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THE EFFECT OF STOCK DENSITY ON THE SURVIVAL, CANNIBALISM AND GROWTH OF SUMMER FRY OF EUROPEAN PIKEPERCH (*Stizostedion lucioperca* L.) FED ARTIFICIAL DIETS IN CONTROLLED CONDITIONS

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A B S T R A C T. Summer fry of pikeperch from the fish ponds was reared in controlled conditions on artificial diets in three variants of fish densities (0.6, 1.2 and 1.8 g/dm^3). Fish survival during a 4-week period of rearing ranged from 57.10 to 59.16 %. Losses were observed only in the first two weeks of rearing. The differences in natural losses and those caused by cannibalism depended in a significant way on fish densities.

Key words: PIKEPERCH, SUMMER FRY, REARING, ARTIFICIAL FEEDS, FISH DENSITIES

INTRODUCTION

Rearing of the pikeperch stocking material in fish ponds is quite effective until the stage of summer fry (Landyshevska *et al.* 1975). Its further rearing is limited due to zooplankton deficits, which usually take place in June, and increasing cannibalism amongst the fish (Berka and Hamackowa 1980). Studies by Zhdanova (1961) showed that summer fry of pikeparch of body weight 0.4-0.5 g was characterised by high vitality and adapted easily to new environmental conditions. Such fry can be directly released into natural waters, or can be still reared in ponds. However, there are no studies on the effectiveness of stocking the water bodies with pikeperch summer fry. Wojda *et al.* (1994) advocated that the effectiveness of stocking natural waters with summer fry was lower than in the case of autumn fry. On the other hand, subsequent rearing to the stage of autumn fry is quite difficult. The material thus obtained is usually characterised by small size and weak condition (Steffens 1986, Zakęś and Szczerbowski, 1995).

Since 1990 complex studies have been undertaken in the Inland Fisheries Institute on the possibilities and effects of rearing pikeperch summer fry originating from the fish ponds to later stages using artificial feeds.

The aim of this study was to determine the effect of stock densities of summer pikeperch fry on the fish survival, cannibalism and growth rate.

MATERIAL AND METHODS

The experimental material consisted of pikeperch summer fry reared in ponds to attain the total length Lt of 3.02 (±0.21) cm and body weight of 0.20 (±0.05) g. After an adaptation period (7 days), in which the fish were fed *ad libitum* with zooplankton, they were stocked into the rearing tanks of 20 dm^3. Water flow was maintained at 1.0-1.5 dm^3/min. Water temperature was 22 (±0.5)°C. Fish were divided into three experimental groups (stock densities: 0.6 g/dm^3 - variant A, 1.2 g/dm^3 - variant B, and 1.8 g/dm^3 - variant C). Each group consisted of three replicates. The tanks were illuminated for 24 h daily. The fish were given trout starter every 4 min. for 16 hours daily (from 5.00 to 21.00 h). Feeding rates were established at 10 % of the fish biomass. Size of pellets increased with fish growth (from 0.5-0.8 mm at the beginning to 1.2-1.7 mm in the final stage of rearing). Every 7 days 10 alive fish from each tank were weighed (up to ±0.01 g) and all fish were counted to determine the losses caused by cannibalism. Number of dead fish was registered daily and used to produce a cumulative mortality curve. Water parameters and fish health were controlled throughout the experiment. The rearing period lasted 28 days.

The results were subjected to statistical analysis of regression and variance (ANOVA). In those cases when analysis of variance showed that there were statistically significant ($p<0.05$) differences between the groups, further analyses were performed using the Duncan's test.

RESULTS

Total losses of pikeperch fry fed artificial diets were composed of natural deaths and cannibalism. They ranged from 40.84 % (A) to 42.90 % (B). The differences in total fish losses between particular groups were not statistically significantly different ($p>0.05$) (tab. 1). On the other hand, the differences of natural deaths differed significantly between the groups, and so did the losses due to cannibalism ($p<0.05$). This was confirmed by high correlation coefficients calculated for linear regression of particular parameters on fish densities (tab. 1).

TABLE 1

Coefficients of correlation (r) and determination (R^2), and linear regression equations (y=ax + b) of the observed parameters on fish densities (in g/dm^3). a - regression coefficient, b- free equation factor, p - level of significance

Specification	a	b	r	R^2	p
Cannibalism	-9.7222	25.2789	-0.8530	72.77	p<0.05
Natural mortality	11.3417	14.9511	0.9469	89.67	p<0.05
Survival	-1.6167	59.7644	-0.2657	7.06	p>0.05

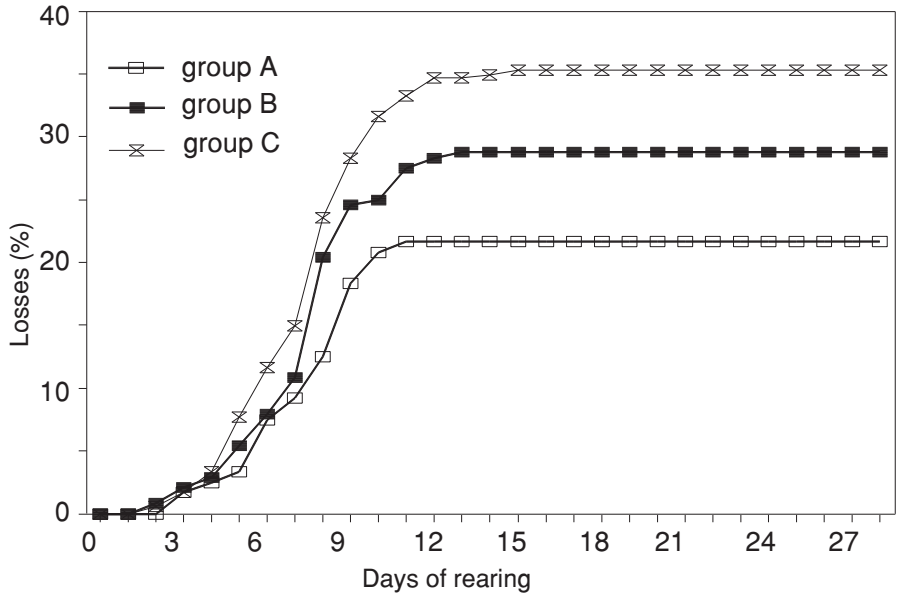

Fig. 1. Cumulated mortality of summer pikeperch fry i particular experimental groups.

Most intensive natural losses and those due to cannibalism were observed in the first two weeks of rearing; later on no losses were noted (fig. 1 and 2). The highest natural mortalities were recorded in group C (35.28±2.94 %). These losses correlated with fish densities, as confirmed by high correlation coefficient (r) and determination coefficient (R^2) (tab. 1). This was not so in the case of cannibalism; as the fish densities increased, the per cent of losses caused by cannibalism decreased.

Rate of growth was similar in all experimental groups. At the end of the experiment the fish attained average body weight of from 1.81 (B) to 1.90 g (A). Differences in the weight and length increments between the groups were not significant (p>0.05)

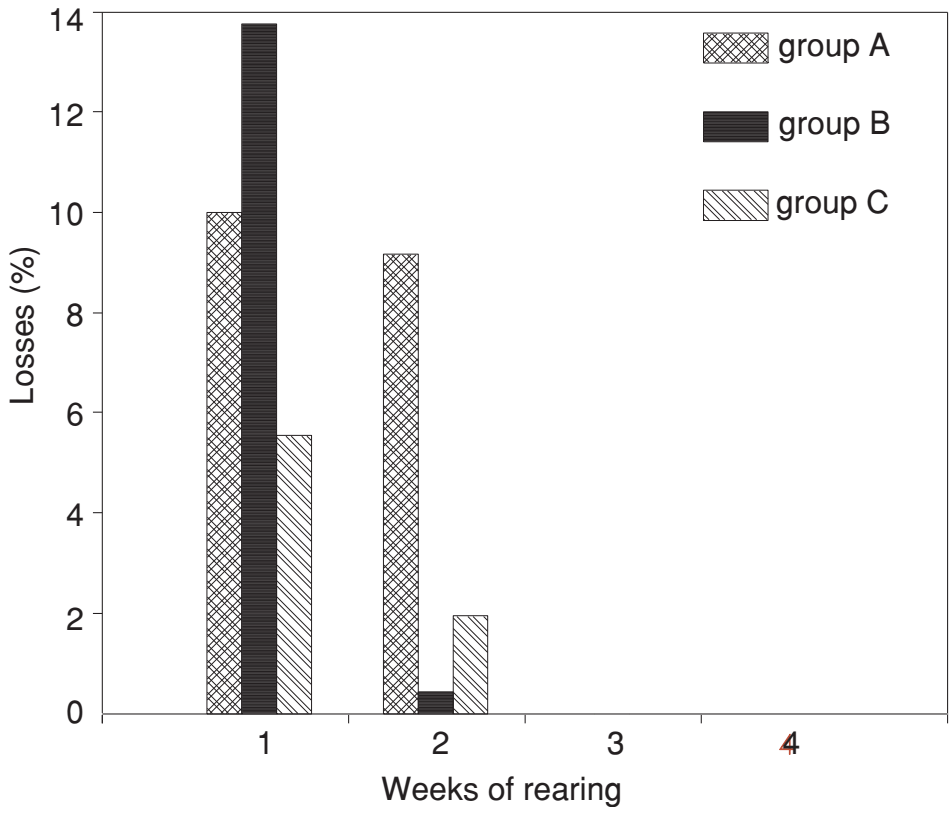

Fig. 2. Losses of pikeperch fry caused by cannibalism.

TABLE 2

Growth, survival and cannibalism of pikeperch fry at the end of rearing in three variants of fish densities. The groups denoted with the same letter in a row do not differ significantly (p>0.05).

Specification	Experimental groups		
	A	B	C
Total length LT (cm)	5.79±0.38^{a}	5.70±0.36^{a}	5.74±0.34^{a}
Body weight (g)	1.90±0.40^{ab}	1.81±0.37^{a}	1.85±0.36^{a}
Condition index K	1.64±0.09^{a}	1.64±0.11^{a}	1.62±0.08^{a}
Standard growth rate of body weight SGR[1]	7.78±0.02^{ab}	7.58±0.08^{a}	7.65±0.10^{a}
Cannibalism (%)	19.17±^{b}	14.18±1.36^{ab}	7.50±3.48^{a}
Natural mortality (%)	21.67±1.36^{a}	28.74±0.33^{b}	35.28±2.94^{c}
Survival (%)	59.16±4.76^{a}	57.10±1.02^{a}	57.22±0.45^{a}

[1]*SGR = ((final ln W - initial ln W)/28) 100*

(tab. 2). Standard growth rate (SGR) calculated for the whole period of rearing was also similar in the experimental groups. Fish densities obviously did not significantly affect fish condition ($p>0.05$) (tab. 2). At the end of the experiment the fish biomass in particular groups was: 3.38 g/dm^3 (A), 6.20 g/dm^3 (B) and 9.55 g/dm^3 (C).

DISCUSSION

Survival of 57-59 % attained in the experiment was slightly lower than in the previous rearing trials: laboratory - 62.5% (Zakęś 1992) and tank one - 66.8% (Zakęś 1993). In those experiments the initial individual weight of pikeperch fry was similar as in this experiment (0.20-0.25 g), and so were the fish densities. Data on the survival of summer fry of American walleye (*Stizostedion vitreum* Mitchill) fed artificial diet in controlled conditions were quite different. Fish survival was usually 20-60 % (Cheshire and Steele 1972, Nagel 1976, Reinitz and Austin 1980). However, Nagel (1985) stated that he had met a case of as low mortality of walleye fry as 3.0 %.

In this experiment, as well as in the previous ones, fry deaths were observed only in the first two-three weeks of rearing (Zakęś 1992, 1993). Deaths of walleye fry were also noted in the first weeks of rearing (Kuipers and Summerfelt 1994).

Losses caused by cannibalism decreased stock survival by several per cents. Cannibalism may also be the cause of considerable losses during walleye rearing on artificial feeds. Cheshire and Steele (1972) reported that losses caused by cannibalism amounted to 13.0 % in their experiment.

My experiment revealed that the differences in natural mortalities between the experimental groups, and losses due to cannibalism in a statistically significant way depended on fish densities. However, the per cent of successful attacks was decisively lower in the groups with higher fish densities. Fish which succeeded in catching a prey were disturbed by other fish, so they often did not swallow it. As a result, total losses were fairly similar in particular groups.

Experiment with American walleye fry reared on artificial feeds also did not show any relationship between fish densities of 0.87 to 3.21 g/dm^3 (at the moment of tank stocking with the fish) and fish survival (Kuipers and Summerfelt 1994). Similarly as in my experiment with the European pikeperch, these authors did not observe a significant effect of fish densities on the growth rate of walleye fry.

CONCLUSIONS

1. Fish densities as in the experiment (0.6, 1.2 and 1.8 g/dm^3) did not affect in a significant way the survival and growth rate of pikeperch fry reared on artificial feeds.
2. A dependence was observed between natural deaths, cannibalism and fish densities. As fish densities increased, natural deaths increased but losses due to cannibalism decreased.
3. In the case of rearing pikeperch fry on a larger scale it may be recommended to use quite high fish densities as they do not affect the effects of rearing, while allowing for attaining higher fish biomass.

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STRESZCZENIE

WPŁYW ZAGĘSZCZENIA OBSAD NA PRZEŻYWALNOŚĆ, KANIBALIZM I WZROST NARYBKU SANDACZA EUROPEJSKIEGO (*Stizostedion lucioperca* L.) KARMIONEGO PASZĄ W WARUNKACH KONTROLOWANYCH

Odłowiony ze stawów narybek letni sandacza podchowywano w warunkach kontrolowanych na paszy sztucznej w trzech wariantach zagęszczenia obsad (0,6; 1,2 i 1,8 g/dm^3). Na straty całkowite narybku sandacza karmionego paszą sztuczną złożyły się śnięcia naturalne i kanibalizm. Wahały się one od 40,84% (A) do 42,90% (B). Różnice w wielkości strat całkowitych w kolejnych grupach doświadczalnych nie okazały się istotne statystycznie (P>0,05). Natomiast różnice w wielkości śnięć naturalnych i strat spowodowanych kanibalizmem były wysoce istotne (P<0,05). Wielkość śnięć naturalnych była dodatnio skorelowana ze wzrostem zagęszczenia ryb. Inaczej wyglądała sytuacja w przypadku kanibalizmu - w miarę wzrostu zagęszczenia obsad procentowe straty nim spowodowane były coraz mniejsze.

Tempo wzrostu ryb w kolejnych grupach doświadczalnych było podobne. Różnice w przyrostach masy ciała i długości całkowitej nie okazały się istotne statystycznie (P>0,05). Nie stwierdzono także, aby zagęszczenia obsad w istotny sposób wpłynęły na kondycję ryb. W momencie zakończenia doświadczeń biomasa obsad w kolejnych grupach wynosiła odpowiednio 3,38 g/dm^3 (A), 6,20 g/dm^3 (B) i 9,55 g/dm^3 (C).

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