Landscape diversity of the Preolkhon region

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Abstract. The Olkhon region is one of the most popular holiday destinations on Lake Baikal, but spontaneous recreational development threatens the preservation of the region's landscapes. The situation does not change even though a significant area of the Olkhon region belongs to the Baikal National Park, the uniqueness of the flora and fauna of which surpasses any other protected territory of the Baikal region. Geosystems studies were carried out on the southeastern macroslope of the Primorskii Ridge, in an area that stretches along the western shore of Lake Baikal for 50 km. Regional patterns, characteristics of climate and relief, differentiation of vegetation and soils, and features of the modern use of the territory were taken into account. At the same time take into account the regional patterns, characteristics of climate and terrain, vegetation and soil differentiation, especially of the modern use of the area. Construction and use of recreational facilities and the movement of vehicles is the main factor in an anthropogenic influence on the landscape of the study area. The landscapes of this site have a pronounced altitude-zonal structure. The goletz and mountain-taiga complex of the Primorskii Range alternates with the subtaiga steppe geosystems of the Preolkhon plateau. We carried out route surveys from the foot of the range to the mountains on four sites of the study area. These are the most interesting, popular places (routes) of the Olkhon region.

1. Introduction
An unprecedented increase in the tourist flow to Lake Baikal has been noted in recent years. The tourism business in China, which has been rapidly developing over the past two years, also contributes to increasing tourist flow. However, most of the popular recreation areas on Lake Baikal are located on the territory of the Pribaikalskii National Park and the territories adjacent to the borders of the park. Spontaneous recreational development endangers the preservation of flora and fauna, and the landscapes of the Baikal catchment [1, 2]. The Pribaikalskii National Park was established on February 13, 1986 for the preservation of the natural complex of the Baikal catchment and creating conditions for the development of organized recreation for the population. It is the "longest" of the national parks in Russia, moreover, it is a large part of the Lake Baikal shore in Irkutsk oblast, including the island of Olkhon. The territory of the Pribaikalskii Park is included in the UNESCO World Cultural and Natural Heritage site "Lake Baikal".

By the presence of a rich and unique flora and fauna, the number of rare species of flora and fauna, variety of landscapes and archaeological sites, the Pribaikalskii National Park surpasses any other protected area of the Baikal region. 64 species of mammals, 303 species of birds, 9 species of amphibians and reptiles live on the territory of the Pribaikalskii National Park. The water bodies of the park are home to 24 species of fish. Many species of plants and animals are endemic in the Pribaikalskii National Park [3].
2. Objects, data and methods

The object of our research is the territory of the Preolkhon region, which partly belongs to the Pribaikalskii National Park. A project is currently being developed with the aim of incorporating some sites into the territory of the park. The urgency of expanding the territory of Pribaikalskii Park is dictated by the need to fulfill the main task of the park to preserve the integrity of the unique landscapes of Lake Baikal.

The Preolkhon region is traditionally the territory in the middle part of the western coast of Lake Baikal, directly opposite the Olkhon Island. The territory stretches from the shore of Lake Baikal to the watershed of the Primorskii Range [4]. Our geosystems studies were carried out on the southeastern macroslope of the Primorskii Range from the village of Shara-Togot and Mount Khargitui to Cape Yadyrtui and Mount Goletz Trekhgolovyi. This site stretches along the western shore of Lake Baikal for 50 km, while the Primorskii Range stretches for 250 km. The range belongs to relatively low mountains with maximum heights of up to 1746 m (Goletz Trekhgolovyi). The study area is located within the boundaries of the Olkhonskii administrative district of Irkutsk oblast and is included in the Central ecological zone of the Baikal natural territory (BNT).

3. Results and discussion

Physico-geographical zoning [5] assigns this territory to the Baikal-Dzhugdzhur mountain taiga and the Baikal mountain taiga-depression province. According to the regional-typological structure, subalpine summit surfaces and slopes with Siberian dwarf pine alternate with subalpine sparse forests of Siberian stone pine, fir and spruce. Further, down the slope, there are mountain taiga larch trees of optimal development with shrub undergrowth, with a predominance of Rhododendron dauricum. They belong to the North Asian alpine and taiga geosystems. Then there are the Central Asian steppe geosystems: terraces and plumes of low-bushgrass lithophyous and slope stony low-grass and sagebrush lithophyous.

The landscapes of this site have a pronounced altitude-zonal structure. The goletz and mountain-taiga complex of the Primorskii Range alternates with the subtaiga steppe geosystems of the Preolkhon plateau [6].

The climate of the Preolkhon region has insufficient moisture, lukewarm summers, moderately severe dry winters, and the Primorskii Range area has optimal moisture and cold summers, moderately severe snowy winters. This territory is characterized by an anticyclonic regime with insufficient atmospheric moisture (100–400 mm), a short growing season (4-4.5 months) and dry winter. The average air temperature in January is -17.3°C, in July -14.4°C, and the average annual temperature is 0.7°C [7].

We carried out route surveys from the foot of the range to the mountains on four sites of the study area. These are the most interesting, popular places (routes) of the Olkhon region. The first one starts near the Shara-Togot village and goes to Mount Khargitui. At the beginning of the route, along the slope of 15°, there are larch-pine forbs and pine cowberry-forb forests (figure 1a). Among them there are areas of small-leaved aspen spiraea forb forests in places of burnt areas (figure 1b). At altitudes above 1000 m Siberian stone pine is admixed with larch forests, Ledum palustre dominates in the herb-dwarf shrub layer (figure 1c). Siberian dwarf pine appears a little higher. The channel way of the intermittent stream corresponds to a spruce-rhododendron-forb forest. At altitudes above 1300 m, Betula divaricata appears in the Siberian stone pine blueberry-ledum forests. The limit of the forest is here at an altitude of 1350-1450 m. Mount Khargitui is located on the alpine plain of subaerial denudation and is represented by mountain-tundra lichen geosystems with areas of alluvial deposits (figure 1d).

The next site under research was the Khorga river valley. The floodplain of the river from the road to Ongureny and to the Mukhor Bay was included in the park in 2020. This is the last relatively large wild area preserved in the Mukhor Bay. The rest of the shore is built up with tourist facilities. There is a floodplain meadow here, areas of larch forest and steppe vegetation typical of the Maloe Sea Bay coast. Due to the mesorelief features, unique landscape diversity has developed in this area, and resulted in a significant species richness of flora and fauna in a relatively small area. This area is home to such
rare species as: Caulinia flexilis, Deschampsia turczaninowii, Orchis militaris, which are included in the Red Book of Russia. And also the species listed in the Red Book of Irkutsk oblast are Potamogeton maackianus, Gagea granulosa, Lilium pumilum, Iris sanguine and Oxytropis microphylla.

![Figure 1. Landscapes of the route from the village Shara-Togot to Mount Khargitui: a – larch-pine forb and pine cowberry-forb forests, b – small-leaved aspen spiraea forb forests, c – Siberian stone pine with larch forests, d – mountain-tundra lichen.](image)

Within the Preolkhon plateau there is a piedmont pine spiraea forb forest in the floodplain of the river (figure 2a). In the upper reaches of the Khorgi, there is an elongated ice glade with a total area of about 0.5 km². The glade is composed of colluvial-alluvial blocks with rare shrub willows. Ice formation is regular here and forms an almost abiotic landscape of the local level.

The site along the Lanenskaya trail to Sarminski goltz (1658.1 m) is also characterized by the presence of altitudinal belts. Goletz-nival belt with mountain-tundra lichen geosystems. Gentle alpine slopes are represented by shrub groups of Pinus pumila, Betula rotundifolia, Betula nana, and single Juniperus. The mountain-taiga belt within the zone of the upper forest limit is represented by sparse Siberian stone pine forests with a dwarf-moss-lichen cover. Various types of larch forests are most widespread in the mountain taiga middle mountains. On the southern slopes there are larch with pine and Siberian stone pine blueberry-ledum and cowberry-green moss facies. The eastern slopes are occupied by dense larch-Siberian stone pine, blueberry-ledum forests of various ages, mixed with larch-birch ledum-moss forests. In some cases, on the slopes of intermediate exposures Pinus sylvestris matters in the composition of forest stands of ledum-cowberry forest type. In the lower part of the mountain-taiga belt, in front of escarpments, larch and pine blueberry-ledum forests alternate with mixed aspen-birch-pine bush-herbaceous, spiraea-herbaceous with Duschekia and Sorbus aucuparia; birch-
larch herb-green moss, often pyrogenically disturbed. On the southern slopes of moderate steepness, there are pine forbs with the underbrush of *Rhododendron dauricum* [8].

![Figure 2. Landscapes of the route from the Sarma river and to Moutn Goletz Trekhgolovy: a – sparse larch forest with abundant aspen undergrowth, shrubby herb, b – meadow-steppe vegetation, c, d – burnt Siberian dwarf pine landscapes)]](image)

The first signs of steppe formation appear in the upper part of the ridge escarpments. In the upper part of the slopes, at the edges of the forest, there are mountain forb meadow steppes, below there are dry mountain petrophytic steppes. Sparse larch trees appear closer to piedmonts.

The submontane subtaiga landscapes of the Preolkhon plateau along the foot of the ridge are represented by dry sparse larch ledum and pine shrub forb forests, which give place to open larch forests closer to Lake Baikal.

In the Sarma river delta there is a site adjacent to the border of the Pribaikalskii National Park and including part of the Sarma delta and a sand spit separating the estuarine part of the delta from the Maloye Sea water area. There are steppe formations on the cone delta, floodplain forests and meadows of varying moisture degrees, wetlands, pebble spits and islands, floodplain lakes and inter-lake kaltus. This area is home to such rare plant species as *Arthonia glebosa*, *Flavopunctelia flaventior*, *Potamogeton maackianus*, *Deschampsia turchaninovii*, *Stipa glareosa*, *Lilium pumilum*, *Dryas sumneviczii*, *Astragalus angarensis*, *Oxytropis popoviana*, *Oxytropis sylvatica*, *Oxytropis triphylla*, *Primula pinnata*, and *Artemisia ledebouriana*. This site, despite its small area, is of great importance in preserving the biodiversity of the Maloie Sea shore of Lake Baikal and was also included in the Pribaikalskii National Park this year.

The valley of the Sarma river, flowing in the gorge with the same name, is no less diverse. The deeply incised river valley with sites of valley expansions is occupied by a sparse larch forest with abundant
aspen undergrowth, shrubby herb on alluvial gray-humus soils (figure 2a) [9]. The steep slopes on the right bank of the river are covered with meadow-steppe vegetation on sod-podzolic and chernozem-like soils (figure 2b). Pine-larch grass and rhododendron forests on sod-podzolic, gray and chernozem-like soils on the southern slopes are also widespread here. Steep northern slopes on the left bank with the development of gravitational and erosion processes are occupied by larch forests with Siberian stone pine on cryozems and peat podzolic soils. The watershed surfaces with flattened summits and gentle slopes of the river basin are covered with fragments of relict overgrown alluvial deposits and corroms with larch and participation of pine and Siberian stone pine, grass-dwarf shrubs and dwarf shrubs-moss. On the burned areas there are secondary birch-aspen herb-shrub and herb-moss forests on illuvial-ferruginous podzols, podburs, sod-podburs and sod-podzolic soils [10].

The next site is located within the territory of Cape Yator – Mount Goletz Trekhgolovyi - the Ulan-Khan river. The foot of the Primorskii Range near Cape Yator is occupied by a pine spiraea dead-cover forest. The steep slopes are mostly covered with willow pine forests after the fires of the 2017th year. Alpine Siberian dwarf pine landscapes were also exposed to fire (figure 2c, 2d). Untouched areas are occupied by Siberian pine dwarf with yernik, crowberry, lichen, and higher by stony tundra.

4. Conclusion

Thus, the Preolkhon territory with the mountain spurs of the Primorsky ridge has significant landscape diversity. A significant territory of the studied sites is included in the national park, since their ecological significance for the preservation of rare and endangered species of flora and fauna is of great importance. Their role is very significant in preserving the integrity of the landscapes of Lake Baikal, which have a high recreational and aesthetic value. The main feature of the modern landscape situation in the region is the interpenetration and close interaction of mountain-taiga and mountain-steppe geosystems that form the ecotone of the mountainous South Siberian and Baikal-Dzhugdzhur taiga and steppe, represented by a combination of mountain-taiga light coniferous, foothill larch steppe and mountainous steppe ecosystems.

Currently, the construction of recreation centers and the use of the mountain steppes of the plateau and coastal plains for recreational purposes has the greatest impact on the natural environment. More than 30 tourist centers with numerous access roads have been built along the coast, where thousands of tourists have a rest every year.

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