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The effects of twine thickness on the catchability of gillnets for pikeperch (*Stizostedion lucioperca* (L.))

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The effect of twine (monofilament) thickness (0.15 and 0.20 mm in diameter) in six mesh sizes (30 to 55 mm, knot to knot length) on the catchability of pikeperch (*Stizostedion lucioperca* (L.)) in the gillnet fishery of Lake Pyhäselkä, eastern Finland, was examined. The study was carried out mainly during two winter seasons (i.e. under-ice conditions) in 1992–1993 and 1993–1994. The mean length of pikeperch in the catches was 38 cm (range 22–51 cm, *S.D.* = 4.6) and the mean weight 490 g (range 70–1 440 g, *S.D.* = 190). In the mesh size range of 30–45 mm, a 5 mm increase caused the modal length of the pikeperch catch to rise by 3–5 cm, while in the sparser mesh sizes such an increase caused the modal length to rise by 1–2 cm. Any given mesh size captured fish mainly within a length range of 10–15 cm. The effects of twine thickness on the catchability of gillnets was significant: the thinner twine caught on average 1.9 times as many pikeperch as the thicker twine.The size composition of the catches was the same for both twine thickness. A large proportion of the fish in the experimental catches were undersized. However, the twine thickness did not effect the proportion of undersized individuals.

1. Introduction

Pikeperch (*Stizostedion lucioperca* (L.)) is found in different freshwater habitats as well as in coastal areas of Finland, although it is known to prefer slightly eutrophic and turbid waters (Mikulski *et al.* 1964, Lind 1977, Lehtonen *et al.* 1984, Lappalainen *et al.* 1995). Pikeperch is a popular target species for both recreational and professional gillnet fishery in Finland. Besides the open water season, it is also a common species in the under-ice gillnet fishing of winter time. Consequently, the greater part of the Finnish pikeperch catch is obtained by gillnets. For example, 65% of the recreational catch in 1994 (Leinonen 1995) was thus obtained.

It is well known that a gillnet of a given mesh size will tend to catch most efficiently fish of a certain size. Generally, few fish are caught whose lengths differ from the optimum by more than 20% (Hamley 1975). Gillnet catchability and selectivity for both pikeperch and the closely related walleye (*Stizostedion vitreum* (Mitchill)) have been examined fairly extensively, while previous studies have mainly focussed on the effect of mesh size (e.g. Hamley & Regier 1973, Van Densen 1987, Lehtonen & Miina 1988, Machiels *et al.* 1994) or snood length

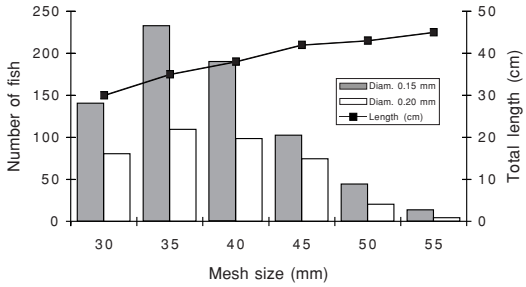

Fig. 1. Pikeperch catch (number of fish) in multi-mesh gillnets (30–55 mm, knot to knot length) with regard to two thicknesses of net twine (0.15 and 0.20 mm in diameter) combined with the modal length of fish for each mesh size.

and hanging ratio (Machiels *et al.* 1994) on selectivity. Generally, the effect of twine thickness on the selectivity and catching efficiency of gillnets has been addressed in only a few studies (Hansen 1974, Suuronen *et al.* 1992, Jensen 1995ab). The present study examines the efficiency (catchability) of pikeperch by gillnets made of two twine thickness and six different mesh sizes. Also, the factors affecting the share of undersized pikeperch in the experimental gillnet catch are described.

2. Material and methods

The study was carried out in 1992–1994 in Lake Pyhäselkä, eastern Finland (area 246 km^2, mean depth 10 m). The lake is mesotrophic and quite rich in humic compounds. Experimental fishing was conducted with multi-mesh gillnet series including mesh sizes of 30, 35, 40, 45, 50 and 55 mm (knot to knot length). Experimental gillnets, as conventionally used in Finnish lakes, were made of grey polyamide monofilament yarns of 0.15 and 0.20 mm in diameter. The gillnets were 30 m in length and 3 m in height. The weight for the footrope was 1.8 kg/100 m and the floating capacity for the headline was 0.9 kg/100 m. The hanging ratio (E), defined as the ratio between the length of the netting frame and the stretched netting, was 0.4 for the headline and 0.6 for the footrope.

Four gillnet series (48 nets in total) were simultaneously used for experimental fishing during the 1992–1994 period in Lake Pyhäselkä. Bottom-set gillnets (4–6 nets in a series) were randomly placed, generally at a depth of 10–15 m. One unit effort was defined as either 4–5 days in wintertime or one night in summertime (typical for Finnish gillnet fishery). A total of 1 105 pikeperch were caught, of which 93% were caught in under-ice conditions from December to April. The total length and weight of each fish was measured and scale samples were taken for age determination.

The length frequency distributions for two gillnets of different twine thickness (pooled data) were compared using the nonparametric Kolmogorov-Smirnov test. Student's t-test was applied to evaluate the differences in catching efficiency (CpUE) between two twine thicknesses in each mesh size.

3. Results

Gillnets with 35 and 40 mm mesh sizes accounted for about 60% of the total catch (Table 1, Fig. 1). Due to low numbers of large individuals in pikeperch population of Lake Pyhäselkä, catches decreased substantially with larger mesh sizes. The mean length of pikeperch in the catches was 38 cm (range 22–51 cm, $S.D.$ = 4.6) and the mean weight 490 g (range 70–1 440 g, $S.D.$ = 190). The mean and modal lengths of fish in each mesh size are given in Table 1.

The length of pikeperch was highly related to mesh size; in the mesh size range of 30–45 mm a 5 mm increase caused the modal length (peak of length frequency distributions, Fig. 2) of pikeperch to rise 3–5 cm but in the mesh sizes from 45 to 55 mm

Table 1. The mean and modal lengths of pikeperch caught in multi-mesh gillnets (30–55 mm; knot to knot length) with two different (0.15 and 0.20 mm in diameter) twine thicknesses (n = number of fish).

Mesh size (mm)	Twine of 0.15 mm				Twine of 0.20 mm				Total			
	n	Length (cm)			n	Length (cm)			n	Length (cm)		
		Mean	($S.D.$)	Mode		Mean	($S.D.$)	Mode		Mean	($S.D.$)	Mode
30	140	33.1	(4.2)	32	80	33.6	(3.7)	30	220	33.3	(3.9)	30
35	232	36.6	(3.6)	35	109	36.5	(3.3)	37	341	36.6	(3.4)	35
40	189	38.8	(3.3)	38	98	38.7	(2.6)	38	287	38.7	(3.0)	38
45	102	41.6	(2.7)	42	74	42.1	(2.9)	41	176	41.9	(2.8)	42
50	44	43.0	(2.3)	43	20	42.2	(5.7)	43	64	42.6	(4.5)	43
55	13	42.7	(6.3)	45	4	41.6	(5.8)	—	17	42.1	(6.1)	45
Total	720				385				1 105			

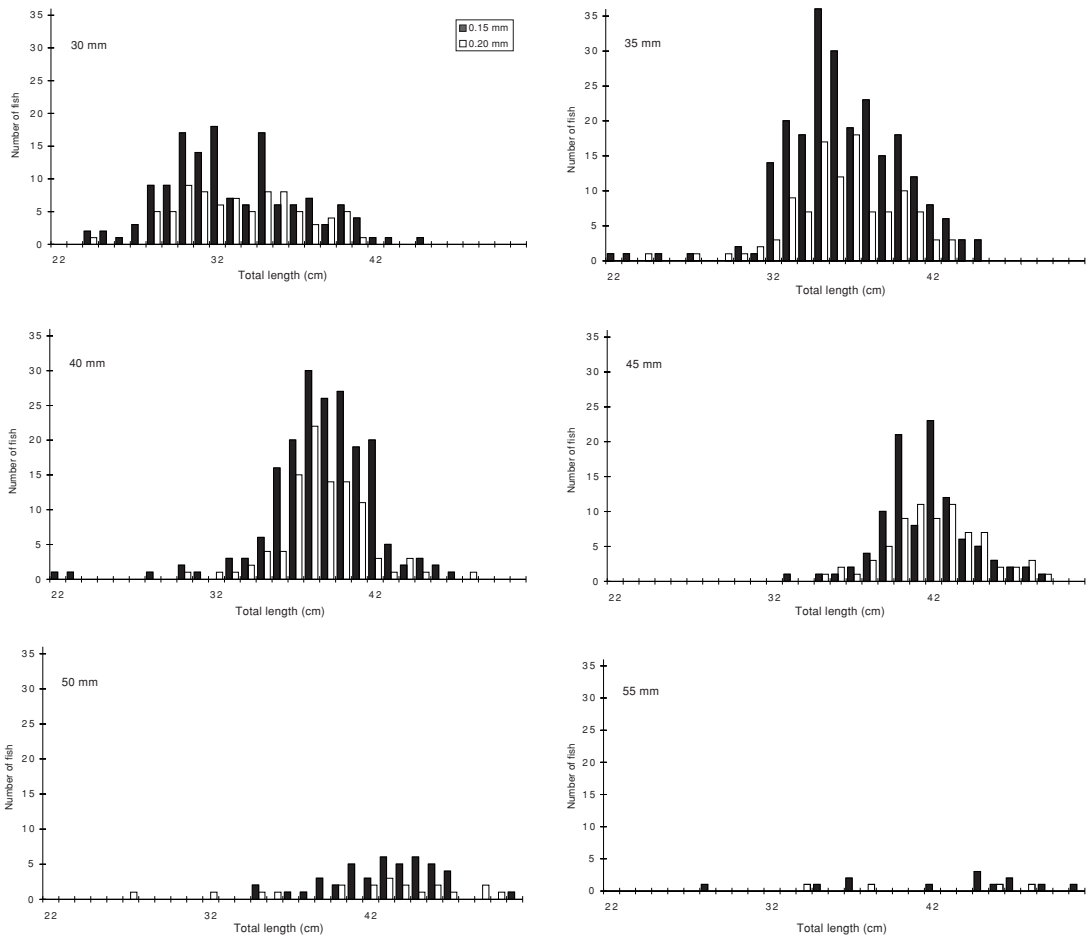

Fig. 2. Length frequency distribution for pikeperch in multi-mesh gillnets (30–55 mm, knot to knot length).

the increase was 1–2 cm (Fig. 1). According to the linear equation $y = 0.59x + 13.8$ (y = the modal length, x = mesh size, $n = 6$), the mesh size explained 95% of the modal length of the pikeperch caught. A given mesh size was observed to capture pikeperch within a length range of 10–15 cm (Fig. 2).

The twine thickness had a considerable effect on the pikeperch catch; the thinner twine (0.15 mm) captured, on average, 1.9 times as many fish as the nets made of the thicker (0.20 mm) twine. The differences in catchability between two twine thicknesses were significant (t-test, $p < 0.01$) for all mesh sizes. There were no significant differences in the length composition of pikeperch between two different twine diameters (nonparametric Kolmogorov-Smirnov-test, $KS = 0.029$, $p > 0.05$, $n = 1\ 105$). The skewness of the length frequency distributions (pooled data) was 0.8 and 0.9, and the kurtosis – 0.8 and – 0.6 for 0.15 mm and 0.20 mm twine thicknesses respectively.

There are generally two alternative minimum landing-size limits in use for pikeperch in Finnish lakes: either 37 or 40 cm in total length. The share of undersized fish in the experimental catch was 45.5% when the size limit was 37 cm. However, a three centimetre increase in legal size has a major effect on the share of illegal fish in test catches; the proportion of illegal fish rose to 72.8%. The proportion of undersized pikeperch for six different mesh sizes is given in Table 2. The results of 50 and 55 mm mesh sizes are not reliable because of an insufficient number of fish in experimental catches. The twine thickness did not affect the proportion of undersized individuals: the share of < 37 cm fish was

45.4% and 45.7% for twines of 0.15 mm and 1.20 mm respectively, and 72.6% and 73.2% for < 40 cm pikeperch.

4. Discussion

The results of this study indicate that both the mesh size and twine diameter of gillnets strongly affect the catchability of pikeperch. Generally, nets of thinner twine have been observed to be more efficient than nets of thicker twine (e.g. Baranov 1914, Andreev 1955; reviewed by Hamley 1975, Jensen 1995b). Thin twine is less visible, easier to stretch, and more flexible; therefore it should entangle more fish and catch larger fish, as long as the twines are not broken by larger fish. Using transparent monofilament nets, Jensen (1995a) found that nets made of 0.1 mm twine caught 2.2 times as many Arctic charr (*Salvelinius alpinus*) per time unit as did nets of 0.17 mm twine. Hansen (1974) reported that nets made of 0.133 mm twine captured larger fish than nets made of 0.267 mm in diameter. This difference was apparently due to the elasticity of the monofilament nylon. Moreover, in the experiments conducted by Suuronen *et al*. (1992), a smaller twine diameter in pikeperch gillnets caused the proportion of undersized individuals to increase. My results did not show the same phenomenon.

Table 2. The proportion of undersized pikeperch in experimental gillnet catches from two alternative landing size limits (37, 40 cm, total length) for mesh sizes of 30–55 mm (knot to knot length).

Mesh size (mm)	Alternative landing size limit (cm)	Proportion of undersized fish (%)	Number of undersized fish in test catch
30	37	79	173
	40	91	201
35	37	53	179
	40	79	268
40	37	16	47
	40	61	174
45	37	3	6
	40	18	31
50	37	9	6
	40	18	11
55	37	18	3
	40	35	6

Gillnets made of two different twine diameters caught on average the same size of pikeperch (i.e. the size structure of the fish was the same with both twine types). Nevertheless, it is important to note that the absolute number of undersized individuals was twice as high with gillnets made of thinner twine. Thus, the use of thin twine cannot be recommended from the viewpoint of stock conservation, for example if fishing pressure is high or if a threat of overfishing appears. Furthermore, gillnets are widely used in biological and fisheries research. Therefore, the effect of twine thicknesses on catching efficiency must be taken into consideration in interpreting the results of fishing trials. On the other hand, the effect of twine diameter on gillnet selectivity and catching efficiency is most likely species-dependent, and results from the present study should not be generalized. The question of whether these results are valid for the summer fishery of pikeperch remains to be seen. Fish behaviour and the characteristics of net materials may differ considerably in cold water conditions *vs*. the warm water season, and the disparity in catchability between the twine types studied may become larger in the cold water season.

The pikeperch stocks of Lake Pyhäselkä are effectively exploited by gillnet fishermen (Karjalainen *et al*. 1996). A large proportion of pikeperch in the study lake, as well as in numerous other Finnish lakes, are caught below their legal size, before their first reproduction (Lehtonen 1987, Karjalainen *et al*. 1996). Innovations in mesh size management for gillnet fishing would be a useful tool in increasing the yield of pikeperch in Finland.

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