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► **To cite this version:**

Marian Leopold. PROBLEMS OF ANALYSING EFFECTIVENESS OF EEL STOCKING IN INTERCONNECTED LAKES. *Vie et Milieu / Life & Environment*, 1986, pp.291-293. hal-03024194

HAL Id: hal-03024194

<https://hal.sorbonne-universite.fr/hal-03024194v1>

Submitted on 25 Nov 2020

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PROBLEMS OF ANALYSING EFFECTIVENESS OF EEL STOCKING IN INTERCONNECTED LAKES

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LACS RELIÉS
ALEVINAGE
CORRÉLATION MULTIPLE

RÉSUMÉ. — Les études de pêches et d'alevinage d'Anguilles dans cinq groupes de lacs reliés entre eux, ont été réalisées d'après des relevés portant sur de longues années. La méthode d'alevinage s'est montrée très efficace. Par contre, l'analyse de la réussite de l'alevinage dans des lacs particulièrement complexes est fort difficile. Une méthode d'étude sur l'efficacité de l'alevinage dans ces lacs, basée sur des corrélations multiples, est présentée.

ANGUILLA ANGUILLA
INTERCONNECTED LAKES
FISH STOCKING
MULTIPLE CORRELATION

ABSTRACT. — Long-term data on eel stocking and catches from five lake complexes forming an interconnected system were analysed. Eel stocking was highly effective in the whole system. However, analyses of the effectiveness in particular lake complexes proved to be very difficult. The paper presents a method of analysing the effectiveness of stocking in interconnected lakes, based on multiple correlation studies.

INTRODUCTION

Studies on the effectiveness of eel stocking in Polish lakes (Leopold, 1986) practically paid no attention to the possible effect of eel migration between the lakes, especially migration of the stocking material. This was partly due to the fact that dependencies between eel stocking and catches were anyway very strict, highly significant statistically, and as such fulfilled cognitive and practical objectives.

However, as eel management in Poland is becoming more and more important, efforts to optimize this management are being made, and the respective studies have been enlarged to embrace this problem as well. The matter became of special importance when the Department of Fishery Economics, Inland Fisheries Institute, undertook complex studies on the state of the environment and fishery management in the so-called Great Mazurian Lake System, and it appeared that the methods used so far are not satisfactory. This paper presents a new method of

analysing the effectiveness of eel stocking in interconnected lakes.

MATERIALS AND METHODS

Analyses embraced materials from the Great Mazurian Lake System. The System consists of 32 interconnected lakes of a total area of over 35 thousand ha. Within the system, 5 more or less integrated lake complexes can be distinguished. These are : Mamry, Niegocin, Mikołajki, Sniardwy and Roś. The complexes Mamry and Roś are peripheral and, thus, connected with only one other lake complex, while the remaining three are located centrally and each is connected with others two (Fig. 1).

The materials consisted of detailed records of eel stocking and commercial catches for each lake over the period 1961-1983. Statistical methods were used to determine the relationship between rate of eel

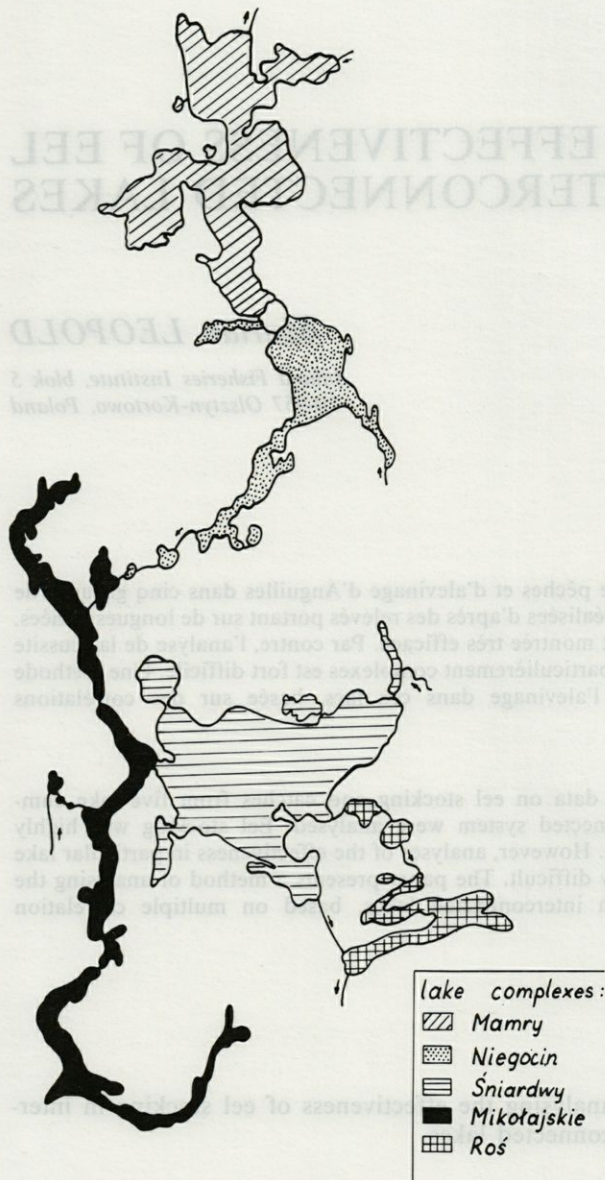


Fig. 1. — Great Mazurian Lake System.

stocking and level of eel catches, especially simple and multiple correlation.

In the first step, simple correlations were calculated between eel stockings and catches in the whole

system and in particular lake complexes. In the second step, a totally different approach was adopted. It was assumed that the total eel catch in the whole system depended on the "input" represented by stocking in particular lake complexes. In this way, the obtained relationship could be used as an illustration of possible eel migrations within the whole system. To achieve this aim, multiple correlation and determination were used, with the eel catch in the Great Mazurian Lake System as the dependent variable (y), and the independent variables represented by eel stocking in particular lake complexes (x — complex Mamry, z — complex Niegocin, u — complex Mikołajki, w — complex Śniardwy, p — complex Roś).

It was also established that in the period under study the fishing effort in particular lake complexes did not undergo any major changes.

RESULTS

Table I contains a characteristic of the eel management in the lake system as a whole, in the distinguished lake complexes, and the dependencies between eel stockings in 1961-1978 and eel catches in 1966-1983.

When the Great Mazurian Lakes are considered as a whole, the dependence between stocking rate and level of eel catches seems very simple and unequivocal. The coefficient of correlation $r = 0.7806$ is highly significant and points to very strict dependency between the two variables.

The matter becomes more complicated when particular lake complexes are taken into account. It appears that the greatest lake complex, viz. Śniardwy, which represents 35.5% of the total area of GML, is characterized by practically insignificant correlation between eel stocking and catch ($p = 0.10$), whereas eel catches are fairly high, and the relation "stocking-catch" very favourable. Moreover, the most obvious conclusion would be that eel stocking in Mikołajki complex should be limited, whereas rate of stocking in other complexes, and in

Table I. — Basic parameters of the eel management in the Great Mazurian Lake System /GML/.

Lake complex	Area (ha)	Average eel stocking (elvers/ ha/year)	Average eel yield (kg/ha/ year)	Average number of elvers per 1 kg of catch	Coefficient of correlation between stocking and catch (r)	Level of significance
Mamry	10 376.0	58.5	2.13	27.4	0.7217	0.001
Niegocin	4 270.4	63.1	3.99	15.8	0.6282	0.001
Mikołajki	5 632.2	96.4	2.29	42.2	0.6780	0.01
Śniardwy	12 475.0	50.7	3.72	18.6	0.4201	0.10
Roś	2 429.4	63.5	2.01	31.5	0.6171	0.01
Totally GML	35 183.0	62.7	2.58	24.3	0.7805	0.001

Niegocin in the first place, should be increased. The latter complex is characterized by the highest level of catches and the lowest expense in terms of stocking material used to obtain a catch of 1 kg. These conclusions — apparently well founded — do not take into account the fact that the lakes are interconnected and in reality do not constitute isolated objects.

A somewhat different picture was obtained with the second approach. Multiple correlation between eel catch in the whole system and stockings in particular lake complexes was very highly significant: $R_{y,xzuwp} = 0.8579$, at $p < 0.0001$. Value of $R^2 = 0.736$ reveals that variation in eel catch in the whole system is in 73.6% explained by the stocking rates in particular lake complexes. This multiple determination is composed of « partial » determinations, connected with eel stocking rates in the lake complexes. Their values are as follows:

Mamry complex	+ 25.3 %
Niegocin complex	- 11.2 %
Mikołajki complex	+ 42.4 %
Sniardwy complex	+ 0.1 %
Rós complex	+ 17.0 %

Conclusions resulting from these values are totally different from those derived from a general approach, and suggest that stocking rates in Mikołajki complex should be increased at the expense of limited stockings in the Sniardwy and Niegocin complexes.

DISCUSSION

The two approaches used to determine the effectiveness of eel stocking in the Great Masurian Lake System gave totally different results. Interpretation and explanation of the apparently contradicting conclusions is neither easy nor univocal. Conclusive statements cannot be made without further studies. Nevertheless, it is highly probable that the results can be explained by eel migrations between particular lake complexes of the Great Masurian Lake System, both of the introduced stocking material and of the catchable stocks.

This statement is confirmed by the fact that the greatest « anomalies » in the results obtained with the two methods are observed in the case of the three centrally located complexes: Niegocin, Mikołajki and Sniardwy. Without doubt the fishes have much more chance to migrate between these complexes than between the other two.

Eel catches from the Mikołajki complex constitute only 14.2% of the total eel catch in the system. Stockings in this complex explain 42% of the variation in total catch. Hence, it is obvious that eels stocked into this complex are caught elsewhere, most of all in the neighbouring complexes Sniardwy and Niegocin. This explains spuriously low use of the stocking material per 1 kg of catch in these two complexes.

Low determination of total eel catch by stockings in Sniardwy complex can also result from migration of the stocking material to other lake complexes and/or immigration of the catchable eel into Sniardwy complex. In other words, eels caught in Sniardwy complex most probably originate mainly from the stockings made in other complexes.

Special attention should be given to the Niegocin complex. Negative coefficient of determination suggests that eel stocking in this complex decreased the total eel catch in the system. On the other hand, highly significant correlation was found between eel stocking and catch in this complex, and eel yield was high (Table I). The greater part of this complex is highly polluted with untreated domestic sewage. Negative effect of stocking into Niegocin upon total eel catch in the system can probably be explained by the fact that water pollution affects elvers, possibly causing high losses. Eels of catchable size are very resistant and not affected by the sewage, and even a beneficial effect is possible. Hence, high yields in Niegocin complex are probably caused by immigration of catchable eel into this complex.

Significant simple correlation between eel stocking and catch found in the latter complex might also be spurious because the high significance results from the fact that stocking rates were more or less similar in all lake complexes. The matter necessitates further studies.

Obviously, not everything is known as yet. Nevertheless, the results obtained with the two methods clearly show that there is no simple and universal approach to the studies on the effectiveness of stocking in interconnected lakes, even if the results seem to be quite adequate. Consideration of one approach only may lead to erratic conclusions and wrong management decisions.

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