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Expected Trends on the 2J3KLMNO Greenland Halibut in *Status Quo* Conditions

by

by
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1.- Introduction

The aim of this paper is to anticipate the trend in stock biomass, spawning stock biomass, and catches of the Greenland halibut stock in NAFO Divisions 2J3KLMNO in status quo conditions. In order to get estimates of the trends a simple model has been developed based on survey indices of numbers at age.

2.- Data

Selectivity at age was derived from de Cárdenas et al. (1995). Mean weight at age and age composition of the fall Canadian survey was obtained from Brodie et al. (1998). Maturity data at age was calculated as the average of the maturity ogive for NAFO Division 3M obtained by Junquera and Saborido-Rey (1995) for the years 1990 and 1994. These data are presented in table 1, 2 and 3.

3.- Method

An abundance ratio between numbers-at-age *a* in 1996 and numbers at age *a+1* in 1997 was calculated for each age presented in the Canadian fall survey (Brodie et al., 1998). Theoretically, these ratios should remained unchanged, without any assumption about natural mortality, or exploitation patterns, if the fleet composition keeps similar, as it is the case, and a status quo situation is maintained. So it can be used to project the number at age caught in a survey to the next year' survey.

An index of the fishable stock for each survey can be obtained by using the selectivity of 130 mm mesh, which is transformed into a fishable biomass index by multiplying each resultant number at age by the corresponding weight-at-age.

The ratio between catch and fishable biomass has to be constant in status quo situation. Therefore, once the 1997/1996 ratio is calculated, the catch for 1998 -and upcoming years in a similar manner- can be calculated as we has calculate the fishable biomass index for these years. At the same time, the mature portion of the fishable biomass index, i.e. a spawning biomass index, can be estimated by applying the maturity ogive to the biomass index at age. This can be used to monitor the expected evolution of the SSB level in the upcoming year.

This method is mainly dependent on the accuracy of the estimation of ratios, which are directly dependent on the precision of the number at age estimated by the surveys and in the 1997 survey which is used as base for the projection. To check the sensitivity of the output parameters to the accuracy of numbers at age estimated in the cruise, a resampling exercise was made. The numbers at age in the cruises were bootstrapped using Montecarlo replicates. The year effect and the age effect on number at age variability were computed separately. Normal errors with CV = 0.3 were used in both cases. Similarly, weights at age used to raise numbers to biomass and the selectivity pattern error were bootstrapped assuming a lognormal error with a s.e. of 0.2 for the weights. Finally, both the maturity ogive and the selectivity pattern were bootstrapped assuming normal errors after logit transformation for both parameters (cv=0.2).

In order to compare the sensitivity of the assumed CV on the outputs, another exercise is presented with CV = 0.2 for either year or age effect on the error of numbers at age in the survey.

5.- Results

Each Montecarlo replicate generates an estimate of Fishable Biomass index and corresponding Fishable Spawning Biomass index and catch estimate. 1000 replicates were made.

Table 4 and 5 shows the point estimates and the results of the resampling exercise. For the estimated index and catches, mean, median, and several percentiles are shown. It is also shown the probability of the TAC being taken if a status quo fish mortality would be applied to the stock in 1998. The results are shown for the assumptions of cv = 0.3 and cv = 0.2 in either year effect and age effect of the errors of numbers at age in the surveys.

Figure 1 shows the cumulative frequency distribution of expected catches in 1997 at status quo. Fig. 2 shows the same for the expected proportion of SSB increase.

6.- Reference

Brodie, W.B., W.R. Bowering, D. Power and D. Orr, 1998. An assessment of the Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO. *NAFO SCR Doc.* 98/47 Ser. No N3038: 7pp.

De Cárdenas, E., A. Avila de Melo, S. Iglesias and F. Saborido. 1995. Selectivity of 130 mm mesh size in deep sea bottom trawl fishery in NAFO Regulatory Area. *NAFO SCR Doc.* 95/47 Ser. No N2558: 7pp.

Junquera, S. and F. Saborido-Rey, 1995. Temporal and spatial variation in length at maturity in 3LM and 3NO Greenland Halibut. NAFO SCR 95/9 N2538. 7pp.

Table 1: Selectivity, mean weight and maturity at age vectors used in the analysis.

Age	Selectivity at age	Mean Weight	Maturity at age
1	0.00		0.00
2	0.00		0.00
3	0.13	0.126	0.01
4	0.26	0.222	0.02
5	0.41	0.383	0.03
6	0.58	0.581	0.05
7	0.90	0.909	0.08
8	1.00	1.264	0.18
9	1.00	1.85	0.32
10	1.00	2.427	0.48
11	1.00	3.104	0.62
12	1.00	3.996	0.74
13	1.00	5.141	0.82
14	1.00	5.943	0.89
15	1.00	6.658	0.92

Table 2: Numbers at age in the Canadian Fall surveys.

	Canadian Fall survey	
Years	**1996**	**1997**
0	41996	19546
1	793447	222012
2	452542	486571
3	267483	398365
4	96586	192045
5	55611	89809
6	22305	40112
7	7422	17321
8	1920	5658
9	1141	1547
10	377	493
11	178	280
12	115	151
13	118	100
14	42	54

Table 3: Abundance ratios for the different cohorts as observed in the 1996 and 1997 surveys.

Ratio 1997/1996	
1/0	5.29
2/1	0.61
3/2	0.88
4/3	0.72
5/4	0.93
6/5	0.72
7/6	0.78
8/7	0.76
9/8	0.81
10/9	0.43
11/10	0.74
12/11	0.85
13/12	0.87
14/13	0.46

Table 4: Point estimates of Stock numbers (at age) indices, Fishable biomass (at age and totals) indices, Spawning Stock Biomass indices, Catch, Catch/Fishable biomass ratio and expected change in these parameters in status quo conditions.

	Stock numbers			**Fishable Biomass**			**Fishable SSB**		
age	**1997**	**1998**	**1999**	**1997**	**1998**	**1999**	**1997**	**1998**	**1999**
0	19546								
1	222012	103330							
2	486571	136146	63366	0	0	0	0	0	0
3	398365	428320	119847	7438	7998	2238	89	96	27
4	192045	286014	307521	10216	15215	16359	204	304	327
5	89809	178570	265946	14198	28230	42044	469	932	1387
6	40112	64779	128802	14345	23167	46064	717	1158	2303
7	17321	31149	50304	13854	24915	40236	1108	1993	3219
8	5658	13204	23746	7134	16649	29940	1270	2963	5329
9	1547	4559	10639	2862	8433	19680	904	2665	6219
10	493	668	1970	1197	1622	4781	572	775	2285
11	280	366	496	869	1137	1541	540	706	957
12	151	238	311	603	949	1241	446	701	917
13	100	131	207	514	675	1062	423	556	874
14	54	46	60	321	272	357	285	242	317
15		0	0	0	0	0			
			Fishable biomass	**73552**	**129261**	**205542**			
			Proportion wrt 1997	**1.00**	**1.76**	**2.79**			
			SSB Biomass				**7028**	**13092**	**24162**
			Proportion wrt 1997				**1.00**	**1.86**	**3.44**
			Catch	**19858**	**34899**	**55494**			
			Catch/FB ratio	**0.270**	**0.270**	**0.270**			

Table 5: Results of the bootstrap (1000 replicates). CV denotes the coefficient of variation assumed for either the age effect or the = 0.3 on numbers at age in the surveys.

	CV = 0.3		CV = 0.2	
	Catch	SSB increase	Catch	SSB Increase
Average	39 446	2.44	37 811	2.18
sd	3.09	1.56	0.89	1.49
median	36 956	1.99	36 657	1.91
percentile 25	25 711	1.35	29 098	1.57
percentile 10	16 784	0.94	23 269	1.27
percentile 5	10 419	0.60	20 268	1.07
Prob<27000	0.28		0.19	
Prob<1		0.13		0.03

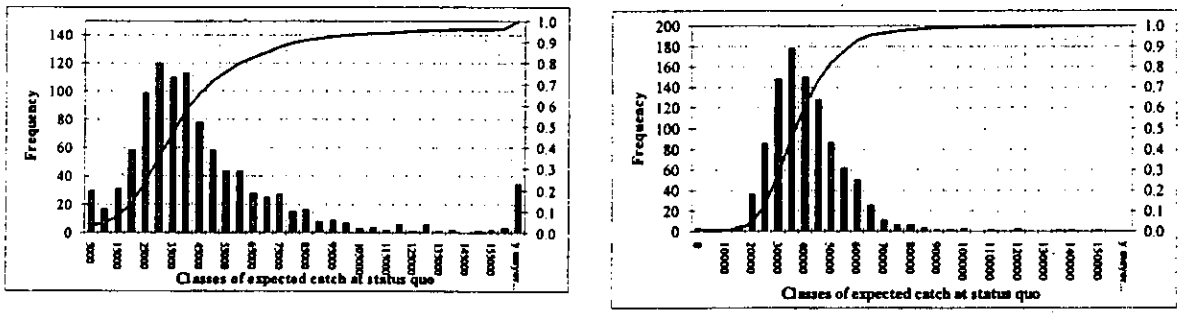

Figure 1: Frequency distribution of the replicates of expected catch estimates. Left, cv = 0.3 on either year and age effect for survey numbers at age. Right, cv = 0.2.

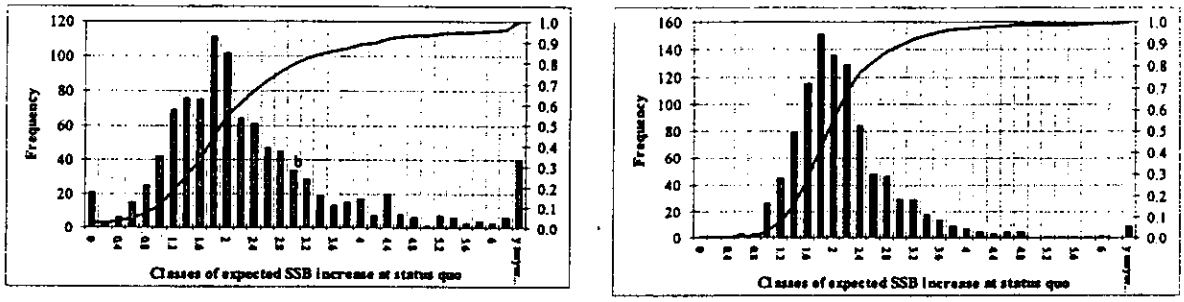

Figure 2: Frequency distribution of the replicates of the ratio of expected SSB increase catch from 1997 to 1998 in status quo conditions. Left, cv = 0.3 on either year and age effect for survey numbers at age. Right, cv = 0.2.