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A Contribution to By-catch of Greenland Halibut (*Reinhardtius hoppoglossoides* Walb.) in the Roundnose Grenadier (*Coryphaenoides rupestris* Gunn.) Directed Fishery in NAFO Subarea 2

by

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Introduction

Due to the discrepancy between the by-catch limit under Canadian law on the one hand and the results of the international commercial fishery on the other hand by-catch levels of Greenland halibut in the roundnose grenadier directed fishery in the NAFO Subareas 2 and 3 have become an issue of discussions and publications respectively (1, 3,8).

In this article results and experiences gathered by the GDR fleet during the commercial fishery in 1982 and 1983 are to be discussed and analysed in connection with international literature.

Material and Methods

570 hauls of all trawlers of the GDR fleet were listed quantitatively and qualitatively and evaluated absolutely and relatively. All hauls analysed were made in the area of positions 55°27'N to 57°58'N (NAFO Division 2 H) in fishing depths from 400 to 1500 m during the period from November 2nd to December 28th 1983. The single hauls are representative of the fishing situation and were made under conditions of licence in the roundnose grenadier directed fishery. Hauls which were impaired by damage to gear or engine were not taken into consideration.

Biological analyses were made in accordance with general directions and standards of NAFO.

Results

Early in November fish was caught in the area of general positions $55^{\circ}56$ 'N to $57^{\circ}57$ 'N in fishing depths from 470 to 1500 m with the roundnose grenadier directed fishery beeing in the foreground.

This roundnose grenadier directed fishery was concentrated on main depths from 1000 to 1300 m and with the quantitative increase in the portion of Greenland halibut in the course of November it changed more and more into a fishery of Greenland halibut within this roundnose grenadier directed fishery in the area of general positions 55°27'N to 56°30'N in depths from 500 to 1200 m (see tables 1 and 2).

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From the end of November there was a high portion of northern wolffish (Anarhichas latifrons) which considerably influenced the nominal catch. The mean portion of northern wolffish in the nominal catch (nominal catch consisting of northern wolffish and fish for consumption) amounted to 15.7 per cent in the period from the end of November till the end of December. The portion of northern wolffish increased with the depth in the period of end of November to end of December.

The results of the biological analysis are shown in tables 3 and 4.

Discussion

The development reflected in the results gives proof of the general fishing situation in the period under consideration in 1983 in dependence on biological facts. The situation is approximately the same as in 1982 though there was a temporal shifting compared with 1983 which is reflected in the c.p.u.e.

Analysis of GDR fishing activities and investigations respectively in the period November/December 1982 and 1983 permit the conclusion for the NAFO Division 2 H that these investigations have to be considered in the sense of a "permanent station". Characteristic of the results during the periods of investigation in 1982 and 1983 is the spatial separation of fishing grounds and fishing depths of the two main fish species roundnose grenadier and Greenland halibut. According to empiric results achieved by the GDR in previous years in about 1970 and 1978/1979 there was a continuously developing horizontal and vertical separation of the main species until 1983 (5, 6). The reasons for changes in the limits of vertical and horizontal distribution should be sought in continuous changes in the hydrographical regime (cooling) in the Northwest Atlantic (7). This reduction in temperature noted since 1970 resulted in a migration of roundnose grenadier stocks of NAFO Division 2 from zones of optimum temperature of about +4 ^oC (Institut für Hochseefischerei Rostock, unpublished) into greater depths and southern areas in the period November/ December.

In dependence on these environmental conditions the main fishing depths of 600-800 m (1968-1971) changed to 800-1500 m. (1982/1983) with Greenland halibut making up the major portion of the catch composition. In the grenadier fishery in 1970 the portion of Greenland halibut amounted to about 15 per cent (9). Under the present environmental conditions this portion had to change as Greenland halibut prefers optimum temperatures of about \pm 0 °C (depending on the physiological state -0,2 °C to +2.5 °C) (4). Therefore the portion of Greenland halibut in the fishery of roundnose grenadier in depths of about 800-1100 m in the cooler and relatively shallower area can amount to more than 50-95 per cent depending on the physiological state of Greenland halibut.

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A comparison of the results with the fishing situation in NAFO Division 2 H in 1982 and 1983 reveals that the vertical separation of roundnose grenadier and Greenland halibut confirms that the process of cooling of the water regions fished is continuing and possibly intensifying as in 1983 the optimal fishing depths of the two species were more distinctive and in creased vertically (Greenland halibut up to 1200 m, roundnose grenadier up to 1500 m).

The situation in 1983 allows the interpretation that the component of cold water from the Labrador Current has continued to intensify in the area of investigation and reached up to a depth of about 1100 m in the period of investigation (5, 6).

The increasing portion of the typically cold-stenotherm northern wolffish (A. latifrons) in 1982/83 nominal catches during the GDR roundnose grenadier Greenland halibut fishery in the area of investigation may be assessed as an additional indication to the dominance of cold water in the strata up to 1100 m.

Variations in the hydrographic conditions necessarily had to result in variation of conditions of concentration of the main species in the fishery ground and thus variations in the catch composition with biological characteristics of the species investigated becoming effective in connection with changing environmental conditions. In this connection the total catch was additionally favourably influenced with a simultaneous positive trend in the development of c.p.u.e. (table 1) in the area of investigation in November/December. According to CHUMAKOV (2) the Greenland halibut migrates from the coastal zone into areas of Central and Northern Labrador in the fourth quarter of the year and forms overwintering concentrations in troughs and hollows of the slope. This migration ends some time in January. While from mid-December on big prespawning individuals (females) are likely to migrate to the spawning area southern of the Greenland-Canada-ridge the overwintering concentrations consist largely of smaller Greenland halibut in December/January (2).

Fishing in the area of the cited "permanent station" began at the beginning of November in 1982 and 1983 with the roundnose grenadier directed fishery being in the foreground. As to the catch composition this roundnose grenadier directed fishery changed into a fishery of Greenland halibut in the course of November (table 1) as with the migration of Greenland halibut (2) the portion of this species has continously increased from an average of 20 per cent (early in November) to an average of 85 per cent (end of December).

The results of the commercial fishery coincide with the analyses by CHUMAKOV (2). From table 2 it is evident that there can be a temporal shifting between 1982 and 1983 in the migration of halibut which is reflected in the c.p.u.e.

The investigations reveal the trend that early in November the migration of males dominated (table 3). In the course of the period of investigation the portion of female individuals has increased continously with time and depth (see tables 3 and 4). With the growth of the females the mean length and mean weight of the catch increased necessarily. The results in the tables 3 and 4 show that larger, mature individuals - first of all females in the stage of development of maturity (table 5) - increasingly migrate to the fishing area. From mid-December on they migrate to the spawning areas in greater depths and thus are not any longer subject to fishery.

In connection with the migration of mature females from mid-December on a decrease of mean lengths and mean weights of females has been observed and thus a decrease in the total catch too (see tables 1, 3 and 4). The mean lengths and mean weights of males remained approximately unchanged until mid-December, then there was a slightly falling tendency (first indication of migration ?) (see tables 3 and 4).

It seems so that from January on the mature males migrate to the spawning area too and that there is a temporal shifting between the migration of males and females. Proofs are very difficult as ice impairs the commercial fishery and regulations of fishing policy (licences) do not allow a realization of fishery activities.

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Summary

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With an increasing migration of Greenland halibut from nearshore areas into the regions of Central and Northern Labrador the c.p.u.e. has increased and continuously changed with Greenland halibut making up the major portion from November to mid-December. Simultaneously with the increase in length and weight the development of maturity of Greenland halibut as well as the relative and absolute portion of halibut in the c.p.u.e. has increased with the depth in the period of investigation.

It is obvious that there is an advantage over maturity of females which accounts for a decrease of mean lengths and mean weights and a slight decrease of the c.p.u.e. due to the migration of mature females from mid-December on.

The process of cooling of the Northwest Atlantic and consequent changes in conditions of concentration are discussed as reasons for the horizontal and vertical separation of the species Greenland halibut and roundnose grenadier. These variations in environmental parameters in connection with fishery biological facts seem to be responsible for the level and trend of by-catch of Greenland halibut in the roundnose grenadier directed fishery during the commercial fishery in the area of Central and Northern Labrador (NAFO Subareas 2 G. 2 H. 2 J) in the fourth quarter of the year.

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 - Fischverarbeitung Rostock(1968,1970) unveröffentlicht
- <u>Table 1:</u> Development of the main fishing depths, of the nominal catch per fishing day (fish for consumtion), and of the portion of roundnose grenadier and Greenland halibut caught by the GDR-fleet (Type "Zubringertrawler") in the NAFO-Division 2 H in November and December 1983

time	Main depth (m)	catch per fishing day (t)	portion Greenland halibut (%)	of range roundnose grenadier (%)
1 5.11. 610.11. 1115.11. 1620.11. 2125.11.	1130 960 780 630 900	8.3 7.2 6.7 6.1 7.1	23 35 51 67 69	74 62 39 13 19
2630.11.		Licenced co	od fishery	
1 5.12.	870	9.5	73	19
610.12.	850	8.5	83	11
1115.12.	950	14.1	86	9
1620.12.	1060	10.6	77	12
2125.12.	940	10.6	87	7
2628.12.	970	7•7	85	7

<u>Table 2:</u> Development of c.p.u.e. (catch per fishing day, fish for consumtion in t) of the GDR-trawler (Type "Zubringertrawler") during the licenced fishery of roundnose grenadier in the NAFO-Division 2H in 1982 and 1983

	November 1982 1983	December 1982 1983
Catch per fishing day		
- total - Greeland halibut - roundnose grenadier	8.62 5.61 6.21 2.24 1.43 2.14	9.18 7.68 6.83 6.04 1.04 1.00
Catch per hour		
total Greenland halibut roundnose grenadier	0.70 0.56 0.51 0.22 0.12 0.21	0.92 0.77 0.69 0.61 0.10 0.11

Table 3: Development of the sex ratio, of the mean weights and mean lengths of Greenland halibut (NAFO 2 H, Nov./Dec., 1983

			Mean weights (kg)	Mean ler (cm)	ngths L _t
Data	88 (%)	₽₽ (%)	ð and ç	8	ę
$\begin{array}{c} 11.11.\\ 14.11.\\ 16.11.\\ 17.11.\\ 19.11.\\ 20.11.\\ 21.11.\\ 22.11.\\ 4.12.\\ 7.12.\\ 15.12.\\ 23.12.\\ 25.12.\\ 25.12.\\ 26.12.\\ 27.12. \end{array}$	76 52 59 59 59 50 59 50 59 50 59 50 59 50 59	24 37 40 50 50 50 50 50 50 50 50 50 50 50 50 50	1.89 1.44 1.67 1.86 2.60 3.67 3.46 6.36 2.67 3.86 2.62 3.66 2.62 1.65 1.69	58.07 50.43 53.18 54.14 57.26 60.93 57.80 63.20 56.58 57.12 53.37 53.77 54.72 51.38 52.14	60.90 58.16 61.00 63.05 73.46 78.40 73.84 86.39 69.77 76.15 70.17 75.50 68.25 58.83 62.31

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Table 4: Demonstration of the mean length (L.) yes you don't need of Greenland balibut in dependence on the relevant AID of fishing depth and period of investigation proposition of an NAFO Division 2. H) dust out to note by COAN edit of reliancy economics to you don't

	Mean	length	t (cm)	
Stratum	Beginning	of Nov.	mid-Dec. till end	
raph sept	till mid-D	ec.	of Dec.	
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21 8 Or. 0.	the states			
500- 600	53 6 62 1	57 0	Suchies Smallers	
600- 700	57.8 67.2	59.8	Terninens Seeasneor	
700- 800	58.7 74.1	67.5		
900-1000	58.2 77.2	68.8	54.1 63.5 58.3	
1000	21.1 10.24	69.1	53.1,65.3 59.2	
11.0 01.0	13.0 81.0		Colbersy economos	

<u>Table 5:</u> Analysis of the stage of maturity of Greenland halibut in dependence on the strata and the period of investigation (NAFO 2 H, Nov./Dec., 1983)

Stratum	stage of matur	ity o bous ô	1921 188	
epitac	-1 <u>-10.</u> . <u>1</u> .1	1120.11.	2130.11.	110.12.
500- 600	02.000 TO a to	2.1(I-IV)	145 - 133	
00- 700	2.9(II/III/V)	3.1(III/IV)	65-05-55	
00- 800		있는 특성의 이상 실행 소설한 것이. 이상 이상 것같은 가운것은	2.8(11-1V."	2.8(11/11
100-1000	Sin Train Star by make	en san Tanta sun di Bardin di Anna i sun Bardin di San	())•/(<u>111/1</u> 4/)	1414 - 107
) 177	65.931.70.40	1843 .6 7 (1991)	4. 49 51	20.1
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00 - 500	SO OFTSY 2	2.2(11/111 2.5(TT/TTT/TV)		· · · · · · · · · · · · · · · · · · ·
00- 800	1.2. VIII/	2•)(11)141/14, 23-2	3.3(II-IV)	3.5(II-I
00-1000	02.27 . 17.67 8	3 - 1 33.60 1	3.7(III/IV)	185-
		- 1. 2. 6 2	12日 (47) 52	25.
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for instance (III/IV)