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

Surveillance of the reinforcement process of the Dinaric - SE Alpine lynx population in the lynx-monitoring year 2021-2022

Action C.5

Including data collected within Slovenian national large carnivore monitoring scheme, InterMuc, Rewilding Velebit, Public Institution Nature Park Velebit and Public institution National park Plitvice lakes.

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* LD - hunting club (in Slovenia), LPN - The special purpose state-owned hunting grounds (in Slovenia), NP - national park, PP - nature park, PLI - Progetto Lince Italia, CUFAA - Carabinieri Command of Units for Forestry Environmental and Agri-food protection, SF = Stazione Forestale, ÖBF = Österreichische Bundesforste, RC T-M = Riserva di Caccia Tarvisio-Malborghetto

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1 INTRODUCTION

The main goal of the LIFE Lynx project (LIFE16 NAT/SI/000634) is preventing extinction of the Dinaric – Southeastern Alpine lynx population through reinforcement. Monitoring of the reinforcement process is fundamental in order to be able to fine-tune the process over the years and to choose and implement the optimal solutions for the upcoming lynx releases. It will be also essential in order to gain a good understanding of the process, upon which long-term lynx conservation strategy will be based, and to share experiences from our project with the broader expert community involved in lynx conservation efforts across the species range and potentially other felid species worldwide. Within the C.5 action, we are annually surveying the lynx population and impact of the reinforcement activities over its entire project range in Italy, Slovenia, and Croatia, using methods that allow us to assess its size, distribution, genetic structure, and several other important population and ecological parameters.

However, we could not have presented such a detailed status of the lynx population if we had not also included the data obtained through funding from other international or national projects (see the acknowledgments). Combining different resources allowed us to produce a result that surpasses any of the individual project's or program's goals. For example, roughly a third of the camera traps in Slovenia were purchased and maintained with funding from the national large carnivore scheme (Ministry of Natural Resources and Spatial Planning of Slovenia) and thus significantly contributed to the level of accuracy of the data collected and presented in this report. Therefore in Slovenia, the field design used for camera trapping surveillance allows us to collect data which can be used to make more robust conclusions about the lynx abundance at a national level. Consequently, all these additional data importantly support the decisions made regarding future lynx translocations which is the core activity of the LIFE Lynx project. This report describes the progress of the reinforcement of the lynx population in the Dinaric Mountains and Southeastern (SE) Alps in the fourth year of the C.5 action "Surveillance and directed management of the reinforcement process". It builds on the first and second annual report within this action (Krofel et al. 2021, Fležar et al. 2022), where the lynx translocations to the Dinaric Mountains and SE Alps were described, together with an updated status about the remnant lynx population. The minimal population size of lynx in the Dinaric Mountains in the 2020-2021 survey season was 95 adult lynx, including 13 translocated lynx from the Carpathians. Five of eight translocated lynx to Slovenia and Croatia have established their territories in the Dinaric Mountains, while the Slovenian Alps have become home to five translocated lynx. Still, just a few verified records of lynx presence were available from the Slovenian pre-Alpine area and no reliable records had been collected in the rest of the SE Alps (Krofel et al. 2021). We could not confirm for three translocated lynx (Doru, Maks, Pino) a successful integration in the population. In 2020-2021, we have detected another generation of offspring of translocated lynx Goru (offspring captured and genetically sampled) and the presumed first generation of offspring from Katalin and Alojzije (females with kittens recorded on camera traps within their territories) which were adding to the other 16 reproductions detected in the entire survey area (Fležar et al. 2022).

In the survey year 2021-2022 we have continued monitoring the progress of the reinforcement with several complementary methods, i.e. camera trapping, non-invasive genetic sampling, GPS telemetry and collecting mortality and reproduction records. We adjusted some aspects of their implementation, e.g. choosing new locations for camera traps, according to the new experiences to increase the monitoring efficiency. We also continued with collecting opportunistic data and categorizing them into SCALP categories (Molinari-Jobin et al. 2021), which gave us additional information about lynx population distribution and helped to fine-tune camera trapping and non-invasive genetic sampling. We have maximized the efficiency of snow-tracking activities, building on experience and data from

the previous survey years to collect non-invasive genetic samples in areas with highest relevance. Furthermore, collaboration with hunters was enhanced and expanded into the new hunting grounds not included in the systematic lynx surveillance in the previous years. We also invest a lot of effort into communication with the general public and as a result each year we are getting more opportunistic signs of lynx presence, primarily from camera traps owned by Croatian hunters.

With this report, we provide the information about the basic demographic parameters (e.g. lynx distribution, minimum number of adult individuals and minimum number of reproductions) and the key parameters describing the genetic status (e.g. inbreeding coefficient) of the lynx population during reinforcement process, as well as detailed information about the history and current status of all the translocated animals after their release.

The surveillance results presented in this report focus on "lynx-monitoring year" 2021-2022 (i.e. 1st May 2021 until 30th April 2022), which is in accordance with the SCALP methodology as an international standard for assessing and reporting the lynx status (Molinari-Jobin et al., 2021). However, we also report some of the data collected outside this time frame (i.e. collected after 30th April 2022), when they were relevant for the further release plan and to obtain a fuller picture of the current situation. Whenever this was done, we noted the extended surveillance period of the data presented.

Chapters of this report are structured so that we first describe the effort and the data obtained with each of the method used (chapters 2.1-2.5) and then we synthesize and interpret the current status of the lynx population for each specific region within the population according to combination of all data obtained by all methods (chapters 3.1-3.4). Based on the results of the surveillance, we also provide recommendations for further lynx releases at the end of the report.

2 METHODOLOGY AND RESULTS

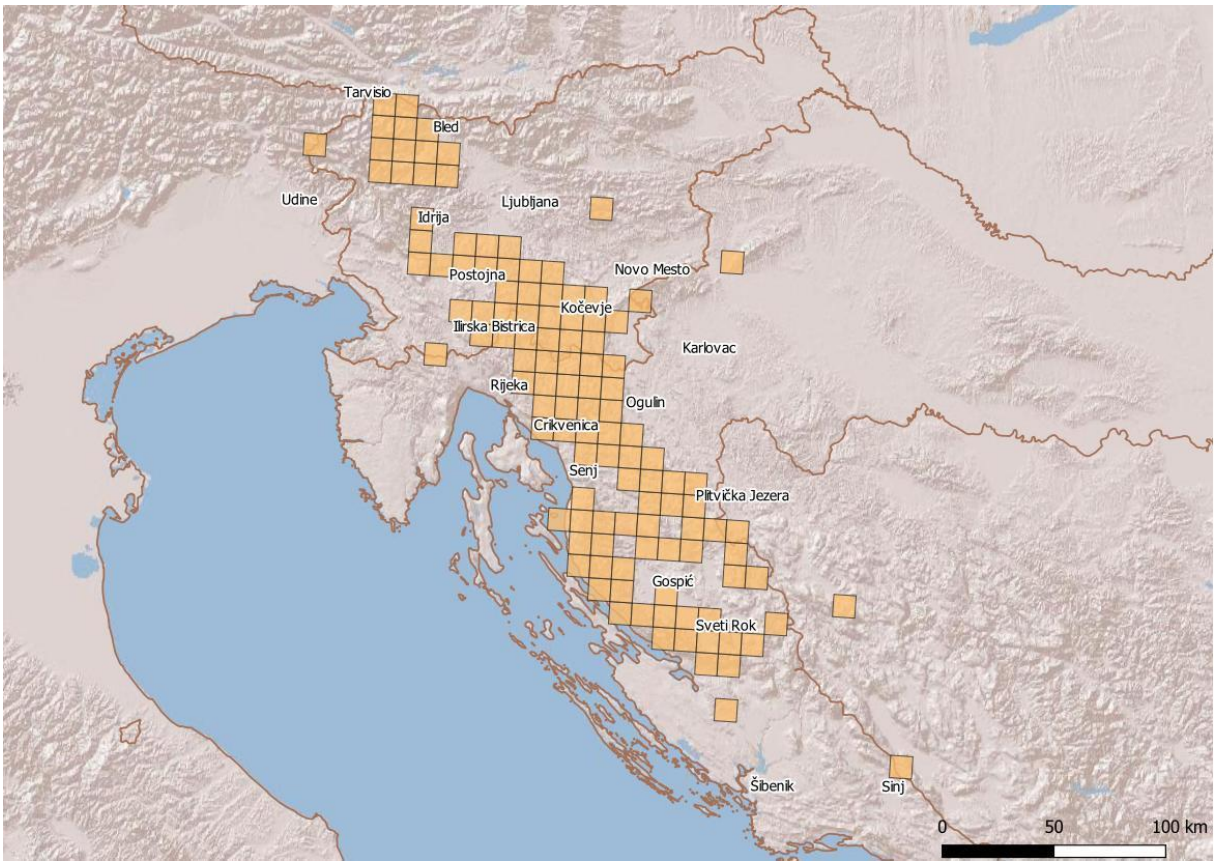

Figure 1. Confirmed lynx distribution in the Dinaric-SE Alpine area based on available data from Italy, Slovenia and Croatia in 2021-2022. Grid cells were colored on the basis of confirmed records of lynx in a standard European 10 × 10 km grid net. Four types of data were considered as confirmed lynx records: opportunistic data categorized as C1 or C2 record, GPS locations from collared animals, camera trapping records and genetic records.

2.1 Opportunistic data collection

Opportunistically-collected data represents the basic information available for lynx presence across the three countries (Italy, Slovenia and Croatia) and is an important guide for all further efforts aiming to evaluate lynx population parameters in a more coordinated and systematic way. The categorization of opportunistically-collected lynx presence data follows an international standard (Molinari-Jobin et al. 2012), making these data comparable over different habitats, regions, and countries. It recognizes three levels of opportunistic data reliability, so called SCALP ("Status and Conservation of the Alpine Lynx Population") categories: unconfirmed records (C3), records collected or verified by lynx experts in the field (C2) and hard facts with material evidence (C1). The data are usually presented in a grid with 10×10km cells (e.g. KORA 2017, Molinari-Jobin et al. 2020). Traditionally, SCALP reports were produced on an annual level following calendar years, but since 2017 it has been agreed that the data is summarized per "biological lynx year" (i.e. from 1st May of the given year till 30th April of the following year), which is also a standard used in this report.

In season 2021-2022 most of the opportunistic data collected were reliable records of lynx presence (C1). While more than a hundred records were collected in Slovenia and Croatia, only a couple of

opportunistic records were collected in NE Italy. Those were one direct observation in Veneto region and lynx prey remains in Friuli Venezia Giulia, close to the border to Slovenia. This record could indicate potential expansion of the stepping stone population created in Slovenian Alps towards West.

In Croatia, most opportunistic records are provided by hunters, primarily images from camera traps used for game monitoring. As the lynx distribution area in Croatia is quite extensive and systematic camera trapping implemented within the LIFE lynx project can not efficiently cover the entire area, these data are very valuable. In the 2021 - 2022 season hunters provided 44 lynx images, while 19 lynx images were provided by the camera trap network operated by the Public institution National park Plitvice lakes. So a lot of effort is put into communication and cooperation with hunters, but also managers of protected areas and the general public. Hunters and the general public are also the main source of opportunistic records outside the main lynx distribution area in Gorski Kotar, Lika and northern Dalmatia. Unfortunately those records often are not backed up with evidence, so they are listed as C3 category data. For instance, this season anonymous, unconfirmed report of lynx poaching came from an area south of Benkovac, around villages Medviđa and Rodaljice, which is about 20 km southwest of the nearest locations of confirmed lynx presence in Dalmatia. We also received an unconfirmed report of a lynx sighting on the northern outskirts of Zagreb, about 15 km from the city center. That kind of info can help us monitor the expansion of distribution or occasional migration of individuals outside of the core distribution area.

Widespread and effective collaboration with hunters in Slovenia provided again most of the opportunistic data. In addition, within the framework of the national large carnivore monitoring scheme, we sent out questionnaires twice per year (in May and August) to the Slovenian hunting grounds (n=217). Each hunting ground answers the questions about the lynx presence, whether that was regular or occasional. We pooled the responses from both surveys, assuming lynx presence if it was reported at least once. 53 hunting grounds (24.4%) reported positively; out of those 31 with regular lynx presence; 161 (74.2%) reported no lynx in their area and 3 did not respond. We received responses that overlap other opportunistic data collected in most of the country. One lynx photo was sent from the easternmost range of reported lynx presence, followed also by the report in the questionnaires. A verified record of lynx was also available in the Southern Primorska region, supported by the questionnaires and indicating potential expansion of lynx to the West. Moreover, questionnaires' responses indicated permanent lynx presence in the pre-Alpine area, where one C2 record was collected (presumed lynx damage on fallow deer; genetic samples taken but did not yield any results) and one verified record (a video of lynx at its kill) collected in Nanos area. That lynx was recognized as the same individual recorded through systematic camera trapping in the adjacent Hrušica area (Figure 51, chapter 3.1 for more details). Interestingly, lynx presence was reported also in Northern Primorska (hunting grounds Most na Soči and Trebuša), but no verified records were available from there. Once again, the questionnaires and opportunistic data proved as a quite reliable source of information to be considered in further exploration of lynx presence in the Dinarics and SE Alps.

Even though in this project we do not have partners from Bosnia and Herzegovina, our monitoring efforts are recognized there also, so this season we also received opportunistic records from there - two camera trap images. As we share the same population, these records were also included in our report. We will invest further efforts into strengthening our cooperation with Bosnian experts and share our knowledge and experience to improve their monitoring system.

Table 1. Opportunistically-collected data about signs of lynx presence, categorised according to SCALP criteria, in lynx-monitoring year 2021-2022.

	Slovenia	Croatia	Italy	All countries
C1	55	87		142
C2	70	28	1	99
C3	15	21	1	37
total	140	136	2	278

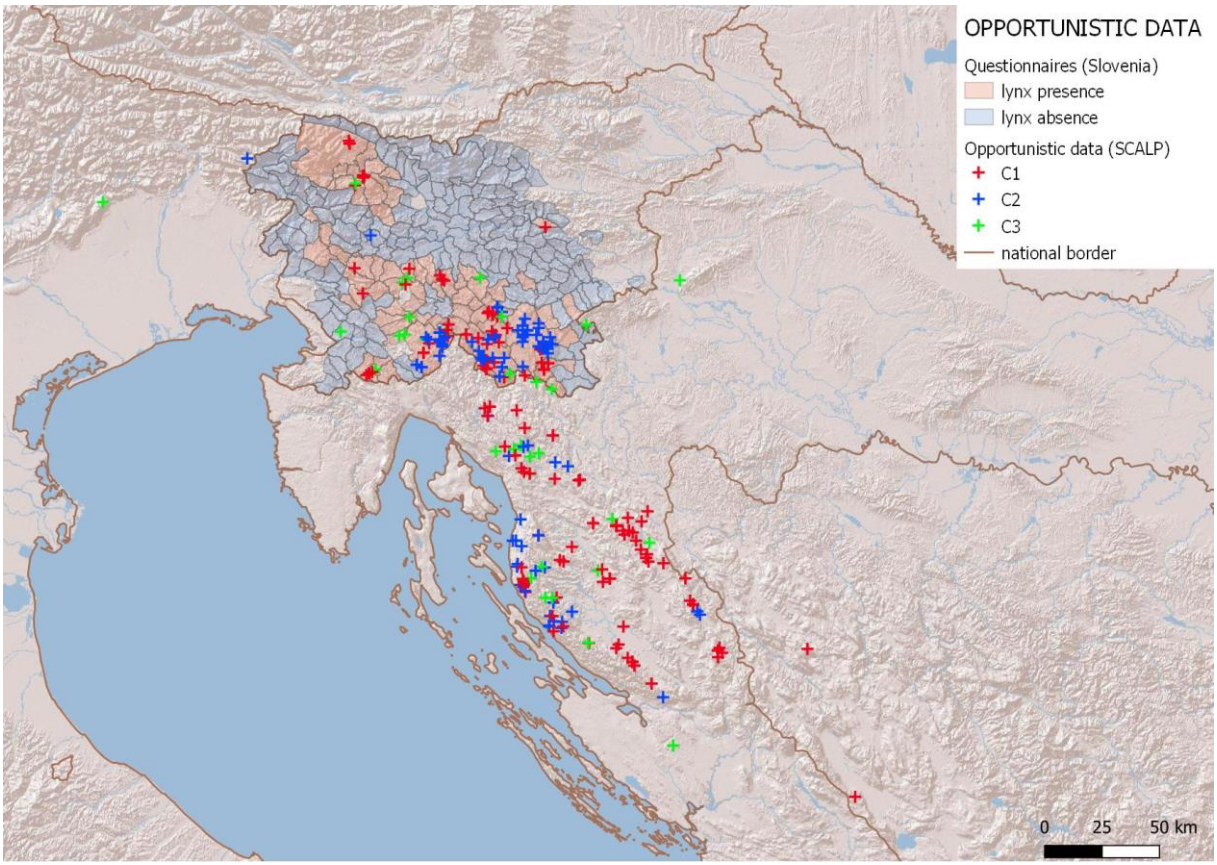

Figure 2. Opportunistically-collected data in 2021-2022, categorised in three SCALP categories (C1, C2, C3) shown together with responses received from the questionnaires sent to Slovenian hunting grounds.

2.2 Systematic camera trapping

Camera trapping is currently recognized as the most effective method for monitoring lynx abundance and distribution in Central Europe (Hočevar et al. 2020; Rovero & Zimmermann 2016; Palmero et al. 2021). It often allows individual identification based on the distinctive coat pattern of each individual animal (although the identification process can be more difficult in cases when lynx pelage has rosettes or is unspotted). Camera trapping and individual identification allows a straightforward and robust

estimation of the minimum number of individuals in the study area or, with appropriate data, also an estimate of abundance and density using a (spatial) capture-recapture approach (Royle et al. 2014). The first estimates of lynx density in the Northern Dinaric Mountains are reported in Fležar et al. (2022).

We covered roughly 13,600 km2 with an extensive network of camera traps over the core area of potential lynx distribution in Slovenia, Croatia and Italy (Figure 3). We placed one or two (exceptionally three) camera traps per location (i.e. camera trap station), either at the same locations that we already surveyed in the previous years (Fležar et al. 2019, Slijepčević et al. 2019, Krofel et al. 2021, Fležar et al. 2022) or at new locations. The main population parameters that we obtained through camera trapping are the minimum number of adult lynx and the minimum number of reproduction events with the number of kittens per such event (Table 2). The sex of the identified animals could be determined in some, but not all cases.

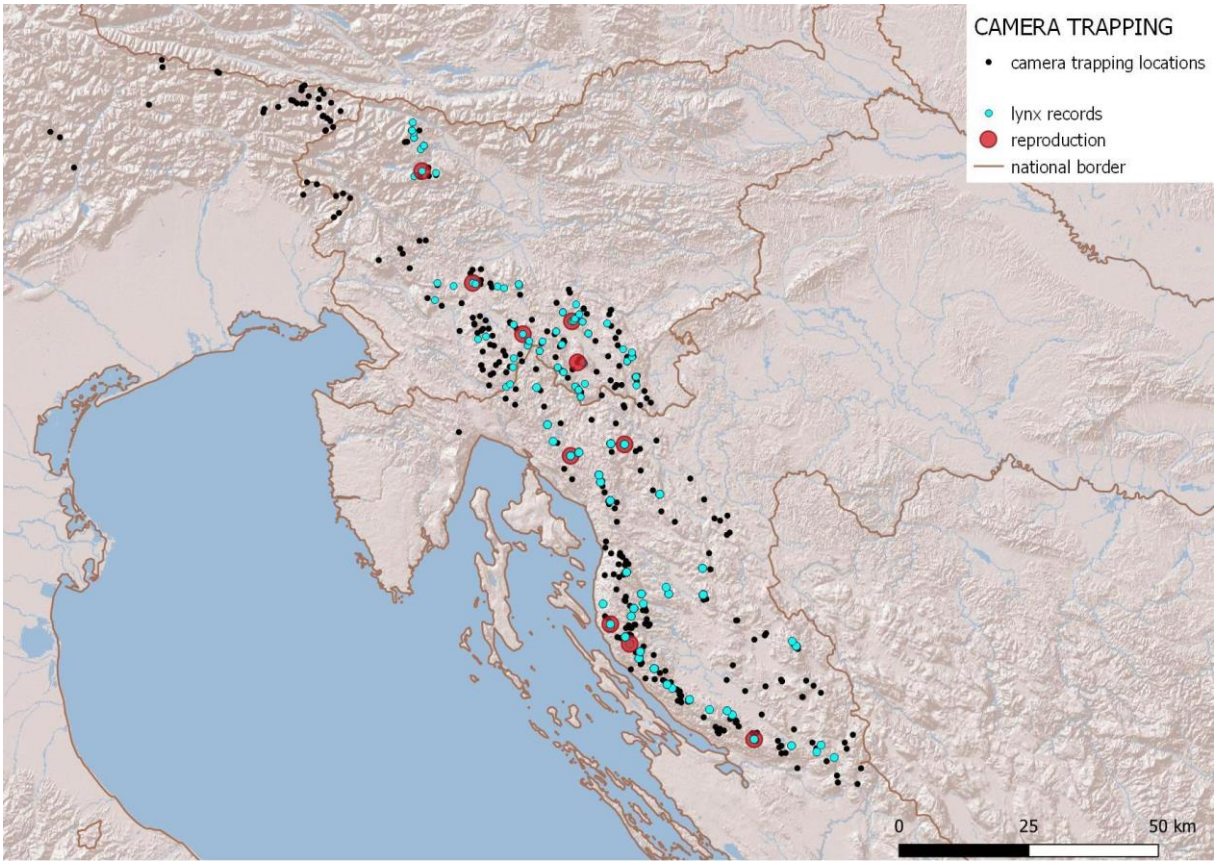

Figure 3. The camera trapping effort and main demographic results from the 2021-2022 survey season. The locations of all camera traps used for camera-trap monitoring are shown as black points. The locations where at least one lynx was recorded are shown in blue and reproduction events are marked additionally with red points (we show each individual female with kittens as one data point, not accounting for possible multiple detections).

In Slovenia, a vast majority of the systematic camera trapping involved help provided by the hunters from the Special purpose state-owned hunting grounds (LPN) or by local hunting clubs (LD). Exceptions to this are three camera-trapping sites, where other volunteers are operating the cameras and retrieving the data and some of the sites that were operated by the project staff. Most of the funding for systematic camera trapping in LPNs was ensured by the national large carnivore monitoring scheme (two-thirds of state-owned LPN locations; n=40), while the funding for the rest of the locations in LPNs

managed by the SFS and all locations in LDs was funded by LIFE Lynx project (in total 123 locations; Table 2), including the locations in LPN Triglav, managed by the Triglav National Park (additional 10 locations). In total, camera trapping involved 6 LPNs and 51 LDs, covering 20.4 % of the entire country. Due to the combination of funding to implement camera trapping over the entire presumed lynx distribution area in Slovenia (Figure 1, Figure 2), we can conduct it in a systematic way on a national level.

For the new locations, we followed the same approach as in the first survey year: we held informative meetings with hunters or other camera trap operators and discussed the potential best locations for lynx camera trapping and visited them together in the field to choose the micro-locations using criteria described in Stergar & Slijepčević (2017) and set up the camera(s). Afterwards, most of the camera traps were operated (i.e. regular maintenance and changing of SD cards and batteries) by hunters and other non-project staff. When we started the new camera trapping season, we held informative meetings with 85 hunters (7 in areas not included in the previous year). In Croatia, camera trapping was conducted in 41 hunting grounds, 3 national parks and one nature park. In Italy, the grid covered 10 hunting grounds, and several meetings were held to build on existing connections with hunters.

A vast majority of the camera trap stations were set up at similar locations as in the previous years (Fležar et al. 2022, Krofel et al. 2021). In Slovenia, the cameras were mostly set to take one photo and one video (10s) when triggered by movement. One type of the camera traps used (StealthCam G45NGX) could not record both photo and video, so we set it to only record photos to standardize data collection with the other two types of camera traps used (Moultrie M40-i and Cuddeback X-Change). Also the Cuddeback camera traps with white flash illumination only collected photos during the night, while also videos were recorded during the daytime. In addition to recordings made upon detection of movement, camera traps in Slovenia were programmed to take an additional one photo per day using the 'time-lapse' function for operability check-up. In Croatia several camera trap producers and models are used for systematic monitoring Cuddeback (X-change; H series Manual 8.0.0; 1279; 11339), Ltl Acorn (6310 3G, 6511W 4G, 6511WMC) and Browning Strike Force PRO XD. The cameras were mostly set to take one photo and (20 - 30 sec) video, depending on the specifics of a location or camera model. As Browning cameras can not capture photos and video for the same event, so they were set to capture 3 photos as fast as possible. In Italy, we used Browning Spec Ops Advantage, IDS IR-Plus HD2, Cuddeback Professional and Spypoint Link Micro. All cameras are set to take 3 photos in a burst each time the camera trap is triggered.

The cameras in Slovenia were deployed in August or September when project staff from Slovenia Forest Service (SFS) and University of Ljubljana (UL) joined the camera operators (mostly hunters) at the initial setup of the camera trap stations. Camera operators alone checked the cameras, retrieved the SD cards and handed the data to the local coordinators from the project team who then processed the data (using software Camelot). This was mostly done monthly until January, based on recommendations from Zimmermann et al. (2013). After January, the cameras were left recording until April, but they were not maintained nor the data retrieved until the withdrawal of the equipment. In Italy and Croatia, the camera trapping stations were operative over the entire year. In Croatia, 54 camera traps are maintained by project personnel, 20 by nature and national park rangers, 5 by foresters and 8 by hunters from collaborating hunting grounds. In Italy, 27 cameras are maintained by project personnel, 12 by Corpo Forestale Regionale staff and 6 by Polizia Provinciale di Belluno.

In total, we identified a minimum of 95 different adult lynx from the obtained photo/video material in the 2021/2022 monitoring season. Two lynx males were detected in both countries (Slovenia and Croatia) and this was accounted for in the summarized data (Table 2). To find the individual adult lynx which could have potentially been recorded in Slovenia and Croatia, we compared all records of adult

lynxes since 2018 in a 15-km buffer from the national border. We assumed that the probability of recording an adult remnant lynx on both sides of the border outside this buffer is low.

Lynx presence in Italy was confirmed by means of a C2 record (see also chapter 2.1) and warrants further investigation. In Slovenia and Croatia, the minimum number of adult lynx identified this year (93 adult lynx; 29 in Slovenia, 66 in Croatia) was similar to the previous survey season (Fležar et al. 2022). However this is a minimum population size, extracted from the raw data (count of identified individual adult lynx) and in the final assessment of reinforcement process (action D.2), we will provide a scientifically-based estimation of the change in the lynx population during the reinforcement. In Slovenia, all of the lynx wearing a telemetry collar (7 translocated and 3 remnant; one of the latter an offspring of a translocated lynx) during most of the camera-trapping season were detected with camera traps. The collared lynx that moved outside of the systematically-monitored area (male Maks) was recorded opportunistically in his home range North of the A1 highway (shown as C1 data points on Figure 2). All three translocated lynx present in Croatia during the 2020 - 21 season were detected by camera traps on their territories. Lynx Boris was photographed 6 times during the 2021-22 season, Alojzije was captured 8 times, while Emil was photographed once. Two remnant males collared in Croatia were also detected by camera traps, Pandora holds a record of being photographed on 23 occasions while Josip was photographed 15 times during the season.

In 2021/2022 we detected a minimum number of 15 reproductions and 35 kittens which indicates a lower number of reproductions, but higher number of kittens per female lynx than previously observed (e.g. 19 reproductions and 30 kittens were recorded in the previous season; Fležar et al. 2022). There was even a case of a remnant collared female Petra giving birth to four male kittens (sampled at the den) and all of them were recorded by cameras until the age of dispersal. In Croatia, opportunistic data contributed five additional records of reproductions (to the 10 records with systematic camera trapping). While we are observing a large fluctuation of number of kittens recorded in Slovenia over the years (a minimum of 2 females with one kitten each in 2019-20 and a maximum of 5 females with 15 kittens in 2021-22), the number of reproducing females remains stable (n=5; except in 2019-20). This survey season (2021-22) we recorded the third reproduction event for the translocated lynx Goru, and presumably the first one of lynx Katalin. In February 2022 we managed to capture and collar two Goru's offspring (Neža and Valentina; see chapter 2.4.3 for further details), which were also recorded by camera traps after the capture. In Croatia on the territory of translocated lynx Alojzije, a female named Mateja was photographed with three kittens, and a female lynx Buna has been monitored with camera traps since 2018 the northwestern edge of the territory of lynx Emil. Unfortunately, almost half of the territory of lynx Boris is suspected to be covered with land mines, so this area can not be monitored with camera traps and we might be missing info about a possible female this lynx is sharing his territory with. Spatial distribution of reproductions in both countries remains more or less similar to the previous years.

Table 2. Summary of the photo/video data obtained per country in 2021-2022 lynx-monitoring year. The minimum number of adult lynx in the Dinaric-SE Alpine region takes into account the fact that two animals were detected both in Slovenia and Croatia. The minimum numbers summarise all photographic data collected (camera trapping and opportunistically collected photos/videos). Sex of some of the animals could not be determined (these lynx are included in the min. no. of adult lynx, but not included in the min. number of males or females).

	Slovenia	**Croatia**	**Italy**	**Dinaric-SE Alpine area**

Total no. of systematic camera trapping sites (funded by LIFE Lynx)	173 (123)	221 (221)	45 (45)	439 (389)
Area monitored (km^2)	4400	7200	2000	13600
Density of camera trapping sites per 100 km^2	4.0	3.1	2.25	3.2
Min. no. of adult lynx	29	66	0	93*
Min. no. of adult females	12	17	0	29
Min. no. of adult males	11	32	0	41*
Min. no. of adult lynx of unknown sex	6	30	0	36
Min. no. of kittens	15	20	0	35
Min. no. of reproductions	5	10	0	15

*includes two lynx (Klif, Damir) which were recorded in Slovenia and Croatia and 10 translocated lynx (Katalin, Goru, Julija, Lenka, Tris, Aida, Zois, Emil, Boris and Alojzije)

2.3 Non-invasive genetic sampling

For genetic analysis, several types of non-invasive samples were collected: scat samples were stored in 95% non-denatured ethanol, urine samples (collected in snow) were stored in DETs buffer, hair samples were stored in sealed bags with desiccant (silica) and saliva samples were collected with forensic swabs (at prey or directly from live animals captured for telemetry or kittens found in dens). Tissue samples were stored in 95% ethanol and blood samples (on WTA cards) were taken from animals captured for telemetry. The number of collected samples is provided in Table 3.

DNA in non-invasive genetic samples is of very low quality and quantity, and contamination (especially with PCR products) is a serious issue. Therefore we used a dedicated laboratory for non-invasive genetic samples for DNA extraction from non-invasive samples and PCR setup. For all non-invasive samples, we used MagMAX DNA Multi-sample Kit (Thermo Fisher Scientific) with the "whole blood" protocol. The extraction protocol is implemented on a liquid handling robot (Hamilton Starlet) to achieve reliable, error-free, and fast DNA extraction (Skrbinšek et al. 2017). DNA extraction from tissue and blood samples is done in a separate laboratory, using manual DNA extraction kit (Sigma GenElute Mammalian Genomic DNA Miniprep Kit) following the manufacturers protocols.

We used ten microsatellite markers for individual ID run in a single multiplex: Fca132, Fca201, Fca247, Fca293, Fca391, Fca424, Fca567, Fca650, Fca723, Fca82. The best (reference) sample of each detected animal was amplified using 9 additional markers (F115, F53, Fca001, Fca132, Fca161, Fca369, Fca559, Fca742, HDZ700 (Menotti-Raymond et al. 1999; Menotti-Raymond et al. 2005; Williamson et al. 2002), bringing the total number of studied microsatellites to 19. SRY locus was used to determine sex of the animal. Microsatellites were amplified in 3 multiplexes, using Platinum multiplex PCR Master Mix (ABI). Protocols from Polanc et al. (2012) were adapted according to the Platinum kit user guide. The SRY sex marker amplifies also in non-felid species and it is used for sex identification also for other carnivores, so prey DNA (like fox) in a scat could cause problems. Also slight contamination from different animals in a sample (urine, hair, saliva from an object), can make the sex determination difficult. That is why in some cases we additionally analysed the sex of the animal with amelogenin genetic marker (Pilgrim et al. 2005).

Good quality tissue and blood samples were re-amplified twice. For non-invasive samples, we used a modified multiple-tube approach (Taberlet et al. 1996; Adams & Waits 2007) with up to 8 re-amplifications of each sample according to the sample's quality and matching with other samples. In the first screening process, each sample was amplified with the 10-marker panel (multiB panel) protocol twice and analyzed on an automatic sequencer (Applied Biosystem ABI 3500 Genetic Analyzer). Results were interpreted using GeneMapper v.6.0. software (Applied Biosystems, USA). Samples that provided no specific PCR products at that stage were discarded. Consensus genotypes were determined using an Access database application programmed by T. Skrbinšek (MisBase, unpublished).

Genetic data were prepared in a laboratory database (MisBase), which we use to keep a record of the field data (T. Skrbinšek, unpublished). All non-GIS analyses were run in R (R Development Core Team 2020).

Table 3. Genetic samples collected in sampling season 2021/2022 and genotyping success.

Sample type	Sampling season 2021/2022	Successfully genotyped	Genotyping success
tissue	4	4	100%
blood	5	5	100%
scat	32	15	47%
urine	10	5	50%
hair	38	18	47%
saliva direct	10	9	90%
saliva from prey	5	0	0%
TOTAL	*104*	*56*	*54%*

Vast majority of non-invasive genetic samples were collected in winter during snow tracking or by visiting known marking sites or kill sites (where we focused on collecting samples from unknown lynx, i.e. kittens) (Fležar et al. 2022, Krofel et al. 2021). Hair trapping was not attempted in Slovenia, while in Croatia hair traps were active on 10 existing marking sites and on 4 of those sites hair samples were collected in the 2021 - 2022 season. The effort needed to find lynx tracks in the snow is high and must be recognized to help understand the manpower needed to collect genetic data about the inbred remnant lynx population and inclusion of the newly introduced lynx in the genepool. Similar to the previous year (Fležar et al. 2022), we collected information on snow tracking effort in Slovenia throughout the entire season with suitable snow conditions. We asked everyone collaborating in snow tracking activities (mostly the project team but also some independent volunteers and a local NGO, Dinaricum society) to report the distance, time and success of each field visit aimed to search for lynx tracks. The results presented in Table 4 are thus approximations based on individual reports, however, we trust that they fairly represent the effort needed for the amount of samples collected.

Table 4. Summary of the effort needed to collect the non-invasive genetic samples for lynx in Slovenia in 2021-2022. The numbers are approximations, based on individual reports; however, the number of samples is accurate.

	without any tracks found	with lynx tracks found	total snow tracking attempts*
no. of field visits	14	9	30
searching - walking (km)	136	29	230
searching - driving (km)	/	53	173
searching - total (km)	136	82	403
searching (hrs)	50	25.5	99
snow tracking (km)		15.8	15.8
snow tracking (hrs)		21.7	21.7
no. of samples collected		26	26

*includes also effort when only wolf tracks were found

The areas with the most collected samples were priority areas defined based on the presence of translocated animals and lack of genetic data from other lynx in the area, e.g. the area south of Ljubljana marshland (Menišija, Mokrc), or based on the expected offspring of translocated animals, e.g. the area of Mala Gora. The areas where new individual lynx (either adult or kittens) were detected via camera trapping were also intensively searched, especially in Kočevsko (Goteniška Gora, Stojna and Kočevski Rog) (Figure 4). Moreover, we responded to information about presumable lynx presence in Jezersko, however, we did not manage to confirm it. Due to poor snow conditions in the winter 2021-2022, the total effort spent for finding lynx tracks and the resulting number of collected samples (Table 4, Figure 4) was much lower than the previous year, i.e. with a total of 85 field visits, resulting in 61 samples collected, respectively. There were only 9 occasions where lynx tracks were found, 6 of them on Mokrc area where we focused on potential offspring of lynx Katalin, and one track each in Kočevski Rog, Suha Krajina and Pokljuka. Luckily, with the help of a trained detection dog, we managed to collect some valuable samples of hair and scat in the vicinity of lynx kill sites.

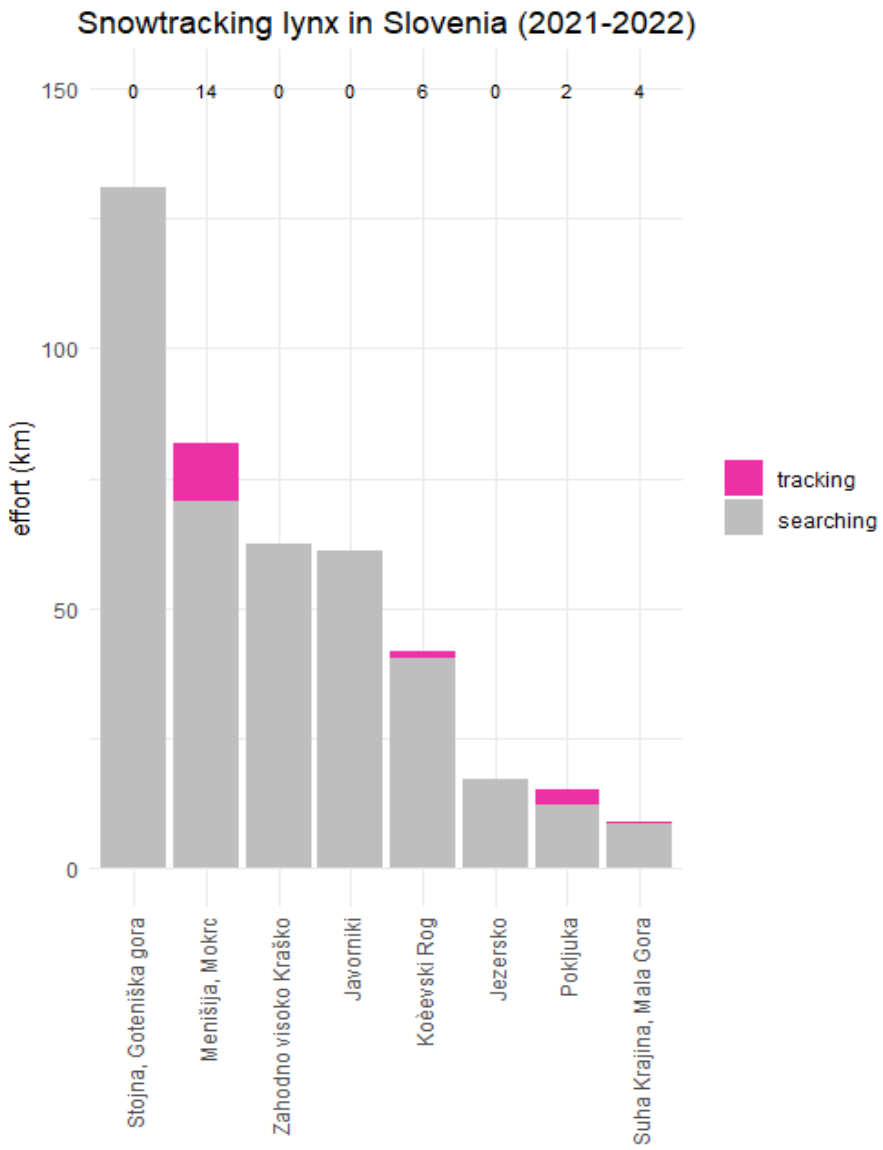

Figure 4. Summary of snow tracking effort in kilometers divided to searching for (grey) or tracking (pink) lynx. Each area outlines a potential home range of known or unknown lynx. The numbers above the bars indicate the number of non-invasive samples collected.

A total of 104 genetic samples were collected in the lynx-monitoring year 2021-2022 in Dinaric Mts. and SE Alps, 95 of them non-invasive. Out of all collected samples, 56 could be used for individual recognition of the animal. Seven samples could not be genotyped or used for sex determination but were confirmed to belong to lynx, while seven samples belonged to wildcats. The rest of the samples were discarded (34).

Overall genotyping success of collected genetic samples was 54%. In comparison with the previous monitoring season, the snow conditions were not good for snow-tracking and consequently we collected only 10 urine samples and half of them were successfully genotyped. The genotyping success of scat and hair samples was 47%.

As in previous years, most of the collected samples were hairs (n=38). The overall genotyping success of hair samples was 47%, which is better than the last year. The part of the hair that has DNA is the follicle, a bulbous end of a pulled-out hair. Not all hairs found in the field have follicles and they're often difficult to observe without a magnifying lens. Often, the hair collected is thin and short coming from the animal undercoat and difficult to work with. In such cases, we took all the hair in the extraction protocol, without cutting off the follicles. These samples worked well and most of them were successfully genotyped. While preparing these samples in the laboratory, we record how many hairs and how many hair follicles we saw in the sample (Skrbinšek 2017). The discarded samples mostly had no more than 4 follicles, however a sample of a single hair was genotyped. It is important to note the age of the sample in the field as that is an important factor in genotyping success (Krofel et al. 2021).

The following guidelines are as follows: 1) entire hair is valuable as it contains the hair follicles and cut-off hair is useless to genotype individuals, 2) the hair has to be collected as fresh as possible thus is crucial to record the sample collection date and 3) the samples must be properly stored, the bag with desiccant and sample envelope tightly sealed in and delivered to the laboratory as soon as possible. We store the envelopes with hair samples at room temperature in a dry and dark place. The hair itself is not very important so its length doesn't matter, it's the follicle that has the DNA; therefore it makes sense to collect as much hair as possible (Skrbinšek 2017). By following these guidelines, we can further improve the genotyping success of hair samples, which are the most important source of non-invasive genetic material in lynx monitoring.

Among the 56 successfully genotyped samples we recognized 29 individuals (21 males, 8 females), out of which 12 were already known from the previous sampling seasons. Again we sampled lynx Goru. In Mala Gora two kittens of remnant lynx Teja (no longer collared) were captured and genetic analysis showed lynx Goru is their father. With the help of a detection dog, we collected samples from Aida's kittens (2 individuals, both males) and confirmed the paternity by the reintroduced lynx Zois. In June 2022 three kittens from Aida's second litter were sampled and we confirmed Zois is also their father.

Genetic analysis also provided some new information on collared remnant individuals. Lynx Bor was known as "Kitten 1" sampled last year among Petra's four kittens. Lynx Igi was already genotyped in the last monitoring season and Klif in the monitoring season 2019-20. Also lynx Josip who was later captured was sampled earlier in the season. Interestingly, genetic samples from remnant lynx Mihec and Teja were again collected this year.

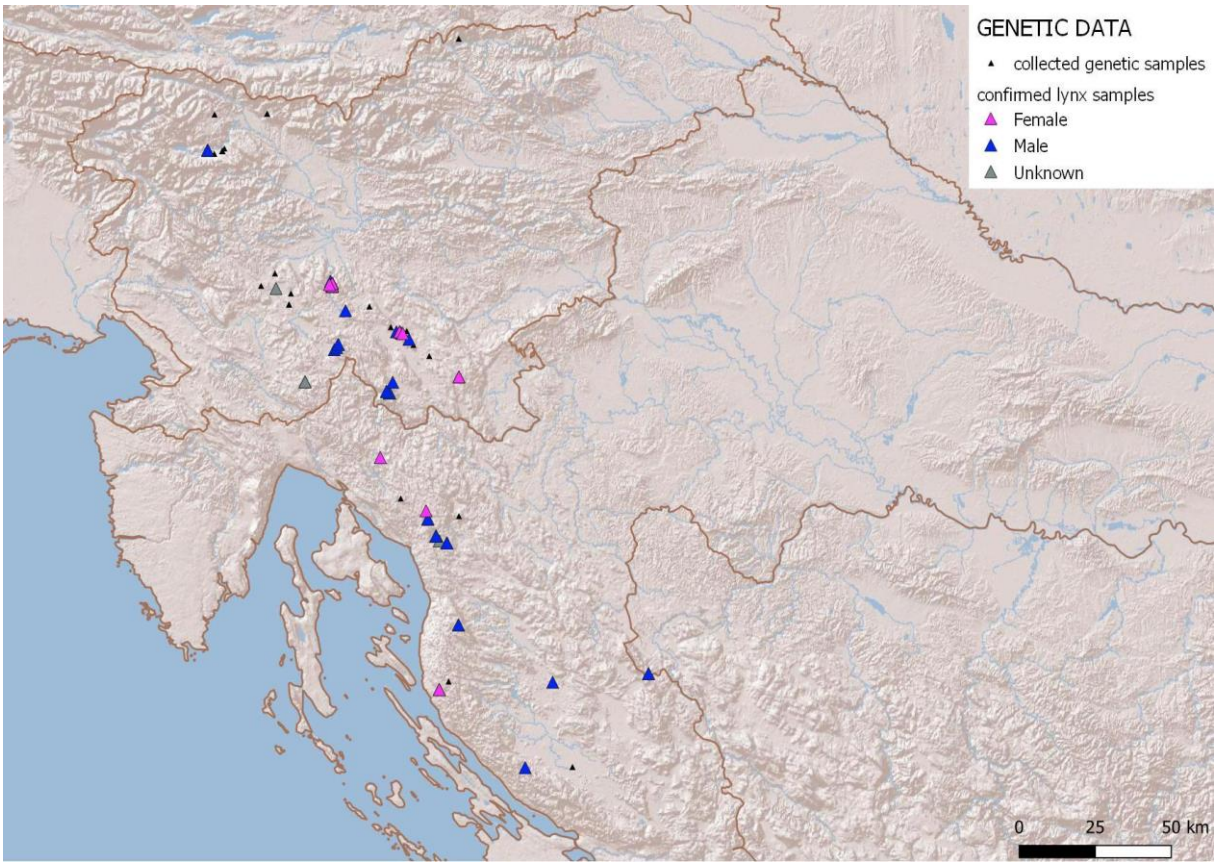

Figure 5. Genetic samples collected in 2021-22 season. Samples which were confirmed to belong to lynx are categorized by those belonging to females (pink triangles) and males (blue triangles) or those for which sex could not be determined (grey triangles). Collected samples that did not yield results are marked with black triangles.

2.3.1 Population genetics - effects of population augmentation

Our baseline population genetics study (Skrbinšek et al. 2019) showed how the Dinaric lynx population deteriorated genetically since the 1973 reintroduction, with the population approaching severe levels of inbreeding relative to the source population in Slovak Carpathians. New samples of the remnant lynx population in the Dinaric mountains (excluding the animals translocated from Romania and Slovakia in this project, and their offspring) allow us to further track this development. On the other hand, the genotypes of the translocated animals and their offspring allow us to catch a glimpse of how we can expect the population to develop if the translocated animals manage to continue successfully reproducing and including their genes into the population.

We analysed the additional samples of the remnant Dinaric lynx, which were collected since our last analysis (Fležar et al. 2022) to track population status. On the other hand, since the newly translocated lynx and their offspring are now physically a part of the Dinaric population, we re-ran the analysis with samples of these animals and their offspring included, to explore the effect they may have on the population assuming their successful integration (reproduction) within the population. During this analysis, samples from the lynx reintroduced to the Alpine stepping stone were excluded since we don't know how well this newly established population will exchange individuals with the lynx in the Dinaric Mountains.

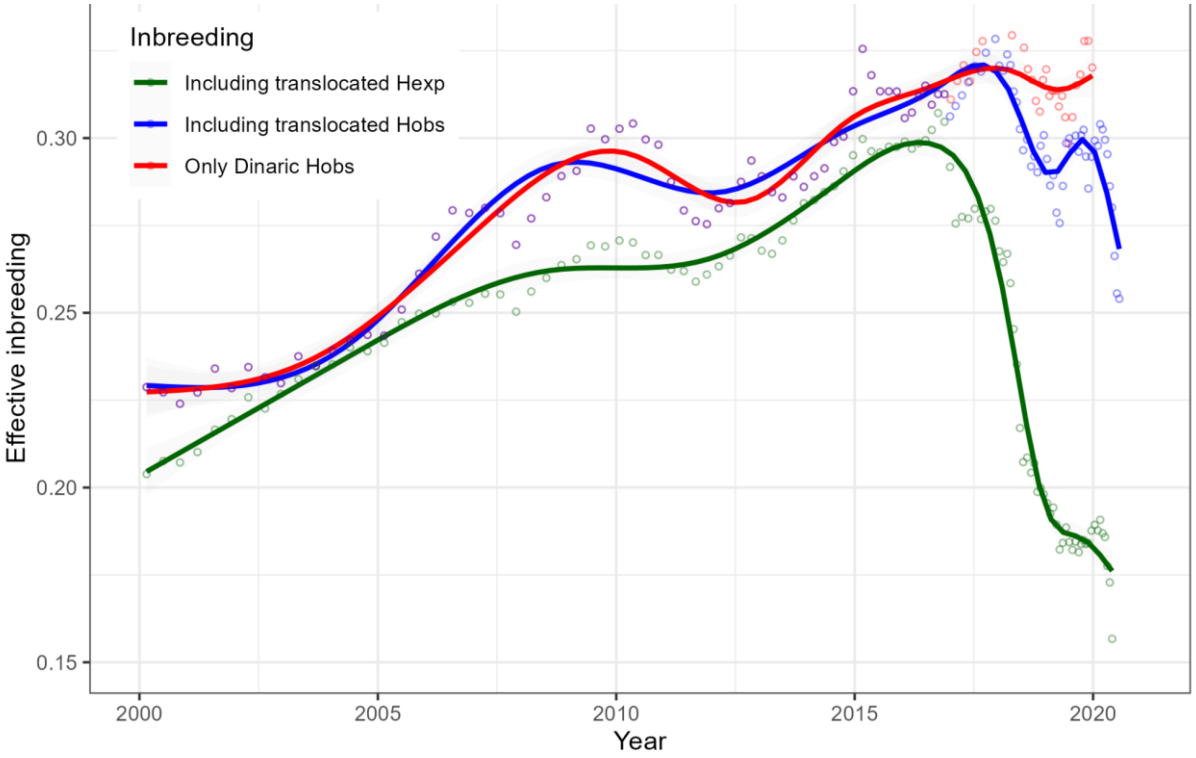

Figure 6. Effective inbreeding (Fe) of Dinaric lynx relative to the source population in Slovak Carpathians, calculated using heterozygosity in the Slovak lynx (estimated from the Slovak samples) and a 60-sample traveling window. Red - Fe calculated without translocated lynx and using observed heterozygosity, indicating situation without translocations; blue - calculated with translocated lynx using observed heterozygosity, indicating the current situation, green - Fe calculated with translocated lynx using expected heterozygosity, indicating the potential for a rapid inbreeding decrease if the translocated animals continue to successfully reproduce and their offspring form ~40% of the population.

With more data available, we can confirm that without translocations, the inbreeding in the Dinaric lynx population would remain high (red line in Figure 6). However, the current situation with translocated animals and their offspring included in the analysis, shows a dramatic improvement (blue line in Figure 6). When using observed heterozygosity for calculations, there is an evident drop in inbreeding even though the translocated animals and their offspring do not form a large proportion of the population yet. However, if the introduced animals and their offspring formed 15% of the total population (simulated through percentage of translocated/offspring animals included in the traveling window sample; green line in years 2019-2020 on Figure 6), the inbreeding estimated from expected heterozygosity would drop to 0.18, and approach 0.15 when translocated animals and their offspring formed around 40% of the population (the right-most green dots on Figure 6 where recently translocated animals for which we cannot yet confirm a successful integration in the population, are included). While this is still high, it is already within the range we observed in the 1980s when population still seemed viable.

In the next few years, a lot will depend on the reproductive performance of the translocated animals. In the Florida panther (*Puma concolor*) population reinforcement there seemed to be considerable heterosis (fitness advantage of outbred animals) in the first generation (F1) crosses between remnant

and introduced animals which contributed to rapid expansion of the introduced genes in the population (Johnson et al. 2010). There is a good chance that this will also happen in the Dinaric lynx, and continuous monitoring should be guaranteed to keep track of the future genetic improvement. The introduced lynx bring many private alleles that were not present in the Dinaric lynx population prior to the translocations (Table 5), which makes the offspring of these animals very easy to detect. So far, we found some of these alleles in all samples of offspring of reintroduced lynx. Nevertheless we tested the genotypes of newly identified animals with PCA, if there are any signs of admixture. We used reference samples from Slovakia and Romania collected and genotyped within A3 action (Skrbinšek et al 2019). The samples from the Dinarics are distinct from the others, so all of them are remnant lynx. This "separation" is caused by genetic drift since the 1973 reintroduction which generated the recognizable genetic signature of this population, but does not indicate any evolutionary uniqueness. First generation offspring of the reintroduced lynx, which were also recognized by the presence of private alleles cluster with the Romanian samples since they are much more diverse than the Dinaric lynx.

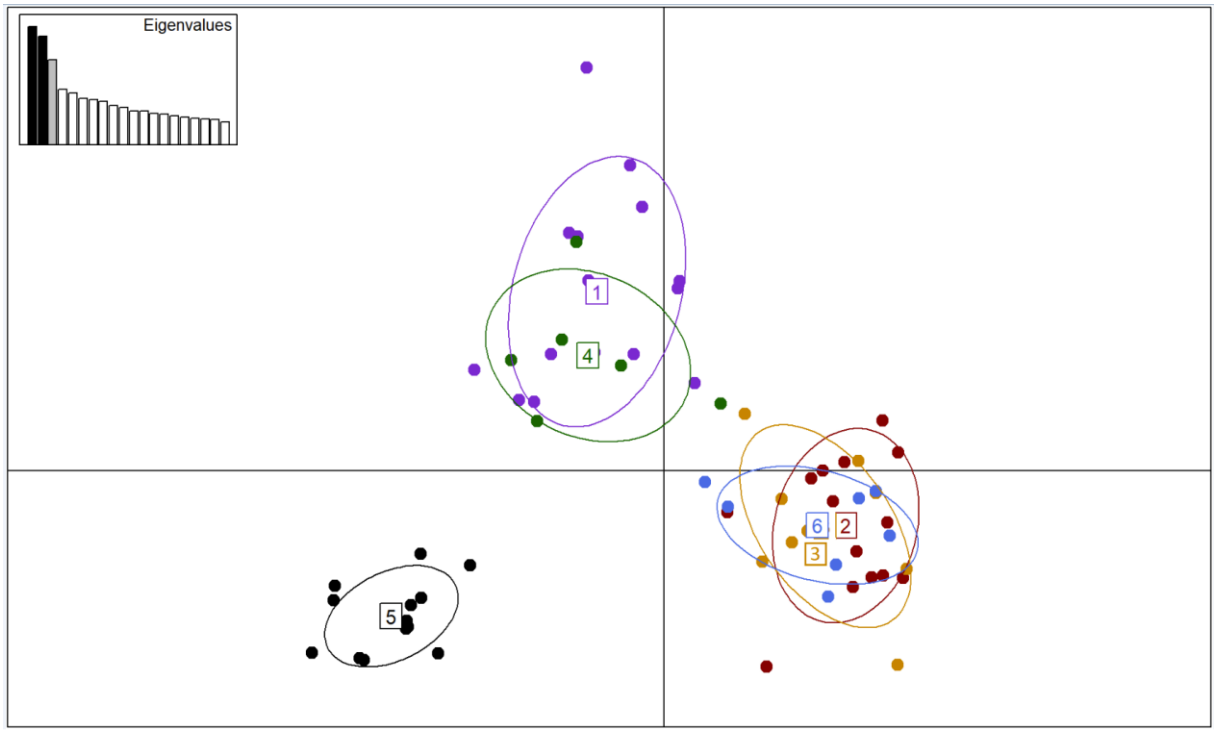

Figure 7: PCA analysis of lynx samples: 1-reference samples from Slovakia (purple), 2-reference samples from Romania (red), 3-reintroduced lynx from Romania (orange), 4-reintroduced lynx from Slovakia (green), 5-samples collected in monitoring season 2021/2022 in the Dinarics belonging to animals not known from before (black), 6- Aida's kittens from both litters and 2 offspring of lynx Goru from monitoring season 2021/2022 (light blue).

Table 5: Alleles found in translocated lynx that were not previously detected in the Dinaric lynx population. These "private" alleles make offspring of the translocated lynx very easy to detect.

Locus	F115	F115	F115	F115	Fca123	Fca132	Fca132
Allele	240	244	248	252	140	179	175
N observations	1	1	6	2	7	6	6
Locus	Fca001	Fca001	Fca001	Fca001	Fca001	Fca650	Fca650
Allele	177	181	191	187	193	131	129
N observations	1	4	1	1	1	2	2
Locus	Fca161	Fca293	Fca424	Fca424	Fca559	Fca559	
Allele	184	172	168	180	110	114	
N observations	1	2	5	2	2	3	
Locus	Fca723	Fca723	Fca723	Fca742	HDZ700	HDZ700	
Allele	179	187	191	131	141	145	
N observations	6	1	1	1	5	1	

2.4 Telemetry

To efficiently monitor the reinforcement process, all translocated lynx, some of their offspring and remnant animals are equipped with telemetry collars. GPS-telemetry can be used for studying lynx behavioral patterns, such as habitat use, dispersal, movements, predation, feeding and reproduction (Krofel et al. 2013, Heurich et al. 2014, Hočevar et al. 2020, Mattisson et al. 2022, Ripari et al. 2022). The main focus of our tracking of the translocated animals is on lynx survival, territory establishment, conspecific interaction, movement patterns, and reproduction. Information about prey species, sex and age structure of the prey are also gathered to help us better understand lynx impact on ungulates and also to implement them into ungulate management plans. Locating fresh kill sites further enabled us to record lynx with the help of video camera traps to assess lynx physical condition and intraspecific interactions among the lynx. Presence of the scavenger species is also being monitored at the kill sites and their influence on prey consumption by lynx.

In 2021/2022, in addition to the translocated lynx, we also collared five remnant lynx and two offspring of translocated and remnant lynx as part of the LIFE Lynx and InterMuc projects. Collars of some of the animals collared in previous years dropped-off during this season (Table 6).

Table 6. Overview of all GPS-collared lynx tracked within the LIFE Lynx project with basic information.

Lynx name	***Origin***	***Date collared/ released***	***End of tracking***	***Current status***	***Home-range size***
Goru	*Translocated (Romania)*	*12.2.2019/14.5.2019*	*24.8.2022*	*Collar dropped off (established territory on Mala gora)*	*215 km^2*
Doru	*Translocated (Romania)*	*27.2.2019/4.5.2019*	*30.1.2020*	*Signal lost, lynx missing since*	*130 km^2*
Catalin	*Translocated (Romania)*	*16.1.2020/31.3.2020*	*still tracked*	*Established territory on Menišija/ Rakitna/Mokrc*	*348 km^2*
Boris	*Translocated (Romania)*	*25.1.2020/28.5.2020*	*25.3.2021*	*Collar dropped off (established territory on Mala Kapela)*	*417 km^2*

Maks	*Translocated after rehabilitation (Slovakia)*	*2.6.2020/23.6.2020*	*27.9.2021*	*Signal lost, lynx missing since*	*N/A*
Pino	*Translocated (Slovakia)*	*25.3.2020/30.5.2020*	*30.5.2020*	*Signal lost, lynx missing since*	*N/A*
Alojzije	*Translocated (Romania)*	*20.1.2020/13.3.2020*	*Still tracked*	*Established territory in Southern Velebit*	*441 km^2*
Emil	*Translocated (Slovakia)*	*26.2.2021/14.5.2021*	*Still tracked*	*Established territory in Baške Oštarije*	*248 km^2*
Tris	*Translocated (Romania)*	*22.1.2021/28.4.2021*	*16.12.2021*	*Established territory on Pokljuka, collar failure, still tracked with camera traps*	*188 km^2*
Lenka	*Translocated (Slovakia)*	*18.3.2021/28.4.2021*	*12.12.2021*	*Established territory on Pokljuka, collar failure*	*126 km^2*
Julija	*Translocated (Slovakia)*	*11.3.2021/28.4.2021*	*Still tracked*	*Established territory on Pokljuka*	*134 km^2*
Zois	*Translocated (Romania)*	*9.3.2021/26.4.2021*	*28.4.2022*	*Signal lost, lynx missing since*	*215 km^2*
Aida	*Translocated (Romania)*	*13.2.2021/26.4.2021*	*Still tracked*	*Established territory on Jelovica*	*208 km^2*
Lubomir	*Translocated (Slovakia)*	*10.4.2022/14.6.2022*	*Still tracked*	*Not yet established a territory*	*N/A*
Blisk	*Established territory in*	*25.2.2022/17.5.2022*	*Still tracked*	*Established territory on Javorniki*	*131 km^2*

Teja	*Remnant*	*19.4.2019*	*9.2.2020*	*Collar dropped-off (established territory on Mala gora)*	*60 km^2*
Mihec	*Remnant*	*21.3.2020*	*24.7.2021*	*Collar dropped off (established territory on Racna gora/Snežnik)*	*343 km^2*
Mala	*Offspring of remnant and translocated lynx*	*19.1.2020*	*1.7.2020*	*Collar battery exhausted (confirmed alive in 2020/2021)*	*78 km^2*
Niko	*Offspring of remnant and translocated lynx*	*6.12.2020*	*20.4.2022*	*Collar dropped off (Scheduled, Unsuccessful recapture)*	*N/A*
Bojan	*Remnant (tracked within 3Lynx Project)*	*1.12.2019*	*3.3.2021*	*Established territory in Gorski Kotar, signal lost, lynx missing since*	*515 km^2*
Petra	*Remnant*	*1.3.2021*	*Still tracked*	*Established territory in upper Kolpa Valley*	*232 km^2*
Martina	*Remnant (after rehabilitation in Croatia)*	*1.3.2020*	*2.6.2021*	*Found dead near Pivka*	*N/A*
Bor	*Offspring of remnant lynxes*	*18.1.2022*	*Still tracked*	*Established territory in South Kočevsko*	*110 km^2*
Klif	*Remnant (tracked within*	*4.2.2022*	*Still tracked*	*Established territory on Goteniška gora and Stojna*	*293 km^2*

	Intermuc project)				
Igi	*Remnant*	*17.2.2022*	*4.5.2022*	*Died because of heart failure during hunting*	*60 km^2*
Pandora	*Remnant*	*30.3.2022*	*Still tracked*	*Established territory in Central Velebit*	*183 km^2*
Josip	*Remnant*	*4.2.2022*	*Still tracked*	*Established territory in Northern Velebit*	*170 km^2*
Neža	*Offspring of remnant and translocated lynx*	*13.2.2022*	*11.5.2022*	*Collar ripped off and blood found, probably killed illegally*	*N/A*
Valentina	*Offspring of remnant and translocated lynx*	*13.2.2022*	*Still tracked*	*Potential territory established near Mala gora*	*110 km^2*

2.4.1 Translocated lynx in Dinaric Mountains

Altogether, 10 lynx were translocated to Slovenian (n=5) and Croatian (n=5) Dinaric Mountains. Six of them were from Romania and four from Slovakia. Six lynx (Goru, Catalin, Boris, Alojzije, Emil and Blisk) have already established their territories, while with Lubomir it is still unclear if he established permanent territory. We lost signal from the collars of Doru, Pino and Maks and did not detect them with any other monitoring method, therefore we declare these three individuals as lost. Below we describe movements and current status of all translocated lynx that were monitored within the reporting period. Detailed status of lynx released in spring 2022 (Blisk and Lubomir) will be provided in the next report.

Goru

Figure 8. Lynx Goru photographed at his kill site on Mala gora, Slovenia.

Lynx Goru was captured in Romania in February 2019. He is an adult male, currently estimated to be around 8 years old. He was transported to Slovenia, where he was released from quarantine in Loški Potok on 14th of May in 2019. After release, he first crossed the national border between Slovenia and Croatia, but soon turned north and returned to Slovenia. 17 days after the release, he arrived to Mala gora in Kočevsko, where he established his permanent territory. In this area, a remnant collared female named Teja is present. After the mating with Teja, on 1st March 2020, still during the lynx-mating season, Goru temporarily left his territory on Mala gora and went on a mating excursion towards Ravna Gora area in Croatia, up to 50 km from the edge of his territory. After a month in Ravna gora area, he returned to his territory on Mala gora in Slovenia on 7th April 2020. In July 2020, he was recaptured and his collar was replaced with a new one that enabled us to monitor him for additional two years. We can confirm that he is the father of at least three litters; one kitten (named Mala) in 2019, three kittens in 2020 (one of them is collared male Niko) and three kittens (two of them were collared; Neža and Valentina) in 2021. After mating with remnant female Teja in 2021, he went again on a mating excursion, towards the south-west (Snežnik and Gorski Kotar), where he stayed for a month. We didn't detect any offspring that could be the result of this excursion. In the mating season 2022 he went on two separate excursions. First one was in the beginning of March, when he went to the southern area of Kočevski Rog for a couple of days before returning back to his home range. The second excursion

was on Velika and Racna gora and only lasted for 2 days. In the last year of his movement monitoring, Goru's home range was expanded to the northern part of Kočevski Rog and now measures around 215 km^2. In summer 2022 his collar dropped off which means his successful telemetry monitoring has come to an end. Within the regular national lynx monitoring with camera traps, Goru is being recorded regularly, with the last time photographed in December 2022.

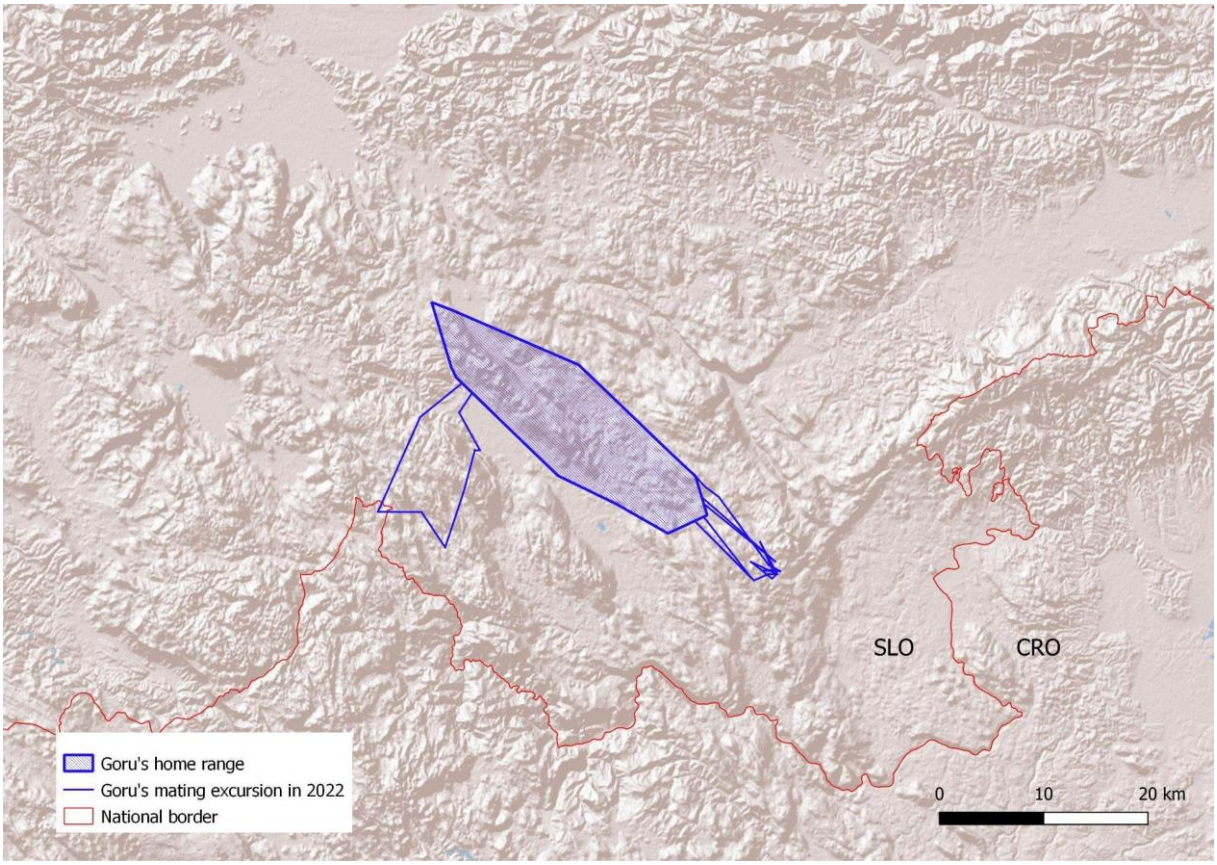

Figure 9. Map of Goru's home range (100% MCP) on Mala gora and Kočevski Rog, and temporary extra-territorial excursions in spring 2022 (blue).

Catalin

Figure 10. Lynx Catalin in an enclosure.

Catalin was captured in Romania in January 2020 and released to Slovenia on 31st March 2020. He is currently estimated to be 6-7 years old and after release in Snežnik plateau, he first went south and crossed the border to Croatia, where he visited the Istra region. Then he turned west and crossed a large part of Gorski Kotar, until crossing the Croatian-Slovenian border again. Back in Slovenia, he first crossed Kočevsko and arrived at the vicinity of Mt. Krim on 19th April. There he established his territory, which covers Menišija, Logatec plateau, Rakitna and some parts of Mokrc. On the western side, his home range is limited by the Ljubljana-Koper highway, which he was so far not able to cross. In summer 2020 he was observed and recorded several times together with a remnant female (known as "Menišija1" from the photo-monitoring). So far he is spending most of his time on Menišija and Logatec plateau, which correspond to this female's territory, but is regularly making excursions via Rakitna to Mokrc, presumably to maintain contact with another remnant female that is remnant in Mokrc. Size of his home range is currently 348 km^2. We regularly recorded him with camera traps when feeding on kill sites. He appears in good physical condition. He was also photographed several times on camera traps within the lynx monitoring program, as well as other camera traps used in the region by hunters and as part of the InterMuc project for monitoring wildcats. In mating season 2021 he went on a short mating excursion to Kočevsko near the Croatian border, which lasted for three days. He went towards the same direction where lynx Goru and Mihec went, which indicates the presence of a female. In his territory, female ''Menišija1'' was detected with kittens in the second half of 2021, who have the same

coat pattern as Catalin, which is rare in Slovenia and therefore makes it likely that he was the father. Catalin was also observed sharing kills with the female and her kittens. However, we could not yet confirm his paternity with genetic analyses. In mating season 2022, he probably mated again with local female ''Menišija1'' before he went on excursion that lasted for 6 days in March. Destination of the mating excursion was to the same area as the year before. On 20th of February, Katalin was recaptured and recollared, which will prolong his monitoring for additional two years. In the last year of his telemetry monitoring, we noticed that he increased his home range to the southeastern area, after neighboring local male Igi died. He is regularly being recorded with camera traps set within lynx national monitoring and cameras on kill sites.

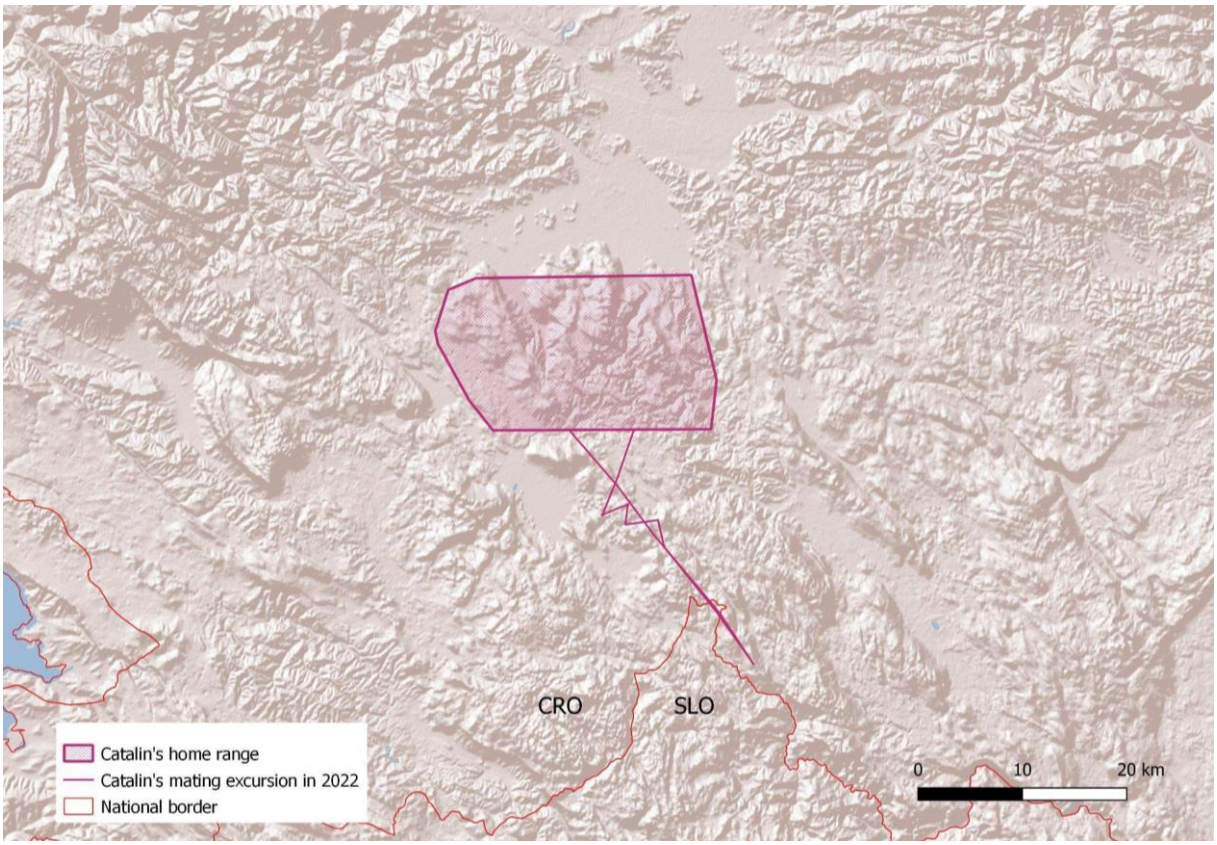

Figure 11. Map of Catalin's mating excursion in 2022 and his home range (100% MCP) established on Menišija, Logatec plateau, Rakitna and Mokrc.

Boris

Figure 12. Lynx Boris during his time in an enclosure in Loški Potok, Slovenia.

Male Boris is a 4-5 year old lynx that was captured in Romania in January 2020. He was translocated to Loški Potok enclosure on 30th of April and released on 28th of May 2020. Soon after the release, he went to Croatia and stayed around Gerovo for about 2 months, apparently establishing a temporary home range. Most likely due to the presence of adult male territorial remnant lynx (Bojan) in the surrounding areas, he abandoned this area. Immediately before this move, we recorded a probable encounter with this collared male, which apparently triggered this movement. He first moved south-east to Vrbovsko where he stayed for a month, and then moved further south to Ogulin and Mala Kapela area where he is present since October 14, 2020 and has established a home range, which measures around 417 km^2. His collar stopped sending GPS locations on 25h of March 2021, but the VHF collar system was still working and we were using it to locate him occasionally. Finally, in April 2022 drop off system was activated and the collar fell off, and was found in July 2022. In November 2021 box trap was activated on the location Boris is using for marking of his territory. Unfortunately we were not successful in capturing him as he successfully avoided entering the trap. In summer of 2022 extensive logging started in that area so capturing had to be stopped. During the 2021 - 2022 season he was recorded with camera traps 6 times and he appeared to be in a good condition.

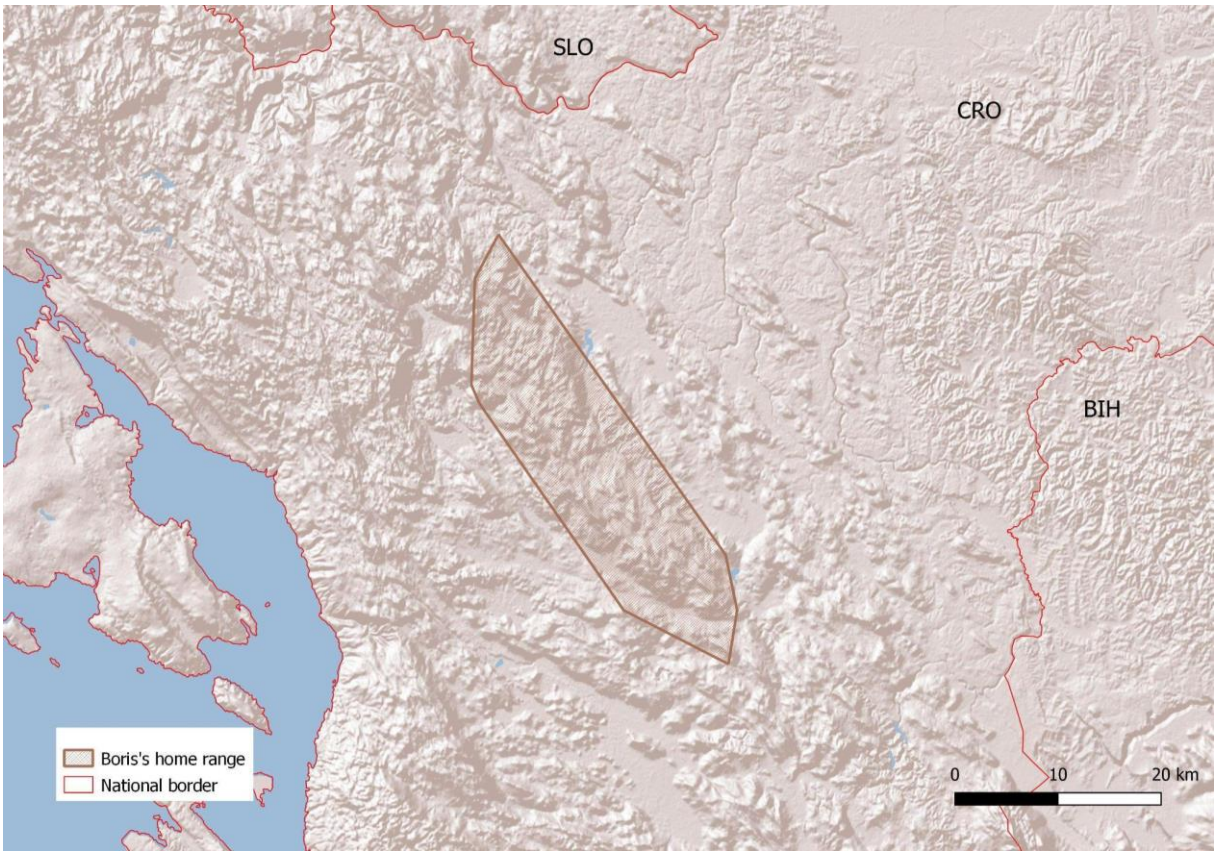

Figure 13. Map of Boris' home range (100% MCP) on Mala Kapela.

Maks

Figure 14. Lynx Maks during release from an enclosure on Snežnik plateau, Slovenia.

Lynx Maks was translocated from Slovakia to Slovenia in summer 2020 where was released from the enclosure in Snežnik plateau on 23rd June. After release, he established three different territories, with first being in Javorniki, second on Menišija and Logatec plateau and his final on Hrušica and Trnovski gozd. During the search for his territory he also went on journey to the Alps, where he reached the Austrian border on Karavanke on 24.12.2020. Later he came back to Menišija where he stayed for three more months before moving to his final home range on Hrušica and Trnovski gozd. In last year's report we reported that the signal from his collar was lost at the end of September 2021 in the Trnovski gozd area. We tried to locate him using VHF telemetry, but were unsuccessful in our attempts. Maks was also not photographed on any of the camera traps set within national lynx monitoring neither with opportunistic data, therefore, we declare him as not integrated.

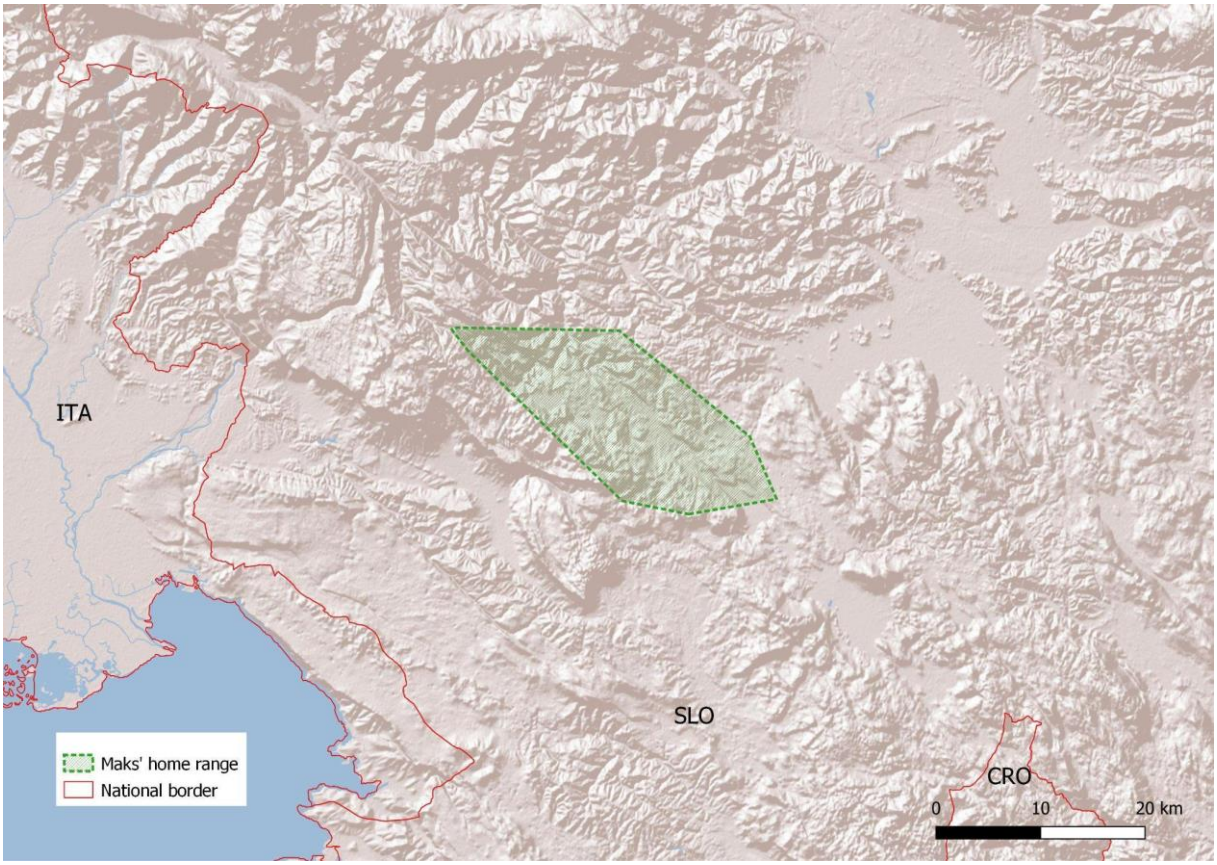

Figure 15. Map of Maks's home range on Hrušica and Trnovski gozd (100% MCP)

Alojzije

Figure 16. Lynx Alojzije when released in Paklenica National Park, Croatia.

Male Alojzije was captured in Romania on January 20, 2020 and is currently estimated to be 6-7 years old. He was released in Paklenica National Park on March 13, 2020 and soon after the release, he first moved north-west on Velebit Mountains until Baške Oštarije, where he turned back towards the south-east and established his territory around Sveti Rok in southern Velebit where he continuously circulates since May 2020. Alojzije's home range measures around 441 km^2 (MCP 100%). We have successfully identified two females which we continuously monitor with camera traps inside his home range. In March 2021, one of the camera traps recorded 3 individuals in one event, which could arguably be a female with two kittens, although the female could not be identified due to poor record quality. As Alojzije was released on the 13th of March 2020, when the mating season was still going on, theoretically he could have already mated in 2020. Furthermore, in September 2021, the same photo trap photographed a lynx kitten. In the season 2021 - 2022 female Mateja was photographed with three kittens on his territory. We did not register any other males in that area and Alojzije was staying on his territory during the mating season so it is very likely he is the father. Unfortunately none of the non-invasive samples collected on his territory could be genotyped. Area where he lives has very low snow cover so collection of samples for DNA analysis is very challenging. Alojzije is regularly captured on camera traps, he was recorded eight times in the 2021 - 2022 season.

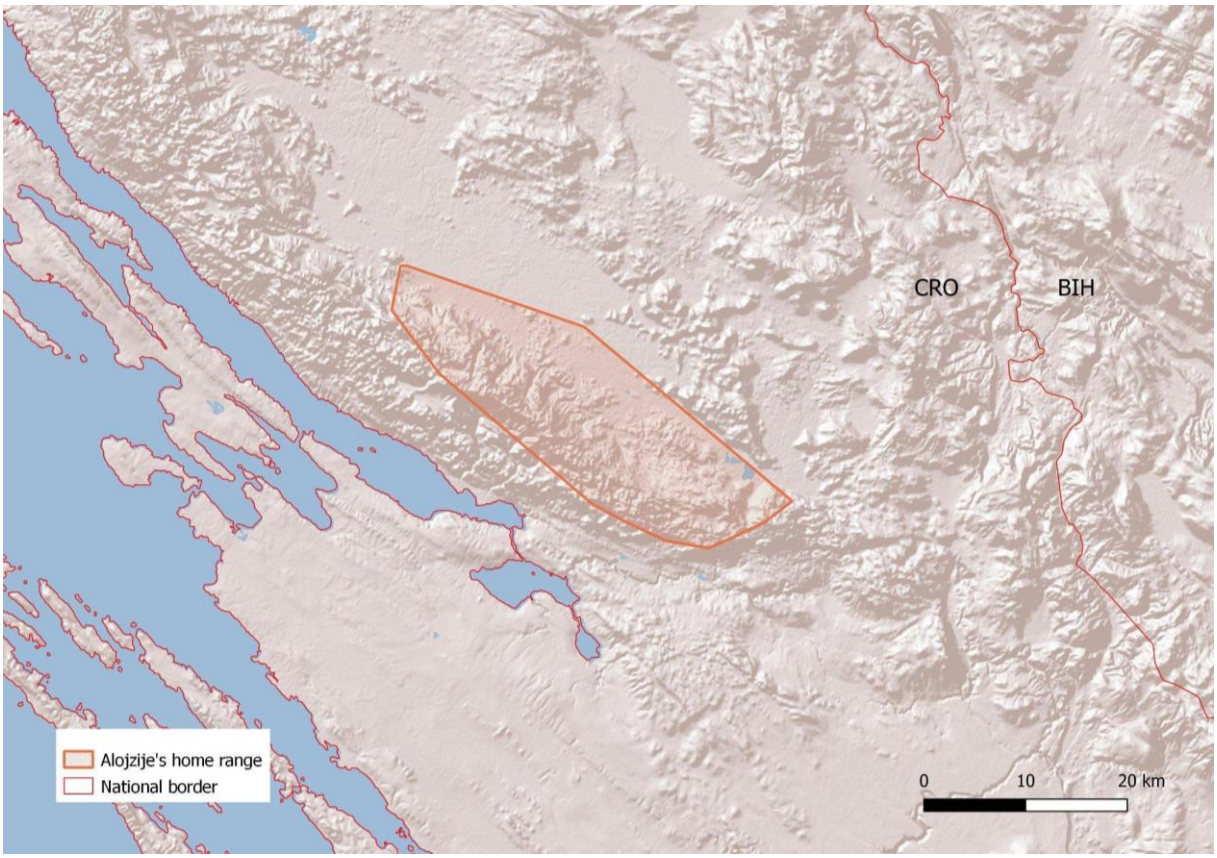

Figure 17. Map of Alojzije's home range (100% MCP) established in the southern part of the Velebit Mountains.

Emil

Figure 18. Lynx Emil after release in Velebit.

Emil is a 5-year old male captured in Slovakia in February 2021 and was translocated to Croatia, where he was released on 14.5.2021 near village Krasno in cooperation with Nature Park Velebit. After exploring northern and central Velebit, he moved southwards where he established his territory in the area of Baške Oštarije, located on the border of the central and southern Velebit. His home range measures around 248 km^2 (MCP 100%). Upper NW border of his home range overlaps with the lower SW border of the home range of remnant collared male Pandora. Also a female, named Buna, is using this area. We surveyed six of his kill sites from which we identified several prey species: mouflon, red deer, roe deer and unidentified bird species. Until now, reproduction was not recorded inside his territory so we plan to invest more effort in snow tracking during the upcoming winter season and to expand camera trap locations Unfortunately, due to poor satellite connectivity and low GPS-fix schedule we are getting Emil´s locations only every 2-3 months. His movements are monitored with an Iridium collar, while all other translocated animals are equipped with a GSM collar. The collar is programmed to send the data every two weeks but if the satellite is not reachable at the moment of sending, the data is stored and sent with the next shipment in two weeks.

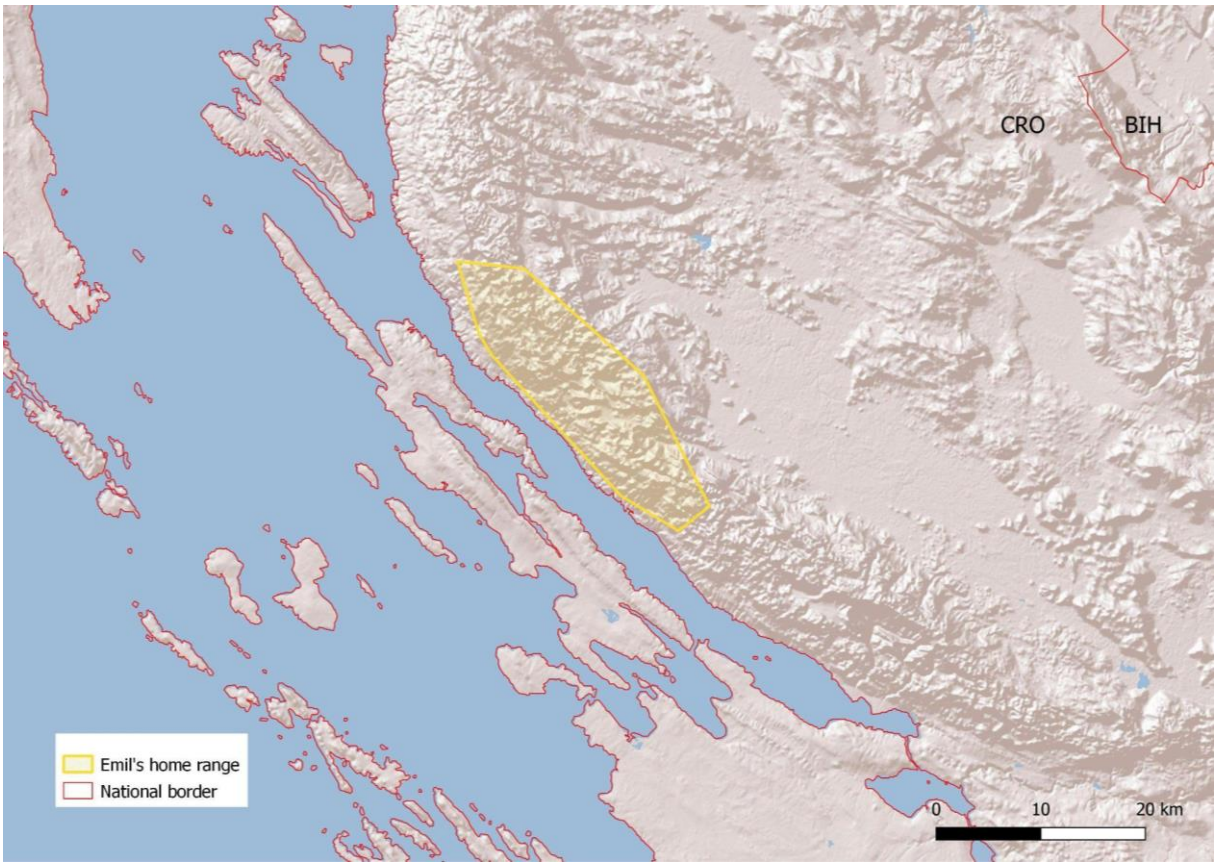

Figure 19. Map of Emil's home range (100% MCP) established in the bordering area of central and southern part of the Velebit Mountains.

2.4.2 Translocated lynx in Alps

At the end of April 2021, five translocations took place in the Slovenian Julian Alps, where two males (Zois and Tris) and three females (Julija, Lenka and Aida) were released into the forests of Pokljuka and Jelovica. Three animals were translocated from Romania and two from Slovakia. All five lynx stayed in the release area and apparently established territories. In this chapter, we describe the status, movements and reproduction for every translocated lynx in the Alps.

Tris

Figure 20: Lynx Tris in Pokljuka enclosure before release.

On 28th of April 2021 adult male Tris was released in Triglav National Park area. He is estimated to be 6 years old and weighed 27 kg at the time of translocation. He was transported from Romania and stayed in Pokljuka enclosure for a month and a half before being released. Soon after release, he established his home range in the Pokljuka area, which measures around 188 km^2. Tris was also monitored moving at high elevations, even at 2400 meters above the sea level. Unfortunately, his collar stopped sending the data on 16th of December 2021 and we could not monitor his movement further with telemetry. However, Tris is regularly recorded with camera traps which confirms he is still around. In mating season 2022, he mated with local female Julija, who was recorded with three kittens. To recapture Tris for changing the collar, we set a box trap in spring 2022, but were so far unsuccessful. With the help of camera traps, more suitable sites for recapturing were found, which will help us in the effort to recapture him in the next trapping season.

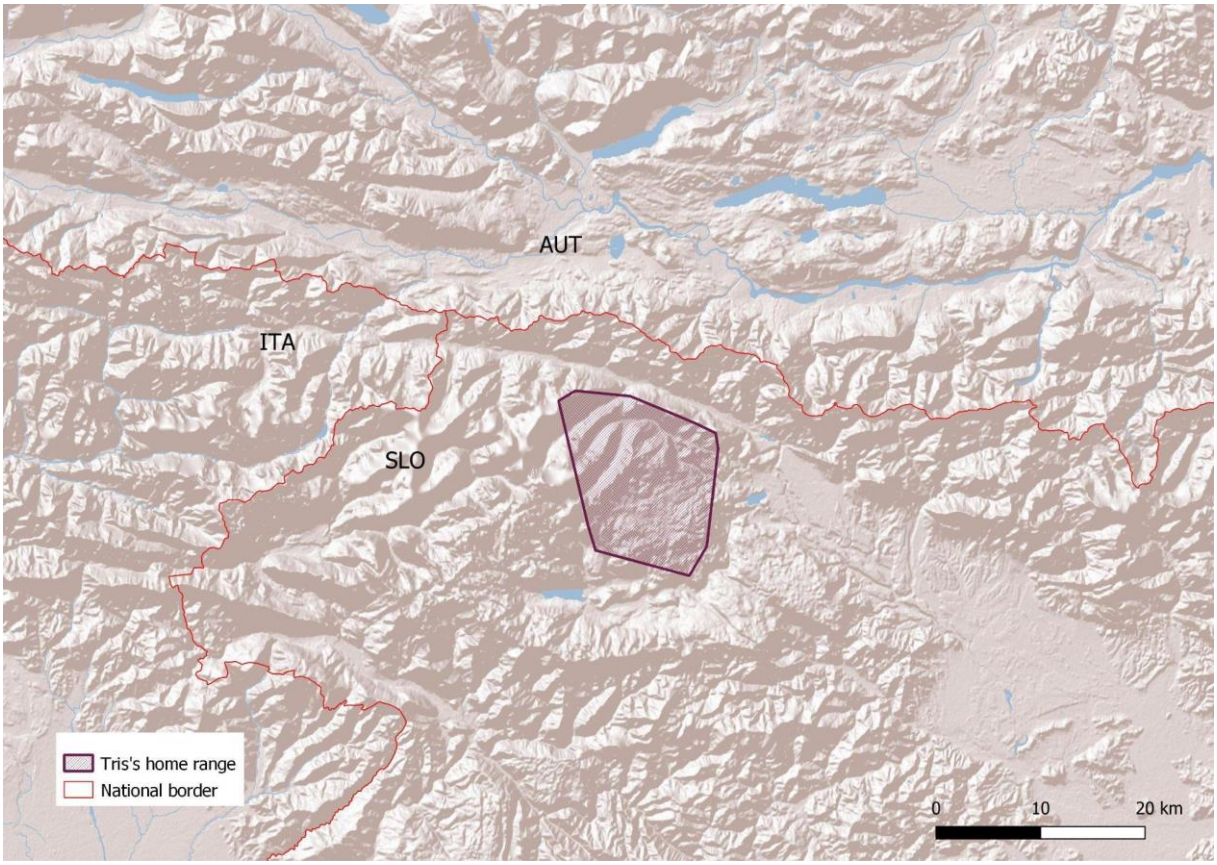

Figure 21. Tris' home range (100 % MCP) in Pokljuka.

Lenka

Figure 22. Female Lenka after release from enclosure in Pokljuka

Lenka is an adult female lynx that was captured in Slovakia on 18th of March 2021. At the time of the capture she weighed 15 kg and was estimated to be around 3 years old. She was transported to Slovenia, to Pokljuka enclosure where she was released on 28th of April 2021. After release, she stayed in the Pokljuka area, where she established her territory. We surveyed five of her kill sites, where she preyed on roe deer. She is sharing her territory with translocated male Tris and, at least in the beginning, also with translocated female Julija, which is not very common in lynx territorial behavior. At one of the Julija's kill sites, Lenka was recorded scavenging. Unfortunately, her collar stopped sending data on 12th of December 2021, which prevented us from monitoring her further with telemetry. After the collar malfunction, we regularly recorded her with camera traps that were set within lynx national monitoring in the southern side of the Triglav National park. The plan is to recapture her and change her collar which would enable us to monitor her reinforcement process in the Alpine region.

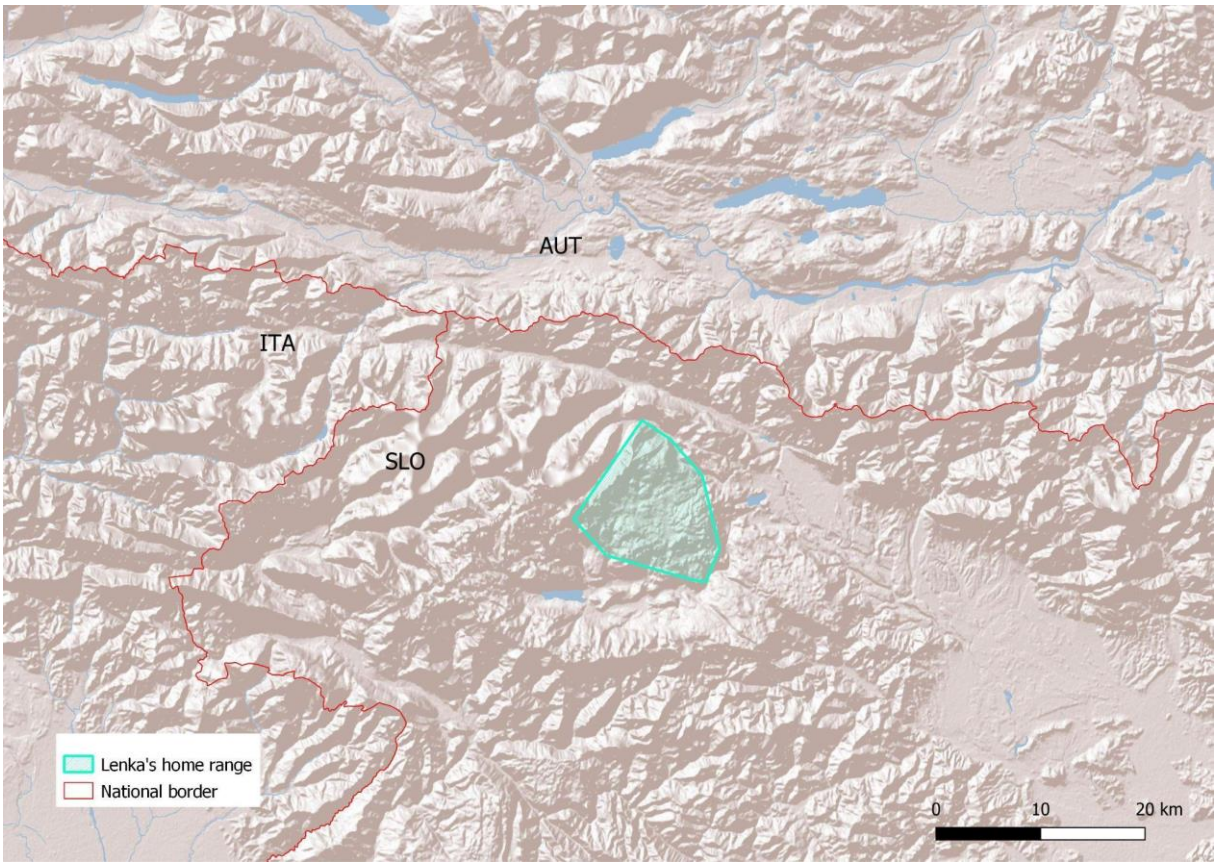

Figure 23. Lenka's home range (100 % MCP) in Pokljuka plateau.

Julija

Figure 24. Female Julija in Pokljuka enclosure before release.

On 11th of March 2021, adult female lynx Julija was captured in Slovakia. She was transported to Slovenia on 24th of April and then released from Pokljuka enclosure along with Lenka and Tris on 28th of April 2021. At the time of translocation, she was pregnant. Soon after the release we could detect denning behavior for a couple of weeks, however, we did not detect kittens later in the summer with camera traps set on her kills and within national lynx monitoring. She established territory in Pokljuka and Mežakla. Most of her home range is shared with Lenka and Tris and measures around 134 km^2. In mating season 2022, she mated with lynx Tris who she shares her home range with, however, also lynx Zois was with her during that period. In May 2022 she gave birth to 3 kittens, which were still alive in autumn 2022. Her collar will stop working in late winter 2023, therefore we will try to recapture her and replace her collar.

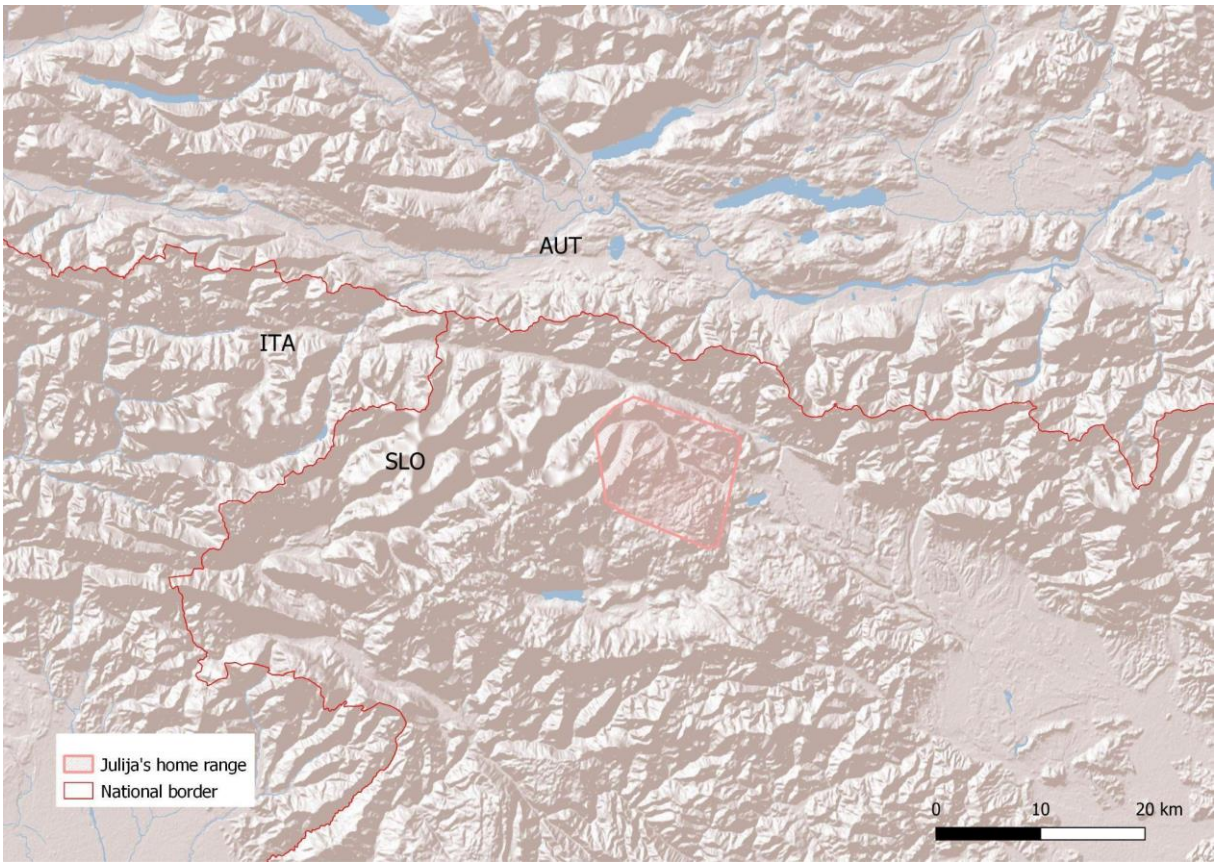

Figure 25. Julija's home range (100 % MCP) on Pokljuka plateau.

Zois

Figure 26. Male Zois moments after release from the Jelovica enclosure.

Zois is an adult male that was captured in Romania on 9th of March 2021. He weighed 19 kg at the time of the capture and was estimated to be 2 years old. He was transported to Slovenia to the Jelovica enclosure where he was released on 26th of April. After the release, he stayed in the Jelovica area where he established his home range. Soon after the release, he mated with translocated female Aida, who later gave birth to 3 kittens. We regularly monitored Zois' kill sites and also his movement. In mating season 2022 he mated with female Aida again and then went on an excursion to Pokljuka where he stayed for one week before returning back to his home range in Jelovica. At the time of excursion, he was together with female lynx Julija. Zois' collar stopped sending the data on 28th of April 2022, one year before the scheduled collar drop off. Since then, we also did not detect him anymore on camera traps that were set within lynx national monitoring neither with opportunistic records. With two successful reproductions with Aida, Zois contributed to the development of the stepping stone population, however his current status remains unclear.

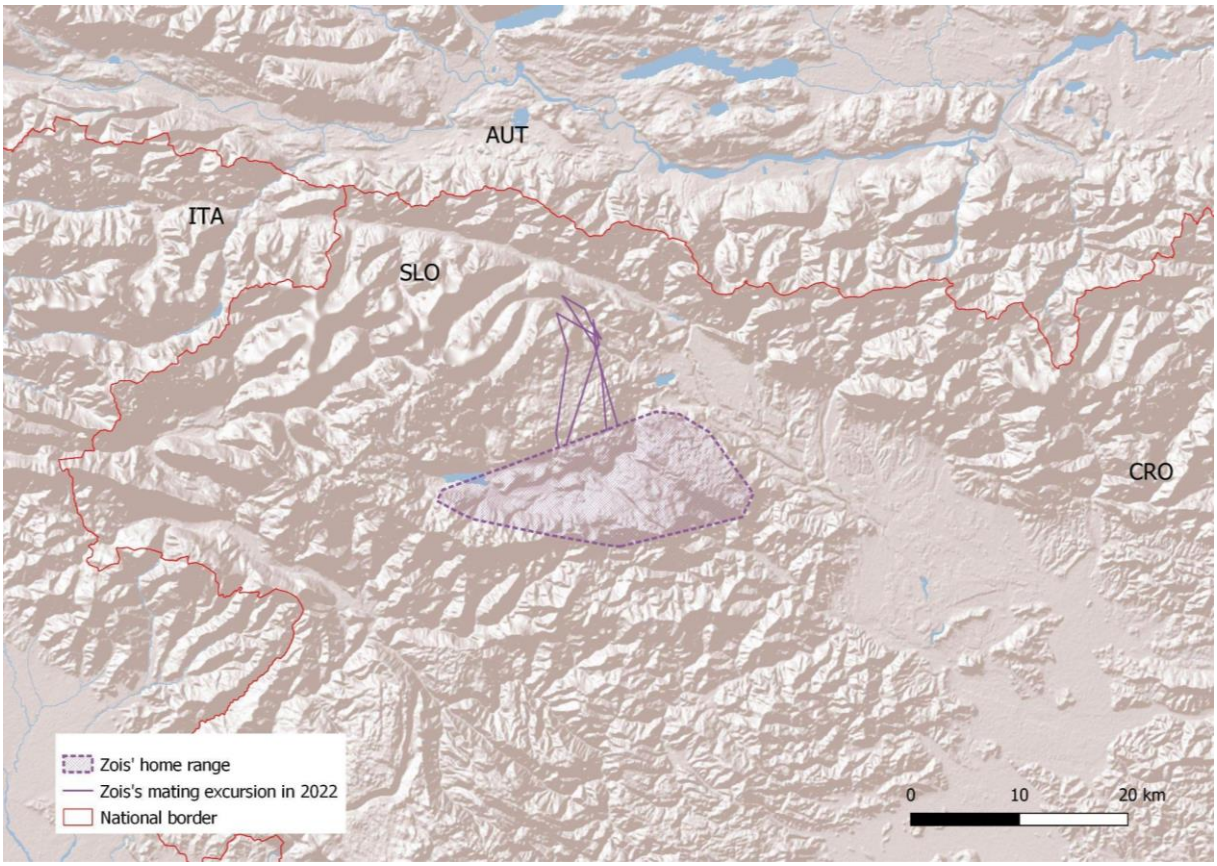

Figure 27. Zois's home range (100 % MCP) on the Jelovica plateau and his mating excursion in 2022.

Aida

Figure 28. Female Aida in Jelovica enclosure.

On 13th of February a female lynx named Aida was captured in Romania. She was estimated to be two years old and weighed 16 kg at the time of the capture. She was transported to a lynx enclosure on Jelovica in Slovenia, where she was released simultaneously with male Zois on 26th of April 2021. Same as Zois, she stayed in the area, where she established her home range, which measures around 208 km^2. After the release she met with Zois on a couple of occasions and also shared one kill with him. In August 2021 it was confirmed that she gave birth to three kittens and two were genetically sampled in winter (see more details in chapter 2.3). With the help of camera traps, we could confirm that at least one kitten survived until spring 2022. In the mating season 2022, the telemetry data indicated another mating with male Zoe dispersal periodis. In late May, she gave birth to three kittens, which were sampled on the field and Zois was confirmed to be a father. Genetic samples will allow us to detect them in the future by matching genotypes extracted from randomly collected non-invasive lynx genetic samples in nature. In autumn 2022 her collar was replaced with a new one, however has stopped working soon after so we will rely on other monitoring methods for further assessment of her contribution to the development of the alpine stepping stone population.

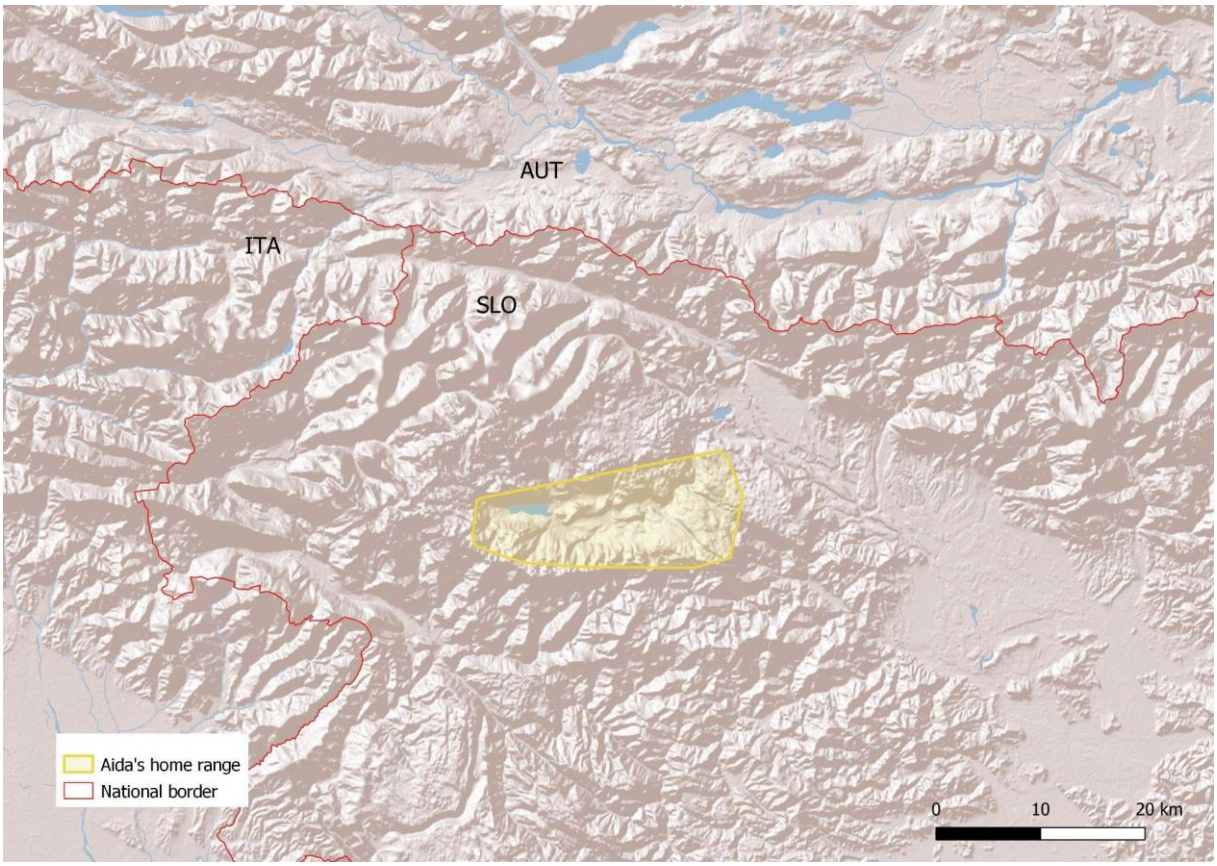

Figure 29. Aida's home range on Jelovica plateau

2.4.3 Remnant lynx and offspring of translocated lynx monitored with telemetry

In addition to translocated lynx, we report on seven additional lynx that were captured and collared in Slovenia (n=5) and Croatia (n=2) within this year's reporting period. This will help us to better understand the territorial distribution of lynx in the current population and gain additional understanding of the reinforcement processes, such as mating with translocated lynx and potential reproduction, as well as destiny and dispersal of their offspring. Within the project so far, we have captured two adult females (Teja and Petra), five adult males (Mihec, Klif, Pandora, Josip and Igi) and six juvenile lynx, among which four were offspring of translocated lynx Goru and remnant lynx Teja (Mala, Niko, Neža and Valentina), one was rehabilitated orphan lynx found in Croatia (Martina) and one offspring of remnant lynx Petra and Klif (Bor).

Below we provide details on the movement of all remnant lynx tracked within our project during the 2021-2022 season. In October 2022 an adult male lynx named Fenix was recaptured in Croatia and his collar was changed. Telemetry monitoring of this animal is not presented in the report as this is part of the project "Spatial ecology of lynx in National park Plitvice lakes", led by prof Josip Kusak and financed by Public institution National park Plitvice lakes. In April 2022 adult male lynx was captured and collared on mountain Plješivica in Bosnia and Herzegovina, within a project implemented by National park Una. We have been monitoring this lynx with camera traps since December 2020 as a big part of his territory is in Croatia. In winter 2022/23, we collared two kittens in the Alps. Their status will be reported in detail in the next report

Mihec

Figure 30. Lynx Mihec photographed after his collar dropped off, Slovenia.

Remnant male lynx Mihec was first captured on December 23, 2010 as a 12-kg kitten in the Snežnik area. He was an offspring of GPS-tracked female Snežka. In April 2011, he dispersed from mother's territory to the north-west and established his own territory on Javorniki, where we tracked him until October 2011, when his collar stopped working (Krofel 2012). The male was spotted in that area several times until 2013, when his collar was found (passively dropped-off). Since then we didn't get any new data about his presence, probably because he became more difficult to identify without a collar. His survival was confirmed in the 2019-20 lynx monitoring season, when he was photographed several times and identified based on a coat pattern. On March 21, 2020 we captured him and genetic analysis confirmed his identity. Telemetry data revealed that sometime during the previous eight years, he shifted his territory from Javorniki to a new territory stretching from the north-eastern part of Snežnik plateau, over Racna Gora to the western part of Goteniška gora region. His home range covers around 340 km^2 (MCP 100%). He is sharing his territory with at least two female lynx. In 2020 we photographed one of these females with her offspring and there is a good chance that Mihec is the father, although this could not be confirmed with genetic analysis. His collar dropped-off on 23rd July 2021. However, we continue to regularly obtain records of Mihec through camera-trapping, with over 20 photos from him in the last camera trapping monitoring season, especially from hunting grounds Iga vas and Babno Polje. His presence is also being confirmed with a genetic sample collected in Racna gora. Despite being one of the oldest known lynx in the Dinaric Mountains, Mihec appears to be in good shape.

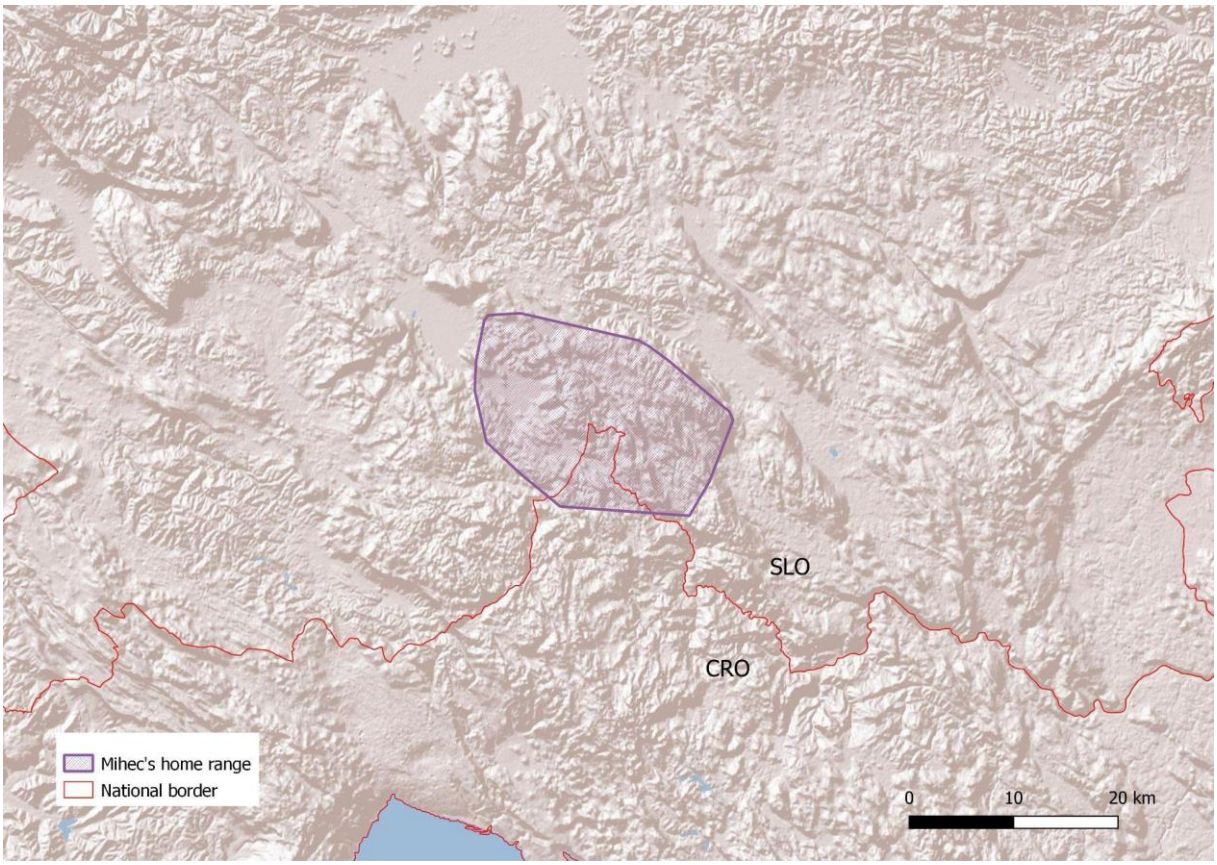

Figure 31. Map of Mihec's home range (100% MCP).

Petra

Figure 31. Lynx Petra photographed in Kočevsko at one of her kill sites.

On 1st of March 2021, an adult remnant female lynx named Petra was captured in the Kočevsko area, in the upper Kolpa valley in Slovenia. Her estimated age is between 6 to 7 years old. She weighed 16 kg and was in good physical condition at the time of the capture. Her home range is estimated to be around 232 km^2. Petra had raised one kitten in the season 2020/21 who had already dispersed outside of her home range and was not detected on camera traps within national monitoring yet. In the mating season 2021, she was seen and recorded with a local territorial male Klif with whom she mated. In mid May 2021, she gave birth to four kittens, which were confirmed to survive to independence. She was regularly recorded on the kill sites, where she appeared in a good physical condition. Her prey was mostly roe deer, but we also found remains of chamois. In the mating season 2022, she met with local collared male Klif and was with him for a couple of days, however, it seems she did not give birth to kittens, as she was always recorded alone and denning behaviour was not detected with telemetry. We plan to recapture her in the beginning of 2023 to replace her collar that will enable us to monitor her further.

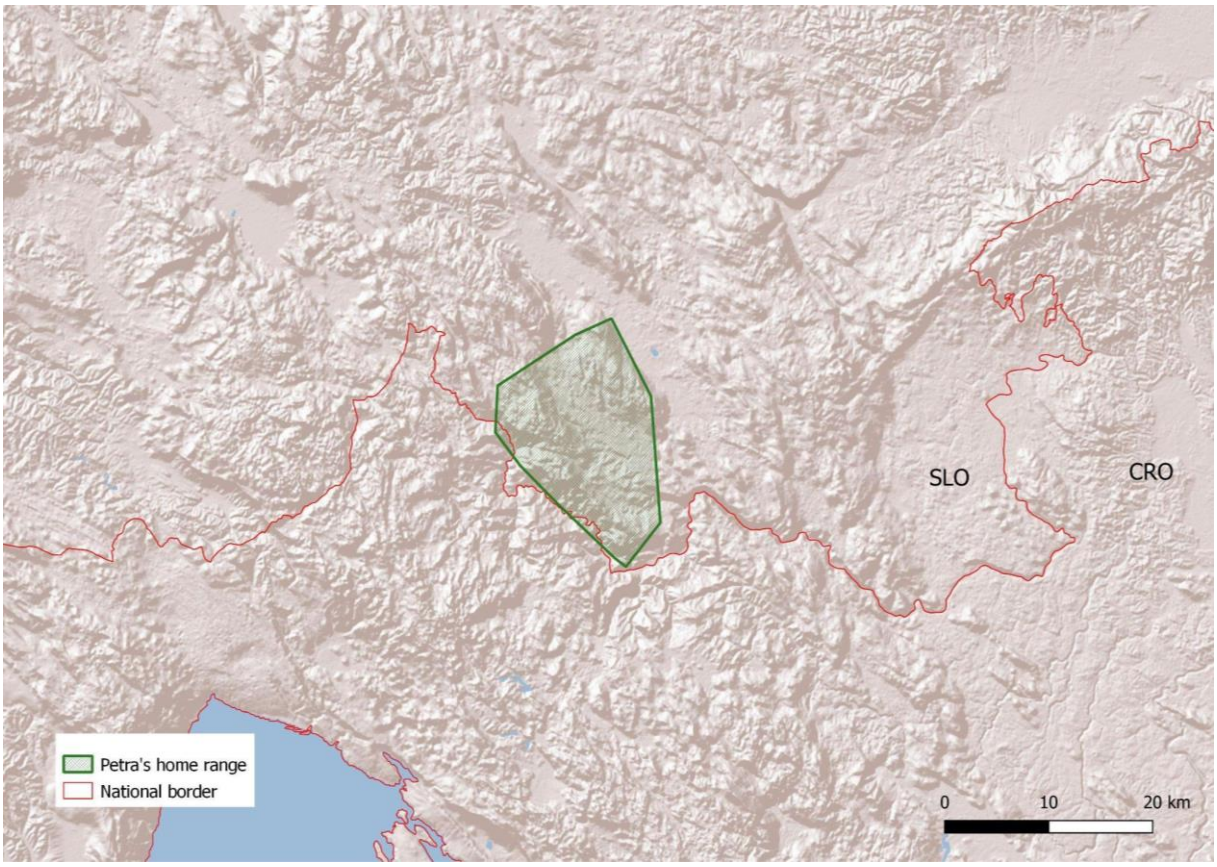

Figure 32. Petra's home range (100 % MCP).

Niko

Figure 33. Lynx Niko, recorded by one of the camera traps close to Črnomelj, Slovenia.

On December 6th, 2020 we collared a young male lynx, one of lynx Teja's and Goru's 2020 kittens At the time of the capture, he weighed 11 kg. In mid-December 2020, he first moved about 15 km away to the eastern part of the Kočevski Rog. In February 2021 his collar stopped working. Luckily we found his prey on the last location that this collar sent, recaptured him and replaced his collar. His movement pattern initially indicated that he would settle in this area, but in early April 2021 he moved approximately 30 km south to the Vrbovsko area in Croatia, where he remained until June 11, 2021. From here, he then moved on to the area southeast of Ogulin and remained there until mid-August 2021. In early September 2021, Niko returned to Slovenia, where he first went in the direction of Stojna but then changed direction and came back to the area of Kočevski Rog. He stayed in this area for about a month, then headed south again, staying in Croatia in the area between Kolpa and Vrbovsko, where we assume he will establish his territory.

During the dispersal, he has so far covered at least 1,355 km. During that time, he crossed the Kolpa River three times and Rijeka-Zagreb highway six times. He probably swam the river, but he crossed the highway via a green bridge or over a tunnel, which shows how important green bridges are for connecting the lynx population.

In March 2022 we attempted to recapture Niko since his collar had been set to drop off at the end of April 2022. We tried to recapture the lynx on three kill sites but unfortunately with no success. His collar dropped off as scheduled on 21th of april 2022.

In total we visited 27 potential kill sites in Slovenia and found 20 prey remains; 19 roe deer remains and on one occasion he was probably scavenging on a male red deer carcass (the cause of death is unknown, could be even his kill).

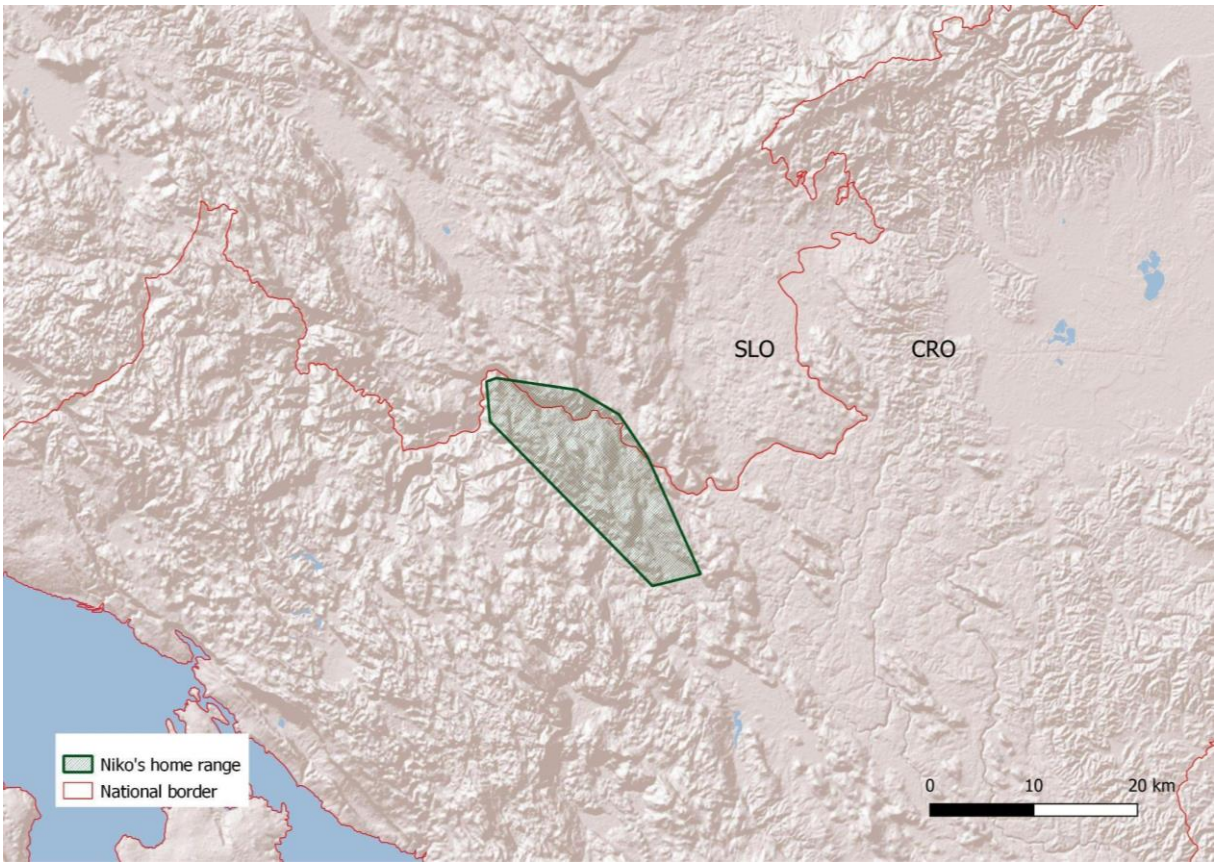

Figure 34. Map of Niko's potential home range in Croatia.

Bor

Figure 35. Lynx Bor during the immobilization.

On 18th of January 2022, a juvenile lynx named Bor was captured in Kočevsko, close to the Borovec village. He is one of the four male kittens of female Petra that were born in May 2021. At the time of the capture he weighed 10,5 kg, but was quickly gaining the weight after capture, confirmed by the records from camera traps from his kills. He was being closely monitored in his dispersal period, which began shortly after the capture in late January 2022. His dispersion path led him first towards northeast, towards Mala gora, where he probably interacted with territorial local male Goru, before moving south to Kočevski Rog. After a few weeks he moved south towards the border with Croatia, in the area around Podlesje and Lapinje above Kolpa river, where he probably established his home range that for now measures around 110 km^2. During his stay in Kočevski Rog he managed to kill his first roe deer, which was a good sign that he is capable of surviving on his own. After this kill, he mostly fed on foxes and also one beech marten, however after April 2022, he mostly started to prey on roe deer successfully. He is regularly being monitored with camera traps set on kill sites where he appears to be in a good physical condition, with visible growing in size.

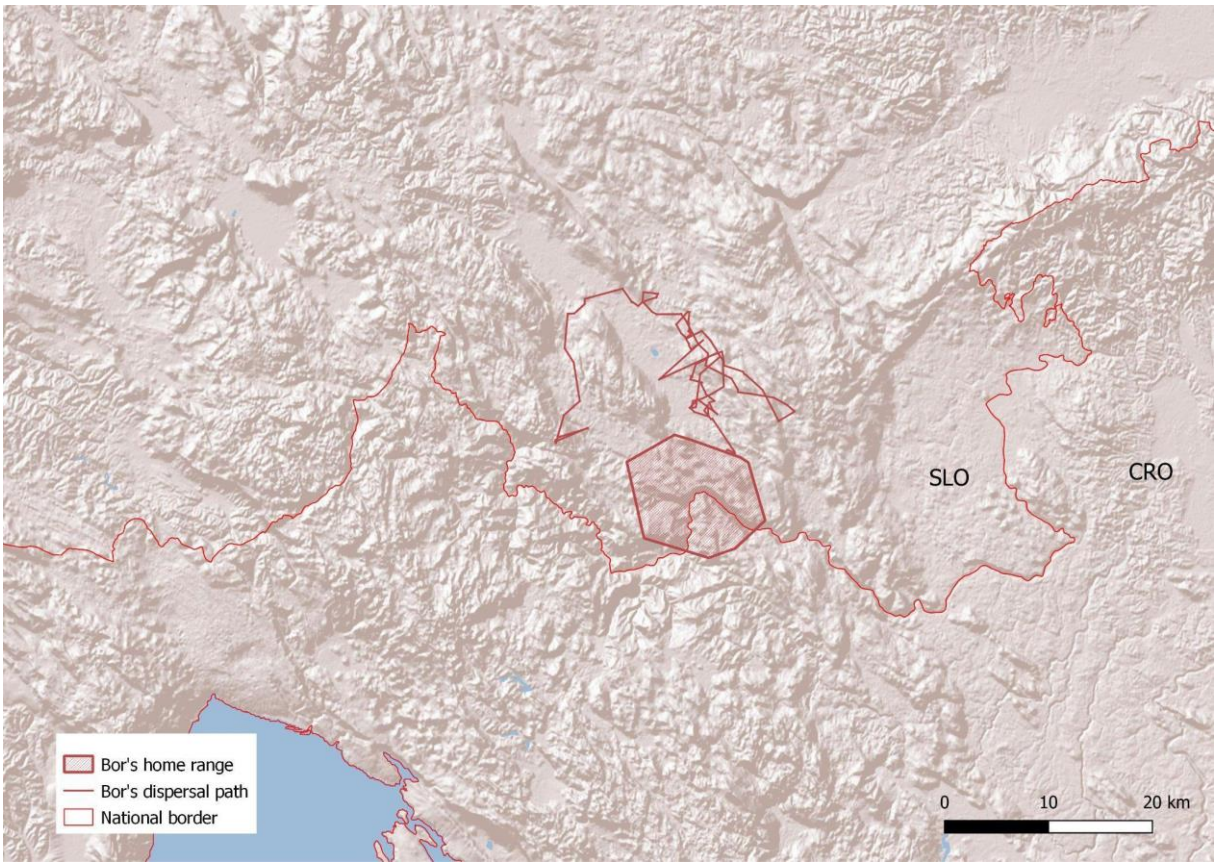

Figure 36. Bor's home range (100 % MCP) and his dispersal path.

Klif

Figure 37. Lynx Klif inside of the box trap during his capture.

On 4th of February 2022, an adult male remnant lynx was captured in the Kočevsko area. He was named Klif and was estimated to be 5-6 years old at the time of the capture. He was in great physical condition and weighed 24 kg. We already knew Klif from lynx national monitoring from 2020 and 2021 with camera traps. He was also recorded sharing the prey with local female Petra with whom he is sharing most of his territory. He is the father of Petra's four kittens of 2021, one of them was also collared in this monitoring season (male Bor). Klif's home range spreads over Goteniška gora, Borovška gora, Velika gora and Stojna and measures around 293 km^2. In mating season 2022, he went on a mating excursion to Croatia in Gorski Kotar area, where he stayed for 29 days before returning back to his home range in Kočevsko. Klif was regularly monitored with camera traps on his kills and appeared to be in good physical condition. Most of his prey were roe deer, while he also preyed on female or juvenile red deer and chamois. He was one of the most photographed lynx in Slovenian lynx monitoring in 2021. Klif was recaptured in August 2022 and his collar was replaced with a new one, which will enable us to monitor him for additional 2 years. His first collar was equipped with audio-logger, which made Klif first Eurasian lynx in the world equipped with a device to record vocalization and will enable us to study acoustic communication within the InterMuc project.

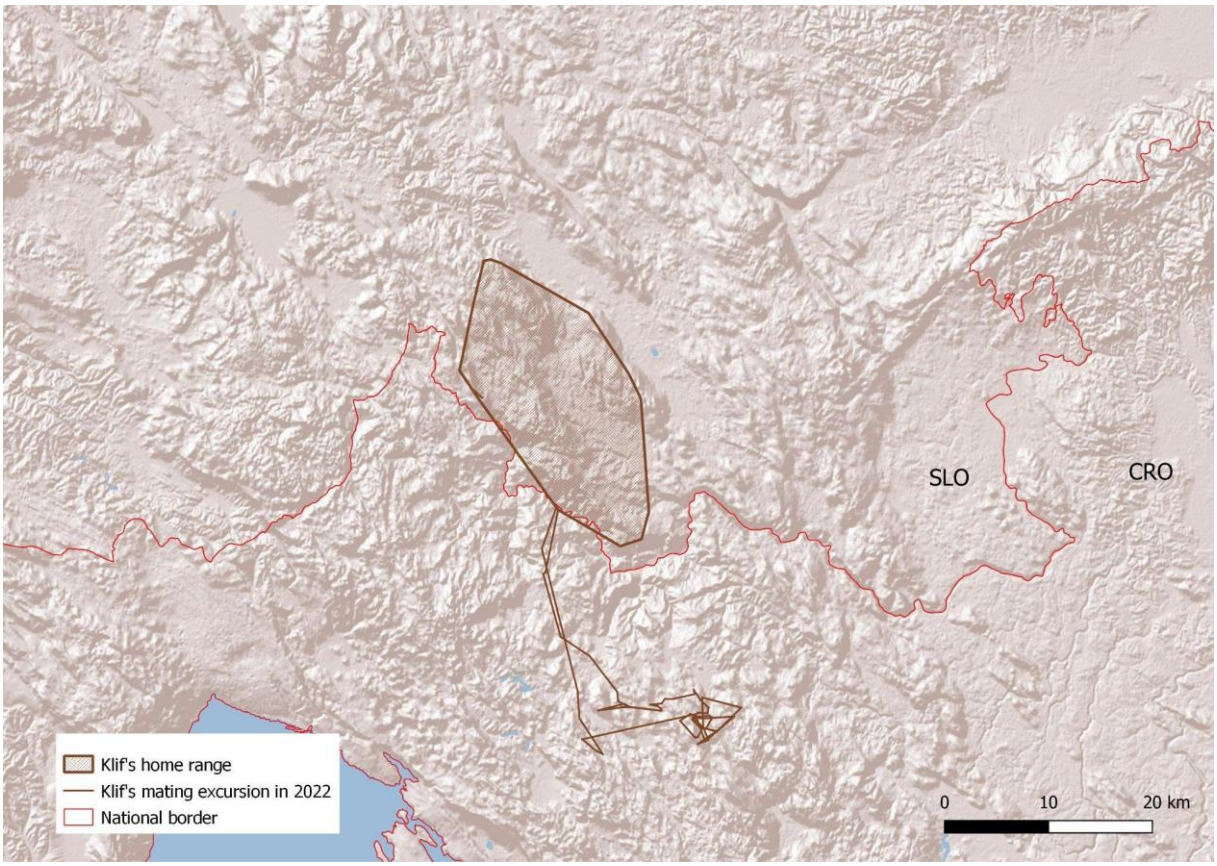

Figure 38. Klif's home range (100 % MCP) in Kočevsko and his mating excursion to Croatia in 2022.

Igi

Figure 39. Lynx Igi at the time of his capture, with his special feature: two ear tufts on the same ear.

A remnant male lynx Igi was captured on 17th of February 2022 in Mokrc area. He was estimated to be around 5 years old and weighed 20 kg. During his immobilization, we detected that he had a heart murmur, which could be a consequence of an inbred lynx Dinaric population. His special feature that distinguished him from other lynx was that he had two tufts on one ear, possibly also a consequence of inbreeding. We already knew Igi from lynx camera trap national monitoring from year before as he was regularly recorded in Mokrc area. His home range was quite small, compared with other males and measured around 60 km^2. During his telemetry monitoring, we surveyed some of his kill sites, where he mostly preyed on roe deer, however we also found one consumed feral cat close to the village, probably killed by him. In the beginning of May 2022, we received a mortality signal from the collar. We confirmed his death and recovered Igi's carcass. From the telemetry data we could see that lynx Igi was confined to a small area of about 1 km^2 for two weeks before his death. The activity data from the telemetry collar further confirmed his stagnation as the activity almost halved after he made his last roe deer kill. Considering several deformations, including a severe heart murmur, we assume his death is a consequence of heart or other internal organ malfunction, which appeared to have been triggered during the hunting attempt.

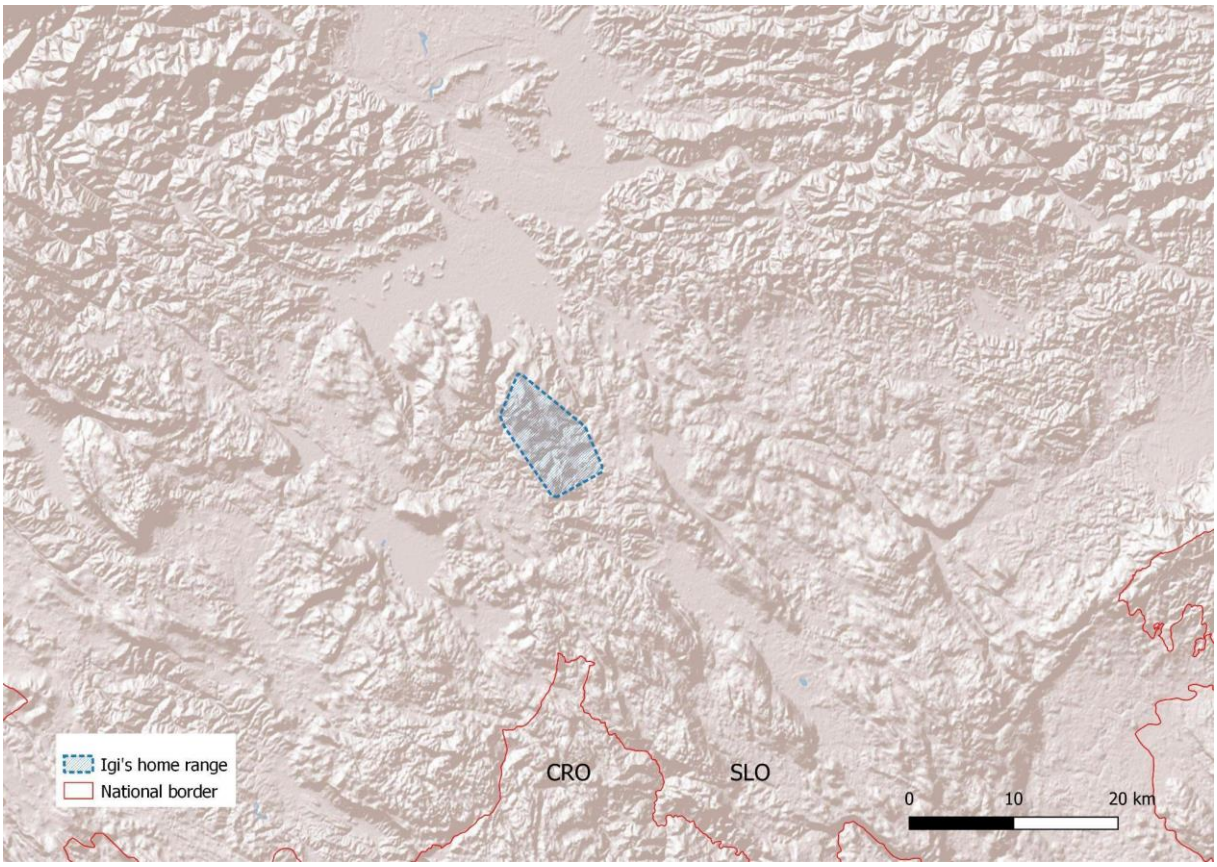

Figure 40. Igi's home range (100 % MCP) in Mokrc area.

Pandora

Figure 41. Lynx Pandora checking the box trap several days before capturing.

The adult remnant male Pandora is an individual we have already known since 2019 from camera traps set in Nature Park Velebit. On 30th of March 2022, he was successfully captured in a box trap and collared with an Iridium collar. He weighed 24 kg and we estimated him to be around 5 years old. Pandora is also holding the record as the most photographed lynx on Velebit as we have more than 60 recorded events on 18 different camera trap locations (since 2019). First locations collected inside this reporting period had shown that his territory partly overlaps with the other territorial male Josip that was collared in February 2022, while the size of his home range is estimated to 183 km^2. Until now, we surveyed two kill sites where he preyed on roe deer. His collar is programmed to drop after one year of monitoring.

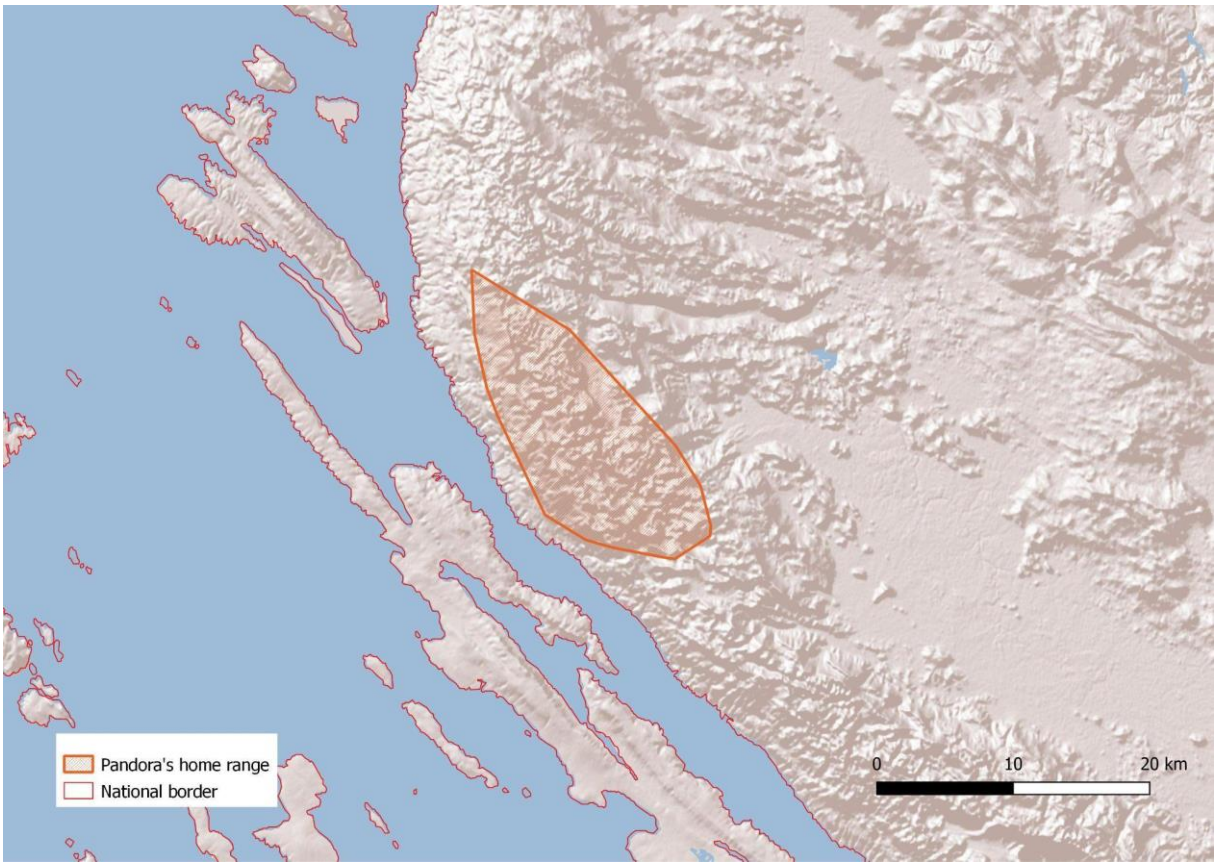

Figure 42. Map of Pandora's home range (100% MCP).

Josip

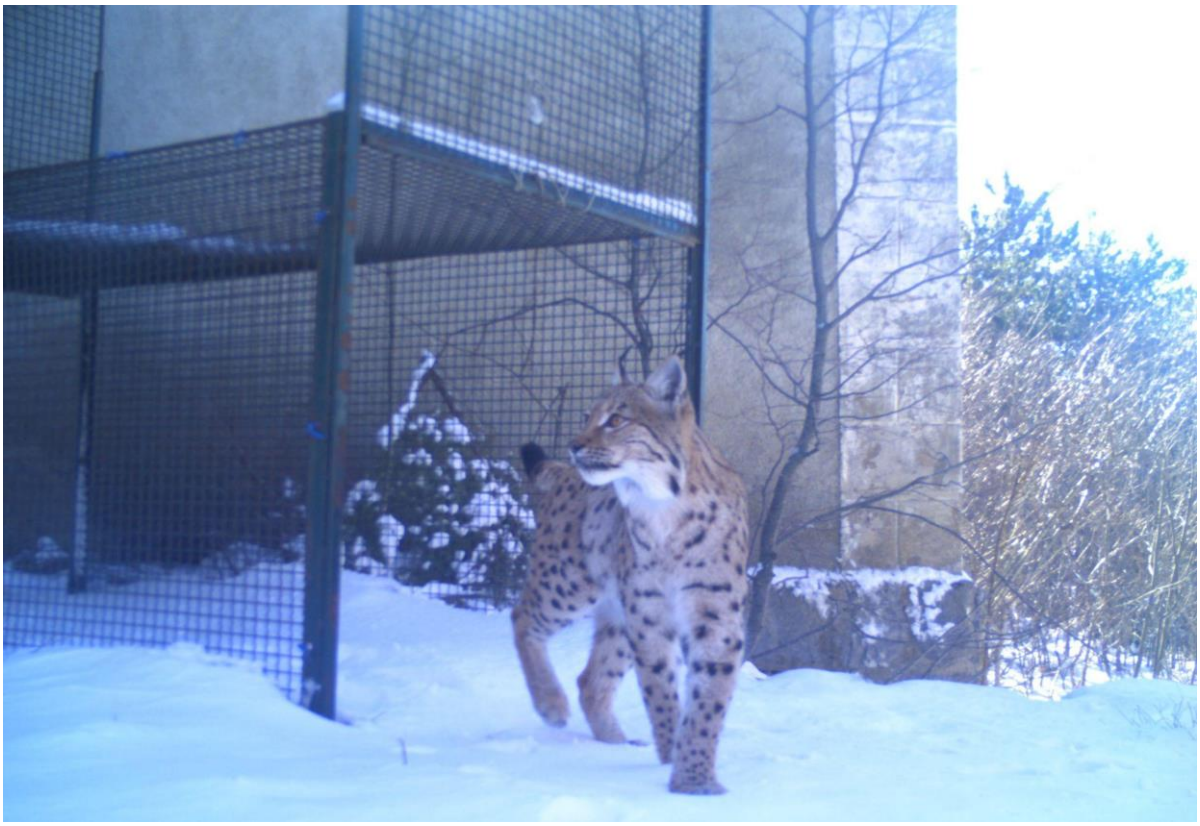

Figure 43. Josip photographed in front of the box trap.

The adult remnant male named Josip was caught and collared with an Iridium collar on 4th of February 2022, same night as lynx Klif in Slovenia. Josip is a big male who weighed 27 kg and we estimated him to be around 5 years old. He was already known since 2019 from camera traps set in Nature park Velebit. The size of his home range is estimated to 170 km^2 and its southern part overlaps with the home range of the collared remnant male Pandora. Until now, we surveyed four kill sites where he preyed on presumably roe deer as in three cases only hair and vertebrae were found. This late kill site detection is due to the poor Iridium satellite communication from which we receive data with a 2-3 weeks delay. His collar is programmed to drop after one year of monitoring.

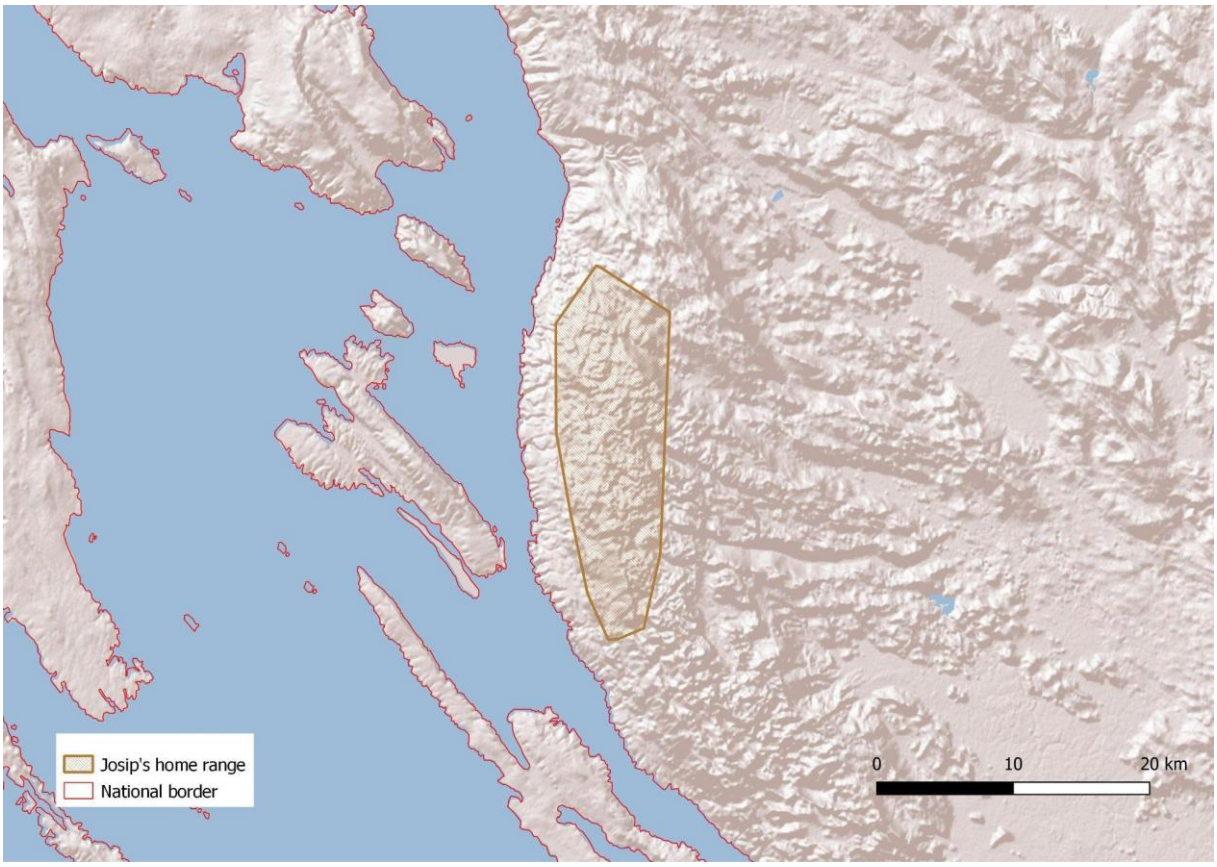

Figure 44. Map of Josip's home range (100% MCP).

Neža

Figure 45. Lynx Neža during her capture.

We collared lynx Neža on the same day (13.2.2022), in the same trap (Mala gora) as her sister lynx Valentina. She was one of the three kittens from Goru and Teja in the season 2021-2022. At the time of the capture Neža weighed 12 kg and she was eight months old. In the first month of monitoring, she stayed near her mother and also fed on her kills. In the end of march 2022 she started to show first signs of dispersion. First she went towards Stojna, south-west from her mother's territory. After a week she turned and came back to her natal territory. She then tried a couple of times different ways mostly towards the east, but each time she came back.
On May 11th 2022 we received a mortality signal and found her collar. The collar was ripped off the lynx and with the help of a trained detection dog, we also found some blood nearby. The genetic analysis showed that the blood was Neža's. With these proofs, the police unit trained for investigation of illegal killing, started with the investigation of a suspected illegal killing. The case has been reported to the court, however, the process has not been finalized yet.

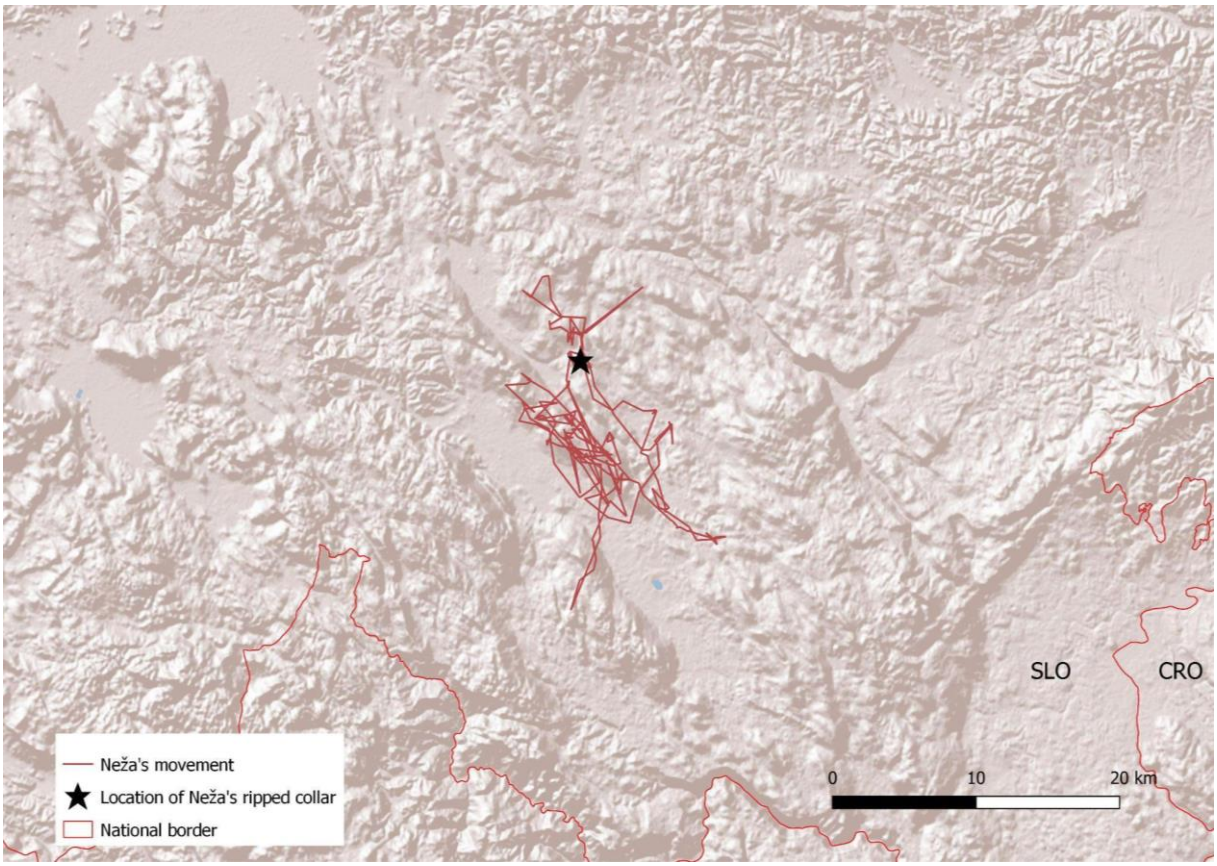

Figure 46. Movement of female lynx Neža and location where her ripped collar and blood were found.

Valentina

Figure 47. Valentina in the boxtrap at the time of her capture.

Lynx Valentina was the first of two lynx sisters captured on February 13th 2022 on Mala gora. She weighed 12 kg. Similar to Neža, Valentina also moved with her mother in the first month after the release. In May 2022, she then distanced a little bit from her mother and started moving more towards the south-east. Until September 2022 she kept visiting her mother's kills and fed on the carcasses. In September she started to regularly hunt by herself. We assume she will establish her territory in the area south-west to her mother's.

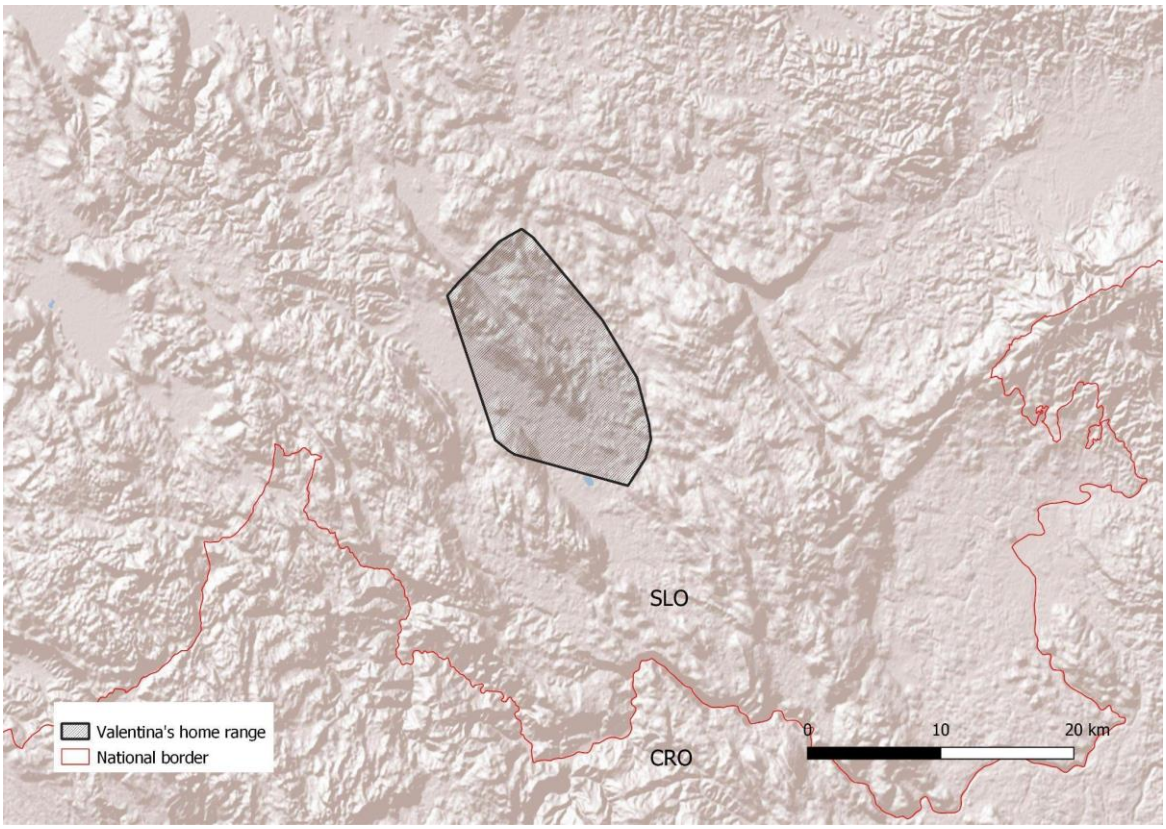

Figure 48. Valentina's potential home range (100 % MCP) in Kočevsko.

2.4.4 Monitoring lynx predation on ungulates

Lynx kill sites were regularly checked in the field, also with the help of hunters. As lynx are returning to their ungulate kills for several days, we could detect kills with telemetry data and survey them in the field (Krofel et al. 2013, Oliveira et al. 2022). Camera traps were deployed on the kills to monitor lynx behavior, lynx's physical condition and to assess the impact of kleptoparasitism of other species (Krofel et al. 2019). Collection of data at the kill sites can provide us with insight about lynx diet, which can be later implemented into ungulate management plans and evaluation of the lynx ecological impact (Krofel et al., 2014).

Between May 2021 and April 2022, we found 121 lynx kill sites in Slovenia and Croatia in total. As expected from previous research in these countries (Krofel et al. 2011), the main prey species found at the kill sites was European roe deer (*Capreolus capreolus*) with 79 % of all detected kills. We also detected red deer (*Cervus elaphus*) (7%), chamois (*Rupicapra rupicapra*) (7%), red fox (*Vulpes vulpes*) (3%), mouflon (*Ovis amon musimon*) (1%), fallow deer (*Dama dama*) (1%) domestic cat (*Felis catus*) (1%) and beech marten (*Martes foina*) (1%) at the lynx kill sites. There was one case when we found a wildcat (*Felis silvestris*) carcass in the direct lynx kill site vicinity. It was probably killed opportunistically by lynx while it was scavenging on the kill. Scavenger species that were recorded at the lynx kill sites within the reporting period were red fox, brown bear (*Ursus arctos*), gray wolf (*Canis lupus*), Beech marten (*Martes foina*), wild boar (*Sus scrofa*), golden eagle (*Aquila chrysaetos*), common buzzard (*Buteo buteo*), common raven (*Corvus corax*), Eurasian jay (*Garrulus glandarius*) and coal tit (*Parus ater*). On Table 7 we present sex and age structure of roe deer killed by the collared translocated and

remnant lynx. Lynx mostly killed adult prey and more females than males. In general, these results suggest similar predation patterns to those observed in previous research on remnant lynx from the Dinaric population (Krofel et al. 2014), as well as in the previous year monitoring years (Krofel et al. 2021, Fležar et al. 2022).

Table 7. Age and sex structure of roe deer killed by collared lynx within the reporting period.

roe deer		sex			Total (%)
		male (%)	female (%)	unknown (%)	
age	adult	26 (27)	30 (31)	12 (13)	68 (71)
	juvenile	1 (1)	2 (2)	1 (1)	4 (4)
	unknown	0 (0)	2 (2)	22 (23)	24 (25)
	Total (%)	27 (28)	34 (35)	35 (37)	96 (100)

2.5 Lynx mortality

In total, there were three mortality events detected in the lynx monitoring year 2021-2022 (1 in Slovenia and 2 in Croatia).

In Slovenia, a subadult male (estimated 1-2 years old) was hit by a car between the villages of Gotenica and Kočevska Reka on 10th of August 2021. It weighed 13 kg at the time of carcass recovery and it was in good physical condition. The cause of death was a crushed skull caused by a vehicle collision. This was the only recorded lynx mortality in Slovenia in the monitoring year 2021-2022 (Igi and Neža died after the end of April 2022 and will be reported in detail in the next report).

Adult female lynx was found dead in October 2021 in Gorski Kotar, Croatia. We have monitored this lynx with camera traps since November 2019 and she was named Jela. The last time she was photographed was in March 2021 and no signs of problems were observed. Necropsy showed lynx was cachectic, dehydrated and anemic, and was infected with scabies. Also mild pneumonia was diagnosed and chronic degenerative changes on the heart muscle. Pathologist concluded that heart condition was not the primary cause of the death, but contributed to the overall bad health.

In January 2022 we were informed that a live lynx was found in an empty underground water tank near an abandoned house in Lika region, Croatia. LIFE Lynx team immediately went to the location, tranquilized the animal and evacuated it from the tank. Lynx was a subadult male, emaciated and dehydrated but without any visible injuries. First aid was provided and the lynx was kept in a transport box indoors and monitored for 24 hours. As he started to consume food and show signs of aggression towards people it was concluded he can be released back to nature. Additional food was provided on the release site and the animal was equipped with a telemetry collar. Unfortunately he was found dead three days later. Pathology exam confirmed the animal died due to starvation.

Finally, we received an anonymous info about lynx poaching in the summer of 2021, south of Benkovac in Dalmatia, Croatia. We could not confirm this info with any hard evidence.

3 REGIONAL SYNTHESES

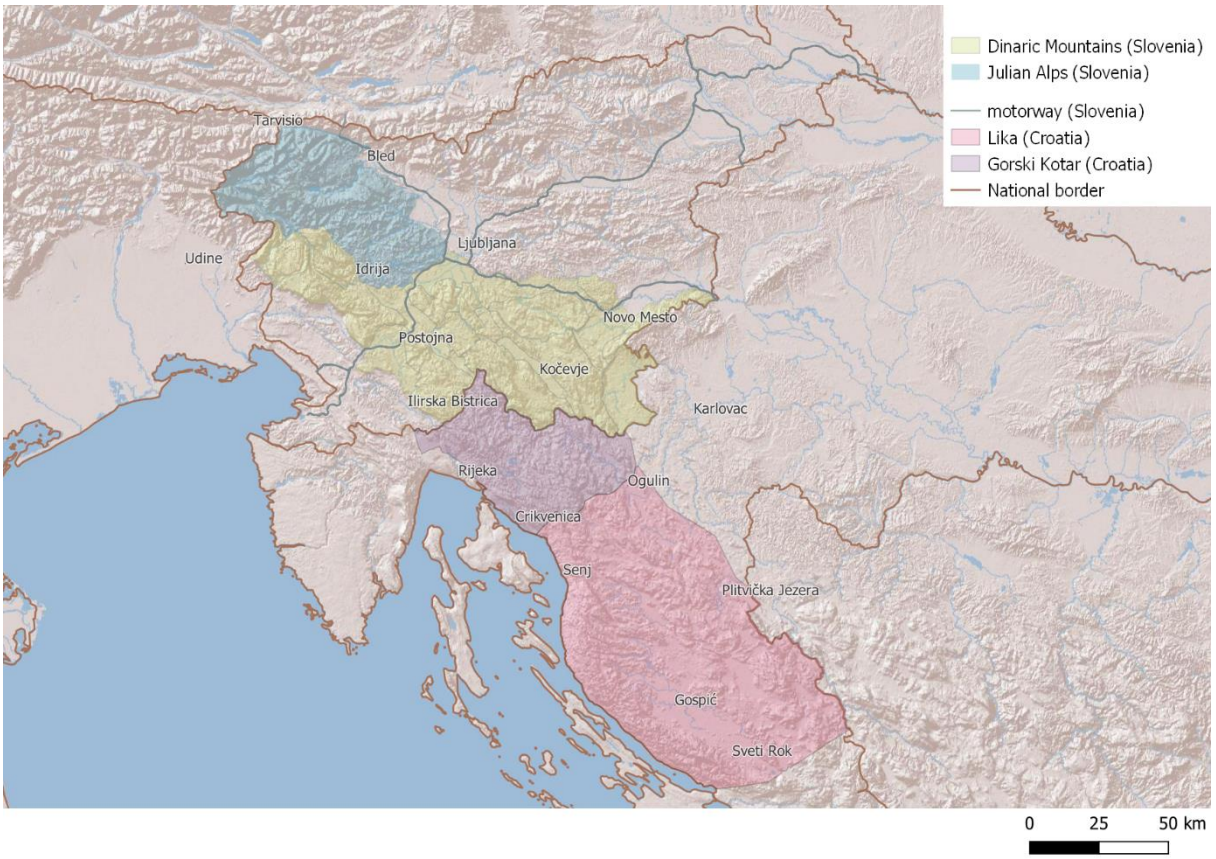

Figure 49. The division of Dinaric-SE Alpine project area in distinctive regions for which we present the syntheses in chapters 3.1 – 3.5. The NE Alpine – Italy region is included within the "Julian Alps" due to only one record of lynx presence collected there.

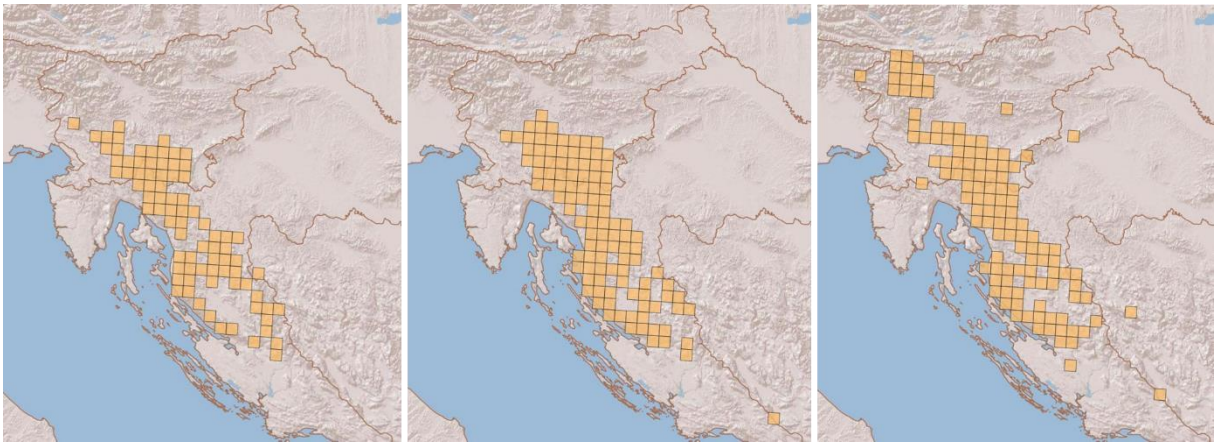

Figure 50. Lynx distribution in Dinaric-SE Alpine project area in 2019-2020 (left), 2020-2021 (middle) and 2021-2022 monitoring season (right). Grid cells were colored on the basis of confirmed records of lynx in a standard European 10 × 10 km grid net. Four types of data were considered as confirmed lynx records: opportunistic data categorized as C1 or C2 record, GPS locations from collared animals, camera trapping records and genetic records (for more details, see Krofel et al. 2021 and Fležar et al. 2022).

3.1 Slovenian Dinaric Mountains

In the Slovenian part of the Dinaric Mountains east of the Ljubljana-Koper highway (i.e. Notranjska and Kočevska) most of the region is currently occupied by lynx, including several territories occupied by both male and female lynx. A minimum of 24 different adult lynx were detected in this region in 2021-2022 lynx-monitoring year, including two translocated males with established territories (Goru and Catalin). In this monitoring year we recorded four successful lynx reproductions, including two successful mating between the translocated males and remnant females. In comparison to the previous lynx monitoring year, the minimum population size and number of detected reproduction events did not show any notable change; however, a high number of kittens per reproductive female was detected; at least 3 kittens in each litter. We also observed an increase in lynx distribution with new animals detected in areas East, South-West and North of the distribution reported in the previous report (Fležar et al. 2022).

Lynx pairs sharing a territory were confirmed in Kočevski Rog/Poljanska gora, Mala gora (with reproduction), Goteniška gora/Velika gora/Kolpa (with reproduction), Racna gora (with reproduction), Snežnik plateau, Menišija/Logatec plateau (with reproduction) and Rakitna/Mokrc. Areas with potential single lynx, although some of them might only be transient dispersers, detected this year include Suha Krajina (a female, offspring of lynx Goru from 2020), Stari Trg pri Ložu (a female), Javorniki (a female), Velika gora, Stojna and northern part of Goteniška gora (lynx of unknown sex), northern part of Kočevski Rog (one male and another individual on camera traps; and one female confirmed genetically, which could be the lynx from the camera traps since it is already known from previous years of camera trapping).

A new lynx female was detected with camera traps in Javorniki, where no lynx was detected the previous season. Single records of two new lynxes in the Snežnik area were available, besides a territorial female which was known as kitten in 2020-2021, and the territorial male known from 2018, having a transboundary territory (Damir). Moreover, photos of single animals were recorded in Brkini (South-Western-most C1 data on Figure 51) and Zasavje (North-Eastern-most C1 data on Figure 51), indicating possible directions of population increase in the future.

The situation in Slovenian Dinaric Mountains east of the Ljubljana-Koper highway seems to have improved in comparison to the previous year, especially in Notranjska due to confirmed reproduction of translocated lynx in Menišija, and the improved situation in Javorniki and Snežnik. In Kočevsko, the situation is more stable in general, however some improvement in Kočevski Rog, Suha Krajina and Stojna is evident. If the single animals (mostly female) remain in the newly occupied area, we can expect a pair forming in the near future. According to available data, the non-occupied areas remain in the buffer around the core area monitored. However, it must be noted that these areas are not systematically monitored, therefore the presence of lynx cannot be excluded.

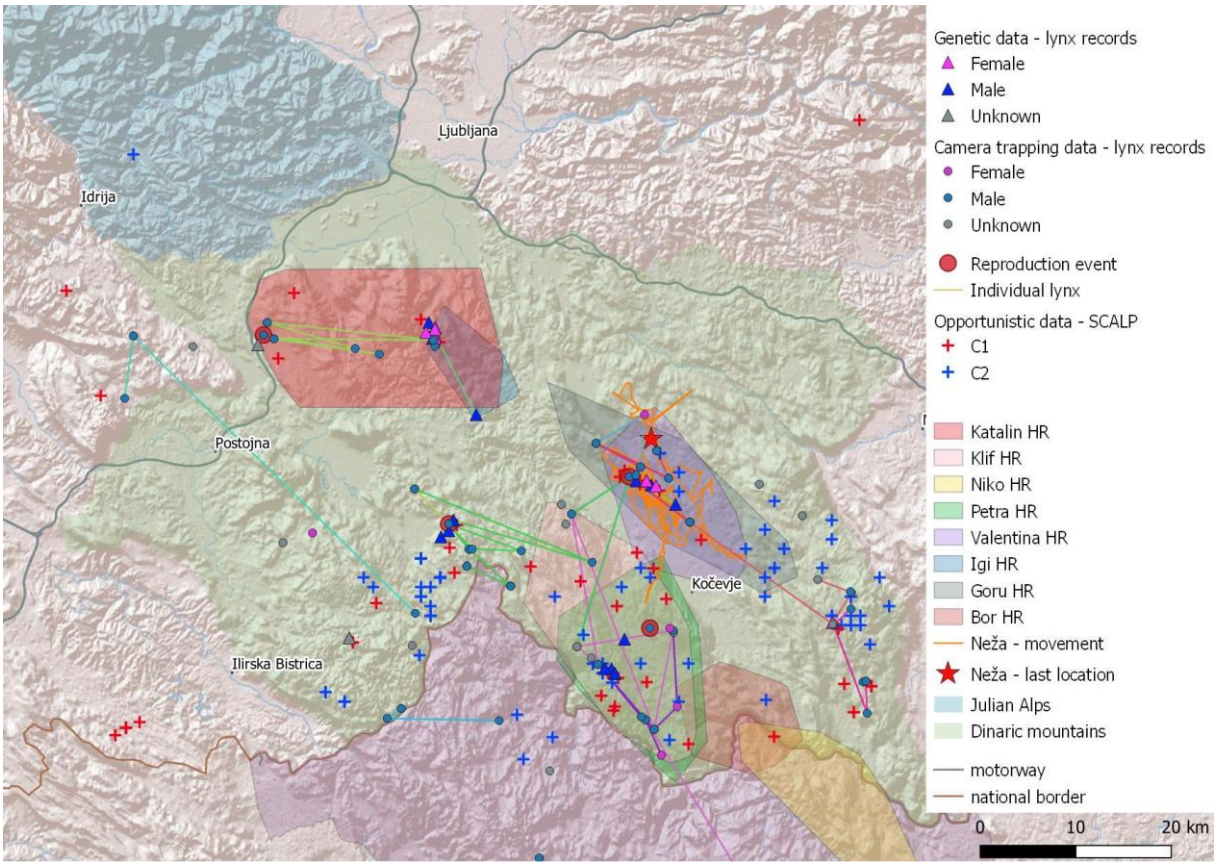

Figure 51. Overview of all confirmed records of Eurasian lynx collected during the 2021-2022 monitoring year in Kočevska and Notranjska regions in Dinaric Mountains of Slovenia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), home-ranges (HR; 100% MCP) of translocated lynx tracked with GPS telemetry and confirmed opportunistically-collected records (C1 and C2 category). Straight lines connect genetic samples and camera-trap records confirmed to belong to the same individual, each line colour representing a different individual.

In the Slovenian part of the Dinaric Mountains west of the Ljubljana-Koper highway we could confirm lynx presence in 2020/2021 lynx monitoring year on Hrušica, Nanos and Trnovski gozd, although we still do not have any confirmed record of reproduction or females present in this region. This year it remains the same, but rather than genetically, a new territorial male was recorded with camera traps. Interestingly, that lynx was recorded on a camera trap also in the Snežnik area in March, possibly going there for a mating excursion. That indicates some permeability of the Ljubljana-Trieste highway for the remnant animals. Moreover, a lynx kitten was recorded at one of the highway overpasses between Vrhnika and Logatec, however crossing could not be confirmed.

3.2 Julian Alps, Slovenia and Italy

Confirmed records of lynx were obtained from this region with the introduction of the translocated lynx in April 2021; a pair to the Jelovica plateau and one male and two females to the Pokljuka plateau. Interestingly, the first reproduction in the Alps was detected soon after with 3 kittens and Aida being photographed by hikers in the Jelovica area. Two of them were genetically sampled (see chapter 2.3 for further details) and also photographed with camera traps within their mother's territory before dispersal. While Julija was pregnant upon translocation, she probably gave birth after the release, but

the survival of kittens was not confirmed as no data was collected from them. In 2022, Aida and Julija gave birth to 3 kittens each. Camera trapping was an important method to confirm Tris and Lenka's presence after their collars failed, and up to the date we did not manage to recapture them. Importantly, a reliable opportunistic record (lynx prey remains) was collected on the Italian side of the Julian Alps, indicating possible expansion of lynx within the Alpine area in Slovenia to Italy. This necessitates that systematic monitoring is continued and expanded in this region in the following years to be able to follow the development of this new stepping-stone subpopulation.

Since Triglav National Park, consisting of state-owned hunting ground and adjacent hunting clubs is a unique protected area in Slovenia with the priority objective of nature conservation, it plays a significant role in the creation of the stepping stone of lynx population. Thus, it is important to highlight the success of the lynx translocations in that area, which is characterized primarily by the fact that all three lynx released within TNP established their territories there. At the end of 2021-2022 survey season, these three adult lynx are so far the only lynx detected in the park, but one reproduction was detected there in 2022 (Julija with 3 kittens).

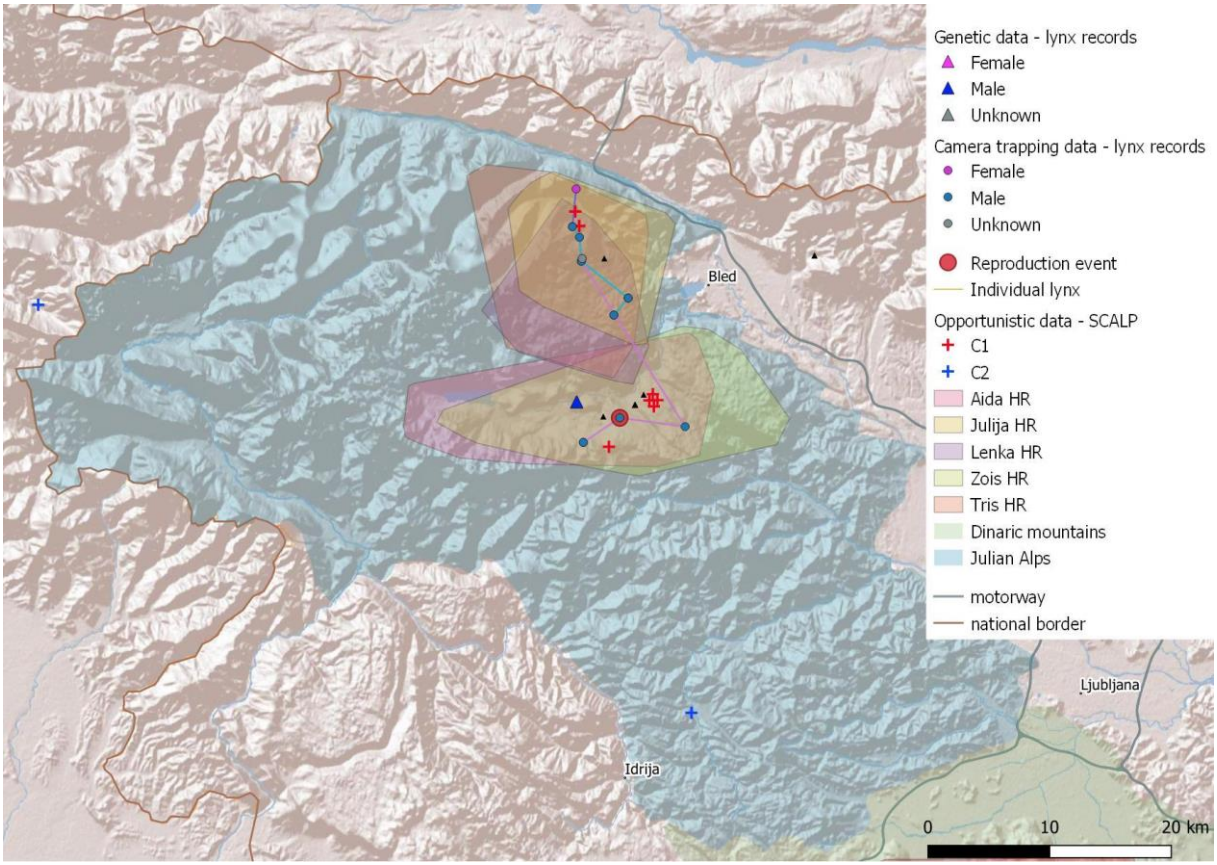

Figure 52. Overview of all confirmed records of Eurasian lynx collected during the 2021-2022 monitoring year in Julian Alps, Slovenia. We obtain different types of data from translocated lynx and their offspring.

3.3 Gorski Kotar, Croatia

In Gorski kotar lynx presence is confirmed in most of the region. Similar as in the previous season, a decrease in the number of opportunistic records is visible. This is partly due to the fact that several individuals that regularly provided the data are not active in the area any more, but also due to the

low snow coverage during the winter so tracks were not observed and reported. But we observed a similar number of lynx identified with systematic camera trapping. While in the last two seasons a total of 25 (2019 – 2020) and 29 (2020 – 2021) adults were identified, in 2021 - 22 the total is 25 adults. Out of the 25 adults, 8 animals are known since the 2019 - 2020 season, while 16 are known from the 2020-2021 season. Also, in this season two reproductions were confirmed.

Territories of collared lynxes Petra and Bor are mostly in Slovenia with small areas reaching Croatia, while the biggest part of Niko´s territory is in Gorski Kotar. The territory of translocated lynx Boris is partly in Gorski kotar and partly in the Lika region. The fact that almost half of the territory of lynx Boris is susceptible to be covered with land mines, monitoring of his territory is challenging.

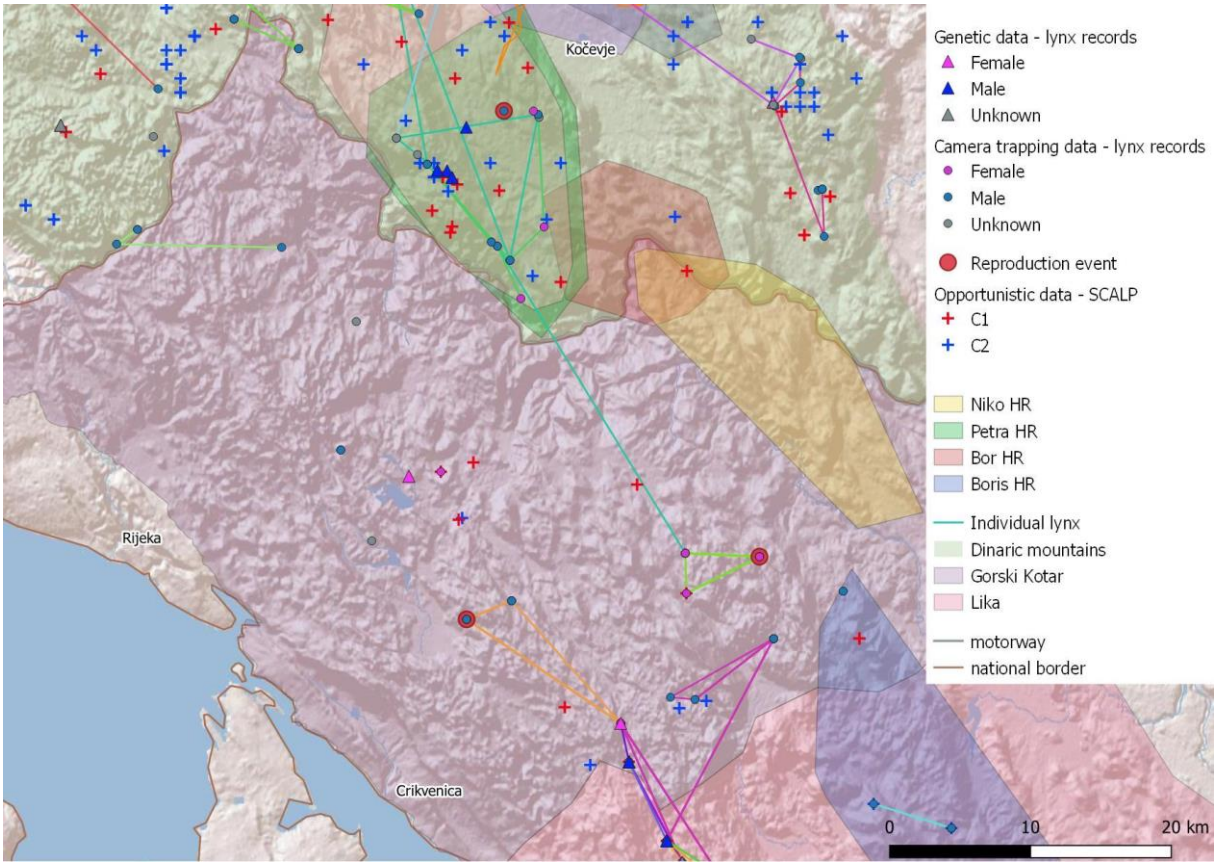

Figure 53. Overview of all confirmed records of Eurasian lynx collected during the 2021-2022 monitoring year in Gorski Kotar, Croatia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), movements of translocated lynx tracked with GPS telemetry and confirmed opportunistically-collected records (C1 and C2 category). Straight lines connect genetic samples and camera-trap records of the same individual.

3.4 Lika and northern Dalmatia, Croatia

Based on all available data we can confirm lynx distribution in the entire Lika region. As visible on Figure 1, the only 10x10 km grid cells with no data confirming lynx presence are areas of unsuitable lynx habitat (open plains and karst fields in central Lika). A total number of identified adults (54) is comparable to the 2019 – 2020 season (58), indicating that last season´s drop to 45 identified individuals is a consequence of the monitoring effort (lack of data from the National park Plitvice lakes).

Among 54 individuals identified on camera traps in the wider Lika and northern Dalmatia region (including animals in Karlovac and Zadar county), 32 were identified from both sides of the body (including the two translocated lynx). A total of 17 animals are monitored since the 2019-2020 season, while 14 are known from the 2020-21 season.

Reproduction was detected on five locations in eight different events. Precisely, we confirmed five litters and 11 kittens, which is somewhat lower compared to the previous year (10 litters and 14 kittens). One litter could be a consequence of mating with translocated lynx Alojzije, but at the moment we do not have genetic proof for this.

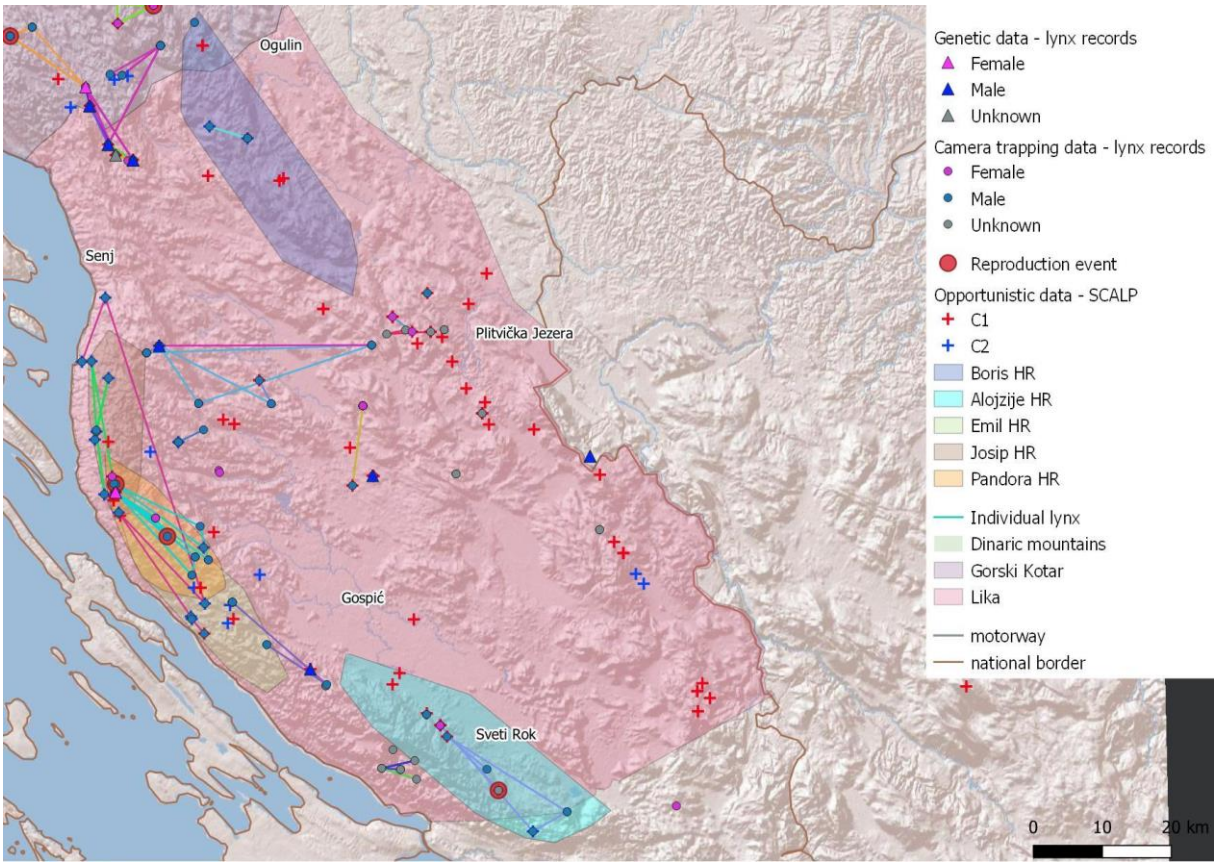

Figure 54. Overview of all confirmed records of Eurasian lynx collected during the 2021-2022 monitoring year in Lika, Croatia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), home range (HR) of translocated lynx tracked with GPS telemetry and confirmed opportunistically-collected records (C1 and C2 category). No telemetry data was received from one of the released lynx, therefore only his release site is indicated.

4 CONCLUSIONS WITH RECOMMENDATIONS FOR FURTHER RELEASES

According to available data, in 2021-2022 the status of Dinaric-SE Alpine lynx population improved compared to the previous year, especially due to a successful reintroduction of lynx to the Slovenian Alps. Several territories across the Dinaric Mountains of Slovenia and Croatia are occupied by lynx of both sex and at least five males translocated from the Carpathian population in 2019-2021 (Goru, Catalin, Emil, Alojzije, Boris) have become successfully integrated in the population and have had confirmed or suspected reproductions. The number of lynx in the western part of Dinaric Mountains in Slovenia (i.e. west of Ljubljana-Koper highway) remains small and no confirmed records of presence of remnant lynx in North-Eastern Italy were collected. However, the situation in the Alpine region considerably improved as five Carpathian lynx translocated to the Slovenian Julian Alps at the end of 2020/2021 lynx monitoring year, established their territories there and even reproduced. We are starting the 2022 - 2023 season with 10 translocated lynxes successfully integrated into the population and 2 offspring of translocated lynxes (confirmed with genetic analyses) integrated into the population. While two translocated lynx in 2022 (Blisk, Lubomir) have stayed in the Dinaric area, they are on the good way to become integrated as well.

Similar to the previous years, camera trapping provided the most informative insight into demographic status of the population, especially in Slovenia where camera-trap density was high and monitoring activities intensively coordinated. This could only be achieved by close cooperation with hunters, which should be further nourished in order to yield good results. In addition to camera-trapping, also genetic and opportunistic data importantly complemented the picture. Genetic monitoring is crucial for assessing genetic status and influence of ongoing translocations. But due to difficulties of collecting enough samples over the entire area (high effort needed to find samples, especially in poor snow conditions), genetic monitoring could so far only be used as supplementary data to camera trapping for understanding the demographic status and population parameters. However, genetic samples gave us important insight into the level of effective inbreeding, which is the most important threat to this population and which could not be monitored with other methods. While inbreeding is still high, we can already see important improvements due to population reinforcement efforts and large increase in expected heterozygosity indicates the potential for rapid decrease of inbreeding if the translocated animals continue to successfully reproduce.

In 2023, additional releases are planned in the Dinaric Mountains, according to the reinforcement plan (Wilson et al. 2019), mostly to compensate for the lynx that disappeared before becoming integrated into the population. In Slovenia and Croatia, several areas appear unoccupied with remnant lynx or only a single territorial animal is present and could represent suitable areas for colonization by the new lynx. In Slovenia, these include Javorniki, Bloke, Vremščica and parts of Kočevski rog/Poljanska gora and Suha Krajina. Based on available information, both enclosures in Slovenia are appropriate for potential releases in Slovenia in 2023. Moreover, due to a lack of data about Zois presence in Jelovica in the beginning of the 2022-2023 monitoring season, translocation of a new male would benefit the established population to further reproduce without the risk of inbreeding. In Croatia, we recommend next releases to take place in areas adjacent to National park Plitvice lakes or park itself. As lynx Boris is present in Gorski Kotar area, while Alojzije and Emil are present on Velebit, by releasing another animal on Plitvice lakes we will spread the positive effect of the new genes all over the lynx distribution area in Croatia.

5 REFERENCES

Adams JR & Waits LP (2007) An efficient method for screening faecal DNA genotypes and detecting new individuals and hybrids in the red wolf (*Canis rufus*) experimental population area. Conservation Genetics V8:123–131.

Fležar U, Pičulin A, Bartol M, Černe R, Stergar M, Krofel M (2019) Eurasian lynx (*Lynx lynx*) monitoring with camera traps in Slovenia in 2018-2019. Ljubljana.

Fležar U, Hočevar L, Sindičić M, Gomerčić T, Konec M et al. (2022) Surveillance of the reinforcement process of the Dinaric - SE Alpine lynx population in the lynx-monitoring year 2020-2021. Ljubljana.

Heurich M, Hilger A, Küchenhoff H, Andrén H, Bufka L, Krofel M, Mattisson J, Odden J, Persson J, Rauset GR, Schmidt K, Linnell JDC (2014) Activity patterns of Eurasian lynx are modulated by light regime and individual traits over a wide latitudinal range. PLoS ONE 9: e114143.

Hočevar L, Fležar U, Krofel M (2020) Overview of good practices in Eurasian lynx monitoring and conservation. INTERREG CE 3Lynx report. University of Ljubljana, Biotechnical Faculty, Ljubljana.

Johnson WE, Onorato D, et al. (2010) Genetic restoration of the Florida panther. Science, 329, 1641–1645.

KORA (2017) SCALP Monitoring Report 2017. 1.

Krofel M, Skrbinšek T, Kos I (2013) Use of GPS location clusters analysis to study predation, feeding, and maternal behavior of the Eurasian lynx. Ecological Research 28: 103.

Krofel M, Fležar U, Hočevar L, Sindičić M, Gomerčić T, Konec M et al. (2021) Surveillance of the reinforcement process of the Dinaric - SE Alpine lynx population in the lynx-monitoring year 2019-2020. Ljubljana.

Krofel M, Jerina K, Kljun F, Kos I, Potočnik H, Ražen N, Zor P, Žagar A (2014) Comparing patterns of human harvest and predation by Eurasian lynx *Lynx lynx* on European roe deer *Capreolus capreolus* in a temperate forest. European Journal of Wildlife Research 60: 11-21.

Mattisson J, Linnell JDC, Anders O, et al (2022) Timing and synchrony of birth in Eurasian lynx across Europe. Ecol Evol 12:e9147. https://doi.org/10.1002/ece3.9147

Menotti-Raymond M, David VA, et al. (1999) A genetic linkage map of microsatellites in the domestic cat (Felis catus). Genomics, 57, 9–23.

Menotti-Raymond M, David Victor A, Wachter Leslie L., Butler John M, O'Brien Stephen J (2005) An STR Forensic Typing System for Genetic Individualization of Domestic Cat (*Felis catus*) Samples. Journal of Forensic Science, Sept. 2005, Vol. 50, No. 5, 1061-1070.

Molinari-Jobin A., Breitenmoser U., Breitenmoser-Würsten Ch., Černe R., Drouet-Hoguet N., Fuxjäger C., … & Zimmermann F. 2021. SCALP: Monitoring the Eurasian lynx in the Alps and beyond. Cat News Special Issue 14, 50–52.

Molinari-Jobin A, Drouet-Hoguet N, et al. (2020) SCALP Monitoring Report 2017 (1. May 2017 – 30. April 2018). KORA and Progetto Lince Italia.

Molinari-Jobin A, et al. 2012. Monitoring in the presence of species misidentification: the case of the Eurasian lynx in the Alps. Animal Conservation 15:266–273.

Oliveira T, Carricondo-Sanchez D, Mattisson J, et al (2023) Predicting kill sites of an apex predator from GPS data in different multiprey systems. Ecol Appl e2778. https://doi.org/10.1002/eap.2778

Palmero S, Belotti E, Bufka L, Gahbauer M, Heibl C, Premier J, Weingarth-Dachs K, Heurich M (2021) Demography of a Eurasian lynx (Lynx lynx) population within a strictly protected area in Central Europe. Scientific Reports 11: 1–12.

Pilgrim KL, Mckelvey KS, Riddle AE, Schwartz MK (2005) Felid sex identification based on noninvasive genetic samples. Molecular Ecology Notes, 5, 60-61.

Polanc P, Sindičić M, Jelenčič M, Gomerčić T, Kos I, Huber D (2012) Genotyping success of historical Eurasian lynx (*Lynx lynx* L.) samples. Molecular Ecology Resources 12:293–298.

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Ripari L, et al. 2022. Human disturbance is the most limiting factor driving habitat selection of a large carnivore throughout Continental Europe. Biological Conservation, 266: 109446.

Rovero F, Zimmermann F (2016) Camera trapping for wildlife research. Pelagic Publishing, UK, Exter.

Royle JA, Chandler RB, Sollmann R, Gardner B (2014) Spatial Capture-Recapture. Elsevier, Inc. 577 p.

Slijepčević V, Fležar U, et al. (2019) Baseline demographic status of SE Alpine and Dinaric lynx population. Technical report for A3 action of LIFE Lynx project: 22 p.

Skrbinšek T (2017) Collecting lynx noninvasive genetic samples. Instruction manual for field personnel and volunteers. Ljubljana.

Stergar M, Slijepčević V (2017) Lynx camera trapping guidelines. Technical report for A3 action of LIFE Lynx project: 9p.

Taberlet P, Griffin S, Goossens B, Questiau S, Manceau V, Escaravage N, Waits LP, Bouvet J (1996) Reliable genotyping of samples with very low DNA quantities using PCR. Nucleic Acids Research 24:3189–3194.

Williamson J, Huebinger RM, et al. (2002) Development and cross-species amplification of 18 microsatellite markers in the Sumatran tiger (*Panthera tigris sumatrae*). Molecular Ecology Notes, 2, 110–112.

Wilson, S. M., R. Černe, et al. (2019) Population level reinforcement plan. Technical report for A4 action of LIFE Lynx project. Slovenia Forest Service, Ljubljana.

Zimmermann F, Breitenmoser-Würsten C, Molinari-Jobin A, Breitenmoser U (2013) Optimizing the size of the area surveyed for monitoring a Eurasian lynx (*Lynx lynx*) population in the Swiss Alps by means of photographic capture-recapture. Integrative Zoology 8: 232–243.