Hnutí DUHA
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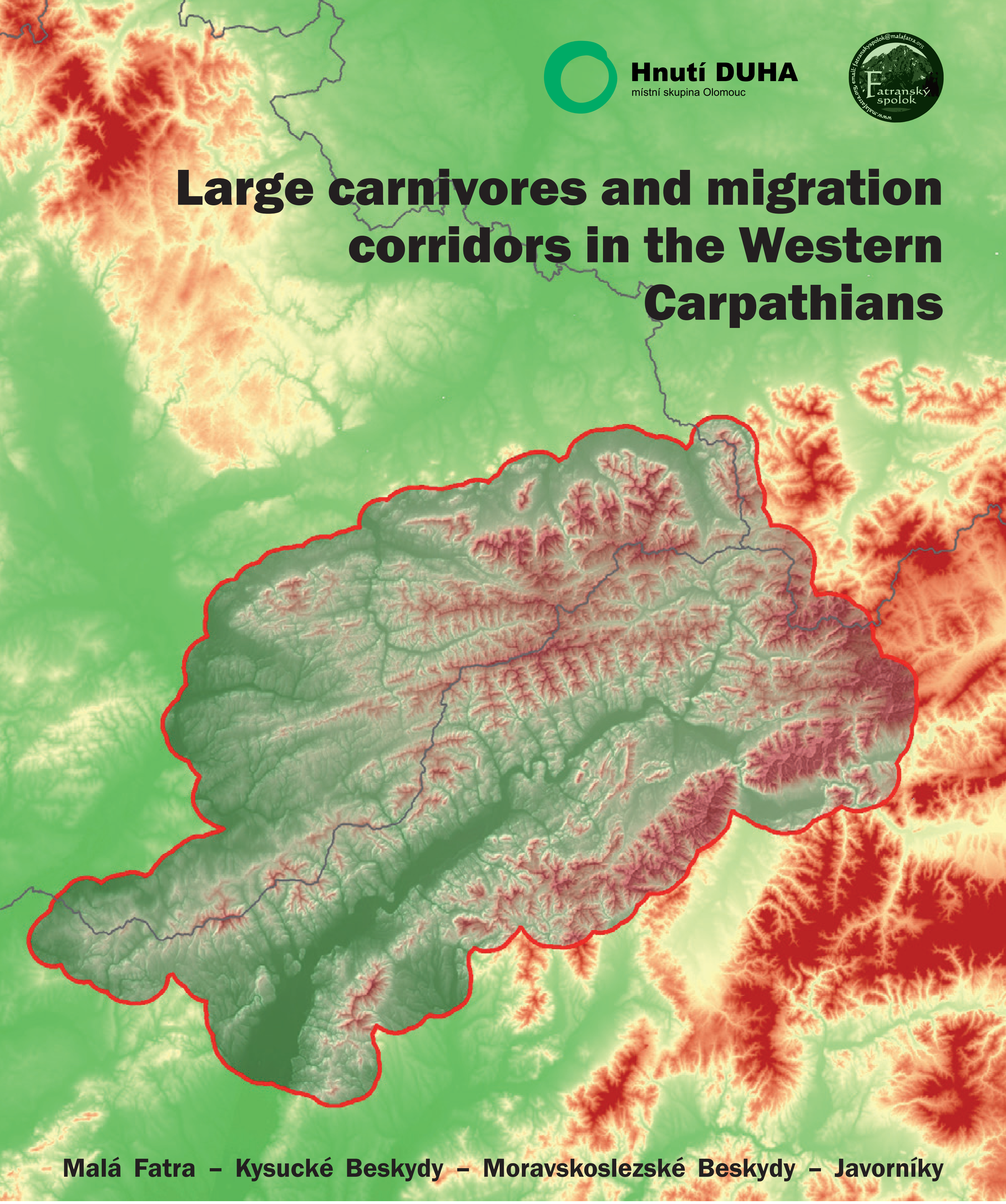
Fatranský spolok



Large carnivores and migration corridors in the Western Carpathians

Malá Fatra – Kysucké Beskydy – Moravskoslezské Beskydy – Javorníky

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Content

Preface...

Wolves, lynxes and bears –these beasts used to be symbols for unbound wilderness, today they rather show how adaptable wild animals are to life in the country inhabited and used by people, as it is the case on the present western edge of the Carpathian mountains. Their small populations inhabit large areas regardless of state borders. The country is more and more densely built up and the area available to the animals capable of at least a certain degree of adaptation is getting smaller and smaller.

Hnutí DUHA Olomouc and the Fatranský spolok worked together on a cross-border project “Protection of large carnivores and migration corridors in the Western Carpathians” during 2011 – 2012, which was supported by the International Visegrad Fund and partially by the Swiss-Czech Cooperation Programme and the European Outdoor Conservation Association.

The aim of the project was to monitor the presence and movement of large carnivores on the Czech and Slovak side of the Beskydy and Javorníky Mountains and the connecting Western Slovak mountain ridges. Apart from the number and location of large carnivores we also analysed their biotope demands and how permeable the country is, the permeability of selected roads, road mortality and how much the migration corridors are used in the model area around Jablunkov. The project also included educational seminars on monitoring of large carnivores for volunteers and the publication of information materials for the public which are also available on www.selmy.cz.

This proceedings summarises the findings of a one-year monitoring of carnivores including the identification of important migration locations. The exact description of all identified corridors is included in the Czech-Slovak version only, released a year earlier. Nevertheless, one year in which the project ran is too short a time for a detailed mapping of the whole large area and for an analysis of all the factors which influence the migration of large carnivores. That is why we also used monitoring data collected over a longer time period. Despite great time and financial limitations the results provide a complex picture of the current findings from the region and identify the important problems which need solving before time is up. Bad decisions in region planning or building permits which make the country impermeable or very dangerous for animals may have fatal impacts especially for the populations of large carnivores on the margins of the area.

The publication should help building authorities, nature protection authorities and experts from the Czech and Slovak Republics with the creation of new building plans and with the evaluation of various building plans including new road and railway infrastructure. The aim is not to limit the development of municipalities but to preserve or renew ecological balance and stability in the country which also depends on sufficient permeability, necessary for the largest representatives of our fauna.

To conclude we would like to thank the national nature preservation authorities – the management of the Beskydy and Kysuce Protected Landscape Areas (PLA) and the Malá Fatra National Park – and also all the volunteers who have contributed to a great degree to the unveiling of life of endangered large carnivores and thus to their protection through their selfless help with terrain monitoring.

Miroslav Kutal,
Hnutí DUHA Olomouc

Michal Kalaš,
Fatranský spolok

Landscape genetics of the grey wolf in the Western Carpathian Mountains

Pavel Hulva, Barbora Bolfíková, Jana Říhová, Milena Smetanová & Miroslav Kutal

Introduction

The grey wolf *(Canis lupus)* is one of the few large mammal predators which have survived the extinction of glacial megafauna at the end of the Pleistocene. Large carnivores belong to animals with a large spatial activity, which is reflected in their interesting phylogeographical history and also genetic structure of their populations. The original grey wolf range involves most of the northern hemisphere and thanks to intense gene flow the individual populations are genetically very similar (Hofreiter et al. 2004). There is evidence for two genetic lineages distributed in both American and Eurasian part of the range from the Quaternary period, marked as haplogroups I and II, which is the result of the connection of both continents by a continental land bridge which arose as a consequence of the world ocean level fluctuations caused by the ice ages (Leonard et al. 2007; Pilot et al. 2010). It is interesting that the representatives of the haplogroup II do not occur in North America nowadays. As the evidence based on the skull and teeth morphology and radioisotope data show, the members of this line from the Beringia specialized in the hunting of representatives of the glacial megafauna (e.g. horses or bisons) and disappeared in the connection with its extinction and were replaced at the present time by wolves of the haplogroup I which probably have different ecological requirements (Leonard et al. 2007). Both lines survived in Eurasia until present day, the representatives of the haplogroup II occur on the Italian Peninsula and the nearby regions and in Eastern Europe including the Carpathian Mountains (Pilot et al. 2010). The data on the current ecological requirements of these lines in Eurasia are not complete, yet a study on the Pleistocene wolves in Belgium proved a similar consistence of the prey (horses, largebovids) as in Beringia (Mech&Peterson 2003). Interestingly enough both lines meet in the Carpathian area. The aim of our study is to provide data about the genealogical structure, spatial behaviour, country genetics and the impact of the anthropogenic changes of the landscape on the population of the grey wolf in the Western Carpathians.

Material and methods

Samples of faeces, fur and also tissues from traffic casualties were collected in the Western Carpathians (Oravská Magura, Kysucké Beskydy, Moravskoslezské Beskydy and Nízké Tatry) in 2006 and 2010-2012 in cooperation with the Wolf Patrols and the Fatranský spolok volunteers. The samples were preserved in pure ethanol and kept at the temperature of -20°C after the transport to the laboratory. Samples of excrements from the Prague ZOO were used as a referential genetic material of the grey wolf with a verified species identification. Because the samples acquired in a non-invasive way may also be of dog origin, apart from the fact that hybridization between the wild and domestic forms may occur in nature, samples of German Shepherd dogs and Czechoslovakian wolfdogs derived from the buccal swabs were used. The genomic DNA was isolated using the QIAamp DNA Stool Mini Kit (Qiagen) or the DNA Blood and Tissue Kit (Qiagen). Nuclear microsatellites, i.e. sections of the DNA consisting of short tandem repeats(most often consisting of 2-4 base pairs motifs), were used as genetic markers for this study. The corresponding loci have high length variability in natural populations and are thus suitable for analysing the population structure, genealogical relations and individual identification. We used Canine Genotypes™ Panel 1.1 (Finnzymes) which contains 19 microsatellite loci. The kit also contains primers for the amplification of amelogenin, the nuclear gene with different length variants on the X and Y chromosomes and can thus be used for the identification of the sex. We obtained the basic view on the population structure from the resultant genotype data with the aid of the Structure 2.3.3 Programme (Pritchard et al. 2000; Falush et al. 2003). Further we used the landscape genetics approach which enables to study the genetic variability in the context of the geographic situation (Manel et al. 2003), and we analysed the acquired genotypes in the Geneland programme (Guillot et al. 2005).

Results and discussion

The preliminary analysis unveiled 20 individuals of the grey wolf in the processed part of the material. Some individuals were sampled twice, which indicates a large spatial activity of the members of the studied species and is a common result when using the non-invasive genetic sampling in populations of large carnivores. An interesting result is the verification of the species identification with the scat from November 2006 from the Vsetínské vrchy and in the case of a young wolf female hit by a car on the road near Krhová in proximity of Valašské Meziříčí on July 8th 2012 (Fig. 1). Although the data of the wolves occurrence in the Beskydy Mountains have become more frequent since the second half of the 1990s compared to previous decades (e.g. Anděra et al. (2004) mentions the permanent residence of 2-3 wolf packs in the Beskydy during 2000-2003), a really verified piece of evidence of a recent occurrence in this area (photograph, finding of a dead animal or a genetic analysis) has not been published yet (Anděra & Červený 2009). Here we present the first direct evidence of the grey wolf occurrence in the Beskydy area since 1914, when the last shooting near Bukovec was documented (Hošek 1976).

Fig. 1: *A young wolf female hit by a car on the road near Krhová near Valašské Meziříčí on July 8th 2012. (Photo: Michal Bojda).*

The analysis of the whole dataset does not indicate substantial introgression of a dog DNA in the genotypes of the West-Carpathian wolves and so it can be assumed that currently there is not much cross-breeding of dogs and wolves in this area. Analyses of further loci which could make these results more precise are carried out in the present. The sex ratio was balanced in the analysed samples which does not indicate significant sex differences in the dispersal within the analysed area (and is contrary to the theoretical assumption of a higher philopatry of the females typical for mammals). Analyses in the Structure programme indicate a differentiation of population in the analysed area (Fig. 2).

However, members of individual subpopulations are not geographically localized (Fig. 3). Such a result indicates a differentiation of the population as a consequence of the genealogical (pack) structure rather than due to the geographical isolation. It can then be assumed that the dispersal within the area is not substantially limited and that the fragmentation of the landscape is not the main factor influencing the structuring of population of the grey wolf in the area of the Western Carpathians so far. This corresponds with the supposed high movement ability of the grey wolf in various types of terrain (Randi 2011). Similar results were gathered also in the Polish Carpathians (Gula et al. 2009). The higher movement rate can also be the result of animal disturbance, problems with finding of a suitable environment, source-sink dynamics caused by shooting and other anthropogenic factors. The detected population structure may point to the ecotypes phenomenon in the analysed species. In the grey wolf, a relatively significant correlation between the genetic variability and the environment type was found, which indicates an adaptive response of the individual populations to the environmental conditions (Pilot et al. 2006; Musiani et al. 2007). A specialization of individual genealogical lines to different types of prey is also possible (Carmichael et al. 2001). The Carpathian region is relatively sparsely investigated from this point of view and can also serve as a bridge and a dispersal corridor between the East-European and Balkan populations. Additionally, wolves of both haplogroups can meet in this region, which offers further options for the enlargement of the genetic variability. An analysis of a larger number of samples together with using other (mainly mitochondrial) markers may give precision to these hypotheses in the future. The comparison to other populations may also help to analyse the effect of the range edge, fragmentation of peripheral populations, metapopulation dynamics and the role of other factors in shaping patterns of genetic structure in the grey wolf.

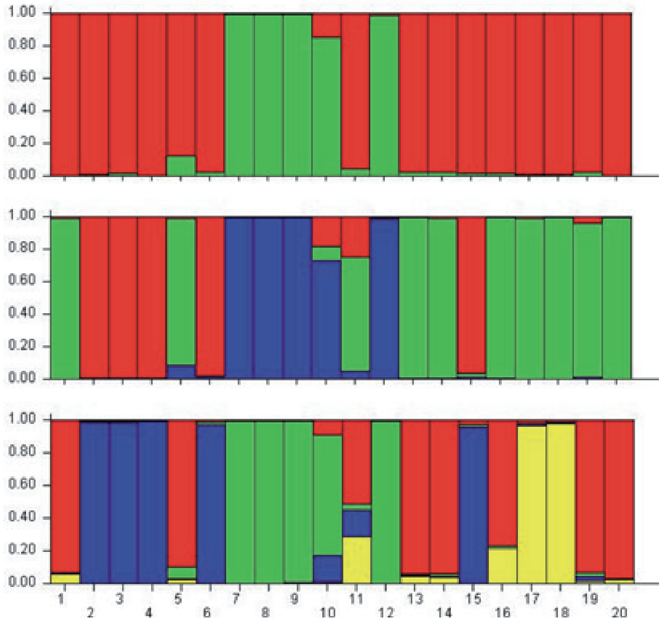

Fig. 2: *The result of the Bayesian clustering in the Structure programme. Each individual is represented by a vertical column divided into K colour segments. K is a beforehand defined number of subpopulations (here K=2-4), the height of segments corresponds to the posterior probability of membership in the given subpopulation.*

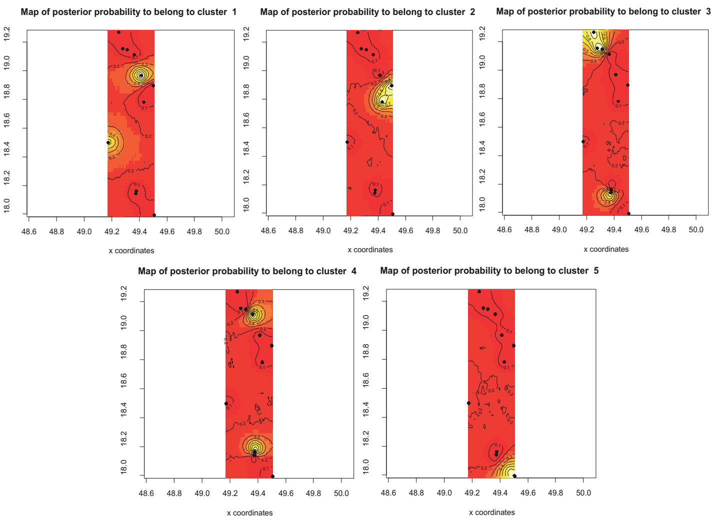

Fig. 3: *The result of the analysis in the Geneland programme. In the particular maps individuals with similar genotype are marked (yellow). The programme found five subpopulations (probably animals with family relationships.*

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The impact of traffic on the brown bear *(Ursus arctos)* population in Malá Fatra

Michal Kalaš

Introduction

The car and railway traffic represents a factor which negatively affects the population of the brown bear in Slovakia. In the area of the Malá Fatra National Park traffic caused more than a quarter of the overall mortality during 1997-2010 (Kalaš 2010a, 2010b). Apart from the direct mortality there is also the question of a barrier effect which is caused by the development of the traffic and residential infrastructure. This contribution is the actualisation of the author's text from 2011 (Kalaš 2011).

Demarcation of the model area

The Malá Fatra National Park lies in the north-west part of Slovakia. It also spreads to the Žilina, Martin and Dolný Kubín counties. It is a part of an orographic complex of the same name, where it takes up its higher, Kriváň part, which lies on the right side of the Váh river. The area comprises 223 km². In the square net of the Fauna databank of Slovakia (DFS) it lies in the following squares: 6779, 6780, 6781, 6881, 6880, 6879, 6979.

With regard to the geographical position the Malá Fatra NP represents an extraordinarily important area with the presence of bears which enables the spreading of the species in the NW and SW direction into the Kysucká vrchovina and the Kysucké Beskydy or the Strážnické vrchy. The Javorníky and Moravsko-Slezské Beskydy mountains are further connected to these orographic complexes.

Traffic infrastructur

The roads and the railway are situated in the 0,1-3,3 km interval from the border of the MaláFatra National Park (Fig. 1). The intensity of the traffic and the localisation of the traffic corridors itself reflect the various rate of the barrier effect and consequently the direct mortality of animals. One of the most problematic is the national road I/18 (E 50). The segment between Žilina and Kraľovany is approximately 42,5 km long with an average traffic intensity 25 000 vehicles / 24 hours (data from the national traffic census in 2010). This segment includes several important collision spots in the cadastre areas Strečno, Vrútky, Turany and Ratkovo.

Significantly less frequented is the road II/583 which leads from the Párnica village northwards to Zázrivá, where it continues westwards through the Terchová village to Žilina. The route is 48 km long. From the mortality perspective, the road I/70 from the Kraľovany village to the Párnica village in Orava is less important. This segment is 8,5 km long.

From the west all through the southern foothills goes an electrified two-track railway route from Žilina to Kraľovany, approximately 41 km long. Extraordinarily critical points are in the cadastre areas Nezbudská Lúčka and Strečno.

Fig. 1: *An overview of traffic collisions with the brown bears (Ursus arctos L.) in the broader area of the Malá Fatra National Park during 1997-2012 (n=26).*

Results

In the not very distant past (second half of the 20th century) the traffic did not representa significantly negative factor for the population of the brown bear in the monitored area. From the 1980s we know only of two cases of collision in the cadastre area of Párnica. One was on the railway but the other case is more interesting because the bear was hit on a forest road. This also reflects the fact that even less frequented roads may be lethally dangerous for the bears.

Collisions with bears

During 1997 – 2012 there were 26 collisions evidenced on the above specified roads and railways, during which 27 bears were hit altogether. Six of them were hit on the railway and the others on the roads (Fig. 2). From the overall number 21 pieces were killed, six were not found after the collision. Although their later death cannot be excluded, the statistics showing the ratio of individuals killed in various ways (Fig. 3) take into account only the verified number of killed animals. In the case of traffic this means 21 pieces (Table 1).

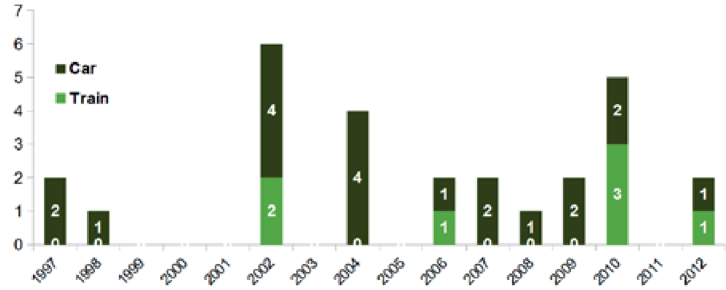

Fig. 2: *An overview of the brown bears (Ursus arctos L.) hit in the broader area of the Malá Fatra National Park and its protection area during 1997 – 2012 (n = 27).*

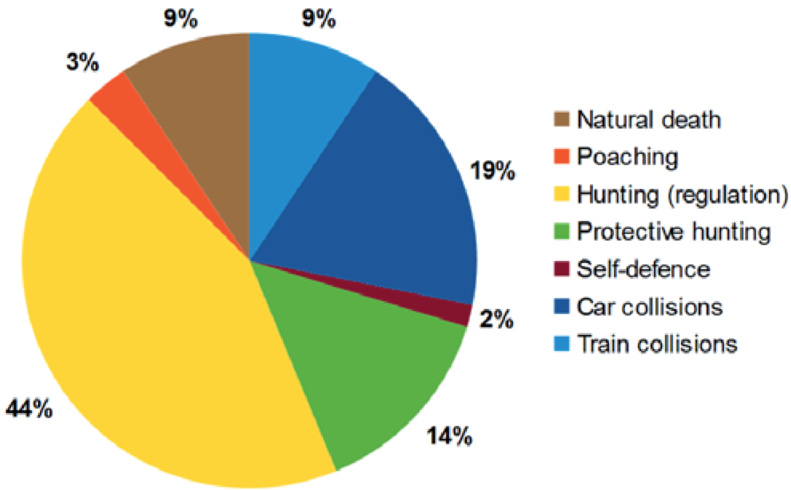

Fig. 3: *The proportion of traffic collisions within the overall known mortality of the brown bear (Ursus arctos) in the broader area of the Malá Fatra National Park during 1999 – 2012 (n = 64).*

Number	Year	Sex	Weight in kg	Age	Kind of vehicle	Road / Railway	Cadastre area	Number of killed animals
1	11/1997	-	-	-	car	I/18	Belá	1
2	1997	-	-	3	car	I/18	Ratkovo / Turany	1
3	1998	♀	60	10	car	I/18	Turany	1
4	2002	♀	80	8	train	railway	Nezbudská Lúčka	1
5	9/2002	♀	65	4	car	I/18	Vrútky	1
6	2002	-	-	-	train	railway	Turany	1
7	2002	-	-	-	car	I/18	Ratkovo	1
8	2002	-	-	-	car	I/18	Turany	1
9	2002	-	-	-	car	I/18	Ratkovo/Turany	1
10	4/2004	♂	215	› 10	car	I/18	Vrútky	1
11	9/2004	♂	270	› 10	car	I/18	Turany	1
12	10/2004	-	25	1	car	I/70	Párnica	1
13	10/2004	♀	140	-	car	I/18	Turany	1
14	8/2006	-	200	-	car	I/18	Strečno	not found
15	12/2006	-	-	-	train	railway	Strečno	not found
16	5/2007	-	60 - 80	-	car	I/18	Strečno	not found
17	6/2007	♂	45	2	car	I/18	Ratkovo	1
18	9/2008	-	60	-	car	I/18	Turany	not found
19	8/2009	♀	70	3 - 4	car	I/18	Strečno	1
20	8/2009	♂	100	5	car	I/18	Strečno	1
21	6/2010	♂	50	2	train	railway	Nezbudská Lúčka	1
22	8/2010	♂	92	5	car	II/583	Párnica	1
23	9/2010	♀	-	-	car	I/18	Turany	not found
24	10/2010	♀, ♂	30	1	train	railway	Vrútky	2
25	8/2012	?	80 – 100*	?	car	II/583	Stráža	not found
26	9/2012	♀	80	3 - 4	train	railway	Nezbudská Lúčka	1
Together		**8 ♀, 7♂**			**20 A, 6 V**			**21**

Tab. 1: *A summary overview of the traffic collisions with the brown bear (Ursus arctos L.) in the broader area of the Malá Fatra National Park during 1997 – 2012 (n = 26).*

Fig. 4: A two-year-old bear hit on the railway in the c.a. Nezbudská Lúčka in 2010. Photo by M. Kalaš.

Bears were usually killed by one, but in October 2010 a train killed simultaneously two bear cubs. This is the first known case. It happened in the cadastre area Vrútky. The number of collisions where the hit bear was not found is relatively high. Five times it was a bear hit by a car (c.a. Turany in September 2010 and September 2008, Strečno May 2007 and August 2006, Stráža August 2012), once a bear hit by a train (c.a. Strečno December 2006).

The last case of a bear hit by a car where the bear was not found after the collision happened in the c.a. Stráža on the 29th of August in 2012. The bear walked out of the plant cover on the side of the road and headed towards the foothills of the Malá Fatra. The driver hit it with the front part of the car. Because the situation was very serious, he did not notice to which side of the road the bear disappeared after the collision. The fur found on the body of the car identified that it really was a bear. There were two fields of corn in that area at the time. Bears used to visit them frequently which was established based on the residential signs and direct sightings of individuals, but also by a telemetric monitoring of an approximately 5-6 years old male.

Another case from 2012 with fatal consequences happened in the c.a. Nezbudská Lúčka where a train killed an approximately 4-year-old bear female. It happened in the night hours only several hundred metres from the case from 2010 (Fig. 4).

In August 2010 at 19:45 two personal cars hit a 92-kg bear male in the c.a. Párnica on the II/583 road. The approximately 5-year-old bear could not get up after the collision. Using his front paws he managed to crawl several metres away from the road where he was then shot dead. Later it was verified that his pelvic bone was broken.

Year 2004 was significant for the traffic mortality, as the most physically developed bears in the region were killed. In April of that year a male of 215 kg was killed in the c.a. Vrútky on the I/18 road. In September another large bear (270 kg) was killed on the same road but in a different part, in the c.a. Turany.

The weight, age and sex structure of the killed bears

The weight was established in 15 cases, although mostly only by estimate (Fig. 5). The smallest was a bear cub in the first year of its life hit on the I/70 road in the c.a. Párnica. It weighed 25 kg. The heaviest bear weighed the mentioned 270 kg. Similarly incomplete are the data regarding the age, but it can be said that younger animals were killed more often. A more accurate ratio is presented in fig. 6. The sex was verified also in 15 cases. There were 7 males and 8 females killed.

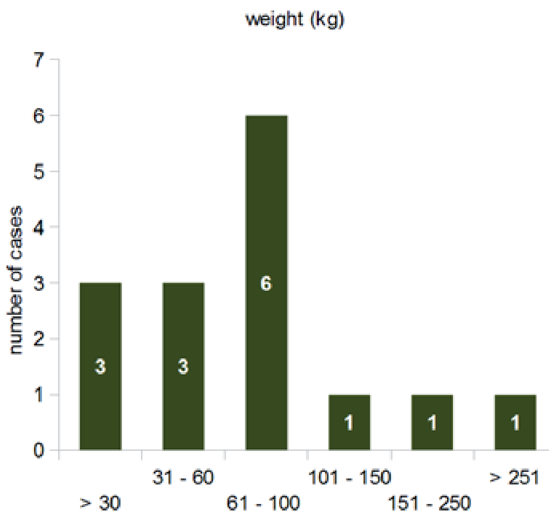

Fig. 5: The weight structure of the brown bear (Ursus arctos) killed by traffic in the broader area of the Malá Fatra National Park during 1997 – 2012 (n = 15).

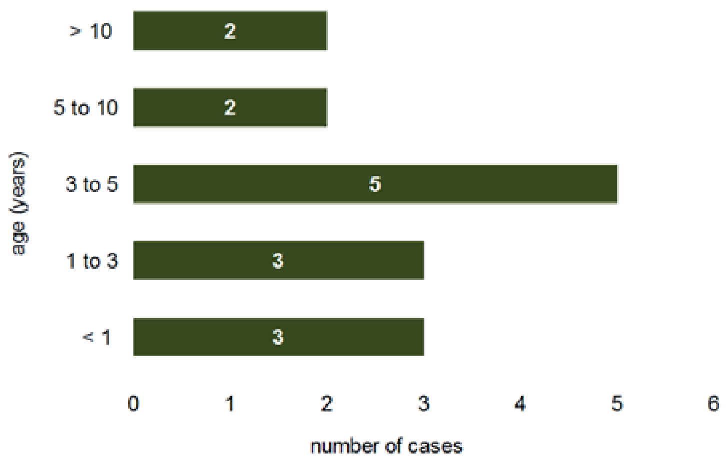

Fig. 6: An overview of the age structure of the brown bear (Ursus arctos) killed by traffic in the broader area of the Malá Fatra National Park during 1997 – 2012 (n = 15).

Time and space specifications of the collisions and the supposed causes of their occurrence

Several risk areas can be demarcated in the monitored area based on the frequency of the collision occurrence, where two of them are very important. There are different reasons why the traffic collisions take place there.

1. The south foothill area of the Malá Fatra NP. It is a cca 3,3 km long section of the I/18 road starting behind the bridging of the derivation canal of the Váh river in the Turany village, going south-east till the beginning of the retaining wall over the I/18 road near the Šútovská epigenéza Natural Monument in the c.a. Ratkovo. Another collision area lies cca 2,2 km in the south-west direction from the above mentioned bridging over the derivation canal in the c.a. Turany.

   From the described area we know of 11 collision cases, where 10 were collisions with car traffic and one with the railway. It is 42,3% of all known collisions from the Malá Fatra NP area and its broader surroundings. With reference to the time of the year, three collisions happened in September, one collision in June and one in October.

   In the described area in the south-east part of the Turčianska Kotlina there are large areas of agrocenoses where apart from others corn and wheat are grown. These crops are an important source of nutrition for bears during the ripening time, which contributes to an increased aggregation of the individuals of the species in question. Although one cannot eliminate the natural migration between the Malá Fatra and Velká Fatra mountains, a large proportion of the mortality will probably be due to bears' transfers to places with abundant and easily accessible food.

2. The Strečniansky prielom area: the cca 8,3 km long section of the I/18 road. This begins behind the rock of the Strečno castle and ends at the Dubná skala stone pit in the Martin county. 10 collisions have been reported from this region, four of which were caused by the railway.

   The area in question is very mountain –like without the presence of any larger agricultural fields (only small fields in the c.a. Nezbudská Lúčka) and it can be defined as exclusively migration corridor between the two parts of the orographic complex of Malá Fatra. The time references from this area are also more accurate. One of the collisions took place in April, one in May, one in June, three in August, two in September, one in October and one in December.

   Other 4 collisions were recorded individually in areas far from one another. In one case it was the I/70 road in the c.a. Párnica in October and three times the collision with a bear took place on the II/583 road in the c.a. Párnica (August), Belá (November) and Stráža (August).

Conclusion

The traffic mortality is an undesirable anthropogenic factor which significantly affects the local bear population. During 1999 -2012 there were at least 64 bears killed in this area, where 28% of the mortality cases were caused by the traffic. If we take into account all the hit and not found individuals, which most probably die later due to their injuries, then this number would reach an alarming 35%.

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Contribution on the collisions of the European Lynx *(Lynx lynx)* with car traffic

Michal Kalaš

Animal mortality caused by traffic has been very topical recently. The overview of all individual cases will never be complete; the smaller and less conspicuous species often pass unnoticed. Cases of collisions with the brown bear *(Ursus arctos)* (Kalaš, 2011a, Kalaš, this volume) and the Eurasian otter (Lutra lutra)(Kalaš, 2011b) are well documented in the area around the Malá Fatra. No complex data on the European lynx *(Lynx lynx)* from the northern part of Central Slovakia have been published. In the following part of my contribution I will therefore shortly outline the situation until now.

Collisions of cars withlynx are less frequent than with bears or the above mentioned otter. In the monitored area reaching to the Dolný Kubín, Martin and Žilina counties, there are 6 known cases (Tab. 1). They all happened in 2001 – 2012. Whereas with the above mentioned species there are several areas with a higher mortality rate, but at the same time quite a high number of places with rare collision spots, this does not apply to lynx. The so far recorded collisions of lynx are connected to three locations, two of which seem to be extraordinarily important with regard to the number of collisions, as altogether 5 lynx have died here (Fig. 1). Three cases happened in the c.a. Horný Hričov (Žilina county). Two of them (in 2001 and 2012) took place on the I/18 road (Fig. 2), one on the newly opened D1 motorway (in 2008). The locations were 80 – 150 m apart from one another. In the case of this area the last collision from September 2012 is very interesting. It happened on the I/18 road which suffered fromfar less traffic due to the opening of the new D1 motorway. The killing of a lynx took place despite the currently relatively low traffic rate. This lynx successfully crossed under the D1 motorway body (in the given section a part of the motorway stands on pillars), but it did not manage to cross the I/18 road. In 2008 in a relatively short time after the opening of D1, another lynx was killed directly on the motorway. The realised fencing of the motorway proved to be (as expected) insufficient means to prevent some animals from getting onto the body of the road.

Number	Cadastre	Country	Road	Year	Month	Sex	Age
1	Horný Hričov	Žilina	I/18	2001	July	?	subadult
2	Šútovo	Martin	I/18	2005	September	Male	subadult
3	Kraľovany	Dolný Kubín	I/18	2008	May	?	subadult
4	Horný Hričov	Žilina	D1	2008	May	?	subadult
5	Kraľovany	Dolný Kubín	I/18	2009	May	?	subadult
6	Horný Hričov	Žilina	I/18	2012	September	Male	adult

Tab. 1: *A summary overview of the traffic collisions with the European lynx (Lynx lynx) in the broader area of the Malá Fatra NP during 2001 – 2012.*

Regarding the number of killed animals another important area is the location in the Dolný Kubín county, in the c.a. Kraľovany, again on the national I/18 road. There were two collisions (in 2008 and 2009). Both cases happened in May and the killed animals were of approximately the same age.

Another case took place in Martin county, c.a. Šútovo. Similarly to the previous cases, this one also happened on the national I/18 road. The first and last mentioned spots (c.a. Horný Hričov and c.a. Šútovo) have a very similar spatial structure. In both cases there are frequented roads I/18, or the D1 motorway respectively (more than 20.000 vehicles in 24 hours), a two track railway (Košice – Bratislava), and also the Hričov and Krpeľany water reservoirs. Animal migration seems to be illogical here for these reasons (there are more ideal conditions not far away), yet animals do get killed here.

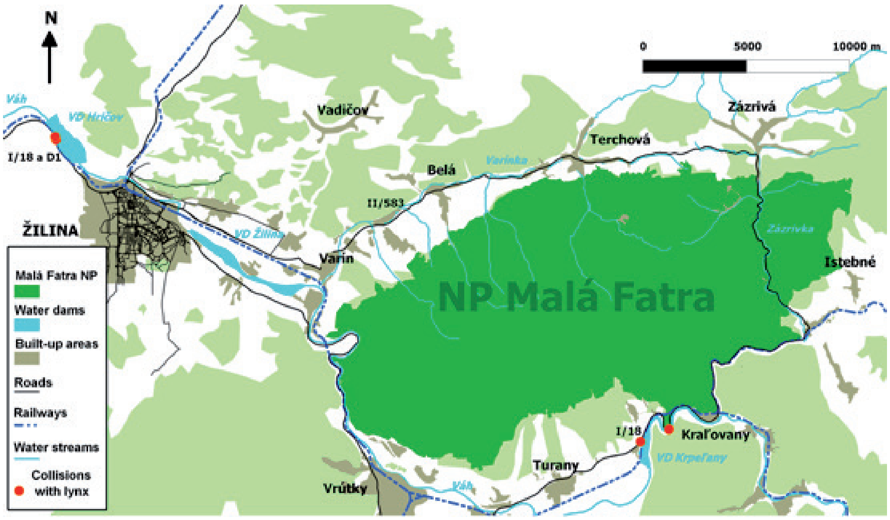

Fig. 1: *An overview of traffic collisions with the European lynx (Lynx lynx) in the broader area of the Malá Fatra NP during 2001 – 2012 (n = 6).*

An interesting finding is the age of the killed animals. Only in one case it was an adult lynx. Also interesting is the time period of most frequent collisions, which is the month of May.

Conclusion

This contribution has no ambition to provide exhaustive information on the given species in connection to traffic. For a more detailed analysis a broader set of data would have been necessary, as well as in the cases of the brown bear and European lynx. However, it pointed out cases which have taken place and which might become forgotten in time.

Fig. 2: *Lynx hit on the I/18 road in the c.a. Horný Hričov (Žilina county) in 2012.*

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The exploitation of migration corridors by large carnivores in the Jablunkov area

Tomáš Krajča

Introduction

The Jablunkovská brázda furrow separating the Silesian and Moravian Beskydy Mountains is an extraordinarily significant area for the migration of large mammals including protected species of large carnivores within the Czech Republic (Hlaváč & Anděl 2001). Yet due to a fast economic development the area is gradually built up and fragmented and the traffic on the I/11 road which goes through the valley is increased. Based on a landscape migration permeability analysis last two areas have been identified that are potentially usable by large mammals (Anděl et al. 2007, Anděl et al. 2010). This was confirmed by a detailed research in preceding years (Krajča & Kutal 2010). With regard to the considerably unsuitable environment for migration in the densely inhabited river Váh valley (Romportl et al., this volume), the selected area has an essential importance also for the migration of large mammals in the broader Western Carpathian area from the Malá Fatra and the Kysucké Beskydy Mountains westwards to the Czech Republic. The aim of this contribution is to summarize the results of monitoring of the exploitation of these corridors by large mammals The monitoring has been carried out in this area since 2007.

Methodology

The "Celnice" ("Custom-house") migration corridor is based in the town of Mosty u Jablunkova and consists mainly of forest complexes along the state border with Slovakia and at the spot of the former custom house it is directly intersected by the I/11 – a 1st class 4-lane highway. The other "Jablunkov" migration corridor (Fig. 1), which lies 7 km away, crosses the I/11 road under a 448 m long and 18 m high elevated road which by farmeets the requirements for the migration of large mammals (Anděl et al. 2006). Another barrier in this area is the international railway track no. 320 where there are two underpasses under the track in the axis of the two migration corridors – the two trapezoidunderpasses (Fig. 2) were completed here based on the suggestion of Hnutí DUHA and the Beskydy Protected Landscape Area Management in 2010 (Jablunkov) and 2012 (Celnice). They both consist of two individual one-track bridges of composite steel and concrete construction with the span of 32 m (Jablunkov) or 28 m (Celnice) and free height of 5 or 8,5 m respectively. The width of the underpasses on the terrain level is 20 (Jablunkov) and 15 m respectively. These parameters also theoretically enable migration of large mammals (Anděl et al. 2006). The monitoring of exploitation of migration corridors was carried out in the winter months during the time of continuous snow cover.

I monitored all the traces of large mammals on the transect drawn in each corridor parallel to the I/11 road. In the case of Jablunkov corridor the transect was drawn along the I/11 elevated road, on the Celnice corridor the transect was drawn on the western side of the railway embankment, 130-330 m from the road. To find the course of migration tracks in the corridor I also monitored footprint trails of roe deer outside the defined line transects and walked through larger environment to monitor residential sings of large carnivores in a greater distance from the road.

During five winter seasons (2007/2008–2011/2012) I carried out altogether 31 mapping visits. On the Jablunkov corridor I started monitoring in the season 2008/2009 and since the 2011/2012 season I have widened the monitoring to detecting footprint trails along the whole length of the forest free part of the corridor and to the area along the railway track in order to monitor the exploitation of the new underpass. I divided this transect to 7 parts based on the character of the terrain and the connection to forest: (1) under the railway bridge on the river bank, (2) edge of the forest and the high steep embankment, (3) connected forests from both sides, (4) connected forests from both sides and a slight embankment, (5) migration underpass, (6) forest (west) and the edge of the forest and field(east), (7) bushes (west) and forest (east). Apart from the absolute numbers of the footprint trails I evaluated also the relative exploitation of the individual parts converted to the equivalent of 10 metres of their length.

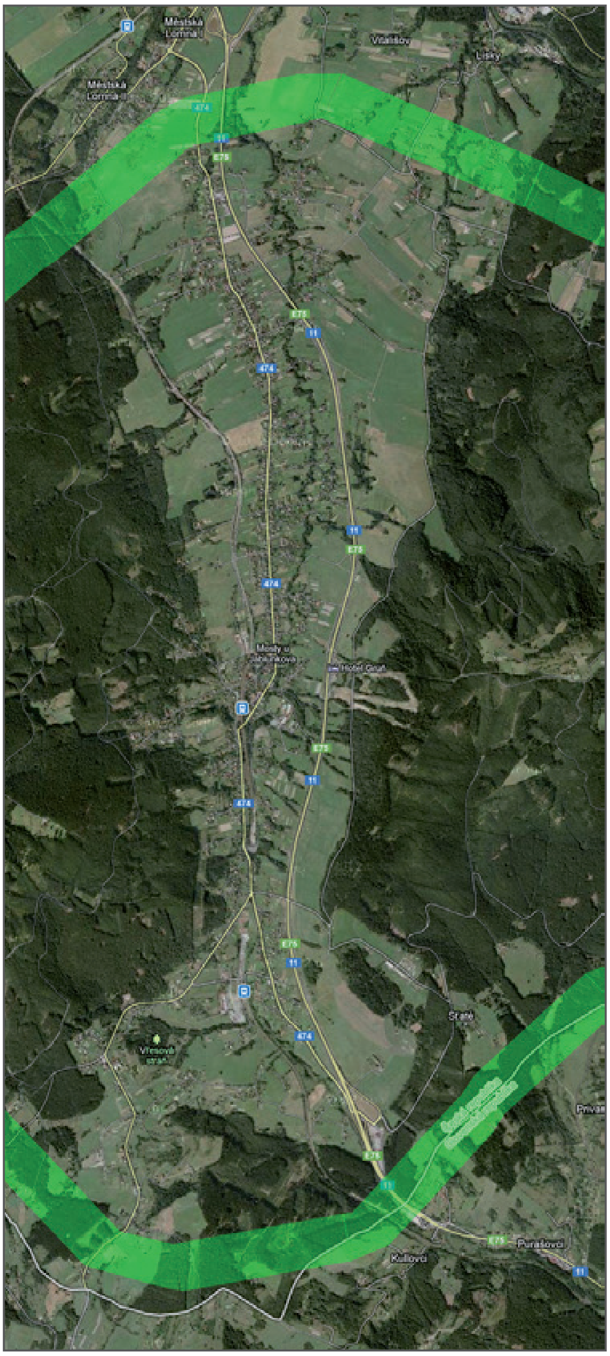

Fig. 1: *Map showing the location of the Jablunkov(above) and Celnice(below migration corridors in the Jablunkov furrow. Maps based on Google.com*

Fig. 2: *New underpass under the international railway track no. 320 in the axis of the Jablunkov corridor. Photo by T. Krajča.*

Results and discussion

When monitoring the transects along the road the most frequently detected species on both corridors was roe deer and red deer, although the intensity of movement and representation differed in the individual corridors (Table 1).

Corridor	Roe Deer	Red Deer	Wild Boar
Jablunkov	98 (81,7 %)	11 (9,2 %)	9 (7,2 %)
Celnice	67 (55,8 %)	25 (20,8 %)	9 (7,5 %)

Tab. 1: *Number of footprint trails of large mammals detected in the Jablunkov (seasons: 2008/2009, 2009/2010, 2010/2011) and Celnice(seasons: 2007/2008, 2008/2009, 2009/2010, 2010/2011) migration corridors.*

In the agricultural landscape of the Jablunkov migration corridor a higher intensity of movement of animals was recorded every year than in the Celnice migration corridor which is probably due to the interchange of the busy I/11 road and a greater food supply in the Jablunkov corridor. On the other hand the presence of red deer was twice as frequent in the Celnice corridor than in the Jablunkov corridor, which is probably caused by a stronger bond of this species to forests (Jędrzejewski et al. 2006) which prevail in the Celnice corridor.

When monitoring the footprint trails of roe deer in the Jablunkov corridor it was established that animals frequently use groves, scattered green areas, terrain depressions, unfenced gardens and partially also the surroundings of deserted or partially uninhabited buildings (Fig. 3). All ungulates crossed the I/11 road only under the elevated road. They crossed the railway in 39%

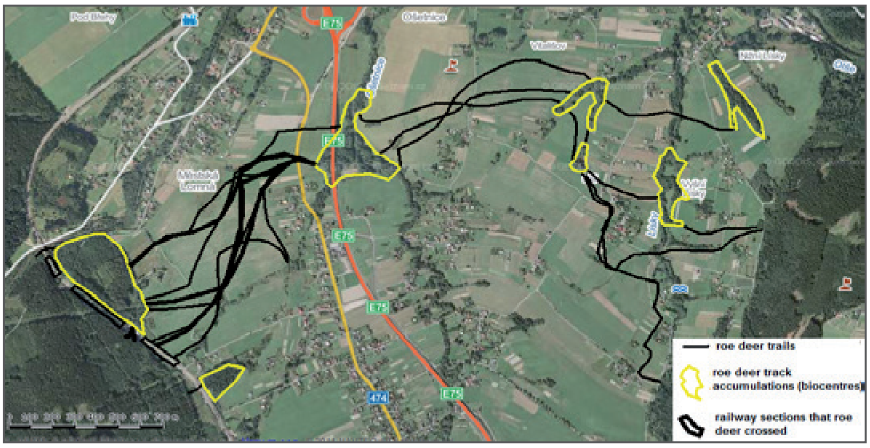

Fig. 3: *Map of the most frequently used migration tracks in the whole Jablunkov corridor based on the established footprint trails of roe deer (n=5) in the 2011-2012 season (map based on mapy.cz).*

of cases on the third section where the track does not lie on the embankment and forest is close from both sides. The fifth section where the migration underpass is located was used in 22,5% (Tab.2). It was used only by roe deer and wild boar. When converting the number of footprint trails to the length of the monitored section it came out that the section with the migration underpass was used twice as often as section number 3 where the forest connects on both sides and the majority of footprint trails were found here (Tab. 2).

Sections on the railway	1	2	3	4	5	6	7
Length of the section (m)	22	130	211	127	48	223	235
Number and percentage of the detected animals	1 (0,83%)	20 (16,67%)	47 (39,17%)	5 (4,17%)	27 (22,5%)	19 (15,83%)	1 (0,83%)
Relative amount of footprint trails on a 10 m section	0,46	1,54	2,23	0,39	5,63	0,85	0,04

Tab. 2: *Exploitation of the individual sections along the railway in the Jablunkov corridor by migrating animals (roe deer, red deer, wild swine) in the 2011/2012 season*

In the Celnice corridor eastward from the road the roe deer moved mainly along the brims of the forest where the slope was not too steep. They crossed the road mainly on spots where there were no crash barriers. Only in three cases roe deer jumping over crash barriers were monitored. Opposite a place without a crash barrier near the state border (between the road and railway)there is a little bridge which roe deer, red deer and wild boar used in majority of cases (97%). The animals used the railway embankment for crossing in places where the slope was mild (Fig. 4).

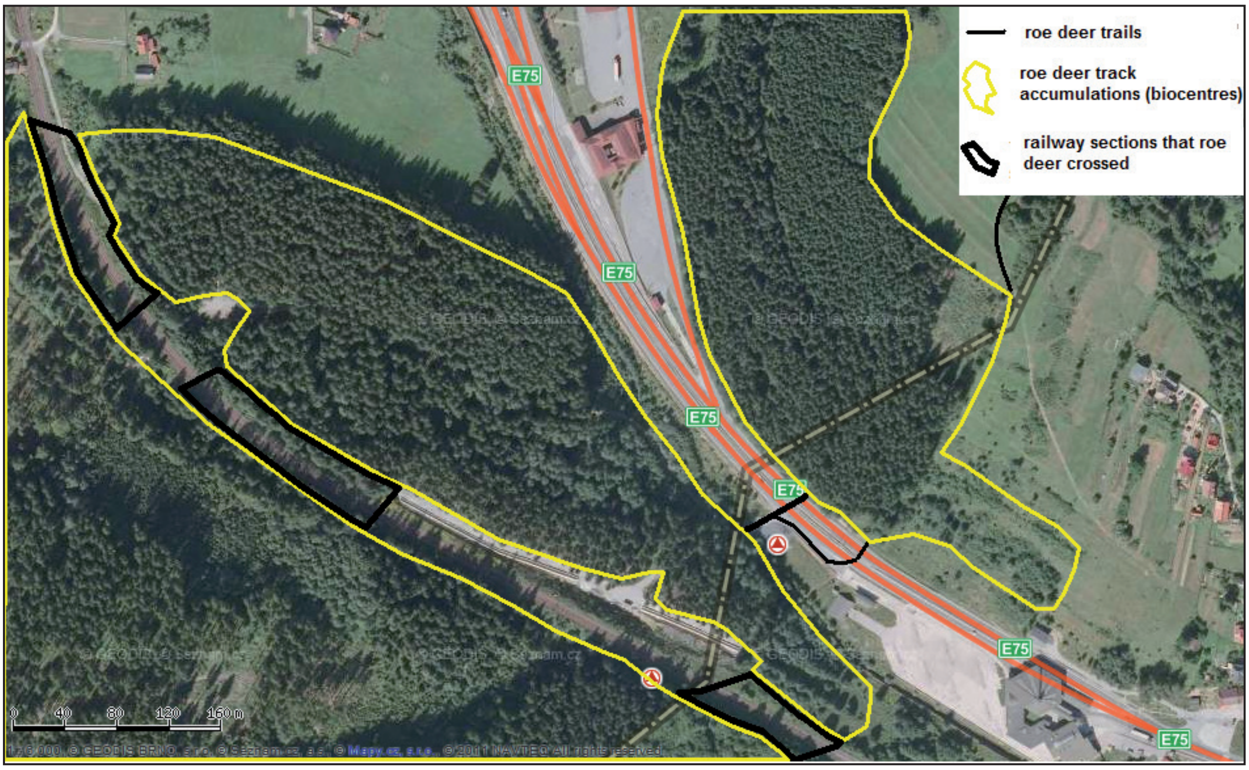

Fig. 4: *Localisation of the place of the most frequent migration in the Celnice corridor based on the established footprint trails of roe deer (n=67) from 2007=2011. Roe deer crossed the I/11 road practically exclusively in places where there were no crash barriers, and the railway in sections with a mild slope (map based on mapy.cz).*

During monitoring we were unable to document a reliable finding of residential signs of large carnivores directly crossing the selected migration corridors, only three times between 2008-2010 we found independently leading footprints of a large canine carnivore where we could not eliminate a wolf. In one case (22nd November 2008), the footprints led from east to the road, but approx. 200 m before crossing of the corridor and the road the animal turned back to the east. We can thus only assume whether it was scared off by the noise from the road. During the snow calamity and a temporary I/11 road closure a canine carnivore crossed the road from east to west (4th February 2009). In the third case monitored on the 27th February 2010 it cannot be proved or disproved whether the animal crossed the road because the traces were found only on the eastern slope and led from the forest eastwards.

The monitoring was carried out only in the winter period under good snow conditions. The absence of a reliable finding cannot be interpreted as a proof that the area is not used by large carnivores, especially when taking into account large spatial requirements of large carnivores and their low population density. Another problem is also the impossibility to distinguish individual footprints of wolves from some breeds of dogs (Kutal et al. 2010), that is why several findings of suspicious footprints found in the mud from spring to autumn were disqualified from evaluation due to the impossibility of exact determination. A well-known example of an attempted migration of large carnivores over the interest area is the bear which was hit by a truck here in 1996 (Bartošová 2004). According to local hunters a bear used the Celnice corridor in 1999 (Turek in lit.). In April 2012 footprints of a bear were found in the town of Mosty u Jablunkova not far from the pass and on the following days on the other side of the road in the Moravskoslezské Beskydy Mountains. On both places the front feet were the same width (12-13 cm) and it can be assumed that this bear used the Celnice corridor for crossing. With regard to the very high intensity of traffic on the I/11 road and blocking of the corridor in the night hours by parked trucks (Váňa et al., this volume) we cannot eliminate the possibility that for crossing in the night hours the bear used unobserved a normal bridge over the I/11 road directly in the highest spot of the pass situated in the town of Mosty u Jablunkova (Fig.4). Nevertheless they may have been two different bears with the same size of footprints. This could be proved only based on a DNA analysis of the fur or excrements, but it was not possible to gain a sample from the area of the Silesian Beskydy or the Jablunkovská vrchovina mountains.

Conclusion

Although the Celnice corridor has better conditions for migration of the focal species mainly due to a higher amount of forests, it is little used because of the absence of any measures to decrease the barrier effect of the I/11 road in this section. With regard to the current situation in the whole Jablunkov furrow it is a location of high importance for the migration of large mammals from the national and even international perspective. It is thus desirable to construct a wildlife crossing which should have been realised (already in 2008) as a compensation for the increased traffic load on the I/11 road connected to the building of the Hyundai car factory in Nošovice. Until that time it is necessary to improve the permeability of the corridor at least by prohibiting the parking of trucks in the location of the former custom house (see Váňa et al., this volume).

The Jablunkov corridor is attractive for roe deer but to be used by large carnivores, especially by the lynx, it is necessary to increase the area of forest at least by gradual purchase of premises and planting groves in the line of the migration corridor which is already a part of the building plan of the town of Jablunkov. Building an underpass under the railway in the line of this corridor improved the permeability and preliminary results from the first season show that roe deer and wild boar prefer the underpass to crossing over the railway. Red deer have not yet been detected in the underpass which indicates higher spatial requirements of the species when crossing line barriers by underpasses if the intensity of traffic (much lower on the railway than on the road) and the configuration of the terrain enable crossing over the railway.

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The road permeability on important migration corridors in the Beskydy PLA

Martin Váňa, Jan Stýskala, Michal Bojda, Miroslav Kutal

Introduction

Highways, motorways and other roads may represent an important barrier for natural movement and migration of freely living animals. The road permeability and the risk of a collision of the animal with a vehicle depend mainly on the intensity of traffic. The most serious consequences for the animal populations have motorways and highways which often create an insurmountable barrier due to the high intensity of traffic (Anděl & Gorčicová 2008). Roads with lower intensity of traffic may also have an important impact on the animal populations, mainly for species naturally living in relatively low population densities and inhabiting large areas, for example large carnivores. Death of - be it only one - animal caused by a collision with a motor vehicle may therefore mean a considerate loss for the small population.

The Beskydy Protected Landscape Area (PLA) is the only region in the Czech Republic where all three species of large carnivores (lynx, wolf, bear) live naturally mainly thanks to the direct connection with the numerous populations in the Carpathian area. Good permeability of roads and motorways which go through the Beskydy PLA or cross important migration corridors connecting the Beskydy with the Slovak and Polish Carpathians, is therefore one of the important conditions for preserving the populations of large carnivores in the Czech Republic. The permeability of migration corridors connecting the Beskydy mountains with the adjoining natural areas (White Carpathians, Vizovická vrchovina, Hostýnské vrchy) is key to further natural spreading of large carnivores westwards. In this contribution we would like to evaluate the road permeability in the locations where they cross the selected important migration corridors passing through or connecting to the Beskydy PLA.

Methodology

For the evaluation altogether 11 road segments were chosen which cross the selected important migration corridors according to the map layer AOPK ČR (Anděl et al. 2010) (Fig. 1). They were two segments outside the Beskydy PLA (crossing 1 and 2), three segments on the border of the PLA (crossings 3, 4 and 11) and altogether five road segments inside the Beskydy PLA (crossings 5, 6, 7, 8, 9, 10).

On each segment three all-day (24-hour) traffic censuses were carried out during 2011 – 2012. The dates for the censuses in each location were timed for the vegetation season in 3 different months (June, August and September). Monitoring went on from 8:00 a.m. till 8:00 a.m. the following day and in all cases on two subsequent working days. The information written down was: the vehicle category, journey direction and the time of passing the checkpoint. The used categorisation was adapted according to the EDIP methodology (Wirland 2005) and divided vehicles into 7 categories: 1) O – passenger cars; 2) N1 – vans and light lorries to 3,5t; 3) N2-3 – medium and heavy lorries over 3,5t; 4) NS&TR – special lorries and tractors; 5) A – buses; 6) M – motorcycles; 7) C – bicycles (Váňa 2010). Trailers, semi-trailers and goods trailers were counted as a part of the trucks.

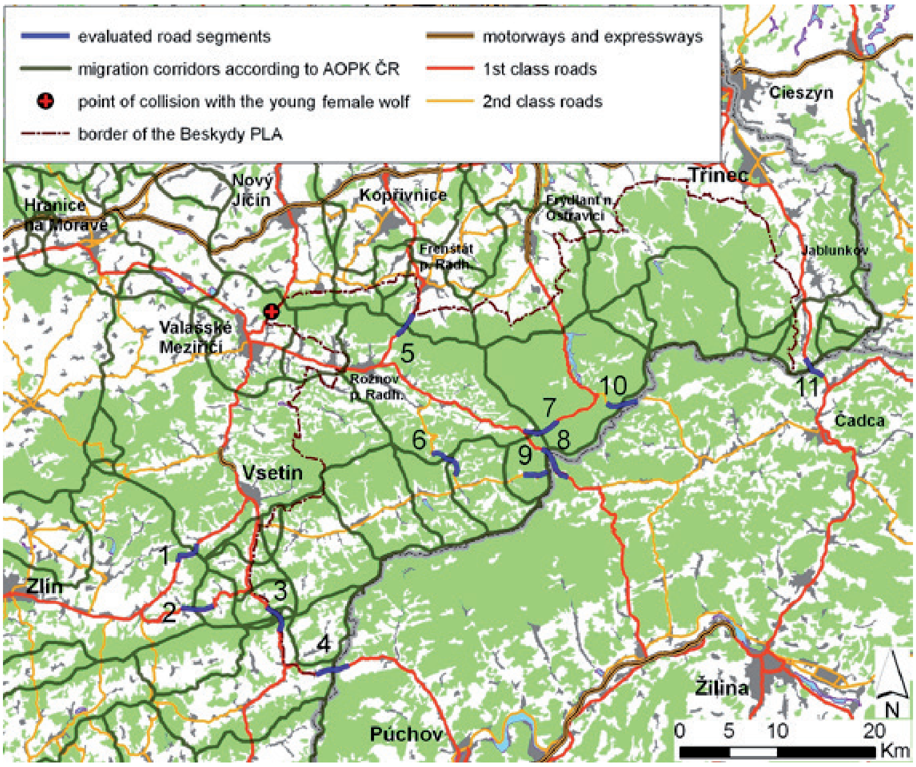

Fig. 1: Evaluated traffic segments crossing important migration corridors. 1 - Syrákov I/69, 2 - Bratřejov I/49, 3 - Lomensko I/57, 4 – Lyský průsmyk I/49, 5 - Pindula I/58, 6 - Soláň II/481, 7 - Bílá I/56, 8 - Bumbálka I/35 (E442), 9 - U Tabulí II/487, 10 - Konečná II/484, 11 - Jablunkovský průsmyk I/11 (E75). The red cross marks the spot where a young wolf female was knocked down in summer 2013. (see Results and discussion).

For each monitored traffic segment and date of census we evaluated the hour and all-day (24-hour) traffic intensities, i.e. the number of vehicles passed in the given time on the given segment, for individual vehicle categories and journey directions separately, but also as a complex for all categories and for both directions. The resultant traffic intensity was calculated as an arithmetical average of the values acquired during all three censuses on the given road segment.

The evaluation of permeability of the monitored traffic segments was based on the evaluation of time gaps between the passing of individual vehicles in the night hours from 9:00 p.m. to 5:00 a.m., when a higher activity and more frequent crossings of large mammals can be expected. For the evaluation of the measured gaps four length classes (or permeability classes) were proposed with the following evaluation of their permeability: 1) shorter than 15s – impermeable;

2) 15 s – 1minute – permeable with difficulties;

3) 1 – 5 minutes – permeable;

4) longer than 5 minutes – well permeable.

The first (i.e. impermeable) class of the proposed classification was taken over from the monitoring carried out by Anděl and Gorčicová (2008), the scaling of the other classes was done by estimation. For each class we subsequently calculated an overall time section which equalled the sum of all gaps of the given length and we expressed the percentage part which the given class took in the context of all night on the given traffic segment. The resulting percentage parts of the individual classes of permeability (p1-p4) were then calculated as an arithmetical average of the values discovered during all three measurements. And finally for each monitored road segment we settled an overall outcome permeability (P) which was calculated as a weighted average of all the permeability classes on the given segment based on this equation:

$$P = \frac{(\%\, p_1 \times 1) + (\%\, p_2 \times 2) + (\%\, p_3 \times 3) + (\%\, p_4 \times 4)}{100}$$

The resultant value was round up to whole numbers and marked the resultant class of permeability 1 – 4, i.e. impermeable to well permeable.

Results and discussion

The average all-day intensities of traffic established on the monitored road segments moved from 747 (U Tabulí) to 8.286 (Jablunkovský průsmyk) vehicles in 24 hours (Tab. 1, Fig. 2). On all segments apart from Jablunkovský průsmyk passenger traffic prevailed over goods traffic (Fig. 2). Average night intensities of traffic moved from 32 (U Tabulí) to 1.240 (Jablunkovský průsmyk) vehicles /8hours, which corresponds on average to 3% (Soláň) to 15% (Jablunkovský průsmyk) of the all-day intensities (Tab. 1). The average night one-hour intensities of traffic reached several times lower values than the average day one-hour intensities of traffic (Fig. 3, 4).

Crossing number	Migration corridor	Road	Average all-day intensity of traffic [vehic/24h]	Average night intensity of traffic [vehic/8h]	Average % ratio of night intensity of traffic to all-day traffic intensity	Yearly average of all-day traffic intensities [vehic/24h] according to CSD 2010
11	Jablunkovský průsmyk	I/11 (E75)	8286 ± 19	1240 ± 26	15 %	6630
8	Bumbálka	I/35 (E442)	4329 ± 408	526 ± 42	12 %	3974
3	Lomensko	I/57	5955 ± 205	493 ± 84	8 %	4059
5	Pindula	I/58	7095 ± 760	330 ± 62	5 %	6182
1	Syrákov	I/69	5610 ± 101	280 ± 8	5 %	5047
2	Bratřejov	I/49	2630 ± 156	181 ± 31	7 %	1939
7	Bílá	I/56	2798 ± 242	191 ± 37	7 %	2956
4	Lyský průsmyk	I/49	1874 ± 180	176 ± 11	9 %	1329
10	Konečná	II/484	1780 ± 225	109 ± 17	6 %	1543
6	Soláň	II/481	1483 ± 158	50 ± 3	3 %	1561
9	U Tabulí	II/487	747 ± 42	32 ± 13	4 %	1341

Tab. 1: *Average traffic intensities (and their standard deviations) established on the monitored road segments. For comparison, the last column shows the yearly averages of all-day intensities established in the national traffic census (CSD) in 2010.*

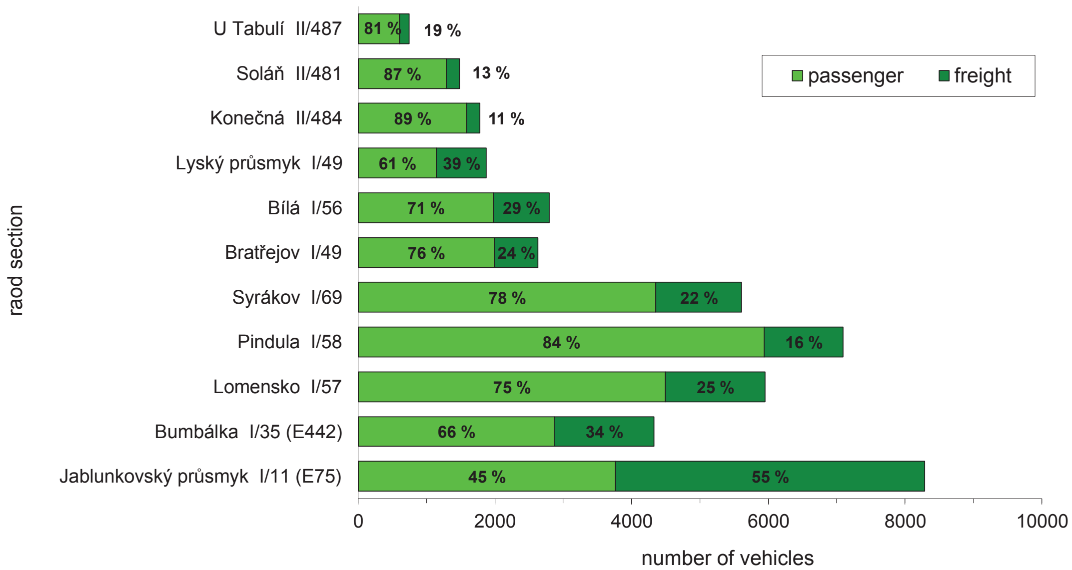

Fig. 2: *Graph of average all-day intensities of traffic established on the monitored roads.*

Divided for passenger (O, A, M and C categories, lighter grey) and reight (N1, N2-3 and NS&TR categories, darker grey) transport.

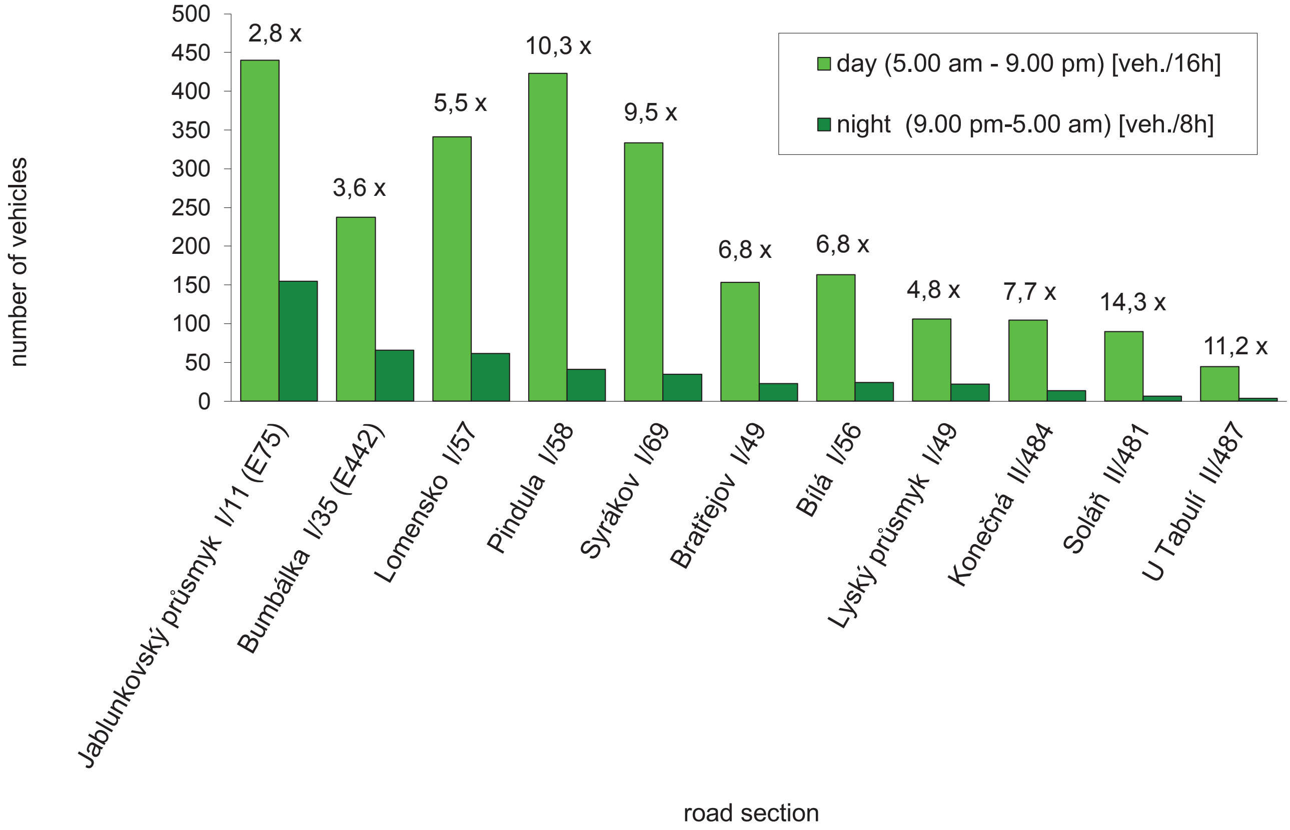

__Fig. 3:__ Comparison of average day and night hourly intensities of traffic on the monitored road segments. Values over the columns show how much higher the day hourly intensities were on average than the night ones.

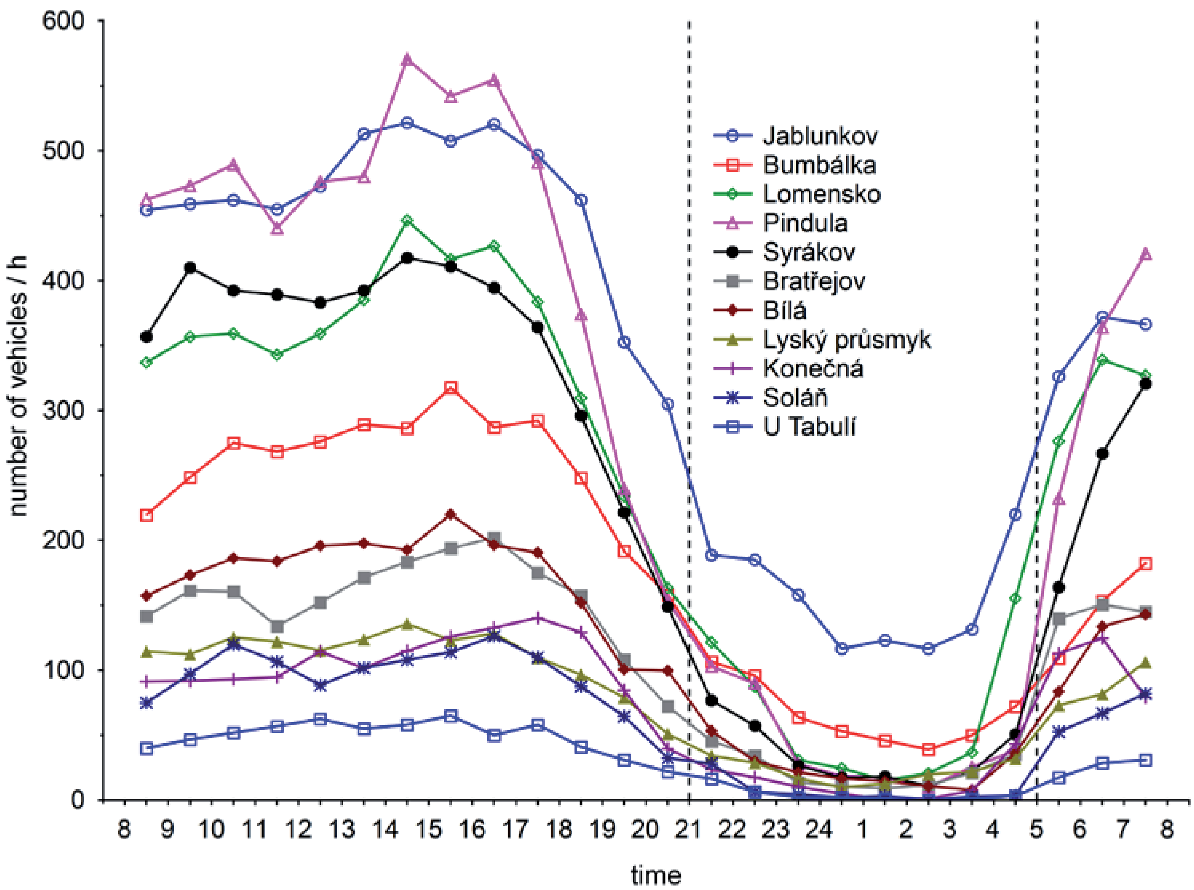

__Fig. 4:__ Flow of the average hourly traffic intensities on the monitored road segments. The dashed axes represent the night time in which the gap lengths between passing vehicles were established.

Evaluating the lengths of gaps between the passing vehicles in course of the night shows that on all monitored road segments apart from Jablunkovský průsmyk the longest part of the night was filled with gaps longer than one minute (Tab. 2, Fig. 5). Roads crossing these migration corridors (crossings no 1 – 10) were therefore permeable or well permeable at least 71 % of the length of the night. From that on three roads (U Tabulí, Soláň, Konečná) gaps longer than 5 minutes, i.e. gaps exclusively of the well permeable class, comprised even at least 80% of the night. Overall these three road segments were evaluated as well permeable (Tab. 3). Other 7 segments (Lyský průsmyk, Bílá, Bratřejov, Syrákov, Pindula, Lomensko and Bumbálka) proved to be overall permeable (Tab. 3). From all evaluated road segments the worst was Jablunkovský průsmyk where 57% of the night were filled with gaps shorter than 1 minute inclusive, i.e. the permeability class of the road was evaluated as permeable with difficulty to impermeable. Completely impermeable was the road on average 20% of the night. The resultant overall road permeability in Jablunkovský průsmyk was evaluated as permeable with difficulty (Tab. 3).

Crossing number	Migration corridor	Road	Road permeability in the night hours (100% = 8h)				Longest measured gap
			impermeable	permeable with difficulty	permeable	well permeable	
11	Jablunkovský průsmyk	I/11 (E75)	20±3 %	37±8 %	42±4 %	1±2 %	5 min 45 s
8	Bumbálka	I/35 (E442)	6±1 %	23±1 %	64±0 %	7±1 %	9 min 45 s
3	Lomensko	I/57	6±1 %	18±1 %	49±5 %	27±5 %	22 min 15 s
5	Pindula	I/58	2±1 %	13±2 %	48±5 %	37±4 %	44 min 0 s
1	Syrákov	I/69	2±1 %	10±0 %	53±4 %	35±4 %	30 min 45 s
2	Bratřejov	I/49	1±0 %	6±3 %	43±1 %	50±4 %	41 min 45 s
7	Bílá	I/56	1±0 %	6±2 %	41±4 %	52±5 %	33 min 45 s
4	Lyský průsmyk	I/49	1±0 %	5±1 %	40±4 %	54±5 %	33 min 15 s
10	Konečná	II/484	1±0 %	3±1 %	16±2 %	80±2 %	1h 59 min 15 s
6	Soláň	II/481	0±0 %	2±1 %	10±1 %	88±2 %	1h 59 min 45 s
9	U Tabulí	II/487	0±0 %	1±0 %	7±1 %	92±3 %	2h 39 min 45 s

Tab. 2: *Percentage rate of the individual road permeability classes to the overall length of night on the monitored road segments.*

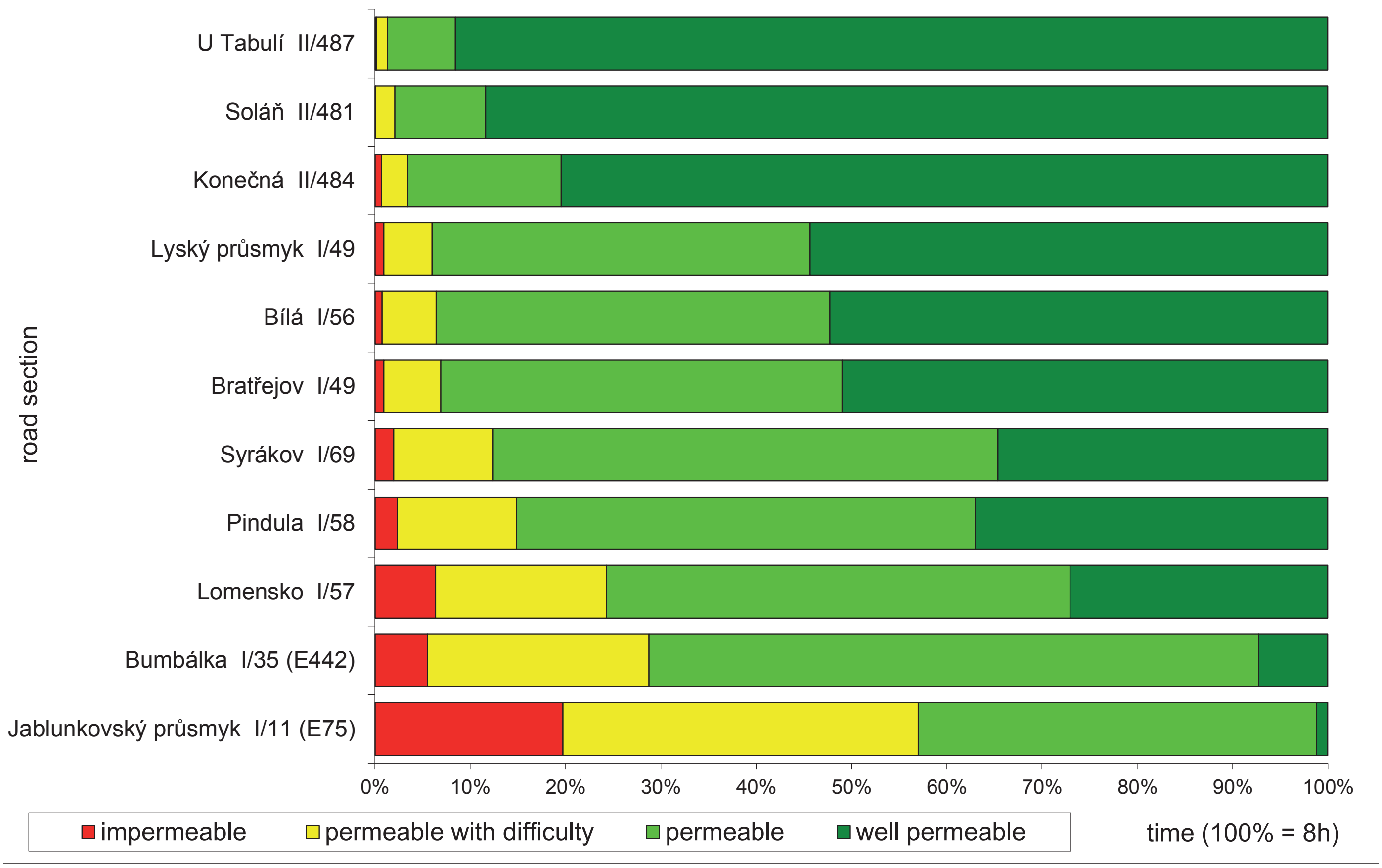

Fig. 5: *Graphic chart of the distribution of the individual road permeability classes on the monitored road segments in the night hours (21.00–5.00). (Red = impermeable, yellow = permeable with difficulty, light green = permeable, dark green = well permeable).*

Crossing number	Migration corridor	Road	Point evaluation of the road permeability	Final evaluation of the road permeability
11	Jablunkovský průsmyk	I/11 (E75)	2,24	permeable with difficulty*
8	Bumbálka	I/35 (E442)	2,73	permeable
3	Lomensko	I/57	2,96	permeable
5	Pindula	I/58	3,20	permeable
1	Syrákov	I/69	3,20	permeable
2	Bratřejov	I/49	3,43	permeable
7	Bílá	I/56	3,45	permeable
4	Lyský průsmyk	I/49	3,47	permeable
10	Konečná	II/484	3,76	well permeable
6	Soláň	II/481	3,86	well permeable
9	U Tabulí	II/487	3,90	well permeable

Tab. 3: *Final evaluation of the permeability on the monitored roads on the scale from 1 (impermeable) to 4 (well permeable). *Due to the trucks parked directly in the axis of the migration corridor, the final evaluation of road permeability in Jablunkovský průsmyk is not decisive and in reality should be evaluated much worse.*

The order of the evaluated road segments in all the tables and graphs correlates with their permeability from the lowest to the highest permeability (Tab. 1, 2, 3, Fig. 2, 3, 4, 5). The longest measured gaps (maximal value from three measurements) varied in monitored locations from 5 min 45 seconds (Jablunkovský průsmyk) to 2 hours 39 min 45 s (U Tabulí) and with regard to the ordering from the longest to the shortest gap practically copied the permeability rate of the monitored traffic segments from the best to the least permeable (Tab. 2, Fig. 5). Further it is obvious that the lower the measured night traffic intensity, the higher the overall final road permeability (Tab. 1, 3). This trend does not apply so much to the comparison with the order of measured all-day intensities (Tab. 1, Fig. 2), because the ratios between the average day and night hourly intensities vary considerably on the monitored segments (Fig. 3). For example the road crossing migration corridor at Pindula had on average the second highest all-day traffic intensity, but thanks to the fact that the night hourly traffic intensities here were on average ten times lower than the day ones, in overall evaluation of the road permeability the road was two places better off before Lomensko and Bumbálka with considerably lower all-day traffic intensities (Tab. 1, Fig. 3, Tab. 3). Pindula even had the highest average maximal hourly traffic intensity in the afternoon rush hour between 2 and 3 p.m.; after 7 p.m. the traffic intensity here dramatically falls (Fig. 4).

The results of the traffic research show that the Beskydy PLA and the immediately adjacent for the migration important mountain ridges are not yet hit by traffic to such an extent which would altogether disable dispersion and migration of large mammals. However, in some migration corridors the situation is critical: in Jablunkovský průsmyk we found a relatively difficult permeability of the I/11 (E75) road where most of the gaps at night are shorter than 1 minute and a gap longer than 5 minutes appears on this segment on average once a night. Also in the axis of the migration corridor on the Czech-Slovak border in the direction to Slovakia a lot of trucks are parked as a consequence of the full usage of the parking capacity of the adjacent Slovak rest area. We noticed parked trucks on all three nights always for several hours when the migration corridor was practically impermeable. This fact could not be taken into account in the used methodology when evaluating the road permeability on the base of evaluating gaps, nevertheless it is absolutely vital because the corridor is in reality much worse accessible than what the evaluation might show.

An enlarged risk for the migrating animals can be seen in the road segments Bumbálka and Lomensko, which were evaluated as permeable in the results, yet the gaps shorter than 15 seconds in both cases filled 6% of the night, which cannot be considered as wholly insignificant. This is proved by the young wolf female knocked down this year on the I/57 road near Krhová (Hulva et al., this volume), which crosses the migration corridor in the forested part of the Veřovické vrchy between Valašské Meziříčí and Nový Jičín. This road segment was not monitored within our study, yet it is the same highway (I/57) going also through Lidečko – Lomensko and it can therefore be assumed that night traffic intensity will be here very similar to the intensity measured in Lomensko. The Directory for roads and railways (ŘSD, 2011) claims a yearly average of all-day traffic intensities in the height of 5.527 vehicles/8 hours on this segment near Valašské Meziříčí.

With regard to the possible similar evaluation of the road permeability e.g. in another area, it is interesting to notice that when it comes to permeability, the worst evaluated were the road segments of national importance (E75, E442). On the contrary the best evaluated were the segments of 2nd class roads (II/481, II/484, II/487), all of them identically evaluated as well permeable. This indicates the priorities for the future selection of road segments to be evaluated, where the evaluation of roads of 2nd class with all-day intensities lower than 2.000 vehicles day appears to be of little use. In connection with the Beskydy PLA we believe it would be beneficial to evaluate the permeability of the E75 road in future also in the Slovak territory, in such places where the road is crossed by key migration corridors connecting the Slovak and Moravian Western Carpathians (Bojda et al., this volume).

To conclude we must add that the evaluation results must be taken with a pinch of salt, because the permeability classes used for evaluating were stated by estimate (see methodology) and are therefore not verified by any exact research which would really validate a sufficient permeability of the gaps longer than 5 minutes and on the other hand a complete impermeability of gaps shorter than 15 seconds. Animal reactions to traffic density will understandably vary with different species and various individuals of the same species and it is necessary to pay further attention to this research. On the other hand, the stated length of night (9 p.m. – 5 a.m.) does not fully correspond to the migrating animals' needs, most of the year it is longer than 8 hours and also the activity of large mammals is often concentrated mainly on the dusk and dawn when the road traffic intensity is still (or already) quite high. Despite these inaccuracies the presented assessment based on the evaluation of night traffic intensity and the gaps lengths offers a much greater value than the pure information on the all-day traffic intensity acquired from the national traffic census which was until now the only available piece of information. We present the results of the national traffic census from 2010 from the same segments for comparison in Table 1. On 8 road segments out of 11 the average all-day traffic intensity we established surpasses the results of the national traffic census by 8 – 32 %. This can be caused by timing of the traffic monitoring which in our case was carried out outside weekends and national holidays and only in the summer season when one can expect a higher rate of traffic. The resultant average yearly permeability rates of the monitored road segments could then on the evaluation scale 1 – 4 (impermeable – well permeable) turn out a bit better towards the well permeable. The cause of the deviation can partially be also the usage of different methodology when the national traffic census did not continue whole 24 hours in one go, but only in 8hours intervals and the resultant values were consequently calculated with the help of conversion coefficients which may lead to some error rate (ŘSD 2011). Last but not least the reason may be the light increase in traffic intensities since 2010 when the national traffic census was carried out, which corresponds to the by roughly 20 % lower values of the national census carried out in 2010 on three migration corridors on the I/49 and I/57 roads (Váňa 2010) than in the here presented results from 2011and 2012.

Conclusive recommendations:

- **Migration corridor Jablunkovský průsmyk (I/11)**

  An ecoduct, which would have solved the insufficient permeability of the migration corridor, should have been built in the axis of the migration corridor at the state boarder in 2008. However, the preparation of the construction of the overhead crossing has been stagnating for some time. To ensure at least a minimal road permeability until it is realised, we propose to forbid parking of vehicles in the length of 200 meters from the state boarder in direction towards the Czech Republic along both road shoulders.

- **Migration corridors Bumbálka (I/35) and Lomensko (I/57)**

  Due to the established 6% impermeability the traffic roads in the segments of migration corridors Bumbálka and Lidečko – Lomensko may represent an increased risk of collision for migrating large mammals with the passing vehicles. We propose to carry out a terrain monitoring of footprints trails in winter months and to monitor animal mortality caused by collisions with cars during the whole year. In migration routes which are critical from the perspective of migration and traffic, the speed limit should subsequently be lowered.

- **Migration corridor Pindula (I/58)**

  Although the road crossing this migration corridor was evaluated as permeable and the gaps shorter than 15 seconds comprised on average only 2 % of the night, we propose to lower the maximal allowed speed to 60 km/h on the segment from the Pindula mountain pass towards Frenštát pod Radhoštěm in the length of 1 km in the night hours. This area is vital for the migration of large mammals, in 2012 it was used several times by a bear (based on its verified presence) and probably at least once by a wolf, knocked down later near Krhová (see above). Its significance is supported also by the outcome of the “Monitoring of large carnivores in the Beskydy SAC” project which implies that this migration corridor is regularly used by a telemetrically monitored lynx female in order to migrate from the core area of her home district consisting of forest complexes in the central and eastern part of Veřovické vrchy to the area of the connected Radhošť and Smrk massifs (Krojerová 2012).

- **Migration corridor Krhová–Hostašovice (I/57)**

  Although the traffic intensity and road permeability in this migration corridor were not monitored in detail within this contribution, with respect to the recent case of a knocked down wolf female and a repeated presence of a bear which security cameras filmed in the ammunition depot in Hostašovice in April, we propose to lower the speed limit in the evening and night hours to 60 km/h in the minimal length of 2,5 km on the segment where the animal was knocked down (49.505313 °N, 17.996172 °E) and which is forested on both sides (Fig. 1).

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Habitat analysis of the large carnivores' presence in the Western Carpathian mountains and modelling of migration corridors

Dušan Romportl, Miroslav Kutal, Michal Kalaš, Martin Váňa, Leona Machalová, Michal Bojda

Introduction

Evaluating the environment preferences and spatial requirements of focal animal species is one of the key topics in ecology, or zoology respectively. To understand these characteristics seems to be an essential prerequisite for an efficient protection of the species and its management in a fragmented cultural landscape. When studying ecological requirements of large carnivores, habitat analyses which work with geoinformatic technologies have been used in recent years. Geographical information systems enable a complex evaluation of the relation between the presence of focal organisms and the relevant factors of the environment which can be expressed in the geographical space. The aim of the analysis is then to define the potential of the landscape for a permanent and temporary presence of carnivores and further the demarcation of suitable corridors connecting the core areas. Modelling potentially suitable habitats for the focal organism species belongs nowadays to widely used approaches of protection biology (e.g. Hirzel et al. 2006, Václavík et al. 2009).

Material and methodology

The methodology comprises an analysis of the input data on the distribution of focal species of organisms (so-called presence data), the second step is the preparation of datasets describing the relevant factors of the environment (so-called environmental variables) and the final phase is the establishment of a habitat model (so-called habitat suitability model – further just HSM).

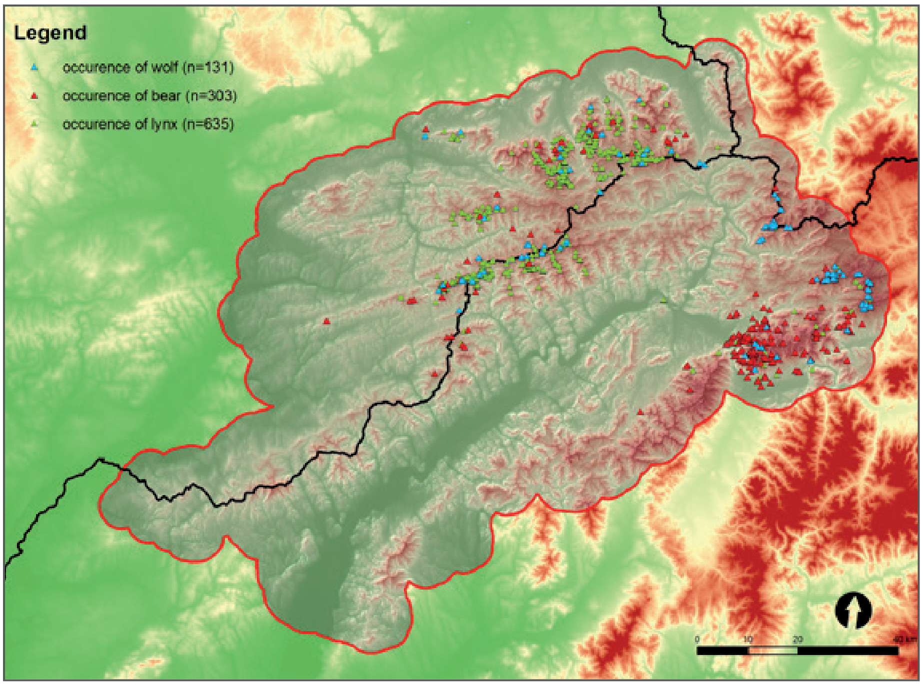

Fig 1: *Presence of large carnivores species in the focal area.*

As the input data on the focal species we used the data on the presence of large carnivores collected during the terrain monitoring by Hnutí DUHA and Fatranský spolok in 2003-2012. The area of interest was demarcated on the Czech side by the selection of bioregions where the presence of one of the studied carnivores was recorded, and in Slovakia geomorphological units were included from both sides of the valley course of the Váh river and its right tributaries which represent important barriers to the potential migrations of large carnivores towards the Moravian Carpathian Mountains. An additional criterion for the choice of area was also the presence of the carnivores.

For the elaboration of the habitat model the ENFA algorithm (Environmental Niche Factor Analysis) was used, which is implemented in the BIOMAPPER programme (Hirzel et al. 2002). The presented study created models of potential presence of all monitored large carnivores as priority species of large territorial scales which are limited by the ongoing landscape fragmentation. Point data on the presence of the European lynx (n=635), gray wolf (n=131) and brown bear (n=303) (Fig.1) were converted into the necessary raster format.

The preparation of the data on the character of the environment was limited by the accessibility of the necessary information. Whereas some basic factors of natural and anthropogenic influence are easy to express, a range of other environmental variables (e.g. the density of prey, anthropogenic disturbance) cannot be expressed with data or visualised in a GIS environment. As input variables the following parameters of the environment were defined (fig. 2-6):

- Factors of abiotic environment: altitude, vertical heterogeneity
- Factors of land cover: type of land cover
- Factors of anthropogenic influence: distance from roads, distance from settlements.

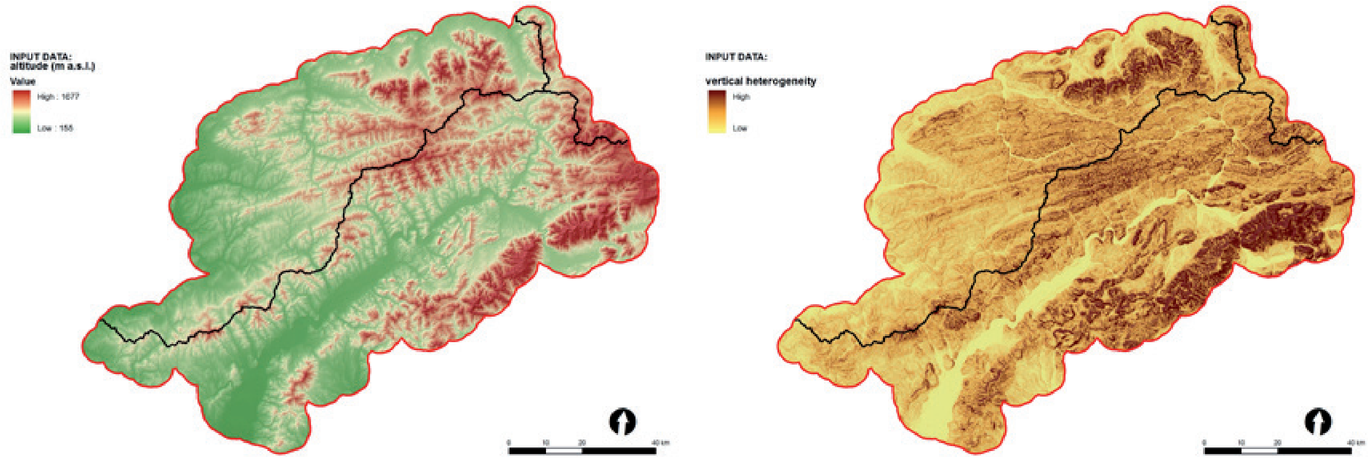

Fig. 2–3: *The altitude and vertical heterogeneity of the relief.*

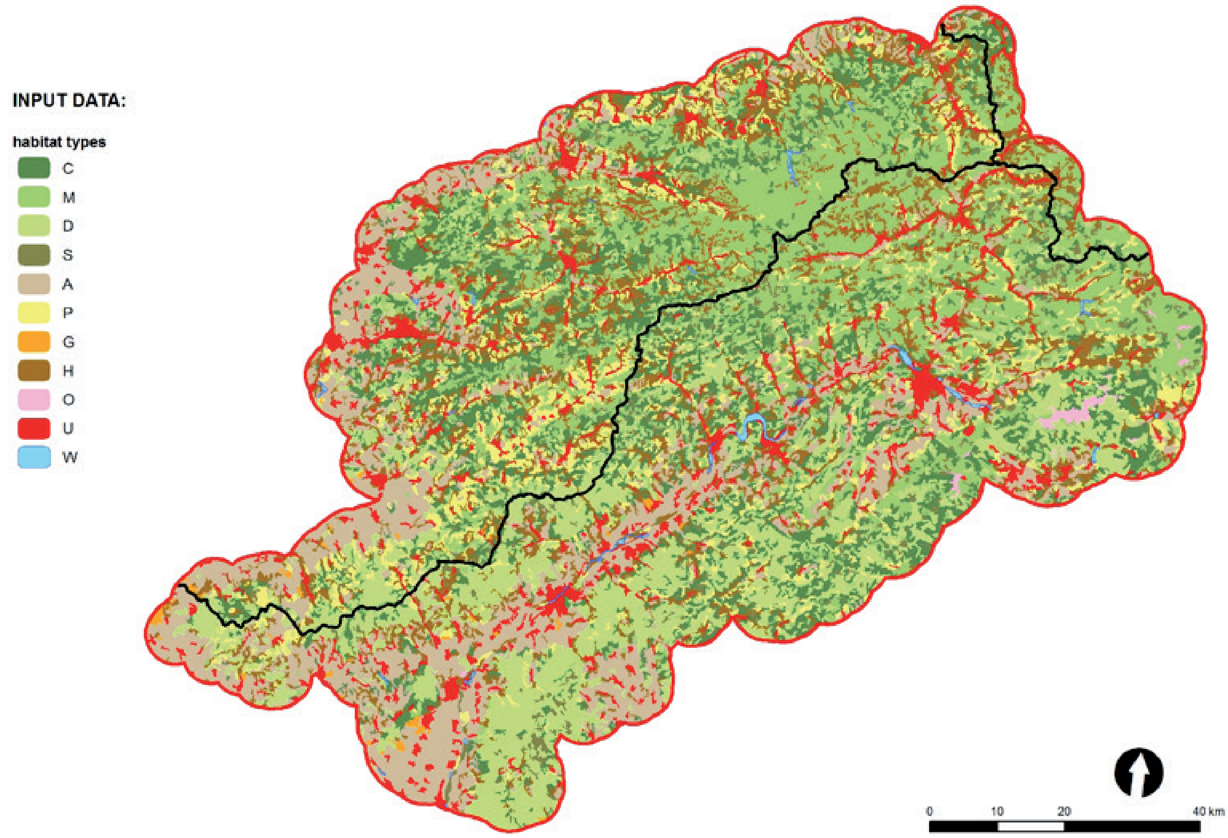

Fig. 4: *General types of lands cover in the focal area.*

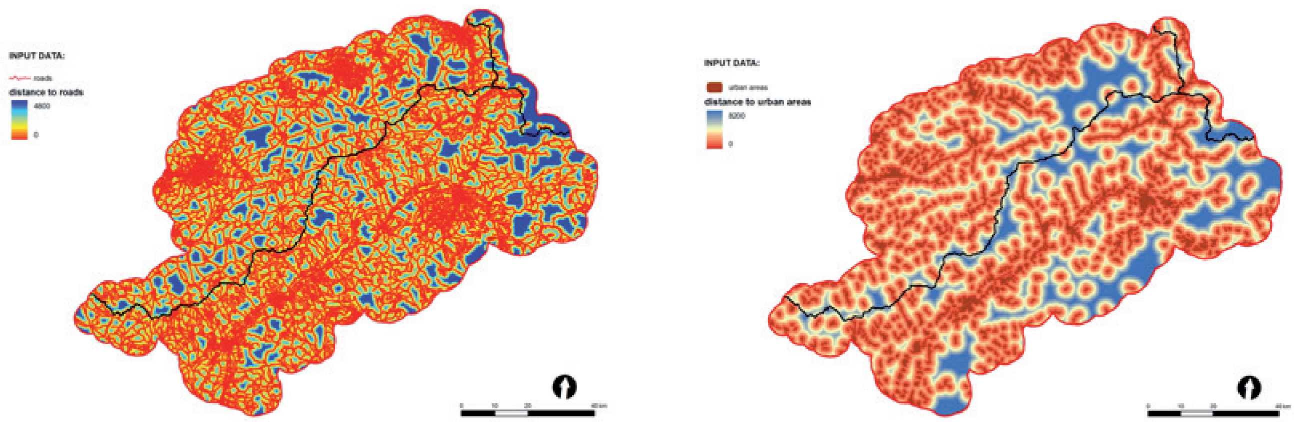

Fig. 5–6: *Distance from roads and settlements.*

The outputs of the model were further evaluated from the perspective of the landscape migration permeability. Based on the published data on European lynx spatial requirements the minimal parameters of the core areas of its real and potential presence were defined. Then the most suitable connections between such defined areas were analysed using the Corridor Designer tool (Majka et al. 2007) as parts of wider migration zones and specific corridor lines.

The results and discussion

The output of the model is a raster characterising the suitability of the environment meeting the criteria of the monitored species on the scale between 0% and 100% (Fig. 7-9). The results reflect to a large degree the frequency of the current distribution of focal species and the number of records in individual areas which are often very different from the perspective of landscape cover, character of settlement or shape of the relief. That is why some area with a relatively frequent presence can be evaluated as not very suitable for the presence of carnivores, whereas in other localities the habitat potential may be overestimated. With any kind of interpretation it is necessary to understand the outputs of the models as only additional information, which should always be confronted with an expert evaluation of the situation.

Despite all the listed objections the models generally well depict the current situation from the perspective of the preference of the environment by large carnivores. Areas of forested mountains are defined as the most suitable environment for a permanent stay, whereas the urbanised and intensely used valley and basin areas are classified as the least suitable. The peak areas of the Malá Fatra Mountains are surprisingly evaluated as not very suitable which can be explained by a low number of records of lynx within the alpine non forest land cover class.

The output habitat model for the European lynx was used as a base material for the delimitation of core zones of the current and potential permanent presence of the focal species, so-called "stepping stones" and their interconnection in the migration model (Fig.10). Detailed knowledge of the spatial and dispersion requirements implied by the telemetric studies in various types of the environment enable a relatively exact setting of parameters of the migration model. These outcomes also represent only a basic review of the migration potential of the focal area which is fundamentally limited by the accuracy of the input environmental data. That is why the migration corridors were finally conducted based on the combination of the outputs of this model and an expert evaluation of permeability in selected localities in the terrain (Bojda et al., this collection).

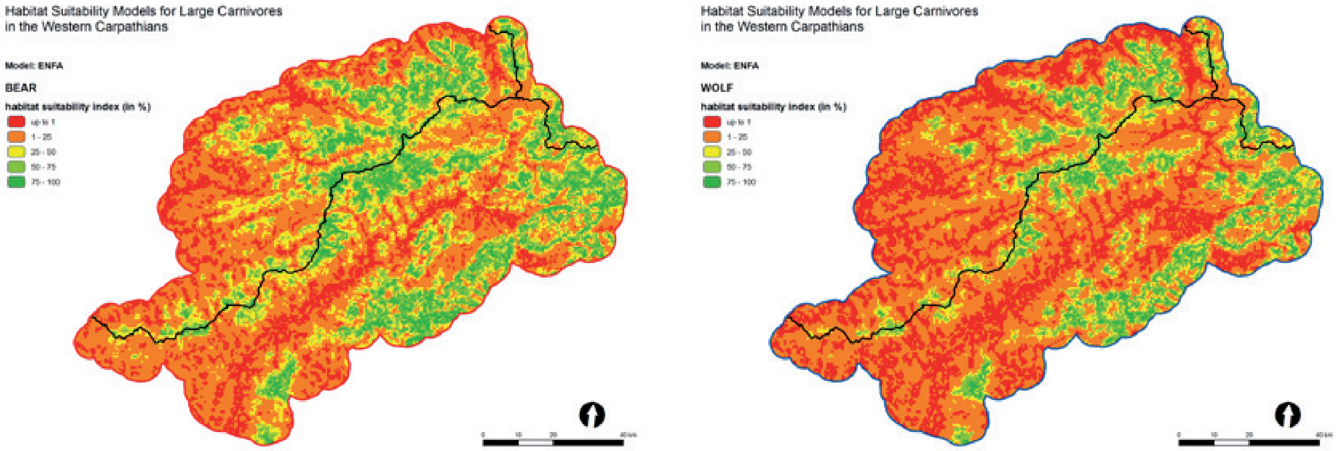

Fig. 7–8: *The output of the habitat model –example of the HSM of the brown bear and gray wolf.*

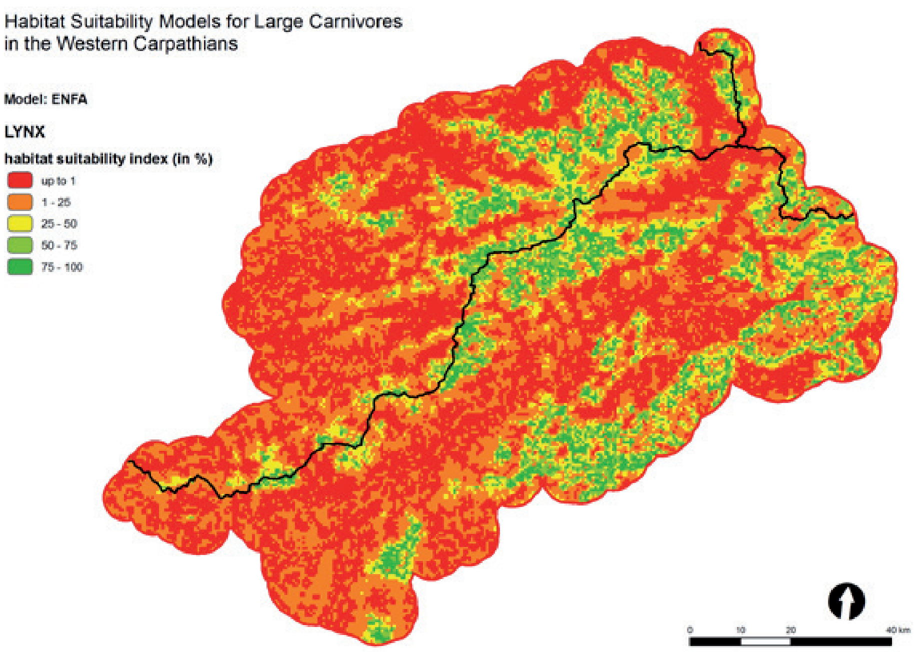

Fig. 9: *The output of the habitat model - example of the HSM of the European lynx.*

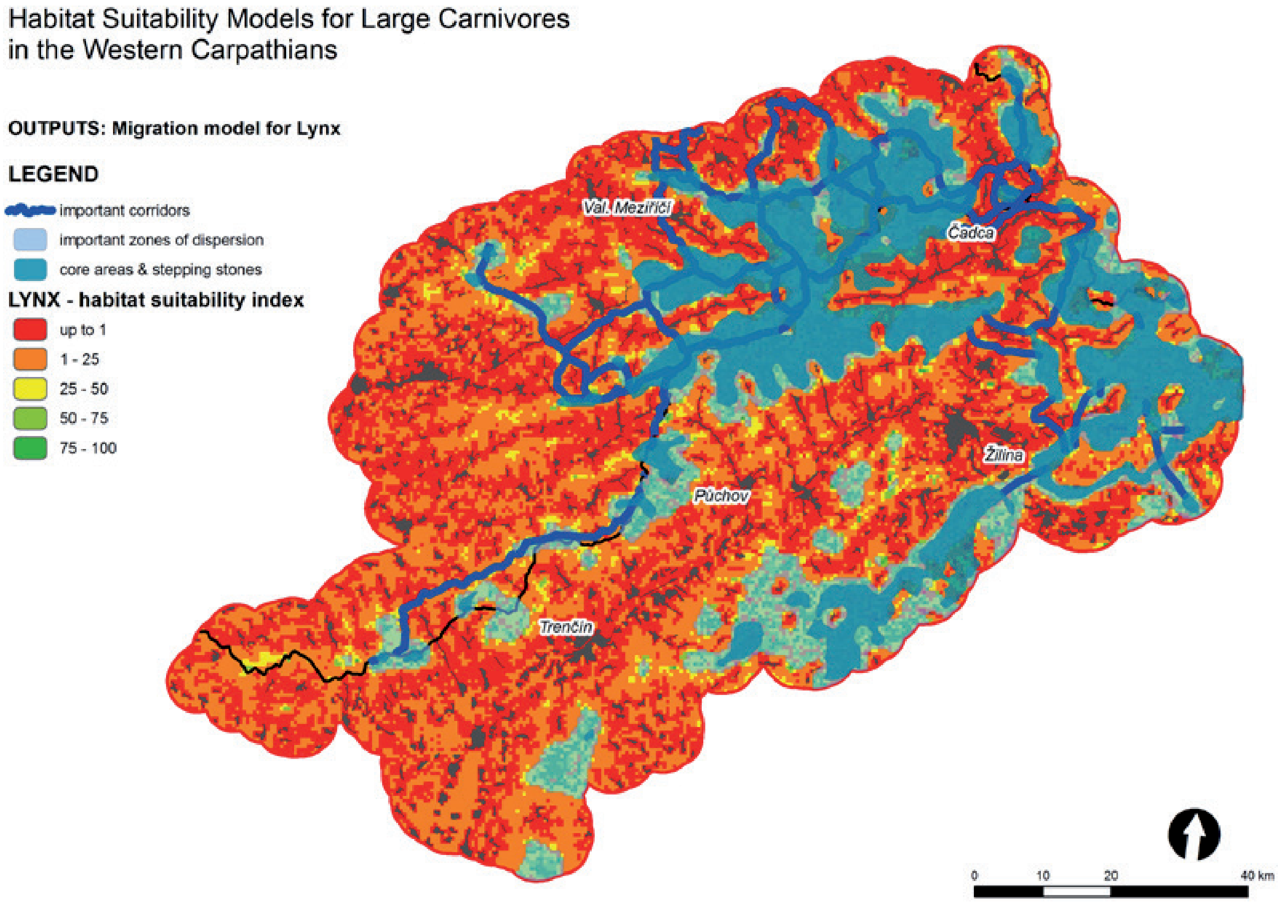

Fig. 10: *The final migration model of the European lynx.*

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