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Assessing the Ecological and Biological Forage Base of the Tobol River: Implications for Planktonic and Benthic Communities

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ABSTRACT

The Tobol River, a nationally significant economic water body, serves various purposes and spans across diverse landscape zones and environmental conditions. An evaluation of the forage base development of the Tobol River was conducted through the survey of six stations along the river in 2019. The investigation revealed a total of 15 species of planktonic invertebrates, including 6 rotifers, 5 cladocerans, and 4 copepods, as well as 28 species of benthic organisms. The survey period of 2016-2019 registered 36 species and forms of benthic organisms within the Tobol River basin, with a high diversity of insect groups. The considerable length and varied landscape zones of the river contribute to the observed high diversity of organisms. In terms of zooplankton development, the Tobol River exhibits a moderate food supply class and, according to S.P. Kitayev's trophic scale, can be classified as a β-mesotrophic water body. Similarly, the river's zoobenthos development indicates a moderate food supply class, designating it as an α-mesotrophic type under S.P. Kitayev's trophic classification. The study of the food spectrum of river perch and roach in the Tobol River suggests relatively high food availability for these species, underscoring the importance of understanding the ecological and biological forage base of the river for maintaining ecosystem health.

1. INTRODUCTION

The composition and abundance of zoobenthos are intrinsically linked to the physical characteristics of rivers, with substrate playing a crucial role in the development and distribution of zoobenthos [1]. Other factors, such as altitude, temperature, and river velocity, also significantly influence the composition and abundance of benthic invertebrate groups [2-4]. The Tobol River, originating from the uplands of the Trans-Ural Plateau at the border of the Republic of Kazakhstan and the Russian Federation, spans 1,674 km in length, with 800 km traversing Kazakhstan's territory. The river ultimately merges with the Irtysh River near Tobolsk, Russia. The Tobol River's source is considered to be the confluence of the Kokpektisay and Bozbye rivers, which are often depicted as dotted lines on geographical maps due to their formation from several mountain seasonal streams.

The Tobol River flows through various natural areas, including steppes, forest-steppes, mixed forests, and southern taiga, before joining the Irtysh River. Within the Tobol basin, approximately 20,000 lakes collectively cover an area of 9,000 square kilometers, providing the foundation for the ecosystem of Northern Kazakhstan and the neighboring regions of Southern Siberia [5]. The river serves as a vital waterway for the region, catering to transportation, fishing, and agriculture, while also offering recreational activities such as fishing and rafting. The Tobol River's historical significance is evident in its role as a major trade route and transportation corridor during the Russian Civil War.

Several tributaries, including the Ishim, Tura, and Ubagan rivers, contribute to the Tobol River's water flow and support the local ecosystem. The northern section of the basin, situated in the West Siberian Plain, is predominantly swampy. Water transportation along the lower navigable section of the Tobol River is crucial for the Tyumen region. While there are no prospects for constructing hydroelectric facilities in this section of the river, dredging and bank clearing are conducted to improve navigational conditions. The Tobol River basin hosts several cities involved in mineral extraction and industry, such as Lisakovsk, Rudny, Kostanay in Kazakhstan, and Kurgan, Tobolsk, and Yalutorovsk in Russia. The river is abundant in various fish species, including perch, pike, roach, ide, char, gudgeon, ruff, pike perch, bream, crucian carp, carp, sterlet, muksun, nelma, Siberian sturgeon, and wild boil.

Ten hydroelectric stations operate within the Tobol River basin, and the water quality of the river and other water bodies in the region is negatively impacted by the discharge of industrial and domestic untreated or insufficiently treated wastewater [5]. Additional detrimental factors include the washout of fertilizers and other pollutants from agricultural fields and land during spring floods and summer rain floods, as well as the substantial amount of pollutants emitted into the

atmosphere near the river. Owing to the Tobol River's national economic importance and the significant anthropogenic impact on its water regime, annual assessments of its hydrobiocenosis, hydrological and hydrochemical parameters, forage base, ichthyofauna composition, and the extent of anthropogenic influence on individual biocenoses are imperative.

The primary objective of this research is to investigate the forage base conditions and the feeding spectrum of fish in the Tobol River. The formation of a natural forage base is driven by a system of biological processes related to solar energy [6], which initiates the breakdown of organic matter at the river's bottom, subsequently enriching the water with mineral salts [7]. Consequently, primary products such as phytoplankton and bacteria are formed, which absorb mineral salts and organic substances from the water. Secondary products, including zooplankton and zoobenthos, are generated at the subsequent stage of the cycle [8-10].

2. MATERIALS AND METHODS

The material was collected as a result of field trips in 2019. Six stations on the Tobol River were surveyed, 12 specimens of zooplankton and zoobenthos were analyzed. Zooplankton and zoobenthos were collected at such points of the Tobol River: Nadezhdinka village, Sadovy village, Lisakovsk city, Antonovka village, Shukubai village, Zhailma village (Figure 1).

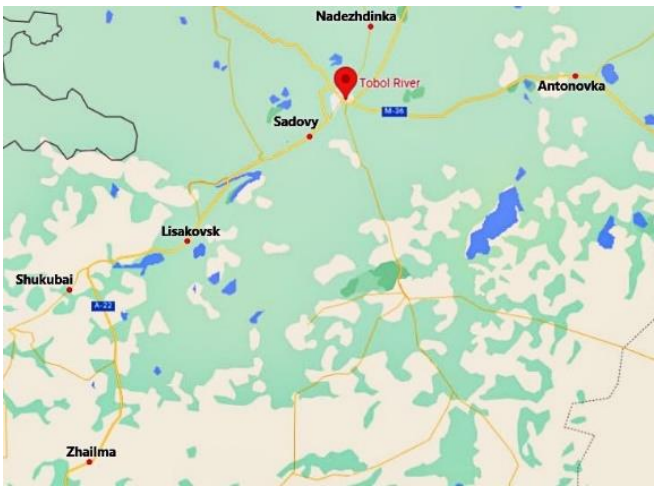

Figure 1. Location of the six stations on the Tobol River

To assess the state of the water body in terms of zooplankton and zoobenthos, data on species diversity in major groups, total number and biomass of organisms, as well as feed of the water body were used. The collection of hydrobiological material was carried out in accordance with generally accepted methods [11]. When detecting their species composition, known determinants were used [12, 13]. The organisms of the zooplankton were counted in a certain part of the sample in the Bogorov chamber, with the following viewing of half of its volume or the entire remainder to identify large and rare specimens. Bogorov's camera is a device that is used to record freshwater zooplankton. The camera looks like a plate of transparent material with a recess in the form of a labyrinth. At calculations of individual weight of zooplankers the equations of linear – weight relationship was applied. For each crustacean species, the number and mass of all stages of development were taken into account.

Benthos was collected by a Petersen dredge (S-1/40 m^2). To estimate the number, the organisms were placed in a Petri dish, the forms identified during the calculation were distinguished by systematic groups up to the level of phylum, class or order, followed by more detailed evaluation of the systematic position of the animals up to the level of genus and species, except for groups of organisms which are difficult to detect [14-17]. Weighing was performed after pre-drying in weighing bottle on analytical scales. Numbers and biomass were measured on the basis of methodological recommendations [17].

We used theoretical methods of cognition, studying the Tobol River and in the process of writing this work. We used general scientific methods of cognition, such as: cartographic, statistical and comparative methods. Scientific literature was studied and analyzed according to the research topic. A cartographic research method based on obtaining the necessary information using maps for the scientific and practical study of the phenomena depicted on them. In this article, the cartographic method was used to study the geography of the Tobol River. Using this method, the following were determined: the length and width of the river, the geographical position, the place where the river originates and where it flows. Statistical methods are scientific methods for describing and studying mass phenomena that can be expressed numerically. Descriptive statistics or exploratory data analysis was used during the writing of the paper. These are such methods of data processing, their systematization, visual presentation in the form of tables and graphs, as well as quantitative description of data using a system of statistical indicators. Using this method, information on the dynamics of changes in the annual values of the zooplankton biomass and the dynamics of changes in the average annual values of the biomass of zoobenthos was clearly presented in the form of graphs and tables. The comparative research method is one of the most used and widespread methods of learning information. Using the comparative method, an analysis and comparison of fish feeding and food resources in the Tobol River was carried out.

3. RESULTS AND DISCUSSION

As a result, hydrobiological regime research shows that the river zooplankton is rather homogenous and includes widespread river species. A total of 15 plankton invertebrate species were recorded during the 2019 survey period, including 6 rotifers, 5 cladoceran and 4 copepods (Table 1).

In the samples, the number of species varied significantly between 8 and 12. Based on the results of our studies, the most diverse plankton community is located in various bays, which is due to the hydrological regime of the river and consequently, the availability of organic matter for trophic processes. Concerning rotifers, the most widespread species are B. q. Quadridentatus and B. angularis, which were recorded at all sampling stations. The most common species among cladocerans is D.pulex (Leydig), which is part of the zooplankton community of all surveyed sites [18]. As far as copepods are concerned, M.leuckarti (Claus) species is also well spread. Table 2 shows the average number and biomass of the major zooplankton groups in the Tobol River.

Table 1. Taxonomic composition of zooplankton in the Tobol River

Taxons	Frequency of occurrence, %			
	2016	2017	2018	2019
Rotifera				
Trichocercalongiseta (Sch.)	16.7	33.3	0.0	16.7
EuchlanisdilatataEhrb.	16.7	33.3	16.7	16.7
BrachionusquadridentatusquadridentatusHerm.	66.7	100	83.3	100
B. urceusurceus (Linn.)	33.3	33.3	50.0	33.3
B. angularis (Gosse)	100	100	100	100
KeratellaquadratadispersaCarl.	83.3	100	100	66.7
Filinialongisetalongiseta (Ehrb.)	33.3	50.0	66.7	0.0
Total amount of taxons:	7	7	6	6
Cladocera				
Daphniapulex (Leydig)	100	100	100	100
D. longispinaMull.	66.7	83.3	50.0	66.6
Euricercuslamellatus (O.F. Mull.)	16.7	16.7	0.0	0.0
AlonarectangulaSars	33.3	33.3	16.7	0.0
Acroperusharpae (Baird)	16.7	0.0	0.0	0.0
Chydorussphaericus (O.F Mull.)	83.3	100	83.3	83.3
Ch. gibbusLill.	33.3	33.3	0.0	33.3
Graptoleberistestudinaria (Fish.)	16.7	16.7	33.3	0.0
Bosminasp.	66.7	100	66.7	83.3
Total amount of taxons:	9	8	6	5
Copepoda				
Diaptomidaegen. sp.	83.3	83.3	66.6	100
CyclopssmirnoviRylov	33.3	33.3	16.7	0.0
C. scutiferSars	33.3	33.3	33.3	0.0
EucyclopsserrulatusserrulatusFisch.	16.7	33.3	50.0	16.7
E. macruroides (Lill.)	33.3	33.3	16.7	0.0
MacrocyclopsalbidusJur.	66.7	66.7	33.3	0.0
MesocyclopsleuckartiClaus	100	100	100	100
Harpacticoidagen. sp.	16.7	16.7	0.0	33.3
Total amount of taxons:	8	8	7	4

Table 2. Number (N, thousand specimen/m^3) and biomass (B, g/m^3) of zooplankton in the Tobol River

Sampling points	Rotifers		Cladocerans		Copepods		Total	
	N	B	N	B	N	B	N	B
Nadezhdinka village	24.56	0.01	19.43	0.532	17.42	0.781	61.41	1.32
Sadovy village	17.48	0.01	27.69	0.729	18.63	0.894	63.80	1.63
Lisakovsk city	19.54	0.01	24.56	0.810	22.51	0.921	66.61	1.74
Antonovka village	18.41	0.01	26.54	0.897	18.45	0.792	63.4	1.70
Shukubai village	19.28	0.01	19.45	0.493	28.75	1.101	67.48	1.60
Zhailma village	18.56	0.01	34.26	1.032	29.53	1.241	82.35	2.28

The total amount of zooplankton in the Tobol River was from 61.41 thousand specimen/m^3 (Nadezhdinka village) to 82.35 thousand specimen/m^3 (Zhailma village). Cladocerans dominated at most sampling stations (except for Nadezhdinka and Shukubai villages). The biomass of the zooplanktom varies from 1.32 g/m^3 (Nadezhdinka village) to 2.28 g/m^3 (Zhailma village). The dominant role in the formation of the biomass of the zooplankton community at all stations (with the exception of Antonovka village) was played by copepods – from 52.9% (Lisakovsk city) to 68.6% (Shukubai village). The share of rotifers in the biomass of the zooplankton community is extremely small and did not exceed 0.75%. Due to the fact that the study of the Tobol River is only in its fourth year, Figure 2 shows the dynamics of changes in the average values of zooplankton biomass for these years only.

Analyzing the data presented in the figure, it can be noted that the quantitative development of plankton community in the Tobol River in 2019 is 1.2 times lower than in 2018 and averaged 1.80 g/m^3. In general, it should be noted that according to the development of zooplankton, the Tobol River is a water body of moderate class of food supply and in accordance with the "scale of trophicity" of Kitayev [19] can be classified as β-mesotrophic water body.

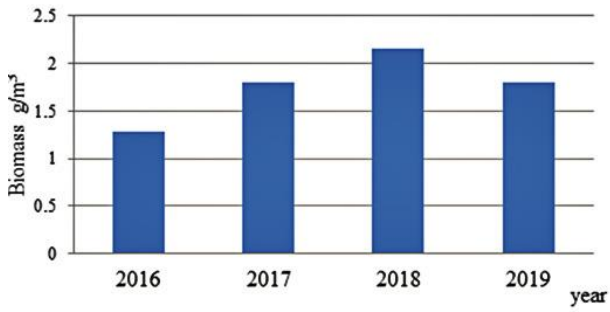

Figure 2. Dynamics of change in annual values of zooplankton biomass

The Tobol River zoobentos is represented by oligochaetes, molluscs, water bugs, beetles, mites, mosquito larvae and other heterotopic insects, crustaceans. A total of 28 species were recorded during the study period in 2019. The greatest

variety of representatives are insects. Among the insect samples, the Chironomidae family of the Dipterans is dominant. The taxonomic composition of benthic organisms is presented in Table 3.

During the period from 2016 to 2019, 36 species and forms of benthic organisms were registered in the Tobol River basin. There is a great variety of insect groups such as hemipterans, dragonflies and coleopterans [20]. The high diversity of organisms is primarily due to the considerable length of the river, located in various landscape zones and environmental conditions. Of the benthic organisms, C. plumosus Linnaeus и T. tibifex are the most widely spread species in the Tobol River. Table 4 represents average numbers and biomass of the Tobol River zoobenthos.

The number of zoobenthos depends on both biotope and season characteristics. Number of this group of aquatic invertebrates in 2019 ranged from 680 (Lisakovsk city) to 1240 specimen/m^2 (Shukubai village), and the biomass was in the range from 1.60 (Lisakovsk city) to 4.92 g/m^2 (Shukubai village). In terms of number and biomass, the majority of samples were dominated by chironomids larvae, their share from the total number reached 41.3% (Zhailma village), and biomass in some samples reached 44.2% (Nadezhdinka village). Due to the fact that the study of the Tobol River is only in its fourth year, Figure 3 shows the dynamics of changes in average values of zoobenthos biomass for these years only.

Table 3. Taxonomic composition of the benthic fauna of the Tobol River basin

Group, species	Frequency of occurrence, %			
	2016	2017	2018	2019
Class Bivalvia				
Colletopterumanatinum (L., 1758)	16.7	33.3	33.3	33.3
Amesodacfscaldiana (Nordmand, 1844)	16.7	50.0	66.6	33.3
Total amount of taxons:	2	2	2	2
Class Gastropoda				
Cincinnadepressa (Pfeiffer, 1828)	33.3	50.0	33.3	16.7
Bythiniatentaculata (L., 1758)	66.7	83.3	50.0	0.0
Acroloxuslacustris (L., 1758)	16.7	33.3	33.3	16.7
Lymnaeastagnalis (L., 1758)	66.7	83.3	50.0	66.6
L. ovata (Draparnaud, 1805)	33.3	50.0	0.0	33.3
L. fontinalis (Studer, 1820)	16.7	33.3	33.3	0.0
Physaadversa (da Costa, 1778)	16.7	33.3	0.0	16.7
Total amount of taxons:	7	7	5	5
Class Oligochaeta				
Aulodrilusspluriseta (Piguet, 1906)	50.0	66.6	33.3	0,0
LimnodrilushoffmeisteriClapaŕede, 1862	33.3	50.0	0.0	16.7
Tubifex tibifex (O. F. Müller, 1773)	100	100	100	100
Lumbricusariegates (O. F. Müller, 1773)	50.0	50.0	50.0	66.6
Total amount of taxons:	4	4	3	3
Class Hirudinea				
Glossiphoniacomplanata (L., 1758)	50.0	83.3	66.6	33.3
Erpobdellaoctoculata (L., 1758)	16.7	50.0	0.0	0.0
Total amount of taxons:	2	2	1	1
Class Crustacea				
Gammaruslacustris L., 1758	33.3	100	50.0	83.3
Total amount of taxons:	1	1	1	1
Class Insecta				
Argionvirgo (L., 1758)	33.3	50.0	33.3	0.0
Coenagrionpuella (L., 1758)	50.0	33.3	16.7	0.0
Gomphusvulgatissimus (L., 1758)	33.3	50.0	33.3	50.0
Aeschnacyanea (O. F. Müller, 1764)	16.7	50.0	33.3	16.7
Potamanthusluteus (L., 1758)	33.3	33.3	0.0	16.7
Caenishoraria (L., 1758)	50.0	66.6	66.6	83.3
TanypusMeigen	83.3	100	50.0	100
Chironomusplumosus Linnaeus	100.0	100	100.0	100
Sigaralateralis (Leach, 1817)	33.3	33.3	33.3	66.6
Notonectaglauca L., 1758	16.7	33.3	33.3	0.0
Gerriscostae (Herrich-Schäffer, 1853)	33.3	16.7	0.0	0.0
G.argentatusSchummel, 1832	16.7	33.3	33.3	0.0
GyrinussubstriatusStephens, 1827	50.0	50.0	50.0	33.3
Hyphydrusovatus L., 1761	33.3	50.0	16.7	33.3
Hydrobiusfuscipes (L., 1758)	50.0	50.0	33.3	16.7
Platambusmaculates (L., 1758)	16.7	33.3	0.0	16.7
Ecnomustenellus (Rambur, 1842)	16.7	50.0	50.0	33.3
PhryganeabipunctataRetzius, 1783	33.3	33.3	33.3	0.0
Ph. grandilis (L.,1758)	16.7	16.7	0.0	0.0
Lepidostomahirtum (F., 1775)	16.7	33.3	33.3	16.7
Total amount of taxons:	20	20	16	13
TOTAL	36	36	28	25

Table 4. Number (N, thousand specimen/m^3) and biomass (B, g/m^3) of the Tobol River zoobenthos

Sampling points	Mollusca		Oligohchaeta		Hirudinea		Crustacea		Insecta		Total	
	N	B	N	B	N	B	N	B	N	B	N	B
Nadezhdinka village	0.0	0.0	420	0.61	0	0.0	20	0.31	560	1.74	1000	2.66
Sadovy village	20	0.55	340	0.64	20	0.34	40	0.59	420	1.37	840	3.49
Lisakovsk city	0.0	0.0	280	0.56	0	0.0	0	0.00	400	1.04	680	1.60
Antonovka village	0.0	0.0	360	0.67	40	0.72	60	0.87	560	1.87	1020	4.13
Shukubai village	40	1.14	460	0.71	20	0.39	40	0.54	680	2.14	1240	4.92
Zhailma village	40	1.28	400	0.58	0.0	0.0	80	1.05	520	1.71	1040	4.62

Analysis of the data presented in the figure indicates that the quantitative development of the benthic community in the Tobol River in 2019 decreased compared to 2018 and averaged 3.57 g/m^2. According to the average value of zoobenthos development, the Tobol River is a water body of moderate class of food supply and in accordance with the "scale of trophicity" of S.P. Kitayev can be classified as α-mesotrophic water body.

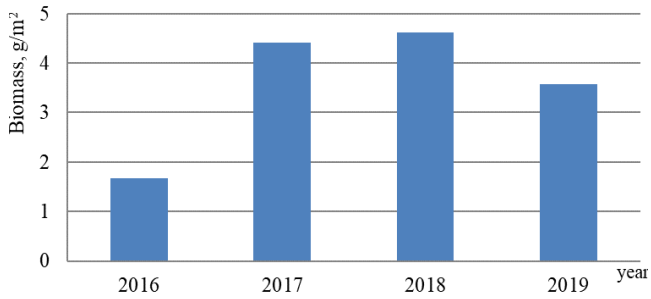

Figure 3. Dynamics of change in average annual values of zoobenthos biomass

In general, the biomass of forage organisms in the river is low, which is quite understandable, given that the river has a fairly fast flow, lack of any ducts, bights, bays, where invertebrate hydrobionts could produce their biomass. Also, during the study, the spectrum of nutrition of common fish species, such as river perch and roach, in the Tobol River was studied. The spectrum of nutrition was studied by the frequency of occurrence of components and the index of intestinal filling of fish [21]. There are 11 feed components registered in perch nutrition: 3 species of fish, chironomids, back swimmers, dragonflies' larvae, beetles, crustaceans (mysids and gammarus). Five specimens had algae in their food bolus and four had sands. Table 5 shows the distribution of feed components in perch feeding.

The share of chironomide in the food bolus is insignificant and does not exceed 0.05 % and does not affect the perch nutrition, this object is additional. The basis of the nutrition of the size group from 8 to 10 cm was a backswimmer. Fish represented by young dace, roach and perch was found in individuals from 13.7 cm long [22]. In the size groups from 16 to 20 cm and from 21 to 25 cm, the basis of nutrition is fish. Crustaceans played a significant role in perch nutrition in 2019. The most common food component in the food bolus of perch is the dragonfly larvae, which were observed in 14 specimens. The roach mainly eats plant objects [23]. Thread algae predominate in the diet of the roach in the Tobol River, sometimes reaching up to 90% of the mass of food bolus. In general, the composition of the diet depends on the availability of certain types of feed. In early spring the roach consumes large amounts of animal food due to a decrease in plant biomass [24]. Table 6 shows the distribution of feed components in the feeding of the Tobol River roach.

Table 5. Nutrition of river perch in the Tobol River

Size Group, cm	Components weight ratio, %				
	fish	dragonfly larvae	back swimmer	crustaceans	others
8-10	-	11.6	68.5	9.8	10.1
11-15	28.6	25.8	32.4	8.3	4.9
16-20	69.4	13.2	4.1	6.8	6.5
21-25	79.6	8.9	3.2	2.6	5.7
Frequency of occurrence, %	39.3	50.0	42.9	28.6	64.3
Filling index, ‰$_{000}$			24.64		
Amount of fish, specimen			28		
Empty fish, %			10.7		

Note: others – vegetation, sand, beetles.

Table 6. Nutrition of roach in the Tobol River

Size group, cm	Components weight ratio, %				
	Thread algae	Other plants	Organic debris	zoobenthos	zooplankton
6-10	59.6	14.5	10.8	11.2	3.9
11-14	62.6	9.1	6.8	17.3	4.2
15-19	55.4	8.2	5.6	28.7	2.1
19-22	48.2	7.1	5.4	38.9	0.4
Frequency of occurrence, %	76.4	35.2	38.7	91.6	27.5
Filling index, ‰$_{000}$			11.8		
Amount of fish, specimen			46		
Empty fish, %			10.9		

The analysis of the table shows that the basis of roach nutrition in the Tobol River is food of plant origin. As previously stated, the development of zooplankton and zoobenthos in the river is low, and given the presence of a significant number of competitors in this spectrum, it is natural that this species, having a relative unpretentiousness in nutrition, will choose the most available food, in our case it is aquatic vegetation [25-27]. Thus, in the roach of size groups from 6 to 14 cm, the share of food of animal origin does not exceed 21.5%, in the size group 19-22 cm this figure increases to 39.3%. In general, it should be noted that there is a relatively high level of food availability for this species in the Tobol River, taking into account almost unlimited forage resources of plant origin.

4. CONCLUSIONS

Thus, the Tobol River, flowing through the territory of Kostanay region, is an important national economic water body and is used for various purposes, including fishing resources. Six stations on the Tobol River were surveyed and feed base development was assessed. A total of 15 species of planktonic invertebrates (including 6 rotifers, 5 cladocerans and 4 copepods) and 28 species of benthic organisms were recorded during the 2019 survey period.

The authors identified 15 species of planktonic invertebrates and 28 species of benthic organisms in the Tobol River during the survey period in 2019. This information is important in understanding the ecosystem of the river and its potential for supporting different types of aquatic life. Also, it was provided an assessment of forage base development in the Tobol River, which is important for understanding the potential of the river for supporting fish populations and other aquatic life.

The study classified the Tobol River as a β-mesotrophic water body for zooplankton development and α-mesotrophic type for zoobenthos development according to the trophic scale of S.P. Kitayev. This information is important for understanding the nutrient status of the river and its potential for supporting different types of aquatic life. The study found relatively high food availability for river perch and roach in the Tobol River, which is important for understanding the potential of the river for supporting fish populations.

Based on the results of our studies, the most diverse plankton community is located in various bays. Analyzing the data, it can be noted that the quantitative development of plankton community in the Tobol River in 2019 is 1.2 times lower than in 2018. In general, it should be noted that according to the development of zooplankton. During the period from 2016 to 2019, 36 species and forms of benthic organisms were registered in the Tobol River basin. The high diversity of organisms is primarily due to the considerable length of the river, located in various landscape zones and environmental conditions. In general, the biomass of forage organisms in the river is low, which is quite understandable, given that the river has a fairly fast flow, lack of any ducts, bights, bays, where invertebrate hydrobionts could produce their biomass. Also, during the study, the spectrum of nutrition of common fish species, such as river perch and roach, in the Tobol River was studied. As a result of the study of the nutrition spectrum of river perch and roach, relatively high food availability of these species in the Tobol River should be noted.

Based on the findings of the study on the Tobol River, there are several areas of focus for future research:

Long-term monitoring: The study provides information on the biodiversity and ecological conditions of the Tobol River over a specific period. Future research could involve long-term monitoring of the river to assess changes in the ecosystem over time and to evaluate the effectiveness of management and conservation measures.

Fish populations: The study highlights the food availability for river perch and roach in the Tobol River. Future research could focus on assessing the status and trends of fish populations in the river, including their abundance, distribution, and reproductive success.

Trophic status: The study classifies the Tobol River as a β-mesotrophic water body for zooplankton development and α-mesotrophic type for zoobenthos development. Future research could investigate the factors influencing the river's trophic status, including nutrient inputs and water quality.

Impacts of human activities: The Tobol River is an important national economic water body, and human activities such as agriculture, industry, and urbanization can have significant impacts on its ecosystem. Future research could assess the impacts of these activities on the river's biodiversity and ecological conditions and identify measures to mitigate negative impacts.

Climate change: Climate change is expected to have significant impacts on freshwater ecosystems, including rivers such as the Tobol River. Future research could investigate the potential impacts of climate change on the river's biodiversity and ecological conditions and develop strategies for adaptation and mitigation.

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REFERENCES

[1] Sá-Oliveira, J.C., Isaac, V.J., Soares Araújo, A., Ferrari, S.F. (2016). Factors structuring the fish community in the area of the coaracy Nunes hydroelectric reservoir in Amapá, Northern Brazil. Tropical Conversation Science, 9(1): 16-33. https://doi.org/10.1177/194008291600900103

[2] Yi, E., Sun, Y., Liu, X., Hou, G., Lv, S., Yuan, J., Sun, M. (2018). A comparative study of radiocarbon dating on terrestrial organisms and fish from Qinghai Lake in the northeastern Tibetan Plateau, China. The Holocene, 28(11): 1712-1719. http://dx.doi.org/10.1177/0959683618788671

[3] Kyrychuk, G., Ye., Muzyka, L.V. (2017). Peculiarities of carotenoid pigments' distribution in organism of the freshwater mollusks. Hydrobiological Journal, 53(5): 85-

93. https://doi.org/10.1615/HydrobJ.v53.i5.90
[4] Bal'-Prylypko, L.V., Derevyanko, L.P., Slobodyanyuk, N.M., Starkova, E.R., Androshchiuk, O.S. (2018). Using of the Ampullaria glauca snails' caviar for correction of the effects of the ionizing radiation exposure in small dose. Nuclear Physics and Atomic Energy, 19(2): 159-165. https://doi.org/10.15407/jnpae2018.02.159
[5] Ye Kyrychuk, G., Muzyka, L.V. (2016). Peculiarities of the distribution of β-carotene in the organism of lymnaea stagnalis under the influence of the ions of heavy metals. Hydrobiological Journal, 52(5): 63-72. https://doi.org/10.1615/hydrobj.v52.i5.70
[6] Goldberg, H., Sun, Y., Hickey, T.J., Shinn-Cunningham, B., Sekuler, R. (2015). Policing fish at Boston's museum of science: Studying audiovisual interaction in the wild. I-Perception, 6(4): 1-11. http://dx.doi.org/10.1177/2041669515599332
[7] Waltham, N.J., Fixler, S. (2017). Aerial herbicide spray to control invasive water hyacinth (Eichhornia crassipes): water quality concerns fronting fish occupying a tropical floodplain wetland. Tropical Conversation Science, 10(1): 1-10. https://doi.org/10.1177/1940082917741592
[8] Buchanan, N. (2017). Which fish? knowledge, articulation, and legitimization in claims about endangered and culturally significant animals. Science Technology and Human Values, 42(3): 520-542. http://dx.doi.org/10.1177/0162243916682597
[9] Kirichuk, G.E., Stadnichenko, A.P. (2004). The trematode invasion and accumulation on heavy metals by the mollusc Colletopterum ponderosum (Bivalvia: Unionidae: Anodontinae). Parazitologiia, 38(4): 359-365. https://pubmed.ncbi.nlm.nih.gov/15493288/
[10] Shcherbak, V.I., Korneychuk, N.N. (2006). Influence of hydrological and morphological characteristics of the Teterev river on the structure of phytomicroepilithon. Hydrobiological Journal, 42(5): 25-38. https://doi.org/10.1615/HydrobJ.v42.i5.30
[11] Abakumov, V.A., Bubnova, N.P., Kholikova, N.I., Goridchenko, T.P., Liepa, R.A., Svirskaya, N.L., Ganshina, L.A., Semin, V.A., Khromov, VM., Nikitin, D.I., Katanskaya, V.M., Raspopov, I.M. (1983). Guidelines for methods of hydrobiological analysis of surface waters and bottom sediments. Leningrad: Gidrometizdat, 240.
[12] Tsalolikhin, S.Y. (Ed.). (1994). Identify the freshwater invertebrates in Russia and adjacent territories. St. Petersburg: Nauka, 400.
[13] Tsalolikhin, S.Y. (Ed.). (1995). Keys to freshwater invertebrates of Russia and adjacent territories. St. Petersburg: Nauka, 632.
[14] Barulin, Y.A. (Ed.). (1984). Guidelines for the collection and processing of materials in hydrobiological research in freshwater bodies. Zoobenthos and its products. http://docs.cntd.ru/document/1200060089
[15] Tsalolikhin, S.Y. (Ed.). (2000). Keys to freshwater invertebrates in Russia and adjacent territories. St. Petersburg: Nauka, 977.
[16] Tsalolikhin, S.Y. (Ed.). (2001). Keys to freshwater invertebrates in Russia and adjacent territories. St. Petersburg: Nauka, 825.
[17] Tsalolikhin, S.Y. (Ed.). (1994). Keys to freshwater invertebrates in Russia and adjacent territories. St. Petersburg: Nauka, 528.
[18] Polak-Juszczak, L. (2017). Methylmercury in fish from the southern Baltic Sea and coastal lagoons as a function of species, size, and region. Toxicology and Industrial Health, 33(6): 503-511. http://dx.doi.org/10.1177/0748233716685647
[19] Kitaev, S.P. (2007). Fundamentals of Limnology for Hydrobiologists and Ichthyologists. Petrozavodsk: Karelian Scientific Center of the Russian Academy of Sciences, 395.
[20] Benson, I., Barnett, B., Helser, T. (2020). Classification of fish species from different ecosystems using the near infrared diffuse reflectance spectra of otoliths. Journal of Near Infrared Spectroscopy, 28(4): 224-235. http://dx.doi.org/10.1177/0967033520935999
[21] Mohammad Shuhaimi-Othman, M., Yakub, N., Ramle, N., Abas, A. (2015). Comparative toxicity of eight metals on freshwater fish. Toxicology and Industrial Health, 31(9): 773-782. http://dx.doi.org/10.1177/0748233712472519
[22] Lv, H., Xu, W., You, J., Xiong, S. (2017). Classification of freshwater fish species by linear discriminant analysis based on near infrared reflectance spectroscopy. Journal of Near Infrared Spectroscopy, 25(1): 54-62. http://dx.doi.org/10.1177/0967033516678801
[23] Iaria, C., Saoca, C., Guerrera, M.C., Ciulli, S., Brundo, M.V., Piccione, G., Lanteri, G. (2019). Occurrence of diseases in fish used for experimental research. Laboratory Animals, 53(6): 619-629. http://dx.doi.org/10.1177/0023677219830441
[24] Alkan, N., Alkan, A., Gedik, K., Fisher, A. (2016). Assessment of metal concentrations in commercially important fish species in Black Sea. Toxicology and Industrial Health, 32(3): 447-456. http://dx.doi.org/10.1177/0748233713502840
[25] Basim, Y., Khoshnood, Z. (2016). Target hazard quotient evaluation of cadmium and lead in fish from Caspian Sea. Toxicology and Industrial Health, 32(2): 215-220. http://dx.doi.org/10.1177/0748233713498451
[26] Maira, U., Kunsulu, Z., Zinigul, S., Gulmira, B., Gulyaim, A., Alexandr, S., Zhanar, T., Akhan, A. (2020). Diversity and characterization of lactic acid bacteria from Common Carp (Cyprinus carpio L.) intestine in winter (Northern Kazakhstan). Vestnik Tomskogo Gosudarstvennogo Universiteta, Biologiya, (52): 34-47. https://doi.org/10.17223/19988591/52/2
[27] Shcherbak, V.I., Yakushin, V.M., Pligin, Yu.V., Korneychuk, N.N. (2007). Biotic components in the fouling of various substrata in the regulated and non-regulated sections of the river. Hydrobiological Journal, 43(6): 23-39. https://doi.org/10.1615/HydrobJ.v43.i6.20