Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2011, 8, 119–130

CHANGES IN THE ICHTHYOFAUNA OF KRAŚNIK RESERVOIR IN ITS EARLY YEARS IN CONDITIONS OF ANGLING PRESSURE

Jacek Rechulicz, Wojciech Płaska

Department of Hydrobiology, University of Life Sciences in Lublin
Dobrzańskiego str. 37, 20-262 Lublin, jacek.rechulicz@up.lublin.pl, wojciech.plaska@up.lublin.pl

Summary. The aim of this study was to determine how ichthyofauna has changed in new Kraśnik Reservoir in the conditions of angling fisheries. In early days of Kraśnik Reservoir and pre-dam reservoir control fish catch were conducted using gill net method. Moreover on the basis of angling register since 2007 to 2009 the species composition and number structure as well as biomass of fish caught by amatory angling of fish were set. In reservoir 10 fish species finally occurred, additionally two more species from angling register and one from field observation. In the first year of catch in number structure perch dominated with significant share of roach, but in the second year of research dominant was roach (more then 70%) and number of perch decreased three times. In biomass structure in the first year perch dominated but roach and pike was significant. In second year of examination perch decreased five times and roach increased almost three times. During two years decrease of predatory fish was observed from about 95% on spring 2008 to 21% on autumn 2009. Analysis of angling catch records revealed that in the number of structure ichthyofauna roach dominated, with a considerable share of perch, pike and carp, and the largest biomass were characterized by carp and pike.

Key words: ponded reservoir, ichthyofauna, fish catch, Kraśnik Reservoir

INTRODUCTION

One of the most important problems associated to pre-dam reservoirs working and fishery management in these reservoirs is fast growth of water richness caused by accumulation of deposits brought by the river. In many reservoirs this process is imitated by building pre-dam reservoir. It can be a macrophytes filter and settlement tank allowing removing of depositions without must of empting the whole reservoir [Pikul and Mokwa 2008, Wiśniewolski 2008]. It is also good to locate reservoir near the river in the way it decreases disturbances of river continuity and directs high water through the river with omitting of barrage reservoir.

Relatively high barrage reservoirs susceptibility to eutrophysation has also its reflection in dynamic of ichthyofauna changes on different stages of reservoir succession. In polish literature there are a lot of studies describing changes in water ecosystem of large and small barrage reservoirs built by partition of river valley including river bed with no pre-dam reservoir. Characteristic domination of predators is described – mainly pike and in following years in strong eutrophy phase gradually exchange the dominant to bream and roach [Mastyński and Wojdanowicz 1994, Wiśniewolski 2002, Starmach and Jelonek 2003]. In such case the study on modern barrage reservoir constructed according to guidelines of this kind of water preservation seams to be especially interesting. The aim of this work is to describe the structure of ichthyofauna in main and pre-dam reservoir in early they days. It was possible to identify directions and causes of ichthyofauna structure modifications in early days of Kraśnik Reservoir thanks to specific construction of reservoir as well as fish restock and angling register analyze.

STUDY AREA

Kraśnik Reservoir raised in 2006. It is supplied with water from Wyżnica river. Quality of Wyżnica river water in 2006 was of IV category (quality not satisfactory). Only in spring section water was on the level of III clarity category (Lublin Province environment condition raport in years 2006 and 2007 [Raport... 2011]. Reservoir filling and maintaining the water level is realized from river bed by weir to pre-dam reservoir in which the part of suspension is deposited and next water from pre-dam reservoir comes into Kraśnik Reservoir. Outlet from main reservoir is done by overflow weir situated on the opposite shore of the Reservoir. The Reservoir is located in the river valley but outside the river bed what makes possible to ensure river continuity, directing high water to river bed with omitting Reservoir and allows keeping stable water level in reservoir. Kraśnicki Reservoir is based on naturally sloping river valley slop from south site. Other shores are surrounded by embankments. The area designed for flooding contained meadows, pastures and wastelands as well as fish ponds (Wyżnica Centre) with area abort 40 ha. Part of them was transformed to reservoir. The bottom of reservoir was cleaned before flooding and from surficial layers of soil islands was formed. Currently there is a lack of bottom sediments on the bottom of reservoir.

From its early days in Kraśnik Reservoir cyanide plants bloom in summertime. It's limited recreational usage of reservoir as well as submerged macrophytes colonization. Water plants of reservoir are poor. On shallow areas surface plants appear. Submerged macrophytes also occur and during phytoplankton bloom partially disappear. In pre-dam reservoir emergent plants as well as submerged plants is much richer and due of his small depth his surface is entire covered. Since creation of Kraśnik Reservoir, the fishery management is based mainly on fish stocking (Tab. 1).

Table 1. The fish stocking of Kraśnik Reservoir in years 2007–2009 (Polish Angling Assoc., Lublin 2010)

Species	Form/Year	2007		2008		2009	
		ind.	kg	ind.	kg	ind.	kg
Pike	summer fingerling	60000	-	-	-	40000	-
Pike	autumn fingerling	850	428	500	400	800	400
Perch	-	1000	200	-	-	-	-
Tench	1-year old	2000	350	1000	210	700	210
Tench	3-years old	200	50	-	-	-	-
Roach	mature	400	100	-	-	-	-
Ide	1-year old	700	100	500	80	700	60
Common carp	1-year old	1600	400	1910	600	1400	600
Common carp	3-years old	820	650	-	-	-	-
European eel	1-year old	250	85	50	45	50	45
Crucian carp	1-year old	2000	200	-	-	-	-
Prussian carp	3-years old	800	200	850	410	3000	410

MATERIALS AND METHODS

Research on pre-dam reservoir and Kraśnik Reservoir were conducted during years 2008 and 2009. Control fish catch in pre-dam and main reservoir was done tree times (in spring, summer and autumn) in 2008 and once in 2009 (in summer) with the usage Norden S multimesh gillnet (10, 60, 30, 6.25, 43, 22, 50, 33, 12.5, 25, 8, 38, 75, 16.5 mm) [Appelberg 2000, CEN document 2005].

All catch fish were qualified to its species, measured and weight, species composition was determined in Wyżnica river and ichthyofauna species composition of pre-dam and main reservoirs in two years of research 2008 and 2009.

In order to compare research results in each fish catch in pre-dam reservoir and Kraśnik Reservoir all results were calculated into NPUE (number per unit effort), described in specimen per 12 hours with the use of one net (specimen 12 h^{-1} net^{-1}) and WPUE (weight per unit effort), described in kilogram per 12 hours of fishing using one net (kg 12 h^{-1} net^{-1}).

Using results from 489 angling registers delivered by water user (Polish Angling Assoc., Lublin) the number and weight of fish caught by anglers from 2007 to 2009 was calculated. Moreover changes of composition and structure of ichthyofauna in Kraśnik Reservoir was characterized caused by angling pressure on this reservoir.

Results were statistically analyzed and diversions in general number and biomass of dominating fish species (perch and roach) in main reservoir were compared using univariate analysis of variance ANOVA with level of signification $p = 0.05$ [SAS 9.1].

THE RESULTS

As a result of control fish catch 10 species of fish were generally found in pre-dam and main reservoirs. 4 and 8 species were found in 2008 and 5 and 6 in 2009 (Fig. 2). Angling register analyze proved that two additional species are caught in this reservoir: crucian carp and European catfish. Moreover samples of shallow littoral (> 0.5 m), where „gill net" were not used specimen of topmouth gudgeon were observed [own observations].

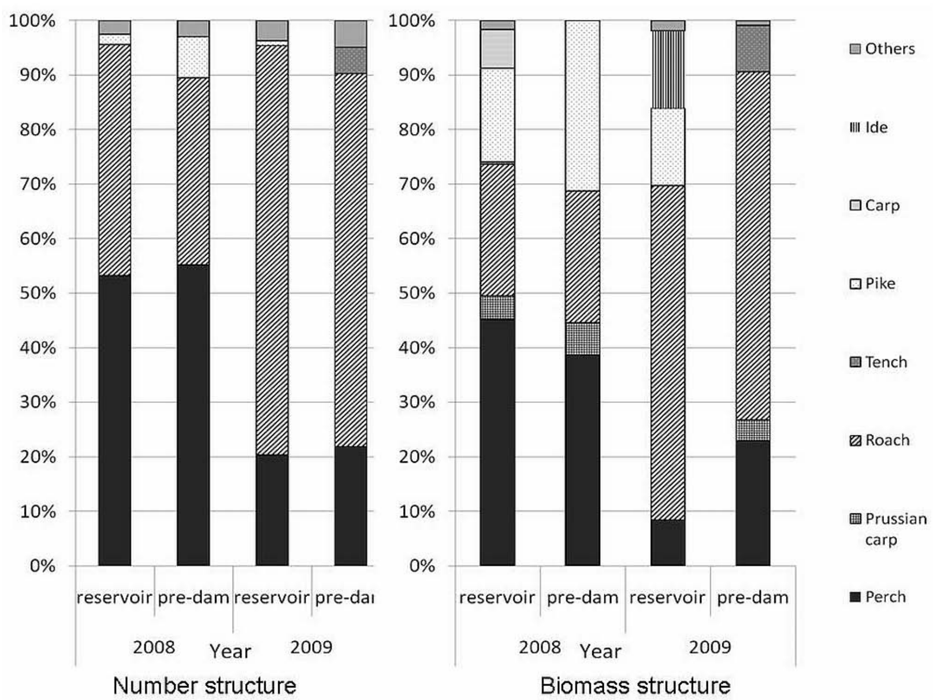

Fig. 1. The number structure and biomass structure of ichthyofauna of the main reservoir and pre-dam reservoir in the years 2008 and 2009

Pre-dam and main reservoirs ichthyofauna was very similar in case of species composition and domination structure. It differed slightly according to number and general biomass of caught fish (Fig. 1). Owing to prohibition of angling in pre-dam reservoir ichthyofauna structure changes was specified on the basis on main reservoir results.

Perch and roach were dominating species in number structure and they were accordingly 53.2 and 42.4% of total number of fishes. The rest of species occurred in a few number totally less then 3%. In second year of observation reconstruction of domination ensured. Roach were about 75% of whole number of fish but the second species perch only 20.4% (Fig. 1).

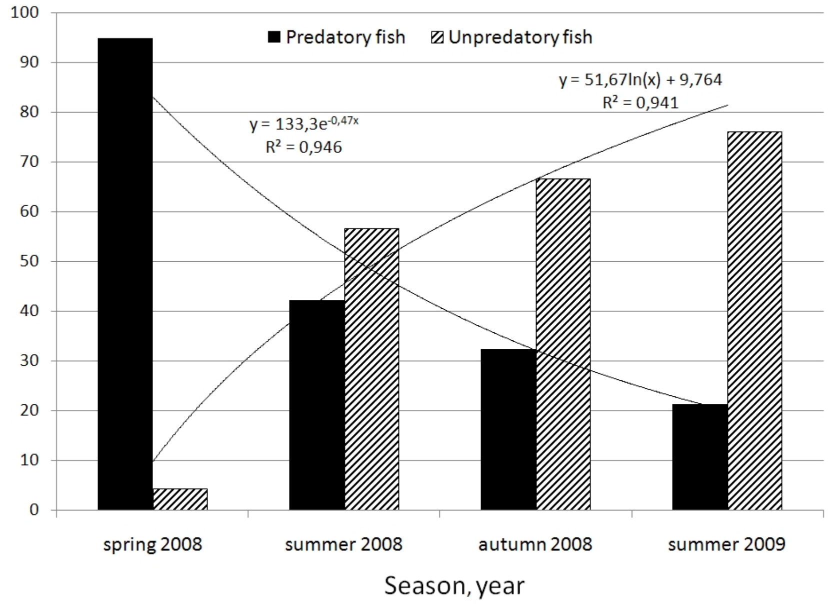

Fig. 2. Changes in the total number of predatory (perch, pike) and non-predatory fish (crucian carp, rudd and roach) in the results of control fishing in years 2008–2009

Table 2. The number of individual fish species (NPUE) in Kraśnik Reservoir in years 2008 and 2009

Species	2008		2009	
	Mean ± SD	Min–max	Mean ±SD	Min–max
Perch *Perca fluviatilis*	155.93 ± 87.76	69.00–244.50	44.00* ±30.98	16.00–88.00
Crucian carp *Carassius auratus gibelio*	1.82 ± 1.88	0.00–3.75	-	-
Rudd *Scaridinius erythrophthalmus*	2.17 ± 2.57	0.00–5.00	2.00 ± 2.31	0.00–4.00
Roach *Rutilus rutilus*	124.19 ± 104.97	6.00–206.00	162.00 ±79.36	48.00–228.00
Tench *Tinca tinca*	0.25 ± 0.43	0.00–0.75	-	-
Pike *Esox lucius*	5.20 ± 5.23	0.86–11.00	2.00 ±2.31	0.00–4.00
Common carp *Cyprinus carpio*	0.50 ± 0.87	0.00–1.50	-	-
Ruffe *Gymnocephalus cernuus*	2.71 ± 2.58	0.00–5.14	3.00 ± 2.00	0.00–4.00
Ide *Leuciscus idus*	-	-	3.00 ± 3.83	0.00–8.00
Total number	292.77 ±66.00	248.00–368.57	216.00 ±98.99	140.00–280.00
Species richness	8		6	

SD – standard deviation
*significant differences at $p < 0.05$

Table 3. The biomass of individual fish species (WPUE) in Kraśnik Reservoir in years 2008 and 2009

Gatunek	2008		2009	
	Mean ±□SD	Min–max	Mean ±□SD	Min–max
Perch *Perca fluviatilis*	3.24 ±□4.13	0.25–12.81	0.17 ±0.15	0.03–0.34
Crucian carp *Carassius auratus gibelio*	0.76 ±1.03	0.01–2.58	-	-
Rudd *Scaridinius erythrophthalmus*	0.59 ±□0.03	0.56–0.61	0.05 ±0.00	0.05–0.05
Roach *Rutilus rutilus*	1.60 ±0.77	0.33–2.55	1.22 ±0.47	0.55–1.63
Tench *Tinca tinca*	0.32 ±0.00	0.32–0.32	-	-
Pike *Esox lucius*	1.73 ±1.78	0.57–5.39	0.56 ±0.02	0.55–0.58
Common carp *Cyprinus carpio*	3.15 ±0.92	2.50–3.80	-	-
Ruffe *Gymnocephalus cernuus*	0.01 ±0.01	0.01–0.02	0.02 ±0.01	0.01–0.02
Ide *Leuciscus idus*	-	-	0.57 ±□0.22	0.41–0.72
Total biomass	6.70 ±4.35	1.71–14.34	1.99* ±□0.93	1.18–3.30

SD – standard deviation
*significant differences at $p < 0.05$

In biomass structure in first year perch dominated (45.2%) but significant part had also roach (24.1%) and pike (17.2%). In second year the biggest total biomass had roach. It was more than 61.2% of all fish. Pike share decreased about 3%, but perch share rapidly dropped to about 8.5%. Additionally ide had 14% part in total fish biomass (Fig. 1).

Total caught fish number amounted 292.7 NPUE (SD = 66.00) in first year of research and 216 NPUE (SD = 98.99) in 2009, with not confirmed statistical differences. In period since 2008 to 2009 roach number increased by 30% (with not important statistical differences) and perch number decreased almost 4-times from 155.93 NPUE in 2008 to 44.00 NPUE in 2009. That changes turned out statistically significant (ANOVA, df = 1, F = 4.715) (Tab. 2).

Total biomass of fish caught in first year of research appeared statistically significantly bigger then their total biomass in 2009 (ANOVA, df = 1, F = 0.486) and amounted accordingly 6.70 WPUE and 1.99 WPUE.

Control caught showed that two dominating fish biomass changed in second year. In case of perch it decreased from 3.20 WEPUE to 0.17 WPUE and in case of roach from 1.60 to 1.22 WPUE, but these differences turned out not significant statistically (Tab. 3).

Research showed that in successive caught results predatory fish share decreased according to not predatory fish (roach, rudd and Prussian carp). In spring 2008 predators made almost 95% of total fish number but in summer 2009 their share amounted only 21,3% of total fish number. Opposite relationship was noted in case of not predatory fish (Fig. 2).

Angling results analyze on the basis on register showed that roach was catch the most often (43.3%), perch was also caught in large number (16.9%) as well as pike (12.1%) and common carp (10.6%). Whereas in caught fish biomass common carp dominated (41.7%) as well as pike (28.5%) (Fig. 3).

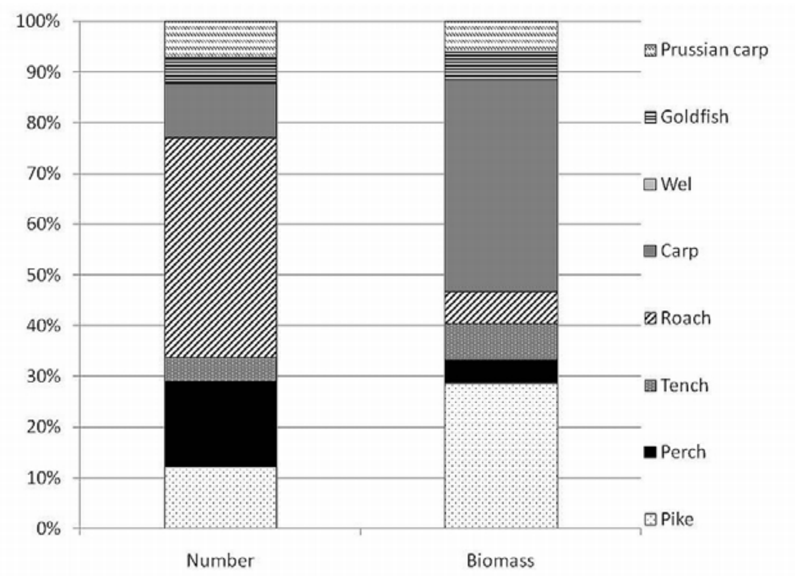

Fig. 3. The number structure and biomass structure of ichthyofauna in results of angling catches in the years 2007–2009 (N = 489)

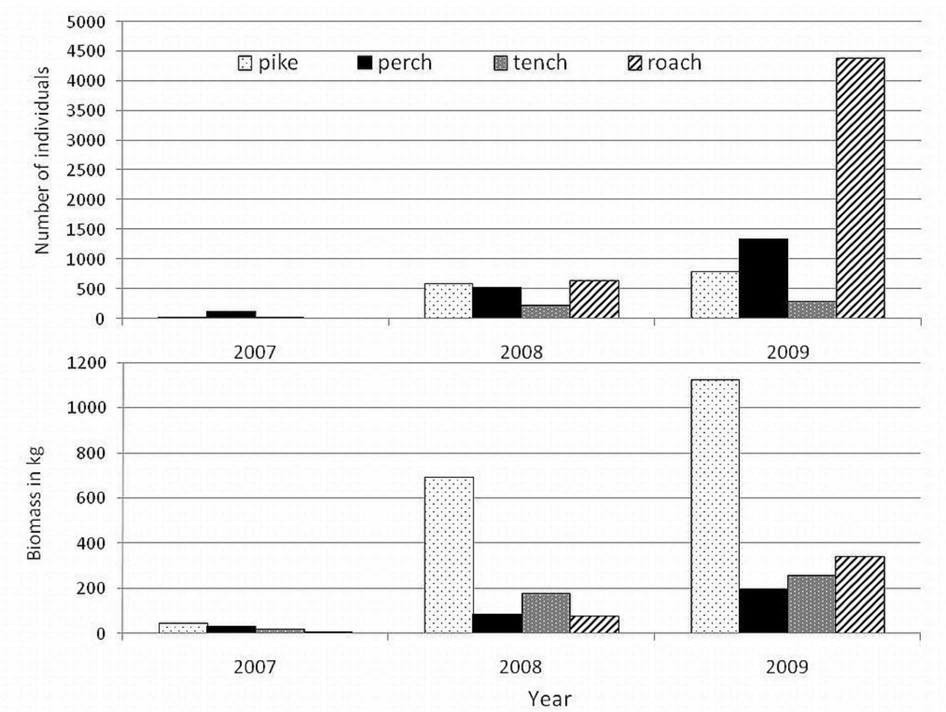

Fig. 4. Fishing catches in individuals and kilograms of selected fish species according to angling records in years 2007–2009 (N = 489)

Results comparison after angling register analyze shows that from 2007 to 2009 angling pressure significantly grew particularly on predatory species (ex.: pike in 2009 was caught almost 1 tone), but in the same time large amount of roach was caught (about 4400 specimen) (Fig. 4).

DISCUSSION

The problem of fishery management in the reservoirs has already been discussed repeatedly in the literature. Many researchers claim that the formation of structures forming the fish stock is the result of many factors. The most important of them are initial conditions prevailing in the river and the reservoir, limiting fish migration, manipulation of water level and pollution of various origins (outflow from the catchment area, the introduction of large amounts of nutrients in the form the groundbaits by anglers) [Jelonek and Amirowicz 1987, Mastyński and Wajdowicz 1994, Łysak and Ligaszewski 1998, Andrzejewski and Mastyński 2004, Jelonek and Wierzbicki 2008, Wiśniewolski 2008].

Barrage reservoir on Wyżnica river in Kraśnik has specific construction that make easier to protect against eutrophication. It contains pre-dam reservoir cumulating deposits carried by the river Wyżnica and it is not situated directly in the river but next to it what reduces its influence on that ecosystem. From the other hand reservoir is in type of carp pond what may cause problems with water quality in the future. It will influence on predatory species. In effect problems with improving reservoir conditions and keeping desirable fish species may occur [Penczak 1989, Epler *et al*. 2005a, b, Wiśniewolski 2008].

Kraśnik Reservoir ichthyofauna was represented only by 12 fish species what indicates its poor composition. That fact is also confirmed by researches of Jelonek and Amirowicz [1987] in Rożnów Reservoir which showed 12–13 fish species.

This research shows that in Kraśnik Reservoir in first year two species were dominating: perch and roach at the same time in biomass structure pike has significant share (Fig. 1). It is obvious that species composition strictly depended on restocking species composition (Tab. 1). Domination of those two ubiquitous species in Wióry reservoir in Świślina and Pokrzywianka rivers was observed by Buras *et al*. [2007]. In second year of researches rapid change of domination was observed to predatory species disadvantage with growth of roach share (Fig. 1). According to Wiśniewolski [2002] in early days of functioning of dam reservoirs predatory species are dominating. If fishery management and fish stocking are correct they can dominate for a few years [Starmach and Jelonek 2003, Wrona and Guziur 2006]. Along with reservoirs became stale species composition changes and species like bream and roach may become even 70% of total fish number. Such phenomenons are confirmed by researches of Mastyński and Wajdowicz [1994] in Malta Reservoir and Lorenzoni *et al*. [2005] in Monteglio Reservoir. That is the reason why, as many authors state, [Heese and Mastyński 1990, Skóra 1997, Wiśniewolski 2002, Wiśniewolski *et al.* 2005, Wrona i Guziur 2007] fishery management in new reservoir should lead to keep the lowest number of Cyprinides fishes.

Main tool for species composition regulation in barrage reservoirs are proper restoring with predatory species and not introducing of Cyprinides fish**.** At the same time anglers opinion must be considered as main fishing users, whose opinion is usually not the same as rational fishing management. Lack or incorrect fishery management may lead to absolute Cyprinides fish domination as it happened in '80s in Włocławski Reservoir and Zegrze Reservoir [Wiśniewolski 2002, 2009].

On the problem of adverse changes in ichthyofauna construction in the direction of non-predatory fish species domination alter many factors. One of the most important is the type of fishing exploitation. In Kraśnik Reservoir angling is main type of exploitation. That is not proper in case of new reservoirs because as Wiśniewolski [2002] and Bieniarz *et al.* [1990, 1993] state anglers catch mainly predators. While net catch are more efficient in regulation of unwelcome cyprinids fish species and are rather a must in case of bream [Skóra 1997, Klich 2002, Wrona and Guziur 2007]. Therefore in case of angling fishery management in the future increases of unwelcome fish species and increase of water eutrophy [Penczak *et al.* 1993, Buras *et al.* 2007, Wiśniewolski 2008]. In Kraśnik Reservoir because of large number of predators there is a risk of anglers selectivity, who according to their like catch predators in their first choice. Large scale of that type of fishing may significantly influence on species composition in reservoir. It might have also influence on results of control catch in second year of research (Fig. 2). This problem can be solved by setting the fishery management on the so-called „angling fishery management". That kind of fishery management is functioning in Sieniawski (Besko) and Solina Reservoirs. Regulation catch in those lakes are limited for more efficient methods of population regulation which is angling. For purposes of this economy also adapts fish stocking, which is geared toward anglers preferences [Wiśniewolski *et al.* 2005].

In improving of ichthyofauna structure of barrage reservoirs and particularly in reproduction and grow conditions plants may turn out very important. They are not much evolved in Kraśnik Reservoir. Thanks to plants species like for example pike will be able reproduce in natural way and to increase its number regardless of restoring [Buras *et al.* 1996, Stani 2005, Buras *et al.* 2007].

Researches on conducting fishery management in dam reservoirs and conditions in different barrage reservoirs are quite common but results very diverted. It is interesting that often proper conducting of fishery management may lead not to expected results. Nevertheless forecast of ichthyofauna changes is done during reservoir construction process. It allows introducing actions leading to making easier work on later stages of its development [Mastyński and Wajdowicz 1994, Klich 2002, Buras *et al.* 2007].

CONCLUSION

Fish catches conducted in early days of Kraśnik Reservoir showed typical for new reservoirs predatory species domination. Maintaining such a structure of fish fauna and advantageous construction of the reservoir with functioning pre-dam reservoir, helps to protect Reservoir Kraśnik before the eutrophication process. But in order to fulfill these conditions improvement of Wyżnica river water is obligatory as well as rational fishery and angling management. For proper ichthyofauna structure keeping it will be necessary to conduct selective non-predatory fish catch, consistent restock with predatory fish and enforce angling limits.

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ZMIANY ICHTIOFAUNY ZALEWU KRAŚNICKIEGO W PIERWSZYCH LATACH JEGO FUNKCJONOWANIA W WARUNKACH PRESJI WĘDKARSKIEJ

Streszczenie. Celem badań było ustalenie, jak zmieniła się ichtiofauna nowego zbiornika w warunkach presji wędkarskiej. W zbiorniku wstępnym i Zalewie Kraśnickim w pierwszych latach ich funkcjonowania wykonano odłowy kontrolne ryb używając sieci typu *gill net*. Ponadto na podstawie rejestrów wędkarskich z lat 2007–2009 ustalono skład gatunkowy i strukturę liczebności i biomasy ryb odłowionych w wyniku amatorskiego połowu ryb. Ogółem w zbiorniku w wyniku połowów kontrolnych stwierdzono występowanie 10 gatunków ryb, dodatkowo dwa gatunki z rejestrów wędkarskich oraz jeden z obserwacji terenowych. W pierwszym roku odłowów w strukturze liczebności dominował okoń, przy znaczącym udziale płoci, jednak w drugim roku badań dominującym gatunkiem była płoć (ponad 70%), a liczebność okonia spadła 3-krotnie. W strukturze biomasy w pierwszym roku badań dominował okoń, ale znaczący udział miały także płoć i szczupak. W drugim roku badań ponad 5-krotnie zmniejszył się udział okonia, a płoci zwiększył się niemal 3-krotnie. W okresie dwóch lat zaobserwowano zmniejszenie się udziału ryb drapieżnych z ok. 95% wiosną 2008 roku do ok. 21% latem 2009 roku. Analiza rejestrów połowów wykazała, że w strukturze liczebności połowów wędkarskich ryb dominowała płoć, przy znacznym udziale okonia, szczupaka i karpia, a największa biomasą charakteryzowały się karp i szczupak.

Słowa kluczowe: zbiornik zaporowy, ichtiofauna, połowy wędkarskie, Zalew Kraśnicki