MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

FEDERAL STATE BUDGETARY SCIENTIFIC INSTITUTION FEDERAL RESEARCH CENTER
"YAKUTSK SCIENTIFIC CENTER OF SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES"

THE INSTITUTE FOR BIOLOGICAL PROBLEMS OF CRYOLITHOZONE
OF THE SIBERIAN BRANCH OF THE RUSSIAN ACADEMY OF SCIENCES

REPORT
on the results of research work
"MONITORING OF BIORESOURCES AND CRYOLITHOZONE
OF THE SEVERO-TALAKANSKY, VOSTOCHNO-TALAKANSKY, ALINSKY SUBSOIL
PLOTS OF "SURGUTNEFTEGAS" PJSC IN THE REPUBLIC OF SAKHA (YAKUTIA)"
(final)

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Yakutsk – 2023

INTRODUCTION

The final report is presented in accordance with the terms of reference, calendar plan for monitoring (recomparative study) at the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots of “Surgutneftegas” PJSC in the Republic of Sakha (Yakutia) completed in 2023, which is a continuation of the research started in 2016 (hydrochemical composition – since 2019). The study was carried out without changing the methods (Report..., 2016, 2019).

Field activities and their location, therefore, basically corresponded to those carried out in 2016 and 2019. The following tasks were solved:

Characteristics and assessment of the state of the active and upper layers of permafrost;

Characteristics and assessment of the state of land resources and soil cover;

Characteristics and assessment of the state of surface waters of main water bodies;

Characteristics and assessment of the state of phyto- and zooplankton, zoobenthos and ichthyofauna;

Characteristics and assessment of the state of vegetation cover and plant resources;

Characteristics and assessment of the state and resources of the animal world;

Establishing the presence/absence of the dynamics of the state of the objects under study, assessing the ecological state of the territory at the present stage and forecasting the development of the environmental situation.

1. PERMAFROST

1.2. Severo-Talakansky subsoil plot

1.2.4. Assessment of dynamic processes in the state of cryogenic rocks and permafrost landscape in a 5-year interval

The comparison of materials obtained during field work in 2019 with materials from 2023 showed that processes of mass degradation of permafrost landscapes were not observed in the permafrost area.

The analysis of high-resolution remote sensing data showed that permafrost degassing processes ended at the border of cutting down for technological facilities (Fig. 1.2.4.1). The recorded processes consist only of successional changes in tree cover in the form of trees overgrowing old burnt areas. As can be seen in the illustration, the processes that arise at the beginning of construction in the form of watering (left fragment for 2019) are subsequently normalized (right fragment for 2023). There is no degradation of landscapes outside the technological facilities, either above or below the natural flow of water.

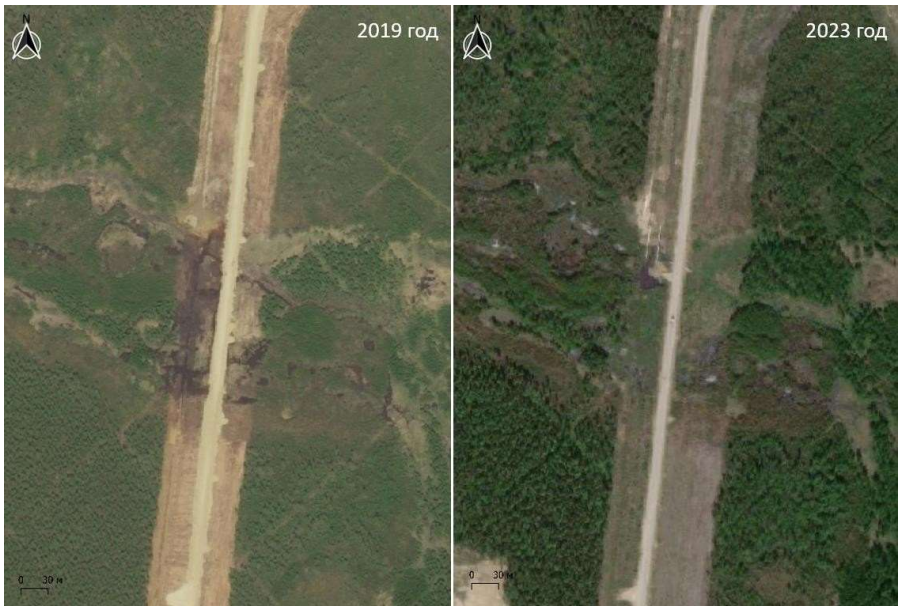

Fig. 1.2.4.1. The comparison of the state of the valley permafrost wetland (mari), which is crossed by a section of the technological road on satellite images for 2019 and 2023. 59°58'19.3799"N, 110°42'37.0465"E

Studies at the monitoring sites also showed us the absence of external signs of large-scale processes of permafrost degradation at them.

1.3. Vostochno-Talakansky subsoil plot

1.3.4. Assessment of dynamic processes in the state of cryogenic rocks and permafrost landscape in a 5-year interval

The analysis of thermal channels of Landsat-8 satellite images for 2019 and 2023 also showed that there were no significant changes in permafrost soils at the plot.

The field work revealed fluctuations in the water table level of a small natural reservoir in these areas of the plot. Thus, the analysis of plots with permafrost using thermal channels of Landsat-8 (B6) satellite images with verification of these data using field observations showed that there was no large-scale destruction of permafrost at the studied plot.

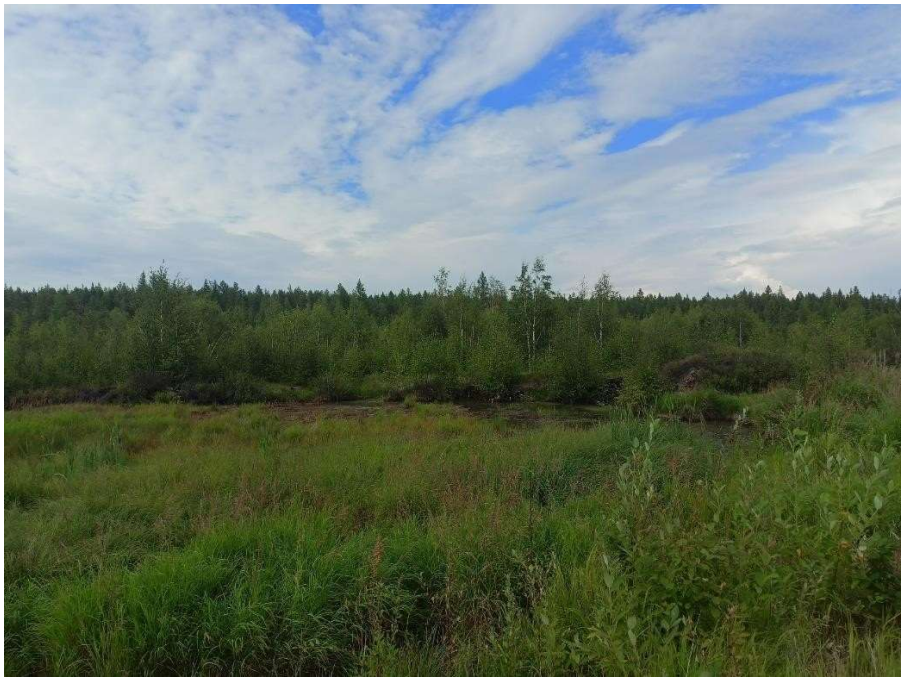

Fig. 1.3.4.1. Exterior view of monitoring site No. 5 (photo by N.V.Filippov, August 2023)

The field work at the monitoring sites also showed us the absence of large-scale processes of degradation of permafrost landscapes.

1.4. Alinsky subsoil plot

1.4.4. Assessment of dynamic processes in the state of cryogenic rocks and permafrost landscape in a 5-year interval

The plot covers an area of 11,547 hectares. In this regard, it is characterized by a concentration of man-made facilities and is subject to stronger anthropogenic pressure relative to other plots. Man-made facilities on this plot are represented mainly by fills for roads and well pads; there are very few industrial facilities like buildings. Objects are concentrated mainly in the central part and occupy upland and slope areas of the landscape.

A visual inspection of permafrost landscapes showed that there were no processes of degradation of the permafrost layer, namely, the processes of solifluction and frost heaving in areas with permafrost adjacent to production facilities. There were no permafrost soil subsidences either.

2. SOIL COVER

2.2. Severo-Talakansky subsoil plot

Assessment of dynamic processes in the state of soil cover in a 7-year interval

In 2023, the third stage of soil monitoring was carried out at the Severo-Talakansky subsoil plot. Soils were opened in key areas identified in 2016, unaffected by technical work, located in close proximity to roads and other objects of human economic activity (power lines, household landfills, well pads, etc.).

The study showed that all the identified reference points did not fall into the industrial development zone for three years. All noted changes are insignificant, varying within acceptable values. It can also be noted that no changes were detected in soils sufficiently remote from roads and other sources of anthropogenic influence.

2.3. Vostochno-Talakansky subsoil plot

2.3.5. Assessment of dynamic processes in the state of soil cover in a 5-year interval

In 2023, the third stage of soil monitoring was carried out at the Vostochno-Talakansky subsoil plot. Soils were opened in key areas identified in 2016, unaffected by technical work, located in close proximity to roads and other objects of human economic activity (power lines, household landfills, pads, etc.).

Almost all the identified reference points did not fall into the industrial development zone for seven years. All noted changes are insignificant, varying within acceptable values.

2.4. Alinsky subsoil plot

2.4.5. Assessment of dynamic processes in the state of soil cover in a 5-year interval

Soil and land degradation is a combination of natural and anthropogenic processes leading to changes in soil functions, quantitative and qualitative deterioration of their composition and properties, and a decrease in the natural and economic importance of lands.

The degree of soil and land degradation is understood as a characteristic of their condition, reflecting the deterioration of their composition and properties. The extreme degree of degradation is the destruction of soil cover and damage to land.

The following main types of soil and land degradation are distinguished:

- technological (operational) degradation, including land disturbance, physical degradation, agrodepletion;
- erosion, including water erosion and wind erosion;
- salinization, including salinization itself and alkalinization;
- water logging.

When developing deposits, the main nature of degradation is technological, that is, accompanied by deterioration of soil properties, their physical condition and agronomic characteristics, which occurs as a result of operational loads. Land disturbance in this case is the mechanical destruction of the soil cover and is caused by open and closed mining of minerals and peat, construction and geological exploration work, etc. Disturbed lands include all lands with the humus horizon removed or covered, completely buried under dumps and unsuitable for use without first restoring fertility, i.e. lands that have lost their original value due to their disturbance. Physical degradation of soils is characterized by disruption (deformation) of soil composition, deterioration of the complex of their physical and physicochemical properties.

In 2023, the third stage of soil monitoring was carried out on the territory of the Alinskoye subsoil plot. Soils were opened in key areas identified in 2016, unaffected by technical work, located in close proximity to roads and other objects of human economic activity

(power lines, household landfills, well pads, etc.).

The study showed that all the identified reference points did not fall into the industrial development zone for seven years. In addition, the soils of the territories adjacent to the operating oil and gas refining facilities were also not subject to any particular impact, which suggests that the anthropogenic impact on the ecosystem remains minimal outside the areas directly allocated to human activity. All noted changes are insignificant, varying within acceptable values.

The degree of soil degradation at monitoring points corresponds to the acceptable level.

3. SURFACE WATERS

3.2. Severo-Talakansky subsoil plot

3.2.2. Assessment of dynamic processes in the chemical composition of natural waters in a 5-year interval (2019-2023)

In the temporal aspect, for the examined objects it was revealed that the content of oxygen, potassium, easily oxidized organic substances, ammonium, nitrates, phosphates, petroleum products, phenols, surfactants, nickel, mercury, lead, chromium, zinc, copper, pH value, hardness and color index are characterized by relatively stable values. There is no increase or decrease in these components. The content of sodium decreased by 1.2 times, calcium and bicarbonates – by 1.1 times, chlorides – by 2.4 times, nitrites – by 1.6 times, total phosphorus – by 6.0 times. The content of silicon, difficult-to-oxidize organic substances and magnesium increased by 1.2 times, sulfates – by 1.8 times, iron – by 2.4 times, manganese – by 4.3 times. The concentration of chemical components in natural waters largely depends on surface runoff and input from the basin. Therefore, the detected fluctuations may be associated with interannual changes in water content, which is caused by different amounts of precipitation.

3.3. Vostochno-Talakansky subsoil plot

3.3.2. Assessment of dynamic processes in the chemical composition of natural waters in a 5-year interval

In the temporal aspect, for the examined objects it was determined that the content of oxygen, potassium, ammonium, nitrates, phosphates, petroleum products, phenols, surfactants, manganese, nickel, mercury, lead, chromium, pH value, hardness were characterized by relatively stable values. There is no significant increase or decrease in these components. The concentration of sulfates decreased on average by 17.4 times, chlorides – by 7.4 times, total phosphorus – by 1.6 times, calcium – by 1.2 times, sodium – by 2.0 times. The content of iron increased by an average of 3.4 times, zinc – by 1.4 times, nitrites and easy-to-oxidize and difficult-to-oxidize organic substances – by 1.2 times, silicon – by an average of 1.1 times. The concentration of chemical components in natural waters largely depends on surface runoff and input from the basin. Therefore, the detected fluctuations may be associated with interannual changes in water content, which is caused by different amounts of precipitation.

3.4. Alinsky subsoil plot

3.4.2. Assessment of dynamic processes in the chemical composition of natural waters in a 5-year interval (2019-2023)

In the temporal aspect, for the examined objects it was determined that the content of oxygen, potassium, ammonium, nitrates, phosphates, petroleum products, phenols, surfactants, nickel, mercury, lead, chromium, zinc, copper, pH values were characterized by relatively stable values. There is no increase or decrease in these components. There is a slight decrease in calcium (by an average of 1.1 times), color index (by 1.2 times), potassium (by an average of 1.5 times), sodium (by an average of 3.0 times) and total phosphorus (by an average of 4.4 times). The content of magnesium, silicon and TOOV increased by an average of 1.1 times, nitrites and easy-to-oxidize organic substances – by an average of 1.3 times, bicarbonates and chlorides – by an average of 1.7 times, iron – by an average of 3.4 times, sulfates – by an average of 4.1 times, manganese – by an average of 5 times. The concentration of chemical components in natural waters largely depends on surface runoff and input from the basin. Therefore, the detected fluctuations may be associated with interannual changes in water content, which is caused by different amounts of precipitation.

4. HYDROBIOCENOSES OF SURFACE WATER

Findings Thus, today, in individual areas, the state of phytoplankton in the studied water bodies can be locally assessed as favorable based on the composition of phytoplankton, quantitative indicators of development and the calculation of a number of indices. However, sharp changes observed in places in the structure of the dominant species and quantitative indicators of its development indicate existing anthropogenic pressure.

It should be noted that under conditions of such changes, algal communities, located at the very beginning of food chains, are the most sensitive component of aquatic ecosystems, which in turn has a transformative effect on other structural and functional elements.

In addition to anthropogenic factors, an important characteristic of water bodies is flow, which is of great importance for the formation of water quality in them and their ability to self-purify. In this regard, there is a need for long-term hydrobiological monitoring of water bodies of “Surgutneftegas” PJSC in the Republic of Sakha (Yakutia).

The forecast for the further development of the state of phytoplankton and its composition, quantitative indicators depend mainly on the level regime, the concentration of nutrients, relief, flow, the degree of overgrowth of higher coastal, aquatic vegetation in shallow waters and the anthropogenic impact on the ecosystem as a whole.

5. FLORA, MYCOBIOTA, VEGETATION COVER

5.2. Severo-Talakansky subsoil plot

5.2.6. Assessment of dynamic processes in the state of flora, mycobiota and vegetation cover in a 7-year interval

Changes in the floristic composition of communities at the plot that happened over 7 years of observation are mainly associated with changes in landscapes and a more detailed study of the area. As of 2019-2023, in the territory of the Talakanskoye oil and gas field, the flora of vascular plants includes 318 species from 183 genera and 58 families, which is 17 plant species more than in 2016 (then, the list of species included 301 species from 179 genera, 58 families). In 2023, no new plant species were discovered.

The typological composition of forests and the characteristics of tree stands in monitoring forest areas underwent virtually no changes. There are some changes in the taxation indicators of tree stands, which lie within the variability of characteristics and permissible measurement error, and in the reserves of raw materials of some types of plant resources, which is mainly associated with the biological periodicity of the development of generative organs (berries, fruits, fruiting bodies) and the weather conditions of a particular year.

Currently, in technogenically disturbed areas, the primary stages of the succession process are observed, including active reforestation of tree species due to natural seed deposits. Self-restoring processes also occur in previously burned areas.

5.3. The Vostochno-Talakansky subsoil plot

5.3.6. Assessment of dynamic processes in the state of flora, mycobiota and vegetation cover in a 7-year interval

Changes in the floristic composition of the communities of the Vostochno-Talakansky subsoil plot over 7 years of observation are insignificant and are associated mainly with the redistribution of species in space due to the fragmentation of forests, the strengthening of the positions of weed species and open space species, as well as a more detailed study of the area. As of 2023, in the territory of the Talakanskoye oil and gas field, the flora of vascular plants includes 318 species from 183 genera and 58 families, which is 17 plant species more than in 2016 (then, the list of species included 301 species from 179 genera, 58 families). In 2019, the following rare plant species were discovered on the territory of the Vostochno-Talakansky subsoil plot: martagon lily (*Lilium martagon L.*), spotted lady's slipper (*Cypripedium guttatum Sw.*), common spotted orchid (*Dactylorhiza fuchsii (Druce) Soo.*), single-flowered violet (*Viola uniflora L.*), pinesap (*Hypopitys monotropa Crantz*). In 2023, the previously noted Siberian fir, which became a rare species only in the latest edition of the Red Book of Yakutia (2017), was also found among that list of rare species.

The typological composition of forests and the characteristics of tree stands in monitoring forest areas have undergone virtually no changes (Fig. 5.3.6.1). There are some changes in the taxation indicators of tree stands, which lie within the variability of characteristics and permissible measurement error, and in the reserves of raw materials of some types of plant resources, which is mainly associated with the biological periodicity of the development of generative organs (berries, fruits, fruiting bodies) and the weather conditions of a particular year.

A B C

Fig. 5.3.6.1. Larch forest with spruce trees covered with wintergreen and mulch in 2016 (A), 2019 (B) and 2023 (C)

Currently, in technogenically disturbed areas, the primary stages of the succession process are observed, including active reforestation of tree species due to natural seed deposits. Self-restoring processes also occur in previously burned areas.

5.4. Alinsky subsoil plot

5.4.6. Assessment of dynamic processes in the state of flora, mycobiota and vegetation cover in a 7-year interval

Changes in the floristic composition of communities at the Alinsky subsoil plot are insignificant and mainly associated with a more detailed study of the area. As of 2023, in the territory of the Talakanskoye oil and gas field, the flora of vascular plants includes 318 species from 183 genera and 58 families, which is 17 plant species more than in 2016 (then, the list of species included 301 species from 179 genera, 58 families). In 2019, two additional rare species belonging to the III rarity category were discovered in the territory of the Alinsky subsoil plot: single-flowered violet (*Viola uniflora L.*) and goatsbeard (*Tragopogon sibiricus Ganesch.*).

The typological composition of forests and the characteristics of tree stands in monitoring forest areas have undergone virtually no changes. There are some changes in the taxation indicators of tree stands, which lie within the variability of characteristics and permissible measurement error, and in the reserves of raw materials of some types of plant resources, which is mainly associated with the biological periodicity of the development of generative organs (berries, fruits, fruiting bodies) and the weather conditions of a particular year.

Currently, in technogenically disturbed areas, the primary stages of the succession process are observed, including active reforestation of tree species due to natural seed deposits. Self-restoring processes also occur in previously burned areas.

6. ANIMAL POPULATION

6.5. Assessment of animal population dynamics in a 5-year interval

Invertebrates

In total, according to the summed up data for 2016, 2019 and 2023, 242 species from 62 families and 7 orders of insects are found in the studied areas. Among them are protected species listed in the Red Book of the Republic of Sakha (Yakutia). T.2 (2009) is the dragonfly *Aeshna grandis*, the bug *Labops kerzneri* and the beetle *Lygistopterus*. The dragonflies *Calopteryx japonica* and *Ophiogomphus obscurus* are listed in the Red Book Appendix as species that require special attention to their state in nature.

In addition, rare species of bedbugs (*Acalypta elegans, Chlamydatus wilkinsoni, Hallodapus pumilus, Saldula orthochila*), beetles (*Carabus regalis, Lagria hirta*), colorful and attractive species of beetles (*Potosia metallina, Trichius fasciatus*) and butterflies *(Limenitis populi, Argynnis paphia, Argynnis adippe, Argynnis aglaja*) were identified. The composition of the entomofauna of the studied area in general has a homogeneous taiga appearance, rich with southern taiga elements.

As research results show, in most forest stations there is an increase in the number of hymenoptera insects, represented mainly by ants – they turned out to be the main environment-forming component in the invertebrate community. The increasing dominance of ants over others and the depletion of the faunal composition in tree communities may be explained by the establishment of conditions favorable for their reproduction, under which the activity of other arthropods, on the contrary, is inhibited. Such conditions include the drying out of the forest due to the cooling effect of frost and strong winds, mainly on the edges, in areas thinned out by selective felling, as a result of which a sharp increase in the number of xerophilic ant species can be observed.

The chortobiont entomofauna is based on almost the same groups: Homoptera, Hemiptera, Coleoptera, Hymenoptera and Diptera. In the studied herbaceous communities, an increase in the number and species diversity of chortobiont invertebrates is observed, which indicates rather rapidly occurring processes of secondary succession, during which the destroyed areas, without subsequently experiencing strong anthropogenic impact, begin to gradually recover. In the grass cover, legumes and forbs begin to occupy ever larger areas, which also leaves an imprint on the species composition of the entomofauna.

Thus, faunal and monitoring studies carried out at the Alinsky, Severo-Talakansky and Vostochno-Talakansky subsoil plots over a 5-year period showed no significant negative impact of the oil and gas production enterprise on the insect fauna. The presence of rare and protected species of insects in the fauna, a large species diversity generally indicates the effectiveness of environmental measures carried out by “Surgutneftegas” PJSC to minimize the negative consequences during the construction of industrial oil and gas production facilities and to prevent pollution of natural biocenoses by industrial waste.

Amphibians and reptiles

Compared to 2019, in 2023 the number of the viviparous lizard increased slightly, which is most likely due to more favorable conditions for it that year.

Birds

In the area of the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots, 174 species of birds belonging to 14 orders may be present (Appendix 6.4). The basis of the nesting avifauna here is made up of tree and shrub species of birds.

Currently, fragmentation of natural bird habitats in the study area is not critical; anthropogenic transformation of natural landscapes only increases the mosaic nature of biotopes.

This partly even leads to a slight increase in the diversity and number of birds in watersheds. In the undisturbed natural biotopes of the study area (forests of various types, river valleys and river banks), the bird population typical of the taiga zone of the Lena Plateau is preserved. In the areas with fragments of anthropogenic landscapes of the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots, as a result of an increase in the mosaic of biotopes, the species diversity and population density of birds increases slightly.

During the study, in the first ten days of August 2023, seven species of birds which can be classified as hunting objects were registered in the territory of the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots. Mallard and teal (waterfowl), hazel grouse (upland game), lapwing, sable, fifi and large ulit (swamp-meadow game) were noted here.

During the study, in the first ten days of August 2023, we did not note birds included in the Red Book of the Republic of Sakha (Yakutia) (Red Book of the Republic of Sakha (Yakutia), 2019) in the territory of the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots.

Based on the available data, there is no traceable change in the bird population in the period 2019-2023 in the territory of the Severo-Talakansky, Vostochno-Talakansky and Alinsky subsoil plots. The main parameters of the bird population (primarily species composition) over the past four years (2019-2023) did not change significantly here and remain stable.

In the future, the bird population parameters of the Alinsky, Severo-Talakansky and Vostochno-Talakansky subsoil plots will remain relatively stable, since intensive industrial development here has ended, and secondary succession in disturbed areas is slow. It is only possible that there will be local changes in the diversity and number of birds associated with minor man-made disturbances of biotopes limited in area during further development of the field.

Mammals

The population of small mammals is typical for the taiga part of Yakutia, the main background species are the northern red-backed vole, tundra and common shrews, in more open areas they are joined by the field vole and the tundra vole. The level of anthropogenic pressure on the population of small mammals can be considered insignificant, species diversity in 2019-2023 remains close to the natural landscape.

The widespread dominant species of taiga biotopes – the northern red-backed vole and the common and tundra shrews – remained the most common species. All these species are eurytopic species of the taiga zone; changes in the population of small mammals are small; typical fluctuations in numbers and species composition are associated with climatic changes in nature.

The number of game animals is quite stable, but compared to 2019, a decrease in the number of squirrels can be observed. Finding traces of animals near production facilities indicates that animals feel safe here. We can also note the stable presence of the Manchurian wapiti here. This is a fairly new species for the Lensky region. In recent decades, the species' range expanded in Yakutia.

Brown bears are found in the areas, and, as before, traces of their presence were also recorded in all three areas. According to our observations, the company manages to minimize the preconditions for conflict situations with predators and ensure strict control over the discipline of its employees; the number of bears does not increase, but their constant presence on the sites remains.

Thus, the analysis of data on the density of game animals at the studied subsoil plots shows a fairly stable number of game animals.