Ecological evaluation of natural water bodies in the south part of Noginsky Region Moscow District

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Abstract. Floristic composition of terrestrial and aquatic plants in the ecotopes of surface water bodies, Blue Lakes and Lake Biserovo, was studied to assess environmental health of aquatic ecosystems in the Moscow region. The research was carried out both in the field and in the laboratory. Blue Lakes were lacking aquatic vegetation and the dominant synusia of the following plant species was found along the coastal zone: meadow clover (Trifolium pratense L.), meadow bluegrass (Poa pratensis L.), sedge coastal (Carex riparia Curt.), chamomile (Matricaria chamomilla L.), plantain (Plantago major L.), Timothy meadow (Phleum pratense L.). The vegetation cover of Lake Biserovo was patchy: submerged vegetation was most widespread, Canadian Elodea (Elodea canadensis Michx.) was the dominant species. Pure thickets of vegetation were formed only by the common American water plantain (Alisma plantago-aquatica L.), lake cattail (Schoenoplectus lacustris L.), common reed (Phragmites communis Trin.) and sedge coastal (Carex riparia Curt). It should be noted that in all the studied water bodies, the pH of the water area can be classified as very clean: Blue Lakes (7.8), samples from Lake Biserov (8.32). Water samples from Lake Biserova had the highest turbidity (11.5), which was associated with the accumulation of particles of the silt fraction of the reservoir, which began the process of eutrophication, high anthropogenic load. According to the results of a comprehensive assessment (hydrological indicators, calculation of the Mayer index) of the studied samples from the reservoirs, it was concluded that the water area of the Blue Lake had the best environmental status in the Noginsk region.

Keywords: Mayer index, overgrowth of the water area, turbidity, organoleptic indicators, biotesting of the water area, eutrophication

1. Introduction

The hydrosphere is part of the biosphere. The ecological state of small and large water areas in regions, regions, countries directly reflects the level of anthropogenic pressure on a single ecosystem. In the world from the point of view of ecology, the problem of preserving water sources, as well as their restoration to the level preceding the negative anthropogenic impact, is of particular importance.

Of course, the rivers and lakes of the Moscow region do not have such pollution as Indian river Ganges [1-5], but this does not remove the environmental problem for aquatic ecosystems under anthropogenic impact. Anthropogenic water pollution and the resulting consequences are reflected in scientific reviews [6-8]. Of course, these articles contain survey results for large aquatic ecosystems.

The presented results for the Noginsk district reflect the state of small water areas. These studies were carried out in the system of impact monitoring with the aim of eliminating the "white spots" in
the system of state environmental monitoring of the Moscow region. The total number of lakes in the
Moscow region exceeds two thousand. Their total area is more than 130 square kilometers. Significant
in size water bodies (with depths up to 40 m) make up about 350, and their total area reaches 78
square kilometers [9]. All lakes are classified into oligotrophic, mesotrophic, eutrophic, dystrophic
[10]. Our studies will help to supplement the characteristics of small water areas of this region [11]
and to identify the degree of environmental stress experienced by aquatic ecosystems presented in this
paper.

2. Research methods
Studies were conducted on a group of indicators:
- Organoleptic indicators;
- Indicators of organic pollution (ammonia nitrogen (ammonia) and nitrites, dissolved oxygen and
permanganate oxidation);
- General indicators

Organoleptic indicators include hydrogen (pH), color, turbidity, and odor. Method for
determination of pH with RD 52.24.495-2005. Method for determining color - GOST 31868 - 2012
Water. Methods for determining color» (method for photometric determination of color. (GOST - here
and beyond - State standard). The method for determining turbidity is GOST 3351-74 Drinking water.
Methods for determining taste, smell, color and turbidity. The method is based on comparing the
optical density of the analyzed water samples with the optical density of standard turbidity suspensions
by photometric determination». The method for determining odor is GOST 3351 - 74 Drinking water.
Methods for determining taste, smell, color and turbidity. The method for determining the mass
concentrations of ammonia and ammonium ions (total) in water GOST 33045-2014 Methods for the
determination of nitrogen-containing substances. Method for determination of nitrite content in water
- GOST 33045-2014 “Methods for determination of nitrogen-containing substances. Method for
determination of permanganate oxidizability in water - GOST R 55684 - 2013 “Drinking water.
Method for the determination of dissolved oxygen in water - PND F 14.1: 2: 3: 4.123-97 GOST R
8.754-2011 Dissolved oxygen analyzers. The method for determining alkalinity in water is GOST
31957-2012 Methods for the determination of alkalinity and mass concentration of carbonates and
bicarbonates. Method for determination of total hardness in water - GOST 31954 - 2012 Drinking
water. Methods for determining stiffness. The ecological state of the water was assessed using the
Mayer index [12].

3. Results and discussion
The beginning of our research was the description of the floristic composition of terrestrial and aquatic
plants in the ecotopes of surface water bodies: Blue Lakes, Biserovo Lake.

Blue Lake is located in the Noginsk region. Another name is Esinskoe ponds, near the village of
Esino - Nosovikhinskoe highway, 37 km from the Moscow ring road (MRR).

Biserovo Lake is located directly next to the village of Kupavna.

3.1. Blue Lakes
The structure of the floristic composition in the coastal ecosystem was dominated by the following
plant species synusia: meadow clover (Trifolium pratense L.), meadow bluegrass (Poa pratensis L.),
sedge coastal (Carex riparia), chamomile (Matricaria chamomilla L.), plantain (Plantago major L.),
timothy grass (Phleum pretense L.). Aquatic vegetation: not found

3.2. Biserovo Lake
The vegetation cover is not continuous, the most widespread is submerged vegetation, among which
Canadian Elodea (Elodea canadensis Michx.) predominates. Pure thickets of vegetation are formed
only by the common American water plantain (Alisma plantago-aquatica), lake cattail
(Schoenoplectus lacustris L.), common reed (Phragmites communis Trin.), and sedge coastal (Carex riparia Curt.).

Wetland vegetation is found in swampy areas of the coast and in shallow waters. The dominant are the formations (Alisma plantago-aquatica L.), lake cattail (Schoenoplectus lacustris L) and sedge coastal (Carex riparia Curt.), less common the spreading «Spiralis» (Juncus effuses L.), field horsetail (Equisetum arvense L.).

There is a pondweed (Potamogeton natans). Elodea Canadensis is the most powerful association of higher aquatic vegetation on Lake Biserovo.

The electronic resource notes that Lake Biserovo, which bears the status of a natural monument of regional significance, is the closest relict lake to Moscow. Its area is nearly a square kilometer, it is shallow and therefore well warmed up [11,13].

The research results are presented in tables that reflect environmental and hydrochemical indicators, which in general allows a comprehensive assessment of the reservoir as an environmental unit of the biosphere complex. Table 1 contains the organoleptic indicators of water in 2 reservoirs of the Noginsky district.

In terms of pH, the water area can be classified as very clean: Blue Lakes (7.8), and objects according to samples from Lake Biserovoy (8.32) should be classified as clean in terms of pH.

Water samples from Lake Biserovoy (11.5) have the highest turbidity, which is associated with the accumulation of particles of the silt fraction of the reservoir, which began the process of eutrophication, high anthropogenic load.

Table 1. Organoleptic indicators (Moscow region, Noginsky district).

| Indicators | 1. Blue Lakes | 2. Biserovo Lake | Gradation characteristic |
|------------|---------------|------------------|--------------------------|
| pH         | 7, 8          | 8, 32            | 6.5-8 are very clean; 6.5-8.5 clean; 6.0-9.0 moderately contaminated; 9-10 contaminated; 10-11 are dirty; 11-13 are very dirty |
| Turbidity* | 2, 5          | 11, 5            | norm not standardized |
| Color **   | 7             | 13               | norm not standardized |
| Smell      | fish          | earthy, seaweed  | weak, only when heated |
| Smell (in points) | 1 | 3 | 1-very clean; 2-clean; 3-moderately contaminated; 4-polluted; 5 dirty; over 5 very dirty |

* turbidity on the formazine scale
** degrees of color

The most environmental favorable conditions for the analysis of organoleptic indicators have been identified in the Blue Lakes. The ecosystem of blue lakes can be classified according to the results of initial studies to the water area as very clean, because the turbidity is 2.5, the color is 7, and the smell is felt only when heated. Organic pollution indicators are presented in table 2.

Table 2. Organic pollution indicators in the studied water samples (Moscow region, Noginsky district)

| Indicators | Objects of study 1 | Objects of study 2 | Gradation characteristic |
|------------|--------------------|--------------------|--------------------------|
| Ammonia (ammonium ion), mg l^-1 | 0, 145 | 0, 47 | Very clean -0.05; pure 0.1; moderately polluted 0.2-0.3; |
According to the ammonia content, the lowest value was noted in samples from the Blue Lakes (0.145mg L⁻¹). Based on the analysis of water samples from the examined water areas, we can conclude that the samples from Lake Biserova are the most polluted.

Table 3 presents the general indicators of water quality (salt composition). An analysis of water samples taken from the water areas allows us to conclude that the water from Lake Biserova has high natural hardness, which is probably due to the presence of high concentrations of carbonate - calcium and magnesium ions in the water.

Thus, the water from the waters of the Blue Lakes is undoubtedly valuable, and the object itself can be classified as a natural and strategic reservoir of clean fresh water.

Bioindication method using the Mayer index (Figure 1).

**Figure 1.** Moscow region, Noginsky district.

### 3.3. Blue Lakes

In the water area of the Blue Lakes, the following species were found: spring larvae (Plecoptera), clam bivalve (Unionidae), mayfly larvae (Ephemeroptera), caddis larvae (Trichoptera), circular coil (Planorbidae vortex), keel coil (Planorbidae carinatus), and dragonfly larvae (Sympecma paedisca), common pond (Lymnaea stagnalis), lapworm larvae (Sialis lutaria).

\[ Z = A \cdot 3 + B \cdot 2 + C \cdot 1 = 5 \cdot 3 + 3 \cdot 2 + 1 \cdot 1 = 22 \]
In the water area of Lake Biserovo, the following were discovered: cyclops (Cyclopidae), clam single leaf (Lymnaea stagnalis), spring larvae (Plecoptera), river live-bearer (Viviparus contectus), common toothless (Anodonta cygnea), clam bivalve (Unio pictorum), keel coil (Planorbidae carinatus).

\[ Z = 3 \cdot A + 2 \cdot B + C \cdot 1 = 3 \cdot 3 + 2 \cdot 2 + 1 \cdot 1 = 14 \]

In the scientific literature, materials of environmental studies on Lake Biserovo have not yet been published, which is why these studies are relevant and it is necessary to create a program of monitoring studies in the small and unique aquatic ecosystems of the Noginsky region.

4. Conclusion
According to the results of a comprehensive assessment (hydrological indicators, calculation of the Mayer index) of the studied samples of reservoirs, it was proved that the water area of the Blue Lake has the best environmental condition. Based on the analysis of water samples, it should be noted that the water area of the Blue Lakes belongs to the reservoirs of the best ecological state - the dissolved oxygen content is 8.7 mg l⁻¹, and permanganate oxidation is 3.4 mg l⁻¹, and compared to samples of Lake Biserova (7.1 mg l⁻¹) this indicator is significantly less. According to the results of the calculation of the Mayer index for the examined reservoirs, the lowest pollution index was obtained in the conditions of the Blue Lakes (Im-22) (Figure 1).

Acknowledgements
I would like to express my profound appreciation to Dr. Dmitri Andreev for help with English translation of this paper. And also, to graduates of the Timiryazev Academy E. Oleinikova and E. Kashirsky.

Reference
[1] Chaudhary M and Walker T R 2019 River Ganga pollution: Causes and failed management plans (correspondence on Dwivedi et al. 2018. Ganga water pollution: A potential health threat to inhabitants of Ganga basin. Environment International 117, 327–338) Environ. Int. 126 202-6
[2] Del Bello L 2018 Indian scientists race to map Ganges river in 3D Nature 560 149
[3] Dwivedi S, Mishra S and Tripathi R D 2018 Ganga water pollution: A potential health threat to inhabitants of Ganga basin Environment International 117 327-338
[4] https://www.bbc.com/news/magazine-28112403
[5] Rawat M, Ramanathan A L and Subramanian V 2009 Quantification and distribution of heavy metals from small-scale industrial areas of Kanpur city, India J. Hazardous Mate. 172 1145-9
[6] WWAP 2017 The United Nations World Water Development Report (Paris: United Nations Educational, Scientific and Cultural Organization)
[7] Zhang W, Jiang F and Ou J 2011 Global pesticide consumption and pollution: with China as a focus Proc. Inter. Academy of Ecology and Environmental Sciences 11(2) 125–44
[8] Donat-P H, Anastazia T B, Virginia E V, Maite A N, Raúl A G and Helbling E W 2020 Anthropogenic pollution of aquatic ecosystems: Emerging problems with global implications. Sci. Total Environ.713 136586
[9] Wagner B B 2003 Lakes near Moscow region. Directory of local historian, fisherman and tourist (Moscow: Moscow Lyceum) p128
[10] Wagner B B and Dmitrieva V T 2004 Lakes and reservoirs in the Moscow region (Moscow: Moscow State Pedagogical University Faculty of Geography) p 105
[11] Kuznetsova M A and Subbotina Yu M 2011 Brief physical and geographical characteristics of Lake Biserovo Sat. student articles 5 52-8
[12] Abakumov V A, et al. 1992 Guidelines for Hydrobiological Monitoring of Freshwater Ecosystems (SPb: Gidrometeoizdat) p 318
[13] http://www.priroda.ru/reviews/detail.php?ID=11788