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Age and growth rate of perch (*Perca fluviatilis* L.) from a special angling lake Skomielno

Wiek i tempo wzrostu okonia (*Perca fluviatilis*) z jeziora Skomielno użytkowanego jako jeziorowe łowisko specjalne

Summary. During control fishing surveys carried out in the 2005 and 2006 on the special angling lake Skomielno, 56 perches were captured and their scales examined for determination of this species age and growth rate. There were performed individual measurements of fish, while its growth rate and body weight were established by the length-based methods and back-reading procedure. Perch condition was determined by calculating the Fulton coefficient. The age of perch from Skomielno fishing site ranged within I+ up to VIII+ age classes, while IV+ age group was a clear dominant (contributing 30.5% of all fish examined) as well as VI+ (22.2% of fish). The highest average perch length increment was recorded for juvenile fish of VII+ age-group (172 g) and slightly lower for V+ and VI+ ones, i.e. 91 g, 80 g, respectively. A condition coefficient calculated for perches from Skomielno Lake averaged 2.3.

Key words: perch, *Perca fluviatilis*, fish age, growth rate, Skomielno Lake

INTRODUCTION

Perch (*Perca fluviatilis*) has been widely distributed throughout the country and well established in many lakes and rivers. Its abundance, however, may be critical to other freshwater fish communities and reduce their population through significant nutritional competition and predation pressure. Perch is a high priority species for both fishermen and consumers; therefore, it is advisable to study its age and growth – the factors determining the perch population dynamics.

The problems regarding perch age and growth have been repeatedly addressed in the academic literature and data concerning these factors are collected from various regions of Poland. Zawisza and Karpińska-Waluś [1961] reported perch growth in Wdzydze Lake, while Żuromska described growth rate of this species in the lakes situated in Węgorzewo region. Epler *et al.* [2005] published their findings on the age composition and

growth of perches caught in the dam reservoirs in Solina and Rożnów, whereas Skóra [1964] from the dam lake in Kozłowa Góra. Starmach and Jelonek [2003], studying the status of ichthyofauna and water environment of the Czorsztyński Reservoir, discussed the growth rate and age distribution of roach, bream and perch. In literature, there are numerous mentions concerning the age composition of growth rate and condition of perch not only from freshwaters but more saline ones as well [Włoszczyński 1967, Krawczak 1965, Szypuła 1998, 1999, 2002, Trella 2003].

Although the issue of perch age and growth rate is broadly discussed in literature, there is rather scanty data on this species in the lakes in the Łęczyńsko-Włodawski Lakeland.

The objective of the present research was to determine the age and the growth rate, condition, population size and age distribution of perch from Skomielno lake used as a special angling site and thus under heavy fishing effort. The sound scientific data concerning the analyzed fish species growth is needed to effectively implement and manage quality fishery on this lake. Besides, the results from this research will provide information necessary to compare the changes recorded in perch growth rate dynamics under angling pressure conditions.

MATERIAL AND METHODS

Skomielno is a lake located in the Łęczyńsko-Włodawskie Lakeland of 6.5 m maximum depth and 75 ha acreage. The present reservoir was formed on the basis of the natural lake of 30 ha area at the turn of 1950's/1960's when the lake was dammed and water supplied from the Wieprz-Krzna Canal.

Table 1. Technical-operative data of the Skomielno reservoir [Girsztowtt 2002]
Tabela 1. Dane techniczno-eksploatacyjne zbiornika Skomielno [Girsztowtt 2002]

Area, Powierzchnia	75.0 ha
Area for fishing, Powierzchnia przydatna dla rybactwa	55.0 ha
Maximum depth, Głębokość maksymalna	6.5 m
Entire volume, Objętość całkowita	1237 thousand m^3, tys. m^3
Useful volume, Objętość użyteczna	757 thousand m^3, tys. m^3

The whole reservoir bottom surface is covered by the organic sediment layer which reaches the thickness up to a few meters in some sites. Numerous trees and shrubs, predominantly black alder and osiers, grow around the lake as a fringe and along the damming. Thus, round the Skomielno reservoir an emergent zone of dense rush vegetation of 20–300 m width developed [Wilgat 1954, Girsztowtt 2002]. Since 2003, this lake has been used as a special angling site and the stocking program, mainly predator fish, is run over there. The rate of lake perch stocking was low as in 2003 it amounted to 600 ind. (40 kg) per the entire lake. In the successive years, however, this fish species stocking was not continued. Skomielno Lake is under strong commercial fishing effort and in 2004 alone, the perch harvest reached 93 kg.

The study material consisted of scales collected from 56 perches caught in the Skomielno Lake in 2005 and 2006. The fish for examinations were captured at control fishing. The caught fish were measured at 1 mm accuracy, taking into account the total length (*Longitudo totalis* – Lt) and body length (*Longitudo corporis* – Lc) as well as body weight at 1 g accuracy.

Table 2. Size structure of the population of the perch from the lake Skomielno
Tabela 2. Struktura wielkości populacji okonia z jeziora Skomielno

Specification Wyszczególnienie	Year Rok	N	Mean Średnia	Min.	Max.	SD	V (%)	Total Suma
Total length (cm)	2005	181	14.1	6.2	35.2	6.7	47.6	
Długość całkowita	2006	96	17.1	5.2	31.8	6.6	38.9	
Body length (cm)	2005	181	12.2	5.2	32.0	6.0	49.1	
Długość ciała	2006	96	14.4	4.3	27.1	5.7	39.9	
Body weight (g)	2005	181	60.0	2.0	634.0	102.0	170.0	10854.0
Masa ciała	2006	96	92.0	1.0	422.0	100.0	108.0	8865.0

SD – standard deviation, V – coefficient of variation
SD – odchylenie standardowe, V – współczynnik zmienności

Table 3. Size class and its share in perch population from Skomielno Lake
Tabela 3. Klasy wielkości i ich udział w populacji okonia z jeziora Skomielno

Specification Wyszczególnienie	Year Rok	Klasy wielkości (cm), Size class (cm)					
		do 6	6–12	12–18	18–24	24–30	30–36
Number of individuals	2005	10	107	26	30	5	3
Liczba osobników	2006	7	36	22	28	3	0
Participation in population (%)	2005	5.5	59.1	14.4	16.6	2.8	1.6
Udział populacji	2006	7.3	37.5	22.9	29.2	3.1	-

Table 4. Age, total length (Lt), body length (Lc) and annual increments of the perch from lake Skomielno
Tabela 4. Wiek, długość całkowita (Lt), długość ciała (Lc) i roczne przyrosty okoni z jeziora Skomielno

Specification Wyszczególnienie	Age group Grupa wiekowa							
	I+	II+	III+	IV+	V+	VI+	VII+	VIII+
Percentage Odsetek	2.8	2.8	13.9	30.5	13.9	22.2	11.1	2.8
Mean Lc (cm) Średnia Lc	8.0	12.0	17.2	20.0	22.4	23.4	28.9	30.2
Range Lc (cm) Zakres Lc	-	-	14.2–19.5	18.0–22.0	21.5–23.9	21.5–25.9	24.9–30.5	-
Mean Lt (cm) Średnia Lt	12.5	16.0	19.6	23.3	26.3	28.1	33.3	33.5
Range Lt (cm) Zakres Lt	-	-	16.0–22.1	21.1–25.6	25.7–27.2	25.5–29.0	29.0–35.2	-

Table 5. Mean body length and annual increments of perch from Skomielno Lake on the basis of back-calculated data
Tabela 5. Średnie długości ciała i przyrosty roczne okoni z jeziora Skomielno obliczone na podstawie odczytów wstecznych

Specification Wyszczególnienie	Age, Wiek							
	1	2	3	4	5	6	7	8
Age group, Grupa wiekowa								
I+	4.9							
II+	5.8	9.9						
III+	6.7	10.4	13.9					
IV+	6.7	10.5	13.7	17.3				
V+	7.0	10.9	14.1	17.0	19.7			
VI+	6.5	9.9	12.5	15.3	17.9	20.6		
VII+	7.1	10.9	14.4	17.0	20.5	23.6	26.1	
VIII+	7.0	10.0	12.0	14.9	17.4	22.3	25.0	27.6
Mean body length (cm) Średnia długość ciała	6.5	10.3	13.4	16.3	18.9	22.1	25.5	27.6
Annual increments (cm) Przyrosty roczne	6.5	3.8	3.1	2.9	2.6	3.2	3.4	2.1

Table 6. Weight and annual body weight increments of perch from skomielno lake
Tabela 6. Masa i przyrosty roczne masy ciała (g) okonia z jeziora Skomielno

Specification Wyszczególnienie	Age group Grupa wiekowa							
	I+	II+	III+	IV+	V+	VI+	VII+	VIII+
Mean body weight Średnia masa ciała	19	52	88	150	241	321	493	500
Range Zakres	-	-	42–125	109–209	199–285	220–410	211–635	-
Annual increments Przyrosty roczne	19	33	36	62	91	80	172	7

Table 7. Comparison of the mean body weight (in g) of perch from lake Skomielno with the mean weight of this species in other reservoirs
Tabela 7. Porównanie średniej masa ciała (g) okonia z jeziora Skomielno ze średnią masą tego gatunku z innych zbiorników

Reservoir Zbiornik	Author Autor	Age group Grupa wiekowa				
		III+	IV+	V+	VI+	VII+
Skomielno	own research dane własne	88	150	241	321	493
Solina	Epler *et al*. 2005	49	92	128	172	194
Tajty	Zawisza 1953	38	77	126	181	-
Wdzydze	Zawisza and Karpińska-Waluś 1961	30	68	185	304	-
Vistula Bay Zalew Wiślany	Krawczak 1965	45	84	144	221	276
Kozłowa Góra	Skóra 1964	45	83	156	221	279

Table 8. Comparison of mean values of the coefficient of condition (K) of perch from other reservoirs
Tabela 8. Porównanie średnich wartości współczynnika kondycji (K) okonia z różnych zbiorników

Reservoir Zbiornik	Author Autor	Age group, Grupa wiekowa								Mean Średnia
		I+	II+	III+	IV+	V+	VI+	VII+	VIII+	
Skomielno	own research dane własne	3.8	3.0	1.7	1.9	2.1	2.5	2.0	1.8	2.3
Tajty	Zawisza 1953	2.2	1.9	1.9	1.9	1.8	1.8			1.9
Wdzydze	Zawisza and Karpińska-Waluś 1961		1.3	1.5	1.7	1.8	1.9			1.6
Kozłowa Góra	Skóra 1964		1.7	1.9	1.8	2.1	2.2	2.3		2.0
Zalew Wiślany Vistula Bay	Krawczak 1965	1.3	1.5	1.8	1.9	2.0	2.1	1.9		1.8
Solina	Epler *et al*. 2005			1.9	2.0	2.0	2.0	2.1	1.9	2.0

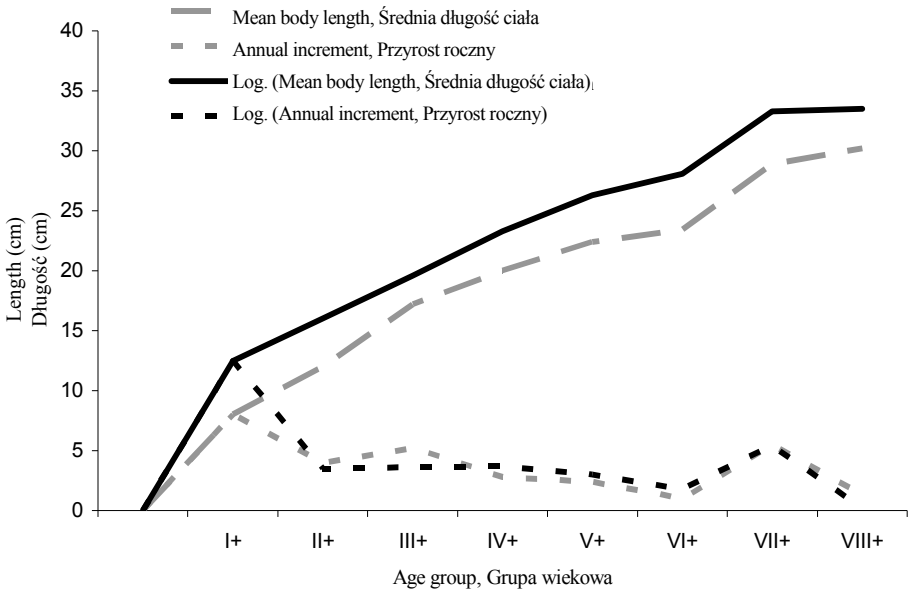

Fig. 1. Growth rate and length increments of pearch from lake Skomielno determined by real measurements
Rys. 1. Tempo wzrostu i przyrosty długości okonia z jeziora Skomielno wyliczone na podstawie pomiarów rzeczywistych

Perch age and growth rate evaluation was based on a few scales collected from each fish, on the left side of the body midway between the lateral line and the first dorsal fin. The specimens were rinsed in 5% ammonia solution, cleaned and processed to obtain scale preparations. The age was determined on the grounds of the annual rings – winter ones created due to sclerity thickening [Heese 1992].

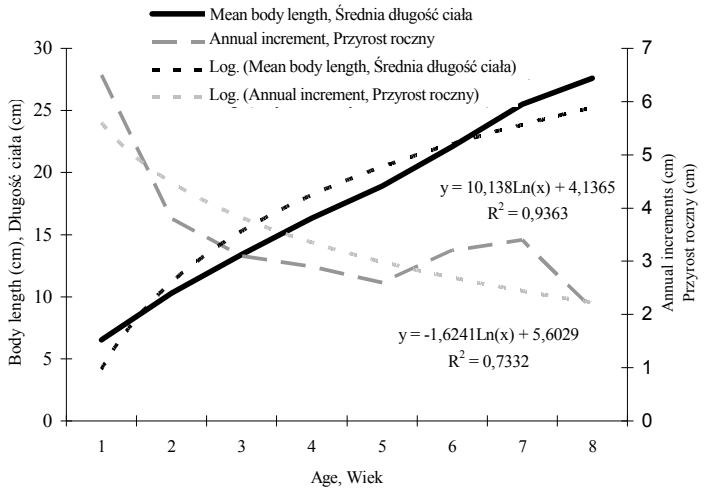

Fig. 2. Body length growth and annual increments of perch from lake Skomielno
Rys. 2. Wzrost długości ciała i przyrosty roczne okonia z jeziora Skomielno

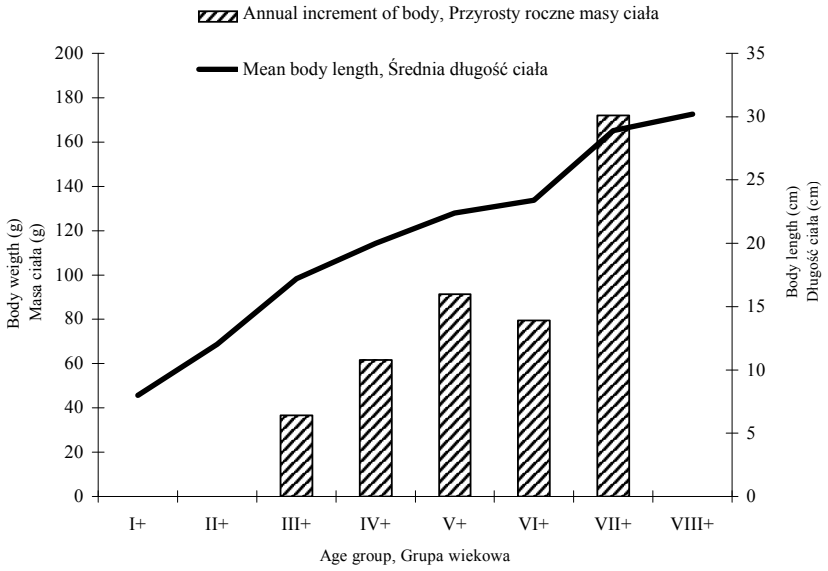

Fig. 3. Body weight increment and mean body length of perch from lake Skomielno
Rys. 3. Przyrost masy ciała i średnia długość ciała okoni z jeziora Skomielno

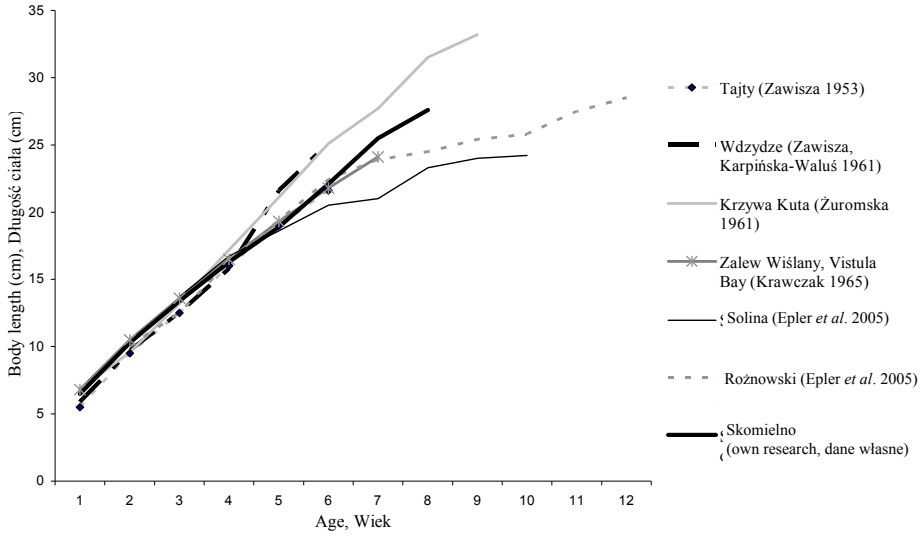

Fig. 4. Comparison between growth rate of perch from Skomielno Lake and the growth of this fish species in other reservoirs
Rys. 4. Porównanie tempa wzrostu okonia z jeziora Skomielno ze wzrostem tego gatunku w innych zbiornikach

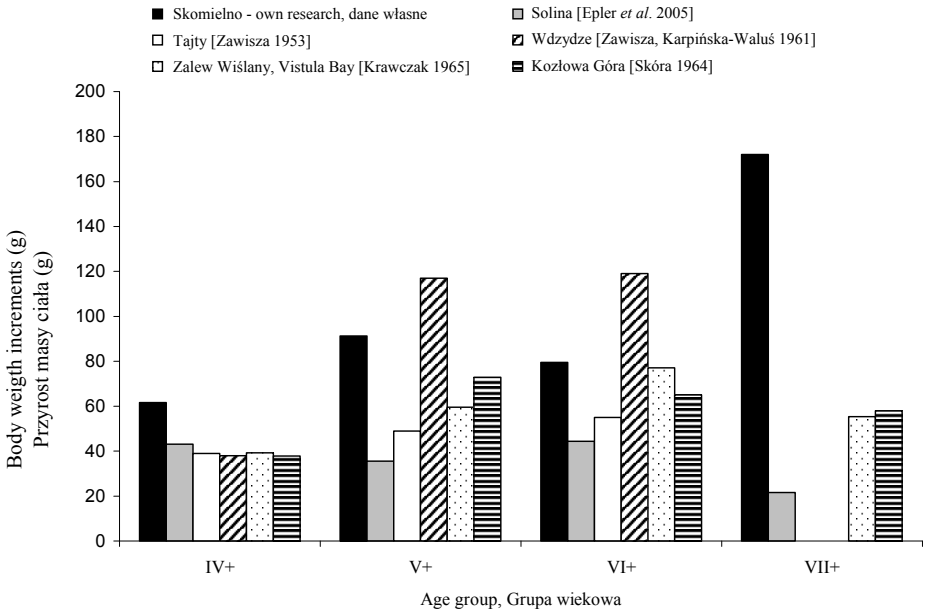

Fig. 5. Comparison of annual body weight increments of perch from different reservoirs
Rys. 5. Porównanie rocznych przyrostów masy ciała okoni z różnych zbiorników

Perch growth rate was established using the back readings method which resulted from the relationship between body length attained in the consecutive years of life and the length of the caudal scale radius without any corrections for the time of scale formation [Heese 1992]. The obtained research results allowed to determine the age composition of the fish under investigation. There were established body lengths and annual increments for each age-class of perch. Besides, there was calculated the condition coefficient (Fulton) expressed as

$$K = \frac{W}{L^3} \times 100$$

where:

W – body weight (g),
L – total body length (cm).

RESULTS

In control fishing carried out in Skomielno Lake in 2005–2006, 277 perches were caught. The analysis of this species size structure revealed its substantial variation. Considering the entire ichthyofauna of this lake, perch share in the total number of fish approximated 19%, while 30% in the biomass structure. The population of the analyzed fish showed higher average total lengths, body lengths and body weights in the second experimental year. Besides, it demonstrated their lower variation as compared to the first year (Tab. 2).

In perch total number in both experimental years, the fish between 6 and 12 cm dominated and their percentage ranged from 37% up to nearly 60% in the total number of fish. Fish of total length 12–18 cm and 18–24 cm (Tab. 3) constituted a substantial share as well.

The results of the experimental catches in the Skomielno Lake and age analysis of the examined fish species revealed the occurrence of perch whose age averaged from 1 year (1+) up to 8 yrs (VIII+). The individuals aged 4 yrs (IV+) and 6 yrs (VI+) accounted for over 52% of the total population under investigation. However, the highest share in population structure (30.5%) was demonstrated by 4-year-old fish, while the lowest (2.8%) by individuals aged 1 yr (I+), 2 yrs (II+) and 8 yrs (VIII+) (Tab. 4).

According to the analyzed real measurements of the discussed perch population at all class-ages, fish of varied total length from 12.5 to 33.5 cm were found. It is also noteworthy that the studied population showed relatively marked variation of body length within each age group.

The real measurement-based curves present the lengths and annual increments of individuals of this species aged between 1 yr and 8 yrs (Fig. 1). The course of body length growth curves indicates its progressive increase as the fish age advances.

One-year-old perches were characterized by the highest annual increment of fish length – approximately 6.5 cm., i.e. more than 2 times than in the individuals in the advanced age. Subsequently, a gradual reduction in length increment was observed. The fish at 2 years of age attained 3.8 cm length increment, while the 8-year old ones only 2.1 cm. Besides, the analysis revealed slightly higher increments of this fish species in 6 and 7 year of age, that is 3.2 cm and 3.4 cm, respectively (Tab. 5). Therefore, the course of mean body length curves and annual increments of fish reveals the distinct falls concerning the 1 yr as well as 6 yr and 7 yr old individuals (Fig. 2).

The analysis on the range of body weight variation within each age-class showed the highest differences in fish at 6 and 7 years of age that averaged 190 g and 424 g, respectively. The perches from the other age groups were characterized by the values oscillating within 100 g.

The analysis of the present results indicated a relationship between mean body length and annual increments of body weight. Perches aged six years (VI+) had a lower body weight increment compared to 5-year-old individuals (V+). In the examined fish, the growth rate appeared to be inhibited, which was illustrated by a fall of the mean body length curve (Fig. 3). The three-year-old fish (III+) obtained the annual increment of 36 g, whereas the fish from the seventh age group (VII+) had an average increment of 172 g.

The estimated Fulton condition coefficient (K) revealed high variation within the fish group studied. However, no typical downward or upward trend was observed in this parameter value. The results indicate that the best condition and the highest nutritional conditions characterized one-year-old perch, whose coefficient (K) reached 3.8. The lowest value of the parameter was recorded for perch from the third age group (III+) – 1.7 (Tab. 8).

DISCUSSION

The present research study obtained aimed at determining the age and growth rate of perch (*Perca fluviatilis*) obtained in the special angling Skomielno Lake situated in the Łęczyńsko-Włodawskie Lakeland. The results confirmed that the perch population in the investigated lake was abundant. During two years of the lake monitoring, there was found a slight decrease in fish numbers and the ichthyofauna biomass structure. That is likely to be associated with a perch response to the negative environmental changes. Czerwiński [2002] reports that already the first stage of lake degradation may induce a decreased perch stock. The experimental catches allowed to note severe reduction of small perch up to 12 cm in length (Tab. 3). That may imply the highly unsuitable conditions for reproduction, recruitment and survival of juvenile perch in Skomielno Lake. On the other hand, the ichthyofauna of the reservoir may partly benefit from such a situation because perch abundance means not only strong competition for food for other more valuable fish communities but predation as well that reduces severely their numbers. That predator pressure is mainly on hatched larvae and juveniles [Zawisza and Karpińska-Waluś 1961]. Therefore, knowledge on the contribution of this fish species to the general structure of ichthyofauna may in some way reflect the advantageous or disadvantageous conditions for this fish community existence which in turn is illustrated by the growth rate of this fish species. The age analysis showed that perch age varied between one and eight years and the individuals aged four (IV+) and six years (VI+) accounted for over half of the total population studied. There were found some differences in fish length growth and their mean annual increments subject to fish age, especially the falls were observed for the yearlings as well as for six- and seven-year olds (Fig. 2, Tab. 5). Most likely the situation was associated with the most beneficial environmental conditions that promoted the growth of individuals at this age. In most cases, neither a marked

inhibition increment rate was observed which is supposed to occur after sexual maturity has been attained (approximately at 10 cm) nor sudden growth acceleration owing to a serious change in feeding behavior, i.e. transition from omnivorous to strictly piscivorous (approximately at 15 cm) [Żuromska 1961].

A comparison of body length growth rate of perch from Skomielno Lake and from other reservoirs is presented in Fig. 4 and it shows that perch body length growth corresponds with the data reported for this species by the other authors. A comparison of the growth rate of body weight of the perch population under study against the background of the perch populations from other Polish lakes was restricted only to individuals aged 3–7 yrs due to limited sample size of other age classes. The performed analysis revealed very high variation of the body weight recorded for the fish at the same age. The individuals from Skomielno Lake were characterized with the values nearly twice as high as those reported for perch from other reservoirs (Tab. 7), which gives evidence that perch had a very good food source in this lake. What is more, perch population from the Skomielno lake between 4 (IV+) and 7 (VII+) years of age showed higher body weight increments. Similar or even greater weight increments were recorded only for 5- and 6-year-old perches from Wdzydze Lake. The studied 7-year-olds (VII+) from Skomielno Lake demonstrated extremely high weight increment of over 170 g, which makes multiplicity of this parameter represented by fish from the other reservoirs (Fig. 5). Variation in perch body weight estimates may be attributed to the development of gonads recorded in fish that are over 14 cm in length followed by a very rapid growth of gonad weight in longer individuals [Żuromska 1961]. Besides, emphasis should be laid on another aspect that is considerable perch angling pressure as this fish species still attracts more attention than any others. Actually, catching large individuals resulted in higher growth rates of young fish that are thus provided with available food source and lower nutritional competition.

The estimated coefficient of condition (Fulton) indicated great variation within the investigated perch group as it averaged between 1.7 for 3-year-old individuals and even 3.8 for one-year-old. The calculated condition coefficient (K) for the studied fish population from Skomielno Lake was compared to the data supplied from various reservoirs in Poland (Tab. 8). This parameter value was mainly dependent on the qualitative and quantitative composition of food, its availability and utilization, whereas the condition of the fish evaluated reflected the environmental conditions of a given water reservoir. Hence, differences in this coefficient value are most likely to be related to ontogenetic shift in the diet of older fish [Żuromska 1961]. The 1-year-old (I+) and 2-year-old (II+) fish compared to individuals inhabiting various water reservoirs showed a markedly better condition. The other age groups of fish from Skomielno Lake were characterized by a similar value of the coefficient of condition. Higher values of the coefficient may confirm good-quality food resource of the lake which promotes perch growth.

CONCLUSIONS

1. Age analysis of perch from Skomielno Lake revealed the dominance of IV+ and VI+ individuals.

2. The highest annual body length increment (6.5 cm) was recorded for one-year-old (I+) perches, whereas the lowest for those aged 8 years (VIII+) (2.1 cm). The highest annual weight increment (172 g) was attained by perches aged 7 years (VII+).

3. Body length growth of fish up to 4 year of age from the Skomielno reservoir is comparable to that determined for fish from other lakes and may be defined as very stable. No changes in fish length increment rate were recorded upon sexual maturity attainment or ontogenetic diet shift.

4. Considering the values of chosen major characteristics of perch from Skomielno Lake, it may be stated that the analyzed population reflects a reasonable management strategy of this species. High value coefficients of condition, length growth rate and body weight, as compared to other water reservoirs in Poland, are likely to be responses to good food sources, appropriate management of fishery as well as specific arrangement of various biotic and abiotic factors of Skomielno Lake.

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Streszczenie. Podczas odłowów kontrolnych w r. 2005 i 2006 na jeziorowym łowisku specjalnym Skomielno pozyskano 56 okoni, z których łuski posłużyły do określenia wieku i tempa wzrostu tego gatunku. Wykonano indywidualne pomiary ryb, a wzrost i jego tempo oznaczono metodą pomiarów rzeczywistych i odczytów wstecznych. Obliczono kondycję okoni za pomocą wzoru Fultona. Wiek okoni z jeziora Skomielno wahał się z I+ do VIII+, przy czym dominujące były roczniki IV+ (30,5% wszystkich badanych ryb) i rocznik VI+ (22,2% ryb). Średni przyrost długości ciała był największy w przypadku ryb młodych, z rocznika I+ i II+. Największe roczne przyrosty masy ciała okonia stwierdzono w przypadku rocznika VII+ (172 g), a nieco mniejsze – roczników V+ i VI+ (odpowiednio 91 g i 80 g). Współczynnik kondycji wyliczony dla okoni z jeziora Skomielno przyjmował średnią wartość równą 2,3.

Słowa kluczowe: okoń, *Perca fluviatilis,* wiek ryb, tempo wzrostu, jezioro Skomielno