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IMPACT OF NATURAL CHANELIZATION OF A SMALL LOWLAND RIVER ON BIODIVERSITY OF FISH COMMUNITIES

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Summary. Fish were caught by electroshocking 4 times during the period of seven months after chanelization of the river Gałęzówka, situated in Lublin Upland. The river works resulted in a drastic decrease of species richness (from 10 to 3 species), disappearance of 3 species protected by law (stone loach, bitterling and spined loach), and in a drop in biodiversity (mean values of H' index: 1.14 at the reference and 0.66 at the disturbed site). Density of fish was significantly higher at the disturbed site, with a growing tendency (mean: 100.3, range: 1-241 ind. · 100 m^{-1}), than at the reference one (mean: 90.5, range: 59-135 ind. · 100 m^{-1}). The mean biomass amounted to 2172 and 2046 g · 100 m^{-1}, respectively.

Key words: rivers, fish, rivers regulation, biodiversity

INTRODUCTION

There is a growing interest in problems associated with chanelization of rivers and its impact on their biota [e.g. Guziur 1993]. Recently, the Polish Ministry of Environment presented its critical attitude in this matter [The decree... 2002, The Ministry ... 2004]. According to the Ministry, natural rivers should not be chanelized, and especially straightening of riverbeds should be stopped. This is because chanelized rivers, as it can be observed in western Europe [Radtke 1994, Riis 1999], sooner or later have to be renaturalized, which is both complicated and very costly [The decree ... 2002]. In order to mitigate negative impacts of channel works on flora and fauna the new concept of so called natural chanelization of rivers, without removing river meandering, has been developed.

The influence of this new technique of channel works on river biocenosis are little known [Bondar-Nowakowska 2000], and the data on fish do not virtually exist. The aim of the present paper was to estimate the impact of natural chanelization of a small-sized lowland river Gałęzówka on its fish communities.

STUDY AREA, MATERIAL AND METHODS

River Gałęzówka belongs to the drainage basin of Bystrzyca Lubelska river (Lublin Upland). According to the Polish Ministry of Environment regulations [2004] the water properties of river Gałęzówka excludes it as a suitable habitat of salmon and cyprinid fishes [Gorzel and Kornijów 2004]. For details on the river hydrology, hydrochemistry and morphometry see Gorzel and Kornijów [2004]. In October 2003 on the prevailing water course of the river the channel works were undertaken, according to the concept of natural chanelization. About 20 cm of the upper layer of the bottom sediments together with woody debris and water vegetation were removed and the banks were reinforced with willow twigs. Two sites of the river, each 100 m long, were chosen to study: the one disturbed by channel works, and placed upstream, not disturbed reference site (R). They were situated in a lower river course on the suburbs of a small town Bełżyce.

Studies were carried out before channel works on 28 VIII 2003, and then after the river chanelization on the following days: 6 XI 2003, 6 II 2004 and 20 IV 2004. The material was collected by electroshocking (IUP – 12), walking upstream on the riverbed. The fish caught were weighed and their length (both the body length and the total one) was measured. The Shannon-Wiener biodiversity index H' of the fish communities was calculated according to the equation:

$$H' = \sum_{i=1}^{s} (p_i)(\log_2 p_i)$$

where:

s – number of species,

p_i – proportion of total sample belonging to *i*-th species.

In order to obtain the coefficient of condition (K) of fish the following formula was used:

$$K = \frac{100G}{L^3}$$

where:

G – body weight,

L – total length.

Statistical analyses were performed using GLM procedure of SAS.

RESULTS

Just after channel works only one species, roach, occurred at D site. Consecutive samplings revealed single individuals of gudgeon (*Gobio gobio*) and a growing numbers of perch (*Perca fluviatilis*). Thus only 3 fish species were found to occur at D site. At R site the total number of 10 fish species (from 4 to 8 in separate dates) were found, including 3 species protected by law: stone loach (*Noemacheilus barbatulus*), bitterling (*Rhodeus sericeus*) and spined loach (*Cobitis taenia*). Values of biodiversity at D site (mean: 0.66, range: 0.09-0.99) were almost twice lower than at R (mean: 1.14, range: 0.6-1.35). The fish density at D site ranged from 1 to 241 ind. · 100 m^{-1} and tended to

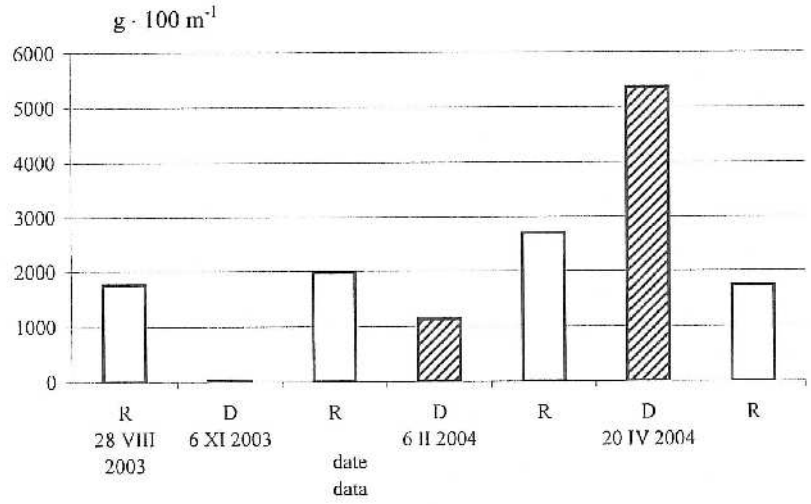

Fig. 1. Density of fish (ind. · 100 m^{-1}) at the disturbed (D) and reference sites (R) in the Gałęzówka river

Rys. 1. Liczebność ryb (osobn. · 100 m^{-1}) na odcinku uregulowanym (D) i kontrolnym (R) w rzece Gałęzówce

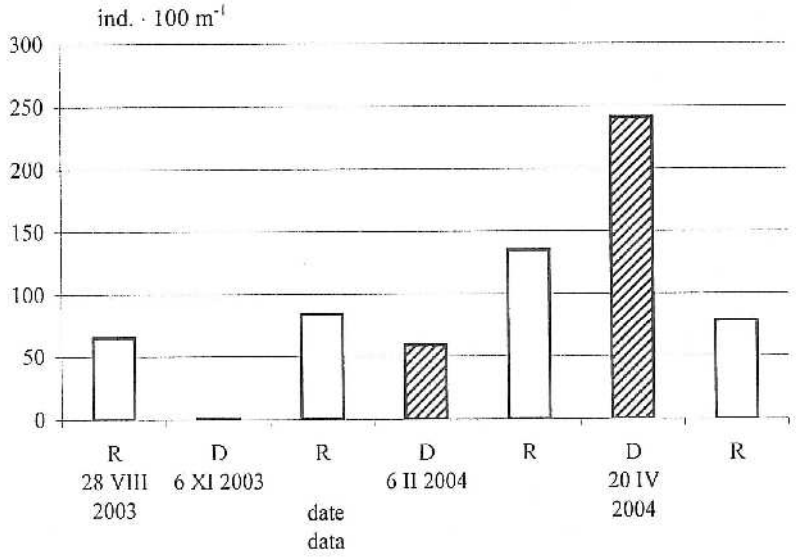

Fig. 2. Biomass of fish (g · 100 m^{-1}) at the disturbed (D) and reference sites (R) in the Gałęzówka river

Rys. 2. Biomasa ryb (g · 100 m^{-1}) na odcinku uregulowanym (D) i kontrolnym (R) w rzece Gałęzówce

Table 1. Total length (LT) and body length (LC) in cm as well as individual mass of fish in g at the disturbed (D) and reference sites (R) in the Gałęzówka river

Tabela. 1. Długość całkowita (LT) i długość ciała (LC) w cm oraz masa ciała ryb w g na odcinku uregulowanym i kontrolnym w rzece Gałęzówce

Species Gatunek		D					R				
		N	min	max	mean średnio	SD	N	min	max	mean średnio	SD
Roach Płoć	LT	214	10.5	146	14.36	9.10	273	9	17	13.71	1.32
	LC		8.4	14	11.05	0.93		6.8	16	11.06	1.16
	Mass Masa		10.4	55.59	26.78	7.98		6.36	57.12	25.73	8.10
Perch Okoń	LT	82	7.5	14.3	9.37	1.10	52	5.7	14.3	9.88	1.72
	LC		6	11.5	7.78 B*	0.94		4.7	12.5	8.26 A	1.44
	Mass		1.1	41.01	8.84 B	5.01		1.73	35.6	11.87 A	7.17
Gudgeon Kiełb	LT	5	9	12.2	10.58	1.19	16	6.5	14.2	11.89	2.21
	LC		7.2	9.8	8.58 B	1.05		5.5	12	9.76 A	1.76
	Mass		7.2	17.9	12.04	4.14		2.5	30.38	18.39	8.97

*Mean values denoted with identical letters are not significantly different at $p \leq 0.05$

*Średnie oznaczone tymi samymi literami nie różnią się statystycznie przy $p \leq 0,05$

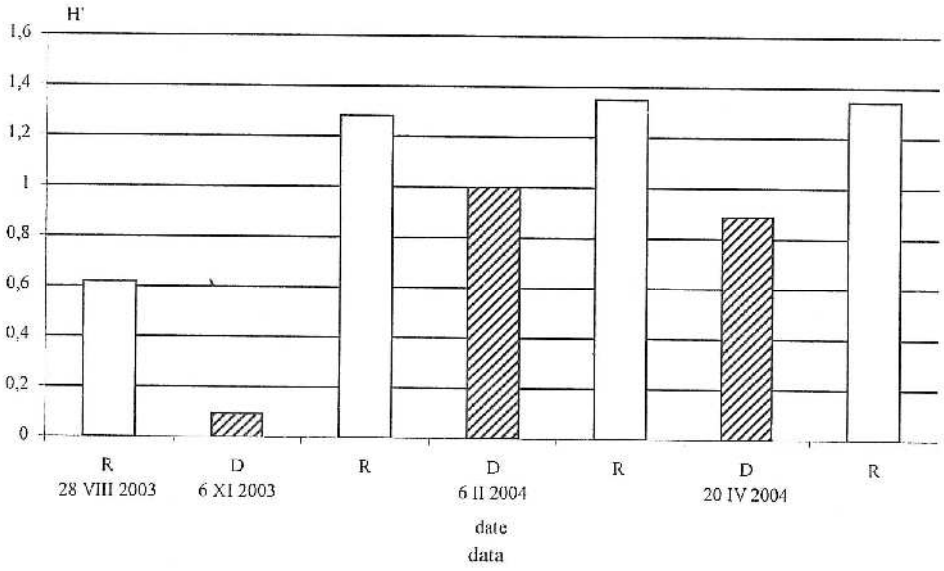

Fig. 3. Values of Shannon-Wiener biodiversity index for fish at the disturbed (D) and reference sites (R) in the Gałęzówka river

Ryc. 3. Wartości wskaźnika różnorodności Schannona-Wienera obliczonego dla ryb na odcinku uregulowanym (D) i kontrolnym (R) w rzece Gałęzówce

increase (Fig. 1). The density at R site was 59-135 ind. · 100 m^{-1}, with maximum values in February. The mean densities were significantly higher at D site (100 ind. · 100 m^{-1}) than at R (91 ind. · 100 m^{-1}; $p \leq 0.5$).

The dominance structure at the compared sites was similar. The fish were dominated by roach (75 at D and 77% at R, of the total numbers of fish). The second most numerous species was perch (24 and 13%, respectively).

The biomass at D site was growing steadily, from 24 g · 100 m^{-1} after channel works to 5340 g · 100 m^{-1} seven month later. At R undisturbed site it fluctuated from 1745 to 2690 g · 100 m^{-1} (Fig. 2). The mean densities (2046 g · 100 m^{-1} and 2172 g · 100 m^{-1}, respectively) were not significantly different ($p \leq 0.5$). The fish contributing to the biomass the most included roach (88% at D and 86% at R site) and perch (11 and 7%, respectively). Average values of condition coefficient in the majority of fish species at both site was similar, amounting to around 1.0. They were higher only in case of perch at R site (1.12).

The body length of perch and gudgeon, as well as individual mass of perch were significantly higher at R site ($p \leq 0.05$) – Tab. 1. The rest of the metric features measured were similar at both river sites.

DISCUSSION

It is known that fish communities in small-sized rivers are more vulnerable to environmental disturbances resulting from chanelization than in bigger ones. This was confirmed by e.g. Wolter and Vilcinskas [1998a i b] in some German rivers, chanelization of which caused alterations in fish communities and decrease in their biodiversity.

The chanelization of river Gałęzówka brought about a drastic decrease in species richness and diversity of fish. Seven fish species, including three protected by law, lost their habitats at the disturbed site, most probably not because of the changes in physical and chemical properties of water, which were negligible [Gorzel and Kornijów 2004], but due to alterations made in riverbed morphology (removing bottom sediments, vegetation and tree debris).

The species most resistant to the changes were roach and perch, predominating in the fish communities. The same species were also the most numerous in Wieprz-Krzna Canal in south Podlasie [Danilkiewicz 1985] and in some German canals and rivers [Wolter and Vilcinskas 1998a i b]. It is worth to notice that distribution of fish at the disturbed site of river Gałęzówka was very irregular. The shallow riffles were almost deprived of fish, which were found to occur mostly in two deep pools. At the reference site the distribution was rather equal. Nevertheless, the overall densities of fish found in river Gałęzówka corresponded with those found in other Polish rivers [Błachuta and Witkowski 1990].

Fish collected at D site were smaller and their individual mass was lower. This might have resulted from higher density, and associated with it, higher competition for food. This was confirmed by lower values of condition coefficient calculated for perch at D site. Another explanation might be that the chanelized river section site was inhabited by younger fish than the reference one, which, however, was not studied.

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WPŁYW REGULACJI NATURALNEJ MAŁEJ RZEKI NIZINNEJ NA RÓŻNORODNOŚĆ BIOLOGICZNĄ ICHTIOFAUNY

Streszczenie. Połowy ryb przeprowadzono czterokrotnie w ciągu siedmiu miesięcy, po zakończeniu tzw. naturalnej regulacji rzeki Gałęzówki, położonej w dorzeczu Bystrzycy Lubelskiej. Na odcinku niepogłębionym (R) stwierdzono obecność 10 gatunków ryb, w tym 3 chronionych: śliza, różanki i kozy. Wyraźną dominacją w strukturze liczebności i biomasy charakteryzowały się płoć i okoń. Na odcinku pogłębionym (D) po regulacji początkowo stwierdzono tylko płoć, a w miarę upływu czasu pojawiły się także okoń i kiełb. Wartości wskaźnika różnorodności biologicznej H' na odcinku D były prawie 2-krotnie niższe (średnio 0,66) niż na odcinku R (1,14). Zagęszczenie ryb kształtowało się w granicach od 1 do 241 osobn. · 100 m^{-1} na odcinku D i od 59 do 135 osobn. · 100 m^{-1} na odcinku R. Ogólna średnia biomasa ryb na badanych odcinkach rzeki wyniosła odpowiednio 2172,37 i 2046 g · 100 m^{-1} (1745-2690), z wyraźną tendencją wzrostową na odcinku uregulowanym.

Słowa kluczowe: rzeki, ryby, regulacja rzek, różnorodność biologiczna