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An Assessment of the Greenland Halibut (*Reinhardtius hippoglossoides*) Stock Complex in NAFO Subarea 2 and Division 3KL

by

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The fishery

The more intensive fishery for Greenland halibut in this stock area essentially began in the mid 1960's mainly by Canada(N) with heavy exploitation in Trinity Bay (Div. 3L) resulting from the introduction of highly efficient synthetic gillnets . From 1969 to 1977 the major exploiters of the stock were Canada(N) fishing the deepwater bays of eastern Newfoundland with gillnets and Poland, USSR and to a lesser extent GDR fishing the continental slopes with large otter trawlers (Table 1). During this time catches ranged from about 25,000-30,000 t annually. Since that time Canada(N) has been the main prosecutor of this fishery with Poland being the only other major exploiter particularly in 1983 where it accounted for over 20% of the landings.

Landings peaked at nearly 39,000 t in 1978 as a result of several large year-classes (1972-74) which entered the southern contingent of the stock and were heavily fished by gillnet fishermen on Newfoundland's east coast. The landings have declined steadily since 1978 to just over 24,000 t in 1983. This decline has been attributed mainly to a substantial reduction in effort as well as the migration of the large year-classes to the northern offshore regions where the fishery is much less intense.

Due to the variable nature of this fishery and the distribution and migratory patterns of this species, obtaining good long-term catch/effort statistics as accurate indicators of abundance except in relative terms has been difficult. Some directed effort, however, by Newfoundland (TC5) trawlers since 1980 were available and although based upon relatively low levels of directed catch were considered to be reasonably reliable since the fishery in each year was carried out in the same general areas. Some similar information for comparison was available from the foreign observer program for Poland from 1979-83 except for 1980. The data are presented as follows:

Year	NAFO Div.	Months	Mean CPUE (t/hr.)	Sets observed	Directed catch (t)
			Canada(N)		
1980	3K	Mar.-May	0.559	-	1148
1981	3K	Mar.-May	0.485	-	3118
1982	3K	May	0.416	-	304
	2J	Aug.-Sept.	0.610	-	1132
	2H	Aug.-Sept.	0.924	-	3406
1983	3K	May-July	0.587	-	1471
	2J	Aug.	1.153	-	1465
	2H	Aug.-Sept.	1.423	-	2168
			Poland		
1979	3K	May-June	1.53	88	-
	2H	Aug.	0.51	25	-
1981	3K	Jan.-June	1.54	117	-
	2H	Q3	0.71	103	-
1982	2H	July-Aug.	1.53	61	-
1983	2H	July-Aug.	1.50	63	-
	3K	May-June	0.85	221	-

The Canada(N) CPUE declined in Div. 3K from 1980-82, however, increased again in 1983. A decline occurred in the Polish catch rates for Div. 3K, however, the decline continued to 1983. In Div. 2J the Canadian catch rate increased from 0.610 t/hr. in 1982 to 1.153 t/hr. in 1983, nearly double that of 1982. In Div. 2H the Canadian catch rate also increased substantially from 0.924 t/hr. in 1982 to 1.423 t/hr. in 1983. The Polish catch in Div. 2H rates tripled from 0.51 t/hr. in 1979 to 1.53 t/hr. in 1982 and remained stable at 1.50 t/hr. in 1983. The increase in catch rate in Div. 2HJ may be attributed to the strong year-classes migrating from the southerly regions with the opposite being the case for Div. 3K.

Estimates of biomass from Groundfish surveys in NAFO Div. 2J3KL

Stratified-random biomass surveys were carried out in autumn in Div. 2J and 3K by the research vessel Gadus Atlantica since 1978 and in Div. 3L by the A. T. Cameron in 1981 and 1982 and the W. Templeman in 1983. The survey results by stratum are presented in Tables 2, 3, and 4 for Div. 2J, 3K, and 3L respectively.

For the area covered, the biomass estimate for Div. 2J in 1983 was 78,500 t compared to 104,200 t in 1982 (Table 2). The estimate for Div. 3K in 1983 was 97,800 t compared to 70,900 t in 1982 (Table 3). In Div. 3L the 1983 estimate was 6,600 t compared to 11,600 t in 1982 (Table 4). However, it should be pointed out the 1983 survey in Div. 3L missed several critical strata and was carried out by a different vessel than previously. The total for the three divisions was about 183,000 t compared to 187,000 t in 1982 and 167,000 t in 1981. The overall average for the past three years for the three divisions is 179,000 t. This is considered to be a minimum estimate since much of the deep water is not surveyed where the largest fish are found and catchability is considered to be equal to 1 which is unlikely to be the case for Greenland halibut.

Catch numbers at age from groundfish surveys

Average numbers at age caught per set for Div. 2J+3K autumn surveys are presented in Table 5 for 1978-83. Only strata common to all years were used in the calculations. Total numbers and their 95% confidence limits are shown in Fig. 1 while numbers at age 4 and 95% confidence limits for the 1974-79 year-classes inclusive are shown in Fig. 2.

The total numbers caught per tow (Table 5; Fig. 1) range from 38.60 in 1981 to 54.48 in 1978. Within the area surveyed, however, considering the confidence levels, the trend has been relatively stable (Fig. 1).

The strong 1972-74 year-classes now appear to have passed through the southern contingent of the stock although they are still more abundant at the same ages compared to other year-classes in the short time series. Although it is difficult to determine from such a short time series, the 1974-79 year-classes appear to be reasonably strong again in 1983. These year-classes at age 4 are compared to the 1974 year-class in Fig. 2. The 1974 year-class is the largest in the series with 1976 the lowest. There is an increasing trend in strength from the 1976 to 1979 year-class with 1979 the strongest since 1974. It should be pointed out, however, that 95% confidence limits overlap in all cases and those of the 1974 year-class are particularly wide.

Biomass estimates and length frequency distributions from shrimp surveys in the Labrador Channels

Since 1979, surveys have been conducted annually in July for shrimp in Hopedale Channel (Div. 2H) and Cartwright Channel (Div. 2J). The gear used was an 1600 Sputnik shrimp trawl and the vessel, the Gadus Atlantica except for the 1979 survey where the Zagreb was used. Estimates of biomass and 95% confidence limits for 1979-83 inclusive are shown in Fig. 3 (taken directly from Parsons and Tucker, 1984) and Fig. 4 (taken directly from Parsons and Veitch, 1984) for Cartwright Channel and Hopedale Channel respectively. In Cartwright Channel the biomass level in 1979 was less than 1800 t and increased to over 5300 t in 1980 (Fig. 2). Biomass dropped again in 1981 but has been steadily increasing since that time. In Hopedale Channel the biomass level in 1979 was less than 4100 t, however, this rapidly grew to about 23,000 t in 1980 (Fig. 4). It fell again in 1981 to less than 8600 t but has been increasing again and in 1983 was at an estimated level of over 24,000 t. The large increase in 1980 was attributed to a mass migration into the channels possibly for feeding on shrimp.

The length frequency distributions for both channels combined are presented in Fig. 5. The most striking feature of the length distribution is the predominence of the 1979 year-class from 1980 through to 1983. It would suggest that the 1979 year-class is quite strong as suggested from the groundfish surveys (see Table 5 and Fig. 2). It would also suggest that the 1980 year-class may also be quite strong as shown particularly in 1981 and 1982. In 1983, four distinct year-classes are present (1979-82), however, the 1979 year-class is still predominent. On the other hand, the 1979 year-class may be better recruited to the

fishing gear in 1983, therefore, the 1980, '81, '82 year-classes may be stronger than they appear in 1983.

Commercial data

Numbers and weights at age - The numbers and weights at age for 1975-82 were taken from SCR Doc. 83/VI/55 and the 1983 catch numbers and weights at age were computed using the sampling scheme shown in Table 6. The results are presented in Table 7. More than 92% of the catch was comprised of the 1974-77 year-classes with nearly 70% coming from the 1975 and 1976 year-classes. The strong 1972-74 classes only contributed 13% to the 1983 landings compared to 52% in 1982.

Partial recruitment - Partial recruitment for 1983 was derived as in previous years by comparison of the catch at age from the research vessel survey in 1983 in NAFO Div. 2J+3K with that of the commercial catch at age. Since the numbers were low in the last three age groups, a mean = 0.39 was taken for ages 12-14 years and applied to the 12+ age groups. The results of the calculations are shown in Table 8. The partial recruitment vector is dome-shaped as is normal for this fishery, however, not as pronounced as in previous years. This can be attributed to the reduced fishing effort by gillnets which normally heavily fish the middle ages in the fishery. It should be pointed out, however, that since the surveys do not adequately sample the larger fish in the population, the partial recruitment for the older fish may be substantially overestimated.

Fully recruited fishing mortality

As in the previous assessment, determining an accurate level of fishing mortality was not possible due to the short time series of both catch/effort data and the survey data. In 1983, a fishing mortality was calculated by computing a catch curve on the 1972-74 cohorts in the survey series since they contributed most to the fishery. An F was determined to be near F = 0.11. This was considered to be an upper estimate because of the emigration factor in progressive years. This calculation was not considered practical in this assessment since the emigration factor would now be even more influential in the regression.

Considering the level of catch in 1983, however, it is believed that the fully-recruited F is as low or even lower than in the previous year. Since F could not be accurately tuned, several cohort analyses were run at fully recruited F's of 0.05, 0.10, 0.15, and 0.20 and the results shown in Tables 9, 10, 11, and 12 respectively.

Yield per recruit

A Thompson and Bell yield per recruit analysis was performed and the results presented in Table 13. The weights used were the mean weights at age for all years from Table 7. The partial recruitment vector used was determined from average F's at age from 1975-83 using a cohort run at input F = 0.10 and partial recruitment as calculated for 1983 in Table 8. The average F-value at age 9 was normalized to 1 and average F's for other ages were adjusted proportionately. Using these parameters the computed $F_{0.1}$ value was determined to be $F_{0.1} = 0.29$.

REFERENCES

Parsons, D. G., and G. E. Tucker. 1984. A review of shrimp (Pandalus borealis) biology and environmental changes in the Cartwright Channel (Div. 2J), 1977-83. CAFSAC Res. Doc. 84/22.

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Table 1. Greenland halibut landings (metric tons) by year and country for Subarea 2 and Div. 3KL.

	Year																	
Country	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82*	83*
Canada(M)	-	99	95	-	1	2	-	-	-	25	221	229	1182	1863	523	560	1554	837
Canada(N)	16209	16505	13227	11553	10705	9406	8952	6840	5745	7782	9085	17738	23510	28077	31251	23565	17695	16237
FRG	355	42	4	202	13	-	86	707	515	622	927	755	1022	15	55	-	57	-
Poland	1114	3296	5806	5406	8266	5234	6986	9060	7105	8447	5942	5998	5215	1813	203	1806	1111	5258
Iceland	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	4	-	-	1389	501	117	-	6	15	3	8	1	-	-	-
USSR	-	-	-	9279	7384	9094	10183	8652	9650	9439	6799	4308	5632	1961	238	3325	979	176
Romania	-	-	-	-	225	7	120	80	-	-	-	-	3	-	-	-	-	-
GDR	-	-	-	-	-	647	402	1681	2701	2025	1512	1953	1636	178	316	1350	2487	-
Den-F	-	-	-	-	-	-	970	950	4	-	-	350	268	-	-	-	-	-
Spain	-	-	-	-	-	-	3	-	-	-	1	-	-	4	-	-	-	-
UK	-	-	-	-	-	-	731	201	1112	62	-	476	53	110	22	-	1	-
Den-G	-	-	-	-	-	-	-	65	2	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	207	161	231	73	119	-	38	21	16	1822	-
FRA-M	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
FRA-Sp	-	-	-	-	-	-	-	-	6	48	32	-	5	1	-	-	7	-
Japan	-	-	-	-	-	-	-	-	-	-	-	-	3	-	12	60	26	-
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2054
Total	17678	19942	19132	26445	26594	24392	29822	28944	27123	28681	24598	31941	38532	34068	32642	30682	25739	24562

*Provisional

Table 2. Average weight (kg) of Greenland halibut caught per set from 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 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58 1981	Gadus 71&72 1982	Gadus 86,87,&88 1983
201	7.26(2)	1.36(3)	0.45(2)	2.83(3)	2.70(5)	9.67(6)	3.72(6)
202	21.34(2)	25.20(2)	7.48(2)	51.00(2)	34.50(2)	45.50(2)	30.75(2)
203	31.55(2)			25.75(2)	52.00(2)	64.33(3)	226.83(3)
204	175.70(2)				170.50(2)	284.00(3)	250.83(3)
205	20.97(4)	6.58(4)	10.21(2)	3.75(4)	14.94(8)	24.09(12)	14.25(8)
206	20.80(11)	7.78(7)	8.11(8)	10.11(7)	37.18(11)	18.72(18)	8.70(14)
207	77.77(5)	25.54(4)	10.39(5)	6.90(5)	18.22(9)	10.33(15)	7.65(10)
208	186.14(4)	183.12(3)	127.46(2)	189.25(2)	240.75(2)	348.67(3)	110.00(2)
209	65.25(7)	15.66(4)	47.61(5)	144.37(4)	55.67(6)	129.64(11)	52.77(7)
210	19.41(6)	5.20(4)	4.09(2)	3.50(3)	5.00(3)	20.88(6)	41.50(2)
211	34.96(2)	64.92(2)	36.28(2)	32.70(3)	35.75(2)	55.75(2)	134.75(2)
212	189.61(4)				147.75(2)	144.10(5)	44.75(3)
213	16.46(8)	17.59(4)	8.84(4)	11.70(5)	29.33(6)	34.19(10)	23.25(10)
214	38.97(6)	67.76(4)	12.93(4)	11.33(3)	60.10(5)	84.31(8)	44.63(8)
215	37.68(4)	34.14(5)	8.00(4)	23.00(2)	12.30(5)	38.28(9)	14.46(8)
216	102.83(2)		111.58(2)	137.50(2)	63.25(2)	215.25(2)	102.67(3)
217	141.95(3)				41.00(2)	58.25(2)	64.50(2)
218	217.92(2)				156.50(2)	40.00(2)	39.00(2)
219					48.00(2)		103.00(2)
220							
221							
222	115.32(4)	42.07(3)	8.39(2)	16.25(2)	55.75(2)	188.00(3)	131.50(3)
223	251.52(2)				94.75(2)	88.00(2)	61.75(2)
224	173.65(2)				115.00(2)	36.50(2)	50.50(2)
225	39.95(2)						
226							
227	115.32(4)				43.50(2)	54.90(5)	38.50(4)
228	6.53(8)		4.88(4)	4.33(3)	8.00(6)	9.25(10)	10.33(6)
229	39.03(4)	19.52(2)	28.35(2)	5.25(2)	30.50(2)	21.50(4)	36.50(4)
230	243.28(3)				60.25(2)	30.80(2)	93.00(2)
231	64.24(2)					93.75(2)	51.25(2)
232	49.03(2)						
233							
234	49.03(2)	18.38(2)	101.38(2)	101.50(2)	52.00(2)	98.00(3)	46.71(3)
235	117.59(4)				39.00(2)	89.67(3)	252.50(2)
236	98.06(2)				44.75(2)	66.75(2)	101.00(2)
Biomass (tons)	106,834	32,064	28,319	45,119	76,661	104,233	78,546

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

Stratum	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58&59 1981	Gadus 71&72 1982	Gadus 86,87,&88 1983
620	24.13(7)	37.32(7)	24.80(9)	25.72(10)	22.33(9)	19.25(10)
621	159.03(7)	120.09(8)	54.42(10)	32.77(11)	14.68(14)	31.87(12)
622				132.50(2)	120.83(3)	224.00(2)
623	154.06(3)	36.55(3)	111.00(4)	83.33(4)	146.20(5)	217.17(6)
624	14.57(3)	11.34(2)	1.25(2)	3.75(2)	5.25(4)	2.38(4)
625	21.49(3)	11.19(3)	10.25(4)	31.50(4)	8.75(2)	66.33(3)
626	51.87(4)	35.08(3)	178.50(3)	58.20(5)	120.40(5)	101.75(4)
627				189.75(6)	124.43(7)	220.83(6)
628	39.95(5)	72.13(2)	36.56(4)	16.33(6)	12.92(6)	36.08(6)
629	8.63(3)	13.38(2)	19.83(3)	31.33(3)	68.50(2)	65.67(3)
630		11.11(2)	11.25(2)	117.25(2)		67.75(2)
631				68.60(5)	38.00(2)	66.70(5)
632	4.15(3)	2.04(2)	3.88(2)	6.25(2)	7.50(3)	3.43(3)
633	7.49(5)	5.41(6)	14.64(7)	9.98(8)	7.93(7)	12.38(12)
634	5.72(5)	9.26(6)	5.80(5)	5.41(7)	14.09(11)	6.60(5)
635	6.06(5)	5.17(5)	23.13(4)	12.00(5)	17.10(5)	7.83(6)
636	1.97(3)	4.40(5)	14.00(5)	12.75(6)	21.85(10)	4.05(6)
637	5.11(4)	6.58(4)	6.63(4)	8.25(6)	9.71(7)	14.80(5)
638	10.73(5)	11.97(7)	12.50(6)	21.31(8)	20.39(15)	18.05(11)
639	5.33(5)	4.31(2)	7.88(4)	7.38(6)	19.05(10)	11.71(7)
640				36.00(2)	21.50(2)	
641				21.80(2)	24.50(4)	61.33(3)
642				9.33(3)	33.33(6)	
643						
644						
645				21.75(2)	17.67(3)	3.25(2)
646				63.25(2)	15.50(2)	91.25(2)
647				82.50(2)	39.50(2)	
648						
649						
Biomass (tons)	65,695	52,641	52,819	77,966	70,870	97,790

Table 4. Average wt. (kg) of Greenland halibut per set from research vessel surveys in Division 3L in autumn. 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
328			
341	0.50(3)	0.19(4)	0.80(4)
342	1.33(3)	2.83(3)	0.87(4)
343	0.88(4)		0.53(3)
344	6.94(4)	1.00(3)	4.34(6)
345	20.75(4)	8.67(6)	9.25(8)
346	9.00(3)	11.63(4)	17.50(5)
347	1.83(3)	3.02(4)	2.58(6)
348	0.42(6)	2.08(5)	0.30(11)
349	0.09(7)	0.03(5)	0.43(9)
350	0.00(6)	0.00(2)	0.00(8)
363	0.00(4)	0.00(3)	0.00(3)
364	0.49(9)	0.25(11)	0.87(11)
365	2.88(4)	2.75(4)	1.30(5)
366	5.00(3)	9.58(6)	6.00(4)
368	21.50(2)	28.75(2)	
369	13.25(2)	13.00(4)	14.00(6)
370	0.00(4)	0.50(6)	0.44(6)
371	0.01(4)	0.00(5)	0.00(5)
372	0.00(5)	0.00(7)	0.00(4)
384		0.00(4)	0.00(3)
385	0.26(8)	2.19(8)	3.20(5)
386	37.00(3)	21.75(4)	
387	67.50(2)	43.67(3)	
388		2.33(3)	
389		7.88(4)	
390	0.00(3)	3.50(4)	0.07(3)
391		2.75(2)	21.50(2)
392		14.00(2)	15.25(2)
735		33.00(2)	
736			30.00(2)
	12,722	11,649	6,634

Table 5. Average numbers caught per set for 2J+3K November surveys weighted by stratum area. Only common strata fished in each survey were used in calculation.

Age	Gadus 15 1978	Gadus 29 1979	Gadus 44 1980	Gadus 58,59 1981	Gadus 71,72 1982	Gadus 86,87,88 1983
1	0.60	0.54	0.22	1.57	0.35	0.09
2	3.61	3.58	0.79	3.14	0.90	0.47
3	7.22	5.27	1.79	5.56	4.25	3.34
4	9.04	5.59	3.60	4.90	6.54	7.16
5	12.78	10.61	8.64	7.00	7.85	9.55
6	10.59	9.05	13.32	7.44	7.15	8.34
7	6.82	3.30	8.05	5.13	7.81	7.68
8	1.82	0.79	1.78	2.11	7.82	4.67
9	0.59	0.30	0.42	0.82	2.84	1.54
10	0.37	0.35	0.27	0.35	0.94	0.44
11	0.46	0.13	0.34	0.26	0.48	0.31
12	0.27	0.12	0.20	0.10	0.28	0.21
13	0.13	0.12	0.07	0.05	0.19	0.13
14	0.06	0.03	0.07	0.02	0.18	0.09
15	0.02	0.01	0.00	0.01	0.11	0.03
16	0.04	0.01	0.01	0.00	0.03	0.00
17	0.02	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.01	0.00
UK	0.03	0.00	0.01	0.14	0.01	0.00
Total	54.48	39.79	39.60	38.60	47.75	44.03
Z						
$6+/_{5+}$	0.67	0.01	0.71	+0.18	0.42	

Table 6. List of length frequency and age-length key samples available for the Subarea 2 and Div. 3KL Greenland halibut stock for 1983.

Month	Country	Gear	NAFO Div.	No. measured	No. aged	Catch (MT)
August	CAN(N)	OT	2H	534		1981
Sept.	CAN(N)	OT	2H	835		2462
July	CAN(N)	LT	2J	182		137
August	CAN(N)	OT	2J	986		1720
October	CAN(N)	GN	2J	1335		1315
July	CAN(N)	GN	3K	3781		2063
August	CAN(N)	GN	3K	697		1398
Sept.	CAN(N)	GN	3K	2715		2693
May	CAN(N)	OT	3K	873		1388
June	CAN(N)	OT	3K	1343		1765
July	CAN(N)	OT	3K	424		5006
July	CAN(N)	GN	3L	2234		2513
August	CAN(N)	GN	3L	1011		959
Sept.	CAN(N)	GN	3L	2156		840
Q2	CAN(N)	OT	3K		554	
Q3	CAN(N)	OT	2H		584	
Q3	CAN(N)	OT	2J		555	
Q3	CAN(N)	OT	3K		141	
Q3	CAN(N)	GN	2J		170	
Q3	CAN(N)	GN	3K		470	
Q3	CAN(N)	GN	3L		486	
Q4	CAN(N)	GN	2J		403	
Q4	CAN(N)	GN	3K		481	
Q4	CAN(N)	GN	3L		433	

Table 7. Catch at age and weights at age matrices.

CATCH AT AGE (x10^3)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	322	19	464	3016	2162	204	810	236	672
6	2719	680	4351	8511	7980	2032	4242	2020	3411
7	5547	3600	9374	9072	11726	8913	9209	5552	9398
8	4731	6030	6377	7662	5611	9429	10753	5064	7206
9	3821	4199	2546	2898	1669	5258	4045	3112	2201
10	1628	2457	679	1454	440	3729	836	1480	663
11	677	923	191	731	262	967	240	524	201
12	130	290	113	371	136	125	133	225	73
13	269	113	101	225	131	52	40	143	102
14	131	36	26	110	84	14	27	70	62
15	63	21	18	98	76	9	20	55	65
16	41	1	22	54	56	2	13	29	9
17	43	1	7	39	44	1	5	14	12
5+	20172	18370	24469	34201	29797	30755	30373	18524	24095

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TITLE'PERCENT CATCH AT AGE'
3 OUT SHOW
```

PERCENT CATCH AT AGE

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.016	0.001	0.019	0.088	0.073	0.007	0.027	0.013	0.028
6	0.135	0.037	0.178	0.249	0.268	0.066	0.140	0.109	0.142
7	0.275	0.196	0.383	0.265	0.394	0.290	0.303	0.300	0.390
8	0.237	0.328	0.261	0.224	0.188	0.307	0.354	0.273	0.299
9	0.189	0.229	0.104	0.085	0.056	0.171	0.133	0.168	0.091
10	0.081	0.134	0.028	0.043	0.015	0.121	0.028	0.080	0.028
11	0.034	0.050	0.008	0.021	0.009	0.032	0.008	0.028	0.008
12	0.006	0.016	0.005	0.011	0.005	0.004	0.004	0.012	0.003
13	0.013	0.006	0.004	0.007	0.004	0.002	0.001	0.008	0.004
14	0.006	0.002	0.001	0.003	0.003	0.000	0.001	0.004	0.003
15	0.003	0.001	0.001	0.002	0.003	0.000	0.001	0.003	0.003
16	0.002	0.000	0.001	0.002	0.002	0.000	0.000	0.002	0.000
17	0.002	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.000

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TITLE'WEIGHTS AT AGE (KG)'
3 OUT SHOWAT
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WEIGHTS AT AGE (KG)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.609	0.609	0.609	0.609	0.609	0.514	0.392	0.547	0.431
6	0.760	0.760	0.760	0.760	0.760	0.659	0.598	0.711	0.654
7	0.955	0.955	0.955	0.955	0.955	0.869	0.789	0.923	0.892
8	1.192	1.192	1.192	1.192	1.192	1.049	0.985	1.168	1.215
9	1.580	1.580	1.580	1.580	1.580	1.145	1.235	1.444	1.697
10	2.209	2.209	2.209	2.209	2.209	1.256	1.700	1.839	2.292
11	2.699	2.699	2.699	2.699	2.699	1.573	2.460	2.445	3.081
12	3.371	3.371	3.371	3.371	3.371	2.708	3.507	3.554	4.055
13	3.884	3.884	3.884	3.884	3.884	3.115	4.794	4.605	5.169
14	4.563	4.563	4.563	4.563	4.563	4.418	5.944	5.966	6.180
15	5.918	5.918	5.918	5.918	5.918	5.037	8.055	7.669	7.454
16	7.144	7.144	7.144	7.144	7.144	7.022	8.710	8.841	8.755
17	7.887	7.887	7.887	7.887	7.887	10.147	9.576	11.719	11.507

Table 8. Calculation of PR for 1983 fishery.

Age	1983 Survey index 2J+3K	1983 Comm. catch	Total	% At age research + comm.	Comm.	Rel. P.R.		Estimated PR	
5	37,246	672	37,918	21.00	2.79	0.13		0.09	
6	32,030	3,411	35,441	20.00	14.16	0.71		0.47	
7	35,591	9,398	44,989	25.39	39.00	1.54	$\bar{x}$	1.00	
8	28,790	7,206	35,996	20.32	29.91	1.47	1.505	1.00	
9	10,727	2,201	12,928	7.30	9.13	1.25		0.83	
10	3,005	663	3,668	2.07	2.75	1.33		0.88	
11	2,020	201	2,221	1.25	0.83	0.66		0.44	
12	1,463	73	1,536	0.87	0.30	0.34		0.23	$\bar{x}$ =
13	1,059	102	1,152	0.66	0.42	0.64		0.43	0.39
14	709	82	791	0.45	0.34	0.76		0.51	
15	305	65	370	0.21	0.27	1.29		0.86	
16	81	9	90	0.05	0.04	0.80		0.53	
17	44	12	56	0.03	0.05	1.67			
T =	153,070	24,095	177,165						

Table 9. Fully recruited F = 0.05.

POPULATION NUMBERS

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	76735	66425	98543	104268	163395	311901	320535	198095	165123
6	52568	62534	54367	80260	82638	131802	255178	261699	161973
7	41264	40595	50583	40575	58010	60438	106072	205084	212433
8	17256	28765	29979	32932	25012	36885	41418	78512	162685
9	12564	9802	18095	18775	20029	15401	21667	24180	59698
10	6525	6829	4225	12511	12749	15431	7851	14079	16981
11	2743	3870	3368	2664	8928	10040	9260	5672	10188
12	1613	1633	2333	2585	1520	7072	7327	7364	4167
13	1421	712	1075	1808	1780	1121	5677	5878	5826
14	761	920	480	789	1277	1339	871	4612	4684
15	322	505	720	370	546	969	1084	689	3713
16	79	206	394	573	250	378	785	869	514
17	209	28	166	303	421	154	308	631	685
5+	213479	222823	264331	298412	376555	592932	778033	807364	808871
6+	136744	156398	165786	194144	213160	281031	457498	609269	643749
7+	84156	93864	111421	113884	130522	149229	202320	347570	481776
8+	42892	53269	60838	73309	72511	88791	96248	142486	269343
9+	25636	24503	30859	40377	47500	51906	54830	63975	106658
10+	13073	14702	12764	21602	27470	36506	33163	39795	46760

POPULATION BIOMASS (MID-YEAR)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	42260	36659	54255	56658	89543	145252	113728	98147	64363
6	35213	42824	35823	52086	53930	78073	137073	167945	94927
7	33081	33443	39277	30721	44554	43737	72274	169070	167660
8	15709	27439	28538	30930	23625	30006	31549	80213	175106
9	14863	10471	23908	24598	27856	12830	21738	29413	90002
10	11227	10816	7477	23457	25052	15178	11394	22121	34536
11	5777	8196	7986	5503	21495	13547	20359	11937	28149
12	2877	4499	6942	7273	4417	17194	23063	23332	15180
13	4474	2285	3590	5930	6018	3086	24574	24215	27038
14	2848	3723	1928	3011	5091	5332	4614	24735	25968
15	1538	2646	3812	1812	2705	4402	7834	4579	24847
16	351	1333	2475	3523	1417	2401	6144	6840	4041
17	1320	195	1175	2012	2836	1413	2649	6625	7081
5+	171538	184530	217188	247513	308538	372451	476994	669173	758918
6+	129279	147871	162933	190855	218995	227199	363266	571026	694556
7+	94065	105047	127110	138769	165065	149127	226192	403080	599628
8+	60984	71604	87832	108049	120512	105390	153918	234010	431968
9+	45275	44165	59294	77118	96887	75384	122369	153796	256862
10+	30412	33694	35386	52521	69031	62554	100632	124383	166860

FISHING MORTALITY

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.005	0.000	0.005	0.032	0.015	0.001	0.003	0.001	0.005
6	0.059	0.012	0.093	0.125	0.113	0.017	0.019	0.009	0.024
7	0.161	0.103	0.229	0.284	0.253	0.178	0.101	0.030	0.050
8	0.366	0.264	0.268	0.297	0.285	0.332	0.338	0.074	0.050
9	0.410	0.641	0.169	0.187	0.061	0.474	0.231	0.153	0.041
10	0.323	0.507	0.261	0.137	0.039	0.311	0.125	0.123	0.044
11	0.319	0.306	0.065	0.361	0.033	0.115	0.029	0.108	0.022
12	0.153	0.218	0.055	0.173	0.104	0.020	0.020	0.034	0.020
13	0.235	0.193	0.110	0.148	0.085	0.053	0.008	0.027	0.020
14	0.211	0.044	0.062	0.167	0.076	0.012	0.035	0.017	0.020
15	0.244	0.047	0.028	0.190	0.167	0.010	0.021	0.092	0.020
16	0.847	0.005	0.064	0.110	0.284	0.006	0.018	0.038	0.020
17	0.257	0.040	0.047	0.153	0.122	0.007	0.018	0.025	0.020

WEIGHTED FISHING MORTALITIES AGES 5 TO 17

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
	0.119	0.108	0.113	0.140	0.096	0.066	0.047	0.026	0.034

Table 10. Fully recruited F = 0.10.

POPULATION NUMBERS

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	62443	58051	81810	81679	98296	167086	165904	100301	82741
6	41099	50832	47511	66560	64144	78504	136614	135098	81906
7	32157	31188	41003	34962	46794	45296	62435	108011	108781
8	15994	21309	22277	25088	20416	27701	29020	42785	83409
9	10882	8769	11990	12469	13608	11638	14148	14030	30447
10	5106	5452	3380	7513	7587	10174	4771	7924	8671
11	2084	2709	2241	1972	4635	5813	4955	3149	5148
12	720	1093	1383	1662	953	3722	3866	3840	2104
13	939	472	633	1030	1025	657	2934	3045	2940
14	510	525	284	427	640	721	491	2366	2364
15	214	299	397	209	250	448	577	378	1874
16	65	118	226	309	119	136	356	455	259
17	143	16	96	165	204	47	109	282	346
5+	172358	180836	213231	234045	258870	351942	426184	421663	410990
6+	109916	122784	131421	152366	160574	184856	260280	321362	328249
7+	68817	71952	83910	85806	96430	106352	123666	186265	246343
8+	36660	40764	42908	50844	49636	61056	61231	78253	137563
9+	20666	19455	20630	25756	29220	33355	32211	35468	54154
10+	9783	10686	8640	13287	15613	21717	18063	21438	23707

POPULATION BIOMASS (MID-YEAR)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	34371	32037	45019	44168	53610	77788	58790	49664	32181
6	27296	34764	31696	42634	41173	46237	72808	86361	47464
7	25178	25292	30939	25823	34779	31767	41022	87852	83830
8	14330	19317	20147	22370	18616	21160	20316	42360	87553
9	12414	8932	15133	15526	18656	8817	13260	16081	45001
10	8356	7978	5773	13422	14713	9112	6637	11837	17268
11	4145	5323	5228	3782	11482	7509	10760	6337	14075
12	1981	2839	4038	4442	2684	8970	12062	11978	7590
13	2765	1438	2031	3183	3355	1776	12655	12388	13519
14	1803	2091	1117	1508	2455	2655	2567	12590	12994
15	956	1542	2079	946	1107	2022	4136	2415	12423
16	251	762	1384	1807	551	857	2775	3517	2020
17	849	112	659	1023	1285	424	926	2912	3541
5+	134693	142427	164643	180654	204466	219296	258715	346291	379459
6+	100322	110391	119624	136486	150856	141507	199925	296627	347278
7+	73026	75627	88527	93852	109684	95270	127116	210266	299814
8+	47850	50335	57588	68009	74905	63503	86094	122414	215984
9+	33520	31019	37442	45639	56289	42343	65779	80054	128431
10+	21106	22087	22309	30114	37633	33525	52519	63973	83430

FISHING MORTALITY

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.006	0.000	0.006	0.042	0.025	0.001	0.005	0.003	0.009
6	0.076	0.015	0.107	0.152	0.148	0.029	0.035	0.017	0.047
7	0.212	0.136	0.291	0.338	0.324	0.245	0.178	0.058	0.100
8	0.401	0.375	0.380	0.412	0.362	0.472	0.527	0.140	0.100
9	0.491	0.753	0.267	0.297	0.091	0.692	0.380	0.281	0.083
10	0.434	0.689	0.339	0.241	0.066	0.519	0.215	0.231	0.088
11	0.445	0.472	0.099	0.527	0.062	0.208	0.055	0.203	0.044
12	0.222	0.347	0.095	0.283	0.172	0.038	0.039	0.067	0.039
13	0.381	0.307	0.194	0.276	0.152	0.091	0.015	0.053	0.039
14	0.334	0.079	0.107	0.335	0.157	0.022	0.063	0.033	0.039
15	0.393	0.081	0.051	0.366	0.410	0.022	0.039	0.175	0.039
16	1.191	0.009	0.114	0.215	0.736	0.016	0.041	0.073	0.039
17	0.399	0.070	0.084	0.301	0.270	0.024	0.052	0.056	0.039

WEIGHTED FISHING MORTALITIES AGES 5 TO 17

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
	0.151	0.140	0.145	0.185	0.144	0.118	0.092	0.052	0.067

Table 11. Fully recruited F = 0.15.

POPULATION NUMBERS

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	57679	55260	76233	74153	76608	118850	114399	67708	55280
6	37269	46933	45226	61994	57982	60747	97122	92929	55221
7	29121	28653	37810	33091	43056	40251	47897	75678	74256
8	15574	18823	19711	22474	18884	24641	24890	30882	56936
9	10322	8425	9955	10367	11467	10384	11643	10649	20702
10	4973	4994	3098	5847	5866	8421	3744	5872	5903
11	2201	2599	1865	1741	3471	4405	3521	2309	3468
12	798	1190	1292	1354	764	2605	2713	2665	1416
13	951	536	712	956	773	503	2020	2101	1979
14	546	535	336	491	579	514	365	1617	1591
15	228	329	406	252	303	398	409	274	1261
16	66	129	250	316	154	179	318	316	175
17	152	17	105	185	210	75	145	248	233
5+	159882	167822	196999	213222	220117	271974	309183	293249	278421
6+	102203	112562	120766	139069	143509	153123	194784	225541	223140
7+	64934	65630	75540	77075	85527	92376	97662	132612	167919
8+	35812	37576	37730	43984	42471	52125	49766	56934	93663
9+	20238	18753	18020	21510	23587	27484	24875	26052	36727
10+	9916	10328	8065	11142	12120	17100	13233	15403	16025

POPULATION BIOMASS (MID-YEAR)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	31742	30496	41941	40034	41638	55317	40491	33505	21454
6	24657	32077	29521	39483	36920	35631	51401	59186	31642
7	22537	22573	28154	24187	31511	27771	30589	60792	55887
8	13870	16595	17334	19499	16941	18187	16522	29730	58369
9	11594	8413	12197	12489	15589	7453	10412	11615	30001
10	8081	7017	5202	10065	11267	7058	5047	8395	11512
11	4437	5047	4308	3203	8144	5491	7560	4465	9383
12	2219	3136	3761	3495	2105	6228	8396	8192	5060
13	2809	1664	2309	2920	2466	1339	8683	8445	9013
14	1955	2133	1333	1776	2204	2030	1885	8542	8663
15	1028	1702	2123	1177	1393	1795	2904	1692	8282
16	259	833	1542	1851	785	1132	2453	2409	1347
17	917	118	723	1167	1324	687	1233	2558	2360
5+	126105	131806	150449	161344	172288	170119	187574	239527	252973
6+	94363	101310	108508	121311	130650	114802	147084	206021	231519
7+	69706	69233	78988	81828	93730	79172	95683	146835	199876
8+	47169	46659	50834	57641	62218	51400	65094	86043	143989
9+	33299	30065	33500	38142	45277	33214	48572	56313	85621
10+	21705	21651	21303	25654	29688	25761	38160	44699	55620

FISHING MORTALITY

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.006	0.000	0.007	0.046	0.032	0.002	0.008	0.004	0.013
6	0.084	0.016	0.112	0.165	0.165	0.038	0.049	0.024	0.071
7	0.236	0.153	0.320	0.361	0.358	0.281	0.239	0.085	0.150
8	0.414	0.437	0.442	0.473	0.398	0.550	0.649	0.200	0.150
9	0.526	0.800	0.332	0.370	0.109	0.820	0.484	0.390	0.124
10	0.449	0.785	0.376	0.321	0.087	0.672	0.283	0.326	0.132
11	0.415	0.498	0.120	0.623	0.087	0.285	0.078	0.289	0.066
12	0.198	0.314	0.102	0.361	0.219	0.054	0.056	0.098	0.058
13	0.375	0.265	0.171	0.301	0.207	0.121	0.022	0.078	0.058
14	0.308	0.077	0.089	0.264	0.175	0.031	0.085	0.049	0.058
15	0.365	0.073	0.050	0.294	0.325	0.025	0.056	0.251	0.058
16	1.155	0.009	0.102	0.209	0.515	0.012	0.046	0.107	0.058
17	0.370	0.067	0.076	0.264	0.262	0.015	0.039	0.064	0.058

WEIGHTED FISHING MORTALITIES AGES 5 TO 17

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
	0.165	0.154	0.160	0.207	0.171	0.158	0.131	0.077	0.102

Table 12. Fully recruited F = 0.20.

POPULATION NUMBERS

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	55298	53865	73445	70394	65772	94759	88675	51416	41550
6	35355	44983	44083	59712	54904	51876	77398	71868	41882
7	27604	28486	36214	32155	41187	37731	40633	59530	57013
8	15364	17581	18427	21167	18118	23111	22827	24935	43715
9	10042	8253	8938	9317	10397	9757	10390	8959	15833
10	4604	4764	2958	5014	5006	7545	3230	4846	4520
11	1958	2296	1677	1626	2790	3700	2604	1888	2629
12	680	991	1045	1201	670	2047	2136	2078	1072
13	802	439	549	753	647	425	1563	1629	1498
14	457	413	257	358	413	411	301	1243	1204
15	190	255	306	187	193	262	324	222	955
16	61	98	190	234	101	90	207	247	132
17	128	13	80	136	143	32	72	157	176
5+	152544	160438	188169	202254	200342	231747	250560	229021	212179
6+	97245	106574	114724	131860	134569	136987	161885	177604	170629
7+	61891	61591	70640	72148	79665	85112	84487	105736	128746
8+	34287	35105	34427	39993	38478	47380	43853	46207	71734
9+	18923	17524	16000	18826	20360	24270	21026	21271	28018
10+	8881	9271	7062	9509	9963	14513	10637	12312	12185

POPULATION BIOMASS (MID-YEAR)

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	30428	29726	40402	37958	35657	44094	31351	25428	16091
6	23337	30734	28733	37907	34795	30331	40708	45614	23732
7	21217	21214	26759	23368	29876	25772	25365	47272	41915
8	13640	15229	15923	18056	16103	16691	14605	23408	43776
9	11183	8153	10725	10964	14055	6761	8976	9369	22501
10	7328	6532	4917	8380	9543	6016	4250	6667	8634
11	3832	4289	3848	2910	6475	4479	5960	3525	7037
12	1857	2521	3004	3019	1815	4858	6562	6298	3795
13	2278	1322	1734	2199	2021	1121	6697	6474	6759
14	1581	1629	1006	1219	1515	1617	1544	6518	6497
15	823	1309	1589	826	798	1175	2287	1329	6212
16	224	634	1154	1320	428	563	1575	1654	1010
17	742	90	542	813	843	288	597	1590	1770
5+	118471	123383	140336	148943	153922	143765	150479	185347	189730
6+	88044	93657	99933	110985	118265	99671	119127	159919	173639
7+	64706	62923	71201	73078	83471	69340	78420	114306	149907
8+	43489	41709	44441	49710	53595	43568	53055	67033	107992
9+	29850	26480	28518	31652	37493	26876	38449	43626	64216
10+	18666	18327	17793	20687	23438	20116	29472	34256	41715

FISHING MORTALITY

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
5	0.006	0.000	0.007	0.049	0.037	0.002	0.010	0.005	0.018
6	0.089	0.017	0.116	0.171	0.175	0.044	0.062	0.032	0.094
7	0.251	0.163	0.337	0.374	0.378	0.303	0.288	0.109	0.200
8	0.421	0.477	0.462	0.511	0.419	0.599	0.735	0.254	0.200
9	0.546	0.826	0.378	0.421	0.121	0.905	0.563	0.484	0.166
10	0.496	0.344	0.398	0.386	0.102	0.790	0.337	0.412	0.176
11	0.481	0.587	0.134	0.687	0.110	0.349	0.099	0.366	0.088
12	0.237	0.391	0.127	0.418	0.254	0.070	0.071	0.127	0.078
13	0.463	0.334	0.227	0.401	0.253	0.145	0.029	0.102	0.078
14	0.381	0.101	0.118	0.415	0.255	0.038	0.104	0.064	0.078
15	0.457	0.095	0.067	0.419	0.570	0.039	0.071	0.320	0.078
16	1.338	0.011	0.137	0.294	0.952	0.025	0.072	0.139	0.078
17	0.457	0.087	0.102	0.378	0.412	0.035	0.080	0.103	0.078

WEIGHTED FISHING MORTALITIES AGES 5 TO 17

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983
	0.174	0.164	0.169	0.221	0.190	0.190	0.167	0.100	0.136

Table 13. Results of yield per recruit analysis.

AGE	WEIGHT-AT-AGE	PARTIAL RECRUITMENT
5	0.548	0.039
6	0.714	0.234
7	0.916	0.644
8	1.153	0.987
9	1.491	1.000
10	2.015	0.888
11	2.562	0.619
12	3.409	0.394
13	4.123	0.432
14	5.036	0.342
15	6.423	0.465
16	7.672	0.555
17	9.154	0.362

NATURAL MORTALITY RATE : 0.2

F0.1 COMPUTED AS 0.2893 AT Y/R OF 0.5417

FMAX COMPUTED AS 0.5645 AT Y/R OF 0.5837

YIELD PER RECRUIT ANALYSIS

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.186	0.327	1.762	1.749
	0.2000	0.305	0.479	1.569	1.280
F0.1---	0.2893	0.378	0.542	1.432	1.000
	0.3000	0.385	0.546	1.418	0.973
	0.4000	0.442	0.574	1.300	0.766
	0.5000	0.482	0.583	1.208	0.622
FMAX---	0.5645	0.503	0.584	1.160	0.552
	0.6000	0.513	0.584	1.137	0.519
	0.7000	0.538	0.581	1.081	0.443
	0.8000	0.557	0.578	1.037	0.386
	0.9000	0.574	0.574	1.001	0.341
	1.0000	0.587	0.571	0.972	0.305
	1.1000	0.600	0.569	0.948	0.276
	1.2000	0.610	0.566	0.928	0.252
	1.3000	0.620	0.564	0.911	0.232
	1.4000	0.628	0.562	0.896	0.215
	1.5000	0.636	0.561	0.882	0.200

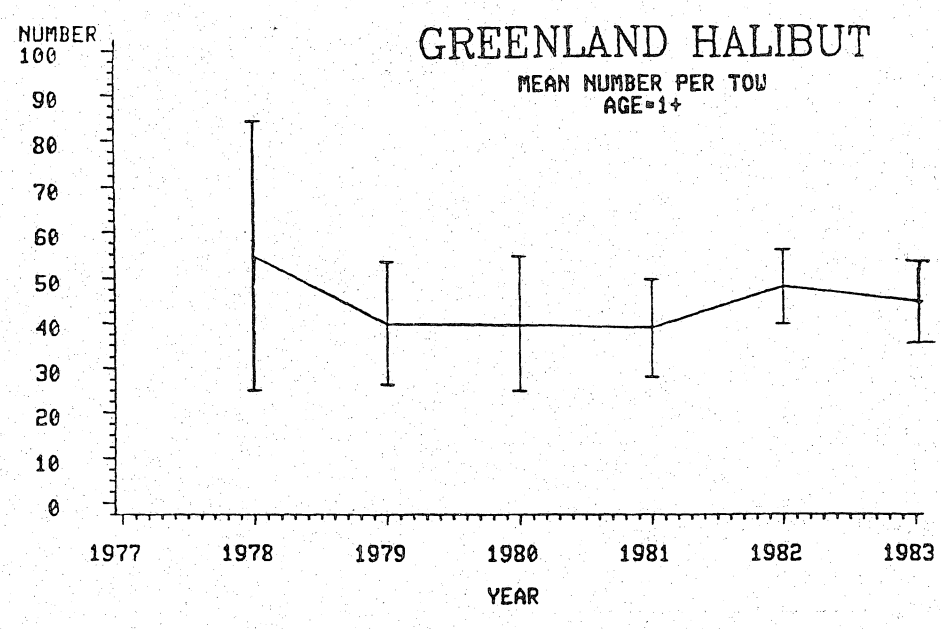

Fig. 1. Abundance indices (with 95% confidence limits) of Greenland halibut (age 1+) from research vessel surveys in Div. 2J and 3K, 1978-83. (Only strata fished in all years were used in the calculations.)

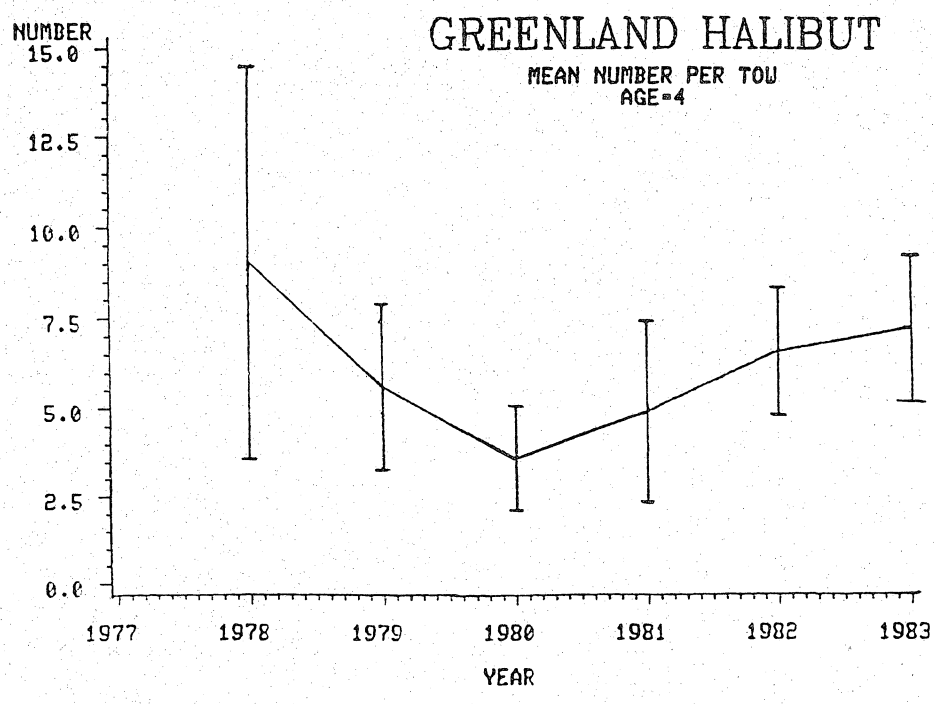

Fig. 2. Abundance indices (with 95% confidence limits) of Greenland halibut (age 4) from research vessel surveys in Div. 2J and 3K, 1978-83. (Only strata fished in all years were used in the calculations.)

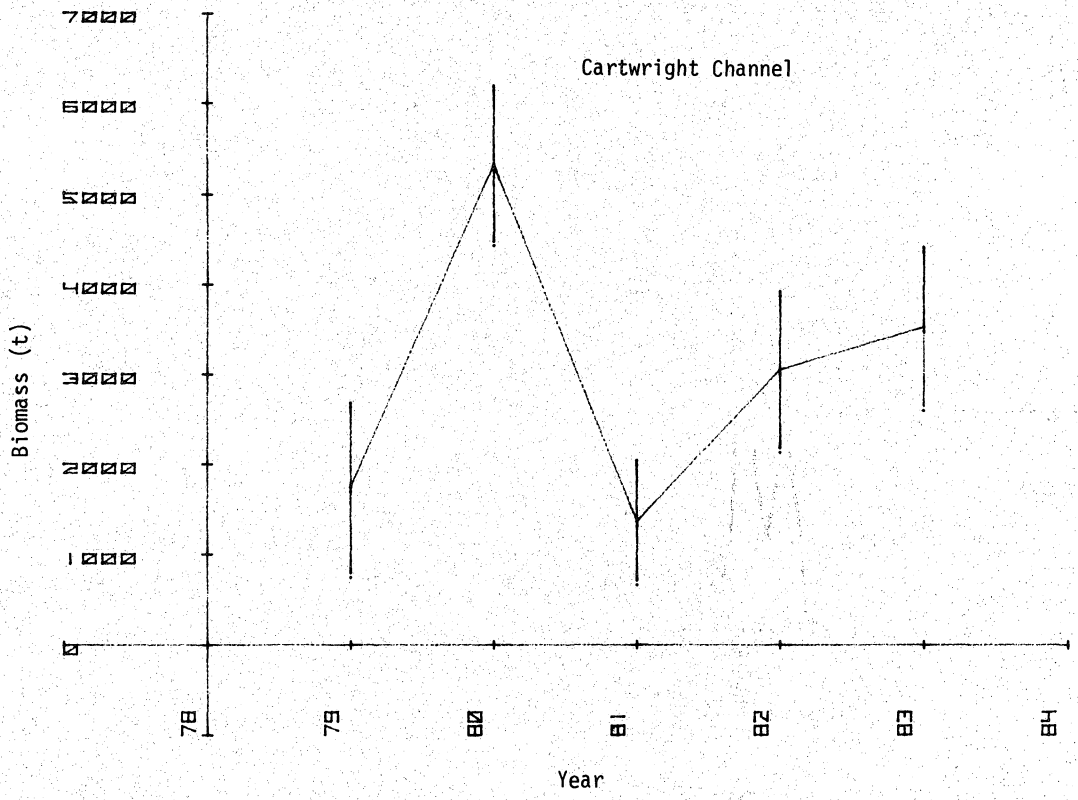

Fig. 3. Biomass estimates (with 95% confidence limits) of Greenland halibut from shrimp surveys in Cartwright Channel (Div. 2J), 1979-83.

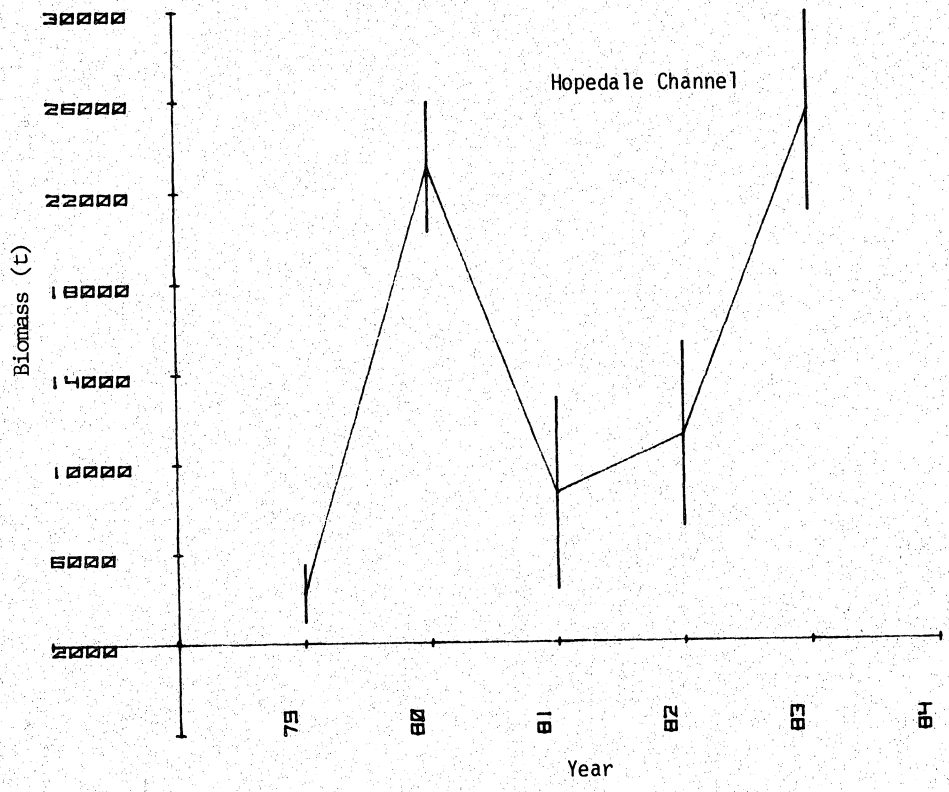

Fig. 4. Biomass estimates (with 95% confidence limits) of Greenland halibut from shrimp surveys in Hopedale Channel (Div. 2H), 1979-83.

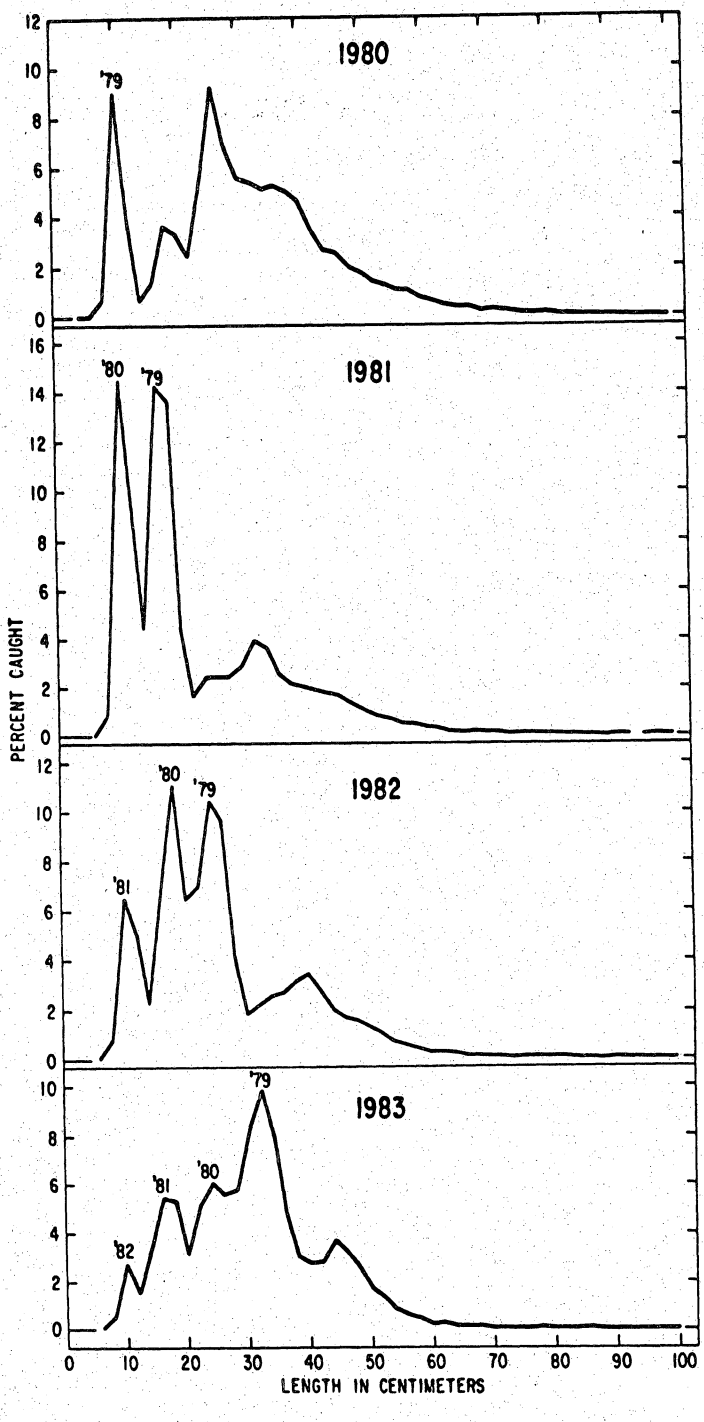

Fig. 5. Length frequency distributions of Greenland halibut from shrimp surveys in Cartwright (2J) and Hopedale (2H) Channels, 1980-83.