



Technology of formation of replacement-brood stock of pikeperch in conditions of fish farms in Kazakhstan

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Abstract

The article presents biotechnical measures for harvesting spawners and individuals of different ages of pikeperch from a natural reservoir and transporting pikeperch from fishing sites to a fish farms. The values of body weight, minimum allowable length and fatness of spawners and younger age groups of pikeperch are given. Comparative characteristics of fish-breeding and biological indicators of males and females with statistical processing of indicators are given. The characteristic of the production capabilities of wild pikeperch spawners during spawning, incubation of eggs and obtaining larvae is given. The article describes the biotechnical methods of conducting pikeperch spawning in spawning cages on nests in pond conditions of fish farms, incubation of eggs in "Amur" devices. Data on the culturing pikeperch juvenile in cages and the cultivation of fingerlings and two-year-old pikeperches in ponds are presented. The characteristic of fish-breeding and biological indicators of fingerling and two-year-old pikeperch cultured in a polyculture with cyprinid fish is given. The data of statistical analysis of indicators of weight final values, minimum allowable length and fatness of fingerlings and two-year-old pikeperches cultured in ponds for selection in the formed replacement-brood stock of pikeperch are presented. The dynamics of the main hydrochemical indicators of ponds is presented. The developed biotechnical standards for the formation of replacement-brood stock of pikeperch in the conditions of fish farms in the South of Kazakhstan are recommended.

Keywords: domestication, pikeperch, spawners, larvae, fingerlings, two-year-olds, replacement-brood stock, spawning, incubation, ponds, fish-breeding and biological indicators, polyculture

Badryzlova N, Koishybayeva S, Assylbekova S, Isbekov K (2020) Technology of formation of replacement-brood stock of pikeperch in conditions of fish farms in Kazakhstan. Eurasia J Biosci 14: 441-447.

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INTRODUCTION

Due to intensive industrial and commercial fishing, the number of pikeperch in natural reservoirs of Kazakhstan is decreasing. Currently, there is an urgent need to reproduce pikeperch in aquaculture. At the same time, one of the primary tasks is to form replacement-brood stocks and live numbers of pikeperch on fish farms of the Republic.

To date, no work has been carried out on the formation of productive replacement-brood stocks of pikeperch in order to obtain the offspring of this object in pond farms in Kazakhstan. In this regard, the preservation of the gene pool and the formation of productive replacement-brood stock of pikeperch as one of the most valuable commercial fish of Kazakhstan, without prejudice to the operation of major commercial stocks is one of actual tasks of fisheries development of RK.

The purpose of these studies was to assess the possibility of forming a replacement-brood stock of pikeperch in the conditions of fish farming in the South of Kazakhstan.

The formation of the replacement-brood stock of pikeperch in the conditions of fish farm of "Halyk Balyk" LLP is carried out in two ways. The method of domestication, which involves catching different-age individuals and spawners of pikeperch in the Kapshagay reservoir and adapting to the conditions of the basic fish-breeding host. As well as the method of "from caviar", i.e. getting offspring from wild pikeperch spawners and culturing fish-planting material of pikeperch in ponds with subsequent selection by growth, weight and exterior of fingerlings, two-year-olds in the replacement-brood stock.

MATERIAL AND METHODOLOGY

Research on the formation of replacement-brood stock of pikeperch was conducted in the fish farm of "Halyk Balyk" LLP (Almaty region, VI fish breeding zone) in the 2018-2019 seasons. The objects of research were

Received: May 2019

Accepted: February 2020

Printed: March 2020

wild spawners and immature individuals of pikeperch harvested for reproduction purposes, as well as fingerlings and two-year-old pikeperches cultured in ponds.

Pikeperch was caught using fixed nets in the Kapshagay reservoir. From fishing sites, pikeperch was transported to adaptation cages by boat in plastic barrels with a capacity of 85 liters. Cages made of metal sieves were installed in the coastal zone of the reservoir at a depth of 1.5 m. The time of adaptation of spawners and replacement of pikeperch in coastal cages was determined experimentally and amounted to 1 day.

To conduct research, wild pikeperch spawners were transported from adaptation cages installed in the reservoir to the basic fish farm. Transportation of replacement stock and pikeperch spawners was carried out in plastic barrels with a volume of 85 liters, installed in a vertical position at a water temperature of 10-12°C. The journey time was up to 2 hours. The caught females and males were planted in spawning cages made of a metal sieve with a mesh of 1x1 cm² and a volume of 1 m³, installed in a pond at a depth of 1.5 m. For spawning, males and females were placed 1:1 in a cage, each with one nest-"frame" of 50x50 cm in size. Incubation of pikeperch eggs deposited on the nests was carried out in "Amur" incubation devices. They cultured juveniles in cages made of sieves. Live and artificial starter feeds were used for feeding. When accounting for larvae that are reared in cages, the volumetric counting method was used. To assess the effectiveness of reared pikeperch juveniles in cages, the method of expert assessments was used. Fingerlings and two-year-old pikeperches were cultured in polyculture in carp ponds with an area of 0.2 hectares.

When determining the main biological indicators of different-age pikeperches, methods that are generally accepted in ichthyological studies are used (Pravdin 1966). The obtained data were processed by methods of biological statistics using computer programs (Lakin 1990). Water quality was assessed using methods generally accepted in hydrochemical studies (Guide to chemical analysis of land surface waters 1997, Collection of normative and technological documentation for commercial fish breeding 1986).

The following normative and technological literature was used for reproduction of pikeperch, rearing of juveniles, culturing of fingerlings, two-year-olds, and formation of replacement-brood stock of pikeperch (Delmukhametov 2012, Karpanin and Ivanov, Privezentsev 2000, Khrustalev and Delmukhametov 2009, Kirilenko 1992, Korolev 2000, Kozlov et al. 2006, Krepis et al. 1998, Kupinsky 2007, Mamedov 2008, Mikheyev and Meisner 1966, Minayev 2008, Mishchenko and Begmanova 2013, Muntyan 1975, Ponomareva et al. 2007, Pyanov et al. 2016, Radko et al. 2011, Sabodash 2006, Tamash et al. 1985, Tereshenkov and Korolev 1997, Zhmurova et al. 1996).

Table 1. Dynamics of hydrochemical indicators of the environment in the ponds of "Halyk Balyk" LLP

Month	Decade	Value of indicator					
		2018			2019		
		t°C	pH	mg O ₂ /l	t°C	pH	mg O ₂ /l
April	I	14.2	7.3	5.7	14.1	7.2	5.8
	II	15.8	7.6	5.9	15.5	7.4	5.7
	III	16.9	8.1	6.1	16.5	7.9	6.2
May	I	17.9	7.7	6.3	17.7	7.5	6.5
	II	19.6	7.2	6.0	19.4	7.4	6.1
	III	21.4	7.3	6.6	21.2	7.1	6.4
June	I	22.2	7.1	6.4	21.6	7.0	6.2
	II	22.9	7.4	6.3	22.5	7.2	6.0
	III	23.7	7.2	6.8	23.3	7.3	6.2
July	I	25.5	7.0	6.2	25.2	7.6	6.4
	II	26.9	7.7	6.9	26.5	7.5	6.5
	III	27.1	8.0	6.0	27.3	8.1	6.2
August	I	25.9	7.5	6.3	25.6	7.7	6.4
	II	25.1	8.1	6.5	24.8	8.2	6.6
	III	23.8	7.9	6.9	23.4	7.8	6.5

Note - *values of oxygen content in pond water in the morning

The study and evaluation of the growth rate and survival rate of fingerlings and two-year-old pikeperches were carried out according to control catches. To assess the influence of abiotic environmental factors, the dynamics of temperature and oxygen levels were monitored daily (2 times a day), and the level of the hydrogen index (pH) was monitored once every 10 days.

RESULTS AND DISCUSSION

Characteristics of hydrochemical indicators of ponds.

The dynamics of hydrochemical indicators in the ponds of "Halyk Balyk" LLP in the 2018-2019 seasons is reflected in **Table 1**.

The water temperature values in the ponds during the two seasons, in general, were within the limits allowed for pikeperch values. The exception was the third decade of July, when the water temperature in the ponds increased above 27°C. The acid content in the morning hours in the pond water did not fall below 5.7 mgO₂/l and was within the limits of biotechnical standards for carp fish ponds used for culturing fingerlings and two-year-old pikeperches (Collection of normative and technological documentation for commercial fish breeding 1986). The data analysis showed that in 2018, the fluctuation of the values of the hydrogen index in the range of 7.0-8.1 is typical; in 2019, the pH values varied between 7.0 and 8.2. In general, hydrochemical indicators of ponds of "Halyk Balyk" LLP indicate optimal rearing conditions for pikeperch.

The results of the spawning and incubation of pikeperch eggs. In the 2018 spawning campaign, 9 pikeperch spawners participated in "Halyk Balyk" LLP, including 4 females and 5 males. Morphometric characters of pikeperch spawners used for spawning are shown in **Table 2**.

There were no significant differences in body weight, zoological body length, body length to the end of the middle arms of the caudal fin, head length, caudal peduncle depth, body thickness, and maximum body

Table 2. Indicators of morphometric characters of pikeperch that participated in the spawning campaign

Q, g	L, cm	l, cm	Head length (l _c), cm	Caudal peduncle depth (h _c), cm	Body height (H), cm	Body thickness (Br), cm	Body girth (Girth), m	Stage of maturity
males								
2300	64.0	56.0	15.5	4.7	11.2	6.2	33.0	IV-V
2400	60.0	54.0	15.3	4.7	11.0	8.0	30.4	IV -V
1850	57.0	49.5	14.5	4.3	10.8	7.2	31.8	IV -V
1900	57.5	50.0	14.0	4.4	11.0	6.8	32.1	IV -V
1300	53.5	45.5	13.5	3.6	8.2	4.3	24.3	IV -V
females								
2350	62.0	54.5	14.6	4.8	13.8	7.5	34.2	IV-V
2500	65.0	57.0	16.2	4.5	12.0	7.0	33.5	IV -V
2200	58.5	50.5	14.5	3.8	11.0	6.5	31.0	IV -V
1950	62.0	56.0	14.3	4.0	13.0	7.0	31.0	IV -V

Table 3. Fish-breeding and biological characteristics of female and male of pikeperch participating in the 2018 spawning campaign

Indicators	Values	
	males	females
Average body weight		
X±m, g	1950.00±194.94	2250.00±117.26
C _v , %	22.35	10.42
Body length to the end of the middle arms of the caudal fin		
X±m, cm	51.00±1.84	54.50±1.43
C _v , %	8.05	5.24
The fatness on Fulton		
X±m	1.450±.05	1.410±.12
C _v , %	6.94	17.62
Body fineness ratio, l/H		
X±m	4.92±0.18	4.40±0.18
C _v , %	8.23	7.99
Head length index, l/l		
X±m, %	28.60±0.004	27.36±0.006
C _v , %	2.98	4.70
Body thickness index, (Br/l)		
X±m, %	12.70±0.0105	12.850±.0016
C _v , %	18.43	5.08

girth of males and females who participated in the spawning campaign. Differences in the body height of females and males are statistically significant ($p < 0.01$). For the body weight of female pikeperch that participated in the spawning campaign, the average variation was noted, close to significant; a similar indicator in males is marked by an average variation close to weak.

The values of the zoological body length, body length to the end of the middle arms of the caudal fin, head length of males are characterized by a weak variation of these characteristics; caudal peduncle depth, body height, body thickness, the maximum body girth of males – average variation. In females, the values of zoological body length, body length to the end of the middle arms of the caudal fin, head length, body height, body thickness, and maximum body girth are characterized by a weak variation; the average variation is the caudal peduncle depth. The fish-breeding and biological characteristics of female and male of pikeperch participating in the 2018 spawning campaign are presented in **Table 3**.

The fatness of females according to Fulton is characterized by an average variation in the values of this characteristic, while males have a weak variation. All other studied signs shown in the table, except for the

Table 4. Size indicators of spawned pikeperch spawners, ratio of females to males in the nest

Cage	Ratio of females to males in the nest	Weight of females, g	Weight of males, g
1	1 : 2	2350	1850+1300
2	1 : 1	2500	2400
3	1 : 1	2200	2300
4	1 : 1	1950	1900

Table 5. Recommended biotechnical standards for pikeperch spawning in cages

Indicators	Unit	Values
The area of the pond for installation of spawning cages	ha	0.2
Number of cages installed in the pond	pcs.	10
Size of the spawning cage	m	1 x 1 x 1
"Dry stock" during the installation of the cages in the pond	m	0.2
Distance from the bottom of the cage to the bottom of the pond	m	0.2
Ratio of spawners in the spawning cage	males : females	1 : 1, 2 : 1
Selection of spawners	-	equal to the body length
The nature of the spawning	-	on nests, in cages
Number of nests in the cage	pcs.	1
Spawning water temperature	°C	11 – 14
Location of a nest with fertilized eggs in a cage	-	stage of the rotating embryo (stage IV)
Percentage of fertilization of eggs	%	80

index of body thickness of males, are characterized by weak variation. For the male body thickness index, an average variation was observed. The differences in the values of body fineness of females and males statistically accurate - ($p < 0.05$). There were no significant differences between the other studied features listed in the table.

Pikeperch spawning took place on nests-"frames" placed in cages, installed in the pond. The conditions for pikeperch spawning in the 2018 season, the size indicators of spawners and their ratios in the nest are presented in **Table 4**.

Recommended biotechnical standards for conducting pikeperch spawning in cages on nests placed in them are presented in **Table 5**.

Incubation of pikeperch eggs laid on nests was carried out in "Amur" incubation devices. During the incubation of pikeperch eggs, the course of the incubation process, the timing of incubation in pond conditions and pre-incubation in the incubation shop, the dynamics of larvae hatching and their transition to mixed

Table 6. Recommended biotechnical standards for incubation of pikeperch eggs in the “Amur” devices

Indicators	Unit	Values
Fecundity of female pikeperch	thousand pcs. of eggs	80 – 100
Method of incubation of eggs	-	placement of nest with eggs in the “Amur” devices
Water consumption per 1 “Amur” device	l/min	9,0
Number of nests with fertilized eggs of pikeperch in the “Amur” device	pcs.	1
Duration of incubation of eggs	days	4 – 7
Duration of larvae hatching that have switched to a mixed diet	days	4 – 5
Water temperature during incubation of pikeperch eggs	°C	15 – 18
Duration of incubation	degree days	90
Hatching of larvae from fertilized eggs	%	95
Hatching of larvae that switched to mixed food, from one female	thousand pcs.	85

Table 7. Fish-breeding and biological indicators of productivity of pikeperch females

Weight of females, g	Operating fecundity, thousand pcs.	% of egg fertilization	Hatching of 3 daily larvae, thousand pcs.
2350	73	77	59.1
1950	64	65	52.7
2200	76	85	66.2
2500	110	93	104.3

Table 8. Recommended biotechnical standards for keeping spawners and the replacement stock of pikeperch in ponds

Indicators	Unit	Values
Pond area for keeping spawners and replacement stock of pikeperch	ha	0,4
Planting density of spawners and replacement stock of pikeperch in the summer keeping	pcs./ha	125
Average unit growth of spawners and replacement stock of pikeperch for the period of summer keeping	g/pcs.	0,3
Survival rate of spawners and replacement stock of pikeperch during the summer keeping		
- spawners	%	50
- replacement stock	%	90
Fish productivity of adaptation ponds	kg/ha	30 – 35
Exterior features of replacement stock of pikeperch in Kapshagay reservoir		
- fatness on Fulton	unit	1,307±0,06
- fineness ratio (high-back) (l/H)	unit	5,153±0,09
- thickness index (wide-back) (Br/l)	%	11,79±0,32
- index of the largest girth	%	57,65±3,55
Exterior features of pikeperch spawners in Kapshagay reservoir		
males:		
- fatness on Fulton	unit	1,402±0,05
- fineness ratio (high-back) (l/H)	unit	4,917±0,18
- thickness index (wide-back) (Br/l)	%	12,7±1,05
- index of the largest girth	%	59,41±2,15
females:		
- fatness on Fulton	unit	1,44±0,12
- fineness ratio (high-back) (l/H)	unit	4,40±0,18
- thickness index (wide-back) (Br/l)	%	12,85±0,33
- index of the largest girth	%	59,57±1,63

(external) nutrition were monitored. Recommended biotechnical standards for the incubation of pikeperch eggs in the “Amur” incubation devices are presented in **Table 6**.

Based on the results of the pikeperch spawning campaign conducted on the farm, fish-breeding and

Table 9. Recommended biotechnical standards for rearing pikeperch juveniles in cages

Indicators	Unit	Values
Area of the pond for installing cages for rearing juveniles	ha	0.2
Number of cages installed in the pond	pcs.	20
Sizes of cage made of a sieve for rearing juveniles	m	1 x 1 x 1
“Dry stock” during the installation of cages in the pond	m	0.2
Distance from the bottom of the cage to the bottom of the pond	m	0.2
I stage of rearing		
Density of planting larvae that have switched to a mixed diet in cages for rearing	thousand pcs/m ³	5.0
Survival rate of juveniles reared from larvae	%	50
Average weight of juveniles at the end of the stage	mg	10
Average length of juveniles at the end of the stage	mm	12
Duration of the stage	days	10
II stage of rearing		
Planting density of I stage juveniles	thousand pcs/m ³	5.0
Average initial weight	mg	10
Average final weight	mg	30
Average initial length	mm	12
Average final length	mm	20
Survival rate of II stage juveniles reared from I stage juveniles	%	65
Duration of the stage	days	10

biological indicators of female productivity were determined (**Table 7**).

The weight of pikeperch females that took part in spawning varied from 1950 g to 2500 g. The average operating fecundity was 81 thousand pcs., the average value of the fertilization rate of eggs - 80%. These indicators are optimal for domesticated pikeperch spawners (Tamash et al. 1985, Radko et al. 2011). Pikeperch spawners, after the spawning campaign, as well as replacement stock were placed for summer maintenance in an adapted carp pond with an area of 0.4 hectares. The waste of pikeperch spawners after spawning was 45%.

Recommended biotechnical standards for the keeping spawners and the replacement stock of pikeperch in ponds by the method of domestication are shown in **Table 8**.

Rearing pikeperch juveniles in cages. In order to obtain a viable pikeperch juveniles, rearing was carried out in cages in two versions: with larvae planting densities of 10.0 and 5 thousand pcs/m³, in two stages lasting 10 days each. Recommended biotechnical standards for the rearing pikeperch juveniles in cages of the sieves is presented in **Table 9**.

Culturing pikeperch fingerlings in ponds. Stocking of ponds was carried out by reared pikeperch juveniles. Culturing pikeperch fingerlings was carried out in polyculture with yearlings of carp. After planting pikeperch juveniles in ponds, feeding was carried out with live feed (zooplankton, benthos) (Mazhibayeva et al. 2017). To stimulate the development of natural forage base in the ponds was conducted a complex of fish-breeding and reclamation activities, including the application of organic and mineral fertilizers, mowing and removing soft aquatic vegetation, depositing

Table 10. Recommended biotechnical standards for culturing pikeperch fingerlings in ponds

Indicators	Unit	Values
Method of culturing pikeperch fingerlings	-	in polyculture with two-year-olds of carp
Area of the pond for culturing pikeperch fingerlings	ha	0.2 – 1.0
Period of culturing fingerlings reared from pikeperch juveniles	days	100
Planting density of reared pikeperch juveniles	thousand pcs./ha	10.0
Average initial weight of pikeperch juveniles	mg	30
Average final weight of pikeperch fingerlings	g	30
Average initial zootechnical length of pikeperch juveniles	mm	20
Average final zootechnical length of pikeperch fingerlings	cm	16.5
Survival rate of fingerlings reared from pikeperch juveniles	%	15.0
Planting density of carp yearlings	pcs./ha	500
Fish productivity of carp ponds	kg/ha	250 – 500
Indicators of the exterior of pikeperch juveniles reared in order to form a replacement-brood stock		±
- fatness on Fulton	unit	1.08±0.05
- fineness ratio (high-back) (I/H)	unit	4.95±0.06
- thickness index (wide-back) (Br/l)	%	11.81±0.05
- index of the largest girth	%	51.31±0.10
Selection of fingerlings for a breed during formation of replacement-brood stock	%	20
Average body weight of pikeperch fingerlings sampled for a breed	g	40

sheaves of reeds. Further, the pikeperch was fed with juveniles of weed fish (Akpan et al. 2017).

Recommended biotechnical standards for culturing pikeperch fingerlings in ponds in polyculture in order to form a replacement stock of pikeperch are presented in **Tables 10**.

As a result of research in the 2018 season, viable pikeperch fingerlings were cultured. In order to further form the replacement-brood stock of pikeperch by method “from caviar”, the selection of 120 pieces of fingerlings with an average weight of 40 g was made.

Culturing two-year-old pikeperches in ponds. For culturing two-year-old pikeperches, ponds with an area of 0.2 ha with a dense soil depth of 1.0-1.5 m and a growth rate of no more than 20% of the area were used. Stocking was carried out by yearlings of pikeperch in poly-culture with yearlings of carp and white amur. Planting densities of pikeperch yearlings were selected to determine the most optimal values for culturing them in ponds in a polyculture. For unhindered entry of small weedy fish forage for pikeperch into the ponds, a metal grid with a 10 mm mesh was installed on the water supply. The high growth rate of two-year-old pikeperches was provided by the presence in the ponds in sufficient quantities of forage weed fish and the implementation of the cultivation technology. As a result, satisfactory values of the final weight of fingerlings and fish productivity for pikeperch in ponds were obtained, which correspond to the data of literary sources (Badryzlova et al. 2019, Koishybayeva et al. 2018, Radko et al. 2011, Tamash et al. 1985). Recommended biotechnical standards for culturing two-year-old

Table 11. Recommended biotechnical standards for culturing two-year-old pikeperches in ponds

Indicators	Unit	Values
Method of culturing two-year-old pikeperches	-	in polyculture with two-year-olds of carp and white amur
Area of the pond for culturing two-year-old pikeperches	ha	0.2 – 1.0
Period of culturing two-year-old pikeperches reared from yearlings	days	150
Planting density of pikeperch yearlings	pcs./ha	100-115
Average initial weight	mg	30-50
Average final weight	g	220-250
Average initial zootechnical length	cm	14-15
Average final zootechnical length	cm	24-26
Survival rate of two-year-old pikeperches	%	88-92
Fish productivity of pikeperch ponds	kg/ha	
Planting density of carp yearlings	pcs./ha	1000
Fish productivity of carp ponds	kg/ha	374
Planting density of white amur yearlings	pcs./ha	100
Fish productivity of white amur ponds	kg/ha	857
Indicators of the exterior of two-year-old pikeperches reared in order to form a replacement-brood stock		
- fatness on Fulton	unit	1.19±0.04
- fineness ratio (high-back) (I/H)	unit	4.91±0.07
- thickness index (wide-back) (Br/l)	%	11.96±0.14
- index of the largest girth	%	52.6±1.5
Selection of two-year-olds for a breed during formation of replacement-brood stock	%	20
Average body weight of two-year-old pikeperches sampled for a replacement-brood stock	g	250

pikeperches in ponds in a polyculture for the purpose of forming a replacement stock are presented in **Table 11**.

As a result of research in the 2019 season, viable two-year-old pikeperches were cultured. In order to further form the replacement-brood stock of pikeperch by the method “from caviar”, 100 pieces of two-year-olds with an average weight of 250 g were selected.

CONCLUSIONS

As a result of the research the size-age and sex composition, and the estimation of reproductive qualities domesticated spawners of pikeperch of Kapshagai reservoir was studied, the efficiency of pikeperch spawning on the spawning nests in cages, the incubation of eggs in the “Amur” device, the rearing of pikeperch juveniles in cages were determined, biotechnical processes of culturing pikeperch in ponds in polyculture were developed and the fish-biological indicators of fingerlings and two-year-olds in order to select in the replacement-brood stock of pikeperch were identified.

In the fish farm of “Halyk Balyk” LLP, the first replacement-brood stock of pikeperch in Kazakhstan was formed, consisting of domesticated spawners and replacement stock caught from the Kapshagay reservoir, as well as fingerlings and two-year-old pikeperches reared in ponds, produced by the “from caviar” method.

In the course of the work, the standards of individual weight of different age groups of replacement and

pikeperch spawners were clarified. The size and age indicators of individuals selected for the replacement-brood stock of pikeperch should not be lower by weight than the following: spawners: males - 1500 g; females - 2000 g; fingerlings - 40 g; two-year-olds - 250 g.

Based on the results of the work performed and the analysis of practical experience, for the first time in Kazakhstan, the main biotechnical standards for the formation of replacement-brood stock of pikeperch in ponds in fish farms were developed and prepared.

Biotechnical methods of breeding and culturing pikeperch from domesticated spawners were developed in Kazakhstan for the first time, are available to farmers and can be used by them when breeding pikeperch. In contrast to similar technologies developed abroad, domestic biotechnical techniques for breeding and rearing pikeperch are characterized by simplification of the stages of obtaining offspring, incubating eggs, rearing juveniles, culturing fingerlings and two-year-olds in ponds.

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