Report on identified barriers to ecological connectivity in the Carpathians

European Academy
of Bolzano/Bozen

Institute for Regional Development and Location Management
Filippo Favilli, Christian Hoffmann, Mariachiara Alberton and Marianna Elmi
Viale Druso 1, 39100 Bolzano

Bolzano, June 2014

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

Ecological connectivity is ‘the degree to which the landscape facilitates or impedes daily wildlife’s movements among resource patches’. Landscapes are the setting for all human and wildlife activities, providing the basis of human welfare and the resources necessary for all the other life forms.

Providing connections for the wildlife does not mean forgiving about human populations living in a certain landscape, but integrating the needs of all the living forms towards an ecological network of shared spaces. Ecological connectivity means working with communities to find solutions that are practical and that may provide mutual benefits for humans and wildlife. It has to be taken in consideration not only the perspective of science but also of residents, farmers and industry.

From these premises, the aim of the Work Package 5 “Connectivity and Continuum” was to analyze the effects of human-related infrastructures, society and laws on the degree of current and future ecological connections throughout the Carpathians arc. The work package aimed at identifying the current attitude of people towards wildlife species (large carnivores in particular), considering the socio-economic, the legal and natural environment. It was not driven only by an ecological approach to the topic, but by the desire to encourage for an integration of human and nature needs towards a situation of mutual benefit.

Seven umbrella species (plus one) were selected by the BioREGIO partners as main representatives of the Carpathians terrestrial and aquatic fauna and habitats, choosing charismatic and emotional species, preys and predators, evasive and adaptable species, all of them indicators of environmental quality. The selected species inhabit habitats that are continuously subjected to the infrastructures and plans of human society.

The strategy followed took in consideration the ecological preferences of those species, their ranges of distribution and their sensitivity to human-related infrastructures. The collected information were used to develop GIS maps of habitat suitability in order to predict potentially the species’ current distribution and daily/seasonal movements. Data on human activities (current/foreseen roads, settlements, hunting, forestry, agriculture and social attitude) were collected and integrated to detect the locations of possible human-wildlife conflicts and derive subsequently specific recommendations for their positive solutions.

The GIS analysis of the collected data and the identification of principle core areas and dispersal paths for selected umbrella species in the Carpathians was developed starting from the methodology developed in the Alpine Space project ECONNECT. Compared to ECONNECT, the

GIS approach followed in BioREGIO focused on detecting the species' suitable areas and not only the general permeability of the landscape.

This approach, although no perfect solutions exist, tried to "see" the landscape through the eyes of each species and get closer to their chosen environment analyzing their inter-species interactions together with the spreading of the human activities. The "umbrella species" approach was considered more valuable in the case of BioREGIO because the general permeability of the landscape is not in danger, but the movements and the genetic exchange of the single, charismatic and environmental indicators' species. For this reason, it was worth to consider also the human attitude towards large carnivores and wildlife in general. A holistic approach may be fulfilled and specific solutions can be found only if all the factors influencing the choice of habitats and distribution of the species are taken into account.

Generic local conflict points or barriers to ecological connectivity (hot spots) were identified through a visual analysis by the GIS model and subjected to project partners. Local partners selected specific site for an in loco analysis collecting field data on wildlife presence and known conflicts, socio-economic environment, legislation and actions done in favor of ecological connectivity and human-wildlife landscape sharing.

The analysis of the data collected in the pilot areas and the identification of the barriers in these areas was done to elaborate recommendations to advance NATURA 2000 and ecological networks in the Carpathians based on the analysis developed and the results of stakeholders meetings.

The results of the connectivity analyzes were reported on a Web GIS application, elaborated as a tool for metadata, data storage and visualization of the regional and Carpathian wide data collected and outputs produced.

1.1 Study area

According to the necessity of integrating the analysis on physical, legal and social barriers, it was fundamental to apply the investigation on the Carpathian Perimeter following the administrative NUTS3 approach. This was done because "animals do not stop at borders" and because the protection of wildlife species with big home ranges necessities to be considered in trans-boundary policies. It is recent the news that the European Commission launched a platform where farmers, conservationists, hunters, landowners and scientists can exchange ideas and best practices on sharing the same land with large carnivores.

Additionally, the inclusion of socio-economic and legal barrier investigation needed the enlargement of the study area beyond the orographic units, as followed by the Daphne project Carpathian Eco Region Initiative (CERI). For considering both ecological connectivity and how it is hindered by physical and non-physical barriers, a broader territory needed to be covered which extends over the Carpathian Convention Perimeter.

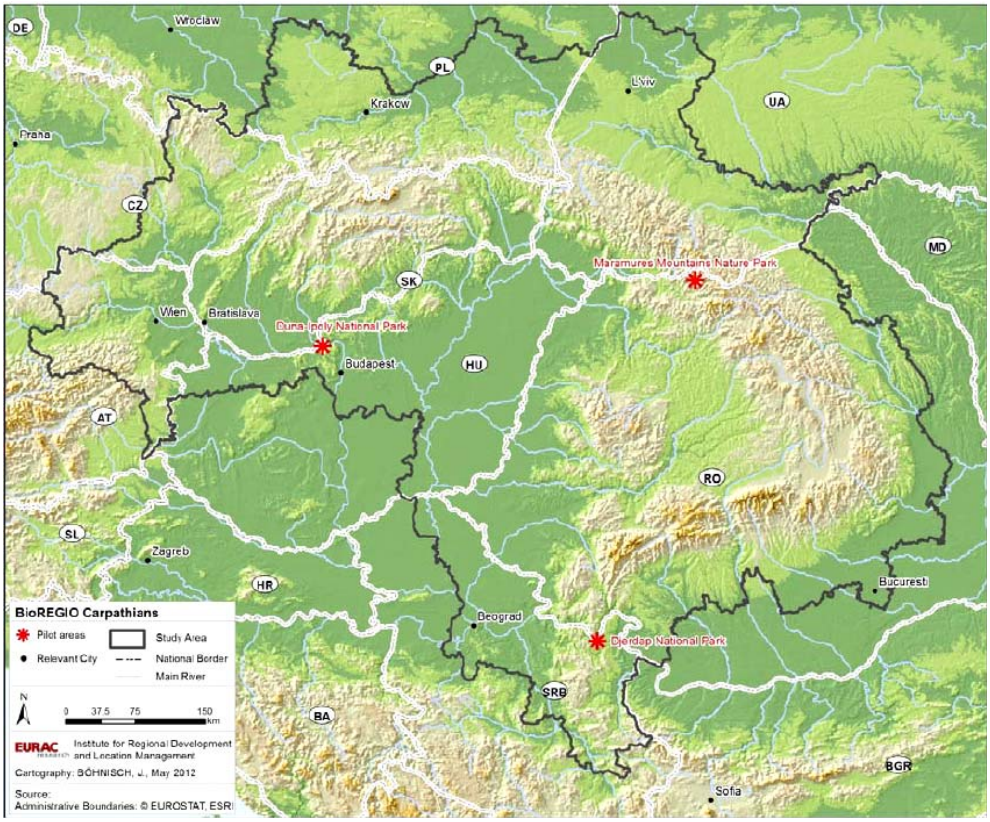

***Figure 1**: Investigation Area and Pilot Regions of the BioREGIO project*

1.1.1 Carpathians & Pilot Area approach

The continuity and connectivity approach started from the research on the most suitable landscape patches for the selected umbrella species, analyzing their chances for reaching another suitable patch for living or breeding. The main questions behind the permeability of the possible paths the species could use are then the following:

- Are there barriers in the identified routes?

- Are they surmountable?
- Which is the local socio-economic and legislative situation?

The approach to detect the core areas and ecological corridors was two-fold and based on the application of a GIS model:

1 – Carpathian-wide approach: It aimed at detecting the general Carpathians ecological network, highlighting the main potential distribution and core areas of the selected species and the most probable routes for their dispersal. Identification of the main structural and functional connectivity of the whole Carpathians mountain range

2 – Pilot Area / local approach: it utilized closer scale geo data and data collected on the local social/legal situation for the identification of main core areas and dispersal routes connecting the studied area with the main Carpathians ecological network. This approach enabled the identification of the main local physical, legal and social barriers for connectivity.

The necessary geo-data at different scales concerning the land cover and ecological characteristics have been collected by open databases and directly from the project partners. Regarding the legal barrier approach, national legal experts were hired to analyze the legal issues having an impact on ecological connectivity. On the other side, qualitative interviews with experts and local stakeholders were providing motives of socio-economic groups for enabling or hindering the dispersal of large carnivores and herbivores.

1.2 Barriers to ecological connectivity

Wildlife and humans share the same need for connected landscapes for the provision of food and the continuous exchange of genetic resources.

In their run-to-development, humans have often shaped landscapes with little thoughts to the cumulative impacts on the environment and at a pace that is unprecedented. Transport infrastructure and urban development have not taken much in consideration the value of landscapes and of biodiversity. The fast modernization of the Carpathian countries, mainly concerning the building of new motorways and urban sprawl, may increase the degree of landscape fragmentation, limiting dispersal and the genetic exchange of wildlife species. These artificial and often insurmountable barriers along traditional dispersal paths raise also the risk of collisions with cars. Beside the most obvious barriers like roads and settlements, additional barriers may come from the attitude of local people towards the presence of wildlife (especially large carnivores) in their territories and by the effects of economic activities carried on in mountain

ranges like hunting or forestry. The legal protection of each state and local laws concerning wildlife management may pose additional threats to the free wildlife movements.

The need to move is most obvious for migratory animals and the large animals that need big tracts of territory. Most of us are aware of large and charismatic animals like deer, bear, or lynxes. However, plants, and smaller, less itinerant animals, also benefit from connections to wider spaces.

Ecological connectivity between large natural and protected areas is essential for both species and humans, who benefit from the Ecosystem Services in their everyday life.

Ecological corridors can provide a solution to fragmentation and encourage a sense of space sharing, since they are “landscape elements which serve as a linkage between historically connected habitat areas”. Ecological connectivity isn’t only fostering the welfare of wildlife populations, but represents also an indispensable value for human society and the economy, as it plays a central role in ecosystem functioning.

1.2.1 Physical barriers strategy

Ecological connectivity focuses on conserving areas that facilitate dispersal and on awareness-raising concerning the human-wildlife coexistence. Nevertheless, connectivity can be interrupted by areas of human facilities or natural features that impede movement. Physical barriers are thus landscape or artificial features that impede dispersal paths between ecologically important areas. For this reason, it is essential to collect information on human society distribution and future plans and not only on wildlife biology. Data on roads, railways, dams, human settlements and human activities (e.g., hunting areas) were collected in order to detect potential conflict points.

The landscape need to be mapped to detect its permeability and identify the most probable paths. Once identified the barrier and the local social environment, specific recommendations for their removal can be derived. Many techniques are available to restore pristine ecological connectivity by removing fences or installing highway underpasses for wildlife etc.

From an ecological context, barriers are inverse to ecological corridors. They are distinguished in impermeable features and those partially hindering dispersal. The impermeable once are mostly human-made like roads, fences, or urban areas. Only sometimes natural features as rivers, canyons or huge agricultural fields also become impermeable. In contrast, there are land cover types or facilities partially hindering dispersal relative to ideal conditions but not disabling connectivity totally. Following traditional connectivity concepts, the impact each barrier has differ

among species and should be evaluated considering how it reduces connectivity through behavioral inhibition, increased mortality, or other means.

1.2.2 Socio-economic barriers strategy

The expansion and the limitation of ecological connectivity is not only a matter of physical barriers. Besides, economic and social aspects have a significant impact too. This is particularly true for the Carpathian countries, which are currently experiencing quick social and economic transformation processes. Additionally, the attitude and awareness of local population towards protected areas and wildlife presence enhances significantly the effective implementation of connectivity measures. These aspects are underestimated in research and in the development of concrete connectivity initiatives as well. Due to this reason, an analysis on socio-economic potentials and barriers has been carried out, besides the legal and physical barriers analysis. Therefore, an “on-field” approach has been chosen, combining interviews with researchers and professionals working in Carpathian-wide. They were interviewed during a series of site visits at selected hotspots identified by the ecological corridor model applied for particular umbrella species in the Carpathians.

The research questions adopted for the study are:

- Which are the main stakeholder categories affected by the topic of ecological connectivity in the Carpathians? And why are those the main ones (motivation, impact etc.)?
- How can the specific socio-economic activities related to these stakeholder categories affect ecological connectivity (both in a positive and negative – opportunities and barriers – way)?
- To which extent can the specific socio-economic activities related to these stakeholder categories affect ecological connectivity?
- Which are the actions that these stakeholder categories can undertake in order to enhance ecological connectivity?
- What recommendations can be given to the different stakeholder categories identified?

1.2.3 Legal barriers strategy

A supporting legal framework to deal with trans-boundary issues, spatial planning and different sectorial legal aspects, touching diverse landscape patterns are essential to foster an ecological continuum in Carpathians. Each of the Carpathian countries are applying their own legal acts on environment and biodiversity according to their principals of subsidiarity. Often the legal acts applied are not fulfilling their target. Sometimes they are lacking the legal coherence across national borders. In other cases, the legal acts proposed are never enforced, or it even happens that legal acts, which are already anchored in legal frameworks, are sometimes not even administrated.

Legal gaps dealing with these problems indicated here should reveal the necessity to design applicable solutions to safeguard biodiversity and the large carnivores and herbivores in the Carpathians. Some legal instruments already adopted can be considered as stepping-stones for being transferred and further developed in favor of ecological coherence. The awareness for the need of ecological continuity and connectivity to design trans-boundary solutions for solving the inconsistency among administrative units within the Carpathian countries requires legal solutions to follow a common harmonized strategy to sustain biodiversity. Despite the effort to intervene on various legal levels, significant progress is still lacking, yet.

The research identifies those ‘legal barriers’, such as institutional and legislative frameworks that prevent, affect, and hinder the maintenance or further improvement of ecological connectivity and the protection of habitats and species.

1.3 Umbrella Species – the theoretic background

We follow the theory that a corridor, which is appropriate for large carnivores and herbivores to disperse, should also be adequate for many other species, too. Before this background, the selection of appropriate species for either Carpathians approach or Pilot Areas approach (ambassador or umbrella species) was done. For deriving ecological corridors they are most likely used, particular needs and requirements regarding continuity and connectivity of landscape of these species are hence assumed.

These umbrella species should be typical for the study area and should be characterized by:

- Their habitat and spatial requirement

- Their degree of protection in each of the studied countries
- Their relation with the human society and infrastructures
- Characteristics and reaction to the presence of barriers
- The relations predator-prey

Each umbrella species has been described and characterized by its ecological habits and requirements/needs regarding their core areas (habitats).

Umbrella species were selected also according to their social impact, especially related to their impact on human activities and emotional feeling. Furthermore, the protection level in the Carpathian countries was considered for their selection.

The final decision on Umbrella species' was taken within a Project Partners' discussion aimed at identifying the most suitable species for the detection of ecological corridors, considering also the available distribution/presence data from the partners themselves.

Selected species: Eurasian Lynx (Lynx lynx), Brown Bear (Ursus arctos), European Wolf (Canis lupus), European Otter (Lutra lutra), European Hare (Lepus europaeus), Carpathians Chamois (Rupicapra rupicapra carpatica), Capercaillie spp. (Tetrao urogallus major + Tetrao urogallus ridolfi). Another species was added, the Red Deer (Cervus elaphus L.). This species was added to estimate the potential prey abundance for the wolf and the lynx and reduce the first habitat suitability maps.

1.4 Habitat suitability and Dispersal paths

Natural habitats are being lost at an incredible rate due to anthropic pressures, and what remains is becoming increasingly fragmented. Increased fragmentation dramatically alters species and landscape relationships and usually increases the risk of extinction. Taking in consideration the increasing impact of human activities and the modernization of many infrastructures that may cause even more fragmentation, always more researchers, institutions and universities are trying to define the best approach to highlight the threats and to identify the possible solutions to the increasing fragmentation. One of the approaches that it is used more frequently is the GIS Habitat-suitability model approach. GIS Habitat Suitability modelling is based on the visual identification of the main areas of wildlife occurrence and movements. The model is built on the ecological preferences and requisites of each considered species, giving percentages of habitat suitability values (between 0 and 100%; 0: no habitat; 100: best habitat) to the different environmental features hosting the different activities of a species (feeding, breeding, resting and dispersing).

This kind of approach is not predictive but probabilistic. This approach is focused on wildlife species and on the potential threats, they may encounter during their daily movements. The basic assumption is that the identification of the most probable paths for wildlife dispersal and of the current and future barriers could enable the formulation of recommendations to overcome future threats due to the expansion of human infrastructures. In the Carpathians environment where a high degree of wilderness is present, this approach is more valuable because it does not point to solve but to prevent possible new landscape fragmentation and potential conflicts. The Carpathians landscape is still highly permeable but foreseen planned infrastructures may become barriers to the ecological connectivity, in case the current ecological network is not identified and secured.

1.5 GIS Modelling

The GIS approach to the ecological network is a wide-used method to detect with an accepted rate of uncertainties, the most probable areas for the presence and the passage of the investigated wildlife species. Several GIS tools are available aiming all at giving the closest-to-reality image of a territory, of the landscape structure and of the possible conflicts sites between humans and wildlife.

GIS modelling does not have the pretention to be comprehensive nor to prevent where new conflicts between humans and wildlife could arise. GIS modelling for ecological network can focus on the general landscape permeability (not on specific wildlife species but analyzing the impact of human infrastructures and the possibility for the landscape to be permeable – it is usually used in highly fragmented landscapes), or on the selected species ecological network (used more in more remote and wild areas, that could be subjected in the future to a high impact from newly built human infrastructures).

Being mathematical models, these tools need to be filled with information coming from the analyzed landscape. According to the objectives of each project in which they are used, these models can fit well together and be combined, in order to adapt the methodology of investigation to the specificities of each site and at every scale.

In the BioREGIO project, the decision to use a combination of two free GIS tools was taken for the following reasons:

a) The species-approach to connectivity, focusing on the main potential core areas and the least-cost paths in a heterogeneous landscape at a regional scale. The use of umbrella species as indicators enables a comprehensive analysis of the ecological connectivity of the whole landscape.

b) The difficulty in collecting local data needed for the calculation of the ECONNECT model indicators.

c) Data at a higher level of resolution are needed to deepen the knowledge of the landscape and be able to provide concrete guidelines (the CORINE LAND COVER having a 100 m of resolution enables a suitability evaluation of each landscape feature in the Habitat Suitability Model, although not detailed enough at local scale).

d) This kind of approach, coupled with ground-data on human infrastructures, enables the identification of potential barriers, the localization of possible intervention zones and the development of recommendations.

The results of the model application to the study area are then projected on an open GIS platform on the web (Web-GIS). The aim of a Web-GIS application is to allow everybody to see the results of the connectivity analysis without having the GIS installed on their computers. The Web-GIS is a visualization tool that may be useful for both experts and administrators to define the areas to be preserved and those where a deeper analyzes is needed in order to overcome potential (or foreseen) barriers.

1.6 Recommendations – to sustain and restore ecological connectivity

The final recommendations produced at the end of the BioREGIO project wanted to give a general overview of the main barriers that, at current time, or in the future reduce the general permeability of the landscape. The recommendations were redacted from the information gained from the project partners, from the GIS analysis of the Carpathians and of the pilot areas, but especially from the site visits in the specific locations decided by the partners.

The ten recommendations were divided referring to the identified barriers:

- Physical and Natural barriers
- Socio-economic barriers
- Legal barriers

Due to the fact that each country has its own story, landscape structure, laws, socio-economic environment and relationship with the local wildlife species, the ten final recommendations did not

want to be comprehensive for the whole Carpathians mountain range. In order to better plan future projects and local activities, each project partner was asked to rank each of the produced recommendations and to explain their choice. With these fundamental contributions, the WP5 partners were able to produce specific strategies for each country to sustain the national ecological network.

2 Methods

2.1 Physical barriers

2.1.1 Data Collection and Analysis

The BioREGIO Carpathians Work Package on Continuity and Continuum (Work Package 5) focuses its data collection on Carpathian wide data concerning the main natural, legal, social and economic features having an impact on ecological connectivity of natural areas. The same collection of available data is carried out also in the pilot areas.

2.1.1.1 Required basic Geographic information

Land cover data (Raster and vector): The data requested were chosen according to the GIS approach that was decided to follow. The GIS data were essential for the application of a GIS suitability model and linkage design, with the aim to identify barriers hindering the species' dispersal. CORINE Land Cover, orthophotos and Classified Land Use satellite Images are essential to visualize the landscape structure and land use in order to adapt the GIS model to the ecological preferences of the selected species. According to the species' habits, the landscape can be classified in different preferential zones, showing the potential core areas and dispersal paths.

- **Carpathian Approach**: GIS application, visualization of data from all the Project Partners about Carpathians' land use (CORINE LAND COVER), topography (Elevation Model), main roads, urban areas, agricultural areas, hunting areas, private/public ownership, planned infrastructure at Carpathian level (e.g.,1:500.000, 1:1.000.000/2.000.000)
- **Pilot Area approach**: Visualization of the PA's landscape structure in GIS using satellite images (Landsat, Spot, Aster) and orthophotos considering scales of 1:100,000 or 1:50,000 or even 1:25,000 if possible.

Linear Data: Data on human infrastructures (e.g., settlements, roads, ski infrastructures, fenced hunting areas, planned roads, overhead power lines, watercourses, railways etc.) provide useful information on the current and future potential barriers hindering animals' dispersal. The knowledge about the location and the specifics of each of the mentioned barriers was for WP5 essential. Coupling detected core areas and least-cost paths with the location and the

characteristics of the supposed barriers, enabled to perform a deeper analyzes and to elaborate specific recommendations for their overcome.

The requested data are always included in studies concerning ecological connectivity in relation with the presence of human infrastructures.

2.1.1.2 Strategy for data collection

The necessary data for a comprehensive GIS analysis needed to cover all the relevant aspects of the Carpathians environment and human society. In a first step, free available public data were collected (Table 1).

The acquisition of necessary data for ecological connectivity and barriers analysis needed the cooperation among all the project partners. Geo-data are often not easily shared by local administrations and the presence of local partners to deal directly (also to overcome language barriers) was of great help for data collection. Project partners contributed to this task contacting data owners and helping in collecting free data sets or in discussing for purchasing prices.

Table 1: *Free available datasets (public)*

GIS available data	Source	Year	Scale	Geographic Extent
Rivers, Lakes	JRC	2008	1:500.000	EU
Forests	JRC	2008	25 m	EU
Landuse	EEA: CORINE land cover	2006	1:100.000	Car, except UA
Lakes	JRC	2008	1:500.000	EU
Rivers	JRC	2008	1:500.000	EU
NUTS2 - boundaries	EUROSTAT	2008	1:500.000	EU
NUTS3 - boundaries	EUROSTAT	2006	1:3.000.000	EU
Municipality Boundaries	Eurogeographics	2006	1:3.000.000	Car
large cities	ESRI	2001	1:1.000.000	EU
national borders	ESRI	2001	1:1.000.000	EU
landscape types	GISCO, EUROSTAT	2003		EU
elevation model	USGS	2000	90 m	Car
Relief (topography)	USGS	2000	90 m	Car
nationally designated areas	EEA	2008	1:100.000	EU
Wildlife species' distribution	IUCN	2009		Car
Habitats, orographic units	Carpates.org	2007	Shp-file	Car

JRC…Joint Research Centre; EEA…European Environmental Agency; ESRI…Supplier of GIS software and geodatabases; USGS…U.S. Geological, Survey, IUCN… International Union for Conservation of Nature

Additional necessary data needed to be purchased. Due to the fact that requested and necessary data were not always available, or of easy sharing with the data owners, decision was taken to overcome this problem by purchasing the necessary data from an institution outside the Carpathians Convention area but active in the region of interest. EURAC decided to purchase Land use and land cover maps for the entire Ukrainian Carpathians based on LANDSAT TM/ETM Images from the year 2000 from the Humboldt Innovation GmbH (Technology Transfer Office of Humboldt University). Data were purchased at the price of Euro 3.000 (excl. VAT 19%). This institution was the only provider that offered already classified Landsat-Images (Pixel data) with a resolution of 30 m.

Information on street data is one of the most important issue to be considered in ecological connectivity. Due to the cross-border character of the project and for a reliable spatial data application in the model on ecological networks, a harmonized dataset for the whole study is required.

Therefore, the data had to be acquired by purchase. The company “WIGeoGIS” from Munich was selected as they provide the street data for the whole study area without any restrictions within our web-GIS.

2.1.1.3 Umbrella species

The GIS model is based on the production of potential distribution maps. To adapt the results of the GIS model to real situation, wildlife presence and distribution data are of fundamental importance for the validation of the results.

The model results are in the form of habitat maps based on the ecology of the species. However, since every species selects its best habitat based on availability of resources, breeding opportunities and protection, rest, passage, the general species' ecology cannot justify local habitat selections, which are due to local characteristics and human presence. That is why a punctual, reliable and recent data on animals’ presence and distribution is needed. This kind of data, due also to the difficulties in obtaining them (through direct continuous observation, monitoring, labelling, signs identification and/or radio tracking) and to the monetary costs that they require, are often missing or incomplete.

Nevertheless, data about wildlife presence, to get a rough picture of their distribution areas can be obtained from different sources. Very broad distribution maps have been elaborated by IUCN to show a sort of habitat potential. They can be useful to know whether the species could live there and if there have been continuous signs of its presence.

Punctual presence, although sporadic, can be reported by hunting bag data based on National Game Management Databases.

Several researchers have contributed to the knowledge of wildlife presence, movements and conflicts, by sharing their data only for internal use. Punctual data on wildlife presence (especially related to big mammals) are very sensible data and, if projected in the Web GIS application, could be used by poachers to identify the passage sites of these species.

Finally, historic distribution of species can be found on the literature but they can be just partially used to validate the model.

2.1.2 Questionnaires

Closed interviews (data collection, umbrella species, physical barriers)

EURAC prepared questionnaires for the project partners in order to get a clear picture of the available GIS data owned or reachable by the partners, on the presence and distribution of umbrella species and on the effects of several kinds of physical barriers in their national territories and in the Pilot Areas.

The objective of the first questionnaire was to obtain geographic data information about the land structure, characteristics, animal spatial data, existing corridors and barriers in your country or area of interest and in the Protected Area(s) in your country. The obtained geographic data have been harmonized and then used to define the landscape characteristics in order to identify potential animals' corridors. This information have been coupled with those regarding the characteristics of the selected umbrella species as to highlight through Web-GIS the ecological network within the Carpathians range.

The second questionnaire asked the partners to state the importance of each of the selected umbrella species in their country / Pilot Area. Finally, the questionnaire aimed at knowing whether a presence/distribution GIS database for the selected umbrella species was available.

2.1.3 GIS modelling to identify habitat suitability and dispersal paths by advanced tools and methodologies

2.1.3.1 Conceptual steps for building a model

Ecological networks provide for several functions in the maintenance of the health of the environment. They enable the conservation of the biodiversity at ecosystem and regional scale, putting an emphasis on the reinforcement of the ecological coherence and continuum and integrating biodiversity conservation into broad environmental management plans. Ecological networks may buffer critical areas from the effects of potentially damaging activities and helping in the restoration of degraded ecosystems. Ensuring the ecological continuum, without limiting the human development, can contribute to the promotion of the sustainable use of natural resources and to the raising of people's awareness towards a pacific coexistence and sharing of common spaces with wildlife species. The extension of the Carpathians area and the diversification of the local situations required a GIS methodology, which enabled either a general overview of the habitat suitability and connectivity and a more detailed analysis of the sites where potential barriers were detected.

2.1.3.2 Selection of ArcGIS 10.0 free toolboxes

After a careful literature review on GIS wildlife habitat modelling, we identified the more appropriate GIS tools for our purposes. Among the available GIS habitat suitability models, we selected the ArcGIS 10.0 tool *CorridorDesign* and ArcGIS 10.0 tool *Linkage Mapper*. These tools are free of charge, relatively easy to apply and do not require the collection of empirical data on wildlife presence. *CorridorDesign* (http://corridordesign.org/) given a set of habitat factors (e.g. land cover, elevation, topography), produces a map of the general suitability of an area. By adding species-specific factors that concretely limits a species' dispersal, *CorridorDesign* allows the identification of the main core areas through the reduced extension of the general habitat suitability. The considered factors are:

- Landcover (forests, agricultural fields, water bodies, human settlements, grasslands)
- Altitude (range of preferred altitudes for each species)
- Slope (preferred exposition and slope)
- Influence of human presence (Euclidean distance from settlements and roads)

The GIS system put together all the factors and their values and calculate a Habitat Suitability Model for the selected umbrella species through a geometric mean value. Subsequently, the

model identifies the most probable ecological routes that are keener to be chosen for dispersal (Least Cost Paths).

The identified core areas can be used in *Linkage Mapper* (https://code.google.com/p/linkage-mapper/) to point out the dispersal and connection paths requiring a minor expense of energy (Least Cost Paths). *Linkage Mapper* is a GIS tool that uses GIS maps of core areas (from *CorridorDesign*) and resistances to identify the possible linkages between the core areas.

2.1.3.3 Collection of available data (part of data collection)

Three type of data were collected for the purpose of the connectivity analysis:

a) Data gathered from questionnaires
b) Qualitative information collected during the site visits and related to the pilot areas
c) Geo-data, collected either through open-access databases or with the help of the project partners.

While qualitative data were very essential for the analysis of socio-economic barriers, geo-data were necessary for the identification of the umbrella species' habitat suitability and connectivity as well as for the detection of physical barriers. Geographical data, applied in the GIS model to create thematic maps, consist mainly of vector data (e.g. shapefile of road, rivers or settlement) and raster data (e.g., CORINE land cover, Digital Elevation Model – DEM) as well as of orthophotos representing at closer scale important areas for connectivity, especially at pilot area scale.

2.1.3.4 Choosing habitat factors

The choice of the habitat is species-specific and it is driven by availability of food, breeding sites, safety from predators and other hazards, presence of competitors or facilitating species, and other factors. However, these factors are rarely included in GIS suitability models because they are difficult to quantify. No GIS layer is available with this information and besides this kind of information is not site-specific. Some of these factors may be obtained indirectly, for examples the suitability habitat for a prey species (e.g. red deer) can be used as an indicator of "prey abundance" for a predator one. Typical GIS suitability models are based on one to five factors, including land cover, one or two factors related to human disturbance, and one or two topographic factors. The reason to focus on these factors is pragmatic and simple: these factors are relevant to characterize landscape patches and aside geo-referenced data are available for the entire planning area. The Habitat Suitability Model is a mathematic calculation that produces a geometric mean among the different suitability values given to each habitat factor. The factors, their separation in classes and the assignments of weights are due to the necessity to adapt the model to the ecological requirement of certain umbrella species. Since every species is bonded to

ecologically crucial habitat characteristics, it is essential to divide the habitat factors in categorical (land cover, topographic classes) or continuous (percent slope, distance from a cover type or road) variables. Only species having clear seasonality (e.g. bear), the values assigned to the factors' classes change between summer and winter – in order to gain a more complete view of the locations of possible occurrence of this species. GIS layers used in BioREGIO habitat suitability models include land cover, topographic variables (elevation, slope), distance to streams, human disturbance/facilities.

2.1.3.5 Technical steps

First step: Application of the Corridor Designer – creation of a Habitat Suitability Model

For each class of the habitat factors (such as forest or grassland within land cover) a particular suitability score is assigned. Meaningful thresholds are set to allocate appropriate habitat suitability scores to the categories, whereby the defined thresholds are related to the habitat requirements of breeding sites. A score of zero is assigned when already one particular class of a habitat factor does not correspond to the ecological requirements of the species considered. To assign a suitability score to each class within each factor, we use a fixed scale between 0 (no suitability) and 100 (maximum suitability) having in mind the following biological interpretation:

- 100: best habitat, highest survival and reproductive success
- 50: sub-optimal habitat, food availability and passage
- 25: occasional use and passage
- 0: avoided/barrier

First sub-step: Adding a Critical Species' Specific factor

After defining the habitat suitability in a general term, we have to define the quality of the habitat patches according to each species' specific factor.

Objective of this sub-step is the recalculation of the habitat suitability according to each species' strict (fundamental) ecological parameter and not only to the land cover characteristics, moving then closer to real species' habitats.

Each species has its own ecological preferences strictly dependent on a few ecological factors or landscape features. Adding a new factor to the habitat suitability model and performing a new suitability calculation enables a re-categorization of the landscape suitability and therefore the identification of the main areas of possible species' occurrence.

Second Step: Linkage Mapper – model design – identification of least-cost paths

Once detected the most probable core and occurrence areas, it is necessary to identify, in the areas of minor landscape resistance, the most probable paths for wildlife to disperse. The resistance map and the core areas created in the previous step are then used to detect the paths. This step allows the identification of possible barriers hindering the free wildlife dispersal through the overlapping with human infrastructures layers. *Linkage Mapper* uses GIS maps of core areas and resistances to identify and map linkages between core areas. Each cell in a resistance map is attributed with a value reflecting the energetic cost, difficulty, or mortality risk of moving across that cell. Resistance values are typically determined by cell characteristics, such as land cover or housing density, combined with species-specific landscape resistance models. As animals move away from specific core areas, cost-weighted distance analyzes produce maps of total movement resistance accumulated.

The tool identifies adjacent (neighboring) core areas and create maps of least-cost corridors between them. It then mosaics the individual corridors to create a single composite corridor map. The result shows the relative value of each grid cell in providing connectivity between core areas, allowing users to identify which routes encounter more or fewer features that facilitate or impede movement between core areas. *Linkage Mapper* also produces vector layers that can be queried for corridor statistics.

Virtual Model Validation

The produced maps of core areas and least cost paths need to be validate by real data or field analysis in order to represent a situation close to reality. There are two ways to validate the Suitability model map:

1. Using available real data on the observed presence of the umbrella species in the area derived from empirical research (e.g., radio tracking) and/or national databases based on reliable published literature.
2. Performing site visits in specific areas of probable occurrence following a holistic approach. The on-the-ground analysis of an area has to be coupled with interviews and discussions with local experts and stakeholders (hunters, farmers, foresters, touristic associations, nature conservation agencies etc.).

The habitat suitability model addresses to wild land areas whose ecological characteristics and distance from human activities are more favorable for the creation (or maintenance) of ecological corridors.

The identification of suitable habitat patches for the considered species, within the different ecological preferences and along with the assessment of the resistance of the land matrix to dispersal, provide a general framework to interpret the wildlife's movements within and between different habitats. This procedure allows assessing each catchment in terms of its ability to host source or sink populations.

2.1.3.6 Web-GIS development

A WebGIS is a GIS application to visualize the results of a GIS analysis. The WebGIS is developed on the web to manage a large extent of geographical information and make it available to a large audience.

Within the framework of the BioREGIO project, a WebGIS has been designed in the attempt to spread the results of the research project, allowing people to know more of the structure of the Carpathians ecological network and its functionality. It contains both raster, vector data, and is fully accessible for visualization purposes. It is structured into three main components: an information window, which is a real time maps browser with different layers containing general information concerning both the landscape and the species' connectivity specifically and a search engine.

2.2 Socio-economic barriers

2.2.1 Site visits

Site visits in specific locations of the Carpathians countries were not foreseen in the Application Form. However, the decision was taken because the data gathered, especially concerning the socio-economic issues and the relations human-wildlife, were not sufficient to get a clear picture of the country's situation. Site visits were performed in five of the seven Carpathians countries in specific sites decided by local partners selecting among several possible "hot-spots" (potential barriers for ecological connectivity) detected by the GIS analysis.

2.2.1.1 Explorative analysis of different Carpathian realities

The explorative analysis took in consideration the issues highlighted by the partners in their locations. Analyzed countries were Serbia, Hungary, Slovakia, Romania and Ukraine. Discussed issues with local partner and stakeholders ranged from hunting, tourism, socio-economic

development in protected areas, road kills, actions for raising awareness towards ecological connectivity and transboundary cooperation.

2.2.1.2 Investigation of selected hot-spot zones concerning ecological connectivity

Hot spots for connectivity were identified firstly through a visual analysis of the Carpathians. Due to the absence of a deep knowledge on specific locations and to the low resolution of the produced maps (100 m × 100 m), each intersection of the identified ecological corridors with the road network or with human-related settlements was considered a potential hot spot (see Figure 2 for Romania).

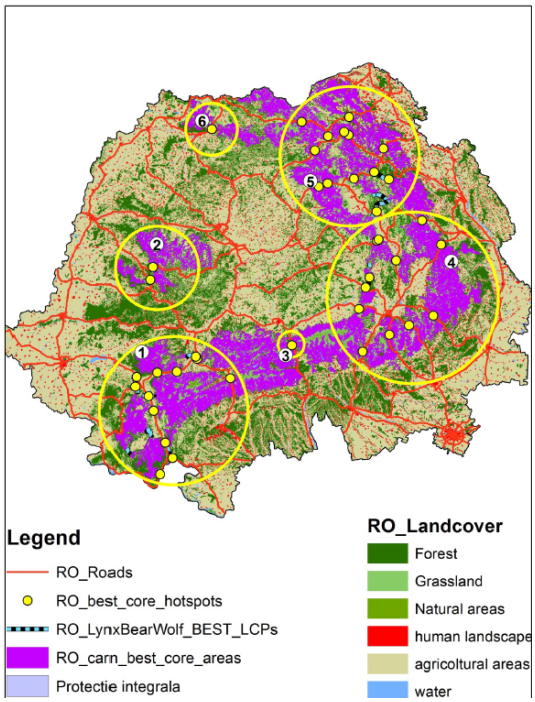

***Figure 2**: Ecological corridors in Romania*

All the maps produced with the (potential) hot spots were analyzed by local partners in order to identify those that could be (or are) real hot spots for connectivity. Locations where a real problem/conflict with wildlife exist and where there is the need for an intervention.

2.2.1.3 Identification of main social and economic barriers and challenges related to ecological connectivity

The collection and elaboration of data on the interaction between the social and economic activities and ecological connectivity has been carried out through three main methods: a series of

semi-structured interviews, an online questionnaire for partners and the site visits in the hotspots identified via the elaborated GIS model. Since the site visits are already described in section 2.2.1, the next paragraph describe the semi-structured interviews and the questionnaire approaches.

2.2.2 Semi-structured interviews

In order to obtain relevant background information both on the state of research regarding the socio-economic aspects of ecological connectivity and on current practices, a series of semi-structured interviews was carried out with two main groups of interviewees:

- Researchers and NGOs in the Carpathians and Alps working on the topic of ecological connectivity; the interviews (30–40 min each) were carried out during the 2012 edition of the Forum Carpaticum in Slovakia. Mainly researchers in the field of agriculture and land use planning were interviewed.
- Stakeholders at Carpathian level mainly from park administration and local administrations; the interviews (30–40 min each) were carried out during the 2013 edition of the CNPA (Carpathian Network of Protected Areas event) in Slovakia.

The interviews' structures were different according to the interviewee's background and were composed as follows:

- Researchers/NGOs: connection, in the Carpathians of the topic they research/work on and ecological connectivity, critical aspects regarding the interaction of human activities and wildlife and possible solutions.
- Stakeholders: concrete experiences of conflicts between human activities and wildlife, initiatives undertaken at local protected area/administrative level, level of awareness towards the topic of ecological connectivity, critical issues in the interactions among stakeholders from different sectors.

2.2.3 Online questionnaire for partners

In parallel with the semi-structured interviews, an online questionnaire for the BioREGIO consortium partner has been developed. In this questionnaire, partners were first provided with a list of sectors (such as agriculture, forestry, protected area management, water management, administration); they then had to list, for each of this macro-sectors, the stakeholder categories they deemed more relevant for the issue of ecological connectivity (for example, for the sector protected area managers, park directors and rangers). In a following step, the partners had to evaluate on a scale from 1 (min) to 5 (max), for each of the identified stakeholder categories, the

level of three main dimensions regarding stakeholders connected to ecological connectivity: awareness, influence and activity. With the term awareness, we have referred to the degree in which the different stakeholder categories are informed and know about the topic of ecological connectivity. With the term influence, we have referred to the extent to which these stakeholder categories have the power to do/foster initiatives promoting ecological connectivity. Finally, with the term activity, we have referred to the degree in which these stakeholder categories actively contribute to the promotion and fostering of ecological connectivity.

2.3 Legal barriers and possibilities

Objectives of legal activities were:

- definition and identification of main "legal barriers" as institutional frameworks and legislation that prevent/affect/hinder the maintenance or further improvement of ecological connectivity and the protection of habitats and species in the Carpathian countries;
- analysis of legislation that supports the maintenance or further improvement of ecological connectivity and the protection of habitats and species in the Carpathian countries and is in place but not adequately implemented/enforced in the Carpathian countries and
- elaboration of recommendations to overcome existing "legal barriers" to connectivity and improve the use of existing legal instruments.

Geographical and institutional level of analysis included:

- Supranational (international and EU legislation relevant to ecological connectivity of the Carpathian countries): EURAC;
- Carpathian States (national frameworks and national legislation relevant to ecological connectivity): EURAC with selected legal experts;
- Pilot areas (cross-border cooperation and subnational legislation relevant to ecological connectivity) EURAC with selected legal experts.

Accordingly, a multilevel and comparative analysis was carried out:

- relevant international, European and national legislative acts and measures on the protection of biodiversity and ecological networks, ground water and surface water, cultural landscape/countryside and forestry;
- relevant constitutional and institutional framework affecting biodiversity and ecological connectivity;

- relevant national legislation on hunting, spatial planning, transport, tourism and agriculture;
- relevant legislation on cross-border cooperation (in the field of nature protection).

Based on these analyzes recommendations were elaborated, to point out, which legal instruments could be appropriate/or improved to deal with the detected legal barriers, thus maintaining and/or restore ecological connectivity and protecting particularly big carnivores & herbivores.

2.3.1 Desk research on international and European legal acts

On supranational level relevant international and EU legislation (in force in the Carpathian countries) regarding the protection of biodiversity, ecological connectivity and cross border cooperation instruments in this field were analyzed and preliminary check on implementation of above mentioned instrument in the national legislation of Carpathian countries was made. Based on the institutional framework and legislation affecting ecological connectivity in the Carpathian countries questionnaire and guidelines were developed and submitted to the legal experts of Carpathian countries. The guidelines enabled a deeper analysis of institutional frameworks and relevant national and of sub-national (only for pilot areas) legislations.

Analysis of national institutional frameworks and legislation affecting ecological connectivity, sub-national legislation and cross border cooperation instruments affecting ecological connectivity in pilot areas and relevant case law included these sectors:

- Legislation on protected areas;
- Legislation on landscape;
- Legislation on land use planning and control (spatial planning, land use and management within the transport sector);
- Environmental impact assessments and strategic environmental assessments;
- Legislation on agriculture and agro-environment;
- Legislation on forestry;
- Legislation on water;
- Legislation on hunting;
- Legislation on tourism.

The legal analysis was presented to the project partners in various workshops and national legal reports on biodiversity and ecological connectivity are published on the national BioREGIO website. This enabled the partners to give feedbacks on possible missing aspects. Partners' feedback was then integrated in the report and the recommendations.

2.3.2 In depth analysis of legal issues for Carpathian countries

Selected national legal experts analyzed the institutional and legislative frameworks of their country on the basis of the questionnaire and guidelines elaborated and provided by EURAC and drafted national reports.

National legal experts provided information on the form of constitutionalized division of power of their countries (e.g. federal/unitary model) and described how are the legislative and administrative competences in the field of environmental/landscape protection/land use and spatial planning/water/hunting/agriculture/transport/tourism/energy/mining divided among different government levels. They provided the information on what are the bodies in charge of nature protection (for legislation, implementation and enforcement) and at what level (state/regional/local) have monitoring and controlling authorities been established for nature and forest protection and how are they financed.

Questions on legislative/administrative frameworks relevant for biodiversity and ecological connectivity included protected areas, ecological connectivity and related sectors, hunting and cross-border cooperation. Experts were also asked to quote and summarise existing law cases in the sectors concerning ecological connectivity/networks.

A report was written explaining both national institutional and legal frameworks affecting biodiversity protection and ecological connectivity in specified country, highlighting institutional and legal gaps and identifying legal tools (also cross border cooperation tools) that could be improved or better implemented/enforced to assure biodiversity protection and ecological connectivity in specified country.

3 Results and Scientific Outputs

3.1 Findings according to physical barriers

3.1.1 Habitat Suitability Map and Least Cost Paths for the umbrella species derived from the corridor model

The application of the GIS Habitat Suitability Model to all the Umbrella Species allowed us to produce seven suitability maps for the whole Carpathians range (see Figure 3 for the Lynx).

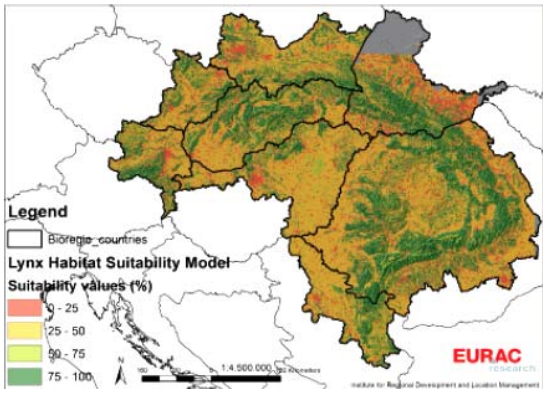

***Figure 3**: Carpathians Habitat Suitability Map for the Lynx*

This kind of maps do not want to be predictive about the presence of a certain species in a certain area. They are based on suitability values given to ecological factors in order to obtain a probabilistic map that needs to be verified with real empirical and field data. According to these first results, and considering the absence of reliable empirical data at local scale to verify the actual presence of a certain species in a specific location, the necessity of organizing site visits came out. The suitability map process identified the supposed core areas of presence for each species, according to their ecological preferences (extension or other ecological features – see Figure 4 for the Lynx in the Pilot Area Djerdap/Iron Gate).

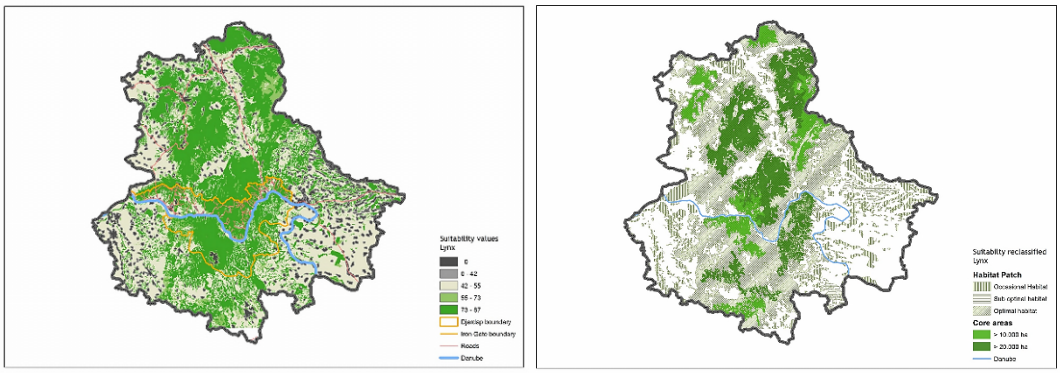

***Figure 4**: Suitability and Core Areas identification for the Lynx in the Pilot Area Djerdap/Iron Gate*

Considering both prey and predator species suitability maps overlapping (e.g. wolf/deer; lynx/chamois etc.), it is then possible to reduce the potential suitability of a certain area for a certain species to a closer to reality situation.

The subsequent application of *Linkage Mapper* to the results of *CorridorDesign* enabled the identification of the most probable paths connecting the different core areas based on the resistance of the matrix (the energy cost needed to cross a less suitable environment – see Figure 5 for the Lynx in Djerdap/Iron Gate).

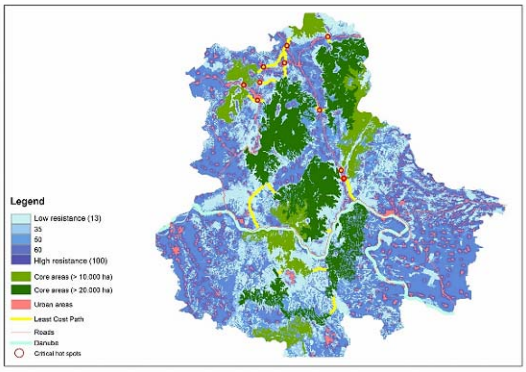

***Figure 5:** Identification of Least Cost Paths for the Lynx in the Pilot Area Djerdap/Iron Gate*

The visual overlapping of the Least Cost Paths for each species with human infrastructures (mainly roads) allow the first identification of possible physical barriers (hot spots).

It has to be considered that the Linkage Mapper calculation finds all the possible connections between all the core areas, selecting the paths passing through the less-resistant matrix. All the detected paths have to be analyzed in order to choose only those, which are more probable to be used by the selected species (see Figure 5).

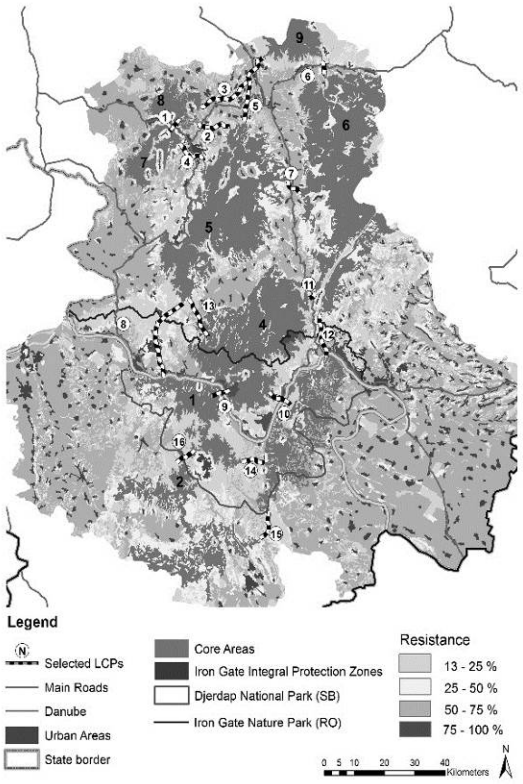

Figure 6: *Identified LCPs for the Lynx in Djerdap/Iron Gate*

For the Pilot Region Djerdap/Iron Gate, referring to the Lynx's connectivity, Linkage Mapper detected 31 LCPs in the territories with the lower resistance. We selected 16 LCPs as those highlighting a general view of the ecological network (see Figure 6). LCPs were categorized according to the CWD (cost-weighted distance), their length, the presence of barriers that increase their mortality risk (LCP risk), and the presence of a protected area, which increases their safety (LCP safe). LCPs were then divided in 5 cut-off categories (1 – Best; 5 – Worst) to identify the sites where the lynx may disperse most likely (see Table 2).

Table 2: *LCPs classification for the Lynx in the Pilot Area Djerdap/Iron Gate*

LCP ID	CWD (Meters)	LCP (Meters)	LCP risk	LCP safe	Land Cover*	Barrier	Usage	Category
16	34.082	1838	0	1	1	None	Highly Probable	**1**
14	167.728	7887	0	1	1	Agriculture	Highly Probable	**1**
10	87.806	3455	1	1	1-6	DN57/ Danube	(?)	**2**
12	83.860	3289	1	1	1-6	DN6/ DN57/ Danube	(?)	**2**
15	147.597	10.166	0	0	1-3	Agriculture	Probable	**2**
9	41.314	865	1	1	1-6	DN57/ Danube	(?)	**3**
13	225.601	13.340	0	0	1	Urban zone	Possible	**3**
1	28.443	624	1	0	1	DN58b	Possible	**3**
2	247.331	11.142	1	0	1-4-5	DN58	Possible	**3**
6	154.113	4462	1	0	1-3-4	DN68	Possible	**3**
8	482.063	28.736	0	2	1-6	DN57/ Danube	(?)	**3**
11	77.503	2997	1	0	1-5	DN6	Possible	**3**
7	172.290	5797	1	0	1-3-5	DN6/ Agriculture	Possible	**3**
4	240.811	10.315	2	0	1	DN58/ Urban zone/ Mine	Difficult	**4**
3	771.166	29.277	1	0	1-4-5-6	DN6/ Agriculture	Extremely Difficult	**5**
5	679.716	23.185	2	0	1-4-5-6	DN6/ DN58b/ Agriculture	Extremely Difficult	**5**

**Land Cover classes: 1 = Forest; 2 = Grassland; 3 = Open Areas; 4 = Urban Areas; 5 = Agriculture; 6 = Water Bodies*

This kind of analysis has been done for all the selected umbrella species and projected on the Web-GIS application. Only the most mobile species (Lynx, Wolf and Bear) have been analyzed in terms of their general connectivity along the whole Carpathians range and in each pilot area. Since the highest number of conflicts usually happen with the high-mobile species, this kind of analyzes has enabled the identification of the site visits for a deeper investigation. Less mobile species have been analyzed only in terms of the general landscape suitability, since they do not use least-cost paths and ecological corridors in the same way as big carnivores.

Additionally, the detection of the most suitable landscapes for the prey species has enabled the reduction of the suitability of predator species, having a closer-to-reality image to better detect potentials and future conflicts.

3.1.1.1 Eurasian lynx

The Eurasian lynx (*Lynx lynx* Linnaeus, 1758; order Carnivora; family Felidae) is the largest felid in Europe. In the Carpathians, it normally lives in mixed forests, cliffs and rocks between 700 and 1500 m a.s.l. with home ranges up to 300.000 ha, out of human reach. This species was selected as an umbrella species due to its strict ecological requirements and its sensitiveness towards human society and facilities. Within the BioREGIO project, the assessment of occurrence for this species was done in order to define its main distribution areas and analyze the limits of the human disturbance. Although the number of individuals are difficult to estimate and can change rapidly (currently ca. 2400 and 3400 individuals), the population in the Carpathians is considered stable Scientific assessments stated clearly that the Lynx should be considered as the most vulnerable large carnivore species in the region. Nevertheless, Romania and Slovakia permit hunting within hunting season of 5–6 months and defined quotas.

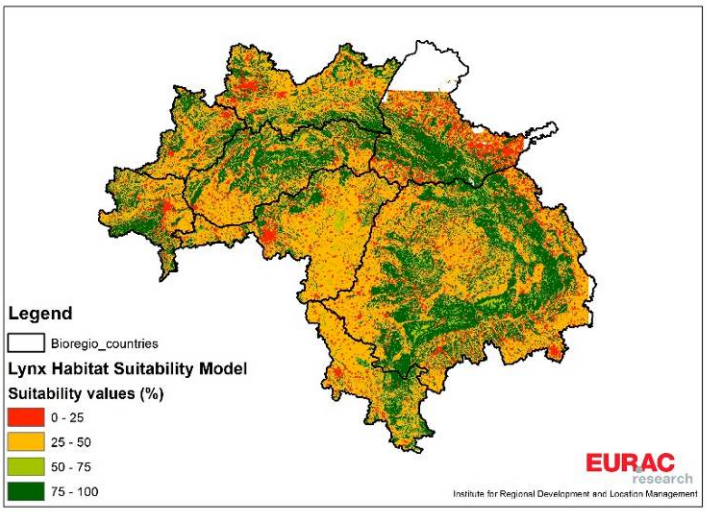

Figure 7: *Carpathians Habitat Suitability Model for Lynx*

Romania and Slovakia have a special responsibility and relation to the population. More than half of the Carpathians lynx population (1500 and 400 individuals) is dispersed and two main areas of presence and distribution are located there. Although they monitor the individuals with GPS transmitters, there are particular research programs, information campaigns or education initiatives dedicated to the lynx population are still rare. Analyzing the potential connectivity in the

Carpathians should stimulate the definition of a management plan for the individual countries as well as for the continuous Carpathian populations. The facts collected during the project and with the interviews carried on during the site visits have identified the main threats for this species in the Carpathians. Local farmers and hunters do not perceive this species as a competitor; on the contrary, they are used to its presence and it is seen as an ally in keeping the ungulate populations under control. The main identified threats for this species' connectivity are the loss of habitat due to habitat conversion and increase of human disturbance (e.g., deforestation, expansion of settlements and of touristic infrastructures) and fragmentation (development of new motorways). The loss of prey due to decline of ungulates (chamois and red deer) and other local threats may drastically reduce the size of suitable habitat for this species only to remote mountain areas and have a dramatic effect on the distribution of this species.

3.1.1.2 Brown bear

The brown bear (*Ursus arctos* Linnaeus, 1758; order Carnivora; family Ursidae) is the most widespread bear in the world, with a Holarctic distribution in Europe, Asia, and North America, ranging from northern arctic tundra to dry desert habitats. The Carpathians are home to about 8,000 brown bears in Slovakia, Poland, Ukraine and Romania. Bears are considered of high priority in conservation. Given their dependence on large natural areas, they are important management indicators (umbrella species) for a number of other wildlife species. The bears' preferred habitats are usually mixed and open forests between 500 and 1500 m a.s.l. Bears are very adaptable to changing habitats and have home ranges up to 30000 ha.

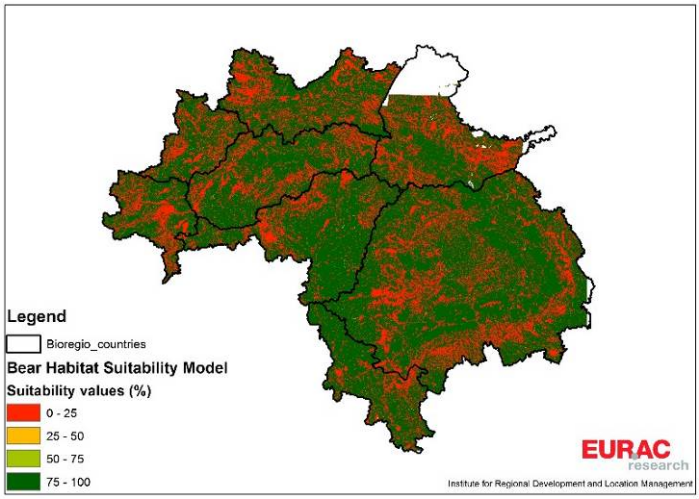

Figure 8: *Carpathians Habitat Suitability for Bear*

The brown bear is not a harmful animal except during periods of food shortage in the spring and fall. At this time, they prey upon wild animals and domestic stock, invade cultivated agricultural areas damaging fruit trees and stripping bark from tree trunks. However, according to the information gained during the site visits of the BioREGIO project, the damage to crops is insignificant; cultivated areas on the fringe of the forest near outlying human populations are the only areas affected. Generally only isolated bears prey on cattle. Among wild ungulates, only the sick or the injured are the prey of the bear. In this respect, bears play a positive role in the health of the wild ungulates of the Carpathians. The brown bear is not only an interesting and beautiful animal but it is especially esteemed as a trophy animal. The Carpathian bear is one of the best subject for sport hunting. Hunting (in different quotas) is allowed in Romania, Ukraine and Slovakia. Under the conditions of the Carpathians, the most effective means of hunting the bear is to watch for feeding animals from a tower. However, this hunting technique provokes changes in the behavior of the bear, since feeding points are located usually outside the main core areas. Brown bears have a low reproductive rate and are very vulnerable to human-caused mortality, to habitat changes and to landscape fragmentation. Motorways represent one of the most relevant barriers for the bear. Although being road-killed does not represent a threat for the conservation of this species, the foreseen motorways in the Carpathians should be planned considering the large habitat requirement of this species. Additional, identified threats, as poaching and decrease of suitable habitat due to the expansion of human society, may increase the risk of conflicts with this species and have to be investigated locally. As for the lynx, a Carpathians-wide management plan would be needed. Improper management may result from lack of knowledge about bears and their biology among people, politicians and managers in general, and especially due to political and economic instability.

3.1.1.3 Western Carpencaille

The Western Capercaillie (*Tetrao Urogallus*, Linneus 1758, Order Galliformes, Family Phasianidae) is the largest member of the grouse family. Found across Europe and Asia, it is renowned for its mating display. It is a large ground-nesting grouse species with precocial chicks inhabiting in small isolated populations related to mixed spruce-beech-fir and mountain spruce forests between 500 and 2000 m a.s.l. Potential Capercaillie egg and chick predators are corvid birds, hawks, golden eagle and owl. Among mammals, there are red fox, mustelids, wild boar, brown bear and lynx. Capercaillie is an important element of the natural heritage of Carpathian Mountains since its habitat is closely related to the mountain primeval forests.

Capercaillie is an umbrella species, since it is an indicator of healthy community of mountain forests, which includes other rare and protected species.

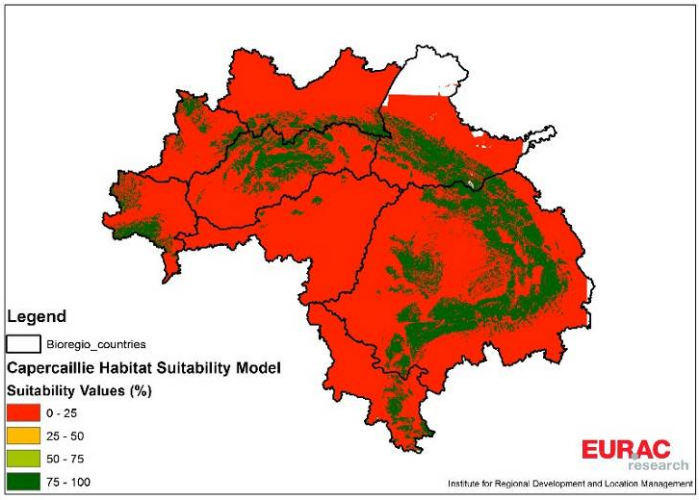

Figure 9: *Carpathians Habitat Suitability for Carpencaille*

The anthropogenic activities appear to be the strongest indicator of male numbers in the lek centers (“dances” used by male birds to strut their stuff in the hope of getting a mate). These forests underwent radical changes from natural regime to managed system especially in the course of the last century. Continuous multi-aged forests were transformed to a mosaic of even-aged stands. Poor management practices, often triggered by socio-economic and institutional change, are the main causes of loss. Large-scale logging and deforestation are widely spread across such areas and resulting in the habitat fragmentation. Large-scale deforestations have a considerable negative impact on Capercaillie numbers. The most of the lek centers situated in fir-beech forests have disappeared, due to habitat alterations. Although the general suitability for this species in the Carpathians is high, the existing suitable Capercaillie habitats are represented in many areas only by straps of forest stands under the upper timberline. Recent trends in old-growth forest cover in Romania, revealed that forest cover declined by 1,3% from 2000 to 2010. On the other hand, Romania’s protected area network has been expanded substantially since the country’s accession to the European Union in 2007, and most of the remaining old-growth forests now are located within protected areas. Studies reveal that 72% of the old-growth forest disturbances are found within protected areas, highlighting the threats still facing these forests. It appears that logging in old-growth forests is, related to institutional reforms, insufficient protection and ownership changes since the collapse of communism in 1989. The majority of harvesting activities in old-growth forest areas are in accordance with the law. Without improvements to their

governance, the future of Romania's old-growth forests and the conservation of this species remain uncertain.

3.1.1.4 Chamois

The chamois (Rupicapra rupicapra, Linneus 1758, order Artiodactyla, Family Bovidae) is a goat-antelope species native to European mountains. In the Carpathians, the species is currently distributed in two main populations, one in the Tatra Mountains (Rupicapra rupicapra tatrica), with around 400 individuals) and one in Romania (Rupicapra rupicapra carpatica), occurring in many populations throughout the Transylvania alps and the Carpathian mountains, estimated in around 9000 individuals with an increasing trend. There have been a number of successful reintroductions both in Slovakia and in Romania, often of subspecies from other geographic areas (especially R. r. rupicapra), which may lead to hybridization and genetic swamping. The use of main habitat types by chamois varies greatly within the chamois range include alpine meadows, cliffs, ridges, ravines, boulder fields and dwarf pine (occasionally). Chamois eat various types of vegetation, including highland grasses and herbs during the summer and conifers, barks and needles from trees in winter.

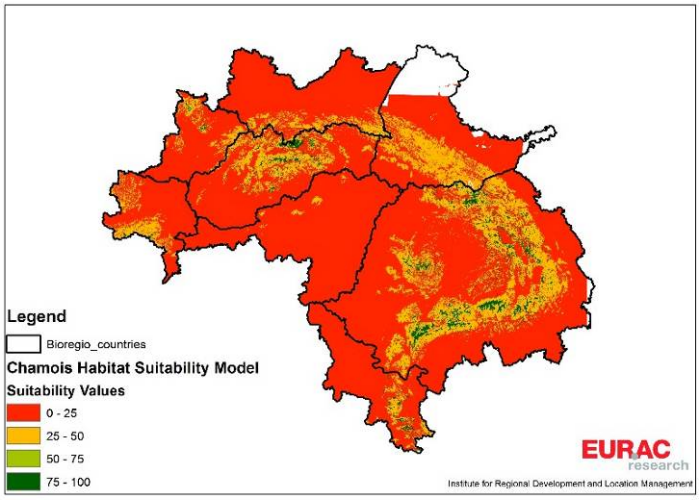

Figure 10: *Carpathians Habitat Suitability for Chamois*

Primarily diurnal in activity, they often rest around mid-day and may actively forage during moonlight nights. Common causes of mortality can include avalanches, epidemics and predation. The main predators of Chamois are Eurasian Lynxes and Gray Wolves, although a few may

predated by Brown Bears and Golden Eagles as well. The main predator of chamois now are humans. Chamois usually use speed and stealthy evasion to escape predators, can run at 50 kilometers per hour, and can jump 2 m vertically or over a distance of 6 m. Chamois' preferred habitat lays usually far away from the typical human habitat, but nonetheless, they are constantly subjected to human impact. Many studies and direct observation reported that chamois are usually tolerant to human presence but their response to people and behavior varied greatly up to a distance of 200 m. Therefore, the transformation of habitats, grazing of high densities of domestic sheep in summer and the presence of mountain lodges that are opened all-year round for summer and winter outdoor sports, represent the main threats for their survival, as it is currently happening in the Tatra Mountains and in the Transylvanian Alps. The chamois and large predators are sympatric and usually inhabit the same areas. The intensity of habitat use is different and depends mostly on the species requirements, distribution of food resources, suitable hides and human disturbance. The modeled spatial distribution of locations of target species (chamois, bear, wolf and lynx) and their possible connectivity, allow an indication of habitat overlaps. Therefore, the presence of large predators may affect the chamois distribution and habitat use.

3.1.1.5 European Hare

The European Hare (*Lepus europaeus*, Pallas 1778, Order Lagomorpha, Family Leporidae) also known as the brown hare, is a species of hare native to Europe and western Asia. It is a mammal adapted to temperate, open country. Hares are herbivorous and feed on grasses, herbs, twigs, buds, bark and field crops. Their natural predators include hawks, falcons, wolves, bears and lynxes. They rely on speed to escape from predators. This species is native in all the Carpathians countries and can be found at elevations ranging from sea level up to 2,300 m a.s.l. As visible from the Habitat Suitability Map, the species is widespread through all the Carpathians range but high mountain areas and apparently does not suffer of any connectivity problem. Its selection as an umbrella species was due to its relation with the agricultural transformation that are taking place in all the Carpathians countries and being one of the favorite prey of the selected carnivores, whose presence may affect hare's distribution. *Lepus europaeus* is a highly adaptable species that can persist in any number of habitat types. To detect the most suitable habitats and to evaluate the effects of agricultural transformation, the GIS model took in consideration the positive association between hare abundance and habitat diversity (e.g., Shannon Index).

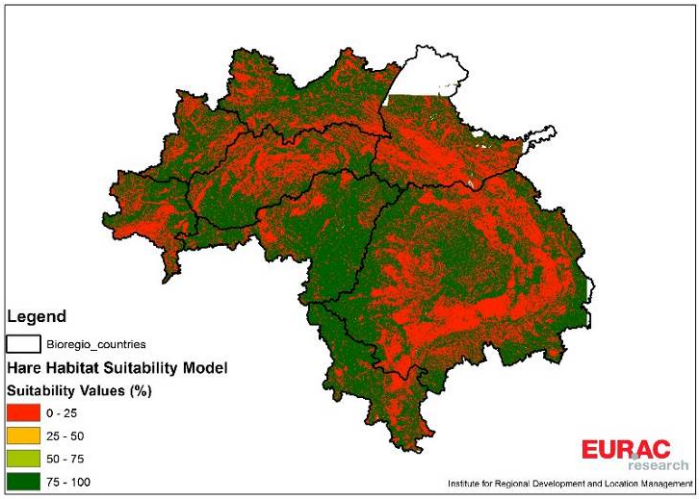

Figure 11: *Carpathians Habitat Suitability for European hare*

Anthropic and natural factors greatly influence the presence and densities of hares. The diversity ratio regarding the ground cover (particularly the ratio between fields, arable land, grassland, woods and shrubs), together with kind of plant species and size of areas with woods and shrubs, are all critical factor for the presence of this species. Weeds and wild grasses are highly selected by *L. europaeus*; however, intensified agro-practices have reduced this food source forcing the selection of crop species. This shifting to another food source has provoked many conflicts with humans. The hare is considered a pest in some areas and is known to damage crops. They are also hunted as game animals. The natural predation and deliberate killing, human presence, natural and artificial barriers (rivers and roads), may all greatly affect their mortality rate. The population is in decline in all the Carpathians countries, as a direct result of agricultural intensification, increased application of fertilizer, landscape homogeneity and mechanization. Although this general decline in hare densities in the last few decades, natural densities are usually temporarily improved by the release of non-native animals. Additional threats to the hare are the diseases European brown hare syndrome, pasteurellosis, yersiniosis (pseudo-tuberculosis), coccidiosis and tularaemia, which are the principal sources of mortality.

3.1.1.6 European otter

The European Otter (*Lutra lutra*, Linneus 1758, order Carnivora, Family Mustelidae) is a semiaquatic carnivore whose habitat is usually linked to the existence of freshwater, available shelter (riparian vegetation, rocky structures) and abundant prey. European otters are territorial; an individual's territory may vary between about one and 40 kilometers long with about 18 km being usual. Fish is the major prey of European otters sometimes exceeding more than 80% of their diet. In addition to fish, a whole range of other prey items have been recorded in their diet in variable proportions. These include aquatic insects, reptiles, amphibians, birds, small mammals, and crustaceans. This species is an important environmental indicator because it is extremely sensible to water pollution and human habitat transformations.

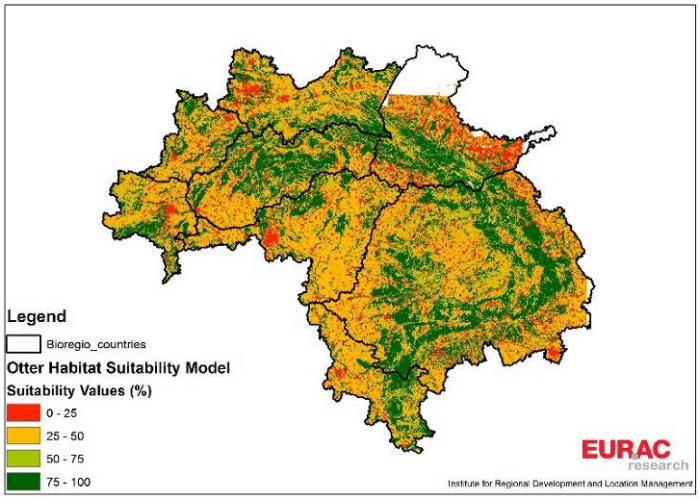

Figure 12: *Carpathians Habitat Suitability for European otter*

Identified core areas for this species in the Carpathians range from north to south, with habitats developed along the hydrographical systems. In most parts of its range, its occurrence is correlated with bank side vegetation. BioREGIO's connectivity analyzes of the landscape, along linear features – like rivers – took in consideration both: the longitudinal (otters moving within one river system) and lateral (dispersal movements toward neighboring rivers as well as the maintenance of gene flow among populations living in different river basins) connectivity. As river catchments can be considered as closed systems, the longitudinal connectivity can be simply

evaluated through the distribution of suitable habitat patches. Besides, the lateral connectivity must also consider the resistance (permeability) of the land matrix to dispersal by otters between catchments plus the physical barriers the species may encounter. During the BioREGIO's site visits, the main identified threats and barriers for the conservation and the connectivity of this species were due to the anthropic changes of the landscape. Intensive agriculture, canalization of rivers, removal of bank side vegetation, dams (e.g., Iron Gate dam in Romania/Serbia), draining of wetlands, aquaculture activities and associated anthropic impacts on aquatic systems are unfavorable to otter populations. The otter is endangered from road kills when passing from one river catchment to another. In specific cases (e.g., Slovakia) some mitigation structures (underpasses) to protect the movements of the otter have been put in place. Aside local poaching and river pollution are additional threats. Coastal populations on the opposite are particularly vulnerable to oil spills. Acidification of rivers (e.g., the Danube) and lakes results in the decline of fish biomass and reduces the food resources of the otters. The same effects evolves from organic pollution by nitrate fertilizers, untreated sewage, or farm slurry.

3.1.1.7 Grey wolf

The grey wolf (*Canis lupus* Linnaeus, 1758; order Carnivora; family Canidae) is the second largest predator in Europe, after the brown bear. The largest populations in Europe are found in eastern countries, particularly Romania, the Balkan area, Poland and its neighboring countries on the eastern border. Wolves live in the most diverse types of habitat where humans do not kill the species and their broad distribution ranges show the species' adaptability to the most extreme habitat conditions. The wolf is a true generalist that feeds opportunistically on what is most available in its habitat. Its distribution, geographic range and seasonal variations depend on the relative abundance of potential prey, as well as their accessibility and availability. Habitat quality should then be interpreted in terms of human disturbance, prey densities and range size. In the Carpathians countries, the wolf population represents around 30% of the total European one. The estimated population sizes for the wolf in the Carpathian countries is reported to be around 3000 individuals, mainly in Romania, Ukraine, Poland and Slovakia. All four countries have signed the Bern Convention, but effective legislation for the protection of wolf has been adapted to local situations. The species is strictly protected only in some countries (e.g., Poland), where compensation for the damage they cause is offered by conservation agencies, whereas in others (e.g., Ukraine) it is still considered a pest and bounties are paid for its removal.

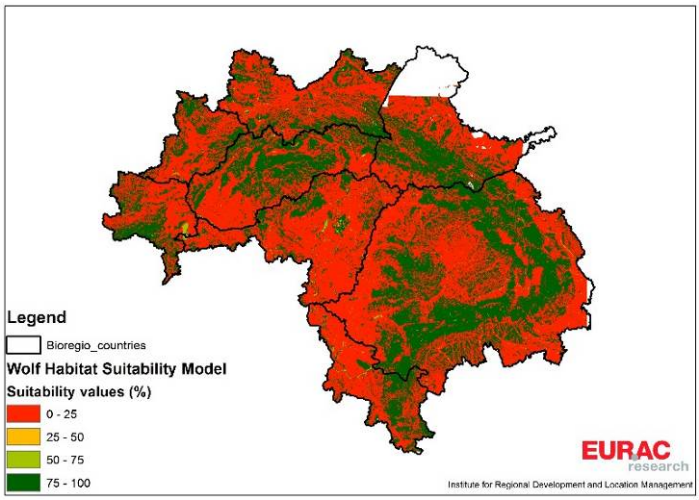

Figure 13: *Carpathians Habitat Suitability for Grey wolf*

The main threats are then intended at local/national level. Poaching is widespread and can be considered the most important mortality factor for the wolves. Human encroachment and habitat components that are linked to human presence are the most significant threats to wolf habitat. Wolves usually tolerate disturbance given by roads and tourism as long as they also have safe retreat areas where they can escape human pressure. Wolves live in large areas but have simple needs for small and safe retreat areas. Although wolves may survive in the most diverse types of habitat, vegetation cover and availability of some food resources are at least two limiting environmental factors. Most of the economic conflicts occur in areas of high livestock production, and this habitat feature have to be taken into account when planning wolf management. Prey populations are generally of high quality in the Carpathians and only few areas suffer from a shortage of natural prey. Competition with hunters is often a reason for eliminating wolves. Prey species are managed from the hunters' perspective alone without accounting for the needs of the wolf, and temporary or seasonal shortages may occur. Alternative food resources are generally also available, but their poor quality is a threat to the long-term survival of the wolf.

3.1.2 Web GIS Application

Web-GIS are interactive GIS applications on the web to manage a large extent of geographical information. Compared to desktop GIS solution a WebGIS application enables the distribution of information among a large audience. Within the framework of the BioREGIO project, a WebGIS was designed with the attempt to spread the results of the research project, allowing people to

know more of the structure of the Carpathians ecological network and its functionality (http://webgis.eurac.edu/bioregio/). The WebGIS contains both raster and vector data and is fully accessible (everywhere, anytime and by anyone). As concerning the design, it is structured into three main components: an information window; a real time maps browser with different layers containing general information concerning both the landscape and the connectivity specifically and a search engine (see Figure 14).

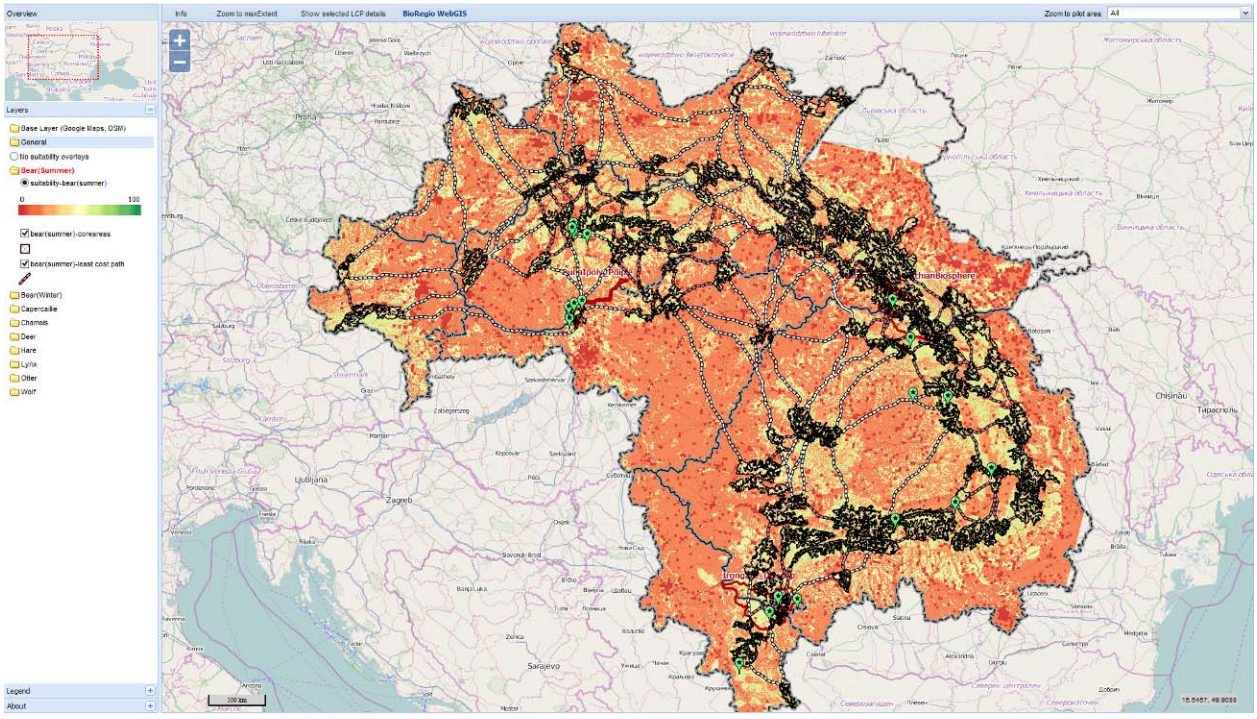

Figure 14: *Suitability map, core areas and least cost paths for the Bear (Summer Model) in the Carpathians*

3.1.3 Lesson learned

This suitability model developed in the framework of the BioREGIO project wanted to be a first attempt to identify the most probable areas of occurrence and dispersal of seven Carpathians' flag species.

The BioREGIO analysis started from the results obtained in previous investigations in the Carpathians:

- Ardeleanu, A.D., Mirea, I., 2009, Modelarea GIS a unei reţele ecologice, instrument pentru dezvoltarea durabilă – ghid practic, Editura Silvică, Institutul de Cercetări şi Amenajări Silvice 9
- Maanen, E., Predoiu, G., Klaver, R., Soule, M., Popa, M., Ionescu, O., Jurj, R.,Neguş, Ş., Ionescu, G., Altenburg, W., 2006, Safe guarding the Romanian Carpathian ecological network. A vision for large carnivores and biodiversity in Eastern Europe. A&W ecological consultans
- Salvatori, V., 2004 Mapping conservation areas for carnivores in the Carpathian mountains, University Of Southampton, Faculty Of Engineering, Sciences &Mathematics, Doctoral thesis
- Project "Open borders for bears in the Carpathians of Romania and Ukraine". Beneficiary WWF DCP Branch Maramures
- Project LIFE+ Nature "Best practices and demonstrative actions for conservation of Ursus arctos species in the eastern Carpathians, Romania" under coordination of Environmental Protection Agency Vrancea, having as partners Environmental Protection Agency Covasna, Environmental Protection Agency Harghita, Association for Biological Diversity Conservation Focsani and Association for Nature Values Conservation from Balan

The analysis took in consideration biological, environmental and human feature in order to identify the main barriers blocking or hindering the dispersal and the socio-economic situations of each Carpathians country. The obtained results do not want to be very comprehensive; the large extension of the Carpathians' arc, the different habitats and ecosystems, the socio-economic and legislative aspects of the different countries require following local investigations and actions to improve the connectivity and the human/wildlife relationship.

The model tested in the BioREGIO project is a powerful tool that needs few available data to create a probabilistic map of the regional ecological connectivity. To perform a valuable analysis, it needs to receive inputs from local experts regarding the values to give to each factor's class and each factor's weight. More species are involved, more experts are needed and this issue

sometimes can be an obstacle. If the input data, factors, values and weight used are correct (or close to the real situation), the model is able to visualize both the structural and the functional connectivity, such as the longitudinal and lateral ones. Local data on the presence and the extension of human-related infrastructures are needed to detect potential barriers to wildlife dispersal. In many cases, depending on the investigated region, this data could be obsolete and incomplete. Due to the use of the CORINE LAND COVER 2006 as a base Landcover map, some landscape features could not be projected in the actual way and some results could be badly interpreted. Therefore, it is essential to perform site visits in specific areas to evaluate and validate the situation detected through the GIS analysis.

In this case, the help of local experts and stakeholders is essential, in order to know the real wildlife presence and dispersal and to know which could be the real barriers for a local and regional ecological connectivity. The model does not want to be predictive; but the results derived from the least cost paths can be useful to prevent future threats to the ecological network due to the development of human infrastructures. Following a species-based approach, the model identifies the most probable least-cost paths according to the resistance of the landscape. For this reason, it is essential to select properly the umbrella species in order to cover most of the ecological preferences of all the other ones. This model is mainly ecological-related. The results could be improved, especially at local scale whether more detailed land cover data would be available. The minimum mapping unit of the CORINE LAND COVER is 25 ha and this impedes the comprehensive visualization of all landscape features. Working with Landsat classified land cover images with a higher resolution could improve the results and provide a better evaluation of the potential barriers.

3.2 Findings according to socio-economic barriers

The analysis on socio-economic barriers was mainly based on the preliminary semi-structured interviews and questionnaire for partners and on the site visits. Main aim was to identify the most crucial issues regarding the analyzed sectors and to propose a series of recommendations. First, this analysis provided a clear identification of the most relevant sectors connected to ecological connectivity in the Carpathians: the most relevant are protected areas, infrastructure planning, forestry, agriculture, energy, industry and the public administration at state level (ministries). Other relevant, to a lesser extent, sectors are local administrations, tourism and water management. A particularly relevant role is played, although in different measure according to the Carpathian country considered, by hunting.

All these sectors have different levels of awareness and influence towards ecological connectivity. The main relevant gaps are shown in Figure 15, which represents the results of a questionnaire administered to the BIOREGIO consortium. The evaluation scale for awareness and influence goes from 1 (lowest level) to 5 (highest level). It can be observed that the stakeholder group classified as the most aware (scientific community) is also the one that is considered as having the less influence. Although the results may be biased by the fact that the respondents came largely from the scientific community (and therefore they would possibly tend to overemphasize the perceived lack of influence), the results nevertheless show how, often, a high influence is not associated to a high awareness.

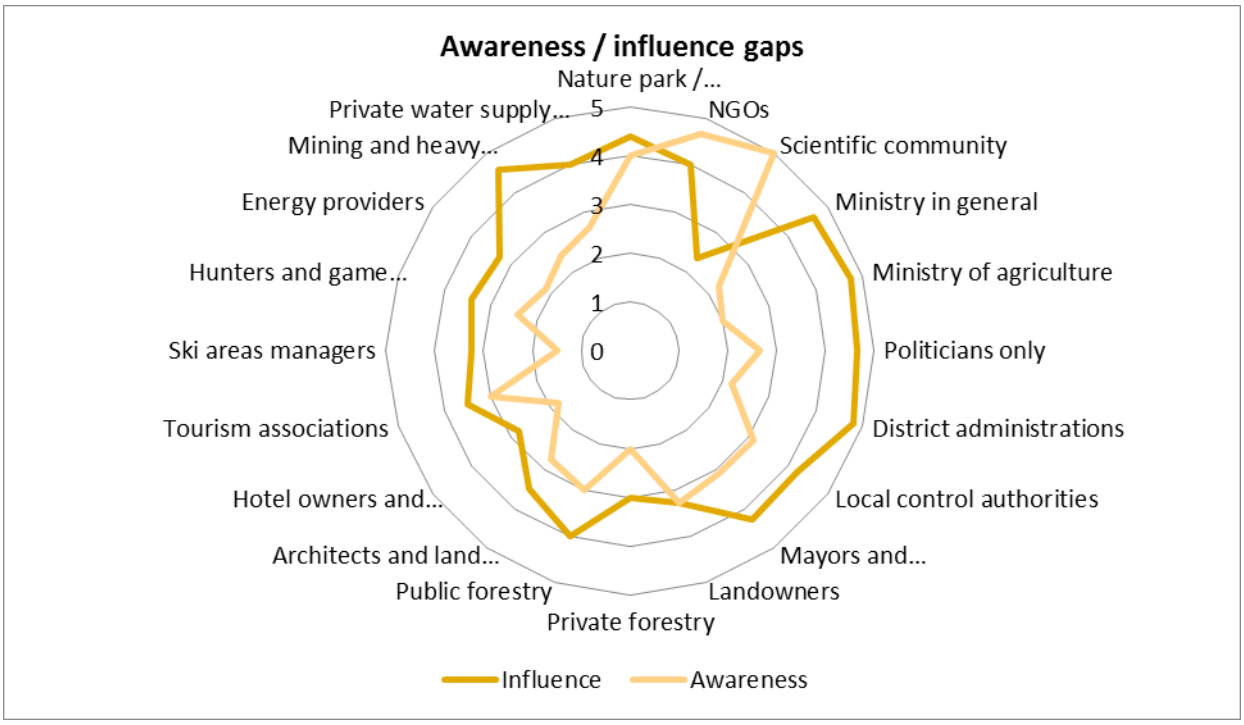

Figure 15: *awareness – Influence gaps (n = 8).*

Socio-economic barriers and possibilities take in consideration the expansion and the limitation of ecological connectivity coming not only from physical barriers. Besides, economic and social aspects have a significant impact too. This is particularly true for the Carpathian countries, which are currently experiencing quick social and economic transformation processes. Additionally, the attitude and awareness of local population towards protected areas and wildlife presence enhances significantly the effective implementation of connectivity measures. The socio-economic

analysis tried to consider the impact of the different stakeholder in the different countries on the ecological connectivity (see Figure 16).

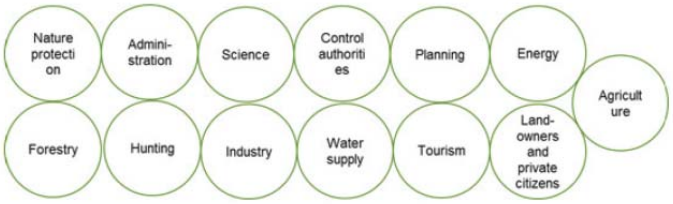

Figure 16: *Involved stakeholder and economic sectors*

The site visits allowed identifying four main fields of intervention in which it is necessary to intervene on economic and social activities:

1. Planning:

The concept of ecological connectivity should be already considered in the planning phase – particularly for new transportation infrastructure or urban expansion, but also for the extension of agriculture or forestry activities. The availability of subsidy means for connectivity–friendly measures in these fields could support a preventive approach to reduce conflicts between human and wildlife.

2. Intervention:

A quick and clear response in case of an emergency deriving from the interaction between human activities and wildlife can have a positive impact on the attitude of citizens towards ecological connectivity. Nevertheless, there is currently still little engagement in the Carpathians for the development of clear and homogeneous compensation measures for private farmers or landowners, for example in case of damages caused by wildlife.

3. Awareness:

Stakeholders have different and contrasting levels of influence and awareness towards ecological connectivity. The analysis in BioREGIO showed that the scientific community is aware concerning the necessity and priories for ecological connectivity, although its influence can be evaluated as low. On the other hand, there is still the need to raise the awareness among all relevant stakeholders, mainly of those involved in infrastructure planning, urban expansion and policy development at different levels.

4. Monitoring:

Monitoring is essential for assessing the effectiveness of measures. The analysis has shown the potential in strengthening data collection at Carpathian level and in involving local population for the monitoring wildlife presence, applying simpler, clear structured and efficient reporting system of damages.

Another main result was the highlighting of the differences within the single Carpathian countries. While in general, the level of awareness is not subjected to relevant variations within stakeholder groups belonging to different countries (e.g. with park administration being Carpathian – wise more aware and agriculture less), the level of influence of certain stakeholder groups varies substantially according to the local cultural specificities. An example is the role of hunters and their varying level of influence according to the Carpathian country considered. The results of the analysis show that not only the construction of big infrastructural projects, such as motorways, but also small intervention at local level have an impact on ecological connectivity; this is the case of the expansion of settlements and urban sprawl. Two contrasting factors have an impact on this issue: on the one hand, the rapid socio-economic transformation are resulting in the willingness of local communities to expand dwelling areas. In this context, there is often an underestimation that even minor changes in the local settlement expansion, such as the allocation of garbage deposal area, can have an effect on the behavior of selected species (such as bears), especially in rural areas. Parallel to this process, urban sprawl and settlement extension can be driven also by the expansion of specific sectors. One example is the tourism sector, where growth often underlines the subsequent expansion of the hospitality and leisure infrastructure. Legislation and planning procedures are the main instrument of intervention in order to discipline the phenomenon; nevertheless, especially at the levels of small communities, the regulatory framework and the enforcement can have a low effectiveness. Moreover, shared approaches to spatial planning among different municipalities are still not widespread; this result in a fragmented planning also in small areas. Finally, the spatial planning regulation at local, regional, national and Carpathian level does not integrate the concept of ecological connectivity and ecological corridor.

Impacts are multifold: on the one hand, the penetration of urban features into the landscape can affect important areas such as feeding or breeding areas; on the other hand, the expansion of settlement can influence the movements of selected species due to fencing or disturb. Finally, fragmented planning among municipalities or provinces can result in a loss of overall connectivity.

While the drivers of this expansion (such as the creation of new touristic attractions or new dwellings) are positive signals of economic diversification for local communities, there is the need to intervene in a planning phase in order to avoid negative impacts of the phenomenon.

Possible recommendations regarding this field of intervention should address the following points:

- Include the concept of ecological connectivity also in local spatial planning, in order to adequately address land – use change phenomena.
- Promote the enforcement of spatial planning regulation and the integration of different levels of planning.
- Promote intermunicipal plans for municipalities belonging to the same geographical areas (for example, a valley), in order to functionally share big infrastructures, to effectively locate critical areas (such as garbage disposal areas) and to be able to design ecological corridors at intermunicipal level.

The analysis highlighted another main obstacle in the promotion of ecological connectivity Carpathian – wide, namely the diffused perception among different stakeholder groups that a protected area is needed in order to make an ecological corridor. This perception is widespread among different actors at local, regional and national level, even among actors that are responsible for protected areas and conservation.

While the legislative aspect remains essential for the establishment of protected areas and nature parks, which constitute the essential ecological structure whose connection ecological corridors must protects, the preservation of corridors themselves can be carried achieved also through a combination of legislation and practices of sustainable integrated management.

This is particularly relevant where economic activities, such as forestry and agriculture, are in place. Here corridor development strategies can be combined with adequate incentives to land owners for the sustainable maintenance of these zones according to connectivity criteria. One main advantage of such integrated management is that it could also be advantageously carried out at transnational level, where the presence of different legislations could be a main barrier.

Possible recommendations regarding this field of intervention should address the following points:

- It is essential to highlight through reliable models potential ecological corridors, in order to highlight the areas where a sustainable integrated management should be fostered.
- Legislation should be combined with the promotion of sustainable practices in agriculture or forestry.
- Adequate incentives should be allocated to private landowners and firms in order to promote an integrated management.
- Adequate prevention and compensation measures for damages should be developed.

Finally, the analysis pointed out that an effective approach to ecological connectivity should address the different steps in which conflicts between human activities and wildlife can arise,

starting from the planning, through implementation up to the management of possible conflictual events. In this framework, a reliable and clear system of compensation of damages caused by wildlife is essential, since it can strengthen the trust of the local communities in the authorities responsible for nature preservation and wildlife management. This can also lead to a more positive attitude towards initiatives aiming at promoting ecological connectivity.

There are several factors that hinder an effective application of compensation mechanisms: one of these is the lack of transparency and clarity regarding the compensation. Often, local stakeholders have not a clear idea of who can benefit from compensation, what can be compensated and how to access the compensation scheme. Moreover, this situation is influenced by an uncertain governance of the management of damages caused by wildlife in specific case, for example a kill caused by a train or a car. In this case, the different authorities involved may not have regular structures of dialogue (such as regular meetings or exchange) and often there is a lack of coordination in the intervention after a damage occurs. This affects the recipients of compensations, especially in case of a scarce coordination between the authorities that should evaluate the entity of the damage and the ones that should compensate the damage.

A situation of uncertainty could discourage the application for damages compensation and could foster a negative attitude towards measures for ecological connectivity and the coexistence between wildlife and economic activities. Moreover, a lower rate of report of damages by private citizen can also represent a negative aspect in the monitoring system of wildlife presence and associated damages, which could profit from precise and updated information.

Recommendation on this aspect should therefore address three main points:

- Improvement of governance of compensation mechanisms: a positive coordination among all the authorities responsible for an intervention in case of damage should be promoted, for example through regular exchanges and meetings.
- Improvement of transparency and promotion of compensation mechanisms: a clear communication to private citizens should be promoted, in order to clarify who can be the beneficiary of the compensation system, the amount, the conditions, and which are the steps in order to receive the compensation. Specific attention should be given by the local authorities to the information and promotion of forms of damages prevention and related schemes (e.g. insurances).
- A clear system of complaint management should be set up and fostered, in order to increase the trust of citizen in the responsible local institutions.

3.2.1 Statements and lessons learned from the site visits

The site visits were organized to check on the ground the barriers identified through the GIS analysis. Each local partner was requested to verify the proposed barriers for connectivity and select those being actually a barrier and the locations where socio-economic issues could act as additional barriers.

Due to the differences in environmental, socio-economic and legislative aspects in the Carpathians countries, each partner selected the most relevant locations and stakeholder in order to get a clear (although incomplete) image of the country.

Several topics related to ecological connectivity were discussed with nature conservers and local stakeholder in five of the seven Carpathians countries: Serbia, Hungary, Romania, Ukraine and Slovakia.

Animal-Vehicle collision (AVC) (Road kills) and building of new infrastructures:

The problem of animal-vehicle collisions interested all the Carpathians countries, although with local differences. During the BioREGIO project, EURAC collected data concerning AVC from Romania, Hungary, Slovakia and Czech Republic in order to identify an additional impact of road infrastructures on wildlife connectivity.

Road kills do not appear, at present moment, as one of the main threats for Carpathians' ecological connectivity. The current road network in the most important presence and distribution areas does not constitute an insurmountable barrier for dispersal wildlife species.

However, the foreseen expansion of roads, motorways, and interchanges that is interesting all the Carpathians' countries can create the conditions for a higher impact of this phenomenon, both on wildlife and on humans. Only few of the Carpathians countries have developed a database to collect and monitor this phenomenon, although the data are often incomplete and not punctual referenced (usually the road-kill number is referred to an administrative level). The site visits highlighted the local people knowledge of road kill since the most risky places are well known by local inhabitants. Nonetheless, much has still to be done in order to solve this issue.

In **Serbia**, road kills on national roads, inside or outside the National Park Djerdap, is a very important topic that goes together with the habit of fast driving. In several locations, no protection/prevention and monitoring systems exist. Many national roads cross edge environments forest/agricultural fields with a high attraction potential for several species. The national roads have

a total absence of mitigation / prevention infrastructures and no panels are available to inform the drivers that they are inside of a highly frequented wildlife area with a high risk of road crossing. Many accidents happen between cars and wildlife but still no decisions has been taken to mitigate this situation. In some parts of the road, there are fences but their height, size and length does not represent a barrier for many wildlife species.

In **Slovakia**, the issue has a great impact in specific locations related to railways, where railway kills are more important than road kills. In the region of Valka Fatra National Park, there are 22 tunnels on the railway and no fences. The problem of the railway is the installation of the fences. Concerning that, responsible ministries should be involved that they recognize this priority. Another problem regarding the fence is the lack of information. The responsibility of single authorities and stakeholders remains unclear, when implementing initiatives and build infrastructure. The police works in collaboration with the hunting association when a road kill happens: the hunting association cleans the rails and the tracks. For the hunting association a road kill is a loss, while shooting (harvesting) is an income (3-4.000 € for shooting). Usually the person that killed the animal cannot be identified. The police places marks on the roads. In general, it is the driver's responsibility to consulate a hunter to inform on the road kill. Hence, initiatives are taken to prevent road kills.

In **Hungary**, hunters and nature conservers agree on the possibility of creating an "important area for conservation" and to avoid road kills. Additional collaborations exist between Hungarian and Slovak hunters. Road kills are a hot issue also in this country but something has been done in terms of proper fences along the main highways and the installation of infrastructures to facilitate wildlife's crossing. One of the main issue regarding new motorways is the construction of the new M2 that will connect the Budapest area with Slovakia. The absence of connectivity studies in locations interested by new motorway construction goes together with the absence of a clear system for compensation for landowners.

In **Romania** (see Figure 19) the current motorway network does not constitute a barrier for wildlife species. Road kills are frequent, especially close to settlements and at edge environment but many projects concerning the application of green infrastructures have been implemented in order to connect ecosystems and solve current and future fragmentation problems.

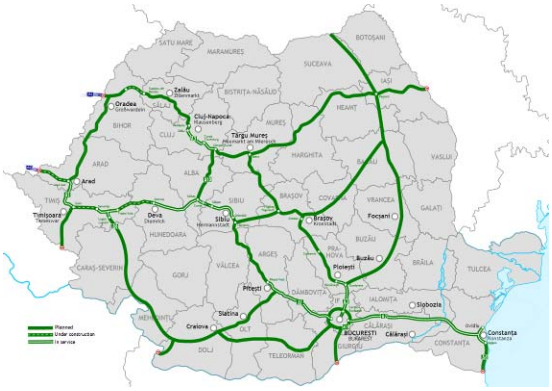

Figure 17: *Motorway network in Romania (planned, under construction, in operation) (http://commons.wikimedia.org)*

To avoid AVC conflicts and reducing risks, for both humans and wildlife, the BioREGIO project partners agreed on the following recommendations:

- Analyze the socio-economic impact of road kills
- Establish a monitoring system of the most risky road sections
- Develop national databases on AVC
- Share local and international experiences to know the available instruments for reducing the risks
- Railway kills have to be also considered. Railways offer the opportunity to be easier to control and to reduce risk significantly in contrary to car traffic.
- Individual traffic like car traffic are most meaningfully affected. Reasons are:
- Lacking facilities like information-signs to avoid road kills
- Driving behaviors, lacking awareness and education
- Strategies to avoid road kills:
- Special devices along the corridors to control the migration paths of the umbrella species spatially
- Herbivores are affected usually more from road kills – thus imitated “wolf eyes” enlightened form car-lights, should stimulate herbivores to flee

Hunting procedures and laws

The Carpathians landscape is dominated by forest and game species (mainly ungulates but in some countries also bears, lynxes and wolves). The forest is an important link in the connectivity of the landscape and has a high significance as a habitat. Appropriate hunting activity is extremely important in the context of ecological connectivity, as it may help to preserve a near-natural forest

and create the ideal conditions for the propagation of the widest possible spectrum of species. Areas with no or limited hunting can be used by sensitive animal species as core zones or stepping stone biotopes. Habitat restoration measures can also be taken to support this.

In some Carpathians' countries, hunting is a large business. The protection of a landscape for the creation of an ecological corridor has to face with all the related economic interests. Conservation is less economically attractive than forestry and hunting. The high numbers and densities of game species attract many foreign hunters. Hunters may pay up to 7000 € for shooting a bear in Romania. The economic income generated by the game species' trophies is much higher than the one coming from conservation. Due to that, carnivores can be seen as competitors by the hunters (e.g., Hungary), because they reduce the number of game individuals. The idea of competition and that carnivore species are "a pest" for game management, stimulates the "protection" of the game species for the economic income they provide. Although protected, carnivores are killed by hunters and poachers. The high presence of hunters and their negative relation with carnivores, in some countries, may push carnivores to other locations that are not highly suitable to their ecological needs and are not good enough for connectivity.

Hunting Law Acts are commonly approved at state level, however they often contain (e.g. Poland) express authorization to local organs to adopt sub-national acts, which may constitute a derogation from the national law and lead in fact to a diminished protection of some species. Thus, derogations should be limited and granted only under strict conditions: preventing that at local level species are not protected.

The big challenge comes from the harmonization of the different and often contradictory interests among hunters, ecologists, gamekeepers and the local populations. In some locations, due to an (estimated) oversize of game populations, farmers and foresters complain about the damages they create. Hunting offices managing a certain hunting area have to compensate the damages that in some cases may be extremely high.

Hunters may take a very important role in the preservation of ecological connectivity, helping in identifying the actual least cost paths used and reducing the hunting pressure at local level.

The information gained have highlighted the need for the following recommendations:

- Increase the cooperation among different hunting units: state owned hunting areas, private and fenced hunting clubs, private landowners having the permission to hunt.
- Definitive hunting quotes should be requested every year for each game species. Forest or national park rangers should be responsible that these quotes are achieved or not exceed. They have to count each shot game-animal.

- In Slovakia particular agricultural sites are fenced to avoid potential damages from wildlife

Forest and Agriculture

Forest and agriculture represent, together with hunting, the main economic activities that may have a conflict with nature protection in favor of ecological connectivity.

One of the main issues highlighted during the site visits is the low awareness of foresters and farmers concerning the concept of ecological connectivity and their contribution to establish a regional ecological network. These ideas and concepts should become self-evident for sustainable forest and agriculture management. This has to be agreed with several stakeholders to be in line with Natura 2000 areas, the Environmental Impact Assessment (EIA) as well as with the certification conditions of the Forest Stewardship Council or the Pan-European Forest Certification (PEFC).

Management plans should include forest/agricultural fields and NATURA 2000 sites. Ecological corridors and herein stepping-stones should be included as a relevant ecological elements in forest planning.

Concerning agriculture, the main issue in the Carpathians is land abandonment, more than damages of wildlife. Especially young people move away from agricultural lands to main settlements.

To deal adequately with the theme of landscape fragmentation and ecological connectivity it would be best to include it as a measurement in the agro-environmental program of the rural development plan. In this case it would be required to estimate the costs, which may evolve for compensating the agricultural fields, allocated to ecological connectivity like wind shelters and comparable stepping stones.

To motivate farmers to support connectivity a contractual mechanism needs to be installed. Therein a kind of “Trust-Fond” could be appropriate to sustain a heterogeneous landscape structure and to avoid landscape fragmentation. The planning procedures hereby should be conducted by the local authorities. Here the fear could be faced that the plans and measurements foreseen are good designed but unfortunately not adequately applied. Hence, the donors “the Trust Fond” for instance should only agree on the distribution of subsidies if the process is prepared and implemented correctly.

Integrate measurements to foster ecological connectivity, as an agro-environmental measure in the rural development plan (2014-2020) would be a preferred option to claim support from the European Union to find at least a compromise to solve the land-use conflict.

The agricultural sector in the Carpathians needs a new vision and forecast, in order to conserve existing structures, avoid land abandonment and enforce new measures.

Transboundary issues and protection beyond protected areas

In different Carpathian countries, similar category names of protected areas are applied to sites that diverge in terms of the protection regime, thus a harmonization of definitions and related protection regime should be promoted especially in transboundary areas. Protected areas apply simultaneously other plans or programs, which influence them – like forest management plans or municipal and regional land-use plans. Thus, both at national and cross border levels, it is recommended to integrate all approved and applied management plans for each of the protected areas into one management plan to avoid their mutual competition and use protected areas in accordance with their original purpose. The main issue, in this case, is the differences in legal requirements and frameworks for spatial and landscape planning which prohibits the establishment of unique management plans for transboundary protected areas. While the legislative aspect remains essential for the establishment of protected areas and nature parks, which constitute the essential ecological structure whose connection ecological corridors must protect, the preservation of corridors themselves can be achieved also through a combination of legislation and practices of sustainable integrated management

Urban sprawl and compensation of damages

The rapid socio-economic transformation are resulting in the willingness of local communities to expand dwelling areas. In this context, there is often an underestimation that even minor changes in the local settlement expansion, such as the allocation of garbage collection place, can have an effect on the behavior of selected species (such as bears), especially in rural areas. . Small intervention may prevent bears to make damages and stimulate them to find alternatives for their movements. Parallel to this process, urban sprawl and (illegal) settlement extension can be driven also by the expansion of specific sectors. While the drivers of this expansion (such as the creation of new touristic attractions or new dwellings) are positive signals of economic diversification for local communities, there is the need to intervene in a planning phase in order to avoid negative impacts of the phenomenon.

An effective approach to ecological connectivity should address the different steps in which conflicts between human activities and wildlife can arise, starting from the planning, through implementation up to the management of possible conflicting events. In this framework, a reliable and clear system of compensation of damages caused by wildlife is essential, since it can strengthen the trust of the local communities in the authorities responsible for nature preservation

and wildlife management. This can also lead to a more positive attitude towards initiatives aiming at promoting ecological connectivity. Several factors hinder an effective application of compensation mechanisms. One of these is the lack of transparency and clarity regarding compensation. Often, local stakeholders have not a clear idea of who can benefit from compensation, what can be compensated and how to access the compensation scheme. Moreover, this situation is influenced by an uncertain governance of the management of damages caused by wildlife in specific case, for example those caused to cars in a road collision. In this case, the different authorities involved may not have regular structures of dialogue (e.g. regular meetings or exchange) and often there is a lack of coordination in the intervention after a damage occurs. This affects the recipients of compensations, especially in case of a scarce coordination between the authorities that should evaluate the entity of the damage and the ones that should compensate the damage.

3.2.2 Recommendations

- Adopt monetary compensation mechanisms in case of a damage caused by wildlife.
- Adopt clear regulations regarding reimbursements in case of damage attributed to wildlife. The regulation should be clear not only regarding the monetary compensation, but also regarding what to do in case of a damaged caused by wildlife.
- Attentively monitor human activities that can affect wildlife's behavior (e.g. feeding for hunting, leaving garbage unattended), especially for the species that era more likely to provoke conflicts. Even though wildlife has suitable habitats, in some cases it has been observed that there is a change of behavior when artificial feeding is introduced.
- Foster data collection on wildlife presence on a Carpathian – wide scale.
- Foster the active involvement of the local stakeholders in the monitoring and observation of wildlife presence and of damages.
- Adopt active financing systems that should enable ecological connectivity and not only when a damage occurs. This is particularly important in the fields of agriculture, hunting and forestry.
- When adopting a regulation not accompanied by an active financing system, make sure that the regulation will bring economic advantages and increase the attractiveness of the territory (e.g. sustainable agriculture or certified timber).
- Foster evaluation mechanisms (e.g. for contracts with the public administration) that foster "good" behaviors towards connectivity in different initiatives (e.g. sustainable forest management, sustainable agriculture practices).

- Optimize the governance regarding the daily management and the emergencies linked to the presence of wildlife. This could foster a better relationship between protected areas, the public administrations and the population dedicated to traditional sectors (agriculture, hunting, berries and mushrooms collectors) that can be damaged by the presence of wildlife.
- Even though wildlife is a part of the local culture, the relationship between human and wildlife is ambivalent. It is important to raise awareness among different stakeholder groups, especially in rural communities. Enhance the communication of the park administration with local communities and involve local communities in the initiatives.
- Overcome the idea that “to make a corridor you have to make a protected area”, by integrating forms of management between protected areas important topic in connection with the legal barriers, since at the moment there is no specific legal instrument for corridors, that are the areas where more often human / wildlife interaction takes place.
- Clarify also the procedure when you find a dead animal: who you should contact, where you should go. Give flexible and in-time instrument and coordinate the data about these observation, since they are important for improving and monitoring.
- Strengthen the integration of the concept of ecological connectivity into planning, most of all in the sectors that will are being subjected to changes in the recent years:
    - Land use: integrate concepts of connectivity and permeability in the planning of new dwelling areas, most of all in the zones where sprawl and building are more evident.

3.3 Findings according to legal barriers

The need for ecological coherence to safeguard biodiversity has been taken into account in several policy and legal instruments. An in depth analysis of these instruments and their impact on ecological connectivity was carried out by several national legal experts and collected in national reports, in a book and in the final report.

The book ‘Toward the Protection of Biodiversity and Ecological Connectivity in Multi-Layered systems’ aims at investigating the legal and policy instruments which directly or indirectly affect biodiversity protection and ecological connectivity at the international, EU, regional (Alpine and Carpathian Conventions), national and subnational levels. At national and subnational levels, some of the Carpathian countries, e.g. Hungary, Poland, Romania, the Slovak Republic, Serbia and Ukraine, have been selected for in depth analysis. Cross-border cooperation between these States is examined as an instrument for promoting biodiversity within and outside national borders.

In the last decades, several legal and policy documents have been adopted or increasingly stretched to enhance ecological connectivity:

- at the international level the Convention on Biological Diversity (CBD) and the Ramsar Convention on Wetlands,
- at the regional level the Alpine Convention and the Carpathian Convention, and
- at the European level the Pan-European Biological and Landscape Diversity Strategy and Directive 2009/147 on the Conservation of Wild Birds and Directive 92/43 on the Conservation of Natural Habitats and Wild Fauna and Flora, which form the legal basis of Natura 2000 network.

In all the countries examined, the Constitution does not refer directly to the concept of ecological connectivity. Not even ordinary law contains a legal definition of ecological connectivity or the composition, management and financing of ecological networks. The protection of the countryside beyond protected areas (such as landscape protection, preservation of historical forms of land-use and protection of the landscape elements ensuring ecological connectivity of the territory) is minimal.

Although some more recent reforms aim to integrate biodiversity conservation into other policy sectors, the actual success of such acts depends on the degree of detailed implementation and enforcement within existing institutional structures and practices. As the cases of Hungary, Serbia and Ukraine show, some decrees or regulations have been adopted with the specific aim of providing definitions and guidance on ecological connectivity.

Ecological connectivity is considered in these strategic plans as the basis for spatial planning, which will allow for the organic connection of natural systems and sub-systems. However, these guiding documents are not binding or detailed.

Even if ecological connectivity is far from being pursued in legislative acts and policy plans, national laws generally provide for the creation of protection zones in the territories adjacent to the protected areas in order to prevent the negative consequences of business and other economic activities and to preserve the regime of such protected areas. However, they are not so detailed and other sectorial interests, plans and administration may once more play a stronger role and dominate the environmental protection concerns.

Some more factors reducing biodiversity protection and ecological connectivity may be identified with regard to the creation and management of protected areas.

The analysis carried out sheds some light on some positive trends, aspects and improvements in biodiversity and ecological connectivity protection at different governmental levels.

When looking more specifically at the case of biodiversity protection and ecological coherence in the systems examined, some of the previously identified gaps may also reveal hints at potential solutions and some important strengths may be emphasised as elements for building stronger environmental governance (Folke et al., 2007).

First, notwithstanding the general implementation gaps of EU policy and legislation detected with regard to biodiversity and ecological connectivity, the EU has certainly pushed the Member States like Poland, Hungary, Romania and the Slovak Republic, acceding countries like Serbia, and even bordering States like Ukraine, to take into consideration environmental concerns both at the structural/institutional setup level and at the substantial/legislative level. National environmental law of Member States has been considerably influenced by EU law. During the accession process in particular, a number of new legislative and executive acts have been adopted and existing ones have been revised to include new obligations. The implementation of the Birds Directive and the Habitats Directive broadened the existing national catalogues of the forms of protected areas and strengthened the protection of species. The implementation process required the introduction of numerous new tasks and powers for administrative authorities and new obligations and rights for individuals. Moreover, the influence of the EU resulted in introducing the principle of integrated protection, which at the State level required a switch from a sectorial protection approach to a complex, integrated and coherent protection approach enhancing environmental and biodiversity protection and ecological connectivity in sectorial policies and activities (Young et al., 2005). This shift may be observed in particular in Poland and Serbia, among others.

In cases of implementation failures, the role played by the EU Commission is essential and should be strengthened. The infringement procedure to be initiated by the Commission against Member States constitutes a strong argument and effective tool to enhance compliance with regulations and directives dealing in particular with maintaining biodiversity and promoting ecological connectivity.

In this regard, important instruments are also the Aarhus Convention[1] and the related EU Directives[2] that increase opportunities for 'public' or 'public concerned' access to environmental information, participation in the decision-making process and litigation. With regard to the third pillar of the Aarhus Convention, e.g. access to justice, in particular the adoption of legislative action at the EU level, would add value in ensuring effective and non-discriminatory access to justice in environmental matters across the EU Member States and would increase the impact of public action in favour of biodiversity and ecological connectivity.

The involvement of the society (individuals, groups, NGOs) acting to protect the environment as a 'common good' plays or at least can play a vital role in attaining the biodiversity and ecological connectivity protection objectives. Particularly enlightening to this end is the case Rosia Montana described in the Romanian chapter, in which, thanks to the active role of NGOs and civil society more broadly, some law amendments hampering environmental and biodiversity protection and ecological connectivity might be stopped.

The participation of society in environmental matters at the policy, legislative, executive and enforcement levels may result in a greater protection, especially in cases where national and sub-national authorities lack the will and funds for ensuring biodiversity protection. Positive examples are offered by those countries that allow a more pluralistic participation in regulating and managing biodiversity related issues. For instance, while protected areas in the Slovak Republic can be declared, depending on the case, only by State and regional authorities, thus excluding municipal authorities and other stakeholders, Polish legislation prescribes that besides governmental authorities, other stakeholders such as non-governmental organisations, relevant nature conservation organs of a consultative and advisory nature and property owners, participate or can participate in the process of creating new protected areas. Hungary and Ukraine even grant the right to make proposals for establishing protected areas to individuals. Thus, protected areas and other sites may be established based on the decisions of the State authorities and local authorities

[1] The United Nations Economic Commission for Europe (UNECE) Convention on 'Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters' was adopted on 25 June 1998 in Aarhus and entered into force on 30 October 2001. The Decision on conclusion of the Aarhus Convention by the EU was adopted on 17 February 2005 (Decision 2005/370/EC).

[2] Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on Public Access to Environmental Information and Repealing Council Directive 90/313/EEC; Directive 2003/35/EC of the European Parliament and of the Council of 26May 2003 Providing for Public Participation in Respect of the Drawing Up of Certain Plans and Programmes Relating to the Environment and Amending with Regard to Public Participation and Access to Justice Council Directives 85/337/EEC and 96/61/EC.

and on requests to public authorities by civil organisations and citizens. In particular, in Ukraine NGOs may also administer and manage protected areas if their charter documents provide for environmental protection activities. These organisations may facilitate the management and administrative activities of the State bodies, participate in the environmental expertise of protected areas, exercise control over adherence to the protected areas regime and carry out other activities provided under their charter documents in accordance with the legislation.

Also the judiciary has proven to often be a key factor in favour of biodiversity conservation and ecological connectivity. For example, in Poland several judgments have been issued ensuring the duty to integrate the legal regimes of protected areas into spatial plans, limiting investments and activities in protected areas and buffer zones, and insisting on the need to maintain ecological connectivity.

Several horizontal measures potentially enhancing biodiversity protection and ecological connectivity already have been adopted in all countries examined and should be implemented through a more supportive ecological connectivity lens. In particular, both strategic environmental impact assessments (SEA) and environmental impact assessments (EIA) of projects having a significant impact on environment, as well as assessments of the impact on Natura 2000 sites, can provide the comprehensive warranty for the protection of natural values through the duty to take into consideration before authorising a plan or a project both the findings of environmental impact study and the results of consultation with specialised environmental authorities and the public. The environment and/or Natura 2000 impact study should, however, stress biodiversity and ecological connectivity-related issues, thus ensuring a sound implementation of Natura 2000 legislation and an effective national biodiversity and ecological connectivity protection. In addition, exemptions should be limited and granted on a stricter basis.

A much more rigorous interpretation of EIA and SEA objectives is already provided and can be further pursued by courts. As both the case law of the EU Court of Justice and the national case law quoted in the book show, some interference of planning measures in environmentally protected areas can be limited or even blocked by the courts rulings.

Also, the provisions on the prevention and remediation of environmental damage, which introduce a mechanism of public liability for a threat of damage or damage to the environment caused by operators carrying out an operational activity, may constitute a strategic tool for maintaining or restoring biodiversity conservation and ecological connectivity. To this regard, competent authorities on one side may play a more active role when it comes to necessary preventive and remedial action. On the other hand, civil society/NGOs may play an important part in stimulating proper actions by competent administrations, as they are granted the right to request the

competent authority for action or even the right to appeal before a court or other independent public body to review the decision.

As for cross-border natural areas, the EU and the Alpine and Carpathian Conventions certainly play strategic roles by promoting cooperation on the political level, supporting trans-boundary initiatives and (the EU) becoming the most significant facilitators and donors in the region for environmental-related initiatives and activities. Besides bilateral/multilateral and international agreements, other instruments, such as the European Grouping of Territorial Cooperation (EGTCs)[3], could be further developed and adopted by Member States, regional authorities, local authorities and/or bodies governed by public law to facilitate and promote specifically cross-border, trans-national and inter-regional cooperation in favour of ecological connectivity.

All the recalled instruments already exist, they may thus correctly be considered as stepping-stones for the fragmented governance described in previous paragraphs and better developed or largely used in favour of ecological coherence.

Some of the identified gaps reveal hints at potential solutions. Some legal instruments already adopted may thus correctly be considered as stepping-stones and better developed or used in favour of ecological coherence. A summary of main findings is reported in the tables below.

Table 3: *Legal impacts enabling and impeding ecological connectivity*

Main critical aspects are:			
International level	**EU level**	**State level: Carpathian countries**[4]	**Cross-border level**
Obligations are defined broadly, leaving a wide margin of discretion to theState Parties	Legal and policy acts on the environment and biodiversity and specific funding programmes (e.g. LIFE and LIFE+) were adopted, however national implementation	• No reference to ecological connectivity or ecological networks in Constitutions; • No reference in most of ordinary law; • No reference in sectorial legislation • Reference mainly in strategic documents that are not binding; • Protection of countryside beyond protected areas (e.g. landscape protection, preservation of historical forms of land-use) is minimal; • Environmental legislative powers are mainly centralised at the State level, while administrative tasks/powers are often diluted	• Similar category names of protected areas are applied to sites that diverge in terms of the protection regime; • Common standards and management measures are lacking in cross-

[3] Regulation No. 1082/2006 of the European Parliament and of the Council of 5 July 2006 on a European Grouping of Territorial Cooperation (EGTC).
[4] See national reports published in the Project website: www.bioregio-carpathians.eu.

	and enforcement pose problems	and not coordinated among different public bodies; • Creation and management of protected areas: although an autonomous right to local authorities is foreseen, in practice their role is quite limited; • Several protected areas do not have valid management plans; • Lack of national/local funds for protecting and managing natural areas	border protected areas.

Table 4: *Legal impacts enabling and impeding ecological connectivity at different administrative units*

Main strengths/recommendations are:			
International level	**EU level**	**State level: Carpathian countries**	**Cross-border level**
Promote Aarhus Convention as a relevant instrument increasing opportunities for 'public' or 'public concerned' access to environmental information, participation in the decision-making process and litigation	• The EU pushed States to include environmental concerns both at the structural/institutional setup level and at the substantial/ legislative level • In case of implementation failures, EU infringement procedure is a strong argument to enhance national compliance • EU Directives increase opportunities for 'public' or 'public concerned' access to environmental information and participation in the decision-making process; • Horizontal measures, e.g. the strategic environmental impact assessments (SEA), the environmental impact assessments (EIA), the assessments of the impact on Natura 2000 sites, and the prevention and remediation of environmental damage (ELD), are important instruments to avoid ecological fragmentation and environmental instances, thus they could be further implemented through a more supportive ecological connectivity lens	• A number of new environmental acts have been recently adopted and existing ones revised to include new obligations in favour of biodiversity protection • The implementation of the Birds Directive and the Habitats Directive broadened the existing national catalogues of the forms of protected areas and strengthened the protection of species. • National courts have proven to be a key factor, as several judgments have been issued in favour of ecological connectivity. • Introduce reference to ecological connectivity or ecological networks in environmental and sectorial legislation • Implement EIA/SEA and other horizontal measures by limiting exemptions • Promote protection of countryside beyond protected areas by increasing landscape protection, preservation of historical forms of land-use, etc. • Promote a better coordination between administrative authorities at horizontal (different sectors) and vertical (same sector) levels. • Promote the participation of society in environmental matters at the policy, legislative, executive and enforcement levels	The European Grouping of Territorial Cooperation (EGTCs) could be further developed and adopted by public authorities to promote cooperation in favour of ecological connectivity

3.4 Dissemination

The BioREGIO Project, due to its international approach and to the relevance it has for the Carpathians Convention and its Biodiversity protocol, was presented in its aims, objectives and results to several conferences and in scientific articles.

3.4.1 Articles, presentations and conferences

The BioREGIO project gained a lot of international attention from the scientific community, both in the Carpathians and in the rest of Europe. The Work Package 5's concept, methodology and results were presented at a series of conferences dealing with ecological connectivity, GIS or biodiversity in general terms.

WP5 was invited to present its results also in other projects' and international conference not dealing with the Carpathians territories in order to exchange experiences and encourage knowledge transfer.

The methodology and the results from the WP5 analysis were included in the conference proceedings and received a positive feedback from reviewers of books and of scientific journals.

3.4.2 Presentation of BioREGIO WP5 at International conferences

- **Ecological Connectivity in the Carpathians - GIS model to detect the permeability of the Carpathians for particular "Umbrella Species".** Forum Carpaticum 2012. 30th May – 2nd June 2012, Stara Lesna (Slovakia).
  (http://www.forumcarpaticum.org/FC-main/Download/FC2012_Conference_Abstracts.pdf)
- **Model Design for ecological connectivity in the Carpathians**. GIS approach to point out dispersal routes of selected umbrella species (IENE – Infra Eco Network Europe International Conference, Potsdam, Germany, 21st – 24th October 2012) (http://iene2012.iene.info/?page_id=71)
- **The BioREGIO Project.** 14a ESRI Italy Conference. 17-18 April 2013, Rome (Italy). (http://www.esriitalia.it/eventi/conferenza-italiana-utenti-esri/14a-conferenza-italiana.html)

- **WP5 – Connectivity and Continuum. BioREGIO Carpathians Mid-Term Conference.** Tatranska Javorina, 23rd April 2013.

  (http://www.carpathianconvention.org/tl_files/bioregio/meetings/20130423_CNPA_Conference/Favilli_Mid-term%20Bioregio_DEFWP5.pdf)
- **The Carpathian Ecological Network: GIS Approach to Detect the Landscape Permeability for Particular Umbrella Species.** 2nd International Symposium on Kaz Mountains and Edremit - Human Environment Interactions (May 2-4, 2013 - Edremit-Balikesir/Turkey) (http://www.kazdaglarisymposium.org.tr/WebEN/index.htm)
- **The Carpathian Ecological Network: GIS Approach to Detect the Landscape Permeability for Particular Umbrella Species.** Conference Volume 5thSymposium for Research in Protected Areas (10 – 12 June 2013, Mittersill (Austria)) (http://www.hohetauern.at/en/research/forschungssymposien.html)
- **Ecological Connectivity in the Carpathians: GIS model to detect the permeability of the Carpathians for particular "Umbrella Species".** INFRASTRUCTURE AND WILDLIFE CORRIDORS – LEARNING FROM EXPERIENCE IENE 2013 Scientific Workshop. 16–18 October 2013, Hotel Fontana, Luhačovice, Czech Republic. (http://iene.cdv.cz/)
- **BioREGIO Carpathians.** "Cross-border solutions for sustainable growth in mountain and sensitive regions". Green Mountain Final Conference. Brussels, 20th February 2014. (http://www.greenmountain-see.eu/?page_id=2643)
- **Identification of ecological corridors in the Carpathians - The Bioregio Project**. International conference "*Securing the ecological connectivity for large carnivores in the Carpathians".* Baia Mare, Maramures, Romania 23rd – 25th April 2014. (http://www.openbordersforbears.org/)
- **The BioREGIO Carpathians project: aims, methodology and results from the "Continuity and Connectivity" analysis.** IENE International Conference. Malmö (Sweden) 16 – 19 September 2014. (http://iene2014.iene.info/)
- **The BioREGIO Carpathians project: aims, methodology and results from the "Continuity and Connectivity" analysis**. Forum Carpaticum 2014. 16 – 18 September 2014. Lviv, Ukraine. (http://geograf.lnu.edu.ua/FC_2014/FC-2014_sz/FC_2014.html)

3.4.3 WP5 results inclusion in conferences proceedings and scientific papers

- **Ecological Connectivity in the Carpathians - GIS model to detect the permeability of the Carpathians for particular "Umbrella Species".** Forum Carpaticum 2012. 30th May – 2nd June 2012, Stara Lesna (Slovakia).

  (http://www.forumcarpaticum.org/FC-main/Download/FC2012_Conference_Abstracts.pdf)
- **Model Design for ecological connectivity in the Carpathians.** GIS approach to point out dispersal routes of selected umbrella species (IENE – Infra Eco Network Europe International Conference, Potsdam, Germany, 21st – 24th October 2012) (http://iene2012.iene.info/?page_id=71)
- **WP5 – Connectivity and Continuum. BioREGIO Carpathians Mid-Term Conference.** Tatranska Javorina, 23rd April 2013.

  (http://www.carpathianconvention.org/tl_files/bioregio/meetings/20130423_CNPA_Conference/Favilli_Mid-term%20Bioregio_DEFWP5.pdf)
- **The Carpathian Ecological Network: GIS Approach to Detect the Landscape Permeability for Particular Umbrella Species.** 2nd International Symposium on Kaz Mountains and Edremit - Human Environment Interactions (May 2-4, 2013 - Edremit-Balikesir/Turkey) (http://www.academia.edu/4814159/Proceedings-The_Second_International_Symposium_on_Kaz_Mountains_and_Edremit-Human_-_Environment_Interactions)
- **The Carpathian Ecological Network: GIS Approach to Detect the Landscape Permeability for Particular Umbrella Species.** Conference Volume 5thSymposium for Research in Protected Areas (10 – 12 June 2013, Mittersill (Austria)) (http://www.landesmuseum.at/datenbanken/digilit/?litnr=37550)
- **Ecological Connectivity in the Carpathians: GIS model to detect the permeability of the Carpathians for particular "Umbrella Species".** INFRASTRUCTURE AND WILDLIFE CORRIDORS – LEARNING FROM EXPERIENCE IENE 2013 Scientific Workshop. 16–18 October 2013, Hotel Fontana, Luhačovice, Czech Republic. (http://iene.cdv.cz/)
- **The BioREGIO Carpathians project: aims, methodology and results from the "Continuity and Connectivity" analysis.** IENE International Conference. Malmö (Sweden) 16 – 19 September 2014. (http://iene2014.iene.info/)

- **The BioREGIO Carpathians project: aims, methodology and results from the "Continuity and Connectivity" analysis.** Forum Carpaticum 2014. 16 – 18 September 2014. Lviv, Ukraine. (http://geograf.lnu.edu.ua/FC_2014/FC-2014_sz/FC_2014.html)
- **The Carpathian Ecological Network: GIS Approach to Detect the Landscape Permeability for Particular Umbrella Species.** In: Tourism, Environment and Ecology in the Mediterranean Region. Cambridge Scholars Publishing, 2014. (In Press).

4 Guidelines and strategies to sustain, restore and enhance ecological connectivity in the Carpathians

4.1 Introduction

The guidelines are providing a final assumption of topics touched during the project lifetime in BioREGIO concerning ecological connectivity. This brief overview should enable a compact knowledge transfer, in which problems, opportunities, threats and strengths in dealing with dispersal of wildlife are focused at, for which the particularities and natural assets of the Carpathians are playing a major role.

During the project lifetime these 10 guidelines derived here as recommendations were indicated as the most relevant ones. They all refer to the initial concept to separate the barriers/possibilities influencing ecological continuum and connectivity into a physical, legal and socio-economic part. The first five recommendations refer to physical barriers/possibilities, while the transboundary aspect and the hunting law is more likely touching legal fields. Finally, urban sprawl or ecological connectivity beyond protected area as well as compensating wildlife damages cover socio-economic topics. Consequently the guidelines developed in the context of connectivity are enlightening evident deficits concerning landscape fragmentation. Thus, the field around maintaining and restoring ecological corridors is touching task areas from spatial and land use planning and their various legal directives regulating these aspects.

Since, due to the large investigation area of the project (the entire Carpathians range), it was not possible to develop single national or local strategies to overcome the identified barriers, partners were asked to provide their feedback on the developed recommendations through a specific questionnaire (see below).

Partners were asked to give a short feedback on their own experiences/estimatios how strong these 10 themes (guidelines) are affecting ecological connectivity in their country. This national evaluation could contribute to give an outlook on priorities the single countries should focus at when considering ecological connectivity in any national guideline or strategy they may develop.

4.2 Guidelines for ecological connectivity

4.2.1 New infrastructure, roads & motorways

Countries in the Carpathians are experiencing a growth of infrastructures since the end of the communism. New motorways are foreseen in Romania, Czech Republic, Hungary and Slovakia that causes at different locations an expansion of human settlements (urban sprawl). The purpose of road developments is to ensure an effective connection of new-EU states with other EU countries through the Trans-European Transportation Network (TEN-T). In this unprecedented era of urban expansion and road building, the opportunity is given to revisit the design for connectivity, rather than discussing about fragmentation. The question is not focused on "whether to build a road", but on adopting a different approach to transportation planning that focus on the enhancement, maintenance and re-establishment of ecological connectivity.

The data collected during the BioREGIO project have highlighted that the current road network in the Carpathians do not act as unsurmountable barriers for wildlife. Rather there is the need to reconcile the notion of mobility in order to (re)imagine the road as a device for (re)connection between humans and wildlife, culture and nature. The foreseen motorways need to be developed following the guidelines for the new TEN-T corridors of the European Union. The guidelines propose a multidisciplinary approach to analyze the impact of the trans-European transport network, posing great emphasis on the safety and environmental friendliness of transport infrastructure by promoting innovative technological developments. In addition to the Habitats and Bird Directives, the EU issued a directive (97/11/EC)[5] that calls for a strategic environmental assessment (SEA)[6] and, for major infrastructure projects, an environmental impact assessment

[5] *Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on environment; OFFICIAL JOURNAL NO. L 073, 14/03/1997. URL:* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31997L0011

[6] *Strategic Environmental Assessment - SEA, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on environment. URL:* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0042

(EIA)[7] to foresee potential environmental problems from plans and projects. Specific guidance for transportation planning is being developed under the COST 341[8]. The goal of BioREGIO analysis on wildlife connectivity is to assist transportation managers to consider the protection of wildlife connectivity in their strategic decisions, when designing new and expanded road projects.

In case of generated discussions on possible alignments (e.g. Deva – Lugoj Motorway in Romania; M2 motorway in Hungary, new motorways in Czech Republic and Slovakia), it is essential to:

- Perform a systematic analysis of wildlife presence and dispersal through GIS and field work.
- Develop a framework to identify the ecologically strategic locations for enhancing wildlife connectivity.
- Provide planning level mapping tool highlighting the strategic locations.
- Invite local communities, NGOs and experts for public debating.
- Provide mitigation and monitoring recommendations for areas interested.

[7] *Environmental Impact Assessment - EIA, Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on environment, URL: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0092*

[8] *COST 341: Iuell, B., Bekker, G.J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlavác, V., Keller, V., B., Rosell, C., Sangwine, T., Tørsløv, N., Wandall, B. le Maire, (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions, URL: http://www.iene.info/wp-content/uploads/COST341_Handbook.pdf*

Examples:

Lugoj-Deva Motorway (Romania)

Lugoj-Deva Motorway sector is part of the Pan-European Transportation Corridor no IV (Europe Aid 122273/D/SER/RO ISPA 2004/RO/16/P/PA/002/01; part of TEN-T Corridor IV)[9]. The proposed alignment would intersect the last ecologic corridor for large carnivores between Western and Southern Carpathians in Romania, isolating the Apuseni Mountains (Western Carpathians) from the rest of Carpathian Range in Romania (see Figure 1).

Large carnivores have been detected in the interested area, although bears are present only during seasonal movements, lynx and wolf are residential. The IENE Network (www.iene.info), the greatest European network for ecological connectivity and transportation, organized a workshop in May 2013[10] about this motorway inviting local stakeholders, road administration and European experts to find mitigation strategies for the maintenance of connectivity.

The main conservation goal is to assure long-term functional connectivity between the Western and Southern Carpathians populations, protecting the main populations at a healthy level, and to allow natural expansion in favorable ranges and safeguard movement/dispersal routes.

From a social and legal point of view, there is the additional need to overcome a series of barriers going from the management and coordination between the various stakeholders, the lack of public awareness, law enforcement and damage/conflict prevention and compensations. The major barriers remaining are the physical ones. For the new planned infrastructures in that area, they are pointed out in the map as yellow arrows. The ecoducts or underpasses planned here, need to be well designed that wildlife considers these ecological reconstructions also for dispersal.

---

[9] *EuropeAid/122273/D/SER/RO: B-Brussels: ISPA — technical assistance for the preparation of road project pipeline for the Cohesion Fund, in Romania — contract No 1, detailed design and tender documents, URL: http://www.dgmarket.com/tenders/np-notice.do?noticeId=1790865*

[10] *IENE 2013, Scientific and Technical Workshop, 23-25 May 2013, Lugoj, Romania, URL: http://iene2013romania.wordpress.com*

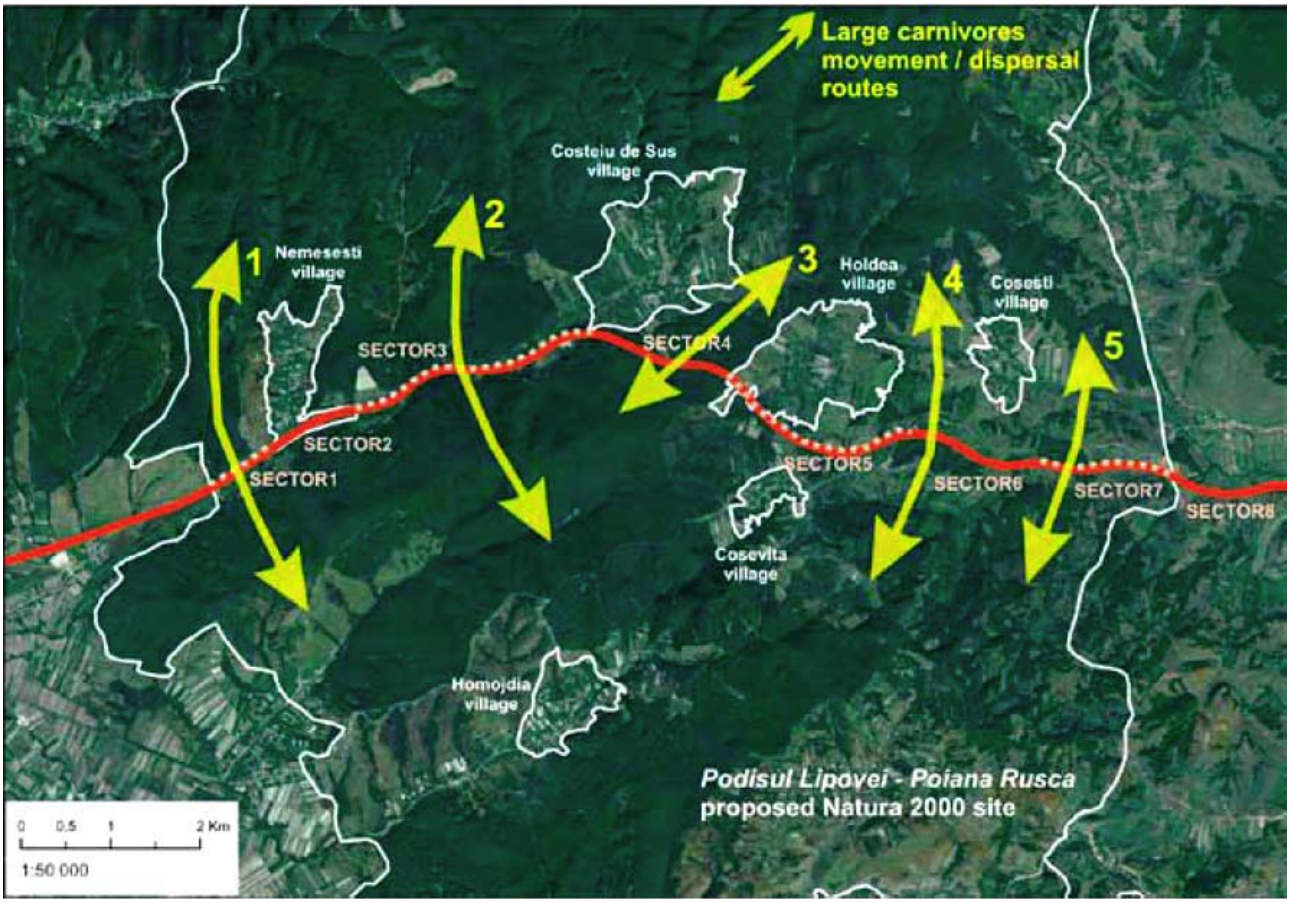

Figure 18: *The Deva-Lugoj alignment and the intersection with a NATURA 2000 site and wildlife dispersal routes (Fauna and Flora International, WWF Danube-Carpathian Program, Greenlight Services, Romanian National Environment Guard, Romanian Forest Research and Management Institute, Faculty of Silviculture and Forest Engineering Brasov, Carpathian Wildlife Foundation, The European Nature Trust).*

Planned highway D1 from Turany – Hubová, passing Malá and Veľká Fatra (Slovakia)

The construction work into this very sensitive area – a small valley with unique Natura 2000 sites and a high relevance for ecological connectivity – has already started before Slovakia entered in the European Union (EU). Since Slovakia is now a member of the EU, the continuation of building this highway is interrupted. The EU requested a Strategic Environmental Assessment (SEA) and to tunnel these ecologically sensitive area.

Planned Highway M2 from Budapest to the Hungarian/Slovak Border (Hungary)

The project aim is to build a new express-way that will cross the Slovakian border at Balassagyarmat, much more east form the present alignment versions (this alignment would cross the Natura 2000 part of the Ipoly river at the border that it is not so rich (valuable) than near Borzsony mountain at Dregelypalank). Another realistic reason is that the road from the settlement Retsag to Balassagyarmat (today the road number 22) is much busier than the road from Retsag to the border on the old (current) road number 2. The only problem is with this eastern alignment-version, that in Slovakia there is still no planned express-road-connection that would go to the north, but at the "Dregelypalank-versions" there is already an express road in Slovakia, so the EU says that would be better for a TEN-T road (and it is wanted to be a TEN-T road).

Final considerations

In order to analyze correctly the different alignments of a foreseen motorway concerning ecological connectivity, it is fundamental to provide:

- Site location and site plan: locations, types and sizes of ecological connections close to the foreseen infrastructure;
- A list of the wildlife species identified;
- The location of the main core areas and most probable passage sites;
- Strategic Environmental Assessment (SEA) & Environmental Impact Assessment (EIA);
- According to the species present in the location, the kind of ecological infrastructures/connections that may be required;
- A list with location of new dedicated connections for wildlife (bridges, culverts, fences);
- 3D rendering of the project with the dedicated crossing structures for public debating.

A multidisciplinary study considering the environmental, social and legal issue should join the engineering to detect all the potential and future barriers for connectivity and to identify new and dedicated wildlife crossing structures and protective fencing if needed.

In current roads, existing culverts and fencing structures that may be in-kind, retrofit, or structurally deficient, damaged, obsolete, insufficiently sized, or otherwise inadequate should be replaced.

Public debating becomes continually more important. Local people, living in locations interested by the new roads construction, need to be advised and want to give their contribution to the choice of the alignment. Public debates concerning the construction of new motorway can fulfil additional aims. It may be used to spread the concept of connectivity and the need of re-thinking our vision of movements and transportation. Public debates can stimulate people to see their environment in a different way, or can maturate the need for sharing spaces with wildlife in order to gain concrete benefits from a healthy ecosystem.

Specific recommendations formulated together with local stakeholders and NGO to highlight the impact of new infrastructures can be presented to the national government. There is, anyhow, a gap between the formulation of recommendations and their presentation to the governments. Many international projects do not include so far the presentation of recommendations to national governments in order to gain and “official approval”. Also the provision of recommendations to highway planners and administrators remain only a suggestion and has no legal value. In the Carpathians, this process usually takes a lot of time, mainly after the lifetime of the project ended.

- A solution for that could be to include already in the writing phase, the presentation of recommendations to national government and their implementation on the ground.
- New projects concerning the evaluation of the impact of new infrastructures should include the training of people not directly connected with Nature Protection.
- Different stakeholders in the fields of spatial planning and administrations can fill the gap in dialogue between Nature Agencies and national government.
- Raising awareness among responsible authorities for the environmental loss and the meaningfulness of protected and Natura 2000 areas, when designing and implementing new motorways is very important for the Carpathian countries.

In terms of recommendations, the information gained during the life time of the project are pointing to the following issues:

- Adoption of the prudence principle – it has to be considered already in the planning phase that the negative impact to wildlife is reduced to a minimum.

- The EU guidelines force investors and constructing companies to collaborate and to find a deal with all interested groups to prohibit potential conflicts and problems preventively.
- What is herein negative are the short periods for announcing any critics what requires to be organised quite well to open the opportunity to all stakeholders to state their opinion.
- Analysis of the potential conflicts with wildlife has to be done in advance through monitoring of their movements and indicating their core areas:
    - This could concern analysis of the current and potential future conflicts due to the presence of hydropower plants for the otter or
    - The analysis of the conflicts between migratory birds and overhead power lines or
    - The increase of awareness for ecological connectivity among local population
- Establish a public consultation to enable local people to express their concerns about:
    - Analysis of the financial and technical barriers
    - Requirement of alternative alignments
- The challenge is to create technical solutions that are economically affordable and ecologically as well as practically reasonable. This requires to find acceptable compromises within the stakeholder consultation process.
- It should become obligatory to integrate the ecological corridor approach in landscape and spatial planning in form of a background document like in Slovakia, which is called “The territorial system of ecological stability”

4.2.2 Animal-Vehicle Collision (AVC)

The phenomenon of Animal Vehicle Collision (AVC) is interesting for those European countries, which are struggling with increasing road kills due to a natural return of many wildlife species (ungulates but also carnivores) at locations from where they were almost disappeared.

The AVC phenomenon interests also the Carpathians countries. Many animals are routinely captured and killed by vehicles during their basic quest for “survival”. Since few years, many institutions and research centers have started to monitor data on involved species, on costs (for biodiversity, for economy and human health) and on locations at higher collision risk to get a clear picture of AVC in their countries and to provide solutions for mitigation.

Road kill is a concrete result of the conflict between the needs of humans and animals. The humans’ need to travel safe and quick to any location, is a basic expectation of modern society.

Yet wild animals need connected landscapes: they must cross roads to search for food, mates, and shelter. Furthermore a connected landscape is able to provide apart from ecological corridors, additional other ecosystem services in favor for human society. The road kills issue, as for the construction of new motorways, can be used to raise awareness to broaden the idea of connectivity and the threats related to fragmentation among the citizens mainly those living close to high-risk areas.

The road kill problem is not only related to wilderness, but it is a problem affecting everyone. Growing numbers of animal-vehicle collisions are leading to higher levels of personal injury and property damage, and with this, rising insurance premiums. Many countries miss a compensation program to refund the damages caused by AVC. While human deaths are not high compared with other accidents, AVC have increased significantly. This represents a significant danger to human safety and to wildlife populations. Animal-vehicle collisions are also increasing relatively in relation to the total roads' accidents. Even if not physically hurt or economically affected by a collision, many people report that they feel traumatized after hitting an animal. Besides, these obvious concerns for motorist safety have serious implications on wildlife. Road mortality is documented as one of the major threats to the survival of many species listed threatened or endangered. On a much larger scale, conventional road building results in significant losses of habitat for game species. Road networks fragment the landscapes into ever-smaller, disconnected patches in which wildlife must live and move, faced with declining genetic fitness as populations become separated and isolated. Road kill is not simply "bad luck" or an unfortunate consequence of driving; it is an avoidable cost and a preventable loss. AVC is not only a matter of physical road effects but also of the driving behavior. An increase in the ecological awareness is fundamental to allow the mitigation structures to work properly. Thus there is the need to rethink our dominant model of mobility and our awareness to understand that both humans and wildlife share a common need to move. Based on these premises, the opportunity is to redesign the roads to provide safe passage for all.

During the BioREGIO project, EURAC collected data concerning AVC from Romania, Hungary, Slovakia and Czech Republic in order to identify an additional impact of road infrastructures on wildlife connectivity. Currently road kills is still not considered, as a meaningful threat for Carpathians' ecological connectivity. However, the foreseen expansion of roads, motorways, and interchanges that is interesting all the Carpathians' countries creates the conditions for a higher impact of this phenomenon, both on wildlife and on humans. In general terms, all the Carpathians countries do not have a proper system of road kill monitoring yet and, although local people know which the most risky places are, much has still to be done to improve the situation.

Example: AVC in Serbia

Location: road 25-1. The road 25-1 runs along the Danube River at the northern border of Djerdap National Park (see Figure 2). In many locations (red dots), the road cuts the access to water for wild animals in an environment rich in wildlife species and individuals. The road is a 2-lanes national road, narrow and very curvy. The speed limit is 80 km/h. The road is used also by many bike tourists but there are no specific bike routes. The normal attitude in Serbia and Romania is to drive quite fast.

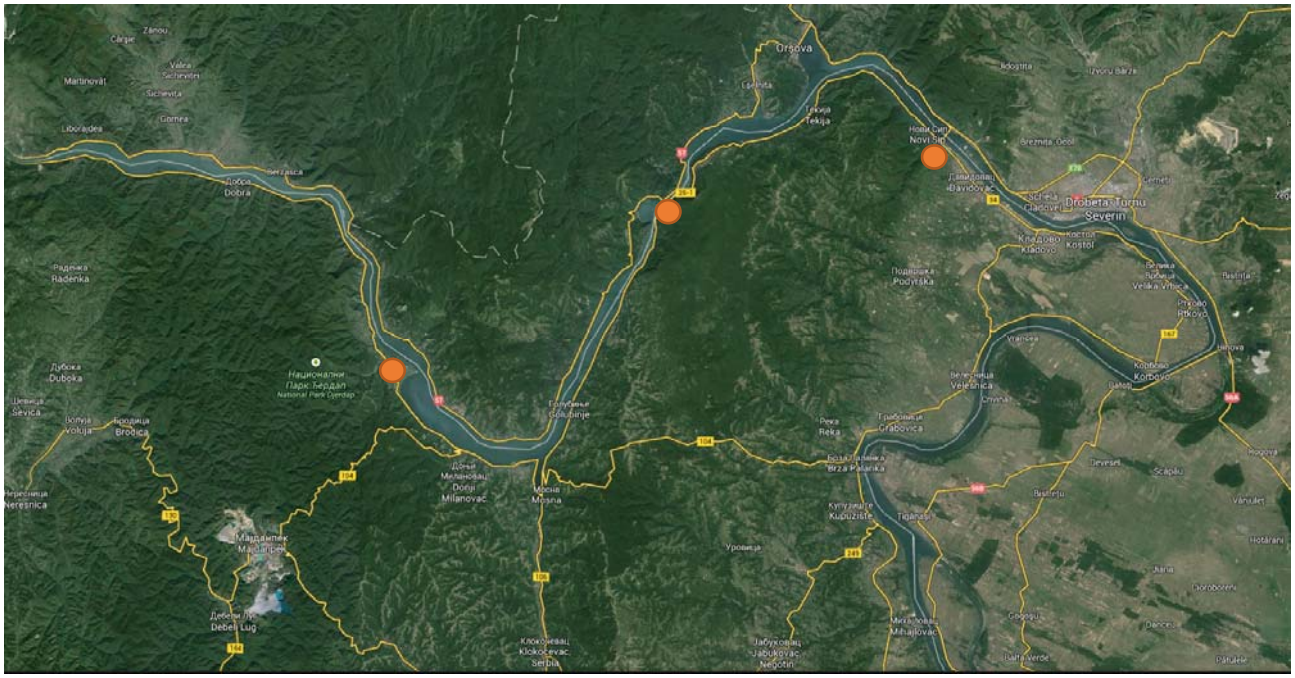

***Figure 19**: Road 25-1 in Djerdap National Park (Serbia) and locations of road kills hotspots (Google Maps).*

The major problem is represented by the cumulative effects given by the high speed of the cars, by the scarce visibility, the low awareness of drivers on this issue and the absence of fences, signals and mitigation structures. The main locations of wildlife crossing, identified by direct observation or by wildlife cadavers, occur at positions with a limited visibility situation, e.g., just after a big curve. There is no detection system to identify the road killers and no information are available concerning the real numbers associated with this phenomenon. The driving behavior and the absence of remote speed control are probably the main obstacles for reducing this phenomenon.

Location: road E-761: The same situation happens in the road E-761 between Boljevac and Paracin (see Figure 3). This road is highly frequented, with a speed limit of 70 km/h. The road cuts a forested area surrounded by agricultural fields. Also at this location, official data on wildlife road kills are not recorded, although leftovers and direct observations indicate clearly the evidence.

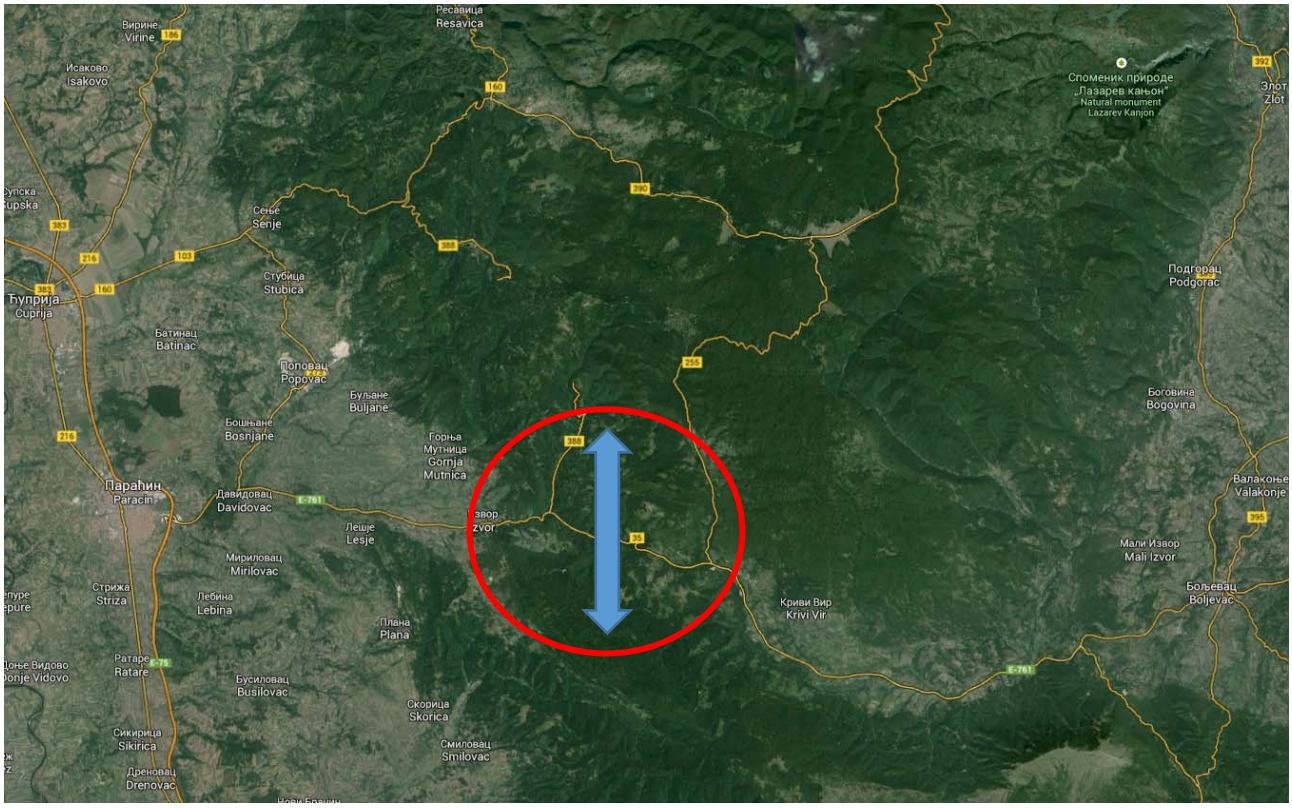

Figure 20: *Road E-761 between Boljevac and Paracin (Serbia) (Google Maps).*

The area has been detected by the BioREGIO GIS analysis as a probable passage sites for wildlife, connecting the Danube part of Serbia with the Balkans in Bulgaria. Direct observation by local people and researchers have confirmed this hypothesis. The presence of forest, agriculture and of edge habitats provide an ecological diversification what is attractive to many different wildlife species and individuals.

Unfortunately, this national road has a total absence of mitigation / prevention infrastructures and no signals inform the drivers that they are inside of a highly frequented wildlife area with a high risk of crossing wildlife. Also along this road, due to the absence of remote speed control, drivers are

used to drive over the speed limits. Many accidents happen between cars and wildlife but still no decisions has been taken to mitigate this situation.

Fences are present in some parts of the road (see Figure 4 – left) but their height, size and length does not represent a barrier for all the wildlife crossing.

Just as a comparison: the fences in the right picture of Figure 4 are those used in Hungary on the Motorways to avoid car-wildlife accidents.

Figure 21: *Fences along the road E-761 in Serbia (left); and fences along a Hungarian motorway (right) (photos by Filippo Favilli and Elisa Ravazzoli)*

Final considerations

The situation briefly described for Serbia finds analogies in many other locations of the Carpathian countries (Romania, Hungary, Slovakia, and Czech Republic). That makes the need evident, to find new solutions to wildlife crossing infrastructures, for reducing the costs and to tailor each type of crossing to the specific needs of species in various landscape contexts. In this new modernization era of Carpathians' infrastructures, there is an increasing need to repair existing and often crumbling transportation infrastructure. There may be opportunities to reuse adaptively some structures for wildlife crossing purposes, whereas new structures may test alternative and emerging sustainable materials at lower lifecycle costs. New solutions to the construction approach and material of crossing structures must also be considered in the context of long-term ecosystem change. The new structures should be adaptable to changing wildlife movement patterns due to changes in habitats, climate, or other factors that become apparent over time. This implies a continuous monitoring of the wildlife species present in a certain area interested by the AVC phenomenon. It is important to emphasize that this is not a new idea. Providing crossing in-

frastructure at key points along transportation corridors has been shown to improve safety, reconnect habitats, and restore wildlife movement. Throughout Europe, Asia, Australia, and North America, hundreds of crossing structures, or "ecoducts," have already been implemented successfully. That includes underpasses and overpasses covering the whole variety-range of size and design. Although wildlife underpasses are generally less costly to build and commonly more used by a wider range of species, wildlife overpasses are preferred by certain wide-roaming and iconic species-at-risk, such as lynx, bears, and wolves, for example. These structures should be joined by a large campaign of environmental awareness to underline that the best prevention system is always a correct driving behavior.

To avoid AVC conflicts and reducing risks, for both humans and wildlife, the BioREGIO project partners agreed on the following recommendations:

- Analyse the socio-economic impact of road kills
- Establish a monitoring system of the most risky road sections
- Develop national databases on AVC
- Share local and international experiences to know the available instruments for reducing the risks
- Railway kills have to be considered, too. It is assumed that railways can be controlled easier and are reducing significantly the risk of AVC in contrary to car traffic.
- Individual traffic like car traffic are most meaningfully affected. Reasons are:
    - Lacking facilities like information-signs to avoid road kills
    - Driving behaviors, lacking awareness and education

Strategies to avoid road kills:

- Special devices along the corridors to control the migration paths of the umbrella species spatially
- Herbivores are affected usually more from road kills – thus imitated "wolf eyes" enlightened form car-lights, should stimulate herbivores to flee.

4.2.3 Hunting procedures

The Carpathian landscape is dominated by forest and game species (mainly ungulates but also bears, lynxes and wolves). The forest offers an important link for connecting landscape patterns and has a high significance as a habitat. Forest workers, mainly hunters and foresters, may act as

promoters of its importance, and contribute actively to the establishment of an ecological network. They can theoretically contribute to the promotion of a sustainable use of the forest resources and contribute to the awareness raising among the population.

Appropriate hunting measures are extremely important for ecological connectivity, as it helps to preserve a near-natural forest and to create ideal conditions for sustaining a wide spectrum of possible species. Areas with no or limited hunting activities are used as core zones or stepping stone biotopes by more sensitive species and habitat restoration measures could support that.

The information gathered during BioREGIO site visits have highlighted several regional differences concerning the impact of hunters for promoting and restorating ecological connectivity.

In some Carpathian countries, hunting is a large business. The protection of landscape to sustain or to restore an ecological corridor has to face with all the related economic interests. Nature protection is less economically attractive than forestry and hunting.

The high numbers and densities of game species attract many foreign hunters. Hunters may pay up to 7000 € for shooting a bear in Romania. The economic income gained from the trophies is much higher than the one coming from conservation. Thus hunters may find the carnivores as their competitors (e.g., Hungary), because they reduce the number of game individuals. The idea of competition and that carnivore species are “a pest” for game management, stimulates the “protection” of game species to assure the economic income. Nevertheless even protected carnivores are killed by hunters and mainly poachers. The high presence of hunters and their negative relation with carnivores, in some countries, may push carnivores to other locations that are not enough suitable due to their habitat requirements and are not allocated close enough to any ecological corridor to enhance connectivity.

To summarize, hunters and game managers on one hand are considering mainly the economic benefits of applying their hunting rights and are thus avoiding the promotion of a strategy to stimulate cooperation among different actors and interests. On the other hand, hunters from other countries feel the presence of big carnivores (especially Lynx) as an ally in keeping game population under control.

The big challenge comes from the harmonization of the different and often contradictory interests among hunters, ecologists, gamekeepers and the local populations.

In some locations, due to an (estimated) oversize of game populations, farmers and foresters complain about the damages they create. In these cases the organization that manages the hunting area, where the damage occurred, is usually responsible to compensate damages. In some cases they may be extremely high, what consequently leads to a high conflict-potential.

The establishment of feeding points is a highly used technique to steer game species out of the forest to provide the “paying hunters” (mainly foreigners) a safe shoot. The presence of feeding point is helpful for the hunters, because it generates “easy preys”; it rises the economic income and keep game species away from causing economic damages in forestry or agriculture.

Big carnivores are themselves attracted by feeding points, too. The provision of prey at less suitable territories, can change their behavior. If they get used to the availability of prey and remain permanent at these marginal areas, they are more exposed to hunting and poaching.

Besides, it has to be considered that at many locations, carnivores and ungulates’ species have started to spread in territories where local people are not used to their presence. A higher wildlife presence creates fear among local people justifying the intervention of hunters for their safety. Elsewhere, where rural people are used to co-exist with wildlife, hunting has not that economic weight and the presence and damages by carnivores and ungulates are more accepted. As for other issues, the low awareness and education concerning the benefits coming from a restored ecological connectivity pose a serious barrier.

The core areas and least-cost paths identified in BioREGIO could be used, to identify the stripes of land necessary for the establishment or maintenance of ecological corridors. On the contrary, the information, where these species tend to pass, could be misused from poachers and hunters. Hence the proposal to dedicate stripes of forestland for the establishment of an ecological network has to be coordinated with the economic interests of the game management authorities.

Hunters may take a very important role in the preservation of ecological connectivity. They could help to identify the currently used least cost paths and to reduce the hunting pressure at local level.

Example: **Feeding points in Romania**

The presence of feeding point supports hunting. This attracts on the opposite also bears and thus they attend areas they normally don’t use. This changes their behavior. They start choosing less attractive dispersal paths as they get used to the food provided by humans (see Figure 6).

Figure 22: *An observation/hunting structure close to a feeding point (Brasov area, photo by Filippo Favilli).*

Poaching in many locations in Romania is under control by the game managers and hunters try not to shoot bears because the sector is benefitting from the “paying hunters” coming from abroad.

Connectivity is considered to determine the occurrence of hunting species (also bears) and to share the information among different hunting units. Bears’ shooting quotes can be shared among those hunting organizations. Hunters analyze the area and identify the crossing sites for wildlife. There are no studies on connectivity in many areas but locally they are known due to observations. In the area close to the city of Sibiu, hunters monitor NATURA 2000 sites, because hunting is allowed in these areas and to prevent poaching. An estimation of bear individuals is done every year, at the same time in two neighboring hunting units using the feeding points and signals of presence. Some studies on the genetics of bear populations gave contradictory results, without revealing whether the bears living at both sides of the valley belong to the same population.

In areas attractive for planning new motorways, local hunters should be motivated to collect data on wildlife crossing sites and to cooperate with road agencies to evaluate the real impact coming from the planned infrastructure. Hunters may then help in the identification of hunting ban areas, game protection and quiet zones and of game reserves. This would contribute meaningfully to steer various different interests.

Final considerations

The role of hunters in relation to ecological connectivity has to be derived from the social attitude towards big mammals’ species: in countries where hunting has a high economic weight, the concept of ecological connectivity needs more time to be accepted. The preservation of ecological

corridors from hunting and forest works can be obtained only through a long process of awareness raising among the local populations, highlighting the benefits coming from a maintained ecological network.

The information gained have highlighted the need for the following recommendations:

- Increase of cooperation among different hunting units: state owned hunting areas, private and fenced hunting clubs or private land owners should have the permission to hunt.
- Definitive hunting quotes should be allocated every year to each game species. Forest or national park rangers should be responsible that this quotes are achieved or not exceed. They have to count each shot game-animal.
- In Slovakia particular agricultural sites are fenced to avoid potential damages from wildlife.

4.2.4 Forest

Forest Management and ecological connectivity*:* Adaptation of forest management measures in silviculture and harvesting practices can improve the habitat quality for particular umbrella species and thus the appropriateness for ecological connectivity. Particular linear afforestation strips could connect large forested areas or improve the heterogeneity of landscape. This enhances the dispersal options for wildlife. Awareness for measures like that to promote the maintenance of ecological connectivity are among foresters still low. Thus initiatives would be required mainly at the local level. Hereby the local knowledge of protected areas are playing a major role, although their territorial contribution to connectivity is usually only of minor relevance.

To enhance connectivity at locally, foresters and forest managers have to focus on their joint-up thinking to which they are used in terms of silvicultural treatments at different forest stands concerning the different functions a forest site has to fulfill. Nevertheless they have to include also the demands and requirements of other “users” like people seeking for recreation as well as hunters and game managers. Partly the contradictory interests are sometimes causing a conflicting situation. If e.g. agricultural land is affected from game damages or afforestation, conflicts are programmed as this reduces their income. Besides, through an applied knowledge transfer, these economically driven conflicts are more likely solved with politically granted subsidies. They are capable to compensate the territorial loss and to initiate a rethinking of farmers. Regulations and guidelines for sustainable forest management should particularly be considered for maintaining protected areas but also beyond protected and forested territories.

Due to the numerous initiatives in the past, the state owned forest association Romsilva in Romania and different other forest associations are considering rules of sustainable forest management – mainly regarding harvesting techniques and silvicultural programs. For instance in the case typical and site adopted tree species like autochthone broad leaved tree species are replaced by coniferous tree species. The ecosystem of fir (douglas fir) or spruce is much different. These secondary coniferous forests planted for economic reasons have usually not any soil-vegetation. Concerning ecological connectivity this remarks a reasonable barrier for animals used to structured broad leaved forests with different tree species and a heterogeneous vegetation.

Nature conservation versus economic interest in forest areas: To raise awareness and to maintain the population of large carnivores, the two-annual reports to the EU on NATURA 2000 species is an instrument to put pressure on the hunting and forest management sector. Contradicting to that is the common responsibility of the ministries that are sometimes sharing

nature conservation, forestry and hunting. As particularly in the Carpathians the majority of forest areas are state owned, the economic interests of forestry and hunting are traditionally on a higher priority. This economic purpose corresponds with the opinion of the rural society. People are convinced that only forestry creates jobs and income for the rural area, while nature conservation is from their view not able to. Hereby it is a disadvantage that only a low percentage of protected areas have management plans but not enough money to implement them, although the EU provides subsidies to enhance nature conservation and biodiversity.

Low income and poverty in rural Carpathian areas may be one of the main reasons of the persistency of illegal hunting and logging. Additionally, it is well known that legal prosecution to uncover the offenders is nearly impossible.

In contrast city-people are strongly supporting the conservation approach and have herein a strong voice to claim for conservation measures and management plans to maintain the ecological continuum and biodiversity. Maintaining ecological structures is a main purpose in the Carpathians, whereas in Western European countries and the Alps the restoration of ecological corridors to reduce landscape fragmentation is of greater importance.

Forest versus game management: Due to economic interests we have to face here contradictory interests among hunters and gamekeepers versus forest and protected areas managers. Particularly game-keeping in forested areas requires to protect animals with fences from predators or on the other hand forest stands foreseen for economic use are fenced to protect them from game species. Both realities may interrupt dispersal paths and thus connectivity. On the opposite restrictions of legal acts are sometimes harming economic interests in harvesting trees, particularly when they protect large carnivores. Here forest management can become a main threat for these animals, when the legal act states that only forest stands can be harvested, if large carnivores are thereof not impacted. Thus forest managers remove them usually from forest stands foreseen for being harvested. In that case foresters are collaborating successfully with the hunting community, as also they still see the predators like “pests” for game species. And in general the results of the corridor model applied in BioREGIO plays here a contradictory role, as the most probable pathways delineated for carnivores makes their detection and hunting easier.

Prevention from road & railway kills: Along infrastructures like roads and railways the task of forest management is to prevent the animals from crossing roads or railways. Therefore it is required to create intelligent guidance systems with natural and artificial fodder-grounds that guarantee a save landscape dispersal. On the other side forest management has to take responsibility to share or to cover the costs for installing and maintaining fences along roads and railways touching forested areas to protect animals from getting killed. Fences at the edge of forest

areas or along hedges are leading the animals to green infrastructures like eco-ducts or subways to cross roads or railway tracks safely.

Recommendations regarding forest management in order to make it a positive contribution to the development of ecological connectivity can be summarized as follows:

- Awareness-raising among foresters and farmers regarding ecological connectivity and their contribution to the establishment of an ecological network: These ideas and concepts should become self-evident for sustainable forest management. This has to be agreed with several stakeholders to be in line with Natura 2000 areas, the Environmental Impact Assessment (EIA) as well as with the certification conditions of the Forest Stewardship Council or the Pan-European Forest Certification (PEFC).
- Management plans should include forest/agricultural territories and NATURA 2000 sites. Ecological corridors and herein also stepping stones should be included as relevant ecological elements in forest planning.
- Forest plantations for gaining energy wood or Christmas trees should be fenced to protect them from any damages.

4.2.5 Agriculture

Farms and carnivores: The size of intensively used agricultural fields are for most species a barrier and even a dangerous trap for dispersal and ecological connectivity. Hence monoculture fields would require at least some landscape structures as stepping stones for covering and orienting. Besides, the application of technical harvesting machines as well as the application of herbicides and pesticides has to follow standardized rules to minimize the killings of dispersing animals. Such farm types are rather typical for the foothills and the fringes of the Carpathians, whereas in the Carpathians subsistence and semi-subsistence farming is more common. Concerning the presence of large mammals, the situation differs from place to place. In many cases farmers are used to them and to the damages they may cause and have accepted to live in this coexistence. Losses of breeding-animals or damages at bee-houses are avoided by holding dogs and the permission to shoot this animals if they attack human facilities. Farmers are advised to fence their territory preventively, as this is a precondition to claim compensation-payments for damages from carnivore attacks. Occasionally sheep in the mountains are killed by large carnivores and farmers have to face with a compensation system that is not everywhere regulated and transparent. In particular situations the authorities or the hunters associations are paying, but the whole process-cycle needs to be considered.

As farmers in rural areas are sometimes less experienced with legal restrictions and bureaucratic procedures, it is highly recommended to install an advisory-service centre to throw lights on policy measures and legal restrictions to enable those remote located farmers at least the possibility to access public funds to reimburse the created damages.

Farming and game-keeping*:* Usually this is not *per se* contradicting. Only in the case of game-keeping the overpopulation of game species for economic reasons causes damages in agriculture, what makes conflicts unpreventable. The operators and their hunting guest are often not residents or even from abroad and are thus less caretaking in nature conservation. Normally they are not interested in carnivores but rather on their prey-species (wild boar, red or roe deer) carrying hunting-trophies. Damages to farmers are compensated by those hunting clubs directly. As farmers are becoming even less tolerant to the damages their attitudes towards large mammals is not positively driven. To cope with these problems in the long run and gain trust among the farmers, two solution variants are discussed. Either these hunting clubs are restricted to fenced private land what is even negative to ecological connectivity. For the case hunting activities are applied on state owned territories, responsible authorities should introduce particular hunting permissions that enables them to supervise hunting activities, to control the game species populations and thus to limit damages.

Wind-farms and flight paths of birds*:* Wind farms are obviously disturbing the flight paths of birds and are moreover impacting the habitat-attractiveness for large animals negatively. The allocation of these wind parks should thus concisely consider in an SEA or EIA the effects of the rotors and the produced noise on the fauna and biodiversity.

New planned infrastructures and farming*:* If the territory where new infrastructure facilities are planned is covering agricultural land, an agreement on selling prices has to be found, which usually varies between utilized agricultural area and industrial territory. For those cases the land is not intensively cultivated or the proprietors even don't have any relation to their agricultural land anymore, these (new) farmers are most likely interested in selling their land. On the other hand, those farmers economically addicted to agricultural production and who are often strongly integrated in the local network, are not willed to abandon the management of their agricultural land. This requires the development of alternative variants or other compromises. To sustain ecological connectivity, eco-ducts or subways along these new infrastructure facilities are installed as this is required in the SEA and EIA to offer save crossing-passages to wildlife and to avoid road kills. These infrastructures should be well integrated into existing ecological structures like stepping stones and linear corridors. As along this ecological networks agricultural damages cannot be avoided, legal regulations (contracts on nature conservation) have to be defined to reimburse the incidental damages through wild boar, red deer or carnivores from public funds.

Concerning agriculture, the main issue in the Carpathians is land abandonment, more than damages of wildlife. Especially young people move away from agricultural lands to main settlements.

To deal adequately with the theme of landscape fragmentation and ecological connectivity it would be best to include it as a measurement in the agro-environmental program of the rural development plan. In this case it would be required to estimate the costs, which may evolve for compensating the agricultural fields, allocated to ecological connectivity like wind shelters and comparable stepping stones.

For sustaining these stepping stones and to motivate farmers to support connectivity a contractual mechanism needs to be installed. Therein a kind of “Trust-Fond” could be appropriate to sustain a heterogeneous landscape structure and avoid landscape fragmentation. The planning procedures thereby should be conducted by the local authorities. Here the fear could be faced that the plans and measurements foreseen are good designed but unfortunately not adequately applied. Hence the donors “the Trust Fond” for instance should only agree on the distribution of subsidies if the process is prepared and implemented correctly.

Integrate measurements to foster ecological connectivity as an agro-environmental measure in the rural development plan (2014-2020) would be a preferred option to claim support from the European Union to find at least a compromise to solve the land-use conflict.

The agricultural sector in the Carpathians needs a new vision and forecast, in order to conserve existing structures, avoid land abandonment and enforce new measures.

4.2.6 Trans-boundary issues

Both strategic environmental impact assessments (SEA) and environmental impact assessments (EIA) of projects having a significant impact on environment, as well as assessments of the impact on Natura 2000 sites, can provide the comprehensive warranty for the protection of natural values. Both assessments take into consideration both the findings of environmental impact study and the results of consultation with specialized environmental authorities and the public, before authorizing a plan or a project. The environment and/or Natura 2000 impact study should, however, stress biodiversity and ecological connectivity-related issues, thus ensuring a sound implementation of Natura 2000 legislation and an effective national biodiversity and ecological connectivity protection; exemptions should be limited and granted on a stricter basis; public participation in the procedure should be enhanced especially in trans-boundary context.

Management plans are key management documents for protected areas. They provide the basis for ensuring ongoing management of protected areas or their buffer zones and for protected areas of international importance. Only a few protected areas approved valid management plans. Thus protected areas do not have clear and concrete rules on how to restructure and organize their territories. At the same time, protected areas apply simultaneously other plans or programs, which influence them – like: forest management plans or municipal and regional land-use plans. Thus, both at national and cross border levels, it is recommended to integrate all approved and applied management plans for each of the protected areas into one management plan to avoid their mutual competition and use protected areas in accordance with their original purpose. The main issue, in this case, is the differences in legal requirements and frameworks for spatial and landscape planning which prohibits the establishment of unique management plans for trans-boundary protected areas. Additionally, the identification of common interests and topics of protected areas (PA) operating in a trans-boundary surrounding would encourage to anchor guidelines on common trans-boundary aspects and decisions taken in a “Memorandum of Understanding (MoU)” which would be available to different PAs dealing with trans-boundary issues.

In different Carpathian countries, similar category names of protected areas are applied to sites that diverge in terms of the protection regime, thus a harmonization of definitions and related protection regime should be promoted especially in trans-boundary areas.

As for cross-border natural areas, besides bilateral/multilateral and international agreements, other instruments, such as the European Grouping of Territorial Cooperation (EGTCs) regulation, should be further developed and adopted by Member States (as foreseen by the EU-Commission), regional authorities, local authorities and/or bodies governed by public law to facilitate and promote specifically cross-border, trans-national and inter-regional cooperation in favour of ecological connectivity.

Cooperation, interfaces and coordination among trans-boundary protected areas and between EU/non-EU state should become more intensive. An open collaboration should be aimed and compromises for solving problems should be found. Herein the centralization of competences would be contradictive.

4.2.7 Hunting laws

Hunting Law Acts are commonly approved at state level, however they often contain (e.g. Poland) direct authorization to local organs to adopt sub-national acts, which may constitute a derogation

from the national law and lead in fact to a diminished protection of some species. Thus, derogations should be limited and granted only under strict conditions: preventing that at local level species are not protected.

In some of the Carpathian countries, hunting laws are only in fragmentary compliance with the EU legislation, in particular with the EU Bird Directive. Some infringements procedures have been already initiated by the EU Commission against Carpathian countries, e.g. Infringement procedure against Slovakia – No. 2012/4003 – for inappropriate implementation of Art. 2, Art. 7.1, (3) and (4) and Art. 9. (1) and (2) point. b), c) and d) of Directive 2009/147/EC on the conservation of wild birds. The reason is the lack of protection of selected bird species and discrepancy in the Nature conservation regulations and the Hunting regulations, especially the fact of missing the so called 'non-hunting zones' in some Special Protected Areas. EU Court of Justice has already delivered Judgements against some of the Carpathian countries to this regard (e.g. European Commission vs. Republic of Poland, Case C-192/11, in which the Court declares that by not applying national conservation measures to all species of naturally occurring birds in the wild state in the European territory of the Member States, which are entitled to protection under Directive 2009/147/EC on the conservation of wild birds, and also by not correctly defining the conditions to be complied with in order to be able to derogate from the prohibitions laid down by that directive, the Republic of Poland has failed to fulfil its obligations under Articles 1, 5 and 9 (1) and (2) of that directive. Thus, national legislators shall integrate without delay (if not done yet) hunting laws with the Natura 2000 legal framework and authorities shall improve their enforcement both at national and local level.

In some Carpathian countries (e.g. Slovakia) sensitive species (e.g. *Canis Lupus* L.) are not protected, and can be hunted, previous a permission from the provincial government (NUTS2). Thus, legislation should grant protection to these species as they do not longer exist in most of the countries of the European Union.

Although wolves are protected in Romania, selective hunting is applied to control their population. It is in the competence of the provincial government (NUTS2) to provide license for wolf hunting.

4.2.8 Urban sprawl and settlement expansion

Not only the construction of big infrastructural projects, such as motorways, but also small intervention at local scale have an impact on ecological connectivity; this is the case of the expansion of settlements and urban sprawl. As in Figure 7, settlements that are continuously interested by the "visits" of bears, need to adopt strategies to limit their impact. The bears are

attracted by garbage and, although they do not cause any harm to local population, their presence is a serious disturbance.

***Figure 23**: A "bear-safe" garbage-collection-place (Băile Tuşnad, photo by Filippo Favilli).*

Two contrasting factors have an impact on this issue. On the one hand, the rapid socio-economic transformation are resulting in the willingness of local communities to expand dwelling areas. In this context, there is often an underestimation that even minor changes in the local settlement expansion, such as the allocation of garbage collection place (see Figure 7), can have an effect on the behaviour of selected species (such as bears), especially in rural areas. Small intervention like the one in Figure 8 may prevent bears to make damages and stimulate them to find alternatives for their movements. Parallel to this process, urban sprawl and (illegal) settlement extension can be driven also by the expansion of specific sectors.

***Figure 24**: Example of urban sprawl in a peripheral zone in the Carpathians*

One example is the tourism sector, where growth often underlines the subsequent expansion of the hospitality and leisure infrastructure. Legislation and planning procedures are the main instrument of intervention in order to discipline the phenomenon; nevertheless, especially at the levels of small communities, the regulatory framework and the enforcement can have a low effectiveness. Moreover, shared approaches to spatial planning among different municipalities are still not widespread; this result in a fragmented planning also in small areas. Finally, the spatial planning regulation at local, regional, national and Carpathian level does not integrate the concept of ecological connectivity and ecological corridor.

Impacts are multifold: on the one hand, the penetration of urban features into the landscape can affect important areas for feeding or breeding; on the other hand, the expansion of settlement can change the behaviour and the movements of selected species due to fencing or disturb. Finally, fragmented planning among municipalities or provinces can result in a loss of connectivity.

While the drivers of this expansion (such as the creation of new touristic attractions or new dwellings) are positive signals of economic diversification for local communities, there is the need to intervene in a planning phase in order to avoid negative impacts of the phenomenon.

Possible recommendations regarding this field of intervention should address the following points:

- Add the concept of ecological connectivity in local spatial planning, in order to adequately address land – use change phenomena.
- Enforce spatial planning regulation and the integration of different planning levels.
- Make a management plan obligatory for protected areas.

- Promote inter-municipal plans for municipalities from the same geographical area (for example, a valley), to share infrastructures commonly (like garbage disposal areas) and to be able to design ecological corridors at inter-municipal level.
- Elaborate a foresight-analysis concerning potential urban sprawl and uncontrolled settlement development due to the new motorways.
- To avoid urban sprawl and probable conflicting targets concerning landscape fragmentation, facilities to sustain connectivity should also be included in the agro-environmental program.

4.2.9 Ecological connectivity: beyond protected areas

One of the main obstacles that can be highlighted in the promotion of ecological connectivity is the diffused perception among different stakeholder groups that a protected area is needed in order to make an ecological corridor. As the site visits in the overall Carpathians have shown, this perception is widespread among different actors at local, regional and national level, even among actors that are responsible for protected areas and conservation.

While the legislative aspect remains essential for the establishment of protected areas and nature parks, which constitute the essential ecological structure whose connection ecological corridors must protect, the preservation of corridors can be achieved also through a combination of legislation and practices of sustainable integrated management.

***Figure 25**: Agriculture in mountain environments and its interaction with other relevant features regarding ecological connectivity (such as roads).*

This is particularly relevant where economic activities, such as forestry and agriculture, are in place. Here corridor development strategies can be combined with adequate incentives to land owners for the sustainable maintenance of these zones according to connectivity criteria. One main advantage of such integrated management is that it could also be advantageously carried out at transnational level, where the presence of different legislations could be a main barrier.

Possible recommendations regarding this field of intervention should address the following points:

- It is essential to highlight the potential ecological corridors through reliable models, in order to show up the areas where a sustainable integrated management should be fostered.
- Abandoned lands should be integrated in the restoration of corridors.
- The relevancy to maintain or restore ecological corridors should become also part of landscape and spatial planning – e.g. in Slovakia this is already considered in the "territorial system on ecological stability".
- Legislation should be combined with sustainable practices in agriculture or forestry.
- Adequate incentives should be allocated to private landowners and firms in order to promote an integrated management.
- Adequate prevention and compensation measures for damages should be developed.

4.2.10 Compensation of damages

An effective approach to ecological connectivity should address the different steps in which conflicts between human activities and wildlife can arise, starting from the planning, through implementation up to the management of possible conflicting events. In this framework, a reliable and clear system of compensation of damages caused by wildlife is essential, since it can strengthen the trust of the local communities in the authorities responsible for nature preservation and wildlife management. This can also lead to a more positive attitude towards initiatives aiming at promoting ecological connectivity.

There are several factors that hinder an effective application of compensation mechanisms: one of these is the lack of transparency and clarity regarding compensation. Often, local stakeholders do not have a clear idea of who can benefit from compensation, what can be compensated and how to access the compensation scheme. Moreover, this situation is influenced by an uncertain governance of the management of damages caused by wildlife in specific case, for example those caused to cars in a road collision. In this case, the different authorities involved may not have

regular structures of dialogue (e.g. regular meetings or exchange) and often there is a lack of coordination in the intervention after a damage occurs. This affects the recipients of compensations, especially in a case of a scarce coordination between the authorities that should evaluate the entity of the damage and the ones that should compensate the damage.

A situation of uncertainty could discourage the application for damages compensation and could foster a negative attitude towards measures for ecological connectivity and the coexistence between wildlife and economic activities. Moreover, a lower rate of report of damages by private citizen can also represent a negative aspect in the monitoring system of wildlife presence and associated damages, which could profit from precise and updated information.

Recommendation in this aspect should therefore address three main points:

- Improvement of governance of compensation mechanisms: a positive coordination among all the authorities responsible for an intervention in case of damage should be promoted, for example through regular exchanges and meetings.
- Improvement of transparency and promotion of compensation mechanisms: a clear communication to private citizens should be promoted, in order to clarify who can be the beneficiary of the compensation system, the amount, the conditions, and which are the steps in order to receive the compensation. Specific attention should be given by the local authorities to the information and promotion of forms of damages prevention and related schemes (e.g. insurances).
- A clear system of complaint management should be set up and fostered in order to increase the trust of citizen in the responsible local institutions.

4.3 Recommendations for national strategies regarding ecological connectivity in the Carpathians

The final guidelines produced at the end of the BioREGIO project wanted to give a general overview of the main barriers that, at current time, or in the future reduce the general permeability of the landscape. Due to the fact that each country has its own story, landscape structure, laws, socio-economic environment and relationship with the local wildlife species, the ten final guidelines did not want to be comprehensive for the whole Carpathians mountain range.

Ecological connectivity means working with communities to find solutions that are practical and that may provide mutual benefits for humans and wildlife. It has to be taken into consideration not only the perspective of science but also of residents, farmers and industry. In order to better plan future projects and local activities, each project partner was asked to rank each of the produced guidelines and to explain their choice. With these national evaluation the WP5 partners were able to produce specific strategies for each country to sustain the national ecological network and give an outlook on priorities the single countries should focus at when considering ecological connectivity in any national guideline or strategy they may develop.

4.3.1 Slovakia

Due to the close collaboration with the state nature conservancy, the organized site visits and the contribution of Slovakian experts at the workshops during the mid-term and final conference we received a quite broad view on the Slovakian situation. Generally spoken, the environmental awareness of both people and politicians in Slovakia appear to be still quite low. Particularly after joining the EU – where the priorities are put on Natura 2000 sites – responsible people felt insecure as they thought the new legal acts will be less practical than their former conservation approach from the socialist era.

Anyway Slovakia is suffering from the need to design a national plan on connectivity as new-infrastructure facilities are planned to foster the “economic connectivity” between Bratislava and Košice. This would require a proper coordination to apply the environmental impact assessment (EIA) and to give the society a proper time to announce their doubts to react on planning strategies. In this process Slovakia is benefitting from the already applied tool on “Territorial System of Ecological Stability” that fosters ecological connectivity, which unfortunately is still lacking in being implemented as designed. Due to its practical relevancy there is the idea to integrate this system at the EU level for maintaining and restoring ecological networks.

Concerning the installation of new road infrastructures to enforce the economic corridor between Bratislava and Košice, the EU membership foresees proper Environmental Impact Assessments (EIA) before constructing new motorways. Due to that, the D1 motorway planned to be built through the Malá and Veľká Fatra National Park was stopped. Nonetheless, studies on ecological connectivity have been done, but they remain at the “report level” without a proper application in real cases.

Besides it seems that the theme of Animal-Vehicle Collision does currently not have an optimistic prognosis. A national database or any mitigation measures foreseen to cope with this aspects have not been installed yet. And up to now, only two green bridges are connecting patches of virgin forests. To summarize the statements of various stakeholders, Slovakian politicians responsible for constructing infrastructures, don’t have a sufficient awareness and sensitivity for questions on landscape fragmentation and ecological connectivity.

Although the Slovakian Territorial System of Ecological Stability lacks in implementation, it is foreseen that the measures are considered also in the spatial planning act. There are also foreseen migration corridors for big animals – but currently not "applied" on the ground. Thus there are no urban and landscape plans to control urban sprawl. Regulations are still mainly unapplied – leading to the loss of ecological connectivity. Thus stepping stones and ecological corridors should be included in the forest management plans as sustainable managed forests are either business orientated and support targets of biodiversity.

Regarding policies beyond ecological protected areas, Slovakia has a need to foster the economy. That creates pressure on the National and Nature Parks. Environment authorities lack the political power to enhance landscape permeability as capacities and money for nature conservation are continuously reduced. Herein the impact of the now usually designated IUCN-V areas have only a weak protection effect. This underlines that nature conservation is not a major topic in the Slovakian policy. This lack of interest can be seen also in water and river basin management, important to protect from floods, and is on the other side a relevant corridor element. The problem is that farmers do not want to give up their agricultural managed land and there is no strategy for compensation from the public authorities. Furthermore, hydropower plants are causing problems to connectivity along the river – for the otter and the fish.

Slovakia is in need to adopt a multi-layer and multi-sectorial approach in order to raise the general population awareness on environmental topics and put different actors and interests at the same table.

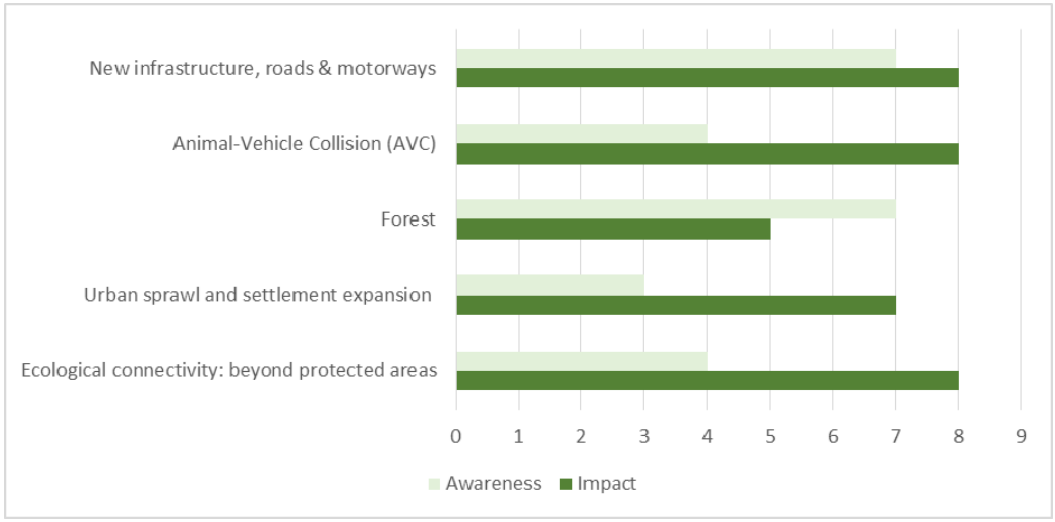

***Figure 26**: Essential Guidelines to sustain Ecological Connectivity in Slovakia concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.2 Czech Republic

No site visit was performed in Czech Republic. The information and recommendations were provided from the partners' view, which considers the common situation of ecological connectivity and continuum in the Czech Republic very generally.

Nonetheless of the organizational problems of the Czech partner in the SEE program, the Czech Republic is very active in identifying conflict areas. They particularly put emphasize on animal-vehicle collisions or on the adoption of the best mitigation strategies as they are aware of the barriers new foreseen motorways could pose for connectivity. Thus for these new infrastructures the road planners have foreseen at least some new overpasses (eco-ducts), underpasses and tunnels in an appropriate way. The problem is worse on old highways that weren´t equipped well with these mitigation structures. The idea of adding eco-ducts or creating underpasses on existing roads is gaining concrete opposition at the political level and is registered as a loss of money.

As in Slovakia, the general environmental awareness is still quite low although Czech Republic is also running a Territorial System of Ecological Stability. Since the modernization and the construction of new infrastructures is seen as a priority that could gain growth for the state general economy, whereas environmental protection issues are considered as less important in the short time view.

Besides, Animal-Vehicle Collision (AVC) is causing main problems on roads of first category as well as at lower road categories. Information are taken from a database that records continuously in a monitoring system car accidents with animals.

As observed in other Carpathian's countries (e.g. Slovakia, Romania and Ukraine), additional threats for wildlife and nature conservation come from poaching and illegal urban sprawl. Hence in general, more focus should be paid to management plans and spatial planning procedures in relation to migration corridors and especially to their critical sections, where free animal movement is expected to be restricted.

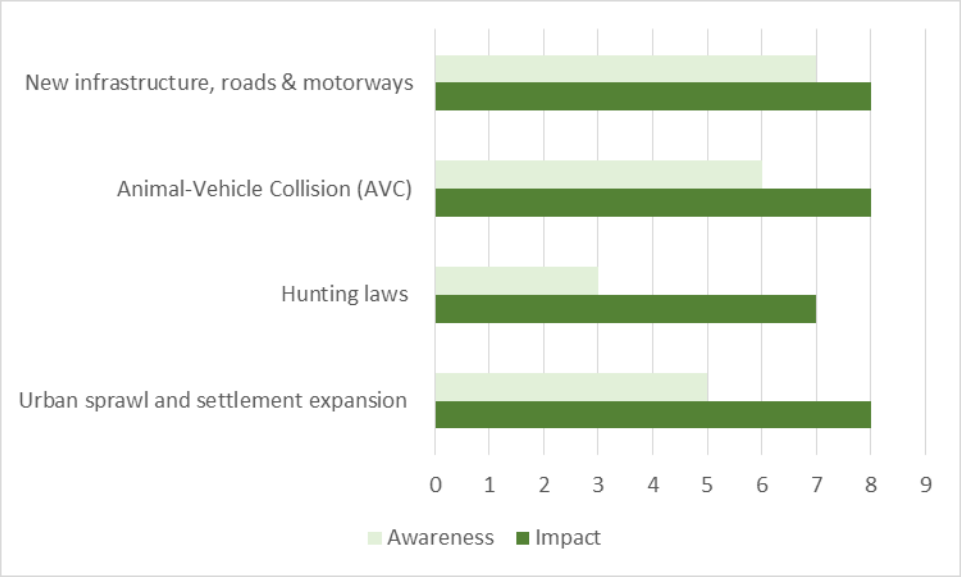

Figure 27: *Essential Guidelines to sustain Ecological Connectivity in the Czech Republic concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.3 Hungary

In Hungary, the dominating aspect is economic income coming from the exploitation of nature. Nature conservation gains less money than hunting, forestry or agriculture. Hunters and foresters' lobbies have a great decisional power regarding the usage of natural resources, both inside and outside protected areas. National Parks, although striving for nature conservation and awareness raising, have a limited power even inside their own territories.

Forest management makes a great use of fenced areas, due to different reasons and interests: (1) protection against damages at forest trees from game species; (2) fame farming for meat production (small areas); (3) hunting gardens (> 200 hectares). And secondly due to economic reasons native tree species are replaced by foreign species – like beech trees, which are in hilly territories sometimes substituted by spruce or silver fir, what is causing an obstacle to species dependent on beech forests.

Thus, the ecological corridor approach has to consider the habitat requirements and ecological habits of species: large-scale sustainable forest management does not necessarily correspond to the needs of species. Also those species which used to live on wide and open territories and avoid forests have to be considered. And awareness has to be put on the seasonal impact. During winter, when there is the tree-harvesting season, the workers are causing stress to the animals when they are in a recovering phase as fodder is rare and moving (fleeing) in the snow costs a lot of energy.

Besides, the hunting regulations are more likely to promote the economic interest than ecological requirements for nature protection. The hunting right is at the owner of the land, but only the state can give the permission to shoot the game. That's not unique to Hungary only. Romania applies the same regulation. Hunting gardens or hunting farms are renting these hunting rights from other land owners. It is their interest to gain these hunting rights to breed a high number of game species to guarantee attractive trophies for their customers. On the other side forest owners, from whom they have rented these rights - independent if state or private owned - are suffering from damages the game species are causing to trees and soil. Sustainable forest management procedure is here competing directly with intensive and economically driven hunting interests. As these hunting territories are usually fenced they become a 100% obstacle for ecological connectivity.

Concerning the social perception, there is a great difference in environmental awareness comparing people from the cities and people from the countryside. "City people" have an emotional approach to nature even beyond protected areas. They wish to have more "green areas", and to observe wildlife in their native environment, while rural people have a more materialistic view,

suffering from the conflicts they have with wildlife and influenced from the target to gain as much economic income from nature as possible.

Thus Hungary needs to find the “middle-way” between economic interest and nature conservation, developing programs for environmental awareness and projects to study the benefits coming from a functional ecological network, both ecologically and economically.

Figure 28: *Essential Guidelines to sustain Ecological Connectivity in Hungary concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.4 Romania

Romania is subjected to big new motorways construction. Due to the EU regulations, studies on ecological corridors and recommendations for planners are available, although they are remaining at paper level. Nonetheless, negotiations with the highway administration are going on to decide the best motorways alignments providing less impact to nature.

Regarding forest management, in Romania, large fenced forest areas are not a big problem. Much more relevant would be particular harvesting strategies to maintain protected areas. Romsilva, the state owned company managing the Romanian state forests and other private forest associations and owners should follow a sustainable forest management strategies that consider also measurements to foster ecological connectivity. A feasible procedure to guarantee that could be the introduction of a permission fee for harvesting that is only provided to forest holders following a sustainable forest management strategy. Another comparable approach would be a certification procedure, in which measurements fostering ecological corridors are considered in the evaluation.

In none of the Carpathian countries agriculture was announced to have a meaningful impact to ecological connectivity. In Romania this seems to be different. The maintenance of the typical patterns of agriculture in the foothills of the Carpathians in south Romania is causing land use conflicts. Agro-environmental compensation payments were designed and foreseen but are practically not applied yet. Hence, this traditional agricultural landscape patterns are for that reason integrated into large intensively managed agricultural fields, where each square meter is used. There is no space anymore for wind-shelters to avoid soil-erosion or diversified agriculture patterns for offering the species little options for coverage or orientation.

Intensive agriculture in the Carpathian Convention territory of Romania is usually not very common. Usual are subsistence and semi-subsistence farming. Normally the farm holders are fencing their agricultural land, which is not influencing connectivity a lot. This small-structured agriculture creates diversified landscape patterns, which is supporting the connectivity and ecological corridors. On the opposite, land abandonment can become an obstacle for some species adopted to agriculturally cultivated landscape structures, when the fields are gradually changing to forested structures.

Hunting in Romania is often practiced for economic reasons: private forest owners in Romania are not the owner of the animals, and hunting rights are distributed to districts by the ministry of environment. Usually the hunting permissions are given to large entities, in which private landowners can become a member to apply their hunting rights. Hence, the state and mainly the ministry of environment has the central coordination for hunting procedures. Thus the limits, restrictions and guidelines of the ministry for giving the permission, could also include measurements to sustain the population of large carnivores and their habitats. On the contrary hunting procedures like feeding point could cause a disliked situation, when some mobile species (wolf and bear) are changing their migration behaviour, as they are used to follow ungulates that are attracted by hunters to these feeding points. Mainly bears could become more confident to human society, which may lead to conflicting situations even in densely populated areas.

Due to the large numbers of wildlife species and individuals, it is essential for Romania to develop a national strategy to combine and valorise human and wildlife needs, which may bring several benefits, from a health and socio-economic points of view.

Apart from this general recommendations for Romania, site visits have highlighted particularly the problem of urban sprawl which is almost impossible to detect and to stop, due to the remoteness of locations compared to the central government and to the low updating of maps. Together with developing programs for environmental awareness, Romania should increase the presence of authorities to raise the state power in remote areas. If people feel protected from the state and

involved in the decision processes, they may stop to use nature in an unsustainable and legally not acceptable way. A higher control could help solving several local problems and meanwhile a vision could be created enhancing the respect between nature and human society.

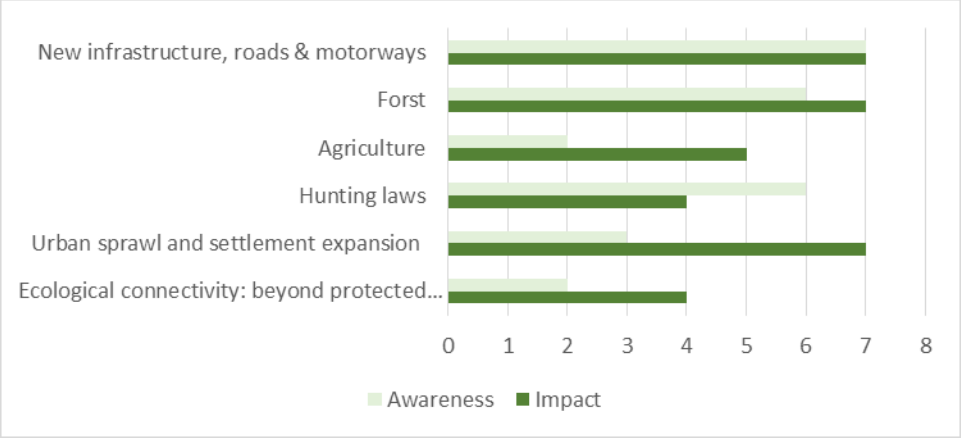

Figure 29: *Essential Guidelines to sustain Ecological Connectivity in Romania concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.5 Serbia

The main problem highlighted during the explorative site visit is the total absence of a road kill recording and monitoring system. Road kills are frequent on national roads but no mitigation strategies are applied yet nor in development. The general awareness of drivers is low and there is no concern related to the impact of wildlife-car accidents on human health and wildlife populations.

Serbia should develop more programs for raising drivers' awareness on this topic and start to identify road sections of higher risk for collision and to install there mitigation structures.

This problem does not affect only wildlife and human health, but has several repercussions also in the touristic attraction of the country. National roads running along the border of National parks, protected areas, wetlands or riverbanks, are usually highly frequented by bike tourists. The absence of bike routes and mitigation structures for avoiding wildlife-car accidents, together with the general habit of very fast speed driving, may discourage tourists to visit this sites.

A national/local strategy to combine touristic opportunities with a higher nature protection and valorisation of cultural sites, may bring several benefits to the protected areas themselves and to the general image of the country. Hence it is highly recommended to apply more studies to

connectivity and adopt a comprehensive strategy on road kill mitigation and prevention. Moreover this helps to get prepared for attaining EU standard and rules.

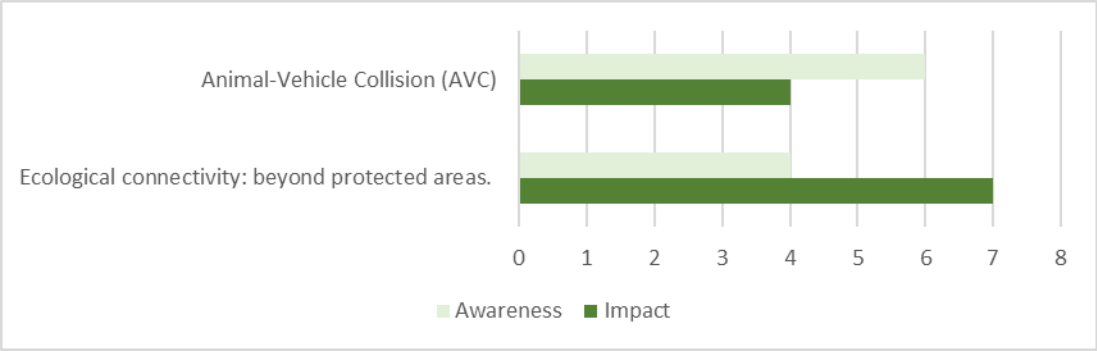

Figure 30: *Essential Guidelines to sustain Ecological Connectivity in Serbia concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.6 Ukraine

The initiatives on ecological connectivity in the Carpathian part of the country is quite good. According to the local partners and administrators, the country does not suffer from the impact of the human society on the natural environment. The procedure to hold the ungulates populations are at an optimum level and to accept predators as part of the environment with the same needs of humans to live and move, should be continued.

During the site visit it was stated that no new roads or main extensions of settlements are currently foreseen. At the moment is thus no need for predicting their impact. As soon the situation is changing ecological measurements sustaining ecological corridors and avoiding landscape fragmentation have to be considered already during the planning phase.

More attention was paid at the visit to another main problem – the high presence of poaching, which is seen as a sort of “family tradition”. Due to that tradition and the corporate acceptance this phenomenon is extremely difficult to change. Surprisingly it turned out that according to the experts’ view poaching does not have a meaningful impact on nature protection and connectivity. The wildlife species, which suffers more for that, is the Capercaillie (*tetrao urogallus*), but specific studies, both on its population dynamic and impact of poaching are missing.

Specifically it is recommended for the Ukraine to continue the transnational cooperation and the creation of studies on connectivity with Romania and Slovakia to allocate the dispersal routes of the most important (umbrella) species analysed in the BioREGIO Carpathian project.

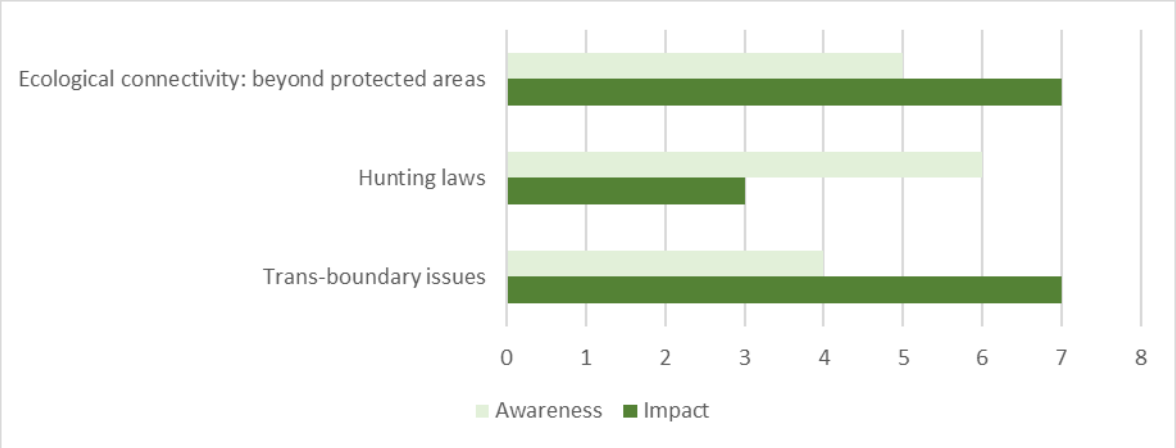

Figure 31: *Essential Guidelines to sustain Ecological Connectivity in Ukraine concerning their relevancy and awareness (estimations derived from the explorative statements).*

4.3.7 Poland

In the past years Poland has been quite active in the protection and valorisation of the national ecological network and its trans-boundary integration to the Carpathians' wide corridors. Currently this network of migration corridors in Poland is seriously threatened with disruption by the building of several new motorways and express roads protected with a fence on both sides. Since 2004, researchers, planners and investors have thus started to develop the handbook "Animals and roads: methods of mitigating the negative impact of roads on wildlife" to prevent the Polish ecological network from further landscape fragmentation in the future. The handbook has been revised in 2006 and 2009 (English version) and the recommended mitigation measures and recommendations have been updated to the current situation. Polish researchers on ecological connectivity are continuously lobbing at the Polish Government, to include regulations for migration corridors into the following documents: Nature Conservation Law, Environmental Law, Forest Management Law, Spatial Planning Law, and other regulations concerning preparing the Environmental Impact Assessment. Additional negotiations are ongoing for the conservation and restitution of migration corridors in several operational programs. As a result of these new operational programs on Environment and Transport Infrastructure as well as Development of Rural Areas some resources are guaranteed for wildlife corridors restoration and resolving conflict with the transportation infrastructure. These strategies to foster afforestation of private lands and pro-ecological management of private forests and to install eco-ducts or subways, where wildlife is crossings existing roads should be continued.

The main barriers and endangerments for the Polish ecological network identified in the literature and in discussions with local stakeholders are concentrated on: (1) current and foreseen linear Infrastructures; (2) deforestation of vast areas and low forest cove; (3) compact housing/urban sprawl in rural areas within important wildlife corridors; (4) the extension of industrial zones and (5) the installation and extension of ski-resorts. Mainly these recommended advice to deal reasonable with high sensitive natural sites should be applied also to the ecological corridors, crossing the Polish Carpathians too.

Although active in the identification of the locations for placing mitigation measures (e.g. over/underpasses), the amounts of conflicts due to linear infrastructures are still very high. Sometimes this is occurring, as wildlife crossings have been positioned in the wrong location and not sufficiently used by game species. To continue and support the process already started in Poland the so far developed recommendations from the BioREGIO Carpathians project are ready to be adopted to the Polish situation. They are corresponding to various demands from Polish study authors to put the focus on sustaining the ecological network by promoting a positive coexistence between humans and wildlife.

Concerning the main threats coming from infrastructure facilities, the authors are thus preferring to identify current wildlife passages through GIS analysis and field work, to design and build wildlife crossings' / underpasses in coherence to methodical recommendations, with the main objective, to minimize its interference with Natura 2000 sites.

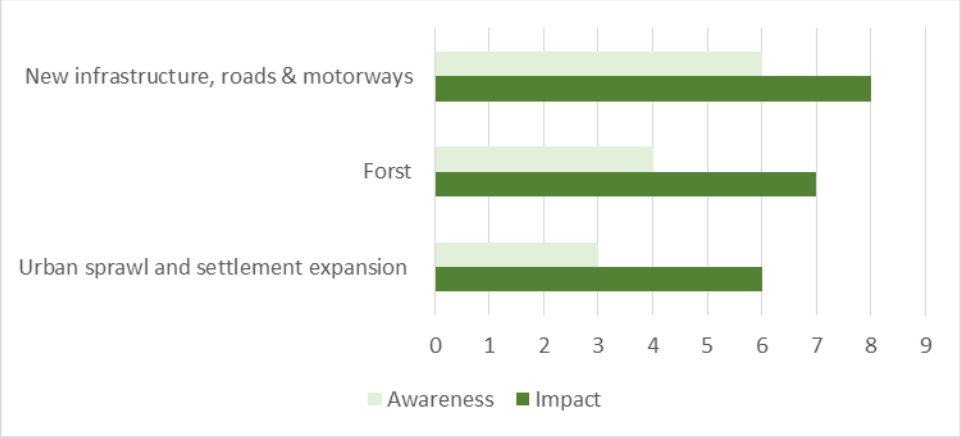

Figure 32: *Essential Guidelines to sustain Ecological Connectivity in Poland concerning their relevancy and awareness (estimations derived from the explorative statements).*

5 References

Ardeleanu, A.D., Mirea, I., 2009, Modelarea GIS a unei reţele ecologice, instrument pentru dezvoltarea durabilă – ghid practic, Editura Silvică, Institutul de Cercetări şi Amenajări Silvice 9

CorridorDesign (http://corridordesign.org/)

Folke C. et al., 'The Problem of Fit Between Ecosystems and Institutions: Ten Years Later', (2007) 12(1) Ecology and Society 30.

Linkage Mapper (https://code.google.com/p/linkage-mapper/)

Maanen, E., Predoiu, G., Klaver, R., Soule, M., Popa, M., Ionescu, O., Jurj, R.,Neguş, Ş., Ionescu, G., Altenburg, W., 2006, Safe guarding the Romanian Carpathian ecological network. A vision for large carnivores and biodiversity in Eastern Europe. A&W ecological consultans

Project "Open borders for bears in the Carpathians of Romania and Ukraine". Beneficiary WWF DCP Branch Maramures

Project LIFE+ Nature "Best practices and demonstrative actions for conservation of Ursus arctos species in the eastern Carpathians, Romania" under coordination of Environmental Protection Agency Vrancea, having as partners Environmental Protection Agency Covasna, Environmental Protection Agency Harghita, Association for Biological Diversity Conservation Focsani and Association for Nature Values Conservation from Balan

Salvatori, V., 2004 Mapping conservation areas for carnivores in the Carpathian mountains, University Of Southampton, Faculty Of Engineering, Sciences &Mathematics, Doctoral thesis

Young J. et al., 'Towards Sustainable Land Use: Identifying and Managing Conflicts Between Human Activities and Biodiversity Conservation in Europe', (2005) 14 Biodiversity and Conservation 1641-1661.