Interreg
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ALPBIONET2030

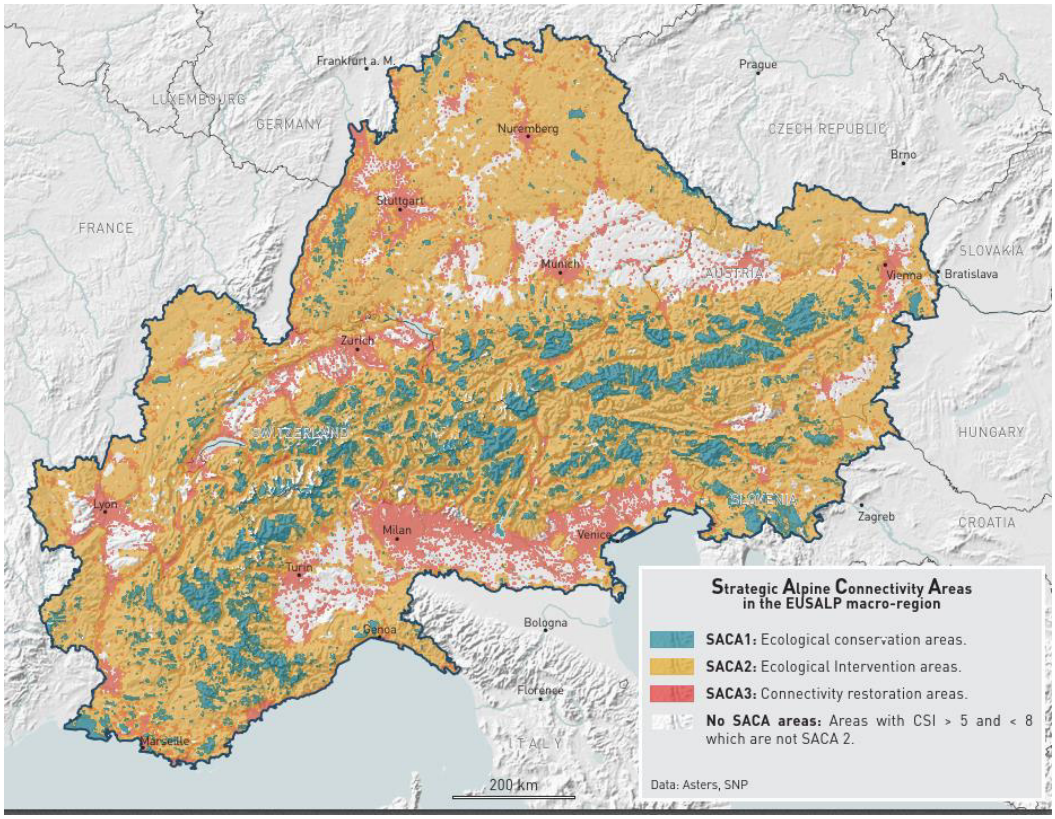
Integrative Alpine wildlife and habitat management for the next generation

Super Strategic Connectivity Areas in and around the Alps

The ´Super-SACA´ approach – very important areas for [ecological] connectivity in the Alps

1) Strategic Alpine Connectivity Areas - a basis for the Super SACA identification

The ALPBIONET2030 project tried to bring together, analyse and combine a series of different indicators influencing ecological connectivity at different levels in order to illustrate the current situation of connectivity in the alpine and EUSALP territory and to elaborate, through a collection of the maps, a concrete foundation for planning a sustainable strategy of land use in the Alpine Space. The project integrated essential factors of such a strategy by defining Strategic Alpine Connectivity Areas (SACA) with an especially dedicated tool (JECAMI 2.0), evaluating wildlife management and human-nature conflict management aspects and generating recommendations. The extent of the project encompassed, for the first time in this thematic field, the whole area of the European Strategy of the Alpine Region (EUSALP).



Map1: Strategic Alpine Connectivity Areas in the Alps and EUSALP

Map N°1 displays all three of the different types of Strategic Alpine Connectivity Areas at once. The map clearly illustrates that the Ecological Intervention Areas (EIA) constitute the largest percentage of the Strategic Alpine Connectivity Areas. The EIA act as linkages between Ecological Conservation Areas (ECA) as well as buffer zones.

Looking at the Alpine and EUSALP picture, it appears that the ECA, mostly located in the higher Alpine areas, are, to a large extent, already benefiting from an existing protection measure (some category of protected area) and therefore need commitment to long term preservation of this status without any degradation of ecological functioning.

Connectivity Restoration Areas (CRA), located in the lower altitudes, are concentrated at the border area between the mountain zone and the lower lands surrounding the Alps. Here, interventions to improve ecological connectivity require participation of a larger number of stakeholders as well as significant financial investment. As these areas are often located in densely urbanized areas or areas with intensive land use, actions must also be closely coordinated with the spatial planning sector.

Since the EIA represent the greatest surface area and are geographically distributed over the different altitudes and areas of the Alps and the EUSALP, they are the focus of this approach. Their relative abundance also illustrates the high potential both in and around the Alps for ecological connectivity improvement by implementing the corresponding actions. Large parts of the landscape would benefit from a coherent initiative of ecological network building.

All Strategic Alpine Connectivity Areas together cover 77% of the EUSALP territory (84% of the territory of the Alpine Convention). Therefore, 23% of the area is not covered by any of the three SACA categories.

Areas with CSI values between 5 and 8 would normally fall into the category of the Ecological Intervention Areas (SACA 2). Based on their individual geographic context, they have, nevertheless, been excluded from this category because of their location in areas where interventions concerning improvement of ecological connectivity would not make much sense according to the criteria defined by the project (lakes, high altitudes above 2500m asl). They have also been excluded from this category if they do not act as connecting elements between two Ecological Conservation Areas. This is the case if distances between two ECAs are too great to ensure connectivity between them.

It is noticeable that the areas not considered in the Strategic Alpine Connectivity Areas categories are mostly located on the border between the EUSALP territory and the territory of the Alpine Convention.

The intensive land use observed in this zone explains the absence of protected areas and, according to our findings, therefore also the absence of Ecological Conservation Areas that could be connected. The main land use type leading to these results is agriculture, which is practiced in an intensive way in the concerned zones. Improvement of the permeability of the landscape matrix and creation of larger protected areas in these zones could certainly improve the situation and would lead to a classification in the Ecological Intervention Areas category.

2) Main barriers in, from and to the Alps

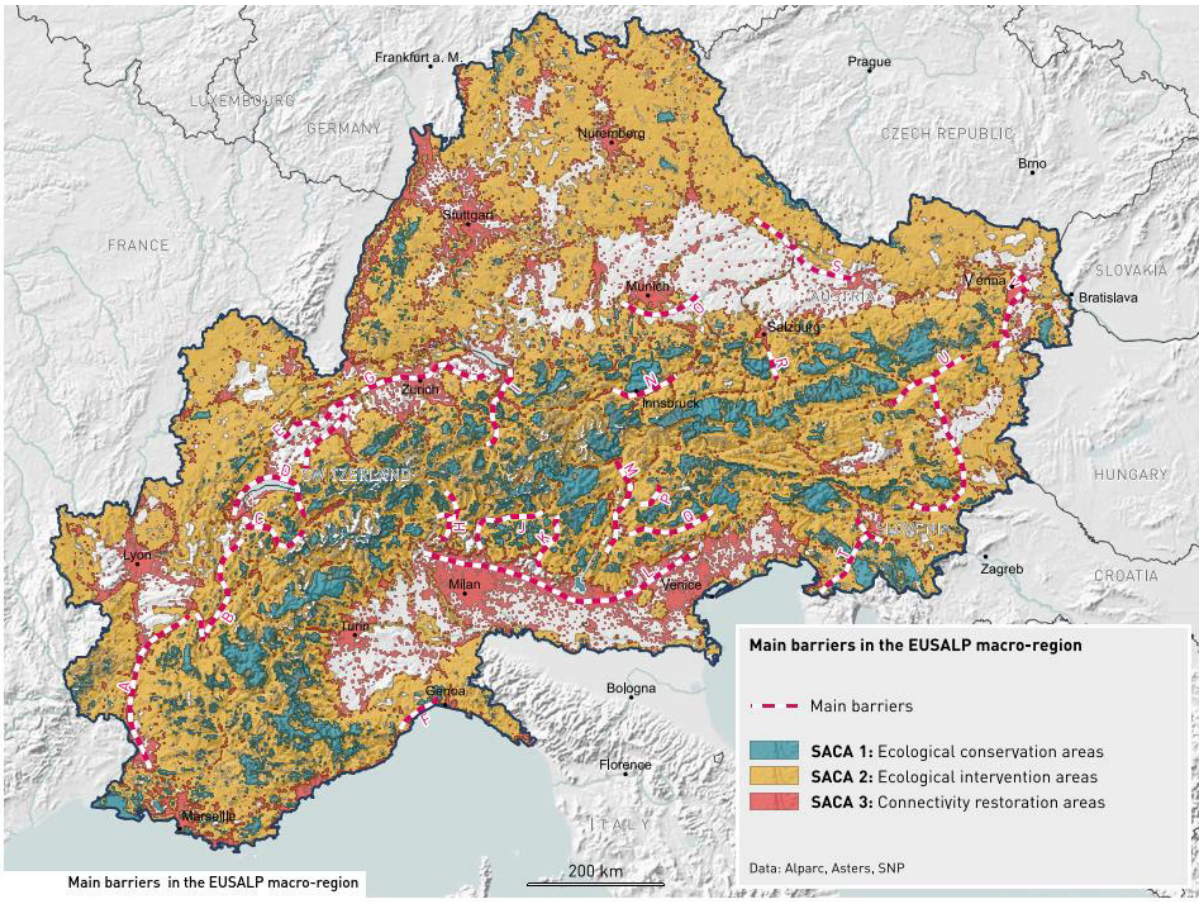
Some forms of land use and their intensity have negative effects on ecological connectivity. This map highlights important barriers to ecological connectivity for the Alps due to high impact land use, important infrastructure and human activities. The barriers have been identified based on an exhaustive analysis of data, expert knowledge and verification "in situ".

The most important barriers are located around the Alps mainly in the transition zone between the Alps and the EUSALP territory (Alpine Macro-Region). They are characterized by a significant concentration of urban and economic infrastructure generating high transport and energy flows. These peri-Alpine barriers are situated in upper Italy (Po flat plane); the southern French Rhône valley up to lake Geneva by way of some intensively used pre-Alpine valleys (e.g. the French Isere valley); the central Swiss region between the Jura and the Alps; the urban belt south of Munich (DE) with a very high transport flow to and from the Alps and a large discontinuous sector of agglomerations, infrastructure and intensive traffic between Vienna (AT) in the North and Maribor (SI) in the South continued by a barrier of transport infrastructure between Ljubljana (SI) and Trieste (IT).

A series of inner-Alpine valleys have been identified as inner Alpine barriers due to a combination of varied factors such as high traffic of people and merchandise, important settlements linking all economic activities, intensive agriculture, canalization of riverine systems, monocultures, and heavy infrastructure, such as highways and railways protected by fences and energy lines concentrated in some important valley floors. Such inner-Alpine valleys include: the Isere valley between Grenoble and Albertville (FR); parts of the Arve Valley (FR) between Annemasse and

Sallanches; the lower Rhône Valley (Valais, CH); the Rhine Valley between Chur and Bregenz (CH, AT); parts of the Inn valley (AT); the area around Lake Como, parts of the Adige, Adda, Camonica, Brenta and Fiemme valleys (IT); the northern Salzach valley and parts of the Mürztal (AT).

Nevertheless, most of these inner Alpine barriers still have hybrid areas allowing for migration of some species. It is essential that those areas are conserved to avoid isolating even more Alpine nature and species.

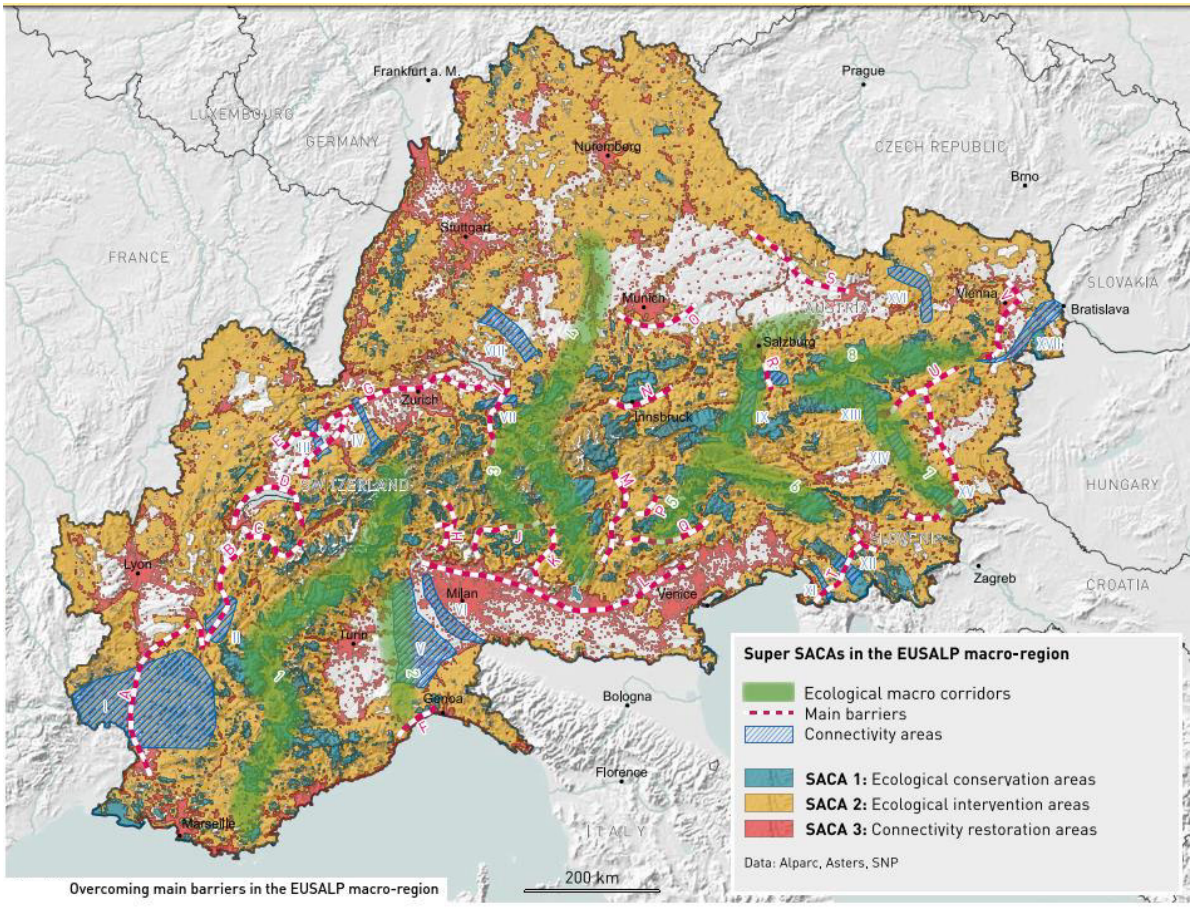


Map N° 2: Main barriers in the EUSALP macro-region

3) Overcoming main barriers

Ecological connectivity is no longer ensured in many parts of the Alps, especially in the large belt area around the Alpine arc. To protect biodiversity and enable enough gene exchange and migratory movements of species, it is crucial to concentrate on measures in areas where connectivity is the most needed and where implementation is feasible. Transalpine ecological macro corridors and strategic connectivity areas are hot spots of connectivity allowing species to overcome barriers by improving landscape permeability through adequate measures and strategies.

The main features of Alpine ecological connectivity (barriers, ecological macro corridors and connectivity areas) are summarized on the map “Super SACA” (N°3), which illustrates the high priority areas for action to ensure ecological connectivity for generations to come. Adapted measures need to be taken in these areas.



Map N°3 Overcoming main barriers in the EUSALP macro region

Identification of these areas reflects the output of a complex data analysis of several indicators such as land use. It also relies on the classification of the Alps into three SACA types as well as expert knowledge from the different Alpine countries and ALPBIONET2030 project partners. Connectivity areas are strategic regions, where protection, planning and specific ad-hoc measures are necessary to avoid isolation of Alpine biodiversity at the Alpine periphery (EUSALP) and to allow the conservation of large-scale wildlife corridors reaching neighbouring mountain massifs of the Alps. Connectivity areas represent pathways through identified obstacles or bridging areas where SACA 1 areas (made of “biotopes” and “stepping stones” of an ecological network) are missing or are insufficient in number.

Ecological macro corridors functionally ensure long distance links between habitats and less fragmented regions by providing both north-south and east-west ecological connectivity in (and through) the Alps. North-south “corridors” are highly significant for species migration and constitute an important “green-infrastructure” and an adaptation strategy addressing climate change. It is of high ecological interest to conserve these areas along the macro corridors, which are often composed of protected areas. It is essential to understand that these macro corridors and the areas surrounding them are part of the last non-fragmented sectors of the Alps covering numerous SACA 1 areas.

Some of the connectivity areas (e.g. I, III, IV, V, XII, XVII) and the macro corridors (e.g. 2, 4, 7) have a very high importance not only for the Alps and the EUSALP area but also for larger parts of Europe by interconnecting European mountain massifs or different biogeographical regions. Defining “Super SACA”, the map provides the first concrete indication of where to prioritize action. This does not, however, represent an exhaustive list.

4) Description of the main barriers, connectivity areas and ecological macro corridors (Super-SACAs) in the Alps and the EUSALP

i) Connectivity areas

Connectivity Areas	
I	Pyrenees - Central Massif – Alps
II	Path of Life corridors Isere valley (Gresivaudan)
III	Jura - Seeland - Alps connectivity area
IV	Oberaargau connectivity area
V	Western Po catchment area
VI	Ticino River connectivity area
VII	Rhine Valley connectivity area
VIII	Swabian connection Black Forest/Alps
IX	Berchtesgaden-Hohe Tauern connectivity Area
X	Salzachtal connectivity area
XI	Karst connectivity area
XII	Alps-Dinarics connectivity area
XIII	Mustair connectivity area
XIV	Lavanttal Alps connectivity area
XV	Drautal connectivity area
XVI	Bavarian Forest - Bohemia - Danube connectivity area
XVII	Alpine - Carpathian connectivity area

ii) Main barriers

Main barriers	
A	Rhône Valley
B	French Northern prealpine valleys
C	Arve valley
D	Lake Geneva region
E	Jura Alps
F	Wester Sea Alps
G	Northern Swiss Plateau
H	Lago di Como agglomeration
I	Rhine Valley agglomeration
J	Como-Adda agglomeration
K	Rovato-Edolo
L	Central southern Alps - Upper Italy

M	Adige Valley
N	Inn Valley
O	Southern Munich Area
P	Fassa Valley
Q	Trento-Belluno transit corridor
R	Tauern Highway north-south transit axe
S	Danube valley transit axe
T	Central Sovenian Transit axe
U	Leoben - Grazer Bassin - Klagenfurt - Slovenian Border
V	Alps – Carpathians trafic corridors

iii) Ecological macro corridors

Ecological macro corridors	
1	Western North-South transect
2	Alps – Apennine transect
3	Central North-South alpine transect W
4	Central North-South alpine transect E
5	Eastern North-South transect
6	South Eastern transect
7	Eastern transect
8	Far east transect

Detailed description

Barrier A (Rhône Valley) / B (French Northern prealpine valleys) Connectivity area II (Path of Life corridors Isere valley (Gresivaudan)

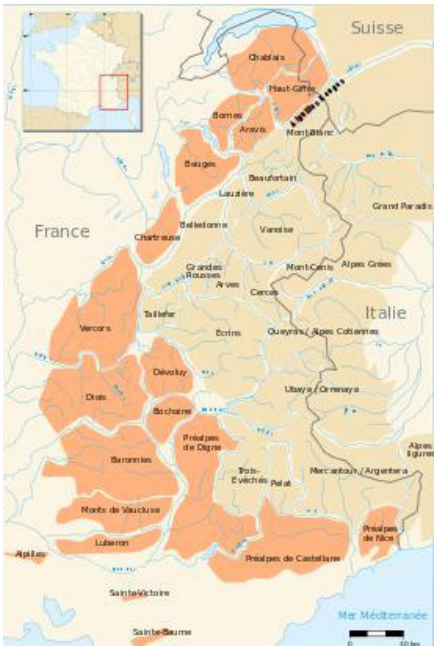
Description of the area

The **French Prealps** (*Préalpes*) are a group of subalpine mountain ranges of medium elevation located immediately west of the French Alps. They roughly stretch from Lake Geneva southwest to the rivers Isère and Drôme; east to a line running from Chamonix, to Albertville, to Grenoble, to Gap, to Barcelonette; and south from Grasse to Vence in France.

In the northern subalpine regions, the various ranges are easily identifiable by geographical separations, such as the Voreppe Gorge between Vercors and Chartreuse, or Chambéry, which sits in a valley between the Bauges and Chartreuse ranges. In the southern subalpine regions, the ranges are generally disorganized and lack the wide, deep valleys that divide them in the north.

Three non-contiguous ranges traditionally comprise the southern French Prealps: the Alpilles, Mont Sainte-Victoire, and Sainte-Baume. (Wikipedia, 2019)

The Prealpine System is composed by series of small or middle-sized mountain ranges from North to South of the French Alpine Arch:



Ranges and peaks

Chain	Range	Highest Summit	Elevation (m/ft)	Comments
Savoy Prealps	Haut-Giffre Massif	Dents du Midi - Haute Cime	3,257 metres (10,686 ft)	Highest summit in the French Prealps
Savoy Prealps	Aiguilles Rouges	Aiguille du Belvédère	2,965 metres (9,728 ft)	
Savoy Prealps	Chablais Alps	Hauts-Forts	2,464 metres (8,084 ft)	Peak on French side of the range
Savoy Prealps	Bornes	Pointe Blanche	2,438 metres (7,999 ft)	
Savoy Prealps	Aravis Range	Pointe Percée	2,750 metres (9,022 ft)	
Savoy Prealps	Bauges	Arcalod	2,217 metres (7,274 ft)	
Savoy Prealps	Chartreuse Mountains	Chamechaude	2,082 metres (6,831 ft)	
Dauphiné Prealps	Vercors Plateau	Grand Veymont	2,341 metres (7,680 ft)	also called the French Dolomites
Dauphiné Prealps	Diois Mountains	Mont Jocou	2,051 metres (6,729 ft)	
Provence Prealps	Baronnies	Mont Mare	1,603 metres (5,259 ft)	
Dauphiné Prealps	Dévoluy Mountains	Grande Tête de l'Obiou	2,789 metres (9,150 ft)	
Dauphiné Prealps	Bochaine	Mont Céüse	2,016 metres (6,614 ft)	also called the Pays du Buëch
Provence Prealps	Massif des Trois-Évêchés	Tête de l'Estrop	2,961 metres (9,715 ft)	
Provence Prealps	Digne Prealps	Les Monges	2,115 metres (6,939 ft)	
Provence Prealps	Vaucluse Mountains	Signal de Saint-Pierre	1,256 metres (4,121 ft)	
Provence Prealps	Luberon Mountains	Mourre Nègre	1,125 metres (3,691 ft)	
Provence Prealps	Castellan Prealps	Puy de Rent	1,996 metres (6,549 ft)	also called the Grasse Prealps
Maritime Prealps	Nice Prealps	Pointe des Trois Communes	2,080 metres (6,824 ft)	Highest point on the Authion Massif
Non-contiguous	Alpilles	Tour des Opies	498 metres (1,634 ft)	Traditional southern range
Non-contiguous	Mont Sainte-Victoire	Pic des Mouches	1,011 metres (3,317 ft)	Traditional southern range
Non-contiguous	Sainte-Baume	Joug de l'Aigle	1,148 metres (3,766 ft)	Traditional southern range

(Wikipedia, 2019)

The main geological component of these massifs is limestone. The vegetation and habitats differ a lot due to different climate situations.

There are as well main differences in land use between the northern and the southern pre-alpine mountain ranges:

The main land use is characterised by traditional farming but losing more and more its importance, pastoralism and settlement completed in the North by a quite intensive touristic activity due to the proximity of big cities such as Grenoble, Chambéry, Lyon or Geneva.

These mountain ranges have the particularity to be all characterised by very important karst phenomena. The whole pre-alpine system is geologically marked by limestones with a very high degree of calcium carbonate facilitating deep karstification generating a high fragility for ground water pollution.

The main cities are in the north the Geneva (CH) agglomeration, Annecy, Chambéry, Grenoble – the largest alpine city and agglomeration, and some small cities in the southern Alps (Gap, Sisteron, Grasse…) without important impacts towards fragmentation.

Description of possible problems or potential concerning ecological connectivity

Characteristic of barriers, importance of the area as linking element in an alpine context (strategic importance of the Region), etc.

Connectivity is definitely a topic for the northern French Prealpine system, the southern Alps are less concerned presenting low urban and infrastructural pressure beside some local spots. The hot spot of ecological fragmentation in this northern pre-alpine area concerns the valley of the Isere river (Gresivaudan) and, at a lower degree the Arve Valley. In the Gresivaudan we find a classical multi aspects fragmentation system composed by numerous infrastructure elements such as highways, canalisation, high tension lines, intensive traffic on national roads but as well urban sprawl and intensive agriculture.

Further important fragmentations are mainly presented by the valleys separating the pre-alpine mountain ranges of the Northern Alps. They are all intensively used by infrastructure, settlement and economic activities, often by intensive agriculture. The importance of the regions for connectivity and migration is characterised by its function as border habitats between the peri-

alpine area and the alpine system. Climatic change is favouriting the migration of several species towards the north or vertically (e.g. the rock partridge)

Generally, difficulties for connectivity are more important in the northern alpine valleys than in the southern ones due to higher urbanisation. An exception is the very southern part, close to the coastline of the Côte d'Azur. In this area important urbanisation and heavy traffic are fragmenting considerably the connectivity from the Alps to the peripheric area. In the West, the Rhône valley form an important barrier, with infrastructure, urbanisation and intensive agriculture.

The western pre-alpine system has a high importance for linking the Alps to neighbour massifs such as the Swiss and French Jura, the French Central Massif and finally the Pyrenees.

Existing knowledge about ecological connectivity in the area

Already existing studies/analysis/planning documents on ecological connectivity aspects in the area; Is the area identified as important area for connectivity by national/regional/local administrations or other institutions

Several studies have been realised in the area and both, the Northern and the Southern French Alps and Prealps are part of the French strategy of green and blue paths (or corridors). Especially in the department Isère intensive analysis, studies, projects, establishment of special measures and infrastructure in favour of ecological connectivity have been realised to reduce the ecological impact of one of the most fragmentated alpine valleys – the so called "Gresivaudan" (or otherwise said – the valley of the Isere river).

In charge of those studies and measures are the French regions by establishing plans of regional ecological coherence [SRCE]; strategies for green and blue belts and other planning tools. Some departments are particularly active such as the department of Isère and sometimes single communities are proceeding to concrete implementation measures. Protected areas haven't been explicitly involved in these approaches besides NATURA 2000 sites and some other non-specially managed areas.

Some studies about the region have been realised by ALPARC and its partners, especially in the frame of the projects "Life Belt Alps", "GreenAlps" and the ongoing "ALPBIONET2030".

An exhaustive summary for the Northern west-alpine region is given by the following description mainly based on the pre-alpine part:

Green corridors in the Rhône-Alpes region

The Rhône-Alpes region, which is remarkably rich in plant and animal species, has undertaken steps to preserve its natural heritage. There has, however, been progressive landscape fragmentation, especially in the area around the urban center of Lyon and other cities over past decades.

With co-financing from the EU, the region has created a series of 'green corridors in areas where biodiversity is threatened. These corridors are meant to connect or restore different natural core areas in order to preserve the ecological continuity of the region. These green corridors are based on a system of land contracts constructed around a detailed five-year action programme, which are on average financially supported to about 50% by the region (total grant limited to EUR 1 million per contract). The contracts are drawn up through an ongoing dialogue between state authorities, associations and local stakeholders.

The main objectives of the contracts are to restore corridors, ensure their sustainability, and to improve knowledge on species and ecosystems. They also aim to foster environment-friendly farming methods to protect biodiversity and counter obstacles to biodiversity conservation. As of 2012 five corridor contracts were in place and covered 5 % of the Rhône-Alpes region (**Grésivaudan, Bauges-Chartreuse, Chartreuse-Belledonne,** Massif Central, Saint-Etienne). In 2019, six contracts are in place in this area (Arves Porte des Alpes, Coeur de Savoie, Grenoble Alpes Métropole, Pays Bièvre-Valloire, Grand Rovaltain and Mandement-Pays de Gex) and several pre-feasibility studies are current. The contracts have led to the construction of wildlife passages, hedges have been planted, riverbanks have been restored in some areas, and sustainable farming and wetland management measures have been implemented.

The green corridor contracts form the basis of the SRCE and are part of the green and blue network "*Trame verte et bleue*- TVB)".

The main funders of the corridor's contracts are the Rhône-Alpes Region, the General Councils and the Water Agency RMC. The EU is involved in corridor contracts for Champagne-Genève and Arve-Lac through an Interreg project. Other kind of contracts are in place, like the "territory contract" in Haute-Savoie. The ecological connectivity is one of the main topics of this contract.

The region won an EU RegioStars Award for the green corridors in 2012 in the category of "sustainable growth – investments in ecosystem services and green infrastructure leading to sustainable regional development".

Other French Pre-Alpine implementation examples of the Trame verte et bleue:

There are also other activities, besides the green corridor contracts, that support the implementation of the TVB. Some examples from the Département de l'Isère region are worth mentioning: In 2001, the General Council of Isere realized the departmental ecological network of Isere (REDI), which identified more than 600 points of conflict on the territory of the Department. These points of conflict have been prioritized and 10 emerged as priorities, including the Grésivaudan valley and gorge Voreppe.

Since 2001, five small wildlife crossings were made and a European project was launched. In 2004, the Department wanted to implement a comprehensive project for the restoration of biological corridors in the Grésivaudan valley between the Chartreuse, Vercors and Belledonne. After studies and consultation with all partners (municipalities, infrastructure managers and space), a global project was launched in 2008, the “Corridors of Life” (Couloirs de vie) project, which includes provisions for small wildlife passages in Cheylas.

The town area features a last stronghold of green tree frogs in the Grésivaudan valley. This project includes awareness and communication activities, evaluation, work on highways and county roads (laying fauna detectors, realization of ramps, installation of opacifying elements, etc.) and spatial management (study on the evolution of agricultural practices, agroforestry, etc.).

The Isère region has also since 2011 been testing a wildlife detection system110, which was installed in seven zones along departmental roads. This system allows the detection of small and large wildlife species that are in proximity of the road. Detection poles are arranged on either side of the road, with masts covering a lateral radius of 300 m and an axial distance of 50 meters, thus covering the entire target area. Once an animal is detected, a signal is sent to motorists. Within a one-year period more than 4000 animals have been detected across the seven sites.

In the Savoie area, the Commune de la Motte Servolex, where the dominant land use form is agriculture and forestry, but where urbanisation pressures are also increasing, has decided to preserve old trees and dead wood as biodiversity elements in the landscape. They have been creating nine “old tree islands” in commonly held forests.

This approach is part of an action plan for the establishment of a natural forest network in the Rhône-Alpes region. La Motte-Servolex has also signed the Action Plan for Wetlands proposed by the Chambéry metropolitan administration and actively participates in the development of the Regional Plan of Ecological Coherence driven by the Savoie administration.

Also in Savoie, The departmental forest of Combe d'Aillon is partly located at the Natura 2000 site "Mont Colombier" (about 300 hectares). As such, and as part of the revision of the planning document, the General Council of Savoy, the National Office of Forests and Regional Natural Park of Bauges Massif looked for a type of forest management that would reconcile economic and environmental issues.

A number of surveys were conducted in this forest. To go further in the process, the establishment of a network of “senescence islets” in the production area was conceived. The county forest in Muret sector has benefited from a Natura 2000 forestry contract ("Measure promoting the development of senescent wood to facilitate the establishment of the network of islands"). The measure concerns a method for favouring the development of an old growth forest in order to improve the conservation status of species associated with old/dead wood and with the Habitats Directive´s demands of representativeness and naturalness of habitats. Under the plan, particular identified “remarkable trees” (at most 4 trees per hectare) are to be marked and excluded from forestry measures for a 30-year period as long as they do not represent a threat to people.

Like in Isère, there is also a project in support of amphibian crossings in Combe de Savoie (Détrier) and Maurienne (Aiguebelle). The project addresses two of the main amphibian mortality sites on county roads in Savoy. On the RD73 in Aiguebelle, every year on average some 3500 amphibians were crushed, while about 2000 were killed on the RD925 to Détrier, a road with heavy traffic of some 5000 vehicles / day.

During the spring of 2012 and 2013 some smaller crossings and lateral guiding devices were constructed and are now operational. These have restored connectivity for small wildlife, and as a bonus have also allowed an optimisation of the annual amphibian counting campaigns by NGOs.

An example of a “blue corridor” is the very recent reconnection of the rivers Drac and Romanche. The Drac is a 130-km long river and a tributary of the Isère River. The Natural Reserve of the Drac Isles was created in July 2009. It covers an area of 15 km along the Drac for a total of 804 ha. The gazetting decision was taken by the Rhône-Alpes Regional Council, following a strong mobilization of the territory for this project and the advice of the Regional Scientific Council of Natural Heritage.

Recently the water of the Drac river was topped up downstream, which had been proposed since the 1990s, so as to increase instream flow from 3 to 5.5 m3/second at the dam of Our Lady of Commiers. This topping-up became effective in early September 2015. It allows the Drac, formerly dry for some 300 days of the year to join the 78 km long mountain river Romanche and thus restore the ecological connectivity of this area.

(extracted and adapted from ALPARC Study, 2016: Life Belt Alps, Karin Svadlenak-Gomez)

Potential threats/need for action

Are (future) large scale project planned (for example infrastructure, etc.)

In the northern pre-alpine System, the valleys and mid-altitudes near to the main agglomerations continue to be under a high urbanistic and economic pressure. Land-use is intensive concerning the sealing of surfaces, intensive agriculture and general artificialisation of landscapes.
Some projects for tourism or other economic sectors could extend fragmentation: new infrastructures, new business park, new transport infrastructure. In the southern Alps, the construction of a highway (A41) is still not definitively abandoned.

In the whole pre-alpine area, there will be probably new high-tension lines, further use of waterpower due to the political decided but slowly ongoing energy transition towards more renewable energies.The tourist development in mountain could create an important treat due to climate change, because more and more tourists are going to be in altitude during summer times.

Species concerned

All vulnerable animals are suffering about fragmentation. Only opportunist species are not really concerned.

The main species concerned by the fragmentation in this area are mostly the typical species for this kind of threat as mammals and especially the large ungulates but as well birds as the black grouse, animals suffering from climate change needing fresh habitats (snow grouse) or to move vertically or to the north.

Insects are concerned. Populations decrease and fragmentation is one of the reasons.

Wetlands animals endure this problem too. Some population of amphibian or insect are isolated.

Perspectives and possible solutions/recommendations for actions

The work started by the department of Isère is one of the best examples how to proceed and partially restore connectivity:

https://www.isere.fr/sites/default/files/corridors-evaluation-scientifique.pdf

The contracts with Region Auvergne-Rhône-Alps gives interesting outlook for further actions in favour of ecological connectivity and biodiversity conservation. For example, the contract Arve-Porte des Alpes include a list of measures:

http://www.riviere-arve.org/cvb-apa-derniere-version-05122016.pdf

With the real implementation of the measures foreseen in the SRCE and biodiversity strategies and plans of the regions and more generally of the French Ministry of the Environment, an important step would be realised. Concepts are existing, the implementation of the ground is still lacking for very important parts. A better zoning of natural areas in national and regional plans with effective protection measures such as restriction of the extension of industrial and commercial areas sealing important surfaces every year is one of the most important and efficient measures to be employed.

In the same time, it is crucial to proceed to the establishment of operational corridors for the most fragmented areas in the pre-alpine valleys including contractual agreements with various stakeholders. This is as well relevant for fragmented habitats in mid and high altitudes due to touristic activities and especially outdoor sports activity development.

Barrier C (Arve valley) / D (Lake Geneva region)

Description of the area

The area Leman-Mont-Blanc is located in France (Upper-Savoie) and Switzerland (Geneva, Vaud and Valais cantons). The land use is mixed, with cities, Leman lake, forests, grassland and high mountain.

Several mountain ranges compose the landscape. Most of them are middle sized mountain ranges, composed by limestone (Aravis, Chablais, Fiz, Salève…). The Mont-Blanc, Aiguilles Rouges and Beaufortain are crystalline ranges. The highest point is the summit of the Mont-Blanc (4809m) and several pics are higher than 4000m. The ranges are separated by glacial valleys. Flora and fauna differ due to altitude.

The main city is Geneva, with 200 000 inhabitants in the city and 1 000 000 in the surrounding. Lausanne, in the border of the Leman lake with 140 000 inhabitants is the second city. Several cities are located in the Arve valley (Bonneville, Cluses, Sallanches…) and the Rhone valley (Martigny, Monthey…). Annecy conurbation, near the Annecy lake, totalise 145 000 inhabitants.

The Upper-Savoie is the area with the highest demographic growth in France (+1,4%/year).

This area is dynamic. The topography is one of the biggest difficulties for human development, but it is an attractive feature too.
Tourist economy is important, with several big ski resorts in mountain and beaches on the banks of Leman lake.

Description of possible problems or potential concerning ecological connectivity

Topography and human activities are threats for ecological connectivity in this area. Fragmentation is important, because of numerous infrastructures, urbanisation and human activities. The Arve valley, the Rhone valley and the border of the Leman lake are important barriers with very few sites for species to cross it. These is among the most important barriers in the Alps, and the barrier of Leman lake is a barrier between Alps and Jura. With the climate change, species will go north, but some of them will be stopped by these barriers.

The boarder of the Leman lake is characterised by continuous urbanisation, a dense network of transport infrastructures and intensive agriculture.

The Arve valley is an industrial valley for bar turning. Fragmentation is due to several human modifications:

- the A40 motorway, from Geneva to Chamonix is fenced until Passy and there are just a few passages underneath. The traffic is heavy, with cars and lorries, days and nights.
- The railway is a barrier in some sites because of fences and because the topography is modified in slope.
- Urbanisation (residential areas, industry, commercial areas…) is present in all flat areas. In the bottom of the valley, this is continuous

Protected or preserved areas are mainly located in the mountain. Nature Reserves, Natura 2000 sites and some other areas are hot spots for biodiversity. A lot of infrastructures are present in ski resorts, and seasonal attendance is another threat for ecological connectivity. Tourism constitute a secondary kind of fragmentation, mainly seasonal and located in the mountains.

Hot spots for biodiversity are especially isolated because of barriers in the valley, where human pressure is very important.

Existing knowledge about ecological connectivity in the area

Several studies have been realised in this area with different scales. They include projects or measures to conserve ecological connectivity.

The SRCE (plan of regional ecological coherence) of **Rhône-Alpes** includes the whole Upper-Savoie. The main objective is to identify corridors and hot spots for biodiversity. The report, the maps and the abstract can be downloaded here: http://www.auvergne-rhone-alpes.developpement-durable.gouv.fr/srce-rhone-alpes-a10983.html

The **Upper-Savoie** department develops territorial contracts, and an ecological connectivity study is now obligatory.

An important study has been made in the **Rhone Valley** in 2005 for the REC (ecological network for canton) of the Valais, in Switzerland. Preliminary studies of the Rhone correction integrate this topic.

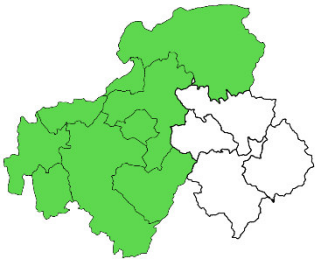
Lausanne and the north border of the Leman lake area are concerned by the REC of Vaud canton. The study was realised in 2012 and can be downloaded here : https://www.asitvd.ch/media/easysdi/md-attachment/56cf85ad-e64f-3d74-5d64-2a970f33b0aa_Rapport_REC_VD.pdf

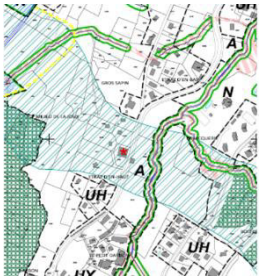
Studies were made in 2009-2010 in eight areas around **Geneva**, thanks to an Interreg project and partners from Switzerland and France. This study is based on the REN (National ecological network of Switzerland) and the SRCE.

A study of the lower part of the **Arve valley** has been realized by the contract “Arve-Porte des Alpes” with the Region Auvergne-Rhône-Alpes and several partners. This kind of contracts form the basis of the SRCE and are part of the green and blue network (Trame verte et bleue).
A study about the Upper Arve valley have been realised by Asters through the ongoing “ALPBIONET2030” with the work in the Project Working Region “Mont-Blanc”

Planification documents:

There are 9 SCOt (plan for a territory coherence) in Upper-Savoie (green territories in the map on the right). Ecological connectivity is studied in each plan.





In France, municipalities study ecological connectivity of their territory and integrate corridors in the new PLU (Plan for urbanisation). An example on the left with a corridor in blue.

Potential threats/need for action

The Geneva conurbation continues to be under a high urbanistic and economic pressure. The territory plan of “Grand Genève” include environment issues, but constructions are planned. The pressure is important in the valley too, with an important artificialisation of landscapes. A new motorway will be built in the Chablais.

The tourist development in the mountain area could create an important threat due to climate change. In summer, more and more tourists want to go on higher altitude. New equipment will be created in the Mont Blanc area, from the valley to the ski resort.

Species concerned

All vulnerable animals are suffering fragmentation. Only opportunist species are not really concerned.

The main species concerned by the fragmentation in this area are mostly the typical species for this kind of threat as mammals and especially the large ungulates but as well birds as the black grouse, animals suffering from climate change needing fresh habitats (snow grouse) or to move vertically or to the north.

The insects and wetlands animals are really concerned. Many populations decrease and fragmentation is one of the reasons. The international strategic plan is the best scale, because these species are threated in all Europe. Topics like wetlands artificialisation and agriculture practices have to be studied in all the countries of Europe.

Perspectives and possible solutions/recommendations for actions

Strategies, projects or concepts are existing in Rhône-Alpes region and in Switzerland. Give priority to biodiversity and ecological connectivity in human activities is a general recommendation. Some specific measures should be implemented:

To protect and preserve

To protect with a statute more surface of hot spot and corridors is one of the solutions for the ecological network. To work with stakeholders about attendance in mountain, especially outdoor sports.

To reduce artificialisation of soil, and to stop it in the ecological network (corridors, relay areas…).

To restore

The contracts with Region Auvergne-Rhône-Alps gives interesting outlook for further actions in favour of ecological connectivity and biodiversity conservation.

These contracts have led to the construction of wildlife passages, hedges have been planted, riverbanks have been restored in some areas, and sustainable farming and wetland management measures have been implemented.

The contract Arve-Porte des Alpes include a list of measures:

http://www.riviere-arve.org/cvb-apa-derniere-version-05122016.pdf

Barrier E (Jura Alps)
Connectivity Area III (Jura - Seeland - Alps connectivity area)

Description of the area

The region connecting the mountain ranges Jura and Alps described here reaches from Biel and Neuchatel towards the Fribourg and Bernese Alps. The Jura mountain range is dominated by forests, meadows and other agricultural land use, settlements and smaller commercial and industrial areas. The lowlands contain three main lakes (Neuchatel, Bienne and Morat). In between those lakes one of the most intensely agriculturally used areas of Switzerland is located. The so-called “Seeland” where mainly vegetables are produced in a former fen area of 400 km^2, which has been extensively drained of water some 150 years ago[1]. The lowlands are fragmented by transportation infrastructure (roads of various importance and a railway network) and settlements of various size with few intermittent forests. The Fribourg and Bernese Prealps and Alps are less densely populated and also less densely used. They are dominated by forestry and agriculture, in some regions by tourism and higher elevated areas may exhibit almost no use. The Franche-Comté region, in France, is the continuity, with low density and an environment composed of forests and grasslands. In the Jura mountain range as well as in the Prealps of the region several regional nature parks are located while in the lowlands smaller protected areas exist. The remnants of fen and floodplains as well as important habitats for e.g. amphibians and migratory birds are to be emphasized.

Description of possible problems or potential concerning ecological connectivity

In an Alpine context the area is an important linking element between Vogesen, Jura and the Alps. But also, within Switzerland it is one of the only possibilities to connect the Jura mountain range with the Alps. The area located in the lowlands itself contains remnants of fen and floodplains as well as objects of national importance and important habitats for e.g. migratory birds and amphibians. It is a cultural landscape which is not as densely populated as other low elevated areas in Switzerland in which exhibits high potential for the restoration of ecological connectivity. The barriers consist of transportation infrastructure, settlements and intense agriculture.

[1] https://www.bafu.admin.ch/bafu/de/home/themen/naturgefahren/dossiers/juragewaesserkorrektion/150-jahre-juragewaesserkorrektion-kulturlandgewinn-mit-folgen-fuer-die-natur.html

Implementation and documentation on ecological connectivity in the area

Spatial planning

Spatial planning in Switzerland is regulated at various administrative levels. An important instrument is the cantonal structure plan. The structural plan is binding on the federal government, cantons, neighbouring cantons, regions and municipalities. Each canton has a structure plan, which serves as a central planning instrument. It determines for around 20-25 years how the canton is to develop spatially in concrete terms. It coordinates spatially relevant activities such as the development of settlements, transport and infrastructure and also ensures the protection of nature and the landscape. It also regulates the planning of major construction projects such as leisure or shopping centres. This is done with binding specifications over a longer period of time. The cantonal structure plan is approved by the Federal Council and then serves as the basis for all other planning instruments at cantonal, regional and communal level. In this report a summary of the aspects relevant for ecological connectivity of the cantonal structure plans is given. Other planning instruments are not included in the report.

In Switzerland exist 305 **wildlife corridors**[2] of interregional interest. They are interconnected with wildlife corridors of regional and local interest. Approximately one third of the wildlife corridors of interregional interest is intact, some 14% are widely interrupted and the remaining 58% are affected (Bafu, 2018). The structure plan of **Bern**[3] contains the removal of barriers to wildlife dissemination which is closely related to the wildlife corridors of interregional and regional interest. The individual sites are listed according to their priority. The structure plan of the canton of **Fribourg**[4] integrates a section on ecological connectivity aiming to maintain and improve existing ecological corridors – among others the wildlife corridors of interregional and regional importance.

The structure plan of **Bern** contains in addition aims and measures for biodiversity in forests, preferred areas for ecological compensation measures in agriculturally used land, nature protection areas and national inventories on nature and landscape.

The structure plan of the canton of **Fribourg** contains a section on ecological connectivity aiming to connect important areas for biodiversity, restore impaired areas and maintain existing ecological networks. It applies explicitly to wildlife corridors and biodiversity locations (e.g. inventoried objects, bird protection reserves) and for the different sectoral administrations (forest, spatial planning, environment, agriculture etc.) specific tasks are defined. Further sections on species exists which does not only focus on habitat protection for specific species / species groups but

[2] Wildlife corridors are for specific target species. Many of them are for ungulates but also amphibian species, reptiles and other species are considered.
[3] as of 14th December 2018
[4] as of 2nd October 2018

also on ecological connectivity of those habitats. Further nature conservation sections on landscape and parks of national importance do not contain explicit aims of ecological connectivity.

In France, there are three levels of spatial planning :

- The SRCE, a scheme of ecological connectivity for all Franche-Comté Region, with a diagnostic, a map and a strategic plan. This main corridor between France and Switzerland in Jura is identify. Ecological connectivity is treated for each habitat (forest, grassland, fen and floodplains…)
- The Scot, for groups of municipalities. These documents plan the main projects. They identify areas for biodiversity.
- The PLU/POS for each municipality. These documents are detailed for each parcel. Some of them integrates corridors and all of them identify nature conservation areas.

Nature conservation initiatives and implementation

The cantons of Bern and Fribourg contain several protected areas of different types (objectives, protection status, area). There is currently no strategy on how to connect them. In the regional nature parks, pilot studies on ecological infrastructure were carried out and partially implemented. These investigations were carried out as part of the biodiversity action plan for Switzerland. The action plan defines measures for the various sectoral policies and includes pilot projects on various aspects of enhancing biodiversity.

In Franche-Comté region, the Natura 2000 network and other types of status preserve biodiversity in some sites. Specific actions are carried out between the Jura and the Vosges to connect this two mountain ranges.

Non-governmental organisations launch different initiatives on ecological connectivity, conduct studies and realize specific projects – also in the region.

Further specific projects

The “Seeland” has been set up for intense agriculture by the first and second correction of the Jura waters. A **third correction of the Jura waters** is called for by an organisation set up specifically for this purpose due to the reason that the soils in “Seeland” are settling and problems exist with too much water or in some years with too little water[5]. The project is argued with food security anchored in the federal constitution. While the project is mainly a threat to the restoration of ecological connectivity it creates also opportunities for the integration of specific measures in implementation.

[5] https://proagricultura.ch/wp-content/uploads/2018/03/Arbeitspapier-Dritte-Juragewa%CC%88sserkorrektion-Medien.pdf

The **planned motorway around Biel** fills one of the last gaps in the national road network. While the eastern bypass is already in operation, planning for the western bypass project is currently suspended[6].

Perspectives and possible solutions/recommendations for actions

- Ensuring the protection of land in the higher elevated areas

These areas should be remaining, through an identification in spatial planning like areas for biodiversity or protected with a specific status. To avoid new infrastructures and urbanisation project.

To preserve habitats for improving the permeability of the ecological network :

- The forest habitats could be preserved with an adapt forest management.
- The conservation of grassland is important to receive biodiversity and to allow fauna's mobility. Decrease grassland area with an intensified management, adopt different agricultures practices particularly benefit like cutting later, no use mineral fertilizer and keep or plant trees and hedges. Adding value to local and ecological agricultural products or give compensations to farmers are solutions to preserve this habitats and ecological connectivity.
- Rivers and aquatic areas are very important. Restoration and ecological practices are the solutions to protect this ecosystem.

- conserve and enhance ecological connectivity in the lower elevated areas

Identify a network of corridors in spatial planning.

In these corridors, to stop the artificialization of the soil and to restore habitats. To improve the infrastructures for fauna mobility.

Others actions could be carried out, like the promotion of nature in cities, with trees, vegetation on the roof, a specific management in city parks… The conservation of grassland is very important, the actions described above could be implement.

[6] https://www.a5-biel-bienne.ch/

Barrier F (Wester Sea Alps)
Connectivity Areas V (Western Po catchment area)

Description of the area

The Apennines are a mountain range consisting of parallel smaller chains extending about 1200 km along the length of peninsular Italy. In the northwest they join with the Ligurian Alps at the city of Altare. In the southwest they end at Reggio di Calabria, the coastal city at the tip of the Italian peninsula.

In the frame of the macro-corridor described here reference is made to the northern of the three sectors of the Apennines, the *Appennino settentrionale*.

The Alps Apennines macro corridor links the two mountain ranges of the Alps at their far southern End to the northern part of the Apennines. It stretches from the French Riviera located in the Region Provence-Alpes-Côte-d'Azur (Département Alpes Marittimes) to the Italian Province of Tuscany including portions the Italian provinces of Piemonte, Liguria, Lombardia, Emilia Romagna.

In the Alps the spatially connected protected areas of the Nature Park Alpi Marittime on the Italian side and the French National Park Mercantour can be considered as important hotspot and alpine starting point of the linkage. They form a unique geographic entity and are also similar from a cultural point of view and can be thus considered a one local entity. It's also for these reasons that the transboundary cooperation is already well consolidated and contributes to a strong link between the Alps and the Apennines.

Description of possible problems or potential concerning ecological connectivity

The area of this macro-corridor benefit from particular climatic conditions as it is located at a crossing between 3 different climatic zones: the Mediterranean climate, the alpine climate and the continental climate. These particular climatic explain the extraordinary panel of different species present in the area.

The corridor comprises more than 2200000 hectares between France and Italy. On the Italian side, representing the larger part of the corridor, about 63000 different species can be found, among them 5600 vascular plants, 56170 invertebrates and 1176 vertebrates.

The area a crucial migration zone for species moving West and North, due to climate change effects and the intensification of human land use in the Po plain. Its conservation is a main challenge for biodiversity for many of these Mediterranean species.

For alpine biodiversity the area plays also an important role as it represent a link to the diversity hotspot in Italy as well as a link between relatively isolated priority conservation areas like the Mercantour, the Ecrins Massif or the Mont Ventoux area. In this sens the corridor is an important element of the French Green and Blue infrastructure at local and regional level.

Existing knowledge about ecological connectivity in the area

The importance of this area has been identified by several projects as well as in the regional ecological network analysis.

One example is the Alps App project. In the frame of this project a list of 22 critical barriers have been identified and mapped. A Manifesto for the future of this area was produced and spread to stakeholders for supporting and lobby against main threats (urbanisation, new roads, new wind farms). Also a conservation plan has been established for the area with the local scientific community.

The Lombardy region has identified and studied the functionality of critical ecological corridors, and the possibility of implementing a regional ecological network (Rete Ecologica Regionale - RER). One of the weak links of the network, the connection between the Alps and the Apennines through the Po Plain – the only possible route of dispersal for many species – is threatened by human activities.

The LIFE TIB project aims to rectify this situation by improving and protecting a green area, a portion of the main ecological corridor traversing the Po Plain. It is an element of primary importance for the Natura 2000 network, which extends on a European scale, since it links the Alpine and Continental bioregions. In particular, the portion affected by the LIFE TIB project extends from the Pre-Alpine foothills of Campo dei Fiori (north of Varese) and the Ticino River Valley.

In the French Scheme of Ecological Coherence (SRCE) of the PACA Region the French-Italian border are is identified as highly natural area (except a couple of skiing resorts, certain infrastructures and the Riviera belt). Linked to the French work ecological corridors have been identified in the Piemonte Region (technical work of IPLA – Instituto per le Piante da legno et l'Ambiente) using a similar methodological approach as the French one: definition of biodiversity hotspots (nodi) and connections (connessioni). IN addition to these connecting elements supra regional corridors have been defined (fasce di connessione sovraregionale), as well as buffer zones (aree tampone). The Italian study considers the entire border region between France and Italy as biodiversity hotspot (about 90% of the border between PACA and Piemonte).

The area has been identified as cornerstone of a Pan European Green Corridor Network (as presented by the European Wilderness Society).

Potential threats/need for action

The area is under great pressure concerning urban development, especially in the belt along the coast. Some connectivity aspects have already been identified by regional and local planning tools (SRCE, SCOT and for example the Ecological network of the Piemonte Region) but their translation in binding spatial plans is still pending.

Species concerned

It is via this corridor that the wolf populations that still were present in the Italian Apennines, concentrated in the central parts of this massif, expanded and moved to the north-west of the country until they reached the Alps and France at the beginning of the century. Wolves with Apennines DNA who's ancestors used this passage can nowadays be found spreading all over Europe.

The corridor represents one of the unique possibilities for many species to reach areas where climate still fits to the needs.

The corridor area is an important site for reptiles and endemic flora. Also migrator species use the area on their way to African winter sites as for example the great part of the Short-toed Eagle (Snake Eagle) European population who uses use a bottle-necks in this area (e.g.north of Genova) for the migration.

Perspectives and possible solutions/recommendations for actions

Several smaller projects are ongoing in the area, especially in Italy. Cross-border cooperation on the issue needs to be intensified.

Barrier G (Northern Swiss Plateau)
Connectivity Area VIII (Swabian connection Black Forest/Alps)

Description of the area

The area between the Vogesen, the Black Forest, The Lake Constance and the Alps is characterized by intensive land use and high population density in the lower areas and forestry but also well-structured landscapes with mainly extensive land use in the highlands. Especially the Swiss Jura is an important stepping stone for habitat connectivity in N-S direction as it is connected to the Vogesen by the Belfort Gap and connected directly to the Black Forest. Along the Rhine Valley intensive agriculture (with a crop rotation strongly influenced by maize) is dominating. In the eastern foothills of the Black Forest the High Plain Baar is a richly structured landscape with a cold climate and arctic-alpine relict flora and fauna.
The main cities in Germany are Freiburg im Breisgau, Lörrach, Weil am Rhein, Neuenburg am Rhein and Konstanz in France Mullhouse and Colmar and in Switzerland Basel, Bern, Zürich and Luzern.

Description of possible problems or potential concerning ecological connectivity

As the Black Forest and the Vogesen are comparatively high uplands a huge amount of alpine species is indigenous in the higher levels. Especially for these species a well working habitat connection to the larger populations in the Alps is important. Also, the large and uncut forests of the Vogesen and Black Forest are habitat of typical species with larger populations in the Alps.
Core zones concerning ecological connectivity in Vorarlberg are 39 European protected areas (https://naturvielfalt.at/). In the Rhine valley, there are mainly wet habitats like litter meadows, moors, floodplains and the Rhine delta at Lake Constance as the biggest wetland area with high international importance. In Switzerland, the Emerald site project Oberaargau could be one of the single areas where the Jura mountain range would be connected to the Alps. A local association tries to enhance this project.

Main barriers are especially busy highways like the German A5 and the French A35 along the Rhine Valley and the Swiss highways 1, 3 and 5 between the Black Forest and the Alps.
In Vorarlberg urban areas and the high degree of building development are another main problem. From north to south meanwhile, there is a continuous settlement-corridor. Ecological connectivity from east to west, between mountains and valleys is hardly existing. Infrastructural barriers like the highway A14, the two-lane railway between Bregenz and Feldkirch or several expressways are further problems for EC.

Existing knowledge about ecological connectivity in the area

Switzerland

Spatial planning in Switzerland is regulated at various administrative levels. An important instrument is the cantonal structure plan. The structural plan is binding on the federal government, cantons, neighbouring cantons, regions and municipalities. Each canton has a structure plan, which serves as a central planning instrument. It determines for around 20-25 years how the canton's space is to be developed spatially in concrete terms. It coordinates spatially relevant activities such as the development of settlements, transport and infrastructure and also ensures the protection of nature and the landscape. It regulates the planning of major construction projects such as leisure or shopping centres. This is done with binding specifications over a longer periode of time. The cantonal structure plan is approved by the Federal Council and then serves as the basis for all other planning instruments at cantonal, regional and communal level. In this report a summary of the aspects relevant for ecological connectivity of the cantonal structure plans is given. Other planning instruments are not included in the report.

In Switzerland exist 305 wildlife corridors[7] of interregional interest. They are interconnected with wildlife corridors of regional and local interest. Approximately one third of the wildlife corridors of interregional interest is intact, some 14 % are widely interrupted and the remaining 58 % are affected (Bafu 2018). The structure plan of the canton of Aargau[8] currently contains four wildlife corridors of interregional interest. For the next revision the canton of Aargau needs to check whether to include the remaining wildlife corridors of interregional importance. The structure plan of Bern[9] contains the removal of barriers to wildlife dissemination which is closely related to the wildlife corridors of interregional interest. The individual sites are listed according to their priority for action. The structure plan of "Basel Landschaft"[10] includes the wildlife corridors explicitly by the principle that a settlement separation belt needs to be conserved. The structure plan of the canton of Solothurn[11] lays down 28 of the wildlife corridors of interregional or regional interest. They shall be secured and, where necessary, improved or restored.

The structure plan of the canton of Aargau contains in addition areas for nature and landscape protection of different importance (national, cantonal). While nature and landscape protection areas of national importance were already included in the

[7] Wildlife corridors are for specific target species. Many of them are for ungulates but also amphibian species, reptiles and other species are considered.
[8] as of 23th August 2018
[9] as of 14th December 2018
[10] as of 31th January 2019
[11] as of 17th September 2017

former structure plan, objects of cantonal importance were integrated in 2018. Like the canton of Basel Landschaft Aargau also designates settlement separation belts.

The structure plan of Bern contains in addition aims and measures for biodiversity in forests, preferred areas for ecological compensation measures in agriculturally used land, nature protection areas and national inventories on nature and landscape.

The structure plan of Basel Landschaft contains priority areas for among others the settlement separation belt, forests, nature and landscape. The section on priority areas for forests contains e.g. the explicitly the aim of a network of forest reserves as well as for example the priority areas for nature shall be connected.

The structure plan of Solothurn contains areas for nature and landscape protection and protected areas. Ecological connectivity is mentioned regarding ecological compensation areas in agriculturally used land but without mapping specific areas.

On the official Swiss GIS-Service there are two layers “Wildlife Network System” and “Interregional Wildlife Corridors”, which illustrate the routes of wildlife corridors, their importance and their conditions.

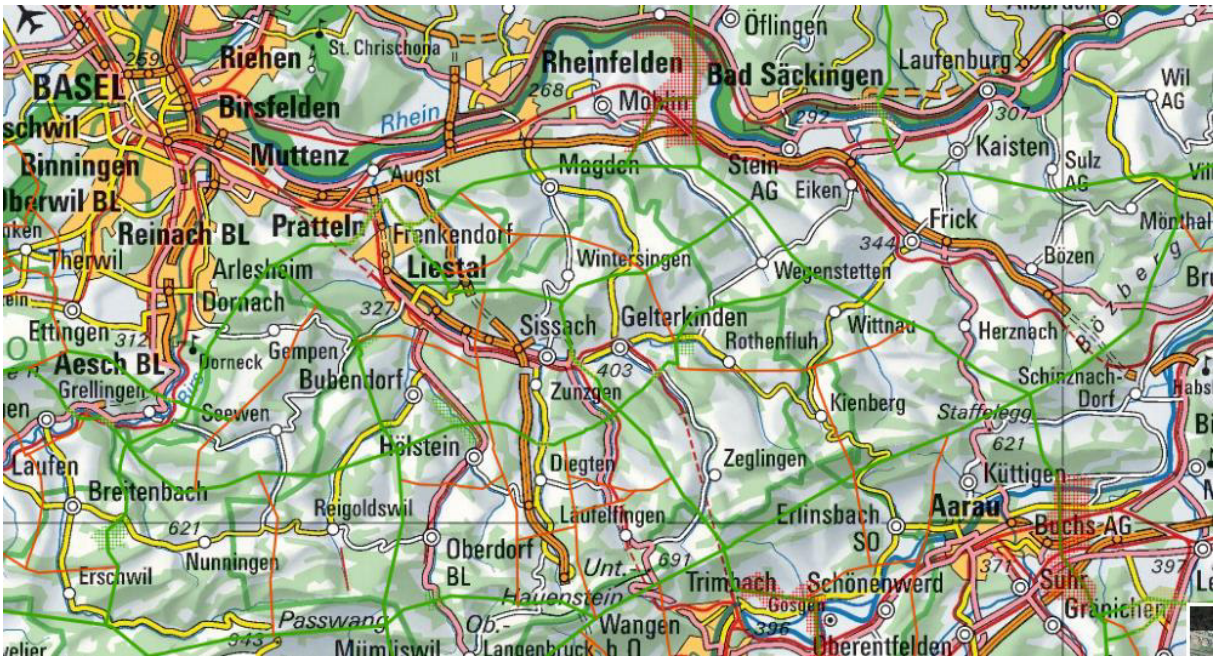
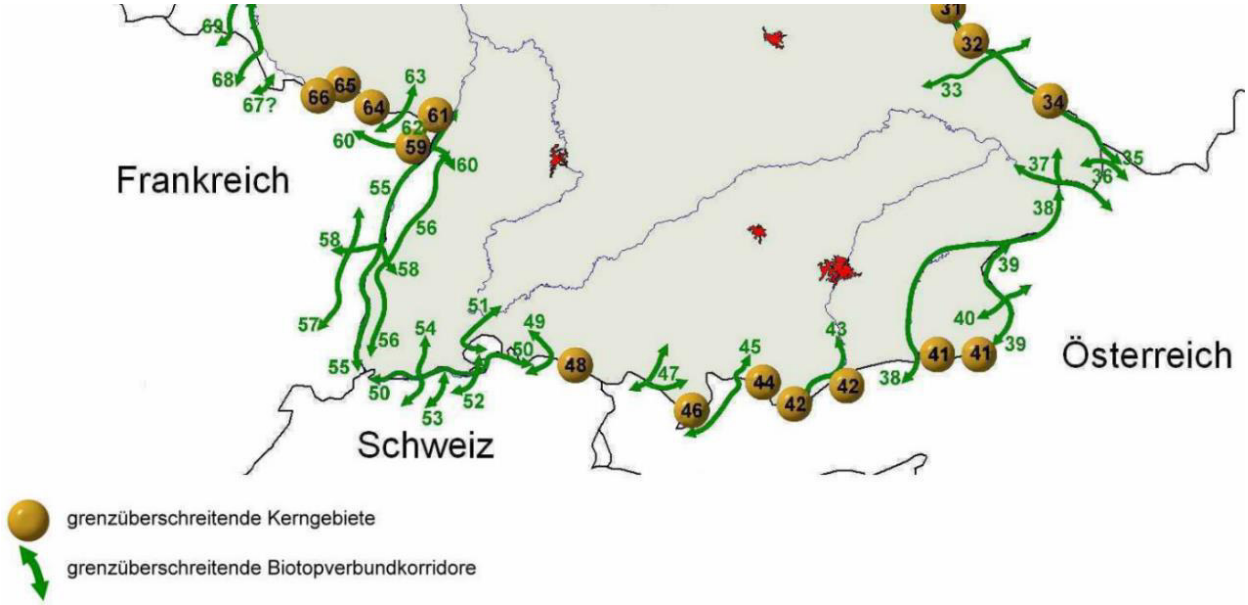


Figure 1: Swiss Wildlife Network System with Interregional Wildlife Corridors (https://map.geo.admin.ch)

On the example screenshot from the Swiss map it is obvious that the Swiss A1 and A3 are two of the gravest barriers for habitat connectivity in north-south direction.

Germany

The German Environmental Ministry (BfN) figured out several international and cross-border spots for EC, shown in **Erreur ! Source du renvoi introuvable.**. These are mainly water systems, wetlands, forest networks and dry habitats.



45	Streaming waters and floodplain network along Lech
46	Alpine habitats in Allgäu Alps and Adelberg
47	Mountain forest network and moors around Bregenz, Upper Swabia, West Allgäu
48	Lake Constance, Untersee: crossborder wetland of international significance
49	Bodanrück (BW): potential biotope corridor to CH
50	Hochrhein: border-parallel streaming water corridor
51	Potential network of dry habitats around Swabia Alp, Heuberge, Wutach, Randen
52	Potential network of dry habitats and crossborder traditional cultural landscape around Randen, Klettgau, Rafzer field
53	Aare, Hochrhein: wetlands close to the border with international significancce (bird habitats)
54	Potential biotope corridor between Aargau Jurassic (CH), Black Forest and Swabia Alp in the area around Murg and Alb
55	Border-parallel along upper Rhine with close wetlands, floodplains, dry habitats
56	Potential border-parallel network of dry habitats along foothills of Black Forest and screes of subsidiary streams of Rhine
57	Potential border-parallel network of dry habitats along foothills of Vosges and screes of subsidiary streams of Rhine
58	Potential wildlife corridor for Wild Cat between Vosges and Black Forests
59	Forest area close to the border: Hagenau and gravel terraces with wet and dry habitats
60	Potential corridor between Vosges and forest Hagenau

Figure 2: Extract from BfN map with explanation (BfN 2019)

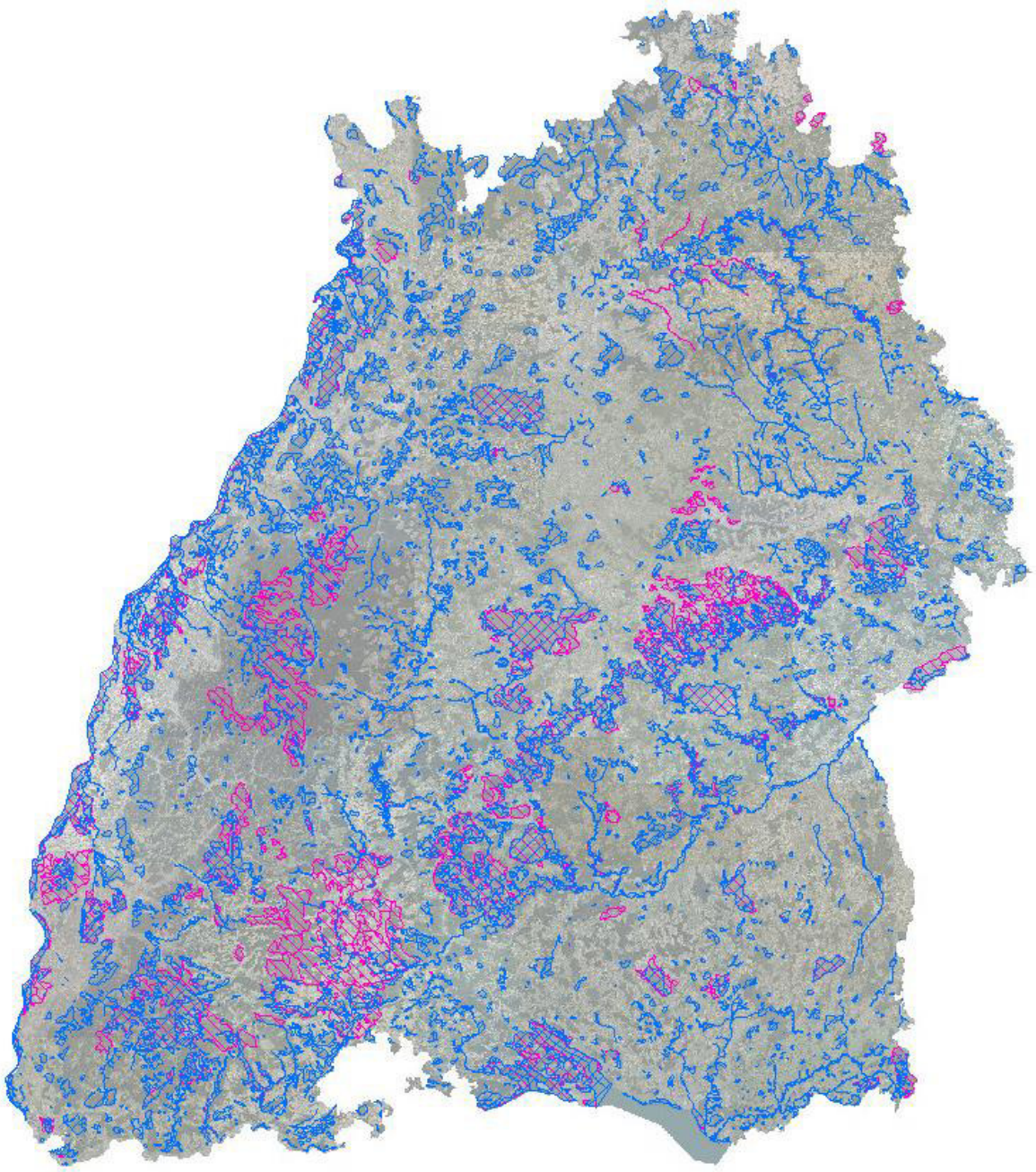


Figure 3: Natura2000 Sites in Baden Württemberg (GeoportalBW 2019)

Further, the implementation of the European Natura2000 network plays a major role in supra-regional biotope network planning. The network of existing FFH and bird sanctuaries as displayed in the map of Figure 3 should therefore also be used as a backbone for a transnational biotope network.

The Environmental Agency of the State of Baden-Württemberg has made a state-wide biotope network in 2012. This strategy focuses on open landscape and is combined with the Strategic Wildlife Corridor Plan. Dry and wet core zone areas are built of legal protected biotopes, areas of species protection programs and grassland sites. In this strategy, 125 main conflict zones and 25 main wildlife migration areas

are defined (VM BW 2015a). For each migration area there is a detailed fact sheet with recommended actions[12].

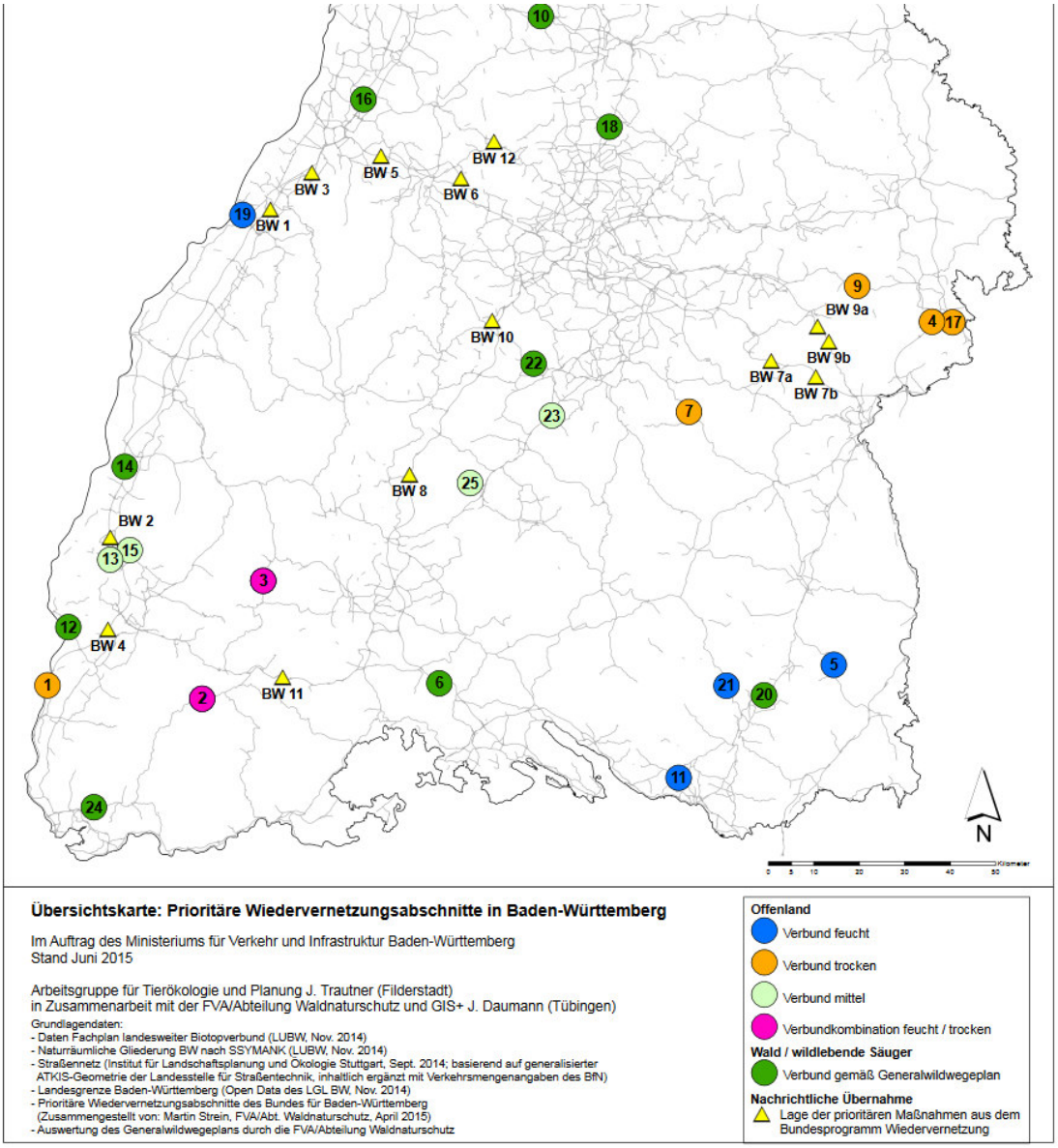


Figure 4: Map of the main migration areas in Baden-Württemberg (VM BW 2015b)

The governmental forestry (Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg FVA) developed a Strategic wildlife corridor plan[13], where main wildlife corridors are defined and categorized by local, national and international significance (see *Figure 5*).

[12] https://vm.baden-wuerttemberg.de/fileadmin/redaktion/m-mvi/intern/Dateien/PDF/Wiedervernetzung_Steckbriefe-Konfliktstellen_160125.pdf
[13] Generalwildwegeplan http://www.fva-bw.de/forschung/index2.html

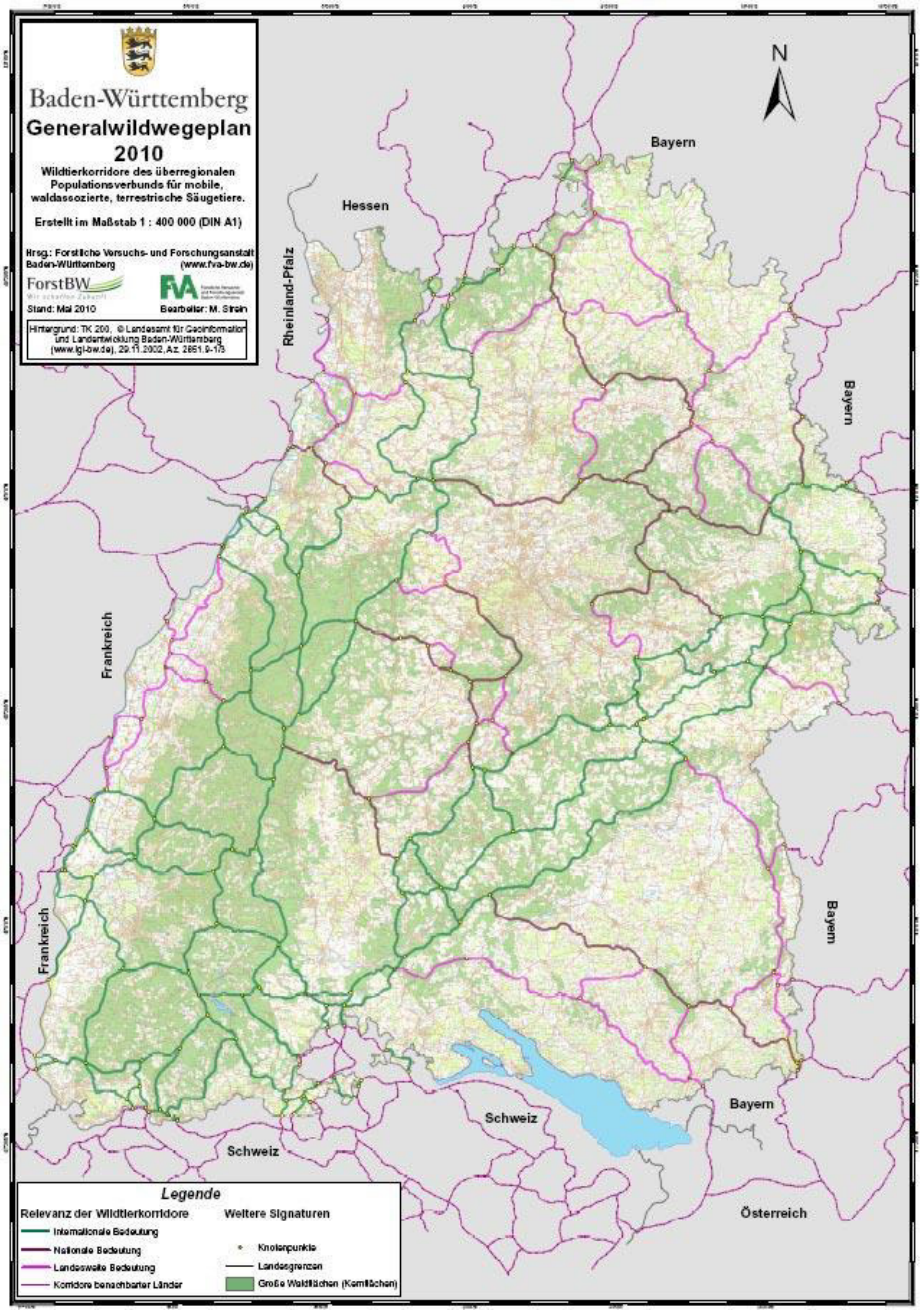


Figure 5 Strategic wildlife corridor plan Baden-Württemberg (FVA 2010)

NABU district group of Baden-Württemberg has several projects on green infrastructure. Aims are at least 10 % of the state area integrated in a biotope network and at least 100 communities having redesigned their public green sites and improved them for EC. One of the projects is called „Natur nah dran“ and is about the support for biological diversity in communities and urban residential areas (Nabu 2019). The model region Biotopverbund Markgräfer Land („MOBIL“) has a project on „eco-accounts“. In this project ecological accounts („Ökokontos“) have a big potential as a network for ecological connectivity. Strategic connectivity areas were defined by sensitive habitats and biotopes. Measures for developing habitat types like limestone neglected or dry grasslands were defined in this project.

There are several more local and regional projects on EC, e.g. Lebensraum Lechtal e.V. (www.lebensraumlechtal.de), which is working on the river banks and floodplains of the river Lech. Here, a very important corridor in middle of highly fragmented areas has the potential to connect flora and fauna of the Alps to EUSALP. The „Trinational Environmental Center“ realises projetcs on EC in the crossborder region in Switzerland, Germany and France. There was an Interreg IV project Grenzüberschreitender Naturkorridor 2012 to 2015[14].

The German large scale project on nature conservation Baar[15] faces among other topics the national and international habitat connectivity. The area is an important component for the connection of the river systems of Rhine and Danube. But also the connectivity between the dry, wet and forest habitats of Black Forest, Swiss Jura and the Swabian Alps shall be improved by purposeful measures.
The cantons of Aargau, Bern, Basel-Landschaft and Solothurn contain several protected areas of different types (objectives, protection status, area). There is currently no strategy on how to connect them. In the regional nature parks, pilot studies on ecological infrastructure were carried out and partially implemented. For the emerald region of Oberaargau, a toolbox was developed and tested to establish an ecological infrastructure in the Swiss lowlands. These investigations were carried out as part of the biodiversity action plan for Switzerland. The action plan defines measures for the various sectoral policies and includes pilot projects on various aspects of enhancing biodiversity. Non-governmental organisations launch different initiatives on ecological connectivity, conduct studies and realize specific projects, also in the region.

There is currently a project planned on ecological connectivity in Vorarlberg where core zones, stepping stones and corridors of the habitats and species of Vorarlberg are defined. This biotope network “Vorarlberger Rheintal“ will be the basis for future projects and is meant as a regulation for interferences into landscape. There are projects on connectivity in the Rhine valley in Switzerland and Austria: The revitalization of the alpine river Rhine from Feldkirch to Lake Constance[16]. Right now, the river Rhein is canalized and will be opened and revitalized. This will be important for flood protection and for the function as corridor in north-south direction (Loacker 2019).

[14] http://www.truz-naturschutz.org/home.html
[15] http://www.ngp-baar.de/projekt/bedeutung/
[16] see http://www.rhesi.org/

Species concerned

Typical species affected by the loss of large, uncut or near nature forests are Wild Cat, Lynx and Capercaillie. The unlimited migration of these animals is stopped since the beginning of the 20th century but there is still some sprawl of young individuals in search of own territories. Bats need a well-structured landscape with guidelines and hunting habitats like hedges and orchards for their migration. The ongoing expansion of wind power in the higher areas is an increasing threat for the migration of bats and birds (Strein 2019).
Migratory insects like butterflies, birds and plants demand stepping stone and resting habitats of the diverse open habitats to ensure genetic interchange.[17]

Perspectives and possible solutions/recommendations for actions

The central aim for a supra-regional EC network is cross-border communication of strategic corridors, existing barriers and affected species. Planning should be made in close cooperation of all administries.
There should be more regional planning tools for ecological connectivity in Austria and across the borders. Local connectivity projects often fail because of spatial planning of supra-regional corridors (Loacker 2019).
On a regional level, preservation and development of regional interconnected axes is necessary as well as the improvement of continuity within landscapes and natural areas through regional planning. Local biotope networks must be realised through the preservation of existing biotope complexes and the networking of individual biotopes is a main aim of urban land-use planning and landscape planning by local authorities. Biotope network plans at regional and local level should be implemented with the proven approach of the Landcare Associations in Baden-Württemberg. In the end, also voluntary and equal cooperation between municipalities, land users and nature conservationists, or in Switzerland tools extracted by the experiences within the Emerald site approach are necessary.

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Barriers O (Southern Munich Area)

Area description

The city of Munich and the area south of Munich is internationally famous for its attractive peri-alpine landscape, and at the same time has a big impact on ecological connectivity between the Alps and the areas north of it. Besides less favourable land use and a high population density, there is as well a strong fragmenting impact by leisure activities and traffic that comes along with it. The close distance to beautiful (peri-) alpine landscapes, like the lakes in the Alpine Foothills (Chiemsee, Tegernsee, Schliersee, Starnberger See, Kochelsee, Walchensee, Osterseen, Staffelsee, Ammersee), cultural landscapes with alpine meadows or famous cultural heritage sites like the castles of the Bavarian king Ludwig II., small traditional villages and the broad offer for outdoor sports like hiking, biking or skiing are reasons for many people to come to Munich and the surrounding area. This region does not only attract tourists, but also people looking for employment or a city with a high quality of life and thus become residents of the area.

The surroundings of the city of Munich can easily be reached by several highways, in detail the 'Autobahn 8' (A8) direction northwest to Augsburg and east to Salzburg, A9 direction north to Nurnberg, A95 direction south to Garmisch-Partenkirchen and A96 direction south-west to Lindau. People can easily reach alpine destinations within 150 km for daytrips (if a 1.5 to 2 hours ride is accepted).

The city of Munich covers an area of 310 km² and has 1.5 million inhabitants 18, thus constituting a hotspot of the EUSALP area in population density next to sensitive alpine landscapes and biotopes. Around the metropolitan area of Munich, there are many smaller cities like Weilheim with around 22500 inhabitants in 2018 19 or Rosenheim with 61.500 inhabitants in 2014 20.

Tourism is a main economic sector in Bavaria in general, and in the EUSALP area which connects the Alps with the surrounding lowlands but has high social, economic and ecological impacts on the Alpine regions. In 2018, tourism figures in Bavaria broke the records: More than 39.1 million guests visited the state with around 99 million overnight stays. In view of these figures, Bavaria is one of the most important all-season destinations of Europe and most visited state of Germany, especially appreciated by international tourists (20 % of all overnight stays)21. One day trips are most important in the tourism sector: The share of day tourism reaches 50 % of a total of 33.9 Mio. € of tourism revenues (dwif 2018).

[18] https://www.muenchen.de/sehenswuerdigkeiten/muenchen-in-zahlen.html
[19] https://www.weilheim.de/attachments/article/1763/Jahresbericht_2018.pdf
[20] https://rosenheim.de/de/aktuell-rathaus/in-vier-jahren-ist-rosenheims-bevoelkerung-um-fast-3-prozent-gewachsen.html?no_cache=1
[21] https://www.stmwi.bayern.de/tourismus/daten-fakten/

Alpine rivers and floodplains form the landscape picture of the Munich area: The Lech, Loisach, Isar and Inn valley as ancient human settlement areas are strongly cultivated by humans, but they remain important habitats for many species with an important function as green infrastructure corridors. Rivers with natural biotopes like lime neglected grasslands, gravel banks or floodplain forests are perfect corridors for EC between Alps and Alpine Foothills. Besides, there are still some big wetlands like the moors around Chiemsee, Murnau and Kochel which form stepping stones and a 'moor corridor' in the south of Munich. The main mountain ranges at the northern part of the Alps are Karwendel, Wettersteingebirge and Mangfallgebirge.

Geologically these are limestone ranges where alpine meadows traditionally have been used for grazing since about 6000 years (Mair 2019) and continue to play an important role for cultural identification, tourism as well as for the diversity of biotopes and species. Extensively grazed meadows in alpine regions show impressive high rates of plant diversity, following Bavarian agricultural institute LfL, with partly more than 50 plant species on 25 m² (LfL). Today, many alpine meadows are turning to brush land because of given up agriculture. There are around 1463 Alpine meadows left in Bavaria (Mair 2019) but in the last ten years, around 2000 ha of alpine meadows turned into brush. This phenomenon has many reasons, such as this business is hard work for poor incomes and the numbers of agricultural enterprises is constantly declining (StmELF 2018). There are some funding programs for ecological farming but systems have to be overthought and alpine agriculture has to become more attractive and the very special biotopes with lots of rare species could be saved.

Problems concerning ecological connectivity

Fragmentation

The high population density and urbanisation of the Munich metropolitan area lead to a high landscape fragmentation. Barriers are mainly physical, but especially in the Munich area also 'social' or 'man-made' barriers by leisure activities cause fragmentation and must be considered. Sports activities like trail running, mountain biking and ski touring lead to wildlife disturbance, trash and traffic: Results of a study of the German Alpine Association (DAV) show that more than 71 % of the visitors arrive by their own car at the starting point of their tours, only 17 % come by public transport. The medium distance for day-tours counts 144 km and 472 km for multi-day tours. The average DAV member covers 5456 km per year for an average number of 18 day tours per year, thereby causing 537.9 kg CO2 whereof 82 % are produced by car arrival (DAV).

Intensive leisure activity requires a good infrastructure with the reciprocal effect on leisure activities. Streets and highways, ski lifts, bike parks, toboggan runs, climbing

woods and a lot more of infrastructural equipment has become an usual part of sensitive natural areas in the EUSALP perimeter.

Along with the development of infrastructure for different purposes goes the land take. Most recent figures for Bavaria show that still 11.7 ha per day were used in 2017 for settlement and transport facilities22. This value still significantly exceeds the target path towards the 2020 national goal (Alpine Convention 2017, p. 102 ff) and Bavaria has the aim of a land take maximum of 5 ha per day until 20305. In rural areas there is a higher land take indicator than in urban areas, due to lower land prices. In total, land take is still ongoing and forces the pressure on nature and ecological connectivity, on ecosystem services like climate regulation, flooding protection or water store and landscape scenery. For reducing land take figures in Bavaria, several measures are foreseen. Municipalities are supposed to be more careful in designing new housing or commercial areas (on a voluntary basis), e.g. by the alliance for saving surface, a database for surface management at the Environmental Agency or a calculator for follow-up costs (LfU 2019). The results so far, however, are not very promising and land take has even slightly increased in the last years (LfU 2018a).

Water ecosystems as hot spots for outdoor activities and resource capture

Bavaria's landscape is famous for beautiful lakes, rivers and streams which play an important role for ecological connectivity towards the areas north and northeast of the EUSALP area, e.g. the Bavarian Forest/Czech Republic. However, they are also used as important resource, e.g. as drinking water or for (renewable) energy production and they are equipped with flood protection installations like dams.

The rivers are widely used for leisure activities like canoeing, rafting or swimming, with many thousands of people spending their weekends with a barbecue at the riverside in the different bathing locations, e.g. along the river Isar which is passing through Munich city. Hiking and bicycle routes are situated along the rivers and lakes are heavily frequented from spring to autumn season. At the different lakes bathing is possible and as well different water sports like sailing, surfing, rowing, etc. All these activities affect and disturb the wildlife occurring in these areas and have an impact on ecological connectivity in many different aspects.

In the catchment areas of the alpine rivers Loisach and Mangfall, the water supplier for Munich, the 'Stadtwerke München' extracts water for the 1.4 million Munich citizens. The spring sources are constantly monitored to detect environmental damages caused in the catchment areas (Alpine Convention 2017).

[22] StmUV 2018

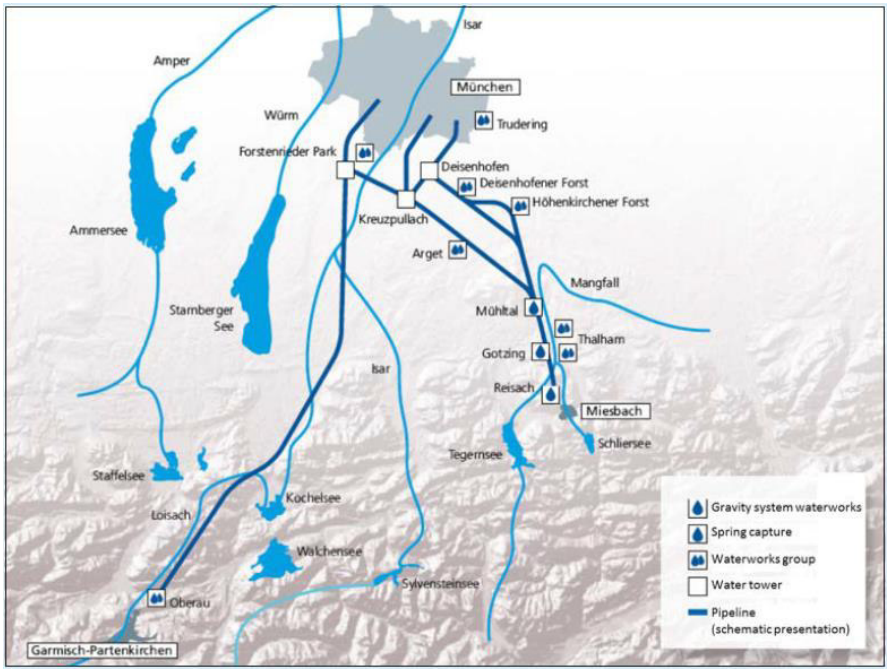

Figure 1: Munich water catchment area (Alpine convention 2017 p. 150)

In 1992, the water supplier started the initiative ‘eco-farmer’, in support of organic farming in the catchment area of the Mangfall valley. About 150 farmers have shifted their production from conventional to organic farming, together managing an area of about 3500 hectares, which is one of the largest organic farming areas in Germany. The farmers are paid for organic farming by the water supplier. This financial support is transferred to the consumers via a small supplement to the water price of about 0.5 ct/m³ to a price of finally 1.63 Euro/m³ (SWM 2019).

The Sylvenstein dam is located between the nature areas of Kochel mountains, Isar valley, Mangfall mountain range and Karwendel mountain range and has a catchment area of about 1100 km². The fjord-like lake is surrounded by the international protection area of the ‘Upper Isar’. Though the area is manmade cultural landscape, meanwhile it is an integrated part of the natural environment composed by forest ecosystems, special ecosystems like spring water mires or dry meadows and the floodplains of the river Isar which supply habitats for many rare species of flora and fauna (WWA WM 2009). The very special and rare habitats of the approx. 100 km long Upper Isar valley is internationally protected (FFH area of approx. 50 km²). This area includes gravel banks with natural river dynamics of bypasses and erosion of floodplains and with a result of all kinds of floodplain development stages (BfN 2018).

Existing knowledge about ecological connectivity in the area
Species concerned

According to the European nature protection legislation, Bavaria has a special responsibility for many alpine species: Black Grouse (Tetrao tetrix), Capercaillie (Tetrao urogallus), Chamois (Rupicapra rupicapra), Alpine Ibex (Capra ibex) as well as grassland species of sensitive biotopes like moors, wetlands, dry neglected grassland, litter meadows etc. belong to those species for which Bavaria has an important responsibility and is obliged to ensure its favourable conservation status. Furthermore, particular species of river banks like Kingfisher (Alcedo atthis), Little Ringed Plover (Charadrius dubius) or flora like the rare German Tamarisk (Myricaria germanica) are just some examples for it. These species appear often in areas which are also interesting for recreational use. In the middle of the city area of Munich, populations of reptiles like Viper (Vipera berus), Smooth Snake (Coronella austriaca) or Grass Snake (Natrix natrix), which are widespread in this area of Isar valley are declining. The same applies for birds like Wood Warbler (Phylloscopus sibilatrix) or Woodcock (Scolopax rusticola) which are most likely under pressure by leisure activities. Traffic safety measures in the city area might endanger Eagle-Owl (Bubo bubo) populations and other species which depend on deadwood. Though, there are no recent scientific proofs for disappearance of species yet in the Munich Isar valley (Hänsel 2014).

„Undissected low-traffic areas"

Undissected low-traffic areas are valuable for nature as well as for mankind. These are areas with more than 100 km² dissected by streets with less than 1000 vehicles per day. Those areas have a mean mesh size of about 73 km² in Bavaria, which shows a relative high fragmentation compared to other German States (e.g. the value in Mecklenburg-Western Pomerania is about 168 km², the national average is about 82 km²). This is the reason why Bavarian government defined the goal of protecting the remaining undisturbed areas and to interconnect these by corridors (e.g. green bridges) (LfU 2018b).

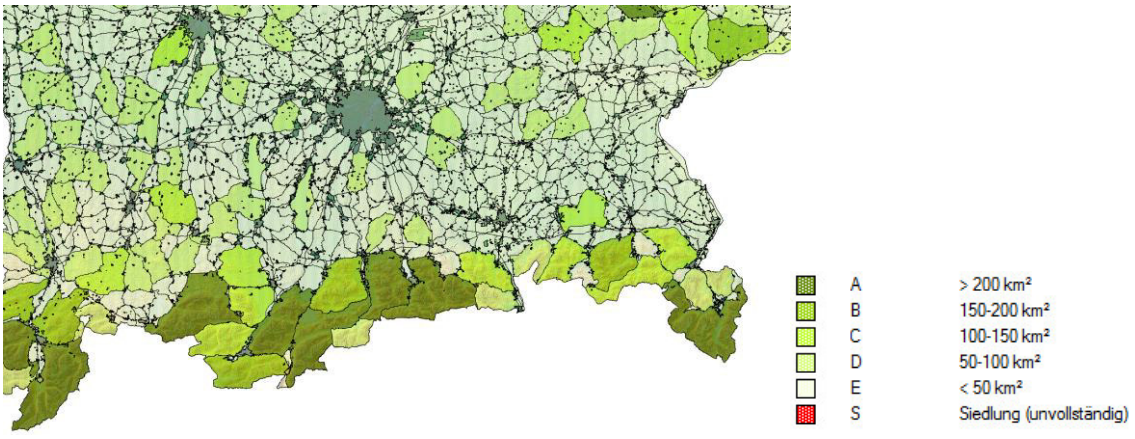

Figure 2: Undissected low traffic areas Munich area (FIN View)

Projects concerning EC

While in Bavaria about 400 projects have been realized under the umbrella of the Bavarian biodiversity strategy (released in 2008), some projects are undertaken in heaths and moors around Munich as well as projects for amphibians or nature recreation in the Isar valley in southern Munich23.

Alpine Foothills are very special in moors, wetlands and extensive grassland. There are cooperation projects on moors within the districts of Garmisch-Partenkirchen, Weilheim and Bad Tölz. The project "Tölzer Moorachse" focuses on the local moor network24 and the Center for Environment and Culture Benediktbeuern (ZuK25) on landcare projects in the moor area Loisach-Kochelsee. The Association for Heathland (Heideverein e.V.) in the north of Munich area is reactivating and caring for heathland and integrating the sites into a regional stepping stone system. This typical landscape type for the area, however, strongly attracts tourists and recreationists26. LBV Munich is currently working on a map of biotope network in the city area with aim of defining main biotopes for the network (LBV 2019).

The "Alps Plan" (Alpenplan) is a central element of the Bavarian regional development program and since 1972 it regulates the infrastructural exploitation of streets, cableways, ski slopes etc. It is the aim to prevent an overuse of nature and landscape as well as to ensure the protection against alpine hazards (Job et al. 2017).

Visitor guidance is a current issue in the district Bad Tölz-Wolfratshausen. Since 2019 a legal boat regulation on the river Isar should help to control the boat tourism in the FFH site. The German Association for bird protection LBV has a project for gravel breeders by guiding leisure activities along the river Isar, too27. A resolution to protect the upper Isar valley was made in the district of Munich to handle the pressure of recreation in the alluvial Isar forests28: Dirtbike facilities have been installed around Munich to have a nature-compatible offer. Together with the German Alpine Association (DAV) and the German Federal Agency for Nature Conservation a project on conflicts between mountainbikers and nature conservation sites started in 2018 in the two pilot regions Oberallgäu and Bad Tölz-Wolfratshausen. Trail concepts, signage and guidelines are part of it29. DAV has projects for a gentle mountain tourism like cooperations with railway companies

[23] „NaturErholung Isartal im Süden von München"; http://www.biken-isartal.de/; https://www.naturvielfalt.bayern.de/projekte/bayernnetznatur/muenchen_lkr/index.htm
[24] https://www.lra-toelz.de/moorachse
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[29] „Bergsport Mountainbike – nachhaltig in die Zukunft" https://www.alpenverein.de/der-dav/presse/presse-aktuell/umweltministerium-foerdert-mtb-projekt-des-dav_aid_32207.html

to reduce the car traffic or “Natürlich auf Tour”, a project for skitouring routes to avoid conflicts with wildlife protection areas. There are some official routes in ranges like Wetterstein, Mangfall, Kochel and Chiemgau mountains, which are areas highly frequented by day tourists coming from Munich. “Natürlich Klettern“ as a new campagne of DAV is working a sensibilization of climbers and a nature-compatible climbing.

There are projects on reactivation and maintenance of alpine meadows like the alpine farmers of the community Sachrang (district Rosenheim). They joined forces and initiated measures together with the community, landcare and governmental nature conservation (Sachranger Bergbauern). By clearing the brush lands, mowing and optimizing the grazing, the valuable biodiversity of these alpine meadows is preserved.

Threats and perspectives
Potential threats/need for action

The sustained growth of population in the Munich area in interaction with the intensive trend to outdoor recreation requires strong steering measures from the environmental point of view, even entry bans in ecological sensitive areas may be an option. Attractive public transport systems adapted to the needs of outdoor recreationists and combined with passing and parking bans to avoid high pressure by traffic in sensitive areas would help a lot. The recreational offers in cities away from sensitive biotopes should be optimized. Near and attractive sites could relieve sensitive alpine and pre-alpine areas. However, visitor guidance in alpine areas is indispensable combined with information of the visitors and environmental education. Furthermore, river axes such as Isar, Loisach, Mangfall or Tiroler Ache have a high potential for ecological connectivity. The ecological network of these should be connected with surrounding wetlands and is to be widened and preserved.

Possible solutions/recommendations for actions

There are not many peer-reviewed scientific studies on wildlife disturbance by outdoor sports and recreationists. This is a problem for the communication of entry bans or wildlife protection zones. The clearest proof of disturbance is population decrease of animal or plant species. As this is not acceptable, the principle of precaution applies and clear communication and information of the recreationists is needed. Unfortunately, information is often not enough and “hard” measures like temporal or spatial bans are required. A main task here is the control by rangers in protected areas and the persecution of the infringements. More scientific studies are needed to know more about the disturbance and influence of outdoor recreationists.

Creating attractive offers in less sensitive areas to relieve hot spots could be an option and should be discussed in some cases. The question should be investigated

whether a concentration in some single areas is better for ecological connectivity than an equal distribution on the whole area. A solution could be to translocate into less sensitive areas, but this discussion is needed with experts of all interest groups to obtain the desired effect. Aside mass tourism, city tourism or nature tourism new forms of tourism appeared which correlate to social developments. “Touristification” is the adaption to new demands of recreation considering key words like quality and pleasure, inspiration, recreation, “having a good time” or “Slow Culture”. A report of the Future Institute predicts a higher sense for mobility in 2040 and sharing approaches will be coming more into focus. Suburban areas will have to reorganise thinking about Smart mobility or Smart grids and the development of tourism in rural regions has a big potential provided that the foundation is laid now (ADAC 2017). Though tourism brings problems concerning EC, the landscape around Munich (as well as in other Alpine and Pre Alpine regions) must be preserved as it constitutes high values for humans and for flora and fauna.

Social Media has big potential for ecological connectivity, however it brings many problems. It is an important key word in current tourism developments, considering that “instagramability” is, considering current trends, a main factor for destination choices. For ecological connectivity this phenomenon is highly problematic because masses of tourists now come to former unknown and sensitive nature sites to take photos and to share it with the digital community. Sensibilisation campaigns for Social Media use in sensitive areas are needed. This work could be done by “digital rangers” who inform about sensitivity, behavioural rules and the danger of geotagging photos. Final aim is to have a self-regulating community with multipliers for ecological sensibility.

In general, a careful handling of nature is important, and humans are asked to hold back single personal desires. The big task of changing social values is urgent but slowly coming through movements like the Bavarian petition against species loss 2018 which forced political developments and legal adjustments but also an expansion of consciousness. The international youngster movement Fridays for Future shows how the next generation develops new values in the discussion of climate change and species protection. However, climate change can not just be handled by society and movements. Politics are asked to create for example new legal guidelines like tax adjustments to reward ecological behaviour.

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Barriers S (Danube valley transit axe)
Connectivity area XVI (Bavarian Forest - Bohemia - Danube connectivity area)

Description of the area

Between the Danube and the Alps, the Austrian and Bavarian Alpine foothills are an area of intensive land use and prosperous economy. The population is strongly growing in most of the regions. The main land use in the higher regions is intensive used grassland, in the lower regions, intensive farmland, with a crop rotation strongly influenced by maize. Further, there are some partly larger economic forests. The main Austrian cities in the area are Wels, Linz, Salzburg and Steyr. The main German cities are Straubing, Deggendorf, Landshut and Passau.

The large-scale interconnected axes of biological connectivity, which take into account the demands of species with very large spatial requirements and migratory species, lie in particular along the larger watercourses Inn, Salzach, Traun and Enns. In the floodplains large, near natural forests as well as dry biotopes especially along the dikes can be found. In general, structural diversity in terms of habitats improves in southern direction.

Description of possible problems or potential concerning ecological connectivity

The area is important to connect the montane zones of the Bavarian Forest as well as the dry habitats of the Subdued Mountains with those in the alpine region.

The main physical barriers are infrastructural facilities like highways and railways in E-W-direction. The main barrier concerning ecological connectivity is rather a structural matter by intensive landuse with widespread dissemination which causes a proceeding isolation of stepping stone habitats for small species. There are less large-scale protected areas (with more than 100 ha) which provide important diversity of habitat structure and species. For ecological connectivity on a macro-scale like EUSALP those areas are important to take care for special local species and habitats with a regional or international importance. According to the Federal Agency for Nature Conservation (BfN)[30], only 30-40% of native species can be preserved in viable populations under the current system of protected areas, which often concentrates on the protection of these mostly small isolated biotopes in a "supply-oriented" manner.

[30] https://www.bfn.de/themen/biotop-und-landschaftsschutz/biotopverbund.html

In order to enable the survival of a substantial part of the native fauna and flora, suitable living conditions must therefore also be created outside protected areas in the partly fragmented landscape characterized by agriculture and forestry. This includes, above all, creating the conditions for the spread and migration of the species. A stepping stone approach is obvious to realise connectivity in those areas.

Stepping stones and corridor network in Bavaria
Existing knowledge about ecological connectivity in the area

In Bavaria, the implementation of the European Natura2000 network plays a major role in supra-regional biotope network planning. The network of existing FFH and bird sanctuaries should therefore also be used as a backbone for the transnational biotope network. Most of the Natura2000 sites are located in the near of a river system (see map below).

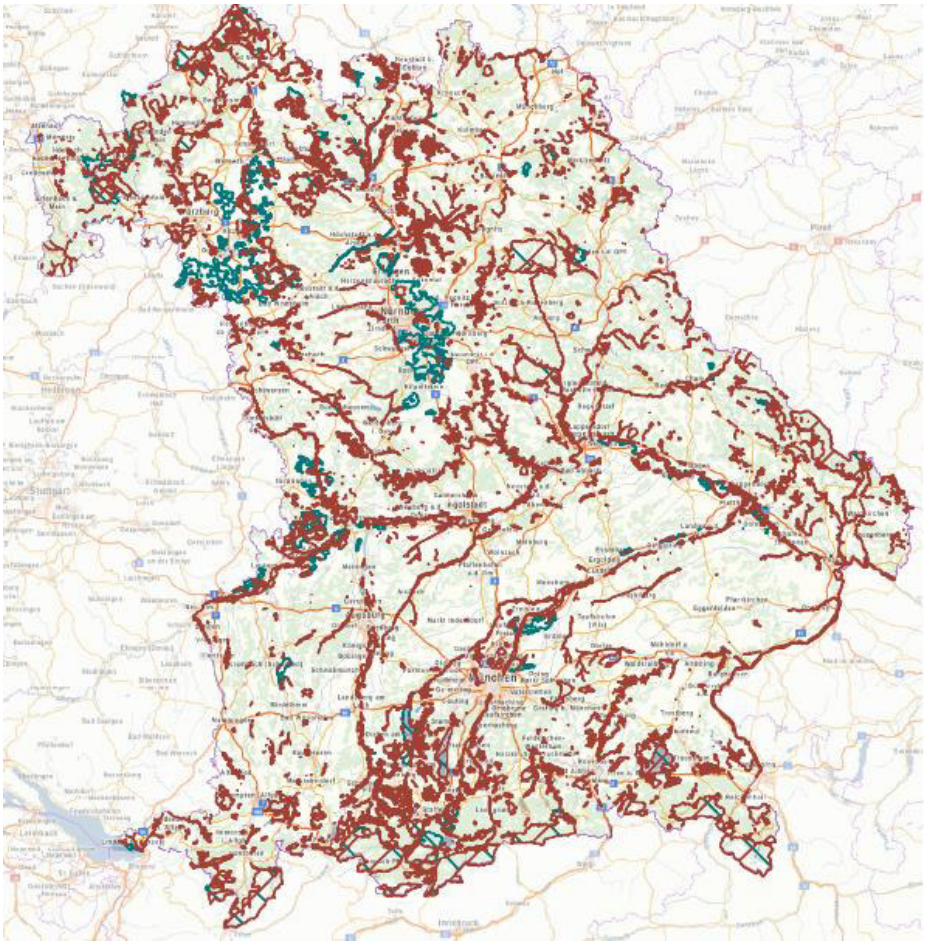


Figure 1: Natura2000-sites (Bayern Atlas 2019)

Several concepts exist for regional and supra-regional wildlife corridors in Bavaria and between bordering countries.

In the maps of Federal Agency for Nature Conservation (BfN) there are main corridors and network regions on a macro-regional scale near the borders. Here, rivers and floodplains play an important role to connect the protected areas of the south-eastern cross-border region. There are main forest axses, wet axes and dry axes for flora and fauna (see Figure 2 and 3).

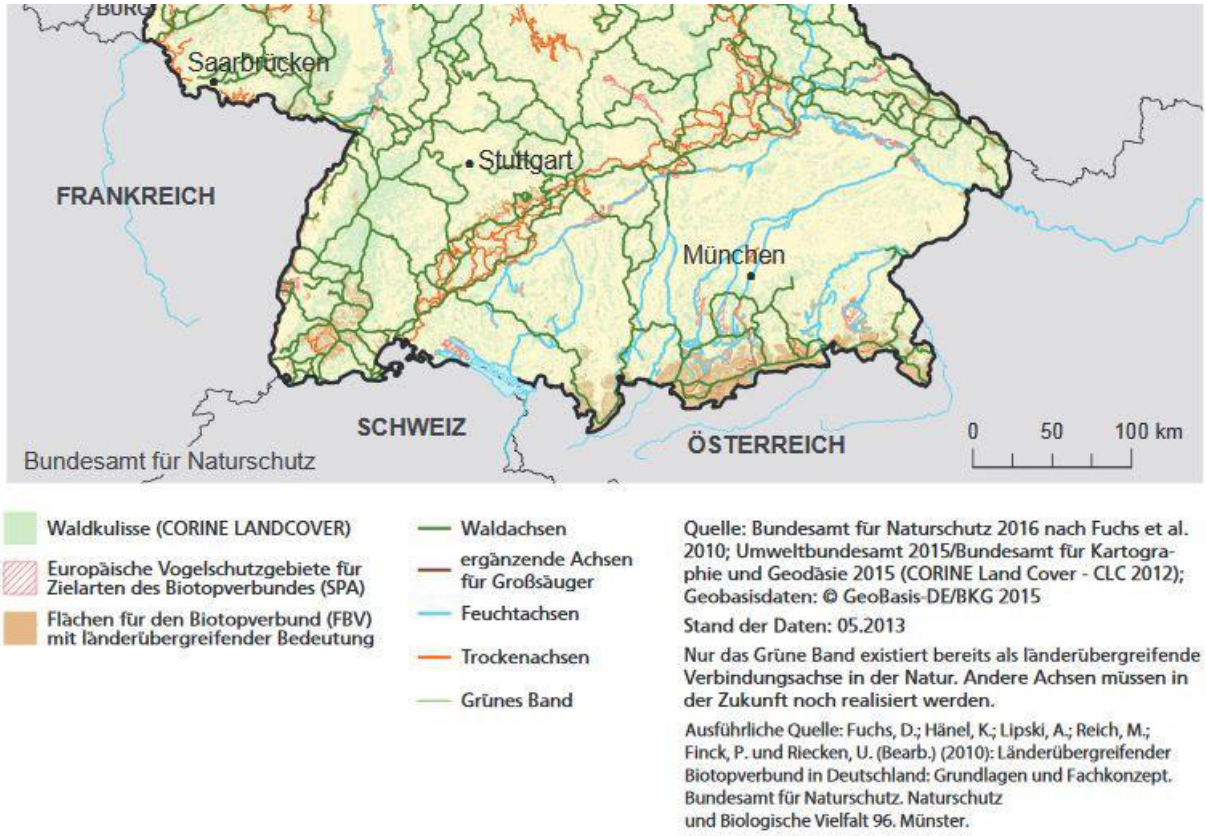
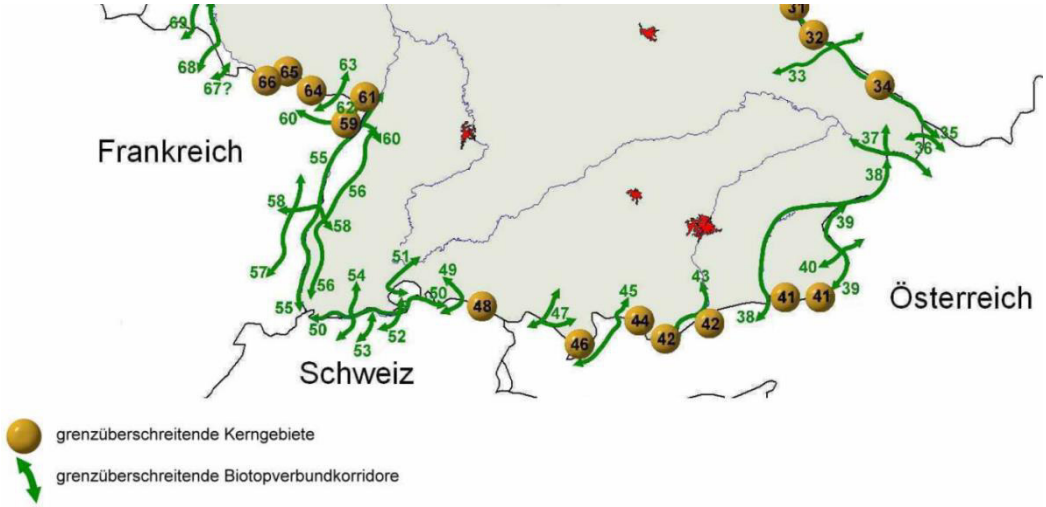


Figure 2: Biotope network and corridors with national and international significance (extract from BfN 2016)



34	*Bavarian Forest and Sumava: Forest-National Parks*
35	*Westbohemian forest network*
36	*Potential biotope network from forest region Waldviertel to river network Ilz*
37	*River and floodplain network along Danube river*
38	*Potential dry habitat network along Inn valley*

Figure 3: Main core areas, biotope network and description of these (extract from BfN)

There are strategic wildlife corridors for lynx and red deer in Bavaria from Bavarian Environment Agency and wildlife corridors in Upper Austria and corridor concepts for Wild Cats („Wildkatzenwegeplan“). In this concepts, mainly big forest networks appear for potential lynx and deer habitat and migration corridors are mainly along rivers (see figures 4-6). These concepts are species based but as target species for uncut near-natural forests they serve as umbrella species and cover the needs of lots of other forest species.

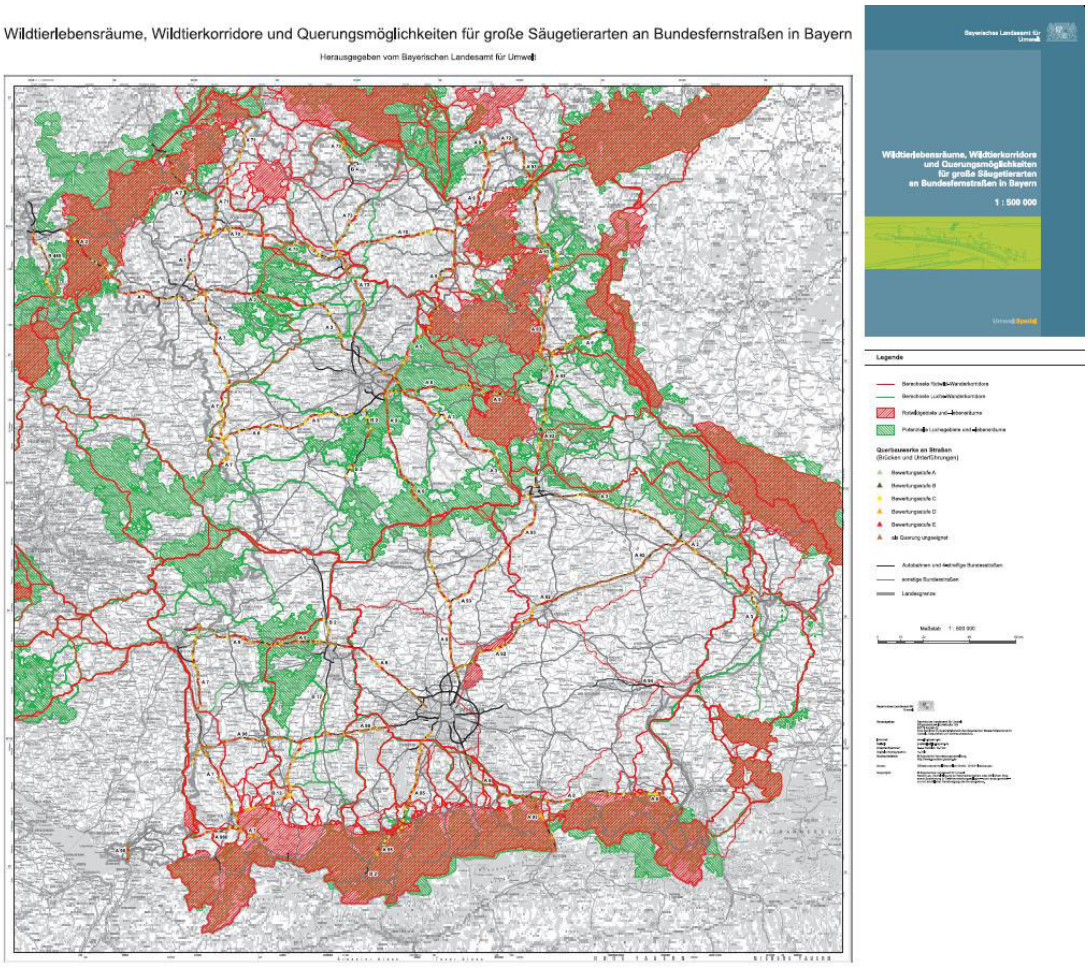


Figure 4: Wildlife corridors for mammals along main streets (LfU)

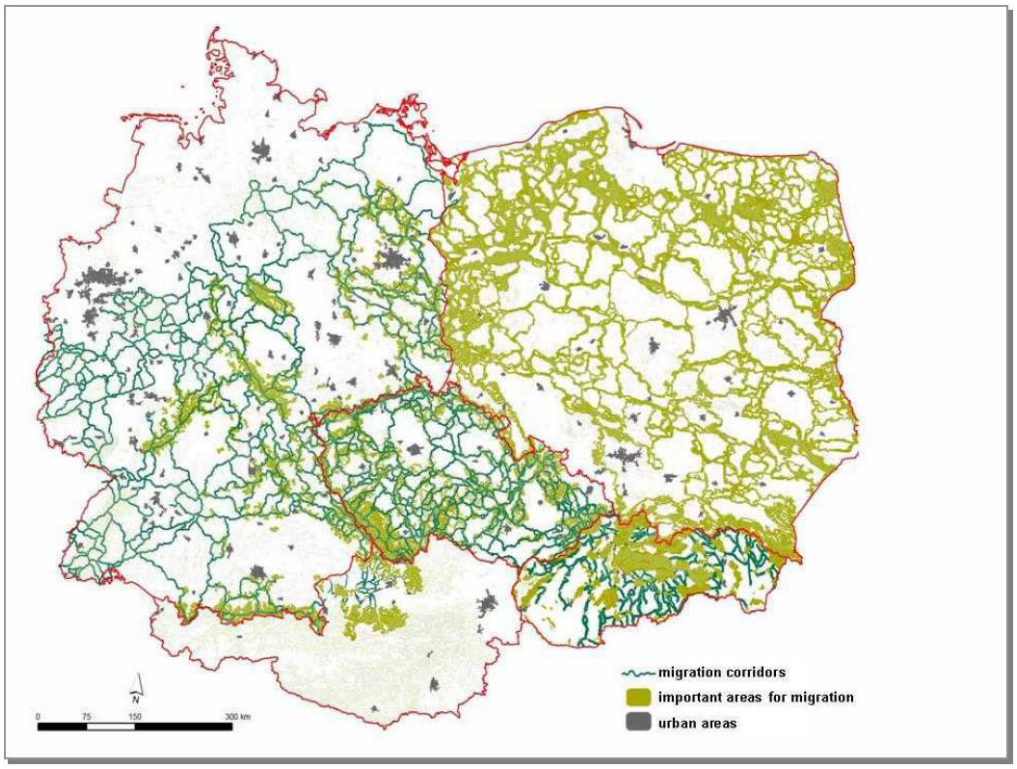


Figure 5: Main areas and corridors for migration in Upper Austria (Umweltanwaltschaft OÖ 2012)

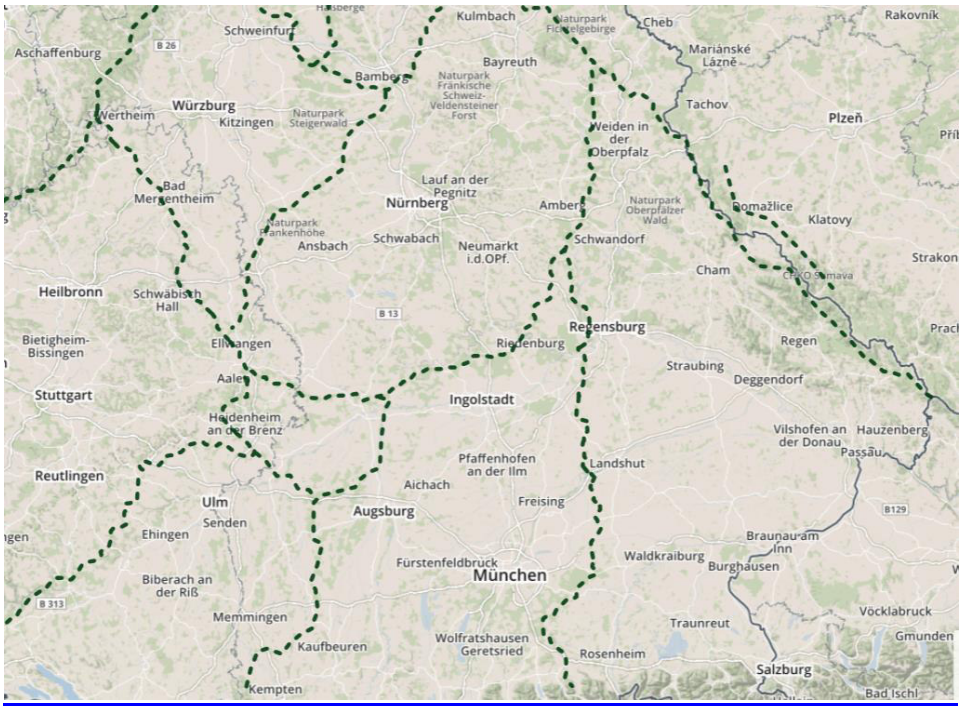


Figure 6: Main corridors vision "forest network" (NABU, German Association for Conservation)

The Landscape Structure Plan of the region Donau-Wald is a concept for ecological connectivity and consists of the development of a regional and supra-regional strategic planning approach. The object for EC is to reach at least 10 % biotope network sites according to the legal requirement by Federal Act for the Protection of Nature for biotope network. This target is pursued by a stepping stone concept and by developing core zones, patches and green linear elements like hedges or forests. Furthermore, waterbodies, dry and low-nutrient sites are in the focus of this habitat concept as well as supra-regional important migration corridors for large carnivores and deer (LfU 2011a).

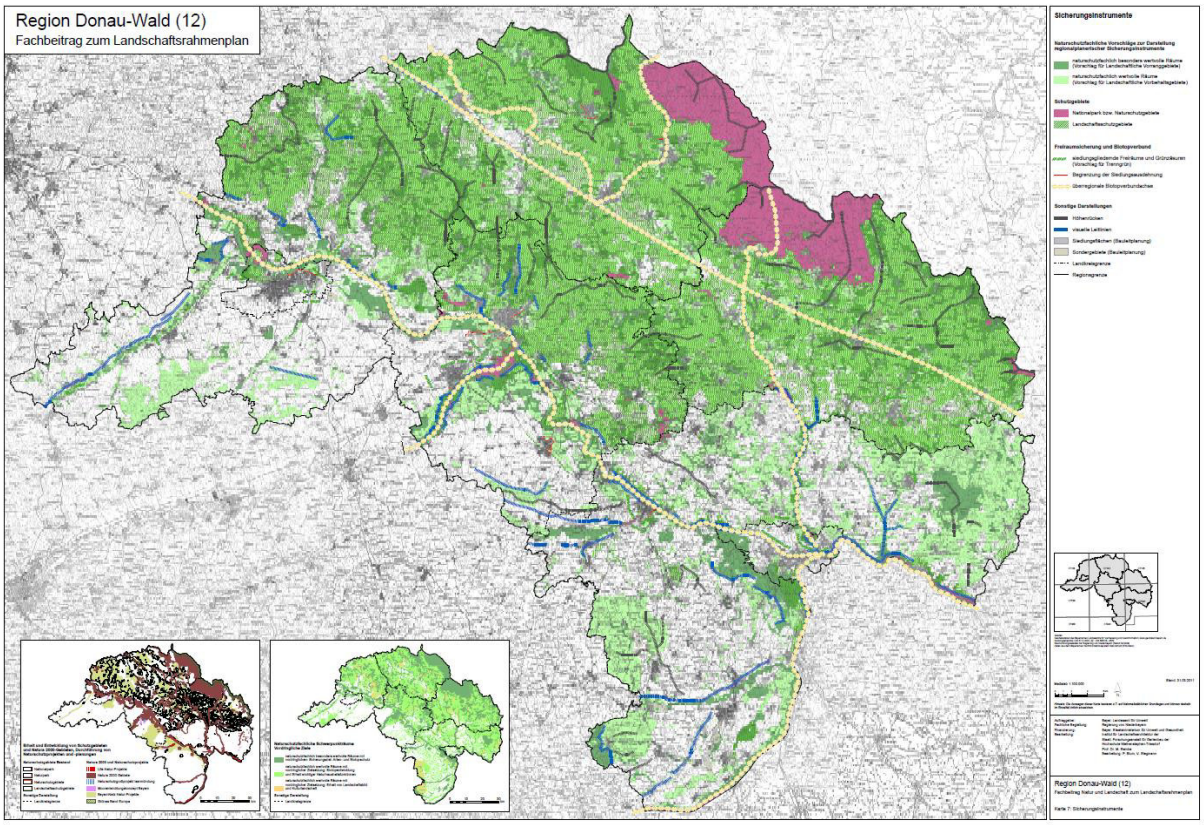


Figure 7: Landscape Structure Plan Donau Forests (LfU 2011b)

Potential threats/need for action

In general, the BfN's statements31 continue to apply: The increasing pressure on the landscape from roads and settlement construction as well as the intensification of agriculture and forestry leads to a loss of valuable biotopes. These do not only lose their total area but are also broken down into isolated individual parts which, due to their small sizes, are increasingly exposed to "marginal effects", i.e. disturbing influences from their surroundings. The remaining biotope islands are too small for many species and their isolation hampers the exchange of individuals between the areas. This leads to genetic impoverishment of the populations and endangers their long-term survival, such as the resilience of small populations is lower than of big, heterogeneous populations.

Perspectives and possible solutions/recommendations for actions

An integration of settlements and existing infrastructure facilities like railway dams, river dikes as well as watercourses as buffer strips is crucial for the success of a biotope network in such intensively used landscapes. Through adapted land management, valuable sites for the biotope network can be preserved or optimized. It is important to secure and create new, also small stepping stone biotopes in the landscape with high human impact. The municipalities and land users must be integrated into the process of planning and implementation. Also, constructions for green crossing like green bridges along highways are crucial to prevend the isolation of populations. NABU Germany already defined 125 priority spots where green crossing should be enabled by 2020 (NABU 2007).
In Germany, the legally defined instrument of compensation for landscape incursions is also suitable for the implementation of targeted integrated concepts. This tool should be extended by cross-border communication of strategic corridors, existing barriers, affected species and the planning should take place in close cooperation with administrations of Bavaria, Austria and Czech Republic.

On a regional level, preservation and development of interconnected axes and improvement of continuity within landscapes and natural areas is a main task for regional planning concerning EC. Local biotope networks must be extended through the preservation of existing biotope complexes and the networking of individual biotopes within the framework of urban land-use planning and landscape planning by local authorities. This biotope network of stepping stones might be realised through implementation and expansion of the proven approach by the Bavarian Landcare Associations. Voluntary and equal cooperation between municipalities, land users

[31] https://www.bfn.de/themen/biotop-und-landschaftsschutz/biotopverbund.html

and nature conservationists is the basis for this practical concept with the chance for landscape integrated biotope and species protection.

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Barriers T (Central Sovenian Transit axe)
Connectivity area XI (Karst connectivity area) / XII (Alps-Dinarics connectivity area)

Description of the area

Dinaric Mountains are situated in the Western part of the Balkan Peninsula along the Adriatic coast and run in the NW-SE direction **merging with southern Julian Alps in Slovenia without a clear boundary**. From geological perspective a part of Julian Alps belongs to Dinaric Mountains which are dominated by carbonate rocks (Griffiths, Kryštufek, & Reed, 2004). In the south Dinaric Mountains continue into the Greek Pindus Montains and the Greek island which are geologically different as they are dominated by volcanic or metamorphic rocks (Griffiths et al., 2004).
The transition zone between Dinaric Mountains (South), the Alps (North), Adriatic Sea (West) and the Pannonian plain (East) is located within Slovenia. Consequently the area is very diverse with average altitude of 732 m a.s.l. in the Alps, 580 in Dinaric Mountains, 352 m a.s.l. in the Adriatic basin and 261 m a.s.l. in the Pannonian plain. The predominant land cover of Slovenia is forest (61%), followed by agricultural land (32 %), urban artificial areas (5 %), water areas (1 %) and other types of land cover (2 %).

Structure and tree species composition of forests is well preserved, which is the result of more than half of century of close to nature forest management. In fact, forests are well structured, the growing stock and annual increment are among highest in Europe (302 m^3/ha and 7.5 m^3/ha, respectively), large diameter trees amount to 31 % and nearly all forests regenerate naturally (Poročilo…, 2019). Furthermore, tree species composition is generally favourable, since the share of preserved forests exceeds 50 % and forests with strongly modified and altered tree species composition is just a tenth of the total (ibid).

According to national environmental indicators between 60 – 80 % of agricultural land (representing 20 – 30 % of total area of Slovenia) is high nature value farmland. In 2011 almost 25 % of agricultural areas of Slovenia were located within nature protection zones. According to (European Environment Agency, 2017) the loss of high nature value farmland due to agricultural intensification in Slovenia was 0 % in the period between 2006 – 2012.

In 2016, approximately 37 % of the area of Slovenia was included in Natura 2000 network of protected areas (355 sites covering 768.433 hectares). Predominant land use in Natura 2000 areas is forest (70 %).

Population density of Slovenia is intermediate (102 inhabitants / km^2) with dispersed distribution of settlements which are small compared to European average. Out of

approximately 6.000 settlements 95 % of these have fewer than 1000 inhabitants. Only two cities (Ljubljana and Maribor) have more than 50.000 inhabitants.

In 2014 the average density of roads was 1.9 km of roads / km^2.

Description of possible problems or potential concerning ecological connectivity
Importance of the area in an Alpine context

The connection between the Balkan peninsula and northern Europe was important historically as the Balkan peninsula was one of the three major European peninsulas (in addition to Iberian and Italian) which **acted as glacial refugia** to almost all European species of Mediterranan origin (Schmitt, 2007). Among the four different paradigms of postglacial re-colonisation of Central and Northern Europe by Mediterranean species, the importance of the Balkan Peninsula is most pronounced in the "grasshopper" example (major expansion to Central Europe only from the Balkans and trapping of the Atlantic- and Adriatic-Mediterranean lineages by the Pyrenees and Alps, respectively) which has been shown for species such as black alder (*Alnus glutinosa*), common beech (*Fagus sylvatica;* (Magri, 2008)) and great crested newt (*Triturus cristatus*) (Schmitt, 2007).

The Balkan peninsula has also been described as an important **biodiversity hotspot of Europe** due to the level of endemism resulting from complex processes underlined by its role as glacial refugium, its high environmental stability, topographic and climatic diversity and the presence of land bridges (Griffiths et al., 2004).

Dinaric mountains are considered as one of the European hotspots for large carnivores (wolf, lynx and bear) (Chapron et al., 2014) which reflects the quality (in terms of composition and remaining intact area) of the forest habitats in this area (Griffiths et al., 2004). Slovenia hosts the north-western part of the Alps-Dinaric-Pindos brown bear population which is considered the **only viable potential source population for natural re-colonization of the large part of the Alps** (Austria, Italy, Switzerland, Germany, Lichtenstein) where there are currently fewer bears as the habitat can support (Boitani, Ciucci, Corsi, & Dupre, 1999; Güthlin et al., 2011; Jerina, Jonozovič, Krofel, & Skrbinšek, 2013).

Following its extinction **lynx** was reintroduced in the 1970s in several areas (Dinaric Mountains, Alps, Jura, Bavarian forest). Population of lynx in Dinaric – south-eastern Alpine population is estimated at 130 animals and is spatially separated from other populations. The Dinaric population established from 6 reintroduced animals in 1973 in Slovenia and is consequently highly affected by inbreeding of individuals resulting in reduced fitness leading to population decline. The only long-term warranty for survival of this isolated population is establishment of connectivity with other lynx populations in Europe (i.e. with Swiss Alpine lynx population).

Characteristics of existing barriers

The oldest **Slovene highway A1 connecting Ljubljana – Postojna** (and further towards Trieste and Koper) was constructed in the beginning of 1970s and it cuts through large forested areas presenting a barrier for movement of large carnivores (bears, wolf). This highway is one of the main traffic axes for tourists coming from or travelling through Austria, Germany and Hungary towards the Adriatic Sea. The design and construction of the highway does not include green bridges or underpasses dedicated solely to ecological connectivity which would enable animals to safely cross the highway. Three sections of the A1 highway are especially problematic for large carnivores: Vrhnika-Logatec, Unec-Postojna and Razdrto-Senožeče. The A1 highway posed a home range boundary to resident bears but was not an absolute barrier (Kaczensky et al., 2003). The A1 highway has been identified as an important barrier for **bear** movement which is mostly crossed towards the eastern Alps by dispersing males, which ultimately biases the sex ration there, and presumably also the trends of habitat selection (Recio et al., 2018). A1 highway has also been identified as a potential barrier for **lynx** as animals equipped with telemetric collars and living in vicinity of the highway did not cross it (Krofel, Potočnik, Skrbinšek, & Kos, 2006). The A1 highway has been identified as a barrier between Dinaric and Alpine populations of lynx (*Strategija ohranjanja in trajnostnega upravljanja navadnega risa (Lynx lynx) v Sloveniji 2016 - 2026*, 2016).

In some parts of the A1 highway the **railway line Ljubljana – Trieste runs parallel to the highway** thus presenting an additional barrier to the above described ecological connectivity between Dinaric and Alpine populations. Analysis of traffic-related mortality of bears between 2004-2012 showed traffic was the cause of 15 % of all detected bear mortality and was after hunting the second most important mortality cause (Al Sayegh Petkovšek et al., 2015). The highest rate of traffic mortality was on local and regional roads (50 %; N=71), followed by railway collisions (44 %; N=62) and lowest on highways (6 %; N=9).

In addition to physical barriers, a **lack of coordinated spatial planning on the regional, national and international levels** also poses a significant threat to ecological connectivity. In addition to large linear infrastructure (roads, railways) habitat fragmentation is also caused by urbanisation which is especially problematic in locations which act as corridors between habitat patches (*Strategija ohranjanja in trajnostnega upravljanja navadnega risa (Lynx lynx) v Sloveniji 2016 - 2026*, 2016). An example of such unsuitable location was construction of industrial estate near Podskrajnik between Rakek and Cerknica which reduced ecological connectivity for lynx between habitat patches of Menišija and Logaška planota in Slovenia.

Existing knowledge about ecological connectivity in the area

Examples of physical exchange of species between Dinaric and Alpine populations are most numerous for large carnivores because they are well studied and their movements are relatively easy to track with GPS collars.

The Dinnaric-Balkan and Alpine populations of **grey wolf** were believed to be separated for more than a century. However, a recent dispersal of a GPS-collared male wolf from the south of Slovenia to the Eastern Italian Alps proved a connection between the two populations exists. The dispersing wolf from Dinaric mountains paired with a female from Italian Alps and recolonised an area in Italy where wolves were extirpated more than a century ago (Ražen et al., 2016). The dispersing wolf from Dinaric mountains travelled for 98 days and covered a distance of 1176 km crossing Slovenia, large part of Austria and part of the Italian Alps. A wolf nicknamed “Slavc” paired with a female from Italian Alps (nicknamed “Julia”) and recolonised an area in Italy where wolves were extirpated more than a century ago.

Source: Ražen etal. 2016, European Journal of Wildlife Research

Natural dispersal of **bears** from Slovenia into the alpine areas of adjacent Italy and Austria has been observed and the Slovenian bear population has been considered as the only source for natural re-colonisation of the Alps (Kaczensky et al., 2003). An example of bear dispersal was documented for bear named Rožnik which was caught near Ljubljana in Slovenia in 2009 and equipped with a GPS collar. Rožnik was translocated to the south of Slovenia, travelled towards south to Croatia and afterwards changed direction and migrated to the north of Slovenia and crossed the border to Austria where it was killed (Krofel & Jerina, 2009). Rožnik travelled 650 km in 40 days.

Potential threats / needs for action

Several **infrastructural projects** are planned including the second track of the railway Koper – Divača.

Other infrastructural projects potentially affecting ecological connectivity are **wind farms** which might affect migratory birds but also other animals. In their study of sensitive areas for the placement of wind farms in Slovenia (Bordjan, Jančar, & Mihelič, 2012) identified 17 bird species sensitive to the presence of wind farms. Their study showed Slovenia is not one of the countries with a high share of territory sensitive to wind farm placement owing to sensitive species of birds. The high sensitivity areas cover no more than 15.1 % of Slovenian territory, whereas moderately sensitive areas cover further 14.7 %. No less than 70.3 % of Slovenian territory does not belong to any of the sensitivity categories.

Climate change is expected to influence species physiology, phenology and distribution (Bellard, Bertelsmeier, Leadley, Thuiller, & Courchamp, 2012) resulting in extinction for those unable to adapt. One of the ways species are adapting to climate change is by shifting their range (Hughes, 2000). Due to large difference in elevation in mountain regions the obvious shift is expansion to higher elevations as has been shown in models and confirmed in reality (Chen et al., 2009; Pauli, Gottfried, Reiter, Klettner, & Grabherr, 2007). Models of climate change threats for European plant species showed projected habitat loss is greater for species distributed at higher elevations (Engler et al., 2011; Thuiller, Lavorel, Araujo, Sykes, & Prentice, 2005) therefore maintaining ecological connectivity between Dinaric Mountains and the Alps will be especially important for species living at higher elevations in mountain ranges of the Balkan Peninsula. Ecological connectivity with the Alps will present a potential for their spread towards the north and towards higher elevations in the Alps.

Species concerned

Analysis of **spatial connectivity of three brown bear populations** (“Dinaric”, “the eastern pre-Alps” and “Trentino-Swiss”) in the area between Dinaric Mountains and the Alps showed that the largest and most important patches for connectivity occurred in the current distribution range of the species, with the most suitable habitat lying in the pre-Alpine and Dinaric populations (Recio et al., 2018). The authors estimated that there is potential for connecting these three populations, although “the eastern pre-Alps” population contains smaller and more abundant fragmented patches than the other two populations. However, “the eastern pre-Alps” population contains habitat patches of importance for the hypothetical flux and connection between “Dinaric” and “Trentino-Swiss” populations (Recio et al., 2018). Habitat suitability model also showed there are some large suitable patches of connectivity importance for the survival and movement of bears in Austria under a

hypothetical scenario of bear colonization of this region. These patches are surrounded by other smaller ones that could act as stepping-stones connecting mainly with “Dinaric” population (Recio et al., 2018).

Importance of connectivity between the Dinaric Mountains and the Alps has been described also for **lynx and wolf** populations (see previous chapters).

Climate change is expected to affect many species and the most threatened will probably be species bound to cooler and more humid habitats. A typical example is **Western Capercaillie (*Tetrao urogallus*)** which is still relatively abundant in the northern boreal forest, where it has a contiguous distribution. However, south-central and western European populations are highly fragmented and reduced (EU Wildlife and Sustainable Farming project, 2009). In Slovenia capercaillie breeding sites (leks) were present at the south-eastern edge of the Alpine metapopulation and at north-western edge of Dinaric metapopulation (Čas, 2010). Regular monitoring of capercaillie population at leks by hunters and foresters revealed a decline in the number of leks in the Eastern Slovenian Alps and Julian Alps between 1980 – 2000, after which the population stabilized (Čas, Kobler, & de Groot, 2017). However, the number of leks in the Dinaric Mountains in the south of Slovenia declined steeply throughout the entire monitoring period 1980 – 2010 (Čas et al., 2017). A similar trend was recorded in the Dinaric Mountains of Croatia (Frković, 2012). In 2015 monitoring of capercaillie in Kočevsko Natura 2000 areas in southern Slovenia did not record any remaining active leks (Potočnik, Perušek, & Kos, 2015). Hunters and foresters listed several potential reasons for capercaillie decline in Slovenia such as logging of old growth forests, increase in the number of predators (martens, wild boar) and increase in mountain tourism (Čas, 2010). Among other factors climate change also seems to be affecting capercaillie populations with some studies showing a decline in reproductive success (Baines, Aebischer, & Macleod, 2016; Jahren, Storaas, Willebrand, Fossland Moa, & Hagen, 2016; Selås et al., 2011) but others with opposite effects (Wegge & Rolstad, 2017). If climate change is an important factor driving the decline of capercaillie population in the Dinaric Mountains, the importance of ecological connectivity between the Alpine and Dinaric population will increase. In the future the Alpine population will present a potential source of individuals for recolonization of the habitats in the Dinaric Mountains.

Capercallie adult male, foto: Miran Krapež, Source: LIFE-Kočevsko website

Perspectives and possible solutions / recommendations for actions

The existing barrier of Slovene highway A1 connecting Ljubljana – Postojna (and further towards Trieste and Koper) still **remains without green bridges for animal crossings** although several studies have been conducted for selecting an optimal location of potential green bridges (Adamič, Kobler, & Jerina, 2000; Gonc, 2012). At least two green bridges are needed to ensure suitable overpassing of Ljubljana-Koper highway for large carnivores and other animals (i.e. on sections Vrhnika-Logatec and Unec-Postojna). Slovenian highway company (DARS) recently initiated preparation of baseline expertise for potential construction of green bride(s) or other suitable over- or underpassing objects on this highway.

Several **mitigation measures along the A1 highway** have been implemented by the LIFE DINALP BEAR project (LIFE13 NAT/SI/000550) including installing electric fence along the 15 km of the most problematic section which will prevent bears from climbing over the fence (Al Sayegh Petkovšek et al., 2015).

LIFE DINALP BEAR project also implemented **mitigation measures along the railway Ljubljana – Trieste** using acoustic deterrents in pillars (Al Sayegh Petkovšek et al., 2015) and along the state road Ljubljana – Kočevje (which crosses Slovenian bear core area) using dynamic traffic signs at the locations with previously recorded highest traffic related mortality. Important additional measure to increase permeability on this road for large carnivores that should be implemented in the future is construction of green bridge near Jasnica – the hot-spot location for large carnivores crossing of this state road.

The same project initiated an action with the aim to integrate bear habitat connectivity and suitability into spatial planning. Habitat connectivity for brown bear in northern Dinarics and SE Alps has been analysed within this action. The next necessary step

toward increasing permeability of this area for bear (also wolf and lynx) should be identification of most critical ecological corridors, followed by legal protection of identified areas.

Government of the Republic of Slovenia adopted **Transport Development Strategy of the Republic of Slovenia** and Environmental report for the Strategic Environmental Assessment for the Transport Development Strategy of the Republic of Slovenia on July 27, 2015 (ref.nr. 37000-3/2015/8). It foresees measures to prevent or mitigate impacts of the railways and roads could have on environment and nature by avoiding nature conservation areas (Natura 2000 areas, protected areas, ecologically important areas, areas proposed for protection) for new and existing infrastructure. If the electrification of a railway line is planned in the area of flight and migration routes of birds, appropriate technical solutions for preventing the collisions of birds with power lines must be anticipated. Variants with less impact on the migration paths of wild animals should be given priority (those with long sections in tunnels, covered burrows; those which cross fewer migration paths). When fragmenting migration paths, adequate passages must be provided pursuant to good practices in the European Union. The Strategy foresees pursuing of environmental objectives by monitoring environmental indicators:

- Environmental objective 6: Ensuring the cohesion of populations and conservation of biodiversity – monitoring of environmental indicator Collisions with wild animals.
- Environmental objective 7: Protect areas with nature protection status against activites with considerable impacts – monitoring of environmental indicator Habitat fragmentation [SEBI013].

The Strategy also foresees several general but also targeted guidelines and mitigation measures for sustainable preservation of the natural environment and biodiversity.

Currently the new **Strategy for spatial development of Slovenia** is in preparation and according to the timeline it should be implemented in 2019 however at the time of preparation of this document its contents was not yet public.

On the level of Municipalities the **Institute of the Republic of Slovenia for Nature Conservation** (ISNP) oversees the preparation of spatial plans and issues instruction on nature conservation protection measures. In special nature protection areas ISNP also participates in comprehensive environmental impact assessments by providing expert opinion which should take effects on ecological connectivity into account.

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Barrier U (Leoben - Grazer Bassin - Klagenfurt - Slovenian Border)

Description of the area

The main cities in the area are Klagenfurt (AT), Villach (AT) and Ljubljana (SI), and on the Styrian side Leibnitz (AT), and Maribor (SI).

Description of possible problems or potential concerning ecological connectivity

Please see the chapter on Alps-Dinaric Arc by the Slovenian partners, which outline the impact of traffic routes from Austria to Slovenia and beyond.

Highways, such as the Villach route (A2, A10) – Karawanken Tunnel border crossing that connect to the Slovenian A2 highway, or the Voralpenkreuz interchange (A1, A8) – Graz – Spielfeld border crossing to the Slovenian A1 highway do constitute a barrier (this has been documented, e.g., for bears). It is, however, also the case that a lot of road kill happens on smaller and local roads.

Existing knowledge about ecological connectivity in the area

According to a recent study ((Leitner et al., 2016) on habitat connectivity in Austria, different provinces have different implementation approaches to habitat connectivity. In Carinthia, the forestry sector does not see itself playing a major role in connectivity measures, unlike in Styria, where this is seen as an important topic and included in forest development plans (Waldentwicklungspläne). On the other hand, in both Styria and Carinthia spatial planning considers habitat connectivity an important issue. In both provinces hunting associations also consider this an important topic.

As far as agriculture is concerned, all over Austria the national agro-environment programme ÖPUL plays a guiding role in involving farmers in environmental measures that contribute to ecological connectivity, such as the provision of biodiverse and richly structured habitats (e.g. hedgerows, fruit tree meadows (agroforestry), flowering meadows).

In 2006 a “Freiraumkonzept” was developed in Carinthia under the auspices of the EU Interreg IIIb project CONSPACE. It listed all important habitat types of Carinthia and mapped them according to different criteria, such as the degree of endangerement, the degree of fragmentation. In this context, wildlife corridors were defined as areas that are meant to allow migration of wildlife between core habitat areas. The results of this study were intended to secure a commitment to the maintenance of such wildlife corridors in spatial planning programmes. Every Carinthian municipality are legally obliged to develop local development plans, and the idea was to anchor green corridors in these concepts, which then form the

foundation for the issuance of a zoning plan. Although the marked wildlife corridors are viewable in the KAGIS (Carinthia GIS) in the area of "nature inventory" (Naturinventar), they are not yet legally obligatory.

Potential threats / needs for action

Land-use management

Sustainable land-use patterns (e.g. in agriculture and forestry) shall support the permeability of corridors and contribute to a multifunctional land-use. As specified in the provincial hunting law of 2000 (amended repeatedly in subsequent years) the Board of the Carinthian Hunters has to issue a wildlife-ecological spatial plan for planning the hunting of all huntable species for the entire provincial territory, which has to be monitored and adapted as needed at least every five years (or sooner). This must take into account the need to secure wildlife habitat on the one hand, and to avoid wildlife damage and other damage to the vegetation on the other hand. The plan has to include habitat zones for each wildlife species, including natural and man-made boundaries of such habitat zones. Red deer habitat has to be divided into core zones, peripheral zones and red-deer free zones. Core zones have to contain about 80 percent suitable habitat for red deer, while in the peripheral zones red deer should only be present temporarily or in low densities. Areas that are not generally suitable habitat for red deer should be declared as free zones and then kept red deer-free to the extent possible. To issue such a spatial plan the hunting board has to hear the opinions of the provincial hunting advisory council, the provincial government, the forestry service, the chamber of agriculture, the chamber of labor, and the chamber of commerce.

(SOURCE: ALPINE-CARPATHIAN CORRIDOR ACTION PLAN, AVAILABLE AT WWW.ALPENKARPATENKORRIDOR.AT)

Nature protection

The Nature Protection Act does not make specific reference to ecological connectivity or ecological networks. (These terms are only directly mentioned in the provincial laws of Salzburg, Lower Austria, and Vienna.)

The Carinthian Nature Protection Act of 2002, modified in 2017, defines obligations to protect landscapes in general and the Alpine region (which here is defined as the area above the tree line) in particular. In open landscape, i.e. outside settlements, any infrastructure plans are subject to special approval and in principle green areas should not be sealed through construction. Special approval must not be granted if a project would jeopardise the "landscape view" (Landschaftsbild) or the natural ecosystem function would be damaged (e.g. endangered species or habitat

destruction). Above the tree line, there must not be any measures that would change the terrain (such as mining, or destroying the top soil, or sealing the soil through asphalt, except for maintenance of hiking paths or for previously approved heliports to supply mountain huts). Some ecosystem types, such as glaciers and moors, are specially protected. For any permits granted that endanger important natural habitats of endangered species, substitute habitats must be created – or damages paid that the government should use for implementing the nature protection act´s provisions.

The Styrian Nature Protection Act from 2017 has quite similar provisions. However, in its new version it also mentions habitat networks specifically in the general goals: The law is to protect the functioning and the self-regulatory capacity of nature as well as a largely undisturbed natural balance (e.g. through the facilitation of natural processes or the creation of a habitat network (Biotopverbund)). The province has a Land Stewardship Fund (Landschaftspflegefonds) that is to be used to finance the costs of protection and landscape care measures. This fund is administered by the provincial government and is to be used for all protection measures including the specifically mentioned measure to improve ecological infrastructure (which also includes land management measures such as extensive use, the protection of characteristic landscape elements and ecologically important structures, or the creation of a habitat network).

In addition to provincial laws, where connectivity is not (yet) mentioned, the theme of habitat networks and connectivity was entered as a goal in the Austrian Biodiversity-Strategy 2020+, where goals 10 and 11 demand a strengthening of connectivity measures, the securing of wildlife corridors, and green infrastructure to increase the permeability of traffic routes for wildlife, as well as a reduction of green-land sealing.

(Source: Alpine-Carpathian Corridor Action Plan, available at www.alpenkarpatenkorridor.at)

Species concerned

The Slovenian-Austrian border is regularly crossed by bears, and other large carnivores, such as lynx and wolves. More details in the Slovenian partner report.

Perspectives and possible solutions / recommendations for actions

Plans for ecological connectivity have existed for almost two decades, at least for high priority areas. Apart from green bridges across highways, one should not neglect the impact of smaller roads and railroad tracks.

As pointed out by Leitner et al (2016), to ensure a proper implementation of connectivity measures it is essential that a public awareness and communication campaign accompany any such plans, so that people – and the politicians that make

the policies – become more aware of the dangers of landscape fragmentation, not only for wildlife, but also for human wellbeing.

Apart from that, it is essential to go beyond recommendations and guidelines and to make green networks legally mandatory, which then has to be reflected in spatial planning laws, nature protection laws, forestry laws, farming laws, hunting laws and all associated legal devices. This of course again hinges on a realisation of politicians of the importance of connectivity. The main implementation has to be through the spatial planning sector.

In order for spatial planning to be able to do its job with regard to green networks, it is also necessary to have accurate and up to date data, e.g. on existing barriers, in fences apart from those along highways, on the regulation of rivers, etc.

(SOURCE: ALPINE-CARPATHIAN CORRIDOR ACTION PLAN, AVAILABLE AT WWW.ALPENKARPATENKORRIDOR.AT)

Barriers V (Alps – Carpathians trafic corridors)
Connectivity area XVII (Alpine - Carpathian connectivity area)

Description of the area

The entire area starting in Vienna South towards Baden -> Wiener Neustadt/Eisenstadt -> Lake Neusiedl (an important bird area and transboundary National Park region) is highly fragmented by settlements, roads and agricultural land-use.The main cities in the area are Vienna (AT) and Bratislava (SK)

Rosaliengebirge

With a maximum elevation of 748 m, the Rosalien mountainrange (Rosaliengebirge) are part of the north-eastern foot-hills of the Alps. It is comprised of woodland rolling hills at the border between the provinces of Lower Austria and Burgenland. The lower regions have a richly structured cultural landscape with grasslands and orchards. This area is still highly usable for wildlife migration. A part of the mountainrange is located in the protected nature park Rosalia-Kogelberg (Note that the label “nature park” designates a relatively weak form of protection).

Wiener Neustädter Pforte

The “Wiener Neustädter Pforte” is a 13 km wide valley, stretching from the Rosaliengebirge in the south to the Leithagebirge in the northeast. Farmland and vineyards dominate the valley bottom. Generally, wildlife migration is possible here, although the motorway A3 and growing settlement areas constitute infrastructure barriers.

Leitha Mountains

Southeast of the Vienna Basin and dominated by forests, the Leithagebirge is a large connected core habitat for Red deer. This area constitutes an important stepping stone for wildlife migration. There are nearly no infrastructure barriers present.

The northeastern part is classified as a Natura2000- area (“Nordöstliches Leithagebirge”) and partly as protected area (Naturpark Neusiedler See – Leithagebirge, which is part of the Nature- and landscape protected area Neusiedlersee and surroundings). The area of the 11.000 ha Nature Park is entirely designated as Natura2000 region, as well as protected under the Ramsar Convention and as a UNESCO Biosphere Reserve. It is also part of the UNESCO world heritage designated cultural landscape Fertö/Neusiedlersee.

Leitha floodplains, Arbesthal hill country and Ellander Forest

This area stretches from the Leitha floodplains in the south to the Danube floodplains in the north. Some parts of the former river area are dominated by intensive agricultural land-use. Higher, warmer sites are used for vineyards. Settlements are relatively few and far in between. The Ellender forest area is an important stepping stone in this area, which is however partly fenced. Some areas are intensively used for agriculture. The motorway A4 is an impervious barrier for species as Red deer. The federal highways B9 and B10 also have an barrier effect. Roadkill is frequent here.

Danube-floodplains

The Danube floodplains are protected as a national park since 1996. This area also belongs to the Ramsar- and Natura2000 areas. 65 % of the area are floodplain forests. Land-use is limited to local forestry and meadow use, hunting and fishing. The national park is an important stepping stone and a core habitat for Red deer and many other, in part endangered, species. The Danube itself does not constitutes a serious barrier for wildlife, embankment constructions and shipping hinder wildlife crossings.

March-Thaya-Auen & Marchfield

North of the Danube, the Marchfield is an intensively used agricultural area. Large unfragmented areas with steppe character exist in the eastern parts of the region. Industrial parks and growing settlements are a problem for connectivity in this area. The planned motorway Vienna (S8) – Bratislava (D4) could severely disrupt the landscape network in this region. The Slovakian side of the border was formerly used only for agriculture. The floodplain parts of the March-Taya-Auen are Natura2000-, Ramsar- and protected landscapes.

Záhorie plain

The Záhorie plain is part of the Viennese basin. The plane consists of flat river floodplains along the March, as well as terraces, hills and mountain ridges. The areas in the Záhorská nížina region are the largest lowland forests of Slovakia with 52.000 ha. The D2 motorway constitutes a large barrier for wildlife movement. Additionally, there are fenced areas, hunting grounds, settlements, and large industrial parks in the northern parts of Bratislava. The „Záhorie“-landscape is characterized by dunes with forests, grassland, brownfields, sand areas, swamps and moors.

Little Carpathians

The Little Carpathians are the southwestern foothills of the Carpathians and stretch over a length of 100 km, with a width of 16 km width and up to 768 m elevation. More than 80 percent of the mountain range is wooded, largely with deciduous forests. Unwooded areas consist of mixed cultural landscape with grassland, vineyards,

orchards and farmland. Land use by forestry and recreational activities is increasing in this area. A main barrier is the highway 503 between Pezinok and Pernek, as well four fenced hunting estates. The area of the Little Carpathians was designated as the Nature protection area “Malé Karpaty”. 56.000 ha are designated Natura2000-area.

(SOURCE: ALPINE-CARPATHIAN CORRIDOR ACTION PLAN, AVAILABLE AT WWW.ALPENKARPATENKORRIDOR.AT)

Description of possible problems or potential concerning ecological connectivity

Important migration routes in this area are the Danube river, Alps-Carpathians Corridor and the European Green Belt (the area of the former “Iron curtain”). The mountain ranges of the Alps and the Carpathians are the largest sources of biodiversity in Central Europe. Historically, the Alps- Carpathians Corridor has been a traditional migration route for wildlife, but has been disrupted by road-networks, settlement expansion and other economic pressures on land use.

(SOURCE: ALPINE-CARPATHIAN CORRIDOR ACTION PLAN, AVAILABLE AT WWW.ALPENKARPATENKORRIDOR.AT)

Existing knowledge about ecological connectivity in the area

Alps-Carpathians Corridor

The connection of the Alps and the Carpathian Mountains was formerly used by large mammals such as red deer, bear, wolf and lynx, as well as other forest-dependent species. This makes the Alps-Carpathian Corridor today, a connection of supraregional importance. The connective potential however, worsened over the last decades. Land use changes, intensive agriculture, expanding settlements and industrial parks, main motorways (S4, A2, A3, A4, D2) reduced near natural habitats and disrupted the connections between the Alps and the Carpathians.

(SOURCE: ALPINE-CARPATHIAN CORRIDOR ACTION PLAN, AVAILABLE AT www.alpenkarpatenkorridor.at)

Situation in the Austrian federal states:
Lower Austria

A study was implemented from 2008-2012 to analyze the connectivity potential of the Alps-Carpathians Corridor. The cross-border project of Slovakia and Austria's "AKK Centrope" aimed to define and implement concrete measures for securing a habitat networking. The follow-up project "AKK Centrope Add-on" (2009-2013) also aimed to restore or secure the wildlife corridor between the Alps and the Carpathians by 2022.

An Action Plan was prepared by the WWF and the Daphne Institute based on preparatory studies and a comprehensive analysis of specific issues. The management plan for the Alps-Carpathian Corridor used a GIS-modelled wildlife corridor, including action lists and necessary activities for a sustainable spatial management.

(EGGER, G., JANAK, M. & SCHMITZ, Z. 2012: AKTIONSPLAN ZUM SCHUTZ DES ALPEN-KARPATEN-KORRIDORS)

A report „Raumplanerische Verankerung des Alpen-Karpaten-Korridors im Burgenland und in Niederösterreich“ was created for the spatial management implementation of the Alps-Carpathian Corridor in the Weinviertel region.

(HUYSZA, F., KOLLAR, H. P., ZUNA-KRATKY, T., EDER, S. & LEHMANN, M. 2012: RAUMPLANERISCHE VERANKERUNG DES ALPEN-KARPATEN-KORRIDORS IM BURGENLAND UND IN NIEDERÖSTERREICH. STUDIE IM AUFTRAG DES WEINVIERTEL MANAGEMENTS, SULZ IM WEINVIERTEL.)

The Alps-Carpathian Corridor is the only designated supraregional wildlife corridor in Lower Austria, but it is not yet secured in spatial planning.

Burgenland

Besides the Alps-Carpathian Corridor, which is named in the State Development program, another state development program named “hunting” (“Landesentwicklungsprogramm Jagd”) exists in Burgenland. This program considers wildlife corridors for Red deer. Other corridors with different levels of precision exist but are not considered in practice.

(CECIL, L. & HACKLÄNDER, K. 2007: LANDESENTWICKLUNGSPROGRAMM JAGD – BURGENLAND. BURGENLÄNDISCHER LANDESJAGDVERBAND.)

Wildlife corridors considered in the state development plan are to be considered in regional spatial planning. Further, a development concept for wind energy parks was created (wind park exclusion zones), that is considered in decisions of green space networking. The European Greenbelt is considered in state nature protection decisions.

Vienna

The technical concept “green- and open-space” (Grün- und Freiraum) was developed in 2014 as consolidation to the present urban development plan 2025 – STEP 2025. It serves as a strategy paper for administration and politics for the future direction of the urban development. An integral part is the “Freiraumnetz Wien” (Openspace Vienna). This concept, consisting of twelve land use types, aims to meet different functions of urban space development (recreation, urban-ecology, etc.). Some of

these use types also consider habitat needs for animals and plants, which, however, are of secondary consideration.

(STADT WIEN 2015: STEP 2025 FACHKONZEPT GRÜN- UND FREIRAUM 'GEMEINSAM DRAUßEN'. MAGISTRATSABTEILUNG 18 – STADTENTWICKLUNG UND STADTPLANUNG, WIEN.

Slovakia

Ecological corridors in Slovakia are part of the "Territorial system of ecological stability" (TSES), which defines Bio-centres, Bio-corridors and stepping stones. This system is integrated into the nature- and landscape protection laws and is the basis for the spatial development politics. They reach binding authority, when implemented into spatial development plans and when respective maintenance provisions are instated in the spatial development documentations. Slovakia was involved in the development of the Alps-Carpathian Corridor project.

(EGGER, G., JANAK, M. & SCHMITZ, Z. 2012: AKTIONSPLAN ZUM SCHUTZ DES ALPEN-KARPATEN-KORRIDORS.)

Other implementations

Landscape account („Landschaftskonto"): Based on the German Eco-account ("Ökokonto"); developed in 2011 by the bureau "Stadt Umland Management Wien/NÖ" together with the federal states, regional politics, infrastructure managers and NGOs. Substitution measures, which resulted from the widening project of the Eastern-motorway (Airport Wien Schwechat/Fischamend) as well as the project "Skylink" at the Airport Wien Schwechat, were implemented in the Alps-Carpathian Corridor.

(SOURCE: LEITNER ET AL., 2016, „LEBENSRAUMVERNETZUNG ÖSTERREICH. ENDBERICHT.)

Potential threats / needs for action

ACC: Implementations planned:

Traffic Infrastructure

Motorways and Railways that constitute a barrier for migrating species will be made traversable. The functionality of existing wildlife corridors shall be secured/improved. In prospective projects, habitat disruption shall be prevented where possible.

Spatial planning

The ACC shall be made compulsory by integration into spatial planning instruments on regional and local scale. The ACC shall also be integrated in regional development concepts, in regional financing instruments (e.g. ETZ program), in strategic environmental reviews and environmental impact assessments, where applicable.

Land use management

Sustainable land use forms (e.g. in the field of agriculture and forestry) should support the continuity of the corridor and contribute to multifunctional land use - benefiting people and nature.

Nature conservation
Protected areas should be regarded as an integral part of the ecological networks and contribute significantly to the coherence of the Natura 2000 network. Supraregional wildlife corridors should be included in the area management plans. The preservation of viable populations of the target species as well as communication and monitoring should be priorities. Wildlife corridors should be taken into account in licensing procedures in accordance with nature conservation laws.

Planting measures: In poorly structured areas small measures can be valuable. The goal is to create an open cultural landscape with natural individual structures.

Wildlife protection measures along roads should be implemented, especially at particularly sensitive spots (for example, in the area of planned green bridges). So that close-to-nature area in the corridor really benefit the wildlife, nocturnal hunting is prohibited by the NÖ Landesjagdverband in the vicinity of green bridges during migration times.

Some suggested measures in bottleneck areas are:

- Close-to-nature management of ditches and meadow paths.
- The creation of "compensation areas" for infrastructure / construction projects
- Removing fences that are a migration obstacle for wildlife.

Examples of particular projects:

In Lower Austria, as part of the ÖPUL 2014-2020, farmers of the bottleneck Göttlesbrunn-Arbesthal also have the opportunity to receive support for land sparing measures, orchards or the care of meadows.
Project SK:

- Borova - removal of pines for restoration
- Deepening of the Jánsky Canal to rescue the occurrence of the rare European dogfish (Umbra krameri Walbaum, 1792)
- Feasibility Study Ramsar-Center March-Thaya-Auen Implemented by Richard Resch & Partner.

Small projects in Ramsar-SKAT and AKK

- Visitor center, seat for area management
- The Ramsar network at various locations in AT, CZ and SK can be used to revive the entire region through ecotourism revival.
-

Species concerned

The corridor between the Alps and the Carpathians is one of the most important migration routes of many wild animals, including deer and lynx. In September 2012, a brown bear was run over exactly at the spot where the Green Bridge for Wildlife at the D2 near Moravský Svätý Ján, prepared as part of the Alpine-Carpathian Corridor project, is being built.

Perspectives and possible solutions / recommendations for actions

In November 2013 the Asfinag completed the planned green bridge over the A4-Ostautobahn. The contract for the construction of the Slovak Green Bridge on the D2 near Moravský Svätý Ján was signed in 2015.

Connectivity area I (Pyrenees - Central Massif – Alps)

Description of the area

This European macro corridor stretches from the Cantabric and Pyrenees mountains to the Alpine Arc crossing the south parts of France via the Massif Central. Doing so it links three major European mountain areas.

The characteristics of the territory are very diverse, reaching from highly urbanised areas and a couple of important cities to very natural and remote areas in the mountains.

Description of possible problems or potential concerning ecological connectivity

Given the size of the area the problems linked to ecological connectivity are the usual main threats: urbanisation, fragmentation, intensive land use.

The importance of this macro corridor lays more in the symbolic image the approach represents, offering a large scale landscape vision in an European context, comparable to the Y2Y (Yellowstone to Yukon) Initiative in North America by proposing a vast unbroken ecological corridor connecting natural landscapes in Europe.

Existing knowledge about ecological connectivity in the area

An in depth analysis of the Central Massif Ecological Network has been carried out by the IPAMAC Network identifying an ecological network on a 1/100 000 scale for the entire Central Massif and the French Languedoc Roussillon Region (http://www.trame-ecologique-massif-central.com/). This work has also been linked to the definition of the Schemes for Ecological Coherence (SRCE) in the concerned French Regions breaking down results and using the experience gained in the inter-regional approach.

Potential threats/need for action

The link towards the Alps is mainly hindered by the Rhone valley forming a considerable barrier stretching from south to east and therefore preventing permeability towards the Alps. As a large part of the traffic of the south eastern of France is concentrated on this axis and several large agglomerations are located in the area the barrier formed by the Rhone valley is a considerable obstacle. To overcome this obstacle very targeted and well planned action to restore connectivity are needed.

Species concerned

The IPAMAC work focuses on open grassland species. The entire corridor plays a major role for migrating species on their way to African winters sites.

Perspectives and possible solutions/recommendations for actions

The idea about this European macro corridor was first born in 2005 during a expert conference about ecological networks. It has since then been picked up several times in different contexts leading to implementation guidelines (common work of IUCN branches in France and Spain) or several project ideas. As large scale European landscape project the macro corridor could be an interesting signboard making the issue of ecological connectivity more known and serving as model for the implementation of a large scale green infrastructure of European interest.

Connectivity area IX (Berchtesgaden-Hohe Tauern connectivity Area)

Description of the area

The area of Salzburg and Berchtesgaden is important not only for humans (cultural and touristic hot spot, high quality of life) but also a hot sport for ecological connectivity (EC). As a gate to the Alps for EUSALP region, the Alps of Chiemgau, Berchtesgaden and Tennengebirge connect with Tauern range reaching from west in Brenner Area to east in the valley of Enns or Mur. Westside, there is a link to the Alps of South Tyrol, in the east transects to the very eastern alpine area of Vienna and the link to Dinaric Alps have been worked out by experts (see 9.). The valley of the river Salzach is located in the northeast of the Alpine Arc and is an important north-south transect when it comes to connectivity. For humans, the Salzach valley is a main trading structure since millenniums. Also for traffic and migration, this area has a certain importance because it links north and south Alps over resp. through the Hohe Tauern range. In former times, the riverbeds were important for landuse because of the fertile land, today, industrial parks, urban areas and linear structures like highways, streets and railways shape picture of the valley.
In the region there are important UNESCO World heritage cities and touristic hotspots like the city of Salzburg or fortresses such as Hohenwerfen, natural attractions like Wolfgangsee, Zell am See, ice caves and also protected areas like National Park Hohe Tauern (e.g. Großglockner Hochalpenstraße) or National Park Berchtesgaden (Königssee, Watzmann). These areas benefit by the tourism of regional attractions but suffer of the touristic pressure showed by traffic the same way.

Main cities are Salzburg with 156.095 residents (on 1.5.2019, Stadt Salzburg 2019), Bad Reichenhall with 19.322 residents (on 31.12.2018, Stadt Bad Reichenhall), Berchtesgaden with around 7800, St. Johann im Pongau or Bischofshofen with around 11.000 inhabitants each. These urban or touristic hot spots with their urban and infrastructural belts bring problems for EC: High landuse (commercial use, infrastructure etc.) and population density (urban areas, traffic, pressure by leisure) are the main problems.

Agriculture is important for the region but with a high amount of extensive use. In Salzburg, 27 % of the area is in agricultural use (Land Salzburg 2019), mainly constituted by around 1800 Alpine pastures (Almwirtschaft 2019). This sector is, compared to other alpine regions, characterized by small-scaled family farms and farms with focus on ecological agriculture (84 % of all farms). In the district of Berchtesgadener Land there is an agricultural use on 22 % of all area with 11.5 % of ecological farms (Bavaria: 7.5 %) (AELF 2019).

Problems or potential concerning ecological connectivity

There is a high responsibility of these regions for ecological connectivity on a macro-regional scale because of the central geographic position in EUSALP as well as in Alpine Convention perimeter and the connection through the rivers of Salzach and Saalach to the Danube region.

Important habitats in this region Berchtesgaden-Salzburg are alpine to montane forests and alpine pastures, which constitute a relevant factor for the characteristic cultural landscape. Grazing from valley sites up to the higher mountains has a tradition since millenniums. When the management of the grazing is managed not too intensively with e.g. less than 1,4 livestock units per hectare and a mowing regime of maximum three times per year (Adelmann 2019), the ecological value of these sites is high and they show very high rates of plant biodiversity. These sites represent important biotopes for many insects, birds, bats, reptiles etc. For tourism, cultural landscape is important, too, as the management of grazing combined with maintenance work and pushing back the abandonment of pastures prevents scrub encroachment. This is a main problem for Alpine pastures, as farming developed to a more intensive form and the maintenance of high or medium high sites is very complex and elaborate. In Salzburg, the EU accession of Austria saved the Alpine pastures as grazing slowly was concentrated to the low and accessible sites. In Austria, there is still a loss of 20 hectares per day of the Alpine pastures for brush land. So, several projects for revitalizing Alpine pastures in Salzburg were initiated and fund structures and concrete projects were institutionalized also in other counties. Since 2004, there is a project for pasture revitalizing with funds by nature conservation (Aigner 2019). The importance of these landscapes initiated the project “Salzburger Almensommer” of the government, tourism and players of Alpine pastures, where 167 pastures in Salzburg are promoted for tourism (Almwirtschaft 2019). There are supervisors for Alpine pastures in some areas who work together with the farmers on a management of the sites with the aim of a high biodiversity value.
The high attraction for Alpine tourism, including day-tourism, is a problem for sensitive biotopes as the pressure by outdoor activities rises: Winter sports like skiing, skitouring, snowshoeing etc. have influence on wildlife like Black Grouse (*Tetrao tetrix*) or Chamois (*Rupicapra rupicapra*) which are very sensitive on disturbances in winter because of their low energy budget. Further the trends of E-Biking, very light headlights and flexible working models lead to a spatial and temporal expansion of accessibility to the mountains. Social media fires the pressure on sensitive areas, as former unknown places are internationally widespread by posts in Instagram etc. or tracks are geotagged and published in open communities like Outdooractive.

Rivers and floodplain corridors as well as extensive used grassland and low nutrient meadows have important functions as corridors and stepping stones for species in and along the Alps. Ecological connectivity is mainly reduced in the big valleys to the

rivers and river beds: Along Salzach and Saalach as main river corridors, and subsidiary streams like Königsseeache, Lammer, Taugl, which are hotspots for EC from north to south (Berchtesgaden mountains - Hohe Tauern transect) and east to west (Osterhorn mountains and Tennengebirge – Chiemgau mountains). There is also green infrastructure in this area in middle of the cities like Salzach or Saalach corridors which are habitats for reptiles like Aesculapian snake (*Zamenis longissimus*) or sand lizard (*Lacerta agilis*). Further, cultural nature monuments like Hellbrunner Allee, parks or city mountains are valuable biotopes for many species.

In alpine residential areas, the protection against natural hazards is important. Torrent control is obvious but often a huge intervention in biotopes. Such as in Hallein, where a torrent control construction in middle of the popular recreation area Bamsteine is currently planned. This is right next to the Bavarian border, a crossborder coordination of the planning process is highly recommended by Naturschutzbund Salzburg (2019).

Constructions like hydro power plants are problematic for EC, sometimes even if there is a fish pass. In Schneizlreuth/Unken a hydropower plant is planned but nothing officially fixed yet. The group Saalach-Allianz is active to prevent this intervention by information about problems for fauna but also damages for tourism and landscape (Saalach Allianz 2019).

Main barriers in this region are the Salzach valley especially from Salzburg to Golling and further south to Bischofshofen. North of Bischofshofen there is Pass Lueg as natural and artificial barrier. The valley between Golling and Hallein is characterized by high landuse, commercial or industrial use, railway and highways. This barrier extends further to Zell am See. High landuse impact is shown by the nitrate values on groundwater, which has disastrous impact on amphibians (Stanjek 2019). The highways A8 Salzburg-Munich and A1 to Tauern provide no nominal possibility for green crossing.

The SACA model does not properly show the fragmentation neither the connectivity by linear structures in this area. Probably the high weighted population prevails the other factors. Furthermore, the touristic impact by traffic and infrastructure is not shown in the map, though with a high impact because of landscape offers.

Existing knowledge about ecological connectivity in the area

Existing plans

The Bavarian species and biotope protection program (ABSP Arten- und Biotopschutz Programm) is made for the district Berchtesgadener Land. And is a Bavaria-wide biotope mapping on district scale initiated by Bavarian Environment Agency. This tool gives information on existing potential for EC in the district of Berchtesgadener Land on biotope basis including target species with regional and super-regional importance. It has no legal status but serves as orientation tool for authorities or landscape planning or programs like contractual nature conservation. There is a list of district-relevant species in this program, which provides an overview for authorities and agencies.

As a product of Interreg Alpine Space project Econnect, the Landscape structure plan of Alpenpark Berchtesgaden was worked out together with local stakeholders. It provides the basis for the management plans and includes biotope networks, concerning also the projects of BayernNetzNatur and Natura2000.

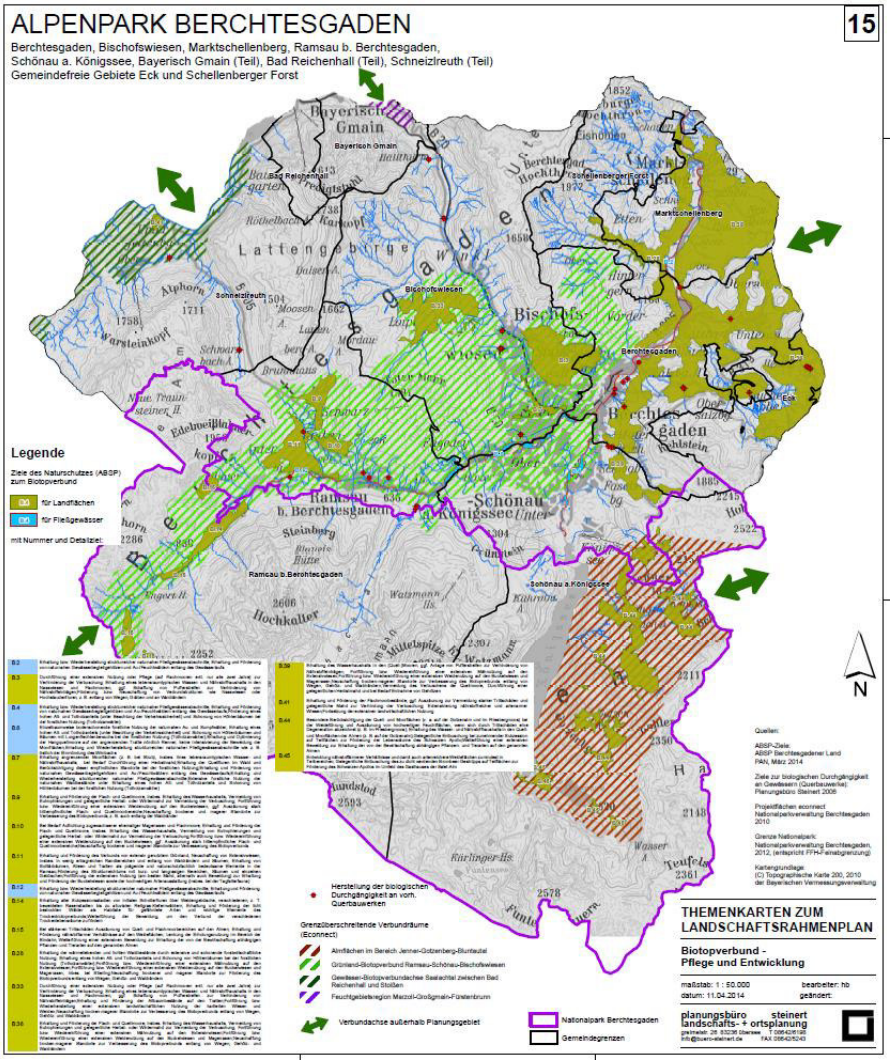

Figure 6: Landscape structure plan Alpenpark Berchtesgaden, Map "Biotope network"

There are strategic plans on Ecological connectivity in Salzburg as well. The map shows wildlife corridors and core areas in the state. The river valleys appear as “white corridors” with few corridors for passing.

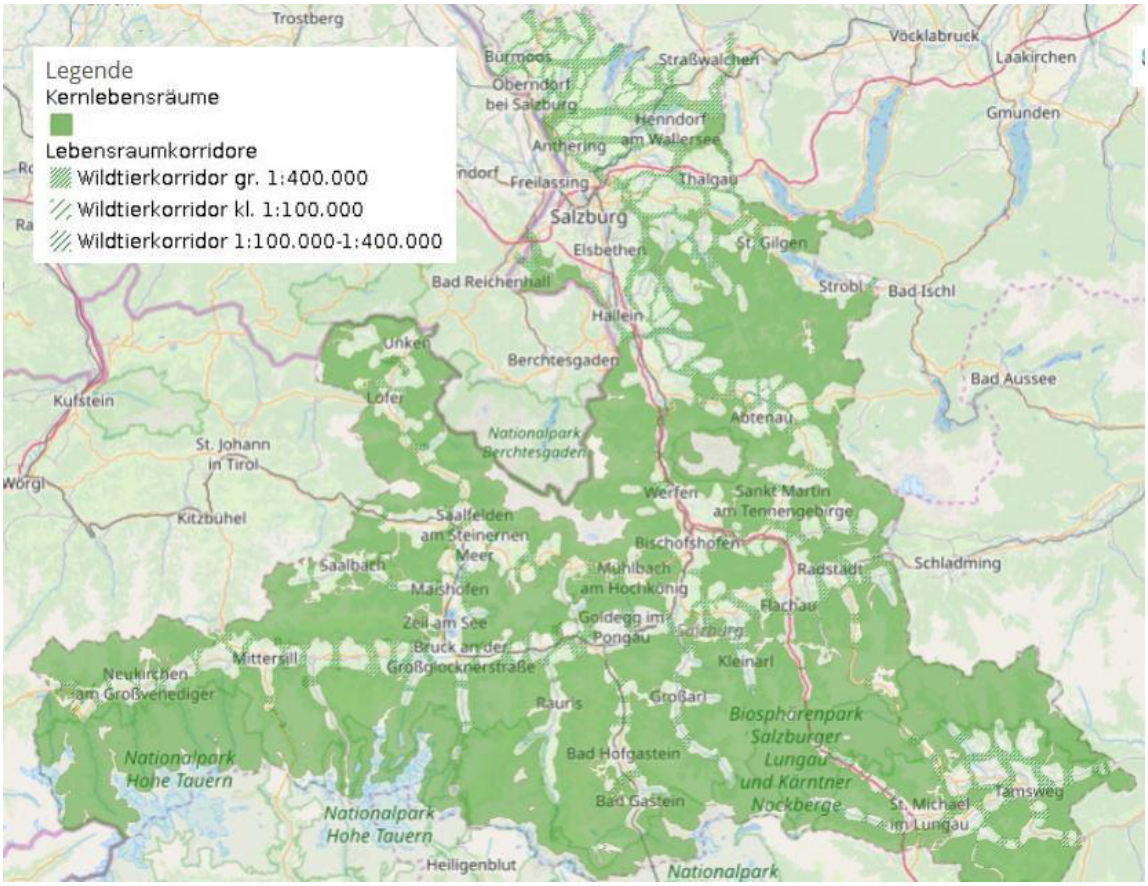

Figure 7: Corridors and core areas in Salzburg (lebensraumvernetzung.at)

Institutions and projects

These institutions are working or worked on the topic of ecological connectivity in wider sense:

- Biosphärenregion Berchtesgadener Land
- ANL Laufen Akademie für Naturschutz & Landschaftspflege
- Landschaftspflegeverband Biosphärenregion Berchtesgadener Land
- Nationalpark Berchtesgaden
- Bund Naturschutz district group Berchtesgaden
- Bund Naturschutz local groups
- LBV Berchtesgaden
- Biotopschutzgruppe Halm Salzburg
- Lebensraumvernetzung.at
- SIR Salzburger Institut für Raumplanung (e.g. Interreg Alpine Space LOS_DAMA and further planned projects on urban green infrastructure)
- Naturschutzbund Salzburg
- National Park Hohe Tauern

There are several projects working on EC in the PWR or in a bigger scale but with an effect for the region:

- After the referendum “Save the bees” in Bavaria 2018 was highly successful and forced the public discussion as well as political action, also in Salzburg the campagne “Aktionsplan: Rettet die Bienen” started with demands for agriculture and open space planning.
- Interreg Alpine Space LOS_DAMA: Landscape and Open Space Development in Alpine Metropolitan Areas. Project Partner in Salzburg is SIR Salzburger Institut für Raumordnung und Wohnen. The project is about implementing an eco-account database in the city area of Salzburg. SIR is planning further projects on the topic.
- The community “Vielfaltleben” supports projects on biodiversity in small communities in the district of Salzburg such as in the city of Salzburg, where community gardens are popular
- The association “Blattform” is a platform for urban gardening in the city of Salzburg

Perspectives and possible solutions/recommendations for actions

In urban areas, there should be a special focus on green infrastructure and the link to periphere biotopes for defined species and habitats should be made – including also crossborder networking for a regional biotope network. This could be managed by a transnational institution for strengthening the network between Berchtesgadener Land and Land Salzburg and to facilitate boundless work on EC.

Along the linear fragmenting elements (highways, railways, streets) a better concept for green passing is urgently needed in the Salzach valley along the river to connect core zones better. Also, a stepping stone approach in areas with high land use is obvious to offer at least the possibility to cross those regions. This is already made institutionalised in Germany by Landcare Associations. The implementation of structures for cooperations between nature conservation, agriculture and politics (funds, consultation, exchange) outside protected areas is a main force of it. To make extensive agriculture more attractive and profitable, it requires sufficient compensation and a good consultancy of the farmers. Politics are asked to lay track for a more ecological agriculture now. Developing concepts of Alpine pastures should be initiated and the topic Alpine pastures (e.g. grazing management, biodiversity loss) should be part of the agricultural education. Children as well should get an idea of what biodiversity and ecological connectivity in Alpine regions means and how one can react. Tourism should become an ally of nature conservation. “Soft” tourism is social and ecologically compatible and local economic structures profit of it.

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Ecological macro Corridor 3 (Central North-South alpine transect W)

Description of the area
Montafon – Rätikon – Ela region – Orobie Valtellinesi

The transect reaches from Montafon (Austria) and Rätikon (Austria / Switzerland) via parc Ela (Switzerland) to the park Orobie Valtellinesi (Italy).

land use: (high) alpine areas, alpine pastures, more intense agriculture in the valley grounds, forestry, no major industries, road and railway infrastructure, tourism
main cities: none
particularities: several parks

Description of possible problems or potential concerning ecological connectivity
potential:

- some protected areas
- project on the international nature park Rätikon (https://www.raetikon.net/)
- collaboration in the framework of the pilot region Rhaetian triangle (except Ela and Orobie Valtellinesi)
- collaboration Swiss parks network
- large areas with close to nature conditions
- emigration of local population

problems:

- tourism
- valley grounds
- transportation infrastructure
- agriculture
- construction activity in some of the valley grounds

strategic importance:

- according to Schoville et al. (2018) at the Austrian Swiss border a protected area is missing in order to preserve the genetic connectivity (of vascular plants) in the protected area network

Implementation of and documentation on ecological connectivity in the area

Spatial planning

Spatial planning in Switzerland is regulated at various administrative levels. An important instrument is the cantonal structure plan. The structural plan is binding on the federal government, cantons, neighbouring cantons, regions and municipalities. Each canton has a structure plan, which serves as a central planning instrument. It determines for around 20-25 years how the canton is to develop spatially in concrete terms. It coordinates spatially relevant activities such as the development of settlements, transport and infrastructure and also ensures the protection of nature and the landscape. It also regulates the planning of major construction projects such as leisure or shopping centres. This is done with binding specifications over a longer period of time. The cantonal structure plan is approved by the Federal Council and then serves as the basis for all other planning instruments at cantonal, regional and communal level. In this report a summary of the aspects relevant for ecological connectivity of the cantonal structure plans is given. Other planning instruments are not included in the report.

In Switzerland exist 305 **wildlife corridors**[32] of interregional interest. They are interconnected with wildlife corridors of regional and local interest. Approximately one third of the wildlife corridors of interregional interest is intact, some 14% are widely interrupted and the remaining 58% are affected (Bafu, 2018). In the canton of **Graubünden** the wildlife corridors will be integrated in the currently processed structure plan making binding rules for interregional and regional wildlife corridors, giving recommendations and listing known planned projects and spatial planning adaptations.

The currently valid structure plan of **Graubünden** contains landscape and nature conservation areas for the conservation and establishment of protected areas. Ecological connectivity is mentioned but not yet explicitly integrated.

Nature conservation initiatives and implementation

The canton of Graubünden contains several protected areas of different types (objectives, protection status, area). There is currently no strategy on how to connect them. In the regional nature parks, pilot studies on ecological infrastructure were carried out and partially implemented. These investigations were carried out as part of the biodiversity action plan for Switzerland. The action plan defines measures for the various sectoral policies and includes pilot projects on various aspects of enhancing biodiversity.

Non-governmental organisations launch different initiatives on ecological connectivity, conduct studies and realize specific projects – also in the region.

[32] Wildlife corridors are for specific target species. Many of them are for ungulates but also amphibian species, reptiles and other species are considered.

Perspectives and possible solutions/recommendations for actions

- establishment of a protected area at the Austrian Swiss border (→ international nature park Rätikon)
- mitigation of tourism impact
- restrictions on construction activity

References

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Ecological macro Corridor 4 (Central North-South alpine transect E)

Description of the area

Allgäuer Hochalpen – Swiss National Park Region – Stelvio – Alto Garda Bresciano

The transect reaches from the Allgäuer Hochalpen (Austria) via the Swiss national park in the canton of Graubünden (Switzerland), the national park Stelvio in South Tyrol (Italy) and park Adamello (Italy) to the pre-Alpine regional park Alto Garda Bresciano (Italy).

land use: (high) alpine areas, alpine pastures, more intense agriculture in the valley grounds, forestry, some industry in the valley grounds, road and railway infrastructure, intensive touristic use especially in winter and in the area between Allgäuer Hochalpen and Switzerland but less pronounced also in the other regions.
main cities: none
particularities: several national and nature parks

Description of possible problems or potential concerning ecological connectivity

potential:

- many protected areas
- collaboration in the framework of the pilot region Rhaetian triangle
- collaboration Swiss parks network
- large areas with close to nature conditions
- emigration of local population

problems:

- tourism
- valley grounds
- transportation infrastructure
- agriculture
- funding of protected areas

strategic importance:

- region around SNP is a region with high genetic diversity of vascular plants (Taberlet et al., 2012)

according to Schoville et al. (2018) at the Austrian Swiss border a protected area is missing in order to preserve the genetic connectivity (of vascular plants) in the protected area network

- Stelvio National Park (Lombardy region): species of importance: Gypaetus barbatus

- Capra ibex[33]
- Very localized: Podarcis muralis, Coronella austriaca, Natrix natrix)[34]

- Stelvio National Park (South Tyrol): species of importance:
  - Golden Eagle (no longer threatened by extinction but this trend could easily be reversed by humans)[35]
  - Bats: All the species predominantly live in the lower areas of the valley and its neighbouring surroundings. Due to their complex lifestyle with temporal and spatial separate habitats, bats are extremely endangered species. If only one part of their habitat fails, this can lead to grave changes in the consistency of a population within a region and even lead to extinction[36]
- Stelvio: The seasonal migration of red deer population between the Swiss national park and the national park Stelvio are well known and investigated. Settlements and infrastructure may interrupt such traditional migration routes. Targeted measures to ensure connectivity may be required.[37]

Implementation of and documentation on ecological connectivity in the area

Spatial planning

Spatial planning in Switzerland is regulated at various administrative levels. An important instrument is the cantonal structure plan. The structural plan is binding on the federal government, cantons, neighbouring cantons, regions and municipalities. Each canton has a structure plan, which serves as a central planning instrument. It determines for around 20-25 years how the canton is to develop spatially in concrete terms. It coordinates spatially relevant activities such as the development of settlements, transport and infrastructure and also ensures the protection of nature and the landscape. It also regulates the planning of major construction projects such as leisure or shopping centres. This is done with binding specifications over a longer period of time. The cantonal structure plan is approved by the Federal Council and then serves as the basis for all other planning instruments at cantonal, regional and communal level. In this report a summary of the aspects relevant for ecological connectivity of the cantonal structure plans is given. Other planning instruments are not included in the report.

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[37] https://www.cipra.org/de/dossiers/13/341_de/inline-download

In Switzerland exist 305 **wildlife corridors**[38] of interregional interest. They are interconnected with wildlife corridors of regional and local interest. Approximately one third of the wildlife corridors of interregional interest is intact, some 14% are widely interrupted and the remaining 58% are affected (Bafu, 2018). In the canton of **Graubünden** the wildlife corridors will be integrated in the currently processed structure plan making binding rules for interregional and regional wildlife corridors, giving recommendations and listing known planned projects and spatial planning adaptations.

The currently valid structure plan of **Graubünden** contains landscape and nature conservation areas for the conservation and establishment of protected areas. Ecological connectivity is mentioned but not yet explicitly integrated.

Nature conservation initiatives and implementation

The canton of Graubünden contains several protected areas of different types (objectives, protection status, area). There is currently no strategy on how to connect them. In the regional nature parks, pilot studies on ecological infrastructure were carried out and partially implemented. These investigations were carried out as part of the biodiversity action plan for Switzerland. The action plan defines measures for the various sectoral policies and includes pilot projects on various aspects of enhancing biodiversity.

Non-governmental organisations launch different initiatives on ecological connectivity, conduct studies and realize specific projects – also in the region.

Perspectives and possible solutions/recommendations for actions

- Mitigation of the impacts on birdlife, in particular on species with priority of conservation due to risk of electrocution and collision, due to the presence of low, medium and high voltage power lines[39]
- Restoration, creation and conservation of wet areas
- Promotion of informed use and interpretation of the natural landscape of the Park in compliance with the protection objectives[40]
- Establishment of a protected area at the Austrian-Swiss border
-

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[38] Wildlife corridors are for specific target species. Many of them are for ungulates but also amphibian species, reptiles and other species are considered.
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Ecological macro Corridor 6 (South Eastern transect)

Description of the area

This area is characterized by an Alpine landscape with high mountains alternating with valleys shaped by the quaternary glacialism includes Julian and Carnic Alps, a part of Drava Valley and the southern portion of High Tauren. The Julian Alps are extended in Italy and in Slovenia.

The Italian part, which is steeper and more inaccessible than the Slovenian one, extends over the area between the river Fella (tributary of the river Tagliamento) and the river of the upper Soča region (Upper Isonzo / Soča). The Julian Alps are characterized by the impressiveness of dolomitic limestone walls and the territory is rich in morphological, fluvial, glacial and karstic variety. The powerful Julian walls tops end with grassy ledges with tops alternating with rocky and compact ruffles or on the contrary, even flaky. The main mountain tops are 2500 meters, but they never exceed 2864 mt. Another feature is related with the valley floor, it keeps a rigid harsh climate in winter even if it never reaches high altitudes at all (600-800 mt.). This fact is caused by the constant flow of the North Eastern cold currents coming from the Siberian regions and the Danubian area. The low altitude of the valley floors compared to the summits give rise to great elevation differences that in some cases exceed 2000 metres. The vast majority of vegetation within the Park is constituted by the predominance of beech wood, mixed with black hornbeam and flowering-ash (*Ostryo-Fagetum*) woods. The beech forest with its variants (Hacquetio-Fagetum, Dentario-Fagetum, Polysticho-Fagetum) covers above all the north-facing mountainside, all the altitudes, from the valley floor to the subalpine area, where it is replaced by the dwarf mountainpine and the Larch (*Erico-Pinetum prostratae*). The Black Pine woods (Fraxino orni-Pinetum nigrae) are very widespread thanks to the great extension of primitive lands such as screes, ground debris and calcareous rock walls. Next to the dominant species, which is naturally the black pine, vegetate shrubby species such as the privet, the raven pear, etc. The upper altitudinal bands are occupied by primitive prairies evolved on limestone (*Gentiano terglouensis-Caricetum firmae, Ranunculo hybridi-Caricetum sempervirentis, Ave parlatorei-Festucetum calvae*) and by the typical vegetation types of the screes (*Papaveri julici-Thlaspietum rotundifolii, Leontodontetum montani, Dryopteridetum villarii, Moehringio-Gymnocarpietum robertianii*) and of the rock (*Spiraeo-Po tentilletum caulescentis, Potentilletum nitidae, Phyteumato-Asplenietum selosii*).

Due to its cross-border geographical position, it's an area where we can observe the sharing of cultures and traditions of different villages and we consider it as a kind of "hallway" in a geological, botanical, wildlife and ecological view. Furthermore in the district area, especially in the southern part of the Julian Alps, there is also the meeting between three different biogeographical regions: Mediterranean, Illyrian and

Alpine. This certainly constitutes an additional source of value for the all area because although this we can observe within the district a variety of communities of plant and animal species which doesn't exist in other areas. There are numerous animal species listed in the attachments of the Habitat Directive (some under total protection as Eurasian Lynx (*Lynx Lynx*) and the brown bear (*Ursus arctos arctos)* as well there are large areas of priority habitat.

The central area of Carnic Alps in characterized by calcareous rocks, dolomite and silex and includes the oldest rocks of the Italian peninsula. The fluvial erosion and the glaciation have formed the traditional glacial-river valleys with a typical strict "V"-shaped section resulting in a territory dominated by the presence of the mountains with a reduced number of areas suitable for settlements and human activites. The regime of the watercourses is mostly torrential while the changes in rainfall patterns is mostly very high with an average annual rainfall of over 1700 mm.

The most common types of land-use are coniferous and lumber mixed forests. Most of the territory is covered by different types of forests. Generally the natural areas altogether occupy almost all of the total area.

The very strict valleys don't allow a free atmospheric circulation resulting in cold air retentions in the valley floor while the hot air persists at the highest altitudes: this climatic overthrow often results in a reversed stratification of the vegetation. Large areas are covered by the beech woods which is present with all the different varieties: submountain beach woods (*Ostryo-Fagetum, Hacquetio epipactido-Fagetum*) , high-mountained (*Dentario pentaphylli-Fagetum*) and subalpine (*Polysticho lonchitis-Fagetum*). In the more external region, these forests represent the terminal forest vegetation, while in the inner forest they are replaced by subalpine spruce woods (*Adenostylo glabrae-Piceetum*). In the steeper areas of external reliefs the beech wood is replaced by the black pine wood, which is considered a pioneer species on primitive calcareous soils. There are also notable examples of scofs pine (Pinus sylvestris).

The residential areas as well as agricultural activity occupy a small percentage of the all territory. The forested areas are alternated with natural grazing areas, mixed vegetation areas, wet rocks, cliffs and woody vegetation and shrub evolving areas: these environmental characteristics allow the preservation of a high biodiversity and they determine a high natural value at the regional level as well as at the interregional level.

In the western part confluent in the High Tauren the dominant tree vegetation consists mainly of conifers. However, some hardwoods can also be found in isolation, such as the rowanberry and, where there is a good water availability, also willows and alders trees. On the shade mountainside exposed to the north dominates the spruce, forming extensive highlands and subalpine and high-mountain spruce woods; where the forest is more dispersed and it is sunny the larch is also widespread, together with the spruce forms the *piceo-laricetes*.

The area is also characterized by high altitude. The temperature and the shortness of the growing season play an important role in the vegetational distribution at these altitudes.

The extreme environmental conditions of these places make the responses of living organisms more evident to the action of specific ecological factors, in particular climatic ones. In fact, the edge of the forest is one of the most obvious aspects of the altitude vegetation zone and it has to be considered more than a simple border line with the overhanging grassy-shrub cenosis of the alpine level, this environment has to be considered a real ecotonal system, interposed between the terminal areas of the closed subalpine forest and the isolated arboreal avant-gardes.

The three large mountain ranges of the South Eastern Transect (The Julian Alps, Carnic Alps, High Tauren) are interspersed with glacial alpine valleys, described with a strong rising and the presence of wide valley floors; here groups the settlements, usually of small dimension. Generally the urban fabric is safeguarded by the impact of the major communication routes while main road generally laps only the villages, without entering inside them. However, in some periods of the year, mainly during summer there is a lot of vehicle traffic on these roads, although they are generally travelled at low speed. Due to the large number of permanent meadows, extensive livestock with small farms has developed in these valleys. Livestock species are generally rustic native ones with dual or triple aptitude, particularly adapted to live in the mountains (e.g. Alpine Grey, Pinzgau. Bruna Alpine etc.). In the valley floor it is also significant the presence of areas mainly occupied by agrarian cultures interspersed with important natural spaces; there the agriculture is also extensive.

All the area is also characterized by the presence of many water courses with torrential character which enters in major river basins. Along the main rivers and streams, an environment consisting mainly of igrophilic vegetation with poplar (*Populus nigra*), lime (*Tilia tomentosa*), black locust (*Robinia pseudoacacia*) etc. has developed.

Description of possible problems or potential concerning ecological connectivity

Importance of the area in an Alpine context

The Eastern Italian Alps are considered one of the wildest places in the Alps, with limited problems related with the tourist pressure and low presence of large infrastructure. In a particular way, large roads and railways are lacking, so they aren't a real problem for the connectivity of wildlife species.

Due to this fact this alpine region is strategic in terms of ecological connectivity with bordering areas and of natural features of the territory. In the Austrian sector, on the mountains of Carinthia and East Tyrol, much more widespread anthropic presence can be found up to the High Tauern mountain range. This presence is linked to the traditional rural economy still well represented in this area. This results in the presence of inhabited settlements, farms and access routes up to the medium and often high altitudes that creates less wild environments and generally less favorable for large carnivores and predators. Also considering the connection with the hunting rights and the importance of this for the income of the public and private reserves of the mountain territories. Therefore the hunting allows good densities of ungulates and other hunted species but from a management and social point of view it doesn't create a favorable environment for the predators. The situation on the Italian side and partly on the Slovenian one is different. Here traditional forms of hunting and the decline of rural activities create minor conflicts and a greater presence of wild and remote areas which become important shelters for large carnivores and other species. Therefore the area assumes a particular importance as a corridor for the movement of various species (bear, wolf, lynx, jackal) mainly from Slovenia (but also from the west for the bear and wolf) to the central Alps and also to Austria. The situation could also evolve positively over time with the presence of stable and reproductive populations of these species due to the suitable and favorable environmental conditions. The Austrian sector is also currently important due to the quite new increase in species that are not present or very rare in the FVG region and neighboring regions. The recent increase in otters in Austria, in fact, has created a significant rise in the species that goes as far as areas near the Italian border, with some animals that have already settled in the Tarvisio area as well as in South Tyrol (Pavanello et al., 2015). Also thanks to various reintroduction projects the beaver population is increased significantly in recent years in Europe, (Halley, et al., 2012). The reintroduction of the beaver in Austria has also led to a fast growing in the species and the presence of some individuals in the Tarvisio area. Colonization will likely continue and may affect ever larger areas. The eastern Alps are also important in terms of bird migrations and in particular for the aestivation of the vultures who frequents during the summer alpine pastures rich in wild and domestic grazing ungulates (Genero, 2009; 2017).

Characteristics of existing barriers

As already mentioned, there are few barriers related to structures and infrastructures in this area, but some of these may become significant at local level or for some species. Particularly in the Carinthian area, the large Drava Valley has concentrated communication routes (Villach-Salzburg highway, railways and national roads) which represents a potential danger to wildlife. A barrier that also takes on greater importance for the neighboring presence of the Drava: a river, almost entirely dammed and with several barriers, which can hinder the movements of certain

species. Another important barrier is the Udine-Tarvisio-Villach highway. It's a highway with fences on either side passing through the mountainous areas. The territory has a great ecological importance for connectivity, but the crossing points for wildlife are numerous considering the numerous sections through the tunnel and the viaducts. Only in the stretch of open valley of Tarvisio's area this road becomes more dangerous. Some cases of crossing bears with rare roadkill accidents have been recorded. On the Austrian section the problem is similar. Close to Arnoldstein, a bridge was built for the passage of bears and other animals. It works well but certainly not enough to allow crossings in that long stretch lacking in tunnels and viaducts. The highway, with less traffic, less speed and no nets at the sides, does not present these problems. The railway in Tarvisio area cross through areas near or inside the forest with various accidents, especially related with ungulates, every year. The danger of roads and railways increases during periods when animals move into the valley bottom to find food during the spring or due to the abundant snowfall. There can be a lot of accidents during this period. Considering the provinces of Udine and Pordenone about 350 roe deer, 60-80 deer and as many wild boars roadkill are recovered on the roads or drowned in the canals every year (CFR and Cornino Lake Nature Reserve data). Roads are dangerous for many species. More than 200 day and night birds of prey are collected annually in the FVG Region (FVG Region Data, CFR). Concerning the otter and the beaver, there it doesn't seem to be any kind of barriers that can explain the slow colonization of these species. Next the numerous artefacts and communication routes, the only section that seems relatively problematic is located at the Coccau crossing, with a barrage on the Austrian side and a underground section of the stream Slizza on the Italian side. The power lines represent barriers or mortality factors for birds from electrocution and collision. High voltage lines crossing the reliefs are more dangerous for collision, while lower medium and low voltage lines are more dangerous for electrocution. Among the first we have to consider the large power lines on the High Tauern and, in the border area, the Somplago-Wurmlach, for which was planned to bury the stretch that crosses the SPA of the Carnic Alps to reduce its danger and landscape impact. However the lines are numerous on the territory and represent an important factor of mortality that in some situations can damage the day and night birds of prey populations and other species (Pirovano & Cocchi, 2008). In the FVG region in the foothills sector at least 10 griffon vultures died by electrocution (Genero, Ined.).

The wind turbines are a potential danger for birds and bats. They must be carefully designed and implemented to reduce the risk of impact. These structures are still not site-specific widespread but various facilities are planned on the High Tauern in Austria and they will probably be built in other alpine areas as well. The wind turbines are also present in areas where migratory flows are concentrated and developing high danger for birds, such as the two large rotors placed on the Pass of Monte Croce/ Plöckenpass on the Austrian side.

Existing knowledge about ecological connectivity in the area

The area of great importance from the point of view of biogeographical life is very significant for the movements of different animal species of all classes.

In the case of connectivity, we speak referring to the postnatal dispersive movement, and migratory flows. In the first case these movements allow to colonize new areas forming new populations and in the second case they respond to the seasonal variability of resources and refuge areas. This area shall be considered important for connectivity between the Dinaric and the Alpine areas and also between the eastern and western Alpine areas, especially for large and medium-sized carnivorous and ungulate but we have also to consider it as a connection area between the Mediterranean, the central Europe and the north-eastern Alpine areas for different types of migration carried out from many species of birds, in terms of seasonal sequence length and departure and arrival location. The connectivity value of an area must also be related to the species, which often have dispersive capacities or migratory strategies very different from each other: for example, the wolf unlike the bear has a relatively dispersal capacity similar between females and males and combining it with the increased tolerance to urbanised and agricultural elements it allows an easier colonization capacity. On the other side the bear is a species which generally uses to move sufficiently extended forest environments and medium and high mountain area himself in addition to the low tendency of females to disperse. In this perspective, it will also be important to understand a metapopulation scenery if this area will or will not allow the connection between different populations, i.e. the individual exchanges, or if even may support the creation of local sub-populations.

The most obvious case concerns connectivity with Slovenia for large carnivores, representing an important route of penetration to the Alps and Central Europe for these species. However, some studies also carried out with the help of telemetry have provided and are providing objective data of great importance for the analysis of the situation and the planning of future actions. Concerning bear, Alpine ibex, chamois and griffon vulture.

About these studies, several algorithms to evaluate the environmental connectivity can be found in bibliography to ensure the survival of fragmented populations and the exchange of individuals.
Concerning the South Eastern Transect area two recent studies analyzed connectivity related to the Brown bear presence; they are based on two of the more widely used methods: the Least-Cost Path for connectivity analysis (published) for the Life DinAlp Bear project (Recio et al., 2018), and the Circuit Theory (about to be published). Through these methods it was possible to establish a connectivity map, referred to the Tarvisio hunting district, delineating anthropogenic and ecological barriers that can hinder the brown bear dispersion. They're summarized in Appendix 1.

About the recent historical presence of some species there is no certainty and it is assumed that the deep valley bottoms, typical of the eastern Alps, have been represented hardly overcomed barriers for their movements, making them disappear after the periods of the Glaciations: we have to talk about the marmot and the ibex. Marmot has been extinct in FVG for centuries, having not been mentioned since 1700s. However, the causes of the extinction are also unclear because the species has been subjected to high hunting pressure by humans already in the Paleolithic and also in the Neolithic (Borgo, 2004). The positive results of recent reintroductions show good environmental suitability, although assessments need to be carried out in the long term. Some authors consider the ibex present in the eastern Alps until the 17th century, according to others it's extinct since the ice age. Again, it is likely that strong hunting affected its presence. The study of existing colonies and reintroductions in the Alps, however, shows that although the ibex is not a good colonizer of new areas, he makes movements and he is able to occupy new alpine sectors (Favalli, 2007).

Now the aim is to deepen the situation of the chamois and ibex that have been one of the main topic of study within the AlpBioNet2030 project for the Julian Prealps / Triglav pilot region. The chamois area is more or less continuous, with different potential sectors separated by few valley floors with inhabited settlements and intensive crops. The species, on the Italian sector, present different attitudes linked to the historical hunting management often incorrect and with poor compliance with the rules. This has has also led to the density of FVG region to be among the lowest in the entire alpine arc and areas where the species have virtually disappeared (Mustoni et al., 2009). When the protected areas were established in the FVG Region (Regional law 42/1996) the situation was precarious, with good consistencies only in the Tarvisio Forest and greater presences along the Austrian border. The establishment of the two regional parks, restocking projects and an increased management attention have allowed a rapid growth in species, although a significant gap between stocks and densities inside and outside protected areas remains. The studies carried out in the Julian Prealps Nature Park with the project of restocking the species (55 chamois released in 1998-1999) and telemetry have highlighted the great movements of the species and connectivity between the different alpine sectors (Genero, 2004). For the ibex the presence is linked to the reintroduction projects with the current presence of vital colonies on the Montasio-Jof Fuart (estimate 600 ibex), M. Canin (150-200), and M. Plauris (100), in addition to the Slovenian colony of M. Triglav and the Austrian colony of the High Tauern (Favalli, 2007).

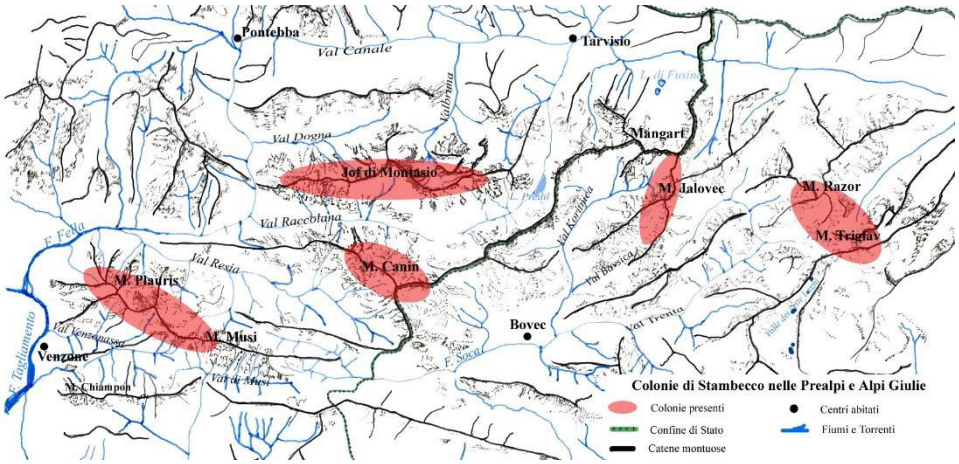

Fig. 1 Ibex colonies in Julian Alps (Da Favalli, 2007).

The low and wooded mountains and the wide valleys (Drau, Gail) create a little connectivity between the Austrian colonies and those of the Julian Alps. In the Julian Alps the massifs are separated by deep valleys (Raccolana valley, Koritnica valley, Trenta valley) and therefore the movement between the various colonies, according to some authors, could represent an obstacle to the animal exchange between the different populations. There are only natural barriers and not other infrastructures that can create significant obstacles. However, this hypothesis doesn't appear to be significant in the light of various observations and data obtained in the recent years with satellite telemetry. After the releasing of the first Ibex on M. Canin in 2000, other male individuals probably from the Montasio colony began to be seen. Some ibex were seen crossing the Raccolana Valley at the beginning of the Valley, at altitudes of about 400 m a.s.l. Some animals have also made remarkable movements such as the male who few months after release in November 2000 suddenly wandered away walking in few days many pre-alpine ridges until arriving on M. Cjampon (Fig. 4). It crossed two valleys at altitudes of less than 600 m. It is known that, in several alpine colonies, some males undertake seasonal displacements moving tens of kilometers through deep valleys and high reliefs (PNPG data; Favalli, 2007).

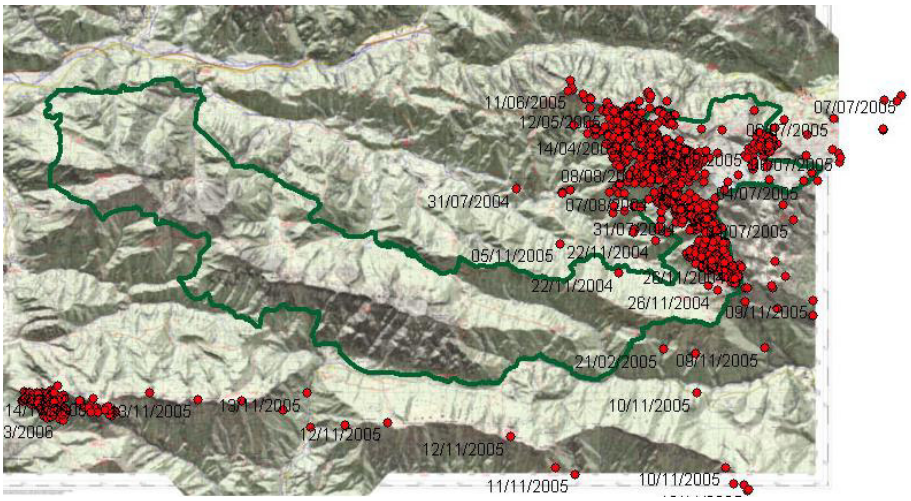

Fig. 2 Remarkable and rapid displacement of a male ibex freed on M. Canin in 2000.

With regard to griffon vulture, several studies have been done with satellite telemetry, allowing to identify roosts, used zones and displacement lines. The results highlight the connectivity between the main frequented areas: the Cornino Lake Regional Nature Reserve, the nearby alpine areas, the Salzburg High Tauern and the Kvarner / Quarnero areas in Croatia. This underlines critical areas, represented by the main slopes and ridges followed during the flights to reach the most preferred areas for nesting and trophic research.

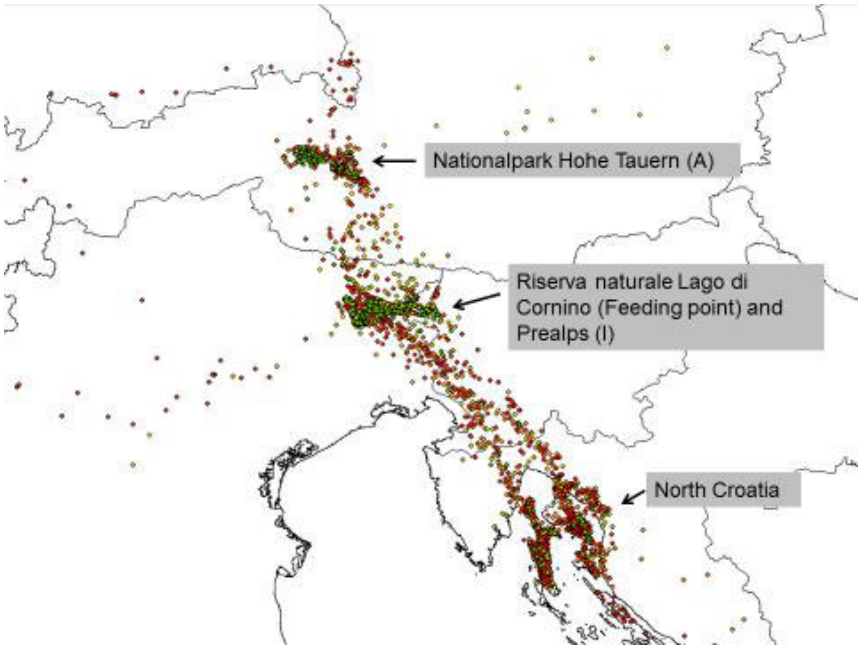

Fig. 3 GPS locations in the study area with the three most important zones.

Figure 3 shows the localizations obtained since 2006 to 2015 with 12 griffon vultures satellite radios. The data obtained provided objective information in order to avoid the building of wind turbines in dangerous areas both in Italy and in Slovenia (Michelič & Genero, 2015) and it can provide accurate and detailed information for the planning of wind turbines, power lines and other infrastructure (Genero, 2017).

Potential threats / needs for action

There is no knowledge of major communication routes projects which could further affect the ecological connectivity of this alpine sector. With regard to fish, the connectivity in the waterways could be further compromised by the building of barriers and power plants, as repeatedly proposed for some streams and mountain rivers (Es. Isonzo / Soča, Uccea/ Učja). Any intervention on rivers must be carefully assessed for all effects on the environment and wildlife (AA. VV, 2013). As regards the birds, various wind farm projects are proposed for the High Tauern, and they will probably affect in the future other areas in Italy and Slovenia. There are many

species of birds and bats threatened and in particular mortality could increase for high-value species such as griffon vulture and the bearded vulture, whose recent return on the Alps is linked to important international conservation projects. Power lines and cableways can create significant hazard for birds from electrocution and collision. The design of these structures, constantly increasing in the territory, should always try to minimize the risks, avoiding areas regularly frequented by birds and alpine passes (Pirovano & Cocchi, 2008). The increasing of summer and winter tourism creates a raise of the impact of human penetration in all environments. The opening of roads and tracks greatly promotes the rising in noise in areas where important wildlife refuges were difficult to reach. The spreading of relatively law budget sophisticated and efficient equipment allows climbing and hiking in all seasons. The main consequences are: general increase of the negative impact, particularly dangerous in wildlife areas of summering, wintering or reproduction which happens with climbing on rock faces of different size and height, representing the most important nesting and resting sites for EU community-protected species such as day and night birds of prey. Also the remarkable increase in all types of aircraft, paragliding and drones, creates a disturbance that can reach anywhere making the sites that birds and mammals use for reproduction and rest no longer safe. In particular, the rapid technical progress of drones creates an increasingly widespread use of them. Equipment able to fly faster and farer will easily have a massive use for photography and shooting animals. Naturalistic photography is already a high disturbance factor in many situations (tetraonid lek arenas, nests, wintering areas) given the increase in photographers and the use of the means (acoustic calls, phototraps, webcams) that if not used properly can compromise the dynamics of some populations.

There are also global threats that are shocking the entire planet balance and will certainly have a strong impact on many alpine species as well. Climate warming has already created a rise in the altitudinal limits of the flora and fauna distribution and it will lead to a further rapid deterioration in the future (Bellard et al., 2012). Monitoring in recent years has shown, for example, an increase in white partridge nesting areas from 1600m in the 1980s to over 2000m (PNPG data). In the Carnic Alps, the average altitude of the breeding areas in the mountain have risen by 150 m since the 1990s to 2015 (De Luca & Colombi, Ined.).

Species concerned

For large carnivores, the importance of the area for connectivity between Slovenia populations and new expansion areas in the Alps and in Central Europe has already been emphasized several times, as well the possibility to create new population units able to breed in the eastern Alps. There are no known new infrastructure projects or works that can adversely affect the movements of these animals. As pointed out, for the griffon vulture and other birds of prey, the proliferation of power lines presents a

further threat, as well as the construction of new wind turbines. As regards the otter and the beaver it has already been shown that the works on the Torrente Slizza on the state border with Austria can get in the movement of animals from abroad to Italy. Further works such as barriers, tunnels or covered sections, bridles could hinder the movements of these animals and fish in this and other river sections. The increase in the traffic and mountain frequentation of areas also creates, as mentioned, various forms of direct and indirect disturbance directly to the fauna.

Perspectives and possible solutions / recommendations for actions

The solutions should cover planning tools (landscape plans, regulatory plans, management plans, etc.) able to prevent the most impactful works for wildlife species, at least for most threatened species or accorded priority. As regards the construction of new roads and infrastructure in sensitive wildlife sites such as wintering or summering areas and reproductive areas should be avoided. In many situations an objective problem is related to the lack of knowledge of these areas, due to the lack of adequate monitoring, and therefore to the difficulty of applying the rules effectively. The same applies to power lines and wind turbines: their implementation should be based on the availability and evaluation of a large number of data, which can often be collected only with the use of satellite telemetry or at least with an accurate monitoring. The solutions, regarding the existing roads with a high number of wildlife accidents, concern the use of optical or acoustic bollards in addition to adequate signage. However, the functionality of these systems is partial and satisfactory solutions are still lacking. We can obtain good results with the tunnels made to allow the passage of animals, but these are expensive and don't always have the hoped-for result. As regards the danger of electrocution and collision on the cables, visual and sound bollards are used in different realities. for preventing the electrocution plastic sheaths are also used to insulate conductors as well as modifications to the pylons. The best solution would be to bury the cables. The interventions are not only for electrical cables but also for suspended cables (cableways, ski lifts). These interventions are expensive and demanding jobs which can be carried out even more easily with the drone use. Not always the laws in force permit the intervention, for this legislative changes should be encouraged. About the disturbance of anthropogenic origin in sensitive areas it would be important to apply clear rules such as access to roads and trails only to authorized vehicles, or closing areas in some seasons or delicate periods for some species. Human activities (hiking, climbing, bikers, flying, using drones, photography) must be strictly regulated to avoid excessive disturbance to the protected species. In relation to climate change, it's certainly difficult to find local solutions and remedies because of the problem should be addressed in terms of global general strategies.

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Ecological macro Corridor 7 (Eastern transect)

Description of the area

This transect crosses the Austrian province Styria from Northwest (Dachstein area) to south east (Slovenian border west of Maribor) and then also crosses the eastern part of Slovenia. This route is a very important corridor from the Alps to the Dinaric arch (Croatia, Bosnia). The northern third of this transect lays within the most unfragmented core habitat of Austria neighbouring the the pilot region of the Northern Limestone Alps for Ecological Connectivity north of it. The remoteness from big cities in combination with the landscape is the reason why here one can find natural alpine landscapes. In the Upper Enns valley there is a highway (Ennstal-Bundestraße from Liezen to Schladming) and a railway track also which crosses this transect. Even if this road is relatively strong frequented the barrier effect seems to be low. There are several tunnels and bridges which seem to minder the barrier effect quite well.

South of Enns valley the Niedere Tauern mountain range as one of the less fragmented area in the Alps is a core habitat for many species.

South of the Niedere Tauern mountain range there is another distinctive valley: the river Mur valley. Here you can find two sections: In the area east of Judenburg there is quite a lot of human impact. There is a motorway from St. Michael to Judenburg and beside the settlements there is also a huge military airbase (Zeltweg) where the whole area is fenced. West of Judenburg you can find much less infrastructure in the Mur valley and road and railway seems to be no big barrier here due to many bridges and relatively low frequency.

Animals therefore may prefer the route west of Judenburg to migrate from north to south or the opposite direction. South of Mur valley the Seetaler Alps offer another very undisturbed but still viable area. The road from Judenburg south to Wolfsberg in Carinthia seems to be the only barrier on the way further to south east. Then the Stubalpe area stretches to the city Voitsberg where the low area of the Grazer Becken starts. The corridor turns no to a straight south direction. Here you can find the only motorway which crosses this transect in Austria: the Motorway A2 from Graz to Klagenfurt. Luckily this barrier is broken by three longer tunnels. Therefore the way south is possible. After passing the small city of Deutschlandsberg and the village St. Lorenzen there is the Slovenian border. On Slovenian side there are only few kilometres before the transect crosses the river Drau (Drava).

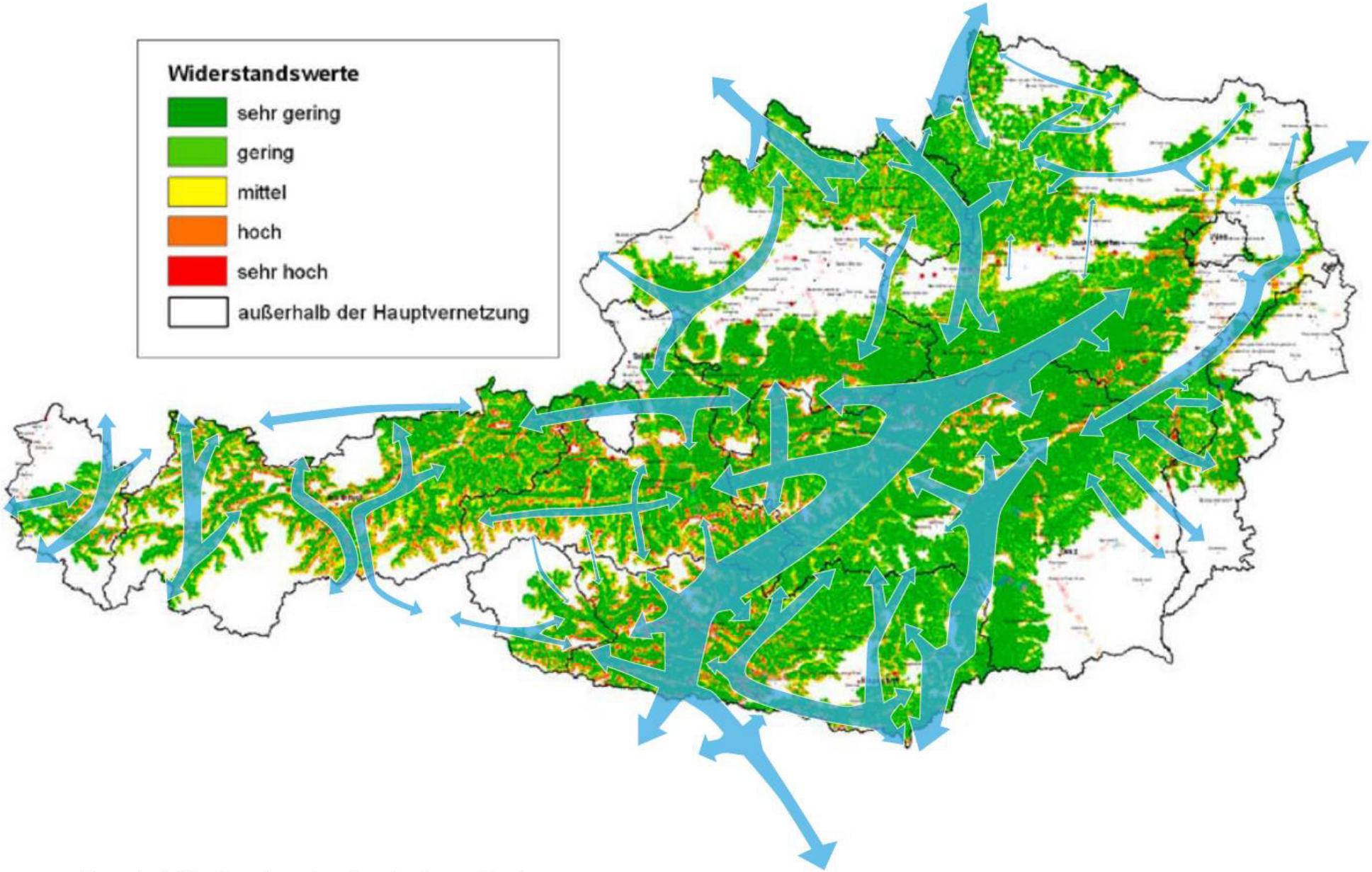
South of river Drau (Drava) the situation for connectivity seems to be quite good. A bottleneck seems to be the area around Slovenska Bistrica where the motorway from Maribor to Lubljana (E57) crosses. Southwest of city of Slovenska Bistrica there are several tunnels and bridges which enable animals to cross. After passing this

motorway the way to south east to Croatian border is open and therefore the connection to the Dinaric region.

As the altitude at this transect is quite different. Starting in the higher part of the eastern Alps the Niedere Tauern region is also relatively low for alpine protected areas the region is dominated by forests. The mountains are not as steep as in the western Alps and most of this mountain ranges are viable.

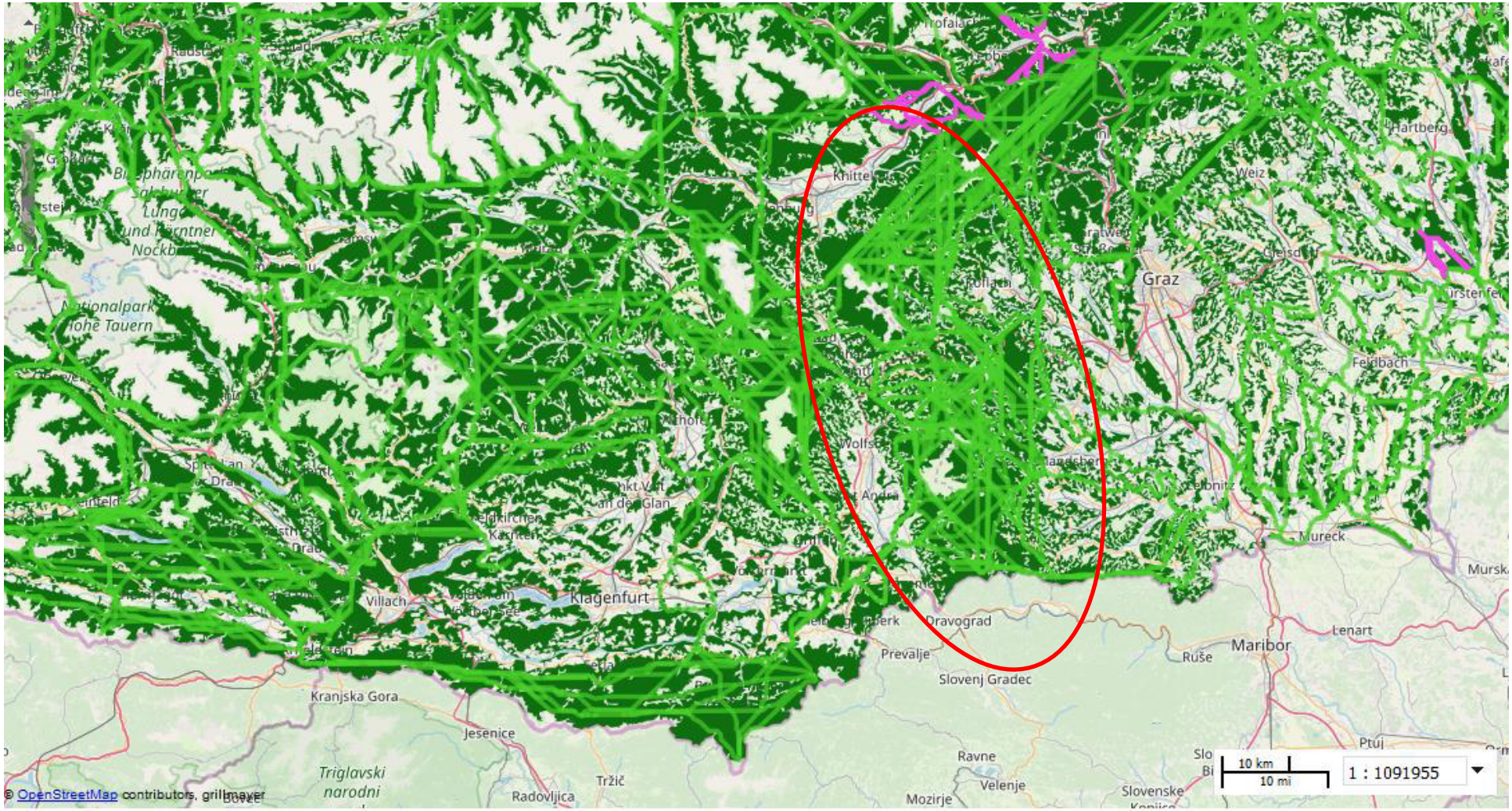
Existing studies about wildlife corridors in Austria show up the main corridor southwards a little bit more west (see C. Köhler, 200541). But one can also see that the Eastern Corridor is stated as an area with very low resistance. Therefore, it can be supposed, that it is one big Corridor in Styria southwards which splits into two branches north west of Graz

41 Clemens Köhler, Habitatvernetzung in Österreich - GIS-Modellierung von Mobilitäts-Widerstandswerten für waldbevorzugende, wildlebende Großsäuger in Österreich, diploma thesis at University of Natural Resources and Life Sciences, Vienna, June 2005



Wildtier-Korridore (hellblau gekennzeichnet) in Österreich , Quelle: © Clemens Köhler et al.

The newer models[42] show the Eastern Corridor in a very impressive way and show that the former more western corridor is obviously not that important:



[42] Map from www.lebenraumvernetzung.at from 17th of may 2019; © Grillmayer

Description of possible problems or potential concerning ecological connectivity

Four main barriers can be found at this transect. Beginning north, the Enns valley with its road and railway and relatively intense infrastructure is the first barrier.

The Mur Valley is the next distinctive obstacle. But as mentioned above, west of Judenburg and the end of the motorway there are several underpasses and tunnels. Travelling further south east the area around Obdach seems to be quite viable so, that the next barrier is the motorway from Graz to Klagenfurt.

This motorway may not be a big obstacle as there are three larger tunnels close together. They reduce the barrier effect very much.

The last big obstacle ion the way south east is the Slovenian motorway from Maribor to Lubljana. It crosses the transect south west of Slovenska Bistrica. The aerial photos show some underpassings and a shorter tunnel in this area. This would be the chance for some migration. But this seems to be the most intense barrier at this transect.

Existing knowledge about ecological connectivity in the area

The activities to connectivity are coordinated by the Austrian Environmental Agency (UBA). Under the website www.lebensraumvernetzung.at you can find a lot of information and also an interactive map. Beside the studies on national and transnational connectivity (C. Köhler[43], F. Völk et al[44], H. Leitner et al[45], etc.) there are several works on regional level. In Austria for the Province of Styria there are detailed evaluations. In this provincial document there is a zonation to keep important bottlenecks of connectivity working.

There could not be found documents for Slovenia. (maybe due to language reasons).

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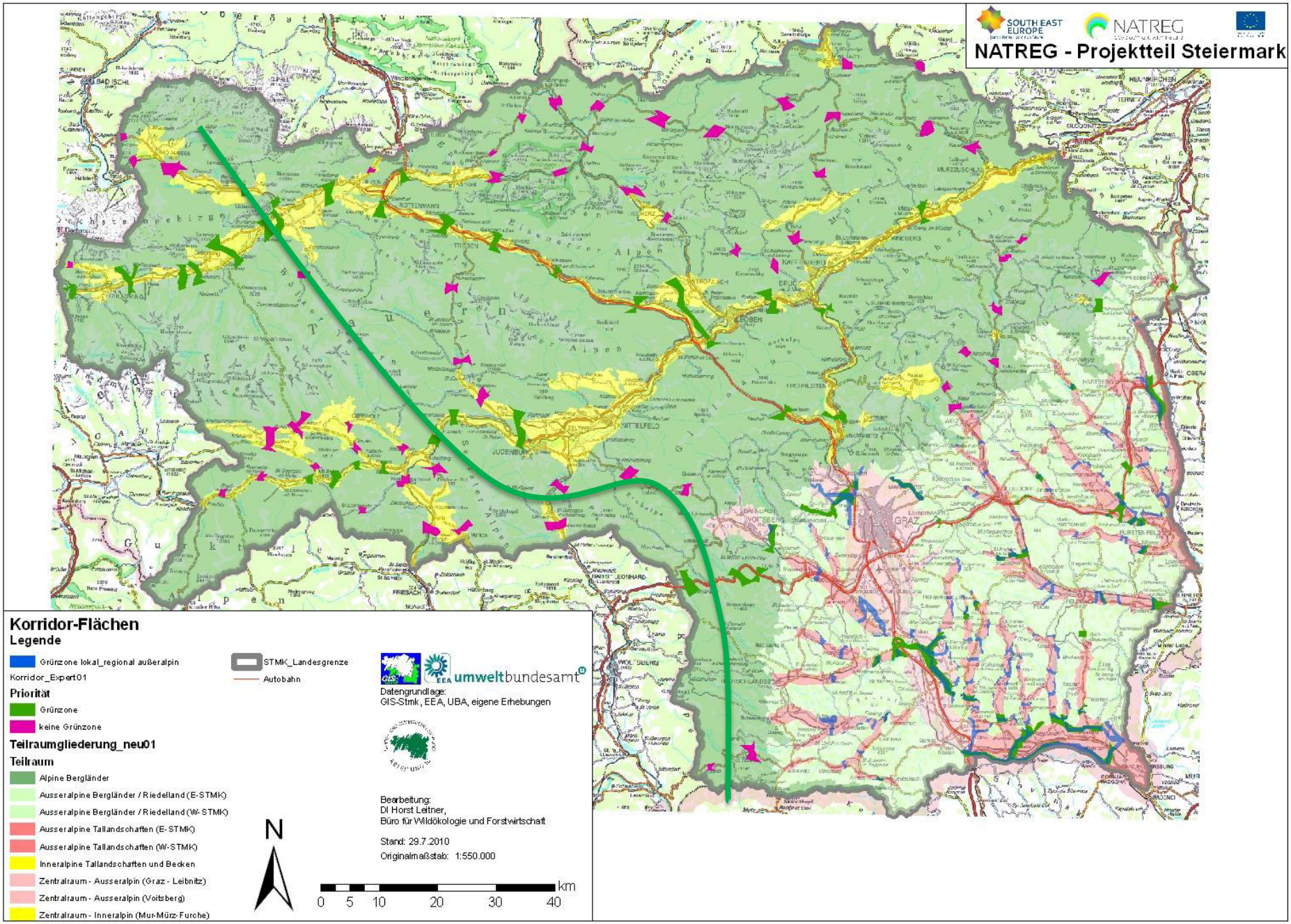
[43] Clemens Köhler, Habitatvernetzung in Österreich - GIS-Modellierung von Mobilitäts-Widerstandswerten für waldbevorzugende, wildlebende Großsäuger in Österreich, diploma thesis at University of Natural Resources and Life Sciences, Vienna, June 2005

[44] Fritz Völk (ÖBf) und Viktoria Reiss-Enz (ministry), Überregional bedeutsame Wildtierkorridore in Österreich und ihre planerische Sicherung, 2006

[45] Leitner et al, LEBENSRAUMVERNETZUNG ÖSTERREICH Grundlagen – Aktionsfelder – Zusammenarbeit, Austrian Environmental Agency, 2016


NATREG - Projektteil Steiermark
Korridor-Flächen
Legende
Grünzone lokal_regional außeralpin
Korridor_Expert01
Priorität
Grünzone
keine Grünzone
Teilraumgliederung_neu01
Teilraum
Alpine Bergländer
Ausseralpine Bergländer / Riedelland (E-STMK)
Ausseralpine Bergländer / Riedelland (W-STMK)
Ausseralpine Tallandschaften (E-STMK)
Ausseralpine Tallandschaften (W-STMK)
Inneralpine Tallandschaften und Becken
Zentralraum - Ausseralpin (Graz - Leibnitz)
Zentralraum - Ausseralpin (Voitsberg)
Zentralraum - Inneralpin (Mur-Mürz-Furche)
STMK_Landesgrenze
Autobahn
umweltbundesamt
Datengrundlage:
GIS-Stmk, EEA, UBA, eigene Erhebungen
Bearbeitung:
DI Horst Leitner,
Büro für Wildökologie und Forstwirtschaft
Stand: 29.7.2010
Originalmaßstab: 1:550.000
N
0 5 10 20 30 40 km

Potential threats/need for action

At the moment there are no big infrastructure projects known is the Austrian part of the transect.

The main goal in this region is to keep the situation as good as it is. Together with Slovenian colleagues the situation around Slovenska Bistrica should be analysed and evaluated. It should be find out, if connectivity still works or if additional measures (e.g. green bridges) would be necessary).

Species concerned

It is supposed that this corridor is important mainly for the mobile large mammals (bear, wolf, lynx, red deer, wild boar etc.) the typical Alpine species will probably not leave their Alpine habitat to migrate south.

Perspectives and possible solutions/recommendations for actions

- Field visits at the 4 main barriers mentioned here to evaluate the assumptions
- Evaluation of the situation with Slovenian colleagues – especially at the motorway south west of Slovenska Bistrica
- Awareness rising at the responsible stakeholders that the Eastern Corridor is an important corridor not only for the Eastern Alps but at least also for the Dinaric region
- Wise planning for regional development which considers the existing analysis and recommendations on national, regional and local level

Ecological macro Corridor 8 (Far east transect)

Description of the area

Localisation, general description (land use, main cities, particularities)

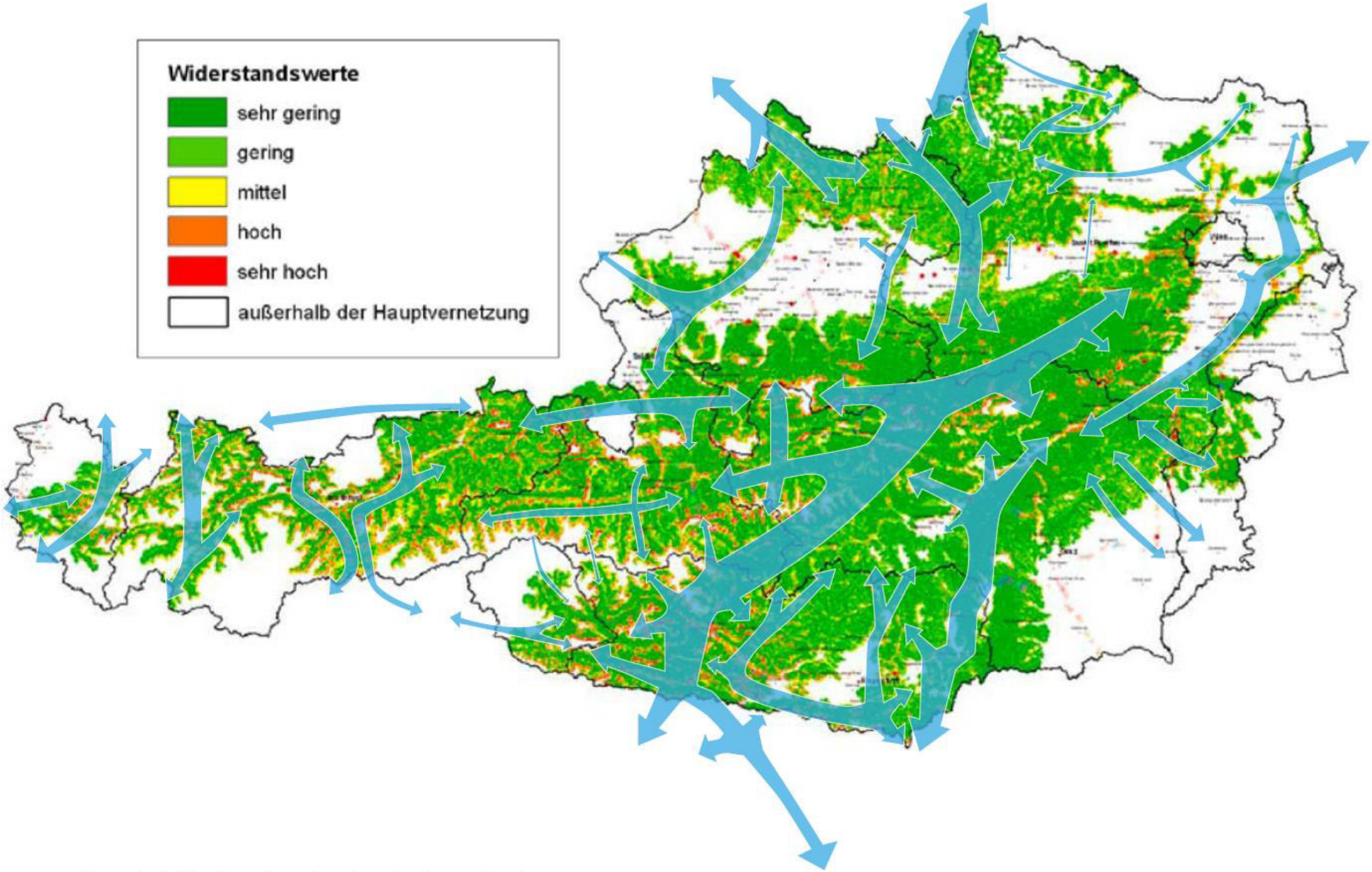
This transect is mainly the centreline of the pilot region of the Northern Limestone Alps for Ecological Connectivity and stretches out to the end of the Carpathians. Located at the junction of three Austrian provinces Upper Austria, Lower Austria and Styria this is where the green heart of Austria pulsates. Beside three international protected areas (NP Kalkalpen, NP Gesäuse and Wilderness area Dürrenstein) there are several areas protected at national level. The remoteness from big cities in combination with the landscape is the reason why here one can find the green heart of Austria. As the altitude is relatively low for alpine protected areas the region is dominated by forests. Last primeval forests are found here. Also, the only component parts of the UNESCO world heritage of beech forests within the whole Alps are found here. Even if located in the center of Europe the situation is quite outstanding. Beside the analysis within ALPBIONET2030 the light pollution maps are good indicator for the relatively unspoiled status.

There are no big cities in the region and there is one main motorway (A9 Pyhrnautobahn) crossing the region from north to south and fragmentation is mostly relieved by many tunnels and bridges or even green bridges. Other roads are usually not very much frequented.

Railway show also more or less only secondary tracks where fragmentation is not only relieved by low frequency but also by tunnels and bridges.

Existing studies about wildlife corridors in Austria show this region as the main branch of corridors. (see C. Köhler, 200546)

[46] Clemens Köhler, Habitatvernetzung in Österreich - GIS-Modellierung von Mobilitäts-Widerstandswerten für waldbevorzugende, wildlebende Großsäuger in Österreich, diploma thesis at University of Natural Resources and Life Sciences, Vienna, June 2005



Wildtier-Korridore (hellblau gekennzeichnet) in Österreich , Quelle: © Clemens Köhler et al.

Description of possible problems or potential concerning ecological connectivity

For every of the three provinces the area of the Northern Limestone Alps are the parts far away from the big cities, less inhabitants and therefore with less developed infrastructure. As mentioned above beside the motorway A9 there are no big traffic ways.

Therefore, the region has a tremendous strategic importance as a core habitat and as a corridor. It is the hub of connectivity in Austria not only for the migration within Austria but also for wider connectivity from east to west and from north to south in the eastern Alps. Located at the eastern end of the Alps the connectivity to the Carpathians (direction from and to north east side), to the Bohemian forests (direction from and to north west side) and to the Dinaric region (direction from and to south side)

For mobile species migration through this region should be good. Some telemetric and other data (photos, DNA, etc.) show that connectivity for larger mammals works quite well in this region.

As this region is quite good for connectivity of mammals it is even possible and go a step further and focus on connectivity for less mobile species.

Existing knowledge about ecological connectivity in the area

The activities to connectivity are coordinated by the Austrian Environmental Agency (UBA). Under the website www.lebensraumvernetzung.at you can find a lot of information and also an interactive map. Beside the studies on national and transnational connectivity (C. Köhler[47], F. Völk et al[48], H. Leitner et al[49], etc.) there are several works on regional level. For Upper Austria there is a wildlife corridor evaluation done by the Province of Upper Austria in 2012 based on a resistance model. Also, for the Province of Styria there are detailed evaluations. In both provincial documents there is a zonation to keep important bottlenecks of connectivity working.

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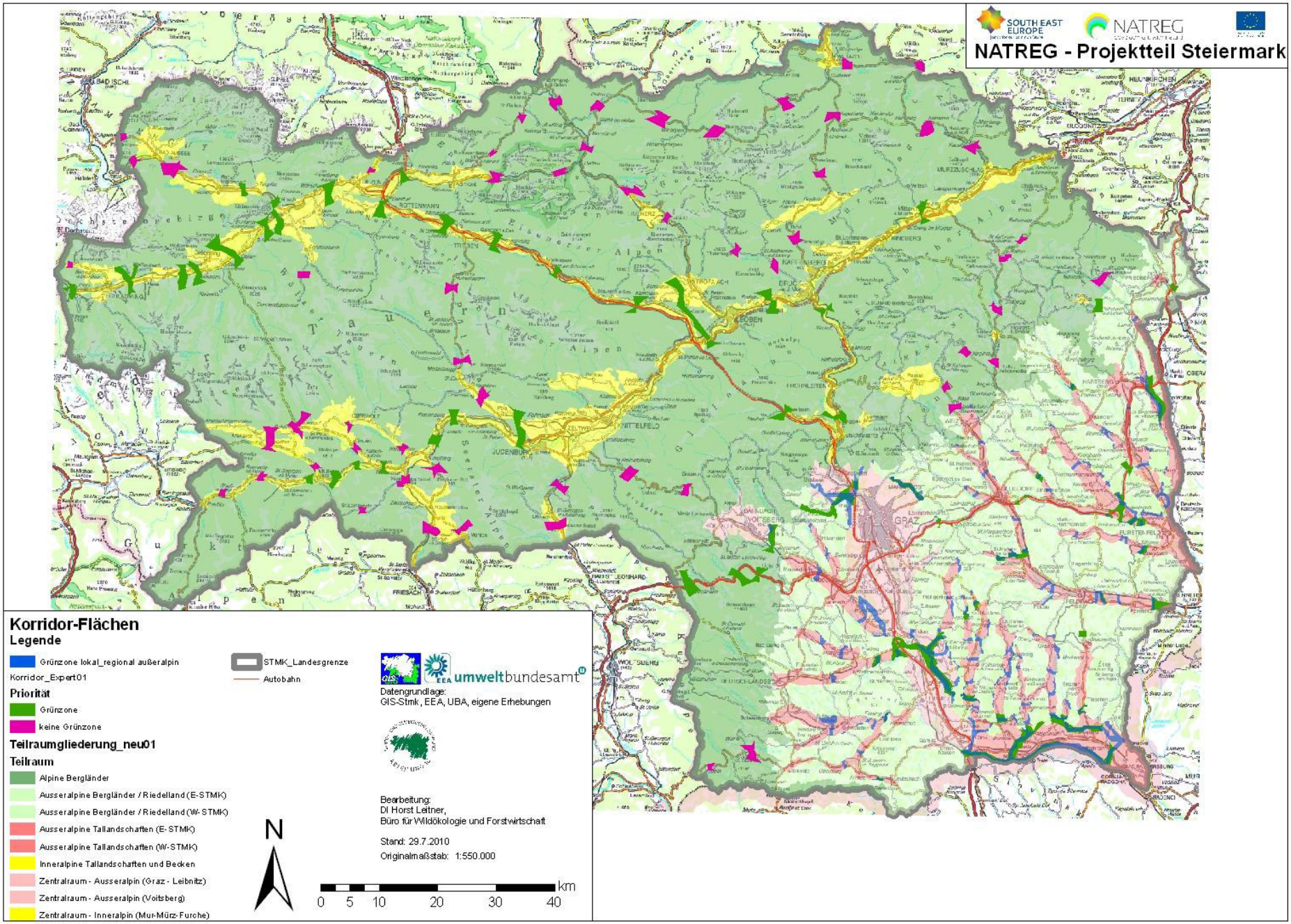
[47] Clemens Köhler, Habitatvernetzung in Österreich - GIS-Modellierung von Mobilitäts-Widerstandswerten für waldbevorzugende, wildlebende Großsäuger in Österreich, diploma thesis at University of Natural Resources and Life Sciences, Vienna, June 2005

[48] Fritz Völk (ÖBf) und Viktoria Reiss-Enz (ministry), Überregional bedeutsame Wildtierkorridore in Österreich und ihre planerische Sicherung, 2006

[49] Leitner et al, LEBENSRAUMVERNETZUNGÖSTERREICH Grundlagen – Aktionsfelder – Zusammenarbeit, Austrian Environmental Agency, 2016


SOUTH EAST EUROPE
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Korridor-Flächen
Legende
Grünzone lokal_regional außeralpin
Korridor_Expert01
Priorität
Grünzone
keine Grünzone
Teilraumgliederung_neu01
Teilraum
Alpine Bergländer
Ausseralpine Bergländer / Riedelland (E-STMK)
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STMK_Landesgrenze
Autobahn
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Stand: 29.7.2010
Originalmaßstab: 1:550.000
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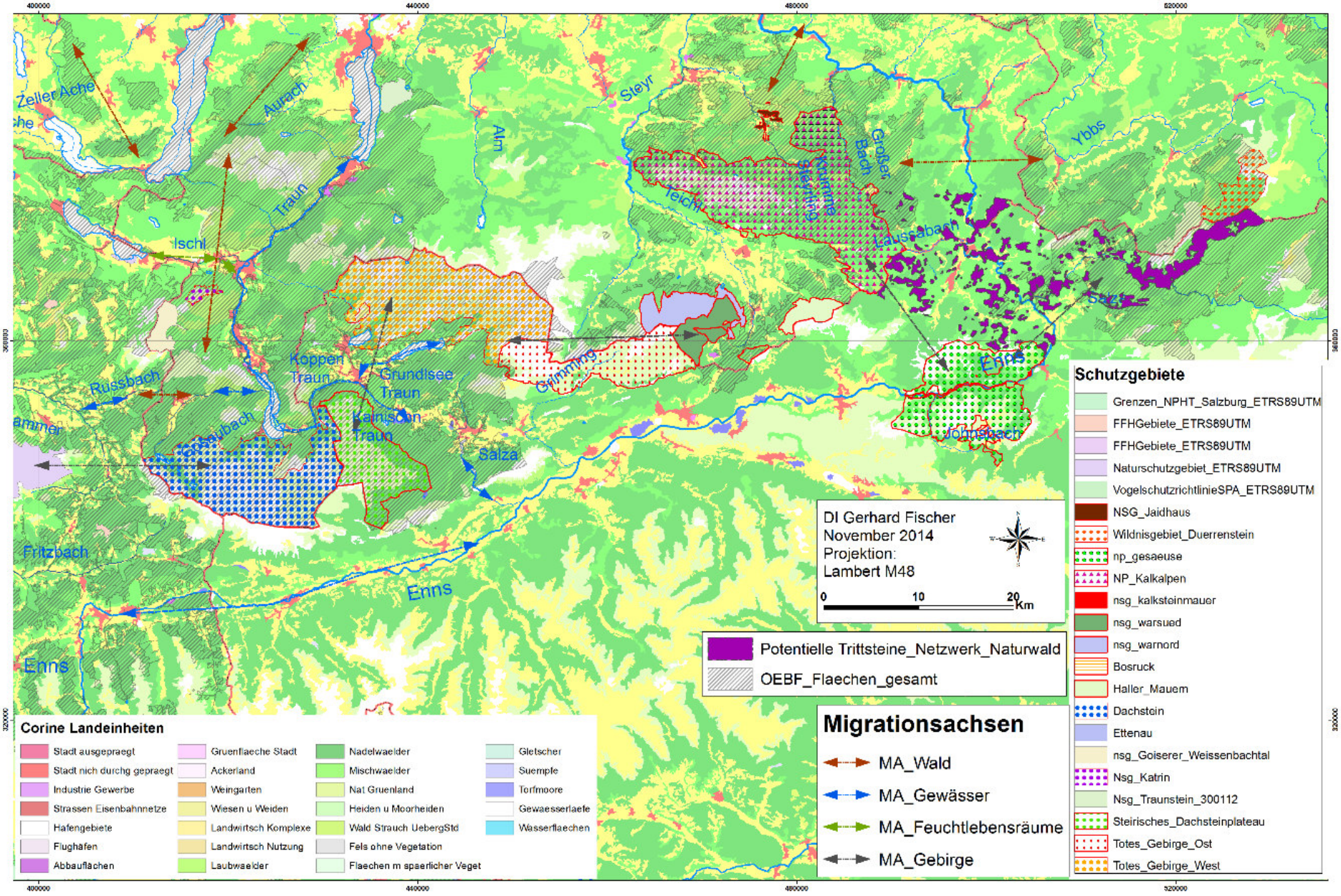
Also, the Austrian State Forests as landowners are working on the connectivity topic. In their current studies the region is also stated as an important axis within the Alps and for the connectivity of the Alps to neighbouring mountain ranges. Here you can see the axis in the analysis of the ÖBf50:

[50] Gerhard Fischer, Austrian State Forests – ÖBf, Konzept für den Ökologischen Verbund im Bereich der Nördlichen Kalkalpen, december 2014

Biotopverbund vom Wildnisgebiet Dürrenstein bis zum Dachstein

ÖSTERREICHISCHE BUNDESFORSTE



To enhance connectivity for less mobile species in 2012 the three international protected areas initiated the Network for Natural Forests. The project aims to a advanced connectivity between the three core areas by stepping stones and a matrix of a forestry which is done in a sensible way to support connectivity for less mobile species51. www.netzwerk-naturwald.at

Potential threats/need for action

At the moment there are no big infrastructure projects known is this region. At the latest since the forests in the National Park Kalkalpen and in the Wilderness Area Dürrenstein are awarded as the one and only UNESCO natural world heritage in Austria the attention to this outstanding region rises on national and on provincial level.

The main goal in this region is to keep the natural situation as it is. There are several outstanding old grown forests which should be protected – if necessary, also by private contracts as done by the stepping stones in Network of Natural Forests yet.

For connectivity on a regional scale focusing on the less mobile species the goal should be to transform existing spruce monocultures back to near natural forests and to encourage land owners to do to their forestry in the most natural way possible.

Species concerned

On a larger scale the region is not only a hub but also a core habitat for all migrating larger mammals. In the Kalkalpen there is a project to reintroduce lynx. After 150 years of extinction there is now a small reproducing population again even if several cases of poaching threatened it. First individuals of returning wolf population had been detected already. The brown bear reintroduction failed about 15 years ago – probable due to poaching. Also, for the capercaillie, black grouse, hazel grouse, the region is an important refuge in the eastern Alps.

On the regional and local level connectivity should be thought also for less mobile species. There is an are outstanding set of very rare insects depending on dead wood and indicating primeval and very natural forests. As these species are a very sensible indicator for the status of the forests, they are used for monitoring also. Fragmentation for theses species is mainly caused by patches of artificial forests dominated by spruce.

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[51] Nitsch et al, Lebensräume verbinden – Neue Wege finden, Planungskonzept zum Schutzgebietsverbund Nationalpark Kalkalpen, Nationalpark Gesäuse und Wildnisgebiet Dürrenstein, april 2015

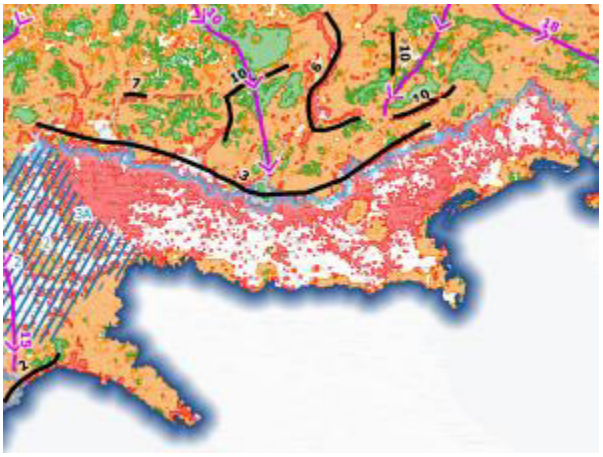
Perspectives and possible solutions/recommendations for actions

- Step by step implementation of the network of natural forest stepping stones in the region
- Encourage for the landowners to do the forestry in the most natural way possible
- Wise planning for regional development which considers the existing analysis and recommendations on national, regional and local level

Barriers H (Lago di Como agglomeration) / J (Como-Adda agglomeration) / L (Central southern Alps - Upper Italy) / M (Adige Valley)
Connectivity area VI (Ticino River connectivity area)
Ecological macro Corridor 2 (Alps – Apennine transect)

a) Description of the area

Localisation, general description (land use, main cities, particularities)



Transect 3 is mainly following the southern line of the Alpine Convention, north of a belt of bigger connected urban areas from Milano, Bergamo, Brescia to Verona. It crosses the two regions of Lombardy and Veneto almost along the line of the motorway A4. As visible in the Land Use Impact Map provided within the Alpbionet2030 project as well as maps showing the light pollution over Europe, the area south to the study region is a highly used and impacted by immense anthropogenic activity. The spread of urban housings as well as transport and energy infrastructure are sealing off the north of Italy and the Alps from central Italy and the South regarding ecological connectivity.

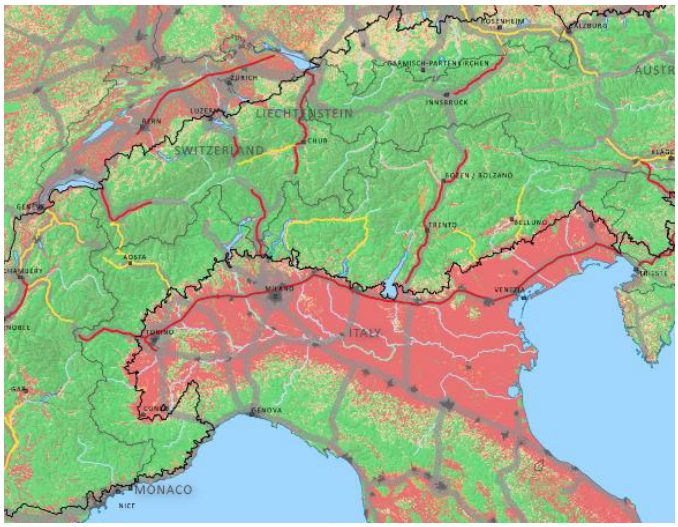


Figure 1: Land Use Impact and SACA 3[1]

Lombardy region is characterised by a population of about 10 million people, forming one-sixth of Italy's population. Therefore, it is the second most densely populated region in Italy right after Campania and the third most populated area in Europe with an overall population density of 415.6 inhabitants per square kilometre (with the Italian national average at 201 inhabit. /km²). The barrier effect area describes the separation between Milano, Lombardy's capital, being the second largest city and largest metropolitan area in Italy with a highly concentrated population of 2000 inhabit. /km² and less disturbed areas such as the Parco Naturale Adamello to the north. Three distinct natural zones can be easily distinguished in Lombardy: mountains, hills and plains, which have been intensively cultivated for centuries. This has led to strong reduction of the original environment remaining in lower altitudes. Nevertheless, 22,83% of the regional territory are described as protected areas of different kinds[2].

To the east, the Veneto region indeed shows a lower population pressure with a density of 260 inhabitants per square kilometre but its lower plains, rich of water sources and arable terrain are the mainstay of agricultural production and the most populated part of the region. Farming covers about 57% of the Veneto region territory and is mainly concentrated in the Venetian plain, while the remaining territory area is occupied by woodlands, urban areas (8%) and wetlands. For biodiversity conservation in the Veneto Region, several protected areas (parks and reserves) and 128 Natura 2000 areas (22,5% of the regional territory) have been established[3].

[1] https://alpine-space.eu/projects/alpbionet2030/mtc_ppp/20180703_mtc_alparc_introduction-abn2030.pdf
[2] http://www.regione.lombardia.it/wps/portal/istituzionale/HP/servizi-e-informazioni/enti-e-operatori/ambiente-ed-energia/parchi-e-aree-protette
[3] https://www.vetmeduni.ac.at/fileadmin/v/fiwi/Projekte/20160628_LIFE_BELT_ALPS_REPORT_ON_ECOL._CONNECTIVITY.pdf

b) Description of possible problems or potential concerning ecological connectivity

As mentioned above, the barrier effect area 3) runs along a belt of big cities and urban areas densely populated and connected in terms of transport and energy infrastructure. This human influence builds a mostly impermeable wall between the Alps and central Italy.

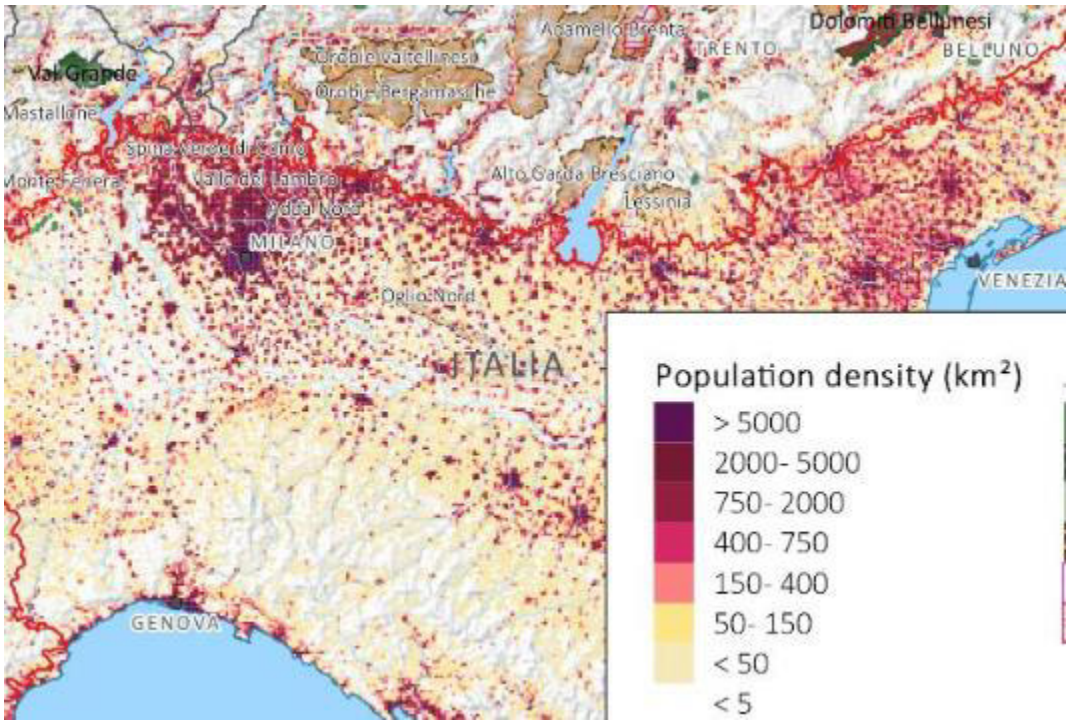


Figure 2: Alpine population and alpine recreational areas (Cutout) prepared by ALPARC[4]

The motorway A4 is an important west-east transport way from Turin to Trieste, intersecting also Milano and Venezia and mostly consists of 6 lanes, seldomly bridged by overpasses. Furthermore, an intensive agricultural use of non-urban areas contributes to the separation between the two sides of the barrier area. 57% of the Veneto region[5] and 43,7% of Lombardy are areas dedicated to agricultural use[6]. For some species, for example bats, the light pollution in densely populated areas and infrastructure rich territories can constitute an additional barrier.

[4] https://alpine-space.eu/projects/alpbionet2030/mtc_ppp/20180703_mtc_alparc_introduction-abn2030.pdf
[5] https://www.recare-hub.eu/case-studies/veneto-region-italy
[5] https://alpine-space.eu/projects/alpbionet2030/mtc_ppp/20180703_mtc_alparc_introduction-abn2030.pdf
[6] http://dspace.crea.gov.it/bitstream/inea/926/1/SE5-1373.pdf

Therefore, the region has a tremendous strategic impact on the dispersal of animal and plant species, cutting of the exchange between northern Italy and southern habitats, mostly regardless of the mobility of the species.

c) Existing knowledge about ecological connectivity in the area

The activities regarding ecological connectivity are coordinated on different levels by private as well as state actors. Although both regions are covered by various projects regarding ecological connectivity, the urban areas are mostly left out due to extremely high resistance values and a focus more directed to the territories north of the barrier area 3).

On a territorial scale, the regions of the Lombardy and Veneto are working on action plans and projects dedicated to biodiversity conservation and ecological management to preserve connectivity:

In the region of Lombardy, “La Rete Ecologica Regionale” has been developed as a regional territorial plan and is an orientation tool for planning activities. It should help to perform a coordination with respect to regional plans and sector programs and to identify the priority sensitivities about ecological functions. The interactive tool[7] provided by the Region of Lombardy functions to set specific targets so that ecological needs can be considered for the identification of compatible action plans.
The region has promoted and published action plans, different studies and provided a base for various projects such as “Dai Parchi alla Rete Regionale”. In the course of the LIFE IP Gestire 2020, Lombardy published, besides others, the “Piano d’azione per i Chirotteri in Lombardia” focusing on the state of the art of bats occurrence and population development[8]. Another project focusing on specific target species was LIFE WOLFALPS. To support the natural recolonization process of the wolf in the Alps and beyond, the LIFE WOLFALPS project was implemented to support a coordinated conservation program implemented within the different administrative divisions in Italy and Slovenia[9].

The Veneto Region developed the project “La Rete Ecological del Veneto” adopted by the resolution of the Regional Council No. 372 in February 2009. The plan contains a chapter on biodiversity, including an aspirational map that depicts the Regions ecological network with core zones, parks and ecological corridors. The region plans to

[7] http://www.sibio.servizirl.it/viewer25/index.jsp?config=config-sibio.xml&parameters={%27rlregis%27:{%27config%27:%27config-rlregis-sibio.xml%27,%27ctrlTopo%27:{%27layerName%27:%27%27,%27id%27:%27%27}}}
[8] http://www.regione.lombardia.it/wps/wcm/connect/22a75760-0546-40b6-ade7-c3896c6bc2ef/PIANO%20D%E2%80%99AZIONE%20PER%20I%20CHIROTTERI%20IN%20LOMBARDIA%20-%20NEW.pdf?MOD=AJPERES&CACHEID=22a75760-0546-40b6-ade7-c3896c6bc2ef
[9] http://www.lifewolfalps.eu/en

put the regional ecological network concept into practice by promoting experimental projects that safeguard and develop ecological corridors in the municipalities of Belluno, Vicenza and Verona in collaboration with local authorities.

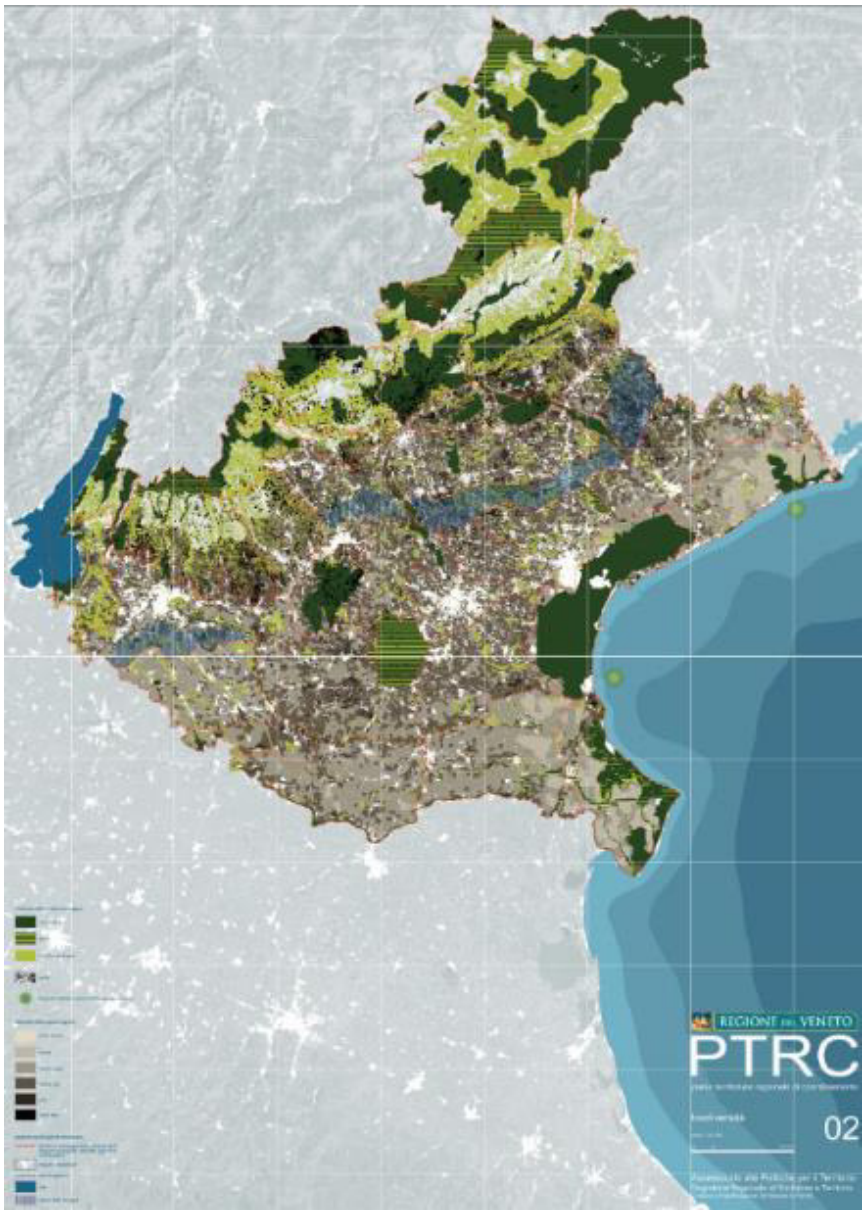


Figure 3: The ecological network of the Veneto region.[10]

Further non-state studies focused on specific species such as the PhD Thesis by Dondina Olivia on the "Ecological Network for forest-dwelling species" and the question how to design an ecological network for these species in a highly fragmented agro-

[10] http://www.lifeten.tn.it/binary/pat_lifeten/agenda/VITI.1369722082.pdf

ecosystem adopting a multi-species and multi-scale approach[11]. Questions approached in the dissertation were focused on the correct management of forest remnants, the definition of secondary nodes and connectivity elements and to identify priority areas where connectivity elements should be located to increase landscape connectivity.

d) Potential threats/need for action

With the perspective on future infrastructure projects upgrading and improving the already existing road system such as the interconnection between the motorways A35 and A4 as well an improvement of the rail connection to the Malpensa airport in Milano, and larger scale projects of new transport ways such as the construction of the High Speed Railway Line Turin – Venice, which include the section Treviglio – Brescia in Lombardy, the compaction of the urban area will increase and lead to an intensification of the barrier effect by the belt of cities that will constantly grow south of the Alpine Convention.

An overview about current and planned infrastructure projects in the region of Lombardy can be found here: http://www.infrastrutturetracciati.servizirl.it/.

e) Species concerned

On a larger scale, the barrier effect area leads to a division of northern and central/southern Italy which is surrounded by fauna and flora over the Alps-Apennines transect to the west of Milano.

This is especially pertaining for larger species such as ungulates and large carnivores such as Bear, Wolf and Lynx. But also, smaller species such as bats and some insects are heavily affected by the reduction of food sources and the light pollution by urban areas[12]. Less mobile species and species with a small dispersal radius are blocked off by the wide urban area without a chance of crossing it, separating gene pools and populations.

f) Perspectives and possible solutions/recommendations for actions

[11] https://boa.unimib.it/retrieve/handle/10281/158193/225367/phd_unimib_787842.pdf

[12] http://www.regione.lombardia.it/wps/wcm/connect/22a75760-0546-40b6-ade7-c3896c6bc2ef/PIANO%20D%E2%80%99AZIONE%20PER%20I%20CHIROTTERI%20IN%20LOMBARDIA%20-%20NEW.pdf?MOD=AJPERES&CACHEID=22a75760-0546-40b6-ade7-c3896c6bc2ef

This area is one of the most urbanized and polluted of the whole Italy and Alps. It includes a very important highway transect connecting the eastern and western sides of the Po plain and represents the southern side of the Alpine Convention, separating the Alpine areas from the plain ones and the Apennines.

As visible from Google maps (Fig.4.), the area looks like a dead-end for the Alpine connectivity. The potential actions for enhancing ecological connectivity should focus first in ensuring the east-west connectivity and then establish the connection with the southern part of the Po plain mainly through the rivers floating north-south form the Alps to the Po river (see below, transect 3A).

It will be also important to check the potentials and the need for ecological connectivity along the highways (A4, A35) through underpasses and green bridges.

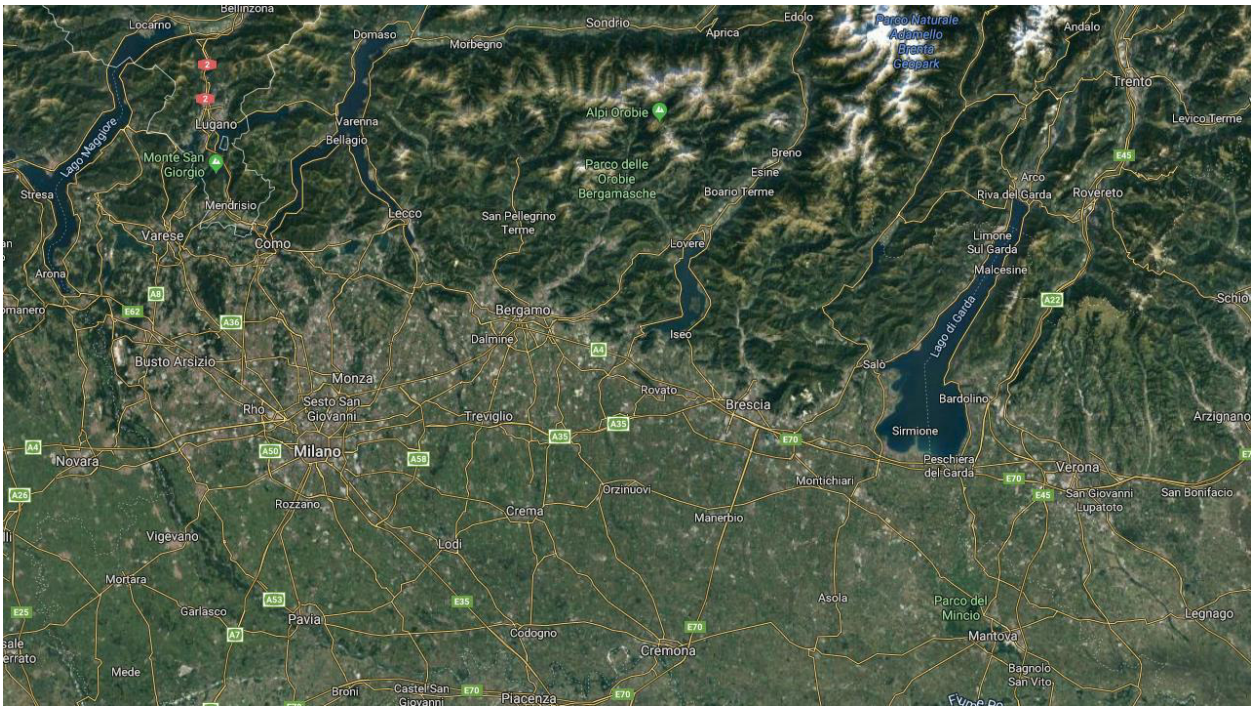
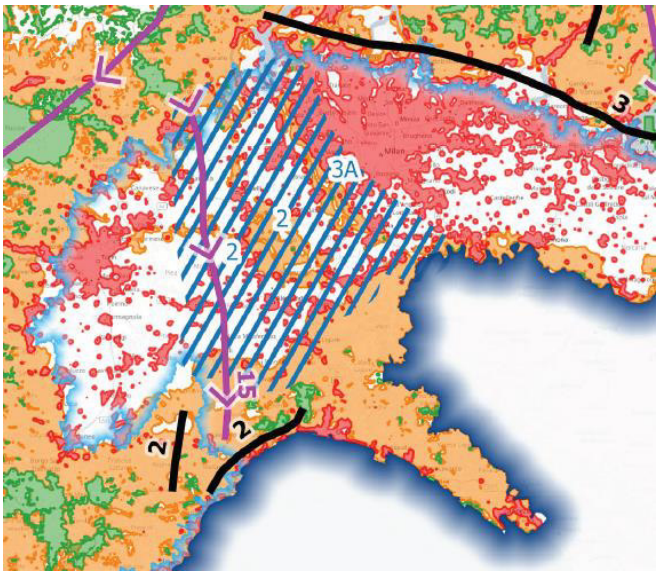


Figure 4 - Google map of the area

3 A) Central Southern Alps – Upper Italy (Eurac + Federparchi)

a) Description of the area



Like the barrier effect area 3) the transect 3A) is located in between the Lombardy and Piemonte but rather following a north to south-east instead of an east-west course, crossing the provinces of Varese, Milan and Pavia. It covers the western urban area of Milano and runs along the Ticino river. Coming from Val Bedretto in Switzerland and running through the Lake Maggiore, the 248 km long river is an important natural connection for many species living in the reserves in and along the territory. As part of the periodic review procedure, the "Valle del Ticino" Biosphere Reserve, as declared according to UNESCO MAP programme, has significantly expanded in Piedmont, including the municipalities belonging to the Ticino Park of Piedmont and about twenty neighbouring municipalities including areas of significant naturalistic value but also agricultural and inhabited areas where 420.000 people live and work[13]. Currently, the Reserve includes an area of almost 150.000 ha, of which around 14.000 are classified as core area (main objective is the conservation of ecosystems and scientific research), 33.000 ha are designated as buffer zones (reinforcing the protective action of the core areas and field for experimental methods considering forestry, agriculture and ecotourism) and 100.000 ha as transition zone (area for economic activities to support the well-being of the local communities with respect to the environment) (see figure 4). Therefore, the implementation of the Habitat Directive (1992) in this area aims at guaranteeing the protection of nature while also considering "economic, social and cultural needs, as well as regional and local particularities" (Art. 2.).

[13] https://ente.parcoticino.it/il-parco/il-piano-territoriale-di-coordinamento/

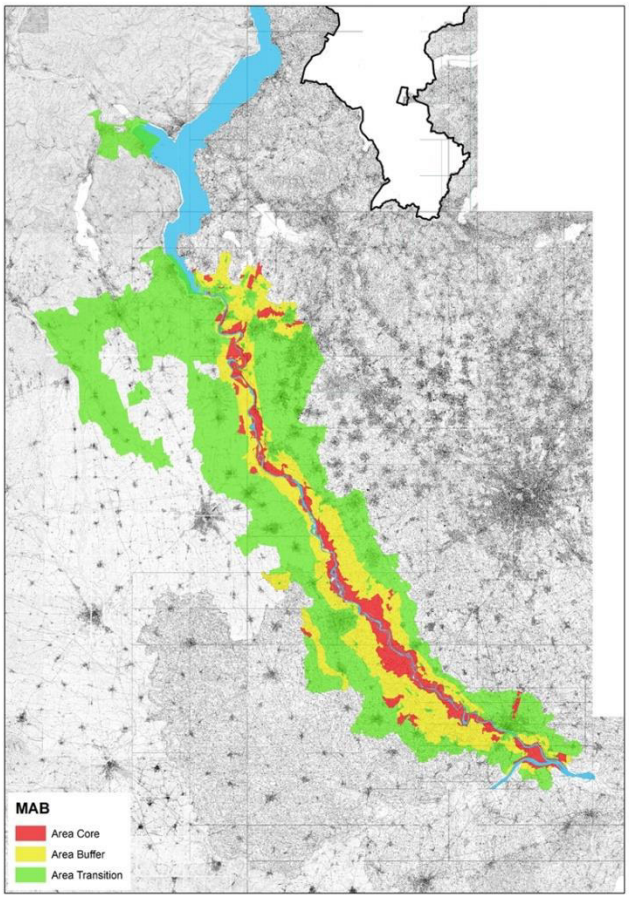


Figure 5: The Ticino Park with 3 different area types (Core, Buffer, Transition)[14]

The area of the park is counted in the 20% of the Lombardy territory declared as nature reserves[15]. The Ticino Park is occupied for almost 55% by agricultural areas, 22% forests, 20% urban areas and 3% hydrographic network. The presence of a rich and varied set of ecosystems which is in many areas well preserved, indicates that the Park covers a heritage of biodiversity that is unparalleled in the Po valley. The high value of the area for conservation practices allowed for the recognition of 14 special conservation zones (SACs) and 1 Special protection Zone (ZPS) in the park pursuant to the Natura 2000 Network[16]. The Ticino Park is part of the General Plan of the protected regional areas of natural and environmental interest established by the Regional Law 86/1983. The integrated nature reserve “Bisco Siro Negri” in the Municipality of Zerbolò, a reserve of the University of Pavia which contains one of the last edges of the lowland forest of the Ticino Valley, is only one of the habitats highlighting the importance of the

[14] https://ente.parcoticino.it/wp-content/uploads/2015/04/mappa.jpg
[15] http://www.en.regione.lombardia.it/wps/portal/site/en-regione-lombardia/discover-lombardy/nature
[16] https://ente.parcoticino.it/il-parco/rete-natura-2000/

region for biodiversity and habitat securing. Of importance is the complex of the river vegetation, continuously renewed by the river with its floods and composing a natural sequence of arboreal and shrub willows, poplars, alders and further from the river elm and English oaks. The Ticino is probably the last south-European river where these extraordinary natural phenomena occurs due to the possibility of wandering freely in its river bed. The vicinity to the highly used urban areas of Milan and the in general high land use pressure (see Figure 1) shows the significance of the area for wildlife and connectivity issues.

b) Description of possible problems or potential concerning ecological connectivity

The extent and complexity of these ecosystems means that they are not only biodiversity reservoirs but also corridors and rest areas to facilitate species dispersal and migration, making Ticino a major ecological corridor between the Alps and the Apennines[17]. Despite the composite mosaic of natural environments represented by the river and an articulated system of lateral wetlands and riparian environments with dry meadows and moors, with the largest and well-preserved surfaces of the primary lowland forest, the Park also holds a wide variety of traditional agricultural areas and semi-natural ecosystems but also housing and infrastructure of the 420.000 inhabitants of the region. The heaths of the Park, in particular those surrounding Malpensa airport, have a very peculiar characteristics and host a rich fauna, including 230 rare and protected species of birds[18]. Agriculture is fundamental for the composition of the Ticino Park but still, agricultural processes and forest management can have a huge impact on the environment if not managed sustainably. The Park is connected to one of the country's most urbanized areas and partially even integrates it with the Milan metropolitan area to the east. Even if infrastructure, agriculture and housing are managed and thought in terms of ecological connectivity and biodiversity issues inside the park, an increase in road-network and landscape transformation with more intensive agriculture close to the park area can infiltrate the park territory due to open borders and radiation effects. Therefore, sufficiently **shielding buffer zones and transition areas** are needed to protect the remaining connectivity elements from negative impacts and the growing disconnection in very large parts of the alpine surroundings, also visible in large parts of the Po plain[19],[20]. With the strategic position of the Lombardy, exactly at the intersection of the axis that links the Atlantic Ocean with eastern Europe and northern

[17] http://ticinobiosource.it/en/project/objectives-actions/
[18] https://ente.parcoticino.it/natura-e-paesaggio/ecosistemi-e-biodiversita/
[19] http://www.parcs.at/npa/pdf_public/2018/36364_20180524_112137_091_KohlerY_FINAL_2p_pag.pdf
[20] https://wilderness-society.org/ecological-connectivity-alps-apennines/

Europe with the Mediterranean region[21], the area is prone to urban sprawl and industrial development. The maps developed by the Park organisation during the ecological monitoring visualize not only the main corridors used but also infrastructure and agriculture critical to the permeability of the landscape (1-5)[22],[23],[24],[25],[26].

c) Existing knowledge about ecological connectivity in the area

The knowledge regarding ecological connectivity in the area of the Ticino Park is mainly gathered by the Park organisation itself, which is performing various projects within the park in parallel. The projects cover different issues from agriculture to fauna and flora as well as forests and the Natura 2000 Network.

The park conducted a continuous study, renewed and adapted every few years, with the purpose of discovering the components of the ecosystems represented in the park, starting with the Malpensa region in 2002. During the work, a potential ecological network design was developed and led to the concept of an interpretative system for the treatment of some fundamental qualities of the ecosystems usable by the GIS system of the Ticino Park[27].

In 2005, a study was carried out in the ecological corridor of Cascina Tangitt between Busto Arsizio and Gallarate which has been historically reconstructed in terms of its environmental characteristics after the extension of the HUPAC airport. The research proposes possible mitigation and compensation measures in order to preserve the ecological connectivity for this strategic area[28].
In the same year, the Ticino park continued the research project conducted in the Malpensa region, extending the definition of the potential ecological network to the whole territory of the park. The main aim of this research was to provide practical suggestions and environmental planning to design an effective ecological network with an integrated relationship between the anthropized and natural areas to reduce and avoid the fragmentation and isolation of natural ecosystems[29]. A detailed plan was developed indicating the important primary and secondary ecological corridors as well as barrier effects and their intensity due to (linear) infrastructure and land use (see

[21] http://www.en.regione.lombardia.it/wps/portal/site/en-regione-lombardia/discover-lombardy/territory-and-population
[22] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav1.pdf
[23] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav2.pdf
[24] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav3.pdf
[25] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav4.pdf
[26] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav5.pdf
[27] https://ente.parcoticino.it/wp-content/uploads/2015/05/22.-Monitoraggio-della-componente-ecosistemi-dellarea-di-malpensa.pdf
[28] https://ente.parcoticino.it/wp-content/uploads/2015/05/34.-Un-paesaggio-che-scompare.pdf
[29] https://ente.parcoticino.it/wp-content/uploads/2015/05/35.-La-Rete-ecologica-del-parco-del-ticino.pdf

Figure 6). With the latest publication in 2017, which was drafted after the conclusion of the Cariplo project “Consolidation of an ecological corridor linking the Barco Visconteo and the valley of the Ticino and Po rivers” in cooperation with the University and Municipality of Pavia, the Park summarizes the state of the art of the ecological network and the interventions implemented during the last 20 years[30].

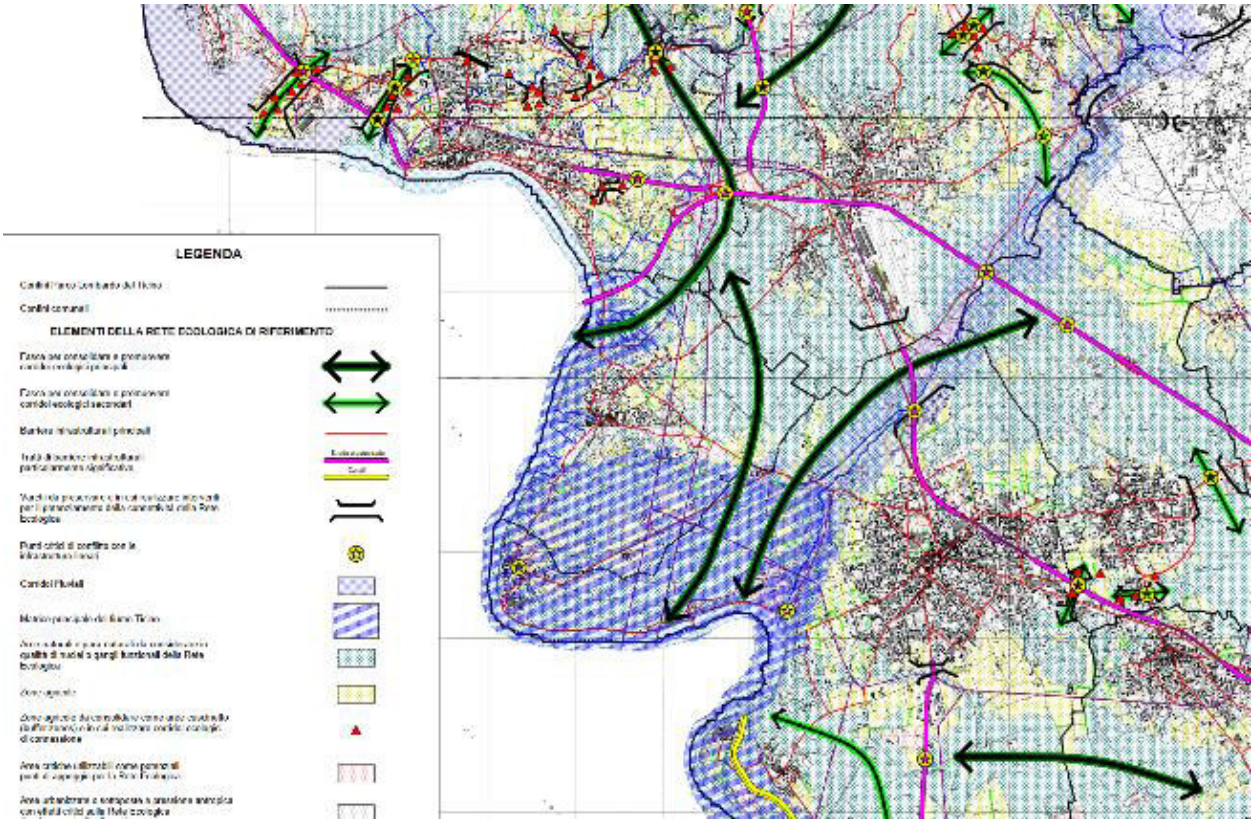


Figure 6: Cut-out of the "Carta della Rete Ecologica del Parco del Ticino" (Map 1).[31]

In addition to the projects and research executed by the Park itself, a Life project “Ticino Biosource” was launched for the improvement of the biodiversity in the Ticino Park. The interventions are targeted at a specific list of species and run in different sites of the Park territory[32]. The target species were mainly fishes and birds, but also some amphibian species. To increase permeability also in regions outside the Ticino Park and enable movements beyond the barriers of the territory, the “Ambrosiano” Project carried out by Eliante from 2014 to 2016 prepared a feasibility study aimed at improving ecological connectivity between the two major protected areas in the Lombardy from Alto Milanese Park to the Ticino Park[33].

[30] https://ente.parcoticino.it/wp-content/uploads/2018/09/connessioni_ecologichePT.pdf
[31] https://ente.parcoticino.it/wp-content/uploads/2015/06/rete_tav1.pdf
[32] http://ticinobiosource.it/en/project/objectives-actions/
[33] http://www.eliante.it/progetto/un-corridoio-ecologico-tra-il-parco-alto-milanese-e-il-parco-del-ticino?lang=en

A similar aim, to preserve an efficient ecological corridor to the north of the Ticino Park, was followed by the LIFE TIB project in and by the Province of Varese[34]. To remove existing barriers and bottlenecks that would hinder the movements of animals or the spread of plant communities, the LIFE-TIB project implemented defragmentation measures improving the corridor. Besides that, priority species already showing distribution and dispersal problems were selected to concentrate on the improvement of their habitat quality. With “Novara in Rete” the neighboring Province of Novara also put a focus on the importance of the ecological network to form a network linking the areas of biodiversity sources present in the province of Novara, guaranteeing continuity between the pre-alpine area to the plain, the foothill area to the north and the plain area to the south through the realization of a feasibility study[35]. The objective of verifying the restoration of north-south connectivity between the Alpine and continental bioregion for target species with different mobility and of different taxa, completing the natural ecological connection between the Alps and the Po Plain and integrating the connections on the east-west route between the Vecellese plain and the southern Milan agricultural Park, falls directly into the transect 3A). The outcome of a detailed description of the Ecological Network of the Province[36] was accompanied by the identification of priority areas[37] and by an extensive fauna monitoring (mammals & birds)[38].

The number of projects carried out in and around the Ticino Park dedicated to ecological connectivity emphasize the importance of the region as a connecting element between the Alps and the Apennines.

d) Potential threats/need for action

Now, there is no big infrastructure projects known in this region as the Park is managed with regard to ecological functioning. The areas used for building and infrastructure as well as agricultural sites in the Park are monitored and supervised to ensure the detection of threats before arising. In 2007, the Park also published a systematic report

[34] http://www.lifetib.it/En/EN_sx_progetto.html
[35] http://www.novarainrete.org/index.html
[36] http://www.novarainrete.org/download/ALLEGATO%2004_SCHEDE%20DESCRITTIVE%20DEI%20VARCHI%20ECOLOGICI%20ED%20ESITI%20DEL%20MONITORAGGIO%20FAUNISTICO.pdf
[37] http://www.novarainrete.org/download/ALLEGATO%2002_RETE%20ECOLOGICA%20DELLA%20PROVINCIA%20DI%20NOVARA_%20AREE%20PRIORITARIE%20PER%20LA%20BIODIVERSIT.pdf
[38] http://www.novarainrete.org/download/ALLEGATO%2005_RELAZIONE%20FAUNISTICA%20E%20DI%20INQUADRAMENTO%20NATURALISTICO.pdf

on “Valutazione Ambientale Strategica – dei programmi di sviluppo del sistema di trasporto”[39].

Nonetheless, intensification of land use outside of the Park can still have strong effects on the biodiversity inside of the Park, an expansion of the monitoring and adaption activities is therefore indispensable.

e) Species concerned

The Ticino Park is crossed by migratory routes that every year are travelled by birds on their flight from Africa to Northern Europe and vice versa[40], but the protected area is also one of the most important inland Italian wetlands, fundamental for the wintering of many species of aquatic avifauna (i.e., little egret, great egret, common teal, mallard, wigeon) and habitat of choice for numerous amphibians, including the *pelobates fuscus*, endemic to the Po valley and endangered species.

The forest areas present in the protected area include willows, poplars, chestnut woods and pine forests of pino silvestre, but among the forest types that characterize the landscape of the Ticino valley most, the oaks and oak-hornbeam forests are still well preserved and inter-grown with an original understorey of herbaceous and shrubby species. These forests constitute a vast “source area” for numerous animal species, now rare and located in the Lombardy Po plain. Some species have only recently arrived in the Park such as the European pine marten (*martes martes*), the Black woodpecker and the northern goshawk (*accipiter gentilis*). The pebbly shores are used as a nesting site by species of birds whose presence is classified as declining and with an unfavourable conservation status throughout Europe such as the common tern and the little tern which have recently returned to reproduce on the Ticino after a long absence period. The presence of herons in the Ticino River region is linked to the rich fish fauna in the waterways that run through the Park Territory. Among the most valuable species are the marble trout, the pigo and the adriatic sturgeon.

Further species covered in projects mentioned above are (Reference is given after listing all species belonging to the same project):

- Vairone
- Barb
- Eel
- Grayling
- Stag Beetle

[39] https://ente.parcoticino.it/pubblicazioni/valutazione-ambientale-strategica-dei-programmi-di-sviluppo-del-sistema-di-trasporto-2007/
[40] https://ente.parcoticino.it/wp-content/uploads/2015/07/Parco-Ticino-speciale-versione-inglese.pdf

- Hermit Beetle [41]
- River Otter[42]
- Ferruginous Duck (Aythya nyroca)
- Hen Harrier (Circus cyaneus)
- Black-winged Stilt (Himantopus himantopus)
- Little Bittern (Ixobrychus minutus)
- Woodlark (Lullula arborea)
- Kingfisher (Alcedo atthis)
- Large Copper (Lycaena dispar)
- Beluga Sturgeon (Huso huso)
- Ray-finned fish (Cobitis bilineata)
- Lombardy Lamprey (Letentheron zanandreai)
- European Bullhead (Cottus gobio)
- Agile Frog (Rana dalmatina)
- Italian Agile Frog (Rana latastei)
- Tree Frog (Hyla arborea)[43]

f) Perspectives and possible solutions/recommendations for actions

For the further improvement of the ecological connectivity in the region of the Ticino Park and beyond its barriers, the river and its watershed systems constitute the focus for conservation activities. As the river system in the Park itself is held in a mainly well-preserved state, an option for improvement would be an in-depth monitoring of its tributaries coming from outside the Park. Furthermore, anthropogenically altered courses are to be re-dynamized, if possible, to support the multifunctional management of large-scale river valleys such as the Ticino area.

The widening of the traditional land use and agriculture, as done partially inside the Ticino Park, could help to reduce the stress on inner-Park ecosystems and allow the development of higher biodiversity scales compared to intensive land use techniques. The traditional ways of agriculture could be strongly connected to the deployment of green infrastructure elements in the area. A dialogue in agriculture directed to ecosystem services valorisation and green communities could also be an option for outer-Ticino Park villages to support sustainable tourism and green economy in the valley. To promote these and other measures such as the valorisation and supporting of the multifunctional benefit of near-nature managed forests, the initialization of a political process (specifically outside PAs) is necessary.

[41] https://ente.parcoticino.it/wp-content/uploads/2015/07/Parco-Ticino-speciale-versione-inglese.pdf
[42] http://www.lifetib.it/En/EN_sx_area.html
[43] http://ticinobiosource.it/en/project/

6 Inn Valley – Adige Valley (Eurac)

a) Description of the area

The barrier effect areas 6) describe the two valleys of the Inn (Austria) and the Adige (Italy). The northern barrier follows the course of the valley in east-west direction close to the city of Innsbruck, the capital of Tyrol and fifth biggest city in Austria, which is surrounded by high mountains with more than 2000 m in height. The North chain of the Karwendel Alps (Hafelekarspitze 2.334m) in the north and the Patscherkofel (2.246) and Serles (2.718m) to the south build a steep valley where the plains are mostly filled with urban area and agricultural land use.

The climate in the Inn valley, with a focus on the region around Innsbruck, is humid continental and has larger temperature differences than most of Central Europe due to its location in a continental area in the surrounding of high mountains. The region is characterised by cold winters and highly variable and unpredictable summers.

With a population of 132.493 inhabitants, the city has a population density of 1.300 inhabitants per km², shielding the northern mountain chains from the south[44]. With an

44

https://www.statistik.at/web_de/klassifikationen/regionale_gliederungen/statistische_zaehlsprengel/index.html

additional inbound commuter of 48.818 and 15.283 outbound commuters a day[45], the infrastructure network is highly frequented and public transport has still a quite small share in regard to the modal split[46].

Due to its location between high mountains, the valley serves as an ideal place for skiing and other winter sport activities in winter and mountaineering and biking in summer. The North Chain is served by a cable car and several chair lifts further up, allowing a high frequency of visitors also in higher areas. Glaciated areas even allow for skiing in summer months leading to high numbers of visitors every year and all year round. The valley itself is strategically well located directly in the Alps and can be easily reached due to the Brenner Pass. These characteristics make Innsbruck and the Inn valley a substantial tourist centre with more than 1.7 million overnight stays in the city per year[47].

The second barrier effect area covers the Adige Valley in South Tyrol, describing a border along the line from Merano, Bolzano, Trento to Rovereto. The Provinces of Trentino and Bolzano are mostly mountainous lands covered by vast forests (in Trentino even 50% of the territory) with varying climates from alpine to subcontinental climates due to big differences in height. In the last 40 years, the south Tyrolean population has increased by 25%, putting not only a huge pressure on the main cities and urban areas but also on the surrounding nature (see figure 7).

[45] https://www.tirol.gv.at/statistik-budget/statistik/berufstaetige-und-pendler/

[46] http://www.alpconv.org/en/AlpineKnowledge/RSA/transportandmobility/Documents/RSA_eng_20071128_low.pdf

[47] https://www.innsbruck.gv.at/data.cfm?vpath=redaktion/ma_i/allgemeine_servicedienste/statistik/dokumente38/tourismus3/staedtetourismuskalenderjahrpdf

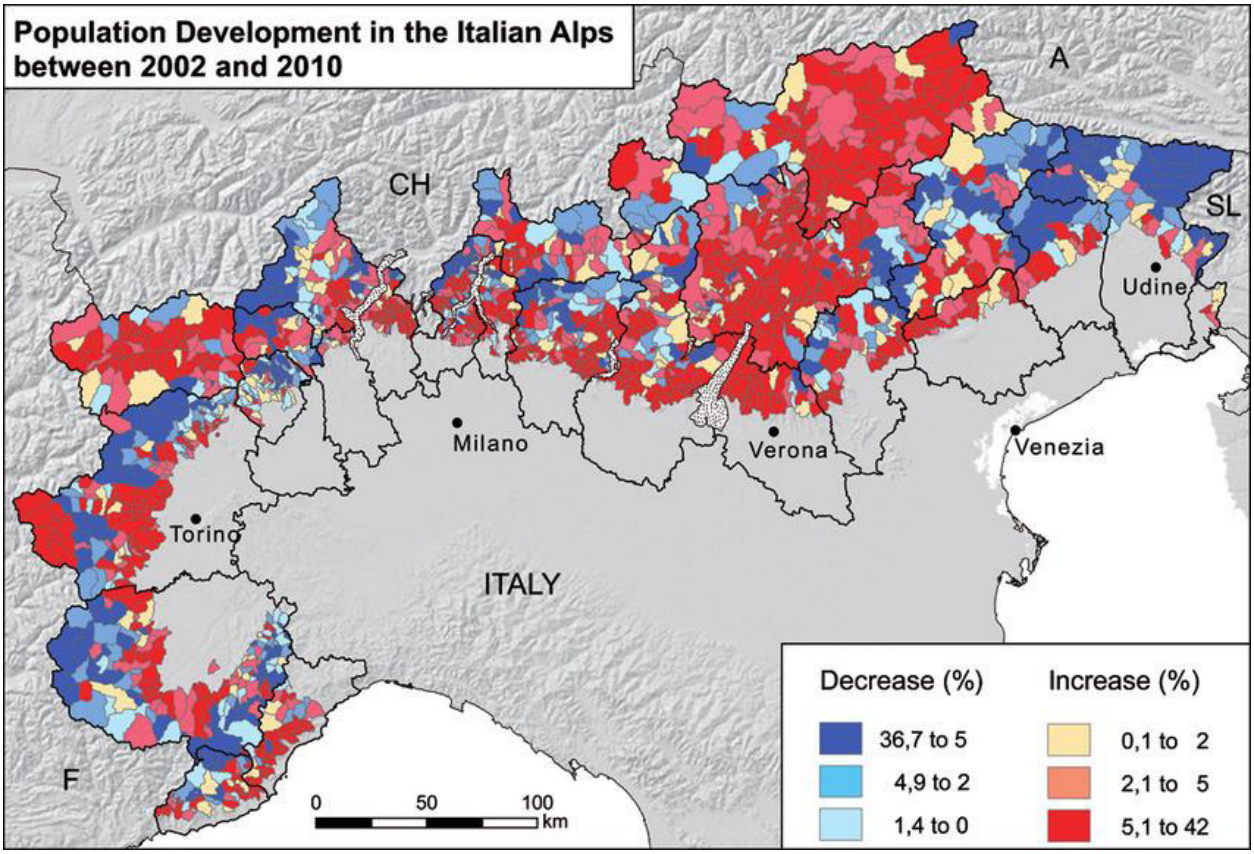


Figure 7: Population Development in the Italian Alps between 2002 and 2010 with high increases in South Tyrol and Trentino.[48]

The mountain ranges surrounding the Adige valley partially stand at well over 3000 m above sea level attracting tourists both in summer and winter, like the Inn valley. The area in the region of Bolzano shows high differences in altitudinal distribution with less than 4% of area under 500m but around 65% of land area above 1.500 m[49].

Economically, since 1996 the valleys of Inn and Adige are bonded by the Euroregion Tyrol-South Tyrol-Trentino. The creation of this transnational region was done by the EU for further cultural and economic integration between the Austrian and Italian Provinces.

In total, only slightly less than 1%, 2% and 3% of the area of Tyrol (Land Tyrol, province of South Tyrol and Trentino respectively), is used for agricultural fields[50]. In addition to pure arable land, this category of use also includes small-scale alternating parcel structure with predominantly agricultural use. Apart from permanent cultures such as

[48] Steinicke, Ernst & Walder, Judith & Löffler, Roland & Beismann, Michael. (2011). Autochthonous Linguistic Minorities in the Italian Alps: New Legislation – New Identifications – New Demographic Processes. Revue de géographie alpine/Journal of Alpine Research. 99. 10.4000/rga.1454.
[49] https://astat.provincia.bz.it/downloads/Siz_2016-eng(2).pdf
[50] http://tirolatlas.uibk.ac.at/topics/corine/query.py/text?id=8120002;lang=de

fruit and wine growing, it is the most intensive form of agricultural use and concentrates in the lowest areas of the large valley, especially in South and East Tyrol as well as the Inn Valley between Schwaz and Landeck. Since about the 1960s, the arable land was strongly reduced in favour of meadows for forage production. Permanent crops also only cover one hundredth of the Tyrolean area and 3% of South Tyrol and Trentino. In the Italian region this mostly concerns fruit and wine, for whose cultivation the Adige valley represents particularly favourable conditions. Fruit and wine cultivation do have a long tradition in South Tyrol. Initially, the cultivation was largely limited to the slopes of the Adige- and Eisack valley but since the reclamation of the Adige river meadows in the 19th century for permanent crops, the cultivation significantly expanded.

Although the use of land for settlements is less than 3 and 2 percent of the Tyrolean area (Trentino, Land Tyrol and South Tyrol respectively), the distribution of settlement areas can be traced along the course of the valleys. Larger towns developed along the traffic axes which are naturally oriented towards the valleys with the largest cities at the crossroads of important trade routes (Innsbruck, Bolzano, Merano, Vipiteno, Bressanone, Lienz).

In the Tyrolean area, grassland farming is of greatest agricultural use. Large areas of the valleys, often also slopes, are used as meadows and pastures. Nevertheless, only less than 8% of the total area of Tyrol and Trentino and 10% of South Tyrol is attributable to this use. Another 25 % of Trentino and 8% of the Tyrolean region are covered by deciduous and mixed forests (South Tyrol: 5%) while coniferous forests make up the main part of land cover in Tyrol and Trentino with 30% and even 36% of South Tyrol (see figure 8).

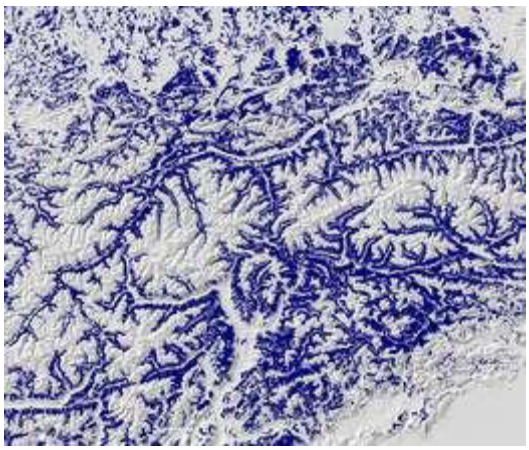


Figure 8: Tyrol and South Tyrol: Corine Land Cover class "Coniferous Forests"[51]

[51] http://tirolatlas.uibk.ac.at/topics/corine/query.py/text?id=8120006;lang=de

b) Description of possible problems or potential concerning ecological connectivity

Indeed, only the most populated and fragmented inner Alpine valleys have an impact on connectivity comparable to that of the very strong barriers in areas surrounding the Alps. In this case, both regions face a similar initial position as they function as major infrastructure routes for transport, inhabitants and passing tourists and are additionally the destination of many tourists itself. The inner Alpine situation is characterised by the fact that mostly all-important communities are situated in the large Alpine valleys such as the Adige and the Inn valley. In these valleys, barriers are mostly man-made with infrastructure and settlements and in some cases due to high traffic[52].

Innsbruck is located along the A12/A13 highway corridor (Inn Valley Autobahn and Brenner Autobahn respectively) providing freeway access to Verona towards Italy and Munich in the direction of Germany. The two highways converge near Innsbruck. Besides the infrastructure of the road network, the city has a highly frequented railway line and an Airport which is located west of the city. The passenger numbers and flight frequency increases during the winter months due to the high numbers of winter sports tourists travelling to the region.
In the Adige valley, a connectivity problem arises from a combination of several factors such as high traffic of persons and merchandises, important settlement with all the economic activities linked, intensive agriculture, canalisation of the riverine systems, monocultures which, in case of fruits, are often protected by nets, and heavy infrastructure, such as highways and railways protected by fences[53]. For the Adige valley, the A22 functions as the main transport route following the course of the valley.

For the valleys such as Inn and Adige valley these phenomena appear on a more local and punctual scale and are not comparable to the fragmentation that encircles the Alpine arch regarding intensity and permeability. Still, the high population pressure in the Inn valley as well as the overall transport pressure and increasing number of vehicles combined with an intensive use of the surrounding area for outdoor sports create a measurable barrier effect in both regions.

Besides the effect of human pressure on the terrestrial ecosystems, also the riverine system of the Inn is affected negatively by the influence of water energy plants on the discharge rate of the river[54]. Further, regulations and straightening are common in urban areas and agricultural lands also visible on the Adige.

[52] http://www.parcs.ch/snp/pdf_public/2017/34379_20170601_092730_AlpineNature2030_plasmann.pdf
[53] http://www.parcs.ch/snp/pdf_public/2017/34379_20170601_092730_AlpineNature2030_plasmann.pdf
[54] https://www.unser-inn.at/der-inn/nutzungen/bestehende-wasserkraftwerke/

c) Existing knowledge about ecological connectivity in the area

Already existing studies and analysis carried out in the area have been conducted by different stakeholders and interest groups of the region. Besides EU projects and province works, associations such as ALPARC, the WWF and universities engage in conducting studies in the Tyrolean region.

The Trentino region for example had a EU LIFE+ project called T.E.N project, researching the Trentino Ecological Network, seen as a focal point for a Pan-Alpine Ecological Network. The project run from April 2012 until the end of 2016[55]. It was dedicated to plan 12 "reserve networks" and to plan an integrated long-term management system and restoration programme targeting the Natura 2000 network under the jurisdiction of the Trento Province. It was implemented based on a decentralized management involving local communities and included economic and social dimensions in addition to conservation one. One of the actions foreseen in the LIFE+ project was the establishment of an ecological corridor by planting a forest belt along the Avisio stream north of Trento in the Adige Valley.

With the focus on the Pilot region "Engadine – Alto Adige – Valle dell'Adige", ALPARC together with CIPRA, ISCAR and the WWF conducted a 19-month project in 2007 to lay the foundations for the long-term implementation of a coherent ecological network in the Alps. The "Continuum Project"[56] is a joint alpine set of methodologies for connecting important areas and a catalogue of possible measures to enhance connectivity was developed. The activities in the pilot region (one of four) included: zoning measures, protected area enlargement based on the needs of ecological systems, the creation of a coherent communication strategy for ecological corridors and sustainable use agreements with farmers, foresters, hunters and tourism operators. The outcome of the Continuum Project was the foundation for the work of the "Platform Ecological Network" of the Alpine Convention.

With a similarly holistic approach, the "Econnect" project[57], implemented in the framework of the Alpine Convention, is conducted in order to promote model implementation of ecological networks in several pilot regions such as the "Rhaetian Triangle" along the Inn and Adige Valley. Work package 7 covered the identification of ecological anthropogenic barriers. Based on this overview, the need of selected species and an assessment of existing connectivity-gaps was undertaken and measures developed accordingly.

[55] LIFE+ T.E.N.: Website: http://www.lifeten.tn.it/
[56] https://www.alpine-ecological-network.org/
[57] http://www.econnectproject.eu/work_packages.php#wp5

To put increasing awareness for key brown bear habitats and corridors, especially in potential ecological traps within cultural landscapes, was an important and necessary step to increase large carnivore conservation. In their research on "Resource selection and connectivity reveal conservation challenges for reintroduced brown bears in the Italian Alps" of 2015, Peters et al. used GPS-collared bear data to predict post-reintroduction habitat selection in Trentino[58]. During their study, they identified road crossings of predicted paths between preferred habitats, with two of these potential crossings in the Adige Valley, which was evaluated as one of the biggest constraints for the study population to expand eastward and impeding the dispersal towards the closest bear population, namely the Dinaric-Pindos population.
A further project covering bear presence and connectivity of bear habitats in Trentino and the Adamello-Brenta Nature Park was LIFE ursus[59].

With "Unser Inn"[60], the WWF started an initiative focusing on the river Inn. A high number of water energy plants and regulations are impacting the important waterways and Inn catchment area, which are legally protected as taboos. The WWF set their aim at doubling alluvial habitats in the Tyrolean Inn valley on 500 hectares through the revitalization and measures on ecological flood protection as well as minimizing the burdens from surge operation and continuum interruptions of the water energy plants. These strategies shall enhance the species conservation as well as the (successful) return of disappeared species.

Regarding the fact that projects and plans on ecological connectivity are conducted not only by the local government itself but also/mainly sees contributions by private and non-state actors shows the importance of the area to further develop also the networks within the alpine range. Especially the continuous separation in the Adige valley creates a high level of interest but still, knowledge and interventions on the Adige itself are insufficient. Apart from smaller initiatives such as "Siepi" of the Province of Bolzano[61] there seems to be a lack of knowledge on ecological connectivity in the political leadership and the implementation on connectivity measures is due to single towns, which only can act on small scales[62].

d) Potential threats/need for action

[58] https://grandicarnivori.provincia.tn.it/content/download/12800/229632/version/1/file/Peters_etal_2015_BiolCons.pdf
[59] https://grandicarnivori.provincia.tn.it/L-orso/Storia-sull-arco-alpino/Il-Progetto-di-reintroduzione-Life-Ursus
[60] https://www.unser-inn.at/wwf-programm/
[61] http://www.provincia.bz.it/natura-ambiente/natura-territorio/incentivazioni/siepi.asp
[62] http://www.lifestrade.it/files/Favilli.pdf

Along the already existing barrier effect areas in the highly populated valleys, the shielding is assumed to intensify in the years to come if no further steps towards ecological connectivity will be taken. Reasons are for example increasing population pressure and urban sprawl, infrastructure expansion and agricultural intensification.

A further intensification could appear with the realisation and commissioning of big infrastructure projects such as the full Brenner Base Tunnel[63] not only by increasing vehicle numbers but also by the impact on the landscape due to construction works and deposits of rubble in other areas, leading to a delocalisation of the direct impacts. The new Brenner Railway, eliminating slopes and increasing the efficiency of the connection between Munich and Verona will further be realised step by step.

Figure 9: New Railway Line between Munich and Verona.[64]

The Inn is heavily used over long distances with 31 transverse building structures along its total course[65]. For land reclamation for agriculture as well as for flood protection purposes, heavy build-ups have been carried out in the catchment area of the Inn over the last 300 years[66]. These include extensive puddle barriers on the side waters designed to hold back the gravel that the river carries with it. In some places, this led to a massive depression of the river accompanied by a reduction of the groundwater levels in some areas. These build-ups have transformed the formerly branches banks into a stretched, canalized river. As a result, floodplains were cut off from the main river leading to wetland dry outs in the Inn Valley due to a lack of water supply. Well known examples of such habitat losses are the Amraser or the Völser lake near Innsbruck. A special feature, however, is the remaining free flow in Tyrol without cross structures or dams. Until now, no bigger infrastructure projects are planned but this permeability has to be preserved to ensure further habitat connectivity for many aquatics but also terrestrial species.

[63] http://www.provincia.bz.it/natura-ambiente/natura-territorio/pianificazione/grandi-progetti.asp
[64] http://www.provincia.bz.it/natura-ambiente/natura-territorio/pianificazione/grandi-progetti.asp
[65] http://www.unser-inn.at/wp-content/uploads/2015/12/Tabelle_Querbauwerke_01.pdf
[66] https://www.unser-inn.at/herausforderungen/flussverbauung/

e) Species concerned

It is evident that the ecological barrier areas in 6) do have a separation effect on the valley sides and subsequent areas but "as important as these phenomena may be, they are located in a punctuated fashion and do not present a continuous belt like the fragmentation that encircles the Alpine arch"[67].

The projects in the region therefore mainly cover bigger species with a need of a wide habitat and large roaming distances that would face the problem of crossing blocked valleys. The Econnect project for example focused on 6 different species, namely the black grouse, red deer, brown bear, the wolf, the griffon vulture and the lynx.

In the lowlands, habitat loss and fragmentation are the main factor for decreasing numbers of the black grouse in the Alps since 2000[68]. Shifting tree lines due to abandoned grazing is also mentioned as a contributing factor.
Red deer[69] in contrast is a very adaptive species which originally was adapted to woodland environments. Large scale reductions in this habitat forced the deer to adapt to open landscapes which also has an influence on the ethology of the species. Despite these facts, deer free zones raise the question and need for a more conscious and active integration of wildlife species into cultivated landscapes. In doing so, natural interactions – like with large carnivores like the wolf and bear – should be promoted to achieve a natural and sustained deer regulation.

A human-driven decline in numbers is also visible for the brown bear. The current distribution of Ursus arctos in the Alps is limited to the eastern Alps in Trentino. In the course of the Econnect Project, the morphological spatial image analysis revealed that more than 60% of potential bear habitat (in the total Econnect region) was not classified yet: From a nature conservation view of perspective it would be desirable to protect all bear habitat not protected yet[70].
Wolfs are a very agile species, wherefore single roads i.e., are usually not identified as a barrier for wolf dispersal. However, in Italy many wolves are killed in car accidents as proven by Lovari et al. (2009)[71]. Densely settled territories with a high road density, such as the Adige and Inn Valley constitute a major limitation to pack settlement (rather than wolf dispersal itself). Furthermore, human settlements, low forest cover and high

[67] http://www.parcs.ch/snp/pdf_public/2017/34379_20170601_092730_AlpineNature2030_plasmann.pdf
[68] http://www.econnectproject.eu/cms/sites/default/files/Econnect_Black%20grouse_2011.pdf
[69] http://www.econnectproject.eu/cms/sites/default/files/Econnect_Red%20deer_2011.pdf
[70] http://www.econnectproject.eu/cms/sites/default/files/Econnect_Brown%20bear_2011.pdf
[71] LOVARI,S.,SFORZI,A.,SCALA,C.&FICO,R. (2007): Mortality parameters of the wolf in It-aly: does the wolf keep himself from the door? Journal of Zoology, 272, 117–24

rock elevation presence are considered as factors increasing dispersal resistance.

f) Perspectives and possible solutions/recommendations for actions

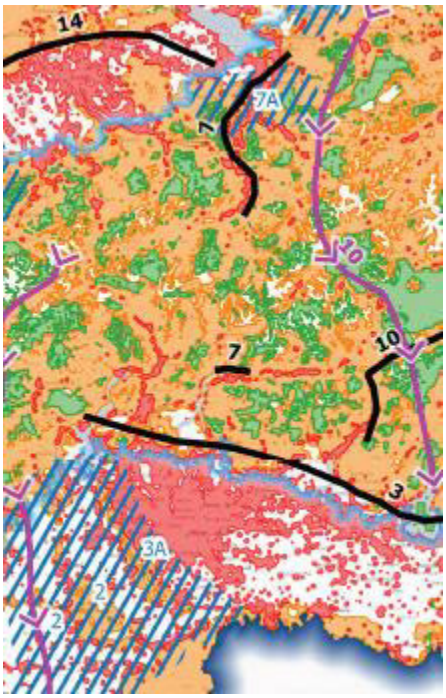
The activities on ecological connectivity and in the Tyrolean and south Tyrolean area are from an expert point of view still in their infancy. Few people, especially on high levels of political influence, have the knowledge and a focus set on the issue[72]. To improve the situation, one approach would be to broaden the knowledge on the concept of ecological connectivity in-between decision-making stakeholders as well as interested actors such as architects and engineers through capacity building. As the concept must be integrated and set as an inherent part of existing nature protection criteria of the provincial regulations, also the broad public has to be sensibilised and incorporated into the communication process. This participatory process would not only be important for the acceptance and the support of the residents towards projects but furthermore also to increase pressure and surveillance of ongoing political processes and projects from different sides. Due to the extension of the barrier effects 6) over country borders, another factor that can also affect connectivity is management fragmentation resulting from different management strategies within several countries. Therefore, a shared management program within the different alpine countries is a key step to maintain ecological connectivity, as advocated by the Guidelines for Population Management Plans for Large Carnivores in Europe approved by the European Commission in 2007 (Linnell et al. 2007)[73].

An early learning process, for example in form of school activities, and small-scale activities can contribute to the anchoring of the topic in public awareness. To be able to work towards a (South-)Tyrolean connectivity network on different levels, research organisations and nature conservation associations should enhance the participation in superregional and EU projects with the involvement of local stakeholders. A holistic approach, deepening activities simultaneously on different political levels and regional scales, could enhance the promising activities on ecological activity already started and ongoing in the barrier effect areas 6).

[72] http://www.lifestrade.it/files/Favilli.pdf
[73] LINNELL,J.D.C.,SALVATORI,V.&BOITANI,L. (2007): Guidelines for population level man-agement plans for large carnivore in Europe. In:LCIE report prepared for the Eu-ropean Commission, pp. 1–78

7 Rhine Valley – Lago di Como (Eurac + SNP)

a) Description of the area



The first part of area 7) is part of the Rhine valley and reaches from Chur via Landquart, Sargans and Buchs to St. Margrethen and Lake Bodensee. It extends over a height of 400 m a.s.l. to almost 3000 m a.s.l. The valley ground is dominated by settlements, transportation infrastructure (highway, railway and main road aside), industry and agriculture. Its use is dense, and conflicts of use are common. The higher elevated and steeper areas are forested, used for agriculture and / or tourism. Only the most remote areas exhibit almost no anthropogenic use.

The second part of area 7) further south describes Hinter Rhine valley, parts of the Valtellina in the Province of Sondrio bordering Switzerland. The valley is closely connected to the metropolitan area of Milano and known for its ski resorts and wine areas. The population density of 1.032 inhabitants per km² in and around the city of Sondrio with its 21.586 inhabitants[74] is five times higher than the national average. The structure and composition of the land use types in the valley shifted significantly in the last century: The Valtellina experienced a strong decrease in loss of meadows (-18.5%) during 1980-2000 related to agricultural land decrease, other agricultural uses (such as

[74] http://demo.istat.it/bilmens2018gen/index.html

cultivation, orchard, vineyards), bushland and uncultivated land as well as human settlements increase (urban, industrial and roads) (Monteiro et al. 2010)[75]. Intensified agricultural use and monocultures (i.e., vineyards) and high touristic activity, especially in winter times[76], contribute to a further hollowing of the missing ecological connectivity in the region.

b) Description of possible problems or potential concerning ecological connectivity

Both valley grounds are densely used and offer only few ecologically valuable areas. For many species and processes it represents an almost unsurmountable barrier. In the area of the Alpine Convention the distribution of core protected areas according to the different altitudinal levels shows that plains and lowlands are heavily underrepresented with only 11% of protected areas at elevations below 1000m and 72% of the area assigned to the strongest protection categories are at an altitudinal location of 1500m and above[77].

Important cities around the Alps such as Milano do have a significant impact on fragmentation issues due to their relative dispersal of human settlements, and regarding barrier effect areas 7), their con-urbanisation and satellite towns needing transport and energy infrastructure[78]. In the Lombardy region, urbanized area has increased enormously and today, new buildings and settlements as well as industrial and commercial areas consume more than 10 hectares per day of natural or agricultural land leading to a progressive fragmentation of natural areas[79].

The Rhine valley between Chur and Lake Bodensee is an important barrier between the Alpstein / Churfirsten region and Liechtenstein / Montafon / Prättigau as well as between the valleys of Calfeisen and Weisstannen and Prättigau / Schanfigg. It therefore impairs important connections from west to east and partly also from north to south. Like the Lombardy region, in the Rhine valley between Chur and Lake Bodensee settlements, industrial and commercial areas are increasing. The Rhine valley around Chur is the economic driving force in Graubünden with many commuters from the surrounding regions[80]. The Rhine valley in the canton of St. Gallen is still dominated by

[75] Monteiro, A.T., Fava, F., Hiltbrunner, E., Della Marianna, G., Bocchi, S. (2010): Assessment of land cover changes and spatial drivers behind loss of permanent meadows in the lowlands of Italian Alps. Landscape and Urban Planning. 100 (3): 287-294.
[76] https://astat.provinz.bz.it/de/aktuelles-publikationen-info.asp?news_action=4&news_article_id=596819#accept-cookies
[77] http://www.isprambiente.gov.it/files/pubblicazioni/periodicitecnici/reticula/Reticula_n8.pdf
[78] http://www.parcs.at/npa/pdf_public/2018/36364_20180524_112137_091_KohlerY_FINAL_2p_pag.pdf
[79] http://www.naturachevale.it/en/ecological-connections/
[80] https://www.chur.ch/_docn/414378/Wirtschaftsperspektiven_Chur_als_Zentrum_des_Bnder_Rheintals.pdf

industries, location advantages consist of tax reductions and comparatively cheaper housing which leads to still ongoing building activities far exceeding the demand[81].

c) Existing knowledge about ecological connectivity in the area

Spatial planning

Spatial planning in Switzerland is regulated at various administrative levels. An important instrument is the cantonal structure plan. Each canton has a structure plan, which serves as a central planning instrument. It determines for around 20-25 years how the canton is to develop spatially in concrete terms. It coordinates spatially relevant activities such as the development of settlements, transport and infrastructure and also ensures the protection of nature and the landscape. It also regulates the planning of major construction projects such as leisure or shopping centres. This is done with binding specifications over a longer period of time. The cantonal structure plan is approved by the Federal Council and then serves as the basis for all other planning instruments at cantonal, regional and communal level. In this report a summary of the aspects relevant for ecological connectivity of the cantonal structure plans is given. Other planning instruments are not included in the report.

In Switzerland exist 305 **wildlife corridors**[82] of interregional interest. They are interconnected with wildlife corridors of regional and local interest. Approximately one third of the wildlife corridors of interregional interest is intact, some 14% are widely interrupted and the remaining 58% are affected (Bafu, 2018). In the canton of **Graubünden** the wildlife corridors will be integrated in the currently processed structure plan making binding rules for interregional and regional wildlife corridors, giving recommendations and listing known planned projects and spatial planning adaptations. In the canton of **St. Gallen** interregional and regional wildlife corridors are already integrated in the structure plan with binding rules for their conservation and improvement.

The currently valid structure plan of **Graubünden** contains landscape and nature conservation areas for the conservation and establishment of protected areas. Ecological connectivity is mentioned but not yet explicitly integrated.

The structure plan of **St. Gallen** contains in addition **priority areas for nature and landscape**. They contain e.g. bog and fen of national and regional importance, amphibian spawning grounds of national and regional importance, habitats of threatened species, protected areas and so on. In agricultural areas exist **ecological**

[81] https://www.credit-suisse.com/corporate/de/articles/news-and-expertise/die-zeichen-in-st-gallen-und-appenzell-stehen-auf-erholung-201705.html

[82] Wildlife corridors are for specific target species. Many of them are for ungulates but also amphibian species, reptiles and other species are considered.

compensation areas. In order to increase their effect on biodiversity priority areas for ecological compensation measures are included in the structure plan.

In the Lombardy region, the regional Ecological Network is recognized as a priority infrastructure of the Regional Territorial Plan and is an orientation tool for regional and local planning. The RER (Rete Ecologica Regionale)[83] and the criteria for its implementation provide the Regional Territorial Plan with the framework of existing naturalistic priorities and a design of the supporting elements. The interactive tool[84] provided by the Region of Lombardy functions to set specific targets so that ecological needs can be taken into account for the identification of compatible action plans.

Nature conservation initiatives and implementation
The cantons of Graubünden and St. Gallen contain several protected areas of different types (objectives, protection status, area). There is currently no strategy on how to connect them. In the regional nature parks, pilot studies on ecological infrastructure were carried out and partially implemented. These investigations were carried out as part of the biodiversity action plan for Switzerland. The action plan defines measures for the various sectoral policies and includes pilot projects on various aspects of enhancing biodiversity.

Non-governmental organisations launch different initiatives on ecological connectivity, conduct studies and realize specific projects – also in the region.

The region of Lombardy did not only develop a project for a provincial ecological network but also conducted a project specifically for the Province of Sondrio to implement three ecological corridors[85] with particular attention to the necessary connections in the valleys more comprised due to urbanization and rich in natural and artificial barriers to contribute to the deepening of the Regional Ecological Network approved by the Lombary Region. With the “MI-RA-RE” project, short for “MIglorare e RAfforzaento della Rete Ecologica di provincial di Sondrio” the province itself aimed at improving the environmental matrix along the axis of the Valtellina valley floor between Morbegno and Sondrio and further adapted parts of the electricity lines of the province to ensure the conservation and safety of wild bird in the context of the project “Linee elettriche sicure per l’avifauna”[86].

[83] http://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioRedazionale/servizi-e-informazioni/enti-e-operatori/ambiente-ed-energia/parchi-e-aree-protette/biodiversita-e-reti-ecologiche/rete-ecologica-regionale/rete-ecologica-regionale
[84] http://www.sibio.servizirl.it/viewer25/index.jsp?config=config-sibio.xml&parameters={%27rlregis%27:{%27config%27:%27config-rlregis-sibio.xml%27,%27ctrlTopo%27:{%27layerName%27:%27%27,%27id%27:%27%27}}}
[85] http://www.provincia.so.it/ambiente/tutela/rete%20ecologica/sintesi/default.asp
[86] http://www.provincia.so.it/ambiente/tutela/rete%20ecologica/Brochure_linee_elettriche_avifauna.pdf

With the LIFE GESTIRE and the follow-up LIFE GESTIRE 2020 projects[87], the Lombardy furthermore promoted ecological connectivity, not only limited to the Valtellina valley but to the whole province.

Further specific projects
New flood protection measures for the Rhine are currently protected. In the context of this large-scale project, the riverbed is widened, and the course of the river becomes more natural allowing also for more natural processes and flow regimes.

d) Potential threats/need for action

Like the barrier effect areas 6) the impacts of the areas 7) in the highly populated valleys are assumed to intensify in the years to come if no further steps towards ecological connectivity will be taken. Reasons are for example increasing population pressure and urban sprawl, infrastructure expansion and agricultural intensification.

The valley ground is already densely used (settlements, transportation infrastructure, industry, intensive agriculture) and the pressure on these areas is still increasing. More natural or close to nature area is needed in order to enhance / allow for ecological connectivity.

e) Species concerned

As seen in this area as in area 6) the main species covered in the projects are concerning bigger species, such as large carnivores and ungulates. Of big importance respectively attention in the inner-alpine Wolf and Bear are target species as i.e., in the "Remote areas for bears" project carried out by Eliante in the Lombardy Alps funded by the WWF[88].

Besides these more common target species, another focus is set on migratory avifauna with projects as the "Linee elettriche sicure per l'avifauna". Migratory birds, and birds in general are among the animals that suffer most from the effects of the fragmentation of the territory due to road and energy infrastructures. In Italy, the distribution of the electricity network reaches an average of 2.6 km/km². Therefore, these powerlines have a high impact on bird populations due to to electrocution and collision. Tucker & Heath (1994)[89] have shown that at least 7% of threatened species in Europe suffer from significant losses by power lines. Also, in the province of Sondrio the mortality of birds

[87] http://www.naturachevale.it/en/
[88] http://www.eliante.it/progetto/aree-remote-gli-orsi?lang=en
[89] Tucker, G.M. & Heath, M.F. (1994) Birds in Europe: their conservation status. BirdLife Conservation Series No. 3. Cambridge, UK: BirdLife International.

due to power lines is high as studies have shown (Ferloni & Bassi 2009)[90]. In Italy, to date safety measures have been implemented on power lines in the following areas: Reg. Park. Po Delta, Grossetano (Monte Labbro and Valle dell'Albegna, Orbetello, Palude, Diaccia Botrona and Lago di Burano), Padule Orti Bottagone Nature Reserve (LI), Natural Park of Gola della Rossa and Frasassi (AN), while feasibility studies have been conducted in the province of Trento, in the Monte Corno Nature Park (BZ) and in the Toce Fiume SPA (VCO)[91].

Among the main threats to wildlife and to habitat conservation in forest environments are intensive timber harvesting, extensive clearcutting, understory clearings, forest floor clean-ups and further activities disturbing natural and slow processes in these habitats. In the course of the LIFE Gestire 2020 project therefore project areas of choice include the following (partially inadequate) habitats as well as wildlife species which can function as markers for good environmental quality: Luzulo-Fagetum beech forests, Illyrian Fagus sylvatica forests, Tilio-Acerion forests, Acidophilus Picea forests with indicator species such as saproxylic beetles (especially rosalia alpine), owls including the boreal owl and the Eurasian pygmy owl as well as piciformes (f.e. the black woodpecker)[92]. Furthermore, various bat species are covered in the course of the project, as the conservation status of these species was listed as not favorable due to habitat reduction and poor awareness among the general public[93]. Further species falling into the wide array of species concerned in the Lombardy area are freshwater crayfish as well as amphibians and reptiles listed in the annexes of the European "Habitats" Directive, threatened by an unfavourable conservation status (Italian agile frog (Rana latastei), the Italian crested newt (Triturus carnifex), the Italian spadefoot (Pelobates fuscus insubricus), the yellow-bellied toad (Bombina variegata), the alpine salamander (Salamandra atra) and the European pond terrapin (Emys orbicularis))[94].

f) Perspectives and possible solutions/recommendations for actions

To optimize the possibility of (free) movement for animals and plants and reduce anthropogenic impact on existing habitat connections, some perspectives and recommendations are concerning the following:

Both regions are considered in regional planning on various administrative levels but ecological connectivity, apart from wildlife corridors, is mostly not mentioned explicitly in

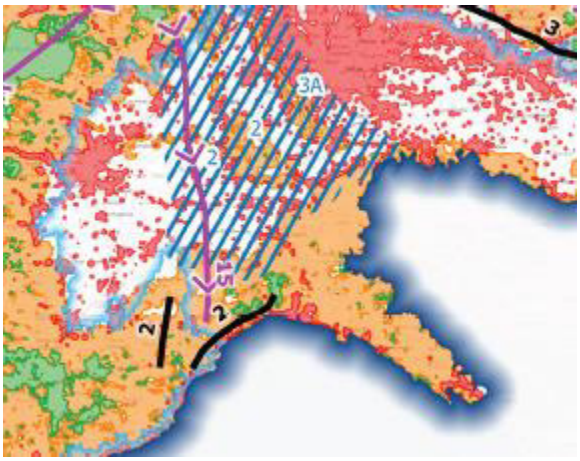
[90] Bassi, Enrico & Bionda, Radames & Trotti, Paolo & Grazia Folatti, Maria & Ferloni, Maria. (2011). Mitigazione dell'Impatto delle linee elettriche per la conservazione del gufo reale Bubo Bubo in Provincia di Sondrio.
[91] http://www.provincia.so.it/ambiente/tutela/rete%20ecologica/Brochure_linee_elettriche_avifauna.pdf
[92] http://www.naturachevale.it/en/habitats-and-plant-species/forest-habitats-and-plant-species/
[93] http://www.naturachevale.it/en/animals/actions-for-bats-conservation/
[94] http://www.naturachevale.it/en/animals/actions-for-amphibians-and-reptiles/

the swiss regulation tools and documents. This issue must be integrated into planning procedures and political discussions to allow for a wider awareness and focus on connectivity implementation. An important aspect that also must find a better access into regulation measurements is the strict reduction and control of sealing of soils to reduce the impact of fragmentation also on species with a lower dispersal radius.
As the valleys show a distinctly higher level of land use impact and conservation areas are mostly situated in higher elevations, nature conservation areas in the valley grounds are difficult to implement but would keep the few but especially important migration and connecting areas open.

Concluding, the issue of ecological connectivity must be put into the focus of politics and the wider public to ensure not only awareness raising but also implementation pressure from different stakeholder groups. Although the disrupting effect of the inner alpine valleys is more punctual than the belt of cities of the alpine surrounding, valleys such as Valtellina and the Rhine valley must not be neglected in this context[95], especially when it comes to securing crossing opportunities for bigger species and species with small dispersal abilities.

[95] http://www.parcs.ch/snp/pdf_public/2017/34379_20170601_092730_AlpineNature2030_plasmann.pdf

15 Transect Alps – Apennines (Eurac + Federparchi)



a) Description of the area

The Transect 15) describes one of the main, if not the main, corridor connecting the inner Alpine area over the western bank of the Po river to the Apennines. The transect crosses the Regions of Piedmont and Liguria until it reaches the northern tail of the Appennino Settentrionale.

The region of Piedmont is surrounded by the Alps on three sides and hosts a population of 4.390.000 inhabitants[96][97] in a geography that is mainly dominated by mountains (43.3% of the region) and extensive areas of hills (30.3%) that pass over to the plains (26.4%). 7.6% of the region are considered as protected area of different kinds distributed over the territory. The National Park **Val Grande** with a size of 15.000 ha is located at the northern end of the transect and builds with Regional Parks such as **Alta Valsesia e Alta Val Strona**, **Bosco delle Sorti della Partecipanza di Trino** and **Capanne di Marcarolo** a more or less connected network of protected areas along the route of the transect.

[96] https://knoema.com/atlas/Italy/Piedmont
[97] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/piedmont

The lowlands of the region are, if not used as urban areas, widely used as agricultural land with a specialisation in cereals such as rice, maize, grapes, fruit and livestock production.

Land use varies widely between the provinces of the Piedmont region but shows a dominance in Forests and semi-natural areas besides agricultural lands (see Figure 10).

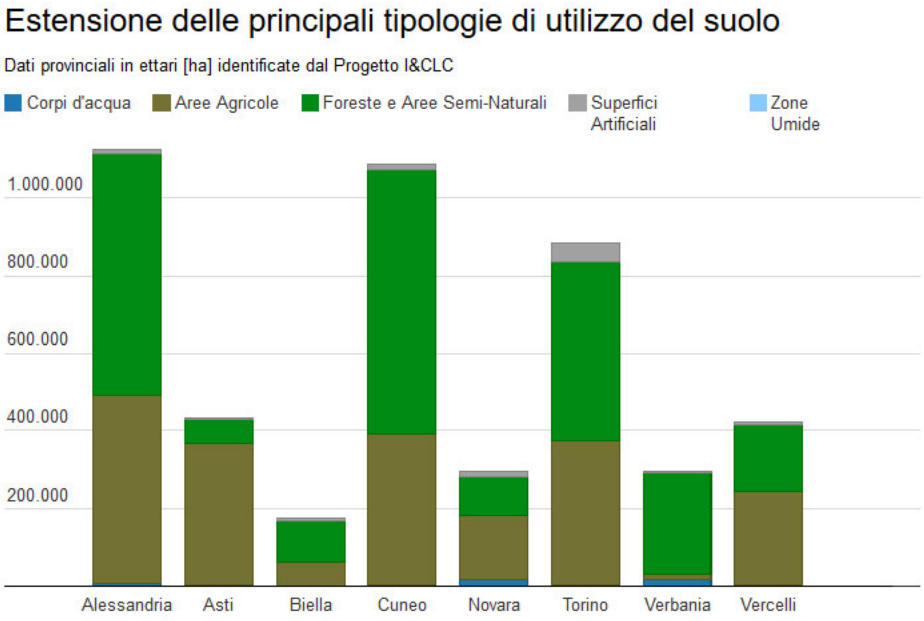


Figure 10: Land use in the Piedmont provinces.[98]

Liguria in contrast is a narrow winding arch following the coast from Ventimiglia to La Spezia and inhabits 1.600.000 people. The landscape is mainly described by forest and other wooded land (69,2%). Further 8,1 % are used as agricultural area, with the highest turnover produced by flower production (75%), animal farming (11,2%) and vegetable farming (6,4%).

In Liguria 12% of the entire region are classified as natural reserves, whereas bigger cities such as Geneva have a significant impact on the ecological fragmentation due to their relative dispersal of human settlements, their con-urbanisation and adjacent towns[99]. The infrastructure outgoing from these settlements shows a strong negative footprint on the surrounding area, impacting the narrow strip of land. The Ligurian coast is almost completely covered with human settlements, shielding off the high relief coast from the inner landscapes.

[98] http://www.arpa.piemonte.it/reporting/indicatori-on_line/componenti-ambientali/suolo_uso-del-suolo-corine-land-cover
[99] http://www.parcs.at/npa/pdf_public/2018/36364_20180524_112137_091_KohlerY_FINAL_2p_pag.pdf

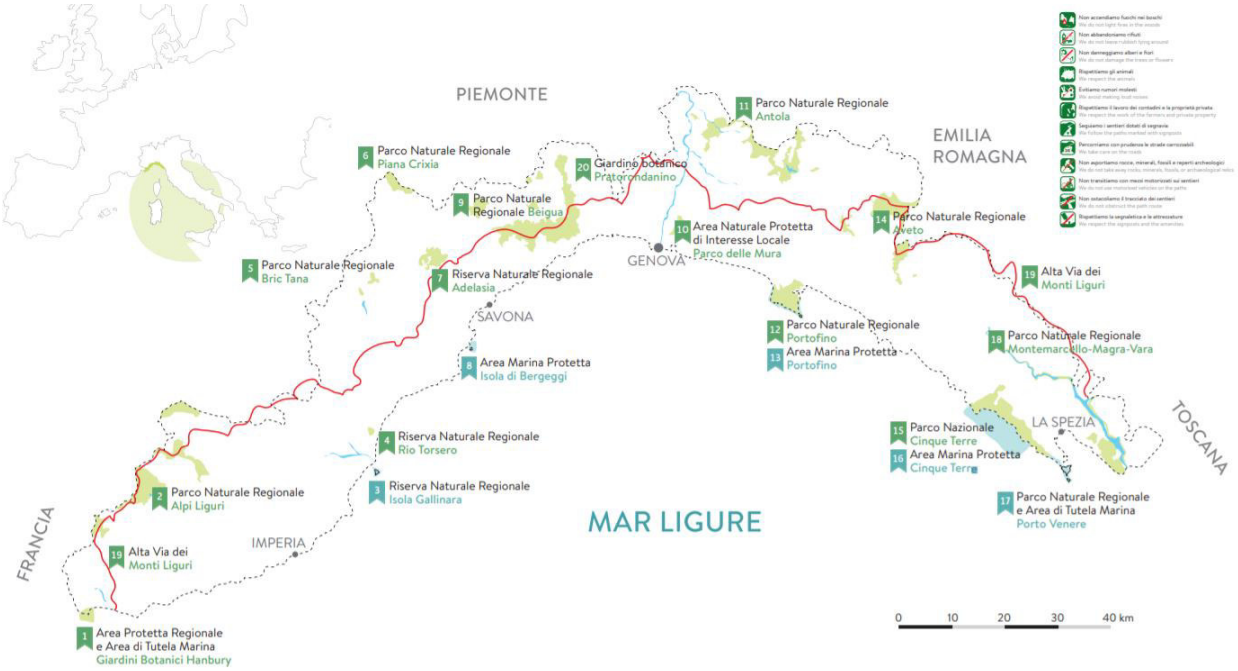


Figure 11: PAs in Liguria.[100]

In Liguria, 25% of the region were identified as SCI (Sites of European Community Importance), looking at the percentage of territory proposed for the Natura 2000 network[101]. Regarding an analysis of the diversity index distribution maps, the fundamental role of the Apennines as a biodiversity hotspot requires a strong connection to the Alps, which are revealed as of lesser fundamental importance: they are the ecological corridors that are invaluable for Italian vertebrates. A permeable corridor between these two habitat pools is striking for the maintenance of various species.

b) Description of possible problems or potential concerning ecological connectivity

Regarding the highest diversity values of the mountainous terrain, at least three large areas are notable: the central Apennines between Molise and Abruzzi, the Ligurian Apennines, constituting the southern end of the ecological corridor 7) and the maritime Alps further to the south west[102]. The area between the Casentine forests (Tuscany) towards the border of France shows high mean diversity values, including the whole stretch of the Apennines across Tuscany and Romagna, together with the Ligurian Apennines.

[100] https://www.arpal.gov.it/files/Carta_prodotti_Arpal_def2.pdf
[101] http://www.montemaggiori.it/Download/Italian%20Ecological%20Network.pdf
[102] http://www.montemaggiori.it/Download/Italian%20Ecological%20Network.pdf

In contrast to the central Apennines, the rest of the Apennine chain would show low levels of coverage if the SCI network would not be provided, which, in many cases, helps to provide solutions of quasi-continuity between existing PA and other important areas devoid of other protection[103].

In Liguria, the system of PA shows a marked bias towards certain types and is hugely dependent on SCI and SPA. Regarding reptile distribution for example, the area of biodiversity with the lowest coverage of PA network is, below others, central and western Liguria. In Liguria, the network of proposed SCI works well to cover mountainous and inland territory, but the coastal strip seems very unprotected.

This might mainly be due to intense human settlements near the bigger cities of Torino and Geneva arising from the infrastructure needed to support these metropolitan areas[104]. In addition, the intensive use of the flood plains of important European rivers such as the Po is of great concern for the further conservation of the diversity of life within the Alps as they connect inner alpine populations to outer edge ranges[105].

c) Existing knowledge about ecological connectivity in the area

Regarding the already existing knowledge, Liguria has developed a database containing information on species and habits present in the Ligurian territory, organized, validated and made available for use by the Ligurian biodiversity observatory (LiBIOss), manages by ARPAL. Based on this knowledge, the Habitats Directive and the Decree of the President of the Republic 357/97, which reports the need to identify all ecological-functional connections that allow the maintenance of the coherence of the Natura 2000 network in the territory, the Region of Liguria developed a cartographic representation of the ecological-functional connection areas (see Figure 12).

[103] http://www.montemaggiori.it/Download/Italian%20Ecological%20Network.pdf
[104] http://www.parcs.at/npa/pdf_public/2018/36364_20180524_112137_091_KohlerY_FINAL_2p_pag.pdf
[105] http://www.parcs.ch/snp/pdf_public/2017/34379_20170601_092730_AlpineNature2030_plasmann.pdf

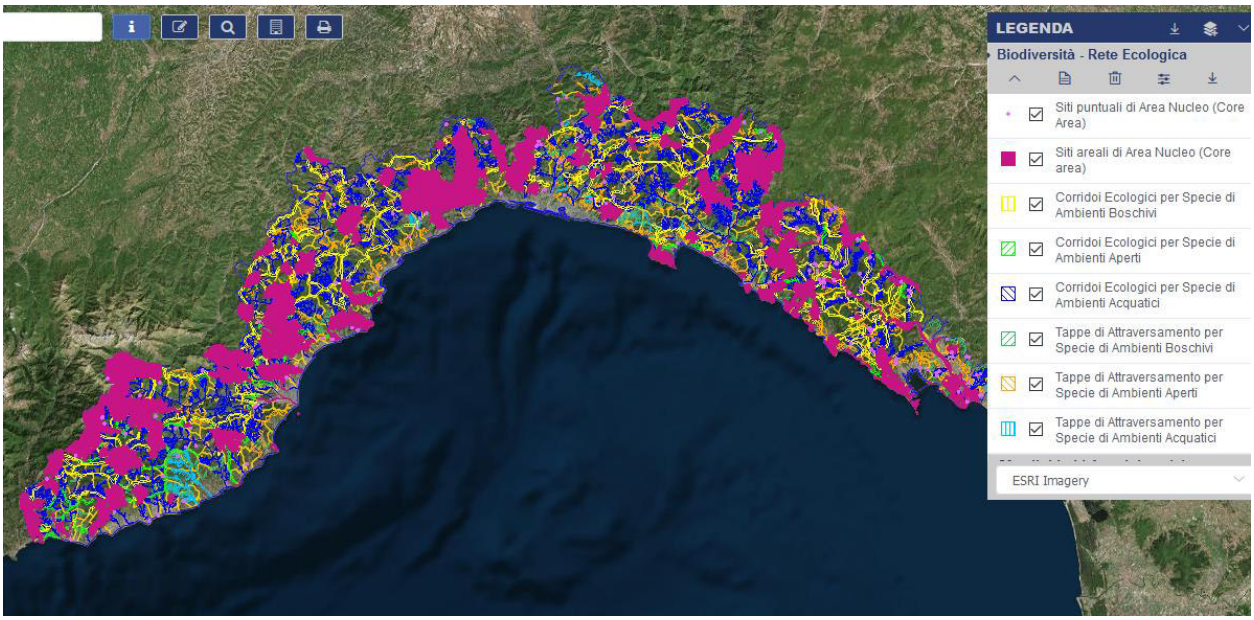


Figure 12: Rete Ecologica di Liguria.[106]

Like the work of the Ligurian region, Piedmont started in 2013 with preparatory activities on their Regional Ecological Network. A specialized working group was formed in which technical and scientific support is provided for the "Environment and Nature" of Arpa Piemonte. The objective of this task force is the implementation of the design of the Regional Ecological Network contained in the regional planning tools and foreseen by the L.R. 19/2009 "Consolidated text on the protection of natural areas and biodiversity"[107].

Besides this regional coverage of planning documents on, besides others, ecological connectivity aspects smaller projects conducted by non-state actors and private organizations supplement the already existing knowledge: The project "AlpApp" carried out by Eliante in Tuscany, Liguria, Piedmont, Cote d'Azur and Rhone-Alpes was dedicated exactly to the transect 15), the ecological corridor between Alps and Apennines[108]. The project has foreseen both, a detailed analysis of the state of conservation areas in the corridor area as well as participation and communication activities enhancing social support of the main stakeholder groups important in the region. With the additional effort put on removing existing environmental barriers, already existing ecological corridors are supposed to be maintained and enhances, while fragmented passages are opened and restored.

[106] http://srvcarto.regione.liguria.it/geoviewer2/pages/apps/ambiente-tematiche/index.html?canale=40
[107] https://www.arpa.piemonte.it/approfondimenti/temi-ambientali/ecosistemi-e-biodiversita/reti-ec
[108] http://eliante.it/progetto/alpap-un-corridoio-ecologico-tra-alpi-e-appennini?lang=en

Funded by the firs call for Strategic Projects of the “Maritime” Italy-France Operational Program, the Co.R.E.M.[109] is dedicated to the topic of the cooperation within the Ecological Network of the territories of Corsica, Liguria, Sardinia and Tuscany. The project contributes to the enhancement of the natural heritage of the Ecological Network through activities of sharing models of governance practices at a cross-border level to expand, consolidate and integrate the synergies between the networks of the identifies priority areas.

d) Potential threats/need for action

e) Species concerned

Species or whole taxa concerned in this ecological corridor can be discovered partially by having a look at the species distribution maps, showing that the ecological network for amphibians is worth of attention. Besides the levels of biodiversity in amphibian species in the Apennines in Tuscany and Emilia, the Ligurian Apennines as far north as Genoa, the highest levels of amphibian diversity can be found that are not well covered by the network of PA. The poor mobility of many amphibian species contributes to a rapid decline in areas where ecological conditions are degrading. The same problematics can be seen for Reptiles where Liguria represents a major important area for this taxon[110].

A further species facing bottle-necks at the intersection of the Alps and the Apennines, is the short-toed Eagle (Snake Eagle) whose European population uses the corridor for migration. [111]

The ecological connection between the Alps and the Apennines through the regions of Piedmont and Liguria therefore represents a major hotspot of attention. “This is an extremely important corridor for biodiversity, several species of animals but also an

[109] http://www.parcoappennino.it/pagina.php?id=290
[110] http://www.montemaggiori.it/Download/Italian%20Ecological%20Network.pdf
[111] https://wilderness-society.org/ecological-connectivity-alps-apennines/

important site for reptiles and endemic flora. The Apennine Wolf story is the best example highlighting importance of this corridor."[112]

While facing a fast-changing climate, the corridor between the Alps and the Apennines further gains in importance as the area is especially crucial also for the adaption to climate changes. Many species will use the area for adaption processes, slowly changing distribution and habitats from the Mediterranean ecoregion to the alpine one.[113]

f) Perspectives and possible solutions/recommendations for actions

The area between the Alps and the Apennines faces specific threats also in the future. One of the biggest challenges in the Alpine area is to control the road traffic by promoting alternative transport systems. Transalpine cargo for example has doubled over the last 30 years, but the modal split still shows a high importance of the tire compared to the railway. Since there is few road passages available through the Alps, the traffic on these routes has grown exponentially. A This situation is not only hard to stand for the population itself but also for ecological connectivity and species distribution. A change in the modal split therefore could contribute not only to the reduction of CO2 emissions but also help to reduce barrier effects on the connection between major urban areas and main transport routes.

[112] https://wilderness-society.org/ecological-connectivity-alps-apennines/
[113] https://wilderness-society.org/ecological-connectivity-alps-apennines/