QUALITY 0F WATER OBJECTS OF THE STATE NENETS NATURE RESERVE

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Abstract

Relevance. At the present time the emission of oil products is observed from emergency well No. 9 located on territory the Nenets Nature Reserve. The oil products get into in the Pechora delta`s waterways and then get into the Korovinskaya guba of the Barents sea, influencing the fortune of ecosystems. In connection with the eutrophication processes the expansion of the geographic areas of many water plants takes place. This work is aimed at studying the water quality using the methods of bioindication and the development of recommendations to eliminate the transfer of oil and gas condensate in the water courses of the delta of the Pechora river and Korovinskaya guba of the Barents sea. Similar activities in water courses of the delta of the Pechora river has not previously been conducted, so the data from our studies are relevant for this area.

Hypothesis. If the water objects of the reserve are polluted with oil products in varying degrees, species and phytocoenotic structure of their higher water plants differs depending on water quality.

Work purpose. To determine the class of water quality in the studied water objects using the methods of bioindication.

Research tasks: 1) to determine the species composition of macrophytes, which inhabit diverse water objects of the Nenets Nature Reserve; 2) to study the phytocoenotic structure of the higher water plants, to trace the spread of communities in diverse water objects; 3) to determine the quality of water with the use of indicative properties of macrophytes communities and the methods of Woodiwiss-Yakovlev; 4) to elaborate recommendations for recovery of destroyed dam of well No. 9

Scientific novelty. The research of water quality with the use of indicative properties of macrophytes is carried out for the first time ever. *Practical implications.* Collecting of data for the Nature records of the Nenets Nature Reserve. The work results allow us to estimate the level of organic pollution of river bed. The elaborated recommendations provide an opportunity to take action for restoration the dam and to decrease the emission of oil products into the water objects of the Nenets Nature Reserve.

Object of researches. The water quality of the studied water objects. *Subject of researches.* The spread of macrophytes and their communities in diverse water objects.

Conclusions: 1) As a result of this study there were identified 39 macrophyte species from 24 genera, 17 families, 5 classes, 4 departments. The brooks has the highest species diversity, because they contain less oil products; 2) there were identified 17 types of communities, the most

widely distributed of which are: Potametum pectinati, Potameto pectinati-Potametum perfoliati, Potametum perfoliati, Heteroherboso- Warnstorfieto- Caricetum aquatilis. The communities Heteroherboso -Sparganietum hyperborei are dominated in brooks. There is high phytocoenotic diversity in the brooks; 3) wide spreading of communities Potametum pectinati, Potameto pectinati-Potametum perfoliati indicates the eutrophication of the studied water ecosystems. According to the method of Woodiwiss-Yakovlev the water in the studied channels generally has III class of quality. In the griffin water has VI class quality. The water has II class quality in the Maliy Gusinets brook, in lakes it has II – III class quality; 4) developed recommendations will accelerate the recovery process of a dam of emergency well No. 9 and will reduce transfer of the oil products into the Pechora river.

Introduction. *Relevance.* The Nenets Nature Reserve (fig. 1-2) was founded in 1997. The need for a reserve occurred during an intensive development of geological exploration works. On the territory of the reserve there are thirty wells of gas condensate (Skorobogatko, 2003). The oil products get into in the Pechora delta`s waterways and then get into the Korovinskaya guba of the Barents sea, influencing the fortune of ecosystems. In connection with the eutrophication processes the expansion of the geographic areas of many water plants takes place. This work is aimed at studying the water quality using the methods of bioindication and the development of recommendations to eliminate the transfer of oil and gas condensate in the water courses of the delta of the Pechora river and Korovinskaya guba of the Barents sea. Similar activities in water courses of the delta of the Pechora river has not previously been conducted, so the data from our studies are relevant for this area.

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Object of researches. The water quality of the studied water objects. *Subject of researches.* The spread of macrophytes and their communities in diverse water objects.

Review of scientific literature. The story of the accident at the well No. 9 is described in detail in the work of V. Tolkachev (Tolkachev, 2000). Analysis of consequences of this accident is given in the book by Lavrinenko (Lavrinenko). The harmful influence of the emission of petroleum condensate over living organisms is analyzed. Mass fish mortality is registered. The nature reserve's report covers the details about condition of emergency well at the present time. There is a constant blowout of petroleum condensate from the bottom of griffin and high concentration of oil products in water samples from the stream flow of the delta of Pechora river (Glotov, Lavrinenko, 2005). There is no data about water quality and influence on structure and spreading of higher plants in this book. The influence of eutrophication on vegetation cover of the water objects and waterways of northern districts is, in general, poorly researched. There are known works of V.N. Vekhov and N.V. Vekhov (V.N. Vekhov, 1980, 1993; V.N. Vekhov, N.V. Vekhov, 1980; N.V. Vekhov, 1986 1987a, 1991 a, b, 1993, 1994) dedicated to processes of water eutrophication in areas of development. These researchers identified the peculiarity of distribution of plants in relation with the specificity of water objects and waterways. The authors have shown the outbreak of invading species associated with progressive anthropogenic eutrophication of natural waters. Data collected by V. N. Vechov (1980-1991) and other authors (Postovalov, 1966, 1969; Potokin, 1985) indicates active territory invasion by new species of water vascular plants. In 1992-1994 the structure and peculiarities of spreading of hydrophilic flowering plants on the coastal shallow water areas and wetlands areas of the coasts of the 35 lakes with different ecological types in Kenozersky national park were studied (Arkhangelsk region) (V. N. Vekhov, 1998).

Materials of researches. I stage. The material for this work was the results of a research conducted from june to september of 2013 on the territory of "Nenetskiy" reserve (fig. 1-2). The vegetation cover of the Korovinskaya guba water area near Kashin island, island No. 14 and Svizev Shar girt was researched. The vegetation cover of girts Bolshoy Gusinets, Maliy Gusinets, Kozlyukov Shar, Svizev Shar and 3 brooks was examined (fig. 1). Vegetation mapping and plant communities description was carried out by standard methods (Voronov, 1973; Katanskaya 1981; Mirkin, Rosenberg, 1978). 238 descriptions of plant communities were made. Associations (types of community) of macrophytes were allocated. During making of every description we measured depth, pH of water (Appendix, table 4) and determined the composition of bottom sediments (Appendix, table 1). The spreading of plants in the waters of the studied watercourses and southern coast of Korovinskaya guba of the Barents sea was traced. The schematic map and a profiles of overgrowing by

vegetation were made. **II stage.** From August to September of 2014 we studied the vegetation cover of the Northern part of the Korovinskaya guba and the 12 lakes of the Kostyanoy Nos peninsula (Fig. 2). We examined in detail the Maliy Gusinets griffin and the Svizev Shar gist (Fig. 1). Measured the length, width and height of dam (58 m, 9.8 m, 4.9 m) to calculate the volume of the destroyed part of the dam, and the estimated costs necessary to restore the destroyed dam. Revealed a class of water quality in water objects located at different distances from the griffin and ecologically distinct from each other based on the indicator properties of communities of macrophytes and methods of Woodiwiss-Yakovlev (Appendix, table 1).

Methods of researches: 1) route (travel by motor boat to identify the species of macrophytes and their communities); 2) stationary (description of test areas, sample collection from benthos); 3) laboratory (determination of species of macrophytes and water quality, computer processing of the material); 4) comparative analysis (comparison of water quality of different water objects); 5) statistical data processing (determination of the mean pH of water in the communities, deviations from the average). We used a dominant-determinant approach in the allocation of types of communities (Papchenkov, 2001, 2003). Latin names of associations are given according to the Code of phytocoenological nomenclature (Barkman, 1988). The plants were identified by field guides of M.L. Ramenskaya and V. N. Andreeva (1982), L. I. Lisitsyna, V. G. Papchenkova, V. I. Artemenko (1993) and "Flora of the North-East of the European part of the USSR" (1977).

Results

A brief analysis of systematic and ecological structure of flora. As a result of this study there were identified 39 macrophyte species from 24 genera, 17 families, 5 classes, 4 departments. Flowering plants are 32 species from 18 genera, 15 families, 2 classes. The leader is the *Potamogetonaceae* family (10 species, 27%). The second is the *Cyperaceae* family, there are 4 species in it, 10%. The rest of families include up to three species. During the analysis of *species diversity* in different water objects, it is revealed that the greatest number of species of macrophytes is growing in the Maliy Gusinets channel and brooks (Appendix, table 2). There were found 18 species of macrophytes in the brooks (Appendix, table 2). The maximum number of species of macrophytes in water objects of this type is due to the lack of strong currents, less influence of tides, fresh water draining from the peat bogs.

Water objects in the delta of Pechora. *Bolshoy Gusinets channel (Appendix, fig. 1; tables 1-2).* In the area of the confluence of the channels in Korovinskaya guba a large community of Potametum pectinati is revealed, which is changed to community of Potametum perfoliati with the increase of the depth. pH here is 8 - 8.4. Upstream the influence of sea water becomes smaller, and communities of Myriophylletum spicati and Sparganietum hyperborei are dominated in vegetation cover.

Maliy Gusinets channel near the quay (Appendix, fig. 1; tables 1-2). Here moored vessels, bringing sand and gravel for the construction of a dam, so the depth here is about 5 – 10 m. The vegetation cover near the shore is dominated by the community of Potametum pectinati, Potametum perfoliati, which are characterized by a low level of vitality. Plants do not exceed the size of 0.5 – 0.7 m. In shallow water there are small communities of Callitrichetum palustre, which are changed to communities of Batrachium. Southward the thickets of Potamogeton pectinatus become more grown and viable. Communities of Potametum pectinati and Potametum perfoliati were found in the area of the islets, where waterfowl are living. The islets are covered by tidal water, a large community of Cardaminetum nymanii was found here. We think that the lack of Potametum pectinati communities near the dam is due to the sandy nature of sediments.

Maliy Gusinets griffin (Appendix, fig. 1; tables 1-2). In 1981 there was an accident at well No. 9 of the Kumzhinsky field. As a result gas and oil leaked out in the Pechora for six years. The accident had been partially eliminated only in 1987. The emergency site (griffin) was protected by a dam built of sand. Until 2014, during flood oil products were washed out from the griffin and got into Korovinskaya guba (Anufriev et al., 2004, Tolkachev, 2000). The Northern part of the dam collapsed due to high floods in 2014. At the present time the oil products get into the Korovinskaya guba of the Barents sea freely. Higher water plants are presented by a large communities of Potametum pectinati. The swans are feeding in this waters. In the summer of 2014 we took samples of the benthos. There were no known groups of benthic invertebrates in the griffin. According to the method of Woodiwiss-Yakovlev water in the Maliy Gusinets griffin has a VI class of quality.

Svizev Shar channel (Appendix, fig. 1; tables 1– 2). Connects Bolshoy Gusinets with Korovinskaya guba. The channel is shallow. Higher water plants are well grown. Dominated by the communities of Potametum pectinati and Potametum perfoliati. In area of the Bolshoy Gunisets channel total projective cover degree is 100%. Communities of Warnstorfieto-Caricetum and willow thickets is dominated in the vegetation of the shores. In 2014 there were found a small communities of Lobeliatum dortmanni in a channel.

Kozlyukov Shar channel (Appendix, fig. 1; tables 1– 2). The communities of Potametum pectinati on a sandy-muddy bottom were found in the mouth. There are large communities of Potametum pectinati along the coast of the channels at a depth of up to 1.2 m, which are then replaced by communities of Potametum perfoliati. The projective cover of plants in communities is up to 100%.

The vegetation of the brooks of the delta of the Pechora river. Higher water plants of creeks differ from the plants of lager waterways. This difference is explained by the remoteness from the sea and little influence of tidal waters, the pH ranges from 7.1 to 7.8. The water from the peat bogs drains into these brooks. Typically, the brooks originate in peat bogs.

Bolshoy Gusinets brook (Appendix, fig. 1; tables 1-2). The brook starts in the peat bog. The bottom is clay and silt. Riparian vegetation consists of sedge and willow-herb communities that alternate each other. There are many hollows, in which Comarum palustre grows abundantly. The communities of Sparganietum hyperborei, Myriophylletum spicati, Callitrichetum palustre are dominated in the vegetation cover. Small areas are occupied by Potamogeton tenuifolius, Potamogeton alpinus, Potamogeton perfoliatus. Interesting thing is the lack of Potamogeton pectinatus, which is widespread in other water objects. We assume this is due to the clayey nature of the sediments and a decrease in pH of the water environment through wetland waters rich in humic acids and a smaller quantity of oil.

Maliy Gusinets brook (Appendix, fig. 1; tables 1– 2) starts in the peat bog. The vegetation of the coasts is represented mainly by willow communities. Communities of Caricetum aquatilis forms small broken stripe. Dominated by the communities of Potametum pectinati, Potametum perfoliati and Myriophylletum spicati. There is an awlwort in Subularia aquatica. There are large communities of Sparganietum hyperborei and a small coenoses of Batrachium sp. upstream from Maliy Gusinets channel. The only location of lesser Utricularia minor was found here. There are small communities of Subularietum aquatici at the water's edge. Waterfowl eat this plant in great numbers.

Kozlyukov Shar brook (Appendix, fig. 1; tables 1– 2). The brook starts in the peat bog. Riparian vegetation consists of willow thickets. Its width does not exceed 10 m. River bed is overgrown. The bottom is clay and silt. The water level fluctuates dramatically. There are communities of Cardaminetum hymanii and Rumexetum aquatilis in low tide coastal area. There are communities of Subularietum aquatici at the water's edge. There are cenoses of Heteroherboso-Sparganietum hyperborei, where there are Potamogeton perfoliatus and Potamogeton Gramineus. There is small amount of Potamogeton alpinus and Myriophyllum spicatum.

Southern part of Korovinskaya guba (appendix, fig. 1). The water from southern part of Korovinskaya guba is fresh and muddy. The bottom is mostly sandy with clay sheet. The guba is shallow. Higher aquatic plants cover a significant part of the water area. Dominated by the thickets of Potametum pectinati. Its communities are common to a depth of 1.5 m. There are often coenoses of Potametum pectinati beyond thickets of Potametum perfoliati to a depth of up to 2 m. Waterfowl, which are live here in large numbers, eat rhizomes of these pondweeds. The part of the water area at the mouth of Svizev Shar is of interest. There are coenoses of Myriophylletum spicati and a small community of Sparganietum emersym apart from communities of Potametum pectinati and Potametum perfoliati. Projective cover is up to 100%.

Thus, the vegetation of Korovinskaya gub is dominated by thickets of Potametum pectinati. Potamogeton pectinatus often forms a community with Potamogeton perfoliatus. Community of these species occupy a wide area. These communities also occupy a considerable area in the chan-

nel vegetation, but there are cenoses of Myriophylletum spicati, which sometimes forms pure thickets. A small area in the channel are occupied by thickets of Batrachium. The communities of Sparganietum hyperborei are dominated in brooks.

Northern part of Korovinskaya guba (appendix, fig. 2). The vegetation of the Northern part of Korovinskaya guba is represented by communities of Potametum tenuifoli, Potametum perfoliati and Potametum pectinati. These communities are pattern. Communities of Potametum perfoliat are abundant at greater depths. Unlike the southern part of Korovinskaya guba there are no massive communities of Potametum pectinati in its northern part. We explain this by sandy and weakly silty bottom. This area is exposed to strong influence of ice during the breakup on rivers.

The vegetation of the lakes of the Kostyanoy Nos peninsula. Higher water plants in the lakes are not well grown. The communities of Sparganietum hyperborei are dominated in vegetation. Riparian vegetation is dominated by coenoses of Caricetum aquatilis. Morphological parameters of the lakes are presented in Appendix (tab. 1).

The water quality of the studied water objects. Widespread communities of Potametum pectinati with high projective cover indicates the eutrophication of the aquatic environment in Korovinskaya guba and in large channels, which we associate with the transfer of oil from the griffin of well No. 9 into water. Eutrophication of Korovinskaya guba also occurs due to the feces of birds that are standing here in large numbers. According to the method of Woodiwiss-Yakovlev the water in the studied water objects generally has III or IV class of quality. Only in the Maliy Gusinets brook and lakes No. 3 and No. 6 the water has II class of quality (Appendix, table 1). The oil products are not transferred into these water courses.

Recommendations for the restoration of the dam. To restore the dam gravel and sand should be delivered to the accident site in spring to strengthen it. Work on the restoration of the dam will be conducted using surface transport, which shall be delivered to the accident site by water. The issue was discussed at the academic council with the reserve staff. The cost of restoration of the dam is about 1 million rubles, which will be used to pay water transport and work (table). It will require 2785,16 m^3 (58 m, 9.8 m, 4.9 m) of sand to restore the dam. This sand can be collected from the bottom of water courses with the help of an excavator.

Table

Cost estimates to repair the dam

Types of work	Cost of renting	Amount
Equipment: *The barge route: Naryan-Mar – Maliy Gusinets duct; Maliy Gusinets duct – Naryan-Mar*	Work: 7000 rubles per hour × 20 hours	140000
	Down time: 2000 roubles per hour × 24 hours × 7 days	336000
Excavator *For the construction of a dam*	Work: 1500 roubles per hour × 8 hours × 7 days	84000
	Down time: 500 roubles per hour × 16 hours × 7 days	56000

Workers services (*6 workers)*	3000 roubles per day × 7 days × 6 men	126000
Total amount		742000

Conclusions

1) As a result of this study there were identified 39 macrophyte species from 24 genera, 17 families, 5 classes, 4 departments. The brooks has the highest species diversity, because they contain less oil products from the emergency well No. 9.

2) There were identified 17 types of communities, the most widely distributed of which are: Potametum pectinati, Potameto pectinati-Potametum perfoliati, Potametum perfoliati, Heteroherboso- Warnstorfieto- Caricetum aquatilis. The communities Heteroherboso -Sparganietum hyperborei are dominated in brooks. There is high phytocoenotic diversity in the brooks.

3)Wide spreading of communities Potametum pectinati, Potameto pectinati-Potametum perfoliati indicates the eutrophication of the studied water ecosystems. According to the method of Woodiwiss-Yakovlev the water in the studied channels generally has III class of quality. In the griffin water has VI class quality. The water has II class quality in the Maliy Gusinets brook, in lakes it has II – III class quality.

4) Developed recommendations will accelerate the recovery process of a dam of emergency well No. 9 and will reduce transfer of the oil products into the Pechora river.

Hypothesis confirmation. Thus, the hypothesis was confirmed. Korovinskaya guba, the water courses of the delta of the Pechora river, lakes of Kostyanoy Nos peninsula are characterized by different water quality class, and phytocoenotic structure of higher water plants.

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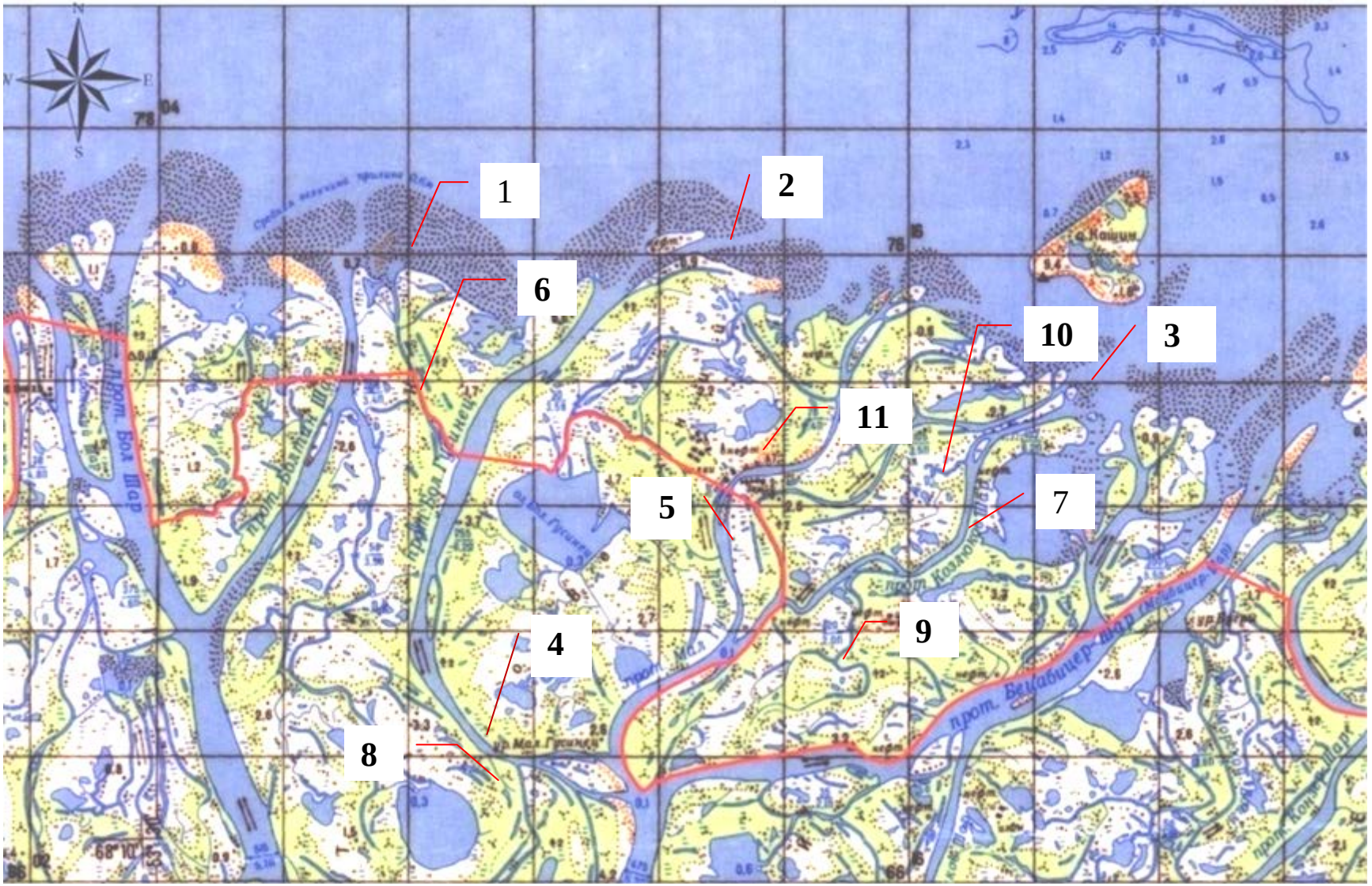

Fig. 1. The study area: 1 – Korovinskaya guba near Svizev Shar; 2 – Korovinskaya guba near island No. 14; 3 – Korovinskaya guba near Kashin island; 4 – Bol'shoy Gusinets; 5 – Maliy Gusinets; 6 – Svizev Shar; 7 – Kozljukov Shar; 8 – brook No.1 (Bol'shoy Gusinets); 9 – brook No.2 (Maliy Gusinets); 10 – brook No.3 (Kozljukov Shar); 11 – Maliy Gusinets griffin. M 1 :10000

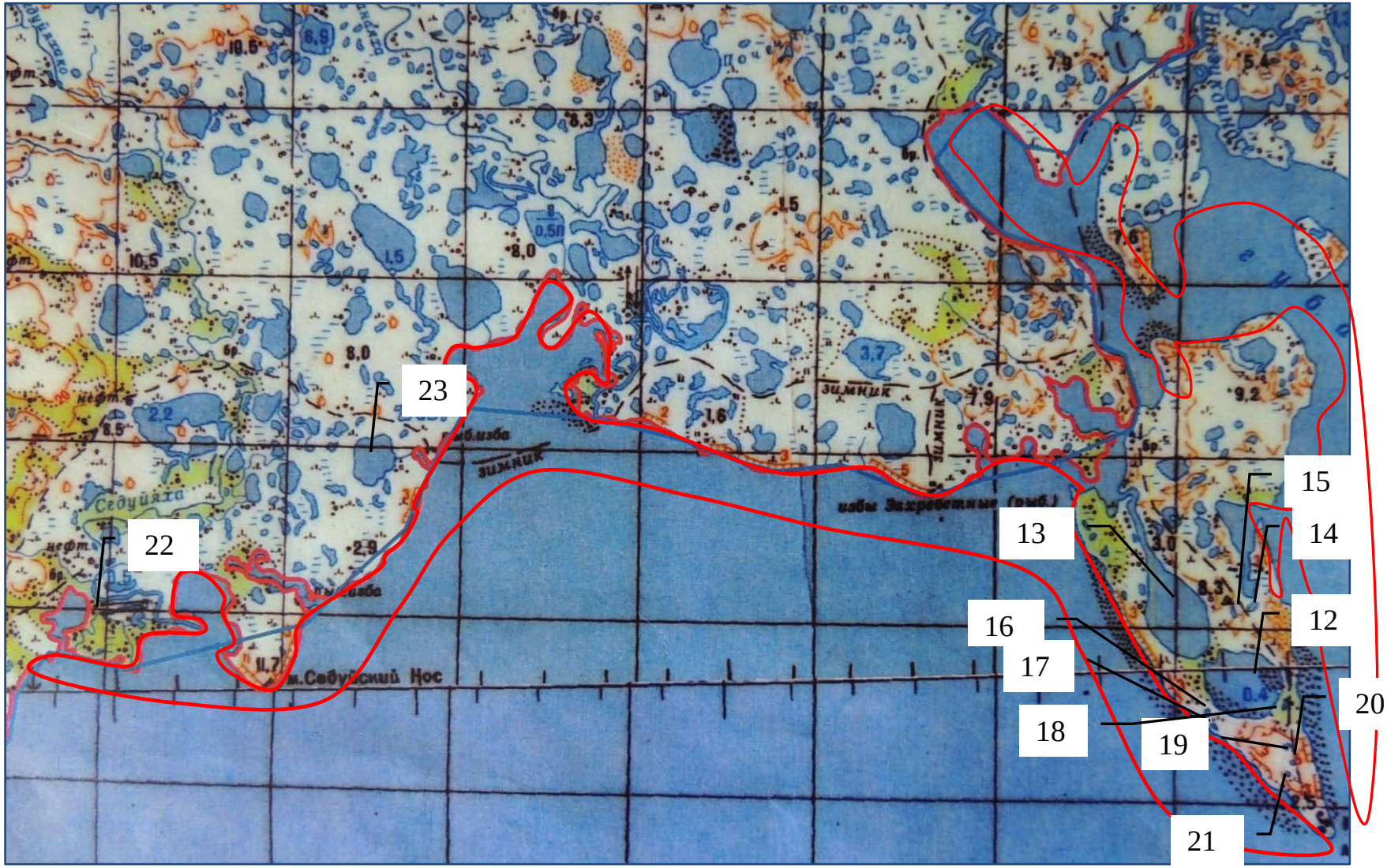

Fig. 2. The study area (northern part of Korovinskaya guba): 12 – lake No. 1; 13 – lake No. 2; 14 – lake No. 3; 15 – lake No. 4; 16 – lake No. 5; 17 – lake No. 6; 18 – lake No. 7; 19 – lake No. 8; 20 – lake No. 9; 21 – lake No. 10; 22 - lake No. 11; 23 – lake No. 12. Sandbank, on which the research was conducted, is outlined.

Table 1. General characteristics of the studied water objects of the delta of the Pechora river and the southern part of Korovinskaya guba

Properties	Water courses (the numbers correspond to the map, fig. 2)										
	1	2	3	4	5	6	7	8	9	10	11
Coordinates	N 68º14.735' E 053º41.833'	N 68º11.648' E 053º43.717' N 68º14.748' E 053º41.796'	N 68º13.484' E 053º52.047' N 68º13.291' E 053º51.121'	-	N 68º12.759' E 053º43.819' N 68º11.463' E 053º43.559'	N 68º14.735' E 053º41.833'	N 68º12.008' E 053º48.123' N 68º10.561' E 053º39.830'	N 68º09.193' E 053º37.717' N 68º10.207' E 053º38.621'	N 68º10.295' E 053.38.634' N 68º11.714' E 053º46.598'	N 68º12.940' E 053º49.217' N 68º12.831' E 053º48.391'	N 68°72.906' E 053°44.015'
Hydrological regime	Channels join	Channels join	Channels join	Channels	Channels	Channels	Channels	Channels	Channels	Channels	Secured griffin
The influence of the sea	At full tide salt water falls into it	At full tide salt water falls into it	At full tide salt water falls into it	Little effect	Little effect	Little effect	Little effect	No effect	No effect	No effect	No effect
Colour of water	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Dark brown	Greenish
The structure of bottom sediments	Silty-sandy	Silty-sandy	Silty-sandy	Silty-clay	Silty-sandy	Silty-sandy	Silty-clay	Silty-clay	Silty-clay	Silty-clay	Silty-sandy
Water quality class according to the method of Woodiwiss-Yakovlev	-	3/IV	-	-	-	-	-	-	6/II	-	0/VI
	The biotic index is in the numerator, class quality is in the denominator										
Waterfowl	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan	Bewick's swan
The influence of mammals.	Musk beaver				Musk beaver				Musk beaver, traces of elk		
Communities, which is dominant in the vegetation	Potametum pectinati, Hetero-herboso-Warn-storfieto-Caricetum aquatilis	Potametum pectinati, Hetero-herboso-Warn-storfieto-Caricetum aquatilis	Potametum pectinati, Hetero-herboso-Warn-storfieto-Caricetum aquatilis	Potametum pectinati, Potametum perfoliati	Potametum pectinati, Potametum perfoliati	Potametum pectinati, Potametum perfoliati	Potametum pectinati, Potametum perfoliati	Hetero-herboso - Sparga-nietum hy-perborei	Hetero-herboso - Sparga-nietum hy-perborei	Hetero-herboso - Sparga-nietum hy-perborei	Potametum pectinati

Reference: 1 – Korovinskaya guba near Svizev Shar; 2 – Korovinskaya guba near island No. 14; 3 – Korovinskaya guba near Kashin island; 4 – Bol'shoy Gusinets; 5 – Maliy Gusinets; 6 – Svizev Shar; 7 – Kozljukov Shar; 8 – brook No.1 (Bol'shoy Gusinets); 9 – brook No.2 (Maliy Gusinets); 10 – brook No.3 (Kozljukov Shar); 11 – Maliy Gusinets griffin;

Table 1. General characteristics of the studied water objects and lakes of Kostyanoy Nos peninsula and the Northern part of Korovinskaya guba (continued)

Properties	Water objects (the numbers correspond to the map, Fig. 3)												
	12	13	14	15	16	17	18	19	20	21	22	23	24
Coordinates	N 68°19.744' E 053°38.262'	N 68°20.137' E 053°37.596' N 68°20.141' E 053°37.061'	N 68°20.431' E 053°38.351'	N 68°20.408' E 053°38.050'	N 68°19.764' E 053°37.624'	N 68°20.408' E 053°38.050'	N 68°19.832' E 053°38.864'	N 68°19.565' E 053°38.817'	N 68°19.428' E 053°38.769'	N 68°19.565' E 053°38.819'	N 68°20.523' E 053°18.917'	N 68°21.427' E 053°44.928'	N 68°11.844' E 053°46.219' N 68°21.345' E 053°29.791'
Hydrological regime	Lake	Flows into Korovinskiy Gulf	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Flows into Korovinskiy Gulf	Flows into Korovinskiy Gulf	Ducts join
Colour of water	Light brown	Yellowish	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Light brown	Greenish	Greenish	Greenish
The structure of bottom sediments	Sandy	Sandy	Silty-sandy	Sandy	Sandy	Sandy	Sandy-clayey-silty	Peat-clay	Peat-clay	Peat-clay	Sandy, silty-sandy	Silty-clay	Sandy
Water quality class according to the method of Woodiwiss-Yakovlev	4/III	3/III	6/II	4/III	4/III	5/II	4/III	4/III	-	-	-	-	4/III
	The biotic index is in the numerator, class quality is in the denominator												
Waterfowl	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
The influence of mammals.	Musk beaver						Musk beaver						
Macrophyte communities	Potametum perfoliati, Potametum tenuifoli	Potametum perfoliati, Potametum tenuifoli	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Heteroherboso - Sparganietum hyperborei	Sphagnum cuspidatum	Potametum perfoliati, Myriophyllletum spicati	-	Potametum perfoliati, Potametum tenuifoli

Reference: 12 – lake No. 1; 13 – lake No. 2; 14 – lake No. 3; 15 – lake No. 4; 16 – lake No. 5; 17 – lake No. 6; 18 – lake No. 7; 19 – lake No. 8; 20 – lake No. 9; 21 – lake No. 10; 22 – lake No. 11; 23 – lake 12; 24 – the Northern part of Korovinskaya guba.

Table 2. The occurrence of macrophytes in the studied water objects

Plant species	Water objects																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
1. *Nitella cf. opaka* Bruz. Ag.								3																	1
2. *Warnstorfia exannulata* Guemb. in B. S. G. Loeske.	1	1	1	1	1	1	1	1	1	1									2						11
3. *W. fluitans* Hedw. Loeske	1	1	1	1	1	1	1	1	1	1															10
4. *Calliergon giganteum* (Shimp.) Kindb.																					1				1
5. *Scorpidium scorpioides* Hedw. Limpr.								2	1	1						2									4
6. *Sphagnum cuspidatum* Ehrh. ex-Hoffm																3	2		3	3					4
7. *Equisetum fluviatile* L.					1					1								1							3
8. *Batrachium sp.*					3				2	1												1			4
9. *Cardamine nymanii* Gand					1			1	1	1		1	1												6
10. *Subularia aquatica* L.					1	1		1	1	1															5
11. *Hippuris vulqaris* L.					2						1			2		1	1	1							6
12. *H. lanceolata* Petz.					1					1									1						3
13. *Comarum palustre* L.								2		2				1				1							4
14. *Callitriche palustris* L.	2	1		1	3			3	2	2															7
15. *Bistorta sp.*					2																				1
16. *Rumex aquaticus* L.					1				1	1															3
17. *Myriophyllum spicatum* L.	1				3	2	1	3	3	1												2			8
18. *Utricularia minor* L.									1																1
19. *Potamogeton alpinus* Balb.								1	1																2

Reference: 1 – Korovinskaya guba near Svizev Shar; 2 – Korovinskaya guba near island No. 14; 3 – Korovinskaya guba near Kashin island; 4 – Bol'shoy Gusinets; 5 – Maliy Gusinets; 6 – Svizev Shar; 7 – Kozljukov Shar; 8 – brook No.1 (Bol'shoy Gusinets); 9 – brook No.2 (Maliy Gusinets); 10 – brook No.3 (Kozljukov Shar); 11 – Maliy Gusinets griffin; 12 – lake No. 1; 13 – lake No. 2; 14 – lake No. 3; 15 – lake No. 4; 16 – lake No. 5; 17 – lake No. 6; 18 – lake No. 7; 19 – lake No. 8; 20 – lake No. 9; 21 – lake No. 10; 22 – lake No. 11; 23 – lake No. 12; 24 – the Northern part of Korovinskaya guba. 1 - the species is rare; 2 - species occurs occasionally; 3 - the species occurs frequently.

Table 2. The occurrence of macrophytes in the studied water objects (continued)

Plant species	Water objects																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
20. *P. tenuifolius* Rafin								1	1	1															3
21. *P. Gramineus* L.								2		3															2
22. *P. obtusifolius* Mert. et Koch					1			1														1			3
23. *P. pectinatus* L.	3	3	3	3	3	3	3		3		3	1	1											1	12
24. *P. rutilus* Wolfg.				1																					1
25. *P. perfoliatus* L.	3	3	3	3	3	2	3	3	3	3		1	1									2			13
26. *P. praelongus* Wulf								1																	1
27. *P. filiformis*																								1	1
28. *Zannichèllia* L.																								1	1
29. *Carex acuta* L.	3																	1							2
30. *C. aquatilis* Wahlend	3	3	2	2	3	2	2	2	3	3	2				2	2	2		2	2	3	1	1	2	20
31. *C. rostrata* Stokes														2											1
32. *C. chordorrhiza* Ehrh															1										1
33. *Sparganium angustifolium* Michx							1																		1
34. *S. emersum* Rehm	1																								1
35. *S. hyperboreum* Laest						2		3	3	3				2	2	2	1	1	1		3				11
36. *Ranunculus reptans* L.																									
37. *Lemna trisulca* L.				2	1	3	2	3	3	3															7
38. *Menyanthes trifoliata* L.																		3							1
39. *Lobelia dortmanna* L .						2																			1
Species in total	10	7	6	8	16	10	8	18	18	18	3	3	3	4	3	5	4	6	5	2	3	5	1	4	

Reference: 1 – Korovinskaya guba near Svizev Shar; 2 – Korovinskaya guba near island No. 14; 3 – Korovinskaya guba near Kashin island; 4 – Bol'shoy Gusinets; 5 – Maliy Gusinets; 6 – Svizev Shar; 7 – Kozljukov Shar; 8 – brook No.1 (Bol'shoy Gusinets); 9 – brook No.2 (Maliy Gusinets); 10 – brook No.3 (Kozljukov Shar); 11 – Maliy Gusinets griffin; 12 – lake No. 1; 13 – lake No. 2; 14 – lake No. 3; 15 – lake No. 4; 16 – lake No. 5; 17 – lake No. 6; 18 – lake No. 7; 19 – lake No. 8; 20 – lake No. 9; 21 – lake No. 10; 22 – lake No. 11; 23 – lake No. 12; 24 – the Northern part of Korovinskaya guba. 1 - the species is rare; 2 - species occurs occasionally; 3 - the species occurs frequently.