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Natural Mortality of Greenland Halibut (*Reinhardtius hippoglossoides*)  
in NAFO Subareas 0 and 2 and Divisions 3KL

by

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Introduction

For Greenland halibut in the North Atlantic successful calculations of the natural mortality rate ( $M$ ) are only known for the stock in the Gulf of St. Lawrence (CADDY 1984). Trials to estimate the natural mortality of Greenland halibut in ICES Subareas I and II by plotting  $Z$  versus the total effort were without suitable results (Anon. 1977). Therefore  $M = 0.15$  was assumed and taken for stock assessments. BOWERING and BRODIE (1981) used  $M = 0.2$  for estimating stock sizes and yield-per-recruit curves of the Greenland halibut in NAFO Subarea 2 and Divisions 3 K, L.

This paper presents the estimations of  $M$  for Greenland halibut of the western Greenland - Canadian stock (Ernst 1987a) for both the sexes separately as well as combined. Because there are no effort data of the fishery directed toward Greenland halibut, three methods that were mainly based on growth parameters were used. The results of the methods are compared.

Material and Methods

The methods used for estimating the  $M$ -values were according to PAULY (1978), TAYLOR (1959), and CADDY (1984).

The method of PAULY takes into consideration the relation between  $M$ , the parameter of the von BERTALANFFY-growth equation and the mean annual environmental temperature in  $^{\circ}\text{C}$  ( $T$ ). If growth in length is considered, the resulting equation based on data of 122 ground-fish and pelagic species is

$$\log M = 0.1228 - 0.1912 \log L + 0.7458 \log K + 0.2391 \log T \quad (1).$$

There is also an equation where growth in weight is considered.

But because length measurements are more exact than weighing under conditions at sea, for this paper (1) was chosen.

The growth parameters used (Table 1) were calculated from commercial data sampled during the G.D.R. fishery in the period 1977 - 1984. The mean environmental temperature was derived from analysis by ERNST (1987 b) and assumed to be  $T = + 2 ^\circ\text{C}$ .

According to TAYLOR (1959) the natural mortality rates were calculated by means of the formula

$$M = \frac{2.996 \cdot K}{2.996 + K \cdot t_0} \quad (2).$$

For  $K$  and  $t_0$  the values were taken from Table 1.

CADDY (1984) proposed a method applicable for solving natural mortality rates of species where the two sexes indicate different growth and total mortality rates ( $Z$ ). Because this is true for Greenland halibut this method was incorporated into the analysis.

On this place the main equations are only given again. Because

$$Z_F = M_M \left[ (K_F/K_M) - a \right] + a Z_M \quad (3)$$

the natural mortality rates by sex are

$$\hat{M}_M = \frac{\hat{a}}{(K_F/K_M) - a} \quad (4)$$

$$\hat{M}_F = \hat{M}_M (K_F/K_M) \quad (5)$$

Equation (3) was solved by functional regression of the form

$$y = \hat{a} + \hat{\gamma} x \quad (6)$$

where  $\hat{a} = \hat{\gamma}$ . The suscripts M and F denotes males and females, respectively.

For  $K$  the same values were used as for the methods described above (Table 1). The  $Z$ -values calculated by catch curves by age are given in Table 2.

#### Results and Discussion

As can be seen from Table 3, the results of the three methods used are in a good concordance especially those according to PAULY (1978) and CADDY (1984). The natural mortality rates are in the range from  $M = 0.230$  to  $M = 0.249$  for males and from  $M = 0.026$  to  $0.070$  for females. For both sexes combined the estimates are  $M = 0.075$  and  $M = 0.065$  respectively. It is

obvious that in all cases the natural mortality rate of females is much lower than that of males but similar to that of sexes combined, which is due to the higher proportion of females in the catch.

By reason of the results be in hand it is proposed to use  $M = 0.1$  for stock assessments of Greenland halibut in the NAFO divisions 0 to 3 L.

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Table 1: Parameters of the von BERTALANFFY equation for growth in length of Greenland halibut in NAFO Subarea 2 and Divisions 3 K, L

Sex	$L_{\infty}$	K	$t_0$
Males	68.257	0.2265	-0.084
Females	208.881	0.0238	-5.920
Sex combined	125.338	0.0597	-2.305

Table 2: Total fishing mortality rates by sex for Greenland halibut estimated from catch curves by age

Year	Division	$Z_M$	$Z_F$
1982	3 K	0.62	0.32
1983	2H+3K	0.37	0.13
1984	2 H	0.47	0.17
1985	2H+0B	0.63	0.20

Table 3: Natural mortality rates for Greenland halibut in NAFO divisions 0 to 3 L.

Method	Natural mortality rate		
	Males	Females	Sex combined
PAULY (1978)	0.230	0.034	0.075
TAYLOR(1959)	0.228	0.070	0.062
CADDY (1984)	0.249	0.026	-