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Assessment of the Greenland Halibut Stock Component in NAFO Subarea 0 + Divisions 1B-1F

by

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1. TAC, description of the fishery and nominal catches.

Between 1979 and 1994 TAC has been at 25,000 tons for SA 0+1, including Div. 1A. In 1994 it was decided to make separate assessments for Div. 1A and Sub 0+Div.1B-1F. TAC for Sub. 0+Div.1B-1F was set to 11,000 tons for 1995.

In the period 1982-1989 nominal catches of Greenland halibut in Sub. 0+Div.1B-1F fluctuated between 300 and 4,500 tons. From 1989-1990 catches increased from 2,200 tons to 15,500. In 1991 catches dropped to 11,000 tons and then increased to 17,800 tons in 1992, the highest in the time series. Since then catches have gradually decreased through 12,900 tons in 1993 to 10,598 tons in 1994. The increase in catches from 1989 to 1990 was mainly due to a new trawl fishery by Canada and Norway in Div. 0B. The increase from 1991 to 1992 was due to the introduction of a fishery by Russia in Div. 0B.

In 1983 annual catches in Division 0B was at about 4,500 tons. Catches then dropped to a level of 1,000 tons or lower where they remained until they increased from 907 tons in 1989 to 14,513 tons in 1990. Catches decreased in 1991 to 8,606 tons, to increase again in 1992 to 12,358 tons. Catches then decreased through 7,441 in 1993 to 4,722 tons in 1994 (Table 1). 4,322 tons were taken offshore by trawlers chartered by Canada (Russian and Japanese) and 400 tons were taken by long-lines inshore in Cumberland Sound. The trawl fisheries took place in July-October and the inshore long-line fishery in February-May, respectively.

The catches in Subarea 1 (Div. 1B-1F) were below 1,500 tons during the period 1982-1990. In 1991 catches increased to 2,376 tons and further through 5,500 tons in 1992 and 1993 to 5,876 tons in 1994. In 1994 5,673 tons were caught offshore in Div. 1CD, mainly by Norway and Japan, 663 tons were taken offshore by a Greenlandic longliner and 203 tons were taken inshore (Table 2).

2. Input data

2.1 Research trawl surveys

Since 1987 bottom-trawl surveys have been conducted in Subarea 1 jointly by Japan and Greenland. In 1994 a survey was conducted, in August (SCR Doc. 95/23). The survey covered Div. 1B to 1D at depths between 400 and 1500 m. The trawlable biomass was estimated to be 31.300 tons compared to 37.700 tons in 1993. As in 1993 estimate the estimate from 1994 is significantly lower than the estimates from 1992 (62,000 tons) and 1991 (77,00 tons) (Table 3). The decrease between 1993 and 1994 was mainly due to a decline in the estimated biomasses in Div. 1B and depth stratum 1000-1500 m in Div. 1D, while the estimate for 1C increased. Abundance estimates for Div. 1CD for the period 1988-1994 are given in Table 4. Total abundance fluctuated between 35 mill. and

53 mill. from 1988 to 1991, and declined gradually from 53 mill. to 25 mill. in 1994. From 1993 to 1994 the decline is seen for all age groups, except age 4 and 5.

From July to August 1994 a trawl survey with a shrimp trawler was conducted off West Greenland between 59°N and 72°30'N, from the 3-mile limit to the 600 m depth contour line. (SCR Doc. 95/19). Estimated trawlable biomass in the offshore areas increased from 2,943 tons in 1991 to about 9,000 tons in 1992 and 1993 and further to 12.222 tons in 1994, of which 17% was located in Div. 1A. The catches were almost exclusively comprised of one and two year old fish. The abundance was estimated to 253 mill, which is at the same level as in 1992 and 1993 and somewhat higher than the 70-80 mill. recorded in 1990 and 1991.

In the summer of 1994, an exploratory trawl was fished in the outer part of Cumberland Sound outside the winter fishing ground. The trawlable biomass ranged from 0 kg km^{-2} at < 275 m to 2,678 kg km-2 at 900 m depth. Exploratory longline and gill net sets during the summer in the traditional winter fishing area yielded low catches (SCR Doc 95/50).

2.3 Commercial fishery data.

From the offshore fishery in Div. 1CD length frequency samples were obtained from the Japanese trawler 'Shinkai Maru' and from the Greenlandic longliner 'Bjalto'. Furthermore, length frequency samples from the inshore fishery in Div. 0B and 1D were available.

Catch weight-at-age was calculated from data sampled in 1994 from the Greenland/Japan survey, the Greenlandic trawl survey and from the commercial offshore long-line fishery. Table 5 and 6 shows catch-at-age and weight-at-age, respectively. The relative age distributions for trawl and offshore longlines are given in Fig.1. The shift towards younger age groups seen in 1993 has become more evident in 1994 (Table 5). In the latest years, however, three different age readers have been involved in otolith reading, and there seems to be some discrepancy in there results. Catch-at-age data were also available from 0B inshore.

Maturity data were available only from the inshore areas in Div. 0B, where 97% of the fish sampled were females. All fish were either immature or not in spawning condition.

Standardized catch rate series were calculated by means of division, tonnage, month and year based on available logbog data from the offshore otter trawl fishery in Subarea 1 (1CD) in 1988-1994. The catch rate series was fairly constant during the period 1988-1992, but have shown a decrease of about 30% since 1992.

Catch rates for the Japanese trawler 'Shinkai Maru' were available for the period 1987-1994. No values were obtained from 1993, as there was no commercial fishery by this vessel in West Greenland waters this year (Table 7). Average catch rates from the Norwegian trawl fishery in Divisions 0B and 1CD and from Russian/Baltic States trawl fishery in Division 0B were available for the period 1991-1994 (Fig. 2, Table 8). Catch rates from 'Shinkai Maru' decreased substantially from 1992 to 1994. Norwegian catches in SA 1 also decreased from 1991-1993, but seems to have stabilized between 1993 and 1994. Norwegian catch rates in SA 0 have increased from 1991 to 1993, while Russian/Baltic catch rates have been stable in the same period. Most of the unstandardized CPUE series are, however, incomplete and it is difficult to make any firm conclusions about the development based on them.

Inshore in Div. 0B CPUE decreased, in terms of number of fish, gradually from 1989 to 1991. In 1992 the CPUE, increased to slightly above the 1987 level, where it has remained since. The age compositions in the catches have remained the same through out the years, with ages 10, 11 and 12 being the most abundant, comprising 65 % of the catches. The mean-weight-at-age has decreased significantly during the last three years.

3. Biological studies.

It is uncertain whether adult Greenland halibut in Cumberland Sound contribute to the spawning population in Davis Strait. The shallow sill (about 300 m) between Cumberland Sound and Davis Strait may act as a barrier between the areas and prevent Greenland halibut from passing freely between the two areas. Water temperatures on top of the sill during the summer are colder than -0.5 degrees celsius, while temperatures near the bottom of the Sound are slightly above 0 degrees. It may be that cold water above 300 m depth acts as a barrier to adult migration. A stock identification program based on genetic and morphological indicators, now in progress, may contribute to the solution of the problem concerning the status of the inshore stock component.

4. Assessment.

4.1 Yield per Recruit Analysis.
The recent level of total mortality was estimated by means of a catch-curve using data from the offshore longline fishery in Div 1D in September. Z was estimated from a regression on age 11-17 and was found to be 0.62. Assuming a natural mortality of 0.15, overall F is 0.47. The input parameters for the Y/R analysis is given in Table 9. $F_{(max)}$ and $F_{(0.1)}$ were estimated to be 0.36 and 0.25, respectively (Fig. 4). STACFIS considered the Yield per Recruit analysis unreliable due to uncertainty in the estimation of weight-at-age and relevant partial recruitment pattern.

4.2 Extended Survivors Analysis (XSA).
Abundance estimates from RV 'Shinkai Maru' for the age groups 9-13, during the period 1988-1994, standardized CPUE data from SA 0 for the age groups 5-15 during the period 1990-1993 (Atkinson et al. 1994) and CPUE data from SA1 for the age groups 5-13 during the period 1988-194 were used to tune the catch-at-age data using a XSA. Natural mortality was set to 0.15, catch-at-age and weight-at-age data used are shown in Table 6 and 7. STACFIS considered the XSA unreliable due to uncertainty in the age determination. Furthermore, the XSA results showed that neither the survey data nor the two CPUE series did match the catch data as shown by high log-catchability residuals, systematic shift in the residuals by year and unrealistic high F values for the older age groups. The output from the analysis is given in Appendix 1.

4.3 Pope's Cohort analysis
A Pope's Cohort analysis was performed using the catch-at-age data in Table 6, mean weight-at-age data for the period 1988-1994 and M=0.15. F_{term} was estimated from the catch curve mentioned earlier and is shown in Appendix 2. Fbar is the average of age 8-11. The recruitment used for the prognosis is the average recruitment in the period 1987-1993. The fishing pattern is considered to be unchanged in 1996. STACFIS considered the analysis unreliable due to ageing problems and problems in estimating reliable F_{term}. The output from the analysis is shown in Appendix 2.

4. Prognosis.

Subarea 0 + Div. 1B-1F.

After 1989 the offshore fishery in subareas 0+1 (Div 1B-F) has expanded considerably. This increased exploitation is expected to cause a change in the stock composition in the area towards younger fish and a lower total biomass. The decline both in the commercial catch rates and in the survey biomass are however marked and suggests a high exploitation level.

5. References

Atkinson, D.B., W.R. Bowering and W. Brodie. 1994. Analysis of Data Collected by Observers During the Greenland Otter Trawl Fisheries in Subarea 0 During 1988-1993. NAFO SCR Doc. 94/47.

Bech, G. 1995. Recruitment of Greenland halibut at West Greenland NAFO SCR Doc. 95/19.

Pike, D.G. and J.A. Mathias. 1995. Status of the Greenland halibut Fishery in Cumberland Sound, Baffin Island. NAFO SCR Doc. 95/50.

Yokawa, K., H. Shimuzu, O. Jorgensen and H. Yamada. 1995. Results of a Stratified Random Bottom Trawl Survey off West Greenland in 1994. NAFO SCR Doc. 94/23.

Table 1. Greenland halibut landings (metric tons) by year and country for Subarea 0 from 1983 to 1994.

	YEAR											
Country	83	84	85	86	87	88	89	90	91	92[a]	93[a]	94[a]
CAN	-	-	-	-	-	2	-	589	256	2194	883	400
E/DEU	-	-	335	-	-	-	-	-	-	-	-	-
EST	-	-	-	-	-	-	-	-	-	-	631	-
FRO	765	370	525	240	388	963	596	2252	2401	463	609	-
JPN	-	-	-	-	-	-	-	113	232	337	252	599
LAV	-	-	-	-	-	-	-	-	-	-	83	-
NOR	-	-	-	-	-	-	282	10031	3959	-	754	-
RUS	3772	109	179	32	-	59	29	1528	1758	9364	4229	3723
Total	4537	479	1039	272	388	1024	907	14513	8606	12358	7441	4722

[a] Provisional data.

Table 2. Greenland halibut landings (metric tons) by year and country for Subarea 1 from 1983 to 1994.

	YEAR											
Country	83	84	85	86	87	88	89	90	91	92[a]	93[a]	94[a]
E/DEU	14	15	-	-	-	-	-	-	-	-	46	217
GRL	4136	6509	9127	8333	8385	7003	7492	8352	10209	12171	13054	866
FRO	-	-	-	-	-	-	-	54	123	151	130	-
JPN	-	26	5	-	907	1581	1300	988	677	2903	1432	819
NOR	-	2	-	-	-	-	-	-	611	2432	2957	3194
RUS	-	-	-	-	-	-	-	-	-	-	5	-
1A	4136	6509	9127	8333	8385	7003	7492	8352	9244	12171	12136	14067
1B-F	14	43	5	0	907	1581	1300	1042	1523	5486	5488	5876[b]
Total	4150	6552	9132	8333	9292	8584	8792	9394	11620	17657	17624	19943[b]

[a] Provisional data. [b] Including 780 tons non-reported catches.

Table 3. Biomass estimates (000' tons) from Greenland/Japanese surveys and USSR(RUS)/DDR(FRG) surveys for the years 1987-1993 in Subareas 0+1.

	USSR(RUS)/DDR(FRG) SURVEY		JAPAN/GREENLAND SURVEY		
	0B	1BCD	1ABCD	1BCD	0B+1ABCD
1987	37	56	58[a]	54[a]	91
1988	55	47	63	53	118
1989	79	-	-	63[c]	142
1990	72	88	56[b]	53[b]	128
1991	46	-	79	77	125
1992	38	-	64	62	102
1993	-	-	-	38	-
1994	-	-	-	31	-

- no survey
[a] In 1987 the survey did not cover the depth stratum 1000-1500 m.
[b] Average values of two surveys.
[c] Estimate only for Division 1CD

Table 4. Shinkai maru abundance 1988-1994

AGE	1988	1989	1990	1991	1992	1993	1994
2	233667	999	39653	81442	177352	246951	97526
3	824877	33120	180794	203924	603235	830089	95556
4	904683	135846	381028	475877	1176244	804394	236180
5	1149580	851510	939230	1450093	1422248	1346292	1673950
6	3528429	5343530	3425214	6430029	5400272	4360004	5992432
7	9682494	14409742	9446792	15945431	13675362	8827242	7808977
8	11513663	15878658	11313019	16536178	14699904	7951066	4534467
9	6011974	8368264	5834808	7490318	6837729	3598001	2889085
10	1964384	3122991	1681039	1985161	1628587	1033467	522848
11	1108287	1876087	858729	1049217	851909	546716	203918
12	528384	951817	343344	491207	379638	237588	160081
13	348397	640065	190215	325502	229556	153837	106146
14	304134	473411	175170	320871	209676	146353	119445
15	212210	350603	135833	222022	164241	109022	105161
16	81195	56094	66475	53230	72466	44209	43591
17	102960	61352	72065	90491	78903	37815	13053
18	62093	17980	49672	62013	52681	25271	21180
19	16208		12655	6388	11442	1818	4187
20	5403		5625	5536	3814	606	
21			2109	5110			
22	7718						
TOTALS	38590740	52572070	35153470	53230040	47675260	30300740	24627781
CHECK	38590740	52572070	35153470	53230040	47675260	30300740	24627781

Table 5 Catch numbers at age (*1000)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE								
5,	2,	1,	1,	121,	22,	50,	322,	371,
6,	31,	29,	36,	895,	322,	672,	761,	1910,
7,	182,	190,	244,	3192,	1775,	2931,	2631,	3241,
8,	296,	354,	408,	2884,	2734,	4253,	2408,	2029,
9,	193,	245,	212,	1602,	1453,	2567,	1059,	1194,
10,	77,	115,	75,	769,	549,	938,	611,	208,
11,	40,	80,	47,	419,	226,	390,	245,	62,
12,	18,	61,	48,	406,	147,	230,	144,	35,
13,	10,	58,	44,	243,	110,	152,	79,	22,
14,	9,	46,	42,	143,	59,	82,	73,	20,
15,	6,	35,	26,	34,	39,	45,	46,	6,
16,	3,	15,	12,	3,	7,	22,	36,	1,
17,	4,	4,	2,	1,	2,	2,	6,	0,
+gp,	2,	1,	0,	0,	0,	0,	3,	0,
TOTALNUM	873,	1234,	1197,	10712,	7445,	12334,	8424,	9099,
TONSLAND	1295,	2605,	2207,	15555,	10982,	17844,	12929,	10598,
SOPCOF %,	101,	100,	100,	100,	100,	100,	100,	100,

Table 6 Catch weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE								
5,	.289	.290	.290	.380	.338	.326	.590	.337
6,	.508	.510	.510	.560	.538	.558	.760	.599
7,	.739	.740	.740	.810	.795	.802	1.000	.942
8,	1.078	1.080	1.080	1.100	1.124	1.132	1.290	1.261
9,	1.410	1.420	1.420	1.520	1.577	1.594	1.840	1.830
10,	1.965	2.050	2.000	2.110	2.275	2.283	2.460	3.119
11,	2.582	2.800	2.680	2.940	3.225	3.027	3.250	4.281
12,	3.522	3.880	3.730	3.910	4.238	4.031	4.060	5.937
13,	4.643	5.010	4.870	4.960	5.504	5.336	5.190	7.035
14,	5.789	6.160	6.200	6.270	6.813	6.764	6.090	8.911
15,	6.605	7.440	7.640	7.880	8.348	7.803	7.350	10.307
16,	7.987	8.880	9.420	7.990	10.077	8.585	8.010	11.910
17,	9.557	9.860	10.580	9.560	9.557	11.951	9.240	13.800
+gp,	11.334	11.334	11.330	11.347	11.334	11.951	10.250	13.800
SOPCOF	1.0093	1.0017	1.0016	.9981	1.0002	1.001	1.001	1.0003

Table 7. CPUE in Div. 1C+D by the Japanese trawler Shinkai Maru in the period 1987-1994.

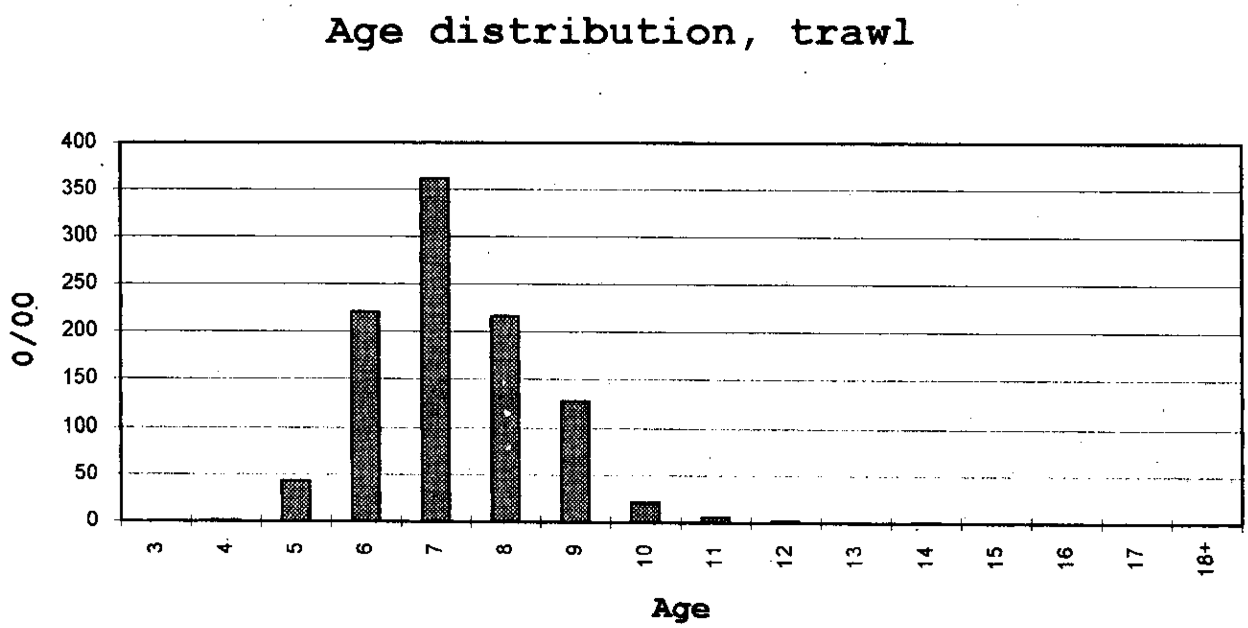
Year	min.	Catch (tons)	CPUE tons/hour
1987	39,285	877	1.34
1988	75,878	1,566	1.24
1989	61,845	1,298	1.30
1990	52,020	963	1.11
1991	42,210	657	0.93
1992	16,000	328	1.23
1993	-	-	-
1994	18,956	242	0.77

Table 8. CPUE in Divs. 0B and 1C+1D by Norwegian factory trawlers 1991-1994 and by Russian/Baltic States trawlers in Div. 0B 1990-1993.

DIVISION		1990	1991	1992	1993	1994
0B Norwegian trawlers	min		236,259		24,191	
	catch (t)		3,032		379	
	CPUE		0.77		0.94	
0B Russian and Baltic trawlers	min	255,660	241,980	964,680	615,600	
	catch (t)	1,332	1,438	5,731	3,361	
	CPUE	0.31	0.36	0.36	0.33	
1C (NOR)	min		12,279	19,702	20,222	
	catch (t)		176	243	182	
	CPUE		0.86	0.74	0.54	
1D (NOR)	min		42,495	207,802	238,500	261,931
	catch (t)		687	2,459	2,226	2,532
	CPUE		0.97	0.71	0.56	0.58

Table 9. Input parameters for Yield per Recruit analysis.

Age	Mean weight	Relative S	Natural Mort.
5	0.337	0.62	0.15
6	0.599	0.89	0.15
7	0.942	1.0	0.15
8	1.261	0.93	0.15
9	1.830	0.86	0.15
10	3.119	0.58	0.15
11	4.281	0.36	0.15
12	5.947	0.18	0.15
13	7.035	0.07	0.15
14	8.911	0.07	0.15
15	10.308	0.07	0.15
16	11.910	0.07	0.15
17	13.800	0.07	0.15
18+	13.800	0.07	0.15



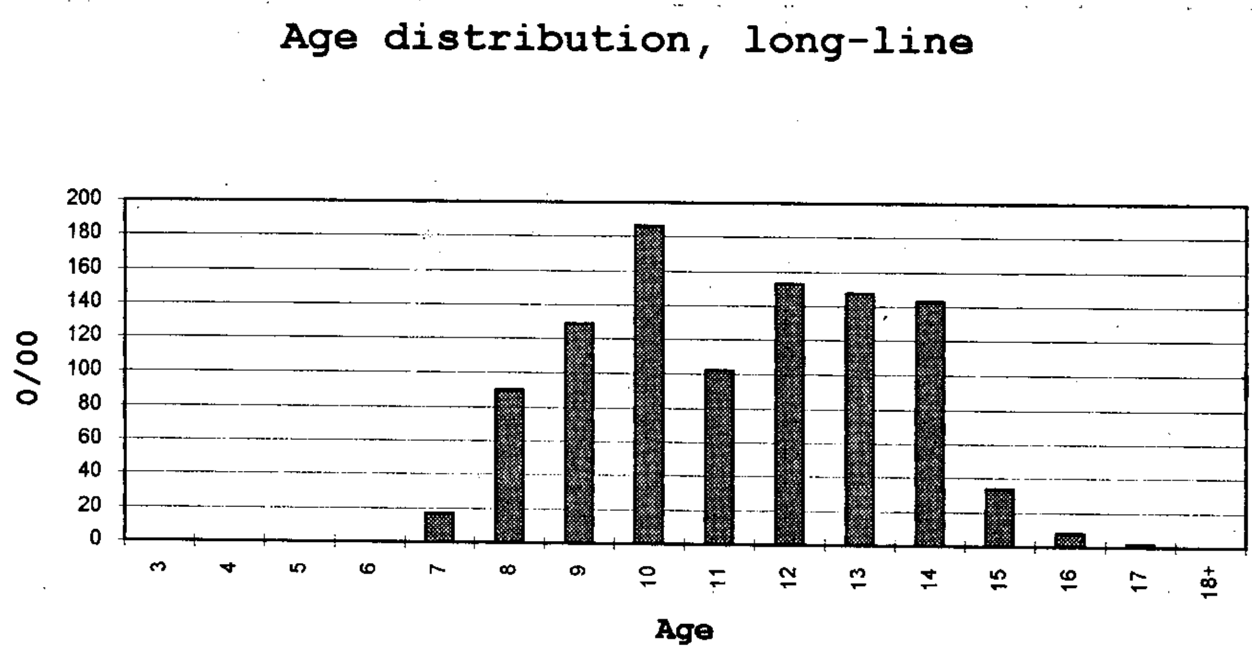


Fig. 1. Age distribution in the off shore trawl and longline fishey in SA 0+1.

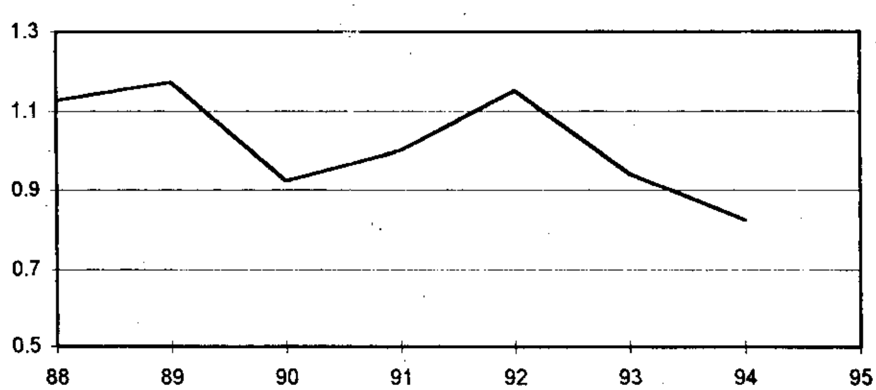


Fig. 2. Standardized CPUE series from Div. 1CD.

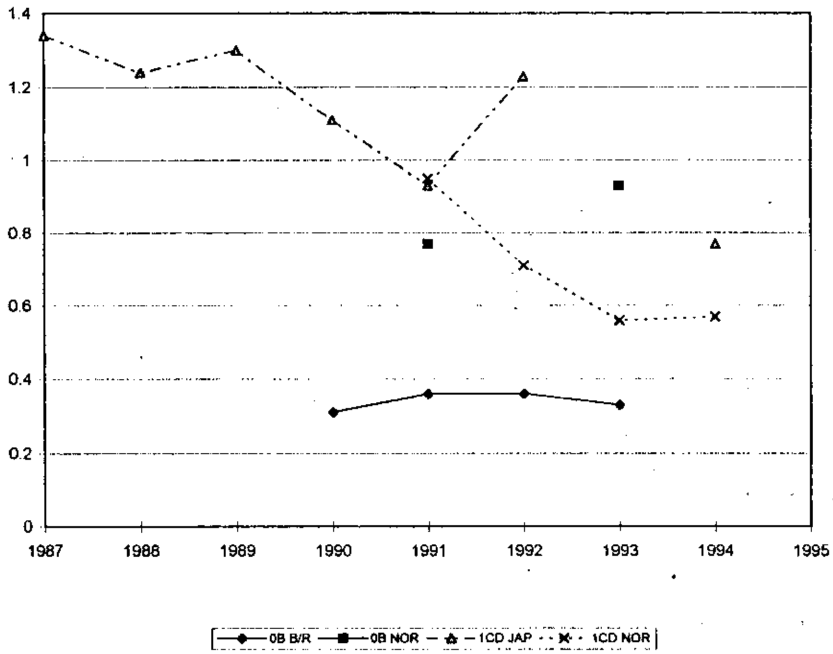


Fig. 3. Unstandardized CPUE Series from SA 0 and SA 1.

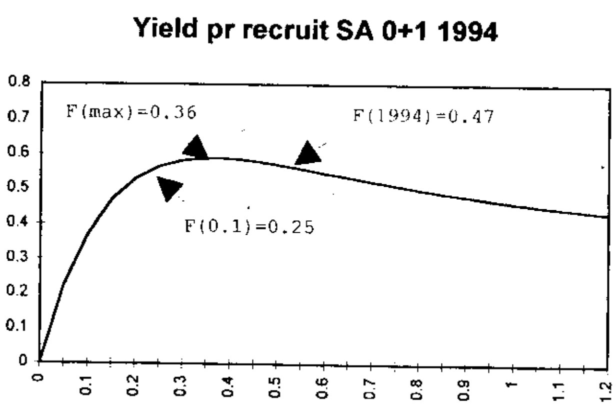


Fig. 4. Yield pr Recruit analysis for SA 0+1 for 1994.

APPENDIX 1.

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

GREENLAND HALIBUT NAFO SUBAREAS 0+1

CPUE data from file c:\vpa\data\tunred.dat

Catch data for 8 years. 1987 to 1994. Ages 5 to 18.

Fleet,	First, year,	Last, year,	First, age,	Last, age	Alpha,	Beta
SHINKAI MARU SURVEY ,	1988,	1994,	9,	13,	.000,	1.000
CPUE SUB.0 ,	1989,	1994,	5,	15,	.000,	1.000
CPUE SUB. 1 ,	1988,	1994,	5,	13,	.000,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 7

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 7

Catchability independent of age for ages >= 15

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .02274

Final year F values

Age ,	5,	6,	7,	8,	9,	10,	11,	12,	13,	14
Iteration 29,	.0177,	.1126,	.3443,	.5708,	1.0543,	.8291,	.6115,	.5369,	.6514,	1.0334
Iteration 30,	.0177,	.1126,	.3443,	.5708,	1.0543,	.8291,	.6115,	.5369,	.6514,	1.0334

Age ,	15,	16,	17
Iteration 29,	1.6203,	5.0606,	.0000
Iteration 30,	1.6203,	5.0833,	.0000

1

Regression weights
, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities

Age,	1988,	1989,	1990,	1991,	1992,	1993,	1994
5,	.000,	.000,	.011,	.002,	.003,	.017,	.018
6,	.003,	.003,	.089,	.028,	.072,	.059,	.113
7,	.041,	.033,	.362,	.202,	.454,	.393,	.344
8,	.145,	.110,	.627,	.471,	1.254,	.730,	.571
9,	.168,	.115,	.761,	.608,	1.366,	1.201,	1.054
10,	.106,	.067,	.724,	.564,	1.218,	1.551,	.829
11,	.119,	.055,	.598,	.406,	.954,	1.245,	.612
12,	.161,	.092,	.826,	.386,	.992,	1.302,	.537
13,	.409,	.158,	.840,	.506,	.940,	1.151,	.651
14,	.796,	.554,	1.039,	.435,	.885,	2.300,	1.033
15,	1.152,	1.604,	1.190,	.796,	.644,	3.759,	1.620
16,	1.567,	1.986,	.761,	.792,	1.165,	20.593,	5.083
17,	.823,	.886,	.939,	.583,	.920,	5.848,	.000

1
XSA population numbers (Thousands)

YEAR	AGE 5	6	7	8	9	10	11	12	13	14
1988	1.53E+04	9.35E+03	5.09E+03	2.82E+03	1.71E+03	1.23E+03	7.68E+02	4.43E+02	1.86E+02	9.03E+01
1989	1.31E+04	1.32E+04	8.02E+03	4.21E+03	2.10E+03	1.25E+03	9.55E+02	5.87E+02	3.25E+02	1.06E+02
1990	1.22E+04	1.13E+04	1.13E+04	6.68E+03	3.24E+03	1.61E+03	1.00E+03	7.78E+02	4.61E+02	2.39E+02
1991	1.26E+04	1.04E+04	8.90E+03	6.79E+03	3.07E+03	1.30E+03	6.72E+02	4.75E+02	2.93E+02	1.71E+02
1992	1.72E+04	1.08E+04	8.71E+03	6.26E+03	3.65E+03	1.44E+03	6.38E+02	3.85E+02	2.78E+02	1.52E+02
1993	2.28E+04	1.48E+04	8.65E+03	4.76E+03	1.54E+03	8.00E+02	3.66E+02	2.12E+02	1.23E+02	9.34E+01
1994	2.28E+04	1.93E+04	1.20E+04	5.03E+03	1.98E+03	3.98E+02	1.46E+02	9.08E+01	4.95E+01	3.35E+01

Estimated population abundance at 1st Jan 1995

, 0.00E+00, 1.92E+04, 1.49E+04, 7.32E+03, 2.45E+03, 5.92E+02, 1.49E+02, 6.82E+01, 4.57E+01, 2.22E+01,

Taper weighted geometric mean of the VPA populations:

, 1.54E+04, 1.14E+04, 7.86E+03, 4.62E+03, 2.26E+03, 1.04E+03, 5.53E+02, 3.36E+02, 1.89E+02, 1.04E+02,

Standard error of the weighted Log(VPA populations) :

, .2846, .3420, .4054, .3924, .3409, .4558, .6377, .6934, .7304, .6081,

YEAR	AGE 15	16	17
1988	5.51E+01	2.04E+01	7.69E+00
1989	3.51E+01	1.50E+01	3.67E+00
1990	5.27E+01	6.07E+00	1.77E+00
1991	7.26E+01	1.38E+01	2.44E+00
1992	9.54E+01	2.82E+01	5.38E+00
1993	5.41E+01	4.31E+01	7.57E+00
1994	8.06E+00	1.08E+00	4.23E-08

Estimated population abundance at 1st Jan 1995

, 1.02E+01, 1.37E+00, 5.66E-03,

Taper weighted geometric mean of the VPA populations:

, 4.19E+01, 1.19E+01, 5.26E+00,

Standard error of the weighted Log(VPA populations) :

, .7718, 1.1526, 1.1231,

1

Log catchability residuals.

Fleet : SHINKAI MARU SURVEY

Age	1988	1989	1990	1991	1992	1993	1994
5	No data for this fleet at this age						
6	No data for this fleet at this age						
7	No data for this fleet at this age						
8	No data for this fleet at this age						
9	.15	.25	-.25	-.01	.03	.19	-.34
10	-.16	.27	-.30	.00	-.02	.23	-.03
11	-.17	.10	-.48	.04	.12	.35	.02
12	-.10	.17	-.80	-.14	.07	.33	.46
13	.33	.27	-.99	-.15	-.26	.24	.57
14	No data for this fleet at this age						
15	No data for this fleet at this age						

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	9	10	11	12	13
Mean Log q	1.2614	.7530	.6712	.4313	.5629
S.E(Log q)	.2248	.2036	.2603	.4155	.5243

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
9	1.31	-.852	-4.08	.61	7	.30	1.26
10	1.12	-.579	-1.67	.83	7	.24	.75
11	1.18	-.969	-1.94	.86	7	.31	.67
12	1.80	-2.760	-5.49	.71	7	.51	.43
13	2.12	-2.585	-7.11	.53	7	.79	.56

1

Fleet : CPUE SUB.0

Age	1988	1989	1990	1991	1992	1993	1994
5	99.99	99.99	99.99	.20	.49	-.69	99.99
6	99.99	99.99	-.81	.33	.89	-.42	99.99
7	99.99	-2.57	-.13	.90	1.23	.46	99.99
8	99.99	-1.73	.42	.41	.83	.00	99.99
9	99.99	-1.32	.56	.21	.44	.07	99.99
10	99.99	-.82	.50	.02	.21	.06	99.99
11	99.99	-.25	.46	-.10	.04	-.14	99.99
12	99.99	.79	-.02	-.35	-.04	-.35	99.99
13	99.99	1.19	.22	-.35	-.27	-.73	99.99
14	99.99	2.34	.25	-.75	-.60	-1.12	99.99
15	99.99	2.84	.78	-.64	-1.59	-1.26	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	7	8	9	10	11	12	13	14	15
Mean Log q	-11.9833	-10.6387	-10.1526	-9.9897	-10.2189	-9.9938	-9.7018	-9.4959	-9.0009
S.E(Log q)	1.5045	.9963	.7499	.4858	.2757	.4636	.7344	1.3790	1.8087

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
5	-2.26	-.984	-4.50	.08	3	1.40	-16.05
6	-.73	-.807	6.44	.10	4	.59	-13.41

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	.26	.425	9.87	.10	5	.45	-11.98
8	.20	2.731	9.05	.80	5	.12	-10.64
9	.49	1.008	8.97	.57	5	.36	-10.15
10	.69	.439	9.10	.41	5	.38	-9.99
11	.78	.766	9.41	.81	5	.23	-10.22
12	.68	.965	8.76	.76	5	.32	-9.99
13	.52	1.314	7.74	.72	5	.35	-9.70
14	1.70	-.193	12.67	.03	5	2.70	-9.50
15	-.32	-2.847	2.51	.62	5	.34	-9.00

1

Fleet : CPUE SUB. 1

Age	1988	1989	1990	1991	1992	1993	1994
5	-.21	-.02	.18	.09	-.26	.17	.04
6	.04	-.14	.00	.07	-.08	.10	.01
7	.19	.22	-.21	-.19	-.26	.26	.02
8	.56	.52	.06	-.31	.09	-.45	-.41
9	.49	.34	.00	-.44	-.05	-.30	.02
10	.24	.00	-.23	-.66	.04	.54	.09
11	.26	-.29	-.40	-.58	.39	.80	-.19
12	.43	-.23	-.51	-.72	.43	1.14	-.53
13	.99	.05	-.42	-.60	.11	1.15	-1.21
14	No data for this fleet at this age						
15	No data for this fleet at this age						

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	7	8	9	10	11	12	13
Mean Log q	-10.6354	-9.7562	-9.5673	-9.9216	-10.0518	-10.3246	-10.4927
S.E(Log q)	.2240	.4192	.3242	.3791	.4987	.6884	.8530

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
5	.18	2.768	10.70	.70	7	.19	-15.37
6	.35	4.160	10.52	.89	7	.09	-12.54

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
7	1.60	-1.144	11.57	.43	7	.35	-10.64
8	4.14	-1.481	13.61	.04	7	1.58	-9.76
9	1.41	-.702	10.30	.38	7	.48	-9.57
10	1.44	-.938	11.22	.49	7	.55	-9.92
11	1.19	-.493	10.76	.58	7	.64	-10.05
12	1.17	-.344	11.09	.46	7	.87	-10.32
13	.86	.329	9.75	.52	7	.79	-10.49

A

Appendix 2. Pope's Cohort Analysis

Stock

Age	1987	1988	1989	1990	1991	1992	1993	1994	Fterm	M
5	10656	13061	11344	10834	8951.9	7702	4011.6	786.78	0.7	0.15
6	5609.4	9170.5	11241	9763.2	9235.3	7688.7	6592.2	3214.2	1	0.15
7	3535.5	4805	7871.6	9648.4	7740.2	7710.3	6119.9	5110.2	1.12	0.15
8	2054.5	2908.2	3995	6594.4	5939.8	5347.1	4465	3318.3	1.05	0.15
9	1343.1	1549	2240.9	3136.3	2798.5	3087	1451.6	2059.2	0.96	0.15
10	780.8	1013	1151.7	1771.7	1512.6	1332.3	755.35	464.89	0.65	0.15
11	453.53	614.99	786.71	935.75	955.2	895.21	451.85	197.49	0.41	0.15
12	189.16	360.73	470.07	642.31	495.01	654.72	481.6	207.41	0.2	0.15
13	92.001	149.48	265.29	369.03	252.07	317.16	393.14	307.84	0.08	0.15
14	58.038	71.778	85.687	195.74	137.61	135.47	160.37	279.85	0.08	0.15
15	22.488	43.287	27.702	42.637	62.539	74.732	55.85	83.955	0.08	0.15
16	6.5821	14.911	11.328	4.5821	11.51	24.936	30.985	13.993	0.08	0.15
17	1255.2	3.4428	1.7214	0.8607	1.7214	4.7214	5.1642	0	0.08	0.15
18	2154.8	1077.4	0	0	0	0	2.5821	0	0.08	0.15
Fold	0.001	0.001	0.001	0.01	0.01	0.01	0.01	0.01		
Biomasse	57583	39542	34315	43059	37322	36402	26676	20159		

B

Fishing Mortality

Age	1987	1988	1989	1990	1991	1992	1993	1994
5	0.0002	7E-05	8E-05	0.0097	0.0021	0.0056	0.0716	0.7
6	0.0048	0.0027	0.0028	0.0822	0.0305	0.0782	0.1047	1
7	0.0453	0.0346	0.027	0.3351	0.2199	0.3963	0.4621	1.12
8	0.1324	0.1107	0.092	0.7071	0.5045	1.1539	0.624	1.05
9	0.132	0.1463	0.0849	0.5792	0.5922	1.2578	0.9886	0.96
10	0.0887	0.1028	0.0577	0.4678	0.3745	0.9313	1.1915	0.65
11	0.0789	0.1187	0.0528	0.4868	0.2277	0.47	0.6287	0.41
12	0.0855	0.1573	0.092	0.7854	0.2952	0.3601	0.2975	0.2
13	0.0982	0.4064	0.154	0.8365	0.471	0.5319	0.1899	0.08
14	0.1433	0.8021	0.548	0.991	0.4605	0.7361	0.4972	0.08
15	0.2609	1.1905	1.6493	1.1595	0.7695	0.7304	1.2341	0.08
16	0.4981	2.0089	2.4273	0.829	0.7411	1.4245	#DIV/0!	0.08
17	0.0027	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.4535	#DIV/0!	0.08
18	0.001	0.001	0.001	0.01	0.01	0.01	0.01	0.08
Fbar	0.108	0.1196	0.0719	0.5602	0.4247	0.9532	0.8582	0.7675

Mean W	N-1995	C-1995	N-1996	Catch	Catch	Catch	Catch	Catch	Catch	Catch	Catch	Catch
0.355	9508.7	4483.7	9508.7	597.5	2619.0	3044.1	3441.4	3812.6	4159.5	4483.7	4786.8	5070.1
0.568	4064.2	2415.0	4064.2	359.6	1494.2	1715.5	1916.4	2098.8	2264.5	2415.0	2551.8	2676.1
0.821	2434.5	1544.0	1286.9	126.8	516.0	589.6	655.7	715.0	768.3	816.2	859.2	897.8
1.143	2165.3	1324.0	683.7	63.4	261.0	299.1	333.5	364.5	392.6	418.0	441.0	461.8
1.576	1610.5	933.8	652.2	55.5	232.3	267.1	298.8	327.7	354.1	378.2	400.1	420.1
2.283	1017.4	455.2	530.8	31.0	137.3	159.9	181.2	201.1	219.9	237.5	254.0	269.5
3.098	598.6	187.9	457.1	17.1	78.9	92.9	106.3	119.2	131.6	143.5	155.0	166.0
4.163	511.4	86.3	342.0	6.3	30.3	36.0	41.6	47.0	52.4	57.7	62.9	68.0
5.319	461.4	33.0	360.3	2.7	13.1	15.7	18.2	20.8	23.3	25.8	28.2	30.7
6.625	252.0	18.0	366.6	2.7	13.4	16.0	18.6	21.1	23.7	26.2	28.7	31.2
7.921	107.6	7.7	200.2	1.5	7.3	8.7	10.1	11.5	12.9	14.3	15.7	17.0
9.107	59.4	4.2	85.5	0.6	3.1	3.7	4.3	4.9	5.5	6.1	6.7	7.3
10.513	19.8	1.4	47.2	0.3	1.7	2.1	2.4	2.7	3.0	3.4	3.7	4.0
11.585	3.8	0.3	18.7	0.1	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6
Yield		9609.1	Y-1996	885.2	3820.7	4427.7	4992.2	5517.8	6007.7	6464.8	6891.7	7291.0
				0.1	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2

APPENDEX 3

Concerning SCR Doc. 96/68, Assessment of the Greenland Halibut Stock Component in NAFO Subarea 0 + Div. 1B-1F

by

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A Review of the data used for making the catch rate sereies for SA 0B given in fig 2., showed that the data point for 1989 was based on a very small catch. The other data differed significantly form those presented in SCR Doc 94/47. It was considered that the 1994 data were more reliable. See fig. and output of the analysis.

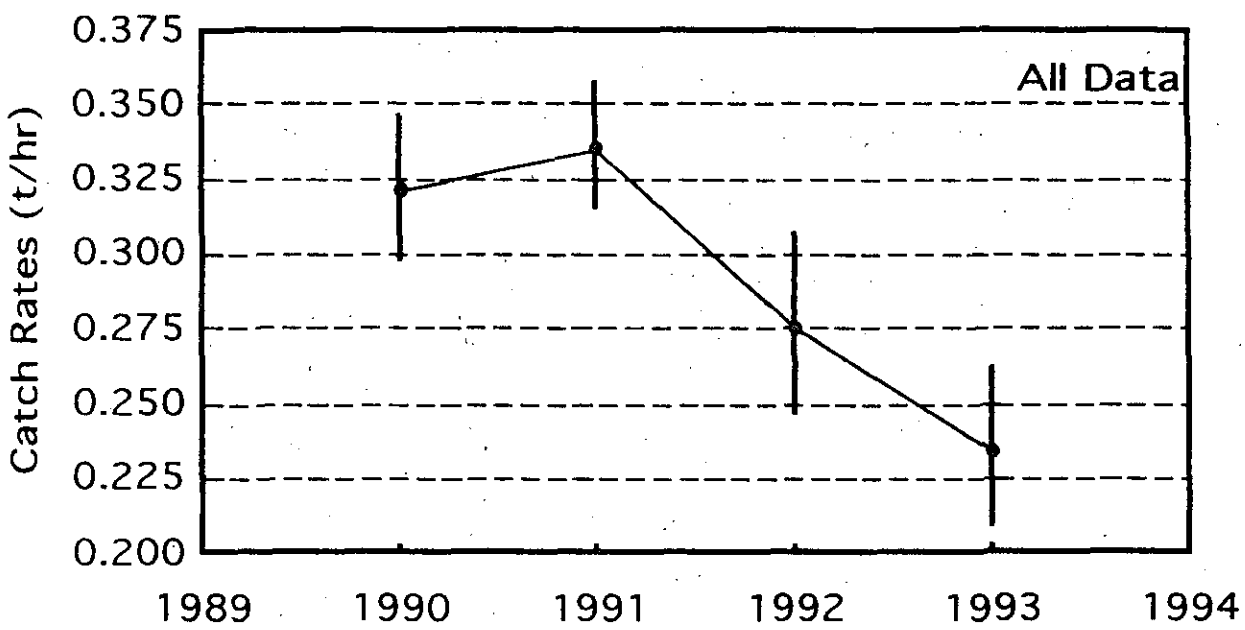

FIGURE 1: STANDARDIZED CATCH RATES FROM MULTIPLICATIVE ANALYSIS SHOWING 95% CONFIDENCE LIMITS.

TABLE 1: REGRESSION OF MULTIPLICATIVE MODEL.

MULTIPLE R............. .875
MULTIPLE R SQUARED...... .765

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.009E2	3.009E2	
REGRESSION	18	9.630E1	5.350E0	99.861
COUNTRY	7	4.193E1	5.990E0	111.808
TONNAGE	3	9.824E-1	3.275E-1	6.112
MONTH	5	4.288E0	8.576E-1	16.008
YEAR	3	2.647E0	8.823E-1	16.468
RESIDUALS	551	2.952E1	5.358E-2	
TOTAL	570	4.268E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
COUNTRY	20	INTERCEPT	-1.161	0.045	570
TONNAGE	6				
MONTH	9				
YEAR	90				
COUNTRY	2	1	0.712	0.089	12
	3	2	0.678	0.062	36
	5	3	0.632	0.052	68
	14	4	0.643	0.109	28
	15	5	0.954	0.039	112
	32	6	-0.035	0.096	15
	34	7	0.305	0.064	219
TONNAGE	4	8	-0.287	0.107	28
	5	9	-0.176	0.128	5
	7	10	0.095	0.033	159
MONTH	7	11	0.041	0.040	50
	8	12	0.035	0.030	117
	10	13	-0.053	0.030	124
	11	14	0.156	0.036	103
	12	15	0.351	0.054	39
YEAR	91	16	0.043	0.035	147
	92	17	-0.154	0.052	187
	93	18	-0.316	0.057	102

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED	
YEAR	MEAN	S.E.	MEAN	S.E.
1990	-1.1612	0.0020	0.321	0.014
1991	-1.1180	0.0014	0.336	0.013
1992	-1.3154	0.0044	0.275	0.018
1993	-1.4776	0.0047	0.234	0.016

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.054