Assessment of the quality of fish habitat in the area of Ulyanovsk CHHP-1

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Abstract. Water - the most important mineral on Earth, which can not be replaced by any other substance. It makes up most of any organisms, both plant and animal. The problem of preserving water quality is at the moment the most urgent. Science knows a lot of pollutants of natural waters, which adversely affects the health of the population, leads to the death of fish, waterfowl and other animals, as well as the death of the plant world of reservoirs. At the same time, not only toxic chemical and oil pollution, but also the excess of organic and mineral substances coming with flushing of fertilizers from fields, are dangerous for aquatic ecosystems. A very important aspect of pollution of the Earth's water basin is thermal pollution, which is the discharge of heated water from industrial plants and thermal power plants into rivers and lakes.

Introduction
Among the natural resources of great importance are the water resources, which are involved in social production in ever-increasing scale. Intensive development of industry, agriculture, population growth are the cause of pollution of water bodies, industrial, agricultural and domestic wastewater are discharged into them [1]. Pollution of reservoirs by sewage can cause sustainable water pollution and adversely affect the fauna and flora of water sources. At the same time, the commercial qualities of fish as a food product deteriorate, young fish and food organisms die, the productivity of water bodies decreases. Pollution of water bodies can affect people's health in the form of infectious diseases and poisonings. Especially dangerous are discharges to the reservoir of untreated or under-treated sewage containing toxic substances [2].

One of the most acute and urgent environmental problems of water reservoirs-coolers of energy facilities is their thermal pollution, which is observed as a result of the receipt of thermally heated water discharged after the cooling of power equipment. There is a so-called “thermal pollution”. The rise in water temperature in the reservoir leads to the growth of blue-green algae, as a result of which the concentration of dissolved oxygen in the water decreases. This is the cause of death of the inhabitants of water bodies that do not tolerate high temperatures. An increase in water temperature can lead to the inhibition of aquatic organisms, and when the food base is limited or the threshold (lethal) temperatures are exceeded, they die [3].

Quality of the aquatic environment by chemical indices
Chemical pollution is the main, both in terms of scale and impact, and causes very great damage to water bodies. The most dangerous chemical pollutants of the environment are heavy metal ions. This
is due, above all, to their high toxicity in relation to hydrobionts and humans. The danger is aggravated by the fact that metals are not subjected to chemical and biological degradation, as is characteristic of organic toxicants, so once they fall into the surrounding environment, they are only redistributed between biotic and abiotic links, changing the form of finding and interacting with different categories of living organisms [4]. The special danger of the accumulation of heavy metals in water bodies is that they are stored permanently under any conditions.

Deterioration of water quality in polluted water bodies has a negative impact on the conditions of feeding, feeding, spawning of fish, reduces the effectiveness of their natural reproduction and, consequently, the population as a whole [5]. There is also a decrease in the quality of processed fish products due to the accumulation of various toxicants in their organisms. Petroleum products, along with heavy metals, are dangerous contaminants in water bodies. They are distinguished by great resistance, due to which they remain in the reservoir for years, without losing their toxic properties [6].

The ability of reservoirs to self-purification is not unlimited, and their protection from pollution is impossible without the maximum neutralization of sewage. If the wastewater were not treated, in a few months the ecosystems of inland water bodies would be completely degraded. Therefore, the discharge of untreated sewage is universally prohibited, the required degree of purification is regulated by law. With the help of physical, chemical and biological methods, waste water at treatment plants is brought to a state that meets certain hygienic and biological requirements. The various substances remaining in the waste water should not be in an amount exceeding the maximum permissible concentration (MPC). Establishment of MPC is conducted taking into account hygienic requirements and interests of ecosystems protection of water bodies [1].

The purpose of the studies, the results of which are outlined in this paper, was to determine the effect of sewage from Ulyanovskaya CHPP-1 on the quality of the river Sviyaga. Water quality was assessed by chemical and hydrobiological indicators. In connection with this, water and soil samples were taken in the river. Sviyaga, as well as hydrobiological tests in the spring-autumn period 2016-2017. Samples were collected at different stations above and below the sewage discharge of Ulyanovskaya CHHP-1 (UCHHP-1).

At the beginning of December 1946, the first plant in Ulyanovsk was built at an automobile plant. Over the years, constantly expanding and improving in accordance with the growing needs of the city in heat and electricity, UCHHP-1 has turned into a powerful enterprise. In 1973, UCHHP-1 switched to gas as the main fuel. At present, the installed electric power of UCHHP-1 is 435 MW, the installed heat capacity is 1539 Gcal/h.

In the composition of waste water, a large number of various pollutants are discharged into reservoirs, which are included in the trophic chains and the circulation of substances. Therefore, in order to preserve the environment, sewage treatment plants were put into operation at UCHHP-1. Formation of the hydrochemical regime of the river. Sviyaga occurs under the influence of surface and ground runoff. The oxygen content in the surface and deep horizons of the river. Sviyaga did not fall below 4.5-5.5 mgO/l, i.e. corresponded to normative values. Sviyaga refers to rivers with high mineralization (hydrocarbonate character with predominance of calcium ions in the salt composition). Mineralization of the river. Sviyaga ranges from 400-1100 mg/l. The heterogeneity of the chemical composition of water is due to the underground feeding of the river, as well as the influence of tributaries. The average long-term content of organic and biogenic substances in the waters of the Sviyaga River is presented in Table 1.

**Table 1.** Average long-term content of organic and nutrient substances p. Sviyagi, (mg / l).

| Stations | pH | Mineralization | BOD₅ | Chlorides | Sulphates | Nitrogen ammonium | Nitrites | Nitrates | Phosphorus | Iron |
|----------|----|----------------|------|-----------|-----------|-------------------|----------|----------|------------|------|
| 1        | 8.9| 627            | 6.0  | 48.66     | 399.2     | 0.20              | 0.043    | 0.04     | 0.015      | 0.21 |
| 2        | 8.2| 548            | 3.2  | 24.93     | 60.15     | 0.26              | 0.145    | 3.97     | 0.199      | 0.51 |
| 3        | 8.2| 577            | 4.8  | 17.00     | 40.10     | 0.21              | 0.112    | 4.21     | 0.165      | 0.04 |
Note: 1 - the place of production of waste water; 2 - above the output of 100 m; 3 - below the output of 200 m.

In wastewater of various industrial enterprises, including UCHHP-1, a certain amount of pollutants such as heavy metals is contained. In this case, they can accumulate in water, in soils, in hydrobionts, in fish. Average annual concentrations of heavy metals in the water and in the soils of the river Sviyagi are represented in Figures 1 and 2.

![Figure 1](image1.jpg)

**Figure 1.** The average annual concentration of heavy metals in the water p. Sviyagi: 1 - Copper, 2 - Zinc, 3 - Cadmium, 4 - Lead, 5 - Chrome, 6 - Manganese, 7 - Petroleum products.

![Figure 2](image2.jpg)

**Figure 2.** The average annual concentration of heavy metals in the ground r. Sviyagi: 1 - Copper, 2 - Zinc, 3 - Cadmium, 4 - Lead, 5 - Chrome, 6 - Manganese, 7 - Petroleum products.

The analysis of the obtained results showed that in water samples the cadmium content is less than 0.005, and the chromium is less than 0.02, which corresponds to the standards, since the maximum permissible concentration of cadmium in water is 0.005 mg/l, and the MPC of chromium is 0.02 mg/l. Concentration of lead is also within normal limits. The copper content did not exceed the maximum
allowable concentrations of 0.001 mg/l. The content of zinc in water samples was in the range from 0.01 mg/l to 0.017 mg/l, manganese - in the range from 0.01 mg/l to 0.013. Given that the maximum permissible concentration for zinc is 0.01 mg/l, and that of manganese 0.01 mg/l.

Concentration of oil products in the water samples of the Sviyaga River and the discharged waters of the CHP is within the permissible concentrations of 0.04-0.05 mg/l.

There are a large number of standards for the content of pollutants in the bottom sediments of the reservoir. These are background concentrations used in the USA, Belgium, Holland, the Netherlands. There are also such standards, which are offered in Russia on the example of different reservoirs in different regions of the country. But the fact is that the soils are very different in composition. On different reservoirs try to determine their standards of pollutants in the ground. Therefore, it is best to use the norms of those freshwater systems whose soils are similar in composition to the soils of the particular water body under investigation. For several years the Kuibyshev reservoir has been carrying out soil research and establishing certain standards of pollutants in the bottom sediments [7]. The soils of the Kuibyshev Reservoir of the Ulyanovsk Reach are very similar in composition to the soils of the site under study. Therefore, we relied on these proposed standards. Exceeding the maximum permissible concentrations of the metals under investigation in soils is not observed.

Thus, in the samples of water and soil r. Sviyaga in the area of Ulyanovsk CHHP-1 there are certainly certain polluting substances, but their content does not exceed the maximum permissible concentration.

Quality of aquatic environment by hydrobiological indicators

Along with the chemical characteristics of water, samples of hydrobiological indicators (phytoplankton and zooplankton) and the quality of the waters was determined.

As you know, water is an essential component of human life. The impact of sewage discharged into reservoirs adversely affects both the inhabitants of reservoirs and humans. Pollution of water bodies strongly affects the species composition of living organisms. Disappearing ambitious species, and there are organisms that are characteristic of contaminated sites. As a result, the productivity of the fodder base of fish is undermined, which in turn leads to further profound consequences. At present, the quality control of surface waters by hydrobiological indicators has been widely applied [8].

In the practice of ranking the level of water pollution, an integrated biological indicator of species diversity (IVR) is widely used - the Shannon index. Therefore, the quality of water in the investigated plots by phytoplankton was determined with the help of this index. The degree of water pollution, characterized by the index of saprobity, was also determined. For this, the method of indicator zooplankton organisms according to Pantle and Buk in the modification of Sladechek was applied [8].

The species diversity of the zooplankton community in September is small in the areas studied. Indices of species diversity vary at different stations from 0 to 2 (in number) and from 0 to 2.8 (biomass). The average values of the indices in the sector are 1.05 ± 0.18 in number and 0.75 ± 0.22 in terms of biomass.

The average saprobity index (by number) in the studied water area is 1.53 ± 0.06, which corresponds to the mesosaprobic zone, moderately polluted degree, to the III class of water quality. In general, the index values at different stations vary from 1.3 (oligosaprobic zone) to 2.1 (mesosaprobic zone).

The species diversity of the zooplankton community in October is very low. Indices of species diversity vary at different stations from 0 to 2.32 (in number) and from 0 to 1.62 (by biomass). The average values of the indices in the sector are 1.05 ± 0.041 in number and 0.81 ± 0.35 in terms of biomass. According to the study area, the saprobity index (by number) is 1.75 ± 0.08, which corresponds to the -mesosaprobic zone, the moderately polluted degree, the III class of water quality (Table 2).
Table 2. Integrated indicators for determining water quality.

| №/№ | Index of species diversity in Shannon | Index of saprobity for Pantle and Buk | Zone saprobity | Characteristic quality water |
|------|-------------------------------------|---------------------------------------|----------------|-----------------------------|
| 1    | 2.69                                | 2.21                                  | β-α- mesosaprobic | Moderately polluted - contaminated |
| 2    | 2.30                                | 1.57                                  | β- mesosaprobic | Moderately polluted          |
| 3    | 1.32                                | 1.55                                  | β- mesosaprobic | Moderately polluted          |
| 4    | 2.18                                | 1.55                                  | β- mesosaprobic | Moderately polluted          |
| 5    | 2.37                                | 1.55                                  | β- mesosaprobic | Moderately polluted          |
| 6    | 1.93                                | 1.50                                  | oligosaprobic   | Pure                        |
| 7    | 1.62                                | 1.55                                  | β- mesosaprobic | Moderately polluted          |
| 8    | 1.90                                | 1.37                                  | oligosaprobic   | Pure                        |
| 9    | 1.94                                | 1.64                                  | β- mesosaprobic | Moderately polluted          |

Thus, the values of the IWR at different sampling stations in the fall period are in the range 0.18-1.62, and the index of saprobity varied from 1.3 to 2.1. The waters are characterized as “moderately polluted” and belong to the third class of water quality.

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