Northwest Atlantic Fisheries Organization

Serial No. N4658 **NAFO SCR Doc. 02/46**

SCIENTIFIC COUNCIL MEETING – JUNE 2002

The Greenland Halibut (*Reinhardtius hippoglossoides*) Fishery In NAFO Division 0A

by

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Abstract

In 1996, 1997 and 1998 exploratory licenses were issued for a relatively small (approx. 300 tons) offshore otter trawl fishery directed for Greenland halibut (*Reinhardtius hippoglosoides*) in NAFO Div. 0A. The fishery expanded to five vessels in 2001 with a TAC of 4,000 tons for Div. 0A and 1A (offshore). These vessels harvested 2,625 tons between 4 September and 30 November 2001. Two of the class 7 vessels used both the single trawl and double trawl gear configurations. The paper presents catch, effort and length data for the fisheries from 1996 to 2001. Effort has been primarily concentrated approximately 200 m on either side of the 1000 m depth contour. The mean catch rate for a single trawl (non-standardized) has varied from 336 to 641 kg/h. The mean catch rate for the twin trawls was 862 kg/h in 2000 and 882 kg/h in 2001. In 1996 lengths ranged from 20 cm to 95 cm with two distinct modes, one at 41 cm and another at 50 cm (Fig. 4). In subsequent years there has been a narrowing of the distribution and a shift to a single mode, 50 cm in 1997, 47 cm in 1999 and 44 cm in 2001. The proportion of fish in the catch that are below 45 cm in length is unusually high. It is important to determine the relationship between fish in Baffin Bay with those areas to the south as well as the inshore.

Introduction

In the early to mid-1990s interest in offshore fisheries development emerged in what is now the Canadian territory of Nunavut. Exploratory fishing using multiple gear types was undertaken in 1993 (Hathaway, 1993) and 1994 (Northlands Consulting 1994). In 1996, 1997 and 1998 exploratory licenses were issued for a relatively small (approx. 300 tons) offshore otter trawl fishery directed for Greenland halibut (*Reinhardtius hippoglosoides*) in NAFO Div. 0A (Treble, 1999).

In 1999 a single vessel fished within Division 0A waters for Greenland halibut under a standard commercial license issued for NAFO Subarea 0. There was no exploratory fishery license issued for Div. 0A in 1999.

An exploratory fishery license was re-issued for Div. 0A in 2000. Under this license the vessel was required to fish 27 "sentinel" stations established during the exploratory fisheries conducted previously (Treble, 1999).

The fishery in Div. 0A expanded to five vessels in 2001 following a NAFO Scientific Council recommendation for a TAC of 4,000 tons for Div. 0A and 1A (offshore). None of the vessels conducted any fishing at the sentinel locations described above.

Materials and Methods

Tows were not included in any of the catch rate analysis presented below if they were less than 2.0 hours in duration, or if fish were reported lost as a result of net damage. Due to the increased use of the twin trawl in 2000 and 2001 two separate catch rates have been calculated, one for a single trawl and one for a twin trawl. Total catch (kept weight plus discard weight) was used in the calculation of CPUE.

A list of 27 "sentinel locations" distributed throughout Div. 0A were identified during the first three years of the Div. 0A exploratory fishery. This was done in an attempt to establish a standardized index that could provide additional information for stock assessment. In 1996 and 1997 the only condition was to keep the length of tow between 2 and 4.5 hours. In 1998 the length of tow was changed to 1 hr, the tow speed was to be constant at 3 knots and the direction of tow standardized (SSE to NNW). Only single trawls were used at these locations. Fishery observers were required to collect biological data at the sentinel locations and throughout the fishing area using standard protocols developed for the Canadian groundfish observer program.

Results and Discussion

Catch and Effort Data

The MV *Atlantic Enterprise* (Canada), a Class 7 otter trawl vessel, harvested 310 tons (observer estimated) in 1999 over a 29 day period between September 22 and November 8. Fishing was concentrated in the south-east area of Baffin Bay (Fig. 1).

The *Acadienne Gale II* (Canada), a Class 7 vessel, fished for 30 days between August 3 and September 22, 2000 and harvested 320 tons (observer estimated) with effort concentrated in the northern area of Div. 0A (Figure 1). Two types of otter trawl gear were used, one gear was rigged with a single trawl and the second gear rigged with a twin trawl.

Five otter trawl vessels harvested 2,625 tons between 4 September and 30 November 2001. Three Class 7 vessels, *Sundaberg* (Faroe Islands), *Esther* (Poland), and *Acadienne Gale II* (Canada) harvested 660 tons, 448 tons, and 784 tons, respectively. The *Atlas* (Lithuania, Class 6) harvested 413 tons and the *Heltermaa* (Estonia, Class 5) harvested 346 tons. These vessels fished for a combined total of 288 days. Two of the class 7 vessels used both the single trawl and double trawl gear configurations. Fishing was distributed across the entire Division (Fig. 2). As in previous years the effort is primarily concentrated approximately 200 m on either side of the 1000 m depth contour. Approximately 20 species or families of fish were listed as by-catch by the observers but most occurred in amounts less than 1 ton. Greenland shark or boreal shark (*Somniosus microcephalus*) was caught in 138 of 716 tows for a total of 70 tons. Several skate species were caught, including Arctic skate (*Amblyraja hyperborea*), for a total of 7 tons. Roughhead grenadier (*Macrourus berglax*) were also relatively abundant with 2 tons recorded as by-catch. Wolffish (*Anarhichas* sp.) were caught in 8 sets for a total of 57 kg. No Atlantic halibut (*Hippoglossus hippoglossus*) were caught.

Table 1 provides the catch history for this fishery from 1996 to 2001. The mean catch rate for a single trawl (non-standardized) has varied from 336 to 641 kg/h, (Table 2 and Fig. 3). The mean catch rate for the twin trawls was 862 kg/h in 2000 and 882 kg/h in 2001. Effort was greatest in the month of October in 1999 (Table 3) and 2001 (Table 4a). The catch rates in 2001 for all vessel classes and gear types were also slightly higher in October (Table 4a). Catch does not appear to be correlated with vessel class (Table 3 and 4). For example in 2001 the Class 6 vessel had a slightly higher catch rate than the Class 7 vessels (single trawl only).

Div. 0A was divided into 4 general areas (SE, SW, Central and North) and mean CPUE calculated by area and depth (Table 4b). Rates were highest within the depth range 1001 to 1250 m. The data suggest slightly higher catch rates in the Central area located between 68.29^{o} N and 70.1^{o} N.

There have been differences in the distribution of effort from year to year (See Fig. 1, Treble 1999 for 1996 and 1997 distributions). A greater number of tows were conducted in the more northern portion of Div. 0A in 1996 and in 2000.

Fishing was limited in 1998 and greatly expanded in 2001. The majority of tows throughout all years have been between 1000 m and 1300 m.

Sentinel locations were fished in 1996, 1997, 1998, and 2000. Unfortunately, there has not been any consistency in the vessels used from one year to the next. In 1996 it was the "*Vestervon*", in 1997 the "*Fame*", "*Ocean Castle*" and "*Atlantic Enterprise*", in 1998 the "*Atlantic Enterprise*" and in 2000 the "*Acadienne Gale II*". The mean duration of the sentinel tows was 4.7 and 4.1 hrs in 1996 and 1997, respectively. In 1998 and 2000 the mean duration was 1.0 hr and only single trawls were used at these locations. Tows were not completed at each location every year for varying reasons, including bad bottom. In an effort to provide a summary of these data only the results from Class 7 vessels are presented. Also, only those sentinel locations with two or more points have been selected. The locations have been divided into two sections, those located in southern Baffin Bay and Davis Strait and those located further north in Baffin Bay. The mean catch rate in the southern area was highest in 1996 at .674 kg/h and has been stable at .212 to .245 kg/h for subsequent years (Table 5). Unlike in the south the northern area catch rate for 1996 is comparable to that for 1998 and 2000, ranging from .594 to .765 kg/h (Table 5). It is difficult to explain why the mean CPUE for the South Baffin Bay area is so much higher in 1996 compared to subsequent years and that this same pattern was not observed in the North. However, these data should be interpreted with caution, as only those from the Atlantic Enterprise for 1997 and 1998 are directly comparable.

Length

In 1996 lengths ranged from 20 cm to 95 cm with two distinct modes, one at 41 cm and another at 50 cm (Fig. 4). In subsequent years there has been a narrowing of the distribution and a shift to a single mode, 50 cm in 1997, 47 in 1999 and 44 cm in 2001. The modal lengths and mean lengths for males and females show a similar decreasing pattern (Table 6). There is also a downward trend in the proportion greater than 45 cm from 1998 (73.2%) to 2001 (48.2%) (Table 6). The percentage of fish above 45 cm in 1996 is comparable to that for 2001, however this can be explained by the by-modal distribution observed only in 1996 (Fig. 4).

The regulated mesh size for this fishery is 145 mm in the codend. Mesh size has varied from 145 to 152 within and between years although the 145 mm mesh has been used most frequently (Table 7). The mesh size used in the body of the net has fluctuated considerably within and between years ranging from 100 to 200 mm (Table 7). The 100 mm mesh was used for the first time in the Div. 0A fishery in 2001. Two Class 7 vessels that together accounted for approximately 50% of the overall catch and effort both used 100 mm mesh in the body of the net. Such a small mesh in the body and wings of the trawl has been tested in Greenland halibut fisheries to the south. It was found to be effective in reducing the amount of fish caught or "meshed" in the body and wings and vessel operators have reported improved quality of the catch (Anon., 2001). It is uncertain whether the use of this small mesh in the body of the trawl has had any affect on the overall proportion of small fish caught, as the shape of the length distributions in 2000 and 2001 do not appear to be substantially different.

Otolith samples have been collected for age determination purposes but data for 1996-1998 (Treble, 1999) are contradictory and no recent data are available at this time. Investigations into age determination methods and age validation techniques have been initiated.

Conclusions

Overall catch rates for the single trawl gear have fluctuated from a low of 340 kg/h in 1997 to a high of 667 kg/h in 1996 with no clear trend over time. The length distribution has changed since 1996 from having 6 (3 cm) length classes with greater than 10% abundance to only 4 in 2000 and 2001. Also, there is a downward trend in modal and mean lengths and in the % of fish >45 cm between 1997 and 2001. We might expect the abundance of larger length classes to decline as the fishery develops from essentially a "virgin" state. However, the proportion of fish in the catch that are below 45 cm in length is unusually high. It is important to confirm the age distribution for these fish as soon as possible as well as to determine the relationship between fish in Baffin Bay with those areas to the south and the inshore.

Additional information concerning the fishery resource in Div. 0A is available from scientific surveys conducted in 1999 (Treble *et al*., 2000) and 2001(Treble, 2002).

References

ANONOMOUS. 2001. Greenland halibut (turbot) experiments carried out aboard commercial vessels. Fisheries Diversification Program: Environmental Awareness and Conservation Technology. Project Summary: EACT-7.2001.DFO(FDP 258), 11 pp.

HATHAWAY, B.L. 1993. Exploratory fishing in Davis Strait/Broughton Island Area (Summer, 1993). Unpublished report to Baffin Region Sub-Committee for Fisheries, Decemb er 1993. 29p + appendices.

NORTHLANDS CONSULTING. 1994. 1994 Exploratory fishery: A report on exploratory fishing for shrimp and groundfish in Cumberland Sound, Davis Strait, and Resolution Island survey areas. Northlands consulting. P.O. Box 66 Iqaluit. 46p + appendix.

TREBLE, M.A. 1999. Exploratory fishery results for Greenland halibut (Reinhardtius hippoglossoides) in NAFO Division 0A, 1996-1998. NAFO SCR Doc. 99/45, Ser. No. N4104, 12 pp.

TREBLE, M.A., BRODIE, W. B., BOWERING, W. R. and O. A. JORGENSEN. 2000. Analysis of data from a trawl survey in NAFO Division 0A, 1999. NAFO SCR Doc. 00/31, Ser. No. N4260, 19 pp.

TREBLE, M.A. 2002. Analysis of data from the 2001 trawl survey in NAFO Subarea 0. NAFO SCR Doc. 02/47, Ser. No. N4659, 27 pp.

Table 1. Catch of Greenland halibut as estimated by onboard observers for NAFO Div. 0A, 1996-2001.

Year	Catch (t)
1996	329
1997	241
1998	42
1999	310
2000	320
2001	2,651

Table 2. Non-standardized mean CPUE (kg/h) in NAFO Div. 0A for all vessels combined, (no net damage or loss of fish, tow duration >=2hrs.).

Year	Single Trawl Mean CPUE (kg/h)	s.d.	# tows	Twin Trawl Mean CPUE (kg/h)	s.d.	# tows
1996	641	366	106			
1997	336	277	91	498	430	38
1998	619	302	12			
1999	628	217	84			
2000	339	178	10	863	454	47
2001	494	228	369	882	557	256

Table 3. Catch rate for the 1999 and 2000 Greenland halibut fishery in NAFO Div. 0A by year, month and gear type. Only sets with tow duration =>2 hours and no net damage or fish loss were used. Vessels were both Class 7.

Year	Trawl Type	Month	CPUE (kg/h)	s.d.	# of Tows
1999	Single	September	662.6	247.4	37
		October	626.9	171.9	41
		November	423.2	208.1	6
Sub-total			**628.1**	**216.7**	**84**
2000	Single	August	312.8	158.7	8
		September	443.2	278.6	2
Sub-total			**338.9**	**176.7**	**10**
	Twin	August	484.8	202.2	9
		September	952.8	451.5	38
Sub-total			**863.2**	**453.6**	**47**

Table 4. CPUE (kg/h) for the 2001 Greenland halibut fishery in NAFO Div. 0A: a) by vessel class, gear type and month and b) by depth and area. Only sets with tow duration => 2 hours and no net damage or fish loss were used.

a)

Vessel Class	Trawl Type	Month	Mean CPUE (kg/h)	s.d.	# tows
7	Twin	Sept.	908.4	416.6	86
	Single		403.6	142.2	13
	Twin	Oct.	956.8	602.0	113
	Single		567.1	226.2	71
	Twin	Nov.	695.7	613.8	57
	Single		403.0	194.7	58
Sub-total	Twin		882.4	557.0	256
	Single		485.1	221.8	142
6	Single	Sept.	464.4	241.9	51
	Single	Oct.	587.6	204.6	67
Sub-total			534.4	228.8	118
5	Single	Sept.	406.7	238.9	8
	Single	Oct.	556.5	243.1	56
	Single	Nov.	351.1	156.7	45
Sub-total			460.7	231.9	109

b)

Depth Range (m)	Trawl Type	Area in Div. 0A	Mean CPUE (kg/h)	s.d.	# tows
501-750		Central	529.7	.	1
751-1000	Twin	SE	.	.	.
	Twin	SW	859.9	583.8	13
	Twin	Central	1006.2	537.9	21
	Twin	North	859.0	305.4	43
	Single	SE	428.2	236.9	29
	Single	SW	257.7	174.9	4
	Single	Central	480.1	238.0	23
	Single	North	413.6	221.9	17
1001-1250	Twin	SE	723.5	548.1	65
	Twin	SW	818.4	502.3	24
	Twin	Central	1098.7	642.5	72
	Twin	North	516.7	286.9	6
	Single	SE	367.5	158.2	95
	Single	SW	289.1	235.6	7
	Single	Central	588.8	219.0	125
	Single	North	581.2	216.2	62
1251-1500	Twin	SE	598.9	680.1	8
	.	SW	.	.	.
	Twin	Central	746.1	344.9	4
	Single	North	590.3	131.6	6

Table 5. CPUE (kg/h) for Sentinel Locations in NAFO Div. 0A.

Location	Region within 0A	Latitude N	Longitude W	Average Depth (m)	1996* CPUE	1997* CPUE	1998** CPUE	2000** CPUE
1	South	67 13'	58 15'	1137	0.488	0.069	0.151	
3	South	67 06'	59 36'	1144	0.508	0.108	0.259	0.257
5	South	67 49'	59 21'	1182	1.690	0.763	0.357	
6	South	68 03'	59 50'	873		0.390	0.103	0.167
8	South	67 16'	60 07'	1147	0.572	0.106	0.268	0.136
9	South	67 28'	61 00	730		0.155	0.206	0.410
10	South	67 53'	62 18'	1144	0.110	0.123	0.143	0.136
Mean					0.674	0.245	0.212	0.221
15	North	69 07	64 00'	1148	0.954		0.524	
17	North	68 23'	63 51'	838			0.143	0.391
18	North	70 01	65 02'	1131	0.511		0.697	1.517
20	North	70 11'	65 19'	658			1.120	0.693
21	North	71 05'	67 20'	1242	1.013		0.182	0.231
22	North	70 17'	65 18'	835			0.252	1.498
23	North	70 21'	65 39'	669			0.180	0.746
24	North	71 16'	67 59'	1251	0.153		2.180	0.588
25	North	71 21'	68 24'	998	0.568			0.589
26	North	71 57'	70 56'	897			0.065	0.631
Mean					0.640		0.594	0.765

* Mean duration of tow was 4.7 h in 1996 and 4.1 h in 1997.
** Mean duration of tow was 1.0 h in 1998 and 2000.

Table 6. Overview of length (cm) parameters for the NAFO Div. 0A fishery 1996-2001.

Year	Length range Male	Female	Unknown	Modal Length Male	Female	Unknown	Length Mean Male	Female	Unknown	Percent >45 cm
1996	22-80	20-95	30-46	49	50	40	45.5	48.3	38.9	49.4
1997	24-78	24-94		48	50, 52		47.6	50.0		68.0
1998	30-75	30-87		46	49		48.1	50.8		73.2
1999	30-81	30-99		46	47		48.0	50.2		65.7
2000	27-68	28-94		45, 48	47		44.1	47.7		60.2
2001	26-80	23-104	26-98	45	45	46	44.9	46.7	49.1	48.2

Table 7. Mesh used in the otter trawl gear during the NAFO Div. 0A Greenland halibut fishery 1996-2001.

Year	Codend Mesh (mm)	Body Mesh (mm)
1996	147, 148	147, 149, 150
1997	145, 147, 148	153, 152, 160
1998	145	146
1999	145, 147	152, 153
2000	145	160
2001	145, 148, 150, 152	100, 135, 150, 155, 160, 200

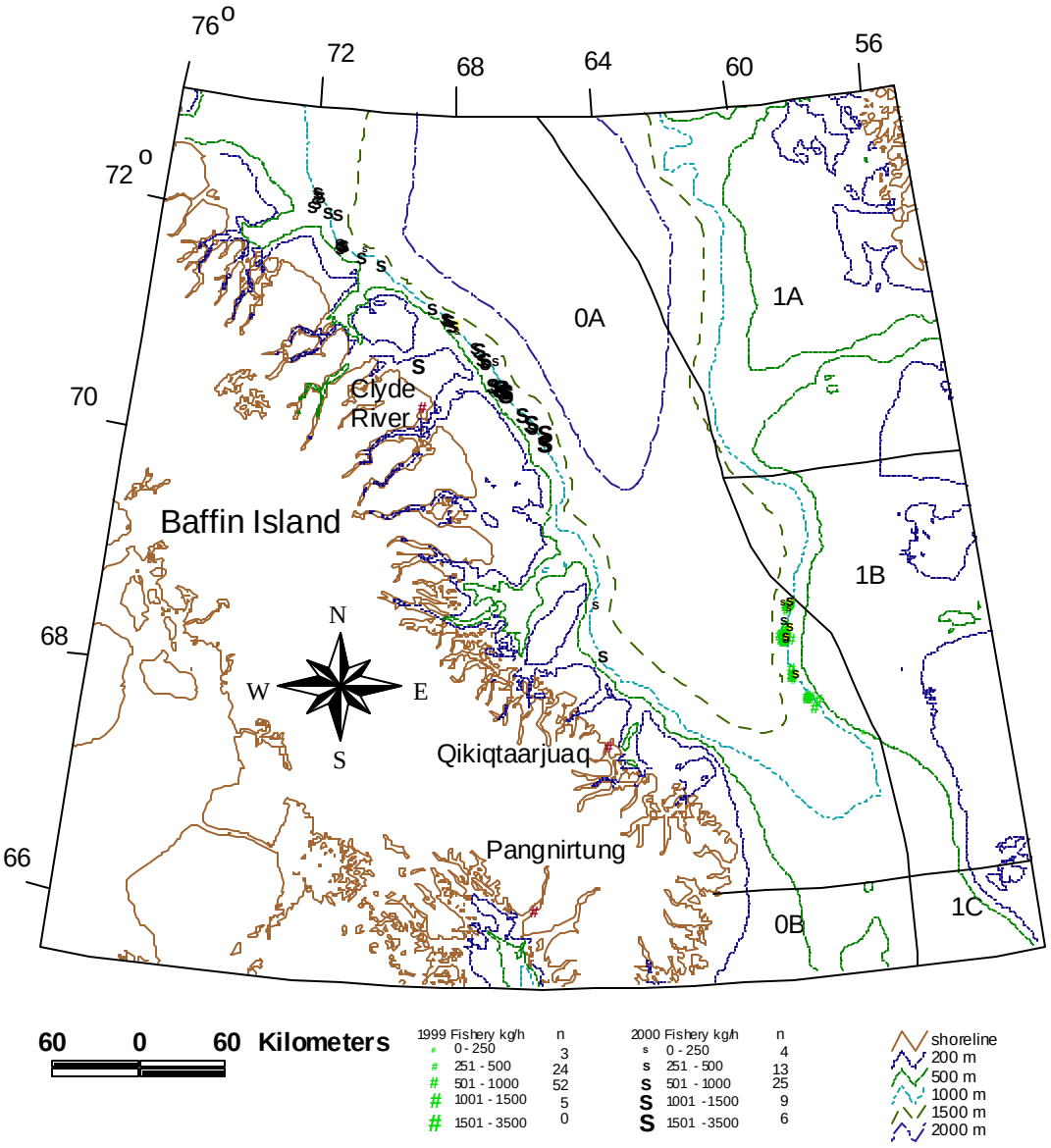

Figure 1. Catch distribution, non-standardized CPUE (kg/h) for 1999 (solid circles) and 2000 (open circles). A single vessel fished in NAFO 0A in each year. In 2000 both a single trawl and a double trawl were used.

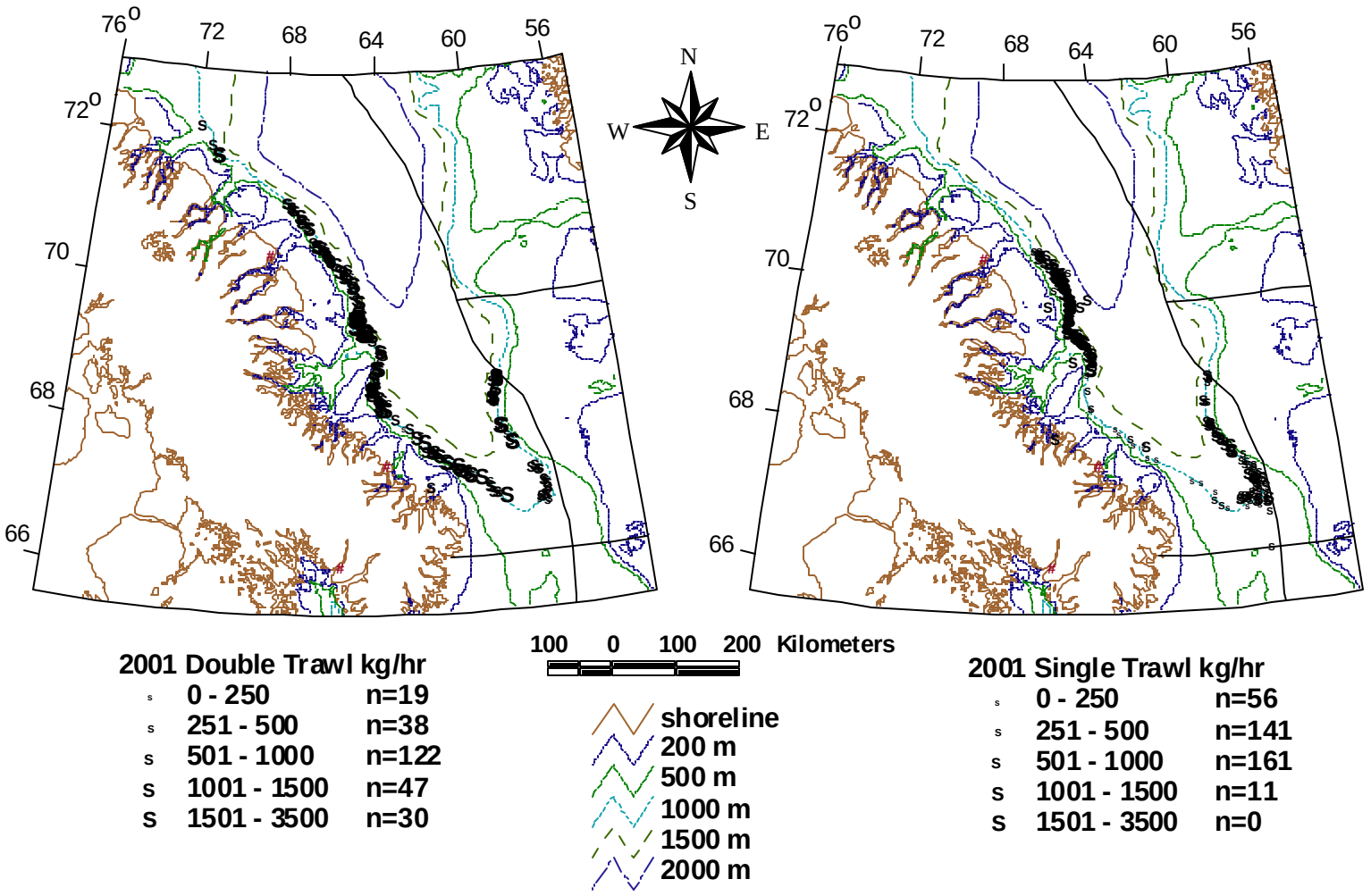

Figure 2. Catch distribution, non-standardized CPUE (kg/h) for 2001 for both single and double trawls. Two of the five vessels fishing in NAFO 0A used both a single trawl and a double trawl (see table 2).

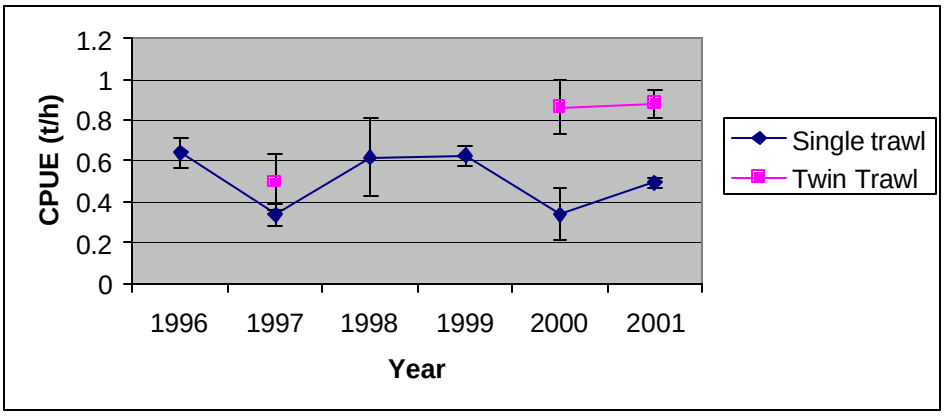

Figure 3. Mean catch per unit effort (CPUE) with 95% confidence limits for NAFO Div. 0A, 1996-98.

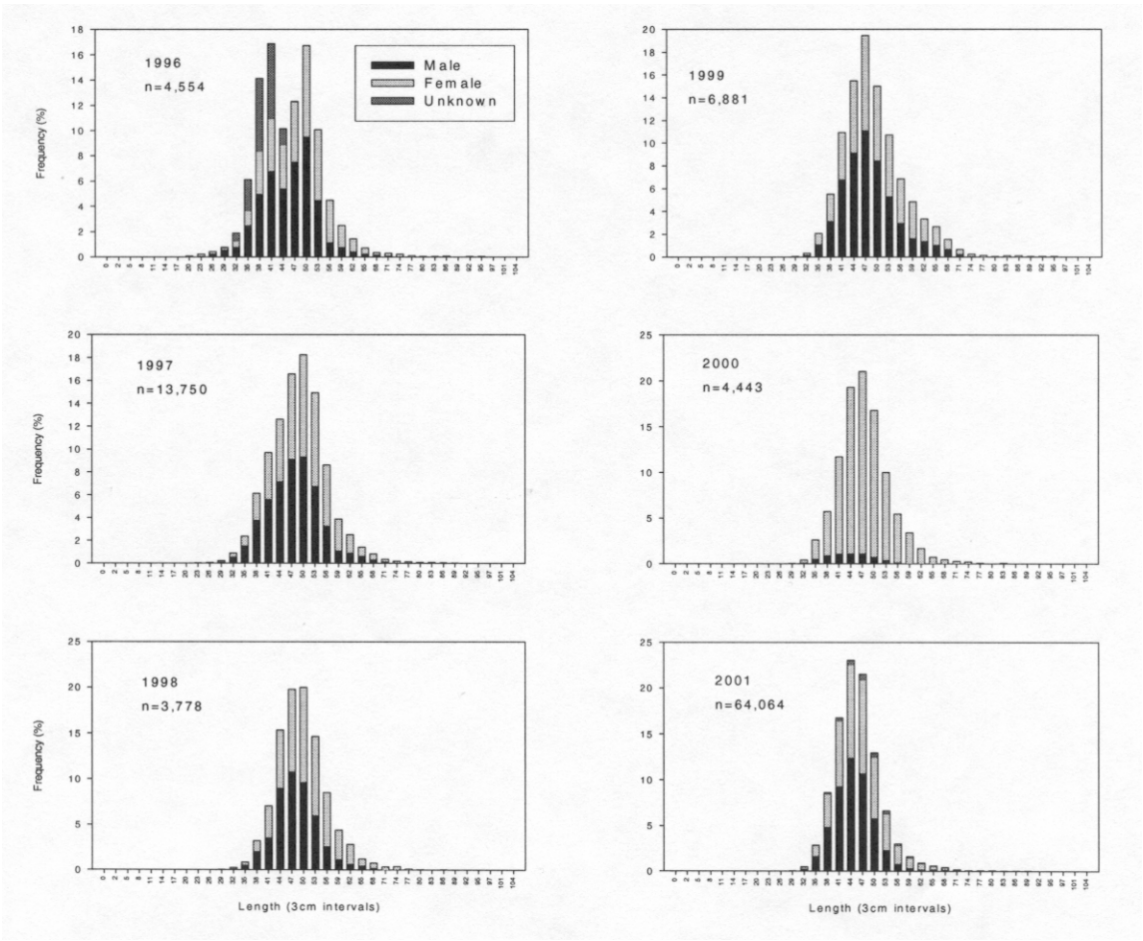

Figure 4. Length frequency of Greenland halibut from NAFO Div. 0A.