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 2022-2023: final report

Action C.5

Including data collected within Slovenian national large carnivore monitoring scheme, InterMuc Project (N1-0163), Croatian Ministry of Economy and Sustainable Development project "Development of a monitoring program for large carnivores with capacity building of stakeholders in the monitoring and reporting system", Rewilding Velebit, Public Institution Nature Park Velebit and Public institution National park Plitvice lakes.

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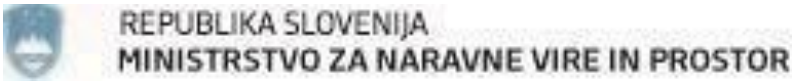

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Thanks to all of the funding available, this report presents a fifth comprehensive dataset about the status of the Dinaric SE Alpine lynx population, building on the knowledge obtained so far (Slijepčevič et al. 2019, Krofel et al. 2021, Fležar et al. 2022, Fležar et al. 2023a) to provide a robust assessment of the reinforcement process of the Dinaric-SE Alpine lynx population.

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 lynx releases. It was 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 "Surveillance and directed management of the reinforcement process", 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. Moreover, in Croatia, the camera trapping effort was additionally reinforced within the OPCC project "Development of a monitoring program for large carnivores with capacity building of stakeholders in the monitoring and reporting system", coordinated by Croatian Ministry of Economy and Sustainable Development. This fourth report about the status of the Dinaric SE Alpine population describes the progress of the final stage of the reinforcement of the lynx population in the Dinaric Mountains and Southeastern (SE) Alps. It also includes information from the ULyCA2 (Urgent Lynx Conservation Action), a project for the reinforcement of the south-eastern Alpine lynx population in the Italian Julian Alps.

The minimal population size of lynx in the Dinaric Mountains in the 2021-2022 survey season was 93 adult lynx, including 10 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. Additionally, just before the end of the 2021-2022 reporting period, two additional males were released to the Dinaric Mountains. All five lynxes reintroduced to Slovenian Alps have persisted there, while a new territorial male lynx appeared in the Slovenian pre-Alpine area (Fležar et al. 2023a). We obtained no data that three translocated lynx (Doru, Maks, Pino) would get integrated in the population.

In the survey year 2022-2023 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 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. 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 and camera traps operated by protected areas (National park Plitvice lakes and National park Paklenica) so this year number of opportunistic records in Croatia is the highest ever (341). Just before the end of survey year 2022-2023, two more lynxes were translocated to the Dinaric Mountains (a female to Slovenia and a male to Croatia) and one male lynx to the Alpine area.

With this report, we provide the information about the populations status (e.g. lynx distribution, minimum count of adult individuals and minimum number of reproductions), as well as the estimate of the population density and abundance using SCR modelling 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 is limited to "lynx-monitoring year" 2022-2023 (i.e. 1st May 2022 until 30th April 2023), 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 2023), when they were relevant for a better picture of the situation at the end of the surveillance activities within the C.5 action. Whenever this was done, we noted the extended surveillance period of the data presented (e.g. chapter 2.4).

This is the final report of the C.5 action, building on the previous annual reports published within this action (Krofel et al. 2021, Fležar et al. 2022, Fležar et al. 2023a). All reports follow the same structure with an aim to describe the lynx translocations to the Dinaric Mountains and SE Alps and the updated genetic and demographic status of the remnant lynx population. 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).

Since no more releases are planned within the LIFE Lynx project, this report does not include any recommendations for that issue.

2 METHODOLOGY AND RESULTS

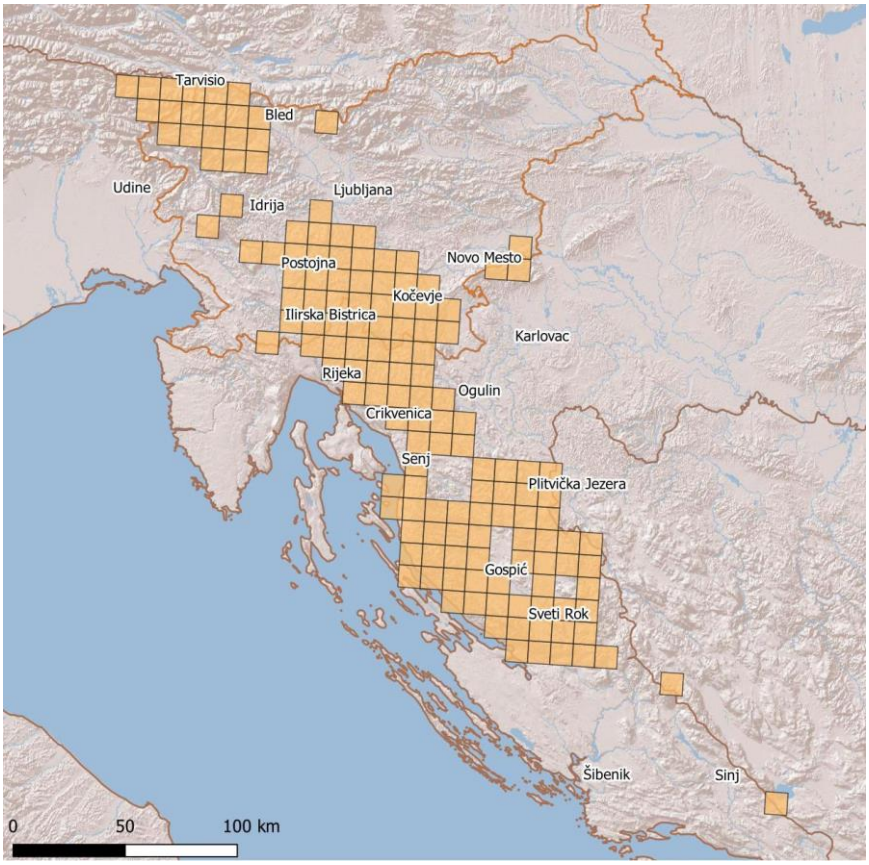

Figure 1. Confirmed lynx distribution in the Dinaric-SE Alpine area based on available data from Italy, Slovenia and Croatia in 2022-2023. Grid cells were colored on the basis of confirmed records of lynx in a standard European 10 × 10 km grid net. Four types of data were considered as confirmed lynx 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. 2003), 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 2022-2023 most of the opportunistic data collected were reliable records of lynx presence (C1). A notable increase in the amount of C1 and C2 data in Slovenia and Croatia was observed this season. More than six hundred records were collected in Slovenia and Croatia, in NE Italy only a few C3 records were collected (mostly direct observations). In total, this was the season when we have collected most opportunistic records since the start of the LIFE Lynx project.

In Croatia, a total of 341 opportunistic records were collected, significantly more than in previous seasons (2020/2021 - 130; 2021/2022 - 136). Over two thirds of opportunistic records were images provided by National park Plitvice lakes, Rewilding Velebit foundation, National park Paklenica and hunters. 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. So a lot of effort was put into communication and cooperation with hunters, managers of protected areas and the general public. Also, in the 2022-2023 season additional cooperation was established with the Rewilding Velebit foundation so their staff and volunteers participated in snow tracking, providing valuable samples for DNA analysis. Samples from 54 lynx footprints in the snow were collected, significantly contributing to the overall number of opportunistic records.

In Slovenia, 289 opportunistic records were collected, predominantly of C2 reliability. In addition, the interpretation of opportunistic data is combined with questionnaires which are sent out twice per year (in May and August) to the Slovenian hunting grounds (n=243) within the framework of the national large carnivore monitoring scheme. 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. 90 hunting grounds (37 %) reported positively; out of those 62 with regular lynx presence; 147 (60.5 %) reported no lynx in their area and 6 did not respond. We received responses that overlap other opportunistic data collected in most of the country. In the Southern Primorska region and the South-Eastern part of the country (reflected also by records across the border with Croatia), lynx presence was as the year before reported with verified record (C1) and questionnaires responses, which indicated lynx successfully spreading outside the core Dinaric area. Moreover, questionnaires' responses indicated permanent lynx presence in the pre-Alpine area, where 10 opportunistic data points were collected in the wider area of Trnovski gozd. Lynx presence was reported through questionnaires in the Northern Primorska as well as two verified records and a genetic sample was collected there. This indicates that lynx is persisting in the pre-Alpine area as well as slowly spreading from the core translocation area in the Alps. That was supported by questionnaires and opportunistic data that show that lynx distribution increased notably in the Eastern Alps too, indicating lynx presence in the Karavanke area, but probably due to the presence of translocated lynx Lukaš. The questionnaires and opportunistic data are showing us the potential expansion of the lynx population and should remain a primary source of information for the future evaluations of the distribution of the lynx in the Dinarics and SE Alps.

Even though Bosnia and Herzegovina is not officially part of the LIFE Lynx project, our monitoring efforts are recognized there also, so this season we also received opportunistic records from National park Una - 12 images from eight locations, as well as two records of lynx prey. As National park Una is bordering Croatia, this data is coherent with our monitoring system and a very valuable start of the national monitoring program in Bosnia and Herzegovina. We will invest further efforts into strengthening our cooperation with Bosnian experts and share our knowledge and experience to improve their monitoring system. On the photos received from National park Una six lynxes were

identified, and 4 of those are monitored from both sides of the border - in Croatia and in Bosnia and Herzegovina.

Table 1. Opportunistically-collected data about signs of lynx presence, categorised according to SCALP criteria, in lynx-monitoring year 2022-2023.

	Slovenia	Croatia	Italy	All countries
C1	85	228		313
C2	167	70		237
C3	37	43	6	86
total	289	341	6	635

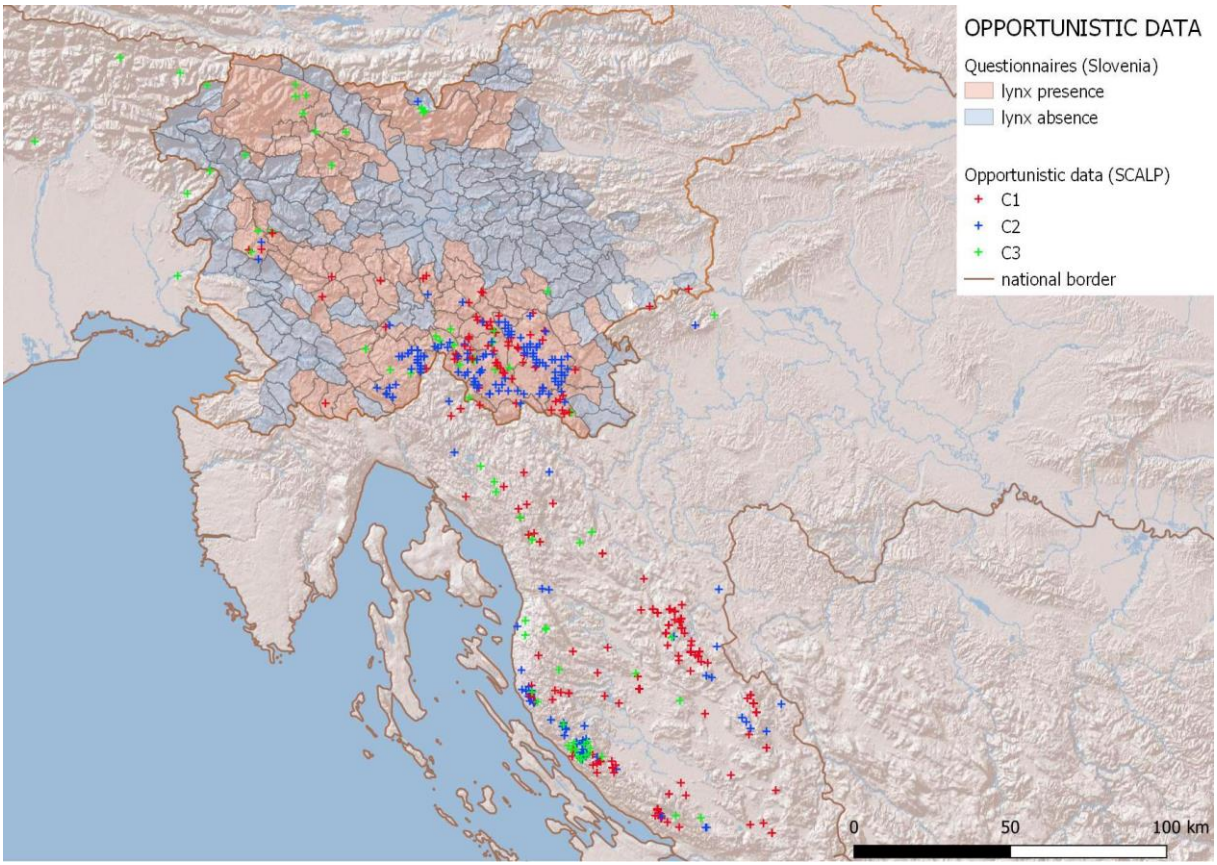

Figure 2. Opportunistically-collected data in 2022-2023, categorised in three SCALP categories (C1, C2, C3) shown together with responses received from the questionnaires sent to Slovenian hunting grounds. The hunting grounds on the eastern side of the country did not receive the questionnaires due to the absence of large carnivores in that area. To increase the clarity of the map, the scale was adjusted in a way that it does not show one C1 record from Sinj, Croatia (located far South from other data points).

2.2 Coordinated 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). From good quality records, we can individually identify the lynx 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 count 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). For example, lynx density in the Northern Dinaric Mountains for the survey season 2019-2020 was estimated at 0.83 (0.60-1.16) lynx/ 100 km^2 (Fležar et al. 2023b), while we present the updated estimates in the following chapter (2.2.3 and 4.2).

2.2.1 Methodology – field design

In this survey season, we covered roughly 13,000 km^2 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, Fležar et al. 2023a) or at new locations. Similarly to the previous survey years, we used camera trapping to first obtain the minimum count 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.

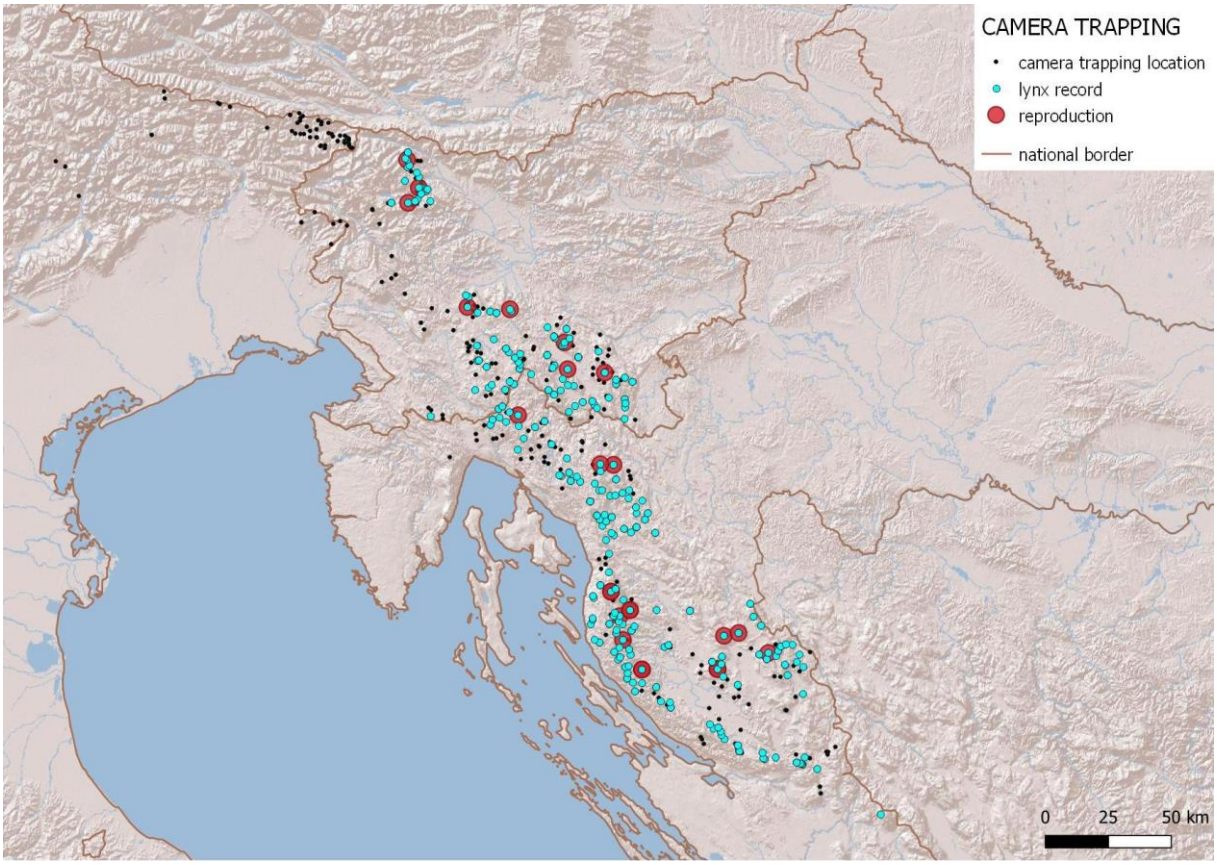

Figure 3. The camera trapping effort and main demographic results from the 2022-2023 survey season. The locations of all camera traps used for camera-trap monitoring are shown as black points. The locations where at least one lynx was recorded are shown in blue and reproduction events are marked additionally 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), including the LPN Triglav-Bled, which is located in Triglav national park, 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 (n=43), while the funding for the rest of the locations in LPNs managed by the SFS, the locations in Triglav national park and all locations in LDs were funded by LIFE Lynx project (in total 144 locations; Table 2). In total, camera trapping involved 5 LPNs and 57 LDs, covering 22% of the entire country over the entire presumed lynx distribution area. This number of LPNs accounts for the change in the organization of the LPNs in Kočevje region, where three LPNs (LPN Medved, LPN Snežnik - Kočevska Reka and LPN Žitna gora) have merged into one (LPN Kočevsko). Due to the combination of funding to implement camera trapping over the entire presumed lynx distribution area in Slovenia (Figure 2), we can conduct it in a systematic way on a national level. For camera trap placement, we continued with the approach used for the past four years. We held informative meetings with hunters or other camera trap operators in the start for the survey period and discussed the potential best locations for lynx; either the locations where lynx was already recorded in some of the previous years, or new locations. Together, we visited them in the field and set up the cameras following the camera-trapping guidelines by Stergar & Slijepčević (2017). 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 on a monthly basis. In total, we met with 92 hunters (7 in areas not included in the previous year).

In Croatia, systematic camera trapping within the LIFE Lynx project was conducted in 39 hunting grounds, 3 national parks and 2 nature parks. Also, camera trapping was implemented in a total of 38 hunting grounds within the OPCC project "Development of Monitoring Systems for Species and Habitat Types".

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 as we were optimizing the camera trapping site choice since 2018 (Fležar et al. 2019, Slijepčević et al. 2019, Krofel et al. 2021, Fležar et al. 2022, Fležar et al. 2023a). In Slovenia, the cameras were 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 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. Most cameras are set to take 3 photos in a burst each time the camera trap is triggered, the rest is set on video modality.

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 once per month, 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 done 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 Croatia, 127 LIFE Lynx camera trapping stations were operative over the entire year, and 49 of them were maintained by project personnel, 47 by nature and national park rangers, 13 by foresters and 18 by hunters from collaborating hunting grounds. While cameras set within the OPCC project "Development of Monitoring Systems for Species and Habitat Types" were active in two 60-day periods (14.9. – 14.12.2022 and 16.1. – 16.4.2023), 60 camera trap locations in each period (total of 120 camera trap locations). In Italy, 43 camera trap sites are maintained by project personnel, 12 by Corpo Forestale Regionale staff, 6 by Polizia Provinciale di Belluno and 3 by hunters.

2.2.2 Minimum count and reproduction

Once again, we obtained lynx records in Croatia and Slovenia, but not Italy. Lynx was recorded on over 60% of all camera trapping locations in Slovenia and Croatia. In total, we identified 136 different adult lynx from the obtained photo/video material in the 2022-2023 survey year. Three lynxes were detected in both countries (Slovenia and Croatia) and this was accounted for in the summarized data (Table 2).

In Slovenia and Croatia, the number of adult lynx identified this year (136 adult lynx; 37 in Slovenia, 96 in Croatia, and 3 recorded in both countries) was higher than the previous survey season (95 adult lynx identified; Fležar et al. 2023a). In Slovenia, all (11) of the lynx wearing a telemetry collar (7 translocated and 4 remnant; one of the latter an offspring of a translocated lynx) were detected with camera traps. Four translocated lynes present in Croatia during the 2022-2023 season were detected by camera traps on their territories. Two remnant males collared in Croatia were also detected by camera traps, while lynx Kras, as well as the two females, Margy and Sofia, which were released in March 2023, were not detected by camera traps during this reporting period.

In 2022-2023 we detected a minimum of 22 reproductions and 36 kittens which indicates an increase in the total number of reproductions (females with kittens), but a negligible change in the overall number of detected kittens (e.g. 15 reproductions and 35 kittens were recorded in the previous season; Fležar et al. 2023a). The distribution of reproductions in both countries expanded, especially in the Alpine area (Slovenia) and Lika (Croatia).

In Slovenia, the increase in the number of detected reproductions and kittens was mostly due to the successful reproduction of translocated lynxes in the Alps, where all females reproduced, with two having three kittens, and one female a single kitten. In the Slovenian Dinaric Mountains however, the number of reproducing females remains unchanged over the years (n=5; except in 2019-20; Krofel et al. 2021), even though it is not always the same five females with kittens detected every season. This survey (2022-2023) we recorded the fourth reproduction event for the translocated lynx Goru, and presumably the second and third one of lynx Catalin. In Croatia, on the territory of translocated lynx Emil, three females were recorded; female Tara was photographed with one kitten, while two other

females were without kittens; female Trubaja and female lynx Buna, which has been monitored with camera traps since 2018 on the northwestern edge of his territory. On the territory of lynx Boris, a female Pangea with one kitten was photographed.

Table 2. Summary of the photo/video data obtained per country in 2022-2023 lynx-monitoring year. The minimum count of adult lynx in the Dinaric-SE Alpine region takes into account the fact that three animals were detected both in Slovenia and Croatia. The numbers summarize 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)	187 (144)	211 (93)	66 (60)	462 (297)
Area monitored (km^2)	4600	6300	2100	13000
Density of camera trapping sites per 100 km^2	4.3	2.7	3.25	3.1
Min. no. of adult lynx	37 (3)*	96 (3)*	0	136*, **
Min. no. of adult females	16	30	0	46
Min. no. of adult males	16	23	0	38*
Min. no. of adult lynx of unknown sex	8	46	0	54
Min. no. of kittens	15	21	0	36
Min. no. of reproductions	8	14	0	22

*accounting for three lynx (Kambrce2, Grajsevka1, Osilnica3) which were recorded in Slovenia and Croatia
**including 11 translocated lynx (Catalin, Goru, Blisk, Julija, Lenka, Tris, Aida, Lubomir, Emil, Boris and Alojzije)

To detect the individual adult lynxes which could have potentially been recorded in Slovenia and Croatia, we uploaded all identified lynx to the Whiskerbook.org online platform (www.whiskerbook.org). We uploaded the photographs of 68 and 106 individual lynx from Slovenian and Croatian database, respectively, to the program. That represented the total number of different individuals identified during the surveillance of the Dinaric SE-Alpine lynx population (A3 and C5 actions; 2018-2023) for Slovenia, and all identified lynx from the 2021-2023 period for Croatia. The Whiskerbook software compared all the uploaded photos from the national database and detected that 8 lynx were photographed in both countries over these years. For four lynxes we were aware that they have a transboundary territory, which was also reported in the past reports of this action. The other 4 animals were a new finding; three of them were new individuals from this survey season (2022-2023) and one was an individual recognized in the past survey years. Moreover, we discovered that one lynx had been given a double identification and we could account for this in the final figures (Table 2). Finally, using the Croatian dataset, we attempted to identify the lynx in the photos where we could

not do so with a human eye. Out of 853 photos of lynx, 297 were unidentified and the software found a match only for 4 of them (1,3%). The program thus proved to have a substantial prospect for transboundary programs of lynx camera trapping programs as it simplifies and speeds up the identification process, especially when dealing with transboundary data comparison. However, we could not confirm that the program could identify the lynxes from poor quality photos better than a human eye.

2.2.3 Density and abundance of lynx in the Dinaric Mountains

The density and abundance of lynx in the Northern Dinaric Mountains (Slovenia and Croatia; hereafter Dinaric Mountains) was assessed following the approach used in the first estimation of lynx densities in the same region (Fležar et al. 2023b.), i.e. using spatial capture recapture.

The camera trapping data presented in the previous chapter (2.2.2) was adjusted to meet the requirements of the SCR models, i.e. i) limited to the period defined above to ensure demographic closure assumption, ii) discarded where no camera operability data was available or photos were obtained outside the systematic camera trapping grid and iii) spatially limited to south of the A1 highway in Slovenia, which is a major barrier for lynx connectivity between the Dinaric Mountains and the Alps (see chapter 3.1) and no permanent lynx presence could be detected north of the highway (apart from the steeping stone population). Altogether, we used 234 capture histories from individually identified adult lynx from the Northern Dinaric Mountains in Slovenia and Croatia from August 15th 2022 to February 15th in each survey year, i.e. 2019-2020, 2020-2021, 2021-2022, 2022-2023, which represented 55% of all camera trapping data about individual lynx.

Data from the Alps was not used, as that part of the population probably remained isolated and only contained a few individuals at the time of this survey. Moreover, these were all most likely the translocated animals or their offspring which makes the status of the lynx in the Alps straightforward to interpret and it should be presented as such separately from the following results.

We ran multi-session spatial capture recapture (SCR) models using oSCR package (Sutherland et al. 2019) in R 4.3.0 (R Core Team, 2023). For the multi-model framework, we defined each survey season as “session”. To find the model best describing our data we ran 12 candidate models, testing the combinations of potential effects of camera trap setting and individual lynx traits on baseline detection rate and spatial scale parameter. The best model showed that the baseline detection rate differs for female vs male lynx, as well as by the type of camera trap setting (marking site, road, other location). Specifically, the males were detected roughly twice often by the camera traps than the females, and the camera trap set up on lynx marking sites had an almost double, or triple, the chance of detecting lynx than roads, or other types of locations (ridges, stone walls, or similar features), respectively. It was also clear that the distance at which the females were detected from the center of their presumed home ranges was smaller than males, i.e. indicating that the females have smaller home ranges, which is also confirmed by telemetry data presented in section 5.2.

Over the state space encompassing 12,275 km^2, the lynx population density was estimated at 1.27+-0.15 lynx/100 km^2 (95% CI: 1.00-1.61), which translates to 156+-19 (95% CI: 123-198) adult lynx in this area. Compared to the 2019-2020 estimate (mean 0.88 lynx/100 km^2 in a state space of size 12,350 km^2; Table 8), that is a roughly 44% increase in mean population density over the Dinaric Mountains in the course of four years, with negligible changes in the size of the effective area sampled.

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 4.

2.3.1 Field effort

The non-invasive genetic samples were collected mostly in winter during snow tracking or by visiting known marking sites or sampling lynx kills which belonged to unknown lynx. Hair trapping was not attempted in Slovenia, while in Croatia hair traps were active on 7 existing marking sites and on 3 of those sites hair samples were collected in the 2022 - 2023 season. The effort needed to find lynx tracks in the snow is high, thus significant manpower is needed to collect lynx genetic samples. Similar to the previous years, 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. Moreover, similar reports were collected in Croatia, however with a limitation to the Velebit Mountains where snow cover appeared. The results presented in Table 3 are thus approximations based on individual reports, however, we trust that they fairly represent the effort needed for the amount of samples collected.

Table 3. Summary of the effort needed to collect the non-invasive genetic samples for lynx in Slovenia and Croatia, where we only added the information where available (indicated with "(CRO)") in 2022-2023. 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	25	11 (SLO), 17 (CRO)	36 (SLO), 30 (CRO)
searching - walking (km)	154.7	91.4	246.1 (SLO), 133 (CRO)
searching - driving (km)	52.7	208.4 (SLO), 1003 (CRO)	261.1 (SLO), 1820 (CRO)
searching - total (km)	207.4	299.8	507.2 (SLO), 1953 (CRO)
searching (hrs)	70	78.4	148.4
snow tracking (km)		14.7	47.7
snow tracking (hrs)		13.1	33.1
no. of samples collected		6 (SLO), 9 (CRO)	40

*includes also effort when only wolf tracks were found

This season, the snow conditions were even worse than the previous season (Fležar et al. 2023a). The areas where translocated animals were present and lacked of genetic data from other lynx (females and/or offspring) were recognized as priority areas. In Slovenia, these were the area south of Ljubljana marshland (Menišija, Mokrc); territory of lynx Catalin, Suha Krajina, Mala Gora; territory of lynx Goru, and the Alps (Figure 4). Due to poor snow conditions in the winter 2022-2023, the total effort spent for finding lynx tracks and the resulting number of collected samples (Table 3, Figure 4) was even lower than the previous year (30 snow tracking events and 26 samples collected; Fležar et al. 2023a), i.e. during 36 field visits, including 261 km driving and 246 km walking, only 6 samples were collected. There were only 11 occasions (30% of attempts) where lynx tracks were found, samples were collected on four lynx tracks, which means that only 11% of snowtracking attempts resulted in lynx samples being found. Two and three samples were collected in Menišija and Suha Krajina area, respectively, but none belonged to a yet unknown animal. The only novelty was a sample from an offspring of Aida and Zois from 2021, collected in the Western part of the Julian Alps, where no lynx was detected since early 2000s.

In Croatia, snow tracking was focused primarily on mountain Velebit, and was implemented in cooperation with the Rewilding Velebit Foundation. The effort needed to collect non-invasive genetic samples was even higher than in Slovenia. In 30 field visits to Velebit Mountains, 1820 km were driven

by car and 133 km walked to collect 9 samples. Roughly, this translates to an average of 200 km drive and 15 km walk to collect one sample. In 43% of field visits (13 out of 30) lynx tracks were not found, while in 83% of field visits samples were not collected (25 out of 30). Out of 43 locations where lynx tracks were found, in only 20% of cases (9 out of 43) samples were found following the tracks.

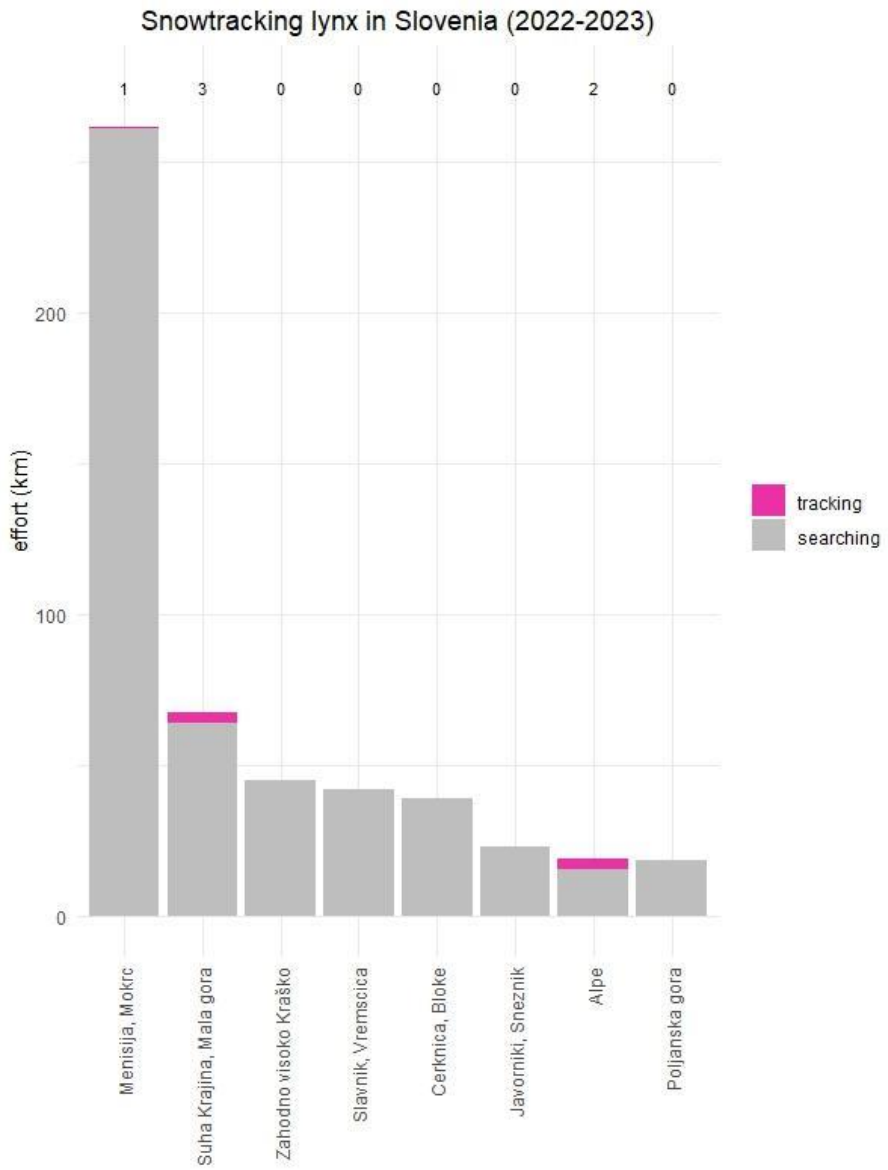

Figure 4. Summary of snow tracking effort in Slovenia in kilometers divided to searching for (grey) or tracking (pink) lynx. Each area outlines a potential home range of known or unknown lynx. The numbers above the bars indicate the number of non-invasive samples collected.

2.3.2 Laboratory analyses

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).

A total of 95 genetic samples were collected in the lynx-monitoring year 2022-2023 in Dinaric Mts. and SE Alps, 87 of them non-invasive. Most collected samples were scats (n= 36), followed by hair samples (n=32). The overall genotyping success of hair samples was lower (31%) than in scats (47%). 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. While preparing these samples in the laboratory, we record how many hairs and how many hair follicles we saw in the sample (Skrbinšek 2017). 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).

Only 36 samples could be used for individual recognition (38% genotyping success). Three samples could not be genotyped or used for sex determination but were confirmed to belong to lynx and in three samples we identified wildcats. The rest of the samples were discarded.

Table 4. Genetic samples collected in sampling season 2022/2023 and genotyping success.

Sample type	***Sampling season 2022/2023***	***Successfully genotyped***	***Genotyping success***
blood	*2*	*2*	*100 %*
scat	*36*	*17*	*47 %*
blood noninvasive	*2*	*0*	*0 %*
urine	*9*	*1*	*11 %*
hair	*32*	*10*	*31 %*
saliva direct	*6*	*3*	*50 %*
saliva from prey	*8*	*3*	*37 %*
TOTAL	*95*	*36*	*38 %*

Among the 36 successfully genotyped samples we recognized 21 individuals (15 males, 6 females), out of which 13 were already known from the previous sampling seasons. Noninvasive genetic samples were collected from translocated lynx Goru, Emil and Lenka. Collared remnant lynx Klif, Petra and Pandora were among genetically sampled individuals.

In June 2022, three kittens from Aida's second litter were sampled and we confirmed Zois is also their father. A female lynx captured for telemetry named Rozi is one of these offspring. Two noninvasive genetic samples from the Alps belonged to lynx Andrej, one of Julija and Tris' offspring.

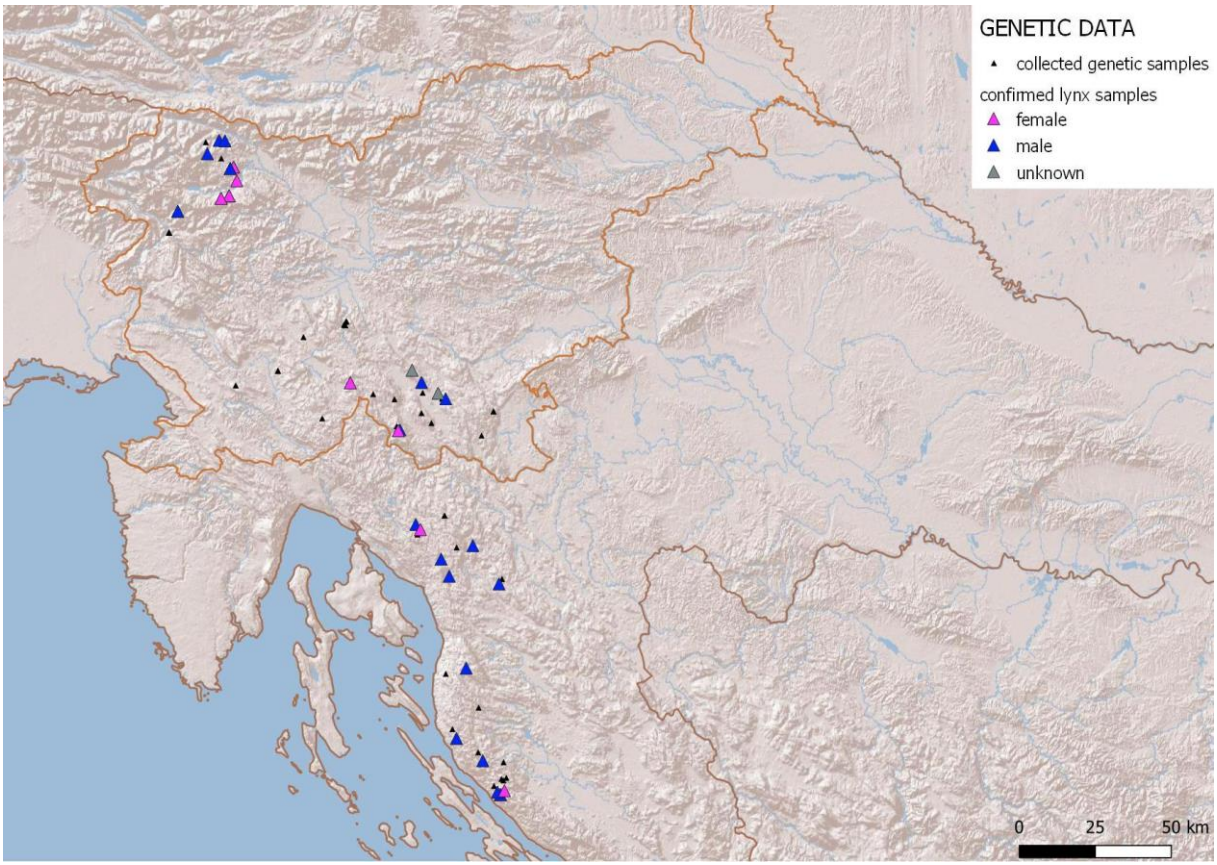

Figure 5. Genetic samples collected in 2022-2023 season. Samples which were confirmed to belong to lynx are categorized by those belonging to females (pink triangles) and males (blue triangles) or those for which sex could not be determined (grey triangles). Collected samples that did not yield results are marked with black triangles.

2.3.3 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.

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. Offspring of reintroduced lynx in the Alpine stepping stone also group with the non-dinaric lynx (Figure 6).

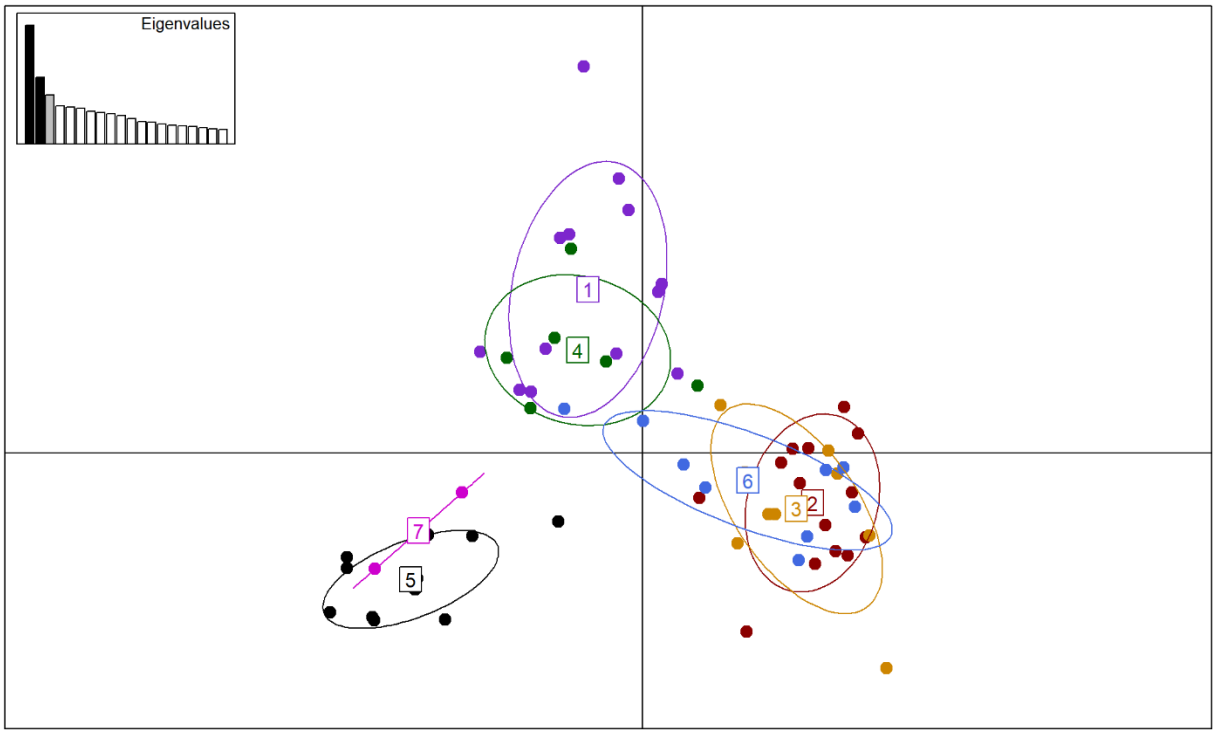

Figure 6. PCA analysis of lynx samples: 1-reference samples from Slovakia (purple), 2-reference samples from Romania (red), 3-reintroduced lynx from Romania (orange), 4-reintroduced lynx from Slovakia (green), 5-samples collected in monitoring season 2021/2022 in the Dinarics belonging to animals not known from before (black), 6- Aida's kittens from both litters, 2 offspring of lynx Goru from monitoring season 2021/2022 and two offspring from lynx Julija (light blue). 7 - two samples from 2022/2023 monitoring season.

In the last report (Fležar et al., 2023a) we showed that without translocations, the inbreeding in the Dinaric lynx population would remain high. Current situation with translocated animals and their offspring included in the analysis, shows a dramatic improvement and an evident drop in inbreeding was observed. Simulations showed the inbreeding estimated from expected heterozygosity would approach 0.15 when translocated animals and their offspring formed around 40% of the population. While this is still high, it is already within the range we observed in the 1980s when population still seemed viable. For 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.

In this year's monitoring five out of seven newly recognized animals were from the Alpine stepping stone, the offspring from translocated lynx (n=5). Since this would mean only two additional samples of Dinaric lynx would be included in analysis, it was omitted from this report and it will be presented in the final report of action D2.

Table 5. Alleles found in translocated lynx that were not previously detected in the Dinaric lynx population. Data updated with lynx translocated in year 2023. 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	7	7
Locus	**Fca001**	**Fca001**	**Fca001**	**Fca001**	**Fca001**	**Fca650**	**Fca650**
Allele	177	181	191	187	193	131	129
N observations	1	4	1	1	1	3	2
Locus	**Fca161**	**Fca293**	**Fca424**	**Fca424**	**Fca559**	**Fca559**	**Fca247**
Allele	184	172	168	180	110	114	151
N observations	1	2	6	2	2	3	1
Locus	**Fca723**	**Fca723**	**Fca723**	**Fca742**	**HDZ700**	**HDZ700**	**Fca201**
Allele	179	187	191	131	141	145	141
N observations	7	3	1	1	5	1	1

2.4 Telemetry

In order to efficiently monitor the reinforcement process, all translocated lynx, some of their offspring and animals are fitted with telemetry collars. GPS telemetry can be used to study 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 translocated animals is on lynx survival, territory establishment, interaction with conspecifics, movement patterns and reproduction. Information on prey species, sex and age structure of prey is also collected to better understand the impact of lynx on ungulates and to inform ungulate management plans. Finding fresh kill sites also allowed us to record lynx using video camera traps to assess the physical condition of lynx and intraspecific interactions between lynx. The presence of the scavenger species is also monitored at the kill sites and their influence on lynx prey consumption.

In 2022/2023, 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. We also present data of two translocated lynx in the frame of ULyCA2 project, which were released to the Italian Alps until the end of this reporting period (30.4.2023). The data on other three translocated lynxes in the frame of ULyCA2 project were released between May and June 2023 are not presented here. Similarly, we do not include any data on the two male lynxes (one remnant and one adult offspring of a translocated lynx), which were captured in the Dinaric Mountains after the reporting period. 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. Names of lynxes that were confirmed to be alive until 30th April 2023 are presented in bold letters.

Lynx name	***Origin***	***Date collared/ released***	***End of telemetry tracking***	***Current status***	***Home-range size (100% MCP)***
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*	*405 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, collar ripped off, potential illegal killing*	*N/A*
Alojzije	*Translocated (Romania)*	*20.1.2020/13.3.2020*	*14.2.2023*	*Collar dropped-off (established territory in Southern Velebit)*	*441 km^2*
Emil	*Translocated (Slovakia)*	*26.2.2021/14.5.2021*	*23.1.2023*	*collar failure (established territory in central Velebit)*	*248 km^2*
Tris	*Translocated (Romania)*	*22.1.2021/28.4.2021*	*16.12.2021*	*collar failure (established territory on Pokljuka)*	*188 km^2*
Lenka	*Translocated (Slovakia)*	*18.3.2021/28.4.2021*	*12.12.2021*	*collar failure (established territory on Pokljuka)*	*126 km^2*
Julija	*Translocated (Slovakia)*	*11.3.2021/28.4.2021*	*24.3.2023*	*Collar dropped-off (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*	*17.12.2022*	*Collar failure, (established territory on Jelovica)*	*208 km^2*
Lubomir	*Translocated (Slovakia)*	*10.4.2022/14.6.2022*	*Still tracked*	*Established territory in Ramino Korito*	*153 km^2*
Blisk	*Translocated (Romania)*	*25.2.2022/17.5.2022*	*Still tracked*	*Established territory on Javorniki*	*131 km^2*
Sneška	*Translocated (Slovakia)*	*14.3.2023/23.4.2023*	*Still tracked*	*Established territory on Rakitna plateau*	*67 km^2*
Kras	*Translocated (Romania)*	*19.1.2023/24.3.2023*	*Still tracked*	*Established territory on Gorski kotar*	*115 km^2*
Lukaš	*Translocated (Slovakia)*	*27.1.2023/19.4.2023*	*14.8.2023*	*Signal lost, lynx missing since*	*N/A*
Margy	*Translocated from Switzerland (ULyCA2)*	*09.03.2023*	*Still tracked*	*Moved to Austria, not established territory yet*	*N/A*
Sofia	*Translocated from Switzerland (ULyCA2)*	*16.3.2023*	*August 2023*	*Illegally killed in Austria*	*N/A*

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 failure, lynx not detected since 2021*	*78 km^2*
Niko	*Offspring of remnant and translocated lynx*	*6.12.2020*	*20.4.2022*	*Collar dropped off, (established territory in South Kočevsko)*	*N/A*
Bojan	*Remnant (tracked within 3Lynx Project)*	*1.12.2019*	*3.3.2021*	*Signal lost, lynx missing since,*	*515 km^2*
Petra	*Remnant*	*1.3.2021*	*Still tracked*	*Established territory in upper Kolpa Valley*	*201 km^2*
Martina	*Remnant (after rehabilitation in Croatia)*	*1.3.2020*	*2.6.2021*	*Found dead near Pivka*	*N/A*
Bor	*Remnant*	*18.1.2022*	*19.12.2023*	*Collar dropped off, (established territory in South Kočevsko)*	*120 km^2*
Klif	*Remnant (tracked within*	*4.2.2022*	*Still tracked*	*Established territory on Goteniška gora and Stojna*	*316 km^2*

	Intermuc project)				
*Igi**	*Remnant*	*17.2.2022*	*4.5.2022*	*Natural mortality*	*60 km^2*
Pandora	*Remnant*	*30.3.2022*	*14.5.2023*	*Collar dropped-off, (established territory in Central Velebit)*	*183 km^2*
Josip	*Remnant*	*4.2.2022*	*5.4.2023*	*Collar dropped-off, (established territory in Northern Velebit)*	*221 km^2*
*Neža**	*Offspring of remnant and translocated lynx*	*13.2.2022*	*11.5.2022*	*Collar ripped off and blood found, suspected illegal killing*	*N/A*
Valentina	*Offspring of remnant and translocated lynx*	*13.2.2022*	*7.4.2023*	*collar failure, lynx missing since*	*39 km^2*
Meri	*Offspring of translocated lynx*	*25.12.2022*	*Still tracked*	*Potential territory established on Pokljuka plateau*	*131 km^2*

Flori	*Offspring of translocated lynx*	*3.3.2023*	*Still tracked*	*Not established territory yet*	*N/A*
Andrej	*Offspring of translocated lynx*	*15.3.2023*	*Still tracked*	*Not established territory yet*	*N/A*
Rozi	*Offspring of translocated lynx*	*13.1.2023*	*Still tracked*	*Potential territory established on Posočje and Triglav National park*	*177 km^2*

**detailed status description in Fležar et al. (2023a).*

2.4.1 Translocated lynx in Dinaric Mountains

Altogether, 12 lynx were translocated to Slovenian (n=6) and Croatian (n=6) Dinaric Mountains. Seven of them were from Romania and five from Slovakia. Nine lynx (Goru, Catalin, Boris, Alojzije, Emil, Blisk, Kras, Lubomir and Sneška) have already established their territories. We lost signal from the collars of Doru, Pino and Maks and did not detect them with any other monitoring method as well as we did not detect any of their potential offspring, therefore we declare these three individuals as not integrated in the population. Below we describe movements and update the current status of all translocated lynx that were monitored within this year's reporting period.

Goru

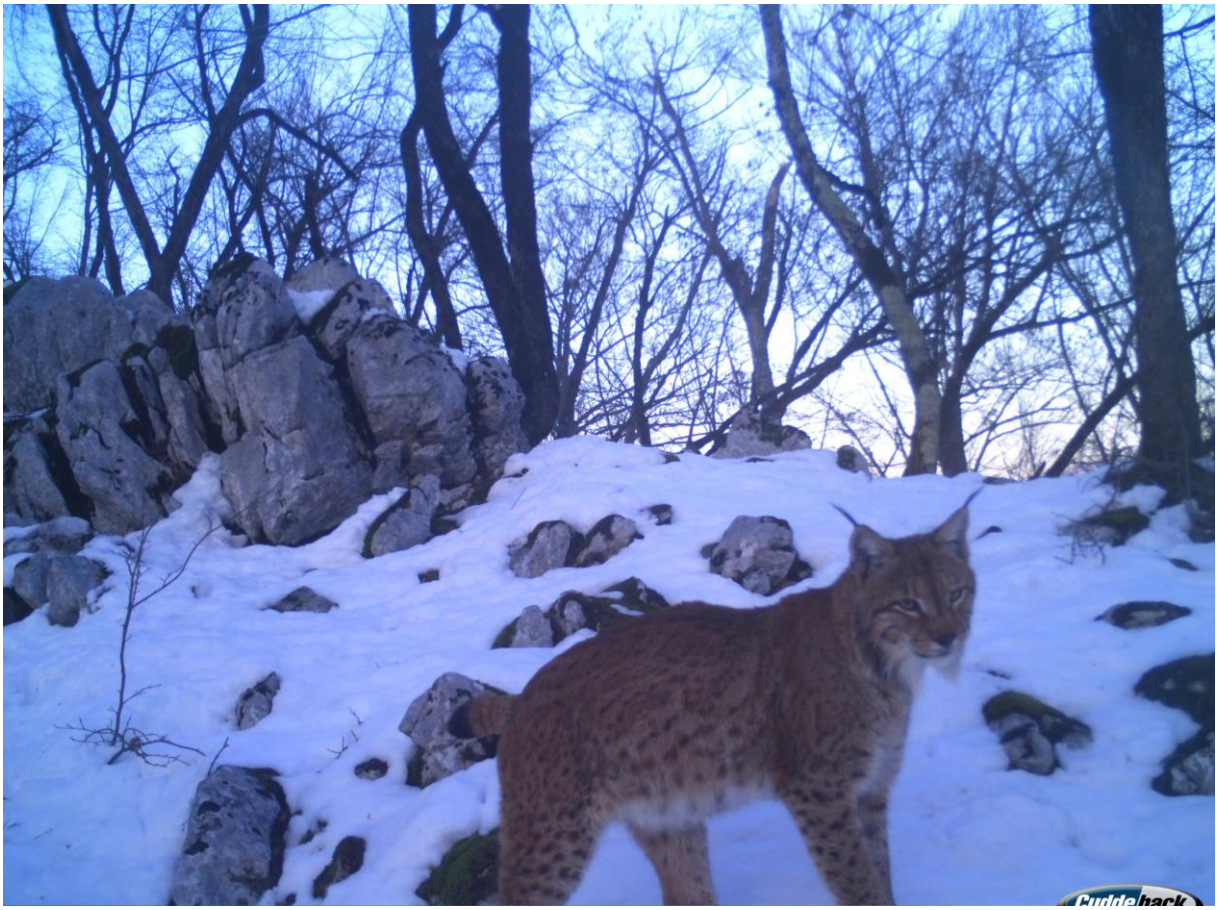

Figure 7. Lynx Goru photographed with a camera trap in Mala gora, Slovenia.

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 (all of them were collared; Neža, Valentina and Matic) in 2021. Teja also had kittens in 2022 (1) and 2023 (2), however we did not confirm Goru's paternity with genetics. 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, therefore we don't know the location of his mating excursion in 2023. Within the regular national lynx monitoring with camera traps, Goru is being recorded regularly, with the last time photographed in November 2023.

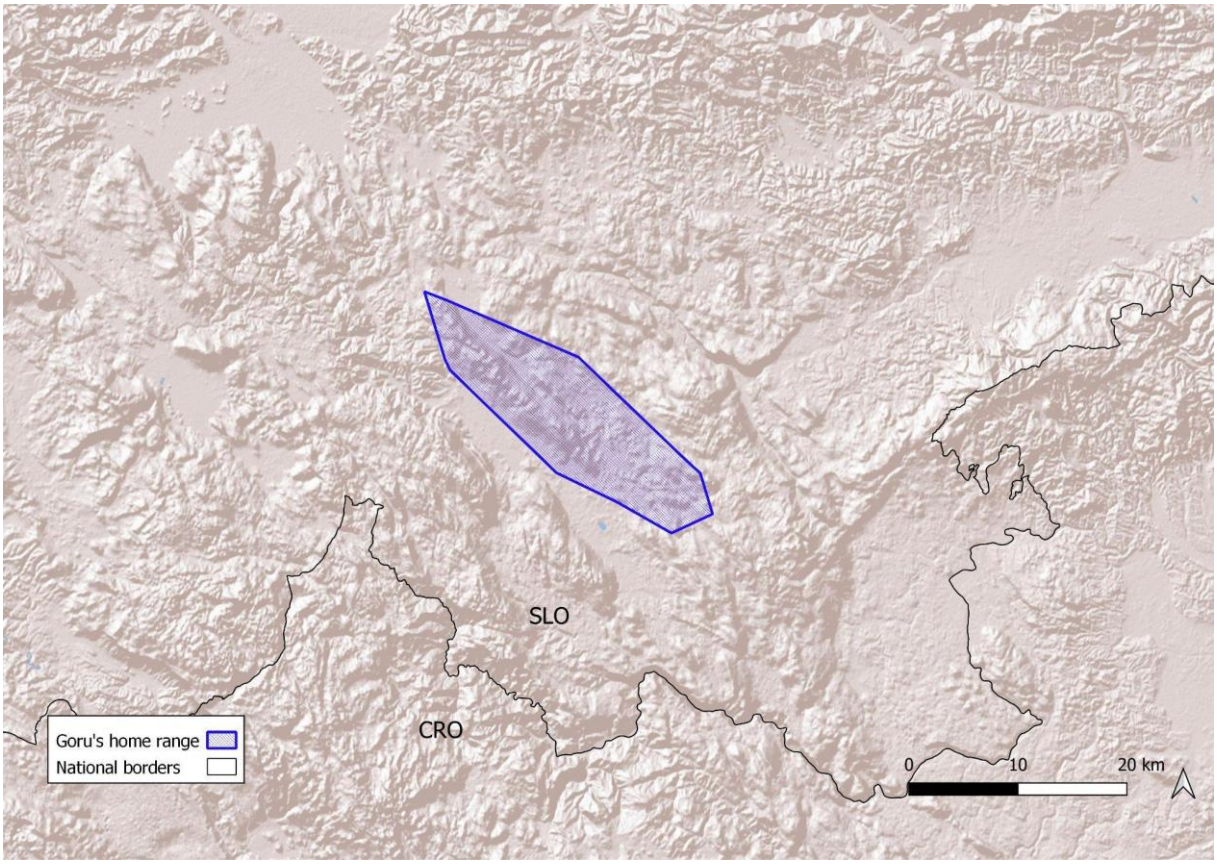

Figure 8. Map of Goru's home range (100% MCP) on Mala gora and Kočevski Rog

Catalin

Figure 9. 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 recently also Mokrc area. 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). 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 indicated 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. However, we could not 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 2022, Catalin was recaptured and recollared, which prolonged 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. Size of his home range is currently 405 km^2. In mating season

2023, Catalin had three shorter mating excursions, with all being south of his territory (two towards Kočevsko and one close to Loški Potok). They lasted a couple of days each. He was recorded sharing his kill with a local female from Mokrc in mating season, which probably means they mated. Catalin seems to be in good physical condition as he is regularly being monitored with camera traps set on his kill sites.

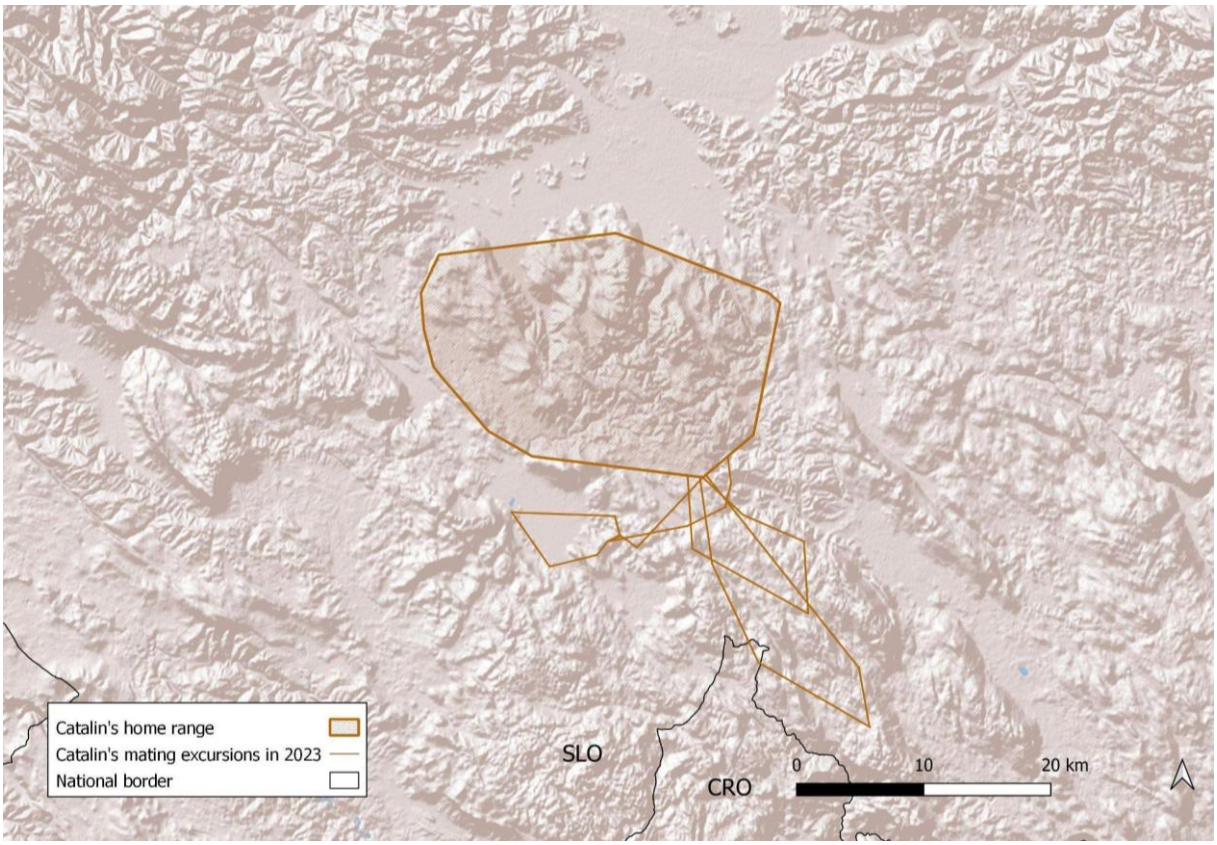

Figure 10. Map of Catalin's home range (100% MCP) established on Menišija, Logatec plateau, Rakitna and Mokrc and his three short mating excursions in 2023.

Alojzije

Figure 11. 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 of all observed kittens. In the 2022 - 2023 season no females with kittens were observed on the territory of lynx Alojzije. 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, while in the 2022 - 2023 season he was photographed once. The last time he was photographed was in January 2024.

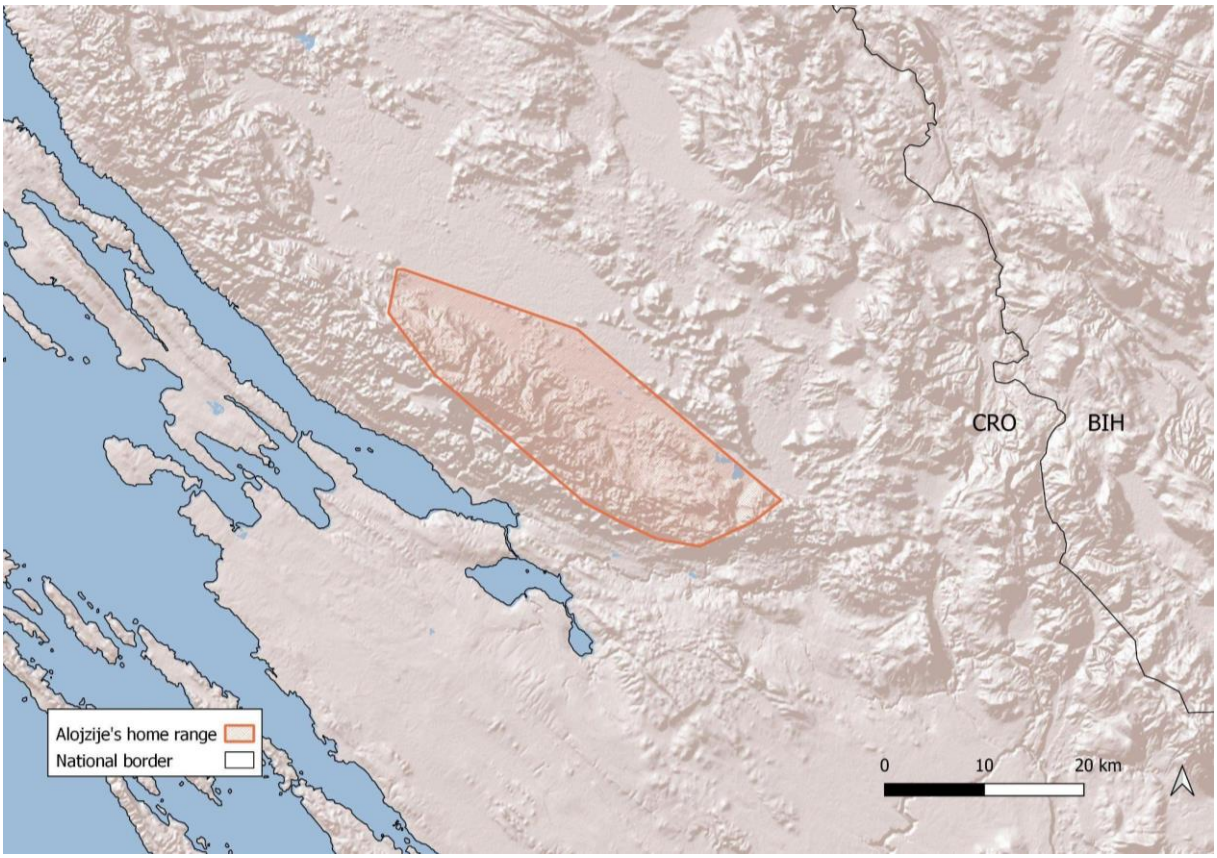

Figure 12. Map of Alojzije's home range (100% MCP) established in the southern part of the Velebit Mountains.

Emil

Figure 13. Lynx Emil after release in Velebit.

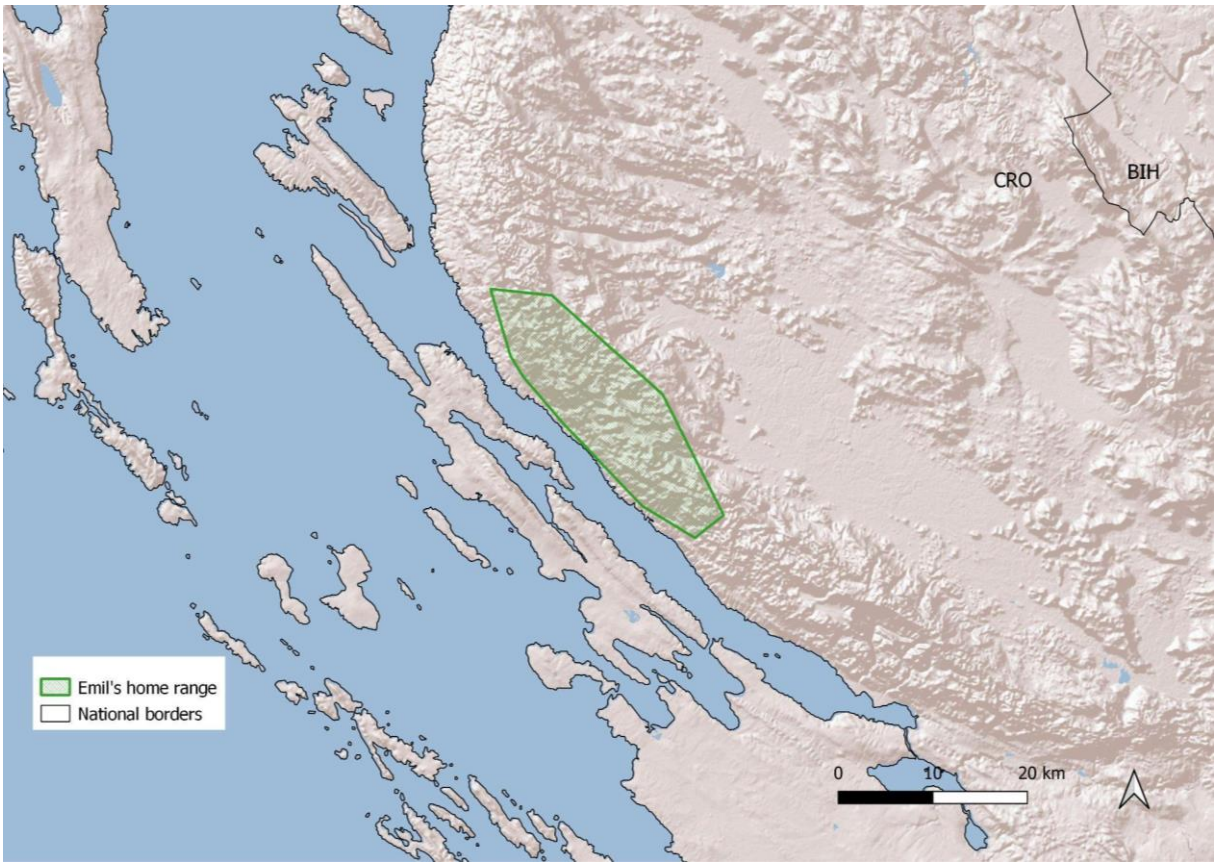

Figure 14. Map of Emil's home range (100% MCP) established in the bordering area of central and southern part of the Velebit Mountains.

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 249 km2. Upper NW border of his home range overlaps with the lower SW border of the home range of remnant collared male Pandora. In the season 2022 - 2023 on the territory of translocated lynx Emil, three females were recorded; a female named Tara was photographed with one kitten, while two other females were photographed without kittens; female Trubaja and female lynx Buna, which has been monitored with camera traps since 2018 on the northwestern edge of his territory. Unfortunately, Emil's collar stopped working in December 2022, a year and a half after his release. His movements were monitored with an Iridium collar, 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. In January 2024 we searched for the VHF signal of his collar from the airplane, but the signal was not found. Lynx Emil was photographed 16 times during the 2022-23 season and his presence was confirmed by genotyping of 3 scat samples. The last time his presence was confirmed by camera trap photo was on March 30th 2023 and since then we can not confirm his status.

Lubomir

Figure 15. Lynx Lubomir release. Photo: Marko Matešić

Lubomir (nicknamed Ljubo) is an adult male lynx captured in Slovakia, released on June 14, 2022 in hunting ground Ramino Korito (Croatia) managed by the Rewilding Velebit Foundation. The first locations obtained from his collar showed that the lynx stayed on the release site area for almost ten days after the release. After successfully sending first locations, the collar failed to connect with the satellite many times and during the first 2.5 months the collar sent only two sets of locations showing Ljubo` s movement. Ljubo made a circle around Velebit Mountain and ultimately established territory that measures around 154 km^2 in the hunting ground neighboring Ramino Korito, occupying an area between territories of two other translocated lynx - Emil and Alojzije. During the season 2022- 2023, there were no records of females with kittens within his territory, while Ljubo was photographed with camera traps four times during the season.

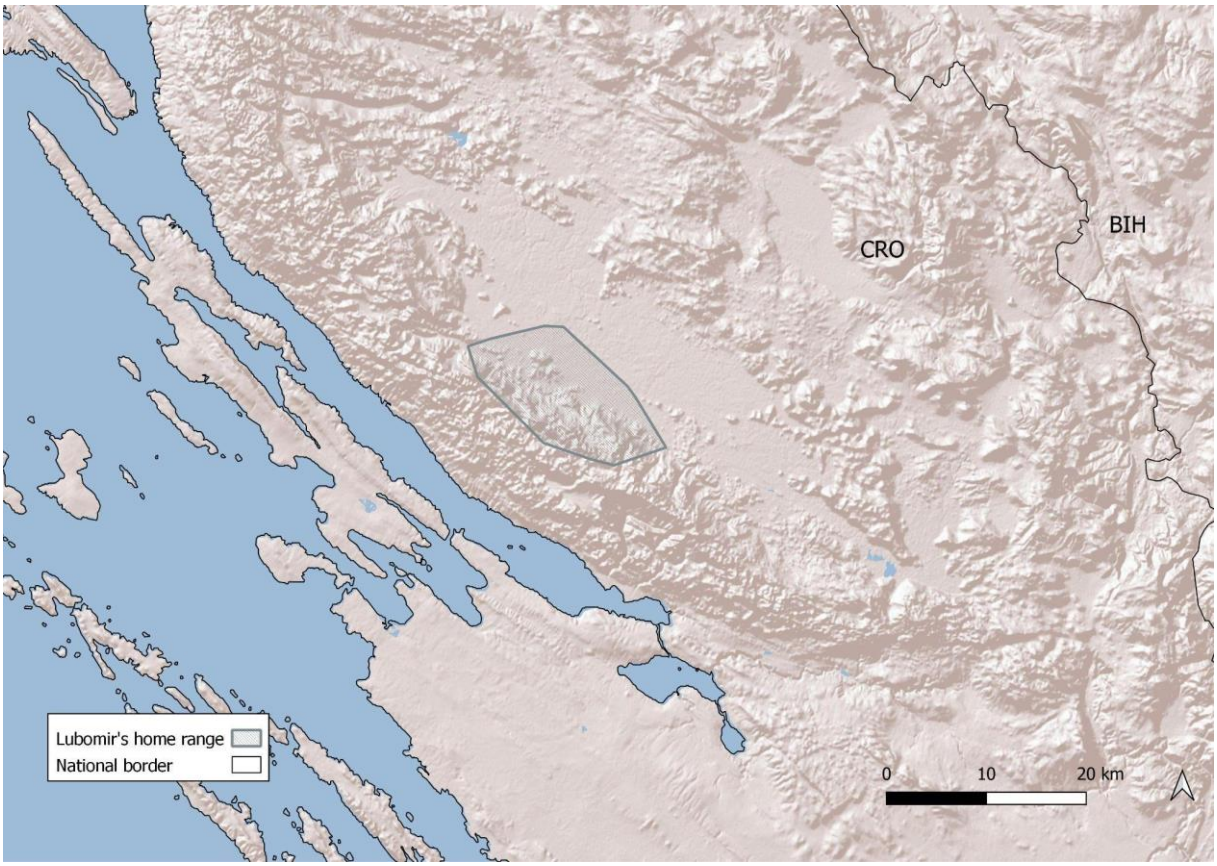

Figure 16. Map of Lubomir's home range (100% MCP) established in the southern part of the Velebit Mountains.

Blisk

Figure 17. Lynx Blisk in the enclosure in Snežnik mountains

Lynx Blisk was captured at the end of February 2022 in Romania. He weighed 27kg at the time of the capture. On 8th of April 2022, he was translocated to Slovenia, in Snežnik soft release enclosure where he stayed around 40 days. In mid May 2022, he was released into the forests of Snežnik, where he stayed for one month, before moving north towards Javorniki plateau, where he established his territory that measures around 130 km^2. Blisk is sharing his territory with at least one female that was detected in his home range with camera traps. During mating season 2023, he went on a mating excursion to Gorski Kotar, Croatia, that lasted three days. We checked some of his kill sites, where camera traps were deployed and he looked in good physical condition. We also recorded him with camera traps within national lynx monitoring.

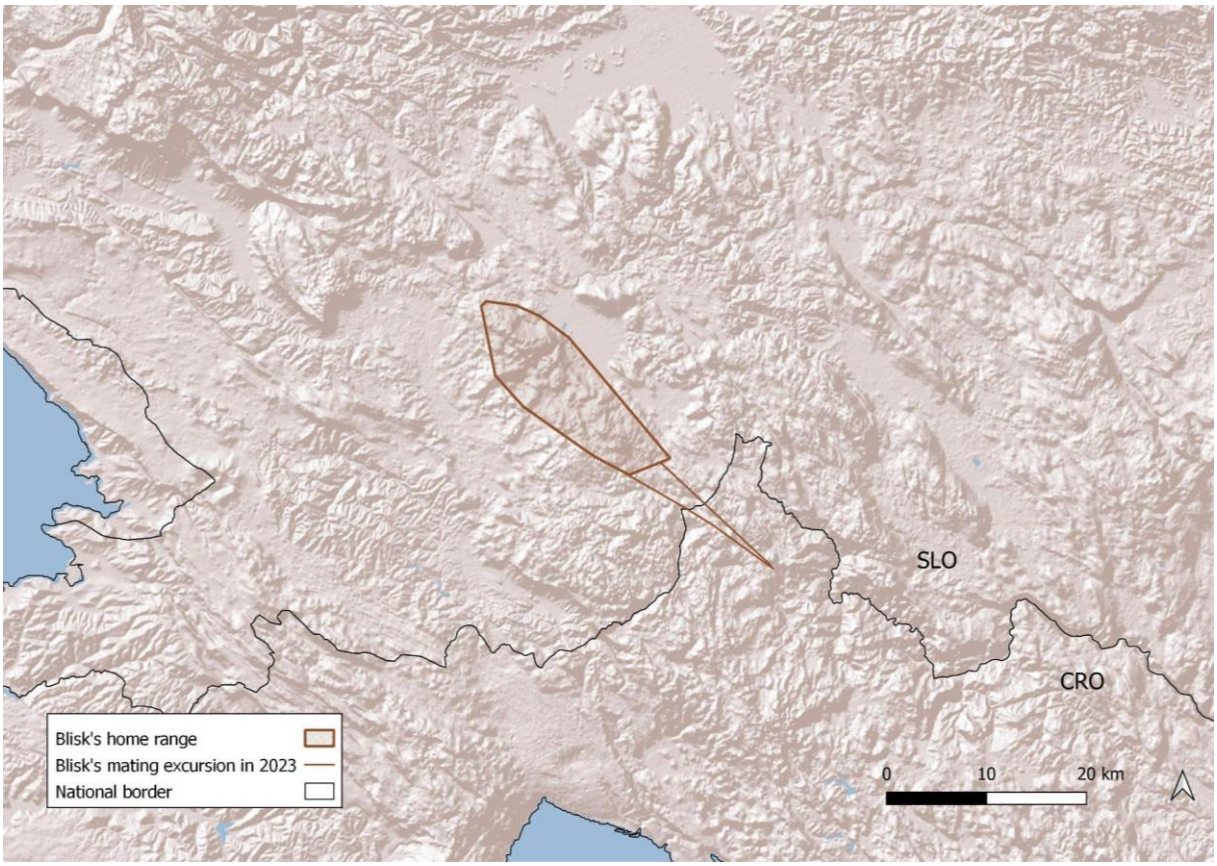

Figure 18. Blisk's home range (100% MCP) and his mating excursion in 2023

Kras

Figure 19. Lynx Kras release. Photo: Vedran Slijepčević

On March 24, 2023, an adult male lynx captured in Romania was released in the Plitvice Lakes National Park. Kras is the sixth and the last lynx released in Croatia within the LIFE Lynx project. Kras started exploring the area shortly after his release. The first set of data obtained from the telemetry collar showed that within the first two weeks, Kras crossed the border of Bosnia and Herzegovina, but soon returned to the area of the Plitvice National Park, near the release site. Soon after, he changed his direction and headed towards Gorski Kotar, where he stayed for three weeks, after which he returned for the second time to the Plitvice area. In May, Kras went north to the Gorski Kotar area and started to form a territory. By visiting the locations that pointed to the place where he caught the prey, we found that Kras is feeding regularly and it seems to us that he is adapting well to his new environment. In June 2023 he was photographed by a camera trap.

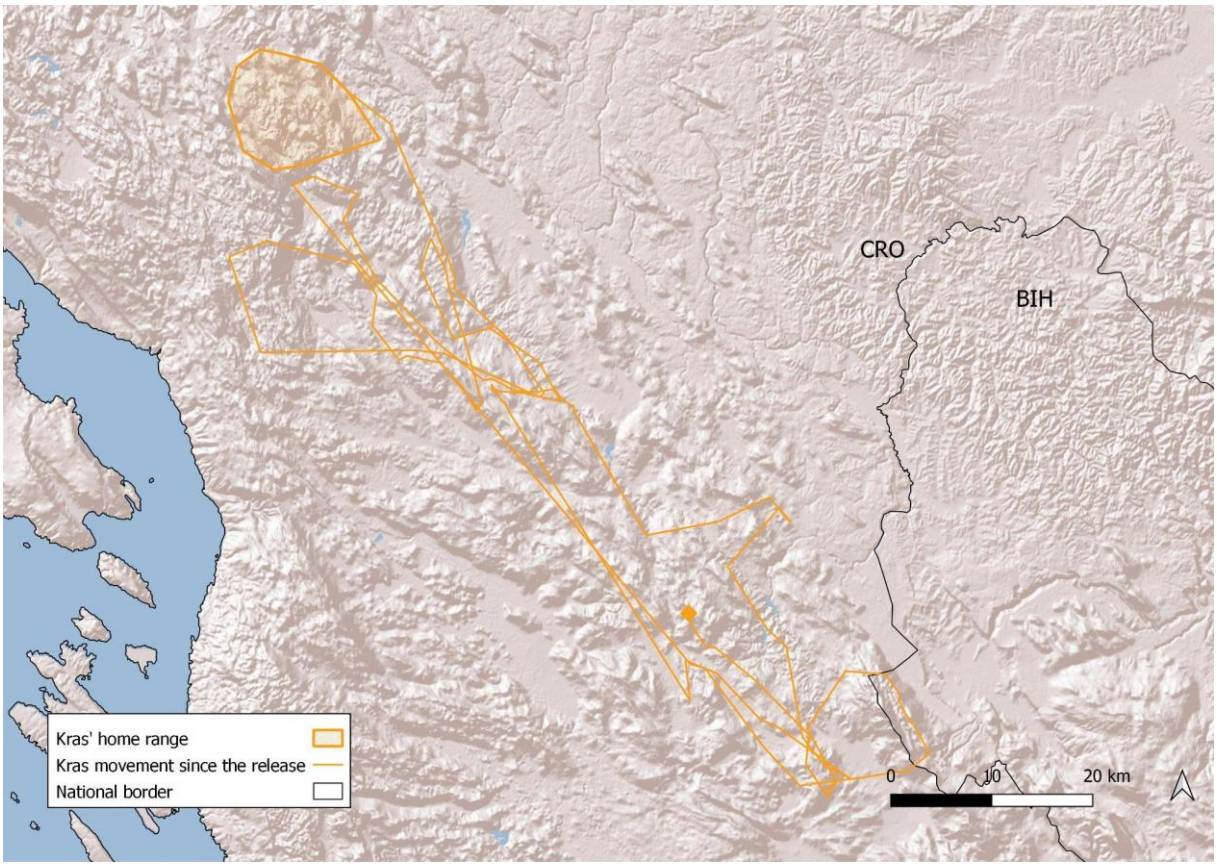

Figure 20. Map of Kras' movement and home range (100% MCP) established in the Gorski Kotar area.

Sneška

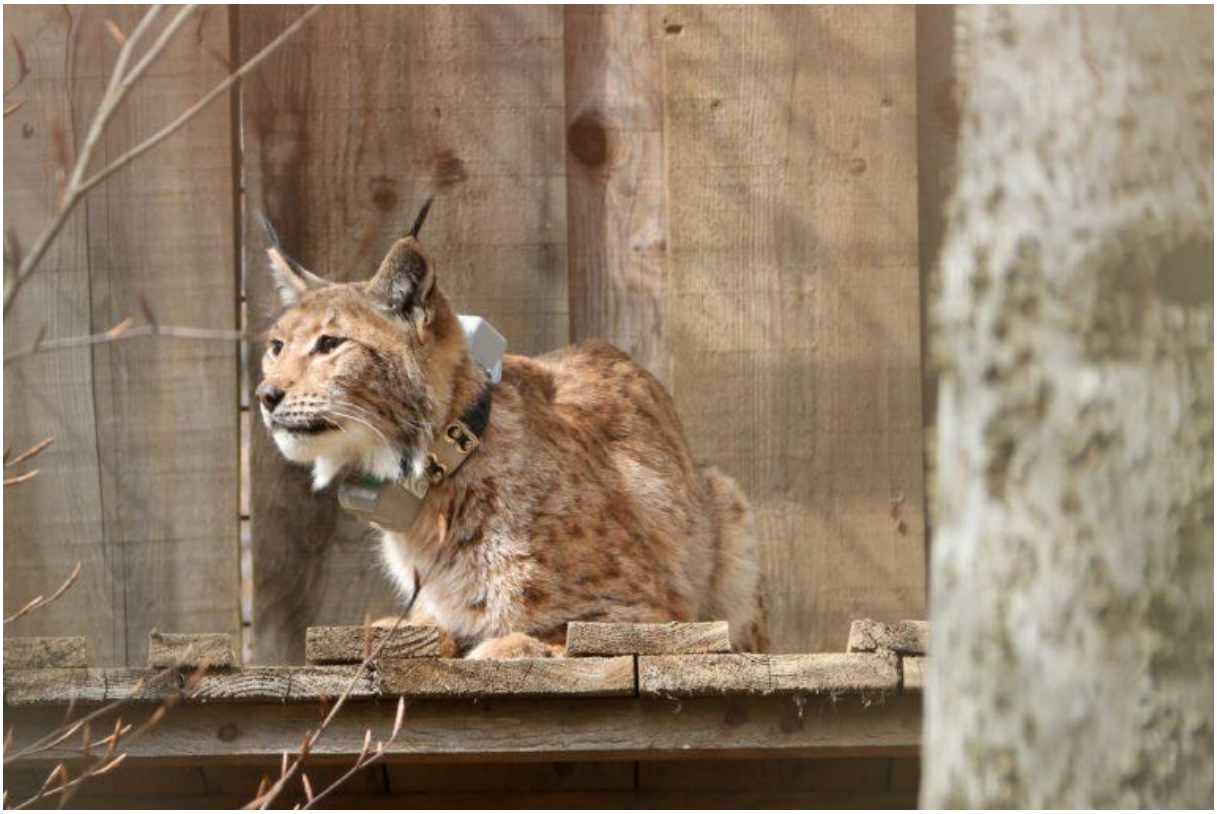

Figure 21. Lynx Snežka in the enclosure before the release in Snežnik forests

Sneška was the last lynx that was released in Slovenia within LIFE Lynx projects. She was captured on 14th of March 2023 in Slovakia and was estimated to be five years old at the time of the capture. She was released in the Snežnik mountains in Slovenia. Soon after release, she went east, towards the Velika gora area close to Ribnica, where she stayed for some time. Then she turned west towards Loški Potok, but soon she headed north towards Iška and Rakitna area, where she arrived in the beginning of August 2023 and has been staying there since. In 2023, we did not detect any offspring of her, however we confirmed she met with another translocated lynx Catalin, with whom she is sharing her territory. We monitored some of her kill sites with camera traps and she was in good physical condition.

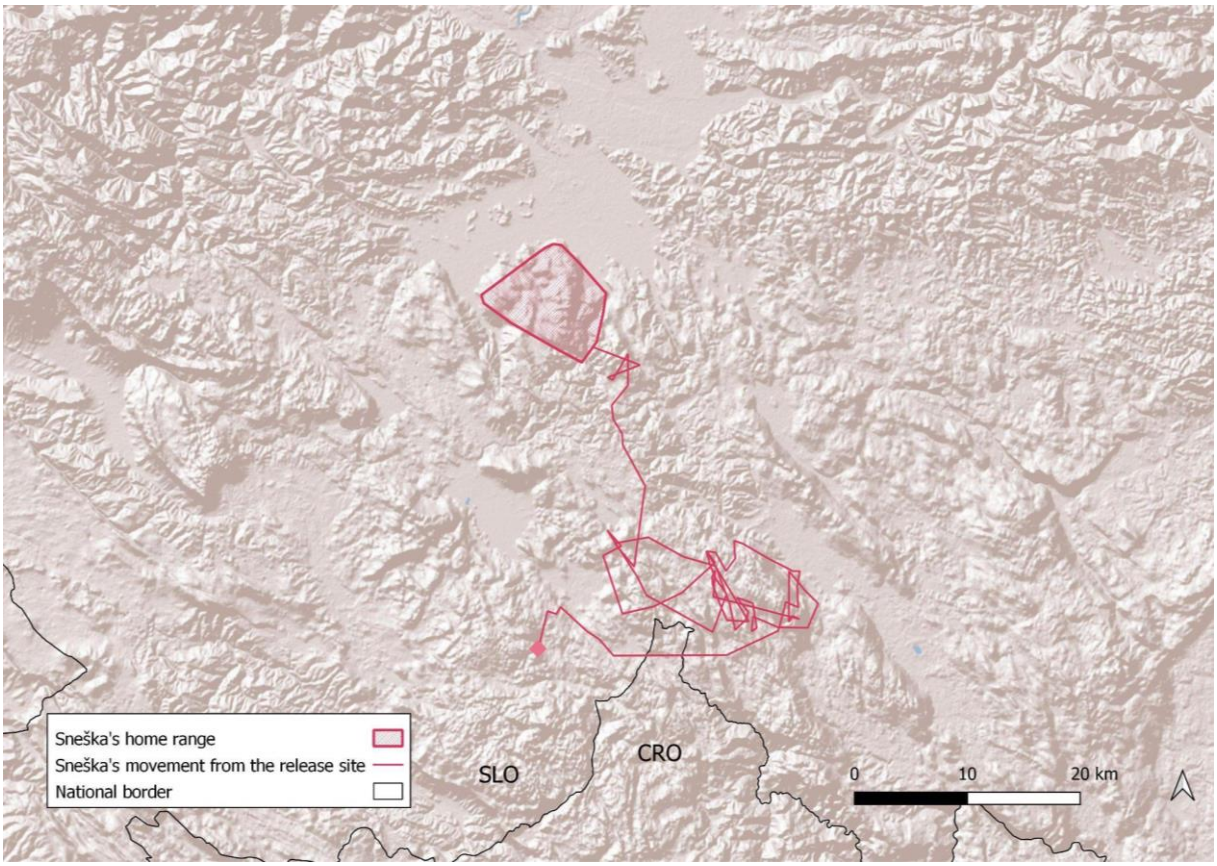

Figure 22. Sneška's home range and movement from the release site

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. In 2023, another lynx (Lukaš) was released in the Jelovica forests. . All together, three animals were translocated from Romania and three from Slovakia. Male Zois was not recorded in the area since spring 2022 and Tris' and Lenka's collar stopped sending the data in the end of 2021, therefore we will not describe them in detail in this telemetry chapter. Additionally, two female lynx were translocated to the Italian Julian Alps in the frame of the ULyCA2 project in March 2023. In this chapter, we describe the status, movements and reproduction for every translocated lynx in the Alps that was monitored with telemetry within the reporting period.

Julija

Figure 23. Female Julija with her three kittens on the kill site.

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 all captured and equipped with telemetry collars. We regularly monitor Julija with camera traps on kill sites and within lynx national monitoring. Before her collar stopped working in late winter 2023, we tried to recapture her, but we were not successful.

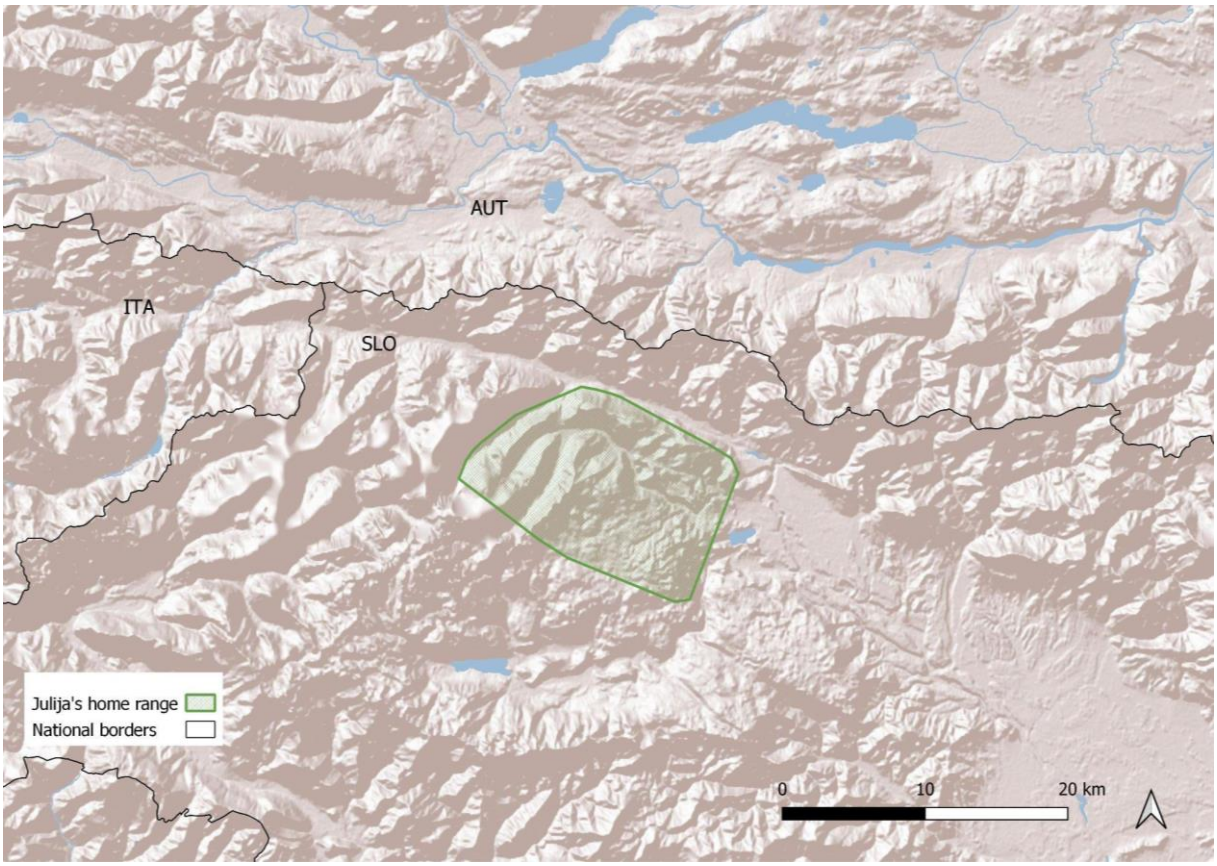

Figure 24. Julija's home range (100 % MCP) on Pokljuka plateau.

Aida

Figure 25. Female Aida photographed on a camera trap.

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. With the help of camera traps, we could confirm that at least one kitten survived until spring 2022. After a successful mating season in 2022, Aida gave birth to three kittens in late May, 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, it stopped working soon after. The plan is to recapture her and equip her with a new telemetry collar. As for now, we will rely on other monitoring methods (camera traps) for further assessment of her contribution to the development of the alpine stepping stone population.

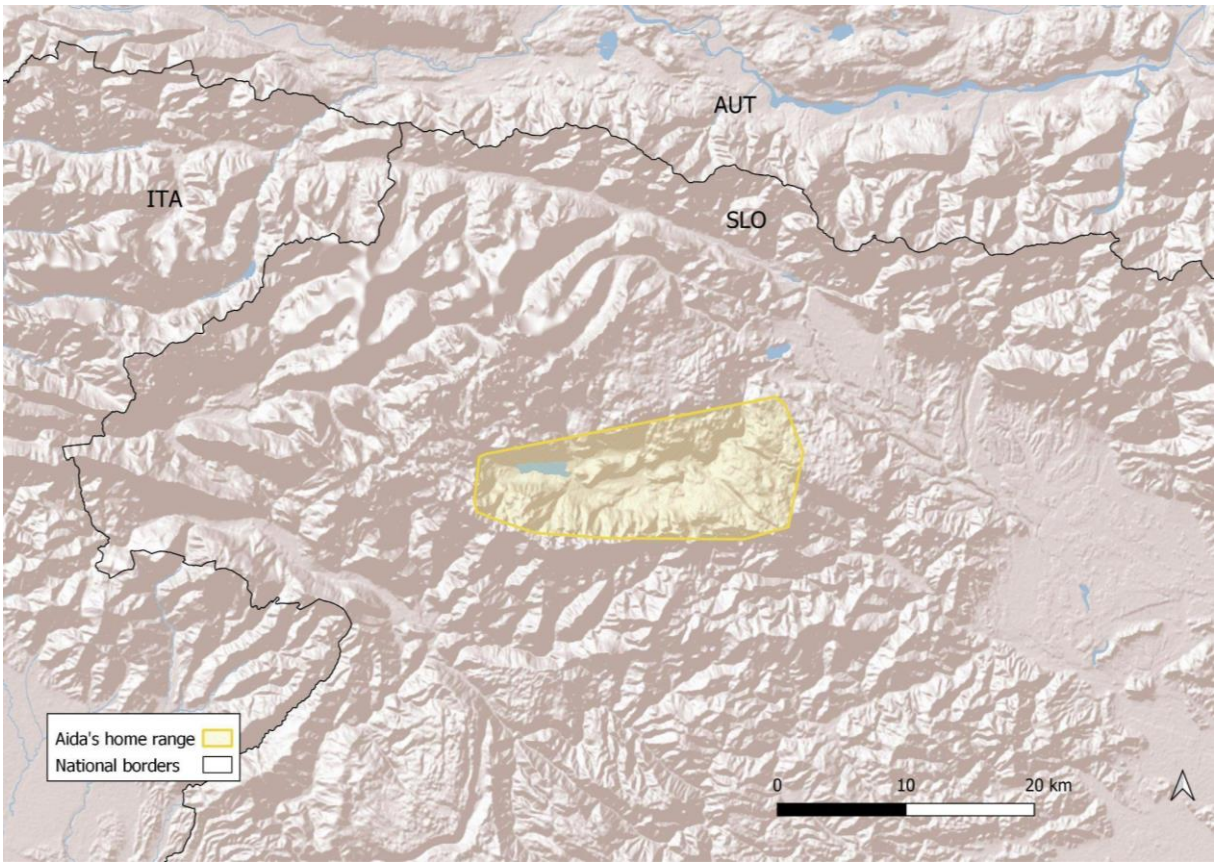

Figure 26. Aida's home range (100% MCP) on Jelovica plateau

Lukaš

Figure 27. Lynx Lukaš after being released from enclosure in Jelovica

Lynx Lukaš was the last lynx that was translocated to Slovenian Alps within the LIFE Lynx project. He was captured in Slovakia on 27th of January 2023 and was translocated to Jelovica south release enclosure on 12th of March 2023. On 19th of April, he was released soon after he went east where he crossed river Sava and Gorenjska highway in direction towards Karavanke mountains. It seemed at first that he established his territory somewhere in between Karavanke and Kamnik - Savinja Alps where he stayed for 4 months. In mid-August his telemetry collar stopped sending GPS data, which meant we did not know his status, as he was in the area where there were no camera traps set within national lynx monitoring. We tried to find Lukaš with a VHF antenna, however we were not successful. His current status is therefore unknown.

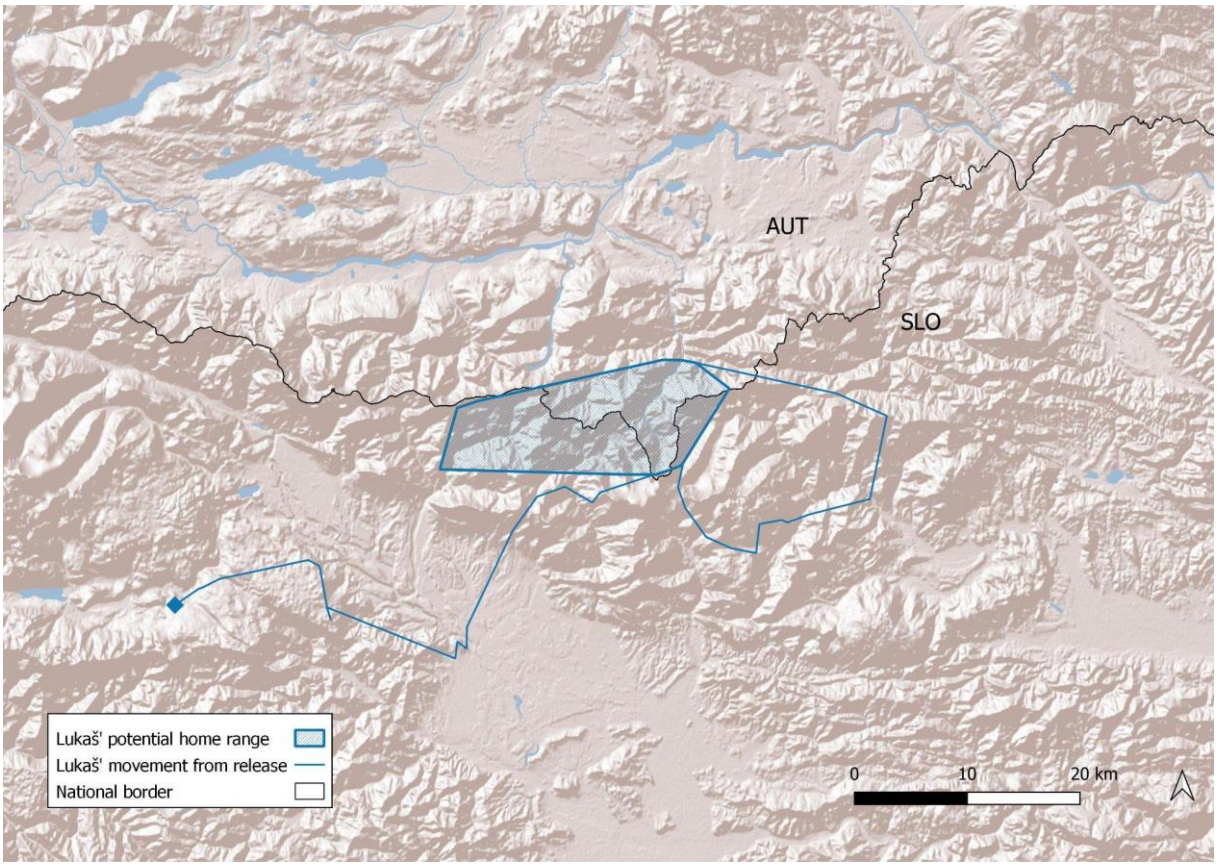

Figure 28. Lukaš journey from the release and his potential home range

Margy

Figure 29. Release of Margy in the Italian Julian Alps, March 2023 (photo: E. Furlani/PLI).

On March 9 2023, Margy, an adult female lynx captured in the Swiss Jura Mountains was released in Tarvisio, Julian Alps of Italy within the ULyCA2 project. She soon started to move north and at the end of April 2023 she had reached the Nockberge National Park in Austria, 50 km north of the release site.

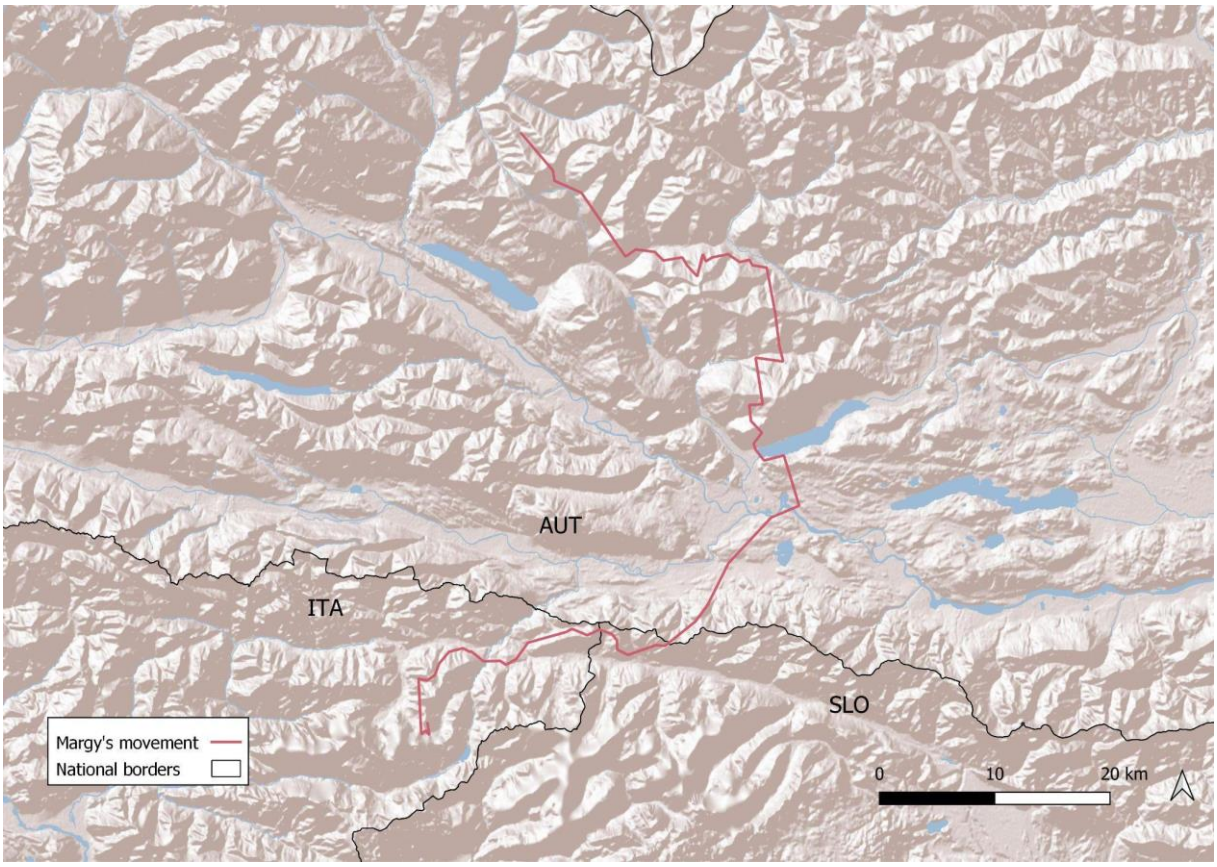

Figure 30. Margy's movement since release until 30th of April 2023.

Sofia

Figure 31. Female lynx Sofia photographed by camera trap (photo: P. Molinari/PLI).

On March 16 2023, the adult female Sofia was released in the Italian Julian Alps in the frame of ULyCA2 project. She was born in 2017 in the Swiss Jura Mountains and translocated to Tarvisio after rigorous health check and genetic screening. For the first two weeks after her release she explored the Foresta di Tarvisio, crossing three times the freeway Venice-Vienna. After two weeks she decided to move north and established a territory between Villach and Bad-Kleinkirchheim in Carinthia, Austria. In August 2023, she was illegally killed.

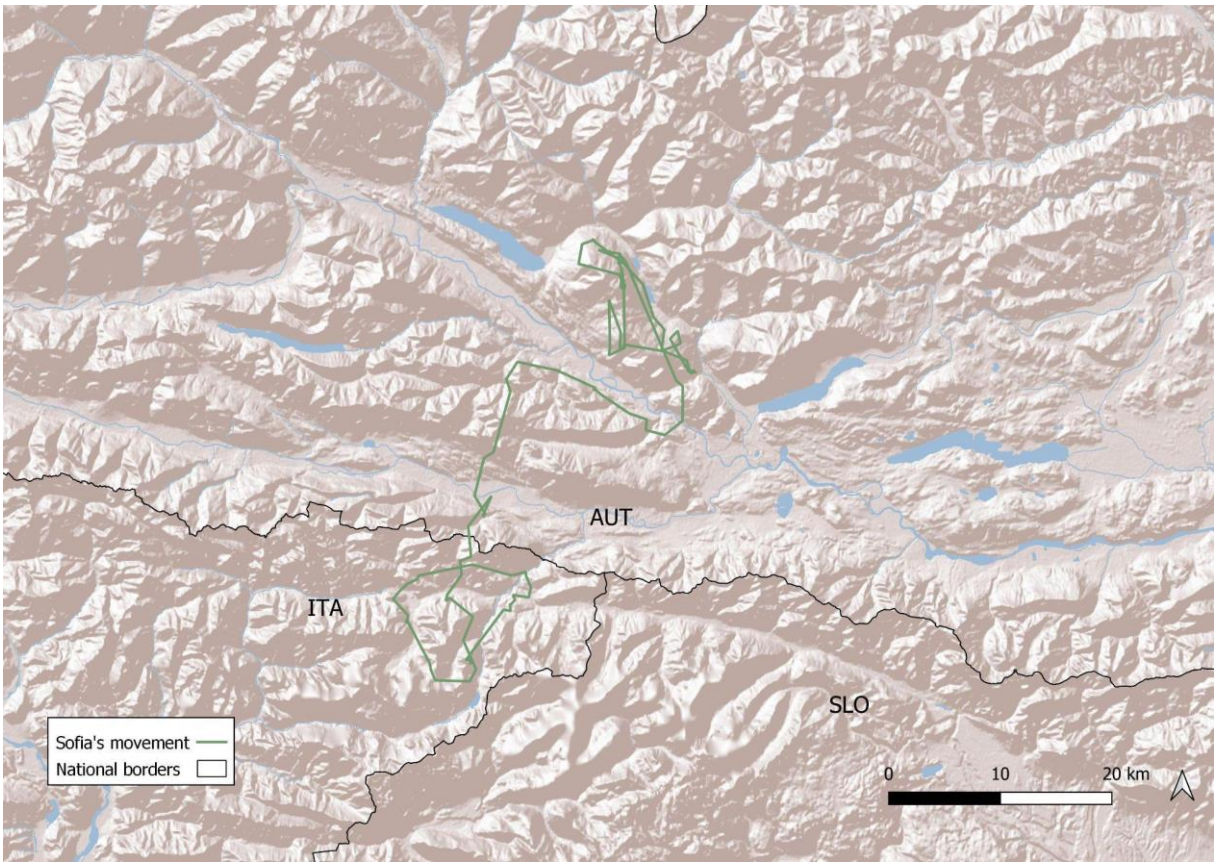

Figure 32. Sofia's movement since release until 30th of April 2023

2.4.3 Remnant lynx and offspring of translocated lynx monitored with telemetry

In addition to translocated lynx, we report on ten additional lynx that were monitored with telemetry in Slovenia (n=8) and Croatia (n=2) within this year's reporting period. This helped us to better understand the territorial distribution of lynx in the current population and gained additional understanding of the reinforcement processes, such as mating with translocated lynx and potential reproduction, as well as destiny and dispersal of their offspring. Altogether within the project so far, we have captured two adult females (Teja and Petra), seven adult males (Mihec, Klif, Pandora, Josip, Igi, Slavko and Matic) and 10 juvenile lynx, among which four were offspring of translocated lynx Goru and remnant lynx Teja (Mala, Niko, Neža and Valentina), three were offspring of translocated female Julija (Andrej, Flori and Meri), one was offspring of translocated female Aida (Rozi), 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 with telemetry within our project during the 2022-2023 season.

Petra

Figure 33. Lynx Petra photographed in Kočevsko at one of her marking 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. In 2022, she did not have any kittens with her. Her collar failed in mid - December in 2022. In April 2023, she was recaptured and fitted with a new collar that will enable us to monitor her for another year and a half. During the immobilization, we detected that she was pregnant and carried 2 kittens. Her health status was also checked. She had one canine damaged, but was in good physical condition overall. In mid - May, she gave birth to two kittens, which survived at least until early autumn in 2023.

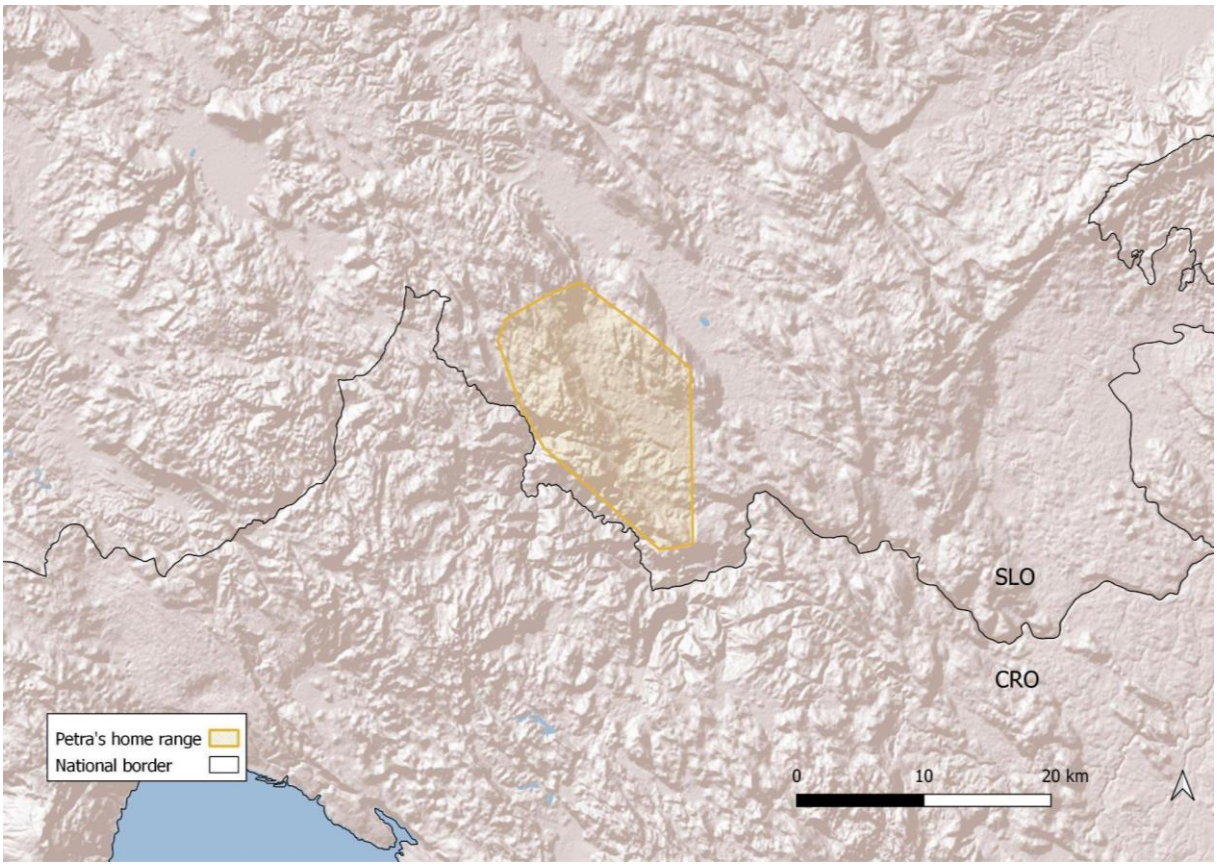

Figure 34. Petra's home range (100 % MCP).

Bor

Figure 35. Lynx Bor as an adult lynx

On 18th of January 2022, a juvenile lynx named Bor was captured in Kočevsko, close to the Borovec village. He was 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, Lapinje and Podstene area above Kolpa river, where he established his home range that measures around 120 km^2, which is a bit smaller compared to other males' home ranges. In 2023 he was regularly crossing the border river Kolpa as he was spreading his territory in Croatia. He is sharing the territory with at least one female that was detected in that area. We were monitoring him with telemetry and camera traps that were set on some of his kill sites where he appears to be in a good physical condition, with a full grown body size. On December 20th 2023, his collar dropped off and with that, his monitoring has come to an end.

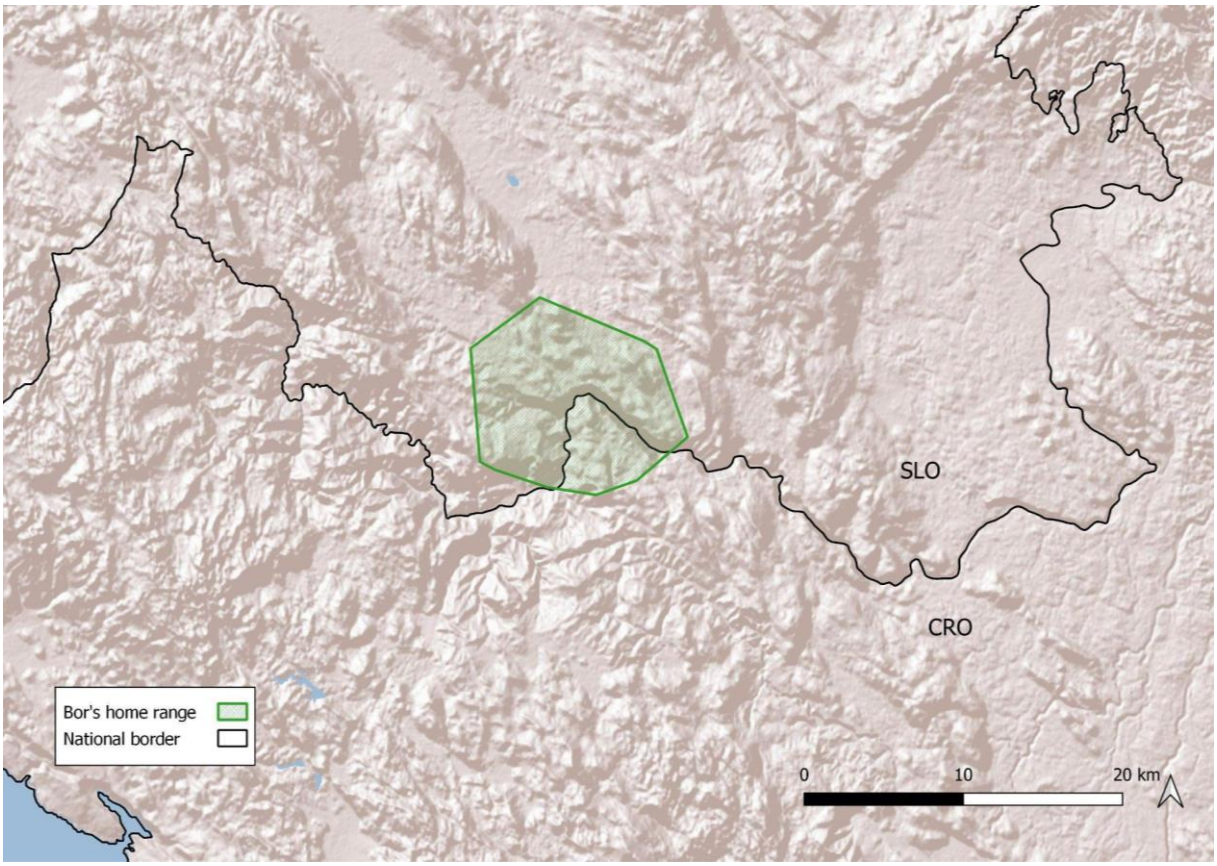

Figure 36. Bor's home range (100 % MCP).

Klif

Figure 37. Lynx Klif on patrol around his territory.

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 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 an audio-logger, which made Klif the first Eurasian lynx in the world equipped with a device to record vocalization. In the mating season 2023 he again went to a mating excursion in Gorski Kotar area, Croatia. He stayed there for 13 days. After he returned to his home range, we detected that Klif suffered a leg injury due to unknown cause. It could be a fight with another male during mating season or maybe it was a vehicle collision. He was recorded limping badly. After the injury we noticed he couldn't hunt as he was scavenging at the hunting feeding places. He lost a lot of body mass due to lack of food, however, after a month he completely recovered. We still track him with telemetry up to this day.

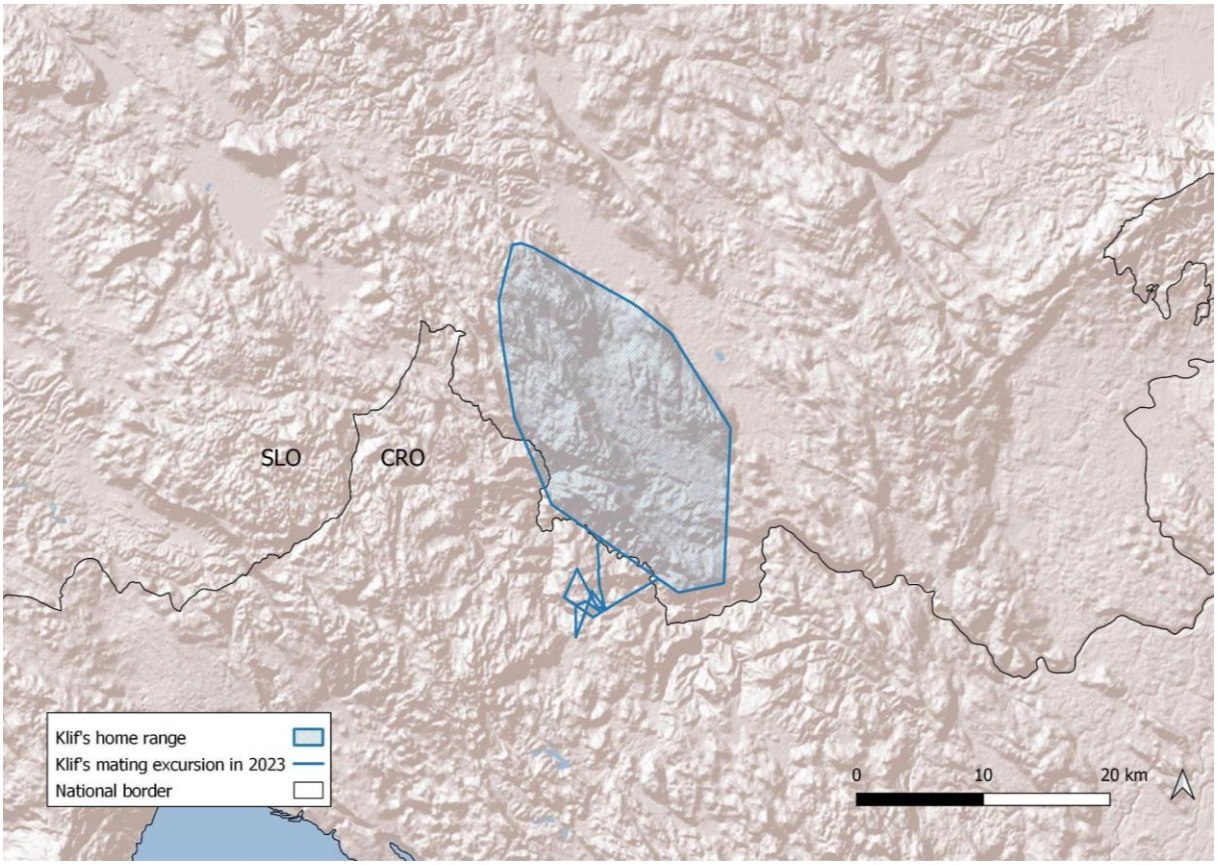

Figure 38. Klif's home range (100 % MCP) in Kočevsko and his mating excursion to Croatia in 2023.

Pandora

Figure 39. 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. The telemetry data 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. During the monitoring period, we found three kill sites – two roe deers while the species of the third prey could not be determined as only hair was found. His collar dropped off according to the schedule, after one year of monitoring. Pandora is also holding the record as the most photographed lynx on Velebit as we have more than 70 recorded events on over 18 different camera trap locations (since 2019). Interestingly, Pandora and translocated lynx Emil were photographed on multiple occasions on the same location, within a few days or even hours apart.

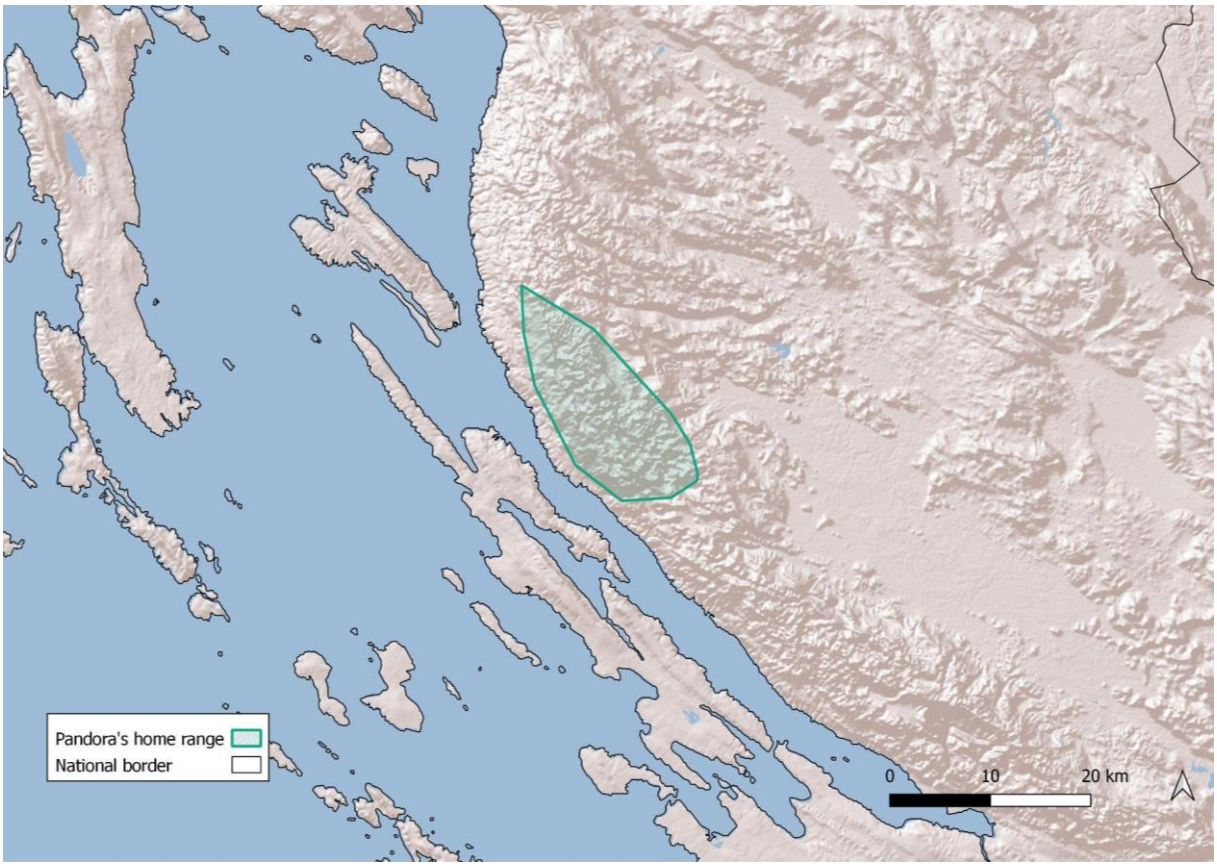

Figure 40. Map of Pandora's home range (100% MCP).

Josip

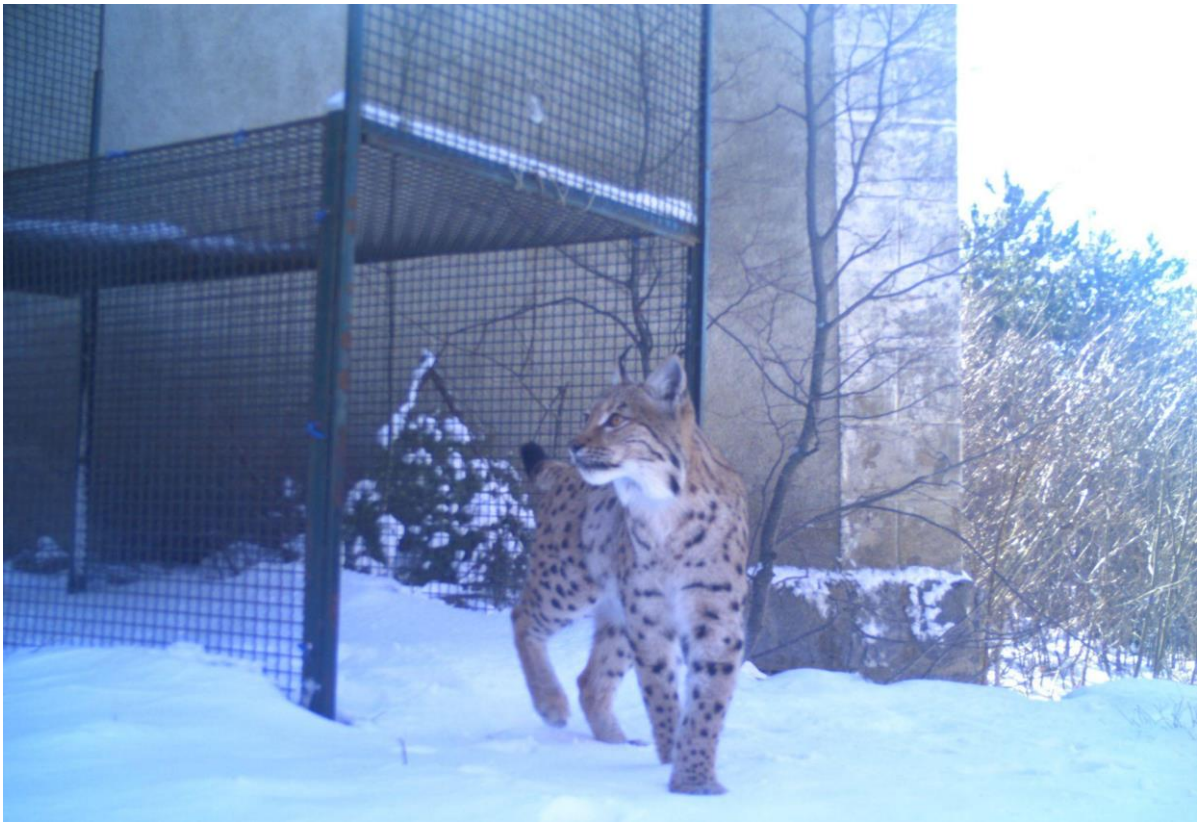

Figure 41. Josip photographed in front of the box trap.

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 221 km^2 and its southern part overlaps with the home range of the collared remnant male Pandora. During the monitoring year, we successfully found five kill sites where he preyed on presumably roe deer as in three cases only hair and vertebrae were found. These late findings of the prey are a result of the poor Iriduim satellite communication with the collar, as we received the data with a 2-3 weeks delay. After one year of monitoring, the collar dropped off according to schedule. During the monitoring year, Josip was recorded six times with camera traps.

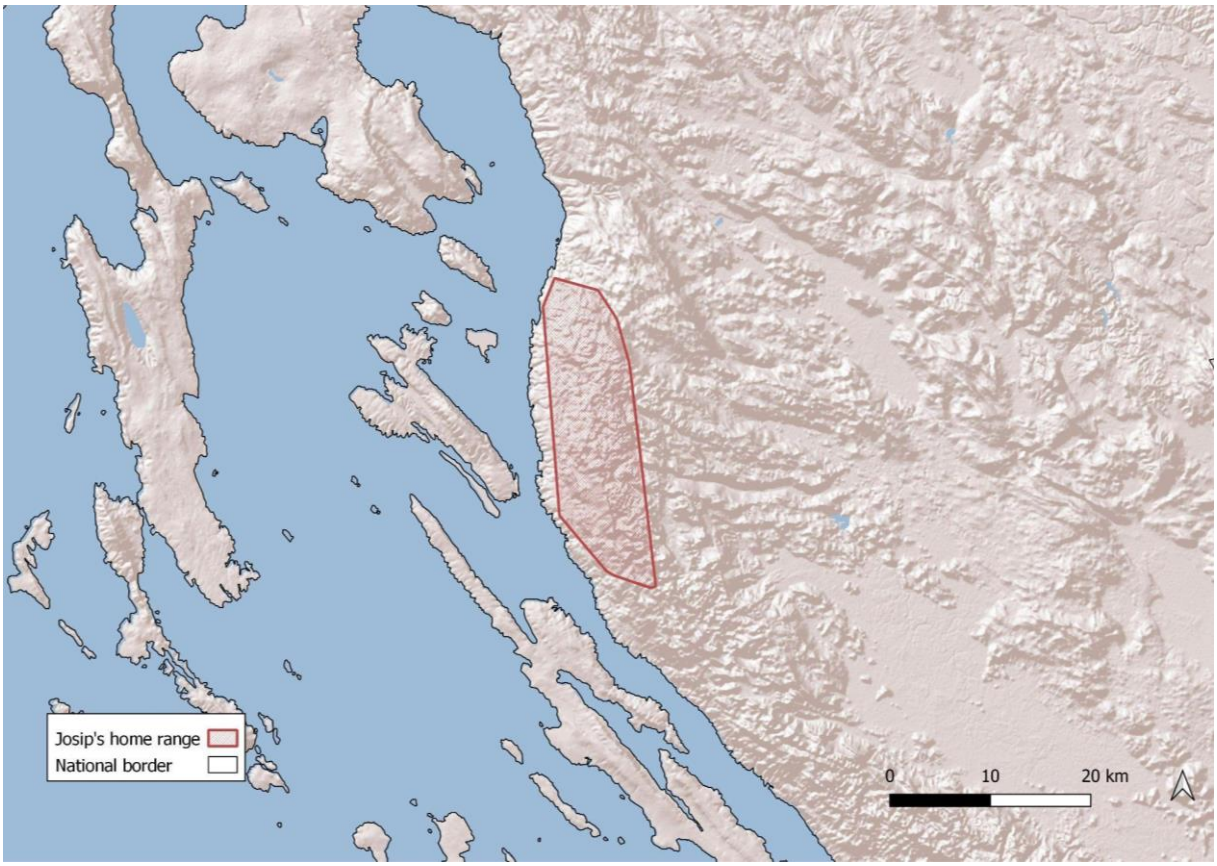

Figure 42. Map of Josip's home range (100% MCP).

Valentina

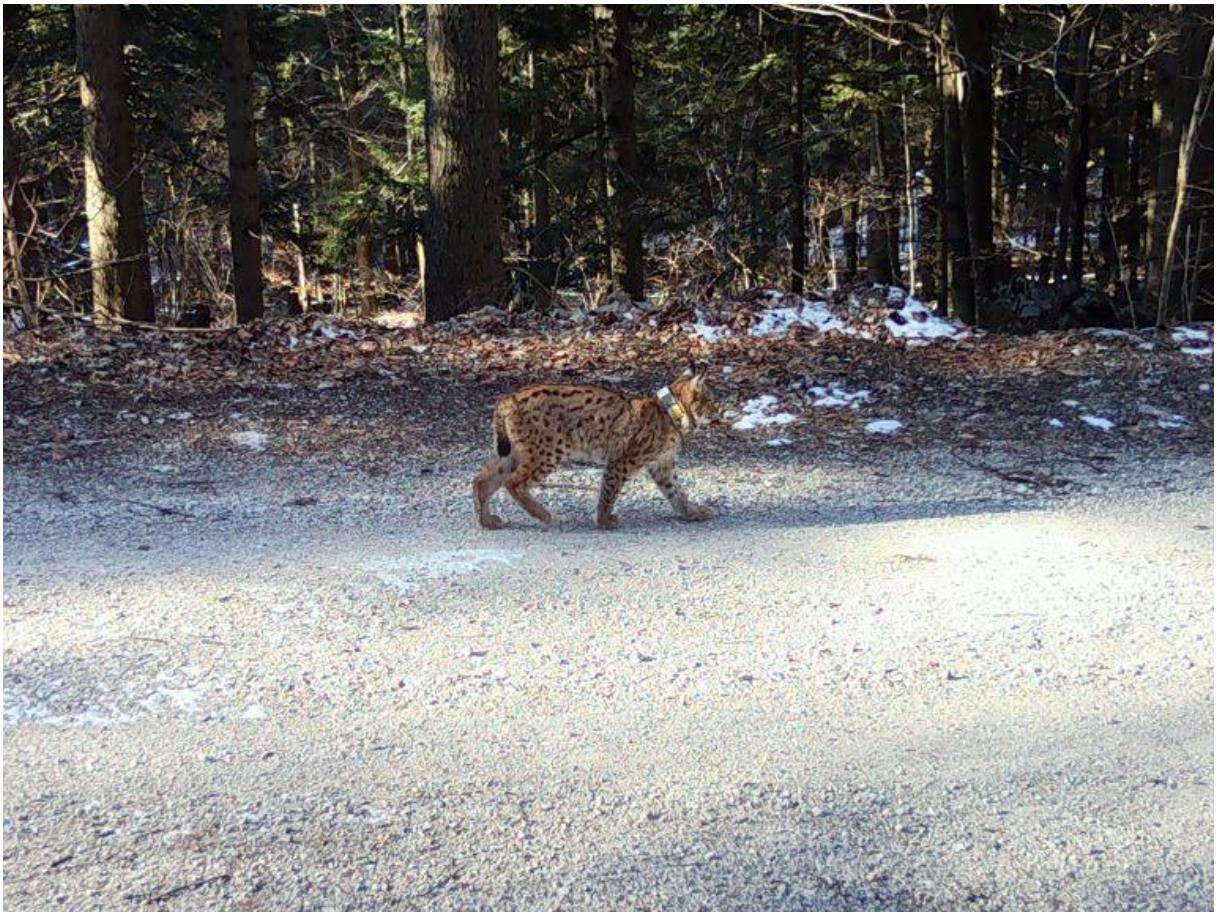

Figure 43. Valentina recorded with a camera trap.

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. In the beginning of 2023, it looked like she started to establish her territory in the south east from her mother's home range, however in April 2023, we lost the signal of her collar, therefore her status is currently unknown.

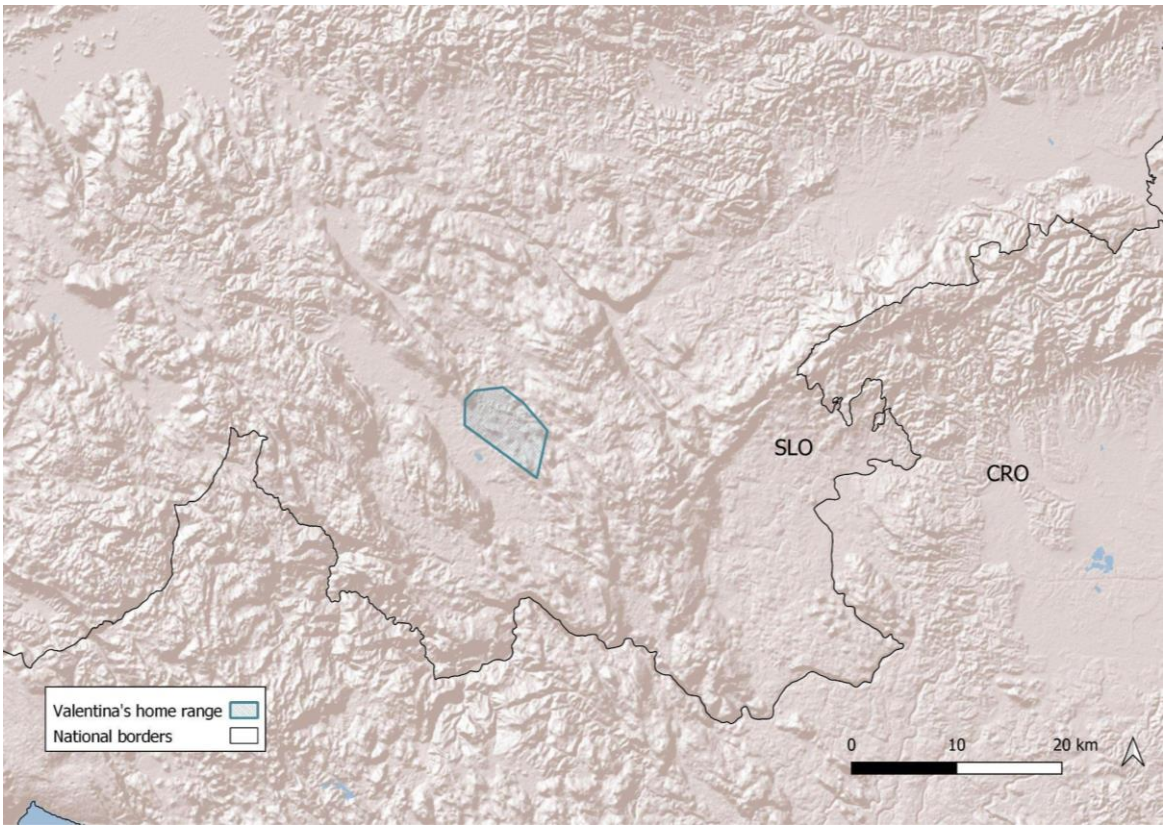

Figure 44. Valentina's potential home range (100 % MCP) in Kočevsko.

Meri

Figure 45. Lynx Meri after being equipped with a telemetry collar

On December 25th 2022, we captured a male lynx Meri in a box trap in the Pokljuka area. He is the offspring of the first litter of translocated lynx Julija and Tris. His estimated age was about 7 months. He weighed 11 kg and was in good physical condition at the time of the capture. After the capture, he did not rejoice with the mother Julija but went to the southern part of the Triglav Mountains, where it is still moving around, establishing its territory.

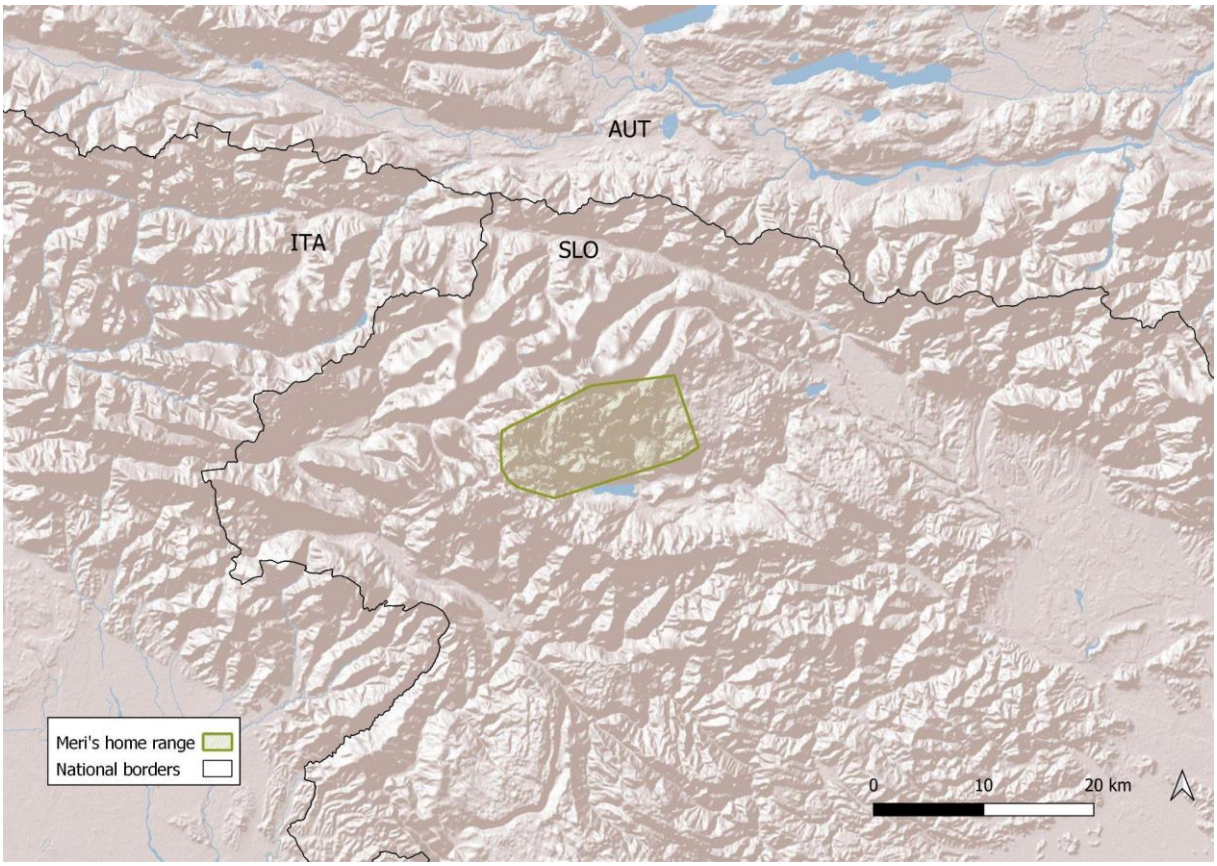

Figure 46. Meri’s home range (100% MCP) in Pokljuka

Rozi

Figure 47. Lynx Rozi after being equipped with the collar

On January 13th 2023, we captured a female lynx Rozi in a box trap in the Jelovica area. She is the offspring of the second litter of translocated lynx Aida and Zois. Her estimated age was about 7-8 months. She weighed 10,5 kg and was in good physical condition at the time of the capture. After the capture, she went on to the southern part of the Triglav Mountains, where she and Meri had several meetings. She then extended her range of movement towards the Posočje area. Rozi spends most of her time in the Triglav Mountains, including the areas above the tree line (over 2000 m altitude).

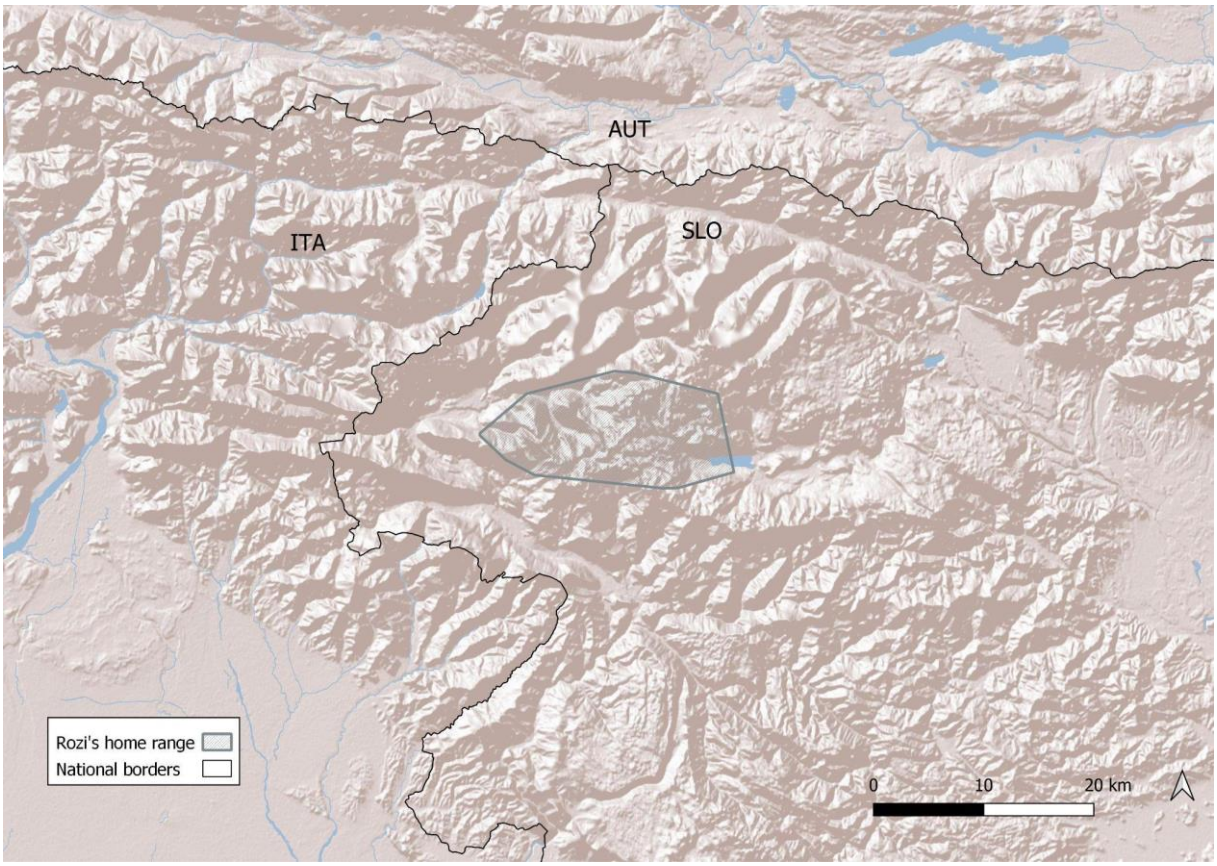

Figure 48. Lynx Rozi's home range (100% MCP)

Flori

Figure 49. Lynx Flori photographed on a camera trap

On March 3rd 2023, we captured a male lynx Flori in the Pokljuka-Radovna area. He is the offspring of the first litter of translocated lynx Julija and Tris. His estimated age was about 9 months. He weighed 15 kg and was in good physical condition at the time of the capture. After the capture, he stayed for some time together with Julija and Andrej in the area of Mežakla and Radovna. In April, he dispersed towards the Tamar valley and later towards Italy. Most of the time, he moves on the north-western border between Slovenia and Italy. So far, he has not established his territory yet.

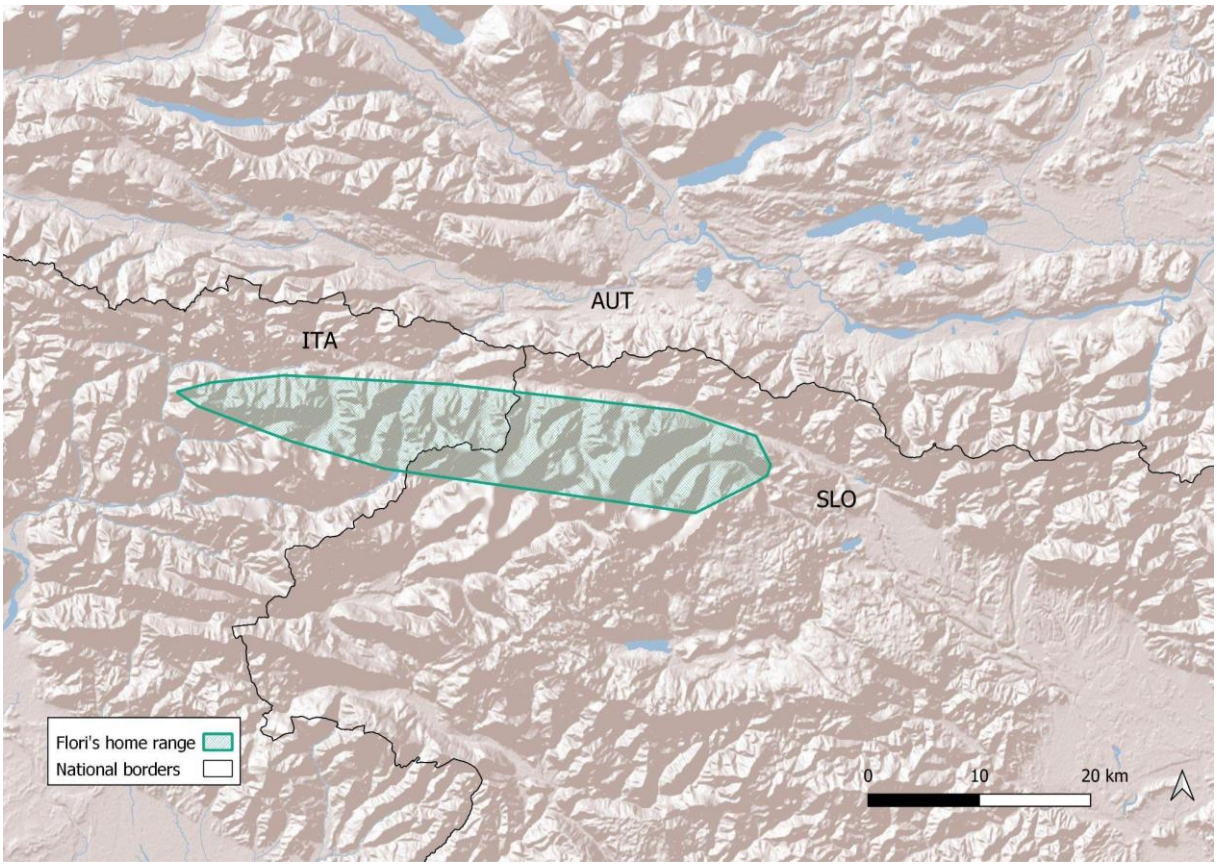

Figure 50. Flori's home range (100% MCP)

Andrej

Figure 51. Lynx Andrej recorded with camera trap in Gorenjska

On March 14th 2023, we captured a male lynx Andrej in the Mežakla area. He is the offspring of the translocated lynx Julija and Tris. His estimated age was about 9 months. He weighed 16,5 kg and was in good physical condition at the time of the capture. After the capture, he stayed for some time together with Julija and Flori in the area of Mežakla and Radovna. He started dispersing in April. Most of the time he is in the area of the Martuljek group of mountains, around Vršič and Trenta. Same as Flori, he did not yet establish his territory.

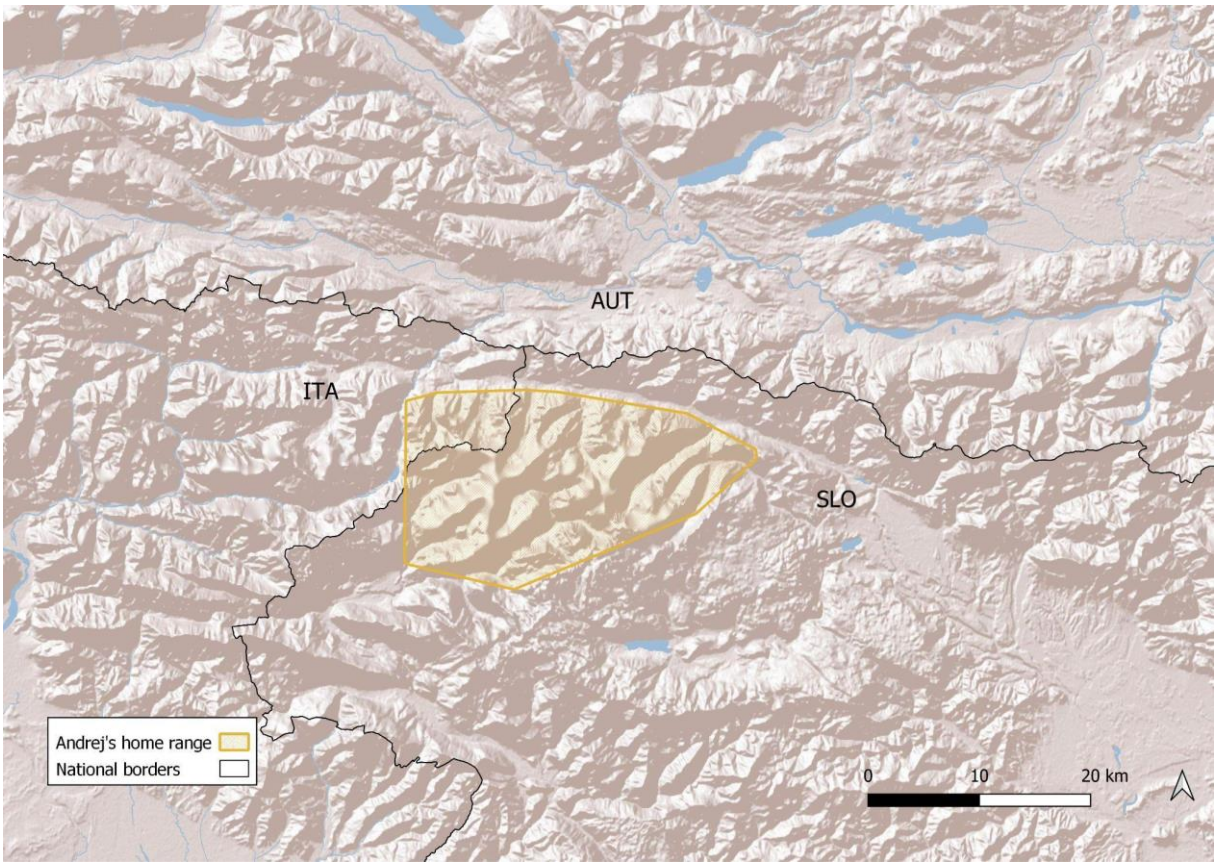

Figure 52. Lynx Andrej's home range.

2.4.4 Monitoring lynx predation on ungulates

We continue to regularly monitor lynx kill sites 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 2022 and April 2023, we found 111 lynx kill sites in Slovenia and Croatia in total. Same as the seasons before, the main prey species found at the kill sites was European roe deer (*Capreolus capreolus*) with 68 % of all detected kills. We also detected red deer (*Cervus elaphus*) (14%), chamois (*Rupicapra rupicapra*) (12%), mouflon (*Ovis amon musimon*) (2%), European hare (*Lepus europaeus*) (2%), red fox (*Vulpes vulpes*) (1%) and European badger (*Meles meles*) (1%) at the lynx kill sites. 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*), white-tailed eagle (*Haliaeetus albicilla*), Eurasian jay (*Garrulus glandarius*) and other lynx. 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, Fležar et al. 2023a).

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	19 (25)	18 (24)	3 (4)	40 (53)
	juvenile	3 (4)	8 (11)	12 (16)	23 (30)
	unknown	1 (1)	1 (1)	11 (14)	13 (17)
	Total (%)	23 (30)	27 (36)	26 (34)	76 (100)

2.5 Lynx mortality

Only one mortality event was detected in the lynx monitoring year 2022-2023. That was a collared lynx (Igi, more information about him is available in Fležar et al. 2023a), which died in Slovenia within his home range. He was found based on a collar mortality message in a very poor state, i.e. withered and with an infected wound on one of his fingers in the front right paw. Based on the knowledge about his health status from the capture (heart murmur, anatomical deformations), combined with the GPS and accelerometer data from the collar, we assume he died of natural causes after a hunting attempt, possibly due to heart malfunction.

During the reporting period lynx mortality was not recorded in Croatia.

3 REGIONAL SYNTHESES

In the following sections, we summarize all the data about lynx collected within the range of the Dinaric - SE Alpine lynx population in Croatia, Slovenia and Italy between May 1st 2022 until April 30th 2023.

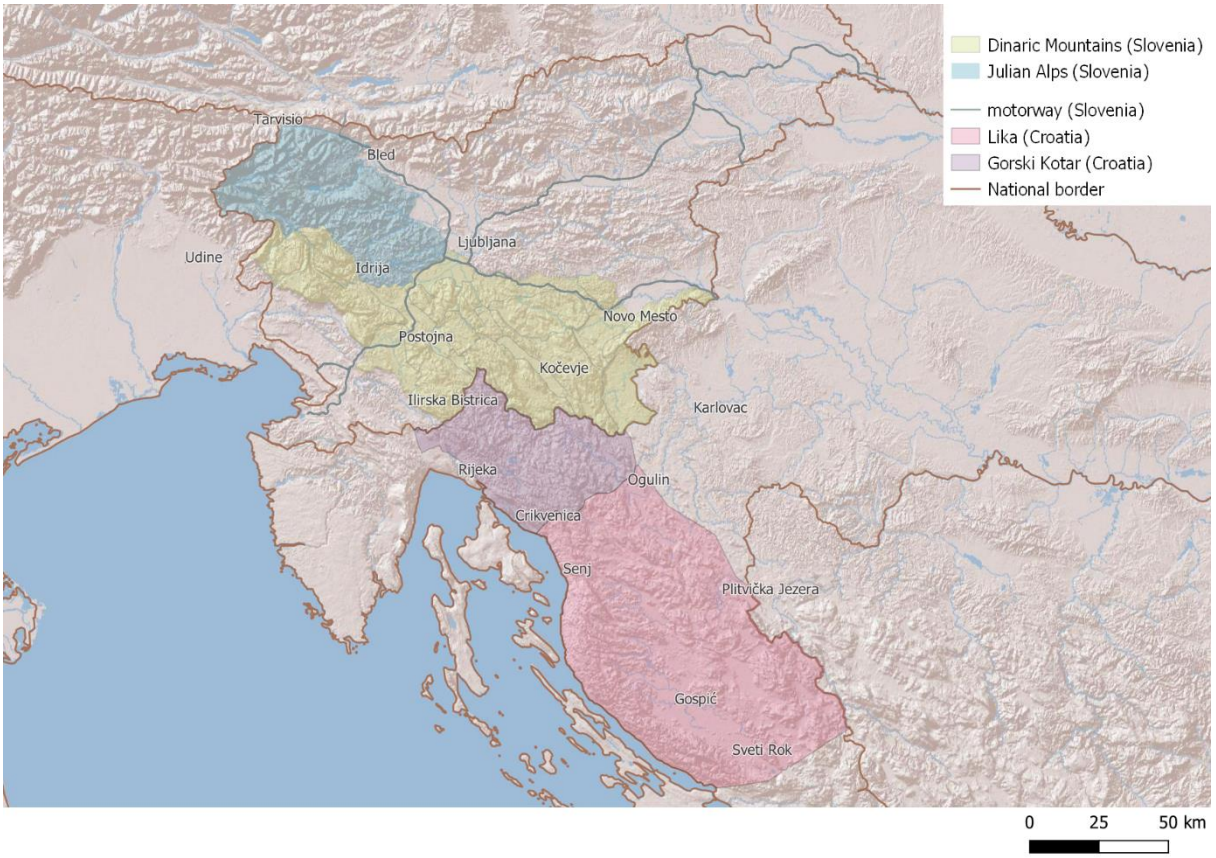

Figure 53. The division of Dinaric-SE Alpine project area in distinctive regions, for which we present the regional syntheses in chapters 3.1 – 3.5. The situation in NE Alpine – Italy region is included within the "Julian Alps" chapter.

3.1 Alpine area, Slovenia and Italy

In Slovenia, we detected six adult lynx in the Alpine area; four translocated animals (Julija, Lenka, Aida, Tris) and two non-collared individuals (both in Jelovica plateau). We assume that the non-collared lynx might be the offspring of the translocated pair from 2021, however, we could not confirm that by visual identity (no reference photos of kittens from 2021), or genetic sampling. We successfully genetically sampled an individual in the Posočje area in the Western part of the Slovenian Julian Alps and confirmed he is a male offspring of Aida and Zois. With camera trapping, we detected three reproduction events in the Slovenian Alps; all translocated females had litters; with Julija and Aida having three and Lenka one kitten. Entire litter from Julija and Tris (three males; Flori, Meri, Andrej) were captured and collared, as well as one female offspring from Aida and Zois (Rozi). The collars are working and we are regularly tracking their movements during dispersal and potential territory establishment.

As we did not collect any data about Zois, whose collar signal was lost, another male lynx (Lukaš) was released to the Jelovica plateau in April 2023. However, he left the area immediately after release, crossing an urbanized valley and established a home range in Karavanke Mountains along the

Slovenian-Austrian border, where no information about other lynx being present is available. Moreover, in March 2023, two females were released in the Italian Julian Alps in the frame of the ULyCA2 project. They dispersed to Austria and were not detected with opportunistic monitoring or camera trapping until the end of April 2023. Three more lynx, including Karlo (see Ch. 3.3 for details), were released to the Italian Alps after the 2022-2023 survey season which is covered in this report.

Since Triglav National Park, consisting of state-owned hunting grounds 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 the lynx population. At the end of 2022-2023 survey season, three adult lynx which were translocated to the park in 2021 remained present and reproduced (Julija with 3 kittens, Lenka with 1 kitten). Moreover, all collared offspring (Flori, Meri, Andrej and Rozi) have survived and started to establish their territories at least partially within the park, mostly on its Western side. At the end of 2022-2023 season, there were at least 3 adult and 4 subadult lynx present within the park.

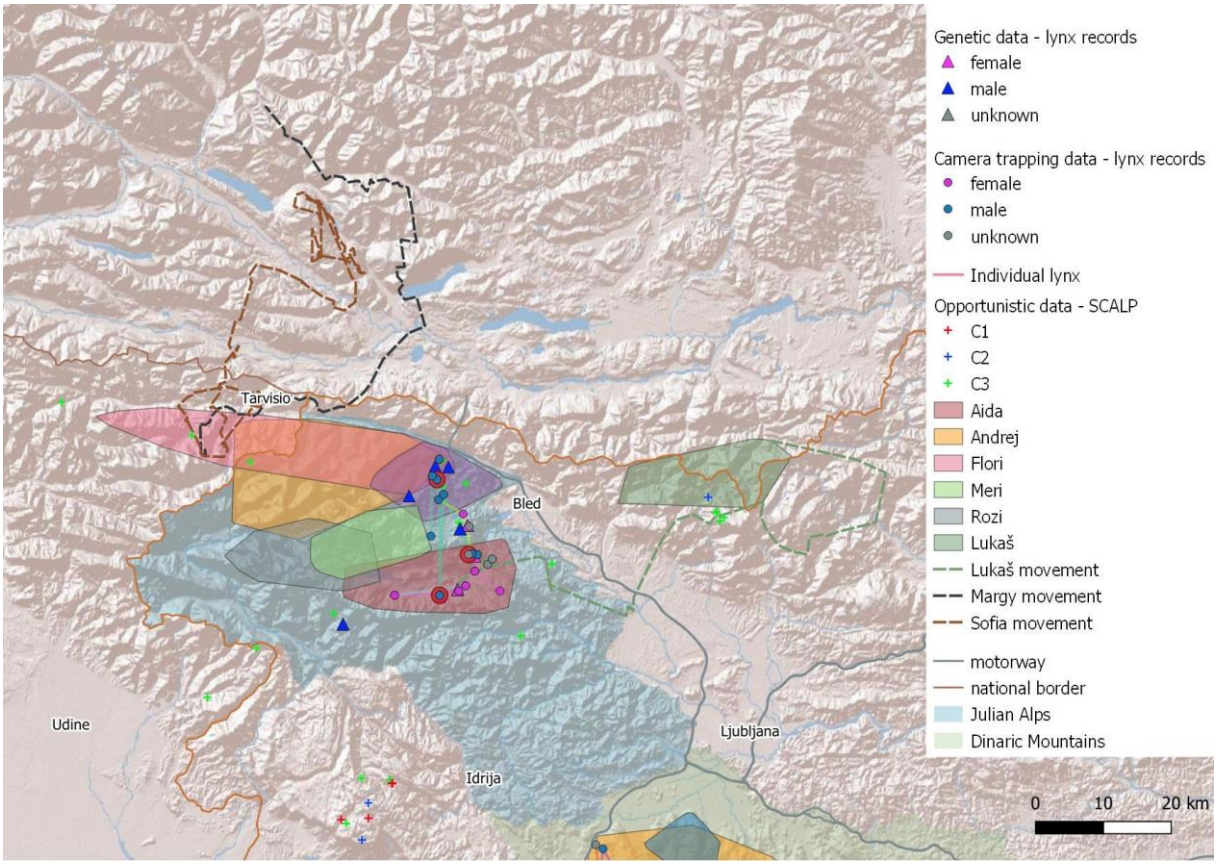

Figure 55. Overview of all confirmed records of Eurasian lynx collected during the 2022-2023 monitoring year in Julian Alps, Slovenia, and the adjacent countries. We obtain various types of data from translocated lynx and their offspring.

3.2 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 suitable habitat in the region is currently already occupied by lynx, including several territories occupied by both male and female lynx. A minimum of 34 different adult lynx were detected in this region, including three translocated males with established territories (Goru, Catalin and Blisk), and female Sneška which was translocated at the end of the season. We recorded five lynx

reproduction events in the Slovenian Dinaric Mts, including three within the territories of translocated males. In comparison to the previous survey season (2021-2022), the minimum count of adult lynxes were notably higher, but the number of reproductive events did not. The increase in the number of lynx in Slovenian Dinaric Mts was confirmed also by the abundance and density estimates, which showed more than 100% increase from the 2019-2020 season (Fležar 2024, unpublished). Opportunistic records and questionnaire responses also indicated an expansion of the lynx distribution as lynx presence was confirmed in areas South-East, East and South-West of the core Dinaric distribution, confirming the indications of spatial expansion from the previous report (Fležar et al. 2023a). We can thus expect that those would be the areas where lynx could become permanently present and potentially reproduce in the future. However, it must be noted that systematic monitoring (i.e. camera trapping) should take place there to document such change.

Lynx pairs sharing a territory were confirmed in Kočevski Rog/Poljanska gora, Kočevski Rog/Suha Krajina (with reproduction), Mala gora (with reproduction), Goteniška gora/Velika gora (with reproduction), Stojna/Kolpa (with reproduction), Racna gora, Snežnik plateau, Javorniki, Menišija/Logatec plateau (with reproduction) and Rakitna/Mokrc (with reproduction). New lynx were detected throughout the Dinaric Mountains, although some of them might only be transient dispersers, as was the case with an individual, who was recognized as a kitten in Croatia (offspring of female Frida) and then as an independent animal in Slovenia in the area close to the national border. Two other lynx were found to have a cross-border territory, both of them being unknown from previous years and seem to have replaced the lynx detected in the same areas the previous survey seasons.

The situation in Slovenian Dinaric Mountains east of the Ljubljana-Koper highway seems to have substantially improved in comparison to the previous years, especially in terms of lynx density and abundance increase. In Kočevsko, we are observing higher stability of the population, where the territorial lynx pairs are continuously present but also new animals appear, establish a territory and eventually reproduce (3 such cases were observed in the last 5 years). On the contrary, the situation in Notranjska seems to be stable only within the home ranges of translocated animals. A high fluctuation of individuals was recorded in the Snežnik-Javorniki area, with no lynx cubs being recorded there in 2022-2023, which makes a total of only two reproductive events being detected in that region over the course of 5 years. Based on the data from the past monitoring and our experience and knowledge of that area, we cannot conclude what is the underlying reason for such poor lynx status and high turnover rate, however, it calls for further investigation.

Over the years, we have noticed that some lynx shifted their home ranges or changed the size of their territory. That could be a consequence of low lynx density at the beginning of the translocations (Fležar et al. 2023b), thus a substantial amount of space was available for some individuals. As the density notably increased only during this survey season, we cannot deduct how these changes might continue to occur and whether we are already approaching carrying capacity in the Slovenian Dinaric Mountains.

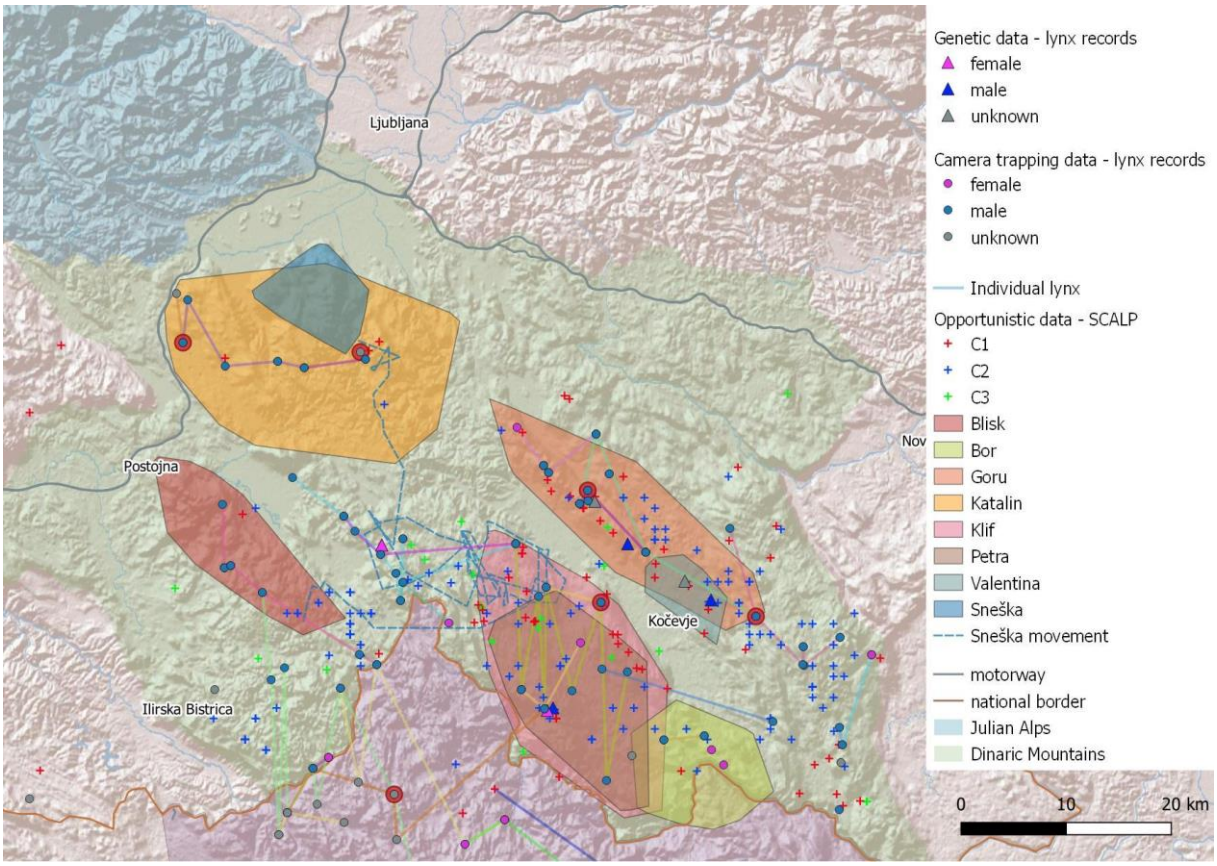

Figure 54. Overview of all confirmed records of Eurasian lynx collected during the 2022-2023 monitoring year in Kočevska and Notranjska regions in the Dinaric Mountains of Slovenia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), home-ranges (HR; 100% MCP) of 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 color representing a different individual.

In the Slovenian part of the Dinaric Mountains west of the Ljubljana-Koper highway (the pre-Alpine area) we could confirm lynx presence with C1 records only. Most of them were collected in Trnovski gozd, which is further North from the previously-known lynx records in that region (Figure 55 in Ch. 3.2), but two were also collected in the Nanos area (Figure 54). From the photos, the lynx seems to have a rosette coat pattern, which was rarely detected in Slovenia prior to the translocations. Thus, we assume it could be an offspring of translocated lynx. Similarly to the previous years, there are still no confirmed records of reproduction or females present in this region.

3.3 Gorski kotar, Croatia

All suitable lynx habitat in Gorski kotar is occupied by territorial individuals. While in the last two seasons a total of 29 (2020-2021) and 25 (2021-2022) adults were identified, in 2022-2023 a total of 30 adult individuals were identified. The 2022-2023 increase in the number of identified individuals is primarily due to the increased monitoring effort within the OPCC project ''Development of a monitoring program for large carnivores with capacity building of stakeholders in the monitoring and reporting system“. Out of the 30 individuals, 16 animals are monitored since the 2021 - 2022 season, while 12 are newly identified in this season. Reproduction was detected on four locations in five

different events. Precisely, we confirmed three litters and four kittens, which is comparable to the previous year (two reproductions). Additionally, male lynx kitten was found in October in southern Gorski kotar. As it was confirmed as an orphan, small and malnourished, this lynx orphan named Karlo was translocated to Slovakia for rehabilitation for release back to nature. Since it was genetically proven to be an offspring from the resident population (no parenthood from released lynx), it was decided for it to be released in the Italian Alps as a contribution to the Italian ULyCA2 project.

The territory of translocated lynx Boris covers the southern part of Gorski kotar region. In the season 2022-2023, a female with a kitten was recorded in lynx Boris' territory, through reinforced camera trapping effort within the OPCC project "Development of a monitoring program for large carnivores with capacity building of stakeholders in the monitoring and reporting system".

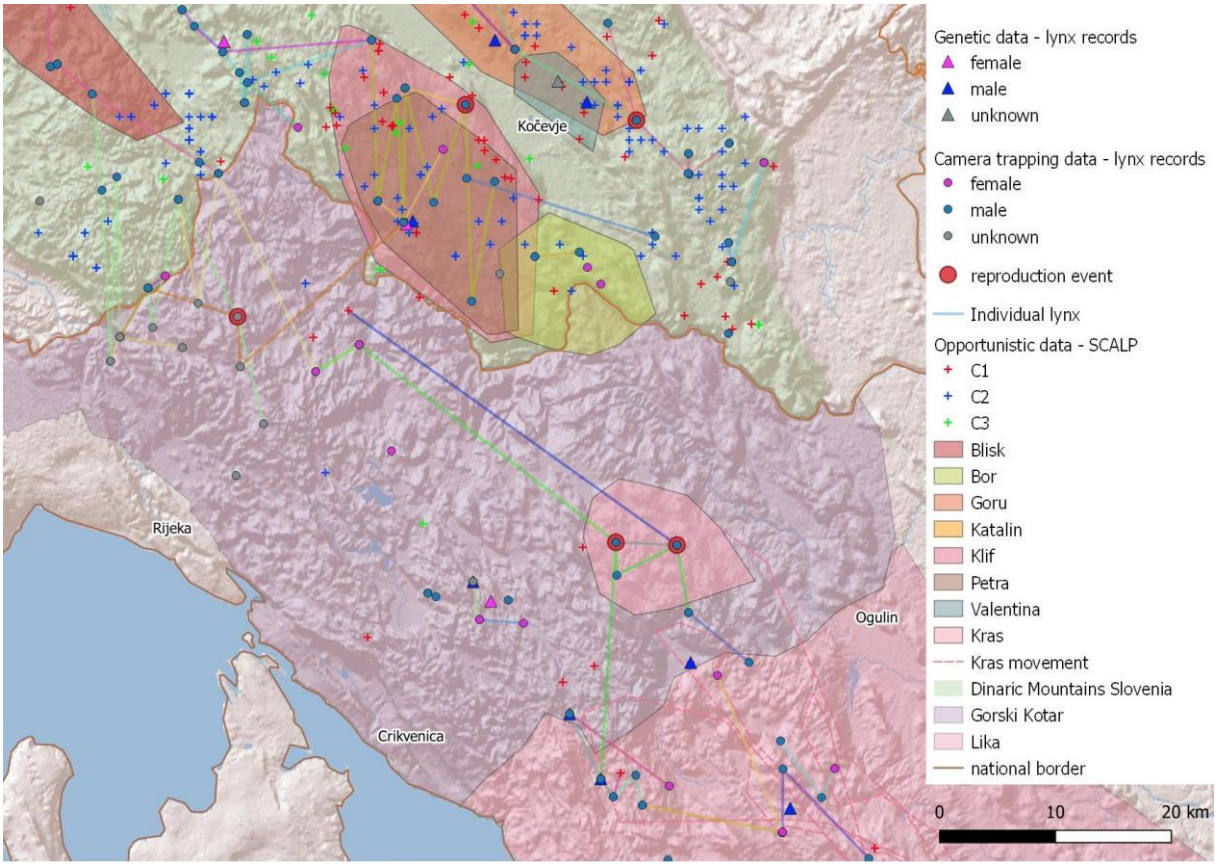

Figure 56. Overview of all confirmed records of Eurasian lynx collected during the 2022-2023 monitoring year in Gorski Kotar, Croatia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), movements 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, only unsuitable open plains and karst fields in central Lika are not occupied by lynx as this is unsuitable habitat. In the season 2022 – 2023 a total of 69 adults were recorded with camera traps. The increase in the number of identified animals compared to the last season (69 vs 54) is primarily due to the increased

monitoring effort within the OPCC project ''Development of a monitoring program for large carnivores with capacity building of stakeholders in the monitoring and reporting system“. Among 69 individuals identified on camera traps in the wider Lika and northern Dalmatia region (including animals in Zadar county), 40 were identified from both sides of the body (including the three translocated lynx). A total of 25 animals are monitored since the 2021-2022 season, while 37 are newly identified in this season.

Reproduction was detected on 12 locations in 17 different events. Namely, we confirmed 14 litters and 22 kittens, which is higher compared to the previous year (five litters and 11 kittens). One kitten was recorded within the territory of lynx Emil, but at the moment we do not have genetic proof for this potential reproduction of the translocated lynx.

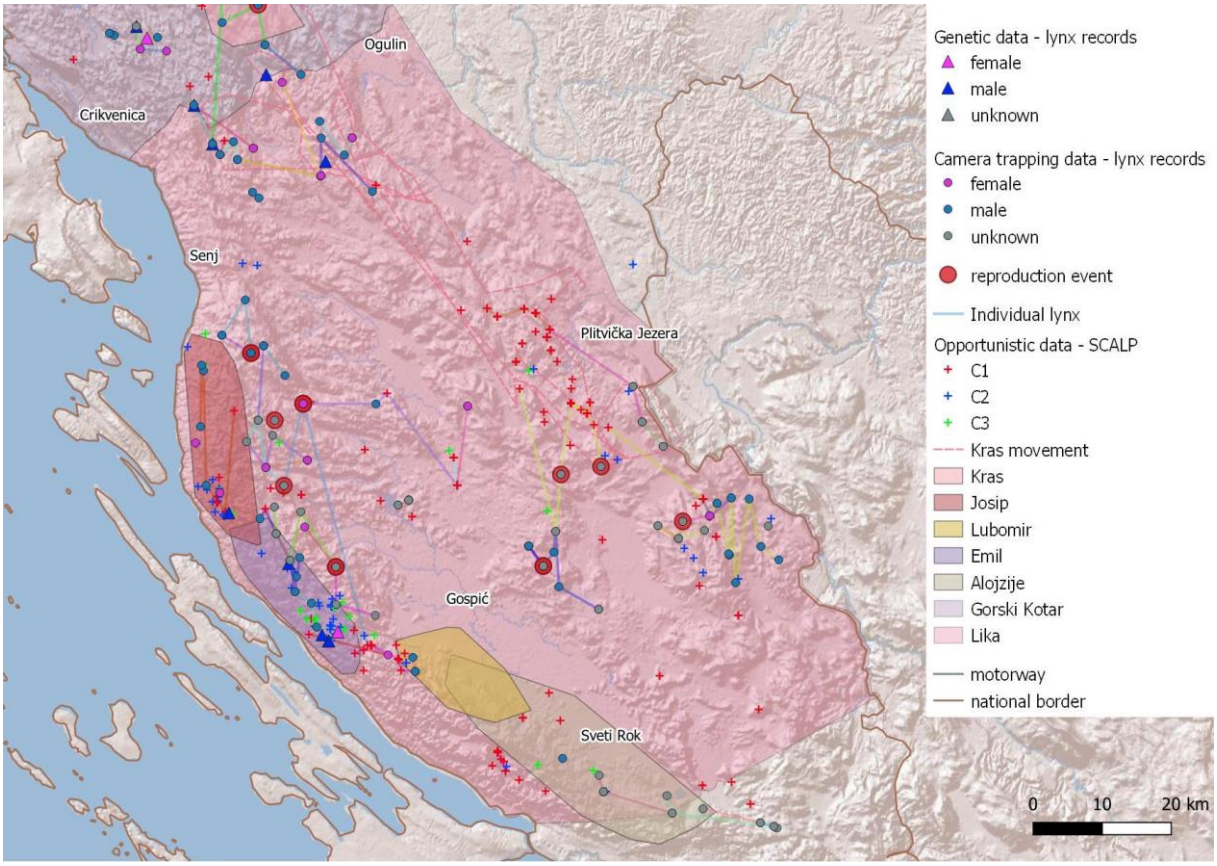

Figure 57. Overview of all confirmed records of Eurasian lynx collected during the 2022-2023 monitoring year in Lika and northern Dalmatia, Croatia. Shown are records from the systematic camera-trapping and non-invasive genetic monitoring (with information about the sex of detected lynx, when available), 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 DISCUSSION AND CONCLUSIONS

4.1 The Dinaric-SE Alpine lynx population in 2022-2023

In the 2022-2023 survey season, the status of Dinaric-SE Alpine lynx population improved dramatically in comparison to the previous years (Table 8). We noticed a slight increase in the distribution compared to the previous year (2021-2022), while the increase in the population density, abundance and the reproduction was noticed over the entire survey area, with the largest increase in Slovenia. We detected an 44% increase in lynx density in the Dinaric Mountains compared to 2019-2020, as well as a similarly large increase in abundance over the same area (Table 8). Additionally, the number of reproductions in 2022-2023 was the highest recorded since the beginning of the action (2019-2020), reaching 19 detected females with cubs (and additional 3 in the Alpine area; Table 2). This confirms the demographic recovery of the lynx population in the Dinaric Mountains in Slovenia and Croatia in the course of the last 4 years.

Numerous territories across the Dinaric Mountains of Slovenia and Croatia are occupied by lynx of both sex and it seems that 9 translocated animals from the Carpathian population (Goru, Catalin, Blisk, Emil, Alojzije, Boris, Lubomir, Kras, Sneška) are successfully integrated in the population, with confirmed (genetically) or suspected (based on telemetry and/or camera trapping) reproductions. Importantly, the successfully integrated lynxes reduced the inbreeding level of the population, and the positive impact on the genetic status of lynx in the Dinaric Mountains will continue if the translocated animals and their offspring continue successfully reproducing.

The number of lynx in the pre-Alpine area in Slovenia (i.e. west of Ljubljana-Koper highway; see chapter 3.2) remains small and also no confirmed records of presence of remnant lynx in North-Eastern Italy were collected. Over the duration of the C.5 action, we could confirm by telemetry tracking and camera trapping data, that the A1 highway in Slovenia remains an important barrier limiting the expansion of lynx within Slovenia from the Dinaric Mountains to the (pre)Alpine area. On the other hand, we have been detecting lynxes with transboundary (Slovenia-Croatia) territories meaning that the population is well connected between the two countries.

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 and reproduced. We have detected reproductions of all translocated females (n=3) with all except one litter having 3 kittens, and the tracking data shows that most of them reached their sub-adult stage. Simultaneously, we are detecting the expansion of the population stepping stone to the South and Western direction.

We are finishing the C.5 action with 14 translocated lynx successfully integrated into the Dinaric - SE Alpine population. Additionally, at least two offspring of translocated lynx (confirmed with genetic analyses) have remained within the population, one of them already producing the first litter of second-generation offspring.

4.2 The changes in the Dinaric-SE Alpine lynx population between 2019 and 2023

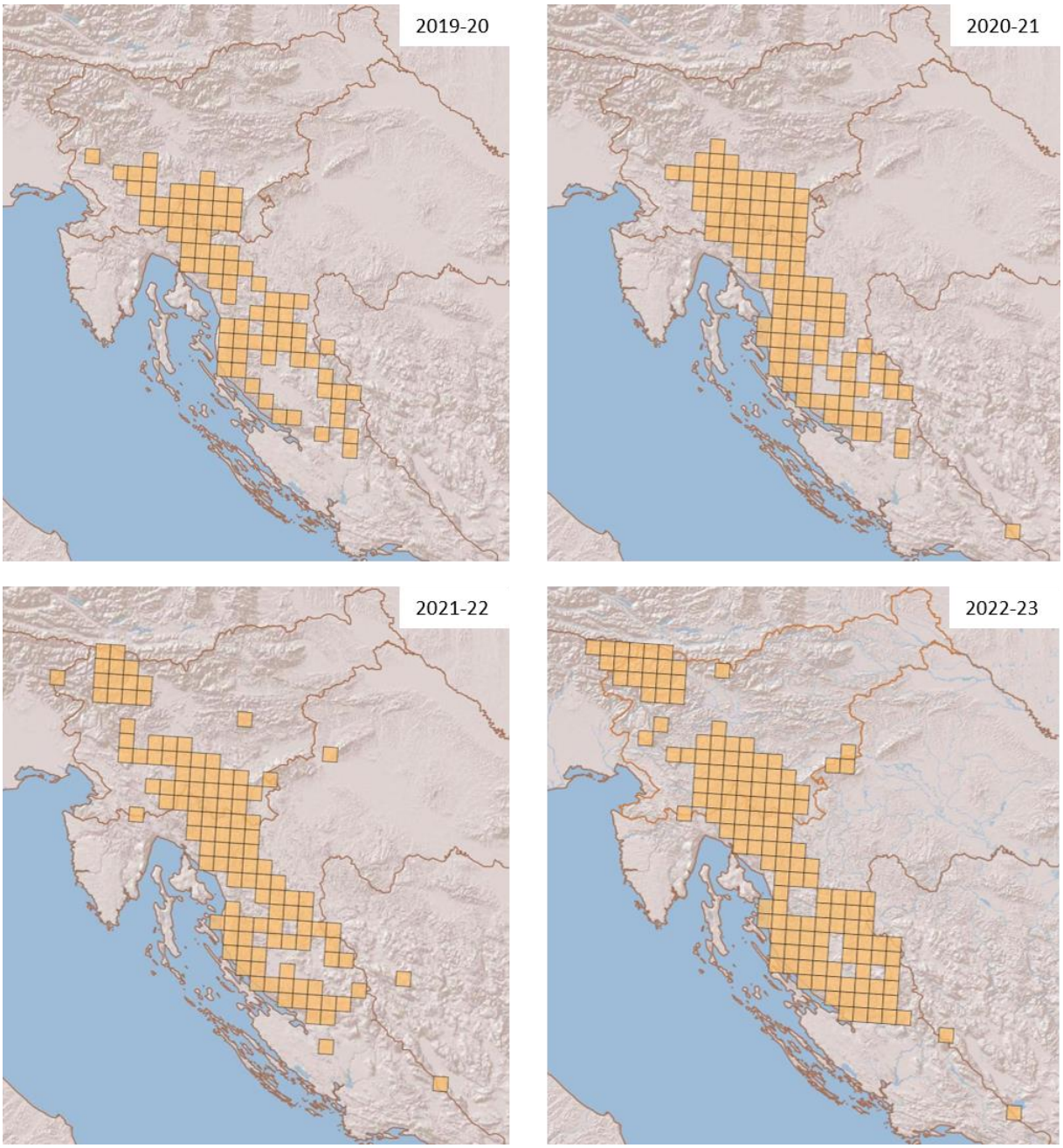

Figure 58. Lynx distribution in Dinaric-SE Alpine project area over the duration of the C.5 action (2019-2023). Grid cells were colored on the basis of confirmed records of lynx in a standard European 10 × 10 km grid net. Four types of data were considered as confirmed lynx records: opportunistic data categorized as C1 or C2 record, GPS locations from collared animals with an established home range, camera trapping records and genetic records.

The creation of the Alpine stepping stone population in 2021 significantly increased the distribution of the Dinaric-SE Alpine lynx population. In the Dinaric Mountains, the distribution increased to a smaller extent between 2019 and 2023. In general, the size of the area surveyed, the number of operating camera trapping sites and the number of collaborating people has been increasing over the years. The

only drop in the camera trapping effort in 2020-2021 was due to the absence of some external data providers in that year. Still, we have been effectively surveying roughly 12.000 km^2 annually with camera traps, which is one of the highest camera trapping efforts reported (Tourani 2022), and it gave us an unprecedented insight into the annual population status. We also noticed an increasing trend in the amount of opportunistically collected data over the years. The amount of data has been slowly increasing between 2019 and 2022, while it almost tripled in 2022-2023. The increase is mainly due to the good cooperation with public institutions for management of protected areas in Croatia who implement camera traps for wildlife monitoring and provided lynx data. Moreover, in Slovenia, the majority of opportunistic data is collected by hunters or other enthusiasts from the general public. It shows that we have established a good relationship with the people, which are the main data providers (rangers and hunters), as well as that we managed to reach a wide audience that is aware of the relevance of any lynx-related information for us. We believe that an increase in the amount of collected opportunistic data indicates an improvement in overall lynx surveillance over the years as well as an increase of the lynx numbers.

Table 8. An overview of effort and data collected about the lynx in the Italy, Slovenia and Croatia within the C.5 action (lasting from 2019 to 2023). For details, see annual reports: Fležar et al. (2020) for 2019-2020 survey, Krofel et al. (2021) for 2020-2021 survey, Fležar et al. (2022) for 2021-2022 and this report for the 2022-2023 survey.

		2019-2020	**2020-2021**	**2021-2022**	**2022-2023**
EFFORT	*collaborating hunters, ranger and volunteers (institutions)*	136 (77)	153 (81)	171 (92)	198 (94)
	opportunistic data points (SCALP C1)	225 (102)	220 (87)	278 (140)	635 (313)
	camera trapping sites, LIFE Lynx and other (total area surveyed)	348 (10.600 km^2)	307 (9.800 km^2)	439 (10.900 km^2)	462 (13.000 km^2)
	genetic samples collected (successfully genotyped)	130 (56)	149 (71)	104 (56)	95 (36)
	collared lynx tracked (translocated, remnant, offspring)	9 (4, 4, 1)	12 (6, 4, 2)	20 (10, 8, 2)	24 (13, 7, 4)
	kill sites checked and prey found	148	103	121	111
RESULTS	*mean population density in the Dinaric Mountains (lynx/100km^2, with 95% CI)*	0.88 ± 0.15 (0.63-1.23)*	1.05 ± 0.15 (0.80-1.38)	0.91 ± 0.13 (0.68-1.20)	1.27 ± 0.15 (1.00-1.61)

	mean population abundance in the Dinaric Mountains (with 95% CI)	110 ± 18 (79-152)*	129 ± 18 (98-169)	112 ± 16 (84-149)	156 ± 19 (123-198)
	number of detected adult lynx in the pre-Alpine and Alpine area	2	1	5	6
	number of reproductions (females with kittens) – entire area	15	19	15	22
	number of recorded dead lynx – entire area	1	4	3	1

*these estimates slightly differ from the ones published in Fležar et al. (2023) due to a different modeling approach; here, "multi-session" instead of "single session" (Sutherland et al. 2019) SCR models were used.

Despite the increasing effort in population surveillance, the number of identified adult lynxes (minimum count) in Slovenia and Croatia was rather constant during the first three seasons (Fležar et al. 2020, Krofel et al. 2021, Fležar et al. 2022) and notably increased only in 2022-2023 survey. However, this information sources from all available data about visually identified adult lynx (from the Dinaric and the Alpine part, from both opportunistically and systematically collected photos, from the entire survey year, i.e. May 1st 2022-April 30th 2023).

The status of lynx in the Alps was closely monitored by tracking all translocated individuals through telemetry and camera trapping. We were also successfully detecting their litters, as well as capturing a large proportion of the cubs (n=4) for telemetry tracking. By 2022-2023, five translocated lynx reproduced at least once, and four of them persisted in the stepping stone area until the end of 2023. Additionally, two new individuals were detected there, most probably being offspring of the translocated lynx, and all four collared cubs dispersed to the neighboring areas of the territories of their parents. No data from the Alpine or pre-Alpine area was used for spatial capture recapture (SCR) modeling (see below for more details).

The surveillance of the lynx in the Dinaric Mountains, where the majority of the Dinaric-SE Alpine lynx population is present, was designed in a way that the status of the lynx could be evaluated with SCR approach. Thus, we present the demographic changes occurring between 2019 and 2023 using the results of SCR modeling, with further details being presented in the final report of the LIFE Lynx D.2 action. For this purpose, the camera trapping data from each survey year needed to be adjusted spatially and temporally to meet the requirements of the SCR models (see section 2.2.3 and the paragraph above), resulting in between 52 % and 73% camera trapping data being suitable for use for SCR. In addition, the identity of some lynx on the photos collected in the past survey years (e.g. 2019-2020) could have been determined using additional photos collected in the following survey years (e.g. 2021-2022). Therefore, the estimates of SCR modeling cannot be directly compared to the minimum

counts reported in the previous C.5 reports, even if limiting the minimum count to the Dinaric Mountains. Interestingly, even when accounting for that, the minimum counts still fell into the confidence interval of the respective SCR derived abundance estimate (e.g. in this season, the minimum count was 136 lynx, while SCR abundance was estimated between 123-198 lynx (Table 8). Nevertheless, due to known robustness of the SCR models, the derived estimates should stay the preferred choice for any further evaluation of the status and abundance of the lynx in the Dinaric Mountains.

Using SCR modeling, we documented that the lynx population density in the Dinaric Mountains increased for roughly 44% within the course of C.5 action (Table 8). Looking at the annual estimates, we see that the trend in density and abundance first slightly increased, but in 2021-2022 dropped to a similar level than 2019-2020 (Table 8) and then jumped to a 1.27 ± 0.15 lynx/100km^2 in 2022-2023, corresponding to 156 ± 19 lynx in the area of 12,275 km^2. The low standard error of the estimates shows that we could estimate the density and abundance of the lynx in the Dinaric Mountains at a relatively high precision throughout the entire C.5 action. It seems that over the past four years, the positive change in the Dinaric Mountains is a consequence mostly of an increase in the population density within a similar area of distribution, rather than the spatial expansion. The improvement in the lynx status was especially evident in Slovenia being the northern edge of the lynx distribution in the Dinaric Mountains, where the abundance of lynx almost doubled (Fležar, unpublished).

Besides population size, reproduction is one of the most important demographic parameters for a population status assessment. The lynx reproduction (number of females with kittens) in Croatia and Slovenia steadily increased since the first season, starting with 25 kittens in 15 litters and ending with 36 kittens in 22 litters in the 2022 - 2023 season. Interestingly, in Slovenian Dinaric Mountains the number of reproduction events remained the same (n=5) over the years (except in 2019-20) despite the increase in the number of females in the area. The reproducing females in the Alps thus importantly increased the total number of reproductions for Slovenia. Most importantly, until 2023, we registered 19 litters within the territories of translocated lynxes (6 of them genetically confirmed). Lynx Goru was the most successfully reproducing lynx, as he fathered 4 litters with at least 8 kittens in total since his translocation.

With a high number of collared lynx individuals (13 females and 27 males) over the course of C.5 action, we also gained a good insight into the spatial needs of translocated and remnant lynxes. The average male lynx territory size in the Dinarics is 249 km^2 large, while the female is roughly half the size; 109 km^2. In the Alps, the difference in territory size between sexes is smaller; 201 km^2 vs 156 km^2, respectively. All subadult lynx had smaller home ranges; around 100 km^2. Interestingly, we noticed that over time, the lynx may shift their territories and change their size, which we observed in Goru, Catalin, Aida and Alojzije.

Finally, genetic monitoring was crucial for assessing genetic status and influence of ongoing translocations. However, despite an increasing amount of data collected with methods described above, non-invasive genetic samples were getting more difficult to find each year. We have observed a high unpredictability in snowfall and increasingly poor amount and quality of snow cover. With climate change, there is less snowfall in general, the elevation at which it falls is increasing and if it falls, it melts quickly due to non-frozen ground and above zero air temperatures. Thus, genetic

monitoring remains only to be used as supplementary data to camera trapping for understanding the demographic status and population parameters. However, it remains the only insight into the level of effective inbreeding, which was the most important threat to this population. While inbreeding is still at relatively high levels, we can already see important improvements due to population reinforcement efforts. The large increase in expected heterozygosity indicates the potential for rapid decrease of inbreeding if the translocated animals and their offspring continue successfully reproducing.

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