CHANGES OF STRUCTURE OF ICHTHYOFAUNA
IN THE RESERVOIR DEPRESSION NADRYBIE
(ŁĘCZYŃSKO-WŁODAWSKIE LAKE DISTRICT)

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Summary. The analysis of structure of fish communities were examined in three-years intervals in each of two research seasons: spring-summer and summer-autumn during the years 2000–2012. The results showed that the studied reservoir inhabited eight fish species representing five families. Species structure was poorly differentiated, but was characterized by quite high values of species diversity index. Both in the total fish abundance and the total fish biomass was dominated alien species: German carp *Carassius auratus gibelio* and sumik karłowaty *Ictalurus nebulosus*. Noteworthy is the fact that in the structure of fish communities was determined loach (*Misgurnus fosilis*) which is a protected species.

Key words: depression reservoirs, ichthyofauna, long term changes, Łęczna-Włodawa Lakeland

INTRODUCTION

The knowledge of the biocenosis of depression reservoirs in Poland is quite extensive, especially in the area of Upper Silesia [Rzętała 1998]. It cover both invertebrate fauna [Bielańska-Grajner and Gładysz 2010, Deryło *at al.* 2002] as well as fish parasites [Kwiatkowski and Pokora 1996]. In other regions of the country, these studies are trite because of the small number of such reservoirs.

The Nadrybie reservoir was created at the end of 90.XX. The anlysis of periphytic ciliates [Mieczan 2002], phytoplankton [Krupa and Czernaś 2003], macrophytes [Sender 2011] oraz zoopleustonu [Płaska 2009] was conducted in this reservoir. After a few years of its functioning to assess the evolution of the structure of fish fauna the ichthyologic research was started.

STUDY AREA

The Nadrybie depression reservoir was created at the end of 90. XX. as the result of the subsidence due to coal mining by the Mine „Bogdanka". Sinkholes forming a reservoir was formed on the area of extensively used wet meadows. The feeding area in 80% has a rural character. Previously in this area was located four small pit-bogs reservoirs angling used, which is extensively used.

The actual surface area is about 40 ha, and the maximum depth is about 1.5 m [Borchulski and Łyszczarz 2002].

MATERIAL AND METHODS

The study was carried out in three years intervals during the years 2000–2012 The structure of fish communities was based on in seasons: spring-summer an summer-autumn. Fish were collected by means of passive fishing tools, like modified traps with one catching cage (frame size 30 × 70 cm; mesh size 0.5 × 0.5 cm) with bait inside, fishing nets of various mesh size and power generator type Samus 725 MP. The net was set in the evening and removed on the daylight of the following day during about 12 hours. The catches of fish by the means of power generator were carried from 2 to 3 hours in the afternoon.

All the captured fish were species identified; their total lenght (up to 1 mm) was measured and body weight (up to 1 g) checked. In the order to compare the abundance and biomas of the captured fish, the results of the catches were converted into CPUE (catch per unit effort), i.e. per 12 hours of fishing with one net.

The biodiversity of the fish assemblages was assessed by Shannon-Wiener index (H') and species similarity (r).

Shannon-Wiener index: $H' = -\Sigma\, n_i/N \ln n_i/N$

Species similarity: $r \quad = \dfrac{nW}{nA + nB - nW}$

where:
  n_i – number of species of the ith species,
  N – number of all individuals of all species,
  n_w – number of shared species,
  n_A – number of fish species in lake A,
  n_B – number of fish species in lake B.

RESULTS

In studied reservoir were noted eight fish species, represented five families: *Cyprinidae* (4 species), *Percidae, Ictaluridae, Esocidae, Cobitidae* (1 species each). The species richness in Nadrybie reservoir was poorly differentiated. Except for two first years (2000, 2003) all recorded species were noticed (Tab. 1). Among them, only loach was under protection and carp, Prussian carp and brown bullhead are classified as alien species both in the region and the country.

Table 1. Species structure of ichthyofauna of investigated reservoir

Species	2000	2003	2006	2009	2012
Esox lucius L.		+	+	+	+
Cyprinus carpio L.			+	+	+
Carassius carassius (L.)	+	+	+	+	+
Carassius auratus gibelio (Bloch)	+	+	+	+	+
Rutilus rutilus (L.)	+	+	+	+	+
Ictalurus nebulosus (Le Sueur)	+	+	+	+	+
Misgurnus fossilis (L.)	+	+	+	+	+
Perca fluviatilis L.	+	+	+	+	+
Number of species	7	8	9	9	9

Particular research dates were distinctly different in the number of captured fish expressing by the value of CPUE. Significantly higher amounts of fish were caught in the 2009 season (108 ind. per net $^{-1}$12 h^{-1}) and 2012 (122 ind. per net $^{-1}$12 h^{-1}), the smallest number of fish was recorded in first two research seasons, in 2000 (57 ind. respectively, per net $^{-1}$12 h^{-1}) and in 2003 (46 ind. respectively, per net $^{-1}$12 h^{-1}) (Fig. 1).

The value of Shannona – Wienera index for each research date was high and not very diverse. The lowest values was noticed in the spring season season in 2000 (1.85), the highest in 2003 (2.4) in summer season as well (Fig. 2).

There were slight difference between Shannon-Wiener index *H'* and fish abundance in analyzed research periods (Fig. 3).

Analysis of the species similarity showed that the most closely similar to each other were the last research periods: 2006–2012. At that time the value of the index was 1.0 (Tab. 2).
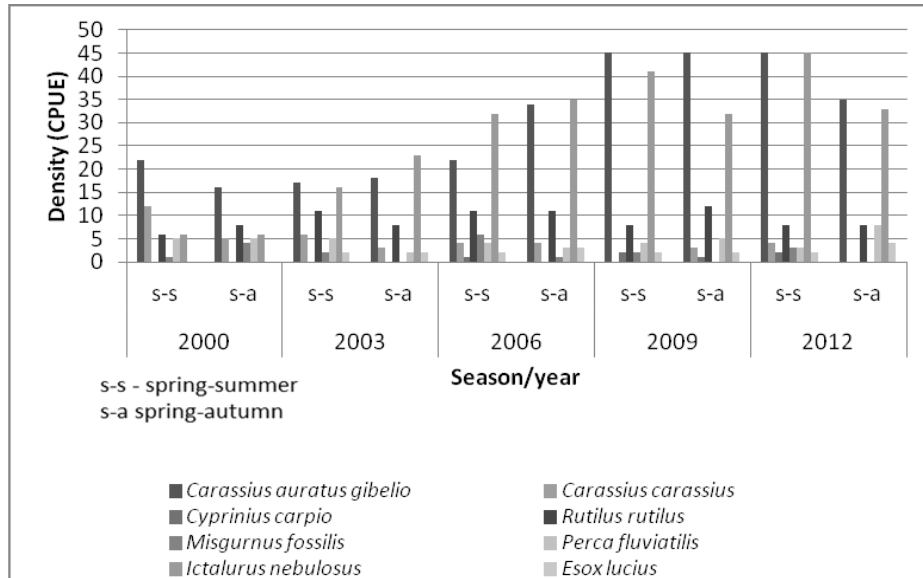
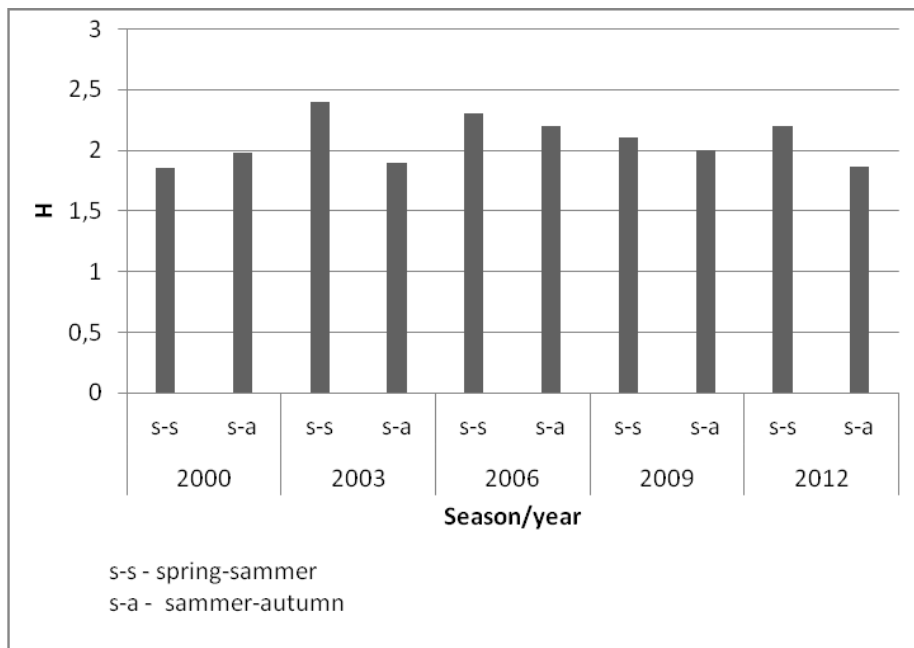Fig. 1. Fish fauna density structure in depression reservoir „Nadrybie"

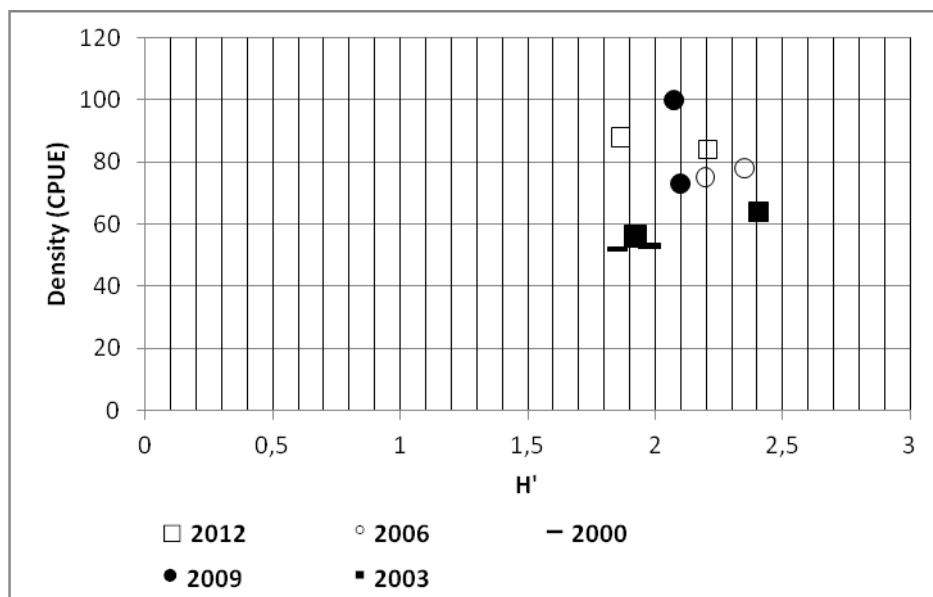Fig. 2. Values of Shannon-Wiener index of investigated reservoir

Fig. 3. The dependence between Shannon-Wiener index *H'* and fish abundance

Table 2. Fish species similarity (r) in each research period

	2000	2003	2006	2009	2012
2000	1	0.85	0.75	0.75	0.75
2003		1	0.88	0.88	0.88
2006			1	1	1
2009				1	1
2012					1

The research revealed that the dominant species were *Ictalurus nebulosus* and *Carassius auratus gibelio* The proportion of this species increasing gradually, the first one showed the fluctuating increase (2000 – c.a. 40%, 2003, 2006 – c.a. 35%, 2009, 2013 – over 40%), wereas the second one increased systematically (2000 – slightly more than 10%, 2003, 2009 – c.a. 40%, 2009, 2013 – over 40%). The sub-dominant species were *Rutilus rutilus* and *Carassius carassius*. Wherein the proportion of the latter, with the development of the tank being evidently decreased (Fig. 4).
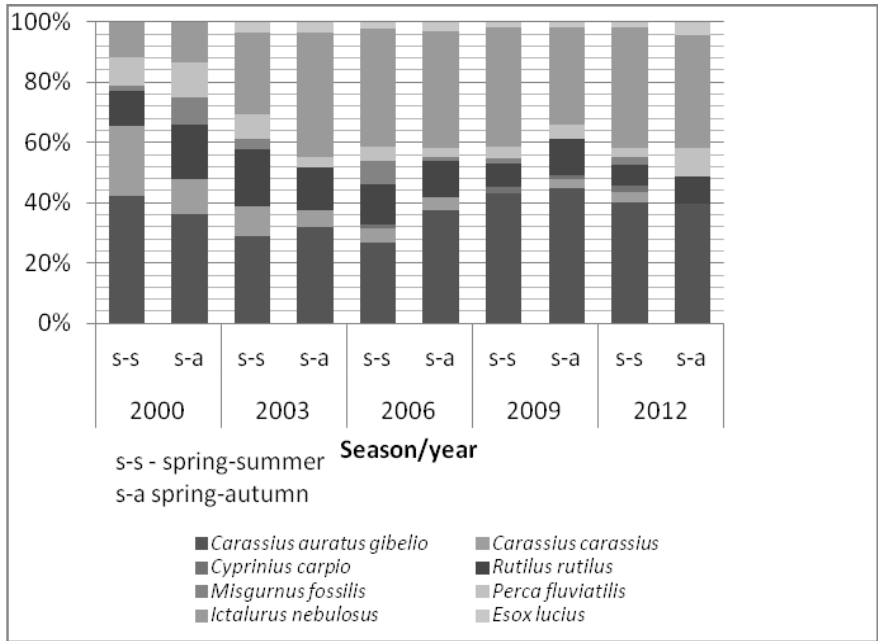
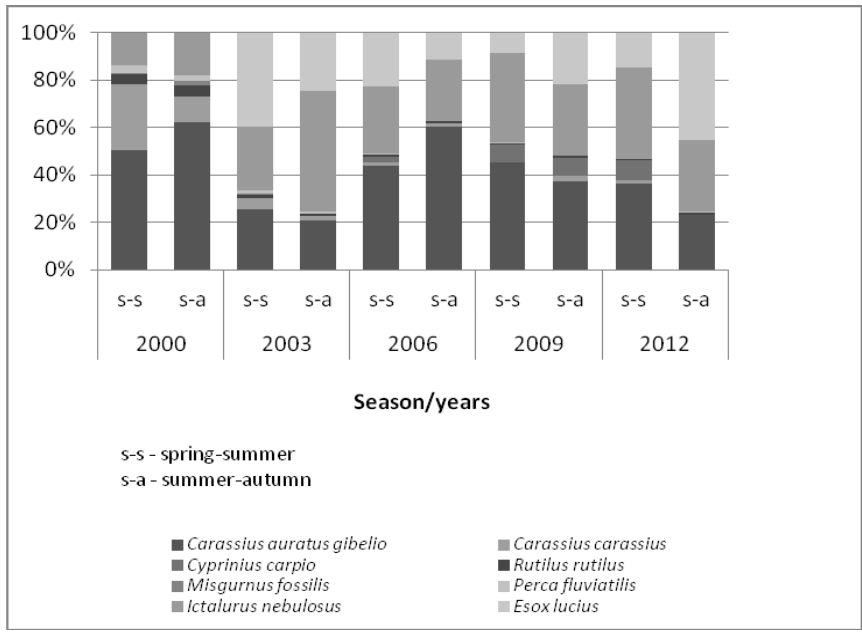Fig. 4. Fish fauna dominance structure in investigated reservoir

Fig. 5. Fish fauna biomass in investigated reservoir

The structure of domination in respect of the total fish biomass was quite diverse. Nevertheless, the dominant species were: *C. auratus gibelio, I. nebulosus i Esox lucius*, but its biomass value was characterized by the fluctuating character (Fig. 5).

DISCUSSION

At the turn of the twentieth and twenty-first century water reservoir showed eutrophic character as evidenced by: low visibility (0–35 cm), high abundance of phytoplankton (11.5–168.9 indiv. m^{-3}) and chlorophyll *a* contents (272.8–628.2 mg m^{-3}), as well as intensive cyanobacterial or green algea blooms [Krupa and Czernaś 2003]. After several years of reservoir functioning zone phytolittoral of 37 species of vascular plants was development. Among the most numerous helofitów were: *Phragmites australis, Typha latifolia* i *T. angustifolia*, and among elodeidów – *Ploygonum amphibium* [Sender 2007]. It was also found the 18 species of planktonic crustaceans and 7 species of zoobenthos [Radwan *et al.* 2002].

After 10 years of reservoir existence greatly increased the diversity of macrophytes, mainly emergent [Sender 2011]. At the same time, Płaska [2009] found 17 species of *Heteroptera aquatica* of density of more than 146 ind./m^{2}.

As the result of conducted research it can be concluded that Nadrybie reservoir is a very good habitat for the development of local aquatic biocenosis.

During the research were found nine species of fish in 2012. Periodic testing over several years have shown that the slight changes in the structure of the species. The number of fish species ranged from 7 in 2000 years to 9 in 2006. It remained at this level until 2012.

The natural reservoirs of the region's fish species richness is much higher. This is confirmed by results of the last few years in more than 10 lakes. This was primarily one of the largest and deepest lakes in the Lakeland with a meso- or eutrophic character [Kolejko 2009, 2010, Rechulicz 2006, 2011]. In turn, in several small and shallow mezohumusowych lakes as Brzeziczno and Moszne number of species did not exceed 9 [Kolejko 2009].

Biodiversity assessment based on the Shannon-Wiener index was significantly higher than in most reservoirs of the region.

In the Nadrybie reservoir the dominant species were *I. nebulosus* and *C. auratus gibelio*, whose share gradually increased with the development of the reservoir. The subdominant species belonged to *R. rutilus*, which in the most of the Lakeland reservoirs is the dominant species. Also, the first two have a significant share in the waters of the region, inhabiting both shallow eutrophic lakes and mezohumus [Kolejko 1998, 2006, Kornijów *et al.* 2003].

CONCLUSION

1. The species diversity of ichtiofauna in analyzed reservoire is quite high.

2. The highest species similarity was observed in years 2006–2012.

3. The dominant species both in the structure of population and the total fish biomass was *I. nebulosus* i *C. auratus gibelio.*

4. The share of these two species has increased significantly with the development of the reservoir.

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ZMIANY W STRUKTURZE ICHTIOFAUNY W ZAPADLISKOWYM ZBIORNIKU NADRYBIE (POJEZIERZE ŁĘCZYŃSKO-WŁODAWSKIE)

Streszczenie. Analizę struktury ichtiofauny prowadzono w latach 2000–2012 w odstępach 3-letnich w dwóch sezonach badawczych – wiosna–lato i lato–jesień. W składzie gatunkowym ichtiofauny stwierdzono 8 gatunków ryb należących do 5 rodzin. Struktura gatunkowa ryb była mało zróżnicowana, jednak cechowała się dość wysokimi wartościami wskaźnika zróżnicowania gatunkowego. Zarówno w ogólnej liczebności, jak i biomasie ryb dominowały gatunki obce, karaś srebrzysty *Carassius auratus gibelio* i sumik karłowaty *Ictalurus nebulosus*. W składzie gatunkowym ichtiofauny stwierdzono dość licznie chronionego piskorza *Misgurnus fosilis*.

Słowa kluczowe: zbiorniki zapadliskowe, ichtiofauna, zmiany w czasie, Pojezierze Łęczyńsko-Włodawskie