BIOLOGICAL SCIENCES

ON THE STATE OF FISH STOCKS AND THEIR POSSIBLE CATCHES IN THE AYDAR-ARNASAY SYSTEM OF LAKES OF UZBEKISTAN

Sobirov J.J.
Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan
Namozov S.M.
Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan
Kamilov B.G.
Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan, Tashkent State Agrarian University
Dekhkonova D.R.
Tashkent State Agrarian University
Yuldashov M.A.
Tashkent State Agrarian University

Abstract
In 2020 - 2021, research of state of commercial fish stocks and the volume of permissible fish capturing in the Aydar-Arnasay lake system in Uzbekistan (the middle reaches of the Syrdarya River) has been conducted. The data on the coefficients of loss, natural and commercial mortality of fish and statistical data on catches by species are given. The total ichthyomass of the commercial fish species mature part of the populations in the system of lakes is about 20 - 21 thousand tons in total (without species separation). The number of fish that can be captured without damage (total commercial stock) in these years is about 7 - 7.5 thousand tons. At present, the main commercial fishes are roach (Rutilus rutilus), pike perch (Sander lucioperca) and common carp (Cyprinus carpio), in some years there may be noticeable catches of gibel carp (Carassius gibelio).

Keywords: Fish stocks, allowable catch of fish, common carp, pike-perch, roach, Aydar-Arnasay lake system, Uzbekistan

Fish is the most important food product, the most balanced, and rich in valuable protein. Doctors have set the minimum rate of fish consumption necessary for the growth of a healthy population of the country - 16 kg/person, / per year. Unfortunately, fish consumption in Uzbekistan is about 4 kg/person/year. This means that there is a deficit in the full nutrition of the population of the republic. Objectively, this is due to the remoteness of the republic from the World Ocean, its location in the very center of the largest continent, and the poverty of fish resources. It is necessary to use every opportunity to increase fish production, one of the directions of which is the rational use of available water resources.

But fish production should not come into conflict with the conservation of biodiversity, in which the anthropogenic factor becomes the most important. At the present time, issues related to the state of fish stocks are especially acute, because stocks limit catches, and the whole nature of the fisheries of one or another reservoir is determined by-catches.

The Aydar-Arnasay system of lakes (Uzbekistan) is located in a saline depression in the east of the Kyzylkum desert in the middle reaches of the Syr Darya and has a total area of more than 400 thousand hectares and extends for more than 250 km in length (**Fig. 1**). The system of interconnected lakes of Aydarkul, Tuzkan and the East Arnasay reservoir (formerly the East Arnasay channel of lakes) is the largest fishery reservoir in terms of area and fish catches in the republic. However, catches fluctuate greatly, only in the 2000s the annual figures varied within 1-8 thousand tons. This raises the question of the rational use of available fish resources for the needs of fisheries. With regard to the Aydaro-Arnasay system of lakes, there are no objective data either on stocks or on possible and reasonable catches for any species of fish from the local ichthyofauna. The purpose of this work was to assess the state of the stocks of the lake system and the volume of allowable fishing of the main objects of fishing, in which there is no negative pressure of fishing on the emerging stocks of fish stocks in reservoirs at the present time.

Figure-1. Aydar-Arnasay system of lakes and its location on the territory of Uzbekistan

Material and Method

Material from June 2019 to June 2020 (the first analyzed year, assumed to be conditionally 2019) and further to June 2021 (the second year under study, assumed by us conditionally to be 2020) during research fishing. Fish were caught with fixed nets with a mesh size of 24–120 mm in East Arnasay (Arnasay reservoir with fresh water), in Tuzkan and Aidar lakes throughout the water area. The nets were set according to generally accepted methods, in the same order during research fishing, one net 24, 36, 45, 55, 60, 70, 80, 90, 100 mm was included. We also analyzed the commercial catches of fishing brigades working in the Aidar-Arnasay system of lakes.

In the studied fish, the standard body length (to the end of the scale cover) (SL, cm) was measured with an accuracy of 0.1 mm, the scales were collected, from which the age was determined by conventional methods (Pravdin, 1966).

Used data on fish catches.

Calculations were carried out according to the method of analysis of fish stocks in inland waters (Metodicheskie…, 1990). Numerical data were processed on computers using the methods of variation statistics.

Results

Carp (carp), *Cyprinus carpio*. According to the current Fishing Rules in the republic, the fishing measure is set for carp at 28 cm. But commercial fishermen in the studied system of lakes actually catch larger carp due to consumer demand. The smallest commercially significant body size of carp is currently 31 cm. As a result of the above, we took into account and used in the calculations only carp larger than 31 cm. life (SL_{t+1} and SL_t - standard body length of a carp at the age of *t* and *t+1*) in carp, according to our data for the period of research years, looks like:

$$SLt_{+1} = 16.7 + 0.89 * SLt$$

Table 1.

Size composition of the commercial carp stock in 2019-20, pcs.

Year	***Standard body length (cm)***													
	31	***34***	***37***	***40***	***43***	***46***	***49***	***52***	***55***	***58***	***61***	***64***	***66***	***69***
2019	71	60	fifty	32	fifty	58	43	24	fifteen	eight	6	5	0	3
2020	83	65	fifty	thirty	48	65	42	28	19	eight	9	5	2	3

In the first year of research, there were 425 carp pieces with a body length of 31 cm or more in the control catches. During the year, these fish grew, according to the formula, up to 44 cm or more. There were 229 of them in the second year of research. The loss amounted to 196 pieces. The calculation shows that the overall mortality rate in this case can be estimated as 0.46. For carp, according to long-term studies, the natural mortality rate is 0.25. Then the estimated fishing mortality rate is 0.21. For the data obtained, we introduce a correction factor equal to 0.04 according to the literature data for the indicated mortality rates (Methodological ..., 1990). Then the fishing mortality rate is 0.25, and natural 0.21.

The average weight of fish with a length of 31 cm or more in catches was 1.1 kg, and that of fish with a length of 44 cm or more was 2.1 kg. Then the average weight of one carp in catches is 1.6 kg.

The catch of carp in 2019 amounted to 300 tons, in this catch, there are only 190 thousand individuals of the species on average. The total loss is estimated at 350 thousand individuals with a total weight of 551 tons. Natural mortality - 251 tons. The rest amounted to 400 thousand fish or 644 tons of fish. The total commercial biomass of carp in the system of lakes can be estimated at 1194 tons.

Pike perch (*Sander lucioperca*). The commercial measure of pikeperch according to the current fishing measures in the republic is 36 cm. The data of research catches on the number of pikeperch of different body sizes in the studied system of lakes are given in **Table 2**. The calculated dependence of the growth of pike perch for the year has the form:

$$SLt_{+1} = 7.7 + 1.0 * SLt$$

Table 2.

Structure of the commercial herd of zander in 2020-2021, pcs.

Year	*Body length, cm*													
	36	***39***	***42***	***45***	***48***	***51***	***54***	***57***	***60***	***63***	***66***	***69***	***72***	***75****
2020	85	75	40	28	29	25	26	27	ten	9	6	one	3	3
2021	79	68	36	35	thirty	29	24	25	eleven	eight	5	2	2	3
* - 75 cm and more are indicated.														

According to the results of research catches and comparison of data for 2 years, the calculations showed: out of 367 individuals of commercial size in the first year, 139 individuals remained in the reservoir in the second year (42 cm or more), a decrease was 228 individuals. Thus, the attrition rate was 0.62. Calculations have shown that the natural mortality rate for the applied technology is 0.21, and the commercial mortality rate is 0.41.

The average weight of fish with a length of 36 cm or more is 2.2 kg, a length of 42 cm or more - 2.5 kg, in total in catches - 2.4 kg.

The commercial catch of zander in the studied system of lakes in 2020 amounted to 340 tons. The average catch included 213,000 zanders. According to calculations in 2020, in the entire system of lakes, the commercial stocks of pike perch are at least 520 thousand individuals with an ichthyomass of 830 tons (i.e., that part of the herd that can be safely removed without the threat of biological or economic overfishing). Estimated natural mortality of zander is 124 tons.

The rest of the fish can be divided into two groups:

- roach, *Rutilus aralensis*, is the main object of fishing in the Aydar-Arnasay system of lakes, in the mass - short-cycle fish, in catches it is represented mainly by two age groups (2-3-year-olds), according to which it is not practical to determine the state of the stocks and the impact of commercial loss;
- The rest of the fish, which in the catches in some years can take 2-10%. It is not possible to calculate their stocks using this method due to too strong fluctuations in catches, because it is possible to calculate only the reserves of that herd or that part of the herd that is fished.

We present tabular data obtained similarly to the above for carp and pike perch (**Table 3**).

Table 3.

Assessment of fish stocks in the AASO and their use in 2021

View	**Stock, t**	**Commercial catch, t**	**Natural mortality, t**	**Remaining, t**
Cyprinus carpio	1191	300	251	644
Sander lucioperca	830	340	174	316
Rutilus aralensis	3400	1730	714	956
Carassius gibelio	1120	466	157	497
Other	5640	200	205	5440
TOTAL	12181	3036	1501	7853

Discussion

The Aydar-Arnasay system of lakes has been the largest fishery reservoir in Uzbekistan in recent decades. However, it should be understood that this is a very young, artificially created reservoir. Until 1965, such lakes did not exist, and in the Syrdarya region of Uzbekistan, there was the Arnasay channel of small lakes with a total area of up to 20,000 hectares. All the lakes were in a state of disrepair; silted, and overgrown with reeds and cattails. There was no fishing on the lakes. Also, there was a saline lake Tuzkan (periodically appearing from the runoff of flood waters in the spring and drying up by the end of the summer) (Luzanskaya, 1965). As a result of the release of extreme flood waters in the spring of 1969, the Aydar-Arnasay system was formed from the emergency discharge of the Chardarya reservoir, which has been used since then as a drainage water storage lake. In fact, it was the flooding of steppe landscapes in a natural depression. At the end of the 20th century, the area of the lakes was about 170,000 ha. When water was released into the newly formed system of lakes from the Chardarya reservoir, an indefinite but significant number of fish got into it, which gave an outbreak of catches taken by the newly created and fishing brigades of the State Fisheries Committee of Uzbekistan for several years. The system of reservoirs began to be used as a fishery. Taking into account the potential of the lakes and the extremely poor naturally formed ichthyofauna, a system was created for stocking the lakes with cultivated cyprinids and fishing brigades. In the 1980s, there was even such a system of pasture aquaculture as a lake-commercial farm. Catches amounted to 3-5 thousand tons per year, once reaching about 8 thousand tons (from a total lake area of 170,000 he.). By the beginning of the 1990s, due to the drying of the Aidar and Tuzkan lakes, the salinity of the water increased (up to 10 - 15 ‰), the fishery significance of the lakes fell sharply, and the question arose of closing the fishery on these lakes.

In the first half of the 1990s, as a result of the discharge through the emergency locks of the Chardarya reservoir of huge amounts of water discharged along the Syr Darya from the Toktogul reservoir (Kyrgyzstan), the area of the Aidar-Arnasai system increased significantly and reached up to 370,000 ha. As a result of these processes, a much larger steppe was flooded, and the entire coastal

infrastructure of the fishing crews was disrupted. At the same time, there was a noticeable improvement in the ecological state of lakes as freshwater reservoirs, the ichthyofauna quickly revived, and fishing was resumed both in Jizzakh and Navoi regions. The rational use of emerging fish resources was also affected by the transition of the economy from planned to market principles, including the privatization of the entire fishery sector of now independent Uzbekistan. As a result, completely unprepared people entered the newly created fishing enterprises, as well as the fishery administration managing the system. Fishing is completely transferred to the use of fixed nets. The modern fishery system was established under greatly changing conditions of its organization. Until 2003, there was a system for setting fishing limits and distributing quotas between fishing enterprises by the State Committee for Nature Protection. Quotas were based on catch statistics (essentially). Further, as a result of a number of decisions of the Government of the Republic, fishing began to be carried out on the basis of lease agreements without quotas, which fishing enterprises concluded with the local regional administration. The leadership of the management of the fishery was entrusted to the newly created Association "Uzbekbaliksanoat" and LLC "Aydar Arnasoy system lakes" under inaccurately negotiated terms of the relationship. At the same time, small-scale activities for stocking lakes with fish continued, but no biological justifications were developed. At present, there is a huge shortage of specialists who are familiar with at least the basics of fishing at all levels (management, fishing, storage, fish processing, and marketing). status of fish stocks in the system of lakes.

The total fish catches in the Aydar-Arnasai system of lakes from the 1990s - 2000s after the completion of the phased privatization of the fisheries sector increased by 2014, which can be considered the result of the involvement of capital in fishing by newly organized fishing enterprises (**Fig. 2**), at the level of 7.8 - 8 thousand tons catches were maintained until 2017, fish productivity in 2014-2017 reached the level of 20 kg/ha, and this is the average level of the technology that has been used at AASO since the 1980s (pasture aquaculture option). Subsequently, the catches began to fall sharply.

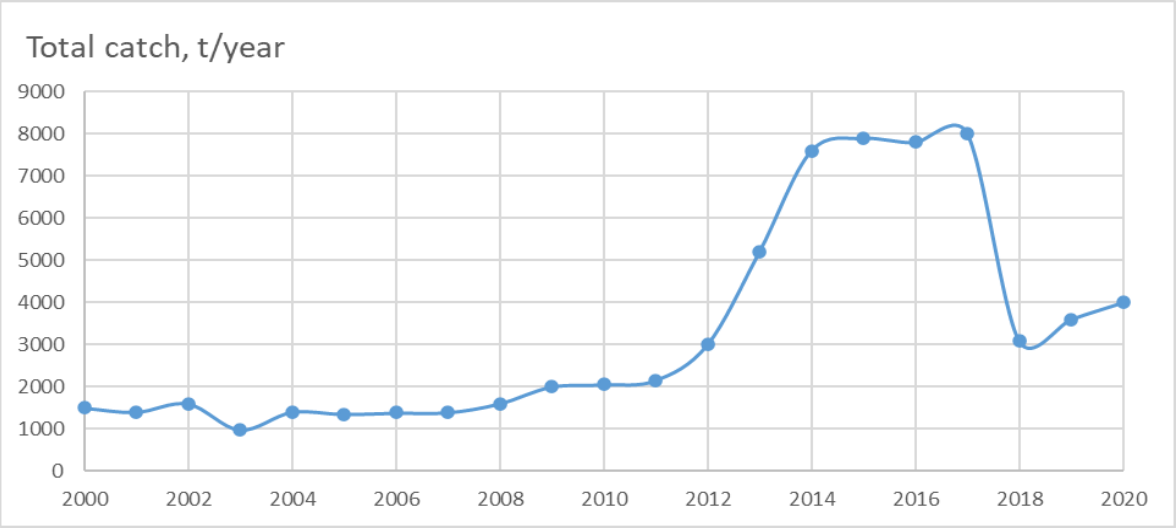

Figure 2. Total fish catches in the Aydar-Arnasay system of lakes

Note that reserves do not mean the entire number of fish of a particular species that lives in the studied reservoir, but only the number of fish that can actually be caught by the technologies used. This value is less than the total number of fish species in the reservoir. In addition, if there are stocks of fish species in the lakes that are not caught, they are also not counted as stocks. Those. stocks of fish stocks is a fishery assessment that shows how efficiently fish stocks are used. Since in Uzbekistan the fish stocks in the AASO are the absolute property of the state, the assessment shows how effectively these resources are used.

Fish stocks are a renewable natural resource. Those. every year there is a renewal of fish production in the lake, regardless of whether the fisheries use it or not. If these products are not used, then the fish will die naturally.

According to the statistics and the results of our research catches, fishery in the system of lakes in recent years is based on three types of fish: roach (an average of 50% of the catch), pike perch (23.7%), carp (carp) (17.7%); then. their total share exceeds 90% of fish catches. Another 6 species of fish (Aral asp, goldfish, eastern bream, common catfish, Amur snakehead) in total make up to 10%, although in some years one or another species can give an outbreak of catches (like silver carp in 2019, when its catches popped up to 466 tons).

Let us especially note the catches of roaches in the Aydar-Arnasai system of lakes. Until 2000, only large roaches were caught, which was regulated by the minimum mesh size allowed for fishing in the net material. At the same time, fishing did not master the slow-growing form of roach, which is very abundant in lakes. At that time, fishing was regulated by the State Committee for Nature Protection to prevent the negative impact of fishing on the ichthyofauna by controlling the fishing measure. After the biological substantiation of the then-existing State Joint Stock Association "Uzbalik", starting from the autumn of

2000, the State Committee for Nature Protection allowed catching smaller roaches, after which its catches began to grow, and roach became the main object of fishing in the lake system.

It should be borne in mind that the most important limiting factor for any large-scale activities (acclimatization, development of the latest fishing technologies, construction of coastal infrastructure, etc.) at the Aydar-Arnasai system of lakes is currently quite unusual in world practice for water bodies of this kind. size - the instability of the size of lakes. Due to the instability of lakes, it is risky to build coastal infrastructure. Spawning grounds may change annually. It is impossible to create a developed coastal infrastructure, and prepare and clean the tony.

Our analysis showed that the herd of carp in the studied system of lakes is caught weakly. The commercial loss is comparable to the natural one. And in the lakes remains a very large part of the fish stocks. Recall that we took as a commercial measure not 28 cm of fish, but a larger one - 31 cm. Otherwise, the size of the stocks will increase even more.

With regard to zander, it should also be noted that stocks are used inefficiently, and catches can be increased without fear of economic overfishing.

Stocks of other fish species in the AASO are not used at all without any reservations.

Thus, without changing the technology of fishing, but only by optimizing the mode of operation and organizing fishing, it is possible to increase fishing by 4-5 thousand tons of fish more than today without damage to fish stocks. Indeed, in such southern reservoirs as ours, up to 50-70% of fish of a commercial measure can be caught. According to long-term research data in the region, including in the Aydar-Arnasay system of lakes, the ratio of the commercial stock (i.e., the possible catch of fish per year) to the value of the total fish biomass (and this indicator is relatively constant over a number of subsequent years and found empirically for each major fishery water body subject to relative hydrological stability) is at least 30%.

The main underlying reason for the low efficiency of the use of AASO fish stocks is in the organization of fishing. It is not professional, there is no biological justification, there is no clear strategy for managing the fishery. A water leasing regime, when even the Fisheries Rules are not applied, could only be effective if well-designed industrial programs were in place. To optimize just fishing, the mode of renting water bodies does not make much sense. It should be introduced only for the implementation of various pasture or other aquaculture technologies.

Even with the objective poverty of the fish resources of the Aydar-Arnasai system of lakes, the State can raise the issue of organizing a much more efficient fishery of at least 7.5 - 8 thousand tons of fish, with a focus on inefficient fishing with fixed nets. The issue of transferring fishing to active fishing gear (trawls, nets, etc.) remains open, since the lakes do not have a resource base for such fishing technologies (there is not even a corresponding schooling object).

Comparison of the results of catches from the beginning of privatization to the present shows that in the last decade the indicators of the food supply do not change significantly, there is some stability. Taking into account the size and stability of the food base of water bodies and the given catches per fishing effort, the following conclusion can be made: the total ichthyomass of the mature part of the populations of commercial fish species in the Aydar-Arnasai system of lakes in the first years of the 2020s will be about 20-21 thousand tons in total (t.e. without division into types). Based on this, the number of fish that can be removed from water bodies without damage (total commercial stock) in these years is about 7 - 7.5 thousand tons. All technologies are based on specific fish species, at present the main fisheries are roach, pike perch and carp, in some years there may be noticeable catches of silver carp.

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