Fluctuation of the values of the qualitative characteristics of reservoirs in the Saratov region during the growing season

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Abstract. The article presents the results of determining the quality indicators of water from several ponds No. 3 (drain), No. 4 (non-drain), No. 8 (drain) Privolzhsky branch of the Federal State Budgetary Institution "Management "SARATOVMELOVODKHOZ" of the Marksovsky district of the Saratov region. In the course of the studies carried out, it was revealed that during the growing season, under the influence of fish-breeding processes and the ability of reservoirs to self-purification, as a result of the vital processes of various hydrobionts, the chemical and microbiological characteristics of water changed for the better.

Introduction. Our country is characterized by a wide variety of different conditions, including hydrological and climatic, which entails different types of environmental management, as well as differences in the intensity of development. Currently, there is a progressive deterioration in the quality of the aquatic environment, which is a threat to Russia's vital national interests in the areas of environmental, food and national security. Environmental protection has recently become of world importance. Pollution of water resources, atmospheric air, soil and vegetation occurs due to urbanization and intensification of industrial and agricultural production. More than 1900 rivers flow through the territory of the Saratov region, there are 3800 reservoirs, 32 underground water deposits and about 700 lakes. Their distinctive features include a small area, often-changing outlines and volumes. The sustainability of food production is increasingly ensured by the rational and efficient use of water resources and methods of their conservation, consisting mainly in the development and organization of irrigation, including the rational development of water resources for dry farming, water supply for livestock, inland fisheries and agroforestry. Achieving food security is one of the top priorities for many states, and agriculture should not only provide food for the growing population, but also contribute to resource conservation and efficient environmental management in various areas.

1. Introduction
The relevance of the study of the reservoir qualitative characteristics is indisputable. Works of many domestic scientists (Kulachenko V.P., Voshkin A.G., Barsukova N.N., Barenboim G.M. et al.) are devoted to this topic. The content of oxygen, sulfates, nitrates, nitrites, pH, and water hardness in ponds must meet certain requirements, since the farmed fish is in constant interaction with the aquatic environment. At the same time, during the season, water quality characteristics are subject to significant fluctuations as a result of fish-breeding processes. In this regard, it is necessary to trace the changes taking place in the intensively exploited fish-breeding reservoirs of the IV fish-breeding zone. In the growing season of 2020, research was carried out on the chemical and microbiological
indicators of the water of several ponds: No. 3 (drain), No. 4 (non-drain), No. 8 (drain) of the Privolzhsky branch of the FGBU "Saratovmeliiovodhoz" of the Marksovsky district of the Saratov region. Water sampling was carried out throughout the entire growing season of 2020. The ponds were fed by melt water and the Volga River. The water from the ponds is drained into the Karaman River.

2. Materials and methods
The study objects were water samples from different places of reservoirs, collected by the side (sample No. 1), on the surface (sample No. 2) and near the bottom in the center of the reservoir (sample No. 3), in accordance with the relevant environmental regulations of the Federal level (PND F).

Samples were collected, preserved and stored in accordance with GOST R 5192-2000. During the research, the most important indicators of water (temperature, pH, dissolved oxygen content) were analyzed according to generally accepted methods. The oxygen content and hydrogen index (pH) were measured using a Samara-3pH thermooximeter and a pocket pH-meter, the depth of the reservoir was investigated with an echo sounder.

The concentration of biogenic elements (nitrites, nitrates, ammonium nitrogen, phosphates) was evaluated according to the "Instruction for the chemical analysis of pond water" (VNIIPRKh, 1984).

3. Results and Discussion
In pond No. 3, during the entire growing season, water hardness indicators had optimum values. The iron content at the beginning of the season was at the MPC level; then, in the process of utilization by aquatic organisms, it decreased by July and increased again by the end of the season (table 1).

| Index                                    | Month          | MPC    |
|------------------------------------------|----------------|--------|
| Sulfates, mg/dm³                         | May: 30.80±2.16, 13.73±6.46* | | |
| Hardness, mg-equiv/L                     | June: 4.80±0.12, 4.07±0.07*** | 400 |
| Ammonium, mg/dm³                         | July: 0.012±0.003, 0.005±0.002 | 4.00 |
| Total iron, mg/dm³                       | August: 0.161±0.08, 0.04±0.02 |
| Phosphates, mg/dm³                       | September: 0.617±0.08, 0.42±0.11 |
| Biochemical oxygen demand, mgO₂/l        | October: 2.90±0.3, 3.63±0.19* | 20 |
| Chemical oxygen demand, mgO₂/l           | May: 9.56±0.68, 8.42±0.68 |
| Nitrates, mg/dm³                         | June: 12.03±0.23, 4.74±0.10*** |
| Nitrites, mg/dm³                         | July: 0.023±0.002, 0.017±0.005 |
| Total microbial count, cfu/ml            | August: 210.33±9.33, 438.67±19.23*** |

Note: *Р≥0.95; **Р≥0.99; ***Р≥0.999

The content of phosphates from May to July exceeded the MPC by 3 times, and by October it decreased. In July, an increase in biochemical oxygen demand and chemical oxygen demand was observed. This indicates intensive oxidative processes of organic compounds.
During the entire period, sulfates content was optimum. Only in September–October it is increased sharply due to the water mineral pollution.

During the growing season, the processes of ammonification and nitrification were very intensive, which is confirmed by the optimal values of ammonium and nitrates. In October, due to a decrease in the number of microorganisms, the content of nitrates increased; however, it was still within the MPC limits. In May, a large amount of nitrates was detected, but their content decreased by August, under the influence of nitrification processes, and in September it sharply increased again.

A similar trend was in pond No. 4. The parameters of water hardness and iron content during the growing season were optimal. In October, the iron content reached the MPC level (table 2). The content of microorganisms decreased, which contributed to the increase in iron content in the water.

### Table 2. Basic chemical and microbiological indicators of pond No. 4.

| Index                  | May       | June      | July      | August    | September | October   | MPC       |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Sulfates, mg/dm³       | 49.47±4.39| 7.53±0.41***| 12.33±1.05***| 44.87±4.96| 104.60±2.00| 96.4±12.45| 100       |
| Hardness, mg-eq/L      | 5.20±0.31 | 3.93±0.07***| 3.67±0.12***| 3.37±0.22***| 6.20±0.75 | 6.03±0.89 | 3.0-7.0   |
| Ammonium, mg/dm³       | 0.025±0.013| 0.002±0.001| 0.01±0.002 | 0.002±0.001| 0.013±0.002| 0.003±0.001| 0.5       |
| Total iron, mg/dm³     | 0.070±0.014| 0.065±0.04 | 0.003±0.003**| 0.039±0.001*| 0.056±0.001| 0.100±0.01| 0.1       |
| Phosphates, mg/dm³     | 0.647±0.04 | 0.643±0.05 | 0.733±0.07 | 0.583±0.001| 0.233±0.03*| 0.420±0.26| 0.2       |
| Biochemical oxygen demand, mgO₂/l | 3.35±0.58 | 3.21±0.47 | 4.03±0.10 | 3.41±0.001 | 2.51±0.13* | 3.44±0.12 | 3         |
| Chemical oxygen demand, mgO₂/l | 10.24±1.59 | 10.16±0.98* | 13.35±2.25* | 10.58±0.001 | 10.25±0.48 | 9.25±0.48 | 10-15     |
| Nitrates, mg/dm³       | 13.80±0.17 | 6.21±0.07***| 6.54±1.13***| 2.30±0.001***| 11.36±0.54***| 2.56±0.61***| 40        |
| Nitrates, mg/dm³       | 0.026±0.004| 0.023±0.002 | 0.006±0.001***| 0.007±0.001***| 0.003±0.003***| 0.020±0.047**| 0.08      |
| Total microbial count, cfu/ml | 82.67±9.49 | 112.33±7.37* | 113.33±10.78* | 497.00±0.001*** | 70.33±15.03 | 421.67±52.63*** | 30000*** | 3000       |

Note: *P≥0.95; **P≥0.99; ***P≥0.999

Sulfates content fluctuated strongly from May to October. In May, it was increased; in June and July, under the influence of bacteria, sulfur was assimilated by aquatic organisms, which reduced their amount. However, in September, sulfates content increased due to a decrease in the number of microorganisms. And then, with an increase in total microbial count in October, the content of sulfates in the pond water tended to decrease.

The phosphate content was elevated, but within the MPC level. In September, the phosphate content was the lowest that is caused by active absorption by microorganisms.

Biological and chemical oxygen consumption throughout the season was at an acceptable level, without sharp fluctuations.

The amount of ammonium and nitrite was also within the optimal range. Only in October, the content of nitrates increased, which was due to a decrease in bacteria. It led to a decrease in nitrates content. It should be noted that the amount of nitrates in the water was high and subject to fluctuations, as in pond No. 3, and their minimum content was in August and October.
Sampling from drain pond No. 8 was carried out from May to August, since it was already drained in September (table 3).

Water hardness and iron content were optimal and within the MPC level during May and summer months.

| Index                      | May        | June       | July       | August      | MPC         |
|----------------------------|------------|------------|------------|-------------|-------------|
| Sulfates, mg/dm³           | 79.2±16.63 | 28.33±1.71*** | 40.10±2.54*** | 41.97±2.37*** | 100         |
| Hardness, mg-equ/L         | 4.60±0.00  | 4.5±0.10   | 2.67±0.20*** | 2.28±0.02*** | 3.0-7.0     |
| Ammonium, mg/dm³           | 0.032±0.001| 0.009±0.004*** | 0.026±0.001*** | 0.002±0.001*** | 0.5         |
| Total iron, mg/dm³         | 0.137±0.45 | 0.005±0.005** | 0.109±0.061  | 0.063±0.001 | 0.1         |
| Phosphates, mg/dm³         | 0.467±0.05 | 0.793±0.03*** | 1.667±0.54*  | 0.633±0.001** | 0.2         |
| Biochemical oxygen demand, mgO₂/l | 3.67±0.24 | 3.46±0.14 | 4.65±0.07*** | 3.36±0.001 | 3           |
| Chemical oxygen demand, mgO₂/l | 10.29±0.74 | 7.42±1.46 | 9.10±1.10 | 9.24±0.001 | 10-15       |
| Nitrates, mg/dm³           | 14.59±0.29 | 5.84±0.19*** | 5.61±0.37*** | 1.44±0.001*** | 40          |
| Nitrites, mg/dm³           | 0.014±0.002| 0.009±0.003 | 0.014±0.001 | 0.009±0.001 | 0.08        |
| Total microbial count, cfu/ml | 180.00±13.32 | 494.00±68.53*** | 470.67±33.6±9.44*** | 807.67±0.001*** | 3000000     |

Note: *P≥0.95; **P≥0.99; ***P≥0.999

The amount of sulfates in May after filling the pond with melt water was quite high, then their content in the pond, due to the development of hydrobionts, decreased and slightly increased in summer.

The phosphate content was very high, and in July it even exceeded the MPC limit by 8 times.

The processes of ammonification and nitrification were quite intensive, due to the optimal values of ammonium and nitrites. Only in July, the amount of nitrites increased slightly, which led to a slight increase in biochemical oxygen demand. In other months, the values of biochemical oxygen demand and chemical oxygen demand were at the optimum level.

The content of nitrates in the water of the pond was high in May, then in the summer months it decreased, and in August it reached its optimum.

The total microbial count increased from May to August.

According to the results of studies of the water quality of several ponds No. 3, No. 4, No. 8 of the Privolzhsky branch of the Federal State Budgetary Institution "Administration" SARATOVMELOIOVODKHOZO of the Markovsky district of the Saratov region, a significant content of sulfates and phosphates was noted. However, during mechanical water treatment (sedimentation, filtration, drainage) of ponds, the maximum allowable concentration of sulfates was not exceeded. The subsequent self-purification was the result of the work of bacteria. As a result of their activity, sulfates underwent chemical transformations, and sulfur was assimilated from these salts by hydrobionts. The content of the phosphate index during the growing season decreased due to the absorption by microorganisms and the accumulation of these substances in the polyphosphate form in their cells. Thus, in pond farms due to the flow of physical, chemical and biological processes with the participation of hydrobionts, water was subjected to self-purification and fishery activities did not have a negative impact on water quality. In this regard, the importance of maintaining the ratio and vital activity of hydrobionts at the optimal level in the biocenosis of fish ponds is indisputable in order to activate the self-purification of the aquatic environment.
4. Conclusion

As a result of the research, it can be noted that during the growing season there was an improvement in the chemical and microbiological characteristics of water in ponds. This is due to the ability of reservoirs to self-purify due to the vital processes of various aquatic organisms.

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