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Status and Prospect of the Effective Utilization of Tuyabguz Reservoir in Uzbekistan

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Abstract: ***Article presents the results of research of assessment the current status of the ichthyologic fauna of Tuyabuguz reservoir, factors influencing on fish stocks and proposals for the rational use of fish resources. It was revealed that the ichthyologic fauna of Tuyabuguz reservoir was formed from representatives of the native fauna of the Akhangaran River and acclimatizers, and consists of 20 species of fish belonging to 3 orders and 8 families.***

Keywords: reservoirs, macrophytes, zooplankton, zoobentos, species, fish, fish resources

1. Introduction

Research of biological resources' state is a necessary stage in the general problem of knowing general biological patterns in water bodies, without which it is impossible to have a whole view of the state of the ecosystem.

In conditions of natural and economic accelerating processes, operating in similar directions: anthropogenic eutrophication of water bodies as a result of pollution and climatic alterations, as well as an increasingly intensive commercial use of fish stocks in water bodies of Uzbekistan, the most dynamic and significant economically and fish conservation problem is fish productivity, which has a downward trend recent years.

The most scientifically interesting and relevant problem for fish conservation practice is research of the current state of biological resources and the bioproduction potential of numerous medium-sized reservoirs in Uzbekistan that are not used in fisheries

In this regard, one of the most promising reservoirs is Tuyabuguz reservoir, located within the Tashkent region, i.e. near the capital city of the Republic.

Tuyabuguz reservoir is located in the channel below the river crossing with the Tashkent-Pskent highway, watercourse, built with the purpose of seasonal regulation of Akhangaran River flow. Built in 1961 for irrigation purposes. Akhangaran is a river of snow nutrition. The flood period lasts from late March to June 20. Maximum water consumption is observed annually in the first half of May.

So, Tuyabuguz reservoir is a promising object, both for organizations of the recreation complex for residents of the capital, and for the development of fisheries

The purpose of this research is to assess the current state of the ichthyologic fauna of Tuyabuguz reservoir, factors affecting fish stocks, and develop recommendations on the rational use of fish resources.

2. Material and Research Methods

Collection of material was carried out in April-June and in September-October 2017-2018. Determination of the ecological and biological parameters of fish was carried out according to generally accepted methods (Pravdin, 1966; Nikolsky, 1974). Species affiliation of the fish was determined by L.S. Berg (1948-1949).

Mass measurements of fish in catches were carried out in accordance with the "Guidelines for monitoring the state of fish stocks and assessing the number of fish based on bio statistical data" (Moscow, 1987). Processing of the obtained results by catch was carried out according to methods of I.F. Pravdin (1966).

Hydrobiological material was collected by methods traditional in hydrobiology: collection by plankton nets (kapron gas #76), fixation with 4% of formalin.

Hydrological, hydrochemical regime and hydrobiological characteristics of the Tuyabuguz reservoir. Tuyabuguz reservoir is the second reservoir on Akhangaran River, built near the village of Tuyabuguz, 40 km from Tashkent city. The total volume of water mass is 250 million m^3. The area of the water mirror is 20 km^2, length - 9 km, maximum width - 3 km, average width - 1.88 km. Depth: maximum - 31.5 m, average - 16 m. Reservoir for purely irrigation purposes, two irrigation canals departs from the right and left-bank parts of the dam. Water consumption on the right-bank channel is 55 m^3/s; on the left bank - 20 m^3/s.

Tuyabuguz reservoir is characterized by strong fluctuations in water level, which is determined in addition to the flood in the supply river by the timing of the level discharge. The highest water levels occur in the spring and partially summer periods, by autumn the water level drops sharply, then again there is an increase in the level due to an increase in the groundwater entering the reservoir. In some years, the drawdown of the reservoir level is so large that the reservoir bowl is almost completely drained, as was the case in the summer of 1989.

Thermal regime of the reservoir is significantly influenced not only by Akhangaran River, whose waters have time to warm up in the summer after Turkic reservoir, but also the

Burgulyuk River and the waters coming from streams and irrigation ditches.

Water temperature in the upper section of the reservoir in the period from April to September ranges from 15.8-24.4°C, in the lower section during the same period - 17.2-26.6°C. According to the thermal regime, Tuyabuguz reservoir belongs to the moderately warm water bodies of the lake type.

Gas regime in different parts of the reservoir varies and during the growing season (April-September) undergoes significant changes. The maximum content of oxygen dissolved in water is observed in September (117-138%), the minimum - in June (65.6-98%). In June, in the conditions of a sharp decrease in the level, most of the bottom of the reservoir is drained, and a small amount of water has great contact with the bottom soils. The oxidation of water ranges from 4.0-5.6 mg/l at the surface and 4.5-8.5 mg/l of oxygen at the bottom (during high water). The active reaction of water is slightly alkaline with fluctuations of 7.6-8.2. The total salinity of the water in the reservoir is 175.8-329.5 mg/l; according to the composition of the main ions, it belongs to the hydro carbonate-calcium type.

Soil of different sections of the reservoir varies. River sediments predominate in the upper section - sand mixed with silt and clay, in the central part - clay-silty soil of gray color, in the lower section - bulk pebbles with sand, partially silted.

Macrophytes in the reservoir are poorly developed. The main bottom area of the reservoir, flooded when the level is raised, is covered by a variety of terrestrial vegetation, which serves as a substrate for spawning of phytophilic fish and a feeding ground for young fish.

Zooplankton of Tuyabuguz reservoir are represented by the following main organisms: *Synchaeta pectinata*, *Acplanchna priodonta*, *Cyclopc strenuous*, *Moina marocopa*, *Bosmina longiroctris*, *Daphnia longispina*, D. *Cuculata*, *Brahionus calicyeoris*. Rotifers have the maximum quantitative development in zooplankton, mainly: *Sijnchaeta pectinata* and *Asplanchana priodonta* - up to 18 thousand ind./m^3 each. Copepods have a maximum development in the estuarine sections of the Burgulyuk and Akhangaran (*Ciclops strenuous*) rivers - 21 thousand ind./m^3. The average abundance of zooplankton in the reservoir is 44 thousand ind./m^3, the average biomass is 3.4 g/m^3.

Zoobenthos of Tuyabuguz reservoir is represented mainly by chironomid larvae and low-bristle worms. In spring, chironomids are found in large numbers: *Cricotapus ex.gr. silvestris, cr aldarum, Polipedium ex. gr. nubeculosum, Tanitarsis ex. gr. gregarious*. In summer, they have mass development: *Proclodius sp., Tenolipes sp*. In Autumn marked: *Tenolipes seneridiktus, Pelopia sp., Criptohironotus gr. conjugons*. The bottom fauna reaches its greatest development in the deep places of the reservoir, where the soil is less compacted, more silty, where water is always or for the longest period. The number of zoobenthos in the coast reaches 300 ind./m^3, biomass - 0.3 g/m^2. In the open part of the upper section, the benthos abundance is higher than in other areas up to 4280 ind./m^2, biomass 2.36 g/m^2. In the middle section, the average benthos abundance is 600 ind./m^2, biomass 0.5 g/m^2.

The state of the ichthyologic fauna of Tuyabuguz reservoir

In the 1960s and early 70s, the ichthyologic fauna of Tuyabuguz reservoir was represented by 16 species of fish. The leading place in the fishery was occupied by *Cyprinus carpio* (66.5% in catches), *Silurus glanis*, *Schizothorax curvifrons* (Kasimova, 1967; Kamilov, 1973). In subsequent years, the ichthyologic fauna of the reservoir (up to 23 species) was significantly enriched with fish species of the Far Eastern complex due to their penetration from fish farm ponds, as was the case in other reservoirs of the basin. However, in 1989, Tuyabuguz reservoir was almost completely drained as a result of water drainage, so in 1990 there was a significant depletion of ichthyologic fauna (Mirzaev, 2006). In the control catches, only low-value and weedy fish from Akhangaran River were recorded: *Opsariichthys bidens*, *Hemiculter leucisculus*, *Rhinogobius brunneus*, *Abbottina rivularis*, *Alburnoides taeniatus*, *Carassius gibelio*, *Gambusia holbrooki*, *Alburnoides taeniatus*, *Gobio lepidolaemus.*

So, initially, the ichthyologic fauna of Tuyabuguz reservoir was formed from the funds of the original water system - Akhangaran River, then due to acclimatizers. To date, a peculiar ichthyologic fauna has formed in the reservoir, consisting mainly of representatives of the native fauna and acclimatizers.

To date, a peculiar ichthyologic fauna has formed in the reservoir, consisting mainly of representatives of the native fauna and acclimatizers. Currently, we have noted 20 fish species in the reservoir (table 1). Apparently, the departure from the reservoir of the previously numerous river fish - rheophiles: *Schizothorax curvifrons* and *Luciobarbus capito conocephalus*, in addition to increasing the degree of eutrophication with organic substances, is largely due to their displacement by fish by limnophiles, due to food competition.

Table 1: Species composition of the ichthyologic fauna of Tuyabuguz reservoir of Akhangaran river basin (in 2017-2018)

№	Family, species, subspecies	Tuyabuguz reservoir		
		I	II	III
	Cyprinidae family			
1.	*Hemiculter leucisculus*	B	-	B
2.	*Carassius gibelio*	A	A	A
3.	*Cyprinus carpio*	+	+	+
4.	*Abbottina rivularis*	B	-	B
5.	*Gobio lepidolaemus*	+	-	+
6.	*Abramis brama orientalis*			
7.	*Pseudorasbora parva*	B	-	B
8.	*Abramis brama orientalis*	+	-	+
9.	*Alburnoides taeniatus*	+	-	-
10.	*Hypophthalmichthys molitrix*	-	A	A
11.	*Leuciscus squaliusculus*	+	-	-
12.	*Rutilus rutilus aralensis*	+	-	+
13.	*Schizothorax curvifrons*	+	-	-
	Cobitididae family			
14.	*Sabanejewia aurata aralensis*	+	-	-

	Balitoridae family			
15.	*Silurus glanis*	-	-	+
	Poeciliidae family			
16.	*Gambusia holbrooki*	A	-	A
	Percidae family			
17.	*Sander lucioperca*	A	A	A
	Odontobutidae family			
18.	*Micropercops cinctus*	-	-	B
	Gobiidae family			
19.	*Rhinogobius brunneus*	-	-	B
	Channidae family			
20.	*Channa argus*	-	+	B
	Total species content (subspecies)	14	5	15
	number of native species	8	2	5
	number of introducers	6	3	10

Note: A - acclimatized species; B - randomly introduced species; + - native species; I - the upper part of the reservoir (the place of the confluence of the river), II - the middle (central) part of the reservoir, III - the lower (dam) part of the reservoir

Factors that undermine the fish stocks of Tuyabuguz reservoir are its irrigation purpose, i.e. annual periodic water discharges for irrigation of crops lead to strong fluctuations in water level. There are no fish protection facilities at the drainage in the dam of the reservoir, therefore, along with the water, the fish, mainly large, fishing from the near-dam deepwater part, are also dumped into the lower pool.

Analysis of the state of ichthyologic fauna according to the results of studies conducted in different seasons of the year

In 2017, due to insufficient snow cover in the mountains, a high flood was observed in the first half of April. Since the beginning of June, a low-water period was observed with a water flow in the river of 3-3.5 m/s (versus 4-5 m/s in high-water years). For this reason, in the reservoir at the beginning of July (during the study), water reserves amounted to 55-65% of the average annual values, and water level marks decreased by 3-4 meters compared to long-term average values. The control fishing in the middle (central) part of the reservoir with nets of 18-60 mm mesh showed the following: snakeheads (*Channa argus*), white carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), and crucian carp (*Carassius gibelio*) were found in the catch. Due to low water availability, shallowing of the reservoir, intensified heating of water to 30°C and overgrowing of coastal shallow water in an area of about 3/10 of the entire water area, conditions were created under which fish were absent in the surface layers of the water of the main part of the reservoir. This was shown by the results of the first control fish catch.

Subsequently, the networks were installed in two areas: the first at a depth of 3 to 5 meters in the area of the dam of the reservoir (lower part of the reservoir) and the second in the upper reaches of the reservoir, at the confluence of Akhangaran River. In these areas, in connection with the arrival of fresh, cool, oxygen-enriched water, a certain concentration of commercial and low-value fish was observed, which made it possible to somehow determine the species and size composition of the ichthyologic fauna in this period of the year.

In nets with a mesh of 45 mm, the species composition of fish in the catch was as follows: common carp (*Cyprinus carpio*), small crucian carp (*Carassius gibelio*), pikeperch (*Sander lucioperca*), roach (*Rutilus rutilus aralensis*) and small bream (*Abramis brama orientalis*). During the day, 12 fish were included in the net: 5 carp (*Cyprinus carpio*), 4 zander (*Sander lucioperca*), 3 roaches *(Rutilus rutilus aralensis*) and 1 bream (*Abramis brama orientalis*). 2 crucian carp (*Carassius gibelio*), 3 roaches (*Rutilus rutilus aralensis*), 1 catfish (*Silurus glanis*), 5 zander (*Sander lucioperca*) got into the network of 60 mm mesh per day. Networks were placed in the dam part of the reservoir at a depth of 4-5 and more meters.

In the upper part of the reservoir (the confluence of Akhangaran River), on sandy-pebble substrate and in silty clay shallow waters (0.5-2.0 meters deep), nets with a mesh of 18, 22 and 36 mm were placed. In these places, juvenile commercial fish prevailed, where it concentrates on a stream of fresh water, as well as low-value and weedy fish, very numerous in the reservoir.

The nets of 18 mm mesh were dominated by juvenile pike perch (*Sander lucioperca*), crucian carp (*Carassius gibelio*) and roach *(Rutilus rutilus aralensis*), as well as marinka (*Schizothorax curvifrons*) and chinensis (*Hemiculter leucisculus*).

In nets with a mesh of 22 mm, juveniles of common carp (*Cyprinus carpio*) and crucian carp (*Carassius gibelio*), as well as the common-bellied (*Hemiculter leucisculus*) and roach (*Rutilus rutilus aralensis*). Juveniles of common carp (*Cyprinus carpio*), pikeperch (*Sander lucioperca*), crucian carp (*Carassius gibelio*) and chuba (*Rutilus rutilus aralensis*) predominated in 36 mm mesh networks

During the survey of the reservoir, at the end of July (2018), the water level dropped significantly compared to that observed in early June. In the dam zone (especially on the left bank), on the site of the old channel of Akhangaran River, there are backwater pits with a depth of 25 to 35 meters. Numerous catfish juveniles (*Silurus glanis*) are caught in pits off the left bank of the reservoir. 5-6 catfish (*Silurus glanis*) of 25-40 cm in size and weighing from 700 to 2020 fall into the network of 28-36 mm mesh in a day, and many (up to 7 specimens per network) of catfish (*Silurus glanis*) get into the mesh network of 45 mm 40-55 cm long and weighing 1.5-2.8 kg. Catfish (*Silurus glanis*) 60 cm - 1 meter in size (82 cm average) and 4-12.5 kg in weight (10.2 kg average) fall into large-mesh networks (with mesh up to 100 mm). In pits in the network of a mesh of 28-36 mm, pike perch (*Sander lucioperca*) 18-36 mm long with an average length of 30.5 cm and a weight of 150-450 gr, an average of 320 gr. In a small amount in the dam zone, a snakehead (*Channa argus*) weighing 850 g to 3-4 kg and a long body from 30 to 65 cm gets into a network with a mesh of 55-85 mm.

In September-October (2018), the most numerous tall-growing form of silver crucian carp (*Carassius gibelio*) from 10 to 16 cm (average 12.5 cm) and weighing from 75 g to 250 g. (an average of about 113 g.). In the network of a 36 mm cell, carp from 15 to 21 cm in size and weighing from

250 to 550 g (an average of 320 g) fall. Large individuals up to 10-12 kg weigh fall into the net of a mesh of 100 mm and above. The average sizes of common carp in fishing nets are 35.5-45 cm, and body weight is 1.5-2.7 kg.

Currently, carp (*Cyprinus carpio*) is one of the largest commercial fish in the reservoir and is significantly ahead of all other commercial fish in terms of ichthyomass or specific gravity in catches. In the reservoir, carp (*Cyprinus carpio*), crucian carp (*Carassius gibelio*), and pikeperch (*Sander lucioperca*) make up about 93.6% of the ichthyomass of all commercial fish in net and amateur catches. Of these, 53.5% is carp (*Cyprinus carpio*).

Factors undermining the fish stocks of Tuyabuguz reservoir

The specificity of Tuyabuguz reservoir, as well as the majority of reservoirs built in the riverbed, lies in its irrigation purpose, which causes periodic discharges of water for irrigation of crops.

For this reason, annual strong fluctuations in water level are observed, which affects fish stocks. There are no fish protection facilities at the outlet in the dam of the reservoir, therefore, along with the water, the fish, mainly large, fishing from the near-dam deepwater part, are also dumped for irrigation.

There are no pumping intakes on the reservoir, which positively affects the reproduction of fish and feeding of juveniles.

The greatest negative impact on fish stocks is exerted by the full (non-annual) discharges of water from the reservoir, and seasonal (annual) discharges of water for irrigation of crops.

Over the past 10 years, a full runoff of water has been observed 2 times. The last of them was noted in the current 2008, when water remained in the reservoir only in the dam zone, on an area of about 80 hectares, which is 5% of the total area of the reservoir. For comparison, we can point out that in 2017, which was normal for the water supply of the reservoir; almost the full water level remained until August. And only in the autumn period did the water level drop slightly.

Thus, non-annual complete or almost complete drains of water occurring in especially shallow years cause severe damage to the status of the fish ichthyologic fauna, as a result of which in the reservoir for the next 1-2 years there is an almost complete absence of commercial fish

The second hydrological factor undermining the fish stocks of the reservoir is the annual seasonal (spring and autumn) water discharges for irrigation of crops.

Annually, as a rule, in May-June there is a discharge of water for irrigation. Water quickly leaves the coast by 10-15 meters. In the same period, in shallow water, phytophile fish eggs are laid on soft aquatic vegetation. These are late spawning cyprinids: common carp (*Cyprinus carpio*), crucian carp (*Carassius gibelio*), bream (*Abramis brama orientalis*), roach (*Rutilus rutilus aralensis*). Larvae and juveniles of early spawning fish such as pikeperch (*Sander lucioperca*) are also kept here. As a rule, all deposited caviar and many early juvenile fish in the coastal zone die.

The second decline in water in the reservoir occurs in the autumn period (in October-November), when the water is used to irrigate winter wheat. In this case, it is used to irrigate up to half the water remaining in the reservoir in the fall. Damage to fish stocks in this period is much smaller than in the spring period, since with the decline of water, young juveniles and large commercial fish manage to go to a depth.

Other limiting factors include violation of the reproductive conditions of the main commercial fish, as a result of the competitive effects of short-cycling invading fish, such as chinensis (*Hemiculter leucisculus*).

Thus, with all the variety of adverse factors affecting the ecosystem of the Tuyabuguz reservoir, successions are moving towards a decrease in the number of commercially valuable fish.

At the same time, the problems of reconstructing the ecosystems of Tuyabuguz reservoir seem extremely relevant. Due to fish breeding and land reclamation measures (in particular, stocking the reservoir with young fish of the main commercial fish species), the fish productivity of Tuyabuguz reservoir can be increased several times.

3. Conclusion

Ichthyologic fauna of Tuyabuguz reservoir was formed from representatives of the native fauna of Akhangaran River and acclimatizers. Currently, 20 fish species belonging to 3 orders and 8 families live in the reservoir. The rheophilic fish originally inhabited here: Turkestan barbel (*Luciobarbus capito conocephalus*), marinka (*Schizothorax curvifrons*), and asp (*Aspius aspius iblioides*) were gradually replaced by higher-yielding lake species of limnophilous fish: common carp (*Cyprinus carpiopera, Sanoproder, carpop*), catfish (*Silurus glanis*), snakehead (*Channa argus*).

At present, the composition of the ichthyologic fauna in the reservoir cannot be considered optimal, since small low-value fish prevail here in numbers (82.3%) and in ichthyomass (57.4%): crucian carp (*Carassius gibelio*) and common-bellied fish (*Hemiculter leucisculus*). The nutrition of these fish is detritus, the remains of aquatic plants and benthic organisms numerous in the reservoir. These fish are short-cycled, puberty in a tall (dwarf) crucian carp (*Carassius gibelio*) and in the common-bellied fish (*Hemiculter leucisculus*) is very early (about 2+ years), spawning is annual. It is also very important that during periodic complete discharges of water from the reservoir, these fish, as very small, accumulates in pits in the dam part and are not affected at all by the fishery. At the same time, commercial fish populations are almost completely caught.

As it is known, fishing on the reservoir was started in 1962 (Kasimova, 1967). Currently, the reservoir has a higher fish

productivity from 3 to 5 kg/ha than in the first years of its formation (2-3 kg/ha).

Factors affecting fish productivity are: the lack of fish protection facilities at the outlet of the dam of the reservoir, as well as regular discharges of water with the discharge of commercial fish concentrated in the depths of the dam (this is the main factor in the periodic decrease in the number of commercial fish). An additional factor is the catch of fish remaining in the pits by networks of poachers. The absence of pumping water intakes is a factor significantly increasing the survival rate of juvenile fish, both commercial and low value.

The studied reservoir, located 40 km from Tashkent - the largest metropolis of Central Asia, is the largest body of water used as a mass recreation and sports place for the population of the city of Tashkent and the region for hunting and recreational fishing. Currently, the leisure industry is booming. Over the entire perimeter of the coast of the reservoir, more than 90 recreation zones are registered, belonging to various departments and organizations of Tashkent and the Tashkent region.

In connection with the above circumstances, we consider the most promising direction of the development of the reservoir - recreational fishing and hunting (possibly on a licensed basis), as well as more active stocking of the reservoir and the acclimatization of valuable species of fish and food organisms in it. All this should be developed on the basis of improving the leisure industry and monitoring compliance with hunting and fishing rules.

Necessary measures and practical recommendations

In the field of natural reproduction, exploitation of stocks and increasing fish productivity of Tuyabuguz reservoir, it seems necessary to carry out the following activities:

1) It is necessary to study the intrapopulation structure of herds of commercial fish species, develop and implement ways to maximize the safety of reproduction conditions in the fisheries and recreational development of Tuyabuguz reservoir and develop methods for regulating the number of valuable commercial and amateur sports species;
2) Annual stocking of the reservoir with valuable species of fish (*Abramis brama orientalis*) and high-backed carp species is necessary.
3) To reduce the number of Korean common-bellied fish (*Hemiculter leucisculus*) in the reservoir, it is necessary to increase the qualitative composition of predatory fish species by acclimatizing new species.
4) It is recommended to install fish protection structures equipped with fish catchers at the outlet of the dam to prevent loss of fishing stocks.

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