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GROWTH RATE AND HISTOLOGICAL PICTURE OF THE GONADS OF PIKE, *ESOX LUCIUS* L., AND PIKEPERCH, *SANDER LUCIOPERCA* (L.), FROM THE TRESNA RESERVOIR (LAKE ŻYWIECKIE)

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ABSTRACT. The aim of this study was to determine the growth rates of pikeperch, *Sander lucioperca* (L.), and pike, *Esox lucius* L., from the Tresna Reservoir. Back-calculations were used to determine fish age. Histological pictures were used to determine the spawning success of the two species compared. The study material was comprised of 18 pikeperch females and 13 males, and 20 pike females and 12 males. The growth rate of pikeperch from the Tresna Reservoir was higher in comparison to populations inhabiting other basins in Poland. The histological analyses of the gonads indicated that pikeperch spawned successfully in the reservoir. The growth rate of the pike in the reservoir was comparable to that of this species in other basins. However, the histological picture of the ovaries indicated that spawning was only partially successful since 25% of females did not spawn and their eggs were in a state of resorption.

Key words: GROWTH RATE, GONAD HISTOLOGY, PIKEPERCH, PIKE

INTRODUCTION

Pike, *Esox lucius* L., occurs in the fresh and brackish waters of Europe and North America (Załachowski 2000). Until the 1970s, it occurred rather commonly in Poland (Kowalska et al. 1976), but currently the abundance of populations of this species are in decline in various basins, including dam reservoirs (Jelonek et al. 2003a). Pike populations increase in size in the first years following reservoir inundation, but then they begin to decline (Heese and Mastyński 1990) due to limited reproductive opportunities or from intense angling and fishing pressure (Bieniarz et al. 1990a, b). The share of pike in commercial catches made in reservoirs in Poland is small

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(Falkowski and Wiśniewolski 2003, Falkowski 2005, 2006, 2007). In the 2002-2006 period, it ranged from 2 to 3.8% of the biomass of the fish caught.

Pikeperch, *Sander lucioperca* (L.), was introduced to Polish reservoirs mainly through stocking programs. In recent years, an increased share of this species has been noted in commercial catches. In the 1960-1974 period, the biomass of pikeperch in overall catches ranged from 0.9 to 1.3% (Terlecki 2000), while in the 2002-2006 period this figure had increased to a range of 2.2 to 4.4% (Falkowski and Wiśniewolski 2003, Falkowski 2005, 2006, 2007).

The aim of the study was to determine the ages and growth rates of pike and pikeperch from the Tresna Reservoir and to identify the maturity stage of the gonads during the catch period as this would permit determining spawning success.

MATERIALS AND METHODS

The study material was comprised of scales and gonad samples collected from pike and pikeperch from commercial fishing and angling in July and August from 1999 to 2001 in the Tresna Reservoir. Thirty-two pike and 31 pikeperch were obtained for the study (Table 1). Scales were collected from these individuals, they were weighed, and their body lengths were measured. Ages and growth rates were determined based on back-calculations from scales. Gonad samples were preserved in Bouin's solution and stained with hematoxylin and eosin. The maturity stage was determined according to the Sakun and Bucka scale (1968), and egg diameter was measured. Four maturity stages were identified: II – oocytes in protoplasmatic growth; III – oocytes in various phases of trophoplasmatic growth (vitellogenesis); IV – oocytes after completion of vitellogenesis with a centrally located nucleus. The gonadosomatic index (GSI) was also determined as the gonad volume of the total fish body weight.

RESULTS

The results of the scale analyses confirmed that the age of the pike caught ranged from 2 to 7 years while that of the pikeperch ranged from 2 to 6 years (Table 1). The growth rate readings indicated that the mean body length of pikeperch from the Tresna Reservoir at ages 1 to 6 were 15.0, 30.5, 38.3, 44.9, 55.3, and 60.0 cm, respectively (Table 2). The largest increase in mean body length was noted in the first two years of

life (15.0 cm), while the smallest was noted between years 6 and 7 (4.7 cm). The analysis of pike growth indicated that in the first year of growth pike reached a mean length of 23.3 cm, while in the seventh year it was 70.0 cm (Table 3). The greatest increase in body length was noted in the first year of life (23.3 cm) and the least in the fourth year of life (4.1 cm).

TABLE 1

Sex ratio (females : males) and number of pike and pikeperch in each age group

		Age groups						
Species	N	2	3	4	5	6	7	Sex
Pikeperch	31	12	9	4	3	3	-	18 : 13
Pike	32	3	6	7	7	5	4	20 : 12

TABLE 2

Total length growth rate of pikeperch from different waters

	Total length (mm) at age (years)					
Basin and author	1	2	3	4	5	6
Tresna	150	305	383	449	553	600
Zemborzyce – Jarzynowa et al. 1990	131	225	308	371	438	504
Dobczyce – Jelonek et al. 2003a	104	214	324	407	468	516
Goczałkowice – Kołder 1969	127	222	324	411	476	519
Rożnowski – Kołder 1969	116	207	285	363	422	490
Otmuchowski – Kołder 1969	145	242	343	418	497	-
Turawa – Nagięć 1961	156	292	334	489	538	-
Mean from lakes in north Poland – Nagięć 1961	146	255	358	438	498	-
Vistula River – Nagięć 1964	157	251	371	446	502	572

The histological analyses of gonads indicated that the samples caught were comprised of 20 pike females and 12 males, and 18 pikeperch females and 13 males (Table 1). In pike aged 2+ (females only) 80% of the oocytes were in maturity stage II at a mean size of 60 μm while 20% of them were in maturity stage III. The testicles of the male pike at ages 3 to 7 were in maturity stage III. In females it was confirmed that in the ovaries there were oocytes of a diameter of 60 μm in maturity stage II, which comprised 64.8% of all the egg cells, as well as oocytes in maturity stage III at a mean diameter of 180 μm. Among them, five did not spawn and their ovaries were in a state of resorption. The female GSI ranged from 0.4 to 1.4, while that of the males ranged from 1.0 to 1.2.

TABLE 3

Total length growth rate of pike from different waters

Basin and author	Total length (mm) at age (years)						
	1	2	3	4	5	6	7
Tresna	233	337	422	463	535	593	700
Goczałkowice – Wajdowicz 1965	208	315	425	620	710	-	-
Zemborzyce – Jarzynowa et al. 1990	197	328	428	537	632	728	-
Jeziorsko – Heese and Mastyński 1990	192	275	351	420	-	-	-
Dobczyce – Jelonek et al. 2003b	-	-	360	445	526	640	748
Orawa – Balon 1965	231	337	426	490	618	664	-
Mean from lakes near Węgorzewo – Antosiak 1961	206	304	388	478	650	-	-
Wyżyna Łódzka River – Kopczyńska and Penczak 1969	227	264	310	363	403	455	534

The analysis of the histological picture of the pikeperch gonads indicated that ovaries of females ranging in age from 3 to 6 years contained oocytes in maturity stages II, III, and IV. The most abundant were the smallest oocytes (58 μm) in maturity stage II (mean 80.4%). Oocytes in maturity stage III at a mean size of 130 μm comprised an average of 17.7% of the total, while the largest oocytes (mean 160 μm) in maturity stage IV comprised 5.7%. Empty follicular membranes were observed in the histological preparations. The gonadosomatic index of the analyzed pikeperch ranged from 2.4 to 4.4 (females) and from 1.9 to 2.1 (males).

DISCUSSION

Pike and pikeperch are essentially the only obligatory predatory fish species inhabiting the reservoirs of southern Poland. The results of studies by Falkowski (2005, 2006, 2007) and Falkowski and Wiśniewolski (2003) prove that the share of pikeperch and pike has stabilized in spite of significant stocking efforts. Since both of these species are of interest to anglers and are also key to the proper functioning of fisheries management, it is necessary to study their growth rates. It is also key to analyze the histological pictures of their gonads, since they indicate, among other things, if a given species spawned successfully (Epler and Bieniarz 1979, Epler et al. 1996, Epler et al. 2005).

The growth rates of pikeperch from the Tresna Reservoir were slightly higher than those of this species in most other dam reservoirs (Table 2), especially in the fifth and sixth years of life in the Rożnów (Kołder 1969), Goczałkowice (Kołder 1969), and

Dobczyce (Jelonek et al. 2003b) reservoirs. The mean pikeperch body length in the Tresna Reservoir was higher in each year of life than the mean from many other lakes in northern Poland (Nagięć 1961) and equal to the growth of pikeperch in the Vistula River (Nagięć 1964).

The pikeperch sample from the Tresna Reservoir analyzed during the current study was comprised of 18 females and 13 males. The ovaries were dominated by oocytes in the protoplasmatic growth stage (mean 80%), which is characteristic of maturity stage II and is the beginning of ovary preparation for the subsequent spawning season (Sakun and Bucka 1968); oocytes in the process of vitellogenesis (mean 17.7%) that are characteristic of maturity stage III; and oocytes in the final phases of vitellogenesis that belong to maturity stage IV, but at the beginning of this phase when the egg cell nucleus (embryonic sac) is located in the center of the cell (Bieniarz and Epler 1991, Epler and Sokołowska-Mikołajczyk 2007). The histological pictures of the ovaries were similar in all of the female year classes. Empty follicular membranes were in the resorption process which signaled that the fish had spawned at the appropriate time. The lack of females with ovaries in the state of resorption indicated that pikeperch spawning in Tresna Reservoir had been successful. The testicles of all the males were in maturity stage III, which denotes intense spermatogenesis and involves the processes of the growth, maturity, and formation of the male germ cells (Sakun and Bucka 1968).

The growth rate of pike in the Tresna Reservoir was close to that of this same species in other dam reservoirs (Balon 1965, Wajdowicz 1965, Jarzynowa et al. 1990, Jelonek et al. 2003a, b). Lower growth rates were noted in pike from Jeziorsko Reservoir (Heese and Mastyński 1990) and other lakes in northern Poland (Antosiak 1961). Substantially lower growth rates were noted in pike from the rivers in Central Poland (Kopczyńska and Penczak 1969, after Załachowski 2000) in comparison to the fish from the Tresna Reservoir. Differences in mean body length were especially apparent between the fourth and eighth years of life (Table 3).

The histological picture of ovaries in year class 2 pike females indicated that 80% of the oocytes were in the protoplasmatic phase, and 20% were in the vacuolization phase, which is considered to be the first stage of vitellogenesis (endogenic vitellogenesis) still prior to the incorporation of the yolk (stage III). This indicates the second stage of maturity, and the small percentage of oocytes in the beginning of vacuolization indicates that the ovary building process for the first spawning had begun (Bieniarz and Epler 1991).

Fish in age classes from 3 to 7 exhibited a majority of oocytes in protoplastic growth stage that is indicative of maturity stage II (mean 64.8%), and a mean of 35.2% oocytes in maturity stage III at the initial period of vitellogenesis, which is evidence of the rebuilding of the ovary following the most recent spawning. Although no empty follicular membranes were observed (it had been about four months since spawning), it is a fact that five females (two of which were from year class 3) had ovaries in the resorption state. This indicates that spawning was not entirely successful, which might have been related to the lack of appropriate spawning substrate or the large fluctuations in the water level in the reservoir. The testicles of the pike from age classes 3 to 7 did not differ with regard to the maturity stage and all were in stage III.

The data presented clearly indicates that pikeperch have good conditions for growth and spawning in Tresna Reservoir, but while those for pike growth are good, they are only moderately good for spawning. Both of these species can be supported by stocking and are valuable components of the ichthyofauna of the Tresna Reservoir.

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STRESZCZENIE

TEMPO WZROSTU ORAZ OBRAZ HISTOLOGICZNY GONAD SZCZUPAKA, *ESOX LUCIUS* L. I SANDACZA, *SANDER LUCIOPERCA* (L.) ZE ZBIORNIKA ZAPOROWEGO TRESNA (JEZIORO ŻYWIECKIE)

Celem badań było określenie tempa wzrostu sandacza, *Sander lucioperca* (L.) i szczupaka, *Esox lucius* L. ze zbiornika zaporowego Tresna. Wiek ryb określono metodą odczytów wstecznych. Na podstawie analizy histologicznej gonad określono sukces tarłowy porównywanych gatunków. Materiał badawczy stanowiło 18 samic i 13 samców sandacza oraz 20 samic i 12 samców szczupaka (tab. 1). Tempo wzrostu sandacza w zbiorniku Tresna było wyższe w porównaniu z populacjami żyjącymi w innych akwenach w Polsce (tab. 2). Analiza histologiczna gonad wskazuje na sukces tarłowy sandacza w zbiorniku. Tempo wzrostu szczupaka w zbiorniku Tresna jest porównywalne z tempem wzrostu tych ryb w innych akwenach (tab. 3), natomiast obraz histologiczny jajników wskazywał na częściowy sukces tarłowy, gdyż 25% samic nie przystąpiło do rozrodu i ikra znajdowała się w stanie resorpcji.