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ATTEMPTS OF USING THE DISCRIMINANT FUNCTION BASED ON SCALE STRUCTURE OF BALTIC SALMON TO DISTINGUISH BETWEEN THE WILD AND HATCHERY-REARED SMOLTS

by
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ABSTRACT

This paper is an "interim" of Finnish-Polish cooperative task. Discriminant functions were derived, using the scale characters and smolt age of wild and hatchery-reared Baltic Salmon. Accuracy of applying the functions to separations of these fish of known origin ranged from 90 % to 100 %. Proportions of hatchery-reared salmon and the wild one estimated with the help of functions in a sample of fish from commercial catches were equal to 74 % and 26 %, respectively. Divergency of this result from estimations made according to the criteria described in Antere and Ikonen (1983) has been revealed and discussed.

INTRODUCTION

This paper should be treated as an interim document from Finnish-Polish cooperative task. It is, simultaneously, a response to the Council Resolution 1988/4:6a.

Problem of distinguishing between the wild and hatchery-reared fish is still important for management of salmon stocks. The first methodical trials of this distinguishing based on Baltic salmon scales were made at the Finnish Game and Fisheries Research Institute. It was found among others that the wild and hatchery-reared smolts can differ in age composition and in "regularity" of scale structure (Antere and Ikonen 1983).

Those statements inspired to submit the propositions that differences noticed in scale pattern could be represented in some measurable forms together with the fish age, and that discriminant function might be therefore used for more precise separation of wild and reared salmon, too.

The propositions have been verified chiefly by support of the Inland Fisheries Institute in Poland which had already got an experience in applying the discriminant procedures (Sych and Tuszynska 1983, Wisniewolski, Gorczynski and Madry 1989). The task being in progress was preliminaryly announced to the Baltic Salmon and Trout Assessment Working Group (Borzecka 1988).

MATERIALS AND METHODS

The salmon, Salmo salar, originated from Finland and caught in various areas of Baltic Sea in the 70-ties and 80-ties was an object for this study.

Two standard scale samples served for derivation of discriminant functions: the scales of 50 salmon of wild origin, mainly at the age of 3.2 (from 52 fish sampled): the scales of 49 hatchery-reared and released salmon of

prevailing age 2.2+ and 3.2+ (from 58 fish sampled). Some fish from the whole number of them given in brackets had to be rejected on account of regeneration and other destructions of their scales.

An additional small scale sample of 13 salmon from the Neva River, which only consisted of hatchery-reared fish aged 2.1+ (mainly) and 2.2+, was applied to verify the discriminant function derived. Finally, a routine classification of fish without information about their actual origin was exemplified on a scale sample of 35 salmon from commercial catches. The age of fish was differentiated in this case as usual, ranging from 1° to 3° in fresh water and from 1+ to 3+ in the sea.

The linear discriminant functions were constructed for following characters:

CR_i number of circuli in consecutive annual zones of fish scale in fresh water (i=1->4),

WR_i width of consecutive annual zones of fish scale in fresh water (i=1->4),

CS_1 number of circuli in the first annual zone of fish scale in the sea,

WS_1 width of the first annual zone of fish scale in the sea,

A age of fish at the smolt stage.

It was assumed by including CS_1 and WS_1 that the fresh-water life of fish can have an influence on its start in the sea. The parameter A might be omitted, if discriminant function for subsample of fish of uniform smolt age was established.

The scale impressions on plastic plates and Zeiss projection microscope were applied to estimate the character values. The age of fish in standard samples was determined by Finnish and Polish scale readers, and the results were abjusted. The ageing of fish from routine commercial sample, like a whole discriminant procedure applied to this sample, was conducted in Finland and Poland independently.

The width of annual zone was measured along the oral radius of scale with an accuracy of 0.01 mm, and the circuli intersecting this radius were counted.

RESULTS

The first discriminant function was derived for salmon of three years stay in fresh water. Thus, the fish aged 3.B$^+$ were selected from the standard samples only (N_1=33, N_2=22), and the characters were limited to CR_i, WR_i, CS_1 and WS_1 (i=1,2,3).

The following equation was obtained:

(0,1) $Y = 1.114 - 0.054CR_1 + 0.007CR_2 + 0.041CR_3 + 0.158WR_1 + 1.115WR_2 - 1.929WR_3 - 0.001CS_1 + 0,087WS_1,$

with average discriminant values in the group of wild (1) and hatchery-reared (2) fish

$Y_1 = 0.3143$ and $Y_2 = -0.3143$

Using of equation (0,1) for the same subsamples of standard fish (N=55) was resulted in a misclassification rate equal to 5.5 %.

The second discriminant function was based on complete standard samples (N_1 = 50, N_2 = 49) in which the smolt age was differentiated as usual. This function assumed following form:

(0,2) $Y = -1.725 - 0.041CR_1 - 0.006CR_2 + 0.02CR_3 - 0.142CR_4 + 0.478WR_1 - 0.231WR_2 - 1.028WR_3 + 0.69WR_4 + 0.006CS_1 + 0.002WS_1 + 1.006A.$

and the means of discriminant values were

$Y_1 = 0.3077$ and $Y_2 = -0.3077$

The misclassification rate reached 10.1 %, when separation of fish from the standard samples (N = 99) was attempted by use of function (0,2). However, no fish was misclassified in a sample of Neva River salmon additionally taken to test the function (0,2).

Finally, it was indicated by identicifation of wild and hatchery-reared salmon in routine sample from Finnish

commercial catches that 74.3 % of those fish had been originated from stockings. The function (0,2) could only be applied in this case, since age of fish at smolt stage varied in the sample. However, this result appeared to be questionable. Quite different proportion of hatchery-reared fish, equal to 40 %, was obtained for the same sample from commercial catches according to the criteria proposed by Antere and Ikonen (1983).

DISCUSSION

The background of discrepancy mentioned is considered to be methodological or even logistical. Verification of routine procedure had to be conducted with no information about actual origin of fish. Therefore two independent methods were applied, and one of them was assumed to be corrected. Secondly, it should be always clear that the standard and routine samples belong to one universe, meant mathematically, when deriving and applying the discriminant function. Following this constraint, the used materials are being reviewed in addition.

The wild standard salmon was originated from Simojoki River. The reared standard salmon came from hatchery-reared fish released between Oulujoki River and Kemijoki River. All the fish in standard samples were tagged as smolts and recaptured mainly in the Gulf of Bothnia (62 %), and to a less extent in the Proper Baltic (21 %) and the South-West Baltic (17 %). The routine sample was taken from commercial fishing of salmon near the Åland Islands. Hence, both standard and routine samples could be thought to belong to northern stocks of salmon, distributed wide on the Baltic feeding grounds, but with no significant differentation of scale structure dependent geographically (Sych and Tuszynska 1983).

Time of fish sampling could rather be treated as convergent, too, since the recaptures for standard samples were caught from 1976 to 1984 and the routine commercial sample was

collected in 1983.

Sampling of scales might involve some disturbances in required uniformity, on the other hand. Different fishermen were engaged to this sampling, what could be resulted in an inconsistency of position on fish body the scales were taken from. Then, that "routine" verification of discriminant function was tried at a part of scale collection not randomly chosen: only some "easier" scales were selected. But it can not be exclude that readability of scale structure has an effect on the discriminant values and their distributions.

Finally, it must be mentioned that the latest test with routine discrimination was carried out in Finland and Poland with no confrontation of scale reading or measuring.

CONCLUSIONS

It has been indicated in this paper that the wild and hatchery-reared salmon can be separated by means of discriminant functions involving the scale characters and smolt age. The separation accuracy ranged from 90 % to 100 % according to the function and fish sample. Those successful results were achieved as far as the functions could be tested on standard samples in which the fish origin was known from tagging.

An inconsistency appeared when separation of wild and reared salmon was tried on a sample from commercial catches by using two different rules: the discriminant function (0,2) and visual criteria after Antere and Ikonen (1983). Possible reasons of this inconsistency have been discussed, what may be a basis for continuing the work.

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