Ecological monitoring of overgrowing of the GRES reservoir

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**Abstract.** Hydrobiological monitoring is currently widely used in the study of the water quality of cooling ponds of thermal power plants. With a high level of anthropogenic load, overgrowing gives a reliable integral result of the overall ecological condition of the reservoir. However, there is insufficient volume of actual field studies and their analytical processing in the scientific literature. In this study, an analysis of the ecological state of the object overgrowing was carried out, the main types by seasons were determined and the relationship with anthropogenic activity was established. The study showed an insignificant area of overgrowing of the reservoir surface, as well as the absence of a positive effect from the placement of biomodules. The research results expand knowledge about pond overgrowing, and can also be useful to a wide range of environmental specialists.

1 Introduction

The Iset lake-type reservoir is located in Verkhniaia Pyshma district in the north of Yekaterinburg, its distance from the latter is 37 km (by road) and has good access roads. Iset is a shallow, well-heated reservoir, used as a cooler for Sredneuralskaya GRES.

Hydrobiological studies included selection for the following indicators: phytoplankton; zooplankton; zoobenthos; toxicity. 90 samples were selected for the research [1-4].

2 Materials and methods

Hydrobiological studies were conducted by accredited scientific laboratories. The author’s team carried out analytical processing of research results [5-10].

Temperature measurements were made and the species composition of supreme aquatic plants was evaluated at 29 sites of the Iset reservoir water area, control over the operation of the biomodule was carried out, temperature measurements were made and the species composition of supreme aquatic plants was evaluated.

Acute and chronic toxicity of the waters was assessed following a certified methodology using a synchronous culture of entomostracan *Daphniama magna Straus* as a test object. The

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The biotesting method is based on the determination of changes in survival, fertility, and physiological state in the analyzed sample (experiment) and cultivation water (control).

**The work objective** is to collect and analyze data from hydrobiological monitoring of the reservoir to control the water quality of the Iset reservoir and the discharge channel of the Sredneuralskaya power plant (SUGRES).

### 2.1. Research Object

The Iset reservoir was chosen as the object of research. Reservoir at the source of the lake Isets–r. Iset was created in 1725. The average annual amplitude of water level fluctuation is 41 cm, in certain years it reaches 90 cm.

To study the species composition of phytoplankton, the sedimentary method of sample concentration was used. The biomass of algae was determined by the calculation method. Species, varieties, and forms of algae were identified according to domestic determinants and reports of foreign authors [11-15].

### 3. Results and discussion

The research results are summarized in a single Table 1.

During the period of maximum development of macrophytes according to the existing methodology, the species composition of supreme aquatic plants, the distribution of macrophytes in the reservoir and the phytomass of submerged macrophytes were evaluated. As a result of the analysis of temperature data on the reservoir, 3 temperature zones can be distinguished: warm (the area from the Chernaya river to the Tepliy Bay – the area of discharge of warm waters from SUGRES); cold (the area of the dam and Krasnenkiy island) and moderate (the area of SUGRES water intake).

Supreme aquatic vegetation in the Iset reservoir is represented by a large species diversity, 32 species have been found. Aquatic vegetation is mainly distributed in shallow pre-estuarine areas, as well as in the northern and north-western lowland, swampy coastal zones of the reservoir. Three main successions of aquatic plants are clearly traced:

- **Surface:** *Menyanthes trifoliata, Turha latifolia, Schoenoplectus lacustris, Hippuris vulgaris, Butomus umbellatus, Acorus calamus, Sagittaria sagittifolia, Phragmites australis, Alismat lantago-aquatica, Glyceria maxima, Callitriche palustris, Carex.*

- **With floating leaves:** *Nuphar lutea, Nymphaea alba, Muriophyllum spicatum, Hydrocharis morsus ranae, Rhersicaria amphibia, Ranunculus aquatilis, Potamogeton natans.*

- **Underwater:** *Stratiotes aloides, Nodeacanadensis, Segatophyllum demersum, Myriophyllum spicatum, Potamogeton crispus.*

#### Table 1. Results of water sample studies.

<table>
<thead>
<tr>
<th>Selection point</th>
<th>Selection place</th>
<th>Season</th>
<th>Temp., °C</th>
<th>Toxicity index</th>
<th>Taxonomic structure of algae (total)</th>
<th>Phytoplankton biomass g/m³</th>
<th>Zooplankton biomass g/m³</th>
<th>Biomass of zoobenthos g/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mouth of discharge channel</td>
<td>Spr</td>
<td>17.0</td>
<td>6.17±1.85</td>
<td>51</td>
<td>97.12</td>
<td>0.122</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sum</td>
<td>27.2</td>
<td>5.20±1.56</td>
<td>64</td>
<td>40.35</td>
<td>0.632</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aut</td>
<td>20.2</td>
<td>8.50±2.60</td>
<td>64</td>
<td>29.98</td>
<td>0.802</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>BNS-1 water intake</td>
<td>Spr</td>
<td>10.0</td>
<td>4.83±1.45</td>
<td>85</td>
<td>157</td>
<td>0.461</td>
<td>5.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sum</td>
<td>24.2</td>
<td>5.57±1.67</td>
<td>69</td>
<td>41.96</td>
<td>0.891</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aut</td>
<td>16.4</td>
<td>8.5±2.6</td>
<td>79</td>
<td>59.8</td>
<td>0.534</td>
<td>0.72</td>
</tr>
<tr>
<td>3</td>
<td>Dam</td>
<td>Spr</td>
<td>12.5</td>
<td>5.67±1.70</td>
<td>64</td>
<td>62.96</td>
<td>0.372</td>
<td>-</td>
</tr>
</tbody>
</table>

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and reports of foreign authors [11-14]. In certain years, it reaches 90 cm.

The Iset reservoir was chosen as the object of research. Reservoirs at the source of the lake Iset–r. Iset was created in 1725. The average annual amplitude of water level fluctuation is 54-58 cm, in certain years, it reaches 90 cm. The research results are summarized in a single Table 1.

Table 1. Resultsof water samples studies.

<table>
<thead>
<tr>
<th>No.</th>
<th>Site name</th>
<th>Dominant plant species</th>
<th>Phytomass, kg/m²</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>warm zone, coastal</td>
<td>reed, cattail, sedge</td>
<td>12.7</td>
</tr>
<tr>
<td>2</td>
<td>warm zone, littoral</td>
<td>cow lily, pondweed</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>water intake, coastal</td>
<td>reed, cattail</td>
<td>7.8</td>
</tr>
<tr>
<td>4</td>
<td>water intake, littoral</td>
<td>cow lily, water pepper (joint weed)</td>
<td>2.9</td>
</tr>
<tr>
<td>5</td>
<td>cold zone, coastal</td>
<td>reed, cattail, cane, sedge</td>
<td>10.2</td>
</tr>
<tr>
<td>6</td>
<td>cold zone, littoral</td>
<td>cow lily, water pepper, pondweed, water soldier</td>
<td>3.9</td>
</tr>
</tbody>
</table>

On average: littoral 10.2

Table 2. Dominant plant species on the studied sites.

<table>
<thead>
<tr>
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On average: littoral 10.2

3.1. Territorial location of macrophytes

The largest area of the reservoir was occupied by surface plants, including floating bogs and false shores. Reed beds made up 62% of total area occupied by mesophytes, cattail about 28% and the remaining 10% accounted for cane, sedge, manna grass. Arrowhead, water starwart, calamus, flowering rush, mare’s-tail, water plantain, and buck bean met only once.

Macrophytes growing directly in the water occupied about 27 hectares, or 1.1% of the reservoir’s water area. The main role in these communities was occupied by cow lily, water pepper (joint weed), and pondweed.
Berezoviy, the coast is quite steep – there is no vegetation. Reed and elodea grow at the mouth of the Mulyanka river. In the coastal waters in front of Cape Vesely and before the water intake, the coast is steep, the area is ennobled and there is no higher vegetation on the water. In the water area in front of the intake turbid water with algae, mud about 1mm, visible particles on the surface. On the northeastern part of the shore near the intake and in the water area after the intake, reeds and colonies of water lilies grow, about 20-50 m in diameter, five to seven colonies. In the Tepliy Bay behind the stone island, the water is calm, algae and elodea are visible in the water. In the area of the mouth of discharge channel – a large number of reeds, at the northern shore of the mouth of the discharge channel — four colonies of water lilies, with a diameter of 30-50 m. In the Bay of Lebyazhye near the stone in the water area, clusters of water lilies are visible, further in the direction of Murzinka village colony of cow lilies. In the area of Murzinka village, to the west are also visible reed beds and colonies of cow lilies. At the confluence of the Chernaya river, water lilies occupy one third of the territory of the mouth, reed beds, sphagnum, and cattails are visible along the banks, the water is dark brown. From the Chernaya river to Cape Tolstik there is a reed. In front of the territory of the pioneer camp there are reeds, sphagnum, and cattail. There is no vegetation in the water on the territory of the pioneer camp. Cape Tolstik has steep rocky shores, there is no vegetation as well. Further towards the Solnechniy bereg recreation center, water lilies are found near the shore with a diameter of about 50 m, reeds are found in the bay. On the territory of the recreation center Solnechniy bereg is a lowland, vegetation is not observed. In the coastal waters after Solnechniy bereg in the lowlands there are reed beds. Before reaching the hospital, as well as on its territory, there is no water lily. Reeds, ferns, duckweed are observed outside the hospital. In the water area of the arc in the area of the Kedrovka river and the Iset river, reed and cane grows. On the territory of the dam, reed, cane, and a few water lilies are observed. Reed beds and cane are also visible in the area of the Energetik recreation center.

Control over the operation of the biomodule was carried out in spring, summer, and autumn: in May, July, and September. The highest aquatic vegetation growing in the cages of the biomodule is represented by the following species: reed, manna grass, sedge, water hyacinth. The most common plant is water hyacinth. This species was found in 12 cages of the biomodule and occupied 30% of the cage area in mid-September. The concentration of the remaining macrophytes was no more than 10 m² of the cage area. Herbivorous fish (silver carp) live in the cages of the biomodule.

In May, the fish were three-year-old, by September — four-year-old. In the diet of silver carp, about 90% of the food bolus was phytoplankton and about 10% was detritus. The predominant groups of phytoplankton in the diet of silver carp are blue-green (about 50%), diatomic (25-30%), and green (15-20%) algae.

4. Conclusion

According to research results, toxicity index of all studied samples does not exceed the norm. According to the integrated ecological classification of the quality of surface waters, according to toxicity level, the water quality class is characterized by various indicators as "completely clean", which corresponds to “2b” class of water quality.

Hydrobiological monitoring data indicate a different degree of development of biocenoses in certain areas of the reservoir. The trophic status of the reservoir corresponds to the eutrophic type. Attention should be paid to a significant fluctuation in the development of zoobenthos, the complete absence of which at the mouth of the discharge channel is a signal of trouble.
Supreme aquatic vegetation in the Iset reservoir is represented by a large species diversity, 32 species have been found. Aquatic vegetation is mainly distributed in shallow pre-estuarine areas, as well as in the northern and north-western lowland, swampy coastal zones of the reservoir.

The area of overgrowth of the Iset reservoir was 3.6% of its entire water area, of which: the area of overgrowth of the reservoir with surface vegetation was 2.5%, aquatic vegetation —1.1%.

From herbivorous fish species in the cages of the biomodule, silver carp are grown, whose age is 3-4 years. The growth rate and indicators of fatness of fish can be considered average. Phytoplankton is of primary importance in the nutrition of silver carp.

Excess of hydrochemical indicators, an increase in the number of phytoplankton, a decrease in biomass in the reservoir indicate the absence of a positive effect of bioengineering facilities on improving the ecological condition of the reservoir.

References

12. A.I. Kochetkova, E.S. Bryzgalina, O.V. Filippov, M.S. Baranova, Princ. Ecol. 1(43), 63-73 (2022)