International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Common Carp (*Cyprinus carpio* L.) Characteristics under Conditions of Culture Based Fisheries in Tudakul Reservoir, Uzbekistan

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Abstract: ***As a result of reorientation of fish capturing to culture based fisheries in Tudakul reservoir, Uzbekistan (reservoir area 21 000 ha), fish catch increased from 150 - 210 tons/year before 2003 up to 624 – 1458 tons/year since 2006. Fish productivity increased from 5.3 to 31.4 – 69.3 kg/ha. Since 2004 reservoir is stocked every autumn by summerlings of common carp (Cyprinus carpio) and chinese carps. Fattening period lasts 2 years. Fish catch is oriented only to large (more than 1.5 kg) fish. Correlation between summerlings biomass stocked and catch of stocked species after 2 years of fattening period was determined (r = 0.77). The largest common carps catches were after 2 fattening years as a result of stocking density on the level 200 summerlings/ha.***

Keywords: Common carp, Cyprinus carpio, growth, fish productivity, reservoir, Uzbekistan

1. Introduction

Due to geographical peculiarities, fish productivity of lentic water bodies under natural conditions in the Aral Sea basin is 1 – 5 kg/ha. From 1960s, methods of artificial commercial ichthyofauna construction were developed and conducted in order to increase fish productivity in several plain water bodies in Uzbekistan. Promising commercial fish species from other regions of temperate zones of Eurasia were chosen and introduced. As a result, since 1980s fish productivity in such water bodies increased up to 10 – 15 kg/ha That concerned also to Tudakul reservoir in the lower stream of the Zarafshan river basin. In 1980s – 2003, fish yield in reservoir was 150 - 210 tons per year including 60 – 70 t of common carp (*Cyprinus carpio*). Fisheries company "Aqua-Tudakul" was created in 2003 and has constructed fish hatchery for common carp, silver car (*Hypophthalmichthys molitrix*), bighead carp (*H. nobilis*) and grass carp (*Ctenopharyngodon idella*) summerlings production and stocking reservoir every autumn. Such regime can be concerned to culture-based fisheries. In 2003 – 2016, common carp summerlings stocking varied because company specialists couldn't estimate the effect of stocking. As a result, fish catch also varied.

Common carp is endogenous fish in Uzbekistan which has high priority for fish consumption of the local community. Many aspects of biology were studied under natural conditions of water bodies (Kamilov, 1973; Salikhov et al, 2001; etc), but data for conditions of culture based fisheries with huge stocks of cultured species are not studied yet. The goal of this work was to analyze common carp growth, age structure of in catches, relationship between stocking and yield catch in Tudakul reservoir in conditions of culture-based fisheries.

2. Materials and methods

Common carp individuals were collected in March and April in 2013 – 2017 in Tudakul reservoir by using gill nets with 24, 32, 36, 40, 50, 60, 70, 90, 100, 110 and 120 mm in mesh size so as from industrial seine catch. The standard length (SL) to the nearest 1 mm and total body weight (W) to the nearest 1 g were recorded for each fish. Scales (4-5 units) were collected under the first ray of dorsal fin above lateral line. Scales were used for determination of the age and back-calculation of growth rate using Dahl-Lea model (Pravdin 1966). Stocking return was calculated as a percentage of quantity of common carp in seines catch from the total quantity of fish stocked 2 years before.

Data of fish catches were kindly provided by the administration of "Aqua-Tudakul" fishery company. Data of common carp growth in Tudakul reservoir under conditions of artificially constructed ichthyofauna was obtained from G.Kamilov (1973).

Tudakul reservoir characteristics

Tudakul reservoir was created for water storage and transition in the lower stream of the Zarafshon River, Uzbekistan (39°51'15"N 64°50'29"E) (Fig 1).

Figure 1: Tudakul reservoir and hatchery of "Aqua – Tudakul" fisheries company

Uzbekistan is an arid country with an extremely continental temporary climate. Summer is hot (average monthly air temperature is 29 - 30.2 ^{o}C in July; it often reaches 35-42^{o}C in daytime and can be even higher). Winter is rather cold (average monthly temperature in January is -2.6^{o}C, water bodies with stagnant water are often covered with ice for up to 1.5 months). The total area of the reservoir is 21,000 ha; the average depth is about 5 m; the maximal depth, 22 m. "Aqua-Tudakul" fisheries company stock Tudakul reservoir summerlings each autumn since 2003. "Aqua-Tudakul" is a single company carrying out fishing activities in the reservoir; it uses 5-8 commercial seines with large mesh (70-90 mm mesh in wings of the seine net) because catch is oriented to large fish (of more than 1.5 kg).

3. Results

Fish yield and productivity

In 2003, total fish yield was 166 tons; real fish productivity was 5.3 kg/ha. First stocking of summerlins was conducted in 2003. Since 2006, first generation of stocked fish entered commercial stock represented in fish catch. In 2006 – 2017, total fish yield increased up to 624 - 1458 tons/year; fish productivity increased up to 31.4 - 69.3 kg/ha. Common carp yield was 64.1 tons in 2003, in conditions of culture-based fisheries common carp yield increased up to 208.1 – 574 tons in 2006-2016.

Species composition of catch

In 2003 – 2017, 10 fish species were represented in fish catches in the reservoir. Fish species can be devided to groups according to there importanse in yield. In 2003-2011, yield of 7 species was less than 50 tons/year each, since 2014 yield of 5 species was less than 50 tons/year. Group of the the most important group includes species which yield was 200 tons/year and more. In all years (2006 – 2016) common carp was represented in that group, silver carp and bighead carp entered that group in 2012-2016, pike-perch entered in 2013 – 2016.

Common carp growth

Common carp growth rate is shown in fig. 2. During first 3 years of age, growth increased at the higher rate, whereas, during further years, growth rate slowed due to the fish maturation. The Lee phenomenon has not been found. Also, common carp growth in 1970s, when fish productivity in reservoir was 8 – 12 kg/ha/year, is shown. One can see that common carp growth in conditions of culture-based fisheries with regular reservoir stocking in much higher.

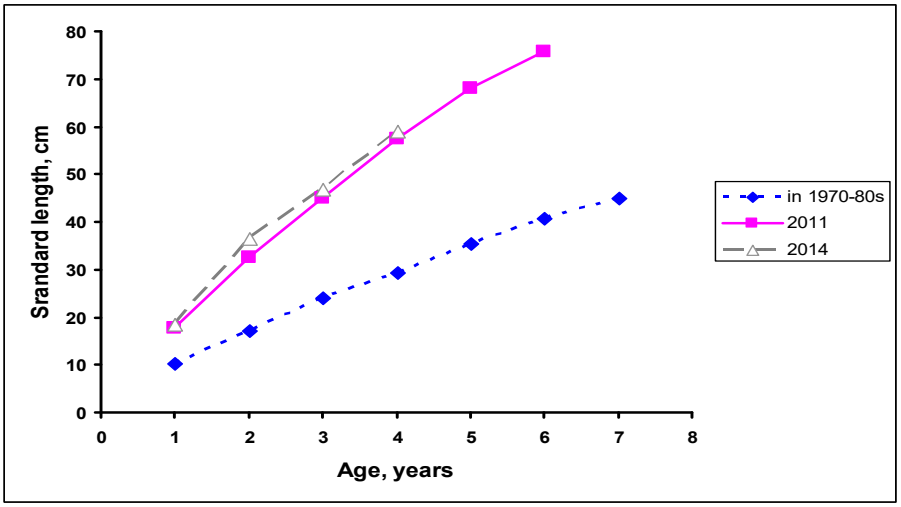
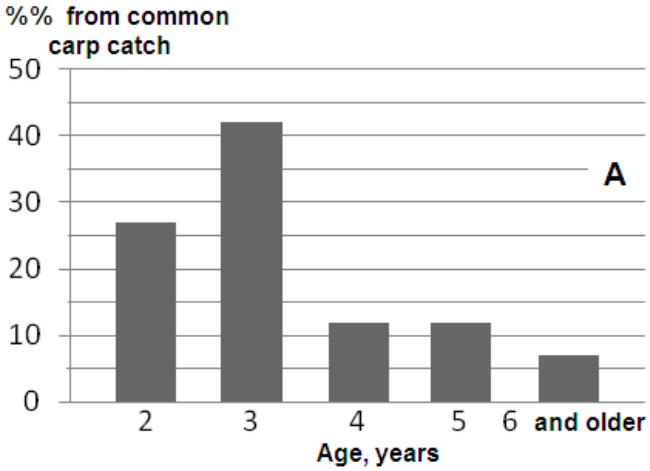


Figure 2: Common carp growth rate: under natural conditions (in 1970-1980s) and under conditions of culture based fisheries (generation of 2011th year and 2014th year)

Age structure of common carp in catch

In 2013 - 2017, common carp catch was consisted from 3-year-old and older fish with the average weight of 2.5 kg. In 2013, common carp with body weight ranged from 1.1 to 12.9 kg (on average 3.6 kg) were represented in commercial catches. The age structure included generations from 2+ to 7-years in catch (Fig. 3 A). The carps that were at age 2+, were seined in the late Autumn-Winter. In 2016 and 2017, common carp weighed from 1.6 to 12.9 kg (on average 4.2 kg) were represented in commercial catches and fish were at the age of 3 to 7 years (Fig. 3 B).



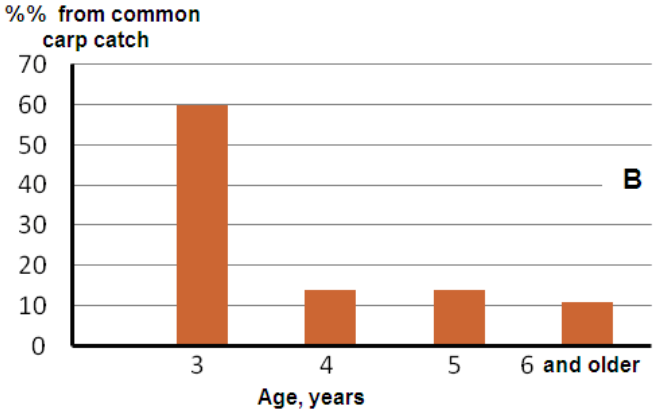


Figure 3: Age structure of common carp catches in Tudakul reservoir, Uzbekistan (A- in 2013, B – in 2016, 2017)

Relationship between stocking and fish catch

Common carp capturing in reservoir was mostly based on 3-years-old and older fish. The great part of stocked common carp would be caught at age of 3 years, though not all 3-year-old fish would be seined in that age, some fish in generation would be represented in catch in the next years (Fig. 3 A-B).

For calculating of stocking return we assumed that the majority of stocked common carp would be caught at age of 3 years. Before initiation of culture-based fisheries program in Tudakul reservoir, common carp catch was on average 70 tons in 1994 - 2003 (data not shown). We assumed that 70 tons of common carp catch was provided by the natural common carp stock in the water body. The common carp catch over 70 tons we decided to consider as a result of summerlings stocking and designated as catch return of stocked fish in this work. Data of common carp summerlings stocking (2011-2015) and catch (2013 - 2017) are shown in Table 1.

Table 1: Stocking and catch in 2 years of common carp from one generation in Tudakul reservoir. Mean W of caught fish is 2.5 кг

Year of stocking	Biomass of stocking (t)	Mean W (g)	Stocked fish (mln)	Stocking density (fish/ha)	Fish yield in 2 years			Stocking return (%)
					Total (t)	Common carp (t)	Common carp (ths.)	
2011	112	30	3.73	169	656.4	367.8	119	3.2
2012	113	50	2.26	103	642.6	265.0	78	3.5
2013	73	100	0.73	33	1245.0	326.2	103	14.0
2014	38	100	0.38	17.3	1080.7	141.3	29	7.5

For example, in 2011, 112 tons of common carp summerling were stocked to the reservoir. The mean stocking weight of fish was 30 gram. Thus, 3.7 millions of common carp were stocked. In 2014, when that stock entered fishing size, 368 tons of common carp were seined. So, we assume that result of stocking was: 368 – 70 = 298 tons of common carp. An average weight of common carp was 2.5 kg, which corresponded to the 119 thousands individuals in fish catch. The stocking return could be estimated as: 0.119 millions : 3.7 millions = 0.032 or 3.2 % in 2011. In 2012 - 2014, stocking return was 3.1 - 3.7 %, correspondently.

Since 2013, the stocking strategy of "Aqua-Tudakul" company has been changed. Company managers have put attention that quantity of pike-perch increased in catches and supposed that considerable amount of stocked fish would not be survived due to the presence of that carnivorous species. They decided to increase summerling weight up to 100 g on average and decrease stocking density. Those changes provided us with good data to analyze relationship between stocking quantity of fish and stocking return. As bigger summerlings are more strong and viable, stocking returns form generations of 2013 and 2014 were higher - 14 % and 7,5 %, respectively (Table 1).

Rather strong positive correlation between biomass of stocked summerlings and common carp catch was observed for generations stocked in 2010 - 2015 (r = 0.74) (fig. 4).

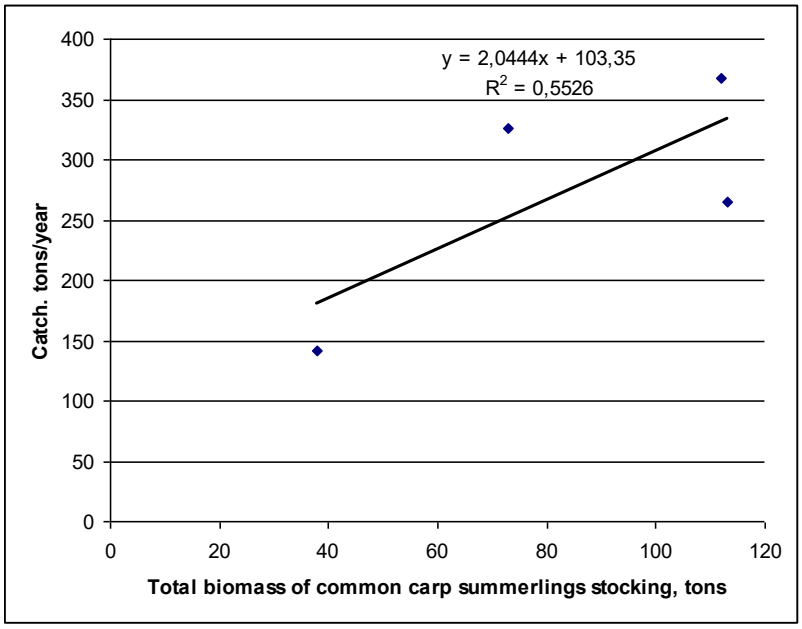


Figure 4: Relationship between common carp summerlings stocking and fish catch in 2 years after stocking in Tudakul reservoir, Uzbekistan

4. Discussion

Fisheries are beginning to be recognized as an important secondary user of reservoir water resources; stocking of reservoirs is one of the widespread forms of the culture based fisheries (De Silva, 1988). Culture-based fisheries are capture fisheries which are mostly or entirely maintained by the regular stocking of seed fish (Lorenzen, 1995). Culture-based fisheries rely entirely on the natural productivity of the water body for growth, and on artificial stocking for recruitment. In countries where increasing of fish production from available water bodies is important, plankton and benthos feeders are used for stocking (Baluyut, 1983). The same way was chosen in Tudakul reservoir; common carp is a benthos feeder. At the same time common carp (especially large size) is a very popular fish at the local market.

Reservoirs can be classified, for example, as small (<1000 ha), medium (1000 to 5000 ha) and large (>5000 ha), like in India (De Silva, 2000). Lakes and reservoirs with area 100-5000 ha are recommended for culture based fisheries in countries rich with inland lakes in temperate zone (Russia, Kazakhstan, Byelorussia etc.). Well controlled system can be created in such water bodies (Rijkov, 1987). But in arid Uzbekistan there are no such natural lakes or reservoirs under conditions of completely stocked Basin of the Aral Sea. There are only large reservoirs or artificial lakes for residual waters storage (with area 15-250 thousands ha). All those water bodies were created not long ago (in 1960-1990s); ichthyofauna is permanently under human activity impact. Therefore, culture based fisheries has to be oriented to the large water bodies which have the first function in regional irrigation. Another aspect is the level regime which can change from year to year and depends from precipitations in the basin. Some reservoirs can be almost empted what negatively impacts the natural reproduction of the fish.

In the former USSR, there were the following norms of return for common carp stocking for water bodies of the Aral Sea basin: by eggs - 0.004%, larvae - 0.06%, fry (1 g) - 0.05% and 5 g - 2%. But at that time there was strong centralized regulation of water flow in rivers and irrigation system with guaranteed minimal water limits. Nowadays, this regulation is destroyed and water resources are used by 5 countries. Therefore, fisheries enterprises look for methods which guaranteed maximal independence of level regime changing. Stocking by summerlings can be an alternative for such conditions.

There is a first precedent of culture based fisheries in Uzbekistan up to now. After creation of “Aqua-Tudakul” fisheries company and installing of culture-based fisheries regime, fish yield in Tudakul reservoir increased from 150-210 tons to 624 – 1458 tons/year. Mainly it was related to the regular stocking. As our work shown, fish fattening period lasts 2 years and more. Fish capturing is oriented only to the large fish (more than 1.5 kg) by using seines with the large mesh. The Lee phenomenon has not been found, when catch takes out fast growing fish from generation at the younger ages. It indicates that common carp stock is in preferable conditions in Tudakul reservoir and the problem with overfishing is not existed. The same was shown by comparing of common carp growth rate before 2003 and in modern conditions; common carp growth is much higher in modern conditions.

A positive relationship was found between biomass of common carp stocking and fish yield after fattening period of 2 years. Stocking of 30-gram summerlings resulted in 3.2 % of stocking return. Increasing stocking size of summerlings enhanced stocking return (even if quantity of fish decrease).

Two parameters are important characteristics of common carp stocking: quantity and body size of stocked fish. Though better return was revealed after stocking of larger

fish, the economical aspect has to be taken into consideration.

Hence, stocking by common carp summerlings with average body size of 30 g and with density of 200 fish per ha can be recommended. The experience of first culture based fisheries company can be replicated in other plain reservoirs and lakes for residual water storage. Total area of such water bodies is about 560 thousands ha in Uzbekistan. Culture based fisheries can be an alternative for such water bodies as a new promising activity. In Tudakul reservoir, further monitoring of the availability of natural food resources and relationship with stocking density is needed.

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