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Report on Greenland Halibut caught during the 2008 Trawl Surveys in NAFO Division 0A

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Abstract

Two stratified-random otter trawl surveys were conducted in southern Division 0A (Baffin Bay) in 2008. The surveys were conducted on the same cruise, using two different trawl gears, between October 8 and November 4, 2008. A Cosmos shrimp trawl was used at randomly selected stations between 100 m and 800 m. An Alfredo III trawl was used at randomly selected stations between 400 m and 1500 m. For the shallow water survey all 75 stations were successfully completed. A new stratification scheme was introduced for the deep water survey in 2008 which resulted in an increase in the stratified area from 49834 km^2 to 56445 km^2. In the deep water survey 86 of 91 planned stations were successfully completed. Greenland halibut were distributed throughout the deep water survey area and were present in all tows. In order to facilitate comparison to previous surveys the survey stations were plotted against the old stratification scheme and the number of stations present in each strata was determined post-hoc. Biomass and abundance were estimated to be 77182 t (S.E. 8465) and 1.16 x 10^8 (S.E. 1.1 x 10^7), respectively. Mean biomass per tow was 1.67 t/ km^2, higher than in 2006 and 1999 but lower than was observed in 2001 and 2004. Mean abundance per tow was 2598 per km^2, an increase over estimates in 2004 and 2006 but lower than was observed in 1999 and 2001. The overall length distribution ranged from 6 cm to 99 cm with a relatively flat top on the distribution (the mode stretched between 33 cm and 39 cm) and is most similar to that seen in 2006 and 1999. Slightly higher modes were seen in 2001 (42 cm) and 2004 (45 cm). Biomass and abundance based on the new stratification scheme were 94740 t (S.E. 9891) and 1.45 x 10^8 (S.E. 1.4 x 10^7), respectively.

Introduction

Two multi-species bottom trawl surveys were carried out in the southern portion (below 73 ^oN) of the North West Atlantic Fisheries Organization (NAFO) Division 0A (Baffin Bay). The surveys were conducted on the same cruise, using two different trawl gears, between October 8 and November 4, 2008. A Cosmos shrimp trawl was used at randomly selected stations between 100 m and 800 m (shallow water survey). An Alfredo III trawl was used at randomly selected stations between 400 m and 1500 m (deep water survey). Deep water surveys have been conducted in 1999 (Treble et al., 2000), 2001 (Treble 2002), 2004 (Treble 2005) and 2006 (Treble 2007).

The objectives were:

1. Collect the data required to establish age structure, estimate population abundance, biomass, and recruitment of Greenland halibut;
2. Collect the data required to establish age structure, estimate population abundance, biomass, and recruitment of shrimp;
3. Record numbers caught and collect length and weight data on all other commercial species caught, to allow calculation of abundance, biomass, and size structure of these species;
4. Record numbers and collect weight data on all non-commercial species caught, to allow calculation of abundance and biomass of these species;

5. Collect additional data and biological samples as desired and as time permits (e.g. lengths for by-catch, maturity information, coral samples, other special requests);
6. Collect temperature data at each fishing station;
7. Collect oceanographic data at pre-determined standard stations.

Materials and Methods

Stratification and Set Selection

In 2008 a change was made in the stratification scheme applied to the deep water survey. This change was made in order to match the stratification scheme used in Greenland surveys of SA1 which will facilitate comparisons between surveys conducted in Canadian and Greenland waters in the future. This also made it easier to combine the shallow water and deep water surveys into a single trip which reduced survey time and cost. The stratification was completed using an equidistant projection in ArcGIS software. The stratification for both surveys is shown in Figure 1. Very few Greenland Halibut have been found in the shallow water areas of Div. 0A and the data are not used in the assessment of Greenland Halibut in SA0 +1A (offshore) and 1B-F, therefore, only information from the deep water survey is presented in this document.

The stratification scheme used in the deepwater surveys is given in Table 1. The total area between 401 m and 1500 m encompassed by the new stratification in southern Div. 0A (to just north 72^o N) is 56445 km^2. This is an increase of 6611 km^2 over the 49834 km^2 covered by the old stratification scheme (Fig. 2 and Table 4). Some of the difference will be due to the fact the earlier stratification was measured by hand using paper charts while the new stratification was done using GIS software but most of the difference is likely due to the inclusion of additional area in the new strata, north of 72^o N and between 400 m and 500 m at several points along the Baffin Island coast. Survey coverage was approximately 1 set per 750 km^2 with a minimum of 2 sets per stratum. This coverage was similar to that used in previous surveys. A total of 91 stations were randomly selected from numbered units within each stratum using a buffered random design (Kingsley et al. 2004). The stations were assigned to depth categories as shown in Table 2.

Vessel and Gear

The surveys were conducted by the M/Tr Pâmiut, a 722 GRT stern trawler measuring 53 m in length. An Alfredo III bottom otter trawl with rock hopper ground gear was used for the deep water survey. Mesh size was 140 mm with a 30 mm mesh liner in the cod end. Trawl doors were Injector International, measuring 7.5 m^2 and weighing 2800 kg. These doors replaced the Greenland Perfect doors (9.25 m^2 and 2420 kg) in 2004. The average net height was 20 cm higher with the new doors but the overall net performance was not significantly different (95% level). Jørgensen (1998) contains more information about the trawl and gear. A Furuno based system mounted on the head rope measured net height and was used to determine bottom contact and the start/finish of each tow. Scanmar sensors measured the distance between the trawl doors. Wingspread, taken as the distance between the outer bobbins, was calculated as: distance between outer bobbins=10.122 + distance between trawl doors (m) x 0.142. This relationship was based on flume tank measurements of the trawl and rigging (Jørgensen 1998).

Oceanographic Sampling

A Seabird 19© CTD (conductivity, temperature and depth recorder) was mounted on the headrope and was used to determine temperature, depth and confirm the time spent on the bottom. In the few cases where there was no data from the CTD data from the Furuno trawl eye sensor was used.

A Seabird 19© CTD system equipped with a fluorometer was deployed at 5 to 6 stations on sections at Cape Christian and Broughton Island. Readings were taken to the bottom or within the top approx. 700 m of the water column at the deepest stations.

Trawling Procedure

The targeted tow duration was 30 minutes, however, tows down to 15 minutes in length were considered acceptable. Average towing speed was 3.0 knots. The towing speed used in the calculations for abundance and biomass was estimated from the start and end positions of the tow, or in a few cases from GPS observations (mean of records made every 5 minutes during the tow). Trawling took place throughout a 24 hr period in order to maximize the ships time and complete the necessary tows.

Biological Data Collection and Analysis

Numbers and total weight caught were recorded on a set by set basis for each species. Detailed sampling was carried out on Greenland halibut and shrimp. For other commercial species (e.g. redfish, grenadiers, skates) sexed length measurements were collected. Lengths were measured to the lowest 1 cm total length (0.5 cm pre anal fin length for grenadiers) using a standard meter board. Large catches of either Greenland halibut or shrimp were sub-sampled. Sub-samples of Greenland halibut were comprised of at least 200 fish. Adjustments were made during analysis to estimate total number caught in each case.

Greenland halibut sampling consisted of a visual assessment of maturity for all individuals based on maturity stages described in Riget and Boje 1989. For each sampled fish the whole weight was recorded at sea using an electronic balance. Otoliths for age determination were collected, 10 per 1 cm length group per sex. However, research on age determination methods for Greenland halibut is on-going so the otolith samples were not analyzed.

Various species from the catch were collected or had tissue samples taken for use by other researchers within DFO, the University of Dalhousie and the University of Manitoba.

Biomass and Abundance Indices

The swept area method was used in the estimation of biomass and abundance for Greenland halibut: Swept area=wingspread (m) x trawl time (min) x trawl speed (kn/hr) x $1.852/6x10^4$. Abundance and biomass were calculated for each set and standardized to 1 km^2:

Abundance (no./ km^2)=catch (no.)/sweptarea (km^2)
Biomass (tons/ km^2)=catch (kgs)/swept area (km^2)/1000.

Mean and standard error for abundance and biomass were calculated for each depth category. An estimate of total abundance and biomass was then calculated for each depth strata (mean x area surveyed within each depth strata (km^2)) as well as over all depths. Standard error values were also calculated for the overall total.

Abundance at length was calculated for each depth category (standardized to km^2 and weighted by tow), and a total abundance at each length (weighted by the strata area), was calculated (mean number/ km^2. x area surveyed within each depth strata (km^2)). The sum across all lengths and depth strata was calculated and compared to the overall abundance value determined above as a means of confirming the results.

Abundance, biomass and abundance at length were calculated for both the new and old stratification schemes. To get estimates based on the old stratification scheme survey stations were plotted against the old strata and the number of stations present in each strata was determined post-hoc.

Results and Discussion

For the new strata area 86 of 91 planned stations were successfully completed (Table 2) with the actual survey area covering 55734 km^2 out of a possible 56444 km^2 (Table 6 and 7). Only two strata were missed, one at 1401-1500 m and one at 601-800 m.

Of the 91 stations selected 86 were found to lie within the old stratification area and of these 83 were successfully completed. The resulting area surveyed was 46333 km^2 out of a possible 49834 km^2. This compares to survey

areas of 44915 km^2, 44484 km^2, 40475 km^2 and 44580 km^2 in 2006, 2004, 2001 and 1999, respectively. The post-hoc stratification resulted in similar coverage compared to previous surveys for most depths (Table 5). Coverage of the deepest strata (1001-1500 m) was better than in 2006 with the fewest hauls taken in depths 401-500 m.

Catches of most species other than Greenland halibut were small in number and so detailed analysis of these species is not presented here.

Mean near bottom temperatures throughout the 400 m to 1500 m depths varied from 1.6 ^oC to 0.2 ^oC in 2006 (Table 3). Mean bottom temperatures showed a declining trend with depth. The majority of tows (96.5%) had temperatures less than or equal to 2.0 ^oC (Appendix 1).

Greenland Halibut

Greenland halibut were distributed throughout the deep water survey area and were present in all tows (Fig. 3 and Appendix 1). Catch numbers varied from 2-769 and catch weight from 0.92-687.45 kg. Catch distribution for years 1999, 2001, 2004 and 2006 are shown in Figures 4 and 5.

Analysis Based on the Previous Stratification Scheme

The 2008 estimate of biomass based on the old strata area is 77182 t (S.E. 8465) (Table 6 and Fig. 6). This compares to 52271 t in 2006, 86176 t in 2004, 81002 t in 2001 and 68760 t in 1999. Biomass estimates at all depths are similar to or slightly greater than those observed in previous years.

There were problems with survey coverage in 2006 with two important strata missing from depths 1001-1500 m that was a contributing factor to the lower estimate for that year (Treble 2007). In 2004 there were 5 stratum missed but they were all at depths below 750 m and likely contained little biomass (Treble 2005). In 2001 eight strata were missed but only one was likely to contain substantial biomass (Treble 2002). There were 4 stratum missed in 1999, all below 750 m (Treble et al. 2000).

Mean biomass per tow or density in 2008 was 1.67 t/ km^2, higher than in 2006 and 1999 but lower than was observed in 2001 and 2004 (Table 6). Density was highest (2.3 to 3.0 t/ km^2) between 751 m and 1250 m as was the case in previous surveys. For depth strata 1001-1250 m density was lower compared to 2006 and 2004 but similar to or higher than observed in 2001 and 1999.

Abundance in 2008 is estimated at 1.16×10^8 (S.E. 1.1×10^7) (Table 7 and Fig. 6). This is greater than that observed in 2006 (9.22×10^7) but similar to other years (1.11×10^8 in 2004, 1.19×10^8 t in 1999 and 2001).

Mean abundance per tow was 2598 per km^2, an increase over estimates in 2004 and 2006 but lower than was observed in 1999 and 2001. For depth strata 1001-1250 m mean abundance was lower compared to 2006 and 1999 but similar to that seen in 2004 and 2001 (Table 7).

Length frequency distributions by depth strata for 2004, 2006 and 2008 are given in Figure 7. The number of fish at larger length classes increases with depth. There are a larger number of fish < 45 cm at depths 751-1000 m in 2008 compared to the most recent surveys. At depths 1001-1250 there are fewer fish at lengths 30-50 cm compared to 2006 but more fish <42 cm compared to 2004.

The overall length distribution in 2008 (adjusted for survey area) ranged from 6 cm to 99 cm with a relatively flat top on the distribution (the mode stretched between 33 cm and 39 cm) and is most similar to that seen in 2006 and 1999. Slightly higher modes were seen in 2001 (42 cm) and 2004 (45 cm) (Table 8, Figures 9 and 10).

The percentage of fish <45 cm was 69.5%, similar to the 2001 level but lower than was observed in both 2006 and 1999 (77%) (Table 8).

Note that the 1999 total abundance by length class in Table 7 does not match the overall abundance calculated for 1999 shown in Table 6 but it is reasonably close. The 1999 length frequency data were in a different format so the

SAS© programs used in subsequent years for biomass, abundance and length frequency calculations could not be applied. Instead the Excel© spreadsheet program was used and so the difference observed could be due to rounding or errors in performing the Excel calculations.

Analysis Based on the New Stratification Scheme

The 2008 estimate of biomass based on the new strata area is 94740 t (S.E. 9891) (Table 6 and Fig. 6). Biomass was greatest at depths 1201-1400 m. Mean biomass or density in 2008 was 1.70 t/ km^2, similar to that estimated using the old stratification scheme (Table 6). Density was highest (3.0 t/ km^2) between 1201 m and 1400 m.

Abundance is estimated at 1.45 x 10^8 (S.E. 1.4 x 10^7) (Table 7 and Fig. 6). Mean abundance was 2607 per km^2, similar to that estimated using the old stratification scheme.

The overall length distribution adjusted for survey area is given in Table 7 and is very similar in shape to that described above for the old stratification and so it has not been plotted. Length frequency distributions by depth strata are given in Figure 8. The number of fish at larger length classes increases with depth and the modal length changes from 33 cm to 48 cm.

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Table 1. New stratification scheme for Div. 0A based on 200 m depth intervals and implemented in 2008 (see Fig. 1).

Stratum	Depth (m)	Area (sq km)	Stratum	Depth (m)	Area (sq km)
A1-4	400-600	2151.56	A4-4	400-600	1921.58
A1-5	600-800	794.75	A4-5	600-800	2483.22
A1-6	800-1000	603.81	A4-6	800-1000	1375.61
A1-7	1000-1200	745.21	A4-7	1000-1200	1635.65
A1-8	1200-1400	812.76	A4-8	1200-1400	1071.88
A1-9	1400-1500	497.50	A4-9	1400-1500	709.73
A2-4	400-600	4649.39	B1-4	400-600	936.25
A2-5	600-800	2250.41	B1-5	600-800	741.28
A2-6	800-1000	1144.81	B1-6	800-1000	1190.02
A2-7	1000-1200	1873.10	B1-7	1000-1200	1288.00
A2-8	1200-1400	2151.49	B1-8	1200-1400	1778.91
A2-9	1400-1500	1153.19	B1-9	1400-1500	1035.21
A3-4	400-600	784.79	B2-4	400-600	2519.44
A3-5	600-800	759.93	B2-5	600-800	5107.81
A3-6	800-1000	1020.40	B2-6	800-1000	2656.17
A3-7	1000-1200	1306.99	B2-7	1000-1200	1788.51
A3-8	1200-1400	1145.95	B2-8	1200-1400	3329.50
A3-9	1400-1500	683.94	B2-9	1400-1500	345.99
Total Area	56444.73	sq. km.			

Table 2. Number of successful hauls, number planned in ( ) and depth stratum area for the new depth strata.

Depth Stratum (m)	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500	Total
Area (sq. km)	12963	12137	7991	8637	10290	4426	56444
Hauls planned	19	19	14	12	15	12	91
Hauls completed	19	17	13	12	15	10	86

Table 3. Mean temperature and S.E. in ( ) by depth stratum for NAFO Division 0A.

NAFO Division 0A	Depth Stratum (m) 401-500	501-750	751-1000	1001-1250	1251-1500
South-					
1999	1.6 (0.50)	1.4 (0.16)	1.0 (0.03)	0.6 (0.05)	0.1 (0.04)
2001	0.7 (0.10)	1.5 (0.22)	0.9 (0.07)	0.7 (0.05)	0.2 (0.05)
2004	1.3 (0.21)	1.5 (0.25)	1.0 (0.05)	0.6 (0.05)	0.1 (0.04)
2006	1.5 (0.34)	1.4 (0.12)	1.3 (0.09)	0.9 (0.08)	0.4 (0.25)
2008	**1.6 (0.39)**	**1.5 (0.10)**	**1.3 (0.05)**	**0.6 (0.05)**	**0.2 (0.03)**

Table 4. Stratification scheme for Southern Division 0A used from 1999 to 2006 (see Fig. 1). A conversion factor of 3.430 was used to calculate square kilometres from square nautical miles.

Stratum	Sq. N Miles	Units	Sq. Km.	Depth (m)
First roughed out by hand in 1986 and corrected in May 2004				
024	281	90	963.8	401-500
025	1527	510	5237.6	501-750
030	1004	330	3443.7	751-1000
031	832	280	2853.8	1001-1250
032	391	130	1341.1	1251-1500
033	305	100	1046.2	501-750
034	156	50	535.1	401-500
	4,496		**15,421**	
First done in March 1999 and corrected in May 2004				
040	1296	480	4445.3	1251-1500
041	546	200	1872.8	1001-1250
042	443	160	1519.5	751-1000
043	472	170	1619.0	501-750
044	289	110	991.3	401-500
045	268	100	919.2	501-750
046	281	110	963.8	751-1000
047	686	250	2353.0	1001-1250
048	653	240	2240.0	1251-1500
049	547	200	1876.2	1251-1500
050	491	190	1684.1	1001-1250
051	437	160	1499.0	751-1000
052	477	180	1636.1	501-750
053	214	80	734.0	401-500
054	649	240	2226.1	501-750
055	253	100	867.8	401-500
056	125	60	428.8	401-500
057	416	190	1426.9	501-750
058	220	100	754.6	501-750
059	377	170	1293.1	751-1000
060	422	190	1447.5	1001-1250
061	471	210	1615.5	1251-1500
	10,033		**34,413**	
TOTAL	**14,529**		**49,834**	

Table 5. Area, hauls planned in previous surveys, hauls planned and completed in 2008. Variation in previous coverage (hauls planned) is due to corrections made in 2004 to measured area (see Table 4 above).

Depth Stratum (m)	401-500	501-750	751-1000	1001-1250	1251-1500	Total
Area (sq. km)	4521	14866	8719	10211	11518	49835
Hauls planned in previous surveys	12	22 and 27	13 and 16	13 and 15	15 and 20	75 and 90
Hauls planned in 2008	7	28	14	20	17	86
Hauls completed in 2008	7	25	14	20	17	83

Table 6. Biomass estimates (tons) of Greenland halibut by depth stratum for NAFO Division 0A.

Year/Section	Stratum (m)	Survey Area (sq. km)	No. Sets	Mean Biomass (t/sq. km)	Biomass (tons)	SE
1999	401-500	2919	8	0.3914	1142.6	431.2
0A-South	501-750	11213	18	0.8232	9230.7	2825.8
	751-1000	8719	12	1.5764	13744.3	2559.2
	1001-1250	10211	12	2.9763	30391.4	7857.9
	1251-1500	11518	15	1.2373	14251.4	4588.4
	Overall	*44580*	*65*	*1.5424*	*68760.4*	*18262.5*
2001	401-500	429	2	0.3621	155.3	153.5
0A-South	501-750	11213	18	1.8865	21153.1	5107.0
	751-1000	8719	7	3.3261	29000.3	7665.9
	1001-1250	10211	7	2.5958	26505.5	7075.2
	1251-1500	9903	14	0.4228	4187.4	869.4
	Overall	*40475*	*48*	*2.0013*	*81001.6*	*20871.1*
2004	401-500	2823	5	0.6149	1735.9	504.2
0A-South	501-750	11213	13	1.4800	16595.5	6040.8
	751-1000	8719	12	2.0645	18000.8	5948.9
	1001-1250	10211	11	3.2376	33058.8	5589.9
	1251-1500	11518	17	1.4573	16785.4	7273.9
	Overall	*44484*	*58*	*1.9372*	*86176.4*	*12501.6*
2006	401-500	4092	10	0.2868	1173.6	197.4
0A-South	501-750	13439	20	0.3531	4745.9	569.4
	751-1000	8719	12	1.2338	10757.4	2020.4
	1001-1250	8763	8	3.4553	30278.4	9470.3
	1251-1500	9902	12	0.5368	5315.4	1052.3
	Overall	*44915*	*62*	*1.1638*	*52270.8*	*9759.0*
2008-old strata	401-500	3787	7	0.3396	1285.9	372.6
0A-South	501-750	13439	25	0.9026	12130.2	2914.6
	751-1000	8719	14	2.3468	20461.4	2719.4
	1001-1250	10211	20	3.0100	30734.7	4059.5
	1251-1500	10177	17	1.2352	12570.2	6256.1
	Overall	*46333*	*83*	*1.6658*	*77182.4*	*8464.5*
2008-new strata	401-600	12963	19	0.4875	6319.4	1319.0
0A-South	601-800	12137	17	1.1173	13561.0	3658.7
	801-1000	7991	13	2.4605	19662.2	2506.5
	1001-1200	8637	12	2.5909	22377.5	2445.9
	1201-1400	10290	15	3.0110	30983.4	8383.0
	1401-1500	3716	10	0.4941	1836.1	397.8
	Overall	*55734*	*86*	*1.6999*	*94739.6*	*9890.6*

Table 7. Abundance estimates (000's) of Greenland halibut by depth stratum for NAFO Division 0A.

Year/Division	Stratum (m)	Survey Area (sq. km)	No. Sets	Mean Abundance (sq. km)	Abundance	SE
1999	401-500	2919	8	1229.90	3.6E+06	1.3E+06
0A-South	501-750	11213	18	2327.80	2.61E+07	8.5E+06
	751-1000	8719	12	3482.70	3.04E+07	5.5E+06
	1001-1250	10211	12	4579.40	4.68E+07	1.3E+07
	1251-1500	11518	15	1045.40	1.2E+07	3.6E+06
	Overall	*44580*	*65*	*2666.22*	*1.19E+08*	*3.2E+07*
2001	401-500	429	2	553.60	2.4E+05	2.3E+05
0A-South	501-750	11213	18	3840.20	4.31E+07	1.0E+07
	751-1000	8719	7	4100.60	3.58E+07	9.9E+06
	1001-1250	10211	7	3456.60	3.53E+07	1.1E+07
	1251-1500	9903	14	439.60	4.4E+06	8.4E+05
	Overall	*40475*	*48*	*2932.65*	*1.19E+08*	*3.3E+07*
2004	401-500	2823	5	1892.90	5.34E+06	2.0E+06
0A-South	501-750	11213	13	2977.10	3.34E+07	1.1E+07
	751-1000	8719	12	3000.40	2.62E+07	9.5E+06
	1001-1250	10211	11	3319.00	3.39E+07	6.2E+06
	1251-1500	11518	17	1066.10	1.23E+07	5.1E+06
	Overall	*44484*	*58*	*2496.53*	*1.11E+08*	*1.7E+07*
2006	401-500	4092	10	1124.92	4.60E+06	1.1E+06
0A-South	501-750	13439	20	1110.16	1.49E+07	2.5E+06
	751-1000	8719	12	2651.23	2.31E+07	4.7E+06
	1001-1250	8763	8	5103.15	4.47E+07	1.4E+07
	1251-1500	9902	12	493.60	4.89E+06	1.0E+06
	Overall	*44915*	*62*	*2053.77*	*9.22E+07*	*1.5E+07*
2008-old strata	401-500	3787	7	915.03	3.47E+06	9.2E+05
0A-South	501-750	13439	25	2129.00	2.86E+07	6.5E+06
	751-1000	8719	15	4172.23	3.64E+07	5.5E+06
	1001-1250	10211	19	3735.31	3.81E+07	5.5E+06
	1251-1500	10177	17	945.24	9.62E+06	4.6E+06
	Overall	*46333*	*83*	*2508.26*	*1.16E+08*	*1.1E+07*
2008-new strata	401-600	12963	19	1400.37	1.82E+07	4.2E+06
0A-South	601-800	12137	17	2436.01	2.96E+07	8.0E+06
	801-1000	7991	13	4387.83	3.51E+07	5.2E+06
	1001-1200	8637	12	3628.08	3.13E+07	4.6E+06
	1201-1400	10290	15	2887.19	2.97E+07	8.3E+06
	1401-1500	3716	10	393.05	1.46E+06	3.2E+05
	Overall	*55734*	*86*	*2606.80*	*1.45E+08*	*1.4E+07*

Table 8. Length distribution (3cm groups) estimated total number (000's) for Greenland halibut from NAFO Div. 0A surveys (weighted by survey area).

Length Class (3cm)	1999	2001	2004	2006	2008 old strata	2008 new strata
0						
3						
6	73.240			1.707	22.507	28.385
9	26.119	7.370		10.101	0.000	0.000
12	61.248	16.925	25.854	24.231	6.104	7.698
15	21.036	192.867	722.746	463.183	318.896	407.562
18	322.593	181.545	443.925	1045.423	852.031	1102.517
21	639.739	766.476	1408.294	4342.790	1913.626	2495.620
24	2902.035	2130.242	1881.047	3895.186	2645.373	3463.112
27	8512.532	2464.872	5011.075	5402.579	5381.191	7399.898
30	12473.322	4327.508	5605.143	6754.058	9745.802	12556.852
33	15944.903	8561.021	8367.771	9331.157	15021.200	**19230.805**
36	16947.771	16223.824	10617.731	13128.299	15193.625	19141.755
39	***17014.003***	22102.681	13436.041	***14054.939***	**15541.288**	19056.068
42	14621.133	***23835.554***	15697.215	12623.585	14147.428	17361.246
45	10750.969	17459.631	***15979.390***	9052.162	12127.768	14917.451
48	6443.782	10695.541	13845.141	6147.754	8814.899	10759.702
51	4122.988	5219.180	9238.186	2945.622	5907.879	7138.504
54	2247.477	2096.945	4329.138	1826.323	3844.472	4539.230
57	1250.561	1189.117	2095.964	655.492	2321.885	2805.023
60	704.208	592.811	976.217	141.346	1366.325	1624.650
63	471.663	255.268	532.397	91.726	495.987	592.079
66	242.111	140.190	317.073	77.932	366.032	435.396
69	117.638	131.897	141.182	30.591	90.544	113.758
72	127.133	40.866	126.200	24.271	37.175	42.684
75	9.577	23.947	69.875		20.238	26.233
78	18.739		45.719		6.290	8.354
81	9.427		42.088		0.000	0.000
84	0.000	28.336	17.519		13.601	15.098
87	0.000		33.085		0.000	0.000
90	0.000		14.255		0.000	0.000
93	9.290		10.644		6.423	9.055
96			6.874		0.000	0.000
99		14.516			6.804	8.636
missing				175.886		
Total	116085.240	118699.128	111037.788	92246.343	116215.394	145287.370
Total <45 cm	89559.675	80810.884	63216.842	71077.237	80789.071	102251.518
percent <45 cm	77.150	68.080	56.933	77.052	69.517	70.379
percent <=35 cm	35.299	15.711	21.133	33.899	30.897	32.138

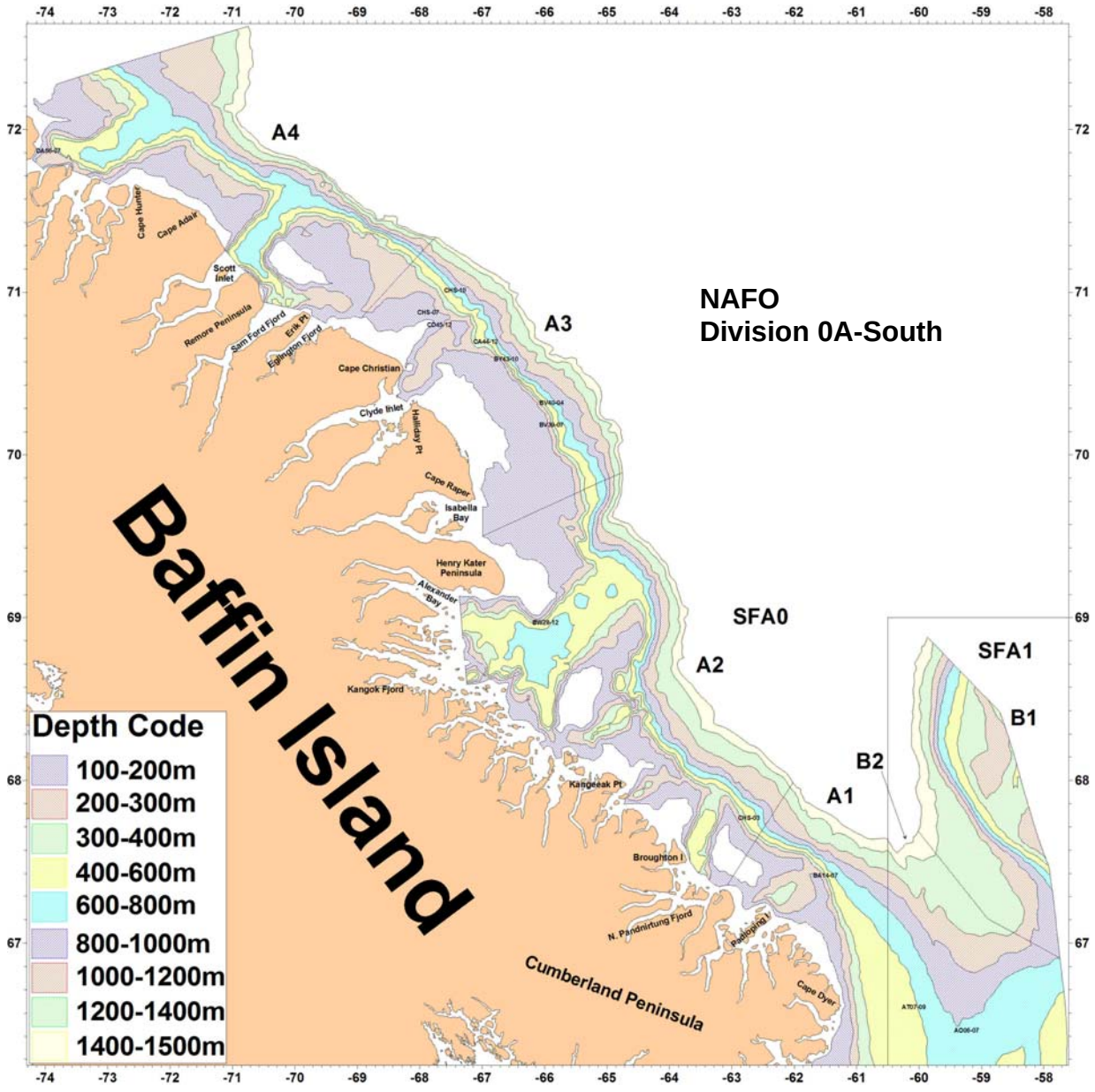


Figure 1. New stratification scheme for NAFO Division 0A-south for depths 100 m to 1500 m.

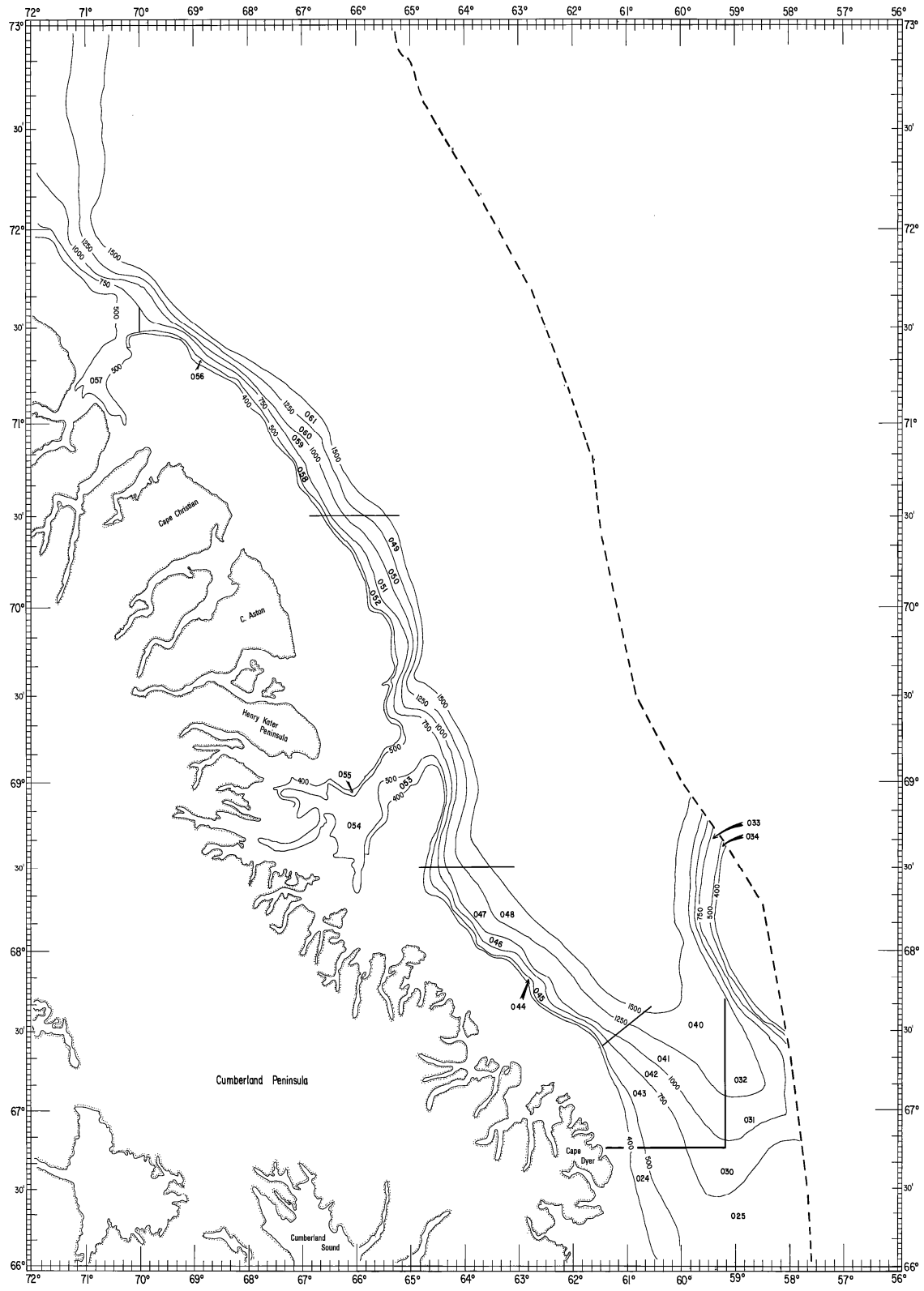


Figure 2. Stratification scheme for NAFO Division 0A depths 400 m to 1500 m from 66^{o} 15’ N to 72^{o} N, used from 1999 to 2007.

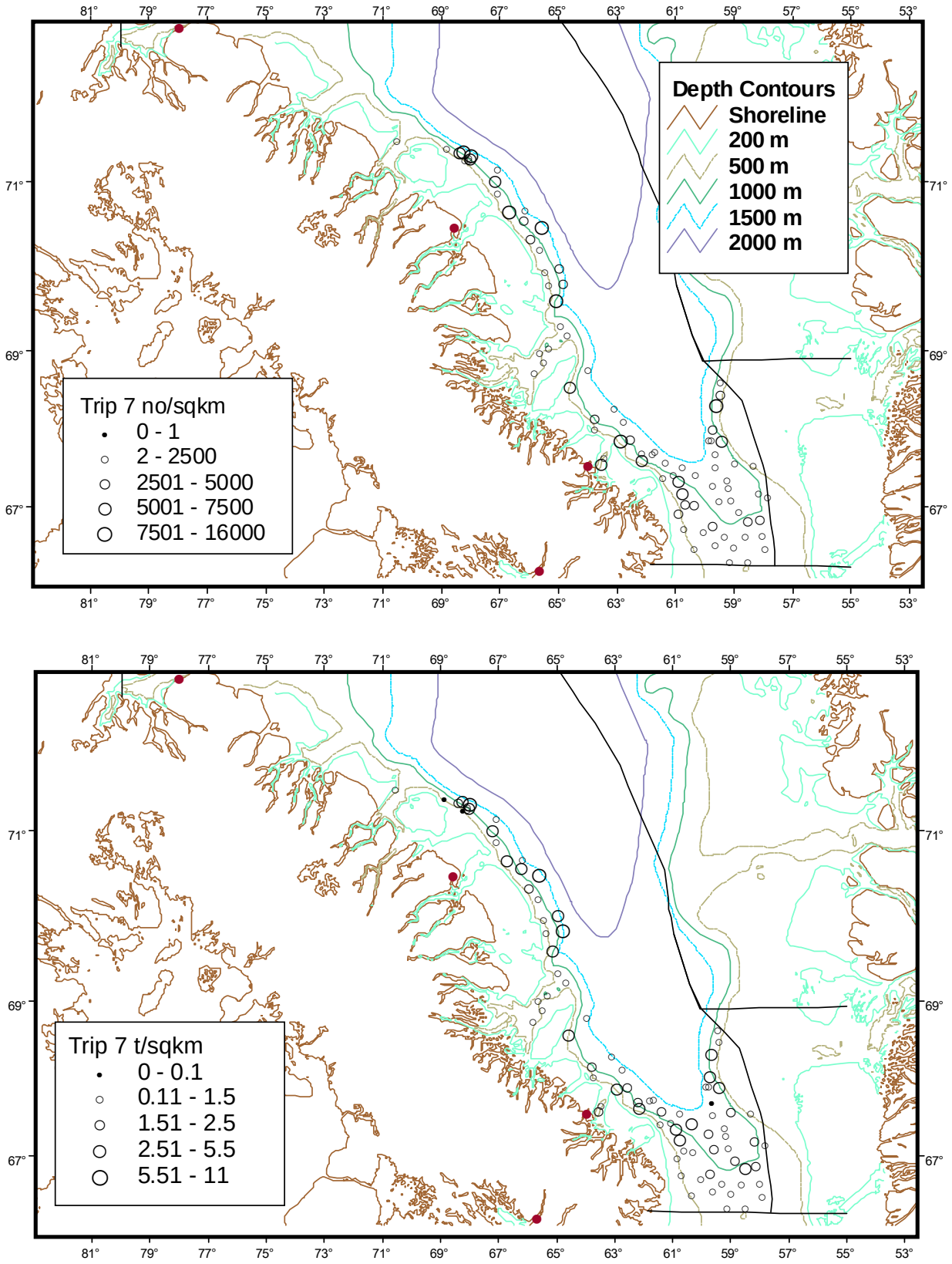


Figure 3. Distribution of catches (numbers/km^2 and t/ km^2 for the 2008 Division 0A survey for depths 400 m to 1500

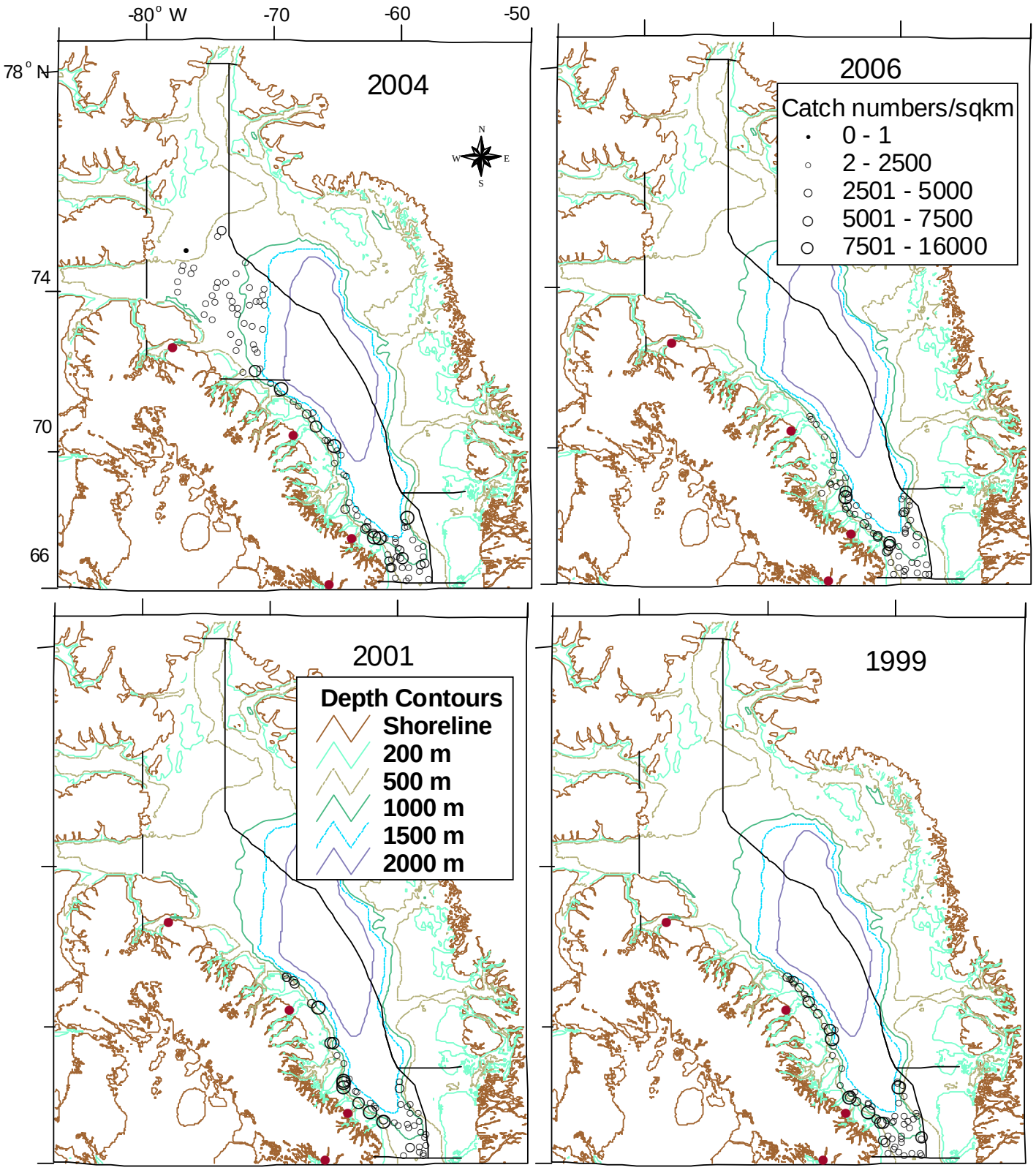


Figure 4. Distribution of catches (numbers/km^2) in Division 0A, 1999, 2001, 2004 and 2006.

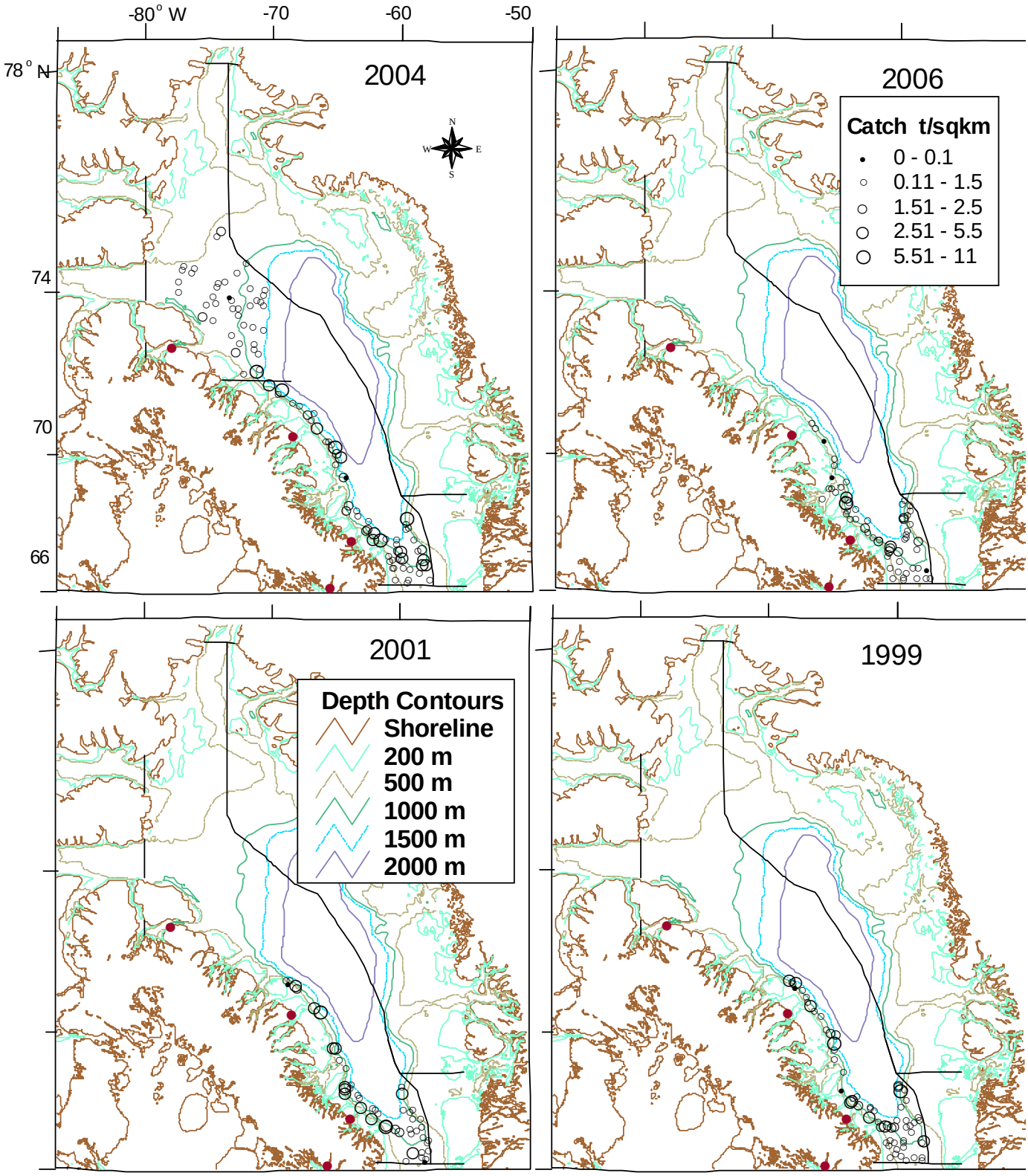
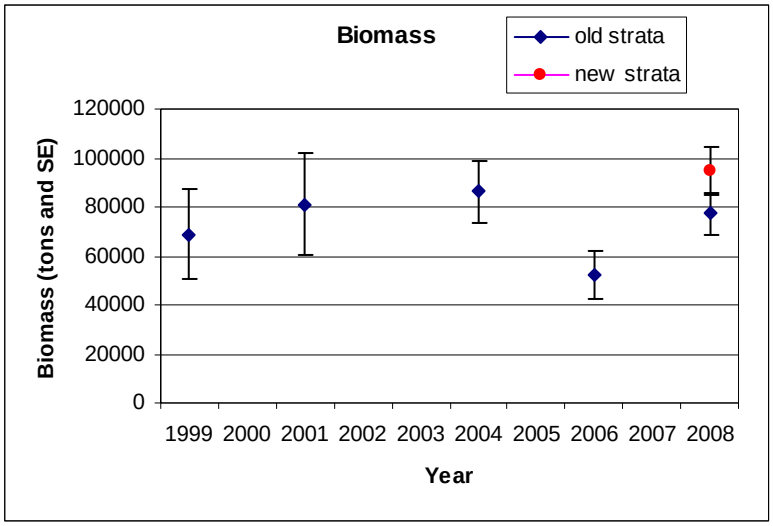


Figure 5. Distribution of catches (t/km^2) in Division 0A, 1999, 2001, 2004 and 2006.



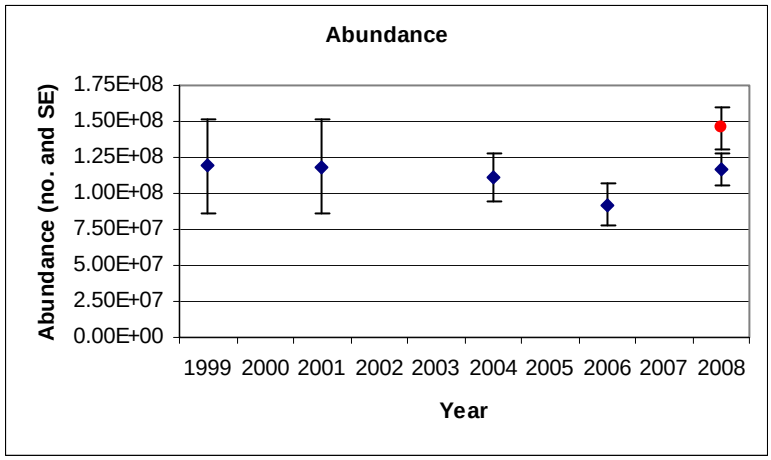


Figure 6. Biomass (top) and abundance (bottom) estimates for Greenland halibut in Division 0A-south.

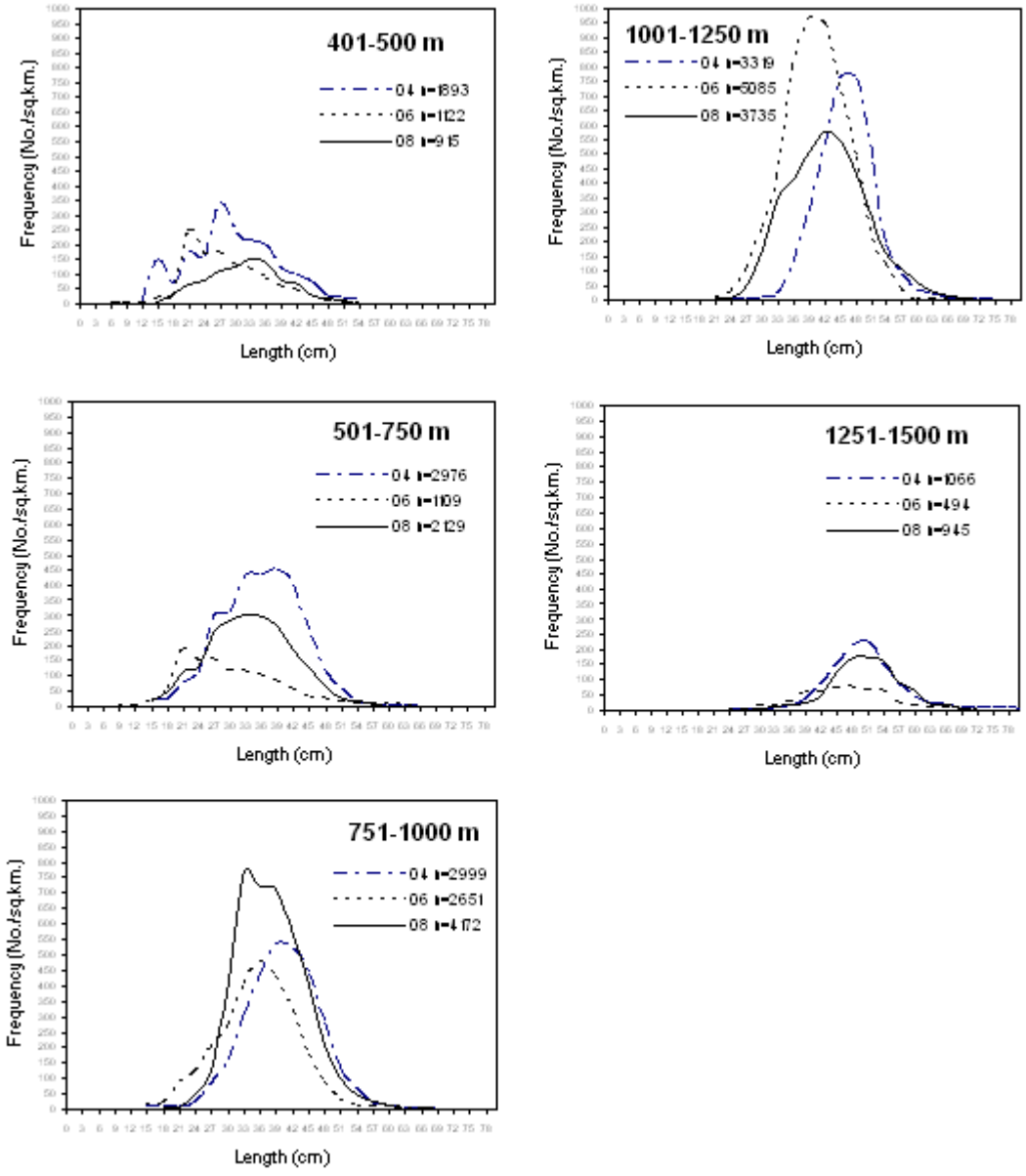


Figure 7. Greenland halibut length distribution, by depth for Division 0A-south, 2008 based on old stratification (standardized to numbers/km^2 and weighted by number of tows in each depth strata).

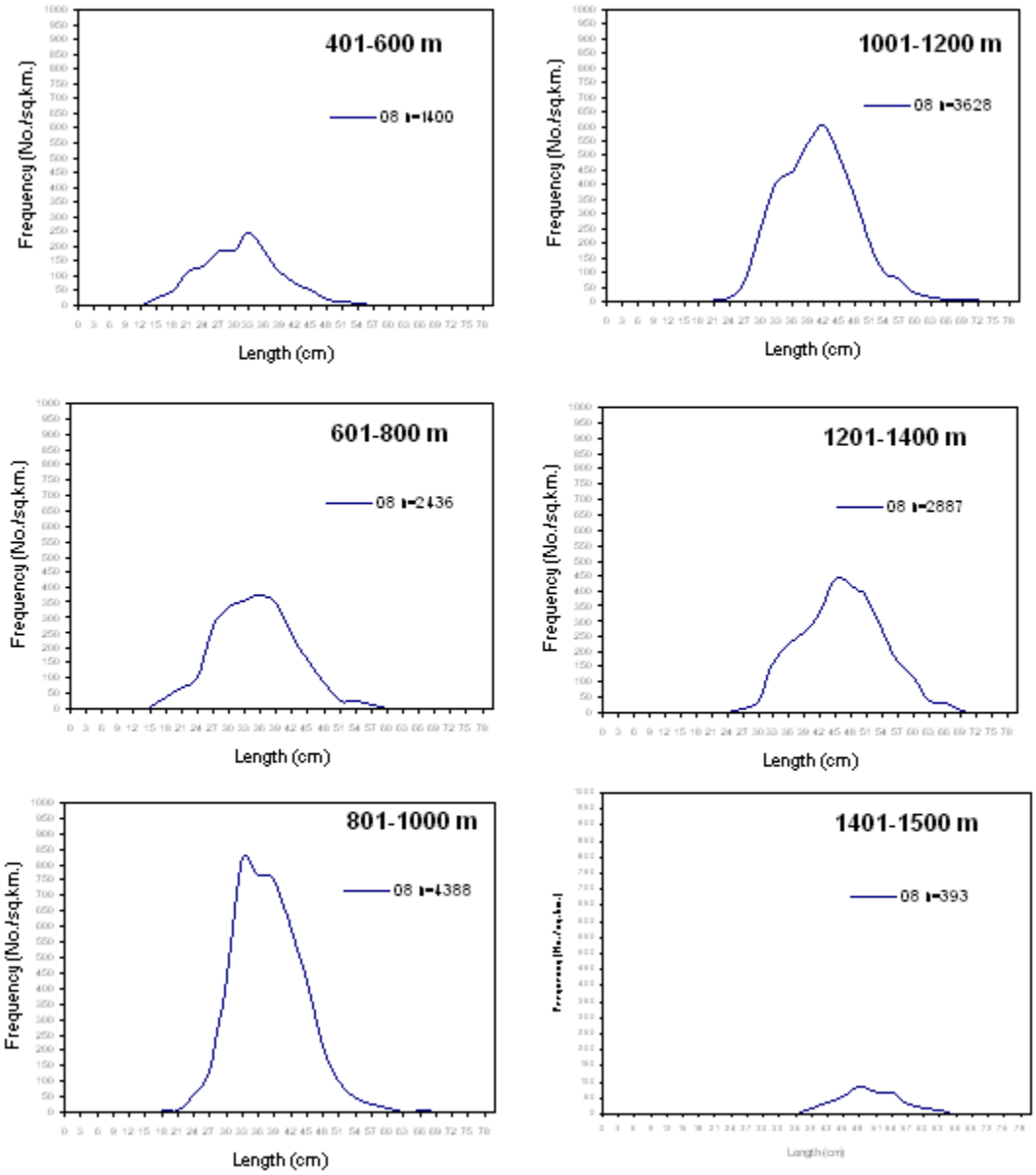


Figure 8. Greenland halibut length distribution, by depth for Division 0A-south, 2008 based on new stratification (standardized to numbers/km^2 and weighted by number of tows in each depth strata).

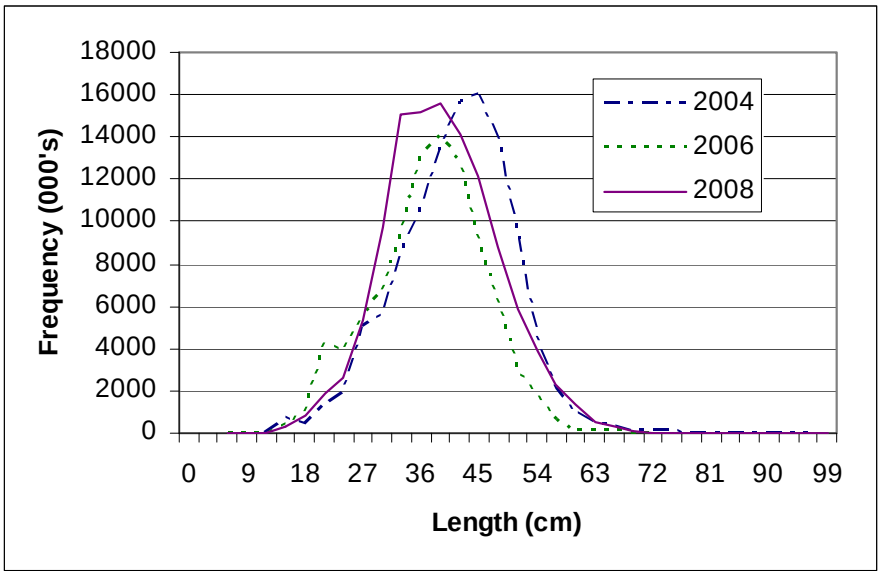


Figure 9. Estimated abundance at length for the Greenland halibut in NAFO Division 0A, 2004, 2006 and 2008 (weighted by stratum area). 2008 data based on old depth strata.

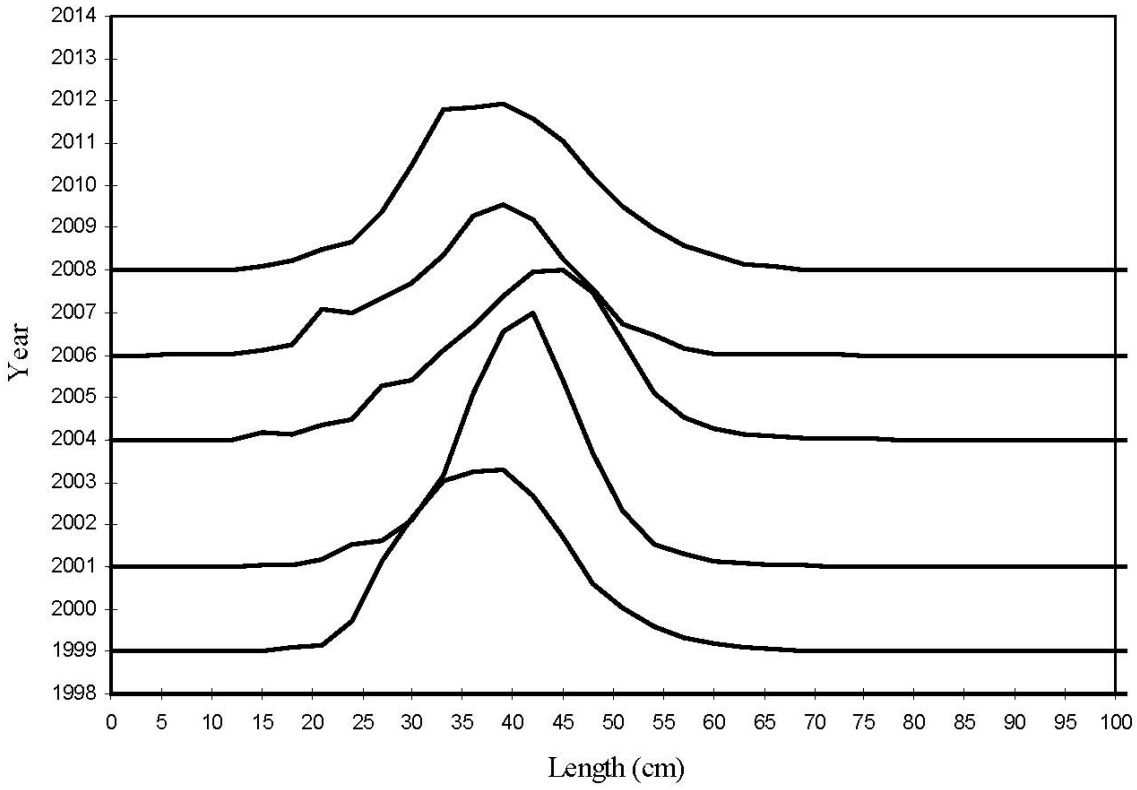


Figure 10. Length frequency distribution for Division 0A 1999-2008 (numbers/km^2 weighted by stratum area and scaled to maximum number over all years). 2008 data based on old depth strata.

Appendix 1. Catch weight and numbers (not standardised to kg/km2) of Greenland halibut, by haul for the 2008 survey of Division 0A depths 400 m to 1500 m.

Trip	Gear	Set No.	Stratum No.	Month	Day	Mean Depth (m)	Sweptarea (sq. km)	Depth Stratum	Temp. (°C)	Time (UTC)	Greenland halibut Number	Kg
7	Alfredo	1	B1-5	10	8	664.4	0.08546	800	2.15	13:09	190	74
7	Alfredo	3	B1-4	10	8	535.1	0.08258	600	2.96	17:58	308	90
7	Alfredo	6	B1-5	10	9	625.8	0.07344	800	1.8	1:13	584	335
7	Alfredo	9	B1-7	10	9	1125.7	0.08560	1200	0.83	10:45	357	331
7	Alfredo	12	B1-6	10	9	811.7	0.09203	1000	1.79	17:51	628	345
7	Alfredo	19	B1-4	10	10	442.1	0.07211	600	3.95	12:19	29	10
7	Alfredo	20	B1-8	10	10	1228.1	0.07498	1400	0.26	14:55	101	115
7	Alfredo	21	B1-9	10	10	1429.1	0.08270	1500	0.01	19:32	15	18
7	Alfredo	22	B2-9	10	10	1435.4	0.08017	1500	-0.02	22:19	15	20
7	Alfredo	23	B1-9	10	11	1418.3	0.08300	1500	0.04	1:20	5	6
7	Alfredo	28	B2-4	10	12	479.5	0.05682	600	1.25	1:49	54	15
7	Alfredo	31	B2-5	10	12	617.5	0.07810	800	1.5	9:56	85	38
7	Alfredo	32	B2-6	10	12	848.3	0.07781	1000	1.22	12:04	220	145
7	Alfredo	33	B2-6	10	12	863.7	0.08208	1000	1.28	14:21	125	82
7	Alfredo	34	B2-5	10	12	752	0.07741	800	1.41	16:53	106	67
7	Alfredo	36	B2-5	10	12	711.3	0.07845	800	1.38	22:10	55	50
7	Alfredo	37	B2-5	10	13	671.6	0.07806	800	1.39	0:25	66	34
7	Alfredo	39	B2-4	10	13	538.9	0.07288	600	1.34	3:57	89	22
7	Alfredo	42	B2-4	10	13	557.5	0.07901	600	1.97	11:33	46	26
7	Alfredo	44	B2-5	10	13	627.4	0.07991	800	1.36	16:31	63	45
7	Alfredo	47	B2-5	10	13	695.7	0.07269	800	1.37	22:32	69	31
7	Alfredo	49	B2-6	10	14	841	0.08307	1000	1.16	4:28	276	233
7	Alfredo	51	B2-6	10	14	839.7	0.07152	1000	1.13	9:08	180	168
7	Alfredo	53	B1-6	10	14	831.3	0.08623	1000	0.97	14:45	142	92
7	Alfredo	54	B1-7	10	14	1073.7	0.08901	1200	0.82	17:56	148	137
7	Alfredo	55	B2-7	10	14	1051	0.07949	1200	0.79	22:14	176	189
7	Alfredo	57	B2-8	10	15	1238.6	0.07844	1400	0.47	2:28	43	50
7	Alfredo	58	B2-7	10	15	1122.5	0.08935	1200	0.66	5:48	218	218
7	Alfredo	59	B2-8	10	15	1324.5	0.06482	1400	0.2	9:38	38	52
7	Alfredo	60	B2-8	10	15	1283.5	0.07390	1400	0.41	12:55	98	133
7	Alfredo	61	B1-8	10	15	1348.1	0.08992	1400	0.2	16:21	26	35
7	Alfredo	62	B2-9	10	15	1416.9	0.08924	1500	0.06	21:20	26	31
7	Alfredo	63	B2-8	10	16	1247.2	0.07676	1400	0.45	10:57	176	197
7	Alfredo	64	A1-6	10	16	930.2	0.08162	1000	1.15	14:32	438	299
7	Alfredo	65	A1-5	10	16	716.3	0.08354	800	1.47	17:02	523	259
7	Alfredo	67	A1-5	10	16	614.6	0.08428	800	1.5	20:56	232	80
7	Alfredo	68	B2-5	10	16	708.9	0.08185	800	1.43	23:20	213	115
7	Alfredo	71	A1-4	10	17	491.4	0.08863	600	1.22	6:01	155	63
7	Alfredo	74	A1-4	10	17	504.6	0.06790	600	0.07	11:42	258	76
7	Alfredo	76	A1-4	10	17	444.8	0.07819	600	1.19	16:44	128	51
7	Alfredo	78	A1-7	10	17	1016.4	0.05874	1200	0.99	21:12	94	68
7	Alfredo	79	A1-9	10	18	1427.6	0.06482	1500	0.07	0:45	52	66
7	Alfredo	80	A1-9	10	18	1423.1	0.07905	1500	0.18	5:44	33	40
7	Alfredo	81	A1-8	10	18	1236.1	0.07213	1400	0.33	8:14	53	62
7	Alfredo	82	A1-8	10	18	1324.2	0.08283	1400	0.34	11:00	121	143

7	Alfredo	84	A1-6	10	18	830.8	0.09121	1000	1.23	16:19	494	293
7	Alfredo	86	A1-7	10	18	1004.5	0.08997	1200	0.65	22:46	196	168
7	Alfredo	87	A2-7	10	19	1089.2	0.08684	1200	0.5	3:22	223	192
7	Alfredo	88	A2-5	10	19	688.8	0.08165	800	1.43	6:54	757	245
7	Alfredo	89	A2-8	10	19	1308	0.08545	1400	0.27	10:53	34	25
7	Alfredo	91	A2-7	10	19	1038.1	0.09460	1200	0.69	17:33	311	223
7	Alfredo	92	A2-9	10	19	1413.4	0.08586	1500	-0.02	21:23	25	34
7	Alfredo	93	A2-8	10	20	1324.1	0.08477	1400	0.22	1:54	10	14
7	Alfredo	94	A2-9	10	22	1444.5	0.04834	1500	0.27	21:22	45	54
7	Alfredo	96	A2-6	10	23	867.9	0.07292	1000	1.31	4:06	413	208
7	Alfredo	102	A2-4	10	23	550.5	0.08086	600	1.56	22:40	98	49
7	Alfredo	104	A2-4	10	24	524.5	0.06399	600	1.44	2:48	38	18
7	Alfredo	105	A2-6	10	24	898.5	0.09230	1000	1.22	6:36	769	323
7	Alfredo	107	A3-4	10	24	420.3	0.07868	600	1.23	11:11	42	17
7	Alfredo	108	A2-8	10	24	1225.4	0.06572	1400	0.45	13:40	316	447
7	Alfredo	109	A3-8	10	24	1211.8	0.07168	1400	0.52	16:18	354	373
7	Alfredo	111	A3-4	10	24	499.7	0.08124	600	1.39	19:49	90	32
7	Alfredo	114	A3-5	10	25	737.7	0.07833	800	1.5	1:18	74	28
7	Alfredo	116	A3-6	10	25	801.7	0.07814	1000	1.47	5:24	348	126
7	Alfredo	117	A3-8	10	25	1279.6	0.06326	1400	0.35	8:31	504	687
7	Alfredo	118	A3-7	10	25	1088.7	0.08176	1200	0.78	11:22	365	286
7	Alfredo	119	A3-9	10	25	1438.9	0.07147	1500	-0.01	13:40	30	42
7	Alfredo	121	A3-6	10	25	884.1	0.05833	1000	1.48	19:07	438	218
7	Alfredo	124	A3-5	10	26	627.9	0.07974	800	1.43	0:27	156	62
7	Alfredo	125	A3-7	10	26	1010.9	0.07934	1200	0.91	2:41	512	367
7	Alfredo	127	A3-9	10	26	1410.1	0.08311	1500	0.1	8:08	29	36
7	Alfredo	129	A4-8	10	26	1230	0.08876	1400	0.27	15:10	682	465
7	Alfredo	132	A4-4	10	26	432.5	0.07979	600	1.21	22:19	2	1
7	Alfredo	138	A4-4	10	27	435	0.05979	600	0.99	16:21	12	6
7	Alfredo	140	A4-7	10	28	1054.6	0.07828	1200	0.91	4:44	494	213
7	Alfredo	141	A4-7	10	28	1047.8	0.07613	1200	1.04	7:31	472	184
7	Alfredo	142	A4-8	10	28	1200.6	0.05739	1400	0.53	11:25	506	359
7	Alfredo	143	A4-6	10	28	946.5	0.07934	1000	1.27	13:37	130	47
7	Alfredo	144	A4-5	10	28	730.1	0.08530	800	1.41	15:28	50	13
7	Alfredo	145	A4-4	10	28	506	0.08114	600	1.29	17:12	9	2
7	Alfredo	162	A2-5	11	1	657.1	0.04278	800	1.16	12:44	35	12
7	Alfredo	163	A2-4	11	1	566.7	0.04834	600	1.21	14:49	78	26
7	Alfredo	164	A2-4	11	1	524.8	0.08163	600	1.33	17:29	26	12
7	Alfredo	165	A2-5	11	1	613.8	0.07670	800	1.1	20:16	23	9
7	Alfredo	175	A2-4	11	3	562.5	0.07632	600	0.32	5:37	126	45
7	Alfredo	176	A2-4	11	3	557.5	0.07697	600	0.37	8:43	398	135