



## Original researches

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## Fish farming and fishing industry development in the Dnipropetrovsk Region (Ukraine): Current problems and future prospects

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**Abstract.** Based on ichthyologic and fishery researches and our own observations during 2015–2021 in the reservoirs of the Dnipro and the processing of official statistics, we provide original data on the state of fisheries in the region. We analyzed the global tendencies and directions in the growth of consumption of fish products. It is noted that the main trajectory in the development of the fishing industry is the development of aquaculture. Over the recent years, in the area of the fishery in the Dnipro river region, the production has significantly declined (by 2.5–4.0 times). Over the last 10 years, 1/3 of the farms have not been able to adapt to work in the new economic conditions and have become unprofitable. In 2020, 473,149 tons of fish products were grown in Dnipropetrovsk region, which is one of the lowest figures in the recent years. Not a single kilogram of fish products was obtained in pools and breeding ponds. Such facts clearly indicate the negative tendency in aquaculture of the region. Growing fish is becoming a non-profit business. In the absence of any special-purpose state aid to fishery, the latter will collapse inevitably. By means of commercial fishing (fishery), 1,939,463 tons of fish and 1,131 tons of crayfish in the reservoirs of Dnipropetrovsk region were caught officially. It is noted that the total value of these aquatic bioresources at the exchange price is only 10.76 million UAH. The cost of aquatic bioresources in Ukraine today is extremely low. This stimulates the development of commercial fishery and prompts the growth of illegal and undocumented fishery. The growing role of recreational (amateur) fishing in the use of aquatic bioresources of Ukrainian reservoirs is noted. It is proposed to introduce month, seasonal, annual permission for recreational and sport fishing. The estimated amount of economic contribution to the budget of Ukraine from amateur fishermen of the Dnipro region for fishing permissions can be at least 10 million UAH per year. This is quite comparable to the state profit from commercial fishing in the reservoirs of Dnipropetrovsk region. We propose measures to support state fishery in the Dnipro river region, to improve the existing approaches to fishery and aquaculture.

**Keywords:** aquaculture; aquatic bioresources; nature management; fish farming; recreational fisheries; commercial fisheries.

### Introduction

Modern aquaculture (fish farming) can be considered as a specialized branch of animal husbandry, aimed at the production of high-quality food products, valuable raw materials for food and light industry, the use, protection and reproduction of biological resources and their biological diversity. The organization and provision of recreational services (active water recreation, amateur (recreational) and sports fishing, etc.) is also an important area of modern fish farming.

Today, the fishing industry is one of the main sources of food supply for the world population (FAO, 2016, 2020). On the global scale, fish products provide animal protein to more than 1.5 billion people. It has been proven that meat of sea and freshwater contain ideal proportions of proteins, vitamin D and micro elements necessary for the vital activity of the human body. Due to the presence of phosphorus, sulphur, and unique minerals that ensure the growth and healthy development of bones and tissues of living organisms, including humans, fish is an indispensable product in our diet (Bernatchez et al., 2017). Omega-3 polyunsaturated fatty acids from fish oil reduce the risk of blood clotting and the formation of cholesterol plaques and blood clots.

Currently, fish and fishery product account for an insignificant part of the diet of modern people. According to WHO studies, fish consumption per person should be at least 19.0 kg/year (FAO, 2015, 2016). The fish consumption fund includes fresh, salted, smoked fish, canned fish and other types of fishery products in physical weight per fish. The lowest rate of fish consumption is observed in African countries, equaling about 9.1 kg per person. In Asian countries it is 20.7 kg, 22.0 kg in Europe, and 24.1 kg in North America. The highest level of

consumption of fish and fishery products is observed in China – at least 31.9 kg/person. In Ukraine, this indicator has been increasing since 2015: 8.6 kg/person in 2015; 12.5 kg in 2019. In 2020, the rate of consumption of fishery products by Ukrainians decreased insignificantly to 12.4 kg per person. This growth corresponds generally to the global tendencies in the growth of fish consumption (FAO, 2016, 2020).

For the most part, fishery products are more valuable and at the same time cheaper agricultural products than cattle meat. It should be noted that the increase in the share of fish in the diet of Ukrainians is accompanied by a continuous increase in the prices of fish and fishery products, not only imported, but also grown in fish farms and caught in reservoirs and seas of Ukraine. The cost of 1 kg of some types of fish meat is already higher than a similar weight of pork or beef. Fish and fishery products remain one of the most profitable products on the global food market. For example, in 2015, the global seafood market (including fresh, frozen, and canned fish) accounted for \$370 billion (FAO, 2016). Moreover, the global amount of fish catches and breeding, obtaining fishery products in 2015–2016 reached a record number of 166.3 million tons (FAO, 2020).

The offer of fish and seafood on the global world market is formed by the three main resources (FAO, 2012):

- 1) fishing in the world ocean (44–61% of the total production of fishery products);
- 2) fishing in inland water bodies (up to 6% of the world production of fishery products);
- 3) fish farming (aquaculture) products, which provide 33–50% of the world production of fish and related products.

As known, fishing and fish farming is a highly concentrated and globalized type of activity. Twenty countries of the world provide up to 80% of the total production of fishery products. China is currently the undisputed leader in the development of fishery and aquaculture. Peru, the USA, Chile, Indonesia, Japan, India, the Russian Federation, Thailand, Norway, Latvia, Estonia have been the leading countries in terms of the aquaculture development for a long time (World Bank and FAO, 2009; FAO, 2015).

The main tendency in the development of the fishing industry is the development of aquaculture (Baudron & Giller, 2014). In 2016, the share of produced aquaculture products for the first time exceeded the share of fish and seafood produced by fishery (Watson et al., 2016). Over the past 10 years, the importance of aquaculture in the fish business has been growing rapidly, which determines the leading position of fish farming in world food production (Kapetsky et al., 2013; Ye et al., 2017). The fishery sector is a source of income and means of subsistence for millions of people around the globe. Over the last 30 years, the employment in the field of fishing and aquaculture has increased by 3 times from 16.7 million people in the 1980s to 60 million people at the beginning of 2016. The growth of employment in fishing and fish farming outruns the rate of increase in the employment in the field of traditional agriculture. Moreover, the number of workplaces in aquaculture is increasing rapidly, while the share of workplaces in industrial (commercial) fishing is decreasing.

In addition to the primary production sector, fishery and aquaculture are the source of a large number of workplaces in subsidiary activities such as processing, packaging, sales and distribution, production of fish processing equipment, production of nets and netting materials, other fishing gear, production and supply of ice, production and ship maintenance, scientific research and administrative work. According to the estimates (FAO, 2020), together with employed people, those workplaces provided means of subsistence for approximately 660–820 million people, which is about 10–12% of the world population.

Therefore, the world fish farming is a powerful specialized branch of animal husbandry with great prospects for further development; fish and fishery products are one of the most profitable products on the world food market. Each year, scientific studies of tendencies in the development of world fish farming are continual, economic monitoring of the fishing and fish farming business are carried out and global reviews of the state of fish farming in the world are published (both general and for each country). The study of multi-vector tendencies in the development of fishery in Ukraine as a European country with rich fishing experience, a comprehensive analysis of regional aspects of the aquaculture and fishing development is, without a doubt, an urgent and relevant issue today.

The objective of the work was the analysis of the state and current tendencies in the development of fish farming and fishing in Dnipropetrovsk Region, highlighting problematic issues and outlining the industry's future prospects.

### Aquaculture (fish farming) in the Dnipropetrovsk Region

The ichthyologic and fishery collections, observations, which were carried out as part of complex scientific expeditions in 2015–2021 in the territory of the river Dnipro region (Fig. 1), are the material for the work: in the Dnipro reservoirs of the region (Dniprovske, Kamianske and Kakhovske), their tributaries (rivers Samara, Oril, Ingulets, Bazavluk, Kilchen, Vovcha), small reservoirs of the Dnipro region, including pond farms of the river Dnipro region. We analyzed the materials from the data bank of the Scientific Research Centre “Aquatic Bioresources and Aquaculture” of the Dnipro State Agrarian and Economic University (DSAEU) for 2011–2021, annual reports of the Department of Ecology and Natural Resources in Dnipropetrovsk region for 2015–2019, materials of the Department of the State Agency for Land Reclamation and Fisheries in Dnipropetrovsk Region for 2016–2021. Also, we used the official statistical data on the characteristics of agriculture in Ukraine for 2017–2019.

At the current stage, pond cultivation of commercial fish in Dnipropetrovsk Region was carried out by 6 specialized fish-breeding farms, which belonged to the former agricultural sector, and were owned by other small producers. Specialized fish farms (PJSC Petrykivskiy Rybhosp, LLC Karachunivske Rybne Hospodarstvo, JSC Kryvorizhrybsilhosp, Taromske and Krynychky fish farms) use an area of about 2,000 ha for commercial fish cultivation, where 1.5–2.0 thou-

sand tons of commercial fish are obtained. Compared with the 1980s, the volume of fish production in almost all the fish farms decreased by 2–4 times.



Fig. 1. Map of the research area location in Ukraine

It is impossible to assess objectively the state of fish farming in the region due to the lack of adequate statistical information on its implementation. At the regional level, there is no institution for coordinating the work of farms with the State Agency of Land Reclamation and Fisheries of Ukraine. The private farms in the region are breeding Siberian and Russian sturgeon, bester (for obtaining commercial fish and caviar – LLC Duko-Technik, LLC Mikron D), Channel and African catfish, tilapia (PJSC “Compania Bastion”), etc. Total of 377 farms in the region have 12,800 hectares of water resources under lease, 10,800 hectares (85%) of which are used for fish farming. The fish productivity of most leased ponds is much lower than the fish productivity of specialized fish farms (by 15–30 times). That is, they are used inefficiently, although the total fund of agricultural ponds is quite significant. In case of fulfilment of all the regulatory and technological requirements and a scientifically based regime of fish stocking of agricultural reservoirs, up to 10.5 thousand tons of high-quality fish products can be obtained on their areas.

In recent years, the fishing industry of the region has undergone a number of significant changes due to the transition of the industry to market relations. A decline in production is observed in almost all the fish farms, the volume of obtained products has decreased by almost 2.5–4.0 times. Over the past 10 years, a third of the farms could not adapt to work in the new economic conditions and became unprofitable. During 2020, 473,149 tons of fish products were grown in Dnipropetrovsk Region; in total: 103,384 tons of common carp, 260,892 tons of herbivorous fish, 6,770 tons of catfish, 61,295 tons of other fishes, being some of the lowest values in recent years.

In ponds with an area of 352.95 hectares, 427,311 tons of fish products were grown in the region, in particular, 102.58 tons of common carp, 260.89 tons of herbivorous fish (silver and bighead (Spotted silver) carp and grass carp), 2.54 tons of catfish, and 61,295 tons of other fishes. Extremely low values of marketable aquaculture products are noted for stocking ponds, where 0.8 tons of carp were grown in 2020. Not a single kilogram of fish products was obtained in the pools and breeding ponds. In 2020, 4.23 tons of catfish (mostly channel catfish) were grown in aquarium systems with a total volume of 120 m<sup>3</sup>.

As a result of the high cost of granular fish feed, commercial fish in fish farms are grown mainly using natural feed base. The forced transition from intensive fish-breeding technology to free-fattening caused a drop in fish productivity in fattening ponds from 18–22 to 7–10 c/ha, and to 3–5 c/ha in some fish farms. The average weight of marketable two-year-old fish is usually 250–300 g, compared to the normative 450–500 g, which has a negative impact on the sale of fish products.

In recent years, the cost of commercial fish has increased significantly; for example, to obtain one kg of commercial carp, fed with high-quality compound feed, it is necessary to spend at least UAH 50. Regional producers of sturgeon caviar cannot withstand unfair competition from illegal traders of black caviar from China. When the cost of 1 kg of illegal product is \$180, the production of local caviar, the prime cost of which reaches \$350–370, is unprofitable. In addition to the increase in the cost of compound feed, the price of natural water and

electricity has increased significantly. Fish farms are forced to store the volumes of collected water and grow fish practically without water exchange in the ponds, which leads to the deterioration of the hydrochemical state of the reservoirs, the stunted growth of the fish and the increase in their prime cost.

Also, we should note the low level of veterinary and sanitary conditions, as well as preventive measures during fish farming in fish farms, and especially in numerous leased farm ponds. As a result, dangerous fish diseases (rubella, saprolegniosis, ichthyophthiriosis, lemniosis, argulosis) occur more often. Their spread is facilitated by uncontrolled transportation of fish between fish farms and farm ponds. Diseases often cause mass death of fish in farms and worsen strongly the commercial indicators of the quality of fish products (Matvienko et al., 2015; Ramos et al., 2021; Matvienko et al., 2022).

### Commercial fishery in Dnipropetrovsk Region

Commercial fishing in the Dnipropetrovsk Region is carried out in the river Dnipro reservoirs and small reservoirs of the region. Fishery is not carried out in small rivers and lakes. The number of legal entities and individuals engaged in fishery (commercial fishing) in the lower part of the reservoirs of the Dnipro Cascade fluctuates. For example, in 2015–2017, 124 users were registered on the Kakhovske, Dniprovske, and Kamianske Reservoirs, which united more than 1,630 commercial fishermen (according www.darg.gov.ua).

Industrial harvest of aquatic bioresources is mainly carried out using such fishing tools as pond nets, fish pots and trap nets. Fishing nets are used in separate areas of the cascade of reservoirs, throw net and fishing trawl are used very rarely (in late autumn in certain reservoirs). The annual industrial harvest of aquatic bioresources in the lower and middle Dnipro reservoirs is not constant and its volumes vary significantly each year (Fig. 2).

According to the industrial significance, the following types of fish are noted in the composition of the ichthyocenoses of the Dniprovske and Kamianske Reservoirs: industrial – 16 species, valuable industrial – 3 species, low-value industrial – 2 species. Other ichthyofauna species belong to the non-industrial category. Some representatives of the non-industrial group (primarily gobies) are objects of recreational fishing. The most commonly captured species in the reservoirs of the Dnipro

**Table 1**

Indicators of the production of aquatic bioresources by commercial fishing in the reservoirs of the river Dnipro region in 2020, according to the data of the Dnipropetrovsk Region Administration of State Agency of Land Reclamation and Fisheries

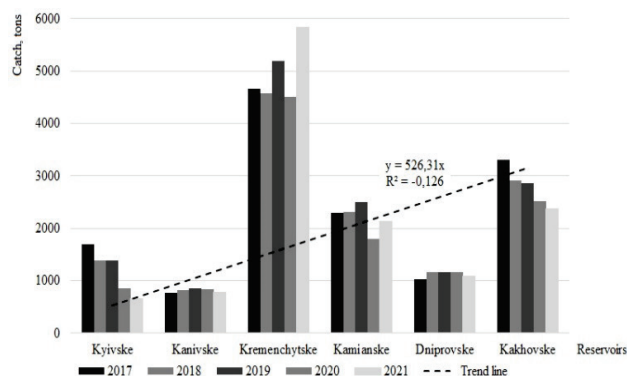
Species	The name of aquatic bioresources	The volume of caught water bioresources, kg	The cost of caught aquatic biological resources (without VAT), UAH	The cost of 1 kg of aquatic biological resources (market, exchange price, (without VAT), UAH	
<i>Alburnus alburnus</i> (Linnaeus, 1758)	Bleak	58,694	58,694	1	
<i>Sander lucioperca</i> (Linnaeus, 1758)	European pikeperch	49,568	743,520	15	
<i>Cyprinus caprio</i> Linnaeus, 1758	Common carp	26,052	390,780	15	
<i>Silurus glanis</i> Linnaeus, 1758	European wels	22,337	446,740	20	
<i>Abramis brama</i> (Linnaeus, 1758)	Bream	239,852	2,398,520	10	
<i>Rutilus rutilus</i> (Linnaeus, 1758)	Roach	237,825	1,902,600	8	
<i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	Rudd	35,091	105,273	3	
<i>Esox lucius</i> Linnaeus, 1758	Pike	19,815	297,225	15	
<i>Aspius aspius</i> (Linnaeus, 1758)	Asp	3,387	33,870	10	
<i>Perca fluviatilis</i> Linnaeus, 1758	Perch	45,289	226,445	5	
<i>Pelecus cultratus</i> (Linnaeus, 1758)	Sablefish	354	3,540	10	
<i>Carassius gibelio</i> (Bloch, 1782)	Prussian carp	977,572	2,932,716	3	
<i>Blicca bjoerkna</i> (Linnaeus, 1758)	White bream	158,314	474,942	3	
<i>Hypophthalmichthys molitrix</i> (Valenciennes, 1844)	Herbivorous fish*	52,696	526,960	10	
<i>Aristichthys nobilis</i> (Richardson, 1845)					
<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	827	12,405	15	
<i>Tinca tinca</i> (Linnaeus, 1758)	Tench	5,624	84,360	15	
<i>Abramisballerus</i> (Linnaeus, 1758)	Blue bream	4,668	46,680	10	
<i>Leuciscuscephalus</i> (Linnaeus, 1758)	Dace	1,464	14,640	10	
<i>Leuciscusidus</i> (Linnaeus, 1758)	Ide	34	510	15	
In total:		1,939,463	10,700,420	5.517 UAH/1 kg	
<i>Astacus leptodactylus</i> Eschscholtz, 1823		Crayfish	1,131	56,550	50 UAH/1 kg
Total biological resources:		1,940,594 kg	10,756,970 UAH	–	

Note: \* – two species (silver and bighead (spotted silver) carp).

A fact that draws attention is that in 2020, the exchange (market) value of aquatic bioresources harvested from natural reservoirs is extremely low. The average cost of 1 kg of live fish from natural reservoirs does not exceed UAH 5.6. For example, 1 kg of a high-value,

Cascade is the resident species – Prussian carp *Carassius gibelio* (27.3% of the total catch). About 5% of the total catch is accounted for herbivorous fish (silver and bighead carp).

In the water area of the Dniprovske Reservoir, 6 native-born industrial species were the main industrial species (production of more than 10 tons) in the last decade, as well as herbivores (silver carp), and low-value species – bleak and sprat. Roach, Prussian carp, silver and big-head carp, bream, white bream dominated in the catch rate.



**Fig. 2.** Harvest of aquatic biological resources in the river Dnipro reservoirs (2017–2021), according to the data of State Agency of Land Reclamation and Fisheries

It should be emphasized that the Dnipro reservoir is characterized by a rather differential fishery load on the water area. In the last 10 years, regular industrial fishing, including expeditionary fishing in the presence of significant concentrations of many commercial fish species, has not been carried out in the upper part of the reservoir.

The total volumes of aquatic biological resources harvested in 2020, their exchange price and the total value of harvested aquatic biological resources are shown in Table 1. According to the official Report of the State Agency for Land Reclamation and Fisheries in Dnipropetrovsk Region, 1,939,463 tons of fish and 1,131 tons of crayfish were caught in the reservoirs of the region during 2020, having the total value of 10.76 million hryvnias (at the exchange price).

resource species – european wels – is valued at UAH 20, and european pikeperch, common carp, pike, white carp, tench, ide – UAH 15.

According to the Resolution No. 125 of the Cabinet of Ministers of Ukraine dated February 12, 2020, the fee for the special use of aquatic

biological resources caught in the reservoirs of Dnipropetrovsk Region (see Table 1) varies from UAH 0.07 to UAH 1.58 for one kilogram of live weight (Table 2). The market price (in autumn 2020) for this fish

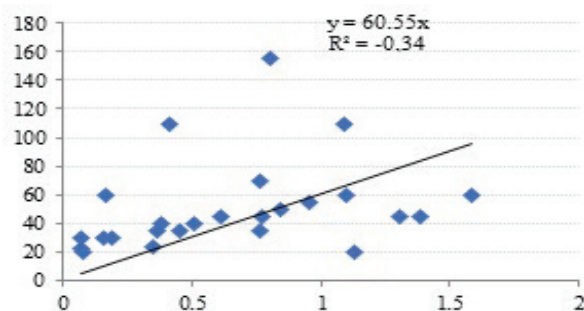
product varies UAH 22–75 for 1 kg. There is a linear relationship between those indicators, which shows that the fee is on average 1.65% of the market value of products (Fig. 3).

**Table 2**

Indicators of average market price of fish in Dnipro in autumn, 2020 and the fee for the special use of aquatic biological resources, according to the data of the Dnipropetrovsk Region Administration of State Agency of Land Reclamation and Fisheries

Species	The name of aquatic bioresources	The average market price of fish in Dnipro as of autumn 2020, UAH/kg	The average market price of fish in Dnipro as of autumn 2020, US\$/kg*	Fee for special use, UAH/kg
<i>Clupeonella cultriventris</i> (Nordmann, 1840)	Sprat	22.0	0.81	0.07
<i>Alburnus alburnus</i> (Linnaeus, 1758)	Bleak	20.0	0.74	0.08
<i>Engraulis encrasicolus ponticus</i> Alexandrov, 1927**	<i>E. encrasicolus</i> BlackSeaanchovy	30.0	1.11	0.16
<i>E. encrasicolus maeoticus</i> Pusanov, 1926**	(Linnaeus, 1758) Azovanchovy	30.0	1.11	0.19
<i>Carassius gibelio</i> (Bloch, 1782)	Prussian carp	23.0	0.85	0.35
<i>Blicca bjoerkna</i> (Linnaeus, 1758)	White bream	35.0	1.30	0.36
<i>Scardinius erythrophthalmus</i> (Linnaeus, 1758)	Rudd	40.0	1.48	0.38
<i>Abramis ballerus</i> (Linnaeus, 1758)	Blue bream	35.0	1.30	0.45
<i>Tinca tinca</i> (Linnaeus, 1758)	Tench	40.0	1.48	0.51
<i>Perca fluviatilis</i> Linnaeus, 1758	Perch	45.0	1.67	0.61
<i>Abramis brama</i> (Linnaeus, 1758)	Bream	35.0	1.30	0.76
<i>Pelecus cultratus</i> (Linnaeus, 1758)	Sablefish	70.0	2.59	0.76
<i>Vimba vimba</i> (Linnaeus, 1758)	Vimba	45.0	1.67	0.77
<i>Cyprinus caprio</i> Linnaeus, 1758	Common carp	50.0	1.85	0.85
<i>Esox lucius</i> Linnaeus, 1758	Pike	55.0	2.04	0.96
<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Grass carp	75.0	2.78	1.09
<i>Sander lucioperca</i> (Linnaeus, 1758)	European pikeperch	60.0	2.22	1.10
<i>Alosa tanaica</i> (Grimm, 1901)	Azov shad	35.0	1.30	1.13
<i>Hypophthalmichthys molitrix</i> (Valenciennes, 1844), <i>Aristichthys nobilis</i> (Richardson, 1845)	Herbivorous fish***	45.0	1.67	1.30
<i>Aspius aspius</i> (Linnaeus, 1758)	Asp	45.0	1.67	1.38
<i>Silurus glanis</i> Linnaeus, 1758	European wels	75.0	2.78	1.58

Note: \* – exchange rate of American currency to hryvnia as of autumn 2020 – UAH 27.0; US\$ 1.0; \*\* – the old name; \*\*\* – two species are meant (silver and bighead (spotted silver) carp).



**Fig. 3.** Dependence between the size of the fee for the use of aquatic biological resources (ordinate, hryvnias per 1 kg of live weight) and the average market price (abscissa, hryvnias per 1 kg of live weight)

The largest systematic deviation from linear dependence was determined for fish species which market value is lower than UAH 35/kg. Of such fish, only the catch of Prussian carp has an adequate fee today. Other species with a price of less than UAH 35/kg have a lower fee (for catch) than the expected compared to other species. Such underestimated types of fish include common sprat, Black Sea sardelle, bleak, Azov anchovy, Black Sea anchovy.

Thus, with a sufficiently high rate of commercial fishing of aquatic biological resources in the reservoirs of Dnipropetrovsk Region (1,939,463 tons of fish and 1,131 tons of crayfish), their total value at the exchange price is only 10.76 million hryvnias. The average cost of 1 kg of live fish from natural reservoirs is no higher than UAH 5.6, although the market price of 1 kg of live fish in autumn of 2020 varied from UAH 20 (bleak) to UAH 75 (grass carp, European wels). In our opinion, the value of water bioresources in Ukraine today is extremely low. This, on the one hand, stimulates the development of commercial fishing (a significant margin between the size of the fee for the use and the market price), and, on the other hand, further contributes to the growth of illegal and undocumented fishing, the sphere that raises significant profits due to practically free fishing and fish reselling on the market.

### Recreational fishery in Dnipropetrovsk Region

In most developed countries, recreational fishing and fishing tourism are popular and highly profitable industries in the field of tourism and entertainment services. In the USA, recreational fishing annually provides workplaces for about 1.0 million people, brings \$45.3 billion in retail trade through federal excise taxes, \$600.0 million of the state funds are allocated for the preservation of fishery and the aquatic environment (Arlinghaus & Cooke, 2005; Sallenave & Cowley, 2006; Arlinghaus et al., 2013; Giovos et al., 2018; Lewin et al., 2019; Boenish et al., 2020).

It is now known (Novitskyi, 2015; Novitskyi et al., 2022) that amateur fishing is a powerful factor in nature management, which competes with traditional fishing in Ukraine. Moreover, unlike the latter, recreational fisheries have significant economic and social advantages, as well as clear prospects of transformation into a profitable branch of the economy (Boenish et al., 2020). If the traditional freshwater fishing industry of Ukraine offers about 4,500 workplaces (according to www.darg.gov.ua), the infrastructure of the recreational fishing sector already has offered 16,000 workplaces (especially in clusters of ecotourism, sport fishing and active recreation services) (according to www.ukrstat.ua). The amount of financial income to the State Budget of Ukraine from the recreational fishing business is from 90 million hryvnias annually, while fishing brings in 65 million hryvnias (according to www.darg.gov.ua) (Novitskyi et al., 2022).

More than 220 species of fish live in the reservoirs of Ukraine, about 70 of them are freshwater. Total of 32 species are objects of freshwater amateur and sport fishing, and 57 species of sea fish.

Of 32 species of freshwater fish, which are of interest to amateur fishermen in Ukraine, 7 species are low-value (Neogobius river gobies, bleak, ruff, river perch), indicating a certain biomelioration role of recreational fishing. The number of species of fish recorded in the catches of fishermen in the river Dnipro region is 23–26 (fishery at this time is based on 18–22 species). Most often, the catch of fishermen contains bleak, roach, white bream, Prussian carp, ruff, perch, carp bream, goby.

Taking into account the large share of low-value fish in amateur catches, it can be argued that amateur fishing performs a very important selective role. The catch of low-value fish by amateur fishermen in the

upper part of the river Dnipro Reservoir reaches 700–950 tons (depending on the season), while such species as gobies and bream are not captured by fishing, and the industrial extraction of perch, white bream, and redfin does not reach an optimal level.

According to the draft of rules of recreational and sport fishing for 2022, the extraction (catch) of aquatic biological resources by fishermen is allowed to be carried out free of charge according to the order of general use of aquatic biological resources for personal needs (without the right to sell) according to the norms of harvest (catch) of permitted types of aquatic biological resources per fisherman a day.

Amateur, sport fishing and spearfishing that exceeds the amount of free harvest (catch) of aquatic biological resources established by these Rules is carried out for a fee and in accordance with the procedure for the special use of aquatic biological resources, established by Resolution of the Cabinet of Ministers of Ukraine No. 992 dated November 25, 2015. The special use of aquatic bioresources is carried out by users of aquatic bioresources on the basis of a permission for such a use in fishery water bodies (parts thereof).

Permissions for the right to carry out recreational fishing based on the special use of aquatic biological resources are issued by fish protection authorities. A fee is charged for the issuance of permission, the amount of which is calculated by the State Agency of Land Reclamation and Fisheries of Ukraine in agreement with the Ministry of Finance of Ukraine.

Using the data obtained in 2018–2020 on the composition, quantitative and qualitative indicators of catches by amateur fishermen in the Kakhovske Reservoir, we have earlier calculated (Novitskyi et al., 2022) the cost of seasonal permissions for the use of aquatic biological resources in the water area of the Kakhovske Reservoir by amateur fishermen. Therefore, according to the calculations, the total cost of seasonal, annual and monthly permissions for amateur and sport fishing can be in the range of: UAH 173 for the winter season; UAH 341.7 for the summer-autumn season; UAH 504.9 per year; and UAH 56.1 for one month.

The cost of permissions for a certain type of fish was also calculated (if a fisherman, for example, is engaged only in spin fishing (fishing for perch, pike, pike-perch, catfish, whitefish) or in angler fishing (fishing for Prussian carp, bleak, bream, white bream). According to our calculations, the cost of a permission for the summer-autumn season for an angler fisher is UAH 235.45, and the cost of a permission for the same season for a spinner is UAH 574.26.

Of course, the cost of a permission for specialized fishing of certain industrially valuable fish (in particular, pike-perch, carp, catfish) would be more expensive.

The total cost of seasonal, annual and monthly licenses for paid recreational fishing must be paid by recreational fishermen in full, regardless of when they purchase it during the year.

Considering that only in the territory of Dnipropetrovsk Region there are about 200,000 amateur fishermen (Novitskyi, 2015), of which at least 10% are organized (members of clubs and associations, societies), the estimated amount of the economic revenues to the budget of Ukraine for fishing permissions purchased by amateurs in the region could be at least UAH 10,000,000 annually. These figures are quite comparable to the state profit from commercial fishing in the reservoirs of Dnipropetrovsk Region.

Thus, recreational (amateur) fishing can compete economically with fishing in terms of revenue to the state budget.

## Conclusion

In recent years, a significant decline (by 2.5–4.0 times) was observed in the fisheries sector of Dnipropetrovsk Region. Over the last 10 years, 1/3 of the farms could not adapt to working in the new economic conditions and became unprofitable. In total, in 2020, 473,149 tons of fish products were grown in Dnipropetrovsk Region (common carp – 103,384 tons, herbivorous fish – 260,892 tons, catfish – 6,770 tons, other fish – 61,295 tons), which is one of the lowest indicators in recent years.

In ponds with an area of 352.95 hectares in the region, 427,311 tons of fish products were grown, in stocking ponds – 0.8 tons of carp. In 2020, 4.23 tons of catfish (mostly channel catfish) were grown in aquarium systems. Not a single kilogram of fish products was caught in the pools and breeding ponds. Such facts clearly indicate the negative tendencies in aquaculture in the region. Fish farming becomes

a non-profit business. In the absence of any special-purpose state aid, the fishing industry faces an inevitable collapse.

Commercial fishing (fishery) officially caught 1,939,463 tons of fish and 1,131 tons of crayfish in the reservoirs of Dnipropetrovsk Region. However, the total value of those aquatic bioresources at the exchange price is only 10.76 million hryvnias. The average cost of 1 kg of live fish from natural reservoirs does not exceed UAH 5.6, although the market price of 1 kg of live fish in the autumn of 2020 varied UAH 20 (bleak) to UAH 75 (grass carp, European wels).

Thus, the value of water bioresources in Ukraine today is extremely low. This, on the one hand, stimulates the development of commercial fishing (a significant margin between the size of the special-use fee and the market price), and, on the other hand, further promotes the growth of illegal and undocumented fishing, which raise significant profits due to practically free production of fish and its reselling on the market.

In recent years, recreational (amateur) fishing has been significantly using the aquatic biological resources of Ukrainian reservoirs. Based on the calculations for the Kakhovske Reservoir, it is proposed to introduce monthly, seasonal, and annual permissions for paid recreational and sport fishing, which can amount to UAH 173.0 for the winter season; UAH 341.7 for the summer-autumn season; UAH 504.9 per year; UAH 56.1 per month. The cost of a permission for the summer-autumn season would be UAH 235.45 for fishing rod for float fishing, and UAH 574.26 for a spin fishing.

The estimated amount of the economic revenue to the budget of Ukraine from fishing permissions purchased by amateur fishermen of the river Dnipro region could be at least UAH 10,000,000 annually, which is quite comparable to the state income from commercial fishing in the reservoirs of Dnipropetrovsk Region.

In order to improve the situation with fish farming and fishery in the region, it is necessary to carry out a stock control of fish farming water objects of the Dnipropetrovsk Region, to design passports and modes of use, as well as biological reasoning. Also, monitoring of the quantitative and qualitative indicators of hydrobionts, primarily aquatic ichthyofauna, the influence of natural and man-made factors on them should be carried out. It is necessary to consider the issue of expanding the bioresources potential of the region fishing reservoirs, justified introduction of economically valuable species of fish and other hydrobionts. It is necessary to monitor the natural feed base of the region reservoirs, to organize the production of balanced, complete feeds of a broad range based on local fodder raw materials, to popularize the production and sale of extruded feeds for feeding fish.

In order to effectively control the activities of industrial fishing, the harvest of aquatic biological resources, their delivery to fish reception points, the impossibility of trading biological resources without a state certificate in Ukraine, it is necessary to introduce the electronic system “E-fish”. Implementation of a permanent analysis of the volume of illegal, undocumented, fishing in the reservoirs of the region should be provided using modern methods of scientific research (GIS technologies, modern aviation technology, etc.).

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