



## The fish fauna in selected rivers of the Mazovian Lowland

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**Abstract:** In 1999–2003, investigations of the fish fauna were carried out in selected rivers of the Mazovian Lowland. Electrofishing was used to investigate species diversity and abundance at 35 sampling sites. In total, 8618 fish representing 29 species were caught, weighing in total 77.9 kg. 13 to 22 species of fish and lamprey were registered. The highest number of species was identified in the Świder River (22), dominated in abundance by roach (35.1%) and stone loach (34.9%), and in the Rządza River (20), dominated by gudgeon (33.4) and roach (24.9%). Ten-spined stickleback dominated in the Długa River (45.5%), roach in the Klusówka river (27.0%), and gudgeon (48.4%) and sunbleak (30.0%) in the Utrata River. 9 reophilic species were identified in particular rivers, accounting for 8.6% to 61.0% of total abundance. The abundance of pike, the major predator of small lowland rivers accounted for 0.1% in the Utrata River to 1.3% in the Rządza River. The highest abundance of fish in terms of numbers and the biomass per 1 km of river course were found in the Klusówka River and the Długa River.

**Key words:** lowland rivers, dominant species, fish communities, stability of occurrence

### INTRODUCTION

So far, studies of the fish fauna of the Mazovian river have been carried out in the Jeziorka River, which flows into the Vistula River near Wilanów and the Czarna Struga River, the tributary of the Długa River in the Narew River basin (Rembiszewski 1964), the Bzura River and its right tributary the Utrata River, the Wkra River, which flows into the Narew River below the Dębe dam, left tributaries of the Narew River, some of which are located in the Mazovian region, as well as the Pilica basin (Penczak 1968, Zalewski & Penczak 1981, Penczak et al. 1991, 1995, 2001). Also the Liwiec River, left tributary of the Bug River in the eastern part of the Mazovian voivodeship was investigated within the boundaries of two macroregions: the South Podlasie Lowland and the Central Mazovian Lowland as well as the Skrwa River (Marszał et al. 2004, 2006). Information on fish can also be found in the study on the fauna conservation strategy in the Mazovian Lowland (Kot & Dombrowski 2001).

In 1999–2003, experimental catches were conducted in selected five small rivers of the Mazovian Lowland, characterised by varied size, river bed morphology and coastal zone structure. Catches were conducted in the following rivers: the Długa River, the Klusówka River, the Utrata River, the Świder River and the Rządza River. They are typical lowland rivers, with a morphology of foothill rivers in some parts. Varied geomorphologic parameters of these rivers are responsible for species composition of fish communities, composed both by species typical for lowland rivers, as well as those characteristic for upland streams (Starmach 1964, Lassleben 1977). A common feature of these rivers is the close vicinity of the Warsaw agglomeration and therefore particular risk of anthropopression. Flowing through highly urbanized areas of the most densely populated Mazovian voivodeship (Baranowski 1999), the rivers in this region collect municipal, agricultural and industrial waste water and are exploited by anglers and recreation.

The purpose of this investigation was to assess the state of the ichthyofauna and species richness in small, lowland rivers, flowing in the vicinity of a big agglomeration.

#### STUDY AREA

The rivers under investigation flow in the Mazovian Lowland, within a few dozen kilometres from the Warsaw agglomeration (Fig. 1).

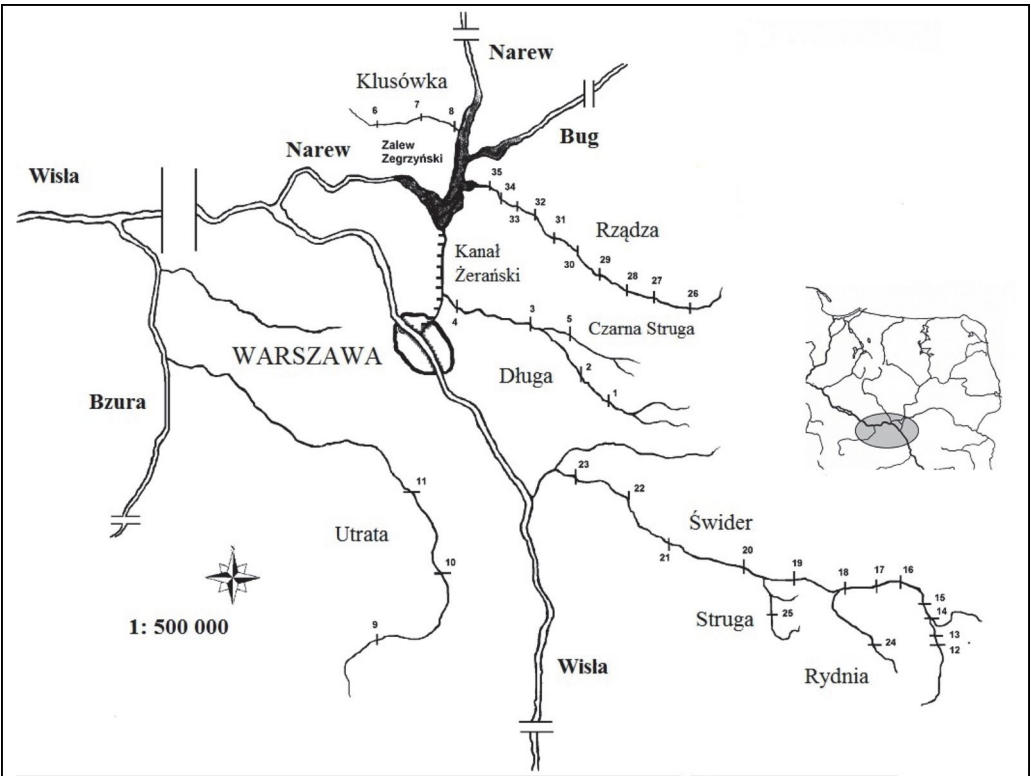


Fig. 1. Location of electrofishing sites in the investigated rivers.

The Długa River has its source at 165 meters above sea level, east of Mińsk Mazowiecki. Its waters flow to the Żerań canal, connecting the Vistula River to the Zegrze Reservoir. The upper part of the Długa River has disappeared. The river appears again in Halinów and its watercourse is visible below the carp ponds. The Czarna Struga River, which starts in the Wołomin forest district, is the only bigger tributary of the Długa River.

The sources of the Klusówka River are located at 115 m above sea level, in the forests close to Żabiczyn. It flows into the Zegrze Reservoir above Wierzbica. Its entire watercourse has a natural, unregulated waterbed.

The Utrata River is the right tributary of the Bzura River, into which it flows at its 25.6 km. It starts from northern slopes of Wysoczyzna Rawska, near Żelechów.

The Świder River has its sources in Wysoczyzna Sądecka, near the town of Stoczek Łukowski, and its mouth at 490 km of the Vistula River, near the town of Świdry Wielkie. In 1978, a landscape reserve "Świder" with an area of 238 ha, covering 41 km of the middle and lower river course was created to ensure river protection. The protected area covers the

riverbed and 20 m wide strip of the embankments (Monitor Polski No. 4, 1978). This reserve is part of the Mazovian Landscape Park, created in 1986 (Official Journal of Mazovian Voivodeship No. 13, 2001).

The Rządza River ends its course in the Zegrze Reservoir. The river sources are located close to the Wiśniew locality, at the altitude of 185 m above sea level. The river meanders, splits into branches and flows through a wide valley with a marshy bed. In its upper and middle course, the river flows within the boundaries of the Mińsk Area of the Protected Landscape created in 1986 under the Regulation of the Governor of the Mazovian Voivodeship (Regulation No. 39).

Basic information on the investigated rivers can be found in Table 1.

Table 1. Characteristics of the investigated rivers.

River	Catchment area (km <sup>2</sup> )	River length	Slope (‰)	Water flows m <sup>3</sup> sek <sup>-1</sup>	Human impact		
					Regulation of river	Hydro-technical	Others
Długa	210.30 km <sup>2</sup>	47.5	0.6	0.89	30–60%	weirs	sewage, fish farms
Czarna Struga	25.00 km <sup>2</sup>	7.7	0.5	0.81	30%	river regulated in the upstream	
Klusówka	135.65 km <sup>2</sup>	18.0	0.5	no data	natural	none	domestic wastewater
Utrata	701.56 km <sup>2</sup>	76.5	0.8	0.01–3.55	30–60%	weir on 52 and 62 km of river, small reservoirs,	domestic and industrial wastewater, fish farms
Świder	1150.00 km <sup>2</sup>	89.0	1.0	4.41	former regulation in the upstream	concrete weirs on 21 and 39 km of river, small reservoir	domestic and industrial wastewater, strong fishing pressure
Rządza	474.00 km <sup>2</sup>	66.5	0.8	1.25	30%	weirs, fish farms	domestic wastewater, strong fishing pressure

## MATERIAL AND METHODS

35 sampling sites were established in the studied rivers. Diversity of riverbed and its embankments as well as the closest vicinity were taken into account in selecting the sampling sites (Buras & Gasiński 2000). Site characteristics is presented in Table 2.

Depending on the river size, two methods were used to conduct catches. In watercourses deeper than 0.8 m, catches were conducted from a boat going downstream close to one of the banks, with a 2.5 kW electrical generator. In sampling sites located in smaller watercourses (depth up to 0.8m) catches were conducted by wading upstream across the entire width of the waterbed. In both cases, 230 V full wave direct current supplied by a 1.5 kW Honda backpack generator was used. Fish were caught in a hand bucket with anode in a form of metal rim with a knotless net of 5mm mesh size. The cathode was made of a 4 meters long copper intertwined wire. Fish caught in sampling sites were first identified, then counted and weighed. Species were classified in ecological reproductive guilds, according to Kryzhanovsky (1948) and Balon (1975), as well as in habitat guilds, according to Schiemer & Waidbacher (1992). Stability of occurrence was evaluated by the following index:  $C_i = n_i/N \times 100$ , where:  $n_i$  is the number of sites where an "i" species was caught,  $N$  is the number of all investigated sites (Głowaciński 1996). The species conservation status was assessed by: AP – active protection (Journal of Laws 2004, No. 220, item 2237); HD.AII – species listed in Annex II of Habitat Directive (Journal of Laws L 206, 22.7.1992, item 7); PRLLF. – Polish Red List of Lamprey and Fish (Witkowski et al. 2009 – criteria and categories IUCN 2001 of the native fish and lamprey species of Poland (PL): EX – extinct; EW – extinct in the wild; CR – critically endangered; EN – endangered; VU –

vulnerable; NT – near threatened; LC – least concern; DD – data deficient); RIF – Regulation on Inland Fishing (Journal of Laws 2001, No. 138, item 1559 with amendments).

Table 2. Characteristics of the sampling sites; S – straight course, W – winding course; -, +, ++ – properly: lack regulation, partial or old, and total; 1, 2 or 3 – overshadowing by canopy in three-grade increasing scale; s – sand, m – mud, g – gravel, st – stones; fo – forest, me – meadow, fi – fields, t/b – trees and/or bushes along river bank, bu – buildings.

Site	River name	Locality	Km from source	Mean width (m)	Mean depth (m)	Course	Regulation	Overshadowing	Plants [% of site surface]	Bottom substrate	Adjacent area
1	Długa	Halinów	20	2	0,6	S	+	2	10	s, m	t/b, me
2	Długa	Okuniew	26	4	1,5	S	+	1	70	s, m	me
3	Długa	Ossów	30	6	0,4	S	++	1	5	s	fi
4	Długa	Kobylak	35	6	1,0	W	-	2	20	s, m, g	t/b, fi
5	Czarna Struga	Ossów	7	1,5	0,6	W	-	1	90	m	fo, fi
6	Klusówka	Pobyłkowo Duże	12	2,5	0,5	S	+	2	60	s	fi, me, t
7	Klusówka	Pobyłkowo Małe	16	4	1,5	S	+	2	20	m	fi, me
8	Klusówka	Klusek	20	3	0,4	S	-	3	5	g, s	t/b, me
9	Utrata	Krakowiany	9	2	0,3	W	-	3	5	g, s	fo, me
10	Utrata	Mlochocin	32	2	0,3	S	++	1	40	s	fi, me
11	Utrata	Zębowice	37	3	0,6	W	+	2	10	s	t/b, me
12	Świder	Kapice	9	3	0,4	W	-	3	5	g, s	fo
13	Świder	Stare Kobiałki	10	3	0,7	W	-	1	80	m, s	me
14	Świder	Rezerwat Kulak	15	3,5	1,0	W	-	3	10	s	me, fi, t/b
15	Świder	Borki	21	5,5	1,2	W	-	3	10	s, g	fi, me, t/b
16	Świder	Latowicz	27	5	1	S	++	1	5	s, m	fi, me
17	Świder	Chyżyny	32	5,5	1,0	S	++	1	5	s	fi, me
18	Świder	Transbór	36	5,5	1,0	S	++	1	20	s, m	fi, me, bu
19	Świder	Rezerwat Górka Wólczkańska	43	8	1,3	S	++	1	30	s, m	fi, me, bu
20	Świder	Huta	46	12	1,2	W	-	3	5	g, st	fo, me, t/b
21	Świder	Gadka	53	15	0,9	W	-	3	5	s, g	t/b, me, bu
22	Świder	Sepochów	58	15	1,2	W	-	3	10	s	t/b, fi, me, bu
23	Świder	Wola Karczewska	68	22	0,7	S	-	2	5	s, g	fo, me
24	Rydnia	Chromin	4	2	0,3	W	-	3	0	g, st	t/b, me, bu
25	Struga	Grzebowilk	5	1,5	1,0	W	-	1	20	s, g	me, fo
26	Rządza	Wiśniew	6	1,5	0,6	S	++	3	10	m	fo
27	Rządza	Rudzienko-Borowo	17	4	0,6	W	-	3	10	s, g	t/b, fi, bu
28	Rządza	Wólka Pieczewska	22	4,5	0,6	W	-	2	5	s, g	t/b, me
29	Rządza	Papiernia	28	6	0,7	W	-	3	5	g, st	fo
30	Rządza	Laskowizna	37	9	0,7	S	-	1	50	s, g	t/b, me
31	Rządza	Klembów	47	3	1,0	S	+	2	70	s	t/b, me
32	Rządza	Stary Kraszew	53	5	0,7	W	-	2	60	s	t/b, me
33	Rządza	Zawady	60	4	1,0	S	+	1	90	s, m	me
34	Rządza	Rejentówka	63	7	0,7	W	-	3	10	s, g	fo, me
35	Rządza	Załużbice	68	12	0,8	S	+	3	5	s, m	fo, me

## RESULTS

The ichthyofauna of the studied rivers was represented by 29 fish and lamprey species belonging to 10 families (Table 3). Representatives of a majority of ecological reproductive guilds found in Polish inland waters were registered in the catches. Lithophylic fish group was represented by four species, namely chub, spirlin, brown trout and the Ukrainian brook lamprey. These species require fast flow and hard bottom for spawning and their populations

are not very dense in the investigated rivers. Their biggest share in the catches was noted in Klusówka River where they accounted for 10.5 % of the total abundance. In the Rządza and the Świder Rivers, the share of lithophylic species in fish communities was respectively 8.5 and 5.2%. Lithophylic fish species were not registered in the Długa and the Utrata Rivers. In the Długa River phytophylic ten-spined stickleback and lithophylic perch, whereas in the Utrata River psammophylic gudgeon and phytophylic sunbleak dominated in the catches.

Table 3. The list of fish and lamprey species caught in the investigated rivers in the years 1999–2003 and their classification into ecological guilds: lithophylic species, L-F – litho-phytophylic species, F – phytophylic species, Ps – psammophylic species, L-P litho-pelagophylic, Os – ostracophylic species; P – predators, R-P – relative predators, I – invertabrates-eating species, O – omnivorous species, H – herbivorous fish; Re – rheophylic species, Lm – limnophilic species, Eu – eurytopic species.

No.	Species	Ecological guilds			Fish a abundance (%) in river				
		Repro-ductive	Tro-phic	Water flow	Długa	Klu-sówka	Utrata	Świder	Rządza
1	Bitterling <i>Rhodeus amarus</i> (Bloch 1782)	Os	H	Eu	0,05		4,7	2,0	
2	Bleak <i>Alburnus alburnus</i> (Linnaeus 1758)	F	I	Eu				0,1	0,1
3	Bream <i>Abramis brama</i> (Linnaeus 1758)	F	O	Eu					0,05
4	Brown trout <i>Salmo trutta m. fario</i> (Linnaeus 1758)	L	P	Re					0,4
5	Burbot <i>Lota lota</i> (Linnaeus 1758)	L-P	R-P	Re		0,2		0,1	1,1
6	Carp <i>Cyprinus carpio</i> (Linnaeus 1758)	F	I	Eu	0,05				
7	Chub <i>Leuciscus cephalus</i> (Linnaeus 1758)	L	I	Re		3,3		1,2	0,3
8	Crucian carp <i>Carassius carassius</i> (Linnaeus 1758)	F	O	Eu	0,1			0,1	0,05
9	Dace <i>Leuciscus leuciscus</i> (Linnaeus 1758)	L-F	I	Re		16,7		0,8	0,5
10	Gudgeon <i>Gobio gobio</i> (Linnaeus 1758)	Ps	I	Re	5,9	5,7	45,8	9,3	33,5
11	Ide <i>Leuciscus idus</i> (Linnaeus 1758)	L-F	O	Re		7,6		0,04	1,1
12	Perch <i>Perca fluviatilis</i> (Linnaeus 1758)	L-F	R-P	Eu	17,1	2,3	4,7	1,5	11,1
13	Pike <i>Esox lucius</i> (Linnaeus 1758)	F	P	Eu	1,0		0,1	0,4	1,3
14	Prussian carp <i>Carassius gibelio</i> (Bloch 1783)	F	O	Lm	0,8	0,1	0,1	0,04	
15	Racer goby <i>Neogobius gymnotrachelus</i> (Kessler, 1857)	L-F	I	Lm		6,6			
16	Roach <i>Rutilus rutilus</i> (Linnaeus 1758)	F	O	Eu	10,4	27,0	1,9	35,1	25,0
17	Rudd <i>Scardinius erythrophthalmus</i> (Linnaeus 1758)	F	H	Lm				0,1	
18	Ruff <i>Gymnocephalus cernuus</i> (Linnaeus 1758)	L-F	I	Eu	0,05				
19	Spined loach <i>Cobitis taenia</i> (Linnaeus 1758)	F	I	Eu		1,4		1,1	0,8
20	Spiralin <i>Alburnoides bipunctatus</i> (Bloch 1782)	L	I	Re				1,0	1,1
21	Stone loach <i>Barbatula barbatula</i> (Linnaeus 1758)	Ps	I	Re	2,6	2,9	12,3	34,9	11,4
22	Stone moroco <i>Pseudorasbora parva</i> (Schlegel 1842)	F	I	Lm			0,3		
23	Sunbleak <i>Leucaspius delineatus</i> (Heckel 1843)	F	O	Lm	6,6	0,2	28,6	0,7	
24	Tench <i>Tinca tinca</i> (Linnaeus 1758)	F	I	Lm	2,1	0,4	0,5	0,1	
25	Ten-spined stickleback <i>Pungitius pungitius</i> (Linnaeus 1758)	F	I	Lm	45,5	0,6	0,1	1,8	0,3
26	Threespine stickleback <i>Gasterosteus aculeatus</i> (Linnaeus 1758)	F	I	Lm	3,5	16,4	0,1	6,6	4,6
27	Ukrainian brook lamprey <i>Eudontomyzon mariae</i> (Berg 1931)	L	I	Re		7,2		3,0	6,7
28	Weatherfish <i>Misgurnus fossilis</i> (Linnaeus 1758)	F	I	Lm	4,3		0,7	0,1	0,3
29	White bream <i>Abramis bjoerkna</i> (Linnaeus 1758)	F	I	Eu		1,4			0,3

Table 4. The dominant fish species at particular sites and abundance of fish species in some of ecological guilds

Site	River name	Number of species	Number of caught fish	Dominant species ( $\geq 25\%$ of total fish number)	% of total fish number	% of total weight	Rheophylic species	% of total fish number	% of total weight	Predatory species	% of total fish number	% of total weight
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Długa	9	311	Perch Ten-spined stickleback	41,2 29,9	40,5 1,8	Stone loach	3,9	3,6	Pike	1,6	14,0
2	Długa	9	331	Ten-spined stickleback Whaeterfish	34,7 24,5	10,3 25,8	Gudgeon, stone loach	3,6	10,2	Pike	0,9	8,7
3	Długa	9	301	Perch Sunbleak	52,8 25,9	52,8 31,9	None			Pike	1,3	6,9
4	Długa	8	343	Roach Gudgeon	49,6 33,8	49,8 19,6	Gudgeon, stone loach	39,1	22,6	Pike		
5	Czarna Struga	7	783	Ten-spined stickleback	90,9	14,8	Stone loach	2,4	5,2	Pike	1,0	37,4
6	Klusówka	7	1038	Threespine stickleback Stone loach	42,3 26,8	19,6 49,8	Gudgeon, chub, Ukrainian brook lamprey, stone loach	49,6	83,1	None		
7	Klusówka	11	91	Threespine stickleback	63,7	15,0	Dace, gudgeon, chub, Ukrainian brook lamprey, stone loach	18,7	41,4	None		
8	Klusówka	15	123	Roach	31,7	38,7	Ide, dace, gudgeon, chub, Ukrainian brook lamprey, stone loach	42,5	39,0	None		
9	Utrata	6	428	Sunbleak Gudgeon	42,2 33,3	12,8 55,1	Gudgeon, stone loach	53,4	79,3	None		
10	Utrata	10	98	Sunbleak	37,8	9,2	Gudgeon, stone loach	27,6	14,7	Pike	1,0	0,2
11	Utrata	6	216	Gudgeon	86,1	61,0	Gudgeon, stone loach	89,8	67,4	None		
12	Świder	3	40	Stone loach	92,5	73,8	Gudgeon, stone loach	97,5	80,3	None		
13	Świder	3	246	Stone loach	89,0	83,8	Gudgeon, stone loach	97,2	98,3	None		
14	Świder	6	231	Roach Stone loach	63,2 31,6	48,6 29,2	Gudgeon, stone loach	34,2	31,1	Pike	0,9	20,0
15	Świder	8	186	Stone loach	58,1	20,5	Gudgeon, Ukrainian brook lamprey, stone loach	64,5	27,2	Pike	1,1	34,0
16	Świder	11	367	Stone loach	54,5	39,2	Gudgeon, Ukrainian brook lamprey, stone loach	70,6	67,1			
17	Świder	12	235	Roach	46,4	72,2	Gudgeon, chub, Ukrainian brook lamprey, stone loach	32,8	21,6			
18	Świder	6	147	Roach	83,7	85,1	None			Pike	1,4	9,5

1	2	3	4	5	6	7	8	9	10	11	12	13
19	Świder	5	51	Roach Threespine stickleback	45,1 25,5	83,6 6,0	Gudgeon	9,8	2,5	None		
20	Świder	8	280	Stone loach	59,6	25,6	Dce, gudgeon, chub, stone loach	68,2	62,7			
21	Świder	12	269	Roach	61,7	54,5	Ide, gudgeon, chub, riffle minnow, stone loach	13,8	13,9	Pike	0,7	24,6
22	Świder	9	89	Roach	77,5	79,9	Dace, gudgeon, chub, riffle minnow, stone loach	12,4	7,6	None		
23	Świder	11	257	Roach Ukrainian brook lamprey	25,7 25,7	28,6 13,5	Dace, gudgeon, chub, riffle minnow, Ukrainian brook lamprey, stone loach	71,2	67,5	None		
24	Rydnia	4	75	Threespine stickleback	74,7	55,1	Stone loach	5,3	24,6	None		
25	Struga	2	24	Stone loach	95,8	56,8	Stone loach	95,8	56,8	Pike	4,2	43,2
26	Rządza	2	79	Threespine stickleback Stone loach	73,3 26,6	26,7 73,3	Stone loach	26,6	73,3	None		
27	Rządza	5	20	Brown trout Stone loach	35,0 30,0	84,9 5,0	Ukrainian brook lamprey, brown trout, stone loach	85,0	91,6	Brown trout pike	35,0 10,0	84,9 7,7
28	Rządza	5	35	Stone loach	77,1	23,5	Ukrainian brook lamprey, brown trout, stone loach	88,6	92,8	Brown trout, pike	5,7 5,7	67,7 5,3
29	Rządza	7	222	Stone loach Gudgeon	48,8 34,1	44,0 46,6	Gudgeon, Ukrainian brook lamprey, stone loach	87,3	94,2	None		
30	Rządza	7	473	Gudgeon,	60,9	52,7	Gudgeon, Ukrainian brook lamprey, stone loach	97,3	97,3	None		
31	Rządza	11	353	Gudgeon	61,8	44,0	Gudgeon, Ukrainian brook lamprey, riffle minnow, stone loach	70,0	54,9	Pike	1,1	3,2
32	Rządza	9	171	Gudgeon Roach	35,7 28,7	26,0 45,3	Gudgeon, Ukrainian brook lamprey, riffle minnow	45,6	31,7	Pike	2,3	2,1
33	Rządza	7	192	Roach Perch	67,2 26,6	62,8 22,3	Ide, gudgeon, chub	2,1	1,5	Pike	3,6	13,3
34	Rządza	10	307	Roach Perch	47,6 29,6	44,9 22,1	Dace, gudgeon, chub, riffle minnow	19,9	27,5	Pike	1,6	1,5
35	Rządza	11	241	Roach	55,6	50,5	Ide, dace, gudgeon, chub	14,5	24,6	Pike	1,2	1,2

In all studied rivers, the group of predatory fish was scarcely represented. The percentage share of pike in the total community abundance amounted to 0.1% in the Utrata River up to 1.3% in the Rządza River, whereas representatives of this species were not observed in the Klusówka River. This major predator of lowland rivers appeared at half of the sampling sites. Facultative predator, perch was more often discovered in electrofishing (Table 4). This species accounted for 1.6% of the abundance in the Świder River up to 17.1% in the Długa River. The invertebrate-eating species dominated among non-predatory fish (Table 3). They were characterised by the highest frequency of occurrence; stone loach was found at 28 sampling sites, gudgeon at 25 sites and three-spined stickleback at 21 sites. Bream, rudd and ruff, and also carp and two invasive species, goad goby and stone morocco were the most rare species at sites (Table 4).

Table 5. Characteristics of the investigated rivers based on fish fauna and some average values of community indices. Explanations: <sup>1</sup> *Abramis brama*, *Abramis bjoerkna*, *Carassius gibelio*, *Carassius carassius*, *Cyprinus carpio*, *Esox lucius*, *Leuciscus cephalus*, *Leuciscus idus*, *Lota lota*, *Perca fluviatilis*, *Rutilus rutilus*, *Salmo trutta m. fario*, *Scardinius erythrophthalmus*, *Tinca tinca*

River	Długa	Klusówka	Utrata	Świder	Rządza
Characteristic					
River length	47,5	18	76,5	93,9	66,5
Number of sites	5	3	3	14	10
Number of species	17	15	13	22	20
Mean fish number per site	414	417	247	178	209
Mean fish weight per site (g)	3464,2	3227,0	1135,5	1680,6	2398,2
Mean individual fish weight (g ind. <sup>-1</sup> )	9,6	6,2	5,0	10,0	19,8
Mean fish number per 1 km of river course (piece km <sup>-1</sup> )	4138	4173	2473	1784	1395
Mean fish weight per 1 km of river course (kg km <sup>-1</sup> )	34,6	32,3	11,4	16,8	16,0
Dominant species in river (% of total fish number)	Ten-spined stickleback – 45,5	Roach – 27,0	Gudgeon – 48,1 Sunbleak – 30,0	Roach – 35,1 Stone loach – 34,9	Gudgeon – 33,4 Roach – 24,9
Rheophilic species (% of total fish number)	8,6	43,4	61,0	50,3	54,9
Rheophilic species (% of total fish weight)	10,2	49,3	63,2	32,1	47,7
Predatory and relative predatory species (% of total fish number)	18,1	2,5	4,8	2,1	13,9
Predatory and relative predatory species (% of total fish weight)	50,2	9,0	15,0	13,9	26,7
Species exploited by anglers <sup>1</sup> (% of total fish number)	31,5	49,5	7,8	41,7	47,3
Species exploited by anglers <sup>1</sup> (% of total fish weight)	80,1	75,2	23,6	72,4	69,1

The highest number of species, namely 22, was registered in the Świder River. The eurytopic roach and psammophilic stone loach were the dominant species but the reophilic species, namely dace, ide, gudgeon, chub, spirin, brown trout, stone loach and lamprey constituted in total 50.3% in terms of abundance and 32.1% of the total biomass of fish caught in the watercourse. In the Rządza River, 20 species were registered and the average share of reophilic species in the total abundance and catch weight amounted to 54.9 and 47.7% respectively. In the Utrata River, 13 fish species were registered, however, the share of



reophilic species was the highest. A high share of reophilic fish species was noted in the Klusówka River. They constituted 43.4% of the abundance and 49.3% of the weight of fish. In the Długa River, reophilic fish constituted 8.6% in terms of the abundance and 10.2% in terms of weight. Ten-spined stickleback and eurytopic perch dominated in the catches (Table 5).

The lowest value of fish abundance at a sampling site per kilometre of a river course, 1395 individuals  $\text{km}^{-1}$  was noted in the Rządza River, and the highest one, 4173 individuals  $\text{km}^{-1}$  in the Klusówka River. The biomass also varied in particular rivers. The highest biomasses, 34,6  $\text{kg km}^{-1}$  and 32,3  $\text{kg km}^{-1}$  were noted respectively in the Długa River and the Klusówka River. In the Świder River and the Rządza River the biomass was twice lower. The lowest biomass, namely 11,4  $\text{kg km}^{-1}$  was registered in the Utrata River, where gudgeon and sunbleak dominated (Table 5).

## SPECIES REVIEW

### Petromyzonidae

#### Ukrainian brook lamprey – *Eudontomyzon mariae* (Berg, 1931)

This representative of lampreys was found at 13 sampling sites. Stability of occurrence: 37%. Not found in the Utrata River. Conservation status: AP, HD, AII, PRLLF (categorie VUE in PL & Vistula basin).

### Esocidae

#### Pike – *Esox lucius* (L., 1758)

The main predator in the investigated rivers. Its occurrence stability index amounted to 49%. Its presence was noted at 17 sites; it was absent from sapling sites in the Klusówka river. Conservation status: RIF (categorie LC in PL & Vistula basin).

### Percidae

#### Perch – *Perca fluviatilis* (L., 1758)

This species had, similarly to stone loach, the highest occurrence stability index. In the Długa, the Klusówka and the Utrata Rivers it appeared at all sampling sites, in the Świder River at 8 sites and in the Rządza River it did not appear only in the river sector close to the source. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

#### Ruff – *Gymnocephalus cernuus* (L., 1758)

It appeared only at one sampling site, in the Długa River. Occurrence stability index: 3%. Conservation status: (categorie LC in PL & Vistula basin).

### Cyprinidae

#### Carp – *Cyprinus carpio* (L., 1758)

It was registered in the Długa River, at sampling site No. 4. Probably, it was an escapee from fish ponds in Halinów farm; Occurrence stability index: 3%. Conservation status: alien species.

**Crucian carp – *Carassius carassius* (L., 1758)**

It appeared at one site in the Długa, the Świder and the Rządza Rivers. It was not recorded in the Klusówka and the Utrata Rivers. Occurrence stability index: 9%. Conservation status: (categorie NT in PL, LC in Vistula basin).

**Prussian carp – *Carassius gibelio* (Bloch, 1783)**

It appeared at 5 sites. Occurrence stability index 14%. It was not recorded in the Rządza River. Conservation status: alien species.

**Tench – *Tinca tinca* (L., 1758)**

It was noted at 7 sites. Occurrence stability index: 20%. was not recorded in the Rządza River. Conservation status: RIF, PRLLF (categorie LC in PL & Vistula basin).

**Ide – *Leuciscus idus* (L., 1758)**

It appeared at 3 sampling sites in the Rządza River and at 1 site in the Klusówka and Świder. Occurrence stability index: 14%. Conservation status: RIF, PRLLF (categorie LC in PL & Vistula basin).

**Chub – *Leuciscus cephalus* (L., 1758)**

It appeared at 11 sampling sites. Occurrence stability index: 31%. It was not recorded at sampling sites in the Długa River. Conservation status: RIF, PRLLF (categorie LC in PL & Vistula basin).

**Dace – *Leuciscus leuciscus* (L., 1758)**

It was noted at 8 sampling sites. Occurrence stability index: 23%. It was not recorded at sampling sites in the Długa and the Utrata Rivers. Conservation status: RIF, PRLLF (categorie NT in PL, LC in Vistula basin).

**Bream – *Abramis brama* (L., 1758)**

It was only noted at site No.35, in the Rządza River, close to its mouth. Occurrence stability index: 3%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**White bream – *Abramis bjoerkna* (L., 1758)**

It was recorded at site No. 1 in the Klusówka River and last site in the Rządza River. Occurrence stability index: 6%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Roach – *Rutilus rutilus* (L., 1758)**

The species was recorded in all rivers. Occurrence stability index: 60%. Roach dominated in abundance in the Klusówka, the Świder and the Rządza Rivers. It was recorded only at site No. 1 in the Utrata River where it accounted for 2% of the abundance and 3.8% of the catch weight. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Rudd – *Scardinius erythrophthalmus* (L., 1758)**

Apart from bream and ruff it was one of the most rare fish species in the catches. Rudd was registered at one site in the Świder River. Occurrence stability index: 3%. Conservation status: RIF PRLLF (categorie LC in PL & Vistula basin).

**Bleak – *Alburnus alburnus* (L., 1758)**

It was noted in 2 sites in the Świder and Rządza Rivers, close to their mouths. Occurrence stability index: 6%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Spirlin – *Alburnoides bipunctatus* (Bloch, 1782)**

This legally protected, lithophilic species was registered only in the Świder River (at sites 21, 22, 23) and the Rządza River (at sites 31, 32, 34). Occurrence stability index: 17 %. Conservation status: AP, PRLLF (categorie EN AI-2 in PL and EN E in Vistula basin).

**Sunbleak – *Leucaspis delineatus* (Heckel, 1843)**

It was recorded at all sites in the Długa and the Utrata Rivers. In the Utrata River, sunbleak together with the dominant gudgeon accounted for 78% of the abundance. It appeared at 2 sites in the Świder River and at 1 site in the Klusówka River, in total at 11 sampling sites. Occurrence stability index: 31%. It was not recorded in catches in the Rządza River. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Bitterling – *Rhodeus sericeus* (Pallas, 1776)**

In the Długa and the Utrata Rivers it appeared at single sites. It was more often registered in the Świder River where it appeared at 7 sampling sites and accounted for 0.5% up to 15.7% of total abundance. It was not registered in the Klusówka and the Rządza Rivers. In total, it appeared at 9 sites. Occurrence stability index: 23%. Conservation status: AP, HD.AII, PRLLF (categorie VUAI in PL and VUA2 in Vistula basin).

**Gudgeon – *Gobio gobio* (L., 1758)**

It was recorded in all investigated rivers. In the Klusówka and the Utrata, it was noted at all sampling sites. At many sites it was considered as dominant species in terms of abundance. In total, it appeared at 25 sites. Occurrence stability index 71%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Stone moroco / topmouth gudgeon – *Pseudorasbora parva* (Schlegel, 1842)**

This invasive, expansive species appeared at one site in the Utrata River. Occurrence stability index: 3%. Conservation status: alien species.

**Cobitidae****Spined loach – *Cobitis taenia* complex (L., 1758)**

In total, it was recorded at 9 sites in the Klusówka, the Świder and the Rządza Rivers. Occurrence stability index: 26%. Conservation status: AP, HD.AII, PRLLF (categorie LC in PL & Vistula basin).. In 1999 publications, spined loach was listed as vulnerable species (VU).

**Loach – *Misgurnus fossilis* (L., 1758)**

In the investigated rivers, loach was rare, only at site No. 2 (in the Długa River) it accounted for 24.5% of abundance. In the Świder and the Utrata Rivers it was registered at 2 sites and in the Rządza River at 4 sites. It was not registered in the Klusówka River. Occurrence stability index: 26%. Conservation status: AP, HD.AII, PRLLF (categorie VUAI in PL, NT in Vistula basin).

## Balitoridae

**Stone loach – *Barbatula barbatula* (L., 1758)**

Together with perch, this species had the highest occurrence stability index of 80%. In the Klusówka and the Utrata Rivers it appeared at all sampling sites. It was not registered in other investigated rivers, namely at 1 site in the Długa River, at 2 site in the Świder River and 4 sites in the Rządza River. Conservation status: AP, PRLLF (categorie LC in PL & Vistula basin).

## Gadidae

**Burbot – *Lota lota* (L., 1758)**

This species representing the Gadidae family, inhabiting in well-oxygenated inland waters, was registered at 6 sites in the investigated rivers. Occurrence stability index: 17%. It was not present in the Długa and the Utrata Rivers. Conservation status: PRLLF (categorie VUAI in PL, VUA2 in Vistula basin), RIF.

## Gasterosteidae

**Three-spined stickleback – *Gasterosteus aculeatus* (L., 1758)**

It occurred in each of the investigated rivers. In the Klusówka River, it was recognized as a dominant species and appeared at each sampling site. Occurrence stability index: 47%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

**Ten-spined stickleback – *Pungitius pungitus* (L., 1758)**

It was registered at 5 sampling sites in the Świder River, at 3 sites in the Rządza River, at 2 sites in the Klusówka River and at 1 site in the Utrata River. In the Długa River it was registered at each sampling site. Occurrence stability index: 60%. Conservation status: PRLLF (categorie LC in PL & Vistula basin).

## Gobiidae

**Goad goby – *Neogobius gymnotrachelus* (Kessler, 1857)**

This invasive species was found in the Klusówka River. Occurrence stability index: 3%. Conservation status: alien species.

## Salmonidae

**Brown trout – *Salmo trutta m. fario* (L., 1758)**

Brown trout was only registered at 2 sites. Occurrence stability index: 6%. Conservation status: RIF (categorie CD in PL & Vistula basin).

## DISCUSSION

The electrofishing method is widely used in studies of species composition of fish communities in small rivers. Fishing ichthyofauna with the use of reversible electric shock is a relatively simple and effective method and gives comparable results (Penczak 1967, Penczak & Zalewski 1973, Laurent & Lamarque 1974, Zalewski 1975, Cowx 1983, Świerzowski 1997). The results of studies of composition of fish communities conducted at 35 sites in five Mazovian rivers presented in this study permit to carry out a credible identification of the species composition as well as qualitative and quantitative assessment of the ichthyofauna.

In analysing the relation between the river size and the fish species diversity in a river on the basis of the published data, Wiśniewolski (2002) concluded that in lowland rivers of different length and with a different degree of modifications, ranging from 60 to 90 km, with different degree of transformations, even 26 fish species, including 14 exploited species could be expected to exist. The number of species registered in the investigated rivers was lower than expected, although in the Klusówka River, a relatively small, 20 kilometres long river 15 species were recorded, with the species potentially attractive for anglers accounting for almost 50% of the total abundance. The occurrence of carp in the Długa River, probably escapees from the stocking centre in Halinów (Stolarz & Sędkiewicz 1995) disturbed the natural composition of fish communities in this river.

Among all species registered in the investigated rivers, there are 20 limnophilic and eurytopic species and their abundance in particular rivers ranged from 43.7% to 91.4% of the total abundance of fish. Such composition of fish communities in rivers reflects the unfavourable changes that occur in the aquatic environment. (Rolik & Rembiszewski 1987, Blachuta et al. 1993, Penczak et al. 1991, Schrimmer & Waidbacher 1992).

Species covered by legal protection were also registered in the catches, namely the Ukrainian lamprey, spined loach, loach, spirlin, bitterling and stone loach (Journal of Laws 2004 No. 220, item. 2237). According to the IUCN classification, spirlin is classified as endangered species (EN). Notwithstanding the shift from the category of endangered species in 1999 (EN) to the category of vulnerable species in 2009 (VU), the Ukrainian lamprey, bitterling and loach have remained on the list of species under the highest extinction risk (Witkowski et al. 2009) and are listed in the Red List of Threatened Species (Głowaciński 2001). The Ukrainian lamprey, bitterling and loach are protected in the framework of the European network "Natura 2000" (Annex II to the EU Habitat Directive). Each of the above-mentioned species has specific, narrow-spectrum, environmental requirements. These elsewhere rare fish occurred at 6–13 sampling sites and usually accounted for a small percentage of the total abundance of investigated fish communities.

Two species alien to the local ichthyofauna were caught in the Klusówka and the Utrata Rivers, namely goad goby belonging to the Black Sea basin and stone morocco, originating from the Amur River basin. The occurrence of the first species is a result of a natural migration from the East through the Bug River system, whereas the second species is an example of unintentional introduction. The expansion of these alien species, competing with local fish fauna in rivers which lack strong populations of predatory species, can be very fast and significant. (Witkowski 1991, 1996, Danilkiewicz 1996, Grabowska et al. 2010).

During spawning, different fish species require not only adequate water temperature and oxygenation, but also specific bottom substrate, in which they lay the eggs (Kryzhanovsky 1948, Balon 1975). Species from all reproductive ecological guilds occurring in the Polish fish fauna were registered in the studied ecosystems, whereas the group of phytophylic and psammophylic species group visibly dominated in every river. It could therefore be concluded that, notwithstanding their transformations, the studied ecosystems are still diversified in terms of the existing ichthyofauna, although some river sections with the morphology characteristic for upland streams, with fast current and rocky bottoms are not fully inhabited by ichthyofauna. This is confirmed by the low occurrence of lithophylic species, especially trout in the ichthyofauna of the Świder, the Rządza and the Długa Rivers (Buras & Gasiński 2000).

The greatest species diversity was recorded in the Świder River flowing into the Vistula River and the Rządza River which is part of the Zegrze Reservoir drainage basin. The smallest number of species were registered in the Długa River ending its course in the Żerań canal and the Utrata River, belonging to the Bzura River basin. The Bzura River is highly transformed (Penczak et al. 2000). Already in 1963–1966, Penczak estimated the fish resources in the Bzura

River, apart from its upper segment close to the source, to be completely destroyed and the ichthyofauna of most of its tributaries as very poor both in terms of quality and quantity (Penczak 1968, 1969), although some parts of the Utrata River were abundant in fish (Zalewski & Penczak 1981). The Długa River is also highly transformed and polluted (Buras & Gasiński 2000), whereas both the Świder River and the Rządza River are relatively less transformed and have preserved their natural character. Large segments of the Świder River and the Rządza River flow through the landscape parks, established also to preserve the natural character of these rivers.

The small share of predatory fish observed in all studied rivers is alarming. Pike occurred only at 17 sampling sites, mainly in the Długa River and the Rządza River. Its abundance was low in all studied rivers and accounted for 0.7 up to 10.0% (Table 4). Low frequency of occurrence may be a result of high angling and poaching pressure in easily accessible rivers located in the vicinity of Warsaw. At the same time, excessive flow in canalized parts and even, often shallow river bed worsens the living conditions for all fish, including the phytophagic species, notwithstanding the presence of vegetation on the river bottom. Fish do not find adequate hiding places, feeding and wintering grounds. Also unregulated sewage management in river basins and the resulting bad water quality cause the disappearance of more sensitive species (Backiel 1958, Wajdowicz 1979, Bless 1985, Backiel 1993).

It could be assumed that a natural morphology of a river may result in higher species diversity in fish communities (Backiel 1993). The highest number of fish species was registered in least transformed rivers, such as the Świder River and the Rządza River, whereas the most transformed Utrata River was characterised by the lowest species diversity. Species distribution observed in the studied rivers proves the existence of highly valuable diversity of the river environment, however, in the case of many species, low indices of occurrence stability indicate an impoverishment of the ichthyofauna in many river segments.

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## STRESZCZENIE

### [Ichtyofauna wybranych rzek Niziny Mazowieckiej]

W latach 1999–2003 zbadano ichtiofaunę kilku nizinnych rzek w pobliżu Warszawy (Fig. 1). Elektropułowy wykonano na 35 stanowiskach w rzekach: Świder, Utrata, Długa z dopływem Czarna Struga, Klusówka, i Rządza (Tab. 1 i 2). Ogółem zarejestrowano 8618 ryb o

łączonej masie 77,9 kg, należących do 29 gatunków. We wszystkich badanych rzekach przeważały gatunki fitotofilne i psammofilne (Tab. 3). Największą liczbę gatunków stwierdzono w rzece Świder – 22 gatunki, z dominującymi: płocią i ślizem oraz Rządzy – 20 gatunków ryb, z dominującymi: płocią i kielbkiem. W najbardziej przekształconych rzekach Utrata, Klusówka i Długa stwierdzono występowanie 13–17 gatunków ryb; dominowały – cierniczek, kielb i słonecznica (Tab. 5). We wszystkich rzekach w połowach przeważały osobniki o niewielkiej średniej masie jednostkowej. Szczupak – typowy drapieżny gatunek nizinnych rzek pojawił się na 17 stanowiskach i wszędzie występował nielicznie. Najwyższy odsetek stanowił w połowach na stanowisku 27 i 28 w Rządzy (Tab. 4). Szczupak wraz z innymi gatunkami drapieżnymi i względnie drapieżnymi stanowił w poszczególnych rzekach od 2,1% w Świdrze do 18,1% w Długiej (Tab. 5). Gatunkami o najwyższym wskaźniku stałości występowania okazały się okoń i śliz, dużą frekwencją charakteryzowały się także kielb i płoc. Najrzadziej w połowach spotykano jazgarza, leszcza i wzdręgę oraz gatunki obce – babkę lysą i czebaczka amurskiego. Średnia liczebność ryb przypadająca na 1 km biegu rzeki osiągnęła największe wartości w rzekach Klusówka i Długa; najniższe w rzekach: Rządza oraz Świder. Najwyższą biomasą charakteryzowały się rzeki: Długa i Klusówka, a najniższą Utrata (Tab. 5).

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