Ministry of Science and Higher Education of the Russian Federation
Federal Research Center "Yakut Scientific Center of the Siberian Branch of the Russian Academy of Sciences SB RAS"
Institute for Biological Problems of Cryolithozone
Siberian Branch of the Russian Academy of Sciences

# REPORT

## on the Program for the Study, Conservation, and Rational Use of the Snow Sheep of the Kharaulakh Ridge

## for the year 2023

***(according to the agreements between CMH and IBPC SB RAS dated July 12, 2023, No. 23n/2023 and May 18, 2023, No. 33n/2022)***

Responsible Executor:

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## INTRODUCTION

The present report is a logical continuation of the research conducted in 2021-22 initiated by the Mountain Hunting Development Fund "The Club of Mountain Hunters" (CMH) within the framework of the Program for the Study, Conservation and Rational Use of the Snow Sheep of the Kharaulakh Ridge, approved by the Ministry of Natural Resources and Environment of the Russian Federation in 2021. The CMH is financing the program for the third consecutive year.

Previously, scientists from the Federal Research Center for Animal Husbandry named after L.K. Ernst (Dubrovitsy, Moscow Region) and the Institute of Biological Problems of the Cryolithozone, Siberian Branch of the Russian Academy of Sciences (Yakutsk), based on genetic research using materials from the Institute of Biological Problems of the Cryolithozone, preliminarily identified the snow sheep inhabiting the Kharaulakh Ridge as a distinct subspecies (Bagirov et al., 2016; Dotsev et al., 2021). This identification prompted the establishment of the Program.

The research under the current project in 2023 was carried out based on the research contract No. 23n/2023 dated July 12, 2023, titled "Assessment of population size and identification of habitats of the snow sheep within the southern slopes of the Kharaulakh Ridge (Bulunsky and Eveno-Bytantaisky districts, Sakha Republic (Yakutia)) and seasonal movements on the ridge," as well as additional agreement No. 1 dated December 22, 2022, under the research contract No. 33n/22 dated May 18, 2022, titled "Determination of seasonal movements and potential distribution boundaries of the snow sheep in the Kharaulakh Ridge mountains, Bulunsky ulus (district), Sakha Republic (Yakutia), using satellite telemetry collars".

The work in 2023 was carried out by the Institute of Biological Problems of the Cryolithozone, Siberian Branch of the Russian Academy of Sciences (IBPC SB RAS) and the Federal Scientific Research Centre for Hunting Development (FSBI "FSRC Hunt", Moscow).

## Chapter 1. Assessment of the Vegetation Condition and Pasture Productivity for Snow Sheep in the Southern Part of the Kharaulakh Ridge

The research was conducted in a mountainous area located in the relatively southern part of the Kharaulakh Ridge from July 15 to August 1, 2023, during the main period of vegetation, flowering, and fruiting of plants. The research was led by the chief scientist of the institute, Dr.Sci. in Biology E.V. Nikolin, and included specialists in GIS mapping, senior researcher, Ph.D. in Biology B.Z. Borisov, and research engineer and geobotanist E.N. Nikiforova.

A total of 20 cuts were taken, predominantly featuring plants of nutritional value to the snow sheep (Fig. 1).

| | | |
|---|---|---|
|  |  |  |
| The turf of the *Alopecurus alpinus*. Cutting №1 | The turf of the *Arctagrostis arundinacea*. Cutting №2 | The turf of the *Deschampsia vodopjanoviae*. Cutting №3 |

| | | |
|---|---|---|
|  |  |  |
| The fragment of the *Salix reptans* thicket. Cutting №4 | The tussock of the *Eriophorum vaginatum*. Cutting №5 | Standard turf of the *Poa glauca*. Cutting №6 |
|  |  |  |
| The stand of the *Salix sphenophylla*. Cutting №10 | The stand of the *Dryas incisa*.Cutting №11 | The fragment of the *Calamagrostis lapponica* thicket. Cutting №12 |
|  |  |  |
| The *Oxytropis adamsiana* shrub. Cutting №15 | The turf of the *Pedicularis amoena*.Cutting №16 | The fragment of the blueberry tundra. Cutting №18 *Vaccinium uliginosum* |
| Fig. 1. Examples of cuttings in the study area, July 2023. Photo by Nikolina E.G. | | |

Based on the results of the research carried out, it can be concluded that the region studied has a sufficiently high content of common and well-known fodder plants for snow sheep, such as *Arctagrostis arundinacea* (Trin.) Beal. – 19-29 c/ha, *Calamagrostis lapponica* (Wahlenb.) C. Hartm. – locally up to32,4 c/ha, *Alopecurus alpinus* Smith. – 2,6-3,9 c/ha, *Poa glauca* Vahl, – locally up to 18,4 c/ha, *Deschampsia vodopjanoviae* Nikiforova – 8-32 c/ha. *Eriophorum vaginatum* L. – 17,4 c/ha, *Astragalus umbellatus* Bunge – 8-15 c/ha, *Hedysarum arcticum* B. Fedtsch. – 2,1 c/ha, *Pedicularis alopecuroides* Adams – 0,8-3,1 c/ha, *Pedicularis amoena* Adams ex Stev. – 1,7 c/ha, *Oxytropis adamsiana* (Trautv.) Jurtz. subsp. *adamsiana* Jurtz. – 11-15 c/ha, *Oxytropis nigrescens* (Pall.) Fisch. – 1,8 c/ha, *Aconogonon tripterocarpum* (A. Gray) Hara – 12,8-25,7 c/ha, *Vaccinium vitis-idaea* L. – locally up to 31,7-40,7 c/ha, *Vaccinium uliginosum* L. subsp. *microphyllum* (Lange) Tolm. – locally up to 34,8-44,7 c/ha, *Dryas incisa* Juz. – до 23,7-29,6 c/ha, *Salix sphenophylla* A.K. Skvortsov – 7,1-17,0 c/ha, *Salix reptans* Rurp. – the stock of useful phytomass 13,2 c/ha, *Cassiope tetragona* (L.) D. Don. – 28-43, locally up to114,1 c/ha.

Based on these data, Table 1 presents the productivity of snow sheep pastures, where the following habitats are characterized by high productivity for the species:

- Mixed herb-shrub tundra;
- Sedge-willow tundra;

- Mixed herb-dryad tundra;
- Tussock shrub tundra.

Table 1

The productivity of snow sheep pastures in the study area in July 2023

| Pasture type | S (ha) | Pasture productivity (average, c/ha) |
|---|---|---|
| Mixed herb-dryad tundra | 7682 | 24,5 |
| Mixed herb-shrub tundra | 4788 | 64,0 |
| Tussock shrub tundra | 3522 | 20,0 |
| Sedge-willow tundra | 1824 | 25,0 |

During the research, high productivity ranging from 32 to 56 c/ha was also found in transformed weed communities (Arctic ground squirrel burrows) within the mixed herb-dryad tundras. It has been observed that the Arctic ground squirrel significantly transforms the vegetation in its habitat. By gnawing on the root systems of plants, it disrupts the tundra turf, exposing the underlying surface of the thin soil layer, scattering and moving its organic horizon.

However, the products of Arctic ground squirrel vital activity enrich the soil with nitrogen compounds, leading to the formation of highly productive weed communities in the burrowing areas of the ground squirrels, which are eagerly consumed by snow sheep. It can be considered that these animals complement each other as typical representatives of mountain animals in Yakutia. However, such areas are extremely rare due to the small number of ground squirrel colonies in this region, but these places are often used by bighorn sheep only for rest and quick food.

The calculation of potential forage capacity was carried out for the 5 specified tundra types as a unified pasture for snow sheep in the study area (see Table 1). The average forage requirement per animal is 0.12 c/animal/day (Nikolin et al., 2020). The average pasture yield, based on the assessment carried out in July 2023, is 24.0 c/ha. The grazing period for the bighorn sheep is 365 days.

Based on this, the calculated potential forage capacity of the pastures indicates that approximately 7,000 individuals of snow sheep could theoretically graze on the southern part of the Kharaulakh Ridge.

## Chapter 2. Assessment of Snow Sheep Population Based on Ground Visual Counting

In the spring of 2023, from 24 April to 15 May, surveys were conducted in the northern part of the Kharaulakh Ridge, covering the areas of the headwaters of the Kendei River and the tributaries of the Khopto-Yuryakh River, including the Khadarylan, Emtenede, Dyandi, Soguru-Gollandsky, Ortoku-Gollandsky and Khotugu-Gollandsky rivers. The surveys were carried out by three surveyors using three snowmobiles. In total, approximately 800 km of survey routes were covered through valleys, slopes and mountain peaks, covering a total area of 29,521.52 ha (see Figure 2).

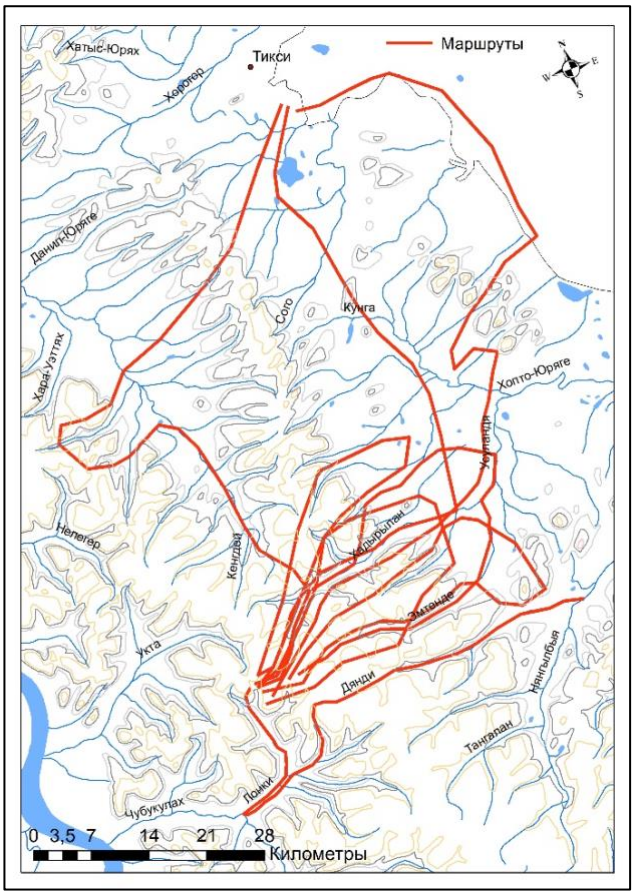


Fig. 2. Survey route schemes from April 24, 2023 to May 15, 2023, in the northern part of the Kharaulakh Ridge

A total of 105 snow sheep individuals were recorded during this period, with the gender visually determined for 69 individuals. The overall gender ratio was 2 males to 1 female, and herd sizes varied from 3 to 23 individuals. The herds were clearly segregated by gender, with no mixed herds or groups observed (see Fig. 3).

The spring survey of the northern part of the Kharaulakh Ridge identified three areas of seasonal concentration of snow sheep (see Fig. 4). The population density of bighorn sheep in zone 1 was 4.0 individuals per 1000 hectares, in zone 2 it was 1.8, and in zone 3 it was 5.3 individuals per 1000 ha. All these areas were associated with snow-free slopes and mountain peaks (see Figure 3 and Figure 5). In areas with continuous snow cover, no sheep or their activity traces were found.

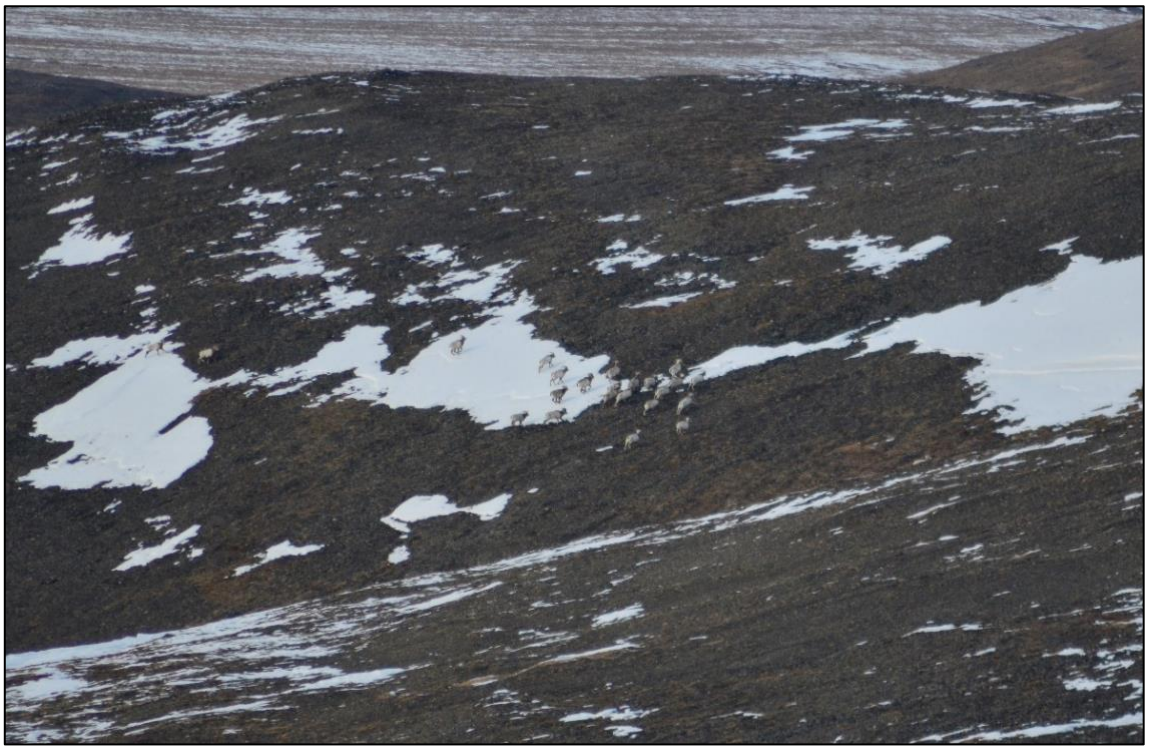

Fig. 3. Herd of males, April 2023. Photo by E.V. Kirillin


Fig. 4. Snow sheep concentration areas in the early spring period in the northern part of the Kharaulakh Ridge

Fig. 5. Typical grazing area for snow sheep in the early spring period on a gentle snow-free mountain peak, April 2023. Photo by E.V. Kirillin

The average population density of bighorn sheep in this surveyed area of the northern part of the Kharaulakh Ridge was 3.5 individuals per 1000 ha.

From August 16 to September 1, 2023, research in the southern spurs of the Kharaulakh Ridge was conducted with the support of FSBI "FSRC Hunt", Moscow

The fieldwork was carried out by two employees of the IBPC - E.V. Kirillin and N.V. Mamaev, and two employees of FSBI "FSRC Hunt"- A.V. Davydov and A.A. Fyodorov. Snow sheep monitoring at model sites from observation points was conducted at the locations of camps – at Sasyr, Ugdama, and Nyosu (names of rivers near which the camps were located). Observation points at Sasyr and Ugdama were specifically tied to snow sheep capture sites. The bulk of the observational data was collected during route surveys using off-road vehicles. The total length of the transport routes was 248 km, covering the central and southern parts of the Kharaulakh Ridge. During the fieldwork period, 230 snow sheep individuals were recorded, including 64 adult mature males, 137 adult mature females, and 32 lambs.

As a result of the conducted survey work, the area of the surveyed territory has been calculated to be 36,675.54 hectares. This area was determined using ArcGIS 10.6 software based on the actual surveyed territories, which included mountain slopes and the erosion zones of stream headwaters (see Figure 6). Valleys of major rivers were not included in the calculation.

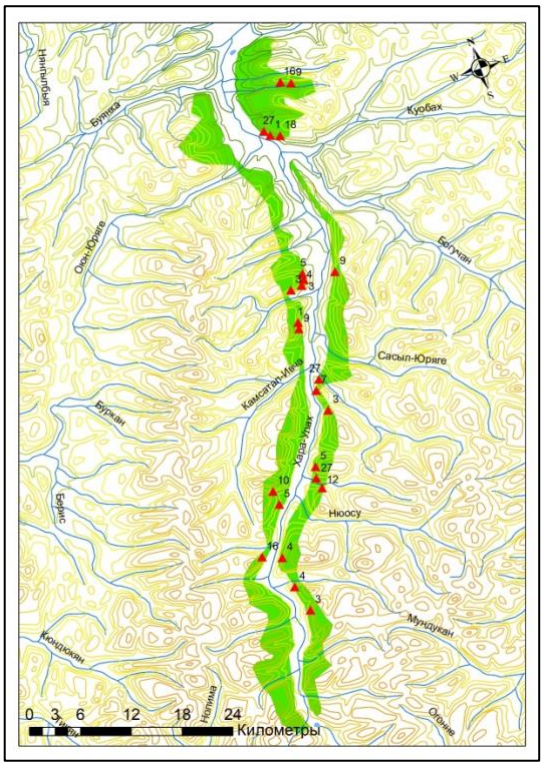


Fig. 6. The territory surveyed during the August 2023 inventory. Red triangles indicate locations where bighorn sheep were detected, with numbers indicating the quantity encountered animals

The work carried out made it possible to identify areas with a relatively high density of snow sheep within the survey area (see Figure 7). The remainder of the surveyed area is classified as zones of average density.

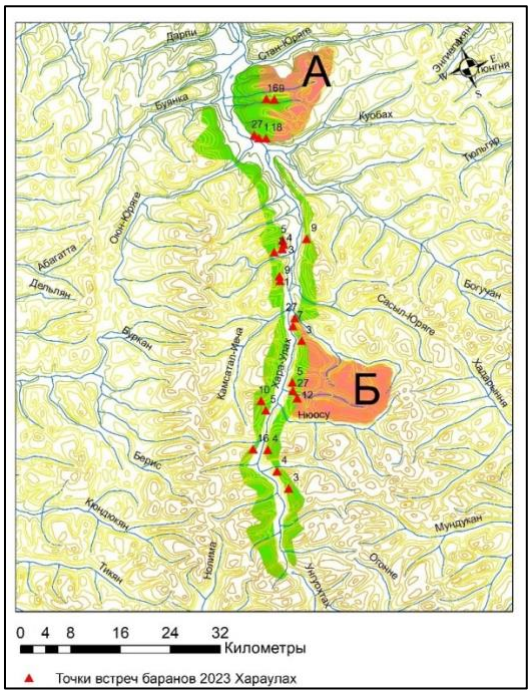


Fig. 7. Zones of high snow sheep population density on the surveyed territory in 2023: Zone A - density 5.5 individuals per 1000 ha; Zone Б - 4.8 individuals per 1000 ha. The zone with moderate density is marked in green - 2.8 individuals per 1000 ha

These high-density zones, identified in August, were associated with the locations of natural salt licks for snow sheep in the middle and upper reaches of the Kharaulakh River. Thus, according to the calculations, the average density of snow sheep in the surveyed area along the central and southern parts of the Kharaulakh Ridge in August 2023 is 6.3 individuals per 1000 ha.

The gender ratio of adult individuals was characterized by a 1:2 ratio, with one female for every two males. The proportion of this year's lambs in the visually recorded groups was 14% overall. Solitary individuals were encountered only twice: in the first instance, a single adult male, and in the second, a female.

Groups ranging from 3 to 12 individuals were most commonly encountered, with the largest group consisting of 27 animals. On average, group size during the observation period was 7.6 individuals. Out of the 22 groups and herds encountered, 8 were all-male (ranging from 2 to 5 individuals per group), 9 herds consisted of females with lambs (including 3 to 10 adult females), and 4 herds were mixed, comprising 4 to 10 adult males and 4 to 19 females.

Thus, the combined spring and summer surveys in the northern, central and southern parts of the Kharaulakh Ridge showed that in spring, and probably also in winter, snow sheep concentrate on snow-free slopes and mountain peaks. In summer, and probably also in autumn, they use tundra pastures above the tree line in a mosaic pattern, concentrating mainly around natural salt licks.

The area of snow sheep occurrence in the mountains of the Kharaulakh Ridge, determined based on sightings, is 1145,7 thousand ha (IBPC Report, 2022). This year, with the southern part of the mountains surveyed for the first time, the total population of the Haraulakh snow sheep group can be relatively estimated at 6000 individuals, with approximately 2000 in the northern part of the range and 3600 in the central and southern parts.

## Chapter 3. Capture and Tagging with Satellite Radio Collars

Continuing its commitment to the Mountain Hunting Development Fund, the Institute carried out field work in the Kharaulakh Ridge from 24 April to 15 May, focusing on the capture and satellite tagging of snow sheep with transmitters.

The trapping was carried out on the Kharaulakh Ridge by members of the Institute, Ph.D. in Biology E.V. Kirillyin and Junior Researcher N.V. Mamaev. Supervision of the capture and tagging was provided by the member of the Bulun Nature Conservation Inspection of the Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia) and an external public nature conservation inspector.

Snow sheep were captured using snowmobiles (see Figure 8) by driving the ungulates into lower mountain areas where they were captured and fitted with transmitters. Three snowmobiles were used for capture from three directions, followed by immobilisation of the animals with a net gun.

During this period, 2 individuals of snow sheep were captured and fitted with "Quasar" radio collars produced by LLC "ES-PAS" (Moscow).

| № | Collar ID | Gender, age | First signal date | Last signal date | Operational period (days) |
|---|---|---|---|---|---|
| 1 | 630291 | Female, 3-4 years old, pregnant | 28.04.2023 | 18.05.2023 | 20 |
| 2 | 630179 | Male | 06.05.2023 | 30.06.2023 | 55 |

Fig. 8. Snow sheep capture and tagging operation using snowmobiles

**Female ID 630291**

On April 28, 2023, a 3-4 year old female was captured on the Khadyrylan River, a tributary of the Usulandya River, (71°04′59.41″ N, 128°51′54.61″ E) (see Figure 9).

Fig. 9. Capturing and tagging of female snow sheep with collar ID 630291 on April 28, 2023, Photo by N.V. Mamaev

The captured female was part of a group of 4 females. A week after the initial tagging, follow-up visits were made to assess the condition of the captured animal. The female was found to be in good condition and was already grazing with another female.

The satellite transmitter operated reliably for 20 days, recording the animal's movements. Only once, on May 7, the signal was briefly interrupted (approximately for 11.5 hours), after which it resumed normal operation without further interruptions. On May 8, the female crossed the Kengdey River and headed towards the Tuora-Sis Ridge. On May 14, she found a feeding site at

the headwaters of the Artyk-Byssita River (a tributary of the Neleger River), 3 km from Mount Sukuydakh-Khayata. However, after 20 days, signals started coming only from a single location (71°15′51.01″ N, 127°50′24.61″ E). After prolonged observation, it was decided to deactivate the collar. The animal did not exhibit signs of fear or distress before its demise; it behaved normally. It is possible that it was suddenly attacked by a predator or perished due to birthing or other causes (see Figure 10).

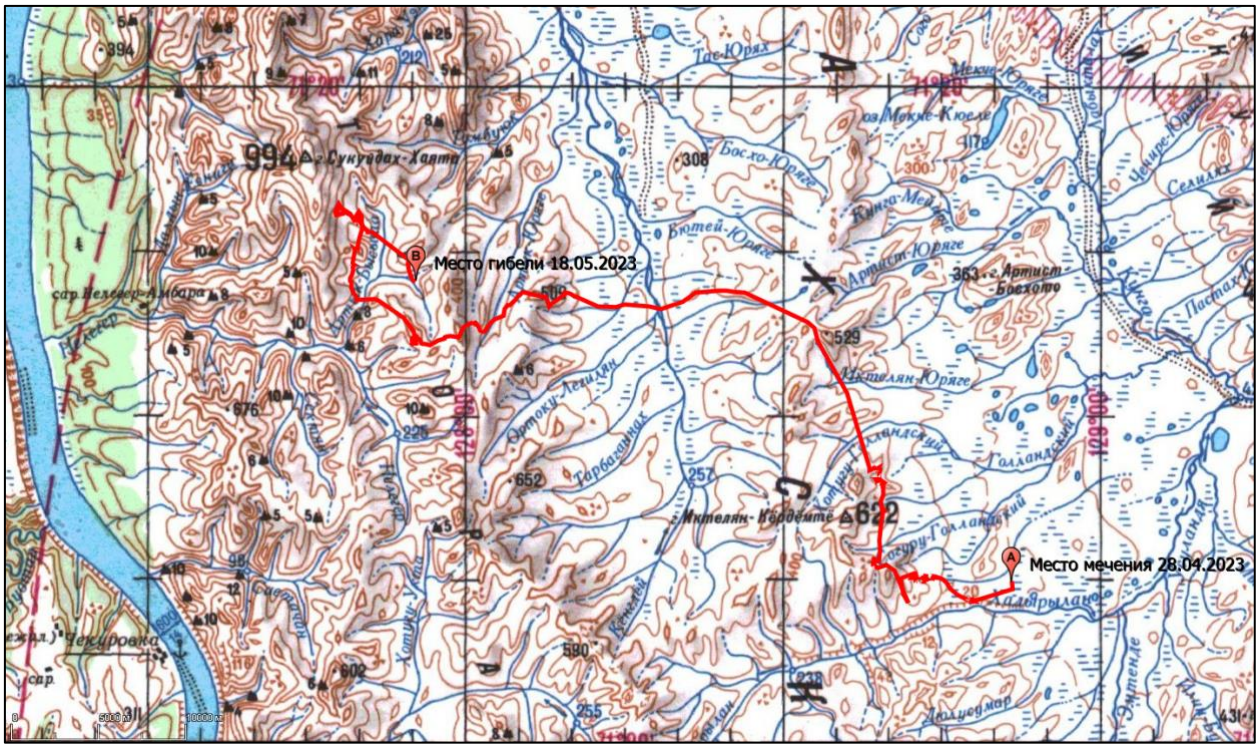


Fig. 10. Movement tracks of the female on a topographic map during the period from April 28, 2023, to May 18, 2023

A total of 4721 location points were obtained during the tagging period. Over the entire period of collar operation, the female travelled a total of 104 km, moving 37 km in a direction of 297 degrees from the tagging point. The average daily movement was 5 km, with a minimum of 1.5 km and a maximum of 12.7 km per day (Table 2, Figure 11).

Table 2

The daily movement of female ID 630291

| Date | Daily movement (km) |
|---|---|
| 28.04.2023 | 3,117 |
| 29.04.2023 | 1,478 |
| 30.04.2023 | 5,717 |
| 01.05.2023 | 2,951 |
| 02.05.2023 | 3,044 |
| 03.05.2023 | 9,543 |
| 04.05.2023 | 5,449 |
| 05.05.2023 | 4,234 |
| 06.05.2023 | 3,333 |
| 07.05.2023 | 9,769 |
| 08.05.2023 | 12,739 |
| 09.05.2023 | 3,561 |

| | |
|---|---|
| 10.05.2023 | 4,09 |
| 11.05.2023 | 2,302 |
| 12.05.2023 | 5,196 |
| 13.05.2023 | 2,405 |
| 14.05.2023 | 6,069 |
| 15.05.2023 | 3,207 |
| 16.05.2023 | 7,364 |
| 17.05.2023 | 3,245 |
| 18.05.2023 | 5,803 |

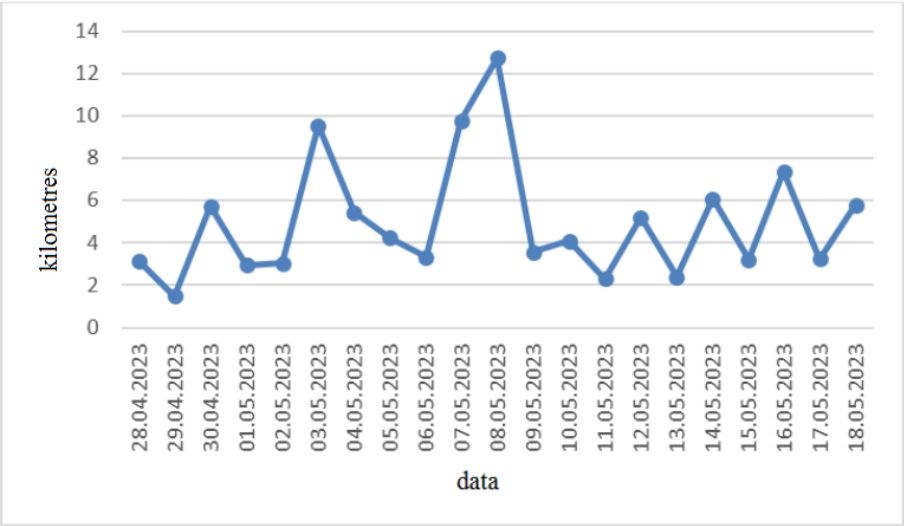


Fig. 11. Daily movement graph of female ID 630291

**Male ID 630179**

The male snow sheep was captured on May 6, 2023 (see Figure 12) while grazing in a group of 3 males, all observed to be of the same age.

Fig. 12. Capture and tagging of the male snow sheep on May 6, 2023, Photo by N.V. Mamaev

The first signal from the transmitter was received on the same day at the mouth of the Kunga River, 3 km west of Mount Kopto-Khayata (71°12′07.81″ N, 129°17′06.61″ E). After tagging, the male snow sheep roamed along the Kunga Ridge, occasionally reaching the headwaters of the Seliyah River (a tributary of the Kunga River). The collar operated intermittently after tagging, providing sporadic signals. Until June 10, the male was located at the headwaters of the Urasa-Yuryage River (a tributary of the Kunga River). Subsequently, the transmitter signal was lost for 20 days. The last signal was received on June 30 on the right bank of the Nyangylbya River near the mouth of the Dyandi River (70°53′33.00″ N, 129°14′12.59″ E), approximately 38 km south of the previous location (see Figure 13).

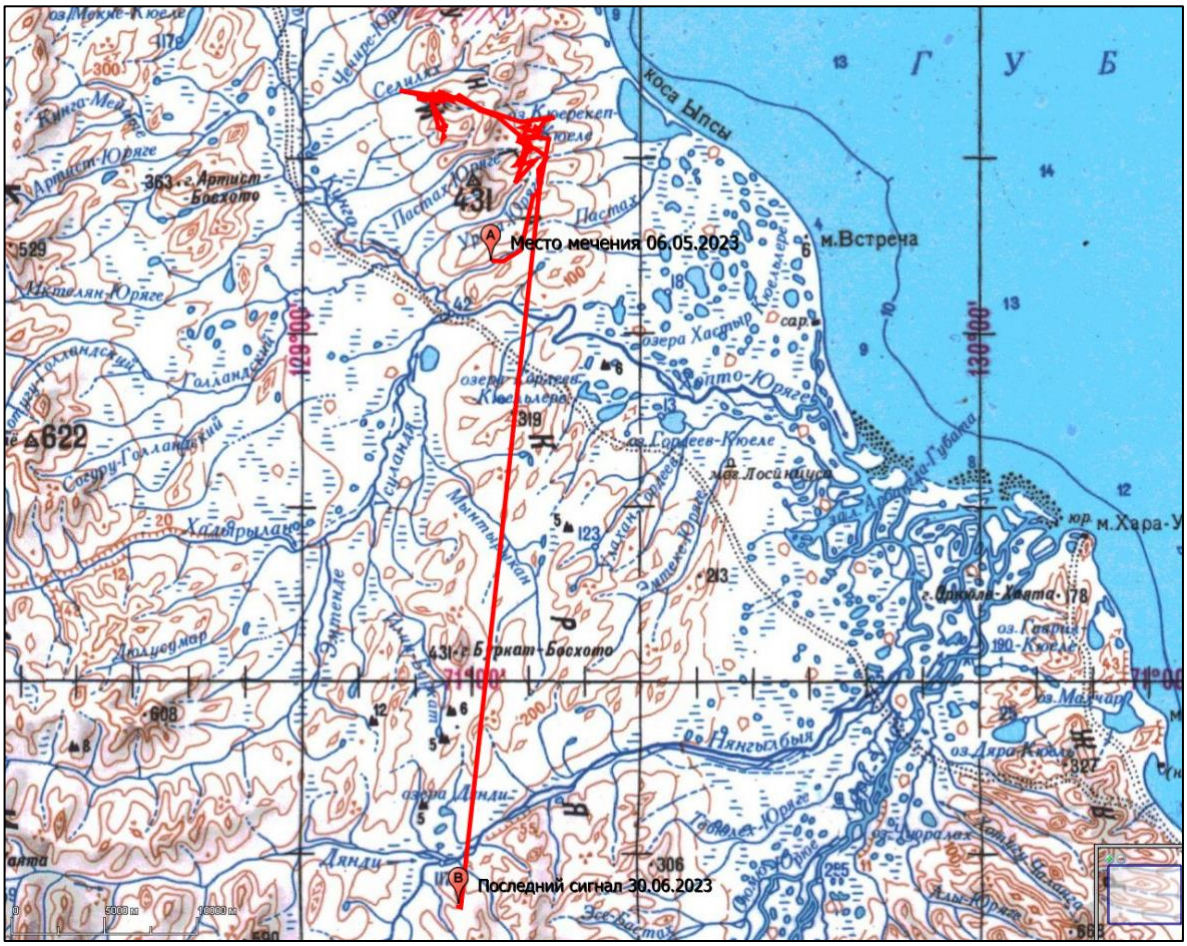


Fig. 13. Movement tracks of the male on a topographic map during the period from May 6, 2023, to June 30, 2023, illustrating technical instability of the transmitter operation

During the entire period of tracking, the collar transmitted a total of 605 location points. There are gaps in the data for the following days: June 7-9 and June 11-29, during which the collar was not operational. Therefore, daily movements were accurately calculated only until June 6. Over the entire operational period, the male covered 90 km and moved 34 km in the direction of 182 degrees from the tagging point. The average daily movement was 2 km, with a minimum of 0.05 km and a maximum of 7.5 km per day (Table 3, see Figure 14).

Table 3

The daily movement of male ID 630291ID 630179

| Date | Daily movement (km) |
|---|---|
| 06.05.2023 | 0,646 |
| 07.05.2023 | 3,188 |
| 08.05.2023 | 3,226 |
| 09.05.2023 | 1,463 |
| 10.05.2023 | 0,719 |
| 11.05.2023 | 1,243 |
| 12.05.2023 | 1,11 |
| 13.05.2023 | 7,512 |
| 14.05.2023 | 0,777 |
| 15.05.2023 | 1,107 |
| 16.05.2023 | 2,989 |
| 17.05.2023 | 3,404 |
| 18.05.2023 | 0,773 |
| 19.05.2023 | 3,04 |
| 20.05.2023 | 0,485 |
| 21.05.2023 | 1,339 |
| 22.05.2023 | 6,875 |
| 23.05.2023 | 1,916 |
| 24.05.2023 | 0,917 |
| 25.05.2023 | 0,452 |
| 26.05.2023 | 0,584 |
| 27.05.2023 | 0,402 |
| 28.05.2023 | 6,639 |
| 29.05.2023 | 3,339 |
| 30.05.2023 | 1,494 |
| 31.05.2023 | 1,019 |
| 01.06.2023 | 1,235 |
| 02.06.2023 | 2,892 |
| 03.06.2023 | 5,431 |
| 04.06.2023 | 1,268 |
| 05.06.2023 | 0,607 |
| 06.06.2023 | 1,954 |

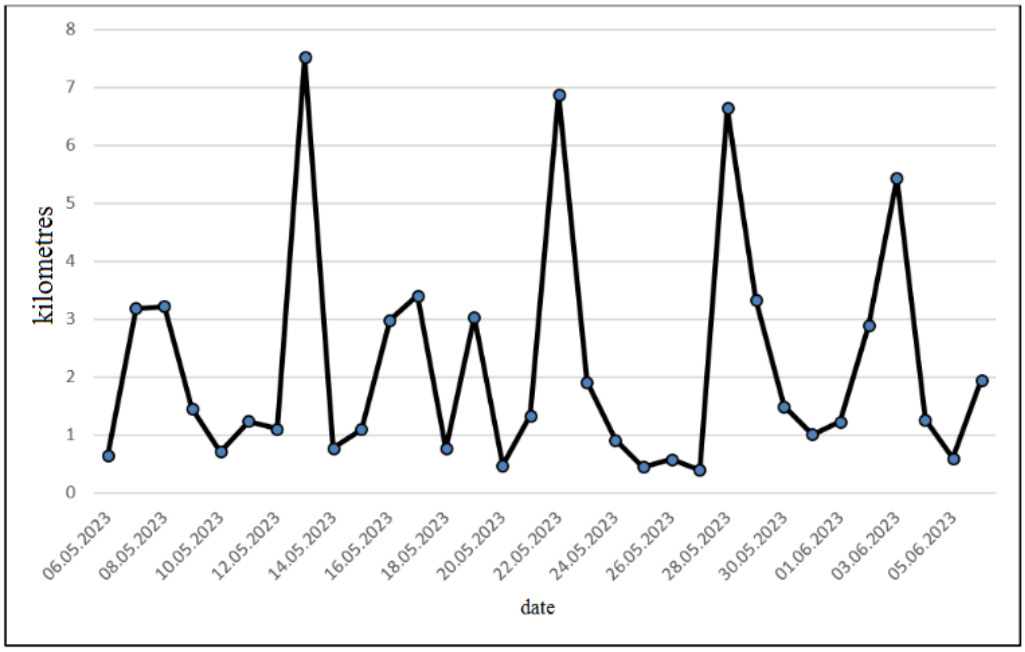


Fig. 14. Daily movement graph of male ID 630179

In August-September 2023, snow sheep capture operations for tagging with "Quasar" satellite radio collars, manufactured by LLC "ES-PAS" (Moscow), were also conducted at natural salt licks located on the Nyosou River and the Sasyr River. A total of 146 traps were set. The capture was overseen by A.A. Fedorov, a specialist from the FSBI "FSRC Hunt", Moscow, who has extensive experience in capturing mountain ungulates in the North Caucasus.

Foot traps with leg-holding cables were set up in areas where the largest concentrations of snow sheep were observed, with many trails present. All traps were also secured with cables to rocks to prevent the animals from escaping with the traps.

During the capture period, a total of 2 individuals were caught:

1. On August 26, 2023, on the Khara-Ulakh River (near the mouth of the Nyosou River, 70°05′33.00″ N, 129°14′34.19″ E), a female approximately 4 years old was captured and fitted with a radio collar ID 630183 (see Figure 15).

The moment of tagging with the radio collar

The released female with a radio collar

Figure 15. Capture and tagging of a female snow sheep on 28.08.23.
Photo by Kirillina E.V.

Unfortunately, the "Quasar" radio collar ceased transmission on August 27, 2023, having only sent signals from 17 location points (see Figure 16).

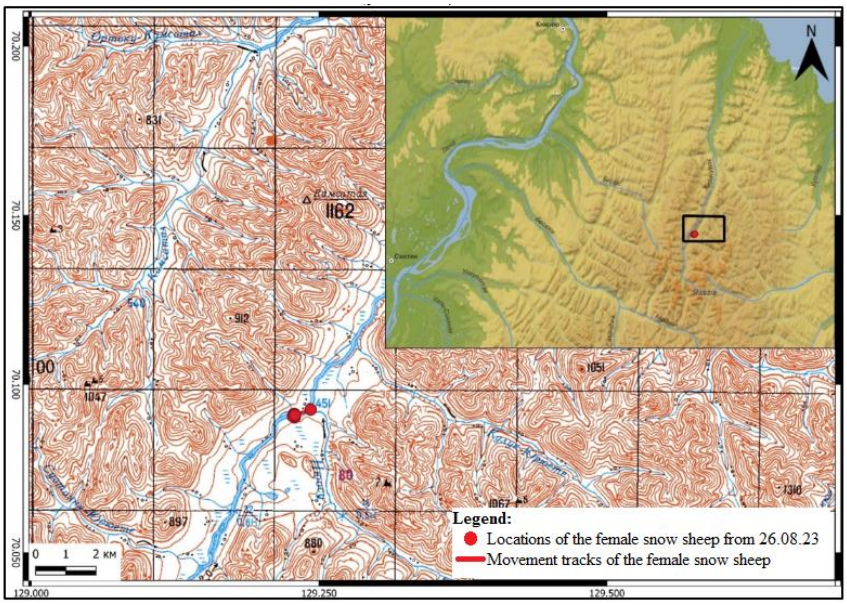

Figure 16. Locations and track of radio collar ID630183 from 26-27.08.2023

A lamb was captured on the Sasyr River, but due to its small size, it was released without being fitted with a radio collar (see Figure 30).


Figure 30. Female snow sheep lamb captured in a trap on the Sasyr River

In 2024, the institute will continue the capture and tagging of snow sheep. The focus should be solely on this work, while population surveys should be carried out by local hunting users in their areas and by the Ministry of Ecology of Yakutia. In addition, a substantial baseline for population characteristics has already been established thanks to three years of funding by the Club of Mountain Hunters.

## Chapter 4. Sampling of bighorn sheep bio-specimens for Genetic Research

In 2023, sampling of bighorn sheep biological specimens for genetic research was conducted in the public hunting grounds of the Bulunsky District (snow sheep of the Kharaulakh Ridge), as well as in specially protected natural areas of regional significance and public hunting grounds of the Eveno-Bytantay District (snow sheep of the Orulgan Ridge).

During the 2022/23 hunting season, the Institute received 8 permits to harvest snow sheep in the Bulunsky district on public hunting grounds. Biological samples were collected from 5 individuals: 2 samples from live captures in April-May and 3 samples from harvested animals. The harvested animals were processed using accepted methods of morphometric and craniometric measurements.

In addition, 20 biological samples were collected from representatives of indigenous small-numbered peoples of the North outside the territory of the hunting user "The Municipal Unitary Enterprise "Primorsky"". Within the territory of the "Primorsky", 2 biological samples were collected from live captures in August 2023. The total volume of collected material in the Kharaulakh Ridge Mountains in 2023 amounted to 27 biological samples.

During the 2022-2023 hunting season, the Institute obtained 4 permits for scientific research in the hunting grounds of the Eveno-Bytantaisky district, of which only 1 was used. This resulted in the capture of a ram on the northern slopes of the Orulgan-Sis ridge. In addition, indigenous small-numbered groups of the North, who are traditionally active on the Orulgan-Sis ridge, contributed 32 samples of biological material. In total, 33 biological samples were collected from snow sheep inhabiting the entire Orulgan-Sis ridge in 2023. The captured animals were also analysed using established methods of morphometric and cranial measurements.

Some of the materials for genetic research have already been transferred, while others are being prepared for transfer to colleagues at the Federal Research Center for Animal Husbandry named after L.K. Ernst. At our institute, the craniometric material is being processed to identify statistically significant differences in the size of snow sheep from the Orulgan-Sis ridge compared to bighorn sheep from other mountain systems in Yakutia and neighbouring territories.

All bio-samples from both the Kharaulakh Ridge and the Orulgan-Sis Ridge snow sheep have been included in the Biorepository Collection (BRK) of original animal tissue samples and the DNA bank of Yakutian snow sheep at the Molecular Genetics Laboratory of our Institute.

According to preliminary data, snow sheep from the northern slopes of the Orulgan-Sis Ridge show a mixed form with snow sheep from the Kharaulakh Ridge. In addition, snow sheep from the central and southern parts of this range are genetically distinct not only from Kharaulakh Ridge sheep, but also from sheep from the central part of the Verkhoyansk Ridge and other mountain systems of Yakutia (unpublished materials of the Federal Research Center for Animal Husbandry NA L.K. Ernst and IBPC SB RAS).

## Chapter 5. Monitoring predators and their activity traces and the impact of limiting factors

During the reporting period, April-May 2023, studies were conducted to assess the main predator influencing the snow sheep population in the Kharaulakh Mountains. The surveys were carried out by the staff of our institute in cooperation with the Bulunsky Nature Reserve Inspection of the Ministry of Ecology of the Republic of Sakha (Yakutia) on the public hunting grounds located here. As a result of the research conducted, the density of the wolf population in the snow sheep habitats in this area was found to be 0.04 individuals.

Following this, our institute processed the wolf survey data provided by "Primorsky" to the Department of Hunting Development and the Ministry of Ecology of the Republic of Sakha (Yakutia). According to this data, the wolf population density in the main snow sheep habitat of the Kharaulakh Mountains is relatively high, reaching 0.11 animals per 1000 ha.

The report of the FSBI "FSRC Hunt" (2023) indicates that, according to V.V. Alexeyev's assessment, the territory of the The Municipal Unitary Enterprise "Primorsky", which covers a significant part of the Kharaulakh population range, is inhabited by at least 5 wolf packs, each consisting of 5-6 individuals, mainly led by female wolves.

During joint fieldwork in the same area in August 2023, expedition participants observed signs of wolf activity (footprints, markings, remnants of molted fur) at the natural salt licks of the Sasyr and Nyosu rivers.

Also, two brown bears were observed, with one individual seen visually. Expedition participants also encountered a Wolverine as it approached our camp on the Nyosu River. According to our survey data conducted in April 2023 during snow cover, the density of Wolverine population in the public hunting grounds of the Kharaulakh Ridge was 0.03 individuals per 1000 ha, while in the territory managed by "Primorsky," according to the hunting user's records for 2023, it was 0.07 individuals per 1000 ha.

The brown bear, however, does not pose a significant threat to thick-horned sheep, as it only occasionally ventures into the Kharaulakh Ridge from the Orulgan-Sis Ridge, where its population has been extremely high in recent years.

Thus, among the predators, the wolf and the wolverine are the most threats and relatively numerous, with high population densities concentrated in the area managed by "Primorsky". This could be due not only to the main habitat of the snow sheep, but also to the presence of domestic reindeer herds.

## CONCLUSION

Based on the results of the conducted pasture studies, it can be concluded that the investigated region contains a high abundance of widely distributed and well-known forage plants for snow sheep. The productivity of snow sheep pastures in this area, particularly in the mixed herb-shrub, sedge-willow and tussock shrub tundras has been determined to be high.

Based on the calculation of the potential forage capacity of the pastures, it has been established that the mountains in the southern part of the Kharaulakh Ridge can theoretically support grazing for approximately 7000 snow sheep.

The average density of bighorn sheep in the surveyed area along the central and southern parts of the Kharaulakh Ridge in August 2023 was 6.3 individuals per 1000 ha. The gender ratio of adult individuals was characterized by a ratio of 1:2, meaning there were 2 males for every female. The proportion of yearlings born in the current year in visually recorded groups was 14%. Most commonly, groups consisted of 3 to 12 individuals, with the largest group consisting of 27 individuals. On average, the group size during the observation period was 7.6 individuals.

The average population density of bighorn sheep in the surveyed area of the northern part of the Kharaulakh Ridge from April 24 to May 15, 2023, was 3.5 individuals per 1000 ha. The overall gender ratio was also 2 males for every female, with herd sizes ranging from 3 to 23 individuals.

The combined spring and summer surveys of both the northern, central, and southern parts of the Kharaulakh Ridge revealed that in spring, and likely during the winter as well, snow sheep concentrate on snow-free slopes and mountain peaks. In the summer, and probably in the autumn, they use the tundra pastures above the tree line in a mosaic pattern, concentrating mainly around natural salt licks.

The snow sheep range in the Kharaulakh Ridge Mountains covers an area of 1,145,700 hectares. This year, the total population of the Kharaulakh snow sheep group, including the newly surveyed southern part of the mountains, is estimated to be about 6000 individuals. Specifically, there are about 2000 sheep in the northern part of the ridge and about 3600 in the central and southern parts.

In 2024, the Institute will continue the capture and tagging of snow sheep. It is important to know that all efforts for the coming year should be focused on this task only, with population surveys to be conducted by local hunters on their territories. Funding for these activities will come from trophy hunting revenues and the Ministry of Ecology of Yakutia. It should also be noted that CMH has been funding this project for three years.

In 2023, a total of 27 bighorn sheep biological samples were collected in the Kharaulakh Ridge mountains for genetic research. Additionally, 33 biological samples were obtained from the snow sheep inhabiting the entire Orulgan-Sis Ridge.

All biological samples from both the bighorn sheep of the Kharaulakh Ridge and the snow sheep of the Orulgan-Sis Ridge have been included in the Bioresource Collection (BRK) of original animal tissue samples and the DNA bank of Yakutian snow sheep. These collections are housed at the Molecular Genetics Laboratory of our institute.

In the predators, the main adversaries and relatively numerous are the wolf and wolverine, with their high population density concentrated in the territory of "Primorsky". This can be linked not only to the fact that this area hosts the primary habitat of the snow sheep, but also due to the presence of domestic reindeer herds.

Currently, the snow sheep population in the surveyed area is in a healthy state, as indicated by both their numbers and a balanced population condition with fertility rates typical of mountain animals. Hunting pressure is minimal here due to the remote accessibility of the territory.

In 2024, the Institute will continue capture and tagging snow sheep in the Kharaulakh Ridge mountains using 8 radio collars. Informational and final reports will be submitted to the Mountain Hunting Development Fund "The Club of Mountain Hunters".

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