CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DEPARTMENT OF APPLIED ECOLOGY

Trails of game crossing selected road sections in the Czech Republic

MASTER THESIS

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DIPLOMA THESIS ASSIGNMENT

Bc. Adam Vacek

Nature Conservation

Thesis title

Trails of game crossing selected road sections in the Czech Republic

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Objectives of thesis

Aim of the thesis is to map trails of the game crossing chosen road sections and gather animal road mortality data in 6 locations in the Czech Repulbic. The thesis output is map of the game trails of each location and analysis of effect of number of trails on roadkills.
Their description and comparison going to be helpful for lowering number of wildlife vehicle collisions by possible prediction of game movement around the roads, occurrence of most risky spots and for future landscape planning (like TSES, road surroundings management...).

Methodology

- data collection personally in field
- creating map output
- comparison of the locations and finding common and most risky places (hotspots) of each location
- GIS analysis of trails and roadkills data
- prediction of possible movement of the game around the roads in Czech republic

The proposed extent of the thesis

40 – 50 pages

Keywords

wildlife movement, wildlife vehicle collisions, road ecology, mapping

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Recommended information sources

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The Diploma Thesis Supervisor

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Declaration:

I hereby declare that I am the sole author of this thesis entitled "Trails of game crossing selected road sections in the Czech Republic". I marked all quotations and any literature used is stated in the attached list of references.

In Prague, date ....

Adam Vacek

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Notably, I would like to thank my supervisor Mr. Ing. Zdeněk Keken, Ph.D. for his wise support and patience with me; and Transport Research Centre (CDV) for the provision of wildlife vehicle collision data.

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Abstract

Wildlife migrates through landscape freely for many years, but in present its migration paths and ability are restricted by transport infrastructure. One of the results is the increasing number of wildlife vehicle collisions (WVC) every year.

This Master thesis aims on mapping the game trails crossing selected road sections and gathering WVC data in 6 locations of Central Bohemian Region of the Czech Republic. Road sections were selected based for occurence of higher numbers of WVC than is average. Mapping of trails and data gathering of WVC were done in 2016 and 2017. Part of WVC data was provided by web application srazenazver.cz, administered by the Transport Research Centre, of the Ministry of Transport of the Czech Republic. Thesis output are maps of each locations with WVC recorded into the map.

The hypothesis is that where there is higher density of trails, there is supposed more wildlife movement, thus higher chance for WVC occurrence at crossing with roads. According to available data it was not possible to prove or decline the hypothesis.

Key words:

wildlife movement, wildlife vehicle collision, road ecology, mapping

Ochozy zvěře křižující vybrané úseky silnic České republiky

Abstrakt

Zvěř se pohybuje krajinou volně od nepaměti, ale v současné době její migrační trasy a schopnosti omezuje dopravní infrastruktura. Jedním z výsledků je každoročně narůstající počet srážek vozidel se zvěří.

Diplomová práce se zabývá mapováním ochozů zvěře křižující vybrané úseky pozemních komunikací a sběrem dat dopravních srážek se zvěří v 6 lokacích ve Středočeském kraji. Úseky silnic byly vybrány na základě častějšího výskytu srážek vozidel se zvěří. Mapování ochozů a sběr dat dopravních srážek se zvěří probíhalo v letech 2016 a 2017. Část dat o srážkách vozidel se zvěří byla poskytnuta aplikací srazenazver.cz, pod správou Centra dopravního výzkumu Ministerstva Dopravy České republiky. Výstupem práce jsou mapy ochozů každé lokace se zaznamenanými srážkami vozidel se zvěří.

Hypotéza: kde je vyšší hustota ochozů zvěře v dané lokalitě, lze předpokládat i více pohybu zvěře, tím pádem je zde větší šance na výskyt dopravní srážky vozidel se zvěří. Nepodařilo se prokázat, zda hustota ochozů má vliv na množství výskytu srážek vozidel se zvěří.

Klíčová slova:

pohyb zvěře, dopravní srážka se zvěří, mapování, ekologie silnic

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1. Introduction

Wildlife was moving through our landscape freely, but from certain time human actions started to change its character and thus patency for wildlife. For some of these changes is responsible human infrastructure and its intensification, respectively expanding road and railway networks and increasing traffic density, heavelly cultivated agriculture areas and spreading residential areas are creating more and more barriers resulting into increase of landscape fragmentation.

Landscape fragmentation have negative influence on habitat, by making it uninhabitable for wildlife, which can not migrate and keep viable populations. Each species is sensitive to fragmentation differently and its needs to migrate did not disappeared even in such fragmented landscape. Probably the most vulnerable are larger mammals, who are demanding for habitat size, inhabiting large areas by small number of individuals and migrating for long distances.

The wildlife created during the past development its own migration network, so called green infrastructure. These perennial trails, typical for larger mammals, can not be easily changed in response to presence of transport corridor. In present landscape it is almost impossible to not avoid the crossing of green and human infrastructure. Results of these crossing sites are wildlife vehicle collisions, which numbers during the past years are increasing.

2. The aims of the thesis

The aim of this master thesis was to map trails of the game crossing selected road section and gather wildlife vehicle collisions data of years 2016 and 2017 in 6 localities of 2 areas in the Central Bohemian Region in the Czech Republic and create map output. Based on data output it should be formulated whether there is an effect of numbers of trails on occurence of wildlife vehicle collisions.

Main objectives

- Map game trails in study area in field
- Gather wildlife vehicle collision data in field and by accessible records
- Create map output and analyse it in geoinformation system (GIS)
- Comparison of the locations and finding common and most risky places (hotspots) of each locations
- Prediction of possible movement of the game around the roads in Czech Republic

3. Literature review

3.1. Wildlife movement

The movement of organisms is a fundamental property of life. It is necessary to recognise differences in the type of movements and the scale at which these occur (Verkaar and Bekker 1991, Seiler and Folkeson, 2006).

Wildlife moves within and between resources areas, home ranges, regions and even continents. These movements are necessary to fulfill its needs and for the daily survival of individuals as well as for the long-term persistence of populations (Taylor et al., 1993, Seiler and Folkeson, 2006, Anděl et al., 2011).

The wildlife movements can be divided into three categories - movements within home range, dispersion and migration (Forman and Godron, 1993, Bennett, 2003, Seiler and Folkeson, 2006).

3.1.1. Movements within home range

Movements within home range, where animal lives, are done regularly and daily between different resources, for example between foraging areas, water and shelter (Anděl et al., 2011).

Home range is big enough for individuals or groups to secure all their needs for resources. Resources are usually connected by network of trails, which animals use for the safest and fastest moving. Home range can be shared by few individuals, with their offsprings, but some species are sharing it in bigger social units. Border of each home ranges are mutually overlapping (Forman and Godron, 1993).

Some species create inside their home range territory, which is defended against members of same or similar species. Among territories there is space mostly for free movement. The territoriality is mostly known within mammals and birds. Some authors are using term territory as home range. Territories are permanent or temporary, in essence during mating period or migration (Veselovský, 2008).

3.1.2. Dispersion

Dispersion is result of territorial behaviour, and serves as regulation of population density at one place by preventing the overwhelming of biotop (Baguette and Van Dyck, 2005, López-Sepulcre and Kokko, 2005).

Dispersion can be described as the one - way movement of an individual, mostly away from parental home range or away from each other to a new area, to establish its own territory (Bennett, 2003). Habitually the new home range of teenage individual is far from original by distance several times larger than average (Sutherland et al., 2000).

Dispersal movements can be also characterized as exploration, where the individual visits many locations and after that chooses the most suitable, or alternates gradually locations, until it inhabits one without returning to the previous places.

Quantum of wildlife species, which dispersion has explorative character is difficult to estimate, because of missing relevant knowledge, but trails used in diurnal movements are often utilised. (Forman and Godron, 1993, Seiler and Folkeson, 2006).

3.1.3. Migration

Migration can be defined as regular movements, conducted by groups of individuals or even entire local populations of one species, between two geographic areas, during which normal use of habitat does not occur (Begon et al., 1997).

Most of the migrations represent an adaptation to seasonally changing conditions of environment to the quality or abundance of their food resources or their reproduction cycle, and is essential to the survival of many species, for example remote seasonal movements of birds moving to wintering grounds (Begon et al., 1997 , Bennett, 2003).

These terms are not used uniformly and there are no sharp boundaries between them. For this reason, it has been practical to simplify the term of migration, which is perceived as a general term describing all movements of wildlife in the landscape (Anděl et al., 2011).

2.2. Landscape

The landscape has number of definitions based on various scientific disciplines such as ecology, geography or demography etc. (Anděl et al., 2011).

The Czech law, Act 114/1992 Collection, on the Conservation of Nature and Landscape, defines landscape as „a part of Earth‘s surface with characteristic relief formed by a complex of functionally integrated ecosystems and elements of civilisation”.

Landscape is characterized by structure (composition), function, and changes (dynamics).

3.2.1. Landscape structure

Landscapes are composed of a mosaic of individual patches, embedded in a matrix. The matrix is the dominant and the most extensive component in the landscape (e.g. in forest area it is a forest), and it plays the dominant role in landscape functioning. Patches (e.g. habitats in ecology) are spatial units that differ from vicinity, matrix (e,g. forest meadow). Patches are connected together by linear units, knows as corridors, that differs from the matrix on either side, and usually follow type of patches (hedgerows between fields) (Forman and Godron, 1993, Seiler and Folkeson, 2006).

The diversity of habitats and the spatial arrangement of individual habitat patches together determine the biodiversity value of the landscape. Biodiversity denotes the total variation among living organisms in their habitats, including the processes that link species and habitats (Hanski, 2005, Krauss et al., 2010).

Landscape is thus spatial heterogenous set of natural ecosystems and spaces artificially created by human. Both of these components can be imagined as mutually intersecting networks (Anděl et al., 2011).

Natural network is represented by variety of biotops (biocenters) - habitats and ecosystems, which are species - specific and allow the permanent existence of individual species. These patches mutually interact (Forman and Godron, 1993) and are interconnected by some way, by various linear or flat landscape structures, in which wildlife migration occurs.

Besides natural network, there is anthropogenic, represented by residential units and other constructions (industrial zones, mining areas), which are connected by transport infrastructure (roads, railways, water channels), and which allows movement of human and material (Anděl et al., 2011). The transport network is at present so dense that it represent a significant threat to wildlife (Dufek et al., 2004).

Because both network are intersected, mutual conflicts occur (Anděl et al., 2011).

3.2.2. Landscape connectivity

Landscape connectivity denotes functional connection between patches and is defined as the degree to which the landscape facilitates or impedes wildlife migration (Bennett, 2003). Connectivity is thus considered as a vital element of landscapes structure for sustaining wildlife migration (Taylor et al., 1993).

This linking function has been performed in past times by our landscape more or less automatically, but today it is losing this function, therefore it is needed to preserve these functions (Anděl et al., 2011).

In the Czech Republic the preservation of landscape connectivity is provided by the Territorial system of ecological stability (TSES), which is included in nature conservation legislation and spatial planning. TSES is the basis for creating an ecological network from local to inter regional scale, and a comprehensive hierarchical system for protection, reinforce or restoration of ecological stability of biocenters and interconnecting corridors and interaction elements, which can be imagined as small isolated patches (e.g. solitary tree or shrubs in field) (AOPKČR, 2019).

But TSES does not provide sufficient protection for long distance migrating animals, especially large mammals, which are very important and suitable model group for the design of conservation measures for landscape patency. Among these larger mammals belongs four specially protected species (Eurasian lynx, elk, wolf and brown bear) and red deer. The reason is their own protection and the fact that they need a wide range, and where will be ensured permeability for them, it will be satisfactory also for other species. Therefore to protect the patency of the landscape for large mammals migration was designed as separate concept (Anděl et al., 2010, Anděl et al.,2011) - The Protection of landscape permeability for large mammals, which is conception based on previous studies and the definition and protection of three hierarchical spatial units.

First, Significant migration areas include sites suitable for both occurrence of target species and their migration capability. They occupy about 42% of the area of the Czech Republic.

Second, Long distance migration corridors are linear structures of a length of tens of km and a width of about 500 m, which connect areas significant for the permanent or temporal occurrence of large mammals populations. They occurs in a place, which are still transit, but critical places exists.

Third are Migration routes, which represent specific technical solution (structures e.g. green bridge or underpass) or landscape measures (alternation of surrounding vegetation of the road) in critical areas of a migration profiles.

It should be mentioned that the mutual connection of the proposed network of migration corridors is similar, linked to and overlapping with networks and protected areas intra and interstate in central Europe, based on the exchange of information regarding the dispersal of the species and their main migration directions across states (Görner and Kosejk, 2011).

3.2.2.1. Wildlife trails

Whether the wildlife migrate remotely or in the local scale, they use constant trails and paths used by previous generations even for hundreds of years (Seiler and Folkeson, 2006, Anděl et al., 2011). The term trail (or pathway) is used within location for a certain way (Feeney et al., 2004). Migration (ecological) corridor as bigger unit include wider lines e.g. hedgerows and field margins, wooden ditches or road verges, which support direct movements, but also serve as a refuge to organisms that are not able to survive in surrounding landscape.

Most of the empirical data on the use of ecological corridors by wildlife refers to insects, birds and small mammals (Bennett, 2003, Seiler and Folkeson, 2006).

Larger mammals - game, such as red deer, roe deer, wild boars, foxes or lynxes are loyal in using these perennial trails, which are utilized by their movement and other behavior like grazing on surrounding vegetation (Drmota, 2014), but little is known yet about the use of these rather small - scale structures by larger mammals (Hobbs, 1992).

Using of perennial trails cannot easily be changed in response to a new phenomenon - presence of barrier in the form of e.g. road (Forman and Godron, 1993, Feeney et al., 2004).

3.2.3. Landscape changes in time

Landscape is not static, but dynamic phenomenon, that changes continuously (Antrop, 1998). Landscape changes are caused by natural events (e.g. landslide or flood), or human activities (e.g. intensive agriculture on big areas or construction of new roads).

By about more than 150 years ago, wildlife still had moved naturally in the landscape. Since then, many fundamental changes have occurred in the landscape, for example introduction of railway or industrial growth, which have changed its character (Anděl et al., 2011).

During whole 19th century area of used arable lands increased by 50 percent at the expense of natural stands, except forest areas remained from the end of the century historically stable at about 30 percent.

At the beginning of the 20th century, agriculture occupied two thirds of the Czech landscape. Country was still relatively passable and was characterized by tiny patches of fields and thick web of country roads lined with trees (Lipský, 2000).

After the Second World War the Czech landscape experienced dynamic history full of dramatic changes (Skaloš and Kašparová, 2012). Due to collectivisation and intensification of agriculture, the heterogeneous mosaic of small patches with many possibilities for wildlife migration pathways was converted into large, homogeneous blocks (Keken et al., 2016). These changes, together with spreading urban areas and rapid increase of transport infrastructure and traffic density during last five decades, started to fragment the landscape, and thus significantly reduced connectivity of landscape and its patency for wildlife (Hlaváč and Anděl, 2001, Di Gulio et al., 2009, Kušta et al., 2017).

3.3. Transportation impacts on nature

In present time wildlife and landscape is more directly affected by transport infrastructure, mostly negatively, in a variety of ways, and the amount of changes, when compared with the historical development, is incomparably bigger (Verkaar and Bekker 1991, Jackson, 2000, Bennett, 2003). Probably the most important negative impacts on nature by transportation are attributed to fragmentation (Seiler, 2001, Dufek et al. 2004).

3.3.1. Landscape fragmentation

Landscape fragmentation by roads, highways and railways is the process of dissecting continuous habitat patches and their connections into smaller and more isolated units, that lose by dividing their original quality and also potential to fulfill their original functions (Jackson, 2000, Dufek et al., 2004).

Fragmented patches are often smaller than is needed for more sensitive species to survive (Niebuhr et al., 2015). Due to their area of occurence, population dynamics, reproduction pattern or ethology, the shrinking area of isolated sites below a certain limit affects the long term survivability of organisms (Miko and Hošek, 2009).

Animals for their existence need not only the living space but also the functional network that allows exchange of genetic informations due to migration, and therefore has crucial role for population survival and metapopulation dynamics (D‘eon et al., 2002).

Landscape fragmentation can even results in the extinction of an endangered and non - adapting species and thus it belongs to very topical and discussed topics, as it is considered worldwide as one of the greatest threats to preserve biodiversity

(Hanski, 2005, Krauss et al., 2010, Dufek et al., 2004). Its preservation should be a strategic goal in the environmental policy of transportation, nature conservation and landscape planning (Seiler and Folkeson, 2006).

According to Anděl et al. (2005) there are 3 basic subjects of landscape fragmentation which need to be evaluated separately – species represented mostly by population with needs to migrate and and specific demands on habitat, in which occurs together with certain phenomenon in the form of barrier, which is causing fragmentation and limit its migration.

Landscape fragmentation has also negative impact on humans and society, because the landscape loses the ability to provide some services required by human, such as the ability to retain water, noise absorption, pollution and recreation or by changing its structure change the aesthetics (Di Giulio et al., 2009, Miko and Hošek, 2009).

According to many authors we recognize the primary and secondary ecological effects of fragmentation by transportation upon nature. These effects are mostly interconnected and can act synergistically and cumulatively, long lasting and in many cases irreversible.

Secondary effects do not affect directly, such as future development of site or changes of local land use.

Primary ecological effects are caused by the physical presence of the infrastructure and we can distinguish between their five major categories of primary ecological effects of fragmentation - habitat loss, disturbance and pollution, barrier effect, creation of corridors and mortality (Dufek et al., 2004, Seiler and Folkeson, 2006, Anděl et al., 2005).

3.3.1.1. Habitat loss

Habitat loss is immediate effect of land occupation caused by construction of new infrastructure (Anděl et al., 2005), which leads to decrease the amount of habitat that is suitable or available for wildlife and isolation, and leads to irreversible changes in the distribution of wildlife species in the landscape (Rybicki and Hanski, 2013). Road network in the Czech republic cover about 0.8 %

of the territory, which is significantly less than in comparison with Western European countries, for example in Germany it is around 5 % (Dufek et al., 2004). At present we can not assume that the road network will be reduced, but increased due to transportation growth (Ministry of Transport of the Czech Republic, 2013).

3.3.1.2. Disturbance and pollution

Disturbation and pollution are result of infrastructure construction, its use and maintenance, and lead to creation of noise, light and soil pollution or smog and toxins (Hegerová et al., 2017). Disturbance and pollution affect physical, chemical and biological environment in a much wider zone than that, which is physically occupied by roads and railroad (Keken et al., 2011). Some species can use traffic noise as warning and thus they avoid very noisy areas, and thus barrier effect is amplified. On the other side some species, e.g. insects, can be attract by light and their presence attract their predators, like bats (Forman and Alexander, 1998).

3.3.1.3. Corridors

Corridor habitat alongside the communications can be seen as either positive and negative. Wildlife, but primarily less demanding species, can benefit from green verges, if they provide in fragmented landscape valuable resources, cover or link between habitats, and support wildlife movements. In reverse it helps spreading of invasive species and lead wildlife to the residential areas. Also there is a higher risk of exposure to predators, which are attracted to road kills and collision with vehicle (Simberloff et al., 1992, Šerá, 2008, Šálek et al., 2009).

3.3.1.4. Barrier effect

Communications act like an obstacle, which can limit or prevent movement of many terrestrial species and can lead to isolation of the population. (Shepard et al., 2007). Most infrastructure barriers do not completely block animal movements, but reduce the number of crossings significantly. For big mammals the communication is obstacle only when is fenced around and transportation intensity is high, but still only 40 percent of the total Czech highway network are permeable for roe deer and wild boar, and only 30 percent are permeable for red deer, elk, and large carnivores (Hlaváč, 2005).

Problem is also multiple fragmentation, when two or more parallel roads are creating corridor. Sometimes it can be positive mainly within multimodal transportation corridors because it creates only one barrier instead of two. Often case is that new highway is parallel to old road in close distance and traffic is intensive on both which results in impassable barrier (Anděl et al., 2005, Dufek et al., 2003).

Barriers cause changes of animal behaviour when approaching the road (Andrew, 1990, Hlaváč and Anděl, 2001) - complete avoidance of road or changes its way after getting closer and leave the surrounding of road due to disruption, copies the road until finds the safe and suitable place for passing the road, or pass the road immediately, which can lead to wildlife vehicle collision and their death.

3.3.1.5. Mortality

Road and railway mortality is probably the most widely acknowledged effect of traffic on wildlife. The quantity of wildlife vehicle collisions (WVC) is a global growing problem not only for species conservation, but also for traffic safety (Seiler and Folkeson, 2006).

According to the records of Czech police, insurance companies and game managers from last decade, numbers of WVC are rising more than a thousand cases per year (Table 1), which is 1 - 2 percentage increase. In the year 2017 wildlife caused 12494 traffic accidents, which was 12% of all 103821 accidents (PČR, 2018).

Table 1. summary of WVC in the Czech Republic through last decade (PČR, 2018).

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
WVC	7499	3076	3523	4064	5912	6782	7846	9635	10917	12494

Accompanying these official records a Czech web application srazenazver.cz was created for scientific and statistical reason, and combine these data with the data added by volunteers. During monitoring between September 2014 and November

2016 as many as 19,498 road kills were recorded, but only 9632 (49%) records had the species listed. The majority of the records with identified species belong to roe deer (68% of the identified), followed by wild boar (12%) and hare (6%) (Bíl et al., 2017). Railway mortality was observed by Kušta et al. (2011) and Keken and Kušta (2017), according by their results, collision with roe deer and hare prevailed.

WVC occurrence may be related to a number of factors, such as technical aspects of roads, traffic volume, vehicle speed, driver‘s attention, type and attractiveness of surrounding vegetation type, time and year period, or the individuals' motivation for crossing the road (Kušta et al., 2014, Kušta et al., 2017).

According to several studies (CDV, 2018, Bíl et al. 2017, Groot Bruinderink and Hezebroek, 1996, Hrouzek et al., 2015, Kušta et al., 2014, Kušta et al., 2017) most of the WVC occurs on long synoptic section of the highways and 1st class roads; least of the WVC occurs on road sections full of curves in wooded areas.

WVC occurrence is also changing throughout out the day and year, and is correlating with time and period of higher wildlife activity. Perceptible numbers of WVC occur from May to June and from October to November due to rut, rearing and dispersion of youngs (Figure 1), and about two thirds of WVC occurs during night time between 18 and 6 hours due to higher wildlife activity and lower visibility (Figure 2).

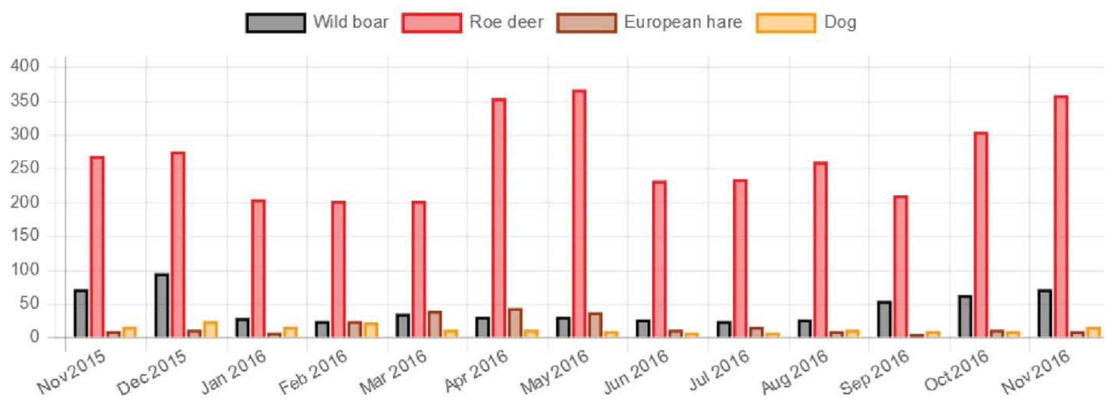


Figure 1. The graphs shows the most abundant wildlife species in WVC during period from November 2015 to 2016. Y axis represent numbers of WVC (Bíl et al., 2017).

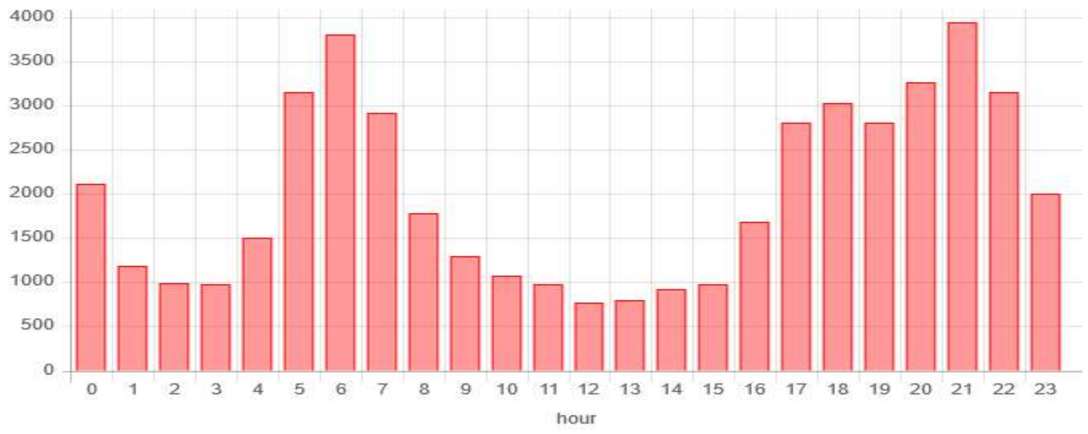


Figure 2. The graphs present total number of WVC during past five years in hours during day (CDV, 2018).

3.5. Target species

Practically every terrestrial animal species is affected by transportation. Currently the most vulnerable are those groups of animals, that are tied to a preserved natural environment, have great demands on the size of their home range, inhabiting large areas by small number of individuals and whose biology includes regular or occasional migration for long distance, all these traits meets larger mammals (Anděl et al., 2010), which on top of are persistent in their use of infrastructure crossing sites (Kušta et al, 2014).

Many smaller species, such as rodents, amphibians, reptiles, rabbits, or birds are not so endangered by presence of highway, due the high population density and they can pass the communication by underpasses (Hlaváč and Anděl, 2001). Traffic mortality is generally considered insignificant within smaller species, accounting only for a small portion (less than 5 %) of the total mortality (Seiler and Folkeson, 2006, Grilo et al., 2016, Oxley et al., 2016).

Attention is thus paid to the larger mammals, from the size of fox or otter to size of deer and elk. Emphasis is placed upon native species, which protection is societal interest. Alien species migration are undesirable. Furthermore attention will be paid to roe deer and wild boar only, for their importance in WVC, and increasing economic, cultural, and ecological importance (Burbaitė and Csányi, 2009).

3.5.1. Roe deer

Roe deer (*Capreolus capreolus* Linné, 1758) is native, smallest and the most abundant cervid in the Czech Republic and its population is regulated by hunting (Červený et al., 2010), statistics showing fluctuation of the population by every 7 - 9 years. During last spring counting in 2016 its population on Czech territory was estimated to circa 295 thousands, and mortality in collision with vehicle accounts for more than 15 % (about 6 thousands) of the annual losses caused by anything else than hunting (Zbouřil, 2017). It prefers mosaic landscapes of woodland, meadows and farmland. Roe deers are well adapted to modern agricultural landscapes, and can survive in non - preferred areas seasonally (Putman, 1986). Territory size depends on quality of habitat, where due to a occurence of suitable conditions in forest are smaller (cca 5 hectares). Roe deer belongs between species with variable social behaviour. It often creates during winter bigger herds, using home ranges up to 800 hectares in field matrix. Beginning of herd disintegration starts in March. Unlike other European countries within Czech population no migration tendencies were recorded (Anděl et al., 2005).

3.5.2. Wild boar

Wild boar (*Sus scrofa* Linné, 1758) is common on whole territory of Czech Republic, with occurrence in urban agglomeration and in intensively managed lowland forests. This species was almost extinct within start of the 19th century and then it started to spread after Second World War. Population was rising up, except the beginning of 1990s, when due to swine fever slightly decreased. In 2017 was population reduced by hunting more than 160 thousand individuals (Zbouřil, 2017) for causing high economical damage to crop, but mostly to prevent spreading of african swine fever (Postel et al., 2016, Ježek and Forejtek, 2017). Its true numbers are not known, due to covert activity during day and high numbers of individuals in herds. Boars are very mobile, it is unstable species and moves within family herds on long distances. These movements are not pointed and are determined by food resource offer, when boars mostly stay in field matrix for whole vegetational growth and after field harvest retreat into forests to cover (Tack, 2018).

4. Methodology

4.1. Study area

Study areas were selected, as a part of the project "Black spots - places of crossing green and transport infrastructure", for occurence of higher numbers of WVC than is average (CDV, 2016).

The study was done in 2 areas (altogether 6 locations - road sections) in the Central Bohemian Region of the Czech Republic (Figure 3 and Table 2). Both areas were circa 22 kilometres far from each other.

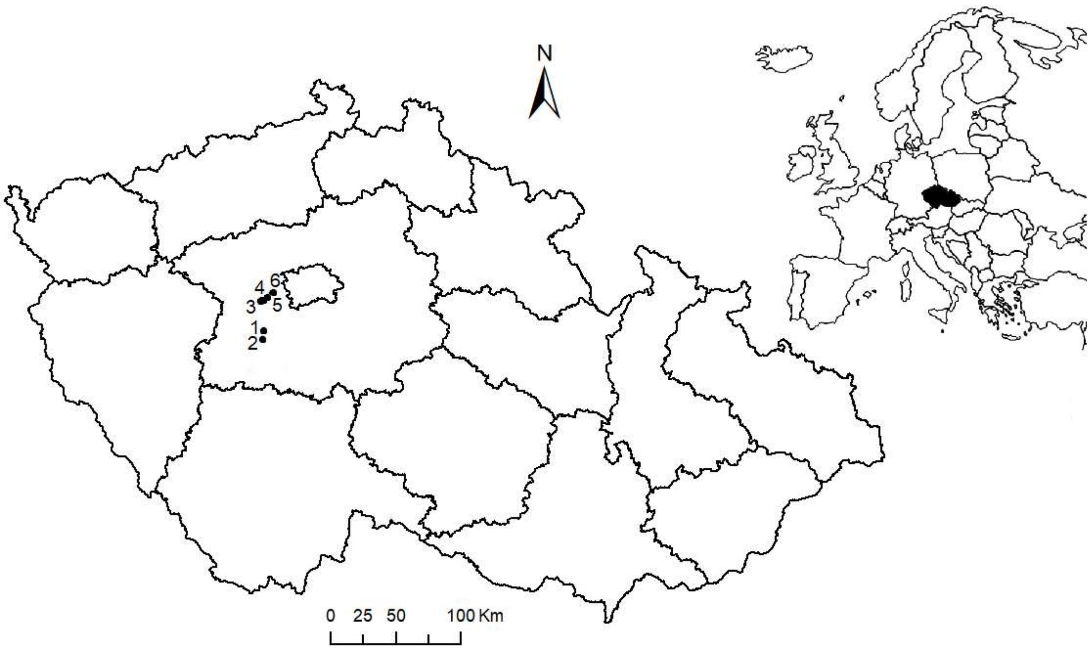


Figure 3. Localization of 6 selected road section in the Czech Republic.

Table 2. Summary of locations.

ID road	Start latitude	Start longitude	End latitude	End longitude
Dobríš, Hostomická 114	49° 47' 29,983" N	14° 8' 20,051" E	49° 47' 17,677" N	14° 8' 58,941" E
Dobříš, Rosovická	49° 46' 25,291" N	14° 8' 39,557" E	49° 45' 50,400" N	14° 7' 27,964" E
Beroun, Pražská 605	49° 58' 34,581" N	14° 6' 15,235" E	49° 58' 21,655" N	14° 5' 20,917" E
Vráž, Pražská 605	49° 58' 45,749" N	14° 6' 59,669" E	49° 58' 36,441" N	14° 6' 22,538" E
Vráž - Loděnice, Pražská 605	49° 59' 28,487" N	14° 9' 0,794" E	49° 59' 21,977" N	14° 8' 32,533" E
Lodenice, Pražská 605	50° 0' 31,0351" N	14° 11' 36,055" E	50° 0' 17,073" N	14° 10' 42,718" E

The first area was located near Dobříš Town in the Příbram District and consisted of 2 locations (locations 1 and 2). Location 1 was 895 meters long section of second class road Hostomická 114 between Dobříš and Trnová. Location 2 was 1800 meters long section of third class road Rosovická heading from Dobříš to Sychrov.

The second area was located between the towns Beroun and Loděnice and consisted of 4 sections (locations 3 - 6) of second class road Pražská 605. Location 3 was long 1200 m and headed from Beroun to East towards exit 14 of Highway D5 / E50. Location 4 was 793 m long and headed from Highway D5 exit 14 towards village Vráž. Location 5 was 598 m long and spreaded between Vráž and Loděnice town. Location 6 was 1200 m long and headed from Loděnice to Nučice village.

Both areas are spreading on the fault region of the paleozoic, proterozoic and cenozoic rocks. Geological foundation in first area is slate and sediment type, and in second area is slate and sediments with rocky to soil foundation (Česká geologická služba, 2018).

Climate of first area is slightly warm and second area is warm due to their altitude, close position to Prague and geological foundation. Annual rainfall of both areas is 450 - 500 mm.

Hydrologically both areas belongs to the basin of Vltava river. Specifically first area belongs to the river basin of Kocába, second area belongs to the river basinof Berounka (Český hydrometeorologický ústav, 2018).

In first area as a natural forest biotop prevailed stony-acidic oak - hornbeam forest passing into acidophilus beech forest (Lat. Luzulo - Fagetum) and spruce forest planted by man. In the second area prevailed stony-acidic oak - hornbeam forest (Lat. Galio - Carpinetum) (Viewegh et al. 2003, Chytrý et at., 2010, Národní geoportál Inspire, 2018, Rostislav Linda, 2018, pers. comm.).

The landscape fragmentation by transportation in the terms of occurence and migration of larger mammals was in both areas evaluated as territory of increased importance. In the first area the landscape patency was evaluated as relatively passable and both locations belongs among Significant migration areas. Second area was evaluated as impassable, between locations 3 and 4 is critical place of Long distance migration corridor for larger mammals, but due to high density of transportation and technical solution of the parallel road and highway in the place, it is almost impassable, thus unfunctional (Anděl et al., 2005, Anděl et al., 2006, Národní geoportál Inspire, 2018). Migration potential of both areas for big mammals is shown on Figure 4 - 6.

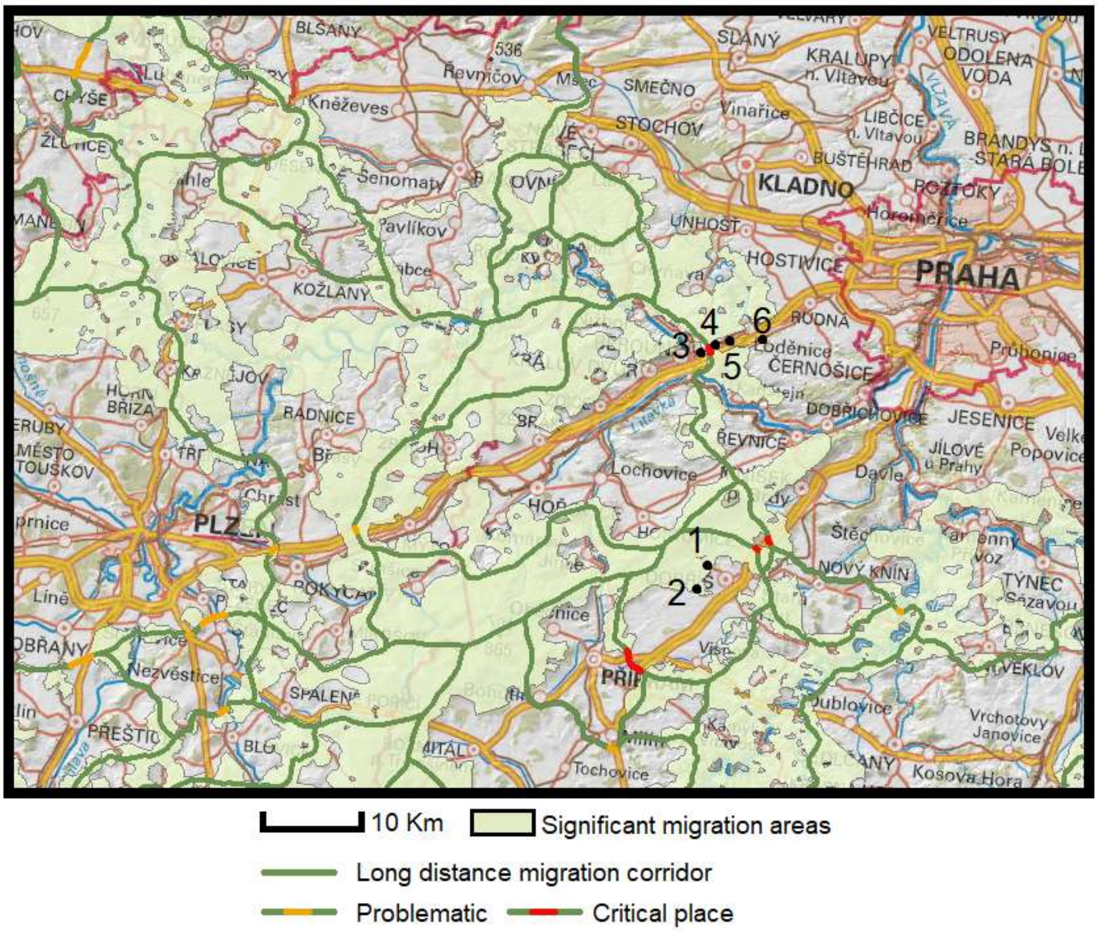
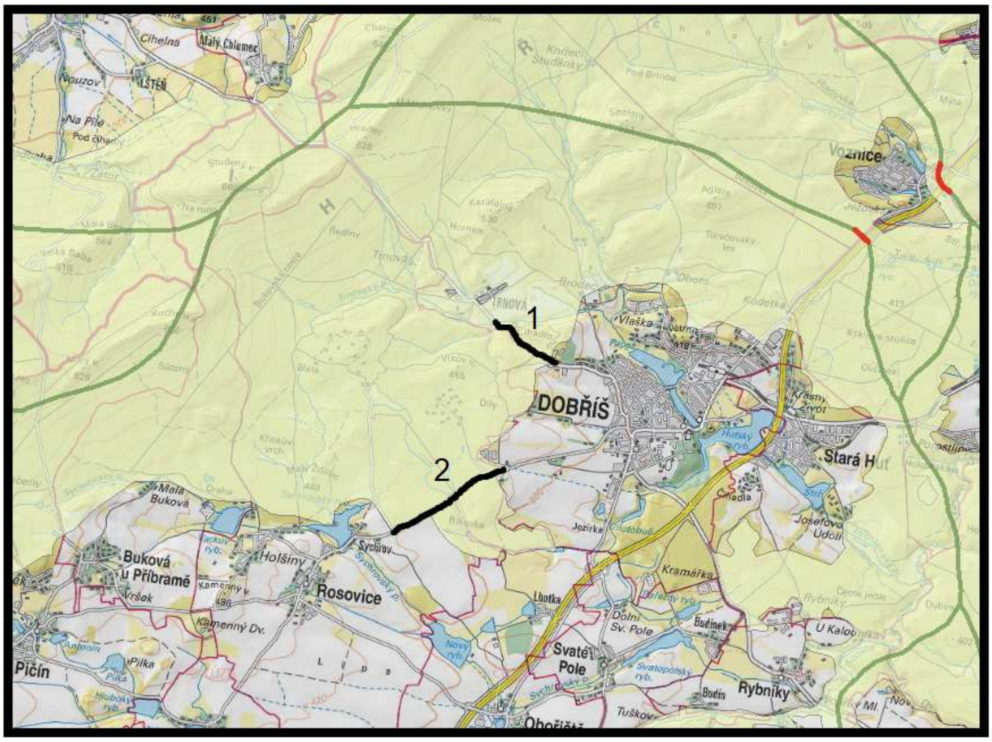
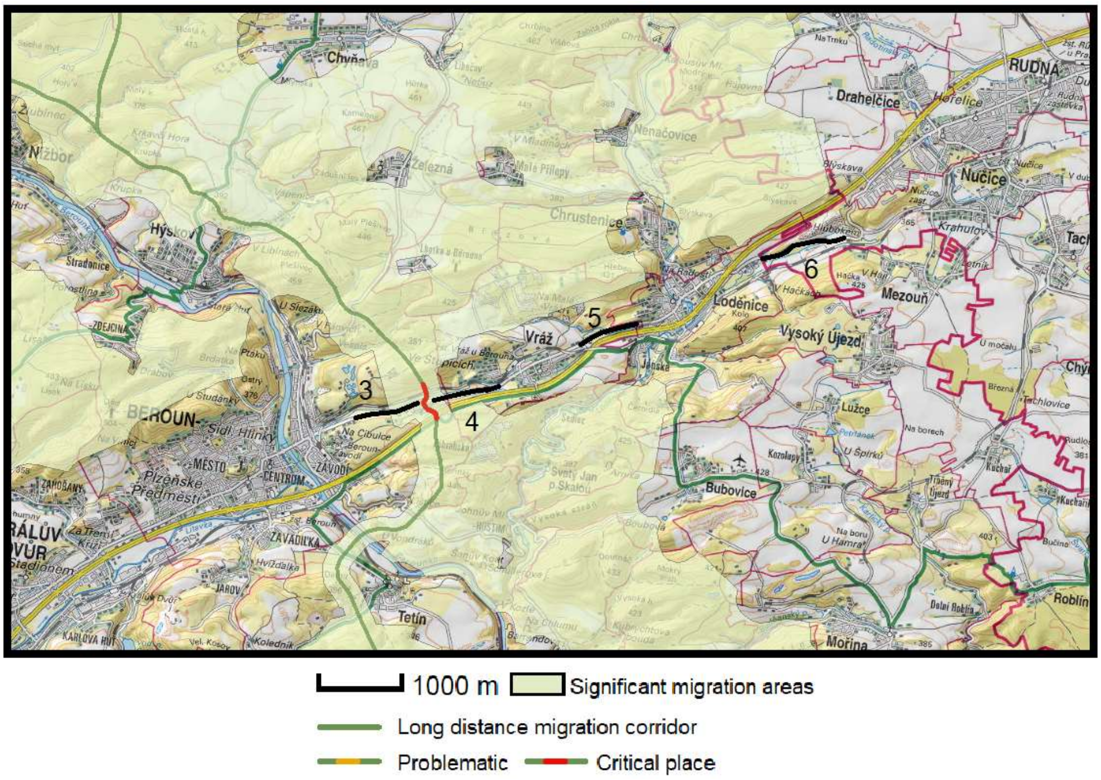


Figure 4. Migration potential for big mammals in the western part of Central Bohemian Region (Národní geoportál Inspire, 2018).





Firgure 5 and 6. Migration potential for big mammals of each areas in closer scale (Národní geoportál Inspire, 2018).

4.2. Data collection

Wildlife vehicle collision data were obtained by two ways.

First way was data collection by personal checks in field. It was done twice per week during the spring (from May to June) and autumn (from October to November) of 2016. When cadaver on or alongside the road was found, the GPS coordinates and photos were taken (Figure 13 in annex), the cadaver was marked by color marker, and if it was possible, the findings was determined into species. Then the WVC data were inputted into the computer for further analysis in GIS software.

The second way was provision of data from study areas from the years of 2016 and 2017 by the Transport Research Centre (CDV), the scientific research public institution under the Ministry of Transport of the Czech Republic. Field data from project Blackspots were inserted by solvers into internet application srazenazver.cz, which is under administration of CDV (Jan Kubeček of CDV 13.11. 2018, pers. comm.).

The mapping of migration trails alongside the roads was performed in person during autumn of 2017 by walking along the trails with gps tracker device, up to 100 metres far from the road within the visibility restriction by ground surface, vegetation stage and presence of game, their footprints or faeces.

4.3. Geographic information system analysis

After game trail mapping and WVC data gathering, all of the available data were inputted into the GIS software ArcGIS, version 10.5., and maps were created. After map creation the analysis of effect of quantity of trails on roadkills was done.

The analysis was performed by creating buffer zone of a radius 25 metres around recorded roadkill, then in this area the lengths of trails were summed to obtain density value of trails in metres. This summation was done for roe deers, wild boars and group marked as others.

5. Results

5.1. Wildlife vehicle collisions

Wildlife vehicle collisions were divided into four record types - roe deer, wild boar, bird and other, which consisted of smaller animals like amphibians, reptiles, small mammals and or unidentified animals.

Table 3. Summary of WVC group from each location.

Species	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Roe deer	2	12	1	1	1	0
Wild boar	0	0	2	0	0	0
Other	0	11	12	7	1	3
Bird	0	0	8	3	8	2

During years 2017 and 2016, either by personal checks and by records of CDV were found total number of 72 individuals killed by collision with vehicle, from this number 17 were roe deers, 2 wild boars, 19 birds and 34 other animals. Detailed records of WVC are in Table 4, and also in the maps (Figure 7 - 10) in the next chapter.

Table 4. Recorded WVC of year 2016 and 2017 - their GPS location, species, lenght of trails and location. 0 stands for no trails founded in radius of 25 m. Trails were not counted for the birds.

Latitude	Longitude	Species	Area	Lenght of trail in r = 25m
50,0079470042878	14,1877183581748	other	6	0
50.0070317	14.1842333	other	6	0
50.0055878	14.1810586	other	6	0
50.0081667	14.1911333	bird	6	X
50.0070167	14.1841167	bird	6	X
49,9905468715849	14,1469687314042	other	5	0
49,9908724228	14,148459434509	bird	5	X
49.9902617	14.1456700	bird	5	X
49.9908050	14.1479550	bird	5	X
49.9897667	14.1444000	bird	5	X
49.9903833	14.1467333	bird	5	X
49.9908667	14.1481500	bird	5	X
49.9905333	14.1465333	roe deer	5	0

Latitude	Longitude	Species	Area	Lenght of trail in r = 25m
49.9907667	14.1443000	bird	5	X
50.0051167	14.1800167	bird	5	X
49,9729526973101	14,0904044398541	other	4	0
49,9790551823375	14,1152960763394	other	4	0
49,9784920908142	14,1130117740174	roe deer	4	0
49,9796576272935	14,1176140203056	other	4	0
49,9772426392685	14,108090196763	other	4	65,72
49,9785377379642	14,1132129735515	other	4	0
49,9778363252423	14,1104099217036	other	4	12,03
49.9783450	14.1123217	other	4	0
49.9772000	14.1084167	bird	4	X
49.9781500	14.1118333E	bird	4	X
49.9777333	14.1096500	bird	4	X
49,9749187239142	14,1003636506308	other	3	0
49,9732597966383	14,0917730860025	other	3	167
49,9733930525353	14,0923351514387	other	3	153,96
49.9739617	14.0958300	other	3	65
49.9731483	14.0909450	other	3	0
49.9735450	14.0933467	other	3	66,13
49.9735667	14.0934367	other	3	64,05
49.9757850	14.1036028	other	3	0
49.9743117	14.0990533	other	3	0
49.9760583	14.1034550	other	3	0
49.9737400	14.0948367	other	3	109,09
49.9739100	14.0958217	roe deer	3	50,19
49.9754667	14.1017500	bird	3	X
49.9745167	14.0991167	other	3	0
49.9736664	14.0932467	wild boar	3	91,17
49.9752500	14.1011167	bird	3	X
49.9752500	14.1011167	bird	3	X
49.9736000	14.0929667	wild boar	3	127,51
49.9747667	14.0997833	bird	3	X
49.9748500	14.0998667	bird	3	X
49.9736000	14.0931167	bird	3	X
49,7695242179952	14,1350939987027	other	2	14,23
49,7694480357984	14,1349564101677	roe deer	2	14,23
49,7770120793162	14,1574652705152	other	2	0
49,7706505559495	14,1369791773275	roe deer	2	50,9
49,768373742265	14,1331440710304	other	2	31,67
49,7729237405365	14,1418670549698	other	2	14,37
49,7702975391093	14,1363972873365	other	2	23,79
49,7720815725776	14,1394148513171	roe deer	2	8,5
49,7684816769281	14,1333307995446	other	2	27,49
49,7670505326874	14,1308954860658	roe deer	2	0
49,7722896891261	14,1399022287467	other	2	28,63
49,7716054414015	14,1385793848774	roe deer	2	19,65
49,7740000141468	14,1454881563093	roe deer	2	0

Latitude	Longitude	Species	Area	Lenght of trail in r = 25m
49,7659777520166	14,1287044348214	roe deer	2	37
49,7680092825395	14,1325366910696	roe deer	2	24,4
49,7668753099794	14,1305692483167	roe deer	2	30,9
49,7643387171804	14,1252913637567	other	2	34,29
49,7662595814581	14,1293017854709	roe deer	2	38,59
49,7708334044015	14,1372897725712	roe deer	2	15
49,7638334775759	14,1241400577929	other	2	0
49,7712511730413	14,137983725322	other	2	61,24
49,7659561636196	14,1286670930418	other	2	36,52
49,7891586234809	14,1464985622482	roe deer	1	54,91
49,7879434243359	14,1511820797901	roe deer	1	0

5.2. Trails

For clarity each location was divided into 2 - 4 parts and description was done from our point of view on the image of each location - from the left (west) to the right (east), top (north) to bottom (south) side. For the description of vegetation alongside the road was used a determination of six basic vegetation types of bands along roads (tree lines, planting area, forest stand, early successful growth, bushes band, grassy - herbal associations) by Šerá (2008) with additional elaboration. Maps of trails of each locations are after each the annex (Figure 7 - 10).

5.2.1. Location 1 (Figure 7)

Surroundings of Part 1 and 2 was created by forest, on the west side of the location were managed meadows. At the start of part 2 was fenced tree planting area. in the northern side of part 3 and 4 was wider tree line formed by young trees, behind the stripe was meadow with forest behind. In southern side of part 3 was after clear - cut early successional growth mostly of blackberry shrubbery. In southern side of part 4 was behind narrow shrubbery band and young forest passing in the east into field.

In the part 1, were found 2 trails near the start of the section, headed downhill connecting into 1 on human pathway.

In the part 2, in the northern side were found 3 long traceable trails, perpendicular to road. First was copying human pathway, second trail was parallel with the first heading towards human pathway. Third trail was created by joining

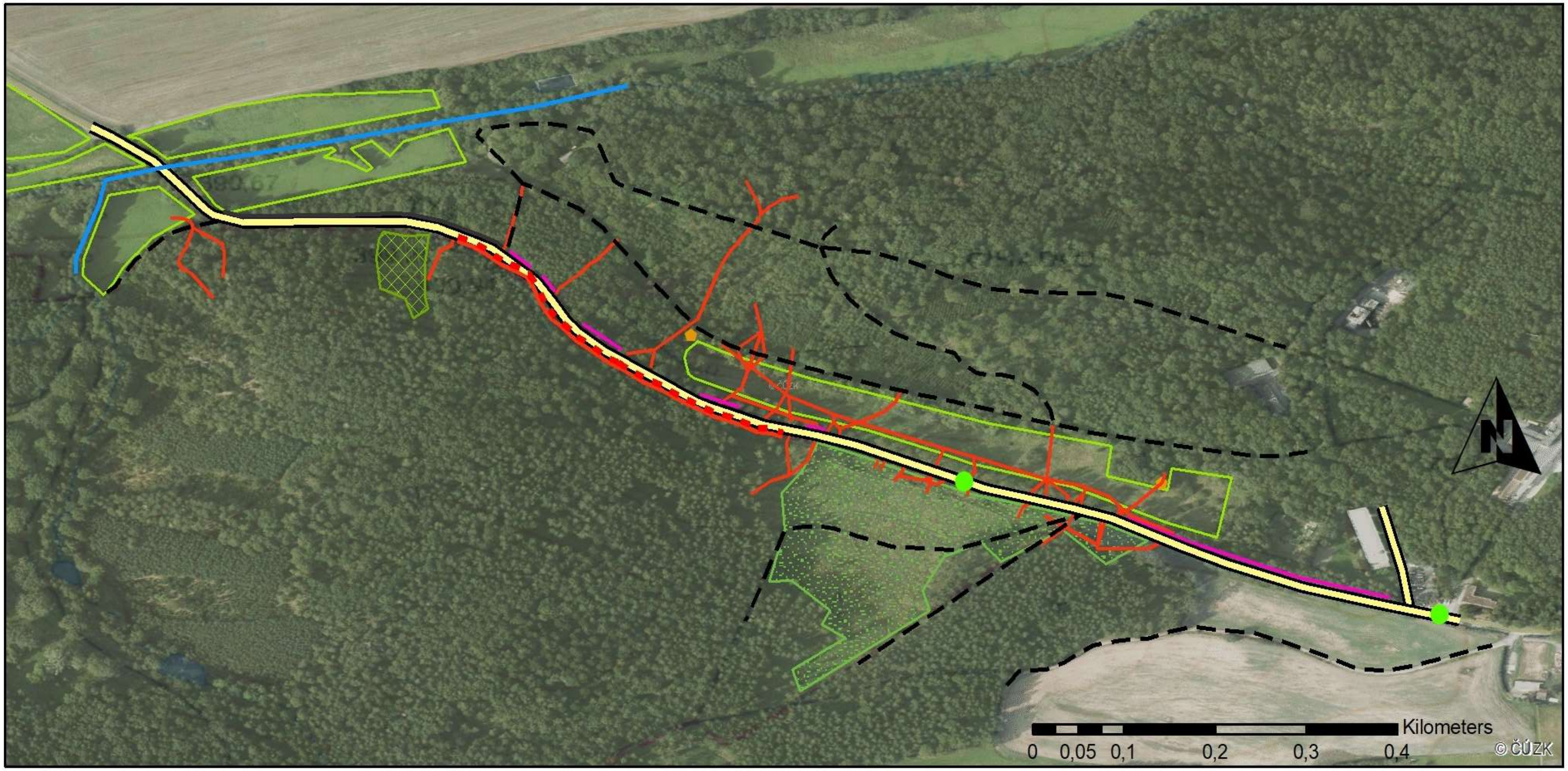


Figure 7. Location 1.

Trails of the game | Eroded bank | Crash barrier | Fence remnant | Plantage | Game feeding place
Road | Human ways | Stream | Meadows | Shrubbery | Roe deer

2 short trails, then was heading to game feeding place through both huma pathways and valley uphill and there it splitted up into 2 trails. In the southern side of part 2 was high spruce forest, where trails were not traceable due to lack of ground vegetation and no material on the ground. Whole road bank was eroded by game movement. Only 1 trail was found there, at the start of the part and it was copying border of the forest at the fenced plantage.

In the part 3, in the north, were trails in the strip very dense, 2 trails were going parallel to the road behind and in the stripe. Another trails were going uprightly from road though stripe, crossing the parallel ones and meadow, where continued into the forest, connected to human pathway or headed towards game feeding place. In the southern side 2 trails were copying border of high spruce forest and after 20 meters connected. Next to the forest in southern side was shrubbery, where it was not possible to trace trails far than 5 - 15 m due to high vegetation density. At the end of shrubbery was 1 trail copying human pathway. 8 trails were connected across the road.

5.2.2. Location 2 (Figure 8)

Whole surroundings of the road was created by forest, and the fields and meadows were on the sides. The forest was in northern side dominated by deciduous trees, in southern side was dominated by coniferous trees up to part 4, where deciduous trees prevailed. Southern side part 1 was created by narrow stripe of forest (circa 20 m wide) with field behind. In part 2 was stream, where forest was more open and created stream meadows. In northern side of part 3 was sapling spruce planting area. In the part 4 at the edge of the forest on both sides were fenced lands.

In the part 1 was found 30 short trails, 9 of them were connected across the road and 5 of these continued through forest stripe into field where they disappeared.

In the part 2 were found 16 trails. Two of them was shortly using human pathway, then it connected other trail parallel to the way. In the area around the stream, 1 trail was was following the border between the meadow and forest,

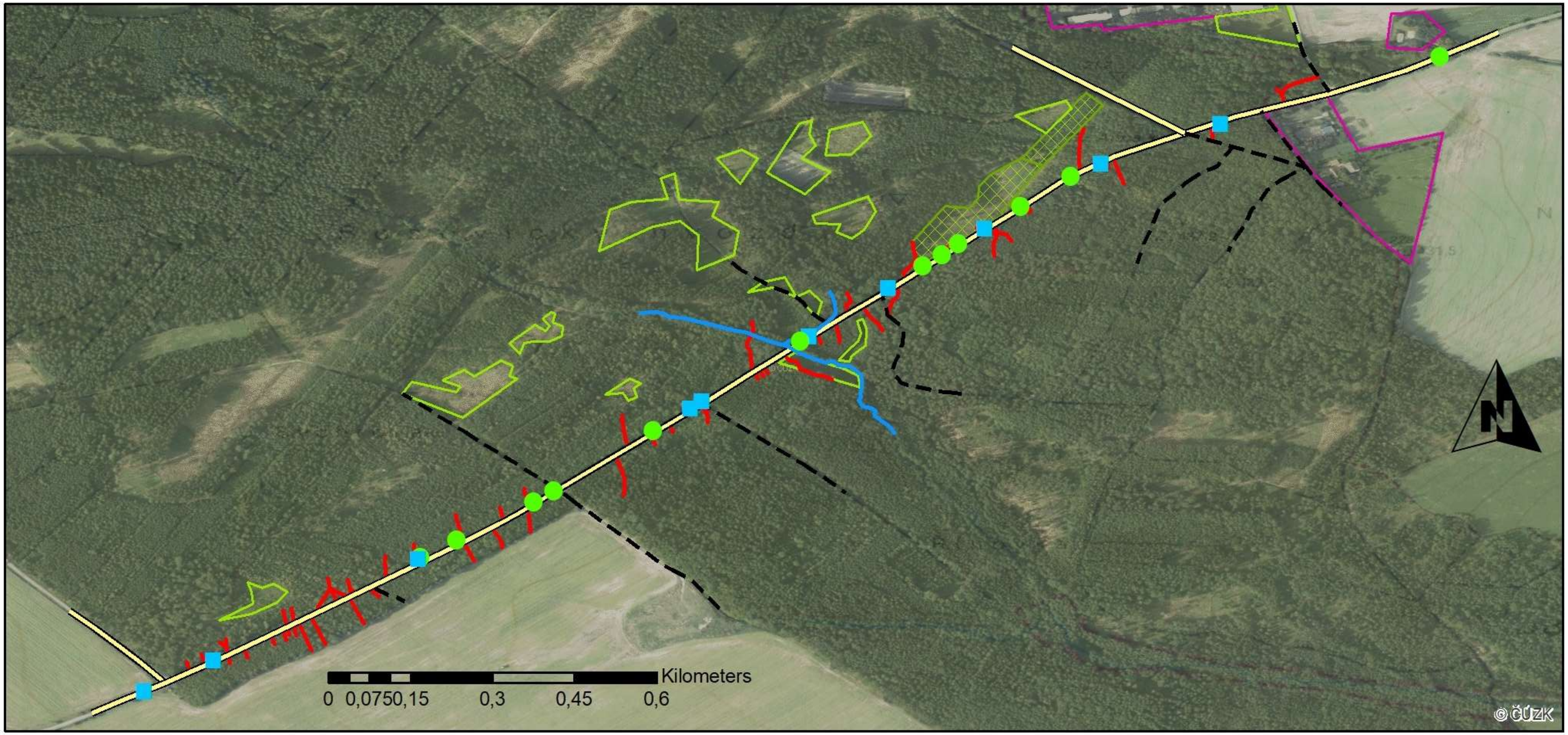


Figure 8. Location 2.

and one trail was found on the opposite side of the human pathway.

In the part 3 were on northern side 2 connected trails following border between high forest and plantage. Into the plantage were heading 8 trails, which after short distance disappeared there. One trail was continuing across the road, where the trail splitted into 2. Further to east were another 6 trails perpendicular to the road.

In the part 4 were 2 trails heading from the road, joining the human pathways.

5.2.3. Location 3 (Figure 9)

In the part 1 alongside the road was on both sides shrubbery and low tree lines with meadows behind. Northern side of part 2 was created by shrubbery and low tree forest and enclosure for farm animals, southern side was created by tree line with meadow behind and shrubbery and low tree forest. Part 3 was created in the north by meadows and in the south by shrubbery and gas station with enlarged hard shoulder. Part 4 was created in north by mixed forest on both sides, with crash barrier on the northern side of the road.

In the part 1 and 2 trails were very dense. There was parallel trail to road behind and in the vegetation stripes on both sides of the road in part 1 and southern side of part 2. From the parallel trails in part 1 and 2 were going perpendicularly to the road on both side, some of them connecting on the opposite side of the road. In southern side‘ meadow, 2 trails were going up the slope into shrubbery behind the meadow. At the end of part 1, were trails following edge of shrubbery and forest.

In the part 2 was found 1 trail heading from the shrubbery towards the road.

Between part 2 and 3 was 1 trail following side of enclosure and continued across the road into the forest.

In the part 3 were no visible trails.

In the part 3 were found 3 trails in the northern side, 2 of them, on the edge of the forest, were connecting into 1 and continued across the road where was only eruded side bank of slope.

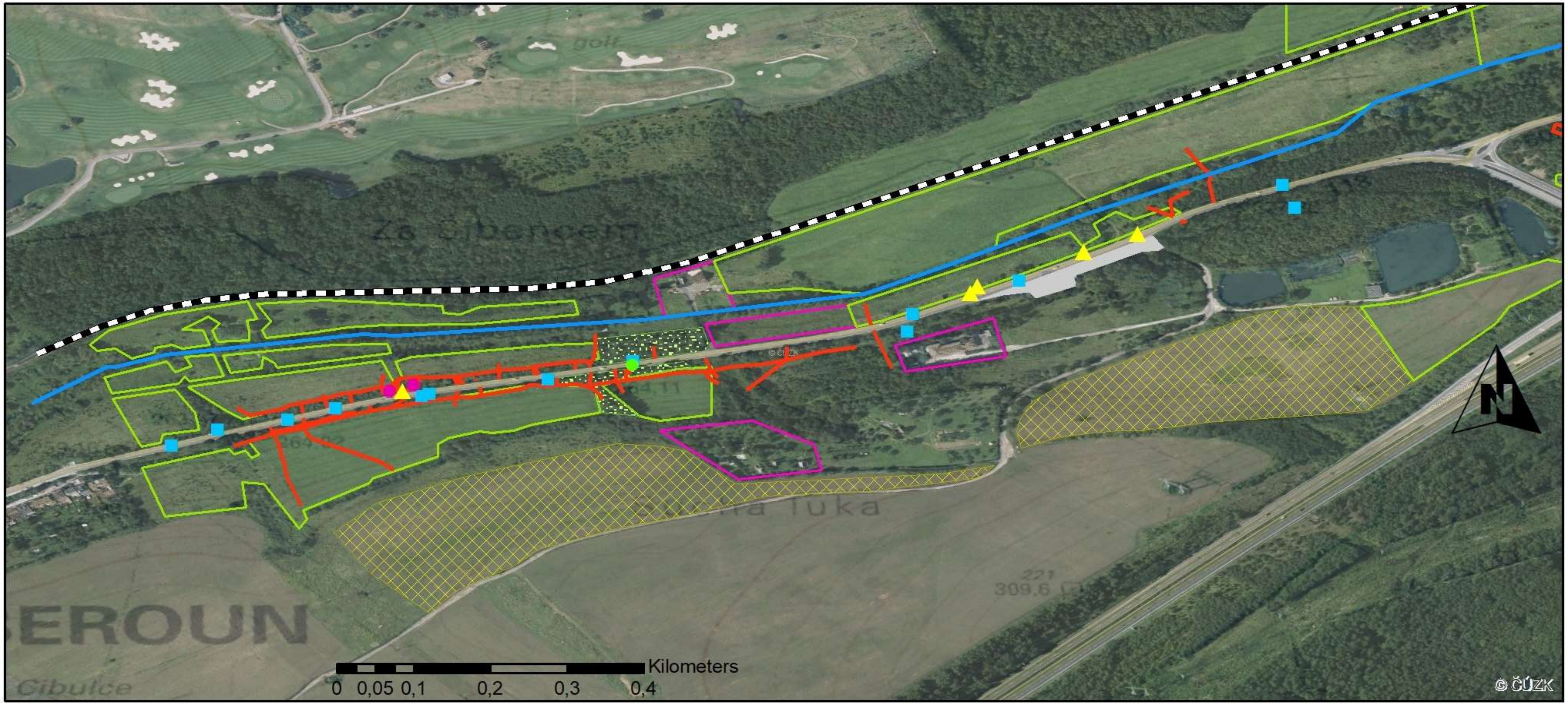


Figure 9. Location 3.

Trails of the game · Stream · Fenced land · Meadow · Hard shoulder · Field · Shrubbery · Roe deer · Other · Wild boar · Bird

5.2.4. Location 4 (Figure 10)

Northern side of part 1 was created by mixed forest and behind enlarged hard shoulder was early successional growth of young trees. Southern side of part 1 was created by coniferous forest passing into mixed forest. In part 2 the road was going through the managed meadows with individual low trees on both sides. Behind the meadow in northern side was railway, in southern side was forest stripe with highway behind.

In part 1 were found 7 trails, 2 in the southern side in coniferous forest going down the hill to the road, 4 in the northern early successional forest, from which 2 connected 1 (of 2) on the opposite side of the road in the mixed forest.

In part 2 was found in north 1 trail following the border of young forest. Another trail was found about 40 meters far, consisting of 3 ways connecting into 1, crossing the road and loosing in the meadow. Last third trail, was found about 100 meters far from the forest edge, was short length in trampled vegetation on both side of the road.

5.2.5. Location 5 (Figure 11)

Within the southern side of the road was parallel highway in close distance. Part 1 was open from the south by grassland and behind the highway by field and from the north by grassland and field. Northern side was created by forest in the part 2, and by shrubbery band in part 3 with field behind. The southern side of part 2 and 3 was created by crash barrier and grass and forest stripe following stream behind. Southerly from the highway in part 2 was field and in part 3 were noise barrier with fenced land and houses behind.

In the part 1, there were found 2 following up trails across the road. They were visible on both side of the road in the high grass.

In the part 2 was found 1 trail on the northern side of the road next to the bridge. On the northern side of the road

No visible trails were found in part 3.

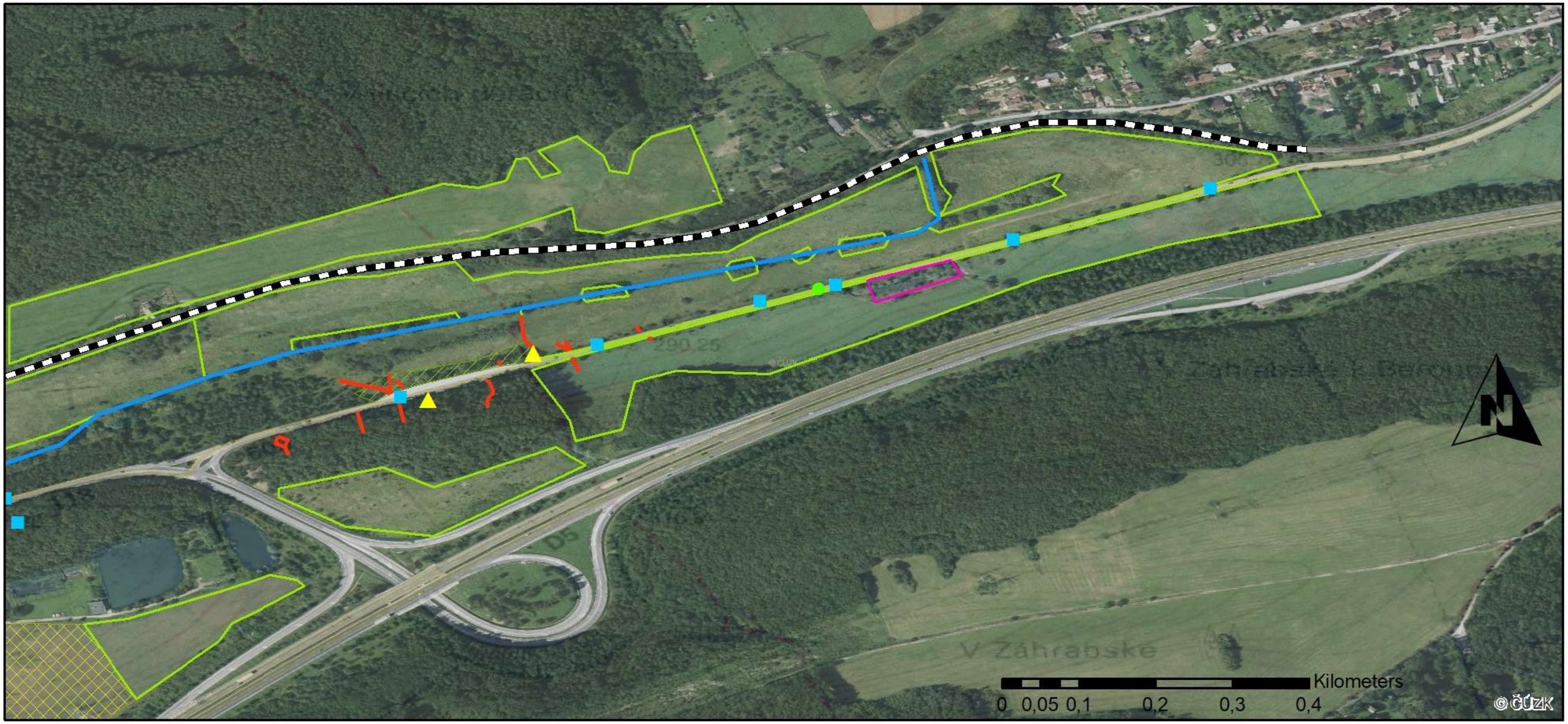


Figure 10. Location 4.

Trails of the game
Stream
Fenced land
Meadow
Hard shoulder
Field
Early successional forest
Roe deer
Other
Bird

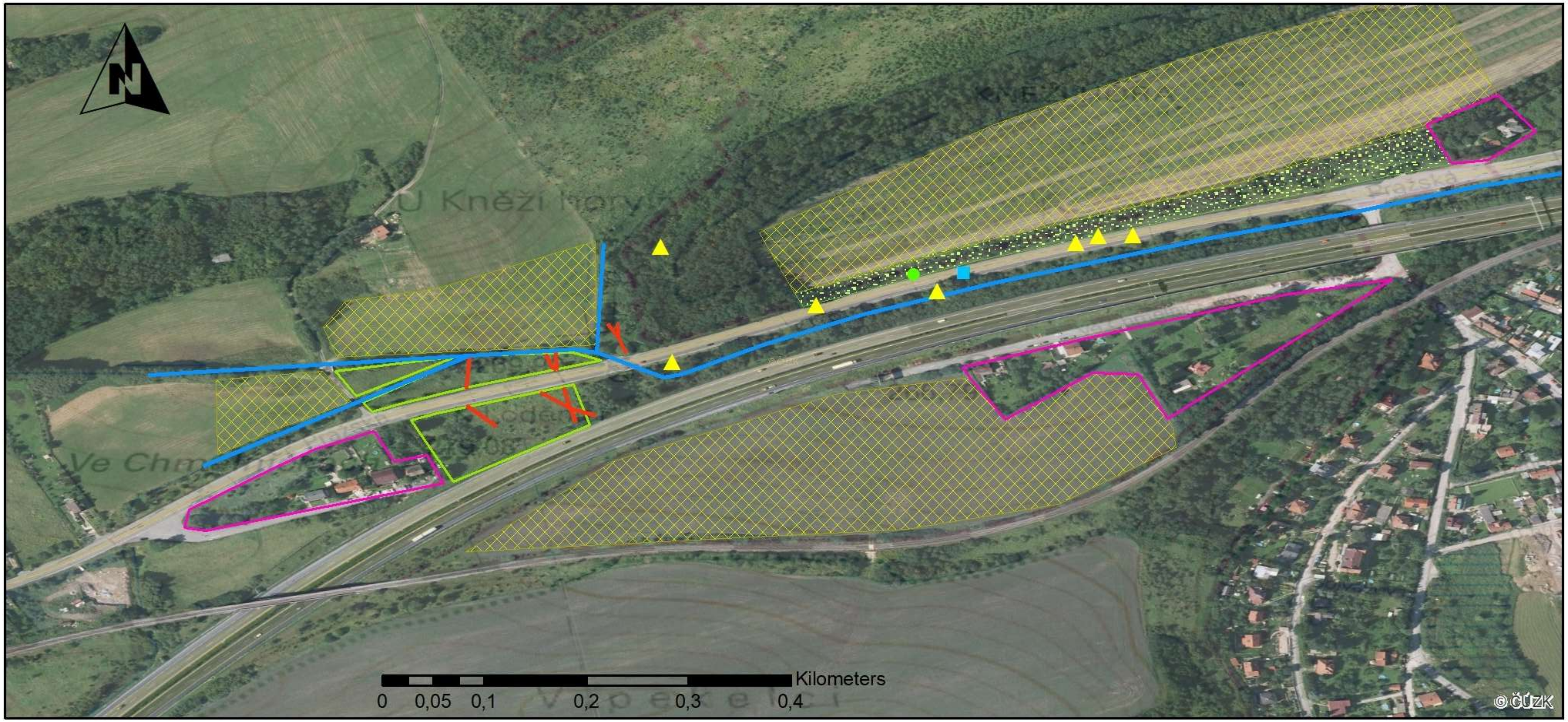


Figure 11. Location 5.

Trails of the game
Stream
Fenced land
Meadow
Field
Shrubbery
Roe deer
Other
Bird

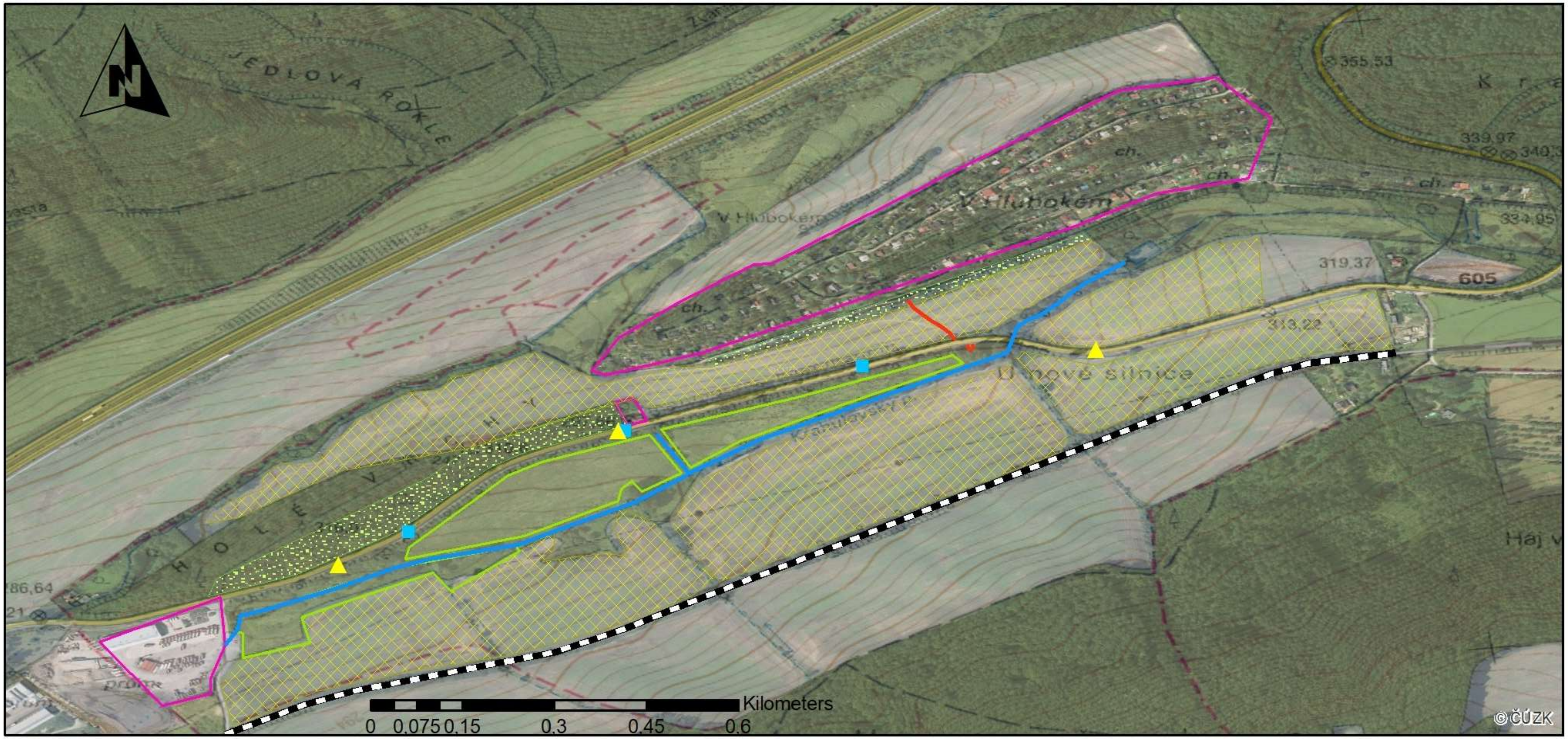


Figure 12. Location 6.

Trails of the game
Stream
Fenced land
Meadow
Field
Shrubbery
Other
Bird

5.2.6. Location 6 (Figure 12)

In southern side of the road were managed meadows, fields and railway, in northern side were shrubbery and forest, fields, summer houses recreation colony and highway. Alongside the road in part 1 was in northern side wide shrubbery stripes passing into trees. In southern side of part 1 was crash barrier with narrow tree stripes behind. In part 2 were on northern side of the road tree line, on the south of the road was forest stripe. In part 3 the road was going through the fields.

At the end of second part, there was only one trail found, thanks to the observation of roe deer. The trail was heading from summer houses recreation colony and continued across the road. This trail was using man created entrance to the field for farmers on northern side.

No visible trails were found in the part 1 and 3.

5.3. Effect of trails

The summarization table for quantum of trails (length in metres) in radius of 25 metres of each WVC, see Table 4, where each WVC has recorded GPS location, species (group), length of trails and location.

6. Discussion

Reason for choosing spring and autumn time for data collection in field was for the known fact of higher wildlife activity correlating with higher occurence of WVC (Bíl et al., 2017, Kušta et al., 2014). The advantage of personal checks was more detailed search, when during them were discovered much more smaller dead animals than is recorded in web application srazenazver.cz (CDV, 2018), which contains only reported collision from police and volunteers. This can be related to the fact, that collision with smaller species oftenly stay unnoticed by drivers, or unreported, because their bodies do not do any or much damage to vehicles (PČR, 2018). The disadvantage was time demands. With combination of both data from personal checks and provided records there may be a problem of possible data duplication, due to difference in GPS recording device or technique or moving with the cadavers.

WVC were divided into 4 groups, due to amount of identified individuals of roe deers and wild boars. Birds were decided not to count into species, because majority of them could not be identified due to stage of cadaver (figure 18 in annex). Other group included rest of findings of variety of smaller species and body parts of unidentified species (Bíl et al., 2017).

Majority of WVC were found in location 2 and 3. From wildlife point of view it can be related to attractivity of habitat, habitat preference or presence of migration routes of certain species. Location 2 stands on the verge of bigger forest unit, and due to numbers of roe deer collisions, we can suppose that it is moving through this location from the surrounding open areas to cover (Putman, 1986, Anděl et al., 2005).

From the drivers point of view these locations are due open areas or high forest stands quite synoptical and most of drivers there do not see a reason to decrease vehicle speed (Hrouzek et al., 2015, Kušta et al., 2017).

The only WVC reduction measures was found in location 2 in a shape of application of wildlife odor repellents on trees alongside the road. Odor repellents has proven reduction of WVC up to circa 40% (Kušta et al., 2015). No traffic signs warning drivers of wildlife movement or reduce speed was found within road section in all locations.

It was supposed that within autumn after seasonal using, the trails will be well developed, thus visible. But during the time when the mapping of the trails was performed, the trails were not much visible. Most of the trails were traceable only within a few meters from road. We can refer it to the type of ground surfaces, when different ground surfaces restricted visibility and thus traceability of the trails, for example trampled trails in grass, leaves or ground. Vegetation also limited the visibility of trails by its stage. The vegetation in its end of vegetational phase was dry and withered, or in its start (due to changing climate) was growing with remnant from previous year. The presence of trails under deciduous trees, on the ground covered by leaves were proved by rutted surface. The trails on the clear ground surface under spruce forest in location 1 were not visible, due to absence of grounded flora or vegetation material, but because the eroded side bank (Figure 15 in annex) next to the road we were able to confirm frequent movement of the wildlife. Eroded road side bank also indicated start of trails in location 2 (Figure 16 in annex).

The presence of game (figure 14 in annex), their footprints and faeces helped with recognition whether the game is using and following human pathways in locations 1, 2 and 6.

Due to low profile of trails in shrubbery, and its density, it was not possible to follow them and map them. Only way used to map them was by sight.

The trails amount and visibility in comparison with aerial views differs. Aerial photos showed existence of bigger trails network than ground search, but it is limited only to open areas and may be inaccurate and possibly outdated.

The absence of trails in locations 5 and 6 can be referred to bad access, high number of barriers, and possible lack of attractivity for the wildlife.

The main hypothesis was that where there are more trails, there is more wildlife movement, thus higher chance for WVC occurrence at crossing with roads.

The highest density and common shape of trails could be found in location 1, part 3 and location 3, part 1 within tree and shrubbery lines parallel to the road, where the trail network consisted of parallel trails with the road and upright crossings. As Andrew (1990) or Hlaváč and Anděl (2001) described that individuals often follows the road till finds suitable place for crossing, this behaviour can stand behind trails shaping. But the number of WVC differs much between these two locations.

The other founded common shape of trails, across locations, were trails copying edge of two different vegetation type (forest and meadow) and following water streams (Bennett, 2003, Seiler and Folkeson, 2006).

Even though majority of WVC occured in the vicinity or "on" trails crossing roads, it was impossible to say whether trails have effect for occurence of WVC and finding hotspots of WVC, due to their low numbers and distribution. Over 50% (17) of other group collisions were with no trail present in radius of 25 m. Within roe deer occurence of WVC was almost equally divided into thirds, where 5 were with no trail in r = 25 m, 5 were close to the trails up to 25 m of length and 7 were with occurence of higher trail density. Both wild boars collision were close to each other and on place where density of trails was very high.

7. Conclusion

It is clear, that human infrastructure fragment landscape for many years and currently due to increasing transportation growth, these activities can not be stopped or even changed easily onto sustainable level of development from wildlife point of view. Wildlife always had its demands on habitat, and in present in most cases, under human influence in our landscape, lose by collisions with vehicles. Increasing quantum of wildlife vehicle collisions due to landscape fragmentation should be a prove for us to start soon or later adapt for the future development by taking more reduction measures for traffic safety and wildlife.

The aims of this work was to gather data about wildlife vehicle collisions and map trails of the game in 6 locations and prove whether the trails have any effect on occurence of wildlife vehicle collision.

Thanks the map output this work offers uniq view onto a shape of wildlife trails in the road vicinity in different areas.

However according to available data it was not possible to prove or decline the hypothesis whether quantity of trails have effect on occurence of wildlife vehicle collision.

For future studies it would be needed to gather more WVC data from time wider period and map trails in more or between linked areas. It would be interesting to compare game trails steadiness in sites after the long - term observation, for example whether the trails path are different or stable during the seasons with snow cover.

8. Refferences

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9. Annex

Figure 13. GPS recording device and founded cadaver of bird.

Figure 14. Roe deer after crossing the road, location 2.

Figure 15. Eroded road side bank, location 1.

Figure 16. Eroded road side bank with linked trail, location 2.

Figure 17. Example of trails, location 3, part 1.

Figure 18. Example of unidentified bird.

Figure 19. Young wild boar founded alongside the road, location 3.