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An Assessment of the Greenland Halibut Stock Component in NAFO Subarea 2 and Divisions 3K and 3L

by

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Introduction

Greenland halibut catches in Subarea 2 and Divisions 3KL area have averaged between 25,000-30,000 t annually from 1970 to 1976 with the 1978 catch being the highest since the beginning of the fishery in the early 1960s at 39,500 t (Table 1, Fig. 1). Catches declined rather steadily since 1978 to reach an all time low of about 16,000 t in 1986 (Table 1). In 1987, the fishery improved to the extent that the 1987 catch of 30,900 t (Table 1) was nearly double the 1986 catch and above the average over the last 18 years. The 1988 (Table 1) and 1989 catches (Table 2), however, were again near the lowest in the time series at 18,900 t and 19,500 t respectively. Most of the 1989 catch was accounted for by Canada with 11,900 t; followed by EEC with 3,200 t; the GDR with 1,700 t; and Faroes Islands, USSR, Japan and Poland accounting for most of the remainder. The Canadian trawler catches were 900 t in 1989 compared to 600 t in 1988, and was taken mainly in Div. 3K during April, May and August (Table 2). The inshore gillnet catches were mainly in the southern divisions of 3K (5,800 t) and 3L (2,500 t) with 2,200 t taken in Div. 2J. The gillnet fishery occurs primarily during the months between July and October. Catches by other countries varied throughout the year, quite often in conjunction with catching other species. However, while Div. 3L had been rarely directly fished for Greenland halibut by countries other than the coastal state, catches of 4,100 and 3,200 t were reported by the EEC in 1988 and 1989 respectively. Catches in 1990 are expected to be much higher.

The TAC has increased from 30,000 t in 1976 to 35,000 t in 1980; 55,000 t in 1981, for Div. 2J3KL only, with an additional 20,000 t in Div. 2GH; and to 100,000 t in 1986 where it has remained through 1988. These increases were attributable to indications of good recruitment, estimated high levels of biomass, and what was considered to be low overall levels of fishing mortality particularly on older fish in deep water. The 1989 assessment indicated that the stock size had decreased substantially in recent years to a level of about half that when a TAC of 100,000 t was introduced. Therefore a TAC of 50,000 t was recommended for 1990. However, the reasons for such a large decline in stock size are largely unknown.

It is worth re-emphasizing that this resource undertakes extensive migrations throughout its life history, with the main spawning component migrating to Davis Strait while the younger immature portion of the stock (particularly, ages 6-10 years old) supports most of the fishery in the southern areas. It has been cautioned by the Scientific Council that catching the TAC would not harm the resource, provided it were spread over all commercial age groups and all areas of the distribution. If, on the other hand, a highly-concentrated effort were directed in localized areas on a few age groups, a significant component of the stock could be detrimentally affected.

Research vessel surveys

i) Biomass estimates and abundance indices in Divisions 2J3KL and 2GH

Results of stratified-random groundfish fall surveys for Greenland halibut in Div. 2J (1977-89), Div. 3K (1978-89), and Div. 3L (1981-89) are presented as mean weight (kg) per set per stratum in Tables 3, 4, and 5 respectively. Biomass was estimated for most missing strata using a multiplicative analysis model. For the area estimated in Div. 2J in 1989 (Table 3), the biomass estimate was 42,774 t, which was the second lowest in the time series. The previous low was in 1988 at 35,450 t. The average biomass estimate over the time series is 69,000 t. In Div. 3K, the 1989 biomass estimate was 72,631 t

(Table 4) which is near the lowest in the time series and very similar to estimates of 1987 and 1988. The average biomass over the time period for this division is 85,000 t. In Div. 3L, the 1989 biomass estimate was 13,319 t (Table 5) and is virtually the same as the 1986, 1987 and 1988 estimates. These estimates are within 20% of the average biomass for Div. 3L of 16,000 t since 1981.

For Divisions 2J, 3K and 3L combined, the estimated biomass for 1989 was 128,724 t compared to 121,597 t in 1988.

Trends in biomass by division as well as the three divisions combined are presented in Figure 2. For Div. 2J there has been a rather systematic decline in biomass from about 108,000 t in 1982 to an average of about 39,000 t in 1988-89, a decrease of nearly 3 times. In Div. 3K, on the other hand, with the exception of high point estimates in 1983, 1984 and 1986 the estimated biomass has been relatively stable at about 75,000-80,000 t since 1978. The biomass in Div. 3L accounts for a much smaller portion of the stock although very little deep water is surveyed. Biomass estimates from this division have been remarkably stable since fall surveys began in 1981 at a level of about 13,000 t. The overall combined trend, however, shows a considerable decline in biomass since 1984 (Figure 2) largely because of the significance of historic levels in Div. 2J. Although stable during 1988-89 recent levels are about half of earlier estimates.

ii) Catch numbers at age from groundfish surveys

Stratified mean numbers per set (from fall surveys) at age are shown in Table 6 for Div. 2J and 3K from 1978 to 1989, and Table 7 for Div. 3L from 1981 to 1989. Relative year class strengths at age 5 (age at entry to the commercial fishery) from these surveys are shown in Figure 3 by Division and in Figure 4 for Div. 2J3KL combined.
It is apparent from the data presented that Greenland halibut do not fully recruit to the survey gear until age 5 as evidenced by the 1979 year-class (Tables 6 and 7) which has been predicted to be a strong year-class, a prediction which has been borne out in fisheries to be true. The 1980 year-class was also predicted to be a strong year-class from data examined from shrimp surveys. Although it was more difficult to reach a similar conclusion here. The dominant age-class in the 1987 survey is age 3 which represents the 1984 year-class and is more abundant than any other year-classes at age 3 in the Div. 2J3KL series (Tables 6 and 7). Up to 1988, this year-class was also more abundant than any other year-class at age 4 than any other in the series (Tables 6 and 7) and again at age 5 in the 1989 survey (Tables 6 and 7, Fig. 3 and 4). The 1989 survey indicates that the 1985 year-class may also be quite strong. In the previous assessment an examination of data from shrimp surveys showed that the 1985 year-class dominated the catches at ages 1, 2 and 3 also suggesting a particularly strong year-class. Unfortunately, similar data from shrimp surveys are unavailable from 1989.

A comparison of relative year-class strengths at age 5 in Div. 2J,3K and 3L presented in Figures 2 and 3 scaled to the 1984 year-class suggests that the 1976, 1977, 1981, and 1982 year-classes are average, with the 1978 and 1980 year-classes possibly average to just above average. The 1983 year-class is estimated to be relatively strong from Divisions 3K and 3L data, however, is weak according to Division 2J data. The 1984 year-class, on the other hand, is estimated to be strong throughout the area and is similar in strength to that of the 1979 year-class.

Commercial data

i) Catch and effort

Considering the nature of this fishery and the migratory behaviour of this species as well as the low levels of directed catch, it is difficult to obtain catch and effort statistics which are accurately representative of total stock abundance. Those that are available (mainly, Canada (N)), however, can be helpful as indicators of distribution and abundance in localized areas. The only directed catch-effort data available during the last couple of years was from Div. 2J in the summer (Table 8). It appears that the catch rate declined in Div. 2J from 1984 to 1986, increased in 1987 to a level higher than 1982 but still below the 1984-85 levels. It subsequently declined in 1988 to the lowest observed during the period examined. There was virtually no directed catch of Greenland halibut from this fleet in 1989 largely because commercial concentrations could not be found.

ii) Catch numbers and weights at age

Catch numbers and weights at age were calculated in the usual manner for the 1989 Canadian fishery only. The data for foreign fisheries were unavailable at the time of the meeting. The results are shown in Table 9. About 53% of the Canadian catch was comprised of fish at age 7 with 94% of the catch being comprised of ages 6-8. Hardly any were caught beyond 12 years old. Matrices of catch numbers at age, percent at age, average weights at age, and catch biomass at age up to 1988 are shown in Tables 10-13 respectively for all countries.

iii) Assessment

Sequential Population Analysis (ADAPT)

On the recommendation of STACFIS at the 1989 meeting, sequential population analysis was attempted, using the catch at age in Table 10 (from 1978 to 1988 only) and the r.v. survey index of abundance for Div. 2J (Table 14), Div. 3K (Table 15), Div. 3L (Table 16) and Div. 2J3KL combined (Table 17). As noted previously, there are insufficient data to allow calculation of an index of abundance from CPUE for this stock. The formulation of the Adaptive framework used is given in Appendix 1.

The estimates of abundance from the model were significant at ages 6-12 (Table 18). The estimates of catchability (RV slopes in Table 18) show an increase from age 5 to 8, relative stability at ages 8 to 10, then a slight increase to ages 11 and 12. However, it should be emphasized that these values are extremely high (over 2.0 for most ages) and considered to be unrealistic for this species, for which previous values of catchability have been estimated to be as low as 0.20. The model also shows patterns in the residual matrix, which can be seen in Table 14 and by the lack of fit in many of the age by age pots in Fig. 5. The correlation matrix (Table 19) shows, in general, an acceptably low level of correlation between most parameters.

Results of the sequential population analysis in population numbers and fishing mortality are shown in Table 20. Given the estimates of stock size obtained from R.V. surveys along with the recent catch levels from this stock, it is obvious that the estimates in Table 16 are not realistic. Although the SPA may be useful in indicating a decline in stock size from the late 1970's to the present, it is known that both immigration and emigration, by age and by year, occurs in this stock and are likely to be highly variable by age annually. Such movements would affect both the estimates from surveys and the age composition of the commercial catch and may explain the variable and high values of F at some ages in certain years. The present analysis appears to serve little more than emphasize the significance of these factors. Thus, little faith can be placed in the SPA as a true measure of stock composition and size until these migration factors can be quantified.

Table 1. Greenland halibut landings (metric tons) by year and country for Subarea 2 and Division 3KL from 1963 to 1989.

	Year													
Country	63	64	65	66	67	68	69	70	71	72	73	74	75	76
Canada	776	1757	8082	16209	16604	13322	11553	10706	9408	8952	6840	5745	7807	9306
FRG	10	35	-	355	42	4	202	13	-	86	707	515	622	927
Poland	691	1834	939	1114	3296	5806	5406	8266	5234	6986	9060	7105	8447	5942
Iceland	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Norway	-	-	-	-	-	-	4	-	-	1389	501	117	-	6
USSR	125	302	479	242	4287	8732	9268	7384	9094	10183	8652	9650	9439	6799
Romania	-	-	-	-	-	-	40	225	7	120	80	-	-	-
GDR	-	-	-	1324	1415	4122	10014	-	647	402	1681	2701	2025	1512
Den-F	-	-	-	-	-	-	-	-	-	970	950	4	-	-
Spain	-	-	-	-	-	-	-	-	-	3	-	-	-	1
UK	-	-	-	-	-	-	-	-	-	731	201	1112	62	-
Den-G	-	-	-	-	-	-	-	-	-	-	65	2	-	-
Portugal	-	-	-	-	-	-	-	-	-	-	207	161	231	73
Fra-M	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Fra-Sp	-	-	-	-	-	-	-	-	-	-	-	6	48	32
Japan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EEC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1602	3928	9500	19244	25644	31986	36488	26594	24392	29822	28944	27123	28681	24598

	Year												
Country	77	78	79	80	81	82	83	84	85	86	87	88[a]	89[a]
Canada	17967	24692	29940	31774	24125	19248	19031	17283	12277	8213	13450	8283	11919
FRG	755	1022	15	55	-	57	2	9	482	15	1	-	5
Poland	5998	5215	1813	203	1806	1111	5258	943	460	177	1001	904	360
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	-
Norway	15	3	8	1	-	-	15	18	1	-	-	-	-
USSR	4308	5632	1961	238	3325	1471	937	440	149	770	6716	1053	1058
Romania	-	3	-	-	-	-	-	-	-	-	-	-	-
GDR	1953	1636	178	316	1350	2487	2587	2498	1850	1868	3268	2246	1726
Den-F	350	268	-	-	-	-	-	-	193	451	2877	921	730
Spain	-	-	4	-	-	-	-	-	-	-	107	-	22
UK	476	53	110	22	-	1	-	3	-	-	-	-	-
Den-G	-	-	-	-	-	-	-	-	-	-	-	-	-
Portugal	119	-	38	21	16	1818	-	2612	2940	3107	1390	-	3168
Fra-M	-	-	-	-	-	-	-	-	-	-	-	-	-
Fra-SP	-	5	1	-	-	7	-	-	-	-	-	-	-
Japan	-	3	-	12	60	14	-	1003	258	1277	2128	1203	477
Other	-	-	-	-	-	-	9	-	-	-	-	-	-
EEC	-	-	-	-	-	-	-	-	-	-	-	4118	-
Total	31941	38532	34068	32642	30682	26206	27839	24809	18610	15878	30938	18878	19465

[a]Provisional.

Table 2. Greenland halibut - preliminary nominal catches during 1989 by month from NAFO Subarea 2 and Divisions 3KL.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total	2H	2J	3K	3L
Can (SF) (Ins)																	
(off)					10	1	1		71*		1		84				
Can (N) (Ins)	3				124	210	2975	3291	2444	1284	339	2	10672	169	2210	5802	2491
(Off)	1		7	158	187	5	103	299	33	33	70	5	901	19	183	622	77
Can (Q)																	
Can (G)									114				114				
Japan													477				
GDR								85	154	200	505	782	1726				
Poland	287	27	46										360				
EEC													3195				
Faroes													730				
USSR													1058				
*71 tons caught Aug - Oct																	
2H																	
Can (N) (Off)							6	4			9		19				
(Ins)								18		39	112		169				
2J																	
Can (N) (Off)	1					2	13	111	22	4	27	3	183				
(Ins)							25	329	1573	275	8		2210				
3K																	
Can (N) (Off)			7	158	186		84	183	3		1		622				
(Ins)	1				72	117	2097	2313	778	408	16		5802				
3L																	
Can (N) (Off)					1	3		1	8	29	33	2	77				
(Ins)	2				52	93	853	631	93	562	203	2	2491				

Table 3. Average weight (kg) of Greenland halibut caught per set from fall research vessel surveys by the GADUS ATLANTICA in Division 2J. Numbers in parenthesis indicate the number of sets per stratum.

Stratum	Gadus 3 1977	Gadus 12, 15 1978	Gadus 27, 29 1979	Gadus 42, 44 1980	Gadus 58 1981	Gadus 71, 72 1982	Gadus 86, 87, 88 1983	Gadus 101, 102, 103 1984	Gadus 116, 117, 118 1985	Gadus 131, 132, 133 1986	Gadus 145, 146, 147 1987	Gadus 159, 160, 161 1988	Gadus 174 175, 176 1989
201	7.26(2)	1.36(3)	0.45(2)	2.83(3)	2.70(5)	9.67(6)	3.72(6)	4.83(3)	0.41(6)	0.98(5)	0.19(6)	0.08(8)	0.80(8)
202	21.34(2)	16.39(4)	22.00(4)	29.00(4)	34.50(2)	45.50(2)	30.75(2)	92.75(2)	10.05(2)	8.50(2)	17.76(2)	-	0.47(2)
203	31.55(2)	40.08(3)	65.32(3)	21.13(4)	52.00(2)	64.33(3)	226.83(3)	179.25(2)	25.00(3)	108.00(2)	27.83(3)	34.00(2)	89.98(3)
204	175.70(2)	484.67(2)	260.36(2)	-	170.50(2)	284.00(3)	250.83(3)	260.00(2)	16.50(2)	267.50(2)	146.50(2)	166.00(2)	567.23(2)
205	20.97(4)	6.58(4)	10.21(2)	3.75(4)	14.94(8)	24.09(12)	14.25(8)	6.97(8)	1.44(8)	1.11(7)	0.35(10)	1.05(6)	0.39(10)
206	20.80(11)	7.78(7)	8.11(8)	10.11(7)	37.18(11)	18.72(18)	8.70(14)	10.86(11)	4.44(14)	4.03(11)	0.41(14)	1.78(14)	0.65(13)
207	77.77(5)	25.54(4)	10.39(5)	6.90(5)	18.22(9)	10.33(15)	7.65(10)	6.26(7)	2.18(13)	1.21(7)	0.26(11)	0.05(7)	0.04(10)
208	186.14(4)	145.98(5)	90.72(4)	149.62(4)	240.75(2)	348.67(3)	110.00(2)	496.17(3)	406.14(3)	189.75(2)	103.00(2)	84.00(2)	201.75(2)
209	65.25(7)	22.01(6)	88.44(7)	104.75(6)	55.67(6)	129.64(11)	52.77(7)	37.42(7)	34.47(9)	13.67(7)	8.55(8)	11.22(5)	10.28(8)
210	19.41(6)	8.81(7)	9.53(4)	10.80(5)	5.00(3)	20.88(6)	41.50(2)	26.88(4)	5.19(4)	3.67(3)	4.00(4)	7.88(3)	6.76(4)
211	34.96(2)	85.30(4)	46.97(4)	72.82(5)	35.75(2)	55.75(2)	134.75(2)	55.75(2)	164.00(3)	103.00(2)	44.50(2)	81.50(2)	23.33(2)
212	189.61(4)	150.82(2)	232.24(2)	103.50(2)	147.75(2)	144.10(5)	44.75(3)	70.83(3)	109.75(4)	383.00(3)	374.69(4)	75.25(2)	42.75(4)
213	16.46(8)	13.16(7)	9.59(7)	22.94(8)	29.33(6)	34.19(10)	23.25(10)	20.50(5)	35.83(9)	19.67(9)	8.82(9)	5.85(8)	2.35(9)
214	38.97(6)	48.18(7)	22.01(6)	15.40(5)	60.10(5)	84.31(8)	44.63(8)	59.75(4)	66.83(6)	8.87(6)	13.75(6)	22.08(6)	5.97(6)
215	37.68(4)	22.03(8)	7.11(6)	18.50(4)	12.30(5)	38.28(9)	14.46(8)	42.00(3)	16.21(6)	14.85(5)	11.87(7)	9.01(7)	5.39(6)
216	102.83(2)	145.78(3)	181.36(4)	186.25(4)	63.25(2)	215.25(2)	102.67(3)	173.00(2)	81.75(2)	34.66(2)	51.15(2)	3.50(2)	12.55(2)
217	141.95(3)	168.28(2)	87.15(2)	156.00(2)	41.00(2)	58.25(2)	64.50(2)	-	145.00(2)	108.75(2)	41.50(2)	43.75(2)	6.03(2)
218	217.92(2)	238.14(2)	-	129.50(2)	156.50(2)	40.00(2)	39.00(2)	-	30.25(2)	82.25(2)	49.00(2)	58.50(2)	17.98(2)
219	-	-	-	-	48.00(2)	-	103.00(2)	-	83.75(2)	286.25(2)	84.00(2)	45.25(2)	35.00(2)
-220	-	56.92(2)	-	-	-	-	-	-	-	-	-	-	-
-221	-	-	-	-	-	-	-	-	-	-	-	-	-
222	115.32(4)	64.52(5)	76.69(4)	90.38(4)	55.75(2)	188.00(3)	131.50(3)	27.67(3)	34.00(2)	2.25(2)	33.00(2)	41.50(2)	8.00(2)
223	251.52(2)	84.82(2)	63.98(2)	136.00(2)	94.75(2)	88.00(2)	61.75(2)	113.75(2)	80.25(2)	127.00(2)	21.00(2)	63.50(2)	15.76(2)
224	173.65(2)	78.70(2)	122.47(2)	32.75(2)	115.00(2)	36.50(2)	50.50(2)	37.50(2)	28.00(2)	244.18(2)	63.50(2)	63.00(2)	2.60(2)
-225	39.95(2)	-	-	-	-	-	-	-	-	-	-	-	-
-226	-	3.17(2)	-	-	-	-	-	-	-	-	-	-	-
227	115.32(4)	86.86(2)	27.47(2)	73.75(2)	43.50(2)	54.90(5)	38.50(4)	36.67(3)	37.13(4)	20.67(3)	36.75(4)	32.00(3)	52.37(4)
228	6.53(8)	2.19(3)	8.39(6)	18.40(5)	8.00(6)	9.25(10)	10.33(6)	16.50(7)	6.36(7)	10.41(6)	5.29(7)	2.60(5)	5.27(8)
229	39.03(4)	14.40(4)	23.82(4)	25.63(4)	30.50(2)	21.50(4)	36.50(4)	11.00(3)	13.00(3)	14.67(3)	5.93(3)	3.23(3)	3.08(3)
230	243.28(3)	80.74(2)	-	169.44(2)	60.25(2)	30.80(2)	93.00(2)	21.50(2)	26.25(2)	102.25(2)	68.00(2)	44.25(2)	43.28(2)
231	64.24(2)	138.57(2)	-	186.50(2)	-	93.75(2)	51.25(2)	98.75(2)	119.75(2)	28.25(2)	38.50(2)	170.50(2)	-
-232	49.03(2)	27.21(2)	-	-	-	-	-	-	-	-	-	-	-
-233	-	-	-	-	-	-	-	-	-	-	-	-	-
234	49.03(2)	98.53(5)	65.21(4)	79.00(4)	52.00(2)	98.00(3)	46.71(3)	90.70(2)	18.33(3)	12.75(2)	5.17(3)	20.25(2)	10.18(2)
235	117.59(4)	107.05(2)	83.99(2)	128.00(2)	39.00(2)	89.67(3)	252.50(2)	82.00(3)	85.00(2)	182.75(2)	118.75(2)	70.25(2)	145.25(2)
236	98.06(2)	-	-	-	44.75(2)	66.75(2)	101.00(2)	53.00(2)	85.25(2)	223.90(2)	94.00(2)	13.00(2)	-
Estimated biomass (t) (surveyed area)	106,834	85,136	66,970	74,564	76,661	104,233	78,546	81,234	62,603	77,555	50,771	35,447	42,339
Estimated biomass (t) multiplicative model (excl. strata 220, 221, 225, 226, 232, 233)	109,175	86,432	74,504	83,972	79,715	107,856	78,547	89,273	62,605	77,554	50,772	35,450	42,774

Table 4. Average weight (kg) of Greenland halibut caught per set from fall research vessel surveys by the GADUS ATLANTICA in Division 3K. Numbers in parenthesis indicate the number of sets per stratum.

Stratum	Gadus 12, 15 1978	Gadus 27, 29 1979	Gadus 42, 44 1980	Gadus 58, 59 1981	Gadus 71, 72 1982	Gadus 86, 87, 88 1983	Gadus 101, 102, 103 1984	Gadus 116, 117, 118 1985	Gadus 131, 132, 133 1986	Gadus 145, 146, 147 1987	Gadus 159, 160, 161 1988	Gadus 174, 175, 176 1989
-618							1.50(5)	4.43(6)	0.20(5)	0.07(7)	0.03(6)	0.33(8)
-619							1.90(7)	0.57(7)	0.22(5)	0.06(8)	0.01(7)	0.27(8)
620	66.73(12)	29.39(10)	28.31(12)	25.72(10)	22.33(9)	19.25(10)	13.08(13)	14.68(14)	12.74(9)	5.96(14)	9.52(12)	1.59(15)
621	126.48(12)	114.39(11)	48.40(13)	32.77(11)	14.68(14)	31.87(12)	18.32(14)	30.53(15)	5.01(14)	8.16(12)	6.77(10)	8.35(17)
622	143.11(2)	119.44(3)	43.75(2)	132.50(2)	120.83(3)	224.00(2)	143.75(4)	60.38(4)	563.76(2)	207.12(3)	221.33(3)	148.27(3)
623	159.51(6)	33.53(4)	83.17(6)	83.33(4)	146.20(5)	217.17(6)	270.00(5)	67.50(6)	179.62(4)	136.80(5)	135.70(5)	82.06(6)
624	9.36(7)	10.60(4)	5.13(4)	3.75(2)	5.25(4)	2.38(4)	5.00(4)	4.97(4)	3.60(2)	5.80(3)	2.30(3)	3.30(3)
625	17.56(6)	14.24(5)	14.50(6)	31.50(4)	8.75(2)	66.33(3)	42.95(5)	55.60(5)	39.00(3)	52.63(4)	30.58(4)	7.04(4)
626	60.74(7)	42.18(5)	139.90(5)	58.20(5)	120.40(5)	101.75(4)	217.75(6)	124.69(5)	155.00(4)	66.30(5)	95.10(5)	98.92(5)
627	71.67(2)	41.73(3)	68.50(2)	189.75(6)	124.43(7)	220.83(6)	300.56(8)	140.36(7)	263.60(5)	136.85(6)	145.15(5)	243.56(6)
628	43.18(7)	35.75(5)	68.21(6)	16.33(6)	12.92(6)	36.08(6)	27.21(7)	81.96(6)	60.38(4)	42.46(5)	40.30(5)	29.90(4)
629	20.57(6)	13.38(2)	26.10(5)	31.33(3)	68.50(2)	65.67(3)	31.13(4)	22.00(4)	54.00(3)	79.67(3)	100.50(2)	66.27(3)
630	27.23(2)	10.78(4)	21.37(4)	117.25(2)	-	67.75(2)	7.73(3)	33.16(4)	30.75(2)	56.50(3)	56.33(3)	39.35(3)
631	45.42(2)	23.30(3)	34.50(3)	68.60(5)	38.00(2)	66.70(5)	105.30(5)	70.86(7)	67.58(4)	108.75(6)	76.52(6)	111.82(7)
632	3.20(7)	2.83(4)	11.69(4)	6.25(2)	7.50(3)	3.43(3)	-	8.57(3)	2.25(2)	2.00(2)	0.80(2)	1.58(2)
633	8.10(9)	9.05(10)	16.10(10)	9.98(8)	7.93(7)	12.38(12)	12.05(10)	14.46(12)	19.70(8)	19.61(11)	13.24(8)	22.34(10)
634	6.31(9)	9.44(8)	5.29(7)	5.41(7)	14.09(11)	6.60(5)	5.93(7)	4.68(9)	3.72(5)	9.05(11)	3.45(6)	2.69(7)
635	6.69(9)	6.12(8)	19.25(6)	12.00(5)	17.10(5)	7.83(6)	10.19(8)	4.21(7)	11.02(6)	11.08(6)	4.54(5)	6.99(7)
636	5.58(7)	4.67(7)	11.79(7)	12.75(6)	21.85(10)	4.05(6)	7.40(8)	4.34(8)	3.40(4)	1.70(7)	3.97(6)	3.52(5)
637	3.93(9)	4.15(7)	6.00(6)	8.25(6)	9.71(7)	14.80(5)	4.97(6)	13.50(7)	10.95(4)	9.08(6)	3.96(8)	3.37(5)
638	15.15(8)	13.24(9)	11.11(9)	21.31(8)	20.39(15)	18.05(11)	12.55(10)	34.52(11)	25.45(4)	18.68(10)	11.00(8)	11.49(11)
639	5.13(9)	7.83(4)	6.58(6)	7.38(6)	19.05(10)	11.71(7)	2.41(8)	4.69(8)	7.33(6)	3.60(7)	3.23(6)	2.76(8)
640	32.91(2)	-	59.25(2)	36.00(2)	21.50(2)	-	13.75(2)	18.50(3)	10.25(2)	20.25(2)	6.25(2)	9.01(2)
641	5.45(2)	26.77(2)	31.75(2)	21.80(2)	24.50(4)	61.33(3)	62.50(3)	22.69(4)	-	25.90(3)	-	-
642	18.63(2)	-	33.25(2)	9.33(3)	33.33(6)	-	81.35(6)	33.50(5)	-	27.70(5)	-	-
-643	7.49(2)	12.94(2)	-	-	-	-	-	-	-	-	-	-
-644	15.22(2)	4.99(2)	-	-	-	-	-	-	-	-	-	-
645	18.61(2)	-	12.00(2)	21.75(2)	17.67(3)	3.25(2)	54.25(2)	41.83(3)	-	25.50(2)	11.40(2)	3.23(2)
646	59.24(2)	88.96(2)	51.50(2)	63.25(2)	15.50(2)	91.25(2)	100.50(2)	66.50(3)	-	30.00(2)	-	
647	160.23(2)	48.13(2)	89.25(2)	82.50(2)	39.50(2)	-	-	114.72(3)	-	-	-	
-648	15.45(2)	-	-	-	-	-	-	-			-	
-649	10.91(2)	-	-	-	-	-	-	-	-	-	-	
Estimated biomass (t) (surveyed area)	99,134	66,330	70,623	77,966	70,870	97,790	111,612	78,804	106,386	76,482	68,270	68,878
Estimated biomass (t) multiplicative model (excl. strata 618,619, 643, 644, 648, 649)	96,896	65,758	70,668	78,098	72,406	104,929	115,399	78,355	112,648	79,475	72,651	72,631

Table 5. Average weight (kg) of Greenland halibut per set from fall research vessel surveys in Division 3L. Numbers in parentheses indicate number of sets per stratum.

Stratum	ATC 323, 324, 325 1981	ATC 333, 334 1982	W.T. 7, 8, 9 1983	W.T. 16, 17, 18 1984	W.T. 37, 38, 39 1985	A.N. 72 1986	W.T. 65 1987	W.T. 78 1988	W.T. 87 1989
328	–	–	–	0.20(4)	0.09(8)	0.52(6)	0.25(4)	0.06(7)	0.10(7)
341	0.50(3)	0.19(4)	0.80(4)	0.50(5)	0.26(7)	0.04(7)	0.62(9)	0.31(8)	0.26(8)
342	1.33(3)	2.83(3)	0.87(4)	0.00(2)	0.73(3)	0.20(3)	0.00(3)	0.23(3)	0.17(3)
343	0.88(4)	–	0.53(3)	0.00(4)	0.08(3)	0.02(3)	0.00(3)	0.00(3)	0.27(3)
344	6.94(4)	1.00(3)	4.34(6)	0.18(6)	2.46(9)	4.63(7)	2.88(4)	3.20(7)	6.89(7)
345	20.75(4)	8.67(6)	9.25(8)	39.60(7)	36.61(9)	6.26(4)	18.00(2)	23.07(7)	12.43(7)
346	9.00(3)	11.63(4)	17.50(5)	27.33(6)	35.80(5)	26.06(3)	22.50(4)	16.00(5)	25.75(4)
347	1.83(3)	3.02(4)	2.58(6)	0.17(6)	0.76(4)	2.94(4)	0.13(2)	20.30(5)	15.10(5)
348	0.42(6)	2.08(5)	0.30(11)	0.11(11)	0.61(14)	0.88(5)	0.43(9)	0.44(10)	0.29(9)
349	0.09(7)	0.03(5)	0.43(9)	0.10(14)	0.07(10)	0.09(9)	0.24(10)	0.00(9)	0.04(10)
350	0.00(6)	0.00(2)	0.00(8)	0.00(12)	0.00(9)	0.00(11)	0.00(9)	0.00(10)	0.00(10)
363	0.00(4)	0.00(3)	0.00(3)	0.00(8)	0.00(10)	0.00(7)	0.00(9)	0.00(10)	0.00(9)
364	0.49(9)	0.25(11)	0.87(11)	0.00(10)	0.05(18)	0.14(5)	0.53(14)	0.27(14)	0.35(11)
365	2.88(4)	2.75(4)	1.30(5)	0.30(4)	0.12(8)	1.08(5)	3.18(6)	0.30(5)	0.90(5)
366	5.00(3)	9.58(6)	6.00(4)	6.23(11)	18.09(9)	10.90(4)	8.11(7)	20.64(7)	11.50(7)
368	21.50(2)	28.75(2)	–	17.75(2)	29.00(2)	6.66(2)	9.00(2)	21.75(2)	27.25(2)
369	13.25(2)	13.00(4)	14.00(6)	5.19(7)	13.33(6)	6.36(3)	9.25(4)	3.64(5)	4.08(5)
370	0.00(4)	0.50(6)	0.44(6)	0.39(7)	1.52(9)	2.30(2)	0.25(6)	0.01(7)	0.04(6)
371	0.01(4)	0.00(5)	0.00(5)	0.00(7)	0.00(7)	0.04(3)	0.00(5)	0.00(6)	0.00(4)
372	0.00(5)	0.00(7)	0.00(4)	0.00(13)	0.00(17)	0.01(9)	0.00(13)	0.00(13)	0.00(12)
384	–	0.00(4)	0.00(3)	0.00(6)	0.00(8)	0.08(5)	0.00(6)	0.00(6)	0.00(5)
385	0.26(8)	2.19(8)	3.20(5)	0.50(12)	1.24(12)	4.67(8)	2.44(9)	0.00(13)	0.17(11)
386	37.00(3)	21.75(4)	–	12.69(8)	37.50(5)	8.34(4)	6.13(4)	4.86(5)	10.90(5)
387	67.50(2)	43.67(3)	–	49.00(3)	42.25(4)	8.00(2)	26.33(3)	12.75(4)	15.33(3)
388	–	2.33(3)	–	24.00(2)	24.75(2)	–	17.25(2)	19.00(2)	15.50(2)
389	–	7.88(4)	–	19.25(6)	26.80(5)	9.80(4)	11.25(4)	8.88(4)	10.25(2)
390	0.00(3)	3.50(4)	0.07(3)	0.00(3)	2.72(7)	3.62(6)	1.06(8)	0.00(8)	0.57(7)
391	–	2.75(2)	21.50(2)	18.75(2)	29.75(7)	8.25(2)	4.10(2)	2.40(2)	13.00(2)
392	–	14.00(2)	15.25(2)	26.50(2)	25.00(2)	18.00(2)	8.25(2)	13.25(2)	12.00(2)
729	–	–	–	70.75(2)	30.50(2)	17.92(2)	–	–	–
730	–	–	–	12.25(2)	6.75(2)	–	–	–	–
731	–	–	–	41.75(2)	15.00(2)	–	–	–	–
732	–	–	–	12.63(2)	21.00(2)	–	–	–	–
733	–	–	–	12.75(4)	35.83(3)	–	–	–	–
734	–	–	–	17.67(3)	37.00(2)	–	–	–	–
735	–	33.00(2)	–	42.00(3)	29.25(2)	47.50(2)	–	–	–
736	–	30.00(2)	–	–	70.00(2)	52.53(2)	–	–	–
Estimated biomass (t) (surveyed area)	12,722	11,649	6,634	17,548	23,848	10,610	9,821	10,851	10,518
Estimated biomass (t) multiplicative model (all strata included)	17,336	14,439	14,255	18,008	24,066	13,543	13,028	13,496	13,319

Table 6. Age composition - numbers/standard tow from groundfish surveys in Div. 2J, 3K (all strata fished).

Div.	Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
3K	1	0.62	0.54	0.34	1.37	0.22	0.14	0.38	1.23	2.37	0.27	1.36	0.73
	2	7.64	3.20	2.53	4.89	1.35	1.09	1.55	2.99	6.24	2.31	4.74	3.35
	3	15.54	6.18	4.33	9.20	6.75	6.20	4.46	4.92	11.39	16.54	10.41	12.93
	4	13.45	5.39	6.03	5.33	6.63	10.75	11.67	6.32	18.75	13.14	19.09	21.33
	5	13.98	7.83	9.06	7.85	7.58	12.35	23.24	12.44	11.07	13.23	22.63	22.14
	6	11.41	9.57	10.91	11.38	7.46	9.94	9.92	12.69	15.70	10.36	13.29	15.46
	7	7.51	4.83	6.45	7.22	7.31	11.33	6.76	8.10	13.70	7.85	7.34	7.07
	8	2.88	1.72	1.68	2.32	7.29	9.39	3.58	2.49	3.37	4.27	1.09	0.91
	9	1.12	0.61	0.58	0.93	2.22	3.18	2.08	0.90	0.75	1.24	0.31	0.15
	10	0.79	0.49	0.46	0.42	0.56	0.73	0.68	0.66	0.16	0.24	0.14	0.04
	11	0.74	0.32	0.50	0.23	0.34	0.41	0.33	0.30	0.12	0.11	0.08	0.02
	12	0.42	0.30	0.28	0.09	0.24	0.21	0.22	0.21	0.19	0.12	0.04	-
	13	0.22	0.26	0.16	0.07	0.15	0.12	0.15	0.09	0.03	0.07	0.02	-
	14	0.05	0.11	0.07	0.01	0.15	0.06	0.11	0.08		0.01	0.01	-
	15	0.04	0.08	0.02	0.00	0.03	0.01	0.03	0.04		0.02		
	16	0.03	0.04	0.01	0.01	0.01	0.00	0.01	0.02		0.02		
	17	0.01	0.01			0.01			0.02		0.02		
	18		0.01						0.01				
	19		0.00										
	20												
	unknown		0.01						0.03	0.03	0.00	0.01	0.02
	Total	**76.46**	**41.50**	**43.41**	**51.51**	**48.33**	**65.90**	**65.16**	**53.54**	**83.88**	**69.81**	**80.56**	**84.16**
2J	1	0.45	0.91	0.63	1.88	0.52	0.09	0.12	1.31	0.67	0.40	0.46	0.42
	2	3.36	7.92	0.79	5.68	0.92	0.37	1.62	1.53	0.76	1.31	0.81	0.91
	3	7.79	7.35	2.15	4.15	3.87	1.43	5.79	1.14	0.98	3.45	2.24	2.38
	4	10.66	5.64	3.32	4.04	8.07	3.55	4.24	2.06	2.49	1.61	3.48	7.88
	5	9.80	7.81	5.53	5.82	6.64	6.92	8.26	4.93	4.99	1.63	2.19	10.30
	6	7.07	7.23	6.56	5.68	5.27	6.73	6.93	7.06	8.33	3.35	3.05	6.39
	7	4.87	3.82	5.44	5.52	7.44	7.14	6.45	6.55	8.66	6.40	5.97	5.43
	8	3.00	1.87	2.49	3.53	9.05	5.52	5.99	3.81	3.85	5.07	3.23	2.75
	9	2.24	1.10	1.27	1.68	4.87	2.42	2.44	1.85	1.59	2.80	0.78	0.88
	10	1.73	1.20	0.98	1.03	2.32	0.86	1.18	1.25	0.58	0.62	0.22	0.19
	11	1.31	0.79	1.11	0.97	1.16	0.68	0.59	0.46	0.45	0.50	0.15	0.18
	12	0.83	0.68	0.78	0.46	0.71	0.58	0.39	0.44	0.29	0.38	0.09	0.04
	13	0.59	0.54	0.53	0.23	0.54	0.46	0.33	0.21	0.24	0.14	0.12	0.01
	14	0.19	0.29	0.31	0.14	0.55	0.33	0.31	0.25	0.17	0.18	0.10	0.03
	15	0.13	0.18	0.12	0.09	0.44	0.16	0.21	0.16	0.18	0.12	0.08	0.03
	16	0.10	0.19	0.07		0.17	0.04	0.16	0.09	0.10	0.00	0.05	0.01
	17	0.05	0.07	0.02		0.02	0.00	0.08	0.08	0.03	0.02	0.02	-
	18	0.00	0.03			0.01	0.02		0.02	-		0.01	-
	19	0.00	0.02						0.01	-		0.00	-
	20	0.01										0.01	-
	unknown	0.04		0.03	0.25	0.02			0.01	0.01	0.10		
	Total	**54.21**	**47.64**	**32.13**	**41.15**	**52.61**	**37.31**	**45.08**	**33.23**	**34.37**	**28.08**	**23.06**	**37.83**

Table 7. Age composition of Greenland halibut - numbers/standard tow for Division 3L.

Age	ATC 323, 324, 325 1981	ATC 333, 334 1982	WT 7, 8, 9 1983	WT 16, 17, 18 1984	WT 37, 38, 39 1985	A.N. 72 1986	WT 65 1987	WT 78 1988	WT 87 1989
1	0.29	0.22	0.12	0.13	0.69	1.55	0.01	0.08	0.23
2	0.37	0.42	0.69	0.26	0.80	1.43	0.15	0.19	0.22
3	0.80	0.74	0.86	0.36	0.46	0.50	0.85	0.52	0.34
4	0.56	0.53	0.69	0.66	0.76	0.32	0.65	0.73	0.77
5	1.51	0.74	0.55	1.53	1.39	0.58	0.49	1.72	1.06
6	1.61	0.84	0.52	1.38	2.56	1.00	0.68	1.64	1.97
7	0.86	1.05	0.65	1.32	1.68	1.15	0.77	1.03	0.96
8	0.21	0.89	0.54	1.02	0.91	0.36	0.79	0.40	0.29
9	0.00	0.23	0.16	0.40	0.50	0.09	0.28	0.16	0.13
10	0.05	0.07	0.00	0.17	0.18	0.02	0.09	0.04	0.03
11	0.01	0.02	0.00	0.03	0.09	0.01	0.06	0.03	0.03
12	0.00	0.01	0.01	0.01	0.06	0.00	0.02	0.02	0.02
13	0.00		0.01	0.02	0.00	0.00	0.01	0.01	0.01
14	0.00			0.00	0.01	0.01	0.00	0.01	-
15	0.00			0.00	0.01		0.01		
16	0.01				0.00				
17					0.00				
Unknown	0.03	0.00	0.03	0.00	0.00	0.03	0.01	0.00	0.01
Total	6.30	5.77	4.80	7.28	10.08	7.05	4.88	6.56	6.06

Table 8. Catch and effort statistics of Greenland halibut in NAFO Div. 2HJ3K from Canada(N) where effort was considered directed in 1978-88.

Year	NAFO Div.	Months	Mean CPUE (t/hr.)	Directed catch (t)
			Canada(N) (TC 5)	
1980	3K	Mar-May	0.559	1148
1981	3K	Mar-May	0.485	3118
1982	3K	May	0.416	304
	2J	Aug-Sep	0.610	1132
	2H	Aug-Sep	0.924	3406
1983	3K	May-Jul	0.587	1471
	2J	Aug	1.153	1465
	2H	Aug-Sep	1.423	2168
1984	3K	May-Sep	0.607	1759
	2J	Jul-Sep	1.115	1603
	2H	Jul-Sep	1.072	1451
1985	3K	May-Sep	0.269	151
	2J	Jul-Oct	0.600	2398
	2H	Aug-Sep	0.892	1265
1986	2J	Jun-Oct	0.424	1098
1987	2J	Aug	0.694	1936
1988	2J	Aug-Sep	0.365	559

TABLE 9 . CATCH AND AVERAGE WEIGHTS AT AGE FOR GREENLAND HALIBUT BY CANADA DURING 1989 IN SUBAREA 2 AND DIV. 3KL.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
4	0.198	30.367	5	2.35	0.43
5	0.403	37.459	166	21.53	0.13
6	0.561	41.339	1878	98.78	0.05
7	0.765	45.337	7076	146.04	0.02
8	1.065	49.987	3568	113.36	0.03
9	1.619	56.646	597	29.30	0.05
10	2.201	62.092	90	9.76	0.11
11	2.980	67.995	19	2.68	0.14
12	3.981	74.053	4	1.28	0.33
13	4.455	76.597	2	1.00	0.58
14	5.623	82.141	1	0.89	0.69
15	6.962	87.423	1	0.48	0.56
16	7.547	89.616		0.30	0.75
17	9.659	96.500		0.00	0.02

Table 10. G.HAL. CATCH AT AGE MATRIX.

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	322	19	464	3016	2182	204	810	236	766	858	1662	245	128	269
6	2719	680	4351	8511	7980	2032	4242	2020	3889	2211	4449	1958	1779	2900
7	5547	3600	9374	9072	11726	8913	9209	5552	10714	5560	4955	5604	10293	7405
8	4781	6030	6377	7662	5611	9429	10753	5064	8215	7308	2933	4450	8358	3986
9	3821	4199	2546	2898	1069	5258	4045	3112	2509	3888	1156	1284	2652	1172
10	1628	2457	879	1454	440	3729	836	1480	756	1198	429	412	798	423
11	677	923	191	731	262	987	240	524	229	387	133	213	359	183
12	130	290	113	371	136	125	133	225	83	136	83	122	263	96
13	269	113	101	225	131	52	40	143	116	101	73	61	210	97
14	131	36	26	110	84	14	27	70	93	55	40	49	157	56
15	63	21	18	58	76	9	20	55	74	73	18	32	99	48
16	41	1	22	54	56	2	13	29	10	28	12	20	53	11
17	43	1	7	39	44	1	5	14	14	18	2	1	17	2
5+	20172	18370	24469	34201	29797	30755	30373	18524	27468	21821	15945	14451	25167	16648

Table 11. G.HAL. PERCENT CATCH AT AGE.

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	1.6	0.1	1.9	8.8	7.3	0.7	2.7	1.3	2.8	3.9	10.4	1.7	0.5	1.6
6	13.5	3.7	17.8	24.9	26.8	6.6	14.0	10.9	14.2	10.1	27.9	13.5	7.1	17.4
7	27.5	19.6	38.3	26.5	39.4	29.0	30.3	30.0	39.0	25.5	31.1	38.8	40.9	44.5
8	23.7	32.8	26.1	22.4	18.8	30.7	35.4	27.3	29.9	33.5	18.4	30.8	33.2	23.9
9	18.9	22.9	10.4	8.5	3.6	17.1	13.3	16.8	9.1	17.8	7.2	8.9	10.5	7.0
10	8.1	13.4	3.6	4.3	1.5	12.1	2.8	8.0	2.8	5.5	2.7	2.9	3.2	2.5
11	3.4	5.0	0.8	2.1	0.9	3.2	0.8	2.8	0.8	1.8	0.8	1.5	1.4	1.1
12	0.6	1.6	0.5	1.1	0.5	0.4	0.4	1.2	0.3	0.6	0.5	0.8	1.0	0.6
13	1.3	0.6	0.4	0.7	0.4	0.2	0.1	0.8	0.4	0.5	0.5	0.4	0.8	0.6
14	0.6	0.2	0.1	0.3	0.3	0.0	0.1	0.4	0.3	0.3	0.3	0.3	0.6	0.3
15	0.3	0.1	0.1	0.2	0.3	0.0	0.1	0.3	0.3	0.3	0.1	0.2	0.4	0.3
16	0.2	0.0	0.1	0.2	0.2	0.0	0.0	0.2	0.0	0.1	0.1	0.1	0.2	0.1
17	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.0

Table 12. G.HAL. MEAN WEIGHTS AT AGE (KG).

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	0.609	0.609	0.609	0.609	0.609	0.514	0.392	0.525	0.412	0.377	0.568	0.350	0.364	0.363
6	0.760	0.760	0.760	0.760	0.760	0.659	0.598	0.684	0.629	0.583	0.749	0.584	0.589	0.569
7	0.955	0.955	0.955	0.955	0.955	0.869	0.789	0.891	0.861	0.826	0.941	0.811	0.836	0.805
8	1.190	1.190	1.190	1.190	1.190	1.050	0.985	1.130	1.180	1.100	1.240	1.100	1.160	1.163
9	1.580	1.580	1.580	1.580	1.580	1.150	1.240	1.400	1.650	1.460	1.690	1.580	1.590	1.661
10	2.210	2.210	2.210	2.210	2.210	1.260	1.700	1.790	2.230	1.940	2.240	2.120	2.130	2.216
11	2.700	2.700	2.700	2.700	2.700	1.570	2.460	2.380	3.010	2.630	2.950	2.890	2.820	3.007
12	3.370	3.370	3.370	3.370	3.370	2.710	3.510	3.470	3.960	3.490	3.710	3.890	3.600	3.925
13	3.880	3.880	3.880	3.880	3.880	3.120	4.790	4.510	5.060	4.490	4.850	4.950	4.630	5.091
14	4.560	4.560	4.560	4.560	4.560	4.420	5.940	5.850	6.060	5.730	6.130	6.090	5.480	6.203
15	5.920	5.920	5.920	5.920	5.920	5.040	8.060	7.530	7.310	6.850	7.160	7.640	6.670	7.644
16	7.140	7.140	7.140	7.140	7.140	7.020	8.710	8.680	8.600	8.330	8.920	9.810	7.850	9.187
17	7.890	7.890	7.890	7.890	7.890	10.100	9.580	11.500	11.300	9.570	11.800	10.100	9.840	11.444

Table 13. 6.HAL. CATCH BIOMASS AT AGE (T).

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	196	12	283	1837	1329	105	318	124	316	323	944	86	46	98
6	2066	517	3307	6468	6065	1339	2537	1382	2446	1289	3332	1143	1048	1650
7	5297	3438	8952	8664	11198	7745	7266	4947	9225	4593	4663	4545	8605	5961
8	5689	7176	7589	9118	6677	9900	10592	5722	9694	8039	3637	4895	9695	4636
9	6037	6634	4023	4579	1689	6047	5016	4357	4140	5676	1954	2029	4217	1947
10	3598	5430	1943	3213	972	4699	1421	2649	1686	2324	961	873	1700	937
11	1828	2492	516	1974	707	1550	590	1247	689	1018	392	616	1012	550
12	438	977	381	1250	458	339	467	781	329	475	308	475	947	377
13	1044	438	392	873	508	162	192	645	587	453	354	302	972	494
14	597	164	119	502	383	62	160	410	564	315	245	298	860	347
15	373	124	107	343	450	45	161	414	541	500	129	244	663	367
16	293	7	157	386	400	14	113	252	86	233	107	196	417	101
17	339	8	55	308	347	10	48	161	158	172	24	10	167	23
5+	27796	27418	27821	39514	31184	32017	28880	23090	30460	25411	17050	15713	30349	17488

Table 14 6.HAL. ABUNDANCE (*10-3) AT AGE FROM CANADIAN SURVEYS IN DIV.2J.

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	837	1607	1436	3405	927	162	213	2249	1418	748	804
2	6213	13953	1795	10280	1645	662	2867	2669	2245	2740	1406
3	14385	12947	4180	7513	6915	2544	10225	1631	4972	5997	3906
4	19690	9930	7528	7315	14411	6312	7499	3431	11549	2717	6076
5	18108	13762	12556	10536	11857	12307	14594	8765	17605	3145	3827
6	13066	12732	14892	10281	9414	11969	12246	11954	18044	6892	5332
7	9003	6728	12356	9999	13279	12715	11400	12134	9444	12978	10425
8	5543	3303	5642	6400	16146	9828	10585	7719	3540	8081	5639
9	4141	1935	2886	3033	8694	4312	4312	3208	1255	3782	1370
10	3194	2107	2216	1872	4145	1525	2081	2224	980	1280	377
11	2412	1387	2524	1751	2075	1212	1038	822	630	617	262
12	1526	1188	1777	830	1275	1041	685	782	528	296	161
13	1082	948	1215	416	958	824	580	350	372	312	216
14	350	515	707	258	976	583	553	497	382	175	181
15	246	326	276	155	782	277	363	273	213	72	136
16	178	329	157	0	301	78	275	164	62	51	81
17	98	128	45	0	30	0	141	154	0	10	38
1+	100071	83824	72188	74045	93833	66352	79657	59026	73240	49892	40238
2+	99234	82217	70752	70640	92906	66190	79444	56777	71822	49144	39434
3+	93021	68264	68957	60360	91261	65528	76577	54108	69578	46404	38028
4+	78636	55318	64777	52847	84346	62984	66351	52477	64605	40407	34122
5+	58946	45388	57249	45532	69935	56672	58853	49046	53056	37690	28046
6+	40838	31626	44693	34996	58077	44365	44259	40281	35452	34545	24219
7+	27772	18894	29801	24714	48663	32396	32013	28327	17408	27653	18887
8+	18769	12167	17445	14715	35384	19681	20613	16193	7964	14675	8462
9+	13227	8863	11803	8315	19238	9853	10028	8474	4424	6594	2823
10+	9086	6928	8917	5282	10544	5541	5716	5267	3168	2811	1453
11+	5891	4821	6700	3410	6398	4016	3635	3043	2188	1532	1077
12+	3479	3435	4176	1659	4323	2804	2596	2221	1558	915	814

Table 15 G.HAL. ABUNDANCE (#10-3) AT AGE FROM CANADIAN SURVEYS IN DIV.3K.

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	1504	1203	726	2986	477	296	861	3160	5424	701	4151
2	18541	7053	5417	10670	2913	2240	3533	13104	14272	5436	14520
3	37709	13646	9271	20095	14547	12785	10190	17025	26019	38863	31857
4	32627	11903	12905	11631	14294	22170	26691	30617	42857	30880	58436
5	33902	17278	19395	17139	16346	25481	53138	31962	25310	31074	40668
6	27680	21120	23352	24847	16073	20500	22691	18116	35879	24341	22460
7	18224	10654	13793	15773	15767	23376	15454	5223	31298	18436	3344
8	6979	3800	3596	5058	15715	19374	8180	2329	7703	10031	941
9	2724	1343	1240	2028	4785	6557	4759	1603	1712	2904	439
10	1917	1079	993	915	1214	1514	1555	739	356	565	252
11	1805	709	1080	504	729	836	747	514	284	250	118
12	1015	658	609	200	517	433	511	259	433	288	47
13	529	575	337	164	320	241	341	155	69	173	17
14	126	248	152	18	331	130	253	110	0	25	0
15	88	168	50	0	55	29	66	29	0	38	0
16	65	98	26	19	25	3	20	46	0	49	0
17	32	25	8	0	21	0	0	0	0	0	0
1+	185467	91562	92951	112047	104129	135965	148990	124995	191616	164055	177250
2+	183963	90359	92225	109061	103652	135669	148129	121835	186192	163354	173099
3+	165422	83306	86808	98391	100739	133429	144596	108730	171920	157918	158579
4+	127713	69660	77537	78296	86192	120644	134406	91705	145901	119055	126722
5+	95085	57757	64632	66664	71897	98474	107715	61088	103044	88175	68286
6+	61183	40479	45237	49526	55551	72993	54577	29125	77734	57100	27618
7+	33503	19359	21885	24679	39478	52492	31886	11010	41855	32759	5159
8+	15279	8705	8091	8906	23711	29116	16433	5786	10557	14323	1815
9+	8300	4904	4495	3848	7996	9742	8252	3457	2854	4292	874
10+	5576	3561	3256	1820	3211	3185	3493	1854	1142	1388	435
11+	3660	2482	2262	905	1997	1671	1938	1115	786	823	183
12+	1855	1773	1183	402	1268	835	1191	601	502	574	64

Table 16 G.HAL. ABUNDANCE (#10-3) AT AGE FROM CANADIAN SURVEYS IN DIV.3L.

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	139	0	835	1180	729	563	380	2050	6072	42	233
2	940	1562	1704	1546	1425	3095	761	2373	5581	503	582
3	2636	2296	1872	3288	2503	3809	1066	1368	1968	2802	1573
4	3629	4000	2259	2294	2507	3049	1938	2176	1247	2131	2221
5	5696	4893	4065	6646	2858	2439	4516	4158	2257	1617	5255
6	4439	4997	3933	3549	3565	2319	4051	7645	3894	2229	4984
7	1711	1484	1809	880	3026	2878	3882	5001	4507	2515	3131
8	865	286	279	0	782	2385	2996	2714	1410	2581	1205
9	0	43	84	222	72	705	1171	1482	334	925	475
10	0	0	0	37	23	0	505	535	93	309	116
11	0	0	0	0	0	0	89	256	45	197	97
12	0	0	0	0	0	24	23	177	0	58	62
13	0	0	0	0	0	24	46	11	0	19	17
14	0	0	0	0	0	0	0	29	28	0	17
15	0	0	0	0	0	0	0	28	0	40	14
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	7	0	0	0
1+	20115	19561	16842	19642	17490	21290	21423	30009	27434	15969	19981
2+	19916	19561	16007	18462	16761	20727	21043	27959	21362	15927	19748
3+	18976	17999	14302	16916	15336	17632	20282	25586	15782	15424	19166
4+	16340	15703	12431	13628	12833	13823	19216	24218	13813	12622	17593
5+	12712	11703	10172	11334	10327	10773	17278	22042	12566	10490	15372
6+	7016	6810	6106	4688	7468	8334	12762	17884	10310	8873	10116
7+	2576	1813	2173	1139	3903	6016	8711	10239	6416	6645	5133
8+	865	329	364	259	877	3138	4829	5237	1909	4130	2002
9+	0	43	84	259	95	753	1834	2524	499	1548	797
10+	0	0	0	37	23	48	662	1042	165	623	322
11+	0	0	0	0	0	48	158	507	73	315	206
12+	0	0	0	0	0	48	69	252	28	118	109

Table 17 G.HAL. ABUNDANCE (#10-3) AT AGE FROM CANADIAN SURVEYS IN DIV.2J3KL COMB.

AGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	2540	2810	2997	7571	2133	1021	1453	7460	12913	1490	5188
2	25693	22568	8916	22496	5983	5997	7162	18147	22097	8679	16508
3	54730	28889	15323	30896	23965	19138	21482	20024	32960	47663	37336
4	55946	25833	22692	21241	31212	31532	36128	36224	55653	35729	66733
5	57706	35933	36017	34321	31062	40227	72248	44886	45171	35836	49750
6	45185	38849	42177	38677	29052	34789	38987	37715	57816	33462	32775
7	28938	18866	27958	26653	32072	38968	30735	22359	45250	33929	16900
8	13386	7389	9518	11458	32643	31588	21761	12761	12652	20694	7784
9	6865	3322	4210	5282	13551	11573	10242	6293	3301	7611	2284
10	5111	3185	3210	2824	5382	3039	4142	3498	1429	2153	745
11	4217	2096	3604	2255	2804	2048	1874	1592	959	1063	478
12	2540	1846	2386	1030	1793	1498	1219	1218	961	642	270
13	1610	1523	1552	579	1278	1089	967	517	441	504	250
14	476	764	859	276	1307	713	807	636	411	200	198
15	335	494	326	155	836	306	429	330	213	151	151
16	243	427	183	19	326	81	295	210	62	100	81
17	130	153	53	0	51	0	141	161	0	10	38
1+	305653	194947	181981	205734	215452	223607	250070	214030	292290	229916	237469
2+	303113	192137	178984	198163	213319	222586	248617	206570	279377	228426	232281
3+	277419	169569	170068	175667	207336	216589	241455	188424	257279	219746	215773
4+	222689	140680	154745	144771	183371	197451	219973	168400	224320	172083	178437
5+	166743	114848	132052	123530	152158	165919	183845	132176	168667	136355	111703
6+	109037	78915	96036	89210	121096	125692	111598	87290	123496	100518	61953
7+	63852	40066	53859	50533	92044	90904	72610	49576	65679	67057	29178
8+	34913	21200	25900	23880	59972	51935	41875	27217	20429	33128	12278
9+	21527	13811	16383	12422	27329	20347	20113	14456	7777	12434	4494
10+	14662	10489	12172	7139	13778	8774	9872	8163	4476	4823	2210
11+	9551	7304	8963	4315	8396	5735	5730	4665	3047	2670	1466
12+	5335	5208	5359	2060	5591	3687	3856	3073	2088	1606	988

18.

TABLE 18. PARAMETER ESTIMATES AND LOG RESIDUALS FROM AN ADAPT ANALYSIS USING RV DATA FOR GREENLAND HALIBUT IN SA2 +DIV. 3KL.

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000378
MEAN SQUARE RESIDUALS 0.302765

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
5	ABUNDANCE	4.41247E4	2.53946E4	1.73756E0	0.58
6	ABUNDANCE	2.65873E4	1.02202E4	2.60144E0	0.38
7	ABUNDANCE	1.89283E4	5.00489E3	3.78195E0	0.26
8	ABUNDANCE	6.74370E3	1.18627E3	5.68478E0	0.18
9	ABUNDANCE	2.62056E3	6.98746E2	3.75038E0	0.27
10	ABUNDANCE	9.39456E2	2.52338E2	3.72300E0	0.27
11	ABUNDANCE	4.26855E2	1.17660E2	3.62787E0	0.28
12	ABUNDANCE	2.25348E2	6.19968E1	3.63483E0	0.28
5	RV SLOPE	1.36519E0	2.46736E-1	5.53301E0	0.18
6	RV SLOPE	1.63401E0	2.82869E-1	5.77657E0	0.17
7	RV SLOPE	2.19421E0	3.78431E-1	5.79819E0	0.17
8	RV SLOPE	2.84662E0	5.00496E-1	5.68761E0	0.18
9	RV SLOPE	2.67729E0	4.75650E-1	5.62870E0	0.18
10	RV SLOPE	2.77816E0	4.96446E-1	5.59610E0	0.18
11	RV SLOPE	3.20896E0	5.74553E-1	5.58515E0	0.18
12	RV SLOPE	3.26623E0	5.84441E-1	5.58864E0	0.18

LOG RESIDUALS FOR RV SURVEY INDEX 3/ 6/90

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	-0.20	-0.27	0.38	-0.32	0.00	0.19	0.52	0.22	-0.27	0.03	0.00
6	-0.34	0.39	0.03	0.17	-0.40	0.33	0.28	0.05	0.57	0.07	0.02
7	-0.30	-0.90	0.49	0.12	-0.20	0.36	0.62	-0.02	0.46	0.76	-0.19
8	-0.59	-1.27	-0.95	-0.58	0.59	0.43	0.88	0.29	0.02	0.90	0.27
9	-0.17	-1.52	-0.53	-0.46	0.62	0.43	0.58	0.55	-0.19	1.00	-0.30
10	0.56	-0.55	-0.10	-0.22	0.57	-0.29	0.27	0.01	-0.32	0.51	-0.43
11	0.79	0.12	0.41	-0.04	0.47	-0.01	-0.34	-0.44	1.01	0.31	-0.27
12	0.62	0.51	0.73	-0.37	0.34	0.26	-0.06	-0.45	0.56	-0.79	-0.22

SUM OF RV 1 RESIDUALS : 0.0000004792 MEAN RESIDUAL : 0.0000000054

TABLE 19. CORRELATIONS BETWEEN ESTIMATED PARAMETERS FROM AN ADAPT ANALYSIS FOR GREENLAND HALIBUT IN SA2 + DIV. 3KL.

PARAMETER CORRELATION MATRIX 3/ 6/90

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.070	0.048	0.019	0.011	0.007	0.006	0.004	-0.312	-0.024
2	0.070	1.000	0.067	0.027	0.016	0.010	0.008	-0.006	-0.224	-0.239
3	0.048	0.067	1.000	0.045	0.022	0.014	0.013	0.010	0.154	-0.158
4	0.019	0.027	0.045	1.000	0.004	0.042	0.074	-0.101	-0.061	-0.064
5	0.011	0.016	0.022	0.004	1.000	0.065	0.056	-0.062	-0.035	-0.038
6	0.007	0.010	0.014	0.042	0.065	1.000	0.071	-0.052	-0.023	-0.025
7	0.006	0.008	0.013	0.074	0.056	0.071	1.000	-0.073	0.018	-0.020
8	0.004	0.006	0.010	-0.101	-0.062	-0.052	-0.073	1.000	-0.014	-0.015
9	-0.312	-0.224	-0.154	-0.061	-0.035	-0.023	-0.018	-0.014	1.000	0.077
10	-0.024	-0.239	-0.158	-0.064	-0.038	-0.025	-0.020	-0.015	0.077	1.000
11	-0.014	-0.020	-0.245	-0.120	-0.050	-0.034	-0.032	-0.025	0.046	0.047
12	-0.008	-0.011	-0.017	-0.289	-0.152	-0.067	-0.064	-0.062	0.024	0.026
13	-0.006	-0.009	-0.013	-0.087	-0.307	-0.171	-0.090	-0.075	0.019	0.021
14	-0.006	-0.008	-0.013	-0.144	-0.083	-0.304	-0.179	-0.100	0.019	0.020
15	-0.006	-0.009	-0.013	-0.186	-0.095	-0.063	-0.296	-0.182	0.019	0.021
16	-0.006	-0.009	-0.014	-0.234	-0.116	-0.064	-0.057	-0.295	0.021	0.022

	11	12	13	14	15	16
1	-0.014	-0.008	-0.006	-0.006	-0.006	-0.006
2	-0.020	-0.011	-0.009	-0.008	-0.009	-0.009
3	-0.245	-0.017	-0.013	-0.013	-0.013	-0.014
4	-0.120	-0.289	-0.087	-0.144	-0.186	-0.234
5	-0.050	-0.152	-0.307	-0.083	-0.095	-0.116
6	-0.034	-0.067	-0.171	-0.304	-0.063	-0.064
7	-0.032	-0.064	-0.090	-0.179	-0.296	-0.057
8	-0.025	-0.062	-0.075	-0.100	-0.182	-0.295
9	0.046	0.024	0.019	0.019	0.019	0.021
10	0.047	0.026	0.021	0.020	0.021	0.022
11	1.000	0.044	0.031	0.032	0.034	0.038
12	0.044	1.000	0.081	0.073	0.082	0.093
13	0.031	0.081	1.000	0.092	0.073	0.074
14	0.032	0.073	0.092	1.000	0.097	0.077
15	0.034	0.082	0.073	0.097	1.000	0.102
16	0.038	0.093	0.074	0.077	0.102	1.000

20.

TABLE [redacted] POPULATION NUMBERS AND FISHING MORTALITY DERIVED FROM AN ADAPT ANALYSIS USING RV DATA FOR GREENLAND HALIBUT IN SA2 + DIV. 3KL.

POPULATION NUMBERS (000S) 3/ 6/90

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	64979	43818	46490	42304	27540	30005	38782	33508	30601	32491	44046
6	55304	50471	33901	37878	33903	22334	23873	30975	25930	24832	26486
7	30624	37578	34102	25917	27174	25929	14767	17545	21335	19458	18721
8	18105	16864	20156	19855	12686	17224	11535	7059	9681	12397	6617
9	6668	7891	8730	7971	6526	5968	6669	2831	3126	4064	2587
10	2786	2837	5493	2390	2866	2528	2616	1942	1272	1397	927
11	1475	965	1925	1123	1200	1007	1385	1058	1202	669	422
12	889	546	553	683	702	508	618	784	746	791	223
13	557	392	324	340	439	371	341	383	567	500	410
14	261	252	203	219	242	230	199	188	247	409	220
15	145	114	131	153	154	135	104	113	118	158	193
16	496	67	25	99	107	77	43	19	76	67	39
17	191	359	4	18	69	62	54	10	5	45	7
5+	182482	162154	152035	138949	113808	106379	100985	96416	95105	97278	100898

FISHING MORTALITY 3/ 6/90

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
5	0.053	0.057	0.005	0.021	0.010	0.029	0.025	0.056	0.009	0.004	0.007
6	0.186	0.192	0.069	0.132	0.068	0.214	0.108	0.173	0.087	0.083	0.128
7	0.397	0.423	0.341	0.499	0.256	0.610	0.538	0.374	0.343	0.879	0.566
8	0.631	0.456	0.728	0.913	0.570	0.749	1.205	0.615	0.689	1.367	1.059
9	0.655	0.162	1.096	0.823	0.749	0.625	1.034	0.600	0.605	1.278	0.682
10	0.860	0.188	1.387	0.489	0.846	0.401	0.705	0.280	0.443	0.998	0.688
11	0.793	0.357	0.837	0.269	0.659	0.289	0.369	0.150	0.218	0.900	0.642
12	0.618	0.322	0.287	0.243	0.437	0.199	0.279	0.124	0.199	0.458	0.636
13	0.592	0.461	0.195	0.139	0.447	0.423	0.396	0.237	0.127	0.624	0.301
14	0.627	0.459	0.079	0.147	0.385	0.593	0.364	0.268	0.247	0.552	0.328
15	0.581	1.333	0.079	0.156	0.500	0.934	1.500	0.193	0.357	1.187	0.319
16	0.128	2.651	0.094	0.157	0.355	0.156	1.252	1.200	0.341	2.040	0.365
17	0.253	0.145	0.336	0.355	0.252	0.287	0.457	0.244	0.267	0.538	0.365

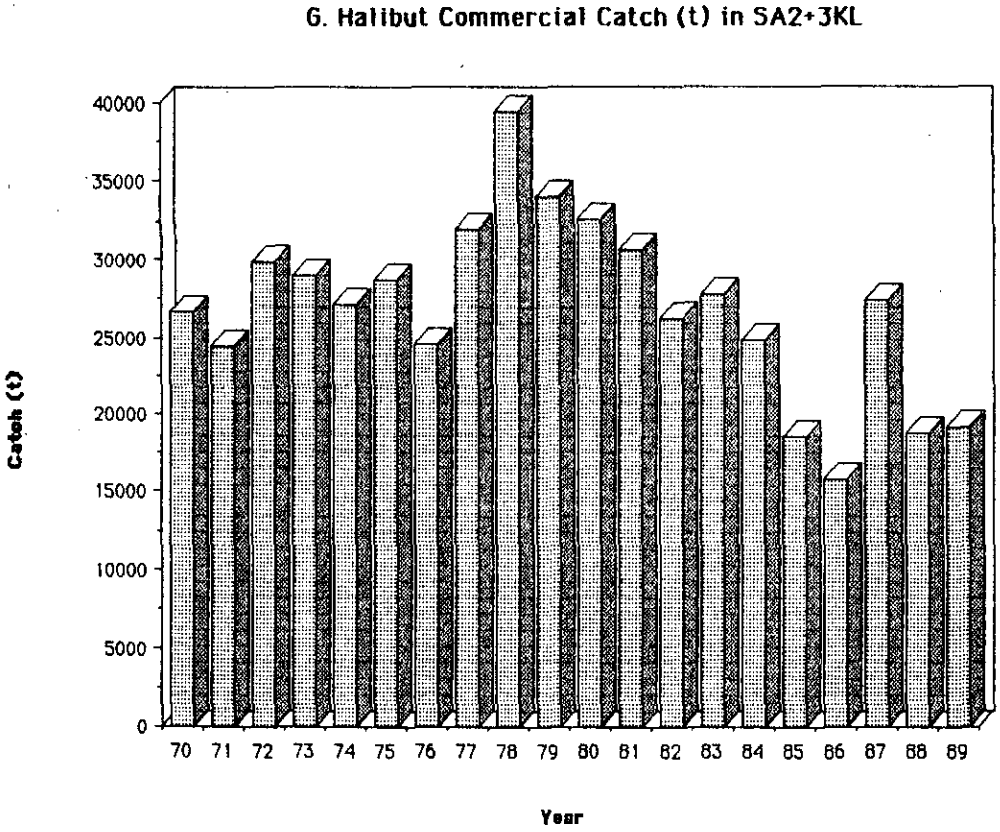


Fig.1 Commercial catch of G. halibut in SA2+ Div. 3KL from 1970-89.

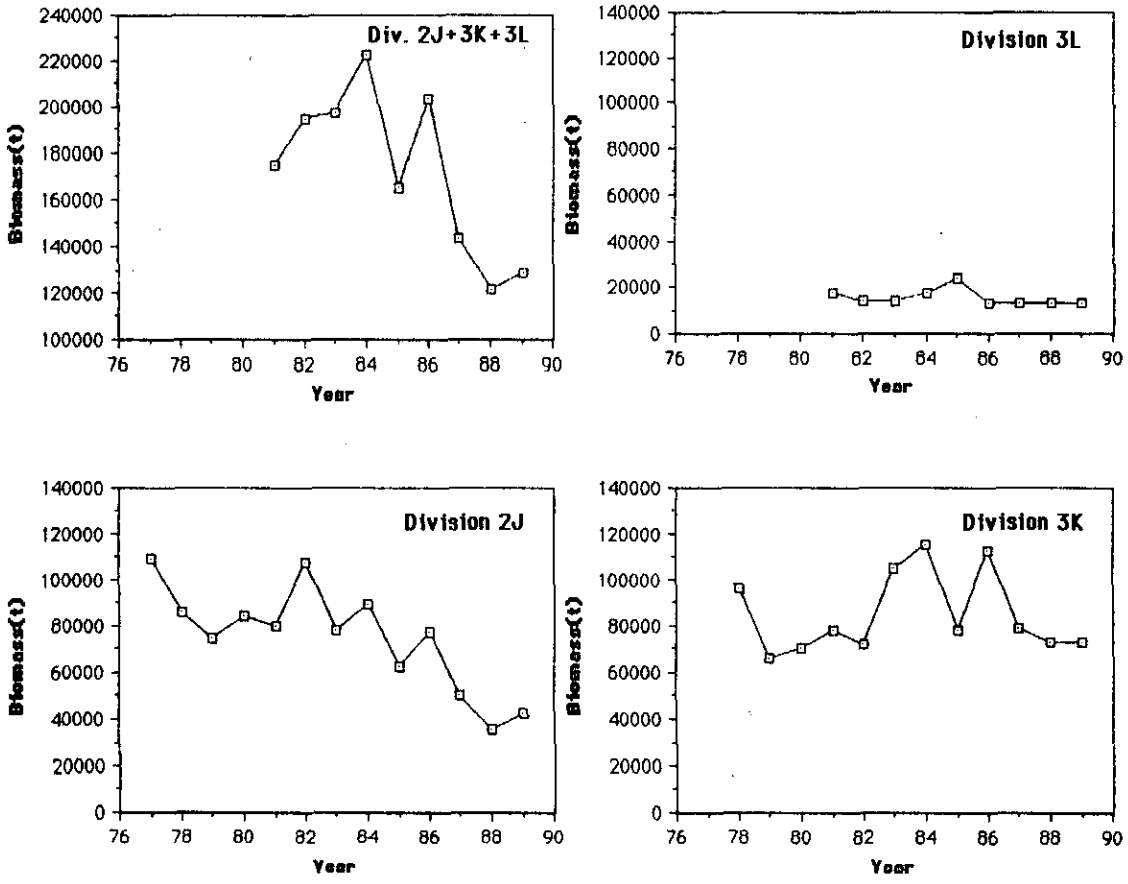
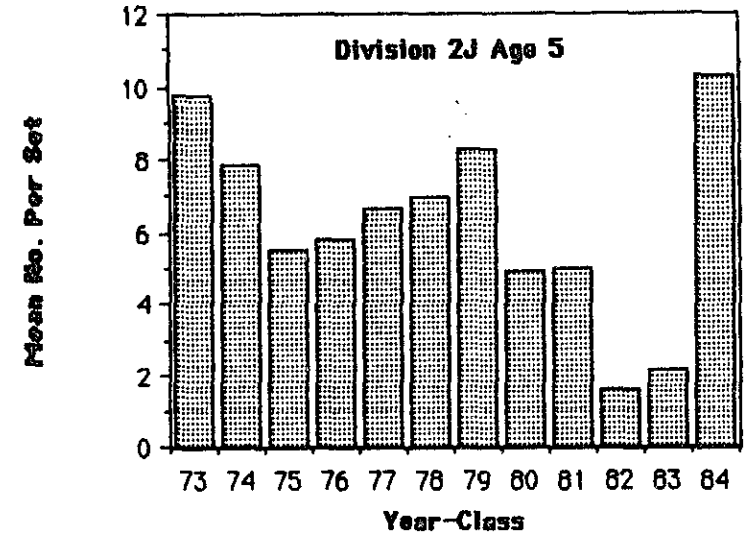
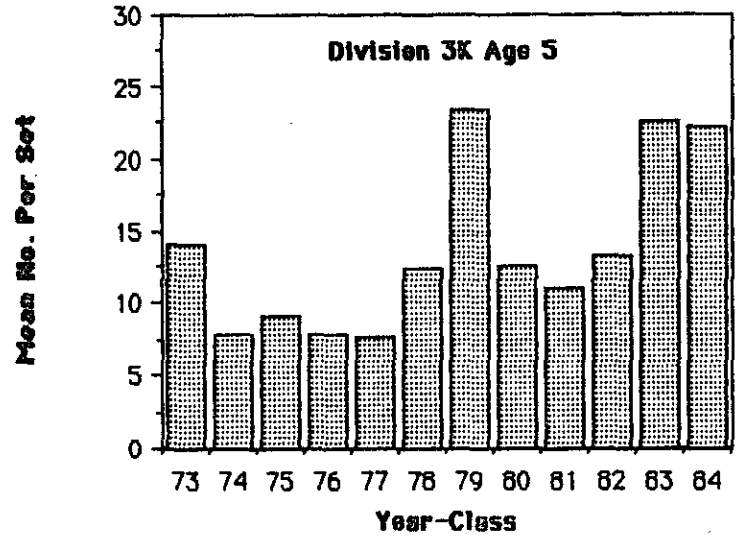


Fig.2 Biomass estimates of G.halibut in Div. 2K,3K & 3L
using a multiplicative model to fill in missing strata.





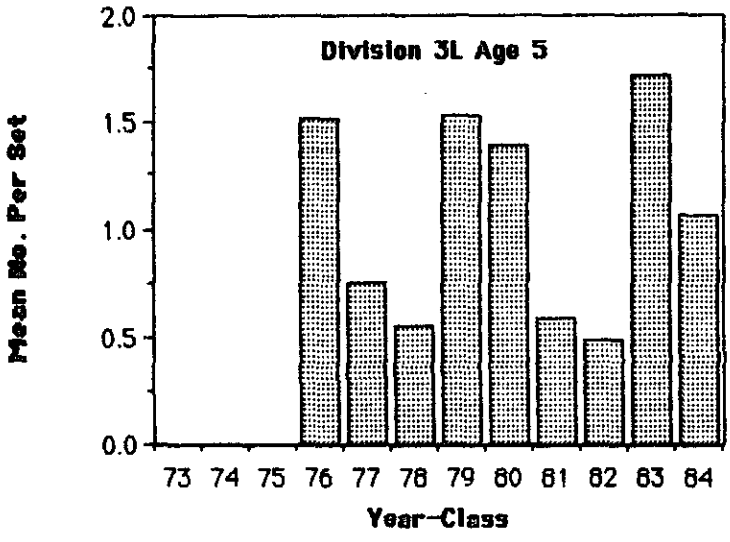


Fig. 3 Relative year-strengths of age 5 G. halibut from Groundfish surveys in Div. 2J,3K & 3L.

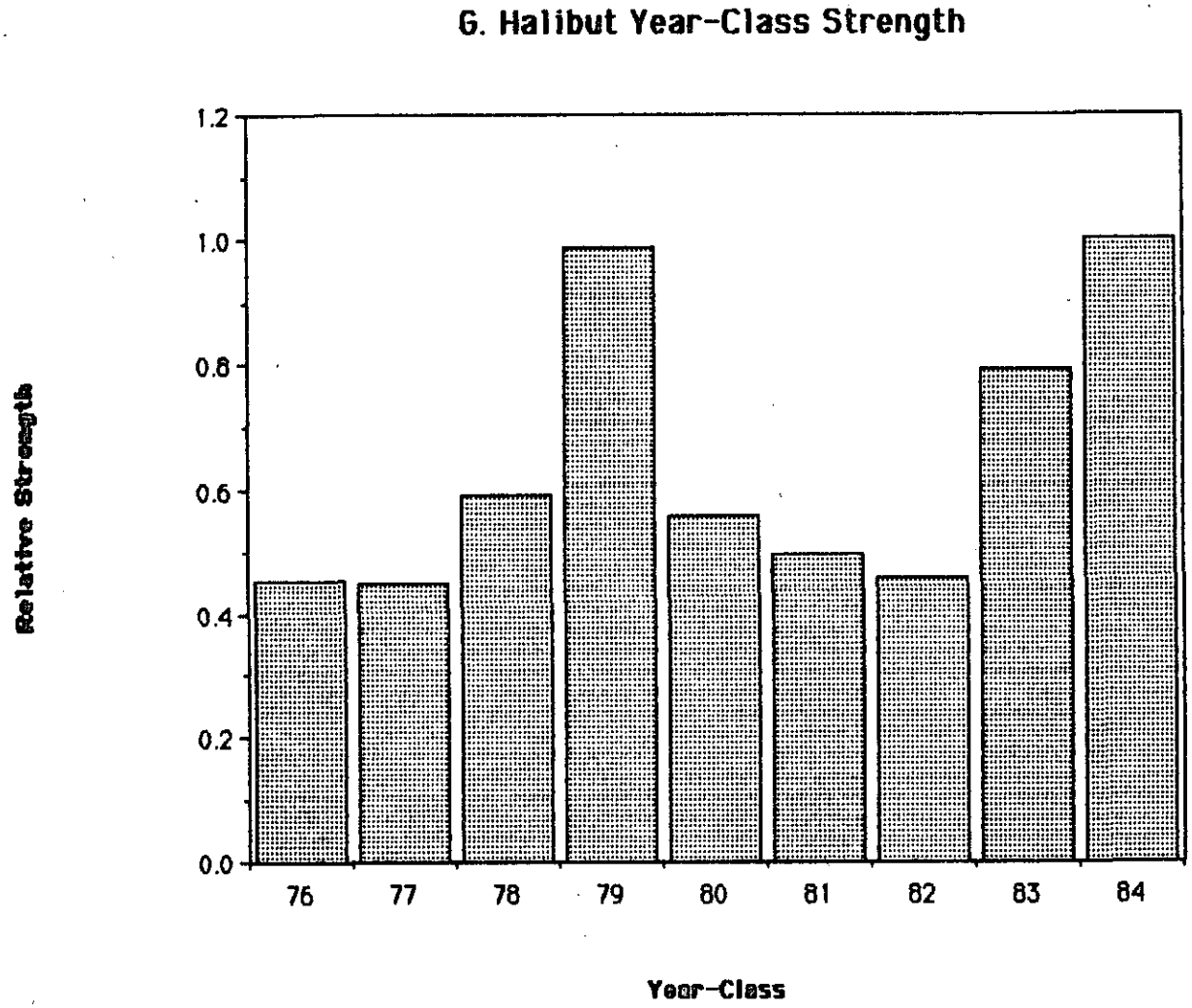
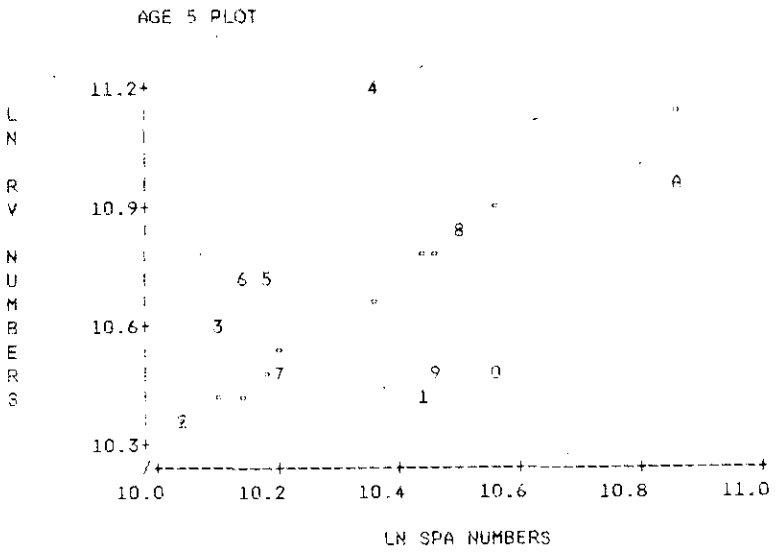


Fig.4Relative year-class strength of G. halibut in Div. 2J,3K & 3L combined. Standardized to the 1984 year-class.



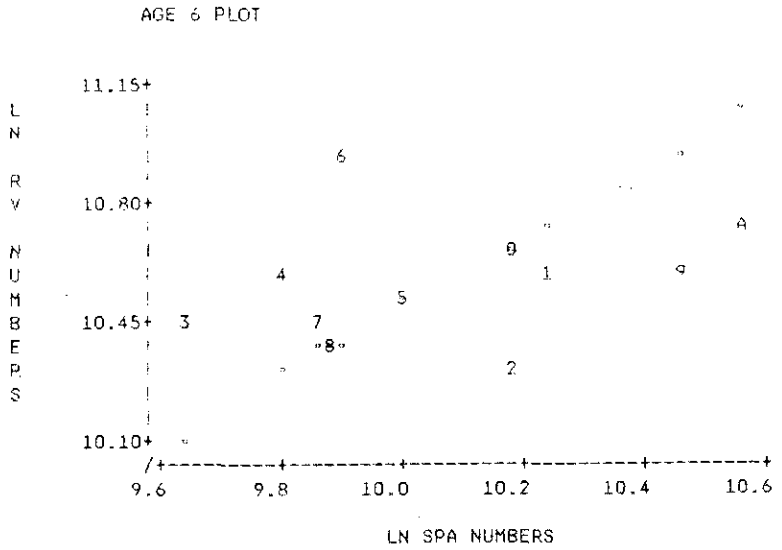
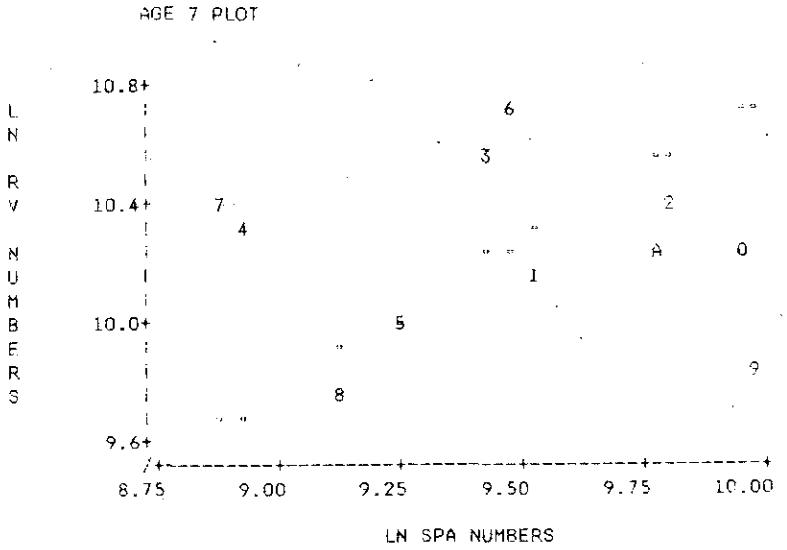


FIGURE 5. AGE BY AGE PLOTS (LN RV VERSUS LN SPA) FROM ADAPT ANALYSIS.



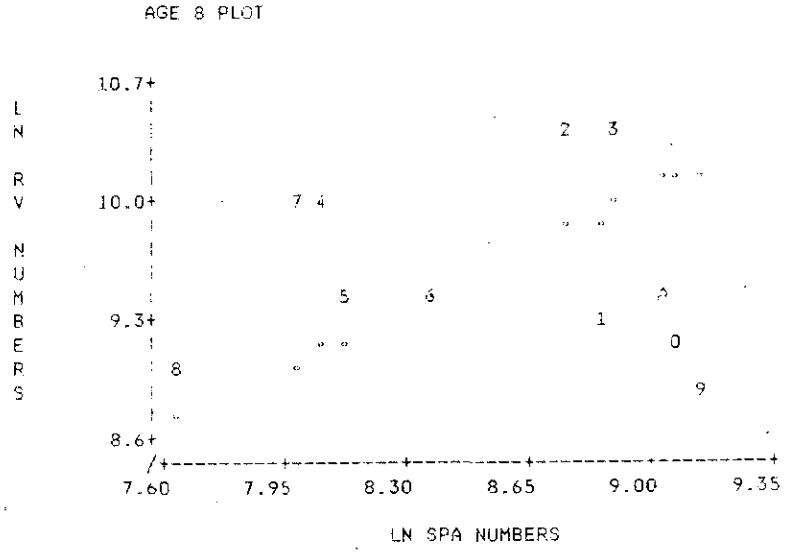
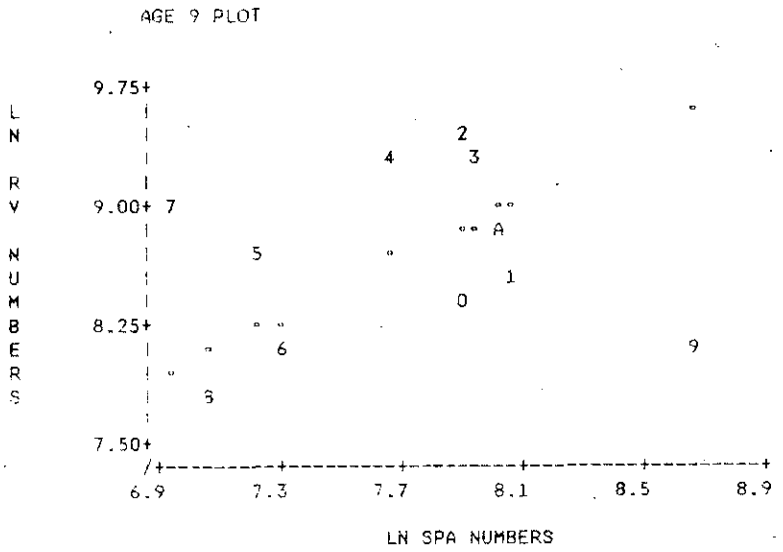


FIGURE 5. CONTINUED.



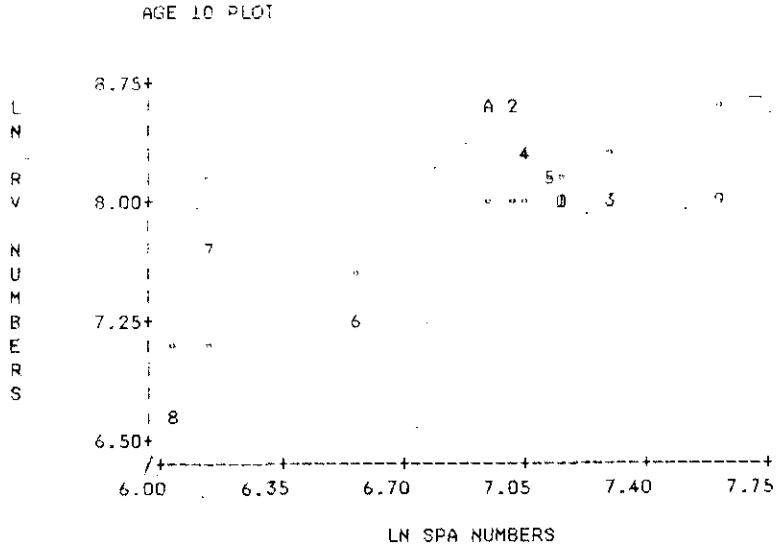
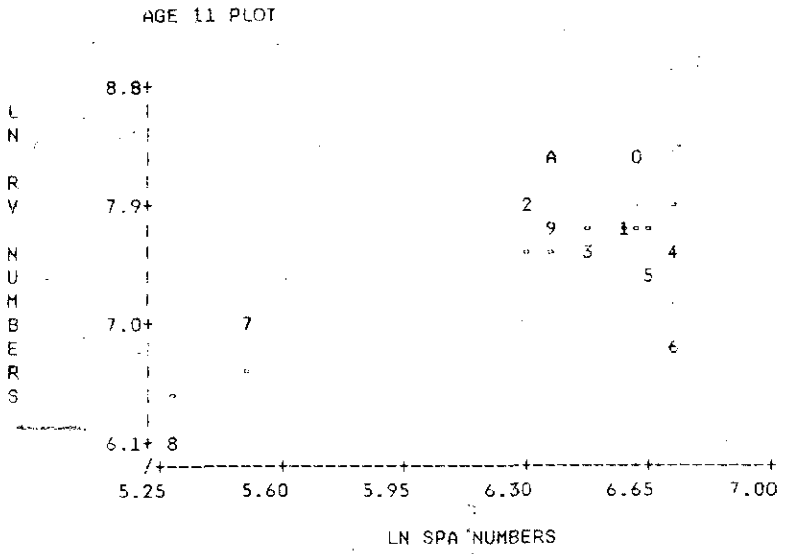


FIGURE 5. CONTINUED.



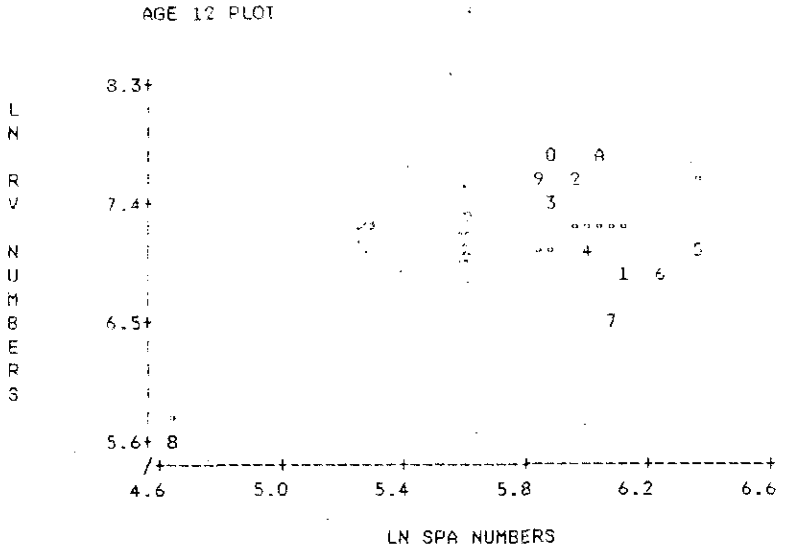


FIGURE 5. CONTINUED.

Appendix 1

Formulation of the Adaptive Framework

Parameters:

- Year-class estimates: $N_{i,1988}$ $i = 5, 12$
- Calibration coefficients for R.V. survey numbers: K_i $i = 5, 12$

Structure:

- Natural mortality = 0.2
- Effor in catch at age assumed negligible
- Intercepts not fitted
- F on oldest age (17) calculated as 40% of Mean F (weighted) by population numbers) at ages 8 and 9.
- F on ages 13-16 in 1988 calculated from the following input PR:

Age	13	14	15	16
PR	.33	.36	.35	.40

Input

- $C_{i,t}$ $i = 5, 12,$ $t = 1978\text{-}88$ Catch at age
- $RV_{i,t}$ $i = 5, 12,$ $t = 1978\text{-}88$ RV survey abundance at age

Objective function:

- Minimize $\Sigma\Sigma_{it}\ [obs(lnRV_{it})-pred(lnRV_{it})]^2$

Summary:

- Number of observations = 8
- Number of parameters = 16