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Data from the Commercial Fishery for Greenland Halibut in Subarea 0.

by

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Abstract

Data on Greenland halibut from the commercial fishery in Subarea 0 were analyzed. Catch at age showed a slight shift to younger fish in recent years, with a peak at age 7. There were no trends in weight at age during the 1990's. There was little range in the standardized catch rate from 1990 to 1997, although CPUE in 1995 and 1997 was slightly higher than previous years. Standardized effort was lower in the 1994-97 period than in the earlier 4 years, due mainly to the reduced quota available for the fleets in the latter period.

Introduction

Catches of Greenland halibut in Subarea 0 increased from less than 1000 tons annually in the late 1980's to an average of about 12,000 tons per year in 1990-92 (Jorgensen 1997). A new management unit was introduced in 1995, which excluded Division 1A in the inshore waters of Greenland from the TAC for Subareas 0+1. As a result, the TAC for Subarea 0+1 offshore was decreased from 25,000 tons to 11,000 tons, and catches in Subarea 0 were reduced to between 5,000 and 6,000 tons per year in 1995 to 1997. With the exception of a relatively small inshore fishery in Cumberland Sound, and recent exploratory fishing in Subarea 0, almost all the catch in Subarea 0 occurs offshore in Division 0B. Catches are taken mainly by otter trawl, although important fisheries by gillnet and longline also occur. In 1997, about 70 % of the catch of 5741 tons was taken by otter trawl. Vessels from Canada, Japan, Faroes, Russia, and Norway have been the main participants in the fishery since the late 1980's, although there have been many changes to fleet compositions over time. During the 1990's, much of the Canadian quota in this fishery has been caught under charter agreements with vessels from most of the nations listed above. This paper presents catch at age and mean weights at age from the offshore fishery in Div. 0B from 1988 to 1997, and an analysis of CPUE data from stern otter trawlers for the period 1990-97.

Methods and Materials

The catch at age and mean weight at age data from 1988-93 were taken from Atkinson et al. (1994), and the data for 1994-96 have been calculated annually and incorporated in the assessments of the G. halibut stock in Subareas 0+1 (eg. Jorgensen 1997). Data from the fishery in 1997 were used to generate the catch at age and weights at age for that year, using the same procedures as for the previous years. Most of the sampling data used in these analyses were collected at sea by observers, although some port sampling information was also included. CPUE data were collected by observers on a set by set basis, and aggregated in this analysis by vessel and month. A multiplicative model (Gavaris 1980) was used to derive a standardized catch rate series. Categories used in the model were country-gear-tonnage class (CGT), month, and year. Observations with fewer than 10 tons of catch or 10 hours of effort were deleted, along with CGT categories with fewer than 3 observations and months with 5 or fewer data points. A total of 347 observations remained from an original dataset of 401. All data used were from the second half of the year, as there were only 5 observations from the first half (all in June). Data from the

exploratory fishery in Div 0A in 1996 and 1997 were included in the catch rate analysis, but excluded from the catch at age calculations, as these will be presented elsewhere.

Results and Discussion

Table 1 shows the catch at age calculations for the 1997 fishery. It must be pointed out that the gillnet/longline data was derived from a single length frequency of 199 measurements, while the otter trawl component contained many samples, consisting of over 45,000 measurements. This discrepancy can be explained by the deployment of observers on all otter trawl vessels in the fishery in 1997. Given this difference in sampling, the C.V.'s on the numbers at age in the gillnet /longline fishery are substantially higher than those in the otter trawl fishery. A combined age length key, again made up largely (744 of 795 otoliths) of samples collected by observers on the otter trawl fleet, was used to derive the age composition in 1997.

Table 2 (a and b) shows the catch at age and mean weights at age for 1988-1997, along with a sum-of-products (S.O.P.) check (Table 2c). The nominal catches used to derive the total catch at age values were taken from Table 1 of Jorgensen (1998). As noted by Atkinson et al. (1994), there was a shift in the catch at age to younger fish with the increased otter trawl fishery in 1990 onward. In 1988-89, catches were taken mainly by longlines in deep water, and contained proportionally more old fish. From 1990-93, age 8 was predominant in catches, but from 1994-97, the modal age in each year was 7 (Fig. 1). This may be due in part to the fishery occurring slightly later in the year in the latter period. Few fish older than 13 years appeared in the catch at age after 1990, although a few individuals as old as 16 were taken in the fishery every year. Mean weights at ages 7 to 12 showed little in the way of trends over time (Fig. 2). The S.O.P. check (Table 2c) indicated a slight bias toward underestimating the catch weight in most years, the reason for which is not apparent.

The results of the CPUE analysis are shown in Table 3. All 3 factors (CGT, month, year) were significant, and the regression explained 81% of the variation. There was a seasonal trend, with CPUE from November, and particularly December, being higher than other months. This is probably due to the formation of pre-spawning concentrations of G.halibut in deep water. There were also significant differences between fleets, with Norwegian CPUE being highest and Russian being lowest. It should be noted that the Russian data include vessels which were previously coded as Soviet Union, and also vessels which were previously Soviet Union but became vessels of Baltic countries. There was little range in the standardized catch rate over time (Table 4, Fig. 3). The CPUE in 1995 and 1997 was slightly higher than previous years, although between-year differences were not significant. Standardized effort was lower in the 1994-97 period than in the earlier 4 years, due mainly to the reduced quota available for the fleets in this period.

The previous analysis of these data, which included the years from 1990 to 1993, showed a decline in CPUE from 1991 to 1992, and then again in 1993 (Atkinson et al. 1994). The reason for the change in the current analysis is not clear, although there are some differences in the earlier model and the current one. These include the changes in country codes noted above, and the use of country and tonnage as separate categories in the earlier analysis. The shortness of the earlier time-series may also be a contributing factor to the differences. As well, the lack of overlap of fleets throughout the time series may cause some problems in the CPUE standardization. This can be seen in the unstandardized catch rates in Fig. 4, where there is not a single fleet which is present in all 8 years of the time series. The longest series, Faroes TC 7, shows a relatively constant increase over time, and none of the fleets in the analysis showed a severe decline between the early and mid-1990's. Other factors not accounted for in the model but which could affect CPUE include learning, since the otter trawl fishery was new in 1990, and migration in either direction between Subarea 0 and 1, given the geographic features of the deep strata in the area of the boundary. There are no recent research vessel surveys of Div. 0B to verify trends in CPUE, although USSR/Russia conducted stratified random trawl surveys in this area from 1979-92 (Gorchinsky 1993). These data show a sharp drop in biomass from higher levels in 1979-86 to a much lower value in 1987. The biomass increased slightly up to 1990, then declined in 1992 to just above the 1987 value.

References

Atkinson, D.B., W.R.Bowering and W.Brodie. 1994. Analysis of data collected by observers during the Greenland halibut otter trawl fisheries in Subarea 0 during 1988-93. NAFO SCR Doc. 94/47, Ser. No. N2417. 10 p.

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37: 2272-2275.

Gorchinsky, K. V. 1993. Results from Greenland halibut assessment in Divisions 0B, 2GH by the data from 1992 trawl survey. NAFO SCR Doc. 93/15, Ser. No. N2192, 7 p.

Jorgensen, O.A. 1997. Assessment of the Greenland halibut stock component in NAFO Subarea 0 + Div. 1B - 1F. NAFO SCR Doc. 97/53, Ser. No. N2887. 10 p.

Jorgensen, O.A. 1998. Assessment of the Greenland halibut stock component in NAFO Subarea 0 + Div. 1A offshore + Div. 1B - 1F. NAFO SCR Doc. 98/56, Ser. No. N3047.

Table 1. Catch at age with associated statistics, and mean lengths and weights at age of Greenland halibut caught in the commercial fishery in Div. 0B in 1997. The 3 tables show the data for gillnet+longline, otter trawl, and total.

Gillnet + longline

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
6	0.648	43.212	3	2.42	0.70
7	0.891	47.405	85	14.43	0.17
8	1.352	53.710	172	19.26	0.11
9	1.872	59.209	148	18.55	0.13
10	2.403	63.786	84	15.15	0.18
11	3.020	68.260	100	16.44	0.16
12	3.860	73.399	62	12.93	0.21
13	4.924	78.940	55	12.20	0.22
14	5.679	82.400	12	5.13	0.43
15	6.794	86.782	7	3.74	0.55
16	8.010	91.250	7	4.41	0.67
17	7.782	90.500		0.58	1.41

Otter trawl

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
* 4	0.241	32.163	6	1.58	0.27
5	0.359	36.195	58	7.38	0.13
6	0.547	41.033	355	24.93	0.07
7	0.862	46.922	1273	49.00	0.04
8	1.276	52.767	1050	47.33	0.05
9	1.838	58.888	478	25.61	0.05
10	2.378	63.591	216	17.84	0.08
11	3.005	68.166	173	17.35	0.10
12	3.831	73.235	90	13.30	0.15
13	4.932	78.971	67	12.27	0.18
14	5.713	82.536	15	5.18	0.34
15	6.783	86.743	9	3.77	0.44
16	8.002	91.222	7	4.42	0.60
*17	8.641	93.045	1	0.59	0.91

Total

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
* 4	0.241	32.163	6	1.58	0.27
5	0.359	36.195	58	7.38	0.13
6	0.546	41.012	351	24.81	0.07
7	0.860	46.887	1188	46.83	0.04
8	1.262	52.582	877	43.23	0.05
9	1.823	58.743	330	17.65	0.05
10	2.362	63.465	132	9.42	0.07
11	2.986	68.036	73	5.55	0.08
12	3.764	72.860	27	3.11	0.11
13	4.968	79.117	12	1.33	0.11
14	5.834	83.021	3	0.75	0.23
15	6.740	86.593	2	0.49	0.28
16	7.930	90.981	1	0.26	0.34
*17	10.125	97.438		0.10	0.43

Table 2. Catch-at-Age (000s) and Weight-at-Age (kg) of Greenland Halibut in the commercial fishery in Div. 0B.

A) Catch-at-Age

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
					Year					
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	9	1	2	0	2	6
5	0	0	2	14	45	28	46	18	28	58
6	0	0	53	208	524	313	183	189	243	355
7	1	2	398	1191	2078	1573	1044	1254	1417	1273
8	5	9	1387	1888	2738	1822	743	641	980	1050
9	9	11	1188	1059	1688	840	488	388	489	478
10	18	13	663	447	657	447	142	245	254	216
11	24	14	335	175	217	147	86	168	110	173
12	31	30	184	122	147	83	83	168	69	90
13	39	32	183	96	120	47	58	62	28	67
14	30	34	111	50	60	20	25	29	14	15
15	24	20	63	30	24	12	17	16	8	9
16	8	6	14	4	6	4	11	5	2	7
17	1	0	2	0	1	0	2	1	1	1
18	0	0	0	0	0	0	1	0	0	0
Total	190	173	4580	5285	8313	5339	2931	3184	3645	3798
Catch(t)	**1024**	**907**	**9498**	**8606**	**12358**	**7060**	**4321**	**5299**	**5519**	**5740**

B) Weight- at Age (kg)

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
					Year					
1										
2										
3										
4					0.196	0.175	0.228		0.269	0.241
5			0.376	0.356	0.333	0.302	0.406	0.358	0.351	0.359
6			0.562	0.554	0.572	0.526	0.559	0.568	0.537	0.547
7	0.818	0.785	0.813	0.820	0.829	0.810	0.857	0.897	0.896	0.862
8	1.200	1.076	1.098	1.143	1.162	1.170	1.210	1.302	1.321	1.276
9	1.781	1.585	1.533	1.632	1.692	1.716	1.690	1.810	1.814	1.838
10	2.446	2.149	2.122	2.333	2.420	2.357	2.235	2.523	2.397	2.378
11	3.244	2.878	2.961	3.390	3.390	3.264	2.767	3.152	3.141	3.005
12	4.169	3.822	3.916	4.364	4.309	4.266	3.426	3.927	3.979	3.831
13	5.136	4.929	4.986	5.610	5.555	5.519	4.608	5.007	5.132	4.932
14	6.317	6.265	6.275	7.022	7.176	6.803	6.038	5.893	5.943	5.713
15	7.736	7.825	8.049	8.669	8.786	7.976	6.534	6.849	6.568	6.783
16	9.511	9.883	10.354	10.849	10.269	9.786	6.106	8.654	8.168	8.002
17	10.772		12.804		11.951		10.006	9.937	8.694	8.641
18							6.655			

C) Sum of products

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
					Year					
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	1.8	0.2	0.5	0.0	0.5	1.4
5	0.0	0.0	0.7	5.0	14.9	8.4	18.7	6.4	9.8	20.8
6	0.0	0.0	29.9	115.2	299.7	164.9	102.3	107.4	130.5	194.2
7	0.8	1.6	324.0	976.8	1722.5	1274.0	894.7	1124.8	1269.6	1097.3
8	6.0	9.7	1522.9	2158.2	3181.9	2132.0	899.0	834.6	1294.6	1339.8
9	16.0	17.4	1817.8	1728.9	2856.4	1441.8	824.7	702.3	887.0	878.6
10	44.0	27.9	1405.9	1043.2	1590.3	1053.6	317.4	618.1	608.8	513.6
11	77.9	40.3	990.9	592.1	736.2	481.3	238.0	529.5	345.5	519.9
12	129.2	114.7	719.6	533.6	631.9	356.1	284.4	659.7	274.6	344.8
13	200.3	157.7	911.5	538.9	665.4	261.0	267.3	310.4	143.7	330.4
14	189.5	213.0	698.0	349.6	433.8	138.8	151.0	170.9	83.2	85.7
15	185.7	156.5	506.0	257.4	206.6	96.2	111.1	109.6	52.5	61.0
16	76.1	79.1	140.2	47.4	57.5	36.3	67.2	43.3	16.3	56.0
17	10.8	0.0	24.8	0.0	13.4	0.0	20.0	9.9	8.7	8.6
18	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
SOP	**936**	**818**	**9092**	**8346**	**12412**	**7444**	**4203**	**5227**	**5125**	**5452**
SOP/catch	**0.91**	**0.90**	**0.96**	**0.97**	**1.00**	**1.05**	**0.97**	**0.99**	**0.93**	**0.95**

Table 3. Results of regression of catch and effort data, with a multiplicative model, for Greenland halibut in Subarea 0. Category 1 is country -gear-tonnage class (CGT), category 3 is month, and category 4 is year. Types 1-3 is the sums of square table refer to the 3 categories.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.901
MULTIPLE R SQUARED..... 0.811

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	8.497E0	8.497E0	
REGRESSION	22	2.180E0	9.908E-2	63.195
TYPE 1	10	1.009E0	1.009E-1	64.379
TYPE 2	5	6.539E-2	1.308E-2	8.341
TYPE 3	7	3.945E-2	5.636E-3	3.595
RESIDUALS	324	5.080E-1	1.568E-3	
TOTAL	347	1.118E1		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	20126	INTERCEPT	-1.087	0.042	347
3	11				
4	90				
1	2126	1	0.339	0.071	9
	2127	2	0.724	0.081	9
	5126	3	0.365	0.125	5
	5127	4	0.803	0.049	48
	14124	5	0.291	0.048	25
	14125	6	0.408	0.122	3
	14126	7	0.544	0.138	3
	15126	8	1.017	0.050	26
	15127	9	0.983	0.067	10
	20127	10	0.007	0.037	51
3	7	11	-0.148	0.049	34
	8	12	-0.036	0.043	62
	9	13	-0.104	0.040	88
	10	14	-0.147	0.036	85
	12	15	0.160	0.058	20
4	91	16	0.046	0.046	52
	92	17	0.128	0.048	83
	93	18	0.005	0.049	72
	94	19	-0.011	0.057	46
	95	20	0.178	0.070	16
	96	21	0.078	0.072	15
	97	22	0.167	0.091	11

CGT code	Definition
2126	Canada, stern OT, TC6
2127	Canada, stern OT, TC7
5126	Faroes, stern OT, TC6
5127	Faroes, stern OT, TC7
14124	Japan, stern OT, TC4
14125	Japan, stern OT, TC5
14126	Japan, stern OT, TC6
15126	Norway, stern OT, TC6
15127	Norway, stern OT, TC7
20126	Russia/USSR/Baltic, stern OT, TC6
20127	Russia/USSR/Baltic, stern OT, TC7

Table 4. Results of catch rate standardization for Greenland halibut in Subarea 0.

STANDARDS USED VARIABLE NUMBERS: 20126 11

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
90	-1.0872	0.0017	0.337	0.014	9498	28174
91	-1.0411	0.0023	0.353	0.017	8666	24555
92	-0.9597	0.0016	0.383	0.015	12358	32266
93	-1.0823	0.0018	0.339	0.014	7060	20840
94	-1.0978	0.0027	0.333	0.017	4321	12960
95	-0.9094	0.0053	0.402	0.029	5299	13181
96	-1.0095	0.0057	0.364	0.027	5519	15177
97	-0.9200	0.0093	0.397	0.038	5740	14459

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.059

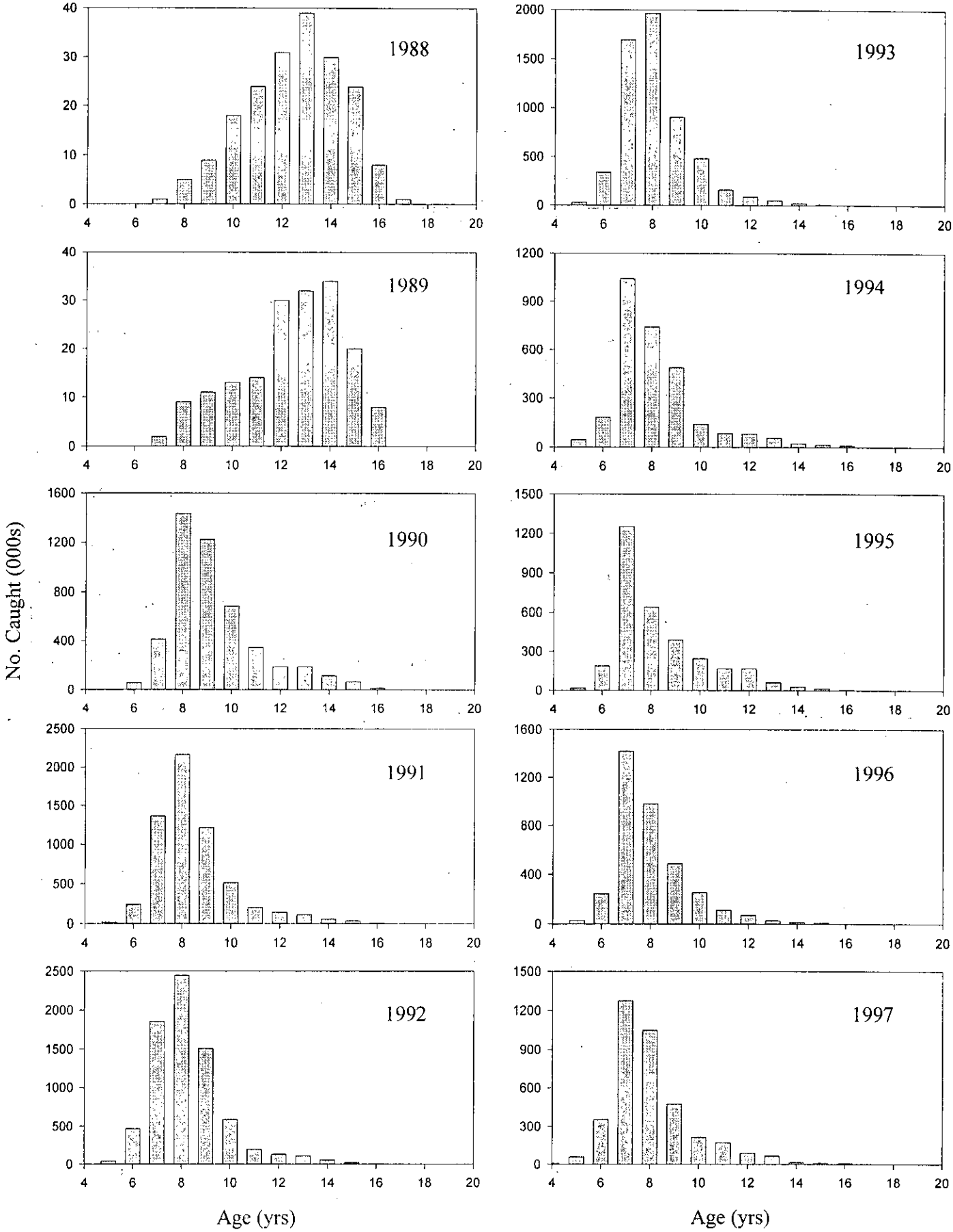

Fig. 1 Catch at age (000s) of Greenland halibut from the commercial offshore fishery in Div. 0B during 1988-97.

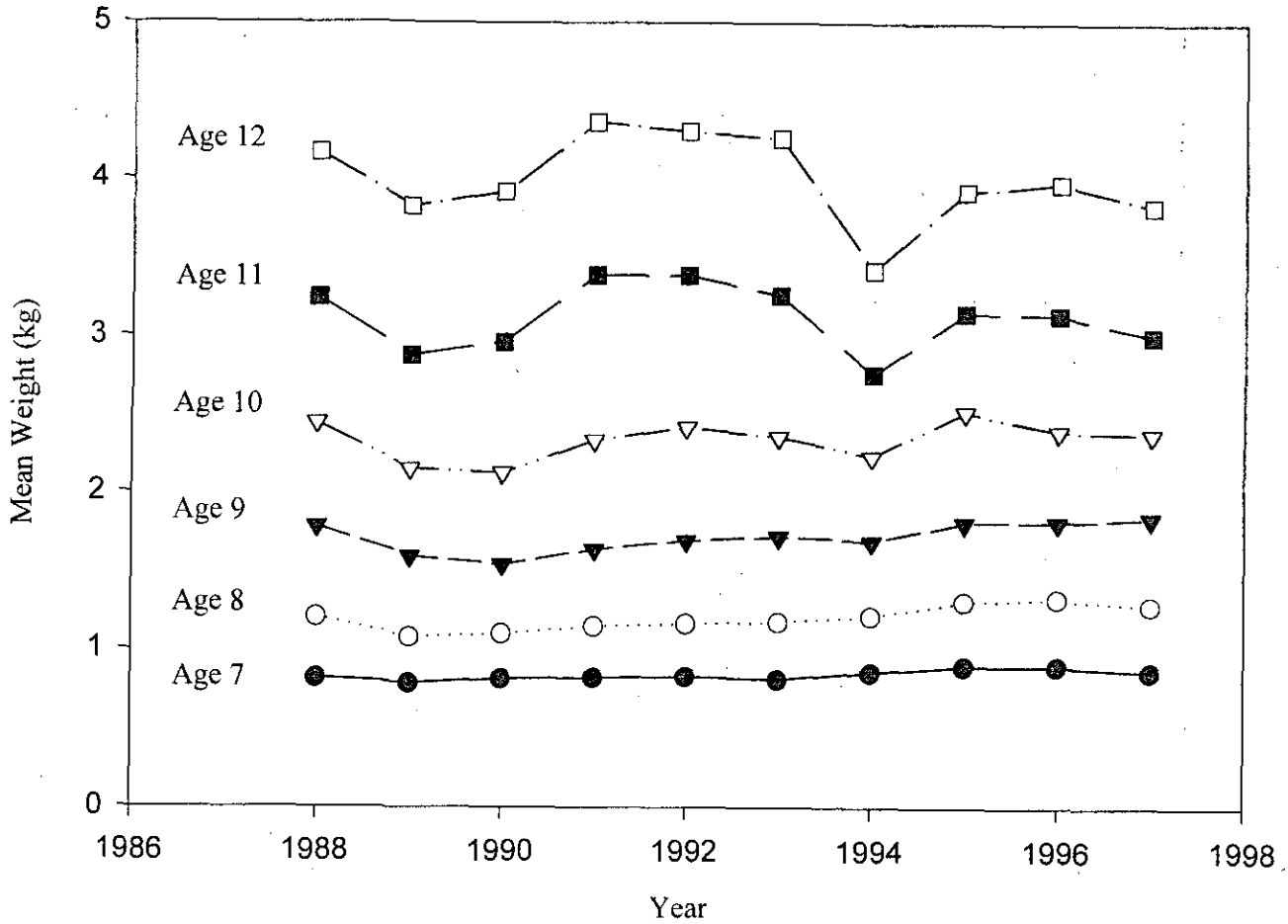

Fig2 Mean weight (kg) at age (yrs) of Greenland halibut caught in the commercial offshore fishery in Div. 0B during 1988-97.

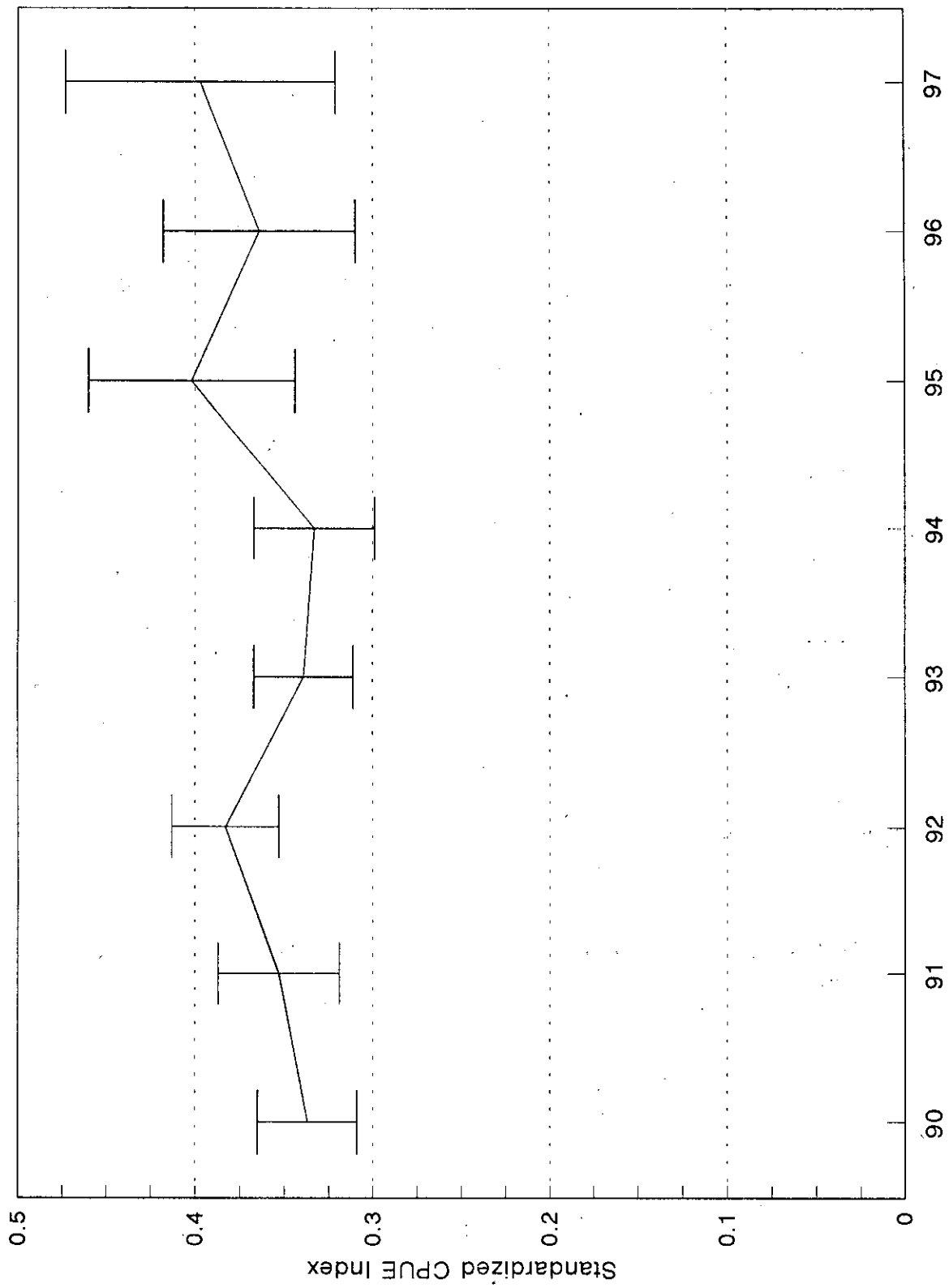

Fig. 3 . Standardized CPUE of G.halibut in SA 0, +/- 2 SE's.

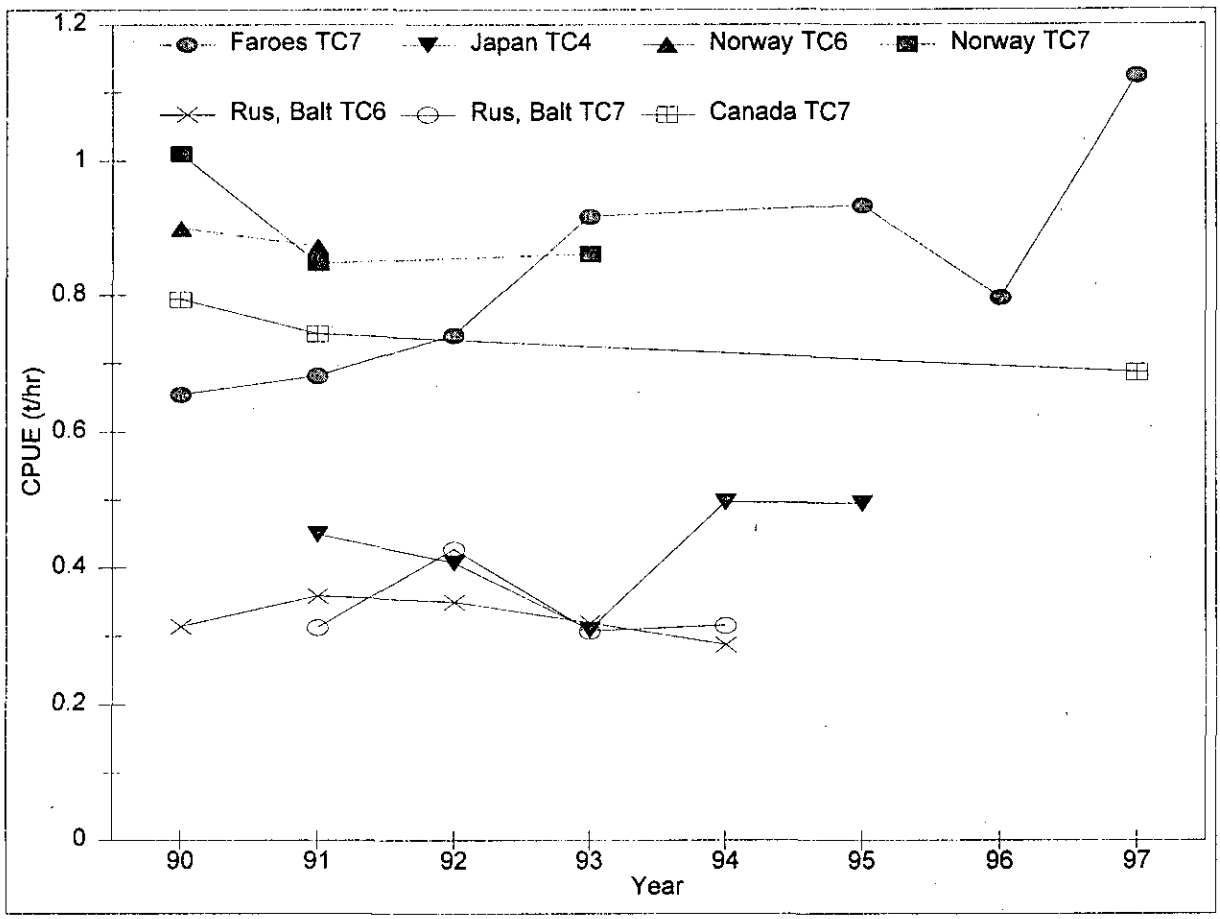

Fig 4 Trends in CPUE (non-standardized) of the major fleets in the catch rate analysis for G.halibut in Subarea 0.