LIFE Lynx

Preventing the extinction of the Dinaric-SE Alpine lynx population through reinforcement and long-term conservation

LIFE16 NAT/SI/000634

Monitoring of Eurasian Lynx (*Lynx lynx*) in the Vepor Mountains and its importance for the national and European management and species conservation

Action A.1 - Assessment and Selection of Sites and Lynx for Live-capture from the Carpathian Source Population in Slovakia

Jakub Kubala, Nuno Filipe Guimarães, Jaroslav Brndiar, Tomáš Iľko, Mirko Krajči, Ľubomír Ferlica, Tibor Pataky, Peter Klinga, Peter Smolko, Branislav Tám and Rudolf Kropil

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Monitoring of Eurasian Lynx (*Lynx lynx)* in the Vepor Mountains and its importance for the national and European management and species conservation.

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Authors:

Jakub Kubala – Technical university in Zvolen, Zvolen, Slovakia

Nuno Filipe Guimarães – Matej Bel University – Banská Bystrica, Slovakia

Jaroslav Brndiar – Technical university in Zvolen, Zvolen, Slovakia

Tomáš Iľko – State Nature Conservancy of the Slovak Republic, Revúca, Slovakia

Mirko Krajči – State Nature Conservancy of the Slovak Republic, Rimavská Sobota, Slovakia

Ľubomír Ferlica – Technical university in Zvolen, Zvolen, Slovakia

Tibor Pataky – Technical university in Zvolen, Zvolen, Slovakia

Peter Klinga – Technical university in Zvolen, Zvolen, Slovakia

Peter Smolko – University of Alberta – Edmonton, Canada

Branislav Tám – Bojnice National Zoo, Bojnice, Slovakia

Rudolf Kropil – Technical university in Zvolen, Zvolen, Slovakia

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JAKUB KUBALA, NUNO FILIPE GUIMARÃES, TOMÁŠ IĽKO, PETER KLINGA, PETER SMOLKO, BRANISLAV TÁM AND RUDOLF KROPIL

Over the past few centuries, many large carnivores populations, including the Eurasian lynx (*Lynx lynx*), decreased dramatically worldwide (Chapron *et al.* 2014). In Europe, from the beginning of the historical era, the lynx extinction was mainly a result of the direct and indirect impacts from anthropogenic activities (Wilson 2018). Within the end of the 18th century, the lynx was widespread only in the Alps, Balkans (up to Greece), Carpathian Mountains, all Eastern Europe, Baltic and Scandinavia (Breitenmoser & Breitenmoser-Würsten 2008). In the middle of the 20th century, the range of the species was minimal, being total extinct throughout the Western Europe (Kratochvíl 1968 a, b), with just four preserved populations: Balkan, Baltic, Carpathian and Scandinavian (Breitenmoser & Beitenmoser-Würsten 1990, 2008, von Arx *et al.* 2009). Around 1950, the decrease of the population stopped mainly because of the legal protection and controlled hunting measures implemented. During the 1970's and 1980's, Carpathian lynx population achieved a positive status of conservation, allowing the realisation of reintroduction programs, with animals from its population, in the Western and Central Europe (Breitenmoser & Breitenmoser-Würsten 2008, Linnell *et al.* 2009, von Arx *et al.* 2009; Fig. 1). These programs included the translocation of approximately 172 to 177 lynx into 15 different regions from 8 countries (Linnell *et al.* 2009, von Arx *et al.* 2009). From all translocated animals, 57% were from Slovak Carpathians and 40% were individuals born in captivity from several locations. The origin of the remaining animals, equivalent to 3%, is unknown (von Arx *et al.* 2009). The choice on the Carpathian lynx population as the source population for these programs was based on its positive status and the geographic proximity to the historical range within the Western and Central Europe (Breitenmoser & Breitenmoser-Würsten 2008, von Arx *et al.* 2009).

The Carpathian Lynx population is nowadays considered as one of the biggest and most preserved in Europe (Kaczensky *et al.* 2013, Kubala *et al.* 2017, 2019), with a population estimated between 2,300 and 2,400 individuals (Kaczensky *et al.* 2013, Boitani *et al.* 2015). Lynx population range covers almost whole Carpathian Mountains and extends further to

Serbia and Bulgaria. Although, the Carpathian lynx population is mainly distributed in Romania and Slovakia, giving therefore a special responsibility to these two countries in the conservation of the overall population (von Arx et al. 2004, Kaczensky et al. 2013, Boitani et al. 2015). The lynx population is autochthonous in the Slovak Carpathians probably since Pleistocene. Osteological findings from the Bronze Age in waste pits of human settlement in the Danube Lowland, supports the assumption of the historical distribution of lynx in the whole territory of Slovakia (Hell *et al*. 2004). Sources about the species, dating the Middle Ages, are absent. But from the 18th to 19th centuries, data is available from two smaller subpopulations in the central and partially western of Slovakia and from the northwest margin of the Eastern Carpathians (Hell & Slamečka 1996). The lowest estimates of the Slovak lynx population were recorded in the beginning of the 1930's, with an estimation of only 50 lynx (Hell 1968). However, within the following decades, Slovak lynx population began to recover (Hell & Slamečka 1996, Hell *et al.* 2004, Kubala *et al.* 2017) and this positive trend, allowed the implementation of several lynx reintroduction programs in the Western and Central Europe. With Slovakia lynx population being able to be the source population, the capture of animals for reintroduction occurred for almost three decades at a population level management, at the same time the species was also being legally hunted (Smolko & Kubala 2017, Smolko *et al.* 2018, Kubala *et al.* 2019; Fig. 1). The proportion of captured lynx oscillated between 10% to 18% from all annually hunted individuals (Hell & Slamečka 1996), showing that the reintroduction programs did not influence negatively upon the lynx demography within the source population (Hell *et al.* 2004, Zatroch 2014, Smolko & Kubala 2017, Smolko *et al.* 2018, Kubala *et al.* 2019). The official lynx reintroduction management programmes and cooperation among the forestry, hunting and conservancy communities within the Slovak Carpathians, it is regarded internationally as an excellent model for the sustainability of lynx in Europe. As a result, it was used as an example to many subsequent large carnivores' conservation programs (Breitenmoser & Breitenmoser-Würsten 2008, Smolko & Kubala 2017, Smolko *et al*. 2018, Wilson 2018, Kubala *et al.* 2019). From this programs, several reintroduced populations were prospering in the initial phase, but the positive trend has stopped and recently it is even being considered negative, mostly a result of inbreeding due to the low number and kinship of founding animals (Breitenmoser-Würsten & Obexer-Ruff 2003, 2015,

Skrbinšek *et al.* 2011, Sindičić *et al.* 2013, Boitani *et al.*, 2015). As an example, at the beginning of the 20th century, the lynx population in the Dinaric Mountains (currently Slovenia and Croatia) was extinct and the species did not occur in this region for almost 70 years. In 1973, a group of hunters and foresters translocated from Slovakia to Slovenia six lynx, releasing them in region of Kočevje on the 2nd of March (Wilson 2018, Wilson *et al.* 2019). After the reintroduction, lynx reproduced, the population increased and expanded, but there were no other populations in its vicinity and therefore they remained isolated. As a result, in the middle of the 1990's, the Dinaric population shrunken significantly, mainly due to genetic and health problems caused by the inbreeding (Skrbinšek *et al.* 2011, Sindičić *et al.* 2013, Boitani *et al.* 2015, Wilson 2018, Wilson *et al.* 2019). The long-term incidence of inbreeding, caused a reduction of the number of individuals as well as their reproductive success (Wilson *et al.* 2019). The lynx in Slovenia is currently estimated between 10 to 20 animals and 40 to 60 in Croatia (Boitani *et al.* 2015, Wilson *et al.* 2019). The actual trend of this population is to collapse until extinction (Wilson *et al.* 2019). Therefore, it is necessary to reinforce this reintroduced population with additional lynx and ensure its long-term sustainability within the Dinaric and South-eastern Alps, as well as in other with reintroduced populations (Breitenmoser 2011, Sindičić *et al.* 2013, Boitani *et al.* 2015).

Following the IUCN directions (International Union for Conservation of Nature), the source population must be monitored prior to any kind of intervention. At the same time, IUCN directions point that the population must be evaluated with the emphasis on the number of individual animals, population trend, genetic diversity and health status (von Arx et al. 2009, IUCN/SSC 2013, Smolko & Kubala 2017, Smolko *et al.* 2018, Wilson 2018, Kubala *et al.* 2019). Consequently, with this specific data, it is possible to evaluate whether the source population of the lynx, within an area of interest, corresponds to a "favourable status" as a species of European importance (Kropil 2005), and whether it is suitable to capture a limited number of individuals without any negative impacts on its population. Just then, with the confirmation of a "favourable status" of the species, it is possible to implement the capture of lynx targeting its reintroduction in the Central and Western Europe (Breitenmoser *et al.* 2000, Boitani *et al.* 2015). IUCN directions are in agreement with the goals of the Management Plan for the Eurasian Lynx (*Lynx lynx*) in Slovakia (hereafter referred as management plan; Antal *et al.*

2016), the aims Habitats Directive 92/43/EEC, from 21st of May 1992, on the conservation of natural habitats and of wild fauna and flora (hereafter “habitats directive“) and the Key Actions for Large Carnivore Populations in Europe (Boitani *et al.* 2015).

The Department of Applied Zoology and Game Management, part of the Faculty of Forestry from the Technical University in Zvolen (hereinafter referred to as TUZVO), started the implementation of the LIFE Lynx project "Preventing the Extinction of the Dinaric-SE Alpine Lynx Population Through Reinforcement and Long-term Conservation" (LIFE16 NAT/SI/000634). TUZVO cooperates in this project with the Ministry of Environment of the Slovak Republic (hereinafter referred to as MoE SR), the National Zoological Garden Bojnice (hereinafter referred to as National Zoo Bojnice) and partners from Slovenia, Croatia, Italy and Romania. The project aims to save the lynx population from extinction in the Dinaric Mountains and in the South-eastern Alps by improving the genetic diversity and the demographic outlook of this population by directly increasing the population viability through reinforcement to safeguard the population well into the 21st century. The project expects to reverse the decline of the Dinaric - South-eastern Alpine lynx population by reinforcing it with the release of animals from a viable source population from the Carpathian Mountains (Slovakia and Romania), in a way that the level of inbreeding can be reduced. Conservation management is established at a transboundary level across all EU countries, which share this population, in order to develop and implement a standardized and systematic approach to ensure long-term viability of the reinforced population. The reinforcement is a stakeholder-supported (hunters, foresters, nature conservation, livestock farmers, etc.) process to foster broad public acceptance at local, regional and national level. The long-term goal of the project is also the interconnection of reintroduced populations in the Dinaric mountains and Alps with the establishment of other population nucleus, known as lynx “stepping stone” (Wilson *et al.* 2019). For this purpose, in 2014, in the Italian Julian Alps, two lynx were released to join other animals that had migrate into the area, as a result of its reintroduction in the Dinaric mountains in the 80s and 90s.

Fig. 1 Štefan Zatroch and his old box trap on the location where he performed lynx captures for reintroduction in the Dinaric Mountains and Western Europe (Štefan Zatroch´s archive © Ludvík Kunc).

2. Systematic monitoring of lynx in the Vepor Mountains using camera traps

JAKUB KUBALA, NUNO FILIPE GUIMARÃES, TOMÁŠ IĽKO, MIRKO KRAJČI, JAROSLAV BRNDIAR, ĽUBOMÍR FERLICA, TIBOR PATAKY, PETER KLINGA AND RUDOLF KROPIL

Introduction

The Slovak Carpathians are commonly considered as home of a large and vital lynx population (Breitenmoser *et al.* 2000, von Arx *et al.* 2004, Hell *et al.* 2004). However, until recently, no relevant data was available to support these assumptions (Breitenmoser *et al.* 2000, von Arx *et al.* 2004, Kubala *et al.* 2017, Smolko & Kubala 2017, Smolko *et al.* 2018). In Slovakia, the MoE SR declared the lynx as a year-round protected species in 1999 followed by the Ministry of Agriculture and Rural Development of the Slovak Republic (MARV SR) in 2001. Nevertheless, its conservation and management was based only in the so-called "expert estimates" (Hell *et al.* 2004, von Arx *et al.* 2004, Kubala *et al.* 2017, Smolko & Kubala 2017, Smolko *et al.* 2018). Furthermore, there was no evidence that legislative protection of the species support the sustainability of the Slovak lynx population, mainly due to the absence of relevant scientific data and specifically the inexistence of a robust systematic monitoring. Slovakia as a member of the European Union is obligated under the Habitats Directive to monitor, evaluate and report the conservation status of protected species where it includes the Eurasian lynx. However, the report to the European Commission for the period from 2007 to 2012 was not established on relevant scientific data (Kubala *et al.* 2017, Smolko & Kubala 2017, Smolko *et al.* 2018), resulting in the status of lynx population in Slovakia being defined as unfavourable – unsatisfactory (Černecký *et al.* 2014). In contrast to this source, data on the lynx population reported in the Green Report (MARV SR) estimated since 2004 more than 1,000 individuals in Slovakia (with 1,717 individuals in 2015; Anonymous 2016). However, systematic research of the Slovak Carpathians lynx population carried out since 2012 clearly proved that lynx statistics provided by hunters and published in the green report (MARV SR) are strongly biased and overestimated by 6 to 9 times (Kubala *et al.* 2017, 2019, Smolko & Kubala 2017, Smolko *et al.* 2018). This fact was unfortunately being ignored on a long-term basis by the state administration and consequently leaded to the presentation of a vague and misleading information when describing the status and lynx population trend at local and national levels. The lack of a scientific based background when reporting and interpreting data

on large carnivores, leads subsequently to conflicts such as illegal hunting. For example, in spite of the 18 years of a "passive" conservation, the lynx population does not reach the favourable status nor does the habitat carrying capacity in some areas of Slovakia (Smolko & Kubala 2017, Smolko *et al.* 2018, Kubala *et al.* 2019).

Effective management and species conservation should be always based on relevant and science based data about the species and its population trend (Primack 1993). However, reliable data on population size can only be acquired by means of a reliable systematic monitoring of population, i.e. using camera-trapping methods (Breitenmoser *et al.* 2006, Breitenmoser & Breitenmoser-Würsten 2008). Over the last decades, camera-trapping methods became a standard method for estimating the population size (abundance and density) of elusive felines species (e.g.: tiger (*Panthera tigris*), snow leopard (*Panthera uncia*), Eurasian lynx (*Lynx lynx*)) (Karanth & Nichols 1998, Laas 1999, Jackson et al. 2006, Weingarth *et al.* 2012, Zimmermann *et al.* 2013, Pesenti & Zimmemann 2013, Avgan *et al.* 2014, Kubala *et al.* 2017). These feline species have a particular natural coat pattern, which allows the exact distinction and identification of different individuals (Rovero & Zimmermann 2016). The goal of the LIFE Lynx project in Slovakia includes realization of the systematic (deterministic camera trapping) monitoring of the lynx in three areas: the Vepor Mountains, Vtáčnik Mountains and Volovec Mountains, in order to evaluate the potential suitable source areas where the lynx population is in favourable status.

Therefore, the main goal of our research was to provide a robust estimate of the lynx population size (population abundance and density) in the Vepor Mountains.

Material and methods

Vepor Mountains is a geomorphological complex of the Slovak Ore Mountains in central Slovakia with a total area of 870 km^2. This mountain range is situated in the Banská Bystrica region within six districts (Banská Bystrica, Brezno, Detva, Poltár, Rimavská Sobota and Lučenec; Fig. 2). Part of the area is located and managed by the Poľana Protected Landscape Area (Poľana PLA, IUCN Category V), characterized by a relatively low human population density (81.5 inhabitants per km^2). The major part of the area is highland, with an uninhabited

forested landscape with lower parts of deforested areas converted into meadows and pastures. Orientation of the mountains are in north-south direction, enabling the occurrence of mountainous and thermophiles species of plants and animals. The European beech (*Fagus sylvatica*) and the silver fir (*Albies alba*) are the most predominant from all existent trees species. In terms of the fauna, there are about 50 species of mammals, 9 species of reptiles, 11 species of amphibians and 174 species of birds. Within the large mammals' species, the region accounts with the three main European large carnivores: lynx, brown bear (*Ursus arctos*) and wolf (*Canis lupus*); and three large ungulates: red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*).

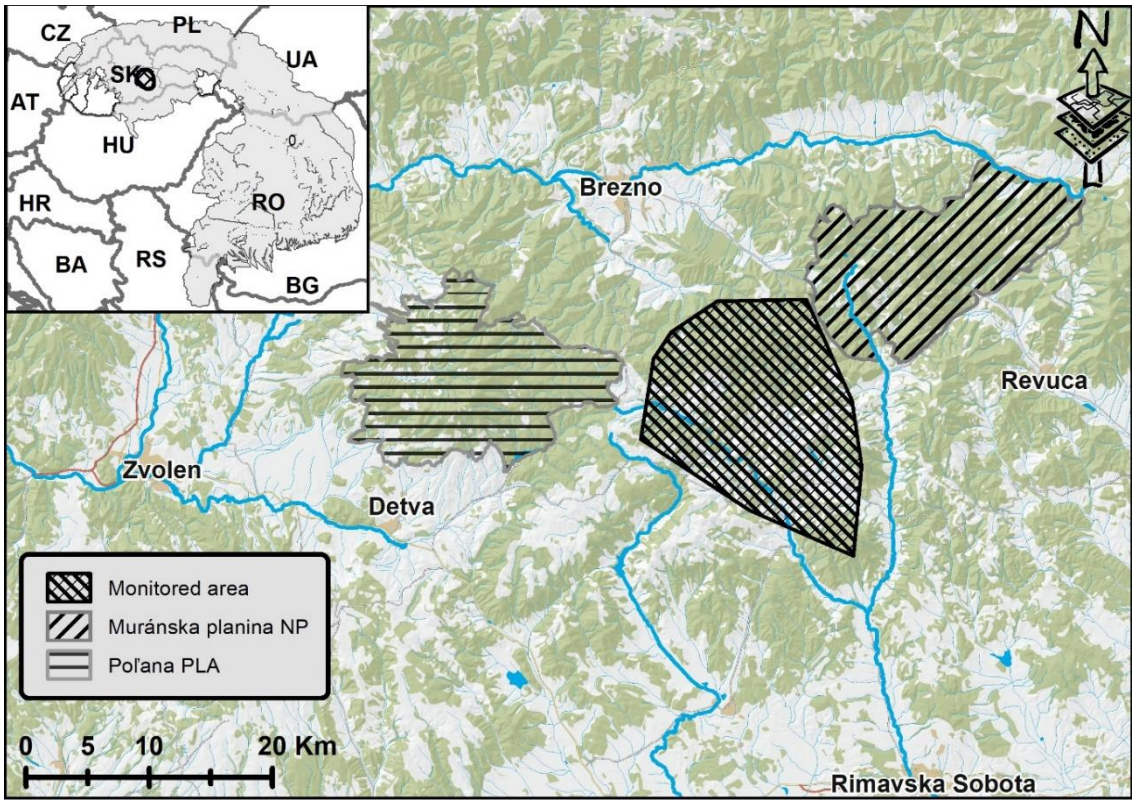

Fig. 2 Location of the monitored area using camera traps within the Carpathian Mountains (black circle in inset) and the Vepor Mountains, including Poľana PLA, Muránska planina NP, and distribution of larger human settlements in the area. The shaded area in the inset shows the lynx´s distribution in the Carpathians (Kaczensky *et al*. 2013).

The systematic monitoring using camera traps, took place in the Vepor Mountains during 60 days, from 29.11.2018 to 28.1.2019. It was implemented by TUZVO in collaboration with the administration of the Muránska planina NP, Cerová vrchovina PLA and Poľana PLA (State

Nature Conservancy of the Slovak Republic), and with local foresters, hunters and volunteers. Camera traps were positioned within the study area on 28 locations with the highest probability of lynx detection. The study area was systematically divided using a square grid of 2.5 x 2.5 km. The camera-traps stations where composed by 2 camera traps positioned opposite to each other and were located into every 2nd square within suitable habitat. Individual lynx were then identified based on the photographic analyse of their coat pattern (Fig. 3). The size of the lynx population in the Vepor Mountains was estimated as in previous studies (Kubala *et al.* 2017, 2019, Smolko & Kubala 2017, Smolko *et al.* 2018) and only individuals older than one year were accounted (i.e. independent lynx). Estimation of the lynx population density was a result of the abundance of independent individuals per 100 km^2 of suitable habitat by means of the spatial capture-recapture method (SCR) following Kubala (2017). This method is also a standard method used in ecology for the determination of the abundance of individuals within a population (Karanth & Nichols 1998, Rovero & Zimmermann 2016). Proportions of suitable and unsuitable habitats derived from CORINE Land Cover 2012 (Copernicus Programme, 2012) with resolution of 100 × 100 m in ArcMap 10.3 (ESRI, Redlands, USA). All types of forest (deciduous, coniferous and mixed), together with shrub, grasslands, and agricultural land were considered suitable habitat for lynx, whereas human settlements and water areas were excluded (Fig. 4).

Fig. 3 An example of the same lynx identification at two different locations using a unique pattern of its spotting. (photo © Technical University in Zvolen).

Results and discussion

Within the systematic monitoring in the Vepor Mountains the 28 camera-stations were active during 60 days (November 2018 - January 2019) representing 1,680 camera days (total number of monitoring days x number of camera-stations) within the monitored area of 249.75 km^2. The presence of the lynx was recorded in 16 camera-stations (57.14%). This result represents the second highest detection rate ever recorded in Slovakia from monitoring this species, being just below the 71.4% achieved in a similar monitoring realised in the Muránska planina NP. Other monitoring results achieved had a detection rate of 53.6% in the Strážov Mountains PLA, 36.4% in the Štiavnica Mountains PLA and 32.6% in the Veľká Fatra NP (Kubala *et al.*, 2017, 2019, Smolko & Kubala 2017, Smolko *et al.*). Reliable estimation of the lynx population size requires a comprehensive process and a rigorous statistical analysis. Some resident lynx might not been recorded during monitoring, which can underestimate the overall results and so their number must be statistically estimated and added to the recorded individuals. On the contrary, lynx that were recorded only in border of the monitored area and their home ranges are therefore located outside the study area would significantly overestimate the population size. For this reason, it was necessary to add an additional buffer of several kilometres to the monitored area, which represents the spatial requirements of the animals, depending on the average size of the home ranges of lynx in the area. By qualitative analysis (Kubala *et al.* 2017), the most suitable buffer was of 14 km with which we increased the monitored area and created the state space (Fig. 4). The size of the state space (i.e. the monitored area + buffer zone) was 1,746 km^2, of which 1,485 km^2 considered as suitable habitat and 261 km^2 as unsuitable habitat for lynx (Fig. 4).

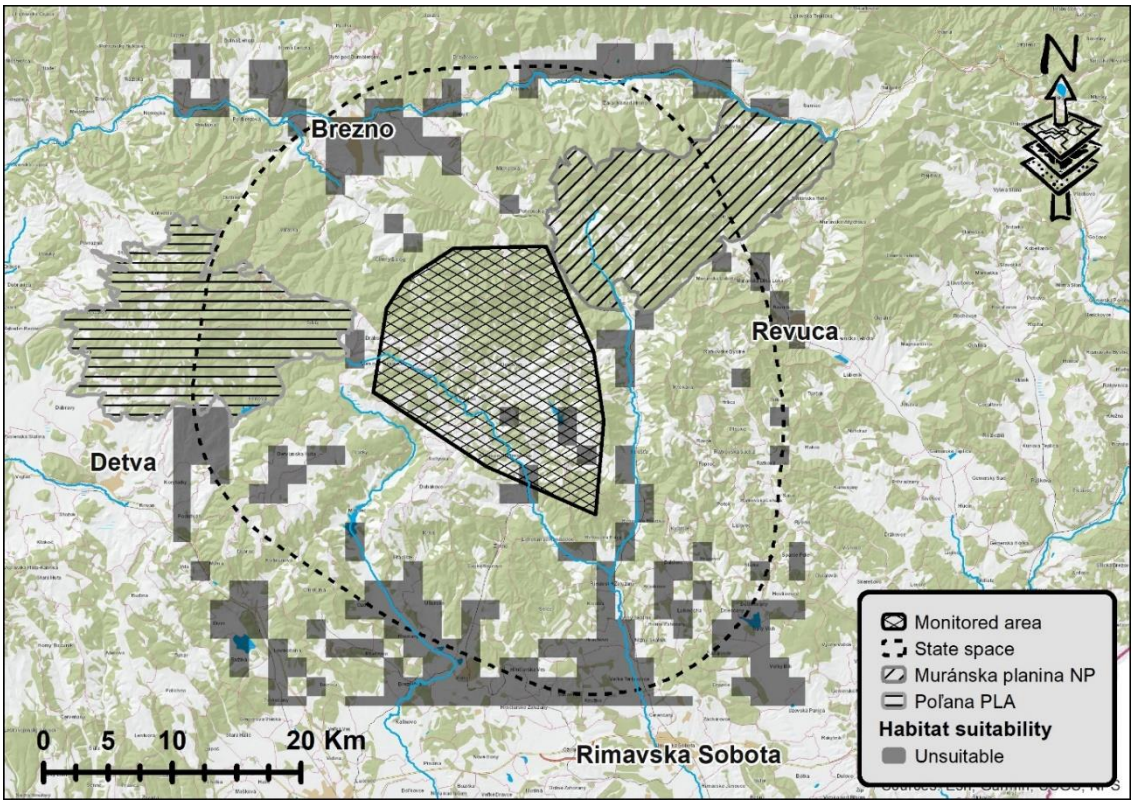

Fig. 4 Schematic location of the monitored area (diamond pattern in black) in the Vepor Mountains, including Poľana PLA and Muránska planina NP. The monitored area was enlarged by buffer of 14 km, resulting in state-spaces (doted polygon) in which we distinguished unsuitable habitat (shaded) for the Eurasian lynx.

The abundance of the population was estimated to be 17.8 (± 7.3) lynx within the suitable habitat of 1,485 km^2, representing a population density of 1.20 (± 0.49) lynx per 100 km^2 of suitable habitat. For comparison, the estimates presented in the green report, representing the counts from 118 hunting grounds located within the monitored area reported 208 lynxes in 2016, what represents an overestimation of 1,100% from the numbers obtained in our systematic monitoring. Similarly, an overestimation from 600% up to 900%, was recorded in other monitored areas: in Štiavnica Mountains PLA, in Veľká Fatra NP, in Muránska planina NP and in Strážov Mountains PLA (Kubala *et al.* 2017, 2019, Smolko & Kubala 2017, Smolko *et al.* 2018). This overestimation is a results of the multiple records of the same individuals within several hunting grounds whose area are much smaller on average, +/- 26.6 km^2 (Kubala *et al.* 2019, Smolko & Kubala 2017, Smolko *et al.* 2018), when comparing with the average of the home range of lynx comprehended between 150 to 300 km^2 (Breitenmoser-Würsten *et al.* 2007). The population density of 1.20 (± 0.49) lynx per 100 km^2 of suitable habitat within the Vepor Mountains is the second highest value among all previous monitoring realized in

Slovakia just behind the Muránska planina NP values, with 1.47 ± 0.37 lynx per 100 km^2 of suitable habitat (Smolko & Kubala 2017, Smolko *et al.* 2018). The differences in the population density can be originated by several factors, especially ecological (inbreeding, lower fitness, and interspecies competition with other species such as wild boar and bear)and anthropogenic (habitat fragmentation, animal vehicle collision and illegal hunting). Nevertheless, the estimations of the population densities in Muránska planina NP, Strážov Mountains PLA and Vepor Mountains correspond to a favourable status of this species in accordance with the Habitats Directive NATURA 2000 (Kropil 2005). Based on the achieved results, it is possible to conclude that lynx population in the Vepor Mountains (and the other two areas mentioned above) is sufficiently viable to provide a limited number of individuals for the reintroduction and reinforcement of populations in Central and Western Europe without any negative consequences for the source population and for its demographic development.

Overall, our results achieved through systematic and robust monitoring, within the five study areas, enabled us to estimate the average lynx density in Slovakia to be 1 +/- 0.31 lynx per 100 km^2 of suitable habitat. Using the average values of the population density and the total suitable habitat available of 28,090 km^2 is possible to estimate the lynx population in Slovakia which results in 280 individuals. Given that the lynx population is not full spread throughout the area with potential suitable habitat, it is possible to assume that the overall estimation number may be slightly lower than 280 animals. Being our studies carried out on comparable and relevant managed areas, within the core and marginal parts of the lynx population in a total of 7,476 km^2 from suitable habitat, we assume that the results are most likely to represent an average rather than a sub-average of this species in Slovakia.

3. Lynx reintroduction in LIFE Lynx and LIFE Luchs projects

JAKUB KUBALA, TOMÁŠ IĽKO, PETER KLINGA, PETER SMOLKO AND RUDOLF KROPIL

The establishment of the LIFE Lynx project was based on the much important work realized previously within two projects: the Interreg DinaRis and ULyCA project (Urgent Protection for the Lynx - Strengthening Lynx in Italy Friuli Venezia Giulia). The critical aspect of the LIFE Lynx's reinforcement in the Dinaric and South-Eastern Alps is the identification of suitable areas and determination of release sites. Therefore, during the first 18 months of LIFE Lynx, project partners focused on identifying the most suitable sites and locations in Slovenia and Croatia. Up to date, a network of camera traps and a program for collecting lynx samples for DNA analysis was implemented in the Dinaric Mountains. During February 2019, the Romanian ACDB team captured two adult males Goru on the 12th and Doru on the 27th, with the support of wildlife administrators and personnel from the Putna Vrancea NP, from the administrative unit of Romsilv. After the capture, both lynx were retained in quarantine in a specialized facility in Romania. The male Doru, was successfully reintroduced in Croatia in the 4th of May 2019, while Goru was first translocated to an acclimatization facility in Slovenia, being reintroduced on May 14, 2019. The lynx adapted well to their new environment and successfully preyed on wild ungulate species. Both males represented the first lynx released in the Dinaric Mountains after 46 years since the translocation of the first founding animals from the Slovak Carpathians. This progress is a positive sign for the future of the whole project and for the lynx populations the Dinaric Mountains and SE Alps.

The achievement of the LIFE Lynx project goals and the rescue of the reintroduced lynx population in the Dinaric Mountains are supported by the results of a similar project implemented in the Slovak Carpathians. From 2016, the organisation DIANA – Carpathian Wildlife Research, started to implement the project LIFE Luchs "Reintroduction of lynx in the Palatinate Forest" (LIFE13 NAT/DE/000755) in cooperation with partners from the Stiftung Natur und Umwelt (Germany), KORA (Switzerland) and National Zoo Bojnice. The LIFE Luchs project aims to establish a lynx population in the Palatinate Forest, which is the largest continuous forest area in Germany. In addition, the area is one of the first cross-border Biosphere Reserve determined UNESCO together with the Palatinate Forest - Northern Vosges (Germany, France). The natural return of lynx to this area has not occurred over the past

decades, and it was also not expected due to the limited dispersion of the species. Therefore, a lynx reintroduction program was proposed, in order to restore the population to its former natural range in Germany and France and to allow the dispersion to the Vosges and Swiss Jura mountains. The implementation of this project proceeded through systematic lynx monitoring in the areas of the Muránska planina NP (Smolko & Kubala 2017, Smolko *et al.* 2018) and Strážov Mountains PLA (Kubala *et al.* 2019). In total, 17 lynxes were translocated and released into the Palatinate Forest until June 2019, 8 of them were from Slovakia and the other 9 from Switzerland. The first three lynx released in this area occurred on the 30th July 2016. They were all orphans, two females (Luna and Kaja) and one male (Lucky), and they were originally from Veľká Fatra NP, Beskids Mountains and Strážov Mountains PLA respectively. The fourth translocated lynx was the wild male Cyril (released April 22, 2017), capture in the Muránska planina NP. In 2017 (December 15, 2017), a rehabilitated orphan female (Labka), originally from the Poloniny NP was released. The release of Labka was followed by the release of two other orphan males: Wrano (September 11, 2018) from the Low Tatras NP and Alfi (September 12, 2018) from the Low Beskids. In the first half of 2019, one wild male lynx (Braňo) was captured in the Strážov Mountains PLA. Before the translocation to the Palatinate forest, this lynx was translocated in quarantine in a specialized facility for the rehabilitation of lynx and other large carnivores in the National Zoo Bojnice. This facility is located in the Zoo's periphery, in a forest area without public access, were animals are under constant camera surveillance in order to minimize the possible impact from the contact of the staff with the animals. The quarantine is problem-free process mainly because the animals has not suffered any injuries. Braňo was equipped with a GPS/GSM telemetry collar, like in all other released lynx, in order to ensure the monitoring of its spatial behaviour and food ecology as well as to monitor the reintroduction process. One week after the release, Braňo had caught his first prey and confirmed that, just as with previous animals, he had successfully adapted to his new environment.

The release of the first three Slovak lynx was followed, by three other animals (male Arcos and two female Bell and Rosa) caught in the Swiss mountains of Jura within March and April of 2017. The male Arcos dispersed relatively quickly after his release for approximately 360 km to the south, to the central part of the French Vosges Mountains. Nowadays, there is still a

small nucleus of surviving lynx in the Vosges Mountains, from the reintroduction programmes with Slovak founding animals at the turn of the 1980s and 1990s. Due to the very low number of lynx in this area. Throughout France, Arcos' arrival was a positive message for the survival of this species in the Vosges. At the end of 2017 (20th December) an orphan female Alosa, was released into the Palatinate Forest and during 2018 two more lynx were released, a male Juri (16th March) and a female Jara (18th April). In 2019 three individuals were released, the females Mala and Gaupa (5th and 22nd February), and the male Libre (7th march).

The LIFE Lynx project has achieved first major success during 2017, the second year of its implementation. After 200 years of absence in this area, successful reproduction from the reintroduced Slovak lynx was confirmed, with the female Kaja giving birth to her first offspring composed by two males named Fila and Palu. Following years confirmed the success of the project, with the birth of at least eight more cubs, five in 2018 and three in 2019. The most significant contribution of the LIFE Luchs project was in fact the reintroduction of orphan lynx. The assumption that these animals were considered unfit for their release in the wild, due to potential human imprinting/habituation within the rehabilitation process, was not confirmed and all orphaned animals were able to hunt in the wild within a week of their release without any complications together with the achieved success of reproduction. The integration of orphans significantly reduced the pressure on wild lynx populations and the number of captured animals. Until today, the LIFE Luchs project manage the translocation and release of nine lynx, being six of them orphans (75%) and two captured in the wild (25%). Within the LIFE Lynx project, the same approach (with the use of orphans individuals) will also be used, in order to reduce the pressure on the lynx source population in the Slovak Carpathians.

4. Conclusion

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Based on the above results and findings, it is possible to drawn these conclusions:

- the viability and long-term survival of the autochthonous lynx population in Slovakia has a great importance for the international management and large-scale conservation of the lynx in Europe,
- the lynx population in Slovakia is significantly lower (6-11 times between different areas) than it is stated by hunter reports and given its great international importance, it is necessary to maintain its status as a protected species in Slovakia,
- the spatial and temporal distribution of the number of individuals (among the particular territories) varies significantly depending on the above mentioned factors being a strong reason to why it is essential to treat each area individually,
- based on our results, it is possible to claim that the lynx population in the Vepor Mountains corresponds to the favourable status according to the Habitats Directive NATURA 2000,
- given the favourable status of the lynx population in the Vepor Mountains, this population can be a source for the reinforcement of this species into the Dinaric Mountains and South-eastern Alps in accordance with the management program, habitats directive, key activities for large carnivores in Europe and recommendations for restitution and further translocation of species to protect them.

Currently, there is a general support and participation of most groups of stakeholders (e.g. foresters, hunters, nature conservationists, etc.) within the research, the monitoring and in the implementation of comprehensive solutions for the mitigation of conflicts between human activities and the large carnivores' presence. The Slovak Carpathians are largely represented with a human dominated landscape and given that since joining the European Union in 2004 more infrastructures were developed. There is a high probability that this anthropogenic driven landscape fragmentation will increase and generate negative impacts on lynx in a near future. The most problematic factors are mainly the construction and development of new infrastructures, in particular connect with transport infrastructures,

causing the fragmentation of suitable habitat, limiting dispersal and connectivity, and increasing the probability of animal vehicle collisions (Kubala *et al.* 2017, 2019, Smolko & Kubala 2017, Smolko *et al.* 2018). The consequence of the disruption of the most important migration routes and the creation of migration barriers limits the genetic flow and drives to a subsequent isolation from the core population specially the ones within marginal parts of the species range (Gregorová 2001, 2004, Kubala 2014).

Another negative factor is the illegal hunting of the species. The belief that the species is responsible for the alleged decrease of roe deer population originate negative attitude of local dwellers towards the presence of lynx. Controversially, the fact is that according to hunters' statistics, there has been a permanent increase in the population numbers of roe deer, over the last 20 years (Konôpka & Kaštier 2013). At the same time, it has been ignored by hunters that apart from lynx (and wolf) as its main predator, roe deer population is also affected by competition stress from rapidly increase of the red deer population, which results in the decreased of fitness of both adults and calves of the smaller deer (Latham 1999, Richard et al. 2010). Nevertheless, the influence of other predators on roe deer calves, such as the highly abundant foxes and inclusive wild boars, is being overlook. Finally, yet important, the growth rate of roe deer can be also influenced by a poor management of the agricultural land with a high mortality rate of the offspring during mowing operations.

All these factors, drive to a conclusion that conflicts between carnivores and humans are more a social and political problem than of biological character (Bath 1989). For any further progress, it will be crucial to reach a common understanding and compromise among all concerned stakeholders groups in Slovakia (nature conservation organisations, hunters, foresters and general public) and based on the acceptance of the independent scientific based data (Bath et al. 2009). Furthermore, the success of these programmes will only be possible to achieve by building cooperation, trust and participation of all concerned stakeholders through the implementation of activities and in the monitoring of Eurasian lynx. In this line, the involvement of all stakeholders groups might be the first step towards solving the predator-human conflicts in the future. The participation of all interested stakeholders groups in previous monitoring actions (Štiavnica Mountains PLA, Veľká Fatra NP, Muránska planina NP and Strážov Mountains PLA), inclusive the one realized in the Vepor Mountains, are an

example of excellent cooperation and mutual trust. This is an important precedent for resolving predator-human conflicts in the future in order to maintain a sustainable lynx population with the capacity of being a source for future reintroduction programmes.

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