EXPEDITION REPORT

Expedition dates: 5 – 18 February 2017

Report published: January 2021

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

BIOSPHERE EXPEDITIONS.ORG

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Marcelo Mazzolli (editor)
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Matthias Hammer (editor)
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Abstract

This report covers the sixth 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 6 to 17 February 2017 and concentrated on the Ľubochnianska valley.

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

The survey area was divided into cells of 2.5 x 2.5 km size. During the expedition 27 transects were surveyed with a total length of 344,56 km, covering 22 cells. The average length of a transect was 12.76 km and the total area surveyed was 137.5 km^2. Signs of target species were recorded in 17 out of the 22 cells surveyed. In terms of frequency, it was the best year in the history of the expedition. A total of 219 trails and tracks left by target species were recorded, of which 23 were identified as being left by lynx (11%), 75 by wolf (34%), 110 by bear (50%) and 11 by wildcat (5%).

Twenty camera traps were placed in a total of 23 positions and took 4290 photographs. Three camera trap recorded wolf (*Canis lupus*), two recorded lynx (*Lynx lynx*) and one wildcat (*Felis silvestris*). Fox (*Vulpes vulpes*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), pine martin (*Martes martes*) and squirrel (*Sciurus vulgaris*) were also photographed.

Eight samples (3 scats and 5 urine samples) were collected for DNA analysis, four of which (50%) were assumed, from footprints, to be from wolf, two urine samples from lynx (25%) and two scats sample (25%) from bear. All samples are currently awaiting DNA analysis to confirm species and enable identification of individuals.

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

In 2017 wolf signs scored their second highest frequency since 2012, but were detected in the second lowest number of cells (n=10), probably associated with normal winter conditions, which meant that prey animals were concentrated in valley bottoms and for that reason wolf signs were found predominantly in the central and lower parts of the valley. The correlation between winter severity and the distribution of prey, and therefore wolves, in the valley is strong, corroborating findings from previous years. Here too artificially high deer prey populations, combined with the wolf's relatively high protection status in Slovakia, appears to contribute to a relatively stable presence of wolves in Veľká Fatra National Park.

A record log of 110 bear footprints found indicate that they were not hibernating and able to feed on the very high amount of beech fruits (*Fagus silvaticus*) present. This corroborates findings of the mild winter of 2014. In any case, bear presence too appears to be relatively stable in Veľká Fatra National Park.

Finally, the wildcat population appears to be stable, if small, as well as evidenced by consistent sign records noted by the expeditions, once each in 2016, 2015 and 2013, six times in 2014 and eleven times in 2017.

This research project had to wind down after the 2017 expedition, because our permit expired and was not renewed by the National Park. The second editor (MH) believes this is due to widespread corruption and destructive practices in Slovakian parks, which authorities did not want to be documented.

Súhrn

Súhrnná správa zo šiesteho ročníka terénneho monitoringu na severe Slovenska v Národnom parku Veľká Fatra s podporou domáceho výskumníka s cieľom získať biologické informácie a prispieť k zlepšeniu menežmentových opatrení pre medveďa hnedého (*Ursus arctos*), vlka dravého (*Canis lupu*s), rysa ostrovida (*Lynx lynx*) a mačky divej (*Felis silvestris*). Terénny monitoring sa sústredil na Ľubochniansku dolinu v období od 6. februára do 17. februára 2017.

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

Záujmové územie bolo rozdelené na kvadranty o veľkosti 2,5 x 2,5 km. Počas terénneho výskumu bolo monitorovaných 27 transektov v celkovej dĺžke 344,56 km, zahŕňajúcich 22 kvadrantov. Priemerná dĺžka transektu bola 12,76 km. Pobytové znaky záujmových druhov sme zaznamenali v 17 z 22 preskúmaných kvadrantov, z hľadiska zaznamenávania stop to bol najlepší rok v histórii expedície. Identifikovaných bolo 219 nálezov stôp a stopových dráh záujmových druhov: 23 patrilo rysovi ostrovidovi (*Lynx lynx*) (11%), 75 vlkovi dravému (34%), 110 medveďovi hnedému (50%) a 11 stôp patrilo mačke divej (5%).

Dvadsať fotopascí bolo umiestnených na 23 miestach v záujmovom území. Získali sme 4290 fotografií. Tri fotopasce zaznamenali vlka dravého (Canis lupus), dve zachytili rysa ostrovida (Lynx lynx) a jedna mačku divú (Felis silvestris). Ďalšie fotografované druhy boli: líška hrdzavá (*Vulpes vulpes*), jeleň lesný (*Cervus elaphus*), srnec hôrny (*Capreolus capreolus*), diviak lesný (*Sus scrofa*), kunalesná (*Martes martes*) a vevericu hrdzavú (*Sciurus vulgaris)*.

Nájdených bolo 8 vzoriek na DNA analýzu (3x trus, 5x moč). Na základe stôp pri vzorke boli zaistené 4 vzorky (50%) vlka dravého, dve vzorky moču patrili rysovi ostrovidovi (25%) a dve vzorky (25%) trusu patrili medveďovi hnedému. Vzorky zatiaľ čakajú na DNA analýzu, ktorá by mala potvrdiť predpokladané druhy zvierat a identifikovať jednotlivé individuá.

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

V roku 2017 boli pobytové znaky vlkov zaznamené v najvyššej miere od roku 2012, ale boli detekované v druhom najmenšom počte kvadrantov (n=10), pravdepodobne kvôli štandardným zimným podmienkam, kedy je korisť vlkov sústredená v doline, a tak ich pobytové znaky sme v prevažnej miere zaznamenali v centrálnych a nižších častiach doliny. V skutočnosti zaznamenávame silný vzťah medzi zimnými podmienkami a distribúciou vlčej koristi a následne vlkov v údolných častiach doliny. Dostatočná potravná ponuka jelenej zvery a relatívne vysoká zákonná ochrana vlka na Slovensku prispieva ku konzistentnej prítomnosti vlka dravého v Národnom parku Veľká Fatra.

110 stopových dráh medveďa hnedého naznačuje, že nehibernovali a boli si schopné nájsť potravu v podobe veľkého množstva bukvíc (*Fagus silvaticus*). Podobná situácia nastala počas miernej zimy v roku 2014. V každom prípade, môžeme konštatovať, že populácia medveďa hnedého v Národnom parku Veľká Fatra je taktiež stabilná.

Populácia mačky divej vyzerá byť malá a stabilná. Tento fakt potvrdzujú nálezy pobytových znakov raz v rokoch 2016, 2015 a 2013 a šesťkrát v roku 2014 a jedenásť krát v roku 2017.

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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 5 to 18 February 2017 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:

5 – 11 February | 12 – 18 February 2017

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

1.4. Local conditions & support

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

Expedition base

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

Weather

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

Field communications

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

Transport & vehicles

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

Medical support and incidents

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

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

1.5. Local scientist

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

1.6. Expedition leader

Malika Fettak is half Algerian, but was born and educated in Germany. She majored in Marketing & Communications and worked for more than a decade in both the creative department, but also in PR & marketing of a publishing company. Her love of nature, travelling and the outdoors (and taking part in a couple of Biosphere expeditions) showed her that a change of direction was in order. Joining Biosphere Expeditions in 2008, she runs the German-speaking operations and the German office and leads expeditions all over the world whenever she can. She has travelled extensively, is multilingual, a qualified off-road driver, diver, outdoor first aider, and a keen sportswoman.

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):

5 – 11 February 2017

Karl-Heinz Berner (Germany), Angela Crossland (UK), Philip Crossland (UK), Edward Durell (USA), Marina Knaz (Germany), Angelika Krimmel (Germany), Gilli Mayo (UK), Peter Pilbeam (UK), Idan Schenberg (Israel), Anne Schroedter (Germany).

12 – 19 February 2018

Timothy Burton (UK), Christian Cummins* (Austria), Edward Durell (USA), Martin Haslam (UK), Holger May (Germany), Vincent Schaller (Sweden), Saskia van Iperen (Netherlands), Connor Williams (UK)

*Press

1.8. Expedition budget

Each team member paid towards expedition costs a contribution of £1,330 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	22,060
Expenditure	
Expedition base includes all board & lodging, and extra food & meals	3,072
Transport includes car fuel UK–Slovakia return, car fuel during expedition, train rides	677
Equipment and hardware includes research materials & gear etc. purchased in UK & Slovakia	2,071
Staff includes local and Biosphere Expeditions staff salaries, travel, expenses	6,733
Administration includes miscellaneous fees & sundries	1,018
Team recruitment Slovakia as estimated % of annual PR costs for Biosphere Expeditions	6,773
Income – Expenditure	**1,716**
Total percentage spent directly on project	**92%**

1.9. Acknowledgements

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

1.10. Further information & enquiries

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

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

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2. Monitoring large carnivores in Ľubochnianska Valley

Tomáš Hulík
Environmental Society LENS

Marcelo Mazzolli (editor)
Projeto Puma

M. Hammer (editor)
Biosphere Expeditions

2.1. Introduction

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

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

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

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

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

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

2.2. Study area

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

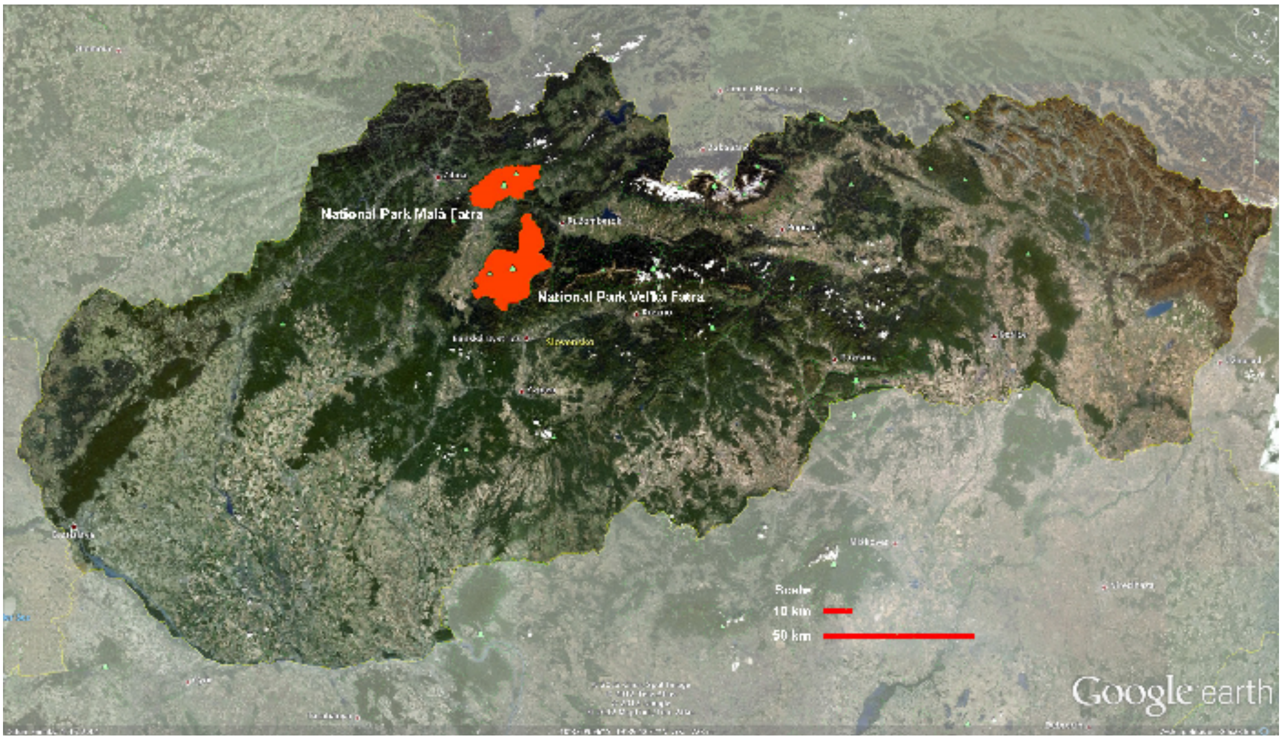

Figure 2.2a. The territory of Slovakia with Malá Fatra (above) and Veľká Fatra National Parks (below) in red.

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

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

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

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

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

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

2.3. Materials and methods

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

Study design

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

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

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

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

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

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

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

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

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

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

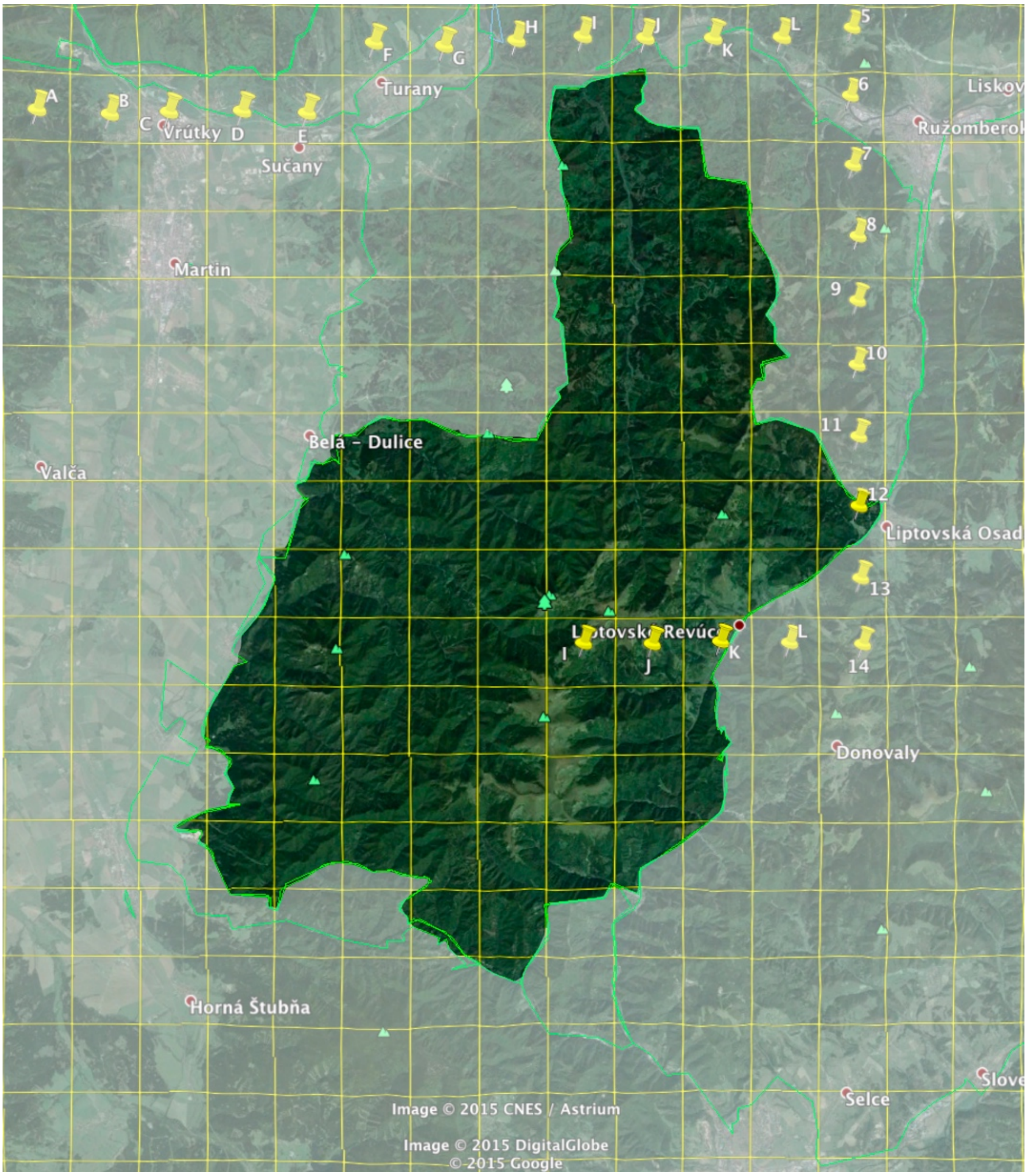

Figure 2.3a. Grid system covering Veľká Fatra National Park.

Training of volunteers

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

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

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

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

Data recording

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

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

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

Data analysis

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

2.4. Results

During the expedition period, 27 transects were surveyed, with a total length of 344 km, covering 22 cells of the grid system and encompassing a surveyed area of 138 square kilometeres. The average length of a transect was 12.8 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, bear and wildcat trails, obtaining information on their occurrence over a large area. In total, lynx trails were followed over 1.6 km, wolf trails over 7.6 km, bear trails over 4.6 km and a wildcat trail over 0.7 km. Besides the target species, the hazel grouse *Tetrastes bonansia* was recorded in one cell. Camera traps recorded red deer *Cervus elaphus*, roe deer *Capreolus capreolus*, red fox *Vulpes vulpes,* wild boar *Sus scrofa*, squirell *Sciurus vulgaris*, pine marten *Martes martes*, wolf *Canis lupus* and lynx *Lynx lynx* (photos and tables in Appendix I). Full tracking and other details are in Appendix I also and a summary of results over the years in Table 2.5a.

Eight samples were collected (3 scats, 5 urine) for DNA analysis: 4 samples (50%) were confirmed, by footprints, to be from wolf, two samples were from lynx (25%) and two samples from bear (25%).

Wolf was detect in 10 cells, lynx in 10 cells, bear in 15 cells and wildcat in five cells. Lynx, wolves, bear and wildcat shared records in 2 cells in which they were recorded (Table 2.4a). Full sampling details, including cell, spatial and temporal resampling effort are in Appendix I.

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

Wolf	Lynx	Bear	Wildcat
I9	I9	I9	I9
J9	J9	J9	J9
I7	I7	I7	J7
I8	I8	I8	J8
J7	I10	J7	J6
J8	J11	J8	
J10	J12	J10	
K10	K9	K10	
I11		I11	
K9		I10	
		J11	
		J12	
		K8	
		I12	
		I6	

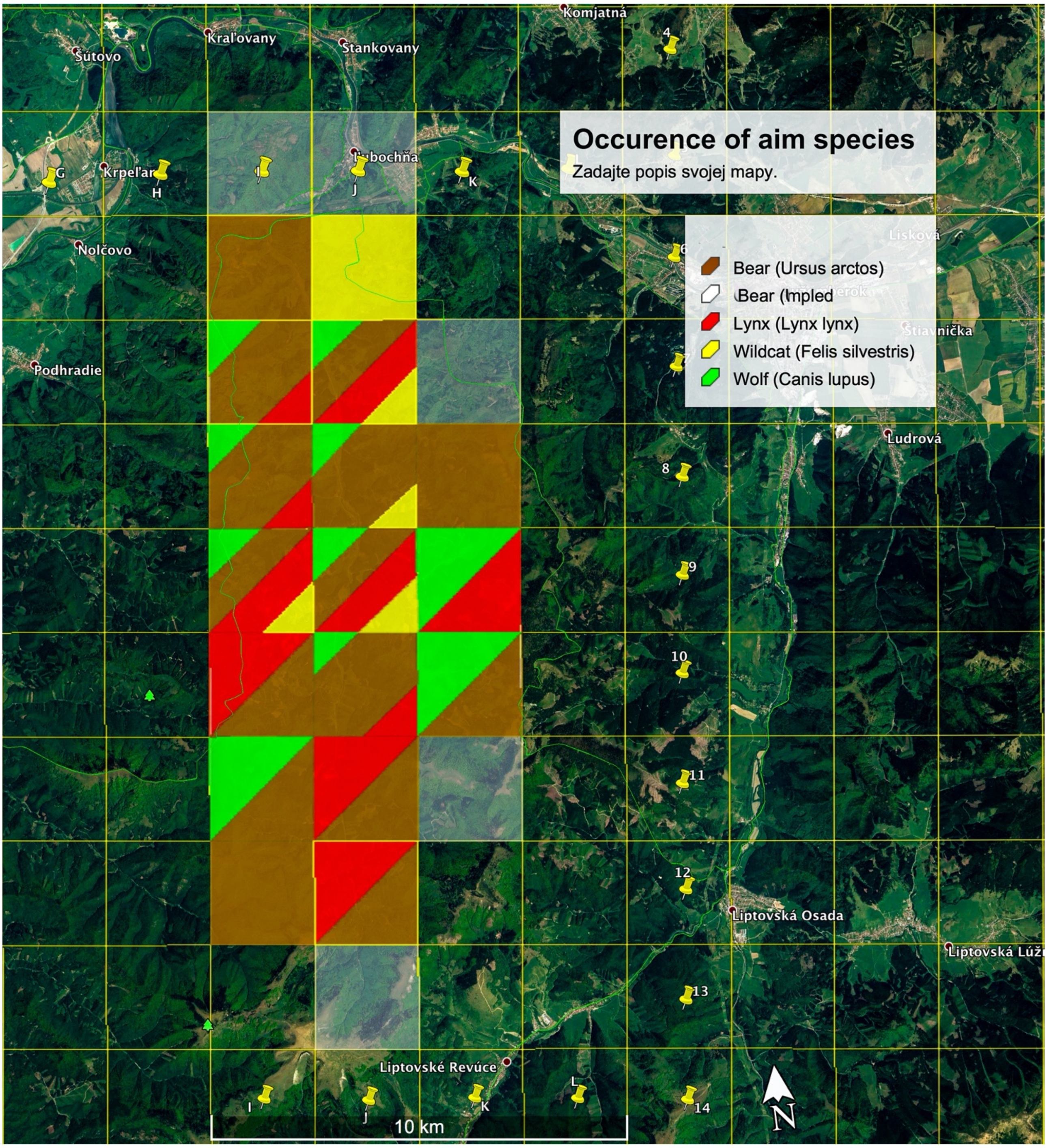

Figure 2.4a. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx, wolves, bears and wildcats per cell.

Lynx *Lynx lynx*

Lynx was recorded in 10 out of 22 cells. Snow-tracking contributed to the recording of lynx, and camera-trapping recorded lynx in two cells. Prospective lynx samples were also collected.

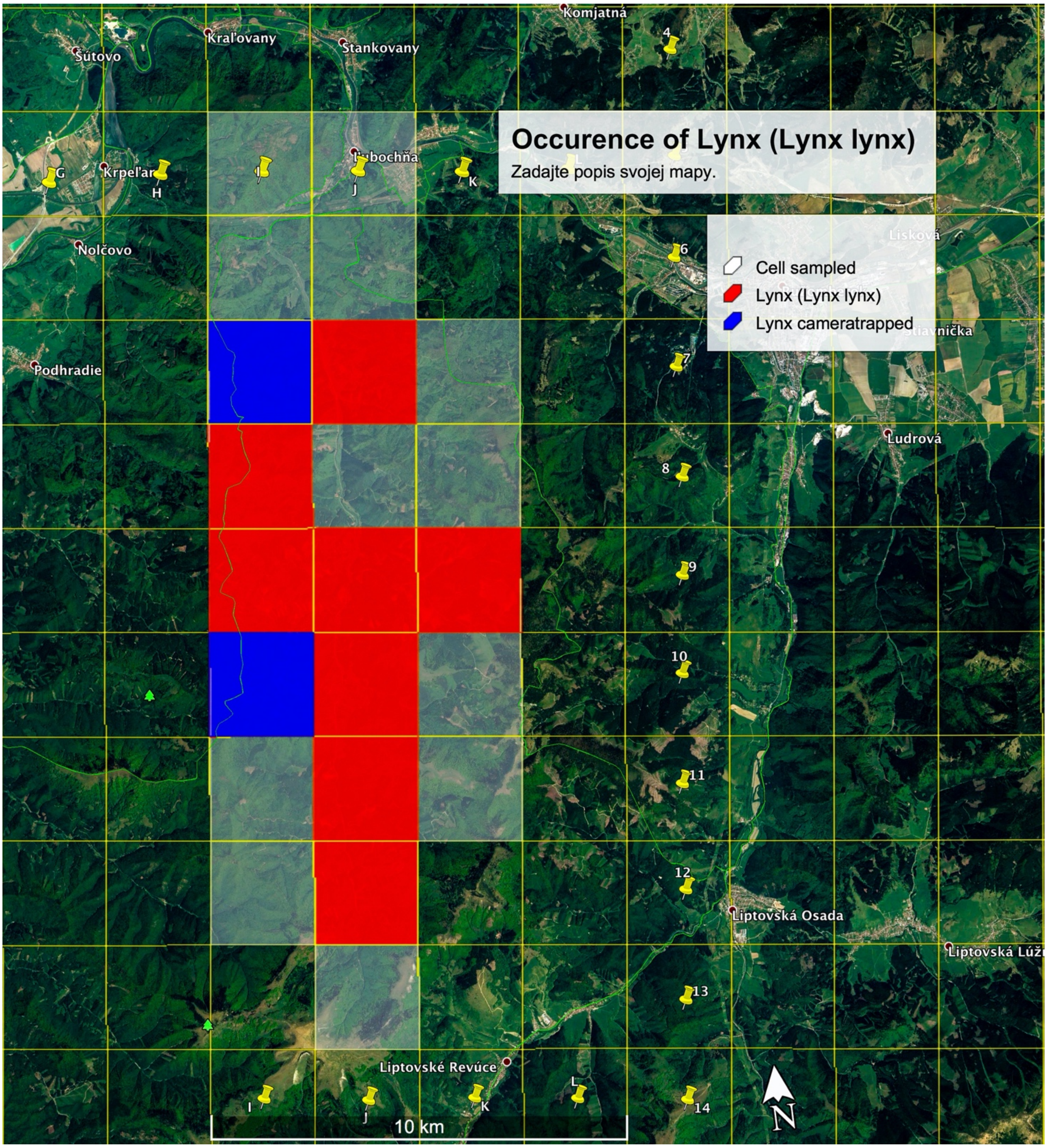

Figure 2.4b. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of lynx per cell according to different recording methods.

Wolf *Canis lupus*

Wolf was recorded in 10 out of 22 cells surveyed. It is also worth noting that snow-tracking contributed to the recording of wolves in all 10 cells and camera-trapping recorded wolves in 2 cells. Prospective wolf samples were also collected.

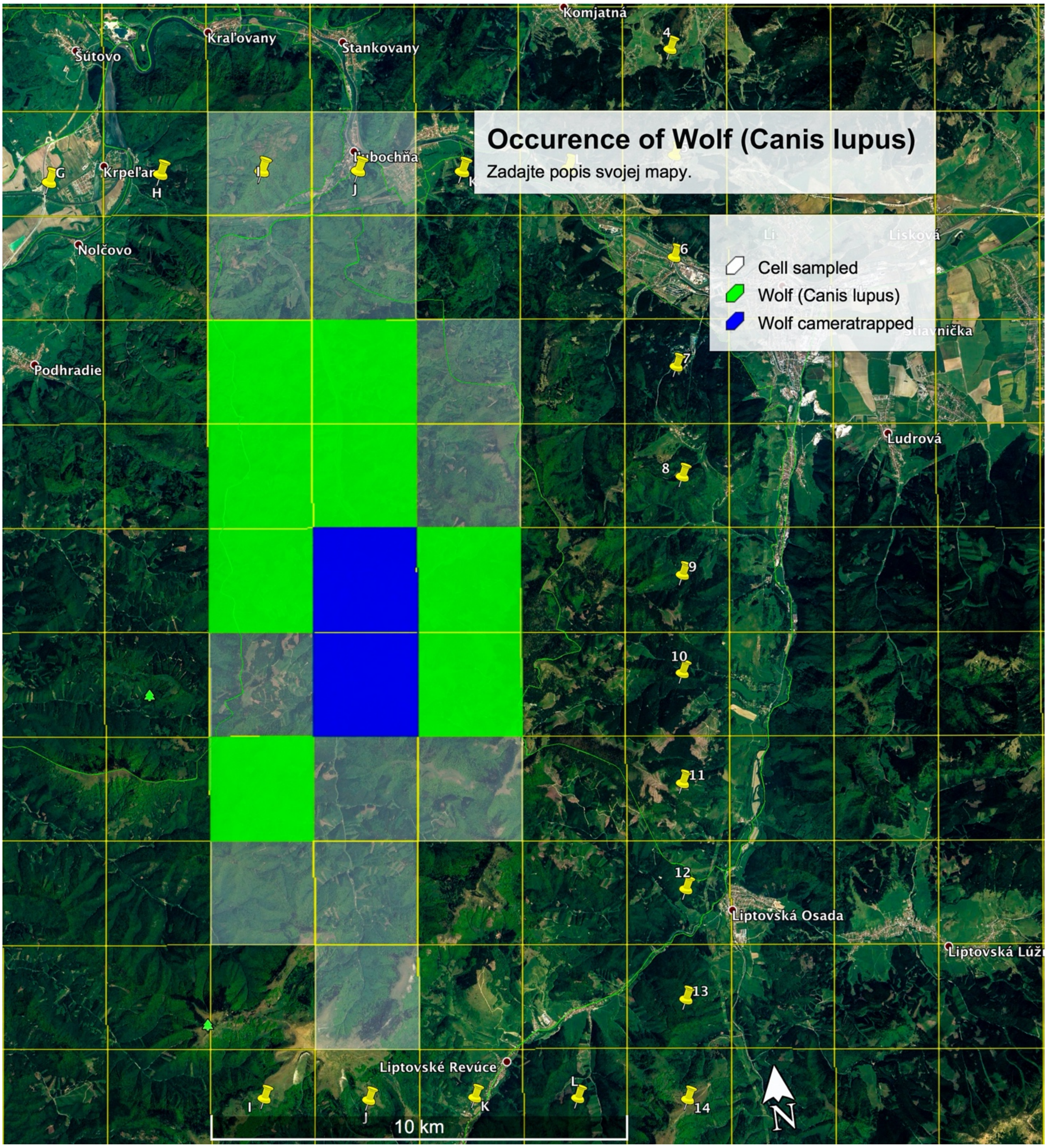

Figure 2.4c. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of wolves per cell.

Bear *Ursus arctos*

Bear presence was recorded in 15 out of 22 cells surveyed by snow tracking. No bears were camera-trapped. The expedition also collected a bear sample.

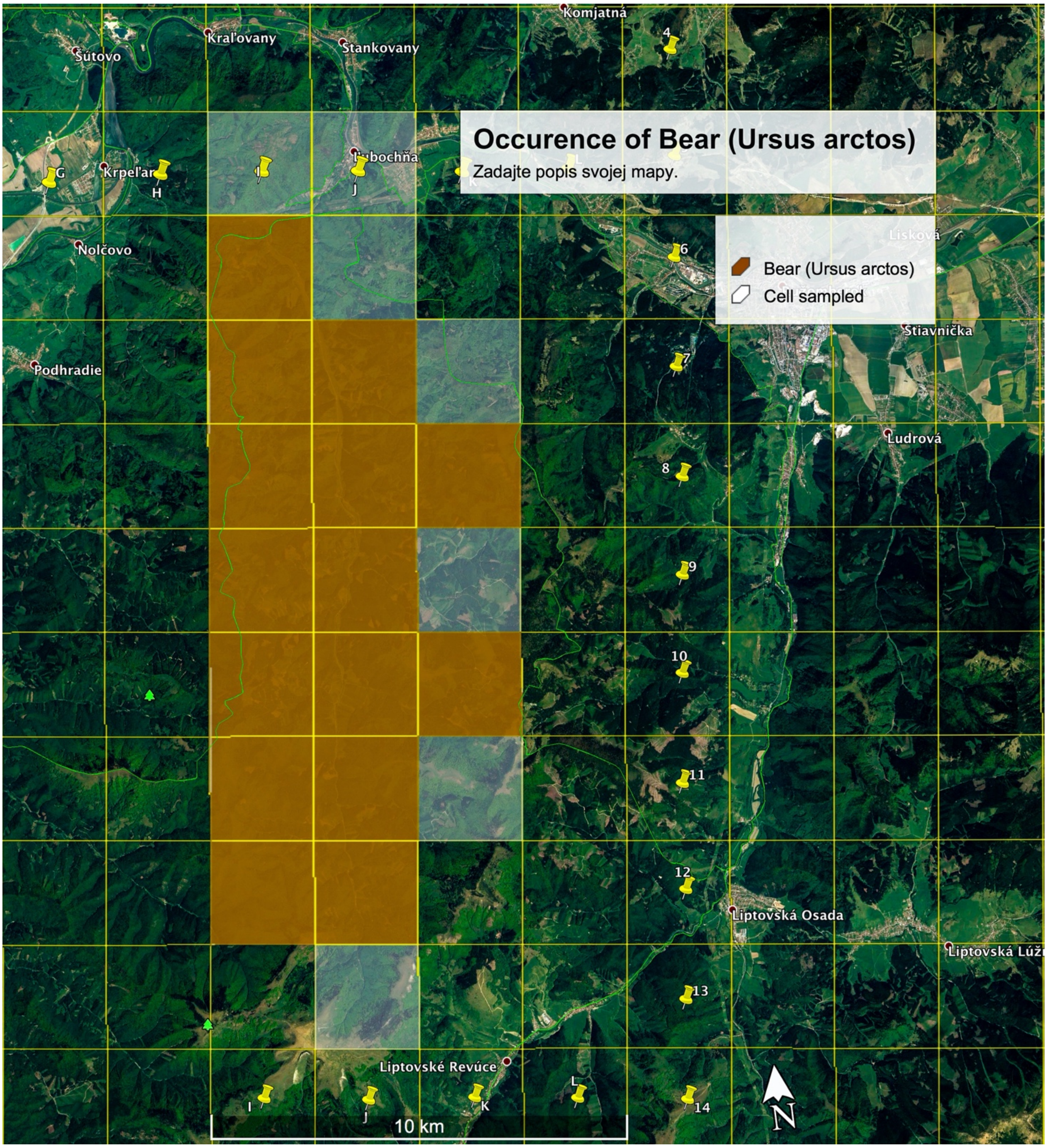

Figure 2.4d. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of bear per cell.

Wildcat *Felis silvestris*

Wildcat presence was recorded in 5 out of 22 cells surveyed by snow tracking and in one cell wildcat was captured by camera trap.

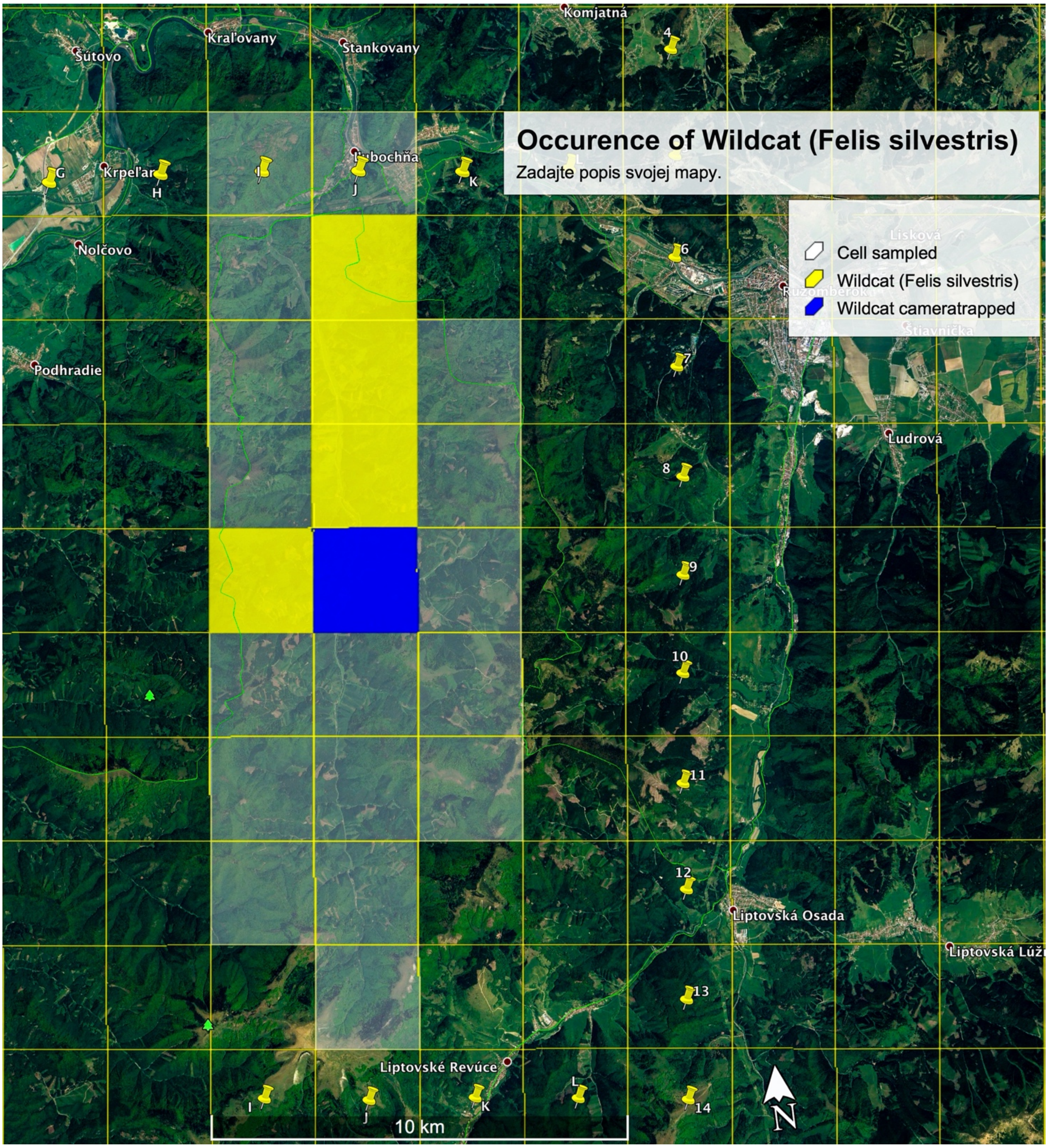

Figure 2.4e. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of wildcat per cell.

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

Recording carnivores other than the main target species is important in order to understand how they interact with target species, and may also give an indication of the quality of the ecosystem. The golden eagle *Aquila chrysaetos* was recorded from observations; badger *Meles meles*, stoat *Mustela erminea* and otter *Lutra lutra* were recorded by snow-tracking; pine marten *Martes martes* was recorded by snow-tracking and camera-trapping; and red fox *Vulpes vulpes* was recorded by camera-trapping. Red fox was the most recorded (n=13 cells), followed by pine marten (n=8 cells), then otter and badger (n=3 cell for each). Golden eagle and stoat were recorded in one cell each.

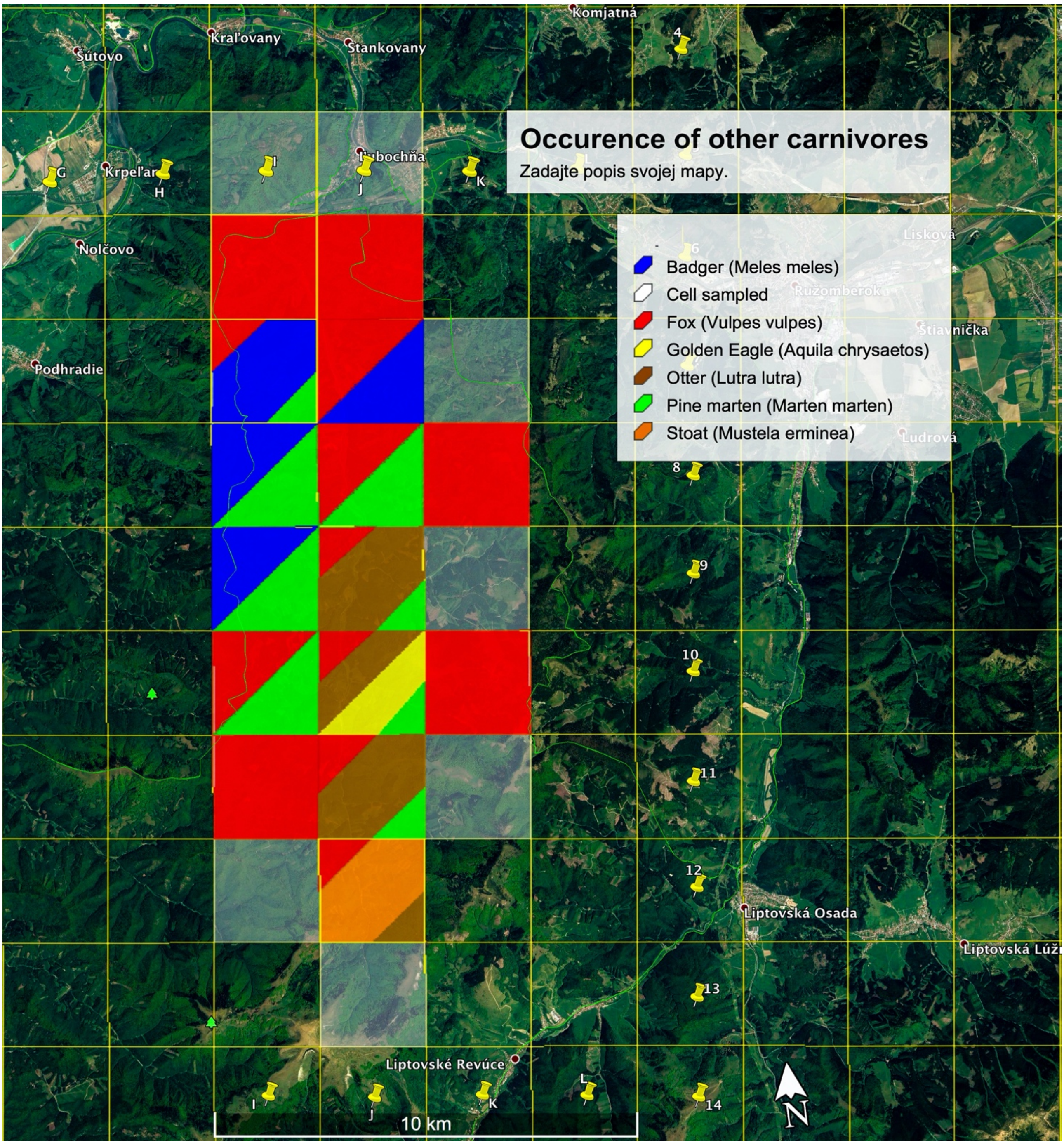

Figure 2.4f. Sampled cells (2.5 x 2.5 km in size) and results of carnivores other than lynx, wolf, bear and wildcat per cell.

Ungulates (roe deer, red deer, wild boar) and hare

Red deer *Cervus elaphus*, roe deer *Capreolus capreolus*, wild boar *Sus scrofa* and hare *Lepus europaeus* are major prey species for carnivores, hence recording their presence is important. Roe deer and red deer were recorded in 6 cells, wild boar in 5 cells and hare in one cell. Roe deer, red deer and wild boar were recorded by observation, snow-tracking and from camera traps; hare were recorded only by snow-tracking.

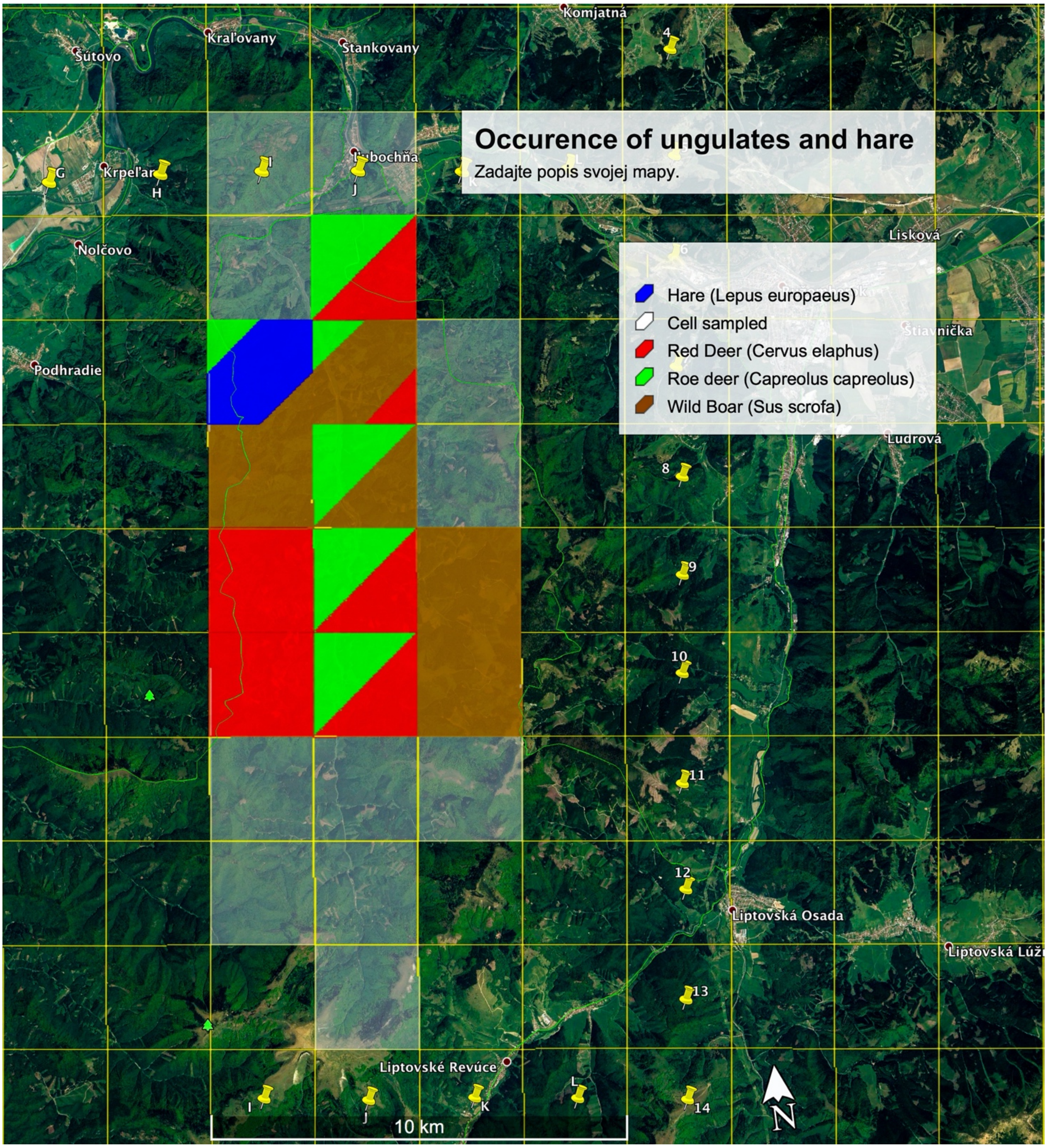

Figure 2.4g. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of roe and red deer, wild boar and hare per cell.

Hazel grouse *Tetrastes bonasia*

By request from the State Forestry Department in Liptovský Hrádok, the expedition also monitored hazel grouse, which was recorded in one cell by tracks in the snow.

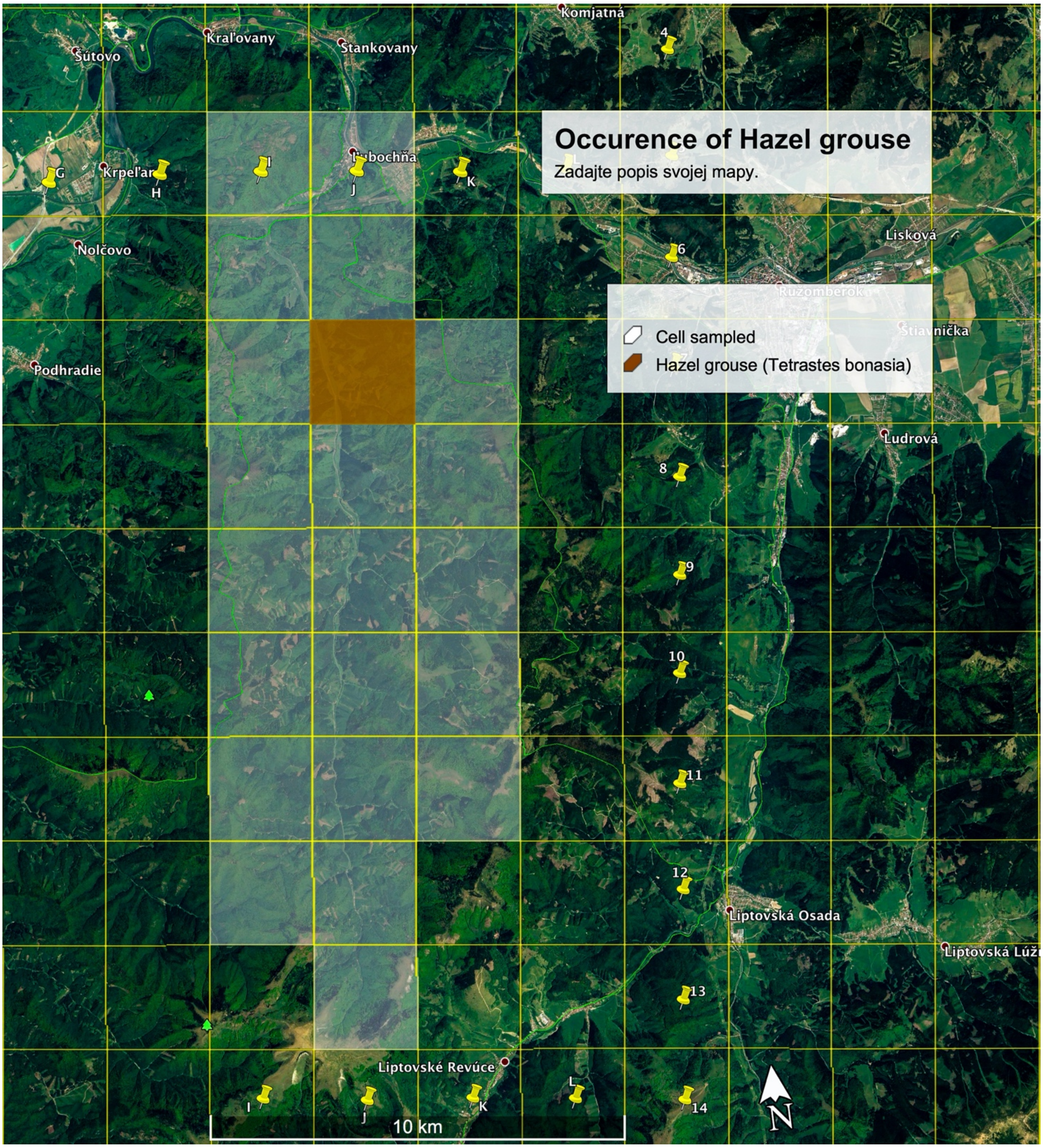

Figure 2.4h. Sampled cells (2.5 x 2.5 km in size) and results of occurrence of hazel grouse per cell.

2.5. Discussion & conclusions

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

Table 2.5a. Survey effort and results over expedition years 2012-2017.

	2012	2013	2014	2015	2016	2017
No. of expedition weeks	3	2	2	2	2	2
No. of expedition participants	21	22	26	22	18	17
No. of transects surveyed	50	38	36	34	33	27
Total transect length surveyed per exp. (km)	356	307	548	438	462	345
Total transect length surveyed per week (km)	119	153	274	219	231	173
Total area surveyed (sq km)	*	136	181	134	169	138
No. of lynx trails found	25	15	27	23	13	23
No. of wolf trails found	25	20	50	49	90	75
No. of bear trails found	9	0	50	1	11	110
No. of wildcat trail found	0	1	6	1	1	11
No. of cells that lynx was detected in	*	7	11	9	6	10
No. of cells that wolf was detected in	*	8	16	12	17	10
No. of cells that bear was detected in	*	1	17	1	6	15
No. of cells that wildcat was detected in	*	1	4	1	1	5
No. camera traps used / in different positions	9/15	10/10	10/12	10/10	8/11	20/23
Lynx recorded on camera trap	Yes	Yes	Yes	Yes	No	Yes
Wolf recorded on camera trap	Yes	Yes	Yes	No	Yes	Yes
Bear recorded on camera trap	Yes	Yes	Yes	No	No	No
Wildcat recorded on camera trap	No	No	No	No	No	Yes
No. of presumed lynx DNA samples collected	9	3	3	15	0	2
No. of presumed wolf DNA samples collected	9	9	13	13	11	4
No. of presumed bear DNA samples collected	0	0	5	0	1	2
No. of presumed wildcat DNA samples coll.	0	0	0	0	0	0

* cell methodology was not used in 2012

Lynx distribution and detection

Six years of annual winter surveys from 2012 to 2017 show the lynx population to be relatively stable and relatively unaffected by winter conditions. The number of cells that lynx was detected in, as well as the number of lynx signs found, were comparable with years 2012, 2014, 2015. Only years 2013 and 2016 - due to unusually mild winter conditions with low snow coverage - are likely to have enabled the lynx to find enough food in higher or remote positions of Velka Fatra, which were not surveyed. This is because the lynx's main prey, the roe deer (Jobin et al. 2000, Okarma et al. 1997), were not concentrated in the valleys at this time. During winters such as 2017, lynx depend on the various feeding stations set up by hunters and foresters to ensure an artificially high roe and red deer population for hunting purposes (Schmidt 2008).

Wolf distribution and detection

Our finding this year corroborate again that there appears to be a strong correlation between winter severity and wolf distribution/detection.

In 2017, during normal winter conditions we detected 75 wolf signs in 10 cells. This is similar to the years of harsher winters of 2012 & 2013, and the normal winter of 2015. In 2017 we only found carcass of a young red deer. In contrast, in 2015 wolves were detected in 12 cells and four wolf kill carcasses were found near the feeding stations in the valley bottom (Hulik et al. 2016). In 2013 wolf presence was detected in eight cells, centred next to three carcasses around feeding stations in the valley bottom (Hulik et al. 2014). The same was true in 2012, when the current cell methodology was not yet being used by the expedition, but six carcasses close to feeding stations and associated wolf signs were found (Hulik et al. 2012). In 2016, during a mild winter, wolf signs equalled the highest frequency since the beginning of annual winter surveys in 2012 (signs were detected in 16 cells). This matches detection rates in 2014, when the winter was also mild and wolf signs were also detected in 16 cells. Thus in 2014 and 2016 wolves had to hunt in a much larger area than in previous years, as confirmed by their detection in 16 cells (Hulik et al. 2015). Corroborating evidence includes the fact that surveys in 2016 did not detect any wolf prey carcasses, as kills would have been spread widely around the study site and as such harder to detect.

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

Bear distribution and detection

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

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

However, the pattern in 2017 was different. Normal winter conditions prevailed, but also a record of 110 bear signs detected in 15 cells. We believe this was due to a bumper crop of beech nuts (*Fagus silvaticus*) in 2017, which meant that bears were able to find enough food supply to survive winter without the need to hibernate. This is corroborated by Cicnja et al. (1987) who in Yugoslavia, and Hashimoti et al. (2003) who in Japan, found nuts to be an important autumn and winter component of bear diet, as well as Jakubas et al. (1983) who in the USA found a strong correlation between bear fecundity and nut production of American beech (*Fagus grandifolia*).

The 2016 survey found 12 fresh and older bear footprints, indicating that a significant part of the Veľká Fatra National Park bear population was not hibernating during the mild winter (Hulik et al. 2017). This matches with 2014, also a mild winter with near autumn-like conditions and an absence of snow cover, when a surprising and interesting number of 50 trails were found (Hulik et al. 2015). In that year bears occurred in a greater number of cells than any other species of interest, in an area we believe containing enough resting places and shelter for winter hibernation (Hulik et al. 2015).

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

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

Wildcat remarks

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

Surveys in 2017 highlighted a surprising presence of wildcat along Ľubochnianska Valley. Five cells yielded eleven signs, most probably from two or three different individuals, and one camera trap photo. Wildcat signs were previously recorded once in 2016 and in 2015 (Hulik et al. 2016), six times in 2014 (Hulik et al. 2015) and once in 2013 (Hulik et al. 2014). It is hard to say why we recorded so many signs, but it may well have been due to simple good luck and stochastic effects.

Cessation of expedition

This research project had to wind down after the 2017 expedition, because our permit expired and was not renewed by the National Park. The second editor (MH) believes this is due to widespread corruption and destructive practices in Slovakian parks, which authorities did not want to be documented.

We wish to thank all those involved in making the expeditions between 2012 and 2017 a success and regret having to take this step.

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

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

Date	Temperature in ºC at 7:00 Švošov	Temperature in ºC at 16:00 Švošov	Temperature in ºC at 8:00 Valley	Fresh snow in valley (cm)
04. 02. 2017	2	0.7	-	-
05. 02. 2017	1.4	2.1	-	-
06. 02. 2017	0.2	1	-2.5	-
07. 02. 2017	-2.5	-3.1	-2	-
08. 02. 2017	-5.8	-4.6	-5	-
09. 02. 2017	-4.8	-4.5	-4	-
10. 02. 2017	1.7	2.5	-1	-
11. 02. 2017	-	-	-	-
12. 02. 2017	1.4	3.2	-	-
13. 02. 2017	3	-1	0	-
14. 02. 2017	-6	0	-8	-
15. 02. 2017	-5	2	-6	-
16. 02. 2017	-4	2	-4	-
17. 02. 2017	-2	2	-2	-

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

	Transects surveyed			Lynx tracks			following lynx trail		wolf tracks			following wolf trail		bear tracks			following bear trail		Wild cat tracks			following wildcat trail	
	n	km	cells	cells	n	track/km	n	km	cells	n	track/km	n	km	cells	n	track/km	n	km	cells	n	track/km	n	km
Slot1	14	168.57	15	6	17	9.92	4	0.74	8	57	2.95	4	1.72	13	77	2.19	14	4.6	3	10	16.86	2	0.65
Slot2	13	175.99	22	5	6	29.33	2	0.89	8	18	9.78	10	5.86	13	33	5.33	0	0	1	1	175.99	0	0
Total	27	344.56	22	10	23	14.98	6	1.63	10	75	4.59	16	16.06	15	110	3.13	1	0.79	4	11	31.32	2	0.65

Table 3. Summary of results: cell resampling information.

Cell number	Number of times cells have been sampled (check cells)												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
J9	x	x	x	x	x	x	x	x	x	x				
J10	x	x	x	x	x	x	x	x	x					
J7	x	x	x	x	x	x	x	x	x					
J6	x	x	x											
I7	x	x	x	x										
I8	x	x	x	x	x	x								
J8	x	x	x	x	x	x	x	x	x	x	x			
I10	x	x	x	x	x									
I9	x	x	x											
J12	x	x	x	x	x									
J13	x													
K8	x	x												
I5	x													
I6	x	x	x											
J11	x	x	x	x	x									
K10	x	x	x											
K9	x													
I11	x	x												
J5	x													
K11	x													
I12	x													
J13	x													

Table 4. Summary of results: temporal resampling of species – “capture history“ in 2017.

Target species	4 Feb	6 Feb	7 Feb	8 Feb	9 Feb	10 Feb	13 Feb	14 Feb	15 Feb	16 Feb	17 Feb
Wolf	x	x	x	x	x	x	x	x	x	x	x
Lynx			x	x	x	x			x	x	
Wildcat			x	x							x
Bear			x	x	x	x		x	x	x	x
Golden eagle		x					x			x	
Otter					x			x		x	
Hazel grouse			x								

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

Species	Cells *(no repeat cells)*	Type of record
Wolf	I7, J7, I8, J8, I9, J9, K9, J10, K10, I11	Footprints, urine, camera trap
Lynx	I7, I8, I9, J9, K9, I10, J11, J12	Footprints, camera trap
Wildcat	J6, J7, J8, I9, J9	Footprints, camera trap
Bear	I6, I7, J7, I8, J8, K8, I9, J9, I10, J10, K10, I11, J11, I12, J12	Footprints, scat
Red deer	J6, J7, I9, J9, J10,	Footprints, camera trap
Roe deer	J6, I7, J7, I8, J8, J9, J10	Footprints, observations, camera trap
Golden eagle	J10	Observation
Otter	J9, J10, J11, J12	Footprints
Wild boar	I7, J7, I8, J8, K9, K10, J12	Footprints, camera trap
Pine marten	I7, I8, J8, J10, J12	Footprints, camera trap
Red fox	I6, J6, J7, J8, J9, J10, K10	Footprints, camera trap
Badger	I7, J7, I8, I9	Footprints
Hazel grouse	J7	Footprints
Hare	I7	Footprints
Stoat	J12	Footprints

Table 6. Overview of footprints and animal trails recorded and samples collected for DNA analysis.

Date	No. #	Species	Position				Footprint size (in cm)		Age of trail				Moving direction	CE LL	Other notes
				deg	min	sec	Width	Length	Very fresh	Fresh	Older	Not sure			
4.2.17	001	Canis lupus	N	49	00	33.21	10	11 0		x				J10	
			E	019	08	44.43									
4.2.17	002 A	Canis lupus	N	49	01	50.54	9	11 0		x				J9	start following wolf trail
			E	019	08	44.43									
4.2.17	002 B	Canis lupus	N	49	01	45.11	10	11		x				J9	following ends
			E	019	09	4.01									
6.2.17	003	Canis lupus	N	49	0	31.6	9	10	x				from 0 to 180, 200	J10	wolf pack 3+
			E	019	08	49.6									
6.2.17	004	Aquila chrysaetos	N	49	0	21.5								J10	2 adult, 1 juvenile
			E	019	9	21.1									
7.2.17	005 A	Felis silvestris	N	49	05	15.6	5	6		x			200	J6	Track followed transect
			E	019	10	25.7									
7.2.17	005 B	Felis silvestris	N	49	05	13.5	5	5		x			325	J6	Leaving track
			E	019	10	19.1									
7.2.17	005 C	Felis silvestris	N	49	05	08.7	5	5		x			255	J6	Track followed transect
			E	019	10	14.4									
7.2.17	005 D	Felis silvestris	N	49	05	07.7	5	5		x			306	J7	Leaving transect
			E	019	10	09.7									
7.2.17	005 E	Felis silvestris	N	49	05	04.4	5	5		x			270	J7	Exits right
			E	019	09	52.9									
7.2.17	005 F	Felis silvestris	N	49	04	52.4	5	6		x			320	J7	Crosses trail
			E	019	09	58.5									
7.2.17	005 G	Felis silvestris	N	49	O4	42.7	5	5		x				J7	Joined trail
			E	019	09	57.3									
7.2.17	005 H	Felis silvestris	N	49	04	42.7	5	5		x				J7	Last print on transect
			E	019	09	57.7									
7.2.17	006	Ursus arctos	N	49	04	41.0	15	20		x			94	J7	Leaving track, start following
			E	019	10	10.3									
7.2.17	006 A	Ursus arctos	N	49	04	27.0	15	20		x			190	J7	Starts on road, finished following
			E	019	09	50.2									

7.2.17	007	Tetrastes bonasia	N	49	04	26.5	5	5		x				J7	
			E	019	10	08.3									
7.2.17	008	Ursus arctos	N	49	04	25:3	15	20			x		290	J7	Following the transect
			E	019	10	16.5									
7.2.17	009	Ursus arctos	N	49	04	20	16	27		x			180	J7	Crossing track
			E	019	09	54.4									
7.2.17	010	Canis lupus	N	49	04	09.7	8	10.5		X			170	J7	
			E	019	09	04.7									
7.2.17	010 A	Canis lupus	N	49	04	09.7	11	13		X			50	J7	
			E	019	09	04.7									
7.2.17	010 B	Canis lupus	N	49	04	09.7	9	11		X			170	J7	
			E	019	09	04.7									
7.2.17	010 C	Canis lupus	N	49	04	09.7	7	10		X			50	J7	
			E	019	09	04.7									
7.2.17	010 D	Canis lupus	N	49	04	7.18				X				J7	
			E	019	08	53.71									
7.2.17	010 E	Canis lupus	N	49	04	09.7				X				J7	
			E	019	09	04.7									
7.2.17	010 F	Canis lupus	N	49	04	09.7				X				J7	sample: Urine
			E	019	09	04.7									
7.2.17	011	Canis lupus	N	49	04	04.6	9	11		X			from 150 to 270	I7	
			E	019	08	39.4									
7.2.17	012	Canis lupus	N	49	04	08.5	9	11			X		from 1 to 128	I7	
			E	019	08	23.1									
7.2.17	013	Canis lupus	N	49	04	11.5	7	8		X			140	I7	
			E	019	08	38.7									
7.2.17	014	Ursus arctos	N	49	04	25.7	20	30			X		140	I7	
			E	019	07	54.0									
7.2.17	015	Ursus arctos	N	49	04	29.0	16	32		X			40	I7	
			E	019	07	46.5									
7.2.17	016	Canis lupus	N	49	04	09.9				X			60	I7	
			E	019	07	26.1									
7.2.17	017	Ursus arctos	N	49	03	55.7						X	0	I8	
			E	019	07	25.8									
7.2.17	018	Canis lupus	N	49	03	55.3						X	0	I8	
			E	019	07	26.1									
7.2.17	019	Ursus arctos	N	49	04	29,0	16	32		X			40	I8	
			E	019	07	46,5									
2	020	Canis	N	49	03	54.1	8	9.5		X			160	J7	

		lupus	E	019	08	49.6									
7.2.17	020 A	Canis lupus	N	49	03	54.1	8.5	10		X			190	J7	
			E	019	08	49.6									
7.2.17	020 B	Canis lupus	N	49	03	55.1	9	11.5		X			190	J7	
			E	019	08	49.7									
7.2.17	021	Canis lupus	N	49	04	05.2	9.5	10.5			X		70	I7	
			E	019	08	20.9									
7.2.17	022	Canis lupus	N	49	04	07.5	8	10			X		50	I7	
			E	019	08	16.5									
7.2.17	023	Lynx lynx	N	49	00	34,8	9				X		75 - 251	I10	start following lynx trail
			E	19	08	04.7									
7.2.17	023 A	Lynx lynx	N	49	00	35.0							115 - 230	I10	LYNX TRACK FINISH
			E	19	08	00.3									
7.2.17	024	Ursus arctos	N	49	00	50.8					X	VERY OLD	127 - 250	I10	
			E	19	08	01.1									
7.2.17	024 A	Ursus arctos	N	49	00	48,1					x	very old		I10	Bear track finished
			E	19	07	57,7									
7.2.17	025	Lynx lynx	N	49	00	12.4					X			I10	start following trail
			E	19	07	24.4									
7.2.17	025 A	Lynx lynx	N	49	00	19.42					X			I10	stop following trail
			E	19	07	40.94									
8.2.17	026	Canis lupus	N	49	02	55.9	10,5	13			X	older	from 0 to 190	J8	
			E	19	08	43.5									
8.2.17	027	Canis lupus	N	49	02	58.8	9	12,5			X	x	from 50 to 220	J8	stop following trail
			E	19	08	33.3									
8.2.17	028	Ursus arctos	N	49	02	59.5	14	19	X				from 330 to 155	I8	bear trail starts
			E	019	08	27.5									
8.2.17	029	Ursus arctos	N	49	02	58.6	18	23			X		from 0 to 180	I8	
			E	019	08	26.1									
8.2.17	028 A	Ursus arctos	N	49	02	54.6	14		X				from 10 to 205	J8	
			E	019	08	34.8									
8.2.17	030	Ursus arctos	N	49	02	54.5	14.5	23	X				from 158 to 340	J8	
			E	019	08	35.6									
8.2.17	028 B	Ursus arctos	N	49	02	51.74			X					J8	bear scat
			E	019	08	39.86									
8.2.17	028 C	Ursus arctos	N	49	02	46.1			X					J8	bear trail end
			E	019	08	50.35									
8.2.17	031	Canis lupus	N	49	02	50.7	9.5	11			X		from down transect to 220	J9	
			E	019	08	43.9									
2	032	Ursus	N	49	02	29.8					X		from 160 to	J9	3 tracks of bears,

		arctos	E	019	08	50.2							transect		splits on transect, pics from Peter
8.2.17	033	Felis silvestris	N	49	02	31.1	5	4		X			from 180 to 40	I9	
			E	019	08	22.2									
8.2.17	033 A	Felis silvestris	N	49	02	31.1	4	4		X			along transect	I9	
			E	019	08	22.2									
8.2.17	034	Lynx lynx	N	49	02	36.7	9.5	8		X			from 86 to 260	I8	two tracks in a loop
			E	019	08	15.8									
8.2.17	035	Lynx lynx	N	49	02	46.4	8.5	8	X				from 62 to NA	I8	two tracks parallel, back and forth
			E	019	08	02.4									
8.2.17	035 A	Lynx lynx	N	49	02	46.4	8.5	8	X				from 62 to NA	I8	Stop following trail
			E	019	08	02.4									
8.2.17	036	Ursus arctos	N	49	02	48.5	12	18			X		from 170 to 329	I8	
			E	019	07	56.4									
8.2.17	037	Ursus arctos	N	49	02	48.8	16	22			X		from 0 to 180	I8	
			E	019	07	51.8									
8.2.17	037 A	Ursus arctos	N	49	02	51.2	17	21			X		from 240 to 110	I8	
			E	019	07	49.2									
8.2.17	037 B	Ursus arctos	N	49	02	53.7	17	21			X		from 76 to 240	I8	
			E	019	07	47.3									
8.2.17	038	Lynx lynx	N	49	02	55.8	6.5	6.5	X				along transect	I8	
			E	019	07	43.7									
8.2.17	039	Ursus arctos	N	48	57	23.91	12	20	X				from 353 to 160	J12	
			E	019	08	15.43									
8.2.17	040	Ursus arctos	N	49	02	55.8	20,0				X		240 --> 30	J8	
			E	19	09	43,2									
8.2.17	040 A	Ursus arctos	N	49	02	51.6	20,0				X		60--> 250	J8	
			E	19	09	44,6									
8.2.17	040 B	Ursus arctos	N	49	02	53.1	20,0				X		35 --> 300	J8	
			E	19	10	04,8									
8.2.17	041	Ursus arctos	N	49	03	04,7	14,0				X		100 --> 325	J8	
			E	19	10	00,6									
8.2.17	041 A	Ursus arctos	N	49	03	9.16	14,0				X			J8	finished following trail
			E	19	09	56.43									
8.2.17	042	Ursus arctos	N	49	03	06.1	13,0				X		50 --> 308	J8	
			E	19	10	00,0									
8.2.17	043	Ursus arctos	N	49	03	10,8	14,0			X	X		240 --> 60	J8	
			E	19	09	53,7									
8.2.17	044	Ursus arctos	N	49	03	11,6	15,0			X	X		dancing	J8	more than one bear
			E	19	09	54,6									
2	044	Ursus	N	49	03	11,6	15,0			X	X		dancing	J8	more than one

	A	arctos	E	19	09	54,6									bear, finished following trail or "dancing" area
8.2.17	045	Ursus arctos	N	49	03	06,9	14 and 12			X	X		160	J8	dancing area, playground
			E	19	10	07,4									
8.2.17	046	Ursus arctos	N	49	02	56.52					x			J8	
			E	19	10	28.95									
8.2.17	047	Ursus arctos	N	49	02	56.52					x			K8	
			E	19	10	28.95									
8.2.17	048	Ursus arctos	N	49	03	01,7	20,0			X	X		6 --> 176	K8	
			E	19	10	43,3									
8.2.17	049	Ursus arctos	N	49	03	02,3	14,0		X	X			320 --> 140	K8	2 bears
			E	19	10	49,0									
8.2.17	050	Ursus arctos	N	49	03	07,7	14 and 12		X	X			346 --> 200	K8	2 bears in one trail
			E	19	10	47,3									
8.2.17	050 A	Ursus arctos	N	49	03	13,0	14 and 12		X	X			70 --> 172	K8	finished following
			E	19	10	44,5									
8.2.17	051	Ursus arctos	N	49	03	16,1	15,0			X			160 --> 346	K8	
			E	19	10	46,3									
8.2.17	052	Ursus arctos	N	49	03	12,4	18,0				X		130 --> 291	K8	
			E	19	10	46,9									
8.2.17	053	Ursus arctos	N	49	03	11,0	17 and 12				X		270 --> 125	K8	mother and cub
			E	19	10	48,7									
8.2.17	053 A	Ursus arctos	N	49	03	08,4				X	X			K8	finishing following all three bears
			E	19	10	53,1									
8.2.17	054	Ursus arctos	N	49	03	15,4	14,0			X	X		351 --> 160	K8	
			E	19	11	01,9									
8.2.17	053 B	Ursus arctos	N	49	03	15,4	16 and 13			X	X		120 --> 160	K8	
			E	19	11	01,9									
8.2.17	055	Ursus arctos	N	49	03	13,3								K8	sample: scat
			E	19	11	09,0									
8.2.17	056	Ursus arctos	N	49	03	15,6							61 --> 140	K8	finishing following bear trail
			E	19	11	15,8									
8.2.17	057	Ursus arctos	N	49	03	40,1				X	X			K8	on the road
			E	19	11	13.46									
8.2.17	058	Ursus arctos	N	49	03	25.96				X	X		222 --> 35	K8	crossing river, road, forest
			E	19	11	12.70									
9.2.17	059	Canis lupus	N	49	02	15,8	12	15			X		200	J9	LONG STRIDE
			E	01 9	09	14,2									
9.2.17	059 A	Canis lupus	N	49	02	20,8	12	15			X			J9	ENTERS TRANSECT
			E	01 9	09	17,1									
2	060	Canis	N	49	03	55.1					X			J7	

		lupus	E	019	09	13.46									
9.2.17	061	Ursus arctos	N	49	06	01,2	16	23			X		QUERY NE FROM TRANSECT	I6	LEFT TRNSECT/UPHILL
			E	019	08	42,4									
9.2.17	062	Ursus arctos	N	49	06	00,5	14	23		X			QUERY NW FROM TRANSECT	I6	LEFT TRANSECT
			E	019	08	40,8									
9.2.17	062 A	Ursus arctos	N	49	06	00,5	10	15		X			QUERY NW FROM TRANSECT	I6	LEFT TRANSECT
			E	019	08	40,8									
9.2.17	062 B	Ursus arctos	N	49	06	00.5	10	15		X			QUERY NW FROM TRANSECT	I6	LEFT TRANSECT
			E	019	08	40,8									
9.2.17	063	Ursus arctos	N	49	06	04,3	14	23			X			I6	CROSSING TRANSECT/DRAGGING SOMETHING, old kill site
			E	019	08	35,6									
9.2.17	062 C	Ursus arctos	N	49	06	00,5				X				I6	female with 2 cubs
			E	019	08	40,8									
9.2.17	064	Lynx lynx	N	48	58	5,5	7	7			X		150 to 330	J12	
			E	019	08	19,3									
9.2.17	065	Ursus arctos	N	48	58	42,0	14	26			X		250 to +120	J11	CROSSING PATH
			E	019	08	09,4									
9.2.17	066	Lynx lynx	N	48	58	56,3	7	7	X				340 to 160	J11	
			E	019	08	44,3									
9.2.17	066 A	Lynx lynx	N	48	58	55,1								J11	URINE SAMPLE
			E	019	08	40,7									
9.2.17	066 B	Lynx lynx	N	48	58	55,25								J11	URINE SAMPLE
			E	019	08	40,7									
9.2.17	067	Lynx lynx	N	48	59	48,6	8	8			X		320 to 140	J11	
			E	019	08	24,4									
9.2.17	068	Ursus arctos	N	48	59	50	15	26			X		90 to 270	J11	
			E	019	08	24,0									
9.2.17	069	Ursus arctos	N	48	59	51,8	15	23			X		300 to 120	J10	
			E	019	08	24,2									
9.2.17	070	Ursus arctos	N	49	00	14,4	15	20			X		120 to 300	J10	
			E	019	08	27,6									
9.2.17	071	Ursus arctos	N	49	01	43.5	13				X		to 70	J9	
			E	19	09	48.5									
9.2.17	072	Canis lupus	N	49	01	44.3	8				X		from 260 to 70	J9	
			E	19	09	47.2									
9.2.17	073	Canis lupus	N	49	01	52.0	8				X		from 300 to 130	J9	other side of the river
			E	19	09	38.1									
2	074	Canis	N	49	01	48.4	10				X		from 102 to	J9	crossing the river

		lupus	E	19	09	02.1							300		
9.2.17	074 A	Canis lupus	N	49	01	47.3					X		from 320 to 140	J9	crossing the road
			E	19	09	01.3									
9.2.17	075	Canis lupus	N	49	01	33.3				x				J9	kill site carcass of yound deer
			E	19	08	45.26									
9.2.17	076	Canis lupus	N	49	01	21.1	9				X		from 210 to 033	J9	
			E	19	08	07.6									
9.2.17	077	Lynx lynx	N	49	01	22.8	9				X		from 266 to 0	I9	start following trail
			E	19	08	13.8									
9.2.17	077 A	Lynx lynx	N	49	01	22.2	8.5	11			X		from 200 to 25	I9	stop following trail
			E	19	08	09.4									
9.2.17	078	Canis lupus	N	49	01	22.1								I9	3+
			E	19	08	05.5									
9.2.17	078 A	Canis lupus	N	49	01	21.86								I9	5+ stop following trail
			E	19	07	58.93									
9.2.17	079	Ursus arctos	N	49	01	19.2	15			X			from 320 to 150	I9	
			E	19	07	20.8									
9.2.17	080	Canis lupus	N	49	01	35.8					X		from 40 to 220	I9	2+ wolves, one big
			E	19	07	26.6									
9.2.17	081	Ursus arctos	N	49	01	40.3	16				X		from 330 to 100	I9	
			E	19	07	40.4									
9.2.17	082	Ursus arctos	N	49	01	39.6	15			X			from 0 to 230	I9	
			E	19	07	47.7									
9.2.17	083	Ursus arctos	N	49	01	42.9					X			I9	
			E	19	07	40.9									
9.2.17	084	Canis lupus	N	49	01	43.2					X			I9	
			E	19	07	41.0									
9.2.17	085	Ursus arctos	N	49	01	43.8								I9	
			E	19	07	41.2									
9.2.17	086	Canis lupus	N	49	01	49.6	7.5				X		from 290 to 230	I9	2+ wolves
			E	19	07	33.1									
9.2.17	087	Canis lupus	N	49	02	00.4								J9	4+ wolves, start following
			E	19	07	31.3									
9.2.17	087 A	Canis lupus	N	49	01	48.68								J9	4+ wolves, stop following
			E	19	08	20.17									
9.2.17	088	Ursus arctos	N	49	01	46.9					x			J9	start following
			E	19	08	27,6									
9.2.17	088 A	Ursus arctos	N	49	01	46,3					x			J9	stop following
			E	19	08	30.97									
9.2.17	089	Ursus arctos	N	49	02	11,6					x			J9	start following
			E	19	09	6.21									

9.2.17	089 A	Ursus arctos	N	49	02	13.85					x			J9	stop following
			E	19	09	3.75									
9.2.17	090	Ursus arctos	N	49	02	16.03					x			J9	sample: scat
			E	19	09	8.79									
9.2.17	091	Canis lupus	N	49	02	18					x			J9	3+ wolves
			E	19	09	9.60									
10.2.17	092	Canis lupus	N	49	00	32.3	10	10			x		road -> 90	J10	
			E	019	08	39.4									
10.2.17	093	Canis lupus	N	49	00	22.9	10	14			x		300 -> 100	J10	crossed the road
			E	019	08	34.3									
10.2.17	094	Ursus arctos	N	49	00	14.30	15	23		X			110 -> 280	J10	
			E	019	08	27.91									
10.2.17	094 A	Ursus arctos	N	49	00	14.0								J10	sample: scat
			E	019	O8	29.1									
10.2.17	095	Canis lupus	N	49	00	33.6	9	12			x		340 -> 210	J10	
			E	019	08	42.6									
10.2.17	096	Canis lupus	N	49	00	3O.7	10	13			x		340 -> 200	J10	at least two
			E	019	08	49.8									
10.2.17	096 A	Canis lupus	N	49	00	30.97	10	12			x		340 -> 195	J10	at least two
			E	019	08	55.3									
10.2.17	096 B	Canis lupus	N	49	00	30								J10	sample: urine
			E	019	08	55.5									
10.2.17	097	Ursus arctos	N	49	00	13.1					x			J10	very old
			E	019	09	41.56									
10.2.17	098	Ursus arctos	N	49	00	05.2	20	16			x		165 -> 180	J10	
			E	019	10	44.8									
10.2.17	099	Canis lupus	N	49	00	O5.8	10	11.5					->260	J10	
			E	019	10	13.8									
10.2.17	100	Canis lupus	N	49	00	34.5	10	13		x			->270	J10	
			E	019	08	34.2									
10.2.17	101	Ursus arctos	N	49	00	35.1	12	21			x		->300	J10	at least two
			E	019	08	39.1									
10.2.17	102	Canis lupus	N	049	04	08,8	11			X	X		260-> 70	J7	
			E	019	08	79,1									
10.2.17	103	Lynx lynx	N	049	04	28,5	9	9			X		170 -> 310	J7	
			E	019	08	79,5									
10.2.17	104	Canis lupus	N	049	04	78,5	7 and 11				x		340 -> 240	I7	two individuals
			E	019	08	28,8									

10.2.17	105	Ursus arctos	N	049	04	54,6	1č				x		270 -> 140	I7	
			E	019	08	20,9									
10.2.17	106	Ursus arctos	N	049	04	53,9	17				X		350 --> 150	I7	
			E	019	08	00,9									
10.2.17	107	Canis lupus	N	049	04	53,4	10				x		300 -> 160	I7	
			E	019	07	48,1									
10.2.17	108	Canis lupus	N	049	03	92,9	8		X				240 -> 90	I8	
			E	019	07	42,9									
10.2.17	109	Canis lupus	N	049	03	54.96			X					J7	
			E	019	08	49.66									
10.2.17	110	Ursus arctos	N	049	00	28,9	15		X				188-> 0	J10	
			E	019	08	25,7									
10.2.17	111	Lynx lynx	N	049	00	34,7	9		X				257 -> 80	I10	
			E	019	08	02,9									
10.2.17	112	Canis lupus	N	049	01	43,2								J9	Sample: scat, from wolfs chcecked 04.02.2017
			E	019	09	04,4									
10.2.17	113	Canis lupus	N	049	01	30,6	10			X	X		79 -> 270	J9	wolf pack 3+
			E	019	08	34,2									
10.2.17	114	Canis lupus	N	049	01	40.43				X	X			J9	wolf pack 3+
			E	019	09	8.57									
13.2.17	115	Aquila chrysaetos	N	49	00	29.93								J10	observation
			E	19	08	56.12									
13.2.17	116	Canis lupus	N	49	00	29.94	9,5	10		X			7 - 180	J10	
			E	19	08	55.36									
14.2.17	116 A	Canis lupus	N	49	00	29.94								J10	Urine: sample
			E	19	08	55.36									
14.2.17	117	Ursus arctos	N	49	01	55.1	14	26			x		342/196	J9	Crossing road
			E	19	09	09.8									
14.2.17	118	Ursus arctos	N	49	01	50.5	16	24			x		52/320	J9	By side of road
			E	19	09	40.8									
14.2.17	119	Lynx lynx	N	49	01	29.4	7	7			x		152	K9	On slope by path
			E	19	11	05.5									
14.2.17	120	Canis lupus	N	49	01	25.6	10	10			x		71 then 40	K9	
			E	19	11	07.1									
14.2.17	121	Canis lupus	N	49	04	08.8	9,5	11,0		x			from 320 to 140	J7	
			E	19	09	06.9									
14.2.17	121 A	Canis lupus	N	49	04	8.2	9,0	10,5		x			from 320 to 140	J7	
			E	19	09	5.0									

14.2.17	122	Canis lupus	N	49	04	14.3	8,5	9,5		x			from 240 to 120	I7	
			E	19	08	36.6									
14.2.17	123	Ursus arctos	N	48	59	27.9	15,0				X			J11	
			E	19	08	16.1									
14.2.17	124	Ursus arctos	N	48	58	46.9	18,5				X		270 - 110	I11	on ridge
			E	19	07	39.7									
14.2.17	125	Ursus arctos	N	48	58	45.7	19,0				X		266 - 120	I11	along trail
			E	19	06	41.1									
14.2.17	126	Canis lupus	N	48	58	34.9	10,0			X	X		170 - 60	I11	near brook
			E	19	07	38.3									
14.2.17	127	Ursus arctos	N	48	58	42.0	17,0				X		48 - 220	J11	on trail
			E	19	08	43109,00									
15.2.17	128	Canis lupus	N	49	02	38.4	13,0	12,5			x		159/179	J8	
			E	19	09	21.4									
15.2.17	129	Canis lupus	N	49	03	o2.5	9,5	11,5			x		188/191	J8	
			E	19	09	o9.2									
15.2.17	130	Lynx lynx	N	48	57	37.5	9,0				X		270 - 36	J12	
			E	19	08	34.6									
15.2.17	131	Ursus arctos	N	48	58	16.3	15,0				X		243 - 327	J12	
			E	19	09	08.1									
15.2.17	131 A	Ursus arctos	N	48	58	19.0	11,0			X			245 - 66	J12	maybe two small ones
			E	19	09	06.9									
15.2.17	132	Ursus arctos	N	49	03	57.6	14,0			x			From 017 to 189	J7	crossed trail
			E	19	10	10.1									
15.2.17	133	Ursus arctos	N	49	03	37.4	12,0			x			From 70 to 260	J8	crossed trail
			E	19	10	28.6									
15.2.17	134	Ursus arctos	N	49	03	20.9	16,0			x			From 100 to 180	K8	crossed trail
			E	19	11	13.7									
15.2.17	135	Ursus arctos	N	49	03	15.3	18,0				x		From 309 to 120	K8	on trail
			E	19	11	16.8									
15.2.17	136	Ursus arctos	N	49	03	15.3	16,0			x			From 309 to 120	K8	on trail
			E	19	11	16.8									
15.2.17	137	Ursus arctos	N	49	03	4.6	20,0			x			From 320 to 240	K8	crossed trail and ascended hill
			E	19	10	53.9									
15.2.17	138	Ursus arctos	N	49	02	50.2	18,0			x			From 330 to 240	K8	followed bear from top of mountain
			E	19	10	40.9									
16.2.17	139	Lynx lynx	N	48	57	44.7	8,0	9,5			x		18o to 0	J12	On road
			E	19	08	21.9									
16.2.17	140	Ursus arctos	N	48	58	1o.7	13,0	22,0	x				6 to 108	J12	On road and departed towards river
			E	19	08	2o.7									
2	141	Ursus	N	48	58	13.o	16,0	24,0		x			To 76	J12	Departed road and

		arctos	E	19	08	21.5									walked towards river
16.2.17	142	Ursus arctos	N	49	05	36.9	14,0			x			90 to 270	I6	On trail next to ski slope.
			E	19	08	33.4									
16.2.17	143	Ursus arctos	N	48	57	27.4	15,0			X			158 - 355	J12	
			E	19	08	38.4									
16.2.17	144	Ursus arctos	N	48	57	26.9	11,0				X		158 - 355	J12	
			E	19	08	07.9									
16.2.17	145	Ursus arctos	N	48	57	54.8	15,0				X		333 - 73	I12	
			E	19	07	17.1									
16.2.17	146	Ursus arctos	N	48	58	43.7	18,0				X		76 - 321	I11	
			E	19	06	57.2									
16.2.17	147	Canis lupus	N	49	02	05.1	9,5	9,5			x			J9	
			E	19	09	11.6									
16.2.17	148	Ursus arctos	N	49	06	28.9	16,0				x		230/55	J10	
			E	19	08	59.1									
16.2.17	149	Ursus arctos	N	49	00	06.6	18,0				x		to 180	J10	
			E	19	10	00.6									
16.2.17	150	Lynx lynx	N	49	00	42.4	9,5			x			188/322	I10	Followed path 1OO metres
			E	19	07	56.8									
16.2.17	151	Aquila chrysaetos	N	49	00	11.39								J10	observation
			E	19	07	44.10									
17.2.17	152	Ursus arctos	N	49	02	58.o	15,0	24,0		x			0 degrees from South to North	J8	
			E	19	08	36.o									
17.2.17	153	Ursus arctos	N	49	03	2.9	17,0	24,0		x			towards 200	I8	At the location of the deer carcasse in front of the hunter hide
			E	19	08	1.9									
17.2.17	154	Ursus arctos	N	49	03	3.5	15,0				x		towards 170	I8	
			E	19	07	52.7									
17.2.17	155	Ursus arctos	N	49	02	54.8	16,0	26,0		x			towards 20	J8	
			E	19	08	35.4									
17.2.17	156	Canis lupus	N	49	02	49.0	10,0	13,0			x		from 60 to 288	J8	
			E	19	08	48.0									
17.2.17	157	Canis lupus	N	49	02	45.1	8,5	14,0		x			went down into the woods	J8	
			E	19	08	47.1									
17.2.17	158	Ursus arctos	N	49	02	42.7	14,0			x			160 following transect	J8	
			E	19	08	39.o									
17.2.17	159	Felis silvestris	N	49	02	42.0	4,0	5,0		x			towards 2 degrees	J8	
			E	19	08	42.3									
17.2.17	160	Ursus arctos	N	49	02	41.5	17,0	27,0			x		towards 240	I8	
			E	19	08	28.2									
17.2.17	161	Lynx lynx	N	49	04	15.0	8,0	10,0	x				326 to 132	I7	
			E	19	08	15.3									

17.2.17	162	Ursus arctos	N	49	04	25.6	17,0	27,0		x			244 to 91	I7	
			E	19	08	01,9									
17.2.17	163	Canis lupus	N	49	04	27.3	9,0	13,0		x			275 to 128	I7	
			E	19	07	37.5									
17.2.17	164	Canis lupus	N	49	04	27.3	9,0	13,0		x			275 to 128	I7	
			E	19	07	37.5									
17.2.17	165	Lynx lynx	N	49	01	29.3	9,5				X		everywhere	J9	Near red deer carcass killed by wolves last week.
			E	19	08	22.3									
17.2.17	166	Canis lupus	N	49	01	2O.9	9,5				X		211 to 324	J9	Crossed trail.
			E	19	08	7.7									
17.2.17	167	Ursus arctos	N	49	01	27.4	16,0				X		206 to 296	I9	Crossed trail.
			E	19	08	14.4									
17.2.17	168	Canis lupus	N	49	01	23.1	11,0				X		295 to 125	I9	Wolf print inside older bear print.
			E	19	04	13.3									
17.2.17	169	Ursus arctos	N	49	01	21.6	18,0				X		80 to 280	I9	Walked on our tracks from last week: on trail.
			E	19	07	56.1									
17.2.17	170	Canis lupus	N	49	01	49.2	10,0				X		286 to 20	I9	Crossed trail.
			E	19	07	33.2									
17.2.17	171	Canis lupus	N	49	01	58.1	10,0				X		110 to 300	I9	On trail, probably made last week. At least two wolves.
			E	19	07	38.3									

Table 7. Summary of DNA samples collected.

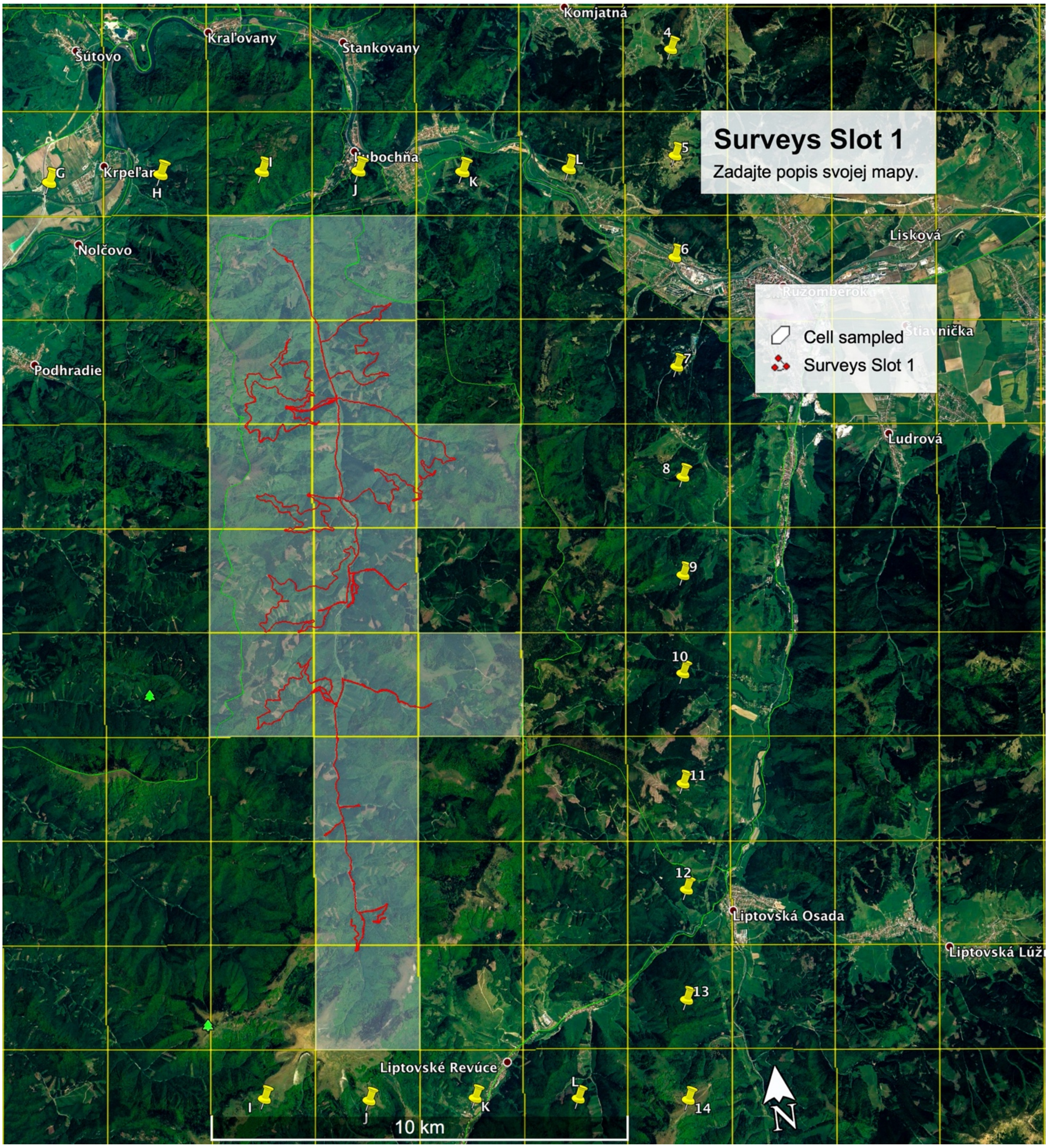
10F	07.02.2016	N49	04 09	09.7 4.7	J7	*Canis lupus*	urine
055	08.02.2016	N49 E19	03 11	13.3 09.	K8	*Ursus arctos*	scat
066A	09.02.2016	N48 E19	58 08	55.1 40.7	J11	*Lynx lynx*	urine
066B	08.02.2016	N48 E19	58 08	55.25 40.7	J11	*Lynx lynx*	urine
094A	10.02.2016	N49 E19	00 08	14.0 29.1	J10	*Ursus arctos*	scat
096B	10.02.2016	N49 E19	00 08	30.00 55.5	J10	*Canis lupus*	urine
112	10.02.2016	N49 E19	01 09	43.2 04.4	J9	*Canis lupus*	scat
116A	14.02.2016	N49 E19	00 08	29.94 55.36	J10	*Canis lupus*	urine

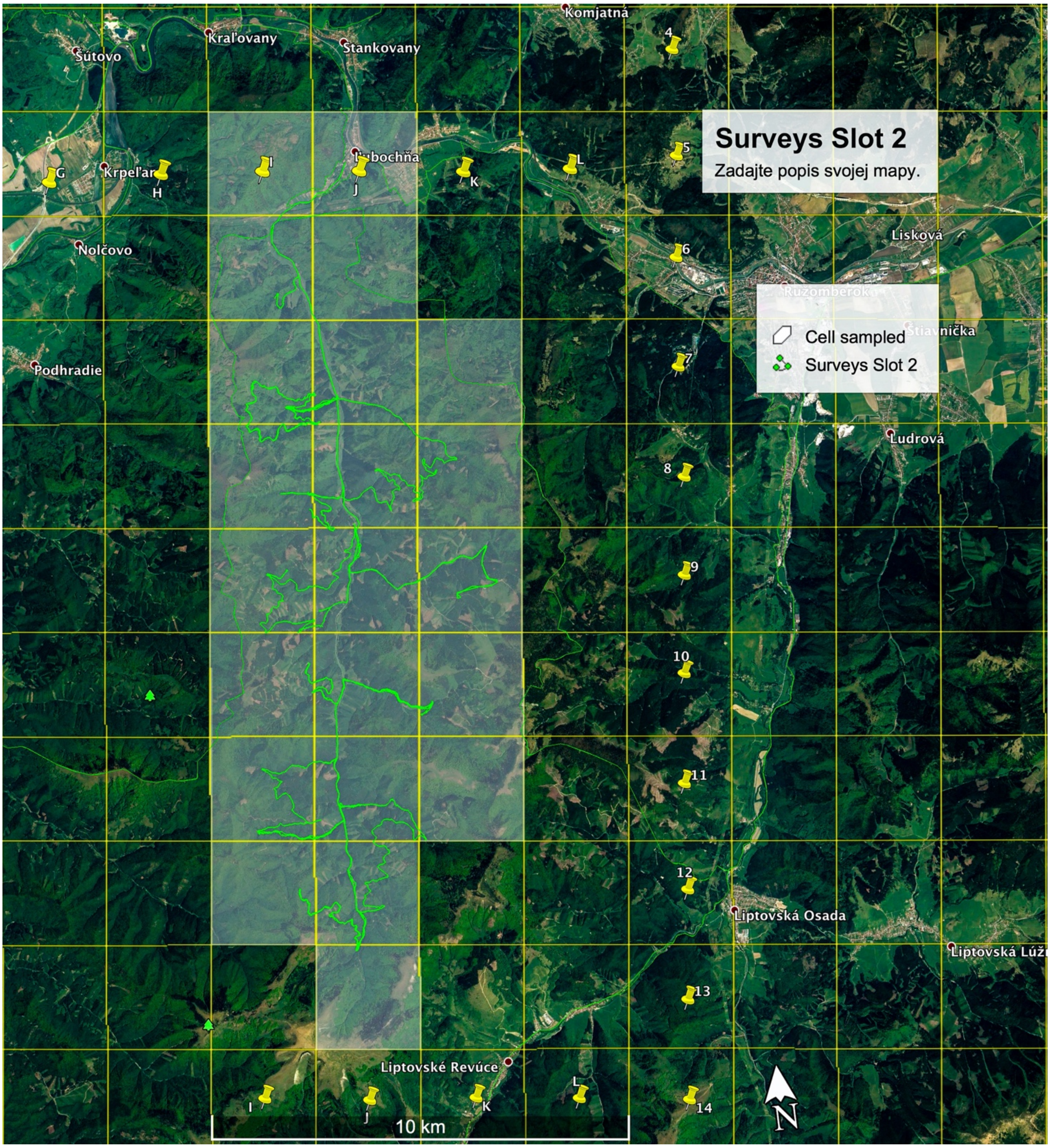
Table 8. Camera trap location, species recorded and time of activity.

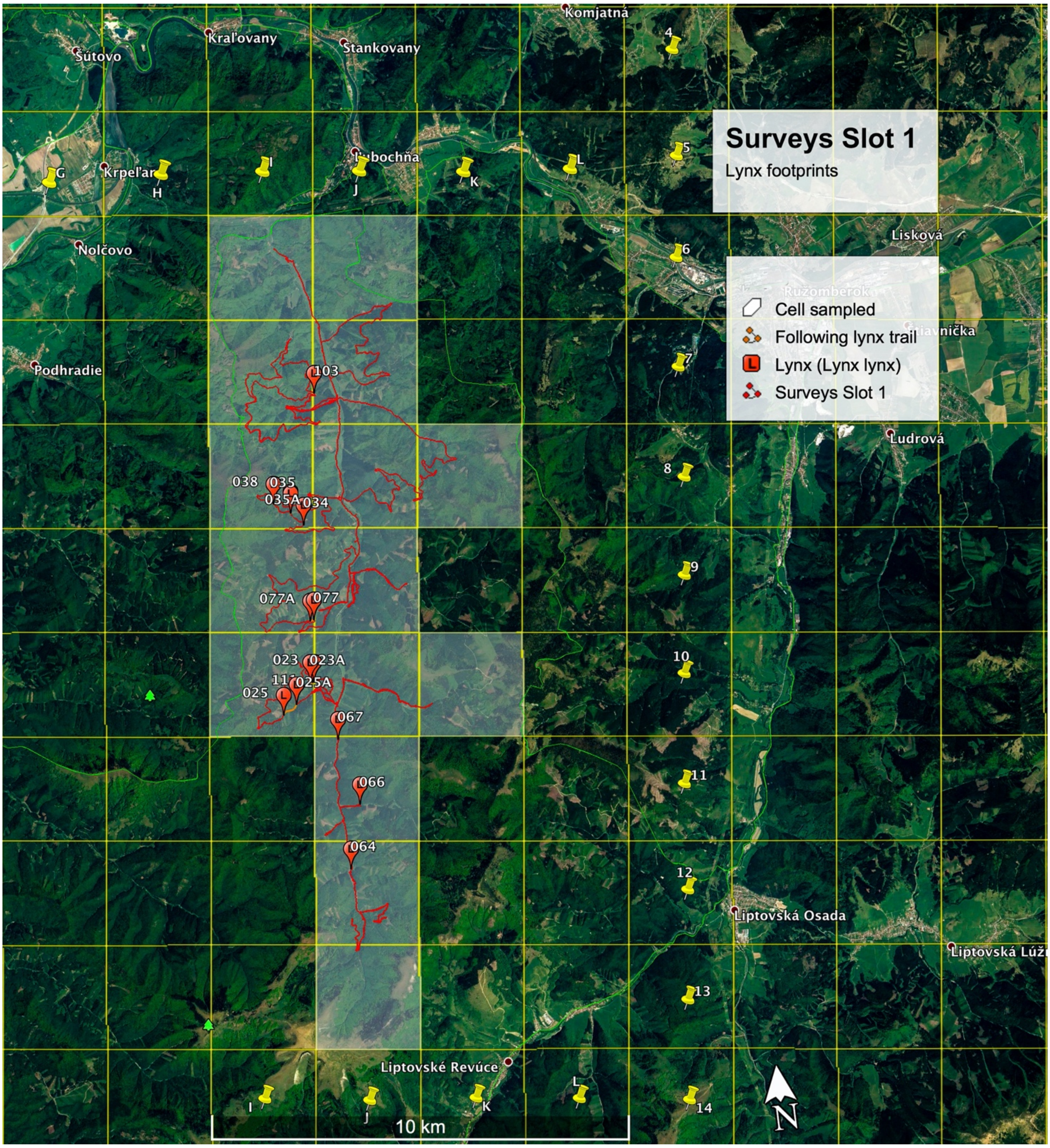
No.	Name	GPS position			Cell	Species recorded	Placed on	Recovered on	Number of photos	Trap nights
		deg	min	sec						
CT1	Above chalet	N49 E19	01 09	39,47 03,32	J9	*Cervus elaphus, Vulpes vulpes, Felis silvestris, Sciurus vulgaris*	04.02.2017	17.02.2017	60	13
CT2	Opposite foresters house	N49 E19	01 08	29,30 55,91	J9	*Martes martes, Canis lupus, Cervus elaphus, Sciurus vulgaris,*	04.02.2017	17.02.2017	39	13
CT3	Blatna lake road	N49 E19	00 09	06,57 44,55	J10	*Cervus elaphus, Vulpes vulpes, Martes martes*	06.02.2017	17.02.2017	99	11
CT4	Blatna waterfall	N48 E19	59 10	57,01 01,21	J10	*Canis lupus, Vulpes vulpes*	06.02.2017	17.02.2017	71	11
CT5	Lynx marking tree	N49 E19	00 08	34,46 03,07	I10	*Cervus elaphus, Lynx lynx, Vulpes vulpes, Martes martes, Canis lupus*	07.02.2017	16.02.2017	203	10
CT6	Bear marking tree	N49 E19	00 08	51,08 01,88	I10	*Vulpes vulpes, Cervus elaphus*	07.02.2017	16.02.2017	166	10
CT7	Turecka feeding station	N48 E19	04 09	09,14 05,00	J7	*Cervus elaphus, Sciurus vulgaris*	07.02.2017	14.02.2017	126	7
CT8	Turecka 01	N49 E19	04 08	05,09 31,27	I7	*Sus scrofa, Capreolus capreolus*	07.02.2017	14.02.2017	27	7
CT9	Turecka 02	N49 E19	04 07	27,93 50,24	I7	-	07.02.2017	14.02.2017	1551	7
CT10	Turecka 03	N49 E19	03 08	55,14 49,76	J7	*Vulpes vulpes, Sciurus vulgaris*	07.02.2017	17.02.2017	150	10
CT11	Bear dancing	N49 E19	03 10	05,34 15,05	J8	-	08.02.2017	15.02.2017	4	7
CT12	Bear crossing	N49 E19	03 11	12,91 25,24	K8	*Vulpes vulpes*	08.02.2017	15.02.2017	724	7
CT13	End of valley	N48 E19	57 08	27,35 27,12	J12	*Vulpes vulpes*	08.02.2017	16.02.2017	798	8
CT14	Lipova	N49 E19	01 07	39,98 40,49	I9	*Martes martes*	09.02.2017	17.02.2017	17	8
CT15	Rakytov lynx	N48 E19	58 08	55,51 41,00	J11	*Vulpes vulpes, Martes martes*	09.02.2017	15.02.2017	48	7
CT16	Wolf carcass	N49 E19	01 08	29,67 22,28	J9	-	10.02.2017	17.02.2017	19	7
CT17	Turecka crossroads	N49 E19	04 08	07,86 13,81	I7	-	10.02.2017	14.02.2017	30	3
CT18	Turecka upper crossroads	N49 E19	04 08	17,47 47,33	J7	*Vulpes vulpes*	10.02.2017	17.02.2017	28	7

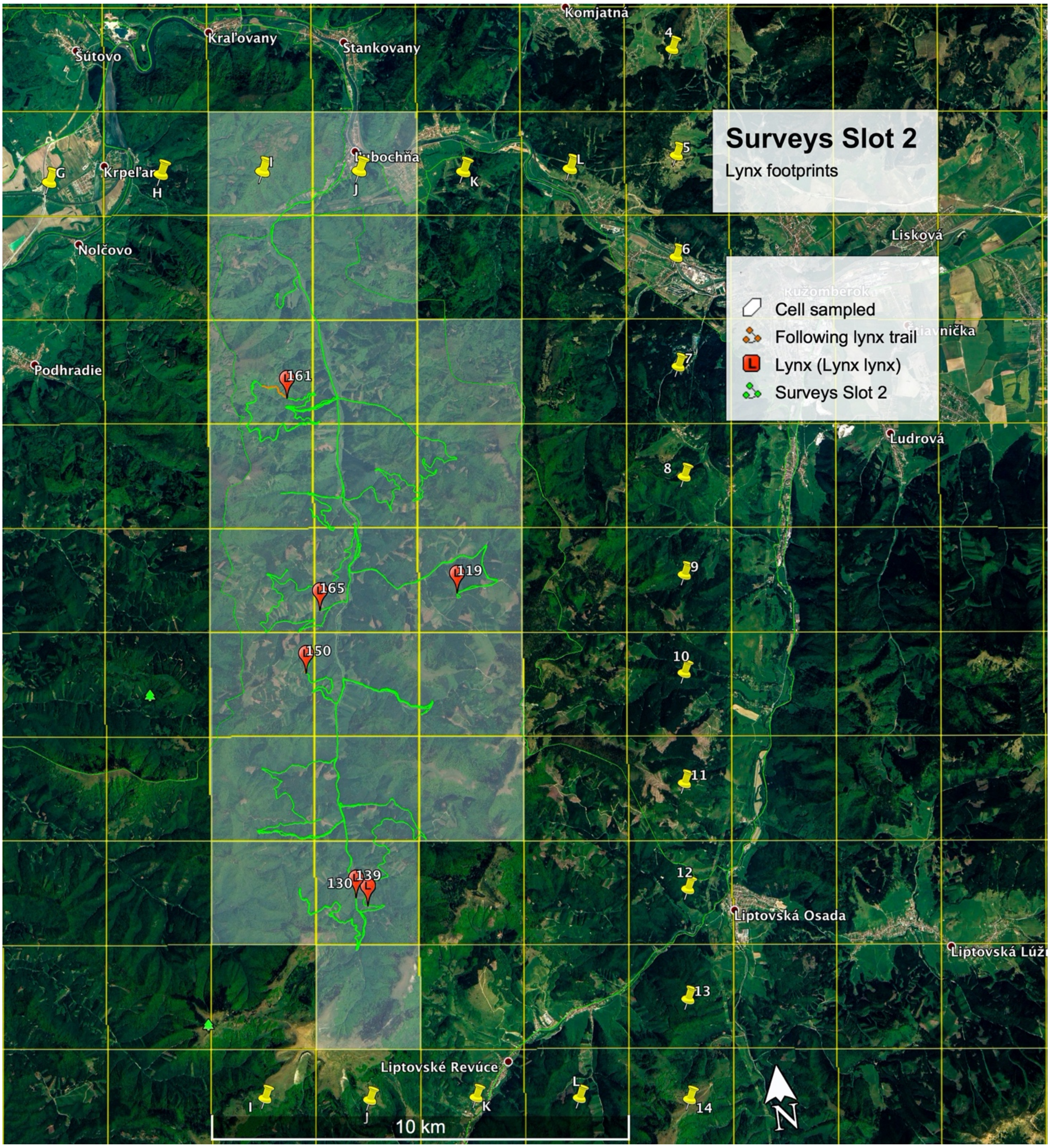
MAPS

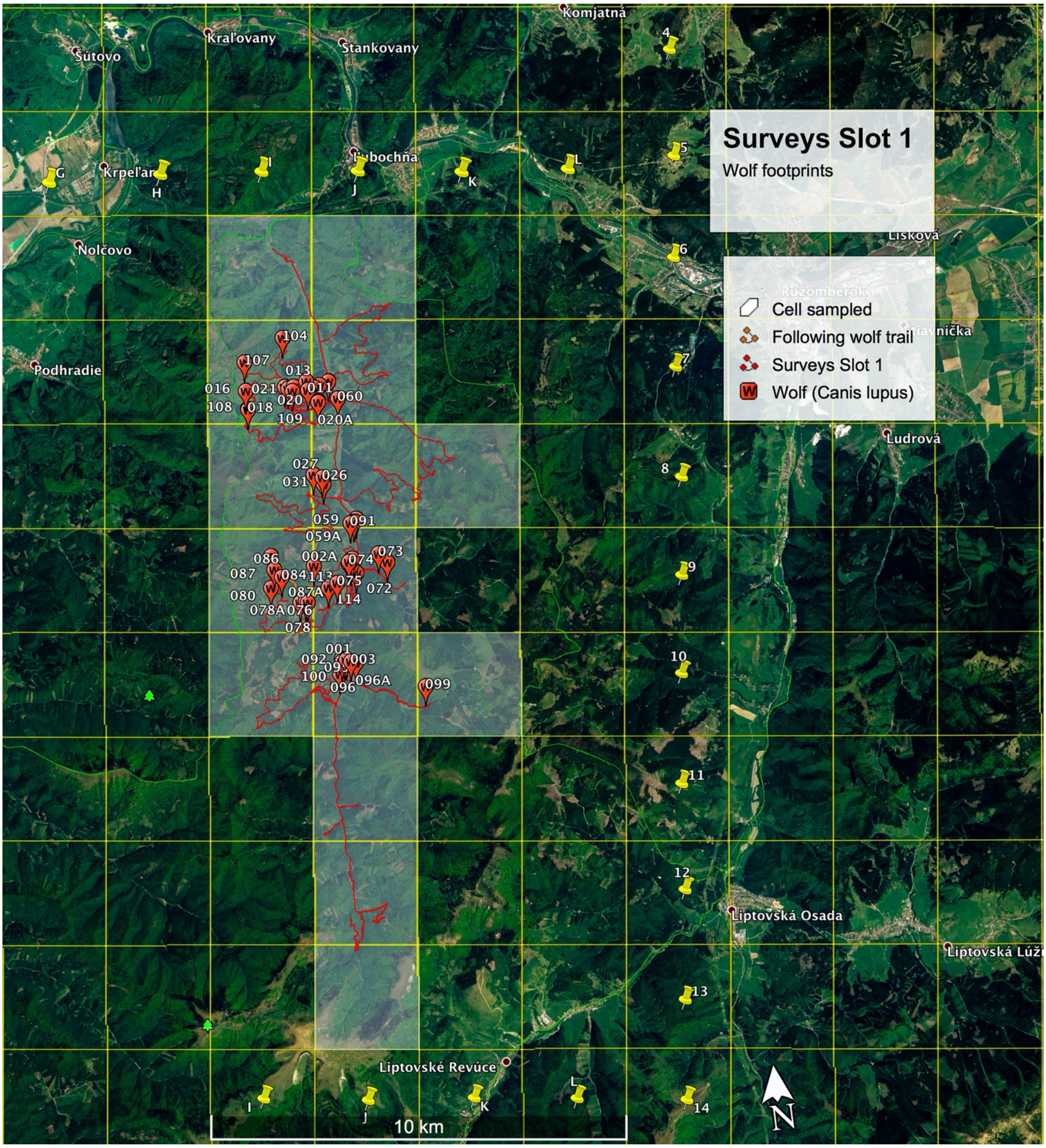
for explanation see white box on each map

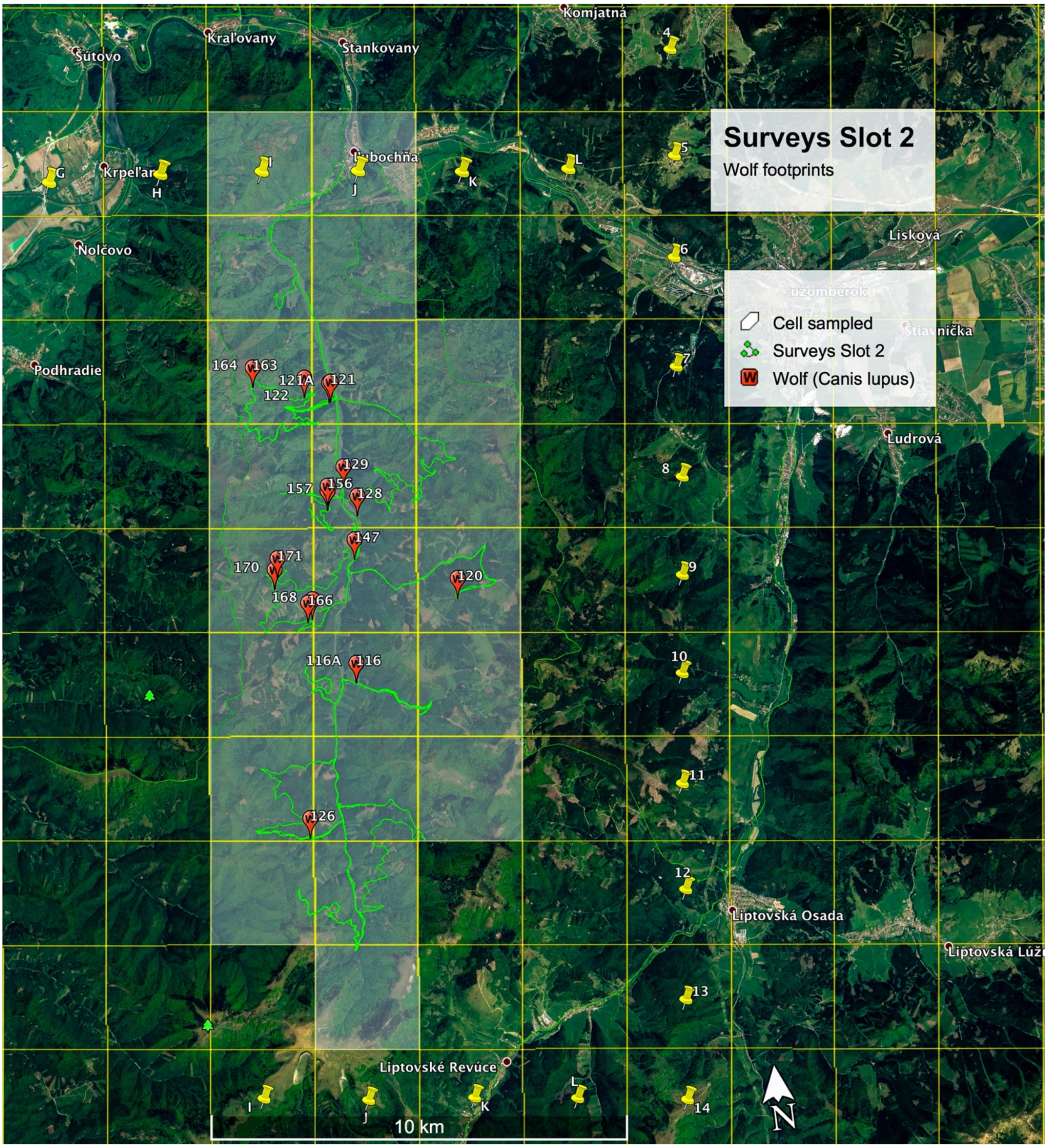


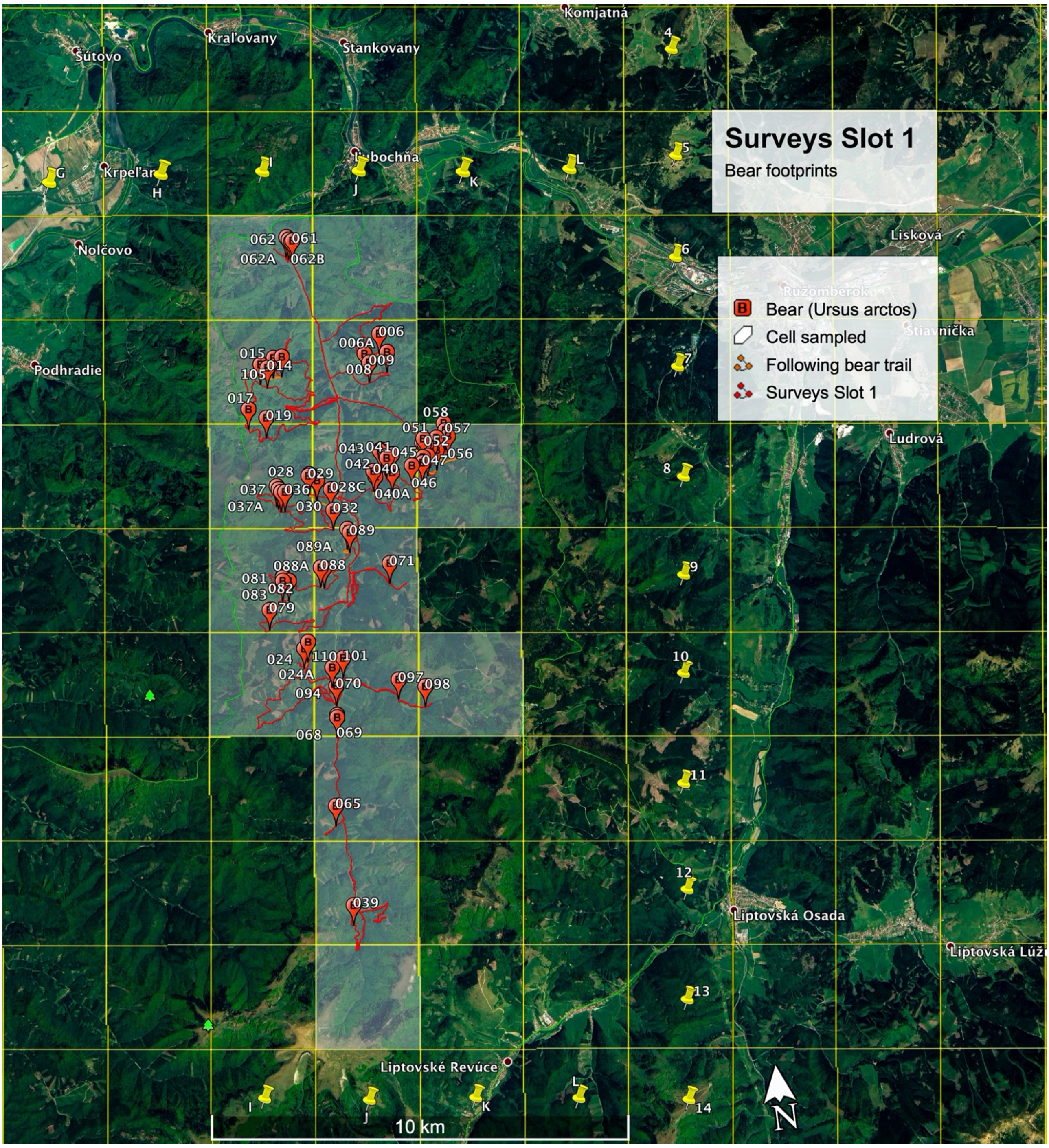

Surveys Slot 2
Zadajte popis svojej mapy.
Cell sampled
Surveys Slot 2
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Lisková
Ružomberok
Štiavnička
Podhradie
Ľudrová
Liptovská Osada
Liptovská Lúžna
Liptovské Revúce
10 km
N

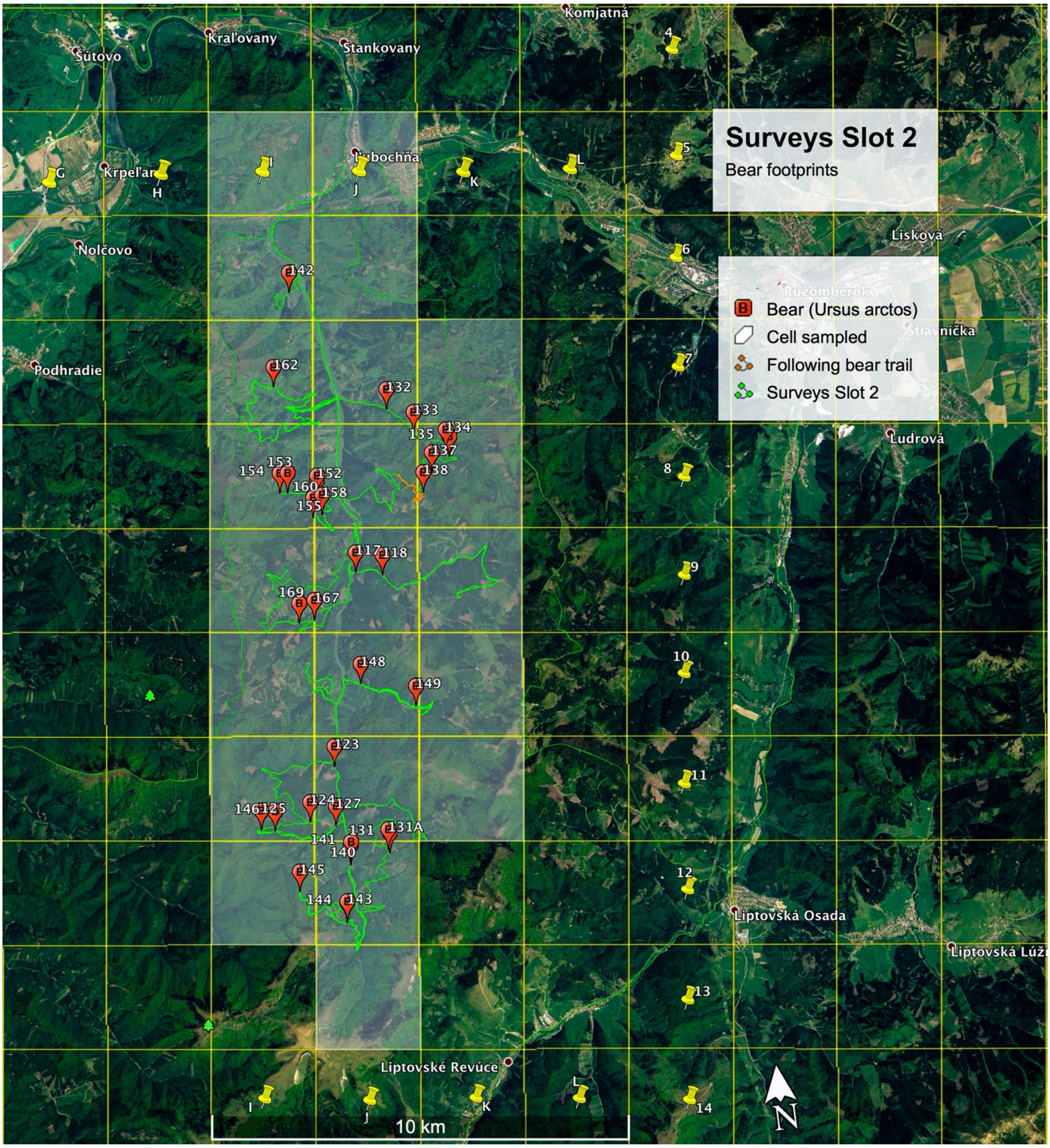

Surveys Slot 1
Lynx footprints
Cell sampled
Following lynx trail
Lynx (Lynx lynx)
Surveys Slot 1
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Lisková
Ružomberok
Podhradie
Ludrová
Liptovská Osada
Liptovská Lúžna
Liptovské Revúce
10 km
N

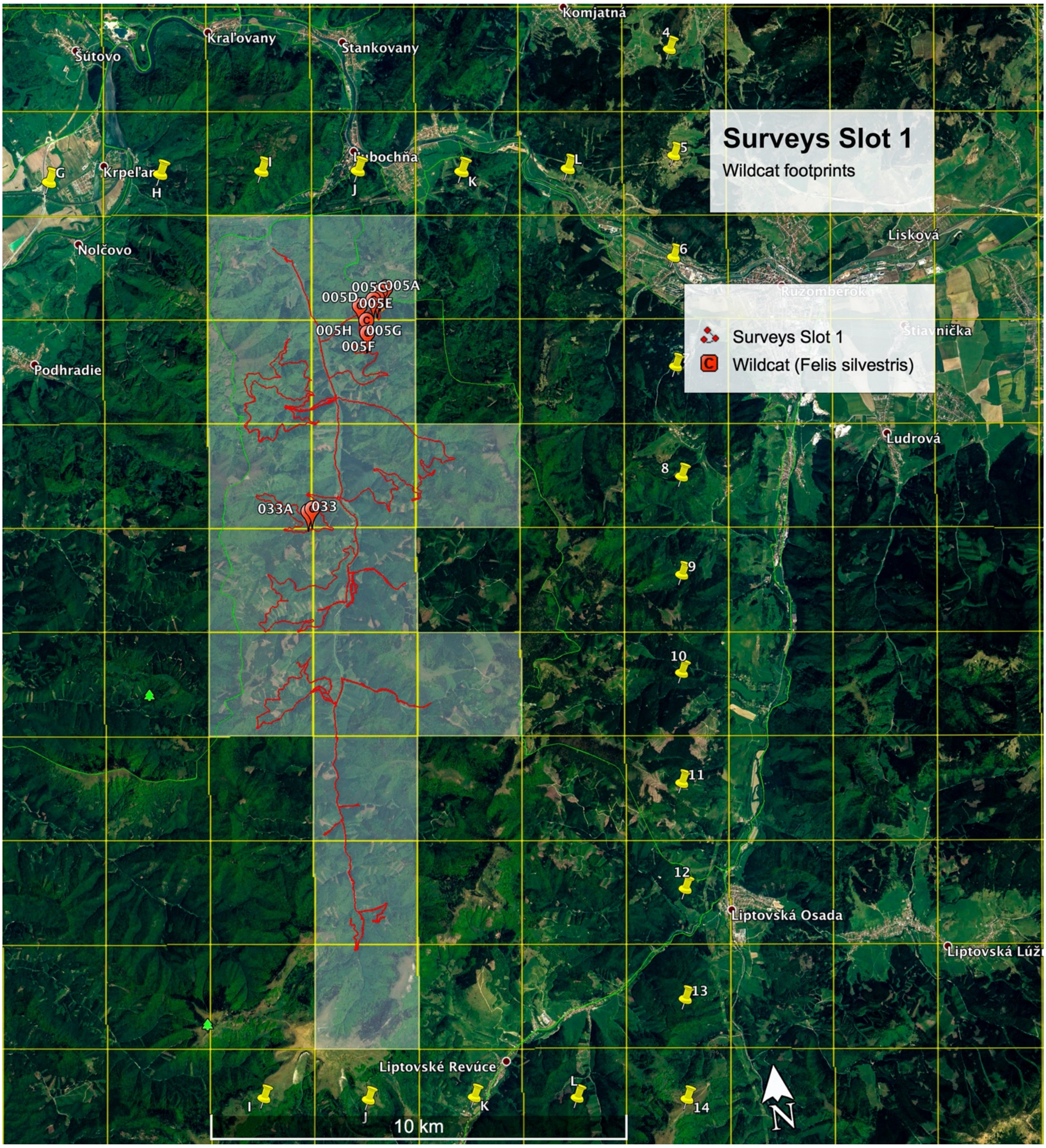

Surveys Slot 2
Lynx footprints
Cell sampled
Following lynx trail
Lynx (Lynx lynx)
Surveys Slot 2
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Lisková
Ružomberok
Podhradie
Ludrová
Liptovská Osada
Liptovská Lúž
Liptovské Revúce
161
165
119
150
130
139
10 km

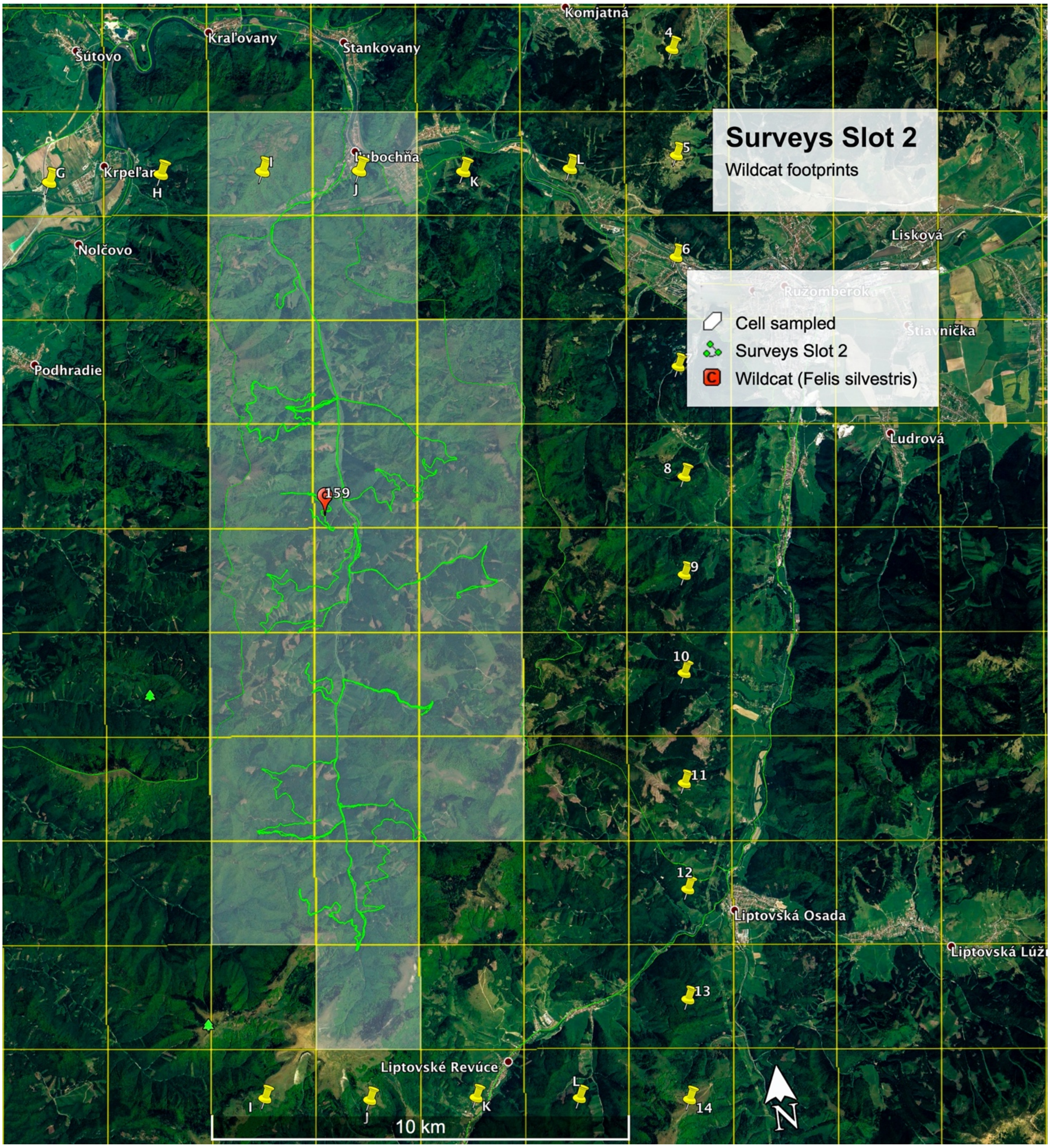

Surveys Slot 1
Wolf footprints
Cell sampled
Following wolf trail
Surveys Slot 1
Wolf (Canis lupus)
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Podhradie
Lisková
Ružomberok
Liptovská Osada
Liptovská Lúž
Liptovské Revúce
Ludrová
10 km
N


Surveys Slot 2
Wolf footprints
Cell sampled
Surveys Slot 2
Wolf (Canis lupus)
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Nolčovo
Podhradie
Lisková
Stiavnička
Ludrová
Liptovská Osada
Liptovská Lúž
Liptovské Revúce
10 km
N

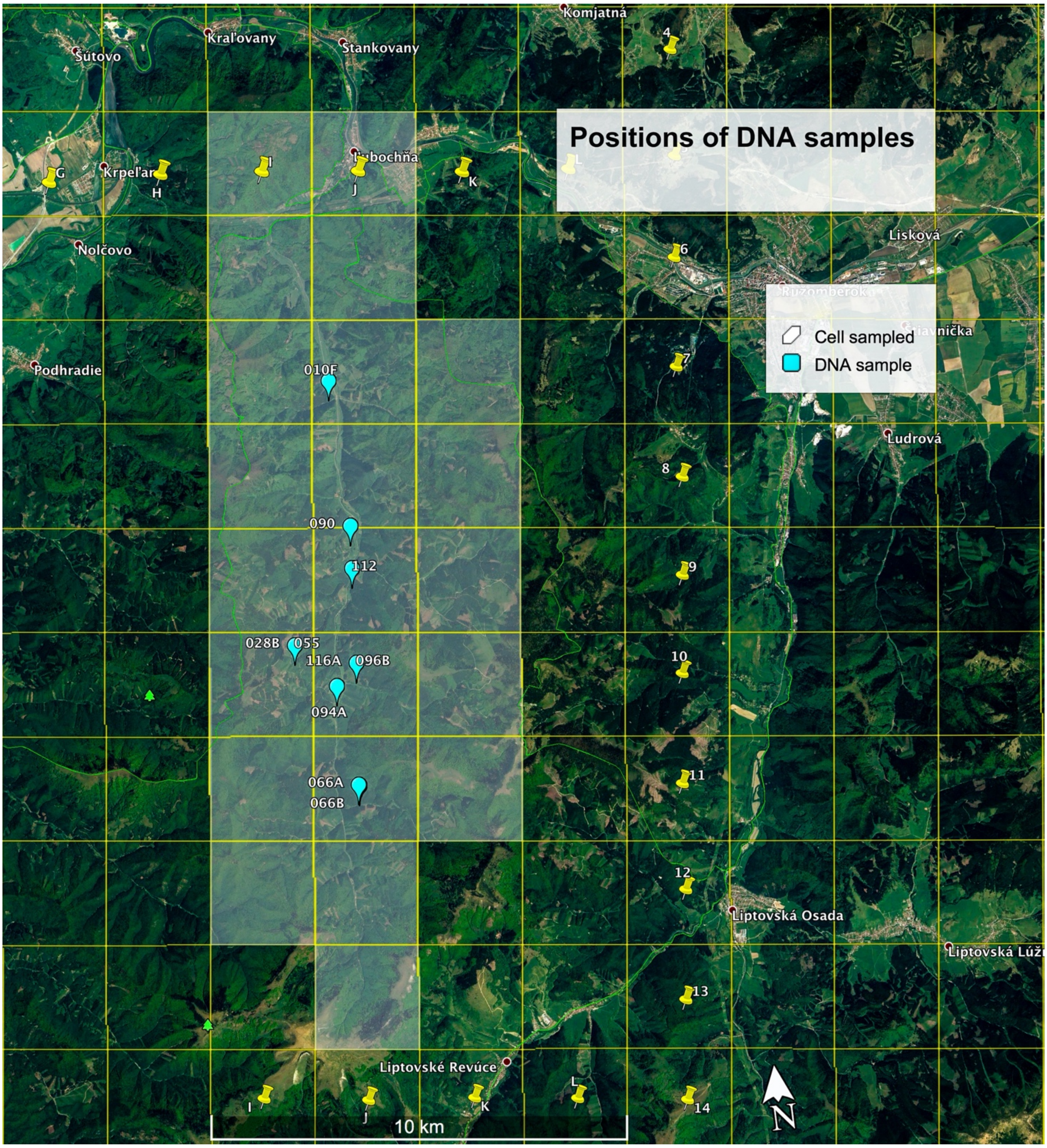

Surveys Slot 1
Bear footprints
Bear (Ursus arctos)
Cell sampled
Following bear trail
Surveys Slot 1
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Podhradie
Lisková
Ružomberok
Stiavnička
Ludrová
Liptovská Osada
Liptovská Lúž
Liptovské Revúce
10 km
N

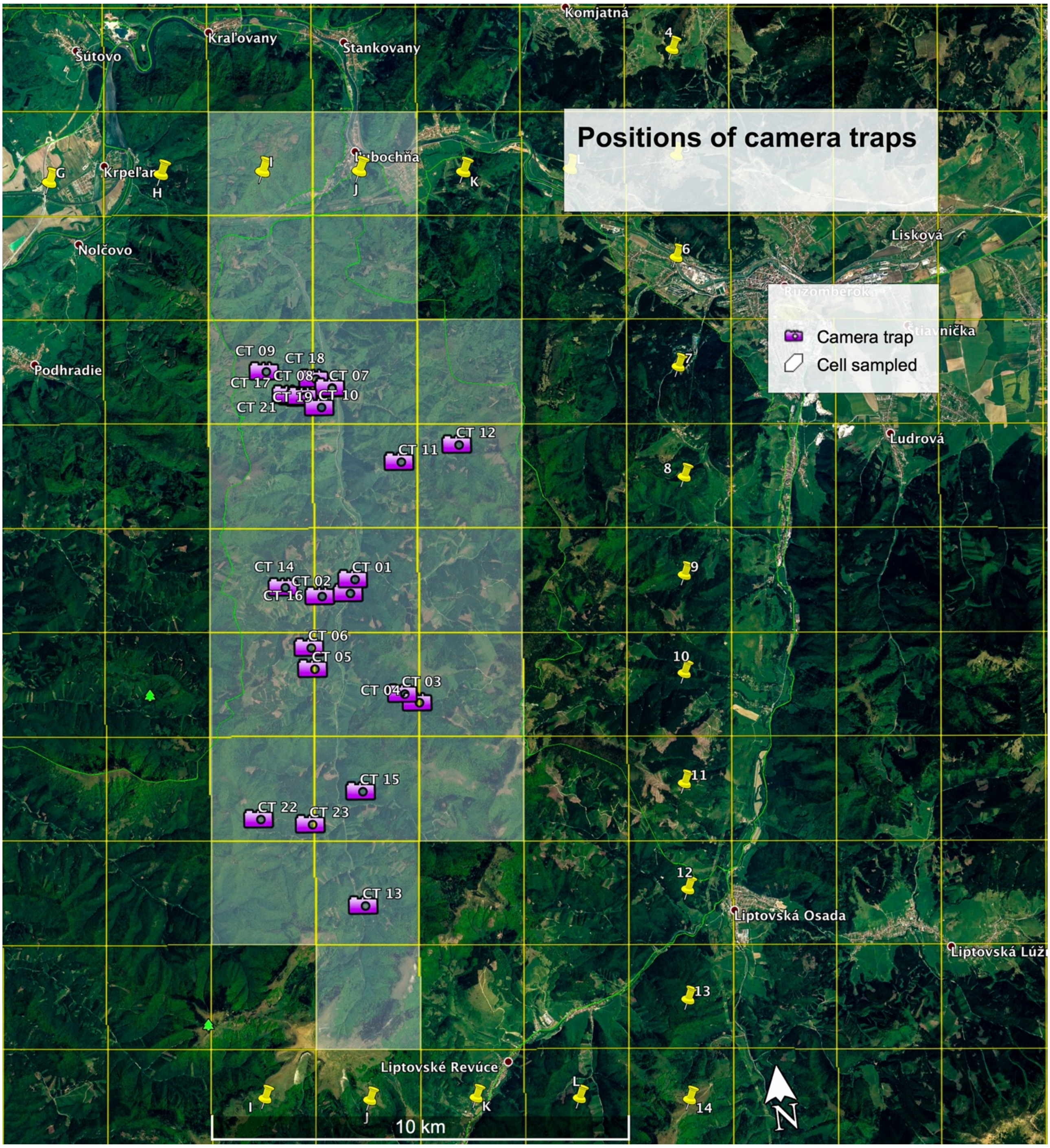

Surveys Slot 2
Bear footprints
Bear (Ursus arctos)
Cell sampled
Following bear trail
Surveys Slot 2
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Nolčovo
Podhradie
Lisková
Ružomberok
Štiavnička
Ľudrová
Liptovská Osada
Liptovská Lúžna
Liptovské Revúce
10 km
N


Surveys Slot 1
Wildcat footprints
Surveys Slot 1
Wildcat (Felis silvestris)
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Ľubochňa
Nolčovo
Podhradie
Lisková
Ružomberok
Štiavnička
Ludrová
Liptovská Osada
Liptovská Lúžna
Liptovské Revúce
005A
005C
005D
005E
005H
005G
005F
033A
033
10 km
N



Surveys Slot 2
Wildcat footprints
Cell sampled
Surveys Slot 2
Wildcat (Felis silvestris)
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Nolčovo
Podhradie
Lisková
Ružomberok
Štiavnička
Ľudrová
Liptovská Osada
Liptovská Revúce
159
10 km
N


Positions of DNA samples
Cell sampled
DNA sample
Komjatná
Kraľovany
Stankovany
Šútovo
Ľubochňa
Krpeľany
Nolčovo
Podhradie
Lisková
Ružomberok
Ludrová
Liptovská Osada
Liptovské Revúce
010F
090
112
028B
055
116A
096B
094A
066A
066B
G
H
I
J
K
L
4
6
7
8
9
10
11
12
13
14
10 km
N


Positions of camera traps
Camera trap
Cell sampled
Komjatná
Kraľovany
Stankovany
Šútovo
Krpeľany
Nolčovo
Podhradie
Lisková
Ružomberok
Štiavnička
Ludrová
Liptovská Osada
Liptovská Lúž
Liptovské Revúce
CT 01
CT 02
CT 03
CT 04
CT 05
CT 06
CT 07
CT 08
CT 09
CT 10
CT 11
CT 12
CT 13
CT 14
CT 15
CT 16
CT 17
CT 18
CT 19
CT 21
CT 22
CT 23
10 km
N

CAMERA TRAP PHOTOS

CT01 Above chalet: wildcat (*Felis silvestris*), fox (*Vulpes vulpes*), red deer (*Cervus elaphus)*

CT02 Opposite foresters house: wolf (*Canis lupus*), 2x red deer – male, female (*Cervus elaphus*)

CT03 Blatna lake road: pine martin (*Martes martes*), 2x fox (*Vulpes vulpes*)

CT04 Blatna waterfall: 2x wolf (*Canis lupus*), fox (*Vulpes vulpes*)

CT05 Lynx marking tree: wolf *(Canis lupus),* lynx (*Lynx lynx*), red deer (*Cervus elaphus*)

CT06 Bear marking tree: 2x red deer (*Cervus elaphus*), fox (*Vulpes vulpes*)

CT08 Turecka 01: wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), CT10 Turecka 03: fox (*Vulpes vulpes*)

CT12 Bear crossing: fox (*Vulpes vulpes*), CT13 End of valley: fox (*Vulpes vulpes*), CT14 Lipova: pine martin (*Martes martes*)

CT15 Rakytov lynx: fox (*Vulpes vulpes*), CT 18 Turecka upper crossroads: fox (*Vulpes vulpes*), CT21 Turecka05: fox (*Vulpes vulpes*)


CT21 Turecka05: lynx (Lynx lynx), 2x fox (*Vulpes vulpes*)



Appendix II: Expedition diary and reports

A multimedia expedition diary is available at https://biosphereexpeditions.wordpress.com/category/expedition-blogs/slovakia-2017/.

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