Growing juvenile beluga and its hybrids with sterlet in environmentally friendly conditions

Tatyana Khoroshailo[1], *Yulia* Alekseeva[2*], *Alexander* Tishchenko[1], and *Tatyana* Kuznetsova[2]

[1]Kuban State Agrarian University named after I.T. Trubilina, Krasnodar, 350044, Russia
[2]Irkutsk State Agrarian University named after A.A. Ezhevsky, Irkutsk, 664038, Russia

Abstract. Currently, the general trend of the global fishing industry is to increase the production of fish food products not only due to the development of aquaculture, but also the biological characteristics of the body of sturgeon. The aim of the study was the theoretical justification and practical implementation of the assessment of the growth and development of beluga juveniles and their hybrids with sterlet aged 0+ to 2+ (three-year-olds) in industrial of the Krasnodar Territory. The determined: fish mass, live weight gain, linear growth. By the end of the control cultivation, the weight of fish in the control and experimental groups was 1728.3 and 2236.4 g, respectively. In the experimental group, the absolute increase in live weight of fish was 2198.2 g, while in the control group it was 1692.2 g. The difference in average daily gains was 0.71 g in favour of hybrids. The body length of the fish in the control and experimental groups was 32.7 and 37.3 cm. The positive effect of heterosis had a positive effect on the first-generation crossbreeds obtained from beluga and sterlet.

1 Introduction

The formation and development of commercial fish farming in the Krasnodar Territory and the Republic of Adygea takes place in conditions of significant depletion of fish stocks in reservoirs due to insufficient stocking. It is possible to restore stocks in reservoirs and provide pond farms in the region with fish stock only through the stable operation of fish breeding enterprises [1-3].

Industrial sturgeon farming is a system of measures for growing sturgeon fish to marketable standards, where all growing processes are controlled by humans. Animal husbandry stands firmly on this path of development and achieves great success. Fish farming is developing along the same path. In a modern economy, a person creates the same conditions that allow him to best control the growth of an animal and direct its metabolic processes in the desired direction [1, 4, 5].

The system of fish-breeding measures for sturgeon breeding must allow breeding sturgeon fish in ponds, lakes, reservoirs and special pools. Moreover, at the present time, cultivation must be carried out under more controlled and more artificial conditions [1].

* Corresponding author: yulia_a72@mail.ru

As biotechnology improves, the proportion of cultivation in ponds will increase. In the latter, it is easier to create optimal conditions and automate many parts of the technological processes for obtaining marketable fish, producers or rearing for commercial caviar [1, 3, 4].

In one of the fish farms, such species of sturgeon as beluga, sterlet, Lena sturgeon, Russian sturgeon are grown in purity, and mating of individuals of different breeds is also practiced, while changing the productive qualities of hybrids. On the basis of which the goal was set - to assess the growth and development of beluga juveniles and its hybrids with sterlet, aged from 0+ to 2+ (three-year-olds of the year) under industrial production conditions. To achieve this goal, the following tasks were set and completed: to study the diet of fish of different weights; determine the dynamics of the live weight of fish and gains; compare the body length of experimental fish; calculate the economic efficiency of sturgeon cultivation.

2 Materials and Methods

Scientific and production studies were carried out from autumn 2019 to autumn 2021 on 100 sturgeons. The experimental fish were kept under combined conditions, i.e. from underyearling to yearling was in the indoor pool; and from the age of one year it was released into the pond, where it remained until the age of three. The first group (control) included underyearlings obtained from beluga breeders; in the second (experimental) - from beluga and sterlet, 50 animals each. Groups were formed from the same litter, which were distinguished by their appearance. The collection and processing of all material was carried out according to the generally accepted fishery methods of I. F. Pravdin.

The weight growth of the fish was determined by weighing, which was carried out on a scale with an accuracy of 0.1 g in the morning. All data were entered into the biological analysis journal at ages 0+, 1 and 2+. At the age of three, the fish were weighed after being caught from the pond by random sampling. The following meristic features were determined: fish weight, g; live weight gain, g. Linear growth was determined by the total body length using a ruler-fish gauge. The accuracy of linear measurements was 0.1 cm.

3 Results and discussion

Beluga is an extremely rare species of the sturgeon family, which is included in the Red Book of the International Union for Conservation of Nature (IUCN). The mass of the beluga can reach a value of about 1.5 tons, in connection with which the beluga is considered to be the largest freshwater fish, occupying one of the leading positions in terms of size among bone fish [1,8].

Bester is a eurythermal fish, which is a hybrid of beluga and sterlet. The prospects for breeding this particular hybrid are based on the fact that Bester successfully combines the high growth rate taken from the beluga and the ability to live and develop in fresh water obtained from the sterlet. Bester's vital activity is possible at temperatures from 1 to 300 C, however, growth and development are most intense at temperatures from 18 to 250 C. This hybrid is also extremely unique in that, being a sturgeon fish, it can mature even in pond farms with stagnant water [1, 2, 5].

Table. 1. The main indicators of full-ration production feeds for feeding sturgeons of different weights.

Indicators	Weight of fish, g			
	< 50		> 50	
	optimum	economy	optimum	economy
Mass fraction of crude protein, %, not less than	35.0	30.0	30.0	26.0

 https://doi.org/10.1051/e3sconf/202339002004

Mass fraction of crude fat, %, not less than	7.0	5.0	5.0	3.5
Mass fraction of crude ash, %, no more	10.0	10.0	10.0	10.0
Mass fraction of crude fiber, %, no more	4.5	6.0	6.0	8.0
Mass fraction of lysine, %, not less than	1.7	1.5	1.5	1.2
Mass fraction of methionine and cystine, %, not less than	0.8	0.7	0.6	0.5
Mass fraction of phosphorus, % not less than	1.2	1.2	1.2	1.2
Acid number of fat, mg KOH, no more	70.0	70.0	70.0	70.0
Fat peroxide value, % iodine, no more	0.2	0.2	0.2	0.2

For feeding sturgeons in industrial conditions, compound feeds containing 26-35 % protein, a complex of mineral and vitamin supplements are used. Feed costs with normalized feeding are 1.5-2.0 kg per 1 kg of fish growth. The effectiveness of feeding largely depends on the thoroughness of control over the thermal and hydrochemical regime of water, the growth of fish, their food intake, as well as on the correctness and timeliness of adjusting the rationed feeding program, taking into account changing environmental conditions [7-9]. The size of the pellets should correspond to the weight of the fish (Table 2).

Table 2. Size of granules depending on the mass of fish.

Weight of fish, g	Granule size, mm
10–40	3.2
40–150	4.5
150–500	6.0
>500	8.0

Sturgeon under artificial feeding (aquarian conditions) and in pond farms differ quite significantly in terms of growth [1,8- 9]. The results of fish growth are presented in Table 3.

Table 3. Indicators of the control rearing of experimental fish.

Indicators	Group	
	control	experienced
Initial weight (0+), g	36.1±0.21	38.2±0.11
Intermediate weight (1), g	218.3±0.12	258.1±0.41
Final weight (2+), g	1728.3±0.36	2236.4±0.48
Absolute growth, g	1692.2	2198.2
Average daily gain, g	2.35	3.06
Duration of the experiment, days	718	718

The given data testify that hybrid sturgeons showed the highest intensity of growth, as sterlet gives precocity. So, at the age of the yearling, the weight of individuals in the control group was 36.1±0.21 g, experimental - 38.3±0.11 g (the difference between the groups is not significant). By the age of one year, the difference in live weight of sturgeons was in favor of the experimental group and amounted to 36.1±0.21 g in the control group, 38.2±0.11 g in the experimental group (the difference between the groups is not significant). By the age of one year, the difference in live weight of sturgeons was in favor of the experimental group and amounted to 39.8 g. By the end of the control rearing, the weight of fish from the control and experimental groups was 1728.3±0.36 and 2236.4±0.48 g, respectively. The difference is 508.1 grams.

It follows that the absolute increase in live weight of fish was also naturally higher in the experimental group and was at the level of 2198.2 grams. In the control group, this figure was 1692.2 grams. The difference in average daily gains was 0.71 g in favor of hybrids obtained from beluga and sterlet.

In our time, if it is necessary to create a diagnostic characteristic of fish, namely, to establish qualitative and quantitative features of many body measurements, preference is given to the biometric method, while previously the descriptive method was the most popular [1 -3, 8, 9].

Studying the intraspecific patterns of the lower taxonomic units, researchers use the biometric method, which makes it possible to establish the signs of tribes, races, ecotypes, etc. using variation statistics. With the help of a mathematical method, many taxonomic units in ichthyology were put in order. Such labor-intensive work requires special schemes for measuring fish, because the schemes of measurements used in our time, due to the distrust of various researchers or research groups, are interpreted differently. Successful work in biological taxonomy requires generally accepted consistency in methods. With this approach, the results of various researchers within the same direction can be processed and compared [3,9].

In the course of the scientific and production experience, an analysis was made of the length of the body of experimental fish. The results are presented in Table 4.

Table 4. Body length of fish, cm, M±m.

Year	**Group, n -10**		**Lim**
	control	**experienced**	
Under yearling (0+)	11.9±0.11	11.2±0.14***	10.8–14.2
Yearbook (1)	13.1±0.36	15.3±0.23**	18.5–28.5
Three-year-olds (2+)	32.7±0.22	37.3±0.81***	27.0–36.0

It can be seen from the data in Table 4 that the growth rate of the fish body length had some differences. At the age of the yearling, the beluga group had a body length of 11.9±0.11 cm, and the Bester group had a body size of 11.2±0.14 cm with a significant difference in the third threshold (*** - P3≥0.999).

At the age of one year, the difference between the groups was 2.2 cm (** - P2≥0.99), but was within the limit. At the end of the control rearing, the body length of the fish of the experimental group was already 4.6 cm, and in the control and experimental groups it was 32.7±0.22 and 37.3±0.81 cm (P3≥0.999), respectively.

Features of production in pond fish farming leave a certain imprint on the organization and nature of production processes and largely determine the specifics of the machines and mechanisms used. In our studies, economic efficiency was calculated taking into account the revenue received, net profit and cultivation costs (Table 5).

Table 5. Economic efficiency of sturgeon cultivation (per 1 head).

Indicators	**Group**		**Experienced to control, +/–**
	control	**experienced**	
Sample at the age of 3 years, kg	1.728,0	2.236	0.508
Price for 1 kg, rub.	800.0	800.0	–
Sales proceeds, rub.	1.382,4	1,788.8	406.4
Growing costs, rub.	1.012,0	1,012.0	–
including cost of feed, rub.	648.0	648.0	–
salary, rub.	88.0	18.0	–
depreciation, rub.	21.0	11.0	–

fuel, rub.	18.0	18.0	–
current repair, rub.	56.0	56.0	–
other direct costs, rub.	112.0	112.0	–
overhead costs, rub.	69.0	69.0	–
Profit, rub.	370.4	776.8	406.4
Profitability level, %	36.6	76.7	40.1

An analysis of the economic efficiency of growing individuals of the sturgeon family - beluga and its crosses with sterlet showed that under the same conditions of feeding and keeping, different data on fish productivity were obtained.

So, at the age of three, beluga individuals weighed 1,728.3 g, and bester specimens – 2,236.4 g. The difference between the sample was 508 g. In the enterprise under consideration, the average selling price for 1 kg of three-year-old sturgeon fish was 800.0 rubles. Hence, the sales proceeds for the control and experimental groups cost 1,382.4 and 1,788.0 rubles, respectively. The difference amounted to 406.0 rubles. in favor of hybrids obtained from beluga and sterlet. Growing costs consisted of feed, wages, depreciation, fuel, ongoing repairs, overheads and other direct costs. In our studies, the cost of growing one individual amounted to 1,012.0 rubles. With further calculation of profits and costs, the level of profitability in the control group was 36.6%, in the experimental group - 76.1%.

4 Conclusion

Thus, based on our own research, we were able to identify the best way to increase fish production under the same conditions of feeding and keeping, using the biological characteristics of different species of sturgeon fish. Based on this, it was found that bester gains weight faster than beluga; this allows to sell a larger amount of sturgeon meat per production cycle, which contributes to an increase in the revenue of fish farms.

References

1. T. A. Khoroshailo, Y. A. Alekseeva, B. D. Garmaev, A. A. Martemyanova, IOP Conference Series: Earth and Environmental Science **839** 042025 (2021). https://www.doi.org/10.1088/1755-1315/839/4/042025
2. H. Einarsdóttir, B. Guðmundsson, V. Ómarsson, Animal Frontiers **12(2)**, 32-39 (2022)
3. Y. B. S. Nunes, R. Milke, L. R. Silva, J. L. S. Nunes, M. B. Figueiredo, Brazilian Journal of Biology **84**, e256697 (2024). https://www.doi.org/10.1590/1519-6984.256697
4. M. N. F. Costa, Y. I. C. Furtado, C. C. Monteiro, A. R. P. Brasiliense, E. T. O. Yoshioka, Brazilian Journal of Biology **84**, e255493 (2022). https://www.doi.org/10.1590/1519-6984.255493
5. M. F. A. Abdel-Aziz, R. M. A. Zied, H. U. Hassan, A. Habib, T. Arai, Brazilian Journal of Biology **84**, e262969 (2014)
6. A. Karim, B. Naila, S. Khwaja, S. I. Hussain, M. Ghafar, Brazilian Journal of Biology **84**, e256242 (2014)
7. T. A. Podoinitsyna, V. V. Verkhoturov, Y. A. Kozub, IOP Conference Series: Earth and Environmental Science **421(4)** 042002 (2020)
8. M. U. Taj, A. Habib, M. Ameer, M. S. Khalid, M. Zohaib, Brazilian Journal of Biology. **84**, e261574 (2014)
9. Y. Zhang, F. Zhang, J. Cheng, H. Zhao, Complexity **2021** 5530453 (2021). https://www.doi.org/10.1155/2021/5530453