

Arch. Ryb. Pol.	Archives of Polish Fisheries	Vol. 6	Fasc. 2	287-293	1998
--------------------	---------------------------------	--------	---------	---------	------

EFFECTIVENESS OF VENDACE STOCKINGS AS AFFECTED BY STOCKING FREQUENCIES

Marian Leopold, Arkadiusz Wołos

The Stanisław Sakowicz Inland Fisheries Institute in Olsztyn

ABSTRACT. Analyses were performed of long-term data on coregonid management in 114 lakes of total area 59.1 thousand ha. Long-term mean values were calculated of vendace landings (in kg/ha) and stockings with larvae (fish/ha), and the index of stocking frequency was determined. Basic parameters characterising vendace management in lakes stocked with different frequency were determined, and multiple correlation was used to determine the dependencies between mean vendace yields, mean stocking rates and stocking frequency. This relationship proved to be statistically highly significant. The obtained equation of multiple regression was used to work out a practical table which can be used to optimise allocation of the stocking material.

Key words: VENDACE, FREQUENCY OF STOCKINGS, CATCHES, EFFECTIVENESS

INTRODUCTION

It is undoubtful that in view of the current state of vendace management, regarded even as a „regression“ by some authors (Falkowski and Wołos 1996), proper allocation of the stocking material and its rational use are the basic prerequisites for making this management more effective, and - consequently - possibly increasing vendace landings. Despite some limitations resulting most of all from progressing water eutrophication, possibilities of effective vendace management are conditioned by proper management policies and still seem not to be fully taken advantage of. So far the only attempt to solve the problem of stocking material allocation on a more general scale, viz. in a large fishery enterprise, was the work devoted to Fishery Enterprise Elk (Wołos, Falkowski, Abramczyk 1995), based on comparative analysis of the effectiveness of stockings in particular lakes. This work, however, cannot be used as a reference point in assessing the effectiveness of stocking with vendace on a national scale, nor to determine other factors (beside stockings) affecting the effectiveness of vendace management.

Majority of the studies devoted to the effectiveness of stocking particular lakes with vendace, in which relationship was established between mean stocking rates

and mean catches of this fish, no attention was paid to the frequency of stocking. In this paper we have determined this frequency as the number of years in which stocking material was released to the given lake in relation to all years taken into consideration in the relationship „mean vendace catch (in kg/ha)-mean stocking rate (fish/ha)“.

Apart from the frequency of stocking, it is usually not taken into account that the same mean stocking in a long-term period can result from fish releasing in a different number of years. Going ahead of the results, this situation is illustrated by the data pertaining to 12 lakes, in which the mean stocking rates were 5000-6000 larvae/ha (usually 5330 fish/ha, at variability coefficient $V\%=4.29$), while the frequency of stocking ranged in a wide range from 0.25 to 0.93 (0.632 on the average, $V\%=33.6$). The first value represents stockings made every 5 years in a 20-year period, the last - made almost every year.

It can be assumed that such differences as to stocking frequencies must affect the effects of this practice, viz. fish yield in kg/ha. Quantification of this effect is the aim of the present study.

MATERIALS AND METHODS

Studies comprised long-term data on vendace catches and stockings in 114 lakes, the same that were used in the paper on the effect of lake morphometry upon the effectiveness of vendace management (Leopold, Wołos, Mickiewicz 1998), and this paper contains lake characteristics.

Frequency of stocking with vendace meant as described in the introduction, called „frequency index“ throughout the paper, was used as the „starting“ point to analyse the relationship „rate of stocking with vendace (larvae/ha)-vendace yield (kg/ha)“ and the resulting index of stocking effectiveness, expressed as the number of larvae needed to produce 1 kg of commercial catch.

The frequency index is of a very general nature as it expresses only the mean stocking frequency in each lake, irrespective of its distribution in time and regularity.

In order to analyse the respective relationships and regularities, statistical methods were used, most of all correlation and regression.

RESULTS

Index of stocking frequency in the analysed 114 lakes, divided into different classes, and parameters characterising vendace management in these frequency classes are given in table 1.

TABLE 1

Średnie wieloletnie parametry gospodarki sielawowej w jeziorach o różnej częstotliwości zarybiania

Grupa jezior	Wskaźnik częstotliwości	Liczba jezior	Powierzchnia jezior (ha)	Średni wskaźnik częstotliwości	Odlów sielawy (kg/ha)	Średnie zarybienie wylęgiem (szt/ha)	V% szt/ha	Wskaźnik efektywności zarybień (szt/kg)	Stosowane dawki (szt/ha)
I	ponad 0.7	20	15831.0	0.807	9.14	7446	55.9	815	9227
II	0.7 - 0.4	31	15104.5	0.547	4.28	5188	56.3	1212	9484
III	0.4 - 0.2	32	12792.1	0.274	3.53	3167	57.6	897	11558
IV	poniżej 0.2	31	15374.6	0.091	1.18	936	91.2	793	10286

Even this very general approach as the one used in table 1 enables formulation of several conclusions, important from a theoretical as well as practical point of view.

There is a noticeable relationship between stocking frequency, stocking rates (fish/ha) and level of vendace catches (kg/ha). The three parameters are proportionally related to each other: an increase of one results in an increase of the other two.

There is a less regular, but still noticeable inversely proportional relationship between stocking frequencies and stocking rates. Stocking rates are much higher at lower frequency index. For example, in group IV, in which stocking frequency index was between 0.2 and 0.4, stocking rates were 25 % higher than in group I, in which stocking frequency was above 0.7.

There is also a relationship between stocking frequency index and variability of the mean stocking rate (in fish/ha): as stocking frequency decreased, variability of stocking rates increased. This suggests some „fortuity” of stocking practice in those lakes, in which this measure is used at the lowest frequency, viz. at stocking frequency index less than 0.2. Range between mean stocking rates calculated in these lakes for the whole period of analysis (936 fish/ha) and the real numbers of fish released in those years in which stocking was performed (10286 fish/ha) seems to confirm that vendace management in this group of lakes was the least consistent, this being also reflected in low frequency of stocking.

The index of stocking effectiveness is less consistent. The worst results were obtained for group II, in which more than 1000 larvae were needed to produce 1 kg of commercial vendace catch. In the other groups this index was little diversified, varying from 793 (group IV) to 897 (group III).

The importance of stocking frequencies when optimising lake stocking with vendace is illustrated by the results of multiple correlation. Coefficient of multiple correlation between average vendace catches in particular years in kg/ha (variable y) and average stocking rates (larvae/ha, variable x) and stocking frequency (variable m) was $R_{y.xm} = 0.7207$, very highly significant. The revealed relationship shows that vendace catches were in 52 % determined by the two variables, in this in 28 % by stocking rates and in 24 % by stocking frequency. The equation of multiple regression describing this relationship is:

$$y = 0.22 + 0.471520 x + 5.20446m$$

The results of this equation, when solved for different stocking frequencies and different stocking rates, are presented in table 2. The table can be treated as a practical tool for the managers in undertaking decisions as to stocking policies.

DISCUSSION

As results from other papers presented in this volume (Bnińska, Wołos 1998, Leopold, Wołos 1998, Mickiewicz 1998, Wołos, Bnińska 1998) effectiveness of stocking with vendace is a specific function of the effect of many inter-related variables, so it cannot be interpreted in a simple way. The results for 114 lakes of Poland seem to prove that stocking frequency is one of the factors deciding about the effectiveness of this measure.

From among a few parameters characterising vendace management in the lakes under study, special attention should be given to the index of stocking effectiveness (number of released fish needed to produce 1 kg of commercial catch). This index should be one of the basic criteria used to undertake management decisions. Taking into account average values of this index, viz. average use of the stocking material per 1 kg of commercial catch, attention is drawn to group IV. At a first glance the results obtained for this group seem controversial. On the one hand, effectiveness of stocking seems to be most satisfactory in this group, on the other hand - it has

TABLE 1

Average long-term catches of vendace (kg/ha) in relation to stocking rates and stocking frequency

Stocking with larvae in th. fish/ha	Yield of vendace kg/ha										
	9.91	10.17	10.69	11.21	11.73	12.25	12.77	13.29	13.81	14.33	14.85
20.0	9.91	10.17	10.69	11.21	11.73	12.25	12.77	13.29	13.81	14.33	14.85
19.5	9.67	9.93	10.45	10.98	11.50	12.02	12.54	13.06	13.58	14.10	14.62
19.0	9.44	9.70	10.22	10.74	11.26	11.78	12.30	12.82	13.34	13.86	14.38
18.5	9.20	9.46	9.98	10.50	11.02	11.54	12.06	12.59	13.11	13.63	14.15
18.0	8.97	9.23	9.75	10.27	10.79	11.31	11.83	12.35	12.87	13.39	13.91
17.5	8.73	8.99	9.51	10.03	10.55	11.07	11.59	12.11	12.64	13.16	13.68
17.0	8.50	8.76	9.28	9.80	10.32	10.84	11.36	11.88	12.40	12.92	13.44
16.5	8.26	8.52	9.04	9.56	10.08	10.60	11.12	11.64	12.16	12.68	13.20
16.0	8.02	8.28	8.80	9.32	9.85	10.37	10.88	11.41	11.93	12.45	12.97
15.5	7.79	8.05	8.57	9.09	9.61	10.13	10.65	11.17	11.69	12.21	12.73
15.0	7.55	7.81	8.33	8.85	9.37	9.89	10.41	10.94	11.46	11.98	12.50
14.5	7.32	7.58	8.10	8.62	9.14	9.66	10.18	10.70	11.22	11.74	12.26
14.0	7.08	7.34	7.86	8.38	8.90	9.43	9.94	10.46	10.98	11.50	12.02
13.5	6.84	7.10	7.63	8.15	8.67	9.19	9.71	10.23	10.75	11.27	11.79
13.0	6.61	6.87	7.39	7.91	8.43	8.95	9.47	9.99	10.51	11.03	11.55
12.5	6.37	6.63	7.15	7.68	8.20	8.72	9.24	9.76	10.28	10.80	11.32
12.0	6.14	6.40	6.92	7.44	7.96	8.48	9.00	9.52	10.04	10.56	11.08
11.5	5.90	6.16	6.68	7.20	7.72	8.24	8.76	9.28	9.81	10.33	10.85
11.0	5.67	5.93	6.45	6.97	7.49	8.01	8.53	9.05	9.57	10.09	10.61
10.5	5.43	5.69	6.21	6.73	7.25	7.77	8.29	8.81	9.33	9.85	10.38
10.0	5.20	5.46	5.98	6.50	7.02	7.54	8.06	8.58	9.10	9.62	10.14
9.5	4.96	5.22	5.74	6.26	6.78	7.30	7.82	8.34	8.86	9.38	9.90
9.0	4.72	4.98	5.50	6.02	6.54	7.06	7.58	8.11	8.63	9.15	9.68
8.5	4.49	4.75	5.27	5.79	6.31	6.83	7.35	7.87	8.39	8.91	9.43
8.0	4.25	4.51	5.03	5.55	6.07	6.59	7.11	7.64	8.16	8.68	9.20
7.5	4.02	4.28	4.80	5.32	5.84	6.36	6.88	7.40	7.92	8.44	8.96
7.0	3.78	4.04	4.56	5.08	5.60	6.12	6.66	7.16	7.68	8.20	8.72
6.5	3.45	3.80	4.32	4.85	5.37	5.89	6.41	6.93	7.45	7.97	8.49
6.0	3.31	3.57	4.09	4.61	5.13	5.65	6.17	6.69	7.21	7.73	8.25
5.5	3.07	3.33	3.85	4.37	4.89	5.42	5.93	6.46	6.98	7.50	8.02
5.0	2.84	3.10	3.62	4.14	4.66	5.18	5.70	6.22	6.74	7.26	7.78
4.5	2.60	2.86	3.38	3.90	4.42	4.94	5.46	5.98	6.50	7.02	7.55
4.0	2.37	2.63	3.15	3.67	4.19	4.71	5.23	5.75	6.27	6.79	7.31
3.5	2.13	2.39	2.91	3.43	3.95	4.47	4.99	5.51	6.03	6.55	7.07
3.0	1.89	2.16	2.68	3.20	3.72	4.24	4.76	5.28	5.80	6.31	6.84
2.5	1.66	1.92	2.44	2.96	3.48	4.00	4.52	5.04	5.56	6.08	6.60
2.0	1.42	1.68	2.20	2.72	3.24	3.76	4.28	4.81	5.33	5.85	6.37
1.5	1.19	1.45	1.97	2.49	3.01	3.53	4.05	4.57	5.09	5.61	6.13
1.0	0.95	1.21	1.73	2.25	2.77	3.29	3.81	4.33	4.85	5.37	5.89
0.5	0.72	0.98	1.50	2.02	2.54	3.06	3.58	4.10	4.62	5.13	5.66
stocking frequency	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00

already been concluded that vendace management is here the least consistent, if not totally „accidental”. This controversy is most probably due to the fact that this group must comprise some lakes in which natural reproduction of vendace is still fairly effective, so the managers do not regularly stock them but release some stocking material from time to time only. This statement is confirmed by the lowest vendace yield (in kg/ha) in this group, which also suggests that lack of consistent stocking policy does not bring satisfactory effects. These results confirm ones again that in Polish conditions vendace landings are strictly dependent on stockings, and that there is still some productive potential to be used. The latter is suggested by the fact that the most unsatisfactory group IV comprises as many as 31 lakes of total area over 15 thousand ha.

Table 2 is self-explanatory and does not necessitate any comment. Attention should only be given to considerable possibilities implicitly related to the stocking practice per se. The results can be considerably improved simply by increasing frequency of stockings, yielding production and economic benefits even if stocking rates are lowered.

To conclude, it is worth to make a comment of a methodical nature: any assessment of stocking effectiveness must necessarily comprise frequency of stocking, or else the results shall not be reliable.

REFERENCES

- Bnińska M., Wołos A., 1998 – Effectiveness of coregonid management versus environment quality – Arch. Ryb. Pol. Vol. 6, Fasc. 2: 295-314
- Falkowski S., Wołos A., 1996 – Stan gospodarki koregonidami: 57-60 – In: Rybactwo Jeziorowe. Stan, Uwarunkowania, Perspektywy. Materiały I Krajowej Konferencji Rybackich Użytkowników Jezior, Uroczysko Waszeta, 23-25 czerwiec, Wydawnictwo IRS, Olsztyn.
- Leopold M., Wołos A., 1998 – Regularities of vendace management and methodical aspects of its assessment on a long-term basis – Arch. Ryb. Pol., Vol. 6, Fasc. 2: 329-344
- Leopold M., Wołos A., Mickiewicz M., 1998. – The effect of lake morphometry on the effectiveness of vendace (*Coregonus albula* L.) management – Arch. Ryb. Pol., Vol. 6, Fasc. 2: 279-286
- Wołos A., Bnińska M., 1998 – Effectiveness of coregonid management on the background of fish yield changes in 25 Polish lakes – Arch. Ryb. Pol. Vol. 6, Fasc. 2: 315-328
- Wołos A., Falkowski S., Abramczyk A., 1995 – Management of coregonines in the big State Fish Farm Elk - production, stocking practice, and effectiveness – Archiv fur Hydrobiologie. Special Issues Advances in Limnology, 46: 387-396

STRESZCZENIE

WPLYW CZĘSTOTLIWOŚCI ZARYBIANIA JEZIOR SIELAWĄ NA EFEKTYWNOŚĆ TEGO ZABIEGU

Poddano analizie wieloletnie dane o gospodarce sielawowej prowadzonej w 114 jeziorach o łącznej powierzchni 59.1 tys. ha. Obliczono średnie wieloletnie wielkości odłowów sielawy (w kg/ha) i zarybień wylęgiem (w szt/ha) oraz wskaźnik częstotliwości zarybień. Określono podstawowe parametry charakteryzujące gospodarkę sielawową w jeziorach zarybianych z różną częstotliwością, a przy użyciu rachunku korelacji wielokrotnej stwierdzono istnienie wysoce istotnego związku między średnią wieloletnią wydajnością sielawy a przeciętnie stosowanymi dawkami zarybień i ich częstotliwością. Uzyskano równanie regresji wielokrotnej, charakteryzujące związek między tymi zmiennymi i na jego podstawie opracowano praktyczną tabelę, która może być pomocna przy optymalizowaniu gospodarowania materiałem zarybieniowym.

ADRESY AUTORÓW:

Prof. dr hab. Marian Leopold
Dr Arkadiusz Wołos
Instytut Rybactwa Śródlądowego
Zakład Bioekonomiki Rybactwa
10-719 Olsztyn-Kortowo
ul. Oczapowskiego 10