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Exploratory Fishery Results for Greenland Halibut (*Reinhardtius hippoglossoides*)
In NAFO Division 0A, 1996-98

by

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Abstract

An exploratory fishery for Greenland halibut (*Reinhardtius hippoglossoides*) began in NAFO Division 0A in 1996 with an initial harvest of 329 t. This fishery has continued with harvests of 241 t in 1997 and 42 t in 1998. Catch values are all based on observer estimates. Restrictions were placed on the fishing effort during the first two years in an attempt to determine stock distribution. In 1998 27 "sentinel" locations were selected and standardized tow protocols established. Catch rates at these locations will be tracked over time to assist in the assessment of the fishery. Catch rates were lower in 1997 (340 kg/h) than in 1996 (667 kg/h) and 1998 (619 kg/h). However, this may be due to inexperience at fishing for Greenland halibut by the captain and crews in 1997. The length and age ranges are similar for all years. However, there were two modes in the 1996 length frequency distribution compared to a single mode in 1997 and 1998. The age distribution is considerably older than that previously reported for Greenland halibut in SA0+1. Investigations are being conducted in an effort to validate these ages.

Introduction

Inuit communities in what is now the territory of Nunavut in Canada's eastern arctic are interested in developing the fisheries potential in the Davis Strait and Baffin Bay areas. In 1996 the Department of Fisheries and Oceans (DFO) granted a request for an exploratory fishery license to fish for Greenland halibut in NAFO DIV. 0A. The exploratory fishery license includes a sampling requirement that provides the DFO with a mechanism to collect information on the harvested stock beyond what would typically be collected during a commercial fishery. This is important in that there had been a limited amount of fishing in Division 0A (Hathaway 1993, Northlands Consulting 1994) and there has not been a biological survey conducted in this area since 1986 when DFO conducted a survey of Division 0B and part of 0A (Bowering 1987). The primary objective of the fishing plan was to collect information on stock distribution, and to establish a catch index. Staff from the Canadian Observer Program was required to be on board all vessels, at industry expense. Funds for aging Greenland halibut otoliths were also provided by Industry.

Materials and Methods

1996

The Vestervon was required to fish a minimum of 6 days in each of four sub-zones (Fig. 1). No further conditions were applied. The vessel used two similar otter trawls, a Bacalao 630TM and a Startrol 630TM with cod end liners of mesh sizes 147 mm and 148 mm.

Standard information on gear, vessel type, set, and catch (numbers and weight) for each tow was recorded by an observer. Each day a random sample of Greenland halibut were sexed and measured for length. Eleven tows were further sub-sampled (up to 20 Greenland halibut from each 1cm length category) for sex and both otoliths.

1997

In 1997 the four sub-zones were further divided, creating 18 (Fig. 1). Each block was further broken down into depth strata. The license holders were required to conduct a set number of tows in each of the depth strata/block combinations that contained depths <1500 m. The Fame and Ocean Castle both used a P.F. Vonin/454 mesh trawl with a cod end mesh of 145 mm. The Ocean Castle also experimented with a twin trawl. The Atlantic Enterprise used a trawl similar to the P.F. Vonin with a cod end mesh of 147 mm. No small mesh liner was used in the cod end of any of these trawls. The Atlantic Enterprise was the only vessel that had electronic equipment on board that measured trawl door spread. The observers estimated door spread for the Fame and wing spread for the Ocean Castle.

The Ocean Castle fished the northern blocks 6.4 to 3.1 and block 2.1. The Atlantic Enterprise and the Fame fished the southern blocks 1.1 to 2.3 and 1.1 to 4.2, respectively. The tow duration was designed to simulate commercial tows; an average of 4.5 hours and a minimum of 2 hours were specified. In addition 10 "sentinel" locations were fished. These locations were not selected randomly but were selected from the tows made in 1996 based on the following priorities: a) the availability of age and/or length data from the location in 1996; b) overall distribution of locations among blocks; and c) highest catch rate if two or more tows met the first two criteria.

Each of the sentinel locations was included in the tows sampled for sex and otoliths (a total of 41 sets were sampled). The sub-sample for otoliths was done by sex (up to 20 Greenland halibut per 1cm length category per sex). Where possible weight and maturity information were also collected by the observers.

1998

Seventeen more "sentinel" locations were added for 1998 from locations fished in 1997. These sites were selected based on: a) representative distribution over the fishable depths and b) highest catch rate if two or more tows met the first criteria. New conditions were established for fishing the sentinel locations: a) the tow direction was to be kept constant from south-east to north-east; b) tow speed was to be kept constant at 3.0 k and c) a tow duration of 1 hour. The Atlantic Enterprise was the only vessel to fish in 0A in 1998.

Each of the sentinel locations was included in the tows sampled for sex and otoliths (a total of 24 sets were sampled). The sub-sample for otoliths was done by sex (up to 20 Greenland halibut per 1cm length category per sex). The observer also collected maturity information.

For all years tows less than 2.0 hours in duration, or which sustained net damage, or where a twin trawl was used (1996) were not included in any of the catch rate analysis.

Results and Discussion

Catch and Effort Data

The MV Vestervon, a Faroese Class 7 otter trawl vessel harvested 329 t (observer estimated) in 1996 over a 30 day period between September 22 and October 23 (Mathias and Treble 1997).

In 1997 three otter trawl vessels harvested 241 t (observer estimated) over a 48 day period between September 28 and November 27. The vessel Ocean Castle (Faroese Class 6) harvested 173 t over 28 days and the vessel Atlantic Enterprise (Canadian Class 7) harvested 58 t over 12 days. These two vessels fished for a combined total of 40 days out of the 55 they were allocated. The vessel Fame, (Canadian Class 6) harvested 10 t in 8 days out of the 10 days allocated to it.

The MV Atlantic Enterprise returned in 1998 and harvested 42 t (observer estimated) in 10 days of the 35 allocated.

The overall catch rate (non-standardized) for 1996, 1997, and 1998 was 667 kg/h, 340 kg/h, and 619 kg/h respectively (Table 1 and 2). The majority of tows were made in October in 1996 and 1997 (Table 1). Despite the increase in the number of fishing days, only 82 of 132 sets in 1997 met the criteria established above, due primarily to the elimination of 32 twin trawl sets. For 1998, there were only 12 sets that met the criteria as effort was considerably reduced and the sentinel locations were all less than 1 hour in tow duration. The mean catch rate by block was lower in 1997 than in 1996 for all but blocks 6.3 and 6.4 (Table 2). The reduced effort in 1998 makes comparison with previous years difficult. However, for those blocks where there were multiple tows (3.1 and 4.3) catch rates were higher than in 1997.

Catch rates for individual vessels varied in 1997. The Ocean Castle had a catch rate of .369 t/hr similar to the Atlantic Enterprise (.363 t/hr) and greater than the Fame (.167 t/hr) (Fig. 2). However, differences in areas fished and number of tows for each of these vessels make it difficult to draw any conclusions from these results.

The Vesturvon fished all sentinel locations in 1996. In 1997 the Atlantic Enterprise conducted the sentinel tows for blocks 1.1 to 2.3 and the Ocean Castle conducted the tows for blocks 3.3 to 6.4. The Atlantic Enterprise fished all locations in 1998. For a majority of the sentinel locations the catch rates were lower in 1997 than in 1996 or 1998 (Table 3). However, only the data from the Atlantic Enterprise for 1997 and 1998 are directly comparable.

The fishing plan in 1997 was designed to distribute effort across the various block/depth combinations. Unfortunately two of the three vessels did not completely follow the plan. Also, each vessel left 0A without fully utilizing the time allowed on their license for fishing in 0A. The highest concentration of effort was in Block 2.1 in both 1996 and 1997 (Table 2, Fig. 1). In 1997 the Ocean Castle was the only vessel to fish the northern most blocks. They found what appeared to be a high concentration of fish in block 6.4 at the beginning of the fishing period but were unable to locate it again upon returning later in October.

In addition to distributing effort across the blocks the 1997 fishing plan was intended to distribute effort across depth strata. Unfortunately one vessel in particular did not follow this aspect of the plan at all and the majority of tows fell in the 1151 m to 1300 m depth range (Table 4). This was very similar to the 1000 m to 1300 m depths fished in 1996 (Mathias and Treble 1997). Table 4 shows the mean catch rate (kg/h) by fishing block and depth combination. Catch rates varied considerably among the blocks and there is not enough data to infer any trends with depth.

It is difficult to make direct comparisons between years because the vessels, gear, and fishing program were different. A comparison of data from 0B for the Ocean Castle and another vessel, the Enniberg fishing in 0B, illustrate how differences in vessels and fishing experience can affect catch rates. The observer on board the Ocean Castle reported that this vessels captain had not had experience fishing for Greenland halibut and that the catch rates may be lower than would be expected with an experienced captain and crew. In an identical region of 0B the Ocean Castle had a catch rate of 592 kg/h over 169 tows while the Enniberg had a rate of 1,132 (kg/h) over 137 tows (Fig. 2). The Enniberg is a Class 7 vessel and had a tow speed of 3.4 knots compared to 3.0 knots for the Ocean Castle that is a Class 6 vessel. This difference in vessel size and tow speed would have affected the catch rates but to a lesser extent than the length of the ground warps used to deploy the trawl (the length chosen can vary depending on depth and bottom type) (Steve Walsh, DFO, Nfld., pers. comm.). Unfortunately information on the length of the ground warp used by the Enniberg is not available.

Length and Age

The 1996 lengths ranged from 20 cm to 95 cm. There were two distinct modes, one at 41 cm and another at 50 cm (Fig. 4). The proportion of the catch less than 40 cm was 23.6% with 37% greater than 50 cm. The 1997 and 1998 length distributions are similar and different from the 1996 in that there was a single mode at approximately 50 cm (Fig. 4). The proportion less than 40 cm and greater than 50 cm was 10% and 51%, respectively for 1997.

There was a difference in the distribution of effort in 1996 as compared to 1997 and 1998. A greater number of tows were conducted in the more northern areas (blocks 4.3 and 5.3, Table 2) in 1996, which may have had an influence on the proportion of smaller fish in the 1996 catch. The majority of tows in 1996, 1997 and 1998 were between 1000 m and 1300 m despite the 1997 fishing plan requirement to distribute effort across all depths.

The age composition of the catches was obtained by applying an age-length key calculated for each year separately. In 1996 ages ranged from 4 to 25 years with a mode at 11 years (Fig. 5). In 1997 ages ranged from 6 to 36 years with two modes at 17 and 21 years. In 1998 ages ranged from 5 to 29 years with peaks at 12, 14 and 15 years.

These age ranges are considerably greater than that published previously for Greenland halibut from Sub-area 0 and 1 (Jorgensen 1997). Our age reader has had proven experience aging marine mammals but was new to aging Greenland halibut. However, many of the aging protocols are similar between structures (teeth and otoliths). Further analysis will be carried out to determine the reader's precision and accuracy. Also, the DFO Central and Arctic region has a tagging project under way which may help to validate Greenland halibut ages using the chemical marker oxytetracycline.

Conclusions

Overall catch rates have fluctuated from a low of 340 kg/h in 1997 to a high of 667 kg/h in 1996. Catch rates from the sentinel locations were lower in 1997 but the data are from different vessels so should be interpreted cautiously. The reason for the low catch rate in 1997 is unknown but may have been due in part to inexperience at fishing for Greenland halibut in these waters as well as the fishing plans requirement to fish at specific depths and locations (although these requirements were not strictly adhered to by all three vessels). The decreased catch rate was likely the primary reason the companies chose not to use their fully allotted time in Div. 0A in 1997 although this does not explain the lack of effort in 1998.

The length range has been similar across years although the frequency distribution for the 1996 sample has two modes (41cm and 50cm) while the 1997 and 1998 frequency distributions have a single mode at approximately 50 cm. This difference may be due to a greater fishing effort in the more northerly portion of the area in 1996.

It is not possible at this time to explain why the age distribution for 1997 is comprised of a greater proportion of older ages (17+) as compared to 1996 and 1998. However, Greenland halibut from the Davis Strait area are difficult to age. Also, the age distribution's shown here are considerably older than those previously reported for Greenland halibut in SA0 and 1. The validity of these ages must be examined further before any conclusions can be drawn. NAFO has sponsored an otolith exchange between labs (including Central and Arctic region) who age Greenland halibut, however, the status of this project is not known at this time. Researchers in Central and Arctic region are also working on examining different techniques and have used oxytetracycline injection to mark otoliths in tagged fish in an effort to validate aging methods.

A biological survey of 0A is being planned for October 1999 and should provide additional data to assist with the assessment of the fishery potential for this area.

References

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Table 1. Non-standardized mean CPUE (kg/h) in NAFO Div. 0A for all vessels combined, by month (single otter trawl, no net damage, tow duration ≥ 2 hrs.).

Year	Month	Mean		
		CPUE (kg/h)	s.d.	# tows
1996	Sept.	648	495	28
	Oct.	674	3	69
	Overall	667	364	97
1997	Sept.	338	295	5
	Oct.	382	286	63
	Nov.	149	114	14
	Overall	340	277	82
1998	Sept.	619	302	12

Table 2. Greenland halibut CPUE (kg/hr) by fishing block (single otter trawl, no net damage and tow duration ≥ 2 hrs).

Block	1996			1997			1998		
	n	mean	std. dev.	n	mean	std. dev.	n	mean	std. dev.
1.1	6	585	204.51	1	270		1	54.32	
1.2	1	559		2	65	62.08			
2.1	43	763	404.39	32	377	262.89	1	282	
2.2	1	625		5	289	165.55			
2.3	2	240	181.08	1	39				
3.1				9	317	160.53	5	737	186.52
3.3	6	405	296.98	4	130	137.86			
4.2				4	166	117.73	1	945	
4.3	13	481	215.12	2	61	44.55	3	757	47.51
5.3	21	801	304.36	4	592	589.94			
6.3	2	389	320.71	7	533	258.06			
6.4	2	193	40.70	11	331	305.90	1	183	
Overall	97	667	364.02	82	340	277.09	12	619	301.57
Min.		111			4			54	
Max.		1839			1406			945	

Table 3. Catch rates (kg/h) and associated information for “sentinel locations” in Division 0A.

Location	Sub-zone	Latitude N	Longitude W	Average	1996*	1997*	1998**
				Depth (m)	CPUE (t/h)	CPUE (t/h)	CPUE (t/h)
1	1.1	67 13'	58 15'	1137	0.488	0.069	0.151
2	1.1	66 58'	59 23'	689		0.038	0.329
3	1.2	67 06'	59 36'	1144	0.508	0.108	0.259
4	1.2	67 12'	58 36'	789		0.02	0.084
5	2.1	67 49'	59 21'	1182	1.69	0.763	0.357
6	2.1	68 03'	59 50'	873		0.39	0.103
7	2.1	67 28'	58 34'	733		0.63	0.08
8	2.2	67 16'	60 07'	1147	0.572	0.106	0.268
9	2.2	67 28'	61 00	730		0.155	0.206
10	2.3	67 53'	62 18'	1144	0.11	0.123	0.143
11	2.3	67 53'	62 40'	692		0.039	0.203
12	3.1	68 35'	59 51'	855		0.117	1.001
13	3.1	68 21'	59 52'	859		0.333	0.741
14	3.1	68 42'	59 37'	746		0.186	0.946
15	3.3	69 07	64 00'	1148	0.861	0.325	0.524
16	3.3	69 13'	64 28'	438		0.004	0
17	3.3	68 23'	63 51'	838		0.114	0.143
18	4.3	70 01	65 02'	1131	0.511	0.233	0.697
19	4.3	69 27'	64 49'	815		0.092	0
20	4.3	70 11'	65 19'	658		0.35	1.12
21	5.3	71 05'	67 20'	1242	1.013	1.406	0.182
22	5.3	70 17'	65 18'	835		0.209	0.252
23	5.3	70 21'	65 39'	669		0.184	0.18
24	6.3	71 16'	67 59'	1251	0.153	0.353	2.18
25	6.4	71 21'	68 24'	998	0.568	0.013	0
26	6.4	71 57'	70 56'	897		0.629	0.065
27	6.4	71 30'	68 58'	672		0.604	0

* 1996 and 1997: The Captain was asked to keep the tow duration between 2 to 4.5 hrs. in order to simulate a commercial tow. No other restrictions were applied.

** 1998: Restrictions standardized - tow duration of 1 hr, the direction of tows SSE to NNW, tow speed constant at 3.0 knots.

Table 4. 1997 Greenland halibut mean CPUE (kg/hr) and std. dev. () by fishing block and depth (data rounded to nearest kg). Not all depth strata were present in each block as marked by the shaded areas in the table.

Block	Depth (m)					Overall
	700-850	851-1000	1001-1150	1151-1300	1301-1450	
1.1				270		270
1.2			108	21		65 (62)
2.1			318 (291)	404 (258)	390	377 (263)
2.2			288 (187)	289 (193)		289 (166)
2.3			39			39
3.1			314 (181)	354 (178)	225(153)	317 (161)
3.3	4.00		77	220 (149)		130 (138)
4.2				194 (167)	138 (102)	166 (118)
4.3	29				92	61 (45)
5.3		47		458 (221)	1406	592 (590)
6.3				570 (192)	505 (326)	533 (258)
6.4	21 (12)	604	554	317 (335)	548 (116)	331 (306)
Total	24 (10)	326 (394)	271 (247)	365 (245)	480 (400)	340 (277)
Count	3	2	17	47	11	82

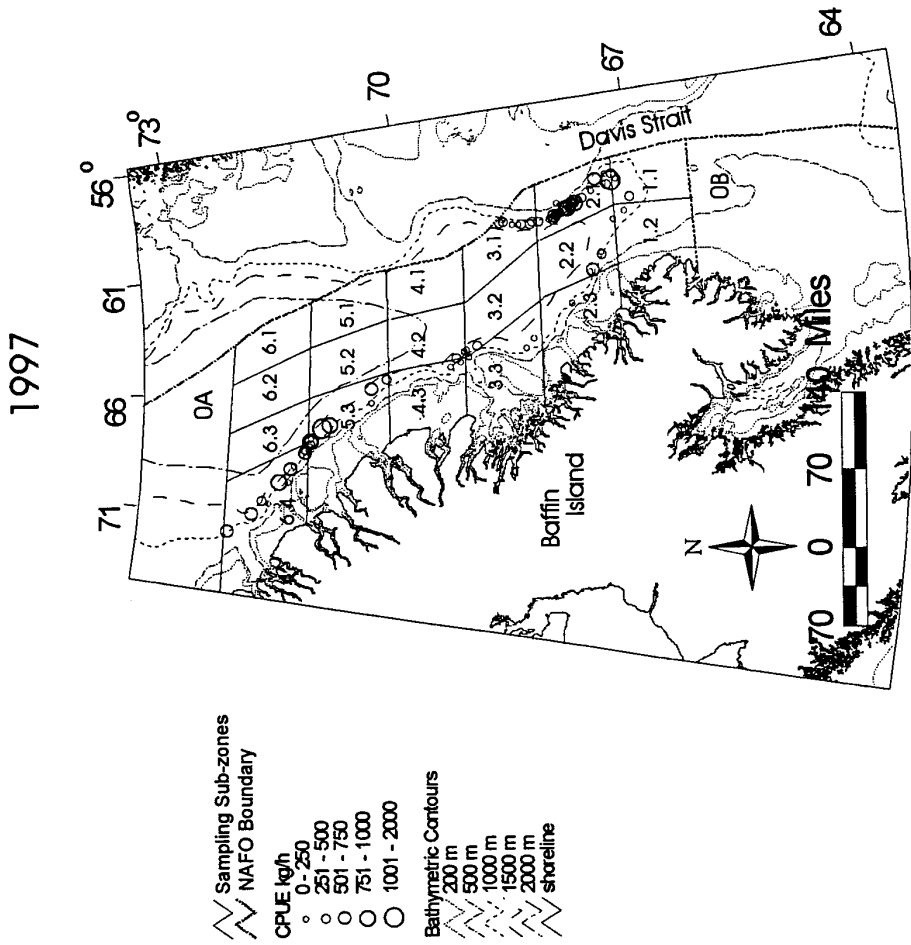


Figure 1. Distribution of fishing effort in NAFO Division 0A for 1996 and 1997.

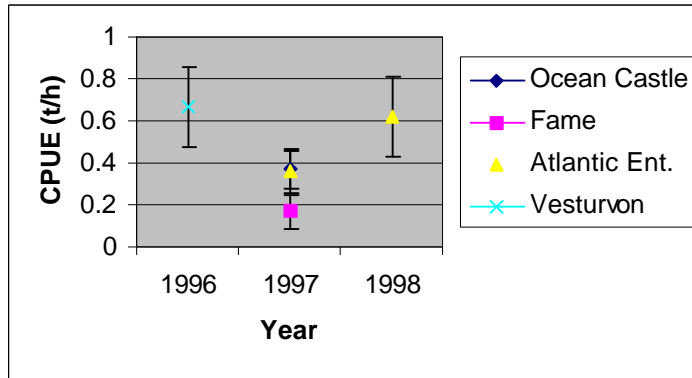


Figure 2. Mean catch per unit effort (CPUE) with 95% confidence limits for NAFO Div. 0A, 1996-98.

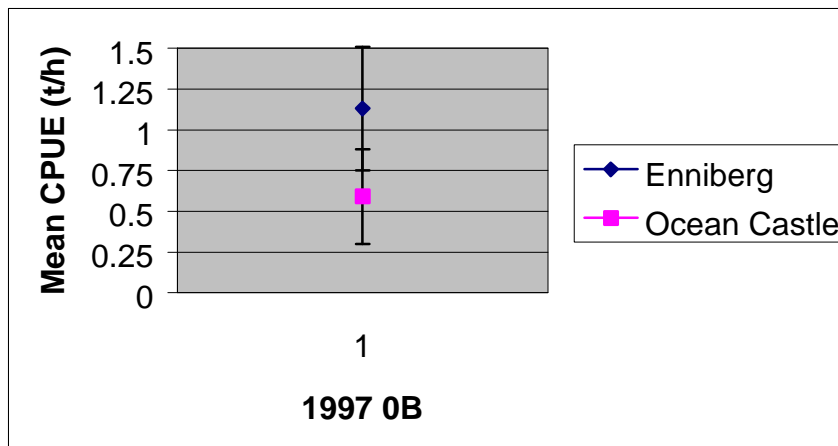


Figure 3. Mean catch per unit effort with 95% confidence limits for two vessels (Enniberg and Ocean Castle) fishing similar trawls in identical areas of Div. 0B in 1997.

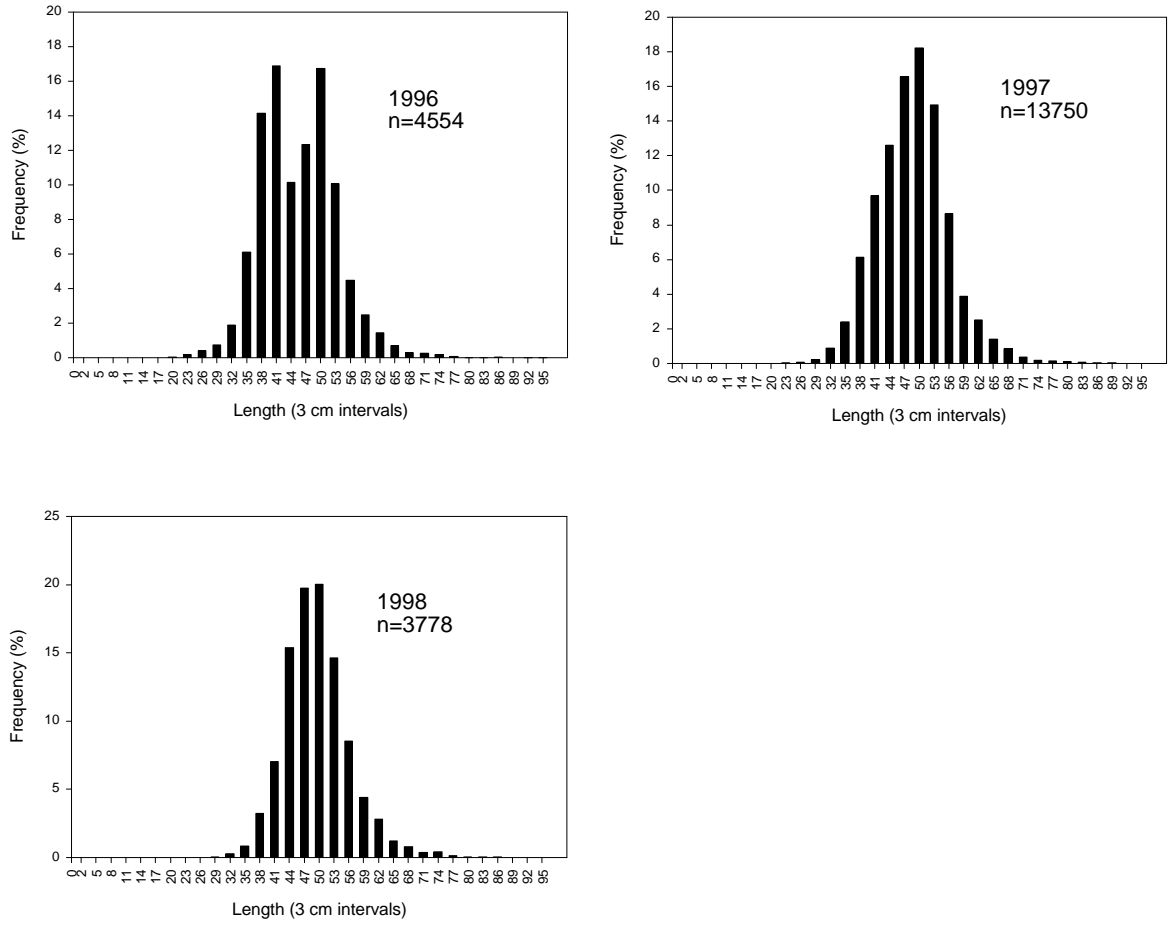


Figure 4. Length frequency of Greenland halibut from NAFO Div. 0A.

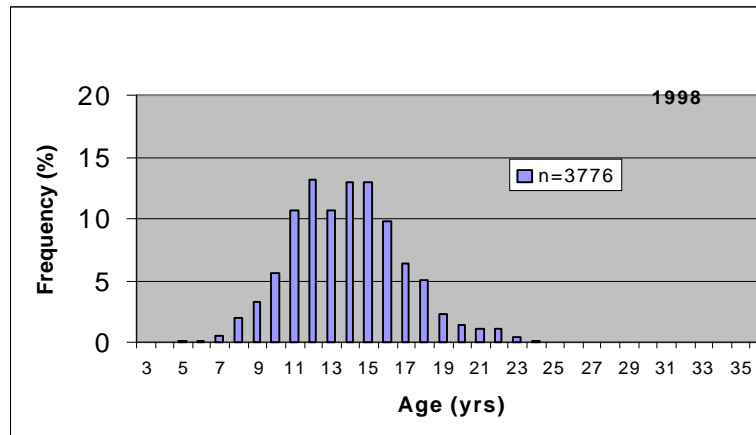
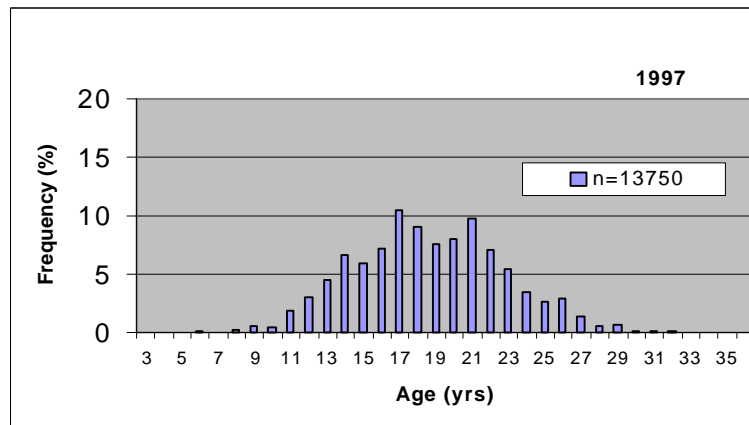
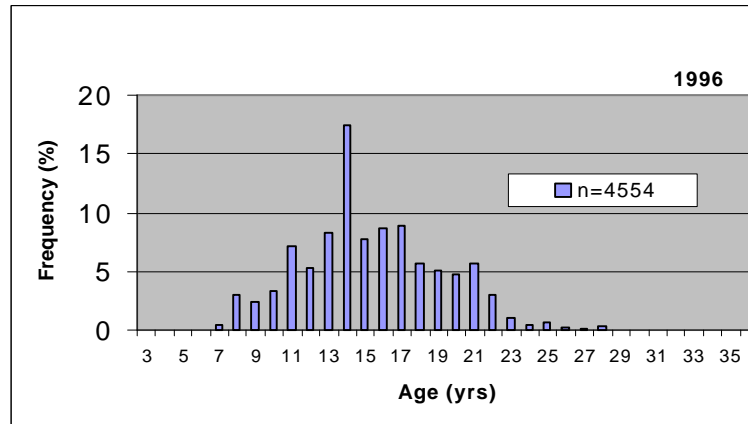


Figure 5. Age composition of the length sampled catch from Div. 0A (derived from age-length keys, for 1996, 1997 and 1998).