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ON THE INTERRELATIONSHIP BETWEEN SOME PARAMETERS USED FOR ASSESSING THE EFFECTS OF THE WEST GREENLAND SALMON FISHERY

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I. INTRODUCTION

The ICES/ICNAF Joint Working Party on North Atlantic Salmon was set up in 1965 to study the state of stocks of Atlantic salmon, and the effects of the fishery for salmon in Greenland waters.

Since then the Working Party has collected a good deal of information on the fisheries and the stocks, and initiated studies aiming at supplying further information necessary for an assessment of the effects of the fisheries on the stocks. In several cases, however, the Working Party has not been able to get exact figures for some important parameters. In such cases the Working Party has had either to give up particular assessment or to assume a reasonable but often very wide range of values for some parameters. Whenever the Working Party lacking exact information has had to make such assumptions this has been carefully pointed out in the reports as has any other basic assumption made.

When setting a range of possible values for the parameters the Working Party has in most cases considered each parameter separately. It should, however, be pointed out that some factors and parameters are more or less interrelated, so that acceptance of certain values of some parameters involves rejection of certain values of other parameters. In the present paper the author tries to point out some such cases.

II. REVIEW OF FACTORS AND PARAMETERS

a) Catches at Greenland are known with probably the highest possible degree of accuracy. In this paper a level of 2000 tons (round, fresh) is used. By a mean weight of 3.2 kg per fish the 2000 tons correspond to a catch of approximately 625,000 individuals.

b) Age composition of catches at Greenland are fairly well known. In any case it is agreed that all individuals are 1+ sea-winter-fish or older. It is also accepted that they would be salmon (.2 or older) if and when they return to home-waters.

c) Exploitation rate at Greenland is unknown. However, tagging experiments at Greenland have for "excellent" fish given a local recapture rate up to 6%. Furthermore, during the August-November fishing season there are no signs of a gradual decrease in catch-per-effort whereas c.p.e. decreases abruptly at the end of the season (see paper by J.Møller Jensen, this meeting). This can be explained by assuming:

i) a low exploitation rate

ii) a constant net-immigration rate of salmon into the fishing area of the same order as the removing rate

iii) a gradually increasing catchability throughout the season

iv) any combination of i-iii

re. ii: The theory of a constant migration of salmon into the fishing area during the season seems to be contradicted by some facts. In some years, for example, salmon are missing in certain inshore areas (not always the same areas from year to year) at the beginning of the normal season in that area. When this has been the case these areas are normally not filled up by salmon later in the season. Also, local tagging experiments seem to contradict the theory since by far the majority of Greenland recaptures from such experiments are taken in the same area as where the tagging was performed. This applies especially to inshore tagging experiments, whereas offshore experiments have given some recaptures in divisions other than the division of tagging.

re. iii: No direct observation on possible fluctuations in catchability exists in Greenland waters. However, the small fishery in the Davis Strait in first quarter of 1970 (see paper by P.Kanneworff, ICNAF Res.Doc. 70/65) was a long-line fishery. Likewise, at the end of the West Greenland season in October-November some long-lining takes place with some success. Also, in the Baltic the two gears are used in each their certain season. There is, therefore, not much support to be found for the theory of increasing catchability for salmon in nets, at any rate not in the last half of the season, whereas the relatively short and light nights at the beginning of the season may tend to diminish catch per net per set, although this tendency may be rather smaller for monofil nets than for nets of braided twine.

The author is, therefore, of the opinion that exploitation rate at Greenland is rather low. A range of 10-30% exploitation rate seems reasonable and is used here.

d) The growth rate between Greenland and home-waters is taken by the Working Party as being so that there is a 50% increase in mean weight. This figure may be too high (see ICNAF Res.Doc. 70/65). A probable range of 10-50% is used in this paper.

e) National contributions to the stock exploited at Greenland is not exactly known, but it is generally agreed that the biggest individual proportions originate from Canada and the UK. Considering the total salmon catches in these two countries as compared to other countries' catch it may be reasonable to assume that 50-80% of the Greenland stock originate from Canada and the UK combined. In the model used (see Section III) it is further assumed that 50-80% of salmon at Greenland are destined to return to Canada plus the UK.

f) Catches in home-waters are fairly well known although the breakdown into salmon and grilse is not very good.

For Scotland a mean annual salmon catch (excl. grilse) in the 1965-69 period may be round about 1100 tons.

For England and Wales the corresponding figure may be close to but not exceeding 300 tons.

Salmon catches from Northern Ireland could hardly be more than 150 tons annually.

If Canadian catches from Nova Scotia, New Brunswick and Quebec are regarded as 100% salmon whereas the catches from Newfoundland and Labrador are divided equally between grilse and salmon then the total Canadian salmon catch is close to 2000 tons annually in the 1965-69 period (see A.May, ICNAF Res.Doc. 70/4).

The mean annual catch of salmon in Canada plus the UK in the 1965-69 period could thus be close to 3500 tons.

g) Exploitation rate in home-waters varies between and even inside countries. The Working Party has used an overall figure of 60%. For Canada and the UK combined a range of 50-80% may, therefore, be acceptable.

h) The natural mortality rate at Greenland and especially from the time when salmon leave Greenland (or when the fishing season ends in October-November) is in reality unknown except that it is not a 100% mortality since some salmon do appear in home-waters after having been tagged at Greenland. Whether this appearance in home-waters is an actual return to native waters is not known, but this is of minor importance for part of the assessments. The Working Party has used upper and lower limits of M of 0.02 and 0.1 on a monthly base which for 10 months correspond to a loss between 18% and 63%.

Since this parameter is the great unknown an attempt will be made to show what values of natural loss one will have to accept when certain combinations of the factors a) to g) are accepted.

III. ACCEPTANCE OR REJECTION OF NATURAL LOSSES BETWEEN GREENLAND AND HOME-WATERS

Having accepted certain values of other parameters it is by simulation possible to accept/reject some values of the natural loss between Greenland and home-waters.

The model of simulation here used starts with the known mean catch of about 2000 tons salmon at West Greenland and ends with a combined British-Canadian catch of salmon as it would be if no natural loss appeared between Greenland and home-waters. If this theoretical catch is greater than the 3500 tons mentioned in Section II, f) then a certain natural loss must have occured. The loss necessary to bring the theoretical catch down to 3500 tons is then calculated. It must, however, be stressed that any value of natural loss found in this way is a minimum value for those salmon which have occurred at Greenland, since it must be accepted that 1+ sea-winter-fish of Canadian and UK origin occur also in other areas of the North Atlantic than that fished at Greenland. Salmon returning to home-waters from such other areas without having been part of the exploited stock at West Greenland may well account for a substantial part of home-

12

water fisheries of salmon.

In cases where the simulated catch (with no natural loss) is higher than the actual catch of 3500 tons no attempt has been made to take into account the effect which catches of "non-Greenlandic" fish has on the calculated natural loss, but clearly if this catch account for a home-water catch of the same order as do fish returning from Greenland, then the number of fish in the latter group should be halved.

In cases where the simulated catch is lower than the 3500 tons the difference is a minimum value of catches based on "non-Greenlandic" fish (minimum because the simulated catch is based on no natural loss).

IV. RESULTS

The various combinations of values of the various parameters and of the calculated losses or catches of "non-Greenlandic" fish are set out in Table 1. From this table some examples are given

i) The natural loss may be at least as high as 4,486,000 individuals or at least 80% of fish which formed the Greenland exploited stock but which were not caught there. This figure will apply if the exploitation rate at Greenland is 10%, weight increase between Greenland and home-waters is 50%, exploitation rate in home-waters is 80%, and if 80% of the Greenland stock originates from (or more correctly are destined to return to) Canada or the UK.

ii) If the exploitation rate at Greenland is 30%, increase in weight 10%, exploitation rate in home-waters 65%, and if 2/3 of salmon at Greenland are destined to return to Canada or the UK to be exposed to an exploitation rate of 65% then no lower limit of natural loss between Greenland and home-waters can be set, but if the loss is negligible then at least 36% (by weight) of home-water salmon catches are based on "non-Greenlandic" fish.

iii) The lower limit of natural loss given by the Working Party (18%) could occur in all cases where the calculated natural loss is below this figure. Taking also the 50% increase in weight used by the Working Party a possible combination of other parameters may be: Exploitation rate at Greenland 20% (but not as low as 10%), home-water exploitation rate 65%, and 50% (but not 2/3 or more) of salmon of Canadian-UK origin.

Some general trends in the interrelationship between some factors in the table should be mentioned. Provided other parameters and factors are kept constant the table illustrates that

i) the higher the exploitation rate at Greenland the lower the accepted natural loss between Greenland and home-waters

ii) the higher the exploitation rate in home-waters the higher the natural loss that must be accepted

iii) the lower the exploitation rate in home-waters the higher the proportion of salmon occurring outside the Greenland fishing area

iv) the higher the growth rate between Greenland and home-waters the higher the loss in numbers between Greenland and home-waters.

v) the greater the proportion of Greenland salmon destined for any particular country the higher the natural loss for such salmon.

Table 1. Text to table, see next page)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Catch at Greenland	Exploitation of Grl.stock at Grl.	Numbers present at Grl. and escaping fishery there	Increase in mean-weight	Exploitation in home-waters	Simulated Can.-UK catch (see full text next page)			Loss between Grl. and h.-w. (see full text next page)			Non-Greenlandic proportion (see full text next page)		
	%		%	%	50%	66.7%	80%	50%	66.7%	80%	50%	66.7%	80%
2000 tons or 625,000 salmon by mean-weight of 3.2 kg	10	5,625,000	10	50	4950	6603	7920	29	47	56	-	-	-
				65	6435	8584	10296	46	59	66	-	-	-
				80	7920	10565	12672	56	67	72	-	-	-
			25	50	5625	7504	9000	38	53	61	-	-	-
				65	7313	9755	11700	52	64	70	-	-	-
				80	9000	12006	14400	61	71	76	-	-	-
			50	50	6750	9005	10800	48	61	68	-	-	-
				65	8775	11706	14040	60	70	75	-	-	-
				80	10800	14407	17280	68	75	80	-	-	-
	20	2,500,000	10	50	2200	2935	3520	-	-	1	37	16	-
				65	2860	3815	4576	-	8	24	18	-	-
				80	3520	4696	5632	1	25	38	-	-	-
			25	50	2500	3335	4000	-	-	13	29	5	-
				65	3250	4336	5200	-	19	33	7	-	-
				80	4000	5336	6400	13	34	45	-	-	-
			50	50	3000	4002	4800	-	13	27	14	-	-
				65	3900	5203	6240	8	33	44	-	-	-
				80	4800	6403	7680	27	45	54	-	-	-
	30	1,458,000	10	50	1283	1712	2053	-	-	-	63	51	41
				65	1668	2225	2669	-	-	-	52	36	24
				80	2053	2739	3285	-	-	-	41	22	6
			25	50	1458	1945	2333	-	-	-	58	44	33
				65	1896	2529	3033	-	-	-	46	28	13
				80	2333	3112	3733	-	-	6	33	11	-
			50	50	1750	2333	2799	-	-	-	50	33	20
				65	2275	3034	3639	-	-	4	35	13	-
				80	2800	3735	4479	-	6	22	20	-	-

TEXT TO TABLE 1.

Lower limit of natural loss of salmon between Greenland and home-waters by certain values of other factors and parameters. In cases where no lower limit of natural loss can be readily calculated a lower limit is given of that proportion (based on weight) of Canadian-UK home-water catches which are based on salmon returning from high sea stocks other than that at Greenland.

Entry Nos.: 6, 7 and 8.
Combined Canadian-UK catch (metric tons) if the stated proportions of salmon at Greenland return to Canada or the UK without any natural mortality.

Entry Nos.: 9, 10 and 11.
Natural loss in % of numbers at Greenland escaping fishery there (entry No.3) necessary to adjust Canadian-UK catches (Nos. 6-8) to 3500 tons. Given for three different values of proportion of Greenland fish destined to return to Canada or the UK.

Entry Nos.: 12, 13 and 14.
Proportion of Canadian-UK home-water salmon catch based on "non-Greenlandic" salmon given as percentage of a Canadian-UK mean salmon catch of 3500 tons. Given for three different values of proportion of Greenland fish destined to return to Canada or the UK.