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ANALYSIS OF CHANGES IN THE STRUCTURE OF ICHTHYOFAUNA IN THE POST EXCAVATION RESERVOIRS IN THE AREA OF WIEPRZ-KRZNA CANAL (POLESIE LUBELSKIE)

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Abstract. Structure of fish communities of five small water reservoirs located near the Wieprz--Krzna Canal was investigated during the years 2002, 2008 and 2014. In the analyzed water bodies seven fish were noted, representing four families: *Cyprinidae* (5 species) and *Esocidae, Cobitidae* and *Ictaluridae* (1 species each). In the structure of collected fish two protected species (*M. fossilis* and *R. sericeus amarus*) and one alien species (*C. auratus gibelio*) were presented. Domination structure of ichthyofauna showed considerable differences. Among the dominant species were: *I. nebulosus* (all five reservoir), *C. auratus* (Jabłoń Center 2, Jabłoń Church and Jabłoń Firlej-Ostrówek), *and R. rutilus* (Jabłoń West and Jabłoń Firlej-Ostrówek). The percentage of each fish species in the biomass was slightly different in relation to the structure of domination expressed by the number of identified individuals. Regardless of the reservoir, larger share held: *E. lucius, I. nebulosus* and *C. auratus* Moreover, one of the purpose of the study was searching for a new stands of lake minnow. However, the species was not recorded in fish communities of any of the reservoirs, despite of the ecological state of reservoirs indicating the potential habitat for lake minnow.

Key words: ichthyofauna, small water reservoir, Wieprz-Krzna Canal, Polesie Lubelskie (Poland)

INTRODUCTION

Till the end of the 70s of 20th century small water reservoirs were an object of hydrobiological research. Only in the 70s, the examined small water bodies, including post excavation pits, constitute an area of 1 ha and depth of no more than 3 m [Drwal and Lange 1985, Drwal *et al.* 1996]. In spite of the determina-

tion and approximation of their nature, were still considered marginally. In time, it became clear that their role in maintaining the biodiversity of inland waters is enormous. Nowadays, small water reservoirs are popular object of many natural research [Brylińska (ed.) 2000, Biggs *et al.* 2005, Davies *et al.* 2008].

Such reservoirs are anthropogenic, created as a result of excavation of mineral and organic resources. On the area of Polesie Lubelskie, that type of water ecosystems is represented by large number of peatbog reservoirs [Wolnicki and Kolejko 2008]. The reservoirs showed wide spectrum of ecological characteristic: mid-forest, mid-meadow, mid-peat bog or their combination [Kolejko *et al.* 2006]. On the areas of intensive land use these reservoirs constitute the only stands of rare and endangered fish species, such as: lake minnow *Eupallasella perenurus*, loach *Misgurnus fossilis*, bitterling *Rhodeus sericeus amarus* [Kolejko and Wolnicki 2006].

Small surface area and depth make the post exclavation reservoirs susceptible to disappearance. On the one hand it is a final phase of ecological succession, from the other the process is accelerated by human activity, such as reclamation of wetlands [Hillbricht-Ilkowska and Pieczyńska (ed.) 1993, Chmielewski and Sielewicz 1996, Urban 2007, Wolnicki and Kolejko 2008].

There are few studies on the structure of fish fauna in these types of aquatic ecosystems. Thus, the main purpose of present study was the evaluation of the structure of ichthyofauna of some small post excavation reservoirs of different ecological state located in the area of the Wieprz-Krzna Canal.

STUDY AREA AND METHODS

Studies were conducted in five small water reservoirs located in the area of Wieprz-Krzna Canal. All reservoirs are shallow, they surface do not exceed 1 ha. All reservoirs were created in the middle of the 20s century and their age is estimated at 20 to 40 years (Table 1).

The faunistic and ecological structure of ichthyofauna was investigated in two seasons, spring and autumn, during the years 2002, 2008 and 2014. Fish were collected by means of power generator type Samus 750 and modified trap with one catching cage (frame size 30 × 70 cm; mesh size 0.5 × 0.5 cm) with bait inside. Collected fish were identified to species level according ichthyological key [Brylińska 2000]. In the order to compare the abundance and biomass of the captured fish, the results of the catches were converted into CPUE (catch per unit effort), i.e. per 12 hours of fishing tools.

Density and biomass of fish were calculated per one hour of catching. The biodiversity of the fish assemblages was assessed by normalized Shannon diversity index (ShD_{nor}). Test t-student was ued to analysed the statistically significant differences in the number and weight of fishes.

Table 1. Limnologic-morphometrics parameters and averages of selected abiotic factor of investigated reservoirs

Reservoir	Geographical situation	Study site type	Surface ha	Depth m	Age	pH	Mean electrolytic conductivity µS cm^{-1}
Jabłoń Center 1	N 51°28'50'' E 23°07'39''	mid-forest	0.5	1.4	30	8.12 (8.1–8.14)	240 (238–245)
Jabłoń West	N 51°43'72'' E 23°05'42''	mid--meadow	0.3	1.3	20	8.1 (8.05–8.12	247 (230–256)
Jabłoń Center 2	N 51°74'04'' E 23°09'35''	mid--meadow	0.3	1.5	40	8.21 (8.2–8.22)	256 (247–259)
Jabłoń Church	N 51°72'82' E 23°08'95''	mid--meadow	0.9	2.2	30	8.23 (8.22–8.24)	375 (365–379)
Jabłoń Firlej–-Ostrówek	N 51°43'19'' E 23°05'25''	mid--meadow	0.8	1.6	30	8.18 (8.1–8.23)	324 (321–327)

RESULTS

In all reservoirs the mean values of pH were typical for slightly alkaline waters. Conductivity in most of the studied reservoirs, was high and indicate high degree of mineralization of organic compounds (Table 1).

In the studied reservoirs seven fish species were noted, representing four families: *Cyprinidae* (5 species) and *Esocidae, Cobitidae* and *Ictaluridae* (1 species each). In the structure of collected fish was presented two protected species (*M. fossilis* and *R. sericeus amarus*) and one alien species (*C. auratus gibelio*) (Table 2, Fig. 1).

Table 2. Structure of ichthyofauna in investigated reservoir

Species	Jabłoń Center 1	Jabłoń West	Jabłoń Center 2	Jabłoń Church	Jabłoń Firlej--Ostrówek
Esox lucius L.	+	+	+	+	+
Carassius carassius (L.)	+	+	+	+	+
Carassius auratus gibelio (Bloch)	+	+	+	+	+
Tinca tinca (L.)	+	+	+		+
Rutilus rutilus (L.)	+	+	+	+	+
Ictalurus nebulosus (Le Sueur)	+	+	+	+	+
Rhodeus sericeus amarus (Bloch)	+	+	+	+	+
Misgurnus fossilis (L.)	+				
Number of species in the reservoir	8	7	7	6	7
Total number of species	8				

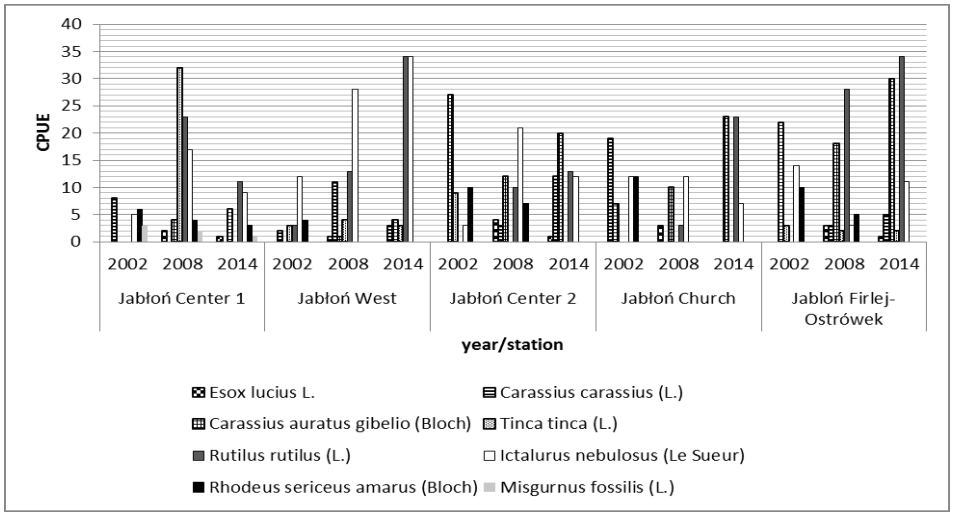

Fig. 1. Structure of the density of fish in the investigated reservoirs in years

The Normalized Shannon diversity index of each reservoir takes different values dependently on the analysed year. In 2002 the highest diversity possess reservoir Jabłoń Centre (ShD_{nor} = 0,94) and Jabłoń West (ShD_{nor} = 0,93). The next analysed year – 2008 – is generally characterized of the lowest diversity of ichthyofaunal, and the highest value of the diversity index possess the Jabłoń Church (ShD_{nor} = 0.88). Year 2012 features the highest values of the Normalized Shannon diversity index, which take the maximum values for the reservoirs Jabłoń Centre 2 (ShD_{nor} = 0.99) and Jabłoń Centre 1 (ShD_{nor} = 0.97). Reservoir Jabłoń Centre 1 features the highest fluctuations of the index as in the year 2008 its value was the lowest among all analysed small water bodies and years (ShD_{nor} = 0.61) (Fig. 2). It should be emphasize, that high or low values of the index are not the result of the number of different fish species, but derives from their even or uneven share in the structure of the ichthyofauna of the whole reservoir.

Student's t-test showed no statistically significant differences in the number and weight of fish in relation to the *C. auratus, C. carassius, R. rutilus. R. sericeus, I. nebulosus* and *M. fossilis* ($p > 0.05$). Significant differences refer only to the number of the tench between reservoirs: Jabłoń West – Jabłoń Church *(*t = 0.009), and Jabłoń Church – Jabłoń Firlej-Ostrówek (t = 0.02), and to the weight of this species in relation to reservoir Jabłoń West and Jabłoń Church (t = 0.02). Significant differences between the years relate to roach 2002– 2008 (t = 0.03) and 2002–2014 (t = 0.01) and bitterling 2002–2008 (t = 0.006) and 2002–2014 (t = 0.001).

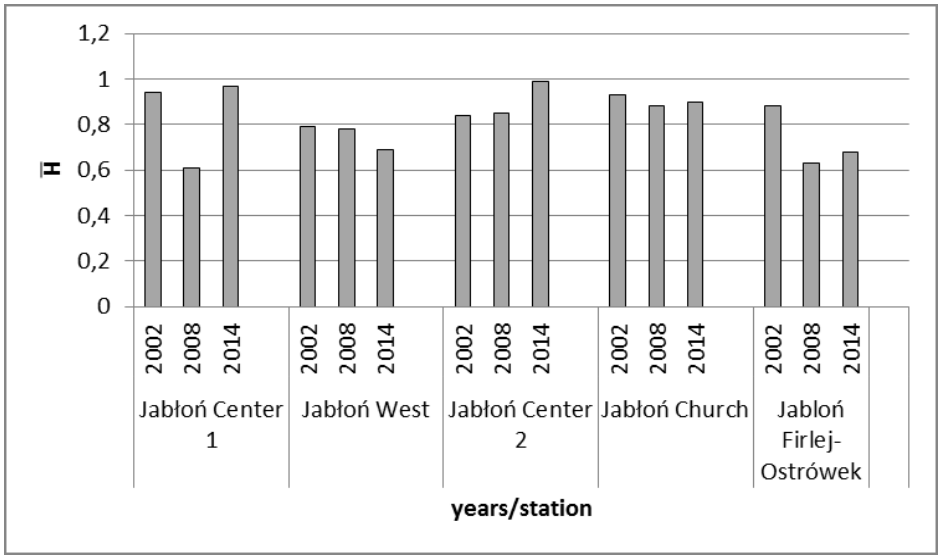

Fig. 2. Values of Shannon-Wiener index in investigated reservoirs in years

Domination structure of ichthyofauna of studied reservoirs showed considerable differences. Among the dominant speces were: *I. nebulosus* (all five reservoir), *C. auratus* (Jabłoń Center 2, Jabłoń Church and Jabłoń Firlej-Ostrówek), and *R. rutilus* (Jabłoń West and Jabłoń Firlej-Ostrówek) (Fig. 3).

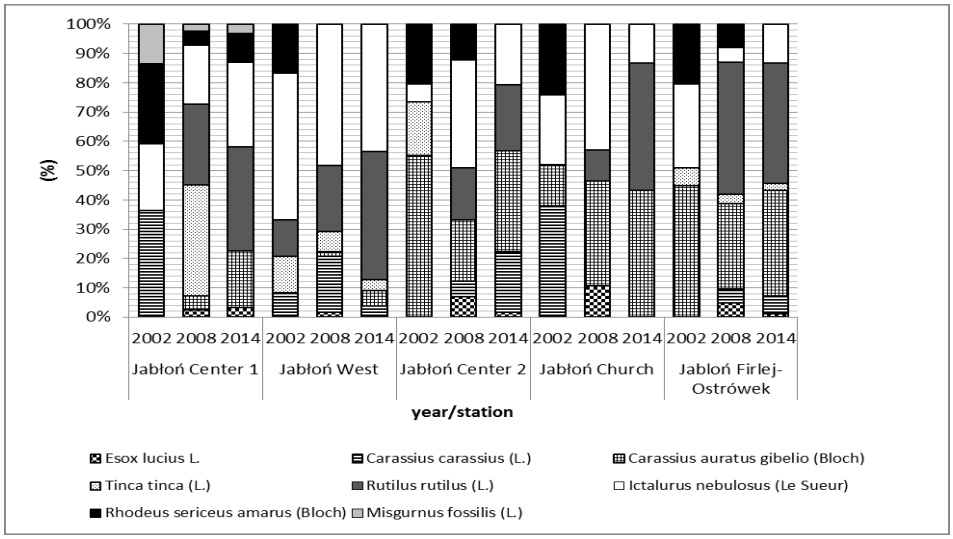

Fig. 3. Abundance structure of fish in the investigated reservoirs in years

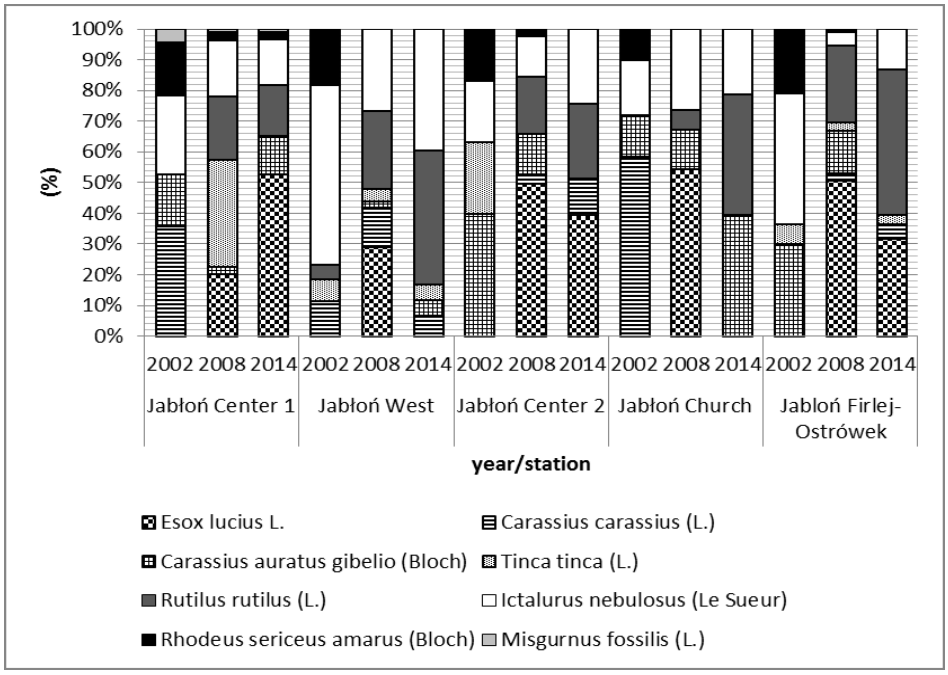

Fig. 4. Biomass structure of fish in the investigated reservoirs in years

The percentage of each species of fish in the biomass was slightly different in relation to the structure of domination expressed by the number of identified individuals. Regardless of the reservoir, larger share held: *E. lucius, I. nebulosus and C. auratus* (Fig. 4).

DISCUSSION

The structure of ichthyofauna of small water bodies from the area of Polesie Lubelskie is dependent on ecological state, succession phase and fish management [Kolejko *et al.* 2010]. Moreover, due to natural or anthropogenic reasons, a magnitude of artificial water bodies created at the beginning and the first half of XX century are not exist [Wolnicki and Kolejko 2008].

Overall, in the studied reservoir a considerably high number of species (6 and 8) was observed. Typically, the number of fish species in lakes of Łęczna--Włodawa Lake Disctrict region, ranged from 6 to 12 species, in extreme cases, for example in Skomielno Lake, up to 18 [Rechulicz 2006, 2008]. As reported Kolejko [2009] in the Bikcze and Mytycze, the other reservoirs of this region connected to the Wieprz-Krzna Canal, the number of species ranged from 12 to 13, and in the mesotrophic lakes, from 18 to 23 species.

The analysis of results showed that in the post excavation, eutrophic reservoirs dominated: *I. nebulosus* (all five reservoir), *C. auratus* (Jabłoń Center 2, Jabłoń Church and Jabłoń Firlej-Ostrówek), and *R. rutilus*. This is interesting, because in most of Europe waters and waters of this region dominant species is roach [Schiemer and Wieser 1992, Kolejko 2009]. On the other hand, not only the dominance of roach, but other cyprinids fish are typically for lakes with higher trophy status, which of course negatively affects their functioning [Carpenter *et al*. 1985, Jeppesen *et al*. 2000].

In all reservoirs high share in domination structure reached brown bullhead. The species is still commonly introduced to most of water ecosystems of the Polesie Lubelskie region [Kolejko 1998, Kornijów *et al*. 2003]. Brown bullhead is presented even in poor, dystrophic and difficult to access peat pools on the catchment area of Lake Zagłębocze [Kolejko *et al*. 2006]. At short time this species has become dominating one, threatening native fish species [Holcik 1991, Witkowski 1996]. Besides, the second alien species – Prussian carp has a high share in the structure of ichthyofauna. Similar increasing tendencies in case of brown bullhead were observed in other, especially shallow lakes like: Bikcze, Rotcze, Kleszczów and Głębokie [Hons and Downing 1994, Kolejko 1998, Radwan and Kornijów 1998, Kornijów *et al*. 2003]. Since the end of the 50s of the 20th century the contribution of Prussian carp has been being increased slowly but systematically – this species is also alien one, nevertheless it acclimatised itself quite well in aquatic ecosystems of the Polesie Region [Kolejko 2000, Rechulicz 2011]. With the increase in alien fish contribution species in ichthyofauna, the native fish contribution like tench and common carp was decreased.

Protected species represented loach and btterlingin, wherein the latter was observed i all the reservoirs. Ecological conditions of studied reservoirs are optimal for lake minnow, but it was not observed in any of the reservoirs. Until the end of 70s last century this species was presented in the most of post excavation reservoirs on the area of the Polesie Lubelskie. However, large scale reclamations led to drain swamps and peatbog areas [Chmielewski and Sielewicz 1996] and to disappearance of most stands of this species [Danilkiewicz 1973].

CONCLUSIONS

Studied reservoirs inhabited 8 fish species, representing 4 families: *Cyprinidae* (5 species), *Ictaluridae* (1 species), *Esocidae* (1 species) and *Cobitidae* (1 species). Among observed species were noted 2 protected species – *M. fossilisand* and *R. sericeus* 1 alien species – *C. auratus.*

Domination structure of fish communities of studied reservoirs showed visible differences, dependently on reservoir dominated *R. rutilus, C. auratus, I. nebulosus* and well *T. tinca*.

The percentage of each species of fish in the biomass was slightly different in relation to the structure of domination expressed by the number of identified individuals. Regardless of the reservoir, larger share held: *E. lucius, I. nebulosus* and *C. auratus*

E. percnurus wasn`t presented in any of reservoirs although ecological state of studied reservoirs suggest their potential role as habitat for that species.

REFERENCES

Biggs J., Williams P., Whitfield M., Nicolet P., Weatherby A., 2005. 15 years of pond assessment in Britain; results and lesson learned from the work of Pond Conservation. Aquat. Conserv., Mar. Frehwat. Ecosyst. 15, 693–714.

Brylińska M. (ed.), 2000. Freshwater fishes in Poland. PWN, Warsaw, 521 pp.

Carpenter S.R., Kitchell J.F., Hodgson J.R., 1985. Cascading trophic interactions and lake productivity: Fish predation and herbivory can regulate lake ecosystems. BioScience 35, 634–639.

Cĕrĕghino R., Biggs J., Oertali B., Declerck S., 2008. The ecology of European ponds: defining the characterisctics of a neglected freshwater habitat. Hydrobiologia 597, 1–6.

Chmielewski T.J., Sielewicz B., 1996. The changes of natural environment in the region of the Poleski National Park in the last century, in: G. Rąkowski (ed.), Euroregion Bug: the natural environment as a platform for cross-border cooperation. Norbertinum, Lublin, 42–50.

Danilkiewicz Z., 1973. The ichthyofauna of Tyśmienicy and Włodawki basin. Fragm. Faun. 19, 121–148.

Davies B., Biggs J., Williams P., Whitfield M., Nicolet P., Sear D., Bray S., Maund S., 2008. Comparitive biodiversity of aquatic habitats in the European agricultural landscape. Agric. Ecosyst. Environ. 125, 1–8.

Drwal J., Lange W., 1985. Some limnological dissimilarities of pond. Zesz. Nauk. Wydz. Biol. Geogr. Oceanogr. UG, 14, 69–82.

Drwal J., Lange W., Kurowska K., 1996. The importance of retention in the water balance of the young glacial areas. Zesz. Nauk. UG, 6, 5–7.

Hillbricht-Ilkowska A., Pieczyńska E. (eds), 1993. Nutrient dynamics and retention in land/water ecotones of lowland, temporate lakes and rivers. Hydrobiologia 251, 378 pp.

Holcik J., 1991. Fish introductions in Europe with particular reference to its central and eastern part. Can. J. Fish. Aquat. Sci. 48, 13–23.

Hons W.A., Downing J.A. 1994. Influence of cover on the spatial distribution of littoral-zone fishes. Can. J. Fish Aquat. Sci. 8 (51), 1832–1838.

Jeppesen E., Jensen J.P., Sondergaardm M., Lauridsen T., Landkildehus F., 2000. Trophic structure, species richness and biodiversity in Danish lakes: changes along a phosphorus gradient. Freshwat. Biol. 45, 201–218.

Kolejko M., 1998. The dwarf catfish (*Ictalurus nebulosus* Le Sueur) in the Łęczyńsko-Włodawskie lakeland. Prz. Ryb. 23, 4, 19–22.

Kolejko M., 2000. The state of ichthyofauna in selected lakes of Poleski National Park. Folia Univ. Agric. Stetin. 214, Piscaria 27, 107–112.

Kolejko M., 2006. Long-Term Changes of Ichtiofauna Structure in Protected Lake (example from Polesie Lubelskie). Pol. J. Environ. Stud. 15, 5d, 582–585.

Kolejko M., Wolnicki J., 2006. The lake minnow *Eupallasella perenurus* (Pallas, 1914) in Nature 2000 sites of Polesie Lubelskie, in: T.J. Chmielewski (ed.), Management of natural resources on Natura 2000 in Poland. Wyd. AR w Lublinie, 128–134.

Kolejko M., Wolnicki J., Radwan S., 2006. Preliminary studies on the occurrence of swamp-minnow *Eupallasella perenurus* (Pallas, 1814) in the aquatic ecosystems of Polesie Lubelskie (Poland). Acta Agrophys. 1, 395–399.

Kolejko M., 2009. Analiza zmian zachodzących w ichtiofaunie badanych jezior, na tle procesów wypłycania się zbiorników, eutrofizacji wód oraz sukcesji roślinnej, w: T. Chmielewski (ed.), Ekologia krajobrazów hydrogenicznych rezerwatu biosfery „Polesie Zachodnie". UP w Lublinie, 219–227.

Kolejko M., 2010, Structure of ichtiofauna of some small waters reservoirs of Polesie Lubelskie. Teka Kom. Ochr. Kszt. Środ. Przyr. 2, 110–134.

Kolejko M., Bojar W., Junkuszew A., 2010. Natural fish farming in small water bodis in Polesie as an alternative to the region's intensive fish farming, in: W. Bojar, Lublin region – ecological region of the XXI century. Ecological or genetically modified food. TNOiK, Toruń, 225–238.

Kornijów R., Rechulicz J., Halkiewicz A. 2003. Brown bullhead (Ictalurus nebulosus Le Suer) in ichthyofauna of several Polesia Lakes differing in trophic status. Acta Sci. Pol., Piscaria 2 (1), 131–140.

Radwan S., Kornijów R., 1998. Hydrobiologiczne cechy jezior – stan aktualny i kierunki zmian, w: M. Harasimiuk, Z. Michalczyk, M. Turczyński (red.), Jeziora łęczyńsko-włodawskie. Monografia przyrodnicza. Biblioteka Monitoringu Środowiska 129, Wyd. UMCS, Lublin, 1998.

Radwan S., Mieczan T., Płaska W., Wojciechowska W., Sender J., Jaszczenko P., 2002. Aquatic ecosystems of Polesia – state and trends. Acta Agrophys. 66, 89–120.

Rechulicz J., 2006. Effectiveness of fishing in shallow lakes using different methods. Acta Sci. Pol., Piscaria 5 (2), 59–68.

Rechulicz J., 2008. Age and growth rate of perch (*Perca fluviatilis* L.) from a special angling lake Skomielno. Annales UMCS, sec. Zootechnika 26 (1), 8–19.

Rechulicz J., 2011. Diversity of the ichthyofaunal in some of the lakes in Łęczyńsko-Włodawskie Lake District, in: M. Jakun, G. Furgała-Selezniow, M. Woźniak, A.M. Wiśniewska (eds.), Water biodiversity assessment and protection. Olsztyn, 165–178.

Schiemer F., Wieser W., 1992. Epilogue: food and feedeing, ecomorphology, energy assimilation and conversion in cyprinids. Environ. Biol. Fish. 33, 223–227.

Sugier P., 2006. Peat pits vegetation of peatlands in the Polesie National Park and its protected zone. Teka Kom. Ochr. Środ. Przyr. 3, 203–208.

Urban D., 2007. Plant communities of peat pits and pools in the area of Sobibór Forests (Łęczyńsko-Włodawskie Lakeland). Teka Kom. Ochr. Kszt. Środ. Przyr. 4, 285–292.

Witkowski A., 1996. Introduced fish species in Poland: pros and cons. Arch. Pol. Fish. 4 (1), 101–112.

Wolnicki J., Kolejko M., 2008. The state of population of lake minnow in aquatic ecosystems of Polesie Lubelskie and basics of its conservation in this region of the country. Liber Duo, Lublin, 88 pp.

Wolnicki J., Sikorska J., Kolejko M., 2011. Lake minnow, *Eupallasella percnurus* (Pall.), in Lubelskie Voivodeship in Poland – occurrence, threats, and protection. Arch. Pol. Fish. 19, 201–208.

ANALIZA ZMIAN W STRUKTURZE ICHTIOFAUNY W ZBIORNIKACH POWYROBISKOWYCH W OBSZARZE ODDZIAŁYWANIA KANAŁU WIEPRZ-KRZNA (POLESIE LUBELSKIE)

Streszczenie. W latach 2002, 2008 i 2014 (w odstępach 6-letnich) przeprowadzono badania nad strukturą zespołu ichtiofauny w pięciu małych powyrobiskowych zbiornikach w rejonie kanału Wieprz-Krzna. W wyniku przeprowadzonych badań stwierdzono, iż zbiorniki te łącznie zasiedla 8 gatunków ryb należących do 4 rodzin. Struktura ichtiofauny była bardzo zróżnicowana zarówno między poszczególnymi zbiornikami, jak i okresami badawczymi. W strukturze ilościowej dominowały: sumik karłowaty, karaś srebrzysty oraz płoć. Z kolei w ogólnej masie ryb we wszystkich zbiornikach dominował szczupak, sumik karłowaty oraz karaś srebrzysty. We wszystkich zbiornikach nielicznie występowała różanka. Wartość wskaźnika zróżnicowania gatunkowego była zróżnicowana i dość niska. Jednym z celów badań było poszukiwanie nowych stanowisk strzebli błotnej. Jednak w zespole ichtiofauny nie stwierdzono tego gatunku, pomimo że charakter ekologiczny tych zbiorników wskazuje, że mogłyby być jej siedliskiem.

Słowa kluczowe: ichtiofauna, małe zbiorniki wodne, kanał Wieprz-Krzna, Polesie Lubelskie