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**Results of the Polish fishing survey of Greenland halibut
(*Reinhardtius hippoglossoides*)
in the Svalbard Protection Zone
(ICES IIb) in April 2008**

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1. Introduction

The Polish bottom fishing survey on Greenland halibut (*Reinhardtius hippoglossoides*) was conducted in April 2008 in the Svalbard Protection Zone (ICES IIb) and was the continuation of the Polish survey carried out in October 2006 and April 2007. The investigations were conducted based on the Polish application 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 9 to 28 April 2008 (temporary break between 11-18 of April because of engine failure) 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° 30'N and 76° 30'N. The Polish flag fishing vessel POLONUS GDY-36 (Fig. 1), which used a bottom trawl, was engaged in the survey. The research team 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 area of investigations 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 one hauls were performed during 12 effective fishing days in the survey area. According to the cruise plan one haul should be carried out in each square. However during the survey it appeared that there were no halibut (or only in trace amount) in some deepest and deeper strata wherever the water temperature at the depth was below 0° C. Such a situations were observed in deepest strata, than one haul covered two squares in this strata with the exception of squares DD 13, 14, 17 and 18 which were omitted because of lack of time caused by engine failure. The distribution and biomass of halibut in this squares were calculated at the level of the adjoining squares. Some hauls in deeper strata, where the temperature at depth was recorded below 0° C., also covered two squares. The positions of starting the hauls and directions of trawling are presented in Figure 3. The speed of vessel during trawling was between 2.7 – 4.0 knots (mean 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 measured (subsample for measurements were taken when the amount of species was higher). This provided information on the species composition of the catches by number, weight and length distribution.

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 below. In total, 6156 specimens of Greenland halibut segregated by sex were measured, and 290 fish were taken for biological analysis. Each analysis included data concerning length, weight (to the nearest 10 g) sex, gonad maturity, and fullness of stomach. The gonad maturity stage was determined according to a 6-grade scale: immature (I), early maturing (II), maturing (III), late maturing (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.). Otoliths were collected for later age determination. The age of halibut were determined from whole otoliths read in water under a microscope with

reflected light. The sex proportion was determined based on the fish collected for length measurements.

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 observed.

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:

$$1. CPUE = \frac{W}{t} * 60$$

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

where:

CPUE – catch per unit effort (1- kg/h and 2 - kg/km²);

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/km²) 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/km²);
A – area of survey (km²);
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 fishing 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 204.2 tons of fish were caught during the fishing survey. Greenland halibut dominated the catches by weight and contributed 200 tons (97.9%) of the total catch (Table 1). Distribution of Greenland halibut was very differentiated by strata. Over 80% of fish by weight was caught in shallower depth strata (500 – 699 m.) and only 1% in the deepest strata (1000 – 1200 m.).

Bycatch was only 4192 kg and consisted of 18 fish species. The most abundant species was redfish (*Sebastes mentella*) – 3808 kg. Redfish was noticed only in three hauls (no. 1, 8 and 12) in the southern part of the survey area in the shallower strata at the depth between 500 and 600m. The bulk of redfish was taken in haul no. 8 (2826 kg).

The second quantitative bycatch species was cod (*Gadus morhua*) – 94 kg. Main diversity of bycatch species (17 species – 7633 kg. by weight) was recorded in the shallower strata (500-699m). In the deeper strata (700-999m) 7 bycatch species (49 kg. by weight) was recorded and in the deepest strata 8 bycatch species (47 kg. in weight) was observed. The species composition of catches by depth strata in numbers and weights of specimens is presented in Table 2. The length measurements and weight of bycatch species are included in the Attachment 1 ([available only in the Report sent to the Institute of Marine Research, Bergen, Norway](#)).

Sebastes mentella, which was most numerous bycatch species, consisted of fish measuring from 26 to 43cm in length, while more than 78% of these fish were between 32 to 36cm. Males dominated, consisting of 66% in the catches. The length measurements *S. mentella* is included in the Attachment 2 and biological data of are included in the Attachment 3 ([available only in the Report sent to the Institute of Marine Research, Bergen, Norway](#)).

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

4. 2. Catch rates of Greenland halibut

A total of 54 squares were designated in the trawl survey area at the three depth strata between the latitudes of 73° 30'N and 76° 30'N. The total surface of the survey area was calculated at 7844 km² of which 2078 km² was at the shallower depth strata, 3346 km² at the deeper strata, and 2420 km² at the deepest strata. The highest catches

(160.0 tons) and catch rates (1.6 t/hr) were achieved in the shallower strata (500 – 699m). In the deeper strata only 38 tons was caught and the catch rates varied from 2.6 to 0.2 t/hr (mean 1.0 t/hr). In the deepest strata (1000 – 1200m) the catch rates was extremely low from 0.0 to 0.3 t/hr (mean 0.1 t/h). The average catch rates of Greenland halibut throughout the survey area was 1.34 t/hr., but it should be mentioned that the distribution of trawls was not equal throughout the whole fishing survey area.

Highest catch rates were observed in the southern part of survey area in the shallower deep strata. The lowest CPUE was observed in the northern part of the survey area especially in deepest strata where CPUE was less than 0.1 t/hr.

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 6156 halibut specimens. The length of the halibut ranged from 27 to 99cm TL. The length distribution of males was different than females by the range of length and shape of length curve (Figure 5). The mean length of females (51.9cm) was higher than males (46.3cm) and the mean length of Greenland halibut was 48.8cm.

The length distribution differed with the depths of fishing (Figure 6). In the shallower and deeper waters to 1000m the length distribution of males and females and mean lengths were similar. The range of females length was much higher than males and mean length was 52.3 cm and 46.8 cm respectively. In the deepest strata below 1000m the mean lengths of halibut females and males were smallest 46.4cm and 42.5cm respectively. Mean lengths of Greenland halibut sampled in April 2008 by depth strata and sex are presented in Table 4. Total length measurements of Greenland halibut during Polish fishing survey in April 2008 in every sampled haul are included in Attachment 4 (*available only in the Report sent to the Institute of Marine Research, Bergen, Norway*).

The distribution and length composition of Greenland halibut was relative to the depth of catches and was connected to the temperature of water at the bottom. In general at the deepest strata the bottom temperature of water was lowest and amount of halibut was very small.

Otoliths collected during biological analysis from 290 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 7a. Year classes 2000 -

2004 dominated during the survey. Males dominated the younger age groups. Greenland halibut from 8 years old were mostly females and the fish after 12 years old were all females (Figure 7b).

The sex ratio was calculated from 6156 specimens during length measurements. Males dominated in the catches and comprised nearly 55% of the sampled fish. The share of males in the stock was much higher in the shallower and deeper strata (55.9 and 53.2%, respectively) than in the deepest strata where males comprised 49.5%.

Maturity stage data were collected for 290 halibut specimens. Observations of gonad maturity indicated that most males (nearly 57%) had gonads in the maturing stage while a considerable part of fish was in early maturing stage (nearly 34%). Most of the females were in early maturing and maturing stages (46 and 45%, respectively). Only 5% of females were actively spawning (Table 5).

Weight was recorded for 290 halibut specimens. Greenland halibut attained weights ranging from 160g to 10140g. The mean weight of the sampled males was 867g while that of females was 1419g. The weight of fish at length classes is presented in Table 6. The relationship between body length and weight for the males was calculated as $W_{(g)} = 0.0037 * TL_{(cm)}^{3.206}$ and for females $W_{(g)} = 0.0025 * TL_{(cm)}^{3.3203}$. The length-weight relationships for males and females are presented in Figure 8.

All the raw data concerning biological analysis, including length, weight, sex, gonads maturity, stomach fullness and age of Greenland halibut collected during the fishing survey are presented in Attachment 5 ([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 tons/km² for each square and depth strata was estimated with the swept area method. The results presented in Table 7 show the density of Greenland halibut calculated for each square in the depth strata. Results indicated that the highest density was observed in the shallower strata (15.1 t/km²), next in the deeper strata (11.2 t/km²) and the lowest density (1.25 t/km²) was noticed in the deepest strata.

Higher density of fish was observed in the southern part of fishing survey area in the deeper and shallower strata mainly between the latitudes 73°30'N and 74°40'N. The lowest Greenland halibut density was observed in northern part of survey area between 75°30'N and 76°30'N where density at all depths didn't reach the value of 8 t/km² and in

deepest strata it was less than 0.1 t/km². Density for all the squares is presented graphically in Figure 9.

The analysis of bottom water temperature (Figure 10) indicates that in April 2008 waters were much colder than in this same period of 2007.

The total biomass of Greenland halibut in April 2008 in the survey area calculated as the sum of biomass in each square was estimated to be 71.9 thousand tons, of this 52.2% of the fish inhabited the deeper depth strata (700-1000m), 43.6% shallower depth strata (500-699m) and only 4.2% the deepest waters 1000–1200m during the time of the survey (Table 7). Different surface between deeper and shallower strata caused that highest biomass of Greenland halibut was calculated for deeper strata in despite of lower density than in shallower strata.

4. 5. Other information

Only one tagged specimen of Greenland halibut was caught during the survey. The protocol was prepared for the tagged fish, and all the available fishery and biological data and photo were included (Annex 1). The tag of the fish was attached to the protocol in the copy of the Report sent to the Institute of Marine Research in Bergen, Norway.

TABLES

Table 1. Catch by species in Polish fishing survey in ICES IIb Area in April 2008

Common name	Scientific name	Total catch (kg)	Percent
Greenland halibut	<i>Reinhardtius hippoglossoides</i>	199 978.50	97,92
Redfish	<i>Sebastes mentella</i>	3 808.35	1.86
Cod	<i>Gadus morhua</i>	94.50	0.05
Spinetail ray	<i>Bathraya spinacauda</i>	79.86	0.04
Roughhead granadier	<i>Macrourus berglax</i>	56.59	0.03
Esmarks eelpout	<i>Lycodes esmarkii</i>	55.85	0.03
Starry ray	<i>Raya radiata</i>	37.51	0.02
Northern wolffish	<i>Anarhichas denticulatus</i>	31.90	0.02
Blue whiting	<i>Micromesistius potassou</i>	22.33	0.01
Arctic flounder	<i>Liopsetta glacialis</i>	13.02	
Spotted wolffish	<i>Anarhichas minor</i>	12.30	
Haddock	<i>Melanogrammus aeglefinus</i>	9.77	
Round ray	<i>Raya phyllae</i>	7.13	
Lumpfish	<i>Cyclopterus lumpus</i>	3.25	
American plaice	<i>Hipoglossoides platessoides</i>	2.58	
Tusk	<i>Brosme brosme</i>	2.17	
Arctic rockling	<i>Onogadus sp.</i>	1.87	
Pale eelpout	<i>Lycodes pallidus</i>	0.81	
Arctic sculpin	<i>Cottunculus microps</i>	0.62	
Total		204 218.87	

Table 2. Species composition of catches by depth strata, number and weight of specimens in Polish fishing survey in April 2008

Common name	Scientific name	Depth strata S (500-699m)			Depth strata D (700-999m)			Depth strata DD (1000-1200m)			Total 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	<i>Reinhardtius hippoglossoides</i>	133 044	160 021.8	1.20	30 201	37 967.7	1.26	2 123	1 989.0	0.94	165 368	27-99	199 978.5	1.21
Redfish	<i>Sebastes mentella</i>	7 160	3 808.35	0.53							7 160	26-43	3 808.35	0.53
Cod	<i>Gadus morhua</i>	37	94.50	2.63							37	33-99	94.50	2.63
Roughhead granadier	<i>Macrourus berglax</i>	55	50.74	0.92	5	3.55	0.71	4	2.30	0.58	64	24-80	56.59	0.88
Esmarks eelpout	<i>Lycodes esmarkii</i>	90	37.63	0.42	1	0.12	0.12	34	18.11	0.53	125	29-63	55.85	0.45
Northern wolffish	<i>Anarhichas denticulatus</i>	5	31.90	6.38							5	61-160	31.90	6.38
Starry ray	<i>Raya radiata</i>	44	27.70	0.63	14	3.45	0.25	19	6.36	0.33	77	28-50	37.51	0.49
Spinetail ray	<i>Bathraya spinacauda</i>	7	26.50	3.79	11	39.93	3.63	4	13.43	3.36	22	54-92	79.86	3.63
Blue whiting	<i>Micromesistius potassou</i>	148	21.85	0.15				3	0.48	0.16	151	25-39	22.33	0.15
Spotted wolffish	<i>Anarhichas minor</i>	4	12.30	3.08							4	60-66	12.30	3.08
Arctic flounder	<i>Liopsetta glacialis</i>	45	11.60	0.26	3	0.40	0.13	4	1.02	0.26	52	21-39	13.02	0.25
Haddock	<i>Melanogrammus aeglefinus</i>	9	9.77	1.09							9	24-60	9.77	1.09
Lumpfish	<i>Cyclopterus lumpus</i>	1	3.25	3.25							1	41	3.25	3.25
American plaice	<i>Hipoglossoides platessoides</i>	14	2.58	0.18							14	16-40	2.58	0.18
Round ray	<i>Raya phyllae</i>	8	2.49	0.31				8	4.64	0.58	16	23-53	7.13	0.45
Tusk	<i>Brosme brosme</i>	2	2.17	1.09							2	53	2.17	1.09
Pale eelpout	<i>Lycodes pallidus</i>	4	0.51	0.13	1	0.30	0.30				5	29-30	0.81	0.16
Arctic rockling	<i>Onogadus sp.</i>	1	0.37	0.37	5	1.50	0.30				6	34-36	1.87	0.31
Arctic sculpin	<i>Cottunculus microps</i>							5	0.62	0.12	5	13-21	0.62	0.12
Total		140 678	164 166.0		30 241	38 017.0		2 204	2 036.0		173 123		204 218.9	

Table 3. Catch and CPUE of Greenland halibut by depth strata and squares in April 2008

Subarea S				Subarea D				Subarea DD			
Sector	Catch (kg)	Time of trawl	CPUE (t/h)	Sector	Catch (kg)	Time of trawl	CPUE (t/h)	Sector	Catch (kg)	Time of trawl	CPUE (t/h)
S-1	6 708.0	2.50	2.683	D-1	1 677.0	1.50	1.118	DD-1	0.0	1.33	0.000
S-2	12 948.0	6.38	2.031	D-2	8 502.0	3.33	2.551	DD-2	0.0	1.33	0.000
S-3	12 966.2	8.63	1.503	D-3	2 886.0	2.58	1.117	DD-3	117.0	1.25	0.094
S-4	9 360.0	6.83	1.370	D-4	2 340.0	2.50	0.936	DD-4	117.0	1.25	0.094
S-5	6 747.0	5.08	1.327	D-5	4 017.0	4.50	0.893	DD-5	78.0	1.71	0.046
S-6	36 517.1	17.67	2.067	D-6	2 015.3	2.92	0.691	DD-6	78.0	1.71	0.046
S-7	36 788.6	19.39	1.897	D-7	4 694.9	3.83	1.225	DD-7	351.0	1.13	0.312
S-8	8 255.0	7.06	1.170	D-8	1 092.0	2.00	0.546	DD-8	351.0	1.13	0.312
S-9	10 121.0	7.06	1.434	D-9	1 560.0	1.33	1.170	DD-9	292.5	1.04	0.281
S-10	11 265.0	9.08	1.240	D-10	3 159.0	2.08	1.516	DD-10	292.5	1.04	0.281
S-11	3 276.0	3.42	0.959	D-11	2 982.6	3.00	0.994	DD-11	78.0	1.21	0.065
S-12	1 443.0	1.42	1.019	D-12	1 365.0	1.58	0.862	DD-12	78.0	1.21	0.065
S-13	858.0	1.75	0.490	D-13	331.5	1.00	0.332	DD-13			
S-14	799.5	1.00	0.800	D-14	331.5	1.00	0.332	DD-14			
S-15	799.5	1.00	0.800	D-15	234.0	1.08	0.216	DD-15	78.0	0.88	0.089
S-16	390.0	1.25	0.312	D-16	234.0	1.08	0.216	DD-16	78.0	0.88	0.089
S-17	390.0	1.25	0.312	D-17	273.0	0.75	0.364	DD-17			
S-18	390.0	1.42	0.275	D-18	273.0	0.75	0.364	DD-18			
Total S	160 021.8	102.2	1.566	Total D	37 967.7	36.8	1.031	Total DD	1 989.0	17.1	0.116

Table 4. Mean length of of Greenland halibut sampled in April 2008 by depth strata

Sex	Subarea S (500-699m)	Subarea D (700-999m)	Subarea DD (1000-1200m)	Research area
Males	46.4	47.1	42.5	46.3
Females	52.4	52.3	46.4	51.9
Males and females	49.1	49.5	44.5	48.8

Table 5. Maturity stages of Greenland halibut sampled in April 2008

Sex		Maturity stages						Total
		I	II	III	IV	V	VI	
Males	N	4	37	62	0	6	0	109
	%	3.7	33.9	56.9	0.0	5.5	0.0	100.0
Females	N	5	83	82	2	9	0	181
	%	2.8	45.9	45.3	1.1	5.0	0.0	100.0
Total	N	9	120	144	2	15	0	290
	%	3.1	41.4	49.7	0.7	5.2	0.0	100.0

Table 6. Mean weight of Greenland halibut in April 2008

Length classes (cm)	Males		Females		Males and Females	
	n	Mean weight (g)	n	Mean weight (g)	n	Mean weight (g)
29	1	160.0			1	160.0
31	1	200.0	1	215.0	2	207.5
32	2	272.5	1	250.0	3	265.0
33	2	275.0	1	300.0	3	283.3
34	2	310.0	1	270.0	3	296.7
35	4	341.3	3	341.7	7	341.4
36	2	370.0	2	395.0	4	382.5
37	2	395.0	3	381.7	5	387.0
38	6	415.0	3	441.7	9	423.9
39	1	450.0	2	505.0	3	486.7
40	3	543.3	2	472.5	5	515.0
41	3	538.3	3	555.0	6	546.7
42	3	565.0	3	571.7	6	568.3
43	3	656.7	3	630.0	6	643.3
44	4	691.3	2	665.0	6	682.5
45	3	725.0	2	827.5	5	766.0
46	2	757.5	3	776.7	5	769.0
47	3	786.7	2	980.0	5	864.0
48	3	861.7	3	960.0	6	910.8
49	4	933.8	4	1202.5	8	1068.1
50	2	1137.5	3	1116.7	5	1125.0
51	3	1141.7	3	1213.3	6	1177.5
52	3	1260.0	1	1280.0	4	1265.0
53	2	1365.0	3	1376.7	5	1372.0
54	5	1377.0	2	1397.5	7	1382.9
55	4	1376.3	3	1590.0	7	1467.9
56	4	1510.0	2	1507.5	6	1509.2
57	5	1572.0	4	1547.5	9	1561.1
58	1	1720.0	2	1660.0	3	1680.0
59	2	1642.5	3	1831.7	5	1756.0
60	1	2015.0	4	2086.3	5	2072.0
61	2	2070.0	3	2110.0	5	2094.0
62	2	1915.0	5	2268.0	7	2167.1
63	1	2245.0	3	2246.7	4	2246.3
64			3	2466.7	3	2466.7
65			3	2696.7	3	2696.7
66			4	2708.8	4	2708.8
67			5	3013.0	5	3013.0
68			4	2992.5	4	2992.5
69			7	2981.4	7	2981.4
70			5	3311.0	5	3311.0
71			5	3623.0	5	3623.0
72			1	2990.0	1	2990.0
74			2	4090.0	2	4090.0
75			2	4287.5	2	4287.5
76			3	4830.0	3	4830.0
77			1	4590.0	1	4590.0
78			1	4800.0	1	4800.0
79			1	5625.0	1	5625.0
80			1	5205.0	1	5205.0
81			1	5970.0	1	5970.0
82			1	6130.0	1	6130.0
83			2	5835.0	2	5835.0
86			2	6425.0	2	6425.0
87			1	8600.0	1	8600.0
90			1	7170.0	1	7170.0
91			1	7360.0	1	7360.0
96			1	10140.0	1	10140.0
97			1	9290.0	1	9290.0
Mean weight (g)	109	866.9	181	1419.3	290	1122.6

Table 7. Density and biomass of Greenland halibut in the research area in April 2008.

Square	Density (t/km ²)	Biomass (t)	Square	Density (t/km ²)	Biomass (t)	Square	Density (t/km ²)	Biomass (t)	Squares S, D, DD	Biomass (t)
S-1	34.50	5 752.4	D-1	14.37	5 122.9	DD-1	0.00	0.0	1	10 875.3
S-2	26.11	3 548.4	D-2	33.92	9 214.7	DD-2	0.00	0.0	2	12 763.1
S-3	19.59	2 216.0	D-3	14.36	1 935.9	DD-3	1.20	133.0	3	4 284.9
S-4	19.51	2 009.3	D-4	12.03	1 903.5	DD-4	1.20	102.4	4	4 015.2
S-5	17.06	1 049.8	D-5	11.87	1 367.8	DD-5	0.59	49.3	5	2 466.9
S-6	27.33	1 455.4	D-6	8.88	733.1	DD-6	0.59	41.8	6	2 230.3
S-7	25.26	2 163.6	D-7	15.75	1 882.7	DD-7	4.01	457.6	7	4 504.0
S-8	15.40	1 918.3	D-8	7.02	1 011.3	DD-8	4.01	318.4	8	3 248.0
S-9	18.44	2 046.0	D-9	15.04	2 521.8	DD-9	3.61	404.3	9	4 972.1
S-10	15.94	2 087.6	D-10	19.49	3 709.5	DD-10	3.61	588.3	10	6 385.4
S-11	12.33	1 628.0	D-11	12.78	2 393.1	DD-11	0.62	99.1	11	4 120.2
S-12	13.10	1 891.0	D-12	11.08	2 136.3	DD-12	0.62	99.9	12	4 127.1
S-13	6.30	1 123.7	D-13	3.20	756.7	DD-13	0.62	100.3	13	1 980.7
S-14	7.71	740.5	D-14	3.20	592.9	DD-14	0.62	84.0	14	1 417.4
S-15	7.71	697.8	D-15	2.08	375.6	DD-15	0.86	120.9	15	1 194.3
S-16	3.01	307.8	D-16	2.08	390.4	DD-16	0.86	140.1	16	838.3
S-17	3.01	380.1	D-17	3.51	779.9	DD-17	0.86	124.5	17	1 284.5
S-18	2.65	324.3	D-18	3.51	748.9	DD-18	0.86	159.9	18	1 233.1
Total S	15.08	31 340.2	Total D	11.23	37 577.0	Total DD	1.25	3 023.9	Total area	71 941.0



Figure 1. Polish fishing vessel “Polonus”

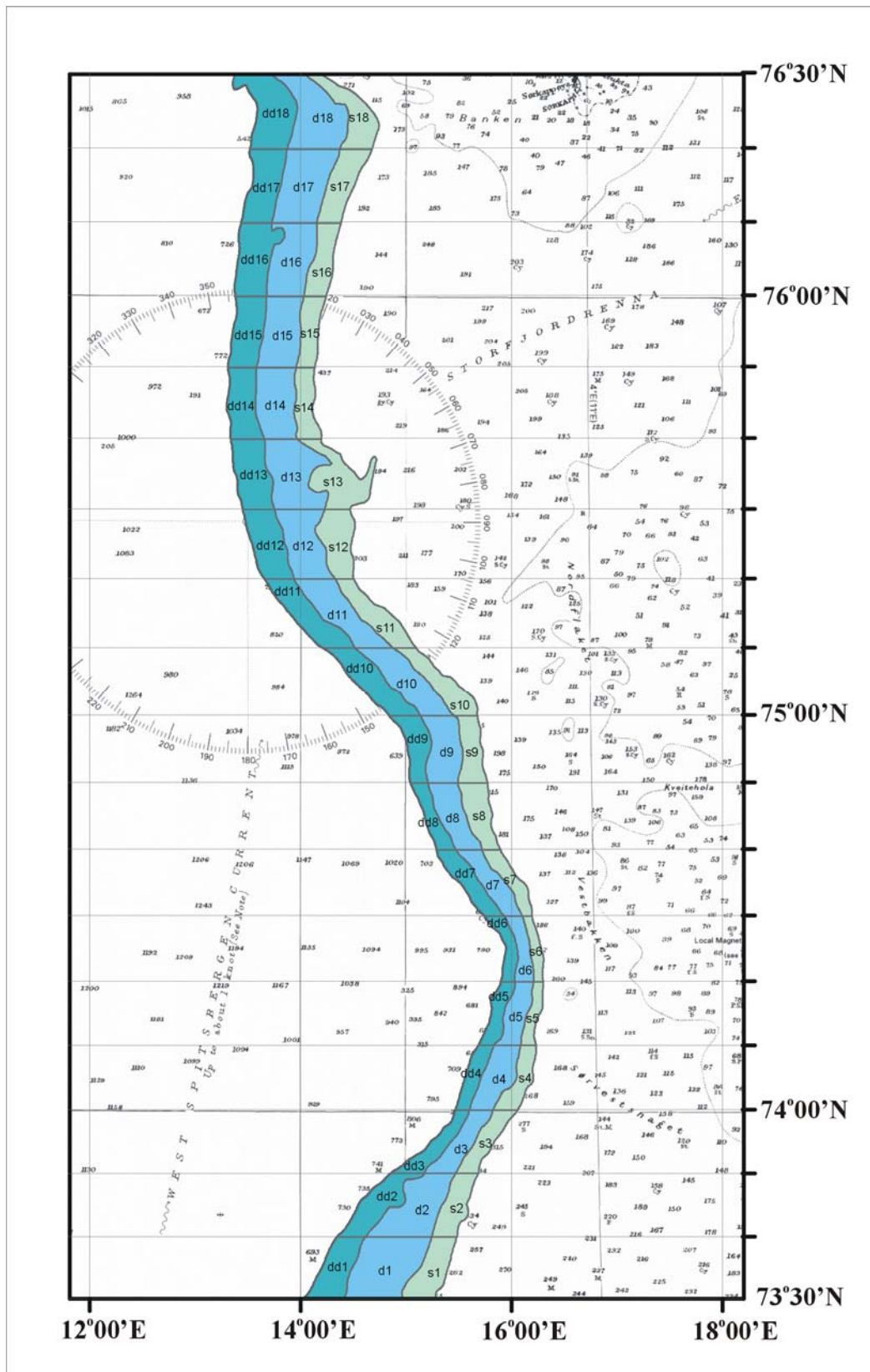


Figure 2. The survey area divided by depth strata and squares in Polish fishing in April 2008

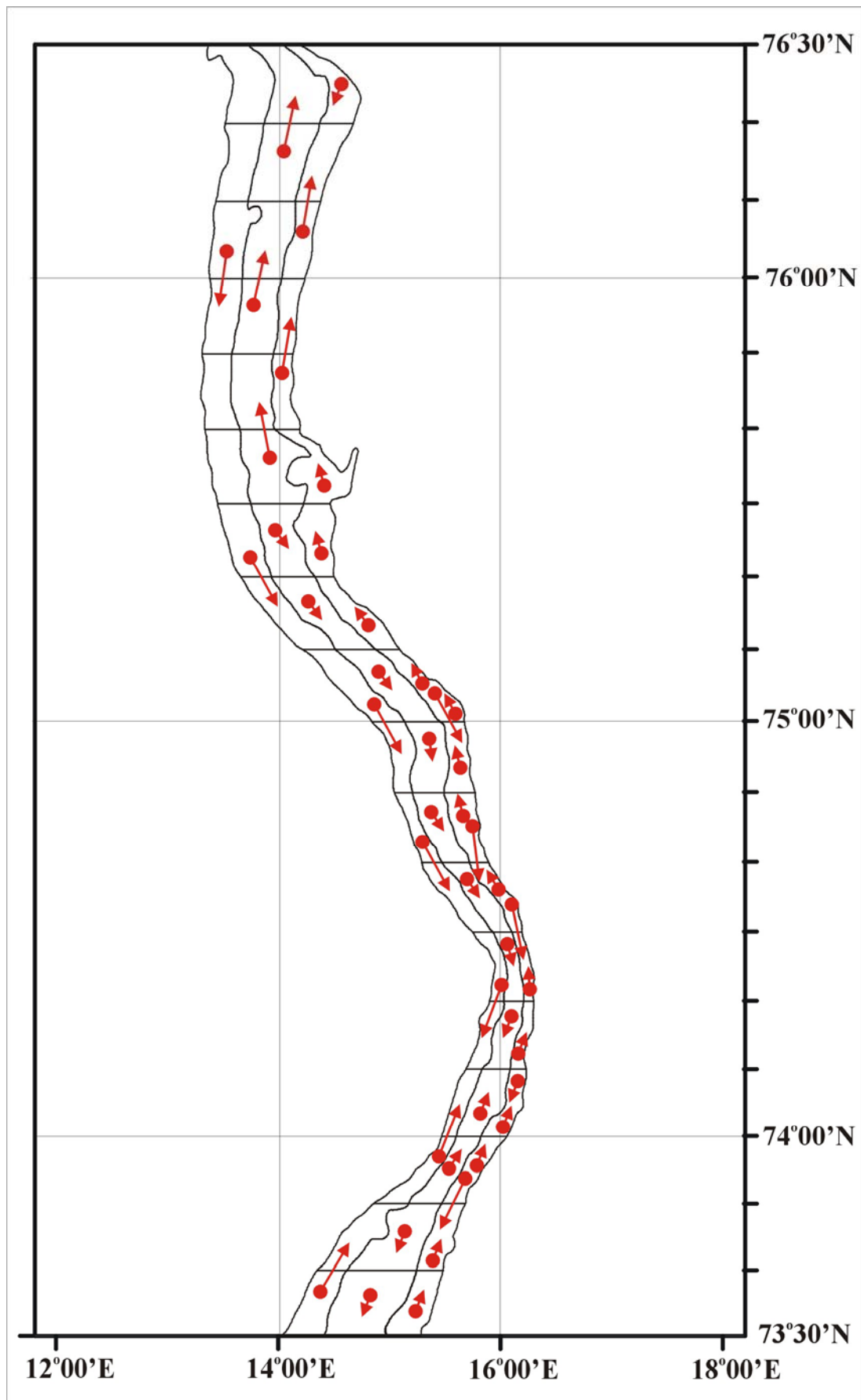


Figure 3. Geographical positions of control hauls and direction of trawling during Polish fishing survey in April 2008

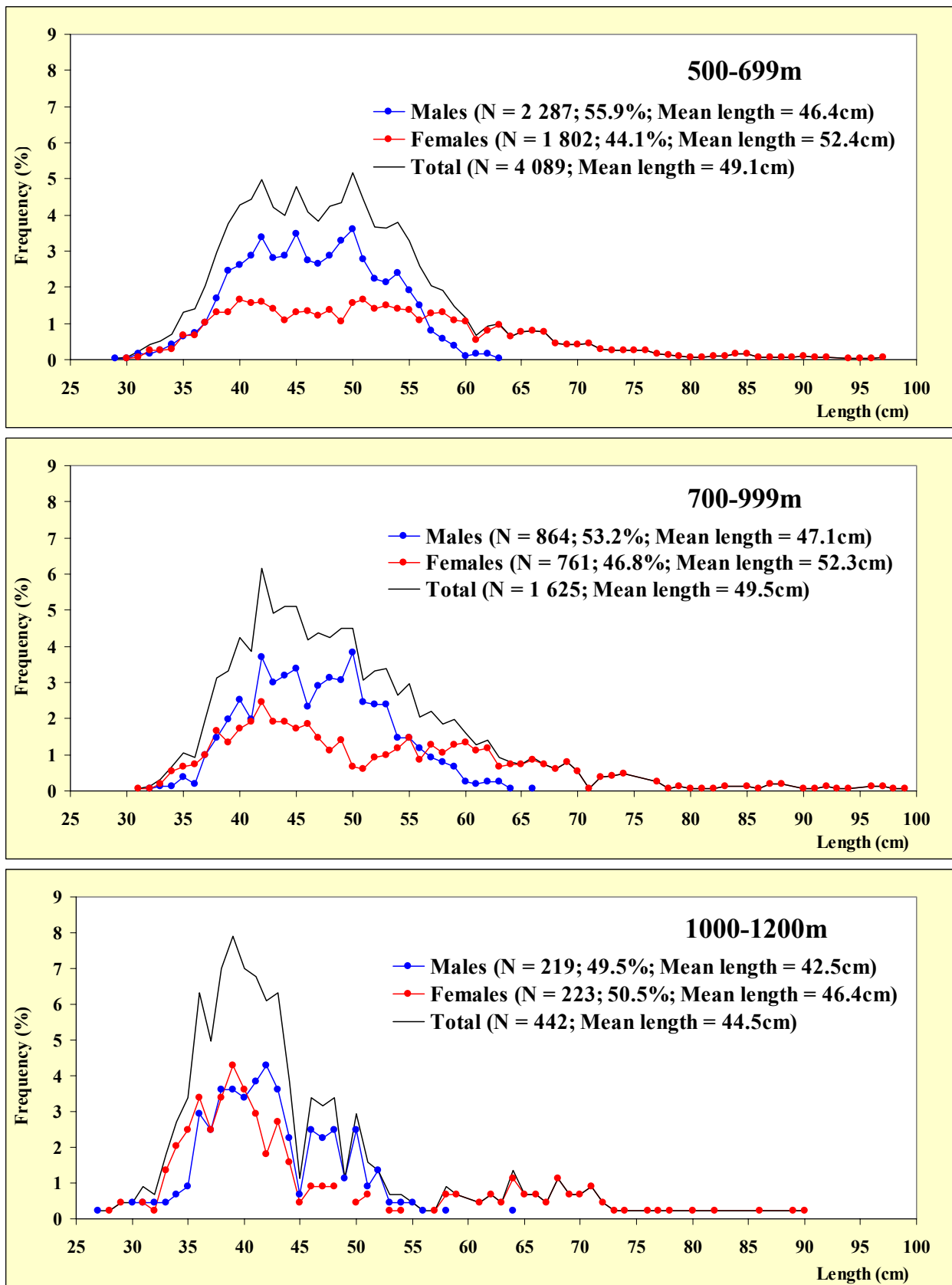


Figure 6. Length compositions of Greenland halibut (by depth strata) in Polish fishing survey in April 2008

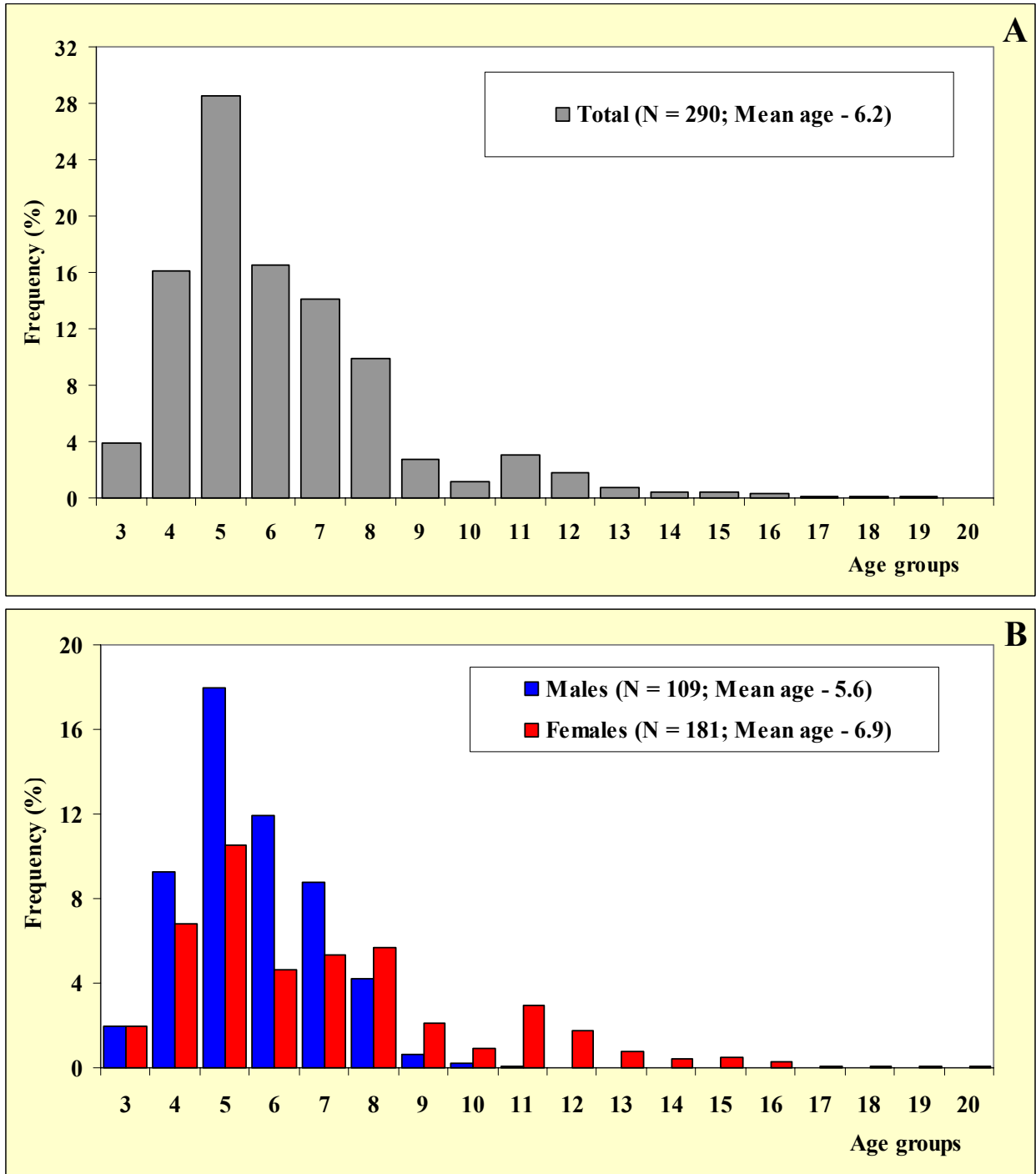


Figure 7. Age compositions of Greenland halibut from age-length key in Polish fishing survey in April 2008. A – sexes combined; B – divided by sex

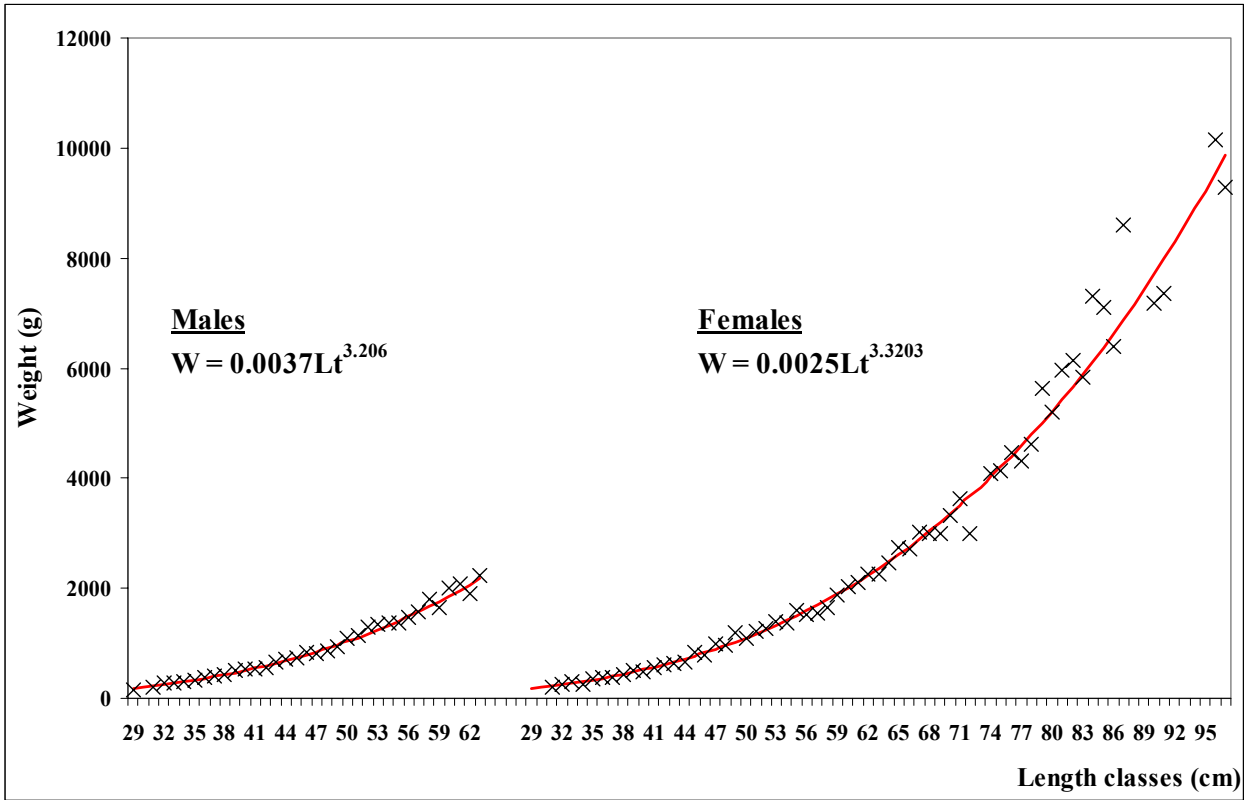


Figure 8. Length-weight relationship for Greenland halibut (males and females) in April 2008

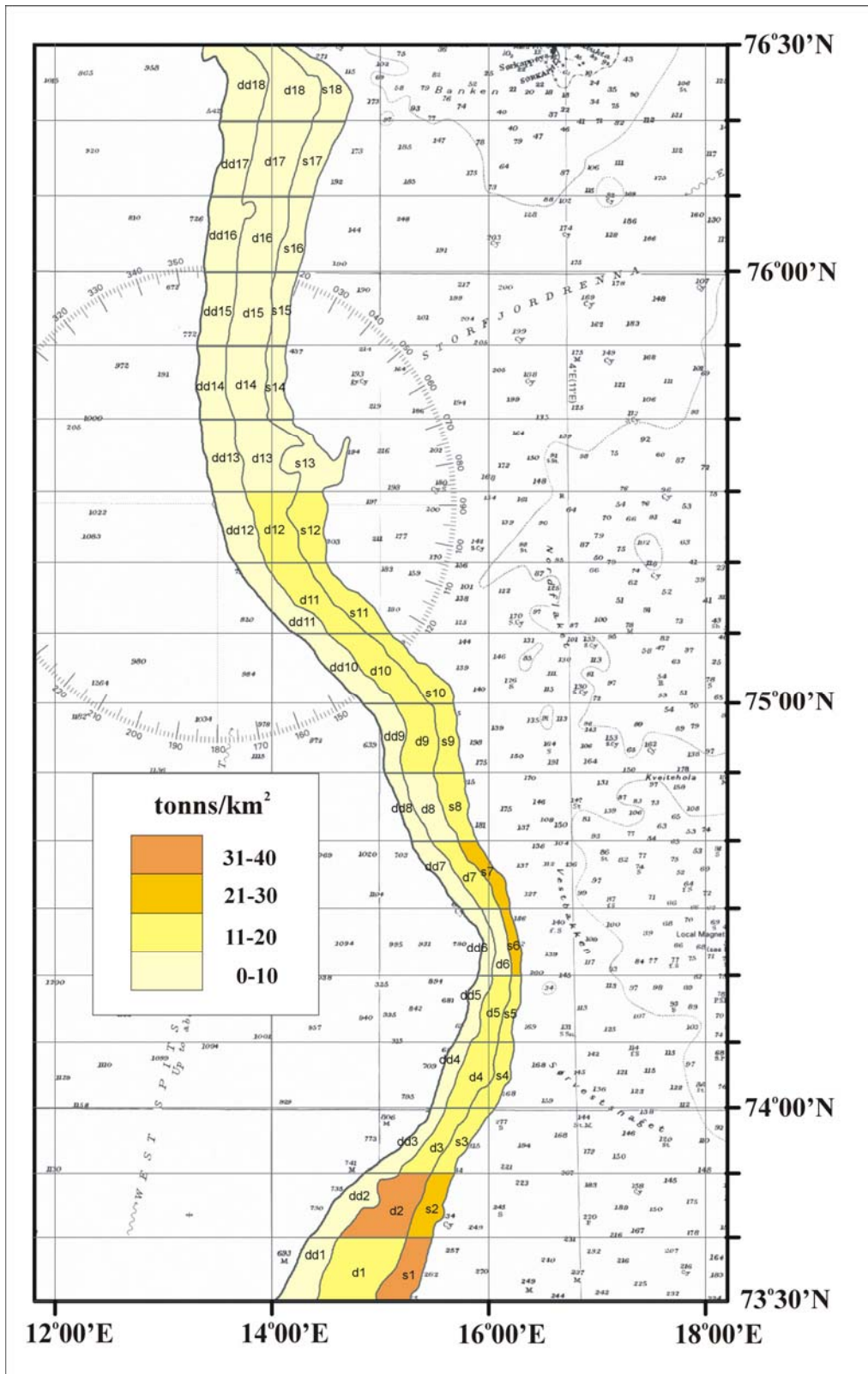


Figure 9. Density of Greenland halibut (tons/km²) in the Polish fishing survey in April 2008

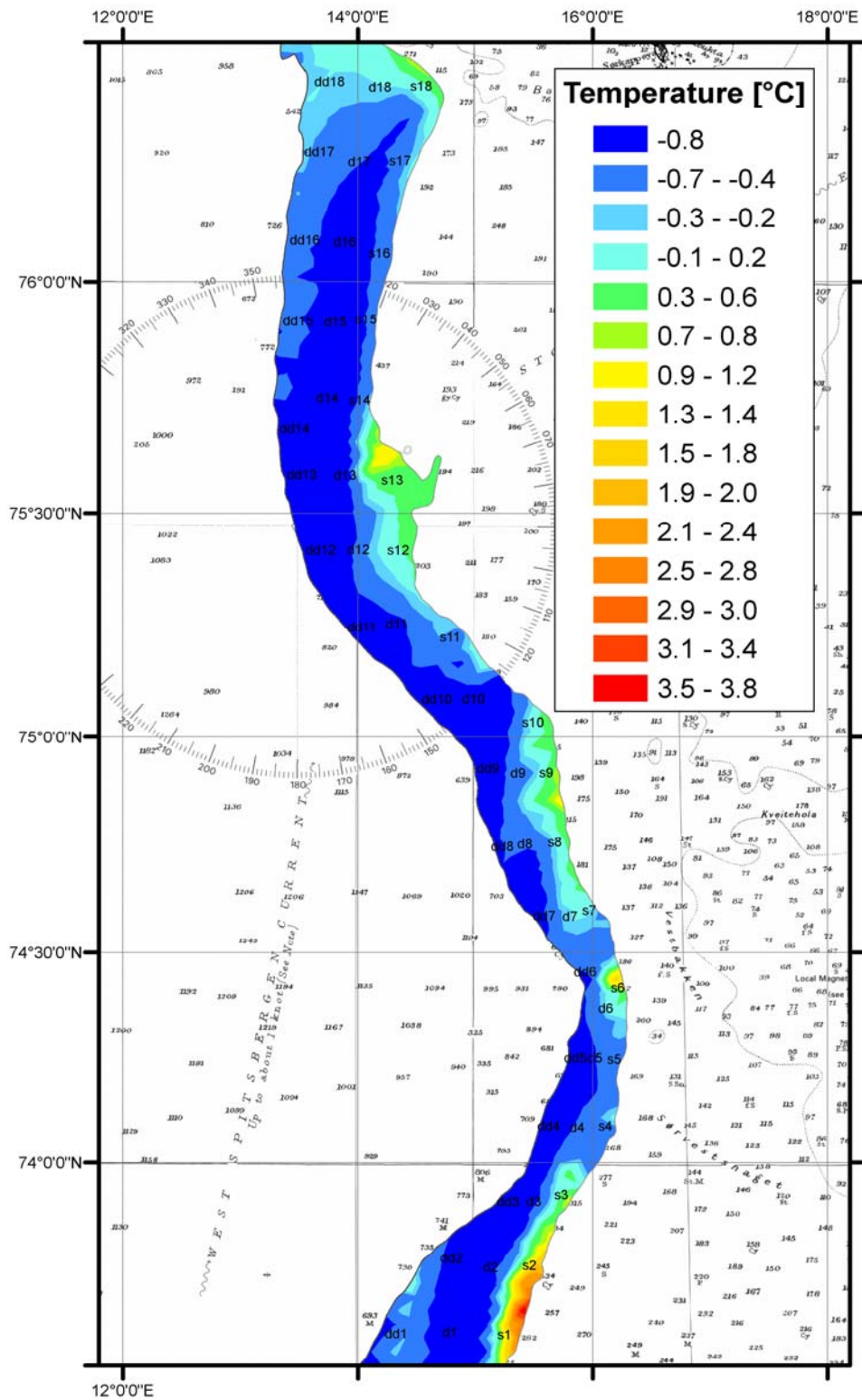


Figure 10. Temperature distribution (°C) of water on the bottom during April 2008

Protocol no 1

Number of TAG: **NO. 28984**

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

Date of catch: **9 April 2008**

Position of catch: **LAT: 73°31'2 N**
LON: 015°05'7 E

Time: **03.35 LT**

Vessel: **f/v Polonus**

Type of cruise: **fishing survey**

Depth: **564-648 m**

Temperature at the bottom during towing: **from “- 0.9°C” to “+4.0°C”**

Length: **55 cm**

Weight: **1415 g**

Age: **7 years**

Sex: **Male**

Gonad's maturity: **3**

Stomach fullness: **0**

Remarks: **photo**

