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ANALYSIS OF THE STRUCTURE OF ICHTHYOFAUNA OF TWO MESOTROPHIC LAKES OF ŁĘCZNA-WŁODAWA LAKELAND[1]

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Summary. Lakes Piaseczno and Białe Włodawskie, due to their high tourism and landscape values, represent the group of lakes of the Łęczna-Włodawa Lakeland which have been intensively used for recreational purpose for the last decades. For the last fifty years physical and chemical water parameters as well structure of biocenosis changed visibly, mostly as a result of changes in the land use structure in their catchment area, and of fishery. These changes are reflected in fish communities, which is documented in the present article.

Key words: ichthyofauna, lakes Piaseczno and Białe Włodawskie

INTRODUCTION

At the turn of the 60s and 70s of the 20th lakes Piaseczno and Białe Włodawskie were intensively used for tourist and economic purposes. At that time the lakes were oligotrophic and classified as white fish fishery type [Fijałkowski 1959]. In the late 80s of the 20th century the trophic status of these two deepest lakes of the Łęczna-Włodawa Lakeland changed to mesotrophic, and the fishery type to bream-white fish [Wojciechowski 1976, Radwan *et al*. 1987, Harasimiuk *et al*. 1998].

The relation between the eutrophication process and the structure of fish communities was already pointed out in the second part of the 20th century

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[Kriegemann 1955, Müller 1966]. Increase of water trophy gradually affects ichthyofauna**,** at the beginning influencing mostly habitat conditions and spatial distribution of fish and, consequently, leading to significant changes in the structure of fish community [Colby *et al*. 1972, Leopold *et al*. 1986, Randal *et al*. 1996].

The main purpose of this study was the evaluation of the present structure of ichthyofauna and its changes through the last 40 years in relation to increase of the trophic status of the studied lakes.

STUDY AREA, MATERIAL AND METHODS

The studies were conducted in lakes Białe Włodawskie and Piaseczno. Both lakes are dimictic and represent the deepest lakes of the Łęczna-Włodawa Lakeland. Up till the turn of the 60s and 70s of the 20th century these mesotrophic lakes were classified as oligotrophic and of the white fish fishery type (Tab. 1).

Table 1. Limnological and morphometric characteristics of studied lakes

Parameter/Lake	Białe Włodawskie	Piaseczno
Area, ha	106.2	84.5
Maximum depth, m	33.6	38
Capacity, thousand m^2	14 998	10 674
Secchi disc visibility in last 5 years, m	3.9	5.8
Lake shore length, m	1 616	1 464
Mixing type	dimictic	
Trophy type	mesotrophic	
Fishery type	bream – white-fish	
Protection status	-	landscape park

Studies of ecological and faunistic structure of ichthyofauna during the years 2007–2008 were conducted in spring and autumn in three zones: littoral (depth of 1–2 m), sublittoral (depth of 5–8 m) and open water zone. Fish were collected by fyke nets and electrofishing. Power generator type Samus 750 was used in the littoral zone; in the sublittoral and open water zones nets of different mesh size were used.

Active and passive fishing gear were set in the evening and retrieved early in the morning; the exposure lasted 12 hours. Electrofishing was performed for 2–3 hours in the evening. Density and biomass of fish collected were calculated per 1 hour of catching. Fish were identified to the species level according to the classification of Brylińska *et al*. [2000]. For detailed information of fish diversity in the studied lakes data from angling, environmental inquiry and fishing books were used.

Species diversity of fish communities was evaluated based on the Shannon-Wiener index of biological diversity (H`) [1963]:

$$H' = -\Sigma\, n_i/N \ln n_i/N$$

n_i – number of individuals of i-species,
N – total number of fish species.

RESULTS

Species structure of fish communities was similar in the studied lakes. Both lakes were inhabited by 18 fish species representing 7 families: *Cyprinidae* (10 species), *Percidae* (3 species), *Salmonidae* (1 species), *Ictaluridae* (1 species), *Anguillidae* (1 species), *Cobitidae* (1 species) and *Esocidae* (1 species). In studied fish communities two protected species (bitterling and loach) and three alien species (carp, German carp and brown bullhead) were noted. The presence of white fish is a consequence of fish frying in the 70s and 80s of the 20th century.

In both lakes the numbers of fish species in the studied zones showed the same values. The highest number of species was noted in the littoral, the lowest in the open water zone (Tab. 2).

Table 2. Species composition of ichthyofauna in studied lakes

Item	Lake	Białe Włodawskie			Piaseczno		
	Species/Zone	L	S	P	L	S	P
1	*Coregonus albula* (L.)		+	+		+	+
2	*Esox lucius* L.	+	+		+	+	
3	*Cyprinus carpio* L.		+			+	
4	*Carassius carassius* (L.)	+			+		
5	*Carassius auratus* (Bloch)	+			+		
6	*Tinca tinca* (L.)	+			+		
7	*Abramis brama* (L.)	+	+	+	+	+	+
8	*Blicca bjoerkna* (L.)	+			+		
9	*Alburnus alburnus* (L.)	+	+	+	+	+	+
10	*Scardinius erythrophthalmus* (L.)	+			+		
11	*Rutilus rutilus* (L.)	+	+	+	+	+	+
12	*Rhodeus sericeus amarus* (Bloch)	+			+		
13	*Anguilla anguilla* (L.)	+				+	
14	*Ictalurus nebulosus* (Le Sueur)	+			+		
15	*Misgurnus fossilis* (L.)	+			+		
16	*Stizostedion lucioperca* (L.)		+		+		
17	*Perca fluviatilis* L.	+	+	+	+	+	+
18	*Acerina cernua* (L.)	+			+		
Number of species in the zone		15	8	5	15	8	5
Total number of species		18			18		

L – littoral, S – sublittoral, P – open water

Index of species diversity (H`) in both lakes decreased along the transect littoral-open water and showed higher values in Lake Białe Włodawskie (Fig. 1).

In the abundance structure, in both lakes and in all studied zones roach was the dominant species, its share ranging from 25 (littoral) to 60% (open water) in Lake Białe Włodawskie and from 65 (open water) up to 70% (littoral) in Lake Piaseczno.

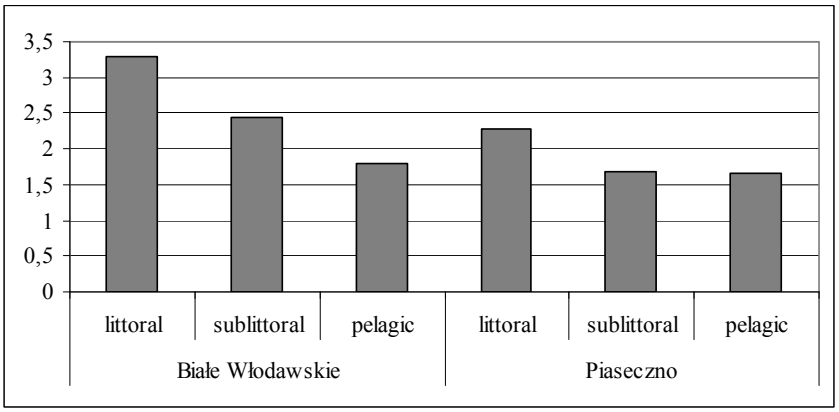

Fig. 1. Values of Shannon-Wiener index for biotic zones of studied lakes

The domination structure of ichthyofauna in the sublittoral and open water zones showed differences. In the littoral of both lakes, brown bullhead, sunbleak and perch were present numerously, additionally in Lake Piaseczno – bream. In the sublittoral of lakes Białe Włodawskie and Piaseczno there dominated bream (25%) and brown bullhead (10%). In the open water zone of both lakes white fish was noted (Fig. 2).

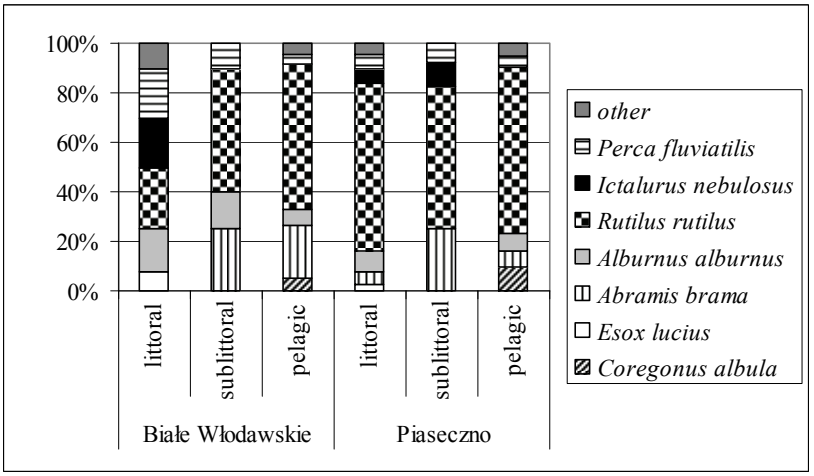

Fig. 2. Structure of abundance of fish community of studied lakes

In total fish biomass pike dominated in the littoral, and in the sublittoral and open water zones – bream. In all studied zones roach contributed in a high percentage in the biomass structure (Fig. 3).

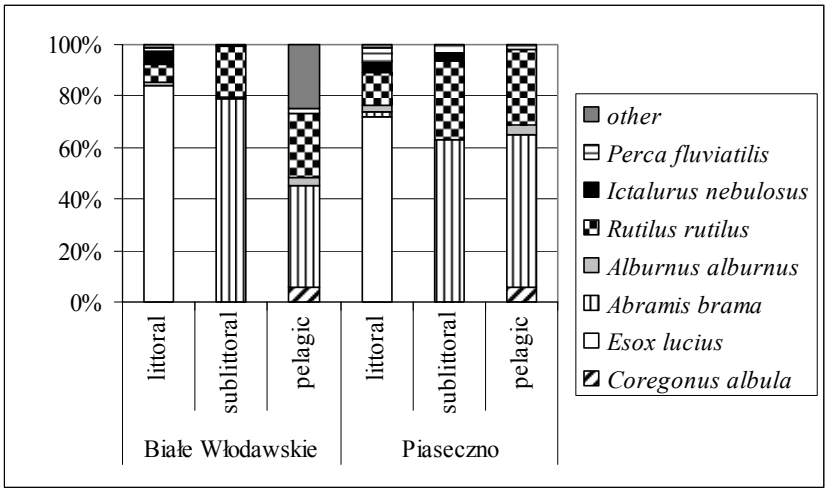

Fig. 3. Structure of biomass of fish communities of studied lakes

DISCUSSION

Lakes Białe Włodawskie and Piaseczno showed high species diversity of fish communities as compared to other mesotrophic lakes of the Łęczna--Włodawa Lakeland. These differences have been already noted during of first studies of fish communities at the beginning of the 80s of the 20th century [Jarzynowa and Stroński 1982] and confirmed in the next decade [Radwan *et al*. 1987, 1992]. At that time the studied lakes were inhabited by 13 fish species, and other mesotrophic lakes – 9 species [Radwan *et al*. 1987, 1992]. Up to now the number of fish species in the mesotrophic lakes of the Łęczna-Włodawa Lakeland increased, mostly due to stocking with carp, Prussian carp, chub, silver carp, big head carp and eel. For the last 20 years Lake Piaseczno was intensively stocked with fry of carp (60 000 ind. in 1995 and 1200 kg in 2001). At the same period, among 500 kg of fish catching, no frying carp was caught. It is worth noting that the most intensive fish management was conducted in the mesotrophic lakes Krasne and Rogóźno [KROiZ 1980–1990].

The presence of different age classes of white fish in lakes Piaseczno and Białe Włodawskie is a result of fish frying during the 70s of the 20th century [Radwan *et al*. 2002]. Optimal spawning conditions for the species are provided by characean meadows; these macrophytes colonise the bottom down to the depth of 6 meters [Sender 2009]. The analysis of alimentary tracts of white fish showed the importance of two cladoceran species of *Daphnia cucullata* and

Daphnia longispina in the diet of fish [Adamczuk 2010]. Thus, foraging pressure of white fish on large cladocerans negatively influences trophic interactions in lake ecosystems [Adamczuk 2010]. Selective foraging contributes to intensive development of phytoplankton and decrease of water transparency. In Poland typical white fish lakes are situated in the area of the Drawieński and Wigierski National Parks. White fish reaches high shares in the structure of ichthyofauna of the lakes of those regions and constitutes a natural component of fish stock [Chybowski and Białokoz 1999].

The number of alien fish species is low, considering that up to the 90s of the 20th century in freshwater ichthyofauna in Poland only 20 introduced or dragged fish species were noted [Witkowski 1992, 1996]. One of the most important competitors for domestic ichthyofauna is brown bullhead, a species of very high ecological flexibility, easily spreading and difficult to eliminate from fish stock in lakes [Kolejko 1998].

In lakes Białe Włodawskie and Piaseczno one of the most important factors determining fish distribution were macrophytes. Both lakes have sandy beaches, and the phytolittoral area is poorly developed [Sender 2009]. Such a structure of the littoral zone does not enhance a rapid development of population of littoral fish species, such as pike, tench and common carp. These fish species need a dense and intensively developed phytolittoral zone which creates optimal habitat and food conditions [Hutorowicz and Zdanowski 1993, Matena 1995, Lillie 1996, Melissa *et al*. 1997, Weaver *et al*. 1997, Olson *et al.* 1998].

CONCLUSIONS

Lakes Białe Włodawskie and Piaseczno support high species diversity of ichthyofauna in comparison to other mesotrophic lakes of the Łęczna-Włodawa Lakeland.

Changes in the structure of fish communities observed during the last 30 years occurred as a result of fry stocking.

Roach dominated in the total density of ichthyofauna of both studied lakes and all studied biotic zones. In the total biomass pike was dominant in the, and in the sublittoral and open water zones – bream.

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ANALIZA STRUKTURY ICHTIOFAUNY DWÓCH MEZOTROFICZNYCH JEZIOR POJEZIERZA ŁĘCZYŃSKO-WŁODAWSKIEGO

Streszczenie. Badania struktury ichtiofauny przeprowadzono w jeziorach Białe Włodawskie i Piaseczno. Obydwa jeziora są dymiktyczne i należą do najgłębszych na Pojezierzu Łęczyńsko-Włodawskim. Te mezotroficzne jeziora jeszcze do połowy lat 60. XX wieku zaliczane były do sielawowego typu rybackiego i określane jako oligotroficzne. Struktura różnorodności gatunkowej obydwu jezior była bardzo zbliżona. W każdym z badanych jezior stwierdzono po 18 gatunków ryb. Należały one do 7 rodzin: *Cyprinidae* (10), *Percidae* (3) oraz *Salmonidae*, *Ictaluridae*, *Anguillidae*, *Cobitidae* i *Esocidae* (po 1 gatunku). W faunie ryb zasiedlających jeziora były 2 gatunki objęte ochroną prawną (różanka, piskorz), a także 3 gatunki obce (karp, karaś srebrzysty, sumik karłowaty). W obydwu jeziorach liczba gatunków w poszczególnych strefach była identyczna. Najwięcej gatunków występowało w strefie litoralu, zaś najmniej w strefie pelagialu. Wskaźnik zróżnicowania gatunkowego (H') w obu jeziorach malał w transekcie od litoralu do otwartej wody. Przy czym we wszystkich strefach biotycznych przyjmował wyższe wartości w jeziorze Białym Włodawskim. W strukturze dominacji we wszystkich strefach biotycznych obydwu jezior dominującym gatunkiem była płoć, której udział w ogólnej liczebności stanowił odpowiednio od 25% w litoralu do 60% w pelagialu (Białe Włodawskie) i od 70% w litoralu do 65% w pelagialu (Piaseczno). W ogólnej masie ryb w strefie litoralu dominował szczupak, zaś w strefach sublitoralu i pelagialu leszcz. We wszystkich badanych strefach jezior znaczny udział miała płoć.

Słowa kluczowe: ichtiofauna, jeziora mezotroficzne