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Analysis of data from a trawl survey in NAFO Division 0B, 2000

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Abstract

A stratified random otter trawl survey covering depths of 400 m to 1500 m and targeting Greenland halibut (*Reinhardtius hippoglossoides)* was conducted in NAFO Division 0B from October 9 to 19, 2000. This survey was a collaborative effort between Fisheries and Oceans Canada, the Nunavut Wildlife Management Board, and the Greenland Institute of Natural Resources. Survey coverage was 1 set per 1030 km^2 with a minimum of two tows per stratum. This criteria was met in all strata with 64 valid tows of the 69 tows conducted. Greenland halibut were present in all tows with the greatest densities between 501 m and 1250 m. Total estimated biomass and abundance for the survey area were 56,212 tons and $74.6x10^6$, respectively. Lengths ranged from 7 cm to 92 cm with 56.5% less than 46 cm. The distribution was bi-modal with peaks at 19 cm and 43-45 cm. Age distribution was estimated using an age-length key from the GINR 2000 survey of NAFO Divisions 1CD. Ages ranged from 0+ to 19 years with a modal age of five years. The majority (90.6%) were less than eight years old. The catch of other commercially important species was minimal. However, data on these and other non-commercial species from the by-catch are also presented.

Introduction

A stratified random survey in the North West Atlantic Fisheries Organization (NAFO) Division 0B was conducted from October 9 to 19, 2000. This was a joint survey between the Department of Fisheries and Oceans, Nunavut Wildlife Management Board, and the Greenland Institute of Natural Resources. The Greenlandic research vessel *Paamiut* was used to carry out the survey. The science crew was comprised of six Canadians and one scientist from Greenland. The survey in Division 0B was conducted immediately following the survey in 1CD. The objectives of the survey were: (1) to fish at randomly-selected fishing stations to determine the distribution and abundance of various groundfish species, (2) to collect biological samples from Greenland halibut, and (3) to collect oceanographic data at each fishing station. Division 0A was surveyed in 1999 (see Treble et al, 2000), and Division 0B was surveyed in 2000. Both Divisions are to be surveyed in 2001. A comparison of survey results between Div. 0B and 1CD is made easier through the use of the same vessel, fishing gear and crew. This should assist in the overall assessment of the stock complex in Subarea 0+1.

Materials and Methods

Stratification of Division 0B, and Set Selection

Table 1 lists the strata (401-1500 m) used for the survey in Div. 0B from Bowering, 1987. This stratification scheme is also shown in Fig. 1. The total area between 401 and 1500 meters encompassed by the strata in Div. 0B is approximately 74,483 km^2 (21,715 nm^2). Survey coverage was intended to be approximately 1 set per 1030 km^2 (300 nm^2), with a minimum of 2 sets per stratum, and sets were allocated proportionally to stratum size. This coverage level is similar to that achieved in the 1999 survey in Div. 0A. A total of 75 sets were randomly selected from numbered units within each stratum, along with an additional 2 sets per stratum to be used as alternate fishing stations if necessary.

Vessel and Gear

The same fishing gear and protocols as used by the Greenland Institute during their groundfish surveys of Subarea 1 on the *Paamiut* were employed in both the 0A and 0B surveys in 1999-2000. The MV Paamiut is 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 survey. Mesh size was 140 mm with a 30 mm mesh liner in the cod end. Trawl doors were Greenland Perfect (370 cm x 250 cm) weighing 2400 kg mounted with an extra 20 kg. 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). The survey trawl was measured using a checklist prior to the start of the trip and after any major gear damage.

A Seamon temperature sensor mounted on one of the trawl doors was used to measure near bottom temperatures to within $\pm 0.1^{o}$ C for each set.

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 kn. 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. Total weight of invertebrates and the % composition of major invertebrate species were also recorded. Detailed sampling was carried out on Greenland halibut, as outlined below. For other commercial species (gadoids, flatfish, redfish, grenadiers, skates) sexed length measurements were collected. Measuring boards using an offset of 0.5 cm were used, and lengths measured to the nearest 1 cm (0.5 cm for grenadiers). For example any fish between 24.50 cm and 25.49 would be measured as 25 cm. Three large catches of Greenland halibut were sub-sampled with 32%, 42% and 71% of the catch sampled in each case.

Greenland halibut were the targeted species and were therefore sampled in more detail. A maturity assessment for all individuals was done visually, based on maturity stages described in Templeman et al. (1978). Fish less than 14 cm fork length were recorded as unsexed. For each sampled fish >=14 cm 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 for fish >=14 cm. For fish <14 cm (unsexed), 6 per 1cm group were collected. Stomachs were collected and frozen for more detailed analysis later, three per 5 cm length group per set.

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

Biomass and Abundance Indices

The swept area method was used in the estimation of biomass and abundance: Swept area=wingspread (m) x trawl time (min) x trawl speed (kn/hr) x $1.852/6x10^4$. A standard trawl speed of 3 knots was used in the calculation of swept area for all tows. Abundance and biomass were calculated for each set and standardized to 1 sq km:

Abundance (no./sq. km)=catch (no.)/sweptarea (sq km) and biomass (tons/sq km)=catch (kgs)/swept area (sq km)/1000. Mean and standard error for abundance and biomass were calculated for each stratum. An estimate of total abundance and biomass was calculated for each stratum (mean x stratum area (sq km)). These values were then summed to determine overall estimates for the survey area.

Abundance at length was calculated using the estimated total abundance and the proportion at length values from the sampled lengths. The length-weight relationship applied to this data was an average from Subarea 2+3: weight (kg) = length (cm) x $(4.03x10^{-6})^{3.1935}$ (Gundersen and Brodie 1999).

DFO-Central and Arctic Region is still developing the expertise to age Greenland halibut otoliths. In the meantime an age-length key from the GINR age determination lab was used to develop the age distribution for Division 0B. This key is based on 406 samples collected during the survey of Division 1CD in September, 2000.

Results and Discussion

Survey Area

Near bottom temperatures ranged from a high of 3.8 ^oC in stratum 4 to a low of 0.9 ^oC in stratum 24 (Table 2, Fig. 1). The majority of tows (95.6%) had temperatures greater than or equal to 1.5 ^oC. Mean temperatures by depth stratum ranged from 2.1 ^oC for the 401-500 m depth stratum to 3.5 ^oC for the 751-1250 m depth strata (Table 4).

The stratified area within Division 0B covers 74,483 sq km (21,715 sq nm) (Table 3, Fig. 1). A minimum of two tows were completed in all strata. Sixty-nine of the 75 hauls planned were conducted with five considered unsuccessful. Several planned sets in stratum 4 were dropped due to untrawlable bottom. Table 4 contains set by set information on stratum, swept area, mean depth, near bottom temperature and catch for Greenland halibut, roundnose grenadier (*Coryphaenoides rupestris*), roughhead grenadier (*Macrourus berglax*), deep sea redfish (*Sebastes mentella*) and American plaice (*Hippoglossoides platessoides*).

Greenland Halibut

Greenland halibut were distributed throughout the survey area and were present in all completed tows (Fig. 2). The catch was comprised of 65.9% males, 33.7% females and 0.4% sex unknown. Catches varied from 0.47 kg (n=1, 500 m) to 254.75 kg (n=262, 1156 m) (Table 4). The greatest densities were within the 1001 to 1250 m depth strata (Fig. 2, Tables 5 and 6).

Total biomass for the survey area was estimated at 56,212 tons (Table 5). The biomass estimated using abundance at length and the length-weight relationship is similar at 51,274 tons (Table 7). This compares to 76,559 tons estimated for these strata in a 1990 survey conducted Oct. 25 to Nov. 9 by the Kapitan Shaitanov (Chumakov and Soshin 1991) which used a different trawl.

Abundance was estimated at 74.6 x 10^6 with the highest values occurring in the 1001-1250 m strata (Table 6).

Figure 3 shows length frequency distribution by depth strata. There is a broader size distribution for depths below 750 m than seen at greater depths. Fish size increased with depth. Modal lengths for strata 401-500 and 501-750 were 18-20 cm and 39-41cm, respectively. Modal lengths for strata 751-1001 to 1250-1500 m were similar varying from 42-44 cm to 45-47 cm. Overall lengths ranged from 7 cm to 92 cm with two modes at 19 cm and 43-45 cm (Table 7, Fig. 4). The depth strata between 401 and 750 comprise 68% of the survey area in Div. 0B. This may explain the presence of the small mode at 19 cm.

Ages ranged from 0 to 19 years with the highest abundance at age five (1995 year class) for males and females combined (Table 8, Fig. 4). This age distribution was developed using an age-length key from Div. 1CD.

Bowering and Parsons (1986) present survey data that show a catchability effect for young Greenland halibut between day and evening tows. Due to time constraints and for reasons of economy the survey of 0B consisted of tows taken throughout the day and night. The length frequency distribution (Fig. 3) shows very few fish below 24.5 cm therefore, it is concluded that if a similar catchability effect occurs for Greenland halibut in the Div. 0A survey area it is likely to have a minimal effect on the overall estimation of abundance and biomass.

Grenadiers

Roundnose grenadier were present in 28 of 64 valid (Table 4). Estimated biomass and abundance were 1,660 tons and 9.2 x 10^6, respectively (Table 8). There were no roundnose grenadier caught below 501 m.

Roughhead grenadier were present in 49 of 64 valid tows (Table 4). Biomass was estimate as 3,585 tons with an abundance of 12.7 x 10^6 (Table 9).

Redfish, American Plaice and Atlantic Cod

Deep sea redfish were present in 44 of 64 valid tows (Table 4). Estimated biomass and abundance were 3,448 tons and 4.2 x 10^6, respectively (Table 10). American plaice were present in 17 of 64 valid tows for a total number and weight of 28 and 6.72 kg, respectively. The least abundant was Atlantic cod (*Gadus morhua*) present in only one tow.

Elasmobranchs

There were five species of elasmobranchs caught during this survey, Black dogfish shark *(Centroscyllium fabricii*) and four species of skates were identified (Appendix 1). The dogfish shark was present in 24 of 64 tows with an estimated biomass of 2231 tons and abundance of 2.5 x 10^6 (Table 11). There were no black dogfish caught below 501 m.

There was a single record for arctic skate (*Amblyraja hyperborea*) (13.25 kg). A single round skate (*Raja fyllae*) was caught in each of 3 tows. One to two spinytail skate (*Bathyraja spinicauda*) were found in three tows. Eight small skate (total weight 0.85 kg) could only be identified to Genus Raja. Thorny skate (*Amblyraja radiata*) were most abundant, 22 fish at 11.93 kg total weight. Estimates of total biomass and abundance for thorny skate were 628 tons and 924,749, respectively (Table 12). There were no thorny skate located at depths >751 m.

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Table 1. Strata used in survey of Division 0B in 2000 (Bowering, 1987).

Stratum	Sq. N Miles	Approx . # units	Depth (m)	SETS per 300 sq mi.	# sets planned
3	2616	748	401-500	8.72	9
4	4671	1335	501-750	15.57	16
5	2070	592	751-1000	6.90	7
6	1975	564	1001-1250	6.58	7
7	1641	469	1251-1500	5.47	6
10	1566	448	401-500	5.22	5
11	2311	661	501-750	7.70	8
12	943	270	751-1000	3.14	3
13	343	98	1001-1250	1.14	2
24	1449	414	401-500	4.83	5
25	2130	609	501-750	7.10	7
Total	21715			72.38	75

Table 2. Mean temperature, S.E. and number of observations for NAFO Division 0B by depth stratum.

Depth Stratum (m)	401-500	501-750	751-1000	1001-1250	1251-1500
^{o}C	2.1	2.5	3.5	3.5	3.2
S.E.	0.20	0.15	0.04	0.03	0.02
number obs.	20	22	12	9	5

Table 3. Area of depth strata for NAFO Division 0B with the number of hauls planned ( ) and considered valid. A factor of 3.430 was used to convert square nautical miles to square kilometers.

Depth Stratum (m)	401-500	501-750	751-1000	1001-1250	1251-1500	Total
Area (sq. nm)	5631	9112	3013	2318	1641	21715
Area (sq. km)	19314	31254	10335	7951	5629	74483
Hauls	(19) 18	(31) 20	(10) 12	(9) 9	(6) 5	(75) 64

Table 4. Catch weight and numbers (not standardised to kg/km^2) of Greenland halibut, roundnose grenadier and roughhead grenadier, sebastes mentella and American plaice by haul for NAFO Division 0B. Depth in m, swept area in km^2 and bottom temperature in ^{o}C.

			Mean	Sweptarea		Temp.	Time	Greenland halibut		Roundnose grenadier		Roughhead grenadier		S. mentella		American plaice	
Set No.	Month	Day	Depth (m)	(sq. km)	Stratum	(^{o}C)	(NST)	Number	Kg	Number	Kg	Number	Kg	Number	Kg	Number	Kg
1	10	9	969	0.07546	12	3.7	7:46	94	84.15	2	0.12	10	4.3	1	0.19	1	0.12
2	10	9	1099	0.07546	13	3.3	23:53	558	427.2	5	0.28	42	14.8	1	0.21		
3	10	10	1251	0.07546	13	3.4	2:00	480	392.6	21	2.82	16	9.2	1	0.19		
4	10	10	1088	0.07546	6	3.4	7:10	90	76.85	17	2.3	34	11.7				
5	10	10	948	0.07743	5	3.5	9:41	72	59.55	3	0.4	11	1.77				
6	10	10	914	0.07940	5	3.5	11:48	132	108.45	16	1.01	16	5.58				
7	10	10	988	0.07861	5	3.6	14:05	132	111.1	7	1.89	7	1.51				
8	10	10	959	0.07861	5	3.5	16:09	70	61.85	6	0.57	13	4.36				
9	10	10	983	0.06520	5	3.5	20:46	95	79.05	13	1.24	12	4.52				
10	10	11	1062	0.08019	6	3.5	0:36	190	186.4	94	26.05	17	9.65				
11	10	11	1140	0.07546	6	3.5	5:50	9	9.1	14	2.54	13	8.25				
12	10	11	1463	0.07546	7	3.2	11:06	166	172.65	39	17.95	9	3.05				
13	10	11	1395	0.07546	7	3.2	13:30	96	95.7	32	7.95	14	6.2				
14	10	11	1344	0.07546	7	3.2	15:43	241	243.9	12	2.31	13	10.5				
15	10	11	1429	0.07546	7	3.3	23:12	80	86.9	35	13.7	6	2.3				
16	10	12	1404	0.07546	7	3.2	1:41	81	105.8	47	19.2	2	1.85	2	0.26		
17	10	12	839	0.06540	5	3.2	5:08	282	184.6	6	0.74	10	5.86	11	1.62		
18	10	12	557	0.03097	4	3.4	7:56	12	7.1			1	0.04	72	7.9		
19	10	12	600	.	4	.	13:02										
20	10	13	437	0.07427	3	2.7	15:21	40	13.95					280	14.55		
21	10	13	500	0.04527	3	3.0	18:34	8	3.25					185	15.4		
22	10	13	489	0.07388	3	3.5	20:41	10	4.94			3	0.48	186	18.35		
23	10	13	500	0.07112	3	3.4	22:05	1	0.47			7	2.06	490	42.97		
24	10	13	477	0.06437	3	3.6	23:49	4	1.36			2	0.43	344	22.65		
25	10	14	444	0.07348	3	2.5	1:45	17	9.75			7	1.34	322	18.7	1	0.12
26	10	14	529	0.07427	4	3.4	8:19	12	13			4	0.57	330	28.1		
27	10	14	500	0.06232	3	3.1	10:46	11	8.7			6	0.93	138	13.5		
28	10	14	619	0.05057	4	3.2	12:50	8	6.6			3	0.9	139	17.6	1	0.3
29	10	14	923	0.07901	5	3.6	14:26	196	151.45	64	3.07	12	8.05	4	0.54		
30	10	14	681	0.07822	4	2.9	16:17	94	66.35			30	5.19	517	72.45		
31	10	14	484	0.03577	3	2.4	17:44										
32	10	14	472	0.07269	3	2.8	19:18	15	8.02			1	0.32	187	15.65		
33	10	14	654	0.04622	4	2.7	21:13	8	5.44			7	1.56	78	12.05		
34	10	14	619	0.07269	4	2.9	23:05	45	24.06			33	8.65	529	66.7	5	1.7

Table 4. Continued.

			Mean	Sweptarea		Temp.	Time	Greenland halibut		Roundnose grenadier		Roughhead grenadier		S. mentella		American plaice	
Set No.	Month	Day	Depth (m)	(sq. km)	Stratum	(°C)	(NST)	Number	Kg	Number	Kg	Number	Kg	Number	Kg	Number	Kg
35	10	15	685	0.07861	4	2.6	2:28	64	45.9			34	6.8	106	14.85	5	1.04
36	10	15	1074	0.07901	6	3.6	6:23	225	211.35	10	2.05	26	10.55				
37	10	15	1156	0.07546	6	3.5	8:43	262	254.75	20	3	28	10.65				
38	10	15	1156	0.07546	6	3.5	11:26	57	53.2	38	5.1	30	14.3	1	0.23		
39	10	15	1088	0.07546	6	3.6	13:57	68	50.95	8	1.74	34	13.32				
40	10	15	705	0.07624	4	3.8	16:16	124	89.7	2	0.06	35	6.4	24	6.35		
41	10	15	713	0.07782	11	3.3	21:52	67	50.6	20	0.52	25	5.96	18	3.96		
42	10	16	617	0.07822	11	2.3	1:15	35	19.75			23	1.75	39	4.65	2	0.49
43	10	16	582	0.04045	11	2.0	3:18	5	2.98			7	0.46	91	8.95		
44	10	16	939	0.07743	12	3.6	6:09	149	124.35	3	0.18	26	6.1			1	0.24
45	10	16	477	0.07506	10	1.6	10:18	51	21.7			4	1.06	52	2.93	1	0.21
46	10	16	820	0.07782	12	3.5	14:04	52	44.9	1	0.01	49	8.45	9	0.37	2	0.18
47	10	16	702	0.05649	11	3.1	18:02	23	14.65			15	1.76	3	0.97	1	0.42
48	10	16	604	0.06036	11	2.3	22:10	28	18.1			5	0.55	23	2.11		
49	10	17	478	0.07585	10	1.5	1:03	28	15.4					14	1.23		
50	10	17	458	0.06858	10	1.5	4:06	21	16.05					16	1.09	1	0.07
51	10	17	450	0.07861	10	1.5	6:19	34	9.15					40	1.68		
52	10	17	428	0.02515	10	1.6	8:52										
53	10	17	434	0.07427	10	1.7	9:42	47	7.5					1	0.01	2	0.61
54	10	17	422	0.07427	24	0.9	12:15	142	16.5					2	0.02		
55	10	17	437	0.07506	24	0.9	14:17	47	7.56							1	0.22
56	10	17	566	0.05030	25	1.6	16:30	21	6.5								
57	10	17	421	0.07348	24	1.1	20:50	36	7.5					1	0.1		
58	10	18	673	0.07151	25	1.6	0:21	45	20.1					1	0.08	1	0.4
59	10	18	613	0.07506	25	1.7	3:50	43	24.35			4	0.42	3	0.27		
60	10	18	606	0.07427	25	1.7	5:17	47	21.4					3	0.33		
61	10	18	560	0.07348	25	1.5	8:25	27	13.3								
62	10	18	483	0.07230	24	1.5	11:51	65	18.6			1	0.46	21	1.27		
63	10	18	489	0.07546	24	1.5	13:05	38	11.7					6	0.35		
64	10	18	550	0.07467	25	1.6	15:10	68	34.5					19	1.66	1	0.3
65	10	18	588	0.07624	25	1.9	16:40	19	9.8			1	0.04	15	1.56	1	0.15
66	10	18	598	0.07269	11	2.7	18:41	42	26.85			1	0.04	40	4		
67	10	18	652	0.05816	11	2.9	20:09	17	7.4			7	1.09	9	1.1	1	0.15
68	10	19	903	0.07585	12	3.6	3:30	115	95.3	2	0.03	14	3.3				
69	10	19	868	0.08019	12	3.6	7:40	88	68.2	3	0.12	21	5.04	2	0.3		
Total All Sets								5549	4250.8	540	116.95	751	234.42	4376	430	28	6.72

Table 5. Biomass estimates (tons) of Greenland halibut by stratum for NAFO Division 0B, 2000.

Depth (m)	Stratum	Area (sq. nm)	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)
401-500	3	2616	8972.88	8	0.09210	0.02187	826
	10	1566	5371.38	5	0.18870	0.03554	1014
	24	1449	4970.07	5	0.16745	0.03158	832
Subtotal		5631	19314.33	18	0.13987	0.01861	2672
501-750	4	4671	16021.53	7	0.48041	0.15431	7697
	11	2311	7926.73	6	0.32641	0.07235	2587
	25	2130	7305.90	7	0.25634	0.04545	1873
Subtotal		9112	31254.16	20	0.35579	0.06128	12157
751-1000	5	2070	7100.10	7	1.46960	0.27029	10434
	12	943	3234.49	5	1.08101	0.17532	3497
Subtotal		3013	10334.59	12	1.30769	0.17675	13931
1001-1250	6	1975	6774.25	7	1.55644	0.46304	10544
	13	343	1176.49	2	5.43230	0.22927	6391
Subtotal		2318	7950.74	9	2.41774	0.67163	16935
1251-1500	7	1641	5628.63	5	1.86851	0.39546	10517
Overall					0.88168	0.14518	56212.02

Table 6. Abundance estimates (000's) of Greenland halibut by stratum for NAFO Division 0B, 2000.

Depth (m)	Stratum	Area (sq. nm)	Area (sq. km)	No. sets	Mean Abundance (sq. km)	SE	Abundance
401-500	3	2616	8972.88	8	192.63	55.75	1728
	10	1566	5371.38	5	484.02	73.42	2600
	24	1449	4970.07	5	886.11	266.76	4404
Subtotal		5631	19314.33	18	466.20	102.05	8732
501-750	4	4671	16021.53	7	679.16	217.54	10881
	11	2311	7926.73	6	508.24	79.94	4029
	25	2130	7305.90	7	539.96	82.30	3945
Subtotal		9112	31254.16	20	579.17	82.31	18855
751-1000	5	2070	7100.10	7	1916.01	447.64	13604
	12	943	3234.49	5	1290.37	209.67	4174
Subtotal		3013	10334.59	12	1655.32	281.19	17778
1001-1250	6	1975	6774.25	7	1665.44	467.63	11282
	13	343	1176.49	2	6878.18	516.86	8092
Subtotal		2318	7950.74	9	2823.83	849.73	19374
1251-1500	7	1641	5628.63	5	1759.97	415.24	9906
Overall					1157.08	170.13	74645

Table 7. Estimated length distribution (3cm groups) in total numbers (000's) and weight (tons) for the Greenland halibut population in NAFO Division 0B.

Length Class (3cm)	Number (000's)	Weight (tons)
0	0.000	0.00
3	0.000	0.00
6	202.164	0.21
9	46.653	0.18
12	513.184	5.12
15	839.756	17.41
18	2177.146	82.03
21	855.307	53.40
24	1430.696	138.33
27	1648.410	234.41
30	1866.125	374.75
33	2954.698	810.77
36	4805.272	1753.41
39	10170.381	4823.57
42	14680.183	8875.39
45	13747.121	10418.74
48	8724.134	8168.39
51	4556.455	5203.37
54	2425.963	3340.82
57	1337.390	2198.58
60	559.838	1088.72
63	373.225	851.59
66	171.061	454.56
69	108.857	334.60
72	108.857	384.66
75	124.408	502.51
78	77.755	357.12
81	62.204	323.29
84	62.204	364.19
87	0.000	0.00
90	15.551	114.13
93	0.000	0.00
96	0.000	0.00
99	0.000	0.00
Total	74645.000	51274.26
Total >35 cm	62110.860	49557.64
Total >45 cm	32455.024	34105.27

Table 8. Estimated biomass (tons/km^2) and abundance for roundnose grenadier (C. rupestris), Div. 0B, 2000.

Depth (m)	Stratum	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)	Mean Abundance (sq.km)	SE	Abundance
401-500	3	8973	.	.	.	.	.	.	.
	10	5371	.	.	.	.	.	.	.
	24	4970	.	.	.	.	.	.	.
Subtotal		19314	.	.	.	.	.	.	.
501-750	4	16022	1	0.001	.	16.02	26.23	.	420260.75
	11	7927	1	0.007	.	55.49	256.99	.	2037122.05
	25	7306	.	.	.	.	.	.	.
Subtotal		31254	2			71.51			2457382.80
751-1000	5	7100	7	0.017	0.004	120.70	215.26	101.87	1528367.53
	12	3234	5	0.001	0.000	3.23	28.38	4.68	91781.89
Subtotal		10335	12			123.94			1620149.41
1001-1250	6	6774	7	0.078	0.042	528.39	369.19	142.79	2500965.03
	13	1176	2	0.021	0.012	24.71	172.29	106.02	202692.76
Subtotal		7951	9			553.10			2703657.79
1251-1500	7	5629	5	0.162	0.042	911.84	437.34	77.16	2461630.67
Overall			28			1660.38			9242820.68

Table 9. Estimated biomass (tons/km^2) and abundance for roughhead grenadier (M. berglax) from Div. 0B, 2000.

Depth (m)	Stratum	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)	Mean Abundance (sq.km)	SE	Abundance
401-500	3	8973	6	0.013	0.004	116.65	62.57	15.65	561406.18
	10	5371	1	0.014	.	75.20	53.29	.	286240.84
	24	4970	1	0.006	.	29.82	13.83	.	68741.04
Subtotal		19314	8	.	.	221.67	.	.	916388.06
501-750	4	16022	7	0.059	0.015	945.27	284.81	71.13	4563124.00
	11	7927	6	0.026	0.011	206.09	182.96	51.92	1450290.37
	25	7306	2	0.003	0.003	21.92	33.20	20.09	242577.80
Subtotal		31254	15			1173.28			6255992.17
751-1000	5	7100	7	0.061	0.012	433.11	155.26	13.49	1102382.83
	12	3234	5	0.070	0.011	226.41	308.88	87.28	999069.27
Subtotal		10335	12			659.52			2101452.10
1001-1250	6	6774	7	0.146	0.011	989.04	340.46	41.80	2306361.16
	13	1176	2	0.159	0.037	187.06	384.33	172.29	452160.40
Subtotal		7951	9			1176.10			2758521.56
1251-1500	7	5629	5	0.063	0.021	354.60	116.62	29.46	656433.35
Overall			49			3585.18			12688787.23

Table 10. Estimated biomass (tons/km^2) and abundance for deepsea redfish (S. mentella) from Div. 0B, 2000.

Depth (m)	Stratum	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)	Mean Abundance (sq.km)	SE	Abundance
401-500	3	8973	8	0.303	0.048	2718.78	3972.10	563.52	35641176.65
	10	5371	5	0.019	0.006	102.06	326.58	121.29	1754206.77
	24	4970	4	0.006	0.004	29.82	102.63	64.21	510063.37
Subtotal		19314	17			2850.66			37905446.79
501-750	4	16022	7	0.443	0.129	48.06	3489.922	1017.11	424666.67
	11	7927	6	0.039	0.008	309.14	311.51	80.54	2469216.03
	25	7306	5	0.010	0.005	73.06	109.11	48.66	797132.14
Subtotal		31254	18			430.27			3691014.84
751-1000	5	7100	2	0.016	0.009	113.60	109.42	58.79	776878.74
	12	3234	3	0.004	0.001	12.94	51.28	32.36	165864.65
Subtotal		10335	5			126.54			942743.39
1001-1250	6	6774	1	0.003	.	20.32	13.25	.	89779.14
	13	1176	2	0.003	0.000	3.53	13.25	0.00	15592.02
Subtotal		7951	3			23.85			105371.16
1251-1500	7	5629	1	0.003	.	16.89	26.51	.	149192.47
Overall			44			3448.20			42793768.64

Table 11. Estimated biomass (tons/km^2) and abundance for black dogfish shark (C. fabricii) from Div. 0B, 2000.

Depth (m)	Stratum	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)	Mean Abundance (sq.km)	SE	Abundance
401-500	3	8973	.	.	.	.	.	.	.
	10	5371	.	.	.	.	.	.	.
	24	4970	.	.	.	.	.	.	.
Subtotal		19314	.	.	.	.	.	.	.
501-750	4	16022	3	0.007	0.003	544.73	15.20	2.29	353883.55
	11	7927	1	0.012	.	95.12	12.85	.	101858.48
	25	7306	.	.	.	.	.	.	.
Subtotal		31254	4			639.85			455742.04
751-1000	5	7100	6	0.097	0.024	688.71	103.65	30.31	735932.47
	12	3234	3	0.020	0.010	64.69	26.20	7.88	84740.40
Subtotal		10335	9			753.40			820672.87
1001-1250	6	6774	7	0.092	0.042	623.23	154.20	84.50	1044582.58
	13	1176	1	0.020	.	23.53	13.25	.	15592.02
Subtotal		7951	8			646.76			1060174.60
1251-1500	7	5629	3	0.034	0.012	191.37	22.09	4.42	124325.18
Overall			24			2231.39			2460914.68

Table 12. Estimated biomass (tons/km^2) and abundance for thorny skate (A. radiata) from Div. 0B, 2000.

Depth (m)	Stratum	Area (sq. km)	No. sets	Mean Biomass (t/sq. km)	SE	Biomass (tons)	Mean Abundance (sq.km)	SE	Abundance
401-500	3	8973	6	0.012	0.004	107.67	18.42	3.05	165316.34
	10	5371	3	0.006	0.003	32.23	26.88	7.26	144393.44
	24	4970	2	0.006	0.001	29.82	20.05	6.59	99669.78
Subtotal		19314	11			169.72			409379.56
501-750	4	16022	2	0.019	0.004	304.41	19.663	5.907	315031.34
	11	7927	1	0.013	.	103.05	12.79	.	101343.24
	25	7306	2	0.007	0.007	51.14	13.55	0.43	98994.95
Subtotal		31254	5			458.60			515369.53
751-1000	5	7100	.	.	.	.	.	.	.
	12	3234	.	.	.	.	.	.	.
Subtotal		10335							
1001-1250	6	6774	.	.	.	.	.	.	.
	13	1176	.	.	.	.	.	.	.
Subtotal		7951							
1251-1500	7	5629	.	.	.	.	.	.	.
Overall			16			628.32			924749.09

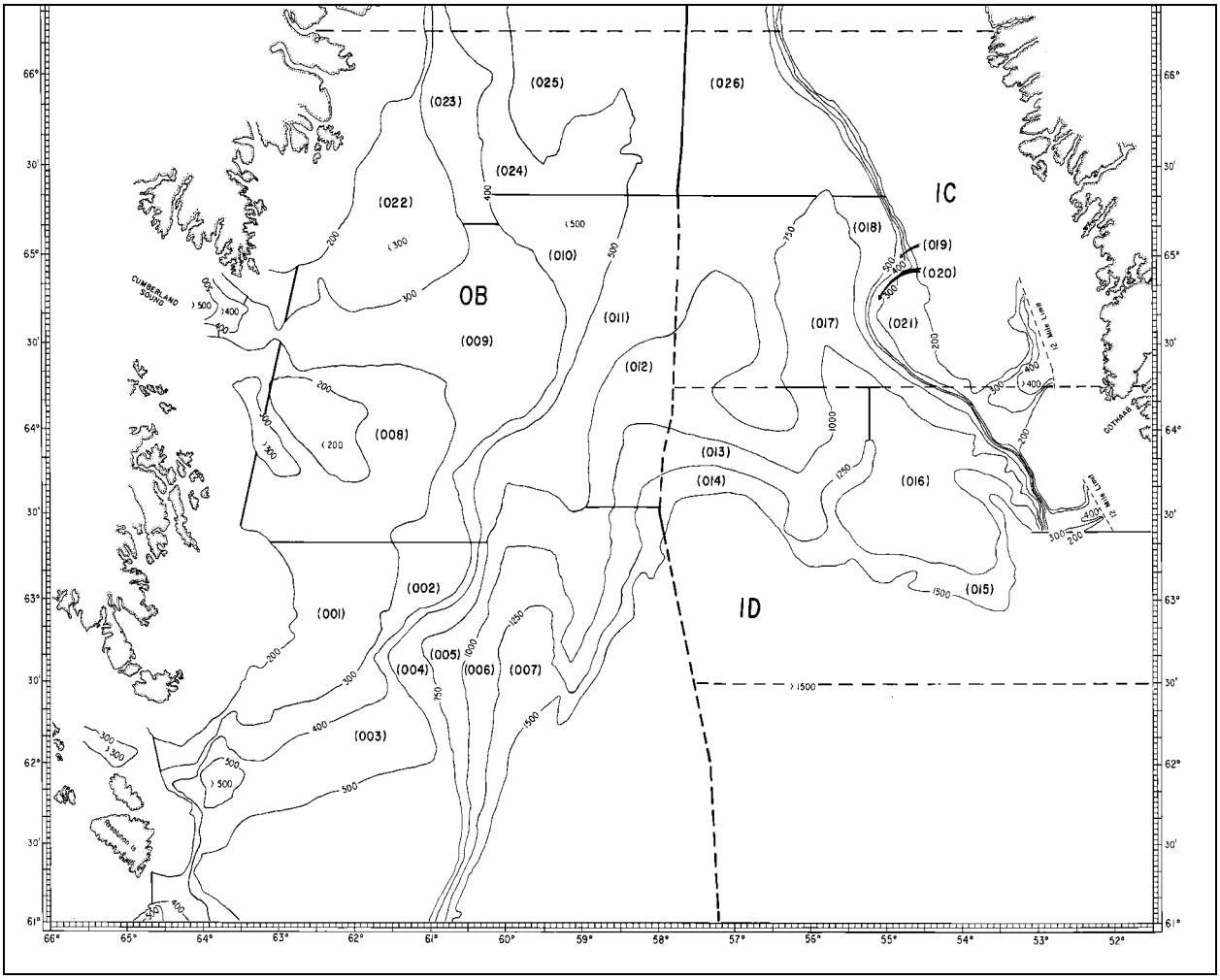

Figure 1. Stratification scheme for North Atlantic Fisheries Organization Division 0B.

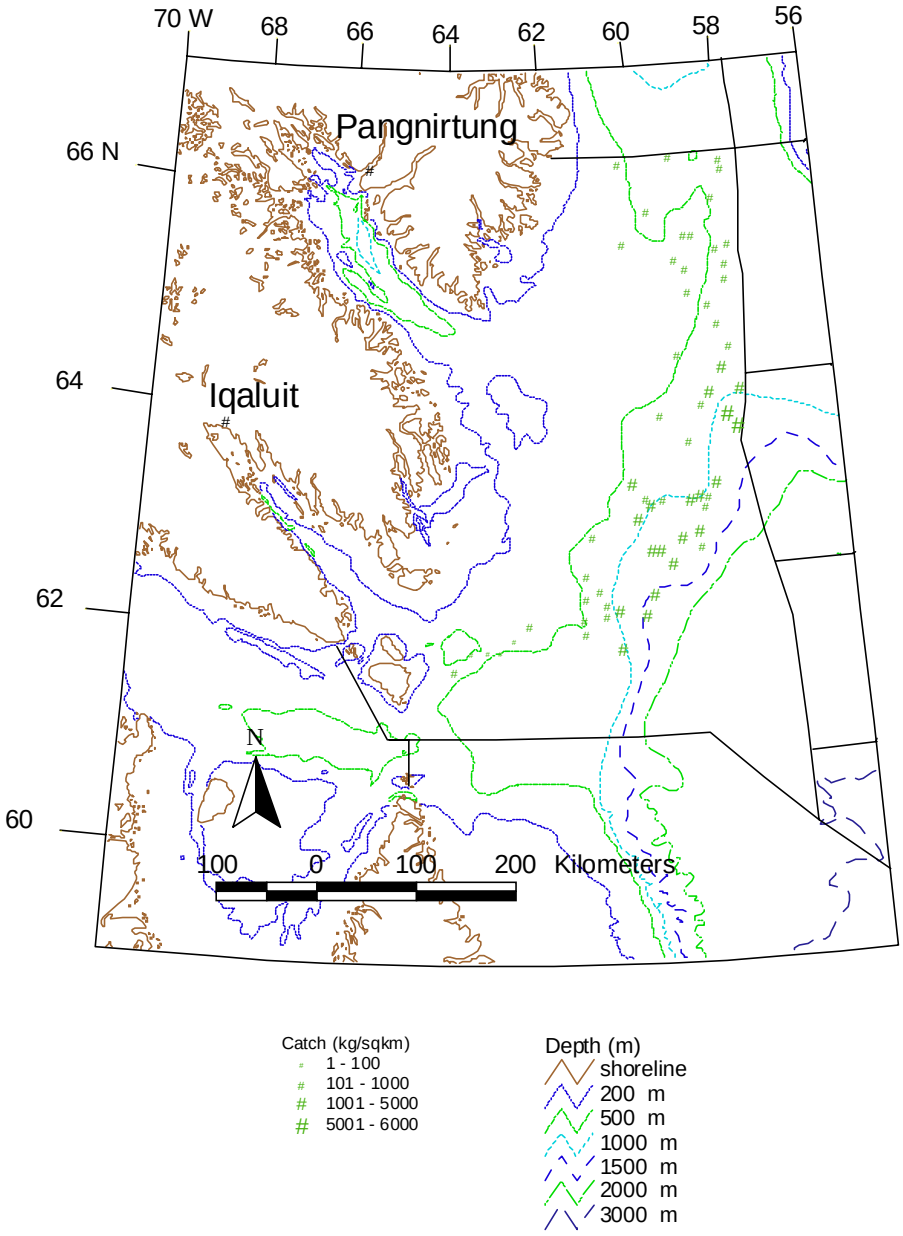

Figure 2. Distribution of Greenland halibut catch (kg/sqkm) from NAFO Division 0B in 2000.

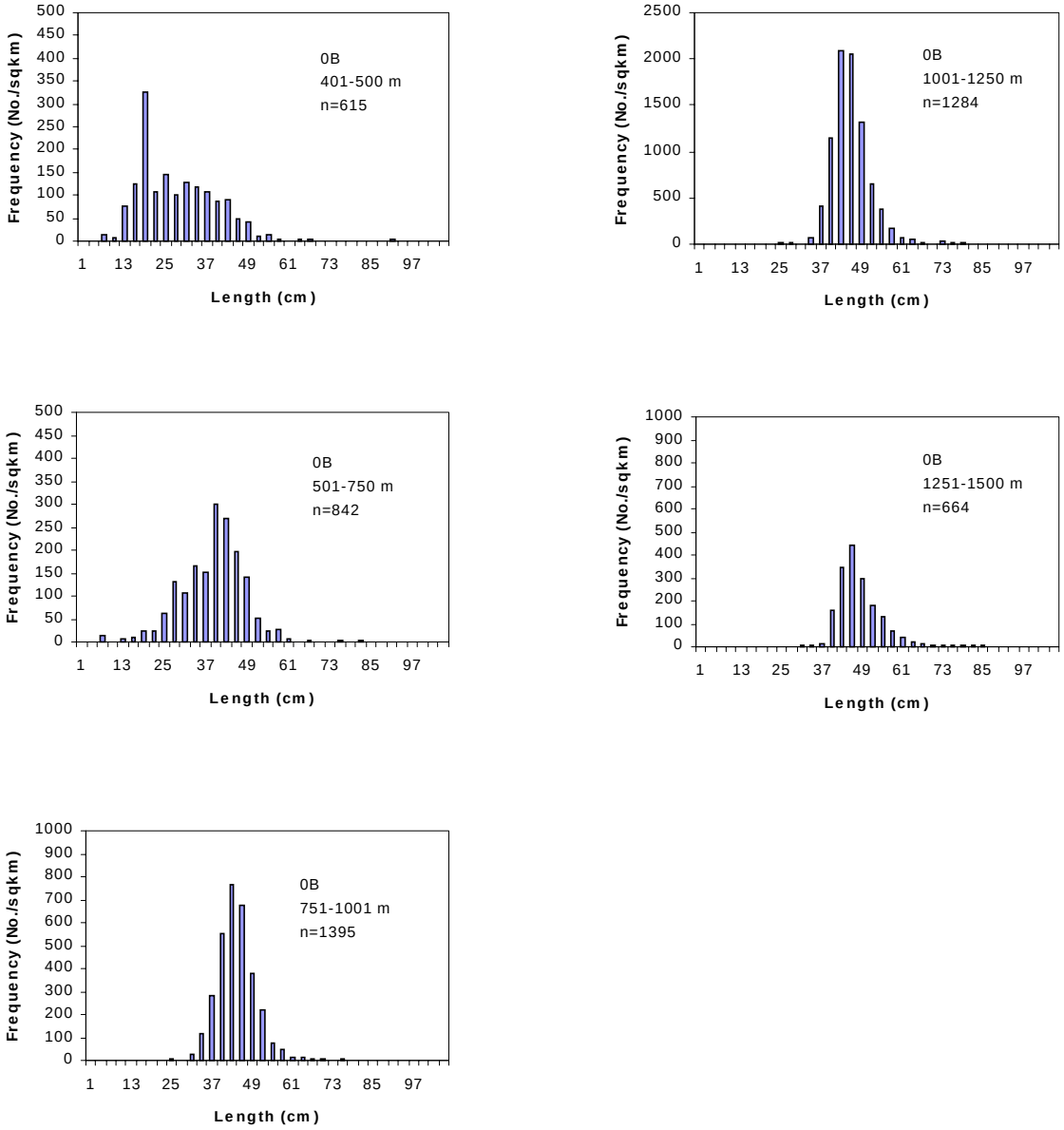

Figure 3. Length distribution (3cm groups) for Greenland halibut from Div. 0B, standardized to numbers/km^2 for the 2000 survey. Sample sizes (n) used in the calculation are also given.

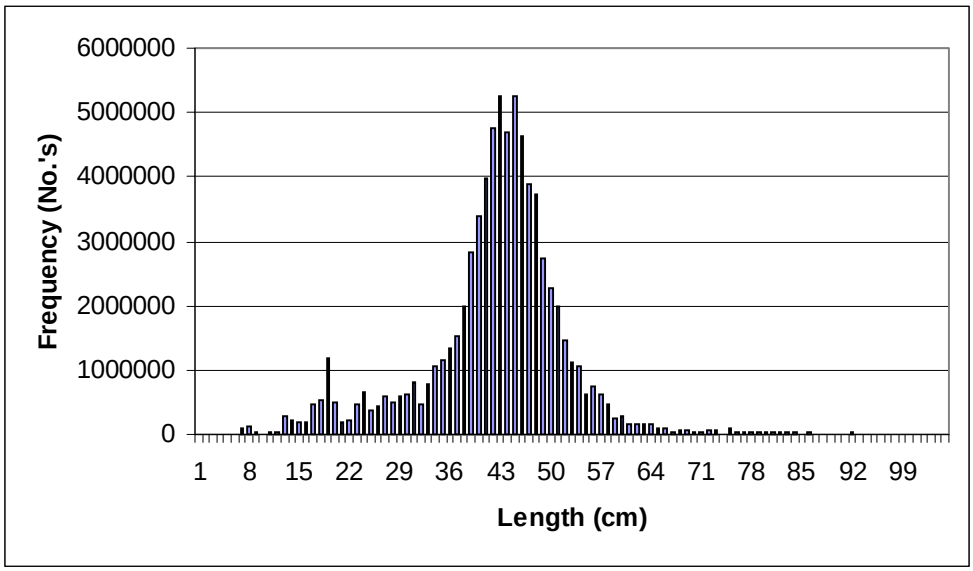

Figure 4. Estimated abundance at length for the Greenland halibut population in NAFO Division 0B in 2000.

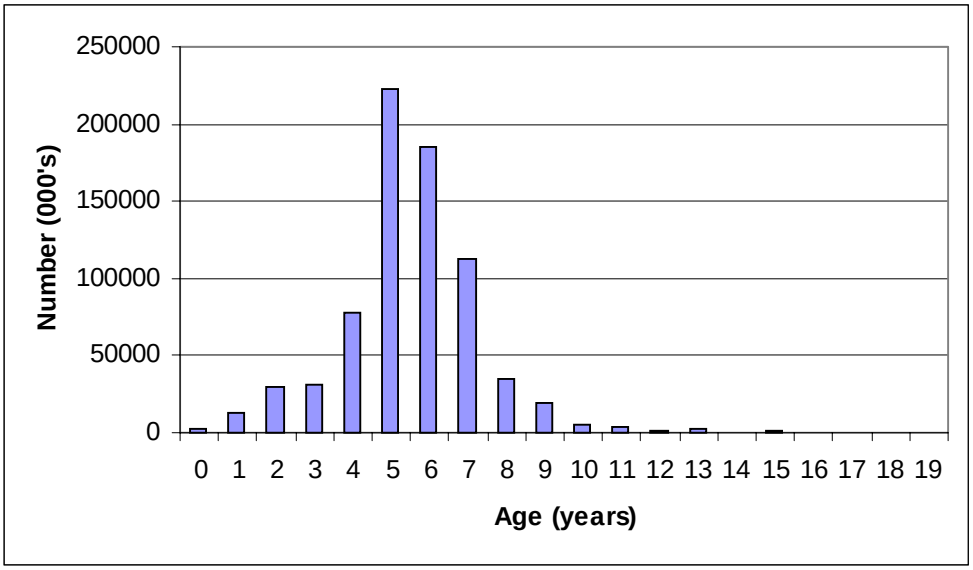

Figure 5. Abundance at age for Greenland halibut from NAFO Division 0B in 2000.

Appendix 1. List of species caught during the 2000 NAFO Division 0B survey, including minimum and maximum weight, minimum and maximum numbers per tow (not standardized to km^2 swept), minimum and maximum length, minimum and maximum depth, minimum and maximum temperature and minimum and maximum latitude.

Obs	Sp. Code	Species name	No. of Sets	Min. Wt. (kg)	Max. Wt. (kg)	Min. No.	Max. No.	Min. Depth (m)	Max. Depth (m)	Min. Temp. (C)	Max Temp. (C)	Min. Latitude (N)	Max. Latitude (N)
1	2	Lycodes sp. 1 (paamiuti)	10	0.02	0.14	1	2	437	673	1.5	3.2	61370	66112
2	10	Myxiniformes	8	0.07	0.35	1	2	582	1156	2.0	3.8	62122	64510
3	27	*Centroscyllium fabricii*	24	0.24	24.50	1	47	619	1404	2.6	3.8	62051	64170
4	89	Raja sp.	6	0.01	0.30	1	3	557	1404	1.6	3.5	61332	66112
5	90	*Amblyraja radiata*	16	0.01	1.90	1	3	422	681	0.9	3.6	61370	66112
6	94	*Raja fyllae*	3	0.06	0.50	1	1	500	839	3.1	3.2	61472	64407
7	95	*Amblyraja hyperborea*	1	13.25	13.25	1	1	1395	1395	3.2	3.2	62402	62402
8	102	*Bathyraja spinicauda*	3	0.03	8.15	1	2	1088	1463	3.2	3.6	62322	63081
9	148	Holtbyrnia sp.	1	0.01	0.01	1	1	550	550	1.6	1.6	65218	65218
10	163	*Bajacalifornia megalops*	1	0.40	0.40	1	1	820	820	3.5	3.5	64273	64273
11	164	Alepocephalidae	2	0.21	2.57	1	6	1404	1429	3.2	3.3	62051	62168
12	165	*Alepocephalus agassizii*	2	0.14	1.59	2	10	1395	1463	3.2	3.2	62322	62402
13	167	Bathytroctes sp.	1	1.50	1.50	1	1	1404	1404	3.2	3.2	62051	62051
14	168	*Xenodermichthys (Alleposomus) copei*	3	0.01	0.02	1	1	705	1062	3.5	3.8	62460	63163
15	200	Bathylagus sp.	24	0.01	4.28	1	116	500	1463	1.5	3.8	61472	66091
16	202	*Bathylagus euryops*	12	0.01	2.44	1	63	598	1251	2.7	3.7	63022	65128
17	210	*Gonostoma bathyphilum*	1	0.03	0.03	1	1	1395	1395	3.2	3.2	62402	62402
18	211	Gonostoma sp.	2	0.02	0.04	1	1	914	1088	3.4	3.5	63081	63150
19	227	*Chauliodus sloani*	7	0.02	0.27	1	4	702	1088	3.1	3.6	61472	64407
20	229	Stomiatidae	1	0.09	0.09	1	1	1099	1099	3.3	3.3	63516	63516
21	230	*Stomias boa ferox*	8	0.01	0.02	1	1	489	1395	1.5	3.6	61472	66091
22	231	*Stomias boa*	5	0.01	0.09	1	4	557	1156	3.4	3.6	61332	63081
23	234	*Borostomias antarcticus*	11	0.01	0.15	1	2	477	1156	1.6	3.8	62086	64407
24	235	Astronesthes sp.	1	0.09	0.09	1	1	557	557	3.4	3.4	61332	61332
25	272	Myctophidae	34	0.01	3.13	1	535	421	1429	0.9	3.9	61332	66091
26	283	*Lampanyctus macdonaldi*	29	0.01	2.21	1	122	422	1463	0.9	3.8	61472	65483
27	289	*Notoscopelus kroeyeri*	4	0.01	0.03	1	3	582	903	2.0	3.6	63528	64170
28	290	*Benthosema glaciale*	32	0.01	0.46	1	90	421	1429	0.9	3.8	61472	66091
29	301	Scopelosaurus sp.	1	0.14	0.14	1	1	1088	1088	3.6	3.6	63081	63081
30	303	Malacosteidae	1	0.06	0.06	2	2	1344	1344	3.2	3.2	62404	62404

31	304	*Malacosteus niger*	3	0.10	0.13	1	2	1251	1463	3.2	3.4	62322	63447
32	315	*Paralepis coregonoides*	2	0.08	0.08	1	1	478	500	1.5	3.1	62042	64582
33	316	Paralepididae	3	0.07	0.08	1	1	483	914	1.5	3.5	61332	65293
34	320	*Arctozenus rissoi*	5	0.04	0.11	1	3	434	903	1.5	3.6	64170	65218
35	367	Nemichthyidae	3	0.02	1.30	1	2	914	983	3.5	3.5	62495	63081
36	368	*Nemichthys scolopaceus*	12	0.01	0.38	1	4	820	1463	3.2	3.6	62051	64273
37	369	*Serrivomer beani*	1	0.30	0.30	3	3	1062	1062	3.5	3.5	62460	62460
38	373	*Synaphobranchus kaupi*	31	0.04	3.76	1	27	477	1463	1.6	3.7	61472	64273
39	379	*Saccopharynx ampullaceus*	1	0.02	0.02	1	1	1099	1099	3.3	3.3	63516	63516
40	386	*Notacanthus chemnitzi*	17	0.51	6.48	1	4	604	1463	2.3	3.7	62051	64510
41	387	*Macdonaldia rostrata*	6	0.14	0.57	1	2	1062	1463	3.2	3.6	62051	63081
42	432	*Antimora rostrata*	34	0.02	23.05	1	46	557	1463	2.3	3.8	61332	64273
43	438	*Gadus morhua*	1	0.28	0.28	1	1	566	566	1.6	1.6	65428	65428
44	451	*Boreogadus saida*	14	0.01	1.03	1	121	421	652	0.9	2.9	64252	66091
45	453	Gaidropsarus sp.	11	0.16	1.41	1	11	500	1404	1.9	3.8	61473	65225
46	454	*Gaidropsarus ensis*	40	0.01	3.31	1	34	421	1463	0.9	3.6	61472	66112
47	455	*Gaidropsarus argentatus*	14	0.01	0.99	1	5	437	948	1.5	3.5	61370	66091
48	470	Macrouriformes	4	0.11	1.27	2	23	1156	1429	3.2	3.5	62051	63073
49	471	Macrouridae	4	0.01	1.05	1	20	983	1404	3.2	3.5	62051	63050
50	474	*Macrourus berglax*	51	0.04	14.80	1	49	444	1463	1.5	3.8	61332	66091
51	477	Nezumia sp.	1	0.03	0.03	1	1	1251	1251	3.4	3.4	63447	63447
52	478	*Nezumia bairdi*	24	0.04	3.40	1	37	529	1156	2.6	3.8	61472	64273
53	480	*Coryphaenoides brevibarbis*	4	0.05	0.90	1	17	1062	1463	3.2	3.5	62322	63073
54	481	*Coryphaenoides rupestris*	28	0.01	26.05	1	94	705	1463	3.2	3.8	61472	64273
55	486	*Coryphaenoides guentheri*	4	0.63	3.03	7	24	1156	1463	3.2	3.5	62168	63073
56	498	Stephanoberyciformes (Xenoberyces)	1	0.08	0.08	1	1	1429	1429	3.3	3.3	62168	62168
57	500	*Anoplogaster cornuta*	3	0.09	0.12	1	1	705	1088	3.6	3.8	62571	63163
58	515	Caristius sp.	1	0.19	0.19	1	1	923	923	3.6	3.6	62086	62086
59	679	*Chiasmodon niger*	10	0.02	0.15	1	4	705	1395	3.2	3.8	62402	64273
60	699	*Anarhichas denticulatus*	3	0.79	2.66	1	1	478	1156	1.5	3.5	62495	64592
61	701	*Anarhichas minor*	1	3.75	3.75	1	1	500	500	3.4	3.4	61482	61482
62	726	Lycodes sp.	6	0.07	1.04	1	2	437	1344	2.7	3.6	61370	64043
63	727	*Lycodes esmarki*	6	0.07	1.04	1	2	437	1344	2.7	3.6	61370	64043
64	730	*Lycodes vahlii*	4	0.11	0.28	1	3	444	939	1.6	3.6	62016	64252
65	732	*Lycodes terraenovae*	1	0.17	0.17	1	1	1251	1251	3.4	3.4	63447	63447
66	736	*Lycodes eudipleurostictus*	17	0.03	1.05	1	15	422	903	0.9	3.6	63528	66112
67	740	*Lycodes pallidus*	10	0.03	0.41	1	8	444	673	1.5	3.6	61540	66112

68	743	*Lycodonus mirabilis*	2	0.02	0.02	1	1	969	1083	3.4	3.7	63150	64046
69	753	*Lycenchelys muraena*	1	0.01	0.01	1	1	673	673	1.6	1.6	66112	66112
70	762	*Bythites fuscus*	1	0.04	0.04	2	2	529	529	3.4	3.4	61564	61564
71	793	*Sebastes marinus*	2	0.52	3.78	1	1	500	588	1.9	3.4	61482	65225
72	794	*Sebastes mentella*	46	0.01	72.45	1	529	421	1404	0.9	3.8	61332	66112
73	811	*Artediellus atlanticus*	4	0.03	0.41	1	13	422	820	0.9	3.5	64252	65265
74	815	*Triglops nybelini*	5	0.01	1.30	1	132	421	458	0.9	1.7	65103	66091
75	828	*Conttunculus thompsoni*	3	0.14	1.70	1	2	713	1140	3.3	3.5	62414	63385
76	829	*Cottunculus microps*	19	0.03	1.34	1	9	450	1074	1.5	3.8	61332	66112
77	836	*Leptagonus decagonus*	10	0.01	0.22	1	16	422	820	0.9	3.5	63528	65395
78	849	*Cyclopterus lumpus*	1	1.05	1.05	1	1	868	868	3.6	3.6	63584	63584
79	853	Liparidae	2	0.03	1.20	1	3	604	613	1.7	2.3	64510	66091
80	856	*Paraliparis copei*	5	0.02	0.08	1	2	988	1463	3.2	3.6	62168	63516
81	859	*Liparis fabricii*	19	0.01	0.48	1	20	421	713	0.9	3.3	63385	66112
82	865	*Careproctus reinhardti*	2	0.01	0.11	1	1	434	478	1.5	1.7	64582	65103
83	889	*Hippoglossoides platessoides*	17	0.07	1.70	1	5	434	969	0.9	3.7	62016	66112
84	890	*Glyptocephalus cynoglossus*	3	0.22	0.76	1	2	685	939	2.6	3.6	62484	64273
85	892	*Reinhardtius hippoglossoides*	66	0.47	427.20	1	558	421	1463	0.9	3.8	61332	66112
86	893	*Hippoglossus hippoglossus*	1	53.65	53.65	1	1	1062	1062	3.5	3.5	62460	62460
87	964	Lophiformies (Pediculati)	1	0.42	0.42	1	1	1404	1404	3.2	3.2	62051	62051
88	967	Oneirodes sp.	3	0.08	0.37	1	1	702	1088	3.1	3.6	63081	64407
89	999	Unidentified fish	1	0.15	0.15	3	3	903	903	3.6	3.6	64170	64170
90	1100	Invertebrata	56	0.15	125.00			421	1463	0.9	3.9	61370	66091
91	1101	Porifera	9	4.20	400.00			444	1429	2.0	3.4	61332	63583
92	2040	Scyphozoa	6	1.00	5.20			434	969	1.5	3.7	61540	65103
93	4545	Cephalapoda	6	0.13	0.64	1	4	422	1404	0.9	3.5	62051	65293
94	4769	Gonatus sp.	8	0.03	0.35	1	4	444	939	1.5	3.6	62016	65483
95	4846	Octopoda	15	0.04	0.86	1	5	422	1156	0.1	3.6	61482	66112
96	4877	Octopodidae	2	2.00	17.35	1	5	948	959	3.5	3.5	63022	63084
97	8020	Natantia	23	0.05	3.66	3	88	422	1156	0.9	3.7	62016	66091
98	8196	Lithodes maja	7	0.20	1.25	1	4	477	820	2.9	3.6	61482	64273
99	8199	Neolithodes sp.	5	0.34	22.66	2	3	557	1463	3.2	3.4	61332	62404
100	8390	Asteroidea	2	0.11	0.26	3	3	529	619	2.9	3.4	61564	62282
101	9982	Stone	1	3000.00	3000.00			582	582	2.0	2.0	63583	63583