CUMBERLAND SOUND GREENLAND HALIBUT (TURBOT) INSHORE FISHERY

Bonnie Ross, Ross Illustrations

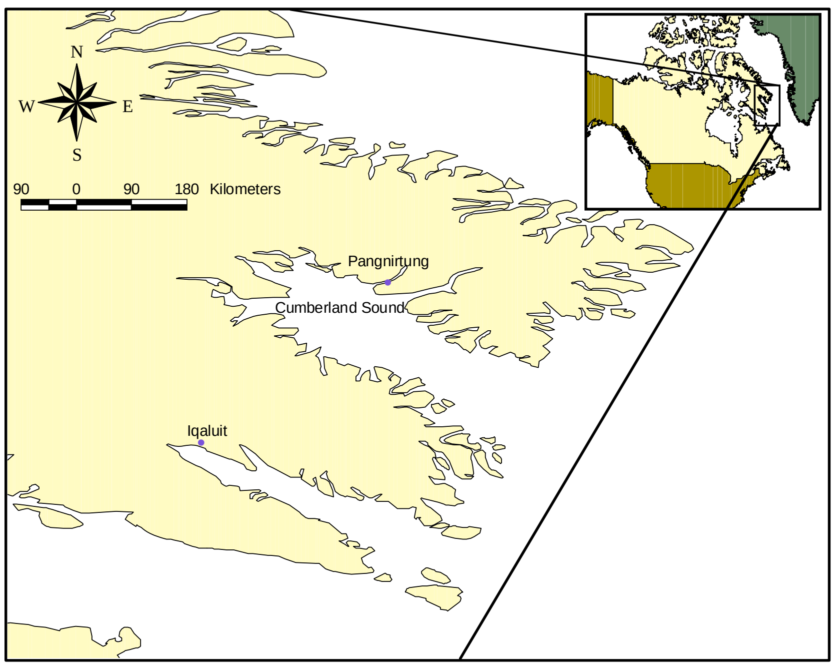

Figure 1: Cumberland Sound, Baffin Island, Nunavut, Canada.

Context :

The Cumberland Sound Greenland halibut fishery has been operating since 1986. It was originally licenced annually under an experimental licence and more recently an exploratory licence. Fisheries and Aquaculture Management, Central and Arctic Region have asked Science if there is sufficient information available to allow for the conversion of the exploratory Greenland halibut fishery to a commercial fishery in Cumberland Sound.

SUMMARY

- The Cumberland Sound inshore management area has supported a small scale turbot fishery for 20 years
- This fishery has been treated as a commercial fishery since the quota was established at 500 t in 1994.
- The data reviewed suggests that the fishery status could be changed from exploratory to commercial.
- There is a lack of information on recruitment processes and Greenland halibut maturation so a conservative management style is recommended.
- Monitoring of the catch should continue and may need to be enhanced if there is a sustained increase in harvest level.
- An introduction of new gear types or changes to the gear used in this fishery should be carefully considered for impacts on Greenland halibut spawning potential and recruitment as well as for impacts on other species such as marine mammals.

BACKGROUND

The Cumberland Sound fishery is a winter fishery using long-lines set through holes in the land-fast sea ice. The total allowable catch (TAC) has been set at 500 t since 1994 (Table 1). Fish are transported to the plant in Pangnirtung in insulated tubs attached to qamatiks (sleds). The ice conditions have an effect on fishing location and depth and consequently on catches, from one year to the next. The timing and extent of development of the land-fast ice varies annually depending on the latent heat of surface waters and weather conditions. The fishermen access fishing areas near Imigen Island in the SW corner of Cumberland Sound first (Figures 1, 2 and 3). They then move with the ice as it expands to cover deeper waters. If it is a poor year for ice formation they may not be able to move from the Imigen Island area which has often been the case since 1997. The fishing season typically runs from late January to mid May (approx. 16 weeks). However in 2005 and 2007, ice conditions were very poor and the season lasted only a few weeks. Prior to 2005, any of the 500 t quota not filled in Cumberland Sound could be transferred to the offshore.

From 1997-2000, a tagging program was carried out on the winter fishing grounds within Cumberland Sound (Stephenson *et al.* 1997, Treble 2003). In June 2004, Fisheries and Oceans Canada requested that the Northwest Atlantic Fisheries Organization (NAFO) Scientific Council comment on “the relationship between Greenland halibut in inshore waters of Cumberland Sound and the offshore waters of Division 0B and advise whether or not a separate management unit would be appropriate for Cumberland Sound Greenland halibut.” The council responded that “… Based on available information, Scientific Council recommends that a separate stock management area be established for the traditional winter fishing grounds for Greenland halibut in the inner portion of Cumberland Sound.” (NAFO 2004). In February 2005, the Nunavut Wildlife Management Board (NWMB) established a Total Allowable Harvest (TAH) for turbot of 500 t within Cumberland Sound (Figure 2). This TAH is separate from and in addition to the existing Division 0B turbot allocation to Nunavut of 1,500 t. Fishing for the 500 t may take place at any time of the year and can no longer be transferred to the offshore. Vessel and gear limitations have affected previous attempts to establish a summer fishery in Cumberland Sound.

ASSESSMENT

Landings or catch data are provided to DFO by Pangnirtung Fisheries Inc. From 1987-1995, biological samples (fish length, weight, sex and otoliths for age determination) were taken from the catch on the sea ice during a one to two week period at approximately the mid point of the fishing season. From 1997 to 2006, these samples have been collected by Pangnirtung Fisheries Inc. staff under contract to DFO, at several times throughout the fishing season. No data were collected in 2007 as the season was too short. Fishermen participating in a voluntary logbook program provide data from which catch- per-unit effort (CPUE) can be estimated. However, logbooks were not received in 2004 or 2005 and in 2006 only 1 logbook was turned in.

Catches and Catch Rates

Catches in the Cumberland Sound winter fishery seem to be strongly linked to the timing and extent of the development of land-fast sea ice and fishing effort, in terms of the number of fishermen. In addition the number of fishermen and the length of time they participate in the fishery could also be related to ice conditions.

During the first half of the 1990s ice conditions were favourable with early formation of a large expanse of ice safe enough to travel and accommodate camps for 40 or more fishermen and their helpers. The fishing season ran from late January to mid May (16-18 weeks) (Table 1). During this period, catches increased from 180 t in 1989 to 430 t in 1992 before dropping down to 285 t in 1995 (Table 1). In 1991, the fishing period was restricted, start-up funding was delayed to mid-February and the fishery was stopped in April when fish from the Quebec fishery entered the market, dropping the price below an acceptable level (Ashley 1993), as a result catches were lower compared to other years during this period.

Significant delays in the formation of land-fast ice were experienced in 1988 and 1989 (Ashley 1993). Fishermen again experienced poor ice conditions beginning in 1996 that have re-occurred most years since then. In mid February of 1996, a severe storm combined with a full moon and high tide resulted in severe break-up of the land-fast ice sheet. There had been approximately 30 fishermen participating in the fishery prior to this storm in which 20 of them lost a significant amount of equipment (T. Stephenson, DFO Biologist, pers. comm.). Most did not return to the fishery in 1996 and many did not return in the years that followed. Only 60 t were caught in 1996 and catches remained at this level through to 2002 when catches increased to 106 t. With the increased effort and a slightly longer fishing season catches increased again to 242 t in 2003 (Table 1).

The fishing season during the late 1990s and early 2000s generally lasted 11-12 weeks, from mid February to late April (Table 1) and the ice did not extend out over the deeper water (greater than 500 m) in the preferred fishing areas (Figure 3). This was particularly true in 1997 and 1999 when fishing was restricted to a small area near Imigen Island in the Western end of Cumberland Sound. In both 2005 and 2007, ice conditions were extremely poor, the ice platform had just begun to stabilize when a winter storm broke it up and the fishery was not able to resume. Catches in these years were less than 10 t (Table 1).

Set duration in the early years of the fishery was, on average 2 hours with very little variation, the majority of sets being less than 3 hours. In the early 1990s, many fishermen began using power winches to lift the lines from the bottom. This enabled them to fish several lines at once often putting two lines down through a single hole. The increase in lines fished affected the set duration for each individual line resulting in a gradual increase in set duration between 1991 and 1995 (M. Keast, pers. comm.). Average set duration now varies from 8 to 10 hours (Figure 4). Set duration for 1997 to 2005 shows a bi-modal distribution for most years with a range from 1 to 28 hours (Figure 5).

A highly significant positive relationship, using linear regression analysis, was found between Greenland halibut catch and both number of hooks fished and set duration for all data within the combined data set, 1987 to 1995 (hooks fished, F=871.295, p=0.000 and set duration, F=632.266, p=0.000). The same was true for the 1997 to 1999 dataset (hooks fished, F=67.346, p=0.000 and set duration F=30.604, p=0.000). However, Pike (1994) noted that the relationship between catch and set duration was weak and variable across individual years. In particular, the years in which mean set duration was less than 3 hours (1987, 1989-1991) showed no significant relationship. When the 1997-1999 data were examined by individual years 1999 showed no significant effect for set duration on catch (linear regression F=0.917, p=0.339). Mathias and Keast (1996) used a lowess smoother to show that the overall relationship between catch and set duration is non-linear with long-lines approaching saturation at approximately 10 hours. Therefore, it did not seem appropriate to standardize catch directly by hours fished. Instead a sub-set of the data were chosen that covered a discrete time period below the saturation point and within which there was sufficient data (i.e. set frequency). Catch standardized to 100 hooks fished has been plotted for sets of 1 to 3 hours duration for 1987 to 1994 and for sets of 5 to 7 hours duration from 1993 to 2005 to account for the observed change in set duration between these two time periods (Figure 6).

Greenland halibut catch rates from 1987 to 1994 (the 1 to 3 hour series) appears stable, fluctuating around 16 fish per 100 hooks. Catch rate fluctuated around 18 fish per100 hooks between 1993 and 1998 (the 5 to 7 hour series) then dropped to a low of 9.6 fish per100 hooks in 1999 before increasing over the next 3 years to a high of 27 fish per100 hooks in 2002. The rate declined slightly in 2003 and in 2006 it was at a level similar to 2002 and 2003 but with a large 95% confidence interval, likely due to the small sample size.

Mean Length

Mean length of Greenland halibut for both sexes combined increased from 67 cm to 70 cm from 1986 to 1991 then dropped to approximately 65 cm for the period 1992 to 1995. Since 1997, mean length has varied between 54 cm and 61 cm (Table 2 and Figure 7).

The overall length frequency distribution appears similar for 1986 to 1990 with modal lengths varying between 70 and 75 cm (Figure 8 and Table 2). There is a change in the frequency distribution beginning in 1992, with the modal length ranging from 62 to 67 cm for 1992 to 1995. The length frequencies for 1997 to 2005 are similar with a majority of the catch falling below 65 cm and the mode varying between 50 and 60 cm (Figure 9).

Similar trends are seen when the data are examined separately by sex (Table 2b). However, the data from 1987-1995 does not likely reflect the proportion of males and females in the population. There may have been some difficulty in differentiating males and immature or resting females (see comments below in section on sex and maturity). Male mean length varied around 54 cm from 1997 to 2002 and dropped to approximately 52 cm during 2003-2005.

During the same period female mean length doesn't show as consistent a decline as that for males, with mean length varying between 56 cm and 65 cm (Table 2b).

A reduction in mean length and shift in the modal length may be expected in the early stages of fishery development as the larger individuals are gradually fished out. An additional factor to consider in this case is that the fishermen have been restricted to relatively shallow waters more frequently in recent years, where, given our understanding of Greenland halibut behaviour, the abundance of small fish would be expected to be greater.

Sex, Maturity and Recruitment

The majority of samples from 1987 to 1989 were classified as sex unknown (Figure 8) and between 1990 and 1995 the majority of the samples were classified as female. Since 1997, the sample is more equally distributed between males and females (Table 2b and Figure 9). Sex and maturity descriptions were modified in 1998 and reference photos of Greenland halibut reproductive organs (from Bill Brodie, DFO, St. John's) were sent to the Pangnirtung fish plant in 1999 in an effort to improve the sex and maturity classifications. Despite the uncertainty with classifications the occurrence of sexually mature male or female Greenland halibut in the Cumberland Sound winter fishery is rare.

A study of Greenland halibut ovary development in Disko Bay, Greenland found mature ovaries only in fish >80 cm in length and only among a small fraction of these large fish (Simonsen and Gundersen 2005). There is a hypothesis that Greenland halibut have a prolonged adolescent phase and may also have a multi-year maturation cycle which is supported by the observations made by Simonsen and Gundersen (2005). This could explain why we see so few mature females in Cumberland Sound.

There may not be sufficient spawning potential within Cumberland Sound to support the stock and therefore immigration from offshore waters would be very important. Until we have more information on Greenland halibut development and recruitment mechanisms it is not possible to comment on recruitment potential for this stock.

Weight-Length Relationship

Regression parameters for the weight-length relationship for Greenland halibut from Cumberland Sound are shown in Table 3. The relationship is highly correlated with the coefficient of variation (r^2) ranging from 0.89 to 0.97. Slope varies between 3.09 and 3.35 and intercept varies between –5.24 and –5.97. There is no observable trend among years in the data.

Round Weight Conversion Factor

Regression parameters for the dressed weight-round weight relationship are shown in Table 4. The relationship is highly correlated with the coefficient of variation (r^2) ranging from 0.97 to 0.99. The ratio of round weight /dressed weight was also calculated and varied from 1.34 to 1.38 for the head off, gutted product that the Cumberland Sound fishermen produce. This value is also known as a conversion factor. The Pangnirtung fish plant uses a conversion factor of 1.4 for this product based on the guide Conversion Factors for Atlantic Canada (STACAC 1984).

Age

Age determination for Greenland halibut is difficult and this is particularly true for fish from northern portions of its range. Research into age validation has shown that Greenland halibut from northern waters are slow growing and long lived (Treble *et al.* in press.) and the whole-otolith method underestimates the age of Greenland halibut. However, a new method for age determination has not yet been validated (Treble and Dwyer 2006, Treble *et al.* in press.).

Ages based on whole-otolith determinations for the sampled catch from 1997 to 1999 ranged from 8 to 28 years with a mode of approximately 14 to 15 years (Fig. 10 and 11). There are not sufficient data to determine trends. Otoliths have continued to be collected but have not been aged, pending the development of a more accurate method.

Ecosystem Considerations

The by-catch in this fishery is primarily comprised of Greenland shark *(Somniosus microcephalus*) and skate (sp.) (Table 5). The skates are predominantly thorny skate *(Raja radiata*) (Pike 1994) but there may also be arctic skate present (*Raja hyperborea*). Occasionally grenadier sp., wolfish (*Anarhichas sp.*) and eelpout (*Lycodes sp*.) are also caught.

There is a resident population of beluga in Cumberland Sound while narwhal and bowhead use the Sound on a seasonal basis. Greenland halibut may comprise an important part of the diet of narwhal and beluga. Cumberland Sound belugas are known to feed on Greenland halibut (Kilabuk 1998) and dive depths as great as 800 m have been observed (Pierre Richard, pers. comm.) They may be targeting Greenland halibut during these deep dives. Narwhal are known to feed on Greenland halibut in other areas (Laidre and Heide-Jørgensen 2004 and Laidre 2003) and this may also be true for narwhal in Cumberland Sound.

Cumberland Sound beluga were designated as Threatened by COSEWIC in 2004. Bowheads in the eastern Arctic and the Baffin Bay population of narwhal were designated by COSEWIC as Threatened and Special Concern (respectively) in 2005. Cumberland Sound beluga and Baffin Bay narwhal are being considered for listing under the Canadian *Species at Risk Act*. Bowheads will be re-assessed by COSEWIC in 2008 on the basis of new scientific information now available.

Sources of Uncertainty

There is a lack of information on recruitment processes and Greenland halibut maturation for this area. Advice is based on the fishery continuing to be a long-line fishery.

CONCLUSION

An observed decline in mean length and a shift to smaller fish in the sampled catch since the fishery began in 1987 could be an initial response to the commencement of a fishery, changes in depth of the fishing grounds, growth over-fishing or some combination of these. There has also been a decline in harvest which may be linked to the quality of the sea ice, which influences season length, fishing location and participation (i.e. fishing effort). The CPUE estimate has varied over the years but the most recent value is near the highest in the time series.

The Cumberland Sound inshore management area has supported a small scale turbot fishery for 20 years and in many ways it has been treated as a commercial fishery since the quota was established at 500 t in 1994. The data reviewed here suggest that the fishery status could be changed from exploratory to commercial.

Given the lack of information on recruitment processes and Greenland halibut maturation a conservative management style is recommended. Monitoring of the catch should continue and may need to be enhanced if there is a sustained increase in harvest level. The introduction of new gear types or changes to the gear used in this fishery should be carefully considered for impacts on Greenland halibut spawning potential and recruitment as well as for impacts on other species such as marine mammals.

SOURCES OF INFORMATION

Ashley, B.D. 1993. Community economic impact of commercial fisheries development in Canada's Eastern Arctic: The Pangnirtung winter turbot fishery. Simon Fraser University, MNRM Research Project, 93 p.

Department of Fisheries and Oceans. 1991. Annual summary of fish and marine mammal harvest data for the Northwest Territories, 1988-1989, Volume 1: v + 59 p.

Department of Fisheries and Oceans. 1992a. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 2, 1989-1990: xiv + 61 p.

Department of Fisheries and Oceans. 1992b. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 3, 1990-1991: xiv + 67 p.

Department of Fisheries and Oceans. 1993. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 4, 1991-1992: xiv + 69 p.

Department of Fisheries and Oceans. 1994. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 5, 1992-1993: xvii + 104 p.

Department of Fisheries and Oceans. 1995. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 6, 1993-1994: xv + 86 p.

Department of Fisheries and Oceans. 1996. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 7, 1994-1995: xiii + 85 p.

Department of Fisheries and Oceans. 1997. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 8, 1995-1996: xii + 80 p.

Department of Fisheries and Oceans. 1999. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 9, 1996-1997: xii + 72 p.

Kilabuk, P. 1998. Final report on a study of Inuit knowledge of the Southeast Baffin beluga. Nunavut Wildlife Management Board, Iqaluit, Nunavut. 74 p.

Laidre, K.L. 2003. Space-use patterns of narwhals (*Monodon monoceros*) in the high Arctic. PhD thesis, University of Washington, Seattle, WA. 166 pp.

Laidre, K.L. and Heide-Jørgensen, M. P. 2004. Seasonal feeding intensity of narwhals (*Monodon monoceros*). North Atlantic Marine Mammal Commission/SC/12-JCNB/SWG/2004-JWG/11. 20 pp.

Mathias, J. and Keast, M. 1996. Status of the Greenland halibut (*Reinhardtius hippolglosoides*) fishery in Cumberland Sound, Baffin Island 1987-1995. NAFO SCR Doc 96/71, Ser. No. N2746, 20p.

NAFO 2004. Northwest Atlantic Fisheries Organization Scientific Council Reports 2004. Northwest Atlantic Fisheries Organization, Dartmouth, Nova Scotia, Canada. 298 p.

Pike, D.G. 1994. The fishery for Greenland halibut (*Reinhardtius hippoglossoides*) in Cumberland Sound, Baffin Island, 1987-1992. Can. Tech. Rep. Fish. Aquat. Sci. 1924:iv+20p.

Simonsen, C. S. and Gundersen, A. C. 2005. Ovary development in Greenland halibut *Reinhardtius hippoglossoides* in west Greenland waters. J. Fish. Biol. 67: 1299-1317.

STACAC 1984. Statistical Co-ordinating Committee for the Atlantic Coast Standards. STACAC Document No. 2, Revision #1, June 1984, 7 p.

Stephenson, T. D., Treble, M. A., Mathias, J. A., and Pike, D. G. 1997. Experimental tagging of Greenland halibut (*Reinhardtius hippoglossoides*) in Cumberland Sound, Baffin Island, during the winter fishery, May 1997. NAFO SCR Doc. 97/48. 7 p.

Treble, M. A. 2003. Results of a Greenland halibut (*Reinhardtius hippoglossoides*) tagging project in Cumberland Sound, NAFO Division 0B, 1997-2000. NAFO SCR Doc. 03/41. 7 p.

Treble, M. A. and Dwyer, K. S. 2006. Report of the Greenland halibut (*Reinhardtius hippoglossoides*) age determination workshop. NAFO SCR Doc. 06/49. 84 p.

Treble, M. A., Campana, S. E., Wastle, R. J., Jones, C. M. and Boje, J. (in press.). Growth analysis and age validation of a deep-water Arctic fish, the Greenland halibut (*Reinhardtius hippoglossoides*). Can. J. Fish. Aquat. Sci.

APPENDIX: Tables and Figures

Table 1. Cumberland Sound Greenland halibut quota (t), harvest (t), number of fishermen and the duration of the fishery for 1987 to 1999 (Sources: Department of Fisheries and Oceans, 1991, 1992a, 1992b, 1993, 1994, 1995, 1996, 1997, 1999 and unpublished data; Ashley 1993 and Pangnirtung Fisheries Inc.).

Year	Quota (t)	Harvest (t)	Number of Fishermen	Length of Season (weeks)
1987	6	4	6	9
1988	100	11	9	7
1989	250	180	43	14
1990	300	255	77	18
1991	300	139	61	12
1992	530	430	93	21
1993	625	425	115	18
1994	500	402	107	18
1995	500	285	97	18
1996	500	61	30	18
1997	500	66	12-15	16
1998	500	63		13
1999	500	34	10-12	14
2000	500	45	13	13
2001	500	78	10-15	12
2002	500	106	30	11
2003	500	242	35	14
2004	500	61	20	10
2005	500	9		2-3
2006	500	70	10	11
2007	500	3	6	3

Table 2. Sample data from Cumberland Sound long-line fishery, a) both sexes combined, b) males and females separate.

a)

Year	Mean Length (cm)	Modal Length (cm)	Mean Weight (Rd) (kg)	Sample Size	Sampling Period
1986	67.5	75		107	May
1987	68.0	70	3.64	250	March
1988	71.9	75	4.14	154	March
1989	72.6	70	4.15	114	March
1990	71.6	70 & 75	4.05	149	Feb/April
1991	75.2	75	5.19	52	March
1992	66.4	55	3.28	147	March
1993	65.7	55 & 56	3.13	150	
1994	65.0	60	3.08	156	
1995	66.0	60	3.21	147	March 25-26
1997	55.4	50	1.81	1372	May 2-9
1998	61.1	55	2.56	847	March 17-May 6
1999	59.4	50	2.28	900	March 23-April 28
2000	58.4	52	2.14	425	Feb. 12-May 4
2001	57.0	56	1.96	1517	March 14-April 9
2002	57.2	59	1.92	1145	March 2-6
2003	56.9	60	1.98	1351	Feb. 25-May 1
2004	54.2	50	1.64	2204	Feb. 3-April 21
2005	54.2	50	1.64	360	Feb. 25-Feb. 26

b)

	Male			Female		
Year	N	Mean Len. (cm)	Mean Wt. (kg)	N	Mean Len. (cm)	Mean Wt. (kg)
1987	5	59.4	2.2	51	65.4	3.2
1990	1	57.0	2.0	104	72.7	4.3
1991	-	-	-	52	75.2	5.2
1992	4	57.0	1.7	137	66.1	3.2
1993	4	65.4	3.0	145	65.8	3.1
1994	8	57.5	1.9	148	65.4	3.1
1995	6	65.2	2.9	140	65.9	3.2
1997	847	53.6	1.5	522	58.5	2.2
1998	354	57.8	2.0	336	65.5	3.3
1999	467	55.8	1.8	431	63.4	2.8
2000	228	54.1	1.6	197	63.3	2.8
2001	775	54.6	1.7	742	59.4	2.3
2002	591	54.6	1.6	553	60.0	2.2
2003	531	52.1	1.4	820	60.0	2.3
2004	920	51.0	1.3	1281	56.5	1.9
2005	252	52.1	1.4	107	59.2	2.2

Table 3. Linear regression parameters for Log_{10} transformed round weight (g) vs. Log_{10} transformed fork length (mm) for Greenland halibut from Cumberland Sound.

Year	Sample Size	Slope	Intercept	r^2
1997	1371	3.23	-5.65	.94
1998	847	3.14	-5.37	.92
1999	900	3.35	-5.97	.95
2000	425	3.34	-5.94	.97
2001	1517	3.20	-5.54	.90
2002	1145	3.09	-5.24	.89
2003	1351	3.30	-5.83	.94
2004	2202	3.15	-5.42	.91
2005	359	3.11	-5.30	.91

Table 4. Linear regression parameters for dressed weight (g) vs. round weight (g) for Greenland halibut from Cumberland Sound. The ratio is calculated using the overall sum for round weight and dressed weight.

Year	Sample Size	Slope	Intercept	r^2	Ratio (round wt./dressed wt.)
1997	1352	0.71	48.19	0.99	1.35
1998	844	0.72	10.55	0.99	1.37
1999	900	0.70	81.00	0.99	1.36
2000	425	0.69	86.59	0.98	1.37
2001	1517	0.74	8.21	0.98	1.34
2002	1145	0.71	64.44	0.93	1.35
2003	1351	0.72	13.30	0.99	1.38
2004	2202	0.73	5.21	0.98	1.37
2005	359	0.72	25.87	0.98	1.36

Table 5. By-catch amount (numbers) in the Cumberland Sound fishery.

Year	No. of Sets Reported	Greenland Shark	Skate (sp.)	Year	No. of Sets Reported	Greenland Shark	Skate (sp.)
1987	111	15	7	1999	596	104	29
1989	824	121	74	2000	710	137	1677
1990	1428	80	149	2001	208	17	318
1991	1317	52	49	2002	705	60	171
1992	498	26	65	2003	528	24	444
1993	496	28	96	2006	74	4	84
1994	717	61	88				
1995	1782	220	211				
1996	221	29	14				
1997	1148	186	193				
1998	601	172	690				

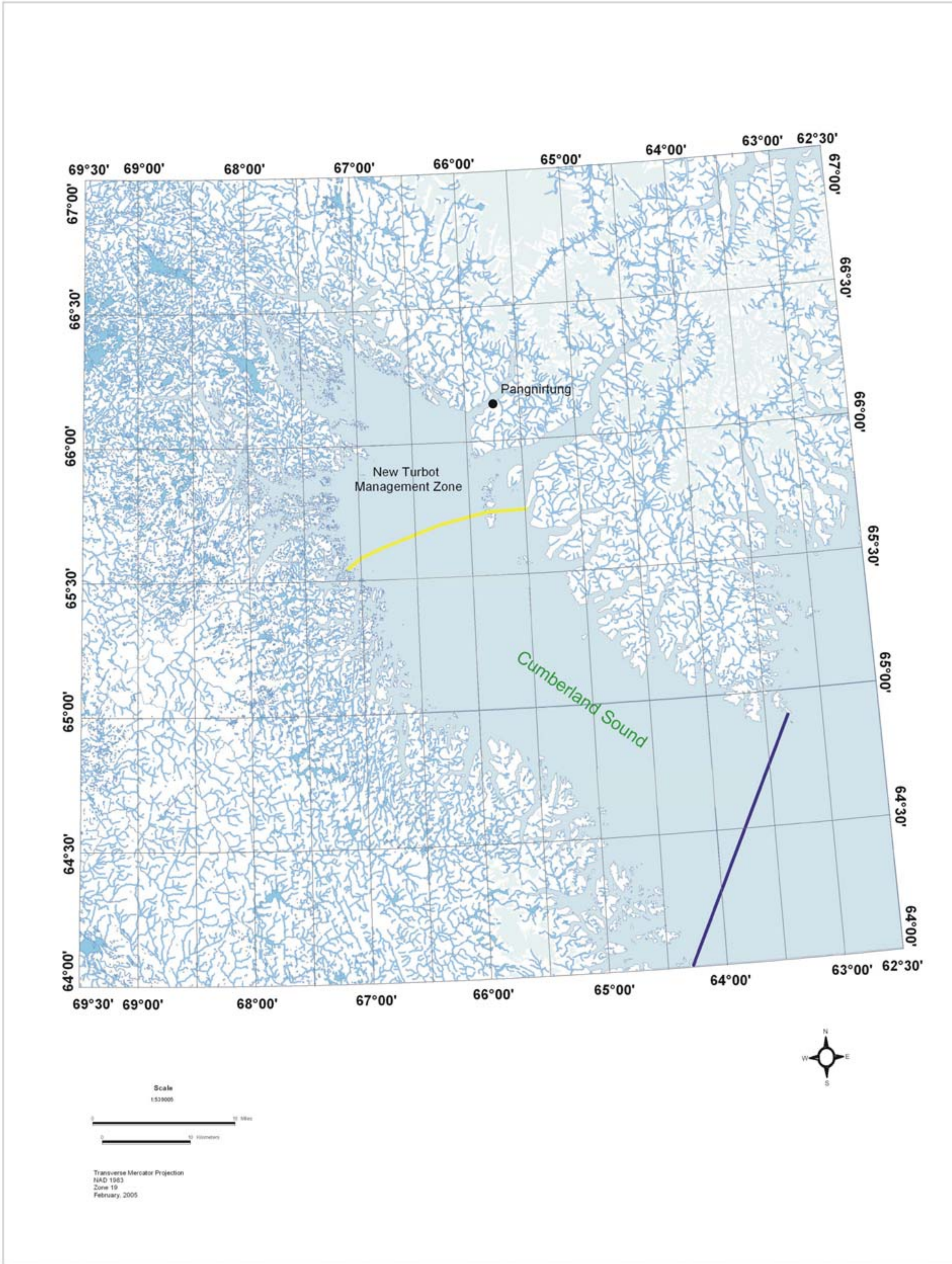

Figure 2. The new turbot inshore management area for Cumberland Sound is shown (area NW of the yellow boundary. Only vessels less than 65 ft (19.8 m) have been approved for use within Cumberland Sound (area bounded by the shoreline NW of the blue line).

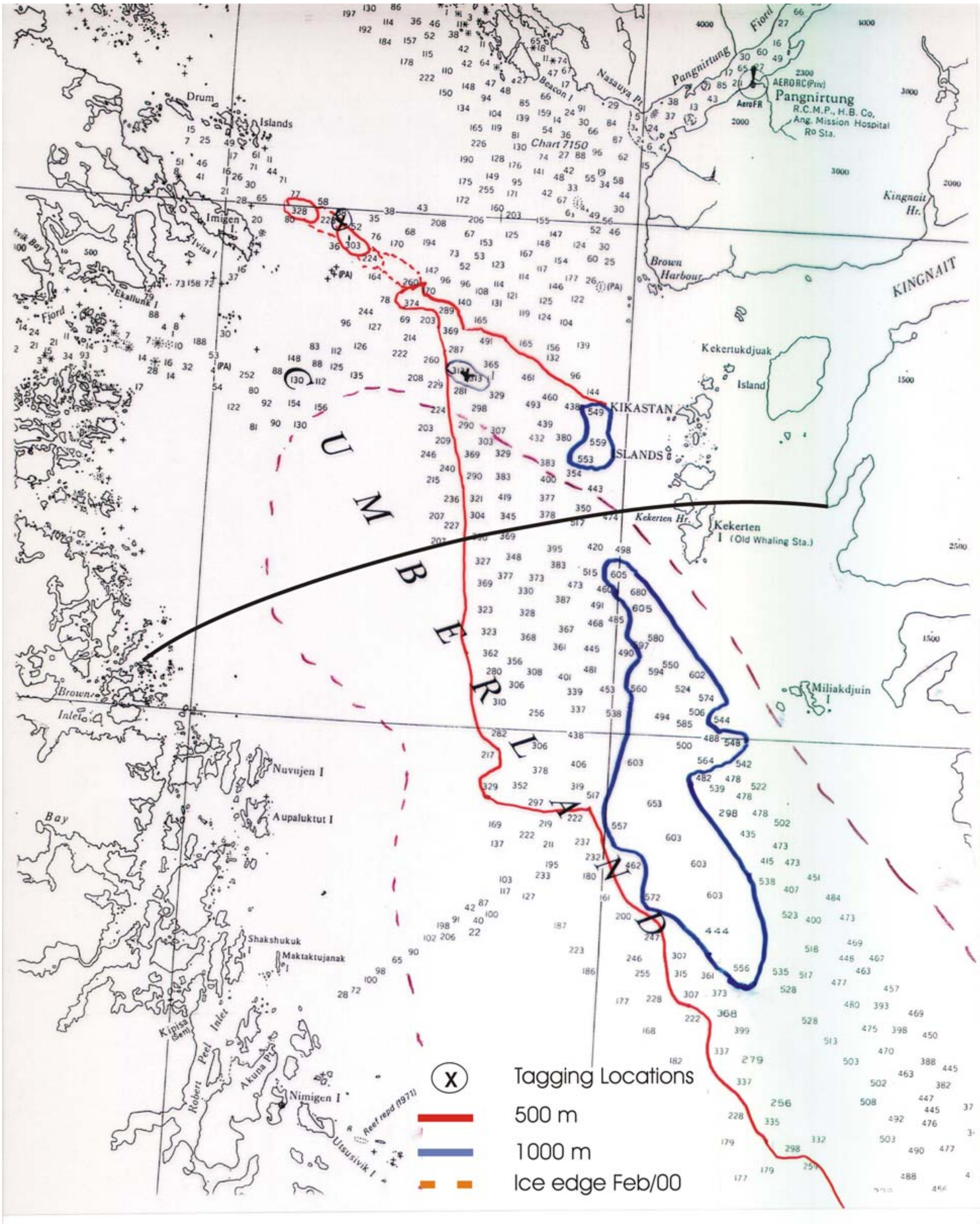

Figure 3. Bathymetric chart of a portion of Cumberland Sound where winter fishing takes place. The extent of the land fast sea ice in February 2000 is shown with a dashed line (as determined from a satellite image). A rough approximation of the 500 m and 1000 m depth contours are also shown. Locations where Greenland halibut were tagged during 1997 to 2000 are marked with an x.

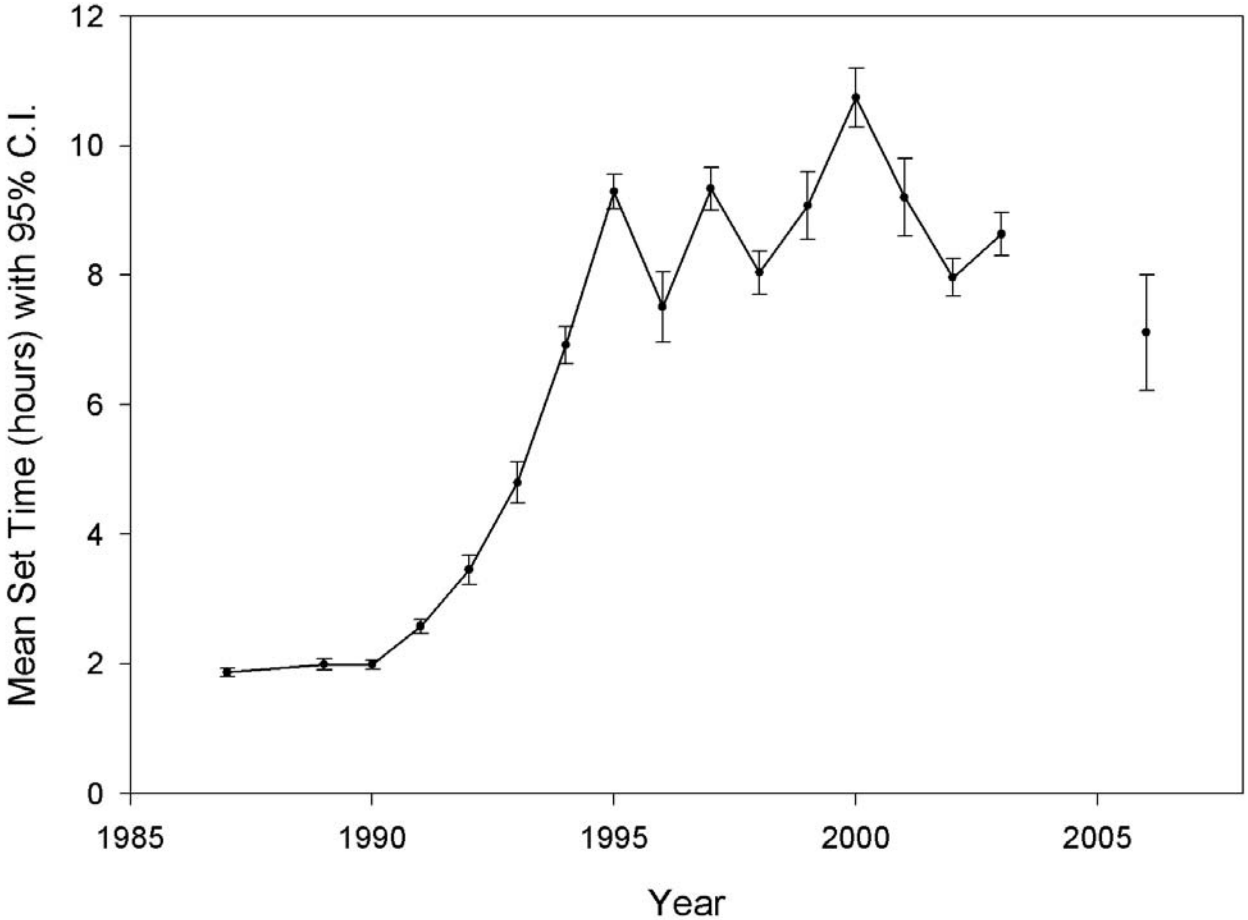

Figure 4. Long-line set duration, annual mean with 95% confidence interval.

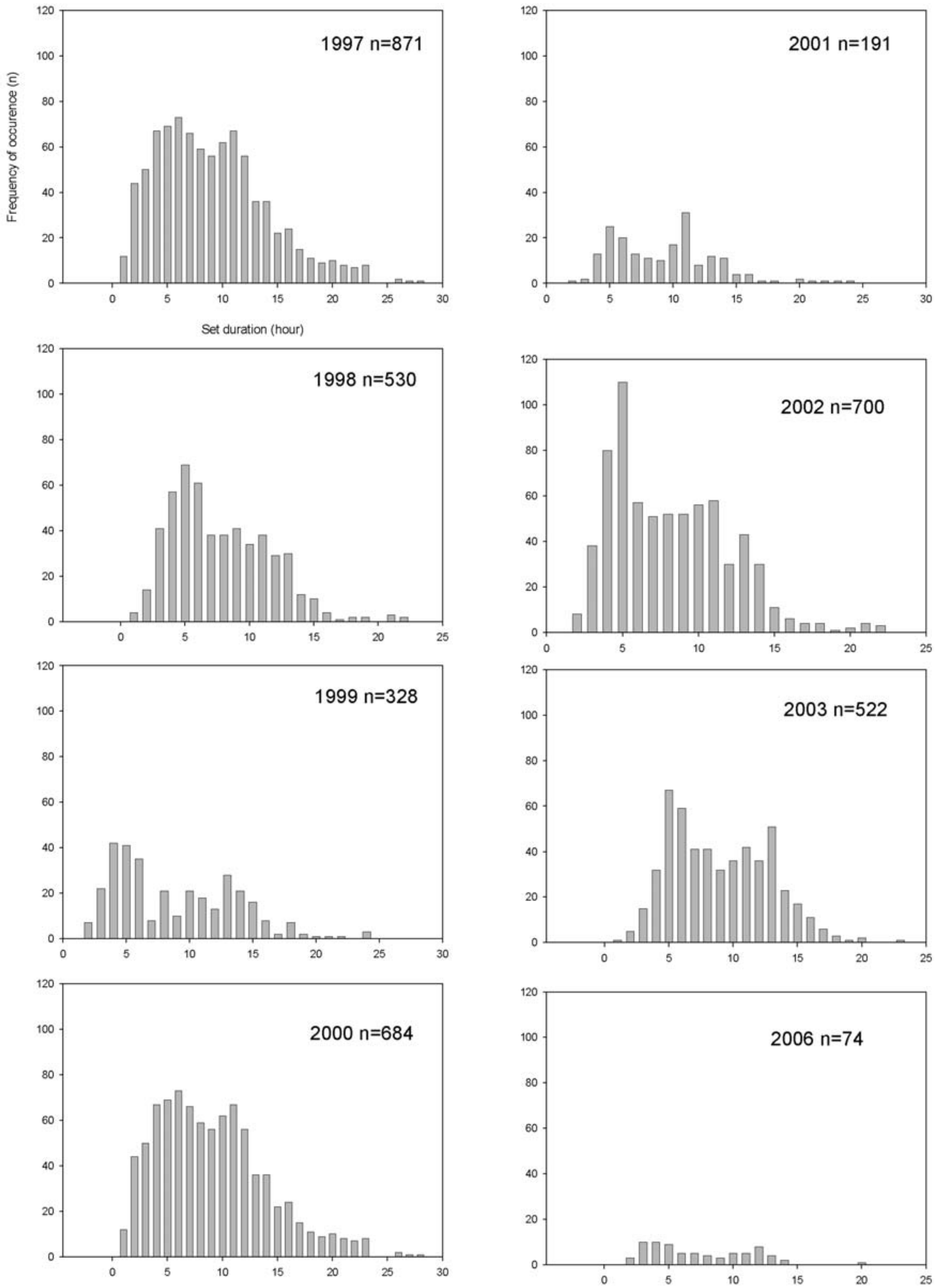

Figure 5. Frequency of long-line set durations, 1997-1999.

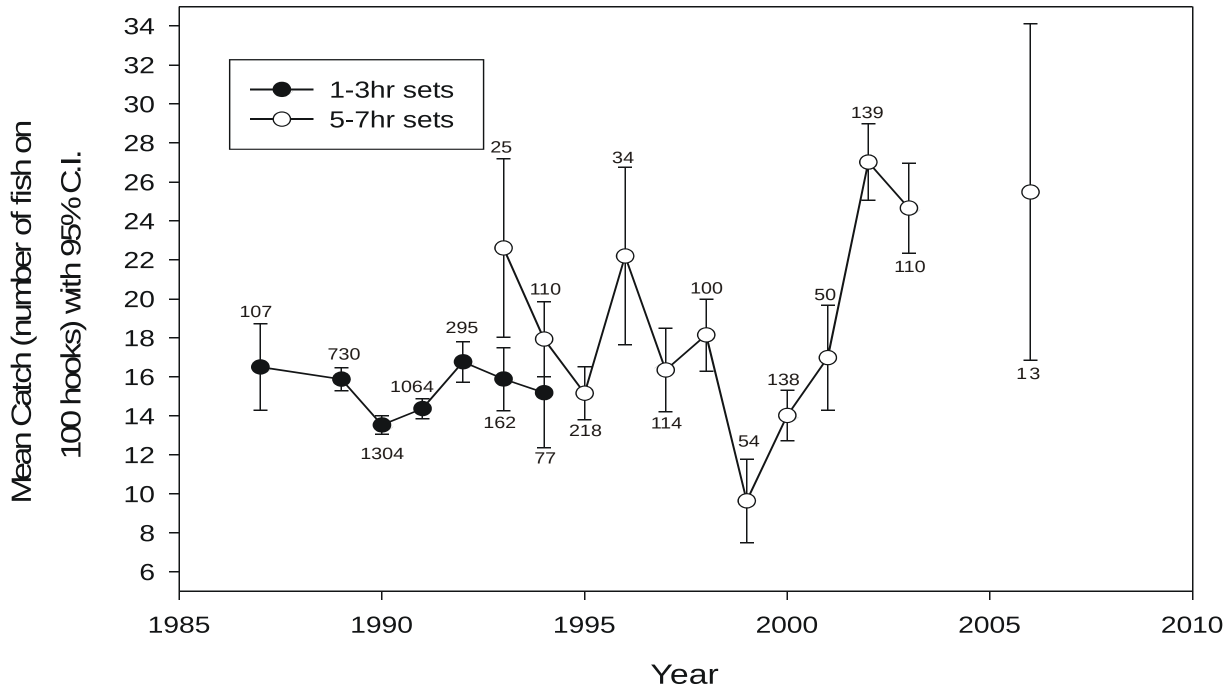

Figure 6. Greenland halibut catch-per-unit effort (CPUE), mean and 95% confidence intervals for 1-3 hour sets (1986-1994) and 5-7 hour sets (1993-2003, no data available for 2004 or 2005). Number of sets used in the calculation is also shown.

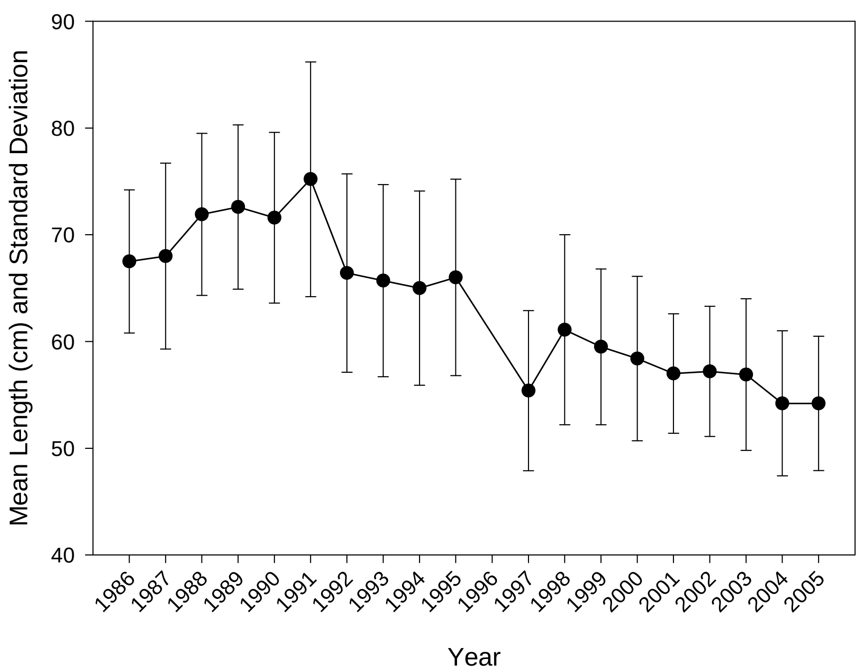

Figure 7. Greenland halibut mean length (cm) and standard deviation 1987-2001. Sample sizes used in the calculation are given in Table 2 a).

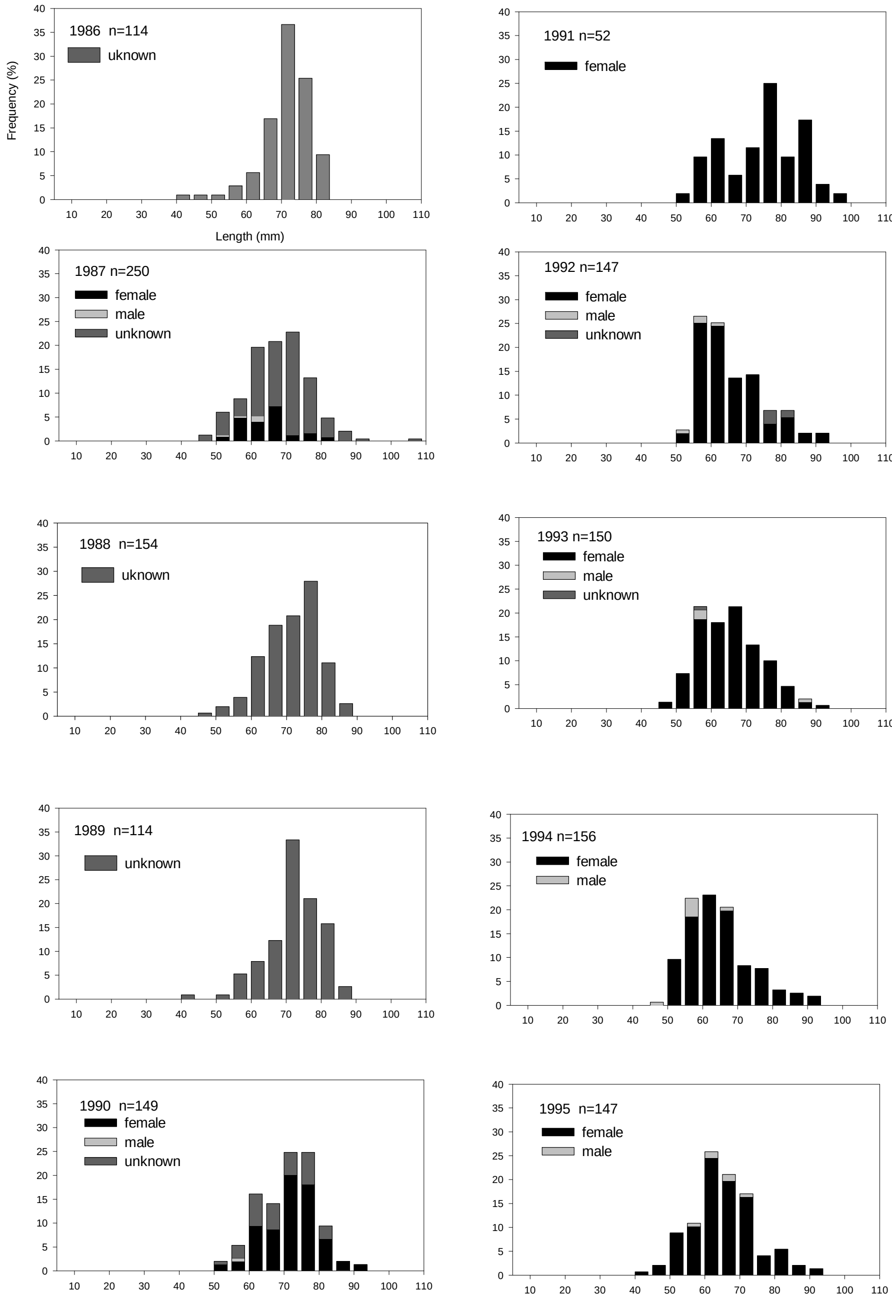

Figure 8. Length frequency distribution for Greenland halibut sampled from the catch,1987 to 1995.

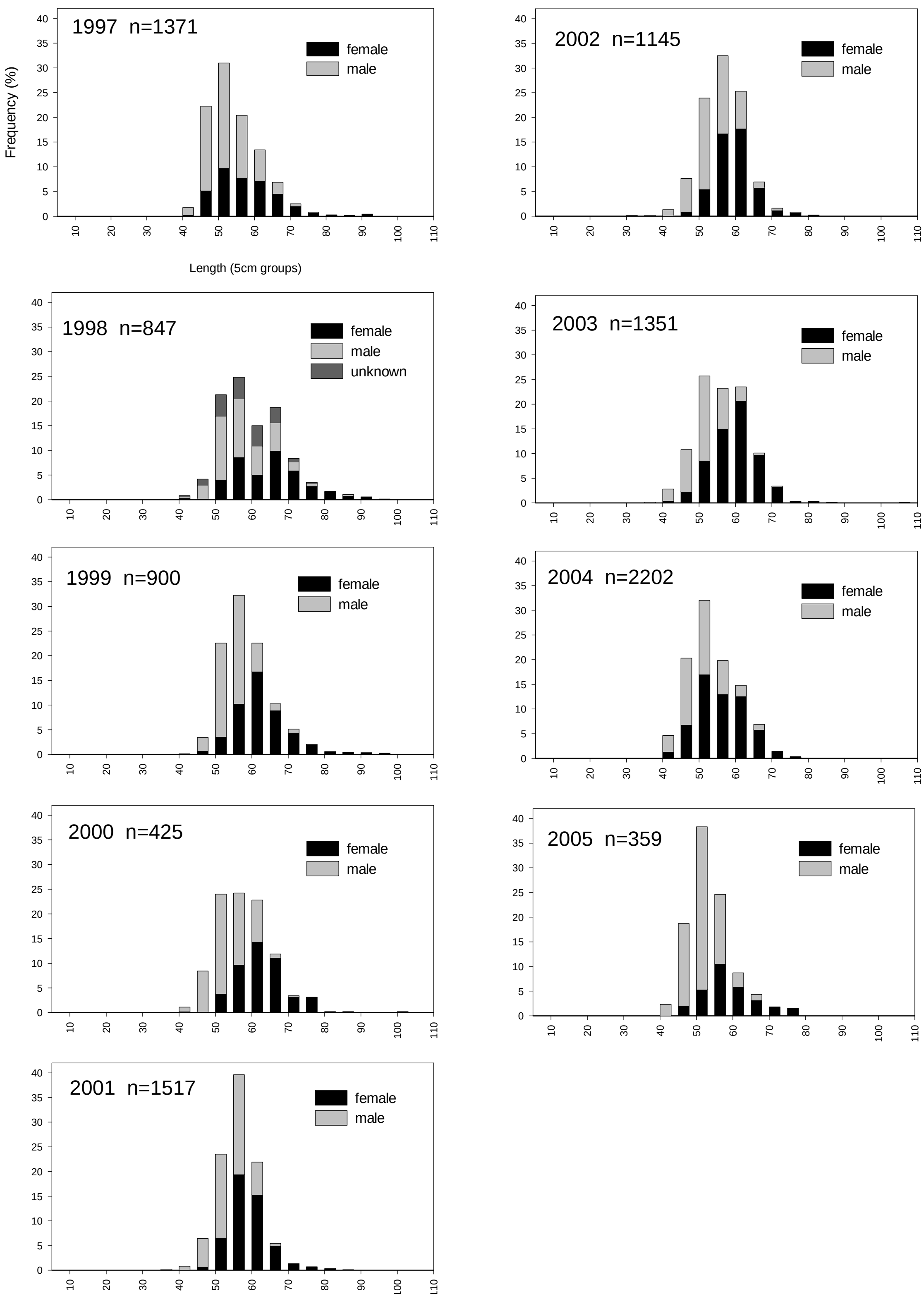

Figure 9. Length frequency distribution from the sampled catch, 1997 to 2002, by sex.

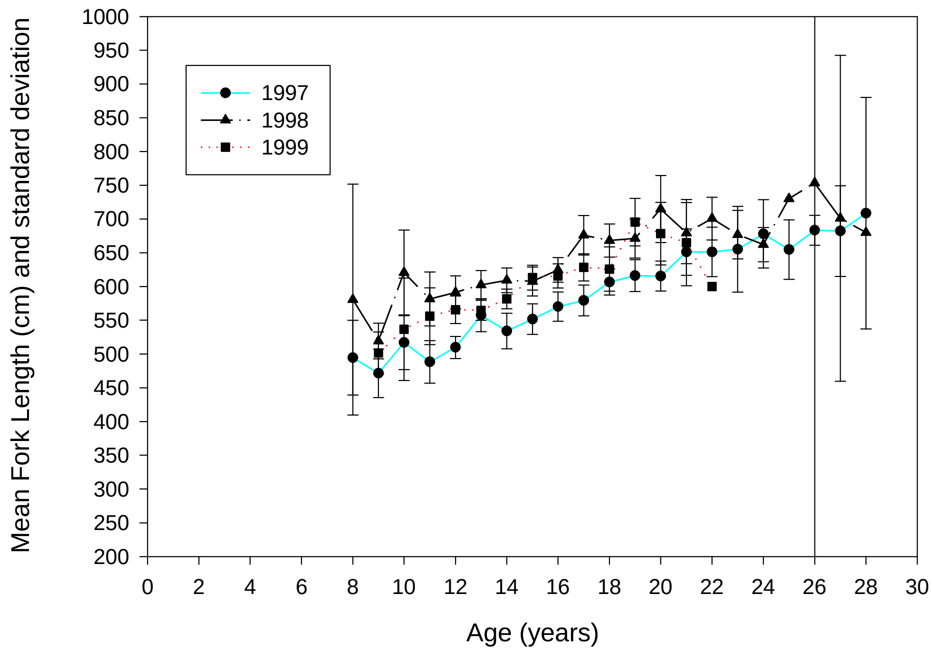

Figure 10. Greenland halibut mean length-at-age and standard deviation for 1997-1999.

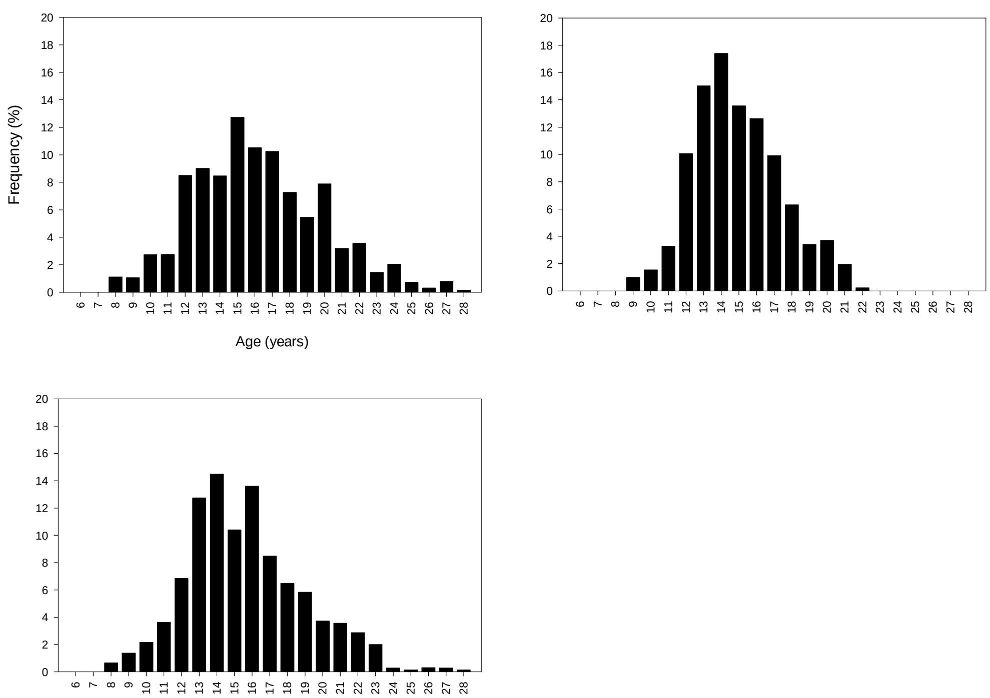

Figure 11. Age frequency distribution from the sampled catch, 1997 to 1999, both sexes combined.

FOR MORE INFORMATION

Contact: Margaret Treble
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB
R3T 2N6

Tel: (204) 984-0985
Fax: (204) 984-2403
E-Mail: Margaret.Treble@dfo-mpo.gc.ca

This report is available from the:

Center for Science Advice (CSA)
Central and Arctic Region
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, Manitoba
R3T 2N6

Telephone:(204) 983-5131
Fax: (204) 984-2403
E-Mail: xcna-csa-cas@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

ISSN 1480-4913 (Printed)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2008. Cumberland Sound Greenland Halibut (Turbot) Inshore Fishery. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/040.