EXPEDITION REPORT

Expedition dates: 6 – 19 February 2016

Report published: January 2017

True white wilderness: Tracking lynx, wolf and bear in the Carpathian mountains of Slovakia

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Authors:
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Projeto Puma

Matthias Hammer (editor)
Biosphere Expeditions

Abstract

This report covers the fifth year of field research in northern Slovakia's Veľká Fatra National Park with the support of citizen scientists and the aim of collecting biological information to improve management practices for bears (*Ursus arctos*), wolves (*Canis lupus*), lynx (*Lynx lynx*) and wildcat (*Felis silvestris*) in the park. Fieldwork was conducted from 7 to 18 February 2016 and concentrated on the Ľubochnianska valley.

The study was a collaboration between Biosphere Expeditions and Environmental Society LENS. It used a cell-based occupancy approach and recorded signs (such as footprints, animal trails of footprints, scats, feeding remains, marking points) of large carnivores and their prey. Samples such as hair and urine were also collect for batch DNA analysis. Camera traps were also used. The different recording methods showed that snow-tracking can yield a substantially higher amount of distribution information on lynx, wolf, bear and wildcat range than any other observation technique employed.

The survey area was divided into cells of 2.5 x 2.5 km size. During the expedition 33 transects were surveyed with a total length of 462 km, covering 27 cells. The average length of a transect was 14 km and the total area surveyed was 169 km^2. Signs of target species were recorded in 19 out of the 27 cells surveyed. In terms of frequency, a total of 115 trails and tracks left by target species were recorded, of which 13 were identified as being left by lynx (11%), 90 by wolf (78%), 11 by bear (10%) and one by wildcat (1%).

Eight camera traps were placed in a total of 11 positions in the study area and 444 photographs were taken. One camera trap recorded wolf (*Canis lupus*) on a forestry road. Fox (*Vulpes vulpes*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), otter (*lutra lutra*), wild boar (*Sus scrofa*) and European robin *(Erithacus rubecula)* were also photographed.

Twelve samples (8 scats and 4 urine samples) were collected for DNA analysis, eleven of which (92%) were assumed, from footprints, to be from wolf and one sample (8%) from bear. All samples are currently awaiting DNA analysis to confirm species and enable identification of individuals.

Survey results since 2012 suggest that the lynx population in Veľká Fatra National Park is relatively stable. During normal winters, the lynx's main prey, the deer, concentrate in the valleys where they are fed at feeding stations by hunters and foresters to ensure an artificially high deer population for hunting purposes. This abundant food supply is likely to be one important reason for the lynx's stable population in the park, as is the high protection status of the species in Slovakia.

In 2016 wolf signs scored their highest frequency since 2012, and were detected in the highest number of cells (n=17), probably associated with mild winter conditions, which meant that prey animals were not concentrated in valley bottoms and therefore that wolf signs were found valley-wide. Indeed, the correlation between winter severity and the distribution of wolves in the valley is strong, with mild winters resulting in a greater valley-wide distribution as prey are not forced into the valley bottoms, and normal and harsh winters forcing prey and predators into the valley bottoms and towards artificial feeding stations. Overall, here too, as for the lynx, artificially high deer prey populations, combined with the wolf's relatively high protection status in Slovakia, appears to contribute to a relatively stable presence of wolves in Veľká Fatra National Park.

The 11 bear footprint found indicated that not all the bears present in Veľká Fatra National Park were hibernating. This is similar to the very mild winter of 2014, when many bear signs of non-hibernating individuals were also found. A correlation between winter severity and hibernation appears to exist. Mild winters can prevent hibernation due to food availability making hibernation unnecessary, as can harsh winters, such as the winter of 2012, when extremely low temperatures are likely to have disturbed the hibernation, especially of young and inexperienced bears, who are unable to build sufficiently warm dens. In any case, bear presence too appears to be relatively stable in Veľká Fatra National Park.

The wildcat population also seems to be stable, if small, as evidenced by consistent sign records noted by the expeditions, once each in 2016, 2015 and 2013, and six times in 2014.

Súhrn

Súhrnná správa z piateho ročníka terénneho monitoringu na severe Slovenska v Národnom parku Veľká Fatra s podporou domáceho výskumníka s cieľom získať biologické informácie a prispieť k zlepšeniu menežmentových opatrení pre medveďa hnedého (*Ursus arctos*), vlka dravého (*Canis lupu*s), rysa ostrovida (*Lynx lynx*) a mačky divej (*Felis silvestris*). Terénny monitoring sa sústredil na Ľubochniansku dolinu v období od 7. februára do 18. februára 2016.

Táto správa je spoluprácou medzi organizáciami Biosphere Expeditions a Environmentálnou spoločnosťou LENS. Využíva metódu prezencie/absencie v EEA sieti štvorcov a zaznamenáva pobytové znaky (stopy, stopové dráhy, exkrementy, zbytky potravy a značkovacie miesta) predátorov a ich koristi. Vzorky ako exkrementy, chlpy a moč sú zhromažďované za účelom DNA analýzy. Využívané sú aj fotopasce. Tieto rôzne metódy zaznamenávania pobytových znakov naznačujú, že zimné stopovanie môže priniesť podstatne väčšie množstvo informácií o rysoch, vlkoch, medveďoch a mačke divej, než akékoľvek iné metódy pozorovania v teréne.

Záujmové územie bolo rozdelené na kvadranty o veľkosti 2,5 x 2,5 km. Počas terénneho výskumu bolo monitorovaných 33 transektov v celkovej dĺžke 462 km, zahŕňajúcich 27 kvadrantov. Priemerná dĺžka transektu bola 14 km. Pobytové znaky záujmových druhov sme zaznamenali v 19 z 27 preskúmaných kvadrantov. Identifikovaných bolo 115 nálezov stôp a stopových dráh záujmových druhov: 13 patrilo rysovi ostrovidovi (*Lynx lynx*) (11%), 90 vlkovi dravému (78%), 11 medveďovi hnedému (10%) a 1 stopa patrila mačke divej (1%).

Osem fotopascí bolo umiestnených na 11 miestach v záujmovom území. Získali sme 444 fotografií. Jedna fotopasca zaznamenala vlka dravého (Canis lupus) na zvážnici. Ďaľšie fotografované druhy boli: líška hrdzavá (*Vulpes vulpes*), jeleň lesný (*Cervus elaphus*), srnec hôrny (*Capreolus capreolus*), vydra riečna (*lutra lutra*), diviak lesný (*Sus scrofa*) a červienka obyčajná *(Erithacus rubecula)*.

Nájdených bolo 12 vzoriek na DNA analýzu (8x trus, 4x moč). Na základe stôp pri vzorke bolo zaistených 11 vzoriek (92%) vlka dravého a jedna vzorka (8%) patrila medveďovi hnedému. Vzorky zatiaľ čakajú na DNA analýzu, ktorá by mala identifikovať jednotlivé individuá.

Prieskum, ktorý sa uskutočňuje od roku 2012 poukazuje na fakt, že populácia rysa ostrovida v Národnom Parku Veľká Fatra je viac menej stabilná. Počas štandardných zimných podmienok, hlavná potrava rysa – srnčia zver je koncentrovaná v dolinách, kde sú prikrmované lesníkmi a poľovníkmi za účelom udržania stavu raticovej zvery a na poľovné účely. Bohatá potravná ponuka je jedným z hlavných dôvodov stabilnej populácie rysa ostrovida, tak ako aj jeho celoročná ochrana na území Slovenska.

V roku 2016 boli pobytové znaky vlkov zaznamené v najvyššej miere od roku 2012. Zaznamenané boli v najväčšom počte 17 kvadrantov, pravdepodobne kvôli miernej zime, kedy korisť vlkov nebola sústredená v doline, hoci pobytové znaky sme v prevažnej miere zaznamenali v centrálnych a nižších častiach doliny. V skutočnosti zaznamenávame silný vzťah medzi zimnými podmienkami a distribúciou vlkov v doline. Počas miernych zím je distribúcia vlkov omnoho väčšia, kvôli faktu, že musia loviť na väčšom území, kedže korisť nie je stiahnutá do údolia. Počas normálnych a studených zím sa korisť sťahuje do údolia ku kŕmelcom. Podobne ako u rysa ostrovida aj tu platí, že dostatočná potravná ponuka jelenej zvery a relatívne vysoká zákonná ochrana vlka na Slovensku prispieva ku konzistentnej prítomnosti vlka dravého v Národnom parku Veľká Fatra.

11 pobytových znakov medveďa hnedého naznačuje, že nie celá populácia vo Veľkej Fatre hibernovala. Podobná situácia nastala počas miernej zimy v roku 2014, kedy sme zaznamenali množstvo nehibernujúcich medveďov. Mierna zima predchádza hibernácii medveďov, vďaka dostupnej potrave, tak ako aj studená zima v roku 2012, kedy extrémne nízke teploty prerušili zimný spánok najmä mladých, nedostatočne skúsených medveďov, ktoré si neboli schopné nájsť vhodné miesto pre hibernáciu. V každom prípade, môžeme konštatovať, že populácia medveďa hnedého v Národnom parku Veľká Fatra je taktiež stabilná.

Populácia mačky divej vyzerá byť malá a stabilná. Tento fakt potvrdzujú nálezy pobytových znakov raz v rokoch 2016, 2015 a 2013 a šesťkrát v roku 2014.

Contents

Please note: Each expedition report is written as a stand-alone document that can be read without having to refer back to previous reports. As such, much of this section, which remains valid and relevant, is a repetition from previous reports, copied here to provide the reader with an uninterrupted flow of argument and rationale.

1. Expedition review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This project report deals with an expedition to the Carpathian Mountains of Slovakia (Veľká Fatra National Park) that ran from 6 to 19 February 2016 with the aim of conducting conservation research monitoring on lynx, wolf, bear and wildcat, including their interrelationships with prey species.

With rising numbers of wolf, lynx and bear in Slovakia since the second half of the 20th century, conflicts with local people have come to public attention. Negative aspects of their presence often make news headlines, promoting a heightened sense of fear. Wolves sometimes cause considerable losses to livestock, particularly sheep, and hunters think they will wipe out game stocks. Such conflicts often lead to calls for culling, which is the approach that almost eradicated carnivores from Slovakia in the past. The concurrent emergence of new threats to wildlife and habitats presented by economic development means that a more sensitive approach is required, one based on a sound understanding of the place of carnivores in ecosystems, but also considering their impact on local people. As very little modern scientific work has been done on large carnivores in Slovakia, there is much to be done in order to achieve these goals.

1.2. Research area

The Carpathians are a range of mountains forming an arc roughly 1,500 km long across Central and Eastern Europe. They stretch in an arc from the Czech Republic (3% of their range) in the northwest through Slovakia (17%), Poland (10%), Hungary (4%) and Ukraine (11%) to Romania (53%) in the east and on to the River Danube between Romania and Serbia (2%) in the south.

The Western Carpathian Mountains cover much of northern Slovakia, and spread into the Czech Republic with Moravia to the east and southern Poland to the north. They are home to many rare and endemic species of flora and fauna, as well as being a notable staging post for a very large number of migrating birds.

The expedition's study area was the Veľká Fatra National Park. The Bradt Travel Guide has this to say about the park: "The gorgeous Veľká Fatra National Park is a vast 403 square kilometre area of unspoilt, undiscovered natural beauty, and you can walk all day in peace and solitude, feeling like the first explorer to set foot in a beautiful, flower-filled mountain meadow. Most of the area is covered by beech and fir forests, in some places by spruce and pines. The area around Harmanec is the richest yew tree region in Europe."

Figure 1.2a. Flag and location of Slovakia and study area. An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

The national park and its buffer zone comprise most of the Veľká Fatra range, which is part of the Outer Western Carpathians. The national park was declared on 1 April 2002 as an upgrade from the Protected Landscape Area of the same name established in 1972. The park protects a mountain range with a high percentage of well-preserved Carpathian forests. Ridge-top cattle pastures date back to the 15th century, to the times of the so-called Walachian colonisation. The Veľká Fatra National Park is also an important reservoir of fresh water thanks to high rainfalls and low evaporation in the area. The core of the range is built of granite, which reaches the surface only in places. More common are various slates, creating gentle ridges and summits of the so-called Hôlna Fatra, and limestone and dolomite rocks, creating a rough and picturesque terrain of the so-called Bralná Fatra. There are also many karst features, namely caves. Various rocks and therefore various soils, and diverse types of terrain with gentle upland meadows and pastures, sharp cliffs and deep valleys provide for an extremely rich flora and fauna. All species of large Central European carnivores live abundantly there: brown bear, grey wolf and Eurasian lynx. The UNESCO World Heritage village of Vlkolínec with well-preserved log cabins lies near.

1.3. Dates

The project ran over a period of two weeks divided into two one-week slots, each composed of a team of international research assistants, scientists and an expedition leader. Slot dates were:

6 – 12 February | 13 – 19 February 2016

Team members could join for multiple slots (within the periods specified). Dates were chosen to coincide with the best chance for snow cover for tracking purposes.

1.4. Local conditions & support

The study was a collaboration between the organisations Biosphere Expeditions and Environmental Society LENS, a Slovakian NGO founded by the lead author of this report, Tomáš Hulík.

Expedition base

The expedition team was based in the village of Švošov. During the heydays of the Austro-Hungarian Empire, the area was a popular spa holiday destination, because of its beautiful mountain setting and the presence of hot mineral springs. The team stayed in a comfortable chalet (Chata Dolinka) with all modern amenities. Team members shared twin or double or triple rooms, some with en-suite showers and toilets; breakfast and dinner were provided at base and a lunch pack was supplied for each day spent in the field.

Weather

The weather during the expedition was mild wintery with temperatures around and above zero degrees. Snow cover was thin and there were only two bouts of snowfall (see Appendix I, Table 1).

Field communications

There was mobile phone coverage in Švošov, but there was very little mobile phone coverage in the national park study site. There were hand-held radios for groups working close together. The villa base had WiFi internet. The expedition leader posted a diary with multimedia content on Wordpress and excerpts of this were mirrored on Biosphere Expeditions' social media sites such as Facebook and Google+.

Transport & vehicles

Team members made their own way to Bratislava or Kraľovany. From there onwards and back to Bratislava all transport was provided for the expedition team.

Medical support and incidents

The expedition leader was a trained first aider and the expedition carried a comprehensive medical kit. Further medical support was provided via a network of mountain rescue stations. The nearest hospital was in the nearby town of Ružomberok (30 km from base). In case of immediate need of hospitalisation, and weather permitting, helicopters of the mountain rescue service were also available. Safety and emergency procedures were in place, but did not have to be invoked, as there were no medical or other emergency incidents during the expedition.

All team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation.

1.5. Local scientist

Tomáš Hulík is a wildlife film maker, photographer and environmentalist. He graduated from the Faculty of Natural Sciences at the University of Komensky, Environmental Department in Bratislava. He has participated in scientific and photographic expeditions to the Far East of Russia, to the island of Sakhalin, as well as to Borneo and Malaysia. Alongside his work as a biologist, he also works in environments such as a television, either as a cameraman or as a producer. His films “Hulík and the beavers”, “High Tatras – wilderness frozen in time”, “Miloš and the lynxes”, “King of heaven Golden Eagle” and “Wild Slovakia” were distributed worldwide. His project “Miloš and the lynxes” has brought him back to science. He is now working on the conservation of lynx and other big predators and trying to establish the size of lynx and wolf territories, as well as the ecology of these carnivores, in the Veľká Fatra National Park.

1.6. Expedition leader

Paul Franklin was born in Oxfordshire, England and studied zoology at Swansea University. His Masters Degree was based on research of the migratory behaviour and ecology of amphibians. After graduation Paul spent a year working as a naturalist guide in the Peruvian Amazon. There, among other things, he was bitten by the travel bug. Since then he has led many expeditions and treks to far-flung corners of the globe. Travels overseas have been interspersed with time spent in the UK working, among other things, as a Nature Reserve Warden and Environmental Consultant. He is never far from a camera, and many of his wildlife and travel images have been published in magazines and books. When not travelling on foot through the world's wild places his preferred modes of transport are a kayak, mountain bike or occasionally a horse.

1.7. Expedition team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence):

6 – 12 February 2016

Louise Ashworth (UK), Christine Davison (UK), Jacqueline Jones (UK), Doris Korowiak (Germany), Katie Mather (UK), Lawrence Ninham (UK), Georg Schiefer (Germany), Edward Sellen (UK), Karolína Skřivánková (Slovakia)*.

13 – 19 February 2016

Nadine Andrews (UK), Voja Lambert (UK), Katie Mather (UK), Vincent Schaller (Sweden), Tiffany Sharpe (USA), Samantha Sharpe (USA), Yvonne Vahlensieck (Switzerland).

In addition for some or all of the time: Matthias Hammer & Tessa Merrie (Biosphere Expeditions staff), Phil Markey (expedition leader in training, UK) and Norbert Sommer (Slovakia).

*Placement kindly supported by the Friends of Biosphere Expeditions and a GlobalGiving crowdfunding campaign.

1.8. Expedition budget

Each team member paid towards expedition costs a contribution of £1,290 per person per seven-day slot. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	£
Expedition contributions	20,347
Expenditure	
Expedition base includes all board & lodging, and extra food & meals	2,671
Transport includes car fuel UK–Slovakia return, car fuel during expedition, train rides	1,227
Equipment and hardware includes research materials & gear etc. purchased in UK & Slovakia	1,391
Staff includes local and Biosphere Expeditions staff salaries, travel, expenses	4,404
Administration includes miscellaneous fees & sundries	190
Team recruitment Slovakia as estimated % of annual PR costs for Biosphere Expeditions	6,430
Income – Expenditure	**4,034**
Total percentage spent directly on project	**80%**

1.9. Acknowledgements

We are grateful to the volunteers, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. Thank you also to the staff of the State Forestry Service in Liptovský Hrádok, specially in Lubochňa and Veľká Fatra National Park in Martin, and to all those who provided assistance and information. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors for their sponsorship. Finally, thank you to František Pompáš for being such an excellent host and making us feel at home in his house.

1.10. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Enquires should be addressed to Biosphere Expeditions at the address given on the website.

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2. Monitoring large carnivores in Ľubochnianska Valley

Tomáš Hulík
Environmental Society LENS

Marcelo Mazzolli (editor)
Projeto Puma

M. Hammer (editor)
Biosphere Expeditions

2.1. Introduction

Populations of large predators have recovered during recent decades (Linnell et al. 1998), particularly in Eastern Europe, and this has brought predators in increasing contact with humans. Conflicts have increased, in the form of livestock depredation and fear of large predators in the vicinity of households. Brown bears, for instance, cause damage to livestock as well as to bee hives, orchards, crops, trees, and even vehicles and buildings (Huber 2013).

Slovakia has one of the most well-preserved populations of indigenous large carnivores in Europe, and even amongst the other Carpathian range countries. From an ecological point of view, the Carpathian arc can be considered a 'model area' due to its relatively high percentage of intact forests. Typically, the Carpathian forests are inhabited by bears (*Ursus arctos*), wolves (*Canis lupus*), lynx (*Lynx lynx*) and wildcats (*Felis silvestris*), all of which are indigenous.

In spite of the relatively stable populations of these species, there is always a risk that management practices adopted to control population numbers may compromise their populations if harvesting quotas are based on inaccurate counts or estimates. The risk is obvious since target species have already declined in the past from overhunting. Sometimes specialists claim that the risk does not exist even though they recognise the inflated counts provided by official sources. According to Okarma et al. (2000) the brown bear, for instance, "cannot be considered a threatened species in Slovakia. Its numbers are the highest in the last 150 years, and only 8–10% of the population may be shot annually (47 bears were harvested in 2012 – about 5% of the specialist-based estimated population). The existing system of bear management as well as the favourable attitude of the public make the future of this species secure in the country." This information has been confirmed recently, with estimates of the total number of brown bears in Europe in the range of 17,000 individuals, with the largest population in the Carpathians (> 7,000 bears), mostly in Romania (Okarma et al. 2000). Slovakia, according to research and DNA analysis of 2,800 samples at Technical University in Zvolen (Suja 2015), harbours around 1,200 bears. In spite of that, the IUCN (International Union for Conservation of Nature) recognises the Carpathian population as Near Threatened. Populations elsewhere in Europe vary from Least Concern to Critically Endangered. Compensation for damages by bears are paid, varying greatly among countries. For example, Slovakia pays on average a total of €16,000 per year as compensation for bear damages (Huber 2013).

In Europe, wolves are found in all countries except in the Benelux countries, Denmark, Hungary and the island states (Cyprus, Iceland, Ireland, Malta, United Kingdom). The estimated total number of wolves in Europe seems to be larger than 10,000 individuals, with the largest populations occurring in the Carpathians and in the Dinaric-Balkan region (> 3,000 wolves) (Chapron 2013). In Slovakia, specialist estimates of population numbers range from 200 to 400 individuals (Chapron 2013). Official estimates, on the other hand, speak of as many as 2,000 individuals, a fivefold difference to specialist estimates. Whatever the true numbers, the wolf is considered widespread over all the Carpathian range of Slovakia, but there is a strong threat from overhunting as wolves are persecuted all over the country, including in protected areas. For example, the official harvesting quota for 2012 was 130 individuals, but 147 were taken. This could represent a 50% decrease in the Slovakian wolf population, if specialist estimates are correct. According to more recent numbers presented by the Ministry of Agriculture and Rural Development of the Slovak Republic, the quota for the 2013/2014 season was decreased to 80 individuals, of which 29 individuals were taken (Doczy 2015).

In addition, wolves and livestock are associated with conflicts over the whole of the species' range. The rough economic cost (based on reported compensation only) over the whole range of the wolves has been estimated at over € 8 million per year, resulting from at least 20,000 domestic animals being predated. In Slovakia alone, around € 16,000 was the cost of damages in the year 2010 (Huber 2013). Doczy (2015) reports that livestock predation has increased in Europe, with estimates of sheep losses doubling from 2013 to 2014 and representing 78.08% of all losses.

Lynx are found in 23 countries and, based on a range of criteria, can be grouped into ten populations. Five are autochthonous (indigenous rather than descended from migrants or colonists), including the Carpathian population, while the others stem from reintroductions in the 1970s and 1980s (Dinaric, Alpine, Jura, Vosges-Palatinian and Bohemian-Bavarian populations), as well as from recent reintroductions, such as in the Harz Mountains of central Germany. The total number of lynx in Europe is estimated to be 9,000–10,000 individuals (excluding Russia & Belarus) (von Arx 2004). The largest and most widely distributed populations are found in the Scandinavian region and vicinities. The Carpathians harbour around 2,300 individuals, and Slovakia about 400 individuals (von Arx 2004). All the reintroduced populations are of smaller size, with fewer than 200 individuals. The population of greatest conservation concern is the autochthonous Balkan lynx population, which numbers only 40–50 individuals (von Arx 2004). The lynx is, like the wolf, widespread over all the Carpathian range, but is considered to occur in smaller numbers (Chapron 2013). Specialists believe official population numbers in Slovakia overestimated the true population by as much as 50% during the 1990s (Okarma et al. 2000). The biggest threat to lynx populations is not derived from retaliation after livestock depredation, but from hunting (including illegal forms) to reduce an assumed impact on ungulates as game animals. This fact has been neglected and no solution has been implemented towards reducing the problem. The IUCN recognises the Carpathian population as Least Concern. Populations elsewhere in Europe vary from Least Concern to Critically Endangered (von Arx 2004).

2.2. Study area

The Veľká Fatra National Park (Fig. 2.2a) is situated between the geographic coordinates N 48°47'–49°09' and E 18°50'–19°18'. The national park is inside the Inner Western Carpathian subprovince, the Fatransko-Tatranská region and the Veľká Fatra subregion. The mountain range is shaped in an irregular ellipse and stretches along a northeast–southwest pattern. The Veľká Fatra is about 40 km by 22 km in size.

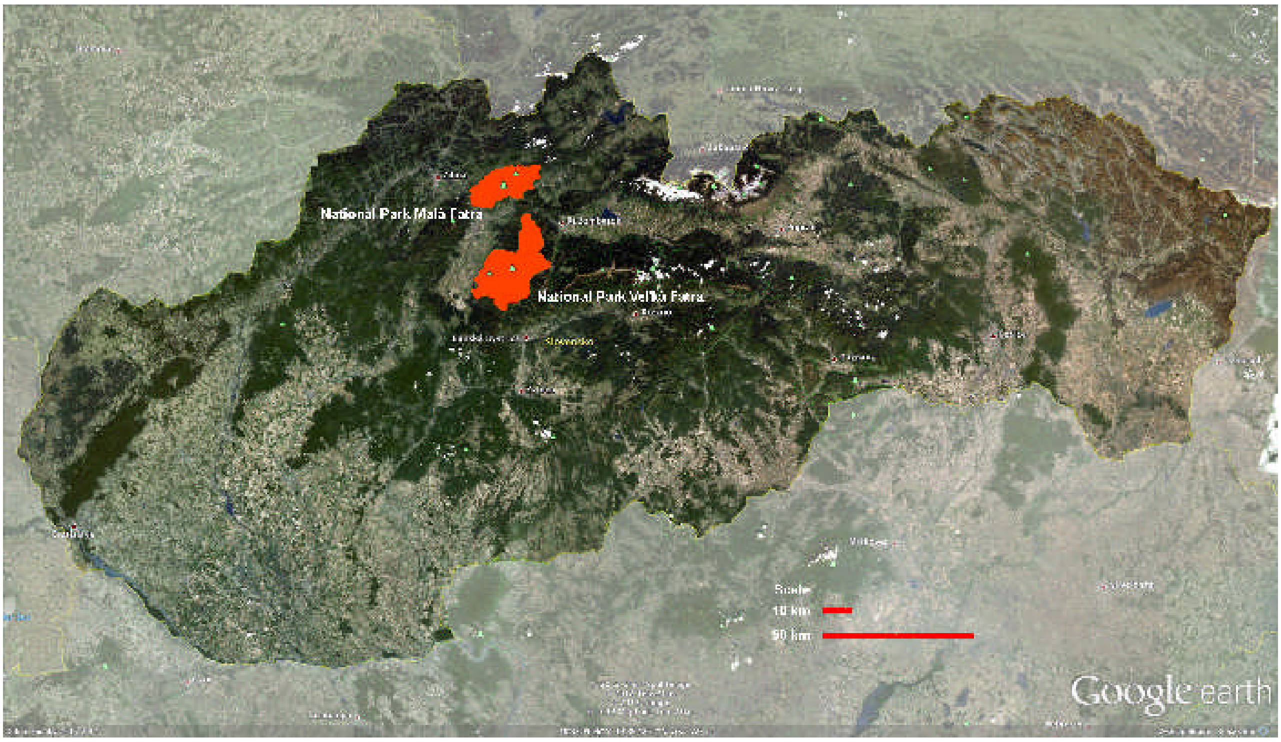

Figure 2.2a. The territory of Slovakia with Malá Fatra (above) and Veľká Fatra National Parks (below) in red.

The Veľká Fatra is one of the largest mountain areas of Slovakia, with relatively little anthropogenic impact. A granite core rises to the surface in the Smrekovica and Ľubochnianska valleys and other parts of the area consist mainly of Mesozoic sedimentary rocks. Streams have carved deep valleys into the Mesozoic crystalline rock, the longest valley being the Ľubochnianska. This valley divides the Veľká Fatra National Park from south to north and runs to the centre of the Liptov and Turiec area (Vestenický and Vološčuk 1986). The park's lowest point is at the River Vah near Krpelianska dam (420 metres), and the highest peak is Ostredok (1,592 metres).

Factors including geological substrate, landforms, soil and climatic conditions facilitated the evolution of different plant species and communities in the Veľká Fatra. More than 1,000 species of vascular plants have been identified in the area (Vestenický and Vološčuk 1986). The Veľká Fatra has retained much of its natural character, especially in the forest communities, which make up about 90% of the land area. The area is a valuable example of the Carpathian type of forest community, as there is a high occurrence of rare and endangered species. In the more remote areas, where there are negligible forest management activities, the true ancient primary forest habitat is preserved.

Veľká Fatra consists mainly of beech and spruce forests. Natural spruce forests can be found close to the treeline. The limestone and dolomite ground supports growth of Scots pine (*Pinus sylvestris*) and smaller oaks (*Quercus* spp.). In higher or exposed areas there are reduced-growth trees. Veľká Fatra is also characterised by a high occurrence of yew trees (*Taxus baccata*), so much so that the species is on the emblem of the national park.

The Veľká Fatra is dominated by native mountain animal species. So far over 3,000 species of invertebrates have been discovered including 932 types of butterflies and 350 spiders (Vestenický and Vološčuk 1986). The region also hosts eight species of amphibians, including the very rare Carpathian newt (*Triturus montandoni*), seven species of reptiles, six species of fish, 110 species of birds and 60 species of mammals (Vestenický and Vološčuk 1986). Common mammals include deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), hare (*Lepus europaeus*) and fox (*Vulpes vulpes*). Large carnivores include the brown bear (*Ursus arctos*), lynx (*Lynx lynx*), wolf (*Canis lupus*) and wildcat (*Felis silvestris*). Chamois (*Rupicapra rupicapra*) occur in the Veľká Fatra too, but are originally from the Alps. Bird species include the rare golden eagle (*Aquila chrysaetos*), capercaillie (*Tetrao urogallus*), black grouse (*Tetrao tetrix*), Alpine accentor (*Prunella collaris*) and wallcreeper (*Tichodroma muraria*).

The climate of Veľká Fatra is temperate/cold, typical of high mountain areas. The highest altitudes of the Veľká Fatra have an extremely cold climate. Precipitation is typically from 800 to 1,200 mm per year. The whole area is characterised by a wealth of surface and groundwater stores, mainly associated with the limestone rocks. Various sources are important for drinking water supplies, so much so that the Veľká Fatra region was declared a protected area of natural water accumulation in 1987.

Ľubochnianska Valley is the longest valley of Veľká Fatra, and indeed Slovakia. It contains the Ľubochnianka River and measures 25 km in length. It runs in a north–south direction starting at the village of Ľubochňa (district Ružomberok) and ending along the ridge of Ploská and Čierny kameň.

2.3. Materials and methods

In this study a combination of snow-tracking and camera-trapping recording techniques were used to provide information on species‘ presence, use of habitat and relative numbers. Signs recorded included footprints, animal trails of footprints, scats, feeding remains, marking points and any other signs of the presence of large carnivores that could be detected. Samples such as scats, hair and urine were collected for DNA analysis. This DNA analysis will hopefully take place in 2017 in a newly built laborortary in Slovakia. Negotiations are under way.

Study design

Study design is one of the most important aspects of a study. Without a proper design, a study is composed of fragments of incoherent information, rather than a construction that allows ecological inferences about the environment and the populations under study. Within studies of rare and elusive species, analyses of population densities (i.e. the number of individuals per area) are often the main issue of a research project, because density relates to the conservation status of a species or population.

Mazzolli and Hammer (2013) argue that density estimates are, however, commonly erroneously obtained from simple counts. Counts do not provide density estimates when the observer does not know the fraction of the total population he has counted. The only way to obtain that information is through capture-recapture statistics. This requires animals to be identified individually, either by trapping them or by recognising individuals from photographs, or by using the ’distance’ procedure. The difference in the counts from the first to the subsequent recaptures gives the statistics necessary to estimate total population size.

However, this report is not the place to detail and compare methodological issues. What is of interest for this study is that estimating parameters related to density requires something to go back to, to check if what was once seen or recorded is still there, in the same location, in similar frequencies, or found with the same effort as before. This is the basis for ecological inferences, or, as noted above, information will be lost.

Given this theory, short-term expeditions can collect useful information such as the locations where different species were found (and not found), and where they were found more or less frequently. Any combination of recording methods can be used to determine these parameters, be it snow-tracking, camera-trapping or DNA analysis (genotyping at species or individual level).

GPS waypoints (coordinates) are not convenient units to analyse large amounts of data related to the presence of species in certain locations. This is because it is difficult to go back to each individual waypoint to verify the recurrence of a species or an individual. Another issue is the estimation of footprint frequency and density during snow-tracking, because by and large this does not take into account autocorrelation – no breaking points are usually established for footprint counts; that is, footprints are counted continuously, not at established intervals as they should be. That is why a grid system is employed here. The size of the grid may vary according to the size of the geographical area. As a rule of thumb, the larger the area and the target species, the larger the grid cell. For example, the European Commission employed cells of 10 x 10 km to verify the status and distribution for large carnivores on the entire European continent (Kaczensky et al. 2013) and some countries use reoccurrence of records in each cell to check if populations of species are increasing, declining, or stable.

Putting it simply, cells of a grid can be traced back (revisited) more easily than GPS waypoints and in theory this is approximately equivalent to a capture-recapture procedure employed for the estimation of population density. This idea was first proposed by MacKenzie et al. (2002) and for management purposes has since often been used as a substitute for population density, also allowing for monitoring of metapopulation dynamics involving local extinctions and recolonisations (MacKenzie et al. 2003).

Alternatively, but following the same reasoning of revisitation of a sampling location, Linnell et al. (2007), in their snow-tracking study of lynx, used over 360 transects crossed by individuals of the species to test indexes employing detection probabilities used in capture-recapture statistics. Instead of grids and cells, they used independent, short transects to detect if lynx were present or not on the transect during consecutive nights.

For this study, presence-absence identification of species using camera traps and footprint identification, as well as snow-tracking, were the main methods employed to record data.

Samples of urine, scats, hair and blood were also collected for future DNA analysis, due in 2017.

In order to generate standardised data, outputs and maps that can be compiled relatively easily, we used the 10 x 10 km EEA grid system. We downsized the size of the grid to 2.5 x 2.5 km cells (Fig. 2.3a). This size is better suited to a foot-based volunteer survey effort and is an ecologically more appropriate size to detect and differentiate the target species in the research area of Veľká Fatra. Within this cell grid system, 33 transects were surveyed, with a total length of 462 km and covering 27 cells.

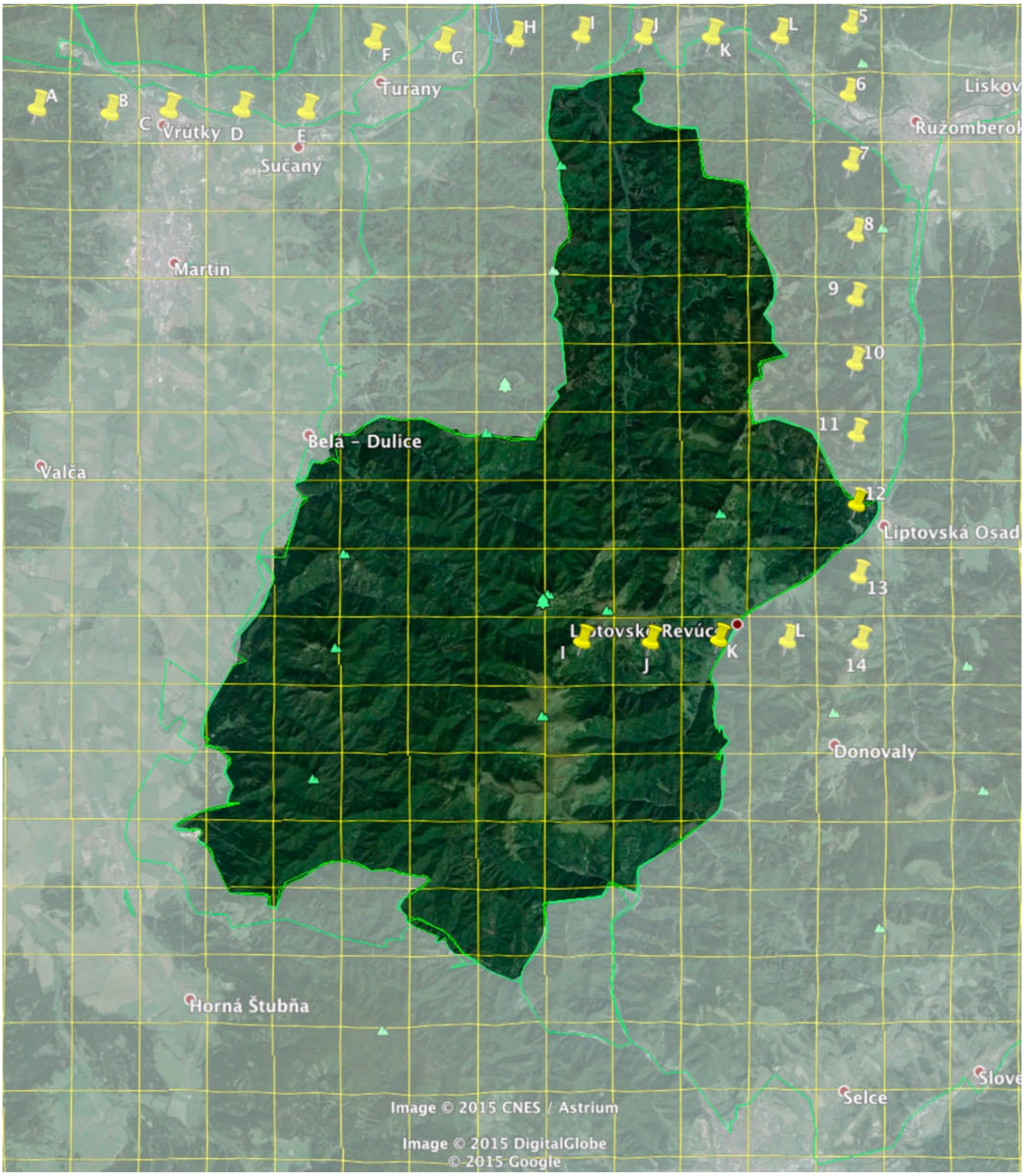

Figure 2.3a. Grid system covering Veľká Fatra National Park.

Training of volunteers

The first two days of each group was dedicated to the training of volunteers. The first day dealt with the identification of signs, including footprints and their recognition/recording on various substrates. Volunteers also received training for working with GPS devices and data collection protocols.

The second day of training focussed on identifying footprints and the practical implementation of newly acquired skills in the field. During the two training days, volunteers were also instructed in the use of snowshoes and other equipment along with the practical application of the GPS protocol directly in the field.

The following four days in each group were dedicated to field research. Volunteers were divided into four groups and surveyed the Ľubochnianska main and side valleys in Veľká Fatra National Park. In previous years, a few surveys were also conducted in Malá Fatra National Park, but beginning with this study it was decided to focus on Veľká Fatra National Park only and all hitherto unsurveyed side valleys.

Each group of volunteers was given field guides, which showed footprints and photos of the target species, a ruler for precise measurements of length and width of footprints, standard sheets for recording data, GPS devices (Garmin eTrex 20), radios for communication between groups and a plastic box with bags and tubes containing alcohol for collecting samples from which DNA can be obtained (from urine, hair, faeces or blood).

Data recording

Standardised data sheets were used by volunteers to record information, with the exact GPS position and cell number along with details such as species observed, number of individuals (in the case of a sighting), characteristics of footprints and animal trails left by species (length, width and estimated age of the footprint), the direction of movement of the individual and the substrate type (condition of snow cover). Route and track data were recorded into a GPS device using the Tracklog and Waypoint features and these were then backed up and consolidated onto a laptop.

Samples suitable for DNA analysis (excrement, urine, hair or blood) were collected in the field into a tube with concentrated 90% alcohol and sealed into a plastic bag. Great care was taken to avoid direct contact and therefore contamination of the sample. The sample was then labelled and recorded. Samples are stored at -16°C in a dedicated laboratory of the Slovak Academy of Sciences in Bratislava. DNA markers will be used according to Mestemacher (2006), Schmidt and Kowalczyk (2006) and Downey et al. (2007) and samples are due to be analysed in 2017.

Following Laass (1999 and 2002), eight camera traps (Cuddeback Capture IR, ScoutGuard SG 560) were placed in ten locations previously determined as having intensive species activity, such as marking sites or carcasses.

Data analysis

Locations where target species had been recorded were visualised in the grid system to check for distribution of populations and to see how different recording methods compared to each other. The frequency of footprints per cell and the number of times a species was recorded in a cell were considered indications of frequency of use of those cells by target species. In case of GPS signal loss due to vegetation or terrain, missing data points were obtained via Google Earth.

2.4. Results

During the expedition period, 33 transects were surveyed, with a total length of 462 km, covering 27 cells of the grid system and encompassing a surveyed area of 168,75 square kilometeres. The average length of a transect was 13,96 km. Comparative data from other expedition years are summarised in Table 2.5a.

Tracking and snow-tracking allowed researchers to identify and follow lynx, wolf and bear trails, obtaining information on their occurrence over a large area. In total, lynx trails were followed over 1.47 km, wolf trails over 16.06 km and bear trails were followed over 0.79 km. One record of wildcat was also obtained. Besides the target species, the hazel grouse (*Tetrastes bonansia*) was recorded in two cells. Camera traps recorded European robin (*Erithacus rubecula*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), red fox (*Vulpes vulpes*), wild boar (*Sus scrofa*), otter (*Lutra lutra*) and wolf (*Canis lupus*) (photos and tables in Appendix I). Full tracking and other details are in Appendix I and a summary of results over the years in Table 2.5a.

Twelve samples were collected (8 scats, 4 urine) for DNA analysis: 11 samples (91,66%) were confirmed, by footprints, to be from wolf and one sample from bear (8,33%).

Wolf was detect in 17 cells, lynx in 6 cells, bear in 6 cells and wild cat in one cell. Lynx and wolves, shared records in 6 cells in which they were recorded (Table 2.4a). Full sampling details, including cell, spatial and temporal resampling effort are in Appendix I.

Table 2.4a. Cells in which lynx, wolves, bear and wildcat were recorded (matching cells for lynx, wolf and bear in green, matching cells for lynx and wolf in orange, matching cells for wolf and bear in red).

Lynx	Wolf	Bear	Wildcat
I7	I7	I7	J12
K8	K8	K8	
J10	J10	K11	
J8	J8	I11	
J7	J7	J11	
I10	I10	J13	
	K11		
	I11		
	J11		
	K10		
	I9		
	I8		
	J9		
	I4		
	I5		
	J12		
	J6		

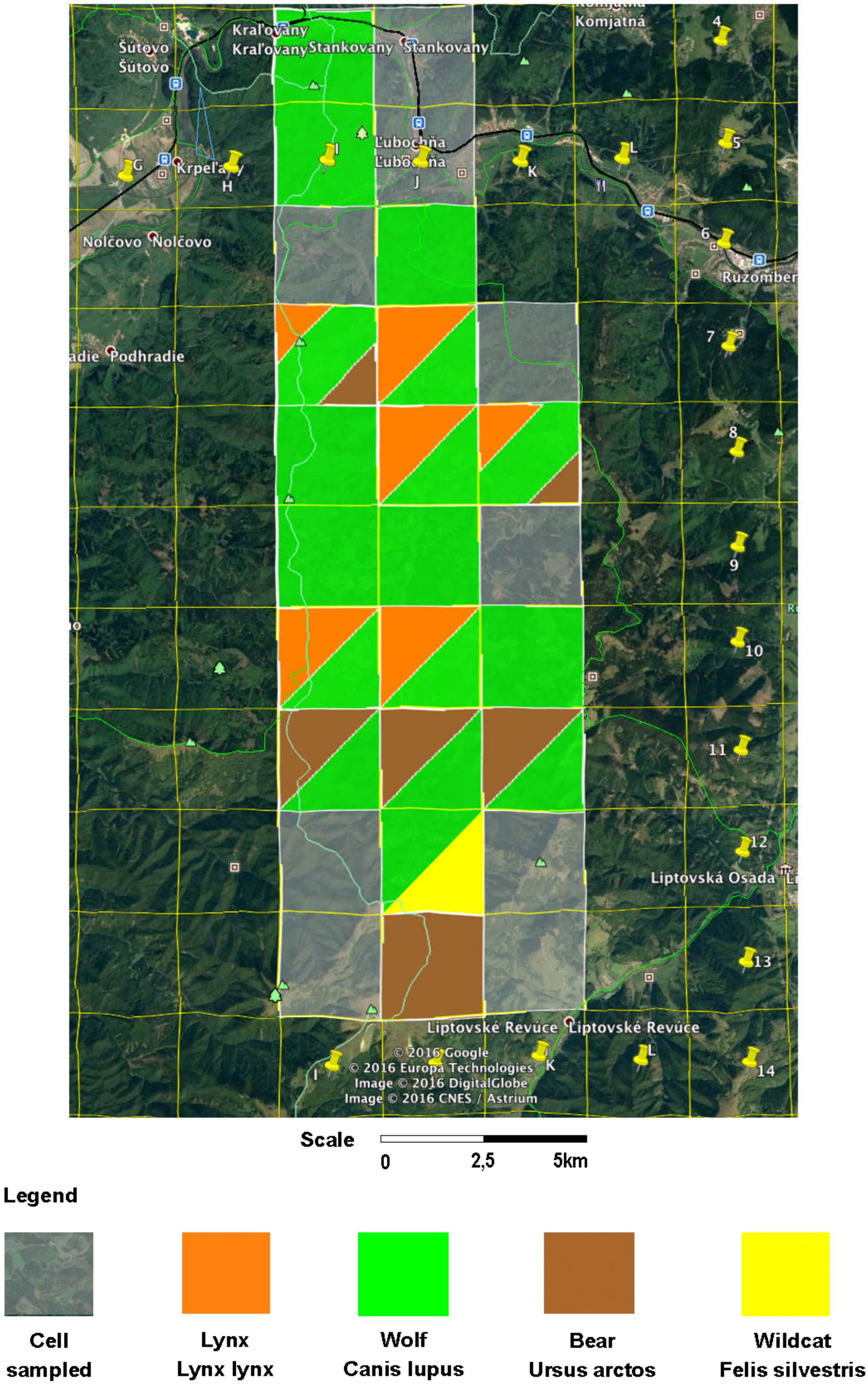

Figure 2.4a. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx, wolves, bears and wildcats per cell.

Lynx (*Lynx lynx*)

Lynx was recorded in 6 out of 27 cells. Snow-tracking contributed to the recording of lynx, while camera-trapping did not record any lynx. Prospective lynx samples were also collected and await genotyping.

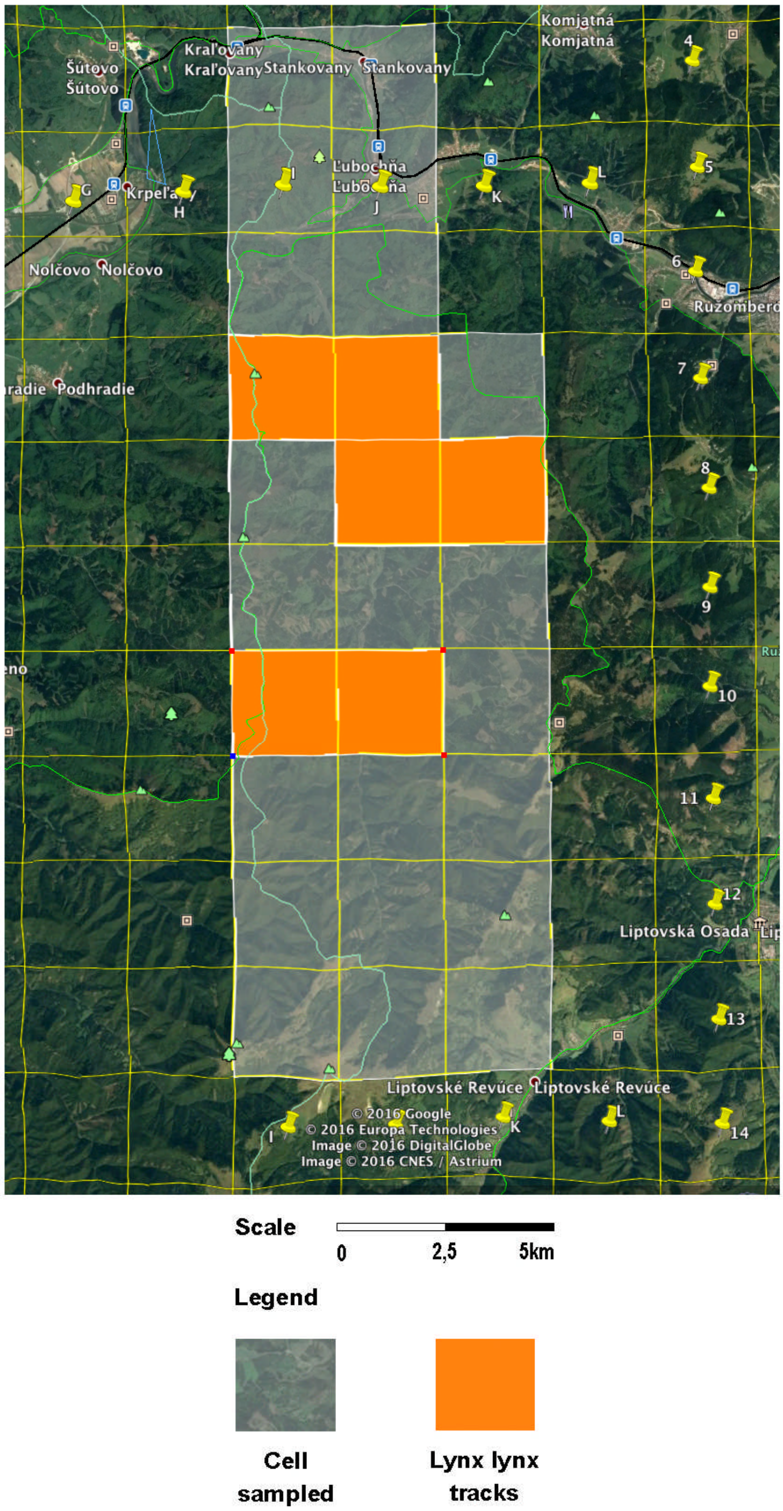

Figure 2.4b. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx per cell according to different recording methods.

Wolf (*Canis lupus*)

The species was recorded in 17 out of 27 cells surveyed. It is also worth noting that snow-tracking contributed to the recording of wolves in all 17 cells, and camera-trapping recorded wolves in one cell. Prospective wolf samples were also collected and await genotyping.

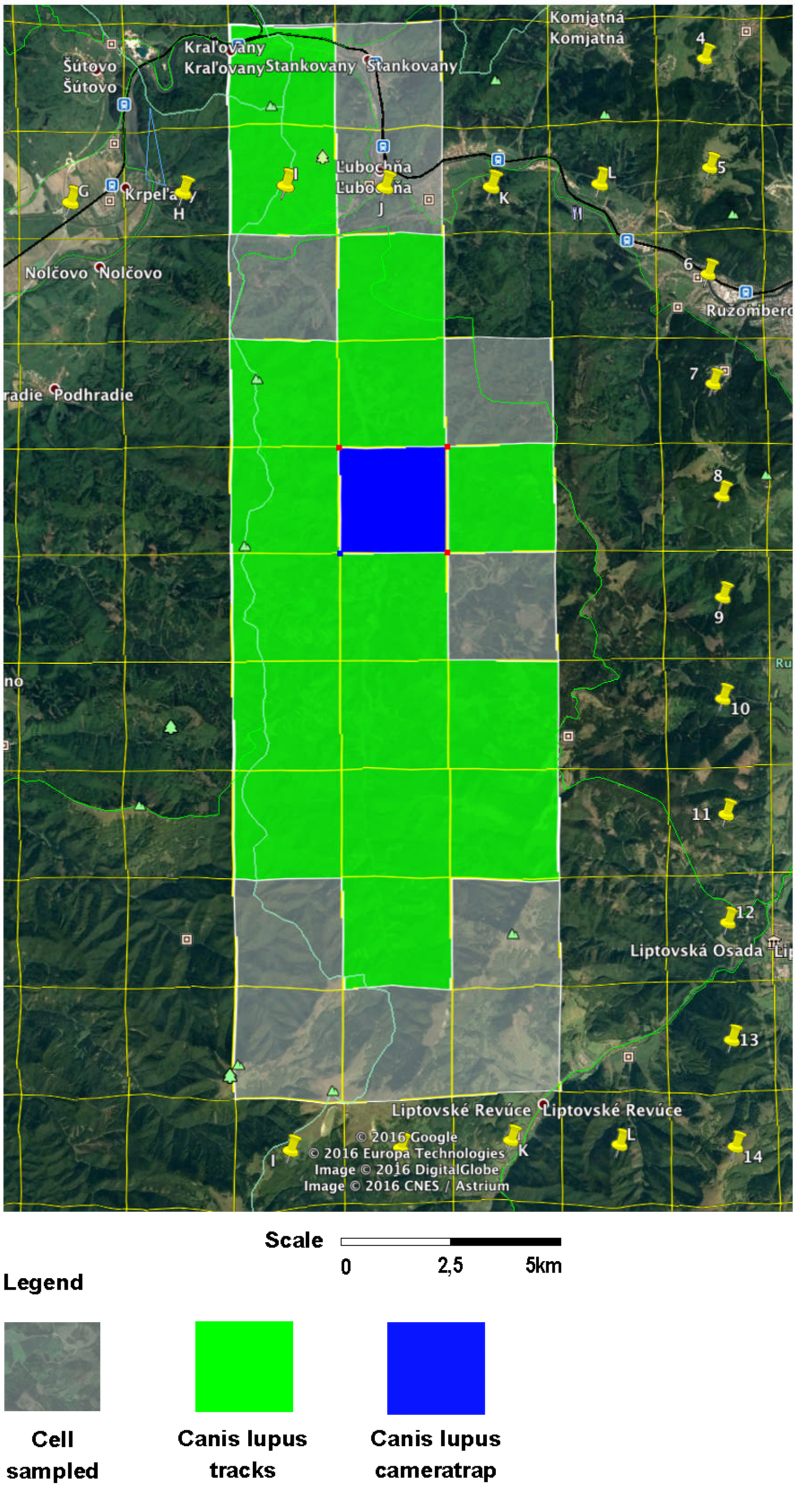

Figure 2.4c. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of wolves per cell.

Bear (*Ursus arctos*) and wildcat (*Felis silvestris*)

Bear presence was recorded in 6 cells and wildcat in 1 cell (by footprints), of the 27 cells surveyed. The expedition also collected a bear sample, which awaits genotyping.

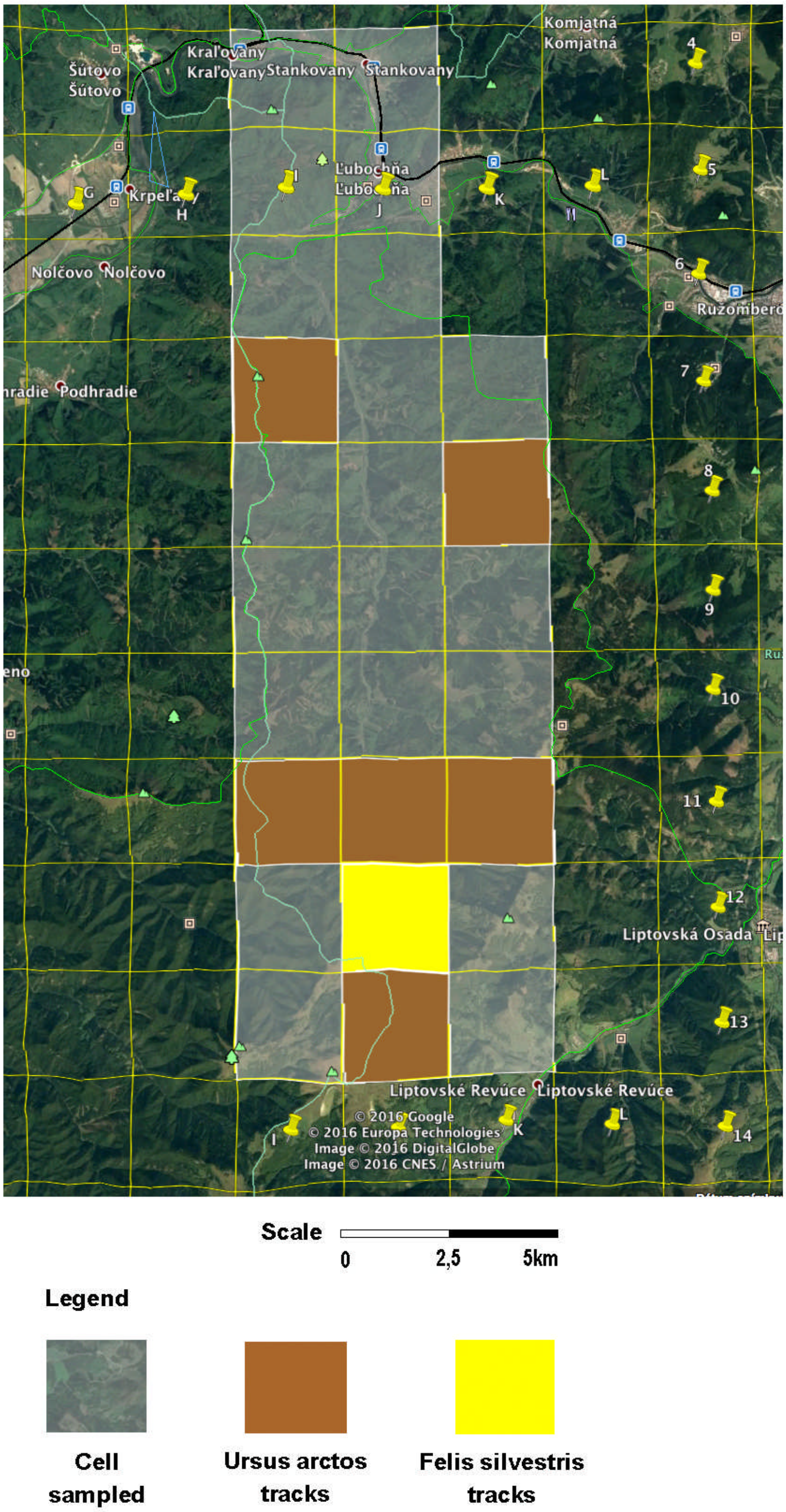

Figure 2.4d. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of bear and wildcat per cell.

Other carnivores (otter, pine marten, red fox, badger, golden eagle)

Recording carnivores other than the main target species is important in order to understand how they interact with target species, and may also give an indication of the quality of the ecosystem. The Golden eagle (*Aquila chrysaetos*) was recorded from observations, badger (*Meles meles*) and pine marten (*Martes martes*) were recorded by snow-tracking, otter (*Lutra lutra*) was recorded by snow-tracking and camera-trapping and red fox (*Vulpes vulpes*) was also recorded by camera-trapping. Pine Marten was the most recorded (n=12 cells), followed by badger (n=8 cells), then golden eagle and otter (n=3 cell for each) and red fox was recorded in two cells.

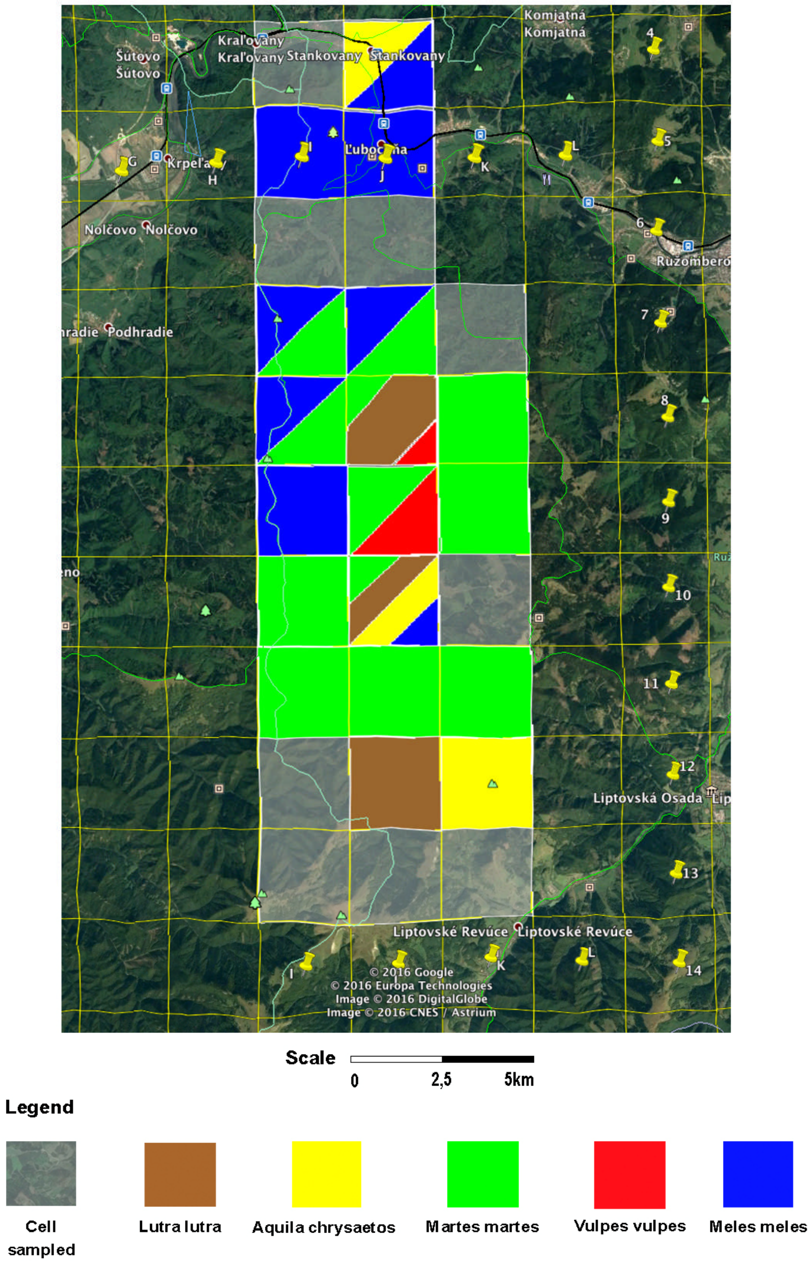

Figure 2.4f. Sampled cells (2.5 x 2.5 km in size) and results of carnivores other than lynx, wolf, bear and wildcat per cell. *L. lutra* = otter, *A. chrysaetos* = golden eagle, *M. martes* = pine marten, *V. vulpes* = red fox, *M. meles* = badger

Ungulates (roe deer, red deer, wild boar)

Red deer, roe deer and wild boar are major prey species for carnivores, hence recording their presence is important. Roe deer were recorded in 18 cells, wild boar in 14 cells and red deer in 3 cells. Roe deer and wild boar were recorded by observation, snow-tracking and from camera traps; red deer were recorded by camera trap.

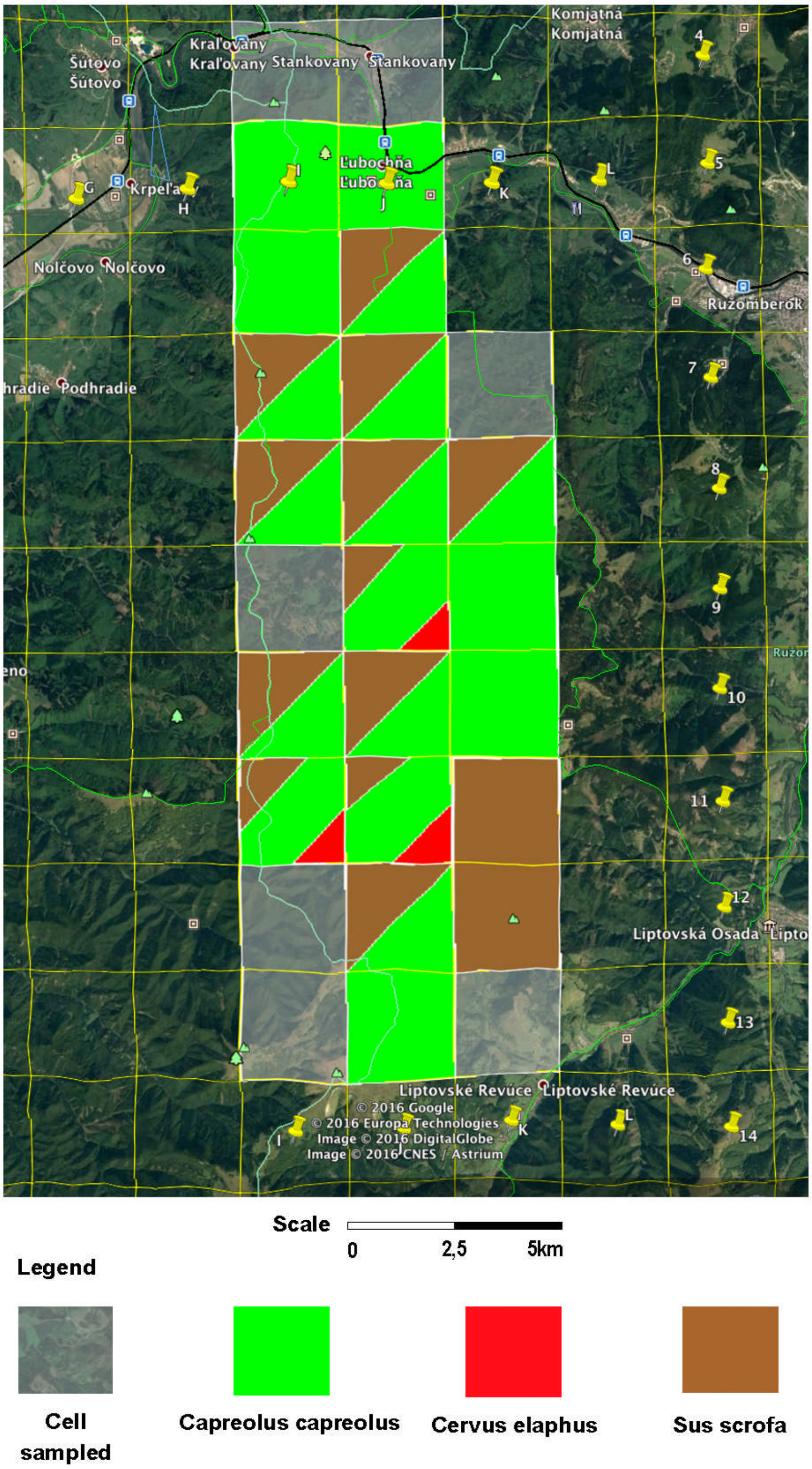

Figure 2.4g. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of roe and red deer, wild boar per cell. *C. capreolus* = roe deer, *C. elaphus* = red deer, *S. scrofa* = wild boar

Hazel grouse (*Tetrastes bonasia*)

On request from the State Forestry Department in Liptovský Hrádok, the expedition also monitored grouse. Hazel grouse (*Tetrastes bonasia*) was recorded in two cells by tracks in the snow.

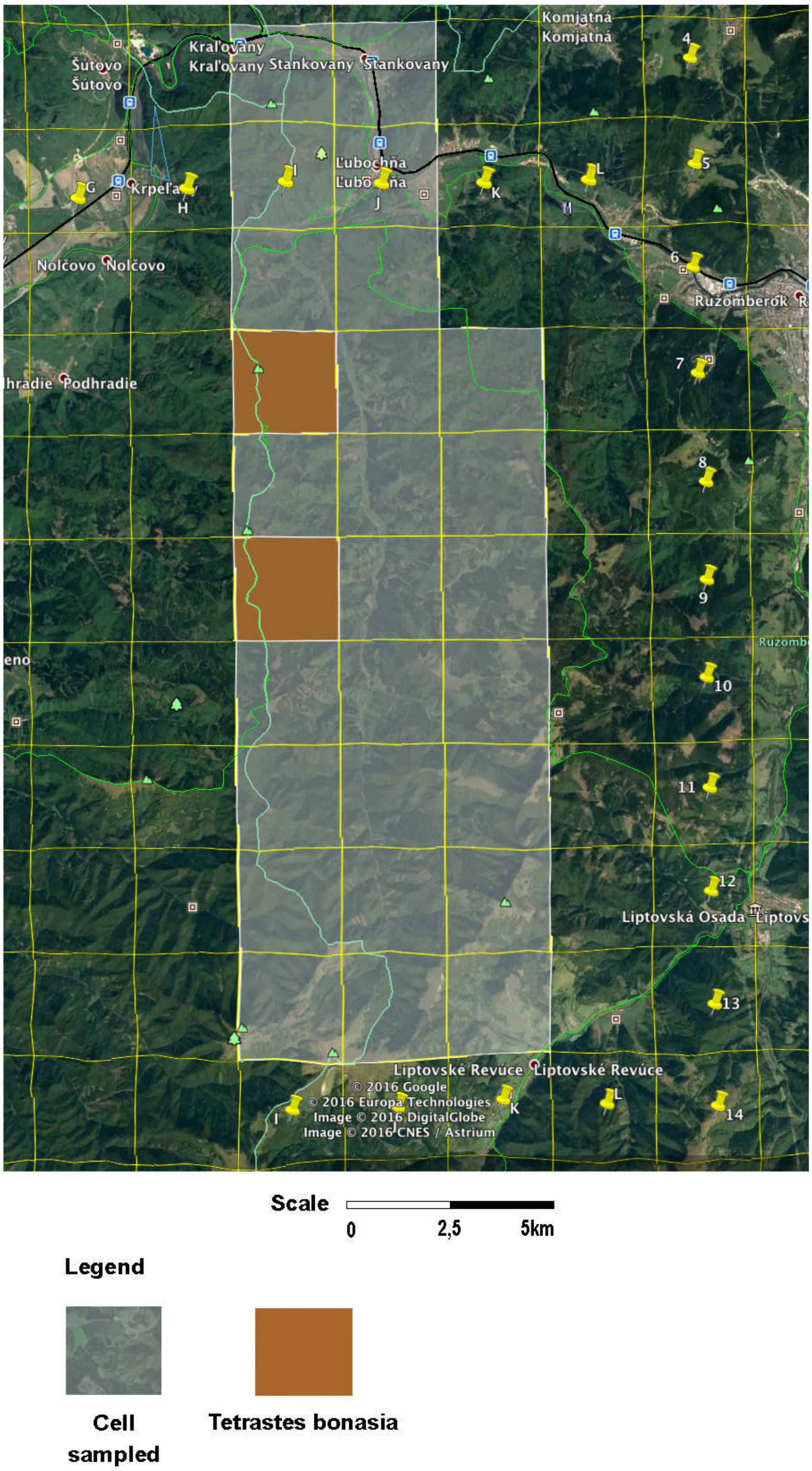

Figure 2.4h. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of hazel grouse (*Tetrastes bonasia*) per cell.

2.5. Discussion & conclusions

Recording of signs is one of the most commonly used method in monitoring large carnivores. Signs such as footprints, animal trails of footprints, scats, feeding remains, marking points and any other signs of the presence of large carnivores are recorded on transects. Passive recording of signs is the most commonly employed method for obtaining the necessary data concerning the size and structure of populations of large carnivores in Slovakia. Linnell et al. (1998) recommend the use of this method for monitoring reproductive and family groups of lynx and wolf in combination with other approaches. For this study the conditions for winter tracking and monitoring have varied in recent years and have not been optimal, because there has been either too little or too much snow. Air temperature and snow cover significantly affect the results of the research. Most prominently, this reflects on the presence of brown bears in the area of interest – Ľubochnianska Valley in Veľká Fatra.

Table 2.5a. Survey effort and results over expedition years 2012-2016.

	2012	2013	2014	2015	2016
Number of expedition weeks	3	2	2	2	2
Number of expedition participants	21	22	26	22	18
Number of transects surveyed	50	38	36	34	33
Total transect length surveyed per expedition (km)	356	307	548	438	462
Total transect length surveyed per week (km)	119	153	274	219	231
Total area surveyed (sq km)	*	136	181	134	169
Number of lynx trails found	25	15	27	23	13
Number of wolf trails found	25	20	50	49	90
Number of bear trails found	9	0	50	1	11
Number of cells that lynx was detected in	*	7	11	9	6
Number of cells that wolf was detected in	*	8	16	12	17
Number of cells that bear was detected in	*	1	17	1	6
Number of camera traps used / in different positions	9 / 15	10 / 10	10 / 12	10 / 10	8 / 11
Lynx recorded on camera trap	Yes	Yes	Yes	Yes	No
Wolf recorded on camera trap	Yes	Yes	Yes	No	Yes
Bear recorded on camera trap	Yes	Yes	Yes	No	no
Number of presumed lynx DNA samples collected	9	3	3	15	0
Number of presumed wolf DNA samples collected	9	9	13	13	11
Number of presumed bear DNA samples collected	0	0	5	0	1

* cell methodology was not used in 2012

Lynx distribution and detection

Five years of annual winter surveys from 2012 to 2016 show the lynx population to be relatively stable and unaffected by winter conditions. The number of cells that lynx was detected in, as well as the number of lynx signs found, varied positively with survey effort (total transect length surveyed each year) in previous years, but 2016 was different. Lynx moved an average of 36 km (in 2015 the figure was 7 km per day). We found no kills from lynx or other predators at all. Jendrzejewska et al. (2002) describe how if a kill is made, the lynx will stay close to it and move very little. Unusually mild winter conditions in 2016 with low snow coverage are likely to have enabled the lynx to find enough food in higher or remote positions of Velka Fatra, which were not surveyed. This is because the lynx's main prey, the roe deer (Jobin et al. 2000, Okarma et al. 1997), were not concentrated in the valleys at this time. During harsher winters they depend on the various feeding stations set up by hunters and foresters to ensure an artificially high roe and red deer population for hunting purposes (Schmidt 2008).

Wolf distribution and detection

There appears to be a strong correlation between winter severity and wolf distribution/detection.

In 2016, during a mild winter, wolf signs equalled the highest frequency since the beginning of annual winter surveys in 2012. Wolf signs were detected in 16 cells. This matches detection rates in 2014, when the winter was also mild and wolf signs were also detected in 16 cells.

Jędrzejewski et al. (2000) and Find'o (2002) have previously argued that during mild winters, deer and wild boar, the main wolf prey species, can remain on high ground, where food is still readily available due to little or no snow cover. By contrast, harsh winters with high snow cover on the hills force ungulates into the valleys in search of food. In mild winters this means that, firstly, prey are not concentrated around feeding stations and therefore distributed more widely through the park making them harder to track down. Secondly, no snow or low snow levels make prey escape easier and therefore hunting success lower, as the snow does not hamper movement.

Thus in 2014 and 2016 wolves had to hunt in a much larger area than in previous years, as confirmed by their detection in 16 cells (Hulik et al. 2015). Corroborating evidence includes the fact that surveys in 2016 did not detect any wolf prey carcasses, as kills would have been spread widely around the study site and as such harder to detect.

During the harsher winders of 2012 & 2013, and the normal winter of 2015, the distribution/detection pattern was different. In 2015 wolves were detected in 12 cells and 4 wolf kill carcasses were found near the feeding stations in the valley bottom (Hulik et al. 2016). In 2013 wolf presence was detected in 8 cells, centred next to three carcasses around feeding stations in the valley bottom (Hulik et al. 2014). The same was true in 2012, when the current cell methodology was not yet being used by the expedition, but six carcasses close to feeding stations and associated wolf signs were found (Hulik et al. 2012).

Bear distribution and detection

As with wolves, there also appears to be a strong correlation between winter severity and bear distribution/detection. This is perhaps unsurprising as bears usually hibernate during winter and hibernation will obviously be strongly correlated to detection.

However, unlike with wolves, it appears that both very mild and very harsh winters can disrupt hibernation. Very mild winters lead to the continued availability of food, thereby removing the necessity of hibernation for survival, and very harsh winters mean that very cold temperatures interrupt hibernation, especially of young and inexperienced bears who lack the skills to build sufficiently insulated dens.

The 2016 survey found 12 fresh and older bear footprints, indicating that a significant part of the Veľká Fatra National Park bear population was not hibernating during the mild winter. This matches with 2014, also a mild winter with near autumn-like conditions and an absence of snow cover, when a surprising and interesting number of 50 trails were found (Hulik et al. 2015). In that year bears occurred in a greater number of cells than any other species of interest, concentrating in cells I7, I8, K7 and K8. In 2016 bear signs were also found in cells I7, K8, as well as in K11, I11, J11 and 13, which we believe form an area with enough resting places and shelter for winter hibernation (Hulik et al. 2015).

In 2013 no bear signs were recorded, but one bear was photographed once (Hulik et al. 2014). In 2015 one older bear footprint was recorded in cell J11 during normal winter conditions (Hulik et al. 2016). This is strong evidence that most bears were in hibernation in those years due to stable winter conditions.

In 2012, when nine bear signs were found, the extremely low temperatures approaching -30°C are likely to have interrupted hibernation, especially of young bears, who are not experienced enough to build or find suitably sheltered places for winter hibernation and so can be woken by very low temperatures (Hulik et al. 2012).

Wildcat remarks

Wildcat in Slovakia mainly occur in the south, as well as the northeast, near the border with Poland and Ukraine. Hell et al. (2004) report that the smallest population denstity of wildcat in Slovakia is in mountainous areas with coniferous forest. Sládek and Mošanský (1985) showed that now cover which last over 100 days, which in Slovakia usually happens above 700 meters, had a negative impact on the ecology of wildcat. Optimal ecological conditions for wildcat is when snow cover is around 10-20 cm, so the ecological optimum for wildcat is at lower altitudes, comparable to lynx habitat preferences (Hell et al. 2004). Wildcat signs, nonetheless, were recorded in our study area, once in 2016 and in 2015 (Hulik et al. 2016), six times in 2014 (Hulik et al. 2015) and once in 2013 (Hulik et al. 2014).

Methodological remarks

The different recording methods showed that snow-tracking can yield a substantially higher amount of information on lynx, wolf, bear and wildcat range than any other observation technique employed. Camera traps are a good tool when the aim is to record unique lynx spot patterns and a wider variety of species. We will aim to have more camera traps in the field for subsequent annual surveys. Similar results have been obtained elsewhere on other Biosphere Expeditions projects, where it was also found that DNA scatology (genotyping from scat DNA), like camera traps, helped to broaden the number of species recorded (Mazzolli et al. 2013).

This fifth year of monitoring of large carnivores in Ľubochnianska Valley in the Veľká Fatra National Park reached its set goals. Participation of volunteers in conjunction with the authorities of Veľká Fatra National Park and the Ľubochňa State Forest Department resulted in gaining further ecological insight into the ecology and behaviour of the target species with important implications for their management throughout Slovakia.

Recommendations for future expeditions

1. Set up more camera traps in suitable locations as suggested by previous research results. Ideally, the expedition will have at least one camera trap in each cell and will continue to use additional camera traps on carcasses. Use scent stations to attract target species to camera traps.

2. Continue to use the grid cell methodology to continue to elucidate species abundance and distribution.

3. Record the revisiting effort, so that it is known whether an index of presence is accurate or is a product of oversampling one area and undersampling others (capture history of grids and trails).

4. Continue to focus exclusively on the area of Ľubochnianska valley in Veľká Fatra National Park, covering all side valleys and therefore a larger area, thus increasing our chance to capture target species.

Recommendations for future research work

5. A strong effort will be made to get DNA analysis of samples collected by the expeditions carried out as soon as possible. The delay so far has been due to the lack of a suitable laboratory able to perform the analysis in Slovakia. However, such a laboratory is being set up at the time of writing and the lead author is in touch with the laboratory.

6. Once DNA analysis can be done, identify individuals from samples, and perhaps using this data, estimate species densities, survival rates and population trends using non-invasive capture–recapture techniques following Marruco et al. (2009).

7. Publish results in a peer-reviewed journal.

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APPENDIX I: Raw data, sampling (effort), maps & camera trap photos

Table 1. Overview of temperature values at Švošov and Ľubochňa valley.

Date	Temperature in ºC at 7:00 Švošov	Temperature in ºC at 16:00 Švošov	Temperature in ºC at 8:00 Valley	Fresh snow in valley (cm)
05. 02. 2016	-1.2	3	-	5
06. 02. 2016	0	3	-	-
07. 02. 2016	1.6	7	4	-
08. 02. 2016	5	5	4	-
09. 02. 2016	5	9	3	-
10. 02. 2016	5	4	4	-
11. 02. 2016	-1	0	1	20
12. 02. 2016	-	-	-	-
13. 02. 2016	-	-	-	-
14. 02. 2016	1.6	3.6	2	-
15. 02. 2016	3	4.4	2	-
16. 02. 2016	1.8	3.4	1	-
17. 02. 2016	1	7.2	1	-
18. 02. 2016	5.8	11	5	-

Table 2. Summary of results: transects surveys by group and presence of lynx, wolf, bear and wildcat tracks on transects.

	Transects surveyed			Lynx tracks			Following lynx trail		Wolf tracks			Following wolf trail		Bear tracks			Following bear trail		Wild cat tracks		
	n	km	cells	cells	n	frequency track/km	n	km	cells	n	frequency track/km	n	km	cells	n	frequency track/km	n	km	cells	n	frequency track/km
Group1	16	222.45	22	3	5	44.9	0	0	11	35	6.36	6	10.20	6	10	22.25	1	0.79	1	1	222.45
Group2	17	239.37	22	4	8	29.92	1	1.47	13	55	4.35	10	5.86	1	1	239.37	0	0	0	0	0
Total	33	461.82	44	7	13	35.52	1	1.47	24	90	5.13	16	16.06	7	11	41.98	1	0.79	1	1	461.82

Table 3. Summary of results: cell resampling information.

Cell number	Number of times cells have been sampled (check cells)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J10	x	x	x	x	x	x	x	x	x					
K10	x	x	x	x										
J7	x	x	x	x	x	x	x	x	x	x	x			
J8	x	x	x	x	x	x	x	x	x	x	x			
K8	x	x	x											
J11	x	x	x	x	x	x	x							
K11	x													
K12	x	x												
I11	x	x	x											

I12	x	x	x									
J12	x	x	x	x	x	x						
I13	x											
J13	x	x	x	x	x							
I9	x	x	x	x								
J9	x	x	x	x	x	x	x	x	x	x	x	x
I10	x	x	x	x	x	x						
K13	x											
I8	x	x	x	x	x	x						
K9	x	x	x									
I7	x	x	x	x								
I6	x											
J6	x	x	x	x								
I4	x											
I5	x											
I6	x											
J4	x											
J5	x	x										
K7	x											

Table 4. Summary of results: temporal resampling of species – "capture history".

Target species	7 Feb	8 Feb	9 Feb	10 Feb	11 Feb	12 Feb	13 Feb	14 Feb	15 Feb	16 Feb	17 Feb	18 Feb
Wolf	x	x	x	x	x				x	x	x	x
Lynx	x	x								x		x
Wild cat			x									
Bear		x	x		x							x
Golden eagle			x		x					x		
Otter					x			x			x	
Hazel grouse			x						x	x		

Table 5. Summary of results: spatial resampling of species.

Species	Cells *(do not repeat cells)*	Type of record
Wolf	J10, K8, K10, K11, J11, I11, I9, I8, J8, J7, J9, I4, I5, I7, J12, I10, J6	Footprints, scat, urine, cametrap
Lynx	J10, K8, J8, I7, J7, I10	footprints
Wild cat	J12	footprints
Bear	K8, K11, I11, J11, J13, I7	Footprints, scat
Red deer	J9, I11, J11	Cameratrap
Roe deer	I5, J5, J6, I7, J7, I8, J8, K8, J9, K9, I10, J10, K10, I11, J11, J12, J13	Footprints, observations, cameratrap
Golden eagle	K12, J10, J4	observation
Otter	J8, J10, J12	Footprints, cameratrap
Wild boar	J6, I7, J7, I8, J8, K8, J9, I10, J10, I11, J11, K11, J12	Footprints, cameratrap
Marten	I7, J7, I8, J8, K8, J9, K9, I10, J10, I11, J11	footprints
Red Fox	J8, J9	
Badger	J4, I5, J5, I7, J7, I9, J10	footprints
Hazel grouse	I9, I7	Footprints, observations

Table 6. Overview of footprints and animal trails recorded.

#	Date	Species	GPS Deg	GPS min	GPS sec	Quadrant (Cell)	Footprint width (cm)	Footprint length (cm)	Direction of travel (bearing)	Age of footprint notes
01	07.02.2016	*Canis lupus*	N49 E19	00 08	33 40	J10	10	12	From 70 to 174	Older, at least 3 animals
02	07.02.2016	*Lynx lynx*	N49 E19	00 09	10.94 42.93	J10	10	9	From 160 to 329	Fresh, male?
03	07.02.2016	*Lynx lynx*	N49 E19	00 09	10.94 42.93	J10	7.5	8	From 160 to 329	Fresh, female?
04	07.02.2016	*Lynx lynx*	N49 E19	00 09	10.94 42.93	J10	5	5.5	From 160 to 329	Fresh, young?
05	07.02.2016	*Canis lupus*	N49 E10	00 09	8.85 50.28	J10	10	12	from 328 to 142	Fresh
06	08.02.2016	*Canis lupus*	N49 E19	03 11	17.2 14.7	K8	8.5	13	From 0 to 125	Fresh, start following
06A	08.02.2016	*Canis lupus*	N49 E19	03 11	10.4 10.3	K8	9	11	To 200	Fresh, finished following. at least 4 ind.
07	08.02.2016	*Ursus arctos*	N49 E19	03 11	13.8 6.1	K8	16	23	From 270 to 180	Fresh. start following
07A	08.02.2016	*Ursus arctos*	N49 E19	03 10	14 44.8	K8			From 270	Fresh, finish following
08	08.02.2016	*Canis lupus*	N49 E19	03 11	5.3 0.5	K8	9.5	13	From 230 to 300	Fresh, start following 3 ind.
08A	08.02.2016	*Canis lupus*	N49 E19	03 10	2.8 50.5	K8				Fresh, finish following
09	08.02.2016	*Lynx lynx*	N49 E19	02 10	46.5 39.5	K8	7.5	10	From 230 to 140	fresh
10	08.02.2016	*Lynx lynx*	N49 E19	02 10	55 12.2	J8	10	12.5	From 180 to 0	older
11	08.02. 2016	*Canis lupus*	N49 E19	00 08	30.7 26	J10	9	11	From 160 to 330	Fresh-older. 3+ind. Start following
11A	08.02. 2016	*Canis lupus*	N49 E19	00 06	33.7 48.9	I10				Fresh – older Finish following animal trail
12	08.02. 2016	*Canis lupus*	N48 E19	59 08	42.4 18.6	K10	10.5	0	From 330 to 140	Older, lone wolf Start following
12A	08.02. 2016	*Canis lupus*	N48 E19	59 10	22.9 15.4	K11	10.5			Finish following
13	08.02. 2016	*Ursus arctos*	N48 E19	58 10	51.6 49.1	K11			Down stream	Older

14	08.02. 2016	*Canis lupus*	N48 E19	58 09	47.1 33.7	J11	10.5		From 111 to 288	Older
15	08.02. 2016	*Canis lupus*	N48 E19	58 08	55.6 31.2	J11	10		From 80 to 260	Fresh
16	08.02. 2016	*Canis lupus*	N49 E19	04 08	29.4 44.6	I7	8	10.5	From 92 to 280	Very fresh
17	08.02. 2016	*Canis lupus*	N49 E19	04 08	40.1 45.6	I7	10	15	From 162 to 352	Fresh. 2+ ind.
17A	08.02.2016	*Canis lupus*	N49 E19	04 08	42.1 45	I7			To 46	Fresh, finish following
18	08.02.2016	*Canis lupus*	N49 E08	04 08	47 17.5	I7			From 188 to 20	Old, scat
19	08.02.2016	*Ursus arctos*	N49 E19	04 08	57.6 24.6	I7				Old, scat
20	08.02.2016	*Canis lupus*	N49 E19	03 07	54.2 37.7	I8	8.5	11	From 350 to 162	Fresh
21	08.02.2016	*Canis lupus*	N49 E19	03 07	47.4 43.8	I8	10	11	From 256 to 64	Older
22	09.02.2016	*Ursus arctos*	N48 E19	59 08	32.4 4.5	J11	13		From 0 to 292	Older
23	09.02.2016	*Canis lupus*	N48 E19	59 07	30.4 19.3	I11	9.5	9	From 208 to 40	Fresh
24	09.02.2016	*Canis lupus*	N48 E19	59 06	35.8 46.5	I11	11		From 98 to 290	Fresh Start following trail
24A	09.02.2016	*Canis lupus*	N48 E19	59 06	38.9 35.7	I11	11		From 154 to 320	Fresh
24B	09.02.2016	*Canis lupus*	N48 E19	59 07	16.44 0.97	I11			along road	Fresh
24C	09.02.2016	*Canis lupus*	N48 E19	59 07	08.7 19.5	I11				Fresh scat
25	09.02.2016	*Ursus arctos*	N48 E19	59 07	04.2 21.2	I11	18		From 60 to 234	Old
26	09.02.2016	*Ursus arctos*	N48 E19	58 07	46.9 41.5	I11			From 80 to 352	Very old
26A	09.02.2016	*Ursus arctos*	N48 E19	58 07	47.48 8.75	I11				Very old
24D	09.02.2016	*Canis lupus*	N48 E19	58 06	46.2 35.5	I11				Finish following trail
27	09.02.2016	*Canis lupus*	N48 E19	58 07	38.9 21.8	I11	10		From 120 to 310	Older
28	09.02.2016	*Canis lupus*	N48 E19	58 07	34.5 27.3	I11	10 + 9		From 30 to 180	Older, two animals

29	09.02.2016	*Canis lupus*	N48 E19	58 07	36.8 57.9	J11	9.5		From 50 to 160	Older. 2+ indv.
30	09.02.2016	*Canis lupus*	N48 E19	59 08	28 16	J11				Older, scat
31	09.02.2016	*Ursus arctos*	N48 E19	57 07	07.2 39.6	J13	20			Old
32	09.02.2016	*Canis lupus*	N49 E19	01 07	57.4 31	I9	9.5	12	From 158 to 330	Older. 2+ indv.
33	09.02.2016	*Felis silvestris*	N48 E19	57 08	21 26.5	J12	6	5	From 280 to 95	Fresh
34	10.02.2016	*Canis lupus*	N49 E19	02 08	51.2 43.3	J8	8.5	9	To 102	Fresh
35	10.02.2016	*Canis lupus*	N49 E19	02 08	36.7 37.8	J8				Scat
36	10.02.2016	*Ursus arctos*	N49 E19	02 08	53 09.9	I8	22	28	From 270 to 90	Older
37	10.02.2016	*Canis lupus*	N49 E19	02 08	52.7 06.8	I8	10	10	To 160	Fresh
38	10.02.2016	*Canis lupus*	N49 E19	02 07	52.8 56.2	I8	9.5	11		Fresh. 2-3 indv.
39	10.02.2016	*Canis lupus*	N48 E19	58 08	42.6 13.6	J11				Fresh
40	11.02.2016	*Canis lupus*	N49 E19	59 10	50.2 10.1	K10				Fresh
41	15.02.2016	*Canis lupus*	N49 E19	03 09	27.4 3.7	J8	8.5	10	From 270 to 90	Older. 4+ indv. Start following
41A	15.02.2016	*Canis lupus*	N49 E19	03 09	53.21 18.24	J7	10		Crossed river	Older Finish following
42	16.02.2016	*Canis lupus*	N49 E19	05 09	46.17 38.73	J6	10	11	To 60	Older Start following
42A	16.02.2016	*Canis lupus*	N49 E19	05 09	34.25 43.08	J6	10	11		Older Finish following
43	16.02.2016	*Canis lupus*	N49 E19	05 09	20.62 25.21	J6				fresh scat
44	16.02.2016	*Canis lupus*	N49 E19	04 09	30.60 33.76	J7	7	10	From 180 to 0	Very fresh. Start following 5 ind.
44A	16.02.2016	*Canis lupus*	N49 E19	04 09	18.70 47.34	J7				Very fresh 5 ind. Finish following
44B	16.02.2016	*Canis lupus*	N49 E19	04 09	25.71 52.85	J7				Very fresh 5+ individuals
45	16.02.2016	*Canis lupus*	N49 E19	01 09	58.9 03.1	J9	9	11	Criss - cross road	Fresh. 2-3+ individ. Start following trail

45A	16.02.2016	*Canis lupus*	N49 E19	01 09	52.4 03.0	J9	8	10	Between road and river	Fresh. 1 indv.
45B	16.02.2016	*Canis lupus*	N49 E19	01 09	47.8 01.6	J9	9	11	Crossing road	Fresh. 1 indv.
45C	16.02.2016	*Canis lupus*	N49 E19	01 09	47.5 00.3	J9	11	12	To 209	Fresh. 3+ individ.
45D	16.02.2016	*Canis lupus*	N49 E19	01 08	48.49 56.92	J9				Fresh
45E	16.02.2016	*Canis lupus*	N49 E19	01 08	47.6 48.7	J9			To 170	Fresh
45F	16.02.2016	*Canis lupus*	N49 E19	01 08	45.6 59.2	J9			To 190	Fresh
46	16.02.2016	*Canis lupus*	N49 E19	07 09	54.5 09.4	I5			From 170 to 350	Very old. 3+ indiv.
47	16.02.2016	*Canis lupus*	N49 E19	07 08	54.3 24.0	I5			From 21 to 210	Old
48	16.02.2016	*Canis lupus*	N49 E19	04 08	0.6 48	J7	10	12	From 0 to 144	Very fresh
49	16.02.2016	*Canis lupus*	N49 E19	04 08	05.4 30.6	I7	9	11.5	From 180 to 24	Older
50	16.02.2016	*Canis lupus*	N49 E19	04 08	05.4 30.6	I7	10	12	From 180 to 24	Fresh
51	16.02.2016	*Canis lupus*	N49 E19	04 08	05.7 29.10	I7	10 + 8	11 + 9	From 180 to 24	Older
52	16.02.2016	*Lynx lynx*	N49 E19	04 08	16 42	I7	9	8	From 10	Older
52A	16.02.2016	*Lynx lynx*	N49 E19	04 08	16.9 48.4	J7			From 130 to 260	Older
53	16.02.2016	*Canis lupus*	N49 E19	04 08	40.7 45.9	I7	9+8+8+8	11+9+11+9	From 340 to 100	Fresh, one day old 4+ individ.
54	16.02.2016	*Canis lupus*	N49 E19	04 08	41.36 15.36	I7				
54A	16.02.2016	*Canis lupus*	N49 E19	04 08	45.30 4.87	I7				
54B	16.02.2016	*Canis lupus*	N49 E19	04 08	38.74 6.71	I7				
55	16.02.2016	*Canis lupus*	N49 E19	04 07	16.41 37.65	I7				
56	16.02.2016	*Lynx lynx*	N49 E19	04 07	16.41 37.65	I7	8	9	From 130 to 260	older
57	16.02.2016	*Canis lupus*	N49 E19	03 08	55 38	I7			From 180 to 30	Older, two days 4+ individ.

58	17.02.2016	*Canis lupus*	N49 E19	04 09	5.34 38.55	J7	7+8+9+8		From SW to 120	Fresh. 4 individ.
59	17.02.2016	*Canis lupus*	N49 E19	03 10	59.98 4.94	J7			To 0	Fresh
60	17.02.2016	*Canis lupus*	N49 E19	03 10	53.23 17.87	J7			To 90	Fresh. 4 individ.
61	17.02.2016	*Canis lupus*	N49 E19	03 11	28.54 2.56	K8	10	12	From 220	Fresh. single
62	17.02.2016	*Canis lupus*	N49 E19	05 09	0.1 20.43	J7	10.5		To 60	Older, start following
62A	17.02.2016	*Canis lupus*	N49 E19	05 09	5.28 28.65	J7	10.5			Older, finish following
63	17.02.2016	*Canis lupus*	N49 E19	05 09	9.8 38.7	J7	10			Older
63A	17.02.2016	*Canis lupus*	N49 E19	05 09	10.68 41.19	J6				
64	17.02.2016	*Canis lupus*	N49 E19	03 10	06.1 00.8	J7	9	10	To 300	Fresh. 3+ individuals Start following
64 A	17.02.2016	*Canis lupus*	N49 E19	05 10	00.7 51.8	J7			To 60	Fresh. 4+ individuals Finish following
65	17.02.2016	*Canis lupus*	N49 E19	02 08	59.9 25.1	I8	7	10	From 20 to 250	Older Two individuals
66	17.02.2016	*Canis lupus*	N49 E19	02 08	31.9 09.0	I9	11		From 0 to 180	Older
67	17.02.2016	*Canis lupus*	N49 E19	02 08	02.4 02.6	I9			From 195 to 3	Older 2individ.
68	17.02.2016	*Canis lupus*	N49 E19	02 07	05.4 51.7	I9			From 180 to 83	Older
69	17.02.2016	*Canis lupus*	N48 E19	57 08	21.97 28.42	J12	11+9+8	14+12+10		Fresh Start following
69A	17.02.2016	*Canis lupus*	N48 E19	57 08	34.44 22.22	J12			Cross river	Fresh Finished following
70	17.02.2016	*Canis lupus*	N48 E19	57 08	57.06 22.72	J12				Fresh
70A	17.02.2016	*Canis lupus*	N48 E19	58 08	05.6 19.99	J12				Fresh
71	18.02.2016	*Canis lupus*	N48 E19	58 8	9.92 20.45	J12	10		To 330	Older start following
71A	18.02.2016	*Canis lupus*	N48 E19	58 8	21.03 18.21	J12	10		To 90	Older Finished following
72	18.02.2016	*Lynx lynx*	N49 E19	00 08	35.3 25.9	J10	9	8	From 120 to 240	Fresh Start following

72A	18.02.2016	*Lynx lynx*	N49 E19	00 08	34.5 02.6	I10	9	8	From 80 to 270	Fresh
72B	18.02.2016	*Lynx lynx*	N49 E19	00 07	42.18 57.21	I10	9	8	To 230	Fresh
72C	18.02.2016	*Lynx lynx*	N49 E19	00 07	46.98 59.84	I10	9	8		
72D	18.02.2016	*Lynx lynx*	N49 E19	00 08	57.05 15.25	J10	9	8	From 50 to 230	Fresh Finish following
73	18.02.2016	*Canis lupus*	N49 E19	00 08	55.5 09.7	J10			From 50 to 230	Older Start following
73A	18.02.2016	*Canis lupus*	N49 E19	00 08	51.20 2.25	I10			From 40 to 260	Older 2+ individ.
73B	18.02.2016	*Canis lupus*	N49 E19	00 07	48.80 57.86	I10			From 330 to 240	Older
73C	18.02.2016	*Canis lupus*	N49 E19	00 07	15.7 31.4	I10			From 20 to 290	Older Finished following
74	18.02.2016	*Canis lupus*	N49 E19	01 08	29.40 56.13	J9				Fresh 2+ individ.
75	18.02.2016	*Canis lupus*	N49 E19	00 08	32.85 44.67	J10	10			Fresh 2+ individ.
76	18.02.2016	*Canis lupus*	N49 E19	04 08	04.5 33.3	I7	9		From 254 to 115	fresh
77	18.02.2016	*Ursus arctos*	N49 E19	04 08	33.16 05.40	I7				Old scat
78	18.02.2016	*Canis lupus*	N49 E19	03 07	54.1 31.8	I8	9		From 328 to 130	Fresh 2 individ.

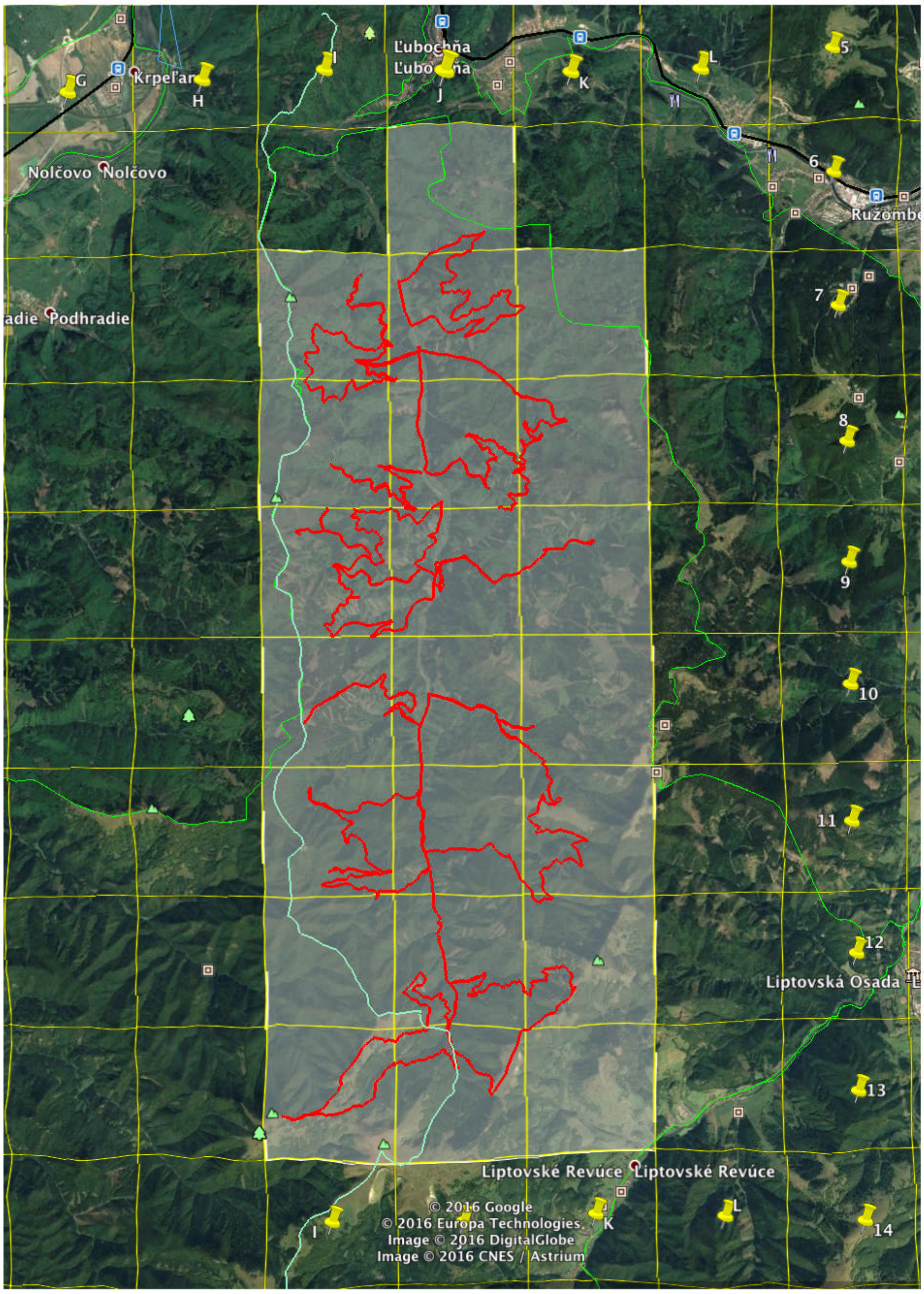
Table 7. Camera trap location. species recorded and trapping effort.

No.	Name	GPS position deg	min	sec	Quadrat (Cell)	Species recorded	Placed on	Recovered on	Trap nights
CT1	Lake Blatna	N49 E19	0 9	10.92 42.72	J10	-	07.02.2016	11.02.2016	4
CT2	Turecka 01	N49 E19	03 08	59.4 29.3	J8	Fox (*Vulpes vulpes*), wolf (*canis lupus*)	08.02.2016	11.02.2016	3
CT3	Lipova lynx trail	N49 E19	01 07	39.8 46.6	I9	-	09.02.2016	14.02.2016	5
CT4	Lipova Forest	N49 E19	01 09	38.5 04.8	J9	Fox(*Vulpes vulpes*), roe deer (*Capreolus capreolus)*	09.02.2016	18.02.2016	9
CT5	River crossing	N49 E19	58 08	43.6 15.65	J11	Red deer *(Cervus elaphus)*	11.02.2016	17.02.2016	6
CT6	Lake Blatna 02	N49 E19	00 09	11.30 42.63	J10	-	14.02.2016	18.02.2016	4
CT7	Lake Blatna 03	N49 E19	00 09	11 42.69	J10	Otter (*Lutra lutra*), European robin (*Erithacus rubecula*)	14.02.2016	18.03.2016	33
CT8	Lipova old road	N49 E19	01 08	30 56.22	J9	Roe deer (*Capreolus capreolus)*, red deer *(Cervus elaphus)*	18.02.2015	18.03.2016	29
CT9	Old road on ridge	N49 E19	01 08	53.58 5.55	I10	*Wild boar (Sus scrofa)*, red deer *(Cervus elaphus)*	18.02.2015	18.03.2016	29
CT10	Turecka 02	N49 E19	04 08	16.91 48.13	J7	-	18.02.2015	18.03.2016	29
CT11	Turecka 03	N49 E19	04 07	15.90 31.04	I7	-	18.02.2015	18.03.2016	29

Table 8. Summary of DNA samples collected.

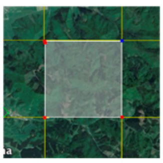
No.	Date	GPS deg	GPS min	GPS sec	Quadrat (Cell)	Species	Sample type
S1	08.02.2016	N49 E19	00 07	43,1 20,1	I10	*Canis lupus*	urine
S2	08.02.2016	N49 E19	00 07	42.3 15.4	I10	*Canis lupus*	urine
S3	08.02.2016	N49 E19	00 07	40.1 12.1	I10	*Canis lupus*	urine
S4	08.02.2016	N49 E19	04 08	47 17.5	I7	*Canis lupus*	scat
S5	08.02.2016	N49 E19	04 08	57.6 24.6	J7	*Ursus arctos*	scat
S6	09.02.2016	N48 E19	59 07	08.7 19.5	I9	*Canis lupus*	scat
S7	09.02.2016	N48 E19	59 08	28 16	J11	*Canis lupus*	scat
S8	10.02.2016	N49 E19	02 08	36.7 37.8	J8	*Canis lupus*	scat
S9	16.02.2016	N49 E19	05 09	20.65 25.21	J6	*Canis lupus*	scat
S10	16.02.2016	N49 E19	04 08	05 31	I7	*Canis lupus*	urine
S11	17.02.2016	N49 E19	05 09	11.8 46.4	J6	*Canis lupus*	scat
S12	17.02.2016	N49 E19	05 09	12.8 50.9	J6	*Canis lupus*	scat

MAPS



Legend

Surveys Slot 1



Cells sampled Slot 1

Scale

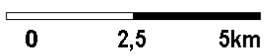


Figure 1. Transects walked by group 1.

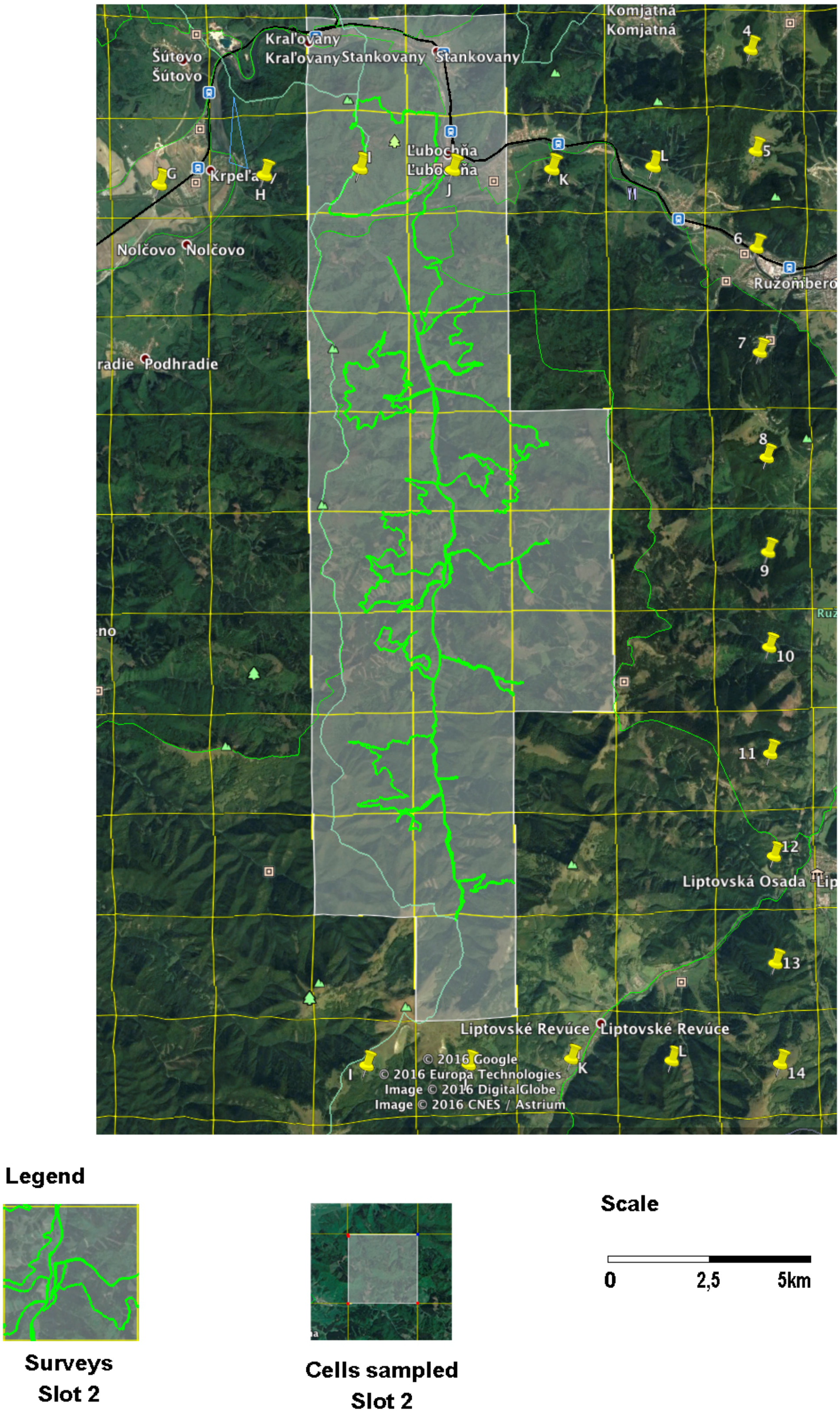


Figure 2. Transects walked by group 2.

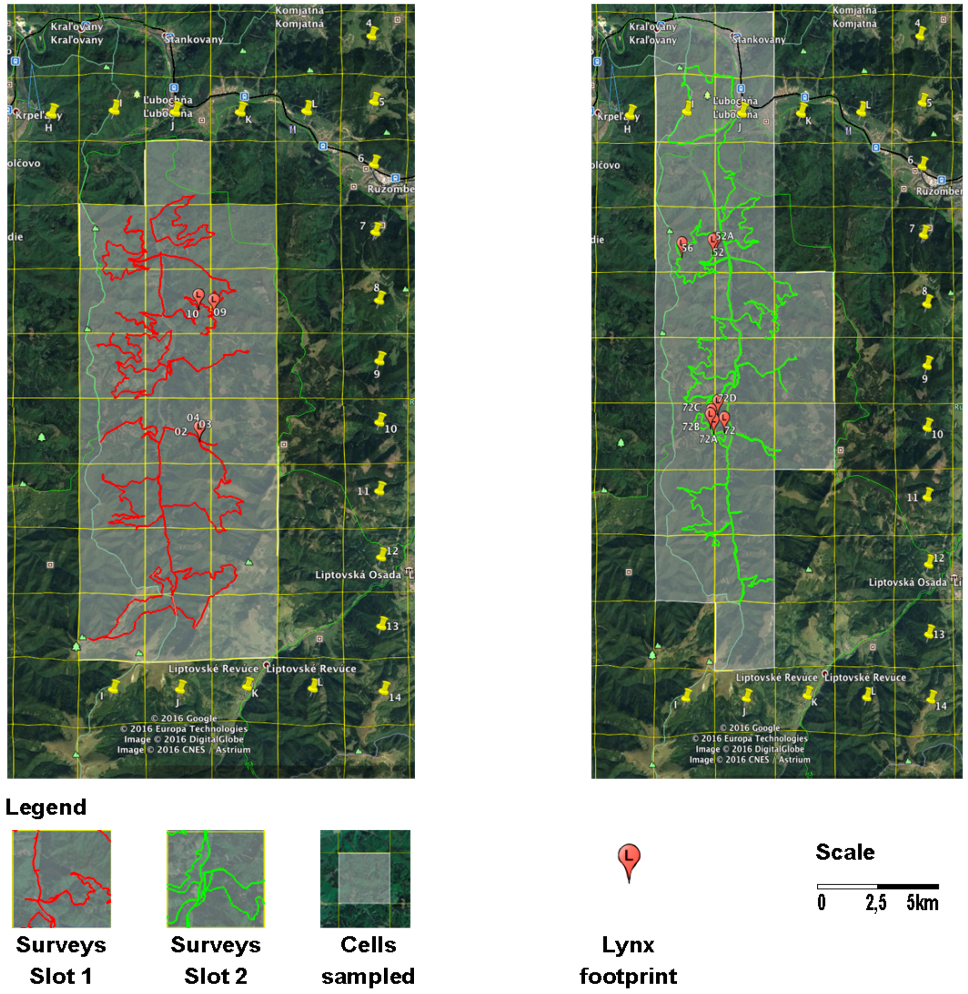


Figure 3. Transects walked by group 1 and group 2 with lynx footprints.

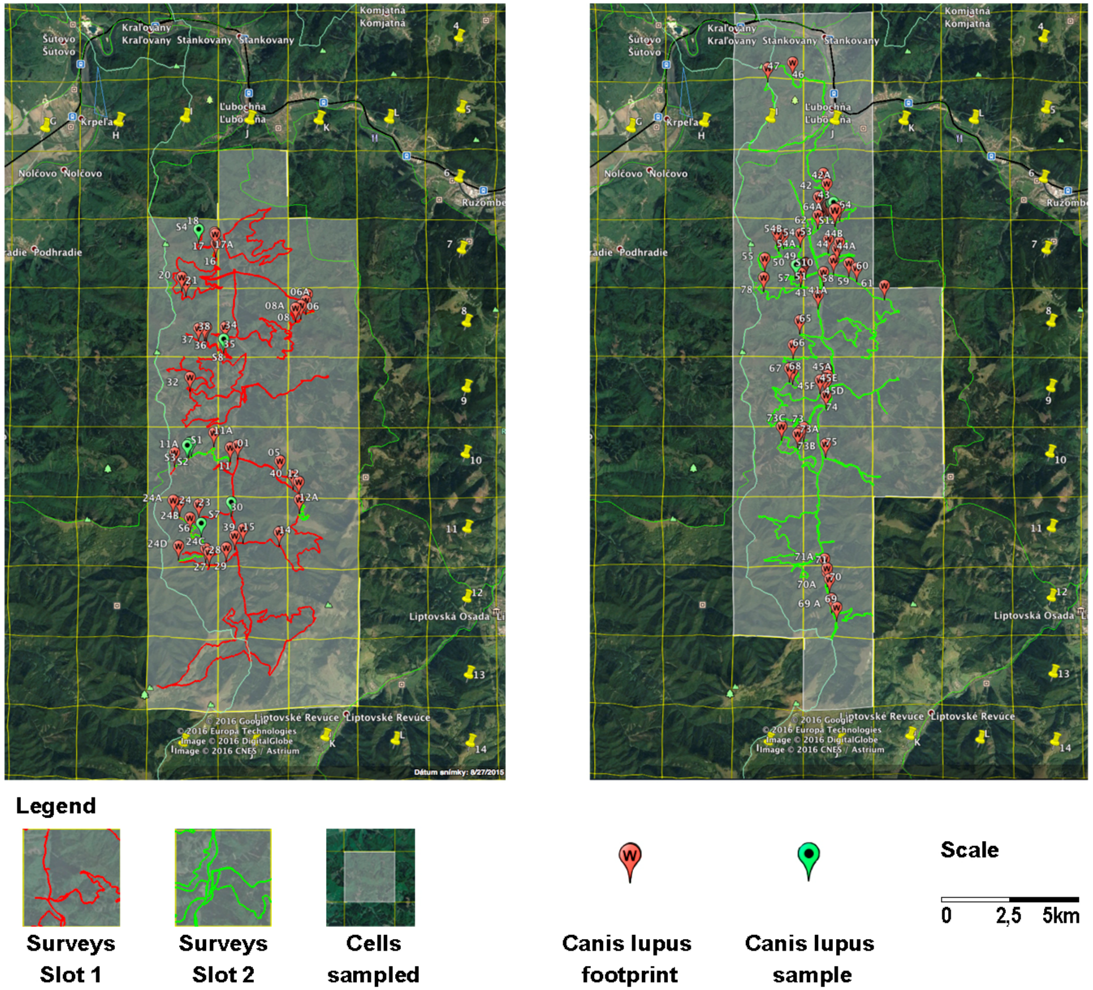


Figure 4. Transects walked by group 1and 2 with wolf footprints and samples.

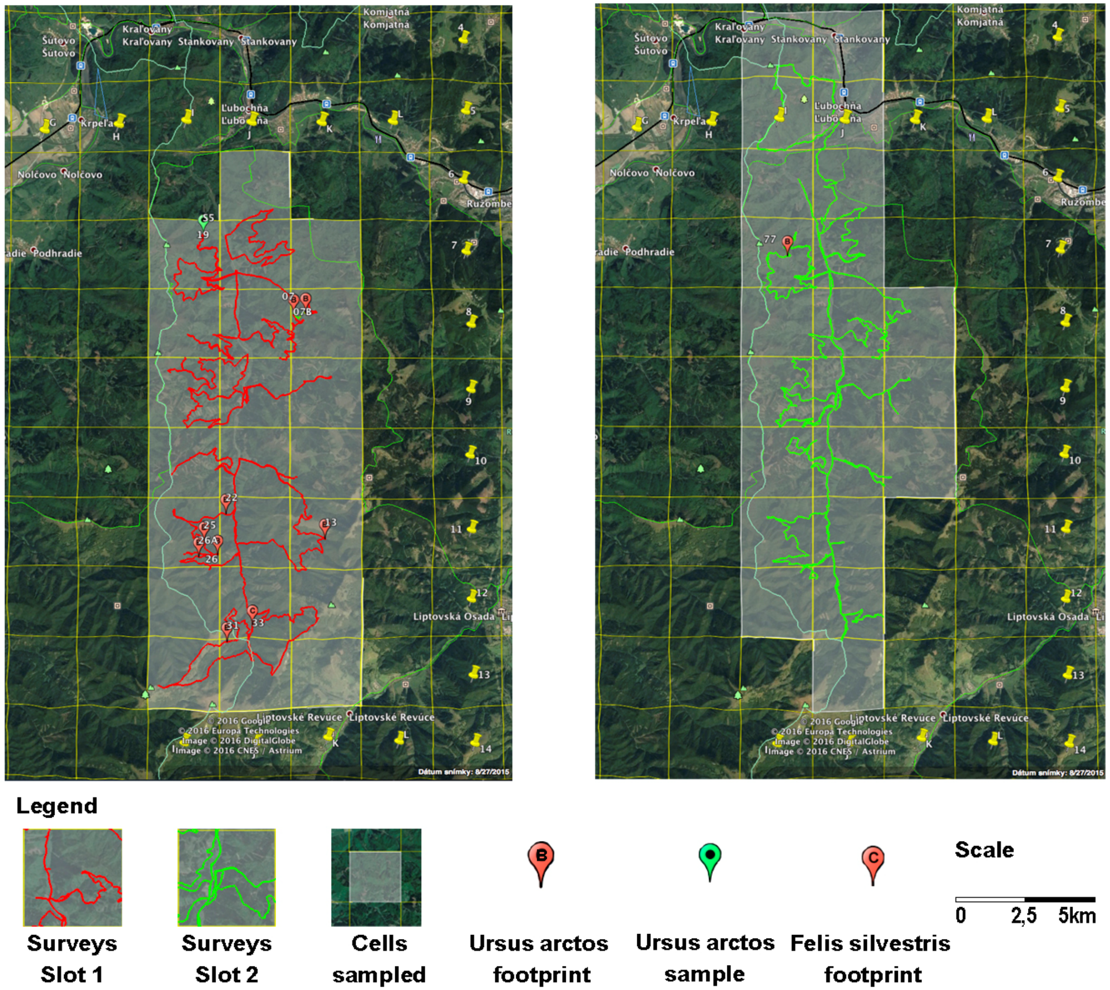


Figure 5. Transects walked by group 1 and 2 with bear footprints and samples and with wildcat footprints.

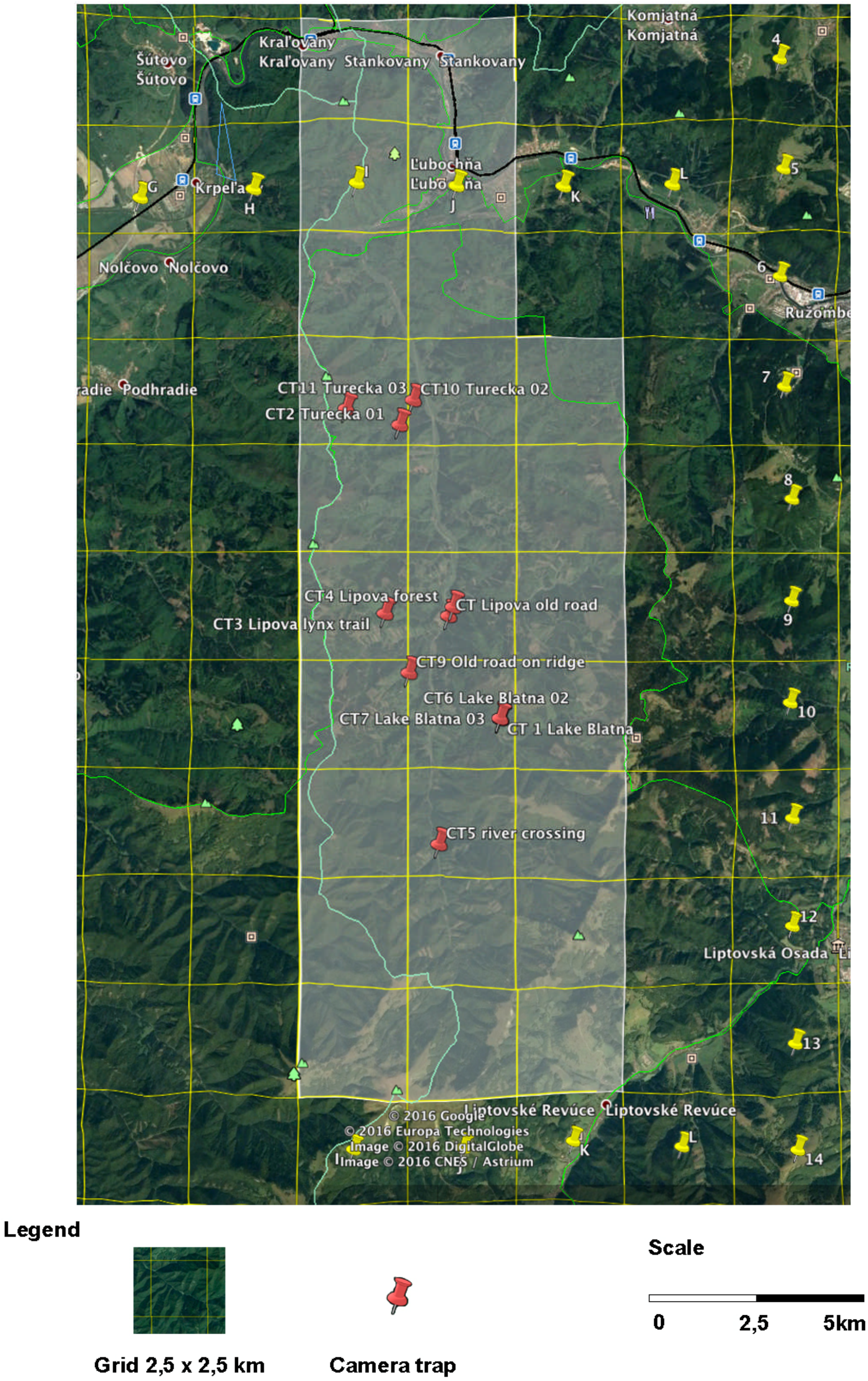


Figure 6. Position of camera traps.

CAMERA TRAP PHOTOS

CT2 Turecka 01: *Vulpes vulpes, 2x Canis lupus*

CT4 Liúova forest: *Vulpes vulpes, 2x Capreolus capreolus*

CT5 River crossing: *Cervus elaphus,* CT7 Lake Blatna 03*: Erithacus rubecul,a Lutra lutra*

CT7 Lake Blatna 03: *Lutra lutra*, CT8 Lipova old road: *Capreolus capreolus, Cervus elaphus*

CT9 Old road on ridge: *Sus scrofa*, 2x *Cervus elaphus,*

Appendix II: Expedition diary and reports

A multimedia expedition diary is available at https://biosphereexpeditions.wordpress.com/category/expedition-blogs/slovakia-2016/ .

All expedition reports. including this and previous expedition reports. are available at www.biosphere-expeditions.org/reports.