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THE STRUCTURE OF ICHTHYOFAUNA AND ANGLING PRESSURE ON FISH IN UPPER SECTION OF BYSTRZYCA RIVER

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Abstract. The upper section of the Bystrzyca River has a character of trout and grayling zone of river. The aim of the study was to determine the species composition of fish in the upper section of the Bystrzyca River and attempt to evaluate angling pressure on fish in this section of river based on analysis of records of amateur fishing. To determine the fish composition the control fishing was conducted using electric fishing gear. The assessment of angling pressure was based on the analysis of 2135 records of fishing in the mountain type rivers in 2012 year, obtained from PAA Lublin. The brown trout and grayling were a dominant fish species in the upper section of the Bystrzyca River, and the first of them was present on the whole length of the river and had the highest average density. The changes of fish community along the river course from Salmonids lead to an increase of the share of Cyprinids fish has been observed. Analysis of records of amateur fish catch revealed that the upper section of the Bystrzyca River is under considerable of angling pressure and the most commonly fished species was brown trout. However, the properly carried fishery management on this section of river and the establishment of „no kill” zone allows for proper maintenance of the populations of fish species valuable for anglers.

Key words: ichthyofauna, upland river, brown trout, angling pressure, Bystrzyca River

INTRODUCTION

The problem of fishery management on open water, especially on the rivers, is extremely important and requires specialized knowledge and of taking a number of activities. The one of the basic actions, in addition to fish stocking, is the monitoring of fish, which allows to determine the fish species composition, the presence of rare species or to eliminate unwanted fish species, including alien species [Penczak 2008].

The ichthyofauna of the rivers of the south-eastern Poland is relatively poorly recognized [Witkowski and Kotusz 2008]. The one of these rivers is the Bystrzyca River, whose previous studies were limited to its ecological status, including occurring there fish species [Radwan *et al.* 1988]. The upper part of its course, ie. above Zemborzycki Reservoir, has a diametrically different nature than below the dam. The upper part of the Bystrzyca River in terms of habitat parameters such as water temperature, bottom type and dissolved oxygen content is conducive to the occurrence of salmonids and is used as a mountain river [Augustyn 2008].

The angling has a major impact on the conduction of fishery management in freshwaters [Wrona and Guziur 2007]. Because of its selectivity it has the greatest impact on the functioning and change of fish community, primarily in rivers [Leopold and Bnińska 1987]. Therefore, it is necessary to know the real angling pressure and its impact on fish community in small rivers. Hence, the aim of the study was to determine the species composition of fish in the upper part of the Bystrzyca River and attempt to evaluate angling pressure on fish in this section of river based on analysis of records of amateur fishing.

MATERIALS AND METHODS

Bystrzyca River is a left tributary of Wieprz River. Its total length is approx. 70 km and the catchment area 1315.5 km². This river has source in Sułów village, and flows into the Wieprz River in the village Spiczyn [Michalczyk 1997a]. Mean slope of the river is 1.14‰ [Michalczyk 1997b]. On the southern part of Lublin agglomeration, on the Bystrzyca River, the Zemborzycki Reservoir is located. The dam of this reservoir is also the border of the upper part of the studied river. A river basin is located on the soils of loess origin and river flows mainly through agricultural areas [Misztal *et al.* 1996]. In terms of fishery management the river is utilized by PAA Lublin as a fishery division „Bystrzyca 1”. The upper part of the river is classified as a trout and grayling zone. The user conducts an annual fish stocking with grayling fry (12 000 pcs.) and brown trout fry (15 000 pcs.) [PZW 2015a].

The control fishing carried out in autumn 2012 on the 8 study sites on Bystrzyca River from Bystrzyca Zakrzewska village to a place below Prawiedniki village (Fig. 1). Electrofishing was conducted using standardized electric device IUP-12 type.

All caught fish were determined to species, their total length (TL) and body mass (W) (in g) were measured. Stability of species occurrence (C_i) was calculated by the following formulas:

$$C_i = 100s_i / s_t$$

where: s_i – number of sites where species ‘i’ was present, s_t – total number of study sites. The species richness and the dominance index ($D_i\%$) and biomass dominance index ($W_i\%$) of fish were calculated using following formulas:

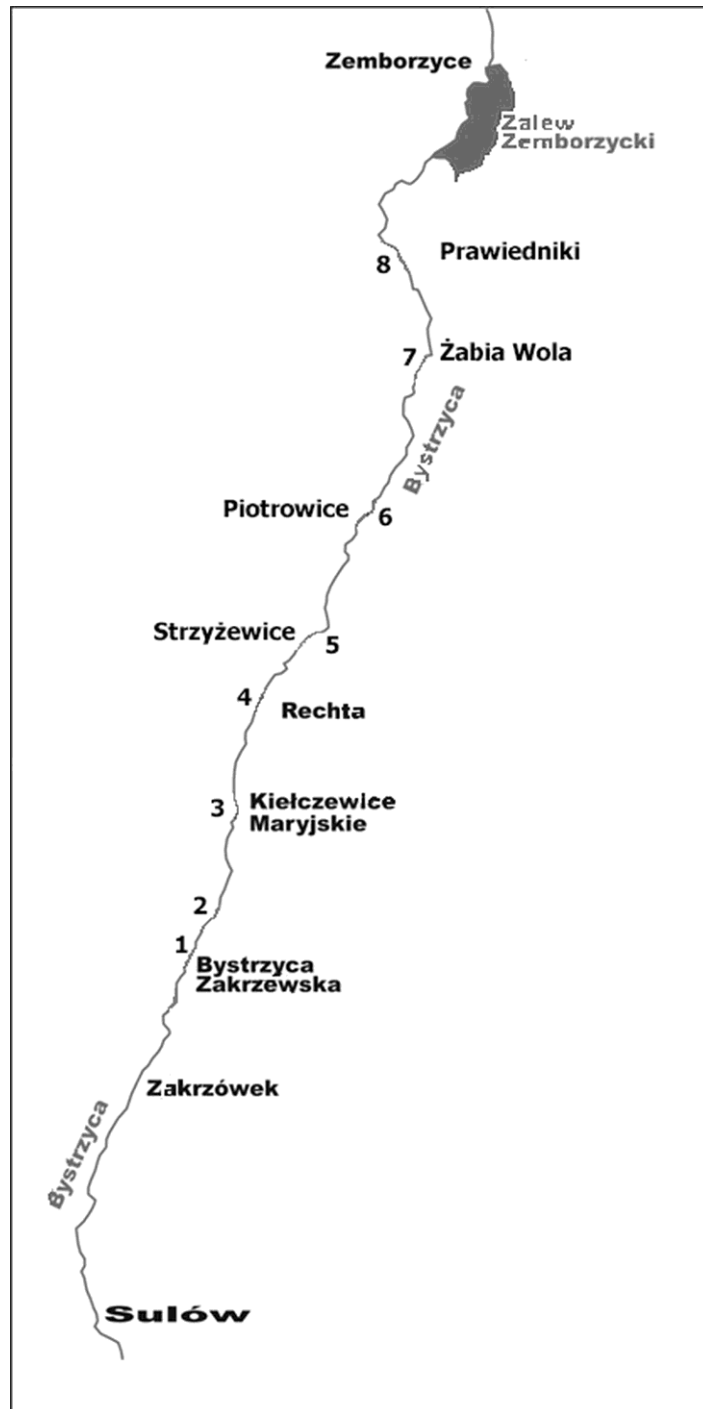


Fig. 1. Localization of study sites on Bystrzyca River

$$D_i = 100n_i / \Sigma n_i$$

$$W_i = 100w_i / \Sigma w_i$$

where: n_i – number of n species individuals, w_i – biomass of n species.

For fish obtained in the study the species richness, density, abundance and domination structure in biomass were determined. The all fish data obtained in control fishing were converted to catch per unit effort (NPUE and WPUE). For the abundance, the NPUE, it was the number per unit effort, i.e. number of fish individuals caught in 100 m² of river (ind. 100 m²) and for the fish biomass, WPUE, it was weight per unit effort, i.e. fish biomass (in grams) of the fish caught in 100 m² of river (g 100 m²).

Table 1. Hydromorphological parameters of river and physical and chemical parameters of water on study sites of upper Bystrzyca River (mean values for summer and autumn 2012)

Study sites	Localization	Length of study sites m	Mean width m	Depth range m	pH	Conductivity $\mu\text{S}\cdot\text{cm}^{-1}$	Disolved oxygen mg l^{-1}	Temperature $^{\circ}\text{C}$
1	Bystrzyca Zakrzewska	150	4	0.3–0.5	6.3	427	9.3	11.3
2	Bystrzyca Zakrzewska Most	100	4	0.2–0.5	6.5	417	9.8	12.0
3	Kiełczewice Maryjskie	100	5	0.5–0.7	6.9	415	12.4	13.1
4	Rechta	100	6	0.3–0.4	6.8	417	10.5	13.2
5	Strzyżewice	50	4	0.4–0.7	6.6	409	10.7	13.0
6	Piotrowice	100	5	0.4–0.6	6.6	413	10.6	13.1
7	Żabia Wola	150	7	0.4–0.8	6.6	443	10.5	13.2
8	Below Prawiedniki	150	8	0.5–1	6.8	451	10.6	13.5

The information about angling pressure on upper Bystrzyca came from the analysis of the 2135 fishing records from 2012 year. The fishing records were made available by the user of river and to the analysis was not used 68 registers, in which there were no entries of 2012. In each of the analyzed fishing records the number of angler exit for fishing, the month of the most intense fishing, and in the case of caught fish their number and weight were noted.

The basic hydromorphological parameters (width and depth) of river were measured. Moreover the physical and chemical parameters of water were examined *in situ* on all study sites. Temperature, conductivity, pH and dissolved oxygen were recorded using a multiparametric probe (YSI 556, USA) and pH of water was measured using SP3000 pH-meter. The characteristics of study sites of river and physical and chemical parameters of water were shown in Table 1.

RESULTS

Totally 16 fish species belonging to 7 families on the upper section of Bystrzyca River were found. The greatest stability of occurrence was characterized by brown trout *Salmo trutta m. fario* ($C_i = 100\%$) and grayling *Thymallus thymallus* ($C_i = 87.5\%$). In all study sites the species richness of fish were reached from 3 to 12 species (Table 2).

The density of all fish was varied depending on the study sites and ranged from 11.3 NPUE to 184.0 NPUE. The highest density of fish were recorded on Strzyżewice and the smallest in Żabia Wola (Table 2). Among the fish species the highest average density characterized brown trout (22.0 ± 23.9 NPUE) and roach *Rutilus rutilus* (16.1 ± 17.2 NPUE), while the smallest density by common carp *Cyprinus carpio* and pike *Esox lucius*, only 0.7 NPUE (Table 2). The pronounced change of dominance in fish community depending on the study sites along river course was observed. The first two sites was dominated by brown trout and grayling and their overall share was over 95% in abundance and 99.8% in the biomass of all caught fish. However, different domination structure was found on these two study sites. In Bystrzyca Zakrzewska (site 1) the highest abundance and biomass had brown trout and in Bystrzyca Zakrzewska Most (site 2) – grayling (Fig. 2).

Along the river course on the following sites (from 3 to 7) increased participation of species such as loach *Barbatula barbatula*, roach, Prussian carp *Carrasius gibelio* and stickleback *Gasterosteus aculeatus*. A dominant but slightly smaller share of both, the number and biomass, was characterized for Salmonids fish species (Fig. 2). The fish community on last study site was totally different. The highest species richness (12 species, Table 2) and mutual domination of many species was there recorded. Here, the dominant species in the abundance turned out to be roach, perch *Perca fluviatilis* and stickleback and in the biomass roach, ide *Leuciscus idus* and chub *Squalius cephalus* (Fig. 2).

Analysis of the results of fishing records from 2012 showed that the largest number of anglers fishing in spring (an average of 179 anglers) and anglers fishing in the spring and summer in total were as many as 72% of all anglers. In the spring season the average number of fishing days was 525, while the least (average 87 days) in winter (Table 3).

In total in 2012 in upper section of Bystrzyca River 113 fish were caught, and 93% of its abundance was a brown trout. Among the other caught fish species were perch, ide and pike (2 specimens) and one individual's of bream *Abramis brama* and grayling (Table 3). It turned out that almost half of the fish (48%)

Table 2. Characteristics, stability of occurrence and density (in NPUE) of fish species observed in upper part of Bystrzyca River; C_i – stability of species occurrence; T – trophy groups: I – benthivorous, O – omnivorous, P – predators; R – reproductive guild [Balon *et al.* 1990]: F – phytophils, L – lithophils, FL – phytolithophils, Ps – psammophils, A – ariadnophils; H – habitat: P – pelagic species, B – bottom species; sd – standard deviation

Fish familie	Fish species	T	R	H	Study sites								C_i (%)	NPUE	
					1	2	3	4	5	6	7	8		Mean \pm sd	Min-Max
<i>Salmonidae</i>	Brown trout (<i>Salmo trutta trutta</i>)	I/P	L	P	x	x	x	x	x	x	x	x	100	22.0 \pm 23.9	0.7–74.0
<i>Thymallinae</i>	Grayling (<i>Thymallus thymallus</i>)	I/P	L	P	x	x	x	x	x	x	x		87.5	11.6 \pm 9.0	4.7–31.0
<i>Cyprinidae</i>	Prussian carp (<i>Carassius gibelio</i>)	O	L	B	x	x		x	x	x			62.5	8.5 \pm 8.0	2.0–20.0
	Roach (<i>Rutilus rutilus</i>)	O	L	P			x	x	x	x	x		75	16.1 \pm 17.2	1.3–42.0
	Ide (<i>Leuciscus idus</i>)	O	FL	P			x						25	3.3 \pm 1.9	2.0–4.7
	Gudgeon (<i>Gobio gobio</i>)	I	Ps	B			x		x	x	x		62.5	1.7 \pm 0.9	0.7–3.0
	Dace (<i>Leuciscus leuciscus</i>)	I	FL	P					x				25	8.7 \pm 10.4	1.3–16.0
	Tench (<i>Tinca tinca</i>)	I	F	B						x			25	2.3 \pm 2.4	0.7–4.0
	Sunbleak (<i>Leucaspis delineatus</i>)	I	F	P						x			12.5	1.0	-
	Chub (<i>Squalius cephalus</i>)	O/P	L	P									12.5	2.7	-
	Bream (<i>Abramis brama</i>)	O	FL	B									12.5	2.7	-
	Carp (<i>Cyprinus carpio</i>)	O	F	B									12.5	0.7	-
<i>Cobitidae</i>	Loach (<i>Barbatula barbatula</i>)	I	Ps	B	x		x			x	x	x	62.5	3.7 \pm 4.2	0.7–10.0
<i>Gasterosteidae</i>	Stickleback (<i>Gasterosteus aculeatus</i>)	I	A	P	x		x						50	2.9 \pm 2.8	0.7–6.7
<i>Esocidae</i>	Pike (<i>Esox lucius</i>)	P	F	P	x								12.5	0.7	-
<i>Percidae</i>	Perch (<i>Perca fluviatilis</i>)	I/P	FL	P				x	x				37.5	10.4 \pm 10.4	2.0–22.0
Species richness					6	3	7	5	7	8	6	12			
Total NPUE					47.4	42.0	54.0	44.0	184.0	53.0	11.3	68.0			

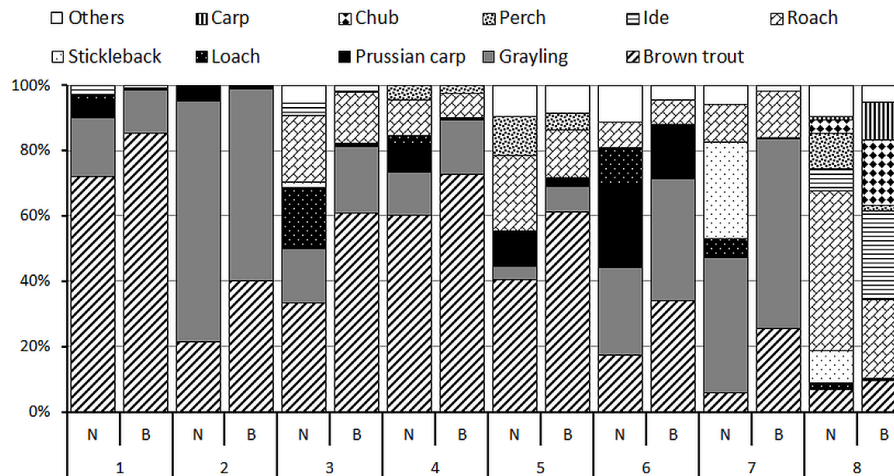


Fig. 2. The number (N) and biomass (B) domination of fish in study sites (1–8) located in upper Bystrzyca River

Table 3. Characteristics of angling pressure and anglers preferences based on records of fish catches in upper Bystrzyca River ($N = 2135$)

Season	Mean numbers of anglers	Numbers of angling days		Favorit months for angling	Anglers abundance %
		mean	range		
Spring	179	525	493–582	March	41
Summer	135	345	301–383	August	31
Autumn	38	95	91–100	September	20
Winter	87	242	25–424	January	8

were caught at spring. Analysis of the size structure of caught brown trout showed that 51% of them had a total length in the range from 36 cm to 45 cm.

DISCUSSION

Bystrzyca River has a completely different character above Zemborzycki Reservoir and in the middle and lower its course. Its upper part is one of the few sections of rivers in the Lublin region having the characteristics of mountain or highland rivers. The presence of brown trout in the Bystrzyca River is the result of conducted by PAA of fish stocking after 1980 year [PZW 2015a]. It is recognized that before this period in the XX century brown trout does not occur in this river [Cios 2013]. Current research indicates the success of the introduction of this

species. The impact on this success had probably the work related to the construction the artificial spawning grounds in some places (the Zakrzówek area), which have been successfully used mainly by the brown trout during the spawning season [PZW 2015b]. At the same time as reported Szczerbowski [2001] restocking of rivers by rheophilic fish species, including Salmonids, are one of the key actions in the fishery management in the freshwaters where the fish have not the possibility for natural spawning. As shown by observations of brown trout and grayling are the most common species occurring in this part of the river (Table 2). It corresponds to the structure of restocking carried out here (by PAA Lublin) and also the results of the analysis of fishing records where brown trout represents about 93% of all caught fish. As follows from the ichthyological research conducted by Wyzga *et al.* [2008] the mountain type rivers, usually characterized by low values of species richness. In addition other research shows that the most dominant species in upper part of river were brown trout and grayling [Radtke *et al.* 2005]. The results obtained in this study also showed a similar pattern, where the dominant fish in the study sites were fish species listed above. A higher abundance of these species may be also the result of establishing on selected sections of river the different rules of fishing, so-called “no kill” zone.

According with the change of the character of the Bystrzyca River, increasing the share of cyprinids in fish community was noted (Fig. 2). On the sites located closest to the river source the brown trout was dominant species and also grayling increased participation on the following sections was determined. Similar changes in the share of species in the fish community are also observed in Nysa Kłodzka and its tributaries [Kotusz *et al.* 2009]. Whereas the increased participation of cyprinids fish on the last site, may be associated with the proximity of Zemborzycki reservoir. This pattern was observed also in other rivers (i.e. Wisłok, San Bauda) in which the water reservoir were builded [Kukuła and Bylak 2011, Radtke *et al.* 2011]. The impact on it may also have the presence of ponds along the Nędznica River, a tributary of Bystrzyca River. Not without significance is also the character of the river in this section. The water flow rate is lower because the width of the river bed increased (Table 1). The weakening of water stream reduced the share of rheophilic species increasing the share of stagnophilic species.

Analysis of fishing records showed a significant angling pressure on that section of the river (Table 3), but it is mainly an angling for satisfaction, without taking a fish. In 2012 year the anglers caught only 113 individuals of fish, including 105 brown trout individuals. In the light of the archival data (year 2008–2010) in the upper Bystrzyca River anglers usually fishing the similar numbers of brown trout, in the range from 90 to 184 per year [PZW 2015b]. According Puwalski [2011] the effects of angling pressure on mountain rivers and improper fishery management may lead to the destruction of naturally occurring there fish species. Hence, the constantly restocking with fry is intended to aimed at maintaining stable populations of endangered fish species and species exposed to high angling

pressure. Also, we are aware that in areas where there is a large angling pressure may occur to increase the dynamics of the eutrophication process, through the use of the fishing baits rich in phosphorus and nitrogen compounds [Czer-niawski *et al.* 2010].

Present observations are part of a growing, but continually unsatisfactory, amount of research on angling pressure on Polish rivers [Wołos *et al.* 2001]. They allow to characterize the specificity of angling pressure on this category of freshwaters, the efficiency of fishery management or determine the preferences and needs of anglers. Moreover, obtained in the present study results provide information on the fish fauna found in the upper section of the Bystrzyca River and may be useful and used by the user to conduct the rational fishery management on this water.

CONCLUSIONS

- In the upper section of the Bystrzyca River were found 16 species of fish belonging to 7 families.
- Brown trout and grayling were dominant species in most of study sites.
- The changes of fish community along the river course from Salmonids lead to an increase of the share of Cyprinids fish were observed.
- The upper section of the Bystrzyca River is under considerable of angling pressure and the most commonly fished species was brown trout.
- The properly carried fishery management on this section of river and the establishment of „no kill” zone allows for proper maintenance of the populations of fish species valuable for anglers.

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STRUKTURA ICHTIOFAUNY I PRESJA WĘDKARSKA NA RYBY W GÓRNYM ODCINKU RZEKI BYSTRZYCY

Streszczenie. Górny odcinek rzeki Bystrzycy ma charakter rzeki krainy pstrąga i lipienia. Celem badań było określenie składu gatunkowego ryb w górnym biegu rzeki Bystrzycy oraz próba oceny presji wędkarskiej na ryby na tym odcinku na podstawie analizy rejestrów amatorskiego połowu ryb. W celu ustalenia składu ichtiofauny przeprowadzono odłowy kontrolne ryb przy wykorzystaniu elektrycznych narzędzi połowu. Oceny presji wędkarskiej dokonano na podstawie analizy

2135 rejestrów połowów ryb na wodach górskich z roku 2012 udostępnionych przez ZO PZW Lublin. Gatunkami dominującymi w górnym odcinku rzeki Bystrzycy były pstrąg potokowy i lipień, z których pierwszy występował na całej długości rzeki i miał największe średnie zagęszczenie. Zaobserwowano, że wraz z biegiem rzeki zmieniała się dominacja zespołów ryb z przewagi ryb łososiokształtnych na wzrost udziału ryb karpiowatych. Analiza rejestrów połowów wykazała, że górny odcinek rzeki Bystrzycy jest pod znaczącą presją wędkarską, a gatunkiem najczęściej odławianym jest pstrąg potokowy. Jednak prowadzona na tej rzece gospodarka zarybieniowa i ustanowienie odcinków „no kill” pozwala na właściwe utrzymanie populacji cennych wędkarsko gatunków ryb.

Słowa kluczowe: ichtiofauna, rzeka wyżynna, pstrąg potokowy, presja wędkarska, rzeka Bystrzyca