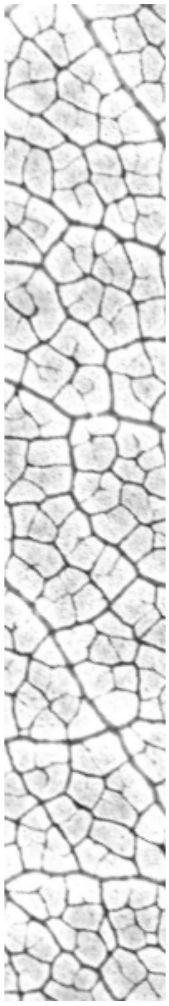

EurAsian Journal of BioSciences
Eurasia J Biosci 13, 409-417 (2019)

Assessment of the production potential of two-year-old pike-perch cultivated in ponds for the formation of RBS

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Abstract
The article presents the results of cultivating two-year-old pike-perch in carp ponds in polyculture. The characteristic of hydrochemical indicators in ponds is presented. The data of hydrobiological analysis of experimental ponds are presented. The values of planting densities and fish-breeding biological indicators of two-year-old pike-perch and fish that make up the polyculture are given. The data of statistical analysis indicators of final mass values, minimum allowable length and fatness of two-year-old pike-perch grown in ponds for the purpose of selection in the formed pike-perch repair-broodstock are presented. The material on the ratio of weight and size groups of two-year-old pike-perch is presented. The conclusions are given in which the results of analysis of the fish productivity data of two-year-olds for pike-perch, variability of body weight values, minimum allowable length and fatness of two-year-old pike-perch, distribution of two-year-olds by weight and size groups are presented.

Keywords: pike-perch, two-year-olds, ponds, productivity, polyculture, fish-breeding biological indicators, statistical analysis, hydrobiological and hydrochemical researches, repair-broodstock

Badryzlova N, Koishybayeva S, Assylbekova S, Isbekov K (2019) Assessment of the production potential of two-year-old pike-perch cultivated in ponds for the formation of RBS. Eurasia J Biosci 13: 409-417.

INTRODUCTION

In recent years, interest in pike-perches as an object of aquaculture has increased. In connection with superintensive industrial and commercial fishing, the number of pike-perch in natural reservoirs of the Republic of Kazakhstan is decreasing. The pike-perch, as one of the most valuable types of commercial fish, is a subject of export of Kazakhstan. Products from Kazakhstan pike-perch are highly rated on the European market. In Kazakhstan, pike-perch breeding in pond farms has not yet become commercial in scale due to the lack of its cultivation technologies. Reducing stocks of pike-perch in the fisheries of the country dictated the need to develop and improve methods of breeding and rearing pike-perch in fish farms in Kazakhstan. At the same time one of the important tasks is the formation of repair-broodstock and living collections of pike-perch at fish farms.

In the period 2012–2017 LLP “Kazakh Research Institute of Fisheries” conducted research on the development of biotechnical methods of breeding and rearing pike-perch in the conditions of fish farms in Kazakhstan. At present, studies are being conducted on the formation of repair-broodstock of pike-perch in conditions of basic fish farming. At the same time, the formation of repair-broodstock of pike-perch is carried out by two methods: domestication and cultivation “from caviar”.

This article provides data on the determination of the production potential of two-year-old pike-perch grown from yearlings, reproduced from domesticated producers of pike-perch in conditions of basic fish farming for the purpose of selection into the formed repair-broodstock.

The aim of the research - to determine the production potential of two-year-old pike-perch at cultivation in ponds in polyculture under conditions of basic fish farming in southern Kazakhstan.

MATERIAL AND METHODS

The material for the research was two-year-old pike-perch and fish that make up the polyculture (carp, grass carp, silver carp, tilapia).

When growing two-year-olds of pike-perch in ponds, foreign regulatory and technological literature was used (Chernomashentsev and Milshtein 1983, Collection of regulatory and technological … 1986, Kozlov et al. 2006, Ponomareva et al. 2007, Privezentsev 2000, Privezentsev et al. 1998, Radko et al. 2011, Sabodash

Received: September 2018
Accepted: April 2019
Printed: May 2019

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

Month	Decade	Values of indicators in ponds					
		variant 1			variant 2		
		t, °C	pH	mgO_2/l^*	t, °C	pH	mgO_2/l^*
April	I	14.2	7.5	5.7	14.3	7.3	5.6
	II	15.6	7.7	5.6	15.5	7.5	5.5
	III	16.8	8.1	6.1	16.3	8.0	6.2
May	I	17.7	7.8	6.3	17.5	7.6	6.3
	II	19.4	7.5	5.8	19.2	7.5	5.7
	III	21.2	7.6	6.4	21.0	7.2	6.4
June	I	22.0	7.3	6.2	21.6	7.1	6.1
	II	22.7	7.4	6.1	22.5	7.3	5.8
	III	23.5	7.2	6.6	23.3	7.5	6.0
July	I	25.3	7.3	6.0	25.0	7.6	6.1
	II	26.6	7.8	6.7	26.5	7.7	6.3
	III	26.7	8.1	5.8	26.9	8.0	5.7
August	I	25.9	7.5	6.1	25.6	7.8	6.2
	II	25.2	8.1	6.3	24.8	8.0	6.3
	III	23.7	7.9	6.7	23.4	8.2	6.6

Note: *The values of the oxygen content in the water of ponds in the morning.

2006, Tamash et al. 1985). The study and assessment of the growth rate and survivability of two-year-old pike-perch were carried out according to the control catches (1 time per month). The assessment of the quality of water in ponds was carried out according to methods generally accepted in hydrochemistry (Guidelines for the chemical analysis of surface waters of the land 1997, Shesterin et al. 1984, State control of water quality 2003). The collection and processing of hydrobiological samples were carried out according to the existing methods in hydrobiology (Kitayev 1984, Kutikova 1970, Kutikova and Starobogatov 1977, Manuilova 1964, Methodological guide for hydrobiological fisheries … 2006, Öztürk et al. 2014).

The collection and processing of ichthyologic material was carried out according to the method of Pravdin (1966). Statistical processing of the material was carried out by P.F. Rokytsky (Rokitsky 1967, Yüksel et al. 2015).

In the ponds, dumped manure was introduced along the coastline in the amount of 2 t/ha and sheaves of dried reed in order to intensify the development of the natural food supply base. The suppression of the development of higher aquatic vegetation was carried out by planting a grass carp of different ages. For unimpeded small-weed (fodder for pike-perch) fish, a metal grid with 10 mm mesh was installed on the water supply.

RESULTS AND DISCUSSION

Research on the cultivation of two-year-old pike-perch in ponds was carried out at LLP "Halyk Balyk" (Almaty region, VI fish farm) in the 2017 season.

Hydrochemical characteristics of ponds of LLP "Halyk Balyk"

The dynamics of hydrochemical indicators in the ponds of LLP "Halyk Balyk" in the 2017 season are reflected in **Table 1**.

The temperature values of water in the ponds was within the allowable values when growing pike-perch. In variant 1 ponds, temperature fluctuations ranged from 14.2°C in the first decade of April to 26.8°C in the third decade of July; in the pond №2 - from 14.3°C to 26.9°C (respectively). In the morning, the oxygen content in the water did not fall in variant 1 and 2 ponds below 5.7 and 5.6 mgO_2/l, respectively, and was within the bio-technical standards for carp fish ponds used in the current year for growing two-year-old pike-perch (Kheiry et al. 2013, Shesterin et al. 1984).

The analysis of the data showed that for ponds of variant 1, fluctuation of the values of the hydrogen index within 7.2–8.1 is characteristic; in variant 2 ponds, the pH values varied from 7.1 to 8.2. The data of hydrochemical indicators of ponds indicate, on the whole, the optimum growing conditions for two-year-old pike-perch (Radko et al. 2011).

Hydrochemical indicators of experimental ponds of LLP "Halyk Balyk" during the vegetation season were within the limits required for quality of the aquatic environment of carp ponds of fish farms.

Hydrobiological characteristics of ponds

Phytoplankton. In the spring-summer period of 2017, the taxonomic list of algae selected in the ponds of LLP "Halyk Balyk" consisted of 47 algae species belonging to 5 divisions. Among them: blue-green - 12, diatoms - 19, green - 11, pyrophytes - 3, euglene - 2. The dominant phytoplankton complex is represented by the following algae species: *N. Gregaria, C. meneghiniana, A. ovalis, C. vulgaris, C. undulatum, Trachelomonas sp., E. cordata*.

The qualitative composition of phytoplankton ponds of LLP "Halyk Balyk", when growing two-year-old pike-perch in them in the 2017 season, is presented in **Table 2**.

As follows from the table, the diversity of the phytoplankton community varied from 4 to 21 taxa. The smallest number of algae species was recorded in May – June in ponds of variant 1 and varied from 4 to 9 taxa. In ponds of variant 2, the taxonomic composition of algae was more diverse and varied from 13 to 21 taxa.

Table 2. The qualitative composition of phytoplankton ponds of LLP "Halyk Balyk"

The name of division and taxon of algae	variant 1				variant 2			
	V	VI	VII	VIII	V	VI	VII	VIII
Division *Cyanophyta* – blue-green								
Merismopedia tenuissima Lemm.	-	-			+	+	+	
M. minima G.Beck.		+						+
M. major (Smith.) Geitl								
Microcystis pulverea f. pulverea (Lemm.) Elenk.			+		+	+	+	+
M. aeruginosa Kütz. emend. f. aeruginosa							+	
Gomphosphaerium lacustris Chod. f. lacustris								+
G. aponina Kütz. f. aponina			+					
Phormidium tenue (Meneg.)Gom.	+		+		+			+
Anabaena sp.								+
Gloeocapsa crepidinum Thur.							+	
G. turgida (Kütz) Hollerb. f. turgid		+						
Rabdoderma lineare Schmidle et Laut.Hollerb.					+			
Oscillatoria sp.						+		
Division *Bacillariophyta* – diatoms								
Cyclotella meneghiniana Kütz.	+	+	+	+	+	+	+	
C.comta Kütz.								+
Navicula Gregaria Kütz.		+	+		+	+	+	+
N. placentula (Ehr.) Grun.					+			
N. cuspidata Kütz. var cuspidata			+	+		+	+	+
N. gracilisEhr.						+		
Navicula sp.						+	+	
Synedra acus Kütz. var. acus							+	
Amphora ovalis Kütz var. ovalis			+		+	+	+	+
Cocconeis pediculus (Ehr.) var.Pediculus			+		+			
Fragilaria intermedia Grün. var. Intermedia			+					+
Fragilaria sp.						+		
Rhopalodia gibba (Ehr.) O. Müll. var. gibba			+				+	
Epithemia argus Kütz. var. Argus			+		+		+	
Rhoicosphaenia curvata (Kütz.) Grun.						+		
Gomphonema lanceolatum Ehr.								+
G.constrictumEhr.						+		
Nitzschia sp.						+		
Surirella ovalis Breb.								+
Division *Chlorophyta* – green								
Chlorella vulgaris Beyer.		+	+	+	+		+	+
T minutissimum Korschik.								+
Cosmarium undulatum Corda			+	+			+	+
Scenedesmus quadricauda (Turp.) Breb. var. quadricauda			+				+	+
S. bijugatus (Turp.) Kütz. var. bijugatus				+				
Cladophora sp.		+						
Dictyosphaerium simplex Korsch.		+						
Pediastrum duplex Meyen. var. duplex			+					
Ankistrodesmus pseudomirabilis Korsch.					+			
Lagerheimia ciliata (Lagerh.) Chod.						+		
Oocystisborgei Snow. var. borgei							+	
Division *Pyrrophyta* – pyrophytes								
Peridinium umbonatum Stein.	-		+	+	+	+	+	+
Exuviaella cordataOstf.	+	+	+	+	+	+	+	+
Gymnodinium sp.	-		+					
Division *Euglenophyta* – euglenes								
Trachelomonas sp.	+	+	+	+	+	+	+	+
Phacus sp.	-				+			
Total:	4	9	19	8	16	17	19	19

Table 3. Quantitative development of phytoplankton in ponds of LLP "Halyk Balyk", g/m^3

Divisions of algae	variant 1				variant 2			
	V	VI	VII	VIII	V	VI	VII	VIII
green	-	0.030	0.080	0.060	0.001	0.002	0.070	0.700
blue-green	0.020	0.005	0.090	-	0.010	0.100	0.200	0.145
diatoms	0.040	0.030	0.580	0.060	0.170	0.300	0.400	1.870
euglenes	0.100	0.200	0.200	0.040	0.110	0.001	0.250	0.100
pyrophytes	0.105	0.100	0.070	0.200	0.400	0.800	0.200	0.200
Total	0.265	0.365	1.020	0.360	0.691	1.203	1.120	3.015

The dynamics of phytoplankton biomass in the ponds of LLP "Halyk Balyk" in the 2017 season are presented in **Table 3**.

Based on the data in the table, in spring period the phytoplankton was poorly developed in the ponds of both variants. Biomass indicators were low and ranged from 0.265 to 0.691 g/m^3.

On the "trophic scale" of Kitayev (1984) phytoplankton biomass values in ponds of variant 1 varied from 0.360 to 1.020 g/m^3 in the summer period. The basis of phytoplankton biomass in June was created

Table 4. The qualitative composition of zooplankton in the ponds of LLP "Halyk Balyk"

The name of division and taxon of zooplankton	variant 1				variant 2			
	V	VI	VII	VIII	V	VI	VII	VIII
Rotifera								
Trichocerca longiseta Schrank			+					
Polyarthra dolichoptera dolichoptera Idelson			+					
Sunchaeta pectinata Ehrnberg				+				+
Asplanchna priodonta helvetica Imhof	+							
A. girodi Guerne		+	+			+	+	
A. sieboldi Leydig		+					+	+
A. brightwelli Gosse	+		+	+		+	+	
L. (s. str.) ungulata Gosse	+	+			+			
L. (M.) bulabula Gosse		+	+		+	+		
L. (M.) crenata Harring		+						
Habrotrocha bidens Gosse		+			+			
Dissotrocha aculeate Ehrenberg		+						
Mytilina ventralis ventralis Ehrenberg		+						
Euchlanis dilatata dilatata Leydig						+	+	
E. pyriformis Gosse		+	+		+		+	
E. incise Carlin								+
Br. q. melheni Barrois et Daday	+							
Br. q. Hyphalmuros Tschugunoff					+			
Br. Calyciflorus amphiceros Ehrnberg	+	+						
Platyias guadricornis guadricornis Ehrnberg		+	+					
Keratella cochlearis cochlearis Gosse	+							
K. c. Tecta Gosse		+						
K. tropica tropica Apstein		+		+				
Hexarthra mira Hydson		+	+					+
Cladocera								
Daphnia gr. pulex s. lat. De Geer	+				+			
Diaphanosoma macrophthalma Korovchinsky et Mirabdullaev	+	+	+	+	+	+	+	+
Ceriodaphnia quadrangular O.F.Muller		+	+	+	+	+	+	+
C. reticulata Jurine	+	+		+	+	+		
C. dubia Richard	+	+					+	
Simocephalus vetulus Muller	+				+	+		
Moina brachiata Jurine		+			+			
Scapholeberis mucronata O.F.Muller	+	+	+	+	+	+	+	+
Dunhvedia crassa King		+	+			+	+	
Chydorus sphaericus Muller		+	+		+	+	+	+
Alona rectangula Sars					+			
A. quadrangularis O.F. Muller					+			
A. costata Sars							+	
Copepoda								
Eucyclops denticulatus Graeter			+		+			
Tropocyclops prasinus Fischer						+		
Paracyclops fimbriatus Fischer					+			+
P. poppei Rehberg		+						
P. chiltoni Thomson		+						
Acanthocyclops americanus (s. lat.)	+	+			+			
A. venustus Norman et Scott	+							
Megacyclopc viridis Jurine					+			
Microcyclops rubellus Lilljeborg		+						
Mesocyclops leuckarti Claus	+	+	+		+	+	+	+
M. arakhlensis Alekseev		+						
Cryptocyclops bicolor bicolor Sars						+		
Neutrodiaptomus incongruen Poppe				+			+	+
Erqasidae sp.						+		
Total taxa	15	28	15	8	20	15	14	11

by euglene algae (54.8 %), in July – diatoms (56.9 %), and in August – pyrophytes (55.5 %). Ponds of variant 1 on the amount of phytoplankton biomass in May, June, August corresponded to a very low trophic class, α-oligotrophic type. In July, the trophic class was slightly higher and corresponded to the moderate one, and the type of the reservoir was α-mesotrophic.

The values of phytoplankton biomass in ponds of variant 2 in June – July corresponded to the moderate class of food supply, α-mesotrophic type. In June, the basis of biomass was created by pyrophyte algae (71.4%), and in July - diatoms (35.7%). In August, the level of food supply of ponds increased to the middle class, and the type of reservoir to β - mesotrophic. At that time, the basis of the phytoplankton biomass was created by diatoms (62%).

Zooplankton. According to the results of hydrobiological research in 2017, the zoo-plankton of the ponds of LLP "Halyk Balyk" is represented by 51 taxa from three main groups, where 24 taxa are rotifera, 13 cladocera and 14 copepoda.

The qualitative composition of zooplankton of the ponds of LLP "Halyk Balyk", when growing two-year-old pike-perch in the 2017 season, is presented in **Table 4**.

The main background of the zooplankton community in the ponds of both variants *was A. girodi, A. sieboldi,*

Table 5. Quantitative development of zooplankton in the ponds LLP "Halyk Balyk", a - abundance, thousand spec./m^3, b - biomass, g/m^3

Sample collection date	Rotifera		Cladocera		Copepoda		Total	
	a	b	a	b	a	b	a	b
variant 1								
20.05	11.90	0.116	76.0	5.027	30.0	0.663	117.90	5.806
05.06	235.90	5.337	54.80	1.268	32.20	0.638	322.90	7.243
20.06	10.30	0.128	430.0	14.401	59.50	0.413	499.80	14.942
05.07	15.0	0.082	331.0	11.915	44.30	0.249	390.30	12.246
20.07	20.60	0.091	500.0	20.757	38.0	0.511	558.60	21.369
05.08	1.20	0.021	96.0	3.407	10.30	0.263	107.50	3.691
Average indicator	49.150	0.963	247.967	9.463	35.717	0.456	332.834	10.882
variant 2								
20.05	1.80	0.002	95.0	7.416	21.20	0.105	118.0	7.523
05.06	24.0	0.045	875.20	21.899	33.60	0.177	932.80	22.121
20.06	8.0	0.027	644.0	22.290	48.30	0.310	700.30	22.627
05.07	6.0	0.126	128.90	4.959	9.30	0.053	144.20	5.138
20.07	3.0	0.007	879.80	32.133	32.60	0.388	915.40	32.528
05.08	20.0	0.10	195.0	5.672	33.80	1.825	248.80	7.597
Average indicator	10.467	0.051	469.650	15.728	29.80	0.476	509.917	16.255

A. brightwelli, L. bulabula, Br. c. amphiceros, D. macrophthalma, C. reticulata, C. quadrangula, M. brachiata, S. mucronata, D. crassa, Ch. sphaericus, A. americanus and *M. Leuckarti* (57-100% occurrence in the spring-summer period).

According to the total number of species, for the period of research ponds differ slightly. The greatest diversity was found in the ponds of variant 1 - 40 taxa, in the ponds of variant 2 - 34. If look at the months, the largest number of species in the ponds was found in May-July, 20-28 taxa respectively, the smallest in August - 8-11 species.

Quantitative development of zooplankton in the ponds LLP "Halyk Balyk" is presented in **Table 5**.

The basis of abundance and biomass in ponds of variant 1 was on average cladocera - 74.5 and 87.0%, respectively. Throughout the growing season, they prevailed in the community, but in early June, rotifera became the dominant group, with predatory rotifera of the genus *Asplanchna* (42.7% in abundance and 72.9% in biomass) laying the foundation. During the season, the highest production indicators were found in the period – mid-June – mid-July, with a peak in mid-July (14.929-12.369-21.369 g/m^3), when the pond bio-productivity reached a high-very high class of food supply with eutrophic-hypertrophic type due to mass development of cladocera of the genus *Ceriodaphnia* (81.3-92.5-95% of the total biomass).

The basis of abundance and biomass in ponds of variant 2 was also cladocera - 92.1 and 96.8%, respectively. The highest biomass indicators were found in June - 22.121-22.627 g/m^3 and in mid-July (32.528 g / 3), where the base was formed by cladocera of the genus *Ceriodaphnia* (97.4-98.0-97.1% of the total biomass).

On the basis of average quantitative indicators for the period of the study, cladocera dominated in all ponds, among them cladocera of the genus *Ceriodaphnia*, whose share in the total mass reached 98%.

In the current season, experimental ponds of both variants were productive in terms of zooplankton. On food supply scale, the values varied from the medium-feed class of mesotrophic type to the very high-feed of hypertrophic type (Kitayev 1984).

Zoobenthos. In LLP "Halyk Balyk", in the season of 2017, it is represented by ostracods, gastropods, malacostracans, hemipterans, coleopterans, maggots and chrysalids.

The quantitative composition of zoobenthos in the ponds of LLP "Halyk Balyk" in the 2017 season is presented in **Table 6**.

In May, in the ponds of variant 1, shellfish crustaceans - ostracods (48.2%) were dominant in terms of abundance, and large larvae of beetles (61.7%) in terms of biomass. The level of zoobenthos biomass (1.36 g/m^2) corresponded to the β-oligotrophic type of reservoir with a low class of food supply. In June, dragonfly larvae dominated in abundance (30%), beetle larvae in biomass (31.8%). The level of zoobenthos biomass (0.66 g/m^2) corresponded to the α-oligotrophic type of reservoir with a very low class of food supply. In July, bugs and larvae of beetles (31% each) were equally dominant in terms of biomass of larvae of beetles (56.9%). The level of zoobenthos biomass (0.54 g/m^2) corresponded to the ultra-oligotrophic type of reservoir with the lowest class of food supply. In August, dragonfly larvae dominated both in abundance and biomass (72.7 and 99.5%, respectively). The level of zoobenthos biomass (0.93 g/m^2) corresponded to the α-oligotrophic type of reservoir with a very low class of food supply (Kitayev 1984).

In May, in the ponds of variant 2, ostracods (62.3 %) were dominant by abundance, by biomass - larvae of beetles (66.6%). The level of zoobenthos biomass (1.17 g/m^2) corresponded to the α-oligotrophic type of reservoir with a very low class of food supply. In June, the number of bugs prevailed (55.9%), and the biomass of dragonfly larvae (51%). The level of zoobenthos biomass (0.41 g/m^2) corresponded to the ultra-oligotrophic type of reservoir with the low class of food

Table 6. Quantitative development of zoobenthos in the ponds of LLP "Halyk Balyk", a - specimen, b - mg

Group of organisms	May		June		July		August	
	a	b	a	b	a	b	a	b
variant 1								
Ostracods	53	38	-	-	-	-	-	-
Gastropods	2	82	3	130	5	54	-	-
Hemipterans	15	171	11	135	13	167	1	4
Coleopterans	8	89	1	11	-	-	-	-
Odonatoptera larvae	2	139	15	163	13	306	8	930
Ephemeroptera larvae	-	-	9	9	4	2	-	-
Coleopterans larvae	22	838	5	211	3	7	-	-
Chironomidae larvae	8	1	2	2	1	1	2	1
Culicoides larvae	-	-	4	2	3	1	-	-
Total:	110	1358	50	663	42	538	11	935
variant 2								
Ostracods	71	53	-	-	-	-	-	-
Gastropods	2	52	1	7	1	1	-	-
Hemipterans	6	67	19	176	2	3	2	7
Coleopterans	7	73	1	15	-	-	-	-
Odonatoptera larvae	3	116	11	210	9	1724	7	910
Ephemeroptera larvae	7	30	1	3	-	-	-	-
Coleopterans larvae	17	782	1	1	-	-	-	-
Chironomidae larvae	1	1	-	-	-	-	4	3
Total:	114	1174	34	412	12	1728	13	920

Table 7. The data of fish-breeding and biological indicators of pike-perch two-year-olds at cultivation in ponds in polyculture

Indicators	Unit of measurement	Values	
Variants		**№ 1**	**№ 2**
Period of cultivation	days	150	150
Planting density	pcs/ha	115	100
Initial mass	g	30.0±1.03	50.0±1.2
Final mass	g	216.8 ±11.7	248.84±9.34
Absolute growth gain	g	186.8	198.8
Average daily growth gain	g	1.24	1.32
Relative growth gain	%	622.6	397.6
Survivability	%	88	92
	pcs/ha	101	92
Fish productivity	kg/ha	21.8	22.8

supply. In July, both in abundance and biomass, dragonfly larvae prevailed (75 and 99.8%, respectively). The level of zoobenthos biomass (1.73 g/m^2) corresponded to the β-oligotrophic type of reservoir with a low class of food supply. In August, predators also dominated - dragonfly larvae (53.8% of the total number and 98.9% of the total biomass). The level of zoobenthos biomass (0.92 g/m^2) corresponded to the α-oligotrophic type of reservoir with a low class of food supply (Kitayev 1984).

As a result of hydrobiological studies, it was determined that the level of indicators of the natural food supply of the ponds during the season corresponded to the optimal values when cultivating two-year-old pike-perch in polyculture.

Cultivation of two-year-old pike-perch in ponds

To determine the potential for cultivation of two-year-old pike-perch in the ponds of LLP "Halyk Balyk", experimental ponds with an area of 0.2 ha with different polyculture composition were used. Experimental ponds stocking of variant 1 was produced by yearlings of pike-perch with an average weight of 30 g with a planting density of 100 pcs/ha. Polyculture in ponds of the variant 1 consisted of tilapia yearlings of average weight 100 g with a planting density of 3000 pcs/ha and a grass carp with an average weight of 50 g with a planting density of 150 pcs/ha.

In variant 2, ponds were stocked with pike-perch tearlingss with an average weight of 50 g with a planting density of 115 pcs/ha. The polyculture consisted of yearlings of carp with an average weight of 50 g and a planting density of 1000 pcs/ha; silver carp with an average weight of 30 g and a planting density of 400 pcs/ha; as well as two-year-olds of grass carp with an average weight of 200 g and a planting density of 100 pcs/ha. The indicated planting densities of pike-perch yearlings were selected in order to determine the most optimal values when growing them in ponds in polyculture.

The period of cultivation of pike-perch and carp fish was 150 days (from April 20 to October 20). Tilapia was grown for 90 days, when the water temperatures in the ponds were in the optimal range for this thermophilic object, i.e. were above 20^{0}C (from June 5 to September 5).

The data of fish-breeding and biological indicators of pike-perch two-year-olds grown in ponds LLP "Halyk Balyk", in polyculture are presented in **Table 7**.

As a result of experimental cultivation in ponds in both variants, high survival values of two-year-old pike-perch were obtained, exceeding the standard values by 18% and 22%, respectively. Two-year-olds of pike-perch

Table 8. Fish-breeding and biological indicators of fish, polyculture objects at cultivation in ponds with two-year-olds of pike-perch

Indicators	Unit of measurement	Values				
		variant № 1			variant № 2	
Type of fish		tilapia	grass carp	carp	grass carp	silver carp
Period of cultivation	days	90	150	150	150	150
Planting density	pcs/ha	3000	150	1000	100	400
Initial mass	g	100.0±3.9	50.0±5.4	50.0±4.73	200.0±23.8	30.0±4.2
Final mass	g	423.0±26.3	560±48.1	430±34.7	660±51.6	370.0±46.9
Absolute growth gain	g	323.4	510	380	460	340
Average daily growth gain	g	3.6	3.4	2.5	3.1	2.26
Relative growth gain	%	324.6	1260	1160	345	1800
Survivability	%	95	90	87	93	85
	pcs/ha	2850	135	870	93	340
Fish productivity	kg/ha	1205.5	75.6	374	857	294
Total fish productivity	kg/ha	1281.1			1525.0	

gained mass well and reached normal weights, which indicates the optimal conditions proposed in ponds (Radko et al. 2011, Tamash et al. 1985). As a result, fish productivity for two-year-olds of pike-perch in ponds above the norm was obtained by 1.8 kg/ha (variant 1) and by 2.8 kg/ha (variant 2). The high growth rate of two-year-olds of pike-perch was ensured by the presence in the ponds of a sufficient amount of food supply litter fish and the correct implementation of cultivating technology. As a result, satisfactory values of fish productivity for pike-perch in ponds were obtained, which correspond to the data of literature sources (Radko et al. 2011, Tamash et al. 1985).

Fish-breeding and biological indicators of fish, polyculture objects at cultivation in ponds with two-year-olds of pike-perch are presented in **Table 8**.

RESULTS AND DISCUSSION

The results indicate a promising cultivation of two-year-olds of pike-perch in ponds with proposed planting densities of different-age polyculture of carp fish and tilapia. Thus, in the ponds of variant 1, two-year-olds of grass carp and tilapia at cultivation in polyculture with two-year-olds of pikeperch, showed a high survival rate of 90% and 95%, respectively. As a result, commercial products of grass carp and tilapia with an average weight of 423 g and 560 g, respectively, were grown. At the same time, fish productivity in the pond increased by 75.6 kg/ha for grass carp and by 1205.5 kg/ha for tilapia and in total amounted to 1281.1 kg/ha. The total fish productivity, together with the values of fish productivity for pike-perch (21.8 kg/ha) was 1302.9 kg/ha.

In ponds of variant 2, the survivability indicator of two-year-olds of carp and silver carp was higher than the normative by 12% and 10%, and three-year-olds of grass carp by 5%. As a result, two-year-olds of carp and silver carp were grown, as well as three-year-olds of grass carp with a high average weight (430 g; 370 g and 660 g, respectively). Due to this, the fish productivity in the pond for two-year-olds of carp and silver carp increased by 374 kg/ha and 294 kg/ha, respectively, for three-year-olds of grass carp - by 857 kg/ha and in total amounted to 1525 kg/ha. The total fish productivity in the pond, together with fish productivity in pike-perch (22.8 kg/ha) was 1,547.8 kg/ha.

At the same time, carp and grass carp, which are part of the polyculture, reached marketable mass during the fish breeding season. When using complex different-age polyculture of fish in variants 1 and 2, there was no negative effect on the change in fish productivity over two-year-olds of pike-perch in ponds. As a result, in both variants fish productivity above the normative was achieved.

It was determined that the cultivation of pike-perch with a two-year turnover allows obtaining an average weight of up to 248 g and fish productivity up to 22 kg/ha. An increase in the planting density of pike-perch to 115 pcs/ha (from the normative 100 pcs/ha) did not negatively affect the growth rate and fish productivity of two-year-olds of pikeperch. The results of the research carried out in LLP “Halyk Balyk” showed a real possibility of growing two-year-olds of pike-perch in polyculture in conditions of fish farms in the south of Kazakhstan. Two-year-olds of pike-perch in the proposed conditions of the fish farms of the south of RK showed high fish-breeding and biological indicators. At cultivation two-year-olds of pike-perch due to polyculture, additional fish productivity of 12.8 c/ha and 15.2 c/ha was obtained, respectively.

As a result of statistical studies, it was found that the obtained mass values of two-year-olds of pike-perch grown in ponds of LLP “Halyk Balyk” varied within 184 - 345 g, the average value - 248.84 g. The coefficient of variation of mass values was 18.77%, which is evidence of the average variability of this trait. The deviation of the median value (248.22 g) from the average value was 0.25%, the mode value (233.95 g) was 6.37%, which speaks in favor of the normal distribution of the obtained mass values of two-year-olds. The resulting positive asymmetry value (0.28> 0) is evidence that there is some predominance of individuals of the weight group less than the mean. The negative value of the excess (-0.27<0) of the distribution of the obtained values of body weight of pike-perch two-year-olds testifies to a “two-peaked” distribution curve of the values of this characteristic.

When analyzing the ratio of the weight groups of two-year-olds of pikeperch, it was revealed that the number of individuals of small weight group (184.00 - 237.65 g) in the sample is 44%, average (237.66 - 291.32 g) - 36%, large (291.33 - 345.00 g) - 20%, i.e., the smallest number of two-year-olds fall to the share of a large weight group.

The obtained values of the fishing length of two-year-olds varied from 24 to 29 cm, the average value was 26.14 cm. The coefficient of variation values of minimum allowable length was 5.98%, which is evidence of the low variability of this feature. The deviation of the median (26.04 cm) from the average value was 0.40%, mode (25.64 cm) - 1.96%, which speaks in favor of the normal distribution of the obtained values of minimum allowable length of pike-perch two-year-olds. The obtained positive asymmetry value (0.28>0) of distribution values of minimum allowable length of body indicates a slight predominance of individuals with minimum allowable length slightly less than the average value; the negative value of excess (-0.45<0) is about the “two-peaked” curve of the distribution values of this attribute.

When analyzing the ratio of the size groups of two-year-olds of pike-perch, it was revealed that the number of individuals of the small size group (24.00 - 25.66 cm) in the sample is 32%, medium (25.67 - 27.32 cm) - 40%, large (27.33 - 29.00 cm) - 28%, i.e., the largest number of two-year-olds is in the middle group.

The fatness values of two-year-olds according to Fulton varied within 1.28 - 1.48 units, the average value - 1.38 units. The coefficient of variation of the obtained fatness values was 4.03%, which is evidence of the low variability of this sign. The deviation of the median (1.375 units) from the average value was 0.36%, mode (1.3786 units) - 0.10%, which speaks in favor of the normal distribution of the obtained fatness values of pike-perch two-year-olds. The obtained negative asymmetry value of this trait (-0.16<0) indicates a slight predominance of individuals with fatness values slightly higher than the average value; a negative value of excess (-0.86<0) is about a “two-peaked” curve of the distribution of trait fatness according to Fulton.

Analysis of fish productivity for two-year-olds of pike-perch showed that the achieved level (22.8 kg/ha) is not the limit. During the autumn (final) catch of experimental ponds, a large number of small crucian was found, which is a potential object of feeding for pike-perch (Collection of regulatory and technological documentation … 1986, Kozlov et al. 2006, Radko et al. 2011, Tamash et al. 1985).

CONCLUSIONS

Based on scientific studies, the following conclusions were made:

- when growing two-year-olds of pike-perch in polyculture, it is recommended to use two-year-olds of carp when the density of carp planting is 1000 pcs/ha, grass carp - 150 pcs/ha, and silver carp - 400 pcs/ha, at the same time, fish productivity in polyculture of more than 13 c/ha achieve;
- the planting density of pike-perch yearlings of 115 pcs/ha in polyculture is not the ultimate;
- the obtained fish productivity over two-year-olds of pike perch up to 22.8 kg/ha can be increased by using the full potential of carp ponds;
- the survivability of two-year-olds of pike-perch depends on the compliance of the pond with the necessary conditions: dense bottom soil, depth up to 1.5 m and overgrowth no more than 20% of the area;
- the survivability of two-year-olds of pike-perch grown in carp ponds from yearlings of an average weight of 30 -50 g is up to 88-92%;
- from the grown two-year-olds of pikeperch, the share of a large weight group (291.33 - 345.00 g) is 20%, of the middle group (237.66 - 291.32 g) - 36%, of the small group (184.00 - 237.65 d) - 44%;
- from the grown two-year-olds of pikeperch, the share of the large size group (27.33 - 29.00 cm) is 28%, of the middle group (25.67 - 27.32 cm) - 40%, of the small group (24.00 - 25.66 cm) - 32%; the largest proportion of grown two-year-olds of pike-perch in terms of minimum allowable length is in the average size group.

Biotechnical methods of cultivation of two-year-olds of pike-perch in ponds in polyculture were developed in Kazakhstan for the first time, they are available to farmers and can be used by them for growing pike-perch in conditions of fish farms.

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