LIFE Lynx

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

LIFE16 NAT/SI/000634

Monitoring of the Eurasian lynx in the Eastern Romanian Carpathians

A2. Assessment and selection of sites and lynx for live-capture from the Carpathian source population in Romania

Sin T., Marocco I., Kraft B., Pop I.M., Gazzola A.

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ACDB
Action for wildlife

Report developed as part of the LIFE Lynx project - "Preventing the extinction of the Dinaric-SE Alpine lynx population through reinforcement and long-term conservation" (LIFE16 NAT/SI/000634)

Realized in the frame of Action A2:
Assessment and selection of sites and lynx for live-capture from the Carpathian source population in Romania

Authors*:
Teodora Sin
Ilenia Marocco
Bogdan Kraft
Ioan Mihai Pop
Andrea Gazzola

*The Association for the Conservation of Biological Diversity, Ion Creangă 12, 620083, Focșani, Vrancea, Romania

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CONTENTS

FOREWORD

This report represents a deliverable required under Action A2 - *Assessment and selection of sites and lynx for live-capture from the Carpathian source population in Romania* of the LIFE Lynx project (LIFE16 NAT/SI/000634 - Preventing the extinction of the Dinaric-SE Alpine lynx population through reinforcement and long-term conservation).

The goal of Action A2 is to identify the most suitable areas and micro-locations for live-capture of animals in Romania.

As such, the following two objectives emerged within this action: i) assessing the number of individuals which are present or visiting the selected study areas, ii) individualizing micro-locations for the live-capture of animals.

This report addresses the first objective and aims to provide comprehensive information on the distribution, abundance, and movement of lynx within the study areas.

The results shown here were obtained over the course of the past four years of survey (2017-2021). As the survey work is carried out throughout the project's lifespan, the data gathered is useful in determining the number of individuals that can be removed from each area without jeopardizing the population and assessing the effects of lynx removal for translocation purposes on source populations (Action D1).

Due to large surfaces of the study areas and limited available resources (i.e. sufficient camera traps to implement a standardized camera-trappping survey in all study areas), systematic monitoring was not feasible for the Romanian lynx population. Therefore, the results presented in this report are based on an opportunistic monitoring approach and only show relative estimates of population parameters.

MATERIALS AND METHODS

Objectives and attributes

Three main objectives have been identified: evaluation of distribution, abundance, and activity of lynx inside the study areas.

The attributes, as well as the sampling strategies and the criteria for analysis and interpretation of the collected data have been described in the previous report (Gazzola et al. 2018).

Study area

The project activities have been conducted in a wide sector of the Central-South part of the Eastern Romanian Carpathians. Whitin this range, five study areas have been selected to conduct lynx surveys (Figure 1).

A cool continental mountain climate with high humidity throughout the year is predominant in all study areas but Bacău, which lies in the wet temperate continental climate zone in the foothills of the eastern Carpathian Mountains (*Köppen Climate Classification, Clima României, Administrația Națională de Meteorologie, Bucharest 2008*). The vegetation in this montane belt is shaped by three species: *Fagus sylvatica*, *Picea abies* and *Abies alba* (Cristea, 1993), mainly as mixed deciduous-coniferous forest, but also with larger coniferous forest stands.

Lepșa (N 45.951018, E 26.537186)

The study area gets its name from a small village in the municipality of Tulnici (Lepșa), which lies entirely in Vrancea county. With altitudes ranging between 500-1784 m above sea level, the area is situated in the Eastern Carpathian Mountains and overlaps the Putna-Vrancea Natural Park. This area is distinguished by an unusual pattern of narrow/wide valleys and a broad expanse of woodland. Although this study area is crossed by many forest roads, its accessibility is limited: the majority of the roads are in poor condition due to the intensive logging activity present in this area.

Bacău (N 46.102312, E 26.852482)

The study area Bacău is located along the border of Bacău and Vrancea Counties. It is situated between 400 m – 1233 m above sea level, at the foothills of the Eastern Carpathian

Mountains. This area is characterized by a regular pattern of wide valleys, smooth reliefs, and a vast expanse of forest at higher altitudes, with clearcut areas, pastures and agricultural fields predominating at lower altitudes and concentrated mostly in the southern and eastern sectors of the site. Because of its well-maintained gravel road infrastructure, the area is accessible almost all year.

Vintileasca (N 45.608333, E 26.705556)

The study area gets its name from the small village of Vintileasca, and it is entirely within Vrancea County. The altitude ranges from 400 m to 1699 m above sea level. This area is characterized by an irregular distribution of mountain chains, dense and vast forests, and low accessibility due to scarcity and poorly maintained road infrastructure.

Dărmănești (N 46.343520, E 26.254868)

Dărmănești is a small town located in Bacău County. The study site Dărmănești overlaps the corner where the counties Bacău, Harghita and Covasna meet. It is situated between 400 m – 1639 m above sea level, in the Eastern Carpathian Mountains. This area is characterized by a regular distribution of narrow valleys, and covered by vast forests. Because of its well-maintained gravel road infrastructure, the study area is accessible almost all year.

Tarcău (N 46.807533, E 26.046669)

Tarcău is a municipality and town in Neamț County. The study area lies solely within Neamț County and its altitude ranges between 750m and 1282m above sea level, in the central part of the Eastern Carpathian Mountains. The size of this study area is currently limited and is circumscribed by just one hunting district.

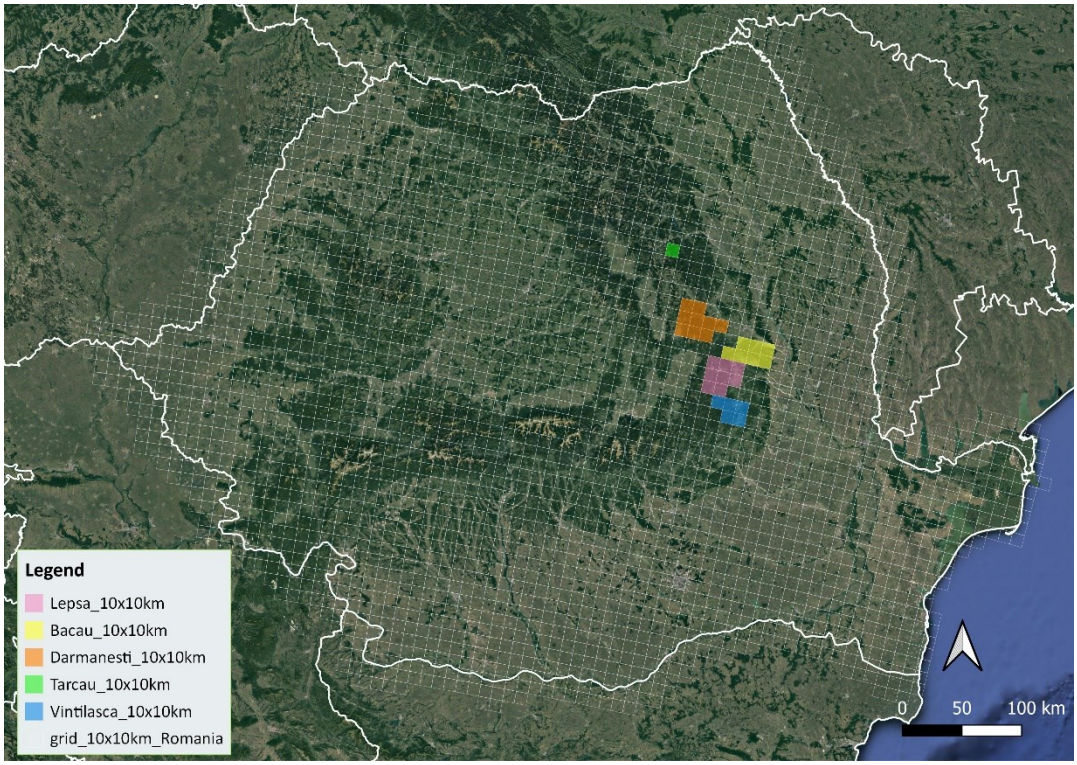


Figure 1. Survey and capturing activities were performed in five study areas (Lepșa, Bacău, Vintileasca, Dărmănești, and Tarcău).

Distribution

The most basic information about a species is its presence in a certain location. Throughout the project, we collected information on the spatial distribution of lynx signs (direct and indirect observations). The spatial information obtained, namely lynx trails followed during snow tracking surveys and the location of camera traps with lynx registers collected during camera trapping surveys, was also used to establish the suitable areas and micro-locations for live-capture of individuals.

Abundance

In order to assess the abundance of lynx in the study areas (i.e. the *minimum number of individuals* and *family groups*), we combined all the information resulting from camera trapping and snow-tracking surveys, radiotelemetry and genetic data.

Family groups are defined as a unit composed by the mother with one or more kittens. In our monitoring season (November-April), this association is particularly frequent before the mating season, during early - mid-winter (November-February).

To assess the minimum number of individuals, the videos/photos with lynx were scanned by multiple operators. The individuals were identified visually based on the distinctive coat patterns (e.g. spots, rosettes, particular signs of the animals; Figure 2; see Rovero & Zimmermann 2016 for more information). The photos with the highest definition were chosen and compared to each other.

A first comparison was made among the material collected at the same station, then a second comparison was made among all those in the same study area, and finally a third comparison was made between study areas that were adjacent. Furthermore, all of the photographs taken last year were compared to those from previous years in order to distinguish individuals recaptured over the years. An identification code has been assigned to each different animal.

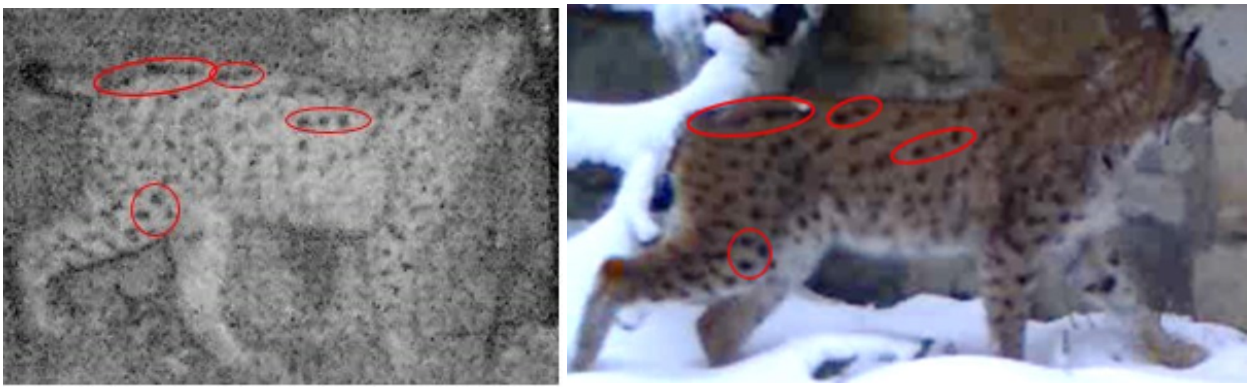


Figure 2. Two photos of the same individual collected in Lepșa study area; at the same station (Roșchila), photos collected on 25/2/2020 and 22/03/2020. Characteristics of the coat that helped in identifying this individual (red line).

Activity

Lynx activity was recorded by camera traps each 24-hour day. The data gathered was useful to determine not only when lynx crosses a specific site, but also the number of times it crosses the same site during the winter (*frequency of events*).

The activity at the camera trap stations was expressed as: *i)* lynx spatial occurrence ($LYNX_{CT}$); *ii)* lynx videos out of the total number of recordings ($LYNX_{V}$); *iii)* lynx temporal occurrence ((camera) trapping rate/ *CT rate index*).

$$LYNX_{CT} = N_{CTl}/N_{CT} \quad \text{(i)}$$

where $LYNX_{CT}$ represents the number of stations with lynx, and N_{CT} the total number of camera-trap stations in a study area

$$LYNX_V = N_{vl}/N_v \quad \text{(ii)}$$

where N_{vl} represents the number of videos with lynx, and Nv the total number of videos in a study area (empty videos excluded)

$$CTrate\ index = N_{vli}/N_{CTdays} * 100 \quad \text{(iii)}$$

where, N_{vli} represents the number of independent lynx recordings (events), and N_{CTdays} the total number of camera-trap working days

Further spatial information was provided by the movements of two radiocollared individuals capured and released in situ during the winter 2020-21.

Survey and trapping effort

Due to large surfaces of the study areas, limited personnel, and technical equipment (i.e. camera traps, box traps), survey and trapping activities followed a sequential order, with 1 to 4 study areas being monitored simultaneously over the period of 1 to 4 years.

Each study area has been surveyed with a different amount of effort over the entire course of the project. In order to define more precisely the boundary and the surface of the surveyed study areas each year, we selected the cells of a 3x3 km grid containing the transects and camera trap locations. Moreover, to express the intensity of the survey, each study area has been categorized as *primary*, *secondary,* and *additional* (Figure 3).

A *primary study area* is an area in which the majority of the effort is concentrated. A study area can be, simultaneously, primary for the survey activity and secondary for trapping activity, or vice versa.

A *secondary study area* is an area in which activities are performed with lesser extent than primary study areas.

Additional study areas are areas opportunistically surveyed, with a minimal effort (few visits, explorative approach). This area might be considered as “area under evaluation” and it

can be raised to primary or secondary rank in case it will be evaluated as logistically good both for survey and capture activities.

The rank, as primary, secondary or additional study area, has been decided considering the situation at a given time. The rank of each study area, for both survey and capture activities, across the years is described in Figure 4.

Figure 3. Diagram depicting how the study areas were categorized according to various survey and capture efforts (blue rectangle, primary study area; orange rectangle, secondary study area; green rectangle, additional study area).

Winter 2017-18

In the first winter season, the team was involved only in survey activities (ground survey, camera trapping), aiming to collect information on lynx distribution, abundance, movements, and activity.

During the winter 2017/18, the survey activity was carried out on three different sites with Lepșa being the *primary study area*, Bacău the *secondary study area* (where sporadic, explorative visits were carried out), while Vintileasca was an *additional study area* where occasional visits were performed (Figure 4).

Lepșa was delimited by 42 3x3 km cells and had a total surface of 378 km^2, Bacău by 26 cells (total surface 234 km^2), and Vintileasca by 15 cells (135 km^2).

A total of 58 camera trap stations were monitored and 1040 km of transects were patrolled on foot (Table 1, Figure 5).

Winter 2018-19

During the winter 2018/19, the survey activity was carried out on four different sites. Bacău was designated as the *primary study area* for the survey activity, while Lepșa was designated as *the secondary study area*. Vintileasca continued to be an *additional study area*, together wih another *additional study area* surveyed this winter: Dărmănești (Figure 4).

As far as the capturing activity is concerned, Lepșa was designated as the *primary study area*, while Bacău was designated as *the secondary study area*. Dărmănești was considered to be an *additional study area.*

A total of 44 camera trap stations were monitored and 1083 km of transects were patrolled on foot (Table 1, Figure 5).

The information collected during the previous season (winter 2017/18) allowed the identification of 5 locations for the live capture of lynx in Lepșa**.** A strong collaboration between ACDB and hunting district managers (RNP Romsilva and regional wildlife management units) has been established in some areas since the beginning of the project. As such, additional trapping sites were identified in Bacău and a new area (Dărmănești) has been included in the project (Table 1, Figure 5). Their support during monitoring and capture activities proved to be extremely valuable for the project's future success.

Bacău was defined by 52 3x3 km cells and had a total surface of 468 km^2, Lepșa by 22 cells (total surface 198 km^2), Vintileasca by 1 cell (9 km^2), and Dărmănești by 2 cells (18 km^2).

Winter 2019-20

During this season, most of the survey effort was carried out in Dărmănești. This site became the *primary study area*, while the amount of effort significantly decreased in Lepșa and Bacău (*secondary study areas*). A new *additional study area* was identified in Neamt County, Tarcău.

As far as the capturing activity is concerned, Lepșa was designated as the *primary study area*, while Bacău was designated as *the secondary study area*. Dărmănești was considered to be an *additional study area.*

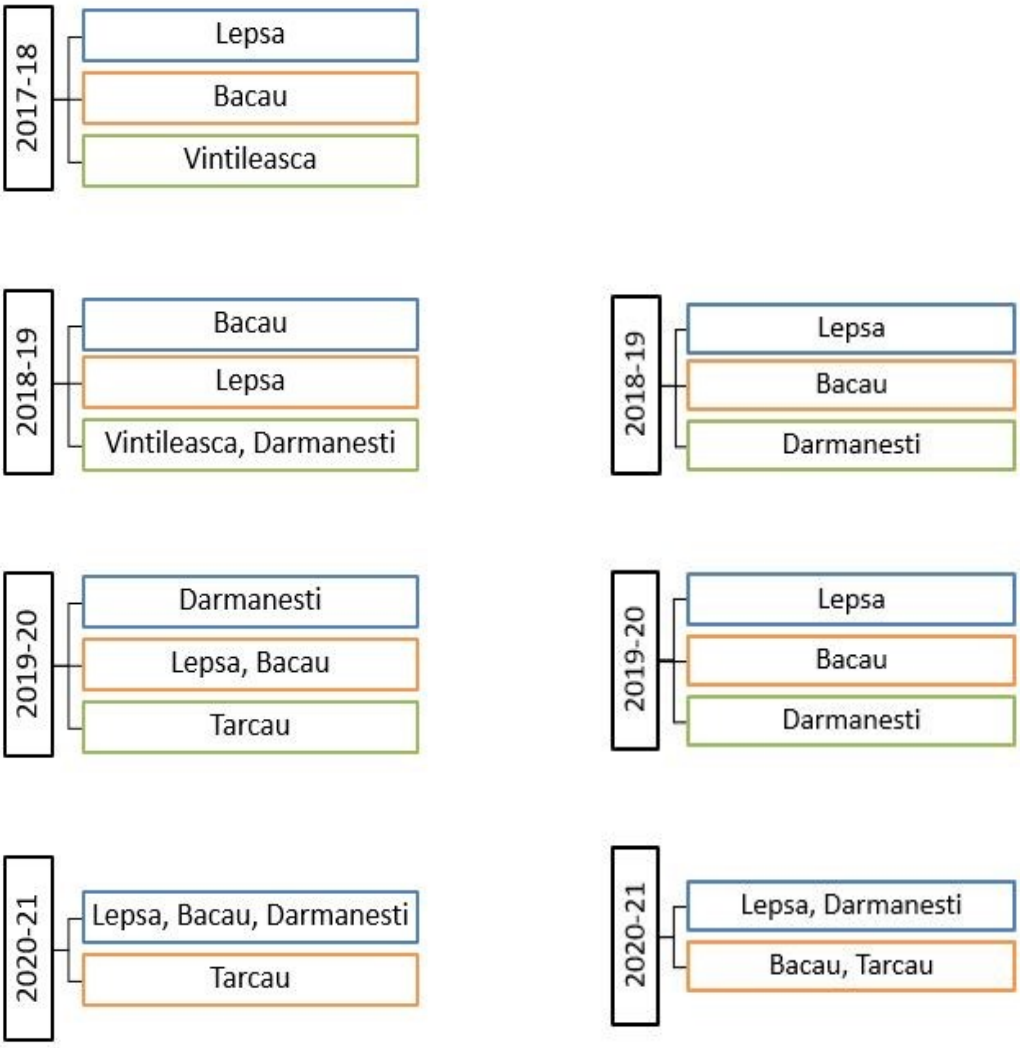
A total of 34 camera trap stations were monitored and 555 km of transects were patrolled on foot (Table 1, Figure 6). Moreover, at the beginning of the capture season, 11 box traps were set and activated in three study areas (Lepșa, Bacău, and Dărmănești).

Winter 2020-21

During the winter 2020-21, a higher survey effort was planned for Lepșa, Bacău, and Dărmănești, while a minimum effort was guaranteed in Tarcău.

As far as the capturing activity is concerned, Lepșa and Dărmănești were designated as the *primary study areas*, while Bacău and Tarcău were designated as *the secondary study areas*.

At the beginning of the capture season, a total of 8 box traps were activated in the four study areas. A total of 75 camera trap stations were monitored and 1534 km of transects were patrolled on foot (Table 1, Figure 7).



Survey activity *Capture activity*

Figure 4. Diagram depicting the rank of each study areas (blue rectangle represents a primary study area; orange rectangle, secondary study area; green rectangle, additional study area) among the winter seasons per survey and capture activity.

Table 1. Winter survey and capture effort in each study area.

Study area	Method	2017/18	2018/19	2019/20	2020/21
Lepșa	*Ground survey*	800	495	39	665
	Camera trapping	32 (1898)	22 (2036)	7 (885)	44 (4401)
	Capture activity	/	7	6	2
Bacău	*Ground survey*	130	567	39	578
	Camera trapping	8 (477)	13 (950)	3 (794)	18 (1986)
	Capture activity	/	1	1	1
Vintileasca	*Ground survey*	110	21	/	/
	Camera trapping	15 (1005)	3 (525)	/	/
	Capture activity	/	/	/	/
Dărmănești	*Ground survey*	/	/	477	277
	Camera trapping	/	3 (187)	21 (1025)	11 (926)
	Capture activity	/	3	2	3
Tarcău	*Ground survey*	/	/	/	14
	Camera trapping	/	/	3 (310)	2 (132)
	Capture activity	/	/	/	2

*Ground survey effort is expressed as: the total number of kilometres patrolled on foot. Camera trapping effort is measured as: the total number of devices set in the field and the total number of working days (this value is reported in brackets). Capture activity effort is represented as: the total number of armed box traps.

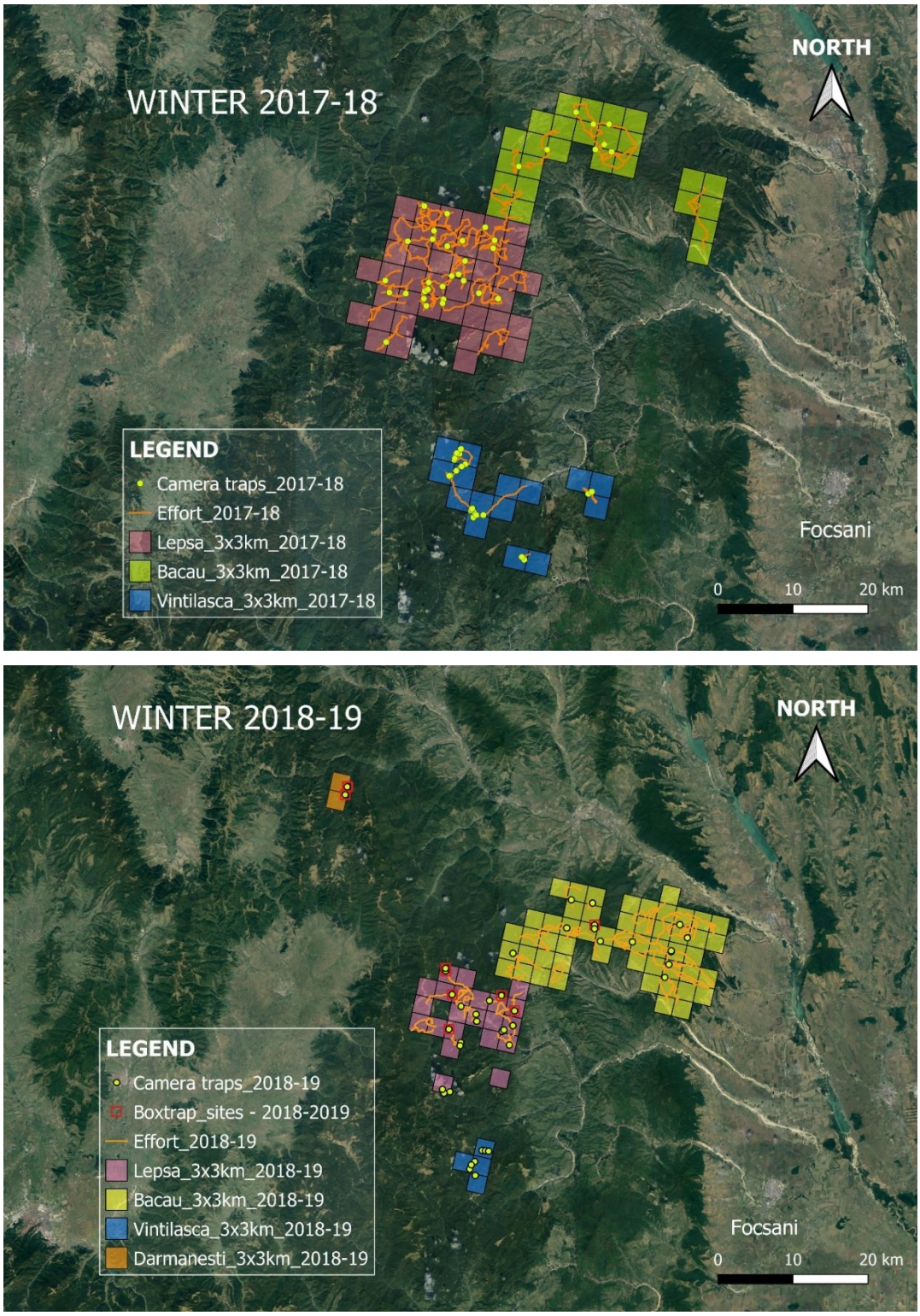


Figure 5. Winter survey and capture effort in each study area – winter 2017-18; winter 2018-19. The orange lines represent the transects performed on foot, yellow dots represent the camera trap stations. The red squares are the box traps that were active during the winter.

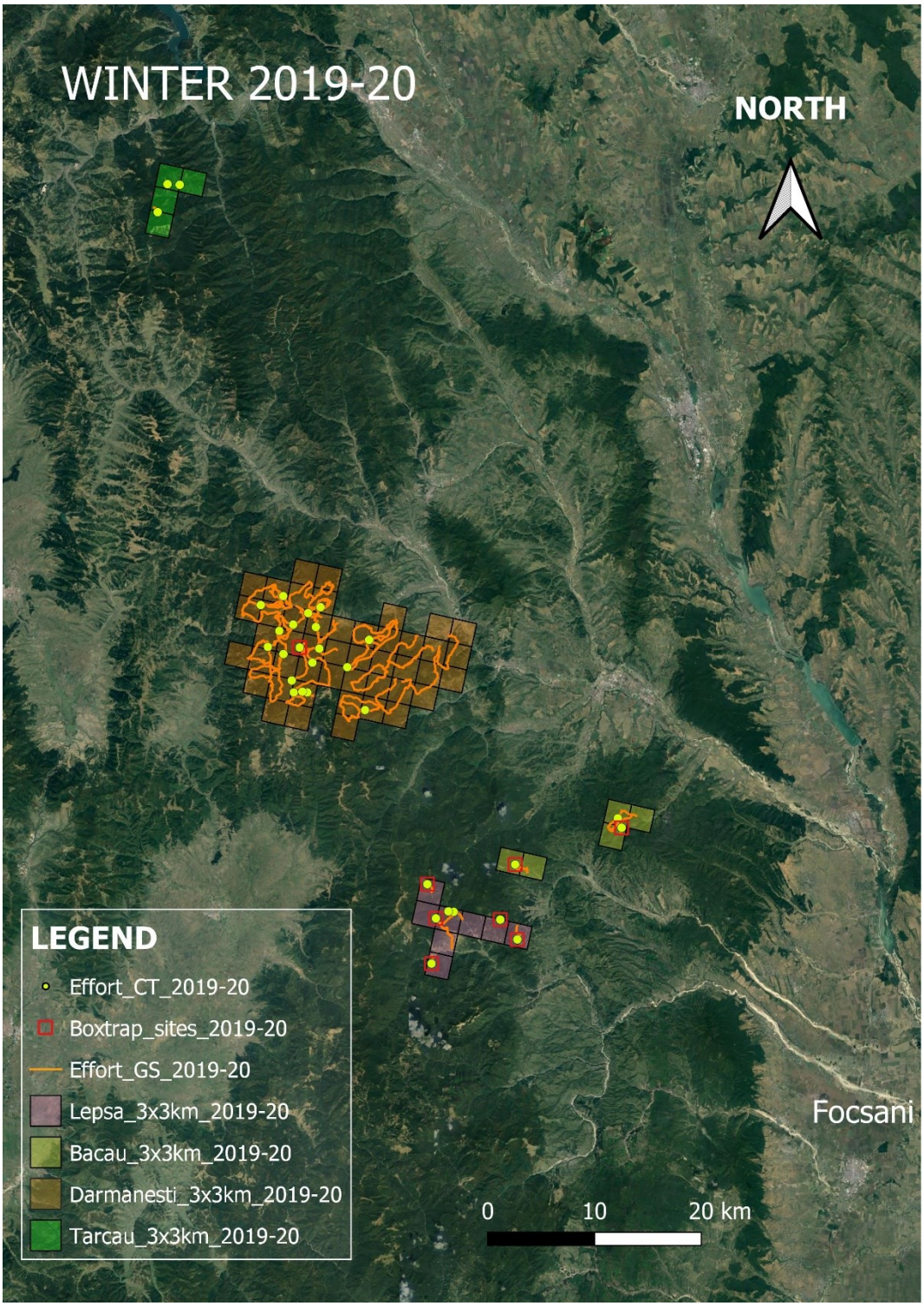


Figure 6. Winter survey and capture effort in each study area – winter 2019-20. The orange lines represent the transects performed on foot, yellow dots represent the camera trap stations. The red squares are the box traps that were active during the winter.

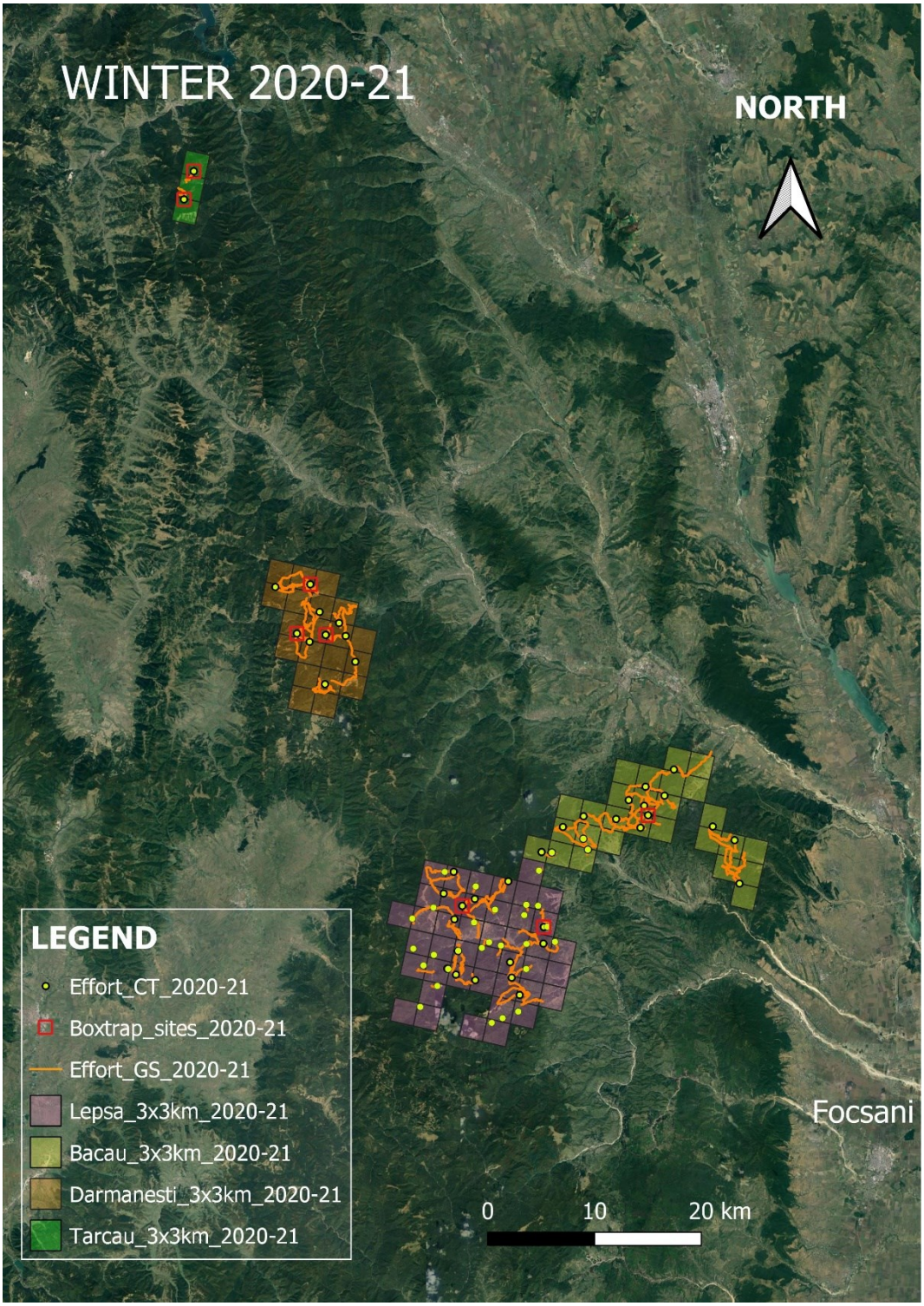


Figure 7. Winter survey and capture effort in each study area – winter 2019-20. The orange lines represent the transects performed on foot, yellow dots represent the camera trap stations. The red squares are the box traps that were active during the winter.

Additional data

Spatial data from two individuals radiocollared and released in situ

Due to the fact that there was a special interest to capture female lynx for the project in 2020-21 (releasing pairs in order to create a stepping stone between the Alps and the Dinarics, Action C4), which so far seem to have had a lesser likelihood to get cought than males, two GPS collars were made available by the Slovenian partners to release surplus males in situ.

The collars are from Vectronic Aerospace, both of the type VERTEX Lite with Internal Drop Off (programmed to one year) as well as Cotton Belt Break Away in case of malfunction of the drop off. One collar is using the Iridium-Satellites and the other one the GSM-Satellites for transmission. Both were set to collect two locations per day (9pm and 3am) and to send this information every 4 days.

Two times it came to in situ releases in 2020-21. Both males where cought in Bacău study area, at the same box trap.

The first event took place on the 24th of January 2021. At the time of capture, the adult male was about 4 years old, had a weight of 24 kg and was in a very good overall health condition. It was microchipped and equipped with the Iridium GPS-collar.

Figure 8. RO7 – the first male caught on the 24th of January 2021 and realeased in situ in Bacău study area (photo Andrea Gazzola).

The second event took place on the 29th of January 2021. At the time of capture, the adult male was about 2-3 years old, had a weight of 19,3 kg and was in a good overall health condition. It was microchipped and equipped with the GSM GPS-collar.

The collected data is providing additional and more detailed monitoring information about the lynx movement and spatial use of the territory within and between the study areas Bacău and Lepșa.

Figure 9. RO8 - the second male caught on the 29th of January 2021 and realeased in situ in Bacău study area (photo Bogdan Kraft).

Genetic analysis of the biological samples collected during the ground survey

The collection of non-invasive genetic samples followed an opportunistic sampling strategy and occurred mainly during the snow-tracking activity.

During the entire period (2017-2021), 79 biological samples have been collected: 22 lynx scats, 30 hair, 22 urine, 5 saliva samples.

Information on procedures for collecting samples and preserving the genetic materials are reported in the specific manual "Collecting lynx non-invasive genetic samples. Instruction manual for field personnel and volunteers" (Skrbinšek, 2017).

The aim of the genetic analyses performed within this specific action of the LIFE Lynx project is to obtain information on: genotype, sex, and relatedness of the individuals. Based on this information it is possible to measure some demographic parameters, such as: distribution, minimum number of individuals, population structure by gender, survival and dispersal rates.

RESULTS

Distribution

Winter 2017-18

Lepșa, Bacău and Vintileasca study areas

The total number of signs collected during ground surveys was 143, while the total number of videos with lynx was 57 during the first year of the project.

In Lepșa, lynx presence was recorded in 18 of the 42 3x3 km cells that were surveyed, accounting for 43% (169 km^2) of the total area (Figure 10, Table 2). In Bacău, lynx presence was recorded in 8 of the 26 3x3 km cells that were surveyed, accounting for 31% (279 km^2) of the total area. In Vintileasca, lynx presence was recorded in 3 of the 15 3x3 km cells that were surveyed, accounting for 20% (27 km^2) of the total area.

Winter 2018-19

Lepșa, Bacău, Vintileasca and Dărmănești study areas

The total number of signs collected during groung surveys was 138, while the total number of videos with lynx was 91 during the second year of the project.

In Lepșa, lynx presence was recorded in 12 of the 22 3x3 km cells that were surveyed, accounting for 54% (108 km^2) of the total area (Figure 10, Table 2). In Bacău, lynx presence was recorded in 13 of the 52 3x3 km cells that were surveyed, accounting for 29% (117 km^2) of the total area. In Vintileasca, lynx presence was recorded in the one cell surveyed.

Winter 2019-20

Lepșa, Bacău, Dărmănești and Tarcău study areas

The total number of signs collected during ground surveys was 74, while the total number of videos with lynx was 125 during the third year of the project.

In Lepșa, lynx presence was recorded in 5 of the 8 3x3 km cells that were surveyed, accounting for 62% (45 km^2) of the total area (Figure 11, Table 2). In Bacău, lynx presence was recorded in 3 of the 5 3x3 km cells that were surveyed, accounting for 60% (27 km^2) of the total area. In Dărmănești, lynx presence was recorded in 21 of the 46 3x3 km cells that were surveyed, accounting for 46% (189 km^2) of the total area. In Tarcău, lynx presence was recorded in 2 out of 3 cells surveyed (18 km^2).

Winter 2020-21

Lepșa, Bacău, Dărmănești and Tarcău study areas

The total number of signs collected during ground surveys was 158, while the total number of videos with lynx was 449 during the fourth year of the project.

In Lepșa, lynx presence was found in 29 of the 42 3x3 km cells that were surveyed, accounting for 69% (261 km^2) of the total area (Figure 12, Table 2). In Bacău, lynx presence was found in 21 of the 27 3x3 km cells that were surveyed, accounting for 78% (189 km^2) of the total area. In Dărmănești, lynx presence was found in 10 of the 20 3x3 km cells that were surveyed, accounting for 50% (90 km^2) of the total area. In Tarcău, the lynx presence was found in 2 out of 3 cells surveyed (18 km^2).

Table 2. Lynx signs (excrement, urine, hair, trail, direct observation), videos with lynx, and individuals captured in each winter season, between 2017-2021, in each of the five study areas.

Study area	Lynx presence	2017/18	2018/19	2019/20	2020/21
Lepșa	*No. of signs*	109	65	2	58
	No. of videos	21	25	22	277
	No. of animals captured	/	1	1	0
Bacău	*No. of signs*	32	72	1	66
	No. of videos	24	63	80	140
	No. of animals captured	/	1	2	3
Vintileasca	*No. of signs*	2	1	/	/
	No. of videos	9	3	/	/
	No. of animals captured	/	/	/	/
Dărmănești	*No. of signs*	/	/	71	33
	No. of videos	/	0	9	20
	No. of animals captured	/	/	0	1
Tarcău	*No. of signs*	/	/	/	1
	No. of videos	/	/	14	12
	No. of animals captured	/	/	/	1

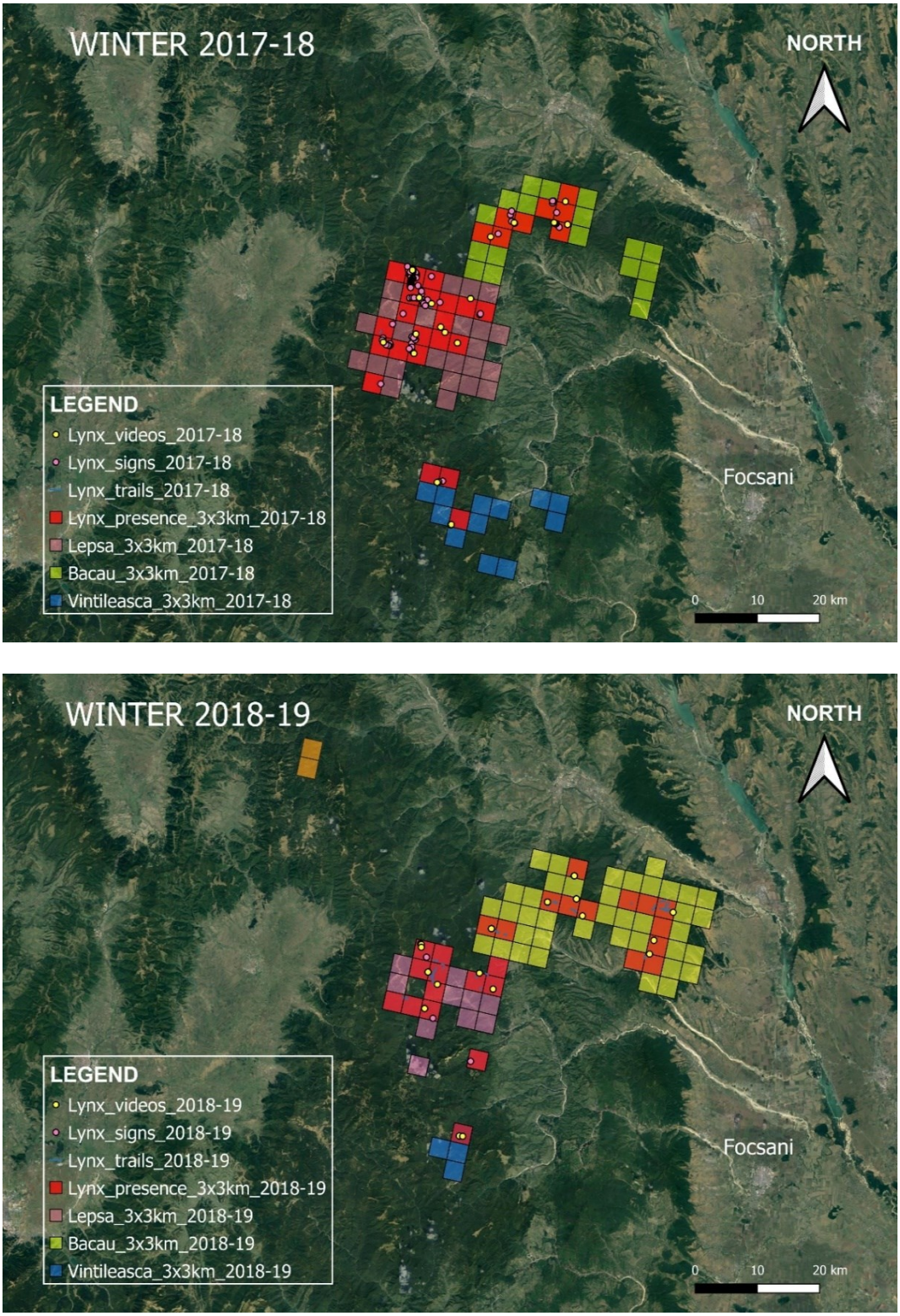


Figure 10. Spatial distribution of lynx based on presence signs (excrement, urine, hair, trail, direct observation-incuding captured animals, and videos) in the winter seasons of 2017-18 and 2018-19. In red are the cells of the 3x3km grid with confirmed presence of lynx.

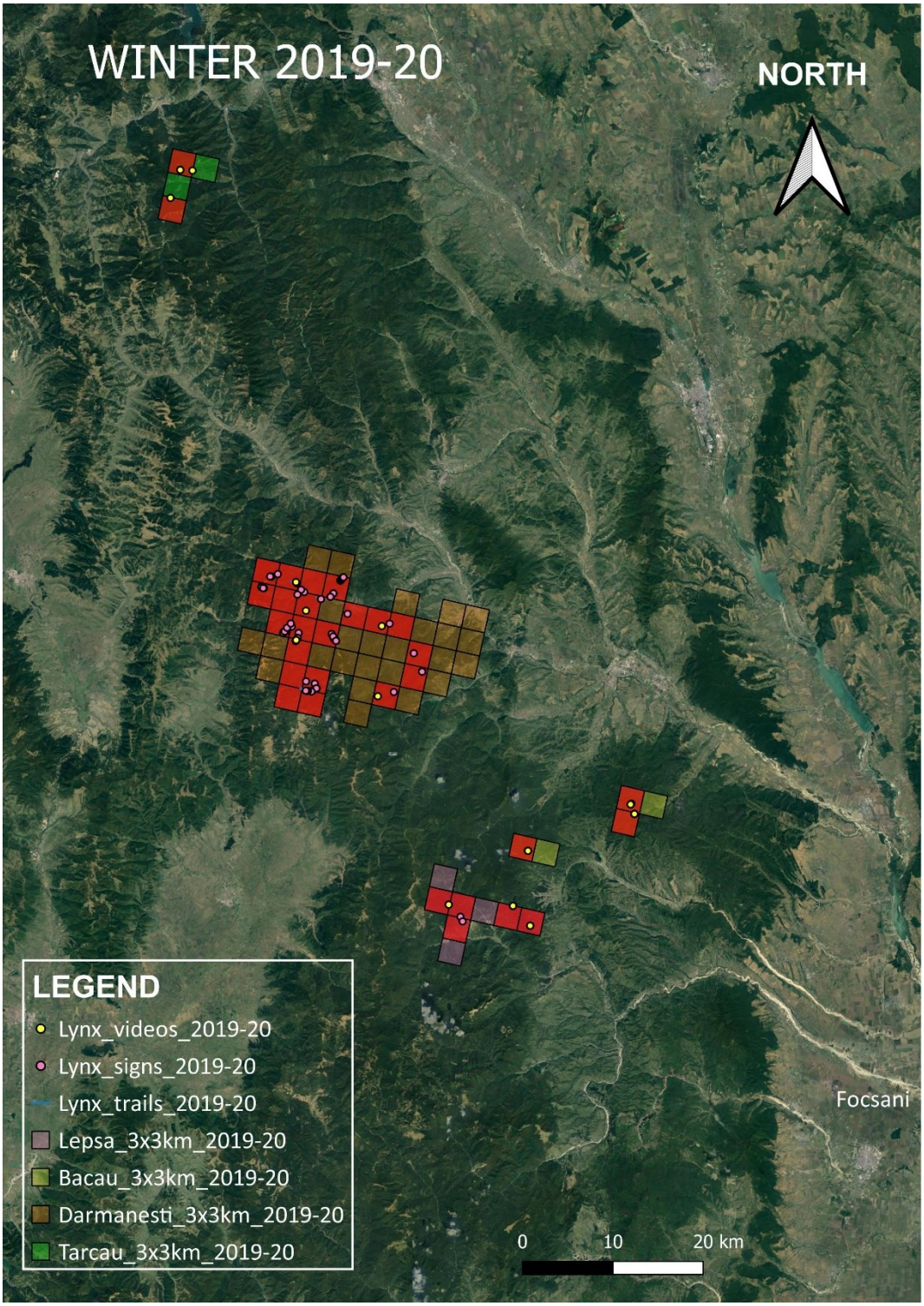


Figure 11. Spatial distribution of lynx based on presence signs (excrement, urine, hair, trail, direct observation-incuding captured animals, and videos) in the winter season 2019-20. In red are the cells of the 3x3km grid with confirmed presence of lynx.

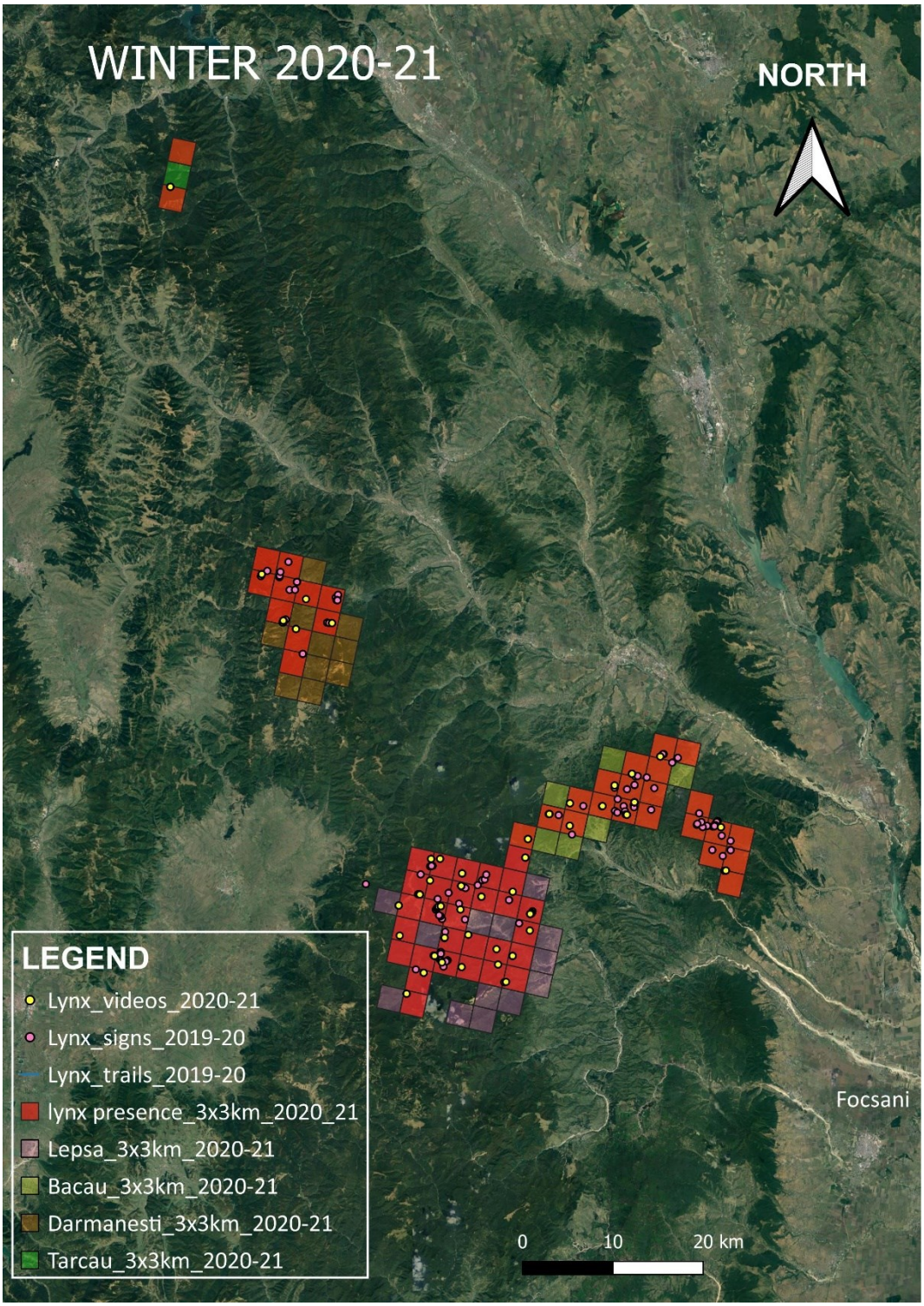


Figure 12. Spatial distribution of lynx based on presence signs (excrement, urine, hair, trail, direct observation-incuding captured animals, and videos) in the winter season 2020-21. In red are the cells of the 3x3km grid with confirmed presence of lynx.

Abundance

Winter 2017-18

Lepșa, Bacău and Vintileasca study areas

Lepșa had the highest lynx presence (five individuals), whereas Bacău and Vintileasca study areas each had two different lynxes. These results were observed after we compared the data from all the surveys (ground survey, camera trapping), and the results from the genetic analysis (Table 5, Figure 13). Ground survey and camera trapping yielded no information on females with or without kittens in any of the three study areas (Table 3). However, the genetic analysis of biological samples revealed the presence of at least two females in Lepșa (Table 5).

Winter 2018-19

Lepșa, Bacău, Vintileasca and Dărmănești study areas

In this second winter, we confirmed the same number of individuals as the previous season in Lepșa and Vintileasca (five and two individuals, respectively), while four individuals visited Bacău study area (Table 3, Figure 13). Furthermore, with the exception of Dărmănești, we collected evidence of females with kittens in all study areas. No ground survey was scheduled in Dărmănești. At that time, the area was surveyed opportunistically with camera traps placed in locations suggested by the local hunter; nonetheless, no videos with lynx were collected during winter 2018/19.

Winter 2019-20

Lepșa, Bacău, Dărmănești and Tarcău study areas

In this winter, the survey activity ended in Vintileasca and it was intensified in Dărmănești. Due to this increased effort, we collected videos/photos of three different individuals, and from snow-tracking we could confirm the presence of one female with two kittens. At the end of the season, two individuals were found dead by hunters. Images of one of the two individuals were provided by the local hunters and it appears that the animal found dead was never recorded by our camera traps.

The minimum number of individuals found in Lepșa and Bacău was four and five, respectively. The presence of lynx females was confirmed in both study areas. The survey effort in Tarcău led to the identification of three different individuals.

Winter 2020-21

Lepșa, Bacău, Dărmănești and Tarcău study areas

This winter, the survey effort in Lepșa and in Bacău study areas was increased, whereas in Dărmănești it was mantained high just in the sectors where a high concentration of lynx signs was found in the previous winter. In Tarcău study area we guaranteed only a low level of effort at the sites suggested by the local hunter.

Most likely as a consequence of the increased effort, a higher number of lynxes was recorded in the first two study areas, with six and five different individuals being observed in Lepșa and Bacău, respectively. In Dărmănești, we confirmed the presence of two individuals, whereas the presence of three lynxes was confirmed in Tarcău. With the exception of Tarcău, females with kittens were found in all study areas.

Table 3. Minimum number of different individuals, females with or without kittens, recognized from direct observations, photos/videos and individuals found dead in each study area per winter season

Study area	Lynx presence	2017/18	2018/19	2019/20	2020/21
Lepșa	*No. of animals detected*	3	3	4	6
	No. of females (with kittens)	nd	1 (2)	1	2 (2)
	No. of individuals found dead	0	0	0	0
Bacău	*No. of animals detected*	2	4	5	5
	No. of females (with kittens)	nd	1 (2)	1 (1)	2 (2)
	No. of individuals found dead	0	0	0	0
Vintileasca	*No. of animals detected*	2	2	/	/
	No. of females (with kittens)	nd	1 (2)	/	/
	No. of individuals found dead	0	0	/	/
Dărmănești	*No. of animals detected*	/	0	3	2
	No. of females (with kittens)	/	0	1 (2)	1 (2)
	No. of individuals found dead	/	0	2 *	0
Tarcău	*No. of animals detected*	/	/	2	3
	No. of females (with kittens)	/	/	nd	nd
	No. of individuals found dead	/	/	0	0

*information reported by the local hunter, we could analyse only the photos from one individual.

Table 4. Individuals caught in each study area per winter season.

Date of capture	Study area	Lynx ID	Name	Gender	Age class	Location of release
12.02.2019	Lepșa	RO1	Goru	male	5-6 years	Slovenia
27.02.2019	Bacău	RO2	Doru	male	4 years	Croatia
16.01.2020	Bacău	RO3	Catalin	male	5 years	Slovenia
20.01.2020	Lepșa	RO4	Alojzije	male	3-4 years	Croatia
25.01.2020	Bacău	RO5	Boris	male	1-2 years	Slovenia
22.01.2021	Dărmănești	RO6	Tris	male	4 years	Slovenia
24.01.2021	Bacău	RO7	/	male	4 years	Romania
29.01.2021	Bacău	RO8	/	male	2-3 years	Romania
13.02.2021	Bacău	RO9	Aida	female	2 years	Slovenia
09.03.2021	Tarcău	R10	Zois	male	2 years	Slovenia

Genetic analysis of the biological samples collected during the ground survey

The genetic analysis of biological samples collected during the ground survey provided additional information about the distribution and number of individuals in each study area.

During the winters of 2017-18 and 2018-19, five individuals were identified in Lepșa (winter 2017-18: two males, two females and one of unknown gender; winter 2018-19: four males and one female).

In Bacău, a smaller number was detected: one individual was identified in the first winter and a second new male has been identified in the following monitoring season (Table 5).

These results are based on DNA analysis of samples gathered throughout the first two seasons. In the near future, more information will be made available.

Table 5. Number of biological samples for genetic analysis collected during the survey activity and number of individuals genotyped in each study area.

Study area	Activity	2017/18	2018/19	2019/20	2020/21
Lepșa	*no. samples for genetic*	19	15	0	8
	no. of individuals	5	5	0	*in progress*
Bacău	*no. samples for genetic*	8	10	3	4
	no. of individuals	1	2	*in progress*	*in progress*
Vintileasca	*no. samples for genetic*	1	0	/	/
	no. of individuals	1	0	/	/
Dărmănești	*no. samples for genetic*	/	/	11	0
	no. of individuals	/	/	*in progress*	0
Tarcău	*no. samples for genetic*	/	/	/	/
	no. of individuals	/	/	/	/

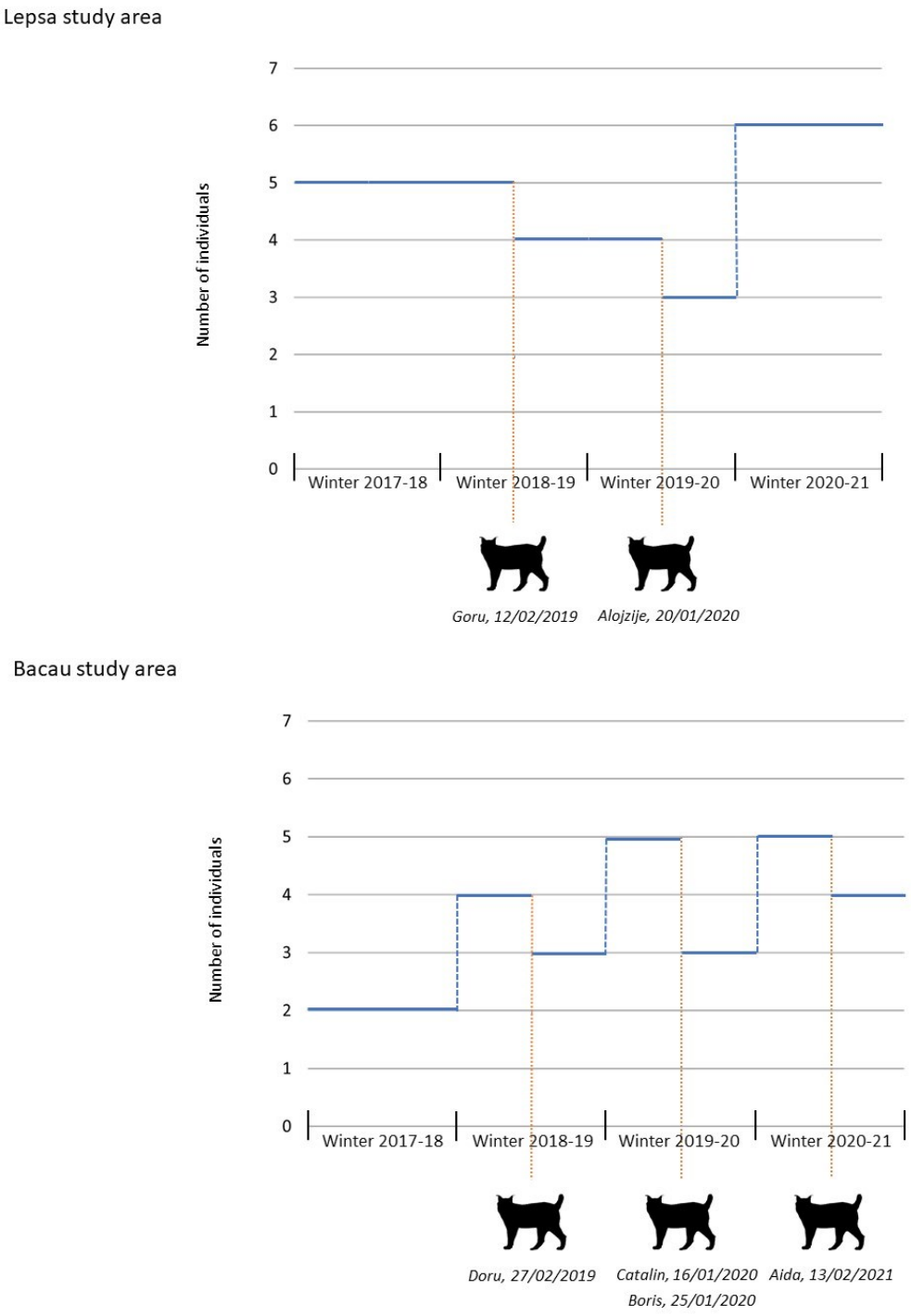


Figure 13. Trend of the minimum number of different individuals recognized from direct observations, photos/videos, and genetic analysis in Lepșa and Bacău study areas through the four winter seasons.

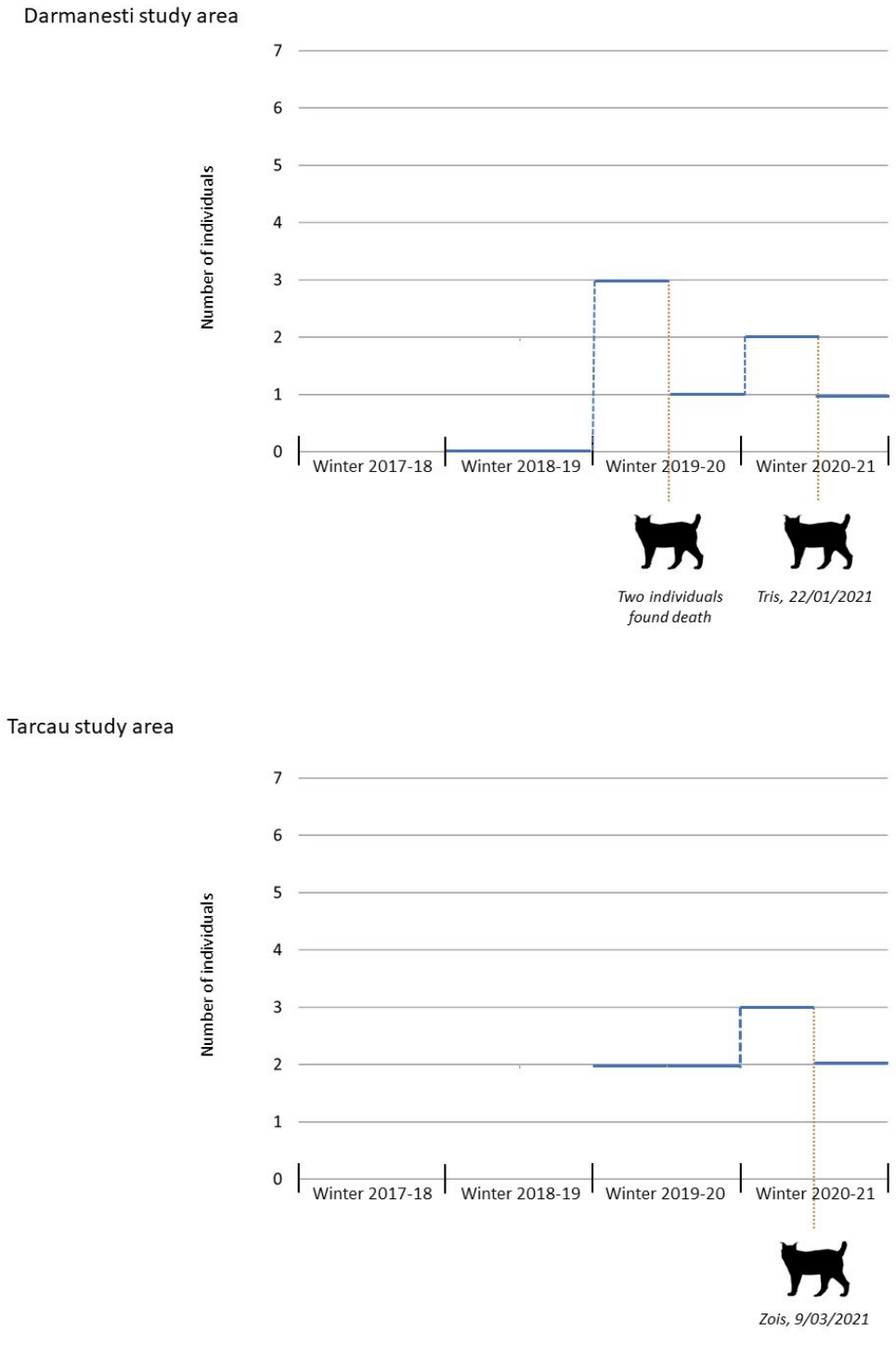


Figure 14. Trend of the minimum number of different individuals recognized from direct observations, photos/videos, and genetic analysis, in Dărmănești and Tarcău study areas through the four winter seasons.

Activity

Winter 2017-18

Lepșa, Bacău and Vintileasca study areas

In the first season, the values of the three parametres were lower in Lepșa and Vintileasca than in Bacău study area (Table 6). These outcomes could be explained by the fact that we used different survey approaches to select the CT stations. In Bacău study area, the CT stations were choosen based on information provided by a local hunter, whereas the locations in the other two study areas, with the exception of a few spots, were chosen at random.

The CT rate index value varied between stations in each study area (Figure 15), and it was very useful in determining where the box traps should be placed.

Winter 2018-19

Lepșa, Bacău, Vintileasca and Dărmănești study areas

The values of the three parametres followed the same pattern as in the previous season, with Lepșa and Vintileasca having lower values than the Bacău study area (Table 6). The survey effort increased in Bacău whereas it decresead in Lepșa and Vintileasca study areas. Nonetheless, as we observed the previous season, the CT rate index values at the box traps sites were also high in this season (Figure 15).

Winter 2019-20

Lepșa, Bacău, Dărmănești and Tarcău study areas

In this season, the survey activity was reduced to a few spots in Bacău and Lepșa study areas, focusing primarly on the box trap sites, and was not carried out in Vintileasca study area (the activities were last carried out in 2018-19, so they ended then and were already finished in 2019-20) (Table 6; Figure 16). In Dărmănești study area, on the other hand, the effort increased considerably and we started to conduct an opportunistic survey in Tarcău. Here, the locations of the CT stations, as in the first winter in Bacău, were chosen based on the information provided by a local hunter.

In Dărmănești, we adopted the same random strategy that was used in the Lepșa study area during the first winter. The results obtained during this season were fundamental in the selection of future box trap sites.

Winter 2020-21

Lepșa, Bacău, Dărmănești and Tarcău study areas

In this season, we increased the survey effort in the areas where the lynxes had been captured in the previous years (Lepșa, Bacău). The survey activity in Dărmănești and Tarcău was limited to sectors where lynx was found the previous season (Table 6, Figure 17).

The sites with the high CT rate index values in prior years also had the high CT rate index values this year. However, two additional activity centers were detected in Lepșa, one in the south-west part of the study area and the other in the north (Figure 17).

Table 6. Lynx activity based on camera-trapping data

Study area	Activity*	2017/18	2018/19	2019/20	2020/21
Lepșa	$LYNX_{CT}$	10 (31,2%)	7 (43,7%)	3 (42,8%)	31 (72,1%) #
	$LYNX_{V}$	21 (2,4%)	25 (5,6%)	22 (10,1%)	35 (2,4%) **
	CT rate index	1 (0 - 6,9)	0,7 (0 – 2,4)	1,4 (0 – 7,5)	2,3 (0 – 26,1) #
Bacău	$LYNX_{CT}$	5 (62,5%)	8 (61,5%)	3 (100%)	10 (66,6%) #
	$LYNX_{V}$	24 (4,9%)	63 (6,9%)	80 (16,3%)	137 (5,5%) **
	CT rate index	2,3 (0 – 4,4)	4,4 (0 – 13,6)	3,9 (0,9 – 8,6)	4,9 (0 – 29) #
Vintileasca	$LYNX_{CT}$	3 (20%)	2 (66,6%)	/	/
	$LYNX_{V}$	9 (2,2%)	3 (4,4%)	/	/
	CT rate index	0,5 (0 – 2,9)	0,6 (0 – 1,1)	/	/
Dărmănești	$LYNX_{CT}$	/	0	5 (29,4%)	5 (45,4%)
	$LYNX_{V}$	/	0	9 (1,8%)	10 (2,2%)
	CT rate index	/	0	0,9 (0 – 6,7)	1,9 (0 – 8,8)
Tarcău	$LYNX_{CT}$	/	/	3 (100%)	1 (50%)
	$LYNX_{V}$	/	/	14 (24,1%)	12 (11,7%)
	CT rate index	/	/	4,5 (1,1 – 8,7)	3 (0 – 10,8)

*Activity is described based on three approaches: 1) $LYNX_{CT,}$ the number of stations having lynx presence per study area, as well as their fraction of the total number of stations (value between the brackets); 2) $LYNX_{V}$, the number of lynx videos per study area and its percentage of the total number of videos (value between the brackets); 3) *CT rate index,* the (camera) trapping rate index (no. of independent lynx videos per camera trap days x 100): average and range (min-max).

University of Bucharest and LifeLynx data cumulated, ** data from LifeLynx.

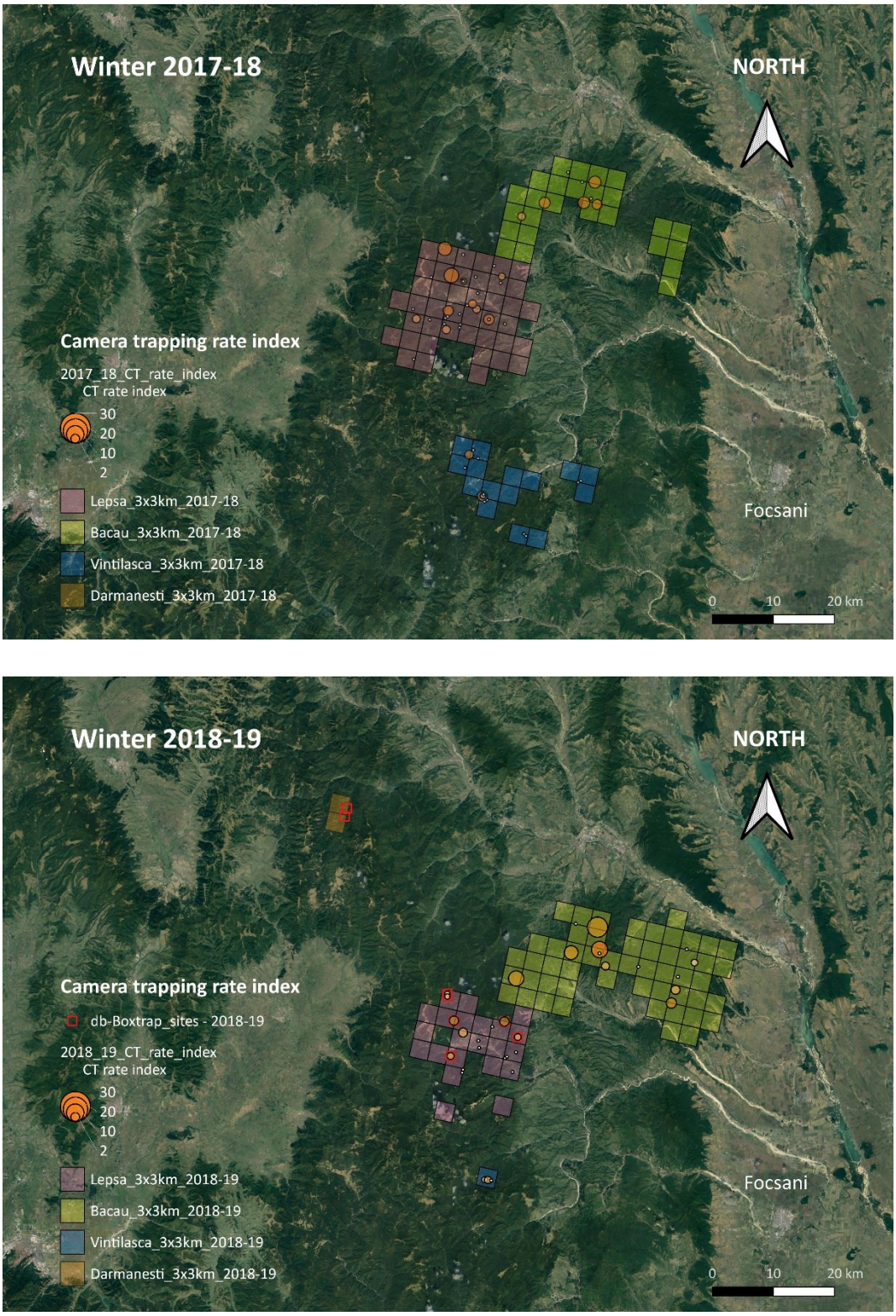


Figure 15. Distribution of the camera trap stations and their (camera) trapping rate index – winter 2017-18; winter 2018-19. The diameter of the circle is proportional to the index value. The white dots represent the stations where there were no lynx observations. The red squares represent the box traps active during the trapping season.

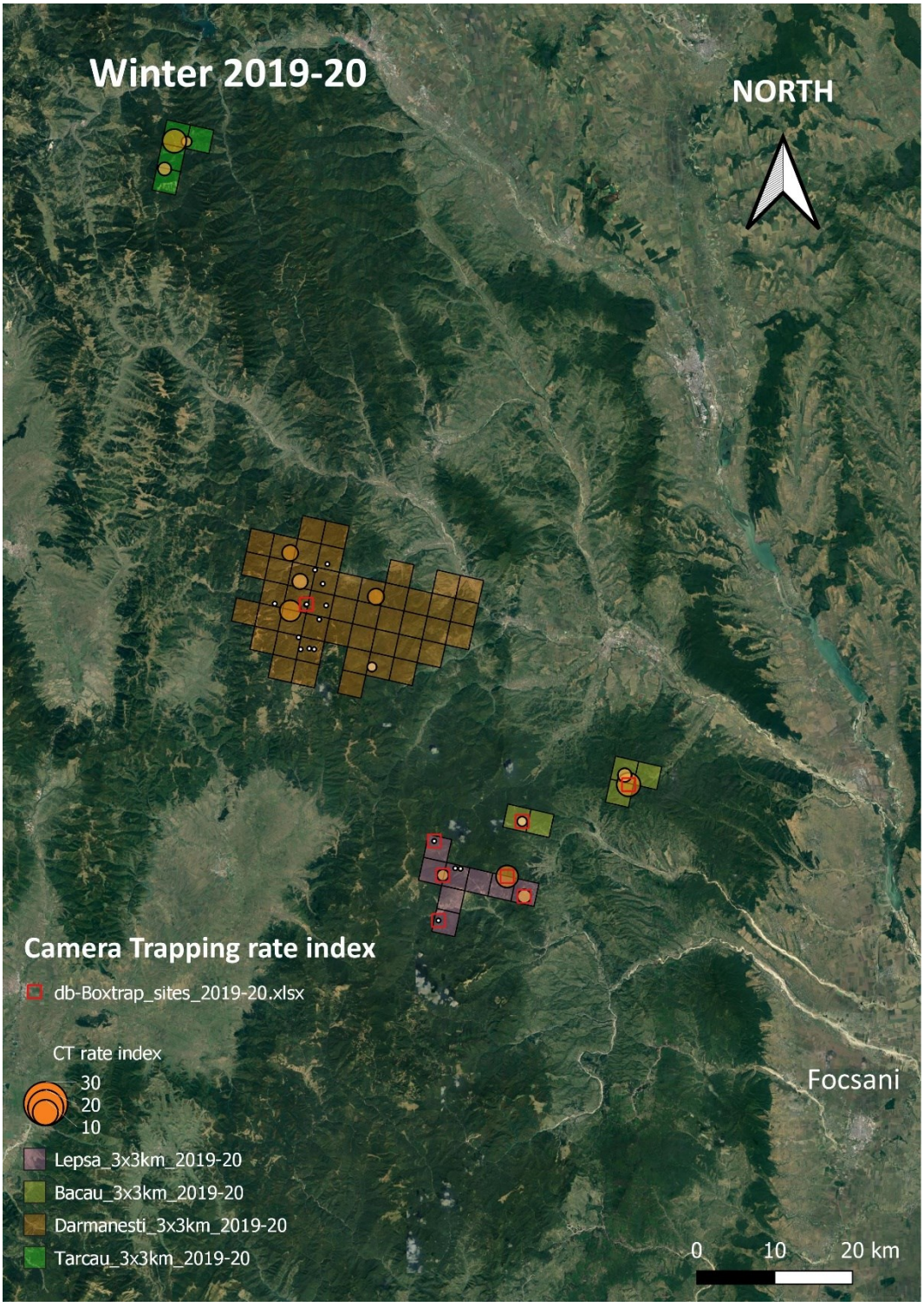


Figure 16. Distribution of the camera trap stations and their (camera) trapping rate index – winter 2019-20. The diameter of the circle is proportional to the index value. The white dots represent the stations where there were no lynx observations. The red squares represent the box traps active during the trapping season.

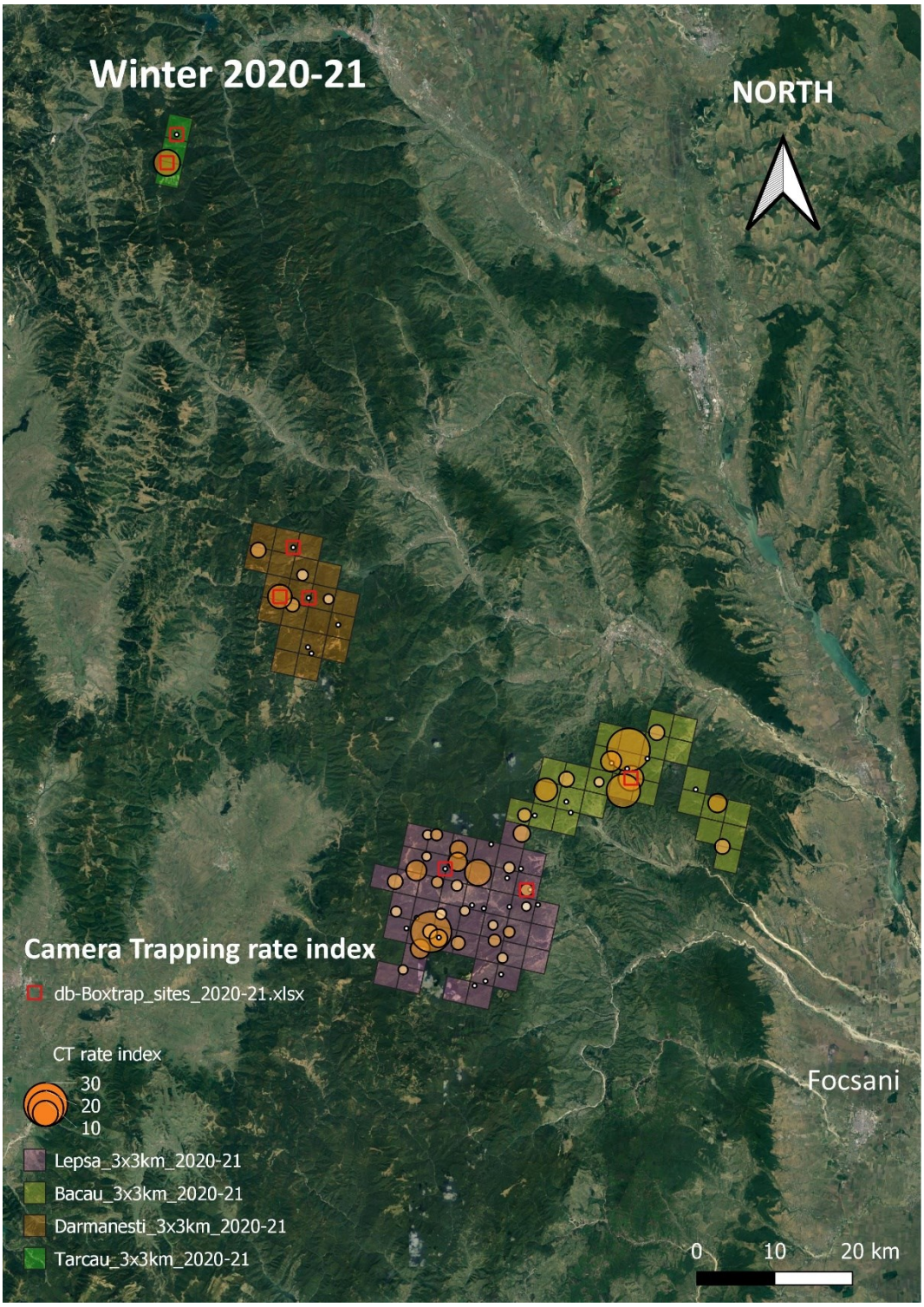


Figure 17. Distribution of the camera trap stations and their (camera) trapping rate index – winter 2020-21. The diameter of the circle is proportional to the index value. The white dots represent the stations where there were no lynx observations. The red squares represent the box traps active during the trapping season.

Additional data

Spatial locations from two individuals radiocollared and released in situ

During winter 2020-21 two males where cought in Bacău study area, at the same box trap. The first event took place on the 24th of January 2021 (Lynx RO7), while the second took place on the 29th of January 2021 (Lynx RO8). The collected data is providing additional and more detailed information about the lynxes movement and teritorry use within and between the study areas Bacău and Lepșa. Since the moment of capture until the end of June, the two individuals traveled long distances across this mountain region (Figure 18). Lynx RO7 (Collar 33094) covered over 700 km^2 in March (MCP_{march} = 739 km^2) and significantly less in the rest of the months (i.e. February, April, May, June) ($MCP_{average}$ = 118 km^2, range 71-149 km^2). RO7 spent the majority of his time in Bacău study area, although he also went for short periods in the nearby Lepșa study area (41 km-*as the crow flies*- between the outermost locations in its March MCP), most likely in search of a mate. The second animal, RO8 (Collar 40571), stayed mostly in Bacău study area's southern sectors. Lynx RO8 covered a smaller area in March (MCP_{march} = 467 km^2), but had a larger overall home-range than RO7 in the rest of the months (i.e. February, April, May, June) ($MCP_{average}$ = 235 km^2, range 154-367 km^2). The longest distance (*as the crow flies)* between RO8s' outermost locations was 28 km.

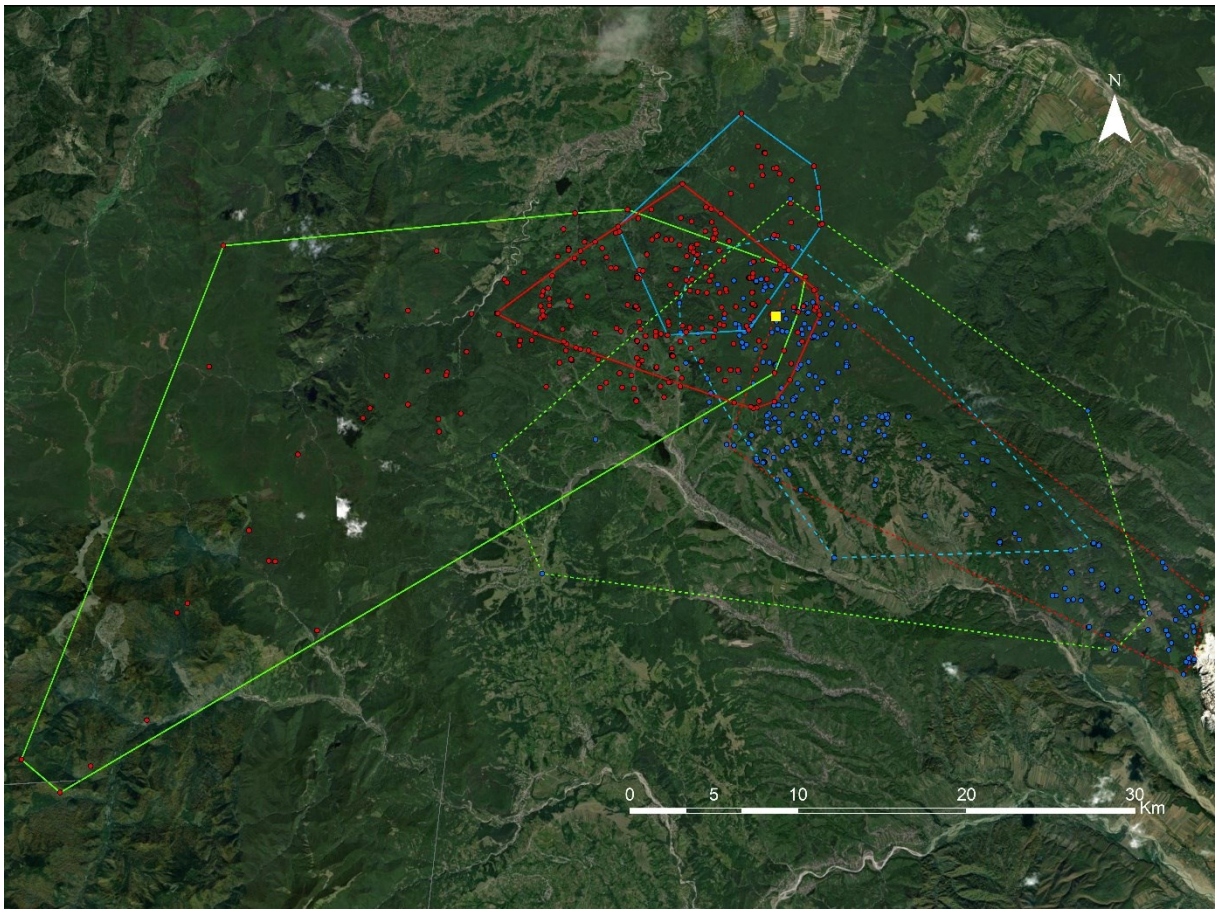


Figure 18. Data from telemetry collars of the two lynxes caught in Bacău study area and released in situ (period of transmission: January-June). The yellow square shows the location of the box trap where the lynxes were caught. The dots show the GPS locations of the two lynxes (red dots RO7; blue dots RO8). The polygons show the lynxes' MCPs (continuous line RO7; dashed line RO8) during winter (light blue), spring (light green), and summer (red).

CONCLUSIONS

The aim of this report is to provide comprehensive information about the *distribution*, *abundance*, and *activity of lynx* within the chosen study areas in Romania. This information was and will be used to determine the best places for the live capture of animals and to decide how many individuals can be removed from a certain study area without compromising the local population.

The evaluation of the effects of lynx removal for translocation purposes on the source populations will provide general information for similar projects in the future.

Distribution

Depending on the year and study area, lynx presence was confirmed in between 20 to 78% of the surveyed 3x3km cells. Taking into account the different levels of monitoring intensity per surface area (e.g. bad conditions for snow tracking in 2019-20; additional camera trap data from another project in 2020-21) and the fact, that in some cells lynx presence could be proven in some years and not the next and vice versa, it can be concluded that lynxes are well distributed over the whole surveyed area.

Abundance

Overall, the minimum number of detected individuals and family groups rises over the years due to a higher monitoring effort and a better knowledge of the areas and the animals' behaviour. This results also in, on average, higher trapping indexes at the camera trap locations. The snow-tracking results are also influenced by snow conditions (e.g. generally less and just in higher altittudes in 2019-20).

In 2020-2021, six lynxes were confirmed in Lepșa, five in Bacău, two in Dărmănești, and three in Tarcău. Except for Tarcău, in the last three seasons lynx reproduction (females with kittens) was confirmed in all the remaining study areas where trapping occurred (Bacău, Lepșa and Dărmănești).

While it has been shown, in Lepșa and Bacău study areas, that the minimum number of detected animals bounces back after the extraction of individuals (Figure 13), next years' survey will have to show whether the same is true in Dărmănești and Tarcău study areas (Figure 14).

Activity

The number of camera-trap stations, as well as the total survey effort improved over the years in the areas where the live-capture effort was focused (except Tarcău). As such, the data gathered was sounder and ensured better identification of the lynxes present in/using the study areas.

Bacău study area shows usually the highest CT rate index as well as highest number of videos with lynx, even so it does not necessarily have the highest number of camera trapping stations. This shows the importance of finding a marking spot frequently visited by lynx to monitor their activity, such as the main capture site in Bacău-where six out of 10 lynxes were captured. This also shows the importance of good cooperation with the local factors involved in wildlife monitoring, as that location was first suggested by a local hunter.

The data of the collared lynxes emphasized the importance of this spot, with both animals staying close to it after their capture and release. And even though they are both males, their territories appear to overlap in that area of high lynx activity.

While the overall monitoring effort has a big effect on the detection of lynx presence, the success of the live-capture and activity monitoring seems to be more connected to the knowledge about marking spots of lynx (most catches and recorded activity at one location with high intensity of lynx marking activity).

To evaluate the abundance of lynx, the angle and quality of the pictures from camera traps is very important. Due to the fact that in this study most camera traps were recording videos, not taking pictures (i.e. lower probability of getting good quality images needed for individual recognition), it is likely that the number of identified individuals was lower.

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