THE PROJECT OF THE TROUT (SALMO TRUTTA LINNAEUS, 1758) POPULATION'S RESTORATION IN THE REPUBLIC OF TATARSTAN AS THE TASK OF WATER MANAGEMENT FOR SMALL RIVERS

[a] NAIL GOSMANOVICH NAZAROV, [b]RENAT IREKOVICH ZAMALETDINOV, [c]TATIANA ALEKSANDROVNA YAMASHEVA

[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]rizamaletdino2016@gmail.com, [c]taleksandrovnayam2017@gmail.com

Abstract: As a result of technological calculation of recirculating aquaculture system, with the capacity of 10 tons of market fish per year, it was established, that the following basic elements are required for the system operation: fish-rearing pools, incubators, equipment for oxygenation and disinfection of water, biological and mechanical filters. The calculation showed that the payback period of the fish farm, designed in the course of the work, is 2 years, with the total costs for the organization of this farming - 12202000 rubles. The volume of the expected proceeds will be 6190000 rubles. The implementation of the project also allows to increase the number of species, rare for the fauna of the Republic of Tatarstan - *Salmo trutta* Linnaeus, 1758. The possible annual volume of release of rainbow trout fingerling, with a mass of 1-1.5 g, into the natural watercourses of the Republic of Tatarstan, with the purpose of recruitment, is 16900 pcs.

Keywords: rainbow trout, recruitment, recirculating aquaculture system, artificial reproduction, fish farming.

1 Introduction

One of the contemporary 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.

Today it is clear, that biodiversity is important for the future sustainability of water resources. This also includes commercial fishing. The widespread reduction of fish resources necessitates the introduction of new approaches to the conservation of biological diversity (Hiddink et al,2008).

Recently, it became clear, that changes in the species and size composition of fish communities affect the structure and functioning of aquatic ecosystems, including the biomass of species at all trophic levels (Frank et al, 2005).

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.

Salmo trutta Linnaeus, 1758 now is one of rare and endangered species in the territory of the Republic of Tatarstan (*Red book of the Republic of Tatarstan (animals, plants, mushrooms),2016).* This species is also an important element for sport and commercial fishing. The latter circumstance also does not contribute to the restoration of the species number.

The widespread reduction of habitable conditions for this type casts doubt on the possibility of its preservation by traditional methods. Therefore, the issue of organizing a specialized fish farm is on the agenda.

Salmonids are one of the traditional objects for artificial reproduction (Fraser ,2008).The creation and operation of such farm will not only provide the economy of the Republic of Tatarstan with a valuable protein product. This farm will also allow to save, and to maintain at a stable level, the number of rare and endangered species.

The aim of this work is to develop an algorithm for the reproduction of rainbow trout in conditions of recirculating aquaculture system, for the conservation and recruitment of their population. At present, there are no such farms on the territory of the Republic of Tatarstan.

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.

The calculation of capital costs and payback period was carried out using the standard algorithm (Sheremet,1998).

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 circuit is shown in Figure 1.

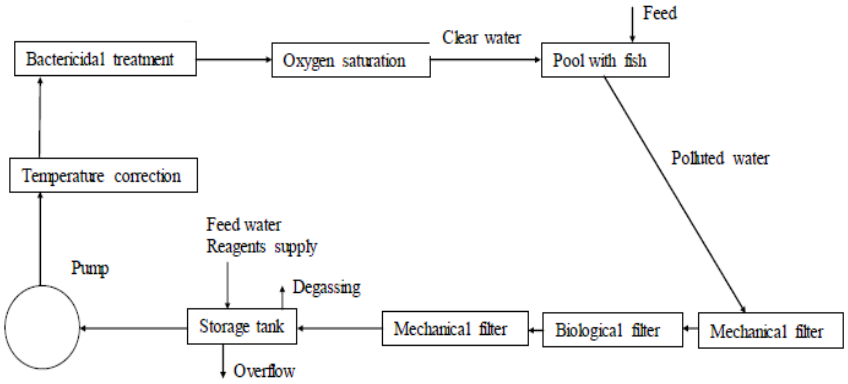

Figure 1. Functional diagram of the used recirculating aquaculture system.

For the calculations we proceeded from the following initial parameters:

- Productivity: 10 t/year (market fish)
- Water temperature in the system: 10°C
- Maximum fish-holding density: 250 kg/ m^3
- Weight of fish seed: 1g
- Weight of market fish: 0,8-1,0 kg
- Amount of dissolved oxygen at the outflow: 8 mg/l
- Intensity of water exchange in the system: 2 times per hour.

According to our data, 13000 pcs of trout juveniles are needed to implement the proposed project. The brood stock requires 23 females and 3 males. The structure of the reserve is similar to the structure of the brood stock.

The total number of received trout juveniles is 29900 pcs, 16900 pcs of them are expected to be released into the natural watercourses of the Republic of Tatarstan.

Taking into account the coefficient of commercial return of the trout, it was found, that having released 16900 pcs of trout juveniles, weighing 1.5g, their commercial return will be 338 pcs.

Table 1 shows the estimated data on the required number of pools for obtaining of market fish.

Table 1.Necessary number of pools for market fish

Fish weight, g	$\rho_{fish\text{-}holding}$, kg/$m^3$	h_{water}, m	V_{water} in 1 pool, m^3	Size of the pool, m	Number of pools, pcs.
>0,3-10	10-20	0,1-0,2	0,4	2,5*0,8*0,6	13
10-50	20-60	0,3	1,2	2*2*0,8	7
50-100	60-100	0,4-0,5	5,5	3,3*3,3*1	2
100-500	100	0,5-0,8	5,6	Ø3*1	9
> 500	100-250	До 1,5	15	Ø4*1,7	3

Table 2 presents the estimated data on the number of pools, necessary for rearing brood stock.

Table 2.Required number of pools for rearing brood stock

Age groups	$\rho_{fish\text{-}holding}$	h_{water}, m	V_{water} in 1 pool, m^3	Size of the pool, m	Number of pools, pcs.
Spawn	-	-	-	0,5*0,3	6
Juveniles	10 kg/m^3	0,2	0,4	2,5*0,8*0,6	7
Breeding females	4 pcs/m^3	1,3	5,8	Ø2,4*1,5	2
Breeding males	4 pcs/m^3	0,9	0,75	Ø1*1,2	2

Table 3 shows the estimated data on the amount of feed, required for fish rearing, according to the specified characteristics.

Table 3.Required amount of fish-feed at a temperature of 10°C

Fish weight, g	Total fish weight, kg	Duration of rearing, days	Title of feed	Feeding rates, kg/100kg per day	Total amount of feed, kg/day
> 0,15	2,4	14	Nutra HP 0,3	3,6	0,09
0,12 – 0,5	1,9 – 7,4	12	Nutra HP 0,5	3,5	0,07 – 0,26
0,4 – 1,0	5,7 – 13,6	20	Nutra HP 0,7	3,4	0,2 – 0,46
0,9 – 2,5	12,3 – 32,5	34	Nutra HP 1,0	3,1	0,38 – 1,0
2,0 – 7,0	27,5 – 91	23	Nutra HP 1,5	2,4	0,6 – 2,2

6,0 – 20	78 – 240	30	Nutra HP 1,8	2,2	1,7 – 5,28
10 – 60	120 – 690	28	Optiline 1P	1,5	1,8 – 10,4
50 – 150	575 – 1650	41	Optiline 2P	1,3	7,47 – 21,5
125 – 350	1375 – 3675	18	Optiline 3P	1,1	15,1 – 40,4
300 – 1000	3150 – 10000	150	Optiline XL	0,8	25,2 – 80

Equipment, necessary for a fish farm, with a capacity of 10 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.	Total cost, rub.
Fish-rearing pool	2,5*0,8*0,6 m	20	9000	180000
	2*2*0,8 m	7	27500	192500
	3,3*3,3*1 m	2	63700	127400
	ø1*1,2 m	2	14600	29200
	ø2,4*1,5 m	2	50700	101400
	ø3*1 m	9	53000	477000
	ø4*1,7 m	3	89700	269100
Incubator for spawn	Capacity 20000 roe corns	2	21500	43000
Oxygenator	15 m^3/h, 0,37 kW	1	78000	78000
	60 m^3/h, 0,37 kW	2	125000	250000
	200 m^3/h, 0,37 kW	1	170000	170000
Aerator	30 W	2	5850	11700
	38 W	1	8320	8320
	65 W	1	10560	10560
UV- disinfectant	16 m^3/h, 75 W	1	18929	18929
	50 m^3/h, 220 W	2	158439	316878
	250 m^3/h, 1800 W	1	502000	502000
Oxygen generator		4	620000	2480000
Pump	2700 l/h, 370 W	3	2080	6240
	6900 l/h, 182 W	2	4600	9200
	12000 l/h, 271 W	1	7400	7400
	18000 l/h, 2100 W	2	25400	50800
	160000 l/h, 15 kW	2	22200	44400
Storage tank	3,4*1,5 m	1	5300	5300
	4,0*2,0 m	1	6800	6800
	6,1*2,0 m	1	8200	8200
	9,0*5,0 m	1	12400	12400
Tank for biological filter	ø0,6*1 m	1	2242	2242
	ø1,2*2 m	1	5605	5605
	ø1,5*1,5 m	1	5740	5740
	ø2,58*2,5 m	1	11210	11210
Bed for biological filter	600 m^2/m^3	8 m^3	31900	255200
Polyethylene pipe	ø17 mm	52	17	884
	ø30 mm	5	35	175
	ø50 mm	50	86	2580
	ø63 mm	42	90	3780
	ø75 mm	4	127	508
	ø110 mm	78	163	12714
	ø180 mm	11	475	5225
	ø200 mm	88	570	5160
	ø360 mm	15	1739	26085
	ø400 mm	2	2235	4470
	ø750 mm	17	7542	128214
Fish seed	1,0-1,5 g	13000	4	52000
Feed	Nutra HP 0,3	1,5 kg	4200 (10 kg)	4200
	Nutra HP 0,5	3 kg	7800 (20 kg)	7800
	Nutra HP 0,7	9 kg	7500 (20 kg)	7500
	Nutra HP 1,0	34 kg	7500 (20 kg)	15000
	Nutra HP 1,5	50 kg	7300 (20 kg)	21900
	Nutra HP 1,8	158 kg	7300 (20 kg)	58400
	Optiline 1P	291 kg	5200 (25 kg)	62400
	Optiline 2P	881 kg	5600 (20 kg)	246400
	Optiline 3P	727 kg	6100 (25 kg)	176900
	Optiline XL	12000 kg	5000 (25 kg)	2400000
Total capital expenditures				8939019
Overhead costs, 5%				446950
Total				9385969

* at average prices for May 2017

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

$$R = 0{,}3 \times 9385969 = 2815790\ rub.$$

Thus, the overall cost is the following:

$$Z = 9385969 + 2815790 = 12201759 \text{ rub.}$$

Table 5 presents the results of economic calculation. The results show the possibility of quick payback of the project.

Table 5.Annual average income

Item	Number	Cost*	Total amount
Rainbow trout 1-1,5 kg	10000 kg	450 rub/kg	4500000
Impregnated roe (1000)	46000 pcs	700 rub/1000 pcs	32200
Juveniles 1,0-1,5 g	16900 pcs	5 rub/pc	84500
Juveniles 1,5-2,0 g	16900 pcs	5,5 rub/pc	92950
Juveniles 2,1-2,5 g	16900 pcs	6 rub/pc	101400
Juveniles 2,6-3,0 g	16900 pcs	6,5 rub/pc	109850
Juveniles 3,1-4,0 g	16900 pcs	8 rub/pc	135200
Juveniles 4,1-5,0 g	16900 pcs	2 rub/g	169000
Juveniles 5,1-10,0 g	16900 pcs	4 rub/g	676000
Fingerling trout 100-200 g	16900 pcs	500 rub/kg	1690000
Total:			6190000

* at average prices for May 2017

Thus, a simple payback period is:

$$PP = \frac{12201759}{6190000} = 1{,}97 = 2 \text{ years}$$

4 Deductions

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 trout breeding in the republic. The most environmentally friendly, promising and economically justified is the breeding of fish in recirculating aquaculture systems.

5 Conclusions

As a result of technological calculation of recirculating aquaculture system, with the capacity of 10 tons of market fish per year, it was established, that the following basic elements are required for the system operation: fish-rearing pools, incubators, equipment for oxygenation and disinfection of water, biological and mechanical filters.

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