

ANALYSIS OF CHANGES OF STRUCTURE OF ICHTHYOFAUNA IN THE POST EXCAVATION RESERVOIRS (EXAMPLE FROM POLESIE LUBELSKIE)

Marcin Kolejko^{*}, Joanna Sender^{*}, Andrzej Demetraki-Paleolog^{**}

^{*} Department of Landscape Ecology and Nature Conservation, University of Life Sciences in Lublin
B. Dobrzańskiego str. 37, 20-627 Lublin, kolejko@op.pl, joanna.sender@up.lublin.pl

^{**} Department of Hydrobiology, University of Life Sciences in Lublin
B. Dobrzańskiego str. 37, 20-627 Lublin, andrzej.paleolog@up.lublin.pl

Abstract. The paper presents the analysis of structure of fish communities in five small post-excavation reservoirs situated in Tyśmienica valley (Polesie Lubelskie). Special attention was paid to the quality of population of lake minnow *Eupallasella percunurus*. By the time the extensive drainage works were done in the 60s and 70s of the 20th century, Polesie Lubelskie was rich in small water reservoirs. As a result of drainage of wetlands, many of them disappeared. Among those which still exist, most of them are located in the Tyśmienica valley. The study revealed that the studied reservoir inhabited seven fish species representing two families. It was also found that structure of dominance and biomass structure is very diverse. In each reservoir the dominant species was different. The lake minnow *E. percunurus* was determined in three reservoirs.

Key words: ichthyofauna, small water reservoir, 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.* 1976]. In spite of the determination 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 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 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 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.

EXPERIMENTAL PROCEDURES

Studies were conducted in five small water reservoirs located in Polesie Lubelskie. 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 50 to 70 years (Table 1).

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	Mean temp. °C	Mean pH	Mean electrolytic conductivity $\mu\text{S cm}^{-1}$
Belcząc	51°40'31"N 22°35'18"E	mid-meadow	> 1	1.7	60	13.5	8.44	433
Skoki	51°41'92"N 22°41'16"E	mid-meadow	> 1	1.5	50	13.3	8.2	467
Stoczek	51°30'25"N 23°52'26"E	mid-meadow	> 1	1.5	50	14.3	7.7	350
Suchowola	51°41'15"N 23°42'55"E	mid-meadow	0.5	1.7	40	14.2	8.15	375
Tchurzew	51°40'71"N 22°32'94"E	mid-meadow	> 1	1.4	60	13.9	7.8	324

Faunistic and ecological structure of ichthyofauna was investigated in two seasons, spring and autumn, during the years 2008–2012. 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 Shannon-Wiener index (H') and species similarity (r).

The test of Shapiro-Wilk was used to verify the normal distribution of collected data. The influence of the site and the year of sampling on the density and biomass of fish assemblages was analyzed using two-way analysis of variance (ANOVA). The analysis was performed by means of Statistica 7.0 Software.

RESULTS

Mean water temperature in spring and autumn showed small differences among studied reservoirs and ranged from 12,6 to 14,2°C. Mean values of pH were typical for slightly alkaline (Stoczek, Tchurzew) or alkaline waters (Belcząc). Conductivity in most of the studied reservoirs, was high and indicate high degree of mineralization of organic compounds (Table 1).

In the studied reservoirs was noted seven fish species, representing two families: *Cyprinidae* (6 species) and *Ictaluridae* (1 species). In the structure of collected fish was presented two protected species (*E. perenurus* and *R. sericeus amarus*) and one alien species (*C. auratus gibelio*) (Table 2).

Table 2. Structure of ichthyofauna in investigated reservoir

Species	Reservoir				
	Belcząc	Skoki	Stoczek	Suchowola	Tchurzew
<i>Eupallasella perenurus</i> (Pall)	+	+		+	
<i>Carassius carassius</i> (L.)	+			+	
<i>Carassius auratus gibelio</i> (Bloch)		+	+		+
<i>Tinca tinca</i> (L.)				+	+
<i>Rutilus rutilus</i> (L.)			+		
<i>Ictalurus nebulosus</i> (Le Sueur)			+		+
<i>Rhodeus sericeus amarus</i> (Bloch)	+		+	+	
Number of species in the reservoir	3	2	4	4	3
Total number of species	7				

Studied reservoirs differ in term of species diversity of ichthyofauna. The lowest values of species diversity index were noted in reservoirs Skoki and Suchowola; the highest in reservoirs Belcząc and Stoczek (Fig. 1). The population structure varied widely among different reservoir, ranging from a few (Tchurzew)

to several individuals in particular reservoir per catch hour (Suchowola, Belcząc) (Fig. 2).

Domination structure of ichthyofauna of studied reservoirs showed considerable differences. In both seasons in the Skoki reservoir dominated *C. auratus gibelio* with high share of *E. perenurus*. In reservoirs Belcząc and Suchowola the most numerous was *Eupallasella p.* with high percentage of *C. carassius*. In Stoczek reservoir dominated *R. rutilus* and *I. nebulosus*. Whereas, in Tchurzew reservoirs very close percentage in the structure of fish communities had: *C. carassius*, *C. auratus gibelio* and *T. tinca* (Fig. 3).

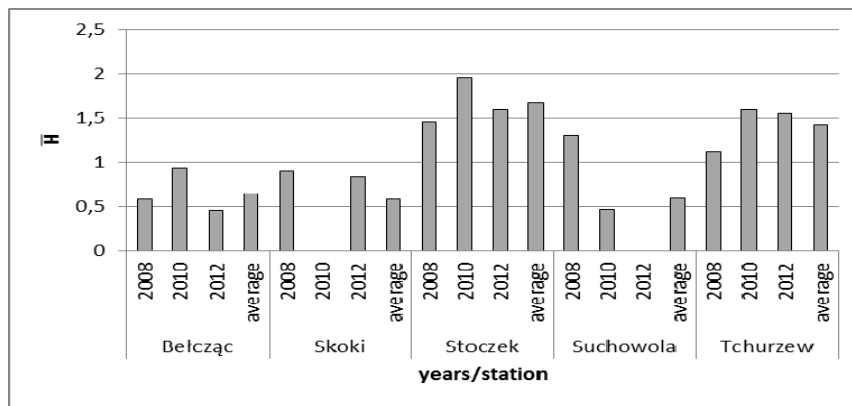


Fig. 1. Values of Shannon-Wiener index in investigated reservoirs

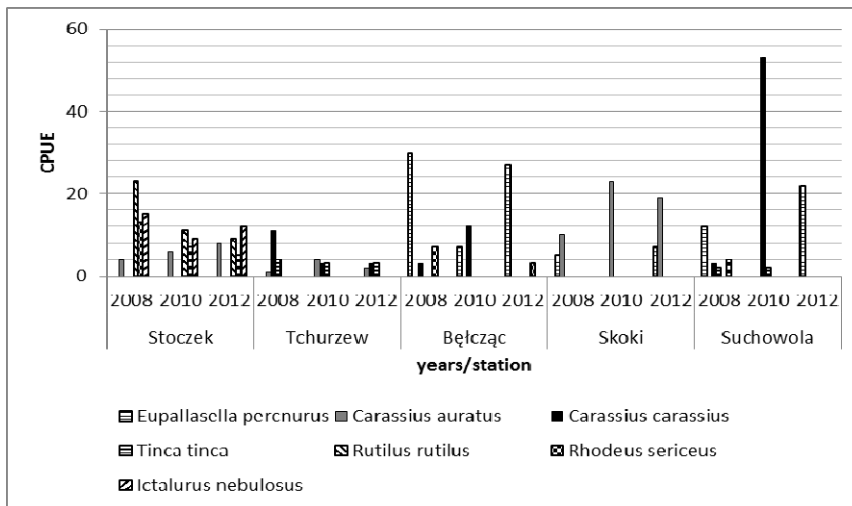


Fig. 2. Structure of density of fish in the investigated reservoirs

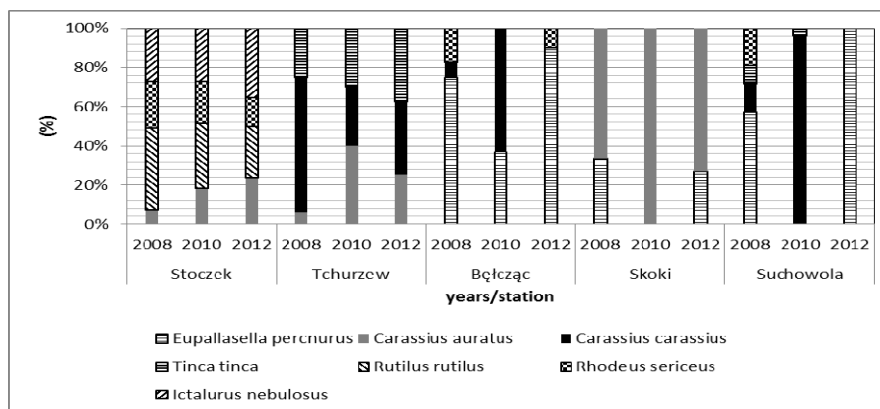


Fig. 3. Abundance structure of fish in the investigated reservoirs

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: *C. auratus gibelio*, *C. carassius* and *I. nebulosus* (Fig. 4).

As a result of statistical analysis, the significant differences in the abundance and biomass of fish depending on testing sites and research period was found. Thus, mean densities of fish differ significantly between studied years (ANOVA, $F = 19.96$; $P < 0.001$) and sites (ANOVA, $F = 33.49$; $P < 0.001$). Similarly to the density, the biomass of collected fish showed significant differences between studied years (ANOVA, $F = 8.76$; $P < 0.001$) and sites (ANOVA, $F = 9.03$; $P = 0.003$).

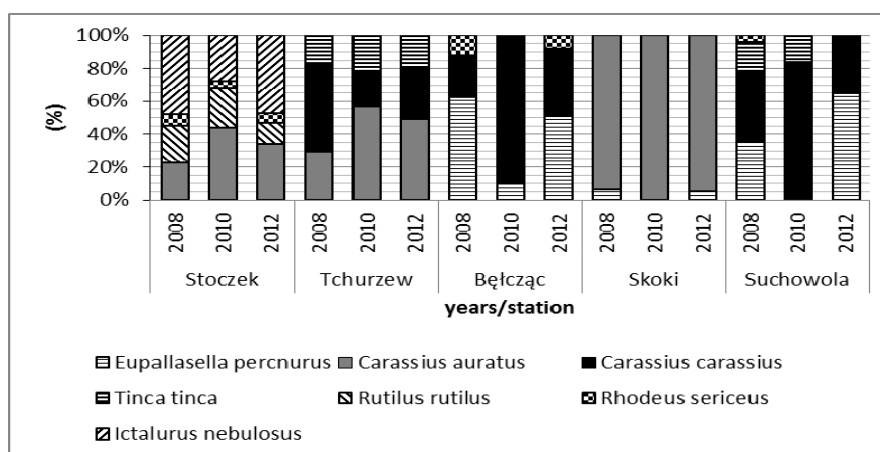


Fig. 4. Biomass structure of fish in the investigated reservoirs

DISCUSSION OF RESULTS

In the Polesie Lubelskie region the structure of ichthyofauna in small water reservoirs is affected by several factors. These are mainly: ecological character, the level of ecological succession and the degree of intensity of their use [Kolejko and Bojar 2010]. The research revealed that despite of the small number of species in the reservoirs, exceptions are Suchowola and Skoki, species diversity index was quite high. Similar values were recorded in others located in different parts of Polesie Lubelskie reservoirs of this type [Wolnicki and Kolejko 2008]. Three reservoirs were inhabited by alien species: *Carassius auratus gibelio* (Skoki, Stoczek Tchurzew) and *Ictalurus nebulosus* (Stoczek). Those species form stable and very large populations in most of the aquatic ecosystems of the Polesie Lubelskie region [Radwan *et al.* 2002, Kolejko 2006, 2010]. Especially *I. nebulosus* in a short time became the dominant species in shallow waters of Polesie, displacing native species, including lake minnow *Eupallasella percnurus* [Kolejko 2006, Wolnicki *et al.* 2011]. *I. nebulosus* was detectable even in poor dystrophic, hardly accessible and post-peat reservoirs in the catchment of Zagłębocze Lake [Kolejko *et al.* 2006].

The structure of fish dominance was very diverse. But the significant share in dominant and biomass structure had German carp *C. auratus gibelio*. This testified to the fact that this species has very good habitat conditions in small water reservoirs and is a real competition for the native populations of tench and crucian carp [Kolejko 2006]. This confirms the fact that in the waters free from the alien species dominant: *Tinca tinca*, *Crucian carp* and *Eupallasella percnurus*.

The current state of population of *E. percnurus* in the Tyśmienica valley can be considered as satisfactory, as the Lublin population has only 44 documented sites [Wolnicki *et al.* 2011].

CONCLUSIONS

Despite the fact that all the reservoirs are located quite close to each other, both species and quantity structure of fish communities very diverse. Periodically in the spring season, at intervals of several years, waters of the Tyśmienica river filled alluvial terraces and peat excavations which allows fish migration. Although, the species typical for flowing water were not identified.

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. Freshwater Ecosyst.* 15, 693–714.
- Brylińska M. (ed.), 2000. *Freshwater fishes in Poland*. PWN, Warsaw.

- Chmielewski T.J., Sielewicz B., 1996. The changes of natural environment in the region of the Poleski National Park in the last century. In: Euroregion Bug: the natural environment as a platform for cross-border cooperation. G. Rąkowski (ed.). Politechnika Lubelska, Norbertinum, Lublin, 42–50.
- Davies B., Biggs J., Williams P., Whitfield M., Nicolet P., Sear D., Bray S., Maund S., 2008. Comparative 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. Oceanol. UG, Geografia* 14, 69–82.
- Drwal J., Lange W., Kurowska K., 1976. The importance of retention in the water balance of the young glacial areas. *Zesz. Nauk. UG, Geografia*, 6, 57–66.
- Hillbricht-Ilkowska A., Pieczyńska E. (ed.), 1993. Nutrient dynamics and retention in land/water ecotones of lowland, temporate lakes and rivers. *Hydrobiologia* 25, 1–3.
- Kolejko M., 2010. Structure of ichthiofauna of some small waters reservoirs of Polesie Lubelskie, *Teka Kom. Ochr. Kszt. Środ. Przyr.* 2, 1110–134.
- Kolejko M., 1998. The dwarf catfish (*Ictalurus nebulosus* Le Sueur) in the Łęczyńsko-Włodawskie Lakeland. *Prz. Ryb.* 23, 4, 19–22.
- Kolejko M., Wolnicki J., 2006. The lake minnow *Eupallasella perenurus* (Pallas, 1914) in Nature 2000 sites of Polesie Lubelskie. In: Management of natural resources on Natura 2000 in Poland. T.J. Chmielewski (ed.). Wyd. AR w Lublinie, Lublin, 128–134.
- Kolejko M., 2006. Long-Term Changes of Ichthiofauna Structure in Protected Lake (Exampel from Polesie Lubelskie). *Pol. J. Environ. Stud.* 15, 5d, 582–585.
- 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 Agrophis.* 1, 395–399.
- Kolejko M., Bojar W., 2010. Natural fishing using of small water reservoirs of Polesie Lubelskie as an alternative to intensive fisheries in the region. W: *Ekolubelszczyzna w XXI wieku. Organic of genetically modified food*. W. Bojar (ed.).Wyd. TNOiK, Toruń.
- Radwan S., Mieczan T., Płaska W., Wojciechowska W., Sender J., Jaszczenko P., 2002. Aquatic ecosystems of Polesia – state and trends. *Acta Agrophis.* 66, 89–120.
- 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.
- 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.
- 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.

The study was partly supported by the research grant MEiN Nr 2 P04G 116 29 „State of population of swamp minnow *Eupallasella perenurus* (Pallas, 1814) in water ecosystems of Polesie Lubelskie and programme of protection of the species in this region of the country” provided by Polish National Science Foundation.

ANALIZA ZMIAN W STRUKTURZE ICHTIOFAUNY W ZBIORNIKACH POWYROBISKOWYCH (POLESIE LUBELSKIE)

Streszczenie. W niniejszej pracy przedstawiono analizę struktury zespołu ichtiofauny w pięciu małych powyrobowiskowych zbiornikach Polesia Lubelskiego, położonych w dolinie rzeki Tyśmienicy. Szczególną uwagę zwrócono na stan jakości populacji lake minnow *Euplatalasella percnurus*. Do czasu rozpoczęcia szeroko zakrojonych prac melioracyjnych w latach 60. i 70. XX wieku Polesie Lubelskie obfitowało w małe zbiorniki wodne. W wyniku osuszania obszarów podmokłych większość uległa zanikowi, najwięcej zachowało się m.in. w dolinie Tyśmienicy. W wyniku przeprowadzonych badań stwierdzono, iż zbiorniki zasiedla 7 gatunków ryb, należących do 2 rodzin. Stwierdzono również, iż zarówno struktura dominacji, jak i biomasa ryb były bardzo zróżnicowane. W każdym ze zbiorników dominował inny gatunek. Lake minnow *E. percnurus* zasiedlała 3 spośród nich.

Słowa kluczowe: ichtiofauna, małe zbiorniki wodne, Polesie Lubelskie