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DETERMINATION OF LIMITS FOR CATCHES OF ROACH, BREAM, ZANDER AND CARP IN ZAPORIZHZHIYA (DNIPRO) WATER RESERVOIR FOR 2018

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The analysis of the current state of roach, straw, bream zander and silver bream populations of the Zaporizhzhya (Dnipro) reservoir was carried out and the size of the admissible industrial extraction of these fish species in 2018 was determined due to the determination of reasonable limits. In the course of the work, the generalized results of ichthyological studies in the water area of the Zaporizhzhya (Dnipro) reservoir during 2010–2017 were used. The basic biological indicators of these fish species were determined, the age and sex structure of the populations were determined, and the values of the industrial reserve were calculated. Basing on the obtained data, the coefficients of natural, industrial and total mortality were determined. The values of the limits of industrial catch of experimental species of fish are calculated

Key words: limits, Zaporizhzhya (Dnipro) reservoir, fisher , zander, silver bream, roach, bream.

Formulation of the problem. The formation of industrial ichthyofauna is characterized by a certain dynamics, which gives grounds for predicting future catches. But in the complex reservoirs, which are under the influence of anthropogenic pressure, destabilization of the ecosystem and unforeseen ichthyological successions occurs, leading to a decrease in industrial stocks of fish. One way to control the number of industrial populations is the long-term seasonal monitoring and ichthyological research, which underlies the biological justification of fishing in the internal waters of the country [1, 2

Nature management in internal waters, which is realized through industrial catch of fish, should have a rational ground, which is realized through measures to preserve and increase the industrial stocks of fish in the Zaporizhzhya (Dnipro) reservoir by forecasting and limiting the catches of certain fish species.

Analysis of recent research and publications, problem statement. At the present stage, due to uncontrolled human activities (excessive selective fishin of older age groups of fish, non-observance of the rules of industrial and amateur fishing, etc.), as well as regulation of river flow and global warming (increased water temperature, increased mineralization, increased area of shallow water with

high sedimentation and overgrown aquatic vegetation) in the Zaporizhzhya (Dnipro) reservoir there is a steady dynamics to the increase of low-value short-cycle species of fish and depletion of the species diversity of industrial species [2, 3]. This also contributes to the fall of the number of predators; the level of reproduction of their populations is at a catastrophically low level.

The results of previous long-term ichthyological and hydroecological studies indicate that the fish-productive potential of the Zaporizhzhya (Dnipro) reservoir is used irrationally, which is reflected in low rates of industrial catches [1–4].

In accordance with the requirements of the current legislation of Ukraine, species, which state may be assessed as unsatisfactory or intensively exploited are subjected to mandatory limitation. In the Zaporizhzhya (Dnipro) reservoir, the catch limit is set for four types of fish: roach, bream, zander and silver bream.

In this regard, the purpose of the work was to carry out a comprehensive assessment of the status of populations of industrial fish species of the Zaporizhzhya (Dnipro) reservoir, which catches are limited, for further development of measures to rationalize their industrial use.

Materials and methods. The research was carried out by order of the Institute of Fisheries of the National Academy of Sciences of Ukraine by the staff of the Oles Honchar Dnipro National University, along with collaborators: private enterprises "RINa", "Foroschuk V.V." and Borisfen-2010 LLC. Control catches were carried out on the basis of permits issued by the Office for the Protection, Use and Reproduction of Water Bioresources and Fishing Regulation in the Dnipropetrovsk Region. The research was conducted on two control and monitoring points located in the Samara Bay and the lower part of the Zaporizhzhya (Dnipro) Reservoir (Voyskove Village). The catches were carried out by standard fish stakes with an angle of 30–120 mm

The object of the study was four species of fish, the catches of which in the Zaporizhzhya (Dnipro) reservoir are subjected to the determination of annual limits for catching: roach, bream, zander and silver bream.

The biological analysis of fish was carried out in accordance with the classical ichthyological methods [5–8] according to the following parameters: standard and absolute body length, individual weight, sex, Fulton coefficient of fattening. Age of fish was determined according to standard ichthyological methods of V.L. Bruzgina [9] and I.I. Chugunova [10]. Parameters of fishing in reservoirs were determined by the methods of P.V. Tyurin [11].

Fish fries were caught in the third decade of July until the first decade of August in shallow waters at standard checkpoints. The catching gear was a fingering trawl of 10 m in length, with a 2 mm mesh size. The relative number of young fish was accepted as the number of yearlings per 100 square meters of catching area. Species of yearlings were determined by A.F. Koblitskaya [8, 12, 13].

Statistical processing of the material was carried out using the computer program STATISTICA 6.0.

Results of research and their discussion. Some researchers note the mandatory limitation of catches of certain resource species, which is associated with the degree of industrial use and the dynamics of stocks. Thus, for all reservoirs of the Dnieper there are obligatory limitation for bream, zander, roach and silver bream [4, 14–16].

In 2017, at the Zaporizhzhya (Dnipro) reservoir, the research catches in the spring period were conducted in full. Hydrological and temperature conditions of spawning were satisfactory. The displacement of the terms of spawning for 3–4 days was noted, due to the protracted and cold spring, but this did not affect the intensity of spawning or its failure. The analysis of catches of fishing gears at the rate of 100 net days of the control kernel for certain species is stable, fluctuating within the limits of indicators for 2014–2016 years, and corresponds to a multi-yearly weighted average. The species composition of the ichtyofauna was represented by species typical for the reservoir. The analysis of age groups and dimensional and weight series does not give grounds for reducing the size of industrial stocks.

The roach (*Rutilus rutilus* Linnaeus, 1758). The average annual catch of roach from 2006 to 2016 reached 144.34 tons. For the last 10 years, the minimum catch of 118 tons was in 2013; the maximum one was in 2009 and reached 167.9 tons. The roach catches in 2016 amounted to 165.03 tons (Table 1).

The age structure of the population of roach had 11 age groups, from 3 (0.95 %) to 12 years (0.95 %). By gender, age groups were distributed as follows: females of 3-12 years old, males of 3–11 years old. The core of the roach population was 4-6 years old individuals – 80.9 %. The average industrial length of roach individuals was kept at the level of 2015–2016 and amounted to 21.8±0.6 cm, the weight was 222.9±12.9 g, and in females the linear and weighted indices were higher respectively by 9 % and 24 %. As in previous years, it is noted that the individuals caught in the Samara Bay of Zaporizhzhya (Dnipro) reservoir were significantly slower in the growth and were characterized by a significant strainability due to the tense ecological state of the ba .

The reproductive core of the roach population was individuals aged 4–6 years. In the spawning population among the females, 5–6-year-olds were dominant, among males the 4–5-year-olds.

The Fulton fattening factor was 2.11±0.04, that is, the roach fattening was practically the same as in previous years. The fattening and fatness ratio (3–4 points) indicates favorable feeding conditions for this species of fish

In 2017, in comparison with 2015, the number of roach in catches of control grids in the Zaporizhzhya (Dnipro) reservoir increased by almost 19 % and amounted to 10846 individuals (2419 kg) per 100 net days. In 2016, there were

7788 individuals. (1659 kg) per 100 net days of control gear, which is less by 15 % than biomass in 2015.

In 2018, we can expect a slight increase in the size of the population of roach, since the 2011 generation was quite productive in comparison with the previous two years, the number of yearlings reached 196 per 100 m2. In 2012, the number of yearlings in the coastal areas was 125.85 per 100 m2. In 2013, the number of roach yearlings in the littoral of reservoir reached 50.68 per 100 square meters, and the number of two-year-olds was 177.39 per 100 square meters. In 2014, the number of roach yearlings in the littoral of reservoir reached 42.15 per 100 square meters, and the number of two-year-olds was 84.11 per 100 square meters. Thus, basing on the results of the analysis of the control of the fish stakes and the results of small-scale fishing, it can be assumed concerning the moderate catch of older age groups on the background of sufficient replenishment, which compensates for the industrial withdrawal of this species.

As in previous years, the main catch of roach was observed for nets with a mesh size of 36–40 mm and amounted to 74 % of the total volume. In the large-mesh grid, the roach hit one-on-one – 1.2 %. According to the indicators of age and size and weight structure of the industrial roach population, the magnitude of industrial replenishment, it can be assumed that the state of the industrial roach population is at a fairly stable level.

Taking into account the natural coefficient (0.26) and total mortality (43.8 %), the magnitude of replenishment and industrial activity, the roach stock in the Zaporizhzhya (Dnipro) reservoir for 2018 was estimated at 1050 tons. The assimilation of the limits in previous years was at the level of 72–82 %. With an optimal catch of about 25 %, we recommend setting a roach catch limit of 210 tons (Table 1).

Bream (*Abramis brama* Linnaeus, 1758). The analysis of the dynamics of industrial catches shows that during 2006–2016 the catch of the bream is fairly stable and remains at the level of 50–67 tons. In 2015, the industrial harvesting of the bream reached 66.58 tons, which is 78.3 % of the established limit (Table 1).

The age structure of the bream is represented by 14 classes; the maximum age in catches was 16 years (0.4 %). The number of age classes in the fishery is at level 12. The core of the population of the bream was individuals aged from 5 to 10 years (92.3 % in the fishery). The static series of the bream had the appearance of a curve with a sufficiently broad vertex for individuals aged 5–7 years and a smooth recession (from 8 to 11 years) with a subsequent gradual decrease in the number of individuals of older age groups. Taking into account the dynamics of catching the bream at 100 net days of the control order, this distribution is due to an increase in the number of modal senior age groups, which are under the main industrial load.

The minimum age groups involved in spawning were in females, 4 years old – 12.4 %, in males 3 years old – 2.3 %. The reproductive core of the population was 4–8 years old fis – 82 %.

The industrial length of individuals according to the data of research fishin was 34.44±0.98 cm; the average weight was 1043.28±86.56 g, which is almost consistent with the figures for 2014–2016. The fluctuation of the minimum and maximum values by weight in the bream was between 260 and 3730 g.

Medium-term values of the Fulton fattening factor over the last ten years are characterized by stability and amount to an average of 2.4±0.05 units.

On average, in 2017, a catch per the 100 net days of control orders amounted to 961 ind. (1002.5 kg), in 2016 – 859 ind. (1003 kg), in 2015 – 994.5 ind. (962.9 kg), in 2014 this indicator was 1008.3 (1050.6 kg). The last five years there is a slight variation of this indicator in the range of 30–50 kg, which indicates a fairly stable state of the industrial bream population.

Approximately 52 % by number (and 64 % by biomass) catches of bream fell into nets with a mesh size of 75-80 mm. During the last seven years, there is a clear tendency to reducing the catches by small-mesh nets with a step a = 30–40 mm, which accounted for 13.2 % of the total catch. Catching bream by nets with a step a = 55–70 mm, that is, those generations that will form the basis of fishing in 2018 reached 37 %, indicating that the industrial core is sufficiently replenished

In 2018, the bream stock will be formed by generations of 2011, 2012, 2013, 2014, which were marked as unproductive – 7.7, 2.38, 0.75 and 4.32 per 100 m², respectively.

The catch limit for catching the bream in recent years is kept at the level of 70–90 %, in 2015 it was 76.3 %, in 2016 it was 78.3 %. Taking into account the coefficient of natural mortality (0.19), catch rate (0.26), the number of individuals of older age groups, the stock of bream is estimated at 440 tons today. Because of the low youth replenishment rates, it is advisable to set the catch limit for the bream in 2018 not higher than 25 % of the total stock – 110 tons.

Zander (*Stizostedion lucioperca* Linnaeus, 1758). The industrial catches of zander in the Zaporizhzhya (Dnipro) reservoir during 2006–2016 are characterized by considerable instability and rather low indicators. The catches of this species range from 5.4 tons (2014 figure) to 13.0 tons (2016), which is the result of an overcatch in 2002, after which its catches dropped sharply. The dynamics of industrial catches of zander during the last two years indicates a positive trend and stable development, 81 % of the limit (Table 1).

The age range of zander in control catches had 13 classes (3–14 years old). The core of the industrial population consisted of 4–7 year old individuals (88.4 %). The share of elderly fish in the main was represented by 8–14-year-olds and was 4.9 %. In the population of zander there is an increase in the proportion

of 3-year-old individuals, indicating its rejuvenation. The curve of the static series has a peak in four-year-olds, then in fewer five-year periods, and a gradual decline in curvature since the six-year period was observed. In the current year, the tendency to significant rejuvenation of the zander is also observed, which is caused by the reduction of the right wing of the static series due to the low number of senior-age individuals in catches. Although there is a slight increase in the average age of fish, in 2017 this figure reached 5.04, in 2016 – 4.4 years, and in 2015 it was 3.85 years. Thus, it is possible to note the decisive influence of natural replenishment on structural indicators of the zander population covered by the fisher .

The industrial length of individuals of zander from control nets ranged from 19 to 87 cm, and the average length of industrial length reached 39.99±1.43 cm. The minimum mass of individuals found in fishing gear ranged from 200 g at three years old fish, maximum at 14 years old fish reached 5.38 kg. The average weight of zander was 1053.6±130.9 g. The Fulton fattening factor was at the level of previous years and was 1.9±0.25.

In 2015, on 100 net days of the control order, zander on average in the Zaporizhzhya (Dnipro) reservoir was 287.5 kg, which is 37 kg higher than in 2014. In 2016, catches on 100 net days of control orders amounted to 239 kg (364 ind.), which is 16.8 % less than last year. In the spring of 2017, catches per 100 100 net days of control orders amounted to 708.5 kg (672 ind.), which is the highest figure in the last 10 years

Catches of zander in current year by number and biomass is based on grids with a mesh a = 40–50 mm – 61 %. In the grids, with the mesh a = 30–36 mm in 2017, the percentage decrease was observed from 34.8% (2016) to 30.4 % (2017). In the Samara Bay, on a grid with a mesh of 30–32 mm there are about 38 % of the total catch of zander, which is caused by sufficient stiffness of individuals caused by the hydroecological conditions of the bay and anthropogenic loading.

The current stock of zander is provided by generations 2012, 2013 and 2014. The number of yearlings in this period was respectively 0.44, 0.54 and 1.23 ind./100 m². The low number of zander was observed in 2010 and 2011 and amounted to 0.10-0.11 ind./100 m² for each year; in 2012 and 2013, the number of two-year-olds in shallow waters of the Zaporizhzhya (Dnipro) reservoir reached 1.22 and 1.5 ind./100 m². In 2014, the number of two-year-old zander in the littoral reached 0.98 ind./100 m².

Thus, taking into account the coefficient of natural mortality (0.26), the catch rate (0.27), the increase in the indicator of industrial activity, the stock of zander in the Zaporizhzhya (Dnipro) reservoir can be estimated at 124 tons. The recommended limit for catching pike perch in 2018 should not exceed 20 tons (Table 1).

As in previous years, there is a significant negative impact on the zander population on the part of fishermen who, in large numbers, catch individuals of under-sized sizes.

Table 1. **Development of catch limits for fish in Zaporizhzhya (Dnipo) reservoir over the last 10 years and determination of catch limits for 2018**

Years	Zander			Bream			roach			Silver bream		
	limit, tons	catches, tons	%	limit, tons	catches, tons	%	limit, tons	catches, tons	%	limit, tons	catches, tons	%
2007	14	9,5	68,2	70	53	75,5	220	161	73,0	70	41	59,0
2008	14	9,8	70,2	75	55,1	73,4	220	144	65,4	70	40	57,3
2009	17	10,81	63,6	80	56,8	71,0	225	167,9	74,6	75	49,0	65,3
2010	12	10,40	86,7	75	58,80	78,4	210	144,57	68,8	70	45,75	65,4
2011	20	14,21	71,1	75	62,41	83,2	180	143,21	79,6	80	52,27	65,3
2012	18	7,35	40,8	75	65,57	87,4	200	141,53	70,8	75	56,45	75,3
2013	9,5 P	8,69	91,47	70,0 P	67,1	95,95	180,0 P	118,09	65,61	63,0 P	52,63	83,53
2014	10,0 L	5,39	53,9	75,0 L	50,7	67,6	190,0 L	122,04	64,23	58,0 L	38,8	66,9
2015	12,0 L	9,743	81,19	80,0 L	61	76,26	187,0 L	133,5	71,41	58,0 L	42,63	73,5
2016	16 L	13,0	81,25	85 L	66,58	78,33	200 L	165,03	82,515	75 L	64,87	86,49
Catch limit												
2017	14,0 L			88,0 L			190,0 L			70,0 L		
2018	20,0 L			110,0 L			210,0 L			90,0 L		

Note: P – is catch forecast, L – is catch of the species is within the established limit.

Silver bream (*Blicca bjoerkna* Linnaeus, 1758). For the last 10 years, the volume of its extraction is kept at the level of 40–64 tons (up to 10 % in total catches). In 2016, the development of the quota was 86.5 %. Silver bream catches are based mainly on individuals aged 4–5 years. In control catches, silver bream are represented by 9 industrial groups, from 3 (0.7 %) to 11 (0.7 %) years. The static series of age indices of silver bream has the appearance of a not symmetric curve with a peak on 4-year-old specimens, as well as a displacement of a row in the right wing due to the catch of 7–11 year old individuals. The increase in catches in the number of individuals of older age groups created conditions for increasing the average age of industrial individuals from 4.7 years (2016) to 5.15 (2017).

The average linear and weight indicators were: industrial length was 17.93±0.50, weight was 157.96±16.84 g. The value of linear and weight indicators almost remained at the level of the past years. The average linear and weight indicators of industrial individuals for almost 10 years are kept almost equal. Females were oppressed in the growth of males by 21 %. In the Samara Bay, individuals of the silver bream were significantly stunted, so it is recommended to remove them with fine-meshed stacked nets

The fattening factor was quite high and reached 2.20±0.17. Stable linear and weight indicators and fattening factors indicate favorable feeding conditions for this species of fish

The research quota for catching silver bream in 2017 was determined as 96.7 %. In 2017, catches of silver bream per 100 net days of the control order of stack nets reached 1332 ind. (210.5 kg), which is 60 % higher than last year's figures. In 2016, catches of silver bream per 100 net days were 653 ind. (126.8 kg), which is 3 % by number and 9.5 % by biomass lower than in 2015, 670 ind. (140.1 kg). The main catch, as in the previous year, fell on the net with mesh size a=30–40 mm (78 % by number and 65.4 % by biomass).

The core of the industrial flock of silver bream was the generation of individuals of 2013 and 2014. The number of yearlings of these years was low and was at the level of 0.3 and 1.52 ind./100 m2.

Taking into account the natural coefficient (0.23) and total mortality (44.6 %), the silver bream stock is estimated at 360 tons, taking into account optimal fishing (25 % of the stock), and given the significant increase in the cathes of the species by 100 net days of the control order, we recommend to set the limit for the catch of silver bream in 2018 in the amount of 90 tons (Table 1).

Some specialists note the mandatory limitation of catches of certain resource species, which is related to the degree of industrial use and the dynamics of stocks. Thus, in all reservoirs of the Dnieper, bream, zander, roach and silver bream are subjected to mandatory limitation.

Conclusions and perspectives of further research. The rational use of the industrial ichtyofauna of internal reservoirs is possible in the implementa-

tion of the basics of forecasting and limiting the catches of certain species of fish. For the Zaporizhzhya (Dnipro) reservoir it is expedient to set limits for the catches of four species of fish: roach, bream, zander and silver bream

According to the results of comprehensive ichthyological studies, the catch limits for industrial fish species in the Zaporizhzhya (Dnipro) reservoir for 2018 are set at the next levels: 210 tons for roach, 110 tons for bream, 20 tons for zander and 90 tons for silver bream.

The prospect of the research carried out is to develop approaches and implement the principles of rational nature management using water bioresources, while preserving the reproductive potential of industrial fish species under the conditions of fishing in the Zaporizhzhya (Dnipro) reservoi .

ВСТАНОВЛЕННЯ ЛІМІТІВ ВИЛОВУ ПЛІТКИ, ЛЯЩА, СУДАКА ТА САЗАНА У ЗАПОРІЗЬКОМУ (ДНІПРОВСЬКОМУ) ВОДОСХОВИЩІ НА 2018 РІК

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Проведено аналіз сучасного стану популяцій плітки, ляща, судака та плоскирки Запорізького (Дніпровського) водосховища та визначено величину допустимого промислового вилучення даних видів риб в 2018 році через встановлення обґрунтованих лімітів. В ході роботи використовувалися узагальнені результати іхтіологічних досліджень, що проводилися на акваторії Запорізького (Дніпровського) водосховища протягом 2010–2017 рр. Встановлено основні біологічні показники даних видів риб, визначена вікова та статева структура популяцій, розраховані величини промислового запасу. На підставі отриманих даних визначено коефіцієнти природної, промислової та загальної смертності. Розраховано величини лімітів промислового вилучення дослідних видів риб.

Ключові слова: ліміти, Запорізьке (Дніпровське) водосховище, промисел риби, судак, плоскирка, плітка, лящ.

УСТАНОВЛЕНИЕ ЛИМИТОВ ВЫЛОВА ПЛОТВЫ, ЛЕЩА, СУДАКА И САЗАНА В ЗАПОРОЖСКОМ (ДНЕПРОВСКОМ) ВОДОХРАНИЛИЩЕ НА 2018 ГОД

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Проведен анализ современного состояния популяций плотвы, леща, судака и густеры Запорожского (Днепровского) водохранилища и определить величину допустимого промыслового изъятия данных видов рыб в 2018 году путем уста-

новления обоснованных лимитов. В ходе работы использовались обобщенные результаты ихтиологических исследований, проводившихся в течение 2010–2017 гг. Установлены основные биологические показатели данных видов рыб, определенна возрастная и половая структура популяций и рассчитаны величины промыслового запаса. На основании полученных данных определены коэффициенты естественной, промысловой и общей смертности. Рассчитаны величины лимитов промыслового вылова исследуемых видов рыб.

Ключевые слова: лимиты, Запорожское (Днепровское) водохранилище, промысел рыб, судак, густера, плотва, лещ.

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