Influence of environmental factors on the development and conservation of sturgeon young

T A Khoroshailo1, Y A Alekseeva2, B D Garmaev3 and A A Martemyanova2

1Kuban State Agrarian University named after I.T. Trubilina, Krasnodar, 350044, Russian Federation
2Irkutsk State Agricultural University named after A.A. Ezhevsky, Irkutsk, 664038, Russian Federation
3Buryat State Agricultural Academy named after V.R. Filippova, Ulan-Ude, 670024, Russian Federation

E-mail: tatyana_zabai@mail.ru, yulia_a72@mail.ru, dylgyr56@mail.ru, sheremetev80@yandex.ru

Abstract. Commercial sturgeon breeding is one of the promising areas of aquaculture. This is not only an integral part of the production of valuable protein products, but also the main source of replenishing the number of sturgeon fish, especially rare and endangered species. This paper examines studies on the influence of environmental factors on the development and safety of sturgeon fry in a sturgeon breeding enterprise in the Krasnodar Territory, carried out on juvenile Russian sturgeon. It was found that the control group was reared for 213 days, the experimental group for 152 days. The average water temperature during the growing period was 20.39°C for the control group and 21.19°C for the experimental group. The oxygen concentration was at the level of 73.6% in the control group and 76.6% in the experimental one. The pH level in water for the control group was 8.15, for the experimental one – 7.51; the concentration of nitrites for the control group was 0.025, for the experimental group it was 0.017. The average nitrate index is 0.96 and 0.84, in the control and experimental groups, respectively. The weight growth of sturgeons of the first group was higher, with the same initial weight, the final weight of juveniles in the experimental group was 97.4 grams, which is 14.8 grams more than juveniles in the control group. And the weight gain was 174.4% in the control group, and 222.5% in the experimental group. The average linear growth was also higher in the experimental group – 25.8 cm, in the control group – 24.1 cm. The increase in length was 76.7% in the experimental group, 68.5% in the control group. The survival rate of juveniles in the experimental group was 90.7% (136 specimens of Russian sturgeon out of 150), in the control group it was 86%.

1. Introduction
When breeding sturgeon, the key points are the creation of a necessary and sufficient sanitary and hygienic regime that ensures the survival of sturgeon juveniles and a decrease in mortality, that is, obtaining high-quality planting material for commercial rearing. In fish farming, it is customary to understand the quality of hatchery fish juveniles as the degree of their resistance to environmental factors of the external environment, both abiotic and biotic [1,2].

Regulatory requirements at each stage include a certain natural percentage of fish mortality. We
know how expensive the planting material is, how much effort it takes for fish farmers to grow juveniles and products from eggs, so naturally, with a decrease in mortality, the survival rate increases and the profit also increases.

A decrease in mortality when rearing juveniles is possible by controlling the conditions for keeping juveniles, which, as we found out, include: ensuring the requirements for water supplied to the rearing ponds; control of temperature and oxygen regimes and surgical interventions in case of sharp deviations of indicators from the norm; purification of water entering the pool module; use of high-quality feed for feeding juveniles corresponding to the age group, timely feeding of juveniles; compliance with the norms for the density of juvenile stocking in the pool; ichthyopathological control and veterinary treatment; – compliance with the rules of quarantine when importing juveniles and feed; round-the-clock monitoring of the operation of technical systems (water supply, aeration, purification, etc.); reducing the impact of handling [3,4,5].

One of the most important factors affecting the life, growth and development of fish is temperature. The study of the temperature factor was carried out by many authors. Changes in temperature lead to a change in the body's response. With an increase in temperature, oxygen consumption increases, the development, consumption and digestion of food, gastric secretion and motor activity of the intestine accelerate, the absorption of solutes from the environment increases and sensitivity to toxins increases. Excessive cooling leads to clouding of the integument, exfoliation of the epidermis. Out-of-range temperatures cause shock and death of fish [4,5].

The temperature factor acts on the fish both directly – through a change in the intensity of enzymatic processes occurring in its body, and indirectly – by exerting its influence on the improvement or deterioration of the development of the food base and the environment [3,5,7,8].

The research material was representatives of the sturgeon family, the Russian sturgeon (Acipenser gueldenstadtii). The research was carried out at a sturgeon breeding enterprise in the Krasnodar Territory. The aim of the research was to assess the influence of environmental factors on the safety of juvenile Russian sturgeon. To achieve this goal, two groups (control and experimental) of juvenile Russian sturgeon were selected in the amount of 150 pieces each. The control group of juvenile Russian sturgeon was launched into the pool in November 2019, the studies were carried out until May 2020. The experimental group was also planted in the pool, but in December of the same year.

During the entire research period, every week, the hydrochemical parameters of the environment were monitored: temperature regime, water saturation with oxygen, pH values, nitrogen compounds (nitrites, nitrates, ammonia) and others. It was maintained at the level of optimal values for both the control and experimental groups. Weight growth was measured by weighing the fish. Fish productivity was calculated using a special formula:

\[ F = \frac{A \times P \times B}{100}, \]

where \( A \) – stocking density;
\( P \) – fish out, %;
\( B \) – weight of fish, g;
100 – correction factor.

The absolute gain was determined by the formula:

\[ P = M_k - M_o, \]

where \( M_k \) and \( M_o \) – final and initial mass of fish, g.

Measurements of the linear mass characteristics of the experimental juveniles were carried out according to the generally accepted method of I.F.

2. The results and discussion

In the room where the experiment was carried out, a suitable microclimate was created, which was achieved with the help of powerful split systems. On the territory of the enterprise there are the necessary
premises in which this value can be fully controlled. Temperature data for the entire growing period are presented in table 1.

Table 1. Average values of water temperature.

| Group, Pool No | Period cultivation, days | Temperature pool water, °C | Indoor air temperature, °C |
|----------------|--------------------------|-----------------------------|---------------------------|
| Control, 1     | 213                      | 20.39                       | 24                        |
| Experienced, 2 | 152                      | 21.19                       |                           |

The rearing of juvenile Russian sturgeon in the first basin lasted 213 days, in the second basin the rearing period was 152 days. The differences in the average water temperature in the fish tanks can be explained by the fact that the rearing time in the first tank lasted longer and the indoor air temperature was slightly higher after the end of the rearing in the second tank. The optimum temperature for raising juvenile Russian sturgeon is in the range of 17–23°C.

Average daily fluctuations in water temperature during the entire period of cultivation were insignificant and for each pool were: in pool No.1: 18.84–23.14°C, average indicator – 20.39°C, in pool No.2: 18.87–23.14°C, the average is 21.19°C. Average values of water temperature in both basins were in approximately similar ranges.

In addition to the temperature factor, work was carried out to establish the effect on the growth of oxygen concentration in water. Aerators were used to regulate the dissolved oxygen content in the water. They are stored in a special room, and the measuring sensor is immersed in a special electrolyte during storage, in order to avoid contact with atmospheric air, as this can affect the accuracy of measurements. The results for the content of dissolved oxygen in water are presented in table 2.

Table 2. Average values of oxygen dissolved in water.

| Group, Pool No | Period cultivation, days | Oxygen content in the pool, % | Temperature air in premises, °C |
|----------------|--------------------------|-------------------------------|-------------------------------|
| Control, 1     | 213                      | 73.6                          | 24                            |
| Experienced, 2 | 152                      | 76.6                          |                               |

Fluctuations in the values of dissolved oxygen in water were insignificant, namely: in pool No. 1: 72.4–75.6%, the average is 74.40%; in pool number 2: 75.2–77.4%, the average is 76.35 percent.

At some points, a slight decrease in the concentration of oxygen dissolved in water was noted, reaching 70% at the same time. This phenomenon can be explained by the fact that during this time period there was an increase in water temperature up to 22–23°C, as well as the formation of biogenic matter. There is a direct correlation between dissolved oxygen content and water temperature. The results of measurements of the concentration of oxygen dissolved in water are shown in figure 1.
Figure 1. Average indicators of the concentration of oxygen dissolved in water.

From figure 1, it can be seen that the indicators for the content of oxygen dissolved in water for the entire observation period were higher in the second basin. Apparently, in this fish tank, the formation of biogenic matter was at a lower level, which influenced the higher indicators. The nutrient directly affects the oxygen content, since a significant part of it is used during its oxidation.

Among the variety of environmental factors, in addition to temperature and oxygen conditions, the hydrochemical regime, or the content of various elements in water, such as fish waste products, nitrogen compounds (nitrates, nitrites), is of great importance. Hydrochemical indicators can vary depending on the time of day or year. In our studies, the data are presented in table 3.

Table 3. Hydrochemical indicators of water.

| Indicator          | Group         | Norm          |
|--------------------|---------------|---------------|
| pH                 | control       | 8.15          | 7.8–8.0       |
|                    | experienced   | 7.51          |               |
| Hardness, mg-equivalent/l | control       | 5.4           | 3.0–10.0      |
|                    | experienced   | 6.1           |               |
| HCO₃⁻, mg/dm³      | control       | 226.36        | 30.0–400.0    |
|                    | experienced   | 224.24        |               |
| SO₄²⁻, mg/dm³      | control       | 123.15        | to 500.0      |
|                    | experienced   | 122.24        |               |
| Ca⁴⁺, mg/dm³       | control       | 77.68         | to 150.0      |
|                    | experienced   | 79.23         |               |
| Cl⁻, mg/dm³        | control       | 12.71         | 10.0–15.0     |
|                    | experienced   | 12.27         |               |
| NO₂⁻, g/m³         | control       | 0.025         | to 0.02       |
|                    | experienced   | 0.017         |               |
| NO₃⁻, g/m³         | control       | 0.96          | to 1.0        |
|                    | experienced   | 0.84          |               |
| PO₄³⁻, mg/dm³      | control       | 0.12          | 0.2–0.6       |
|                    | experienced   | 0.12          |               |
| P, mg/dm³          | control       | 0.18          | 0.2–0.5       |
|                    | experienced   | 0.19          |               |
| Si, mg/dm³         | control       | 3.47          | 2.5–5.0       |
|                    | experienced   | 3.75          |               |
| Fe, mg/dm³         | control       | 0.057         | 0.5–2.0       |
|                    | experienced   | 0.057         |               |

In general, the average water values were similar, in the pools with the control group, the average pH was higher, in this regard, the indicators of nitrites and nitrates are also slightly higher. During the experiment, we studied linear and mass growth. To assess the linear and weight growth, special measuring devices were used, and the overall growth was also determined, which was distributed over
months, since the hinge and length measurement were carried out once a month. The rate of weight growth of the experimental groups of juvenile sturgeon (control and experimental) is shown in figure 2.

![Figure 2](image2.png)

**Figure 2.** Mass characteristics of juvenile Russian sturgeon.

As can be seen from Figure 2, the weight gain in the experimental group was slightly higher. The final weight of juveniles from this group averaged 90.3 g. The final weight of juveniles from the control group was 82.6 g. Also, the weight gain of juvenile Russian sturgeon was calculated by months in both study groups. The results are shown in figure 3.

![Figure 3](image3.png)

**Figure 3.** Increase in juvenile Russian sturgeon.

As you can see, the weight gain in the juvenile Russian sturgeon was higher in the experimental group. At the beginning of the growing period, the increase was 4.9 g or 10.8% in the experimental group. Further, the increase increased and amounted to 13.7% or 6.9 g; in February 15.7 or 27.4%. In
March – 240 g or 33.6%, at the end of the study the weight gain in juveniles in the experimental group was 38.2 g or 55.9 percent.

By the spring, the growth graph again rushed up. In the general picture, the increase was higher in the juveniles of the experimental group, starting from the initial weight of 30 grams; in the end, the average weight of the juvenile Russian sturgeon in the experimental group was 97.4 g. In the control group, the final weight was 82.6 g, the difference in weight between groups was -14.8 grams.

According to the tasks set, a calculation was made based on the linear growth of juvenile Russian sturgeon. The rate of linear growth may differ from the rate of mass growth. Linear growth is shown in table 4.

Table 4. Linear growth of juvenile Russian sturgeon.

| Measurement date   | Height, cm | control    | experienced |
|--------------------|------------|------------|-------------|
| 01.10.2019         | 14.3 ± 0.14| 14.6 ± 0.13|
| 01.11.2019         | 14.9 ± 0.18| 15.2 ± 0.25|
| 01.12.2019         | 15.5 ± 0.22| 15.8 ± 0.29|
| 01.01.2020         | 16.1 ± 0.19| 16.4 ± 0.31|
| 01.02.2020         | 16.7 ± 0.20| 17.1 ± 0.25|
| 01.03.2020         | 18.1 ± 0.29| 18.7 ± 0.43|
| 01.04.2020         | 20.3 ± 0.62| 21.1 ± 0.71|
| 30.04.2020         | 24.1 ± 0.98| 25.8 ± 0.87|

As shown in table 4, at the beginning of the study, the average length of juveniles in both groups was approximately the same, in the control group it was 14.3 cm, in the experimental group – 14.6 cm. By the end of the study at the time of measurement on April 30, the average length of juvenile Russian sturgeon was higher and amounted to 25.8 cm, which is 1.7 cm higher than the average length of juveniles in the control group, where the average length of juveniles was 24.1 cm. Also, throughout the study, the increase in body length was calculated (table 5).

Table 5. Increase in length of juvenile Russian sturgeon.

| Period                | Group | cm | % | cm | % |
|-----------------------|-------|----|---|----|---|
| 01.10.2019–31.10.2019 | control | –  | – | –  | –  |
| 01.11.2019–30.11.2019 | 0.6   | 4.2 | 0.6| 4.1|
| 01.12.2019–31.12.2019 | 0.6   | 4.0 | 0.6| 3.9|
| 01.01.2020–31.01.2020 | 0.6   | 3.9 | 0.6| 3.8|
| 01.02.2020–29.02.2020 | 0.6   | 3.7 | 0.7| 4.3|
| 01.03.2020–31.03.2020 | 1.4   | 8.4 | 1.6| 9.3|
| 01.04.2020–30.04.2020 | 2.2   | 12.1| 2.4| 12.8|
| Total gain from start to end of the study | 9.8 | 68.5 | 11.2 | 76.7 |

The data in Table 6 characterize that the increase in fish of the control group in November was 4.2%, in December – 4.0%, in January – 3.9%, in February – 3.7%, an intensive growth began in the spring, in March the increase was 8.4%, in April – 12.1%. The increase in length by month is shown in figure 4.
Figure 4. Increase in length of juvenile Russian sturgeon.

Figure 4 shows that at the beginning and in the middle of the study, the growth of juveniles was uniform, in both groups it was almost identical. In March–April, the growth of Russian sturgeon individuals increased markedly. Ultimately, the increase in the length of juveniles from the experimental group was 1.4 cm higher than in the control group.

To assess the safety of juveniles, the percentage of their survival after the study was calculated. As well as determining their physiological state. The juveniles of the Russian sturgeon were carefully examined (table 6).

Table 6. Indicators of the safety of juvenile Russian sturgeon.

| Indicator                              | Group                  |
|----------------------------------------|------------------------|
|                                        | control | experienced |
| Average weight of underyearlings at the beginning of the experiment, g | 30.0±0.17 | 30.0±0.16 |
| Average mass of yearlings at the end of the experiment, g | 82.4±0.57 | 97.4±0.62 |
| Weight gain, %                         | 174.4 | 222.5 |
| Increase in length, %                  | 68.5 | 76.7 |
| Skin                                   | normal skin | the integument is in a normal state, there were no skin lesions, no visible diseases were found |
| Survival, %                            | 86.0 | 90.7 |

The gills of some individuals in the control group had damage, possibly due to a higher pH (average 8.15), possibly the effect of ammonia, which, according to literature data [6,9], at a pH of 8.0 is 10 times more toxic than at pH 7.0.

3. Conclusion
As a result of the conducted studies, it can be concluded that the influence of external factors is important for the safety of juveniles. This is evidenced by the growth rates, which were higher in the experimental group. Better physiological condition. The survival rate of juveniles in this group was 90.7%, or 136 specimens of Russian sturgeon out of 150.

References
[1] Takho-Godi A Z, Takho-Godi G A and Podoinitsyna T A 2018 Robots in the production of meat,
dairy and fish products Collection of articles of the international scientific and practical conference: Problems of animal husbandry 81-95

[2] Batishchev V V and Antipova I V 2002 Processing and production of fish products: modern problems and prospects for their solution Bulletin of higher educational institutions. Food technology 5(6) 9-11

[3] Takho-Godi A Z, Komlatsky V I, et al. 2019 Technology, equipment and design of enterprises of the meat industry (Krasnodar: Kuban State Agrarian University: Krasnodar CSTI).

[4] Komlatsky V I, Podoimtysna T A, Verkhoturov V V and Kozub Y A 2019 Automation technologies for fish processing and production of fish products J. Phys.: Conf. Ser. 1399 044050

[5] Costa C, Negretti P et al. 2014 Innovative automated landmark detection for the food industry: a reverse approach Food and biological process technology 7 2291-8

[6] Khoroshailo T A and Kozub Y A 2020 Robotization in the production of dairy, meat and fish products J. Phys.: Conf. Ser. 1515 022007

[7] Baranikov A I and Taho-Godi A Z 2007 Automation of technological processes for the production of meat, dairy and fish products (Rosto-on-Don: DGAU)

[8] Borodin I F and Sudnik Yu A 2016 Automation of technological processes Vestnik KrasGAU 11 24-7

[9] Kozub Y A, Komlatsky V I and Khoroshailo T A 2020 About some automated processes in the production of dairy products To cite this article IOP Conf. Ser.: Mater. Sci. Eng. 862 032021