ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 13(3), 35-42
Received: 07.06.2022 Revised: 12.07.2022 Accepted: 25.07.2022

UDC 639.2.052.2
DOI: 10.31548/animal.13(3).2022.35-42

The state of use of fish resources in small reservoirs of the Rivne Oblast

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Abstract. Poaching and unregulated amateur fishing have led to impoverishment and, in some places, complete extermination of populations of industrially valuable fish species in Rivne Oblast, so the activities of special commercial fisheries ensure the preservation of fish resources. The purpose of the study is to analyse the state of the water fund of the Rivne Oblast, the use of fish resources of these reservoirs, in particular, the results of the activities of special commercial fisheries, industrial and amateur fishing, and aquatic bioresources. According to the State Agency of land reclamation and fisheries in Rivne Oblast, over the past twenty years, there has been a tendency to reduce the volume of fish caught and introduced into natural and artificial reservoirs. Since 2010, due to low profitability, the activities of fishing organisations have been completely stopped, although previously commercial fishing of aquatic living resources took place on large water bodies, in particular in Rivers (Horyn, Ikva, Styr), lakes (Nobel, Putylivske), reservoirs (Mlynivske, Khrinnytske). Nowadays, the main method of fishing, in addition to the activities of special commercial fisheries, is unorganised amateur fishing. Specialised public organisations of amateur fishermen unite from 8 to 15 thousand amateur fishermen and sportsmen, carry out organised amateur fishing, are engaged in the introduction of fish resources into the water bodies of the region (carp, herbivorous fish, common pike, and silver crucian carp). Carp and crucian carp make up the largest share of fishermen's catches; pike, common perch, silver carp, roach and rudd are less common. The state of fishery management in special commercial fisheries of the Rivne Oblast has not changed over the past 10 years. As of 2021, there were only 11 of them left in the region, working on lease terms; and several private enterprises where commercial fish is grown in full-system and non-system farms. The volume of young fish entering almost all farms has tripled compared to 2015, while the volume of fish caught has slightly increased. Analysis of the state of use of fish resources in small reservoirs is necessary for further rational extraction and restoration of fish resources in small reservoirs of the Rivne Oblast

Keywords: water resources, fisheries, industrial catch, catch volumes, fish introduction, amateur fishing

Introduction

Due to the direct anthropogenic impact, in particular, poaching and unregulated amateur fishing, the fish resources of the Rivne Oblast are under significant threat of impoverishment and, in some places, complete extermination of populations of industrially valuable fish species [1]. One of the ways to preserve and increase them is the introduction of fish into water bodies and the rational use of reserves of industrially valuable species of aquatic living resources [2; 3]. Therefore, the analysis of the results of the activities of special commercial fisheries and the state of amateur fishing are relevant issues for further search for ways to solve the above problems.

Researchers [4-6] investigated the dynamics of catch of hydrobionts by regions and fisheries zones on the territory of Ukraine from 2005 to 2020. It was found that production significantly decreased (up to 70-80%) in

Suggested Citation:
Parfeniuk, I., Grokhovska, Yu., & Martseniuk, V. (2022). The state of use of fish resources in small reservoirs of the Rivne Oblast. *Animal Science and Food Technology*, 13(3), 35-42.

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almost all regions of Ukraine [7-9]. In 2019, the catches were dominated by carp and herbivorous fish [10]. 134 tonnes of carp were caught in Rivne Oblast. Throughout Ukraine, the smallest share in catches was made up of common pike, grass carp, and wels catfish [11].

The analysis of publications shows that after 2010, amateur sport fishing in inland waters competes with industrial fishing [12] and exerts additional pressure on the ichthyofauna [13]. In European countries, amateur and industrial fishing brings significant profits and facilitates the development of unused fish resources [14; 15]. The organisation of amateur and sport fishing requires knowledge of fish farming, organisational, and economic and legal aspects [16; 17].

Analysis of the possibilities of using inland water bodies of Ukraine for fishery purposes would allow making a correct assessment of the state of fish reserves, determining the volume of fish withdrawal and introduction, and preventing negative environmental and economic consequences.

Thus, a team of researchers [18] reviewed the estuaries of the north-western Black Sea region, where, in particular, the species composition of the ichthyofauna of the studied reservoirs is presented; a strategy for the fisheries use of estuaries of various types in modern conditions was developed [19; 20]. The state of reserves of some commercial fish species of the cascade of Dnipro reservoirs and the possibility of their use for fishery purposes [21; 22], and other large lowland reservoirs of Ukraine [23] are evaluated.

Legal aspects of the protection of aquatic bioresources also require attention [24-26], because the protection of aquatic bioresources in the field of aquaculture does not lose its relevance and prospects for legal improvement [27; 28].

A number of researchers have been studying the state of fish resources in Rivne Oblast over the years, in particular I.V. Hryb, T.M. Kunchyk, V.O. Mosnitskyi, V.K. Bihun, and others [29-31]. In their studies, researchers noted the impoverishment of the ichthyofauna of water bodies in Rivne Oblast, the disappearance of native, industrially valuable fish species [1]. In particular, V.O. Mosnitskyi and T.M. Kunchyk assessed the capacity of the water fund of the Rivne Oblast for fishery use [31]. Researchers also investigated the species composition of the ichthyofauna [1] and the possibilities of preserving fish resources [1; 28; 30].

The water fund of the Rivne Oblast includes a large number of water bodies that are not fully used for fishery purposes, including industrial fishing. Analysis of the state of use of fish resources in small reservoirs would facilitate rational selection of objects of introduction and withdrawal, species and age composition of ichthyofauna, and allow making forecasts regarding the amount of fish withdrawal and introduction into reservoirs.

To investigate the state of use of fish resources in small reservoirs of the Rivne Oblast, it is necessary to analyse the state of the water fund of the Rivne Oblast, industrial and amateur fishing and aquatic bioresources, study the activities of special commercial fisheries.

The purpose of the study is an overview of the state of use of fish resources in Rivne Oblast, in particular, the results of the activities of special commercial fisheries (SCF).

The following tasks were set to achieve the goal: to analyse the state of the water fund of the Rivne Oblast; to analyse the state of industrial and amateur fishing and aquatic bioresources; to study the activities of the SCFs from the standpoint of replenishing fish resources.

The object of research is the state of fish resources in Rivne Oblast (use and replenishment).

The subject of the study is the characteristics of the state of fish resources of the Rivne Oblast based on the results of the SCF's activities.

Materials and Methods

To analyse the state of fisheries, in particular, the use of fish resources in Rivne Oblast, the authors used the annual reports of regulatory authorities, in particular, the Rivne fish protection patrol (territorial fish protection body of the State Agency of land reclamation and fisheries in Rivne Oblast) [32; 33] and the Main department of statistics in Rivne Oblast for 2010-2020 [34]. In addition, data from specialised public organisations of fishermen were used [32]. Data on the catch and stocking of aquatic living resources in special commercial fisheries are analysed and systematised, which are presented in Table 1. Materials on the state and objects of amateur (organised and unorganised) fishing on water bodies of the Rivne Oblast are summarised. Computer programmes (Microsoft Excel) were used to process the reporting data.

Table 1. *Research objects*

Water body number	Location of the reservoir
1	channel pond, Klyntsi village, Dubenskyi district
2	pond, Kolodiivka village, Koretskyi district
3	pond, Kustyn village, Rivnenskyi district
4	pond, Okhmatkiv village, Demydivskyi district
5	channel pond, Varkovychi village, Dubenskyi district
6	channel pond, Yuchyn village, Goshchanskyi district
7	channel pond, Uizdtsi village, Mlynivskyi district
8	channel pond, Mali Dorohostai village, Mlynivskyi district
9	pond, Zabara village, Koretskyi district
10	pond, Derevyane village, Rivnenskyi district
11	pond, Volodymyrets urban-type settlement, Volodymyretskyi district

To monitor the state of stocks, organise rational fishing and regulation, it is necessary to record the relative number and direct accounting of fish stocks [35-37]. Forecasting of annual changes in the stock is mainly carried out by determining the relative number of fish. The method for determining the relative number of fish is based on four initial processes of population dynamics: replenishment, growth, catch, and natural mortality. In addition, the age, size, and species composition of the catch are determined [38; 39].

Results and Discussion

The issues of using and reproducing fish resources in Ukrainian reservoirs have always been relevant. As of 2019, the production of aquatic living resources amounted to 74.7 thousand tonnes (compared to 2013, the catch of fish decreased by 151.1 thousand tonnes or 70%). This is conditioned by the insufficient amount of fish stocking material, the depletion of stocks of commercial fish species, and geopolitical changes in Eastern Ukraine.

In some regions, the total production of aquatic bioresources has increased [40]. Users who received quotas for special use of aquatic bioresources in 2019 extracted 51.5 thousand tonnes of aquatic bioresources, of which 21.3 thousand tonnes were caught in inland waters, which is an increase of 4.2% compared to the previous year. Domestic commercial fishing is carried out in large inland water bodies, mainly in the reservoirs of the Dnipro, estuaries, and in medium-sized natural reservoirs, where the SCF regime is mainly used. Silver carp, bream, roach, white bream, herbivorous fish species, and common pikeperch were mainly caught. In the structure of production of all aquatic bioresources, the share of fish products of aquaculture is only 21.8% of the total volume [4; 5].

The water fund of the Rivne Oblast has a fairly large number of water bodies: 171 rivers (total length – 4,462.0 km), which belong to the Pripyat river basin; 130 lakes (total area – 2,675,722 ha), the most numerous of which are floodplain, but there are also karst lakes (Bile, Ostrivske, etc.); 12 reservoirs (total area – 3,274.07 ha), the largest are Khrinnytske reservoir (total area – 2,046 ha, within the Rivne Oblast 1,610 ha) and Mlynivske reservoir (total area – 440 ha); 1,300 ponds (total area – 10,099.77 ha), most of them are small water bodies – from 10 to 30 hectares [34].

Control over the protection, use, and reproduction of aquatic bioresources at these facilities is carried out by the Department of the State Agency of land reclamation and fisheries in Rivne Oblast [41].

During 2010-2022, commercial fishing of aquatic bioresources was not carried out, as a result of the suspension of the activities of fishing organisations on the water bodies of the region, as it was unprofitable. Until 2010, commercial fishing of fish and aquatic bioresources took place: in the rivers – Horyn, Ikva, Styr; lakes – Nobel, Putylivske; reservoirs – Mlynivske and Khrinnytske [1; 32; 33].

Now specialised public organisations of amateur fishermen in the reservoirs of the region carry out organised amateur fishing. The most numerous of them are the Rivne regional organisation of the Ukrainian Society of Hunters and Fishermen (USHF), the Rivne Regional Federation of Fishing Sports, and the Society of Military Hunters and Fishermen. Since the 2000s, underwater fishing has gained popularity. Fishermen have the opportunity not only to catch fish, but also to observe underwater life, engage in photo hunting. Organisations that unite underwater hunters were created – the spearfishing club Rivenska Sluch and Harpoon. According to various estimates, public organisations unite from 8 to 15 thousand amateur fishermen and athletes [32; 33].

Most often, the objects of unorganised amateur fishing are reservoirs Khrinnytske and Mlynivske, lakes Nobel, Sosno, Omyt, Bile, and rivers Horyn, Styr, Sluch, Ikva, and Pripyat. In the catches of amateur fishermen on the rivers, reservoirs, and ponds of the region, 24 species of fish were found: chub (*Squalius cephalus* L.), ide *Idus idus* L.), silver crucian carp (*Carassius gibelio* Bloch), common crucian carp (*Carassius carassius* L.), common carp (*Cyprinus sargio* L.), common roach (*Rutilus rutilus* L.), common rudd (*Scardinius erythrophthalmus* L.), tench (*Tinca tinca* L.), gudgeon (*Gobio gobio* L.), common bleak (*Alburnus alburnus* L.), white bream (*Blicca bjoerkna* L.), common bream (*Abramis brama* L.), asp (*Aspius aspius* L.), grass carp (*Ctenopharyngodon idella* Valenciennes), white silver carp (*Hypophthalmichthys molitrix* Valenciennes), common pike (*Esox lucius* L.), common perch (*Perca fluviatilis* L.), common pikeperch (*Sander lucioperca* L.), wels catfish (*Silurus glanis* L.), Eurasian ruffe (*Gymnocephalus cernuus* L.), monkey goby (*Neogobius fluviatilis* Pallas), Amur sleeper *Perccottus glenii* Dybowski), European eel (*Anguilla anguilla* L.) (very rarely).

According to public specialised organisations, in 2020, the catch of aquatic bioresources by amateur fishermen amounted to only 16,393 tonnes [35]. The species composition of the caught aquatic bioresources is shown in Figure 1.

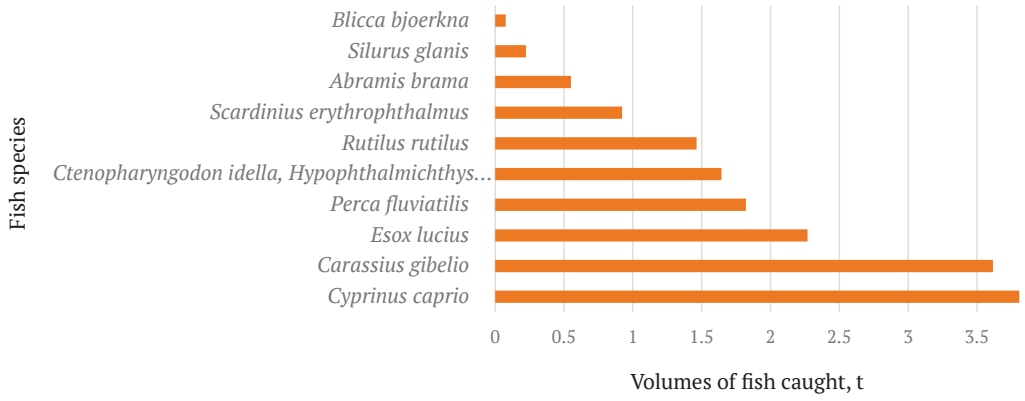

Figure 1. Species composition of aquatic bioresources in the catches of amateur fishermen (2020)

According to the Rivne fish protection patrol, the largest share in fishermen's catches was carp and silver carp – 3.6-3.8 tonnes; less often – such species as pike, common perch, white and mottled silver carp, roach and rudd. The total catch of these fish species was 0.9-2.3 tonnes. Very rarely caught bream, catfish, and white bream, the total catch of these species was only 0.076-0.55 tonnes [32].

In addition to catching fish, public organisations, in particular the Rivne regional organisation of the Ukrainian Society of Hunters and Fishermen, perform settlement of young fish. Thus, in 2019, users of water bodies in the reservoirs of the Rivne Oblast settled two-year-olds of carp, herbivorous fish, and common pike and silver carp (Figure 2).

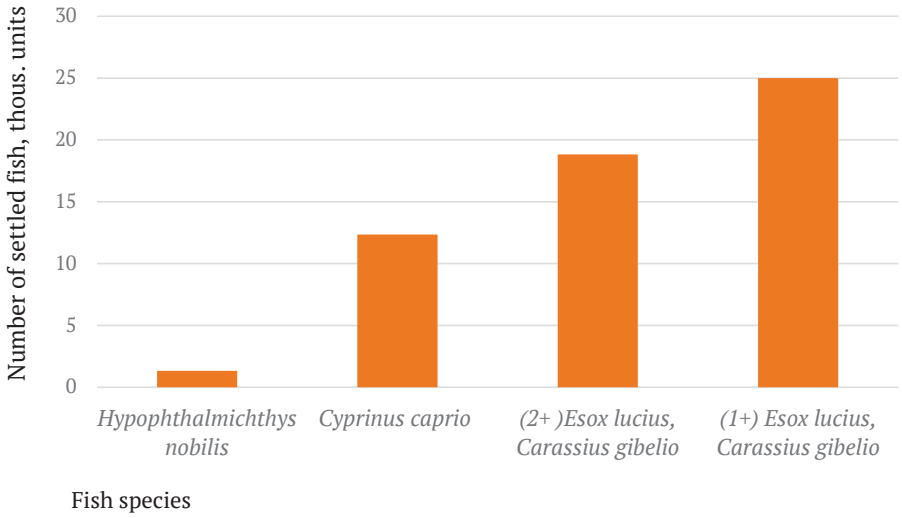

Figure 2. Volumes of the settlement of aquatic bioresources by water body users in 2019

The volume of settlement is relatively insignificant – most of all, two- and three-year-olds of different fish species (pike, silver crucian carp, etc.) are inhabited in the reservoirs of the region – 25 thousand specimens, the least – two-year-olds of the variegated silver carp – 1.33 thousand specimens [32].

Artificial breeding, cultivation, and use of fish and other aquatic bioresources in the SCFs of the Rivne Oblast were carried out by 11 users (the total area of reservoirs used was 204 hectares, most of which were channel ponds). Users start fishing in autumn, in accordance with the technology of growing carp and herbivorous fish of the Far Eastern faunal complex. The planned volume of fish caught in 2020 was 62 tonnes, and in fact, 58 tonnes were caught (that is, 94% of the planned figure). Fish production of reservoirs thus amounted to 285 kg/ha (Figure 3) [32].

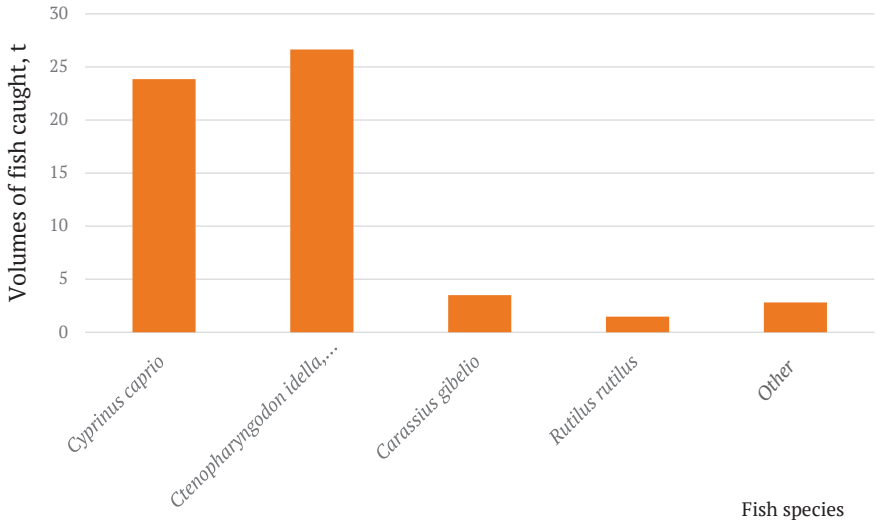

Figure 3. Catch volumes of aquatic bioresources in SCFs of the Rivne Oblast (2020)

Analysing the data on the catch of fish products in SCFs of the Rivne Oblast, it can be noted that most of the herbivorous fish species were caught – 26.6 tonnes; carp fish were 23.8 tonnes; the least amount caught was common roach – 1.5 tonnes [32].

The introduction of fish stocking material can be carried out all year round, but the vast majority of stocking occurs in spring and autumn. In 2020, 97.654 thousand juveniles of various fish species were stocked in the reservoirs of Rivne Oblast (Fig. 4).

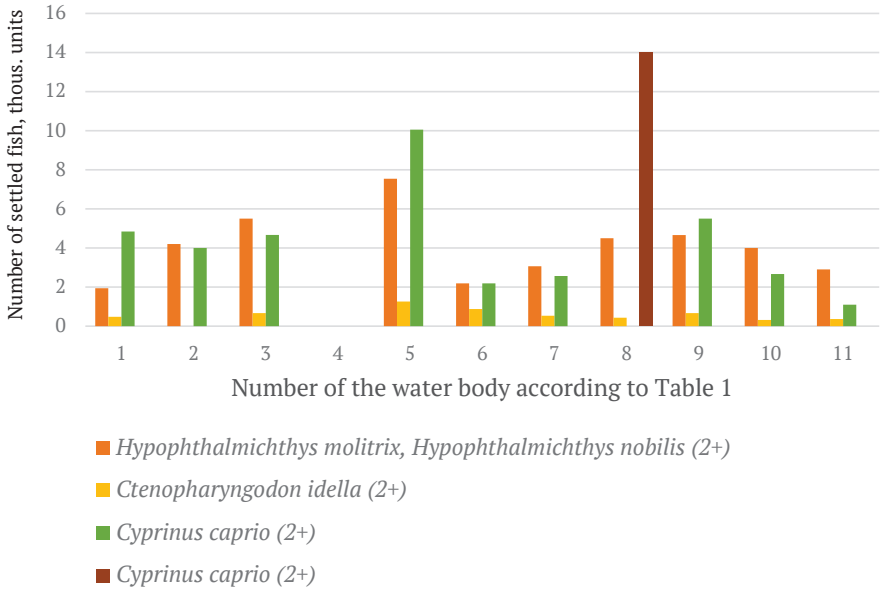

Figure 4. Volumes of settlement of various fish species in SCFs of the Rivne Oblast (2020)

The smallest number of wild fish was made up of two-year-olds of the grass carp – 5,588 thousand specimens; most of all, two-year-olds of silver carp were settled – 40,489 thousand specimens. Analysis of the settlement volumes of the main commercial species of ichthyofauna over a 5-year period showed that all the farms under study are stocked with more herbivorous fish species (grass carp, white and mottled silver carp). According to the reporting data, for five years in almost all farms, the volume of planned stocking coincides with the actual one (Table 2) [32].

Table 2. *Dynamics of fish settlement (thous. units) by users of special commercial fisheries in 2015-2019*

SCF	Years									
	2015		2016		2017		2018		2019	
	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact
1	20.92	20.92	20.92	20.92	20.82	16.01	7.26	7.26	7.26	7.26
2	32.5	30.5	10.83	10.16	10.82	10.82	10.83	10.83	10.83	10.83
3	24.7	24.7	24.7	12.0	24.7	15.0	8.23	4.0	8.7	8.2
4	40.07	–	40.07	–	–	–	–	–	–	–
5	60.32	33.93	56.55	52.78	18.85	9.54	18.85	18.85	18.85	18.85
6	20.02	20.02	17,453	17,453	6.16	2.56	6,158	6,158	6,164	6,164
7	13,993	13,993	15.74	-	15.74	-	5,245	5,245	5,245	5,245
8	21.0	8.0	21.0	21.0	21.0	21.0	21.0	-	7.0	6,985
9	27,933	27,933	28.8	28.8	27.93	27.93	9.59	9.59	18.93	18.93
10	32.5	–	32.5	–	32.5	32.0	10.82	10.82	10.83	10,825
11	13.0	–	13.0	–	12.28	12.28	4.33	4.33	4,365	4,365

According to the reporting data, in 2017-2019, the actual population of commercial fish species mostly coincided with the planned one, except for ponds in Kustyn and Zabara villages. Data on the introduction of aquatic living resources into the channel pond, which is located in Okhmatkiv village has been absent since 2016 [4]. In all farms, there is a tendency to reduce the number of commercial fish species, which is most likely conditioned by difficult economic conditions, in particular, an increase in the cost of fish stocking material. The high cost of grown products creates a high price for consumers, so the demand for live fish is low compared to imported ones. These factors lead to a decrease in the volume of fish population in special commercial fisheries in Rivne Oblast.

Table 3. *Dynamics of fish catch (t) by users of special commercial fisheries in 2010-2019*

2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
plan	fact	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact	plan	fact
Channel pond, Klyntsi village, Dubenskyi district																			
–	–	5.2	5.2	5.4	–	5.5	5.5	5.6	5.6	5.7	5.7	5.9	5.9	6.0	6.0	6.1	6.1	6.3	6.3
Channel pond, Kolodiivka village, Koretskyi district																			
–	–	–	–	5.1	–	5.3	5.3	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Channel pond, Kustyn, Rivnenskyi district																			
–	–	–	–	4.4	–	4.7	3.0	5.2	3.1	5.2	2.9	5.4	2.7	5.4	3.6	5.4	5.4	5.4	5.4
Channel pond, Okhmatkiv village, Demydivskyi district																			
–	–	–	–	1.3	–	6.6	6.6	6.9	6.9	7.2	–	7.5	–	–	–	–	–	–	–
Channel pond, Varkovychi village, Dubenskyi district																			
–	–	9.3	9.3	9.3	–	9.4	–	9.4	7.0	9.4	3.3	9.6	5.0	9.6	3.5	9.6	5.2	9.8	6.0
Channel pond, Mali Dorohostai village, Mlynivskyi district																			
11.3	11.3	12.72	–	3.90	3.90	3.95	–	4.10	4.10	4.15	4.15	4.30	4.30	4.40	4.40	4.45	4.45	4.60	4.60
Channel pond, Yuchyn village, Goshchanskyi district																			
–	–	2.86	2.86	3.16	–	3.36	3.36	3.56	3.56	3.76	3.76	3.86	3.86	4.06	–	4.26	4.26	4.46	4.46
Channel pond, Zabara village, Koretskyi district																			
–	–	–	–	6.01	–	6.12	6.12	6.38	6.38	6.38	3.69	6.38	6.38	7.28	5.60	6.38	6.38	6.38	6.38
Channel pond, Derevyane village, Rivnenskyi district																			
–	–	–	–	5.62	–	6.05	6.05	6.30	6.30	6.36	6.36	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76
channel pond, Volodymyrets urban-type settlement, Volodymyretskyi district																			
–	–	–	–	8.11	–	8.50	8.50	8.80	8.80	9.10	–	9.10	–	9.10	9.10	9.10	9.10	9.10	9.10
Channel pond, Uizdtsi village, Mlynivskyi district																			
–	–	–	–	–	–	–	–	2.20	–	2.29	2.29	2.38	2.38	2.47	2.47	2.56	2.56	2.65	2.65

According to the reporting data in SCFs, since 2015, the actual catch mostly coincided with the planned one, except for ponds in Varkovychi, Kustyn, and Zabara villages. In the channel pond located in Okhmatkiv village, fishing has not taken place since 2016 [32].

The fishery on the channel pond in Mali Dorohostai village was operating before 2010, while most farms started operating only in 2012 (6 out of 11) and the first catch was carried out in 2013. Analysis of catch dynamics based on the reporting data shows a gradual slight increase in comparison with the first years of operation of special commercial fisheries in Klyntsi and Kustyn villages. On the SCF in Volodymyrets urban-type settlement over the 5-year period, the average catch was 8.92 tonnes [32].

Conclusions

One of the problems of the development of fisheries in Rivne Oblast is low profitability, and as a result, the lack of organised industrial fishing of aquatic living resources. To date, the activities of fishing organisations on the water bodies of the region have been stopped. Thus, fishing is mainly carried out by amateur fishermen. There are several public organisations of amateur fishermen in the region, which unite up to 15 thousand fishermen and sportsmen. The catch of fish according to these public organisations amounted to 16,393 tonnes, but the volume of stocking is insignificant – 25 thousand specimens of annual fish of various species (pike, silver crucian carp, etc.) and 1.33 thousand specimens of two-year-old mottled silver carp.

Fish stocks are replenished in fish farms, mainly by herbivorous fish species and carp. However, in 2016-2019, the volume of moving in almost all farms decreased three times compared to 2015, while the volume of fish caught in SCFs, on the contrary, increased slightly and in recent years the actual catch mainly coincided with the planned one.

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Стан використання рибних ресурсів малих водойм Рівненської області

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Анотація. Браконьєрство та нерегульоване любительське рибальство призвели до збіднення і, місцями, повного винищення популяцій промислово цінних видів риб у Рівненській області, тому діяльність спеціальних товарних рибних господарств забезпечує збереження запасів рибних ресурсів. Метою дослідження є аналіз стану водного фонду Рівненської області, використання рибних ресурсів даних водойм, зокрема, результатів діяльності спеціальних товарних рибних господарств, промислового та любительського вилову риби і водних біоресурсів. За даними Управління Державного агентства рибного господарства та меліорації у Рівненській області, впродовж останніх двадцяти років спостерігається тенденція до зниження обсягів вилову та вселення риби у природні та штучні водойми. З 2010 року, внаслідок низької рентабельності, повністю припинена діяльність рибодобувних організацій, хоча раніше промисловий вилов водних живих ресурсів відбувався на великих водних об'єктах, зокрема у річках (Горинь, Іква, Стир), озерах (Нобель, Путилівське), водосховищах (Млинівське, Хрінницьке). На сьогодні основним способом рибодобування, крім діяльності спеціальних товарних рибних господарств, є неорганізоване любительське рибальство. Профільні громадські організації рибалок-любителів організації об'єднують від 8 до 15 тисяч рибалок-аматорів та спортсменів, здійснюють організоване любительське рибальство, займаються вселенням рибних ресурсів у водні об'єкти регіону (коропа, рослиноїдних риб, а також щуки звичайної та карася сріблястого). Найбільшу частку в уловах рибалок складають короп та карась сріблястий; рідше трапляються щука, окунь звичайний, товстолобики, плітка та краснопірка. Стан ведення рибогосподарської діяльності у спеціальних товарних рибних господарствах Рівненської області за останні 10 років фактично не зазнав змін. Станом на 2021 рік у регіоні їх лишилось лише 11, що працюють на умовах оренди; та декілька підприємств приватної власності, де здійснюється вирощування товарної риби у повносистемних та неповносистемних господарствах. Обсяги вселення молоді риб майже у всіх господарствах зменшились утричі у порівнянні з 2015 роком, водночас обсяги вилову риби дещо зросли. Аналіз стану використання рибних ресурсів малих водойм необхідний для подальшого раціонального вилучення та відновлення запасів рибних ресурсів малих водойм Рівненської області

Ключові слова: водні ресурси, рибне господарство, промисловий вилов, обсяги вилову, вселення, любительське рибальство