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Bioekonomic

THE EFFECT OF EXPLOI TATI ONON THE LEVEL OF CATCHES AND EFFECTIVENESS OF PIKEPERCHEXPLOITATI ONIN LAKES

WPŁYW EKSPLOATACJI NA WYSOKOŚĆ ODŁOWÓW I EFEKTYWNOŚĆ POŁAWIANIA SANDACZA W JEZI ORACH

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Pikeperch catches amounted on the average to 2.92 kg/ha in 1970–1985. The analyses embraced 52 lakes of total area 16125 ha. It was found that the level of pikeperch catch depended on the intensity of exploitation ($r_{xy} = 0.588$) and stock size ($r_{xz} = 0.582$), the latter being assessed using a coeficient of the effectiveness of exploitation. This coefficient, calculated jointly for seines and gill nets, was 0.22 kg/UE, varying from 0.06 to 0.64 kg/UE. No statistically significant relation was found between exploitation intensity and the coefficient of effectiveness of pikeperch exkploitation.

INTRODUCTION

Pikeperch is considered as easy to catch and responding strongly to fishery exploitation. This fish, being a predator, frequently acts as an ameliorator in the ichthyofauna, decreasing the densities of weed fish. This view is noticeable in the fisheries management as pikeperch in not exploited by commercial fishermen during the reproductive period (protective season) (Bonar 1987, Bonar and Kempa 1987), and protective size for this fish is constantly being increased (ichthyologists, personal communication).

Commercial catches of pikeperch in randomly selected 22 lakes tended to decrease in 1973–1982 by 0.18 kg/ha on the average (Jakubas 1983). This author stated also that stocking with pikeperch were performed in 15 lakes only, and that they were not systematic. Number of stocking made ranged from 1 to 14 in particvular lakes. No relationship was found between stocking intensity and pikeperch catches (Jakubas 1983).

The literature on predation in lake ichthyofauna points to the function of exploitation in shaping the proportion between numbers and biomas of predatory and prey fish stocks (Bonar 1977, Forney 1977, Holcik 1977, Johnson 1977, Ker 1977, McLean and Magnuson 1977, Lammens 1986, McQueen et al. 1986, Bonar 1990 b).

The results of these studies, as also high economic value of pikeperch and role of this fish in the balance of fish communities, induced me to look for the relationships between intensity of exploitation, pikeperch catches, and stock size.

MATERIALS AND METHODS

Materials consisted of the records kept by the fishery enterprises. The following data were selected: level of pikeperch catches, number of the gear used, dates of fishing, lake names and surface areas. The materials embraced 52 lakes of total area 16125 ha, and the period 1970–1985. Characteristics of the lakes under study are presented in Tab. 1

Table 1

Hydrobiological characteristics of 42 pikeperch lakes

Specification	Units	Average	Values	
			highest	lowest
Area	ha	275.03	3245.4	38.3
Maximal depth	m	9.72	45.8	2.0
Average depth	m	3.99	15.0	0.7
Water transparency	m	1.00	. 2.5	0.35
Conductivity	μ/cm	382.11	670	224
Index of primary productivity (Patalas, 1960)	–	3.87	5.0	2.6
Littoral area	%	10.35	40.0	0.6

Three types of the fishing gear were analysed: summer seines, winter seines and gill nets (Tab. 2). Mesh size varied from 40 to 100 mm. Wing length was 60–180 m for summer seines and 220–300 m for winter seines (Bonar 1990a).Other gears used in the lakes under sudy were of no importance as regards pikeperch fishing, so they were not taken into consideration.

Analyses concentrated on the relations between intensity of exploitation, pikeperch catches, and exploitation effectiveness. Intensity of exploitation was measures as total fishing effort per unit of lake area (UE/ha). Effectiveness of

Characteristics of explatation and catch of pikeperch
(year average — 1970—1985)

	Summer seine with bag	Gill netts	Winter seine with bag	Total
Catch of pikeperch				
kg/ha	1.25	1.16	0.51	2.92
%	42.80	39.73	17.47	100
Fishing effort				
UE/ha	7.27	2.89	3.59	13.75
%	52.87	21.02	26.11	100
Catch/unit effort				
kg/UE	0.17	0.40	0.14	0.21

exploitation was expressed as pikeperch catch per unit of effort (kg/UE).

According to the suggestion by Leopold (1968), total fishing effort was calculated as a sum of products of an average (for Poland) fishing yield of the given gear (taken as the fishing effort in UE) and the number of days in which this gear was used. This rule may be formulated as:

$$N_p = Wp_1 * N_1 + Wp_2 * N2 + WP_3 * N_3 \ldots\ldots\ldots\ldots WP_n * N_n$$

where:

Np – total fishing effort expressed in standard units of effort (UE)

Wp – average (for Poland) fishing yield of the given gear

N – number of gear-days for the given gear.

Fishing records used as the materials may contain errors which are difficult to establish. In view of this, representativeness of the materials was estimated before their statistical treatment. Intensity of exploitation, pikeperch catches, and coefficients of the effectiveness of exploitation showed moderate variability. The highest variability, expressed as standard deviation in relation to the arithmetical mean, was found for pikeperch catches (76%). Variability of the other parameters was lowe. It was also found that the data showed unimodal distribution with· slight right-hand side skeweness (Tab. 3). In view of this,- the materials were defined as

Table 3

Characteristics of statistical distribution (1970–1985)

Varia- bles	Value			Mo	Standard deviation	Variabi- lity v %	Distri- bution skewness %
	average	minimum	maximum				
x	2.92	0.14	12.83	2.46	2.21	75.68	0.21
y	13.75	1.53	37.34	12.85	7.20	52.36	0.12
z	0.22	0.06	0.64	0.21	0.13	59.09	0.08

x – catch of pikeperch (kg/ha)
y – intensity of exploatation (UE/ha)
z – effectivity of exploitation (kg/UE)

representative (Peterman 1990). Statistical variables used in the analyses consisted of arithmetic means calculated for the period 1970–1985 for each lake separately. Significance of the dependencies between the variables was determined using correlation coefficients of Pearson (Lange and Banasiński 1968).

RESULTS

Commercial catches of pikeperch in 52 lakes amounted on the average to 2.92 kg/ha. The lowest catches were about 0.14 kg/ha on the average, the highest 12.83 kg/ha. Coefficient of variability reached 75.68% (Tab. 3).

Variability of pikeperch catches may depend on two groups of factors: density of the exploited   stock (specimens higher than the protective size) and intensity of its exploitation, and catchability of the fishing gear and fishing season (Bonar 1987, Bonar and Kempa 1987).

It was found that the relationship between intensity of exploitation and pikeperch catches was significant statistically, and the correlation coefficient was positive. An increase of the intensity of exploitation by i UE resulted in an increase of catch by 0.18 kg/ha (Fig. 1). Coefficient of determination amounted to $r^2 = 0.346$ i.e. variability of pikeperch catches was in 35% explained by the fishing intensity (Tab. 4). Increase of the intensity of fishing with summer seines by 1 UE/ha caused an increase of pikeperch catch by 0.22 kg/ha. The respective value for winter seine was 0.21 kg/ha, and for gill nets 0.20 kg/ha. Summer seines were most .important in pikeperch fishing (Tab. 2).
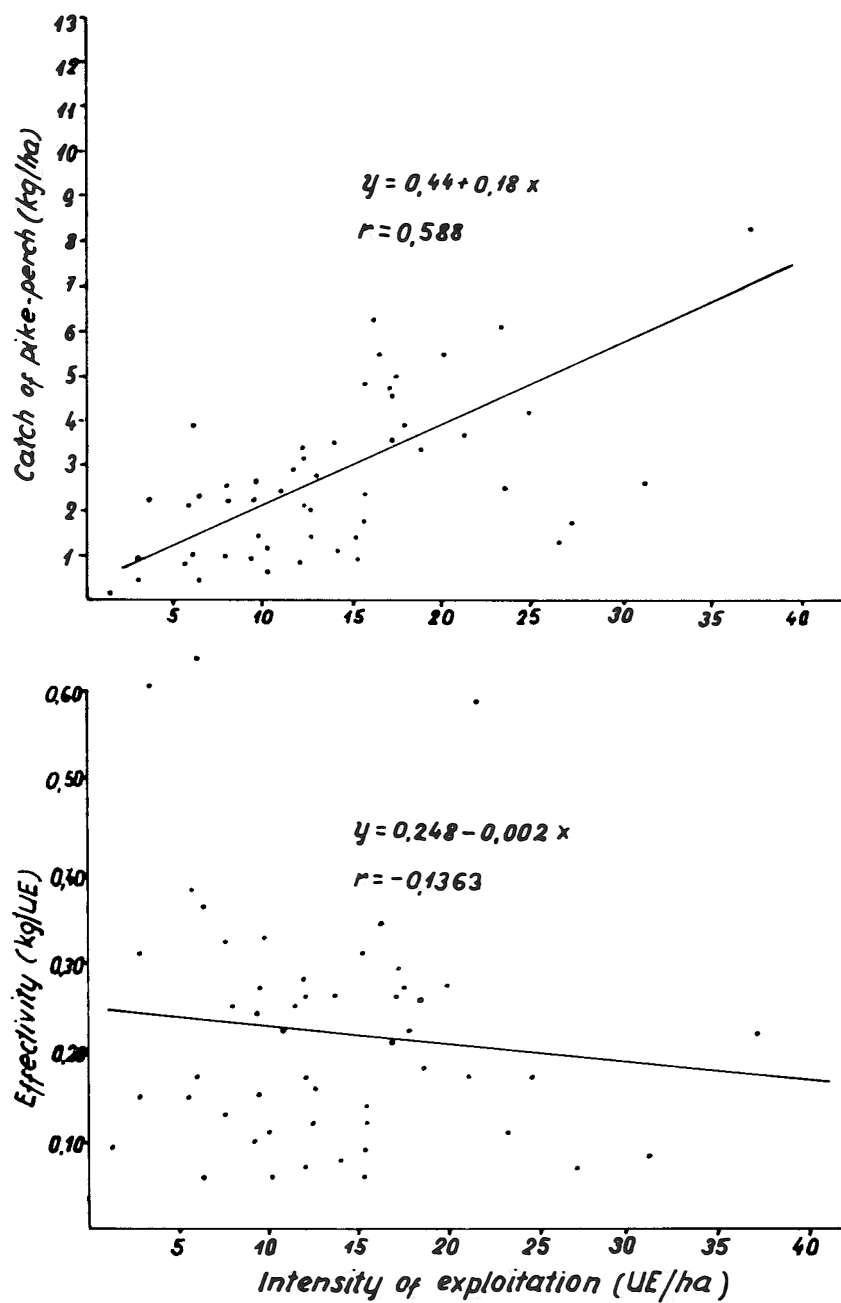
Fig. 1. Relations between intensity of exploitation and catches of pike-perch, and between intensity exploitation and effectivity of pike-perch catches
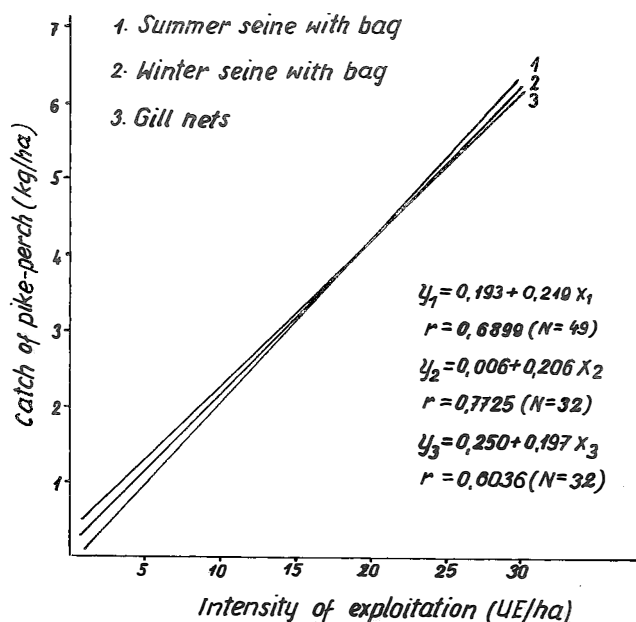
Fig. 2. Relations between intensity of exploitation and catches of pike-perch by summer seine with bag, and winter seine with bag anbd gill nets

Corelation index

Variables	Coefficient of correlation	Coefficient of determination	Linear regressions
y x	+ 0.588	0.346	y = 0.44 + 0.18 x
x z	+ 0.582	0.339	x = 0.74 + 9.89 z
y z	−0.136	0.018	y = 0.248 − 0.002 z

x − catch of pikeperch (kg/ha), y − intensity of exploitation (UE/ha), z − effectivity of exploitation (kg/UE)

Dąbrowski, and Leopold (1969) analysed the relationships between fishing intensity and catches of vendace. They found that an incrase of catch per one unit of the fishing effort was 1.85 kg/ha, at average catch level of 3.8 kg/ha. Average catch of pikeperch was lower and amounted to 2.92 kg/ha (Tab. 3).

The difference may result from different densities of pikeperch stocks as well as from higher pressure of the fishery exploitation on the stock of this predator. Pikeperch was caught with seines and gill nets. Summer seines were most intensively used since July till October, winter seines since October till January, and gill nets since July till November (Bonar 1987, Bonar and Kempa 1987). Most intensive fishing for vendace took place since July till September (Leopold 1972).

Relationship between pikeperch catches and coefficient of the effectiveness of exploitation was also highly significant (Tab. 4). Effectivenes of exploitation, measured in catch per unit of effort, was calculated jointly for summer and winter seines and gill nets. CUE with these nets was used as an index of stock density (after Dąbrowski 1964, Leopold 1968). The lowest effectiveness was 0.06 kg/UE, the highest 0.64 kg/UE (Tab. 3).

There was no siginificant correlation between intensity of exploitation and density of exploited pikeperch stock. Only 1% of the variation was explained by fishing intensity (Tab. 4). The same was found by Dąbrowski and Leopold 1969) for vendace.

DISCUSSION

Ichthyological literature frequently pointed to the relationship between intensity of exploitation, level of catches, and effectiveness of fishing. (Ricker 1958, Leopold 1969, and Dąbrowski Leopold 1969, Bonar 1977).

Leopold (1969) found that an increase of exploitation intensity resulted in an increase of catches and a decrease of catch per unit of effort (224 lakes). These relations were also confirmed by Bonar (1977) for 39 lakes of pikeperch type. In both cases analyses embraced all exploited fish species and total fishing effort i.e. all gear used.

In studying the relations between level of catches, intensity of exploitation and its effectiveness (CUE) in case of single fish populations the results were somewhat different. Dąbrowski and Leopold (1969) noted statistically significant relation between intensity of exploitation with vendance gill nets and vendance catches, but the relation between intensity of exploitation and catch per unit of effort was not significant.

Similar results related to pikeperch exploitation were obtained in this study (Fig. 1). In both cases, only the gear used to fish the analysed species was taken into consideration.

These facts may be explained by Ricker's (1958) theory. According to this author, biomass of any commercially exploited population depends on naural and fishing morality on the one hand, and on recruitment (i.e. biomass increment and supply of new individuals which attained protective size) on the other. Protective size for pike-perch in Poland is 45 cm i.e. about 1 kg. It divides the stock into catchable and protected part.

Pikeperch is both a predator and a prey. It feeds on other fish since the first year of life. In Polish lakes roach and perch represent components of pikeperch diet (Szypuła 1964, Martyniak 1975). In case of insufficient food resources canibalism may occur. The latter is defined as an intrapopulation mechanism regulating stock

density. Strong predator-prey relationships were discussed by Holcik (1977), Johnson (1967), Kerr (1977), McLean and Magnuson (1977), Lemmens (1986), Bonar (1990a, b).

Hence, fishing may disturb natural regulation mechanisms in predator and prey stocks. Roach and perch (prey) as well as pikeperch (predator) are fished out in different proportions. Gear used in pikeperch lakes differs as to its catchability (Bonar 1987, Bonar and Kempa 1987), and pressure of exploiotation varies with respect to particular species.   Share of roach in summer seine catches amounted to 26%, in winter seine to 23%, and in gill nets to 7%, while share of pikeperch reached respectively 7%, 10% and 34% (Bonar 1987, Bonar and Kempa 1987).

Pikeperch is one of many species caught. In practice, the effects of fishing depend on the fishing yields i.e. the sum of all fish caught. Density of a single species is frequently of secondary importance. It was also found that tow nets dominated in total fishing effort (Tab. 2), and their catchability was high, both as regards pikeperch and its prey (Bonar 1977, Bonar and Kempa 1987).

In cases when the food resources for pikeperch are abundant, it may be expected that recruitment will balance the fishing and natural mortalities (Ricker 958). On the other hand, when food resources are poor in relation to pikeperch densities, recruitment will not balance natural and fishing mortalities.

The above leads to a management directive. Increase of the protective size for pikeperch will increase this fish numbers only when prey stocks (roach, perch) are abundant. In Lakes in which prey stocks are not dense, increase of protective size for pikeperch or closed seasons (during pikeperch reproduction) is likely not to give the expected result.

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WPŁYW EKSPLOATACJI RYBACKIEJ NA WYSOKOŚĆ ODŁOWÓW
I EFEKTYWNOŚC POŁAWIANIA SANDACZA W JEZIORACH

STRESZCZENIE

Badaniami objęto 52 jeziora o łącznej powierzchni 16125 ha. Badania dotyczyły odłowów sandacza oraz intensywności i efektywności eksploatacji tego gatunku w latach 1970—1985.

Odłowy sandacza wynosiły przeciętnie 2,92 kg/ha, a średnie roczne dla poszczególnych jezior wahały się od 0,14 do 12,83 kg/ha. Wysokość odłowów tego gatunku zależała od intensywności poławiania (r_{xy} = 0,588) oraz od wielkości pogłowia (r_{xy} = 0,582). Wzrost intensywności poławiania przywłoką o 1 UE/ha powodował przyrost odłowów sandacza o 0,22 kg/ha, niewodem o 0,21 kg/ha, a wontonami o 0,20 kg/ha.

Współczynnik efektywności eksploatacji dla trzech typów narzędzi łącznie wynosił przeciętnie 0,22 kg/UE i wahał się dla poszczególnych jezior od 0,06 do 0,64 kg/UE. Nie stwierdzono istotnego statystycznie związku pomiędzy intensywnością eksploatacji, a współczynnikiem efektywności eksploatacji sandacza.

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