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MANAGEMENT OF VENDACE (*COREGONUS ALBULA* (L.)) IN THE LAKES OF NORTHWEST POLAND IN THE LATE TWENTIETH AND EARLY TWENTY-FIRST CENTURIES

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ABSTRACT. Vendace, *Coregonus albula* (L.), catch and stocking data obtained from 24 fish farms using vendace lakes (total surface area of 22311.77 ha) situated in northwest Poland were analyzed. The average total fish yield from these lakes was 12.53 kg ha⁻¹, of which the average share of vendace was 18%. The highest vendace yield was obtained in lakes with water surface areas of less than 250 ha and with an average depth of more than 10 m. According to the lake classification proposed by the authors, as many as 28 lakes (43.1%) were classified as 'bad lakes' with very low vendace yield (< 2 kg ha⁻¹), while only four lakes (6.2%) were classified as 'very good' with yield exceeding 10 kg ha⁻¹. It was revealed that vendace yield (kg ha⁻¹) depended on the number of vendace larvae stocked and some of the morphometric features of the lakes such as water surface area and average depth.

Key words: VENDACE (*COREGONUS ALBULA*), LAKES, VENDACE MANAGEMENT, MORPHOMETRIC CHARACTERISTICS OF LAKES

INTRODUCTION

The natural range of occurrence of vendace, *Coregonus albula* (L.), includes numerous lakes situated around the Baltic Sea from Germany and Denmark in the west, through Poland (Bernatowicz et al. 1975) and into Estonia, Lithuania, Latvia, and Russia in the east (Berg 1948). According to Winfield et al. (1996), this species also occurs in a few lakes in Ireland, England, and Wales. Vendace is of particular economic significance in the clean, cold, oxygen-rich waters of Norway (Sandlund et al. 1985, Mutenia and Salonen 1992), Sweden (Svårdson 1976, 1979) and Finland (Auvinen 1987, Helminen and Sarvala 1994). In addition to its typical occurrence in lakes, this species is also caught in the Neva and Pasvik rivers (Bernatowicz et al. 1975, Amundsen et al. 1999) and in the brackish waters of the Gulf of Bothnia and in the

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eastern part of the Gulf of Finland (Lehtonen 1981, Lehtonen and Jokikokko 1995). The first reports regarding the distribution of vendace in Poland were published by Tykiel (1858) and indicated the occurrence of this fish in "...numerous lakes of the Augustowska Guberniya". Approximately one hundred years later, specimens of this species were caught in 244 reservoirs comprising a total area 100758.2 ha (Bernatowicz 1953, Walczak 1956, Radziej 1960). As the years passed, fisheries intensified and new, more effective production methods for many varieties of stocking material were introduced. Consequently, the vendace area of occurrence encompassed 4.51% of the total number of lakes in Poland (420 reservoirs) with an area of 126984.9 ha (Bernatowicz and Radziej 1974). Currently, vendace is considered to be one of the most valuable economic components of the ichthyofauna of Polish lakes. This is due to the excellent quality of its meat and the favorable biological features of this species, which, under Polish climatic and environmental conditions, achieve market weight (80-120 g) in the short period of two to three years. This species also forms shoals, which makes catching it easy. These features, combined with the demise of the large nationalized fish farms and the lease of lakes to various parties that frequently apply irrational fisheries management, have led to the current vendace distribution and management situation. Not much information is available regarding the vendace of Pomeranian lakes, and the most recent data can be found in Czerniejewski and Filipiak (2001), which, however, concerns only the distribution and exploitation of vendace in the lakes of western Pomerania and omits the lakes of northwestern Poland.

The aim of the current study is to fill in at least part of this information gap by determining the basic parameters of vendace lake development (catch yield estimates, fishing gear, basic data regarding caught fish, and the quantity of stocking material released) in light of their morphometric characteristics.

MATERIALS AND METHODS

The analysis and evaluation of the fisheries economy of vendace lakes presented in the current paper are based on data obtained from 24 fish farms which use 78 vendace lakes of a total water surface area of 22311.7 ha located in northwest Poland (Fig. 1). The data used to describe the management of these reservoirs was collected through questionnaires sent to fishing farms, interviews, and the study of lake logs. Thanks to

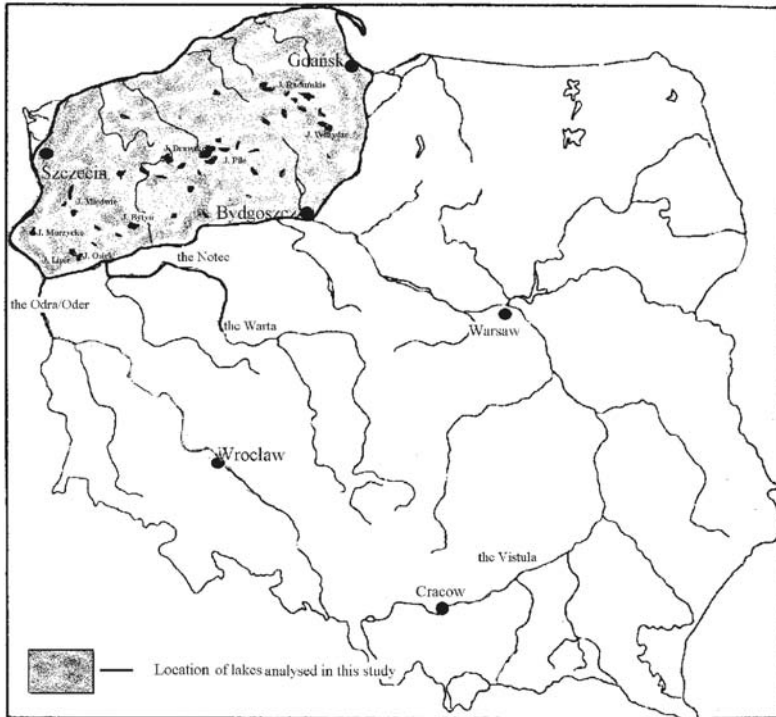


Fig. 1. Location of the Pomeranian lakes analyzed in the 1996-2001 period.

this, information was collected regarding the catch and yield of vendace and other species of fish, the type and quantity of stocking material released, the fishing gear deployed to exploit vendace (including net mesh size), and the size of the fish caught. Arithmetic mean values were determined for the preceding parameters, including those in the 1996-2001 period. Various indexes that describe the vendace fisheries in the lakes of northwest Poland are presented along with the morphometric parameters of these lakes, which were obtained from the atlas of Polish lakes (Choiński 1991). Emphasis was placed upon the following indexes (Filipiak et al. 1999):

- water surface area (P) – the surface area of the water as determined by the shoreline (L), which is the mean value of isobaric line 0 expressed in hectares;
- index of shoreline development (expansion) (WL ; $m\ ha^{-1}$) – the quotient of the shoreline length (L) and two square roots of the product of Π and the water surface area (P), index WL is an abstract number equal to or larger than 1;

- maximum depth (G_{max} ; m), which is determined from the bathymetric plan of a particular lake;
- average depth (G_s ; m) – the quotient of lake volume (V) and its surface area (P);
- index of lake openness (W_o) – the quotient of the lake water surface area (P) and average depth (G_s), which permits determining the degree of influence climate conditions have on the lake.

After collection, the information regarding vendace management was organized with Microsoft Excel software. It was then sorted by class according to particular morphometric indexes. The catch yield was divided into five classes: $< 1 \text{ kg ha}^{-1}$; $1-3 \text{ kg ha}^{-1}$; $3-5 \text{ kg ha}^{-1}$; $5-10 \text{ kg ha}^{-1}$; $>10 \text{ kg ha}^{-1}$. In addition to tabular representation, the relationships between yield and certain morphometric features were charted, which also allowed describing the relationship between the parameters above.

The names of the lakes and their location in the various districts were obtained from interviews and publications by Filipiak and Raczyński (2000) and Czerniejewski and Filipiak (2001). Data regarding lakes located in the Lubuskie, Wielkopolskie, Kujawsko-Pomorskie and Pomorskie administrative districts were obtained from the Department of Environmental Protection representing each district.

RESULTS

Among the lakes of northwest Poland, the occurrence of vendace was noted in 78 reservoirs with a total water surface area of 22311.77 ha. Gillnets and seines were the gear used to catch this species, with the latter used only in 11 lakes (17% of the total number of vendace lakes). Gillnets with a mesh bar length ranging from 22 to 28 mm were used in the remaining lakes in which vendace was caught. Although in the majority of lakes gillnets with a 24 mm mesh bar length were used, which is relatively selective, the average total length and individual body weight of fish obtained ranged from 17 to 25 cm (the mean for northwest Polish lakes was 21.2 cm) and 40-180 g (mean – 88.8 g), respectively. The range noted in these parameters is high and reflects the variety in individual weight and length of the caught fish that is typical of vendace.

The average fishing yield from the 78 vendace lakes was 12.53 kg ha^{-1} (range from 0.41 to 39.84 kg ha^{-1}), although the share of vendace in the catches made in these reservoirs was 18%, on average (Fig. 2). The structure of the fish species caught in these

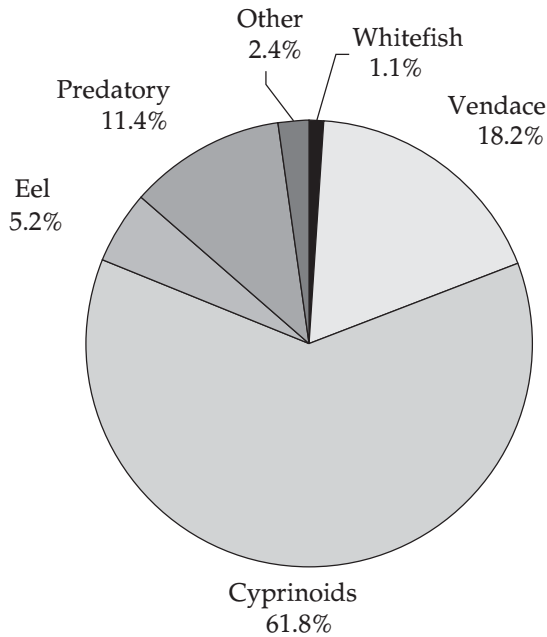


Fig. 2. Share of fish groups in catches made in 78 vendace lakes in northwestern Poland in the 1996-2001 period.

lakes included coregonids and predatory fish (including eel, *Anguilla anguilla* (L.)), which together comprised 35% of the fish caught; this demonstrates that the ecosystems of the lakes are relatively good. Due to the fact that vendace catches are not performed on 13 lakes, they were excluded from further analyses.

In the 65 lakes where vendace catches were performed during the 1996-2001 period, a total of 299335.3 kg (49889.2 t year⁻¹) of fish was caught. The mean annual value was 767.5 kg year⁻¹ lake⁻¹. The yield of this species from these reservoirs varied considerably. The mean value of this parameter was 3.47 kg ha⁻¹ with a wide range from 0.034 kg ha⁻¹ (Lake Ostrzyckie) to 14.62 kg ha⁻¹ (Lake Płesno). After the lakes had been divided into yield classes, it appeared that the majority of them (37), or 56.9% of the total number of lakes analyzed, belongs to the group with the lowest fish yield (below 3 kg ha⁻¹) and average vendace catch (below 500 kg year⁻¹). However, the fewest number of reservoirs was noted in the class with a catch yield of 5-20 and more than 10 kg ha⁻¹ at 12 and 4, respectively, which is just 24.6% of all the lakes analyzed (Table 1).

TABLE 1

Lake classification according to vendace catch yield

Yield classes*	Vendace yield (kg ha ⁻¹)	Number of lakes in yield class		Average vendace catch in yield class	
		(no.)	(%)	(kg year ⁻¹)	(%)
Class < 1	0.37	20	30.7	225.9	4.0
Class 1-3	2.06	17	26.2	487.9	8.6
Class 3-5	3.69	12	18.5	913.5	16.0
Class 5-10	6.82	12	18.5	2137.8	37.4
Class >10	12.77	4	6.1	1940.0	34.0

*Explanations in Material and Methods

It should be stressed that, due to their large water surface area, these lakes are also characterized by a high value of vendace catch at 71.4% of the total catch of this fish species from the lakes of northwest Poland.

There was high variety in the water surface area of the vendace lakes analyzed (from 16 ha in Lake Łabędzie to 3572 ha in Lake Miedwie). After the lakes were divided into classes according to this parameter, the majority of them were 'small lakes' with a surface area of 1 – 100 ha (33 lakes, which is 43.0% of the total number of lakes analyzed). It should be emphasized that the area of these lakes combined is only 7.12% (1590.57 ha) of the total area of all the vendace lakes in northwest Poland (Table 2).

TABLE 2

Lake classification according to water surface area (ha)

Surface area class (ha)	Number of lakes in surface area class		Vendace yield (kg ha ⁻¹)	Average vendace catch in yield class	
	(no.)	(%)		(kg year ⁻¹)	(%)
1 - 100	33	43.0	4	183.0	2.0
100 - 250	21	26.6	3.7	581.1	6.5
250 - 500	11	13.9	2.8	1016.9	11.4
500 - 1000	10	12.7	2.4	1858.4	20.8
>1000	3	3.8	2.7	5298.8	59.2

The fewest lakes were in the class with a water surface area exceeding 1000 ha (3 lakes comprising only 3.8% of the total number of lakes). However, the water surface area of this lake class is as much as 30.1% (6723.3 ha) of the overall area of all the lakes analyzed. The highest vendace yield was in the lake water surface area classes of 1 – 100 ha and 100 – 250 ha; however, in the largest lakes (500 – 1000 ha and above

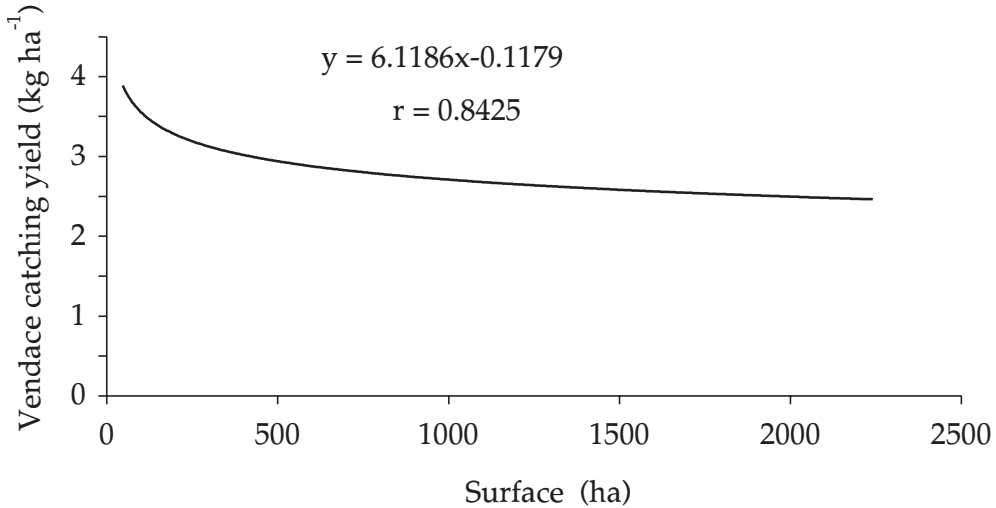


Fig. 3. Relationship between lake water surface area and vendace catch yield in the 1996-2001 period (78 lakes).

1000 ha) the yield was the lowest. Despite the high vendace yield in the smallest lakes (class 1 – 100 ha), the catch in this group of reservoirs was only $183.0 \text{ kg year}^{-1}$, which is just 2.0% of all the vendace catch from the lakes examined here, while the value of this parameter in the largest lakes with a water surface area exceeding 1000 ha was $5298.8 \text{ kg year}^{-1}$ (59.2%). These data were used to describe the relationship between the area of the reservoirs and the vendace catch yield (Fig. 3), and there was a high correlation between these parameters ($r = 0.8425$, $P < 0.05$).

The analysis of the depth of vendace lakes also indicated significant variety with regard to both maximum and average depth. This disproportion was most clearly noted with regard to the first parameter. For example, the range of maximum depth was from 9.8 m in Lake Białe (Kujawsko-Pomorskie District) to 79.7 m in Lake Drawsko (Zachodniopomorskie District). The distribution of the vendace lakes according to maximum and average depth classes is presented in Tables 3 and 4. When the lakes were divided according to distinct maximum depth classes, the majority of them (85.8% – 67 lakes) belonged to three depth classes (*i.e.*, 10-20, 20-30, 30-40 m). The highest average yield was observed in the depth class greater than 60 m at 6.3 kg ha^{-1} (24.6%).

TABLE 3

Vendace lake classification according to maximum depth

Maximum depth classes (m)	Average maximum depth (m)	Number of lakes per class		Vendace yield (kg ha ⁻¹)
		(no.)	(%)	
< 10	9.8	1	1.3	*
10 - 20	16.8	20	25.6	4.4
20 - 30	25.58	31	39.7	2.6
30 - 40	33.98	16	20.5	3.3
40 - 50	43.70	8	10.2	5.5
50 - 60	60.00	1	1.3	3.5
> 60	79.70	1	1.3	6.3

* in 1996-2001 no vendace were caught due to low population numbers

TABLE 4

Lake classification according to average depth

Depth class (m)	Average depth (m)	Number of lakes per class		Vendace yield (kg ha ⁻¹)
		(no.)	(%)	
< 5	4.3	2	2.6	14.6
5 - 7.5	6.5	16	20.5	1.6
7.5 - 10	9	27	34.6	2.1
10 - 15	11.7	28	35.9	4.5
>15	17.4	5	6.4	5.1

Figure 4 presents the relationship between maximum depth and vendace yield from an area of 1 ha. The low value of correlation coefficient r ($r = 0.3525$, $P > 0.05$) indicates that there was weak correlation between these parameters.

Table 4 presents the classification of lakes based on average depth. The lowest value of this parameter was reported for Lake Białe (4.0 m), while the highest value was for Lake Miedwie (19.3 m). The mean value of the average depth of the vendace reservoirs of northwest Poland was 9.79 m. Of all the lakes analyzed, the majority was noted in the two depth classes of 7.5-10 and 10-15 m (55 lakes, which comprises 70.5% of all those analyzed), and the fewest lakes were in the depth class of below 5 m (2 lakes – 2.6%). The lakes in the latter class were characterized by the highest vendace yield (14.6 kg ha⁻¹), but due to the fact that these lakes were not representative in their number, the data were excluded from further analyses concerning the influ-

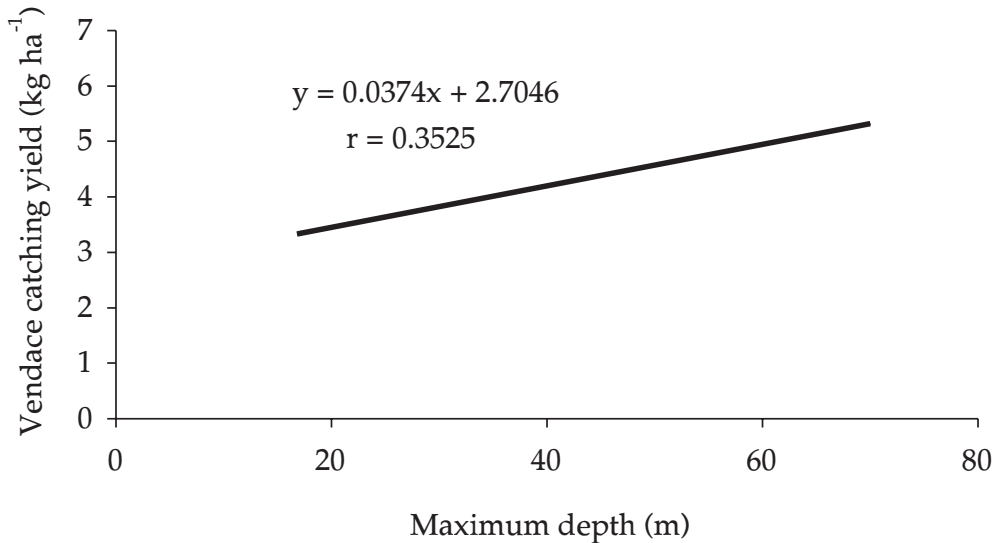


Fig. 4. Relationship between maximum depth and vendace catch yield in the 1996-2001 period (78 lakes).

ence of average lake depth on vendace yield (Fig. 5). The analysis of the value of the correlation coefficient ($r = 0.9441$, $P < 0.05$) of the function presented, indicates its accuracy in adjustment to the empirical values and also indicates the significance of this relationship.

Among the 78 vendace reservoirs analyzed, 34 (43.0%) were characterized by weak or average shoreline development ($WL < 2.0$ m ha⁻¹), and only two of them had very well-developed shorelines ($WL = 4$ m ha⁻¹). The mean value of the shoreline development index of the lakes analyzed was 2.33 m ha⁻¹ at a range of 1.13 m ha⁻¹ for lakes Sadowo and Siejowe (Wałęcki and Choszczeński districts, respectively) to 11.4 m ha⁻¹ for Lake Głębočno (Bytowski District). The analysis of relationships between this parameter and the catch yield, described by linear, power, and exponential functions, had a large spread of empirical points ($r < 0.2$, $P > 0.05$) suggesting that the value of WL had no significant influence on the vendace catch yield in the lakes of northwest Poland.

In addition to the shoreline development index, the lake openness index (W_o) is an important morphometric factor, the value of which determines the influence on lakes of wind, air temperature, and other climatic factors. The values of this parameter in the analyzed reservoirs ranged from 1.6 in Lake Łabędzie (Wałęcki District) to 182.7 in

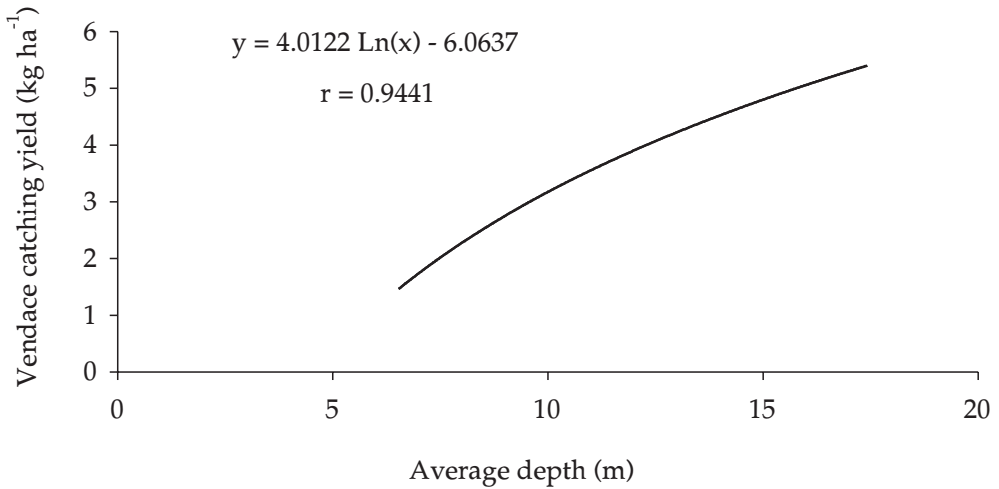


Fig. 5. Relationship between average depth and average vendace catch yield in the 1996-2001 period (78 lakes).

Lake Miedwie (Stargardzki District), with a mean value of 24.44. The majority of vendace lakes (48 reservoirs, 61.6%) were characterized by $W_o < 20$. In the various classes of lake openness, the average vendace catch yield ranged from 1.14 to 4.86 kg ha⁻¹. The statistical analysis of the relationship between these parameters did not indicate any significant correlation ($r = 0.5002$, $P > 0.05$).

Stocking programs are effective in increasing fish populations in lakes and are often the only way to do so. This procedure involves releasing stocking material in the form of eggs, larvae, summer fry, or older fish into lakes; the goals of it is to increase overall fish numbers and effect a subsequent increase in catch yield. Of the 78 lakes analyzed in the present work, 68 (87.2%) were stocked with vendace larvae.

Additionally, two reservoirs (Ińsko and Woświn) were stocked with summer fry (20000 and 50000, *e.g.*, 40 and 62 indiv. ha⁻¹, respectively), which is an indication of the marginality of stocking with pre-breeding material. Table 5 presents the distribution of the analyzed lakes in five categories according to the quantity of stocking material released.

TABLE 5

Lake classification according to stocking material quantity

Stocking material quantity (indiv. ha ⁻¹)	Number of lakes per class		Average stocking (indiv. ha ⁻¹)	Average yield (kg ha ⁻¹)
	(no.)	(%)		
< 1000	12	17.6	528.9	1.8
1000-6000	26	38.2	3427.9	2.9
6000-12000	17	25.0	8819.3	4.0
12000-18000	8	11.8	14067.5	6.2
> 18000	5	7.3	24720.1	6.6

The majority of vendace lakes (43 reservoirs, or 63.2% of the total number of stocked lakes) were stocked with larvae in quantities ranging from 1000-12000 indiv. ha⁻¹. Only in five lakes (7.3%) was the quantity of stocking material higher than 18000 indiv. ha⁻¹. The polynomial curve drawn on the basis of these data (Fig. 6) most precisely describes the relationship between the quantity of stocking material and the vendace catch yield ($r = 0.9824$, $P < 0.01$). The results of this analysis indicate that stocking programs result in increased vendace yield; however, quantities exceeding 20000 indiv. ha⁻¹ do not effect significant increases in the vendace catch yield.

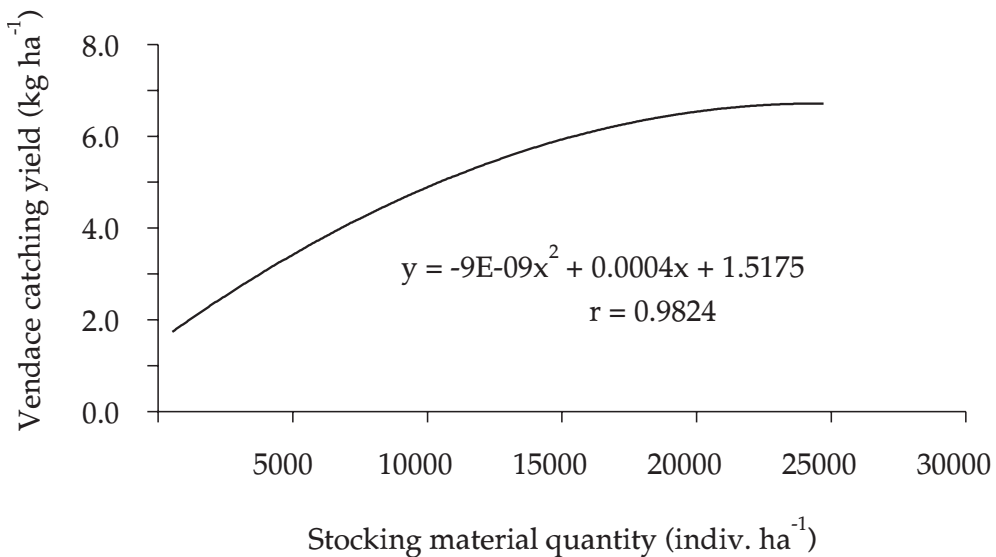


Fig. 6. Relationship between stocking material quantity (indiv. ha⁻¹) and vendace catch yield (kg ha⁻¹) in the 1996-2001 period (78 lakes).

DISCUSSION

The vendace catch reported from different Polish lakes is highly variable. This may be related to environmental conditions during the spawning and stocking periods (Ciepielewski 1974), annual temperature fluctuations (Dąbrowski and Eichler 1972), predation pressure (Huusko and Sutela 1992, Huusko et al. 1996), and also the size of the spawning stock. These variations sometimes also result from irrational pelagic zone management as well as the application of improper catch methods and timing. Vendace should be caught in year 2 or 3 of life, and exploitation should also consider spawning and maximal growth periods (Bernatowicz et al. 1975). It is generally known that vendace is most frequently caught with gillnets, the mesh diameter of which determines the size of the fish caught. The mean value of this parameter in the lakes of northwest Poland varied within a range that was a little wider than that reported by Dembiński (after Łuczyński 1986) for Polish lakes (18-28 mm and 22-28 mm, respectively). The vendace caught with seines was of less significance. According to Leopold et al. (1970), this gear was used to catch only 20% of the vendace in Poland in the 1960s. Currently, this gear is also of marginal significance in the lakes of northwest Poland and was deployed only in 17% of the reservoirs. The use of gillnets for vendace exploitation in the majority of lakes appears to be appropriate due to its high selectivity, which protects fish that are not yet market size (Ciepielewski 1974). However, in some circumstances the deployment of gillnets is inappropriate or even impossible (*i.e.*, in lakes that are exploited intensively for recreational purposes). Due to poaching and damage inflicted on the fishing gear, gillnets should be replaced by seines in these instances.

According to studies performed by Bernatowicz and Radziej (1974) and Wołos (1998), the annual vendace catches in Polish lakes ranged from 190 tons (1952) to 581 tons (1963). However, in the majority of lakes they were low at less than 1 kg ha⁻¹ year⁻¹. In the 1990s, catches only exceeded 12 kg ha⁻¹ in five Mazurian lakes (Maróz, Rospuda, Łańskie, Kośno, Mokre) and in the Pomeranian Lake Piławskie (Wołos 1998). Willer (1934) (cited in Walczak 1956) introduced reservoir classification in response to the wide range of vendace catch yield, and this was modified and adjusted for the lakes of northwest Poland by Walczak (1956). According to this classification, of the 93 lakes assessed by Walczak (1956) in the 1950s, the majority (69.9%) belonged to the 'bad' category (< 5 kg ha⁻¹), while six lakes (6.5%) with a high vendace catch yield were classified as 'very good' (> 20 kg ha⁻¹).

Currently, despite growing interest in the cultivation of this species by fish farms, the average vendace catch yield has decreased probably as a result of unfavorable changes in eutrophication process in lakes (Bnińska and Wołos 1998). According to the classification proposed by Walczak (1956), none of the lakes from northwest Poland can be classified as 'very good'. The maximum yield obtained in these reservoirs was 14.61 kg ha⁻¹ (Lake Płesno), and only 6.1% of the lakes analyzed had yields above 10 kg ha⁻¹. The value of this parameter was low (up to 5 kg of vendace ha⁻¹) in more than three-quarters of the reservoirs (75.4%). As a result, the yield thresholds used in the classification of vendace lakes should be lowered. In accordance with the present state of vendace management, the proposed limits for particular groups classified on the basis of yield are presented in Table 6.

TABLE 6

Lake classification according to yield (from Walczak (1956) with modifications by the authors)

Lake classification	Walczak (1956) classification		Proposed classification for vendace lakes of northwest Poland		
	Yield (kg ha ⁻¹)	Number of lakes		Yield (kg ha ⁻¹)	Number of lakes
		1950s	now		
Bad	<5	65	49	<2	28
Average	5-10	13	12	2-5	21
Good	10-20	9	4	5-10	12
Very good	>20	6	-	>10	4

The morphometric features of vendace lakes exhibit a high degree of variation (Walczak 1956, Bernatowicz and Radziej 1974, Wołos 1998). Of the five morphometric parameters analyzed (water surface area, average depth, maximum depth, lake openness index, shoreline development index) water surface area and average depth had the greatest impact on the vendace catch yield. The highest yield values were observed in lakes smaller than 250 ha and with average depths exceeding 10 m. According to Leopold et al. (1998), the depth parameter is one of the most important morphometric features of lakes that influences the results of vendace fisheries. In addition to the morphometric parameters of lakes, stocking with larvae has a major impact on the efficiency of vendace fisheries (Leopold et al. 1998, Leopold and Wołos 1998a).

Of the 78 lakes analyzed in the 1996-2001 period, 68 (87.2%) were stocked with the goal of increasing the numbers of fish. The application of this procedure is essential in the majority of reservoirs due to the unfavorable environmental conditions prevailing

in spawning grounds during the egg incubation period, including oxygen deficits in the benthic zones of the lakes (Ciepielewski 1974, Wilkońska and Żuromska 1982, 1988). The comparatively high price of stocking materials requires reservoir users to determine optimal stocking quantities. According to Bernatowicz et al. (1975), the standard often applied in Polish lakes was 5000-10000 indiv. larvae ha⁻¹. The relationship between the number of stocked vendace larvae and the subsequent catch yield of this species in the lakes of northwest Poland increased significantly as the quantity of stocking material was increased. However, it should be noted that exceeding the quantity of 20000 indiv. larvae ha⁻¹ did not result in a further increase in the efficiency of the vendace caught, and this level represents an excessive use of stocking material per kg of vendace caught. According to Leopold and Wołos (1998b), the optimal quantity of larvae to be stocked is 7000-8000 indiv. ha⁻¹. While Leopold and Wołos (1998a) reported that the quantity of stocking material significantly increased the quantity of the vendace catch, they also reported that stocking frequency had an important impact on vendace fisheries. The studies of these authors indicate that about 52% of the vendace catch is determined by these two variables (*i.e.*, approximately 28% by the quantity of larvae stocked and 24% by stocking frequency).

Vendace stocking programs for lakes should take into consideration the preceding information, as well as the evaluation of lake fertility, lake environmental conditions (*i.e.*, hydrochemical factors, crustacean plankton contents), and the morphometric characteristics of the lakes.

CONCLUSIONS

1. The 78 vendace lakes of northwestern Poland analyzed in this work were characterized by significantly different morphometric features. The most common lakes are small and medium-sized reservoirs with a water surface area of less than 250 ha (54 lakes – 69.6%), a maximum depth of 10-40 m (67 lakes – 85.8%), and an average depth of 7.5-15 m (55 lakes – 70.5%).
2. In general, the yield of the majority of vendace lakes is low and the share of vendace in the total catches is 18%, on average. This species is caught with gillnets of a mesh size of 22-28 mm, which permits catching fish of an average total length of 17-25 cm and a body weight of 40-180 g, respectively.

3. The highest vendace catch yield was reported for small and medium-sized lakes with water surface areas of less than 250 ha and average depths of more than 10 m. According to the classification by yield proposed by the current authors, as many as 28 lakes (43.1%) were categorized as 'low' (yield < 2 kg ha⁻¹) (i.e., 'bad lakes'), and only four lakes (6.2%), where vendace yield was above 10 kg ha⁻¹, were classified as 'very good'.
4. Of the 78 lakes analyzed, 68 were stocked with larvae, while two other lakes were stocked with summer fry. The majority of lakes (44 reservoirs – 63.2%) were stocked by vendace larvae in amounts of 1000-6000 and 6000-12000 indiv. ha⁻¹. Only in the case of five lakes (7.3%), did fish farm managers decide to stock the lakes with quantities of vendace exceeding 18000 indiv. larvae ha⁻¹.

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STRESZCZENIE

GOSPODARKA SIELAWĄ (*COREGONUS ALBULA* (L.)) W JEZIORACH PÓŁNOCNO-ZACHODNIEJ POLSKI NA PRZEŁOMIE XX I XXI WIEKU

Sielawa jest jednym z najcenniejszych gatunków ryb występujących w jeziorach północno-zachodniej Polski. Ze względu na swoje walory konsumpcyjne, właściwości biologiczne (m.in. szybkie tempo wzrostu, ławicowy tryb życia ułatwiający połowy) jest ważnym obiektem połowu i znaczącym źródłem finansowania wielu gospodarstw rybackich. Z tego powodu od połowy lat 90. ubiegłego wieku w niektórych jeziorach prowadzi się tzw. sielawowy model zagospodarowania, polegający na intensywnym zarybianiu oraz połowach sielawy już w 2 roku życia.

Celem niniejszej pracy było określenie podstawowych parametrów zagospodarowania jezior sielawowych północno-zachodniej Polski, poprzez określenie wydajności połowowej, stosowanych najczęściej narzędzi rybackich do połowu sielawy, podanie danych dotyczących pozyskiwanych ryb na tle cech morfometrycznych tych zbiorników. Analizowano dane połowowe i zarybieniowe pochodzące z 24 gospodarstw rybackich użytkujących 78 jezior sielawowych położonych w północno-zachodniej Polsce o łącznej powierzchni 22311,77 ha. (rys. 1) Średnia ogólna wydajność połowowa tych akwenów wyniosła $12,53 \text{ kg ha}^{-1}$, przy czym udział sielawy stanowił średnio 18% (rys. 2). Najwyższą wydajność połowową sielawy uzyskano w jeziorach o powierzchni lustra wody do 250 ha i głębokości średniej powyżej 10 m (tab. 2 i 4). Według zaproponowanej przez autorów skali oceny tych zbiorników, aż 28 jezior (43,1%) charakteryzowało się niską ($< 2 \text{ kg ha}^{-1}$) wydajnością połowową tego gatunku (tzw. jeziora złe), a tylko w 4 (6,2%) akwenach wartość tego parametru wynosiła powyżej 10 kg ha^{-1} (tzw. jeziora bardzo dobre) (tab. 6). Stwierdzono, iż wydajność połowowa tego gatunku uzależniona jest od liczby wsiedlanego materiału zarybieniowego oraz niektórych cech morfometrycznych akwenu (powierzchni lustra wody i głębokości średniej).