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THREATS TO THE ICHTHYOFAUNA OF THE MAGURSKI NATIONAL PARK AND ITS SURROUNDINGS

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ABSTRACT. Fifteen sites were selected in the upper Wisłoka River drainage basin. Twelve species were recorded. In terms of abundance the dominant species in the material collected were *Phoxinus phoxinus* (L.), *Leuciscus cephalus* (L.) and *Barbus peloponnesius* Val. *P. phoxinus* clearly dominated in the smallest streams and there were significant local contributions of *Salmo trutta* m. *fario* L. to the fish biomass. In the larger streams, the minnow contribution decreased while chub and spotted barbel dominated in the biomass. Spirlin *Alburnoides bipunctatus* (Bloch) was also relatively abundant. Among the trout caught, relatively small specimens dominated. Poaching was most probably responsible for the lack of larger specimens in the samples. The small impoundment on the Wisłoka River and changes in stream beds caused by gravel exploitation, regulation and forestry management works also had an adverse impact on the ichthyofauna of the studied basin.

Key words: FISH, MOUNTAIN STREAMS, POACHING, THREATS

INTRODUCTION

The Magurski National Park was founded in 1995. It covers an area of approximately 20 thousand hectares and its borders are 384 km long. The park is located in the central part of the Low Beskidy Mountains covering the Magura Wątkowska and a part of the main Carpathian ridge that runs along the border with Slovakia (Michalik 1995). The entire area of the park lies in the upper Wisłoka River drainage basin. The waters of the Wisłoka River and its tributaries are relatively clean; however, due to unregulated sewage management in some villages, a bacteriological contamination problem has appeared (Suchy 2000). The highly irregular park border means that only sections of the larger streams in the upper Wisłoka River drainage basin flow through protected areas. The aquatic fauna of the streams is endangered by gravel exploitation which is performed in many places and by changes in stream beds caused by forestry management. These types of activities have also caused degradation in the aquatic environment in the drainage areas of the San River and the central Wisłoka River (Kukuła 1997, Warcholik 2000). Poaching poses an additional threat to the ichthyofauna; in the Carpathian tributaries of the Vistula River poaching

is one of the main causes of insufficient numbers and the distorted age structure of brown trout *Salmo trutta m. fario* L. (Włodek 1975, Skóra and Włodek 1989, 1991, Augustyn et al. 1998).

The aim of this study was to evaluate the current state of the ichthyofauna of the Magurski National Park and its surroundings and to identify threats posed to it.

STUDY AREA

The studies were conducted in southern Poland on the three largest rivers in the Magurski National Park, the Wisłoka, Ryjak and Wilsznia, and in five smaller streams (Fig. 1). The rivers and streams in this region are mountain types with a fairly pronounced gradient and stony bottoms (Table 1). The Wisłoka River flows from the slopes of Dębi Wierch at an altitude of approximately 600 m above sea level. The gradient on the studied length of river is very pronounced, the river itself meanders and there are numerous boulders. Shallow areas with swiftly moving water currents are separated by places up to 2 m deep. Some streams, like the Ryjak, flow through wet meadows. Some of the streams, especially the Wisłoka, have been altered due to regulation works and gravel exploitation. There is a small impoundment in the Wisłoka River in Krempna. In areas where previously there were working farms, the streams are polluted and their beds have been straightened (sites 1 and 9, Table 1).

MATERIAL AND METHODS

The studies were conducted at 15 sites (Fig. 1, Table 1). At the majority of them, fish were caught three times on 22 - 23 May, 21 – 22 July and 20 October 1998. At sites 5, 14 and 15 there was only one catch made in the summer. Electric fishing was conducted using electric pulse catch gear (350 V; 3.5 A; 20 – 100 Hz) by applying the Beklemishev one passage rule (Backiel and Penczak 1989).

Cluster analysis allowed the sites to be divided into groups (Fig. 2). The analysis included the altitude above sea level, the gradient the maximum and minimum width and the maximum and average depth of a given stretch of river and the distance to the source. The data were standardized prior to calculations (Gauch 1982).

Calculations of the average fish density and biomass (Figs 3 and 4, Table 2) were based on the relationship between the effectivity of electric fishing and the logarithm of average specimen weight (Zalewski 1983).

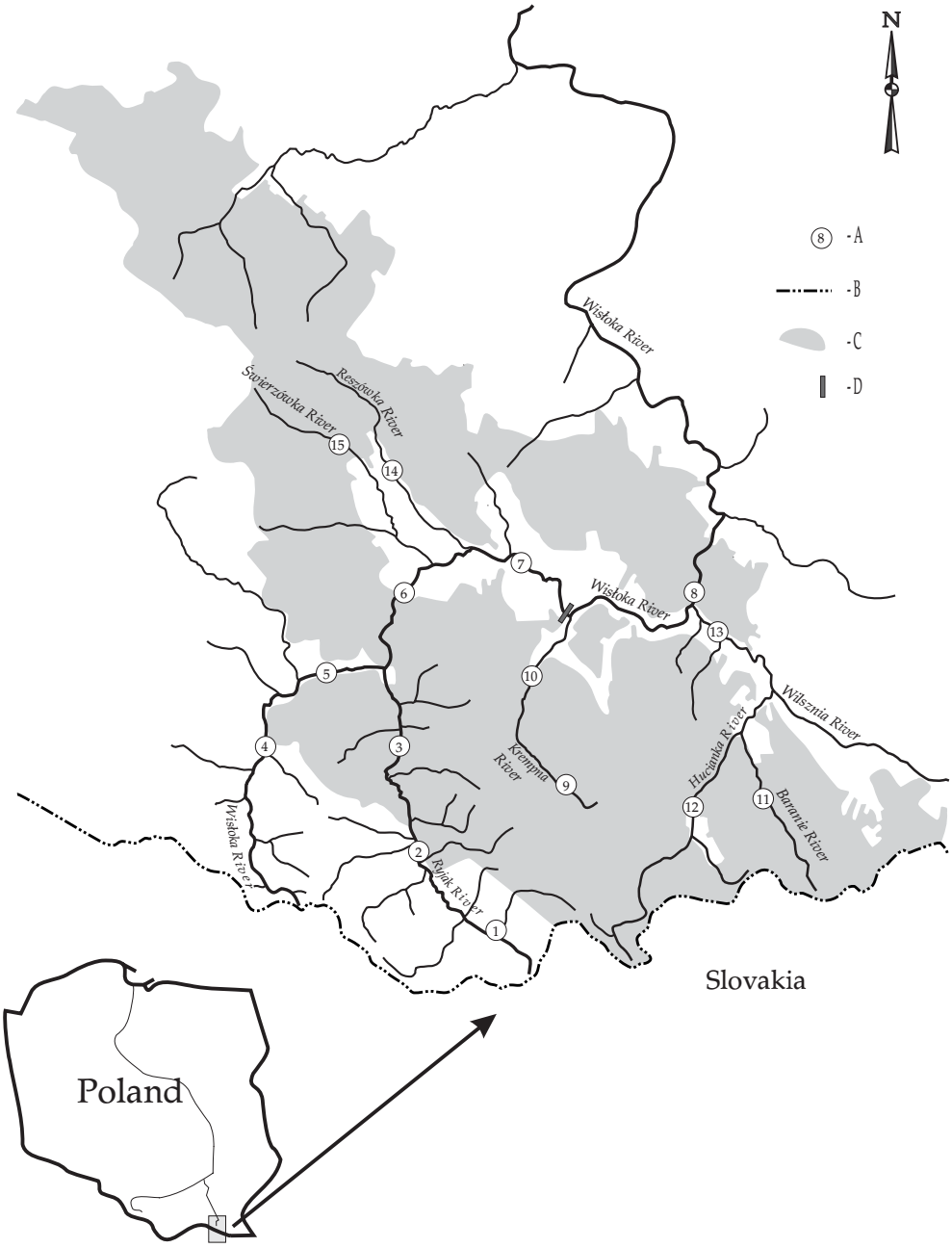

Fig. 1. Location of catch sites in the upper Wisłoka River drainage basin (A – catch site; B – Polish border; C – Magurski National Park; D – small impoundment in Krempna).

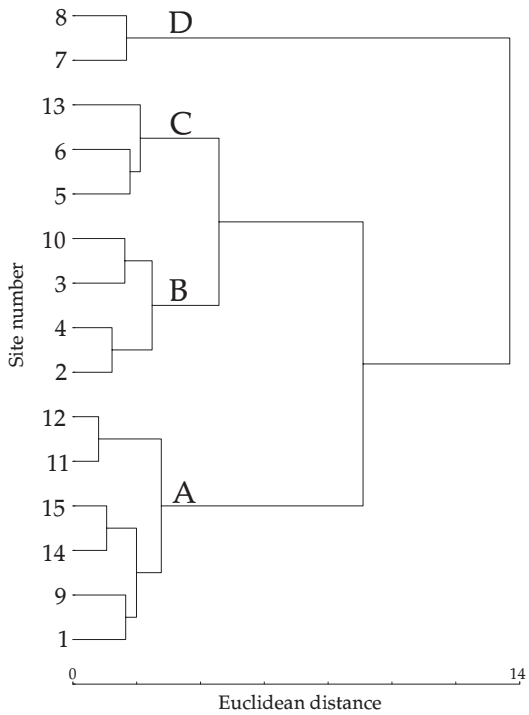

Fig. 2. Dendrogram of 15 fishing sites in the upper Wisłoka River drainage basin created by analyzing concentrations based on 7 morphometric characteristics (A – small streams with a gradient above 40‰; B – streams to up 5 m wide with a gradient up to 25‰; C – small streams up to 8 m wide with a gradient up to 11‰; D – rivers up to 15 wide with a gradient of less than 6‰).

Statistical analyses of the average values of fish density and biomass for particular groups of sites (Fig. 3) and the average species densities and biomass occurring in all the groups of streams (Fig. 4) were carried out using the Kruskal–Wallis test. The LSD test was used to group the averages. The χ^2 test was used for the statistical analysis of the differences between the ichthyofauna assemblages at sites 5 and 7, where the effects of poaching were very evident, and at sites 6 and 8, which are morphometrically the closest to the previous two sites. According to Magurski National Park personnel, poaching rarely occurred in the stretch of the Wisłoka River where sites 6 and 8 were located.

RESULTS

A total of 3,574 fish were caught with a total biomass of 70,653 g. The following species clearly dominated in terms of abundance: minnow *Phoxinus phoxinus* (L.);

TABLE 1

Characteristics of sites in the upper Wisłoka River drainage basin

Name of stream	Site number	Altitude [m]	Gradient [‰]	Distance from sources [km]	Width [m]	Mean depth (max.) [m]	Type of bottom*	Cover (4 grade scale)
Ryjak River	1	520	52.2	1.6	1 - 2	0.1 (0.5)	ms, ss, g, sa	+
	2	470	15.4	5.2	2 - 4	0.2 (0.7)	ms, bs, g	+++
	3	440	8.6	8.8	3 - 4	0.2 (0.4)	ms, bs, ss	++
Wisłoka River	4	465	25.7	5.6	2 - 5	0.3 (0.9)	ms, ss, g, sa	+++
	5	430	10.8	9.3	4 - 6	0.4 (1.2)	ms, ss, g	++
	6	410	6.7	13.7	4 - 8	0.3 (0.7)	ms, ss, bs	++
	7	380	5.7	18.2	6 - 15	0.3 (1.5)	ms, bs, ss, g	+++
	8	340	5.7	25.4	8 - 15	0.3 (1.5)	bs, ms, ss, g	+++
Krempna River	9	480	85.7	1.1	1 - 2	0.1 (0.3)	ms, bs, ss	+
	10	400	24.6	5.1	2 - 4	0.1 (0.4)	ms, ss, g	+++
Baranie River	11	440	53.3	3.2	2 - 3.5	0.2 (0.4)	bs, ms	++
Hucianka River	12	430	55.0	6.4	2 - 5	0.2 (0.6)	bs, ms, ss	++
Wilsznia River	13	345	11.0	7.4	3 - 5	0.3 (1.0)	ms, ss, bs, g	+++
Reszówka River	14	430	41.9	4.9	1 - 2.5	0.1 (0.5)	ms, bs, ss	++
Świerzówka River	15	470	51.4	3.2	1 - 2	0.1 (0.3)	bs, ms	++

* - *(bs – big stones; ms –medium stones; ss – small stones; g – gravel; sa - sand)*

chub *Leuciscus cephalus* (L.); spotted barbel *Barbus peloponnesius* Val. The total biomass was dominated by chub, brown trout *Salmo trutta* m. *fario* L., spotted barbel and minnow.

The sites were divided into four groups (Fig. 2). Group A included streams that were not very wide with a gradient that most often exceeded 50‰ (Table 1). Group B included the upper part of the Wisłoka River, the central and lower parts of the Ryjak stream and the lower course of the Krempna stream. Group C was comprised of sites located in the central part of the studied section of the Wisłoka River and the area near the mouth of the Wilsznia. Group D included sites 7 and 8 on the Wisłoka River.

Five fish species were recorded at the group A sites (Fig. 3), and stream minnow dominated in terms of abundance and biomass. Eastern sculpin *Cottus poecilopus* Heck. constituted 6.2% of the total abundance, while brown trout consti-

TABLE 2

Average densities - N (specimen 100 m^{-2}) and average biomass – B (g 100 m^{-2}) of fish caught in the upper Wisłoka River drainage basin (20 – 21. 07. 1998)

Species		Site number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Phoxinus phoxinus (L.)	N	1,048.6	248.3	264.4	48.3	7.0	32.6	23.0	21.8	2.6	23.5	154.8	243.1	65.6	66.9	127.6
	B	3,506.6	861.7	843.2	170.3	29.8	144.9	65.9	63.8	12.9	97.5	726.0	945.8	259.9	329.1	471.3
Salmo trutta m. *fario* L.	N	3.9	18.5	2.6	9.9	0.8	1.7	1.0	2.8	4.6	6.3		3.2	5.0	6.5	2.9
	B	11.8	1,059.4	156.6	415.7	118.9	267.5	79.8	216.4	121.0	185.0		220.9	359.3	408.9	233.5
Barbatula barbatula (L.)	N	13.2	4.7	6.5		0.7	6.2	2.4	7.2			10.6	0.9	1.9	1.7	
	B	100.4	51.4	56.3		7.2	47.0	11.6	48.0			92.3	14.4	15.6	35.0	
Cottus poecilopus Heck.	N		0.8	4.4	0.8	0.7			0.2	15.7	13.4	32.5	7.9		8.5	7.2
	B		9.1	36.6	9.1	7.2			4.3	113.3	130.1	230.7	7.9		36.7	72.3
Leuciscus cephalus (L.)	N			0.8		4.1	2.2	10.3	11.1					12.8		
	B			71.3		419.0	166.2	681.5	785.6					905.6		
Barbus peloponnesius Val.	N					4.6	9.4	11.1	28.5		1.7		0.7	4.6		
	B					164.8	299.7	306.6	855.2		66.0		36.2	143.8		
Leuciscus leuciscus (L.)	N								1.0					1.9		
	B								48.6					78.4		
Alburnoides bipunctatus (Bloch)	N							0.2	8.9					0.8		
	B							2.6	135.4					12.0		
Gobio gobio (L.)	N							1.2	1.0					4.5		
	B							20.0	10.9					45.2		
Thymallus thymallus (L.)	N						0.9		0.2							
	B						117.2		33.0							
Alburnus alburnus (L.)	N								0.2							
	B								2.2							
Total	N	1,065.8	272.3	278.7	59.0	17.9	52.9	49.1	82.8	22.9	44.8	197.8	255.8	97.1	83.5	137.7
	B	3,618.9	1,981.6	1,164.0	595.1	746.9	1,042.6	1,168.1	2,203.3	247.2	478.6	1,049.0	1,225.2	1,819.8	809.7	777.1

tuted 14.6% of the total biomass of the fish caught (Fig. 3). Brown trout specimens with a total body length of less than 18 cm dominated. Only at station 9 did eastern sculpin dominate in terms of both abundance and biomass (Table 2). In group B, the abundance of minnow decreased and brown trout dominated in the biomass. The majority of the brown trout specimens caught in the drainage area of the upper Wisłoka River originated in this group of streams, mainly from the Ryjak

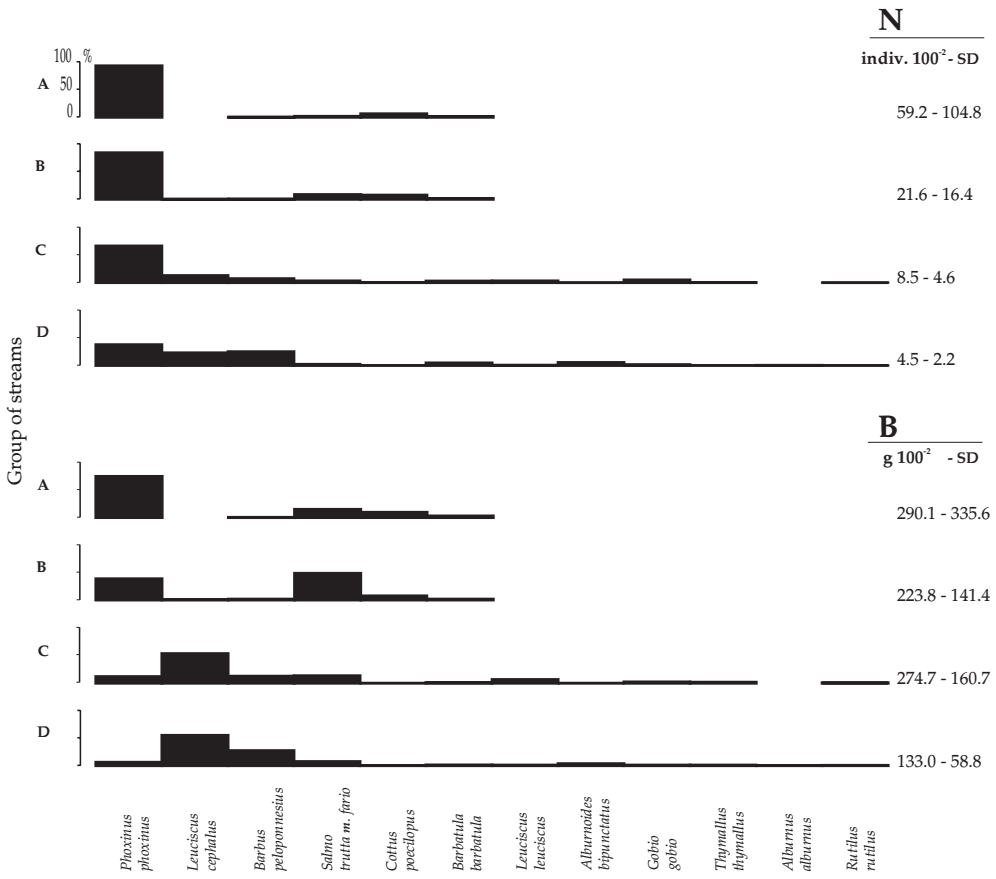

Fig. 3. Average percentage share of fish species in the material collected according to group (N – density; B – biomass; SD – standard deviation).

stream. Minnow dominated in terms of abundance at sites from groups C and D, while chub and spotted barbel also made a significant contribution and they dominated in terms of biomass. Spirlin *Alburnoides bipunctatus* (Bloch) was exceptionally abundant.

The average total fish density (Fig. 3) was the highest in the smallest streams (group A) and the lowest in the lower parts of the Wisłoka River (group D). The difference between the average density was significant (Kruskal–Wallis test, $H = 13.631$, $P < 0.01$). No significant differences were noted among the average biomasses. Significant differences between the average densities and average biomasses were observed

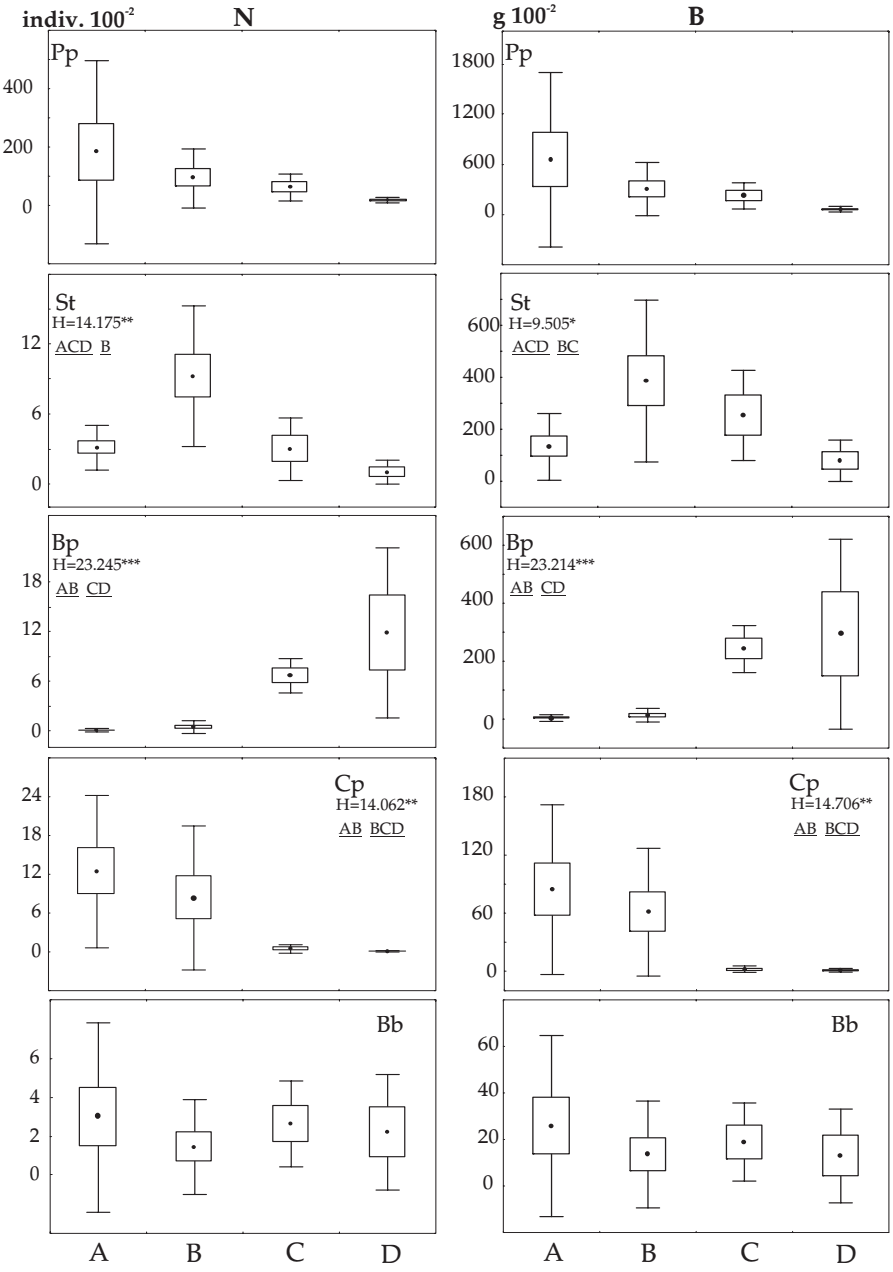

Fig. 4. Average density (N) and average biomass (B) of fish species occurring in all the groups in the upper Wisłoka River drainage basin (A - D –groups, * - P<0.05; ** - P<0.01; *** - P<0.001; underlining signifies homogeneous groups identified with the LSD test). Pp - *Phoxinus phoxinus*, St - *Salmo trutta* m. *fario*, Bp - *Barbus peloponnesius*, Cp - *Cottus poecilopus*; Bb - *Barbatula barbatula*.

for spotted barbel, brown trout and eastern sculpin, all of which occurred in all the groups of sites (Fig. 4). In summer (Table 2), a very high average density and biomass of minnow were observed in the upper course of the Ryjak Stream (station 1). Brown trout was very abundant at station 2, while chub and spotted barbel were abundant at sites 7 and 8.

Statistically significant differences between fish assemblages were confirmed at sites where the anthropogenic pressure factor varied, i.e., for sites 5 and 6: biomass: $\chi^2 = 1668.365$, $P < 0.001$; density: $\chi^2 = 17.449$, $P < 0.001$; for sites 7 and 8: biomass: $\chi^2 = 1119.424$, $P < 0.001$; density: $\chi^2 = 37.55$, $P < 0.001$).

DISCUSSION

The ichthyofauna of the upper Wisłoka River drainage basin resembles the fish assemblages of other rivers which originate in the Low Beskidy (Skóra and Włodek 1989, Augustyn et al. 1998, Włodek and Skóra 1999). Only rarely in the upper parts of small streams did eastern sculpin and brown trout dominate the ichthyofauna (Table 2). This is similar to the high mountain streams in the Western Carpathian Mountains (Skóra and Włodek 1988, 1991, Augustyn et al. 1996) and the Bieszczady Mountains (Kukuła 1999). However, minnow dominated in terms of abundance in the majority of streams (Table 2). Brown trout was very abundant in group B streams. The contribution of minnow to the biomass dropped in groups C and D, while that of chub and spotted barbel increased (Fig. 3). Similarly structured fish assemblages were also observed in the drainage area of the Raba River (Starmach et al. 1988).

Minnow was very abundant (Fig. 3); this has also been noted by Włodek and Skóra (1999). The mass occurrence of minnow was observed in the drainage areas of the Skawa, Soła and Raba rivers (Skóra and Włodek 1988, 1991). The maximum density of this species in the drainage area of the Raba River was 500 specimens per 100 m^2, although other densities were usually significantly smaller (Starmach et al. 1988). Populations of this species as abundant as those noted in many streams of the Wisłoka River drainage area (Table 2) are observed rarely, and only in the upper Wisłok was such a consistently clear domination of this species observed (Skóra and Włodek 1989).

Spirlin, an endangered species in Poland (Witkowski et al. 1999), was relatively abundant in the studied drainage area (Table 2). It was caught along a lengthy stretch of the Wisłoka River downstream from Krempna (Włodek and Skóra 1999) and was

particularly abundant at station 8. Neither barbel *Barbus barbus* (L.) nor Carpathian barbel *Barbus cyclolepis* Heck. were observed during the study, although in the 1960s both species were observed in the upper Wisłoka River (Rolik 1971). The disappearance of barbel is seen in the majority of Polish and European rivers (Lusk 1996, Marszał and Przybylski 1996). Barbel is still relatively abundant in the central and lower parts of the Wisłoka River; however, this species is gradually being replaced by chub (Włodek and Skóra 1999).

Brown trout was recorded at all the study sites (Table 2). Small specimens dominated among the brown trout caught. Poaching was mainly responsible for the lack of older age classes of many fish species, including brown trout (Skóra and Włodek 1988, 1989, 1991, Kukuła 1996). In addition to poaching with fishing rods or nets, contaminating fish with chemicals was also reported in the Magurski National Park and surrounding areas. The irregular park borders make controlling poaching difficult. The greatest source of information regarding poaching came from the areas of the Wisłoka where sites 5 and 7 were located. Significant differences were revealed between the fish assemblages at these sites and the ones with similar morphometry. This is probably related to a great extent to poaching. Many authors, such as Penczak et al. (1988) and Penczak and Mann (1993) associate changes in the structure of ichthyofauna assemblages with poaching.

The impoundment in Krempna plays an important role for fish in this area, since it is a physical barrier that prevents fish from migrating upstream. These types of constructions have an adverse impact on ichthyofauna (e.g. Penczak et al. 1984). Changes in stream beds due to gravel exploitation, regulation works and forestry management also have a heavy adverse impact on the ichthyofauna of the studied drainage area. One consequence of the preceding activities is the decreasing numbers of hiding-places for fish, for example at sites 1 and 9.

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STRESZCZENIE

ZAGROŻENIA ICHTIOFAUNY MAGURSKIEGO PARKU NARODOWEGO I JEGO OTULINY

Badaniami objęto zlewnię górnej Wisłoki. Wyznaczono 15 stanowisk badawczych (rys. 1, tab. 1). Stanowiska podzielono na 4 grupy (rys. 2). Stwierdzono 12 gatunków ryb. W zebranym materiale dominantami pod względem liczebności były strzebla potokowa, kleń i brzanka (tab. 2). W ciekach najmniejszych (grupa A i B) wyraźnie dominowała strzebla potokowa z lokalnie dużym udziałem pstrąga potokowego w biomasie ryb (rys. 3 i 4). W rzekach (grupa C i D) spadał udział strzebli potokowej, a w biomasie dominował kleń i brzanka. Dość liczna była tu piekielnica. Wśród łowionych pstrągów przeważały osobniki o niewielkich rozmiarach ciała. Główną przyczyną braku starszych klas wiekowych było tu kłusownictwo. Niekorzystny wpływ na ichtiofaunę badanej zlewni mają również: próg na Wisłoce w Krempnej, zmiany w korycie potoków wywołane eksploatacją żwiru, pracami regulacyjnymi, a także pracami leśnymi.

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