ECONOMIC AND ECOLOGICAL ASPECTS OF PRESERVATION AND RESTORATION OF POPULATIONS OF STURGEON SPECIES IN THE KUIBYSHEV RESERVOIR

[a]NAIL G.NAZAROV, [b]RENAT I.ZAMALETDINOV, [c]EKATERINA S. VAVILOVA

[a]Kazan Federal University, Institute of Management, Economics and Finance, Department of Environmental Engineering and Water Management,Kazan, 420008, Russia
[b]Kazan Federal University, Institute of Management, Economics and Finance, Department of Environmental Engineering and Water Management,Kazan, 420008, Russia
[c]Kazan Federal University, Institute of Management, Economics and Finance, Department of Environmental Engineering and Water Management,Kazan, 420008, Russia

email: [a]i.ricinus@rambler.ru, [b]Rusia@Prescopus.Com, [c]e.s.vavilova2017@gmail.com

Abstract: As a result of technological calculation of recirculating aquaculture system for starlet breeding, it was concluded, that the following basic elements were required for the operation of the system: pools for fish, equipment for oxygen generation and disinfection of water, mechanical and biological purification filters, incubators. The calculation of profitability shows that the payback period of the fish farm, designed in the course of the work,is 2 years, with the total costs of farming organization - 14490000 rub. The volume of the expected proceeds will be 7500000 rubles per year. The possible annual release of sterletjuveniles for restoring the population of this species in the Kuibyshev reservoir is 275,000 pcs. The yield to the fishery will be 8250 pcs. The possibility of creation a modern high-tech enterprise for the production of high-quality market fish,with the purpose of ensuring the needs of population, was shown in the work.The use of the main approaches to rational water management in the process of operation, and the need to restore natural populations of sterlet were taken into account.

Keywords: restoration of the sterlet population, ecological fish farming,recirculating aquaculture system, artificial reproduction of rare species.

1 Introduction

At present, one of the urgent problems is the reduction of biological diversity. Biodiversity affects the ability of living systems to respond to changes in the environment, supports the functions of ecosystems. The widespread reduction of fish resources necessitates the introduction of new approaches to the conservation of biological diversity (Hiddink et al,2008).

Sturgeons are one of the most ancient of the currently living groups of fish, inhabiting the Northern Hemisphere. Currently, the most of the sturgeon species are under threat of extinction (Ustaoglu et al, 2004).

Along with traditional approaches for the conservation of biological diversity (for example, the creation of protected natural areas (Zamaletdinov et al, 2016)), it is advisable to use artificial methods for the reproduction of rare and endangered species. The latter is particularly effective within the scope of works for creation of aquaculture.

The creation of a cascade of reservoirs on the Volga River in the middle of the last century led to the almost complete cessation of the normal spawning of a whole group of migratory fish, which were of great commercial importance. First of all, the construction of dams allowed the natural reproduction of sturgeons.

To preserve the natural populations of sturgeons, it was decided to create a system of artificial reproduction of sturgeons in the basin of the Lower Volga. Large-scale construction of incubators began in the 1950s after the flooding of rivers, and by the 1980s more than 130 millionof sturgeonfingerlings have been produced from the wild broodstock (Chebanova et al, 2001). However, similar works allowed to preserve to this day the natural populations of a number of sturgeon species only in the Volga delta region.

In all other areas, the abundance gradually has been decreased and now in the Middle Volga basin the sturgeon is represented by a single species - sterlet *Acipenserruthenus* Linnaeus, 1758. It is the only species of sturgeon,which inhabits the Volga. Intensive exploitation of sterlet resources by catching, as well as reduction of places, suitable for spawning, has led to the fact that this species was currently included in the Red Book of the Republic of Tatarstan (Red book of the Republic of Tatarstan (Red book of the Republic of Tatarstan, 2016) (the category III - is a rare species, vulnerable due to low abundance and low prevalence, often found at the border of the area) and a number of adjacent territories. For these reasons, this species should be considered as the most promising among sturgeon for artificial reproduction in water bodies of the Republic of Tatarstan.

The aim of this work is to develop an algorithm for the reproduction of sterlet in conditions of recirculating aquaculture system, for the conservation and recruitment of natural populations.

The work was carried out at the Department of Environmental Engineering and Water Management of the Institute of Management, Economics and Finance of the Kazan (Volga) Federal University.

2 Material And Methods

The proposed fish farm is supposed to be created on the principle of recirculating aquaculture system. Such a choice is due to the stenobiontility of the breeding object to the external conditions (primarily to the oxygen content in the water).

The basic technological calculations were carried out using standard algorithms (Proskurenko , 2003). Technological calculations (the survival rate of fish, the number and volume of containers in recirculating aquaculture system, the leveling of oxygen balance, water flow rate) were carried out according to the algorithms, recommended by V.L. Tsuladze (Tsuladze, 1990).

Recirculating aquaculture systems require the continuous removal of metabolic products. This is especially important for salmonids. The calculations of metabolic products and the volume of bio-loading were carried out according to M.B. Timmons and J.M. Ebeling (Timmons, 2013).

Along with the technological component, we carried out the economic calculation of the planned farm.

In the process of economic calculations, we proceeded from the assumption, that the cost of electricity, heating and water supply is planned to be paid from the federal budget, in accordance with the State Program "The development of Market Aquaculture in the Republic of Tatarstan" for 2015-2020 (Sheremet,1998).

The calculation of capital costs and payback period was carried out using the standard algorithm. The overall calculation was carried out for the farm, designed to produce 15 tons of market fish per year.

3 Results And Discussion

Planned fish husbandry is supposed to be located near the village Popovka, in the Nizhnekamsk municipal district of the Republic of Tatarstan.

The manufacture consists of 3 recirculating aquaculture systems for market fish rearing of different age groups and installation of closed water supply for breeding the spawners and incubation of hard roe.

Schematically, the recirculating aquaculture system includes a number of specific elements:

1. System for bactericidal treatment.
2. System for oxygen saturation of water.
3. System for maintaining the fixed temperature.
4. Mechanical and biological filters.

Functionally, the design is shown in Figure 1.

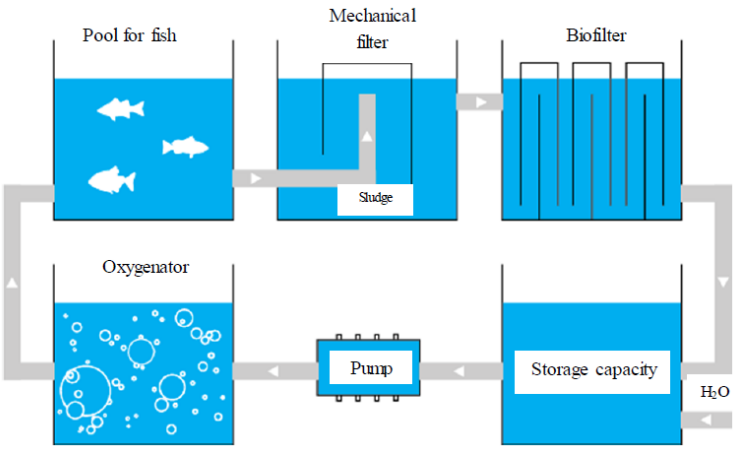

Figure 1.Functional chart of the used recirculating aquaculture system.

The material and technical equipment of the farm involves the use of the following production tanks (Table 1).

Table 1.Necessary number of fish-rearing pools

Type and dimensions of the pool	Number, pcs.
Rectangular; 2,0*1,5*0,6	4
Round; Ø3,5 *1,2 m	21
Round; Ø3 *1,2 m	2
Round; Ø2* 1,2 m	2

For the calculations we proceeded from the following initial parameters:

Weight of fish seed:

- Fingerlings - 3 g
- Yearlings - 300 g

Weight of market fish: 1000 g

For the first year of operation of recirculating aquaculture system, both the 3g fingerlings and 300g yearlings are procured. This will short the time of individuals'selection for the formation of rearing broodstock, and the time of obtaining fish seed material from the own broodstock.

To start the production, 6250 pcs of fingerlings, weighing 3 g, and 5500 pcs of yearlings, weighing 300 g should be purchased.

During 2 years it is necessary to purchase 6250 pcsof fingerlings 4 times, because the own broodstock is formed and will be ready for spawning only for the third year of operation the enterprise.

The results of calculation the amount of fish seed are shown in Table 2.

Table 2.Necessary amount of fish seed

Type of fish seed	The 1st year, pcs	The 2nd year, pcs	The 3rd and subsequent years, pcs.
Fingerlings, weighing 3 g	12500	12500	-
Yearlings, weighing 300 g	5500	-	-
Juveniles from the own brood stock	-	-	17500

In the broodstock, it is necessary to contain 20 females and 5 males. Rearing stockis completely identical to thebrood stock.

Taking into account the coefficients of commercial return of the sterlet, it was found, that having released 275000 pcs of sterlet juveniles, weighing 1.5g, their commercial return will be 8250 pcs.

Table 3 provides data on feed requirements for the rearing of market fish.

For the normal operation of the farm with a full cycle of production, the average amount of feed per year is as follows: Aller Performa EX - 10800 kg; Aller Bronze - 41250 kg.

Table 3.Required amount of feed for sterlet, at a temperature of water 21°C

Fishweight, g	Durationofrearing, days	Title of feed	Dailynorm,% ofmass	Total amount of feed, kg/day
> 0,5-3	105	AllerFutura EX MP	10	0,03
3-50	100	AllerPerformaEX	8	25
50-200			5	62,5
200-300			4	66
300-500	150	Aller Bronze	4	110
500-1000			3	150

Equipment, necessary for a fish farm, with a capacity of 15 tons of market fish per year is given in Table 4.

Table 4.Summary table of capital expenditures

Items	Characteristics	Number, pcs	Cost* per 1 unit, rub.	Totalcost, rub.
Fish-rearingpool	Ø3,5 *1,2m	21	33700	707700
	Ø3 *1,2m	2	27000	54000
	Ø2* 1,2m	2	20800	41600
	2,0*1,5*0,6	4	9000	36000
Incubatorforspawn	Capacity 20000 roecorns	2	27000	54000
Oxygenator	60 m^3/h, 0,37 kW	2	125000	250000
	100 m^3/h, 0,37 kW	1	140000	140000
Aerator	38 W	1	8320	8320
	45 W	1	9200	9200
	65 W	1	10560	10560
UV-disinfectant	50 m^3/h, 220 W	2	158439	316878
	100 m^3/h, 800 W	1	230000	230000
Oxygen generator		3	620000	1860000
Pump	2700 l/h, 370 W	3	2080	6240
	30000 l/h, 2100 W	2	22400	44800
	40000 l/h, 7,5 kW	4	26200	104800
Storagetank	2,0*5,7 m	1	7300	7300
	5,25*2,0 m	2	6800	6800
Tankforbiologicalfilter	Ø2,4 м*1,5 m	1	10800	10800
	Ø3,6м *1.5 m	1	15200	15200
	Ø1,5 * 1,5 m	1	5740	5740
Bedforbiologicalfilter	668 m^2/m^3	15 m^3	31900	478500
Polyethylenepipe	Ø18 mm	15 m	17	255
	Ø75 mm	90 m	122	10980
	Ø110 mm	55 m	220	12100
	Ø560 mm	21 m	2980	62580
	Ø710 mm	21 m	5800	121800
	Ø750 mm	28 m	6542	183176
Fishseed	3 g	12500 pcs	15	187500
	300 g	5500 pcs	150	825000
Feed	AllerPerforma EX	10800 kg	1400(20 kg)	756000
	AllerBronze	41250 kg	2000(20 kg)	4126000
Totalcapitalexpenditures				10615550
Overheadcosts, 5%				530700
Total				11146250

* at average prices for May 2017

Other expenses account for approximately 30% of the amount of capital expenditures.

4 Summary

Rational use of available resources for farming is a guarantee of obtaining high-quality and affordable products. Currently, no more than 60 pond and cage-type farms are engaged in the production and sale of market fish in the Republic of Tatarstan. Currently, there are no organizations, involved in sturgeons breeding in the republic. The most environmentally friendly and economically viable is the breeding of fish in recirculating aquaculture systems.

5 Conclusions

As a result of technological calculation of recirculating aquaculture system for sterlet breeding, it was established, that the following basic elements were required for the system operation: fish-rearing pools, equipment for oxygenation and disinfection of water, biological and mechanical filters, incubators.

The calculation of profitability showed, that the payback period of fish farm, designed in the course of the work, is 2 years, with the total costs for the organization of this farming - 14490000 rubles. The volume of the expected proceeds will be 7500000 rubles per year.

The possible annual release of sterlet juveniles for restoring the population of this species in the Kuibyshev reservoir is 275,000 pcs. The yield to the fishery will be 8250 pcs.

So, the possibility of creation a modern high-tech enterprise for the production of high-quality market fish, with the purpose of ensuring the needs of population, was shown in the work. The use of the main approaches to rational water management in the process of operation, and the need to restore natural populations of sterlet were taken into account.

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