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Influence of Post-Escapement Mortality in the Yield of a Greenland Halibut Trawl Fishery

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1.- Introduction

This paper tries to assess the potential effects of post-escapement mortality on the results of a yield per recruit analysis for Greenland halibut in Subareas 2 and 3, considering a dome shaped exploitation pattern and differences in natural mortality (M) between sexes as formulated by De Cárdenas and Motos (1997).

In order to asses the effect of post-escapement mortality in the yields of Greenland halibut in a trawl fishery, a simple model was constructed. The model simulate the effect of different levels of post-escapement mortality on the long term yield and SSB per recruit and on the estimation of F_{01}.

2.- Methods

The assumption is that the escaped fish suffered a mortality rate α. We can calculate the number of fish passing through the meshes as the difference between the survivors and the survivors if the gear would not have any selection ($Pi = 1$ for all ages classes i). Depending on the gear (trawl in this case) and mesh sizes, different ages will be influenced by the dome-shaped partial recruitment pattern of the Greenland halibut. For this age classes, the number of fish escaping through the meshes should be corrected by the avoidance probability to the net. This can be formalised as follows:

for ages not influenced for the avoidance (dome shape) range.

$$Xi = Ni \exp(-M -(PR*F)) - Ni \exp(-M -F),$$

for ages within the avoidance (dome shape) range.

$$Xi = Ni \exp(-M -(Pi*F)) - Ni \exp(-M -F),$$

where Xi = number of fishes from age i escaping through the mesh,
PR = partial recruitment pattern at age i.
$PR = Pi * Ai$
Pi = selection probability at age y (derived from selectivity experiments)
Ai = avoidance probability to the trawl gear (from Jorgensen & Boje, 1992, 1995)

Then, the survivors at the end of the year will be:

$$N_{i+1} = Ni \exp(-M -(PR*F)) - \alpha Xi$$

The yield per recruit analysis was then performed using the input parameters as detailed in table 1 and the formulation as given by (De Cárdenas and Motos, 1997). The partial recruitment pattern is a combined result of the selectivity probability of the mesh size (De Cárdenas et al., 1995), with the avoidance probability (De Cárdenas and Motos, 1997, Jorgensen & Boje, 1995).

3.- Results

Results are presented in table 1 and ***Figures*** 1 to 4.

Table 2 present the yields and SSB per recruit at the biological reference point of F_{01} .

Figures 2 to ***5*** present the consequences of 0%, 10%, 20% and 30% post-escapement mortality, when comparing the yields and ssb per recruit of 205mm mesh size gear relative to 130mm. ***Table 2*** also shows the losses in yield per recruit and biomass per recruit at the different levels of post-escapement mortality.

The results show that the problem of post-escapement mortality can be important for the management of this an other similar fisheries. The consequence of not accounting the post-escapement mortality in the deaths when we are managing the fishery at a certain level (let's say $F_{0.1}$), is that we are overfishing the population, i.e. at an F level close to F_{max} calculated when post-escapement mortality is not negligible, i.e. 20% (***Table 1***)

4.- References.

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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.

De Cárdenas, E. and L. Motos, 1997. Yield per Recruit for Greenland Halibut in Subareas 2 and 3, Considering a Dome Shaped Exploitation Pattern and Differences in Natural Mortality (M) Between Sexes. NAFO SCR 97/33 N2865. 7pp.

Table 1: Outputs of the y/r analysis. Values of yield and ssb per 1000 recruits are given for the F_{01} and F_{max} reference points. The long term gains obtained with relation to the 130mm mesh size level are also shown as the ratio between the values for 205 mm mesh size and the values for 130 mm mesh size.

mortality level		130mm mesh size			205mm mesh size			ratio 205mm/130mm		
escape	RBP	ref. F	y/r	ssb/r	effort level	y/r	ssb/r	effort ratio	y/r ratio	ssb/r ratio
0	F01	0.31	264	1056	0.67	311	1423	2.16	1.18	1.35
	Fmax	0.51	281	354	1.26	334	497	2.47	1.19	1.40
0.1	F01	0.28	243	1153	0.47	223	1665	1.68	0.92	1.44
	Fmax	0.45	256	449	0.80	238	765	1.80	0.93	1.70
0.2	F01	0.26	224	1247	0.35	171	1854	1.37	0.76	1.49
	Fmax	0.40	235	545	0.55	180	1037	1.38	0.77	1.90
0.3	F01	0.24	207	1332	0.28	138	1988	1.18	0.67	1.49
	Fmax	0.35	218	637	0.41	144	1227	1.16	0.66	1.93

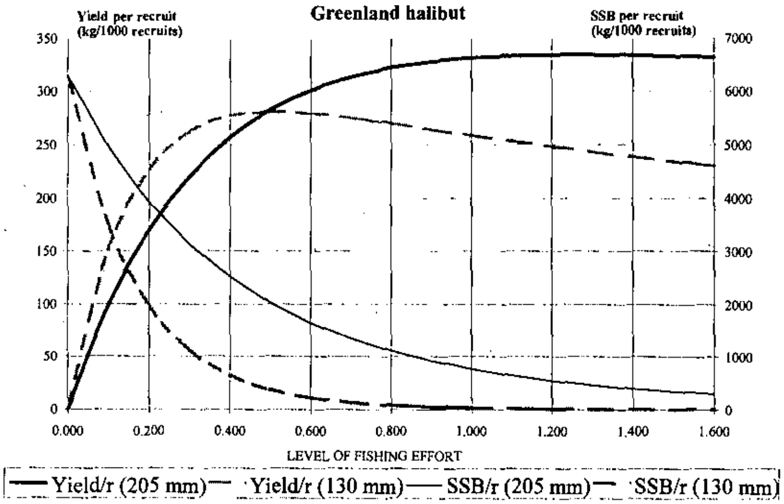

Figure 1: Plots of yield per (1000) recruit and SSB per (1000) recruit for the Greenland halibut population under the two exploitation scenarios: 205mm mesh size trawl and 130mm mesh size trawl. PR not scaled to 1, so the plot shows the effort level necessary to achieve the yields and ssb per recruit relatively to the 130 mm mesh size.

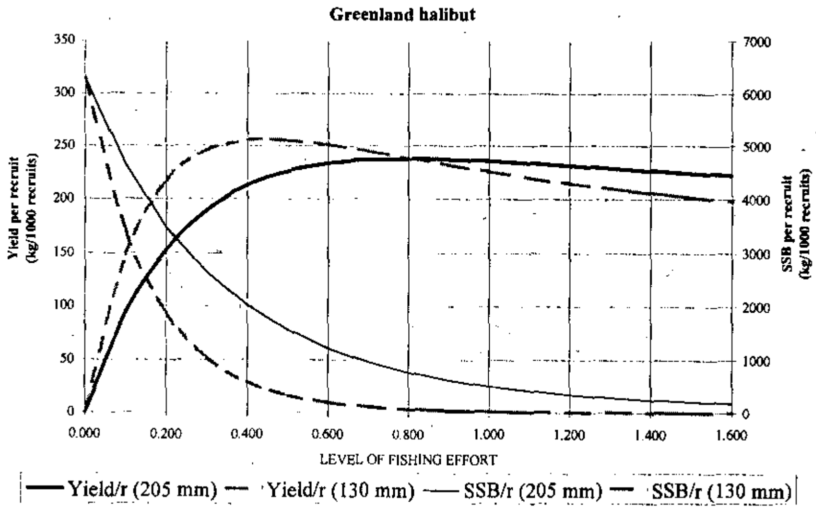

Figure 2: Yield per recruit and SSB per recruit curve when a 10% escapement mortality is assumed. The plot shows the effort level necessary to achieve the yields and ssb per recruit relatively to the 130 mm mesh size.

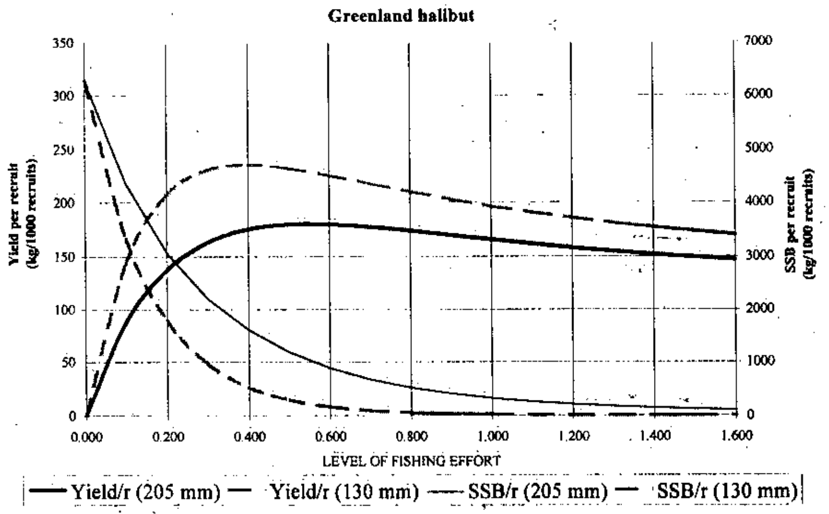

Figure 3: Yield per recruit and SSB per recruit curve when a 20% escapement mortality is assumed. The plot shows the effort level necessary to achieve the yields and ssb per recruit relatively to the 130 mm mesh size.

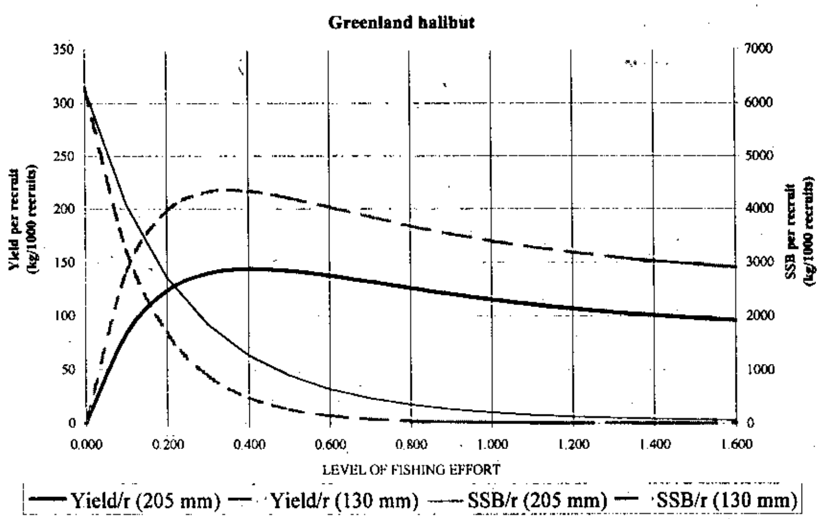

Figure 4: Yield per recruit and SSB per recruit curve when a 30% escapement mortality is assumed. The plot shows the effort level necessary to achieve the yields and ssb per recruit relatively to the 130 mm mesh size.