LIFE Lynx

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

LIFE16 NAT/SI/000634

MONITORING OF THE EURASIAN LYNX (LYNX LYNX) IN THE VTÁČNIK MOUNTAINS, SLOVAKIA: IMPORTANCE FOR THE NATIONAL AND EUROPEAN MANAGEMENT AND CONSERVATION OF THE SPECIES

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Monitoring of the Eurasian lynx (lynx lynx) in the Vtáčnik Mountains, Slovakia: importance for the national and European management and conservation of the species

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JAKUB KUBALA, BRANISLAV TÁM, PETER SMOLKO, TOMÁŠ IĽKO, PETER KLINGA, MICHAL BELÁK, EVA GREGOROVÁ & RUDOLF KROPIL

Due to the direct or indirect consequences of human activities in Europe, the abundance of large carnivores including Eurasian lynx (*Lynx lynx*) has decreased dramatically (Chapron et al. 2014, Wilson 2018). At the end of the 18th century, lynx populations were widespread only in the Alps, Balkans, Carpathians, Eastern Europe, Baltics, Finland and Scandinavia (Breitenmoser & Breitenmoser Würsten 2008). The subsequent and wider trend of extinction of lynx populations continued in the early 19th century, culminating in the total extinction of this species in most of Europe (Wilson 2018). During the middle of the 20th century, the expansion of lynx populations in Europe was minimal (Kratochvíl 1968a, b) and only 4 autochthonous populations, Balkan, Baltic, Carpathian and Scandinavian, were preserved, but their trend continued to decline (Breitenmoser & Beitenmoser- Würsten 1990, 2008, von Arx et al. 2009). Around 1950, the negative trend of lynx in Europe stopped, mainly due to the status of a protected species and the controlled legal hunting, as well as the regeneration of forests and certain prey species (Wilson 2018). Relatively favourable status of the autochthonous population of lynx in Slovakia during the 1970s and 1980s and its geographical proximity to historically extinct lynx in the Western and Central Europe enabled the subsequent implementation of reintroduction programs (Breitenmoser & Breitenmoser Würsten 2008, Linnell et al. 2009). These programs included the translocation of approximately 172 to 177 lynx into 15 different regions from 8 countries. Of all translocated animals, 57% were wild lynx, 40% were individuals born in captivity and the origin of the remaining 3% of animals is currently unknown (Linnell et al. 2009, von Arx et al. 2009, Wilson 2018).

During the 50s and 60s of the 20th century, several zoological gardens of Bojnice, Bratislava, Ostrava and Brno were involved in capturing wild lynx in Slovakia (Kaluža 1966). However, lynx were captured by means of steel foothold traps and the combination of serious injuries caused by this method with excessive stress led to the constant death of the animals. The first successful capture of an uninjured lynx in a wooden box trap was realized on Výchylovka in the Slovak Beskids (northwest Slovakia) in the early 1960s by forester and hunter Bohdan Müller (Stoličný 2009). More lynx were captured in the same area by foresters from the Kysuce Forest Enterprise, Mr. Mlynár and Mr. Vaterka (Kaluža 1966, Zatroch 2014). Also, foresters and game managers from Betliar namely Otto Féher, Ján Mrenica and Ľubomír Árvay, and hunters from the hunting ground Dobšiná - Jozef Klauzman and Jozef Vozár,

performed lynx trapping in the Slovak Ore Mountains (central Slovakia). Further, hunters from the hunting ground Spišské Vlachy, Jozef Vítkovský and his friend František Oľšavský were also very successful in capturing lynx within Spiš region (eastern Slovakia) (Stoličný 2009). However, the most successful at trapping lynx in Slovakia was Štefan Zatroch (a total of 47 captured individuals), a forester from Krásnohorské Podhradie Forest Enterprise, followed by the game manager from the Krásnohorské Podhradie forest enterprise Ladislav Lükö, and foresters and hunters Ondrej Homrok (Bôrka), Ľudovít Kerekeš (Bôrka), Jozef Korcsmáros (Lúčka), Štefan Matesz (Bôrka), Ladislav Török (Hrhov), Mr. Fabo (the Rožňavsko - Silická planina), Benko (Rakovnica), Žúdel (Rakovnica), and Slopovský (the Plešivecká planina, Zatroch 2014). Lynx were also captured in the Gelnica, Habovka, Poprad, and Ružomberok forest enterprises, and in Hranovnica (Zatroch 2014).

Lynx trapping in Slovakia has been realized for almost four decades as a management tool of the lynx population along with legal hunting of this species (Smolko & Kubala 2017, Smolko et al. 2018, Kubala et al. 2019a). Of all hunted lynx (3 230 individuals during the period 1954 - 1999, Kubala et al. 2020), the share of captured animals in certain periods and years represented approximately 10 - 18% (Hell & Slamečka 1996). Despite the excessive number of trapped individuals in combination with legal hunting, these activities had no negative influence upon the lynx demography in the source population (Hell & Slamečka 1996, Hell et al. 2004, Zátroch 2014, Smolko & Kubala 2017, Smolko et al. 2018, Kubala et al. 2019). On the contrary, cooperation among the forestry, hunting and conservation communities alongside with the management of official reintroduction programmes in the Slovak Carpathians are regarded to be an excellent international model for sustainable international conservation of lynx in Europe (Breitenmoser & Breitenmoser Würsten 2008, Smolko & Kubala 2017, Smolko et al. 2018, Wilson 2018, Kubala et al. 2019). Although some of the reintroduced populations initially prospered, the trend of most of them is currently stagnant to declining and the populations suffer from inbreeding due to the low number and kinship of the founding animals. (Breitenmoser-Würsten & Obexer-Ruff 2003, 2015, Skrbinšek et al. 2011, Sindičić et al. 2013, Boitani et al. 2015).

The lynx population in the Dinaric Mountains (present-day Slovenia and Croatia) became extinct at the beginning of the 20th century, and the species did not occur in the country for almost seventy years. In the 1970s, as awareness of the world's environment increased, the lynx reintroduction program to Switzerland illustrated the ethics of next-generation nature conservation, followed by Slovenia and Croatia (Breitenmoser & Breitenmoser Würsten 2008, Linnell et al. 2009, von Arx et al. 2009, Wilson 2018). In 1972, Štefan Zatroch captured six lynx in Slovakia, which were placed in the Ostrava Zoo with the intention of their reintroduction to the Harz Mountains in Germany. However, this reintroduction

program has been postponed. During the visit of the Swiss hunter Karl Weber to Kočevje, Slovenia, interviews were held with Lada Švigelj, Ciril Štrumbelj, and Maks Konečnik, officials from the Rog State Hunting District, about the fact that the six lynx could be available for reintroduction in Slovenia. Weber offered funding for all costs and the lynx were brought to a quarantine facility in the Rog State Hunting District. After a 46-day quarantine, they were released into the Kočevsko region on March 2, 1973 (Wilson 2018, Wilson et al. 2019). This reintroduction program was one of the most successful in Europe. Lynx reproduced and the population increased and expanded, but there were no other populations in its vicinity and therefore they remained isolated. In the mid-1990s, the Dinaric population declined significantly, mainly due to genetic and health problems caused by inbreeding (Skrbinšek et al. 2011, Sindičić et al. 2013, Boitani et al. 2015, Wilson 2018, Wilson et al. 2019). The long-term occurrence of inbreeding has caused a reduction in the survival of lynx as well as their reproductive success. This effect would accumulate until the inbreeding depression causes the population to collapse, and it re-becomes extinct (Wilson et al. 2019). Therefore, in order to save the population from extinction and ensure its long-term viability in the Dinaric Mountains and the South-Eastern Alps (as well as in other reintroduced populations), it was necessary to relaunch reinforcement and reintroduction programs with further lynx from the source Carpathian population (Breitenmoser 2011, Sindičić et al. 2013, Boitani et al. 2015).

Capturing and translocating animals due to their reintroduction, or reinforcement and conservation, requires relevant and systematic research on the source population, with an emphasis on its abundance and trend, as well as its 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. 2019a, b). Results of the research allow us to assess whether the lynx population in an area corresponds with the favourable status for lynx as a species of European importance (NATURA 2000; Kropil 2005), and whether it is suitable for trapping and translocating animals without any negative consequences for its viability (IUCN/SSC 2013). Based on the data, it is then possible to implement the reintroduction or reinforcement of the lynx in the Central and Western Europe (Breitenmoser et al. 2000, von Arx et al. 2004, Boitani et al. 2015, Smolko & Kubala 2017, Smolko et al. 2018, Kubala et al. 2019a, b, 2020b). Such approach is in accordance with objectives of the Management plan for the Eurasian lynx in Slovakia (Antal et al. 2017; hereinafter referred to as the “Management plan”), Council Directive no. 92/43 / EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive), the Key Actions for Large Carnivores in Europe (Boitani et al. 2015), the Recommendations for reintroductions and further translocations of species for conservation purposes

(IUCN / SSC 2013) and the Recommendations for the conservation of Eurasian lynx in Europe (Standing Committee of the Berne Convention, in prep.).

To support current international efforts by Slovenia, Croatia, Italy and Romania to reinforce lynx populations in Alps, the Department of Applied Zoology and Wildlife Management, Faculty of Forestry, Technical University in Zvolen (hereinafter TUZVO) in cooperation with the Ministry of the Environment of the Slovak Republic (hereinafter MoE SR) and the National Zoological Garden Bojnice (hereinafter NZG Bojnice) entered the LIFE Lynx project "Preventing the Extinction of the Dinaric - South-Eastern Alpine Lynx Population Through Reinforcement and Long-term Conservation" (LIFE16 NAT/SI/000634). As the main activity, TUZVO realizes the systematic monitoring of lynx populations in central (Vepor Mountains, Vtáčnik Mountains) and eastern Slovakia (Volovec Mountains) as potentially suitable areas with lynx population in the favourable status. The project aims to save the lynx populations in the Dinaric Mountains and in the South-Eastern Alps from extinction by improving their genetic diversity and demographic trend. In particular, experts plan to reduce inbreeding and reverse the decline of the Dinaric - South-Eastern Alpine lynx population by reinforcing it with animals from a viable source population from the Carpathian Mountains (Slovakia and Romania). 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 process is supported by stakeholders (hunters, foresters, nature conservation, livestock farmers, etc.) to foster broad public acceptance at local, regional and national level. The long-term goal of the project is to achieve a stable gene flow between reintroduced populations in the Dinaric Mountains and the South-Eastern Alps with the establishment of other population nucleus, known as lynx “stepping stone” (Wilson et al. 2019). For this purpose, two lynx were released in the Julian Alps, Italy in 2014, to join other lynx that had migrated into the area, as a result of its reintroduction in the Dinaric Mountains in the 80s and 90s. The long-term viability of lynx populations in the Central and Western Europe can only be guaranteed if the current isolated populations are linked to the autochthonous European meta-lynx population in the Carpathians (Wilson et al. 2019, Fig. 1).

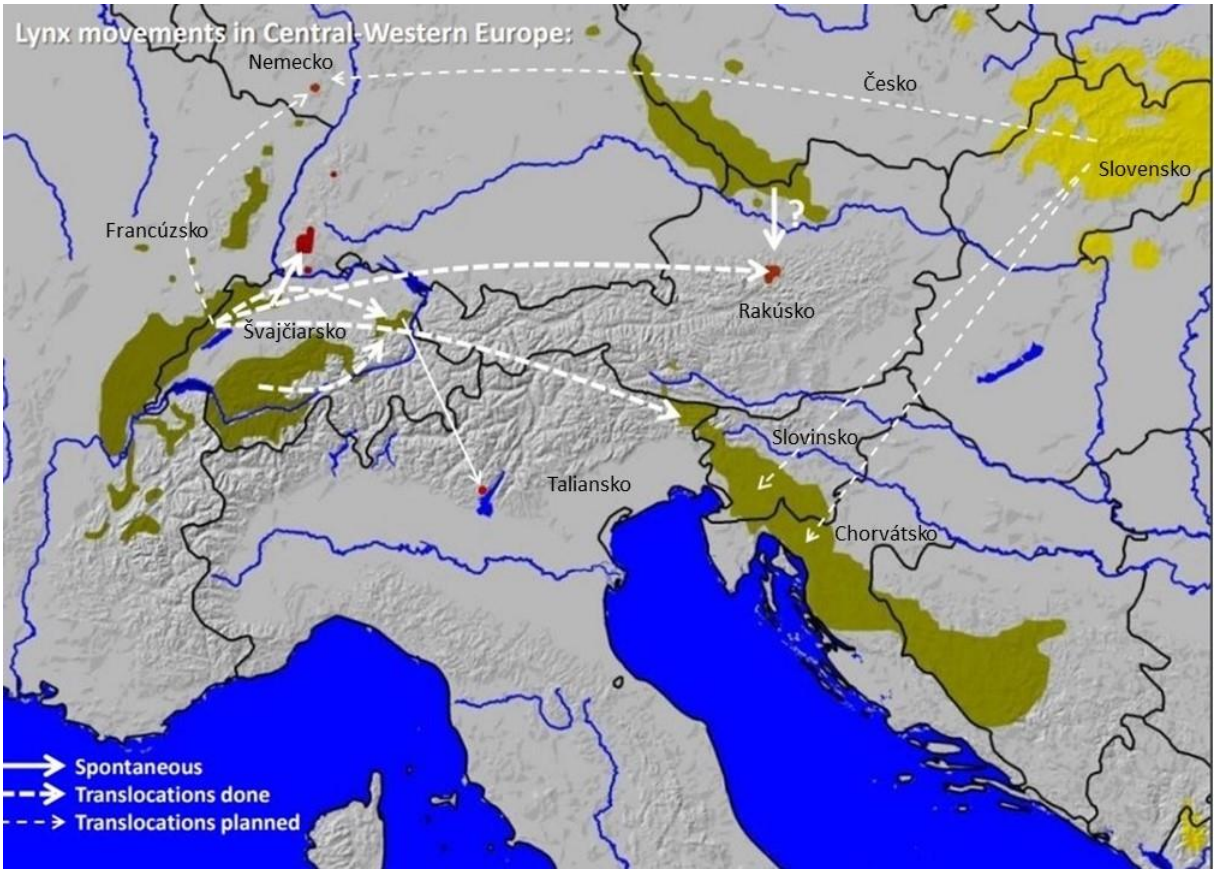

Figure 1. Eurasian lynx translocations in the Central and Western Europe (Breitenmoser & Breitenmoser-Würsten 2016). Bold lines represent spontaneous lynx migrations, while dashed lines already implemented and planned translocations.

2. Systematic camera trapping of lynx population in the Vtáčnik Mountains

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Slovak Carpathians are generally considered to encompass a large and vital lynx population (Breitenmoseret al. 2000, von Arx et al. 2004, Hell et al. 2004), but until recently, no relevant data were available to support this assumption (Breitenmoseret al. 2000, von Arx et al. 2004, Kubala et al. 2019a ,b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). Since 1999 (the MoE SR) and 2001 (Ministry of Agriculture and Rural Development of the Slovak Republic), when the lynx was declared a year-round protected species, the conservation and management of the species were based solely on the expert opinions (Hell et al. 2004, von Arx et al. 2004, Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). This was mainly due to the absence of relevant scientific data and systematic monitoring of the lynx, despite the fact that Slovakia is a member of the European Union since 2004 and is therefore obliged to monitor, evaluate and report information on the status and trend of populations of protected species under the Habitats Directive. Moreover, the state and trend of the lynx in Slovakia, reported to the European Commission for the periods 2007-2012 and 2013-2018 by the State Nature Conservation of the Slovak Republic were defined as unfavourable-insufficient (Černecký et al. 2014, 2020) (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). In addition, information and data on the lynx population reported in the Green Report of the Ministry of Agriculture and Rural Development of the Slovak Republic until 2016 estimated more than 1 000 individuals. However, a systematic survey of the lynx population carried out in the Slovak Carpathians since 2012 showed that these estimates were 6-11 times overestimated (Kubala et al. 2019a, b, 2020a, Smolko & Kubala 2017, Smolko et al. 2018). The absence of relevant data and systematic monitoring of the lynx consequently lead to the presentation of vague and misleading information when describing the status and trend of lynx in Slovakia. The lack of a scientific background when reporting and interpreting data on large carnivores subsequently leads to conflicts between the lynx and human interests, which results in a situation in which the species does not reach the carrying capacity in some areas of Slovakia (Smolko & Kubala 2017, Smolko et al. 2018, Kubala et al. 2019a, b, 2020a, b), despite almost 20 years of conservation, although only passive.

Effective management and species conservation should always be based on relevant and science-based data population size and trend (Primack 1993). However, reliable data on population size can only be acquired by means of a reliable systematic monitoring, for example by using camera trapping methods (Breitenmoser et al. 2006, Breitenmoser & Breitenmoser-Würsten 2008). Over the past few decades, camera-trapping became a standard method for estimating population size (abundance and density) of elusive feline species (Rovero & Zimmermann 2016). These species have a particular natural coat pattern, which allows the exact distinction and identification of different individuals (Karanth & Nichols 1998, Jackson et al. 2006, Breitenmoser & Breitenmoser-Würsten 2008; Fig. 2). Given that the lynx are territorial animals, systematic camera trapping can provide information on their presence and population size, as well as their population trend (Laas 1999, Weingarth et al. 2012, Zimmermann et al. 2013, Pesenti and Zimmemann 2013, Avgan et al. 2014, Kubala et al. 2019a).

Thus, the main goal of our systematic camera trapping was to provide a robust estimate of the lynx population size (population abundance and density) in the Vtáčnik Mountains, central Slovakia.

Figure 2. An example of identification of the same lynx individual on two different locations based on its unique coat pattern (photo © Technical university in Zvolen).

Material and methods

The Vtáčnik Mountains are part of a geomorphological unit of the Slovak Central Mountains with a total area of ~377 km^2 and are spread over the Banská Bystrica and Trenčín regions and four districts (Prievidza, Partizánske, Žiar nad Hronom, and Žarnovica; Fig. 3). The western, northern and north-eastern natural border is the Upper Nitra Basin, the eastern border are the Kremnica Mountains and the Žiar Basin. Further, in the south by the Štiavnica Mountains and Pohronský Inovec, and in the west by the Tribeč Mountains. Part of the area is located in the Ponitrie Protected Landscape Area (PLA,

IUCN category V) and is characterized by a relatively higher population density (110.53 inhabitants per km^2). The larger part of the area is represented by upland to mountainous forested landscape, lower parts are deforested and transformed into meadows, pastures and arable land. The mountain range is located within the moderately warm and cold climate. Forest stands are dominated by deciduous forests with a predominance of beech (*Fagus sylvatica*), oak (*Quercus robur*) and hornbeam (*Carpinus betulus*), as well as a mixtures of beech and fir (*Albies alba* (*Albies alba*).

The most dominant mammals are red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). There is also a presence of the three large carnivores: lynx, brown bear (*Ursus arctos*) and sporadically grey wolf (*Canis lupus*).

Systematic (deterministic) camera trapping in the Vtáčnik Mountains was carried out over a period of 60 days, from 22th November 2019 to 20th January 2020. The monitored area was systematically divided using a square grid of 2.5 x 2.5 km. Each camera station was placed into every 2nd square within suitable habitat and included two camera traps positioned in opposite direction. Individual lynx were then identified based on the visual analysis of their coat pattern (Fig. 3). The size of the lynx population in the Vtáčnik Mountains was estimated using Spatial Capture Recapture (SCR) approach, consistent with previous studies (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). Only individuals older than one year were included into the analysis (i.e. independent lynx). Lynx cubs in the area do not represent resident animals and, after leaving their mother, they are forced to disperse by the resident individuals. Therefore, young lynx are most likely to leave the monitored area, especially in cases where the capacity of the area is reached by resident individuals (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). Estimate of the lynx population density (abundance of independent individuals per 100 km^2 of suitable habitat) by means of the SCR method (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018) represents the standard method for determining population size in ecology since the 19th century (Karanth & Nichols 1998, Rovero & Zimmermann 2016). The proportions of suitable and unsuitable habitat in the monitored area were derived from the CORINE Land Cover 2018 (Copernicus Program, 2018). All forest types (deciduous, coniferous and mixed) together with shrubs, pastures habitats and arable land were identified as the suitable habitat, and human settlements were considered unsuitable habitats (Fig. 4).

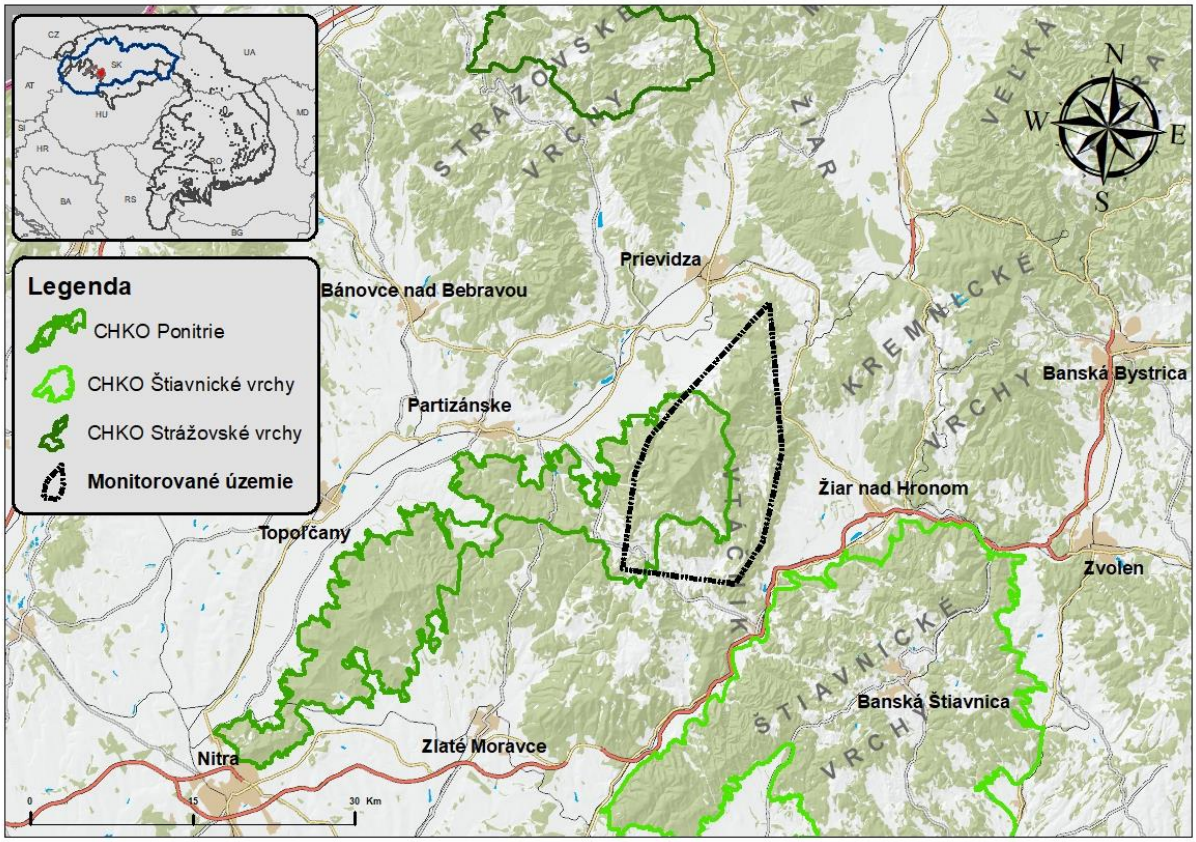

Figure 3. The monitored area (dark dashed polygon) in the Vtáčnik Mountains with lynx distribution in the Carpathians (dark polygon in the inner picture; Kaczensky et al. 2019), including the Ponitrie PLA, the Štiavnica Mountains PLA and the Strážov Mountains PLA

Results and discussion

During the systematic camera trapping in the Vtáčnik Mountains, 28 camera stations were active during 60 days (November 2019 - January 2020). This represented a total of 1 680 camera days (total number of days of monitoring x number of camera stations), within the monitored area of 239 km^2. The lynx was photographically recorded in 22 of 28 camera stations (78.57%), which is the highest detection rate in Slovakia (32.6% in the Veľká Fatra NP, 36.4% in the Štiavnica Mountains PLA, 53.6 % in the Strážov Mountains PLA, 57.14% in the Vepor Mountains and 71.4% in the Muránska planina NP; Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). 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 of it 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. 2019a) the most suitable buffer was of 9 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 1 089 km^2, of which 704,25 km^2 considered as suitable habitat and 384,75 km^2 as unsuitable habitat for lynx (Fig. 4).

Lynx abundance was statistically estimated at 8.28 (± 5.61) lynx in the total area of 1,089 km^2 of suitable habitat, which represents a population density of 1.18 (± 0.08) lynx per 100 km^2 of suitable habitat. For comparison with the data available from hunting statistics, a total of 69 lynx were estimated in the same area (1,089 km^2) within 31 hunting grounds in 2016, which is up to 900% overestimation of the actual population size. A similar 600 – 1 100% overestimation of lynx abundance was also recorded in the previous studies (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). The overestimation of abundance is caused by multiple records of the same individuals within several hunting grounds, which are generally smaller (SR average 26.6 km^2; Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018) than average lynx home range (150-300 km^2; Breitenmoser-Würsten et al. 2007). The population density of 1.18 (± 0.08) lynx per 100 km^2 of suitable habitat estimated in this study is the third highest among all previous monitoring in Slovakia. Lower estimated population densities in the Štiavnica Mountains PLA (0.58 ± 0.13 lynx per 100 km^2 of suitable habitat, 2013/2014; Kubala et al. 2019a) and the Veľká Fatra NP (0.81 ± 0.29 lynx per 100 km^2 of suitable habitat; 2014/2015; Kubala et 2019a) could be caused by several factors. In particular, ecological factors such as habitat fragmentation, inbreeding, lower fitness, and interspecific competition with wild boar and bear, and anthropogenic factors such as traffic accidents and illegal hunting (Kubala et al. 2019a). Population densities in the Muránska planina NP (1.47 ± 0.37 lynx per 100 km^2 of suitable habitat; 2014/2015, Smolko & Kubala 2017, Smolko et al. 2018), the Vepor Mountains (1.20 ± 0.49 lynx per 100 km^2 of suitable habitat; Kubala et al. 2019b) and the Strážov Mountains (0.97 ± 0.25 lynx per 100 km^2 of suitable habitat; Kubala et al. 2020b) corresponded to the favourable status of this species in Slovakia according to the NATURA (Kropil 2005). Based on these results, it can be concluded that lynx populations in these four areas are sufficiently viable to provide a limited number of lynx for reintroduction and reinforcement programs in Europe without negative consequences for the source population and its demographic trend (Kubala et al. 2019b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018).

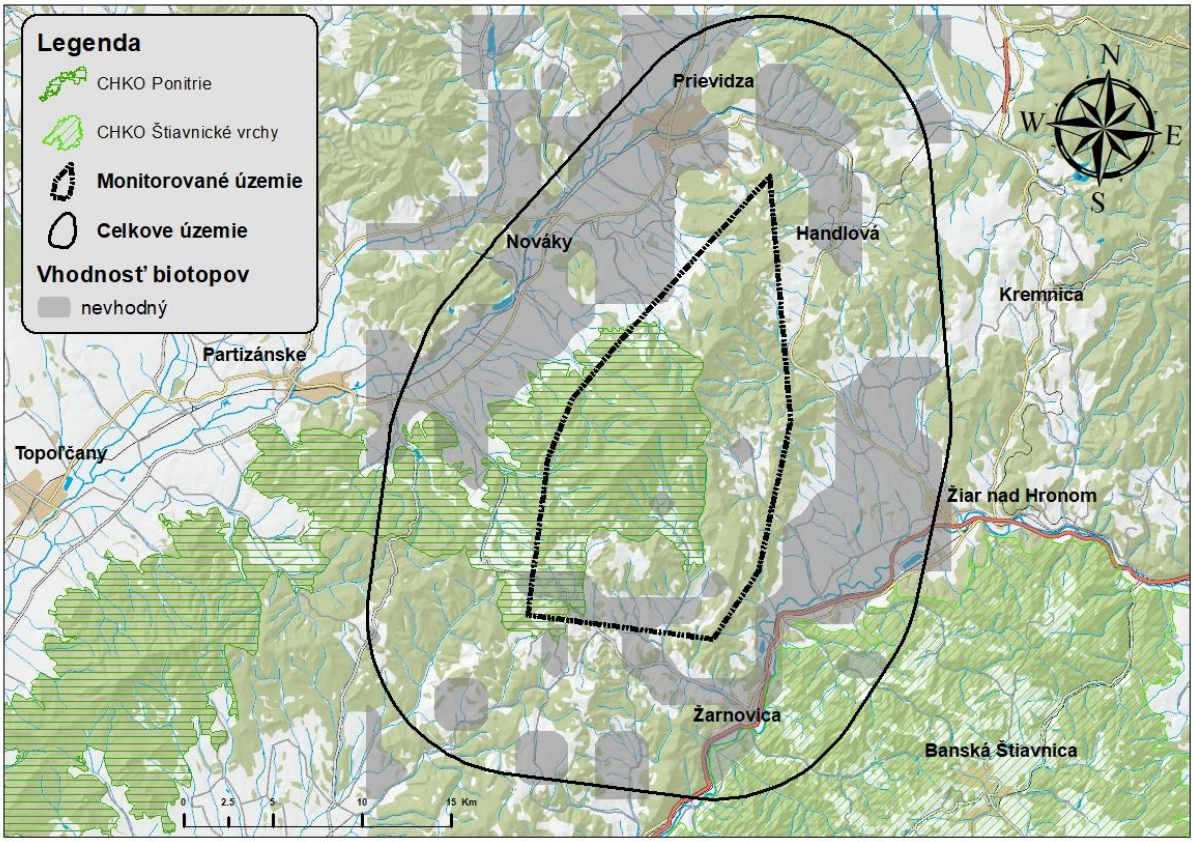

Figure 4. The monitored area in the Vtáčnik Mountains, including the Ponitrie PLA, the Štiavnica Mountains PLA and the Strážov Mountains PLA. The monitored area was increased by the average size of the lynx's home ranges (buffer 9 km) and created the state space. The area of unsuitable habitats was subsequently deducted from the state space (i.e. monitored area + buffer).

Our results in the Vtáčnik Mountains and the previous studies, estimated through systematic camera trapping, allowed us to estimate the average lynx population density in the Slovak Carpathians at 1.04 (± 0.87) lynx per 100 km^2 of suitable habitat. Using the average density values and the population range in available suitable habitat of 28,090 km^2, we subsequently estimated the lynx population in Slovakia which results in 280 independent individuals. Slovak lynx population represents the core of the lynx population in the Western Carpathians, and therefore affects the fate and status of lynx in all neighbouring countries (Czech Republic, Poland, Ukraine and Hungary). Moreover, the majority of the reintroduced populations in Europe depend on the status of the population in the Slovak Carpathians (von Arx et al. 2004, 2009, Boitani et al. 2015, Antal et al. 2016, Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). Therefore, Slovakia has a special responsibility for the international cooperation, management and conservation of this species in the Carpathians and Europe (von Arx et al. 2004, Boitani et al. 2015, Antal et al. 2016). Given that no evidence is currently available that full legal protection of lynx in Slovakia has supported its population, the

continuous implementation of systematic monitoring and scientific studies on the ecology and biology of lynx in the Slovak Carpathians are necessary. Based on relevant data and information, it will then be possible to ensure long-term conservation and management of lynx in Slovakia and Europe with the joint efforts and mutual trust of all interest groups (Kubala et al. 2017, 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018).

3. Lynx reintroduction and reinforcement within the LIFE Lynx and LIFE Luchs projects

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By 2020, seven lynx have been translocated from the Carpathians within the LIFE Lynx project (Fig. 8). During February 2019, the Romanian ACDB team, with the support of wildlife managers and staff from the Putna Vrancea Nature Park, the Romsilva administrative unit, captured two adult males (Goru February 12. and Doru February 27th). Both males were quarantined in a specialized facility in Romania. The male Doru was successfully released in the Risnjak National Park in Croatia (4th of May). Doru remained in the park and in early June crossed the border between Slovenia and Croatia. After returning from Croatia, Doru defined his home range in Slovenia near Postojna. However, since January 2020, his telemetry collar has failed and its further spatial behavior cannot be further monitored. The second lynx Goru was in the acclimatization quarantine in Lokša Potok in Slovenia. Goru was released on May 14. 2019 and established its home range in the area of Mala Gora (Ribnica) near the resident female Teja. In March 2020, he crossed the Kolpa river and explored Gorski Kotar in Croatia. He then returned to his home range in Mala Gora. In 2020, the Romanian ACDB team captured three more males (Alojzije January 16th, Catalin January 21nd and Boris). The male Alojzije was released in the Paklenica National Park in Croatia (March 13th). After exploring the Velebit Mountains, Alojzije stabilized its home range in its southern part near the village of Sveti Rok. The lynx Catalin was released in the forests of Snežník after quarantining in Slovenia (March 31nd). After the release, Catalin moved south to the Slovenia-Croatia border near the home range of the female Martina, a rehabilitated orphan captured by the Croatian team in November 2019 and released in the Risnjak National Park in February 2020. Furthermore, Catalin moved near the Učka National Park in Istria (Croatia), crossed Gorski Kotar and returned to Slovenia. The male lynx Boris completed a longer quarantine at the Loški Potok station (released on May 28nd) and emigrated to Croatia between Gerov and Čabar.

The sixth translocated lynx and the first individual from Slovakia was a five-year-old male Pino (Hron) captured from the wild in the Vtáčnik Mountains on March 25nd 2020. Prior to the translocation itself, the lynx was quarantined in a specialized facility of the NZG Bojnice intended for the rehabilitation of lynx and large carnivores. The quarantine itself can be considered problem-free because the lynx did not suffer any injuries. On July 14th 2020, Pino was released into the forests of

Štirovač in the border area between the Norther Velebit National Park and the Velebit Nature Park. Due to the technical failure of its telemetry collar, it is currently not possible to evaluate its further spatial behavior. The seventh translocated and second Slovak lynx is Maks. The male Maks completed a successful rehabilitation at the NZG Bojnice. Employees of the Poľana Protected Landscape Area Administration from the State Nature Conservation of the Slovak Republic joined forces with the NZG Bojnice and successfully captured this lynx. At that time, the lynx was in poor condition and had broken front leg. He was transferred to NZG Bojnice, where he was successfully rehabilitated. In excellent health, he was the first Slovak lynx to be translocated to the quarantine station in Snežník, 47 years after the historical reintroduction, from which he was released on June 23nd. A few days after release, Maks caught its first prey (roe deer) and confirmed that, despite its previous handicap, it had successfully adapted to its new environment. Together with the male Pino, we also managed to capture a 10-month-old male Timo at the end of winter (March 13th) in the Vtáčnik Mountains. Timo was marked with a telemetry collar for further monitoring and released back into nature.

For the successful reinforcement of the lynx population in Dinaric Mountains and South-Eastern Alps, it is crucial that translocated lynx genes are integrated into the population. Using a combination of telemetry data, records from camera traps and genetic analyses, it was confirmed that the father of the young female Mala, born in 2019 in Slovenia, is the Romanian male Goru. This progress is a positive sign for the future of the whole project and the lynx populations in the Dinaric Mountains and the South-Eastern Alps.

Together with the LIFE Lynx project, a similar project LIFE Luchs "Reintroduction of lynx in the Palatinate Forest" (LIFE13 NAT/DE/000755) was also implemented in Slovakia. It was implemented through the non-profit organisation DIANA – Carpathian Wildlife Research in cooperation with partners from the Stiftung Natur und Umwelt (Germany), KORA (Switzerland) and NZG Bojnice and included the systematic monitoring of the lynx in the Štiavnica Mountains PLA (Kubala et al. 2019a), the Muránska planina NP (Smolko & Kubala 2017, Smolko et al. 2018) and the Strážov Mountains PLA (Kubala et al. 2020b). The LIFE Luchs project aims to establish a lynx population in the Palatinate Forest, which is the largest continuous forest area in Germany. The main goal of the LIFE Luchs project was to establish a lynx population in the Palatinate Forest, which is the largest continuous forest area in Germany, the part of UNESCO and the Palatinate Forest / Northern Vosges Biosphere Reserve (Germany / France), as well as the lynx dispersal to the Vosges and Swiss Jura Mountains. (i.e. rescue of the reintroduced lynx populations in the Vosges and Jura Mountains). Since 2016, a total of 20 lynxes have been translocated and released to the Palatinate Forest in Germany as part of the LIFE Luchs

project, 8 of which came from Slovakia. In order to ensure the monitoring of their spatial behaviour and diet, as well as for the purpose of monitoring the course of reintroduction, all lynx received a GPS / GSM telemetry collar. The first three lynx that were released in this area on July 30nd 2016 were orphans, females Luna and Kaja and male Lucky. The fourth translocated lynx was the male Cyril (released on April 22nd 2017), captured from the wild in the Muránská planina NP (Smolko & Kubala 2017, Smolko et al. 2018). In 2017, Cyril was followed by a rehabilitated orphan, female Labka from the Poloniny National Park (released in the Palatinate Forest on 15th December 2017). The sixth and seventh lynxes that were translocated to the Palatinate Forest were orphans, males Wrano and Alfi, originating from the Low Tatras NP and the Low Beskydy Mountains. Wrano was released on September 11th 2018, while Alfi had to be placed in a rehabilitation station in Germany because his GPS / GSM telemetry collar failed during transport. The next day, September 12th 2018, his collar was replaced and Alfi followed Wrano into the wild. In the first half of 2019 (Jun 6th), there was an another Slovak lynx released, the two-year-old male Braňo, captured in the Strážov Mountains (Kubala et al. 2020b). Within a week of its release, Braňo, like the previous animals, had caught his first prey (roe deer) and confirmed that it had successfully adapted to its new environment. The male Braňo was the last Slovak lynx released in the Palatinate Forest within the LIFE Luchs project (Kubala et al. 2020b).

The first three Slovak lynxes were followed during 2017 by other animals, male Arcos (March 7th) and two females Bell (April 5th) and Rosa (April 14th) captured in the Swiss Jura Mountains. 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. Throughout France, Arcos' arrival was a positive message for the survival of this species in the Vosges (Smolko & Kubala 2017, Smolko et al. 2018). At the end of 2017 (December 20nd), an orphan female Alosa, was released into the Palatinate Forest. During 2018, two more lynx were released, male Juri (March 16th) and female Jara (April 18th). While in 2019 three further individuals, females Mala (February 5th) and Gaupa (February 22nd), and male Libre (March 7th) were released. At the beginning of 2020, the last three lynx were released, females Isis (February 21nd), Lycka (March 20nd) and Tarda (March 20nd). The reintroduction project in the Palatinate Forest recorded its first significant success during the second year of its implementation (2017). After 200 years of absence, successful reproduction of a rehabilitated lynx from Slovakia was confirmed and the female Kaja brought the first offspring (two males Filou and Palu) to this area. More cubs were born in 2018 (provably 5, probably 8) to the female Kaja (at least 1 cub, potentially 2), and for the first time Swiss

females Rosa and (at least 2 cubs, potentially 3) and Jara (1 cub), as well as in 2019 to females Mala and Gaupa. The father of two cubs (Mala) is the Slovak male Wrano. In 2020, reproduction has so far been confirmed to two unidentified females (2 and 3 cubs).

Four lynxes were captured during the winter of 2018/2019 and released back in Slovakia for telemetry monitoring. The lynx male Roman (3-5 years old) was captured in the Strážov Mountains PLA on December 9th 2018, while female Zora (assumed age 10 - 11 years) on February 8th 2019. In addition to the two lynx in the Strážov Mountains PLA, another 2 lynx were captured and collared in the Muránská planina NP. On January 23nd 2019, the male Zoran (3 - 4 years old) and on April 9th 2019 the male Vlado (assumed age 5 years). During the winter of 2019/2020, three lynx were captured and collared in the Strážov Mountains PLA. Male Beňadik on February 2th 2021 (assumed age around 5 years), male Zoro on March 11th 2021 (5-7 years) and female Elza on March 24nd 2021 (expected age 3 years). Results of both projects (LIFE Lynx and LIFE Luchs) are important steps for the conservation of lynx populations in the Central and Western Europe.

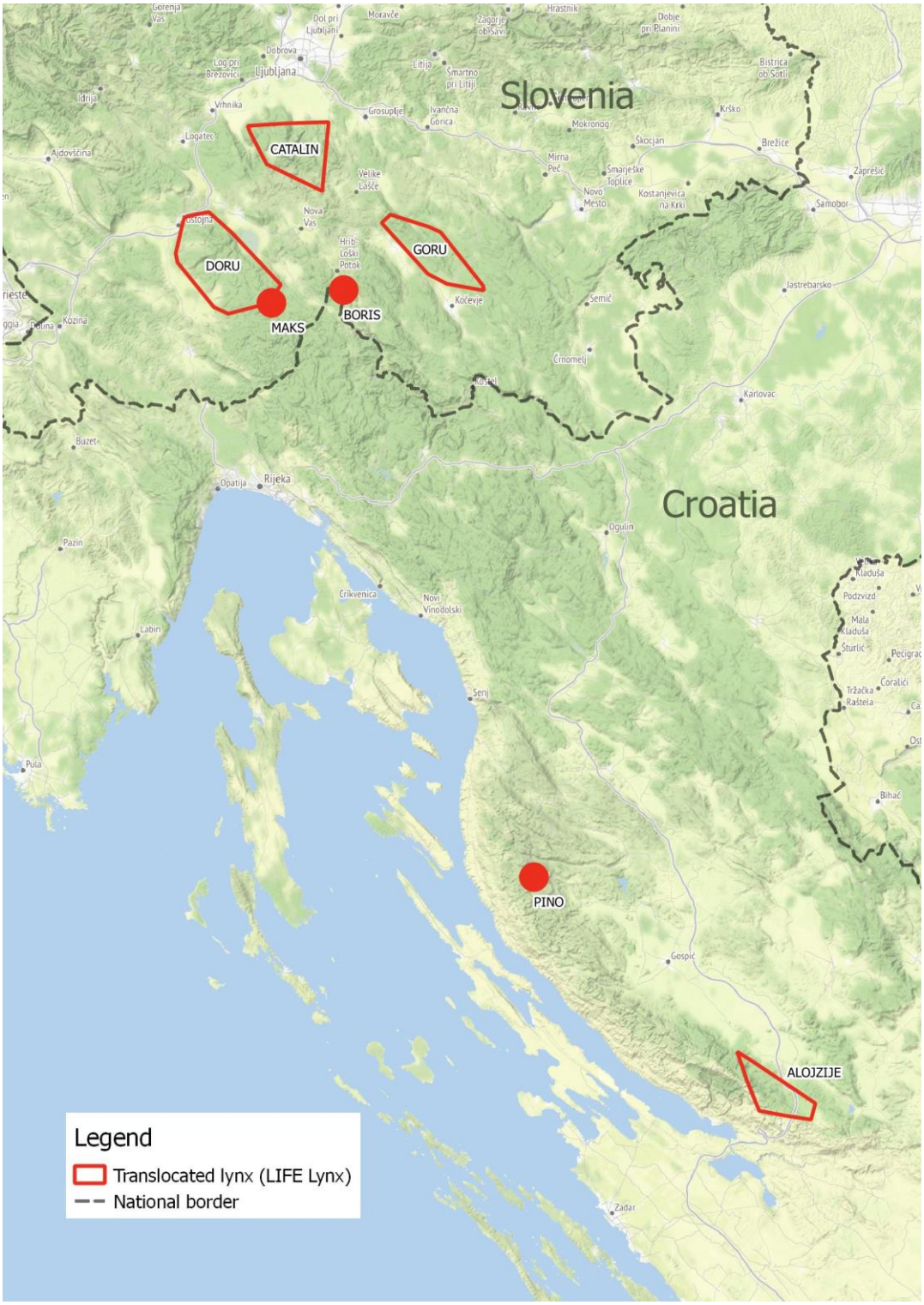

Figure 5. Spatial distribution of translocated lynx from the Carpathians to the Dinaric Mountains within the LIFE Lynx project (orange polygons and circles). The dashed line represents national borders (https://www.lifelynx.eu/great-success-seven-lynxes-translocated-in-two-years/?lang=sk).

4. Conclusions

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

1. the viability and long-term survival of the autochthonous lynx population in the Slovak Carpathians has a great importance for the international management and large-scale conservation of the lynx in Europe,
2. 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 the Slovak Carpathians,
3. 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,
4. based on our results, it is possible to claim that the lynx population in the Vtáčnik Mountains, the Muránska planina NP, the Vepor Mountains and the Strážov Mountains PLA corresponds to the favourable status according to the Habitats Directive NATURA 2000,
5. given the favourable lynx status in the Vtáčnik Mountains and the Vepor Mountains, both populations can be a source for the reinforcement of this species into the Dinaric Mountains and South-eastern Alps in accordance with the Care Program, Habitats directive, the Key Actions for Large Carnivores in Europe (Boitani et al. 2015), the Recommendations for reintroductions and further translocations of species for conservation purposes and the Recommendations for the conservation of Eurasian lynx in Europe.

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. 2019a, b, 2020a, b, Smolko & Kubala 2017, Smolko et al. 2018).

Another significant negative factor is illegal hunting. A negative attitude of local hunters towards the presence of lynx originates in a belief that the species is responsible for the alleged decrease of roe deer populations in Slovakia. However in contrary, according to hunters' records the population of the roe deer steadily increases over the past two decades (Kubala et al. 2019a, b, 2020b, Smolko & Kubala 2017, Smolko et al. 2018). It will be crucial for any further progress to reach a common understanding and a trade-off among all concerned groups of stakeholders in Slovakia (conservationists, hunters, foresters and a general public) and based on the acceptance of the independent scientific based data (Bath et al. 2009, Kubala et al. 2019a, b, 2020a, b, Smolko & Kubala 2017, Smolko et al. 2018). The cooperation of all stakeholders in previous studies as well as in the systematic monitoring in the Vtáčnik Mountains is an excellent example of cooperation and mutual trust, as well as an important precedent for resolving predator-human conflicts in the future.

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