PROJECT REPORT

Expedition dates: 3 – 16 February 2013

Report published: January 2014

True white wilderness: winter wolf and lynx tracking in the Carpathian Mountains of Slovakia

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True white wilderness: winter wolf and lynx tracking in the Carpathian Mountains of Slovakia

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Authors:
Tomas Hulik
Protection of Carpathian Wilderness (PCW)

Marcelo Mazzolli
Projeto Puma

Matthias Hammer (editor)
Biosphere Expeditions

Cover page courtesy of Tomas Hulik

Abstract

There are indications that bear, wolf and lynx population numbers in the Slovak Republic as published by official sources may be unreliable. This may have a serious conservation impact, as harvesting quotas for bears and wolves are based on these estimates.

With the aim of collecting biological information to improve management practices for bears, wolves and lynxes, fieldwork was conducted in Veľká Fatra National Park and concentrated on the L'ubochnianska valley in northern Slovakia from 3 February to 16 February 2013. The study was a collaboration between the organisations Biosphere Expeditions and Protection of Carpathian Wilderness.

During the expedition, 38 transects were surveyed, with a total length of 306.73 km. The average length of a transect was 8.07 km. The sampled area was divided into 34 cells of 2 x 2 km size, 12 of which recorded species of interest in them. Thirty-six tracks and snow-tracked trails were recorded, of which 15 were identified as being left by lynx (41%), 20 by wolf (56%) and 1 by wildcat (3%)

Ten camera traps were placed in the study area and 735 photos were taken. Camera trap no. 9 recorded 268 photographs of lynx, which repeatedly visited the carcass of a roe deer (*Capreolus capreolus*). Camera traps also recorded other target animals such a wolf hunting deer on camera trap no 2. and a bear on camera trap no. 8. Fox (*Vulpes vulpes*), marten (*Martes martes*), red deer (*Cervus elaphus*) and roe deer were also photographed.

Twelve samples (urine and hair) were collected for DNA analysis. Three samples (25%) were assumed, from tracks, to be from lynx and nine samples (75%) were assumed to be from wolf. All are awaiting DNA analysis, which will identify species and individuals.

Lynx and wolves were recorded at a similar rate, but the data indicate that there is some spatial separation between them. This spatial separation could be either a result of interference, i.e. when there is an avoidance of each other, or it may simply be a result of preference for different habitats. Overall, the data indicate that both species are relatively abundant in the study area, probably at similar abundances, and that there is good prey availability of red and roe deer. Despite this, serious levels of overharvesting of wolves in Slovakia, with annual culling rates as high as half the total wolf population, remain a major cause for concern. Better, more reliable ways to set realistic hunting quotas, based on expert estimations such as the ones presented in this study, should be found.

Súhrn

Existujú náznaky, že odhady početnosti populácie medveďa, vlka a rysa na Slovensku, vydávané oficiálnymi zdrojmi môžu byť nespoľahlivé. To môže mať vážne dôsledky v rámci ochrany veľkých šeliem, pretože kvóty na odstrel medveďov a vlkov sú založené na týchto odhadoch.

Terénny monitoring s cieľom získať biologické informácie a prispieť k zlepšeniu menežmentových opatrení veľkých šeliem ako medveď, vlk a rys, bol uskutočnený v Národnom parku Veľká Fatra. Sústredil sa na Ľubochniansku dolinu na severnom Slovensku v období od 3. februára do 16. februára 2013 ako spolupráca medzi organizáciami Biosphere Expeditions a Ochrana karpatskej divočiny.

Počas terénneho výskumu bolo monitorovaných 38 transektov v celkovej dľžke 306,73 km. Priemerná dĺžka transektu bola 8,07 km. Záujmové územie bolo rozdelené na 34 kvadrantov veľkosti 2 x 2 km, v 12 kvadrantoch sa zaznamenali záujmové druhy veľkých šeliem. Identifikovaných bolo 36 nálezov stôp a stopových dráh záujmových druhov: 15 patrilo rysovi ostrovidovi (*Lynx lynx*) (41,67%), 20 vlkovi dravému (55,55%) a 1 stopová dráha patrila mačke divej (2,78%).

V záujmovom území boli na 10 miestach nainštalované fotopasce, ktoré zaznamenali 735 fotografií. Na fotopasci č.9 sa podarilo zachytiť 268 fotografií rysa ostrovida (*Lynx lynx*), ktorý sa opakovane vracal ku svojej strhnutej koristi srny hôrnej (*Capreolus capreolus*). Fotopasce zaznamenali aj vlka dravého (*Canis lupus*) prenasledujúceho korisť na fotopasci č.2, medveďa hnedého (*Ursus arctos*) po prebudení sa zo zimnej hibernácie na fotopasci č. 8. Ďaľšie záznamy z fotopascí zachytili líšku hrdzavú (Vulpes vulpes), kunu lesnú (*Martes martes*), jeleňa lesného (*Cervus elaphus*), srnca hôrneho (*Capreolus capreolus*).

Nájdených bolo 12 vzoriek na DNA analýzu (11x moč, 1x chlp). 3 vzorky (25%) patrili rysovi ostrovidovi (*Lynx lynx*) (určéné na základe stôp pri vzorke) a 9 vzoriek (75%) bol vlk dravý (*Canis lupus*). Vzorky zatiaľ čakajú na DNA analýzu, ktorá by mala identifikovať jednotlivé individuá.

Na záujmovom území bol zaznamenaný rys ostrovid aj vlk dravý v rovnakej miere, aj keď zozbierané údaje naznačujú určité odlišnosti v rámci výskytu na území. Môžu byť spôsobené jednak vzájomným vyhýbaním sa resp. preferencie iných stanovíšť a druhov biotopov. Zozbierané údaje poukazujú na relatívne častú prítomnosť obidvoch druhov v záujmovom území, na základe dostatku vhodnej koristi ako je jeleň a srnec. Napriek tomu, vysoká miera odlovu vlka na Slovensku, skoro v úhrne polovice populácie je veľkým dôvodom na obavy. Je viac než nutné nájsť spoľahlivé spôsoby ako nastaviť realistické kvóty na odstrel vlka založené na expertných odborných odhadoch ako sa snaží prezentovať aj táto štúdia.

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 3 – 16 February 2013 with the aim of conducting conservation research work on lynx, wolf and wildcat, as well as their interrelationships with prey species.

With rising numbers of wolves, lynx and bears 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, 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 big 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:

3 – 9 February | 10 – 16 February 2013.

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

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 and including a sauna. 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 exceptionally cold with good snow cover. Temperatures dropped to below -8°C on many days (see Appendix I).

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 also hand-held radios for groups working closer 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 one Land Rover Defender and one Land Rover Discovery throughout.

Medical support and incidences

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 incidences during the expedition.

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

1.5. Local scientist

Tomas Hulik 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 “Hulik and the beavers”, “High Tatras – wilderness frozen in time” and “Miloš and the lynxes” were distributed worldwide. His last project, “Miloš and the lynxes”, has brought him back to science. He is now working on the conservation of lynxes 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 and Malá Fatra National Parks.

1.6. Expedition leader

The expedition was led by Peter Schuette, who was born in Germany. He studied geography and cartography at the University of Bremen (Germany) and Göteborg universitet (Sweden) and geoinformatics in Salzburg (Austria). He has worked on several mapping and remote sensing projects all over the world. In 2004 and 2005 Peter was involved in wildlife conservation projects in Namibia, where he joined Biosphere Expeditions as a member of the team of local scientists and was promptly bitten by the wildlife expeditions bug. He has travelled in Scandinavia, Iceland, Southern Africa, North America and Central Asia. Peter holds First Aid and Off-Road Driving certificates and has been to Namibia, Altai and Oman for Biosphere Expeditions.

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 (with country of residence):

3 – 9 February 2013

Stephanie Baldwin (UAE), Hans Bouwes (Germany), Peter Bouwes (The Netherlands), Sylvain Kolly (Switzerland), Claudia Martinowski (Austria), Yvette Mcmillen (Australia), Fanny Nicaise (Belgium), Rainer Ofner (Switzerland), Phil Quinn (UK), Melissa Shepstone (USA), Steven Shepstone (USA), Stephanie Wirz (Switzerland).

10 – 16 February 2013

Ann-Marie Davies (UK), Kurt Ersland (Norway), John Haddon (UK), Holly Kirkwood (journalist, UK), Sylvain Kolly (Switzerland), Mirko Macinai (Italy), Richard McCullough (Austria), John Patten (Austria), Helene Rebholz (Austria), Mike Staeck (Germany).

In addition for some or all of the time: Adam Stickler (assistant expedition leader, UK) and Milos Majda (Slovakia).

1.8. Expedition budget

Each team member paid towards expedition costs a contribution of £980 per person per 7-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	19,415
Expenditure	
Expedition base includes all board & lodging, and extra food & meals	3,854
Transport includes car fuel UK–Slovakia return, car fuel during expedition, train rides	1,775
Equipment and hardware includes research materials & gear etc. purchased in UK & Slovakia	181
Staff includes local and Biosphere Expeditions staff salaries	3,977
Administration includes miscellaneous fees & sundries	126
Team recruitment Slovakia as estimated % of annual PR costs for Biosphere Expeditions	6,400
Income – Expenditure	**3,102**
Total percentage spent directly on project	**84%**

1.9. Acknowledgements

The expedition was conducted jointly by Biosphere Expeditions and PCW (Protection of Carpathian Wilderness). 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 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, Land Rover and Swarovski Optik 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

Tomas Hulik
Protection of Carpathian Wilderness

Marcelo Mazzolli
Projeto Puma

M. Hammer (editor)
Biosphere Expeditions

2.1. Introduction

Large predator populations have recovered during the last decades (Linnell et al. 1998), particularly in Eastern Europe, and this has brought predators in increasing contact with humans again. Conflicts with humans have thus increased, in the form of livestock depredation and fear of large predators in the vicinity of households. Brown bears, for instance, cause the greatest 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*), lynxes (*Lynx lynx*) and wildcats (*Felis silvestris*), all of which are indigenous.

In spite of the relatively stable populations of the species above, there is always a risk that management practices adopted to control population numbers may compromise these 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 number 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. Slovakia has a specialist-based estimated population of 800–1,100 individuals. In spite of that, the IUCN (International Union for the 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; Slovakia pays €8 per year of compensation for each existing bear in the country (Huber 2013).

In Europe, wolves occur in all countries except in the Benelux countries, Denmark, Hungary and the island states (Ireland, Iceland, United Kingdom, Cyprus, Malta). The estimated total number of wolves in Europe seems to be larger than 10,000 individuals, with the largest populations occurring in the Carpathian and in the Dinaric-Balkan region (> 3,000 wolves). In Slovakia, however, specialist estimates of population numbers range from 200 to 400 individuals (Chapron 2013). Official estimates were of 2,006 individuals, a five-fold difference from specialist estimates. Considering that the harvesting quota for the year 2012 was 130 individuals and 147 were taken, this could represent a 50% cut down in the Slovakia wolf population if specialist estimates are correct! The wolf is considered widespread over all the Carpathian range of Slovakia, but there is a threat from overhunting. Wolves are hunted and persecuted all over the country, including in protected areas. Wolves and livestock are associated with conflicts over the whole of the species‘ range. The rough economic cost (based on reported compensation only) can be estimated at reaching 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.

Lynx are found in 23 countries, and based on a range of criteria can be grouped into 10 populations. Five are autochthonous, including the Carpathian population, while the others stem from reintroductions in the 1970s and 1980s (Dinaric, Alpine, Jura, Vosges-Palatinian and Bohemian-Bavarian populations), and from recent reintroductions, such as in the Harz Mountains of central Germany. The total number of lynx in Europe is 9,000–10,000 individuals (excluding Russia & Belarus). The largest and more widely distributed populations are found the Scandinavian region and vicinities. The Carpathians harbour around 2,300 individuals, and Slovakia about 400 individuals. 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 2013). The lynx is, like the wolf, widespread over all the Carpathian range, but is considered to occur in smaller numbers. Specialists considered official population numbers in the country as overestimated by 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 hunting) 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, 2013).

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. Samples such as hair and urine were collect for DNA analysis.

2.2. Study area

The Veľká Fatra National Park (see Fig. 2.2a) is situated between the geographic coordinates of north latitude 48° 47' – 49° 09' and east longitude 18° 50' – 19° 18'. The national park belongs to the Inner Western Carpathian subprovince, 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.

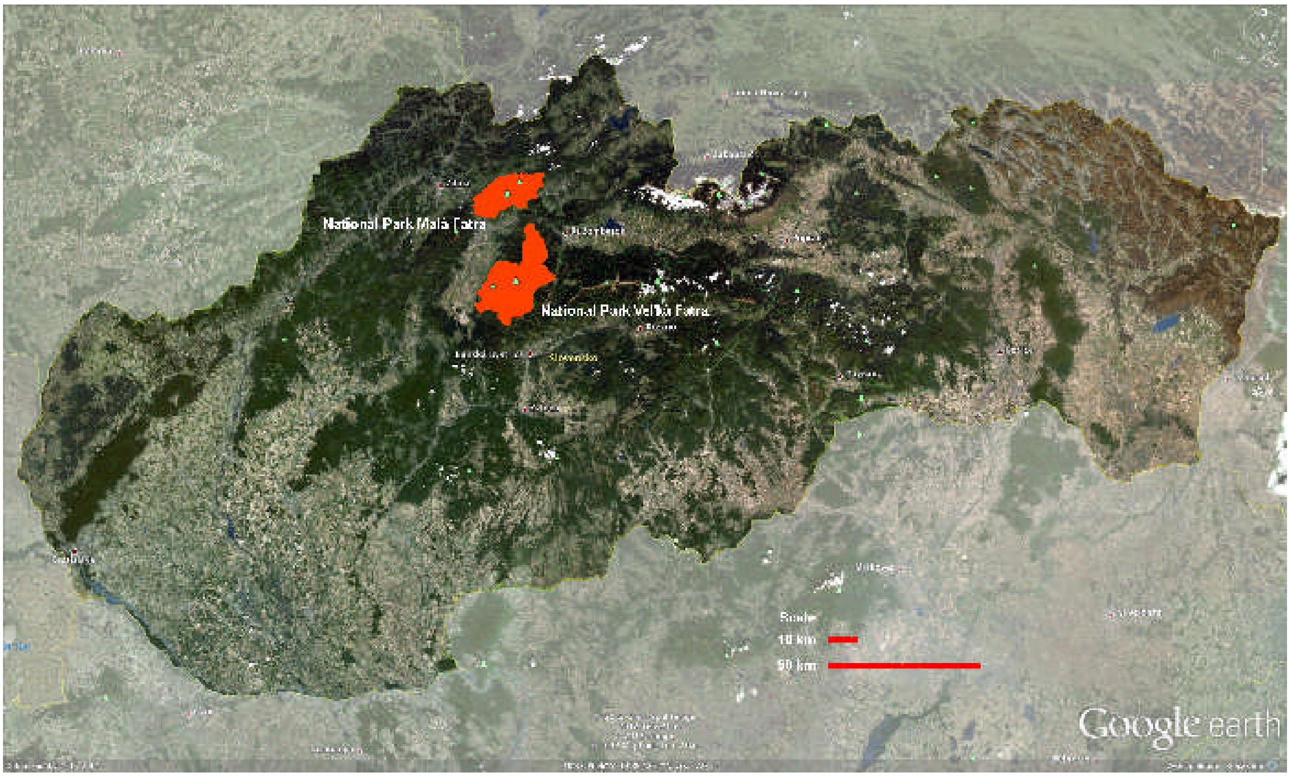

Figure 2.2a. The territory of Slovakia with National Park Malá Fatra and National Park Veľká Fatra in red.

The Veľká Fatra is one of the largest mountain areas of Slovakia. The natural environment is preserved without great 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. Deep streams have carved valleys into the Mesozoic crystalline rock, the longest being the Ľubochnianska. This valley divides the Veľká Fatra Park from south to north and flows 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 timberline. The limestone and dolomite ground supports growth of Scots pine and smaller oaks. In higher or exposed areas there are reduced-growth trees. Veľká Fatra is characterised by a high occurrence of yew trees, 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 is host to 8 species of amphibians, including the very rare Carpathian newt (*Triturus montandoni*), 7 species of reptiles, 6 species of fish, 110 species of birds and 60 species of mammals (Vestenický and Vološčuk 1986).

Common mammals include: red 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. It contains the Ľubochnianska River and measures 25 km in length. It runs in a north–south direction starting at the village of Ľubochňa (district Ružomberok) and ends along the ridge of Ploská and Čierny kameň.

2.3. Materials and methods

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.

Analyses of population densities (i.e. the number of individuals per area) are commonly the main focus of a research project, because density relates to the conservation status of a species or population.

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 following subsequent recaptures gives the statistics necessary to estimate total population size.

However, the current report is not the forum to detail and compare methodological issues. What is of interest for this study is that estimating parameters related to density require something to refer 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 previous efforts. This is the basis for ecological inferences, or, as noted above, information will be lost.

Under the umbrella of 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 track frequency and density during snow-tracking that usually does not take into account autocorrelation – no breaking points are usually established for track count; that is, tracks 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 cell. The European Commission employed cells 10 x 10 km in size to verify the status and distribution of large carnivores on the entire European continent (Kaczensky et al. 2013), and some countries use reincidence 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 McKenzie 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 (McKenzie et al. 2003).

Alternatively, but following the same reasoning of revisitation of a sampling location, Linnel et al. (2007), in his snow-tracking study of lynxes, used over 360 transects crossed by individuals of the species to test indexes employing detection probabilities used in capture-recapture statistics. Instead of grids, 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, track identification and snow-tracking were the main methods employed to record data. Samples were also collected for future DNA analysis.

A grid system with 2 x 2 km cells was established over the area (see Fig. 2.3a) sampled since 2008. Within the grid system, 38 transects were surveyed, with a total length of 306.73 km.

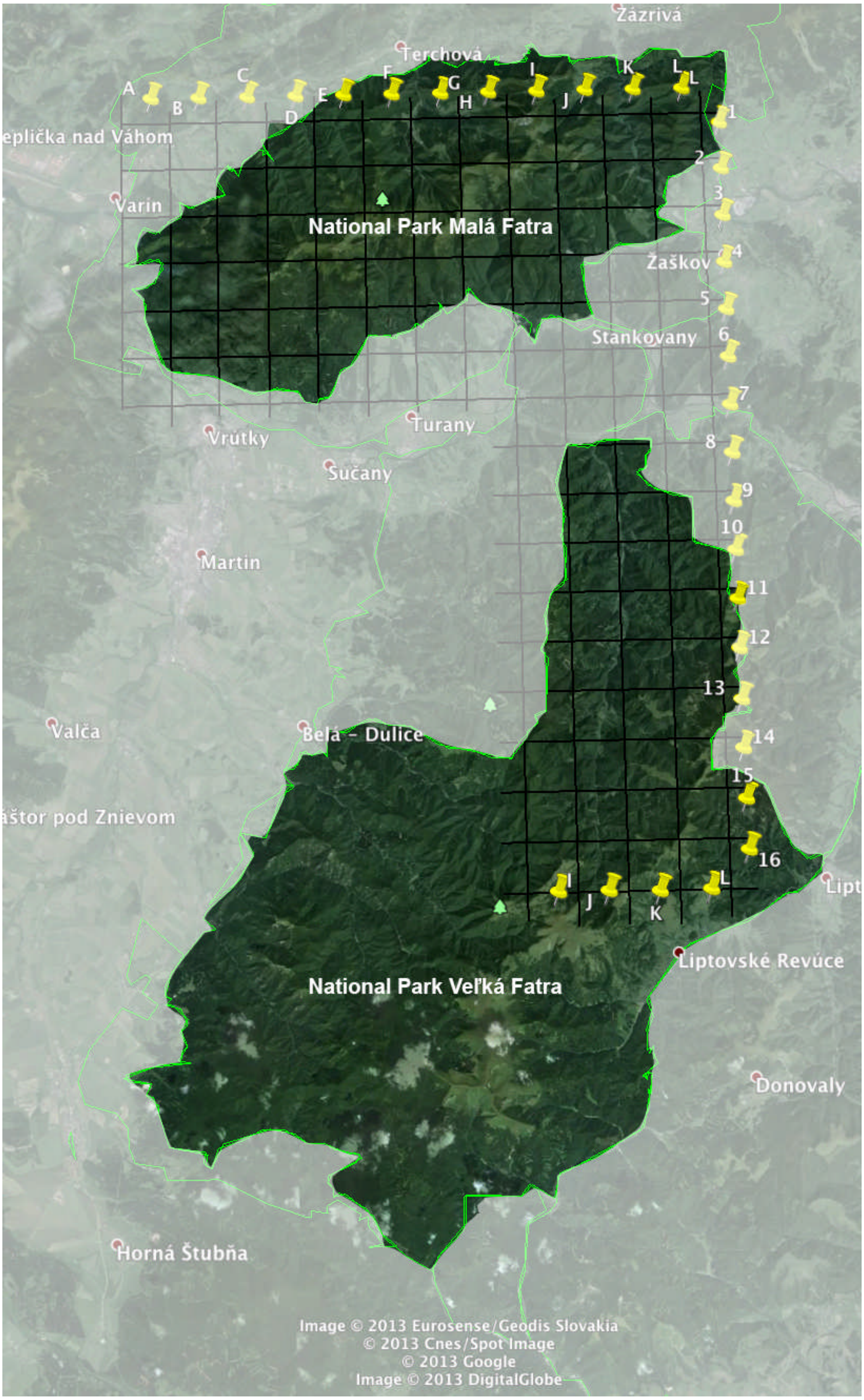

Figure 2.3a. Grid system over the areas of National Parka Malá Fatra and National Park Veľká Fatra.

Training of volunteers

The first day of each group was dedicated to the training of volunteers, especially in the identification of trace elements, including footprints and their recognition/recording on various substrates. Volunteers received training for working with GPS devices and data collection protocols.

The second day of training focused on identifying tracks and the practical implementation of these skills in the field. During these two 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. The volunteers were divided into four groups.

Each group of volunteers was given diagrams which showed tracks and photos of the target species, a ruler for precise measurements of length and width of footprints, research sheets for recording data, GPS devices (Garmin GPS 60), 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

Data sheets were used by volunteers to record information, including 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 tracks and trails left by species (length, width and estimated age of the track), 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 alcohol, and sealed into a plastic bag. Great care was taken to avoid direct contact with the sample, as this would cause its contamination and degradation. The sample was then labelled and recorded. Samples were stored at -16°C in a special laboratory of the Slovak Academy of Sciences in Bratislava. DNA markers will be used according to Mestemacher (2006), Schmidt & Kowalczyk (2006) and Downey et al. (2007).

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

Data analysis

In case of GPS signal loss due to vegetation or terrain, missing data points were obtained via Google Earth.

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 compare to each other. The frequency of tracks 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.

2.4. Results

During the expedition period 38 transects were surveyed, with a total length of 306.73 km, covering 34 cells of the grid system and encompassing a surveyed area of 136 square kilometres. The average length of a transect was 8.07 km.

Tracking and snow-tracking allowed researchers to identify and follow lynx *Lynx lynx* and wolves *Canis lupus* trails, obtaining information on their occurrence over a large area. Wolf trails were followed over 5.2 km, and lynx trails over 7.98 km (detailed trails in Appendix I). A single record of a wildcat was also obtained. Camera traps were installed in fixed locations, recording a larger number of species: red deer *Cervus elaphus,* roe deer *Capreolus capreolus,* red fox *Vulpes vulpes,* grey wolf *Canis lupus,* pine marten *Martes martes,* brown bear *Ursus arctos,* lynx *Lynx lynx*, and common buzard *Buteo buteo* (photos and tables in Appendix I). Red and roe deer were also recorded from carcasses.

Twelve samples were collected (11 urine, 1 hair) for DNA analysis: 3 samples (25%) were confirmed, by tracks, to be from lynx and 9 samples (75%) from wolf.

Wolves and lynxes shared records in only two out of all cells in which they were recorded, an indication of a certain spatial separation (see first two rows of Table 2.4a).

Table 2.4a. Cells in which wolves and lynx were recorded (matching cells in bold).

Wolf	Lynx
12K	**12K**
3K	**3K**
12J	13J
10K	14J
10J	3J
12L	4J
13K	14I
12I	

Wolf

Wolves were recorded in both Veľká Fatra (southern study area) and Malá Fatra (northern study area) National Parks. The species was recorded in 8 out of 34 cells (2 x 2 km in size) surveyed. The proportion of cells surveyed and hits (species recorded) was 9:1 in the northern area and 25:7 in the south. This may be an indication that wolves were more prevalent in the south during the survey period. It is also worthwhile to note that snow-tracking contributed to the recording of wolves in eight cells, while camera-trapping recorded wolves in only one cell. Prospective wolf samples were also collected, but await genotyping analysis.

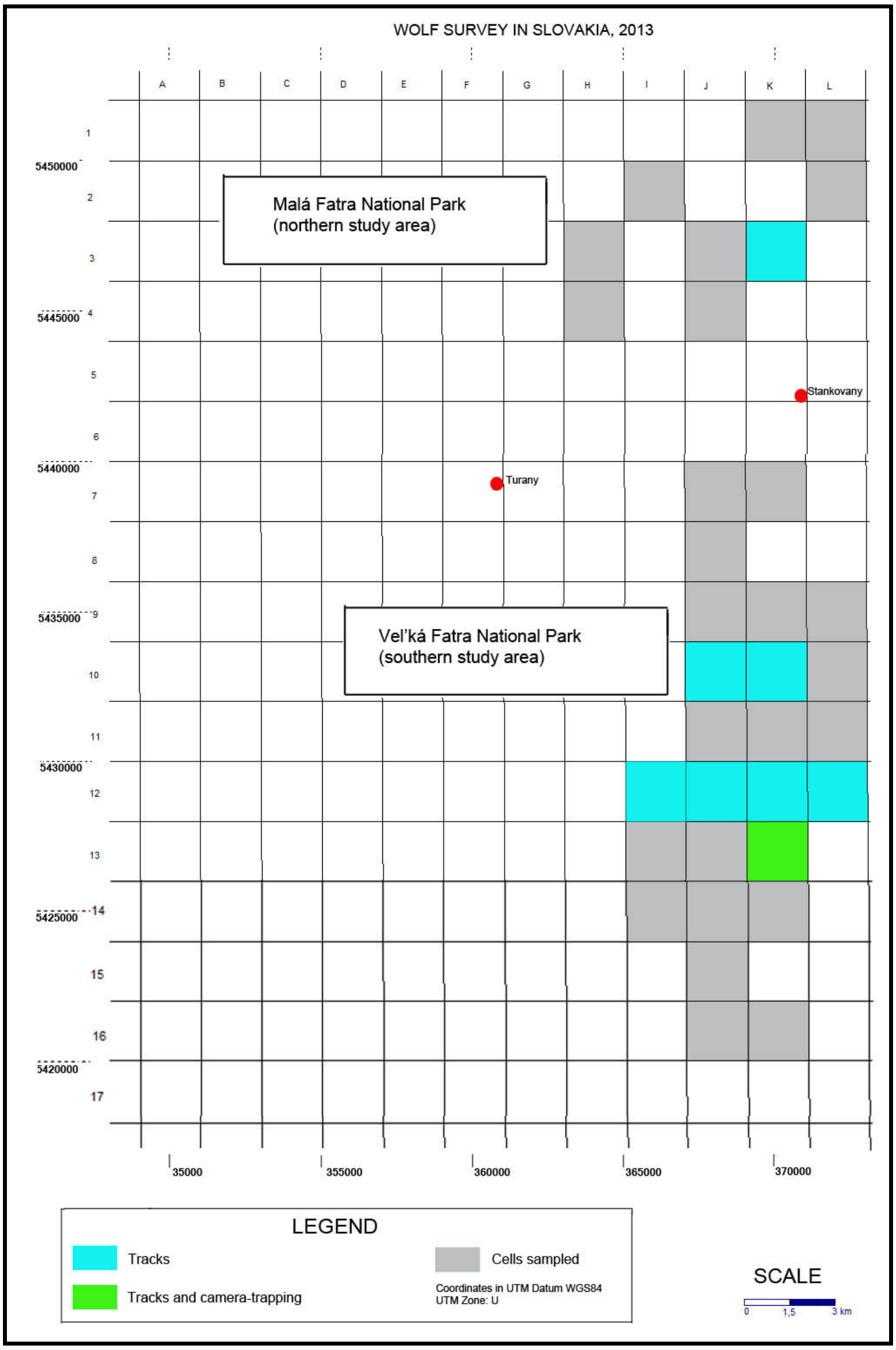

Figure 2.4a. Sampled cells (2 x 2 km in size) and results of occurrence of wolves per cell according to different recording methods.

Lynx

Lynxes, like wolves, were recorded in both southern and northern study areas. The species was recorded in 7 out of 34 cells, nearly equal to the wolf. The proportion of cells surveyed and hits (species recorded) was 9:3 in the northern area and 25:4 in the southern area. Unlike the wolf, the lynx may be more prevalent in the northern area during the survey period. Snow-tracking contributed to the recording of lynx in seven cells, while camera-trapping recorded the species in only one cell. Prospective lynx samples were also collected, but await genotyping analysis.

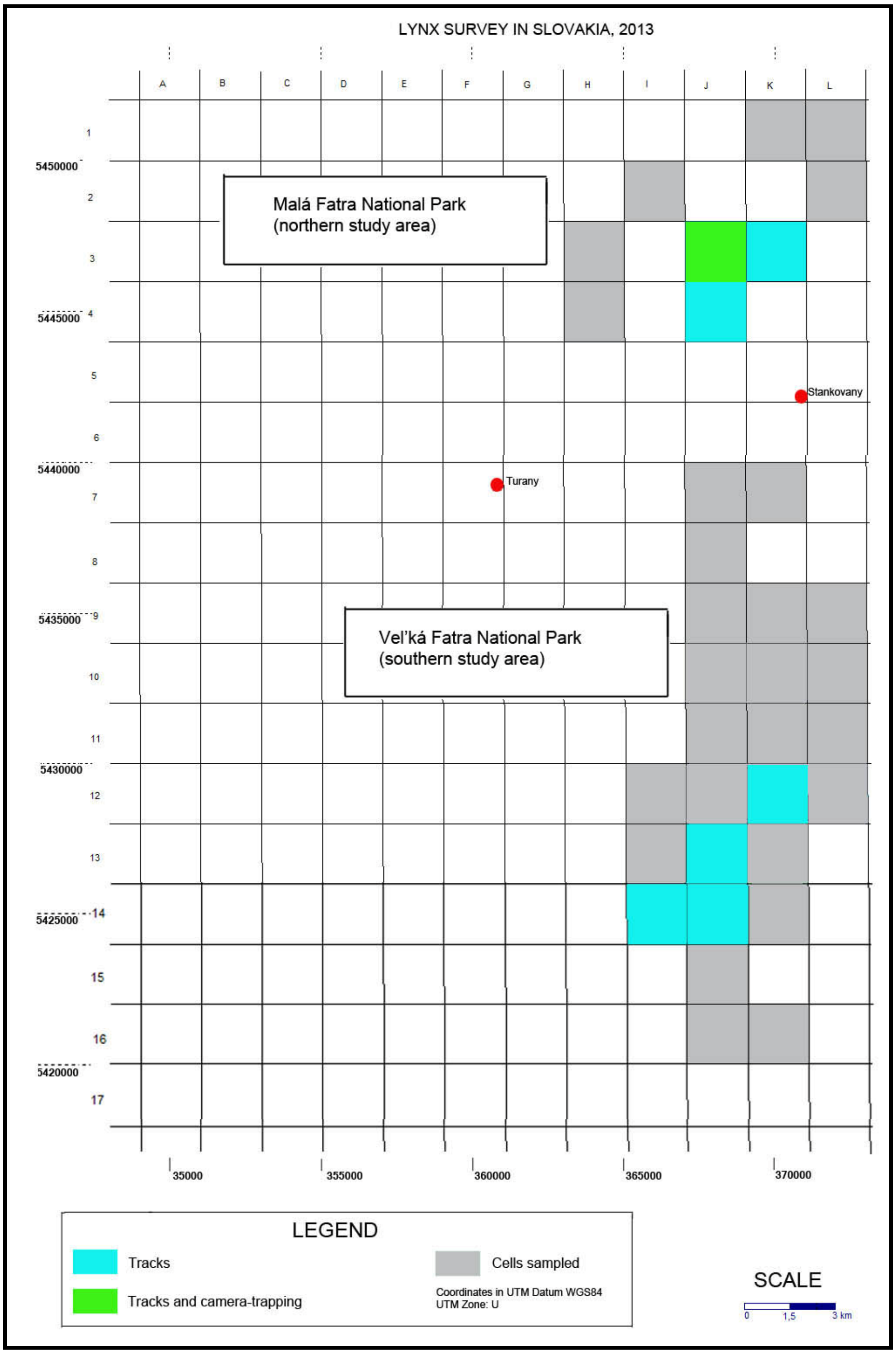

Figure 2.4b. Sampled cells (2 x 2 km in size) and results of occurrence of lynx per cell according to different recording methods.

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 help indicate the quality of the ecosystem. Except the wildcat, which was recorded from tracks, all other species (brown bear, pine marten and red fox) were recorded by camera traps. Red fox was the most recorded (n=5 cells) followed by pine marten (n=4 cells). Brown bear and wildcat were recorded in only one cell each.

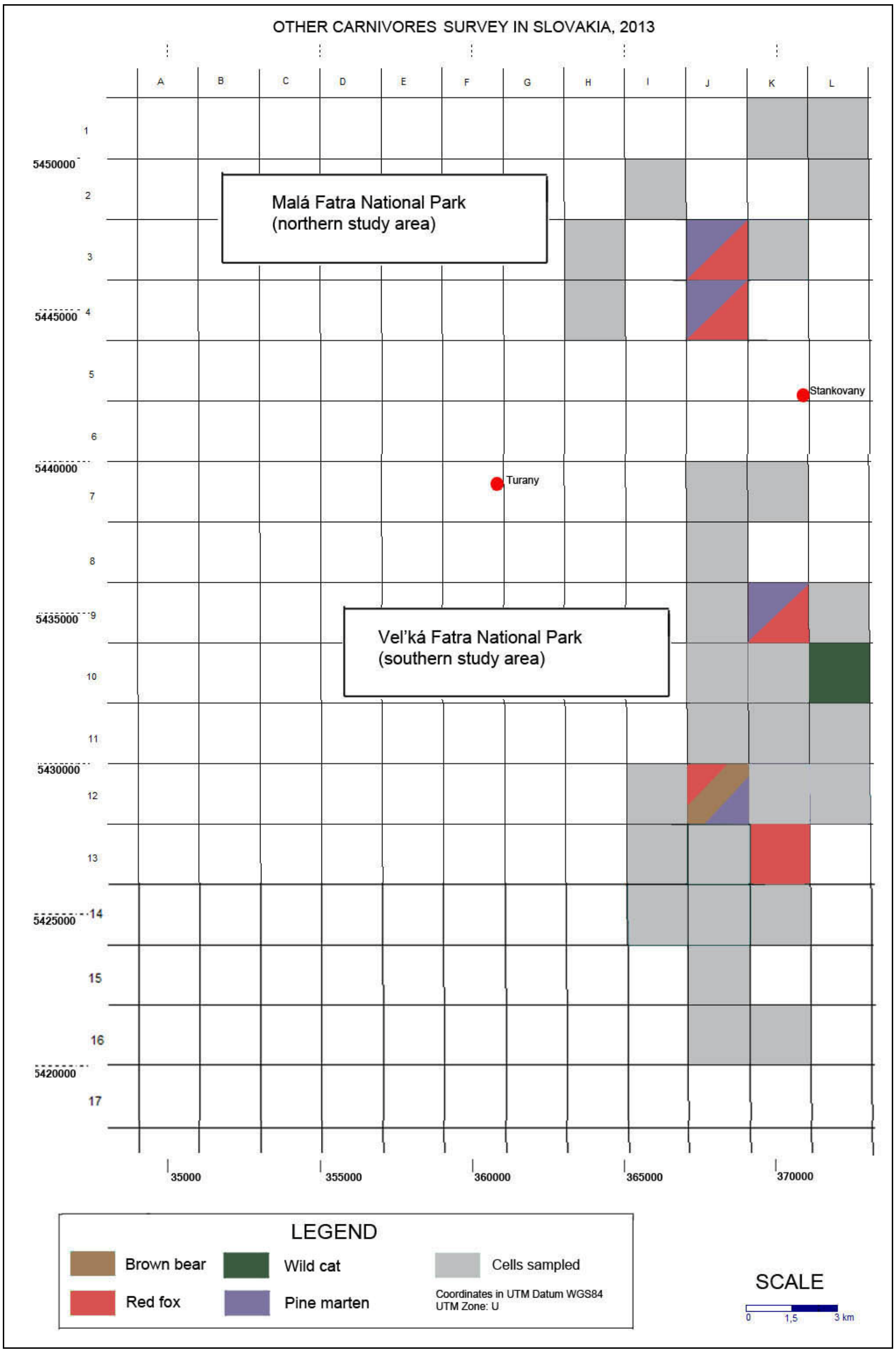

Figure 2.4c. Sampled cells (2 x 2 km in size) and results of carnivores other than the wolf and lynx per cell.

Ungulates (roe and red deer)

Red and roe deer are major prey species for carnivores, hence recording their presence is important. Red deer were recorded in four cells and roe deer in two cells. Both were recorded from carcasses and from camera traps, but red deer was recorded slightly more frequently by both methods.

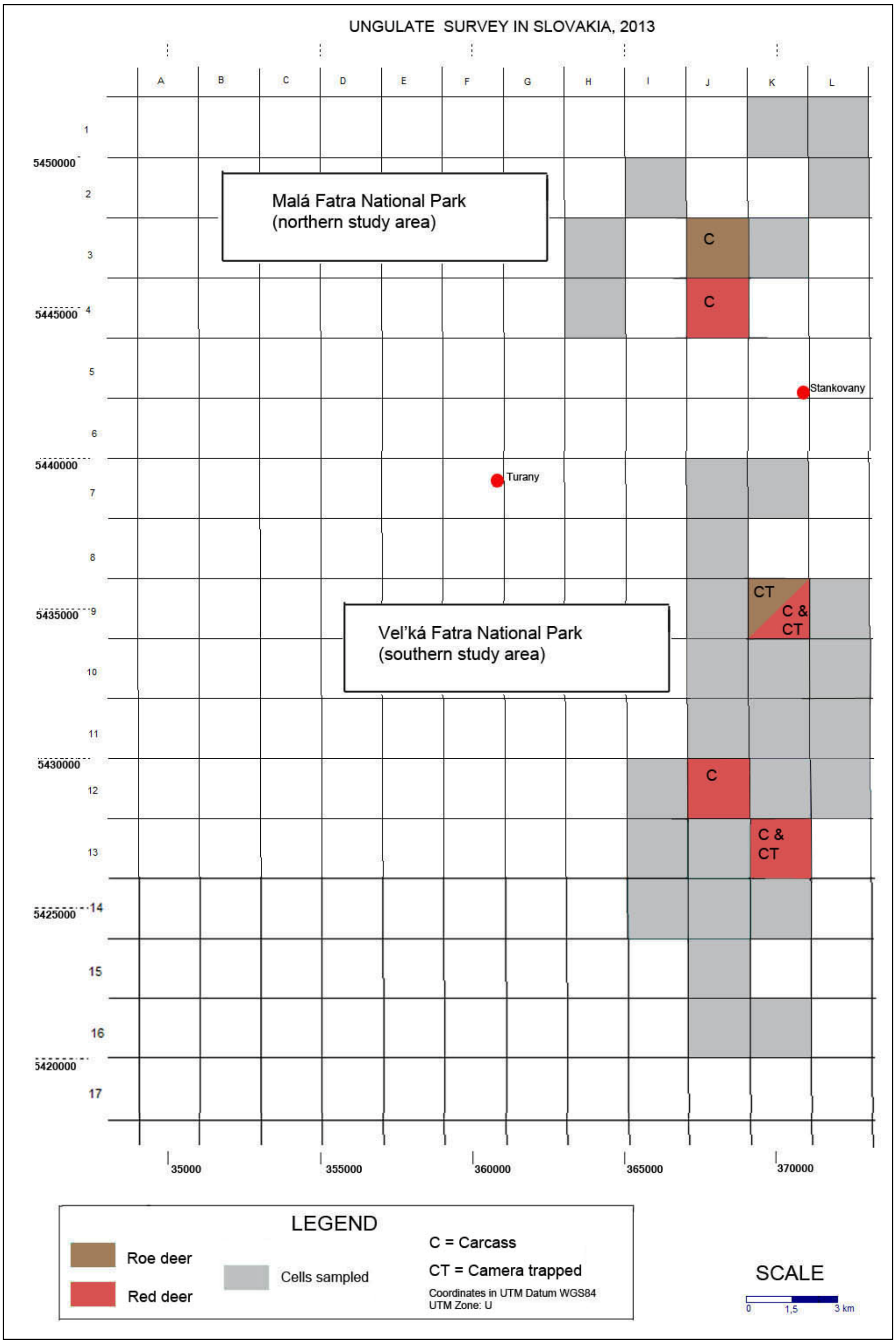

Figure 2.4d. Sampled cells (2 x 2 km in size) and results of occurrence of roe and red deer per cell according to different recording methods.

2.5. Discussion & conclusions

At the end of January and the beginning of February 2013, before the expedition commenced and during its first week, large amounts of snow fell. At the beginning of monitoring, conditions were not optimal for tracking. Towards the end of slot 1 up to 50 cm of fresh snow fell in the valley. Because moving in deep snow is difficult and energy-demanding for large predators, not many animals were observed during the expedition.

Lynx and wolves were recorded at a similar rate, but the data indicate that there is some spatial separation between them. Of the 13 different cells in which wolves and lynx were found, they overlapped in only two cells. This spatial separation could be either a result of interference, i.e. when there is an avoidance of each other, or it may simply be a result of preference for different habitats. There is very little information on the topic in the literature, but those that mention such interactions report that avoidance may or may not occur, depending on the area. In Norway, for instance, May et al. (2008) fond that lynx used denser forests at lower elevations and killed sheep in more rugged terrain than wolves. This may reflect differences in hunting techniques (i.e. stalking vs. chase hunt). An examination of the 2012 expedition data also indicates a spatial separation between lynx and wolves, with wolves being recorded nearer to bears than to lynx (Hulik at al. 2012). In Poland, however, Schmidt et al. (2009) did not find such a spatial separation between the two species, nor did Rigg and Hammer (2011) in the Tatra Mountains of Slovakia.

The fact that both lynx and wolves were snow-tracked for long distances and had their trails found more than once, and in different locations, is a sign that both species are relatively abundant in the area. Moreover, both wolves and lynx were found in nearly equal numbers of cells, which could well be an indication of similar abundance. That would be true if their detectability was the same. However, the literature indicates that wolves travel longer daily distances, turning them into more easily detectable targets than lynxes. On average, lynx have been found to move 7.2 km per day (Jędrzejewski et al. 2002), with the distance increasing with a decrease in prey availability (Schmidt 2008). Wolves, on the other hand, are known to travel an average of 20 km per day (Theuerkauf et al. 2003). Also, the fact that wolves travel in packs and lynxes alone (except during the short mating period and for females with offspring) is something to consider in terms of detectability. The population estimates of both species are similar according to specialists. In Slovakia, specialists estimate wolf population numbers ranging from 200 to 400 individuals (Chapron 2013), and the lynx population as 400 individuals (Von Arx 2013). That means that the similar number of cells in which wolves and lynxes were found during the current research agrees with similar estimates by specialists, and that the pack size may be causing (and therefore compensating) for the higher visibility of trails left by wolves in relation to lynxes. The higher detectability of wolf trails was witnessed by previous expeditions to the Tatra Mountains of Slovakia, where the parameters measured, percentage of transects with tracks and track density, were higher for wolves than for lynx in all three surveyed sectors (Rigg and Hammer 2011). Again, because wolves travel in groups and travel longer daily distances, the chances are that they leave more (recordable) tracks throughout the area, i.e. more wolf than lynx tracks does not mean more wolf individuals than lynx individuals.

Despite this, current information from the literature points towards a significant overharvesting of wolves, with annual culling rates as high as half the total wolf population. Wolves are more easily detected by hunters, not only because they leave longer trails, but also because they cause a great deal more damage to livestock than lynx.

Regarding the prey of wolves and lynxes, red deer was recorded slightly more often than roe deer. This is also supported in the literature. For example, Jędrzejewski et al. (2000) found that red deer populations were up to one third larger than roe deer populations in Poland. Interestingly, wolves were found to prey more on red deer (Jędrzejewski et al. 2000; Find'o 2002; Find'o and Hammer 2004; Find'o et al. 2006) while lynx prefer roe deer instead (Okarma et al. 1997; Jobim et al. 2000). The fact that preferred prey of both lynx and wolves are present at apparently similar rates in the study area is a positive indication of prey availability for both predators.

The different recording methods proved that snow-tracking can retrieve a substantially higher amount of information on wolf and lynx range than any other observation technique employed. Camera traps are a good tool when the aim is to record a wider variety of species. Similar results have been found elsewhere during Biosphere Expeditions studies, where it was also found that DNA scatology (genotyping from scat DNA), like camera traps, also helped to broaden the number of species recorded (Mazzolli et al. 2013).

This second year of monitoring of large carnivores in L'ubochnianska valley, Veľká Fatra National Park has 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 ethology of target species with important implications for their management throughout Slovakia.

Future expeditions should

1. Refine the methodology to estimate frequency and density of tracks, using breaking points to avoid autocorrelation (the proximity of one record to the other, of the same individuals), or, more laboriously, intervals of hundreds of metres before the next count. The continuation of the use of grids replacing the frequency of tracks is suggested.

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

3. Spread the camera traps in different grids to avoid autocorrelation, and particularly in places that are not sampled much. This will avoid sampling lynx and wolves where they have already been sampled by snow-tracking; that is, it will increase the range of the sampling effort.

4. Keep the GPS original formats for trails left by animals, so that the altitudinal profile of their travel can be examined. This information, and others such as time recorded, is often lost when converted to Google Earth format.

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APPENDIX I: Raw data, 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 7:00 Valley	Fresh snow in valley (cm)
04.02.2013	-4.1	-0.5	0	8
05.02.2013	1.5	0.4	2	0
06.02.2013	0.2	1.1	0	5
07.02.2013	-1.7	-1	-2	20
08.02.2013	-7.8	-1.9	-8	50
09.02.2013	-7.9			
10.02.2013				
11.02.2013	-5.3	-6.1	-4	0
12.02.2013	-5.9	0	-5.5	5
13.02.2013	0.9	2.3	0	4
14.02.2013	-1.8	0	-2	0
15.02.2013	-1.8	1.3	-3	3
16.02.2013	-0.1			

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

	Transects surveyed			Lynx tracks		following lynx trail		Wolf tracks		following wolf trail		Wildcat tracks	
	n	km	cells	n	frequency track/km	n	km	n	frequency track/km	n	km	n	frequency track/km
Group 1	19	150.77	34	2	75.385	0	0	3	50.257	2	1.33	0	0
Group 2	19	155.96	20	13	11.997	4	7.98	17	9.174	1	4.12	1	155.96
Total	38	306.73	38	15	20.449	4	7.98	20	15.336	3	5.45	1	306.73

Table 3. Overview of tracks recorded (2 pages).

#	Date	Species	GPS Deg	GPS min	GPS sec	Quadrant (Cell)	Footprint width cm	Footprint length cm	Direction of travel (bearing)	Age of footprint
01	05.02.2013	*Canis lupus*	N49 E19	01 09	56 30	12K	9	12	180	very fresh
02	05.02.2013	*Canis lupus*	N49 E19	01 09	40 03	12J	9	12	180	very fresh
03	05.02.2013	*Lynx lynx*	N49 E19	59 07	28 12	14I			152	older (3days)
04	05.02.2013	*Lynx lynx*	N49 E19	59 07	28 12	14I			152	older (5days)
05	08.01.2013	*Canis lupus*	N49 E19	03 10	36 15	10K	8	9	315	
06	12.02.2012	*Lynx lynx*	N49 E19	01 10	18 35	12K	8	8	from 200 to 290	fresh
07	13.02.2013	*Lynx lynx*	N49 E19	01 09	53 37	12K	8	8		fresh
08	13.02.2013	*Lynx lynx*	N49 E19	01 09	57 28	12K	8	8		fresh
09	13.02.2013	*Felis silvestris*	N49 E19	03 11	28 03	10L	4	4	from 355	fresh
10	13.02.2013	*Lynx lynx*	N49 E19	01 09	47 18	12K	9			2 days old
11	14.02.2013	*Canis lupus*	N49 E19	01 09	42 5	10J	9–10	12	from 60 to 203	fresh
12	14.02.2013	*Canis lupus*	N49 E19	01 09	42 5	10J	10	13	from 60 to 203	fresh
13	14.02.2013	*Lynx lynx*	N49 E19	00 08	23 13	13J	8	10	0	fresh
14	14.02.2013	*Lynx lynx*	N48 E19	58 07	50 43	14J			90	older
15	14.02.2013	*Lynx lynx*	N49 E19	10 07	47 39	3J	9			
16 A	14.02.2013	*Lynx lynx*	N49 E19	11 09	17 4	3K				older
16 B	14.02.2013	*Lynx lynx*	N49 E19	11 08	8 48	3J	6,5		160	older
16 C	14.02.2013	*Lynx lynx*	N49 E19	10 08	47 37	3J				older
17	14.02.2013	*Canis lupus*	N48 E19	11 08	5 48	3K	10	11		older
18	14.02.2013	*Lynx lynx*	N49 E19	10 08	42 33	4J				older

Continued on next page

Table 3. Overview of tracks recorded (continued from previous page).

#	Date	Species	GPS Deg	min	sec	Quadrant (Cell)	Footprint width cm	length cm	Direction of travel (bearing)	Age of footprint
19	15.02.2013	*Canis lupus*	N49 E19	01 09	42 48	12K	8	10	260	older
20	15.02.2013	*Canis lupus*	N49 E19	01 09	40 52	12K	10	13	330	older
21	15.02.2013	*Canis lupus*	N49 E19	01 09	38 56	12K	9	10	190	older
22	15.02.2013	*Canis lupus*	N49 E19	01 09	38 58	12K	8	10	320	older
23	15.02.2013	*Canis lupus*	N49 E19	01 09	38 58	12K			280	older
24	15.02.2013	*Canis lupus*	N49 E19	01 09	38 59	12K	8	10	from 160 to 320	older
25	15.02.2013	*Canis lupus*	N49 E19	01 10	41 9	12K			260	older
26	15.02.2013	*Canis lupus*	N49 E19	01 11	54 21	12L			from 0 to 260	older
27	15.02.2013	*Canis lupus*	N49 E19	01 10	39 31	12K	10	13	from 20 to 260	older
28	15.02.2013	*Canis lupus*	N49 E19	00 09	22 29	13K	7,5	9	from 320 to 160	older
29	15.02.2013	*Canis lupus*	N49 E19	00 10	06 00	13K	7,5	10	from 310 to 160	fresh
30	15.02.2013	*Canis lupus*	N49 E19	00 10	06 00	13K	9,5	11	from 310 to 160	fresh
31	15.02.2013	*Canis lupus*	N49 E19	00 09	22 26	13K	7,5	9,5	from 40 to 0	fresh
32	15.02.2013	*Lynx lynx*	N49 E19	11 07	00 27	3J	8–9		west	older
33	15.02.2013	*Lynx lynx*	N49 E19	11 07	2 26	3J				older
34	15.02.2013	*Lynx lynx*	N49 E19	10 07	56 49	3J				older
35	15.02.2013	*Lynx lynx*	N49 E19	10 08	39 40	4J				older
36	15.02.2013	*Canis lupus*	N49 E19	01 07	50 30	12I			210	older

Table 4. Camera trap location, species recorded and time of activity.

No.	Name	Coordinates deg	min	sec	Quadrat (Cell)	Species recorded	Placed on	Recovered on
1	Tmava road	N 48° E 19°	59′ 9′	59.69″ 57.43″	13K	*Cervus elaphus, Vulpes vulpes*	31.01.2013	15.02.2013
2	Blatna seddle	N 49° E 19°	0′ 9′	2.27″ 56.03″	13K	*Canis lupus, Cervus elaphus, Vulpes vulpes*	31.01.2013	13.04.2013
3	Feeding Station Klencovky	N 49° E 19°	4′ 9′	31.40″ 12.10″	9K	*Cervus elaphus, Vulpes vulpes, Martes martes, Capreolus capreolus*	31.01.2013	14.02.2013
4	Klencovky	N 49° E 19°	4′ 9′	31.74″ 31.29″	9K	*Vulpes vulpes*	07.02.2013	15.03.2013
5	Klencovky	N 49° E 19°	4′ 9′	31.74″ 31.29″	9K	*Vulpes vulpes*	07.02.2013	15.03.2013
6	Ciernavy	N 49° E 19°	1′ 9′	56.38″ 27.83″	12K	-	07.02.2013	stolen
7	Krackov	N 49° E 19°	5′ 9′	8.59″ 34.56″	9K	-	14.02.2013	stolen
8	Wolf carcass	N 49° E 19°	1′ 8′	15.13″ 40.23″	12J	*Ursus arctos, Vulpes vulpes, Martes martes*	14.02.2013	13.04.2013
9	Lynx carcass	N 49° E 19°	10′ 7′	47.42″ 39.69″	3J	*Lynx lynx, Vulpes vulpes, Martes martes*	14.02.2013	01.03.2013
10	Lynx carcass 2	N 49° E 19°	10′ 8′	42.78″ 33.86″	4J	*Vulpes vulpes, Martes martes, Buteo buteo*	14.02.2013	01.03.2013

Table 5. Summary of DNA samples. Group 1 was in the field up to and including 08.02.2013, group 2 afterwards.

No.	Date	GPS			Quadrat (Cell)	Species	Sample type
		Deg	Min	sec			
S1	05.02.2013	49 19	59 07	28 12	14I	*Lynx lynx*	Urine
S2	12.02.2013	49 19	1 10	34.77 29.25	12K	*Lynx lynx*	Urine
S3	14.02.2013	49 19	01 09	42.1 05.7	12J	*Canis lupus*	Urine
S4	14.02.2013	49 19	1 9	36.4 3.5	12J	*Canis lupus*	Urine
S5	14.02.2013	49 19	1 8	32.5 59.5	12J	*Canis lupus*	Urine
S6	14.02.2013	49 19	01 08	30.5 54.1	12J	*Canis lupus*	Urine
S7	14.02.2013	49 19	1 8	11.8 46.2	12J	*Canis lupus*	Urine
S8	14.02.2013	49 19	00 08	59.6 42.7	13J	*Canis lupus*	Hair
S9	14.02.2013	49 19	11 08	7.26 49.10	3K	*Lynx lynx*	Urine
S10	14.02.2013	49 19	01 08	23.43 51.33	12J	*Canis lupus*	Urine
S11	15.02.2013	49 19	00 10	05.1 02.0	13k	*Canis lupus*	Urine
S12	15.02.2013	49 19	00 10	03.5 05.4	13k	*Canis lupus*	Urine

Table 6. Carcasses found during the expedition.

No.	Species	Possible cause of death	GPS position			Quadrat (cell)	Date found
			deg	min	sec		
C1.	*Capreolus capreolus female*	Lynx (*Lynx lynx*)	N 49° E 19°	10′ 7′	47.42″ 39.69″	3J	14.02.2013
C2.	*Cervus elaphus, female, juvenile*	Lynx (*Lynx lynx*)	N 49° E 19°	10′ 8′	42.78″ 33.86″	4J	14.02.2013
C3.	*Cervus elaphus, female*	coldness, deep snow	N 49° E 19°	5′ 9′	8.58″ 34.67″	9K	14.02.2013
C4.	*Cervus elaphus, female*	Wolf (*Canis lupus*)	N 49° E 19°	1′ 8′	15.13″ 40.23″	12J	14.02.2013
C5.	*Cervus elaphus, female*	Wolf (*Canis lupus*)	N 49° E 19°	0′ 10′	5.8″ 4.10″	13K	15.02.2013

MAPS

Figure 1. Transects and tracks for group 1.

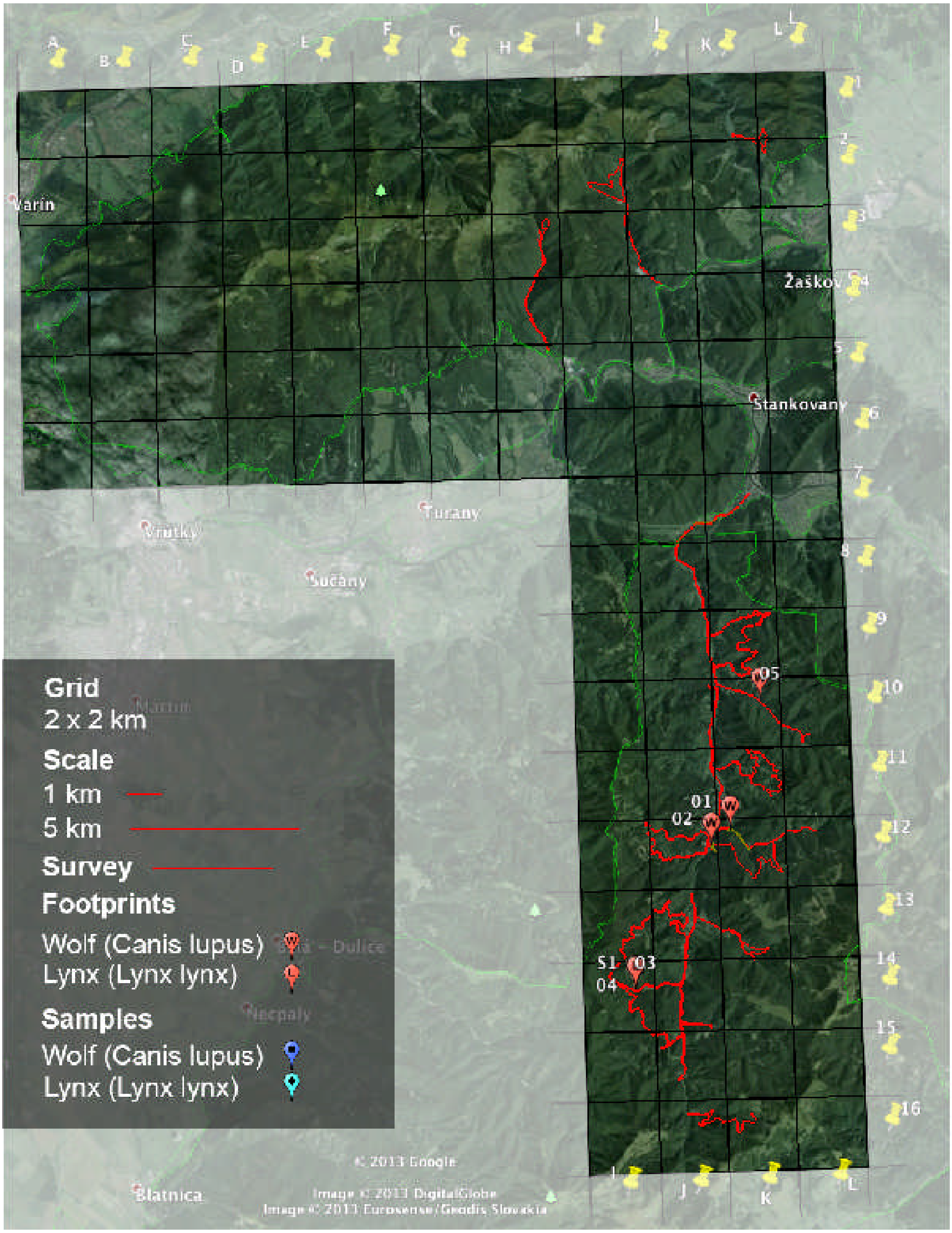


Figure 2. Transects and tracks for group 2.

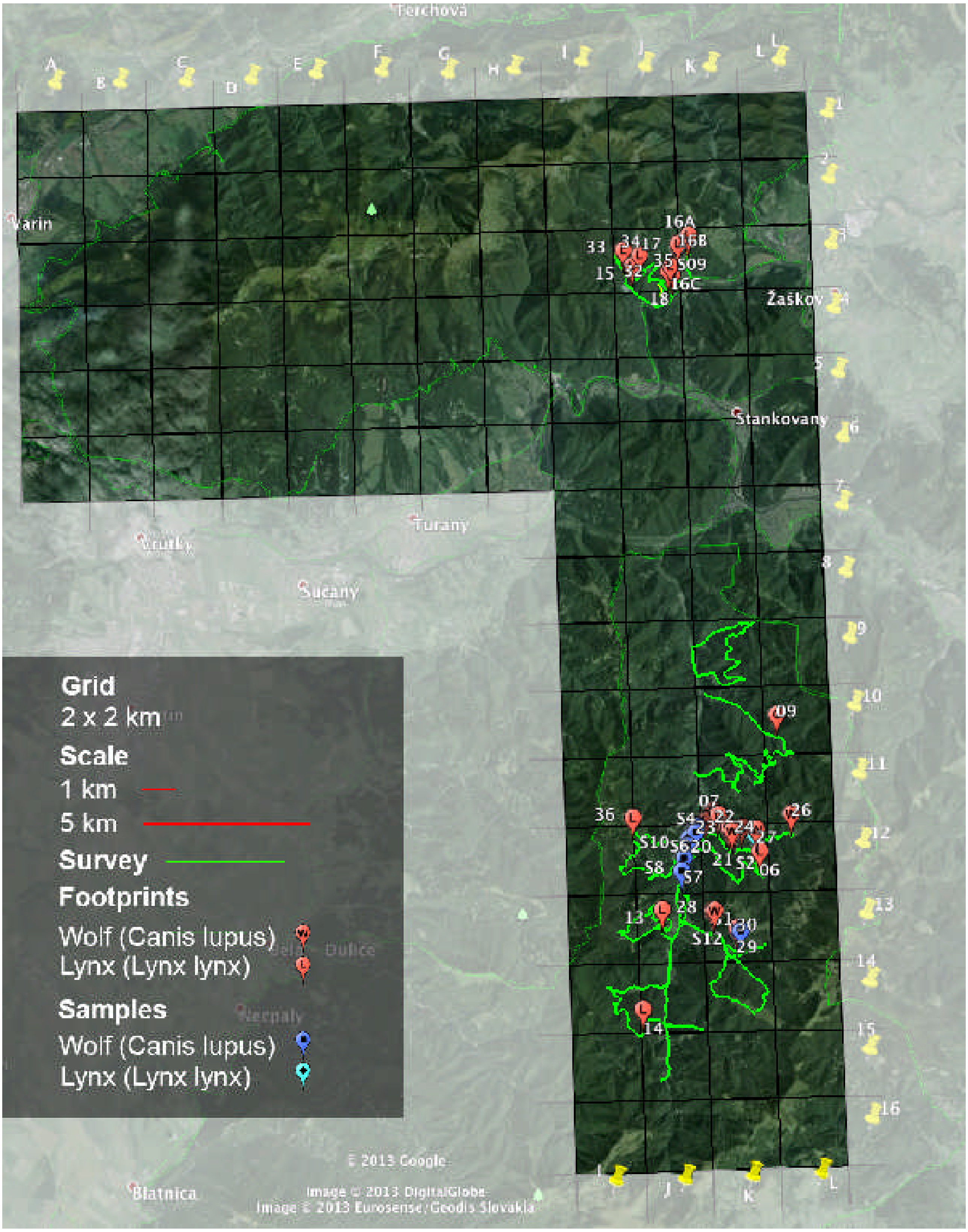


Figure 3. Transects (left) and following animal trails (right) for group 1 with all footprints and trails (green - wolf, yellow - lynx) and samples in the cells 12–14/I–L in area of Velka Fatra – Ľubochnianska Valley.

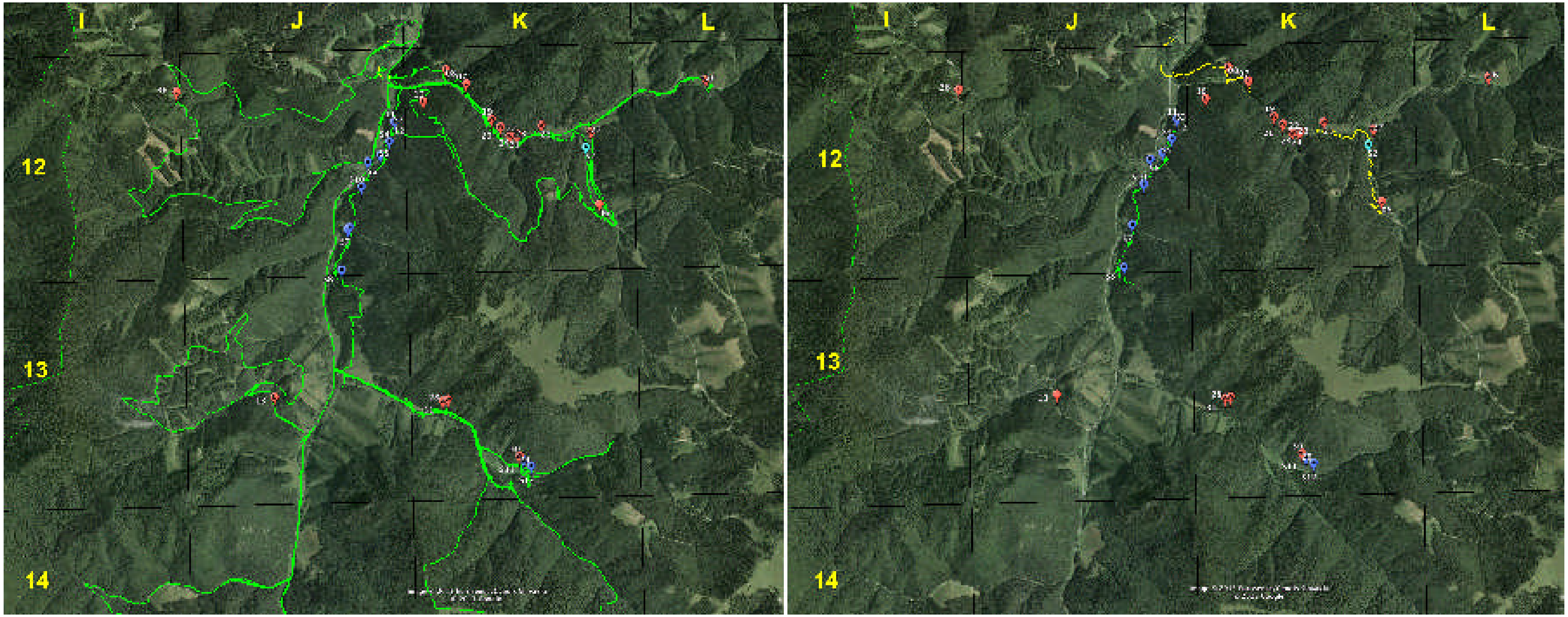


Figure 4. Transects (left) and following animal trails (right) for group 2, with all footprints, samples and discovered lynx marking trees in cells 3–4/J–K in area of Malá Fatra.

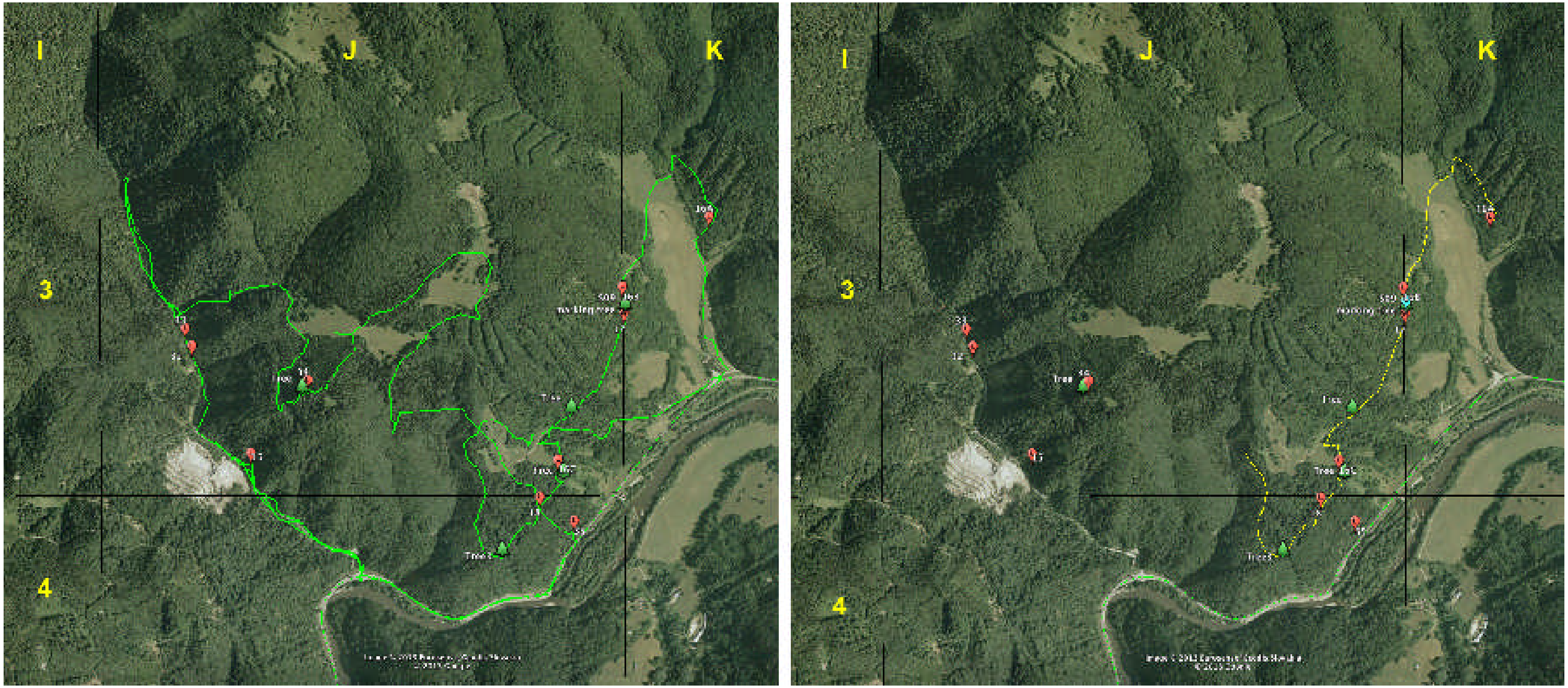


Figure 5. Locations of DNA samples collected.

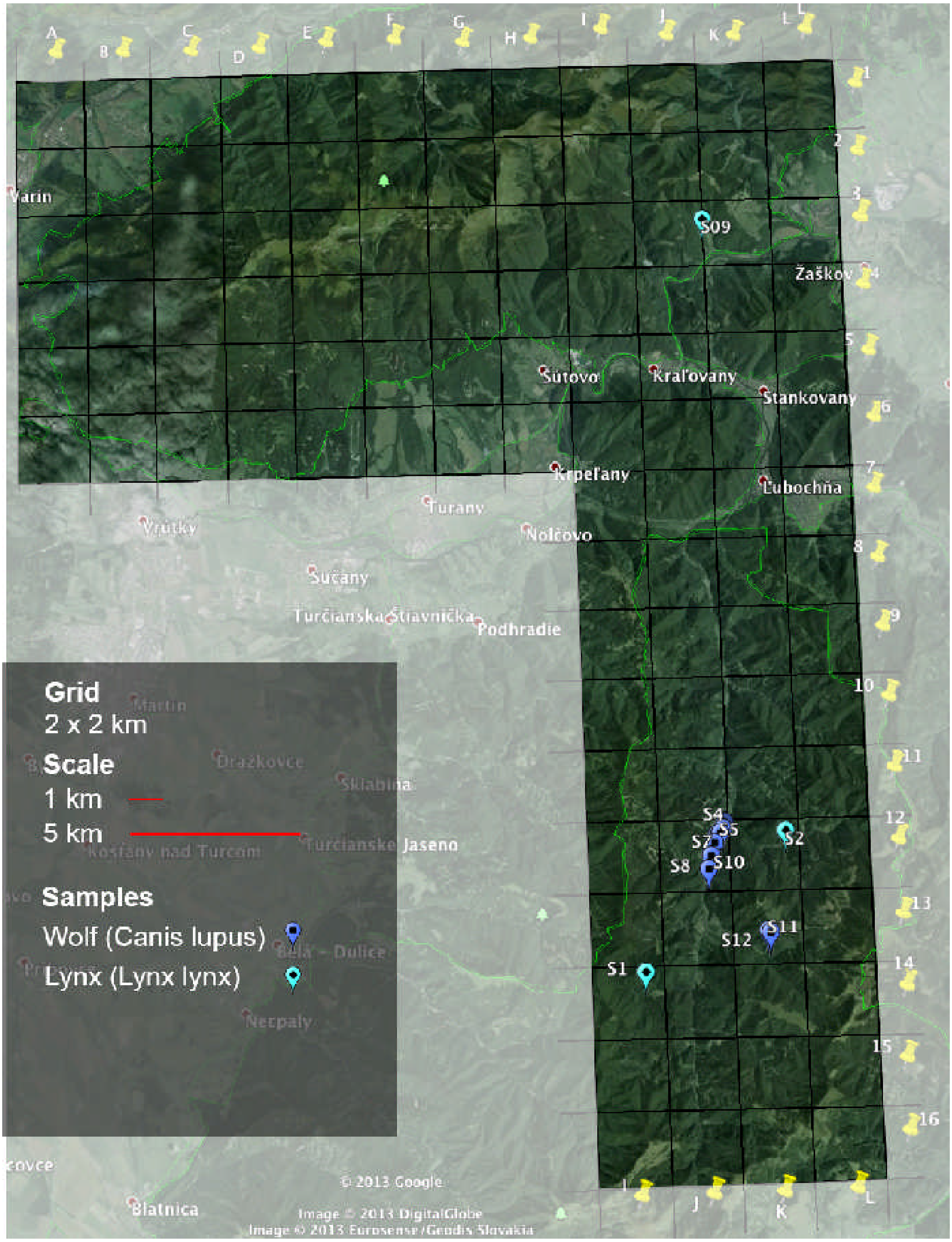


Figure 6. Locations of carcasses found.

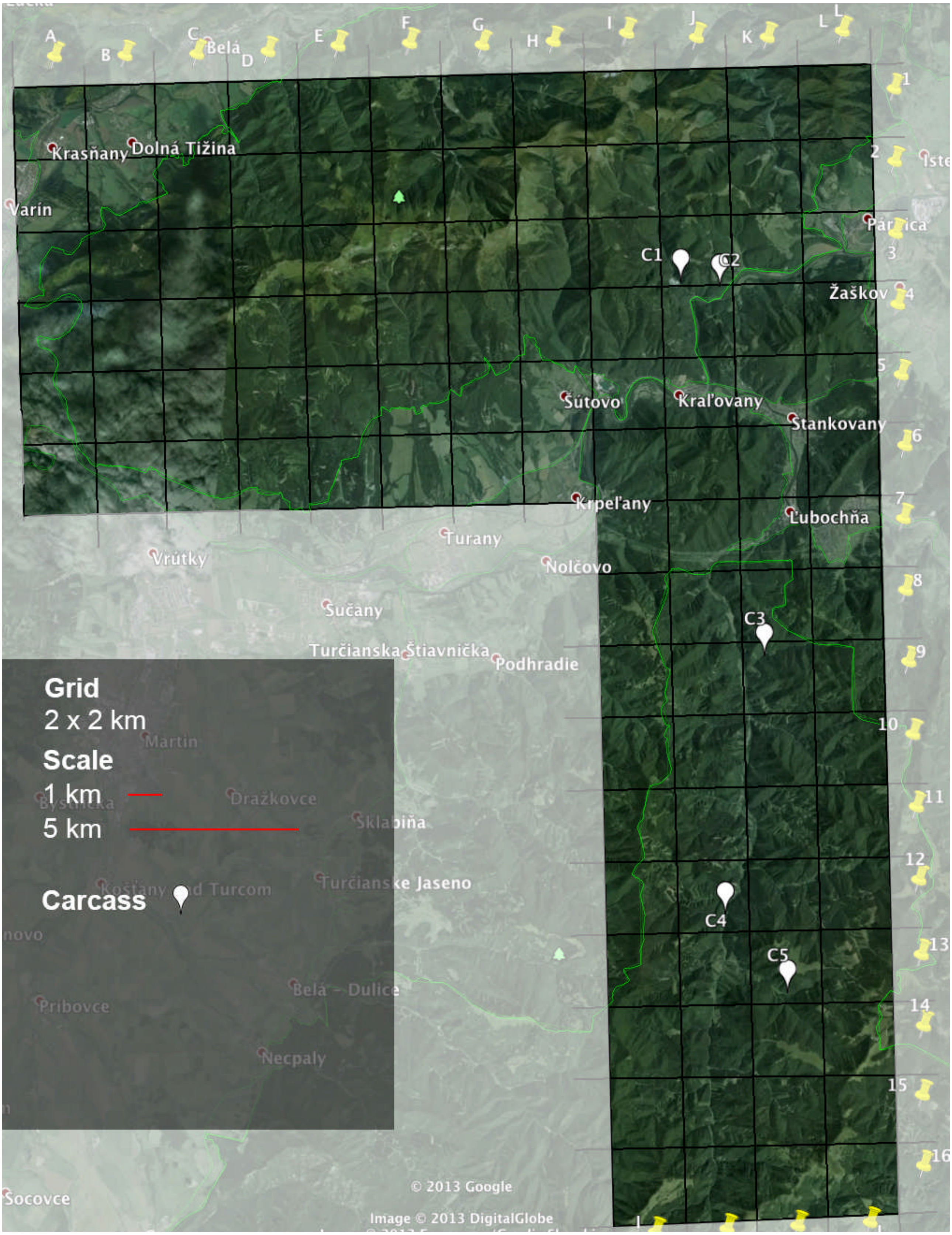
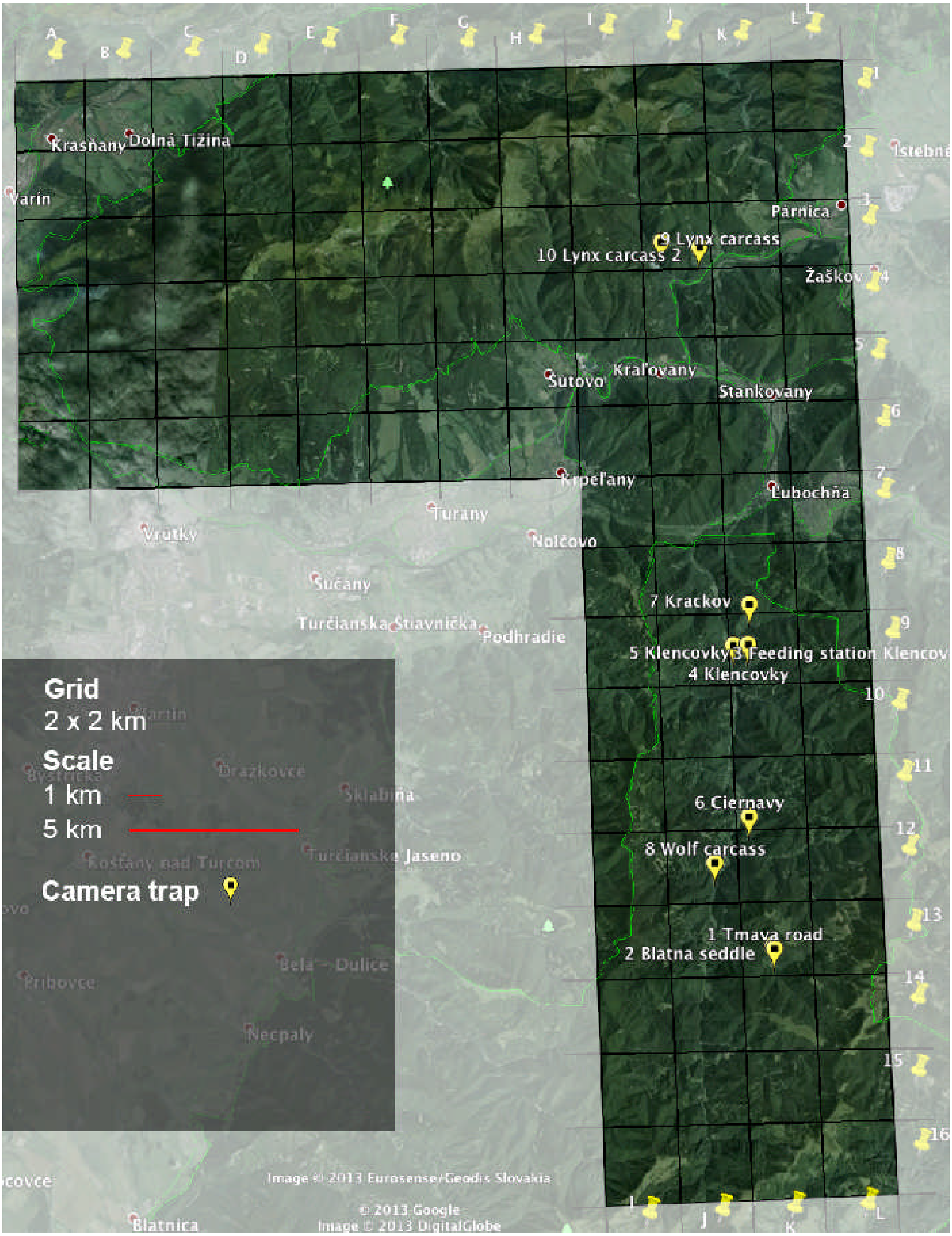


Figure 7. Camera trap locations.



PHOTOS

Figure 8. Camera trap sample photos.

Deer, followed two minutes later by wolf, camera trap no. 2.

Red fox, red deer, wolf, camera trap no. 2

Red fox, red deer, roe deer, camera trap no. 3

Bear, camera trap no 8.

Lynx, camera trap no 9.

Marten (*Martes martes*), camera trap no. 8 and marten, red fox, camera trap no. 9.

Appendix II: Expedition diary and reports

A multimedia expedition diary is available on http://biosphereexpeditions.wordpress.com/category/expedition-blogs/slovakia-2013-expedition-blogs/.

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