MENDEL UNIVERSITY IN BRNO
FACULTY OF FORESTRY AND WOOD TECHNOLOGY

Optimalization of ecological network near Vyskov due to biota migration to the Drahanska highland

Diploma Thesis

2015/2016 Bc. Radim Lainka

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Diploma Thesis Title: Optimalization of ecological network near Vyskov due to biota migration to the Drahanska highland

Abstract: The master thesis deals with optimization ecological network for biota near Vyskov. First part introduces the current knowledge about the large mammal migration in relation with the territory of Czech Republic and ecological networks, Second part of this project talks about relationship of the Drahanska highland.

Third part of this project includes information about my study area. Briefly sum up its history influenced by humans, position of my study area, its abiotic and biotic conditions and landownership relations of area. Further on, it tells something about the wildlife management, mainly about roadkill and introduces the animal occurrence in the area. It includes the updated data about TSES elements inside my study area. Further on examines the current change of supra-regional biocorridor NRBK08 (MH), situation around the town of Vyskov in relation with long distance corridor gets under D1 highway located between Brno and Olomouc city. And introduces information’s about the main migration obstacles for Drahanska highland.

The last part examines mammal migration in the 2014 under the highway bridge. It is also devoted to the optimized ecological network that corresponds with the Long Distance Migration Corridor. The final part talks about optimal size and tree composition in the new planned local biocentre and parts of the supra-regional biocorridor of the ecological network.
Key words: biocorridor, biota, ecological network, migration, Vyskov

Jméno autora: Bc. Radim Lainka
Název diplomové práce: Optimalizace ekologické sítě poblíž Vyškova pro migraci bioty na Drahanskou vrchovinu

Abstrakt: Diplomová práce se zabývá optimalizací ekologické sítě pro biotu, která se nachází v blízkosti Vyškova. První část mé práce uvádí problematiku migrace velkých savců u nás a ekologické sítě. Druhá část práce je věnována Drahanské vrchovině.

Třetí část mé práce zahrnuje informace o mém studovaném území. Stručně shrnuje jeho historii ovlivněnou lidmi, pozici studovaného území, abiotické i biotické podmínky, a vlastnické vztahy. Dále popisuje něco málo o hospodaření se zvěří, hlavně počet

sražené a zabité zvěře a jejím výskytu na mém území. Také obsahuje aktualizované údaje o prvcích ÚSES v rámci mého studovaného území. Dále zkoumá současnou změnu ve vedení nadregionálního biokoridoru NRBK08 (MH), situaci kolem města Vyškov v souvislosti s dálkovým migračním koridorem. V místě, kde se kříží s dálnicí D1 v úseku mezi Brnem a Olomoucí. A uvádí informace o hlavních migračních překážkách na Drahanské vrchovině.

Poslední část se zabývá migrací velkých savců v roce 2014 v rámci dálničního mostu. Následující část věnována optimalizované síti, která koresponduje s dálkovým migračním koridorem. Dále pojednává o optimální velkosti a dřevinné skladbě v nově navrženém lokálním biocentru and částech nadregionálního biokoridoru ekologické síti.

Klíčová slova: biokoridor, biota, ekologická síť, migrace, Vyškov.

Content

1. INTRODUCTION

We live in a fragmented world. We live our lives in gradual separation from the natural world. Our habitat is defined in large measure by automobiles and build environment. There is an increasing trend towards urbanization all over the world. In developed countries, around 80% of the human population now lives in cities or towns. Nowadays western and central Europe is highly fragmented. Urbanization process is often followed by the development of infrastructure, the major cause of the alarming decrease in many European wildlife populations. In order to explore all the effects of roads on wildlife, scientists establish new branch/division/discipline of Ecology – Road Ecology. There is a valuable evidence of negative ecological impacts of roads. Time is running out and defragmentation or at least partly defragmentation is needed for target areas in order to save the endangered wildlife populations from the genetic isolation and other negative consequences. Conservationists discussed the problem of fragmentation and habitat loss. They found that the best option is to establish functional ecological networks. In Europe there was established European ecological network called "EECONET". In Czech Republic was established special ecological network called "Territorial system of ecological stability of the landscape" and later was recognized as a part of the EECONET. It consists of both the existing and the proposed parts. Czech system does not consider the role of big mammals' migration important, as they were absent in the landscape since people eliminated them from our country. In recent years some of the big mammals succeeded in order to fill absent niches in some parts of our country. Actually Czech Republic has got a small population of lynxes and wolves. If they survive, their descendants will try to spread more deeply into some regions. There is study for the possible migration of the big mammals inside the Czech Republic; it is called "Protection of landscape connectivity for large mammals". It defines possible Long-Distance Migration Corridors for focal large mammals.

"Very possibly, migration occurs when a particular threshold value of internal factors is reached, a threshold which may well be different under different environmental conditions or for different races of the same species"

David Lack 1943

2. DIPLOMA THESIS GOALS

The aim of diploma thesis was to answer these following questions:

Are there any migratory trails towards to the Drahanska highland? What is the situation around the city of Vyskov for biota migration? Are there some migration obstacles for the Drahanska highland? Is there any evidence of the mammals using the bridge under the D1 highway near Vyskov? If yes, are they using it on the basis of daily movements or for migration? What species of mammals are present here and how many? What is the animal mortality in the roads? Can be the present ecological network optimized for the biota migration? If yes, who are the landowners of the area southward from the bridge? What would the optimal size and tree composition in the new biocentre and biocorridors?

3. STATE OF ART

3.1. The importance of large mammals' migration

Firstly, we have to describe what migration is and what not migration is. Wildlife tend to have a home range, an area of daily movements where foraging for food occurs. Animal dispersal is movement well beyond the home range to locate and establish a new home range. Migration is cyclic movement between different areas that generally avoids cold or dry seasons (Forman et al., 2003). Stenseth and Lidicker (1992) claim that dispersal or movement from one home site to another is a phenomenon of potentially great importance to the demographic and evolutionary dynamics of populations.

After Anděl et al. (2010) the term "migration" should be understood herein as any of the mentioned types of movement of animals in the landscape, despite the fact that this will not always conform the terminology applied in zoology. The large carnivores (wolf, brown bear and lynx) need to have enough space in order to migrate. At natural state of conditions, we can find certain percentage of individuals that are not permanently bonded to their population. Long distance migration inseparable part of their biology and is precondition of population survival. Migrations could compensate local losses caused by illnesses or natural catastrophic events. Immigrations and emigrations ensure sufficient gene transmission among particular sub populations. Therefore, the gene variability and good condition of populations is maintained. Lot of species are losing the binding to the preferable biotope during the migration process. Therefore, we could meet them in the less favourable places (Anděl et al., 2012). In many cases, this migration may involve dispersing sub adults that are being pushed away from their parent's home ranges, but we may also record vagrancy of adult animals. Animals can migrate tens or even hundreds of kilometres (Anděl et al., 2010).

Long-distance migration is also typical for large ungulates, too. I.e. predominantly Eurasian Elk in our conditions. Red Deer rather migrates medium distances reaching tens of kilometres. The Eurasian Elk is a typical species of forested marshes of northern countries. The current population of Elks (about 30 individuals) in the Southern Bohemia is fully dependent on irregular migration of Elks from Northeastern Poland. During their outstanding journey, the animals have to overcome about 800 km of dense urbanized landscape with motorways, railways and fenced areas to their final destination in the Southern Bohemia. Despite the still unclear motives for such migration, it is obvious that our population will disappear very fast if migration opportunities for these animals are not preserved (Anděl et al., 2010).

3.2 Large mammals' migration in Moravia

In the winter season 2003 – 2004 were detected trails of two lynxes in the area nearby Vrbno pod Pradědem and two lynxes occupied the Zlatohorská vrchovina and were meeting in the Osoblažsko region. These lynxes probably migrated to these places from the Beskydy mountain range (Kunc and Bartošová, 2005).

One young migrating European Brown bear was killed by truck in the 1996 near state boundary transition in the Mosty u Jablunkova. The bear was trying to cross the road from one part of the valley to the opposite part of the valley. Although he got lost between urban area and fences and stay in this space practically jailed utill the truck killed him (Kunc and Bartošová, 2005). The European Brown Bear (*Ursus arctos arctos*) became extinct in the Ostrava region (North Moravia) in the late 17th century. However, in the late 20th century Brown Bears began to return there from Slovakia. In 2002 and 2003 respectively, territorial signs, so-called bear´s mirrors (holes eaten in the bark on trees) were found at some sites near the town of Orlová (in the Ostrava region) (Šuhaj and Kuzník, 2003).

In the September 2012, one European Brown Bear occurred in the Břeclavsko region [3]. In addition, this year in the March, one European Brown Bear occurred in the same region [4]. Both migrated probably from Slovakia.

3.2.1. Large mammals' migration from the east to the Drahanska highland

The oldest observation of the Brown Bear (*Ursus arctos*) migrating from the Beskydy Mountains range was monitored in the 1989, managed to reach as far as the Drahanska highland. The last brown bear (*Ursus arctos*) was observed in the northern part of the Moravian Karst and its surroundings, in the squares 6566 and 6565 between the years 2000 – 2003 (Červený et al., 2004). In the case of lynx (*Lynx lynx*), one individual was observed close to the Jedovnice sawmill in the 1994 (Anděra and Hanzal, 1996).

Although some lynxes were illegally released in the Protected Landscape Area Moravian Karst, their evidence was not recorded though (Červený et al., 2005).

3.3. Migration obstacles

Nowadays our landscape is full of plentiful kinds of barriers. These barriers have various impacts to various animals. It could be natural (big rivers, mountain belts) or artificial origin. Natural barriers were there all the time as the animal evolution continues. However, human made barriers are considered to be relatively short-term components of our landscape. Majority of them were established during the last several decades and their density is still on rise (Dufek, Adamec and Hlaváč, 2000). There are several main types of migration barriers:

- Roads and motorways
- Railways
- Watercourses and other water bodies
- Fences
- Settlements
- Non-forest areas

(Anděl et al., 2010).

Intensities of traffic on highway network have rising trend [5]. Although in the case of highways, the intensive research was done by testing the bridges presented in the highways network of the Czech Republic if they are permeable for the large mammals between 1998 and 1999. Results showed that the actual network of highways and express roads does not represent serious barrier for the small animals like Red foxes, Eurasian badgers and European otters (Hlaváč and Toman, 1999). Migration barriers should be viewed individually considering their effect on site, their potential accumulation, and the permeability of the landscape as a whole. The cumulative effect of barriers should be assessed at two levels:

- Local level – the field survey and verification of permeability of the migration corridor on the given location should seek to assess the potential cumulative effect of all existing barriers. The final level of barrier accumulation and the permeability of the site have to be evaluated by experts within a field survey directly on the site.

- National level – based on the structure of settlements, the density of settlement and road network, and the distribution of non-forest areas, we may identify areas that pose a more potential threat as a whole. The map of areas with a higher cumulative effect of migration barriers presented in Fig. 1. illustrates that most affected are sites in lowlands, where the dense settlement and the road network are accompanied by farmland, i.e. non-forest land augmenting the barrier effect. The main barriers are presented in Fig. 2.

(Anděl et al., 2010).

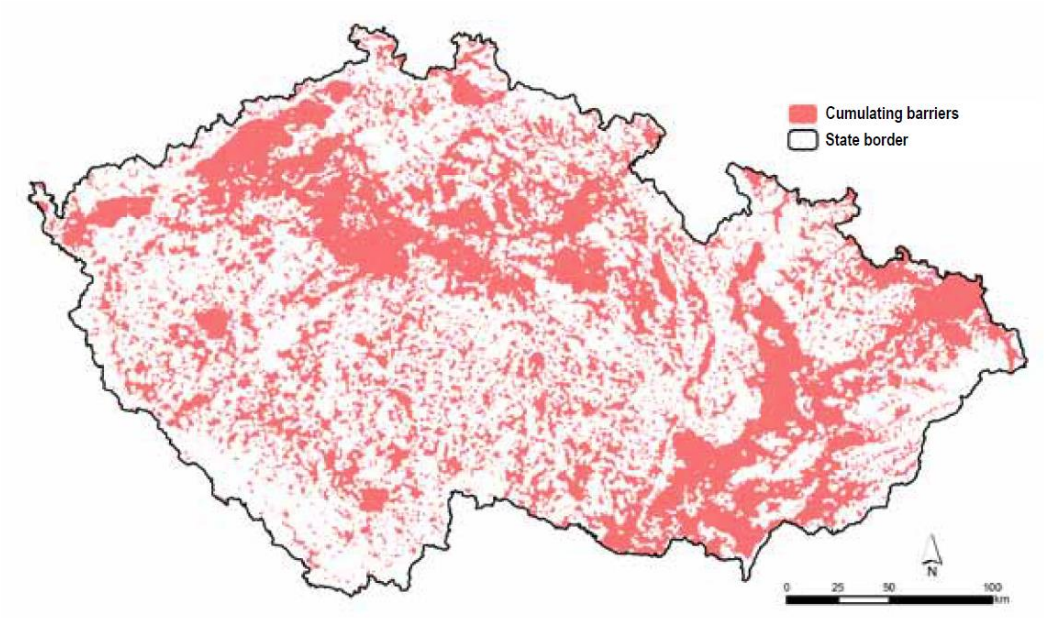

Fig. 1. Areas characteristic with a high cumulative effect of migration barriers (Anděl et al., 2010).

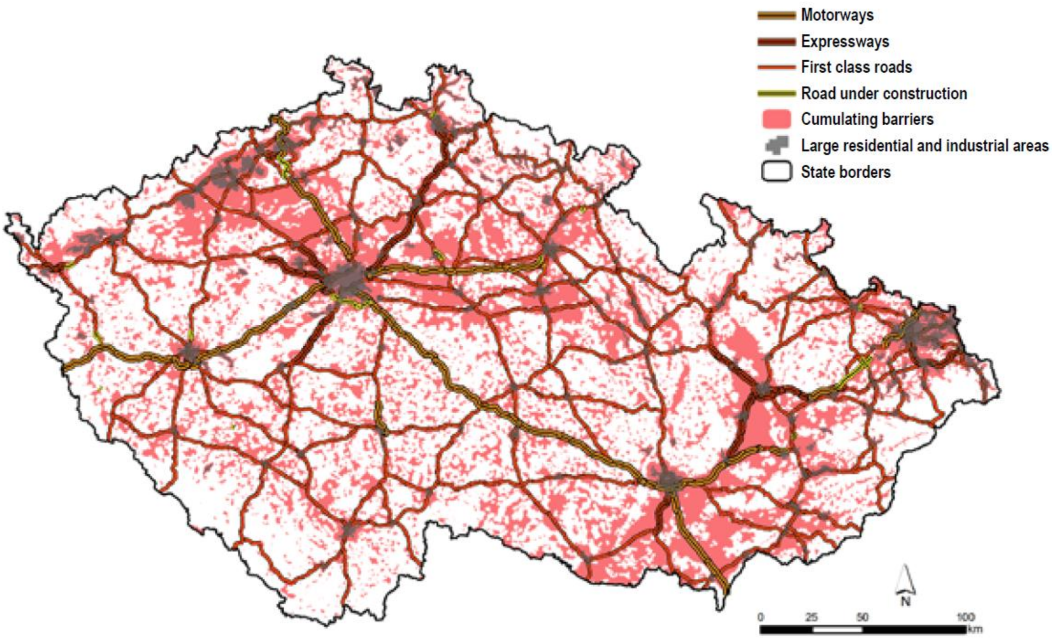

Fig. 2. General map of main barriers in the Czech Republic (Anděl et al., 2010).

Nowadays the stretch between Brno and Vyškov seems to be completely impermeable for the large mammals. The barrier effect of the D1 highway with other parallel communications (railway and roads) is quite big. Drahanska highland should be connected with the Žďánický les area again most likely by highway crossing with supra-regional corridors. However, this idea could be successful only if the other communications will be permeable, too (Dufek, Adamec and Hlaváč, 2000). Hlaváč (2005) propose an official ban on placing impermeable barriers into landscapes.

There are 7 critical sections where impermeable motorways cross important migration corridors of large mammals (Fig. 3.). Although, some of them were built without proper study of large mammals' migration in that areas. There are defined several areas of importance (so-called Significant Migration Areas) in case of large mammals' migration in the Czech Republic. Their importance lies in the provision of permanent habitat for large mammals and migration of forest mammals. These areas used to be connected by the proposed Long-Distance Corridors. However, there are several critical and problematic places within the Long-Distance Migration Corridors and these places lower the real connectivity of these Corridors (Fig. 4.).

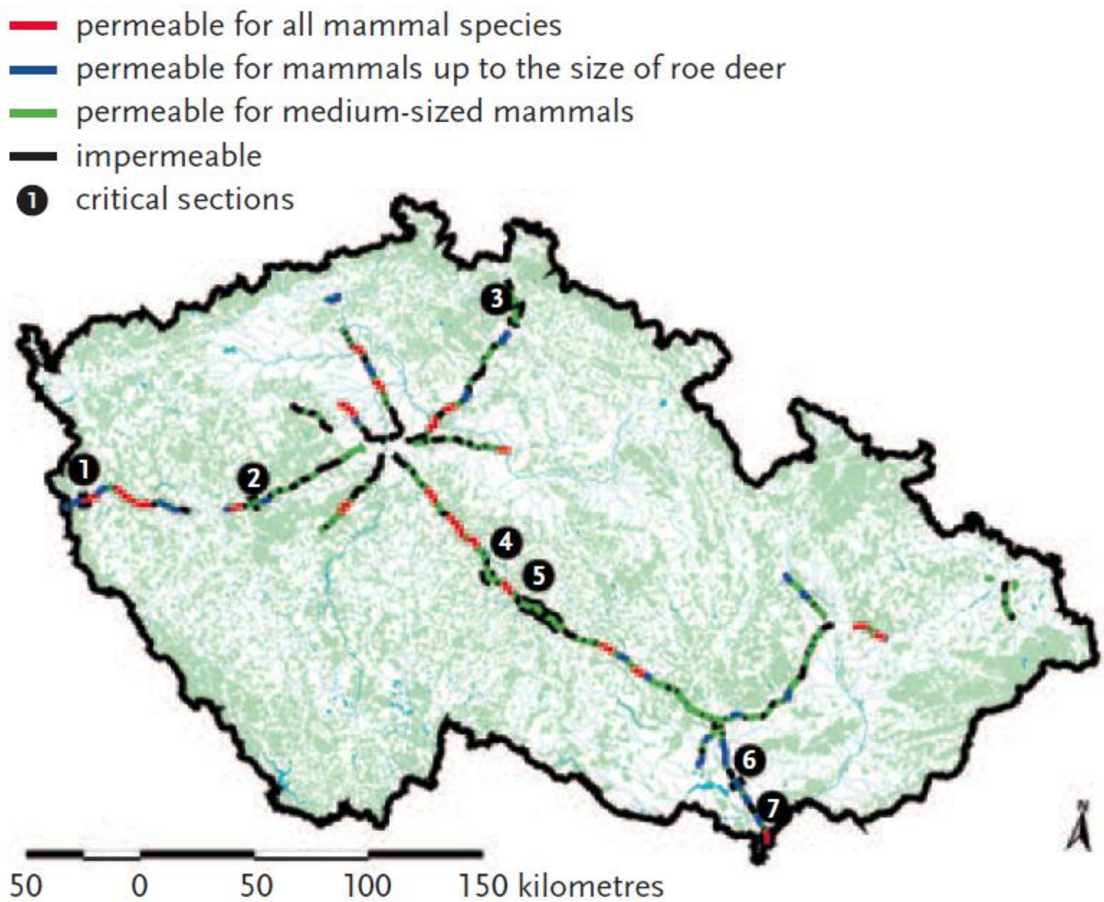

Fig. 3. Highway network permeability in the Czech Republic (Hlaváč et al., 2001 and Hlaváč, 2005)

All the critical and problematic places were identified and precisely recorded through the project VAV SP/2d4/36/08. Within the whole territory of the Czech Republic have been identified places within the migration corridors where the migration was highly deceased or totally stopped. All these places of migration corridors were recorded and divided according to its significance for the migration of wildlife. The places within the migration corridors that are actually impermeable or permeable with big problems have been called critical places (K1), mostly belong to the places where the migration corridors crossing the highways. In the other cases the migration corridor is placed in the localities without forests or heavily urbanized lands. Totally there is 29 critical places (K1). Further on, there were mapped also 178 problematic places (K2) within the migration corridors, where the migration is actually possible, however it is complicated due to the one or more barriers [6].

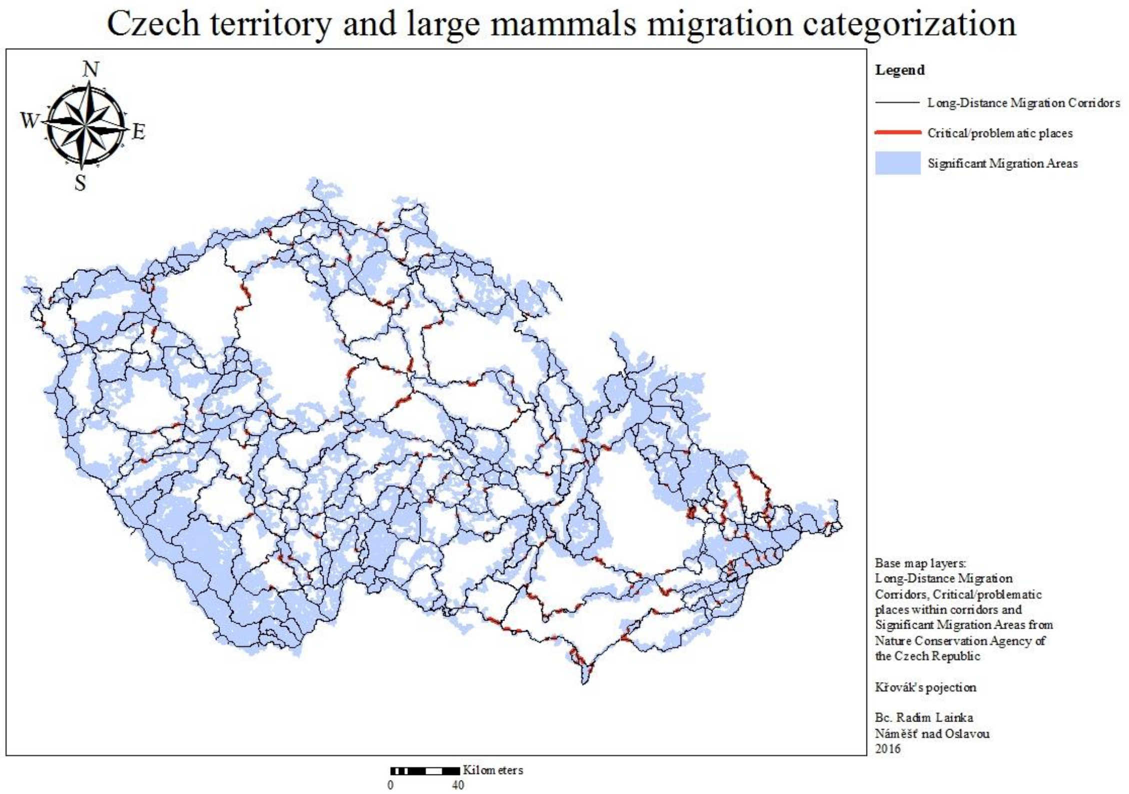

Fig. 4. Representation of Significant Migration Areas (SMA) over the Czech Republic (1 : 2 200 000)

3.4. Actual options for large mammals' migration

Although there are present different barriers in the landscape, fortunately the large mammals could use some suitable artificial constructions like bridges, culverts or tunnels as passages (migration constructions). Specific constructions designed or adjusted in order to facilitate animal migration trough highway is called passage. There are two types of passages, overpasses and underpasses. There is big difference between the terms "bridge" and "passage" (underpasses), especially in the dimensions. Bridge length is defined as the dimension parallel to the axis of highway and its width is defined as the dimension perpendicular to the axis of the highway. However, the length of an underpass is defined as the distance between the "entrances" and the width is defined as the perpendicular distance between the walls of the underpass (Hlaváč and Anděl, 2002).

There are several actually functional overpasses (ecoducts) in the Czech Republic. Namely Hrabůvka, Kletné, Žehuň, Voleč, Cholupice (I.-III.), Šabatka, Jeníšov and Dolní Újezd. Two of them are situated on D1 highway (Habrůvka and Kletné) and one nearby D1 higway (Dolní Újezd, express road R 35) [7]. However, overall permeability of the highway network in the Czech Republic is still not satisfactory.

3.5. New animal crossings

Some of wildlife overpasses (ecoducts) were built at sites where their purpose was not justified according to the latest experience in the Czech Republic. As example can serve four wildlife overpasses on the so-called Prague Ring Road (namely ecoducts Cholupice I.-III. and Šabatka) that were built in low ecological valued areas, at sites where important wildlife dispersal and movement is not documented. At the other hand there are some overpasses that had been built in the proper places, unfortunately the further construction in its proximity fatally reduced its functioning. Analogous cases raised questions about their usefulness and it could badly result in its general refusal even in the cases where these wildlife overpasses are needed. At the end, there is no directive to assess verified functionality the newly built overpasses in the Czech Republic. However, many countries have their own standards within from their whole planning. All the feedback data can create sufficient background to avoid the mistakes and weaknesses in the development of the more effective overpasses [8, 9, and 10].

3.6. Ecological networks

The concept or model of ecological networks was basically formulated as a response to the habitat fragmentation process (Bonnin et al., 2007). Ecological networks represent a practical model to conserve biological diversity and to harmonize the clashes of demand for natural resource use. Their prime role lies in the ecosystems connectivity (linking ecosystems). These networks connect populations of species that are threatened by fragmented habitats, help to facilitate genetic exchange between different populations and therefore increase the probabilities of survival of threatened species. The ecological network concept also provides a tool for ecological design and physical planning that facilitates interaction with other types of land use (Bennett and Mulongoy, 2006).

The first manifestations of the ecological network model are dated back to the 1970s with the main goal to conserve biodiversity through proper maintenance and reinforcement the integrity of ecological and environmental processes (Bennett and Wit, 2001). Despite thes large political consensus around the notion of ecological corridors, infrastructures and networks, its scientific roots are controversial (Angeon at al., 2014). However, the term “ecological network” gained favour and successfully evolved in Europe in the early 1990s and become a practical nature conservation and also landscape management tool. The most important international mechanisms have been used it in recent years, along with IUCN’s World Conservation Congresses, the World Summit on Sustainable Development’s Plan of Implementation, the CBD Conferences of the Parties, and also the programme of work on protected areas. There is certain amount of distinguished elements, which together define all ecological networks. These are:

- a focus on conserving biodiversity at the landscape, ecosystem or regional scale
- an emphasis on maintaining or strengthening ecological coherence, primarily through providing for connectivity
- ensuring that critical areas are buffered from the effects of potentially damaging external activities
- restoring degraded ecosystems where appropriate
- promoting the sustainable use of natural resources in areas of importance to biodiversity conservation

Ecological networks also share a common understanding of how this model should be applied on the ground, namely through the allocation of specific functions to different areas depending on their natural-resource potential (Bennett, 2004). These functions are reflected in itegrated system of areal components:

- CORE AREAS, where the conservation of biodiversity takes primary importance, even if the area is not legally protected
- CORRIDORS, which serve to maintain vital ecological or environmental connections by maintaining physical (though not necessarily linear) linkages between the core areas
- BUFFER ZONES, which protect the network from potentially damaging external influences and which are essentially transitional areas characterized by compatible land uses
- SUSTAINABLE-USE AREAS, where opportunities are exploited within the landscape mosaic for the sustainable use of natural resources together with maintenance of most ecosystem services

(Bennett, 2004).

The design of ecological networks is based on concepts, within certain scientific and planning traditions, mediating specific values, traditions, and relations of power. Specific concepts are selective and will only be valid under specific circumstances they were created (Jongman and Kristiansen, 2001). Therefore, in regional and national settings, different terms are used to describe the ecological network. These include "Ecological Network of Albania" (proposal), "The Flemish Ecological Network (VEN)" and "The integrated multifunctional and supporting network (IVON)" – Belgium, Flanders, "Territorial System of Ecological Stability" – Czech Republic and Slovakia," reserve network" – Western Hemisphere Shorebird Reserve Network, "bioregional planning" – Fitzgerald River National Park in Western Australia, "Ecoregion-Based Conservation (ERBC)" – The Central European Forest-Steppe Ecoregion, „connectivity conservation areas" and various language-specific variants, but also "corridors", "buffer zones" – part of "green paths" concepts and plans of "green structure", in Danish legislation since 1937. As a result, it is not always obvious from the title of a programme or project whether the approach reflects the ecological-network model (Bennett and Mulongoy, 2006; Jongman and Kamphorst, 2002; Jongman and Kristiansen, 2001; Miljø and Energiministeriet, 1995).

3.6.1. Common scientific background of Ecological Networks

The roots of the ecological networks as a nowadays more common part of land-use planning are in Europe and also North America. Particularly in population dynamics, community ecology and landscape and spatial ecology (Pulliam 1988; Ricklefs and Schluter, 1993; Smith and Hellmund, 1993; Forman, 1995; Dias, 1996; Farina, 1998; Naveh, 2001; Opdam et al., 2002; Fortin and Dale, 2005). Island biogeography (MacArthur and Wilson, 1967), metapopulation theory (Levins, 1969, 1970; Hanski 1998, 1999; Hanski and Gaggiotti, 2004) and ecosystem science (Pickett et al. 1992, 1997; Pickett and Ostfeld, 1995) played a crucial role in the development of the ecological network concept. In the other hand, other important theoretical source for the ecological network concept represents conservation genetics, with the main aim to ensure the survival of small (endangered or threatened) populations, often affected by habitat destruction and fragmentation (Young and Clarke, 2000; Frankham et al., 2002; Frankham, 2003). The further development of knowledge about ecological networks leads to the creation of a new specific scientific discipline, called corridor ecology in the United States (Hilty et al. 2006; Van der Ree et al., 2015).

3.6.2. Ecological Networks of Central and Eastern Europe

In Central and Eastern Europe, several national ecological-network programmes were developed in the 1980s inspired by the polarized-landscape theory of the Russian geographer Boris Rodoman. Based on this theory, the “eco-stabilising” approach proposed that the landscape should be zoned in such way that intensively used areas are balanced by natural zones that function as a coherent, self-regulating whole. Ecological networks in Central and Eastern Europe are being developed in three main ways: through the collaborative framework of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), through national or (in Russia) regional government programmes and through various NGO projects (Bennett and Mulongoy, 2006).

The Pan-European Ecological Network (PEEN) is the most ambitious international ecological-network programme (Bennett and Mulongoy, 2006). In 1995, during the Environment for Europe Conference in Sofia, the 54 European Environment Ministers endorsed the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), which contains as one of its priorities an Action Theme to establish a Pan-European Ecological Network (PEEN) within 20 years (Bonnin et al., 2007). However, the Strategy included a range of ambitious actions that went beyond existing international agreements and national policies. The most significant of these was the establishment of the Pan-European Ecological Network (Bennett and Mulongoy, 2006). The aim of the Pan-European Ecological Network is to ensure:

- a full range of ecosystems, habitats, species and landscapes of European importance is conserved;
- habitats are large enough to place species in a favourable conservation status;
- there are sufficient opportunities for the dispersal and migration of species;
- damaged parts of the key environmental systems are restored;
- the key environmental systems are buffered from potential threats.

(Bonnin et al., 2007)

With regard to government-driven programmes, national ecological networks are under development in 11 countries in Central and Eastern Europe, as follows:

- Czech Republic: Territorial System of Ecological Stability (TSES)
- Belarus: National Ecological Network
- Estonia: Green Network
- Hungary: National Ecological Network
- Latvia: Ecological Network
- Lithuania: Ecological Network
- Moldova: National Ecological Network
- Romania: National Network
- Russian Federation: Ruseconet
- Slovakia: Territorial System of Ecological Stability (TSES)
- Ukraine: National Ecological Network

(Bennett and Mulongoy, 2006)

3.7. Territorial system of ecological stability

An interdisciplinary team made up of planners and scientists, mainly from Brno and Bratislava, started to develop ideas about a “skeleton of ecological stability” in the 1970s in the former Czechoslovakia Republic. Whole process started as a feedback to the destruction of landscape systems partly carried out by large technocratic projects that were initiated at that time, and partly by the monofunctional simplification of the collectivised agricultural landscape. The concept of “territorial systems supporting landscape ecological stability” then was formed in the 1980s. The first element in the concept, “territorial system”, consists of biocentres, buffer zones, biocorridors and interacting elements. The other element in this concept of “ecological stabilisation” hint at, that such a system should strengthen ecological stability of a larger area. The fundamental idea is to maintain stability in the landscape and unstable parts of the landscape have to be separated by a system of stable and stabilising ecosystems. When Czechoslovakia was split up both Slovakia and the Czech Republic adopted the TSES system. The difference is that Czech Republic is concentrating more on the spatial structure while Slovakia more on the ecostabilising measures (Buček et al., 1996; Jongman and Kristiansen, 2001).

The TSES concept is based on scientific theories such as island biogeography, sink-source theory, current approaches in landscape ecology (landscape seen as a dynamic of various habitat patches) and spatial ecology (meta-population approach), population genetics, new non-equilibrium paradigm, etc. [13]. The Territorial System of Ecological Stability (TSES) itself is defined in Czech Act No. 114/1992 Gazette, section 3, article a), is a mutually interconnected complex of both natural and near-natural, altered ecosystems that maintain natural balance. Its main purpose is to reinforce ecological stability of the landscape by conservation or restoration of ecosystems and their mutual interconnection [11].

The development of the supra-regional TSES is planned by the Ministry of the Environment of the Czech Republic (Act No. 114/1992 Gazette). Further on, the Agency for Nature Conservation and Landscape Protection of the Czech Republic is responsible for the keeping the files and documentation of the supra-regional TSES. In other hand, the design, development and assessment of the Regional TSES managed by the regional authorities/administrations. The same character posse municipalities with extended competences (powers) for the Local TSES [14].

The five basic criteria listed below are used in the design of TSES:

- the diversity of potential natural ecosystems,
- the spatial relationship of biota in the landscape,
- spatial parameters,
- the present state of the landscape,
- socioeconomical limits and intensions

(Buček et al., 1996)

3.7.1. Landscape segments

The ecological network in the countryside consists of existing and proposed ecologically significant landscape segments. These landscape segments are clearly delimited areas of various in sizes and shapes. And considerably differ from the neighbouring land. Their prime function or service as ecologically significant landscape segments is to provide the ecological stability of the landscape level (Buček et al., 1996).

Natural biocoenoses (remnants of natural forests), or the rest of it, of a particular biogeographical region could be the basis for the ecologically significant landscape segments. In other hand, the basis for the ecologically significant landscape segments could by also the artificially modified biocoenoses (various types of derelict land, semi–natural meadows with a prevalence of natural species and ponds) (Buček et al., 1996).

Ecological significant landscape segments could be separated in relation to its spatial and structural criteria (size, shape, degree of homogeneity of ecological conditions and present state of biocoenoses) into:

- ecologically important landscape elements (1–10 ha)
- ecologically important landscape units (10–1000 ha)
- ecologically important landscape areas (over 1000 ha)
- ecologically important landscape communities (transitional ecotones at the edges)

And further on, with relation to its fundamental function or service, we can divide the ecologically significant segments into these elements (features) of TSES plans:

- Biocentres (centres of biotic diversity)
- Biocorridors
- Buffer zones of biocentres and biocorridors
- Interacting elements

(Buček et al., 1996)

3.7.2. TSES elements in general

- Biocentre – This is defined as a biotope or centre of biotopes in a landscape, which, due to its condition and scope, facilitates the existence of a natural or near-natural, altered ecosystem.
- Ecological corridor – This is a territory that does not facilitate permanent or long-term existence of a significant number of organisms, but does provide for their migration between different biocentres, creating a network of isolated biocentres.
- Interaction element – This is defined as a landscape segment, which, on a local level, mediates the favourable effect of basic TSES elements (biocentres and biological corridors) on surrounding less stable landscape. Besides this, interaction elements often enable the permanent existence of certain species with

limited territorial requirements (besides a range of plant species, these include some species of insects, small rodents, insectivores, birds, amphibians etc.).

[10]

Each element can be further separated in relation to different conditions. In the case of the biocorridors, there we used to separate them according to its state (existing, suggested), function (continuous, interrupted) and degree of biodiversity (modal, contrast). However, the biocentres we gone little farer with the separation. First is the state of the particular biocentre (existing, suggested), right after that we used to separate them according to its origin and degree of development of the ecosystems (natural – natural or semi–natural ecosystems, conditioned by man – pastures, meadows and grasslands), according to its representativeness or uniqueness (representative – prevailing ecosystem, unique – opposite, specific ecological conditions of ecosystem/s), according to its biogeographical location (central – opposite of the contact one, contact – located on the border among two or more biogeographical units), and finally by the most crucial separation, in the ecological sense of mind, according to its spatial relationships within the landscape (connectivity) to connected (linked to other parts of ecological network) and isolated (opposite, refugee hotspots) biocentres (Buček et al., 1996).

3.7.3. TSES categories according to significance

- Supraregional TSES – These are vast (at least 1000 ha) landscape units and areas of ecological significance, forming a network providing conditions for the existence of characteristic coenosis together with complete biota biodiversity in the context of a certain biogeographical region.
- Regional TSES – These are landscape units and areas of ecological significance (minimum area of 10 - 50 ha). A network of these units must represent a diversity of biochore types in the context of a certain biogeographical region.
- Local TSES – These are small landscape units of ecological significance (area about 5 - 10 ha). A network of these represents biogeocoenosis type groups in the context of a certain biochore.

[11]

3.7.4. Implementation of TSES

Realisation of TSES is in progress. In addition, over 90% of the territory of the Czech Republic has been covered by local TSES schemes and plans. The main implementation of the TSES has been carried out on the local level. Implementation can take place through:

- Designation of specially protected areas (National Parks, Protected Landscape Areas, National Nature Reserves, National Nature Monuments, Nature Parks and important Landscape Elements);
- Landscape management schemes and programmes carried out by the Ministry of Environment;
- Land uses and physical/spatial planning which include TSES projects (he TSES project is an obligatory basic document for each land use project and obligatory regulation of territorial planning documentation in three sectors).

The TSES are now being prepared on local level, creating difficult task for local authorities and NGOs (Buček et al., 1996). TSES are established by plans that should include in particular the following:

a) a draft map of existing and proposed biocentres and ecological corridors with marked protected areas to a minimum scale of 1:50 000 (supraregional and regional TSES) or 1:10 000 (local TSES).
b) a table and a theoretical section describing functional and spatial factors
c) detailed rationale including outline measures for its conservation or regeneration.

The TSES plan serves as documentation for TSES projects, land consolidations and land replotting, processing of territorial planning documentation, forest management plans, water management documents and other documents regarding protection and restoration of the landscape.

TSES elements are being established in 2005 in almost all Protected Landscape Areas PLAs territory with a few exceptions.
[11]

3.7.5. PEEN and TSES

The design of PEEN (formerly EECONET) structural elements present in the Czech Republic is based on the theory of TSES and had been developed between 1993-1996 [11 and 12]. Area of PEEN structural elements cover 27.8% of the Czech Republic territory. Majority of these elements belong to the categories of protected areas defined in Czech act no. 114/1992 Gazette, as subsequently amended (National Parks, Protected Landscape Areas, National Nature Reserves and National Monuments and also Natura 2000 sites). Although as PEEN itself so as the draft of this ecological network lack any kind of direct support in the law [14].

3.8. TSES and SMAs

Significant Migration Areas (SMA) represent the highest level of territorial delimitation and are based on a fundamental concept aimed at retaining the permeability of the landscape in the context of larger landscape units (e.g., connectivity of the Carpathians and the Bohemian Massif). These are wide areas both providing space for the permanent occurrence of species and securing permeability for migration. They are interconnected by the Long-Distance Migration Corridors (LDMC). The basic units ensuring conservation of sustainable permeability of landscape for large mammals. They are linear structures tens of kilometres long and on average 500 m wide. And the smallest units with the concept aimed at retaining the permeability of the landscape are so called Migration Routes (MR), but they have not been clearly identified, yet (Anděl et al., 2010).

Significant Migration areas (SMAs) cover an area of 33 508 km^2, that represents 42% of the Czech Republic territory. Great part of the Territorial System of Ecological Stability (TSES) and the Significant Migration Areas (SMAs) overlaps. And this is fundamental as both systems focus on the protecting the landscape connectivity. The most convenient is the overlap of the supra-regional level of the TSES with SMAs, it is about 85%. In the other hand supra-regional biological corridors with buffer zones of 2 km from the axis represent a large scale category exceeding 20 0000 km^2. And about 50% of their total area overlaps with SMAs. However, only about 35% of SMAs are placed within supra-regional biological corridors (Anděl et al., 2010).

3.9. Target species of wildlife included in my research of the mammal migration

Target species were grouped into the three categories (A, B and C) in relation to their common migration features after the methodology called "Migrační objekty pro zajištění průchodnosti dálnic: Technické podmínky/Migration passages for the permeability of roads for wildlife: Technical standard" (Anděl et al., 2006). Particular target species are described in the following subchapters.

3.9.1. Category A

Category A is formed by the most demanding species with relation to the parameters of migration passages (recommended technical parameters of the object etc.), particularly by the Red deer (*Cervus elaphus* Linnaeus, 1758), lynx (*Lynx lynx* Linnaeus, 1758), bear (*Ursus arctos* Linnaeus, 1758), wolf (*Canips lupus* Linnaeus, 1758), wildcat (*Felis sylvestris* Schreber, 1777) and elk (*Alces alce* Linnaeus, 1758).

The optimal solutions are appropriate large bridges structures of deep valleys. However, the realization in the plain landscapes represent challenge, it is often problematic (Anděl et al., 2006). All the species are quite rare, thus they are known as so called "specially protected species" (the act on the conservation of nature and the landscape), with the exception of Red deer. The lynx and the bear are also protected as animal species of Community interest under the Natura 2000 network. The species show considerable demands on free interconnection of individual populations can secure their long-term sustainable existence. All of them are connected with long-distance migrations (Anděl et al., 2010).

3.9.1. Category B

This category is formed by the species that commonly perform local migrations, routes between the food sources, water and places for relax. Wildlife passages are used predominantly by the local populations, that is well adapted for the particular environment (Anděl et al., 2006). The particular species are:

- Wild boar (*Sus scrofa* Linnaeus, 1758) is at present distributed over most (if not all) of the territory of the Czech Republic. Highly adaptable, showing no specific environmental requirements. Prefer regions with broadleaved or mixed woodlands but can be found in all habitat types except the highest elevations (up to 1,300 m a. s. l.). Since the early 1980s, the numbers of wild boars have been increasing almost exponentially, from 10-12 thousand to the present 100-120 thousand wild boars shot every year.

- Roe deer (*Capreolus capreolus* Linnaeus, 1758) is the most abundant cervid species. It inhabits the whole territory of this country (628 quadrats, 100%). Its numbers have been on a long-time increase, the maximum numbers of shot amounting to 131,453 roe deer in 2005.

3.9.1. Category C

These species are smaller in comparison with the previous groups. Thus, the most important for them is the frequency of the wildlife passages, not the parameters of the wildlife passages. The places with the migration pressure, the recommended distance between the wildlife passages is between 500 – 1000 m. These species commonly disperse locally, migrates between the food sources, water, or the young individuals that The particular species are:

- Stone marten (*Martes foina* Erxleben, 1777)), another widespread species distributed over the whole territory of the Czech Republic (624 quadrates, 99.8%). Over the past two decades, the species experienced a marked population explosion. It is a typical inhabitant of open cultivated landscape and it is recently very common in suburban and urban habitats. Its localities range from 140 to 1,315 m a. s. l. (mean 404 m a. s. l.).

- Red fox (*Vulpes vulpes* Linnaeus, 1758) is one of our most widespread mammals (627 quadrates, 99.8%). Bag statistics show a steep population rise since the 1990s due to successful oral vaccination against rabies. In the past two decades, the red fox significantly shifted from woodlands to agrocoenoses. It is even common in close vicinity of human habitations, in cities etc. The elevation range of its occurrence corresponds with the relief of your county.

(Anděra and Gaisler, 2012)

4. DRAHANSKA HIGHLAND NATURAL CONDITIONS

4.2. Geomorphology of Drahanska higland

System: Hercynian System

Sub system: Hercynian Mountains

Province: I Bohemian Upland

Subprovince: II Bohemian-Moravian

Region: IID Brněnská vrchovina (Highland)

Unit: IID-3 Drahanska vrchovina (Highland) (the highest point: Skalky 734,7 m. a. s. l.)

Subunits of Drahanská vrchovina (Highland): IID-3A Adamovská vrchovina (Highland), IID-3B Moravský kras (Karst) and IID-3C Konická vrchovina (Highland)

(Demek and Mackovčin, 2006; Boháč and Kolář, 1996)

4.2 Petrology of Drahanska higland

Monotonous strata/formation of sea Lower Carboniferous form most of the area – culm: shales, greywackes, in the south part conglomerates. Belt of primarily Devonian limestones (Javoricsky and Mladecsky karst), phylittes and basic rocks is stretching between Konice and Litovel. Narrow and discontinuous belt of Devonian shales and limestones is stretching within the west part of the Drahanska highland. Loess loams and slope (deluvial) sediments are prevailing covers. Loess occurs marginally in the forms of islands in the northeast, east up to southeast. Peats developed rarely in the highest parts of the Drahanska highland (Culek, 1995).

4.3 Soils of Drahanska higland

The continuous Dystric Cambisols and more abundant primary Pseudogleys on heavier loams are found in the highest (over 600 – 650 m. a. s. l.) flat part of the bioregion. The typical acid Cambisols, often gleyed, covers lower plateaus and top parts of the boundary slopes. Typical Cambisols are usually developed on boundary slopes. Typical haplic Luvisols are developed on islands of loess loams and loesses in the east edge of the bioregion. Mostly cambic Rendzic Leptosols with more or less decalcified fine grains occur in very limited areas on limestones (Culek, 1995).

4.4. Climatic conditions of Drahanska higland

Lower east and south edges belong to the relatively hot; slightly hot area MT11 after Quitt. Slit canyons/valleys belong to the areas MT 10, MT 9, MT 5. And the top parts belong to the MT2 and cold area CH 7. There is significant climatic gradient from edges toward the centre of the Drahanska highland. The precipitation decreases up to 550 mm, because of a slight precipitation shadow of Drahanska highland, and average temperature achieves 8°C within the southeast edge of the highland. This area is characterized unconvincingly with these meteorological stations: Plumlov 7.9°C, Mohelnice 619 mm and Holubice u Ptení 618 mm. The territory is medium wet. Temperature inversions and followed vegetation inversions in the valleys are typical (Culek, 1995 and Quitt, 1971).

4.5. Hydrology of Drahanska higland

The whole area of Drahanska highland belongs to drainage/catchment area of Black sea. The River Svitava and their tributaries drain West and partly south part of highland – watershed of the River Dyje. Other areas belong to the watershed of the River Morava. There are no big rivers, but it is headstream area thanks to the geography location. The rivers (Big) Velká and (Small) Malá Haná spring here. Their confluence creates the River Haná, which is important water-management right-sided tributary of river Morava. Other rivers that spring here are: The River Bělá, the River Punkva, Křtinský stream (left-sided tributary of the River Svitava), the River Říčka, the River Rakovec and the River Hloučela. Drahanska highland is headstream area of the River Romže main tributaries.

There are natural water reservoirs in the form of small karst lakes in the bottom of Macocha Abyss (Gorge) in the Moravian Karst. Small karst lakes: Upper lake Macocha's mean length is about 31 m, width 13 m and it is 13 m deep is located close to northeast wall of the Macocha Abyss. Lower lake Macocha is 45 m long, 8 m width and 25 m deep is located southeast wall of the Macocha Abyss.

There are some artificial water reservoirs such as ponds. Their sum and distribution fluctuated during the history. There is long-term trend in the loss of ponds in favour of the agricultural land. Most of all ponds are used for fish breeding, recreation and water supply. Dams are other type of artificial water reservoirs. These dams were built for different purposes. For e.g. Boskovice dam was built on the River Bělá, northeast from the town Boskovice. It occupies an area of 52.2 ha with total volume of 6.9 million m^3. It was built in the 1989. The purpose of dam construction was water supply for local. Opatovice dam is located on the River (Small) Malá Haná, to the west from the part of Vyskov holding the same name as the dam. This dam occupies an area of 70.5 ha with total volume of 9.9 million m^3. It was built in the 1972. The purpose of dam construction was water supply for local inhabitants. Plumlov dam is located on the stream Hloučele near to the village holding the same name. This dam occupies an area of 65 ha with volume of 5.57 million m^3. It was built in the 1932. The dam long-term purpose is floods protection and recreation.

(Demek and coll. 1992, Demek and Mackovčin, 2006)

4.6. Biota of Drahanska higland

Recent flora is medium rich with prevailing species of middle European forests. Hairy Sedge (*Carex pilosa* Scop.), Wood Melick (*Melica uniflora* Retz.), Hungarian Widow Flower (*Knautia drymeja* Heuff.) and Dusky Crane's-bill (*Geranium phaeum* L.) exceeds to the Drahanska highland from Carpathians area. Sub mountainous species are found in the highest parts and inverse valley slits of Drahanska highland. Bride's feathers (*Aruncus vulgaris* Raf.), Hairy Reed Grass (*Calamagrostis villosa* (Chaix) J. F. Gmel.), Perennial Honesty (*Lunaria rediviva* L.), White Butterbur (*Petasites albus* (L.) Gaertn.), Purple Lettuce (*Prenanthes purpurea* L.) and Alpine Rose (*Rosa pendulina* L.) are found in the forests. Bistort (*Bistorta major* S. F. Gray), Water Avens (*Geum rivale* L.), Round-headed Rampion (*Phyteuma orbiculare* L.), Globeflower (*Trollius latissimus* Crantz.), Groundsel (*Tephroseris crispa* (Jacq.) Schur) and other flowers are found in meadows. There is an enclave of peat species such as boreal-continental Hare's-tail Cottongrass (*Eriophorum vaginatum* L.) and Small Cranberry (*Oxycocus palustris* Pers.). Xerophilic flora communities spread along hotter east foothills of the Drahanska highland. There are pontic-panonia up to pontic-southsiberian species, for e.g. Red Rose (*Rosa gallica* L.), Large-flowered Selfheal (*Prunella grandiflora* (L.) Scholler), Greater Pasque Flower (*Pulsatilla grandis* Wenderoth), Golden Flax (*Linum flavum* L.), the sedge "Carex de Michaux" (*Carex michelii* Host), Dwarf Sedge (*Carex humilis* Leyss.) etc. Hairy Melic Grass (*Melica ciliate* L.) and Cotoneaster (*Cotoneaster integerrimus* Med.) are typical for the islands of Devonian limestones (Culek, 1995).

Fauna of natural beech forests is relatively conserved here; rarely occur peat meadows with fragments of peat fauna. Warm loving elements such as Southern White-breasted Hedgehog (*Erinaceus concolor* Martin, 1838) and Pygmy Field Mouse (*Apodemus microps* Pallas, 1811) occur in the lower elevations in the east edges. Cold loving element northern bat (*Eptesicus nilssoni* Keyserling et Blasius, 1839) occurs in the cold part of the Drahanska highland. Molluscs for e.g. land snails *Chondrina clienta* (Westerlund, 1883) and *Orcula dolium* (Draparnaud, 1801), insects, for e.g. spotted fritillary (*Melitaea didyma* Esper, 1778) or specific grasshopper communities. Streams and creeks of this area belong to the Trout's zone. Greyling's zone is developed in "Třebůvka" (Culek, 1995). Important species of Drahanska highland:

Mammals: Southern white-breasted hedgehog (*Erinaceus concolor* Martin, 1838), Ural field mouse (*Apodemus microps* Pallas, 1811), Lesser Horseshoe Bat (*Rhinolophus hipposideros* Bechstein, 1800), Geoffroy's Bat (*Myotis emarginatus* E. Geoffroy, 1806), Northern Bat (*Eptesicus nilssoni* Keyserling et Blasius, 1839)

Birds: Tengmalm's Owl (*Aegolius funereus* Linnaeus, 1758), Middle Spotted Woodpecker (*Dendrocopos medius* Linnaeus, 1758), Red-breasted Flycatcher (*Ficedula parva* Bechstein, 1792)

Amphobians: Fire Salamander (*Salamandra salamandra* Linnaeus, 1758), Alpine Newt (*Triturus alpestris* Laurenti, 1768)

Molluscs: land snails *Causa holosericea* (Studer, 1820), *Chondrina clienta* (Westerlund, 1883) and *Orcula dolium* (Draparnaud, 1801), door snail (*Itala ornate* Rossmässler, 1836)

Insects: Spotted Fritillary (*Melitaea didyma* Esper, 1778), Coniferous-tree Borer (*Synanthedon cephiformis* Ochsenheimer, 1801)

(Culek, 1995)

4.7. Natural migratory trails to the Drahanska highland

There is no current evidence on natural migratory trails to the Drahanska highland for large mammals, but there is planned Long-distance Corridor with reference number No. 191 and within this Corridor is delimited it critical place without sufficient vegetation. It should connect this area with the eastern part of Moravia (Anděl et al., 2010, OCHRANAPRIRODY.CZ, 2015).

5. WIDER TERRITORIAL RELATIONS

5.1. History of my Study Area

The oldest things that the archaeologists found there were various stone tools of different shapes and types (territory of Hlubočany village, Rostěnice village and Vyškov town). These stone stools were dated back to the Neolithic (New Stone Age). Other things found in the territory of Hlubočany village were made out of bronze and iron (Hoards of Iron Implements). Also rare findings such as big sledge stone maul with the notch from the times of Únětice culture and coins from the times of Roman Empire were found in the territory of Hlubočany village. Between 12-14th century came to this area German settlers (outer colonisation) and recolonize formerly Czech villages Hlubočany and Rostěnice-Zvonovice (Nekuda et al., 1965).

5.2. Placement of my Study Area

My study area is located in the historical part of Czech Republic called Moravia, in South Moravian region, former district of Vyškov town, in the three territories (Vyškov town, Rostěnice-Zvonovice village and Hlubočany village). More accurately it is located southward from the exit of D1 highway (Vyškov town), partly follow the Foltánek area (Foltánek, 2011), the northwest part. The nearest village is the Rostěnice–Zvonovice village and the largest forest complex is called Hlubočanký háj that is also partly located in my study area (Fig. 5–10.).

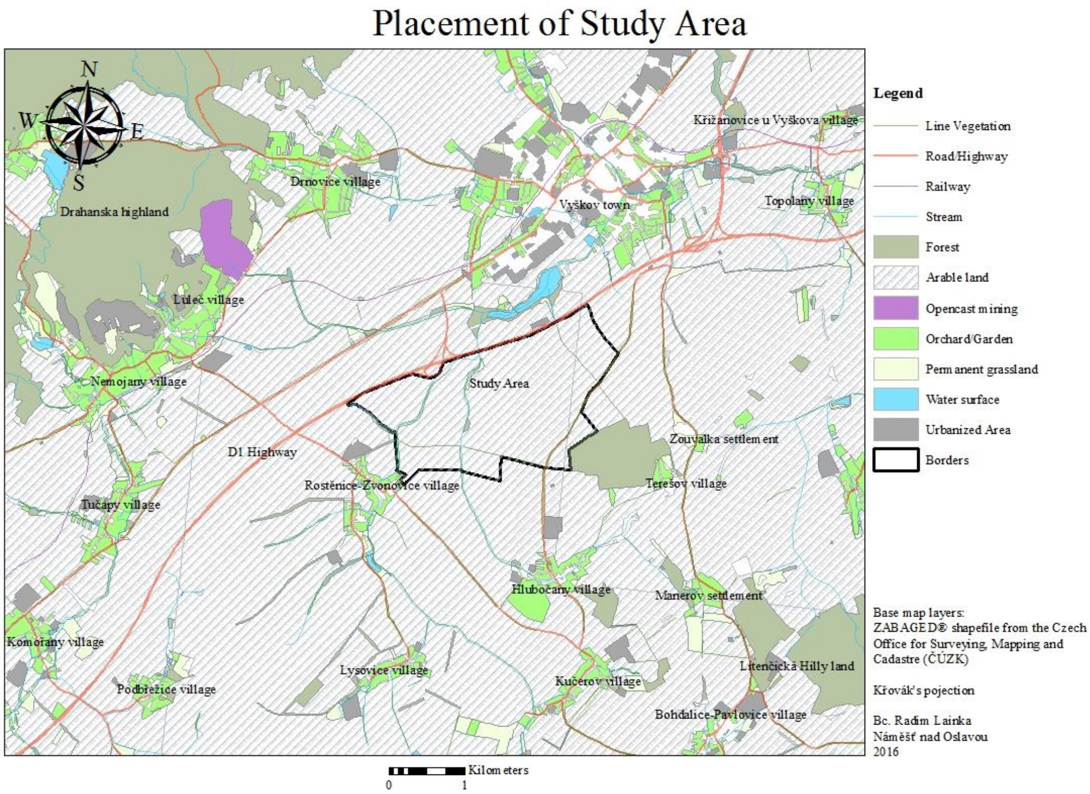

Fig. 5. Wider relations of my study area – 1 : 50 000

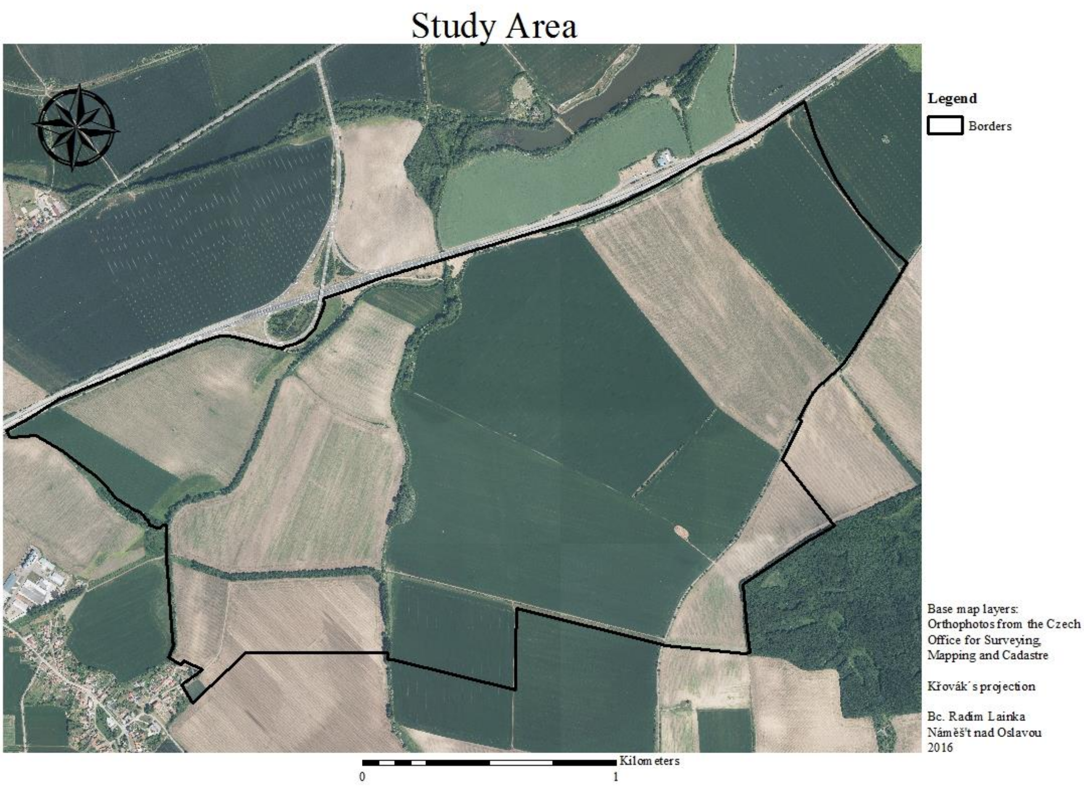

Fig. 6. Study area, closer look – 1 : 15 000

5.3. Characteristics of my Study Area

It is more less agriculture area with quite large fields (Fig. 5–6.). There are also small fragmented patches of former floodplain forest classified here as “Linear vegetation”, “Forest” and “Woodland” within the streams in Fig. 6.

The biggest inhabited area nearby my study area is Vyškov town with 21312 citizens. Second one is Rostěnice-Zvonovice village with 507 citizens and the right after is Hlubočany village with 505 citizens (Tab.1).

Tab. 1 Municipalities and numbers of their habitants nearby my study area [15, 16 and 17]

Municipality	No. of habitants up to 1.1.2015
Hlubočany	505
Rostěnice-Zvonovice	507
Vyškov	21312

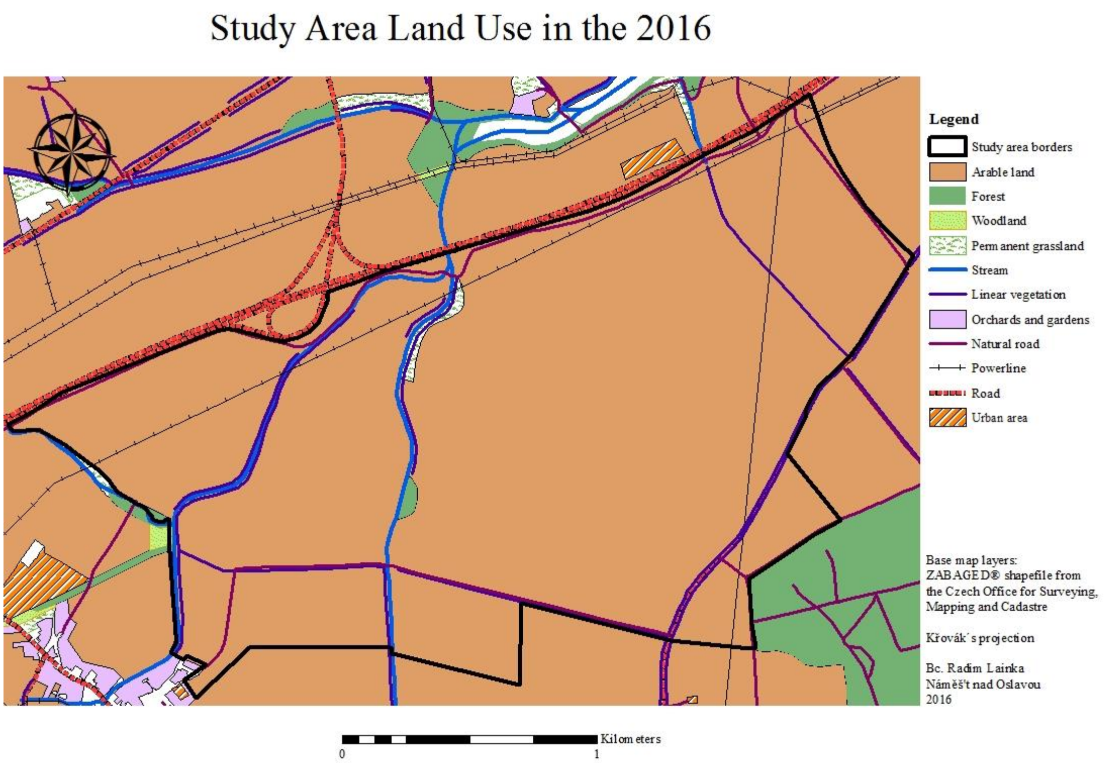

Fig. 7. Actual Land Use of my study area – 1 : 15 000, woodland (not closed canopy), forest (closed canopy), white areas (missing data)

I identified over 150 parcels within my study area. The largest part of my study area is owned by private companies and by individuals (yellow and blue colour), represent about 80% of the whole area. The second largest group of parcels belongs to the public (green colour – Rostěnice and Hlubočany village, Vyškov town – brown colour), represent about 15% of the whole are. The rest of the parcels that contains forest (red colour) towards the Rostěnice village belongs to the Czech Forest Enterprise (Czech state company), other parcels close to the D1 highway (also red colour) belong to the Road and Motorway Directorate of the Czech Republic. The last parcel belongs to the South Moravian Region (violet colour). The problematic, quite big amount of parcels during my research were still not put into the cadastre of real estate's map. These parcels belong to the parcels of simplified registration (so called land register) and they were found in the different map (yellow and brown parcels in the Fig. 7.). There are some parcels (No. 1944/7, 1970/2-3, 1971/4-8 and 1975/5) that supposed to be used for new buildings in the future. They are located in the northeast of my study area and they are actually owned by the private company called KJ invest, LLP. More details of the individual parcels are located on the disc (file called Cadastre_study_area.xlsx).

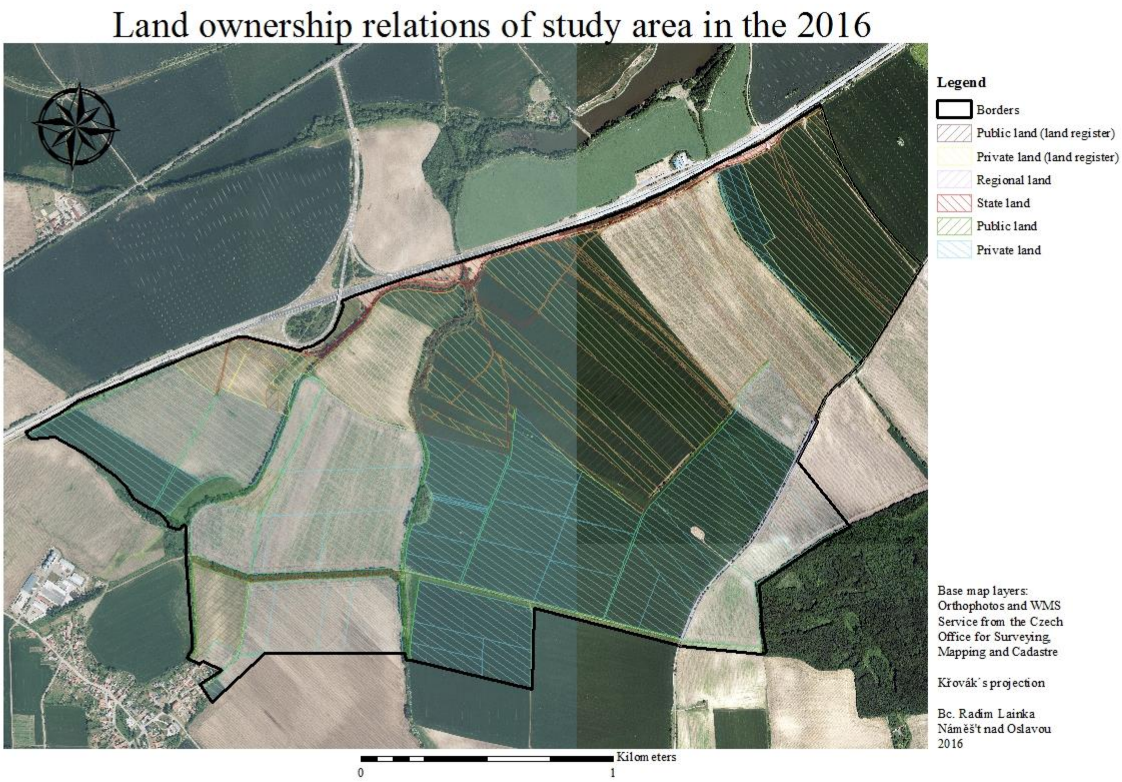

Fig. 8. Actual land ownership within my study area – 1 : 15 000

5.4. Natural conditions of my Study area

5.4.1. Geomorphology

System: Alpine-Himalayan

Sub system: Carpathians

Province: Western Carpathians

Subprovinces: VIII Outer Carpathians Depressions and IX Outer Western Carpathians

Regions: VIIIA Western Outer Carpathian Depressions and IXB Central Moravian Carpathians

Units: VIIIA-2 Vyškovská brána (Gate) (Na hanácké, 339 m. a. s. l.) and IXB-2 Litenčická pahorkatina (Hilly land) (the highest point: Hradisko 518 m. a. s. l.)

Subunits: VIIIA-2B Ivanovická brána (Gate) and IXB-2A Bučovická pahorkatina (Hilly land)

Okrsek (Department) of IXB-2A Bučovická pahorkatina (Hilly land): IXB-2A-2 Kučerovská pahorkatina (Hilly land)

(Demek and Mackovčin, 2006; Boháč and Kolář, 1996)

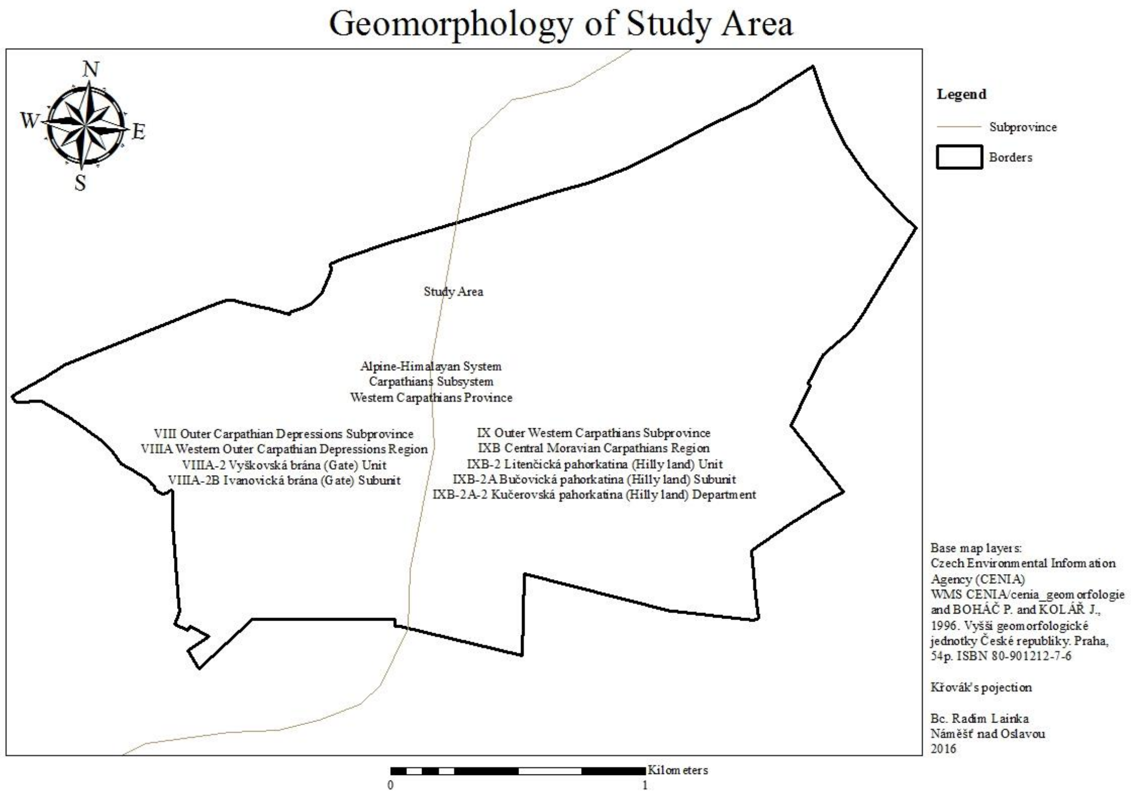

Fig. 9. Placement of my study area within geomorphological classification of the Czech Office for Surveying, Mapping and Cadastre (ČÚZK)

5.4.2. Geology

There are present 2 geological units within my study area. The first one belongs to the Carpathians (southeast from the border of geological units) and the second one, older, belongs to the Bohemian massif rocks. Especially the part of the Western Carpathians, so called Carpathian Foredeep. And in the case of the Bohemian Massif rocks, especially its Quaternary part. The geological background of my study area consists of Neogene sediments, such as calcareous clays (sometimes with sand, former branch with death end of the Rostěnický creek and one small area located towards the Hlubočanský forest complex), loess and loess soils, mixed sediments (former braches with death ends of the Rostěnický creek), clays, sands and gravels (creeks and its closest surroundings) and limestone (Fig. 8.) [19].

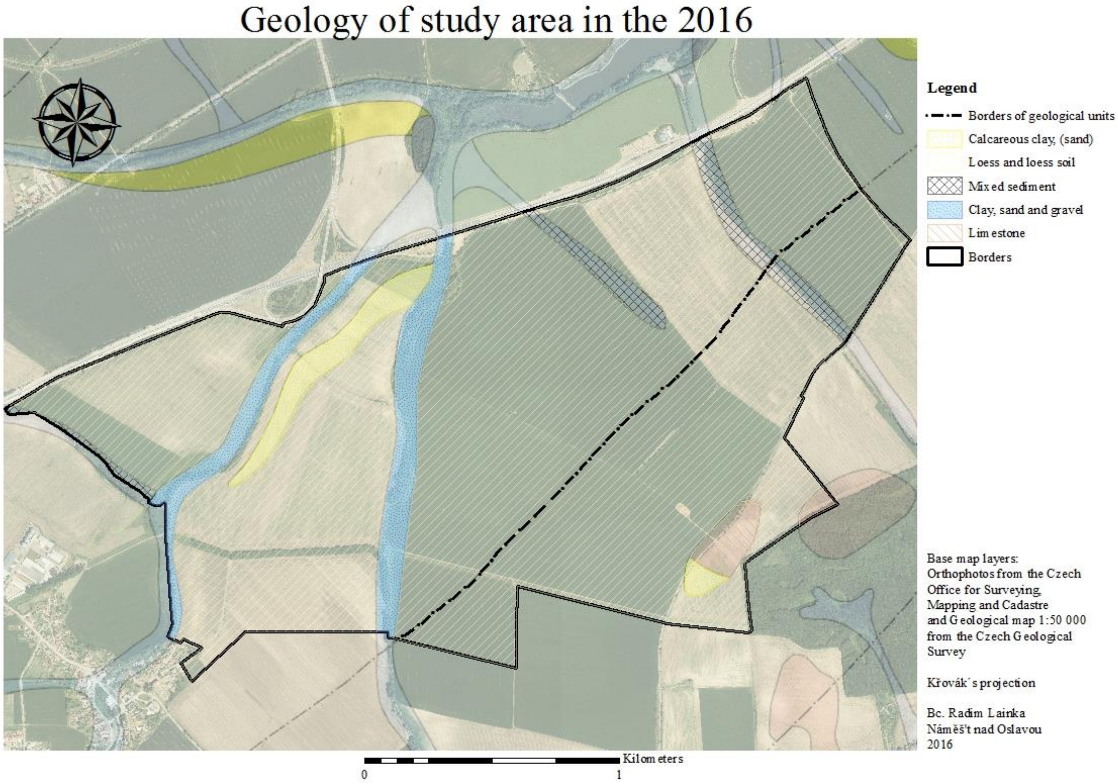

Fig. 10. Geological background of my study area – 1:15000

5.4.3. Soils

The original soils of my study area consists mainly from the (modal) Chernozems (fields), after that there are present Calcaric Gleyic Phaeozems (Rostěnický and Hlubočanský creek and their closest surroundings), Chernic Chernozems (former branches with death ends of the Rostěnický creek), Calcic Chernozems (former branch with death end of the Rostěnický creek) Calcic Melanic Cambisols (small area located towards the Hlubočanský forest complex), Calcaric Leptosols (follow the Calcic Melanic Cambisols) and Rendzic Leptosols (Fig. 9.) [20].

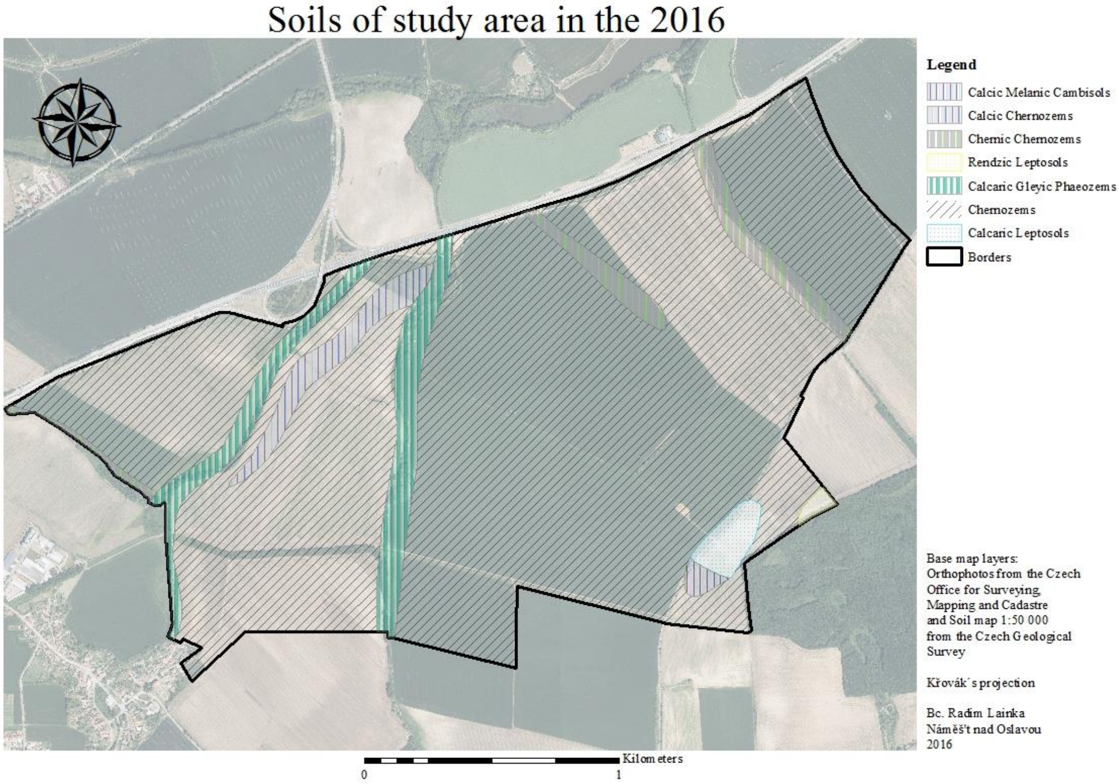

Fig. 11. Soils present within my study area – 1:15000

5.4.4. Hydrology

There are two streams actually present in my study area. One that is located more to the east (close to the centre of my study area) is called Hlubočanský stream and other one is called Rostěnický stream. Rostěnický stream springs nearby Pavlovice village, in the 344 a. s. l. Its catchment area is about 73.3 km^2, the length 14.6 km, average flow in the estuary is about 0.17 $m^3 \cdot s^{-1}$, and average outflow is about 0.0023 $m^3 \cdot s^{-1} \cdot km^{-2}$. Hlubočanský stream enters the Rostěnický stream (Fig. 6.) nearby the D1 highway bridge. Rostěnický stream drains into the river Haná (in 240 m a. s. l.), the river Haná drains into the river Morava, and the Morava is left tributary of the Danube and the Danube drains into the Black Sea (Nekuda et al., 1965; ÚHUL, 2001).

5.4.5. Climatology

There is climatic region called T3 (warm, mildly wet), see Tab.2 and according to the Quitt (1971) classification my Study area belongs to the T2 climatic region (see Tab.3).

Tab. 2 Basic characteristics of the climatic region T3 [17]

Code KR	Symbol KR	Region Attribute	Sum of temperatures over 10°C	Average year temperature °C	Average sum of precipitations (mm)	Probability of dry veg. periods (%)
3	T 3	Warm, mildly wet	2500-2800	(7)8-9	550-650 (700)	10-20

According to the all estimated pedologic-ecological units (BPEJ) in the study area.

Tab. 3 Description of T2 climatic region (adapted after Quitt, 1971)

T2													
LetD	HVO	MD	LD	t I	t VII	t IV	t X	s≥1mm	s VO	s VZ	sp	o > 0.8	o < 0.2
50-60	160-170	100-110	30-40	-2--3	18-19	8-9	7-9	90-100	350-400	200-300	40-50	120-140	40-50

Legend:
LetD **–** days with the maximal temperature reach or overcome 25° C, HVO – days with the temperatures above 10° C, MD – days with the maximal temperature -0.1° C and bellow, LD – days with the maximal temperature -0.1° C and bellow, t I – average temperatures of January, t WII – average temperatures of July, t IV – average temperatures of April, t X – average temperatures of October, s≥1mm – days with the precipitation over 1mm, s VO – amount of precipitation during vegetation period, s VZ – amount of precipitation during winter period, sp – days with snow coverage, o > 0.8 – cloudy days and o < 0.2 – bright days.

5.4.6. Estimated pedologic-ecological units

Estimated pedologic-ecological unit (BPEJ or ¨bonitovaná půdně ekologická jednotka”) is the basic determination and evaluation unit of productivity of agriculture land. It is expressed by five-digit code. The numbers of this code denotes the soil-climatic features of particular soils. These units formed the bordered territorial unit, which possess specific ecological features and so called bioenergetical potential [21]. Estimated pedologic-ecological units within my study area are following (with the description in relation to Geobiocoenology):

- 30100 –> 3 (climatic region), trophic row: BD, (D), hydric row: (2)3, plain (0-3°), all direction exposure and without skeleton, deep;
- 30110 –> 3 (climatic region), trophic row: BD, (D), hydric row: (2)3, plain (0-3°), all direction exposure and without skeleton, deep;

- 30810 –> 3 (climatic region), trophic row: B, (BD), hydric row: (2)3, plain (0-3°), all direction exposure and without skeleton, deep;
- 30600 –> 3 (climatic region), trophic row: BD, (BCD), hydric row: 3-4, plain (0-3°), all direction exposure and without skeleton, deep;
- 31901 –> 3 (climatic region), trophic row: BD, (D), hydric row: (2)3(4), plain (0-3°), all direction exposure and without skeleton up to mildly skeletonized, rarely even only medium deep;
- 36200 –> 3 (climatic region), trophic row: BC, (BCD, CD, C) and hydric row: (3)4 and plain (0-3°), all direction exposure.

5.4.7. Biogeography

It belongs to the Prostějovský bioregion and Ždánicko-litenčický bioregion, especially to the 3 biochores (2BE, 2RE and 3BE). 2BE – Eroded plateaus on loams second vegetation belt Beech – Oak (*Fagus* – *Quercus*). 2RE Plateaus on loams second vegetation zone called Beech – Oak (*Fagus* – *Quercus*), 3BE Eroded plateaus third vegetation zone called Oak – Beech (*Quercus* – *Fagus*) (Culek, 2003). The placement of biochores within my study area is showed on the Fig. 13. Types of Biochores with its descriptions (Culek, 2003):

- **2BE** – Eroded plateaus on loams second vegetation belt Beech – Oak (*Fagus* – *Quercus*). The potential natural vegetation should be formed by the *Melampyro nemorosi–Carpinetum betuli* communities, communities of the *Quercion petraeae* union (associations *Potentillo albae-Quercetum*) on the slopes with southern exposition. Further on, in the depressions in the stream alluvial plains (floodplains) are communities of the *Pruno–Fraxinetum*. Deforested areas are typical for the warmth-loving grasses of *Bromion* union, in the other hand, in the wet localities grasses of *Calthion* union.

- **2RE** Plateaus on loams second vegetation zone called Beech – Oak (*Fagus* – *Quercus*). The potential natural vegetation should be formed mostly by the *Primulo veris-Carpinetum*, these vegetation communities continuously transform its composition on the colder and wetter soils into the *Melampyro nemorosi–Carpinetum betuli*.

- **3BE** Eroded plateaus third vegetation zone called Oak – Beech (*Quercus – Fagus*). The potential natural vegetation should be formed mostly by the *Melampyro nemorosi–Carpinetum betuli* communities, however partly also by the *Carici pilosae-Carpinetum*. Communities of *Carici remotae–Fraxinetum excelsioris* occur in the forest springs and along the smaller streams. Along the bigger streams are communities of association called *Pruno padi–Fraxinetum excelsioris*. Meadow plant communities are formed by the grasses of *Arrhenatherion* union, and wet meadows belong to the unions *Calthion* and *Molinion*.

According to the system of Phytochorotypes my study area belongs to:
2. Species with their centres of distribution in Thermophyticum
2.1 Phytochorotype: *Buglossoides purpurocaerula–Ranunculus illyricus*
Species distributed in both Bohemian and Pannonian thermophyticum (Slavík, 1984).

According to the Phytogeographical system my study area belongs to:
Phytogeographical region: Thermophyticum
Phytogeographical province: Panonian thermophyticum
Phytogeographical districts: 21 Haná
Phytogeographical provinces: 21a. Hanácká pahorkatina (Hilly land)
(Skalický, 1988)

5.4.8. Natural Forest Areas

My study area is mainly (about 95%) located in the Natural Forest Area No. 34 Hornomoravský úval (Graben) and the rest (South-eastern part of my study area) belongs to the Natural Forest Area No. 36 Středomoravské Karpaty (Central Moravian Carpathians) [22].

5.5. Wildlife of Study Area

5.5.1. Animal occurrence in my study area

Data on the wild animals' occurrence in the area are showed in the Tab. 4. Only three hunting associations were present in the larger view of my study area, because Drnovice hunting district was integrated to the Vyškov hunting district (Fig. 12. with the former Drnovice hunting district).

Tab. 4 Wild animals in the study area (Hunting associations' data)

Hlubočany	
Species	Winter stock of game (31th March 2013)
Roe deer (*Capreolus capreolus*)	45
Brown hare (*Lepus europaeus*)	80
Pheasant (*Phasianus colchicus*)	45
Rostěnice-Zvonovice	
Species	Winter stock of game (31th March 2014)
Roe deer (*Capreolus capreolus*)	34
Phaesant (*Phasianus colchicus*)	62
Vyškov	
Species	Winter stock of game (31th March 2014)
Roe deer (*Capreolus capreolus*)	28
Brown hare (*Lepus europaeus*)	55
Phaesant (*Phasianus colchicus*)	105

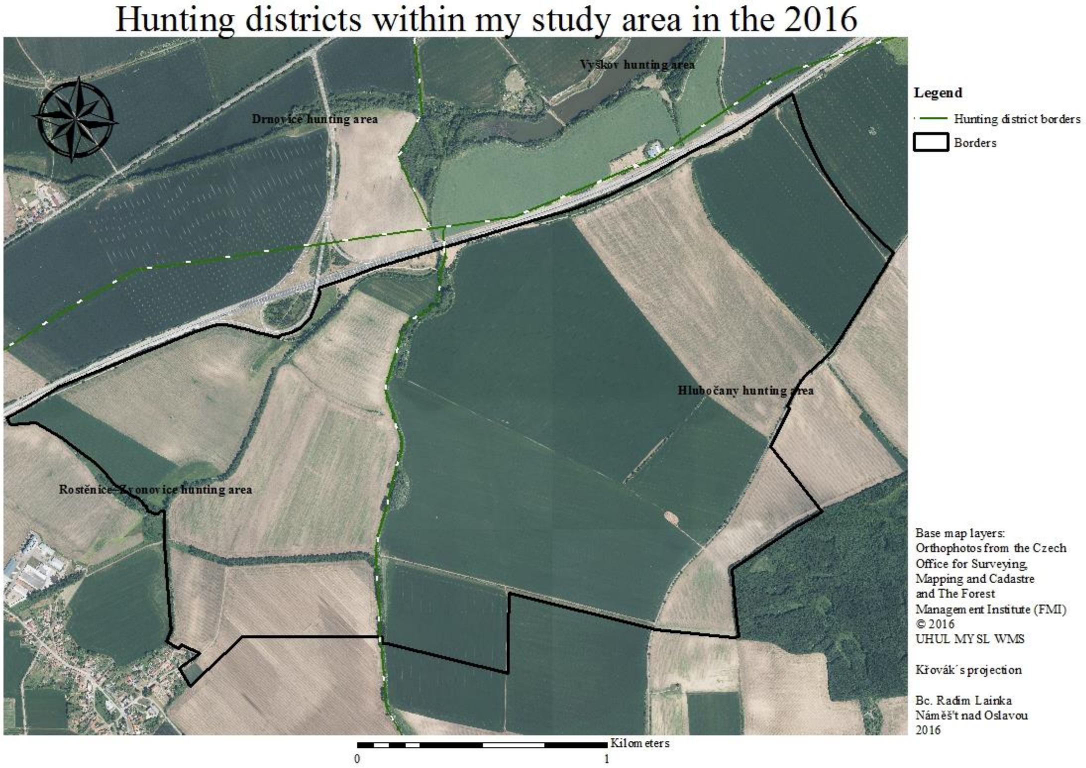

Fig. 12. Hunting districts and my study area (black colour) – 1:15 000

5.5.2. Road–killed wildlife

Between the 1st January 2007 and 1st January 2015 there were 60 wild animal-vehicle collisions in the Vyškov territory, 2 wild animal-vehicle collisions in the Rostěnice territory and 6 wild animal-vehicle collisions in the Hlubočany territory. However, there is no evidence on the species of wild animals, neither the evidence of their gender (MAPS.JDVM.CZ, 2015).

5.6. TSES of my Study Area

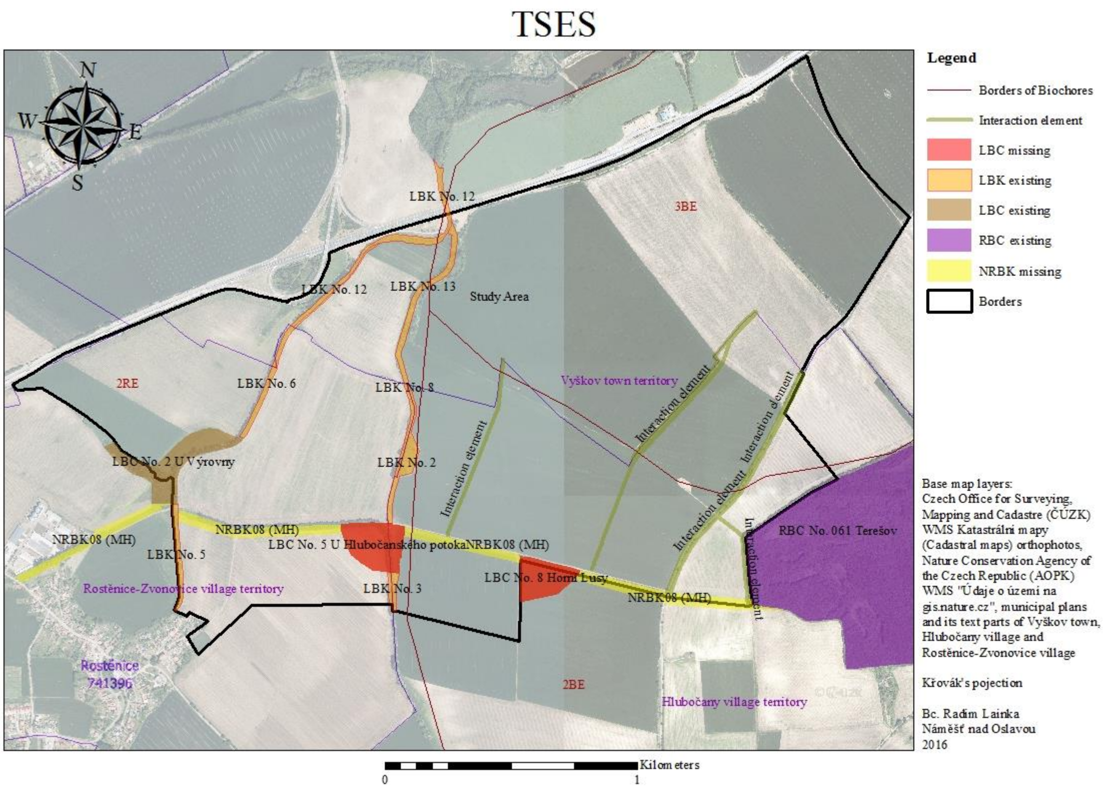

Fig. 13. Actual TSES according to the latest valid municipal plans within my study area plotted with new versions of biochores (1: 15 000)

5.6.1. TSES elements

There are eighteen TSES elements within my study area (Fig. 13.). Some of them existing (local biocentre LBC No. 2 U Výrovny, regional biocentre RBC No.061 Terešov and all the local biocorridors mentioned as LBK) and the rest of them were classified as missing (totally or not yet fully developed). Seven biocorridors of local importance (LBK No. 2, LBK No. 3, LBK No. 5, LBK No. 6, LBK No. 8, LBK No. 12, and LBK No. 13) three biocentres of local importance (LBC No. 2 U Výrovny, LBC No. 5 U Hlubočanského potoka and LBC No. 8 Horní Lusy), one biocentre of regional importance (RBC No. 061 Terešov) and one biocorridor of supra-regional importance (NRBK08 (MH), represented by three parts of this biocorridor. And four interaction elements. All the elements of TSES are described more complexly in Appendix 1.

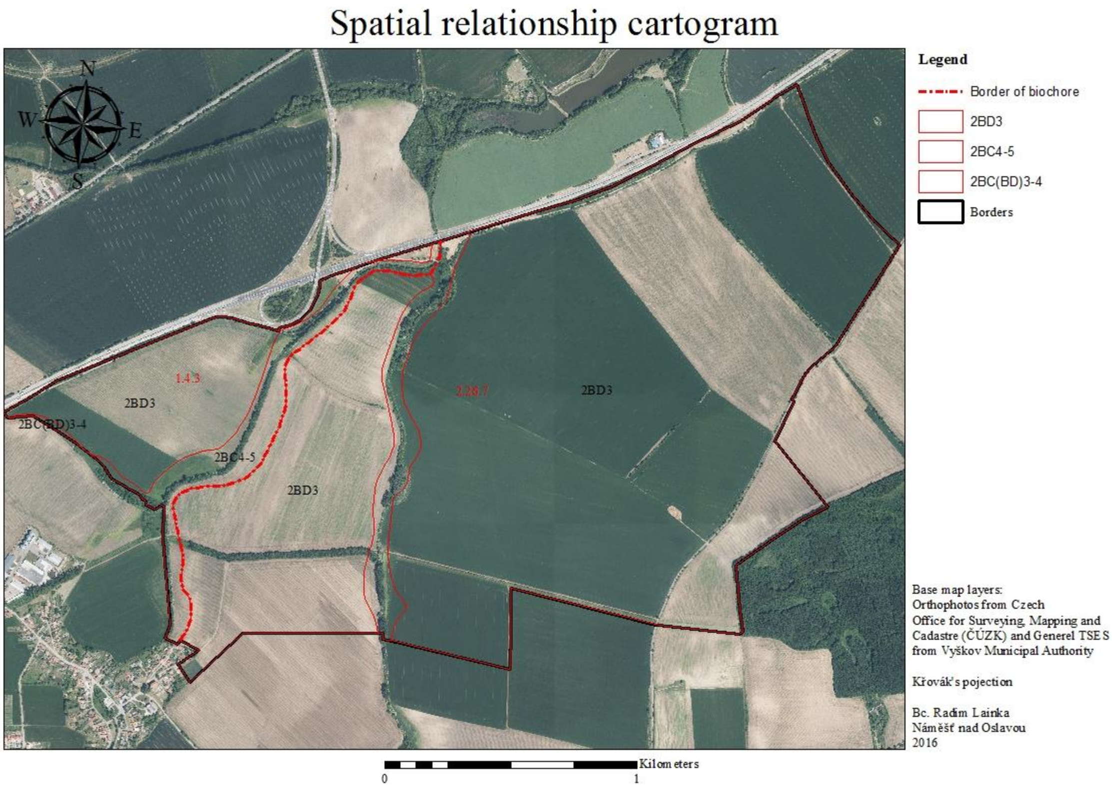

Fig. 14. Groups of geobiocoene types with former biochores within my study area

Supra-regional biocorridor

The axis of the supra-regional bio corridor K134 MH (actually renamed as NRBK08 (MH)), that connects the area of the Kroměříž region and Vyškov region, was projected over my study area (examined area). It consisted of the supra-regional bio centrum (NRBC 94 Buchlovské lesy), regional bio centrum (RBC 202 Klučenice), the closest to the regional bio centrum (RBC 202 Klučenice) and simultaneously part of the same supra-regional bio corridor is regional biocentrum (RBC 195 Terešov), it is located towards southeast over the Vyškovská brana (Kocián et al., 2003). However, the route of the supra-regional bio corridor K 134 MH (Fig. 15.) near Vyškov was changed (Fig. 16.) according to the decision of the South Moravian Regional Authority (Bláha, 2015 and Novotný, 2015). The change was proposed in the "Conceptual delimitation of regional and national TSES in the territory of South Moravian Region. The justification of this change come (translated from Czech language) from the work version of new "ZUR" (Principles of territorial development) from September 2014: "In the territory of Olomouc region was respected connectivity to the supra-regional biocorridor K 92 MB, regional bio corridors RK 1432 and RK 1433B and regional biocentre RBC 1886 located in the north-eastern part of the SO ORP (administrative district of municipalities with extended powers) Boskovice. In the northern and north-eastern part of the SO ORP Vyškov is abided connectivity of the area for the regional bio centrum RBC 258, corridors from supra-regional bio corridor K 132 MB and K 132 T and regional bio corridor RK 1448 on the elements of the TSES at the SO ORP (administrative district of municipalities with extended powers) Konice in the territory of the Olomouc region." (Bláha, 2015). However, this change did not respect the proposed Long-Distance Migration Corridor No. 191 (Fig. 17.) and therefore is unwanted for the possible migration of large mammals (Anděl et al., 2010). However, there is no legal binding document or law that supports the Long-Distance Migration Corridors and TSES main function is not about to support the animal migration. For the purpose of objectivity my supervisor asked other expert, Mgr. Strnad from Nature Conservation Agency of the Czech Republic (division of SAC) for his view of the situation in this case. Mgr. Strnad responded with this statement (translation from Czech language): "According to the findings of field survey from 2009, which took place as part of the undergoing project entitled "Evaluation of migration permeability of the landscape for large mammals and design of protective and optimization measures", proposed the most convenient direction of Long-Distance Migration Corridor (LDMC) located southwards from Vyškov town. This corridor connects Litenčická upland with Drahanska highland. Long-Distance Migration Corridor No. 191 is conducted so as to avoid migration barriers as a residential area. In place of a conflict with a significant line barrier, which in this case is the D1 highway, corridor is directed so as to copy the natural riparian vegetation along the Rostěnický stream. This vegetation provides for many animals the only possibility of hiding in surrounding forestless landscape along which can also move. At the crossing point with D1 highway the Long-Distance Migration Corridor No. 191 is located under the bridge, which the aforementioned stream is converted. This place represents almost the only option for the safe crossing the highway in this section."

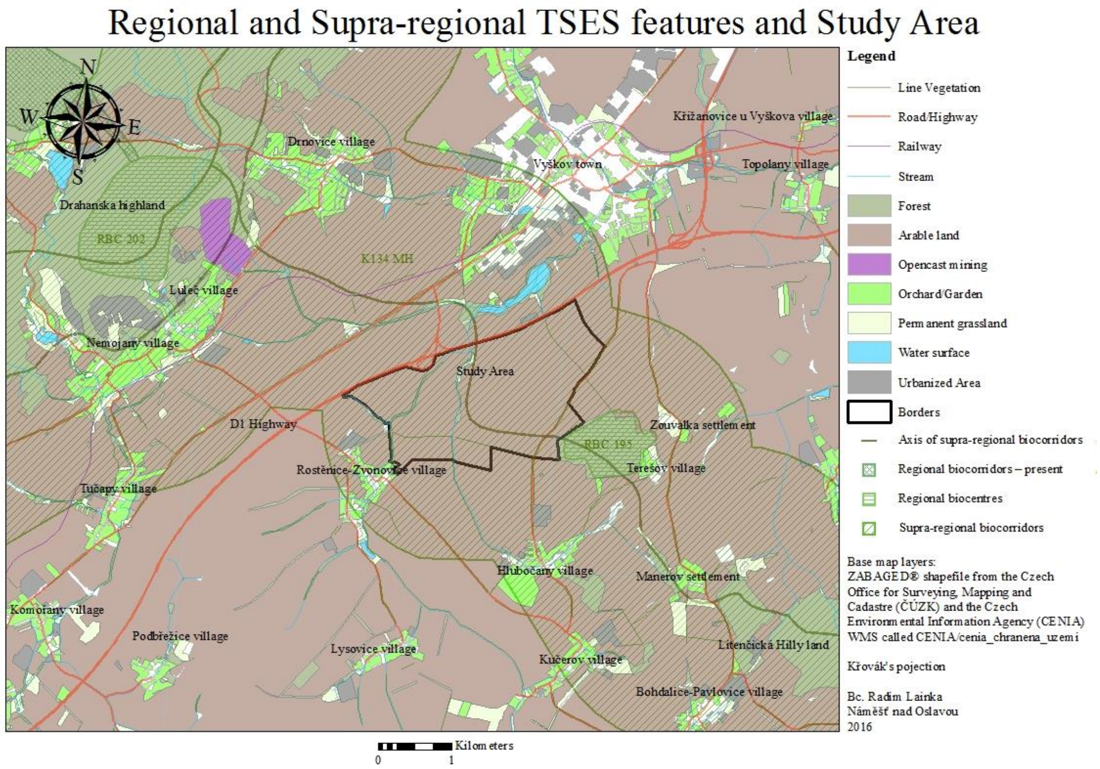

Fig. 15. The former route of supra-regional bio corridor K134 MH, 1 : 50 000

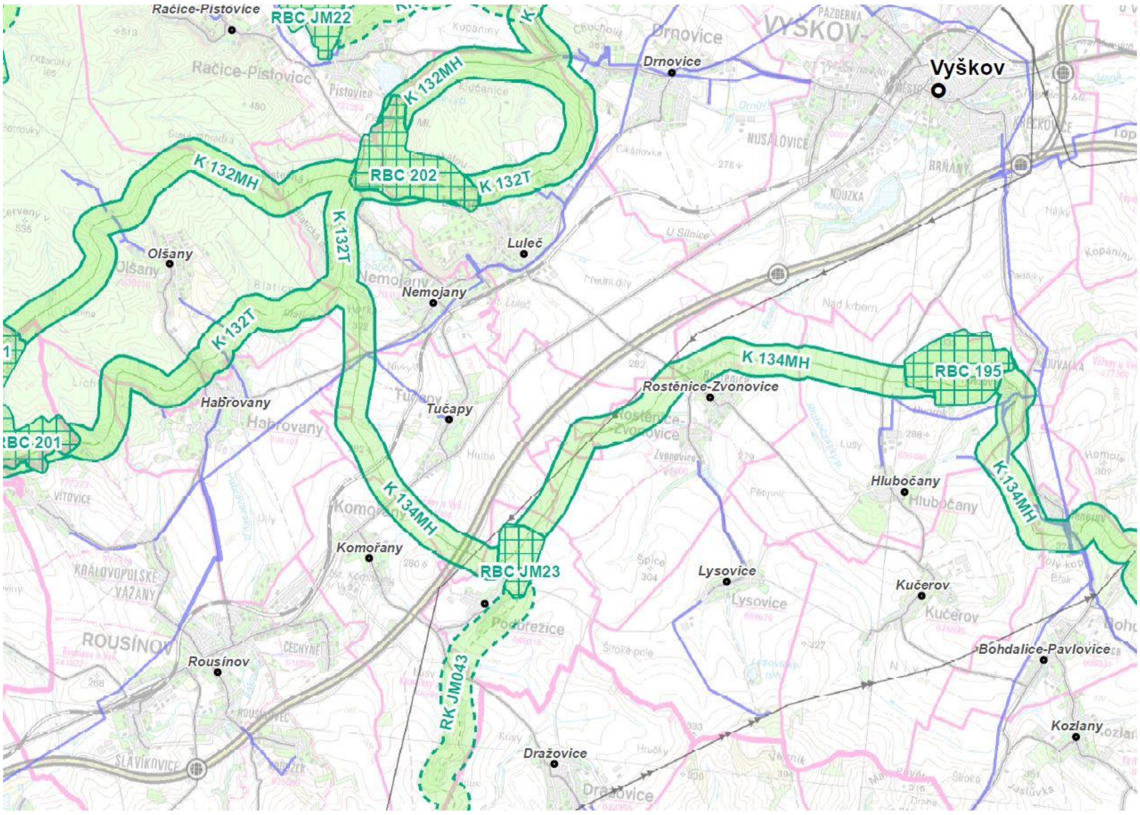

Fig. 16 The new route of supra-regional bio corridor K134 MH according to the proposal version of new “ZUR” or Principles of territorial development (Bláha, 2015)

5.6.2. Biochores

New biochores are represented in Fig. 13. and described in the subchapter called 5.4.7. However, the original ones are still used for comparison (Fig. 14.). According to the so called Generel of TSES (Appendix 1), there are 2 biochores and 3 groups of geobiocoene types (Fig. 14.) present within my study area. Biochore labelled as 1.4.3. warm plain Hilly lands on loess, belonging to the so called sosioekoregion 1.4. Hornomoravský úval (Graben), described in the previous chapter. And biochore 2.26.7. (respectively 11.26.7.) warm bottom loess Hilly lands, belonging to the so called sosioekoregion 11.26. Central Moravian Carpathians (cover the most of my Study area). It is kind of modal biochore. It is widespread in the strip located on the north bottom of the Ždánický les (Forest) and Litenčická pahorkatina (Hilly land). Described as plain Hilly land on tertiary sediments with loess coverage, with prevailing brown earth soils. Climate is mildly warm up to warm, mildly dry (Novotný and Stejskalová, 1993).

Biota: The prevailing is transition between 2^{nd} and 3^{rd} Forest Vegetation Zone, and normal trophical series. The main Geobiocene types groups (STG) are:

- 2 B n: Fagi-Querceta typical (typical beech oak forests)
- 3 B n: Querceta-Fageta typical (typical oak beech forests)

Conditions of the landscape within the range of biochore 2.26.7. (respectively 11.26.7.): Arable land prevails, only rare occurrence of small forest patches – regularly black locust forests and pinewoods, rarely even oak forests (for i.e. nearby Dražovice village). The rest of the small grassland patches are rarely conserved, mostly ruderalized steppe heathland with of naturally seeding shrubs (*Rosa canina* L., *Cornus sanguinea* L.) in the valley of the Litava river (Low et al., 1991).

The most common Geobiocene types groups (STG) present within my study area are STG **2 BD 3**, followed by the **2 BC 4-5**. The minor part of my study area belongs to the STG **2 BC(BD) 3-4**.

5.6.3. Study area STG descriptions

2 BD 3 Fagi-querceta tiliae (linden beech oak forests, FQtil), it is characterized by the trophic series mesotrophic basophilic (semi rich of calcium) and normal hydric series (leading). It is widespread on the large areas in the south-eastern part of Vyškov territory (Low et al., 1995; Novotný and Stejskalová, 1993).

Natural state of biocoenoses:
Woody level there is diverse. The leading trees are oaks, particularly sessile oak (*Quercus petrae* Liebl.), also there can be present even pendunculate oak (*Quercus robur* L.) and rarely even downy oak (*Quercus pubescens* Willd.). Further on, there are present other species such as lindens (*Tilia cordata* Mill. and *Tilia platyphyllos* Scop.), hornbeam (*Carpinus betulus* L.), field maple (*Acer campestre* L.), wild service tree (*Sorbus torminalis* L. (Crantz)). Regular admixture is composed by the European beech (*Fagus sylvatica* L.). Shrub level is usually dominated by some specie that like calcareous conditions – European cornel (*Cornus mas* L.), wayfarer (Viburnum lantana L.), in Moravian part of Czech Republic European bladdernut (*Staphylea pinnata* L. (Crantz)). The European privet (*Ligustrum vulgare* L.) is abundant there, other shrubs that are associated here are Warted Spindletree (*Euonymus verrucosus* Scop.), common dogwood (*Cornus sanguinea* L.), common buckthorn (*Rhamnus cathartica* L.),

common hawthorn (*Crataegus monogyna* Jacq.), common hazel (*Corylus avellana* L.), blackthorn (*Prunus spinosa* L.), European fly honeysuckle (*Lonicera xylosteum* L.) etc.

There is also present diverse synusiae of understorey, characteristic is the common occurrence of mesotrophic and calcareous like species, and there are always present at least some warm loving species. Usually dominated here species of grass like character, such as wood bluegrass (*Poa nemoralis* L.), wood melick (*Melica uniflora* Retz.), mountain melick (*Melica nutans* L.), Slender Cock´s-foot (*Dactylis polygama* Horv.), false-brome (*Brachypodium sylvaticum* (Huds.) Beauv.), various-leaved fescue (*Festuca heterophylla* Lam.), hairy sedge (*Carex pilosa* Scop.), from the calcareous like species Soft-leaved Sedge (*Carex montana* L.) and heath false brome (*Brachypodium pinnatum* (L.) P. Beauv.). Also there are present some of the forest mesotrophic species like sweetscented bedstraw (*Galium odoratum* (L.) Scop.), addersmeat (*Stellaria holostea* L.), Scotch mist (*Galium sylvaticum* L.), Schultes´ Bedstraw (*Galium schultesii* Schult.), spring vetchling (*Lathyrus vernus* L.), Liverleaf (*Hepatica nobilis* Schreb.), Wood Cow-wheat (*Melampyrum nemorosum* L.), tuberous comfrey (*Symphytum tuberosum* L.), sanicle (Sanicula europaea) etc.

Herb layer also consists species with calcareous tendency, commonly widespread are bastard balm (*Melittis melissophyllum* L.), cowslip (*Primula veris* L.), Scentless Feverfew (*Pyrethrum corymbosum* (L.) Scop.), Cushion Spurge (*Euphorbia epithymoides* L.), sickle-leaved hare´s-ear (*Bupleurum falcatum* L.), hairy violet (*Viola hirta* L.). Relatively often there grow abundantly also decorative herbs in the linden beech oak forests, such as Turk´s cap lilly (*Lilium martagon* L.), lady´s-slipper orchid (*Cypripedium calceolus* L.), The White Helleborine (Cephalantera damasonium (Mill.) Druce), and lesser butterfly-orchid (*Platanhera bifolia* (L.) L. C. Rich).

(Buček and Lacina, 1999; Low et al., 1995).

2BC4-5 (respectively **2BC(4)5a**) **Fraxini-Alneta inferiora** (ash alder woods of higher degree, FrAl inf), well distributed along the Rostěnický stream and Hlubočanský stream. Actual vegetation of these streams is formed by the black poplar (*Populus nigra* L.), Canadian poplar (*Populus x canadensis* Moench) as part of preparatory vegetation (however still not removed), aspen (*Populus tremula* L.), alder (*Alnus glutinos*a (L.)

Gaertn.), white willow (*Salix alba* L.), and goat willow (*Salix caprea* L.), black elder (*Sambucus nigra* L.), European fly honeysuckle (*Lonicera xylosteum* L.) and some places are occupied by the invasive tree from Northern America, maple ash (*Acer negundo* L.)

Natural state of biocoenoses:
Tree level is formed by the European alder (*Alnus glutinosa* (L.) Gaertn.) and ash (Fraxinus excelsior), with admixed crack, willow (*Salix fragilis* L.), white willow (*Salix alba* L.) an its hybrids, rarely even black poplar (*Populus nigra* L.), and aspen (*Populus tremula* L.). Understory is usually occupied by the bird cherry (*Padus avium* L.). And so called "lowland spruce" (*Picea abies* (L.) H. Karst.) could be found in the colder inverse elevations with more-less permanent higher humidity. Shrub layer is formed by the goat willow (*Salix caprea* L.), creek banks are usually occupied by the purple willow (*Salix purpurea* L.), almond willow (*Salix triandra* L.), and basket willow (*Salix viminalis* L.), also quite abundant is black elder (*Sambucus nigra* L.), European spindle (*Euonymus europaea* L.), also alder buckthorn (*Frangula alnus* Mill.) and guelder-rose (*Viburnum opulus* L.). Typical is abundant occurrence of hop (*Humulus lupulus* L.).

The synusiae of understorey is very diverse. It is a mixture of wetland (hydrophytes), hygrophytes with mesophytes, where the dominant are species with nitrophilous tendency. There is quite remarkable so called early spring aspect with lesser celandine (*Ficaria bulbifera* Huds.), wood anemone (*Anemone nemorosa* L.), yellow anemone (*Anemone ranunculoides* L.), Alternate-leaved Golden-saxifrage (*Chrysoplenium alternifolium* L.), marsh-gold (*Caltha palustris* L.), Yellow Star-of-Bethlehem (*Gagea lutea* (L.) Ker Gawl), lungwort (*Pulmonaria officinalis* L.), true oxlip (*Primula elatior* Hill.) etc. In the other hand, in the summer aspect dominates ground elder (*Aegopodium podagraria* L.), meadowsweet (*Filipendula ulmaria* (L.) Maxim.), (Scirupus sylvaticus), tufted hairgrass (*Deschampsia cespitosa* (L.) P. Beauv.), common nettle (*Urtica dioica* L.), Wood Stitchwort (*Stellaria nemorum* L.) and addersmeat (*Stellaria holostea* L.) often occur there. Also Water Chickweed (Mysosoton aquaticum (L.) Moench), lesser water-parship (*Berula erecta* (Huds.) coville), butterbur (*Petasites hybridus* (L.) g. Gaertn., B. Mey & Scherb.), Wood–sedge (*Carex sylvatica* Huds.), Giant Fecue (*Festuca gigantea* (L.) Vill.), False-brome (*Brachypodium sylvaticum* (Huds.) P. Beauv.), Wood avens (*Geum urbanum* L.), touch–me–not (*Impatiens noli-tangere* L.), Spotted Dead–nettle (*Lamium maculatum* (L.) L.), cabbage thistle (*Cirsium eleraceum* (L.) Scop.) and lot of other plants

(Buček and Lacina, 1999; Low et al., 1995).

2 BC(BD) 3-4 (respectively **2 B–BD (3)4**) **Tili-Querceta roboris superiora** (linden oak woods of higher degree, TQ sup), cover only small part of my study area, area is related to one formal death end of the Rostěnický stream. Nearby local biocentre C 02 Kutálek (or LBC No. 2 U Výrovny).

Natural state of biocoenoses:
Tree level is formed by the penduncculate oak (*Quercus robur* L.), with admixture of linden (*Tilia cordata* Mill.), somewhere even with sessile oak (*Quercus petraea* Liebl.). Other woods present there are hornbeam (*Carpinus betulus* L.), rarely even Field elm (*Ulmus minor* Mill.), field maple (*Acer campestre* L.). Shrub layer is not continuous, there are present species such as single-seeded hawthorn (*Crataegus monogyna* Jacq.), midland hawthorn (*Crataegus laevigata* (Poir.) DC.), wild privet (*Ligustrum vulgare* L.), common dogwood (*Cornus sanguinea* L.) etc.

The synusiae of understorey is dominated by the mesotrophic species, there are always present at least some basiphilic mesotrophic species and species that can withstand partial waterlogging. As a rule, the most common are grasses – heath false brome (*Brachypodium pinnatum* (L.) P. Beauv.), Slender Cock´s-foot (Dactylis polygama Horv.), wood bluegrass (*Poa nemoralis* L.), Narrow-leaved Meadow-grass (*Poa angustifolia* L.) etc. Herb layer consists of White Cinquefoil (*Potentialla alba* L.), dyer´s plumeless saw-wort (*Serratula tinctoria* L.), fringed pink (*Dianthus superbus* L.), common hedgenettle (*Stachys officinalis* (L.) Trevis. Ex Briq.), ground elder (*Aegopodium podagraria* L.), addersmeat (*Stellaria holostea* L.), windflower (*Anemone nemorosa* L.), Liverleaf (*Hepatica nobilis* Schreb.), lily-of-the-valley (*Convallaria majalis* L.), bastard balm (*Mellitis melissophyllum* L.) etc.

(Buček and Lacina, 1999; Low et al., 1995)

5.7. Long-Distance Migration Corridor

Through Vyškovská brána (Gate), thus also my study area was proposed Long-Distance Migration Corridor No. 191 (Fig. 17.) with approximately 5 km in length section without sufficient vegetation cover (forest), this section was identified and described as critical place No. 105. It is proposed Corridor that connects Chřiby and Moravian Karst through the area of Vyškovská brána (Gate). This particular Corridor was designed by the ecologists and after that evaluated by Mr. Borkovec in the 2009. However, if the proposed route of Long-Distance Migration Corridor No. 191 will be changed in the favour of newly planned bio-corridor. Thus the critical place No. 105 [23] without sufficient vegetation cover would be even bigger than before. There are other options for the animals as Mr. Strnad indirectly outlined in his comment to the change of supra-regional biocorridor NRB 08 (MH), in order to overcome the highway D1, for e.g. two similar bridges near Tučapy village (Tab. 2 and Tab. 3). These options are analysed in the chapter 5.9.

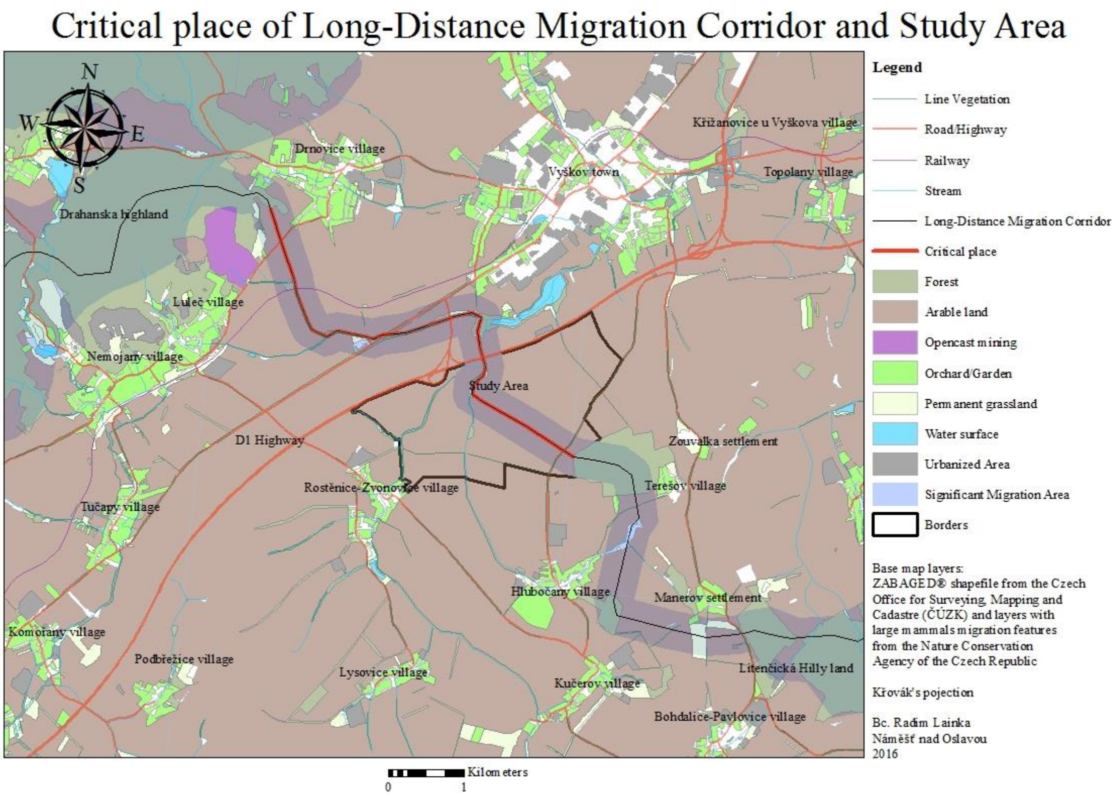

Fig. 17. The route of Long-Distance Migration Corridor No. 191 for large mammals with the critical place No. 105 [22] without sufficient vegetation cover – 1 : 50 000

5.8. Main migration obstacles for the migration towards Drahanska highland

Current main migration obstacle is D1 highway that could be undercrossed safely. However, wildlife cannot use this underpass every time, because of the noise from the highway. In addition, noise from cars that are randomly using the small road near the highway D1. The other obstacles could be (Fig. 18.) fast road, train track (D43) and planned train corridor (DR39).

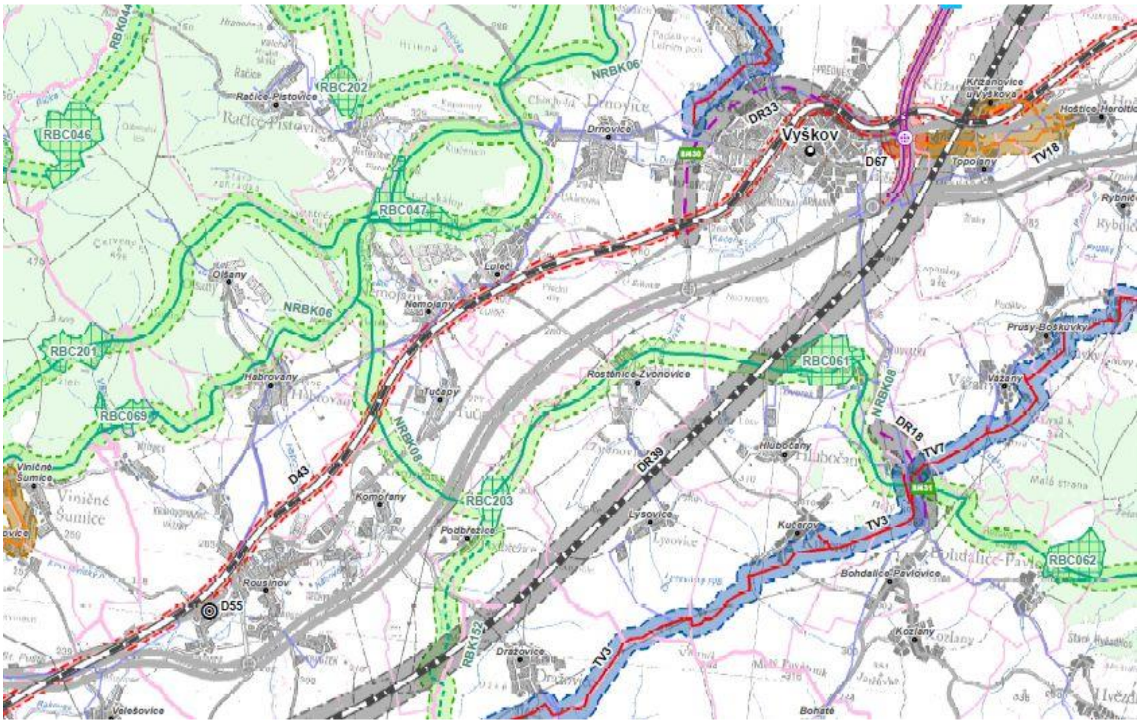

Fig. 18. Actual and planned migration obstacles for large mammals (ATELIER T-PLAN, 2011)

The traffic intensities on D1 represent serious problem, they have rising trend [5]. From 1994 up to 2012 the traffic intensity measured between Vyškov-East (226 km on D1 highway) and Vyškov-West (230 km on D1 highway) tripled (Fig. 19.). Therefore, the noise pollution increased, too. For the 2 years – gaps there was no available data, (without any reason). However, there is big probability that wildlife usually waits for the early morning time, when the traffic intensity is lowest or very low in comparison to the traffic intensities during the day (my deduction from the observations).

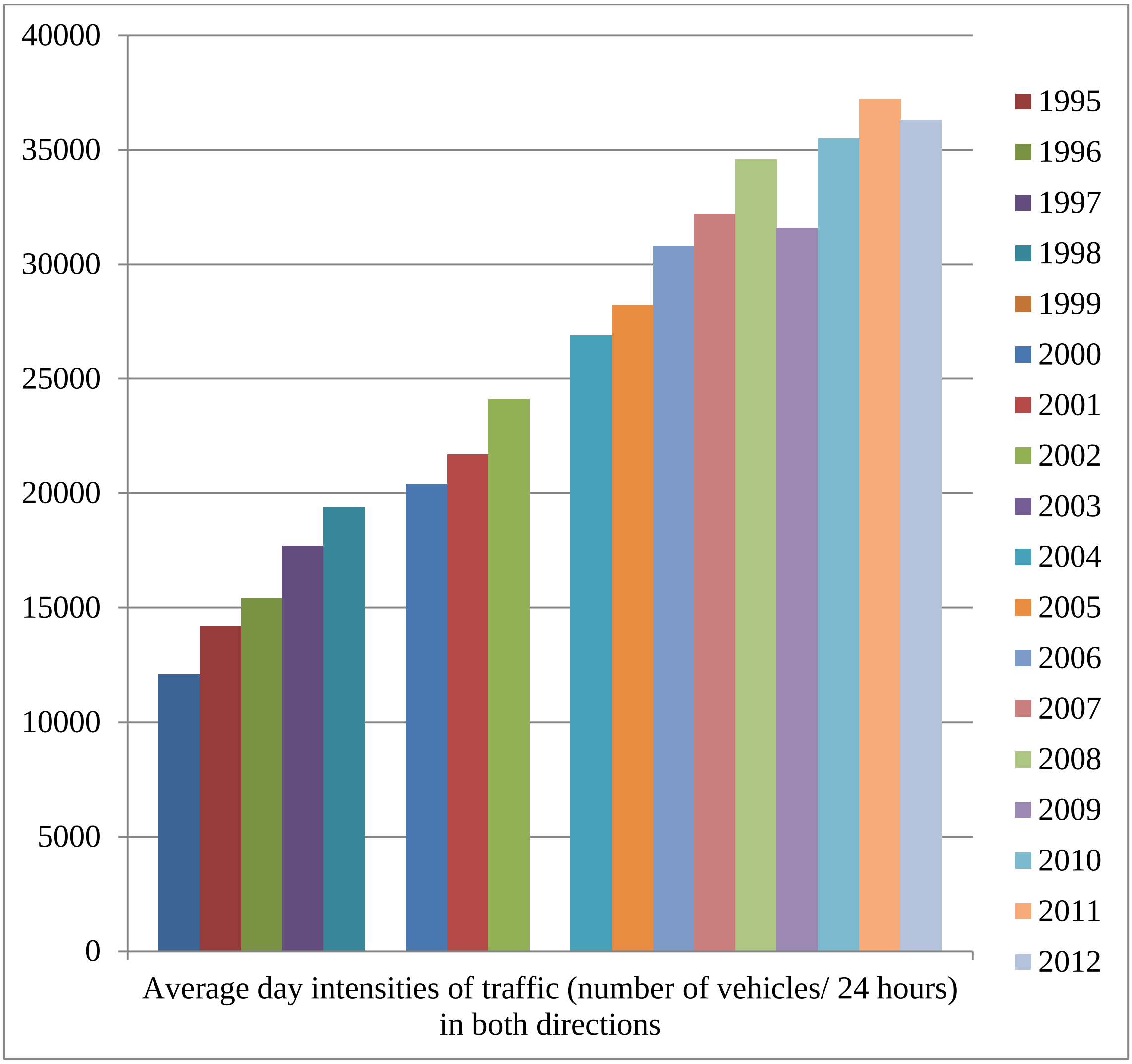

Fig. 19. Average daily intensities of traffic between Vyškov-East (226 km on D1 highway) and Vyškov-West (230 km on D1 highway) [5].

5.9. Migratory options for wildlife to safely overcome D1 highway within and nearby my Study Area

5.9.1. Highway bridge over Rostěnický stream

The route of the Long-Distance Migration Corridor No.191 was planned in the way that it is crossing the D1 in the place with the highway bridge over Rostěnický stream (D1–267 km). In addition, also the former supra-regional biocorridor K 134 MH (now NRBK08 (MH)) was planned through this highway bridge. The bridge (Fig. 20.) was built in the 1992 and since this time it has been providing movement for different kinds of biota under the bridge (Tab. 5). Although it was not specifically designed for the movements of biota. The bridge is made from 13 concrete beams KA-73. The longitudinal angle of the bridge is 0.8 (BMS.VARS.CZ, 2015).

Tab. 5 Highway Bridge over Rostěnický stream (BMS.VARS.CZ, 2015)

Description	Metres
Length of bridge	30
Total width	13.75
Length of bridging	16
Length of bridge structure	18
Building height	1.05
Storage height	1.08
Height above the terrain	4.5
Height above the level of stream	4.09
Depth of water	1.05
Free width	11.75
Width between the fixtures/selvages	11.75

(Open for public database on road objects managed by state http://bms.vars.cz/a_frames.asp)

Fig. 20. Highway bridge over Rostěnický stream (D1–267 km), direction towards Vyškov town (28th April 2016, photo of author)

5.9.2. Closer highway bridge over valley near Tučapy

The first option for the migrating individuals could be probably another the Highway bridge over valley (Fig. 21. and Tab. 6), located nearby the Tučapy village (D1 – 263 km). This bridge was made in the 1991. Just one year before the highway bridge over the Rostěnický stream. This bridge is now in one line with the new route of supra-regional biocorridor NRBK 08 (MH) and have little bit better parameters (Tab. 6) for the large mammals' migration in comparison with the previously mentioned bridge over the Rostěnický stream. However, there is one road that is going through this bridge that is currently used by the traffic. And also another road is in close proximity of this bridge. Hence this bridge is located closer to the critical place No. 105., the cumulating effect of all the barriers (roads) is even bigger than in the case of the previous bridge over the Rostěnický stream. And also the surface is not sufficient for the migrating large mammals.

Tab. 6 Highway bridge over valley, Tučapy, D1 – 263 km (BMS.VARS.CZ, 2016)

Description	Metres
Length of bridge	47
Total width	13.45
Length of bridging	26.52
Length of bridge structure	30.66
Building height	1.6
Storage height	1.7
Height above the terrain	6.5
Height above the level of stream	0
Depth of water	0
Free width	11.75
Width between the fixtures/selvages	11.75

(Open for public database on road objects managed by state http://bms.vars.cz/a_frames.asp)

Fig. 21. Highway bridge over valley (Tučapy, D1 – 263 km), road direction towards Tučapy willage (27th June 2015, photo of author)

5.9.3. Further highway bridge over valley near Tučapy

The second option for the migrating individuals could be another the Highway bridge over valley (Fig. 22. and Tab. 7), located nearby the Tučapy village (D1 – 264 km). This bridge was also made in the 1991. Thus also one year before the highway bridge over the Rostěnický stream. This bridge is now closer to the line of the new route of supra-regional biocorridor NRBK 08 (MH) and have little bit better parameters (Tab. 7) for the large mammals' migration in comparison with the bridge over the Rostěnický stream, too. However, there is one road that is nearby this bridge and it is currently used by the traffic. This bridge is located little bit further to the critical place No. 105. in the comparison with the previously mentioned bridge. However, the surface under the bridge is not sufficient for the migrating large mammals (gravel).

Tab. 7 Highway bridge over valley, Tučapy, D1 – 264 km, made in the 1991 (BMS.VARS.CZ, 2016)

Description	Metres

Length of bridge	46
Total width	13.45
Length of bridging	27
Length of bridge structure	29.96
Building height	1.6
Storage height	1.7
Height above the terrain	7.7
Height above the level of stream	0
Depth of water	0
Free width	11.75
Width between the fixtures/selvages	11.75

(Open for public database on road objects managed by state http://bms.vars.cz/a_frames.asp)

Fig. 22. Highway bridge over valley (Tučapy, D1 – 264 km), direction to south-eastwards from the D1 highway (27th June 2015, photo of author)

5.9.4. Comparison of the bridges

For the proper comparison of previously mentioned bridges I choose to compare their total migration potentials according to the methodology devoted to the establishment of fauna passages (Anděl et al, 2006). The estimated total migration potentials of the bridges nearby Tučapy village are both lower than for the resulting potential of the bridge nearby the Vyškov town (see the Tab.8).

Tab. 8 Estimated total migration potentials for the 3 bridges (D1 – 267 km, 263 and 264 km)

	D1 – 267 km	D1 – 263 km	D1 – 264 km
Category of species	Migratory potential		
A (red deer)	0.13	0.09	0.11
B (roe deer)	0.36	0.25	0.27
C (red fox)	0.52	0.42	0.45

5. METHODOLOGY

Study area delimitation was designed mainly according to the placement of the critical place within the Long-Distance Migration Corridor going and to follow somehow the previous related research done nearby and also partly within the range of my area (Foltánek, 2011). For the analysis of large mammals' migration towards Drahanska highland I evaluated the animal tracks from the sand benches and its surrounding area under the highway bridge. In order to correctly identified the animal tracks I studied the tracks and trails of animals from the books about tracking the animals (David, 2009; Richarz, 2009; Kessler, 2014). Further on I used one trail camera (camera trap) for better identification of migrating individuals. Principally it could be described as a self-operating, remotely activated device that is usually equipped with a motion sensor or an infrared sensor, or uses a light beam as a trigger. Its usage varies, from shooting wildlife or sports up to surveillance applications. After that I collected the data about the positions and operability of the odour fences. After all, for the more complex knowledge I also used the statistical data about wildlife from the hunting associations located within my study area, data about the animal roadkill (wildlife killed by car) and also data provided by the stuff from the Department of Environment, municipal authority of Vyškov town. Further on, I analysed the current state of the TSES (Territorial Systems of Ecological Stability) elements and proposed several changes of the current TSES within and also outside of my study area in order to support the functionality of the Long-Distance Migration Corridor and thus the migration potential of my area. To design the elements of the TSES I partly used the methodical approaches for the establishment of local TSES called "Rukovět projektanta místního územního systému ekologické stability" (Low et al., 1995) and its updated version, so called "Metodické postupy projektování lokálního ÚSES – Multimediální učebnice" (Methodical Approaches for the local TSES design – Multimedia book) (Maděra and Zímová, 2004) and other important additional information about Geobiocenology from Buček and Lacina (1999). For the purpose of the complexity of my work and right use of scientific terminology about TSES I used the special issue of Veronica magazine, devoted to the TSES of my country, called "An Ecological Network in the Czech Republic" (Buček et al., 1995).

The movement of animals throughout the landscape could be explained by many reasons, based on various motivation of animals' actual attitudes and so on (dispersal, to avoid predators, long distance movements, diurnal movements for food etc.). It is impossible to differ them in the landscape. For the purpose of the animal movement, it is often used short scientific name "migration". However, it is not correct from the zoological point of view (Anděl et al., 2010)

5.1. Delimitation of Study Area

My study area was delimited mostly according to the particular output of the project SP/2D4/36/08 - Assessment of landscape migration permeability for large mammals and proposal of protective and optimization measures (2008-2010, MZP/SP), so called "Karty s popisem kritických míst K1" (Tabs with description of critical places K1), where I found the critical place No. 105 without sufficient vegetation cover. In relation with this information I found that Foltánek (2011) already analysed somehow this place, but mostly only the upper part of this critical place, thus I decided to analysed the lower part of the same critical place No. 5 and propose the optimization of TSES. Also there I found the basic information about the actual Long-Distance Migration Corridor No. 191 that is going through out of my study area [23].

5.2. Sand benches

I established two sand benches located in parallel order (Fig. 23. and Fig. 24.) and to copy the surrounding terrain under the D1 highway bridge. For the establishment of sand benches, I used about 200 kg of sand in total and the rest of the sand from the former Foltánek´s sand benches. One sand bench was 380-400 cm in length, 120 cm in width and 2-3 cm thick. Other one was little bit longer, about 425 cm in length, 120 cm in width and 2-3 cm thick. Every single Sunday was collected data on mammal migration throughout the vegetation period (from 11th May to 21st September) in the 2014 from area southwards of the D1 highway bridge over Rostěnický potok (stream) to northwards area, towards to the Drahanska highland. After I took photos of a tracks for documentation, I used to prepare the sand benches for the next evaluation of tracks every Sunday. In this case I used a rake and watering can. A rake to adjust the sand accumulations and watering can to make the sand more wet for better creation of the animal tracks.

Fig. 23. The shorter sand bench (bridge side located more-less eastwards), 28th April 2014, photo of author

Fig. 24. The opposite and little bit longer sand bench (bridge side located more-less westwards), 28th April 2014, photo of author

5.3. Trail camera

Me and my consultant installed one field camera (namely ScoutGuard SG370VB-4M) near by the bridge, in the small patch of the forest nearby the confluence of the 2 streams, Rostěnický stream and Hlubočanský stream (exact location: 9.2555081°N, 16.9808075°E). However, without success, camera did not take a photo of animals.

5.4. Odour fences

In order to assess the current situation of all the types of migration barriers within my study area, I tried also to collect the data about the current distribution and functionality of odour fences. Described as temporal migration barriers and sometimes not so visible be naked eye as the permanent ones (i.e. buildings). In this case I used my personal GPS receiver for the data collection. After that I evaluated data about these odour fences and plotted them into the map of the odour fences of my study area (Fig. 17. Odour fences distribution within my study area – 1 : 15 000).

5.5. Other methods

To identified properly the landowners of my study area and to graphically represent them I used the program ArcGis and electronic resources, such as orthophotos and WMS service from the Czech Office for Surveying, Mapping and Cadastre. Another data, about wildlife occurrence within my study area, I collected from the hunting associations located within my study area. Namely from the Rostěnice-Zvonovice hunting association, Hlubočany hunting association, Drnovice hunting association (now part of the Vyškov hunting association) and Vyškov hunting association. In order to get these data, I had to personally asked the authorities of the hunting associations. Next, I used the data from the database called "Statistical evaluation of traffic accidents in map" (freely translated) that is managed by the organisation called Transport Research Centre CDV (Centrum dopravního výzkumu, v.v.i) and the Police of the Czech Republic. There I collected the data of the road-killed animals within and nearby my study area (D1 highway). After that I gather the data about the TSES, so called "Generely ÚSES" (general maps of TSES) with its text parts that I obtain from the stuff of the Department of Environment, municipal authority of Vyškov town. And finally I collected the data about TSES from the municipal plans of the villages that territories cover at least part of my study area. Then I compare and evaluate the TSES elements from both sources, general maps of TSES (older) and TSES designated in the municipal plans (the latest). For the purpose of the validity of the given information I went out to the terrain of my study area and evaluated the main composition of the TSES elements within the range of my study area. This information's also helped in the decision making, where to place new local biocentre (LBC U Dálnice) and where to place route of the supraregional biocorridor (NRBK08 (MH)). After that I analysed the current situation with the TSES supra-regional biocorridor K 134 MH in relation with the Long-Distance Migration Corridor No. 191, and also the difference between the former supra-regional biocorridor K134 MH and newly planned route of the same biocorridor (just with the different identification name NRBK 08 MH) with justification from the responsible people (Bláha, 2015 and Novotný, 2015). Then I collected data about the current and future main migration obstacles for the large mammals' migration towards the Drahanska highland from the planning document of South Moravian Regional Authority.

5.6. Estimation of total migration potentials of the three highway bridges

In order to compare two bridges nearby my Study Area with the bridge over the Rostěnický potok (stream) I decided to estimate their total migration potential. I tried to estimate their total migration potential according to the technical standard from the Ministry of Transport called Migration Passages For The Permeability Of Roads For Wildlife written by Anděl et al. (2006) and partly with the handbook called On The Permeability Of Roads For Wildlife A Handbook written by Hlaváč and Anděl (2002) approved by Ministry of Environment. This standard describes the comprehensive system arranged to solve one of the most severe influences of transport on the environment which is a barrier effect on the highways and roads with reference to the publication "On the permeability of roads for wildlife" published by the Nature Conservation Agency of the Czech Republic.

According to the authors the wildlife was from a practical point of view (nomograms construction, recommended technical parameters of the subject, etc.) grouped wildlife into five categories with similar characteristics in relation to migration: A – big mammals and species most demanding in the passage parameters (red deer, brown bear, wolf, elk and wild cat), B – medium sized mammals, ungulates (roe deer, wild boar), C – medium sized mammals, carnivores (red fox, Eurasian badger, Eurasian otter, beaver and small carnivores), D – amphibians, E ecosystems (independent category – all ecosystems species including invertebrates and plant species) (Anděl et al., 2006).

After that they propose to count the migration potential (MP) (Anděl, 2000). It represents the basic tool for the selection, recommendation and evaluation of the migration passages. It was defined as probability of functionality of a migration profile. A migration profile is functional if it is being used by the animals and provides safe migration through an overland road (Anděl and Hlaváč, 2002). The functionality of a migration profile is determined by two factors:

a) Ecological – expressed as the Ecological Migration Potential (MPE). This is determined by the properties of the migration route prior to the road construction. Its future use must be considered with a view to the development of the larger region. MPE gives the probability of use of the migration route in the so-called zero events, i.e. when no road is built. It is model of total migration pressure of the area.

   MPE is determined by two basic factors (a) migration route significance (part MPEA), (b) disturbances (part MPEB).

b) Technical – expressed as Technical Migration Potential (MPT). This is determined by the properties of the migration passage, its design, dimensions and other aspects. MPT gives the probability of full use of the migration construction by the animals, i.e. the probability that the original extent of migration will be maintained after the road construction.

   MPT is determined by two basic factors: (a) technical design of the passage (mainly passage dimension, part MPTA), (b) elimination of traffic disturbances (decrease of noise, lighting, etc., part MPTB).

The total migration potential is defined as the multiple of the ecological and technical migration potential: MP = MPE * MPT.

The following theses are fundamental for the migration potential theory:

- All forms of migration potential, being stochastic quantities, have values within the interval <0; 1>. MP=0 represents an extreme situation where the passage of animals through a migration construction is impossible; MP=1 represents an idealized situation where an important and regularly used route has not been affected by an overland road at all. The actual stages between the two extremes may be classified and described (Table 9).

- The concept of migration potential stresses the **equal status of the technical and ecological components.** It is obvious, and the fact is quantified here, that no good migration construction can be built where the ecological as well as the technical conditions are favourable.
- The concept of migration potential is based on a **quantitative estimation** of the level of functionality and usefulness. Despite all the problems presented by the estimation method, it forces both the components equally to quantify their capacity within the given profile.
- Migration potential is also a useful measure for **cost-benefit analysis** for the design of migration constructions. It is possible to compare the cost and the expected effect expressed by the migration potential for each proposed alternative. This makes it possible to use scarce financial resources only for those areas where is a realistic expectation of actual benefit.

  (Anděl et al., 2006)

Tab. 9 Classification of migration potential (Anděl et al., 2006)

Migration potential	Utility classification of migration profile
1.0 – 0.8	Entirely functional, approaching ideal solution
0.8 – 0.6	Above-average, high utility, only small limitations
0.6 – 0.4	Average, medium utility, with obvious limiting components
0.4 – 0.2	Under-average, low utility, number of limiting components
0.2 – 0.0	Functionless, approaching total impenetrability for migrating animals

After that handbook supposed to determine MPE by the estimation of functional migration route that crosses the communication (road). The evaluation is done by the ecologist that deals with the building effect on the environment. Functionality of migration route is based on two factors – importance of migratory route (MPEA) and disturbing effects (MPEB).

The importance of migratory route includes migration supporting features, it creates migration pressure and increase the probability of route usage. Anděl et al., 2006 recommends to use maps of migration routes in supra-regional and in local scale (from the zoological research), data from the territorial systems of ecological stability (TSES) and evaluation of the structure of the landscape, especially migratory supporting features as water flows, mountain ridges and valleys, forest edges, linear vegetation (shrubs along the country lanes, alleys), routes to waterholes, routes to food supply and so on in order to evaluate MPEA. For the proper evaluation after the zoological survey I used the Tab. 10, for the evaluation of the landscape structure I used the Tab. 11.

Tab. 10 Zoological survey evaluation of migration potential (Anděl et al., 2006)

MPEA	Total	General attributes
1.0 – 0.8	Very high Ideal state	Route of extraordinary importance, unequivocally ratified, its interruption may be fundamental negative effect on the migration.
0.8 – 0.6	High Above the average	Route of great importance, ratified, its interruption will negatively affect the migration.
0.6 – 0.4	Medium Average	Route of medium importance, only generally ratified, its interruption may result only in partial significance.
0.4 – 0.2	Low Below average	Route of small importance, uncertain, its interruption will not affect the important changes in the migration.
0.2 – 0.0	Very low Dysfunctional state	Dysfunctional route, only estimated, without importance.

Tab. 11 Evaluation of TSES structural parts and supportive features (Anděl et al., 2006)

MPE	Criteria	
	TSES – Biocorridor	Landscape – Supportive features (Sf)
1.0 – 0.8	Supra-regional – functional	High concentration of Sf
	Regional – functional	
0.8 – 0.6	Local – functional	High amount of Sf, several of them important
	Supra-regional and regional – dysfunctional	
0.6 – 0.4	Local – dysfunctional	Medium amount of Sf
	Interaction elements – functional	At least 1 important
0.4 – 0.2	Interaction elements –	Low amount and

	dysfunctional	unimportant Sf
0.2 – 0.0	Without TSES features	Without Sf

Disturbing effects (MPEB) are determined as effects in close and even in the farther surroundings that can impede migration, decrease the probability of the migratory route usage and finally lead to the change in the usage of migratory route. Traffic, railways noise, industrial complexes, mining, settlement and agriculture production are supposed to be primary disturbing effects. Intensity of traffic on communications and its effect on migration I evaluated after the Tab. 12 and Tab. 13.

Total Ecological Migration Potential (MPE) is calculated as geometric average of both components:

$$MPE = \frac{(MPEA \cdot MPEB)}{2}$$

Tab. 12 Evaluation of disturbing effects (Anděl et al., 2006)

MPEB	Total	General attributes
1 – 0.8	Very high Ideal state	Without disturbing effects in the proximity, only small disturbances in the farther distance
0.8 – 0.6	High Above the average	Small disturbing effects in the proximity, medium disturbing effect in the farther distance.
0.6 – 0.4	Medium Average	Medium disturbing effects in the proximity, great disturbing effect in the farther distance.
0.4 – 0.2	Low Below the average	Great disturbing effects in the proximity or in the farther distance.
0.2 – 0.0	Very low Dysfunctional state	Extremely disturbing effects in the immediate proximity of the migration profile that unable the migration.

Tab. 13 Attributes of traffic intensity (Anděl et al., 2006)

Traffic intensity (vehicles/24h)	Attribute
Low < 1000	Low traffic intensity does not warn the majority of animals and this situation lead them to try to overcome the communications. Its result in the large amount of killed animals of all the sizes on these

	communications. In reality, the measures are only partial that lead to better visibility in the critical parts as for the drivers as for the wildlife.
Medium 1000 – 10 000	This intensity partly repels the animals to overcome the communication. And the disrupted zone is being created in the both directions strip at the same time. The disrupted zone is approximately equal the width of the communication at both sides at the same time. The wildlife avoids this zone and restrict their presence here during the daily movements. In some cases, the wildlife could overcome the communication, so that there are present frequent vehicle-animal encounters.
High > 10 000	This intensity usually leads to the stronger repelling effect for the majority of animals. They used to try to overcome the communication only in the stressful situations. That results in the relatively low amount of the killed animals. The disrupted zone is being extended significantly at both sides up to the double width of communication at the same time. There the wildlife minimizes its common movement. This communication type is often impenetrable for the animals and thus cause the great separation/fragmentation effect on the local populations. The communication provides predominantly strong repelling effect, it is needed in order to reach the demanded functionality of migration profiles ensure even appropriate ecological structure of the entrance to the migration profiles (forestation, linear vegetation etc.), make it easy to overcome the disrupted zone.

Technical Migration Potential (MPT)

Technical migration potential is determined by the features of the migration object, its total construction, dimensions and accompanying measures. It gives the probability of full use of the migration construction by the animals. Functionality of the technical work – migration construction is determined by two basic factors: technical design of the passage (mainly passage dimension, part MPTA), (b) elimination of traffic disturbances (decrease of noise, lighting, etc.) and to create psychical suitable conditions for the usage of migration construction, so called comfort factor (part MPTB).

Total Technical Migration Potential (MPT) is calculated in similar way as the total Ecological Migration Potential (MPE) – geometric average of two factors:

$$MPT = \frac{(MPTA + MPTB)}{2}$$

Dimensions parameters of migration construction (MPTA)

To evaluate the right dimensions of migration constructions was developed frame of nomograms. These nomograms represent dependence of Technical Migration Potential (MPT) on the dimension parameters of migration construction and show how the selected dimension suit for migration of animals.

Tab. 14 Calculations of nomograms for underpasses (Anděl et al., 2006)

Construction	Mark	Parameter of construction
Underpass	MPTA1	Width
	MPTA2	Height
	MPTA3	$Index\ I = \frac{height \cdot width}{length}$

MPTA is determined as geometric average of individual evaluated parameters:

$$MPTA_{underpasses} = geometric\ average_{MPTA1,MPTA2,MPTA3}$$

Tab. 15 Recommended width of underpasses from the MPTA1 for individual categories of species (Anděl et al., 2006)

MPTA1	Category of species – recommended width (m)		
	A (Red Deer)	B (Roe deer)	C (Red fox)
1.0 ideal for migration	60	45	5

0.8 sufficient to ensure migration	45	30	2
0.5 mean value	30	20	1
0.2 extreme value	15	10	0.5
0.0 border of functionality	7	4	0.3

Tab. 16 Recommended height of underpasses from the MPTA2 for individual categories of species (Anděl et al., 2006)

MPTA2	Category of species – recommended height (m)		
	A (Red Deer)	B (Roe deer)	C (Red fox)
1.0 ideal for migration	20	15	3
0.8 sufficient to ensure migration	10	7	2
0.5 mean value	7	5	1
0.2 extreme value	5	3	0.5
0.0 border of functionality	3	2	0.3

Tab. 17 Index I of underpasses from the MPTA3 for individual categories of species (Anděl et al., 2006)

MPTA3	Category of species – Index I		
	A (Red Deer)	B (Roe deer)	C (Red fox)
1.0 ideal for migration	40	20	0.5
0.8 sufficient to ensure migration	15	7	0.2
0.5 mean value	7	3	0.05
0.2 extreme value	3	1.5	0.02
0.0 border of functionality	1	0.7	0.01

Comfort factor (MTB)

Comfort factors include complex solution of the whole migration construction, close surroundings and these factors are equal important as the dimensions. The solution should offer the animals the feeling of safety and minimized effects of traffic disturbances for the possible animal migration. There are assigned effects that counterwork in the closer surroundings of migration construction:

1. Optical perceptions inside the migration construction – There should be diminished the sensual contact between the communication and wildlife. And

extended the sensual contact between the natural surroundings – especially with the vegetation and wildlife.

2. Motions senses inside the migration construction – The importance lies in the type of surface that wildlife have to use. The most suitable is grassed surface or even natural soil without undergrowth. Inappropriate are concrete or asphalt areas, gravel and pebble beds are inappropriate as they cause noise disturbances within wildlife movement (frighten by own movement).
3. Noise load: a) noise load of motor vehicles – so called common noise load, counted as well in the case of human health,

   b) noise induced by the vehicles that goes over the bridge – the most serious are the noise shocks created during the vehicles go over the bridge locks. There is significant importance of this factor for the migration constructions of category A. These migration constructions are designed for the supra-regional migrations, for the wildlife that is not well adapted for the local conditions.

4. Light – Disturbance by the light that is produced by the car headlights at night is depend on traffic intensity and natural shading measures. The most significant importance lies in the species of category A (large mammals and the most demanding species for the migration construction parameters).

The determination of MTB is done by the approximation after the Tab.18. There are not present so great experiences so the selected estimations are moderate. Therefore, it cannot affect the whole MP in serious way (Anděl et al., 2006).

Tab. 18 Evaluation of comfort factor (Anděl et al., 2006)

MPTB	Optical perceptions	Motion senses	Noise protection	Light protection
1	Optimal vegetation modifications	Natural grass surface	Optimal noise measures	Optimal light measures
0.8	Partial vegetation modifications	Natural, not reinforced soil	Partial noise measures	Partial light measures
0.6	Without measures,	Natural,	Without	Without

	construction without vegetation modifications	reinforced soil	measures, without natural noise protection	measures, without natural light exposure protection
0.4		Gravel surface, pebbles		
0.2		Concrete and asphalt surface		

Tab. 19 deals with the total evaluation of Technical Migration Potential.

Tab. 19 Total evaluation of Technical Migration Potential (Anděl et al., 2006)

MPT	Total	General attribute
1	Ideal value	This value signals that parameter change doesn´t lead to the provable improvement of the migration
0.8	Practical optimum	This value could be taken as satisfactory in order to ensure the migration; it is upper border of the interval recommended for the parameter
0.5	Mean	Mean value of recommended intervals
0.2	Practical minimum	This extreme value could be taken as acceptable; it is lower border of the interval recommended for given parameter
0.0	Border of functionality	Border of functionality, whole migration construction is classified as absolutely dysfunctional under this value, evaluated animal cannot pass through the migration construction even in the extraordinary circumstances (it is not the size of the migration construction that wildlife usually not pass through, however in the extraordinary circumstances can pass thought it)

5.7. Optimization of TSES

In order to support migratory route of animals planned by zoologist (Anděl et al, 2010) To design the local biocentre LBC U Dálnice, another local biocentres and also supra-regional biocorridor NRBK08 (MH) I partly used the methodical approaches for the establishment of local TSES called "Rukovět projektanta místního územního systému ekologické stability" (Low et al., 1995) and its updated version, so called "Metodické postupy projektování lokálního ÚSES – Multimediální učebnice" (Methodical Approaches for the local TSES design – Multimedia book) (Maděra and Zímová, 2004) and other important additional information about Geobiocoenology from Buček and Lacina (1999). All these resources are well developed in order to create particular TSES elements itself and also the whole ecological network, thus I did not change the parameters specifically for my study area. TSES elements were well distributed along the two streams (most of the TSES elements of local importance), partly on the arable land (supra-regional biocorridor NRBK08 (MH)), forest land between two streams (supra-regional biocorridor NRBK08 (MH)), and larger forest complex (regional biocentre RBC Terešov) within the range of my study area. All newly proposed TSES elements were designed with the frame of following statements and Tables excerpted from the both methodologies.

The spatial and functional parameters of the individual TSES components rely on the various biotic, hydrological, soil and relief conditions (Tab. 20, 21 and 22). All these biotic and abiotic data are used to reconstruct the original natural (potential) communities with the help of scientific discipline called Geobiocoenology. The essentials of Geobiocoenology was developed by Sukačev. Nowadays TSES planners are obliged to work with the Geobiocoenological Typology of Czech Republic landscape, founded by forest ecologist Professor Zlatník and further developed by landscape ecologist Professor Assistant Buček. Geobiocoenological Typology of Czech Republic is based on the geobiocenes that are integrated to the so called group of geobiocoene types. Geobiocoene alone represents unity of the natural geobiocoenosis and all developed and differently modified geobiocoenosis originated from the natural geobiocoenosis, including its development stages in relation to the changing of the segments within the specific permanent conditions. Group of geobiocoene types that are encoded into the complex system of geobiocenological formulas. There are about 140 groups of geobiocoene types. Their prime role lies in the delineation of local biocentres and biocorridors. The smallest unit of Geobiocoenological typology of local importance is type of geobiocoenosis. Contrary the highest typological unit is biochore, regional level unit, for delineation of regional TSES elements (biocentres and biocorridors) (Buček et al., 1996; Buček and Lacina, 1999; Maděra and Zímová, 2004).

Each geobiocoenological formula denote particular group of geobiocoene types in relation with its specific supra-structural units (vegetation tier, trophic range and hydric range). It is created with minimum of 3 characters. First position always represents only one number (1-8) related to the specific vegetation tier for particular group of geobiocoene types, second position represents minimally one letter related to the specific trophic range (A-D) or intermediate range for particular group of geobiocoene types and the third position (the last one) represents usually one number (1-6) or one number with one small letter (2v, 5a, 5b) related to the specific hydric range for particular group of geobiocoene types (Zlatník, 1976; Buček et al., 1996; Buček and Lacina, 1999).

The essential values of spatial parameters differ in relation to the hierarchic order of the TSES. The examples of the minimal necessary values of spatial parameters for particular TSES elements are given in the Tab. 20 and 22. On the contrary, the example of the maximal values of spatial parameters (lengths) for biocorridors are given in the Tab. 21 (Low et al., 1995).

Tab. 20 The minimal necessary area of biocentres after Low et al., 1995

Community type	Biocentre	
	Local	Regional
Alder woods and “soft” (Willow-Poplar) floodplain forests	3 ha	10 ha
Forest communities of “hard” floodplain forests		30 ha
FVZ 1,2	3 ha	30 ha
FVZ 3,4	3 ha	20 ha
FVZ 5	3 ha	25 ha

FVZ 6,7	3 ha	40 ha
FVZ 8,9	3 ha	30 ha
Running waters	Over 100 m	1–20 km
Standing waters	1 ha	100 ha
Wetlands	1 ha	10 ha
Meadow communities	3 ha	30 ha
Steppe heathland	1 ha	
Rock associations	0.5 ha	5 ha
Combined communities	3 ha	10 ha

FVZ – Forest Vegetation Zone defined by Zlatník (1976)

For representative supra-regional biocentres, the minimum area of 1,000 ha and more is required, and for unique biocentres, the area of less than 1,000 ha is considered to be suitable [13], but it is matter of individual decision (Low et al., 1995). However, the division of supra-regional biocentres for representative and contact ones is negligible, because these biocentres are large and thus include several types of ecosystems all the time. Mostly these biocentres are combined, but the typical (representative) ecosystems for the particular bioregion have to dominate. Supra-regional biocentres have core area and buffer (protective) zone. The core area is supposed to be about 300 ha, because it should include scale of typical ecosystems of particular bioregion. And finally, the minimal area of Provincial biocentre is 10,000 ha. (Low et al., 1995).

Tab. 21 The maximal lengths of corridors and its permissible interruption after Low et al., 1995

Community type	Biocorridor			
	Local		Regional	
	Max. length	Interruption	Max. length	Interruption
Forest communities	2,000 m	15 m	700 m	150 m**
Wetlands	2,000 m	50–100 m*	1,000 m	100–200 m***
Combined communities	2,000 m	50–100 m*	X	X
Meadow communities:	1,500 m	1,500 m	X	X

FVZ 5-9	X	X	700 m	100–200 m***
Floodplain meadow communities:				
FVZ 1-4	X	X	500 m	100–200 m***
Steppe heathland:			500 m	100–200 m***
FVZ 1	2,000 m	50–100 m*	X	X
FVZ 2-3	2,000 m	2,000 m	X	X

FVZ – Forest Vegetation Zone defined by Zlatník (1976), Max. – maximal

* 50 m – interrupted by paved surface, 80 m – interrupted by arable land, and 100 m interrupted by other types of cultures

** 150 m – interrupted, but in the same time have to continue minimally as local biocorridor

*** 100 m – interrupted by building area, 150 m – interrupted by arable land, and 200 m – interrupted by other types of cultures

In case of Regional biocorridors (biocorridors of regional importance), we use so-called "complex biocorridors": within 500–1,000 m, according to the maximal allowed length of simple biocorridor, we used to place biocentres of local importance. Thus the total length of a functionally qualified regional biocorridors can be considerably extended, reaching up to 8 km long (Low et al., 1995).

Tab. 22 The minimum necessary width of biocorridors after Low et al., 1995

Community type	Biocorridor	
	Local	Regional
Forest communities	15 m	40 m
Wetlands	20 m	40 m
Meadow communities	20 m	50 m
Steppe heathland	10 m	20 m

Supra-regional biocorridors have a defined axis and a buffer zone. The minimum width of the axis of a supra-regional biocorridor corresponds with the width of the regional biocorridor of the respective type and is 2,000 m. The maximum width of the buffer zone it is derived from the maximum distance of local biocentres (2 km away from the axis of the supra-regional corridor on both sides). It is also possible to narrow them in the places, where the potential conditions for the existence of particular ecosystems are absent (i.e. canyon valleys up to its edge etc.). In this defined territory, we support the densest placement of biocentres at complex biocorridors within further projection in the along and straight direction. In other hand, we used to place biocentres of regional importance into complex supra-regional biocorridors within 5–8 km (Low et al., 1995).

In order to identify the proper species for the localities I used the book "Metodické postupy projektování lokálního ÚSES – Multimediální učebnice" (Methodical Approaches for the local TSES design – Multimedia book) (Maděra and Zímová, 2004), to estimate the exact number of seedlings of individual species (grouped for better calculation) I used the publication called "5. Experimentální zakládání skladebních částí územního systému ekologické stability" (Experimental establishment of composite parts of territorial system of ecological stability) [24]. In order to identify the current prices of seedlings (bare and container ones) I followed the prices of the seedlings on the web called lesoskolky.cz [25]. And to identify the landownership relations within the proposed TSES elements of my area I used database of landowners that I prepared for whole my study area. Data for this database I gather from the website of the State Administration of Land Surveying and Cadastre.

5.8. Used Tools

In order to evaluate animal tracks accurately I also took photos of them by camera and partly by my mobile phone. To prepare the sand benches for the next evaluation (every week) I used a rake and watering can. For all the map production I used expert software in the field of geoinformatics data processing, so called ArcGis 10.2.2 made by ESRI (Environmental Systems Research Institute). In the case of the graphic representation of the ownership relations of the land within the range of my study area I also used the same software. To locate properly the odour fences I used my personal GPS receiver Garmin eTrex 30. Also I used so called ZABAGED data set and orthophotos from the Czech Office for Surveying, Mapping and Cadastre.

6. RESULTS

6.1. Mammal migration

The results of my survey on the mammal's migration under the highway bridge are showed in the Tab. 23 and Tab. 24. The most common wild mammals were the foxes (*Vulpes vulpes* L.), they were recorded 17 times with the total share of tracks records by 58.62% followed by the Roe deers (*Capreolus capreolus* L.), they were recorded 5 times with the total share of tracks records by 17.24%, the Wild boars (*Sus scrofa* L.), they were recorded 4 times with the total share of tracks records by 13.79% and the least common were Stone martens (*Martes foina* E.), they were recorded 3 times with the total share of tracks by 10.34%. The prevailing direction of migration was towards the north from my study area. The mammals migrated hence there were distributed quite big number of odour fences (137) along the road nearby the highway D1 (Fig. 25.). However, due to the discontinuity of the odour fences distribution, the mammals could migrate relatively easily. I identified two large gaps within the linear distribution of the odour fences. The photos of particular odour fences are located on the electronic appendix. In the case of the determination the wildlife using the bridge over Rostěnický stream I didn´t recognize the particular movements as diurnal movements or particular types of migration.

Tab. 23 Mammal migration in the vegetation period in the 2014

Species	Date (week) from 11th May to 13th July									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Fox (*Vulpes vulpes* L.)	x	x	x	x	x	x	x	x	x	x
Roe deer (*Capreolus capreolus* L.)							x		x	x
Stone marten (*Martes foina* E.)							x			

Wild boar (*Scus scrofa* L.)	x	x								x

Tab. 24 Mammal migration in the vegetation period in the 2014

Species	Date (week) from 20th July to 21st September									
	11th	12th	13th	14th	15th	16th	17th	18th	19th	20st
Fox (*Vulpes vulpes* L.)	x	x	x	x	x		x	x		
Roe deer (*Capreolus capreolus* L.)				x						x
Stone marten (*Martes foina* E.)		x	x							
Wild boar (*Scus scrofa* L.)				x						

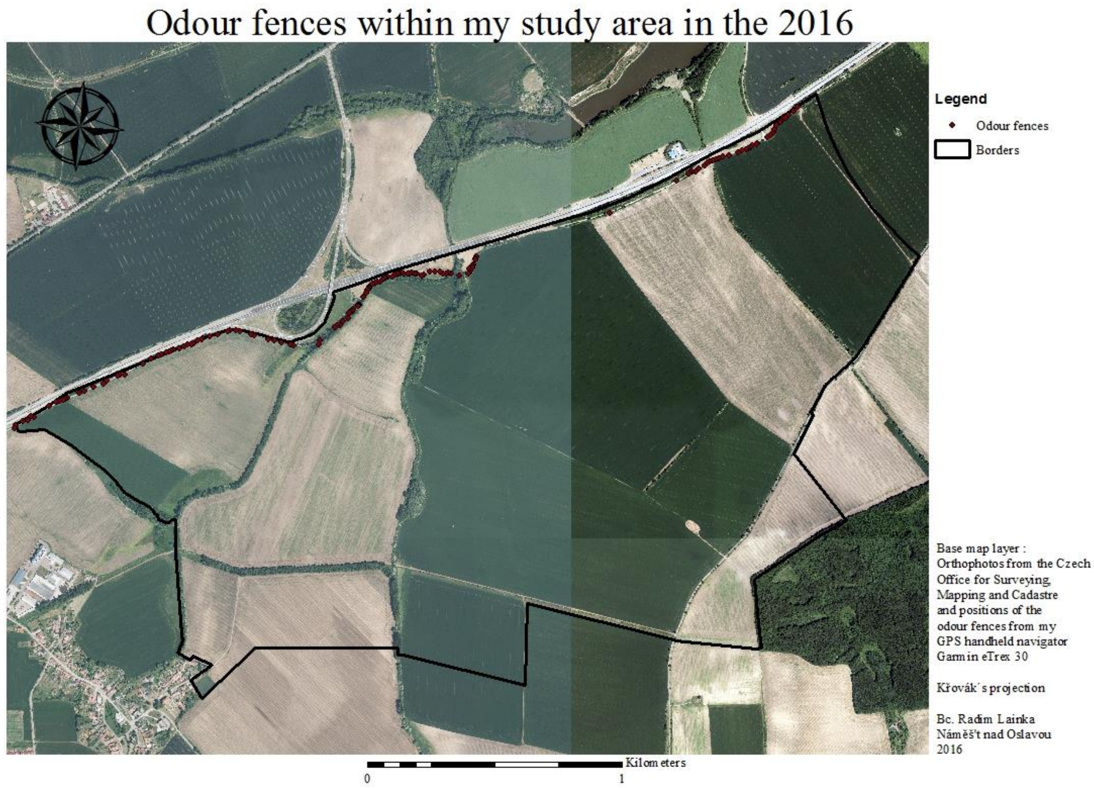

Fig. 25. Odour fences distribution within my study area – 1: 15 000

6.2. Optimized ecological network

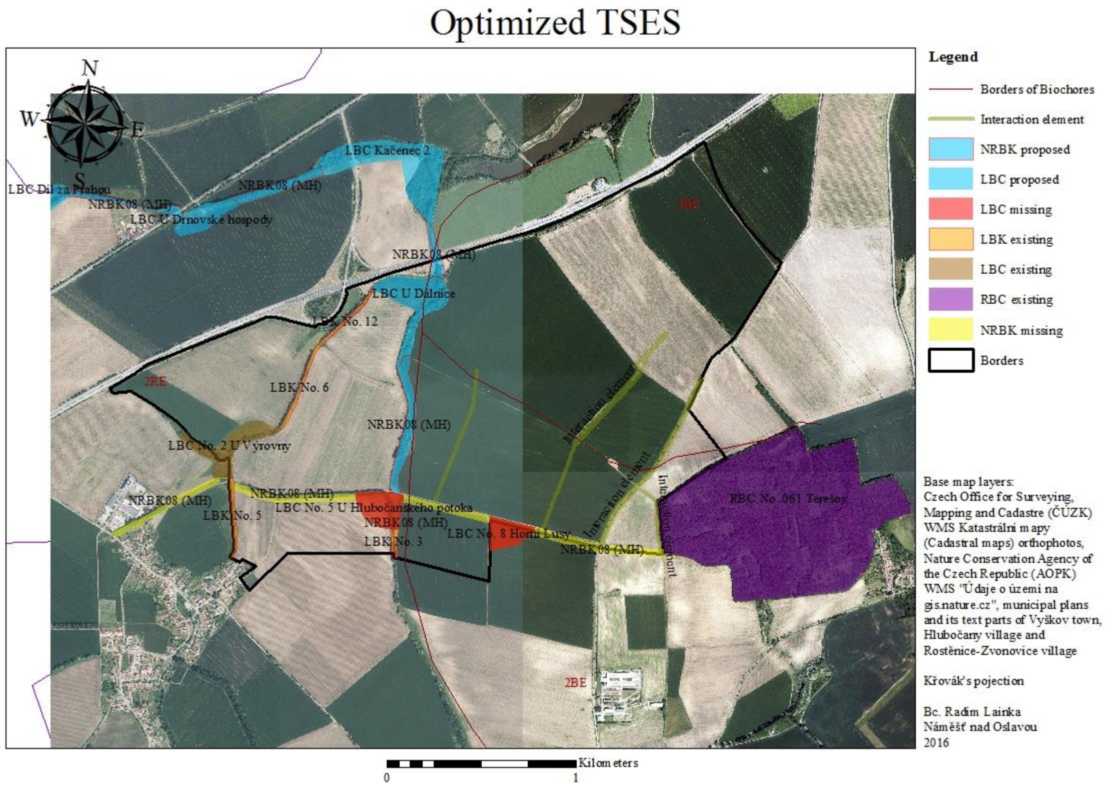

Fig. 26. The placement of the newly designed (suggested) local biocentre LBC U Dálnice and proposed route of supra-regional biocorridor NRBK 08 (MH) – 1:20 000

In order to enhance the migration possibilities for all the large mammals that decide to found something like safe haven for them in the Drahanská Highlands I propose to optimize TSES within my study area. Newly optimized TSES with newly designed elements is showed in the Fig. 26., and the particular elements are listed below:

- Local biocentre (LBC) Díl za Prahou – floodplain forest (3 ha)
- Local biocentre (LBC) U Drnovské hospody – wetland (1.4 ha)
- Local biocentre (LBC) Kačenec 2 – floodplain forest (12 ha), possible extension of the formal LBC Kačenec (not showed on Fig. 19.)
- Local biocentre (LBC) U Dálnice – combined communities (6.6 ha)
- Supra-regional biocorridor NRBK08 (MH) – combined vegetation (floodplain forest and floodplain forest transition)

Newly optimized TSES should contain particular proposed elements within my study area:

Local biocentre (LBC) U Dálnice – combined vegetation (floodplain forest and floodplain forest transition)
Supra-regional biocorridor NRBK08 (MH) – combined vegetation (floodplain forest and floodplain forest transition)

6.2.1 LBC U Dálnice

Description of LBC U Dálnice:
Total area of biocentre: 6.6 ha
Total number of parcels that could be affected the creation of this biocentre: twenty-six
State lands that could be affected the creation of this biocentre: one (in cadastre, parcel No. 3747/24)
Public lands that could be affected the creation of this biocentre: six parcels in land register, particularly 776/2, 775/2, 822/5, 1007, 1009, 1036/1
Private lands that could be affected the creation of this biocentre: about nineteen parcels in land register (ZE), particularly 948/4, 950/3, 953/2, 954/2, 957/2, 958/2, 797, 798, 799, 800, 801/1, 802/3, 803/1, 804, 805, 806, 807, 808/1, 809/1)
Groups of types of Geobiocoenes: 2 BD 3 (mostly) and 2 BC 4
Suggested woody composition for plating: field maple (*Acer campestre* L.), sessile oak (*Quercus petrea* (Matt.) Liebl.), pendunculate oak (*Quercus robur* L.), ash (*Fraxinus excelsior* L.), field elm (*Ulmus minor* Mill.) European White-elm (*Ulmus laevis* Pall.), black poplar (*Populus nigra* L.), aspen (*Populus tremula* L.), silver poplar (*Populus alba* L.), largeleaf linden (*Tilia platyphyllos* Scop.), white willow (*Salix alba* L.), crack willow (*Salix fragilis* L.), European alder (*Alnus glutinosa* (L.) Gaertn.), European spindle (*Euonymus europaeus* L.), bird cherry (*Padus avium* L.), alder buckthorn (*Frangula alnus* Mill), blackcurrant (*Ribes nigrum* L.), goat willow (*Salix caprea* L.), rowan tree (*Sorbus aucuparia* L.), common dogwood (*Cornus sanguinea* L.), and guelder-rose (*Viburnum opulus* L.)
Suggested area for planting: 3.6 ha
Recommended spacing for trees: 1 x 1 m
Recommended spacing for shrubs: 1 x 1 m (between the planted trees, only the edges of the planting area)

Recommended numbers of seedlings for planting and its prices are showed in the Tab. 25:

Tab. 25 Recommended numbers of seedlings for planting and its prices for the LBC U Dálnice

Species groups	Number of seedlings	Price per one seedling in CZK	Price for all seedlings of species group in CZK
Quercus spp. (L.)	36,000	3.8	108,000
Tilia spp. (L.), *Acer* spp. (L.) and *Fraxinus* spp. (L.)	14.400	3.2, 4.0 and 3.2	49,920
Sorbus spp. (L.)	10,800	7.4	79,920
Populus tremula (L.) and *Alnus* spp. (Mill.)	10,800	7.4 and 3.2	57,240
Salix spp. (L.), only forming trees	3,960	24.0	95,040
Populus spp. (L.)	1,440	7.0	10,080

other species	2,600	12.0	31,200
Total:	80,000		460,200

* higher prices of seedlings are for container seedlings (above CZK 7.0)

6.2.2 Proposed parts of NRBK08 (MH) within my study area

Parameters of 1st part of supraregional biocorridor: 1st 700 m in length, 40 to 60 m in width

Location of 1st part of supraregional biocorridor: between proposed local biocentre LBC U Dálnice and LBC No. 5 U Hlubočanského potoka (LBK No. 13, LBK No. 8 and LBK No. 2)

Parameters of 2nd part of supraregional biocorridor: 2nd 500 m in length (only 82 m within my study area), 40 to 70 m in width

Location of 2nd part of supraregional biocorridor: between proposed local biocentre LB U Dálnice and proposed local biocentre LBC Kačenec 2 (LBK No. 13 and LBK No. 12)

Land ownership relations within my study area to newly designed supra-regional biocorridor NRBK08 (MH):

Total lands that could be affected the creation of this biocorridor: forty-five parcels

State lands that could be affected the creation of this biocorridor: six parcels (in cadastre: No.: 3748/46, 3743/29, 3753/6, 3744, 3741/48, 3750/70)

Public lands that could be affected the creation of this biocorridor: fourteen parcels in land register, particularly 1006/2, 1006/1, 1007, 1036/7, 775/2, 775/3, 776/2, 1036/, 935/2, 940/4, 942/3, 945/2, 889/2, 942/2

four parcels in Cadastre: 1198, 2825, 2817 and 2773

Private lands that could be affected the creation of this biocentre: fourteen parcels in land register, particularly 948/4, 950/3, 953/2, 954/2, 957/2, 958/2, 961/2, 963/2, 966/2, 967/2, 970/2, 971/2, 971/1, 973, 977, 980, 981)

seven parcels in Cadastre: 2824, 2823, 2822, 2821, 2820, 2819 2818

Groups of types of Geobiocoenes: 2 BC 4 (mostly) and 2 BD 3

Suggested woody composition for plating: pendunculate oak (*Quercus robur* L.), sessile oak (*Quercus petrea* (Mattuschka) Liebl.), largeleaf linden (*Tilia platyphyllos* Scop.), littleleave linden (*Tilia cordata* Mill.), European White-elm (*Ulmus laevis* Pall.), ash (*Fraxinus excelsior* L.), Norway maple (*Acer platanoides* L.), European crab apple (*Malus sylvestris* (L.) Mill.), European wild pear (*Pyrus pyraster* (L.) Burgsd.), wild cherry (*Prunus avium* L.), silver poplar (*Populus alba* L.), aspen (*Populus tremula* L.), .), European alder (*Alnus glutinosa* (L.) Gaertn.), field elm (*Ulmus minor* Mill.), hornbeam (*Carpinus betulus* L.), wild service tree (*Sorbus torminalis* (L) Crantz.), field maple (*Acer campestre* L.), black poplar (*Populus nigra* L.), white willow (*Salix alba* L.), crack willow (*Salix fragilis* L.) European spindle (*Euonymus europaeus* L.), bird cherry (*Padus avium* L.), alder buckthorn (*Frangula alnus* Mill), goat willow (*Salix caprea* L.), rowan tree (*Sorbus aucuparia* L.), common dogwood (*Cornus sanguinea* L.), and guelder-rose (*Viburnum opulus* L.)

Suggested area for planting of the first part of NRBK 08 (MH): 2 ha

Suggested area for planting of the second part of NRBK 08 (MH): 0.3 ha (within my study area)

Total area for planting of the both parts of NRBK 08 (MH): 2.3 ha

Recommended spacing for trees: 1 x 1 m

Recommended spacing for shrubs: 1 x 1 m (between the planted trees, only the edges of the planting area)

Recommended numbers of seedlings for planting and its prices are showed in the Tab. 26 and Tab. 27:

Tab. 26 Recommended numbers of seedlings for planting and its prices for the first part of NRBK08 (MH) within my study area

Species groups	Number of seedlings	Price per one seedling in CZK	Price for all seedlings of species group in CZK
Quercus spp. (L.)	20,000	3.8	76,000
Tilia spp. (L.), *Acer* spp. (L.) and *Fraxinus* spp. (L.)	8,000	3.2, 4.0 and 3.2	27,733
Sorbus spp. (L.)	6,000	7.4	44,400
Populus tremula (L.) and *Alnus* spp. (Mill.)	6,000	7.4 and 3.2	31,800
Salix spp. (L.), only forming trees	2,200	24.0	55,800
Populus spp. (L.)	800	7.0	5,600
other species	1,000	12.0	12,000
Total:	44,000		253,333

* higher prices of seedlings are for container seedlings (above CZK 7.0)

Tab. 27 Recommended numbers of seedlings for planting and its prices for the second part of NRBK08 (MH) within my study area

Species groups	Number of seedlings	Price per one seedling in CZK	Price for all seedlings of species group in CZK
Quercus spp. (L.)	3,333	3.8	12,665
Tilia spp. (L.), *Acer* spp. (L.) and *Fraxinus* spp. (L.)	1,133	3.2, 4,0 and 3.2	3,928
Sorbus spp. (L.)	1,000	7.4	7,400
Populus tremula (L.) and *Alnus* spp. (Mill.)	1,000	7.4 and 3.2	5,300
Salix spp. (L.), only forming trees	366	24.0	8,784
Populus spp. (L.)	133	7.0	931
other species	35	12.0	420
Total:	7,000		39,428

* higher prices of seedlings are for container seedlings (above CZK 7.0)

The total number of the all seedlings to be planted in the proposed elements of TSES within my study area (NRBK08 (MH) and LBC U Dálnice) is about 131,000 individuals that would cost CZK 752,961.0.

7. DISCUSSION

There is no prior work that could be compared. However, there are lot of works that deal with TSES alone [26], without the connection to the Long-Distance Migration Corridors. The main reason could be that the TSES is far older and resourceful in the case of designing and also testing the TSES elements. Hence in my study I primarily tested the migration of large mammals from the Chřiby and Litenčická pahorkatina (Hilly land) towards the Drahanska highland trough the Long-Distance Migration Corridor No. 191., especially under the highway bridge over Rostěnický potok (stream) in the year 2014. And I found that no one large mammal from group A (ones that perform long distance migrations, except the Red deer) passed under this bridge. Exactly the same results got Foltánek in the case of his own research of the bridge (Foltánek, 2011). The reasons could be many. First, missing sufficient vegetation coverage (forest). Second, the bridge does not fix the minimum parameters (Anděl et al., 2006). And third one, that the large mammals just didn´t tried it at al. In order to identify the migrating individuals, I also set up one trail camera, although without success. The reasons could be many, but one of them I found really logical and obvious. The current distribution of the odour fences nearby the small patch of the forest, where I set up the trail camera.

Thus to know more about the migration within my area I decided also to map the odour fences. After that I tried to plot them to one single map to see how they are distributed. And I found that they are distributed almost in one line, although with lot of gaps (Fig. 17.). Some of them were smaller and some of them larger. Two of them were so large and so close to the bridge that I concluded that these gaps were possibly the main source of the migrating individuals or groups of large mammals going out of the area located under the D1 highway (southwards) to the areas up the highway (northwards). The same mammals that I identified later on through their tracks under the highway bridge. However, I didn´t find out to which category these migrations belong (diurnal movements, long distance migrations etc.). In this case is needed further research.

After that I decided to check the TSES elements. If there are delimited within my study area, and how well are distributed to support the migration of large mammals or not. I found that former supra-regional biocorridor K 134 MH, now renamed as NRBK08 (MH) was changed in order to respect the connectivity of another TSES elements of same or similar importance as the mentioned supra-regional biocorridor (Bláha, 2015). However, these planners don´t know or simply don´t care about the Long-Distance Migration Corridor that was specifically proposed in the similar way as the supra-regional biocorridor in order to gain the benefit from this particular TSES element. To support the connectivity or in other words enhance the permeability of the landscape within the frame of this Corridor, especially diminish the power of critical place No. 105.

And finally at the end I proposed the optimized TSES outside and also inside of my study area. For the purpose of my study area I described more deeply the newly designed TSES elements only within the frame of my study area due to the time that rest to finish my thesis. Particularly one local biocentre called LBC U Dálnice, was named after the exact location nearby the D1 highway. Further on I described to details two parts of the supra-regional biocorridor NRBK08 (MH) in order to connect the local biocentre LBC U Dálnice with the larger regional one called RBC No. 061 Terešov (Hlubočanský háj). Further on, as I identified the owners of the land that could be affected due to the establishment of the proposed elements (all of them), and I found out that the most of the area designed for planting new seedlings belongs to the problematic parcels, that were not put into the cadastre of real estate's map. These parcels are defined as records of agricultural and forest land owned by individuals whose boundaries don´t exist on the ground (are not perceptible), because these units were merged into large land units so called tracts of lands (Kuba and Olivová, 2005).

For the purpose of the continuity of the research, there should be done monitoring of newly designed measures (implementation of vegetation arrangements etc.) in my study area and also further research in order to continue with evaluation of biota migration under D1 Highway Bridge nearby Vyškov town. For the purpose of continuity in research, my follower could draw up monitoring plan and also draw up reports of monitoring results. These data would play significant role for the landscape planners and thus limit future negative changes in the landscape permeability for large mammals. Another research is possible to perform in the Drahanska highland and Chřiby highlands. In the case of the supra-regional biocorridor NRBK08 (MH) change, there should be done evaluation of all its planted parts due to proliferation of the invasive species such as ample ash (*Acer negundo* L.) etc.

8. CONCLUSSION

At first I tried to research and evaluate the migration under the highway bridge over the Rostěnický stream during almost whole vegetation period, for 20 weeks. The evaluation of the large mammals' tracks did not show us that this particular bridge over the Rostěnický stream was used by some of the large mammals from the group A in the year 2014. So there were not long-distance migrating individuals from group A that could validate the proposal route of Long-Distance Migration Corridor No. 191 in the area of critical place No. 105. The most common wild mammals were the foxes (*Vulpes vulpes* L.), they were recorded 17 times with the total share of tracks records by 58.62%, followed by the Roe deers (*Capreolus capreolus* L.), they were recorded 5 times with the total share of tracks records by 17.24%, and the Wild boars (*Sus scrofa* L.), they were recorded 4 times with the total share of track records by 13.79% from the group B. The least common were Stone martens (*Martes foina* E.) from the group C, they were recorded 3 times with the total share of track records by 10.34%. The prevailing direction of migration was towards the north from my study area. However, I didn´t recognize the particular movements, if it belongs to the diurnal movements category or another category. Further on I mapped and identified 137 odour fences located nearby the road close to D1 highway that were used to prevent wildlife migration from the area southwards of D1 highway. However, the odour fences were not distributed continuously. I identified two large gaps that provided enough space for mammal migration under the D1 highway bridge over the Rostěnický stream in the 2014.

In the case of the TSES optimization, I proposed several new elements (features) for sure, the Local biocentre (LBC) Díl za Prahou, Local biocentre (LBC) U Drnovské hospody, Local biocentre (LBC) Kačenec 2, Local biocentre (LBC) U Dálnice and new route of Supra-regional biocorridor NRBK08 (MH) based on the original one. However, for the purpose ow my own study area I suggested further the composition of only two newly designed TSES elements. Local biocentre (LBC) U Dálnice with total area about 6.6 ha and two parts of supra-regional biocorridor NRBK08 (MH) that follow the previous parts of the same biocorridor. Total area to planted within the newly proposed TSES elements is about 5.9 ha. Total number of seedlings to be planted is about 131,000. And total cost for all the seedlings would be about CZK 752,961.0.

9. ZÁVĚR

Nejprve jsem provedl výzkum a vyhodnocení migrace velkých savců pod dálničním mostem přes Rostěnický potok. Vyhodnocení migrace větších savců na základě stop neukázalo využití dálničního mostu přes Rostěnický potok savci ze skupiny A v roce 2014. Takže se zatím neprokázalo využití stávající navržené trasy dálkového migračního koridoru č. 191 v oblasti kritické místa č. 105. Ačkoliv nebyli zaznamenáni žádní větší savci ze skupiny A, avšak savci z ostatních dvou skupin most využívali lišky (*Vulpes vulpes* L.), srnci (*Capreolus capreolus* L.), divočáci (*Sus scrofa* L.) a kuny (*Martes foina* E.). Nejběžnější savci, kteří využívali dálničního mostu přes Rostěnický potok byly lišky (*Vulpes vulpes* L.). Jedinci tohoto druhu byly zaznamenáni 17 krát, což čítá 58.62% ze všech analyzovaných stop. Druzí nejběžnější savci, kteří využívali dálničního mostu přes Rostěnický potok byli srnci (*Capreolus capreolus* L.). Ti byli zaznamenáni celkově 5 krát, což činí 17.24% ze všech analyzovaných stop. Za nimi následovali divočáci, jejichž stopy byly analyzovány v 5 případech, což činí 13.79% ze všech analyzovaných stop. Nejméně využívaly tento most kuny (*Martes foina* L.), jejichž stopy byly analyzovány pouze ve 3 případech, což činí 10.34% ze všech analyzovaných stop. Převážná většina migrující zvěře se pohybovala směrem ven z mého sledovaného území. Nicméně se mi nepodařilo zařadit tyto migrace do patřičných kategorií (denní pohyby zvěře či dálkové migrace atp.). Dále jsem zmapoval na mém území 137 pachových ohradníků poblíž silnice (technické přejímky) u dálnice D1, které tu byly rozmístěny k zabránění migraci zvěře z oblasti pod dálnicí D1. Nicméně nebyly rozmístěny kontinuálně. V rámci jejich lineárního rozmístění jsem identifikoval dvě větší díry, které patrně poskytly dost místa k migraci zvěře pod dálničním mostem přes Rostěnický potok v roce 2014.

V případě optimalizace místního ÚSES, jsem navrhnul několik nových elementů, lokální biocentrum LBC Díl za Prahou, lokální biocentrum LBC U Drnovské hospody, lokální biocentrum LBC Kačenec 2, lokální biocentrum LBC U Dálnice a novou trasu nadregionálního biokoridoru NRBK08 (MH), na základě prvotního návrhu vedení tohoto nadregionálního biokoridoru. Nicméně detailněji jsem navrhnul pouze lokální biocentrum LBC U Dálnice o rozloze 6,6 ha a dvě části nadregionálního biokoridoru NRBK08 (MH) v rámci mého sledovaného území. Celková plocha k osázení dřevinami činí kolem 5.9 ha. Celkový počet semenáčků k osázení byl stanoven na 131 000 kusů. Celková cena všech semenáčků by se měla pohybovat kolem 752 961 Kč.

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11. APPENDIX