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Short communication

THE EFFECT OF STOCK DENSITY ON THE EFFECTIVENESS OF REARING PIKEPERCH *SANDER LUCIOPERCA* (L.) SUMMER FRY

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ABSTRACT. The aim of the experiment was to determine the effect of stock density on the growth, survival and cannibalism of pikeperch fingerlings held under controlled conditions in a water recirculation system and fed an artificial diet. The mean body weight of the fish at the start of the experiment was 0.65 ± 0.11 g and the total length was 4.54 ± 0.28 cm. The fish were divided into three experimental groups with the following stock densities: group A - 0.99 g l^{-1}; group B - 1.65 g l^{-1}; group C - 2.31 g l^{-1}. The rearing period was 42 days long and was divided into the adaptation and rearing proper periods. The results obtained from the experiment revealed that the initial density of pikeperch summer fry, which ranged from 0.99 to 2.31 g l^{-1}, had no effect on the final outcome of the rearing, i.e. neither on growth nor survival (ANOVA, $P > 0.05$). The final mean body weights for groups A, B and C were 9.43, 9.25 and 8.62 g, respectively, while total losses were 52.5, 56.1 and 56.1%, respectively. The high fingerling mortality during the adaptation period, i.e. from first to the fourteenth rearing day (group A - 40.8%, group B - 50.6%, group C - 44.1%), determined the effectiveness of rearing.

Key words: *SANDER LUCIOPERCA*, STOCK DENSITY, SURVIVAL, CANNIBALISM

Knowing the optimal stock density is one of the basic factors of intensive fish rearing. This density should be the resultant value of the environmental requirements of a given fish species and broadly understood economic efficiency (Kilambi et al. 1977, Carr and Aldrich 1982, Holm et al. 1990, Kuipers and Summerfelt 1994). In practice, attempts are often made to increase the effectiveness of production by increasing fish density per unit of water area or volume. However, this can lead to overpopulation which results in a decreased growth rate and, in the case of predatory fish, increased losses due to cannibalism (Fox and Flowers 1990).

The objective of the experiment was to determine the effect of the initial density of pikeperch *Sander lucioperca* (L.) summer fry on the effectiveness of rearing this species under controlled conditions (tank rearing).

The material consisted of fish with a mean body weight W of 0.65 ± 0.11 g and a total length TL of 4.54 ± 0.28 cm. The specimens were caught from a pond and transported in bags with oxygen (1,300 fish per bag) to the experimental rearing unit of the

Inland Fisheries Institute in Olsztyn. Three variants of fish densities were used: group A - 0.99 g l^{-1}; group B - 1.65 g l^{-1}; group C - 2.31 g l^{-1}.

The fish were reared in fiberglass tanks (diameter - 71.0 cm, depth - 72.0 cm) which had a working water capacity of 0.2 m^3 and were connected to two independent recirculating systems. The mean water temperature during rearing was 21.9 ± 0.3°C, the oxygen concentration at the water inflow was 8.4 - 6.8 mg O_2 l^{-1} and the pH was 6.6 - 7.4. The total ammonia nitrogen (TAN = NH_4^+- N + NH_3 - N) at the outflow remained at a level of 0.4 - 0.1 mg TAN l^{-1}. Commercially available FK trout pellets (crude protein – 52.0-50.5%, crude fat – 16.5-18.0%, digestible energy – 15.8-16.1 MJ kg^{-1}) produced by Felleskjopet Havbruk, Norway were fed continuously with clock-steered band feeders for 18 hours daily (09.00 – 03.00 h). The daily feed rations were gradually decreased from 15 to 3% of the total fish biomass.

The experiment was 42 days long and was divided into two periods –adaptation from days 1 to 14 (D1 – D14) and rearing proper from day 15 to 42 (D15 - D42). The daily body weight W (g d^{-1}) and total length TL (mm d^{-1}) gains were determined based on weekly measurements of 30 fish from each tank (W ± 0.01 g, TL ± 0.1 cm).

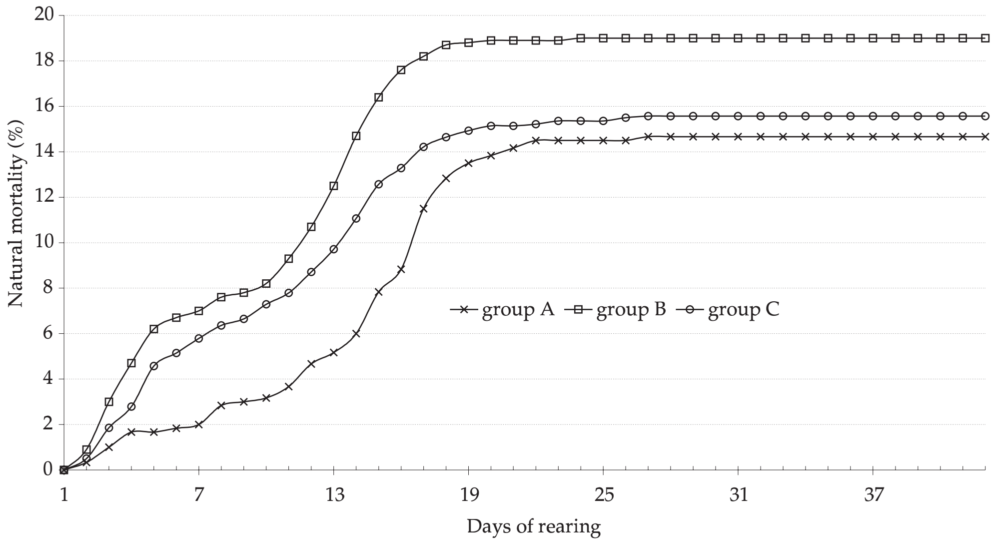

Fig. 1. Natural mortality curves for pikeperch summer fry reared at different stock densities (gropu A – 0.99 g l-1; group B – 1,65 g l-1; gropu C – 2,31 g l-1).

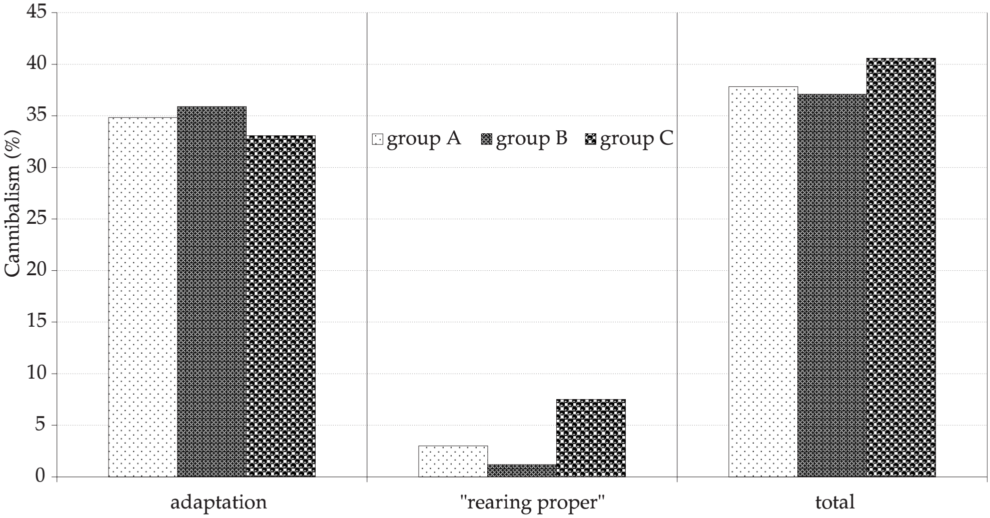

Fig. 2. Fish losses due to cannibalism by groups of pikeperch summer fry.

Natural mortality was estimated daily, and losses due to cannibalism were determined by calculating fish numbers after the adaptation period (D14) and at the end of the experiment (D42).

Growth rates in the fish groups were similar (Table 1). At the end of rearing (D42), the fish had attained a mean body weight from 8.62 g (group C) to 9.43 g (group A); this corresponds to a mean daily body weight increment ($g\ d^{-1}$) that ranged from 0.19 (group C) to 0.21 g (group A). These differences were not statistically significant (ANOVA, $P > 0.05$). Total losses in the experimental groups were also similar at 52.5% for group A, 56.1% for group B and 56.1% for group C (Table 1). They consisted of natural losses (group A - 14.7%, group B – 19,0%, group C - 15.6%; Fig. 1) and cannibalism (group A - 37.8%, group B - 37.1%, group C - 40.6%; Fig. 2). High fish mortality during the adaptation period (group A - 40.8%, group B - 50.6%, group C - 44.1%) determined the effects of rearing. Survival in all experimental variants was relatively low (group A - 47.5%, group B - 43.4%, group C - 43.8%) and did not differ significantly ($P > 0.05$).

TABLE 1

Growth rates, total losses and cannibalism of pikeperch summer fry reared at different stock densities (group A – 0.99 g l^{-1}, group B –1.65 g l^{-1}; group C – 2.31 g l^{-1}). Values with the same superscript in the same row are not significantly different (P > 0.05)

Parameters	Variants of stock densities		
	group A	group B	group C
Initial body weight (g)	0.66 (± 0.11)	0.66 (± 0.11)	0.66 (± 0.11)
Final body weight (g)	9.43^a (± 2.76)	9.25^a (± 2.57)	8.62^a (± 2.72)
Growth rate (g d^{-1})	0.21^a	0.20^a	0.19^a
Initial total length TL (cm)	4.54 (± 0.28)	4.54 (± 0.28)	4.54 (± 0.28)
Final total length TL (cm)	10.32^a (± 0.85)	10.20^a (± 0.84)	9.97^a (± 0.92)
Growth rate (mm d^{-1})	1.40^a	1.35^a	1.29^a
Condition factor K*	0.86^a (± 0.04)	0.85^a (± 0.04)	0.85^a (± 0.04)
Total losses (%)	52.5^a	56.1^a	56.1^a
Cannibalism (%)	37.8	37.1	40.6

* *K = [body weight (g) × 100 / total length TL^3 (cm)]*

The experiment results revealed that the initial densities of pikeperch summer fry that were applied had no effect on the final results of rearing (growth and survival). The same has been observed in earlier studies of this fish in a laboratory setting when similar fish densities were used (Zakęś 1997). In experiments performed on walleye *Stizostedion vitreum* Mitchill fingerlings reared on artificial feeds, initial stock densities from 0.87 to 2.92 g l^{-1} also had no effect on fish survival (Kuipers and Summerfelt 1994). The high losses during the adaptation period (D1 - D14) in the current experiment might have been due to the relatively large size of the summer fry at the moment the specimens were caught and the introduction of artificial food. Zakęś (1999) found that the size of summer fry at the beginning of pikeperch rearing on artificial feeds affected levels of mortality caused by starvation and cannibalism as larger fish are able to starve for a longer period and show a greater tendency toward cannibalism.

REFERENCES

Carr B.A., Aldrich D.V. 1982 – Population density effects on the behaviour and feeding of young striped mullet (*Mugil cephalus*) in 37.8 liter aquaria - J. World Maricult. Soc. 13: 254-260.

Fox M.G., Flowers D.D. 1990 – The effect of fish density on growth, survival and production of juvenile walleye in rearing ponds - Environmental Biology of Fishes 26: 129–142.

Holm J.C., Refstie T., Bo S. 1990 – The effect of fish density and feeding regimes on individual growth rate and mortality in rainbow trout (*Oncorhynchus mykiss*) - Aquaculture 89: 225–232.

Kilambi R.V., Adams J.C., Brown A.V., Wickizer W.A. 1977 – Effects of stocking density and cage size on growth feed conversion and production of rainbow trout and channel catfish – Prog. Fish. Cult. 39: 62–66.

Kuipers K.L., Summerfelt R.C. 1994 – Converting pond-reared walleye fingerlings to formulated feeds: effects of diet, temperature, and stocking density - Journal of Applied Aquaculture 4: 31–57.

Zakęś Z. 1997 – The effect of stock density on the survival, cannibalism and growth of summer fry of European pike-perch (*Stizostedion lucioperca* L.) fed with artificial food in controlled conditions – Arch. Pol. Fish. 5: 305–311.

Zakęś Z. 1999 – The effect of body size and water temperature on the results of intensive rearing of pike-perch, *Stizostedion lucioperca* (L.) fry under controlled conditions - Arch. Pol. Fish. 7: 187 – 199.

STRESZCZENIE

WPŁYW ZAGĘSZCZENIA OBSAD NA EFEKTYWNOŚĆ PODCHOWU NARYBKU SANDACZA *SANDER LUCIOPERCA* (L.)

Celem eksperymentu było określenie wpływu zagęszczenia obsad na efektywność podchowu (wzrost, przeżywalność, kanibalizm) narybku sandacza. Początkowa masa ciała i długość całkowita Lt wynosiła odpowiednio: 0,65 ± 0,11 (g) i 4,54 ± 0,25 (cm). Ryby podchowywano przez 42 dni w trzech wariantach zagęszczenia (0,99 g l^{-1} – grupa A, 1,65 g l^{-1} – grupa B oraz 2.31 g l^{-1} – grupa C). Stosowanie różnych zagęszczeń nie wpłynęło istotnie na końcowe wyniki podchowu (ANOVA, P> 0,05). W dniu zakończenia eksperymentu narybek osiągnął średnią masę ciała od 8,62 g (grupa C) do 9,43 g (grupa A), a średni dzienny przyrost masy ciała (g d^{-1}) mieścił się w przedziale od 0,19 (grupa C) do 0,21 (grupa A; tab. 1). Straty całkowite w poszczególnych grupach doświadczalnych były również zbliżone i wyniosły: 52,5% (grupa A), 56,1% (grupa B), 56,1% (grupa C; tab. 1). Złożyły się na nie śnięcia naturalne (grupa A – 14,7%, grupa B – 19,0%, grupa C – 15,6%; rys. 1) oraz kanibalizm (grupa A – 37,8%, grupa B – 37,1 %, grupa C – 40,6%; rys. 2). Wysoka śmiertelność narybku w okresie adaptacyjnym (dni podchowu 1 - 14; grupa A – 40,8%, grupa B – 50,6%, grupa C – 44,1%) zaważyła na efektach całego podchowu – wskaźniki przeżycia we wszystkich wariantach doświadczalnych były stosunkowo niskie (grupa A – 47,5%, grupa B – 43,4%, grupa C – 43,8%) i nie różniły się istotnie statystycznie (P > 0,05).

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