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**Bulavina N.B.**[1], Senior Researcher
**Fefelov V.V.** [2], Head of the Integrated Laboratory
**Bolatbekova Z.T.** [1], Junior Researcher, Ph.D student
**Abilov B.I.** [1], Researcher, Ph.D student
«Fisheries Research and Production Center» LLP, Almaty, Republic of Kazakhstan
Northern Branch of «Fisheries Research and Production Center», Petropavlovsk, Republic of Kazakhstan

# FISHERIES RESEARCH OF LAKES OF THE NORTH KAZAKHSTAN REGION ON THE EXAMPLE OF A LAKE LARGE SALTY FOR THE ORGANIZATION ON ITS BASIS OF THE LAKE-COMMERCIAL FISH FARMING

**Abstract**

The article provides information on the main parameters of the aquatic environment, the condition of the food supply, the characteristics of the fish fauna of lake Large Salty, an assessment of its suitability for the organization of the lake-commercial fish farm (LCFF). Recommendations on the preparation of the reservoir for the commercial cultivation of fish and the organization of lake-commercial fish farming on this lake are also given. As a result of studies, it was found that the hydrological regime of lake Large Salty is favorable for the commercial cultivation of whitefish (peled) and carp. The natural forage base can increase fish productivity by 112.9 kg/ha. In accordance with the development of the food supply base, the recommended stocking volumes of commercially-cultivated objects: peled (planktophage) - 3500 copies. larvae per hectare (average value for Northern Kazakhstan) and carp (benthophagus) - 100 copies. fingerlings per hectare (minimum value for Northern Kazakhstan).

***Keywords**: aquaculture, lake, hydrochemistry, forage base, fish stock, fish fauna, rearing, whitefish species.*

**Introduction.** Fisheries for the North Kazakhstan region is a traditional industry and therefore the restoration and organization of lake aquaculture enterprises will allow for a significant recovery of the regional economy and the creation of new jobs. The status of the lake Large Salty allows it to be used for commercial fish farming. The creation of commercial lake fish farming on the basis of this reservoir will increase the efficiency of its operation and, accordingly, increase the production and quality of fish products.

The purpose of the work is reconnaissance and assessment of the fitness of the lake Large Salty to create on its basis commercial lake fish farming and the development of recommendations for the preparation of the reservoir for the commercial cultivation of fish.

**Materials and research methods.** The works were carried out on lake Large Salty during the year 2018. During the study period, the hydrological regime of the lake was studied, samples for hydrochemical and hydrobiological analysis were selected and processed, and material was collected to assess the state of the fish fauna.

The determination of the number and location of sampling stations was carried out in accordance with the methodological recommendations on the collection and processing of materials during hydrobiological studies [1-3]. The coordinates of the stations were determined using the GPS navigation system.

At all sampling stations, depth measurements were carried out, the character of bottom sediments was determined, samples were taken for hydrochemical analysis, for determining the quantitative and qualitative composition of plankton and benthic organisms (zooplankton and

zoobenthos) [5,6]. In addition to these stations, depth measurements were carried out in the section along the greatest width and length of the reservoir with an interval of 50 meters. The number of collected and processed material the following: hydrochemistry-21, zooplankton-21, zoobenthos-21, fishes on biological analysis-381, network setups-21.

All calculations were carried out on a PC using the Excel program.

**The results of research and discussion.** *Hydrological and hydrochemical regime.* Large Salty lake is located in the Magzhan Zhumabayev region of North Kazakhstan region, 0.3 km northeast of the village of Poltavka. The pond is located at an absolute height of 113 meters above sea level. This is one of the many lakes occupying the lake basin, located in the former bed of the Kamyshlovka River, which is an ancient valley of melt glacial waters.

According to the reference data characterizing the hydrological regime of the reservoir as of 1944, the lake area was 861 hectares, the greatest length and width - 5.4 and 2.6 km, respectively, the coastline was 14.8 km, the coastline development -1,41[7]. Currently, the maximum length of the lake is 6.28 km, the width is equal to 2.86 km. The coastline is 16.95 km. The development of the coastline - 1.34.The area of the lake at the time of the research was 1273 hectares.

At the time of the survey, more than 100 depth measurements were made, and according to the results of these measurements, the maximum depth was 4.8 meters. The average depth in the pond is 1.3 meters. The catchment area is considerably plowed (up to 60%), the part of the catchment that is not developed is covered with steppe grasses in some areas there are forest spines. From the northeast, the catchment is limited by the railway Petropavlovsk - Isilkul.

Power is supplied by precipitation, inflow of melt and rainwater. In general, the hydrological regime of the lake Large Salty is favorable for fish habitat [8,9].

According to the results of research in 2018, the Large Salty lake is a brackish body of water with a total mineralization of 8239,1 mg / $dm^3$. Table 1 shows the main hydrochemical indicators of water from lake Large Salty.

Table 1 - Hydrochemical parameters of water from lake Large Salty

| Date | pH | $O_2$. mg/$dm^3$ | Biogenic compounds, mg/$dm^3$ | | | | Organic matter, mg/$dm^3$ |
|---|---|---|---|---|---|---|---|
| | | | $NH_4$ | $NO_2$ | $NO_3$ | $P_{PO4}$ | |
| 05.2018 | 6.95 | 6.45 | 2.18 | 0.012 | 1.79 | 0.18 | 29.6 |
| 06.2018 | 6.94 | 7.28 | 1.03 | 0,008 | 1.64 | 0.07 | 13.4 |
| 07.2018 | 6.95 | 9.14 | 0.51 | 0,006 | 1.67 | 0.04 | 9.2 |
| 08.2018 | 6.97 | 9.07 | 0.44 | 0,004 | 1.72 | - | 5.4 |
| 09.2018 | 6.95 | 9.26 | 0.33 | 0,005 | 1.61 | - | 8.7 |
| 10.2018 | 6.94 | 8.24 | 0.37 | 0,004 | 1.57 | - | 10.3 |

Table 2 - General hardness and ionic composition of water from the Large Salty lake

| Rigidity, mg-eq./$dm^3$ | $Ca^+$, mg/$dm^3$ | $Mg^+$, mg/$dm^3$ | $Cl^-$, mg/$dm^3$ | $SO_4^-$, mg/$dm^3$ | $HCO_2^-$, mg/$dm^3$ | $K^+ + Na^+$, mg/$dm^3$ | Mineralization, mg/$dm^3$ |
|---|---|---|---|---|---|---|---|
| 35 , 5 | 180.4 | 322.2 | 2978.0 | 1114.3 | 219.7 | 3424.5 | 8239.1 |

According to the content of the main cations and anions, the excess of the maximum permissible concentrations for fishery reservoirs in 2018 was noted for chlorides (9.9 times), for magnesium (8.1 times) and sulfates (11.1 times). The amount of organic matter in the lake exceeds the maximum permissible concentration (MPC) for fishery reservoirs, evidenced by such indicators as oxidizability, the content of nitrites, nitrates and ammonium salt. The content of total iron in water, which affects the intensity of phytoplankton development and the qualitative composition of microflora, did not exceed the MPC for fishery bodies of water. The active reaction of the medium pH is 6.95 (water has a weak acid reaction). The water hardness is 35.5 mg-ins./l (water is very hard). In general, the hydrochemical regime of the lake Large Salty is favorable for the commercial growth of whitefish and carp.

*The state of the natural food supply.*

In 2018, the *zooplankton of* lake Large Salty was represented by three groups of aquatic invertebrates: rotifers, branchy creeper and copepods. In the composition of zooplankton, 14 taxa were identified, of which rotifers (*Rotatoria*) - 2, branchy (*Cladocera*) - 6 and copepods (*Copepoda*) - 6 species.

Of rotifers, the most common species is *Brachionus quadridentatus hyphalmiros Tschugunoff*, which was noted in all samples on the lake Large Salty [11]. From the branchy branch the most common species is *Daphnia pulex (Leydig)*, which is part of the zooplankton community of all biotopes studied. Among the copepods, the species is also widespread-*Mesocyclops leuckarti (Claus).* Table 3 shows the abundance and biomass of the main groups of zooplankton.

Table 3 - Abundance (A., thousand, ins./$m^3$) and biomass (B., g/$m^3$) of the main groups of zooplankton for 2018

| Group | Station 1 | | Station 2 | | Station 3 | |
|---|---|---|---|---|---|---|
| | A | B | A | B | A | B |
| *Rotatoria* | 15,8 | 0,01 | 7,6 | 0,00 | 9,2 | 0,00 |
| *Cladocera* | 96,5 | 2,71 | 79,3 | 2,13 | 85,4 | 2,47 |
| *Copepoda* | 54,8 | 2,16 | 36,5 | 1,31 | 41,3 | 1,67 |
| Total | 167,1 | 4,88 | 123,4 | 3,44 | 135,9 | 4,14 |

| Group | Station 4 | | Station 5 | | Station 6 | | Station 7 | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| *Rotatoria* | 18,1 | 0,01 | 12,3 | 0,01 | 15,2 | 0,01 | 16,8 | 0,01 |
| *Cladocera* | 98,3 | 2,94 | 85,9 | 2,64 | 91,3 | 2,77 | 87,9 | 2,52 |
| *Copepoda* | 55,3 | 2,29 | 49,5 | 1,93 | 50,4 | 2,01 | 39,5 | 1,55 |
| Total | 171,7 | 5,24 | 147,7 | 4,58 | 156,9 | 4,79 | 144,2 | 4,08 |

The average number of planktonic organisms in a reservoir in 2018 was 149.56 thousand ins./$m^3$. The dominant group in the number are branched crustaceans, the share of these organisms is 59.7%. On average, the biomass of zooplankton organisms in the reservoir is 4.45 g /$m^3$. The dominant role in the formation of biomass of the plankton community belonged to branchy crustaceans - 58.4%. According to the average biomass of zooplankton, the Large Salty lake belongs to α - eutrophic water bodies with an elevated trophic level [10].

*Zoobenthos in* 2018 was represented by the representatives groups of the *Oligohchaeta, Hirudinea, Crustacea, Insecta, Mollusca*. Taxonometric composition of macrozoobenthos: T*axa: Oligohchaeta: Tubificidae sp., Nematoda, Hirudinea, Piscicola Blaiville. Crustacea: Gammarus lacustris. Insecta: Chironomus plumosus Linnaeus, Chironomus cingulatus Meigen, Procladius ferrugineus Kieffer, Tanypus Meigen. Mollusca: Lymnaea Lamarck, Planorbis Geoffroy.* Table 4 shows the abundance and biomass of main groups of zoobenthos organisms in the Large Salty lake.

Zoobenthos biomass in 2018 was 3,63 g/$m^2$, the total abundance was 1171 ins./$m^2$. *Chironomus plumosus Linnaeus* dominated zoobenthos in terms of abundance and biomass, average value 56.2% of the total abundance and 51.2% of the total biomass. According to the average value biomass of zoobenthos, the Large Salty lake belongs to α - mesotrophic water bodies, which corresponds to a moderate trophic level.

*Silver* crucian is the most widespread species in the waters of Northern Kazakhstan. Due to the low demands on the oxygen regime it inhabits most of the reservoirs of the North Kazakhstan region. It can winter, like a gold carp, in water bodies freezing to the bottom, but for this purpose there must be a sufficiently thick layer of sludge buried in which they survive adverse conditions. Spawning is portioned and continues from the end of May to August. It feeds mainly on animal food — zooplankton and zoobenthos, although it sometimes uses aquatic vegetation.

In the lake the Big Salt population of goldfish is represented by age groups from 2+ to 7+ years. In the population of silver crucian, the most numerous was the age group of 2+ years; it accounts for 48.8% of the total number. The age group of 3+ years is 30.7% of the population. Silver crucian growth rate in the Large Salty lake for our region. A special feature of the North Kazakhstan

silver crucian is the almost complete absence of males in its populations. Caviar is fertilized with gold carp or other carp species, as a result of which only females develop from it. All captured specimens were females.

Table 4 - Abundance (A., ins./m$^2$) and biomass (B., g/m$^2$) of the main zoobenthos groups

| Group | Station 1 | | Station 2 | | Station 3 | | Station 4 | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| *Oligohchaeta* | 240 | 0,48 | 320 | 0,64 | 80 | 0,16 | 240 | 0,48 |
| *Hirudinea* | 40 | 0,24 | 0 | 0 | 40 | 0,24 | 120 | 0,72 |
| *Crustacea* | 40 | 0,2 | 0 | 0 | 80 | 0,4 | 120 | 0,6 |
| *Insecta* | 720 | 2,16 | 1000 | 3 | 640 | 1,92 | 1160 | 3,48 |
| *Mollusca* | 40 | 0,32 | 0 | 0 | 0 | 0 | 40 | 0,32 |
| Всего | 1080 | 3,4 | 1320 | 3,64 | 840 | 2,72 | 1680 | 5,6 |
| Group | Station 5 | | Station 6 | | Station 7 | | | |
| | A | B | A | B | A | B | | |
| *Oligohchaeta* | 400 | 0,8 | 280 | 0,56 | 120 | 0,24 | | |
| *Hirudinea* | 0 | 0 | 40 | 0,24 | 0 | 0 | | |
| *Crustacea* | 40 | 0,2 | 0 | 0 | 0 | 0 | | |
| *Insecta* | 920 | 2,76 | 560 | 1,68 | 760 | 2,28 | | |
| *Mollusca* | 80 | 0,64 | 40 | 0,32 | 40 | 0,32 | | |
| Total | 1440 | 4,4 | 920 | 2,8 | 920 | 2,84 | | |

*Recommendations on the organization and management of the lake-commercial fish farm.* The lake-commercial fish farming on the basis of the Large Salty lake of the Magzhan Zhumabayev District of the North Kazakhstan Region will specialize in the commercial cultivation of valuable fish species - carp and whitefish. As additional objects of cultivation will be carp, pike and perch. By virtue of the hydrological and hydrochemical regime, the Large Salty lake can only be a feeding reservoir for the commercial cultivation of carp and whitefish in an extensive way.

To determine the potential for increasing the productivity of lake Large Salty for fish cultivation at the expense of the natural forage base, the potential fish productivity was calculated. It was determined by the state of the food supply. In this case, the magnitude of the invertebrate reproduction rate was used: plankton and benthos (P/B - coefficient), the percentage of feed use by the fish, the feed ratio, etc.

From table 5 it follows that the natural forage base is able to increase the fish productivity from the maximum allowable volume of seizures by 112.9 kg/ha. Based on the foregoing, it is possible to significantly increase the fish productivity of the lake, possibly only by increasing the efficiency of use of the feed base. This can be achieved due to the introduction into the reservoir of objects of commercial cultivation (whitefish and carp). Table 13 reflects the standards of stocking in the Large Salty lake [11,12].

Table 5 - Standards for stocking and the estimated volume of salable fish in the Large Salty lake

| Indicator | Carp | Peled |
|---|---|---|
| Water area, ha | 1273 | 1273 |
| Age composition of stocking | fingerlings | larva |
| Planting regulations, ins./ha | 100 | 3500 |
| Total stocking volume, thousand copies | 127.3 | 4455,5 |
| Survival, % | 20 | five |
| A hinge of commercial fish, g | 400 | 100 |
| The volume of marketable fish, tons | 10.18 | 22.27 |
| Fish productivity, kg/ha | 8.0 | 17.5 |

The operation of the lake in the LCFF mode should ensure the fulfillment of the basic technological operations, which make it possible to increase the efficiency of using the potential of the reservoir.

**Findings.** During the study period, the hydrological regime of the lake was studied, samples for hydrochemical and hydrobiological analysis were selected and processed, and material was collected to assess the state of fish fauna.

The hydrological regime of lake Large Salty is favorable for the commercial cultivation of whitefish (peled) and carp. The natural forage base can increase fish productivity by 112.9 kg/ha. In accordance with the development of the food supply base, the recommended stocking volumes of commercially-cultivated objects: peled (planktophage) - 3500 copies. larvae per hectare (average value for Northern Kazakhstan) and carp (benthophagus) - 100 copies. fingerlings per hectare (minimum value for Northern Kazakhstan). Aboriginal fish fauna of lake Large Salty is represented by a silver crucian. Living in the lake, this species consumes a food base suitable for feeding commercial growth objects (carp and whitefish). In this regard, in order to increase the economic efficiency of the use of the lake, we recommend removing the crucian carp by reclamation. The volume of ameliorative fishing will be 73.63 tons of multi-age crucian. Potential fish productivity in the operation of the lake in the natural mode (fishing) will be 13.4 kg/ha, which will allow annually to catch 17.1 tons of crucian. It should be noted that for the silverfish in the lake the hydrochemical characteristics are unfavorable for natural reproduction. This will lead to the gradual disappearance of this population, and the lake will become fishless. Thus, this reservoir is not promising for operation in fishing mode. As a result of the commercial cultivation of carp and whitefish on the basis of the extensive path, the fish productivity of Large Salty lake can be increased to 25.5 kg/ha, which will allow to grow up to 32.5 tons of valuable fish species in the lake annually - carp (10.2 tons) and whitefish (22.3 tons).

As a result of the creation of lake-commercial fish farming (LCFF) on the basis of the Large Salty lake of the Magzhan Zhumabayev District of the North Kazakhstan Region, the operating efficiency will increase in terms of production by 1.9 times, and the product quality will also increase, which will increase the security of the population of high-quality fish products and employment in rural areas.

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**ТҮЙІН**

Мақалада Большое Соленое көлінің су ортасының негізгі параметрлері, қорек базасы жағдайы және ихтиофауна сипаттамаасы беріліп, оның көл-тауарлы балық шаруашылығын ұйымдастыруға жарамдылығына баға берілген. Тағы, аталған көлде тауарлы балық өсіруге және көл-тауарлы балық шаруашылығын ұйымдастыруға (КТБШ) ұсыныстар берілген. Үлкен тұзды көлінің гидрологиялық режімін зерттеу нәтижелері бойынша, көлдің ақсаха (пелядь) және тұқы балықтарын өсіру үшін қолайлы екені анықталды. Табиғи қоректік базасы балық өнімділігін 112,9 кг/га-ға арттыра алады. Азық-түлікпен қамтамасыз ету базасының дамуына сәйкес сауда-саттыққа шығарылатын объектілерді жинақтаудың ұсынылған көлемі: пелядь (планктофаг) – 3500 дана укі шабақ бір гектарға (Солтүстік Қазақстан үшін орташа мән) және тұқы балық (бентофаг) – 100 дана шабақ бір гектарға (Солтүстік Қазақстан үшін минималды мән).

**РЕЗЮМЕ**

В статье приводятся сведения по основным параметрам водной среды, состоянию кормовой базы, характеристикам ихтиофауны озера Большое Солёное, оценка его пригодности для организации озерно-товарного рыбоводного хозяйства (ОТРХ). Также даны рекомендации по подготовке водоема для товарного выращивания рыб и организации ОТРХ на данном озере. Гидробиологический режим озера Большое Соленое благоприятен для промыслового выращивания сиговых рыб (пелядь) и карпа. Природная кормовая база может повысить продуктивность рыбы на 112,9 кг/га. В соответствии с развитием базы снабжения продуктами питания, рекомендуемые объемы заготовки товарных объектов пелядь (планктофаг)- 3500 экз. личинок на гектар (среднее значение по Северному Казахстану) и карпа (бентофаг) – 100 экз. молоди на гектар (минимальное значение для Северного Казахстана).

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**Бадрызлова Н.С.,** старший научный сотрудник
**Койшыбаева С.К.,** заведующая лабораторией аквакультуры
**Асылбекова С.Ж.,** заместитель директора, доктор биологических наук
ТОО «Научно-производственный центр рыбного хозяйства», г. Алматы, Республика Казахстан

## ЭКОНОМИЧЕСКАЯ ЭФФЕКТИВНОСТЬ ВЫРАЩИВАНИЯ СЕГОЛЕТОК И ДВУХЛЕТОК СУДАКА В ПРУДОВЫХ ХОЗЯЙСТВАХ ЮГА КАЗАХСТАНА

**Аннотация**

В статье приведены расчеты и анализ экономической эффективности выращивания сеголеток судака в прудах при зарыблении подрощенной молодью судака, в аппаратах Амур и в садках из мельничного сита; при одинаковых плотностях посадки и различным возрастным составом поликультуры, сформированной из молоди и годовиков карпа, годовиков белого амура и белого толстолобика. Даны значения плотностей посадки рыб в поликультуре. Рассчитана стоимость рыбопосадочного материала рыб, удельные производственные затраты. Представлены данные по экономической эффективности выращивания сеголеток судака в одамбированных прудах с самотечным водоснабжением в поликультуре. Представлены показатели экономической эффективности выращивания двухлеток судака в прудах в поликультуре с карпом и белым амуром, данные по расчетам стоимости конечной продукции судака. Дан анализ представленных результатов. Выявлено, что наиболее рентабельным является выращивание сеголеток судака в одамбированных прудах, с самотечным водоснабжением составляет 96,36 %, при этом на рыбоводном хозяйстве имеются значительные резервы расширения производства. Наиболее рентабельным является