regression (GÜTHLIN 2008)	GUIDOS (VOGT et al. 2007)	Roads
Griffon vulture	Habitat suitability assessment (BÖGEL 1996)	Identification of core areas and disturbances (BÖGEL 1996)	Electric power transmission lines
Eurasian lynx	Logistic regression (ZIMMERMANN & BREITENMOSTER 2007)	GUIDOS (VOGT et al. 2007)	Roads, settlements
Red deer	Expert based approach, discrimination of presence and absence	GUIDOS (VOGT et al. 2007)	Red deer free zones
Gray wolf	Spatially explicit, individual-based model (SE-IBM by MARUCCO & MCINTIRE 2010)	GUIDOS (VOGT et al. 2007)	Combination of natural and anthropogenic barriers

The next step was the identification of habitat characteristics by functional connectivity corridor models. The aim was to take into account the resistance of the habitat matrix towards the migratory ability of an animal species. Therefore the results of the habitat suitability modelling were further processed with the morphological pattern analysis (MSPA), which is implemented in the software called GUIDOS[3] (VOGT et al. 2007). It is an implementation of the morphological image processing algorithm and classifies a binary image (all cells with an occurrence probability above e.g. 0.5, were classified as 2, cells with an occurrence probability below 0.5 were classified as 1 and cells with no data were classified as 0), where the resulting binary map shows core areas, corridors as well as barriers and allows the identification of highly fragmented regions.

Modelling of habitats and barriers in the Alpine Arc – a challenging approach

After the appropriate models were chosen, occurrence information of the different species hat to be collected and harmonized and handling of data from various sources had to be achieved. CORINE Land Cover datasets, datasets of the main roads and transport routes were collected.

Modelling of the potential distributions of each target species turned out to be challenging because it was very difficult to get information about occurrence records: on one hand some of the species are extinct in large parts of the Alps and so there are no occurrence records, on the other hand access to existing data was often denied by the institutions maintaining them. The best data was obtained for the black grouse but very few to none data was available for the brown bear, the Eurasian lynx and the gray wolf. Nevertheless it was possible to calculate models of potential distribution for all species, either using existing models (brown bear, Eurasian lynx, gray wolf) or generating new ones (black grouse). These models were baseline for all subsequent analyses (Table 2, page 43).

After consultation of experts for the species-specific selection of barriers the “major” barriers for modelling were chosen. The degree of permeability was assessed by cost distance analysis as mentioned in table 2 (column “specific barriers”). Here, the lack of data was challenging again. In order to evaluate the permeability of barriers, radio tracking datasets of a sufficient number of individuals of each species would have been needed. Nonetheless it was possible to picture the influence of selected barriers in a more theoretical approach.

For every target species an identification of potential habitats, a spatial pattern analysis as well as species specific barriers were elaborated for the whole Alpine Arc. Detailed reports on all the terrestrial target species can be found in the download-area of the ECONNECT web page[4].

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[3] http://forest.jrc.ec.europa.eu/download/software/guidos

[4] http://www.econnectproject.eu/cms/?q=download_area/en#Finaldocumentsonspecies

Black grouse (*Tetrao tetrix*)

The black grouse is listed in the Annex I of the Birds Directive hence its habitats have to be protected. In the Alps its home range is concentrated along the forest line but it is also able to live in anthropogenic influenced habitats like alpine pastures (WÖSS et al. 2008). The main problems for the black grouse are changes in land use, artificial structures like ski lifts (WÖSS & ZEILER 2003) and in general, its dispersed habitats and populations.

The black grouse depends on several local habitat types during its annual life cycle, so the availability of these habitat types is crucial. A ski resort, for example, can act as a barrier and also be a stress factor. In summer for breeding the black grouse requires an area of approximately 20 ha of continuous habitat, so fragmentation of this habitat by local disturbances like leisure activities and infrastructure are the main problem. In winter the frequent perturbation is a bigger problem because it induces stress on the black grouse and so imbalances its energy budget.

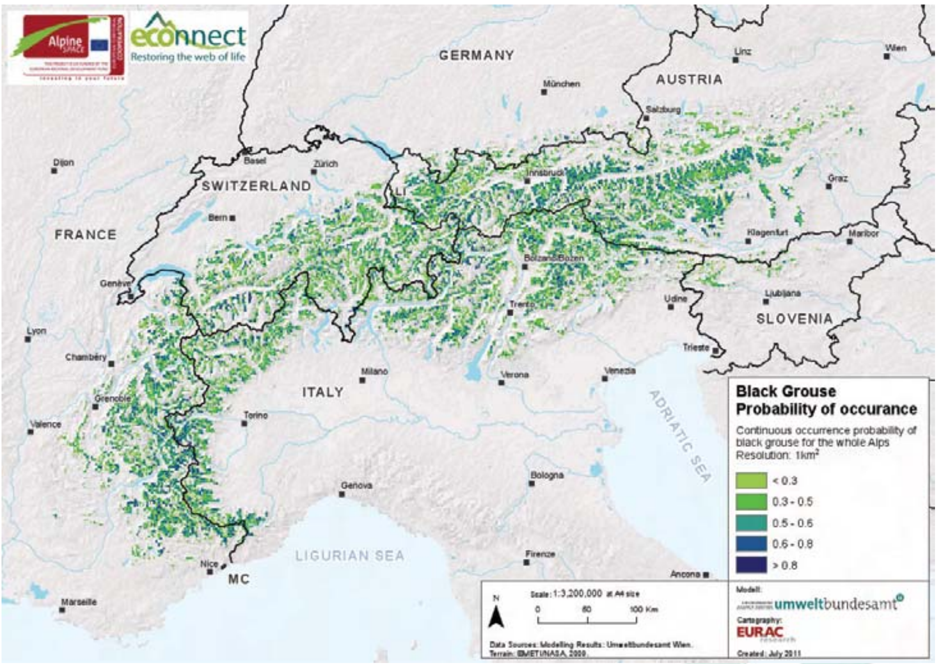
However, the ecological relevance of these results needs to be discussed keeping in mind the expected changes in habitat due to climate change. The back grouse is a sedentary bird, therefore, changes in habitat are of high importance.

Climate change will/might affect the ecosystem that shelters the black grouse. Especially the assemblage of plants the black grouse depends on might change at certain altitudes, forcing the species to migrate to other, habitats.

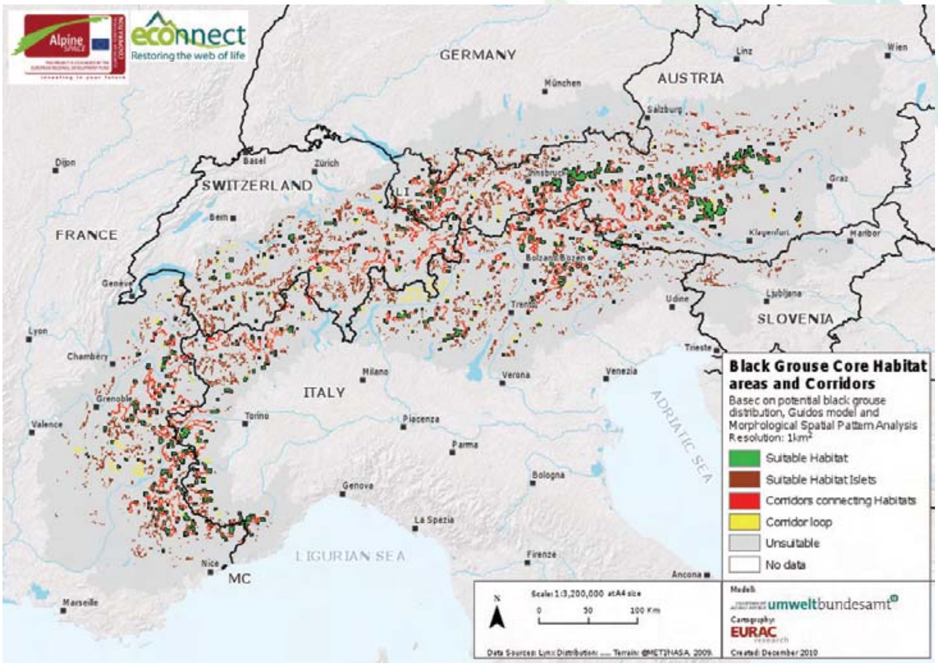
To make this migration successful it is crucial to reduce stressful and energy consuming anthropogenic influences that additionally weaken the energy budget Thus, it is very important to do on-site-inspections of identified hot spots on local and regional scale and to create protected core areas and corridors within these hot-spot regions. Limited use of these areas must be laid down in management plans and public awareness on this issue must be raised.

See maps 2, 3 and 4 on the next pages.

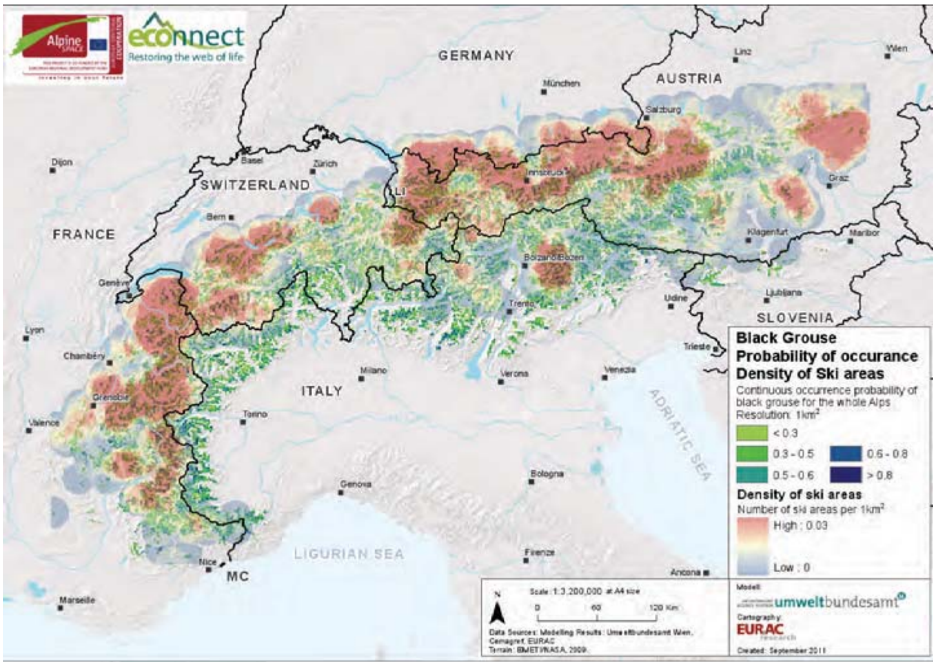

VELLAND Bruno © Parc Naturel Régional du Vercors



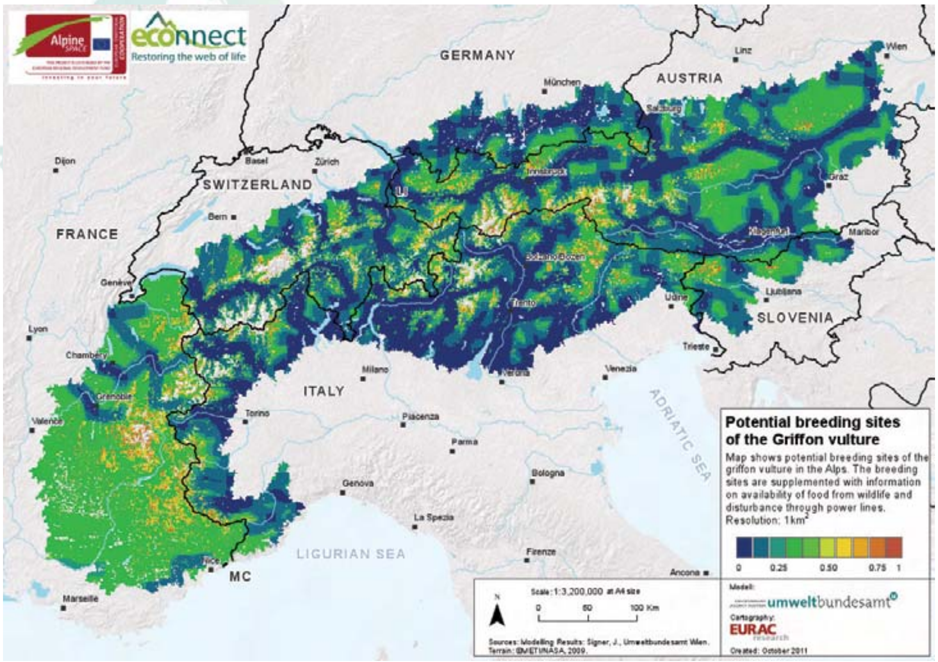
Map 2: Probability of occurrence for black grouse based on females probability of detection.



Map 3: Morphological spatial pattern analysis for black grouse; classification of habitats for the Alpine arch according to GUIDOS (VOGT et al. 2007).



Map 4: Density of ski resorts in potential black grouse habitat in the Alpine arch.



Map 5: Potential breeding sites of the griffon vulture in the Alpine arch. Availability of food and disturbance caused by power lines are considered.

Griffon vulture (*Gyps fulvus*)

The griffon vulture is one of the large birds of prey in Europe. It is widespread but the populations are also quite scattered. Adult vultures tend to stay at one place but young and immature birds are known to migrate (BERNIS 1983).

Connectivity is not the main problem for the griffon vulture as it is able to cover long distances but there are other limiting factors like the presence/absence of carcasses (as food source), the presence/absence of poachers and the presence/absence of rock walls as the provide upward current on which the species strictly depends because of its flight modality.

Potential habitats also need to provide space for certain individuals as vultures hunt cooperatively. Thus, if the number of individuals is beneath a certain number, breeding colonies disappear quickly (see map 5 on the previous page).

Power lines were chosen as an example for anthropogenic disturbing structures and geographical information on high voltage lines was combined with the datasets on potential breeding sites and food availability, to calculate the model.

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Brown bear (*Ursus arctos*)

The main threats for bears in Europe have been evaluated by the Action Plan for Conservation of the brown bear in Europe (JOHN et al. 2000) and are:

(a) Demographic and genetic viability: small population sizes are a problem as such. Studies from Sweden showed that at least six to eight females are required to reduce the risk of extinction through random stochastic effects below 10 % within 100 years. Additionally almost all western European brown bear populations went through genetic bottlenecks. Although no evidence of inbreeding depression was found in the wild.

(b) Habitat loss: it is attributed to the expansion of human activities such as agriculture, forestry, resource extraction, road construction and recreation. Bears might avoid these areas and by that decrease their range. Alternatively they may become accustomed to humans, leading to an increase of conflicts between bears and humans.

(c) Fragmentation: in some cases the fragmentation of habitats caused by infrastructure can be more detrimental to bears than the los of habitat itself. Home ranges are being artificially shrunk and dispersal is made a lot harder which has negative effects on the genetic variability. Also road kills of bears can harm small populations. Previous studies (WIEGAND et al. 2005) identified densely populated valleys with motorways like the Mürz-Mur-Valley (Austria), the Ljubljana-Postojna highway (Slovenia), the Etsch Valley (Italy) Villach-Udine (Austria, Italy) and the Inn Valley (Switzerland, Austria) as the main obstacle to dispersal for bears in the Eastern Alps.

The current distribution of *U. arctos* in the Alps is very sparse and limited to the Eastern Alps mainly. This is the result of human driven persecution and extinction of bears. The potential distribution model for the Alps shows, that there are potential habitats in the Western Alps too. More than 60 % of potential bear habitats aren't classified regarding their legal status so from the perspective of nature conservation it would be desirable to protect all bear habitats not yet protected.


FEDRIZZI L. © Parco Naturale Adamello-Brenta

The ECONNECT results from GUIDOS provided a first step towards a spatial orientated evaluation of bear habitats (see maps 6 and 7 on the next page). Preference should be laid on objects connecting core areas like bridges. Further analysis could consider the importance of connected patches for example in terms of overall occurrence probability.

Despite the ability of bears to sometimes cross motorways they are an anthropogenic barrier but their main problem in the Alps is whether or not they are accepted by local population and managing authorities because at the moment intolerance leads to illegal shooting of bears. Legal protection of bear habitats is crucial and, of course, shootings cannot be tolerated. Surely acceptance can be supported by political decisions. Also a damage prevention policy is necessary (electric fences, dogs, etc.). Last but not least it needs to be considered that in landscapes dominated by human structures, habitats are less suitable for bears, leading to conflicts between them and humans.


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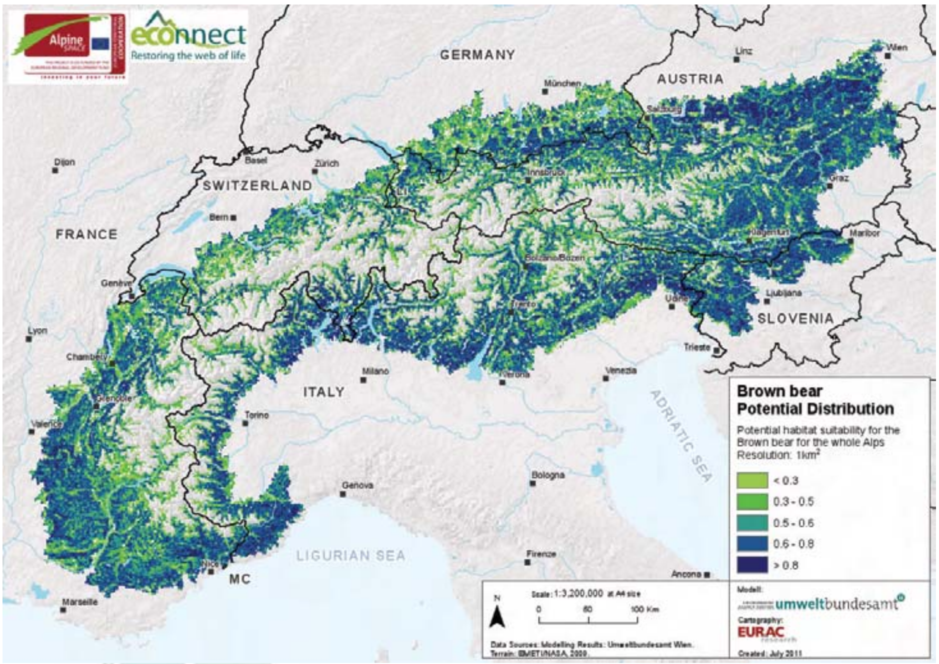
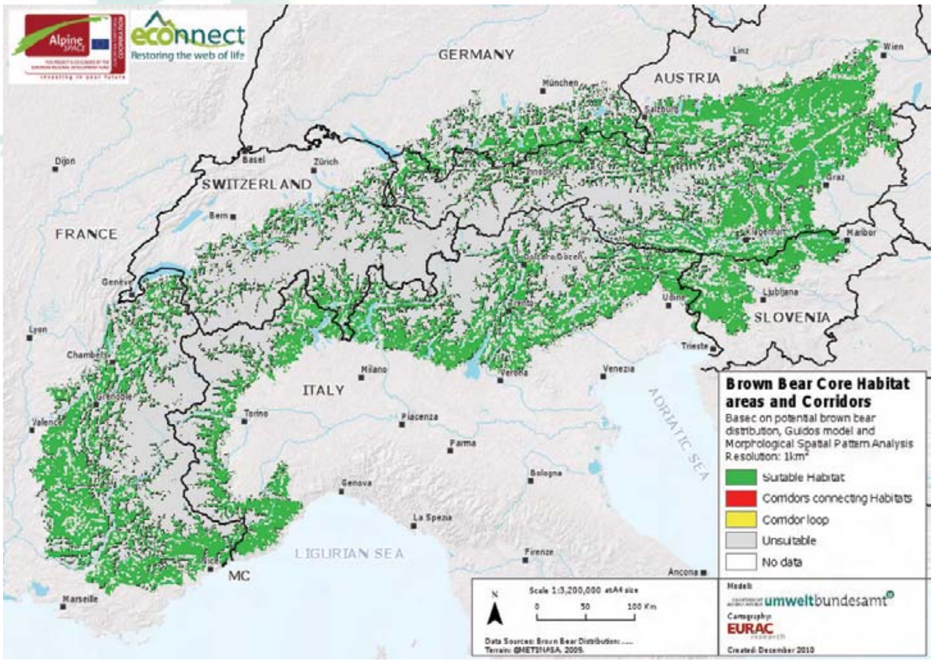


Map 6: Potential distribution of brown bear in the Alpine arch.



Map 7: Morphological spatial pattern analysis for brown bear; classification of habitat for the Alpine arch according to GUIDOS (VOGT et al. 2007).

Gray wolf (*Canis lupus*)

With the beginning of the 20th century the wolf was extinct in almost the whole of Europe, but some small populations survived for example in Italy (BOITANI 2000). Nowadays, the populations are growing (BREITENMOSER-WÜRSTEN et al. 2001) and the wolf has the potential to reestablish itself in many parts of the Alps.

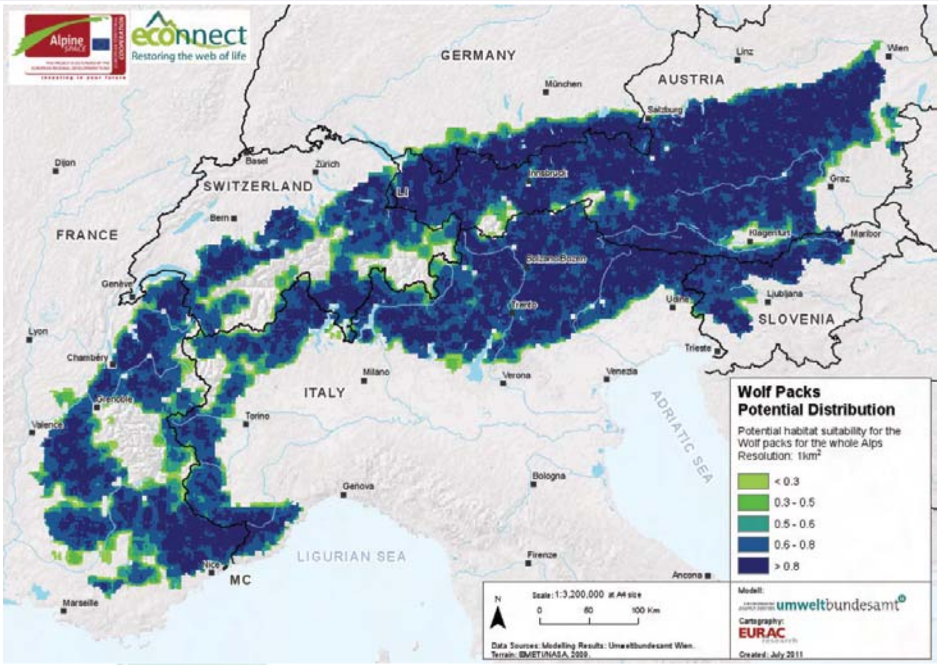
The connectivity analysis was based on the potential wolf source areas identified by the MSPA analysis. Wolves can easily cross roads and highways, as documented by many studies (e.g. BOYD & PLETSCHER 1999, CIUCCI et al. 2009), therefore, a single road is usually not identified as a barrier for wolf dispersal. However, in Italy wolves are often killed by car accidents (LOVARI et al. 2007), especially if they settle in regions with high road density (e.g. AVANZINELLE et al. 2007). Road density is a major limitation for wolf pack settlement but not for wolf dispersal. Other reasons for wolf absence are human settlements, low forest cover and high rock elevation presence (MARUCCO 2009). Thus, to analyze wolf connectivity a combination of these factors was used. Connectivity results have to be interpreted within the strict regulations of wolf sociality and dispersal movement patterns, which is a big difference to other, solitary carnivores. The analysis incorporated these elements to identify the major barriers for wolf connectivity (see maps 8 and 9 on page 53).


LEQUETTE Benoit ©
Parc National du Mercantour

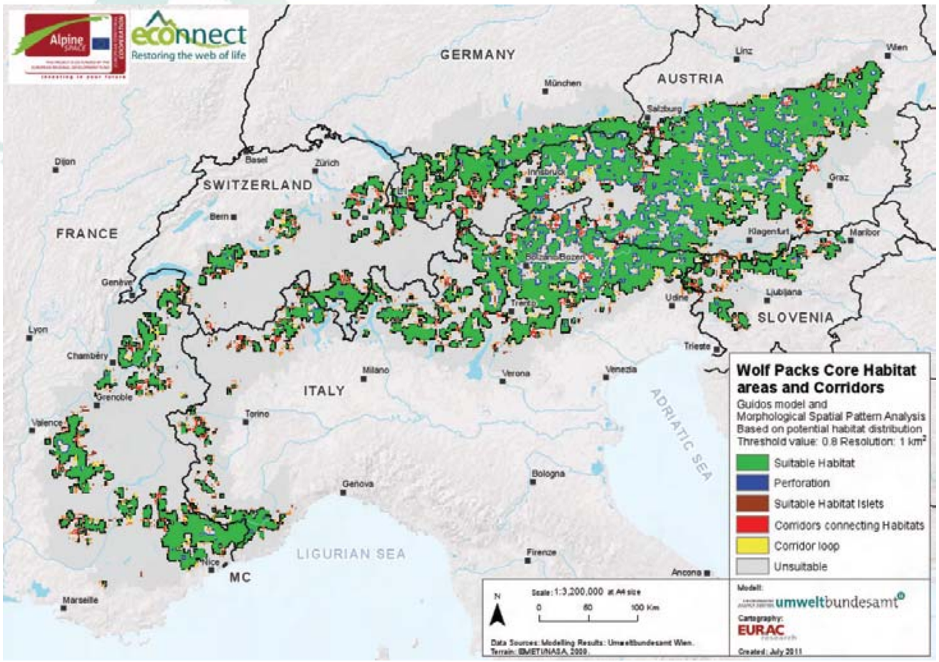
Lowest levels of connectivity were found between the source areas in the Apennine (Italy) and the Lepontine Alps (Switzerland).

An often overlooked reason for missing connectivity is fragmentation by management (LINNELL et al. 2007). A high level of this kind is caused due to the different states in the Alps. For example Switzerland is the only country with a program of legal wolf removals of solitary and dispersal wolves even so there is a very low number of wolves in the country and no packs have settled yet (WEBER 2008). A shared management program within the Alpine states is a key step to maintain wolf connectivity and conservation as advocated by the Guidelines for Population Level Management Plans for Large Carnivores in Europe approved by the European Commission in 2007 (LINNELL et al. 2007).

Obviously, wolf connectivity in the Alps needs to be analysed in a wider context, taking into account that the wolf population was generated by natural dispersal from the south-western Apennines about 20 years ago (FABRI et al. 2007). To guarantee enough genetic diversity in the alpine wolf population, the ecological corridor represented by the Ligurian Apennines must be maintained (FABBRI et al. 2007). An interesting low connection with the Dinaric population (Slovenia) and the Carpathian population has been documented (RAUER & GROFF pers. com.). Supporting for a future wolf metapopulation over the mountain chains in Western-Central-Europe would need spatial analysis of potential connectivity within these areas and the Alps, a characterization of barriers by origin, size, shape and degree of permeability with an assessment of possibilities to diminish them.



Map 8: Wolf packs habitat suitability based on the SE IBM model (MARUCCO & MCINTIRE, 2010)



Map 9: Morphological spatial pattern analysis for wolf packs, classification of habitat in the Alpine arch according to GUIDOS (VOGT et al. 2007).

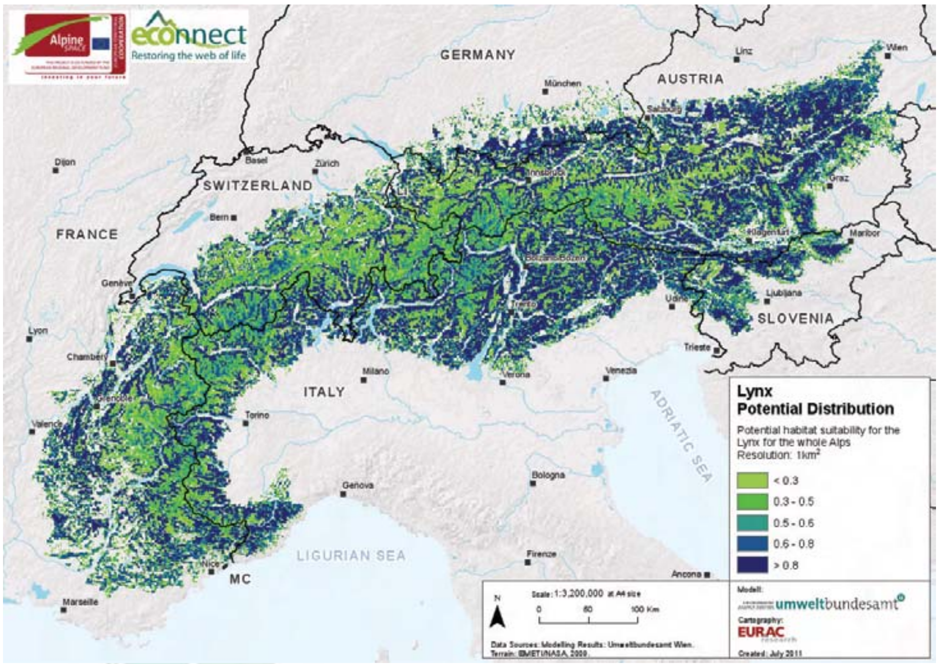
Eurasian lynx (*Lynx lynx*)

The lynx is the biggest feline carnivore in the Alps. Like the other big carnivores it disappeared in the 18th and 19th century from intensively used areas in Europe (BREITENMOSER 1998). Since the early 1970s reintroduction programs, starting in Switzerland, are carried out in the Alps. To accomplish a positive progression of these projects it is very important to connect the dispersed populations (HUBER 2006).

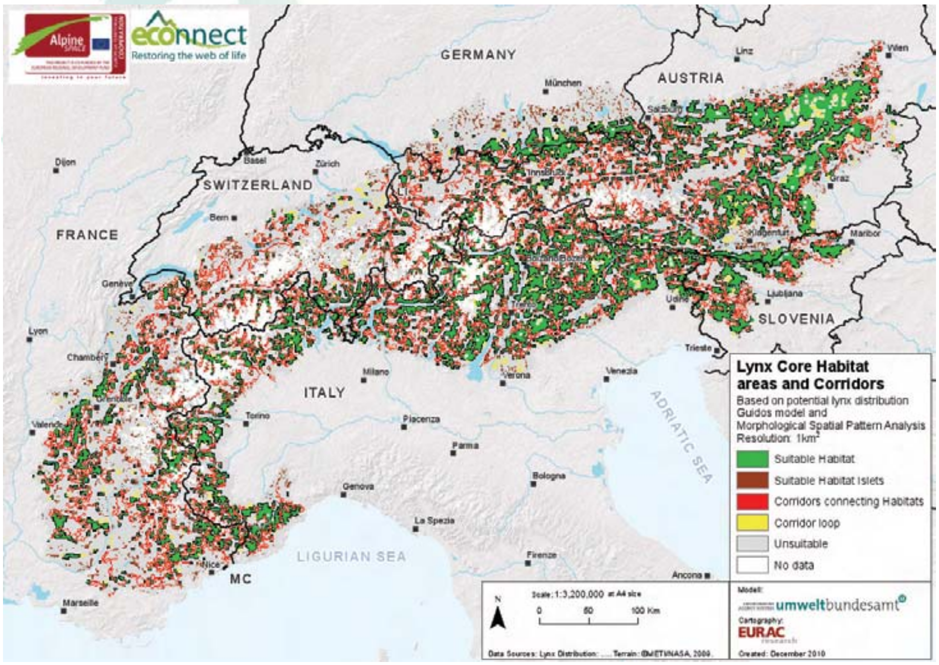
The lynx is distributed substantially in Switzerland (after carrying out some reintroduction projects) and Slovenia. Individuals are scattered over the Western Alps, Trentino (Italy), Friuli (Italy) and Austria. Among ECONNECT pilot regions it is mostly found in the Northern Limestone. Regarding potential distribution, the probability is much higher in the Eastern Alps.

For the conservation of the European Lynx core areas and corridors (= bridges) should be given priority. In the Eastern Alps larger areas are adjacent, while the western part of the Alps is a lot patchier concerning lynx habitats. This can be explained by the lesser altitude of the Eastern Alps which consequently means better lynx habitat.

On page 55 are maps of potential lynx distribution and core habitats and corridors in the Alpine area, based on the GUIDOS calculations.



Map 10: Potential habitat distribution for lynx in the Alpine arch.



Map 11: Morphological spatial pattern analysis for lynx, classification of habitat for the Alpine arch according to GUIDOS (VOGT et al. 2007).

Red deer (*Cervus elaphus*)

Different to the other focal species the red deer is not directly threatened but its populations are very scattered and in Europe only 9 % of its habitat is not influenced (HERRMANN & SCHEURLEN 2009). The hinds live in groups their whole live and long migration roots are common (for example CLUTTON-BROCK et al. 1982). Stags join the females while their heat and are also known for long distance migration (for example DRECHSLER 1991).

The European red deer is adapted to a woodland environment (THOMAS 2002). Its natural habitat are forests, but as numerous great forests throughout Europe were felled over the centuries, most of the populations were forced to live on exposed land, moving into wooden plantations during the winter.

Generally it can be said that for the conservation of *C. elaphus* core areas and corridors (= bridges) should be given priority. In the Eastern Alps are larger areas of adjacent core areas as they are of lesser altitude which makes them a better natural habitat for the red deer.

Man made barriers and the influence of political and land management decisions were assessed by collecting the datasets of Red Deer free zones, defined as areas where Red Deer is excluded although the habitat would be suitable (based on a comparison of CORINE Land Cover 2006 datasets of forest and non-forest areas). These exclusion areas rely completely on anthropogenic criteria of land use. As not all countries or federal states had records of designated red deer free zones (or weren't willing to provide this information) the datasets were patchy.


HALLER Heinrich © Parc Naziunal Svizzer

The existence of these red deer free zones raises the question of existing management conflicts and capability of land use of forests for certain densities of animal population. The relationships between density levels of red deer, hunting pressure and ungulate damage in forests have often been discussed in literature (MAYER & OTT 1991, AMMER 1996, ROONEY 2001).

REIMOSER (2003) stated the need for a more conscious and active integration of wildlife species into cultivated landscapes by providing proper biotopes for plants and animals and thereby reducing overall damage. Furthermore it is suggested that natural interactions, like reintroducing large predators like the wolf, should be utilized to achieve a sustained regulation.

The principals of a proposed integration strategy to manage an acceptable (which means tolerable) level of ungulate damage requires (1) the definition of land use aims for various areas (2) the coordination of habitat- and ungulate-management (regarding composition, area and seasonality) and (3) the inclusion of game as site-factor in land use planning and the coordination of hunting programs, ensuring that local vegetation has the capacity to support the intended game density with tolerable impact. Silvicultural measures alone cannot solve the problems of wildlife management sustainably and thus the need for cooperative actions from all stakeholders arises – from foresters, to hunters, farmers, tourist authorities, conservationists, regional planning authorities and local communities – with coordinated action plans covering regions large enough to be relevant for the red deer and other game species of interest (REIMOSER 2003).

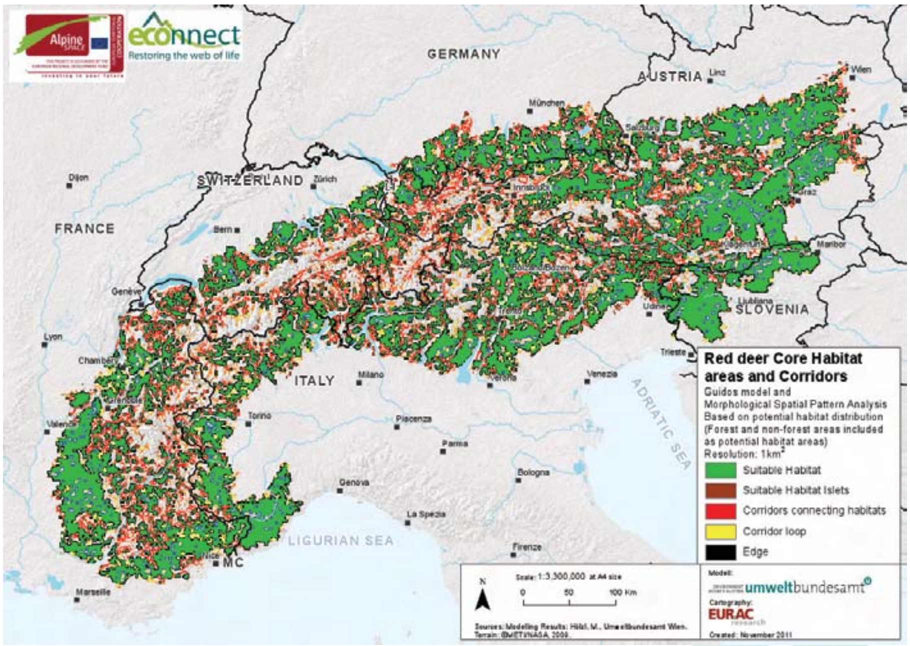
See maps 12 and 13 on the next page.

“The Superspecies Approach” – Ideal Connectivity for several Key Species

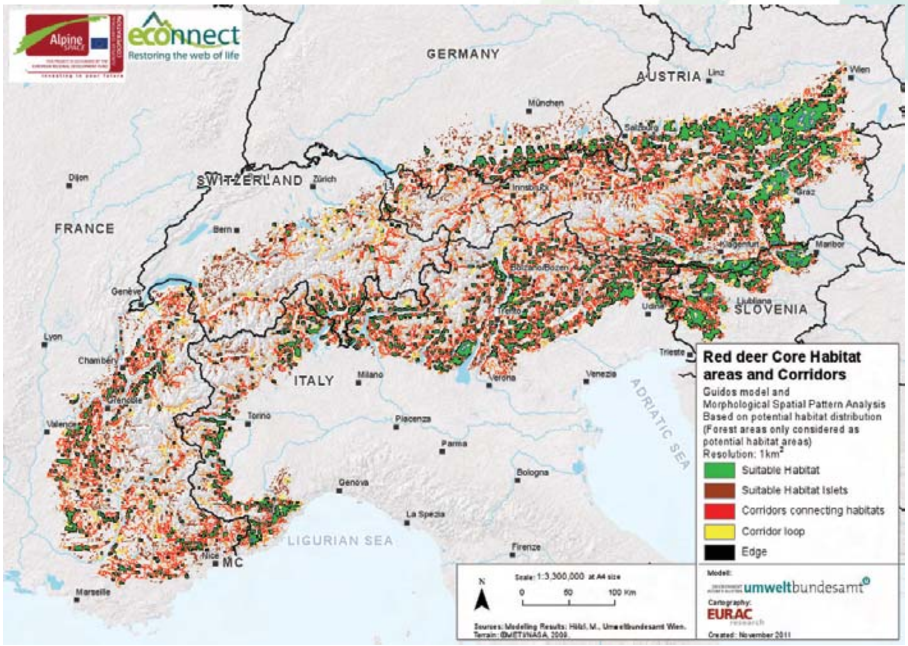
To be able to do cross-species interpretation on habitat distribution and to identify a more generalized effect of barriers a new approach was elaborated: potential habitat distribution within the Alps was combined for bears, lynxes, wolves and red deer. As each species was modelled with different methods the upper quartile was set as a threshold for presence (i.e. top 25 % of all pixels) to overcome difficulties in scaling demarcation. Because the species distribution model for red deer showed presence and absence only and not the possibility of presence a different approach had to be taken: instead of reclassifying all values above the third quartile, core areas of reclassification, using GUIDOS, were used.

The result was a map with values from 0 to 4. Where 0 indicated that none of the four species has a very high likelihood of potential habitats and 4 indicates that all four species have a high occurrence probability in a cell. Heights above 1800 m altitude are shown in grey and represent the average timber line. The four target species are sylvan species so areas without forest cover due to altitude are excluded from the analysis. The eastern part of the Alpine Arc represents higher suitability for target species than the western part, due to lower altitude of the mountains and therefore more closed forest surface. For detailed analyses of local habitat suitability and local disturbance factors it is necessary to zoom into the regions of interest and to use a better resolution. The modelling results on alpine scale can be used for identification of hotspots but the verification needs to be done on local level.

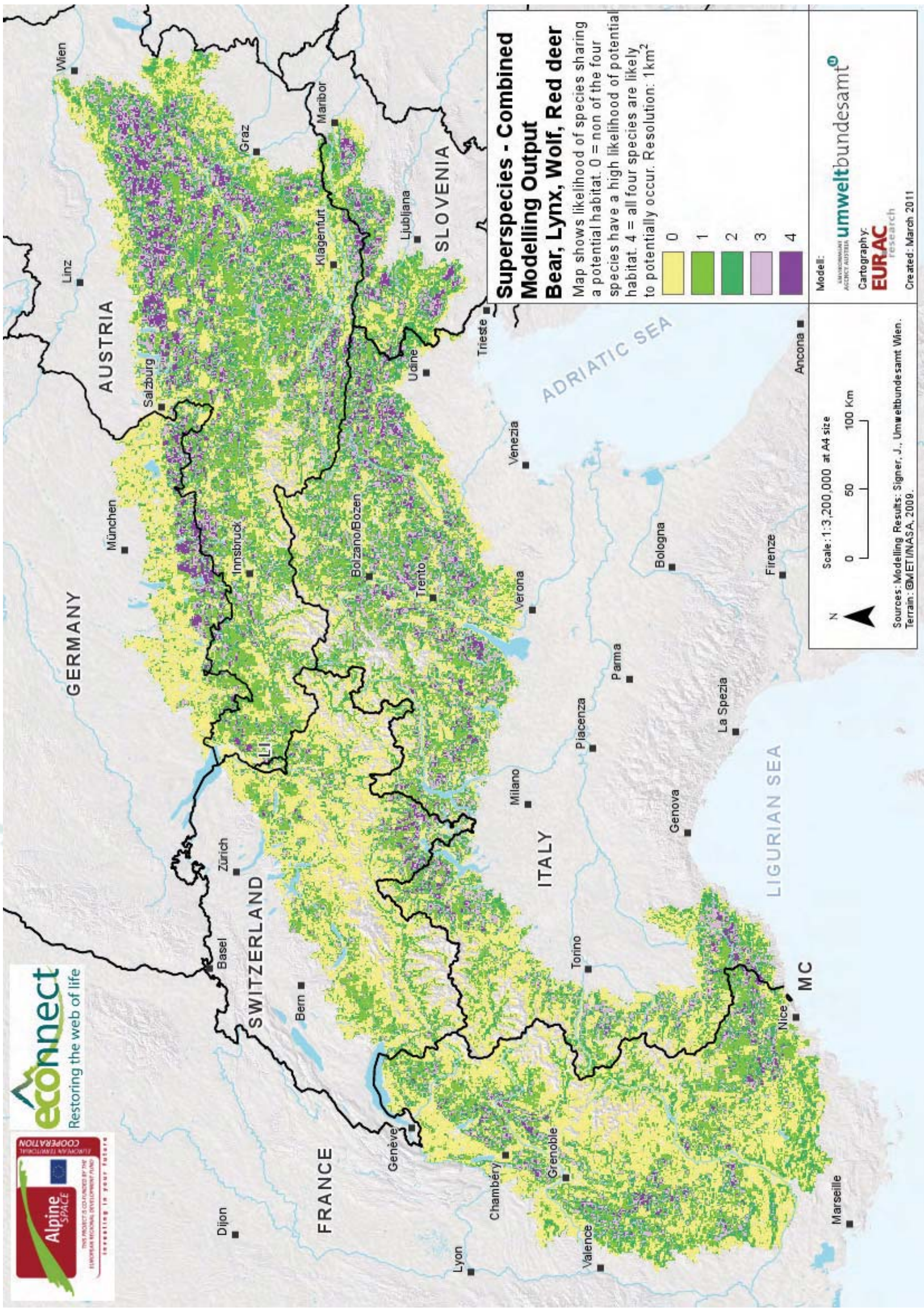
For the result see map 14 on page 59.



Map 12: Morphological spatial pattern analysis for the red deer, classification of habitat for the Alpine arch according to GUIDOS (VOGT et al. 2007).



Map 13: Morphological spatial pattern analysis for the red deer, classification of habitat for the Alpine arch according to GUIDOS (VOGT et al. 2007) and considering forest areas only.



Map 14: The "Superspecies Approach" models the likelihood of potential distribution of four target species in an area

The Aquatic Perspective: Alpine Riverine Landscapes, key species and their potential habitats

Füreder L., Bou-Vinals A., Weinländer M.

Analysis and definition of potential habitats

Riverine landscapes are complex systems with a specific function in connecting aquatic and terrestrial habitats and even larger landscape elements. Besides their role in providing habitats for a variety of organisms, they are also important corridors for animals and plants, favouring their movement and/or dispersal. Along or within riverine landscapes, activity, distribution and migration of freshwater and terrestrial animals are facilitated, some have their distribution range within the riverine habitats others use these landscapes as gateway to new territories. Consequently, besides providing complex habitats, riverine landscapes represent important functional quality characteristics. Only unblocked river systems can guarantee their important role as movement corridors for aquatic species (PRINGLE 2001, CHU et al. 2005).

Today anthropogenic impacts have altered riverine landscapes intensively, resulting in a destruction and fragmentation of aquatic and terrestrial habitats (e.g. DYNESIUS & NILSSON, 1994; NILSSON et al. 2005). Alpine rivers have experienced similar modifications (MUHAR et al. 2000).

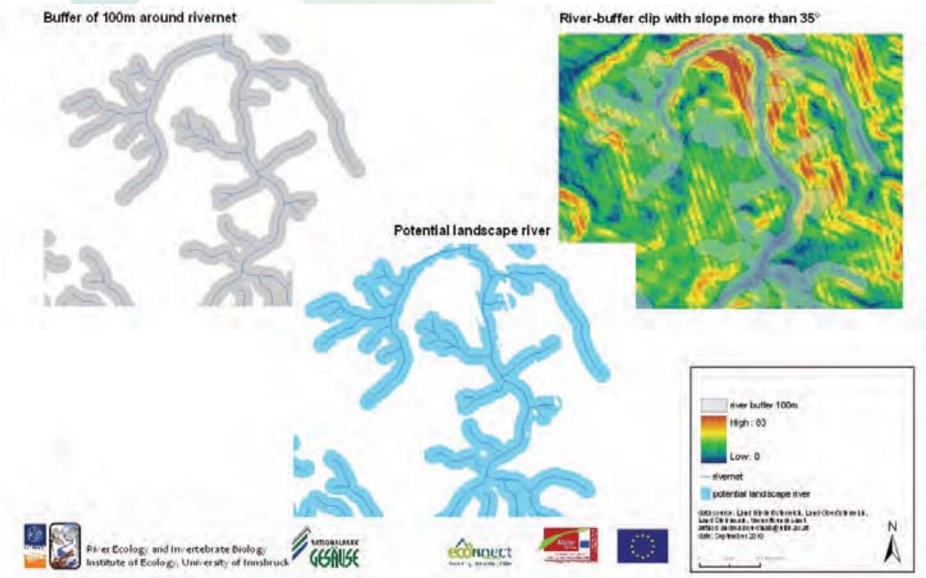
Local habitat and biological diversity of streams and rivers are strongly influenced by landform and land use within the surrounding valley at multiple scales. The rapidly expanding investigation of rivers in the context of their catchments and landscapes clearly indicates that river ecosystems are strongly affected by human actions across spatial scales. The impacts are numerous, both direct and indirect, and complex, owing to the various pathways by which land use influences rivers and the interaction between anthropogenic gradients and the hierarchically structured influence of landform on local stream conditions. Not only does the valley rule the stream, as HYNES (1975) so aptly put it, but increasingly, human activities rule the valley. The extent of change in river health in response to future population growth and development can be anticipated from knowledge of the relationships between land use and stream condition and plausible alternative futures (BAKER et al. 2004).

Within ECONNECT a connectivity analysis for visualisation of potential barriers and obstacles within the riverine systems was applied on the river network of the whole Alpine range and with a more detailed resolution of two pilot regions, i.e. the Northern Limestone Alps and the Hohe Tauern Nationalpark in Austria and Italy.

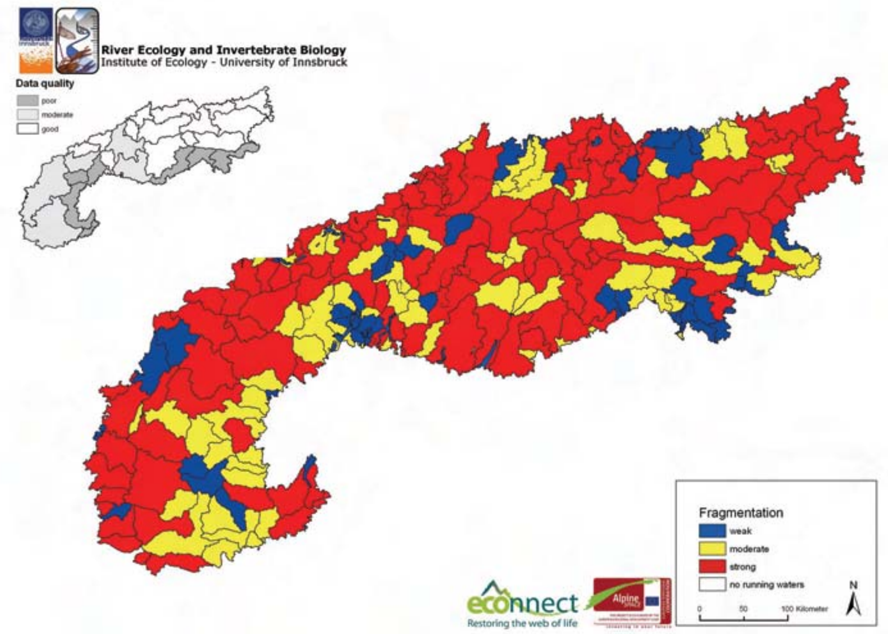
As a first step, the riverine landscape was defined as the river itself and the floodplain as a specific area along its course. This zone was defined by calculating a buffer of 100 m on both sides of the river. The area was then cut at its outer edge when the bordering slopes reached a slope of 35°. The result was a map or GIS-layer of the potential Alpine riverine landscapes. In order to visualise, how land use and natural conditions may affect the landscape pattern, the effective mesh-size (JAEGER 2000), as an index for landscape fragmentation was calculated for the potential riverine landscapes (see maps 15 and 16 on the next page).

The effective mesh size is based on the probability of two points chosen randomly in a region will be connected. The more barriers in the landscape, the lower the probability that the two points will be connected, and the lower the effective mesh size. This method was applied on the priory defined Alpine riverine landscapes. As an ecological unit small river basins (Austrian part < 10km², Italian part < 232 km²) were used to calculate the effective mesh-size. Barriers, obstacles in the longitudinal, lateral, vertical and temporal dimensions of river systems, being potentially effective for selected key species (bullhead, fish otter) were identified and visualised in a map. To place the species aspect in the spatial analysis a habitat suitability model was defined for these focal species. In overlaying the results of potential habitats and their fragmentation as well as barriers, the connectivity is visualised by a map of species specific permeability. The indices were classified by statistical quartiles into three classes.

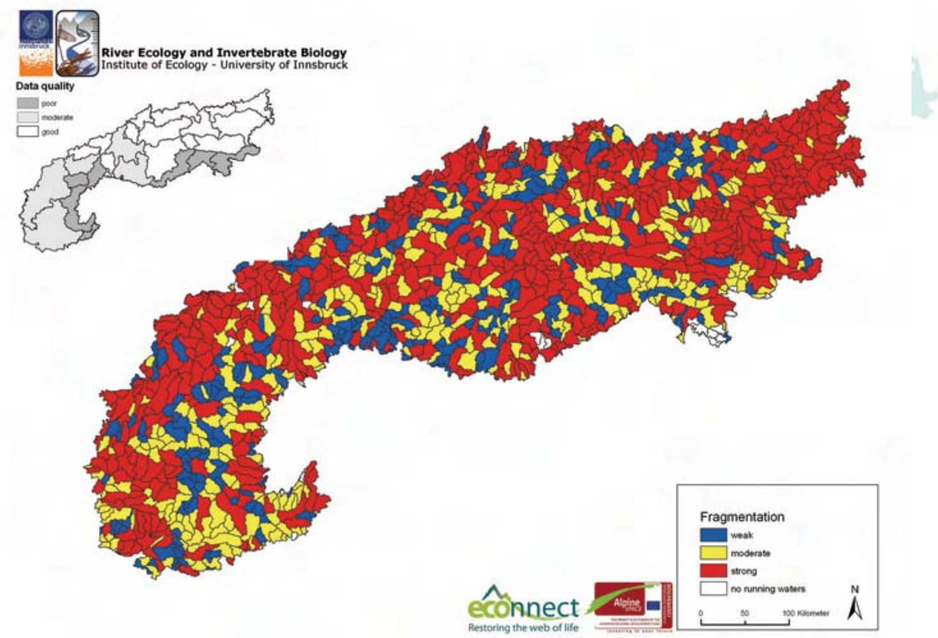
On the one hand the ECONNECT analyses considered the landscape level with fragmentation and connectivity within the riverine landscape and on the other hand a species specific approach. Data on species distribution within the Alps (presence data in point format) were collected for aquatic and river-bound animals. As a first analysis two aquatic species were defined as keystone species, the bullhead (*Cottus gobio*) and the fish otter (*Lutra lutra*). Results for these two species can be found on the JECAMI website.



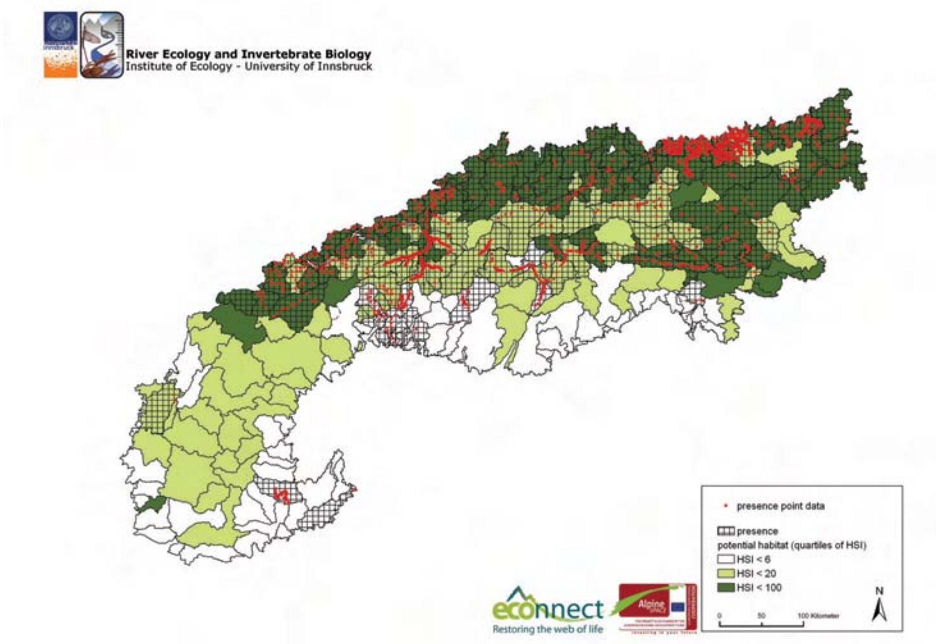
Methodological steps for the definition and calculation of the potential riverine landscape



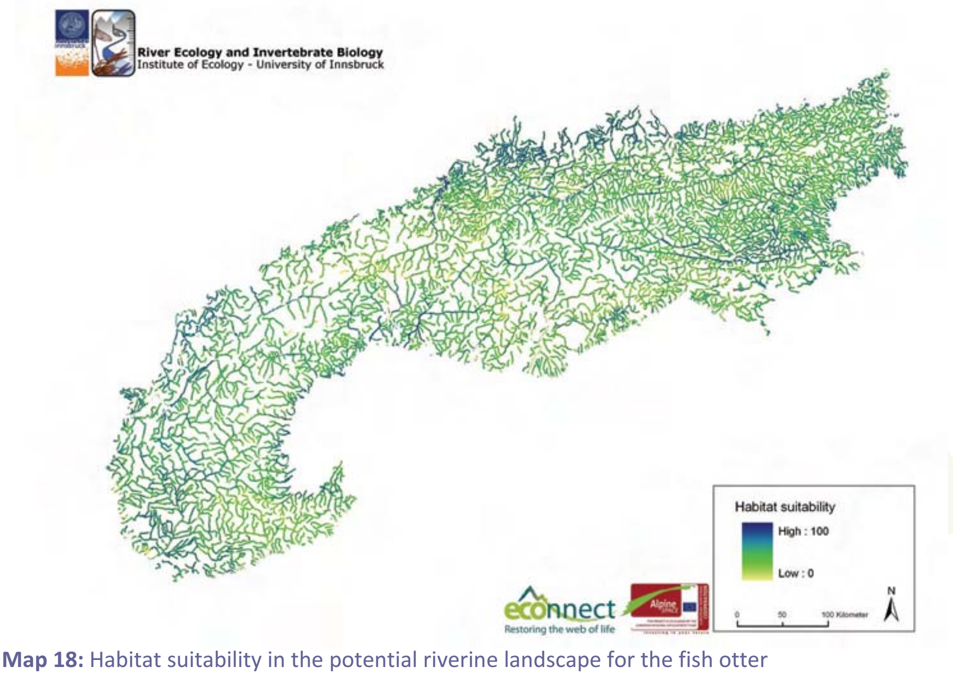
Map 15: Effective mesh-size for river basins (catchment area smaller than 10.000 km²), mind the different data quality!



Map 16: Effective mesh size for river basins (catchment area smaller than 100 km²), mind the different data quality!



Map 17: Habitat suitability for the bullhead combined with presence point data



Map 18: Habitat suitability in the potential riverine landscape for the fish otter

Bullhead (*Cottus gobio*)

The bullhead favours oxygen rich and shallow streams but can also be found in the littoral zone of lakes (HONSIG-ERLENBURG et al. 2002). It is territorial and achieves action rates from four to 350 m (DOWNHOWER et al. 1990, FISCHER & KUMMER 2000). The fish mostly lives on aquatic macro invertebrates, sometimes also fish eggs (HONSIG-ERLENBURG et al. 2002). In some regions (e.g. Hohe Tauern) it can be found up to 2000 m above sea level (STEINER & STAMPFER 1990, STÜBER & WINDIG 1992). As the bullhead is a very small fish that cannot swim very well a head of water with about five to 20 cm is already a big problem and can be count as an insurmountable barrier (for example VORDERMEIER & BOHL 2000). So changing of the water regime because of hydropower plants and the habitat fragmentation caused at the same time has probably the most severe impact on habitats otherwise suitable for the bullhead (FISCHER & KUMMER 2000, MOUTON et al. 2007).

To get the best analysis for the best bullhead habitats, following factors were considered: potential stream landscape, gradient, sea level and mean annual air temperature.

The analysis showed that due to topographic reasons most streams are not suitable for the bullhead and that their limited habitat is further reduced by lots of barriers like hydropower plants for example. As it is an aquatic organism continuous river systems are its only way to disperse and to migrate according to analysis in the past. For example BÜHLER (2006) showed that the bullhead recolonizes habitats pretty fast if barriers are withdrawn. For results see map 17 on page 63 and map 19 on page 64.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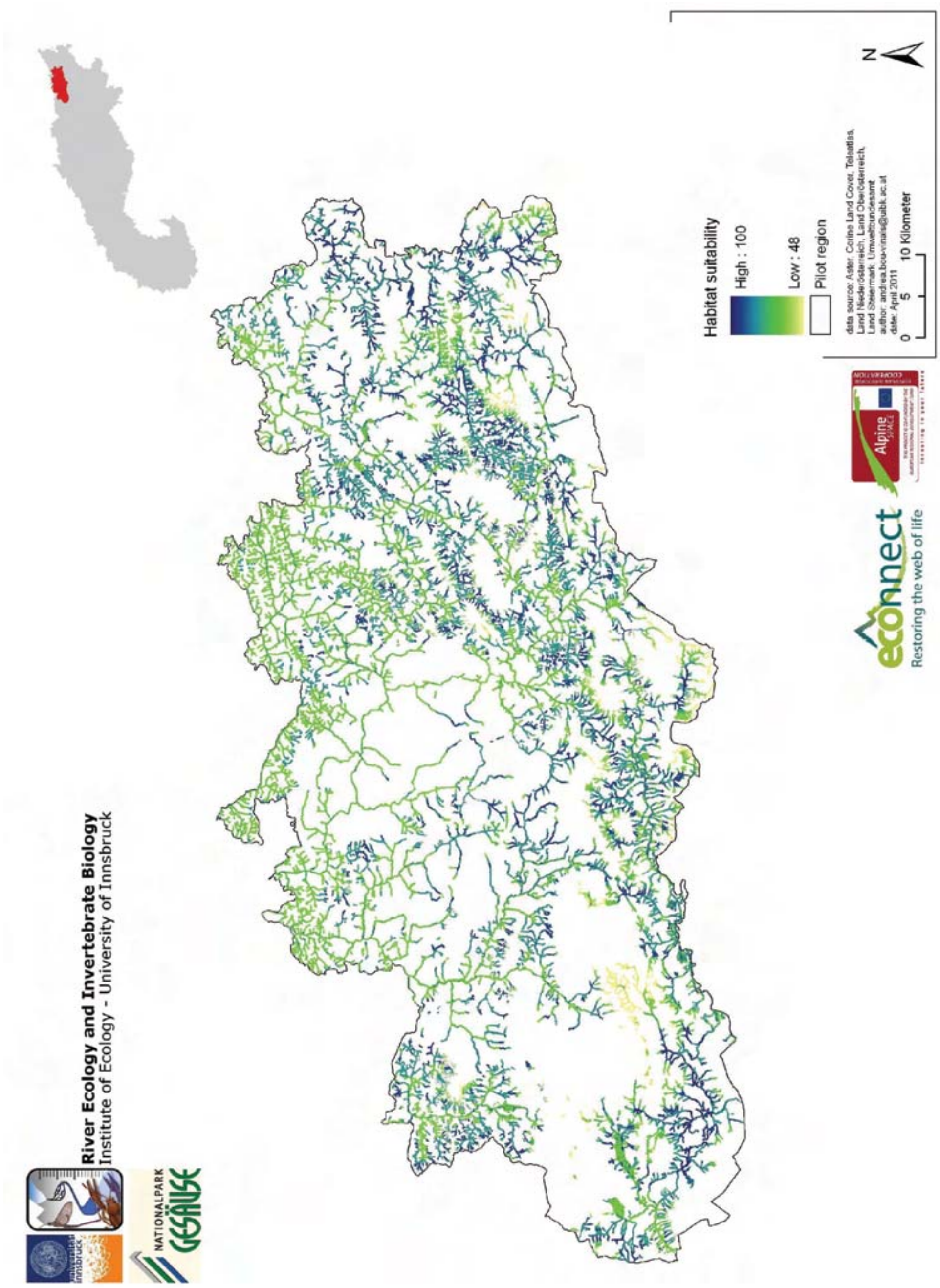


Map 19: Habitat suitability model for the bullhead *Cottus gobio* in the Pilot region "Northern limestone Alps"

Fish otter (*Lutra lutra*)

The fish otter is a semi aquatic species and can live in almost all types of streams (even artificial ones) (KRANZ 2000) as long as enough food is assured (mostly fish but also crayfish, amphibians, insects, sometimes birds and semi aquatic rodents) (KRANZ 2000, NLWKN 2009). The nocturnal fish otter is able to cover a distance of up to 25 km a night (NLWKN 2009).

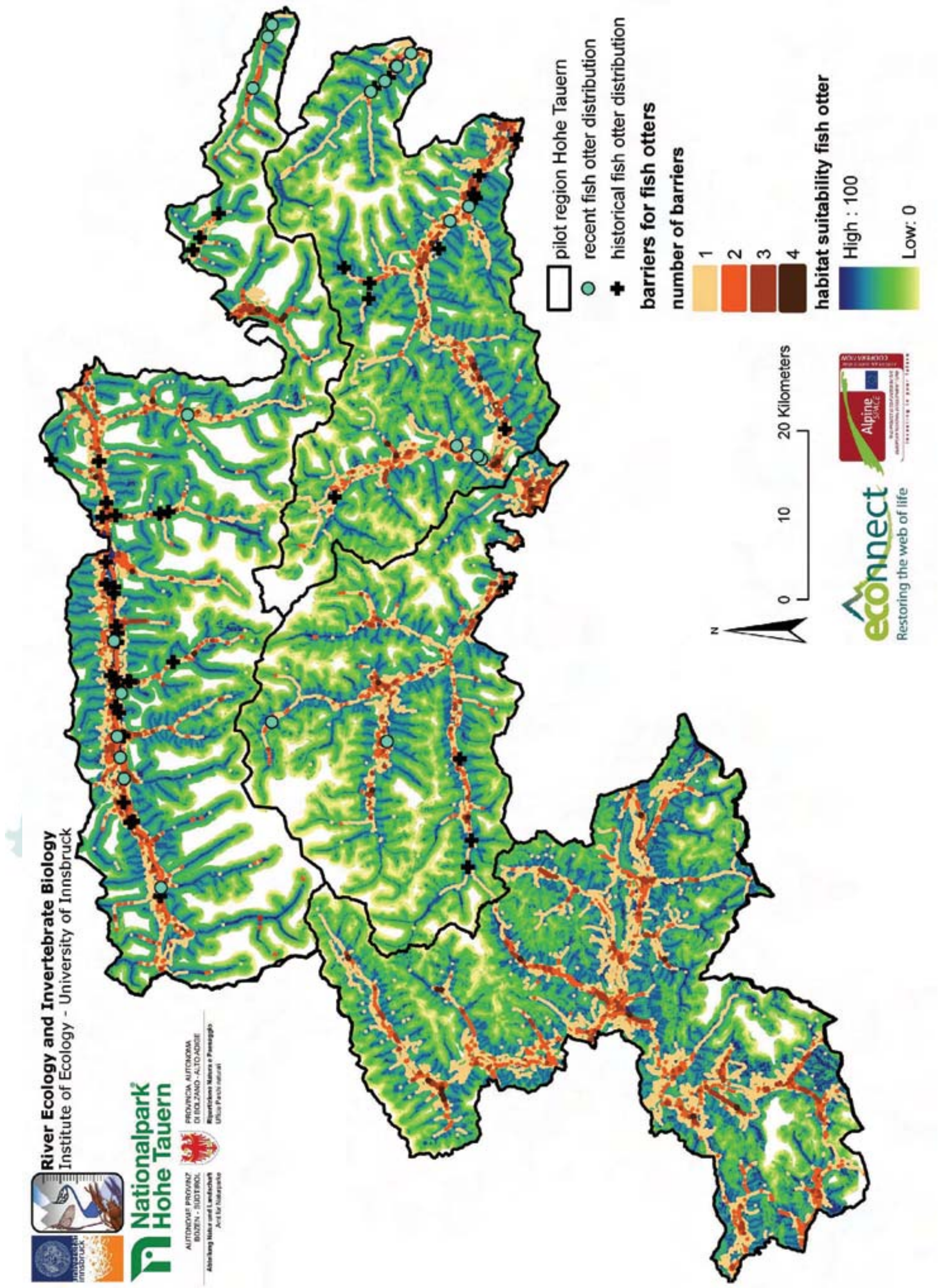
Almost all human activities that have a negative effect on fish can be count as a barrier for the fish otter (KRANZ 2000). The author mentions migration barriers for fish, river training, controlling of torrents and avalanche protection, hydropower usage, reach, pulses, bed load retention and bed load digging. According to CHO et al. (2000), LOY et al. (2009) and MIRZAEI et al (2009) streets, communities, fragmentation of the habitat, intense agriculture, pollution and tourism can have negative effects on otter populations too.

For the modelling streets, communities, disturbance of water morphology, hydropower plants and their use as well as barriers in the streams were considered.

Large parts of the Alps are suitable for the fish otter but with the problem that the best habitats are also the most influenced by human activity. Most barriers are in the valleys which would otherwise be the perfect living space for the otter. However, the fish otter is able to live in close vicinity to humans if enough food is present (KRANZ 2000). The otter can overcome most barriers because it has a high action radius but most fish otter die because they are overrun (NLWKN 2009).

For migration the fish otter needs corridors along water bodies with intact riparian woodland (KRANZ 2000). Lakes of every kind, gravel pits, quarries and wetlands can function as stepping stones as long as a fishing stock is assured (MÖCKEL 1995).

See map 18 on page 63 and map 67 for the results.



Map 20: Habitat suitability model for the fish otter *Lutra lutra* based on distance to water bodies, altitude, slope and land use (CLC 2000) in the Pilot region Hohe Tauern with the number of barriers (roads, settlements, weirs, dams, hydropower stations, impaired river morphology) in its potential range and historical (JAHRL 1995) and recent fish otter distribution (KRANZ, unpubl. data).

4. CONNECTIVITY VISUALISATION – THE JECAMI-WEB SERVICES

Haller R., Abderhalden W., Abderhalden A.

With the ability to determine the past, present and potential distributions of certain species the management and conservation of ecosystems would be a lot easier (SPENS et al. 2007). With powerful techniques like the geographical information systems (GIS) and electronic access to relevant databases, a steady rise of predictive distribution models in ecology and wildlife biology have been observed within the last decade (FERRIER & GUISAN 2006). ECONNECT used various techniques and sources to develop tools for web-supported data analyses and mapping: **JECAMI** – The **J**oint **E**cological **C**ontinuum **A**nalysing and **M**apping **I**nitiative. The JECAMI tool is an easily accessible web tool based on GIS data and consists of several subtools.

Mapping structural and functional connectivity is a key task of every study in this field. The spatial context has to be shown to different stakeholders on different political and spatial levels. The main challenge for ECONNECT was, to combine the visualisation of structural and functional connectivity as well as to allow down-scaling from an Alps wide perspective to local views in the pilot region. Last but not least, the variety of different possible users of ECONNECT's results has demanded a new approach of dissemination of the "maps".

JECAMI – SUBTOOLS

- *The **CSI** service (CSI - Continuum Suitability Index): explore and analyze structural connectivity in the Pilot regions as well as in the whole area of the Alpine convention*
- *The **SMA** service (SMA - Species Mapping Application): detect barriers or corridors for specific animal species in the Alps*
- *The **PAM** service (PAM - Priority Areas Mapping): explore and display data of the Priority Areas of the Alps in context with ecological connectivity*
- *The **CARL** service (CARL - Connectivity Analyses for Riverine Landscapes): explore and display data of the river network in the Alps*

ECONNECT has developed the JECAMI-tool for combining two kinds of information or data – it is to present facts (e.g. land cover and utilisation data, point data) and models (e.g. most recent models for indicators) for further discussion. The simple web based tool should invite stakeholders to gain an understandable insight in the topic, allowing the focus on its own region, and therefore, interest, knowledge and influence. The JECAMI-tool represents a harmonized approach for the analysis and visualization of the structural and functional ecological connectivity in the Pilot Regions of the ECONNECT project as well as Alps wide. Hence, the tool allows identifying areas in the Pilot Regions where connectivity enhancing areas could be located, together with showing the calculated habitats of the species.

The ease of access, the usability and the fast generation of visualized results make it to a most effective tool for stakeholders, but also for the public, decision makers and other sectors.

CSI – Indicators

- *Population*
- *Land Use*
- *Landscape Heterogeneity (edge density, patch cohesion)*
- *Fragmentation*
- *Topography*
- *Infrastructure*
- *Environmental Protection*

CSI - The Continuum Suitability Index

Haller R., Abderhalden W., Abderhalden A

The CSI service defines a continuum suitability index which is calculated by 10 different indicators and which makes it possible to measure and compare the suitability as a matrix of different areas. These indices range from land use, population density, topography but also measures about land use planning.

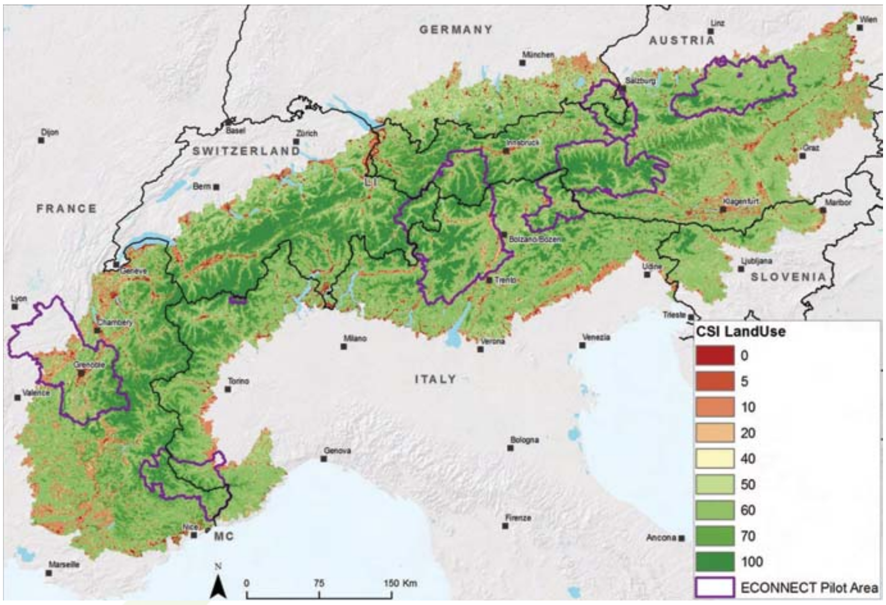
Each indicator is represented by a raster data set with values ranging from 1 = unsuitable to 100 = high suitable as an ecological continuum. This continuous raster approach corresponds to the concept of landscape permeability or resistance respectively cost surface which is conventionally used by ecologists to describe ecological connectivity.

The calculation of an indicator requires a number of steps. Some indicators are more straight forward than others. So for example the “land use indicator” assigns values to existing land uses under consideration of their impact on the natural environment (see map on page 70). The “indicator protected areas” represents a so called “positive attitude towards ecological integrity". It takes into account all protected areas, either nationally designated, Natura 2000 sites of the European Community Habitats and the Bird Directive, the Emerald Network (see map on page 70).

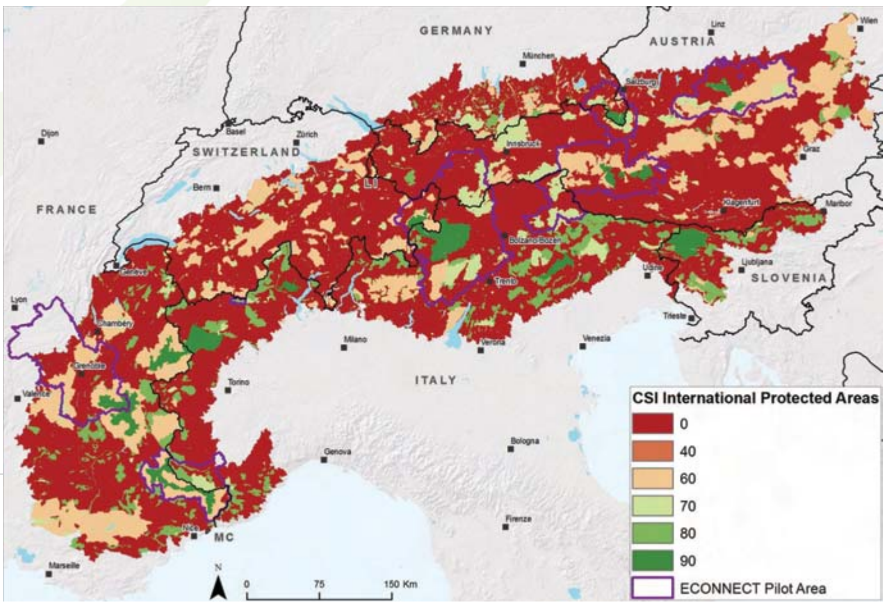
Geoprocessing tools allow interactive selection and analysis of different areas. A spider diagram shows for each indicator separately the quality of the ecological continuum in the selected area, possibly ranging through all landscape scales, from an Alps wide global view to a very local view in a single municipality.

The following chapters will give some results of a CSI-analysis in the Pilot regions of ECONNECT.

The CSI landuse for the Alps



CSI values for protected areas in the Alps



Connectivity analysis – examples from the pilot regions

Region Berchtesgaden Salzburg

Within the Pilot Region Berchtesgaden-Salzburg which consists of 15 Austrian and 16 German communities the values for the CSI read as summarized in Table 2.

In both regions within the pilot region most indicators are more or less equal to each other as natural and human conditions do not differ much.

Even though the data quality values for the Berchtesgaden-Salzburg region are for the thematic valuation pretty low the JECAMI-Tool reflects the real conditions within the pilot region really good. The area is not very densely populated with a low amount of steep territory which is reflected in the high indicator values POP and TOP. On the other hand many roads dissect the area mainly in the northern part of the pilot region which is shown by the low indicator values whereas higher values are reached in the area of the National park Berchtesgaden.

Region Hohe Tauern

Within the pilot region "Hohe Tauern", which consists of parts of three Austrian and one part of an Italian province the values for the CSI indicators read as summarized in Table 3.

It is interesting South Tyrol shows no big differences in most of the indicators compared to the rest of the pilot region. These results do not implicitly indicate that conditions in the Italian part are different to the rest but that there also could be a difference in the quality and quantity of the input data. In such cases the JECAMI-Tool must be handled with caution as the outcome not always can be compared with other results because of different input data. The interpretation of the JECAMI results should therefore always include a closer look at the input data.

Northern Limestone Region

The Northern Limestone Region consists of three parts: Styria, Lower Austria and Upper Austria (Table 4). Within these areas main differences exist between the degree of environmental protection and the values of Edge density and Fragmentation.

For the Limestone Region the JECAMI results show reasonable values for most of the indicators. Only the Land Use Planning results are showing a wrong picture as they indicate that within Styria the most measures were conducted to improve connectivity. Unfortunately the high value results of more input data and cannot be compared to the other two regions were less data was used.

Rhaetian Triangle

Within the Pilot Region Rhaetian Triangle which consists of five different parts from Italy, Switzerland and Austria the values for the CSI indicators read as summarized in Table 5. As the Rhaetian Triangle is the biggest and the most heterogeneous of all the Pilot Regions it is not easy to find special patterns, differences and similarities.

Departement Isère

No other Pilot Region has such a heterogeneous landscape like the Departement Isère. In the Northern part there are huge lowland areas and low mountain ranges. The southern area is part of the French Alps with altitudes up to 4 088 m a.s.l. with the Pic Lory. To display these differences within a study of the whole Departement is not easy and they are not sufficiently reflected in the values of a table but clearly show in the comparison of the altitude levels and in the maps.

The values of the JECAMI study seem realistic for the Departement Isère (Table 6). As the region has a large part outside the Alps and therefore the largest lowland area, it makes sense that the area has the lowest values for fragmentation and land use as these parts are highly used agricultural area. The JECAMI results also display the huge change within the altitude levels as for example the land use values get bigger and the topography values get lower.

The Southwestern Alps

Within the Pilot Region "Southwestern Alps" which consists of 29 French communities and 23 Italian the values for the CSI indicators read as summarized in Table 7.

The higher environment value can be explained by the large protected area within the Mercantour region whereas the Alpi Marittime region has a smaller area protected.

Riverine Landscapes connectivity of the Pilot Regions Hohe Tauern and The Northern Limestone Alps

Bou-Vinals A., Weinländer M., Füreder L.

Riverine landscapes, including the river itself and the surrounding habitats, capture a fundamental part of landscape. In the pilot region NPHT about 14.5 % of the area is occupied by the potential riverine landscape; in the Northern Limestone Alps it is even 23 %. In mountain regions this landscape type is delimited by natural circumstances mainly high elevation and steep slopes.

The results of the effective mesh size showed that the defined riverine systems were highly fragmented in both Pilot areas. This is mainly linked to human activities in the valleys but is also reaching higher areas (e.g. by hydropower development). The natural habitats of the selected key species are delimited, fragmented or even lacking in many river segments. Analysis on the landscape level including biological distribution of riverine organisms identified human land use and activities to denature Alpine landscapes and habitats by an alarming degree. Natural occurrence, movements and migration of most riverine species are expected to be deteriorated.

Table 2: Values for the CSI indicators - Transboundary Area Berchtesgaden Salzburg

MEAN Salzburg	17	-	78	89	29	60	98	18	98	24
MEAN Berchtesgaden	15	5	80	87	-	58	99	40	97	13
MEAN SB-BG	**16**	**-**	**79**	**88**	**-**	**59**	**98**	**29**	**98**	**18**

Table 3: Values for the CSI indicators - Hohe Tauern Region

Name	ED	ECO	COH	TOP	LAP	LAN	INF	ENV	POP	FRA
MEAN Carinthia	17.4	-	84.5	70.8	22.2	67.3	-	25.6	92.6	66.6
MEAN South Tyrol	25.6	-	85.7	72.7	24.3	64.5	98.0	34.7	97.7	42.4
MEAN Tyrol	14.1	-	90.8	65.8	-	73.3	98.0	42.7	97.6	78.7
MEAN Salzburg	11.6	-	91.7	74.0	29.0	70.4	98.7	33.5	95.7	68.7
MEAN Hohe Tauern	**17.2**	**-**	**88.3**	**71.4**	**21.0**	**68.7**	**77.9**	**33.9**	**96.8**	**62.8**

Table 4: Values for the CSI indicators - Northern Limestone Region

Name	ED	ECO	COH	TOP	LAP	LAN	INF	ENV	POP	FRA
MEAN Styria	9	-	88	91	47	63	-	35	97	33
MEAN Lower Austria	14	-	88	86	35	53	-	36	97	22
MEAN Upper Austria	14	-	86	89	21	51	-	12	98	51
MEAN Limestone Region	**12**	**-**	**87**	**89**	**35**	**56**	**-**	**28**	**97**	**36**

Table 5: Values for the CSI indicators – Rhaetian Triangle

Name	ED	ECO	COH	TOP	LAP	LAN	INF	ENV	POP	FRA
MEAN Tyrol	16.1	-	77.0	65.2	19.8	70.3	94.0	21.6	99.1	67.2
MEAN Trentino	34.6	-	65.3	82.0	24.2	70.6	96.8	30.2	97.0	48.2
MEAN Grisons	15.1	1.4	82.3	62.0	63.3	70.2	95.3	28.9	99.8	52.2
MEAN Lombardy	27.6		60.7	73.2	-	72.2	97.2	46.7	80.2	50.3
MEAN South Tyrol	33.3		61.3	76.1	22.8	61.5	94.4	25.6	95.1	62.3
MEAN Rhaetian Triangle	**33.1**	**1.0**	**63.3**	**72.8**	**23.7**	**68.6**	**95.5**	**30.0**	**94.2**	**56.7**

Table 6: Values for the CSI indicators - Department Isère

Name	ED	ECO	COH	TOP	LAP	LAN	INF	ENV	POP	FRA
MEAN min – 1500	7.0	-	84.1	87.7	20.1	40.8	98.5	13.0	-	5.4
MEAN 1500 – 2200	8.1	-	89.1	74.5	20.0	75.2	99.8	46.7	-	33.0
MEAN 2200 - max	8.5	-	89.3	54.5	19.9	96.6	99.5	61.3	-	45.6
MEAN Departement Isère	**7.5**	**-**	**85.1**	**84.2**	**20.1**	**48.2**	**98.8**	**19.8**	**-**	**11.0**

Table 7: Values for the CSI indicators - Southwestern Alps

Name	ED	ECO	COH	TOP	LAP	LAN	INF	ENV	POP	FRA
MEAN Alpi Marittime	7	-	89	84	-	74	99	39	99	48
MEAN Mercantour	29	-	78	80	-	73	95	67	99	43
MEAN Southwestern Alps	**21**	**-**	**82**	**81**	**-**	**73**	**97**	**57**	**99**	**45**

ED = edge density, ECO = ecological measures, COH = cohesion, TOP = topography, LAP = land use planning, LAN = land use, INF = infrastructure, ENV = environmental protection, POP = population, FRA = fragmentation

SMA – The Species Mapping Application

Haller R., Abderhalden W., Abderhalden A.

The SMA persists of habitat distribution and connectivity models (GUIDOS) for key species. These models were developed by the Austrian ECONNECT partners and have a spatial resolution of 1500m. An exception is the model for brown bear which has a resolution of 375m. Five different models are integrated in SMA so far: Brown bear, Black grouse, Griffon vulture, Lynx and Wolf.

The distribution model shows the occurrence probabilities, based on a raster dataset containing values between 0 – 100, where 0 = an absolutely unsuitable habitat and 100 is highly suitable for a certain species. The GUIDOS-model was calculated upon this dataset and is an implementation of the morphological spatial pattern analysis algorithm. GUIDOS classifies a binary image (for example black grouse distribution range) in different categories: each pixel is compared with its neighbouring pixel based on a set of mathematic rules.

On the basis of these models a cost path-function calculates the most barrier-free path for a key species from one point to another in the Alps. The path is overlaid with the map and the barriers (low cell values of habitat models) are marked with a symbol.

CARL - Connectivity Analyses for Riverine Landscapes

Bou-Vinals A., Weinländer M., Füreder L.

The Connectivity Analyses for Riverine Landscapes (CARL) were carried out in combining two different approaches, based on two different datasets, i.e. a) datasets for the analysis of connectivity and potential fragmentation of riverine systems and b) species specific datasets on key species' distribution records and their potential habitat conditions. Habitat suitability models were calculated for the bullhead (*Cottus gobio*) and the fish otter (*Lutra lutra*). Based on their habitat requirements and GIS habitat coverage models, their potential distribution range in the European Alps was assessed and compared to existing records. Within the network of the Alpine riverine landscapes, species specific barriers were identified and their potential effects on the permeability for the focal species evaluated. With the CARL tool, important information on the fragmentation of riverine landscapes in the Alps is visualized, along with the potential to identify corridors for selected threatened species.

The analyses of riverine landscapes with CARL have been applied alpine wide and in two of the Pilot regions, the Northern Limestone Alps and the Hohe Tauern region.

GIS-analysis was performed using ArcGIS 9.3.1 as well as some additional software for ArcGIS like V-late (LANG & TIEDE 2003) and Corridor Designer 1.4.762 (MAJKA et al. 2007). The used coordinate system was UTM, WGS84 - 32Nord.

5. CONCLUSIONS

Füreder L., Kastlunger C., Plassmann G.

The ECONNECT project, implemented to stimulate significant interest for the protection, improvement and development of ecological connectivity throughout the Alpine range, brought up some very clear results why ecological connectivity is not available in the Alpine region:

(a) A dense pattern of human activities prevents ecological connections from being functional.

(b) There is little knowledge on the complex theme of ecological connectivity in administrations, upon stakeholders and the population.

(c) There is a big fear of landowners and stakeholders concerning the establishment of new protected areas, resulting in limitations in land use or even heteronomy.

(d) A lacking will of cooperation and coordination between the different authorities (state, federal, administrative bodies, departments) often leads to a kind of conflict concerning competences and resources, thus hindering work supporting connectivity issues.

It is considered very important that the local/regional managers of protected areas (and/or pilot regions) have the possibility to speak about nature conservation issues outside their limited protected areas. Therefore an extension of the legal mandate of the protected area administration is needed. Even a shift of competences to a central unit, responsible for transnational, trans-boundary or trans-provincial projects at administrative level would be very useful. This unit must be provided with sufficient financial and personal resources and would be working in a trans-sectorial dimension. Presently, a realization of projects dealing with larger areas, habitat connectivity or even an ecological continuum is difficult because of non available-financial means for this type of cooperation and non-existing authorities dealing with this cross-border and cross-sectorial topic. The instances of the Alpine Convention could play a key role in this issue – considering that ecological connectivity is one of the goals of the Convention and official engagement of the Alpine states within this international treaty. Existing cooperation tools in the form of agreements and twinning are not ideal. It would be better to institutionalize them; one way to accomplish this could be the European Grouping for Territorial Cooperation (EGTC).

Another important outcome was the raising awareness of stakeholders, populations and administrations on the performance of ecosystem services. This led to very good results in cooperation and implementation of measures.

Protected areas administrations in pilot regions need sufficient financial and personal resources to fulfil all their complex tasks and functions for creating ecological connectivity, in particular the time intensive communication needs for involving relevant stakeholder groups on connectivity issues.

Ecological connectivity – what does it mean for terrestrial and aquatic key species?

ECONNECT aimed at the enhancement of ecological connectivity in the Alpine Space and developed new methodologies for connectivity analysis, modelled and mapped connectivity, implemented measures in the field, and analysed legal aspects. One of the main objectives was to identify the anthropogenic barriers that influence the movement and/or distribution of different Alpine species, based on their ecological requirements.

For the terrestrial species lynx, brown bear, wolf, red deer, black grouse, griffon vulture, altitude and forest availability are the major factors influencing species distribution. Especially in the Eastern Alps, species seem to benefit from more favourable conditions, probably due in part to the lower altitudes of the mountains. For the aquatic species bullhead and fish otter the analysis showed that rivers, their riparian zones and floodplains are strongly fragmented by artificial structures, associated with human settlements and activities in the valleys.

Analysis also provided general findings about the effect of various barriers species encounter in their life:

(a) Physical barriers are never total barriers as animals still manage to cross them, but manmade barriers seem to delay movements and therefore hinder genetic exchange which can weaken populations

(b) Species benefit from better conditions in the Eastern Alps, caused by lower altitude and forest coverage, which were recognized as major factors influencing species distribution

(c) The densely populated valleys are in many cases the biggest obstacles for animal movement

(d) Building social and political bridges are as important as building green bridges!

The selected terrestrial and aquatic key species clearly showed differences concerning the significance of specific barriers:

Brown bear (*Ursus arctos*) and wolf (*Canis lupus*) are able to cross motorways, even though they are an important barrier and many animal die of run-ins. The biggest problem of these two species, beside fragmentation, is the acceptance by farmers, so it is very important to have Alpine wide management plans considering the fears of the landowners including possibilities to compensate predated livestock.

The European lynx (*Lynx lynx*) on the other hand is seen as a competitor by hunters, so similar management plans with a focus on this preconception are needed. At the moment it is unclear how dramatic motorways are as a barrier for the species, because few road kills are known, but data is limited. As chamois and red deer are the main prey of the lynx their protection and distribution range also influences the predator's presence.

The main problem for red deer (*Cerphus elavus*) is the management conflict in forest areas. To provide proper habitats correct management plans reducing this conflict are important, but of course they are not the only answer.

The black grouse (*Tetrao tetrix*) needs different habitats through its annual cycle. Fragmentation of these habitats and stress due to tourism are the main threats for the bird.

The griffon vulture (*Gyps fulvus*) is the only bird that seems not to suffer by the lack of connectivity as it is able to cover large distances. But it is limited by the lack of food (carcasses) and rock cliffs. Power lines and low numbers in an area (griffon vultures hunt cooperatively) are problems too.

The two selected key species chosen as being relevant for riverine landscapes have very different requirements: the bullhead (*Cottus gobio*) is naturally limited by sea level, gradient and longitudinal barriers (even smaller falls), but its range is further reduced by artificial barriers. Therefore large parts of the Alpine range are not suitable for this species. For the fish otter (*Lutra lutra)* on the other hand, many areas in the Alpine space are suitable even if there is an anthropogenic influence. The fish otter's distribution range is primarily limited by the mountain character of the Alps (the higher the river the lower the fish (=prey) densities, or even no fish) and by the density of artificial barriers in the river.

Call for the promotion of ecological connectivity

While society appears to appreciate the value of protected areas (e.g. sanctuary, recreation) and generally accepts the importance of biodiversity and the associated ecosystem services, there is little understanding of the dynamic needs of our environment. It appears prudent to raise awareness of the limitations of a static protected area approach to Alpine environmental protection in the face of rapid regime changes.

Biodiversity and ecosystem services provide important values to society and economy. Ecosystem services generate much economic value, although commonly the general population is not aware about this. Likewise, ecological connectivity represents an indispensable value for society and the economy, because it plays a central role in ecosystem functioning. When the connectivity between habitats is lost, these habitats gradually degrade and biodiversity levels within them (and associated ecosystem services) decline. Hence, ecological connectivity is a determining factor for the survival, migration and adaptation potential of all plant and animal species present in a given habitat and – by extension – a determining factor for the preservation of ecosystem services.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Necessity of a comprehensive legal framework in support of ecological connectivity in the Alpine Region

A supporting legal framework is an indispensable prerequisite for the establishment of an ecological continuum throughout the Alpine Arc. The necessary legal frameworks are currently inadequate, and, most importantly, do not cover the implementation of transnational ecological connectivity measures. To increase the chances of success, it is imperative to identify legal opportunities and obstacles for the feasibility of every project. An added difficulty is the lack or inadequacy of legal institutions governing private lands, where fragmentation needs to be reduced. Furthermore, due to the absence of an integrated legal framework connectivity issues are insufficiently taken into account in land use planning processes.

Connectivity is an issue involving very different scales and multiple and diverse stakeholders. It became clear within the ECONNECT project that the respect of private landowners´ rights is a key element for the conservation and improvement of connectivity. It is impossible to realise a sustainable ecological continuum without the participation of private and public landowners and interest groups (the ECONNECT pilot region approach is based on such stakeholder involvement).

Spatial planning and landscape connectivity

The central role of ecological connectivity is poorly understood and even less recognised in spatial planning processes. Maintaining and restoring ecological connectivity in the landscape by preserving larger and connected tracts of habitat is essential for biodiversity conservation and for enhancing the resilience of ecological processes in the face of global anthropogenic changes in the multi-functional Alpine landscape. Today, throughout the Alpine Arc, spatial planning and implementation are conducted separately and without coordination by a multitude of individual authorities and institutions (e.g. forestry, water management, transport).

Because the achievement of ecological connectivity requires interdisciplinary planning processes and measures, it must become central to a holistic spatial planning approach. The planning process must be integrated across all relevant sectors, including agriculture, tourism, industry, transport and environmental conservation. Ecological connectivity must be included in the spatial planning instruments of the local, regional and national management and governance authorities. Successful integration of ecological connectivity into spatial planning must consider varied social, cultural, legislative, economic and ecological demands, while assigning sufficient resources and capacities for biodiversity conservation and the maintenance of ecosystem functions.

Protected area authorities as key actors

Protected areas are a key element of ecological networks due to their spatial role in the network and their potentially catalytic function for the initiation and support of the process to maintain and restore ecological connectivity. Protected areas not only have valuable interdisciplinary competences and know-how regarding several aspects which are essential for the process, like communication skills and specific ecological knowledge. Moreover, according to several international and European agreements and guidelines, they are obliged to ensure the spatial and functional integration of the protected area into its surroundings (e.g. Natura 2000).

Nevertheless, these roles have limits, and it is often very difficult for protected area managers to initiate and support a planning and implementation process in territories beyond the protected area itself. It is evident that protected area managers have no direct decision competence for areas outside the protected areas‘ official boundaries, even though, as core zones, protected areas constitute a fundamental element of the ecological network of a certain region. The park manager needs political support and official legitimisation to participate actively and as an initiating organisation within the process. Such legitimisation is particularly important for protected areas featuring a pilot region for connectivity in the Alps. Legitimisation has to be conferred by the competent administrative organ in accordance with the political systems of the individual Alpine countries (federal or centralised systems). Currently legal competence for the landscape between protected areas is situated mainly within local, regional or national agencies and not with the protected area management authorities. Financial and human resources should be strengthened within these authorities to ensure the realisation of an ecological continuum over the long term.

Park borders are generally too constrained to allow for fully functional ecosystems at a scale large enough to conserve biodiversity. Indeed, the Alpine parks and nature reserves alone are too small to protect Alpine biodiversity, especially in times of climate change where increased migration of fauna and flora is essential for the survival of whole groups of species. This migration needs horizontal and vertical interconnected habitats with as little fragmentation as possible.


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Therefore, protected area managers should be enabled to actively support the functioning of ecological processes beyond the borders of the protected area itself. For this reason it is necessary that local or regional authorities grant them official legal competence to engage including within the peripheral zone or entire park region. Close cooperation with the competent administrative authority in questions of ecological connectivity is fundamental.

The need for establishing a common management system for geographic data

Numerous, if not all, European and Alpine projects need access to a significant amount of various georeferenced data. More often than not this data has already been collected through previous European and national initiatives, projects, as well as by public administrations. However, access and analysis is frequently extremely constrained. Data collection and maintenance, for the most part, has been purchased with public funding and it appears an inordinate waste of resources to have to reacquire already existing data sets. Not only is data acquisition very costly, but there is also a risk of breaking copyright laws if licensing agreements of proprietary data are not managed well. Georeferenced data, which is needed for spatial analysis of habitats and barriers, is to a large degree owned by regional and national administrations and is thus public sector information. To reuse this information in an analysis and thus creating new information on which decisions can be based is in everyone's interest. This will enormously reduce time and money spent for data acquisition and management and will generally stimulate the creation of new information.

ECONNECT clearly showed that necessary and important data sets are widely dispersed among diverse institutions and that access is generally difficult, prohibitively expensive or impossible. In the various regions and countries of the Alpine Arc data is often acquired and stored in different formats and with divergent spatial attributes. Lack of common standards and metadata add to this unsatisfactory situation. This constitutes an impediment to the reuse and comparability of public sector information, which is essential for planning cross-border ecological networks well and efficiently. To solve this problem it is necessary to create a joint data management system with common standards, quality assessment, a maintenance strategy and easy user access. Such a system should contain basic spatial data that are commonly needed for European projects in the field of spatial and environmental planning. This data should be easily accessible in order to avoid waste of funds, energy and time. European projects producing such data should have an obligation to populate the database with data following standardised and harmonised data formats.

6. FUTURE CHALLENGES, PERSPECTIVES & OUTLOOK

Füreder L., Plassmann, G.

The ECONNECT project together with The Ecological Continuum Initiative and the Platform Ecological Network of the Alpine Convention, have undertaken major efforts to maintain biodiversity in the Alps by establishing a pan-Alpine ecological network. Their joint activities have produced several important and interesting results. ECONNECT was launched in order to promote model implementation of ecological networks in seven pilot regions. With the support of tools and fundamentals provided by the Ecological Continuum Initiative, the six pilot regions have been working to show how ecological connectivity can be improved in the specific case at the local level and beyond protected areas. ECONNECT also provided additional support in the form of pan-Alpine data bases and analyses of physical and legal barriers to the migration of animals and plants being effective both in the terrestrial as well as in the aquatic ecosystems, respectively. ECONNECT demonstrated in a very lively way at several workshops, conferences and other activities, how the exchange of knowledge is promoted, both among the actors and with other mountain regions.

To counteract the continuous decline of biodiversity in the Alps, quite a number of protected areas were established. All of them contain areas rich in biodiversity and/or beautiful and typical landscape elements of the Alps, including all kinds of common and rare plant and animal species. However, without considering the areas outside the protected areas which are farmed, used or urbanized and therefore acting as a uninhabitable area or barrier for many plants and animals, the decline of biodiversity will continue. In this respect, ECONNECT defined many activities and produced several important results for typical Alpine terrestrial and aquatic species both at Alpine-wide and regional/local level. Nevertheless, these efforts will need to be further deepened, in particular considering further activities at various spatial levels (within and beyond the Alps) and a deeper scientific knowledge about the relevance of connectivity for issues like ecosystem services, distribution of non-native species, pests and disease and climate change.


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The pilot region approach - future perspectives

The ECONNECT measures and implementations undertaken on the important issues of ecological connectivity are continuing on a completely new perception of practices to protect the natural environment. The role of protected areas within their region is being redefined, placing them in a wider territorial context.

After ECONNECT, there are two different aspects concerning the future role of the Pilot regions in ecological networking:

(a) How will the process to achieve ecological connectivity be continued and what is the role of the Pilot regions therein?

(b) In which way the concept of ecological connectivity could be communicated to people living in the Alps and be integrated in the relevant sectorial policies of the Alpine space?

Some examples from the individual pilot regions shall demonstrate the continuation of the process:

- The Transboundary Area Berchtesgaden-Salzburg

In the pilot region "Berchtesgaden-Salzburg" several valuable experiences could be made in the course of ECONNECT. Connectivity is an important topic for the region which is also reflected in the fact that several local partners and stakeholders supported the initiative in different ways. With ECONNECT a foundation could be laid on various levels. For sure knowledge gaps could be filled allowing for profound future decisions and actions towards connectivity. A common transboundary and topic related spatial database as well as methods for analyses have been developed and validated and discussed with local experts.

But also communication and awareness raising are important aspects which need to be continued after ECONNECT so that decision makers are increasingly aware of the complexity of natural processes in the landscape. The harmonization and integration of planning is key to the successful implementation of Alpine ecological connectivity. During the regional process a close cooperation between different sectors and with a wide range of stakeholders and partners was initiated. Based on the positive experiences made within ECONNECT follow-up initiatives have a high potential to be even more successful.

But it became also obvious that is still a long way to go to safeguard the regional webs of life. For this the paradigm shift which has been initiated with the help of ECONNECT needs time to develop and deepen - the integration of sectors, borders, people, nations, opinions, persons as a basis to implement connectivity on the ground includes a change in the way of thinking which needs time to evolve.

ECONNECT was an important starting point for a process in the pilot region, ultimately leading to the successful conservation of biodiversity as livelihoods of the communities in the region. Therefore support for the continuation of the process is inevitable as demands as well as options could be identified.

- The French Departement Isère

The Department leads the project Paths of life until August 2014. The end of the project will be the achievement of a great work. Its evaluation will create an interesting basis to further improve the methods to implement concrete actions. This scientific and technical evaluation is also completed by a sociological study. In addition, the Department works also on other areas (such as Bièvre Valloire or Trièves), where some studies are also on the way to identify more precisely the corridors and lead some actions through. The Department has also created a steering committee to reflect on the methodology to identify the corridors on different scale and to give the tools to the municipalities to identify their own corridors. In the same time the regional council of Rhône-Alpes has to implement the Regional Ecological Network.

The Department has been an active part in the process of reflecting about connectivity and is willing to carry on its work at the level of the department, the region and also Europe.

- The Northern limestone Alps region

The Pilot region "Northern limestone Alps" has an exceptional high potential as region combining an outstanding high value for nature conservation with environmentally-sensitive green tourism. Unifying these targets through integrating landowners and main stakeholders as the ones who are responsible to maintain and evolve this high values in the region could be the way to face challenges in the future, like migration into the cities. This could happen by developing a common project like "VEuER" (German: “VErnetzen und ERleben”), mainly covering the ideas of the different stakeholders, which would built the bracket around their different interests. Referring to the Pilot region “Northern limestone Alps” as a rather rural area its adjective “outback” might become charming in a very special way. These typical values have to be strengthened and outlined in common, cross-provincial land-use planning. A way could be the founding of a new brand like "your region of nature" a kind of macro region covering three federal provinces in the middle of Austria, a hotspot for experiencing wilderness and "near nature management". Another big step in this direction will be the organization of “Connectivity Events 2012”: several big events on ecological connectivity in 2012 in cooperation with European and regional project partners. The programme will focus on the “results of ECONNECT” but also on special topics in the Pilot area Northern Limestone Alps, for example celebrating a day of biodiversity and a day of nature (including the 20th anniversary of the EU LIFE programme).

- The Rhaetian Triangle

The lessons learned during the ECONNECT project can be described as follows: nature conservation strategies and efforts are a common work; in all the areas of the Pilot region Inn-Etsch. Introducing the concept of ecological connectivity is less a question of single measures but more a question to convince acting people to revise their concepts. This is the most demanding task because it requires the change of well established, legitimated actions and behaviour. This means that in the future, the work of changing minds and concepts may need more effort than working on field actions: implementing ecological measures on locations of particular spatial importance could be a key.

In concrete terms, in the pilot region of the Rhaetian Triangle it is planned to proceed with the following initiatives:

(a) To support the foundation "Pro Terra Engadina" in its actions, taking care that the idea of ecological connectivity is the base of all concrete measures.

(b) The WWF has defined the Rhaetian Triangle as one of their main areas to restore biodiversity. Several initiatives have been started recently to establish concrete connectivity actions in the area.

(c) At local level a project has been submitted in the Biosphere reserve Val Müstair – Parc Naziunal Svizzer to support the conservation group of South Tyrol in their engagement against the river canalization of the Rom/Rombach.

- The Hohen Tauern region

The protected areas are one important centre of biodiversity and provide decisive stepping stones for the ecological connectivity. But the legal authority of the protected area ends at their borderlines. Therefore other authorities are in the same way responsible for the building of an ecological web of life for ecological connectivity in the Alps. Several laws and different legal frameworks are concerned by the question of establishing an ecological continuum whereas the responsible authorities for nature protection have to implement the ecological connectivity. The large protected areas are core areas of a regional ecological network and therefore they can play an active role in the establishment of ecological networks as an integral part of regional development. To ensure future biodiversity it is very important to have a landscape that is not fragmentised. One important tool to gain this aim is land use planning and regulation. This was also stated in the EU-conference on biodiversity conservation in Warsaw 2011. For all these topics it is necessary to involve and to integrate the private and public landowners and interest groups.

- The southwestern Alps – Mercantour/Alpi Marittime

The next concrete perspectives of the pilot region are focusing on terrestrial connectivity by equipping all problematic faunal transect routes with light devices to warn automotive drivers about crossing animals. Another possible topic at theoretical level can be the application of the two GIS models Funconn and JECAMI at regional level. This would allow comparing both results with the ecological network designed by the administration of Region of Piedmont (which is currently only available on paper).

However, the priority topic at the moment is to implement aquatic connectivity concerning the legal parameters of Minimal Vital Flow (MVF) on all the Gesso and Stura rivers, inside and outside the park. This topic needs to involve all administrative levels, regional, provincial and municipal level as well as private stakeholders (agricultural and energy stakeholders). A big effort is needed to consult different actors to negotiate an agreement like the "Contratto di fiume" which is a type of agreement foreseen by the Region of Piemont in the Water Conservation Plan (PTA). This tool represents the only tool that could allow a long term conservation of rivers according to the Water Framework Directive.


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Alpine Landscape Connectivity: Biodiversity, Ecosystem Services and Climate Change

Füreder L., Kastlunger C., Sedy K.

Landscape and habitat fragmentation is considered as one of the major threats to species extinction and a consequential loss of biological diversity, making it perhaps the most important contemporary conservation issue (WIENS 1996). Landscape fragmentation is simply the disruption of continuity (LORD & NORTON 1990). Landscape connectivity is understood as a vital element of the landscape structure (TAYLOR et al. 1993) because it is critical to population survival and metapopulation dynamics. Landscape connectivity can be defined as the degree to which the landscape facilitates or impedes movement between resource patches (TAYLOR et al. 1993), being essential requirements for a typical assemblage of species and structural elements.

Ecologists have long known that the size of and distance between habitat patches constrain species richness and influence the distribution of species (MACARTHUR & WILSON 1967). Recently, the spatial arrangement of these patches and their connectivity have also been suggested to play an important role in the assembly of communities at local and landscape scales (GRAY et al. 2004, UEZU et al. 2005). Higher connectivity among habitat patches allows immigration to offset extinction events, leading to higher local species richness but lower variability in community composition across the landscape (i.e. beta diversity, WHITTAKER 1972). In contrast, lower connectivity can isolate patches, leading to lower local species richness but higher species turnover across the landscape (ECONOMO & KEITT 2008).

Connectivity is now widely acknowledged as a fundamental property of all ecosystems. The concept was introduced to ecology through landscape ecology as a factor explaining distribution of species (MERRIAM 1984, MOILANEN and NIEMINEN 2002). However, definitions for this term vary widely and are often based either on metapopulation dynamics or continuity of landscape structure (CALABRESE and FAGAN 2004).

Connectivity, biodiversity and ecosystem services

The correlation between connectivity and biodiversity has been discussed inconsistently. While some authors consider connectivity as very useful to boost biodiversity (e.g. BRUDVIG et al. 2009), others question this (e.g. SIMBERLOFF et al. 1992).

BRUDVIG et al. (2009) demonstrated that connected patches gradually became more species rich and that by increasing species richness in target patches surrounding non-target patches (habitats) benefit from a so called “spillover” effect. So their results strongly suggest that the management of reserve networks can have a large effect on biodiversity. Depending on the kind of management, the matrix of a landscape can be “softened” therefore making it less hostile for organisms or the matrix can get stronger, enhancing its connectivity (FRANKLIN 1993). So the management of habitat connectivity, network arrangement and habitat patch quality is very important to guarantee the conservation of biodiversity in the future (CHISHOLM et al. 2011). Reptiles, amphibian, mammals and some invertebrates are considered to benefit most from an improved matrix, because they have intermediate dispersal possibilities (DONALD & EVANS 2006).

Ecosystems not only are important for a characteristic biodiversity but generate a range of goods and services for human well-being, collectively called ecosystem services (NELSON et al. 2009). Most of these services are crucial for our survival like climate regulation, air purification, crop pollination etc. Others enhance our lives for example a beautiful and scenic natural river system (KREMEN 2005). At the moment the specific contribution a species makes to ecosystem services is unknown, but it is known that they differ in their potential contribution. Therefore the advancement of biodiversity enhances the probability that a species, important in the sense of ecosystem functioning, is present (TSCHARNTKE et al. 2005). Interactions between species may enhance, reduce or do not affect the ecosystem service each species contributes (TSCHARNTKE et al. 2005). There is strong evidence that high-diversity has a positive effect on important ecosystem services, even if it is still unknown how exactly this works (TSCHARNTKE et al. 2005).

The results of ECONNECT provide fresh evidence that the Alpine Arc forms a diverse mosaic of habitats showing various levels of multiple anthropogenic impacts. The present trends in land use lead to further fragmentation and to deterioration of connectivity of habitat suitable for permanent occurrence of large mammals. Today large carnivores (like lynx, wolf and bear) with high territorial requirements inhabit only a few separated islands (patches) of suitable environment (ANDEL et al. 2010).

Landscape fragmentation due to urban sprawl and fast processing constructions of roads and river engineering brings along a number of negative impacts, such as barrier effects, causing a loss of natural connectivity between individual populations of the fauna (SEILER 2002). The subsequent drop in genetic variability may lead, among other effects, to a further loss of biodiversity at both the regional and the Alpine level.

Large carnivores, represented by the focal species wolf, lynx and bear, are highly sensitive to landscape fragmentation. These species are currently restricted to forested mountains or submountain areas, where they can live nearly undisturbed by man. Generally it can be said that the numbers of the subpopulations are poor and dispersed. The potential areas providing suitable environment for the permanent occurrence of their subpopulations are often too distant from another. Young individuals searching for new home ranges are often forced to migrate long distances. The long term sustainability of these small and dispersed living populations is further threatened by illegal hunting or (in the case of wolf) by legal removal programs. These populations are strongly dependent on migrating individuals as a number of populations would have already died out.

The populations of large carnivores can be characterized as minor subpopulations that more or less communicate. Such subpopulations are generally less tolerant to various disturbances, such as newly appeared barriers, lost or altered habitats, or escalated illegal hunting (ANDEL et al. 2010).

These small subpopulations are strongly dependent on gene flow. Even if the distribution is spatially discontinuous, there needs to be sufficient connectivity, in space and time, to permit the dispersal of animals that ensures gene flow and some degree of demographic stabilization (LINNEL et al. 2007).

Hence, there is an urgent need to conserve a high genetic variability and to promote exchange between populations. Increasing numbers of wildlife populations in fragmented habitats (like red deer in Austria) are no indication of viability. In contrast, they bear the risk of sudden extinction without any clear sign of threat (STROHMAIER 2007).

For the wolf, one of the ECONNECT focal species, there is a re-colonizing process that originated from the Apennines. The ECONNECT pilot regions “Northern Limestone Region”, “the Rhaetian Triangle”, “Hohe Tauern” and “Mercantour/Alpi Marittime” region serve as a key source area for this process as they contain a higher percentage of core habitats and corridors. The connection and therewith constant gene flow with the Apennine population is constituted by an ecological corridor represented by the Ligurian Apennines Mountains (MARUCCO 2011).

As ecological connectivity has been identified as one of the key factors for safeguarding biodiversity the improvement and safeguarding of corridors are essential. In order to change the current situation for the better, the concept of ecological connectivity has to reach beyond the Alps. The connection between the Alpine and the Carpathian Arch needs to be maintained and improved by the protection of an Alpine-Carpathian corridor. After first contacts and project implementations for improving the ecological connections between the Alps and their surroundings, this process has already advanced considerably.

The Pan-European Vision - Ecological Networks Within and Beyond the Alps

The establishment of an ecological continuum across the Alps, although achievable only with huge common effort, is only a first step in the realisation of a wider, pan-European network. A common vision for an intact migration and dispersal space for all kinds of organisms is the foundation of a mountain network spanning across Europe from the Pyrenees over the Alps to the Carpathians.

A trans-boundary approach towards ecological concerns is necessary along the mountain ranges crossing the continent. Already existing strategies at European level, e.g. Natura 2000 network, Water Framework Directive, FFH-Directive, Birdlife Directive, have to incorporate the requirements for this pan-European mountain belt. At least 16 European countries with different languages and cultures would have to work on a common topic as complex as nature conservation. Besides the implementation of existing directives, a thematic exchange in order to identify important issues for the enhancement and maintenance of ecological connectivity needs to be addressed (e.g. controlled tourism development, sustainable development and land use, river monitoring, species monitoring, preserving natural habitats, habitat restoration in a larger context). For the successful implementation of such a wide spanning project there is a need for a common strategy and international, multi-level collaborations, including strategic lobbying and activities to increase public awareness for nature conservation. A long-term cooperation between the Pyrenees, the Alps and the Carpathians would be necessary in order to consider the possibility of creating ecological corridors for species migration and genetic exchange, as well as exchange of knowledge among the protected areas of the mountain ranges for the sustainable management of the natural and cultural mountain belt.

Connectivity and Climate Change

Issues related to global climate change now permeate every aspect of our lives. This leaves scientists and managers scrambling to understand how changing climates are impacting major ecological phenomena such as where animals breed, spend the winter and the pathways they take along the way. The nonlinear, complex, and discontinuous nature of global climate change and biological response patterns limits our understanding of how ecosystems will change under projected climate-change scenarios and how these changes will be distributed across geographical regions and biomes. The lack of knowledge currently limits our ability to manage ecosystems and implement strategies that could help mitigate the effects of global climate change.

Scientists are just beginning to scratch the surface of the complex and inter-related issues surrounding how animals will respond to climate change. There are numerous hypotheses and associated predictions regarding the changes, depending on the species, habitat and location. Some will be positive, others negative.

Anyhow, the interest in connectivity was further stimulated by the prediction that climate change will shift the geographic range of habitats. So species must have the ability for dispersal otherwise they face extinction (BERRY et al. 2002). The potential of increasing habitat connectivity at landscape scales to help reduce the negative effects of climate change on wildlife was first proposed in the 1980s (PETERS & DARLING 1985) and has been discussed several times since (DAWSON 1994; CHEN, ZHANG & LI 2003; HULME 2005). Creating or maintaining corridors of natural habitat are unlikely to be the best way of delivering this connectivity for many species (DONALD 2005), especially those with poor dispersal (HULME 2005), although if they were to be deployed for this purpose simultaneously improving matrix quality would improve their function (BAUM et al. 2004).

CHISHOLM et al. (2011) added that two conditions must be met to enable the dispersal of species: (a) high quality habitats must exist and (b) this habitats must be reachable by individuals. By establishing protected area networks along elevation gradients, certain taxa may be able to adapt to climate change. But such networks are only useful for species with the spatial flexibility to shift their distribution along these elevation gradients (MAWDSLEY et al. 2009). An improved matrix based on better landscape permeability may have a positive effect on lots of species but as there is no focus on rare species or species with very specific habitat requirements some of these species may face extinction (MAWDSLEY et al. 2009). Still, in their review on recommendations to face climate change HELLER & ZAVALETA (2009) mention that the attempts to increase connectivity (e.g. designing corridors, removing barriers for dispersal, locating reserves close to each other, reforestation) is the most frequent recommendation to cope with climate change, but they also state that most of these recommendations are very vague, without identification of the actors that should be involved (e.g. reserve managers, policy makers, land owners). ECONNECT executed in a very constructive way how to consider these aspects. Stakeholders at several levels were involved from the very beginning.

EFFECTS OF CLIMATE CHANGE (MAWDSLEY et al. 2009):

- *Shifts in species distribution, often along altitudinal gradients*
- *Changes in the timing of life-history events, or phenology, for particular species*
- *Decoupling of coevolved interactions, such as plant-pollinator relationships*
- *Effects on demographic rates, such as survival and fecundity*
- *Reductions in population size (especially for boreal or montane species)*
- *Extinction or extirpation of range-restricted or isolated species and populations*
- *Direct loss of habitat due to sea-level rise, increased fire frequency, bark beetle outbreaks, altered weather patterns, glacial recession and direct warming of habitats (such as mountain streams)*
- *Increased spread of wildlife diseases, parasites and zoonoses (including Lyme borreliosis and plague)*
- *Increased populations of species that are direct competitors of focal species for conservation efforts*
- *Increased spread of invasive or non-native species, including plants, animals and pathogens*

7. ECONNECT PUBLICATIONS AND FURTHER INFORMATION

ECONNECT Publications

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Important links

The ECONNECT project: www.econnectproject.eu

Downloads from the ECONNECT web side: http://www.econnectproject.eu/cms/?q=download_area/en

The JECAMI tool: www.jecami.eu

Factsheets on ecological connectivity in French, German and Italian: http://www.alpconv.org/theconvention/conv06_WG_d_en.htm

Information platform on Alpine ecological networks and website of the Ecological Continuum Initiative: www.alpine-ecological-network.org

Platform Ecological Network of the Alpine Convention: www.alpconv.org

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9. APPENDIX

Work packages and responsibilities in the Alpine Space project ECONNECT

Work Package	WP Responsibility	Contact Person
WP 1 – Project Preparation	CIPRA International	Aurelia Ullrich-Schneider *aurelia.ullrich@cipra.org*
WP 2 – Project Management	FIWI – University of Veterinary Medicine Vienna (Research Institute of Wildlife Ecology)	Chris Walzer *chris.walzer@fiwi.at*
WP 3 – Information and Publicity	WWF Italy	Riccardo Nigro *r.nigro@wwfrp.it*
WP 4 – Data Management	EURAC – European Academy of Bolzano	Kathrin Renner *kathrin.renner@eurac.edu*
WP 5 – Barriers and Corridors	UBA-AT – Austrian Federal Environment Agency	Katrin Sedy *katrin.sedy@umweltbundesamt.at*
WP 6 – Legal Barriers	MATTM – Italian Ministry for the Environment	Paolo Angelini *angelini.paolo@minambiente.it*
WP 7 – Implementation in Pilot Areas	TFPA – Task Force Protected Areas (Permanent Secretariat of the Alpine Convention)	Guido Plassmann *info@alparc.com*
WP 8 – Transfer of Knowledge within and beyond the Alps	UIBK – University of Innsbruck (Institute of Ecology)	Leopold Füreder *leopold.fuereder@uibk.ac.at*

Examples of connectivity measures in the ECONNECT Pilot Regions

Pilot Region	Title or Description of Measure
The Transboundary Region Berchtesgaden-Salzburg	1. Utilization of extensive grasslands 2. Amphibian fence 3. Saletbach - Revitalization and connectivity study 4. transboundary exchange
The Northern limestone Alps Region	1. Measures for habitats of the white backed woodpecker (*Dendrocopos leucotos*) 2. Measures for habitats of the ural owl (*Strix uralensis)* 3. Awareness raising with public "Connectivity Event" 4. Genetics of western capercaillie (*Tetrao urogallus*): Population dynamics and "turnover" in neighbouring habitats.
The Hohen Tauern Region	1. Western capercaillie (*Tetrao urogallus*) connectivity project Mallnitz 2. Western capercaillie (*Tetrao urogallus*) connectivity project Matrei 3. Winter Sport Visitor management concept Larisa in Mallnitz 4. Fixing of the idea from the ecological connectivity in the Austrian Strategy for National Parks
The Monte Rosa Region	1. Maintenance of landscape elements usefully for ecological connectivity 2. Insertion of new measures for improvement of connectivity on the occasion of ZSC designation 3. Regulation of touristic flows

Examples of connectivity measures in the ECONNECT Pilot Regions (continued)

Pilot Region	Title or Description of Measure
The French Department Isère	1. Sensitization against the light pollution the 1st of October 2. Improvement of a wall identified as obstacle for the fauna 3. Training session organised with the Cemagref 4. Methodological guide about the hierarchical ecological networks
The southwestern Alps - Mercantour/Alpi Marittime	1. Implementing aquatic connectivity 2. Implementing terrestrial connectivity 3. Implementing aerial connectivity
The Rhaetian Triangle	1. Preserve connectivity at the Rom riverine system 2. Implement connectivity in regional planning process 3. Collaboration within the model project INSCUNTER – synergies in rural areas