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Original Article

Evaluation of Production and Economic Performance of Farmed Carp Using Small Lake-Commercial Fish Farms System in Southeastern Kazakhstan

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Abstract

The objective of changing the simple exploitation of fish stocks to highly efficient fish farms in lakes and reservoirs is to improve the productivity of inland freshwater fish. The small- and medium-sized lakes can be used to increase the production of farmed fish with lake management. Therefore, this study proposed to investigate the production and economic efficiency of carp in lake commercial fish farms. In this investigation, the results of carp farming experiments in fish farms in small lake commercial fish farms (LCFF) are evaluated using advanced methods and techniques. The research was carried out based on the Voroshilovsky reservoir, which operated in the LCFF mode. The farm had hatchery and carp fry ponds for expanding fingerlings based on the "Scientific and production center of fishery" LLP from 2019 to 2020. This study was performed on different types of common carp and herbivorous fish (grass and silver carp), and sexual products were collected in fried ponds and the Voroshilovsky reservoir. The absolute growth gain of common carp, silver carp, and grass carp were 301.00, 300.40, and 577.00 grams, respectively, and their mean daily weight gain values were 2.50, 2.50, and 4.80 grams. Common carp recorded the highest level of planned fish productivity (169.30 kg/ha), and the lowest level of this trait was grass carp (43.50 kg/ha). Data of mean weight and body length of common carp, grass carp, and silver carp fishes showed a variation of 4.55 kg and 56.25 cm, 6.06 kg and 75.50 cm, as well as 6.30 Kg and 75.05 cm, respectively. This difference can be justified according to the variance of fish length, which on average, 80 grams of weight is obtained per centimeter of fish length. The economic efficiency of carp was calculated, and the net profit was determined at more than 50% of total income. According to the net profit indicator, due to the implementation of a part of the fingerlings, the carp reared in the pond area; as a result, this method is profitable and accounts for 104% of the total planned economic profit. Therefore, fish production from aquaculture can rise to 10 times to maintain high-quality food security and other essential nutrients, provide job opportunities, and cash income to help job-seeking youth.

Keywords: Aquaculture, Commercial fish, Carp, Lake-commercial fish farm, Reclamation, Reservoir, Stocking material

1. Introduction

Kazakhstan covers an area of 2,724,900 square kilometers and has 30,000 square kilometers of freshwater resources. The country has a gross domestic product (GDP) of $US 24.2 billion (2002), which could increase significantly if resources are used properly. Fish farming in Kazakhstan forms a small part of the economy. The share of fish farming in GDP is less than

10%. However, the Republic of Kazakhstan has vast water resources and good potential for fish production. In Kazakhstan, the development of the commercial fishing industry in natural reservoirs looks promising, enabling a significant increase in commercial fish production at a low cost in a short time. The development of a lake-commercial fishing farm (LCFF) as part of commercial fish farming depends only on the scale of the fish production, and a proper estimate of the aquatic reservoir's potential is essential to achieve maximum productivity in the fish farming industry. Based on scientific studies, the economic estimate of the use of reservoirs is measurable, and the capacity of farmed fish is determined (1).

Optimal use of water resources is an issue that should not be overlooked by specialists and experts because the climatic situation in Kazakhstan requires that the maximum utilization of water resources takes place. Carp is one of the most popular farmed fish in the world. Its breeding distribution in the world includes almost any region that is warm enough. Carp breeding in Asia is developing rapidly. Over the past two decades, production has grown by an average of 12% a year. Carp ensure the production of more than 70% of aquaculture volume not only in Asia but also in the world and is considered the main source of fish protein production. Meanwhile, carp farming can play a decisive role in the prosperity of the country's economy, and its breeding is of particular importance (2-4).

Fish farming techniques refer to the solutions that fish production does at the maximum sustainable level using various tools and methods in the form of scientific principles. The main goal of management in aquatic production is to achieve profitability by integrating basic breeding factors, such as a pond, water, environment, fish larvae, investment, and labor. Fish farming systems can be divided into extensive fish farming systems, extensive fish farming systems, semi-dense fish farming systems, and dense fish farming systems.

Aquaculture in the last two decades has shown the highest growth among other sectors of food production. According to the World Food Organization, among 70 types of breeding systems, it is the only one that has the greatest motivation for poverty alleviation. On the other hand, pressure on marine resources and fishing for food has put many marine species at risk of extinction. The development of aquaculture, in addition to providing food security, is very effective in preserving marine ecosystems (5). Understanding ecological principles is essential to achieving aquatic success. By determining the ideal weight of fish, these principles determine the possibility of harvesting from a unit of water in a certain period and level of culture. To be successful, the farmer needs to understand the relationship among farmed fish, rearing capacity in reservoirs, the number of nutrients per unit area, and the impact of all of these elements on water quality (6). Therefore, this study aimed to investigate the production and breeding of carp in lake commercial fish farms.

2. Material and Methods

In this study, aquaculture information was collected from library studies using internal and external sources. The research was carried out based on the Voroshilovsky reservoir, which operated in LCFF mode, and then by field studies in several carp breeding ponds, some basic breeding parameters, such as water temperature and aquatic nutrition was examined. The farm had hatchery and carp fry ponds for expanding fingerlings based on the "Scientific and production center of fishery" LLP from 2019 to 2020.

This study was performed on different types of carp and herbivorous fish (grass carp and silver carp), and breeds sexual products were collected in fried ponds and the Voroshilovsky reservoir. The feed needed by the fish was obtained from fish feed companies.

2.1. Experimental Fish Farming Method

Green fertilizers were used to enrich the Voroshilovsky reservoir, which contained carp and herbivores. A total of 35 tons of prepared fish feed were purchased to feed commercial fish in the tank. The artificial reproduction of carp and herbivores was used by the producers, which was located in a special part of the fence channel. The stocking material was stored in small ponds with an area of 12.9 hectares when grew to the age of fingerlings. The fried ponds were fished during the fall. Fish fingers are classified and deposited for growth and performance. The classified fish were transferred to ponds to reach the recommended size. The broodstock classification was carried out from May 15 to 17, 2019. Breeders (males and females) of common carp, silver carp, and grass carp were kept together in winter, part on another farm and part in a water supply channel adapted to the content of fish. During classification, female and male carp were placed separately, and breeders of herbivorous fish were placed in the water supply channel (7). For pre-spawning maintenance of females, Yeisk raceways and a special buried concrete tank were used in the located incubation shop. The number of carp males and females was 30 and 49, respectively. Control over the thermal regime of the raceways and a special basin was established, where the females were kept. The temperature was measured three times a day during daylight hours. The graph of the temperature regime is shown in figure 1. When the females were planted in the raceways, the water temperature was 20.5°C. The thermal regime was then stabilized using the water heating system and maintained at an average of 22.1°C.

In addition, 32 carp females were placed in a special basin to reserve them for late caviar retrieval. The temperature regime in the basin is 14.3-16.4°C (average, 15.5°C). Graphs of the temperature regime in a basin with a reserve of females are shown in figure 2.

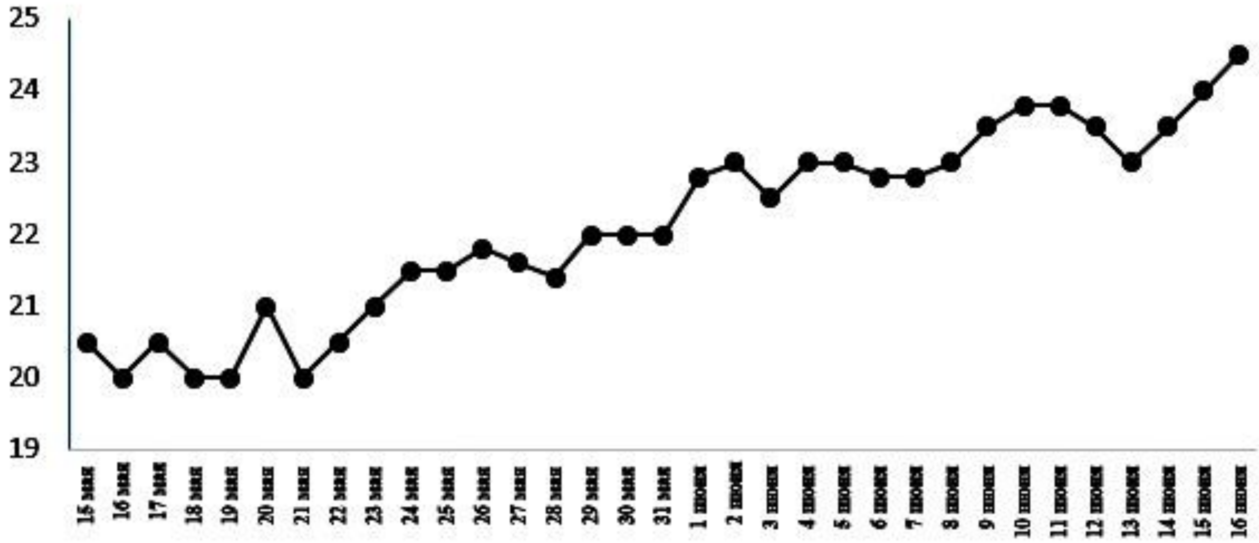

Figure 1. Dynamics of temperature regime in raceways

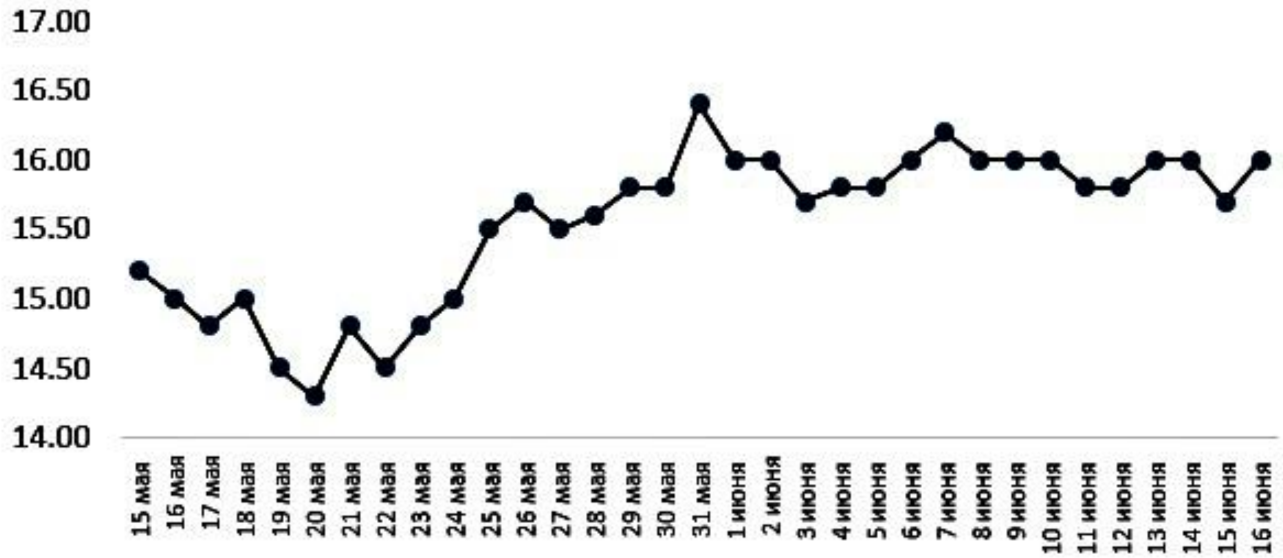

Figure 2. Dynamics of the temperature regime in the reserve basin

The reserve of females was saved until June 10, and 32 females were planted and managed to get caviar from all. The caviar was obtained from high fish-breeding quality. On the farm, 9.3 million carp larvae were obtained, and 4.8 million larvae were stored in fry ponds for further growth. The stocking of the Voroshilovsky reservoir and the surpluses were implemented. During the work on obtaining carp offspring, four Weiss devices and 10 Amur devices were used (the workload of the incubation shop is 100%). Furthermore, six fiberglass trays of the Yeisk type were used for the maintenance of breeders in the shop. The maximum water consumption was 238 l/min [(22×3)+(10×10)+(6×12)], and the pumping water starvation was 260 l/min.

The carp spawning was divided into four rounds, and the average yield from one round was 2.4 million larvae. Moreover, a spawning campaign of herbivorous fish was conducted in the spring and summer. The total numbers of grass and white carps were 1.3 million larvae and 600,000 larvae, respectively.

The obtainment of sexual products was carried out by the factory manual based on injecting breeders with a hormonal drug. The process of incubation of carp eggs took place in the Amur apparatus. After the extraction of mucilage, the caviar immediately stretched into the device. The flowage was set at a level of 10 l/min per 1 million eggs. When unique larvae emerged, the flowage was temporarily reduced to accelerate mass hatching. After hatching, the flowage was developed to 12 l/min to prevent winter kill of the prolarvae. For controlling the oxygen regime with the help of a thermoximeter "OxyGuard Handy Polaris", the content of oxygen dissolved in water for the entire incubation period did not fall below 7.1 mg/l (varying in the range of 7.1-8.2 mg/l). The storage of prolarvae was carried out for 3-4 days before switching to a mixed diet. The larvae are monitored daily as the swim bladder is filled with air under binoculars and buried in ponds (8, 9). Fish-breeding and biological characteristics of carp and herbivorous fish are shown in table 1.

A total of six fry ponds with a total area of 5.4 ha were used for rearing carp and herbivorous fish. In addition, three fry ponds were stocked only with carp larvae, and two ponds were left to be stocked with larvae of carp and herbivorous fish together (polyculture). The carp and herbivorous fish larvae were high with a planting density of 370,000 and 150,000 per hectare, respectively. Stocking was carried out from May 25 to June 19, 2019. Feeding of larvae and juveniles was organized with specialized granulated feeds, and juveniles were fed dry bread in special feeders. Feeding of carp and herbivorous fish larvae was started immediately after fish were stocked at a water temperature of 21.8°C. Feeding was daily and handfed. When juveniles of carp fish reached 7 grams, they were transferred to feed with formulated diet. The growth gain of carp and herbivorous fish is shown in figure 3.

Table 1. Fish-breeding and biological data of the carp broodstock

Indicator	Carp		Grass carp		Silver carp	
	Female	Male	Female	Male	Female	Male
Average weight (kg)	5.20	3.90	7.00	5.10	6.40	6.20
Average length (cm)	60.50	52.00	81.00	70.00	75.00	75.10
Yield of larvae from one female (thousand/pcs)	117.70	-	325.00	-	300.00	-

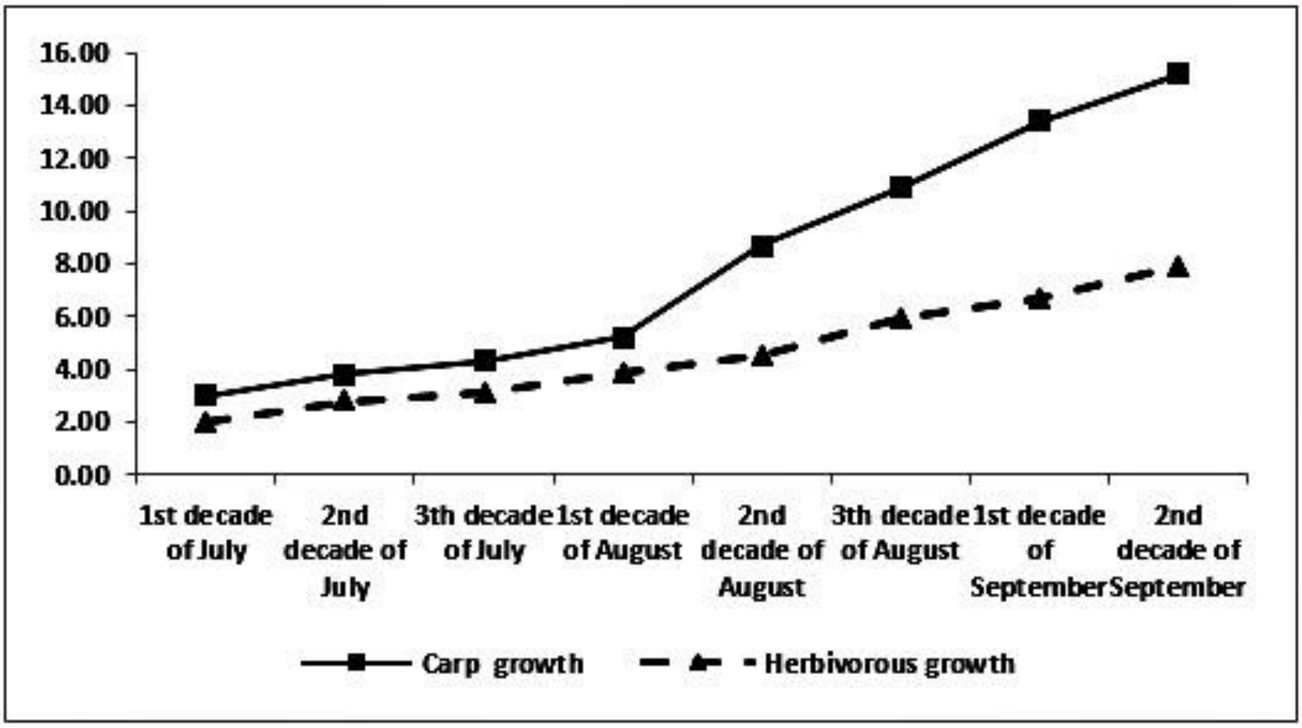

Figure 3. Growth weight of carp and herbivorous fish fingerlings in fry ponds

During the spawning of the carp fish in the incubation shop, preventive measures were carried out with breeders, as well as treatment of fertilized eggs at the stage of the colored eye. Preventive treatment of carp and herbivorous fish breeders was carried out in plastic barrels in a solution of a three-component mixture. The conditions for conducting preventive treatment of products are shown in table 2. On the second day of incubation, carp eggs were treated with a weak solution of potassium permanganate (1 gram per 100 liters) with exposure 20 minutes away. Treatment was carried out directly in the machines at the lowest possible flowage. The content of oxygen dissolved in water was controlled and decreased to the level of 5.5 mg/l. Fish breeding tanks were disinfected at a rate of 250 g/m2 of quicklime and 50 g/m2 of chlorine water. Working equipment, rags, stretchers, sacks, tanks, and buckets were disinfected in a 3% solution of formalin.

The data of fish breeding and biological data were collected according to accepted methods (10-15). The technology of obtaining sexual products by the factory manual was also applied based on Badryzlova, Koishybayeva (16). The weight gain of reared fish was determined by the results of control catches. Reliable scientific sources were used to calculate the growth rate and other desired traits (16-20). The increase in production value through investment was used and considered a net profit to calculate economic efficiency. The ratio of net products for investment was used as an indicator of effectiveness. Measurements of growth expressed in terms of some interval of time (day and month) constitute a growth rate (21). If t_1 is the time at the beginning of an interval, t_2 signifies the time at the end, and if Y_1 and Y_2 are the respective fish size at those times, then:

Absolute growth=Y_2-Y_1

Absolute growth rate=$(Y_2-Y_1)/(t_2-t_1)$

Relative growth=$(Y_2-Y_1) / Y_1$

Relative growth rate=$(Y_2-Y_1) / [Y_1 \times (t_2-t_1)]$

When growth rate is exponential, then:

$G=(\log_e Y_2-\log_e Y_1) / (t_2-t_1)$

2.2. Statistical Analysis

After entering the information about the progress of aquaculture in different places in Excel software, the statistical summary of the data was calculated using descriptive statistical procedures by Minitab software, and the mean values were presented with standard deviation. Charts and calculations of economic efficiency were prepared by formula writing in Excel.

Table 2. Components of mixture for preventive treatment of carp and herbivorous

Indicator	Unit	Value
$KMnO_4$ (Potassium permanganate)	g/m^3	10.00
NaCl (Table salt)	kg/m^3	1.00
$NaHCO_3$ (Baking soda)	kg/m^3	1.00
Treatment capacity	m^3	1.00
Exposition	min	15.00
Temperature	°C	21.50
Content of oxygen dissolved in water	mg/l	6.30
Maximum amount of fish to process *	kg	50.00

* The total number of fish before changing the solution

3. Results

3.1. Growth Weight of Common Carp and Herbivorous Fish in the Pond

The mean±SD weight of carp fry was 4.55±0.92 g. Moreover, the mean weights of herbivorous fish and silver carp were 6.05 and 6.30 g, respectively. Data of mean weight and body length of common carp, grass carp, and silver carp fishes showed a variation of 4.55 kg and 56.25 cm, 6.06 kg and 75.50 cm, as well as 6.30 kg and 75.05 cm, respectively. This difference can be justified according to the variance of fish length, which on average, 80 grams of weight is obtained per centimeter of fish length. This amount was lower in males than females (Table 1).

Figure 3 is a growth chart of crap and herbivorous fishes. Due to the increase in breeding time, the growth rate occurred in both groups, which was a sign of suitable environmental conditions. However, the growth of fish common crap increased sharply from the first decade of August, compared to the group of herbivorous fish.

3.2. Growth Weight of Common Carp and Herbivorous Fish in the Reservoir

Stockings of the reservoir were carried out in the spring according to the following data: carp yearling with a mean weight of 100 grams (40,000 pieces), silver carp yearling with a weight of 50 grams (16,500 pieces), grass carp yearling with a weight of 110 grams (6,000 pieces). The stocking material of the variegated silver carp was not spent; therefore, only the silver carp was reared. Having a surplus of large planting material on the farm, the density of planting in the water increased for carp by 5,000 pieces and silver carp by 10,000 pieces (Table 3). During the rearing period, fish growth gain was monitored in the reservoir, which is shown in figure 4. There was also a partial feeding of carp in the reservoir, and feeding was carried out daily and manually. The feeding areas were placed at a depth of 0.7 to1 m. Figure 4 also clearly shows the difference in the growth rate of fish common crap, compared to fish silver and grass crap.

Table 3. Rearing carp yearlings from June to September 2019

Indicator	Type of fish		
	Carp	**Silver carp**	**Grass carp**
Duration of rearing (days)	120		
Piece weight, g (x±m):			
Planting	100.00±4.10	50.00±2.20	110.00±3.80
Last control catch	401.00±9.50	350.40±9.90	687.00±12.50
Absolute growth gain (g)	301.00	300.40	577.00
Average daily growth gain (g)	2.50	2.50	4.80
Planting density (sample/ha)	1055	435	158
Ratio of commercial return (%)	40.00	60.00	40.00
Planned fish productivity (kg/ha)	169.30	78.40	43.50

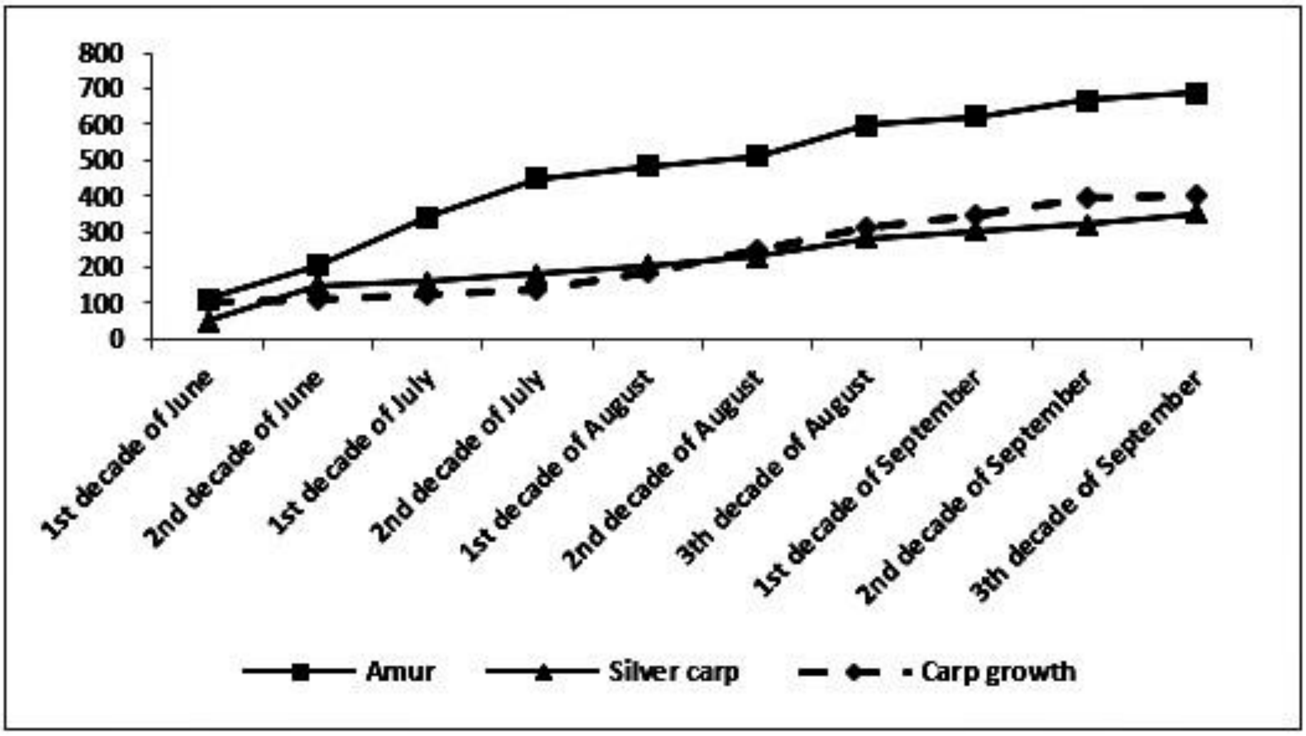

Figure 4. Growth gain of carp fish in the stocked Voroshilovsky reservoir >

The obtained solutions for rearing carp fish in the Voroshilovsky reservoir showed that this watercourse can be used for one-year rearing of commercial production of carp fish on planting material. When organizing a full catch of commercial fish in 2019, the total fish productivity for the Voroshilovsky reservoir for carp, grass carp, and silver carp were 169.3, 43.5, and 78.4 kg/ha respectively (Table 3).

However, considering the low growth weight of carp and herbivorous fish, in conditions of over-compacted planting, as well as with low consumer demand for small fish (weighing up to 400 g), the rearing of carp fish at the Voroshilovsky reservoir will continue until 2020. It is also planned to withdraw large commercial fish and use passive and active hunting tools.

3.3. Development and Implementation of Ichthyo-Pathological Measures at the Voroshilovsky Reservoir

An ichthyo-pathological autopsy and visual examination were performed to assess the condition of the reared juvenile (Figure 5). The fish inspection was carried out in laboratory conditions in proportion to the arrival of fish. An external examination of the fish and an autopsy were performed to examine the state of internal organs. The main fish-breeding and biological indicators were taken (Q: the weight of the fish in grams, L: the total length of the fish in centimeters, and l: the length without the tail fin in centimeters). In addition, the inspection before fixing the fish evaluated the behavior of fish in the tank considering the response to external stimuli and body position in the water, mobility and motor coordination, resembling spasms of muscles and cramps, as well as frequency and rhythm of breathing.

All fish behaved actively; moreover, fish movements were sharp and coordinated. The frequency and rhythm of breathing corresponded to the norms and convulsions; however, spasms were not observed. All carp fish had intact covers; additionally, ectoparasites and traces of their presence were not exposed when examining the gills, and eye deviations from the norm were not observed. All fish were doubtful when opened; endoparasites and their subsequent presence were also not found.

3.4. Economic Efficiency of Carp and Herbivorous Fish in the Ponds

The number of obtained larvae was 9.30 million pieces, which cost 750,510 Tenge. The number of larvae sold was 4.50 million, earning 652,500 Tenge. The purchase costs of rearing of fingerlings, general costs, and wages fund with social security were set at 4,500,000, 686,800, and 1,622,000 Tenge, respectively. The amount of income from the sale of stocking material amounted to 15,402,500, and the net profit was calculated at 784,519 Tenge (Table 4). According to the data obtained from this study, the amount of income in the introduced breeding system was calculated to be about 204%. This means that by using the available resources and the right breeding system, a net profit of 104% can be achieved, and more than 50% of the earned income includes net profit.

Figure 5. Autopsy of carp and herbivorous fish fingerlings grown in ponds

Table 4. Economic efficiency of carp and herbivorous fish in the ponds of "Petrov I. P. "

Indicators	Unit	Value
Reproduction of carp fish		
Specific production costs for obtaining own stocking materials (electricity, purchase of consumables, delivery of breeders)	Tenge	750,510
Number of obtained larvae	Million pcs	9.30
Cost of obtained larvae	tg/ million pcs	80,700
Number of sold larva	Million pcs	4.50
Price of sold larva	tg/ million pcs	145,000
Total amount from the sale of carp larvae	Tenge	652,500
Rearing of fingerlings		
Purchase of artificial specialized feed	Tenge/kg Tenge	180 180×25,000 = 4 5,00,000
Wages fund with social security and social security contributions	Tenge	1,620,000
General costs of rearing fingerlings in ponds	Tenge	686,800
Number of reared fingerlings	pcs	680,000
Cost of reared fingerlings	tg/pcs	1.01
Number of sold fingerlings	pcs	590,000
Price of sold fingerling	tg/pcs	25
The total amount from the sale of fingerling	Tenge	14,750,000
Income from the sale of stocking material	Tenge	15,402,500
Net profit	Tenge	7,845,190

Tenge (tg): Currency of Kazakhstan

4. Discussion

Lack of water resources and increasing people's need to provide valuable food has led to the use of dual or multi-purpose water resources in the country. The use of water for fish farming is one of the important issues. The best way to produce hydrothermal fish is to breed several species in a pool or reservoir. In this method, all the feed levels are used in the pool. Therefore, in the breeding of several fish species, positive nutritional interactions are observed on each other. In warm-water fish farming, unlike cold-water fish farming, single-species farming is not economically viable.

The differences in the obtained results in reproduction and biological data between carps are due to differences between species. Of course, environmental changes, especially water temperature and power supplies, are influential factors in causing these changes. Due to the low growth of carp and herbivores, in over-intensive polyculture conditions and low consumer demand for small fish (weighing up to 400 g), carp farming in the Voroshilovsky Reservoir will take until autumn 2020. Green and Phelps (25) reported that the average total net production after 150 days using chicken litter (1759 kg/ha) was higher than other organic matter. Boyd (23) showed that the addition of nitrogen from organic sources can have a positive effect on fish production in ponds.

This year, the fish-breeding enterprise for the first time held a spawning campaign of carp fish in a new incubation shop, planned with the participation of this article's authors. The scheme of technological processes of production has revised the rearing and production way of carp and herbivorous fish with the help of new scientific sources and many years of experience (Figure 6). Musuka and Musonda (24) stated that fish production per hectare varies between 13 and 18 tons, while its total production is estimated at approximately 4971.37 metric tons.

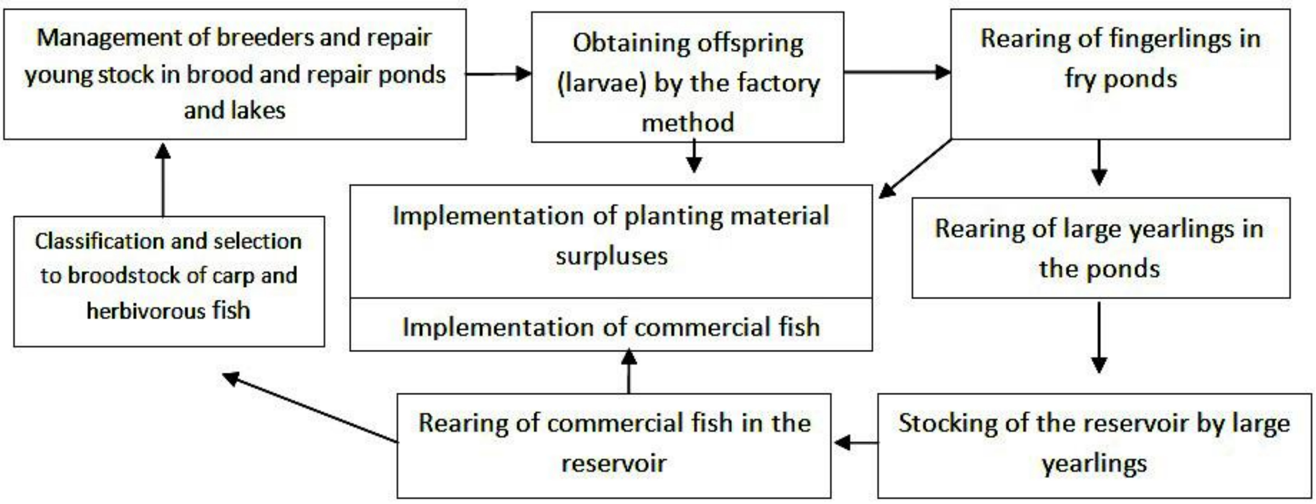

Figure 6. Scheme of technological processes of production at the Voroshilovsky reservoir

Previously, the Petrov I.P. Company operated in a mixed-mode, including rearing purchased planting material (larvae) in fry ponds and selling fingerlings of carp and herbivorous fish in the autumn period. Moreover, one of its main activities is recreation, which can increase the density of fish in this system. HG, CS (25) described that the recommended stocking density for breams was 2.5 fingerlings per square meter of the pond. At the moment, the priorities have been revised, and the main direction of the enterprise is fish farming. The farm can be classified as a full-system one, which has a feeding area (Voroshilovsky reservoir), fry ponds, a plot for keeping a brood stock of carp and herbivorous fish, and the incubation shop. The evaluation of the economic efficiency in the conditions of the fish farm was also given since this process is one of the main ones in the production scheme (Table 4).

From the data exhibited in Table 4, according to the net profit indicator, this method is profitable and accounts for 71% of the total planned economic profit. Therefore, fish production from aquaculture can rise to 10 times to maintain high-quality food security and other essential nutrients and provide job opportunities, as well as cash income (23, 24) to help job-seeking youth. However, some unpredictable circumstances may occur during the further operation of reservoirs in the LCFF regime. First of all, this is an underestimation of the possibilities of catching fish with the use of straining hunting tools (seines), inaccurate determination of fish productivity indicators, shortcomings in the work of the fish hatchery, the unfavorable situation on the site of fish farming, and other fish products. To smooth out the negative factors of the first of these situations, it is necessary to carefully study and plan the terrain of the lake bottom for the preparation of tone sections.

Jobs can be created for workers by building large and medium-sized fish farms. In addition to providing protein, raising fish as a household has also been able to significantly increase incomes for exports. This model makes it possible to calculate economic efficiency concerning harvest volume and reservoir area. In this method, income is calculated based on the wholesale price of raw fish in the market. Due to the mismatch between the growth rate of annual food production and the growth rate of consumption, the free market is facing problems. Indicators, such as profit, profitability, and head-to-head are considered in this method and can help the growth of fish farming industry. In general, the main goal of Kazakhstan's fisheries development program is to create conditions for the protection of valuable fish species and the rational use of fish stocks; moreover, it plays an important role in ensuring the country's food security. Therefore, by knowing the problems of food security, population growth, and the need to use all available potential to turn potential opportunities into action, we can shift to increase the potential of the country. Kazakhstan with its vast environmental diversity can solve the problem of providing quality food for both domestic and export consumption.

Authors' Contribution

Study concept and design: B. I. A.
Acquisition of data: K. B. I.
Analysis and interpretation of data: S. Z. A.
Drafting of the manuscript: N. B. B.
Critical revision of the manuscript for important intellectual content: G. A. K
Statistical analysis: S. K. K.
Administrative, technical, and material support: B. I. A. and L. N.

Ethics

All the procedures were approved by the Ethics Committee at the Kazakh National Agrarian University, Almaty, Kazakhstan

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Isbekov KB, Tsoy VN, Crétaux JF, Aladin NV, Plotnikov IS, Clos G, et al. Impacts of water level changes in the fauna, flora and physical properties over the Balkhash Lake watershed. Lakes Reserv: Res Manag. 2019;24(2):195-208.
2. Ćirković M, Trbović D, Ljubojević D. Meat quality of fish farmed in polyculture in carp ponds in Republic of Serbia. Meat Sci. 2011;52(1):106-21.
3. Dhawan A, Kaur S. Effect of pig dung on water quality and polyculture of carp species during winter and summer. Aquac Int. 2002;10(4):297-307.
4. Wahab M, Ahmed Z, Islam MA, Haq M, Rahmatullah S. Effects of introduction of common carp,

Cyprinus carpio (L.), on the pond ecology and growth of fish in polyculture. Aquac Res. 1995;26(9):619-28.

5. FAO. The future of food and agriculture-Trends and challenges: Annual Report; 2017 [Oct 15].
6. Baryshnikov G, Fomin I, Nasarova T. Using mathematical modeling in predicting the economic efficiency of lake-commercial fish farming in cross-border areas of northern Kazakhstan. IOP Conf Ser Earth Environ Sci. 2019;395:012017.
7. BNB ABI, B. IK. Reconnaissance and assessment of the suitability of the Voroshilov reservoir for the creation of LCFF. Mat Int Sci Prac Conf. 2019.
8. SGY MNI. Influence of temperature regime on embryogenesis in carp fish. Bull ASTU. 2019.
9. ZV V. Optimization of the assessment of the quality of breeders of carp fish in aquaculture

Astrakhan: cand of biol sciences; 2009.

10. Bertmar G, Persson L. Methods for fish biology. Rev Fish Biol Fish. 1993;3(1):82-3.
11. CN I. Methodology for Studying the Age and Growth of Fish. Sovetskaya Nauka. 1952.
12. Krainyuk VN, Assylbekova SZ, Kirichenko O, Isbekov KB, Abzhanov TJEJoB. Growth and length-weight relationships of Aral Sazan Cyprinus Carpio Aralensis Spishakow, 1935 (Cyprinidae; Osteichthyes) in the Sarysu River Watershed. Eurasia J Biosci. 2019;13:533-9.
13. MacKenzie K, Abaunza P. Parasites as biological tags for stock discrimination of marine fish: a guide to procedures and methods. Fish Res. 1998;38(1):45-56.
14. Prista N, Costa J, Costa M, Jones C. New methodology for studying large valuable fish in data poor situations: commercial mark-recapture of meagre Argyrosomus regius in the southern coast of Portugal. Argyrosomus Regius Fish. 2007;57.
15. Vodianitskiy OM, Potrokhov OS, Zinkovskiy OG. Embryonic and Early Postembryonic Development of Carp and Activity of Enzymes of the Energy and Plastic Metabolism under Impact of Water Temperature Fluctuations. Hydrobiol J. 2017;53(1):78-86.
16. Badryzlova NS, Koishybayeva S, Assylbekova SZ, Isbekov KBJEJoB. Technology of formation of replacement-brood stock of pikeperch in conditions of fish farms in Kazakhstan. EurAsian J Biosci. 2020;14:441-7.
17. H G, T H. Species interaction in assessment of fish stocks with special application to the North Sea. Dana. 1985;5(5):1-44.
18. Krupa E, Barinova S, Assylbekova S, Isbekov K. Structural indicators of zooplankton in the shardara reservoir (Kazakhstan) and the main influencing factors. Turkish J Fish Aquat Sci. 2018;18:659-69.
19. Lee JU, Al-Baz A. Assessment of fish stocks exploited by fish traps in the Arabian Gulf area. Asian Fish Sci 2:213-231. Asian Fish Sci. 1989;2:213-31.
20. Lyons J. A hydroacoustic assessment of fish stocks in the River Trent, England. Fish Res. 1998;35(1):83-90.
21. AG M. Assessment of fish stocks in a reservoir by catches of a set of set nets. Materials of Science-Pr conf; November 5-62008. p. 168.
22. Green BW, Phelps RP, Alvarenga HR. The effect of manures and chemical fertilizers on the production of Oreochromis niloticus in earthen ponds. Aquaculture. 1989;76(1):37-42
23. Boyd CE. Nitrogen fertilizer effects on production of Tilapia in ponds fertilized with phosphorus and potassium. Aquaculture. 1976;7(4):385-90.
24. Musuka CG, Musonda FF, editors. Current and future prospects of commercial fish farming in Zambia. AACL Bioflux. 2012;5(1)79.
25. HG M, CS T, K C. Abundance of mouth brooding tilapiines in the Kafue floodplains, Zambia. J Ecol Nat. 2011;3(10):344-50.