REPORT ON THE PROJECT

"POPULATION AND CONSERVATION STATUS OF THE TURKESTAN LYNX (*LYNX LYNX ISABELLINA* BLYTH, 1847) IN THE KAZAKH PART OF THE NORTHERN TIEN SHAN" (2019-2021)

ALMATY, 2021

CONTENT

INTRODUCTION

The development of industry and agriculture, as well as a significant increase in the world's population, have led to an increase in anthropogenic pressure on natural ecosystems, fauna and flora. In particular, human activities have precipitated habitat loss and fragmentation, followed by isolation, loss of genetic diversity, decline in population sizes and extinction of wild animals. Among vertebrates, large carnivorous mammals are more often threatened with extinction since they have lower population density and reproductive rates. Moreover, some of the main threats to carnivores can be due to people's prevailing negative attitude towards them, which may result in their direct or indirect extermination.

The Eurasian lynx (*Lynx lynx* L., 1758) is a felid species especially subjected to anthropogenic pressure. As a species that was widespread throughout Europe, it became extinct in the region in the 19th century due to habitat loss and persecution (Nowell and Jackson, 1996; Breitenmoser and Breitenmoser-Würsten, 2008). The lynx is still considered a rare or endangered species, even after its re-introduction in a number of countries (Kaczensky et al., 2012; Melovski 2012). The case of the disappearance of the lynx in Europe is a good example that indicates the need for measures to study and preserve this species and its subspecies in other habitats, taking into account the developing industry and intensive developing of natural areas.

The Turkestan lynx (*Lynx lynx isabellina* Blyth, 1847) is a rare subspecies of the Eurasian lynx which occupies the mountains of Central and South Asia. This lynx is rare and understudied in all 11 countries of its habitat. Internationally, the lynx is listed in Appendix II of the International CITES Convention. In Central Asia, the lynx is listed in the Red Data Book of Kazakhstan as "a rare subspecies, the range and number of which are decreasing" (III category, Red Data Book of Kazakhstan, 2010); Kyrgyzstan as a "subspecies close to a vulnerable position" (NT, VI category, Red Data Book of Kyrgyzstan); Uzbekistan as a "vulnerable subspecies" (II category – VU: D; Red Data Book of Uzbekistan, 2009); Turkmenistan as "an extinct or endangered species or subspecies" (Category I, Red Data Book of Turkmenistan, 1999); Tajikistan as an "endangered subspecies" (Red Data Book of Tajikistan, 2015); China as an "endangered subspecies" (EN A1cd) (Red Data Book of China, 2004); in Afghanistan, the lynx is considered "vulnerable" (Habibi, 2003; Biodiversity Profile of Afghanistan, 2008). In South Asia, the lynx is common in the northern part of Pakistan, where, according to K.M. Sheikh and S. Molur (2004), "causes Least Concern" (LC). However, the current status and distribution in Pakistan is unknown (Din and Nawaz, 2010), which confirms the need to update the Red Data Book of Pakistan (Sheikh and Molur, 2004; J.U. Din et al., 2015). In India, the lynx is on the verge of extinction (Chundawat & Rawat 1994; A. Kotia et al. 2011) and is listed in

Plan I – protected by the National Indian Wildlife Protection Act since 1972. The lynx is listed in the Red Data Book of Nepal as a “vulnerable subspecies” (Category Vulnerable B1a; D2; protected under the National NPWC Act 2029) (Jnawali et al., 2011). In Bhutan, there is no information available to determine lynx status (Data Deficiency).

The study is complicated by the inaccessibility of lynx’s habitats, as well as its secretive lifestyle. As it is exceedingly elusive, this form of lynx is poorly studied, including in Kazakhstan, where it inhabits in the mountains of the south and southeast of the country (Heptner, Sludskiy, 1972; Zhiryakov, 1995; Zhiryakov, Baidavletov, 2003).

In Kazakhstan, full-scale research on the Turkestan lynx has not been carried out and until now it remains the least studied felid. The distribution of this cat was studied in comparative detail by A.K. Fedosenko (1982), V.A. Zhiryakov (1995), V.A. Zhiryakov and R.Zh. Baydavletov (2003). Earlier works provide fragmentary data obtained along the way when studying other mammalian species (Shnitnikov, 1936; Ognev, 1940; Kuznetsov, 1948; Sludskiy, 1953, 1973).

Considering the main threats to the Turkestan lynx, such as habitat degradation and fragmentation, prey base depletion, poaching and conflict with livestock breeders (fur trade and retaliatory killings due to livestock depredation), it is urgent to conduct research, the results of which will contribute to the creation of conservation strategy of this rare subspecies. Thus, the first step towards conservation measures will be understanding the past and assess the current state of the Turkestan lynx populations and their conservation.

In this report, we present data on the current state of the population and the conservation status of the lynx in the Kazakh part of the Northern Tien Shan, based on the results of research conducted by us since 2013 and funded by the Rufford Foundation from 2019 to 2020.

Keywords: Turkestan lynx, *Lynx lynx isabellina*, Northern Tien Shan, distribution, subspecies, population, conservation status, camera traps.

RESEARCH OBJECTIVES:

1) Conduct an analytical review of the historical and present distribution, abundance, condition of the prey base, daily and seasonal activity of the Turkestan lynx in the Northern Tien Shan;

2) Use traditional and remote sensing methods to determine the distribution of lynx in the mountains of the Northern Tien Shan;

3) Evaluate the influence of the prey base and feeding habits of the lynx on the population’s spatial structure, daily and seasonal activity of the lynx;

4) Study the interspecific competition between the lynx and other carnivores;

5) Identify and assess the impact of the main threats, prepare recommendations for the conservation of the Turkestan lynx in the Northern Tien Shan mountains based on the results of the first year.

RESEARCH AREA

In order to clarify the modern distribution of the Turkestan lynx, we surveyed the mountain ranges located in the Kazakh part of the Northern Tien Shan – Ile Alatau (N43°03', E77°14'), Kungei Alatau (N42°57', E77°36'), Terskei Alatau (N42°46', E79°32') and Uzynkara (Ketmen) (N43°20', E80°40') (Figure 1). The ridges have a latitudinal or nearly latitudinal strike. In the Northern Tien Shan, the main habitats of the lynx are typically located on the northern macroslopes of the aforementioned ridges.

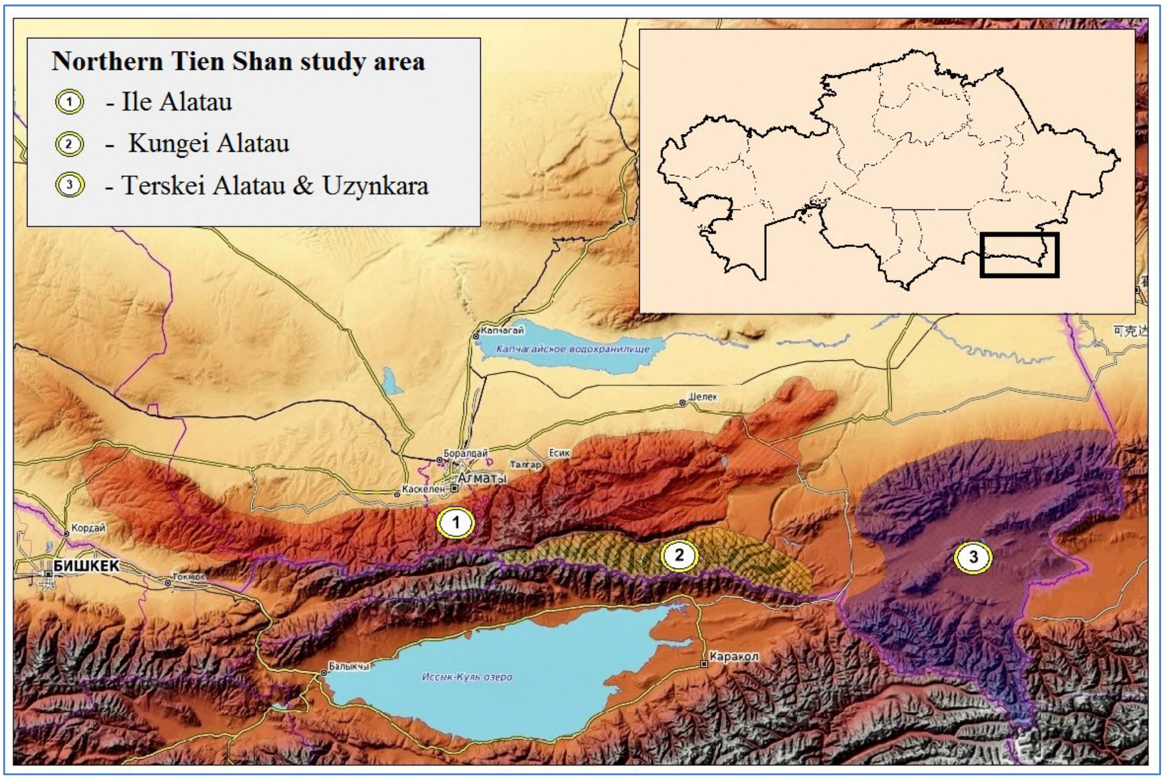


Figure 1 – Three survey areas in the Northern Tien Shan

Within the project area, horse-walking routes with a total length of about 626 km were laid and completed, with 335 km in the Ile Alatau, 185 km in Kungei Alatau, 74 km in Terskei Alatau, and 32 km in Uzynkara.

The climate in the mountains is continental; however, the complexity and vegetation of the relief cause contrasts in temperatures and the degree of moisture (Lukyanov, 2004). Thus, the average annual air temperatures in the Northern Tien Shan decrease to 6.5° C below zero (Vilesov et al., 2009); at the same time, the southern slopes of the ridges are 5-10° C warmer than the northern ones (Vukolov, 2006).

Most of the plant species are found in the mid-altitude mountain forest belt. Above 2000-2200 m, deciduous forests give way to spruce on mountain-forest dark-colored soils with a high (up to 10%) humus content (Mazirov et al., 2013). The most important component of the spruce forests on the northern slope of the Northern Tien Shan ridges is the endemic species, the Schrenk's spruce (*Picea shrenkiana*) (Kelgenbaev et al., 2016).

In addition to the Turkestan lynx, many other mammalian species inhabit the Northern Tien Shan. Among them, there are carnivores (potential lynx competitors), in particular, representatives of the family Cannidae – the wolf (*Canis lupus*), the fox (*Vulpes vulpes*), the family Ursidae – the Tien Shan brown bear, the Mustelidae – the short-tailed weasel (*Mustela erminea*), the least weasel (*Mustela nivalis*), stone marten (*Martes foina*), Asian badger (*Meles leucurus*), and Filidae – snow leopard (*Panthera uncia*), manul (*Otocolobus manul*). The lynx preys on the tolai hare (*Lepus tolai*), the Siberian roe deer (*Capreolus pygargus*), the grey marmot (*Marmota baibacina*), Siberian red squirrel (*Sciurus vulgaris exalbidus*), as well as the Siberian ibex (*Capra sibirica*), wild boar (*Sus scrofa*) and red deer (*Cervus elaphus*).

We conducted our research in three specially protected natural areas (PAs): Ile-Alatau State National Natural Park (SNNP), Almaty State Nature Reserve (SNR) and SNNP Kolsai Kolderi and in the adjacent territories (Figure A.1, see Appendix A).

MATERIALS AND METHODS

Records search and analysis

We searched extensively for observational records within our study area. The data used in this study were collected mainly from zoological and ecological reports of the Institute of Zoology of Kazakhstan and Specially Protected Natural Areas (PAs), zoological articles, books, conference materials, methodological manuals, etc. In order to determine the past state of populations and the distribution of lynx we frequently considered the data of Heptner Vladimir Georgievich, Sludskiy Arkady Aleksandrovich, Fedosenko Alexander Kirillovich, Zhiryakov Vladimir Alekseevich and Baidavletov Ryspek Zhaparkulovich. For modern distribution, we often used the records of the diaries of the inspectors (rangers) of protected areas. The reliability of all regions of lynx encounters, provided in scientific papers, were reviewed and verified. Thus, when the confirmed presence of lynx was indicated in one record, we included only the original source.

Field data collection methodology

During the study, we relied on traditional methods of field mammalogical research (Novikov, 1953; Breitenmoser et al., 2006), which included visual observations, identification of various lynx and its prey traces (paw and hoof prints, prey remains, faeces, scratches on trees and rocks, etc.) with their registration on the GPS (Figure 2).

Figure 2 – Visual observations and determination of lynx tracks (on the left – lynx in Prokhodnaya gorge; on the right – lynx paw prints, Middle Talgar gorge, Ile Alatau, December 2020)

Camera trapping

Investigations with the use of camera traps were carried out in specially protected areas – Almaty Nature Reserve, Ile-Alatau and Kolsai Kolderi National Parks – mainly in areas where the level of anthropogenic pressure is reduced (Figure A.2, see Appendix A). The camera traps were installed in the most potential lynx habitats, which we selected taking into account our own and survey data (Figures A.3 and A.4, see Appendix A), as well as the presence of its prey. In total, we used 74 automatic surveillance cameras (camera traps) were used according to the method of spatial cells (within 10x10 km square of the grid) (Figure 3).

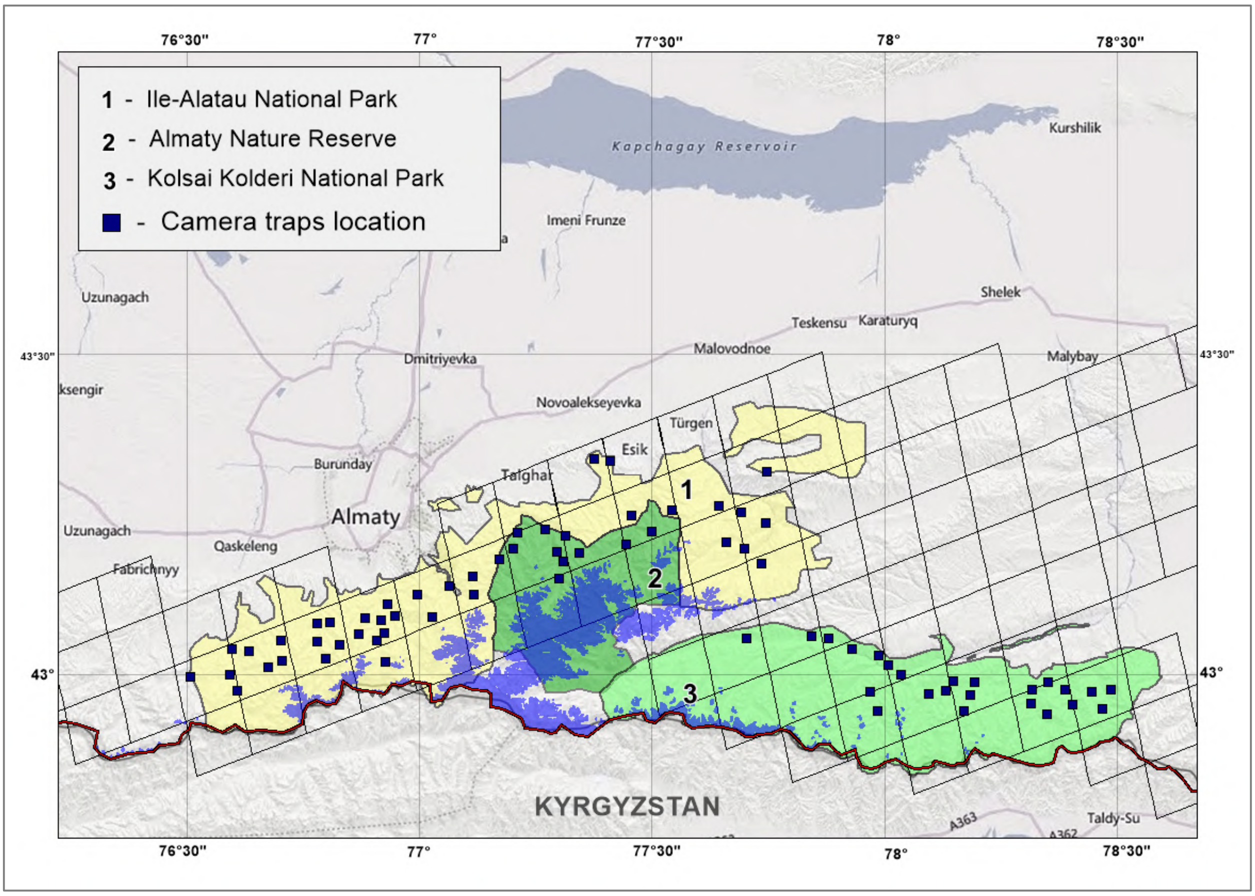
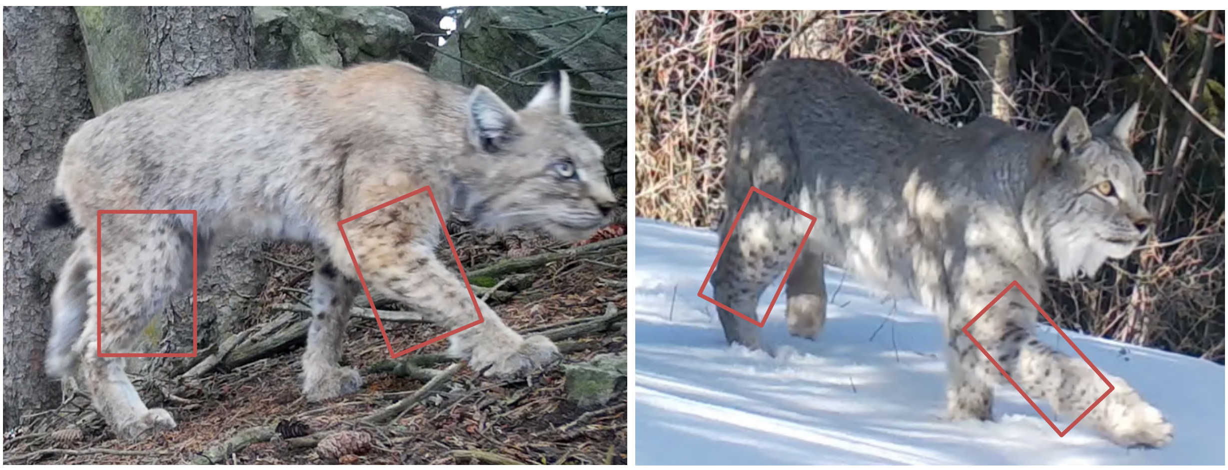


Figure 3 – Distribution of camera traps for observing lynx within the protected areas of the Northern Tien Shan (10x10 km raster unit)

During the research, we used camera traps (models Bushnell, Reconyx, Seelock, ScoutGuard, Browning) equipped with passive infrared sensors triggering to temperature and movement, and photo and video recording in Day/Night mode (Figure 4). The cameras are capable of automatically making high-quality images of animals at a distance of up to 50 m. The locations of the camera traps were based on the results of previous surveys of the territories for lynx the presence, visual observations, tracking in a reverse order.

Figure 4 – Camera traps (left) and the Turkestan lynx caught on a camera, Ile Alatau, Prokhodnaya gorge (right)

In total, we examined 53 independent captures (IC) of the lynx. Based on IC, we made an attempt to individually identify the lynx. Nevertheless, it proved to be successful only for a small number of lynx images, due to the insufficient number of repeated images of probable individuals, the low resolution of some camera traps on which the lynx was recorded, the considerable distance of the lynx from the camera and/or night time during the photo and video recording, making recognition of spots on lynx’s fur impossible. In total, we identified 5 lynx individuals in Ile Alatau and 4 individuals – in Kungei Alatau with a high degree of probability based on the inner side patterns of their forelimbs and hindlimbs (Figure 5, Figures A.5 and A.6, see Appendix A). In addition to comparing the spots on the fur, we took into account the distance between the lynx registration sites.



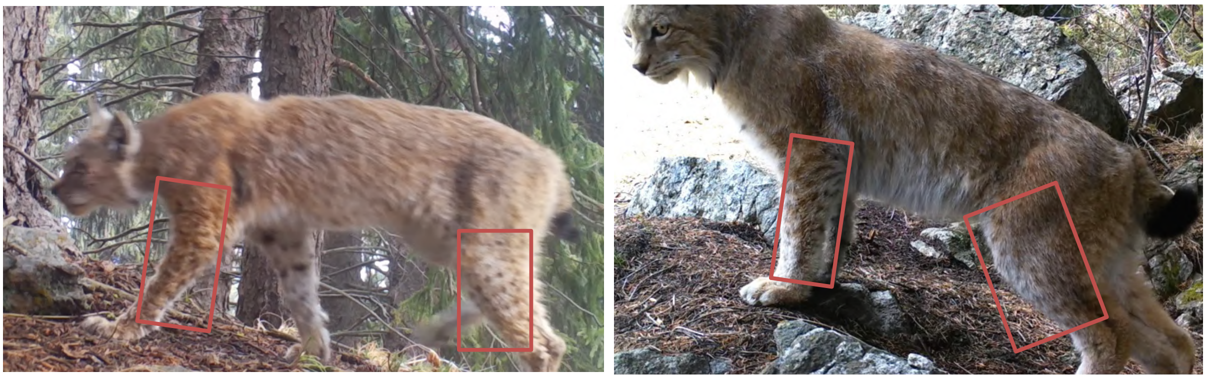


Figure 5 – Different individuals of lynx in the Ile Alatau mountain range, 2019-2021.

Data classification methodology

We considered all field data obtained both by using traditional field methods and camera trapping, as well as data from a survey of PAs staff about random observations (encounters of tracks and the lynx individuals themselves). Considering the fact that the project area occupied a large scale, we followed the data interpretation criteria according to the SCALP methodology, Molinari-Jobin et al. (2003, 2017) for the classification according to their level of reliability (C1; C2; C3). With this approach, we classified information on the historical (Table B.1 (see Appendix B) and the current distribution of the lynx (Table 1 and Figure 6).

Table 1 – The lynx observations in the Northern Tien Shan (according to the SCALP methodology) from 2013 to 2021

Ridge	**Occurrence**			**TOTAL**
	C1 (n)	**C2 (n)**	**C3 (n)**	
Ile Alatau	35	83	17	135
Kungei Alatau	32	37	-	69
Terskei Alatau	2	3	-	5
Uzynkara	1	10	7	18
TOTAL	70	133	24	227

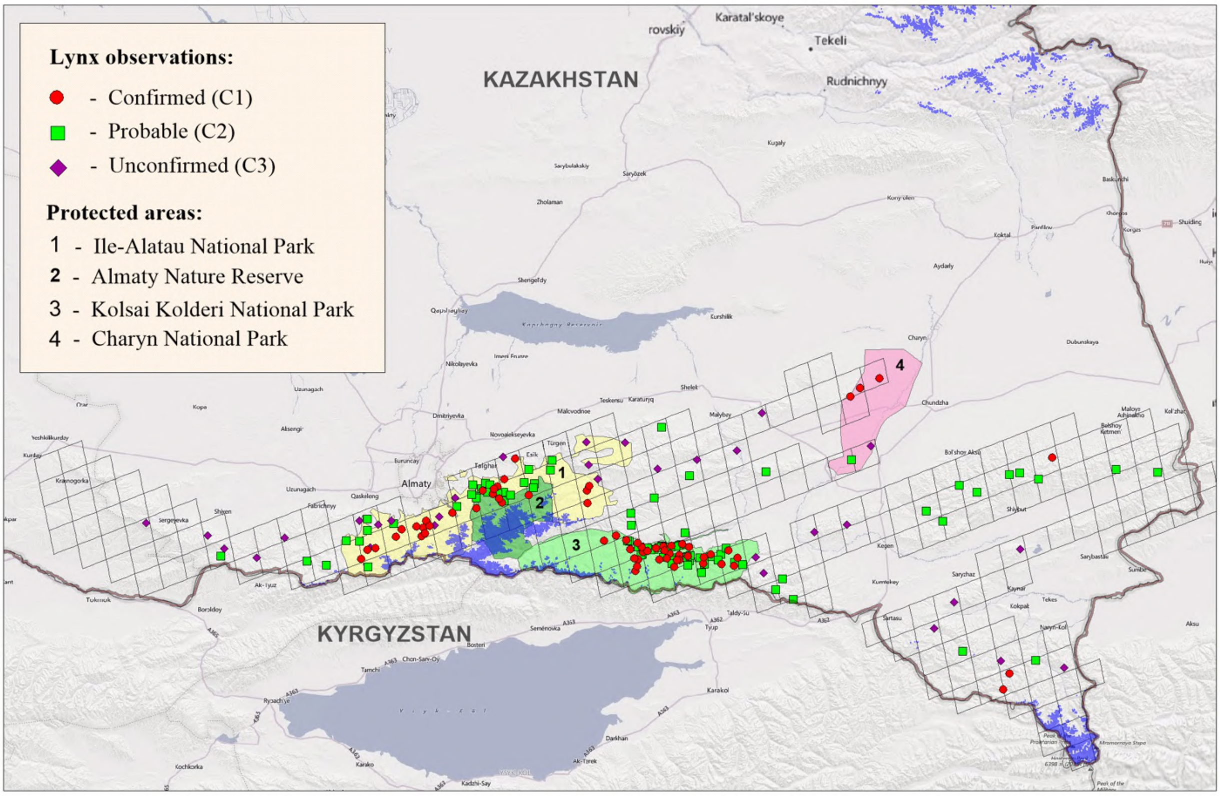


Figure 6 – The lynx in the Northern Tien Shan according to our and survey observations data, 2013-2021

C1 (Category 1): "Confirmed occurrence" – our observations (traditional field methods, camera trapping) and survey (questionnaire) data: verified and reliable data such as (1) dead lynx, (2) captured lynx, (3) videos and photographs of lynx and (4) samples (e.g. fur).

C2 (Category 2): "Probable occurrence" – data checked and confirmed by a specialist (inspector (ranger), hunting biologist, protected area employee, our data), such as (1) remains of livestock or (2) a wild animal killed by a lynx, (3) traces of a lynx or other signs of vital activity, (4) faeces and (5) documented (recorded) and confirmed lynx calls.

C3 (Category 3): "Unconfirmed data" of category 2 such as remains of domestic or wild animals, footprints, faeces, screams and all unverifiable information, like encounters of lynx by local residents without attached evidence.

Mapping

In order to construct standardized maps of the distribution of the Turkestan lynx, we used a spatial grid with a mesh size of 10x10 km, according to the generally accepted methodology proposed and applied by the IUCN / SSC Large Carnivore Initiative for the monitoring of large carnivorous mammals. The distribution of lynx within the study area was divided into two categories: permanent presence (subspecies recorded for three years) and sporadic presence. The processed materials of ground and remote monitoring were combined into databases integrated into GIS programs (MapInfo Professional, ArcGis, SasPlanet), on the basis of which we carried out GIS analysis and compiled maps of lynx distribution. Photos were taken by the authors.

Analysis of data on lynx activity

For the activity rhythm, each occurrence (photos and videos) will be regarded as a single independent capture (IC). Further, we consider the average seasonal index of occurrence and abundance of lynx as seasonal IC (SIC) in Ile and Kungei Alatau (according to camera traps), which is calculated per 100 camera trap days:

$$\text{SIC} = \frac{\text{IC of particular season}}{\text{camera trap days of particular season}} \times 100 \quad (1),$$

where camera trap days represent number of camera traps multiplied by the days they were installed for.

The following formula was used to determine the daily activity rhythm, or the average daily occurrence of the lynx, presented as daily IC (DIC) (Xiaoming Tang et al. 2019):

$$\text{DIC} = \frac{\text{IC of particular time phase}}{\text{total IC}} \times 100 \quad (2),$$

where the time phase was one hour.

RESULTS AND DISCUSSION

1 Historical distribution of the Turkestan lynx

According to our analysis of the literature data, it can be seen that the intensity of lynx study varies depending on the year and place of research (Table 2 or Diagram B.1, see Appendix B).

Table 2 – Facts of encounters of traces of vital activity and lynx individuals in the Northern Tien Shan mountains by years

Ridges	*1930-1940*	*1941-1950*	*1951-1960*	*1961-1970*	*1971-1980*	*1981-1995*	***Total***
Ile Alatau	11	4	5	25	38	54	137
Kungei Alatau	2	1	1	2	10	3	19
Terskei Alatau	-	1	-	2	1	-	4
Uzynkara	-	1	-	1	1	-	3
Total	13	7	6	30	50	57	163

In the Kazakh part of the Northern Tien Shan, the lynx distribution occupied the mountain ranges of Ile, Kungei, Uzynkara, Terskei Alatau and their spurs. Since the 1930s and 1950s, the lynx was rare in the Ile and Kungei Alatau (Shnitnikov, 1936; Ognev, 1940; Kuznetsov, 1948; Afanasyev, 1960; Fedosenko, 1982). In the 1960s, its number in the Ile Alatau grew dramatically significantly and lynx started occurring in all large gorges of the ridge – in the gorges of the Rivers Big and Lesser Almaty, Right and Left Talgar, Issyk, Right, Middle and Left Kyrgauldy. At the same time, by the mid-1960s, there were more lynxes in the western part of the ridge than in the eastern (Fedosenko and Lobachev, 1970). In the 1970s-1980s, in winter, traces were found in every gorge, from the Issyk River to Kaskelen River (Zhiryakov, 1979; Fedosenko and Zhiryakov, 1979; Fedosenko, 1982; Zhiryakov, 1986, 1989). By the mid-1990s, there was a significant increase in the number of lynx and its dispersal in the western direction of the Ile Alatau; in general, 60-70 lynxes lived in the ridge (Zhiryakov, 1995). In Kungei Alatau in the 1970s-1980s, the number of lynx also rose, and traces of its vital activity and the animals themselves were observed in the gorges of Big and Lesser Uryukty, also in the area between the Kuturga River and Lesser Uryukty River and other places (Fedosenko, 1982; Zhiryakov and Baidavletov, 2003; Grachev Yu., 2010).

When comparing the available data from 1930 to 1995, it is apparent that most of them were obtained as a result of studies carried out in the Ile Alatau, while for the rest of the ridges, relatively generalized information was provided or data were absent at all. Nevertheless, despite the existing data being fragmentary, it is possible to judge about fluctuations in the abundance of lynx in the Ile and Kungei Alatau. In particular, there is a notable increase in the number of lynx encounters, and, accordingly, its relative abundance, in these regions in 1960-1980. In the case of the Terskei Alatau and Uzynkara ridges, the lynx was indicated here in isolated cases (Yanushevich et al., 1972; Vyrypaev, 1983), and studies on distribution in these regions were practically not carried out. Based on past data, it becomes evident that it was important to survey these ridges for the presence of lynx. As a result of our short-term studies in the Terskei Alatau and Uzynkara mountains using camera traps, we confirmed the presence of the Turkestan lynx in these mountains. In the Ile and Kungei Alatau ridges, we studied the distribution of the lynx in all large gorges.

2 Present distribution of the Turkestan lynx

As a result of the research conducted, we found the Turkestan lynx in all ranges of the Northern Tien Shan and determined its current distribution (Figure 7).

Among all the ridges we examined, the largest amount of data on lynx was obtained from the Ile and Kungey Alatau (Ile-Alatau SNPP, Almaty Nature Reserve and SNPP Kolsai Kolderi, respectively).

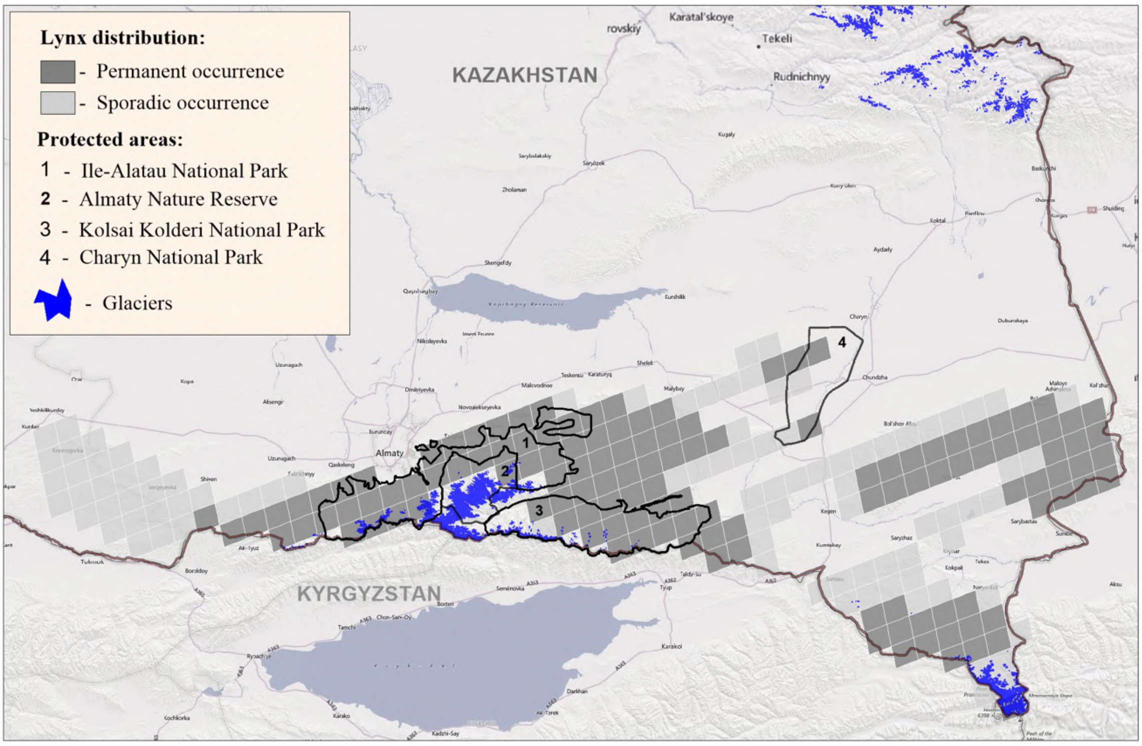


Figure 7 – Modern distribution of the Turkestan lynx in the Kazakh part of the Northern Tien Shan

During our research on the Ile Alatau ridge in 2013-2021, Turkestan lynx was found in almost all large gorges: in the valleys of the Rivers Kaskelen, Aksai, Big and Lesser Almaty, Talgar, Issyk, Turgen, Shelek. This is confirmed by the network of camera traps we have installed. The lynx was recorded by camera traps in the gorges of Kaskelen, Aksai, Left Kyrgauldy, Prokhodnaya, Big and Lesser Almaty, Middle and Right Talgar, Big Iguzek, Rakhat, Komunarov, Sakhnovka, Ayusai, the valley of Shelek River, as well as in the Big Buguty mountains, which recorded periodic lynx passes along the aforementioned gorges. On the territory of the Almaty Reserve, the lynx is constantly found (Zhiryakov and Baidavletov, 2003). Thus, the Turkestan lynx is quite common on the Ile Alatau ridge and is found throughout its entire length.

In Kungei Alatau, during our autumn-winter survey (at the end of October), on the route of about 20 km up the Shelek River, starting from Taldy River to Lesser Uryukty River, we recorded single tracks of 5 individuals of the Turkestan lynx. In the Kolsai gorge, a lynx track was noted on the trail along the shore of the Lower Kolsai Lake, and the remains of a tolai hare, eaten by a lynx, were also found here. In the Taldy gorge, on the 3 km long route, two tracks were recorded. Along the Shelek River, on the right bank, from the Kutorga River to Lesser Uryukty River (10 km) – 7 lynx tracks, on the left bank, from the Big Uryukty River to the Karasai River (12 km) – 3 tracks were recorded.

On the 42 km long route, we encountered 13 lynx tracks (on average, 3.1 per 10 km) in the Shelek River basin, between the Kolsai River in the east and the Kairakty River in the west. Most frequently lynx tracks were found in the canyon of the Shelek River, between the Big Uryukty River and Amanzhol River. Thus, we have determined that the Turkestan lynx in Kungei Alatau is quite common nowadays and its distribution covers the entire Kazakhstani part of the ridge. During the period of our research, using camera traps, we recorded the Turkestan lynx in the gorges of Lesser Uryukty (Salimbai tract), Kolsai, Kaindy, Shelek (Sholak Aral and Aktas tracts), Kutorga.

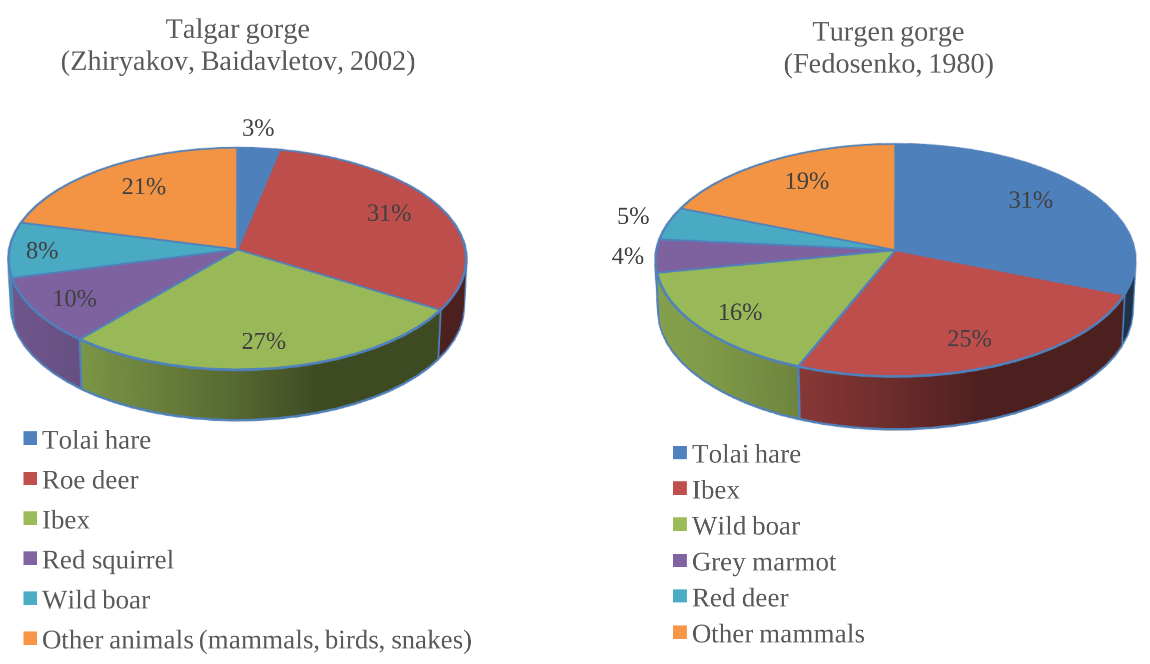
When examining the Terskei Alatau and Uzynkara mountain ranges, including using camera traps, the Turkestan lynx was found in Terskei Alatau in the valley of the Rivers Big Kokpak and Bayankol; in Uzynkara – in the gorge Dardamtysai, Dolatysai. The results of a questionnaire survey of forestry and hunting workers indicate the widespread habitation of the Turkestan lynx in the Terskei Alatau and Uzynkara mountains.

3 Diet and feeding habits. Current state of the prey base

3.1 Diet

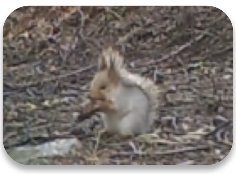
The diet of the Turkestan lynx in the Northern Tien Shan is dominated by tolai hares and ungulates (roe deer, Siberian ibex, wild boar). Occasionally, lynx also hunts rodents (the grey marmot, red squirrel, silver mountain vole (*Alticola argentatus*), other lagomorphs (the Turkestan red pika (*Ochotona rutila*)) and birds (the Northern black grouse (*Lyrurus tetrix mongolicus*), Chukar partridge (*Alectoris chukar falki*), bearded partridge (*Perdix dauurica*), etc.) (Diagram 1).

Diagram 1. Diet of lynx in Ile Alatau (% of findings in faeces)




Roe deer


Tolai hare


Red squrrel


Siberian ibex


Wild boar

In the Ile Alatau ridge, in its eastern part, the lynx preys mainly on the tolai hare; according to A.K. Fedosenko (1982), its occurrence here in lynx faeces is 31.1% (n = 44). In the western part of the Ile Alatau, where the tolai hare is scarce or does not occur, the roe deer becomes the main prey. Similar data (30.6% occurrences of roe deer’s remains for 62 faecal samples) were also cited by V.A. Zhiryakov (1995) for the Talgar River basin. Among the lynx victims found here, the most common were the remains of roe deer (78%), there were also remains of ibex (6.2%), wild boar (3.1%), black grouse (6.2%) and pheasant (3.1%) (Zhiryakov, Baidavletov, 2003). Lynx actively hunts roe deer in those places where they are abundant. Thus, Fedosenko and Zhiryakov (1979) reported how in the Issyk tract, the lynx chased three roe deer, running away along a snowless slope. Lynx also show a preference for young marals (Fedosenko, 1980) and wild boars here.

According to V.A. Vyrypaev (1983), the lynx diet in Terskei Alatau consists of roe deer (occurrence in faeces – 12.3%), tolai hare (20.4%), red pika (12.3%), red squirrel (22.5%), grey marmot (12.3%), muroid rodents (8.2%) and small birds (12.3%) (n = 37). The number of ungulates – lynx prey in the Northern Tien Shan is considered stable (Table B.2, see Appendix B).

When we surveyed the Ile Alatau, in the Prokhodnaya gorge, in November 2020, we observed a lynx chasing two roe deer up the slope. In the Middle Talgar gorge, in December 2020, we recorded fresh tracks of a lynx in pursuit of a group of roe deer. In Kungei Alatau, in the Kolsai gorge, in October 2018, we recorded the remains of a tolai hare, and in December 2019, the remains of a squirrel eaten by a lynx.

3.2 Influence of prey base on lynx's activity

Occurrence in the Northern Tien Shan

When conducting research in Ile and Kungei Alatau using camera traps, the lynx was observed more often in Kungei Alatau (Table 4).

Table 4 – Index of the average seasonal occurrence and abundance of lynx (SIC) on camera traps in Ile and Kungei Alatau

Ridge	Ile Alatau				Kungei Alatau			
Period	Trap days (n)	Observation period	IC	SIC	Trap days (n)	Observation period	IC	SIC
2013-2014	335	June 2013-May 2014	1	0,3	37	March 2013-May 2014	-	-
2014-2015	63	June-August 2014	-	-	846	June 2014-May 2015	11	1,3
2015-2016	638	October 2015-May	1	0,2	617	December 2015-May	7	1,1

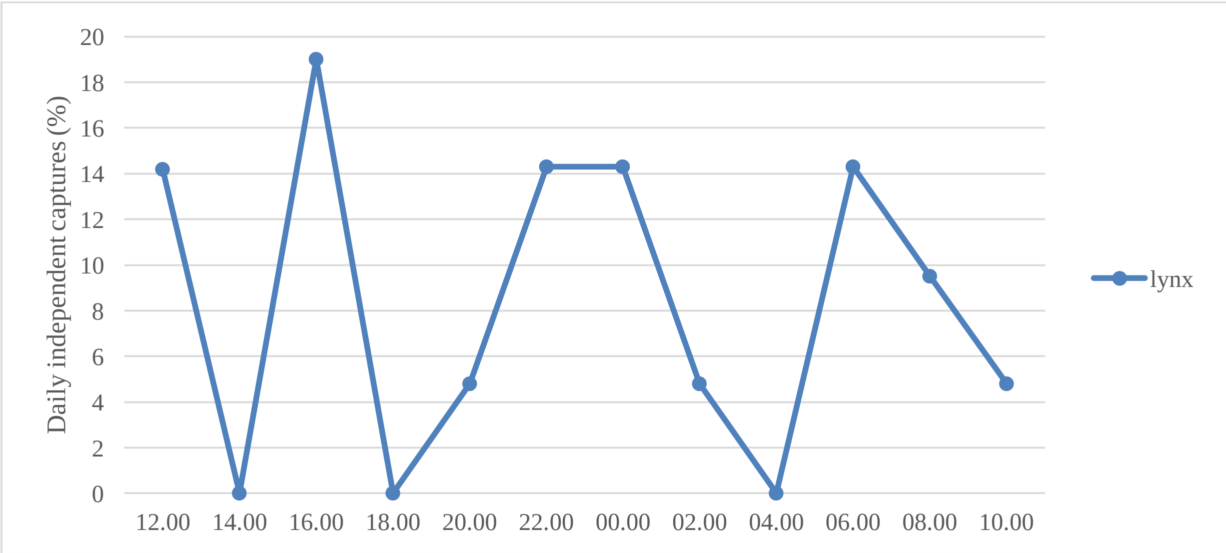
		2016				2016		
2016-2017	-	-	-	-	-	-	-	-
2017-2018	350	June 2017-May 2018	3	0,9	-	-	-	-
2018-2019	1130	November 2018-June 2019	5	0,5	187	December 2018-January 2019	6	3,2
2019-2020	2548	November 2019-May 2020	5	0,2	462	December 2019-February 2020	7	1,5
2020-2021	404	June 2020-January 2021	5	1,2	336	December 2020-January 2021	1	0,2
Total	5468		21	0,4	2485		32	1,3

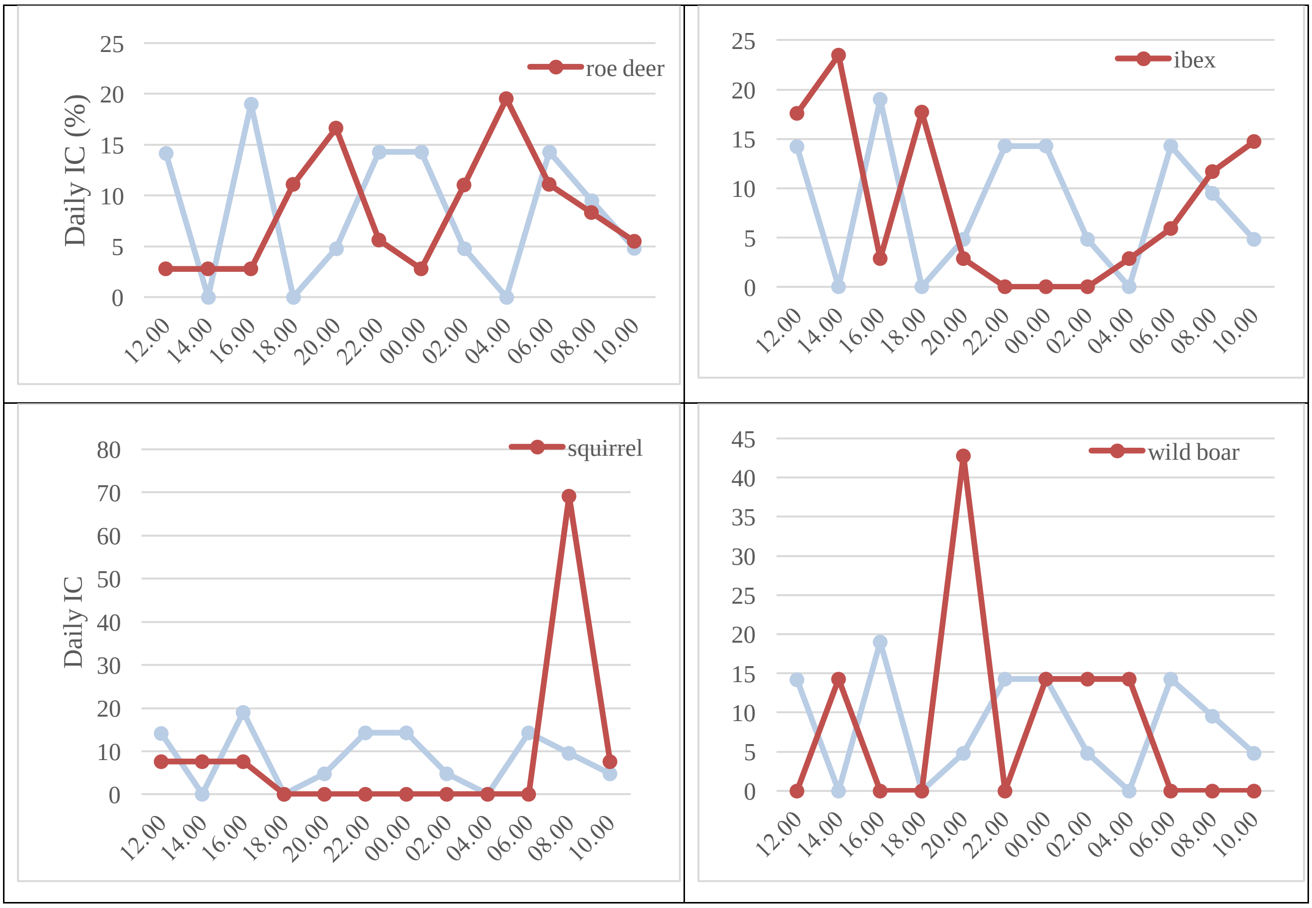
The lynx was more frequently registered by camera traps in the Kungei Alatau ridge (on average, 0.4 and 1.3 lynx individuals per 100 trap days in Ile and Kungei Alatau, respectively). In Kungei Alatau, during the period of our research, 96 independent captures of the tolai hare (on average, 3.8 hares per 100 trap days), the main lynx prey, were recorded on camera traps. In Ile Alatau, hares were not caught on camera traps; however, 36 captures of the Siberian roe deer, another key lynx prey, were recorded (on average, 0.6 individuals per 100 trap days). Thus, in the territory with a relatively high abundance of hares and a smaller number of disturbance factors, a rather high abundance of lynx can be traced, which may indicate a more stable abundance of lynxes in the Kungei Alatau.

Activity of the lynx and its prey

The Turkestan lynx is considered to be a crepuscular animal, although it can also be found during the day (Fedosenko, 1982). Our data on the indicators of the average daily occurrence of lynx and its prey species, obtained with the help of camera traps in the Ile Alatau, are presented in Table B.3 (see Appendix B) and in the diagram below.

Diagram 2. Rhythm of daily activity of the Turkestan lynx and its prey base in the Ile Alatau ridge





The rhythm of daily activity of the lynx in the Ile Alatau had several peaks, with more active hours at dusk and night and inactive or less active hours at noon and late morning.

Among the individual captures we examined, the lynx was most often caught by the camera in the spring. The rhythm of activity during this period almost evenly fell on early morning and noon, with peaks at 06:30-07:30 and 12:00-13:00. In summer and winter, the greatest activity was recorded at night and less frequently at dusk. With the onset of summer, peaks were at night at 23:00-00:00 and at dusk at 16:00-17:00. A similar trend continued for autumn, where, nevertheless, there is a transition to a more twilight period of activity, which lasted from 17:00 to 22:00. In winter, the frequency of lynx activity increased at night, thus winter is the most nocturnal period of activity out of the seasons. The highest peak in winter was at 01:00-02:00. Overall, there were five peaks of activity over the four seasons: 00:00-01:00, 06:00-07:00, 11:00-12:00 and 16:00-17:00 and 22:00-23:00.

Among the lynx prey in the Ile Alatau, four species were considered – the Siberian roe deer (on average, 0.6 individuals per 100 trap days), Siberian ibex (on average, 0.6 individuals per 100 trap days), Siberian red squirrel (on average, 0.2 individuals per 100 trap days) and wild boar (on average, 0.1 individuals per 100 trap days).

The roe deer were most active in the late evening (19:00-20:00) and early in the morning (04.00-05.00). In the period from 06:00 to 10:00, the activity rhythm of roe deer corresponded most closely to the lynx activity. The activity peaks of the Siberian ibex and the red squirrel occurred at noon and late morning, respectively, from 12:00 to 14:00 for the ibex and from 08:00 to 10:00 for the squirrel. In the case of the wild boar, there were several peaks – in the late evening, at 20:00-21:00, and from late night to early morning, from 00:00 to 04:00. The lynx's activity rhythms slightly coincide with the activity of these three species – ibex (at 12:00-13:00), squirrel (at 06:00-07:00 and 10:00-11:00) and wild boar (00:00-01:00).

Field work and installation of camera traps in Kungei Alatau were carried out mainly in the winter period. In general, the activity of the lynx, in comparison with the population in the Ile Alatau, is more nocturnal. Data with the average daily occurrences of lynx in Kungei Alatau are presented in Table B.4 (see Appendix B) and in the diagram below.

Diagram 3. Rhythm of daily activity of the Turkestan lynx and its prey base in the Kungei Alatau ridge

Lynx was most active at night activity from 22:00 to 02:00. At twilight there were two peaks: the first at 06:00-07:00 and the second at 16:00-17:00.

Among the lynx prey in Kungei Alatau, 5 species were considered – Siberian roe deer (on average, 0.1 individuals per 100 trap days), tolai hare (on average, 3.8 individuals per 100 trap days), Siberian ibex (in on average, 2.3 individuals per 100 trap days), wild boar (on average, 0.8 individuals per 100 trap days) and Siberian red squirrel (on average, 3.1 individuals per 100 trap days). The closest correlation was noted with the rhythms of the activities of the tolai hare and wild boar. Roe deer, ibex and red squirrel, being diurnal animals, had a rhythm of activity considerably different from the lynx.

4 Habitat and altitudinal dispersion

In the Northern Tien Shan, the lynx inhabits the middle belt of the montane zone, from deciduous forests to the upper border of a spruce forest within an altitude of 1200-2600 m above sea level (Fedosenko, 1982), and only in snowy winters descends into the foothill zone. Lynx often occupies habitats with thickets of bushes, mainly within the forest and subalpine belts. Prefers steep slopes with outcrops of rocks and stony placers (Grachev Yu., 2010). Occasionally can move to the alpine belt.

The boundaries of altitudinal distribution, as well as the territorial and habitat dispersal of the lynx within the Northern Tien Shan are not the same within all ridges, and depend on the absolute height of the summits and ridges, snow cover, the presence of prey (tolai hare, Siberian roe deer, Siberian ibex, Siberian red squirrel, wild boar, red deer, grey marmot, etc.) and their migrations (Table 5), light regime and disturbance factors.

Table 5 – Altitude distribution of lynx and its prey base in Ile and Kungei Alatau (2013-2021)

Height above sea level (thousand m)	Species													
	Turkestan lynx		Siberian roe deer		Siberian ibex		Siberian red squirrel		Wild boar		Red deer		Tolai hare	
	n – 122		n – 71		n – 273		n – 117		n – 84		n – 94		n – 100	
	IC*	CT**	IC	CT	IC	CT	IC	CT	IC	CT	IC	CT	IC	CT
3.2-3.5	1				13									
2.9-3.2	1				43	11			5	2	3			
2.6-2.9	6	1	1		96	37	11	11	29	8	9	7	4	4
2.3-2.6	49	28	5	1	71	22	45	30	17	16	25	17	35	35
2.0-2.3	36	12	12	12	39	12	27	24	11	9	39	27	51	49
1.7-2.0	19	8	22	12	7	7	14	14	9	7	9	9	8	8
1.4-1.7	7	3	20	15	3	2	9	9	7	6	4	1	2	1
1.1-1.4	2	1	10	9	1		8	2	5	1	4	3		

0.8-1.1	1		1				3		1		1			

* Separate encounters of tracks and lynx individuals – our and survey data (camera trapping and visual observations)

** data from camera traps only

* Note: zones and belts are represented by the colors below:

foothill zone	deciduous forests	spruce forest	subalpine belt	alpine belt	subnival belt

The lower border of the lynx's habitat is the low dry water-scarce mountains Lesser and Big Boguty and thickets of bushes along the Bes-Agach River at an altitude of 800 m above sea level (Zhiryakov, 1995), which is also confirmed by our research. This height corresponds to the mountain-steppe or foothill zone (from 800 to 1200 m above sea level), where the vegetation cover is mainly represented by grass-forb groups – feather grass and fescue with an admixture of wormwood. In the Big Boguty mountains, which have steppe southern slopes, the lynx was recorded twice in March 2016 at an altitude of approximately 1400-1500 m above sea level.

In the Northern Tien Shan, we found the tracks and lynx individuals throughout the entire mountain forest-meadow-steppe (montane) zone (1200-2600 m). A series of lynx passes have been recorded with a camera trap in deciduous forests (forest belt at an altitude of 1200-1700 m above sea level). These forests include the Siever's apple (*Malus sieversii*), common apricot (*Prunus armeniaca*), bird cherry (*Prunus padus*), Eurasian aspen (*Populus tremula*), Tien Shan birch (*Betula tianschanica*), Talas poplar (*Populus talassica*), cinnamon rose (*Rosa cinnamomea*), dwarf honeysuckle (*Lonicera xylosteum*), common barberry (*Berberis vulgaris*), several species of hawthorn (Crataegus) and willow (Salix). In the upper belt of this zone, coniferous forests grow (1700-2600 m above sea level), with prevailing Schrenk's spruce. Among the spruce the lynx is not scarce and has been caught by a camera trap throughout the year.

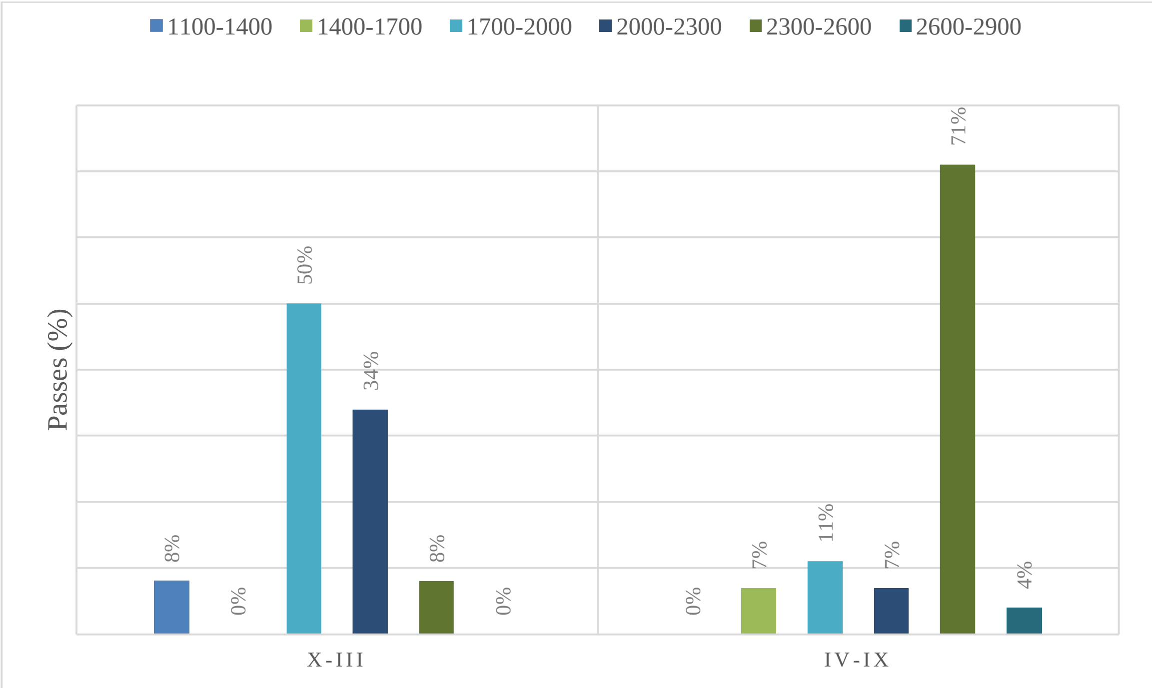
The suitable habitat of the lynx is deciduous and coniferous forests, which is confirmed by the data of camera traps – most of the recorded sightings of the lynx were in the forest belt.

In the zone of alpine meadows and meadow steppes (starting from 2600 m above sea level), the lynx has been captured on a camera trap in the subalpine belt (2600-2800 m above sea level). In particular, in the Prokhodnaya gorge in May 2018 at an altitude 2664 m above sea level. Within the meadows of this belt, thickets of Turkestan juniper (*Juniperus turkestanica*) are abundant, among which we occasionally found traces of lynx activity.

The highest altitude of the lynx encounter was recorded to be at 3000 m above sea level (Zhiryakov, 1995; Zhiryakov, Baidavletov, 2003), in the Right Talgar gorge (information fom ornithologist A.D. Dzhanyspaev, oral communication). Apparently, the lynx from the "Valley of the Scythians" (Middle Talgar), where it was hunting for grey marmots, crossed the Northern Aksu Pass (3300 above sea level) into the gorge of the Right Talgar River. The lynx can occasionally visit this belt of alpine meadows.

Lynx can migrate vertically mainly due to precipitation and the subsequent migration of its prey (Diagram 4).

Diagram 4. Altitudinal distribution of lynx in the Ile and Kungei Alatau in winter and summer (data from camera traps)



* Note: X-III – October-March (snowy/winter period), IV-IX – April-September (snowless/summer period)

With the establishment of a high snow cover in the subalpine and alpine belts of the mountains (in October-November), vegetation for the ungulates that resided here in summer becomes practically unavailable. Following periodic movement of ungulates, lynx migrates to the lower border of the forest belt. During exceptionally snowy winters, the migration can expand to the foothill zone.

When snow melts in spring (in April-May), lynx follows the ungulates and makes vertical movements upward. In summer, the lynx can move up to subalpine and alpine meadows. Such migrations are also associated with the need of ungulates for vegetation, which in the lower zones of the mountains coarsens and dries up, but grows in the highlands in the form of fresh greenery. Seasonal ranges typically stay the same, and the lynx adheres to the belt of the coniferous forest throughout the year. Thus, vertical migrations from the montane zone are possible only in snowy and unfavourable years.

Home range

Territoriality and related behaviour in Kazakhstan has not been specially studied. In the Ile Alatau, in particular, on the territory of the Almaty Reserve, the hunting area of one individual, depending on the season and the availability of forage, ranges from 15 to 60 km^2; with 0.1-3.7 tracks per 10 km of the route (Zhiryakov, 1995). In Kungei Alatau, our tracks on the routes were also constantly registered and amount to 3.1-3.5 tracks per 10 km of the route.

In order to determine lynx's home range in the Northern Tien Shan, we need more accurate data for their sampling. The large area of research and the rarity of the lynx make it difficult to collect such data, while the individual identification of the lynx (by spots on the fur) from the records of our camera traps is not sufficient. To obtain the necessary data, we plan to move to the next stage of the research – GPS tracking. The use of trackers will also make it possible not only to determine the home range of lynx, but also to assess the influence of prey on the pattern of lynx movements in the Northern Tien Shan.

5 Competition with other carnivores

Competition between carnivores is possible when species have similar prey base and habitats. Thus, in the Northern Tien Shan, there is a joint use of habitats by all large carnivores (lynx, snow leopard, brown bear, wolf and domestic dogs). We have repeatedly met the traces of these predators on the same mountain paths. All of them have been also recorded by the same camera traps, with different frequencies and time intervals. We have considered direct (interference) and indirect (exploitation) competition. Based on the analysis of our, survey and the literature data, we have summarized the possible relationships between the lynx and potential competitors in Table 6. At this stage of research, we need more data for a qualitative analysis.

Table 6 – Possible competitive effects on lynx, mediating factors and assessment of the likely impact on lynx populations in the Northern Tien Shan

Type of relationship	Possible competitors	Influence on lynx populations
Exploitation	Birds of prey	Possible

	Fox	Not significant
	Wolf	Significant
	Brown bear	Possible
	Snow leopard	Possible, especially with lynx migrating to the highlands
Interference	Domestic dog	Significant
	Wolf	Significant
	Snow leopard	Not significant

Exploitation, or competition for resources (Buskirk et al., 1999), occurs when predatory species use resources in the lynx's habitat, thereby indirectly affecting the state of its populations. Thus, wolves and snow leopards in the forest belt actively hunt roe deer – one of the main prey for the lynx and one of the most numerous ungulates in the Northern Tien Shan. Wolves predominantly hunt wild boars (2.7-21.8%) and roe deer (11.8-18.8%), but in winter there are considerably more roe deer killed by wolves (Fedosenko and Zhiryakov, 1979). The main prey of the snow leopard is the Siberian ibex (56.1%), but it can rely on other ungulates as well. In the case of birds of prey and brown bear, commensalism and kleptoparasitism are possible. So, Zhiryakov (1995) reported how in the Left Talgar gorge in the Ile Alatau, the bear consumed the roe deer killed by a lynx. A similar behaviour was observed with the fox. The presence of other carnivores and the food niche overlap between lynx and other carnivores may cause direct avoidance, movement from these habitats, or a reduction in prey consumption by lynx; this may have the significant impact when resources are limited (Palomares and Caro, 1999; Creel, 2001).

The intensity of interference between carnivorous mammals is predicted as the highest with intermediate differences in body size (differences by 2-5 times) between competitors (Donadio and Buskirk, 2006). The difference in body mass between the wolf (25-50 kg) and the lynx (15-25 kg) falls within this range, indicating the likelihood of strong competition between the two species. According to survey data, in the Ile Alatau, wolves occasionally hunt single lynxes in packs of 5-7 individuals, often in the summer in the middle montane zone (1700 m above sea level and above). In the 1970s, in the Ile Alatau, there was a case when a snow leopard killed a lynx and ate its head (Fedosenko, 1982). There have been cases of stray dogs attacking lynxes, at the lower border of the forest belt (approximately 1400 m above sea level). During the study period, cases were documented when a lynx climbed up a tree when encountering domestic dogs.

6 Main threats for lynx populations

In the Northern Tien Shan, the main threats are fragmentation and loss of lynx habitat, mainly due to unregulated grazing, forest fires, prey loss, infrastructure development, unregulated tourism, as well as poaching for fur and killing by herders. Conflict situations with a lynx are reported practically in all ranges of the Northern Tien Shan, where cattle breeding is one of the main sources of food and income for local residents. Other threats include accidental mortality from trapping of wolves, as well as disturbance caused by the human presence in the mountains, increasing annually due to population growth and the increasing boundaries of the city of Almaty and the Almaty conurbation.

Cattle grazing. Degradation of animal habitats is most often caused by overgrazing. The negative impact of livestock on ecosystems is manifested in the fact that, with a large concentration of livestock, pastures of wild ungulates are grazed out and destroyed. As the ungulates leave their suitable habitats, so does the lynx, following its prey. The number of domestic animals in the mountains, which sharply decreased in the 1990s, is now again increasing in numerous places, in particular in the valleys of the Rivers Shelek (the southern slope of the Ile Alatau), Zhenishke, Turgen, Aksai, Kaskelen, Uzyn-Kargaly, Kara-Kastek and others. Livestock is kept, albeit in smaller numbers, in specially protected areas as well – i.e., in Almaty Wildlife Sanctuary, Ile-Alatau National Park, Almaty Reserve (private livestock of employees and other personnel). In order to prevent negative consequences, it is necessary to establish rules and norms for grazing livestock in the mountains and maintain an appropriate livestock, taking into account the potential capacity of pastures.

Forest fires. They, sometimes in large areas, deprive animals of food and shelter and force them to look for other habitats. In the Ile Alatau, after a strong windblow in 2011, the subsequent fire completely destroyed the fallen trees and forest plantations on the slopes in the Lesser Almaty gorge and caused a massive migration of animals from this area.

Prey reduction or loss. In harsh winter conditions, lynx cannot successfully feed on smaller prey (Pulliainen, 1992). In winter, it prefers ungulates due to their vulnerability in deep snow. Intensive hunting for lynx prey may also play a role in the decline of the lynx population (Hell, 1992).

Population growth and construction of various infrastructure facilities. The construction of highways, ski resorts, hotels, houses and other buildings causes the reduction, degradation and fragmentation of animal habitats, and the noise generated by the machines is a major stress factor for lynx and other animals. Comparing the well-preserved ecosystems of the Almaty Reserve with the ecosystems of the surrounding, but densely populated and built-up valleys of Lesser and Big Almaty Rivers, we can see a substantial difference between two areas – the number of animals in the Reserve is several times higher than outside it.

Tourism and an increase in people in the mountains. According to the “Concept for the development of the tourism industry of the Republic of Kazakhstan until 2023”, approved by the Government of the Republic of Kazakhstan No. 406 dated June 30, 2017, large-scale projects for the construction of tourism infrastructure are planned in the Northern Tien Shan mountains.

The most attractive tourist sites in the mountains of the Northern Tien Shan, included in the “Almaty mountain tourist cluster”, such as Kolsai Lakes (Kaindy, Upper and Lower Kolsai), Big Almaty lake, Kok-Zhailau, Japanese road, Turgen waterfalls, Sharyn Canyon and others are currently located in key lynx habitats (Figure 9). Due to the implementation of projects for the tourism development, associated with the construction of various facilities and infrastructure, the predictions regarding the existence of the lynx are unfavourable.

Figure 9 – Lynx against the background of Kaindy Lake (Kolsai Kolderi National Park) – the main tourist attraction in the Northern Tien Shan (photo from a camera trap). January 2021

Unlike ecotourism that creates jobs, generates income for the local population, and also encourages people to protect nature, unorganized tourism causes pollution, trampled vegetation, increased danger of fires, and subsequently, damage to animal habitats. The presence of people in the lynx habitat is also a stress factor that can indirectly affect the animal populations. So, in November 2021, a lynx was seen in the Prokhodnaya gorge chasing a group of roe deer. It stopped hunting, noticing a group of tourists down the slope, and immediately retreated.

There are tourist routes in the Almaty Nature Reserve, the Ile-Alatau National Park and the Kolsai Kolderi National Park, but the flow of organized and unorganized tourists increases every year and must be regulated in order to preserve the ecosystems. First of all, it is necessary to develop norms of the recreational load on different ecosystems and their strict observance.

Poaching and killing of lynx by herders. The presence of people close is the source of anxiety for the lynx, which may be caused by illegal hunting for it. According to survey data, in the Northern Tien Shan, there were multiple cases of such hunting. Most of them were the result of conflicts with livestock breeders – retaliatory killings due to depredation of livestock and wild ungulates, where the last ones are in high demand among the local population. In some cases, poachers use dogs to hunt lynxes (Figure 10). There have been reports on a lynx caught on a hunting trap designed for a wolf (set by herders to reduce its numbers), and dying soon after (Figure 11). Presumably, 3 to 5 lynxes are killed annually.

Figure 10 – Lynx driven into a tree by hunting dogs in Ile Alatau. Photo provided by local resident S.S.

Figure 11 – Lynx skulls provided to us on confidential terms by local residents (hunters and herders)

When discussing with some local residents in the Ile Alatau in June 2020, we came to the conclusion that most of them considered the Turkestan lynx as vermin, which, “along with the wolf, should be exterminated”. At the same time, not everyone was sufficiently aware that this species is listed in the Red Book of the Republic of Kazakhstan. Regarding the locals, who know about the Turkestan lynx inhabiting the Northern Tien Shan (and that it is rare), they are sceptical about its taxonomic status, arguing that this subspecies is an Altai subspecies of the common lynx, which is allowed to hunt. They support this belief by the fact that visually the lynx inhabiting the Northern Tien Shan is very similar to the Altai one.

It should be noted that the taxonomic status of the Turkestan lynx has never been specially studied. At the same time, there is an assumption about the possible identity of the Altai subspecies of the Eurasian lynx with the Turkestan lynx (Heptner, Sludskiy, 1972). In our opinion, it is very important to conduct special studies in this direction. In order to determine the position of the Turkestan lynx as a subspecies and the possible strengthening of its conservation status, we plan to carry out a comparative analysis of the degree of differentiation by morphological characteristics between the Altai lynx and Turkestan lynx, as well as an analysis of their mitochondrial DNA.

7 Conducting educational work

During the project implementation period, we conducted workshops for approximately 30 High Tech Academy students on the topic of wildlife conservation in general and rare carnivores in particular (Figure A.7, see Appendix A), as well as more than 100 students from al-Farabi Kazakh National University on the conservation of the Turkestan lynx in particular. We had educational session with the faculty staff of al-Farabi Kazakh National University (Figure A.8, see Appendix A). For 2nd year students, we created and approved a curriculum on the study and conservation of the Turkestan lynx and other rare mammals for field practice in 2020 and tested it with approximately 200 university students during this practice (July-August 2020) in the Ile-Alatau National park.

For employees of three protected areas (5 people in the Almaty Reserve, 25 people in the Ile-Alatau National Park, 20 people in the Kolsai Kolderi National Park), we conducted trainings on the use of camera traps to monitor rare and economically important mammalian species, and separately in Ile-Alatau National Park held a seminar on the conservation of rare mammals and, in particular, the Turkestan lynx (Figure A.9, see Appendix A).

8 Recommendations for the Turkestan lynx conservation in the Northern Tien Shan Mountains based on the first year results

Based on the results obtained, the following main recommendations for the protection of lynx habitats were proposed:

- creation in the near future of a specially protected area with a Nature Reserve regime in the mountains of Uzynkara (Ketmen) and Terskei Alatau;

- an increase in the area of existing protected areas in the Kazakh part of the Northern Tien Shan by 1190 km^2 by the increase in the Almaty Reserve by 275 km^2 (+38%), the Ile-Alatau National Park by 455 km^2 (+23%), the Kolsai Kolderi National Park by 460 km^2 (+28%);

- creation of a network of ecological corridors between the existing PAs of the Northern Tien Shan to preserve and maintain the natural integrity of landscapes;

- in the existing specially protected natural areas, adjusting the functional zoning taking into account the modern distribution of the Turkestan lynx;

- assessment of the scale and causes of poaching in relation to lynx and its prey species and the introduction of an effective system to combat this phenomenon, including the resolution of conflicts with livestock breeders;

- strengthening environmental education of the population and popularizing measures to preserve the Turkestan lynx and habitats;

- carrying out systematic research and monitoring of populations of wild animals using modern methods: automatic cameras, satellite tracking, genetic analysis, etc.;

- expansion of international and interregional cooperation in the study and preservation of transboundary ecosystems of the Northern Tien Shan with neighbouring countries – the Kyrgyz Republic and the People’s Republic of China.

CONCLUSION

Based on the results of the studies carried out, the following conclusions can be drawn.

1. We have analysed all the literary sources and fund data of the Institute of Zoology (reports, archives, field diaries, etc.) on the distribution and diet of the Turkestan lynx in the past from the 1930s to the 2000s. According to this survey, the Turkestan lynx was very rare throughout the Northern Tien Shan.

Currently, within the project area, the lynx populations in the Ile Alatau and Kungei Alatau mountains are relatively the most stable due to the fact that their habitats are located in protected areas (Table B.5, see Appendix B). There are no protected areas in the Terskei Alatau and Uzynkara ridges.

The main preys of the lynx are the tolai hare and roe deer. In gorges, where the hare is absent or few in number, the roe deer becomes the main prey. The state of the lynx population depends to a large extent on the abundance of these two species.

The state of the lynx population in the protected areas is much more stable than outside of them. The lynx is also abundant in hunting grounds due to the fact that its prey species, in particular ungulates, are abundantly found here. Regardless of the fact that the lynx has an insignificant effect on the population of ungulates (Zhiryakov, 1979), many local residents related to hunting or animal husbandry have a negative attitude towards the lynx and tend to view it as vermin. It is worth paying special attention to the awareness of local residents about its ecological significance for ecosystems and nature conservation status.

2. For a reliable assessment of the lynx distribution, we used the data obtained by our research group since 2013 (7 years in total).

Compared to sporadic studies in 2013, the data for 2020 was several times larger due to more systematic studies and an increase in the number of camera traps, thanks to the start of this project and collaboration with protected areas. In total, we used 74 camera traps.

We have been confirmed that the lynx lives in almost all large gorges of the Northern Tien Shan and has relatively stable populations in the Ile and Kungei Alatau. Among the other ridges of the Northern Tien Shan (Terskei Alatau and Uzynkara), which went beyond our project, we confirmed the presence of a lynx here as a result of short field studies.

3. We analysed the data from camera traps on the occurrence of lynx and the main prey species (including data collected by the research group since 2013). A total of 383 frames

out of over 30,000 recordings were obtained with separate passes of the lynx (n = 53), tolai hare (n = 96), roe deer (n = 39), Siberian ibex (n = 91), wild boar (n = 28), red deer (n = 64), Siberian red squirrels (n = 90). The total effective trapping days were 7,953 and 9 lynxes were identified from 53 trapping photos based on the inner side patterns of their forelimbs and hindlimbs.

During the route surveys in the lynx habitats, data on the lynx's prey were also collected (registration of tracks and visual observations, i.e. registration of the lynx hunting for roe deer). There is some overlap in the altitudinal and spatial distribution, as well as the daily activity of the lynx and its prey, in particular the tolai hare and the roe deer.

The lynx occupies mainly the middle part of the forest belt (1500-2500 m above sea level – 66.6% of the occurrences). Depending on the season, prey species that generally occupy different habitats and altitudes than the lynx, and have mismatched peaks of activity, make up a smaller proportion of the lynx's diet.

4. We obtained data on other large carnivores of the Northern Tien Shan (distribution, habitats, diet and rhythms of activity) that can be competitors for the lynx (wolf, snow leopard, brown bear, fox, etc.). It has been established that most species of large predators (mainly wolf, snow leopard, brown bear) share the same habitats and their diet coincides to some extent. In the near future, we plan to continue working in this direction in order to assess the competitive relationship between them.

5. The main threats and limiting factors are habitat degradation and fragmentation, heavy snowfalls, poaching, prey loss, conflicts with livestock breeders.

Degradation and fragmentation of the lynx habitat is observed near the metropolis of Almaty due to urbanization (the city border expands in the mountain direction from year to year) and the construction of various infrastructure in the mountains for the tourism industry. At present, all the foothills around Almaty and other settlements are built up with new residential buildings and even microdistricts, which has led to the irreversible withdrawal of suitable habitats for the Turkestan lynx.

Recommendations are given for the conservation of the Turkestan lynx in the Northern Tien Shan, including the minimization of environmental risks associated with the reduction and loss of its habitats in connection with the planned projects for the development of tourism and other industries. The first and urgently needed measure is to improve the network of specially protected natural areas (PAs).

Based on the results obtained, it was proposed to:

- create protected areas in the near future in the Uzynkara (Ketmen) and Terskei Alatau ridges;

- increase the area of existing protected areas in the Kazakh part of the Northern Tien Shan, in particular, the Almaty Reserve, the Ile-Alatau National Park and the Kolsai Kolderi National Park;

- create a network of ecological corridors between the existing PAs of the Northern Tien Shan to preserve and maintain the natural integrity of landscapes;

- correct functional zoning in existing protected areas, taking into account the modern distribution of the Turkestan lynx;

- assess the scale and causes of poaching in relation to lynx and its prey species and the introduction of an effective system to combat this phenomenon, including the resolution of conflicts with livestock breeders;

- strengthen environmental education of the population and popularizing measures to preserve the Turkestan lynx and habitats;

- carry out systematic research and monitoring of populations of wild animals using modern methods;

- expand international and interregional cooperation in the study and preservation of transboundary ecosystems of the Northern Tien Shan with neighbouring countries – the Kyrgyz Republic and the People’s Republic of China.

FUTURE PLANS

1) Determination of the taxonomic status of the Turkestan lynx (subspecies diagnosability).

- According to Heptner and Sludskiy (1972), the Turkestan lynx is either very close to the Altai lynx, or identical with it. Since that time, there have been no studies on taxonomy. To determine whether the subspecies recognition of the Turkestan lynx is justified, we plan to carry out a comparative analysis of the degree of differentiation by morphological characteristics between the Turkestan and Altai subspecies of the Eurasian lynx. To obtain accurate data, analysis of the mitochondrial DNA sequences will be carried out. This is relevant both from a taxonomic point of view and for a complete determination of the conservation status of the lynx.

2) Preparation of recommendations for the conservation of the Turkestan lynx in the mountains of the Northern Tien Shan, taking into account the data that we will receive from the diagnosis of subspecies, and all other data on the lynx that we have received so far.

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APPENDIX A

Illustrations

Figure A.1 – Expeditions to the Northern Tien Shan, November-December 2020

Figure A.2 - Checking and setting up camera traps for their further installation, Kolsai Kolderi National Park, December 2019

Figure A.3 – Installation of camera traps in the lynx habitat in the Right Talgar gorge, Ile-Alatau National Park, Ile Alatau ridge, November 2020

Figure A.4 – Surveying rangers and researchers of the Ile-Alatau National Park

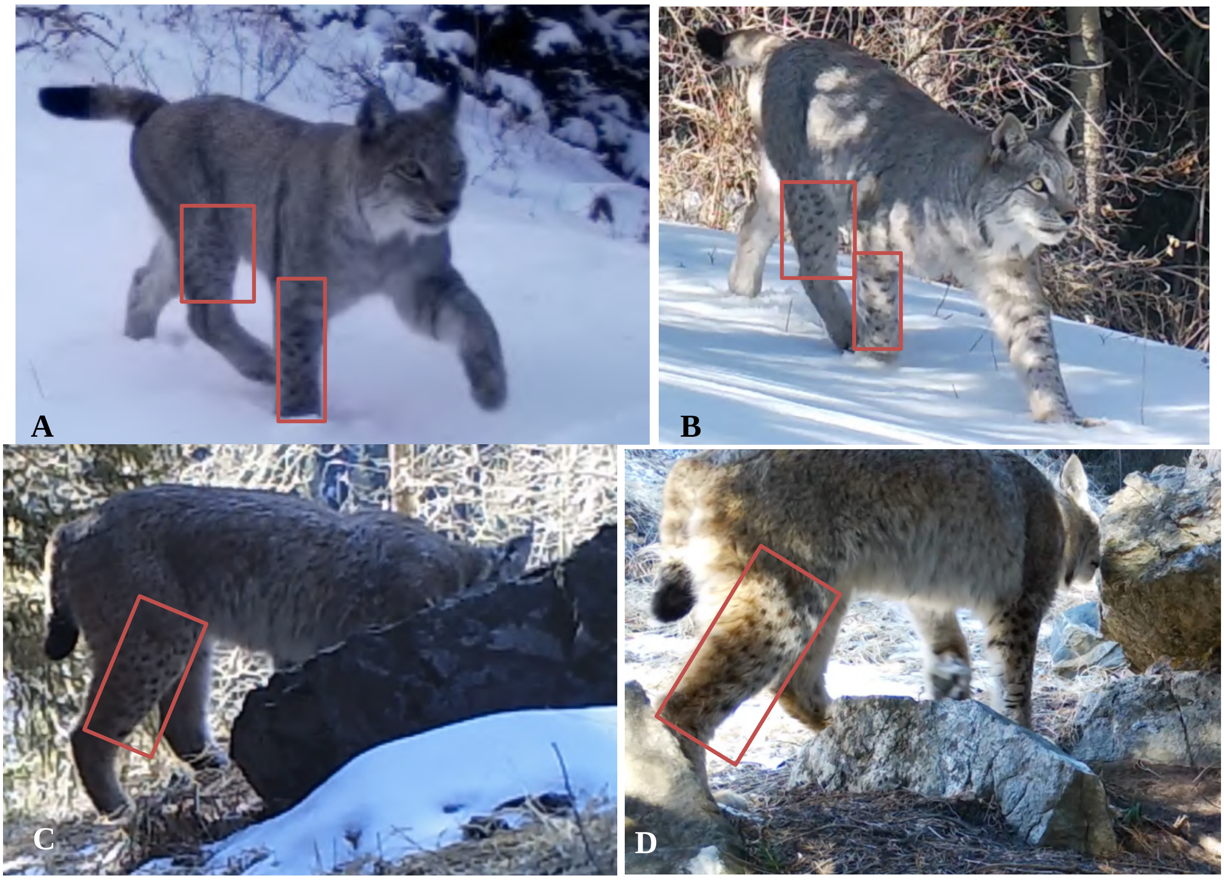

Figure A.5 – Identification of two individuals by spots on the forelimbs and hindlimbs. A and B – an identical individual in the Right Talgar gorge, C and D – Sakhnovka gorge, Ile Alatau

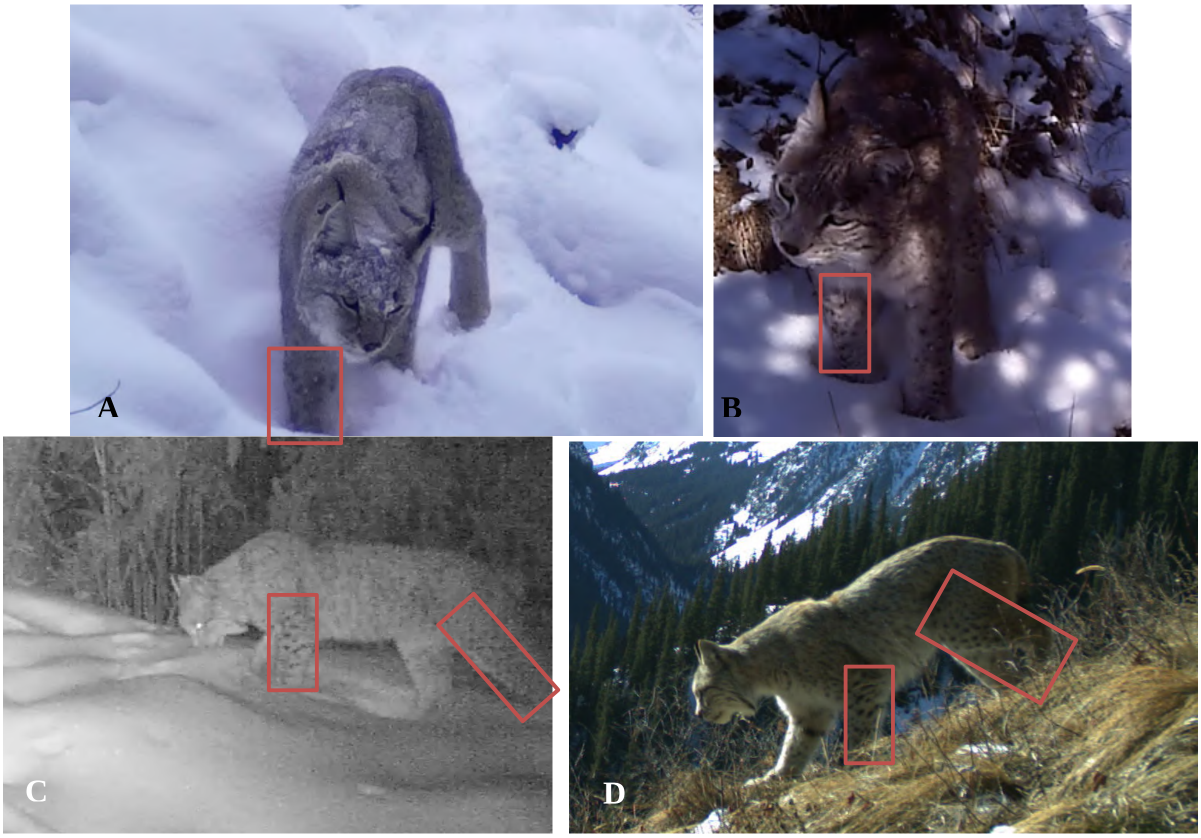

Figure A.6 – Identification of two individuals in the Kungei Alatau ridge. A and B – an identical lynx in the Kutorga gorge, C and D – in the Sholakaral gorge

Figure A.7 – Seminars with High Tech Academy students on the topic of conservation of rare carnivores, September 2020

Figure A.8 – Conducting field practice with senior lecturers of al-Farabi KazNU – Mankibaeva S. and Salmurzauli R., Ile-Alatau National Park, June 2020

Figure A.9 – Seminar in the Ile-Alatau National Park – report on the research results, December, 2020

APPENDIX B

Tables and diagrams

Table B.1 – The occurrences of lynx in the Northern Tien Shan (using the SCALP methodology) in 1930-1995 (literature data analysis)

Ridge	**Occurrences**						**Total**
	1930-1960			**1961-1995**			
	C1 (n)	**C2 (n)**	**C3 (n)**	**C1 (n)**	**C2 (n)**	**C3 (n)**	
Ile Alatau	2	7	11	1	45	71	137
Kungei Alatau	-	-	4	-	14	1	19
Terskei Alatau	-	-	1	1	1	1	4
Uzynkara	-	-	1	-	-	2	3
TOTAL	2	7	17	2	60	75	163

Diagram B.1 – Facts of encounters of lynx's vital activity traces and individuals in 1930-1995 in the Northern Tien Shan mountains

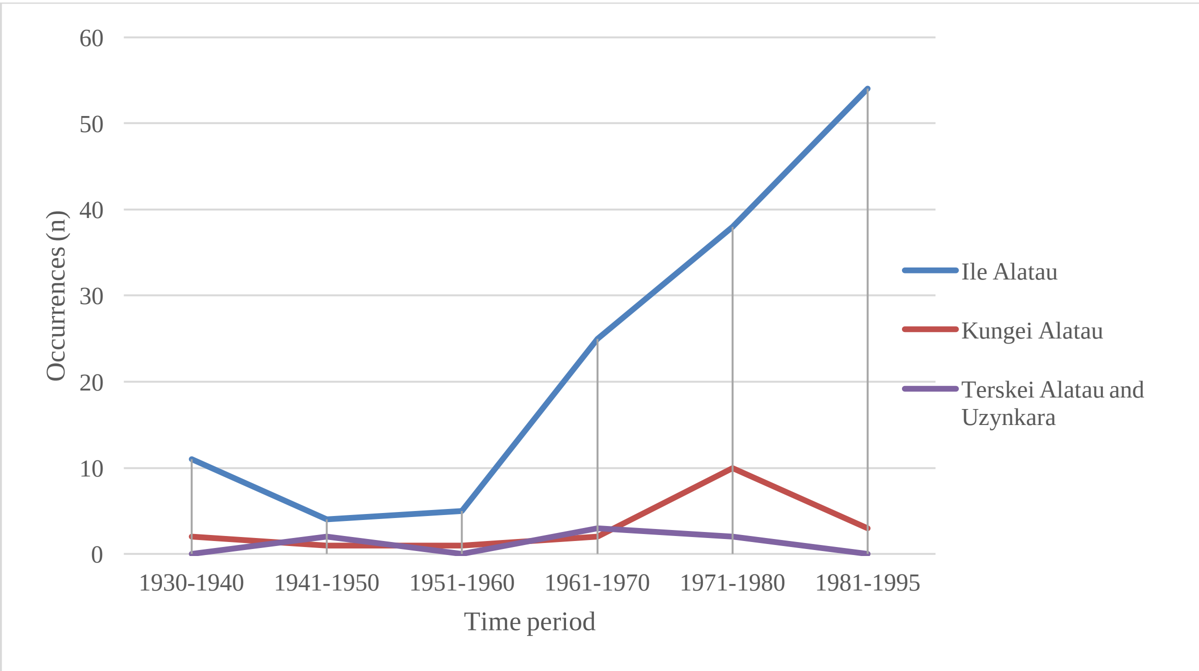

Table B.2 – Cumulative number of ungulates – lynx prey (Siberian ibex, red deer, Siberian roe deer, wild boar) in the Kazakh part of the Northern Tien Shan in 2019

Ridge	Total number, individuals	Including in the territories:		
		PAs	hunting grounds	other lands
Siberian ibex				
Ile and Kungei Alatau	4759	2304	1613	842
Uzynkara	2204	-	1995	209
Terskei Alatau	3976	-	3557	419
TOTAL	10939	2304	7165	1470
Red deer				
Ile and Kungei Alatau	1905	1390	296	219
Uzynkara	1647	-	1575	72
Terskei Alatau	1415	-	1107	308
TOTAL	4967	1390	2978	599
Siberian roe deer				
Ile and Kungei Alatau	7561	5890	1442	229
Uzynkara	1420	-	1267	153
Terskei Alatau	950	-	847	103
TOTAL	9931	5890	3556	485
Wild boar				
Ile and Kungei Alatau	2260	1782	315	163
Uzynkara	1157	-	1064	93
Terskei Alatau	630	-	569	61
TOTAL	4047	908	1948	313

Table B.3 – Daily activity of the lynx in the Ile Alatau

Species	lynx		roe deer		Siberian ibex		wild boar		red squirrel	
Index / Time phase	IC (n)	DIC (%)	IC	DIC	IC	DIC	IC	DIC	IC	DIC
00.00-01.00	1	4,8	1	2,8						
01.01-02.00	2	9,5					1	14,3		
02.01-03.01			2	5,5			1	14,3		
03.01-04.00	1	4,8	2	5,5						
04.01-05.00			1	2,8	1	2,9				
05.01-06.00			6	16,7			1	14,3		
06.01-07.00	1	4,8	3	8,3						
07.01-08.00	2	9,5	1	2,8	2	5,9				
08.01-09.00	2	9,5	1	2,8	3	8,8			5	38,4
09.01-10.00			2	5,5	1	2,9			4	30,8
10.01-11.00			2	5,5	4	11,8				
11.01-12.00	1	4,8			1	2,9			1	7,7
12.01-13.00	3	14,2			3	8,8				
13.01-14.00			1	2,8	3	8,8			1	7,7
14.01-15.00					5	14,7	1	14,3	1	7,7
15.01-16.00			1	2,8	3	8,8				
16.01-17.00	1	4,8	1	2,8					1	7,7
17.01-18.00	3	14,2			1	2,9				
18.01-19.00			3	8,3	2	5,9				
19.01-20.00			1	2,8	4	11,8				
20.01-21.00	1	4,8	3	8,3	1	2,9	1	14,3		
21.01-22.00			3	8,3			2	28,5		
22.01-23.00	1	4,8	1	2,8						
23.01-00.00	2	9,5	1	2,8						
Total	21		36		34		7		13	

Table B.4 – Daily activity of the lynx in the Kungei Alatau

Species	lynx		roe deer		tolai hare		Siberian ibex		wild boar		red squirrel	
Index / Time phase	IC	DIC	IC	DIC	IC	DIC	IC	DIC	IC	DIC	IC	DIC
00.00-01.00	1	5,5			9	9,3	2	3,5	1	4,7		
01.01-02.00	1	5,5			12	12,5			1	4,7		
02.01-03.01					8	8,3	1	1,7				
03.01-04.00	2	11,2			8	8,3						
04.01-05.00					6	6,2	4	7,1	1	4,7	1	1,3
05.01-06.00					9	9,3	4	7,1				
06.01-07.00	1	5,5			2	2,1	5	8,8	2	9,5		
07.01-08.00	2	11,2			2	2,1	4	7,1	1	4,7	4	5,2
08.01-09.00			1	33,3			4	7,1			8	10,4
09.01-10.00	1	5,5					1	1,7			15	19,4
10.01-11.00	2	11,2	1	33,3	1	1,1	6	10,5			11	14,3
11.01-12.00							1	1,7			11	14,3
12.01-13.00	1	5,5					1	1,7	5	23,8	8	10,4
13.01-14.00							1	1,7	2	9,5	5	6,5
14.01-15.00					1	1,1			1	4,7	4	5,2
15.01-16.00			1	33,3	1	1,1	4	7,1			2	2,6
16.01-17.00					1	1,1	7	12,3	2	9,5	7	9,1
17.01-18.00	2	11,2			1	1,1	1	1,7	3	14,3	1	1,3
18.01-19.00					7	7,3	5	8,8	1	4,7		
19.01-20.00	1	5,5			4	4,2	2	3,5				
20.01-21.00	2	11,2			8	8,3			1	4,7		
21.01-22.00					2	2,1	1	1,7				
22.01-23.00	1	5,5			9	9,3	2	3,5				
23.01-00.00	1	5,5			5	5,2	1	1,7				
Total	18		3		96		57		21		77	

Table B.5 – Specially protected natural areas in the Northern Tien Shan

Ridge	Protected area	Area (km^2)	IUCN category
Ile Alatau	Almaty SNR	717	Ia
	Ile-Alatau SNNP	1990	II
	Almaty wildlife sanctuary	5424	IV
	Sharyn SNNP	930	II
Kungei Alatau	SNNP Kolsai Kolderi	1610	II
Terskei Alatau	-	-	-
Uzynkara	-	-	-

APPENDIX C

Members of the research group

Nazerke Bizhanova – Junior Researcher of the Laboratory of Mammalogy at the Institute of Zoology, PhD student and Lecturer of zoology at the Department of Biodiversity and Bioresources at Al-Farabi Kazakh National University. Since 2014, she has been participating in research on the study of large carnivorous mammals in the Northern Tien Shan. The leader of this project.

Dr. Yuri Grachev – leading researcher at the Institute of Zoology. He has been studying ecology and the problems of preserving large carnivores for over 40 years. The leader and responsible executor of all government programs and projects on carnivorous and ungulate mammals. Author of a large number of scientific publications on mammals in Kazakhstan.

Alexey Grachev – Head of the Laboratory of Mammalogy at the Institute of Zoology, founder of the Public Foundation “Wildlife Without Borders Kazakhstan”. Scientific director of the state program for the study of snow leopard conservation in Kazakhstan. Since 2011, he has been continuously observing large carnivorous and ungulate mammals in the mountains of the Northern Tien Shan.

Saltore Saparbayev – hunting biologist. Since 2005, he has been studying large carnivorous and ungulate mammals on the territory of the Almaty Reserve. In 2013-2016 was a national expert on PA management in the international project: “Conservation of biodiversity in the transboundary region of the Northern Tien Shan” (NABU). Professional wildlife photographer and videographer.

Yerlik Baidavletov – Researcher at Institute of Zoology and Ile-Balkhash State Natural Reserve. Specializes in the ecology of rare and endangered mountain ungulates in Kazakhstan. GIS and ecological corridor specialist. Has a number of scientific publications on lynx prey species.

Maxim Bespalov – Senior field assistant at Institute of Zoology. Specialist in monitoring the fauna of mountain ecosystems. For about 10 years he has been observing large mammals of the Northern Tien Shan. An expert on survival in extreme conditions.

Sergey Bespalov – Senior field assistant at Institute of Zoology. Specialist in monitoring the fauna of mountain ecosystems. For about 10 years he has been observing large mammals of the Northern Tien Shan. He is fond of photography and video filming of wildlife. Populariser of biodiversity conservation among youth.

APPENDIX D

List of publications

1. Bizhanova N.A., Malgeldiev D.N., Grachev A.A., Zhaparkulov T.M. (2019) *Turkestanskaya rys' (Lynx lynx isabellina) v Ile-Alatauskom Natsional'nom Parke* [Turkestan lynx (*Lynx lynx isabellina*) in the Ile-Alatau National Park]. *Bulletin of KazNPU. Series "Natural and geographical sciences"*, No. 3 (61): 51-55. (In Russian)
2. Bizhanova N., Grachev Yu.A. (2020) *Primenenie fotolovushek pri izuchenii turkestanskoi rysi (Lynx lynx isabellina) v natsional'nom parke "Kol'sai kol'deri"* [The use of camera traps in the study of the Turkestan lynx (*Lynx lynx isabellina*) in the Kolsai Kolderi National Park] / *Materials of the International Scientific Conference of Students and Young Scientists "Farabi Alemi"*, Almaty, 2020, p. 30. (In Russian)
3. Bizhanova N., Grachev Yu. The relevance of study and conservation of the Turkestan lynx (*Lynx lynx isabellina*) in Kazakhstan / *XVI International scientific conference for students and PhD students "Youth and Progress of Biology"*, Ukraine, Ivan Franko national university of Lviv, LVIV, 2020, p. 120.
4. Bizhanova N. Proshloe sostoyanie populyatsii turkestanskoy rysi v Severnom Tyan'-Shane [The past state of the Turkestan lynx population in the Northern Tien Shan] // *Materials of the International Scientific Conference of Students and Young Scientists "Farabi Alemi"*, Almaty, 2021, p. 27. (In Russian)

APPENDIX E

Additional information on the project

Participation of the research group members at international conferences and seminars on the topic of the project:

1. International Scientific Conference of Students and Young Scientists "Farabi Alemi", Almaty, Kazakhstan, April 6-9, 2020 (Bizhanova N.)
2. XVI International scientific conference for students and PhD students "Youth and Progress of Biology", Ukraine, Ivan Franko national university of Lviv, LVIV, April 27-29, 2020 (Bizhanova N., Grachev Yu.)
3. Conservation of rare carnivores // Seminar with students of High Tech Academy, Institute of Zoology of the Ministry of Education and Science of the Republic of Kazakhstan, October 2020 (Grachev A., Bizhanova N., Saparbayev S.)
4. Results of research on rare and economically important species of mammals: Turkestan lynx in the Ile-Alatau National Park // Seminar – Scientific and technical meeting, Ile-

Alatau State National Natural Park, December, 2020 (Bizhanova N., Grachev A., Saparbayev S., Bespalov M.)

5. International Scientific Conference of Students and Young Scientists “Farabi Alemi”, Almaty, Kazakhstan, April 6-8, 2021 (Bizhanova N.)
6. Problems of modern scientific research in the context of a pandemic / Round table, Department of Biodiversity and Bioresources of Al-Farabi KazNU, Almaty, Kazakhstan, April 20, 2021 (Bizhanova N.)