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Trawl Survey of Greenland Halibut Stocks in the Northwest Atlantic (Subareas 0 and 2

and Divison 3K) from 23 November 1980 to 30 January 1981

by

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# Abstract

The methods of assessment of Greenland halibut abundance and biomass used during trawl surveys and the most suitable terms for their conducting are considered in the paper. The results of the investigations on absolute abundance and biomass of Greenland halibut obtained on MB-0422 "Nikolai Kononov" from 23 November 1980 to 30 January 1981 in the Canadian zone of the North Atlantic are given.

### Introduction

Until now some methods of determining the status of commercial fish stocks and their reproduction are worked out by the scientists. These methods are different but they are aimed at solving the main problem - organization of rational fishery.

The surveys carried out with the help of calibrated bottom trawls (i.e. with application in calculations of average catchability coefficient of a bottom trawl) are important in studying the status of stocks and in assessing the feasible catch. In recent three-four years particular attention was paid to these problems in PINRO. As a result of long-term investigations carried out on the RV "Persey-III" there were determined catchability coefficients of a trawl relative to cod and Greenland halibut which permitted to obtain an absolute estimate of these fishes abundance and biomass (Chumakov, Serebrov, 1978). Considering the exceptionally vast area of Greenland halibut distribution in the North-West Atlantic (over 1500 miles), separate inhabitation of groups of fishes at different age and length, and also unequal fishing effort in the fishery areas, the trawl survey method is the only correct and most suitable for studying the distribution of the commercial stock with the aim of organization of rational fishery.

It is very important to time the trawl survey since without the knowledge of population structure of the stock, yearly migration cycle of fishes and their behavior during a day it is not possible to obtain comprehensive data on stocks.

These problems were solved in the cruise of MB-O422"Nikolai Kononov" the results of which are set forth briefly in the present paper.

# Material and methods

The trawl survey of Greenland halibut stocks was carried out on MB-0422 "Nikolai Kononov" in the NAFO Divisions 0, 2G, 2H, 2J and 3K. A bottom trawl with the small-meshed (10 mm) netting inserted into the codend was used.

The total volume of biological data collected from catches of trawlings, their number and date are given in Table 1.

In all 161 trawlings were made in the economic zone of Canada from 23 November 1980 to 30 January 1981. The trawlings were made at the depths of 170 to 1220 m. When analysing the biological data we used a scheme of fishing areas in the North-West Atlantic.

Due to marked differences in the length-age composition of halibut inhabiting the shelf and continental slope we singled out these large very typical relief forms in each NAFO statistical subarea and analysed all the biological data. It gave the possibility to approach the more accurate estimate of the commercial stock and development of scientific recommendations on its rational exploitation by the fishing fleet. The analysis of trawl catches was made mainly according to the methods worked out in the 21st cruise of RV "Persey-III" and described in detail by A.K.Chumakov (Chumakov, 1978). 400-500 specimens were measured, dissected and determined by sex; the remainder was analysed on the basis of data obtained. If the catch did not exceed one ton all halibut specimens were dissected.

Using the mean weight of separate length groups the total weight of the catch, mean weight of males and females and their number for each trawling were determined. On the basis of the quantity of Greenland halibut specimens in the catch and catchability coefficient the total number of fishes in the area fished was determined.

The catchability coefficient of the trawl relative to Greenland halibut was defined earlier (Chumakov, Serebrov, 1978) as a result of special investigations carried out in the 17th, 19th and 21st cruises of RV "Persey-III" in 1976 to 1978 and was equal to 12.2%<sup>±</sup> 1.49.

The duration of the trawling was one hour at the speed of the vessel being 3-4 knots. The area of 0.127041 sq.m. was fished in one hour of trawling.

After preliminary analysis of data for each trawling the specific abundance of halibut (the number of spec. per sq.m.) was calculated and according to mean weight of one specimen in the catch the specific biomass (W) was obtained thereupon: W=Q ° P where P - mean weight of one specimen in the catch;

Q - specific abundance of halibut in spec. per sq.m.

Since this area was not stratified the data were collected and analysed over the depths ranges at the interval of 100 m.

Due to hard ice conditions on the shelf the trawl survey was carried out in a limited area, it did not cover all the depths and due to insufficient number of trawl stations made the estimate of halibut abundance and biomass was tentative.

A rather high stability of halibut abundance, their length composition depending on the depths over the shelf and continental slope should be noted. The concentration of the main commercial stock on the continental slope and in deep-water areas of the shelf during the formation of wintering and pre-spawning halibut aggregations gave the possibility to decrease much the number of trawlings per unit area in the shallow regions of the shelf. The experience of the surveys in Divisions 2G, 2H and O showed that the relief was described comparatively poorly on the present commercial charts and in this connection the question arose about accuracy of area computation over the depths ranges on the continental slope. The area between isobaths was computed according to the commercial charts. To avoid in future the systematic errors in area computation which will be undoubtedly due to inaccuracy of isobaths position on the continental slope the data of areas are necessary for each 100 m range of depths taken separately on the shelf and continental slope. The stratification of each NAFO Division into depths at the interval of 100 m is, to our mind, reasonable for autumn/winter as it is adequate to the distribution pattern of the main halibut concentrations in this period.

On date of conducting the trawl survey

In recent years a series of investigations were carried out in PINRO which permitted to fix the date suitable for conducting the trawl survey with the aim of obtaining the most accurate data on the commercial stock of halibut in all the NAFO Divisions.

It is very important that the main commercial stock be available during the trawl survey.

The second requirement for the surveys is the obtaining of reliable data on the dynamics of daily catches depended on vertical migrations of fishes.

It is known that Greenland halibut contrary to most other species of <u>Pleuronectidae</u> is not a bottom but bathypelagic fish. The numerous investigators (Konstantinov, 1968; Chumakov, 1969; Lear, Pitt, 1971; Konstantinov, Podrazhanskaya, 1972 and others) point out that Greenland halibut do not lie on the ground but in search of food they perform great vertical migrations. Their appearance and morphological characters are also indicative of bathypelagic mode of life: oblong body, protective colouring of the "blind side", position of eyes ensuring a double-sided vision.

Nowadays there are detailed data available to judge of the reasons causing vertical migrations of fishes during a day. In fact all the investigators describing the diurnal periodicity of halibut

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catches account this for food migrations only. The main food objects of adult Greenland halibut are bathypelagic invertebrates and fishes (Konstantinov, 1968; Smidt, 1969; Chumakov, 1969).

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The comparison of statistical data on day and night catches of commercial vessels fishing in December and January the wintering concentrations of Greenland halibut in deep-water areas of the shelf in Division 3K and on the continental slope of Labrador and Baffin Island did not show marked differences in catches taken at different time of twenty-four hours.

To obtain more reliable information on the dynamics of catches taken during a day the 24-hour station was made in the second half of November. All the trawlings were carried out in succession on the same course from the fishing buoy at depths 940-950 m. To investigate variations in the length composition and to assess the catch more accurately all halibut specimens were measured and analysed for sex. Samples were taken out of all catches for the quantitative estimate of halibut feeding during twenty-four hours.

As a result of investigations it was established that during the formation of wintering concentrations halibut in fact did not feed and perform vertical migrations since no variations were observed in the catches during twenty-four hours. Neither were the differences found in the length composition of halibut during the whole period of investigations on the 24-hour station.

The period from November to January is the most suitable for conducting the trawl survey in Divisions O, 2G and 2H. By that time Greenland halibut stopped in fact the migration from the coastal zone to far offshore areas forming wintering concentrations in the deep-water troughs of the shelf. The bulk of halibut over 30 cm in length were concentrated on the continental slope at depths 700-1200 m.

According to the information obtained from captains of commercial vessels fishing halibut in Subarea O in the second half of December the decrease in the number of large mature specimens in the catches at depths up to 1200 m was observed which was caused apparently by their migration to the spawning grounds located in the south of the Greenland-Canadian Threshold. Due to this it is very important to complete the trawl survey by 15 December on the continental slope of Baffin Island, North and Central Labrador (0, 2G, 2H).

In the south Divisions (2J, 3K) where mainly immature fishes dwelt the most suitable period for conducting the trawl survey are December and January. In these months small halibut gathered from all shallow areas and formed dense wintering concentrations in the deep-water troughs of the shelf. On the continental slope the wintering concentrations of halibut were distributed at depths 760-1100 m.

In mid-January the South Labrador was covered heavily by ice which made the conducting of the trawl survey difficult especially in its coastal areas. That's why these areas should be investigated first.

# Results

The results of the investigations carried out in the cruise of MB-0422 "Nikolai Kononov" corroborate the earlier drawn conclusion concerning the difference between the length composition of Greenland halibut on the shelf and that on the continental slope (Chu-makov, 1975, 1979).

Fig.1 lists weighted mean values of Greenland halibut length composition obtained by depths ranges on the shelf and continental slope.

It is seen from the Figure that a very great by-catch of young halibut 8 to 30 cm long took place in all NAFO Divisions on the shelf. On the continental slope fishes of this length occurred rarely in catches, mainly in its upper regions. The maximum number of young fish was found in Subarea 0 at depths 300-400 m, in Divisions 2G, 2H at depths 201-300 m and in Division 2J at depths less than 200 m. In Division 3K the depths were not determined due to ice cover in the coastal areas of the shelf. Comparing the distribution of young fish in these areas with the near-bottom temperature we found out that their maximum number was observed on the border of cool coastal waters. Males 18 to 75 cm long and females 18 to 105 cm long were caught on the continental slope.

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The main results of the survey obtained in Subarea O and Divisions 2G, 2H, 2J and 3K are presented respectively in Tables 2-5. The Tables list the ranges of depths on the shelf and continental slope and also their areas. The figures in brackets show the number of trawlings for each range of depths. It is seen from Tables that the quantity and weight of catches varied with the increase of trawling depth. The mean weight of halibut catch per trawling hour in the northern Divisions (O, 2G, 2H, 2J) increased with the depth much faster than the mean number which resulted from the greater mean weight of specimens. In Division 3K large specimens prevailed in the upper regions of the continental slope.

The occurrence of large specimens at small depths of the continental slope was apparently due to hydrological conditions in this period. During the survey in the northern **Divis**ions O, 2G and 2H the cooling of water masses reached 250 m depth while in Division 3K - that of 100-150 m.

The formation of wintering and prespawning concentrations of halibut on the continental slope was in fact completed by the beginning of the trawl survey in Subarea O. Catches of the commercial vessels were indicative of this. From the moment of their operation (2-3 November) to 15 November a gradual increase in catches was observed from 1-2 to 5-8 tons per trawling . As is seen from Table 2 the greatest catches of Greenland halibut in this area were at depths 800 to 1100 m. The main halibut stock (abundance and biomass) in this Subarea was concentrated at the same depths.

On the continental slope of the North and Central Labrador at the depths above 700 m all the catches were more than one ton per hour trawling. The highest specific abundance of halibut (118.7 theorem the specific abundance of halibut (118.7)

The trawl survey in the areas of the South Labrador was carried out from 14 to 27 January. The trawlings covered in fact all the accessible depths of the shelf and continental slope.

As is seen from Table 4 the greatest abundance of halibut (154807 thou. spec.) was observed on the shelf of the area and the greatest biomass (133837 t) - on the continental slope. During the survey in Division 3K the maximum halibut catches were at depths

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700-800 m. The mean number of halibut catch at these depths was 816 specimens per trawling hour and the mean weight - 1704.8 kg.

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Table 6 summarizes the results of the trawl survey of halibut stock on the shelf and continental slope in the Canadian zone of the North Atlantic. There were fluctuations in halibut abundance and biomass on the shelf and continental slope from the south to the north beginning from Division 3K towards Subarea O depending on the size of areas of these Divisions, unequal specific abundance of specimens in them and also different length composition.

The highest abundance and biomass of halibut in Division 3K was on the shelf whereas in northern Divisions - on the continental slope. As we moved northward the abundance and biomass increased naturally on the continental slope and decreased on the shelf.

As is seen from Table 6 the mean weight of one specimen in all areas was considerably higher on the continental slope than that on the shelf. In the area as a whole the mean weight of one halibut specimen on the shelf was 622 g and that on the continental slope -1803 g.

Table 7 lists the abundance of Greenland halibut males and females at different age on the continental slope. The data were obtained through evaluation of length frequencies in age. No information on abundance of fishes at age 3 years was given in the Table due to lack of adequate data in age samples for evaluation in length frequencies.

#### Conclusions

The period from November to January is the most suitable for conducting the trawl survey of halibut stocks in the Canadian zone of the North Atlantic.

According to the data of the trawl survey the total biomass of Greenland halibut was 308537 t on the shelf and 831907 t on the continental slope.

The mean weight of one specimen caught on the shelf is nearly three times as less as that from the continental slope. A high abundance and biomass of Greenland halibut on the continental slope of Baffin Island (O) and Labrador (2G+2H) are indicative of a feasible great increase in the total allowable catch in these areas.

To our mind, it is reasonale to determine the size of total allowable catch separately for each NAFO Division.

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Fig 1. Weighted mean values of Greenland halibut length composition obtained by depths ranges on the shelf (1) and continental slope (2 - males, 3 - females) in NAFO Divisions

Table 1. Summary of numbers of Greenland halibut caught and sampled by divisions

NAFO : Date Divi-: sions:	: Range : Number : : of :of trawl+ :depths,m:ings : : : : :	Number of spec. caught	: Number : Number :of spec.:of spec. :analysed:aged :for sex :
0 23 Nov-08 Dec	370–1100 40	14606	8455 300
2G 20 Dec-28 Dec	260–1200 19	19860	7703 383
2H 27 Dec-13 Jan	190-1320 23	10884	4536 100
2J 06 Jan-27 Jar	170-1180 42	10342	6855 300
3K 17 Jan-30 Jar	250-1120 37	6784	5996 100
Total 23 Nov-30 Jar	170-1320 161	62476	33545 1183

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Table 2. Abundance and biomass of halibut at different depths on the shelf and continental slope of Baffin Island (0)

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Depth, Bepth,	Area, sq.mile	Catch per trawling hour, spec.	Specific Specific abundance, thou spec	Catch per trawling hour, kg	Mean weight of one spe- cimen, g	Absolute abundance, thou.of spec	Biomass, t
<				Shelf	l               		
201-300	7258	ľ			l	l	1
301-400	6570	I05(3)	6,8	11,8	II2	44676	5004
401-500	3489	28(2)	1°8	I5,2	542	6280	3404
501-600	57I0	47(2)	3°0	60,5	I287	I7I30	22046
601-700	2300	I02(2)	9.9	92,6	206	15180	I3768
Z, mean	I8069	74(9)	4,6	41,3	53I	83266	44222
			Continer	ital slope			· · · · · · · · · · · · · · · · · · ·
40I-500	620	9	1	1	, , , , , , , , , , , , , , , , , , ,	2	
201-600	920	43(4)	ດ ໃ	45,4	<b>I056</b>	2576	2720
601-700	I500	69(4)	4,5	70,5	IO2I	6750	6892
701-800	I640	I65(2)	10,6	130°0	788	I7384	I3698
801-900	2890	488(4)	ЭĽ, Л	918,4	I882	91035	I7I327
0001-106	116	(11)669	45 J	I379,I	226I	41086	81062
10011-IOOI	392	59I(6)	38,1	I316,0	2227	I4935	33260
II01-I200	410	ľ			ľ	8	8
I201-I500	I352			8			8
Z, mean	8253	450 (3I)	21°0	885,9	1778	I73766	308959
Total (0)	26322	365 (40)	9,8	695,9	I374	256992	353181

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Biomass		675	6304	1	1	l		6469		I327	647	6865	I6089	54442	95I67	76590	63313	40544	1	354984	361963
Absolute abundance, thou. of specimens		3070	I8432	1	9	1	1	21502		923	I224	3402	22597	30229	62900	3758I	25376	I3725	1	197957	219459
Mean weight of one spe- cimen, g		220	345		l l	1	1	325		I438	529	2018	712	IOBI	I5I3	2038	2495	2954	1	I793	I649
Catch per trawling hour, kg		I,I	I5,2		1		8	II,7	lope	37,4	I6,4	217,9	533,6	I736,6	2783,2	2762,2	I831,2	II46,3	1	I699,5	I378,0
Specific abundance, thou.spec. per sq.mile	Shelf	0°3	°2,8	0		1		L,3	Continental s]	Τ.1	2°0	7,0	46,4	62,2	<b>II8,7</b>	87,4	47,3	25,0		42,5	I0,2
Catch per trawling hour, spe- cimens		5(2)	44(6)		1	1		34(8)	U	26(4)	31(2)	I08(2)	749(2)	964(3)	I840(4)	I355(IO)	734(6)	388(I)	1	896(34)	732(42)
Area, sq.mile		I0232	6583	I450	I520	I759	493	I68I5		543	612	486	487	486	530	430	536	549	1794	4659	21474
Depth,		I00-200	201-300	30I-400	401-500	501-600	601-700	Z, meen		301-400	401-500	501-600	601-700	701-800	006-108	000I-I06	IO0I-I00	II01 -1200	I201-I500	Z, wear	<b>Total</b> (2 G, 2H)

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Depth,	Area, sq. mile	:Catch per :trawling :hour, spe- :cimens	Specific abundanc thou.spe per sq. mile	Catch B, per trawlin hour, kg	: Mean : weight ng of the : specime : g	: Absolute : abundanc : thou, of : speci- : mens	Bio- Pinass, t
			Sł	helf			·
< 200	7672	172(2)	II,I	21,2	123	85II3	I0469
201-300	8972	25(7)	I,6	I4,7	588	I4355	8440
301-400	1879	69(2)	3,8	4I,8	606	7140	4327
401-500	1273	294(I)	19,0	267,8	911	24187	22034
501-600	920	405(I)	26,I	380,I	938	24012	22523
Σ, mean	20716	104(13)	7,5	67,4	438	I54807	67793
			Contine	ental slo	pe		
301-400	771	II(8)	0,7	7,5	682	539	368
401-500	635	17(4)	I,I	22,I	I300	698	907
50I <b>-</b> 600	380	IOI(3)	6,5	168,2	I665	2356	3923
601-700	384	492(2)	3I,7	863,5	1755	12172	21362
701-800	370	816(3)	52,6	1704,8	2088	19462	40637
801-900	374	591(6)	38,I	II84,8	2005	I4249	28569
901-1000	379	708(2)	45,7	1353,5	1912	I7320	33116
1001-1100	294	I26(I)	8,I	261,3	2074	2389	4955
II0I-I500	I060	9	8205	1 1919	true	ara	cu
$\Sigma$ , mean	3587	310(29)	19,3	605,9	1934	69185	133837
Total (2J)	24303	246(42)	9,2	439,2	900	223992	201630

Table 4. Abundance and biomass of halibut at different depths on the shelf continental slope off South Labrador (2J)

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Table 5. Abundance and biomass of halibut at different depths on the shelf and continental slope in Div. 3K

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Depth, m	Area, sq. mile	Catch & per & trawling hour, } speci-	Specific : abundance thou.spec ber sq. mile	Catch per traw ling hour, kg	Mean - weight a : of one : : speci- : : men, g :	Absolute bundance thou.of speci- mens	Biomass,
			Sh	elf		· · ·	
< 200	2503	<u>Guno</u>	-		<b>670</b>	enti	aro
201-300	12216	I8(3)	I,2	16,5	917	I4659	13442
301-400	8672	I35(4)	8,7	77,8	576	75446	43457
401-500	3105	731(4)	47,I	663,3	907	I46245	I32644
501-600	378		920	4780	-	82	-Texts
$\sum$ , mean	23993	320(II)	9,8	273,9	802	236350	189543
			Contin	iental slo	pe		n de la secondario. Notas estas
401-500	455	I6(6)	I,0	33,3	2081	455	947
50I-600	397	65(6)	4,2	151,0	2323	1667	3872
601-700	366	125(4)	8,I	276,7	2214	2964	6562
701-800	451	I9I(2)	12,3	241,0	I262	5547	7000
801-900	530	I09(5)	7,0	194,5	1784	3710	6618
901-100	0 536	95(I)	6,I	154,0	1621	3269	5299
IO0I-IIC	0 590	72(2)	4,6	101,6	1411	2714	3829
1101-120	0 600	-	<b>ena</b>	6000	8040	enn .	
1201-150	0 1514	-	840	deta	2000	eirro	<b>8</b> 000
$\sum$ ,mean	3325	83(26)	6,I	154,8	1679	20326	34127
Total (3K)	27318	3 153(37)	9,4	190,2	871	256676	223670

Table 6. Main results of the trawl survey for halibut stock on the shelf and continental slope in Div. 0, 2G + 2H, 2J and 3K

Division	Area	Area surveyed, sq.mile	Per cent of area surveyed	Specific abun- W dance, o thou. s f spec er sq. mile	Mean reight of one pecim. g	Abundance thou. of specim.	Biomass, t
0	Shelf	I8069	66,7	4,6	53I	83266	44222
	Slope	8253	77,6	21,0	1778	173766	30 <i>8</i> 959
2 <b>ઉ+</b>	Shelf	I68I5	76,3	I,3	325	2I502	6979
ટ્રેમ	Slope	4659	77,6	42,5	1793	I97957	354984
2J	Shelf	20716	100	7,5	438	I54807	67793
	Slope	3587	72,7	19,3	1934	69185	I33837
ЗК	Shelf	23993	89,3	9,8	802	236350	189543
	Slope	3325	77,2	6,1	1679	20326	34127
Total	Shelf	79593	84,2	6,2	622	495885	308537
	Slope	19824	6I,I	23,3	1803	461234	831907

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م همه همه ما سه	:		۵۰ عبر میں میں ۱	<b>2</b> G + 2H	2	J °	2000 - 2000 - 2000 6 9	3K
Age	Males	Females	Males	: Fenales	Males	: Females	Males	Females
4	7892	4968	8532	3766	II52	309	370	II4
5	9818	<b>4</b> 65I	13367	II228	3000	I680	1216	1076
6	I2403	12302	I3879	9015	56II	2417	1952	1616
7	I5 <b>3</b> 48	9286	26152	I6860	I3683	609I	3914	3297
8	23563	II786	I437I	I0837	7419	4312	I464	II54
9	20095	7017	I0568	16764	3285	5675	577	1008
IO	7750	7786	4842	I0989	IIO3	3408	I82	505
II	2847	5157	I880	8973	255	3077	36	532
12	680	4494	797	6190	65	2330	4	472
13	94	2307	83	3890	7	I883		356
14	25	974		1702		796		I85
I5		435		902		375		IIO
16		<b>I9</b> 2		786		305		88
17		193		44I		I38		37
18		26		I72		72		II
I9		8		I22		16		12
Total	I005I5	715.82	94471	I02637	35580	32884	9715	10573

Table 7. Numbers of male and female Greenland halibut by age groups on the continental slope in NAFO Divisions (thousands of speciments).

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