

# Changes in the basic biological indicators of blue bream (*Abramis ballerus*, Linnaeus, 1758) in the Sviyaga Bay of the Volga reach of the Kuibyshev reservoir due to anthropogenic impact

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**Abstract.** The study examined the main biological indicators of blue bream in the Sviyaga bay of the Volga reach of the Kuibyshev reservoir. The size, weight and age composition of blue bream from control catches of gill nets in 2018-2021 were studied. The state of the indicators was assessed in comparison with the materials of previous studies. The work was carried out in a reservoir area where commercial fishing has been stopped since the middle of the second decade of the current century. The results of previous studies suggest that there are no significant changes

## 1 Introduction

The Kuibyshev Reservoir is the largest of the reservoirs created on the Volga River. The development of the reservoir ecosystem as a whole and its components had several stages: from the effect of creation or “explosion of biota” to destabilization [1]. Compared to the conditions of the Middle Volga, water quality indicators in the reservoir have significantly deteriorated, the accumulation of silt in the ground has increased, especially in bays, and the biomass of phytoplankton has increased. All this led to a change in the species diversity of hydrobionts, and above all, its important part - the ichthyofauna. The biological indicators of most fish species living in the reservoir have deteriorated, and their catch volumes have decreased.

One of the significant commercial species among the small ones of the Kuibyshev Reservoir is the blue bream *Abramis ballerus* (L.). Blue bream is a fish of the carp family (Ciprinidae), characterized by small scales, a long anal fin and a slit-shaped mouth. This species lives in freshwater bodies of water in the basins of the Baltic, Caspian, Black and Azov seas. In the Volga-Kama region, this species is commercially available in the Kuibyshev, Cheboksary and Nizhnekamsk reservoirs; is rare in the Kama Reservoir and has a small number in the Votkinsk Reservoir [2]. A number of works are devoted to the study of blue bream and its biological indicators (size-weight, age and sex composition) in reservoir conditions [3-5]. The purpose of the research is to consider the size-weight and

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age composition of blue bream catches in the Sviyaga Bay of the Volga Reach of the Kuibyshev Reservoir for the period 2018-2021.

## 2 Materials and methods

The material was collected in the Sviyaga Bay of the Volga Reach of the Kuibyshev Reservoir in 2018-2021. The fish were caught in summer and autumn using fixed nets with a mesh size of 24-65 mm. Age was determined by cuttings of the first rays of the dorsal fin and scales [6]. After catching the fish, the following parameters were determined: standard body length (l), which was measured from the front edge of the snout to the end of the scale cover, using a measuring board with an accuracy of 0.5 cm; weight (g), weighing was carried out on scales with an accuracy of 5 g; To determine the sex and degree of maturity of reproductive products, the fish were dissected [7]. Statistical processing of the material was carried out using the Microsoft Office Excel program; indicators recommended for work of a similar nature were used:  $M \pm m$  – arithmetic mean value and its error;  $lim$  – variations;  $sx$  – standard deviation (standard deviation); CV, % – coefficient of variation. The reliability of the difference in means was assessed using the Student's t test (td) [7-8]. A total of 501 fish were processed.

## 3 Results and Discussion

Blue bream (*Abramis ballerus* Linnaeus, 1758) is a typical fish species that lives in fresh inland waters of Europe. For its habitat, it prefers the lower reaches of rivers, lakes, and reservoirs. From its usual habitat, the bluefish can make small internal migrations to areas of rivers and other bodies of water overgrown with aquatic vegetation, on which it lays eggs in the spring. In summer and autumn, adult fish can form large aggregations in open waters, bays, backwaters, etc. The dynamics of the catch during the collection of scientific material for this study indicate the formation of large aggregations during feeding in the summer and autumn. In late autumn, as the water cools, blue bream move to deep parts of the reservoir.

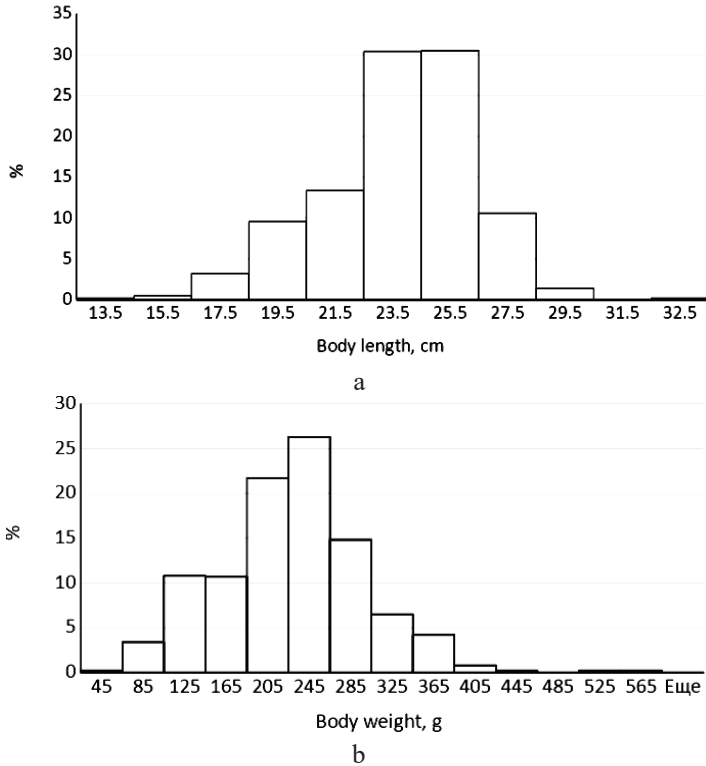
Blue bream is one of the important components of the ichthyocenosis of the Kuibyshev Reservoir. In terms of substrate for spawning, this species is a typical phytophile, so the efficiency of its reproduction largely depends on fluctuations in water levels during the spawning period and on favorable weather conditions. In the first years after the creation of the reservoir for the spawning of blue bream during the spring flood, areas with rich vegetation were preserved in coastal areas, used for laying eggs, which contributed to a slow increase in its number. Subsequently, in the conditions of the reservoir, the blue bream formed a population that spawns when the water level rises again. Spawning of blue bream begins at a temperature of 7-8°C, mass spawning takes place at a temperature of 11-17°C. It is important that the blue bream feed on zooplankton. The main food is crustacean zooplankton, which is poorly used by other fish. The main food competitor is common kilka *Clupeonella cultiventris* (Svetovidov, 1941). Therefore, blue bream has no problems with the food supply. The share of blue bream in the fishery in the conditions of the Middle Volga before the creation of the reservoir was 3-4% by weight [3]. Then the importance of blue bream increased, but after the 90s, a decrease in the catch of blue bream was observed in the reservoir. In the the Sviyaga Bay, since the second decade of the current century, industrial fishing has not been permitted, and individual hook catch cannot be significant since this species consumes zooplankton. In such a situation, an improvement in indicators of this type should be expected.

According to our data, in 2018-2021 in the Sviyaga Bay of the Kuibyshev Reservoir, the body length of the blue bream ranged from 13.5 to 32.5 cm (Table 1). Statistically significant differences between the average body length of blue bream were detected only between individuals caught in 2018 - 2020 and 2021 ( $t_{2018-2021} = 3.3$  for  $n=147$ ;  $t_{2019-2021} = 3.0$  for  $n = 199$ ;  $t_{2020-2021} = 2.3$  for  $n=313$ ). Significant differences between the body length of males and females were detected only in 2018 at a significance level of 5% ( $P = 0.05$ ). The increase in the average body length of blue bream in 2021 can be explained by the fact that fishing was carried out only in the autumn and larger, older individuals were caught and gathered in deeper parts of the bay, while smaller young individuals continued to feed for another shallow waters. Comparison of body length variability using the coefficient of variation shows that the smallest change in size was observed in bluegill caught in 2021 - 6.7%. In other years of observation, this indicator had greater values and was in 2020 - 10.5%, in 2019 - 12.9% and 2018 - 14.6%, that is, in these years the collected material was more diverse and consisted of different size groups.

**Table 1.** Indicators of the size composition of blue bream catches in the Sviyaga Bay of the Volga reach of the Kuibyshev Reservoir (2018-2021), cm.

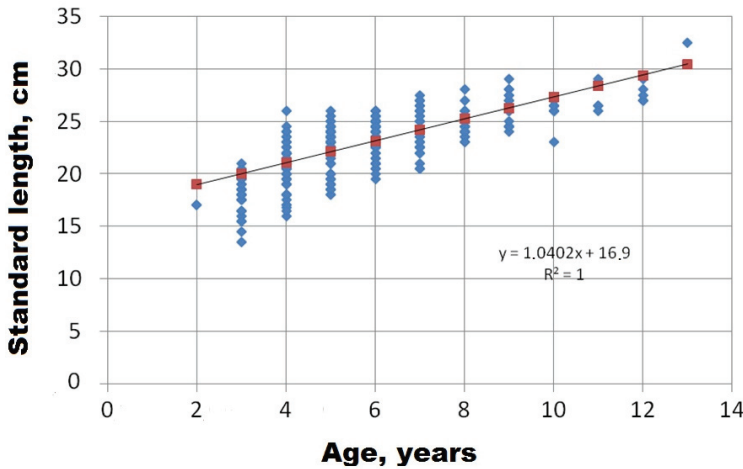
Sex	lim $x_{min}-x_{max}$	$M \pm m$ , cm	$s_x$	$t_d$	n
2018					
female and male	13.5-27.0	22.4±0.4	3.27	-	68
female	16.5-27.0	23.3±0.4	2.47	2.4	41
male	16.0-26.0	21.4±0.7	3.49		25
immature	13.5-16.5	-	-	-	2 (2.9%)
2019					
female and male	14.5-32.5	22.5±0.3	2.9	-	120
female	16.8-32.5	23.2±0.4	2.9	0.8	57
male	18.0-28.0	22.8±0.3	2.4		50
immature	14.5-20.0	8.4±0.5	1.6	-	13(10.8%)
2020					
female and male	17.0-29.0	23.0±0.2	2.5	-	234
female	19.0-29.0	23.9±0.2	2.0	1.7	122
male	19.5-28.0	23.4±0.2	1.9		78
immature	17.0-21.0	19.1±0.2	1.2	-	34 (14.5%)
2021					
female and male	16.5-27.5	23.7±0.2	1.6	-	79
female	21.0-27.5	24.1±0.3	1.5	1.5	31
male	21.0-26.5	23.5±0.2	1.3		47
immature	16.5	-	-	-	1 (1.3)

Individuals of size classes from 23 to 27 cm dominated the catches (Figure 1). The share of such fish was 63.2% in 2018, 47.5% in 2019, 59.0% in 2020, 79.7% in 2021. Large-sized fish, 29.0 cm or longer in length, were rare. The share of such individuals ranged from 0.8 to 3.4% of the total catch. In studies by D.A. Polozova and V.N. Grigoriev [3] in 2007-2009 in this area, fish sizes varied from 12.5 to 34.0 cm, and most of the individuals had a body length from 18.0 to 26.0 cm. When compared with the materials of our study, a general increase in the size of blue bream in net catches is noticeable, which may indicate an improvement in the condition of the group at the present time.



**Fig. 1.** Histogram of the distribution of length and weight of blue bream in net catches in the Sviyaga Bay of the Kuibyshev Reservoir in 2018-2021: a) body length; b) body weight.

The relationship between the body size and age of the blue bream is presented in Figure 2. A noticeable higher rate of body growth of the bluebird up to 3 years of age and then a decrease in the growth rate associated with the gradual puberty of females and males.



**Fig. 2.** Linear relationship between body length and age of a blue bream calculated using regression analysis in catches from the lower part of the Sviyaga bay (based on materials from 2018-2021).

**Table 2.** Linear growth of blue bream of catches in the Sviyaga bay of the Kuibyshev reservoir in 2018-2021.

Years	Parameters	Age, years										n	
		2	3	4	5	6	7	8	9	10	11		12
2018	Standard length, cm	-	16.3	19.0	22.7	24.1	25.9	24.9	-	-	-	-	68
	%	-	10.3	16.2	16.2	35.3	10.3	11.7	-	-	-	-	100
2019	Standard length, cm	16.4	17.9	18.4	20.1	22.3	23.8	24.6	26.5	26.6	27.2	29.7	120
	%	2.5	13.3	25.0	16.7	18.3	3.3	8.3	5.1	3.3	2.5	1.7	100
2020	Standard length, cm	17.0	18.7	21.2	23.2	24.5	24.7	25.5	25.9	26.6	28.0	28.7	216
	%	0.9	9.2	22.7	30.5	14.8	4.2	5.1	7.9	2.8	0.5	1.4	100
2021	Standard length, cm	-	18.0	22.0	23.5	24.6	26.1	27.0	27.5	-	-	-	79
	%	-	3.8	17.7	44.2	22.8	8.9	1.3	1.3	-	-	-	100

Body weight of blue bream in catches 2018-2021 in the Sviyaga bay of the Volga reach of the Kuibyshev Reservoir ranged from 45 to 555 g in different years of observation (Figure 1, Table 3). Average weights for the period 2018-2021 were  $M \pm m = 209.7 \pm 3.20$  g (median 210.0 g, n = 501 specimens). It was revealed that there were significant differences in the weight of blue bream when comparing catches in 2018-2021, 2019-2021, and 2020-2021. Differences in weight were noted for a high probability level of 0.999 ( $t_{2018-2021} = 4.96$  for n=147;  $t_{2019-2021} = 5.51$  for n = 199;  $t_{2020-2021} = 4.65$  for n= 313).

Females had greater weight compared to males, but statistically significant differences in average weights between females and males were found only among blue tit specimens caught in 2018 and 2021. In different years, the catches contained the most abundant individuals of different body weight classes: in 2018 and 2020 – from 200 to 250 g, in 2019 – from 150 to 250 g, in 2021 – from 250 to 300 g. In 2007-2009 the bulk of the blue bream catches had a mass of 50-250 g.

In 2007-2009, the catches included blue tit individuals from 3 to 8 years old. The most abundant fish in the catches were fish from the 2002-2005 generations. In 2018-2021 In the study area of the Kuibyshev Reservoir, blue tit individuals aged from 2 to 8 years were noted in net catches (Table 4).

The most abundant fish in the catches were fish of the following age groups: in 2018 – 4 years (17.6%) generation 2014, 5 years (17.6%) generation 2013, 6 years (32.4%) generation 2012 ; in 2019 – 3 years (22.5%) generation 2016, 4 years (50.9%) generation 2015, 5 years (18.3%) generation 2014; in 2020 – 3 years (23.5%) generation 2017, 4 years (53.0%) generation 2016, 5 years (17.5%) generation 2015; in 2021 – 5 years (46.9%) generation 2016, 6 years (22.8%) generation 2015, 4 years (21.5%) generation 2017. Fish older than 8 years were few in number and were recorded only in certain years. The most abundant generations were in years with a relatively high, stable water level in the spring and summer.

In the first years after the creation of the reservoir (1958, 1959), male blue breams matured at 3-4 years of age, females at 4-5 years [9], at the age of 6 years and older, all individuals were sexually mature [10]. In the 60s, some individuals reached sexual maturity at the age of 3-4 years. Since the beginning of the 90s there has been a slight decrease in growth rates and an increase in the duration of the immature state. Thus, in 1999, immature individuals of 7 years of age were discovered. Studies carried out in 2009-2010 in the Kuibyshev reservoir showed that the maturation of males begins at 3 years of age, females at 4 years of age, and at the age of 4 years they become sexually mature - 90% of males and 80% of females [11]. According to the results of control catches carried out in the period 2018-2021 in the Sviyaga bay of the Kuibyshev reservoir, young blue bream begin to mature at the age of 3-4 years, however, immature individuals were also found among individuals 3-6 years of age.

**Table 3.** Indicators of the weight composition of blue bream catches in the Sviyaga Bay of the Volga reach of the Kuibyshev Reservoir (2018-2021), g.

Sex	lim $x_{min}-x_{max}$	$M\pm m, g$	$s_x$	$t_d$	n
2018					
female and male	45-340	193.2±8.7	71.5	-	68
female	70-340	213.0±9.4	60.4	2.4	41
male	60-270	171.0±14.4	72.2		25
immature	45-80	-	-	-	3
2019					
female and male	55-555	193.7±7.2	79.2	-	120
female	70-555	209.2±11.4	86.2	0.6	57
male	90-350	200.6±8.9	62.8		50
immature	55-130	99.6±6.6	23.9	-	13
2020					
female and male	80-500	210.5±4.5	69.5	-	234
female	110-500	230.3±5.7	63.6	1.0	122
male	120-360	220.9±6.5	57.4		78
immature	80-190	115.7±4.0	23.8	-	34
2021					
female and male	60-390	245.2±5.9	52.5	-	79
female	170-950	263.2±9.8	54.5	2.2	31
male	160-340	237.3±6.0	41.5		47
immature	60	-	-	-	1

**Table 4.** Age composition of blue bream catches in the Sviyaga Bay of the Volga reach of the Kuibyshev Reservoir in 2018-2021.

Years	Number	Age, %							
		2	3	4	5	6	7	8	
2018	68	-	10.2	17.6	17.6	32.4	10.2	12.0	
2019	120	1.7	22.5	50.9	18.3	5.8	0.8	-	
2020	234	-	23.5	53.0	17.5	5.0	1.0	-	
2021	79	-	1.2	21.5	46.9	22.8	7.6	-	

## 4 Conclusion

Analysis of biological indicators (size-weight and age composition of catches) of blue bream from the Volga reach of the Kuibyshev Reservoir for the period 2018-2021 does not show their improvement; in comparison with the data of 2007-2009, there was a slight decrease in the range of fluctuations in body length and weight. It has been established that in the period 2018-2021. In the Sviyaga Bay of the Kuibyshev Reservoir, blue bream began to mature at the age of 3-4 years, but immature individuals were also noted among individuals 3-6 years of age. Considering the good supply of food in the area under consideration and the absence of industrial fishing for blue bream in the Volga Reach since the middle of the second decade of the 21st century, it is assumed that there have been no noticeable improvements in biological indicators. This may be caused by the continued influence of anthropogenic factors associated with the regulation of water level fluctuations during the year and especially in the spring. This leads to a reduction in the area of spawning grounds. In addition to the factors mentioned above, the positive effect of stopping industrial fishing may be absent as a result of illegal and unreported fishing.

## References

1. G.S. Rosenberg, L.A. Vykhristyuk, Kuibyshev Reservoir, IEVB RAS, Tolyatti (2008)
2. S.V. Kozlovsky, Fish, Illustrated guide, Samara House of Printing (2001)
3. D.A. Polozova, V.N. Grigoriev, Main biological indicators of blue bream of the upper part of the Volga reach of the Kuibyshev reservoir, in Proceedings of the reports of the scientific and practical conference of hydrobiologists dedicated to the memory of Professor H.M. Kurbangalieva. Kazan (2010)
4. R.R. Saifullin et al., Bulletin of TSGPU, **4** (22), 96-103 (2010)
5. V.A. Nazarenko, L.D. Nazarenko, S.S. Gainiev, Fisheries, **1**, 36-37 (1984)
6. N.I. Chugunova, Guide to the Study of the Age and Growth of Fish. (USSR Academy of Sciences Publishing House, Moscow, 1959)
7. I.F. Pravdin, Guide to the Study of Fish (Mainly Freshwater) (Food Industry, Moscow, 1966)
8. G.F. Lakin, Biometrics (Higher School, Moscow, 1990)
9. I.V.Egereva, Yu.M. Makhotin, Proceedings of the Tatar Branch of the State Research Institute of Lake and River Fisheries, **9**, 270-279 (1960)
10. G.M. Smirnov, Main features of biology of blue bream and formation of its stocks in the northern part of Kuibyshev Reservoir (Kazan, 1965)
11. Yu.A. Severov, Biology and formation of stocks of blue bream *Abramis ballerus* (L.) of Kuibyshev Reservoir (Petrozavodsk, 2012)