**RESEARCH ARTICLE**

# Use of Fish Resources and Prospects for Aquaculture Conservation in Water Bodies of West Kazakhstan Regions

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**Abstract**

The ability to meet the needs of the population in fish and fish products and its food security is one of the most acute problems in the Republic of Kazakhstan. The purpose of this study is to study the current state of fisheries in the Republic of Kazakhstan and to propose the development of fisheries in the West Kazakhstan region. Methods for studying of a condition of a fishery of Republic Kazakhstan statistical methods of the data analysis have been used, and exclusively the catch of fish and other water animals, and also dependence of physical volume of fish farming production on total quantity of the made production. In research topical questions of production capacity of fishing and fish-canning enterprises, by kinds and volumes of output production, economic indicators, and also on the enterprises which are carrying out purchase and realization of fish production, wholesale and retail trade, problems of marketing researches in the field of manufacture and safety of fish production are considered. Conclusions - proceeding from the received results it has been concluded that it is necessary to create laboratories and fish farming in autonomous objects, that will allow to develop innovative technologies of cultivation, conservation and replenishment of fish resources in water bodies of region, will provide educational base for training of future specialists, will create conditions for conservation and multiplication of fish resources of Kazakhstan, will increase food safety of the country, will solve key problems of fish industry development. Artificial fish farming involves intervention in the development of organisms in order to increase their productivity, such as regular restocking, feeding, protection from predators, etc.

## 1. INTRODUCTION

To meet the global demand for fish by 2030, annual fish production needs to increase by 23 million metric tons. However, wild fish stocks are depleting rapidly. New fish farming and artificial breeding technologies can potentially address the population's demand for this essential food source.

The world is witnessing a decline in fish catches and an increasing focus on closed-loop water systems for aquaculture. Aquaculture, also known as fish farming, has emerged as a key driving force in the fishing industry. Fish cultivation not only boosts wild fish catches but also provides the opportunity to supply consumers in regions far from marine environments with fresh seafood.

As the demand for fish continues to rise, the traditional methods of wild fish capture are unable to keep pace, leading to concerns about overfishing and the sustainability of wild fish populations. Aquaculture offers a promising solution to meet the growing demand for fish while alleviating pressure on wild stocks. By raising fish in controlled environments, aquaculture allows for efficient production, reduced environmental impact, and the ability to supply fish consistently throughout the year.

This scientific article aims to explore the advancements and innovations in artificial fish breeding techniques and their potential to support sustainable fish production. The article will analyze the benefits and limitations of aquaculture as a solution for meeting the global fish demand, examine the technologies and practices involved in fish farming, and discuss the challenges and prospects faced by the aquaculture industry.

The relevance of the study is exclusively due to numerous factors. Firstly, an increasing population and a rising standard of living are leading to increased consumption of fish and other seafood products. However, wild fish stocks are rapidly depleting, and unless action is taken to conserve the resource, it could disappear entirely by 2050.

Secondly, aquaculture can be a consequence of the problem of fish shortages in remote regions. Many countries and regions need help accessing marine areas but can grow fish through aquaculture. This meets the need for fresh fish, creates jobs, and develops opportunities.

Thirdly, aquaculture can answer the problem of overpopulation and marine pollution. With the increasing number of people living on the shores of seas and oceans, the problem of marine waters being contaminated by waste and industrial emissions arises. Growing fish in anomalous conditions is acceptable to reduce the negative impact on the marine ecosystem and reduce the pressure on wild fish stocks.

Thus, aquaculture conservation has great potential for natural resource exploration and economic development. In this regard, aquaculture development is becoming increasingly urgent for many countries and organizations.

Artificial fish farming involves interfering with the development of organisms to increase their production, such as regular restocking, feeding, protection from predators, etc. The most important factors hindering aquaculture development are the need for more regulatory support, the decline in investment attractiveness, and insufficient logistical and scientific support. Let us consider each of these factors in more detail.

Lack of legal and regulatory support is one of aquaculture's main problems because there needs to be legislation to govern it. This can lead to misunderstandings between features and aquaculture businesses about water use regulations, conservation, protection and exploitation. It can also create problems for aquaculture enterprises that arise with unclear regulations and requirements, for example, about exporting their products or obtaining financial credit.

Low investment attractiveness of the industry: another problem that can hamper aquaculture development, falling investment and risks arising in aquaculture development. The factor of inadequate logistics, as aquaculture development, is a matter of responsibility requiring

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significant investment in material resources such as equipment, infrastructure, technology, etc. Some of these resources can be very expensive, which can be a protection for enterprises.

The increasing global demand for fish necessitates exploring innovative approaches to meet this demand sustainably. In this regard, the present study focuses on analyzing and proposing ways to enhance water resource extraction using modern technologies in the West Kazakhstan region. This region, characterized by a need for advanced fishing technologies, requires efficient methods that ensure profitability in industrial fishing and cater to the area's specific needs.

By analyzing the existing practices and considering the advancements in fishery technologies, this article aims to provide valuable insights into improving water resource extraction in the West Kazakhstan region. The proposed methods should not only be effective and economically viable but also align with the region's requirements and contribute to its development.

Based on the outcomes of this research, a compilation of commonly accepted practices in water resource utilization and sustainable aquaculture development in the industry has been compiled. This compilation serves as a valuable resource for stakeholders and decision-makers involved in managing and developing fisheries in the region.

Through the integration of modern technologies and sustainable practices, the West Kazakhstan region can establish a robust and environmentally conscious fishing industry. The findings of this study contribute to the knowledge base in fisheries management and provide a foundation for implementing effective strategies that ensure the long-term viability of water resources and promote the sustainable development of the aquaculture sector. The results and outcomes of this work have been used to form a collection of generally accepted practices for the use of water resources and sustainable development of fisheries in the industry.

## 2. LITERATURE REVIEW

In the aquaculture industry, the emphasis is often on controlling a specific part of aquatic organisms' production process to increase their productivity. This control can take place at different stages of the production process, ranging from protecting juveniles in fish hatcheries in Alaska to catching more prominent individuals for further fattening and adaptation to market conditions, as in the case of bluefin tuna, or providing protection later in the life cycle, such as in wild-caught seed-based oyster farming (Botta et al., 2020).

Farmers often start focusing on a particular stage of the production process in aquaculture and gradually expand their control to other stages until they reach a closed production cycle. A closed production cycle makes the industry independent of wild catches. It represents the predominant model in mature aquaculture industries, providing ample opportunity for innovation and further productivity improvements.

Aquaculture is thus a process of controlled production of aquatic organisms that can go through all stages, from the protection and rearing of juveniles to producing adults with high productivity, thus ensuring the industry's sustainable development. The current ecological and economic conditions require a fundamental rethinking of the theory and practice of fisheries management subject to preserving fish productivity and biodiversity in the country's water bodies. Kazakhstan has water basins with significant biodiversity, including the Zhaik-Caspian, which Kazakh researchers quite well study as (Asylbekova et al., 2017).

Fishery water bodies of Kazakhstan are well enough studied by researchers. However, no scientific works have covered the emerging problems in the complex for all sizeable inland water bodies since the Soviet times. In modern ecological and economic conditions, the cardinal rethinking of the theory and practice of fishery management under the condition of preservation of fish productivity and biodiversity in the country's water bodies is required.

The ecological solutions in aquaculture of the West Kazakhstan region can be confidently attributed to the autonomous fish breeding installations, which are located in the water area. They allow to exclude any impact on the environment, as waste products of fish vital functions, uneaten food, and phosphorus do not get directly into the reservoir but are collected and utilized with the help of unique pumps. These and many other aquaculture inventions will help to make commercial fish farming as efficient and environmentally friendly as possible (Rogovtsov et al., 2018; Hanif et al., 2022).

Restoration of depleted fish stocks is an international policy goal and objective, so many researchers are developing modelling frameworks to characterize the variability of the internal parameter of the productivity and carrying capacity of global fish stocks around the world, ways to restore depleted fish stocks, proof of this work Isbekov et al. (2018).

Also, if to analyse the level of fish stocks, despite management policies, they continue to be fished at unsustainable levels (Coll et al., 2008). While integrating economic aspects into catch recommendations has been identified as a key factor in designing better management, few studies have explored how bio-economic modelling can assist in decision-making. Policy evaluation methods may overestimate reproductive success, jeopardizing the design and evaluation of stock recovery policies.

Currently, research on the social acceptability of aquaculture has mainly focused on expanding marine aquaculture sectors, including both coastal and offshore operations. This body of literature has a predominant interest in fish aquaculture (Alexander et al., 2016; Mather & Fanning, 2019; Cavallo et al., 2021). However, these studies need to address the social acceptability of inland aquaculture sectors specifically.

In contrast, the article "Use of Fish Resources and Prospects for Aquaculture Conservation in Water Bodies of West Kazakhstan Regions" highlights the sustainability of inland aquaculture in western regions of Kazakhstan and its impact on the environment. In this context, the issue of social acceptability of inland aquaculture sectors is narrowly examined, focusing on local socio-economic aspects and the community's perception of aquaculture development and conservation efforts in the region.

Therefore, unlike the studies, this article addresses the specific aspects of social acceptability in the context of inland aquaculture in the western regions of Kazakhstan, providing insights into the interaction with the local population and public opinion regarding the development and conservation of aquaculture in this area. Thus, based on the research, the development of innovative technologies for cultivating, conserving and replenishing fish resources in water bodies in modern conditions is necessary. It will create prerequisites for the conservation and multiplication of fish resources, increase the food security of the country, reduce the deficit of fish products, and provide access to international markets.

## 3. METHODOLOGY

Monographic, abstract-logical and economic-statistical methods were used during the research. Statistical methods of data analysis were used to study the state of fishery in the Republic of Kazakhstan, and exclusively the catch of fish and other aquatic animals, as well as the dependence of the physical volume of fish farming products on the total amount of products produced.

On the basis of principles of classical economic theory and institutional theory, the concepts of development of the aquaculture industry in Kazakhstan were investigated, and features of its formation, taking into account the object of research were revealed. On the basis of economic and statistical methods, the assessment of trends and prospects of growth of food production and export potential of the aquaculture industry was conducted. In addition to some specific methods,

the following scientific approaches to the analysis of the problem were used: dialectics, abstraction, deduction, induction, analysis, and synthesis (Demchuk et al., 2012; Keesman et al., 2019).

In Kazakhstan, it is necessary to take measures to transition aquaculture to an innovative development. Particular attention should be paid to technical and technological modernization implementation of modern technologies in production to reduce the cost of finished products on the consumer market. It is desirable to pay attention to increasing the financing of scientific research in the field of aquaculture (Jacenko et al., 2020).

Unfortunately, nowadays fishery science experiences an acute shortage of qualified personnel, which cannot but affect the quality of ichthyological research, including fish farming. Research requires improvement of quality and emphasis on applied research in terms of issuing recommendations for managerial decisions.

For providing fish-farm enterprises and farms with qualified personnel, it is necessary to organize training of fish-farm personnel in existing higher educational institutions, at it is necessary to provide up to 400 places annually in the state educational order. Also, currently, aquaculture enterprises need help in obtaining loans. Banks do not accept fish and other assets of aquaculture enterprises as collateral. The next problem hindering the development of fish farming is the need for more planting material, mainly fertilized eggs and young fish (especially sturgeon and whitefish species, salmon, and trout).

The problems of fish stocking material shortage are partially solved by partially subsidizing costs for the maintenance of breeding-reproductive breeding herds and acquisition of such material at the expense of funds allocated from the budget of the Republic of Kazakhstan.

The enterprises cannot increase production volumes because of the continuing shortage of fish stocking material. It is necessary to create a network of nurseries (multipliers) focused on the production of juvenile sturgeon, salmon, whitefish and carp fish in the branch institutes of Kazakhstan.

The following suggestions can be considered to improve the research methodology:

1. Study of the consumer market and analysis of the competitive environment: it is necessary to conduct market research on fish products, determine supply and demand, analyze competitors and trends in the market. This will help to determine the market needs and formulate the development strategy of the aquaculture industry.

2. Attraction of investments for the development of the aquaculture industry in Kazakhstan is necessary investments.

3. Use of modern technologies: it is important to research modern technologies in aquaculture and fish farming, which can increase productivity and reduce costs. This will help to increase the competitiveness of fish farms.

4. It is necessary to assess the effectiveness of existing programs and support measures, including state subsidies, tax incentives and other measures. This will help determine which measures should be retained, modified, or eliminated.

5. It is necessary to study the prospects of aquaculture development in Kazakhstan, as well as the problems that may arise in the future. This will help develop plans and strategies for the long-term development of the industry.

## 4. FINDINGS AND DISCUSSION

The use of available capacities with the direct participation of the government in the creation of the reproduction base fully complies with the provisions already laid down in the Program of Fisheries Development by 2030. A similar practice has been successfully implemented in Japan,

where the government was the main customer in the creation of reproduction centers at the initial stages of the formation of the aquaculture system.

Most of the fish caught in the Republic of Kazakhstan is consumed by the population and does not go to processing enterprises. Figure 1 shows data on fish catches for 2015-2021.
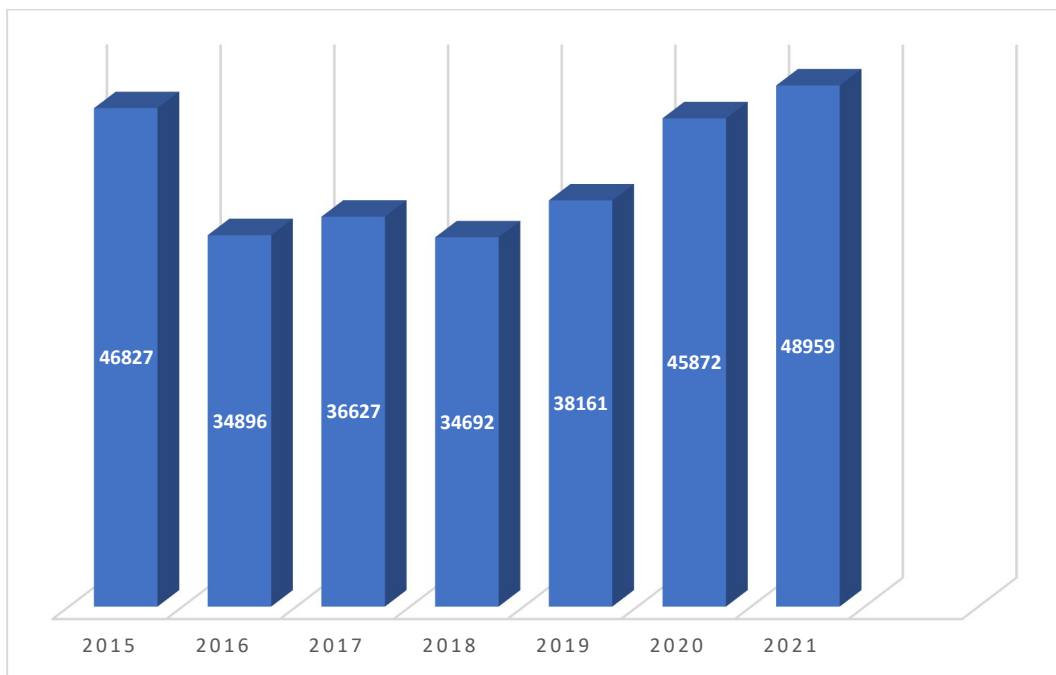


**FIGURE 1.** Catch of fish and other aquatic animals by fisheries in Kazakhstan (2015-2021) in tons

*Note:* compiled by authors based on source Bureau of National Statistics (2021)

By comparison, in the early 1990s, around 100,000 tons of fish per year, including sturgeon species, were caught in our territory. In 2019, only 35-40 tons of fish were caught (according to official statistics). This is due to the COVID19 pandemic. For 2021 almost 49 thousand tons of fish and other aquatic animals were caught. This is 6.7% more than in 2020, which is a positive factor. The catch is also interrelated with the enterprises having the right to export their products to Europe, so in 2000 only three Kazakh enterprises Atyraubalyk, Balkhashbalyk and Rybprom were included in the list of numbered enterprises having the right to export their products to Europe. The sale of products abroad has at one time enabled Kazakhstan's fishing industry to develop thanks to the inflow of foreign currency and investments, including in fish farming (Bureau of National Statistics, 2021).

More than one thousand fishery entities are engaged in fisheries in Kazakhstan, and 1,646 fishery reservoirs and their lots are attached. The industry employs 11 thousand people.

Kazakhstan also has excellent potential for the development of fish farming. Over the last seven years, the volume of fish cultivated increased by nine times - from 800 tonnes to 7.4 thousand tons. 180 fish farms are engaged in fish farming in the country, where more than 1 thousand (1 126) people are engaged.

From 2000 to 2021, fish farming was steadily growing (there are 184 fish farms in the Republic of Kazakhstan, including 99 lake-commodity fish farms, 55 pond farms, 10 cage culture fish

farms, 20 RAS and basin farms), and this growth is directly related to the state subsidization of costs (for feed).

Production in fisheries and aquaculture for 2014-2021 is shown in Figure 2.
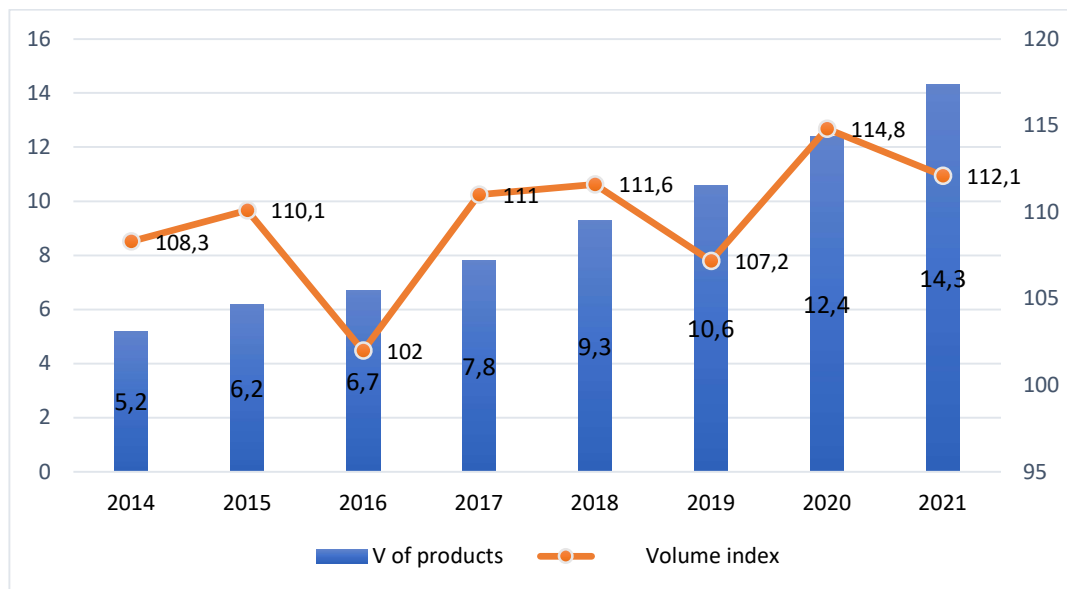


**FIGURE 2.** Volume of production in fisheries and aquaculture for 2014-2021

*Note:* compiled by authors based on source Bureau of National Statistics (2021)

According to statistics, in 2021, the volume of products and services in the fishery and aquaculture sector amounted to 14.3 billion tenge, an increase of 12.1% compared to 2020. During the analyzed period, the production volume increased by 7.2 billion tenge. This is due to the dynamic development of fish farming, as from 2014 to 2021, farmed fish increased from 800 tons to more than 43 thousand tons. The diagram also shows the dependence of the index of the physical volume of fish farming products on the volume of production, which fluctuates from year to year, there is no specific stability.

The State Programme for the development of the agro-industrial complex of the Republic of Kazakhstan for 2017-2021 provides for a significant increase in aquaculture production: in 2021, the production of marketable fish will be 5 thousand tons (an increase of 6.8 times), including sturgeon to 0.7 thousand tons (an increase of 6.8 times), whitefish - to 1.2 thousand tons (an increase of 11.6 times), carp - to 1.7 thousand tons (an increase of 5.6 times). The main challenge in aquaculture development in the Republic of Kazakhstan is attracting fishing enterprises to commercial fish farming. Despite all the difficulties associated with fishing, fishing enterprises do not seek to diversify their business through aquaculture. This is due not so much to the high costs of building fish farming facilities as to the long payback period and the shortage of innovative projects in this area.

The development plan for commercial fish farming should involve measures that will ensure the industry's transition to an innovative way of development. It is necessary to assure investors that aquaculture is profitable. 50 years have passed, and a qualitatively new system of fisheries and ecological and ameliorative use of inland water bodies of the country is required.

According to estimates, to meet the projected global demand for fish, production in fish farms should increase by more than twice: it should be about 140 million tons in 2050. Such an increase

will largely ensure food security and development opportunities. Also, aquaculture will help increase incomes and employment, especially in developing countries, where most of the industry's products are produced.

Kazakhstan is characterized by low fish consumption per capita. For example, WHO recommends consuming at least 16 kg of fish production per capita per year, while in Kazakhstan the consumption is less than 4 kg. Meanwhile, neighboring Russia and China consume 20-40 kg per capita respectively. Thus, considering the border areas, the potential niche for exporting fish products could amount to more than 3 million tons.

The number of artificial farms should increase by many times. To achieve the WHO recommended consumption rate of 16 kg per capita, growing about 300 thousand tons of fish is necessary.

In February 2020, at an offsite meeting on fisheries development in Atyrau, Prime Minister Askar Mamin gave instructions to identify the main barriers to the development of the industry. The Ministry of Ecology, Geology, and Natural Resources of the Republic of Kazakhstan, together with the business, studied these instructions and identified three issues that should be emphasized. These are - the reorientation of water bodies from fishing to fish farming, legal deficiencies, and insufficiency of state support measures.

In this connection, the Program of Fisheries Development by 2030 was approved in December 2020. Within the Program of Fisheries Development by 2030, it is planned to increase fish production by almost 30 times - from 9 thousand to 270 thousand tons; more than 500 new farms and 50 thousand jobs will be created. Export of fish products will increase from 30 to 136 thousand tons per year. The import will drop from 45 thousand to 25 thousand tons per year. At the same time, domestic fish consumption will increase twice - from 67 thousand tons in 2020 to 134 thousand tons in 2030.

For the development of fish farming, it is vital to attach fish-processing capacities to large fishery reservoirs. Atyrau, Almaty, East Kazakhstan and Kyzylorda regions process the primary volume of fish. In 2019, fishing enterprises produced 2,700 tons of marketable fish. They grow mainly sturgeon, trout and carp species of fish using proven biotechnologies of cultivation.

The region annually produces 66 tons of fish products, which is 0.9% of all fish products produced in the Republic of Kazakhstan. Neighboring regions also have an insignificant share in the development of fish farming and cooperate with the West Kazakhstan region enterprises. Mangistau region produces 107 tons of fish products and takes eighth place. Aktobe region ranks tenth in terms of fish production. Atyrau region produces 9 tons of fish products and mainly produces fish stocking material.

60 companies are registered in the Atyrau region and 7 companies - in the West Kazakhstan region. At the moment two sturgeon hatcheries are operating in Kazakhstan and they are located in the west of the country. These are "Ural-Atyrau sturgeon hatchery" and "Atyrau sturgeon hatchery" which produce 6 million juvenile fish per year. However, these fish farms use outdated technologies and cannot maintain fish stocking material year-round and do not provide training for specialists and scientific advisory activities.

The main companies in the West Kazakhstan region engaged in the production of fish products are Educational and Scientific Complex of Experimental Production and Aquaculture LLP and IE Marchenko.

Further, Table 1 presents a comparative characteristic of fishing companies in Western Kazakhstan

**TABLE 1.** Comparative characteristics of fishing companies in the West Kazakhstan region

| No. | Name | Advantages | Disadvantages |
|-----|------|------------|---------------|
| 1 | Educational          and | - regular customers; | - lack of ichthyological and |

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| | Scientific Complex of Experimental Production and Aquaculture LLP | - participation in tenders; - production of food sturgeon caviar and sturgeon. | hydrobiological research laboratories; - lack of tested technology for growing carp, crustaceans and clary catfish. |
|---|---|---|---|
| 2 | IE Marchenko: | - availability of pond stock for carp cultivation; - sale of pond fish; - organization of sport and recreational fishing. | - lack of ichthyological and hydrobiological research laboratories; - lack of tested technology for sturgeon, carp, crustaceans and catfish cultivation in pools; - lack of fish-farming services; - lack of research development in the field of fish farming. |
| *Note*: compiled by authors based on source Bureau of National Statistics (2021) | | | |

In Table 1, companies in the West Kazakhstan region have both disadvantages and advantages in the development of the industry. Therefore, according to the results of the study, it is necessary to ensure state support and investment in the economic development of aquaculture in the region.

Enterprises in the West Kazakhstan region are also engaged in the processing and cultivating fish products. As shown in Figure 3, by the volume of production of fish products West Kazakhstan region ranks ninth in Kazakhstan.
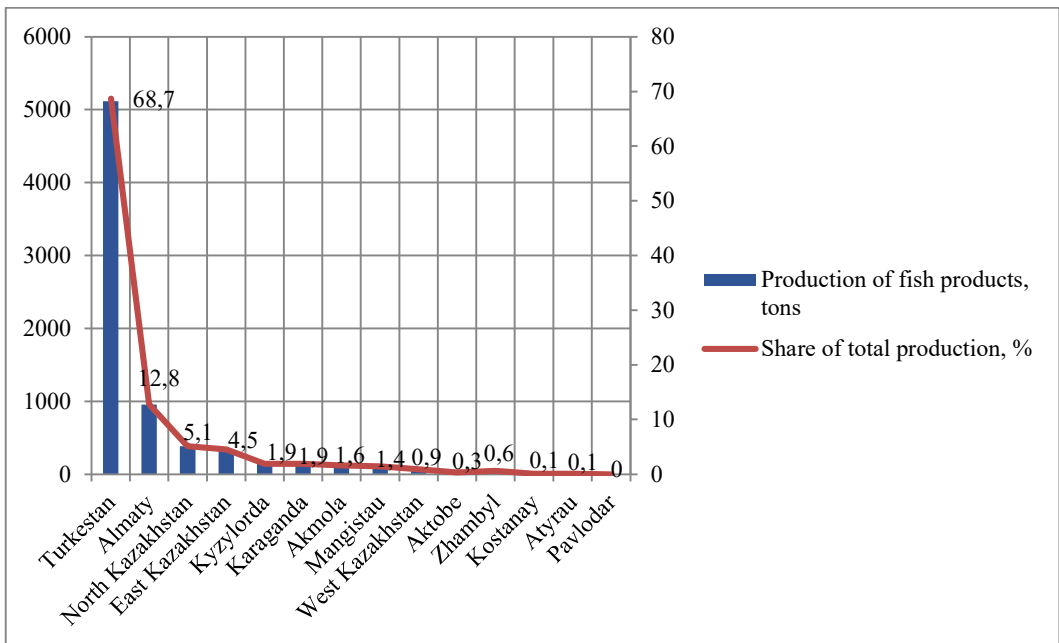


**FIGURE 3.** Production of fish products in Kazakhstan by region

*Note:* compiled by authors based on source Bureau of National Statistics (2021)

Fisheries science has repeatedly pointed to the importance of acclimatization works and mass stocking of inland water bodies with stocking material of herbivorous fish. However, no significant progress has been made. Stocking with herbivorous fish has practically stopped, and the scale of stock of sturgeon species is insignificant and is determined not so much by the possibilities of fish stocking material production as by the state order (Isbekov et al., 2018).

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There is no doubt that the application of commercial aquaculture methods in inland water bodies will make it possible to significantly increase the commercial stocks of valuable fish species and increase their natural fish productivity.

At the same time, it should be noted that when the question arises about the prospects of aquaculture development in inland water bodies by methods of pasture fish farming, there is no exact data on the needs for stocking material. It becomes obvious that for the development of pasture (feeding) fish farming which ensures significant production the main limiting factor is the shortage of stocking material of whitefish, salmon, carp, sturgeon and other fish species.

To start with, the West Kazakhstan region (the city of Uralsk) can become such a testing ground. With natural and climatic features, development of pond fund, an abundance of water bodies of different types, presence of powerful scientific potential and valuable results of long-term observations of ichthyofauna, it is the most suitable region for the implementation of the concept of a new type of inland water bodies exploitation, development of pasture fish farming and aquaculture.

Besides growing fish in closed water supply systems, there is a need to create a laboratory, which will be fully equipped production premises with training and laboratory rooms. The following sectors will function in the laboratory:
- artificial reproduction of freshwater fish,
- ichthyology and hydrobiology,
- fish ichthyopathology,
- the cultivation of crustaceans and live feed.

There is no such laboratory in Kazakhstan. The creation of the laboratory will contribute to the effective implementation of the Program of Fisheries Development by 2030.

Negative impacts of cage aquaculture, arising from the lack of attention to environmental protection:
- organic pollution (eutrophication) - excess nutrients from food and fish excrement from farms increase organic levels in the water, which negatively affects marine ecosystems;
- chemical pollution - antiparasitic drugs, anti-fouling agents, antibiotics, feed dyes can have unpredictable effects on marine organisms and human health;
- genetic contamination - escaped farmed salmon can compete with wild fish and crossbreed with local wild stocks, degrading the genetic diversity of salmon;
- infectious diseases and parasites can be transmitted to wild populations.

The high profitability of cage aquaculture also entails economic and environmental risks that can cancel out all of its benefits. In the European Union, there are serious requirements for fish farms concerning the regulation of water areas. Advanced technology and development are needed to reduce the environmental load of commercial cage aquaculture (Rathod et al., 2019).

Also, the development of fishery resources in the western regions of Kazakhstan will give widespread business development and contribute to the development of the economy of both the region and the country.

## 5. CONCLUSIONS

Autonomous fish breeding units placed in the water area can become ecological solutions in aquaculture of the West Kazakhstan region. They will completely exclude any impact on the environment, as waste products of fish, uneaten food, phosphorus do not go directly into the water body, but are collected and disposed of with the help of special pumps. These and many other inventions in aquaculture will help to make commercial fish farming as efficient and environmentally friendly as possible.

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The authors also propose that the city of Uralsk can become a testing ground for the creation of the laboratory. With natural and climatic features, development of pond fund, an abundance of water bodies of different types, presence of powerful scientific potential and valuable results of long-term observations over ichthyofauna, it is the most suitable region for the implementation of the concept of a new type of inland water bodies exploitation, development of pasture fish farming and aquaculture.

The West Kazakhstan region (the city of Uralsk) can become such a testing ground. With natural and climatic features, development of a pond fund, an abundance of water bodies of different types, presence of powerful scientific potential and valuable results of long-term observations over ichthyofauna, it is the most suitable region for the implementation of the concept of a new type of inland water bodies exploitation, development of pasture fish farming and aquaculture.

Capabilities of the laboratory created in the city of Uralsk, equipped with the latest technology:

1. Development of innovative technologies for growing rare, endangered fish species, as well as promising aquaculture objects in artificial conditions.

2. Increasing the economic efficiency of fishery enterprises by stocking valuable fish species (sturgeons, carps).

3. Monitoring of ichthyological composition and assessment of food reserve of water bodies in the Western region.

4. Development of methods of breeding and feeding ten-legged crustaceans.

5. Systematic monitoring of the state of the natural microbiome of recycled water in RAS to assess the risk of emergence and spread of infectious pathology among the farmed fish;

6. Improving the system of anti-epizootic measures for infectious pathologies of fish, as well as measures to prevent diseases of non-contagious etiology.

7. Providing services and advice to farmers on the organization and management of fish farms.

Thus, the creation of laboratories and fish breeding in autonomous units will allow the development of innovative technologies for the cultivation, conservation and replenishment of fish resources in water areas. It will provide a training base for future specialists, and also will create prerequisites for the conservation and multiplication of fish resources in Kazakhstan, will improve the food security of the country, will reduce the shortage of fish products and provide access to international markets.

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