Changes in the value of the Volga-Sviyazhsky area for fish reproduction the largest reservoir in Europe - the Kuibyshev reservoir

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Abstract. To estimate the current significance of the area for fish breeding, the species composition and abundance of young-of-the-year of the coastal zone of the Volga-Sviyazhsky area of the Volga stretch of the Kuibyshev reservoir for 2021, 2022 were considered. The work to assess the species composition and abundance of the young fish was carried out at 7 coastal stations, at depths less than 2 meters. The number of young-of-the-year was calculated per unit of effort of the fingerling seine. Species diversity was assessed using the Shannon-Weaver index. Young of 23 fish species were identified, which confirms the reproduction of these species in the study area. Observational data are compared with earlier materials from 1993-2020. A trend towards an increase in the relative abundance and the species diversity of the young of fish, mainly due to low-value species, was noted. At the same time, in 2022, a relatively high abundance of the young, the main commercial species of the reservoir, the bream, was revealed.

1 Introduction

The Kuibyshev reservoir was created in 1955–1957, after the Volga River was blocked by a hydroelectric dam in the Zhiguli Mountains [1]. This reservoir has a multi-purpose use and is the largest not only in the European part of Russia, but also in Europe [2,3]. The reservoir has an important fishery value: 30 species are mastered by fishing, the main ones are such valuable ones as bream, pikeperch, carp, pike, european catfish, sterlet; less valuable fish are common kilka, roach, silver bream, blue bream, ziege, golden carp, ide, asp, bleak, white-eye bream, silver carp, burbot, perch, volga pikeperch and others. Commercial stock of aquatic biological resources of this reservoir in 2000–2020 ranged from 29.2 to 37.2 thousand tons, and the catch - from 2.8 to 4.2 thousand tons [4]. In the reservoir the reproduction efficiency for many fish species is determined by the level and temperature regimes during the spawning season [5, 6]. At the same time, it was noted that the importance of different sites of the reservoir for reproduction is not the same and may change over time [7,8]. In this regard, areas where monitoring the efficiency of reproduction are carried out

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regularly are of particular interest. These include the Volga-Sviyazhsky area at the upper part of the Volga stretch of the reservoir. This area includes parts of the Volga, Sviyaga origin, as well as the flooded Volga-Sviyaga floodplain. Evaluation of the efficiency of reproduction of fish stocks is a key component of fisheries research. One of the approaches to studying the efficiency of reproduction is to consider the qualitative and quantitative indicators of young of the current year. In addition to the state of reproduction, the study of juveniles allows you to get a more complete picture of the species diversity of the ichthyofauna. A significant number of species can be found as juveniles, due to the small size of adults or their rarity.

2 Materials and methods

Material was collected using common methods [9]. The work to assess the species composition and abundance of the young fish was carried out in the first half of September 2021 and 2022 at 7 coastal stations, at depths less than 2 meters. Catching was carried out with fingerling seine (12.5 m, mesh in the wings 5 mm, in the bag - 2.5 mm) and gauze seine (3 m, gauze No. 10). The number of young-of-the-year was calculated per unit of effort of the fingerling seine. Species diversity was assessed using the Shannon-Weaver index [10]. To estimate the current significance of the area under consideration, the data obtained were compared with similar materials from 2017-2020 and earlier period 1993-1998. These materials were collected were collected by the authors at the same stations using the same methods and partially published earlier [7,8].

3 Results and discussion

The species composition of young-of-the-year fish in the study area is represented by 23 species, which confirms the reproduction of these species in the study area. Currently, 60 species of fish are found in this reservoir [4]. Not all fish species spawn in the coastal zone. In addition, juveniles of some fish species in the first year of life live near the shore. Therefore, it is quite natural that such fish species cannot be identified in the course of such studies. It is necessary to take into account the behavioral characteristics of some fish species. Such species of fish as bream, bream, pikeperch, volga pikeperch in the autumn after feeding from the coastal area migrate to the depth, while perch, roach and pike are characterized by living in the first year of life near the coast [6]. The young-of-the-year fish belonged to 6 families, two of which, Gobies and Pipefishes, included only alien species. The species abundance of the two considered years was not the same, which indicates a significant influence of the conditions of a particular year on reproduction.

In 2021, 15 species were encountered, in 2022 - 20 species (table.1). In the 1990s, the species abundance in September in this area did not exceed 11 and the average was 9.7. The average number of species over the period 2017-2022 was higher at 15.3. Species diversity, as assessed by the Shannon-Weaver index, was high. The index was 2.55 for 2022 and 2.64 for 2021, indicating a relative evenness in the ratio of different species, compared to an average of 1.8 during the period under review in the 1990s. One of the factors for the increase in the number species of young-of-the-year fish in the coastal area at present, compared with earlier observations, is active bioinvasive processes [11]. At the beginning of the current century, self-reproducing populations of all encountered species of gobies appeared.

Average numbers of young-of-the-year fish according to juvenile surveys in 2021-2022 (Fig.1) differ greatly, but at the same time, comparisons of the results of the two periods indicate a general trend towards an increase in the number of young-of-the-year fish. Numbers of the young were highest in 2022. One of the main abiotic factors influencing the yield of juvenile fish under conditions of regulated flow for most species is the water level

regime. At the same time, it should be emphasized that this year in terms of water level regime did not belong to the most favorable for breeding of the first type according to the typification of V.A. Kuznetsov [6,12].

Table 1. Species composition young-of-the-year fish in the coastal area of the Volga-Sviyazhsky area in 2021, 2022

species	year	
	2021	2022
Family Cobitidae		
Cobitis taenia	-	+
Family Cyprinidae		
Abramis ballerus	-	+
Abramis brama	+	+
Alburnus alburnus	+	+
Aspius aspius	+	+
Blicca bjoerkna	+	+
Carassius gibelio	+	+
Leucaspius delineatus)	-	+
Leuciscus cephalus	-	+
Leuciscus idus	-	+
Leuciscus leuciscus	-	+
Pelecus cultratus	+	-
Romanogobio albipinnatus	-	+
Rutilus rutilus	+	+
Scardinius erythrophthalmus	+	+
Family Gobiidae		
Neogobius melanostomus	+	+
Neogobius iljini	+	+
Proterorhinus nasalis	+	+
Family Esocidae		
Esox lucius	+	-
Family Percidae		
Gymnocephalus cernuus	+	-
Perca fluviatilis	+	+
Sander lucioperca	+	+
Family Syngnathidae		
Syngnathus abaster	-	+
Total	15	20

According to this classification, three main types of water level regime are distinguished. Type I water level regime is characterised by years in which, during the spring flood, the

water level was above the absolute level of 53 m (normal level) and then gradually declined. These years are considered to be the most favourable spawning years for most fish species. Type II water level regime includes years characterised by a relatively low water level in May and early June up to the absolute mark of 53 m, followed by an autumn-winter decrease. Reproduction efficiency in such years varies, but in general it is estimated as average. Type III is characterised by falling water levels throughout the year and is inefficient for reproduction. The high yield of juveniles in 2022 can be partly explained by the coincidence of warming and rising water levels.

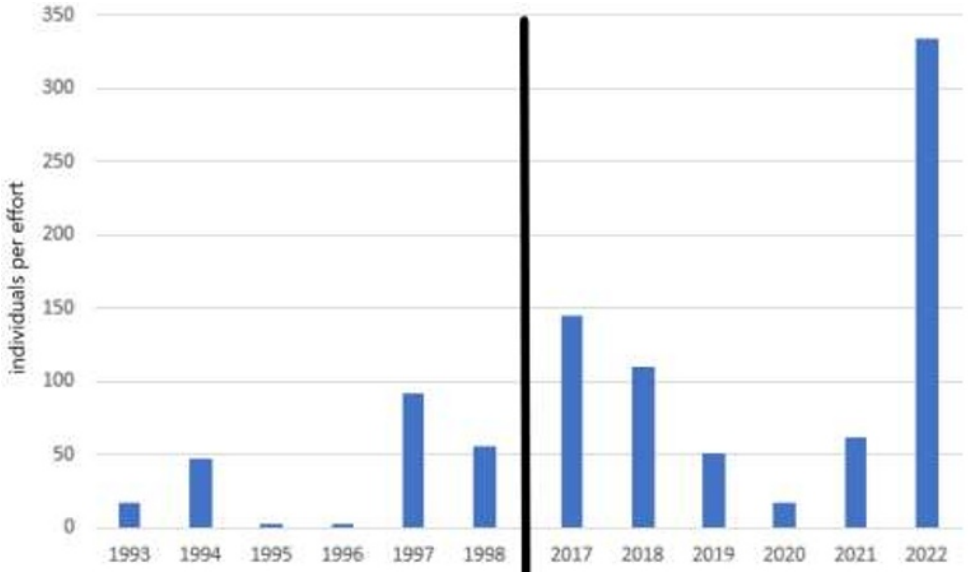

Fig.1. Numbers of young-of-the-year per effort (fingerling seine) in the Volga-Sviyazhsky area of the Kuibyshev reservoir in September 1993-1998 and 2017-2022

In the period 1993-1998, non-target and low-value commercial species dominated among juveniles, while the main commercial species, bream, tended to occur sporadically. The relative exception was in 1998, when bream reached 22.6% of all fingerlings, or 10.2 individuals per effort.

In the autumn of 2021, the river perch was the dominant species in the 2021 catches (44.7% of the total catch), with a relative abundance of 27.2 individuals/effort. In addition, the juvenile roach (24.1%; 14.7 ind./effort) and rudd (13.2%; 8.0 ind./effort) played a notable role in the juvenile catch. River perch were the most abundant species during the 2022 study period (35.9%; 122.0 ind./effort). The proportion of young roach was high (24.1 %; 81.7 ind./effort), and silver bream (20.9%; 71.0 ind./effort). Unusually high numbers of bream were observed in all years considered (8.3%; 22.6 ind./effort).

4 Conclusions

There is a tendency for the area to become increasingly important for fish reproduction, which is reflected in an increase in species abundance and diversity indices, realised mainly at the expense of low-value and weedy fish. The increase in abundance also indicates an increase in the importance of the area. It can be supposed that changes in the above-mentioned indicators can be partly related to the bioinvasive processes, biotopic restructuring of the littoral, as well as to changes in the conservation status of the area. Since 2020, the water area in question has been part of an established regional protected area. This indicates

the potential for use for reproduction and valuable commercial fish and requires further monitoring.

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