EXPEDITION REPORT

Expedition dates: 1 – 14 February 2015

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

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Biosphere Expeditions

Abstract

This report covers the fourth 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 1 February to 14 February 2015 and concentrated on the Ľubochnianska Valley.

The study was a collaboration between Biosphere Expeditions and Environmental Society LENS. It used a cell-based presence/absence 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 scats, hair and urine were also collected for batch DNA analysis. Camera traps were also used. 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.

During the expedition 34 transects were surveyed with a total length of 438 km. The average length of a transect was 13 km and the total area surveyed was 150 square km. The survey area was divided into 24 cells of 2.5 x 2.5 km size, in 13 of which signs of target species were recorded. In total, 74 signs were recorded, of which 23 were identified as being left by lynx (32%), 49 by wolf (66%), one by bear (1%) and one by wildcat (1%).

Ten camera traps were placed in the study area and 1,989 photographs were taken. One camera trap recorded one individual lynx multiple times as it repeatedly visited the carcass of a red deer. Fox (*Vulpes vulpes*), marten (*Martes martes*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*) were also photographed.

Twenty-nine samples (11 scats and 18 urine samples) were collected for DNA analysis. Fifteen samples (52%) were assumed, from footprints, to be from lynx, thirteen samples (45%) from wolf and one sample (3%) from wildcat. All samples are currently awaiting DNA analysis (to be conducted in 2016) to confirm species and enable identification of individuals.

Survey results since 2012 suggest that the lynx population in Veľká Fatra National Park is more or less stable. During normal winters the lynx's main prey, the roe deer, concentrate in the valleys where they are fed at feeding stations by hunters and foresters to ensure an artificially high ungulate 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 2015, wolf signs were as frequent as in 2014, but were detected in fewer cells, a result that is shared with lynx. Wolf was detected in 12 cells, especially in the central and lower parts of the valley, because of higher concentrations of food around deer feeding stations, as evidenced by the expedition finding three carcasses of red deer and wild boar in the vicinity of the feeding stations. Here too, as for the lynx, artificially high deer prey populations, combined with the relatively high protection status in Slovakia of the wolf, appear to contribute to a consistent presence of wolves in Veľká Fatra National Park.

The winter conditions in 2015 were normal and the expedition found only one older bear footprint, indicating that the bear population of Veľká Fatra National Park was hibernating. This is in contrast to the very mild winter of 2014, when many bear signs of non-hibernating individuals were found, or the very harsh winter of 2012 when extremely low temperatures are likely to have disturbed the hibernation, especially of young and inexperienced bears. In any case, a consistent bear presence is evident in Veľká Fatra National Park.

At present the Veľká Fatra habitat appears suboptimal for wildcat. Wildcat signs, nonetheless, have been recorded consistently by the expeditions in Veľká Fatra National Park, once in 2015, six times in 2014 and once in 2013.

Súhrn

Report zo štvrtého ročníku terénneho monitoringu na severe Slovenska v Národnom parku Veľká Fatra s podporou domáceho výskumníka a 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 1. februára do 14. februára 2015.

Terénny monitoring 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.

Počas terénneho výskumu bolo monitorovaných 34 transektov v celkovej dĺžke 438 km. Priemerná dĺžka transektu bola 13 km. Záujmové územie bolo rozdelené na kvadranty o veľkosti 2,5 x 2,5 km. V 13 kvadrantoch sa zaznamenali záujmové druhy veľkých šeliem. Identifikovaných bolo 74 nálezov stôp a stopových dráh záujmových druhov: 23 patrilo rysovi ostrovidovi (*Lynx lynx*) (32%), 49 vlkovi dravému (66%), 1 medveďovi hnedému (1%) a 1 stopa patrila mačke divej (1%).

V záujmovom území boli na 10 miestach nainštalované fotopasce, ktoré zaznamenali 1989 fotografií. Na fotopasci č.10 sa podarilo zachytiť fotografie rysa ostrovida, ktorý sa opakovane vracial ku kadáveru jeleňa. Ďalšie záznamy z fotopascí zachytili líšku hrdzavú, kunu lesnú (*Martes martes*), jeleňa lesného (*Cervus elaphus*), srnca hôrneho (*Capreolus capreolus*) a diviaka lesného (*Sus scrofa*).

Nájdených bolo 29 vzoriek na DNA analýzu (11x trus, 18x moč). 15 vzoriek (52%) patrili rysovi ostrovidovi (určené na základe stôp pri vzorke), 13 vzoriek (45%) bol vlk dravý a jedna vzorka (3%) patrila mačke divej. 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 aj 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 2015 boli pobytové znaky vlkov zaznamené v rovnakej miere ako v roku 2014, avšak v menšom počte štvorcov. Vlk dravý bol detekovaný v 12 štvorcoch, najmä v centrálnej a dolnej časti doliny, kvôli vyššej koncentrácii koristi v okolí krmelcov, čo bolo potvrdené aj nálezom troch kadáverov jeleňa a diviaka lesného v blízkosti krmelcov. Podobne ako u rysa ostrovida aj tu platí, že dostatočná potravná ponuka a relatívne vysoká zákonná ochrana vlka na Slovensku prispieva ku konzistentnej prítomnosti vlka dravého v Národnom parku Veľká Fatra.

V roku 2015 populácia medveďa hnedého v Národnom parku Veľká Fatra hibernovala aj vďaka klasickému zimnému počasiu. Počas expedície sa zaznamenala iba jedna stopa medveďa. Na rozdiel od veľmi teplej zimy 2014, kedy sa zaznamenalo množstvo nehibernujúcich medveďov, alebo veľmi chladnej zimy v roku 2012, kedy extrémne nízke teploty prebrali zo zimného spánku mladé a menej skúsené medvede. V každom prípade, môžeme konštatovať, že populácia medveďa hnedého v Národnom parku Veľká Fatra je taktiež stabilná.

V súčasnosti je centrálne územie Veľkej Fatry suboptimálne na výskyt mačky divej. Napriek tomu je počas Biosphere Expeditions zaznamenaný aj výskyt tohto druhu. Raz v roku 2015, šesťkrát v roku 2014 a raz 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 1 to 14 February 2015 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:

1 – 7 February | 8 – 14 February 2015

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 wintery with temperatures around zero (Celsius), good snow cover and several 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. Courtesy of Land Rover, the expedition had the use of two Land Rover Discovery Sport vehicles throughout.

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):

1 – 7 February 2015

Barbara Bentlage (Germany), Peter Burke (UK), Johan Engelbrecht (The Netherlands), Nicholas Hall (UK), Sarah Hendrix (Belgium), Savi Madan (UK), Katie Mather (UK), David Muiry (UK), Rosie Pope (UK), Helene Rebholz (Austria).

8 – 14 February 2015

Marc Bast (Switzerland), Emma Birnbaum* (Czech Republic), Uwe Draeger (Germany), Christopher Eves (UK), Sarah Hendrix (Belgium), Sergii Kravchenko (Ukraine), Steven MacDonald (Singapore), Katie Mather (UK), Nadine Ormo (blogger, Germany), Alexander Petschnig (Austria), Heather Whalley (UK), Aly Wheatley (UK).

In addition for some or all of the time: Astrid Callomon (assistant expedition leader, UK) and Norbert Sommer (Slovakia). *Placement kindly supported by the Friends of Biosphere Expeditions.

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	31,183
Expenditure	
Expedition base includes all board & lodging, and extra food & meals	4,965
Transport includes car fuel UK–Slovakia return, car fuel during expedition, train rides	2,340
Equipment and hardware includes research materials & gear etc. purchased in UK & Slovakia	4,119
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	4,189
Administration includes miscellaneous fees & sundries	1,315
Team recruitment Slovakia as estimated % of annual PR costs for Biosphere Expeditions	4,186
Income – Expenditure	**10,069**
Total percentage spent directly on project	**68%**

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 and Veľká Fatra National Park in Martin, and to all those who provided assistance and information. Vehicles were kindly loaned by Land Rover and optical equipment by Swarovski Optik. 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 as compensation for bear damages a total of €16,000 per year on average (Huber 2013).

In Europe, wolves occur 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, however, 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) 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.

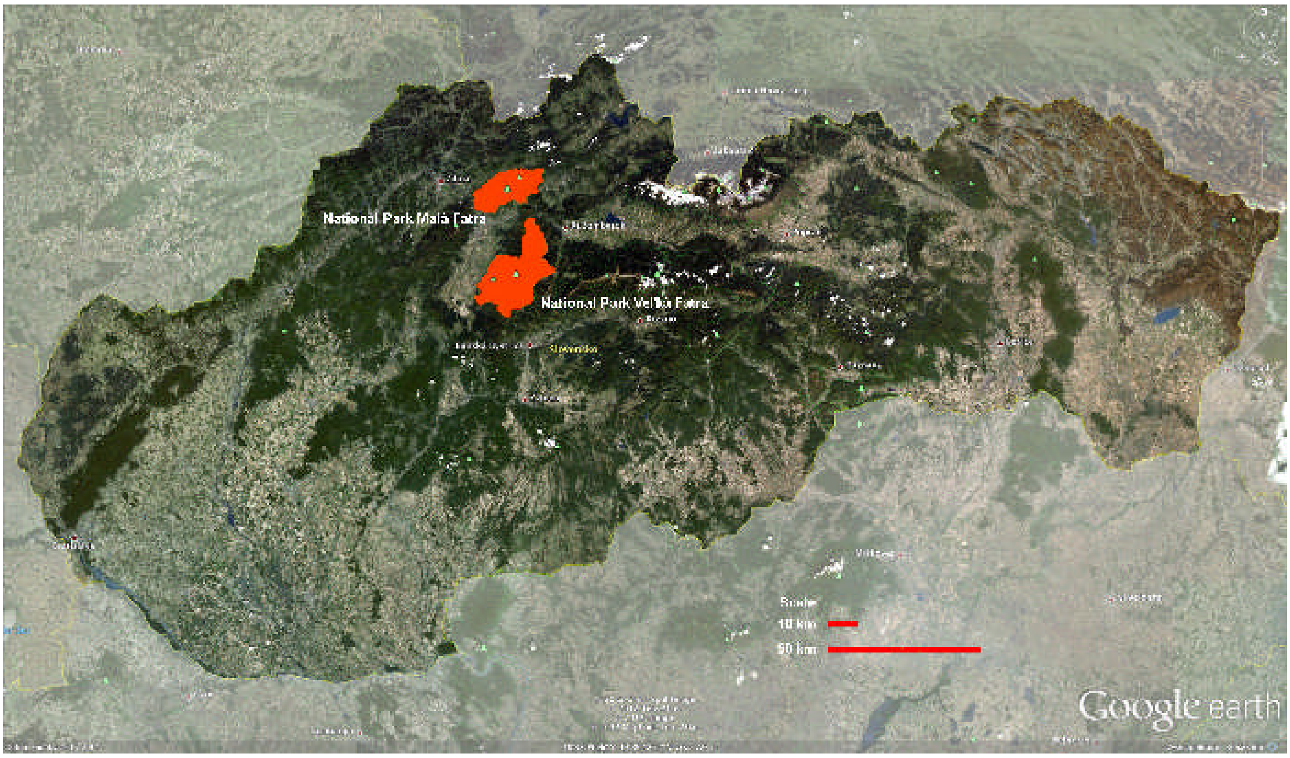

Figure 2.2a. The territory of Slovakia with Malá Fatra (above) and Veľká Fatra National Parks (below) in red.

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. 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.

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 and 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 recurrence of a species or individual. Another issue is the estimation of footprint frequency and density during snow-tracking, because this by and large 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. 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 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 or blood were also collected for future DNA analysis. This analysis will be done in one batch after collecting enough samples after the fifth year of Biosphere Expeditions in Slovakia in 2016.

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 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, 34 transects were surveyed, with a total length of 438 km and covering 24 cells.

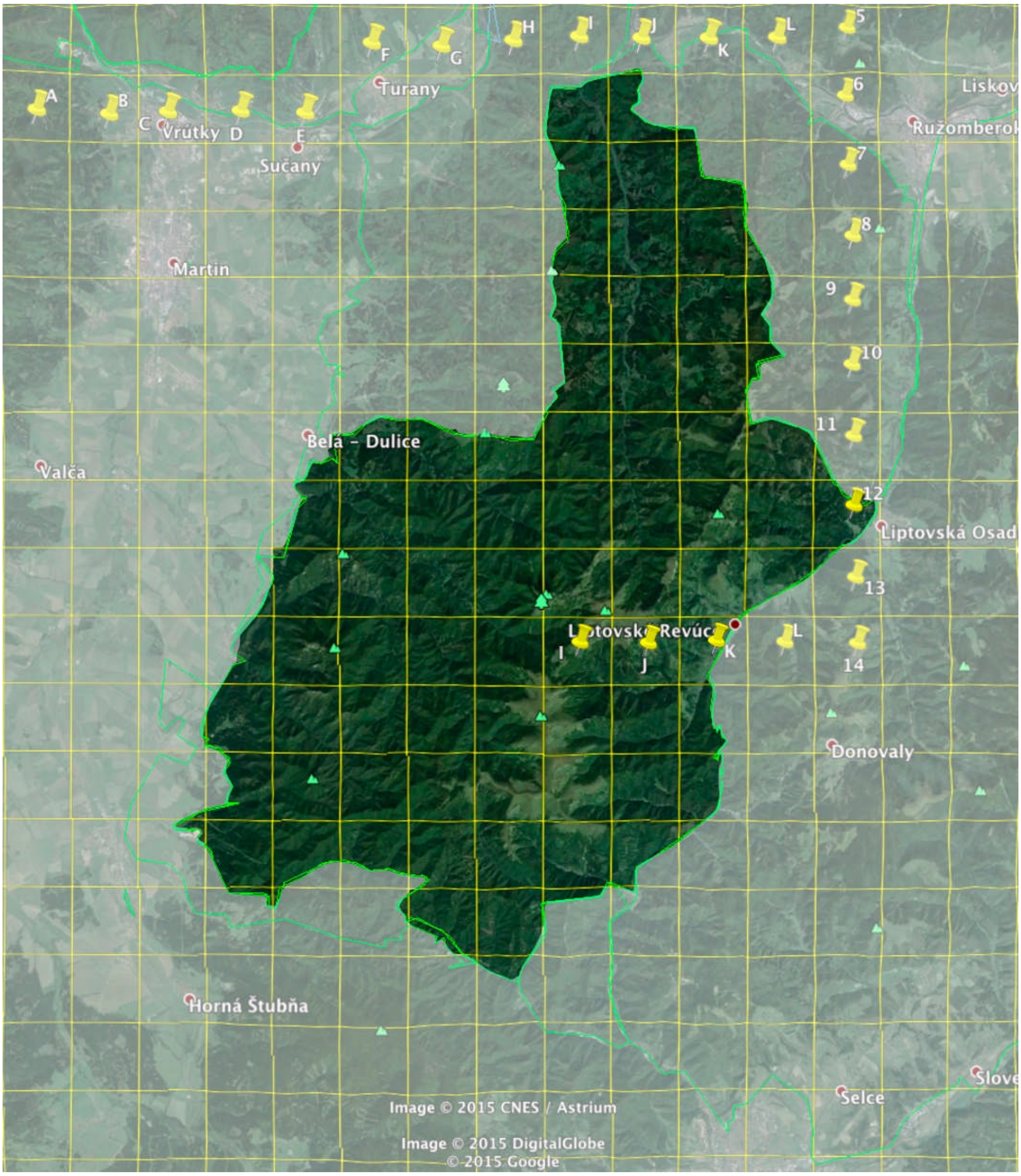

Figure 2.3a. Grid system covering Veľká Fatra National Park.

Training of volunteers

The first day of each group was dedicated to the training of volunteers, especially in 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 after the 2016 expedition.

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, 34 transects were surveyed, with a total length of 438 km, covering 24 cells of the grid system and encompassing a surveyed area of 150 square kilometres. The average length of a transect was 13 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. Lynx trails were followed over 6.06 km, wolf trails over 10.51 km. No bear trails were followed. One record of a bear and wildcat each was also obtained. Camera traps also recorded red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), red fox (*Vulpes vulpes*), pine marten (*Martes martes*), wild boar (*Sus scrofa*) and lynx (photos and tables in Appendix I). Red deer, roe deer and wild boar were also recorded as carcasses. The wild boar camera capture was new in 2015, but cameras in 2015 failed to record wolf, bear and badger (*Meles meles*), all of which were recorded in 2014. Full tracking and other details are in Appendix I and a summary of results over the years in Table 2.5a.

Twenty-nine samples were collected (11 scats, 18 urine) for DNA analysis: 15 samples (52%) were confirmed, by footprints, to be from lynx, 13 samples (45%) from wolf and one sample from wildcat (3%).

Wolf was detect in 12 cells, lynx in nine cells, and bear and lynx in one cell. Lynx and wolves shared records in six 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 and wolf in green).

Lynx	Wolf	Bear	Wildcat
I7	I7	J11	I9
J7	J7		
K8	K8		
J9	J9		
J10	J10		
J12	J12		
I11	I6		
J8	J6		
I9	K6		
	J8		
	K8		
	J11		

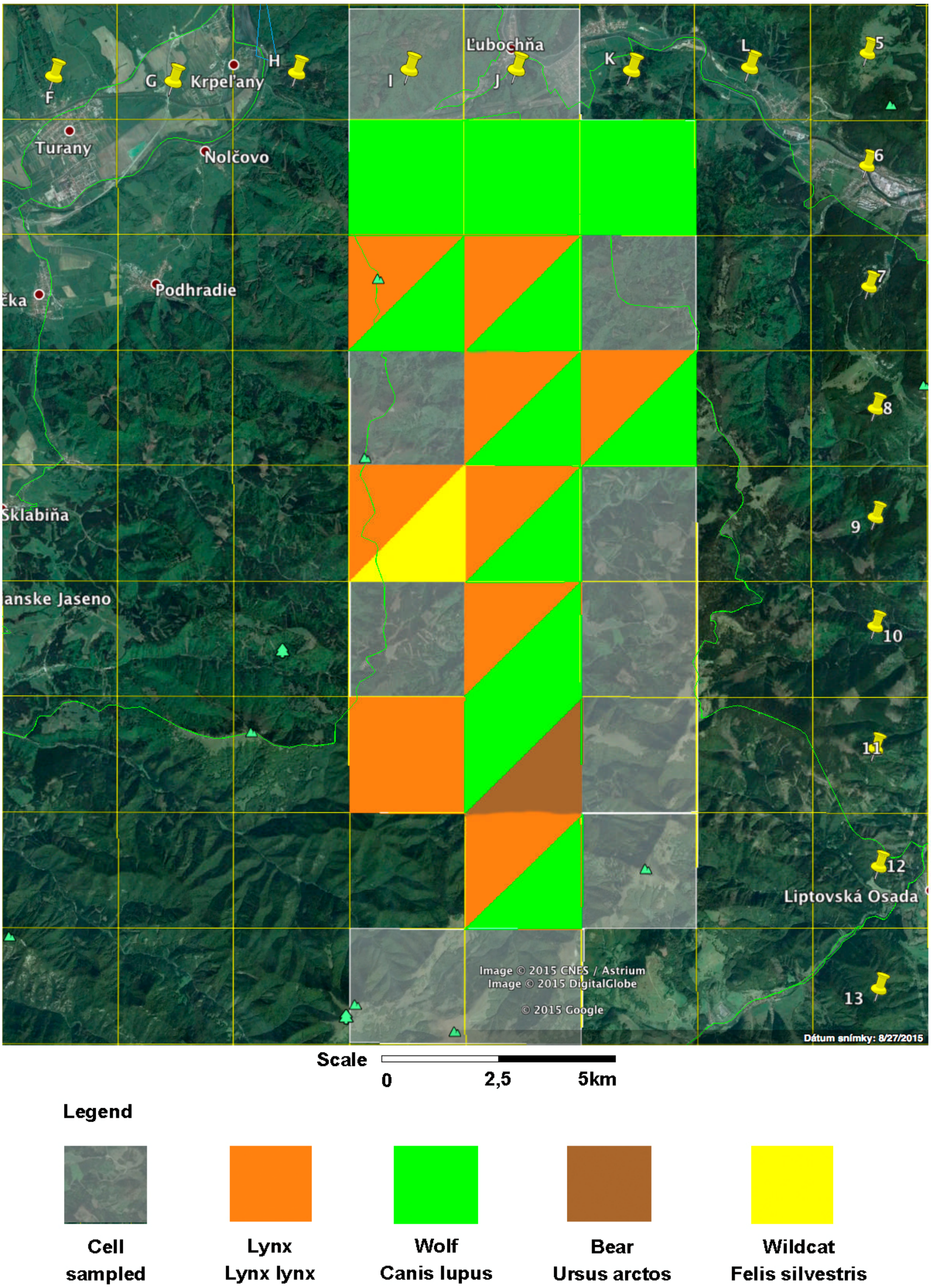

Figure 2.4a. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx, wolves, bears and wildcats per cell.

Lynx (*Lynx lynx*)

Lynx was recorded in nine out of 24 cells. Snow-tracking contributed to the recording of lynx, while camera-trapping recorded the species in only one cell. Prospective lynx samples were also collected and await genotyping/DNA analysis.

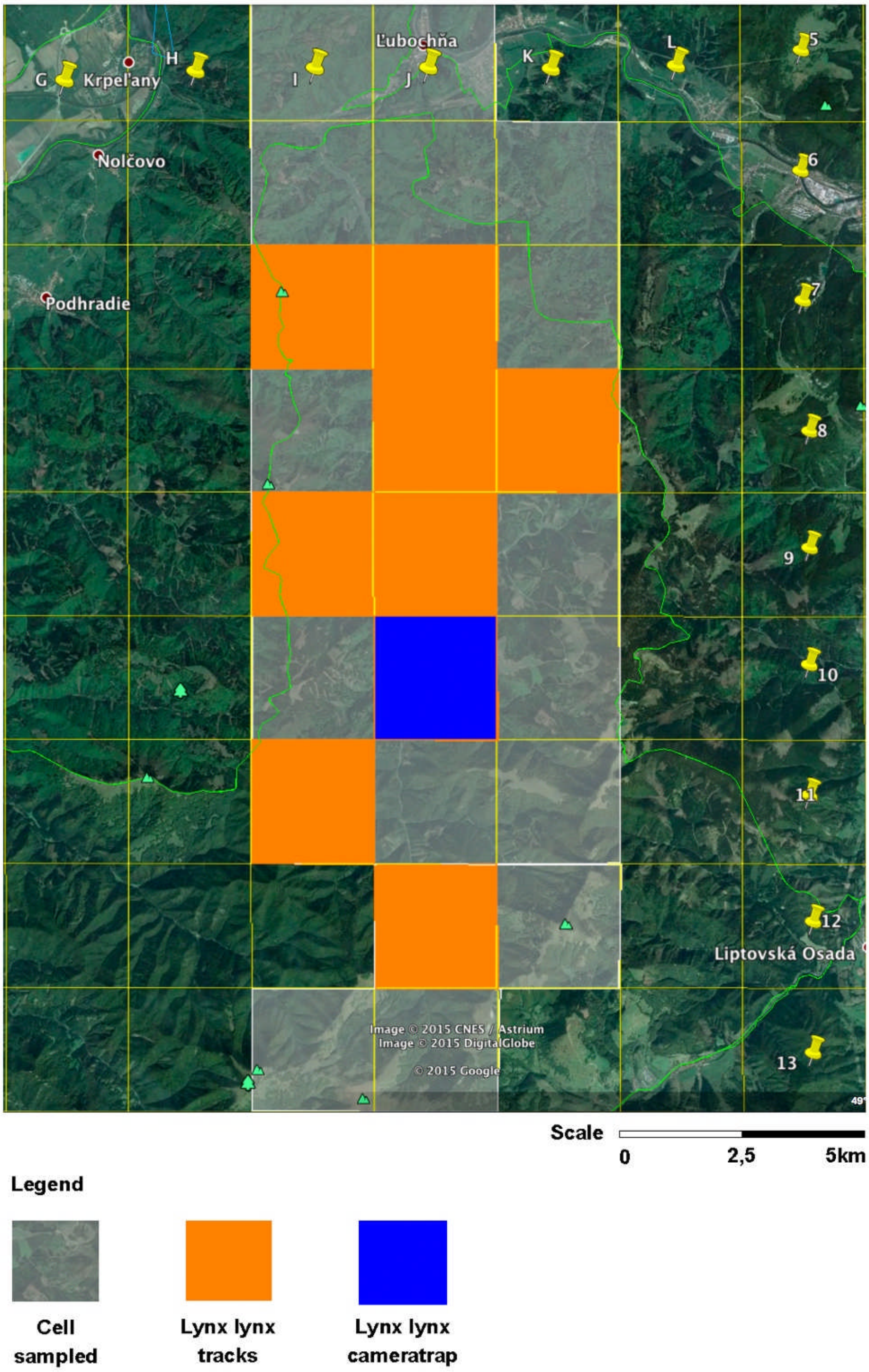

Figure 2.4b. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx per cell according to different recording methods.

Wolf (*Canis lupus*)

The species was recorded in 11 out of 24 cells surveyed. It is also worthwhile to note that snow-tracking contributed to the recording of wolves in all 11 cells, while camera-trapping did not recorded wolves. Prospective wolf samples were also collected and await genotyping.

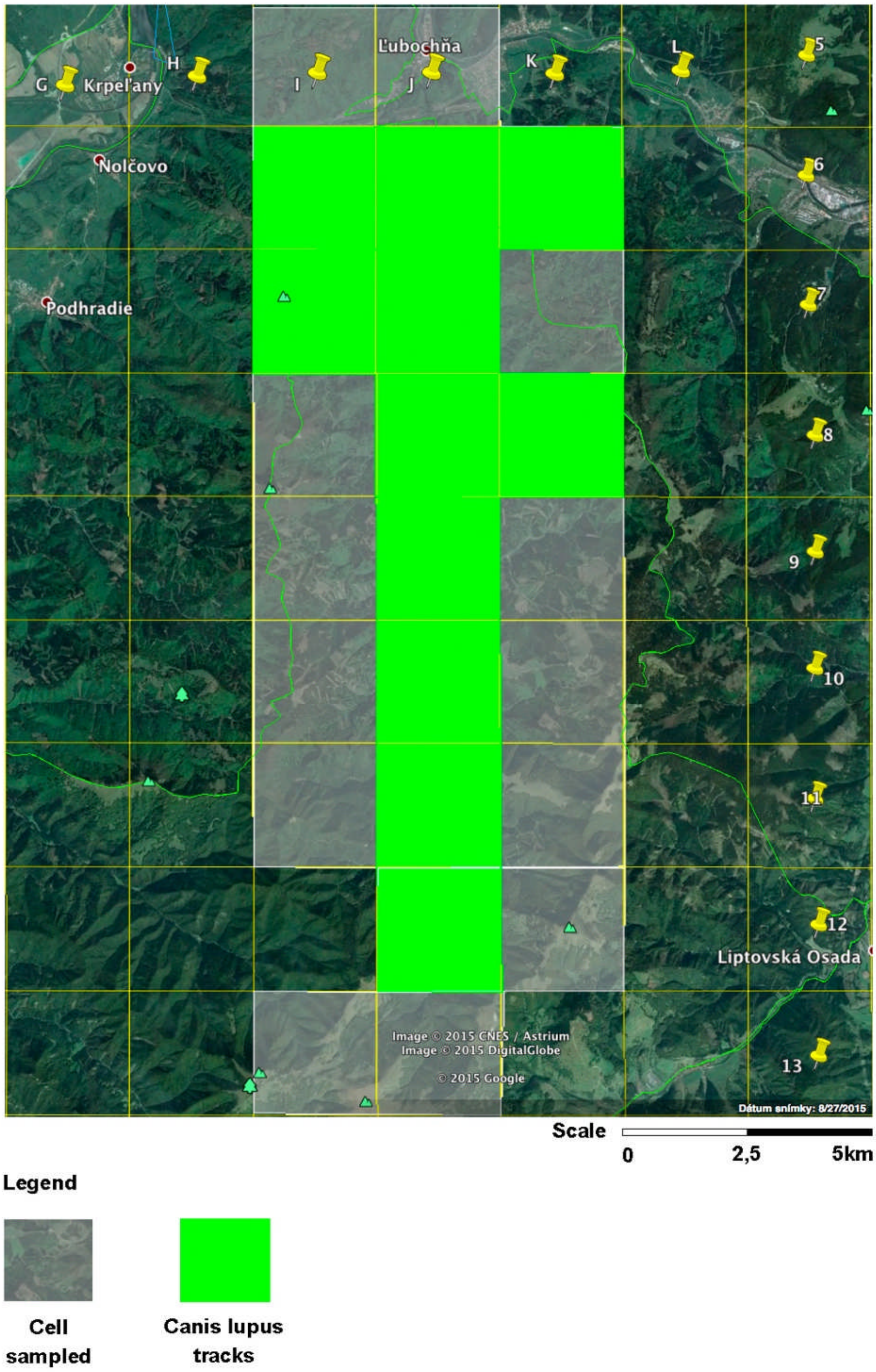

Figure 2.4c. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of wolves per cell.

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

Both species were recorded once, by footprints, in the 24 cells surveyed. The expedition also collected a prospective wildcat sample for the first time, which awaits genotyping.

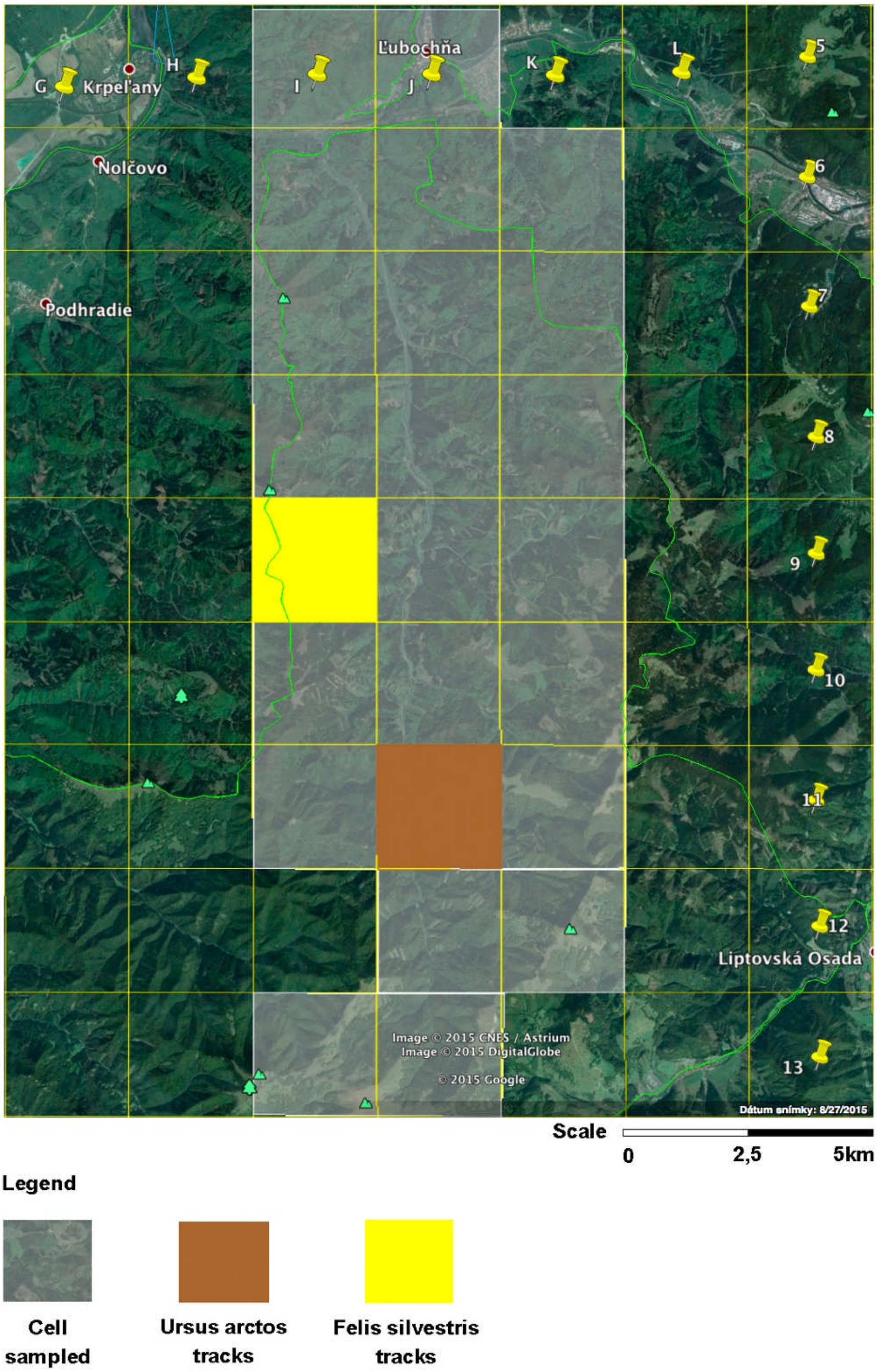

Figure 2.4d. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of bear and wildcat per cell.

Other carnivores

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. Except for the golden eagle (*Aquila chrysaetos*, recorded from observations) and otter (*Lutra lutra*, recorded by snow-tracking), all other species such as pine marten and red fox were recorded by camera traps. Otter was the most recorded (n=4 cells) followed by red fox, golden eagle and pine marten (n=2 cell for each).

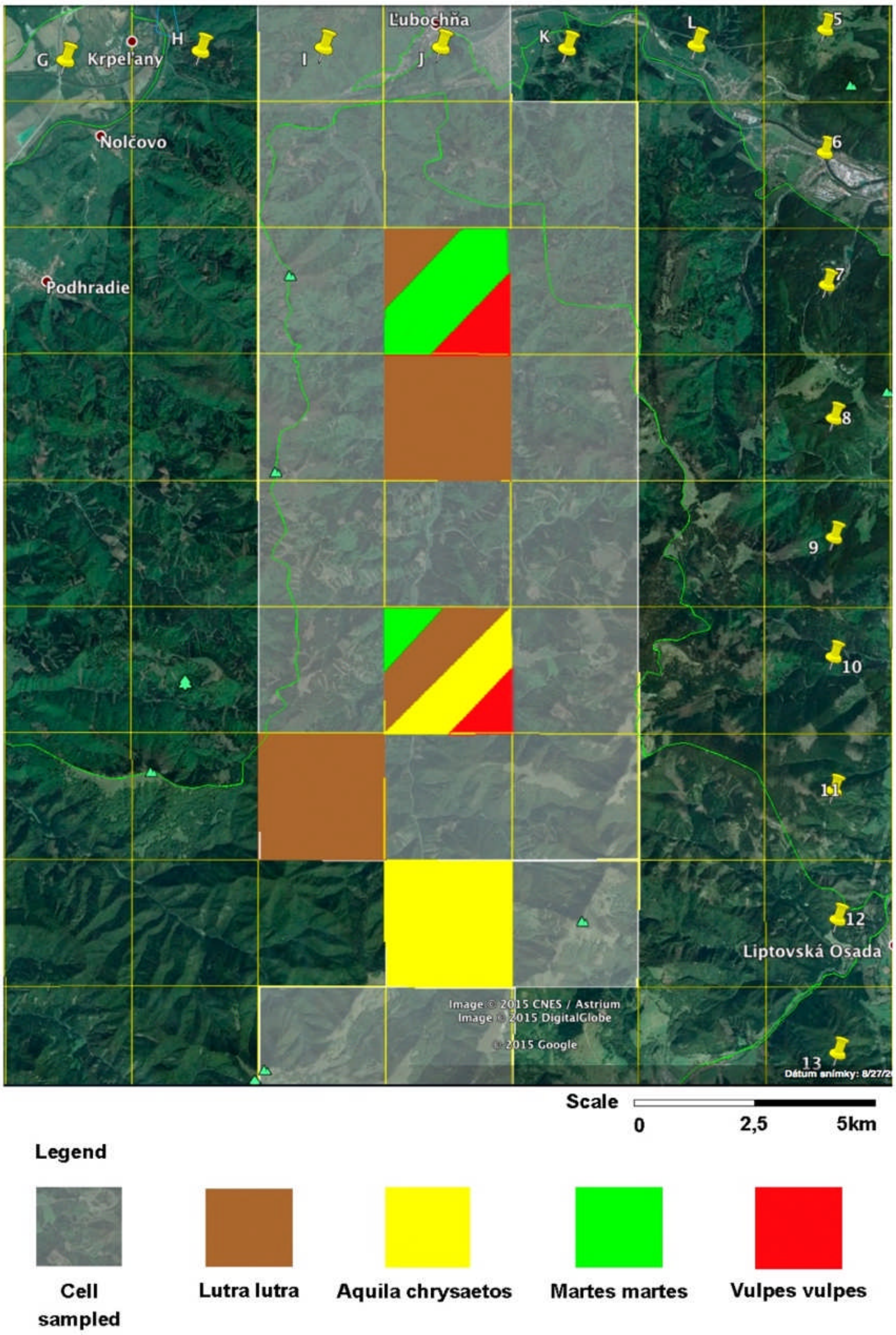

Figure 2.4e. Sampled cells (2.5 x 2.5 km in size) and results of carnivores other than the lynx, wolf, bear and wildcat per cell.

Ungulates: red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*)

Red deer, roe deer and wild boar are major prey species for carnivores, hence recording their presence is important. Red deer were recorded in nine cells, roe deer in 15 cells and wild boar in eight cells. Roe deer and wild boar were recorded by observation, snow-tracking and from camera traps; red deer were recorded as carcasses, by camera trap and by their presence at feeding stations.

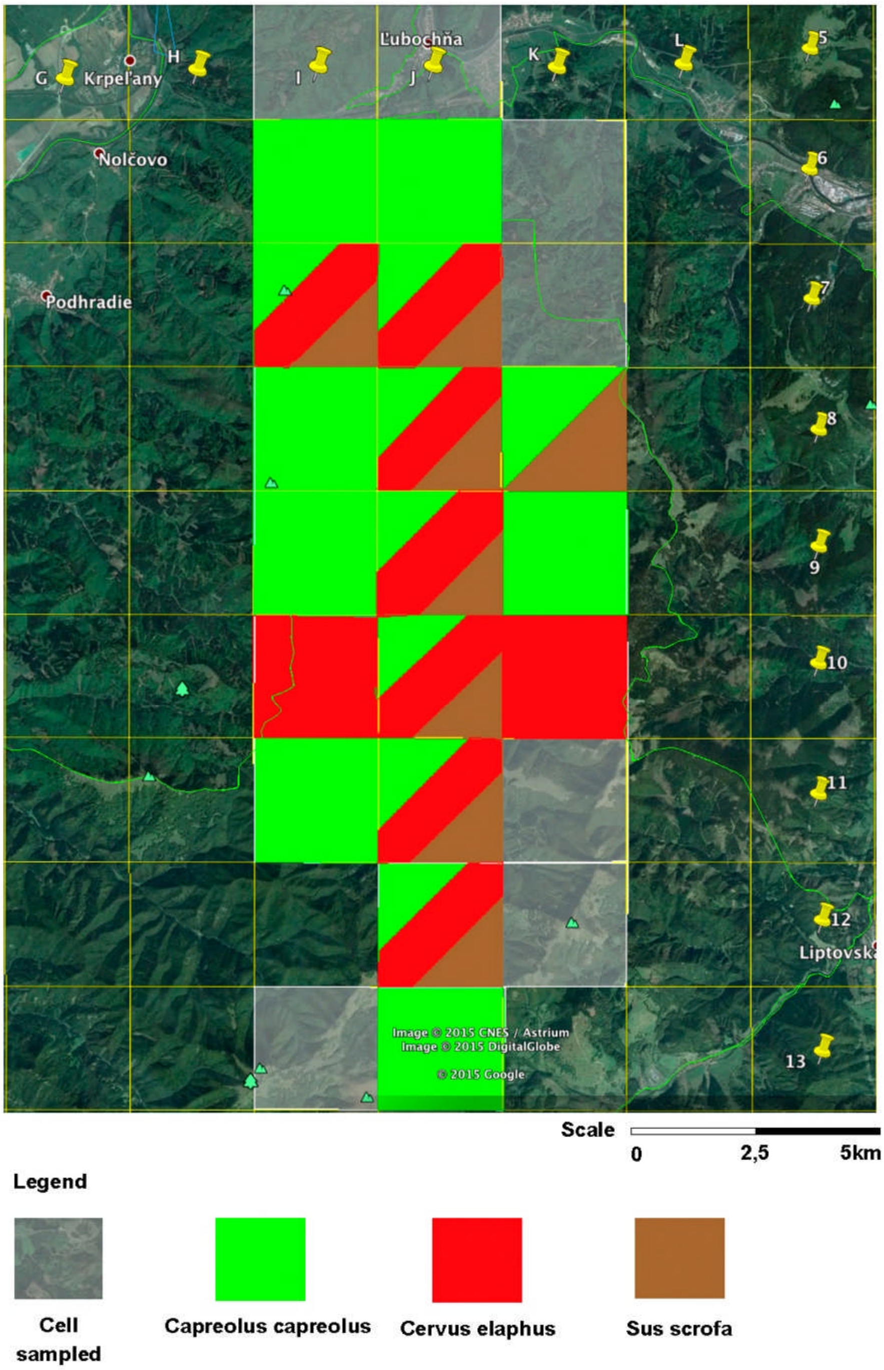

Figure 2.4f. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of roe and red deer as well as wild boar per cell.

2.5. Discussion & conclusions

Recording of signs is one of the most commonly used methods 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. The air temperature and snow cover significantly affect the results of the research. Most prominently, this is reflected in 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 2012–2015.

	2012	2013	2014	2015
Number of expedition weeks	3	2	2	2
Number of expedition participants	21	22	26	22
Number of transects surveyed	50	38	36	34
Total transect length surveyed per expedition (km)	356	307	548	438
Total transect length surveyed per week (km)	119	153	274	219
Total area surveyed (sq km)	*	136	181	150
Number of lynx signs found	25	15	27	23
Number of wolf signs found	25	20	50	49
Number of bear signs found	9	0	50	1
Number of cells that lynx was detected in	*	7	11	9
Number of cells that wolf was detected in	*	8	16	12
Number of cells that bear was detected in	*	1	17	1
Number of camera traps used / in different positions	9 / 15	10 / 10	10 / 12	10 / 10
Lynx recorded on camera trap	Yes	Yes	Yes	Yes
Wolf recorded on camera trap	Yes	Yes	Yes	No
Bear recorded on camera trap	Yes	Yes	Yes	No
Number of presumed lynx DNA samples collected	9	3	3	15
Number of presumed wolf DNA samples collected	9	9	13	13
Number of presumed bear DNA samples collected	0	0	5	0

* cell methodology was not used in 2012

Survey effort over the years and the value of volunteers

The great value of citizen science volunteers in wildlife monitoring projects has been shown time and again (Forrester et al. 2015, Holt et al. 2013, Jones 2013, Lewandowski & Specht 2015) and this study is no exception. Having around twenty volunteers for two to three weeks each winter over many years makes it possible to monitor large carnivores in a Slovakian national park where there would be very little or no scientific monitoring otherwise. This is especially important since Slovakian national parks are threatened by powerful economic interests and activities such as timber extraction, which are often harmful to wilderness areas and the wildlife harbouring within them. After four years of continuous monitoring we now have a much better idea of the distribution and ecology of the larger carnivores and their large-bodied prey species in winter. This information is passed on to the park and other interested authorities and will, we hope, over time, result in wildlife and wilderness being prioritised over timber and profits.

When comparing survey efforts over the years, it is clear that the overall effort, given a roughly stable volunteer base, is a function of the weather, first and foremost, but also of the duration of the expedition each year. For example, the spike in the overall length of transects surveyed in 2014 was clearly due to the mild weather and associated ease of moving around the study site without being slowed down by snow. The number of transects surveyed is primarily a function of the number of expedition weeks, with a spike in 2012 when three one-week teams comprised the expedition, as opposed to two teams on all other expeditions. Within those larger relationships, the fitness and ability of volunteers also play a role, but on the whole volunteer teams even out and there is something to do for people of all abilities and fitness levels on the expedition. The main point, however, as with so much other conservation work that now depends on citizen science volunteers, is that the project would simply not go ahead without the volunteers and their input in terms of finance and labour. From this, and the wealth of supporting literature (see Lewandowski & Specht 2015 for a review), it is easy to see how important a force in conservation volunteering has become.

Lynx distribution and detection

The lynx population appears to be more or less stable and unaffected by conditions in winter. The number of cells that lynx was detected in, as well as the number of lynx signs found, varies positively with survey effort (total transect length surveyed each year). Lynx move an average of 7.2 km per day and distances covered are inversely proportional with kills made; i.e. if a kill is made, a lynx will stay close to it and move very little (see also Jędrzejewski et al. 2002), increasing its detection within a cell. During normal winters the lynx's main prey, the roe deer (Jobin et al. 2000, Okarma et al. 1997), concentrate in the valleys where they are fed at feeding stations by hunters and foresters to ensure an artificially high ungulate population (Schmidt 2008) for hunting purposes. This also helps the lynx population to remain stable. 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.

Wolf distribution and detection

In 2015, wolf signs were as frequent as in 2014, but were detected in fewer cells, perhaps associated with a reduced survey effort, a result that is shared with lynx. Wolf was detected in 12 cells, especially in the central and lower parts of the valley, because of higher concentrations of food around deer feeding stations, as evidenced by the expedition finding three carcasses of red deer and wild boar in the vicinity of the feeding stations. The previous year (2014) was an exceptional year, because of the near-autumn, snow-free conditions and associated mild temperatures increasing ease of movement, as well as a high number of expedition participants. In addition, as our experience, and with it survey efficiency, increased, we were also able to increase our survey effort from 2012 to 2014, despite the total number of expedition participants staying roughly the same.

Also in 2014, deer and wild boar, the main wolf prey species (Jędrzejewski et al. 2000, Find'o 2002), were still present on high ground, where food was readily available due to the mild winter. Thus in 2014 wolves had to hunt in a much larger area than in previous years, as confirmed by their detection in 16 cells (Hulík et al. 2015). In 2013 wolf presence was detected in eight cells, centred next to three carcasses around feeding stations in the valley bottom (Hulík et al. 2014). The same was true in 2012, when the current cell methodology was not yet used by the expedition, but six carcasses close to feeding stations and associated wolf signs were found (Hulík et al. 2012).

Overall, as for the lynx, artificially high deer prey populations, combined with the relatively high protection status in Slovakia of the wolf, appear to contribute to a consistent presence of wolves in Veľká Fatra National Park.

Bear distribution and detection

The winter conditions in 2015 were normal and the current study found only one older bear footprint in cell J11, indicating that the bear population of Veľká Fatra National Park was hibernating. During the previous year, a surprising and interesting number of 50 trails were found (Hulík et al. 2015), certainly due to near autumn-like conditions and lack of snow cover, causing bears of all ages to be able to find enough food in the woods, so they did not need to hibernate at that time. 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, which we believe is an area with enough resting places and shelter for winter hibernation (Hulík et al. 2015). In 2013 no bear signs were recorded, but one bear was photographed once (Hulík et al. 2014). This is strong evidence that most bears were in hibernation 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 very low temperatures can wake them (Hulík et al. 2012). In any case, a consistent bear presence is evident in Veľká Fatra National Park.

Wildcat remarks

At present the Veľká Fatra habitat appears suboptimal for wildcat. Instead wildcats mainly occur in the southern part of Slovakia as well as the northeast near the border with Poland and Ukraine (Hell et al. 2004). Wildcat signs, nonetheless, were recorded in our study area, once in 2015, six times in 2014 (Hulík et al. 2015) and once in 2013 (Hulík 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. 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 and Hammer 2013, Mazzolli et al., accepted).

Densities of lynx were calculated for the first time by Kubala et al. (2015) of the project Living with Carpathian spirits. Their calculations support our findings that lynx occur at relatively high densities in our study area. The total population in the area of Veľká Fatra National Park was estimated as 7–29 individuals (mean 17.5) at a mean density of 0.8 individuals per 100 square kilometres in suitable habitat.

This fourth 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 Forest Department resulted in gaining further ecological insight into the ecology and behaviour of target species with important implications for their management throughout Slovakia.

Recommendations for future expeditions:

1. Set up a closer cooperation with the research team from the project Living with Carpathians spirits, with use of camera traps to capture specific patterns of lynx spots for identification of individuals to compare results from their research and results from Biosphere Expeditions.

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

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

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

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

Table 1. Overview of temperature values and snowfall 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)
31.01.2015	-2	-1		10 cm
01.02.2015	-6.4	-1		
02.02.2015	-4.6	-3.3	-2	10 cm
03.02.2015	-6.8	-2.1	-6	5 cm
04.02.2015	-4.7	-0.6	-5	5 cm
05.02.2015	-6.7	-1	-8	
06.02.2015	-4.4	-4	-5	
07.02.2015	-3.1	-0.5		
08.02.2015	-2.4	0		10 cm
09.02.2015	-6.4	-3	-5	40 cm
10.02.2015	0.4	1.3	0	10 cm
11.02.2015	1.1	1.8	1	
12.02.2015	1.1	1.5	0	
13.02.2015	-4.6	1.6	-6	

Table 2. Summary of results: transect 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		Wildcat tracks	
	n	km	cells	n	frequency track/km	n	km	n	frequency track/km	n	km	n	frequency track/km	n	km	n	frequency track/km
Group1	17	210.29	22	13	16.18	3	1.01	29	7.25	8	8.78	1	210.29	-	-	-	-
Group2	17	228.19	21	10	22.82	6	5.05	20	11.41	3	1.73	-	-	-	-	2	114.1
Total	34	438.48	43	23	19.06	9	6.06	49	8.95	11	10.51	1	438.48	-	-	2	219.24

Table 3. Summary of results: cell resampling information.

Cell number	Number of times cells have been sampled (x = sampling)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J10	x	x	x	x	x	x	x	x						
K10	x	x	x	x										
J6	x	x	x	x										
J7	x	x	x	x	x	x	x	x	x	x	x	x		
K6	x													
J8	x	x	x	x	x	x	x	x	x	x	x			
K8	x	x	x	x										
J9	x	x	x	x	x	x	x	x	x	x	x	x		
K9	x	x												
I7	x	x	x	x										
I8	x	x	x	x	x									
I10	x	x	x	x										

Table 3 (continued). Summary of results: cell resampling information.

Cell number	Number of times cells have been sampled (x = sampling)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I9	x	x	x											
J12	x	x	x	x	x	x	x	x						
I5	x													
J5	x													
J13	x	x	x											
I13	x	x												
I11	x	x												
J11	x	x	x	x	x	x								
K11	x	x												
K7	x													
K12	x													
I6	x													

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

Target species	2 Feb	3 Feb	4 Feb	5 Feb	6 Feb	7 Feb	8 Feb	9 Feb	10 Feb	11 Feb	12 Feb	13 Feb
Wolf	x	x	x	x	x				x	x	x	x
Lynx		x	x	x	x					x	x	x
Wildcat												
Bear					x							
Golden eagle				x						x		x
Otter	x								x	x	x	x

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

Species	Cells	Type of record
Wolf	I6, J6, J6, I7, J7, J8, K8, J9, J10, J11, J12	footprints, scat, urine
Lynx	I7, J7, J8, K8, I9, J9, J10, I11, J11	footprints, scat, urine, camera trap
Wildcat	I9	footprints
Bear	J11	footprints
Red deer	I7, J7, J8, J9, I10, J10, K10, J11, J12	carcass, camera trap
Roe deer	I6, J6, I7, J7, I8, J8, K8, I9, J9, K9, J10, I11, J11, J12, J13	observation, camera trap
Golden eagle	J10, J12	observation
Otter	J7, J8, J, 10, I11	footprints
Wild boar	I7, J7, J8, K8, J9, J10, J11, J12	footprints, camera trap
Marten	J7, J10	camera trap
Red Fox	J7, J10	camera trap

Table 6. Overview of footprints and animal trails recorded.

#	Date	Species	Deg	min	sec	Quadrant (Cell)	Footprint width (cm)	Footprint length (cm)	Direction of travel (bearing)	Age of footprint notes
01	02.02.2015	*Canis lupus*	N48 E19	59 10	56.07 1.06	J10				old
02	03.02.2015	*Canis lupus*	N49 E19	05 09	3 25.3	J7	10	12	from 210 to 282	fresh
03	03.02.2015	*Canis lupus*	N49 E19	05 09	5.7 26.8	I7			from 26 to 26	fresh
S1	03.02.2015	*Canis lupus*	N49 E19	05 09	11.8 45.8	J6				urine
04	03.02.2015	*Canis lupus*	N49 E10	05 11	19.3 7.8	K6			from 70 to 244	fresh, 3–5 individuals
05	03.02.2015	*Canis lupus*	N49 E19	04 09	6.2 34.9	J7	9	10.5	from 120 to 330	fresh
06	03.02.2015	*Canis lupus*	N49 E19	04 09	2.8 51.9	J7	9	11	from 202 to 80	fresh, 2–3 animals
06A	03.02.2015	*Canis lupus*	N49 E19	04 09	2.5 53.8	J7	9	11	to 140	fresh
06B	03.02.2015	*Canis lupus*	N49 E19	04 09	2.2 56.6	J7	9	11	from 202 to 18	fresh, carcass red deer
07	03.02.2015	*Lynx lynx*	N49 E19	04 08	5.3 24.7	I7	7	9	to 300	older
08	03.02.2015	*Lynx lynx*	N49 E19	04 08	16.4 47.1	J7	7	8	from 130 to 90	fresh
09	03.02.2015	*Canis lupus*	N49 E19	04 08	14.5 37.7	I7	8	10	to 260	very fresh
09A	03.02.2015	*Canis lupus*	N49 E19	04 08	13.9 34.5	I7	8	10	to 280	very fresh
09B	03.02. 2015	*Canis lupus*	N49 E19	04 08	17.1 41.6	I7	8	10	to 350	very fresh
10	04.02. 2015	*Canis lupus*	N49 E19	00 08	16.1 30.1	J10	7.5	9	to 24	fresh
10A	04.02. 2015	*Canis lupus*	N49 E19	01 08	26.63 46.59	J9	7.5	9		fresh
11	04.02. 2015	*Canis lupus*	N49 E19	00 08	48.1 36.2	J9	7.5			fresh
12	04.02. 2015	*Lynx lynx*	N49 E19	01 07	53.1 37.5	I9				older

#	Date	Species	Deg	min	sec	Quadrant (Cell)	Footprint width (cm)	Footprint length (cm)	Direction of travel (bearing)	Age of footprint notes
12A	04.02. 2015	*Lynx lynx*	N49 E19	01 07	51.3 44.3	I9				older
13	04.02. 2015	*Lynx lynx*	N48 E19	57 08	26.97 50.80	J12			from 185 to 20	older
14	05.02. 2015	*Canis lupus*	N49 E19	05 08	59.4 42.6	I6	8	11	from 340 to 170	fresh
15	05.02. 2015	*Canis lupus*	N49 E19	06 08	31.7 26.7	I6	8	11		fresh
16	05.02.2015	*Canis lupus*	N48 E19	57 07	33.2 40.3	J12			to 82	older
17	05.02.2015	*Canis lupus*	N48 E08	57 08	25.2 13.6	J12			to 82	older
17A	05.02.2015	*Canis lupus*	N48 E19	57 08	21.9 17.7	J12			to 24	older, two animals
17B	05.02.2015	*Canis lupus*	N48 E19	57 08	17.3 20.1	J12			to 240	older, two footprints
18	05.02.2015	*Lynx lynx*	N48 E19	58 07	57.8 20.5	I11			from 270 to 30	older
19	05.02.2015	*Canis lupus*	N48 E19	58 08	44.2 15.3	J11	9		from 08 to 190	older
20	05.02.2015	*Canis lupus*	N48 E19	59 08	43.78 22.90	J11	7.5	9	to 10	very fresh
21	05.02.2015	*Canis lupus*	N49 E19	00 08	13.54 26.93	J10	7.5	9.5	to 24	fresh
22	05.02.2015	*Canis lupus*	N49 E19	00 08	22.16 34.70	J10	7.5	10	to 24	fresh
23	05.02.2015	*Canis lupus*	N49 E19	01 08	10.80 39.97	J9	7	10.5		fresh
24	06.02.2015	*Lynx lynx*	N49 E19	02 09	06.3 00.3	J9	7	7	from 61 to 35	fresh
24A	06.02.2015	*Lynx lynx*	N49 E19	01 08	59 51.3	J9	7	7	to 110	fresh
25	06.02.2015	*Lynx lynx*	N49 E19	01 08	47.1 27.5	J9	6.5	7	from 14 to 230	very fresh
26	06.02.2015	*Lynx lynx*	N49 E19	02 08	31.1 17.8	I9	6.5	7	from 140 to 350	older
27	06.02.2015	*Ursus arctos*	N48 E19	58 09	40.1 16.8	J11	19		from 282	very old

#	Date	Species	Deg	min	sec	Quadrant (Cell)	Footprint width (cm)	Footprint length (cm)	Direction of travel (bearing)	Age of footprint notes
28	06.02.2015	*Lynx lynx*	N49 E19	00 09	19.3 31.8	J10	7	7	to 180	fresh
28A	06.02.2015	*Lynx lynx*	N49 E19	00 09	04.8 45.3	J10	7	7	to 30	fresh
28B	06.02.2015	*Lynx lynx*	N49 E19	00 09	06.1 54.9	J10	7	7	to 225	fresh
29	06.02.2015	*Canis lupus*	N49 E19	03 10	57.5 10.5	J7	9	11	from 120	very fresh
29A	06.02.2015	*Canis lupus*	N49 E19	04 10	01.8 58.5	J7	9	11	from 120	very fresh
30	06.02.2015	*Canis lupus*	N49 E19	04 08	14.96 42.59	I7			from 316 to 200	older
31	06.02.2015	*Canis lupus*	N49 E19	03 08	53.40 48.15	J7	8			older
32	10.02.2015	*Canis lupus*	N49 E19	03 10	59.9 04.6	J7	7–8	10	from 350 to 190	fresh
32A	10.02.2015	*Canis lupus*	N49 E19	03 10	45.7 29.4	J7	8	9.5	from 240 to 70	fresh
33	10.02.2015	*Canis lupus*	N49 E19	02 09	57.3 40.9	J8				older
34	10.02.2015	*Canis lupus*	N49 E19	03 09	18.18 7.61	J8				carcass, wolf pack
35	11.02.2015	*Lynx lynx*	N49 E19	01 07	55.8 53.2	I9	8	10	to 207	older
35A	11.02.2015	*Lynx lynx*	N49 E19	02 07	05.3 57.5	I9			to 94	older
36	11.02.2015	*Felis silvestris*	N49 E19	02 07	01.4 47.8	I9	5	5		fresh
37	11.02.2015	*Canis lupus*	N49 E19	03 11	13.1 24.2	K8	10	11	from 230 to 80	very fresh
37A	11.02.2015	*Canis lupus*	N49 E19	03 11	14.07 32.54	K8	10	11		very fresh, end following trail
38	12.02.2015	*Canis lupus*	N49 E19	04 08	07.4 54.1	J7	9		from 200 to 30	very fresh
38A	12.02.2015	*Canis lupus*	N49 E19	04 08	9.9 56.0	J7	9			very fresh
39	12.02.2015	*Canis lupus*	N49 E19	04 08	06.8 53.1	J7	7–8			very fresh

#	Date	Species	Deg	min	sec	Quadrant (Cell)	Footprint width (cm)	Footprint length (cm)	Direction of travel (bearing)	Age of footprint notes
40	12.02.2015	*Canis lupus*	N49 E19	04 08	04.8 45.7	J7	10			very fresh
41	12.02.2015	*Lynx lynx*	N49 E19	01 08	50.11 57.42	J9				older
42	12.02.2015	*Lynx lynx*	N49 E19	00 08	22.78 35.21	J10	7.5	8.5	to 116	very fresh
43	12.02.2015	*Lynx lynx*	N49 E19	02 09	27.25 03.17	J10	8.5	9.5	from 80 to 277	very fresh
44	13.02.2015	*Lynx lynx*	N49 E19	03 11	12.1 14.2	K8	10	8–9	to 20	very fresh
44A	13.02.2015	*Lynx lynx*	N49 E19	03 10	02.5 54.1	K8	10	8–9	from 189	very fresh
45	13.02.2015	*Lynx lynx*	N49 E19	02 10	57.5 41.6	K8	6	6	to 19	very fresh
45A	13.02.2015	*Lynx lynx*	N49 E19	02 10	56.4 29.4	K8	6	6	from 263 to 109	very fresh
46	13.02.2015	*Lynx lynx*	N49 E19	00 09	22.2 25.0	J10	8	7	from 90 to 280	fresh
47	13.02.2015	*Canis lupus*	N49 E19	04 08	8.49 35.14	I7	8.5	10.5	from 300 to 120	very fresh
48	13.02.2015	*Canis lupus*	N49 E19	04 08	15.65 44.06	I7	8	13	from 112 to 316	very fresh
49	13.02.2015	*Canis lupus*	N49 E19	04 08	15.65 44.06	I7	9	10	from 112 to 316	very fresh
50	13.02.2015	*Canis lupus*	N49 E19	04 08	13.45 31.60	I7	9	10.5	from 40 to 224	very fresh
51	13.02.2015	*Canis lupus*	N49 E19	04 08	14.33 28.44	I7			from 348 to 168	very fresh, 3 wolves hunting
52	13.02.2015	*Canis lupus*	N49 E19	04 08	14.10 23.24	I7	9	111	from 212 to 56	very fresh
53	13.02.2015	*Canis lupus*	N49 E19	03 08	53.94 41.77	I7	8.5	10.5	from 180 to 28	fresh
54	13.02.2015	*Canis lupus*	N49 E19	04 08	53.94 41.77	I7	8	9.5	from 180 to 28	fresh
54A	13.02.2015	*Canis lupus*	N49 E19	03 08	54.89 42.63	J7			from 180 to 28	fresh
55	13.02.2015	*Canis lupus*	N49 E19	04 08	5.51 26.27	I7	8	10	from 240 to 110	fresh

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

No.	Name	GPS position			Quadrant (Cell)	Species recorded	Placed on	Recovered on	Trap nights
		deg	min	sec					
CT1	Above yellow path	N49 E19	0 10	9.31 26.76	K10	*Cervus elaphus*	02.02.2015	13.02.2015	12
CT2	Besna	N48 E19	59 10	55.13 3.3	K10	*Cervus elaphus*	02.02.2015	13.02.2015	12
CT3	Above cottage	N49 E19	01 09	39.75 3.11	J9	*Cervus elaphus*	03.02.2015	13.02.2015	11
CT4	Wolf carcass	N49 E19	04 09	2.13 57.34	J7	*Vulpes vulpes, Martes martes*	03.02.2015	13.02.2015	11
CT5	Lynx trail	N49 E19	01 07	40.2 46.4	I9	-	04.02.2015	12.02.2015	9
CT6	Feeding station	N49 E19	04 08	16.40 47.10	J7	*Capreolus capreolus, Sus scrofa, Cervus elaphus*	03.02.2015	06.02.2015	4
CT7	Foresters hut	N49 E19	01 08	28.1 51.6	J9	-	06.02.2015	13.02.2015	7
CT8	Turecka	N49 E19	04 08	12.35 41.68	I7	*Cervus elaphus*	10.02.20153	13.02.2015	4
CT9	Lynx kill	N49 E19	00 08	23.16 34.44	J10	*Vulpes vulpes*	12.02.2015	19.02.2015	8
CT10	Red deer	N49 E19	00 08	28.82 31.9	J10	*Vulpes vulpes, Martes martes, Lynx lynx*	13.02.2015	24.02.2015	12
CT1	Above yellow path	N49 E19	0 10	9.31 26.76	K10	*Cervus elaphus*	02.02.2015	13.02.2015	12
CT2	Besna	N48 E19	59 10	55.13 3.3	K10	*Cervus elaphus*	02.02.2015	13.02.2015	12

Table 8. Summary of DNA samples collected.

No.	Date	GPS			Quadrant (Cell)	Species	Sample type
		Deg	Min	Sec			
S1	03.02.2015	N49 E19	05 09	11.8 45.8	J6	*Canis lupus*	urine
S2	06.02.2015	N49 E19	02 08	31.1 17.8	I9	*Lynx lynx*	urine
S3	06.02.2015	N49 E19	00 09	13 41.7	J10	*Lynx lynx*	urine
S4	06.02.2015	N49 E19	00 09	13 41.9	J10	*Lynx lynx*	urine
S5	10.02.2015	N49 E19	03 10	45.7 29.4	J7	*Canis lupus*	urine
S6	11.02.2015	N49 E19	01 07	58.4 38.7	I9	*Lynx lynx*	urine
S7	11.02.2015	N49 E19	01 07	58.4 38.7	I9	*Lynx lynx*	scat
S8	11.02.2015	N49 E19	02 07	01.4 47.8	I9	*Felis silvestris*	urine
S9	12.02.2015	N49 E19	04 08	07.4 54.1	J7	*Canis lupus*	urine
S10	12.02.2015	N49 E19	04 08	08.5 54.4	J7	*Canis lupus*	scat
S11	12.02.2015	N49 E19	04 08	04.8 45.7	J7	*Canis lupus*	scat
S12	12.02.2015	N49 E19	04 09	10.6 02.4	J7	*Canis lupus*	urine
S13	12.02.2015	N49 E19	00 08	22.65 35.94	J7	*Lynx lynx*	urine
S14	12.02.2015	N49 E19	00 08	24.01 35.64	J7	*Lynx lynx*	scat
S15	12.02.2015	N49 E19	00 08	24.01 35.64	J7	*Lynx lynx*	scat
S16	12.02.2015	N49 E19	00 08	24.01 35.64	J7	*Lynx lynx*	scat
S17	13.02.2015	N49 E19	02 10	55.2 39.70	K8	*Lynx lynx*	urine
S18	13.02.2015	N49 E19	02 10	55.1 39.30	K8	*Lynx lynx*	urine
S19	13.02.2015	N49 E19	02 10	49.54 40.01	K8	*Lynx lynx*	urine
S20	13.02.2015	N49 E19	02 10	55.80 31.80	J8	*Lynx lynx*	urine
S21	13.02.2015	N49 E19	00 09	13 41.86	J10	*Lynx lynx*	urine
S22	13.02.2015	N49 E19	00 08	24.1 34	J10	*Lynx lynx*	scat
S23	13.02.2015	N49 E19	04 08	4.38 45.30	I7	*Canis lupus*	scat
S24	13.02.2015	N49 E19	04 08	4.38 45.30	I7	*Canis lupus*	scat
S25	13.02.2015	N49 E19	04 08	4.38 45.30	I7	*Canis lupus*	scat
S26	13.02.2015	N49 E19	04 08	02.65 44.64	I7	*Canis lupus*	scat
S27	13.02.2015	N49 E19	04 08	8.62 35.26	J7	*Canis lupus*	urine
S28	13.02.2015	N49 E19	04 08	15.65 44.06	J7	*Canis lupus* (male)	urine
S29	13.02.2015	N49 E19	04 08	15.65 44.06	J7	*Canis lupus* (female)	urine

Table 9. Carcasses found during the expedition.

NO	Species of cadaver	Probable cause of death	GPS position			Quadrant (Cell)	Date of discovery
			deg	min	sec		
C1.	*Cervus elaphus female*	*Canis lupus*	N49 E19	04 09	2.13 57.34	J7	03.02.2015
C2	*Sus scrofa*		N48 E19	57 08	29.39 50.31	J12	04.02.2015
C3	*Cervus elaphus*		N48 E19	57 08	29.39 50.31	J12	04.02.2015
C4	*Cervus elaphus*		N48 E19	58 09	53.4 21.9	J11	06.02.2015
C5	*Cervus elaphus*	*Canis lupus*	N49 E19	03 09	18.18 7.61	J8	10.02.2015
C6	*Cervus elaphus*		N49 E19	00 08	50.23 0.93	I10	11.02.2015
C7	*Sus scrofa*	*Canis lupus*	N49 E19	04 08	08.0 57.4	J7	12.02.2015
C8	*Capreolus capreolus male*	*Lynx lynx*	N49 E19	00 08	23.16 34.44	J10	12.02.2015
C9	*Cervus elaphus male*	Caught in fence	N49 E19	00 08	25.82 31.9	J10	13.02.2015
C10	*Cervus elaphus*	*Canis lupus*	N49 E19	04 08	01.57 45.51	J7	13.02.2015

MAPS

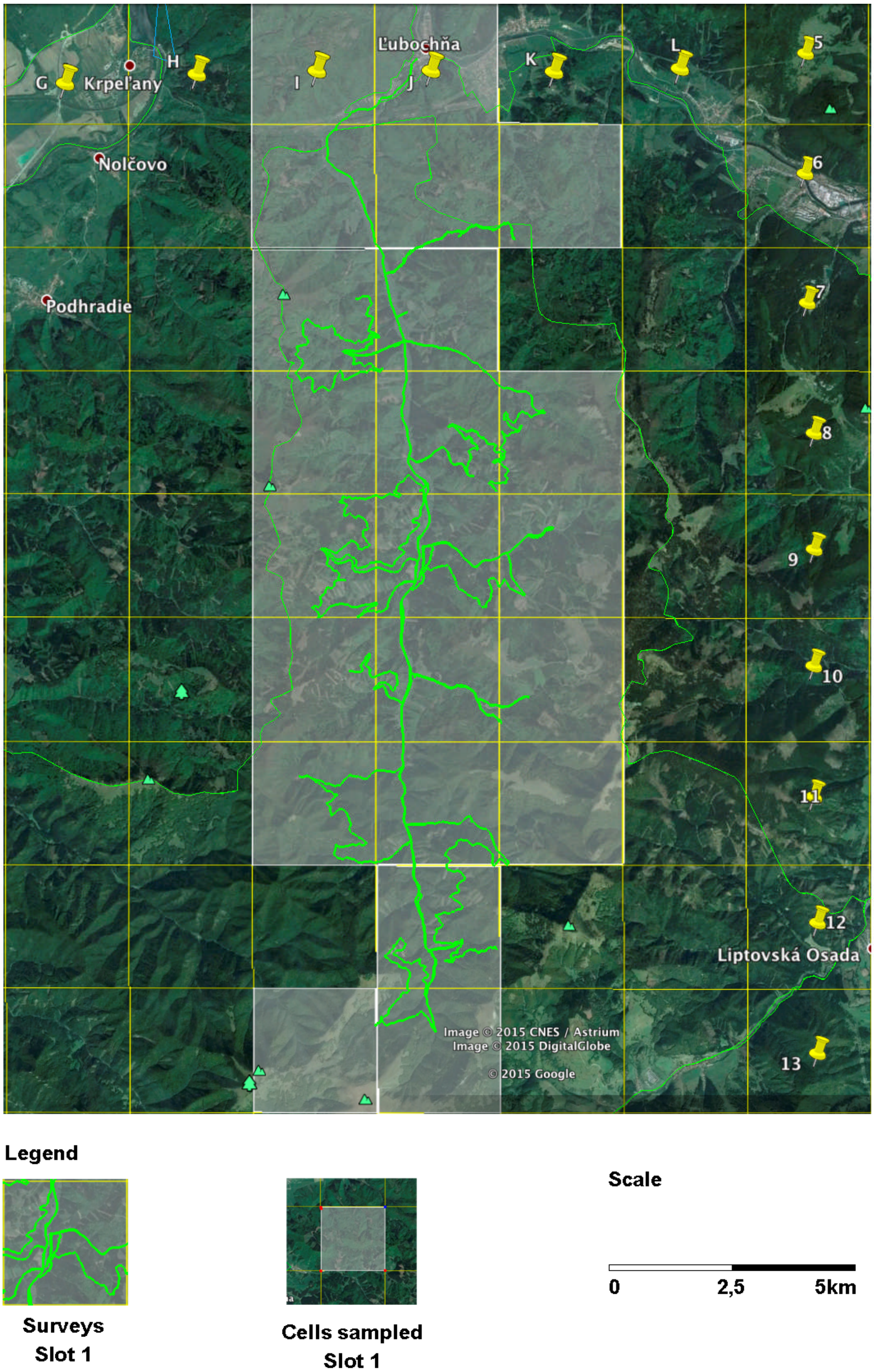

Figure 1. Transects walked by group 1.

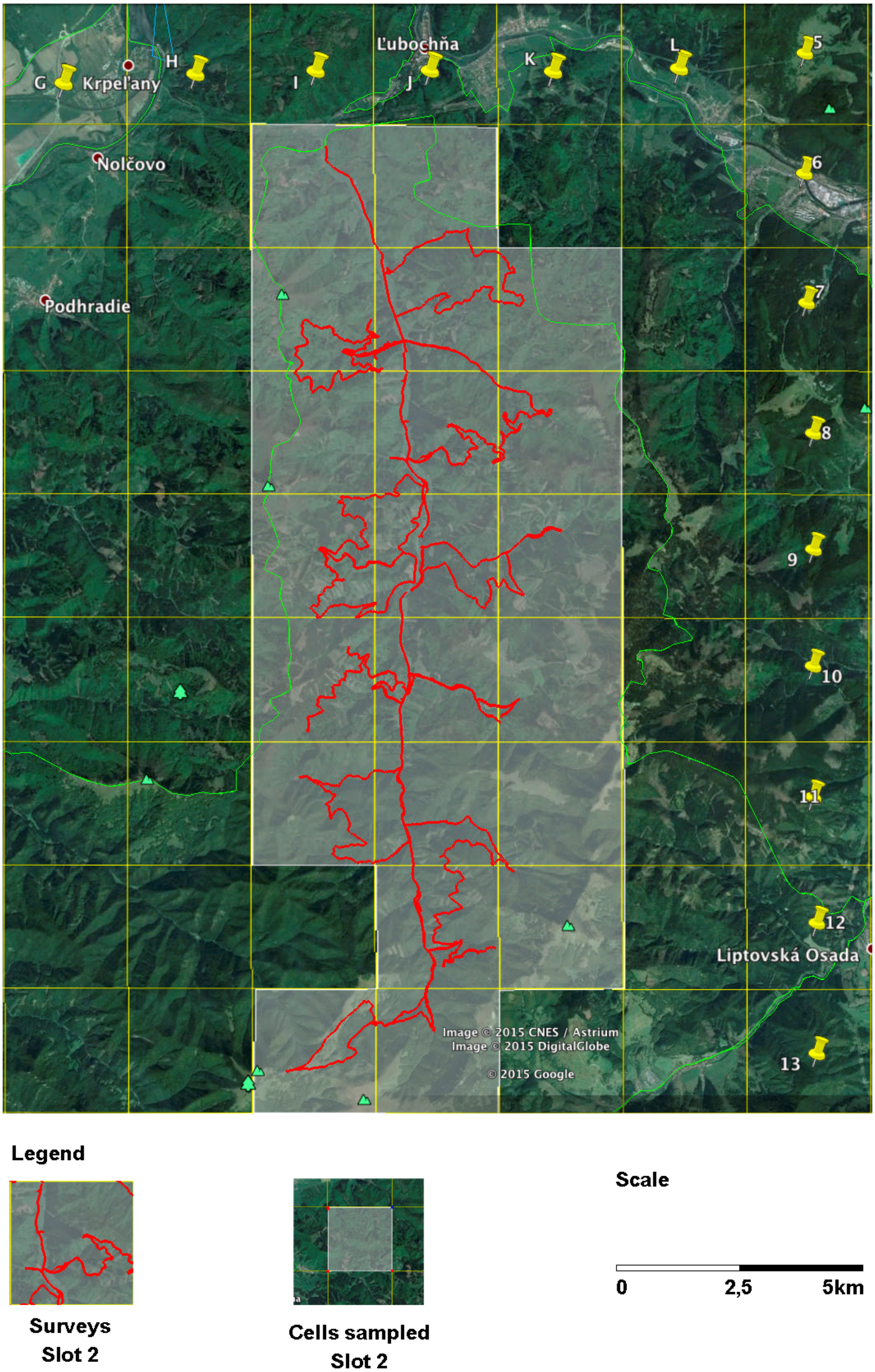

Figure 2. Transects walked by group 2.

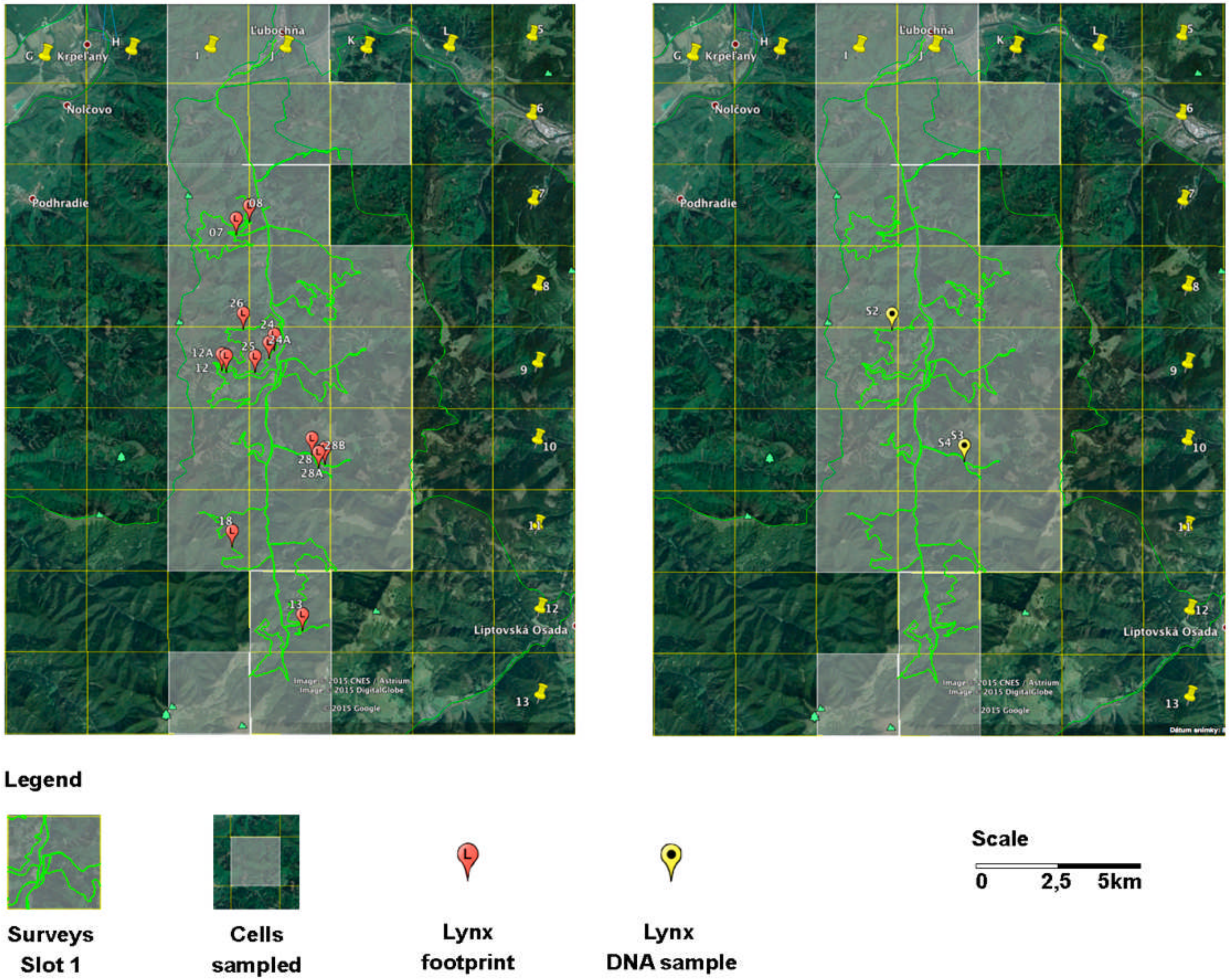

Figure 3. Transects walked by group 1 with lynx footprints and samples.

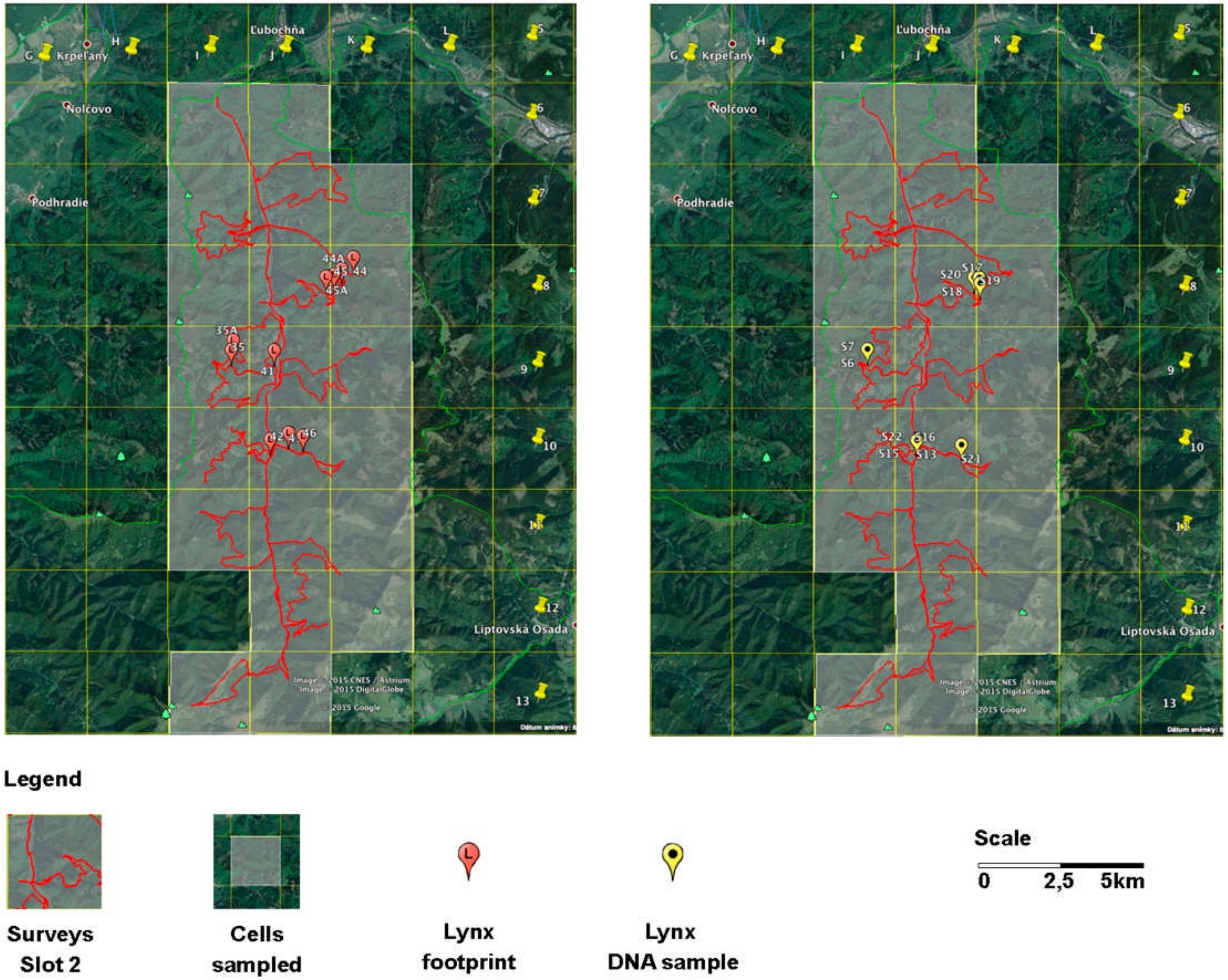

Figure 4. Transects walked by group 2 with lynx footprints and samples.

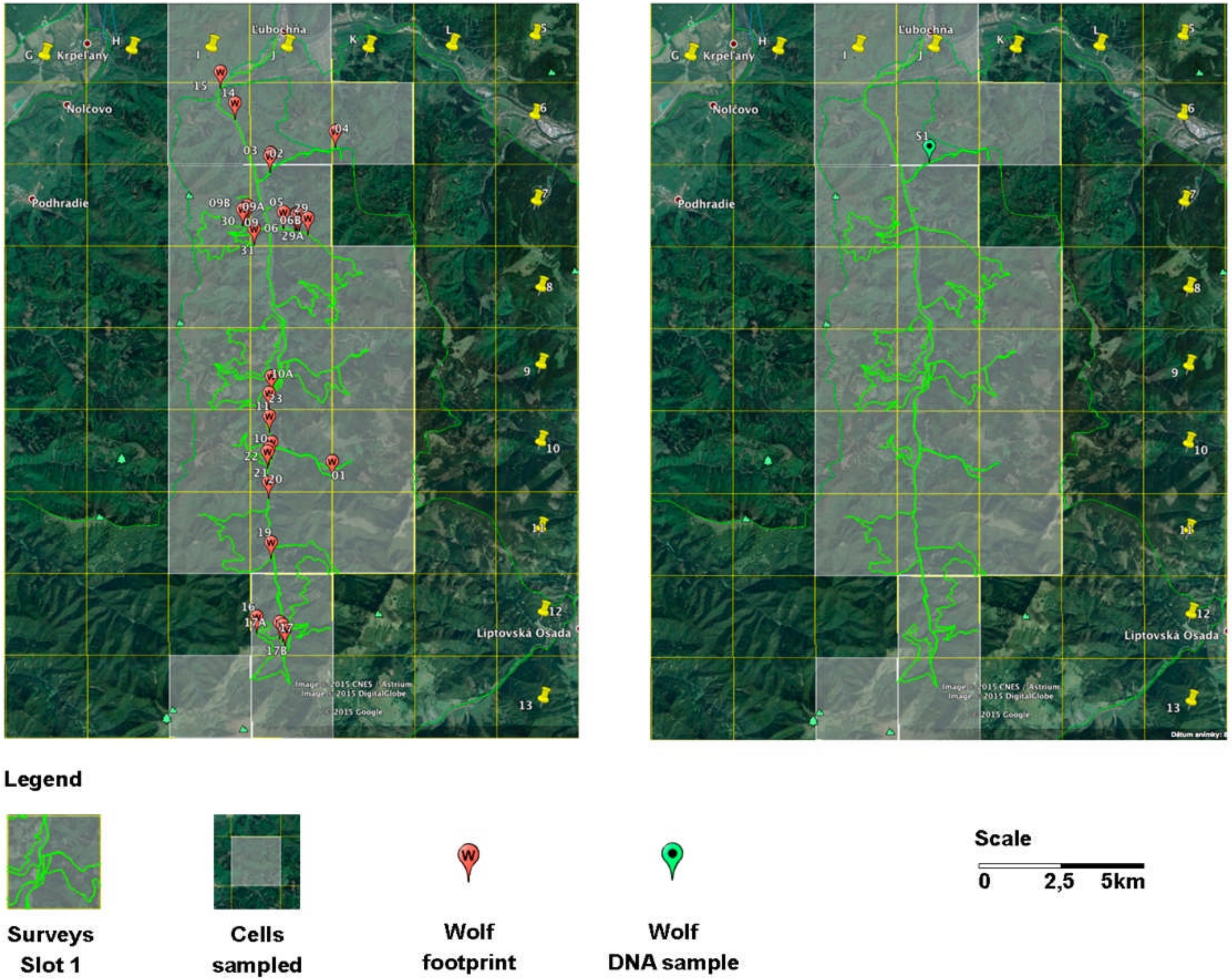

Figure 5. Transects walked by group 1 with wolf footprints and samples.

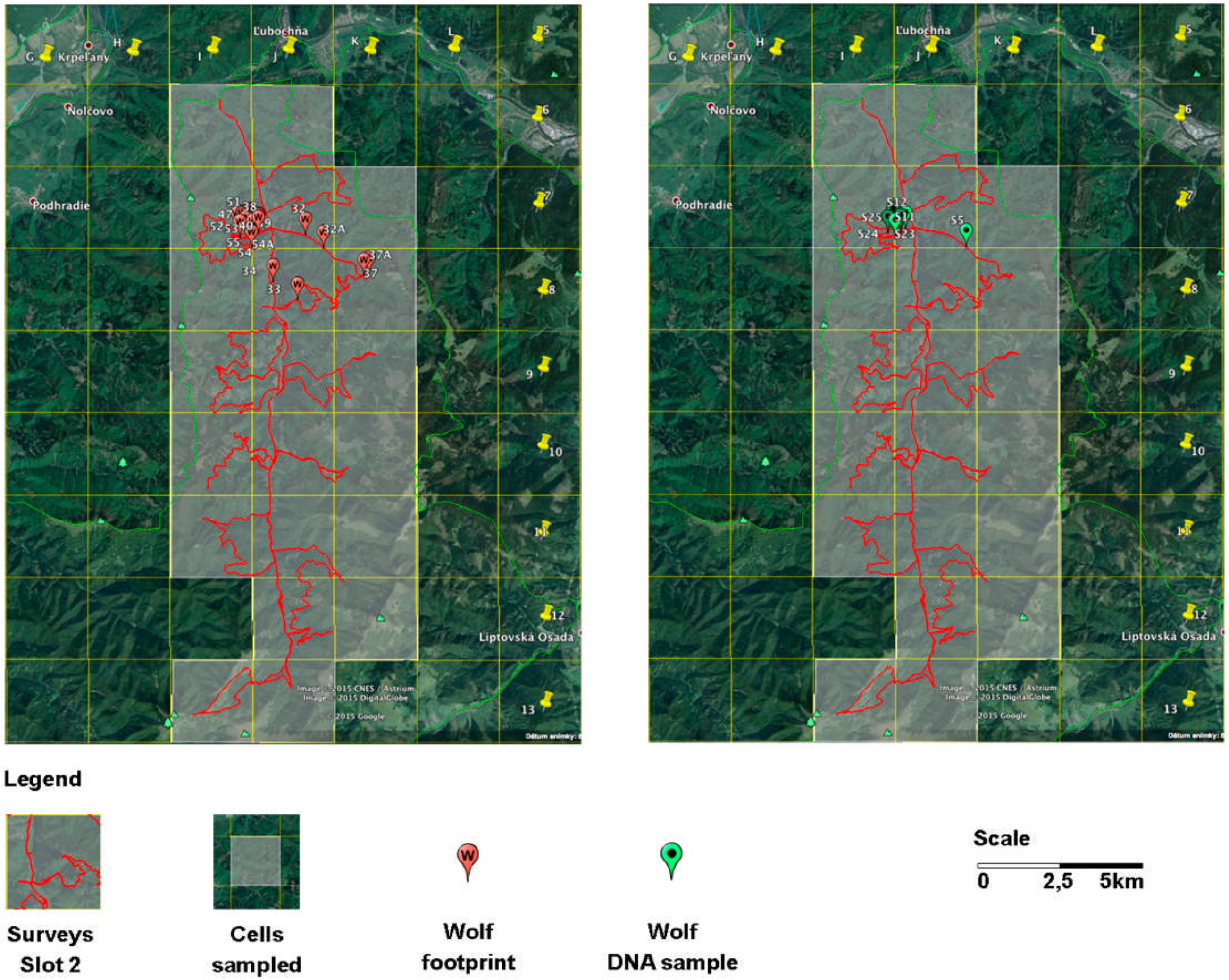

Figure 6. Transects walked by group 2 with wolf footprints and samples.

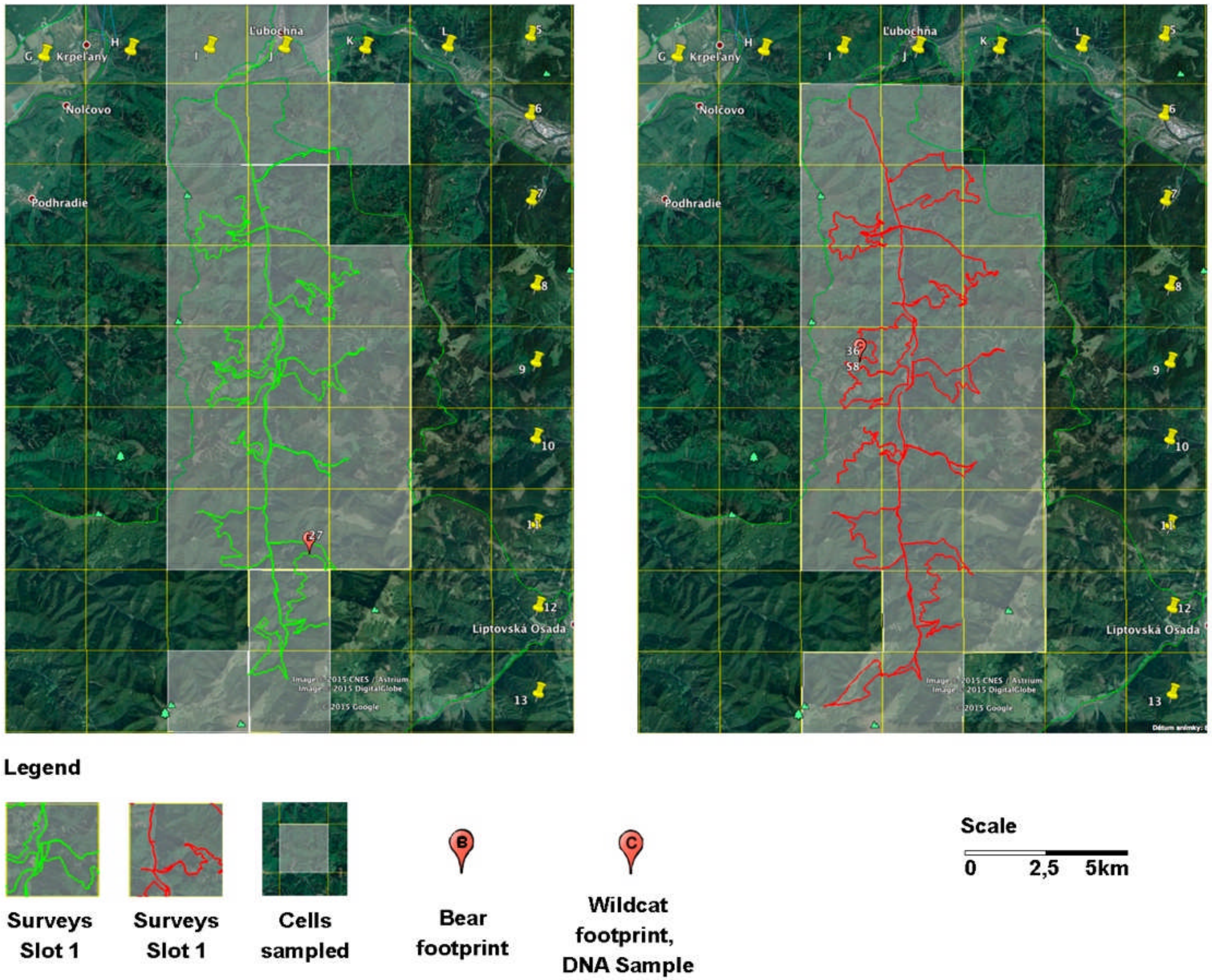

Figure 7. Transects walked by group 1 with bear footprints and transects walked by group 2 with wildcat footprints and samples.

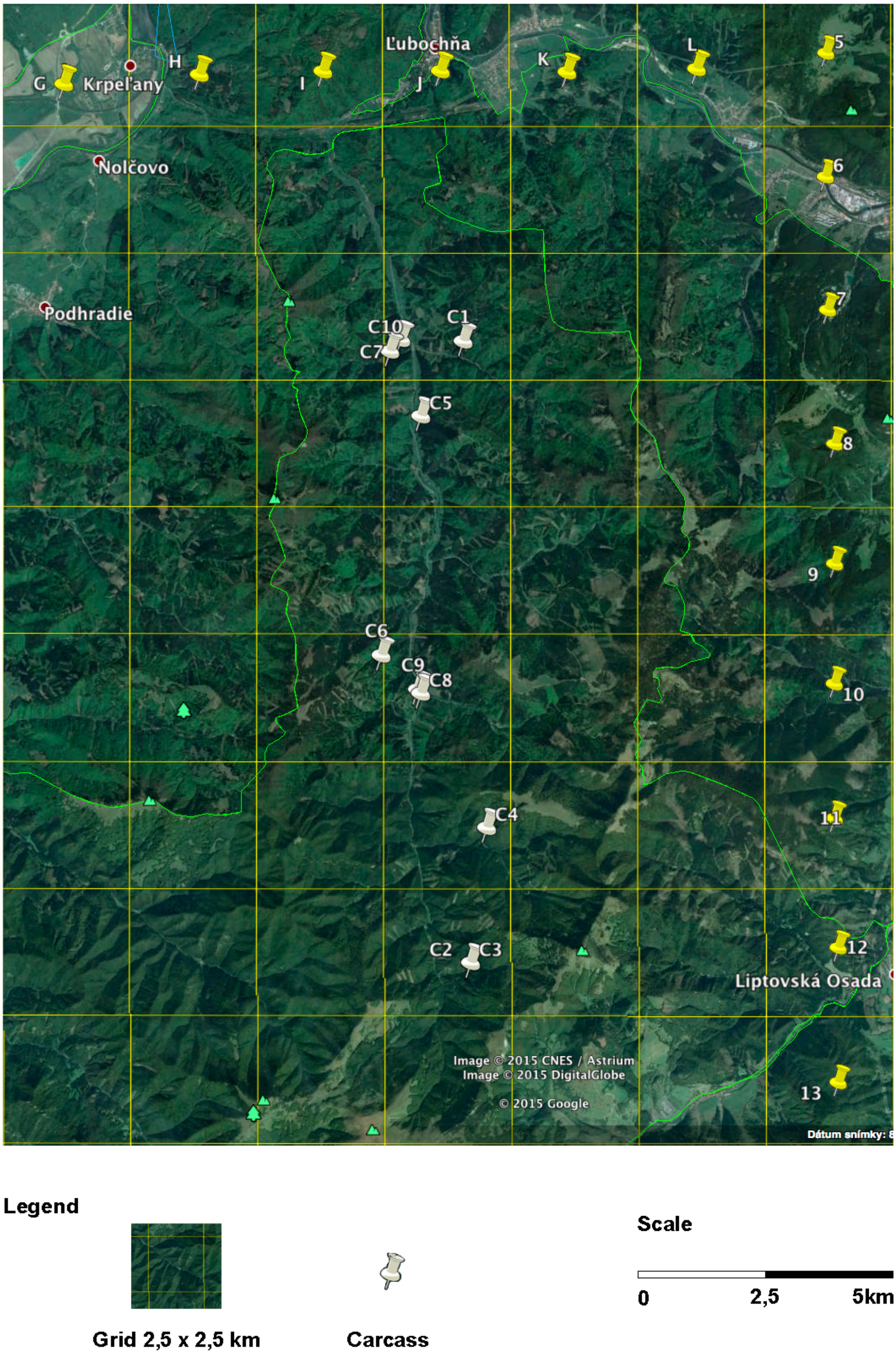

Figure 8. Position of carcasses.

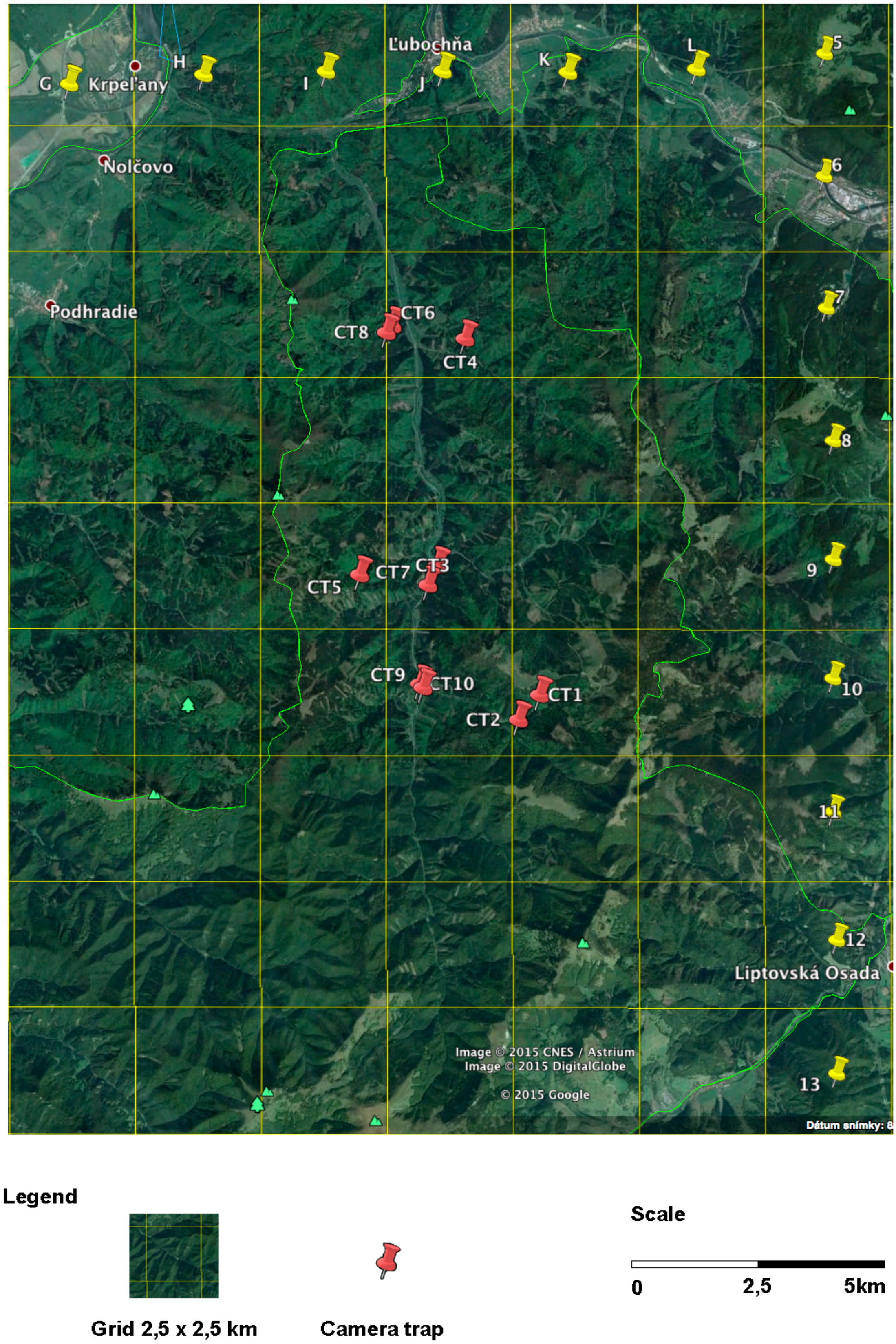

Figure 9. Position of camera traps.

CAMERA TRAP PHOTOS

Figure 10. Camera trap sample photos.

CT1 Above yellow path: *Cervus elaphus*, CT3 Above cottage: 2x *Cervus elaphus*

CT4 Wolf carcass: *Martes martes, Vulpes vulpes*, CT6 Feeding station: *Sus scrofa*

CT6 Feeding station: *Capreolus capreolus*, CT8 Turecka: 2x *Cervus elaphus*

CT9 Lynx kill: *Vulpes vulpes*, CT10 Red Deer: 2x *Martes martes, Vulpes vulpes*

CT10 Red Deer: *Lynx lynx*

Appendix II: Expedition diary and reports

A multimedia expedition diary is available at https://biosphereexpeditions.wordpress.com/category/expedition-blogs/slovakia-2015/.

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