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ANALYSIS OF CHANGES IN THE STRUCTURE OF ICHTHYOFAUNA IN THE POST EXCAVATION RESERVIORS IN THE AREA OF CHODELKA RIVER (LUBLIN UPLAND)

Marcin Kolejko, Andrzej Demetraki-Paleolog, Joanna Sender

Department of Hydrobiology and Protection of Ecosystems
University of Life Sciences in Lublin, B. Dobrzańskiego str. 37, 20-627 Lublin, Poland
e-mail: kolejko@op.pl, joanna.sender@up.lublin.pl, Andrzej.paleolog@up.lublin.pl

Abstract. Structure of fish communities of five small water reservoirs located near the Chodelka river was investigated during the years 2002, 2008 and 2016. In the analyzed water bodies seven fish were noted, representing four families: *Cyprinidae* (4 species) and *Esocidae, Cobitidae, Pericidae* and *Ictaluridae* (1 species each). In the structure of collected fish one protected species (*M. fossilis*) and one alien species (*C. auratus gibelio*) were presented. Domination structure of ichthyofauna showed considerable differences. Among the dominant species were: *R. rutilus* (all five reservoir) and *C. auratus*. 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, R. rutilus* and *C. auratus*.

Key words: ichthyofauna, small water reservoir, Chodelka river (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 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 (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 and Lublin Upland, 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.* 2006b].

Small surface area and depth make the post excavation 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 (eds) 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 Chodelka river.

STUDY AREA AND METHODS

Studies were conducted in five small water reservoirs located in the area of Chodelka river. 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 30 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 guide [Brylińska (ed.) 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}). One-way ANOVA test was used to analysed the statistically significant differences in the number and weight of fishes.

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 8 fish species were noted, representing four families: *Cyprinidae* (4 species) and *Esocidae, Cobitidae, Pericidae* and *Ictaluridae* (1 species each). In the structure of collected fish was presented one protected species

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 elctrolytic conductivity (μS cm^{-1})
Chodelka-Zajączków 1	N 51°28'50" E 23°07'39"	mid-forest, mid-meadow	0.6	1.4	20	8.22 (8.2–8.26)	255 (241–260)
Chodelka-Zajączków 2	N 51°43'72" E 23°05'42'	mid-forest, mid-meadow	1.1	1.3	20	8.1 (8.05–8.12)	310 (305–323)
Chodelka-Grabówka 1	N 51°74'04" E 23°09'35"	mid-meadow	0.4	2.3	30	8.21 (8.2–8.22)	256 (247–259)
Chodelka-Grabówka 2	N 51°72'82' E 23°08'95"	mid-meadow	0.9	2.2	20	8.22 (8.12–8.24)	360 (355–364)
Chodelka-Maciejowa Ruda	N 51°43'19" E 23°"05 25"	mid-meadow	0.5	1.6	20	8.2 (8.1–8.23)	254 (211–259)

Table 2. Structure of ichthyofauna in investigated reservoir

Species	Chodelka-Zajączków 1	Chodelka-Zajaczków 2	Chodelka-Grabówka 1	Chodelka-Grabówka 2	Chodelka-Maciejowa Ruda
Esox lucius L.	+	+	+	+	+
Carassius carassius (L.)			+	+	+
Carassius auratus gibelio (Bloch)	+	+	+	+	+
Tinca tinca (L.)	+	+	+		+
Rutilus rutilus (L.)	+	+	+	+	+
Ictalurus nebulosus (Le Sueur)	+	+	+	+	+
Gymnecephalus cernuus (L.)	+		+	+	+
Misgurnus fossilis (L.)			+	+	+
Number of species in the reservoir	6	5	8	7	8
Total number of species	8				

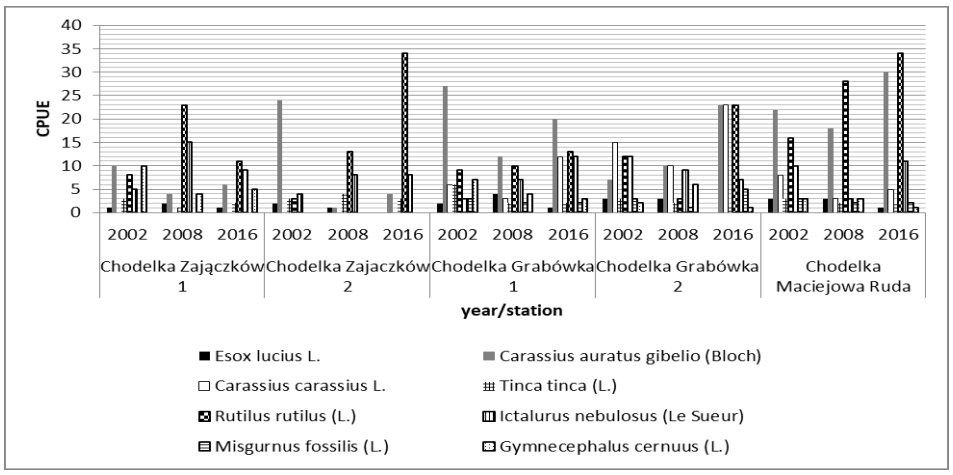

Fig. 1. Structure of the density of fish in the investigated reservoirs in years

(*M. fossilis)* and two alien species (*C. auratus gibelio* and *I. nebulosus*) (Table 2, Fig. 1).

The Normalized Shannon diversity index takes different values dependently on the analysed year as well as on each reservoir (Fig. 1). Generally, higher diversity possess reservoirs Chodelka-Zajączków 1 and Chodelka-Grabówka 1 than other three analysed reservoirs. The first one showed high values of Normalized Shannon diversity index in the year 2002 (ShD_{nor} = 0.90) and 2016 (ShD_{nor} = 0.88), wherein the latter in the year 2008 (ShD_{nor} = 0.91). Reservoir

Chodelka-Zajączków 2 features the lowest diversity, especially in the years 2002 (ShD_{nor} = 0.68) and 2016 (ShD_{nor} = 0.67). Reservoirs Chodelka-Grabówka 2 and Chodelka-Maciejowa Ruda are characterized by quite similar level of diversity, which gradually decrease since 2002 (ShD_{nor} = 0.86) to 2016 (ShD_{nor} = 0.71 and ShD_{nor} = 0.69 respectively). It may be concluded that the statistical tests showed no generally trends in time: the diversity of some reservoirs increase, while the others decrease throug the analysed 14 years.

One-way ANOVA test showed no statistically significant differences in the number of fish in relation to the *C. auratus, C. carassius, T. tinca, R. rutilus, I. nebulosus, E. lucius* ($p > 0.05$). Significant differences refer only to the number of the *G. cernuus* between reservoirs: Chodelka-Zajączków 1 and Chodelka-Zajączków 2 ($p < 0.05$); *M. fossilis* between reservoirs: Chodelka-Zajączków 1 and Chodelka-Grabówka 2 as well as Chodelka-Zajączków 2 and Chodelka--Grabówka 2; and *S. luciperca* between reservoir Chodelka-Grabówka 2 and other reservoirs in which this species does not occurred. One-way ANOVA test applied to the weight showed statistically significance only in relationto *S. luciperca* Significant differences between the years were not detected.

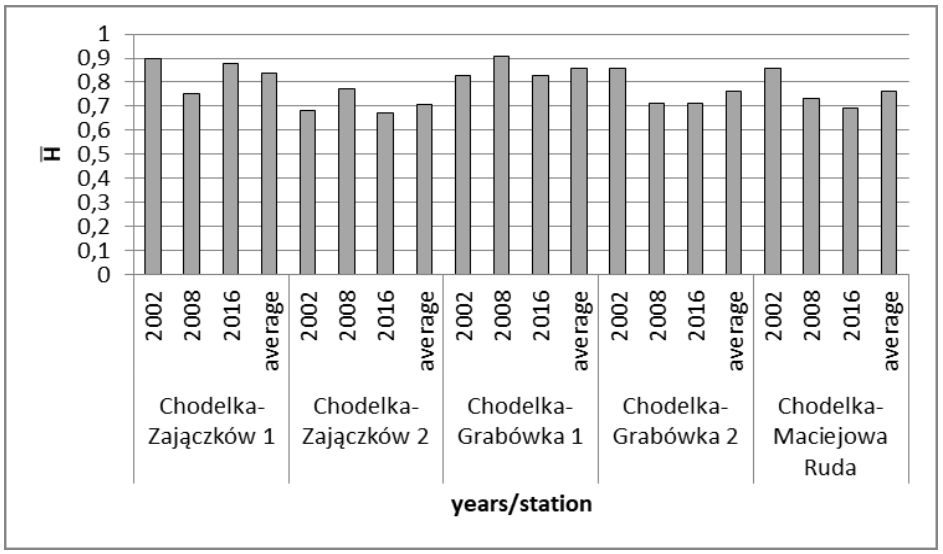

Fig. 2. Values of Normalized Shannon-Wiener index in investigated reservoirs in each year

Domination structure of ichthyofauna of studied reservoirs showed considerable differences. Among the dominant spaces were*: R. rutilus* (all five reservoir) and *C. auratus* (Chodelka-Zajączków) (Fig. 3).

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, R. rutilus and C. auratus* (Fig. 4).

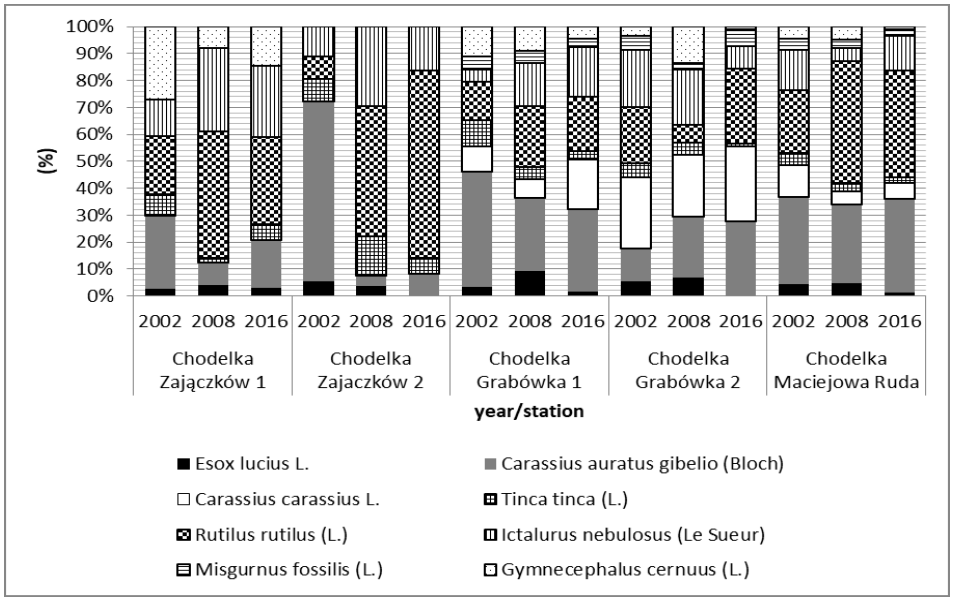

Fig. 3. Abundance structure of fish in the investigated reservoirs in years

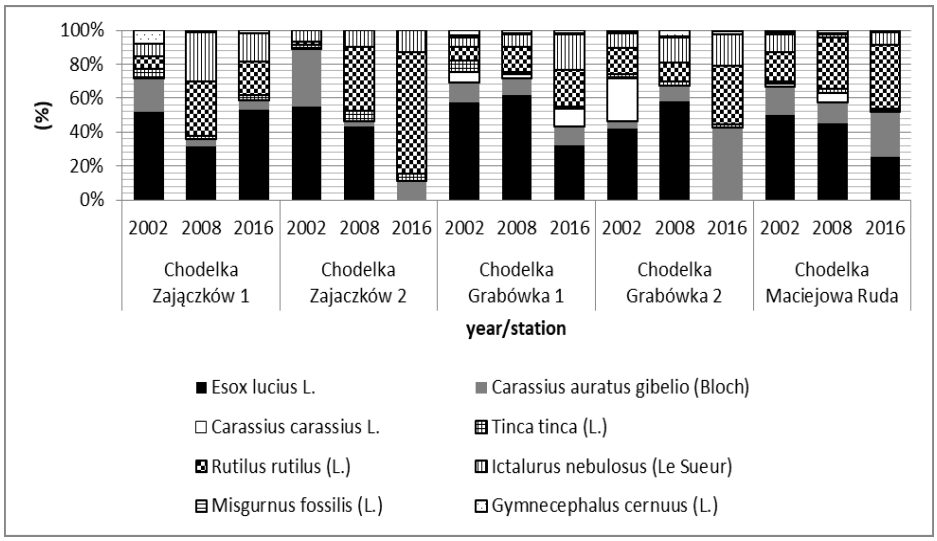

Fig. 4. Biomass structure of fish in the investigated reservoirs in years

DISCUSSION

The structure of ichthyofauna of small water bodies from the area of Polesie Lubelskie and Lubelska Upland 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].

The analysis of results showed that in the post excavation, eutrophic reservoirs dominated: *R. rutilus* (all five reservoir) and *C. auratus* (Chodelka-Zajączków). 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.* 2006a]. 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, Klesczów and Głębokie [Hons, 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 and Lubelska Upland [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.

CONCLUSIONS

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

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ANALIZA ZMIAN W STRUKTURZE ICHTIOFAUNY W ZBIORNIKACH POWYROBISKOWYCH W OBSZARZE ZLEWNI RZEKI CHODELKI (WYŻYNA LUBELSKA)

Streszczenie. W latach 2002, 2008 i 2016 (w odstępach 6-letnich) przeprowadzono badania nad strukturą zespołu ichtiofauny w pięciu małych powyrobiskowych zbiornikach w zlewni rzeki Chodelki. W wyniku przeprowadzonych badań stwierdzono, iż zbiorniki te łącznie zasiedla 8 gatunków ryb należących do 5 rodzin. Struktura ichtiofauny była bardzo zróżnicowana zarówno między poszczególnymi zbiornikami, jak i okresami badawczymi. W strukturze ilościowej dominowały: płoć oraz karaś srebrzysty. Z kolei w ogólnej masie ryb we wszystkich zbiornikach dominował szczupak, płoć oraz karaś srebrzysty. We wszystkich zbiornikach nielicznie występował piskorz. Wartość wskaźnika zróżnicowania gatunkowego była zróżnicowana i dość niska.

Słowa kluczowe: ichtiofauna, małe zbiorniki wodne, rzeka Chodelka