THE STATE OF SECONDARY COMMERCIAL FISH SPECIES IN THE KIEV RESERVOIR

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Commercial fishery exploitation is traditionally a one of the important components of the fisheries complex in the Kyiv reservoir. Fish harvest in this water body has been carried out for almost 50-years. Moreover, due to the presence of a large city agglomeration, the recreational fishing is very widespread in this reservoir. It results in a significant pressure on biological resources of the reservoir that in return requires a continuous scientific monitoring of the state of targeted fish species. It is important to note that the Kyiv reservoir is under heavy human impact, which under the condition of the development of a complex of unfavorable factors, can cause extreme situations, including mass fish kills [3, 5].

Approximately 25 fish species had commercial value in the upper part of the Dnieper river [1]; 21 fish species of native ichthyofauna and 3 introduced Chinese carps have been recorded by fishery statistics in the Kyiv reservoir for last 5 years. At the same time, the major part of the commercial harvest (72.6% of the total catch) is composed of only five species (bream, roach, silver bream, silver carp, and bighead carp).

The highest attention within the framework of the continuous monitoring of the Dnieper reservoir fish fauna is given to major commercial species, while less abundant species are considered only as factors, which modulate the qualitative and quantitative attributes of commercial species [2]. However, it is necessary to take into account the environmental aspect – while these species contribute very little to the total fish production, their role consists in the maintenance of biodiversity and consequently they contribute to the stable structure of the entire

aquatic ecosystem [9, 10]. Moreover, some large commercial species even being non-abundant in the total catch can play an important enough role in the self-organization of commercial fish harvest due to the stimulation of the use of large-mesh gill nets and a positive effect on fish harvest profitability.

The importance of this subject is related to the necessity of the study of all main structural-functional parameters of commercial ichthyocomplex including those from the point of view of the necessity of changing the commercial fishing regime.

Goal of the work – to determine and analyze individual and population parameters, which characterize the conditions of the development of the ichthyomass of secondary commercial species in the Kyiv reservoir.

Materials and methods. Materials for this paper were the results of own field ichthyologic studies conducted at the monitoring-observation stations of the Institute of Fisheries of the National Academy of Agrarian Sciences of Ukraine and fish landing facilities of the users of aquatic bioresources in the Kyiv reservoir during 2012-2014. The materials were collected from catches of the monitoring gill nets with mesh sizes of 30-120 mm; sampling and analysis of ichthyologic materials were done according to the generally accepted methods [7, 8]. In total, for the indicated period, 3052 net-days of the monitoring and commercial gill nets were analyzed; 42.7 thousand fish of different species were measured and 1520 fish were taken for the full biological analysis.

Statistical processing of the obtained data was performed in MS Excel [6]. Amounts of commercial catches were taken according to the data of the official commercial fishing statistics of the central executive authority body, which implements the state policy in the field of fisheries.

Study results and their discussion. Commercial catch dynamics in the Kyiv reservoir during last 10 years showed a clear trend for a growth (with some decrease in 2013). The commercial catch in 2012 reached 900 tons that was significantly higher than the average annual catch of 2001-2010 (578 tons). An increase in catches is mainly due to silver and bighead carps, silver bream, and gibel carp. The total share of valuable large species in the catches for 2013 reached

the level of 40.8% that significantly exceeded the average value for the entire cascade (32.2%). Fish productivity in the reservoir in 2013 was 9.1 kg/ha that was lower than the average one in the cascade (13.5 kg/ha). However, it is necessary to note that that calculation of fish productivity for the entire reservoir area (92.2 thousand ha) in not reasonable. First, the reservoir has sufficiently large areas of zones prohibited for commercial fish harvest; second, the upper part of the reservoir (the most preferred areas from the point of view of commercial fishing) are overgrown with water caltrop that virtually completely excludes it from the total commercial fish harvest fund. In fact, the commercial fishery area during last 5 years composed not more than 50% of the total water area.

The gross values of fish species, which belong to the category of “other large size fishes” (chub, asp, ide), despite their low abundance and low chance to be caught by commercial fishing gears, are characterized by a certain stability (with a general trend for an increase, especially in 2013) with very low share in the total fish catch (Fig. 1).

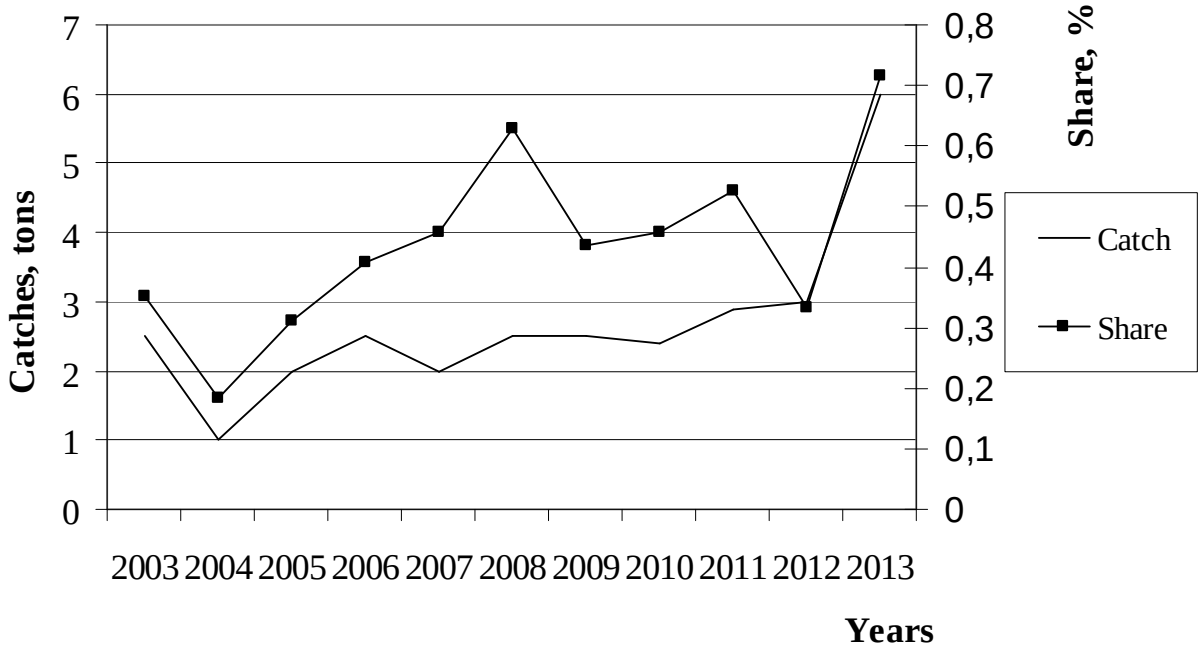

Fig. 1. Values of absolute and relative (share from the total catch) commercial fish catch of the category “other large size fishes” in the Kyiv reservoir.

The main representative of the category “other large size fishes” (more than 75% of the total catch) in the Kyiv reservoir is aps. The population of this species in commercial catches was represented by age 4-9 individuals, the majority (94.3%) was represented by age 4-6 individuals with lengths of 27-34 cm. A moderate fishing pressure on this species (a stable under-exploitation of the limits has been observed for last 5 years) resulted in the transition of the sufficiently abundant surplus to middle and old age groups and, respectively, to an increase in the average weight in catches in 2013 – up to 0.65 kg versus 0.48 kg during the autumn period of 2012. In monitoring catches in 2014, this species was represented by mainly age 5-7 individuals, however, fish of older age groups were also observed. The main catch of this species was in 36-40 mm mesh nets (75.9% by number and 45.7% by weight); at the same time, 16.1% of the total catch weight was formed by large mesh size nets. The total catch of asp per unit effort in the monitoring gill nets in 2014 was 273 individuals (210 kg) that significantly exceeded average annual values. A further increase in the average weight (by 20% compared to previous years) against the background of a sharp increase in the catch-per-unit-effort of the monitoring nets (at the same time, more than 50% of asp total catch in 2014 was done by the gill nets with mesh sizes of larger than 40 mm) indicates on a two-fold increase in the surplus of older age groups, which is available for the harvest by 40-50 and 75 mm mesh nets.

An accumulation of older age groups was also observed for ide, the average weight of which in the monitoring and commercial catches increased up to 1.5 kg that taking into account the stable values of the catch-per-unit-effort indicated on the normal recruitment of its population against the background of a moderate fishing pressure on the middle age groups. Chub in commercial catches is a non-abundant species – its share does not exceed 5% of the catch in the category “other large size fishes”. At the same time, absolute values of this species indicate on stable (however low) qualitative parameters, i.e. the fishery exploitation of this species will be carried out in the by-catch regime in the harvest of the older age groups of small size fishes.

Thus, currently there is an objective possibility to optimize the commercial exploitation of the stock of non-abundant large size fishes by shifting the fishing pressure on the older age groups [11].

Another representative of the ichthyofauna of the Kyiv reservoir, the strategy of commercial exploitation of which requires a separate study, is zope. This species belongs to small size fishes of the lake-river complex, i.e. the habitats suitable for it in the condition of reservoirs strongly depend on their hydrological regime. A certain increase in the flowage of the Kyiv reservoir during last years and an increase in zooplankton biomass [4] resulted in an improvement of the conditions for the existence of this species and formed favorable prerequisites for the growth of its biomass.

Another positive factor is an optimization of the commercial fishing pressure based on length-size groups, which is typical for the last years and is due to the ban for 30-36 mm mesh nets. E.g., the majority of zope harvest (up to 80% of the total number of fish caught) in 2000-2008 was based on the recruitment resulting in a little surplus in the middle age groups. As a result, zope catches stabilized at a low enough level in both absolute and relative numbers.

The dynamics of zope absolute catch during the last 10 years has a shape of a broken curve with a minimum in 2007 and a trend for an increase for 2010-2013, at the same time a sharp (almost two-fold) growth in the catches of this species was observed during the last 2 years.

The commercial harvest of zope in 2010-2011 was based mainly on age 3-5 individuals, which were harvested by 38-45 mm mesh nets. Targeting these age-length groups resulted in a significant decrease in the catch-per-unit-recruit and deteriorated the conditions of the development of the reproductive core of zope population. In catches of 2012, this species was represented by age 3-11 individuals, the majority (88.7%) was composed of age 4-6 individuals with lengths of 20-25 cm. The older age groups in 2012 composed 5.9% of the total ichthyomass, i.e. taking into account the general trend for an increase in catches

(up to 14 tons in 2012), we can make a conclusion on favorable prerequisites for the development of zope commercial stock.

This can be confirmed by the results of the analysis of the summer commercial catches of 2013. Zope in these catches was represented by age 4-10 individuals, the majority of which (50.4%) was represented by age 6-7 individuals with lengths of 27-31 cm (Table 1).

1. Biological parameters of zope of the Kyiv reservoir in commercial catches (July 2013)

Parameters	Age groups							Mean values	N, ind.
	3+	4+	5+	6+	7+	8+	9+		
Age composition, %	3.4	16.9	22.8	25.5	20.2	9.0	2.2	5.8	121
Length, cm	21.0	24.8	27.5	29.3	31.3	32.7	34.0	28.7	121
Weight, g	160	261	395	427	515	545	640	416	121

A shift of the variation series mode to the right resulted in a significant increase in the average population length and weight (these parameters in 2012 were 24.1 and 250 g). At the same time, the catch-per-unit-efforts of gill nets in 2013 were characterized by very high values – 1054 fish (438 kg), i.e. the observed population ageing was first of all due to an increase in the number of the middle and older age groups against the background of a satisfactory recruitment.

Thus, during 2010-2013, a significant improvement of the structural attributes and qualitative parameters of zope was observed, which is manifested first as a gradual accumulation of the middle and older age groups available for the effective harvest by 40-50 mm mesh nets.

An analysis of the actual catch composition showed that the specific ichthyomass of the middle and older ager groups of zope was significantly higher than expected (Fig. 2). At the same time, the actual total specific (calculated per

recruit) commercial stock exceeds the expected one by 1.26 times – 416 kg versus 329 kg.

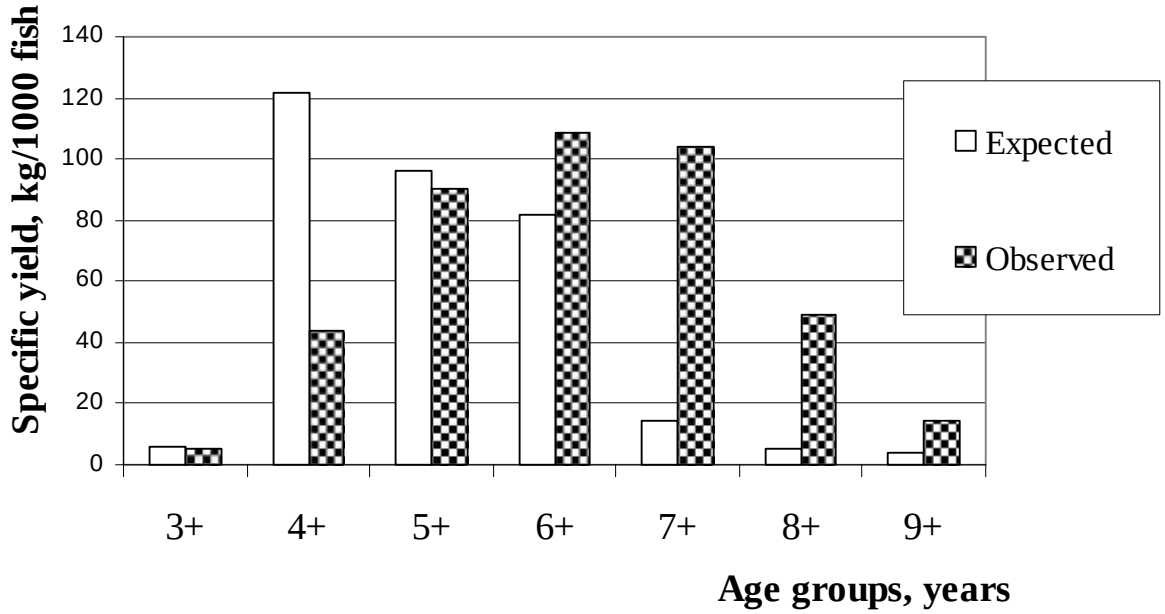

Fig. 2. Zope yield per recruit in the Kyiv reservoir in 2013.

A conclusion on the improvement of the structural attributes and quantitative parameters of the zope population is confirmed by the study results of 2014. The majority of the monitoring catches of this species in 2014 was composed of age 3-6 individuals with lengths of 19-27 cm, however, 10.3% of the total ichthyomass was formed by older age groups (this value was 5.9% in 2012). Taking into account that the commercial harvest of this species in the Kyiv reservoir is based on age 6-7 individuals, we can draw a conclusion on an increase in the number of the middle and older age groups against the background of a satisfactory recruitment. This is also supported by the catch-per-unit-effort values of the monitoring gill nets, which were 4425 individuals (919 kg) in 2014 (versus 110-2050 individuals (50-630 kg) in 2010-2013). Taking into account that 72.1% of the total catch (by number) in 2014 was due to 36-40 mm mesh nets, an implementation of a specialized fish harvest by 50-60 mm mesh nets can ensure the effective harvest of the most valuable age-length groups of this species. It is also necessary to note that opposite to the previous years, zope in 2014 was also

recorded in 70-75 mm mesh nets, which accounted for 1.6% of the total zope catch (by weight). The maximum age in the catches of 2014 was 12 years, i.e. taking into account high values of the catch-per-unit-effort of the monitoring gill nets, the fishing pressure on the older age group can be characterized as moderate. As a result, there is an accumulation of age 5-7 zope (i.e. a contingent, which is harvested by 36-40 mm mesh nets). Taking into account an increase in the absolute catches of 36-40 mm mesh nets in 2014 to 613 kg versus 438 kg, the additional increase of the ichthyomass of the middle age groups is 40%.

According to the forecasts of the harvest of aquatic bioresources approved for 2014, the category “other small size fishes” in the Dnieper reservoirs includes following species: perch, tench, rudd, white-eye bream, nase, vimba, ruffe.

Average population sizes of the majority of small size fishes correspond to their modal mesh size on the level of 30-36 mm (Table 2) and their number and distribution throughout the water area have mainly a discrete nature. Accordingly, qualitative and quantitative attributes of the catches of these species strongly depend on the peculiarities of fish harvest organization (in the part related to the mesh size of fishing gears) and basic limits for main small size fishes – roach and silver bream.

2. Distribution of small size fish catches in the Kyiv reservoir according to the mesh size of monitoring nets (average for 2012-2014)

Fish species	Share by number, %			Mean Length, cm
	30-36	40-50	>50	
Rudd	64.4	26.1	9.5	26.5+4.2
Perch	59.1	30.0	10.9	24.4+2.6
White-eye bream	84.4	14.2	1.5	22.1+1.5
Vimba	49.2	48.5	2.3	25.3+2.1

Taking into account relatively low quantitative parameters of the representatives of this category, their harvest is actually performed in the by-catch

regime. In this aspect, the transition to the harvest based on the total forecast (without partitioning it to individual quotas) is a measure, which ensures more effective exploitation of the developed commercial stocks – the catch of this category in 2013 was maximum in the last 20 years.

As a result, the absolute and relative parameters of the catch of the category "other small size fishes" in the majority of reservoirs of the cascade show a strong trend for instability; at the same time, they grow in the Kyiv reservoir (Fig. 3).

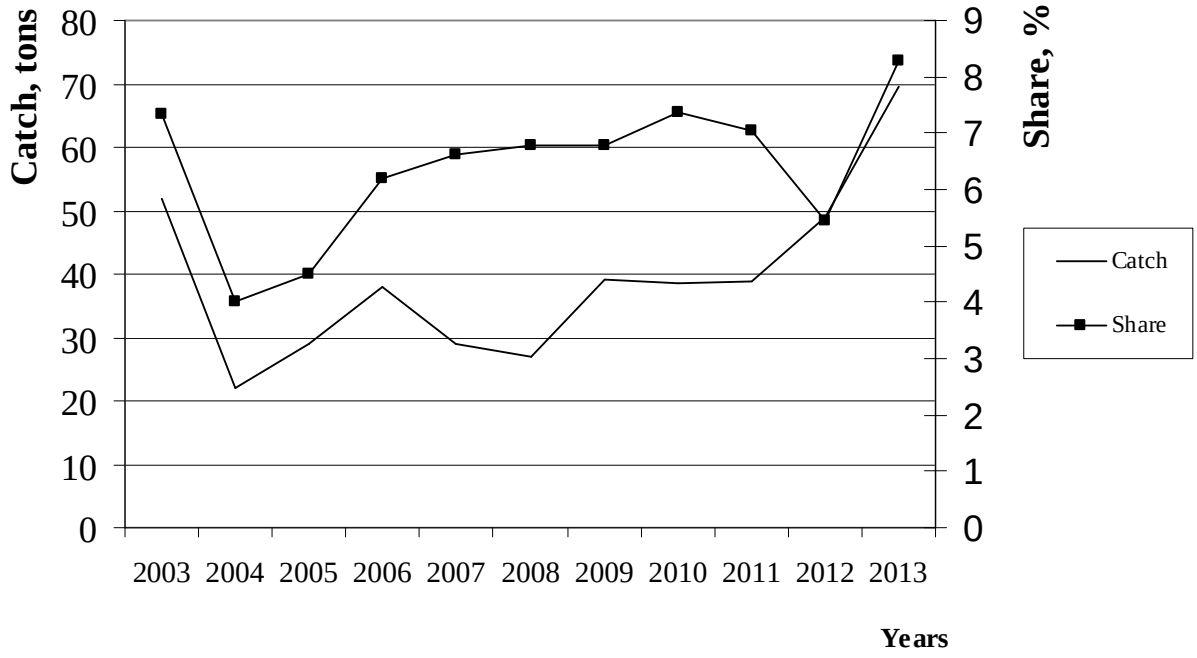

Fig. 3. Absolute and relative (share from the total catch) commercial catch of the category "other small size fishes" in the Kyiv reservoir

As it is typical for a number of species, there was a sharp (two-fold) increase in the catches of small size fishes during the summer of 2013-2014. E.g. the total catch was 27.7 tons by 1.08.2013; 67.6 tons by 1.08.2014. It is also necessary to note that the catch by 11.08.2014 increased up to 76.7 tons, i.e. 10 tons of other small size fishes were caught during the first decade.

The main representative of this category in commercial catches (40% of the total catch in 2014) is traditionally perch, i.e. a short cycle species with an ability for the fast change of its ichthyomass. The variability coefficient of the catches of this species during 2001-2013 was 27% (with fluctuations from 12 to 25 tons) that

has a significant effect on the instability of the catches of the category “other small size fishes”.

An increase in the catches in 2014 the same as in 2013 was due first of all (by 95%) to rudd, a species, catches of which are characterized by very high instability. Statistical calculations show that the variability of the catches of this species, which is due to inter-annual fluctuations of their numbers, can reach (by weight) 350-550% while this value does not exceed 30% for the majority of the commercial species of the Kyiv reservoir.

Rudd in the monitoring catches of 2014 was represented mainly by age 4-6 individuals, however, a significant increase in the share of the older age groups up to 10% was observed. It resulted in an increase in the average population weight up to 0.36 kg; weighed average weight in the catches of commercial nets was 0.39 kg (versus 0.32 in 2013).

A similar pattern was also observed for perch – high relative catch in 36-40 mm mesh nets (49.6% of the total number) indicates on the stable state of the commercial core of its population. It is also necessary to note that perch in 2014 was also recorded in large mesh size nets (9.1% of the total catch by number and 12.2% by weight), i.e. taking into account a significant growth of the catch-per-unit-effort of the monitoring nets up to 1396 individuals (393 kg), there is a certain accumulation of the older age groups of this species in the reservoir. Catch of white-eye bream also significantly increased in 2014 up to 937 fish (141 kg). It mainly occurred due to 40 mm mesh nets, i.e. an accumulation of the older age groups is observed for this species as well.

As it was mentioned before, the major modulating factor in the development of length-weight parameters in small size fishes in catches is fish harvest organization – up to 80% of the catch of these species is done by 30 mm mesh nets. Re-targeting the harvest to the nets with mesh sizes over 36 mm resulted in a significant increase of the actual length-weight parameters of fish caught compared to average population values. A similar trend is observed in the inter-annual aspect (Fig. 4).

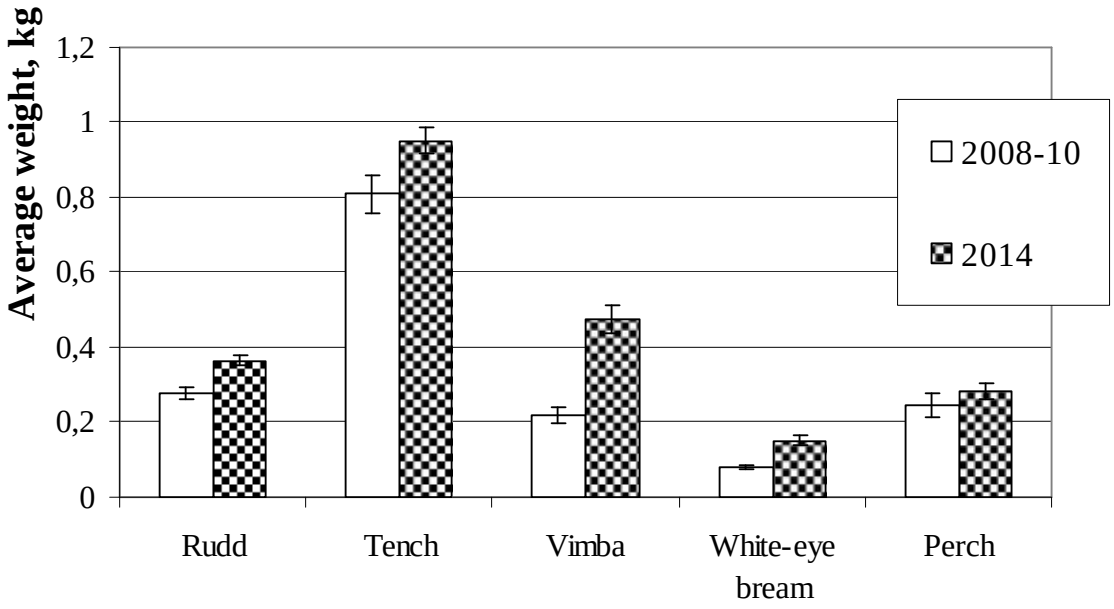

Fig. 4. Average weight of small size fishes in the monitoring catches in the Kyiv reservoir

Perch in commercial catches was represented mainly by 20-25 cm individuals, i.e. middle and older age groups. The weighted average length of perch in commercial catches was 22.3 cm, weight – 0.32 kg, i.e. it indicates on the normal state of perch recruitment with consistently high catch-per-unit-effort values. A similar pattern is also observed for other representatives of this category – the average weight of nase and vimba in commercial catches was 0.34 kg (versus 0.22 kg) and only for tench, which is harvested mainly by 50 mm mesh nets, weight values in commercial catches corresponded to the average population values.

Accordingly, due to the optimization of the fishing pressure on small size fish populations, an additional (compared to the estimated stock when developing the yield prognoses) commercial stock was formed by the middle of 2014, which was based on the most productive middle and older age groups. The actual weighted average increase in the weight in the catches of 38-40 mm mesh nets is 1.3. The acceptable rate of fishing for these species, which belong to the secondary medium cycle ones, with low accessibility of their maximum age groups for the traditional fishing can be set at the level of 40% of their stock. Accordingly, an increase of the yield forecast by 13% will allow exploiting a surplus of the middle and older age

groups of small size species without the disruption of their reproductive capability of their populations and deterioration of the conditions of the development of their commercial stock in following years.

Conclusions

1. Gross values of the yield of species, which belong to the category “other large” and “other small” size fish in the Kyiv reservoir during last years were characterized by the general trend for an increase.

2. Individual and population parameters of secondary commercial species of the Kyiv reservoir indicate on the normal conditions of the development of their commercial stock. The state of the reproductive core of the populations of the analyzed species can be rated as satisfactory.

3. Optimization of the fishing pressure based on age-length groups due to the ban of 30-36 mm mesh nets resulted in an improvement of the structural attributes of small size fish populations that in its turn ensured an increase in their commercial stock and forecasted yield.

СТАН ЗАПАСІВ ДРУГОРЯДНИХ ПРОМИСЛОВИХ ВИДІВ РИБ КИЇВСЬКОГО ВОДОСХОВИЩА

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Встановлено, що для динаміки уловів другорядних об'єктів промислу в Київському водосховищі, особливо синця, чехоні і краснопірки, в останні 5 років характерна чітко виражена тенденція до збільшення абсолютних та відносних показників. Головними чинниками цього є оптимізація розподілу промислового навантаження – основне вилучення припадає на найпродуктивніші розмірно-вікові групи, що зумовлює збільшення улову на одиницю поповнення (в 1,2-1,3 раза) та зростання середньопопуляційної маси (в 1,2-1,5 раза). Структурні показники популяції досліджених видів характеризуються помітним покращенням, зокрема, в частині збільшення частки середніх і старших вікових груп на тлі стабільно високої загальної чисельності.

Ключові слова: іхтіофауна, Київське водосховище, промисловий запас, прогноз вилову.

СОСТОЯНИЕ ЗАПАСОВ ВТОРОСТЕПЕННЫХ ПРОМЫСЛОВЫХ ВИДОВ РЫБ КИЕВСКОГО ВОДОХРАНИЛИЩА

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Установлено, что для динамики уловов второстепенных объектов промысла в Киевском водохранилище, особенно синца, чехони и красноперки в последние 5 лет характерна четко выраженная тенденция увеличения абсолютных и относительных показателей. Главной причиной этого является оптимизация распределения промысловой нагрузки – основное изъятие приходится на наиболее продуктивные размерно-возрастные группы, что обусловливает увеличение улова на единицу пополнения (в 1,2-1,3 раза) и роста среднепопуляционной массы (в 1,2-1,5 раза). Структурные показатели популяций исследованных видов характеризуются заметным улучшением, в частности, увеличением доли средних и старших возрастных групп на фоне стабильно высокой общей численности.

Ключевые слова: *ихтиофауна, Киевское водохранилище, промысловый запас, прогноз вылова*