The State Nature Reserve Pasvik (Pasvik Zapovednik)

Report on scientific research:

Landscape mapping of Pasvik naturreservat (Norway)

Result of summer field research 2008

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Preface Введение

To conserve the planet's biodiversity is one of the tasks for international cooperation in the field of nature protection. To complete it successfully, we firstly need to find out what can maintain biodiversity. There are two main factors to be considered: habitat diversity (natural factor) and the impact of economic activity (anthropogenic factors), with stable natural factors being of principal value.

Therefore, for the purpose of biodiversity conservation it is necessary to study habitats diversity in specific areas. For research results to be comparable the different countries have to unify methods and object of research, especially applicable to adjacent territories and establishing international protected areas.

The research carried out in Pasvik has proved that a set of habitats are closely connected with biodiversity within natural territorial complexes. We therefore suggest the presented **landscape mapping method** to be used as basic in defining various types of habitats. By using it we can ensure unified approach to habitat type identification.

In 2006, N.V. Polikarpova under the guidance of Prof. E.M. Rakovskaya, developed a landscape map, scale 1:25 000, for the Russian strict Nature Reserve "Pasvik" – Pasvik zapovednik. This map is now being used for spatial interpretation of observation results obtained for certain areas and monitoring sites of the reserve, as well as for corrections to be made when carrying out scientific work.

In context of establishing Trilateral Park "Pasvik-Inari" – on the borderline of Russia, Norway and Finland – the issue of using the map for the purposes of international monitoring program is an acute one. Since the Park is to include the protected areas of Finland, Norway and Russia, it is also important that such territories are covered by landscape maps of the same scale and information based on the same methods.

To do this, in August 2008 we carried out field landscape studies within the area of Pasvik Nature Reserve immediately adjacent to the southern part of the Russian Pasvik zapovednik, thus forming a unity.

Executors Исполнители

The work is carried out in the frame of 2008 Program of cooperation between Finnmark County Governor, Department for Environmental Protection and Bioforsk Svanhovd.

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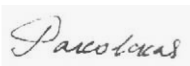

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Pasvik Nature Reserve is situated in Sør-Varanger, Finnmark County, Norway, and forms Norwegian part of the whole trans-border Russian-Norwegian Pasvik Reserve. In 2008, both the sections, together with Øvre Pasvik national park and landscape protected area (Norway) and Vätsäri Wilderness Area (Finland), were made to constitute Pasvik-Inari Trilateral Park.

The Reserve takes up the area from Hestefoss dam in the south to Jordanfoss in the north and stretches for almost 12 km, with maximum width of about 5 km in the southern part. Reserve's total area is 19.1 km^2, including the water area of 4.5 km^2. The landscape research covered about 15 km^2 which included terrestrial complexes (Fig. 1).

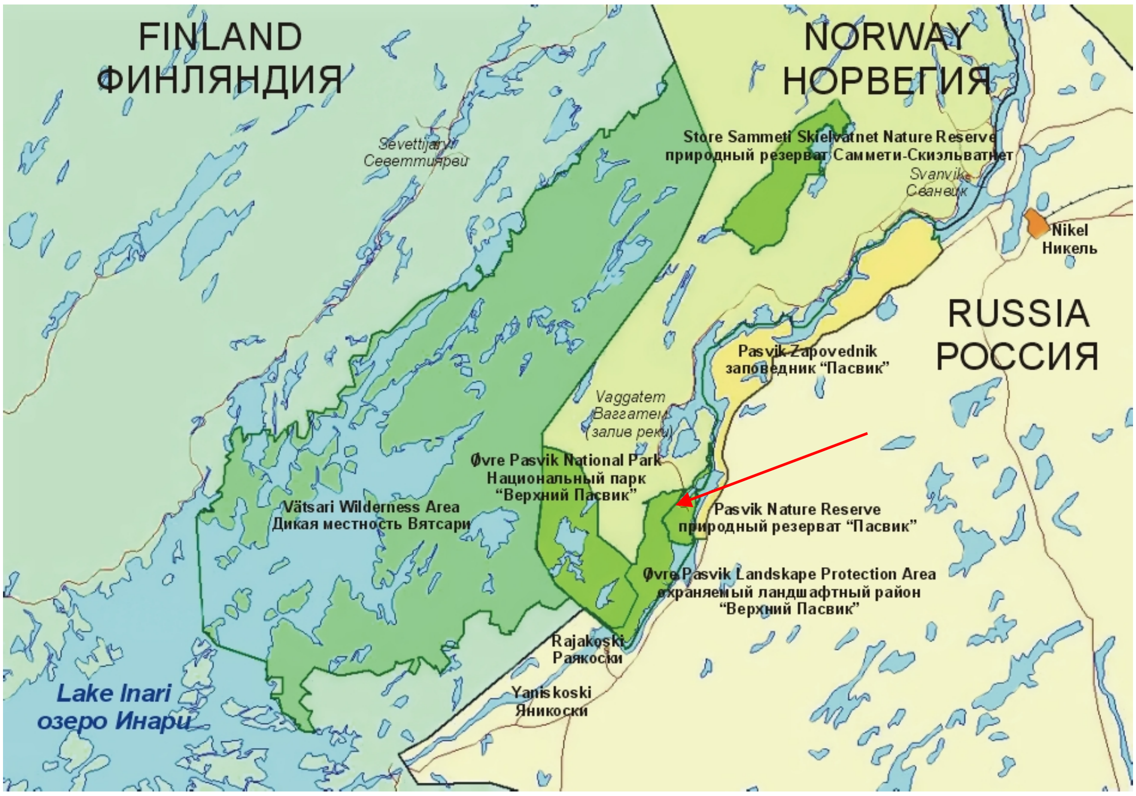

Fig 1. Map of the research area in Pasvik-Inari region.

In tectonic respect, the reserve's area is situated within Lapland granulitic belt, which is a transition zone from Kola to Belomorsky megablock of the Baltic shield – stretching for almost 500 km from Porsangerfjord in northern Norway to southern coast of Kola Peninsula. It is about 100 km wide at the meridian of Inari Lake. The structure of Lapland granulitic belt is quite complex and is presented by intensely dislocated main intrusions of upper archean. Prevailing formations are plutonium-metamorphic complexes represented by piroxene-plagioclase crystal slate stones, acid granulites and granit migmatite-granodiorites with sillimante, metadiorites and gabbonrites (USSR Geology, 1958; Durakova et al., 2002).

Phanerozoe was dominated by washout processes which resulted in sculptured structure of relief to be modified, to some extent, by glacier in the Quaternary. Modern relief was greatly affected by the last (Upper Pleistocene) glaciations. Such relief is associated with sand-and-gravel deposits of esker ridges, which had accumulated in the place of water flows crossing the surface or glacier body, as well as with morainic material formations filled with various-size boulders. Glacial deposits had formed the undulated plains of main moraine with morainic hills and short ridges, which are common for both Sør-Varanger and the whole of Finnmark area. In close proximity to today's Pasvik River valley stretch the esker ridges, with fragments of two of them entering the Reserve.

In late-glacial era, when Baltic shield was still in the state of substantial isostatic submersion and the ice cover had significantly decreased, there started late-glacial (Q_3) marine transgression Portlandia. In the north of Norway and north-west Kola Peninsula, it was of ingressive character, i.e. the sea could penetrate deep into the mainland, thus forming narrow bays, along depressions. In nature, such depressions were tectonic breakups worn-out by water flows and glaciers. The depression, which is now the Pasvik River valley, was the way for the sea to reach the Inari Lake.

Postglacial (Q_4) marine transgression was conditioned by the fact that rapid deglaciation resulted in the sea-level going up with retarded isostatic uplifting of the shield. Thus, the transgression terrace within the mouth of the Lotta River (flowing along Tulomsk-Notozersk depression within Lapland granulite belt eastwards off the Pasvik River), is 70 meters high. The deposits of transgression (Pholas) are composed by heavy loam soil and clay layers, or, in some places, by fissile fine-grained sands. Obviously, when spreading deep into the Nature Reserve, this transgression left those green-grayish loam soils and clays which were repeatedly uncovered in the soil pits. The later holocene transgression (Tapes) cannot be said to have had the same vast spread; along the Pasvik River it could only reach the Menikka island (35 km north of Pasvik Nature Reserve) (actual elevation 32 m). Marine deposits were opened by us at 55-57 m above the sea level.

The marine deposits of the Pasvik River valley build up the flat surfaces of coastal plains, which are embedded by the river bed, and ingressive terraces. They are composed by loam soils and clays, or sparse fine sands and loams, and therefore the plain and terrace surfaces are often swamped, which results in peat accumulation. Various-genesis quaternary deposits continuously cover the whole area of the Reserve, with the effect of original formations on natural terrestrial complexes (NTC) in its area being practically unnoticeable.

Fig. 2. Marine clays at 57 m altitude (not specified on Geology and Quaternary map).
Marine clays on 57 m altitude (not specify on Geology and Quaternary map).

Fig. 3. Sandy-boulder-pebble stone material on the outskirts of esker ridge near western border of nature reserve.

Climatic features of Finnmark County, like those of north-west Murmansk Region of Russia, are influenced by warm North-Atlantic current and its North Cape branch entering the Barents Sea and making the climate milder. Variable weather is typical of the region all the year round, which is explained by frequent air masses change.

The location of Pasvik Nature Reserve – 69^{o} northern latitude – defines the length of polar day (62 days) and polar night (48 days). In addition, there is the so-called "white nights" period which is characterized by longer dusk time with the sun already under the horizont.

The climate of Pasvik can be characterized by observation data collected in Svanvik (Norway), Nikel (Russia, situated northwards off the Reserve) and Yaniskoski (Russia) which is situated southwards off the reserve territory. In Noatun – on Norwegian side – there was also a meteorological station located in the northern part of the Reserve on the shore of the Pasvik River. In January the average temperature is -13.6^{o}C, while in Yaniskoski – -12.8^{o}C. With cold arctic air gusts coming from north-east, the temperature may go down to -35-40^{o}C (absolute minimum for Noatun being – 45^{o}C). Summer temperatures are quite high. In July, the average temperature in Yaniskoski is +13.3^{o}C (Polikarpova, 2006), in Noatun +14.4^{o}C, with the maximum reaching about 30^{o}C (Wikan et al., 1994). Main precipitation falls in warmer period, which is due cyclones passing through Barents marine branch of the Arctic front. Annual precipitation in Yaniskoski is 549 mm. Snow cover forms itself late October. The first snow, however, may appear already late September. Towards the end of winter, the snow cover may be about 60 cm deep.

The main aquatory the protected area is situated along is the Pasvik River, which is confined to tectonic breakup and has poorly defined longitudinal profile. It flows out of the Lake Inari and into Bøkfjord by Kirkenes. The Pasvik River total elevation from Lake Inari is 119 meters. Stretching for 147 km, this river is slow-flowing. Having a cascade of hydroelectric power stations (five Russian and two Norwegian) built on the Pasvik River, it bears little resemblance with a normal river today.

Before the hydroelectric stations were constructed, the river in itself used to be a system of limnetic extensions like bays and lakes, which were interconnected by rapid-flow arms full of rapids and waterfalls, which in turn, favored the construction of hydroelectric stations cascade here. Now the river flow is regulated. Vast areas are taken up by water storages. The original riverbed can be found only within some small sections, the major one being Fjærvann. This is a shallow-water area where water openings appear very early, which attracts water fowl. Fjærvann is considered to be the most favorable area for water fowl along the whole Pasvik Riverbed.

The even terrain, the occurrence of groundwater close to surface and sufficient rainfall facilitate development of mires. Mires mainly feed from precipitation – rains and snow melt water, and to a lesser extent from groundwater. It is the combination of water areas of the Pasvik River and mires – along the river shores – that made basis for creating a nature reserve to protect wetlands and water fowl.

Soil cover of Scandinavian taiga, where the reserve is located, is mostly taken up by alphehumus podzolic soils. Excessive humidity, short vegetation period and sufficiently low summer temperatures make soil microbiological processes very slow. Plant remains decomposition is retarded. On the soil surface, with poor biomass built-up, there forms a moss-lichenous cushion with densely tangled roots of sub-shrub and underwood. While organic remnants are decaying, there form fulvic acids, which make the soil solution strongly acidic. This ensures decomposition of minerals and removal of decomposition products into underlying bed, which causes alphehumus podzols to form. The specific features of such soils include extremely poor profile thickness (50 cm maximum, commonly up to 25-30 cm), well-defined podzolic subsoil immediately below the forest cover (2-10 cm thickness) and that of B-horizon located under the podzolic one. There are three subtypes within alphehumus podzols: illuvial-ferrous, illuvial-ferrous-humus and illuvial-humus.

In Pasvik area, among alphehumus podzols prevail shallow *illuvial-ferrous podzols (*Fig. 4), which are formed on poor-based fluvioglacial and outwash morainic sands and sandy loams, as well as on gravelly or gravelly-rank acid-rock eluvium or diluvium. Such soils can be found in well-drained territories. Illuvial-ferrous podzols are characterized by the presence of poorly humified forest and moss underlayer (A_0), whitish podzolic subsoil (A_2), light ochreous or rusty illuvial horizons (B, BC). Upper subsoils have strongly acid reaction. Such conditions are favourable for formation of ferrous and aluminum fulvates, which colour lower subsoils with bright ochreous rusty hues. These are dry pine forests (lichenous or moss-lichenous) that grow on such soils.

Fig. 4. Профиль иллювиально-железистого подзола.
Illuvial-ferrous podzol profile.

Illuvial-ferrous-humus podzols can be found on poorer drained plain sections and smooth slopes of uplands. They form in conditions of higher humidity and medium intensive draining. With higher humidity, there forms a firm mossy cushion which accounts for poorer oxidizing processes in the upper layers of the soil profile. Due to small amount of illuvial humus, the illuvial sub-soil of such podzols is darker, which is also connected with decreased rate of organic matter decomposition. The thickness of illuvial-ferrous-humus podzols profile layer is to some extent higher, and this can be explained by high accumulation of fine grained soil on the smooth sloped of uplands and increased humidity. These are moss pineries and fruticulose, often mixed with birches, which grows on such soils.

Illuvial-humus podzols often form on poorly drained terrain sections (hollows, slightly sloping hillsides, inter-ridge depressions) with excessive humidity and heavy- or medium-textured soils which prevent moisture drain. No such soils were detected by us in the Reserve.

Sod (turf) soils are common in river valleys and form on marine loamy and agrillaceous deposits. Their podzolic horizon is either very poorly defined or absent. In most cases, the profile of such soils appears poorly differentiated, with occasional gleization traces visible.

Boggy soils are typical of poorly drained plains. They are defined by peat accumulation process that requires atmospheric moisture stagnation in soil and ground water running close to surface, which facilitates reclamation processes and inhibits humification processes and organic remnants mineralization. This also results in peat formation. Lower layers of peat gradually retreat from soil formation process to transform into soil material.

Where underground waters occur close to the surface, on marine loams and clays there form turf (peat humus thickness under 25 cm) and turf-bog (25-50 cm depth of horizon) soils (Fig. 5).


Fig. 5. Turfy-bog soil profile.

With permanently excessive humidifying, along riverbeds and in lake bed depressions there form turf- and peaty-gley soils. The peat layer of such soils is underlain by glaucous gley. Such blue-grey results from protoxidic ferrous compounds – with rusty spots containing ferrous oxides.

In conditions of poor drainage and within areas of inhibited groundwater flow, there may form turf- and turf-boggy soils with marshy pine forests (bog moss pine forests).

Fig. 6. Turfy-humus soil profile, formed on marine clays.

The major part of the Pasvik River basin is situated in northern taiga sub-zone. It is classified by Norwegian researches as belonging to northern boreal zone – Inari-Pasvik Region. Conifer forests of common pine *(Pinus sylvestris lapponica)* dominate here. Forest stands are open-tree dwarf formations vulnerable to windfalls – with narrow and thin crowns, tree branchiness and low productivity.

Scrubby trees with deformed crowns evidence unfavorable soil and climatic conditions for pine to adapt to. These include, first, dwarf soils, where pine forms surface and developed root system. The closing roots prevent forest stands from growing thick, which results in the forests being thinned and having extremely low crown density – 0.2-0.3. A number of scientists (Cherkasova, 1960), however, consider soil dryness to be the main factor to inhibit thick forest stands formation. Considering the soil texture and humidifying characteristics of illuvial-ferrous soils, which are dominant here, they conclude that pine, being tolerant to low soil nutritive value, thick but low-humus profiles, rough boulder undersoil, is at the same time very vulnerable to lack, or excess, of moisture, which can inhibit its growth dramatically.

Mainly, pine forests grow on illuvial-ferrous podzols with cover morainic and outwash plains, low ridges and hills, or upland downslopes. Forest ground vegetation can be lichenous, fructulose-lichenous (crowberry and red bilberry), lichen-mossy (crowberry-blackberry-mossy). Bog moss pine forests are rare.

River valleys are grown by *birch forests* (white birch *Betula pubescens*) or mixed pine-birch forests, sometimes with aspen and rowan. White birch may have various forms – from those of stately white-trunked trees to a gnarled scrubby ones – or be presented by clumps of thin-trunked low-height trees. Birch forests crown density may be various as well. Due to the fact that marine clays and loams are widely spread along river valleys, under the canopy of such forests there form grass-moss and grass-fructulose assemblages, which demand sufficient soil nutrition and moisture content. Occasionally, the brook and river shores are covered by small birch overgrowth mixed with willow.

Fig. 7. Clump of birch *Betula pubescens*, growing on hillock.

Fig. 8. Thin-trunked birch forest along river shore.

In southward areas, ground vegetation serves an important indicator of forest type. However, in conditions of High North the undershrub mostly has a wide edaphic range. (Melekhov, 1960). Thus, for instance, wild rosemary which is typical of mires and swamp forests, can be found practically in all habitats of Pasvik Nature Reserve. The same refers to other species – for instance blueberry, blackberry, heather, which explains polydominance (mosaic pattern) of ground vegetation in majority of forests. Red bilberry and wild rosemary forests are most commonly found in the Pasvik River basin. Crowberry forests are also many, but pure ones never take up vast areas and form only an inclusion in the polydominant cover.

Bogs are commonly found on marine, morainic or lake plains, in depressions between butte uplifts and morainic hills, as well as along river shores. This is formed in conditions of permanent excessive moisturizing. These bogs take up the major part of the nature reserve.

The bog types prevalent in the Pasvik River basin are heterotrophic and mesotrophic, ridge- and hummock -hollow, grassy and moss-grassy. Occasionally one can spot places of subshrub-mossy and shrub-mossy types. Typically eutrophic and oligotrophic bogs are becoming rarer and never take up vast areas.

Bog massif types are differentiated according to dominant vegetation distribution in ecological series 'center – periphery' (Yurkovskaya, 1974). Mesotrophic bogs differ from heterotrophic ones by having eutrophic center and relatively afforested less-moisture oligotrophic periphery. Heterotrophic bogs, or string bogs, are presented by alternating (in relatively even way or over a small section) eutrophic swampy hollows and small lakes with oligotrophic fragments – tussocks or ridges, or both (ridge- and hummock -hollow bogs). Their periphery is either of mesotrophic or oligotrophic character.

As a rule, bogs have a concave surface. The heterotrophic bog type commonly spread in Karelia, Scandinavia and north-west Kola Peninsula, is called 'aapa bog'. The evolution of such bogs is associated with diverse water-mineral nutrition – ground waters and atmospheric precipitation.

Life-forms of plants inhabiting aapa bogs are extremely diverse. The center and the peripheral parts of bog massifs (ridges) are covered by pine. White birch is more common on periphery. Ridges and tussocks are formed by sphagnum mosses and small shrubs (moorwart, cloudberry, crowberry, Dutch myrtle, heath). Eutrophic plots and swampy hollows are excessively flooded and covered by sphagnum or hypnum mosses, gramineous species (moor grass, reed grass), sedge (cotton grass, Trichophora), tinweed. The dead-water is grown by marsh trefoil and bladderworts.

Oligotrophic (ombrotrophic) sections of bogs are inhabited by the following indicator species: *Eriophorum vaginatum, Trichophorum cespitosum,* sphagnum mosses *Sphagnum fuscum, S.magellanicum, S.angustifolium*, etc. Within mesotrophic ecological group the typical sphagna include *S.riparium, S.papillosum, S.russowi* , etc.; eutrophic species – white birch *Betula pubescens, Phragmitas ausltralis,* slender sedge *Carex lasiocarpa,* beaked sedge *C.rostrata, C.chordorrhiza,* marsh trefoil *Menyantes trifoliata,* swamp horsetail *Equisetum fluviatile,* marsh horsetail *E.palustre,* purple moor grass *Molinia caerulea,* rosebay *Epilobium palustre,* sphagnum mosses *Sphagnum warnstorfii, S.squarossum, Warnstorfia exannulata*, etc. (Heikkilä et al., 2001). All the specified species have been detected in the Pasvik River valley (Kostina, 2003; Likhachev, Belkina, 2006f; Neshataev et al., 2007).

Shallow waters of the Pasvik River are overgrown by shore water plants – sedge, swamp horsetail, reed, marsh trefoil – and are gradually transforming into isles.

The main factor to determine the location of vegetation, including tree vegetation, within the reserve, is its surface pattern: flat marine plains are covered by diverse bogs, morainic and outwash hills and ridges – by pine forests, while near-valley sections – by birch and pine-birch forests.

Objects and methods   Объект и методика

The objects of research and mapping are integral natural complexes – natural terrestrial complexes (NTC) – historically and territorially bound regular combinations of interrelated natural elements. Within geographical envelope, there have been formed a big number of various-size and complexity NTCs. They appear to be 'embedded' into one another to form a system of superordinate units. Field research is often aimed at studying NTCs with simpler structure which take up relatively small areas, i.e. layout level NTCs or landscape morphologic units. These are most often facieses and tracts, which can always be designated on any landscape, that are studied in the course of field work.

Facies, being the simplest and elementary natural complex, differs from other NTCs in the way that all natural components within it remain *spatially homogeneous*, i.e. every component within the facies remains unchanged. Facieses are distinguished by equal lithology and uniform relief. Over its whole area, a facies receives equal amount of heat and moisture. This explains typical features of facieses – uniform climate, equal difference of soil formation and sole biocenosis (Rakovskaya, Polikarpova, 2008).

Facieses isolation is often caused by changes in relief, i.e. changes of *location* (Fig.9). As topographical relief is very uneven, it may change within small distances and facieses, as a rule, take up small areas.

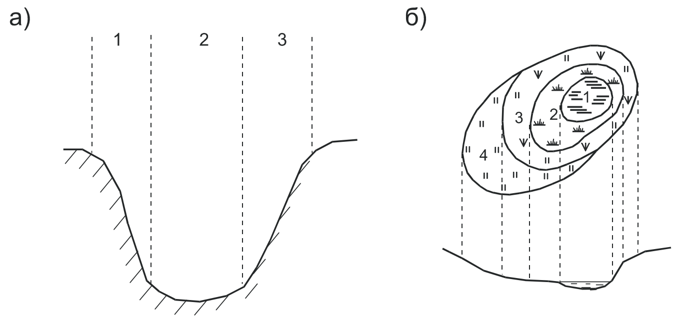

Fig. 9. Impact of relief on facieses isolation in ravine (a) and hollow (b). Numeral 1, 2, 3, 4 – are facieses.

Normally, a facies occupies one element or part of microrelief form. An example of facies is a top of sand bar on terrace above flood-plain with lichen pine forest on alluvial cryptopodzol; or a central part of morainic hillside (southern direction of the slope) with birch-pine horsetail-bilberry forest on illuvial-ferrous podzol, etc.

Sometimes facies isolation may be caused by changes in lithology of area-forming rocks. Thus, if a ravine splits a geologic formation of various sedimentary types, on a hillside line segments made by various strata there may form own facieses, different from one another. Where the relief is hilly or mountainous, facies isolation is partly accounted by direction of slope, which in turn causes differences in insulation and consequently, in warming-up of slopes of different directions.

Thus, the root cause of facies differentiation is the change of lithogenous foundation. This change, in turn causes changes in thermal conditions, ground water depth level, moisture balance, etc. – which results in modified conditions of a habitat (new ecological conditions) and formation of new biocenosis.

As facies is distinguished by spatial homogeneity of its constituents, is it easy to designate it in field. Any visually noticeable change – even in single component – evidences the transition from one facies into another. Facieses are most easily designated in the open spaces, such as meadows or mires, where even a slight change is reflected in vegetation – its composition, density, viability or hue connected with mass flowering of certain plants.

It is far more difficult to designate facieses in the areas covered by forest, where visibility is poor, relief microforms are often not to be seen and existing stands may not be aboriginal ones. Therefore, when delimitating forest facieses one should focus more on ground cover rather than tree layer. Unlike tree layer, the composition of ground cover tends to reflect facies changes more distinctly. As a result, these are grass, moss and small shrubs layers that appear to be the main facies indicator in forest NTCs.

It is clear that any observation point is located within a particular facies, and will therefore characterize this facies - the simplest NTC. Such observation points describe facieses, thus forming our notion of a major NTC, as these are facieses that serve as "atoms" or "bricks" to build any NTC.

Tract is the most important morphologic unit of a landscape and the main object of field research and mapping in the frame of large-scale landscape research. A tract is an integral NTC which consists of dynamically interconnected and genetically and territorially bound facieses. Being a component of landscape, a tract in itself has more or less complex morphologic structure. Usually, tracts are expressly isolated in space, because territorially they overlap certain forms of mesorelief. Tracts are most expressly delineated in conditions of broken relief with repeatedly alternating positive and negative forms of hills and depressions, ridges and ravines, etc.

Spatial overlapping of tracts and certain topographic forms is the most important diagnostic property to designate tracts.

In addition to relief, tracts isolation may be caused by changes in geologic framework of the area (depth and nature of the parent rocks underlying cohesionless sediments, loose deposits composition, etc.) or in groundwater depth level. Where the stretch of single mesorelief form features a change in underlying soil, which is revealed by such form, the tract will take up not the whole but a part of mesorelief form, i.e. the upper stretch with uniform geological structure.

As to biogenic components associated with NTC of a tract type, they cannot be used as diagnostic property for designating it. Soils and vegetation within a tract may vary considerably from facies to facies (facies-wise) and even belong to different types.

As every tract is a regular combination of the facieses forming it, tracts can be designated by studying their internal structure. Such approach is especially important when tracts are to be studied in conditions of undifferentiated dissected relief, where diagnostic property cannot be determined visually and therefore appears insufficient to delineate tracts. In this case, it is necessary to study the morphologic structure of tract's typical plot, and then, based on detected structural change, to trace borders of the tract.

The complete cycle of landscape research includes three stages of works, namely, preliminary (prior to field work), field and cameral stages.

In preliminary stage, a researcher usually studies maps and literature applicable to field work area and compiles preliminary landscape map. It is advisable to have the following maps available: topographic, geological, geomorphologic, forest inventory (forest estimation), land use (lands, land evaluation), vegetation and soil maps.

For the purpose of our research work, we obtained topographic map Krokfjellet, 1:50 000 (Fig. 10), and a fragment of quaternary deposits map, 1:70 000. The satellite image made from the height of 14.77 km (www.google.no) appeared to be medium-scale and practically could not be used. Since we didn't have any other maps or larger-scale aerospace materials as our disposal, it was impossible to make a preliminary landscape map.

Literature and source maps to be studied in preliminary stage enable a researcher to develop general notion of the nature of conditions in the area, determine certain geographic regularities within (confinement of plant communities to certain habitats, NTCs positional relationship, etc.) and determine the plots requiring various depth and exhaustiveness of field work.

As there is little knowledge about the components of natural complexes (soils, vegetation) on Norwegian nature reserves (the Russian side also lacked such knowledge before landscape map was developed), it was impossible to use sector research materials. There is a number of works on mapping the vegetation of Norway. The territory of reserve, however, is classified under one type (which makes it impossible to differentiate NTC components). At the same time, practically all the literature is available only in Norwegian, which also complicates work. But, since we are very well aware of the nature of the neighbor territory of the Russian Pasvik zapovednik and able to apply the regularities and interrelations determined when studying nature reserve, the said difficulties could be overcome.

The comprehensive study of the two available maps allowed us to determine only the main genetic types of NTCs to be encountered in field. These include morainic hills and esker ridge complexes, flat lake swamp plains and river valleys. Even the presence of marine clays on flat swamp plains could but only be supposed by us – given the distribution on the opposite shore of the Pasvik River. The quaternary sediments map available didn't feature them self on the territory of the Reserve. The flat sections indicate peat (organogenic sediments) all over, with no thickness indicated.

As to the third task to be resolved in the course of studying literature and source maps, i.e. to determine the plots requiring various depth and exhaustiveness of field work, as certain natural components are studied to various extent, it remained uncompleted.

When doing landscape research, the role of topographic basis is of special importance. Such basis should ensure the correct terrain orientation, simplicity of elevational and planimetric position identification and sufficiently precise plotting of research objects – in this case, NTC border lines.

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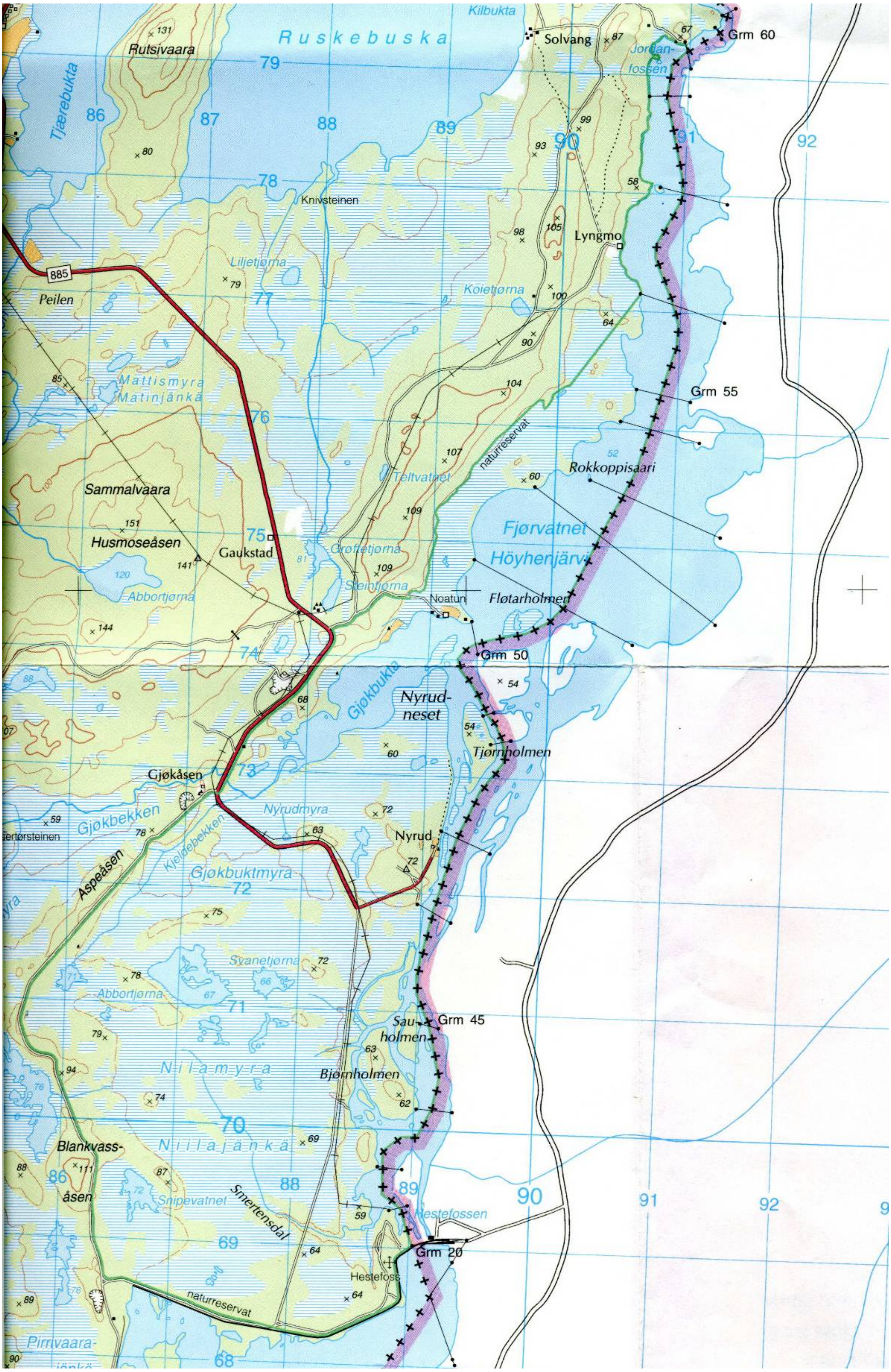


Fig.10. Topography map on Pasvik naturreservat territory (Krokfjellet, 1:50 000). Green bold line – the border of reserve.

However, we faced an unforeseen difficulty here as well: there was a discrepancy between the amount of map's details and its scale, as well as almost a complete lack of good landmarks. Those were only road junctions and their sharp curves that could serve as landmarks. Even islands and detours of rivers could not always be used as orientation due to growth of forestation of the near-river plots and their overgrown shallow waters.

The territory of Pasvik Nature Reserve is distinguished by minor fluctuations of absolute altitudes, with the maximum reaching 94 m. The rim of the Pasvik River is not indicated anywhere and the lowest level within the Reserve is found at 54 m – at Tjørnholmen. Thus, the altitude difference within the area under study is about 40 m, with the value to its major part being less than 20 m. On the map available, the continuous land contours are drawn at the interval of every 20 m (for Russian topographic maps such section to be given only for 1:200 000 scale), while supplementary contours – of every 10. Therefore, the specific features of relief are practically not reflected on this topographic map. Even the really existing lake configuration does not correspond to forms and sizes as shown on the map. In this case, to define the NTC border lines we used the satellite image which appeared to reflect lake configuration and the border between afforested and swampy NTCs better. At the same time, low resolution of the image did not allow us to use to the full extent in our work.

It should also be noted that for harmonizing the scale of landscape maps for the Russian and Norwegian parts of Pasvik, the available source material had to be mechanically zoomed in to reach 1:25 000 scale (twofold), which also accounts for inaccuracies.

Thus, we obtained the cartographical base material, with all its drawbacks, which was further used for the purpose of field work and compilation of landscape map annexed to the report. In pre-field period, we also outlined preliminary research routes which further had to be corrected in the reconnaissance stage.

Field stage usually starts with reconnaissance insight into the territory under study. We toured the Nature Reserve by taking the road along the western and southern border lines and then from Hestefoss Dam northwards to the road to Nyrud, and from there back to the western border. The visual impression of the territory enabled us to detail the network of main routes within the Reserve and schedule our works.

The studied methods and programs for mapping habitats and biodiversity in the European countries (Norway and Finland) enabled comparison with the landscape mapping methods used in Russia (Rakovskaya, Polikarpova, 2008; Klokk, Lindgaard, 2002; Airaksinen, Karttunen, 2001; The Interpretation Manual, 2003). In the field stage in Norway, we obtained an additional knowledge about the Norwegian methods used in mapping vegetation (Rekdal, Larsson, 2005) and the national landscape reference system (Puschmann, 2005). The analysis shows similarity in approach and guidelines used to develop the typology, in differentiating the specific plant communities and in the character of their description. The national landscape reference system developed by Puschmann, represents landscape zoning of 45 designated landscapes of Norway. According to the research, the territory of reserve refers to major Pasvik region and is assigned number 42 (Puschmann, 2005, 174-177 pp.). It takes up the Pasvik River valley, including the "Upper Pasvik" National park and its westward vicinity. This does not enable using the materials of this report in a large-scale mapping.

The study of methods for soil description has also proven their similarity with Russian methods – both in approaches used for specification and horizon indexing (Greve et al., 1999). It should be noted that soil classification used in Norway, differs from the Russian one in many aspects (Nyborg, Solbakken, 2003), and poor knowledge of both the Norwegian language and edaphological approaches which made it impossible for us to use it.

Field landscape research was carried out according to the general landscape methods (Vidina, 1962, 1963; Isachenko, 1961; Zhuchkova, 1977; Zhuchkova, Rakovskaya 2004), which means working at station points and routes to develop complex specification of NTC by way of describing their components (facies). The methods also enable to determine facieses, which build tracts, and their interrelations.

Without a preliminary landscape map, routes has to be laid so that they could more or less uniformly cover the area under study with station points, and cover the potential diversity of NTC to a maximum extent. On daily basis, we mapped 4-5 points of complex descriptions and, where necessary, additional ones if tract's name or structure had to be detailed. Since we lacked substantial topographic basis and due to certain discrepancy between GPS data and topographic map data (altitude and coordinates), as well small amount of field workers (two people), we didn't manage to use in our work the method of complex landscape profiling. We therefore used the itinerary method, which includes both NTC descriptions at points and variability along the route.

We have completed the total of 15 routes and mapped 95 observation points, including 66 points of complex description and 29 cartographic.

Observation materials were registered in the field journal and form sheets for complex descriptions. While journal entries may be free-form, the form sheet provides for strict unification of the contents of observations and results registration, which further simplifies their processing.

The main factual material to describe NTC is obtained from observations points. There are usually facies that are being described at points of complex description. The main focus is the study of relations between components within a complex. The research has to include the exhaustive studying of all the components, as the materials required for their description are to be taken in field. Points of complex description are selected within typical and most common facieses.

After the point has been selected, it is necessary to define its location on the map, plot it and assign the number. The orientation to be used to define the location and input the address, has to include at least two objects which are sustainable (i.e. within the same location over a long period of time) and well seen afield and on the map. As orientation may serve river and streams mouths, water flows confluence, separate hills and remnants, mountain tops, lakes, railway and highway bridges, populated areas, etc. The location of an observation point, as referred to every object, is to be detailed with direction and distance.

The location of the point on mesorelief has to be given as precisely as possible. For instance, as flat plain surface, plain cathole, near-top part of hillside, talus bottom, channel flood-plain, ravine bottom, etc. Further, the mesorelief element has to be described in detail – in terms of form, morphometric data, compartmentalization degree, etc. The absolute and relative altitude has to be specified. For plain facies, normally the relative altitude above erosion base level has to be given. Absolute altitudes are to be given only for highest and lowest points and have to be determined according to be map. In the mountains, on the contrary, relative altitudes are specified rarely, mainly, for valley and bench complexes, while absolute ones have to be specified almost always, as they are important when defining the nature of complexes and components altitude change.

The description of flat surfaces is usually simple and brief. It is much more difficult to describe sloping surfaces (various hillsides) one often has to deal with. When describing hillsides it is necessary to specify their direction (according to the eight courses eller rhumbs), slope gradient (in degrees and words), form and character (straight, concave, convex, hilly, terraced, rutted, billowy, etc.).

Special attention is paid to microrelief description. It is important not only to spot the presence of hollows, catholes, tussocks, contractions or erosive furrows, but also to describe their form and three-dimensional size (length, width, height and depth) and to register their occurrence rate and location within the area.

Relief described, one should proceed to vegetation description**.** The methods of vegetation description, when studying facieses, differs from geobotanical research methods in the way that focus is made on widely spread plants (cenosis-forming plants).

The description of plant communities is tier-wise. Forest communities are being most complex. The forest tier is described in terms of crown density, species composition and quantitative ratio of certain species in points from the total of 10. For example, common pine – 7, white birch – 2, aspen – 1. The general composition of a stand (formula) is generally registered as: 7P2B1As. Every wood species is registered in terms of tier it comprises, height and trunk diameter, and other features.

Tree layer is followed with description of undergrowth and shrub layer. The undergrowth is described in terms of natural regeneration (good or poor) and overall composition in points. Every layer is described in terms of species, abundance, height and distribution. Crown density (in points), is specified for the whole layer. Shrub and moss layers are usually described in terms of species composition, abundance and distribution, while shrubs – in terms of height. With abundant shrubs overgrowth, projective cover degree is to be specified for the whole layer.

The name of forest species reflects the leading species, or sometimes associated one, as well as tree layer, the dominant undergrowth type (if well-developed) and predominant species or a group of round cover species (grassy, small shrub or mossy). For example, pine-moss-blackberry forest, birch-pine forest, lichen-bilberry-crowberry forest, etc.

Soil description refers to soil profile cut, the depth of which may be various and depends on the soil genetic type and parent rock or ground water occurrence depth. The cut, however, must in any case reveal the native (mother) rock, and undersoil, if the native rock is thin.

On a plain surface, it is the best lit wall that is taken for the purpose of description, while of a slant surface – the highest one. When digging the soil profile cut, the ground is not thrown onto the described side of the hole. On completion of work the profile cut is to be carefully filled up. For the purpose of soil section description the face wall of the hole must be ground with spade or knife. A centimeter tape is then has to be pinned to its upper edge. The research of the soil profile cut starts with delineating soil horizons, measuring their depth and indexing. The depth of horizons is to be indicated with two figures referring to location (depth) of the upper and lower borders of horizon.

For each soil horizon should be described in terms of colour, structure, density, inclusions, new formations and transition to adjacent horizon. Such sequence of characteristics is defined by their interrelations. When describing each horizon, one part of the wall is to be made slightly loose by picking it with knife. This is necessary to trace the change in density, soil structure and colour as evidenced by planes of structural separates.

- To index soil horizons, we normally use the system the basis of which was developed by V.V. Dokuchaev: in humus horizon; $A_п$ – humus horizon; $A_т$ – turf horizon;
- T – turf horizon;
- П – humic horizon;
- A_2 – soil removal (eluvial) horizon: podzolic, podzolized, solodized;
- B (B_1, B_2, B_3) – horizon of upwards removed substances (illuvial horizon) – in podzolic, sod-podzol and solodized soils; in other soils - bedrock-transition horizon;
- C – bedrock (parent rock);
- D – undersoil;
- G – gley horizon.

Where gleization processes (protoxidic iron compounds accumulation) of respective horizon are weakly defined, g is to be added to its index (A_{1g}, B_g). Subhorizons are assigned two indices (A_1A_2, A_2B, BC). Where soil profile contains embedded horizons, their respective indices are to be given in brackets: ($A_{пах}$), (A_1). We have also used A_0A_1 – subhorizon typical of Fennoscandic soils.

The detailed description of soil cover is given in standard procedures (Soil Survey, 1959; Classification…, 1977; Soils of USSR, 1979). After lower layer is described, soil is to assigned name – based on combination of genetic horizons and degree of their expressivity. The full name must include soil genetic type and subtype, mechanical composition of the upper layer (which defines soil subvariety) and composition of soil-forming (parent) material. Where the soil-forming material layer is thin, the undersoil is to be indicated as well. For example, podzolic illuvial-ferrous sandy soil on fluvio-glacial sands; sandy clay sod-cryptopodzol on fluvio-glacial sands undercoated with moraine, etc.

The scope of obligatory observation to be made on the point of complex description should also include the type and moistening level. The moistening level indicates the main source of moisture coming into NTC – atmospheric, ground, flood-plain, sinter-delulival moistening – but does not define the whole specific character of moistening conditions of the complex. In addition to type, the degree of moistening is to be indicated as well – insufficient, sufficient or excessive moistening. Where moistening is excessive, it is necessary to indicate its regime – as 'atmospheric, average', 'atmospheric, permanently excessive', 'ground, permanently excessive' or 'ground, temporarily excessive due to snow melt'. If wall or bottom of the hole starts to drip with water, the ground water depth level is to be indicated. For all other cases it should be stated 'ground waters not exposed'.

In the blank form it is also necessary to register the current use of the natural complex and traceable natural processes in place; the natural complex should be named.

The full name of facies must include three components – the relief, vegetation and soil. It is relief that must be indicated first in the name, not vegetation. For instance, morainic hillside of south direction with *Cladonia*-bilberry pine wood on thin podzolic sandy morainic soils.

The blank must always indicate to which tract, or sub-tract, the described facies refers to. Later, when systematizing complexes and defining the landscape structure of the area under observation, this will prove useful.

The additional observations (description of outcrops, specific character of certain component, adjacent complexes and their locations, etc.) which are not included into the blank form are to be registered in the field journal. In the journal, one should also keep description of the mapping points where one is not supposed to study facies components and facies as such in a detailed way. Normally one should indicate their name and role in the structure of the tracts to be mapped.

Route observations, i.e. inter-point descriptions, are also to be registered in the field journal. They may be different in both their contents and volume. On the whole route extent, one should register changes occurring in natural complexes or certain natural components between the points of observations. Focus should be made on currently existing processes which change NTC. In the journal, one should also register the observed regularities in NTCs location or in components' interrelations; the defined diagnostic properties of complexes; the reflections on the origin and tendencies for complexes to develop, etc.

On the route and when working on the points, we used the cartographic basis to fix the defined borders of NTC for the range (tracts) to be mapped. However, it was not always easy to securely fix the borders, as they often constitute transition bands. Thus, for instance, the transition from pine forests to bogs covered with pine can often be represented by more or less broad band of marshy forest. To trace such band is extremely difficult, as any increase in peat thickness results in changed stand thickness and height of trees, which, in turn, may result in excluding of the territory, under certain parameters, from the forest-covered area. As long as we didn't have any data on peat thickness (which would prove the easiest method for delineation), the borders of forest and boggy NTCs were demarcated according to the borderline of forest stands as given by base material.

In the cameral stage**,** we were processing field data, combining tracts according to their similarity degree, developing descriptive data for the landscape map and specifying borders of certain complexes. The application of the Russian topographic map (1:50 000 scale, 5-meter vertical intervals) to Norwegian side enabled more precise demarcation of near-river NTCs borders. It should also be noted that timberline as given on the Russian map, often disagrees with that given by Norwegian base materials. We, however, considered it inappropriate to make any corrections, as discrepancies could be caused by divergence in criteria or numerical ratings used for defining forest-covered area.

Results and discussions Результаты и обсуждение

The result of the research conducted is the final formalization of landscape map, its transmission to electronic format (CorelDraw.12 software), and the characteristics of the marked types of natural complexes.

The landscape map legend is based on genetic principle, which means the combination of NTC according to the similarity of their origin and development on the given territory. The names of NTC reflect the features of the leading components. The sequence of the NTC groups' locations in the legend is based on the transition of NTC from watershed divides to local erosion base. The complexes inside the groups are arranged from the most ancient to the newer ones, from steep to flat ones, from the driest to moist and wet. The specification of the types of NTC is provided thereinafter.

All in all 14 types of NTC of tract rank are separated in Pasvik Nature Reserve.

While formalization of map the colour is used as the strongest means of expression. The typologically similar contours are filled with different shades of the same colour, every section is enumerated according to its ordinal number in the legend. The landscape map is presented in Appandix 1.

Characteristics of the natural-terrestrial complexes (NTC) of Pasvik Nature Reserve.

I. NTC of esker ridges

Esker ridges stretch along the western border of Pasvik Nature Reserve and form a series of separate hills near the eastern border in its southern part. The northwestern border of the natural reserve passes along the foot of the esker ridge and in the Noatun region the border moves over to the bounds of the ridge itself. As far as the ridges stretch high lots are changed to lower saddles. The ridges are formed by stone-boulder materials – watercourse sediments that flew on the surface or inside the glacier during its melting. Within the bounds of the eastern ridge that has a lower hypsometric position the saddles are covered with younger sediments of different genesis, or flooded by the waters of the Passvikelva river.

Esker ridges are covered with pine forests small shrub-lichen-green moss on illuvial-ferrous podzols.

1. **Esker ridges, formed by sand-boulder material with pine forests *Empetrum hermaphroditum-Vaccinium vitis-idaea* with lichen-green moss and green moss cover on illuvial-ferrous sandy podzols.**

Natural-terrestrial complexes of this type stretch along the western and southwestern border of the reserve and include a small division within the bounds of the eastern ridge westwards of Nyrud. They rise above the surrounding plane on 15-20 m, in the lowest places only on 7-10 m. The maximum rise is 20-25 m.

The most characteristic of the ridges are flattened peak plains with rare hummocks, overgrown with small shrubs, mosses and lichens, the base of which is usually boulders or sometimes old stubs of the trees cut. In places, 4-7 m above them there is short apical crests with a considerably larger number of boulders, sometimes not grassed completely or partly. Gentle slopes (5–7º) are typical for esker ridges. Gentle and strongly gentle (up to 15º) slopes are seen in small areas. Only the slope that faces the upstream of the creek Kjeldebekken has the degree of slope of 15-18º on a huge scope.

The esker ridges are covered with full grown pine forest. The height of the forest stand ranges from 16-18 to 25-30 m (points 2, 11), 12-16 m on cleared areas. The diameter of the trunks reaches 25-35 cm. The second tree layer has small number of birch trees with the height of 5-8 m. The projective cover of a subshrub layer varies from 55-60 % to 80-90 %. Among the subshrubs *Vaccinium vitis-idaea*, *Empetrum hermaphroditum*, *Rhododendron tomentosum* are dominated. The most common crowberry-cowberry and cowberry lichen-green moss and green moss pine forest. Usually *Pleurozium schreberi* constitute more than a half of lichen-moss cover. The participation of lichens in ground vegetation increases on the old cleared areas, where there are more or less considerable spots with the lichen predominance.

FIg. 11. Common view of NTC 1.

In all the soil pits made within the bounds of esker ridges the illuvial-ferrous podzols on fluvioglacial sands were uncovered. The maximum soil depth is seen on the flattened peak plain (point 29), or on gentle slopes (point 66).

Point 29 is put 350 m northeast of the road cross to Nyrud and to the south of the reserve, and also 150 m northwest of the extension road cross-Nyrud on a peak plain of the esker ridge with pine forest *Rhododendron tomentosum –Vaccinium vitis-idaea–*green moss. The pit uncovered illuvial-ferrous podzol on fluvioglacial gravel-sand sediments:

A_0 - 0-9 cm – bedding, reddish-brown, fresh, loose.

A_2 – 9-17 (32) cm – whitish, fresh, sandy, amorphous, poorly consolidated, rare bases of plants, the transition is well-marked by the colour, very uneven with cutans and pockets.

B – 17 (32) – 47 cm – unevenly colored, aeruginous-reddish, with yellowish-brown spots and interburdens, fresh, sandy, amorphous, density of the spots of different colour is changing: from consolidate aeruginous-reddish to consolidated lighter ones, there are ferrous-manganese nodules, gravel inclusions and rare bases of plants, the transition is well-marked by the prevailing colour.

BC – 47-59 cm – grayish-yellow, with brownish-yellow spots, fresh, coarse sand with fine gravel, amorphous, consolidate.

Abundance of ferrous-manganese nodules in the pit of the point 40 did not allow passing over the horizon B completely, but more often the depth of the pit was specified by the abundance of calculous-gravel material (point 39 and others).

The traces of human impact within the bounds of the given type of complexes are represented by the old clearings (points 64, 66).

Fig. 12. Pine forest on place after solid cutting in the middle of XX century (NTC 1).

2. **Weak hilly surface of separate hills of esker ridge with Birch-pine forests *Rhododendron tomentosum-Vaccinium vitis-idaea* with green moss cover on illuvial-ferrous sandy podzols.**

Separate hills of esker ridge are situated in the eastern part of the Nature Reserve on the height up to 60-63 m above water level of the Pasvik River (53 m); they represent islands or peninsulas, separated from the other territory by swampy lowlands. Only in the Nyrud region such a separate hill is connected with the higher fragment of esker ridge situated westwards.

Above the water level the surface of separate hills often raises as a clean-cut cliff of 1,5-2 m of height, where in places the sediments that form these hills are revealed. Sometimes it is a fluvioglacial boulder material, but sometimes it is overlapped by river alluvium. For instance, on the western coast of the Bjørnholmen island in a 1,5 meter sediment the laminated fine-graded light-grey alluvial sands are revealed. And on the southernmost separate hill marine clays can be seen under alluvium.

Characteristic of separate hills is flattened surface, which is 5-7 m high above the water level of the Pasvik River. Only in central part the surface acquires weak hilly character and differs by a considerable amount of boulders, including partially grassed ones. The highest peaks on the Bjørnholmen island are 62 m and 63 m.

The separate hills are overgrown with Birch-pine forests. *Pinus sylvestris* with the height from 10-12 m to 16-18 m grows in the first tree level. Only in the point 22 birches, reaching the height of 12 m, appear in the first tree level. The second tree level consists of *Betula pubescens* from 7-8 m to 8-10 m of height. Subshrubs usually cover from 70% to 85% of surface. Their content is prevailed by *Vaccinium vitis-idaea*, *Rhododendron tomentosum* is sufficiently abundant. In a significantly smaller amounts there grows *Empetrum hermaphroditum*, sometimes *Vaccinium uliginosum* and *Vaccinium myrtillus*. Projective cover of a lichen-moss layer constitutes 90-100 %, and green mosses are complete predominants.

Fig. 13. Common view of NTC 2.

Fig 14. Ground cover of NTC 2 mainly *Ledum palustre-Vaccinium vitis-idaea*-green mosses.

In the forests the illuvial-ferrous sandy podzols on fluvioglacial sediments, alluvial sands or binary loads (point 52) are formed: alluvial sands are underlied by marine clays on the depth of 54 cm.

The soil pit cited below (point 53), characterizing illuvial-ferrous sandy podzol, is laid on a peninsula with boundary post 43, 100 m south of the northern shore and 100 m west of the bank of the Pasvik River in the Birch-pine *Rhododendron tomentosum-Vaccinium vitis-idaea* with green moss forest.

A_0 - 0-17 cm – bedding, reddish, fresh, loose.

A_2 –17-22 (25) cm – whitish-grey, fresh, sandy, amorphous, loose, plenty of bases of plants, the lower border is uneven, the transition is well-marked by the colour.

B – 22 (25)-49 cm – yellowish brown, unevenly coloured, fresh, sabulous, amorphous, poorly consolidated, bases of plants, mainly in the upper part of the horizon, the transition is poorly marked by the colour.

BC - 49-57 cm – yellowish-grey with rare brown spots, fresh, tophaceous, amorphous, consolidate, the transition is poorly marked by the colour.

C - 57-89 cm – grayish-yellow, moisted, fine-graded laminated sand.

The traces of human impact are seen only in Nyrud aera.

II. NTC of the separate hills of moraine plain and hills.

Moraine hills are spread in small spots all over the territory of the reserve. They rise above the vast swampy submarine ingression plain in the form of forested separate hills. Only in the southwestern part of the reserve the highest moraine hills are connected directly with esker ridge, merging with it in organic whole. The hills consist of sand-stone-boulder material (moraine).

They differ from esker ridges by a considerably larger boulder accumulations and a small amount of fine earth. Often the abundance of stone material does not allow laying a soil pit properly.

The hills are covered with pine forests, with larger or smaller presence of birch trees, subshrub-green moss on illuvial-ferrous podzols, often dwarfish, and turfy in places.

3. Short moraine ridges and hills with Pine forests *Empetrum hermaphroditum-Vaccinium vitis-idaea* with green moss cover on illuvial-ferrous frequently dwarf podzols.

Short moraine ridges and the highest separate hills of moraine plain are located in the western and southern part of the Reserve. Their foot lies on the height of more than 70 m, the highest peaks reach the height of 85-87 m. Surface of the ridges and separate hills is differentiated by its hilliness, which is connected with abundance of boulders, overgrown with mosses, lichens and subshrubs. On some boulders there are only spots of crustaceous lichens. There are especially many uncovered boulders on tops of ridges and hills.

The surface is overgrown with pine forest. The height of the pines of the first tree level is from 16-20 m to 14-16 m; the prevailing diameter is 20-25 cm. Birch tree, 6-10 m high, is always present in the second tree level. Birches grow in beds of 3-4 and sometimes even more trees. Only in clearings (points 46, 48) the height of tree level of pine and birch do not exceed 8-10 m. Birches are usually lower (5-6 m).

The content of subshrub level is notable for constancy (*Vaccinium vitis-idaea, Empetrum nigrum, Rhododendron tomentosum, Rubus chamaemorus, Vaccinium myrtillus, Vaccinium uliginosum*), but predominance on small distances passes over from one to another. Usually *Vaccinium vitis-idaea* and *Empetrum nigrum* are the most abundant. In larger or smaller amounts *Rhododendron tomentosum* is always present. Green mosses prevail in the ground cover but various lichens are added to them. However, lichens prevail only in small areas of the old clearings. In places where the surface slightly runs low, getting concave character, *Rhododendron tomentosum, Vaccinium myrtillus* and *Vaccinium uliginosum* are more abundant, and Polytrichum commune and Sphagnum join green moss. The same picture can be seen in lows between the hillocks. At times single *Equisetum sylvaticum* appears.

Predominance of stone-boulder material with small amount of fine earth, that constitutes the complexes of this type, makes the processes of soil formation difficult. On hillocks often under the bedding made of fossil parts of mosses and lichens, densely penetrated by subshrub roots, the unweathered stone is revealed. Rather common are dwarfish illuvial-ferrous podzols. Such a podzol was uncovered with the help of soil pit laid in the ridge-top part of moraine ridge, located to the north of the Abbortjørna lake in the Pine *Vaccinium vitis-idaea-Empetrum nigrum* lichen-green moss forest.

A_0 – 6-11 cm – bedding, grey-brown, fresh.

A_2 – 6-11 cm – whitish-grey, fresh, sandy, amorphous, consolidated, abundance of small stones (d=5-7 cm), the transition is well-marked by the colour.

B – 11-16 cm – yellowish-brown, fresh, sandy, amorphous, consolidate, multitude of stones, sheer stones on the bottom.

Fig 15. Common view of NTC 3.

The remains of human impact are traced, first of all, in the form of complete and selective cutting. The considerable areas of old clearings are situated in the southern part of the reserve near the dam of the Hestefoss hydropower station (point 48).

4. **Sloping-waviness surface of separate hills of moraine plain and hills with noncontinuous cover of marine sediments with Pine forests *Vaccinium vitis-idaea-Rhododendron tomentosum* with green moss cover on illuvial-ferrous, sometimes turf, podzols.**

The complexes of this type are scattered as isolated spots all over the territory of the reserve. They form the longest ribbon in the southwestern part of the territory near the bank of the Pasvik River and the dam of the Hestefoss hydropower station, where they occupy angled surface of the bywater slope and adjoining plain areas. The height differences within the bounds of the complex are 7-10 meters. More often forested separate hills rise above the surrounding swampy plain only by 3-4 m. The surface of separate hills is usually flattened, sometimes hillocky. Some hills have convex tops with boulder masses. The complexes are composed of stony moraine, sometimes overlapped by cover of marine greenish-grey clays (point 25, 32) or close-grained sands, underlied with clays (point 31).

In the highest central parts separate hills are covered with pine forests with the height of 16-18 m. on the first tree level and the diameter of the trunks from 20-25 to 30-40 cm. Birch tree, 8-12 m high, is always present in the second tree level, often with the pine (8-9 m high). Usually regrowth of pine and birch is rather abundant in forests. The role of birch rises on marine clays, forest stands become mixed, sometimes goat willow (*Salix caprea*) up to 14 m high (point 31) and individual examples of aspen appear here. Closer to forest borders and in lowlands the height and density of forest stand decreases. Swamp forests appear and outside the complex they turn into peat (oligotrophic) moors overgrown with pines.

Fig. 16.Common view of NTC 4.

Subshrub level of forests is dominated by *Vaccinium vitis-idaea* and *Rhododendron tomentosum*. In the driest places Pine forests *Vaccinium vitis-idaea-Rhododendron tomentosum-Empetrum nigrum* with green moss or lichen with green moss forests on illuvial-ferrous podzols, described in points 27, 47, 59, 62. Point 27 is laid on the top of a hill with a mark of 63 m, where the road to Nyrud passes, in a pine forest *Vaccinium vitis-idaea*-green moss.

A_0 – 0-4 cm – reddish-brown bedding.

A_2 – 4-8 cm – whitish, fresh, sandy, amorphous, slightly consolidated, roots of the plants, many stone ratchels, the transition is well-marked.

B – 8-25 (visible) cm – brownish-yellow, darkening downwards, fresh, sandy, amorphous, consolidate, coherent near the lower border, abundance of stony material.

Cemented sand and abundance of stones do not allow digging a deeper soil pit.

The increase of moisture in subshrub level raises the role of *Vaccinium myrtillus* and *Vaccinium uliginosum* and in lichen-moss cover the role of *Polytrichum* and *Sphagnum* mosses. On marine clays *Polytrichum commune* sometimes become prevailing (point 31), the depth of the bedding in soil profile increases, it becomes turf (point 32).

III NTC of marine plains

NTC of marine plains occupy the largest areas of Nature Reserve and are represented by vast marshy massifs. These NTC are differentiated by plain or slightly inclined surface, often with well-marked hummocky-hilly or hilly-ridgy microrelief. The plains are composed of marine clays, which condition waterlogging, as they are water-tight stratum. The map of quaternary deposits the plains are shown as territories composed of peats (organic deposits). The thickness of peats is unknown, but in soil pits under peats we have revealed greenish-gray clays, sometimes sandy loams or fine-grained sands underlaid with clays, which shows that the peat level is not very thick, at least on selvedges of oligotrophic peat bogs. NTC of marine plains are bogs of different types: oligotrophic, mesotrophic, eutrophic and heterotropheous.

5. Sloping outskirts and streamside parts of marine plain with oligotrophic *Betula nana*-undershrubs-*Sphagnum* bogs with *Pinus sylvestris* on humus-turf and turf-bog soils (humus bog soils).

The complexes of the given type occupy the outskirts of marine plain in central and southern part of Nature Reserve and adjoin esker and moraine ridges and separate hills, covered with forest. The transition from forest complexes to bog ones is gradual and is represented by the strip of swampy pine forest. The greater part of the complexes is situated on the heights of 70-75 m, but in streamside parts their height can lower to 55-60 m. Surface is usually slightly inclined to the east, and hummocky pit-and-mount microrelief (the height of hillocks is 0,3-0,4 m, diameter – 0,5-1 m). On the ourskirts adjoined to carex-sphagnum bogs there are small areas with water holes 3x3 or 2x3 m^2 of size, and hillocks are joined in low short ridges.

The surface of the complexes is covered with *Betula nana*-undershrubs-*Sphagnum* bogs. The height of dwarf birch (*Betula nana*) is 0,8-1 m, and projective cover is 20-25%, sometimes reaching 50-70% on the outskirts (points 35, 45). In the wettest places dwarf birch is accompanied by willow (point 17). Projective cover of subshrub level varies from 55-65% to 80%. *Vaccinium uliginosum* or *Rhododendron tomentosum* prevail as a rule, but sometimes *Rubus chamaemorus* becomes predominant or codominant. *Equisetum sylvaticum* is represented everywhere in small amounts, but sometimes its projective cover increases to 25% (point 16) and even to 40-50% (point 35). The content of lichen-moss cover (projective cover of 80-100%) is rather diverse. Among the mosses there are *Sphagnum*, *Polytrichum*, *Dicranum*, *Pleurozium scherebi*; among the lichens there are *Cladonia rangiferina*, *C. stellaris*, *C. alpestris, C. deformis*, but *Sphagnum* mosses are predominant everywhere.

Fig 17.Common view of NTC 5.

Characteristic of small water holes that sometimes can be met in the outskirts of the complexes are grass-*sphagnum* associations with *Equisetum fluviatile* (point 17) and *Eriophorum vaginatum* (point 44) predominance.

Individual scrubby thin trunk pines rise above the surface of the bogs. Leaf canopy is not joined. The height of the trees is usually 5-8 m, some trees reach 10-12 m, and diameter of trunks is 8-10 cm, sometimes 12-15 cm.

Characteristic of bog soils of the given type is presence of two peat horizons of different degree of reduction and different content. Usually under the tirr (layer of old, decomposed moss), there is a layer of a poorly decomposed peat under which there is a significantly better decomposed humus peat level; that allows talking about humus-turf and (turf-) bog soils. Apparently, it shows the change of the condition of humifying. Gradually, bog forestation increases: pine growth of 1,5 – 3 m and seedling growth, in places rather abundant, with the height from 0,8 to 1,3 m, is marked in all the points.

Humus-turf soil was uncovered in point 65 on the *Betula nana*-undershrubs-*Sphagnum* bog with *Pinus sylvestris* 250 m southwest of the southern outskirt of the Abbortjørna lake and 120 east of the road that goes along the western border of Nature Reserve.

O_4 – 0-7 cm – *Sphagnum* tirr (layer of old, decomposed moss).

T_1 – 7-18 cm – brown, poorly decomposed layer of *sphagnum* peat, interlaced with roots of the plants, wet, loose, transition is well-marked.

TP – 18-23 cm – dark-grey, almost black, turf-humus, wet, uliginous-loamy, weakly consolidated, rare roots, transition is well-marked.

S – 23-37 (visible) cm – greenish-grey, wet, clayed, the upper part is jellylike, the lower one is very consolidate.

6. Levelled surface of marine plain with hillocky oligitrophic undershrubs-*Sphagnum* and undershrubs-*Eriophorum*-*Sphagnum* bogs with *Pinus sylvestris* on turf-bog soils.

NTC occupies flat (relatively flattened) surfaces of marine plain on the heights of 55-70 m, often streamside regions. Microrelief is mostly hummocky, somewhere pit-and-mount, the height of the hummocks varies from 0,2 to 0,5 m, diameter is 0,2-0,5 m, rarer up to 1 m. Hummocks are formed by root mat of *Eriophorum vaginatum*, low hillocks are formed by *sphagnum* cushions with subshrubs and *Eriophorum*. The size of hummocks and loose low *sphagnum* cushions determine the whole microrelief of NTC, the surface can be hummocky, pit-and-mount with *Eriophorum* root mats. The characteristics of microrelief are defined by plant composition peculiar to the given NTC.

NTC represent the complex tract that combines oligotrophic bogs of *Pinus sylvestris*-undershrubs-*sphagnum* and *Pinus sylvestris*-undershrubs-*Eriophorum*-*sphagnum* types. Among the undershrubs it is difficult to mark the absolute predominant, as the cenosis forming role is played by several species - *Rubus chamaemorus, Rhododendron tomentosum, Empetrum nigrum, Vaccinium uliginosum, Andromeda polifolia*.

Pinus sylvestris-Rubus chamaemors-Eriophorum vaginatum-Sphagnum associations are the most widely spread.

The bog is overgrown with *Pinus sylvestris*. The pines with the height up to 1,3 m prevail, less abundant are the pines 2-3 m high. In some cases there are even higher trees of 4-4,5 m.

Betula nana do not form significant groups, it occupies not more than 5-10% of projective cover, its height is from 0,1-0,2 m to 0,6 m. Projective cover of subshrub level varies from 30 to 50% (rarely up to 70%), with *Rubus chamaemorus* being predominant, less common is *Empetrum hermaphroditum* (10-15%) and *Rhododendron tomentosum* (5-10%). Among the other subshrubs there are *Vaccinium uliginosum*, *Vaccinium vitis-idaea, Calluna vulgaris, Andromeda polifolia, Oxycoccus microcarpus* (not more than 5% each). Moss-lichen cover is spotty (80-90%), *Sphagnum sp.* Dominate, in places *Polytrichum* and *Dicranum* can be met, but they do not occupy significant lands. Lichens (*Cladonia rangiferina, C. stellaris, C. alpestris, C.* deformis) are met practically everywhere, but also do not constitute more than 5-10% of cover. Herb stratum as a rule is represented by the only species - *Eriophorum vaginatum*, which hummocks occupy 30-35% of the cover, the average height of the level is 30-50 cm. In some cases *Equisetum sylvaticum* can be seen, it forms small strips and tongues, spread unevenly on the surface of the bog. With *Equisetum* involvement the part of *Eriophorum* do not exceeds 20%. Characteristic of herbal-subshrub level is similar projective cover of *Eriophorum* and subshrubs (50:50%, 30:35%), subshrubs rarely prevail. The pit-and-mount hummocky relief is connected with this: the height of *sphagnum*-subshrub hillocks is 0,4 m, diameter is 0,5-0,8 m, hummocks have a height and diameter up to 0,5 m.

Under such bogs turf-bog soils are widely-spread. Soil profile is laid 150 m west of the road Nyrud-Hestefoss and southwest of the Hestefoss hydropower station.

O4 – 0-12 – grayish-yellow wet *sphagnum* tirr (layer of old, decomposed moss).

T_1 – 12-29 – heterogeneous, with interchanging dark and bright strips of poorly decomposed *sphagnum* peat, loose and wet, the transition to lower horizon is well-marked by colour.

T_2 – 29-39 – yellow, averagely decomposed *sphagnum* peat, weakly consolidated, sated with water, the transition is well-marked by colour.

T_3 – 39-57 (visible) – brownish-yellow, well decomposed *sphagnum* peat, weakly consolidated, wet.

In the soil pit ground waters were uncovered on the depth of 39 cm.

On such bogs pine dead-wood of different height (on average up to 5 m, sometimes 8 m) is often met.

Fig. 18. Common view of NTC 6 with undershrubs-*Eriophorum-Sphagnum* bogs with *Pinus sylvestris*.

Pinus sylvestris-Rubus chamaemors-Sphagnum associations are somewhat rarely met.

Bog surface is pit-and-mount, the hillock height is 0,3-0,5 m, diameter is 0,3-1 m. Bog is covered with individual *Pinus sylvestris* with the height of 6-8 m, diameter – not more than 15 cm (rarely up to 20 cm). A bit less amount of low pines 1,5-1,7 m high. *Betula nana* occurs in subshrub level, 0,6-0,8 m high, it occupies not more than 5-10% of projective cover. Up to 80-85% of projective cover is occupied by undershrubs, among which the predominants are *Rubus chamaemorus* (30-35% of projective cover), *Rhododendron tomentosum* (20-25%); *Vaccinium uliginosum* and Empetrum hermaphroditum grow in groups (5-15%), also Vaccinium vitis-idaea (less than 5%) and other Ericaceae are marked. Moss cover is solid, *Sphagnum* prevails (up to 80%), *Pleurozium schreberi* and *Polytrichum* are sometimes seen forming homogenious cushions. Single *Cladonia rangiferina* (less than 2%) is marked. In some cases only *sphagnum* and *Cladonia* beds are noticed on the ground cover. Occasionaly small areas of microlowerings with *Spagnum* and *Drosera rotundifolia* can be seen on the bogs.

Such plant communities grow on turfy-bog soils characterized in point 23 laid on the western outskirt of the Nyrudneset peninsula, 50 m from the bank of the Pasvik River westwards of the northern end of the biggest nameless island and 600 m south of Noatun. Soil profile is represented:

O4 – 0-1 – *sphagnum* tirr (layer of old, decomposed moss).

T_1 – 1-17 – greysh-dark grey, poorly decomposed *sphagnum* peat, loose and wet peat with subshrub roots, the transition to lower horizon is well-marked.

T_2 – 17-41 – light yellow, sometimes brownish light yellow, poorly decomposed sphagnum peat, a bit consolidated and wet, with little roots of the trees, the transition to lower horizon is well-marked.

T_3 – 41-27 – greysh-yellow, darker than T_2 (closer to T_1 by colour), averagely decomposed sphagnum with thin subshrub roots, slightly consolidated and wet, transition to lower horizon is well-marked. Close to upper border there is water that is uncovered on the depth of 46 cm.

T_4 – 47-62 – yellowish, more slightly painted than T_3, well decomposed *sphagnum* peat, slightly consolidated, wet.

In cases of increased humifying the single 5-meter high dead pine trees are occasionally met on the bogs of this type.

7. Flat surface of marine plain with lakes and complex bog with pools and ridges and swamps on turf-bog soils.

NTC of complex bogs are represented by 10 fragments of different size within the boundaries of Nature Reserve. The largest of them is situated in central part of marine plane and is divided to the marsh massifs Gjøkbuktmyra and Nilamyra. Smaller fragments are located by the foot of esker ridges. Complex includes different components.

Microrelief of the complexes is formed by differently orientated hillocks and ridges that divide pools of different size with flat or slightly hummocky surface. Vegetation here is represented by homogeneous and complex communities. As for the trophicity vegetation of complex areas is uneven too.

The lowest areas, usually in the central part of the complex are occupied by lakes, that have shallow depth, flat shores, a lot of islands and shallow waters overgrown with *Equisetum fluviatile* and *Carex*. The edges of big lakes and many small ones now represent small puddles surrounded by brown *sphagnum* moss where Hepaticae settle. Black spots of *Heptica* with rare *Carex* and *Eriophorum*, sometimes with low loose moss hummocks are rather common here and are the constituent part of the hummocky-bog complex. *Carex* bogs with *Andromeda polifolia*, rare *Eriophorum* and mosses are also common. Sometimes more or less large spots of water sated well decomposed peat and humus are revealed on the surface. On the swampy regions *Eriophorum polystachion* prevails, *Sphagnum* is absent there are some small green moss hummocks. In some places (point 21) where the swamplands overgrow with *Carex*, then mosses and undershrubs the low hillocks and ridges are formed. The areas not covered with vegetation experience excessive humifying and seasonal straight freezing is typical of them. The peat surface in closed spots is dried and chinks (sometimes on the depth of 10 cm), forming original polygons. We have discovered such polygons only in one part of the reserve near the road to Nyrud. This unique complexes need protection and research.


Fig. 19. Common view of NTC 7.

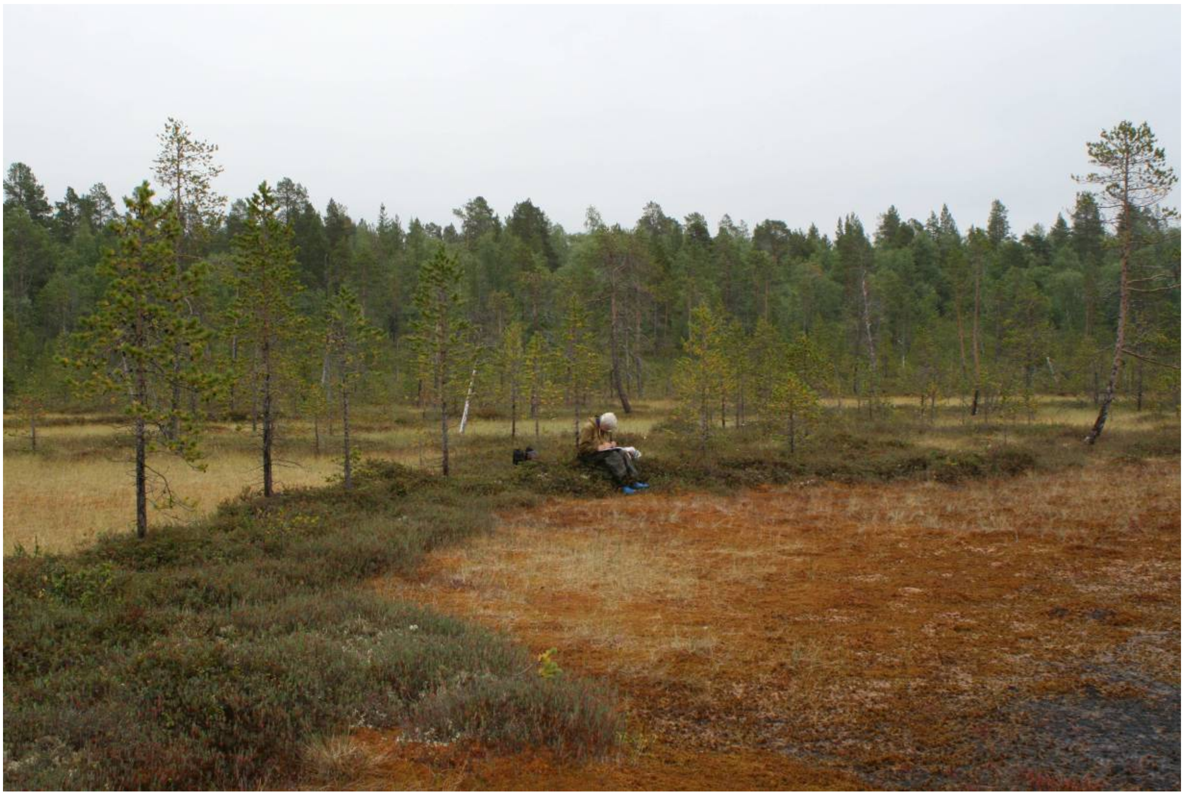


Fig 20. Ridge complex.

Fig 21.Lakes part of complex.

Fig. 22. Depression with *Sphagnum*.

Fig 23. Tussock of *Eriophorum vaginatum* with uncovering turf.

Fig. 24. Hollows with *Sphagnum* cover and *Andromeda polifolia*-lichens hummock.

Fig. 25. Watered hollows (pools) with *Sphagnum, Drosera anglica Huds.* and liverworts.

Fig. 26. Polygonal complex (coordinates N69º09.3` E 029º12.6`).

Herbal-moss bogs, on the surface of which stretch the low flat hillocks and ridges with the height of 0,4-0,7 m, overgrown with *Andromeda polifolia, Rubus chamaemorus* with *Rhododendron tomentosum* and *Betula nana*, green mosses and lichens participation, sometimes with detached pines with the height from 20-30 cm to 3 m, are the constituent part of the complex too.

The ridges are parallel to each other, in some cases they are center (piece of water) orientated. Sometimes the original schemes of the ridges like “combs” are formed, when long (up to 50 m) ridges are parallel to each other and then are joined in square or oval contours by short ridges.

On the edges of the complexes the area, occupied by hillocks and ridges, and their height increases. Here the huger hillocks (height of 0,5-0,7 m, diameter 1-1,5 m) and ridges (height 0,7-0,8 m, length from 5-10 m to 30-50 m and more, width of 5-7 m) prevail. They are overgrown with *Betula nana, Rhododendron tomentosum, Rubus chamaemorus, Vaccinium uliginosum, Vaccinium vitis-idaea, Empetrum hermaphroditum*. Detached pines with the height from 0,5 to 5-8 m, sometimes up to 10 m is met. In lichen-moss cover along with *Sphagnum* there grow *Polytrichum, Pleurozium schreberi, Dicranum*. Lichens are abundant, including the *Cetraria*, which shows the dryness of hillock tops. Occasionally we came across the crack on the hillocks.

Pools occupy depressions between ridges and hillocks, their flora content changes with the movement from the central lake part of NTC. In the same dimension the area of pools that are more often occupied by herbal-moss communities decreases. In the vegetation of pools there were registered *Juncus triglumis, Eriophorum vaginatum and E. polystachion, Andromeda polifolia,* and *Drosera rotundifolia* grows on the wettest areas. Pools between the ridges on the edges of the bogs has different dominant species and the aspect of such pools is different: Carex-*Sphagnum* associations with flat surface (the most common), *Andromeda polifolia*- *Carex*-*Sphagnum* associations (with the equal distribution of species on *sphagnum* cover), *Andromeda polifolia*-lichen hillocks on sphagnum cover, *Eriophorum* hillocks with peat revealed, *Eriophorum* hillocks on *sphagnum* cover, *sphagnum* pools. Pools with quiescent water are characteristic of central parts of complex bogs. As a rule, *sphagnum*, *Drosera anglica* and detached *Cortex* grow here.

It was impossible to lay a soil pit in pools because of the high watering. Turf-bog soils are described on the edge of the complex on the top of the ridge with *Rubus chamaemorus*-*Andromeda polifolia*-lichen-*sphagnum* bogs with detached pines (point 63).

Оч – 0-10 cm – tirr.

T_1 – 10-24 cm – brown, wet, loose, badly decomposed peat, the transition is well-marked by the colour.

T_2 – 24-50 cm – yellowish-light brown, averagely decomposed peat, many roots, from the upper border water drains on the walls of the pit, the transition is hardly marked.

T_3 – 50-70 cm – yellowish-brown, wet, well decomposed peat, slightly consolidated, very few thin roots.

All in all NTC 7 is notable for a diversity of facies, represent the extremely precious type of bogs and needs further research. These complexes are the places for aquatic birds and sandpiper nesting. The largest section is situated in the centre of water-swamp area RAMSAR.

8. Sloping surface of marine plain with mesotrophic *Carex-Sphagnum* and undershrub-*Carex-Sphagnum* bogs on turf-bog soils.

Complexes of the given type occupy the central part of the bog massive, situated between two moraine ridges with adjoined separate hills of moraine plain. They occupy the largest areas in the southern part of the reserve and south of Gjøkbukta. Separate small strips they are met on the shores of some lakes, along the watercourse of the creek Kjeldebekken and within the bounds of the bog between Noatun and Lyngmo where they cannot always be shown because of the scale of the map.

They are connected with weakly revealed, nearly invisible depressions of the marine plane; that conditioned the higher level of humifying comared to the NTC stated earlier and the *Cortex* predominance in vegetation that covers the entire surface.

Projective cover of herbal level where Cortex prevails constitutes about 50-60 %. According to degree of humifying and proximity of ground waters, projective cover varies from 30% on the outskirts (closer to oligotrophic bogs) to 70% in the direction toward the centre of marine plain (closer to eutrophic regions). The main edificators are *Carex stenolepis, C. buxbaumii, C. lasiocarpa, C. juncella, C.vaginata*. In small scattered groups *Eriophorum vaginatum* and *E. polystachion* can be met, moreover latter prefers the wettest regions. In the most humified areas where water literary stays on the surface the amount of *Comarum palustre* increases, *Drosera rotundifolia* and *Menyanthes trifoliate* appear. Close to the borders of NTC 9 *Equisetum fluviatile* appear, its projective cover is increased in direction to eutrophic areas of waterlogged plain. Moss cover is solid and is formed by *Sphagnum fuscum*, *S. girgensohnii* and others. *Polytrichum* form cushions in some places. Subshrubs do not play the important role in vegetation cover. Among them *Andromeda polifolia* that grows in conditions of excessive humifying is predominant, sometimes you can meet *Oxycoccus palustris* and *O. microcarpus*, on moss hummocks there can be detached subshrubs of *Rubus chamaemorus* and *Rhododendron tomentosum*. The detached plants of *Betula nana* and *Salix* of 20-30 cm of height are very rare.

Fig. 27. Common view of NTC 8 near Gjøkbukta.

On the outskirts of NTC of the given type within the bounds of Gjøkbuktmyra there are areas with detached low hummocks and short flattened ridges, overgrown with *Rhododendron tomentosum*, *Rubus chamaemorus, Andromeda polifolia, Vaccinium vitis-idaea, V.uliginosum* and *Oxycoccus*. Moss cover is *Sphagnum*, sometimes there is *Pleurozium schreberi, C. rangiferina* and *C. stellata*. Sometimes root mats of *Eriophorum vaginatum* are found. Detached *Pinus sylvestris* with the height of 2,5-3 m rise above undershrub-lichen-sphagnum cover. The aspects of the main area of the bogs are represented by 3 species: *Sphagnum fuscum, Eriophorum vaginatum* (up to 60 %) and *Andromeda polifolia* (40 %).

Within the bounds of the described complex water stays on the surface or in the peat level 5-7 cm deep (5-10 cm on hummocks), that is why it is impossible to lay a soil pit for soil description.

The transition to neighboring complexes (excluding NTC 9) is usually represented by narrow strip (10-20, sometimes 30 m) of *Salix* and *Betula nana-Salix* brush with the height from 0,3-0,4 m to 0,5 – 0,7 m.

Fig 28. NTC 8 near south border of reserve.

9. **Sloping surface of marine plain with eutrophic intensive watered fens with *Equisetum*.**

Natural complexes of that type can be found in deepened and watered places among other types of bog complexes often within marine plains with *Carex-Sphagnum* and undershrub-*Carex-Sphagnum* bogs. They are often ribbon-like micro- degradations or elliptic splashes badly defined in relief and distinguished by their vivid green flora against the background of bogs. They are often narrow-width (from 2-3 to 10-20 m) to be mapped at this scale.

This type of NTC is presented on the map by two fragments in the south part of natural reserve. One of them stretches along upper and central streamways of the Passvikelva just below the Hestefoss Hydroelectric plant. According its configuration the second resembles the watercourse hollow that can't be seen on a map.

Water in these micro-lowerings is at the surface. It's overgrown with *Equisetum fluviatile*, *Carex rostrata*, *Carex lasiocarpa* and *Carex juncella*. You can find groups of *Eriophorum polystachion, Baeothryon alpinum, Drosera anglica* and *Drosera rotundifolia* in *Equisetum* underbrush.

Among the *Equisetum* underbrush on the water surface there are splashes of *Menyanthes trifoliata* and *Comarum palustre*. Moss cover is presented by different *Sphagnum sp*. On the periphery of the complex you can find *Salix lapponum* and *Betula nana* (50 cm height)(point 50). Soil pit can't be laid because of water-bearing nature of the complex.

Fig. 29. The stripes of Equisetum fens of NTC 9 borders with Carex bog of NTC 8.

IV NTC of river and stream valleys

Riverine natural complexes are stretched along the river bank of the Pasvik River and its bays, and occupy the islands or their outlying areas. All of them are confined to the narrow riverside and are located at altitudes of up to 55 m, i.e. they rise 1,5-2 m above the water's edge.

Apparently they are flooded by river waters during the spring flood at least in the years of its high levels. However, alluvial covered target areas were not found in all soil pit points. Some soils' parts are formed on marine deposits, moraine or fluvioglacial.

The surface of complexes is slightly tilted (3-5º, sometimes up to 10-12º) to the riverbed or bight, often hillocky. The main tree species here are *Betula pubescens*, you can come across *Pinus sylvestris* sometimes. You can also find *Salix lapponum* and rarely *Salix phylicifolia* in the underwood. Undershrubs such as *Equisetum sylvaticum* and *Equisetum arvense*, representing particular splashes, green mosses (*Pleurozium schreberi, Hylocomium splendens*) and *Cladonia* are spread in the ground vegetation.

Soils within the complexes are diverse: from illuvial-ferruginous podzols, weak podzolic to turfy and podzolic humus-peaty.

Stream valleys' complexes in the natural reserve are scarce. They are formed only where streams are cut into the surface, and represented by five fragments in the southern part of the reserve.

10. Levelled surface of marine plain with birch forests *Cornus suecicum-Rhododendron tomentosum-Vaccinium vitis-idaea* with green moss cover on illuvial-humus-ferrous podzols formed on marine clay loam and clay sediments.

Natural complexes of that type are represented by one association, located in the Gjøkbukta peak adjacent to the right bank of the river Kjeldebekken in its lower course and stretching further along the right bank of the bay.

These complexes border with the marginal parts of marine plain, and according to their location along the bay's bank are considered to be NTC of stream valleys. NTC 8 is separated from the water area by *Carex* bogs, and they open directly to the bay's bank in their extreme eastern part. The surface of the complex is almost flat and the microrelief is badly defined.

Fig. 30. Common view of NTC 10.

Vegetation is formed by *Betula pubescens* with greater crown density typical for birch forests of the Pasvik valleys, – 0,4. The height of tree layer is 8-10 m, tree stem diameter is up to 15 cm. Block growth form prevails but there are no hillocks observed. The stands are dense, birch undergrowth of 4,5 m height is lush. Sporadical birch *Betula nana* of up to 0,7 m height appears in the marginal parts of NTC 10 where it borders with NTC 5. Suffruticous layer is spotty – 65 %, *Vaccinium vitis-idaea* prevails. *Rhododendron tomentosum, Vaccinium uliginosum* and *Cornus suecica* are represented in approximately equal proportions (10%). You can also come across *Equisetum arvense* and *Equisetum sylvaticum* growing usually in groups.

Green mosses occupy up to 90% of projective cover.

Soil pit laid in point 18 demonstrates illuvial-humus-ferrous podzols formed on marine clay loam and clay sediments:

A_0 – 0-10 cm – slightly consolidated bedding with no lack of roots.

A_1A_2 – 10-17 cm – grayish light-brown, with conspicuous white roots, fresh, slightly consolidated, the abundance of roots with different diameters, without rubble, transition to the underlying bedding rock is hardly detectable by color and density.

BC – 17-29 cm – grayish light-brown, heavy clay loam, the structure is granulated, slightly consolidated, humid, fine roots of plants, transition is noticeable by density and hardly detectable by color.

C – 29-47 cm – grayish light-brown, a bit lighter than BC, slightly grayish, clay, moist, dense, the roots are practically absent.

Taking into consideration the close proximity of NTC to the river bank and the relatively small height above the river's edge, loamy marine sediments and clays lying beneath them can be found at the depth of 17 cm.

No lack of leaf fall, dead branches and cut trees is marked everywhere.

11. Hillocky surface of terrace with birch forests *Rhododendron tomentosum-Vaccinium uliginosum* with green mosses cover on sod and turf-humus soils formed on marine clay loam and clay sediments, sometimes alluvial sands.

NTC occupy riverine areas of terraces and some of the islands. They are presented by extensive and narrow associations. Typically this type of complexes separates flat surface of the marine plains with hummocky oligotrophic bogs (NTC 6) and partly esker ridges near the river bank (NTC 1) from the river.

The surface of the terrace is raised in the coastal part as a small coastal shaft. Primarily it differs from the other riverine systems by its hillocky surface. Hillocks are of different sizes, their average height is 0,8-1,2 m with up to 1-3 meters in diameter, degradations between these hillocks are «trails and corridors» of natural origin. Vegetation is formed by *Betula pubescens* that grow on hillocks. The height of tree layer is 12-15 m, tree stem diameter is up to 15 cm. In somewhat more humid areas *Salix caprea* appears in the form of accompanying element. As usual there is a second level, where birch trees reach the size of 3,5-4,5 m and grow as group regeneration, however there are sporadic low-growing trees. Shrubs are almost absent, appearing only in more humid areas of the islands. Underwood is formed by *Salix phylicifolia* and *Salix lapponum*, the height of which doesn't exceed 1,5-1,7 m. Suffruticous layer occupies up to 80 % projective cover, where *Vaccinium uliginosum* (30 %) and *Rhododendron tomentosum* (20 %) dominate and they are represented in approximately equal proportions. Such types as *Rubus chamaemorus*, *Vaccinium vitis-idaea* and *Empetrum hermaphroditum* are spread in the ground vegetation, but less frequently and they often grow in groups. *Cornus suecica, Equisetum sylvaticum* and *Equisetum arvense*, *Trientalis europaea*, that grow in groups as stripes and splashes can be found sometimes. Moss cover is almost continuous, formed by green mosses (*Pleurozium* and *Hylocomium*) and *Polytrichum*, growing in degradations between hillocks and spread closer to the river bank. You can find *Cladonia* and *Nephroma arcticum* sometimes.

Fig 31. Common view of NTC 11.

Soils of the complex described are predominantly sod formed on marine clay loam and clay sediments. Soil pit laid in point 10 demonstrates this soil with gleying characteristics:

A_d – 0-7 cm – light brown, bedding rock with a lot of roots, loose.

A_0A_1 – 7-14 cm – grayish-brown, loamy (with distinct grains of loam), loose, fresh, with fine roots of plants, the transition to the lower horizon marked by color.

BC $_{(g)}$ – 14-48 cm – grayish-yellow, spotted, with small bluish-gray and brownish spots; medium-loamy, with very small grains up to 1 mm in diameter, slightly consolidated, moist, permeated with thin and sparse roots of birches.

However, gleying do not occur in all stratifications of this complex.

Peaty-humus soils are formed in alluvial sands in conditions of high humidity, periodic flooding on the islands. Their profile is characterized in point 56, laid down on the island Tjørnholmen and its extreme eastern part:

Оч – 0-18 cm – tirr (layer of old, decomposed moss), formed by *Pleurozium, Hylocomium* and *Polytrichum*

П $_{(т)}$ – 18-29 cm – brownish dark gray, loamy, slightly consolidated, moist, with fine roots, stratified - dark layers - with high content of humus, light - with high content of peat, the transition to the lower horizon is well-marked by density and color.

C – 29-64 cm – yellowish-brown sand, very slightly consolidated, wet, with particles of mica.

Thus, NTC soils are formed on marine clay loam and clay sediments, sometimes alluvial sands.

12. Streamside (near river) sections with *Betula-Salix-Carex* communities on turf bog soils.

NTC occupy narrow riverine areas of terraces, border with main and swamped marine plain NTC. Their distinguishing feature is excessive moistening and, as a consequence, specific kind of vegetation.

Plant complex is formed by *Betula pubescens* combined with different types of osier - *Salix lapponum*, *Salix phylicifolia* as well as with *Betula nana*.

These plant complexes hardly can be called birch forests because their height is usually 2-3 m at an average. These are thin birches (tree stem – 5 cm) growing proportionally on the territory of the complex. These communities look like "apple orchards". The height of willows and dwarf birches is 0,6 m at an average, however willows can be 1m high.

The proportion of birches and willows varies: *Betula-Salix* communities with Birch ones interchange along the whole length of NTC, but the number of willows increases closer to the river bank. The main reason for this is variation in soil humidity. Ground vegetation is non-continuous. None of surface layers, with the exception of moss cover, occupies more than half of the projective cover. Shrubs do not play a coenosis-forming role, occupying the area not more than 10 %: *Rhododendron tomentosum, Andromeda polifolia, Vaccinium uliginosum, Oxycoccus microcarpus, Rubus chamaemorus* are among them. Field cover is much better (up to 20 %): *Carex stenolepis, Carex vaginata, Eriophorum vaginatum, E. polystachion, Equisetum fluviatile, Comarum palustre* prevail. *Pedicularis palustris* is seldom found. The average height of the stand is 50 cm, sometimes it reaches 60-70 cm.

Fig 32.Common view of NTC 12.

Moss cover is presented by *Sphagnum*, but it doesn't form a compact cushion of moss. There are also heavily flooded areas, where the cover is loose and flooded in some places. Soil pit can't be laid because of such soil water content: water occurs at the depth of 8-10 cm if you spit the cushion of moss. Turf bog soils are formed in such conditions.

13. Flat low islands and inshore sections with *Equisetum-Carex-Salix* brushes on silt-sandy-pebbles alluvial.

NTC is represented as a floodplain and occupies the river banks, islands and its' marginal areas located in the southern part of the reserve. The floodplain surface is flat. In fact, these are areas of high floodplains, inundable not annually during spring floods. While opening the spillway at the hydro-electric power station, this type of NTC experiences inundation first of all. The change of vegetation is best observed on the islands: the central part is occupied by *Carex-Salix* brushes changing into *Carex, Equisetum-Carex* and *Equisetum* to the periphery. Willows of *Carex-Salix* communities can be 2—2,5 m high, *Salix phylicifolia*, *S. lapponum, S. myrsinifolia, S. aurita* and so on, are common. *Betula nana* can be also found. In the central parts of the islands you can come across detached birches (tree stem diameter– 10 cm, height – 6 m), often rotten, sometimes with broken crowns and the blackened places of scrapping.

Fig. 33. Small islands to the south of i. Bjørnholmen.

Equisetum-Carex areas differ by significant predominance of *Carex* types growing in standing water: *Carex elata, C. flava, C. rostrata, C. vesicaria, C. aquatilis, Eriophorum russeolum, E. scheuchzeri*.

Fig. 34. Carex bushes on island, located opposite Noatun.

You can find *Comarum palustre* and *Menyanthes trifoliate* here as well.

The narrow and shallow channels between the islands and the islands with river banks are overgrown with *Equisetum*, whereas the intensity of encrustation varies because of water levels and temperature indicators of a particular year.

Thus, the vegetation pattern of the islands located in shallow waters is usually concentric.

Sandy alluvium, with particles of silt was raised from the bottom of the soil in the marginal parts of the island.

14. Stream valleys formed on marine plain with *Carex-Sphagnum* associations, *Salix* brushes, sometimes with birch forests, mainly on turf bog soils.

Stream valleys are poorly formed (cut) on marine plain and they are presented by 5 distinct associations, three of which have access to the river and two of them border with an esker ridge in the western part of the reserve.

Their length is not too large and ranges from 400 to 500 m at the average.

The transversal profile is weakly upward, flanks are low-sloped, mostly symmetrical, downcutting is about 1 m.

Only the most southern NTC differs by the most depleted profile, as it is laid down between the residuals of moraine plain with intermittent cover of marine sediments: it has gentle slopes, downcutting can reach 3 m in the central part of NTC decreasing to 1 m in both sides (to the source and the mouth of the creek).

The width of the valley varies from 5-10 m at the source of streams to 15-20 m in the mouth parts. The stream course can be traced not in all NTC associations, often appearing closer to the mouth. The width of the northern association (the valley Kjeldebekken) is maximum of all marked on the map and it can reach 5 m, sometimes expanding to 10 m. The lapses of streams are weak. The microrelief of valley slopes is slightly hillock, sometimes tussock.

Vegetation of stream valleys is mostly sedge-*sphagnum*. Slopes and the valleys' bottoms in some places are covered with Salix communities. Here you can find *Salix phylicifolia*, *Salix lapponum*, *Salix myrtilloides*, etc. *Betula nana* seldom grows. *Betula pubescens* reaching the Pasvik River bank is mixed with *Salix* associations that grow on slopes.

The surface cover contains *Eriophorum polystachion, Equisetum fluviatile* and *Equisetum palustre*, different types of *Carex* associations such as *Carex elata*, etc. *Sphagnum* prevails in the moss cover. *Polytrichum* cushions are found near stream beds. Com*arum palustre, Caltha palustris, Pedicularis palustris* are also typical for that area. Soil pit can't be laid because of such soil water content. In point 32k small trench was made in the mouth of the valley under the *carex-sphagnum* cover with water standing at a depth of 3 cm. Marine clays of greenish-gray color were discovered here at a depth of 10 cm.

Thus, 14 types of tract and subtract rank NTC belonging to 4 groups were marked on the reserve territory. The following is a brief morphological analyze of Pasvik Nature Reserve landscape structure.

Natural complexes of esker ridges are stretched along the western and eastern borders of the reserve. Only the eastern part of the most extended esker ridge (NTC 1) is included to the reserve and has a band-like pattern.

It borders mainly with marine plain NTC, and three fragments of the moraine ridges are adjacent to the reserve in the southwestern part. The second esker ridge of a less length and height stretches along the bank of Pasvik River and also includes the central part of the islands and peninsulas (NTC 2). Its pattern is spotted, NTC are located as a chain from north to south.

Natural complexes of moraine plain and hills are characterized by scattered patches. They protrude above the surrounding marine plain as orbed and elliptic hills (NTC 4) and random-shaped ridges (NTC 3).

Ridges are concentrated in the south-western and southern reserve parts, and some hills are ubiquitous, their largest areas are adjacent to the river banks in the south-eastern part of the reserve and have irregular shapes. Considering the slight excess of the hills over the maritime plain, the lower parts of slopes were affected by marine transgression, as evidenced by the presence of loam particles in the lower parts of soil profiles; the actual marine clay was found in some places.

The main part of the reserve is represented by natural complexes of marine plain**.** This NTC group is the most diverse (5 types). All the NTC are swamped and formed on leveled or almost flat plain surface in extremely excessive groundwater moistening. Patterns of most NTC are mosaic and spotted or ribbon-like (NTC 9, Rarely NTC 8).

The central part of the plain is occupied by a system of lakes, around which NTC 7, including these lakes was formed. The main part is occupied by large mesotrophic bogs of NTC 8. The southern fragment of NTC 8 is trenched by two rather extensive ribbon-like associations of NTC 9 *Equisetum* bogs. Marginal parts of the plains are occupied by tussocks oligotrophic *Betula nana* (NTC 5) and undershrubs-*Sphagnum* bogs with *Pinus sylvestris* (NTC 6). NTC 6 is dominant in the northern part of the reserve, sometimes reaching the river bank.

All the NTC types of moraine plain border with each other.

Low and small in area NTC 4 of moraine hills and separate hills are inset to the vast areas of all complexes. Natural complexes of river and stream valleys include riverine and terraced NTC (NTC 10-12), lands liable to floods (NTC 13) and NTC of stream valleys (NTC 14). The complexes of that various group are located along the banks of Pasvik River, have a narrow band-like shape, and linearly extended in some places.

The most frequent is NTC 11 stretched along the banks of Pasvik River. The areas, occupied by that NTC are insignificant. Increased moistening is typical; hydroelectric power station escapage is typical for NTC 13 during spring floods. Anthropogenic impact on natural complexes is expressed by shelterwood or clean cutting of NTC 1, 2, 3, 4. Lichen cover that is small in size and height is noticed in these forests; lichen cover petering out due to reindeer grazing is noticed on some areas of esker ridges near the western boundary of the reserve.

In Appendix 2 fragments of landscape map on Russian side of nature reserve are indicated. During the cameral stage of working the mapping legend of the Norwegian part of nature reserve was compared to the Russian in its southern part and similar NTC were found. However, we will need a number of additional ground observations on both sides of the Pasvik River for producing the common mapping legend of a united nature reserve.

Recommendations Рекомендации

1. Drafted landscape map of Pasvik Nature Reserve can be further refined and detailed. In addition to the existing map a more detailed study of soils, bogs and forest estimation can be recommended.

2. Landscape map drafted on the Russian part of the reserve is actively used for scientific research as well as time-lapse surveys about "Chronicles of Nature – Letopis prirody" program and some other practical tasks. This can be used by the Norwegian side. Landscape dynamic analyses, landscape-ecological studies and seasonal dynamics NTC studies of a united reserve can be held in future to quantify the external and internal relations of natural complexes as a promising work in a united Russian-Norwegian Pasvik Nature Reserve. Facial landscape maps for selected key areas (transects) of a larger scale (1:10 000) can be drafted for a number of application tasks (comprehensive environmental monitoring, ornithological research, etc)

3. Norwegian nature reserve was established for the protection and study of waterbirds and wetland complexes, and it was included into The Ramsar List as the key wetland of world importance in 1996. Considering the fact that the nature of the united reserve is indivisible, the Russian side prepares documents for that inclusion in this list. In this regard, it requires more detailed landscape study of wetland complexes and mapping of wetlands on a larger scale (1:10 000). They will receive more detailed information about a united wetland, identify patterns of its dynamics and spatial differentiation of NTC, their components, identify key factors of complexes, optimize ornithological studies in the Schaanning research area (Fjærvann), and identify the most valuable marshy woods. It is a good idea to have a landscape scientist as well as a specialist in bog science.

4. Landscape map of the Norwegian Nature Reserve - is an effective tool for planning and organizing scientific research. Any sectorial data based on the available maps and collected on individual NTC, can be extrapolated to distinguish specific types of complexes.

5. Drafting landscape maps for other protected areas included to Pasvik-Inari Park and Øvre Pasvik national park is relevant and promising. This unified framework devoted to nature protection, scientific research and monitoring, promotion of ecological awareness and tourism (in the park parts that can be visited) will conduct joint activities with the diversity of natural complexes (while establishing monitoring routes; doing excursion planning work; indication of the most valuable and pristine complexes will focus protection, etc.)

Conclusions Заключение

1. Landscape mapping was made in 2008 at a scale of 1: 25 000 according to the landscape mapping available method on the territory of Pasvik Nature Reserve.

2. Landscape map is drafted, 14 types of the natural-terrestrial complexes (NTC) of Pasvik Nature Reserve classified within 4 typological groups (NTC of esker ridges, NTC of the separate hills of moraine plain and hills, NTC of marine plain, NTC of river and stream valleys) are defined. The largest area is occupied by NTC of marine plain

3. Complex characteristics of all NTC are given and its physiographic structure is analyzed.

4. Recommendations for the further use of landscape maps in the planning of scientific research in the reserve are made; perspective ways of research taking into account special nature and purpose of the reserve are given.

5. It is shown that landscape map serves as a tool for planning studies and data extrapolation. Drafting such landscape maps is relevant for the other preserved territories – Pasvik-Inari Park in Norway, Russia and Finland. In this case environmental authorities will have a common basis, which can improve collaboration and will contribute to strengthening of international cooperation.

Literature Литература

1. Видина А.А. Методические вопросы полевого крупномасштабного ландшафтного картографирования // Ландшафтоведение / Отв. ред. Н.А.Солнцев. М.: Изд-во АН СССР, 1963. С. 102-127. (Vidina A.A. Methodical questions of the field large-scale landscape mapping // Landscape science / Editor N.A.Solntsev. Moscow, 1963. P.102-127).
2. Видина А.А. Методические указания к полевым крупномасштабным исследованиям / Под ред. Н.А.Солнцева. М.: Изд-во Моск. ун-та, 1962. 120 с. (Vidina A.A. Methodical guideline to field large-scale research / Editor N.A.Solntsev. Moscow, 1962. 120 p.).
3. Геология СССР. Т. XXVII. Мурманская область. Ч. 1. Геологическое описание / Под ред. П.Я.Антропова. М.: Госгеолтехиздат, 1958. 716 с. (Geology of USSR. Vol.XXVII. Murmansk region. Part 1. Geological description / Editor P.Ya.Antropov. Moscow, 1958. 716 p.)
4. Гребенщиков О.С. Геоботанический словарь: русско-англо-немецко-французский. М.: Наука, 1965. 228 с. (Grebenschikov O.S. Geobotanical dictionary: Russian-English-Germany-French. Moscow, 1965. 228 p.).
5. Жучкова В.К. Организация и методы комплексных физико-географических исследований. М.: Изд-во МГУ, 1977. 184 с. (Zhuchkova V.K. Organization and methods of complex physico-geographical research. Moscow, 1977. 184 p.).
6. Жучкова В.К., Раковская Э.М. Методы комплексных физико-географических исследований. М.: ИЦ «Академия», 2004. 368 с. (Zhuchkova V.K., Rakovskaya E.M. Methods of complex physico-geographical research. Moscow, 2004. 368 p.).
7. Исаченко А.Г. Физико-географическое картирование. Ч.3. Л.: Изд-во ЛГУ, 1961. 268 с. (Isachenko A.G. Physico-geographical mapping. Vol. 3. Leningrad, 1961. 268 p.).
8. Классификация и диагностика почв СССР / Сост. чл.-кор. ВАСХНИЛ В.В.Егоров, проф. В.И.Фридланд, Е.Н.Иванова и др. М.: Колос, 1977. 223 с. (Classification and diagnostic of the soils of USSR / Editors acad. V.V.Egorov, prof. V.I.Fridland, E.N.Ivanova et al. Moscow, 1977. 223 p.).
9. Костина В.А. Сосудистые растения заповедника «Пасвик»: аннотированный список видов // Флора и фауна заповедников. Вып. 103 / Под ред. Д.Д.Соколова. М., 2003. 44 с. (Kostina V.A.Vascular plants of Pasvik nature reserve: annotation list of the species //Flora and fauna of nature reserves.Vol 103 /Editor D.D.Sokolov. Moscow, 2003. 44 p.)
10. Мелехов И.С. Особенности лесов Кольского полуострова и пути их изучения // Леса Кольского полуострова и их возобновление. М.: Изд-во АН СССР, 1960. С. 5-18. (Melekhov I.S. Forest features of Kola Peninsula and the ways of their study // Forests of Kola Peninsula and their restocking. Moscow, 1960. P.5-18).
11. Некрасова Т.П. Некоторые особенности роста сосны лапландской на Кольском полуострове // Леса Кольского полуострова и их возобновление. М.: Изд-во АН СССР, 1960. С. 32-39. (Nekrasova T.P. Some features of Lapland pine on Kola Peninsula // Forests of Kola Peninsula and their restocking. Moscow, 1960. P. 32-39).
12. Почвенная съемка: руководство по полевым исследованиям и картированию почв / Отв. ред. И.В.Тюрин и др. М.: Изд-во АН СССР, 1959. 346 с. (Soil survey: guidance on field research and soil mapping / Editor I.V.Tyurin et al. Moscow, 1959. 346 p.).
13. Почвы СССР / Отв. ред. Г.В.Добровольский. М.: Мысль, 1979. 380 с. (Soils of USSR / Editor G.V.Dobrovolsky. Moscow, 1979.380 p.).
14. Раковская Э.М., Поликарпова Н.В. Единая методика ландшафтных исследований в регионе Пасвик-Инари / Труды Государственного природного заповедника «Пасвик». Вып. 1. Мониторинг биоразнообразия на территории Трехстороннего Парка «Пасвик-Инари»: материалы исследований в рамках проекта «Развитие охраны природы и устойчивого природного туризма в регионе Пасвик-Инари» / Под ред.

Н.В.Поликарповой. Рязань: РИРО, 2008. С. 63-80. (Rakovskaya E.M., Polikarpova N.V. The unifying methodology of landscape research in Pasvik-Inari area / Proceedings of the State Nature Reserve Pasvik (Pasvik Zapovednik). Vol. 1. Monitoring of the biodiversity on the territory of Trilateral Park «Pasvik-Inari»: Proceedings of researches in framework of the project «Promotion of the nature protection and sustainable tourism in the Inari-Pasvik-area / Editing by N.V.Polikarpova. Ryazan, 2008. 63-80 p.)

15. Юрковская Т.К. Типы болотных массивов на обзорной карте растительного покрова лесной зоны Европейской части СССР // Типы болот и принципы их классификации. Л.: Наука, 1974. С. 57-62. (Yurkovskaya T.K. The bog massif types on the vegetation review map of forestry zone of European part of USSR // The bog types and principles of their classification. Leningrad, 1974. P. 57-62)/
16. Airaksinen O., Karttunen K. Natura 2000 – luontotyyppiopas. Ympäristöopas 46. Suomen ympäristökeskuksen julkaisuja. Oy Edita Ab, Helsinki, 2001.
17. Carlson A.B., Sollid J.L., Watterdal T. 1983. Pasvik Kvart Geologisk kart 1: 75 000. Department of Geography, University of Oslo. (legend in English and Norwegian).
18. Greve M.H., Sperstad R., Nyborg A., 1999. Retningslinjer for beskrivelse av jordprofil. Version 1.0. Norsk institutt for Jord- og Skogkartlegging, Ås. NIJOS rapport 37/99. 121 p.
19. Heikkilä R., Kuznetsov O., Lindholm T., Aapala K., Antipin V., Djatshkova T., Shevelin P. 2001. Complexes, vegetation, flora and dynamics of Kauhaneva mire system, western Finland. Finnish environment institute, Helsinki. 98p.
20. Klokk T., Lindgaard A. The national biodiversity mapping program in Norway – methods and status. NMR Workshop Århus Oct. 31st – Nov. 2nd 2002.
21. Krokfjellet. Statens kartverk Norge. 1: 50 000. 2002. Norwegian mapping authority. (legend in English and Norwegian).
22. Nyborg A.A., Solbakken E., 2003. Klassifisjonssystem for jordsmonn i Norge. Feltguide basert på WRB. NIJOS dokument 6/03. 153 p.
23. Puschmann O., 2005. Nasjonalt referansesystem for landskap. Beskrivelse av Norges 45 landskapsregioner. NIJOS rapport, 10/2005. 196 p.
24. Rekdal Y., Larsson J.Y., 2005. Veiledning I vegetasjonskartlegging. M 1:20 000 – 50 000. NIJOS rapport 05/05. 108 p.
25. The Interpretation Manual of European Union Habitats. EUR 25/2003. European Comission publications.
26. Turkart 1: 100 000. Sor-Varanger. Pasvikdalen. 2007. Ugland IT group. (legend in English and Norwegian).
27. Wikan S., Makarova O., Aarseth T. 1994. Pasvik. Norsk-russisk naturreservat. Oslo, Grøndahl og Dreyers Forlag A/S, 96 p.

Un-published literature, reports
Неопубликованная литература, отчеты

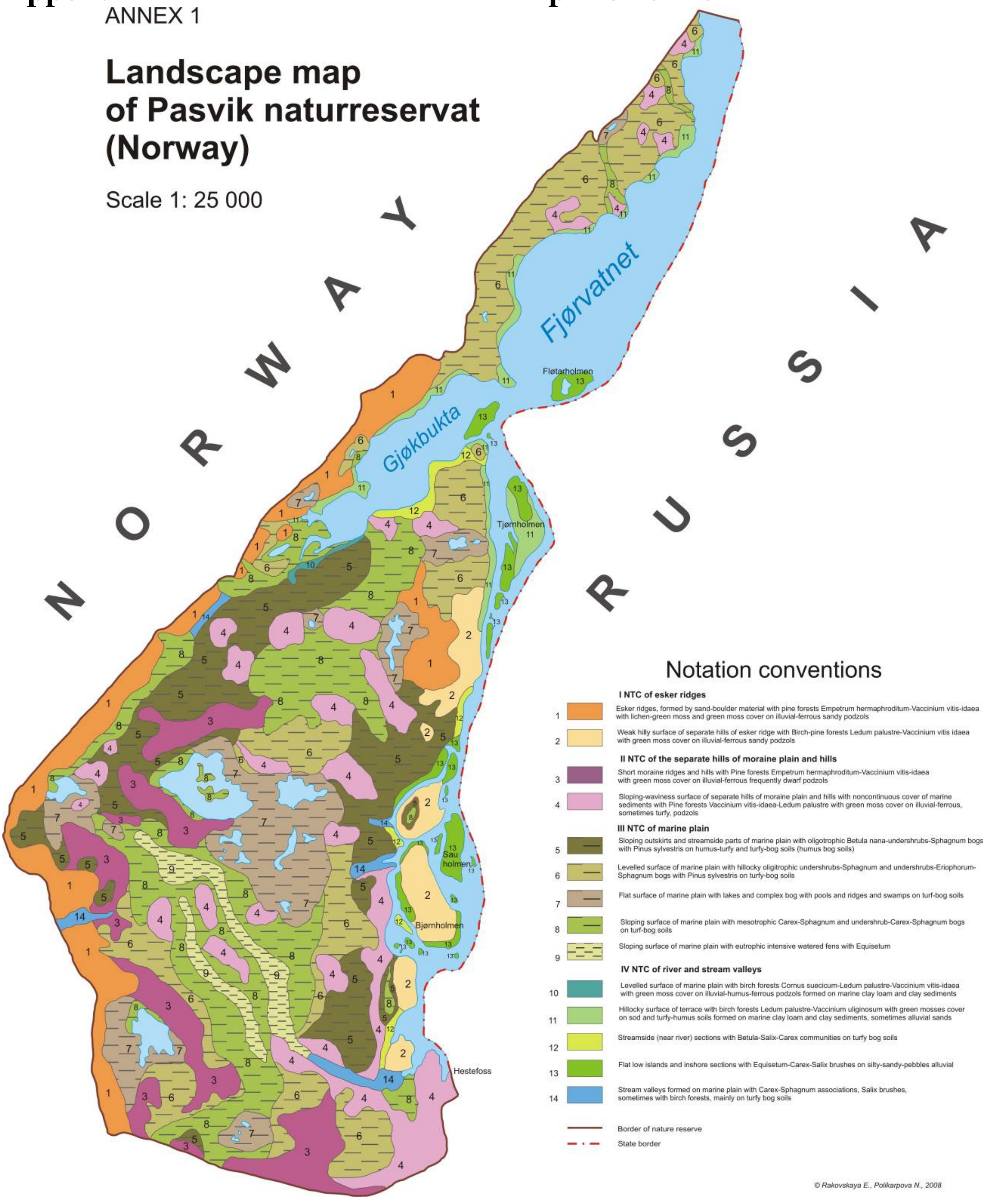
28. Дуракова А.В. и др. Информационный отчет о результатах работ по геологическому доизучению Аллареченско-Солозерской площади в масштабе 1:200 000, составлению и подготовки к изданию Государственной Геологической карты РФ 1:200 000 (новая серия) в пределах листов R35XXIX,XXX (Раякоски), R36XXV,XXVI (Приречный). Мончегорск, 2002. Фонды Мурманкомприроды. (Durakova A.V. et al. Information report about results on geological restudying Allarechensk-Solozersk area in scale 1: 200 000, compositing and preparing to publishing The State Geological map of RF 1:200 000 (new series) within the maps R35XXIX,XXX (Rajakoski), R36XXV,XXVI (Prirechny). Monchegorsk, 2002. Funds of Murmanskcompriroda).
29. Лихачев А.Ю., Белкина О.А. Материалы по флоре листостебельных мхов заповедника «Пасвик» (Мурманская область). Отчет. 6 с. Фонды заповедника «Пасвик». (Likhachev

A.Yu., Belkina O.A. Materials on leafy mosses flora of Pasvik Zapovednik, Murmansk region. Report. 6 p. Funds of Pasvik Zapovednik).

Нешатаев В.Ю. и др. Разработка единой методики картографирования растительности и ее апробация в ходе полевых исследований в рамках международного проекта по созданию трехстороннего парка в регионе Пасвик-Инари». Отчет. Рукопись. Санкт-Петербург, 2007. 126 с. Фонды заповедника «Пасвик». (Neshataev V.Yu. The unifying methodology of vegetation mapping and testing during field research in framework of international project on organizing Trilateral Park in the Pasvik-Inari area. Report. Manuscript. Saint-Petersburg, 2007. 126 p. Funds of Pasvik Zapovednik).

30. Поликарпова Н.В. Ландшафтная карта заповедника «Пасвик» как научная основа «Летописи природы». Дисс.…канд.геогр.наук. М., 2006. 255 с. Рукопись. Фонды научной библиотеки МПГУ, библиотеки ГПЗ «Пасвик». (Polikarpova N.V. Landscape map of Pasvik Zapovednik as scientific base for Nature Chronicles. Dissertation on geographical PhD. Moscow, 2006. 255 p. Manuscript. Funds of Moscow pedagogical state university scientific library, Pasvik Zapovednik).

Appendix 1 **Приложение 1**



Notation conventions

I NTC of esker ridges

1 Esker ridges, formed by sand-boulder material with pine forests Empetrum hermaphroditum-Vaccinium vitis-idaea with lichen-green moss and green moss cover on illuvial-ferrous sandy podzols

2 Weak hilly surface of separate hills of esker ridge with Birch-pine forests Ledum palustre-Vaccinium vitis idaea with green moss cover on illuvial-ferrous sandy podzols

II NTC of the separate hills of moraine plain and hills

3 Short moraine ridges and hills with Pine forests Empetrum hermaphroditum-Vaccinium vitis-idaea with green moss cover on illuvial-ferrous frequently dwarf podzols

4 Sloping-waviness surface of separate hills of moraine plain and hills with noncontinuous cover of marine sediments with Pine forests Vaccinium vitis-idaea-Ledum palustre with green moss cover on illuvial-ferrous, sometimes turfy, podzols

III NTC of marine plain

5 Sloping outskirts and streamside parts of marine plain with oligotrophic Betula nana-undershrubs-Sphagnum bogs with Pinus sylvestris on humus-turfy and turfy-bog soils (humus bog soils)

6 Levelled surface of marine plain with hillocky oligitrophic undershrubs-Sphagnum and undershrubs-Eriophorum-Sphagnum bogs with Pinus sylvestris on turfy-bog soils

7 Flat surface of marine plain with lakes and complex bog with pools and ridges and swamps on turf-bog soils

8 Sloping surface of marine plain with mesotrophic Carex-Sphagnum and undershrub-Carex-Sphagnum bogs on turf-bog soils

9 Sloping surface of marine plain with eutrophic intensive watered fens with Equisetum

IV NTC of river and stream valleys

10 Levelled surface of marine plain with birch forests Cornus suecicum-Ledum palustre-Vaccinium vitis-idaea with green moss cover on illuvial-humus-ferrous podzols formed on marine clay loam and clay sediments

11 Hillocky surface of terrace with birch forests Ledum palustre-Vaccinium uliginosum with green mosses cover on sod and turfy-humus soils formed on marine clay loam and clay sediments, sometimes alluvial sands

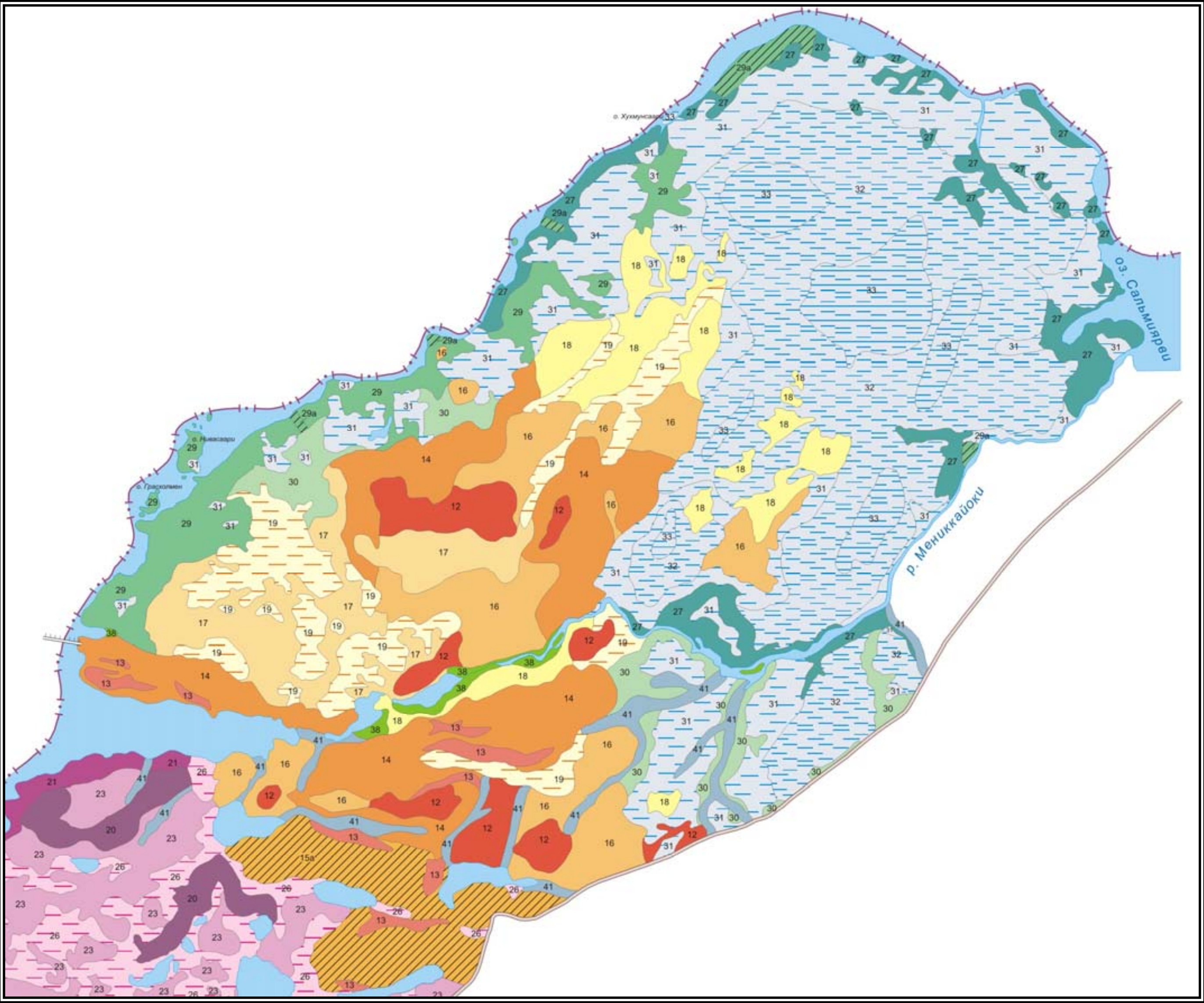
12 Streamside (near river) sections with Betula-Salix-Carex communities on turfy bog soils

13 Flat low islands and inshore sections with Equisetum-Carex-Salix brushes on silty-sandy-pebbles alluvial

14 Stream valleys formed on marine plain with Carex-Sphagnum associations, Salix brushes, sometimes with birch forests, mainly on turfy bog soils

Border of nature reserve

State border

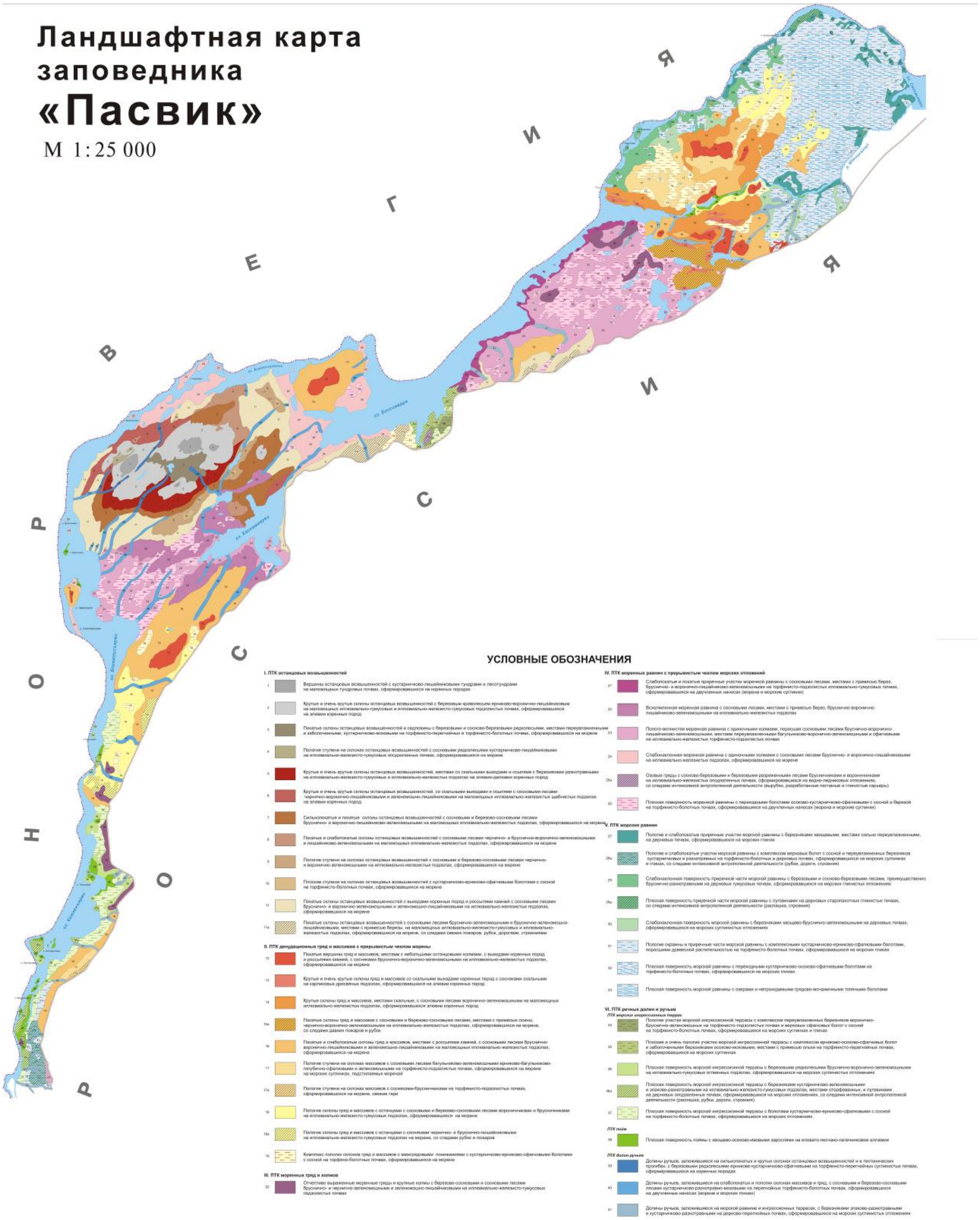


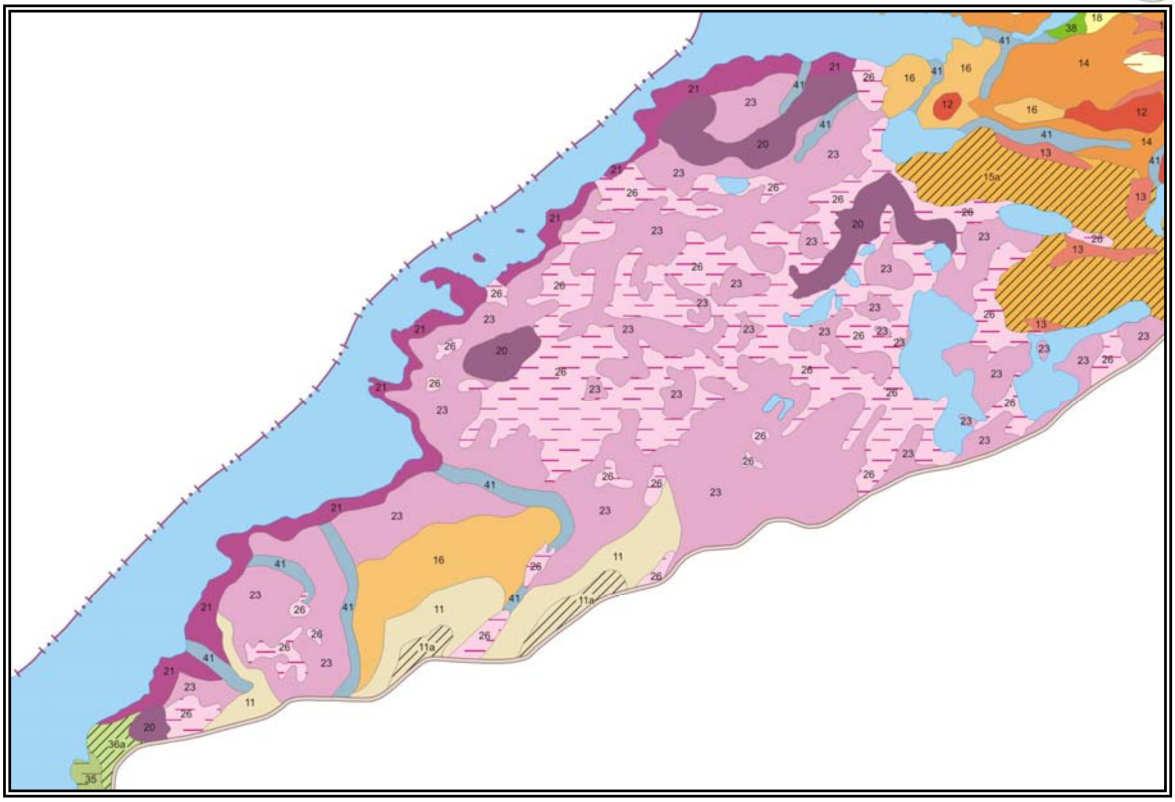
Ландшафтная карта северной части заповедника «Пасвик», район Меникка. Масштаб 1: 25 000. Автор-составитель Н.В.Поликарпова

Landscape map of northern part of Pasvik Zapovednik, Russian side. Menikka area. Scale 1:25 000. Author N.Polikarpova.

Ландшафтная карта заповедника «Пасвик»

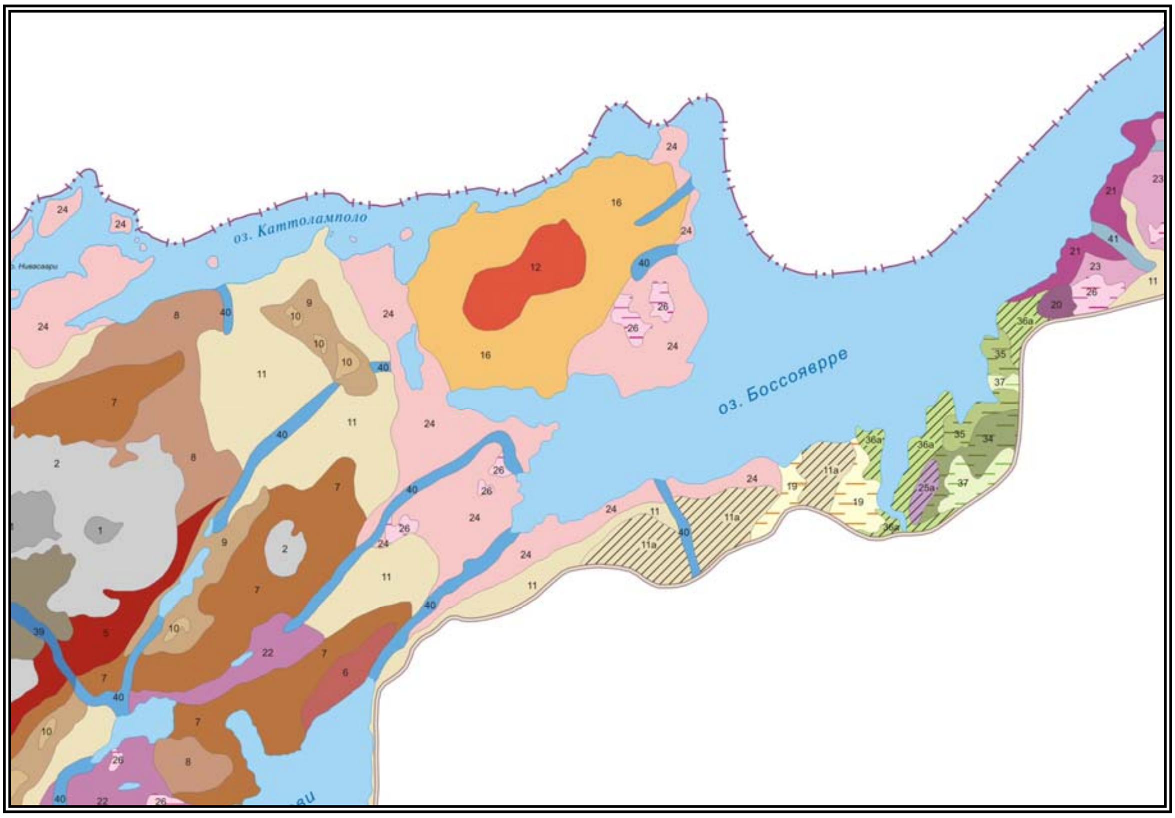
М 1:25 000





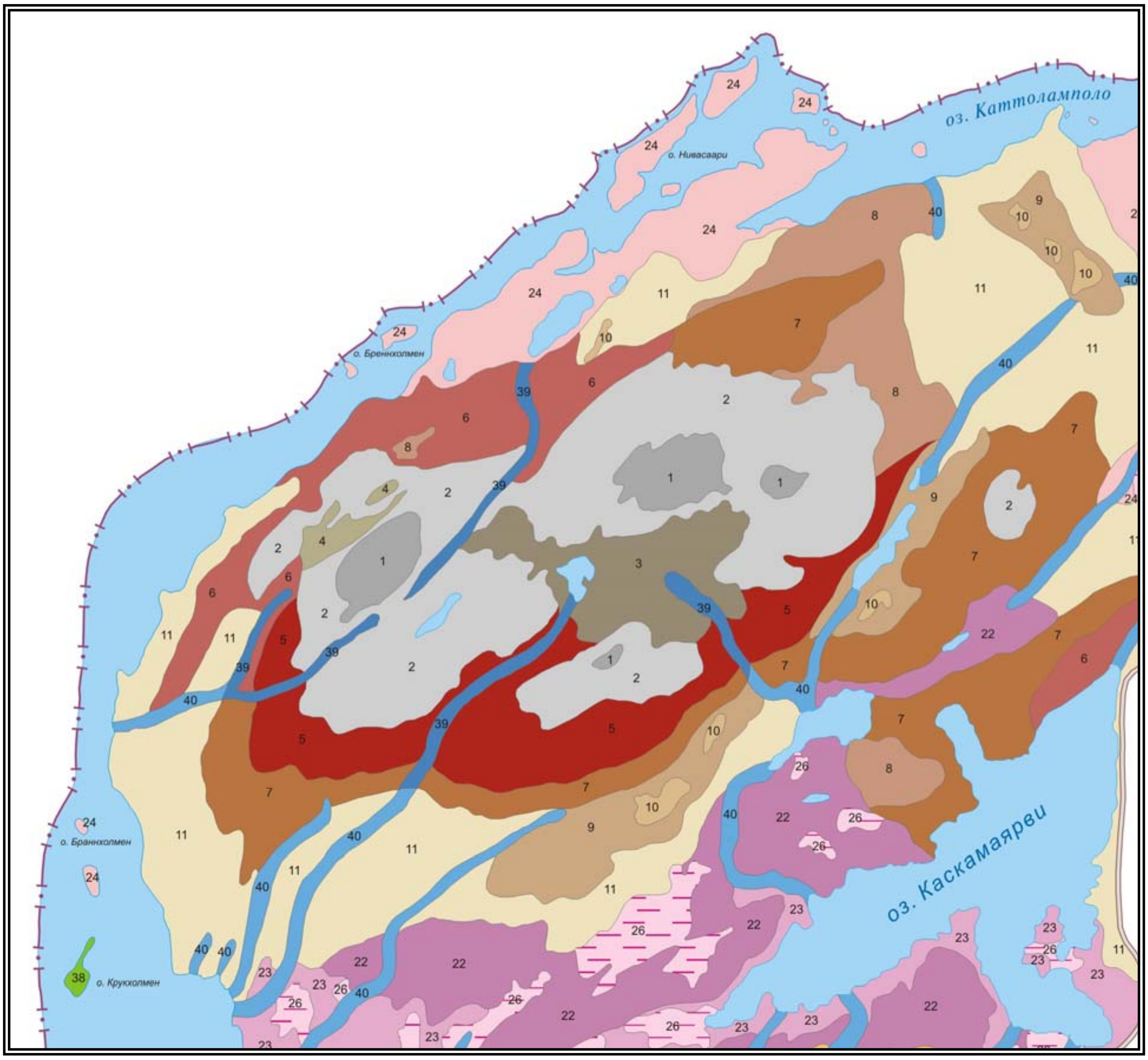
Ландшафтная карта северной части заповедника «Пасвик», район оз.Боссоярвре.

Landscape map of northern part of Pasvik Zapovednik, Bossojavre area



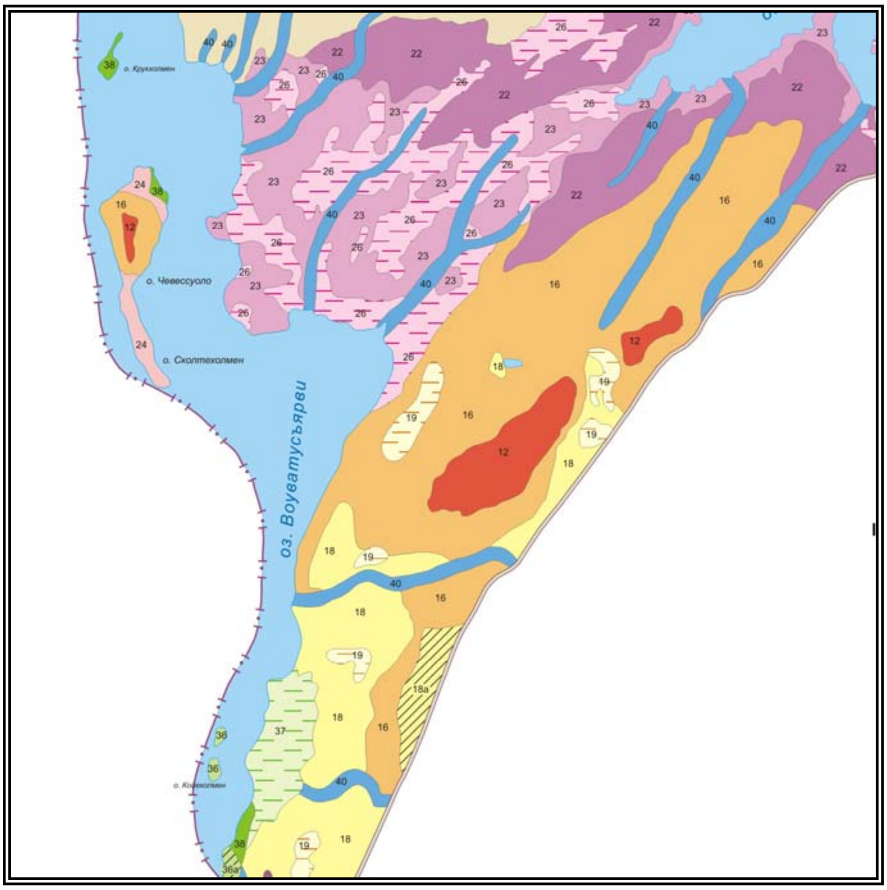
Ландшафтная карта центральной части заповедника «Пасвик», северо-восточная часть горы Калкупя.

Landscape map of central part of Pasvik Zapovednik, north-east of Kalkupya mountain.



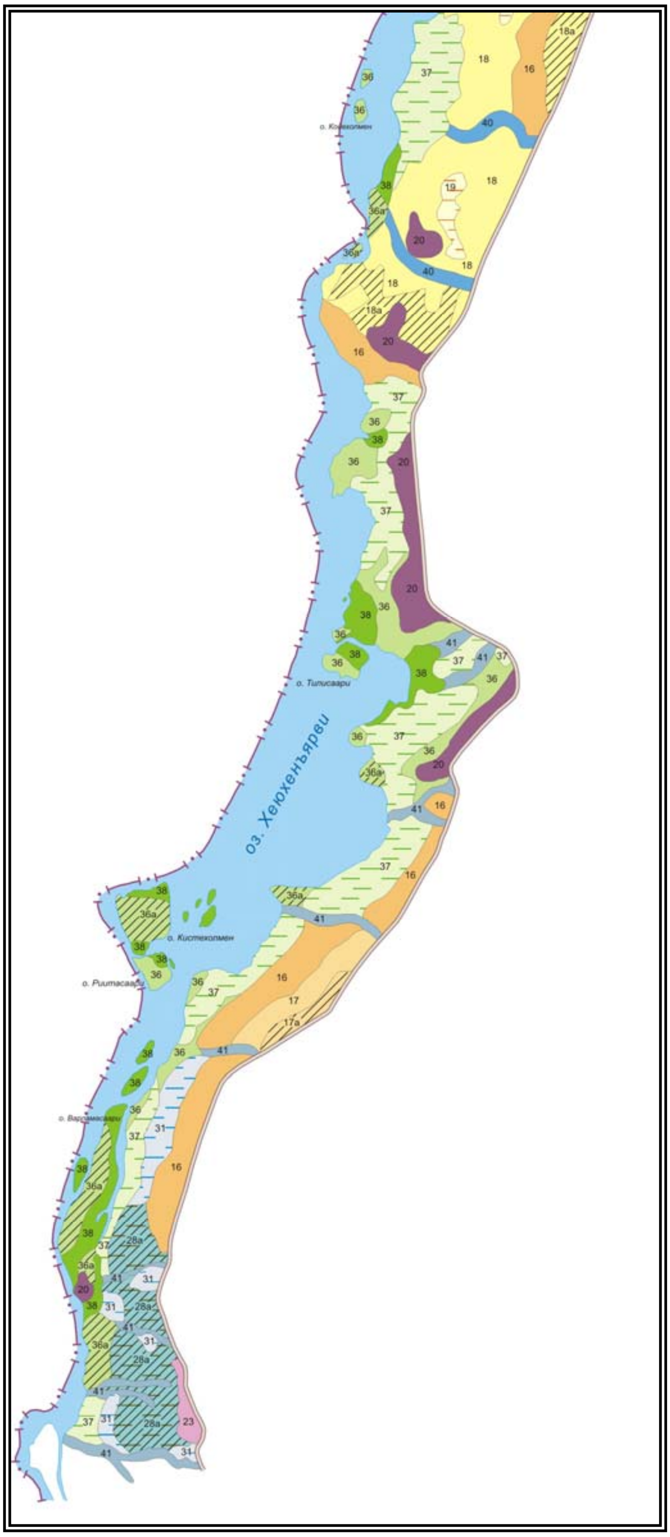
Ландшафтная карта центральной части заповедника «Пасвик», гора Калкупя и окрестности оз. Каскамаярви.

Landscape map of central part of Pasvik Zapovednik, Kalkupya mountain and Kaskamajarvi lake.



Ландшафтная карта центральной части заповедника «Пасвик», район оз.Воуватусъярви и Йорданфосса.

Landscape map of central part of Pasvik Zapovednik, Vagattem and Jordanfoss area.



Ландшафтная карта южной части заповедника «Пасвик», Хестефосс-Йорданфосс.
Landscape map of south part of Pasvik Zapovednik, Hestefoss-Jordanfoss.

I. ПТК останцовых возвышенностей

1	Вершины останцовых возвышенностей с кустарничково-лишайниковыми тундрами и лесотундрами на маломощных тундровых почвах, сформировавшихся на коренных породах
2	Крутые и очень крутые склоны останцовых возвышенностей с березовым криволесьем ерниково-воронично-лишайниковым на маломощных иллювиально-гумусовых и иллювиально-железисто-гумусовых подзолистых почвах, сформировавшихся на элювии коренных пород
3	Покатые склоны останцовых возвышенностей и седловины с березовыми и сосново-березовыми редколесьями, местами переувлажненным и заболоченными, кустарничково-моховыми на торфянисто-перегнойных и торфянисто-болотных почвах, сформировавшихся на морене
4	Пологие ступени на склонах останцовых возвышенностей с сосновыми редколесьями кустарничково-лишайниковыми на иллювиально-железисто-гумусовых оподзоленных почвах, сформировавшихся на морене
5	Крутые и очень крутые склоны останцовых возвышенностей, местами со скальными выходами и осыпями с березняками разнотравными на иллювиально-железисто-гумусовых и иллювиально-железистых подзолах на элювио-делювии коренных пород
6	Крутые и очень крутые склоны останцовых возвышенностей, со скальными выходами и осыпями с сосновыми лесами чернично-воронично-лишайниковыми и зеленомошно-лишайниковыми на маломощных иллювиально-железистых щебнистых подзолах на элювии коренных пород
7	Сильнопокатые и покатые склоны останцовых возвышенностей с сосновыми и березово-сосновыми лесами бруснично- и воронично-лишайниково-зеленомошными на маломощных иллювиально-железистых подзолах, сформировавшихся на морене
8	Покатые и слабопокатые склоны останцовых возвышенностей с сосновыми лесами чернично- и бруснично-воронично-зеленомошными и лишайниково-зеленомошными на маломощных иллювиально-железистых подзолах, сформировавшихся на морене
9	Пологие ступени на склонах останцовых возвышенностей с сосновыми и березово-сосновыми лесами чернично- и воронично-зеленомошными на иллювиально-железистых подзолах, сформировавшихся на морене
10	Плоские ступени на склонах останцовых возвышенностей с кустарничково-ерниково-сфагновыми болотами с сосной на торфянисто-болотных почвах, сформировавшихся на морене
11	Покатые склоны останцовых возвышенностей с выходами коренных пород и россыпями камней с сосновыми лесами бруснично- и воронично-зеленомошными и зеленомошно-лишайниковыми на иллювиально-железистых подзолах, сформировавшихся на морене
11а	Покатые склоны останцовых возвышенностей с сосновыми лесами бруснично-зеленомошными и бруснично-зеленомошно-лишайниковыми, местами с примесью березы, на маломощных иллювиально-железисто-гумусовых и иллювиально-железистых подзолах, сформировавшихся на морене, со следами свежих пожаров, рубок, дорогами, строениями

II. ПТК денудационных гряд и массивов с прерывистым чехлом морены

12	Покатые вершины гряд и массивов, местами с небольшими останцовыми холмами, с выходами коренных пород и россыпями камней, с сосняками бруснично-воронично-зеленомошными на иллювиально-железистых подзолах, сформировавшихся на морене
13	Крутые и очень крутые склоны гряд и массивов со скальными выходами коренных пород с сосняками скальными на карликовых дресвяных подзолах, сформировавшихся на элювии коренных пород
14	Крутые склоны гряд и массивов, местами скальные, с сосновыми лесами воронично-зеленомошными на маломощных иллювиально-железистых подзолах, сформировавшихся элювии коренных пород
15а	Покатые склоны гряд и массивов с сосновыми и березово-сосновыми лесами, местами с примесью осины, чернично-воронично-зеленомошными на иллювиально-железистых подзолах, сформировавшихся на морене, со следами давних пожаров и рубок
16	Покатые и слабопокатые склоны гряд и массивов, местами с россыпями камней, с сосновыми лесами бруснично-воронично-лишайниковыми и зеленомошно-лишайниковыми на маломощных иллювиально-железистых подзолах, сформировавшихся на морене
17	Пологие ступени на склонах массивов с сосновыми лесами багульниково-зеленомошными ерниково-багульниково-голубично-сфагновыми и зеленомошными на торфянисто-подзолистых почвах, сформировавшихся на морене на морских суглинках, подстилаемых мореной
17а	Пологие ступени на склонах массивов с сосняками-брусничниками на торфянисто-подзолистых почвах, сформировавшихся на морене, свежие гари
18	Пологие склоны гряд и массивов с останцами с сосновыми и березово-сосновыми лесами вороничниками и брусничниками на иллювиально-железисто-гумусовых подзолах, сформировавшихся на морене
18а	Пологие склоны гряд и массивов с останцами с сосняками чернично- и бруснично-лишайниковыми на иллювиально-железисто-гумусовых подзолах на морене, со следами рубок и пожаров
19	Комплекс пологих склонов гряд и массивов с межградовыми понижениями с кустарничково-ерниково-сфагновыми болотами с сосной на торфяно-болотных почвах, сформировавшихся на морене

III. ПТК моренных гряд и холмов

20	Отчетливо выраженные моренные гряды и крупные холмы с березово-сосновыми и сосновыми лесами бруснично- и чернично-зеленомошными и зеленомошно-лишайниковыми на иллювиально-железисто-гумусовых подзолистых почвах

IV. ПТК моренных равнин с прерывистым чехлом морских отложений

21 Слабопокатые и покатые приречные участки моренной равнины с сосновыми лесами, местами с примесью берез, бруснично- и воронично-лишайниково-зеленомошными на торфянисто-подзолистых иллювиально-гумусовых почвах, сформировавшихся на двучленных наносах (морена и морские суглинки)

22 Всхолмленная моренная равнина с сосновыми лесами, местами с примесью берез, бруснично-воронично-лишайниково-зеленомошными на иллювиально-железистых подзолах

23 Полого-волнистая моренная равнина с одиночными холмами, поросшая сосновыми лесами бруснично-воронично-лишайниково-зеленомошными, местами переувлажненными багульниково-воронично-зеленомошными и сфагновыми на иллювиально-железистых торфянисто-подзолистых почвах

24 Слабонаклонная моренная равнина с одиночными холмами с сосновыми лесами бруснично- и воронично-лишайниковыми на иллювиально-железистых подзолах, сформировавшихся на морене

25а Озовые гряды с сосново-березовыми и березовыми разреженными лесами брусничниками и вороничниками на иллювиально-железистых оподзоленных почвах, сформировавшихся на водно-ледниковых отложениях, со следами интенсивной антропогенной деятельности (вырубки, разработанные песчаные и глинистые карьеры)

26 Плоская поверхность моренной равнины с переходными болотами осоково-кустарничково-сфагновыми с сосной и березой на торфянисто-болотных почвах, сформировавшихся на двучленных наносах (морена и морские суглинки)

V. ПТК морских равнин

27 Пологие и слабопокатые приречные участки морской равнины с березняками хвощевыми, местами сильно переувлажненными, на дерновых почвах, сформировавшихся на морских глинах

28а Пологие и слабопокатые участки морской равнины с комплексом верховых болот с сосной и переувлажненных березняков кустарничковых и разнотравных на торфянисто-болотных и дерновых почвах, сформировавшихся на морских суглинках и глинах, со следами интенсивной антропогенной деятельности (рубки, дороги, строения)

29 Слабонаклонная поверхность приречной части морской равнины с березовыми и сосново-березовыми лесами, преимущественно бруснично-разнотравными на дерновых гумусовых почвах, сформировавшихся на морских глинистых отложениях

29а Плоская поверхность приречной части морской равнины с луговинами на дерновых старопахотных глинистых почвах, со следами интенсивной антропогенной деятельности (распашка, строения)

30 Слабонаклонная поверхность морской равнины с березняками хвощево-бруснично-зеленомошными на дерновых почвах, сформировавшихся на морских суглинистых отложениях

31 Пологие окраины и приречные части морской равнины с комплексными кустарничково-ерниково-сфагновыми болотами, поросшими древесной растительностью на торфянисто-болотных почвах, сформировавшихся на морских глинах

32 Плоская поверхность морской равнины с переходными кустарничково-осоково-сфагновыми болотами на торфянисто-болотных почвах, сформировавшихся на морских глинах

33 Плоская поверхность морской равнины с озерами и непроходимыми грядово-мочажинными топяными болотами

VI. ПТК речных долин и ручьев

ПТК морских ингрессионных террас

34 Пологие участки морской ингрессионной террасы с комплексом переувлажненных березняков воронично-бруснично-зеленомошных на торфянисто-подзолистых почвах и верховых сфагновых болот с сосной на торфянисто-болотных почвах, сформировавшихся на морских суглинках и глинах

35 Плоские и очень пологие участки морской ингрессионной террасы с комплексом ерниково-осоково-сфагновых болот и заболоченными березняками осоково-моховыми, местами с примесью ольхи на торфянисто-перегнойных почвах, сформировавшихся на морских суглинках

36 Плоская поверхность морской ингрессионной террасы с березовыми редколесьями бруснично-воронично-зеленомошными на иллювиально-гумусовых оглеенных подзолах, сформировавшихся на морских суглинистых отложениях

36а Плоская поверхность морской ингрессионной террасы с березняками кустарничково-зеленомошными и злаково-разнотравными на иллювиально-железисто-гумусовых подзолах, местами оторфованных, и луговинами на дерновых оподзоленных почвах, сформировавшихся на морских отложениях, со следами интенсивной антропогенной деятельности (распашка, рубки, дороги, строения)

37 Плоская поверхность морской ингрессионной террасы с болотами кустарничково-ерниково-сфагновыми с сосной на торфянисто-болотных почвах, сформировавшихся на морских отложениях

ПТК пойм

38 Плоская поверхность поймы с хвощево-осоково-ивовыми зарослями на иловато-песчано-галечниковом аллювии

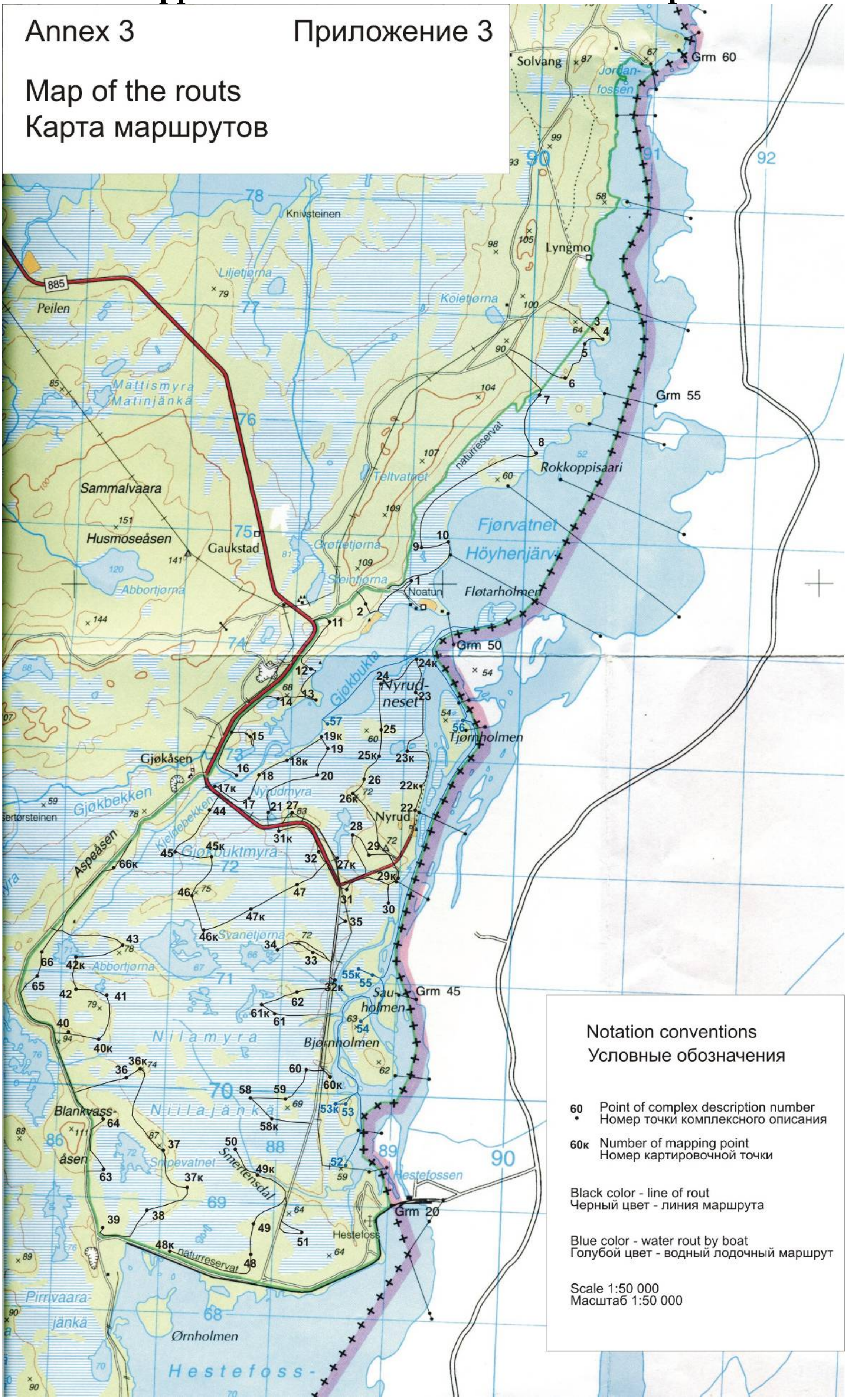
ПТК долин ручьев

39 Долины ручьев, заложившиеся на сильнопокатых и крутых склонах останцовых возвышенностей и в тектонических прогибах, с березовыми редколесьями ерниково-кустарничково-сфагновыми на торфянисто-перегнойных суглинистых почвах, сформировавшихся на коренных породах

40 Долины ручьев, заложившиеся на слабопокатых и пологих склонах массивов и гряд, с сосновыми и березово-сосновыми лесами кустарничково-разнотравно-моховыми на перегнойных торфянисто-болотных почвах, сформировавшихся на двучленных наносах (морене и морских глинах)

41 Долины ручьев, заложившиеся на морской равнине и ингрессионных террасах, с березняками злаково-разнотравными и кустарничково-разнотравными на дерново-перегнойных почвах, сформировавшихся на морских суглинистых отложениях

Appendix 3 Приложение 3



Appendix 4 Приложение 4

Дата: 21.08.2008

ОПИСАНИЕ ФАЦИИ №66

Адрес точки: N 69°08`16.4`` E 29°09`36.5`` В 80 м к ЮЗ от СВ отрезка (самого северного) дороги Gjøkåsen – Hestefoss и к З от южной окраины озера, расположенного в истоках реки Kjeldebekken

Относительная (абсолютная) высота: 83 м

Форма и часть склона: наклонная, срединная

Экспозиция склона по 8 румбам: восточная

Крутизна склона: 2°

Рельеф и микрорельеф (морфометрия): слабонаклонная поверхность озовой гряды, бугристый, муравейники, пни, обилие валежа сосны (свежего и старого)

Тип ассоциации: сосняк багульниково-воронично-брусничный лишайниково-зеленомошный по вырубке

Древостой /общий состав: 10С

Сомкнутость крон в баллах: 0,1

№	Название древесных пород	Ярус	Высота, м	Ø ствола, см
1.	Сосна 35 шт.	1	8-10	10-15
2.	Береза 7 шт.	2	6-8	<8
3.	Сосна 4 шт.	2	5-6	<8

Подрост: общий состав: 8Б2С **сомкнутость (баллы):** 0

№	Название растений	Обилие, шт., R=12 м	Высота, м	Распределение, %
1.	Сосна	7	2	0
2.	Береза	16	2	0
3.				

Подлесок: сомкнутость (баллы): 0

№	Название растений	Обилие, R=12 м	Высота, м	Распределение, %
1.				

Кустарничковый ярус (проективное покрытие): 70%

№	Название растений	Обилие	Распределение, %
1.	Брусника	cop_2	40
2.	Вороника	cop_1	20
3.	Багульник	sp	10
4.			

Мохово-лишайниковый покров (проективное покрытие): 90%

№	Название растений	Обилие	Распределение, %
1.	Мох Шребера	cop_3	60
2.	Политрихумы		
3.	Кладонии оленья, лесная, приальпийская, бесформенная	Cop_2	30
4.	Нефрома арктическая		

Травяной покров (проективное покрытие): 0%

1. Полевица тонкая – единично
Средняя высота травостоя (см): 20

Почвенный разрез:

Генетические горизонты	**A_0**	**A_2**	**B**	**BC**	**C**
Верхняя и нижн.границы	0-8	8-11 (13), нижняя граница неровная	11-24	24-45	45-52
Переход	Заметный по цвету и составу	Заметный по цвету	Постепенный, заметный по исчезновению бурого	Заметный по исчезновениюп ятен	
Цвет	Темно-бурый	Белесовато-св.-серый, чуть более темный верху	Неоднород., с преоблад. рыжевато-бурого	Неравномерно окрашен, зеленовато-серый с буроватыми и желтоватыми пятнами	Желтовато-зеленовато-серый
Мех.состав	Плохо разложившаяся подстилка	Песчаный	Песчаный	Песчаный, тонкозернисты й	Песчаный тонкозернисты й
Плотность	рыхлый	слабоуплотнен	слабоуплотнен	плотный	плотный
Влажность	свежий	свежий	свежий	свежий	свежий
Щебнистость %	0	Единичные камни до 7 см в диам., плохо окатанные	0	0	0
Корни, %	Обильно	Немного	Обильно	Немного	0
Новообразования, включения	0	0	0	0	0
Прочие признаки	0	0	0	0	0

Почвообразующая порода: морские пески
Почва: иллювиально-железистый подзол
Тип и степень увлажнения: атмосф.
Глубина залегания грунтовых вод: 0

Название природного комплекса: Слабонаклонная поверхность озовой гряды с сосняком багульниково-воронично-брусничным лишайниково-зеленомошным по вырубке на иллювиально-железистых подзолах, сформировавшихся на морских песчаных отложениях.
Примечание: ПТК в прошлом подвержен рубкам