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REPORT

"Determination of the snow sheep population status in the southern part of the Kharaulakh Ridge (Republic of Sakha (Yakutia)) based on the results of field studies with the application of methods for population counting, capturing, and tagging of animals "

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Abstract

The report presents the results of a study of snow sheep on the Kharaulakh Ridge, carried out during fieldwork in August 2023. The report includes a description of activities related to the survey, capturing, and tagging of animals. It provides an assessment of the population size, its age and gender structure, and identifies the influence of predators and other limiting factors.

The report contains 35 pages, 22 pictures, 2 tables, 9 sources were used.
SNOW SHEEP, KHARAULAKH RIDGE, SUBSPECIES, POPULATION, COUNTING, CAPTURING, TAGGING.

Contents

Introduction

Snow sheep (*Ovis nivicola*) are widespread in the mountainous part of Yakutia. Until recently, it was believed that the snow sheep living here belonged to one subspecies - the Yakut snow sheep (*O.n. lydekkeri*). However, there are now reasons to revise this statement and recognize the presence of another subspecies. The results of a genetic study of the snow sheep population living on the Kharaulakh Ridge (Northern Verkhoyanye) have revealed a particular uniqueness of this population, allowing it to be identified as a new subspecies.

Obviously, a population that is considered to be a new subspecies requires extensive study.

In 2021, at the initiative of the Ministry of Natural Resources and Environment of Russia, the Mountain Hunting Development Fund "The Club of Mountain Hunters" (CMH), with the direct participation of FSBI "FSRC Hunt", developed and approved the Program for the study, conservation, and rational use of the Snow Sheep of the Kharaulakh Ridge. The financial support for the program's activities was provided by the CMH.

In the same year, as part of the implementation of the Program, the first comprehensive expedition to the Kharaulakh Ridge took place in August. The expedition involved employees of the Federal State Budgetary Institution "Federal Center for Game Management," the Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia), the regional public fund " The Fund for the Study, Conservation of the Snow Leopard (Snow Leopard) and Rare Species of Mountain Fauna," the Faculty of Hunting and Bioecology of Irkutsk State Agrarian University, the Federal State Budgetary Institution "State Reserve "Central Siberian", the Municipal Unitary Enterprise "Primorsky" of the Republic of Sakha (Yakutia), and students of Vyatka State Agrarian Technological University. The primary objective of the expedition was to ascertain the population size of the snow sheep in the Kharaulakh Ridge and understand the spatial distribution of animals in the surveyed area. To achieve this goal, a ground count was scheduled in the central part of the Kharaulakh Ridge, along with an aviation count employing the SK 'Orion'

hydroplane. Additionally, the expedition involved the collection of biomaterial from the snow sheep.

During the research period, expedition members covered 240 km of ground routes, conducted visual observations at 8 monitoring sites, and collected samples (faeces and tissues of animals) for genetic research. In the course of ground counts, 310 individuals of snow sheep were registered, and their gender and age structure were determined. The population density of snow sheep on the monitoring sites was 9.4 individuals/1000 ha. The overall population of snow sheep in the surveyed area, covering 314.2 thousand ha, amounted to 2938 individuals.

The aviation count covered a distance of 1450 km. Along the routes, 164 encounters with snow sheep were recorded. The total population of snow sheep on the Kharaulakh Ridge, based on aviation count, is estimated to be between 2872 and 3600 individuals.

In 2022, field research on snow sheep was conducted by the researchers from the Institute of Biological Problems of Cryolithozone (IBPC) (Siberian Branch of the Russian Academy of Sciences, Yakutsk). At this stage of the study, there are plans to continue monitoring the population, collecting genetic material, conducting capturing and tagging of snow sheep with radio collars, identifying locations of seasonal concentrations of animals, and assessing their grazing grounds.

Fieldwork was conducted during the summer period in the central and northwest parts of the ridge.

At the end of the work the following results were obtained:

1. Two individuals of snow sheep were captured (a lamb and an adult female). The female was fitted with a radio collar. Her movements were observed and tracked for 70 days. The female then died from a wolf attack.
2. Biological material was collected (samples of feces and tissues).
3. The species composition of vegetation in the study area has been presented. A description of snow sheep grazing grounds is provided based on the preferred plant species.

4. Snow sheep were counted along routes and in concentration areas using camera traps in two surveyed areas with a total area of about 163.6 thousand hectares. A total of 199 individuals of snow sheep were recorded. The overall population of snow sheep in the Kharaulakh Ridge is estimated to be 1500-2000 individuals.

In August of the same year, in the central part of the ridge (near the Sasyr River), a snow sheep count was conducted by representatives of the Club of Mountain Hunters. Three autonomous groups worked in different gorges without crossing each other. During 3 days 173 sheep were counted.

The third stage of the study of the snow sheep took place this year. In late April to early May, the IBPC staff conducted an expedition to the northern part of the ridge. The outcome of the work was the capture of two adult snow sheep (male and female), equipped with radio collars. However, it was not possible to conduct long-term monitoring of the animals' movements – the radio collars stopped working in less than a month.

The main complex of fieldwork on studying the snow sheep in 2023 was conducted in the second half of August. The team included IBPK staff members E. V. Kirillin and N. V. Mamaev, as well as staff from the FSBI "FSRC Hunt" - A. V. Davydov and A. A. Fyodorov. Additionally, volunteer S. Stepanov from the institute, guides N. M. Protodyakonov and V. A. Popov, and tracked vehicle drivers I. V. Struchkov and V. V. Alexeev participated in the research. Material support, camp equipment, and transportation to the research site were organized by the director of MUP "Primorsky" V. V. Alexeev and his team (see Figure 1).

Fig. 1. Members of the expedition studying the snow sheep of the Kharaulakh Ridge (August 2023).

The works were carried out in accordance with the set goal and objectives, which were defined and agreed with the KGO - the project initiator.

Goal: To determine the status of the snow sheep population in the mountains of the Kharaulakh Ridge (Republic of Sakha (Yakutia)) using methods of counting, trapping and tagging the animals.

Objectives:

1. Ground visual counts on model sites and routes in the study territory of the Kharaulakh Ridge (15 routes covering a distance of 300 km).
2. Capturing and tagging of animals with radio collars equipped with the "Quasar" radio beacon.
3. Improving methods of counting and capturing snow sheep;
4. Collection of biomaterial from snow sheep for genetic research.
5. counting predators and traces of their activity.

6. Collection of survey data, field observations to assess the impact of limiting factors.
7. Assessment of the snow sheep population's status in the Kharaulakh Ridge based on the analysis of population size count data and spatial distribution of animals.

1. Materials and methods

Ground Visual counting on modeled sites and routes

The snow sheep was surveyed using binoculars (Canon 15x50 IS, Canon 12x36 IS, Nikon 10x42) and a Swarovski spotting scope.

In the modeled sites with a stationary observation point, the territory was visually surveyed by examining the surrounding slopes of the mountains. Upon the appearance of animals, they were counted, and if possible, their age and gender composition were determined (adults and young ones up to one year old).

The counting of snow sheep on modeled sites from observation points was conducted at the locations of the camps – Sasyr, Ugdama, and Nyosu (the names of the rivers near which the camps were situated). Observation points on Sasyr and Ugdama were set up closer to the places of snow sheep capture (see Figure 2).

Fig. 2. Monitoring of snow sheep from an observation point
on the modeled site Sasyr.

To ensure a thorough survey of the surroundings, we undertook hiking routes ranging from 10 to 13 km, covering a total distance of 60 km. These routes allowed us to identify areas where animals congregated on slopes and in mountain valleys beyond the line of sight from observation points.

The main amount of data was obtained during route surveys using all-terrain vehicles (see Figure 3).

Fig. 3. Monitoring of snow sheep along the route using an all-terrain vehicle.

The total length of the transport routes was 248 km. In fact, this distance should be considered as one route that was travelled from the Buyanka River to the lake where the source of the Unguostakh River is located (mainly along the Khara-Ulakh River valley along the central and southern part of the Kharaulakh Ridge) in the period from 16 August to 1 September. The northern part of the Kharaulakh Ridge along the route to the Tiksi settlement was not surveyed.

Six observers with binoculars (three people per rover) monitored the area from the cabins and roofs of the rovers. The all-terrain vehicles were periodically stopped after one or two kilometres to visually survey the area.

All sightings of snow sheep on either side of the direction of travel were recorded and marked with tags on the GPS navigator. The number of animals seen, their gender and age, if possible, were recorded in a notebook.

All tags and tracks of the routes were transferred to the e-map. SASPlanet and ArcGIS programs were used for its visualisation.

Capturing and tagging of snow sheep

To catch snow sheep, traps were used that consisted of a snare (based on Sibir-M snare #5) with a leg-gripping rope d=4 mm attached to it (see Figure 4).

Fig.4. Trap based on the Sibir-M snare with a leg-gripping rope.

To monitor the possibility of snow sheep entering the traps, the trap sites were regularly surveyed by quadrocopter.

Sixteen traps were used over a period of 146 days.

The trap installation procedure included selecting a suitable location, activating and camouflaging the trap, and attaching it to a large stone with a rope (see Figure 5). A perforator was also used to make a hole in the stone, after which an anchor with an eye was inserted to fix the rope (see Figure 6).

Fig.5. Setting the trap on the trail.

Fig.6. Fixing the trap to the stone with a perforator.

Trap sites were monitored during daylight hours from observation points using binoculars and a telescope. Sites that were not easily visible from the observation points were surveyed by quadrocopter (Figures 7 and 8).

Fig.7. Observation of trap sites by quadcopter.

Fig.8. Panoramic view of the mountains from above while tracking with a quadcopter.

The animals were tagged using the “Quasar” radio collar, enabling remote tracking of their movements via satellite communication (see Figure 9 and Table 1).

Fig.9. “Quasar” radio collar.

Technical specifications of the “Quasar” collar

Table 1.

Parameter name	**Parameter value**	**Parameter dimension**
Product type	Satellite beacon for Argos/GPS/GLONASS systems.	-
Model	“Quasar”	-
Purpose	Observation of moving objects based on the Doppler effect and using navigation signals.	-
Type of radio communication	Satellite telemetry	-
Transmitter frequency band	401,620 – 401,680	MHz
Transmitter power	0,7	W
Type of emission	60K0G1D	-
Digital data transmission rate	400	bps
Type of signal modulation	Phase modulation with a modulation index of 1.1 radians.	-
Transmitter polarization	Vertical	-

Type of receiver	Superheterodyne	-
Operating frequencies of the radio receiver	1574,397 - 1576,443, 1598,0625 - 1608,75	MHz
Received radiation class	2M05G7D, 10M7G7D	-
Receiver polarization	Right-hand circular	-
Type of batteries	Li-SOCL2	-
Mass	1400	g

The tagging of captured animals proceeded as follows. Once caught in the trap, the snow sheep was pressed to the ground. A blindfold was placed over its eyes (to reduce stress on the animal), and its legs were secured with insulation tape. Then, the collar was attached to the animal using bolts and nuts.

Collecting samples of biomaterial for genetic analysis

Simultaneously with tagging, samples of biomaterial were collected for genetic analysis. An instrument for skin biopsy with a diameter of 5 mm was inserted into the ear of the captured animal by pressing and rotating (see Figure 10). This procedure allowed for the separation of a piece of skin (sample), which was then placed in a vial with ethanol.

Fig. 10. Skin biopsy instrument.

2. Description of fieldwork procedures

On August 15, the expedition participants departed from the village of Tiksi on two all-road vehicles and arrived at the base camp on the Ugdama River on August 16. Until August 20, there were rains, causing water levels in the mountain rivers to rise. Due to the high water level, it was not possible to use the all-road vehicles to survey the territories.

On August 20, the expedition members set out southwards with the aim of counting snow sheep in the southern part of the Kharaulakh Ridge. By August 21, they had reached the Nyosu River (approximately 30 km south of the Ugdama camp). Here, in the mountainous area, 20 snow sheep were counted, and the presence of a natural salt lick, frequented by the animals, was identified. A decision was made to leave a group of 3 individuals at this location to capture and tag the animals.

The remaining expedition members continued southward. On August 23, they reached a lake located at the pass at the southern foot of the ridge (the source of the Unguostakh River) and turned back. On August 24, they returned to the camp on the Nyosu River. By this time, the first group had set up 10 traps, but no snow sheep had been caught. It was decided to continue trapping while simultaneously conducting animal counts in the area. Additionally, 3 more traps were set up. On August 25, a foot survey was conducted. On August 26, an adult female was captured and fitted with a radio collar. On August 27, the expedition members departed from the location and after spending the night at Ugdama, arrived at the camp on the Sasyr River on August 28. A salt lick, actively frequented by snow sheep, is located 3 km from the camp. On August 28, 16 traps were set up in the vicinity of the salt lick.

On August 29, observations were conducted at the trap sites and the surrounding mountains, including the use of a quadcopter, to detect and count snow sheep. The animals did not come to the salt lick on this day - possibly due to windy and rainy weather. On August 30, 6 snow sheep were observed in the vicinity of the salt lick: two adult females with two lambs and two adult males. One of the lambs got caught in a trap but was released from the loop and set free without fitting a

collar. Hiking routes to the sources of the Sasyr River were undertaken on August 29 and 31.

On August 31, the weather deteriorated, with precipitation turning into snow. The animals did not visit the salt lick. Due to the unfavorable weather forecast and the risk of rising water levels, the decision was made to end the expedition. On September 1, the expedition members departed from the camp, and on September 2, they arrived in the village of Tiksi.

3. Research findings

3.1. Ground visual count of Snow Sheep on modeled sites and routes

During the fieldwork period, 252 individuals of snow sheep were visually recorded. However, a total of 288 individuals have been counted on the surveyed territory since the beginning of August. Some of the animals were counted before the start of the expedition (August 4-10) by the representative of the IBPC, Mr. Protodiakonov N.I., on foot survey routes in the areas of the Sasyr, Ugdama, and Desemin rivers.

In Table 2, all encounters with snow sheep are presented, indicating the number, gender, and age of the animals. Encounter locations are marked as points, numbered and correspondingly displayed on the map (Fig. 11). Additionally, the map indicates encounters with brown bears or their fresh tracks (tracks were recorded when the animal itself was not observed).

Since the routes using all-road vehicles were traversed twice, encounters with snow sheep were observed repeatedly at several locations (points). Over several days, animals were recorded from observation points at model sites. In all locations (points) where snow sheep were observed two or more times, it was highly likely that the same animals were being accounted for. Therefore, when calculating the population size, the maximum number of animals observed on any given day was taken into account.

If multiple groups of animals were observed at one point on the day of observation, their numbers across all groups were summed. By following this

calculation algorithm, the population size of snow sheep at the locations of their encounters along the routes and at the sites amounted to 230 individuals.

Table 2.

Population size and age-gender structure of the Snow Sheep population

Date	Map №	Adult ♂	Adult ♀	Lambs	Total
04.08.	1	5	5	4	14
	1	2 yng	-	-	2
06.08.	6	4+1	-	-	5
	8	-	6	3	9
10.08.	7	3 yng	-	-	3
	10	3	-	-	3
16.08.	3	1	-	-	1
17.08.	10	1	-	-	1
20.08.	9	4	-	-	4
	11	-	1	-	1
	12	5	3	1	9
	14	-	7	-	7
	15	3	-	-	3
21.08.	18	-	10	2	12
	20	5	-	-	5
	17	3	-	-	3
22.08.	20	3	-	-	3
	21	1	8	-	9
	21	-	4	1	5
	21	2	-	-	2
	22	-	3	1	4
	23	?	?	?	4
23.08.	24	?	?	?	3
24.08.	23	?	?	?	2
	17	?	?	?	12
	18	-	2	-	2
25.08.	17	-	11	-	11
	19	3+3	4	-	10
26.08.	17	4	19	4	27
27.08.	17	-	7	2	9
	16	-	5	-	5
	15	2	-	-	2
	13	4	19	4	27
28.08.	4	-	7	1	8
	4	-	4	2	6
	4	-	3	1	4

	5	?	?	2	9
29.08.	2	-	7	2	9
30.08.	4	2	2	2	6
31.08.	2	?	?	?	27
Итого:	-	64	137	32	288

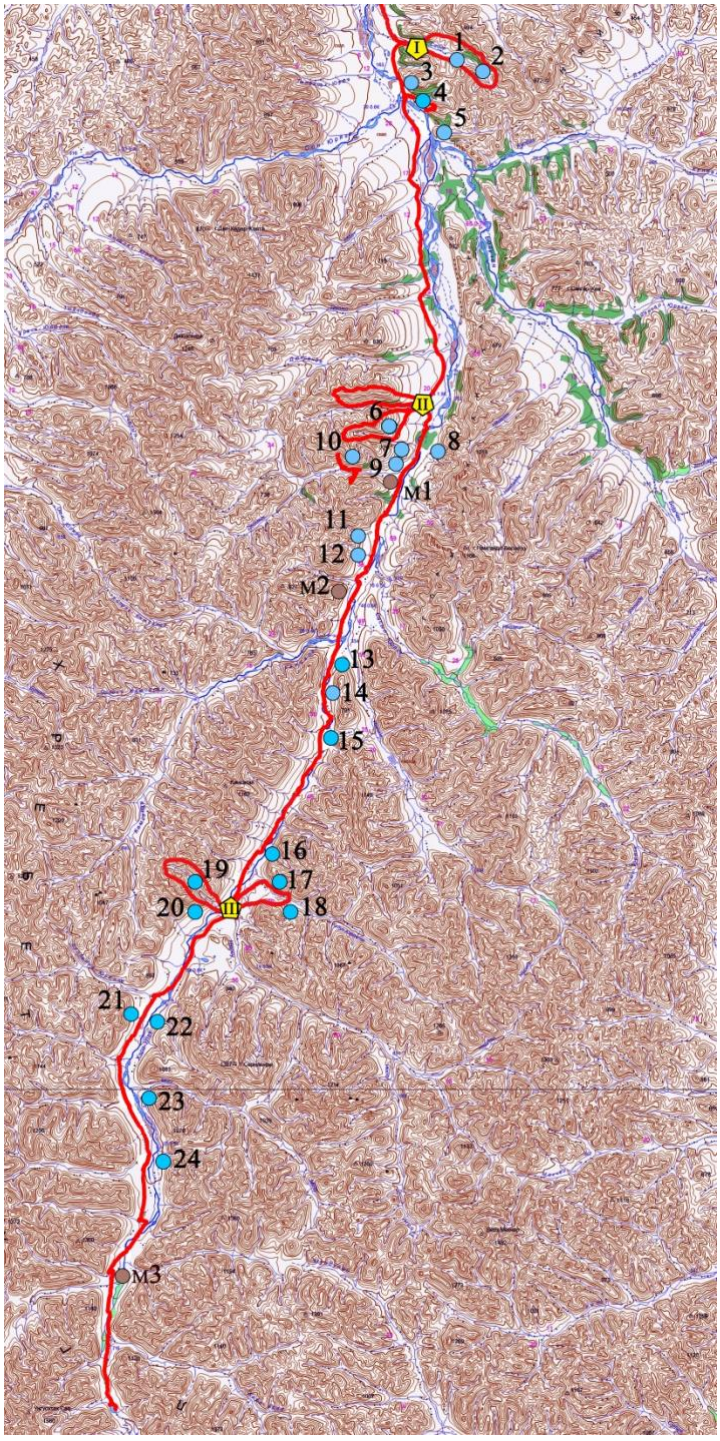

Fig. 11. Animal encounter locations and survey route tracks.

Blue circles - snow sheep encounter locations; brown circles - brown bear encounter locations and their tracks.

The area of the surveyed territory was determined by the width of the observation strip. Snow sheep can be clearly seen with binoculars at distances of up to 1 km. However, even at such distances, there is a chance that they may not be noticed, especially if the animals are stationary.

Snow sheep can be detected at longer distances, but the probability of missing them at distances exceeding 1 km increases significantly. We consider that the most reliable estimate of the snow sheep population can be obtained when conducting ground visual surveys at distances not exceeding 1 km. Based on this, the width of the survey strip was determined to be 2 km (1 km on each side of the route track).

With this width of the survey strip, the area of the surveyed territory amounted to 32.3 thousand hectares. Accordingly, the population density of snow sheep in this area was determined to be 7.1 individuals per 1000 hectares.

Different ground-based methods of snow sheep counting (walking route counting, route counting by transport, counting from stationary observation points) vary in accuracy and completeness of coverage.

During foot surveys and stationary observation point counts, the accuracy of the census is high, but the surveyed area is small. Nevertheless, even with these methods, undercounting is possible.

During foot surveys, the census taker may not always have enough time to count the snow sheep if they come into the animals' field of view. Snow sheep in open mountainous terrain can spot a moving person at a considerable distance and immediately flee, hiding behind folds in the mountains.

Counting from stationary observation points is more objective, but requires multi-day observations. On Sasyr, observations were conducted over a period of 3 days, but the animals ventured onto the mountain slope, where traps were set, only on one of those days. Snow sheep tend to wait out adverse weather conditions such as rain, snow, or wind, presumably selecting the most sheltered areas in the gullies, and avoid grazing. Additionally, these animals have different daytime and nighttime habitats. Based on our observations, snow sheep grazed around 11 a.m. and remained there until approximately 4-5 p.m.

Route counting using vehicles is the least accurate but allows for the survey of much larger areas. However, this method has a significant drawback: a high likelihood of missing animals. When using binoculars with high magnification (10x or higher) from a moving vehicle, spotting snow sheep, especially solitary or stationary ones, is challenging. Therefore, binoculars were rarely used by the counters while driving. Snow sheep do not fear moving vehicles, especially when they are at a distance (see figures 12 and 13).

Fig. 12. Large solitary male snow sheep, counted on the vehicle route.

Fig. 13. A group of adult female snow sheep counted on the vehicle route.

The use of vehicles is effective when stops are made every kilometer or two for territory inspection. This approach significantly increases the accuracy of the count.

It should be noted that even when using highly maneuverable transport, such as a tracked vehicle, the speed of movement in challenging mountainous terrain with numerous and difficult-to-cross rivers and streams is extremely low. In the 2023 expedition, the routes covered by vehicles averaged 25-30 km per day. Considerable time was spent stopping to choose routes when crossing water obstacles (see Figure 14).

Fig. 14. River crossing during route counting.

It is difficult to estimate the amount of snow sheep missed during visual ground surveys, but evidently, it is at least 20-30%. Applying this percentage of missed sightings, the population size of snow sheep in the surveyed area is estimated to be between 280-300 individuals; with a population density of 8.7-9.3 individuals per 1000 hectares (on average 9.0 individuals per 1000 hectares). These figures align with the results of the 2021 research. The high population density of snow sheep does not extend to the high-mountainous part of the surveyed territory, located in the southern part of the ridge, adjacent to the Orulgan ridge. According to our observations, approximately 15 kilometers before the pass, situated at the junction of the ridges (the pass has a lake from which the Unguostakh River originates), snow sheep sightings ceased. Also, there were no tracks of these animals. Reindeer herders encountered along the way, coming from the pass, reported that they had not encountered any snow sheep and that the animals are extremely rare in this area.

To the south, the Kharaulakh Ridge rises to an altitude of 1300-1500 metres, with steep and dark rocky slopes where vegetation is sparse or absent. Apparently, this terrain is not entirely suitable for the snow sheep. In addition, domestic reindeer

are grazed in the intermountain valleys of the southern part of the ridge, which may be another reason why snow sheep avoid this area (see Figure 15).

Fig.15. Domestic reindeer in the intermountain valley.

Perhaps the mountains in the southern part of the Kharaulakh Ridge act as an isolating barrier, hindering the mutual migration of two subspecies – the Kharaulakh subspecies, which inhabits the northern part of the Verkhoyansk Ridge, and the Yakut subspecies, which inhabits other parts of the ridge as well as other mountain systems in Yakutia.

It should be noted that even with the use of modern transport, the ground-based counting methods are only possible to survey limited areas of the snow sheep habitat in the Kharaulakh Ridge, which does not allow for a sufficiently objective assessment of the population sizes of these species across their entire range. Considering the difficulty of accessing the territory, all survey work was effectively conducted only in the mountain ranges lying along the relatively wide and extensive valley of the Khara-Ulakh River, while the rest of the territory of the Kharaulakh Ridge remains largely unexplored (see Figure 16).

Fig. 16. Mountain ranges in the vicinity of the Khara-Ulakh river valley.

In this context, it is worth noting that the Verkhoyansk mountain system, including the Kharaulakh Ridge, remained one of the world's "terra incognita" regions for a long time due to its inaccessibility. It was only in the mid-1960s that a complete orographic description of it was made.

3.2. Capturing and tagging of snow sheep with radio collars. Collection of biological material for genetic research.

Capturing and tagging of snow sheep was conducted over a 10-day period (6 days at Nyuosa with 13 traps set and 4 days at Sasyr with 16 traps set). Despite the substantial effort expended (146 traps/day), no results were achieved, despite the involvement of specialists with extensive experience in capturing wild ungulates, including snow sheep in Yakutia (E.V. Kirillin, N.V. Mamaev), and mountain ungulates in the North Caucasus (A.A. Fedorov).

During the work, special attention was paid to the selection of trap sites. Traps were set where the highest concentrations of snow sheep and their tracks were

observed. For example, 62 snow sheep were observed on Nyuosa (points 17 and 18) from August 21st to August 27th.

On Nyuosa and Sasyr, trapping locations were strategically chosen near natural salt licks. Understanding their significance in the lives of snow sheep requires further reserch. Salt licks consist of whitish deposits on rocks and possess a faintly sour-salty taste, distinct from common sodium-potassium salt (see Figure 17). Snow sheep do not frequent salt licks regularly, but animal concentrations are higher in their vicinity.

Fig. 17. Salt lick in Sasyr.

Traps were set up at salt licks, along trails leading to salt licks or grazing areas, as well as at "bedding sites" (animal resting places, typically near cliff ledges or under overhangs).

The most frequently used trails were selected for trapping. To enhance capturing efficiency, individual trails were artificially connected (trampled) together, and traps were placed at their intersections.

Snow sheep do not always use the same trails, especially in areas of mass animal habitation where there can be numerous trails. Sometimes snow sheep choose

less noticeable trails or travel off-trail. Salt licks may be scattered across the territory and cover an area of ten square meters or more. Occasionally, escapes occur when an animal manages to free its leg from the snare (during the fieldwork, there were 3 escapes). Thus, capturing is often random and does not always guarantee a successful outcome.

On Nyuosa, an adult female was captured in the trap, fitted with a radio collar, and had a sample of biomaterial taken (see Figure 18). During the capturing, the female did not sustain any visible injuries and quickly and easily disappeared after release.

The radio collar was activated for operation immediately after the snow sheep was trapped. After tagging the animal, we contacted the producer of the radio collars, A.L. Salman, by satellite phone, who confirmed the reception of the signal from the tagged female. Subsequently, it was found that the signal was lost within two days after the radio collar was activated.

The second animal was captured in Sasyr (see Figure 19). It turned out to be a lamb, which had to be released without fitting a radio collar (wearing a collar, which weighs 1.4 kg, would inevitably lead to the death of the lamb). A sample of biomaterial was also collected from the animal.

Fig. 18. Tagging snow sheep with a radio collar.

Fig. 19. Captured snow sheep lamb.

3.3. Monitoring predators and traces of their activity. Assessment of the impact of limiting factors on the snow sheep population based on survey data and field observations.

According to survey data, the population of snow sheep has remained stable in recent years, while there has been an increase in the population of brown bears and wolves. V.V. Alexeyev's assessment suggests that within the territory of the the Municipal Unitary Enterprise "Primorsky", which covers the majority of the Haraukhsky population's range, there are at least 5 wolf packs consisting of 5-6 individuals each, predominantly led by female wolves. In 2022, 7 wolves were shooted by reindeer herders. The shooting of wolves is supported financially and materially by the director of the "Primorsky".

Wolf tracks and droppings were observed in Sasyr and Nyuosa. In Sasyr, tufts of wolf fur were found in a rocky niche near a salt lick. Apparently, predators were hunting here for snow sheep.

The brown bear population density is high - in recent years, reindeer herders have encountered up to 3 adult individuals per kilometer. However, representatives of the “Primorsky”, as well as members of previous expeditions, have noticed a decrease in the brown bear population in 2023. During fieldwork, we encountered a bear twice, and it was most likely the same bear (see Figure 20).

In the vicinity of the Ugdama camp and at one of the temporary stops, fresh bear tracks and droppings were observed; at the Nyuosa camp, tracks of a she-bear and two cubs were found (see Figure 21).

Fig. 20. Brown bear encountered along the route.

Fig. 21. Tracks of a she-bear and cubs.

Among other predators posing a threat to snow sheep, we should mention the wolverine. According to survey data, this animal is common in the habitats of

snow sheep. Expedition members observed a wolverine at the Nyuosa camp (see Figure 22).

Fig. 22. Wolverine.

The resources of the snow sheep of the Kharaulakh Ridge are utilized insignificantly. Since 2021, On the territory of the “Primorsky” has officially harvested 10-15 individuals annually, which accounted for less than 1% of the population estimated at 3000 individuals. According to survey data, taking into account illegal hunting in this area, approximately 60 snow sheep are harvested annually. With the existing population size, such a level of harvesting cannot have a noticeable limiting impact on the population's status.

3.4. Assessment of the Kharaulakh Ridge Snow Sheep population based on the analysis of population count and spatial distribution of animals

The research results of 2023 indicate that the snow sheep are most densely populated in the central and southern parts of the Kharaulakh Ridge, located at elevations of 400-1200 meters above sea level. According to surveys of local reindeer herders, there are few snow sheep in the northern part of the ridge, and they are only occasionally observed in the vicinity of Tiksi. The peripheral parts of the ridge are almost unexplored. Fragmentary data on the population density of snow sheep in the southwest and northwest parts, obtained during aerial surveys in 2021 and during research conducted by the IBPK staff in 2022 in the upper reaches of the Kengdey River, are available. According to these data, the population density of this species in the southwest part is estimated at 0.6-0.8 individuals per 1000 hectares; in the northwest part, respectively, - 0.8-1.2 individuals per 1000 hectares.

For obtaining accurate estimates of the snow sheep population on the Kharaulakh Ridge, it is necessary to conduct an aviation count covering the entire territory of the ridge.

Based on the research results, the ratio of adult males to adult females is 1:2.14 (in 2021 - 1:2.6; in 2022 on two surveyed territories - 1:1.21 and 1:1.45). The percentage of lambs accounted for 15.9% of the total number of animals recorded by gender and age (in 2021 - 26%; in 2022 on two surveyed territories - 13.5% and 18%). In 2023, the number of lambs per adult female is lower than previously observed - 0.23:1 (in 2021 - 0.5:1; in 2022 - 0.3:1).

Conclusion

1. According to the results of the conducted work, the population density of snow sheep on the Kharaulakh Ridge in the surveyed area (from the Buyanka River to the source of the Unguostakh River) was 8.7-9.3 individuals per 1000 hectares with a population size of 280-300 individuals. Thus, the population density of this species in the central and southern parts of the ridge, excluding its southernmost part, can be estimated at 9.0 individuals per 1000 hectares, which roughly corresponds to the indicator obtained during field research in 2021 (9.4 individuals per 1000 hectares).

2. It has been observed that there are no snow sheep in the southern part of the Kharaulakh Ridge. It is possible that the mountains in this part of the ridge serve as an isolating barrier, hindering the mutual migration of two subspecies - the Haraulakh subspecies, which inhabits the northern part of the Verkhoyansk Ridge, and the Yakut subspecies, which inhabits the central and southern parts of this ridge, as well as other mountain systems in Yakutia.

3. Based on the results of the conducted research and survey data, it can be concluded that the population of snow sheep on the Kharaulakh Ridge remains stable and sufficiently high, allowing for the harvesting of this species within established standards.

4. The number of large predators (wolf, brown bear) within the range of the specified population remains high, significantly limiting the population of snow sheep.

5. In 2024, we propose to continue the work of capturing and tagging snow sheep to study their movements (migration), with a particular focus on this aspect of research.

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