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Results of the Polish fishing survey of Greenland halibut (*Reinhardtius hippoglossoides*) in the Svalbard Protection Zone (ICES IIb) in April 2007

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1. Introduction

The Polish bottom fishing survey on Greenland halibut (*Reinhardtius hippoglossoides*) was conducted in April 2007 in the Svalbard Protection Zone (ICES IIb) and was the continuation of the Polish survey carried out in October 2006. The investigations were conducted based on the Polish application to and permission granted by the Directorate of Fisheries in Bergen, Norway. The Polish operating authority was the Sea Fisheries Institute in Gdynia (MIR) in cooperation with the North Atlantic Producers Organization Ltd. (PAOP sp. z o.o.).

The main objectives of the survey were:

- to determine the biological structure of Greenland halibut (*Reinhardtius hippoglossoides*);
- to determine the distribution, density, and standing biomass of Greenland halibut in the survey area;
- to determine the species composition of catches;
- to determine the incidental mortality of birds and mammals.

2. Materials and Methods

The surveys took place from 1 to 12 April 2007 and were conducted at a depth range of 500 to 1200 meters on the west slope of Bear Island and Svalbard covering the area between latitude 73^{o} 30'N and 76^{o} 30'N. The fishing vessel POLONUS (Fig. 1), which deployed a bottom trawl, was engaged in the survey. The research team comprised of two MIR scientists collected fisheries and biological data aboard the vessel. Samples were taken at three depth strata – shallower 500-699 m (S) deeper 700-999 m (D), and deepest 1000-1200 m (DD). The depth strata were divided into parallel sections of 10 nautical miles which created squares limited by depth strata. The surface was divided into a total of 54 designated squares (Fig. 2). The surface of each square was calculated using the ArcGIS program. Calculations were made for each square between isobaths obtained from data on the International Bathymetric Chart of the Arctic Ocean (IBCAO) and the SRTM30_Plus model (Shuttle Radar Topography Mission).

Fifty three hauls were performed during 12 effective fishing days. At least one haul was carried out in each square of shallower and deeper strata. Since it was determined that the abundance of Greenland halibut in the deepest strata was very scarce, one haul covered two squares with the exception of square DD-1 where there

was no haul. The density of fish in this square was calculated as the same as that in square DD-2. The positions of starting the hauls and directions of trawling are presented in Figure 3.The mean speed of vessel during trawling was about 3.1 knots.

The fishing data recorded for each haul included the following: date, time and position of start and end of the tow, duration and depth of tow, vessel speed, and catch data. The temperature of the water at depth of trawling was also recorded. Each haul was sorted by species to determine the species composition of catches. The bycatch species were separated from the Greenland halibut and then weighed, counted, and recorded; this provided information on the species composition of the catches by number and weight.

Samples of Greenland halibut, the target species, were collected for length measurements and biological analysis. The fish for length measurement (total length) were collected randomly from the conveyer and measured rounding down to the nearest centimeter. In total, 6085 specimens of Greenland halibut segregated by sex were measured, and 262 fish were taken for biological analysis. Each analysis included recording data concerning length, weight (to the nearest 10 g) sex, gonad maturity, and fullness of stomach. Otoliths were collected for later age determination. Whole otoliths were read in water under a microscope with reflected light. The sex proportion was determined based on the fish collected for length measurements, while gonads maturity was based on the examination of 468 specimens (additional sample was taken). The gonad maturity stage was determined according to a 6-grade scale: immature (I), early maturing-A (II), maturing-B (III), late maturing-C (IV), spawning (V) and resting (VI). (Ridget, F., J. Boje. 1989, Fishery and some biological aspects of Greenland halibut (*Reinhardtius hippoglossoides*) in West Greenland waters. NAFO Sci. Coun. Studies 13: 41-52.).

The relationship between body length and weight was calculated using the formula $W = k * L^n$

where:
W – weight of fish (g);
L – length of fish (cm);
k and n – constant coefficients.

Tagged Greenland halibut and the incidental mortality of birds and mammals were also recorded.

The CPUE was calculated for each square to determine the distribution of Greenland halibut in the survey area. Catches from each haul were standardized to one hour of trawling and to one square kilometer of trawling surface according to the following formulae:

1. $$CPUE = \frac{W}{t}$$

2. $$CPUE = \frac{W}{D \times p}$$

where:
CPUE – catch per unit effort (1- kg/h and 2 - kg/km^2);
W – weight of catch (kg);
t – duration of trawl (hours);
D – towing distance (km);
p – horizontal opening of the net (km).

The area swept by the trawl was defined as the distance between the wings multiplied by the towed distance. It was assumed that the catchability coefficient for Greenland halibut was 1; therefore, the total effect of escapement of fish was equal to 0. The mean catch rates (t/hr) and density (t/km^2) were calculated for each square.

The "swept area" method was also used to determine the biomass of Greenland halibut at depth strata and in the total survey area according to the formula:

$$B = \frac{CPUE \times A}{q}$$

where:

B - biomass (tons);
CPUE - catch per unit effort (t/km^2);
A – area of survey (km^2);
q – catchability coefficient.

3. Vessel and gear specifications

3. 1. Characteristics of the vessel
Name: **POLONUS GDY-36**
Nationality: **POLISH**
Registration port and number: **GDYNIA, GDY-36**

Overall length: (in meters) **60.33**
Maximum draught: (in meters) **7.00**
GRT: **1805**
Net tonnage: **563**
Propulsion e.g. diesel/steam: **DIESEL**
Call sign: **SNHE**

3. 2. Description of gear
Bottom trawl type – BACALO 630
Float rope: 70.2 m
Ground rope: 39.8 m
Vertical opening of trawl: 5 m
Average net opening between wings: 14.0 m

NET
Bag of coral 30 m with 140 mm mesh size
Codend of nylon with 40 mm mesh size
GROUND GEAR:
Central section 39.8 m with 21" rubber discs
DOORS:
Type of doors - INJECTOR 9.5 m²
Weight of doors - 4000 kg
FLOATS :
Number of floats - 210
Float diameter - 250 mm
LEGS - 60/75 m
BRIDLES – 140 m
The diagram of the net used in the fishing survey is presented in Figure 4

4. Results

4. 1. Species composition of catches

A total 203.4 tons of fish were caught during the fishing survey. Greenland halibut dominated the catches by weight and contributed nearly 98.3% of the total catch (Table 1). Bycatch was only 3467 kg and consisted of 16 fish species. The most abundant species were redfish (*Sebastes mentella*) – 1760 kg and cod (*Gadus morhua*) – 1302 kg. All 16 bycatch species with a weight of 2815 kg were noted in the shallower strata (500-699m), 13 species with a weight of 585 kg were noted in the deeper strata (700-999m), and only 5 species with a weight of 67 kg were noted

in the deepest strata (1000-1200m). The species composition of catches by depth strata in numbers and weights of specimens is presented in Table 2.

The *S. mentella*, which was most numerous bycatch species, consisted of fish measuring from 30 to 44cm in length, while more than 80% of these fish were between 33 to 37cm.

Neither sea birds nor mammals were noted in the net during the cruise.

4. 2. Catch rates

A total of 54 squares were designated in the trawl survey area at the three depth strata between the latitudes of 73^{o} 30'N and 76^{o} 30'N. The total surface of the survey area was calculated at 7844 km^2 of which 2078 km^2 was at the shallower depth strata, 3346 km^2 at the deeper strata, and 2420 km^2 at the deepest strata. The average catch rate of Greenland halibut throughout the survey area was 1.34 t/hr. In the shallower and deeper strata the catch rates were nearly similar (1.50 and 1.63 t/hr, respectively), but in the deepest strata the catch rate was very low at just 0.09 t/h. There were also significant differences in catch rates among the squares. Higher catch rates were observed in the vicinity of Bear Island in the shallower and deeper strata. The lowest CPUE was observed in the northern part of the survey area. Table 3 presents the catch of Greenland halibut and catch rates in kg per hour of trawling calculated for each square.

4. 3. Biological characteristics of Greenland halibut

Length measurements of fish, segregated by sex, were collected from 6085 halibut specimens. The length of the halibut ranged from 28 to 98cm TL at a mean length of 50.2 cm. The length compositions at the three depth strata are presented in Figure 5 and the length distribution of fish (males and females) in each sampled haul is presented in Annex 1 (available only in the Report sent to the Institute of Marine Research, Bergen, Norway). The length distribution differed among the depths and fish length decreased with depth. In the shallower waters to 700m the mean length was 51.7cm, in the deeper waters it was 48.6cm, while in the deepest strata the mean length of halibut was the smallest at 46.9cm. Mean lengths of Greenland halibut sampled in April 2007 by depth strata and sex are presented in Table 4.

It was also noted that the halibut length distribution depended on water temperature at towing depth. This was indicated by the share of larger fishes (older) increasing in catches performed where water temperature was higher (Fig. 6).

Otoliths collected during biological analysis from 262 Greenland halibut specimens were used for age determinations. The age composition of catches was calculated from an age-length key and is presented in Figure 7. Males dominated the younger age groups but Greenland halibut from 10 years old were mostly females and the fish after 13 years old were all females (Fig. 7a). Three generation 1999, 2000 and 2001 dominated during the survey (Fig. 7b). The determinate age of Greenland halibut collected during the survey is included in Annex 2 (available only in the Report sent to the Institute of Marine Research, Bergen, Norway).

The sex ratio was calculated from 6085 specimens during length measurements. Males dominated in the catches and comprised nearly 58% of the sampled fish. The share of males in the stock was much higher in the shallower and deeper strata (65.3 and 63.4%, respectively) than in the deepest strata where males comprised 51.3% (Fig. 5).

Maturity stage data were collected for 468 halibut specimens. Observations of gonad maturity indicated that most males (nearly 55%) had gonads in the maturing stage while a decided part of fish was spawning (nearly 27%). Most of the females were in pre-spawning stages and their gonads were in maturing and late maturing stages (23 and 33%, respectively). Only 8% of females were actively spawning (Table 5).

Weight was recorded for 262 halibut specimens. Greenland halibut attained weights ranging from 160g to 9200g. The mean weight of the sampled males was 937g while that of females was 2374g. The weight of fish at length classes is presented in Table 6. The relationship between body length and weight for the sexes combined was calculated as $W_{(g)} = 0.0039 * TL_{(cm)}^{3.2031}$. The length-weight relationship for males and females are presented in Figure 8.

The examination of halibut stomachs indicated that feeding was very weak. About 80% of the fish had empty stomachs (Table 7). While no detailed examinations of food composition were conducted, undigested fish, squids, and shrimps dominated in the stomachs.

All biological data, including age of Greenland halibut collected during the cruise are presented in Annex 2 (available only in the Report sent to the Institute of Marine Research, Bergen, Norway).

4. 4. Density, abundance, and biomass of Greenland halibut in the survey area

The density of Greenland halibut in kg/km^2 for each square and depth strata was estimated with the swept area method. The results presented in Table 8 show the density of Greenland halibut calculated for each square in the depth strata. Results indicated that density was very low in the deepest strata (1.1 t/km^2) while in the deeper strata it was 20.4 t/km^2 and a little less in shallower strata (18.6 t/km^2). Relative and stable high density of fish was observed mainly between the latitudes 74^{o}00' and 75^{o}50'N in the deeper and shallower strata. The highest value of Greenland halibut density was calculated for the squares in the vicinity of Bear Island. Density is presented graphically in Figure 9.

The analysis of the distribution of the bottom water temperature in the survey area indicates that Greenland halibut prefer a water temperature of about 2^{o}C where the density of walleye pollock stock was higher (Fig. 10). The lower density in the southern part of survey area despite higher water temperature is probably caused by very weak migration of Greenland halibut farther to the south.

The total standing biomass of Greenland halibut in the survey area calculated as the sum of biomass in each square was estimated to be 99.0 thousand tons, of this 61.6% of the fish inhabited the deeper depth strata (700-1000m) during the time of the survey (Table 8).

4. 5. Other information

Five tagged specimens of Greenland halibut were caught during the survey. Unfortunately, four of them had been headed before the tags were noted, so it was difficult to obtain a full biological description of these fishes. A protocol was prepared for each of the tagged fish, and all the available fishery and biological data were included. Five tags of the fish with protocols were sent to the Institute of Marine Research in Bergen, Norway on June 21, 2007. The protocols are also included in Annex 3. The both otoliths of the Greenland halibut TAG: NO. 20684; 5817 BERGEN are attached to protocol 1. The age of the fish was determinate as 7 years.

TABLES

Table 1. Catch by species in Polish fishing survey in ICES IIb Area in April 2007

Common name	Scientific name	Total catch	Promille by catch
Greenland halibut	*Reinhardtius hippoglossoides*	199 975,05	982.960
Redfish	*Sebastes mentella*	1 760,83	8.655
Cod	*Gadus morhua*	1 302,00	6.400
Spinetail ray	*Bathraja spinacauda*	180,22	0.886
Esmarks eelpout	*Lycodes esmarki*	67,72	0.333
Roughhead granadier	*Macrourus berglax*	50,84	0.250
Spotted wolffish	*Anarhichas minor*	47,59	0.234
Round ray	*Raja fyllae*	15,10	0.074
Blue whiting	*Micromesistius potassou*	10,80	0.053
Haddock	*Melanogrammus aeglefinus*	9,74	0.048
Wolf-fish	*Anarhichas lupus*	9,40	0.046
Lumpsucker	*Cyclopterus lumpus*	5,67	0.028
Saithe	*Pollachius virens*	2,19	0.011
Argentina	*Argentina silus*	2,15	0.011
Dab	*Limanda limanda*	1,58	0.008
Arctic rockling	*Onagadus sp.*	0,51	0.003
Arctic sculpin	*Cottunculus microps*	0,22	0.001
Total		**203 441.61**	

Table 2. Species composition of catches by depth strata, number and weight of specimens in April 2007

Common name	Scientific name	Subarea S (500-699m)			Subarea D (700-999m)			Subarea DD (1000-1200m)			Research area			
		No of caught	Weight of fish (kg)	Mean weight of fish (kg)	No of caught	Weight of fish (kg)	Mean weight of fish (kg)	No of caught	Weight of fish (kg)	Mean weight of fish (kg)	No of caught	Range of length (cm)	Weight of fish (kg)	Mean weight of fish (kg)
Greenland halibut	*Reinhardtius hippoglossoides*	91 297	124 735.95	1.37	65 792	73 211.10	1.11	1 987	2 028.00	1.02	159 076	28 - 98	199 975.05	1.26
Redfish	*Sebastes mentella*	2 805	1 515.13	0.54	455	245.70	0.54				3 260	30 - 44	1 760.83	0.54
Cod	*Gadus morhua*	346	1 009.05	2.92	89	260.40	2.93	11	32.55	2.96	446	41 - 108	1 302.00	2.92
Spinetail ray	*Bathraja spinacauda*	50	128.96	2.58	10	23.20	2.32	15	28.06	1.87	75	25 - 75	180.22	2.40
Esmarks eelpout	*Lycodes esmarki*	109	61.83	0.57	10	5.33	0.53	1	0.57	0.57	120	28 - 65	67.72	0.56
Roughhead granadier	*Macrourus berglax*	8	43.97	5.50	4	4.55	1.14	3	2.32	0.77	15	40 - 82	50.84	3.39
Spotted wolffish	*Anarhichas minor*	7	10.58	1.51	2	37.01	18.51				9	59 - 73	47.59	5.29
Round ray	*Raja fyllae*	16	13.41	0.84	2	1.70	0.85				18	30 - 55	15.10	0.84
Blue whiting	*Micromesistius potassou*	58	7.93	0.14	21	2.87	0.14				79	24 - 34	10.80	0.14
Haddock	*Melanogrammus aeglefinus*	4	6.55	1.64	2	3.19	1.60				6	48 - 63	9.74	1.62
Wolf-fish	*Anarhichas lupus*	4	9.40	2.35							4	60 - 120	9.40	2.35
Lumpsucker	*Cyclopterus lumpus*	2	2.30	1.15				1	3.37	3.37	3	30 - 41	5.67	1.89
Saithe	*Pollachius virens*	2	2.19	1.10							2	51 - 52	2.19	1.10
Argentina	*Argentina silus*	5	1.90	0.38	1	0.25	0.25				6	36 - 38	2.15	0.36
Dab	*Limanda limanda*	8	1.42	0.18	1	0.16	0.16				9	23 - 32	1.58	0.18
Arctic rockling	*Onagadus sp.*	1	0.21	0.21	1	0.30	0.30				2	26 - 33	0.51	0.25
Arctic sculpin	*Cottunculus microps*	2	0.10	0.05	1	0.12	0.12				3	13 - 17	0.22	0.07
Total		94 724	127 550.85		66 391	73 795.87		2 018	2 094.87		163 133		203 441.60	

Table 3. Catch and CPUE of Greenland halibut by depth strata and squares in April 2007

S	Square	No of hauls	Catch (kg)	CPUE (kg/h)	D	Square	No of hauls	Catch (kg)	CPUE (kg/h)	DD	Square	No of hauls	Catch (kg)	CPUE (kg/h)
Shallower depth strata (500-699m)	s-01	2	3 313.0	0.925	Deeper depth strata (700-999m)	d-01	1	2 272,4	1.136	Deepest depth strata (1000-1200m)	dd-01			0.131
	s-02	1	6 179.1	1.399		d-02	1	4 836,0	1.707		dd-02	1	273,0	0.131
	s-03	1	4 407.0	1.322		d-03	1	4 502,0	1.125		dd-03 & dd-04	1	273,0	0.131
	s-04	1	2 925.0	1.064		d-04	1	5 070,0	1.844					
	s-05	1	4 364.1	2.182		d-05	1	8 970,0	2.990		dd-05 & dd-06	1	780,0	0.425
	s-06	2	10 007.1	1.430		d-06	1	3 861,0	1.782					
	s-07	2	20 724.0	2.391		d-07	1	5 224,4	1.741		dd-07 & dd-08	1	78,0	0.028
	s-08	2	10 842.0	1.859		d-08	1	8 619,0	2.298					
	s-09	1	8 853.0	1.660		d-09	1	6 880,2	2.231		dd-09 & dd-10	1	39,0	0.015
	s-10	3	15 039.1	1.111		d-10	1	1 599,0	0.872					
	s-11	2	14 513.1	1.371		d-11	1	7 249,7	1.706		dd-11 & dd-12	1	273,0	0.113
	s-12	2	11 284.5	2.006		d-12	1	4 420,7	1.263					
	s-13	1	3 900.0	1.337		d-13	1	2 808,0	2.407		dd-13 & dd-14	1	39,0	0.014
	s-14	1	4 134.0	1.711		d-14	1	2 271,0	1.817					
	s-15	1	1 287.0	0.908		d-15	1	1 911,0	0.740		dd-15 & dd-16	1	156,0	0.069
	s-16	1	1 404.0	1.203		d-16	1	572,0	0.458					
	s-17	1	1 326.0	1.061		d-17	1	858,0	0.735		dd-17 & dd-18	1	117,0	0.044
	s-18	1	234.0	0.187		d-18	1	1 287,0	1.030					
	Total	26	**124 736.0**	1.501		Total	18	**73 211.1**	1.633		Total	9	**2 028,0**	0.094

Table 4. Mean length of Greenland halibut sampled in April 2007 by depth strata

Sex	Subarea S (500-699m)	Subarea D (700-999m)	Subarea DD (1000-1200m)	Research area
Males	48,0	46,6	44,6	47,2
Females	55,6	52,6	51,0	54,4
Males and females	51,7	48,6	46,9	50,2

Table 5. Maturity stages of Greenland halibut sampled in April 2007

Sex		Maturity stages						Total
		I	II	III	IV	V	VI	
Males	N	1	26	125	15	61		228
	%	*0,4*	*11,4*	*54,8*	*6,6*	*26,8*	*0,0*	
Females	N		85	56	79	19	1	240
	%	*0,0*	*35,4*	*23,3*	*32,9*	*7,9*	*0,4*	
Total	N	1	111	181	94	80	1	468
	%	*0,2*	*23,7*	*38,7*	*20,1*	*17,1*	*0,2*	

Table 6. Mean weight of Greenland halibut in length classes in April 2007

Length classes (cm)	Males		Females		Males and Females	
	n	Mean weight (g)	n	Mean weight (g)	n	Mean weight (g)
28	1	160,0			1	160,0
30	1	205,0			1	205,0
32	1	255,0			1	255,0
33	2	267,5	1	250,0	3	261,7
34	4	325,0	2	277,5	6	309,2
35	3	345,0	4	327,5	7	335,0
36	3	395,0	1	400,0	4	396,3
37	4	402,5	3	398,3	7	400,7
38	2	412,5	2	487,5	4	450,0
39	5	524,0	2	472,5	7	509,3
40	3	508,3	2	567,5	5	532,0
41	5	577,0	3	588,3	8	581,3
42	4	598,8	3	625,0	7	610,0
43	4	672,5	2	655,0	6	666,7
44	4	655,0	3	695,0	7	672,1
45	7	767,1	3	875,0	10	799,5
46	5	868,0	3	863,3	8	866,3
47	3	866,7	3	996,7	6	931,7
48	4	925,0	3	983,3	7	950,0
49	3	968,3	3	1063,3	6	1015,8
50	11	1100,0	3	1096,7	14	1099,3
51	4	1172,5	4	1261,3	8	1216,9
52	5	1137,0	4	1286,3	9	1203,3
53	2	1220,0	3	1388,3	5	1321,0
54	5	1345,0	4	1465,0	9	1398,3
55	6	1355,8	2	1475,0	8	1385,6
56	4	1541,3	3	1555,0	7	1547,1
57	1	1850,0	6	1783,3	7	1792,9
58	4	1597,5	3	1893,3	7	1724,3
59	2	1762,5	3	1840,0	5	1809,0
60	2	1915,0	2	2005,0	4	1960,0
61	2	1980,0	3	2023,3	5	2006,0
62	1	2090,0	4	2225,0	5	2198,0
63	1	2200,0	5	2225,0	6	2220,8
64			2	2265,0	2	2265,0
65			4	2265,0	4	2265,0
66			4	2643,8	4	2643,8
67			1	2505,0	1	2505,0
68			2	2605,0	2	2605,0
69			1	2880,0	1	2880,0
70			2	3442,5	2	3442,5
71			3	3333,3	3	3333,3
72			2	3330,0	2	3330,0
73			2	3742,5	2	3742,5
74			2	3215,0	2	3215,0
75			2	4035,0	2	4035,0
77			3	3763,3	3	3763,3
78			1	4470,0	1	4470,0
79			1	4660,0	1	4660,0
80			2	4765,0	2	4765,0
82			1	5230,0	1	5230,0
83			2	5830,0	2	5830,0
84			2	5650,0	2	5650,0
86			1	6090,0	1	6090,0
87			1	6320,0	1	6320,0
88			1	6550,0	1	6550,0
89			3	6910,0	3	6910,0
90			4	6971,3	4	6971,3
92			1	7520,0	1	7520,0
93			1	7800,0	1	7800,0
98			1	9200,0	1	9200,0
Mean weight (g)	**118**	**936.8**	**144**	**2373.5**	**262**	**1726.5**

Table 7. Fullness of Greenland halibut stomachs in April 2007

Sex		Fullness of halibut stomachs					Total
		0	**1**	**2**	**3**	**4**	
Males	N	92	8	6	6	6	118
	%	*78,0*	*6,8*	*5,1*	*5,1*	*5,1*	
Females	N	115	7	9	6	7	144
	%	*79,9*	*4,9*	*6,3*	*4,2*	*4,9*	
Total	N	207	15	15	12	13	262
	%	*79,0*	*5,7*	*5,7*	*4,6*	*5,0*	

Table 8. Biomass of Greenland halibut in research area by depth strata and squares in April 2007.

Subarea	Density (t/km^2)	Biomass (t)	Subarea	Density (t/km^2)	Biomass (t)	Subarea	Density (t/km^2)	Biomass (t)
S-01	10.5	1 754	**D-01**	12.9	4 594	**DD-01**	1.3	235
S-02	16.6	2 252	**D-02**	18.8	5 109	**DD-02**	1.3	231
S-03	18.2	2 060	**D-03**	17.4	2 340	**DD-03**	1.5	164
S-04	12.4	1 280	**D-04**	20.9	3 308	**DD-04**	1.5	126
S-05	25.5	1 569	**D-05**	34.9	4 026	**DD-05**	5.0	418
S-06	18.1	964	**D-06**	20.8	1 719	**DD-06**	5.0	354
S-07	32.7	2 803	**D-07**	20.4	2 434	**DD-07**	0.3	38
S-08	26.1	3 256	**D-08**	34.1	4 912	**DD-08**	0.3	26
S-09	21.6	2 400	**D-09**	28.7	4 810	**DD-09**	0.2	19
S-10	15.8	2 067	**D-10**	10.2	1 940	**DD-10**	0.2	28
S-11	18.1	2 396	**D-11**	28.6	5 356	**DD-11**	1.3	210
S-12	26.9	3 887	**D-12**	17.4	3 353	**DD-12**	1.3	212
S-13	15.6	2 786	**D-13**	27.3	6 464	**DD-13**	0.2	27
S-14	19.4	1 864	**D-14**	20.6	3 823	**DD-14**	0.2	22
S-15	10.3	933	**D-15**	8.4	1 513	**DD-15**	0.8	111
S-16	13.7	1 397	**D-16**	5.2	973	**DD-16**	0.8	128
S-17	12.0	1 520	**D-17**	8.3	1 854	**DD-17**	0.5	72
S-18	2.1	259	**D-18**	11.7	2 492	**DD-18**	0.5	93
Total S	**18.5**	**35 447**	**Total D**	**20.4**	**61 019**	**Total DD**	**1.1**	**2 514**

Figure 1. Polish fishing vessel "Polonus"

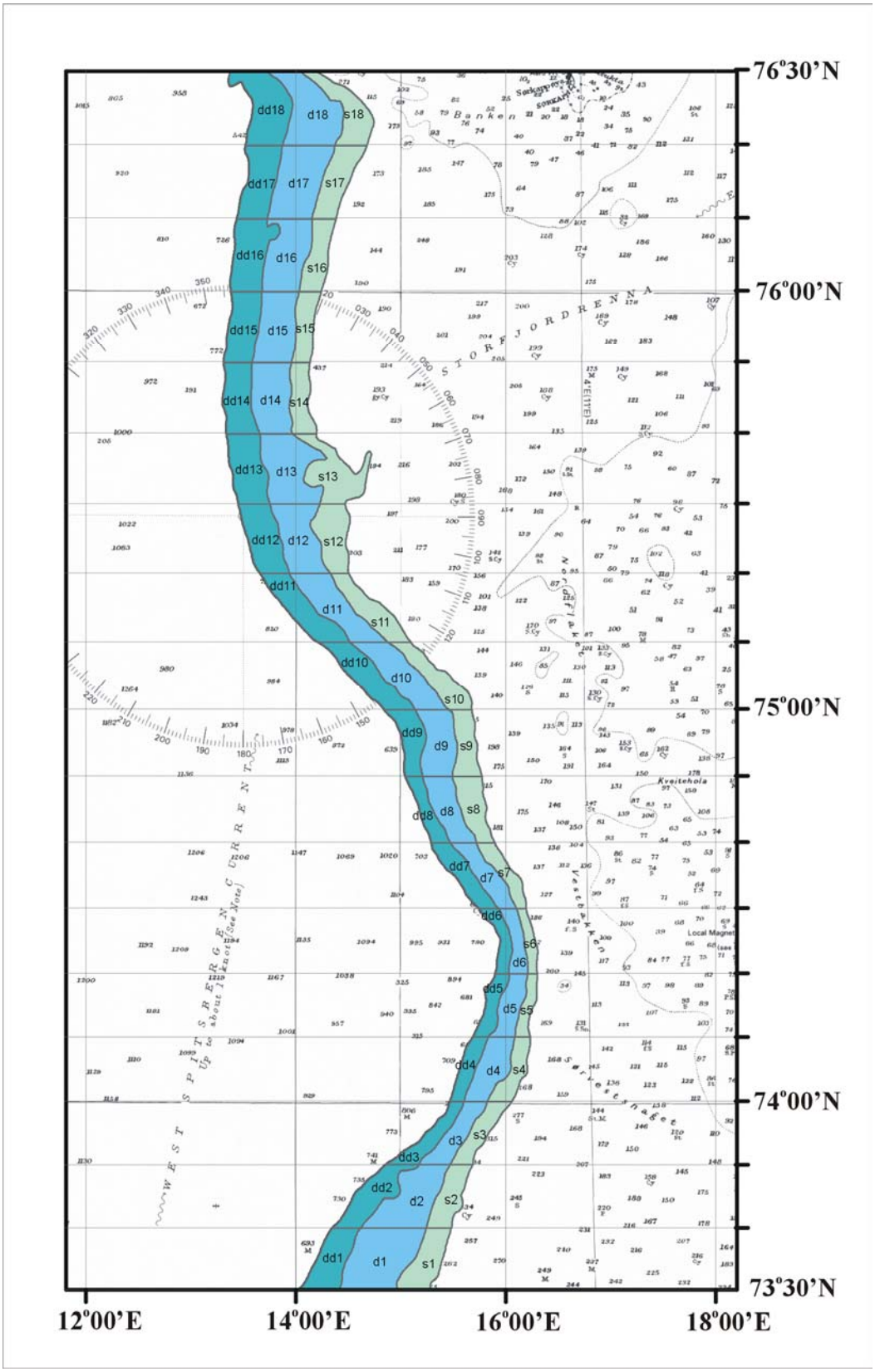


Figure 2. The depth strata and squares in Polish fishing survey area in April 2007

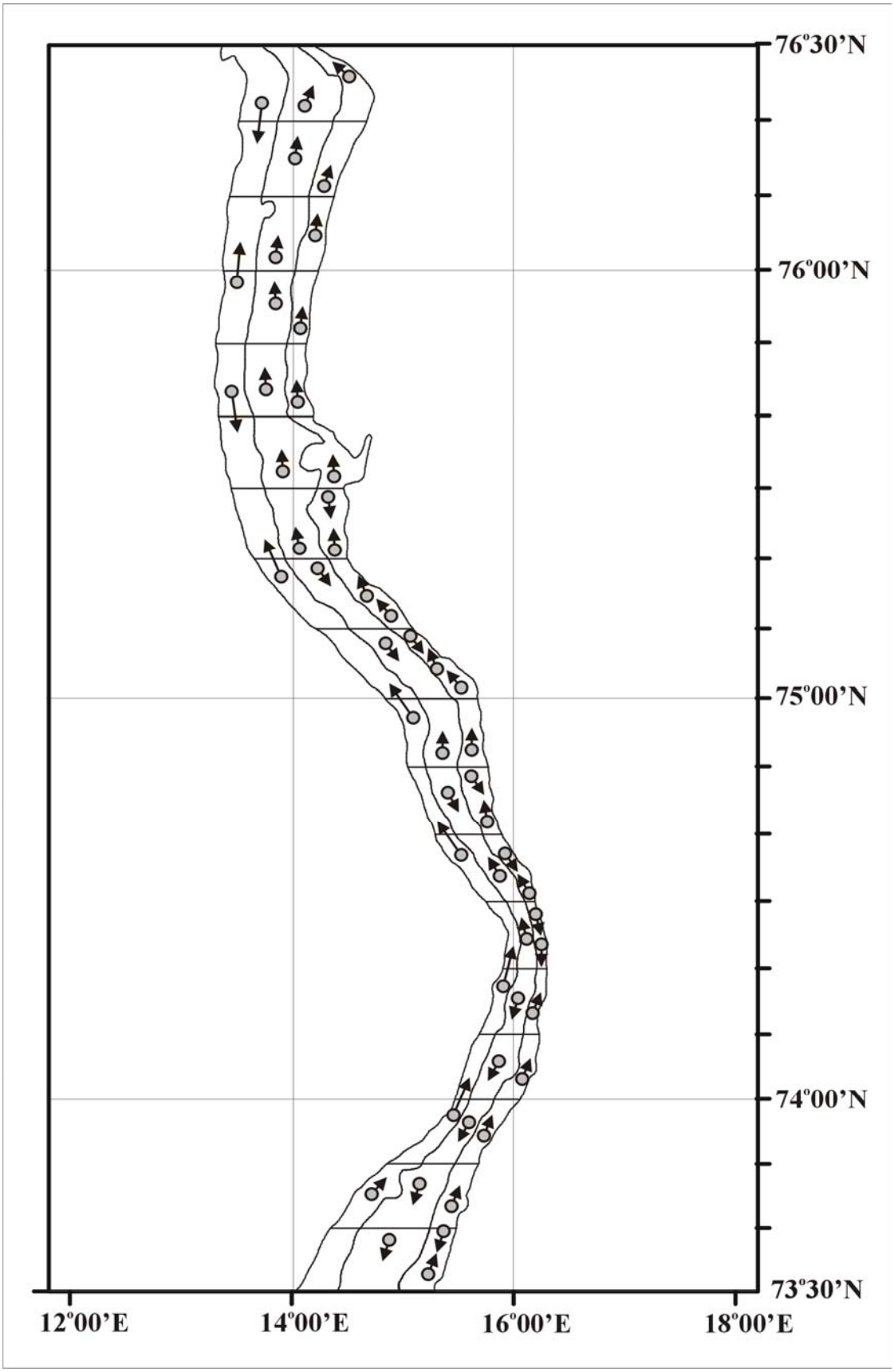


Figure 3. Geographical positions of control hauls and direction of trawling during Polish trawl survey in April 2007

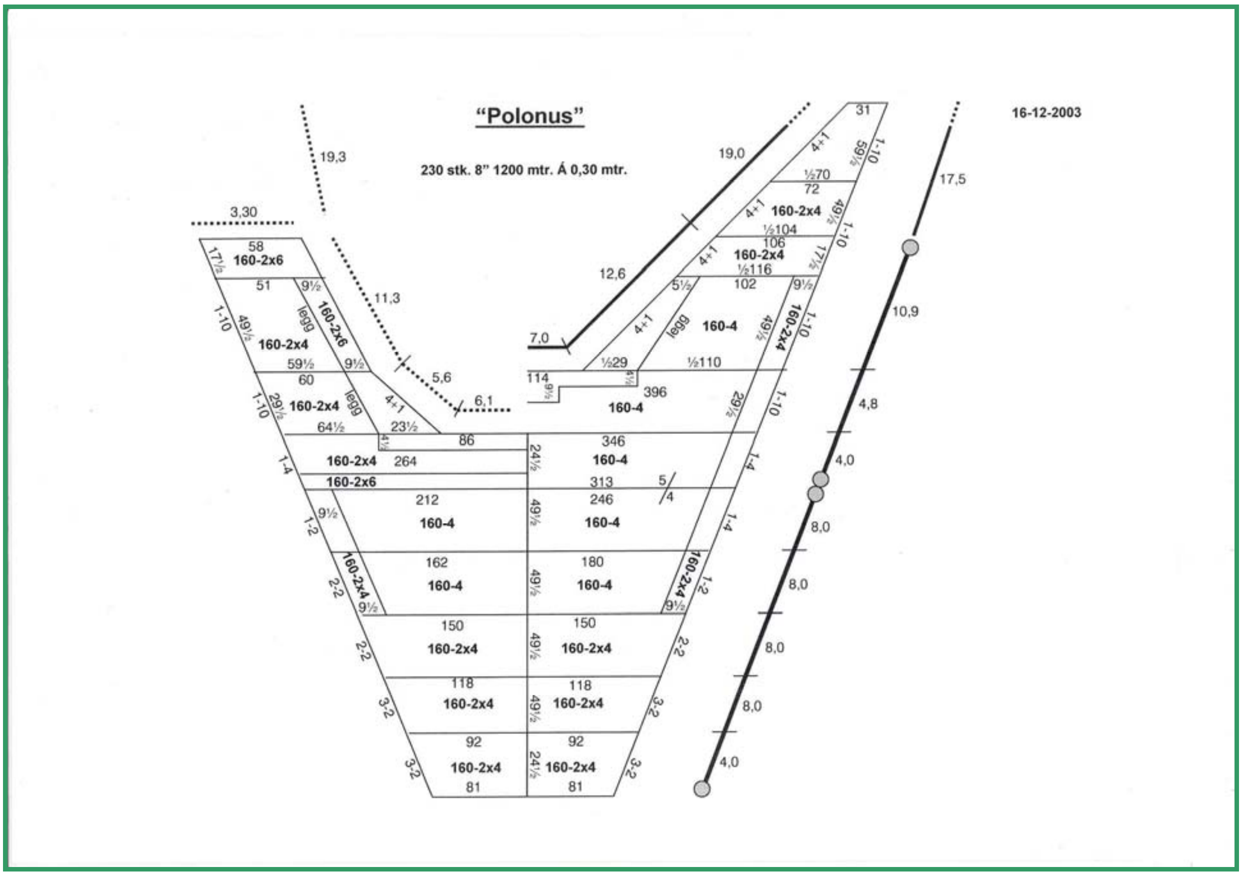


Figure 4. Schema of the net Bacalao 630

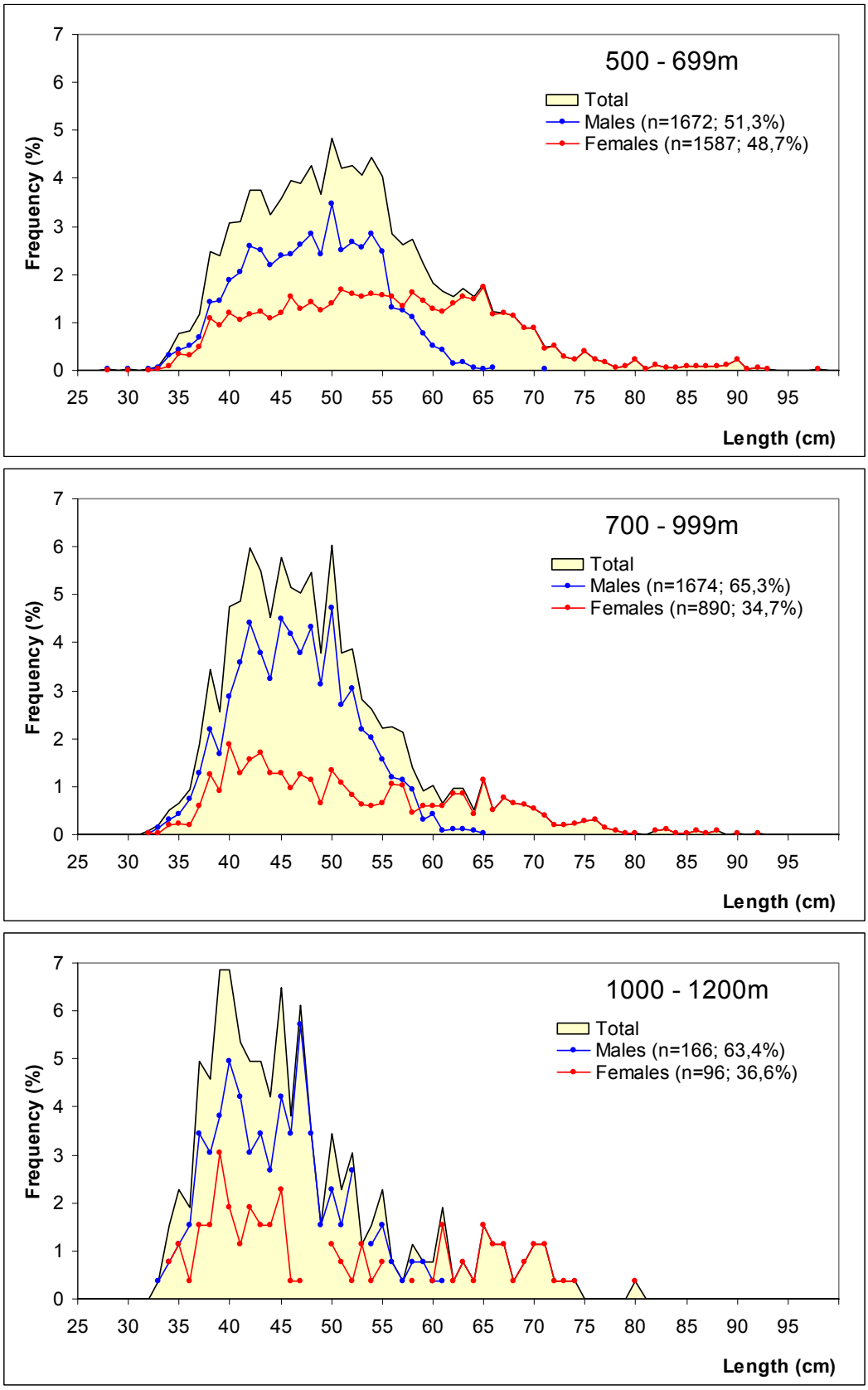


Figure 5. Length compositions of Greenland halibut (by depth strata) in Polish trawl survey in April 2007

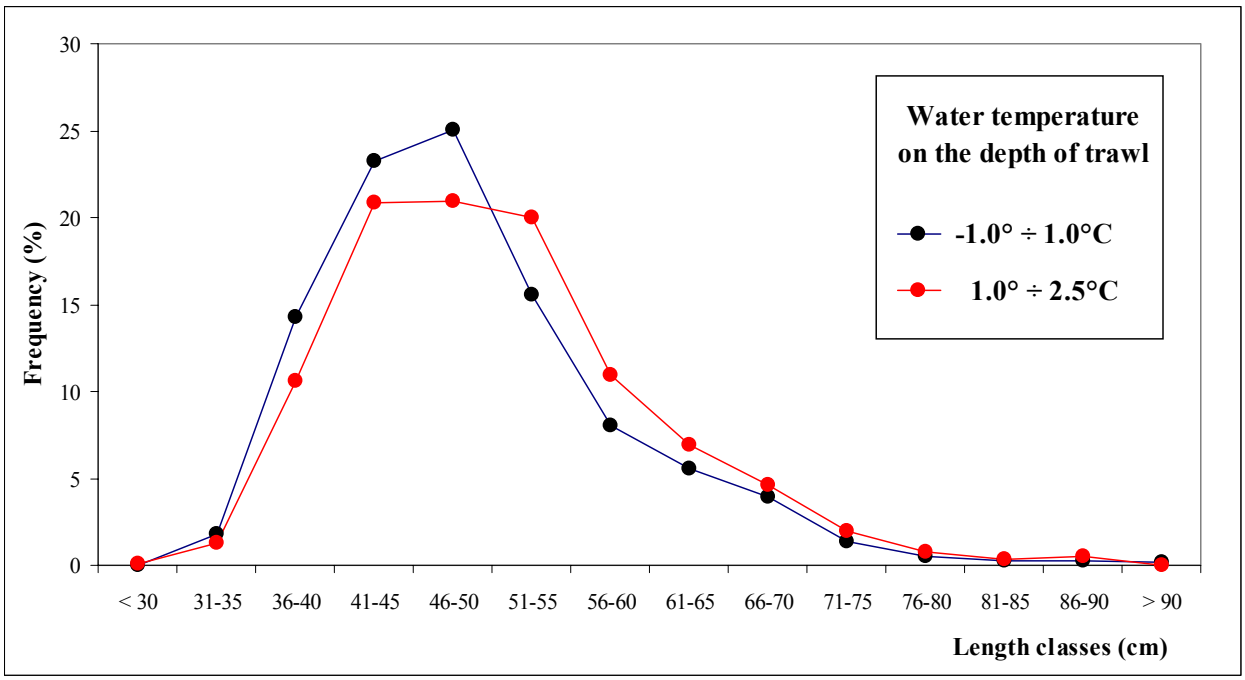


Figure 6. The frequency of the halibut length classes depending on the bottom water temperature in April 2007

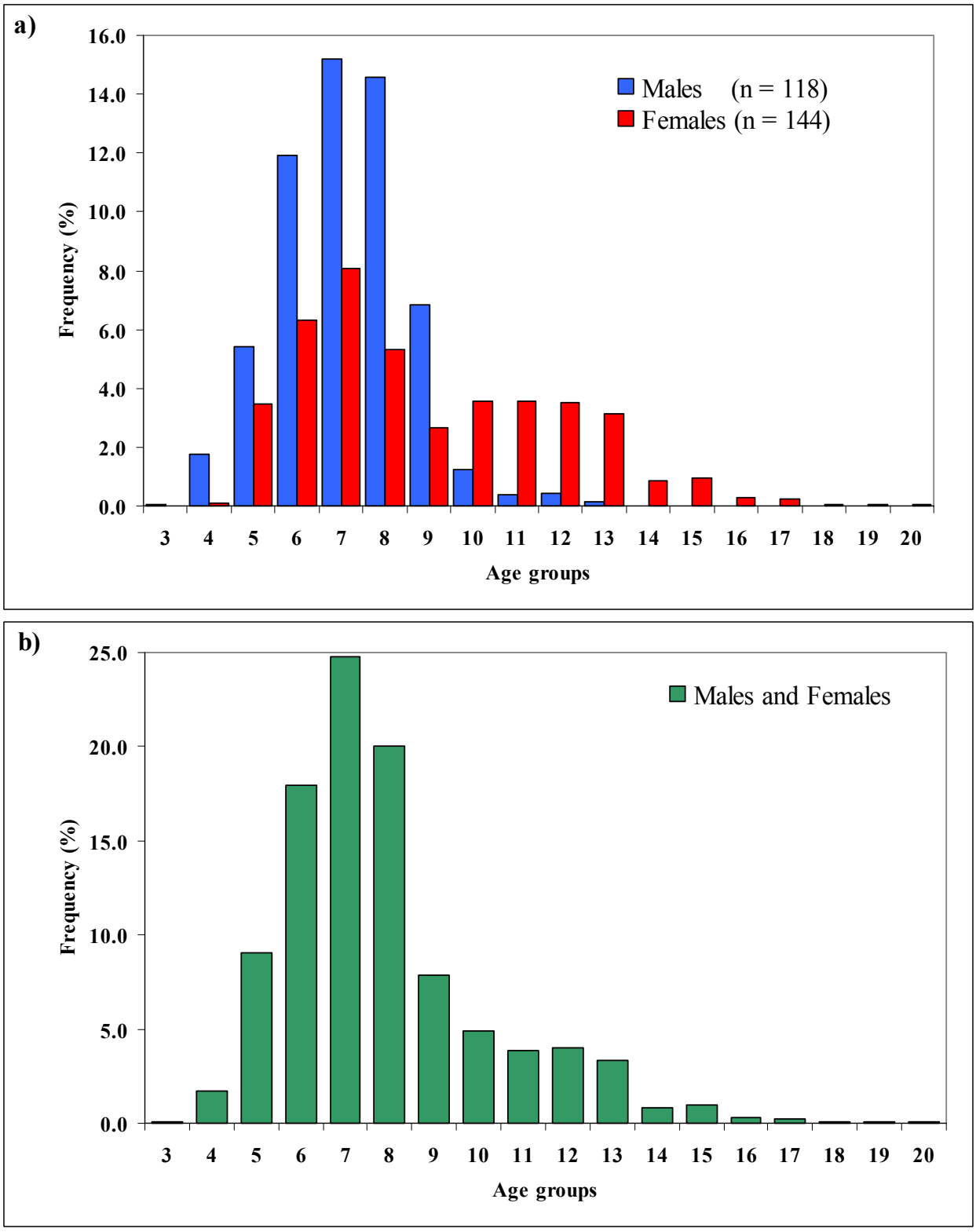


Fig. 7. Age composition of Greenland halibut (from age-length key) in Polish trawl survey in April 2007

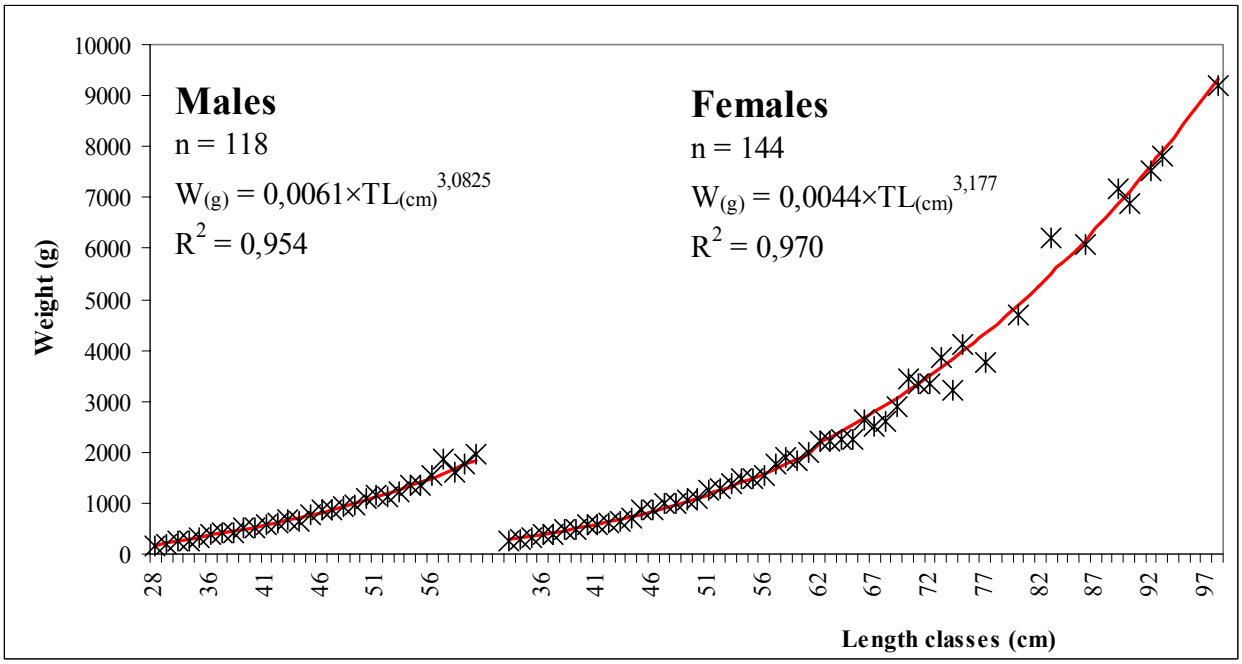


Figure 8. Length-weight relationship for Greenland halibut (males and females) in April 2007

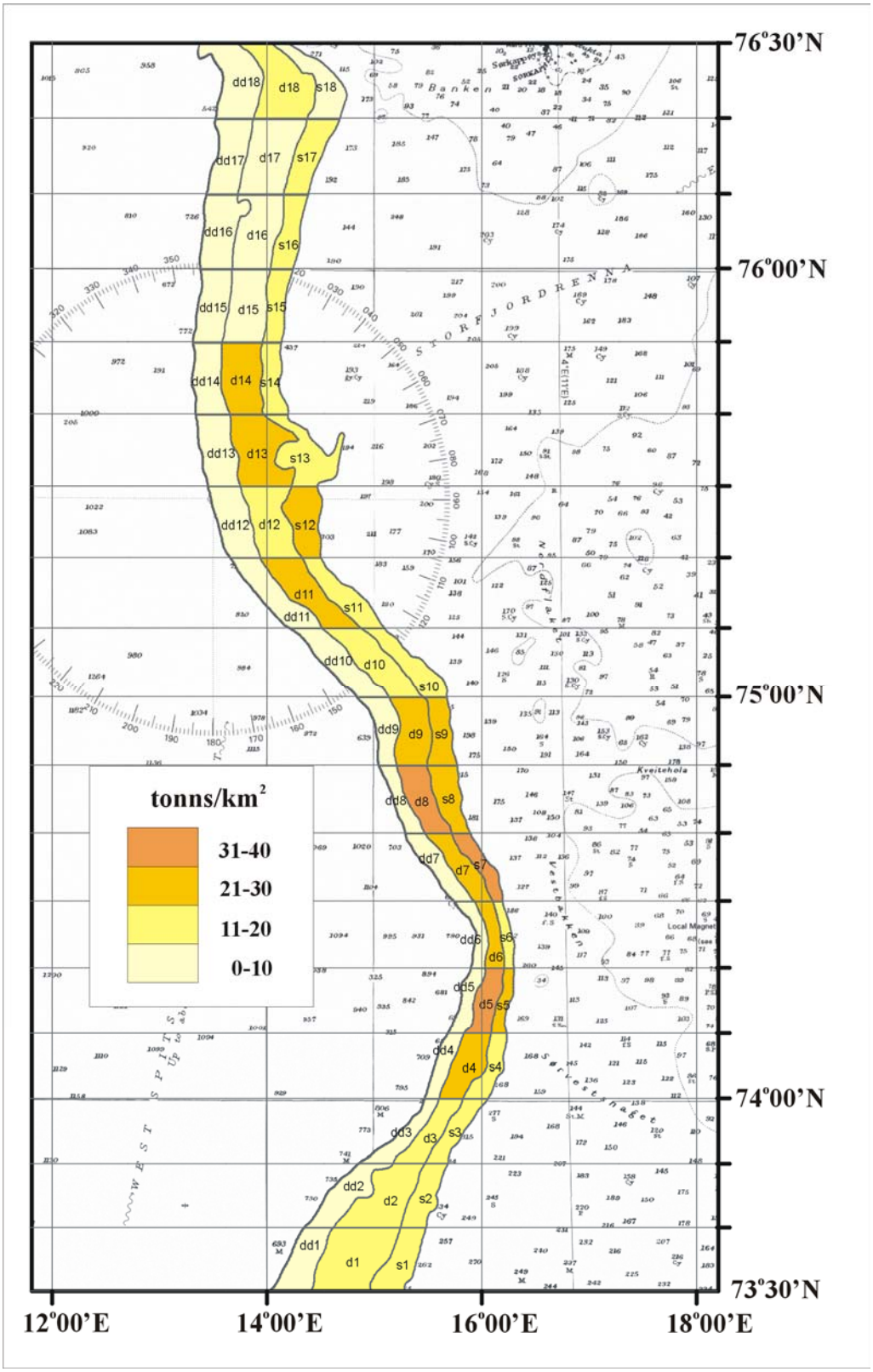


Figure 9. Density of Greenland halibut (tons/km^2) in the Polish trawl survey in April 2007

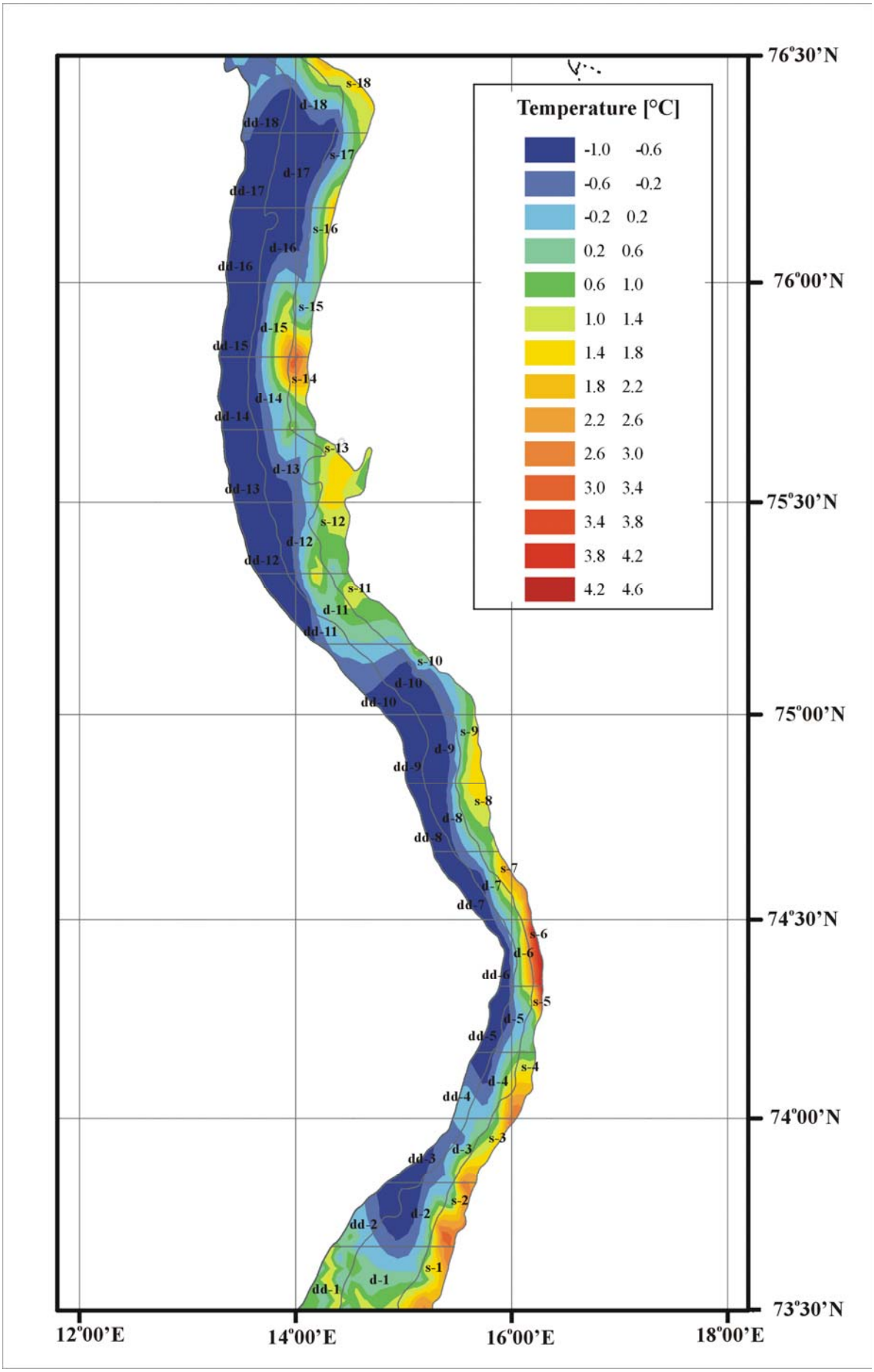


Figure 10. Temperature distribution (°C) of water on the bottom during April 2007

ANNEX 3.

Protocol no 1

Number of TAG: **NO. 20684; 5817 BERGEN**

Species: **Greenland halibut (*Reinhardtius hippoglossoides*)**

Date of catch: **6 April 2007**

Position of catch: **LAT: 74°51'2 N**
LON: 015°30'3 E

Time: **07.00 LT**

Vessel: **f/v Polonus**
Type of cruise**: fishing survey**
Depth: **700-745 m**
Temperature at the bottom: **- 0.3 – 0.7°C**

Length: **44 cm**
Weight: **615 g**
Age: **7 years**
Sex: **Male**
Gonad's maturity: **3**
Stomach fullness: **0**

Remarks: ***photo***

Protocol no 2

Number of TAG: **nr 193754 N**

Species: **Greenland halibut (*Reinhardtius hippoglossoides*)**

Date of catch: **7 April 2007**

Position of catch: **LAT: 75°20'0 N**
LON: 014°20'7 E

Time: **08.15 LT**

Vessel: **f/v Polonus**
Type of cruise: **fishing survey**

Depth: **704-712 m**
Temperature at the bottom: **-0.1 - 0.2°C**

Remarks: ***the mark was found on the fish without head and tail (dressed)***

Protocol no 3

Number of TAG: **No. GH03327**

Species: **Greenland halibut (*Reinhardtius hippoglossoides*)**

Date of catch: **8 April 2007**

Position of catch: **LAT: 75°30,0 N**
LON: 014°14'9 E

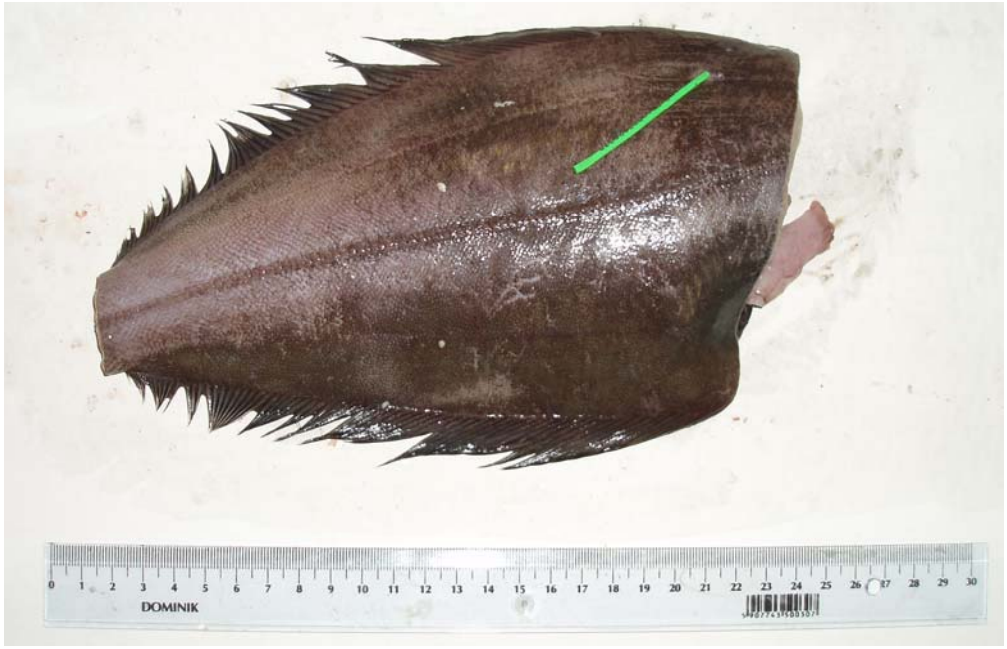
Time: **05.25 LT**

Ship: **f/v Polonus**

Type of cruise: **fishing survey**
Depth: **510-678 m**

Temperature at the bottom: **1.5-1.6°C**

Remarks: ***the mark was found on the fish without head and tail (dressed)***



Protocol no 4

Number of TAG: **NO. 14791**

Species: **Greenland halibut (*Reinhardtius hippoglossoides*)**

Date of catch: **10 April 2007**

Position of catch: **LAT: 75°10'6 N**
LON: 015°06'5 E

Time: **23.40 LT**

Ship: **f/v Polonus**

Type of cruise: **fishing survey**
Depth: **541-611 m**

Temperature at the bottom: **0.7 - 2.2°C**

Remarks: ***the mark was found on the fish without head and tail (dressed)***

Protocol no 5

Number of TAG: No. **GH033848**

Species: **Greenland halibut (*Reinhardtius hippoglossoides*)**

Date of catch: **11 April 2007**

Position of catch: **LAT: 74°57'9 N**
LON: 015°37'6 E
Time: **04.50 LT**

Vessel: **f/v Polonus**

Type of cruise: **fishing survey**
Depth: **622-653 m**
Temperature at the bottom: **0.1 - 1.4°C**

Remarks: ***the mark was found on the fish without head and tail (dressed)***