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An Assessment of the Cod Stock in NAFO Div. 3NO

by

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Nominal catch and catch at age

Catches for this stock increased during the late 1950's and early 1960's and reached a peak of about 227,000 tons in 1967 with a subsequent decline to a low of about 15,000 tons in 1978 (Table 1, Figure 1). Another increase in catch occurred after 1978, peaking in 1986 at 50,000 tons. The catch for all countries has been decreasing in the most recent period with the 1990 catch of 28,800 tons the lowest since 1984.

Landings by month are presented in Table 2. The Canadian catch is divided approximately equally between Divisions 3N and 3O while the catches by other countries, primarily Spain and Portugal, occur mainly in Division 3N, outside the Canadian 200-mile limit.

In recent years catches from the area outside the 200-mile limit have been estimated by Canadian surveillance authorities. These estimates have previously been used for some stock assessments (NAFO SC Reports, 1989 and 1990), mainly for catches by countries that are not members of NAFO. During 1990, surveillance has estimated that 3,600 tons of cod in Divisions 3NO was taken by non-member countries as well as approximately 7,000 tons not reported by some member countries. These estimates are included in this assessment.

Sampling data available for the Canadian fishery in 1990 (Table 3), obtained from Canadian port samplers and offshore observers, was used to adjust monthly catches. In total 7,253 fish were measured for length and 1,071 were aged during 1990. Catch, average weight and average length at age for the 1990 Canadian catch are presented in Table 4. Average weights at age were determined by applying a length weight relationship (log weight = 3.0879 x log length - 5.2106) to length frequencies and age length keys. The calculated Canadian catch was within 2% of that reported. The dominant yearclasses in the Canadian fishery during 1990 were those of 1985 and 1986, ages 5 and 4 respectively (Table 5).

Catch at age for the Spanish and a portion of the Portuguese fleets were obtained from national research reports (Vazquez et al, 1991; Godinho et al, 1991). Sampling for the Spanish pairtrawl catch was available only for October to December of 1990. The quarterly age composition derived was used to estimate total Spanish removals at age for the remainder of the year. With the exception of that for the Portuguese gillnet fishery, there was no adequate sampling for catches by other countries and gears for the area outside the 200-mile limit (Table 2b). Consequently the only sampling available (Spanish PT) was used to estimate most of the removals from this area. These included the estimates, provided by Canadian surveillance, of catch by non-members and members who did report. The dominant yearclasses in the Spanish pair trawl fishery were the same as those dominant in the Canadian fishery

(Table 5). The Portuguese gillnet fishery was dominated by cod of ages 9-12, the 1978-1981 yearclasses, however, the catch by this fleet was only about 4% of the total 1990 catch for this stock.

Catch at age and mean weights at age for the 1959-1990 period are presented in Tables 6 and 7 respectively. During recent years the 1981 and 1982 yearclasses have been dominant in the Division 3NO cod catches. Although these yearclasses are still apparent in the 1990 catch they are no longer dominant. With respect to the mean weights, there does not appear to any discernable trends in recent years with the 1990 values within the range of weights observed during the 1980's.

The 1990 catch at age may not be well estimated as it was obtained using sampling from countries and gears representing only about 60% of the catch. The remaining 40% of the catch camer from the area outside the 200-mile limit and its age composition was estimated using Spanish pair trawl age compositions. The latter was obtained using sampling relative to about 35% (fourth quarter only) of that countries catch.

Commercial catch and effort

Catch and effort data for 1977 to 1988 were obtained from NAFO Statistical Bulletins. Data for Canadian otter trawls for 1989 and 1990 was provided by the Department of Fisheries and Oceans, Canada, while Spanish pair trawl data for these same years were obtained from national research reports. Catch and effort from the otter trawl and pair trawl fisheries were included in separate analyses using a multiplicative model (Gavaris, 1980). These analyses were conducted in a manner similar to those conducted in previous assessments, with annual catch rates standardized by country/gear/tonnage class, NAFO division, and month.

For Canadian otter trawls, the model only explained about 40% of the variation in the data (Table 8). Monthly coefficients (Table 9) indicate that highest catch rates for this fleet occur during January and December while the lowest occur during summer months. Trends in catch rates for the Canadian otter trawl fleet are shown in Table 10 and Figure 2. In general, C/E increased from 1977 to 1982 and have declined steadily since that time. The 1990 index is estimated to be the lowest since 1980.

Spanish pair trawl catch and effort data for 1988 were not available by tonnage class, so this data was excluded from the analysis. The regression of ln catch rate explained about 55% of the variation in the Spanish pair trawl data (Table 11). The seasonal pattern for this fleet is quite different from the Canadian otter trawl fleet with pair trawls obtaining their best catch rates during summer months (Table 12), and the lowest occurring during the first quarter of the year. The Spanish pair trawl C/E have displayed larger year to year variation than the Canadian time series. Catch rates generally increased from 1977 to 1984 with a subsequent decline (Table 13, Figure 3).

During the most recent assessment of this stock (Bishop et. al., 1990) it was concluded that catch rates gave unrealistic estimates when used for calibration of sequential population analysis. In the past these indices have been questioned for other reasons as well: the Canadian index because of the uncertain definition of directed fishing effort as a consequence of the substantial by-catch of cod in flounder fisheries; and the Spanish index because since the early 1980's this fleet has been restricted to an area where a relatively small portion of the stock biomass occurs (Bishop et. al., 1990).

Research vessel survey data

Stratified-random research vessel surveys have been conducted by Canada in Divisions 3N and 3O since 1971 and 1973 respectively with the exceptions of 1983 in Div. 3N and 1974 and 1983 in Div. 3O. Surveys from 1971 to 1982 were conducted by the research vessel **A. T. CAMERON** and those since 1984 have been conducted by the sister ships **ALFRED NEEDLER** and **WILFRED TEMPLEMAN**. Comparative fishing studies indicated that the conversion factor between the two vessel/gear combinations was not different from 1. The stratification scheme used for these surveys is based on depth and is presented in Figure 4.

Biomass estimates by stratum for these surveys are presented in Tables 14-15 and in Figure 5. Biomass for Divisions 3N and 3O combined gradually increased from the early 1970's to the early 1980's and increased considerably between 1982 and 1984. Another sharp increase occurred in 1987 and survey biomass has been declining steadily since that time. The increase in 1987 was caused by a large increase in Division 3O. However, since that time the decline has been observed in both divisions. The 1991 Division 3NO total biomass is the lowest observed since 1982.

Abundance estimates by stratum are shown in Tables 16-17 and Figure 6. Trends in Division 3NO cod abundance are similar to those observed for biomass with a large spike occurring in 1987, caused mainly by a high estimate for Division 3O. The abundances estimated for the 1988 to 1991 period are all among the lowest observed in the Canadian time series of RV abundance for this stock.

Age composition data for 1971 to 1990 are presented in Table 18. The age structure for the 1991 survey was not available in time for the June meeting. The dominant ages in the 1990 survey were 4 and 5 (the 1986 and 1985 yearclasses respectively) as well as those at ages 14+. It should be noted as well that yearclasses from 1983 to 1988 (ages 2 to 7 in 1990) are also among the lowest observed in the time series.

An additional stratified random survey was conducted by Canada during the autumn of 1990. The results of this survey are presented in Table 19. The age composition from this survey is fairly similar to that estimated during the spring of 1990. Some notable exceptions are that age 14+ cod do not appear to be as dominant during the autumn survey and the 1988 yearclass (age 2) appears to be somewhat stronger in autumn than in spring.

Estimation of stock parameters

The adaptive framework used in this assessment included catch per tow from both Canadian and USSR research vessel surveys, both disaggregated by age. The USSR data was that presented in a document by Kuzmin (1991). The accepted formulation, which was that which was also used during the last assessment of this stock, is as follows:

Parameters estimated by ADAPT:

- Yearclass estimates
  $N_{i,1990}$ i = 3 to 11

- Catchabilities for RV numbers at age
      $K(Can)_i$ i = 3 to 11
      $K(USSR)_i$ i = 3 to 11

Additional structure imposed

- Natural mortality was assumed to be 0.20.
- Error in the catch at age was assumed negligible.
- F on oldest age group (12) set at 40% of the weighted (by population numbers) F for age groups 7-10.
- Intercepts not fitted.

Input data

- $C_{i,t}$ i = 3 to 12   t = 1977-90
- $RV(Can)_{i,t}$ i = 3 to 11   t = 1977-82, 1984-90
- $RV(USSR)_{i,t}$ i = 3 to 11   t = 1977-90

Objective function

- Minimize

$$\sum_{age}\sum_{year}\{obs(lnRV(Can)_{i,t})-pred(lnRV(Can)_{i,t})\}^2 \ +$$

$$\sum_{age}\sum_{year}\{obs(lnRV(USSR)_{i,t})-pred(lnRV(USSR)_{i,t})\}^2$$

Summary

- Number of observations = 243
- Number of parameters estimated = 27

In previous assessments it had been established that intercepts were not significant and hence were not included in this analysis. The coefficients of variation (CV's) on the age 4 to 6 abundance estimates were in the range of 21% to 28%, while those on ages 7 to 11 ranged between 42% to 45% (Table 20). The CV on age 3 was somewhat higher at 54%. All research vessel catchabilities were estimated with CV's between 27% and 30%. Residuals indicate that both the Canadian and Soviet survey indices contain several year effects, both negative and positive (Table 21). Correlations between estimated parameters were suitably low (Table 22). The high CV's on most abundance estimates and the patterns observed in the residuals suggest uncertainty with the results of this assessment. This could be the result of highly variable survey indices as well as poorly estimated removals at age.

Assessment Results

The ADAPT results indicate that the fishing mortalities on ages 4 to 6 in 1990 are unusually high, all above 1.2. These high F's are difficult to explain but may have resulted from substantial catches from 4 or 5 successive extremely weak yearclasses. Mean fishing mortalities for ages 7-10 for 1965 to 1975 displayed large year to year variation and were in the range of 0.35 and 1.1 (Table 23, Figure 9). After 1975, F's were considerably lower and up until 1987 were between 0.10 and 0.30. Fishing mortalities for 1988 to 1989 are highest since 1975. The 1990 mean F for ages 7 to 10 was estimated to be 0.35.

Beginning of the year population biomass for ages 3 and older increased in the early 1960's and peaked at about 400,000 tons in 1967

(Table 24, Figure 10). A subsequent decline followed and the estimate for 1975 was 75,000 tons. Biomass again increased and reached 250,000 tons in 1984. Another decline occurred in recent years and the age 3+ beginning of the year biomass for 1990 is estimated to be as low as that for 1975. The age 3+ average biomass is presented in Table 25.

Age 3 population estimates from the sequential population analysis are presented in Table 26 and Figure 11. The highest recruitments occurred during the 1960's when several yearclasses were estimated to be above 100 million fish. Recruitment estimates for the early 1970's to the mid-1980's were at a lower level than the 1960's with most being less than 50 million fish. There has been a recruitment failure in recent years with the age 3 estimates for 1986 to 1989 (1983-1986 yearclasses) the lowest in the time series, averageing below 10 million fish. The age 3 population for 1990 (1987 yearclass) is also estimated to be quite low, however, this yearclass was associated with an extremely high coefficient of variation.

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Table 1. Catch (metric tons) of cod in NAFO Divisions 3NO.

Year	Canada	Spain	Portugal	USSR	Others	Total
1953	39,884	12,633	7,919	-	5,761	66,197
1954	17,392	88,674	24,045	-	4,650	134,761
1955	6,053	64,987	27,711	-	15,605	114,356
1956	5,363	42,624	15,505	-	1,390	64,882
1957	9,641	51,990	21,740	-	6,819	90,190
1958	4,812	29,436	11,608	-	2,195	48,051
1959	3,687	39,994	17,730	48	2,911	64,370
1960	3,408	33,972	14,347	24,204	3,746	79,677
1961	5,428	32,284	9,059	22,854	3,099	72,724
1962	3,235	17,413	3,653	7,971	2,712	34,984
1963	5,079	37,632	10,004	10,184	6,843	69,742
1964	2,882	37,185	8,095	9,510	6,789	64,461
1965	4,229	64,652	1,692	17,166	11,448	99,187
1966	6,501	52,533	5,070	39,023	5,792	108,919
1967	3,446	77,948	9,703	118,845	16,842	226,784
1968	3,287	69,752	6,752	78,820	6,900	165,511
1969	3,664	71,160	4,940	29,173	8,768	117,705
1970	4,771	67,034	3,185	28,338	8,233	111,561
1971	2,311	89,915	6,589	19,307	8,174	126,296
1972	1,736	76,324	11,537	12,198	1,579	103,374
1973	1,832	42,403	7,759	27,849	586	80,429
1974	1,360	38,338	6,602	26,911	178	73,389
1975	1,189	16,616	5,560	20,785	24	44,174
1976	2,065	9,880	2,620	8,992	726	24,283
1977	2,532	8,827	1,742	4,041	462	17,604
1978	6,246	5,813	641	1,819	199	14,718
1979	9,938	13,782	1,140	2,446	545	27,941
1980	5,589	8,999	1,145	3,261	997	19,993
1981	6,096	13,299	1,091	3,187	671	24,344
1982	10,185	14,361	2,466	3,985	608	31,605
1983	11,374	12,320	1,109	3,238	778	28,818
1984	8,705	13,590	1,071	3,306	431	27,103
1985	18,179	13,682	608	3,968	462	36,899
1986	18,035	23,395	6,890	1,181	1,144	50,645
1987	18,652	15,788	4,108	764	2307	41,619
1988	19,727	15,889	3,927	2,973	634	43,150
1989[a]	13,514	17,904	913	108	504	32,943
1990[a]	10,620	4,678	2,145	18	11,385[b]	28,846

[a]Provisional.

[b]Includes 10,622 estimated by Canadian surveillance:
          3,600 not reported by non-member countries;
          7,022 not reported by member countries.

Table 2. Cod landings (t) from NAFO Divisions 3NO by Canada in 1990 by month and gear.

Month	3N Can(N) OT	GN	SSC	LL	3N Can(SF) OT	SSC	LL	3O Can(N) OT	GN	SSC	LL	3O Can(SF) OT	GN	SSC	LL	Total
Jan							7					382			6	395
Feb							24	15		4	158	172			38	411
Mar							15	273	72		90	440			118	1008
Apr				15			50	207	9	98	22	107			32	540
May	138		7	23	22		57	394	13	145	90	318			113	1320
Jun	367			8	12		95	345	17	97	10	53			41	1045
Jul	568	25	50				76	149	26	23					56	973
Aug	706	21	73		35		45	90						5	29	1004
Sep	645	40	34	3	15		77	98				4		1	48	965
Oct	313		126		40	1	47	30				1		2	59	619
Nov	489	67		1			73	50	31	226	30	145			37	1149
Dec	107	2	1				88	383	54	143		232	3	27	151	1191
	3333	155	291	50	124	1	654	2034	222	736	400	1854	3	35	728	10620

Table 2b.   Catches of cod for countries other than Canada in Divisions 3NO during 1990.

Month	Spain	Faroes		Catches not available by month	
Jan	21				
Feb	27			USSR	18
Mar	114	26		USA	7
Apr	173	146		Japan	351
May	197	200		Portugal	2145
Jun	593			Canadian Surveillance:	
Jul	631			a) Non-members	3600
Aug	456			b) Not reported by members	7022
Sep	700				
Oct	848				
Nov	614				
Dec	224				
NK	80	33			
Total	4678	405			

Table 3.   Commercial sampling by Can(N) in NAFO Divisions 3NO during 1990.

Quarter	Gear	Division	No. aged	Month	No. meas.	Landings (t) Month	Landings (t) Total[c]
1+2	OT	3N	451[a]	May	156	160	833
				Jun	473	379	
3	OT	3N	241[a]	Jul	359	568	2170
				Sep	$\overline{1922}$	660	
1-3			$\overline{692}$		$\overline{2910}$		$\overline{3003}$[c,d]
1-4		3N					$\overline{4316}$
1	OT	3Ø	198	Feb	236	187	1692
				Mar	978	713	
2			451[a]	Apr	511	314	1732
				May	708	712	
3			241[a]	Sep	241	102	474
4			181[b]	Dec	$\underline{496}$	615	$\underline{1118}$[d]
1-4		3Ø			$\overline{3170}$		$\overline{5241}$
1-2	SSc	3NO	241[a]	May	170	152	351
3-4	SSc	3NO	181[b]	Dec	$\underline{1003}$	171	$\underline{712}$
					$\overline{1173}$		$\overline{1063}$
1-4	ALL	3NO	$\overline{1071}$		$\overline{7253}$		$\overline{10620}$

[a] A/L keys from qtr's 2 and 3 were combined 3NO.
[b] A/L key from SSc only.
[c] Totals include landings from LL.
[d] Totals include landings from GN.

TABLE 4. CATCH, AVERAGE WEIGHT AND LENGTH AT AGE FOR THE COD FISHERY BY CANADA IN DIVISIONS 3NO DURING 1990.

	AVERAGE			CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.		C. V.
3	0.696	43.275	20	8.21		0.42
4	1.004	48.536	659	73.06		0.11
5	1.355	53.341	1248	89.10		0.07
6	1.875	59.073	376	55.57		0.15
7	2.598	65.531	360	34.40		0.10
8	3.451	71.758	524	38.51		0.07
9	4.147	76.129	424	30.61		0.07
10	5.567	84.157	192	17.74		0.09
11	5.965	85.406	86	12.07		0.14
12	7.829	93.559	39	6.14		0.16
13	7.807	93.725	29	5.74		0.20
14	12.215	108.581	11	2.20		0.20
15	13.027	111.073	17	2.89		0.17
16	12.917	110.561	12	2.68		0.22
17	14.879	115.717	9	2.09		0.25
18	18.360	124.324	4	0.87		0.25
19	14.457	115.626	1	0.95		0.75

Table 5. Catch and average weights at age for the commercial cod fisheries in Divisions 3NO during 1990.

	Canada		Portugal (GN)		Spain (PT)		Others		Total	
Age	No	Wt	No	Wt	No	Wt	No	Wt	No	Wt
1					4	0.05	9	0.05	13	0.05
2					112	0.19	298	0.19	410	0.19
3	20	0.70			285	0.55	759	0.55	1064	0.55
4	659	1.00			1049	1.01	2797	1.01	4505	1.01
5	1248	1.36			844	1.50	2249	1.50	4341	1.48
6	376	1.88			142	2.97	377	2.97	895	2.51
7	360	2.60	1	4.60	17	3.46	44	3.46	422	2.73
8	524	3.45	6	8.30	52	5.98	139	5.98	721	4.14
9	424	4.15	14	8.34	39	7.29	104	7.29	581	5.02
10	192	5.57	16	9.49	63	10.62	188	10.62	439	8.37
11	86	5.97	14	10.71	14	14.59	36	14.59	150	9.29
12	39	7.83	11	11.55	9	15.18	24	15.18	83	11.25
13	29	7.81	8	12.64					37	8.85
14	11	12.22	7	14.12					18	12.96
15	17	13.03	5	13.34					22	13.08
16	12	12.92	2	12.58					14	12.87
17	9	14.88	1	11.96					10	14.59
18	4	18.36							4	18.36
19	1	14.46							1	14.46
#	4,011		85		2,630		7,004		13,730	
Wt	10,620 t		1,075 t		4,678 t		12,473 t		28,846 t	

TABLE 6. CATCH AT AGE OF COD IN DIV. 3NO FOR 1959-1990.

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	1711	1846	812	1026	313	6202	1013	753	20086	16359	8154
4	13036	6503	4400	3882	5757	15555	7611	18413	62442	56775	12924
5	5068	22050	11696	2206	11210	19496	7619	19681	50317	48608	26949
6	6025	3095	15258	1581	4849	7919	13258	11795	18517	18485	11191
7	3935	2377	2014	3594	1935	2273	9861	8486	4774	6337	2089
8	1392	2504	1672	773	3840	1109	4827	4467	4651	1592	1393
9	757	583	847	668	1165	788	1081	1829	236	505	518
10	926	387	196	433	608	328	1248	1694	180	178	292
11	1220	898	25	226	322	37	163	122	71	90	134
12	103	242	245	216	208	112	141	57	45	45	202
13+	1128	1409	392	846	473	56	276	183	335	51	574
3+	35301	41894	37557	15451	30680	53875	47098	67480	161654	149025	64420

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
3	2105	950	69	10058	6425	671	4054	607	920	72	266	505
4	19703	26900	19797	27600	9501	8781	7534	2469	4337	3827	1055	1091
5	10799	30300	12289	15098	10907	3528	5945	2531	2518	9208	3812	1262
6	9481	11700	13432	5989	10872	2505	1084	1500	818	2784	2275	2297
7	3646	3500	5883	1971	2247	3057	211	572	354	883	761	1902
8	1635	2500	1686	972	2147	1059	238	177	102	265	222	574
9	541	500	285	707	1015	921	44	209	58	58	92	192
10	149	200	216	243	676	461	37	65	51	17	31	94
11	227	100	78	137	428	252	13	41	8	12	8	41
12	90	50	74	116	257	152	9	25	5	7	13	13
13+	1472	700	350	173	881	396	17	36	21	16	2	32
3+	49848	77400	54159	63064	45356	21783	19186	8232	9192	17149	8537	8003

	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	305	1179	58	57	153	516	277	1917	1064
4	1978	647	1000	2953	2865	422	318	2182	4505
5	1591	1893	1411	6203	6423	3491	1527	1502	4341
6	1012	1204	2324	3036	4370	3445	6347	1260	895
7	1528	686	1220	2519	1512	1213	3955	1887	422
8	1492	1152	720	797	948	653	1009	1284	721
9	595	774	918	459	558	845	567	485	581
10	211	238	551	533	373	494	425	233	439
11	162	81	106	261	349	398	249	168	150
12	27	41	42	97	135	404	142	100	83
13+	52	36	70	71	86	188	298	285	106
3+	8953	7931	8420	16986	17772	12069	15114	11303	13307

TABLE 7. WEIGHT AT AGE OF COD IN DIV. 3NO FOR 1959-1990.

I	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3 I	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.48	0.48	0.48	0.48
4 I	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.90	0.90	0.90	0.90
5 I	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.35	1.35	1.35	1.35
6 I	1.95	1.95	1.95	1.95	1.95	1.95	1.95	2.14	2.14	2.14	2.14
7 I	2.82	2.82	2.82	2.82	2.82	2.82	2.82	3.16	3.16	3.16	3.16
8 I	3.39	3.39	3.39	3.39	3.39	3.39	3.39	4.21	4.21	4.21	4.21
9 I	3.98	3.98	3.98	3.98	3.98	3.98	3.98	6.34	6.34	6.34	6.34
10 I	4.68	4.68	4.68	4.68	4.68	4.68	4.68	7.69	7.69	7.69	7.69
11 I	5.25	5.25	5.25	5.25	5.25	5.25	5.25	8.46	8.46	8.46	8.46
12 I	6.17	6.17	6.17	6.17	6.17	6.17	6.17	10.24	10.24	10.24	10.24
13+I	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50

I	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3 I	0.48	0.48	0.54	0.57	0.42	0.38	0.50	0.57	0.72	0.65	0.71
4 I	0.90	0.90	0.97	1.00	0.73	0.89	0.91	1.00	1.05	0.98	1.04
5 I	1.35	1.35	1.44	1.43	1.20	1.28	1.41	1.48	1.55	1.39	1.69
6 I	2.14	2.14	2.08	2.19	1.96	2.13	2.33	2.48	2.25	2.09	2.50
7 I	3.16	3.16	2.89	3.63	2.86	3.14	3.25	3.51	3.74	2.87	3.69
8 I	4.21	4.21	3.56	4.63	4.67	4.16	4.03	4.74	4.61	3.70	5.49
9 I	6.34	6.34	5.95	6.25	7.32	5.53	6.67	7.17	6.19	4.75	7.98
10 I	7.69	7.69	7.95	9.56	5.46	6.74	8.74	8.81	7.23	7.15	9.22
11 I	8.46	8.46	8.32	11.17	8.40	5.27	9.14	11.70	9.48	7.98	10.60
12 I	10.24	10.24	10.14	13.99	7.51	7.09	12.49	11.47	12.87	10.11	12.61
13+I	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50

I	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3 I	0.90	0.94	0.85	0.79	0.48	0.39	0.49	0.74	0.51	0.55
4 I	1.27	1.17	1.17	1.15	0.86	1.01	0.82	1.00	0.97	1.01
5 I	1.84	1.50	1.87	1.51	1.37	1.52	1.30	1.38	1.60	1.46
6 I	2.69	2.20	2.63	2.28	2.05	2.16	1.83	1.79	2.24	2.51
7 I	3.55	3.83	3.80	3.04	3.25	3.49	2.89	2.23	3.27	2.73
8 I	5.33	5.26	5.20	4.05	4.65	5.41	4.76	3.77	4.61	4.14
9 I	7.13	7.49	6.27	5.76	6.62	7.95	7.26	5.12	7.08	5.02
10 I	9.10	8.80	8.08	7.22	8.32	9.82	8.95	6.88	8.31	8.37
11 I	9.01	9.82	8.99	8.92	9.15	9.94	9.85	9.37	9.47	9.29
12 I	10.15	12.28	11.01	12.61	11.13	9.88	12.59	11.07	12.25	11.25
13+I	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	11.91

TABLE 8.   ANALYSIS OF VARIANCE FROM THE REGRESSION OF LN C/E FOR
         CANADIAN OTTER TRAWLS FOR COD IN DIVISIONS 3NO.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R............. 0.630
MULTIPLE R SQUARED..... 0.397

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	9.583E0	9.583E0	
REGRESSION	28	9.251E0	$3.304E^{-1}$	10.529
TYPE 1	3	2.072E0	$6.908E^{-1}$	22.016
TYPE 2	1	$3.529E^{-2}$	$3.529E^{-2}$	1.125
TYPE 3	11	4.686E0	$4.260E^{-1}$	13.576
TYPE 4	13	1.493E0	$1.148E^{-1}$	3.660
RESIDUALS	448	1.406E1	$3.138E^{-2}$	
TOTAL	477	3.289E1		

TYPE 1 - COUNTRY/GEAR/TONNAGE CLASS
     2 - NAFO DIVISION
     3 - MONTHS
     4 - YEARS

TABLE 9. REGRESSION COEFFICIENTS FROM THE REGRESSION OF LN C/E FOR
CANADIAN OTTER TRAWLS FOR COD IN DIVISIONS 3NO.

REGRESSION COEFFICIENTS
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CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3124	INTERCEPT	‾0.057	0.202	477
2	34				
3	1				
4	77				
1	3125	1	0.108	0.063	223
	27124	2	0.398	0.091	58
	27125	3	0.495	0.074	95
2	35	4	‾0.055	0.052	311
3	2	5	‾0.353	0.138	30
	3	6	‾0.523	0.130	36
	4	7	‾0.676	0.130	41
	5	8	‾0.936	0.123	55
	6	9	‾0.892	0.122	53
	7	10	‾0.753	0.132	40
	8	11	‾0.686	0.139	33
	9	12	‾0.722	0.143	26
	10	13	‾0.780	0.130	41
	11	14	‾0.380	0.122	53
	12	15	‾0.181	0.124	50
4	78	16	‾0.128	0.177	35
	79	17	0.196	0.172	43
	80	18	‾0.075	0.194	18
	81	19	0.159	0.192	19
	82	20	0.451	0.173	33
	83	21	0.385	0.170	39
	84	22	0.204	0.172	38
	85	23	0.217	0.171	39
	86	24	0.100	0.168	44
	87	25	0.075	0.167	49
	88	26	0.104	0.168	42
	89	27	0.055	0.170	35
	90	28	0.024	0.172	33

CODE 03124 - CAN(N)/OT/TC 4
     03125 - CAN(N)/OT/TC 5
     27124 - CAN(M)/OT/TC 4
     27125 - CAN(M)/OT/TC 5
        34 - DIVISION 3N
        35 - DIVISION 3O

TABLE 10. COMMERCIAL CATCH RATE INDEX FOR CANADIAN
OTTER TRAWLS FOR COD IN DIVISIONS 3NO.

PREDICTED CATCH RATE

| | LN TRANSFORM | | RETRANSFORMED | | | |
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1977	‾0.8965	0.0264	0.409	0.066	2532	6190
1978	‾1.0244	0.0117	0.363	0.039	6246	17228
1979	‾0.7002	0.0090	0.502	0.048	9938	19794
1980	‾0.9716	0.0179	0.381	0.051	5589	14667
1981	‾0.7375	0.0174	0.482	0.063	6096	12656
1982	‾0.4454	0.0100	0.647	0.065	10185	15731
1983	‾0.5110	0.0091	0.607	0.058	11374	18750
1984	‾0.6928	0.0104	0.505	0.052	8705	17223
1985	‾0.6793	0.0100	0.512	0.051	18179	35478
1986	‾0.7963	0.0086	0.456	0.042	18035	39535
1987	‾0.8213	0.0087	0.445	0.041	18652	41927
1988	‾0.7928	0.0092	0.458	0.044	19727	43110
1989	‾0.8419	0.0096	0.436	0.043	13514	31023
1990	‾0.8721	0.0103	0.423	0.043	10620	25134

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.108

TABLE 11. ANALYSIS OF VARIANCE FROM THE REGRESSION OF LN C/E FOR
    SPANISH PAIR TRAWLS FOR COD IN DIVISIONS 3NO.

        REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R............   0.739
MULTIPLE R SQUARED.....   0.546

            ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.254E1	3.254E1	
REGRESSION	26	2.692E1	1.035E0	12.161
TYPE 1	2	1.024E0	5.122E^{-1}	6.017
TYPE 2	1	3.266E^{-1}	3.266E^{-1}	3.837
TYPE 3	11	3.615E0	3.287E^{-1}	3.861
TYPE 4	12	2.081E1	1.734E0	20.366
RESIDUALS	263	2.239E1	8.513E^{-2}	
TOTAL	290	8.185E1		

TYPE 1 - COUNTRY/GEAR/TONNAGE CLASS
     2 - NAFO DIVISION
     3 - MONTHS
     4 - YEARS

TABLE 12. REGRESSION COEFFICIENTS FROM THE REGRESSION OF LN C/E FOR
SPANISH PAIR TRAWLS FOR COD IN DIVISIONS 3NO.

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	19164	INTERCEPT	‾1.607	0.259	290
2	34				
3	1				
4	77				
1	19165	1	0.194	0.070	136
	19166	2	0.582	0.246	10
2	35	3	0.244	0.125	45
3	2	4	0.202	0.311	11
	3	5	0.176	0.270	17
	4	6	0.336	0.261	19
	5	7	0.399	0.240	30
	6	8	0.699	0.239	32
	7	9	0.852	0.246	28
	8	10	0.549	0.250	26
	9	11	0.324	0.247	27
	10	12	0.428	0.241	31
	11	13	0.436	0.241	32
	12	14	0.897	0.251	26
4	78	15	‾1.076	0.161	30
	79	16	1.085	0.207	16
	80	17	‾0.135	0.174	30
	81	18	0.669	0.190	20
	82	19	0.436	0.179	23
	83	20	0.672	0.188	20
	84	21	1.205	0.183	23
	85	22	0.745	0.181	21
	86	23	0.281	0.178	21
	87	24	0.422	0.191	16
	89	25	0.446	0.182	22
	90	26	0.262	0.194	21

CODE 19164 – ESP/PT/TC 4
     19165 – ESP/PT/TC 5
        34 – DIVISION 3N
        35 – DIVISION 3O

TABLE 13. COMMERCIAL CATCH RATE INDEX FOR SPANISH
PAIR TRAWLS FOR COD IN DIVISIONS 3NO.

PREDICTED CATCH RATE

YEAR	LN TRANSFORM		RETRANSFORMED		CATCH	EFFORT
	MEAN	S.E.	MEAN	S.E.		
1977	‾0.7137	0.0246	0.505	0.079	8827	17481
1978	‾1.7896	0.0218	0.172	0.025	5813	33713
1979	0.3716	0.0372	1.485	0.284	13782	9279
1980	‾0.8488	0.0261	0.441	0.071	8999	20415
1981	‾0.0446	0.0269	0.985	0.161	13299	13505
1982	‾0.2773	0.0225	0.782	0.117	14361	18363
1983	‾0.0414	0.0258	0.988	0.158	12320	12464
1984	0.4909	0.0238	1.685	0.259	13590	8066
1985	0.0317	0.0231	1.065	0.161	13682	12849
1986	‾0.4328	0.0217	0.670	0.098	23395	34937
1987	‾0.2913	0.0281	0.769	0.128	15788	20531
1989	‾0.2673	0.0236	0.789	0.121	17904	22679
1990	‾0.4517	0.0280	0.655	0.109	4598	7019

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.159

Table 14. Cod biomass (MT) from random stratified cruises in Division 3N. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	ATC 187 1971	ATC 199 1972	ATC 208-209 1973	ATC 222 1974	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 289+291 1979	ATC 304 1980	ATC 318-319 1981	ATC 328 1982	AN 27 1984	WT 29 AN 43 1985	WT 47 1986	WT 58+59 1987	WT 70 1988	WT 82 1989	WT 95-96 1990	WT 105-106 1991
0-30	375	1593	4611	9691	1012	955	10591	(2221)	5424	3598	369	3229	29835	5943	2404	18475	14585	8034	16512	20104	10230	1141
	376	1499	(682)	1837	783	(162)	383	77	9663	102	868	855	2208	2	1049	391	1883	2876	4454	745	2745	751
Total		3092	5293	11528	1795	1117	10974	2298	15087	3700	1237	4084	32043	5945	3453	18866	16468	10910	20966	20849	12975	1892
31-50	360	2992	(1564)	1910	(927)	(384)	305	1948	4037	2182	1416	1738	3743	1238	7877	9161	1945	1282	494	1202	9486	581
	361	1853	2493	4395	2453	350	3243	2616	5889	8203	2666	4173	(11168)	8125	12838	29220	50957	27584	15887	12722	20240	11883
	362	2520	2230	9416	4102	2231	306	1664	6830	6621	1632	5847	8701	3708	40764	16509	19686	69852	12714	16464	24747	2361
	373	2520	8559	3325	1802	2359	(813)	1030	1749	4300	1838	857	4578	6647	17916	2446	2897	6788	5959	6090	3441	392
	374	931	579	681	266	0	135	(221)	1247	1324	479	0	146	2369	8335	877	769	1058	4032	489	3296	361
	383	674	252	1572	1	17	(13)	46	338	1564	146	0	430	5	295	0	0	818	71	335	326	113
Total		11490	15677	21299	9550	5341	4815	7525	20090	24194	8177	12615	28766	22092	88025	58213	76254	107382	39157	37302	61536	15691
51-100	359	421	(57)	303	251	(6)	(7)	659	147	(76)	190	478	208	13	71	0	134	43	44	21	6	15
	377	100	(35)	535	14	83	283	(15)	1379	130	22	287	428	22	29	13	54	328	0	9	0	0
	382	647	424	2032	7	59	(12)	44	991	2215	220	285	182	36	0	16	61	12	7	419	40	0
Total		1168	516	2870	272	148	302	718	2517	2421	432	1050	818	71	100	29	249	383	51	449	46	15
101-150	358	225	(244)	1030	1721	(66)	(73)	(116)	383	(312)	483	1054	229	236	182	122	547	1803	229	486	159	56
	378	139	575	4028	393	631	(49)	(77)	686	90	281	939	104	303	133	470	256	73	96	81	62	82
	381	182	603	883	1475	228	128	(142)	2797	393	196	427	533	2186	319	1544	747	82	270	39	212	232
Total		546	1422	5941	3589	925	250	335	3866	795	960	2420	866	2725	634	2136	1550	1958	595	606	433	370
151-200	357	164	(52)	(96)	1343	(11)	(13)	(23)	29	(68)	52	332	135	92	0	2102	259	(132)	18	22	62	59
	379	106	(51)	(92)	1776	515	(14)	(23)	50	0	601	178	53	179	129	324	365	4	15	22	61	204
	380	116	(98)	273	1116	180	(29)	(46)	55	(126)	232	57	25	(81)	224	847	135	454	181	176	180	110
Total		386	201	461	4235	706	56	92	134	194	885	567	213	352	353	3273	759	590	214	220	303	373
201-300		420																				351
301-400		352																				6
Total		16682	23109	42101	19441	8236	16394	10969	41698	31305	11694	20737	62706	31184	92564	82515	95278	121222	60981	59425	75294	33620
Mean wt./tow			18.46	33.62	15.53	6.58	13.09	8.76	33.30	25.00	9.34	16.56	50.08	24.90	73.92	65.90	76.09	96.81	48.70	47.46	60.13	14.65
Unadjusted total			20326	41912	18513	7607	15372	8084	41695	30722	11692	20736	51538	31104	92566	82515	95280	121091	60982	59425	75293	18342
Uper limit			39063	57120	27613	13059	36966	13775	62035	38492	16493	28150	120670	46068	123679	108356	162514	159883	80483	81925	98258	33620
Lower limit			1590	26704	9413	2155	-6222	2393	21355	22952	6891	13322	-17595	16141	61452	56675	28046	82300	41481	36925	52329	3064

Table 15. Biomass (MT) from random stratified cruises in Division 3O. Numbers in brackets are estimates for non-sampled strata.

Depth range fath	Strata	Area	ATC 207-209 1973	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 289+291 1979	ATC 303 1980	ATC 318-319 1981	ATC 327-328 1982	ATC 27 1984	ATC 43 1985	ATC 47 1986	AN 58 1987	WT 70 1988	WT 82 1989	WT 94+95 1990	WT[a] 105-106 1991
31-50	330	2089	8986	474	287	592	2218	3753	470	3371	123	3626	4642	2136	5654	2767	1713	2262	90
	331	456	279	728	454	(200)	342	150	609	(422)	38	2630	3423	685	804	1224	183	(919)	98
	338	1898	4174	5558	1874	6947	1334	5729	1795	(5419)	5659	29905	7485	14405	9838	9124	14874	5475	6271
	340	1716	(2491)	2028	2688	298	966	3718	386	4294	2849	6827	5431	5796	77479	12421	2977	6338	70
	351	2520	3003	1561	2681	8134	4334	47954	5629	6621	4498	43255	23490	38217	66032	15852	11619	16567	3890
	352	2580	2986	425	1428	6114	3961	6235	5625	(8585)	6236	34168	29692	15071	49765	57457	34373	28930	16762
	353	1282	3172	77	2	262	84	1573	2	(490)	472	0	6083	951	9610	626	2371	3544	688
Total		12541	25091	10851	9414	22547	13239	69112	14516	29202	19875	120411	80246	77261	219182	99471	68110	64035	27869
51-100	329	1721	205	(200)	6417	180	2008	357	19	517	396	594	840	304	45335	9436	682	1611	1627
	332	1047	(1484)	829	351	939	4525	2266	9	(1824)	3474	2358	13471	2499	9808	8681	1369	8728	4097
	337	948	75	1904	32	629	614	23	133	(525)	610	434	1203	8497	2674	382	2787	1997	2373
	339	585	1086	40	(54)	(84)	249	1475	(39)	505	610	1087	359	29	354	233	146	103	3
	354	474	427	(25)	38	8	(64)	34	273	44	125	489	219	180	2179	530	25	317	2312
Total		4775	3277	2998	6892	1840	7460	4155	473	3415	5215	4962	16092	11509	60350	19262	5009	12756	10412
101-150	333	151	(30)	524	82	0	2	0	28	(38)	153	0	147	232	1057	0	1040	225	500
	336	121	28	0	0	136	3	1	286	(13)	70	0	34	45	17	18	23	191	40
	355	103	74	0	4	(8)	(11)	24	367	32	135	0	135	12	114	19	195	96	86
Total		375	132	524	86	144	16	25	681	83	358	0	316	289	1188	37	1258	512	626
151-200	334	92	(16)	(4)	6	0	6	0	0	(20)	8	0	570	3481	59	248	136	425	776
	335	58	22	(0)	3	(0)	0	0	10	(2)	11	0	0	126	18	39	7	63	2
	356	61	10	(0)	(0)	(2)	(2)	0	49	9	166	0	0	32	7	102	74	142	11
Total		211	48	4	9	2	8	0	59	31	185	0	570	3639	84	389	217	630	789
201-300		245																	11868
301-400		309																	2
Total			28546	14377	16401	24533	20723	73302	15776	32731	25633	125375	97224	92698	280808	119156	74594	77934	
Mean wt./tow			21.24	10.70	12.21	18.26	15.42	54.55	11.74	24.36	19.08	93.30	72.35	68.98	208.97	88.67	55.51	58.00	29.54
Unadjusted total			24527	14148	16346	24238	20647	73304	15735	15393	25632	125373	97223	92699	280807	119157	74595	77016	39697
Upper limit			35742	87352	89006	38369	35818	135612	24518	25204	33925	169977	126100	136099	382599	179304	134314	101143	55540
Lower limit			13312	-59055	-56313	10108	5477	10995	6951	5582	17338	80769	68346	49299	179014	59009	14876	52888	23854

[a] 1991 data are not used to adjust for missing strata; 1991 mean does not include strata >200 fathoms.

Table 16. Cod abundance (000's) from stratified-random cruises in Division 3N. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	ATC 187 1971	ATC 199 1972	ATC 208-209 1973	ATC 222 1974	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 289+291 1979	ATC 304 1980	ATC 318-319 1981	ATC 328 1982	AN 27 1984	WT 29 AN 43 1985	WT 47 1986	WT 58-59 1987	WT 70 1988	WT 82 1989	WT 95-96 1990	WT[a] 105-106 1991
0-30	375	1593	5222	3826	399	1435	6617	(850)	7474	4329	263	508	10583	1578	1746	3184	912	2167	1116	1674	1226	60
	376	1499	(1072)	788	38	(122)	1294	113	3601	225	225	113	225	32	7933	48	177	2813	375	113	177	48
Total		3092	6294	4614	437	1557	7911	963	11075	4554	488	621	10808	1610	9679	3232	1089	4980	1491	1787	1403	108
31-50	360	2992	(4100)	1516	(429)	(552)	2302	3425	4211	1011	1273	2695	524	2118	5679	3004	553	1198	1422	165	569	56
	361	1853	5911	5796	835	904	3624	723	5610	4764	1165	1808	(2978)	4961	3283	10293	3310	10484	2841	1904	2380	817
	362	2520	2554	11823	984	1466	431	1021	5830	7440	757	1204	3859	1608	18970	4385	2392	43871	1702	2605	3443	170
	373	2520	19436	3831	142	426	(1140)	76	946	5959	327	331	1892	1589	8161	769	676	4307	1097	822	227	52
	374	931	1607	175	175	25	140	(100)	1607	1817	297	0	163	1677	2893	175	47	266	363	28	210	14
	383	674	76	1644	51		(72)	17	320	1493	34	0	118	25	34	0	0	422	51	84	25	34
Total		11490	33684	24785	2616	3373	7709	5362	18524	22484	3853	6038	9534	11978	39020	18626	6978	60548	7476	5608	6854	1143
51-100	359	421	(1053)	822	622	(153)	(367)	4709	1359	(749)	561	2133	611	126	95	0	1264	332	269	95	47	32
	377	100	(313)	1066	143	613	413	(50)	2800	105	73	490	1146	278	56	105	23	758	0	19	0	0
	382	647	437	4347	16	130	(149)	24	2639	1943	243	255	146	194	0	134	12	16	24	81	130	0
Total		1168	1803	6235	781	896	929	4783	6798	2797	877	2878	1903	598	151	239	1299	1106	293	195	177	32
101-150	358	225	(1712)	861	4189	(263)	(607)	(284)	262	(1222)	439	1993	135	1343	380	448	760	1478	549	709	456	59
	378	139	636	3673	459	1683	(385)	(180)	657	120	403	1445	193	1236	318	2181	433	151	157	198	172	122
	381	182	1148	779	861	79	156	(171)	3267	364	155	379	779	1851	200	2391	1312	68	191	102	273	55
Total		546	3496	5313	5509	2025	1148	635	4186	1706	997	3818	1107	4430	898	5020	2505	1697	897	1009	901	236
151-200	357	164	(248)	(207)	1157	(34)	(85)	(37)	12	(176)	49	336	37	382	0	2831	137	(206)	6	18	123	148
	379	106	(282)	(236)	1802	785	(98)	(45)	24	0	671	408	40	322	175	525	801	4	8	44	139	406
	380	116	(279)	118	641	70	(97)	(44)	22	(198)	96	26	15	(97)	83	788	136	313	226	118	270	300
Total		386	809	561	3600	889	280	126	58	374	816	770	92	801	258	4144	1074	523	240	180	532	854
201-300		420	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	539
301-400		352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
Total		16682	46082	41506	12940	8739	17975	11869	40640	31913	7008	14124	23440	19420	50107	31262	12943	68855	10397	8772	9866	2373
Mean #/tow			36.80	33.15	10.33	6.98	14.36	9.48	32.45	25.49	5.60	11.28	18.72	15.51	40.02	24.97	10.34	54.99	8.30	7.01	7.88	1.89
Unadjusted total			37027	41062	12511	7615	14976	10108	40641	29569	7030	14125	20464	19321	50006	31260	12943	68649	10399	8778	9867	2372
Upper limit			97726	60525	19420	10765	25131	25080	58111	38156	9512	18899	38028	24878	72633	39382	18459	94509	12770	11226	11844	3550
Lower limit			-23671	21600	5602	4465	4821	-4864	23171	20982	4547	9351	2900	13765	27378	23139	7427	42788	8028	6330	7890	1193

[a] 1991 data are not used to adjust for missing strata; 1991 mean does not include strata >200 fathoms.

Table 17. Abundance (000's) from stratified random cruises in Division 3Ø. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	ATC 207-209 1973	ATC 233 1975	ATC 245 1976	ATC 263 1977	ATC 277 1978	ATC 289+291 1979	ATC 303 1980	ATC 318-319 1981	ATC 327-328 1982	ATC 27 1984	ATC 43 1985	ATC 47 1986	AN 58 1987	WT 70 1988	WT 82 1989	WT 94-95 1990	WT[a] 105-106 1991
31-50	330	2089	2143	418	680	889	1072	3674	1411	941	358	1921	1461	824	3763	993	342	949	86
	331	456	34	49	624	(201)	240	205	1284	(140)	377	993	548	214	650	240	137	(201)	34
	338	1898	2451	4987	3229	9047	1311	2666	1681	(1745)	4103	10116	2390	2976	5303	1781	3818	1371	1382
	340	1716	(1036)	215	4165	258	708	1730	386	859	2340	2898	2734	2576	55431	1178	615	873	186
	351	2520	2837	936	615	4843	2535	39982	1513	3689	8701	18538	4413	32509	28753	2913	1470	2033	315
	352	2580	3409	1289	1791	5965	4648	2292	2113	(2224)	3486	11814	4859	2988	12097	8821	3769	4320	1439
	353	1282	225	706	48	321	1732	4388	48	(209)	257	0	674	165	1700	1674	385	529	69
Total		12541	12135	8600	11152	21524	12246	54937	8436	9807	19622	46280	17079	42252	107697	17600	10536	10276	3511
51-100	329	1721	129	(345)	3682	172	1731	1012	65	129	754	775	501	501	42933	2233	388	1200	1608
	332	1047	(794)	1729	367	1729	7309	2613	118	(613)	5678	236	1839	458	2546	1297	393	1556	19059
	337	948	735	688	356	249	320	516	47	(201)	285	142	939	882	451	249	1281	285	939
	339	585	220	22	(113)	(134)	329	1361	(63)	198	2459	1054	88	29	278	102	15	132	44
	354	474	261	(94)	712	36	(211)	729	2076	107	107	142	261	178	1975	160	36	53	368
Total		4775	2139	2878	5230	2320	9900	6231	2369	1248	9283	2349	3628	2048	48183	4041	2113	3226	22018
101-150	333	151	(15)	958	85	0	4	0	6	(11)	60	0	17	53	340	0	283	74	193
	336	121	9	0	0	141	5	2	95	(3)	27	0	9	45	9	5	5	59	27
	355	103	19	0	4	(15)	(21)	19	128	19	151	0	398	12	54	12	178	50	97
Total		375	43	958	89	156	30	21	229	33	238	0	424	110	403	17	466	183	317
151-200	334	92	(8)	(4)	7	0	2	0	21	(5)	3	0	152	856	14	70	52	235	483
	335	58	7	(0)	1	(0)	0	0	3	(0)	4	0	0	40	4	7	26	26	4
	356	61	2	(0)	(1)	(2)	(3)	5	18	2	48	0	0	0	2	30	37	40	44
Total		211	17	4	9	2	5	5	42	7	55	0	152	905	20	107	93	301	531
201-300																			2347
301-400																			4
Total		17902	14333	12441	16480	24000	22180	61193	11076	11094	29199	48628	21283	45316	156302	21764	13204	13989	26375
Mean #/tow			10.67	9.26	12.26	17.86	16.51	45.54	8.24	8.26	21.73	36.19	15.84	33.72	116.31	16.20	9.83	10.41	19.63
Unadjusted total			12481	11996	16365	23648	21946	61195	11013	5943	29198	48628	21282	45315	156304	21764	13206	13786	26375
Upper limit			16978	72778	36380	38899	54753	115076	18404	11743	45492	63225	27522	101321	237824	28720	19586	17170	72880
Lower limit			7983	-48786	-3649	8397	-10861	7314	3621	144	12904	34031	15043	-10690	74784	14808	6827	10401	-20130

[a] 1991 data is not used to adjust for missing strata. 1991 mean does not include strata >200 fathoms.

TABLE 18. MEAN NUMBER PER TOW AT AGE OF COD FROM RV SURVEYS CONDUCTED BY CANADA IN DIVISIONS 3NO (ADJUSTED FOR MISSING STRATA).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.00	0.01	0.06	0.04	0.41	0.55	0.01	0.55	3.09	0.01	0.32
2	2.56	1.15	2.34	1.13	2.80	3.69	2.28	0.71	0.93	5.29	0.35
3	25.79	8.82	2.38	4.05	4.16	2.74	9.41	7.11	2.33	1.35	4.89
4	3.55	18.88	1.66	0.73	2.34	1.74	6.09	8.22	9.24	0.66	1.43
5	2.71	1.68	2.19	0.36	0.52	1.57	4.49	2.49	7.83	1.05	1.66
6	0.65	0.70	0.44	0.31	0.27	0.25	1.49	0.97	1.76	0.43	2.11
7	0.66	0.57	0.25	0.11	0.53	0.07	0.47	0.61	0.52	0.21	1.03
8	0.29	0.40	0.18	0.03	0.22	0.12	0.21	0.04	0.26	0.18	0.45
9	0.15	0.29	0.19	0.01	0.22	0.06	0.10	0.01	0.10	0.18	0.48
10	0.02	0.17	0.12	0.06	0.07	0.07	0.10	0.03	0.02	0.09	0.22
11	0.05	0.08	0.05	0.02	0.01	0.02	0.01	0.04	0.06	0.05	0.04
12	0.09	0.05	0.08	0.00	0.02	0.00	0.04	0.00	0.00	0.07	0.13
13	0.00	0.00	0.12	0.00	0.01	0.00	0.09	0.04	0.04	0.03	0.05
14+	0.29	0.35	0.44	0.12	0.13	0.05	0.12	0.01	0.10	0.12	0.15
1+	36.80	33.15	10.51	6.98	11.72	10.92	24.90	20.84	26.27	9.71	13.31
2+	36.80	33.14	10.45	6.94	11.31	10.37	24.89	20.29	23.18	9.70	12.99
3+	34.24	31.99	8.11	5.81	8.51	6.68	22.61	19.57	22.25	4.41	12.65
4+	8.45	23.17	5.73	1.75	4.35	3.94	13.21	12.46	19.93	3.05	7.75

	1982	1984	1985	1986	1987	1988	1989	1990
1	1.56	0.01	0.01	0.02	0.21	0.01	0.02	0.04
2	9.35	3.28	0.41	0.70	2.76	1.66	0.25	0.47
3	1.18	6.20	4.47	0.71	2.84	2.20	1.90	0.96
4	3.53	9.90	6.05	7.68	9.29	0.46	1.10	1.34
5	0.60	5.29	2.41	6.44	34.72	0.41	0.28	1.10
6	0.47	5.60	0.88	1.61	21.17	1.05	0.30	0.24
7	0.78	1.87	0.97	0.68	8.30	1.16	0.68	0.47
8	0.58	1.00	0.73	0.65	1.77	0.77	0.62	0.62
9	0.26	1.81	0.88	0.50	1.93	0.81	0.44	0.74
10	0.16	1.57	1.34	0.74	0.69	0.86	0.48	0.52
11	0.07	0.86	0.98	1.20	0.77	0.44	0.64	0.42
12	0.05	0.32	0.49	0.65	0.71	0.55	0.42	0.41
13	0.01	0.11	0.24	0.36	0.81	0.78	0.33	0.22
14+	0.14	0.22	0.39	0.52	0.77	1.23	1.01	1.66
1+	18.73	38.04	20.24	22.44	86.73	12.39	8.47	9.19
2+	17.17	38.03	20.23	22.42	86.52	12.38	8.45	9.15
3+	7.82	34.75	19.82	21.72	83.76	10.72	8.20	8.68
4+	6.65	28.55	15.35	21.02	80.92	8.52	6.30	7.73

1971, 1972, AND 1974 SURVEYS IN DIVISION 3N ONLY

Table 19. Results of a stratified-random survey conducted by Canada during the fall of 1990 in Divisions 3NO.

Depth range (m)	3N			3O			Age	Mean no. per tow (3NO combined)
	Strata	Abundance (000's)	Biomass (t)	Strata	Abundance (000's)	Biomass (t)		
0-30	375	1814	21899	330	1625	2465	1	0.92
	376	1067	2089	331	11	1	2	1.25
Total		2881	23988	338	3437	6639	3	0.95
31-50	360	1492	3727	340	644	1697	4	2.32
	361	1913	14530	351	4634	7031	5	1.37
	362	2218	4180	352	3060	11930	6	0.46
	373	447	4897	353	674	2666	7	0.31
	374	196	1129	Total	14805	32429	8	0.29
	383	84	40	329	215	683	9	0.24
Total		6350	28503	332	196	345	10	0.29
51-100	359	16	1	337	213	1301	11	0.13
	377	49	36	339	73	618	12	0.10
	382	49	47	354	36	2	13	0.14
Total		114	84	Total	733	2949	14+	0.77
101-150	358	127	130	333	6	4		
	378	110	116	336	3	16	Mean	9.55
	381			355			Upper	12.34
Total		237	246	Total	9	19	Lower	6.76
151-200	357	111	128	334	7	8		
	379	56	140	335	4	5		
	380			336				
Total		167	268	Total	11	13		
Total		9746	53088		14840	35409		
Upper limit		13724	96410		21022	47985		
Lower limit		5768	9766		8657	22833		

TABLE 20. PARAMETER ESTIMATES FROM ADAPT USING CANADIAN AND SOVIET
RESEARCH VESSEL RESULTS FOR COD IN DIVISIONS 3NO.

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET.........   0.124467
MEAN SQUARE RESIDUALS 0.889094

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
3	ABUNDANCE	3.29385E3	1.77918E3	1.85133E0	0.54
4	ABUNDANCE	6.70923E3	1.76225E3	3.80719E0	0.26
5	ABUNDANCE	5.94186E3	1.22772E3	4.83975E0	0.21
6	ABUNDANCE	1.39454E3	3.95076E2	3.52980E0	0.28
7	ABUNDANCE	1.12145E3	4.74611E2	2.36289E0	0.42
8	ABUNDANCE	2.42467E3	1.08530E3	2.23411E0	0.45
9	ABUNDANCE	3.12800E3	1.41509E3	2.21047E0	0.45
10	ABUNDANCE	1.76168E3	7.60548E2	2.31634E0	0.43
11	ABUNDANCE	1.28162E3	5.57803E2	2.29763E0	0.44
3	RV1 SLOPE	1.61563E⁻4	4.40005E⁻5	3.67186E0	0.27
4	RV1 SLOPE	2.23131E⁻4	6.05869E⁻5	3.68282E0	0.27
5	RV1 SLOPE	2.16889E⁻4	5.94190E⁻5	3.65016E0	0.27
6	RV1 SLOPE	1.80294E⁻4	5.03670E⁻5	3.57960E0	0.28
7	RV1 SLOPE	1.80156E⁻4	5.16060E⁻5	3.49100E0	0.29
8	RV1 SLOPE	1.57447E⁻4	4.59948E⁻5	3.42315E0	0.29
9	RV1 SLOPE	1.73445E⁻4	5.14642E⁻5	3.37020E0	0.30
10	RV1 SLOPE	2.27483E⁻4	6.77945E⁻5	3.35548E0	0.30
11	RV1 SLOPE	2.37487E⁻4	7.03926E⁻5	3.37375E0	0.30
3	RV2 SLOPE	4.30641E⁻4	1.12978E⁻4	3.81171E0	0.26
4	RV2 SLOPE	3.57411E⁻4	9.36190E⁻5	3.81772E0	0.26
5	RV2 SLOPE	3.14346E⁻4	8.30005E⁻5	3.78728E0	0.26
6	RV2 SLOPE	2.98119E⁻4	8.03123E⁻5	3.71200E0	0.27
7	RV2 SLOPE	2.67154E⁻4	7.38378E⁻5	3.61812E0	0.28
8	RV2 SLOPE	2.24443E⁻4	6.35507E⁻5	3.53171E0	0.28
9	RV2 SLOPE	2.35051E⁻4	6.72983E⁻5	3.49267E0	0.29
10	RV2 SLOPE	2.71492E⁻4	7.81729E⁻5	3.47297E0	0.29
11	RV2 SLOPE	2.13949E⁻4	6.13161E⁻5	3.48928E0	0.29

TABLE 21. RESIDUALS FROM ADAPT USING CANADIAN AND SOVIET RESEARCH
VESSEL RESULTS FOR COD IN DIVISIONS 3NO.

LOG RESIDUALS FOR CANADIAN RV SURVEY INDEX

	1977	1978	1979	1980	1981	1982	1984	1985	1986	1987	1988	1989	1990
3	0.22	⁻0.18	⁻0.28	⁻0.91	0.17	⁻1.11	⁻0.07	⁻0.11	⁻0.54	1.21	0.23	0.35	0.92
4	0.33	0.02	0.02	⁻1.63	⁻0.93	⁻0.22	0.54	⁻0.17	0.37	1.95	⁻0.65	⁻0.42	0.70
5	0.94	⁻0.17	0.48	⁻1.82	⁻0.39	⁻1.48	0.60	⁻0.44	0.32	2.27	⁻0.71	⁻0.51	0.80
6	0.43	0.02	0.10	⁻1.76	⁻0.63	⁻1.16	1.14	⁻0.60	⁻0.04	2.16	⁻0.36	⁻0.08	0.69
7	0.30	⁻0.07	⁻0.20	⁻1.62	⁻0.52	⁻1.34	0.53	⁻0.07	⁻0.34	2.14	⁻0.15	0.06	1.18
8	0.70	⁻1.66	⁻0.51	⁻0.78	⁻0.37	⁻0.54	0.37	0.12	0.23	1.19	0.37	⁻0.01	0.77
9	⁻0.38	⁻2.06	⁻0.59	⁻0.73	0.41	⁻0.66	0.11	0.50	0.04	1.81	0.74	0.17	0.55
10	0.68	⁻1.44	⁻1.37	⁻0.75	⁻0.58	⁻0.63	0.89	⁻0.18	0.41	0.54	1.43	0.35	0.55
11	⁻1.58	0.13	⁻0.55	⁻0.29	⁻1.45	⁻1.46	0.87	0.74	⁻0.08	0.84	0.50	1.72	0.51

SUM OF CANADIAN RV RESIDUALS : ⁻0.9159295387 MEAN RESIDUAL : ⁻0.0078284576

LOG RESIDUALS FOR SOVIET RV SURVEY INDEX

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	0.13	⁻0.21	⁻0.77	⁻0.91	⁻0.51	0.05	⁻0.12	0.63	1.57	1.34	⁻0.07	0.44	⁻0.74	⁻0.93
4	0.63	0.27	⁻1.34	⁻0.61	⁻0.33	0.38	0.40	1.00	1.47	1.59	⁻0.75	⁻1.03	⁻0.89	⁻0.88
5	1.08	0.91	⁻0.74	⁻1.29	⁻0.63	0.98	0.53	1.08	2.00	1.22	⁻1.65	⁻1.79	⁻1.23	⁻0.59
6	0.84	0.94	⁻0.63	⁻0.63	⁻1.70	0.43	1.07	0.89	1.57	1.30	⁻1.40	⁻1.60	⁻0.99	0.01
7	1.24	0.50	⁻0.16	⁻0.25	⁻1.16	⁻0.56	0.70	0.77	1.47	1.18	⁻0.58	⁻1.61	⁻0.86	⁻0.75
8	1.67	0.69	⁻0.43	0.24	⁻0.85	⁻1.96	⁻0.33	0.60	1.11	1.74	0.04	⁻0.58	⁻0.58	⁻1.41
9	0.45	0.63	⁻0.20	⁻0.51	⁻0.77	0.57	0.66	⁻0.69	0.50	1.35	0.63	⁻0.05	⁻0.93	⁻1.75
10	0.53	⁻0.42	0.76	⁻0.11	⁻1.51	0.67	0.50	0.04	⁻0.47	0.80	0.38	0.71	⁻1.40	⁻0.58
11	0.86	⁻1.15	0.07	0.53	⁻0.33	0.11	0.67	⁻0.47	0.36	⁻0.66	0.52	0.23	⁻0.03	⁻0.81

SUM OF SOVIET RV RESIDUALS : ⁻0.9180973868 MEAN RESIDUAL : ⁻0.0072706142

TABLE 22. PARAMETER CORRELATION MATRIX FROM ADAPT USING CANADIAN
AND SOVIET RESEARCH VESSEL RESULTS FOR COD IN DIV. 3NO.

I	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 I	1.00	0.04	0.03	0.03	0.03	0.04	0.05	0.04	0.05	⁻0.21	⁻0.02	⁻0.02	⁻0.02	⁻0.03
2 I	0.04	1.00	0.04	0.04	0.04	0.05	0.06	0.06	0.06	⁻0.09	⁻0.20	⁻0.03	⁻0.03	⁻0.04
3 I	0.03	0.04	1.00	0.05	0.05	0.06	0.08	0.08	0.08	⁻0.07	⁻0.08	⁻0.21	⁻0.04	⁻0.05
4 I	0.03	0.04	0.05	1.00	0.08	0.09	0.11	0.11	0.11	⁻0.07	⁻0.07	⁻0.10	⁻0.22	⁻0.07
5 I	0.03	0.04	0.05	0.08	1.00	0.11	0.14	0.15	0.16	⁻0.08	⁻0.09	⁻0.11	⁻0.16	⁻0.24
6 I	0.04	0.05	0.06	0.09	0.11	1.00	0.17	0.20	0.23	⁻0.09	⁻0.10	⁻0.12	⁻0.16	⁻0.23
7 I	0.05	0.06	0.08	0.11	0.14	0.17	1.00	0.27	0.30	⁻0.12	⁻0.13	⁻0.15	⁻0.19	⁻0.24
8 I	0.04	0.06	0.08	0.11	0.15	0.20	0.27	1.00	0.31	⁻0.10	⁻0.12	⁻0.15	⁻0.20	⁻0.25
9 I	0.05	0.06	0.08	0.11	0.16	0.23	0.30	0.31	1.00	⁻0.12	⁻0.10	⁻0.15	⁻0.20	⁻0.26
10 I	⁻0.21	⁻0.09	⁻0.07	⁻0.07	⁻0.08	⁻0.09	⁻0.12	⁻0.10	⁻0.12	1.00	0.05	0.05	0.06	0.07
11 I	⁻0.02	⁻0.20	⁻0.08	⁻0.07	⁻0.09	⁻0.10	⁻0.13	⁻0.12	⁻0.10	0.05	1.00	0.05	0.06	0.07
12 I	⁻0.02	⁻0.03	⁻0.21	⁻0.10	⁻0.11	⁻0.12	⁻0.15	⁻0.15	⁻0.15	0.05	0.05	1.00	0.08	0.09
13 I	⁻0.02	⁻0.03	⁻0.04	⁻0.22	⁻0.16	⁻0.16	⁻0.19	⁻0.20	⁻0.20	0.06	0.06	0.08	1.00	0.12
14 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.24	⁻0.23	⁻0.24	⁻0.25	⁻0.26	0.07	0.07	0.09	0.12	1.00
15 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.11	⁻0.29	⁻0.30	⁻0.28	⁻0.29	0.07	0.08	0.10	0.13	0.17
16 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.12	⁻0.19	⁻0.36	⁻0.34	⁻0.32	0.08	0.08	0.10	0.14	0.17
17 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.12	⁻0.21	⁻0.28	⁻0.38	⁻0.36	0.08	0.08	0.10	0.14	0.18
18 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.13	⁻0.23	⁻0.30	⁻0.30	⁻0.38	0.08	0.08	0.10	0.14	0.18
19 I	⁻0.20	⁻0.09	⁻0.07	⁻0.07	⁻0.08	⁻0.10	⁻0.12	⁻0.12	⁻0.12	0.08	0.05	0.05	0.06	0.07
20 I	⁻0.02	⁻0.20	⁻0.08	⁻0.07	⁻0.09	⁻0.10	⁻0.13	⁻0.13	⁻0.13	0.05	0.07	0.06	0.07	0.08
21 I	⁻0.02	⁻0.03	⁻0.20	⁻0.10	⁻0.11	⁻0.12	⁻0.16	⁻0.15	⁻0.16	0.05	0.06	0.09	0.08	0.09
22 I	⁻0.02	⁻0.03	⁻0.04	⁻0.22	⁻0.16	⁻0.17	⁻0.20	⁻0.20	⁻0.20	0.06	0.06	0.08	0.12	0.13
23 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.23	⁻0.23	⁻0.25	⁻0.26	⁻0.26	0.07	0.07	0.09	0.13	0.17
24 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.11	⁻0.29	⁻0.31	⁻0.30	⁻0.30	0.08	0.08	0.10	0.13	0.17
25 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.12	⁻0.19	⁻0.36	⁻0.34	⁻0.33	0.08	0.08	0.10	0.14	0.17
26 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.13	⁻0.21	⁻0.28	⁻0.38	⁻0.36	0.08	0.08	0.10	0.14	0.18
27 I	⁻0.03	⁻0.04	⁻0.05	⁻0.07	⁻0.13	⁻0.23	⁻0.31	⁻0.31	⁻0.39	0.08	0.08	0.10	0.14	0.18

I	15	16	17	18	19	20	21	22	23	24	25	26	27
1 I	⁻0.03	⁻0.03	⁻0.03	⁻0.03	⁻0.20	⁻0.02	⁻0.02	⁻0.02	⁻0.03	⁻0.03	⁻0.03	⁻0.03	⁻0.03
2 I	⁻0.04	⁻0.04	⁻0.04	⁻0.04	⁻0.09	⁻0.20	⁻0.03	⁻0.03	⁻0.04	⁻0.04	⁻0.04	⁻0.04	⁻0.04
3 I	⁻0.05	⁻0.05	⁻0.05	⁻0.05	⁻0.07	⁻0.08	⁻0.20	⁻0.04	⁻0.05	⁻0.05	⁻0.05	⁻0.05	⁻0.05
4 I	⁻0.07	⁻0.07	⁻0.07	⁻0.07	⁻0.07	⁻0.07	⁻0.10	⁻0.22	⁻0.07	⁻0.07	⁻0.07	⁻0.07	⁻0.07
5 I	⁻0.11	⁻0.12	⁻0.12	⁻0.13	⁻0.08	⁻0.09	⁻0.11	⁻0.16	⁻0.23	⁻0.11	⁻0.12	⁻0.13	⁻0.13
6 I	⁻0.29	⁻0.19	⁻0.21	⁻0.23	⁻0.10	⁻0.10	⁻0.12	⁻0.17	⁻0.23	⁻0.29	⁻0.19	⁻0.21	⁻0.23
7 I	⁻0.30	⁻0.36	⁻0.28	⁻0.30	⁻0.12	⁻0.13	⁻0.16	⁻0.20	⁻0.25	⁻0.31	⁻0.36	⁻0.28	⁻0.31
8 I	⁻0.28	⁻0.34	⁻0.38	⁻0.30	⁻0.12	⁻0.13	⁻0.15	⁻0.20	⁻0.26	⁻0.30	⁻0.34	⁻0.38	⁻0.31
9 I	⁻0.29	⁻0.32	⁻0.36	⁻0.38	⁻0.12	⁻0.13	⁻0.16	⁻0.20	⁻0.26	⁻0.30	⁻0.33	⁻0.36	⁻0.39
10 I	0.07	0.08	0.08	0.08	0.08	0.05	0.05	0.06	0.07	0.08	0.08	0.08	0.08
11 I	0.08	0.08	0.08	0.08	0.05	0.07	0.06	0.06	0.07	0.08	0.08	0.08	0.08
12 I	0.10	0.10	0.10	0.10	0.05	0.06	0.09	0.08	0.09	0.10	0.10	0.10	0.10
13 I	0.13	0.14	0.14	0.14	0.06	0.07	0.08	0.12	0.13	0.13	0.14	0.14	0.14
14 I	0.17	0.17	0.18	0.18	0.07	0.08	0.09	0.13	0.17	0.17	0.17	0.18	0.18
15 I	1.00	0.20	0.20	0.20	0.08	0.08	0.10	0.13	0.17	0.20	0.20	0.20	0.20
16 I	0.20	1.00	0.22	0.22	0.08	0.09	0.11	0.14	0.18	0.21	0.22	0.22	0.22
17 I	0.20	0.22	1.00	0.22	0.08	0.09	0.11	0.14	0.18	0.21	0.22	0.23	0.22
18 I	0.20	0.22	0.22	1.00	0.08	0.09	0.11	0.14	0.18	0.21	0.22	0.22	0.22
19 I	0.08	0.08	0.08	0.08	1.00	0.05	0.05	0.06	0.07	0.08	0.08	0.08	0.08
20 I	0.08	0.09	0.09	0.09	0.05	1.00	0.06	0.07	0.08	0.09	0.09	0.09	0.09
21 I	0.10	0.11	0.11	0.11	0.05	0.06	1.00	0.08	0.09	0.10	0.11	0.11	0.11
22 I	0.13	0.14	0.14	0.14	0.06	0.07	0.08	1.00	0.13	0.14	0.14	0.14	0.14
23 I	0.17	0.18	0.18	0.18	0.07	0.08	0.09	0.13	1.00	0.17	0.18	0.18	0.18
24 I	0.20	0.21	0.21	0.21	0.08	0.09	0.10	0.14	0.17	1.00	0.21	0.21	0.21
25 I	0.20	0.22	0.22	0.22	0.08	0.09	0.11	0.14	0.18	0.21	1.00	0.22	0.22
26 I	0.20	0.22	0.23	0.22	0.08	0.09	0.11	0.14	0.18	0.21	0.22	1.00	0.23
27 I	0.20	0.22	0.22	0.22	0.08	0.09	0.11	0.14	0.18	0.21	0.22	0.23	1.00

TABLE 23. FISHING MORTALITY MATRIX FOR COD IN DIV. 3NO FROM ACCEPTED
FORMULATION OF ADAPT USING RV INDICES FROM CANADA AND THE USSR.

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	0.036	0.039	0.011	0.011	0.004	0.063	0.007	0.004	0.129	0.196	0.073	0.029
4	0.167	0.186	0.123	0.067	0.076	0.314	0.102	0.167	0.515	0.645	0.234	0.252
5	0.339	0.469	0.594	0.084	0.279	0.393	0.249	0.416	0.933	1.023	0.746	0.314
6	0.518	0.358	0.705	0.144	0.268	0.325	0.511	0.766	0.898	1.177	0.695	0.646
7	0.434	0.396	0.418	0.349	0.263	0.193	0.876	0.738	0.842	0.936	0.371	0.510
8	0.446	0.548	0.541	0.279	0.787	0.237	0.806	1.492	1.310	0.773	0.538	0.560
9	0.342	0.340	0.359	0.431	0.896	0.357	0.383	0.851	0.252	0.445	0.623	0.413
10	0.358	0.294	0.182	0.314	0.912	0.690	1.766	2.232	0.176	0.306	0.503	0.362
11	0.903	0.714	0.027	0.329	0.408	0.117	0.925	0.864	0.555	0.125	0.399	0.970
12	0.413	0.434	0.422	0.342	0.568	0.239	0.845	1.016	0.937	0.833	0.449	0.507

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.012	0.001	0.354	0.192	0.028	0.148	0.013	0.017	0.004	0.013	0.018	0.014
4	0.621	0.377	0.896	0.672	0.435	0.503	0.127	0.122	0.091	0.069	0.067	0.092
5	0.771	0.654	0.557	1.204	0.570	0.599	0.312	0.184	0.410	0.124	0.110	0.132
6	0.669	0.993	0.797	1.066	1.062	0.341	0.292	0.156	0.319	0.166	0.102	0.121
7	0.527	0.880	0.363	0.818	1.060	0.217	0.303	0.103	0.252	0.134	0.204	0.091
8	0.816	0.525	0.335	0.874	1.303	0.198	0.285	0.080	0.104	0.092	0.142	0.244
9	0.329	0.193	0.436	0.709	1.315	0.146	0.267	0.141	0.060	0.048	0.108	0.214
10	0.262	0.230	0.251	1.016	0.849	0.143	0.334	0.096	0.056	0.041	0.063	0.166
11	0.442	0.154	0.224	0.950	1.622	0.047	0.234	0.062	0.029	0.034	0.070	0.147
12	0.572	0.686	0.357	0.836	1.121	0.194	0.120	0.040	0.070	0.040	0.070	0.060

	1983	1984	1985	1986	1987	1988	1989	1990
3	0.036	0.001	0.002	0.021	0.101	0.026	0.235	0.442
4	0.036	0.039	0.092	0.122	0.073	0.083	0.294	1.355
5	0.120	0.104	0.359	0.295	0.215	0.407	0.691	1.647
6	0.140	0.212	0.340	0.464	0.255	0.762	0.707	1.235
7	0.113	0.206	0.374	0.283	0.224	0.522	0.536	0.538
8	0.092	0.167	0.202	0.234	0.189	0.294	0.318	0.398
9	0.193	0.098	0.152	0.212	0.338	0.249	0.224	0.230
10	0.124	0.205	0.076	0.178	0.295	0.284	0.153	0.322
11	0.088	0.074	0.141	0.065	0.293	0.237	0.172	0.139
12	0.050	0.060	0.090	0.100	0.100	0.160	0.140	0.125

TABLE 24. POPULATION BIOMASS AT THE BEGINNING OF THE YEAR (TONS) FOR COD IN
DIV. 3NO FROM ACCEPTED FORMULATION OF ADAPT USING RV INDICES.

I	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3 I	16141	15986	24688	32389	23530	33818	46694	73695	64281	35620
4 I	62365	24892	24572	39033	51229	37446	50763	81358	112682	86734
5 I	19514	65893	29202	30676	51575	67084	38641	67268	101057	92441
6 I	26705	17764	52044	20346	35614	49281	57156	39833	58702	50198
7 I	31795	18835	15278	31625	21666	33507	43799	44624	24099	29961
8 I	13365	20284	13682	10858	24085	17975	29812	21946	25676	11918
9 I	10604	8220	11407	7751	7992	10664	13797	16349	6060	8034
10 I	15023	7253	5631	7666	4847	3138	7181	11603	8605	5214
11 I	10984	9644	5084	4416	5267	1831	1480	1466	1486	6824
12 I	1898	4286	4442	4651	2987	3293	1531	711	748	806
3+I	208393	193057	186031	189411	228792	258036	290855	358852	403397	327752
4+I	192252	177072	161342	157022	205262	224218	244160	285157	339116	292131
5+I	129888	152180	136770	117989	154033	186772	193397	203799	226433	205397

I	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3 I	45056	28343	29061	25009	18798	11741	6501	11493	21687	37195	10997
4 I	44952	64316	42258	47495	37873	13840	16816	12388	16226	32283	40750
5 I	62465	48832	68658	32216	46020	18866	8670	16326	12106	20609	36534
6 I	41948	37414	45041	39514	21398	30688	6765	7169	12253	11406	20293
7 I	19384	26213	24557	27628	19654	11127	12826	3151	6915	12205	11123
8 I	13492	15365	18069	15310	13799	16768	5543	5218	3099	5881	11014
9 I	6380	9134	10176	8978	10432	12860	7072	1883	5299	2635	5169
10 I	5700	3786	6689	8236	9131	6841	6253	2127	1938	4449	2300
11 I	3632	3259	2494	4826	7109	6912	1862	2447	2195	1354	3492
12 I	5689	2303	1168	1506	4568	4522	1885	456	2493	1725	1117
3+I	248697	238966	248170	210718	188782	134165	74193	62659	84210	129742	142790
4+I	203641	210623	219109	185709	169984	122424	67692	51165	62523	92548	131793
5+I	158689	146307	176851	138214	132111	108584	50876	38777	46297	60264	91043

I	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3 I	12173	24381	20860	26725	34437	11135	2222	2045	7674	3669	1275
4 I	14352	17599	25481	20968	28548	30650	19147	3747	3091	8024	4704
5 I	46658	18450	19581	27424	20980	28538	31753	22828	5365	4209	6878
6 I	30623	55936	19672	20211	27807	20491	22366	28230	20063	4830	2735
7 I	18639	33936	62271	20499	20477	24289	18157	16717	21698	12158	2743
8 I	11054	21317	32865	64715	20336	18141	21075	17076	14459	16721	8856
9 I	11869	13007	21583	28006	59272	18602	19635	20413	14017	13812	14951
10 I	5638	14531	12107	17569	22152	55633	20367	18043	13444	11817	13472
11 I	2330	6102	12393	9432	13869	17857	55449	17021	11944	9467	11179
12 I	3667	2198	5375	9637	8464	12371	14857	52312	11035	9027	8342
3+I	157005	207456	232188	245185	256341	237707	225028	198434	122790	93733	75135
4+I	144831	183075	211328	218460	221904	226572	222806	196388	115116	90064	73861
5+I	130479	165476	185848	197492	193356	195923	203659	192641	112025	82041	69157

TABLE 25. AVERAGE POPULATION BIOMASS (TONS) FOR COD IN DIV. 3NO FROM
ACCEPTED FORMULATION OF ADAPT USING RV INDICES.

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3	20091	19866	31100	40809	29735	41553	61746	91285	75006	40277
4	64464	28860	29335	47873	62562	40913	61213	99688	110230	80167
5	18844	59316	24877	32973	50604	62472	38432	64444	74064	65319
6	22912	17007	42771	21503	35527	47893	51086	33415	44864	34319
7	25823	17062	13704	29268	20853	33314	32263	36864	18187	21757
8	10665	15661	10597	9460	16783	15968	20611	12930	15291	8794
9	8878	6884	9470	6229	5260	8861	11330	13834	5984	7268
10	12194	6207	5076	6500	3172	2253	3406	6049	7898	4507
11	7215	6697	4817	3632	4180	1662	941	1213	1094	6111
12	1538	3442	3586	3891	2261	2889	1030	574	492	553
3+	192623	181001	175334	202139	230938	257776	282057	360296	353111	269071
4+	172532	161135	144234	161330	201202	216224	220311	269011	278105	228794
5+	108068	132275	114899	113457	138641	175311	159098	169323	167875	148627

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	53998	34684	37221	30828	16336	14142	8994	13725	26510	39008	12585
4	49930	70863	39475	51293	31307	10451	18120	13769	19577	37462	41245
5	49477	46766	53797	27406	39191	11106	8005	14149	12081	21306	31464
6	34892	31783	37885	28643	16702	20380	5120	7472	12837	11831	18386
7	17949	22802	21207	19632	19851	7979	9231	3184	6669	12932	10105
8	11012	12421	13096	11560	13526	11659	3458	4878	2966	5878	9446
9	5336	8381	9696	8825	10229	10622	3964	2015	5647	2551	4621
10	4508	3190	5899	7495	9317	3699	3716	2263	1726	3868	2181
11	2866	2015	1930	4227	6868	3850	842	2524	2060	1236	3279
12	4604	1816	895	1094	4541	2309	961	580	2390	1609	1011
3+	234573	234721	221101	191003	167867	96197	62409	64560	92463	137680	134323
4+	180574	200038	183879	160174	151531	82056	53416	50834	65953	98672	121738
5+	130644	129175	144404	108882	120224	71605	35296	37065	46376	61210	80493

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	14665	24974	20954	27686	32543	14627	2891	2524	7864	4187	1324
4	15917	20655	25194	20833	29536	27735	23743	4755	3846	7250	3358
5	52348	21096	18106	29674	20552	23863	33293	21195	5216	3524	3848
6	34390	60917	18396	22686	25170	18450	20519	24888	15120	4045	1819
7	21056	33268	64467	23131	18094	22065	18793	15763	17055	11631	2141
8	13257	21703	32298	65397	17576	18479	22062	16521	13033	18768	7500
9	15440	12760	20952	25286	53936	20046	21043	18290	11710	15429	12681
10	6980	13645	11266	15588	19551	58425	20655	15102	10377	12682	11411
11	2530	5286	10879	8283	12744	17036	53233	13457	9901	9273	10025
12	4098	1885	5526	9028	8827	11996	13338	50864	9825	8750	7763
3+	180681	216189	228037	247592	238528	232720	229569	183358	103946	95539	61871
4+	166017	191215	207083	219906	205985	218093	226678	180834	96082	91352	60547
5+	150100	170560	181889	199073	176449	190358	202935	176079	92237	84102	57189

TABLE 26. POPULATION NUMBERS AT THE BEGINNING OF THE YEAR (000s) FOR COD IN
DIV. 3NO FROM ACCEPTED FORMULATION OF ADAPT USING RV INDICES.

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	
3	53698	53181	82135	107755	78281	112506	162747	210231	183377	101615	
4	93901	42416	41871	66511	87294	63808	86501	132329	171441	131962	
5	19498	65084	28843	30300	50942	66261	38167	63934	91681	83864	
6	16469	11378	33335	13032	22811	31565	36609	24354	34537	29533	
7	12362	8032	6515	13486	9239	14289	18678	17977	9267	11521	
8	4272	6561	4425	3512	7790	5814	9642	6369	7040	3268	
9	2889	2238	3106	2110	2176	2903	3756	3526	1173	1555	
10	3400	1681	1305	1776	1123	727	1664	2097	1232	747	
11	2268	1946	1026	891	1062	369	299	233	184	846	
12	334	753	780	817	525	579	269	97	80	87	
3+	209091	193270	203340	240190	261244	298821	358330	461148	500012	364998	
4+	155393	140088	121206	132436	182962	186314	195584	250917	316635	263383	
5+	61491	97672	79335	65924	95669	122506	109083	118588	145194	131421	

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
3	128531	80854	86066	63025	37321	40695	26473	32508	51640	60270	21400
4	68393	97854	64293	69605	51538	21455	27505	21067	22947	41730	48512
5	56669	44301	62288	28299	39075	17222	8969	14574	10431	16554	30241
6	24680	22012	26499	23581	12049	18330	4231	4151	6553	6250	11275
7	7454	10080	9443	11109	7152	4446	5170	1198	2418	4008	4377
8	3699	4213	4954	4565	3772	4072	1607	1467	790	1462	2961
9	1235	1768	1970	1794	2212	2209	1392	357	986	486	1105
10	816	542	958	1160	1211	1171	890	306	253	618	346
11	450	404	309	603	754	771	347	312	217	148	460
12	611	247	125	163	423	494	244	56	243	141	114
3+	292538	262276	256906	203903	155508	110867	76829	75996	96478	131666	120790
4+	164007	181422	170840	140878	118187	70172	50356	43488	44838	71396	99390
5+	95614	83568	106547	71273	66649	48716	22851	22421	21890	29667	50878

|	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	22931	30887	24758	36571	45481	33651	8262	5963	11874	10124	3262
4	17456	18534	24831	19994	28875	37184	27500	6626	4415	9471	6554
5	36255	13337	14187	18540	15784	22736	27772	19922	5043	3327	5780
6	16428	26234	9778	10176	13467	11646	13002	16926	13152	2747	1365
7	6712	11391	19400	7090	7242	8923	6788	6691	10741	5025	1109
8	2785	4807	7605	14501	5184	4825	5026	4190	4381	5215	2407
9	2184	2079	3416	4877	10830	3593	3229	3257	2839	2673	3108
10	852	1705	1528	2258	3292	8036	2526	2139	1902	1812	1750
11	268	669	1311	1060	1634	2197	6097	1731	1304	1173	1272
12	366	212	511	927	795	1242	1563	4676	1057	843	808
3+	106236	109856	107326	115994	132584	134034	101765	72121	56708	42410	27415
4+	83305	78969	82568	79423	87103	100382	93503	66158	44834	32286	24153
5+	65849	60435	57737	59429	58228	63198	66004	59532	40419	22815	17599

Landings ('000 tons)
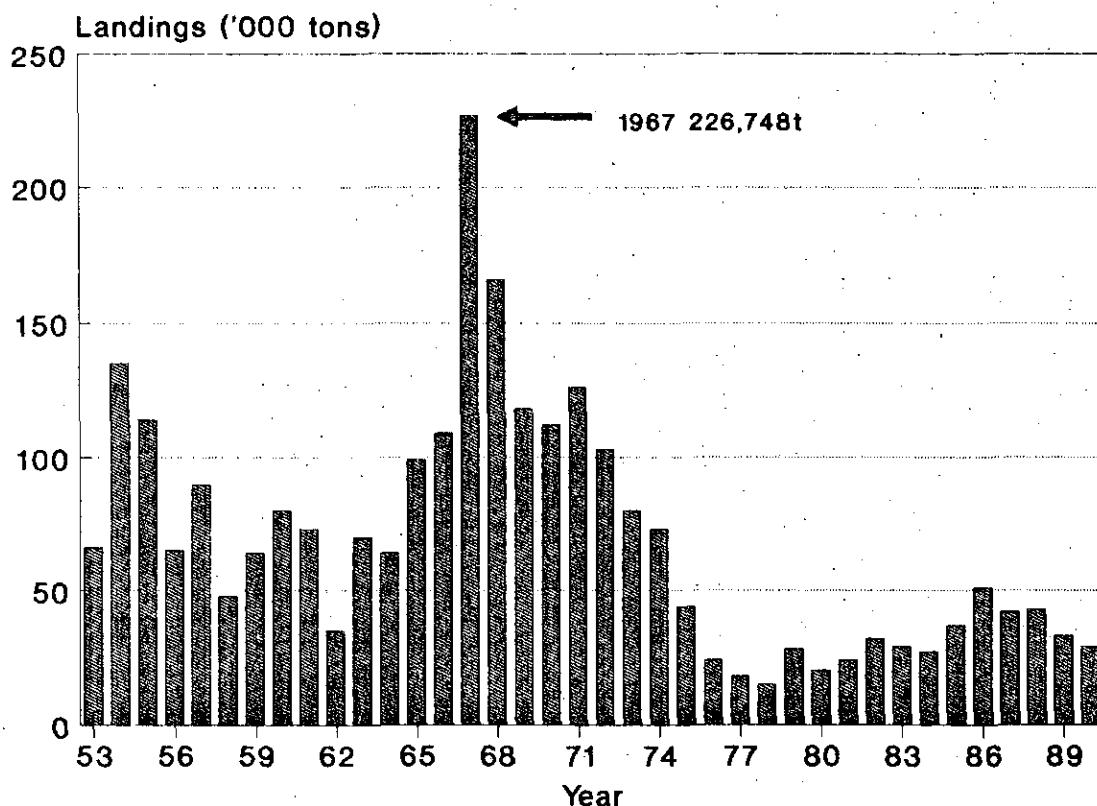
Figure 1. Landings of cod in NAFO
Divisions 3NO for the period 1953-90.
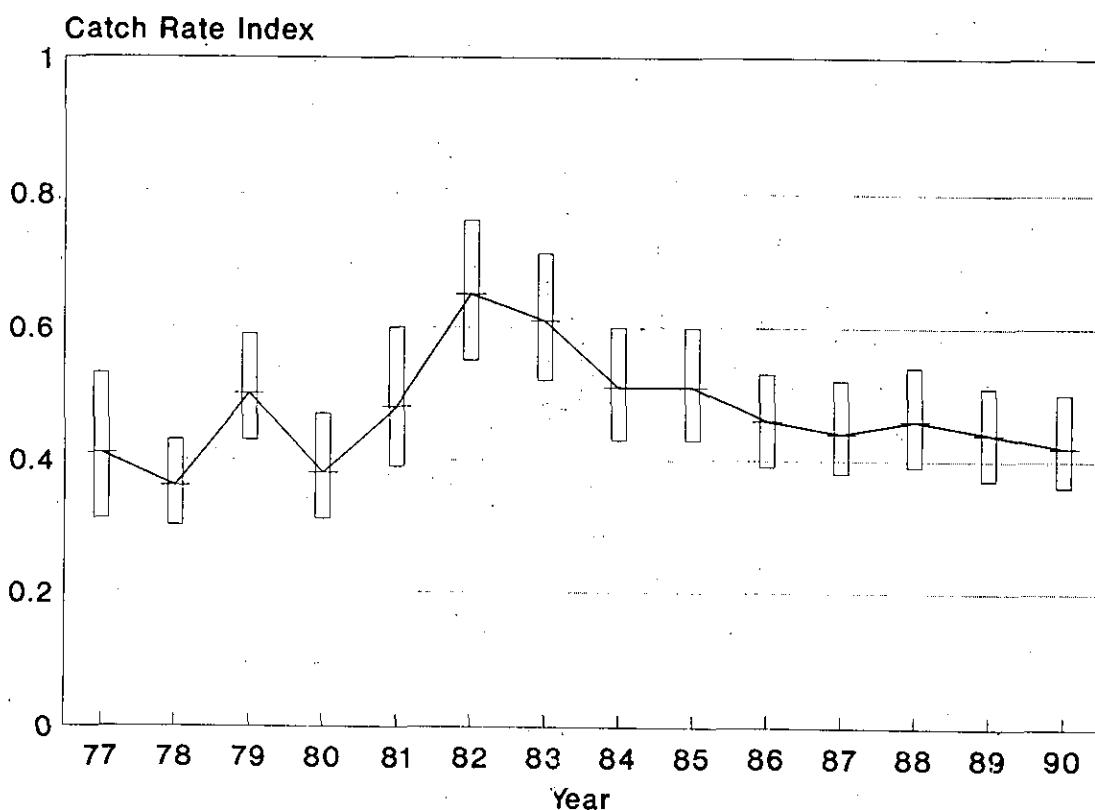
Catch Rate Index

Fig 2. Catch rate index for cod in Div.
3NO by Canadian otter trawls.
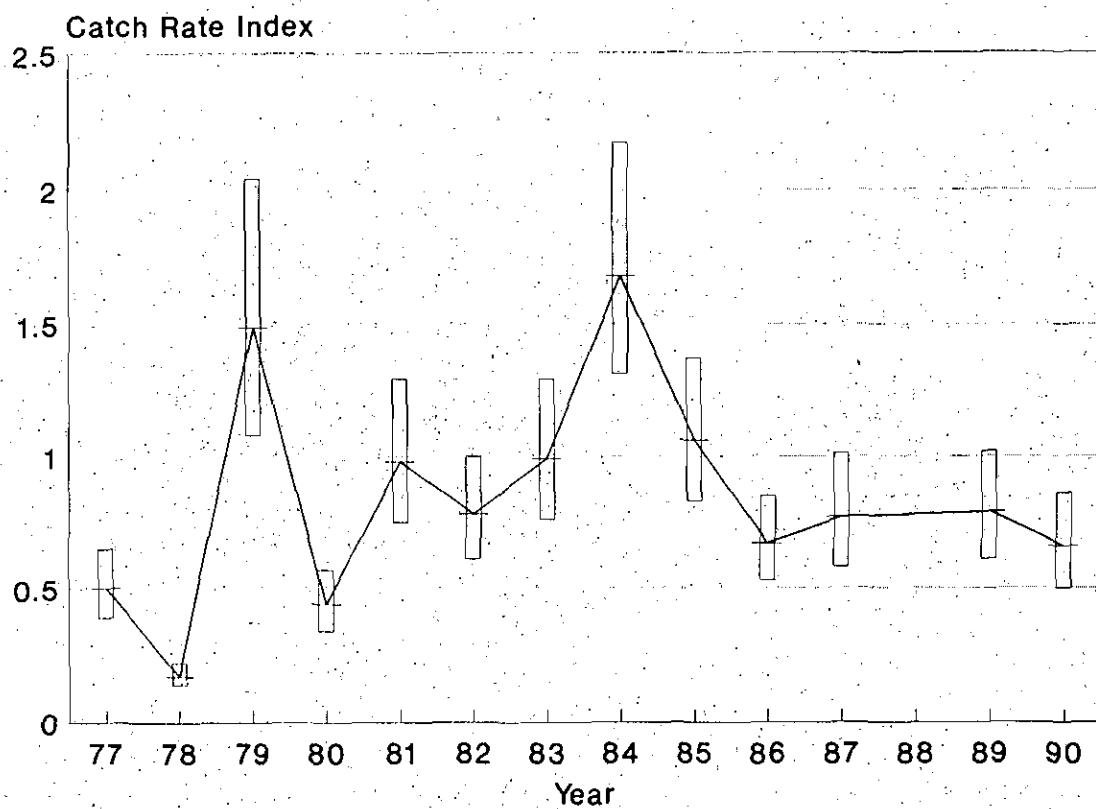
Catch Rate Index

Fig 3. Catch rate index for cod in Div
3NO by Spanish pair trawls.
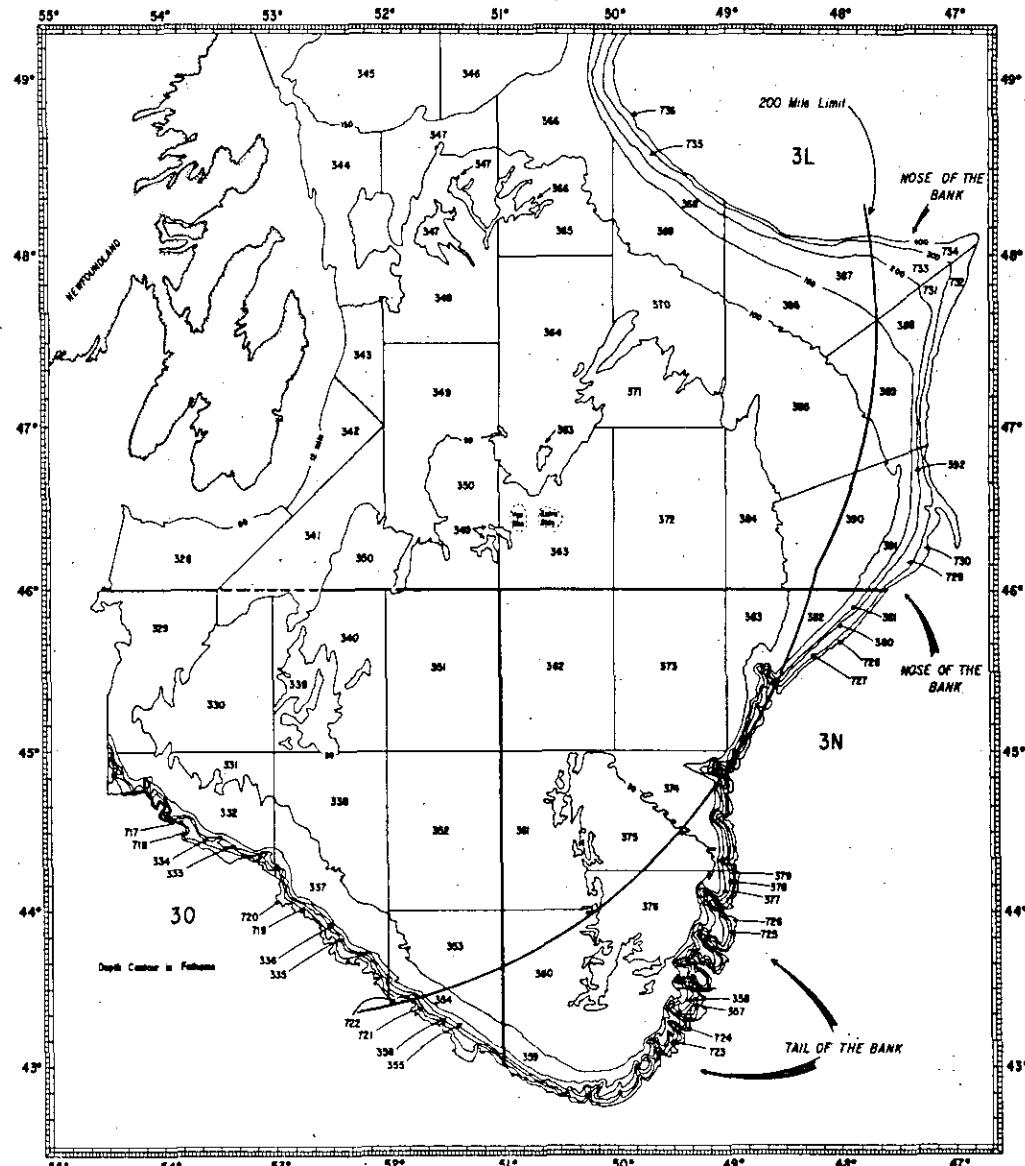
Figure 4. Stratification scheme for NAFO Divisions 3LNO showing
the Canadian 200-mile limit.
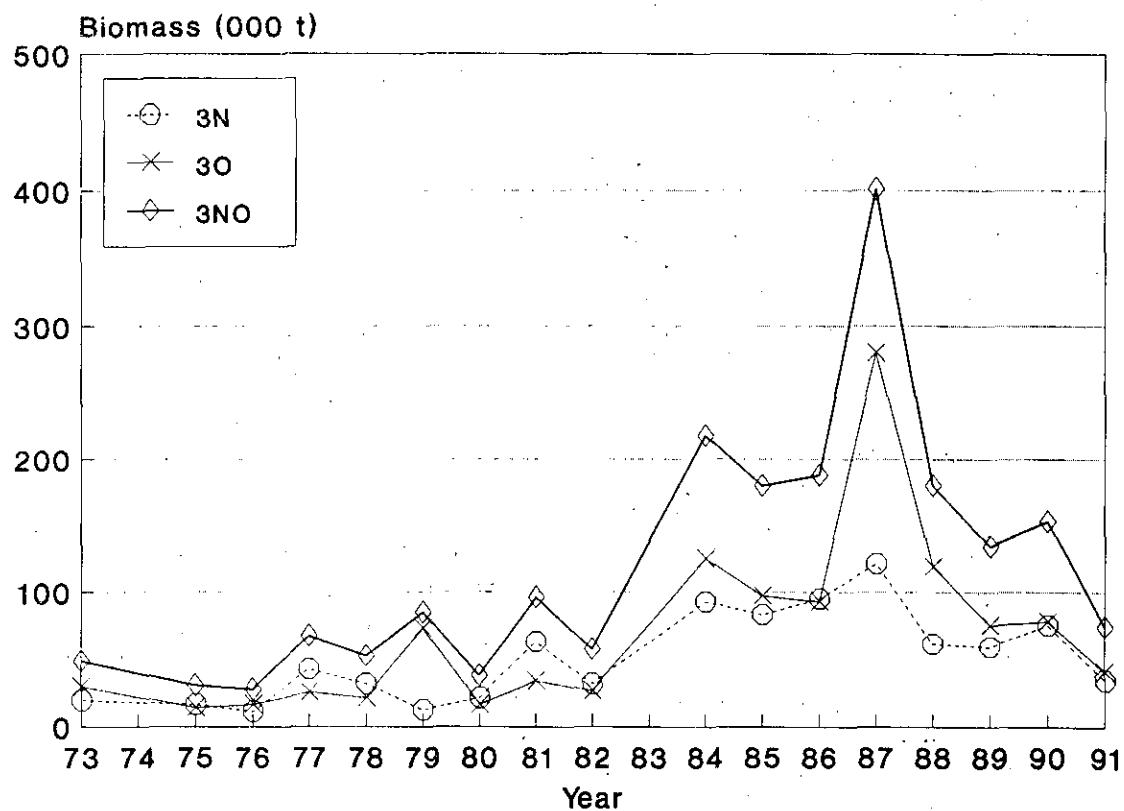
Fig 5. Biomass of cod estimated from
Canadian RV surveys in Divisions 3NO.
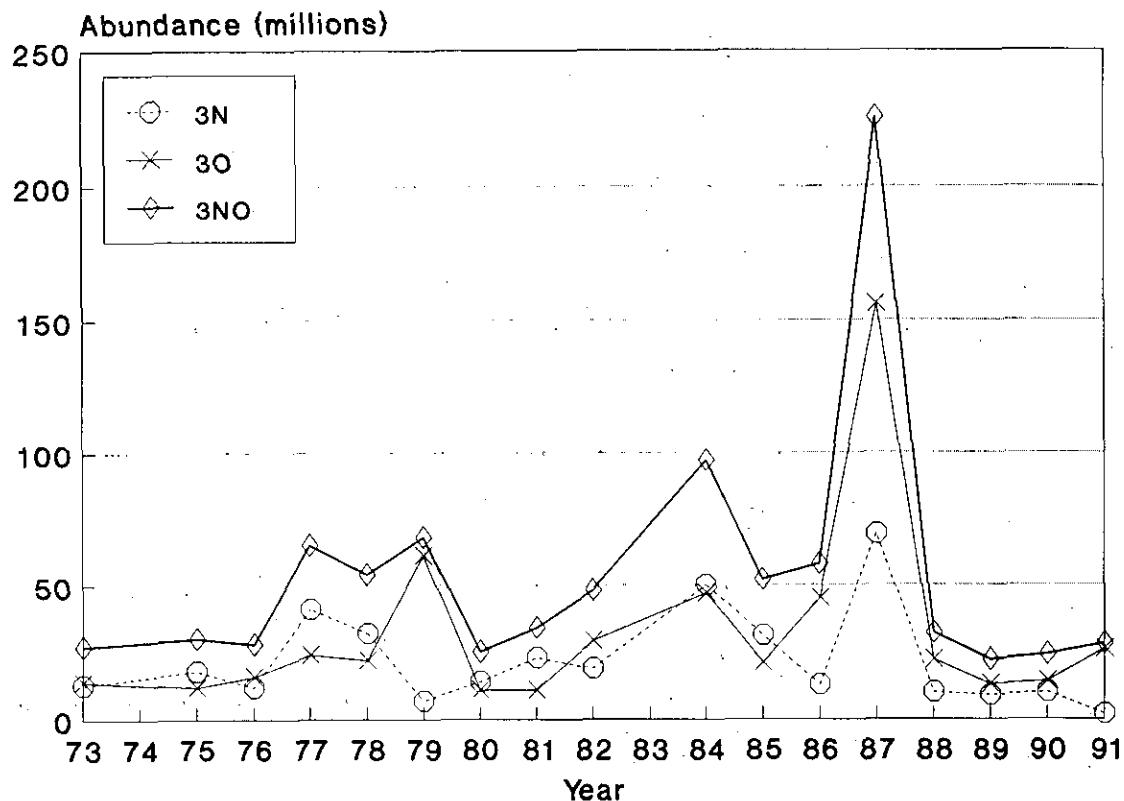
Fig 6. Abundance of cod estimated from
Canadian RV surveys in Divisions 3NO.
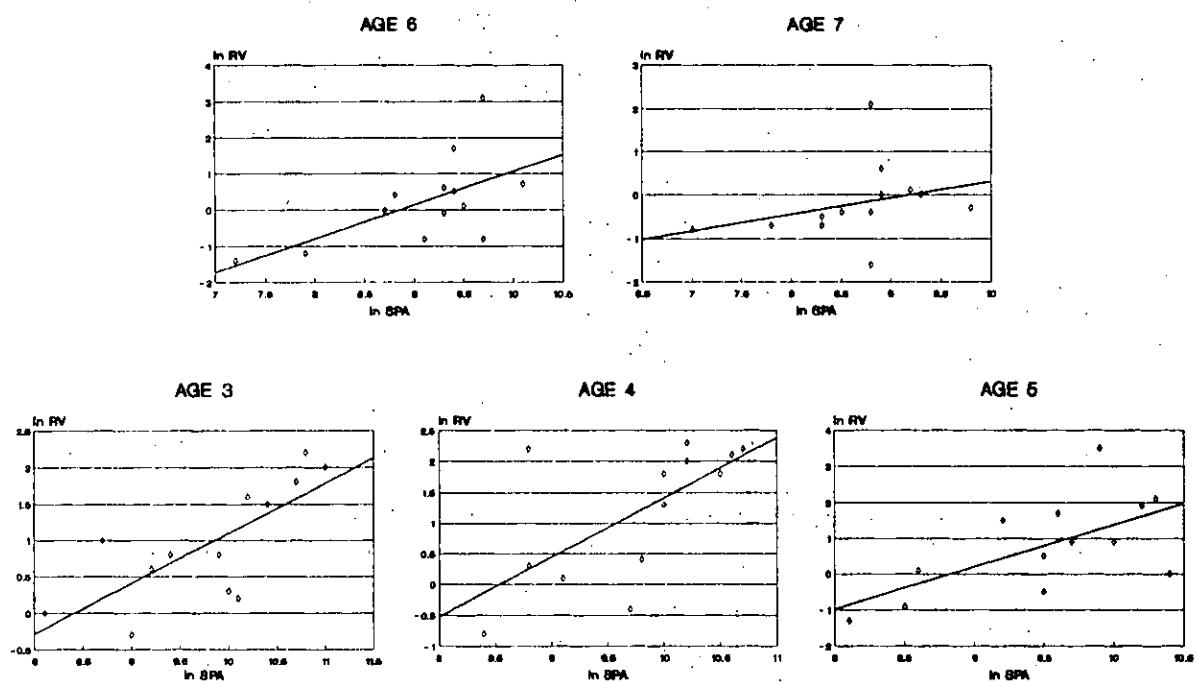
Figure 7. Canadian ln RV versus ln SPA from ADAPT for
cod in Divisions 3NO.
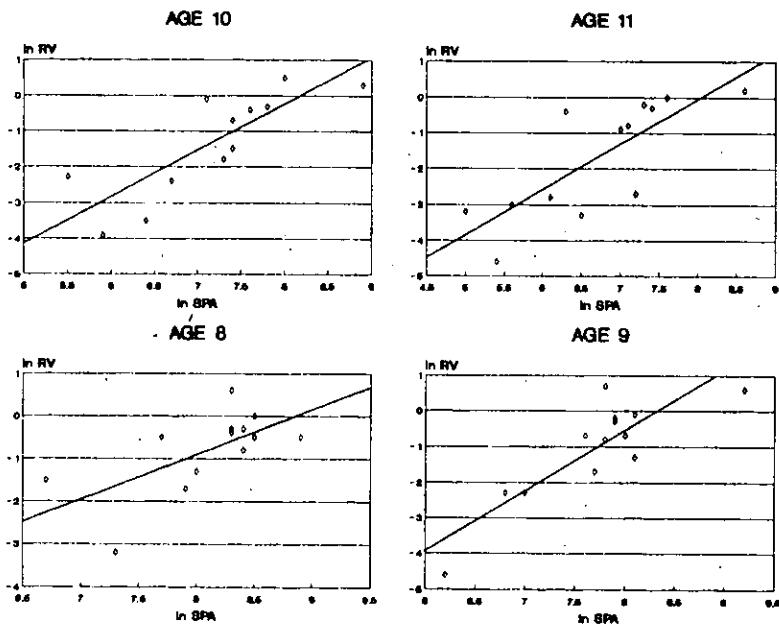
Fig 7. Continued.
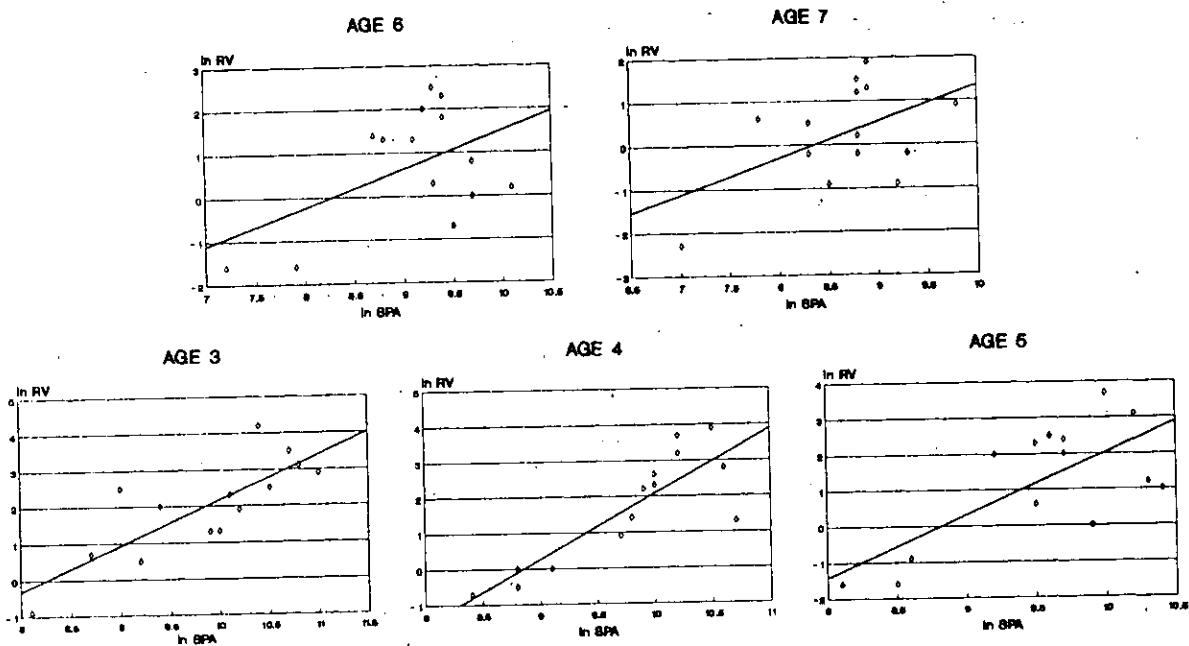
Fig 8. USSR ln RV versus ln SPA from ADAPT for
cod in Divisions 3NO›
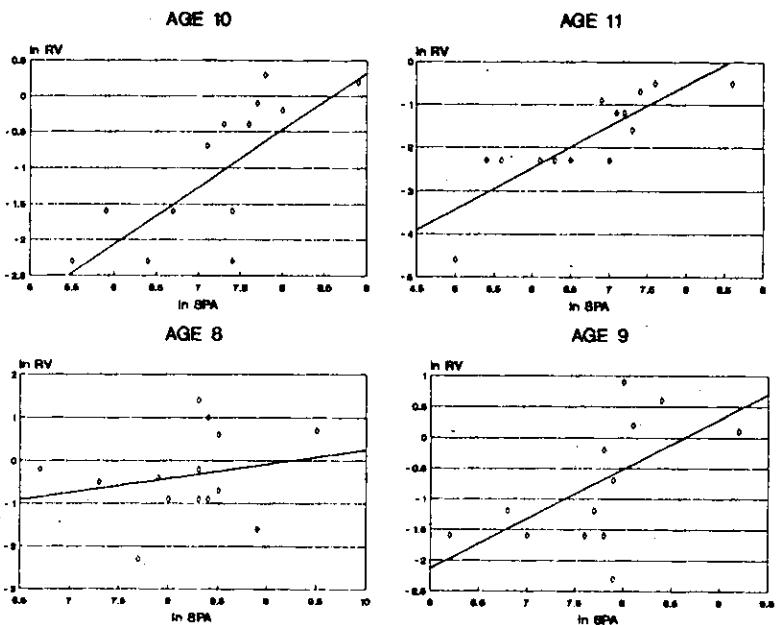
Fig 8. Continued.

Fishing Mortality (Ages 7-10)
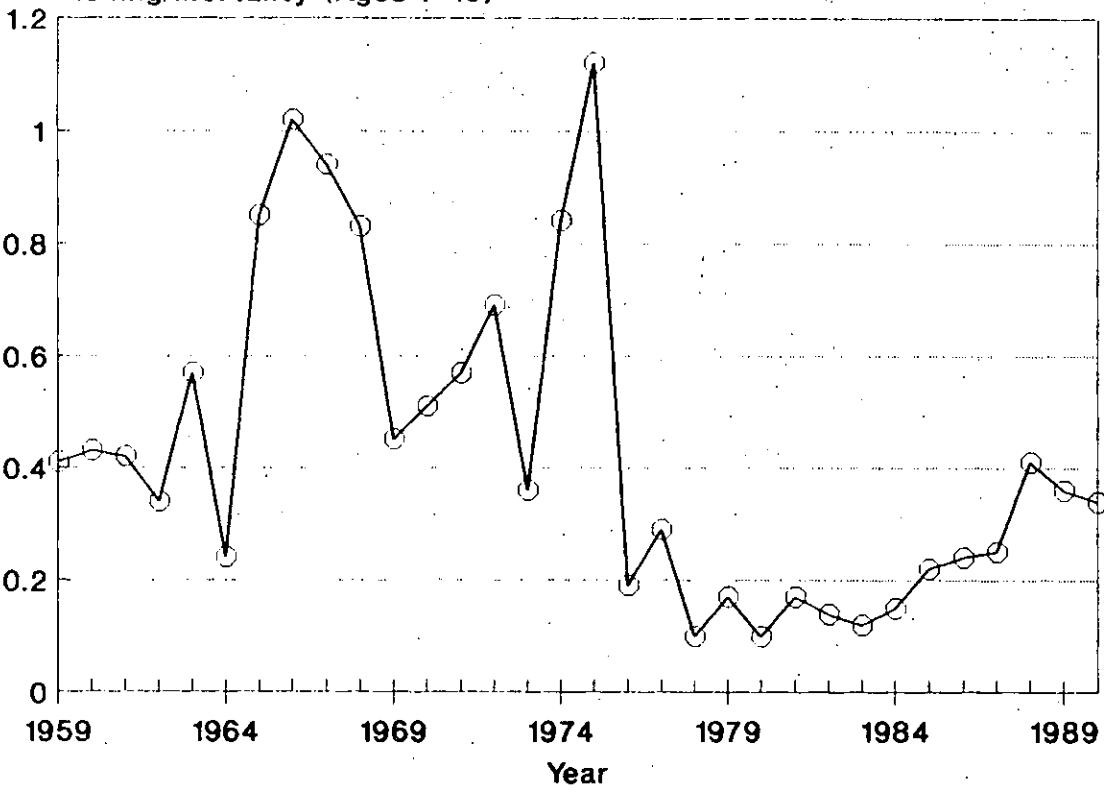
Fig 9. Trends in fishing mortality
(ages 7-10) for cod in Div. 3NO.

Beginning of the year Biomass (tons)
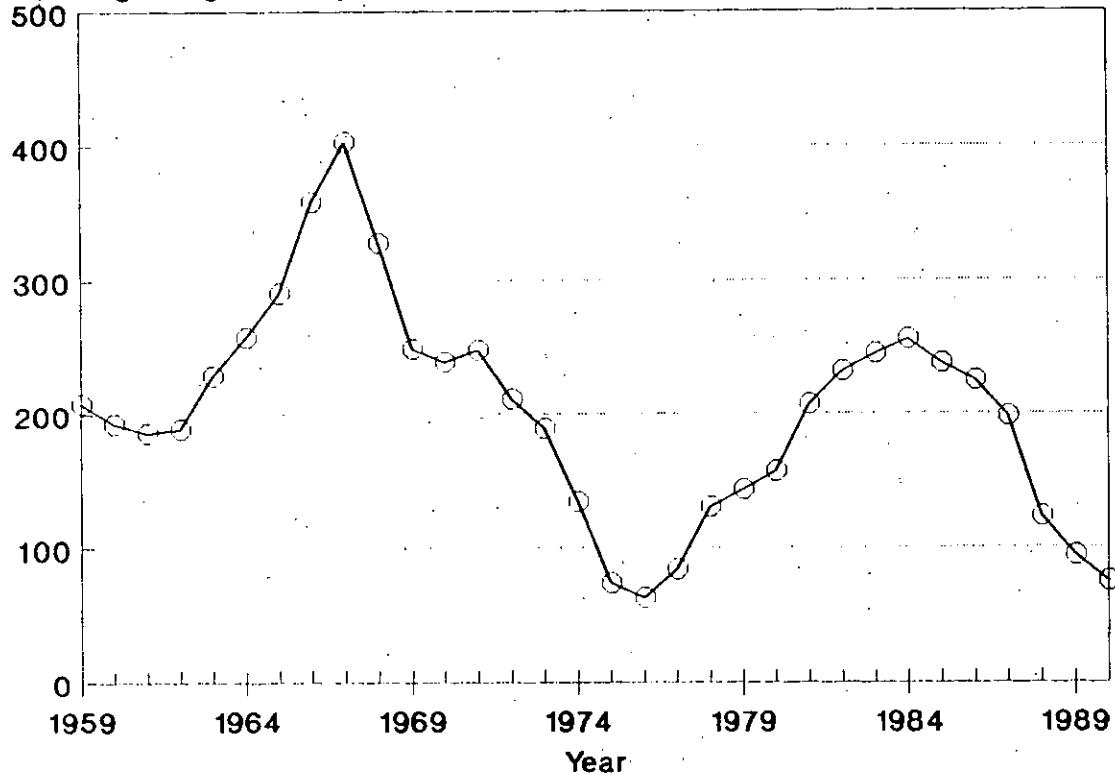
Fig 10. Beginning of the year population
biomass for cod in Div. 3NO.
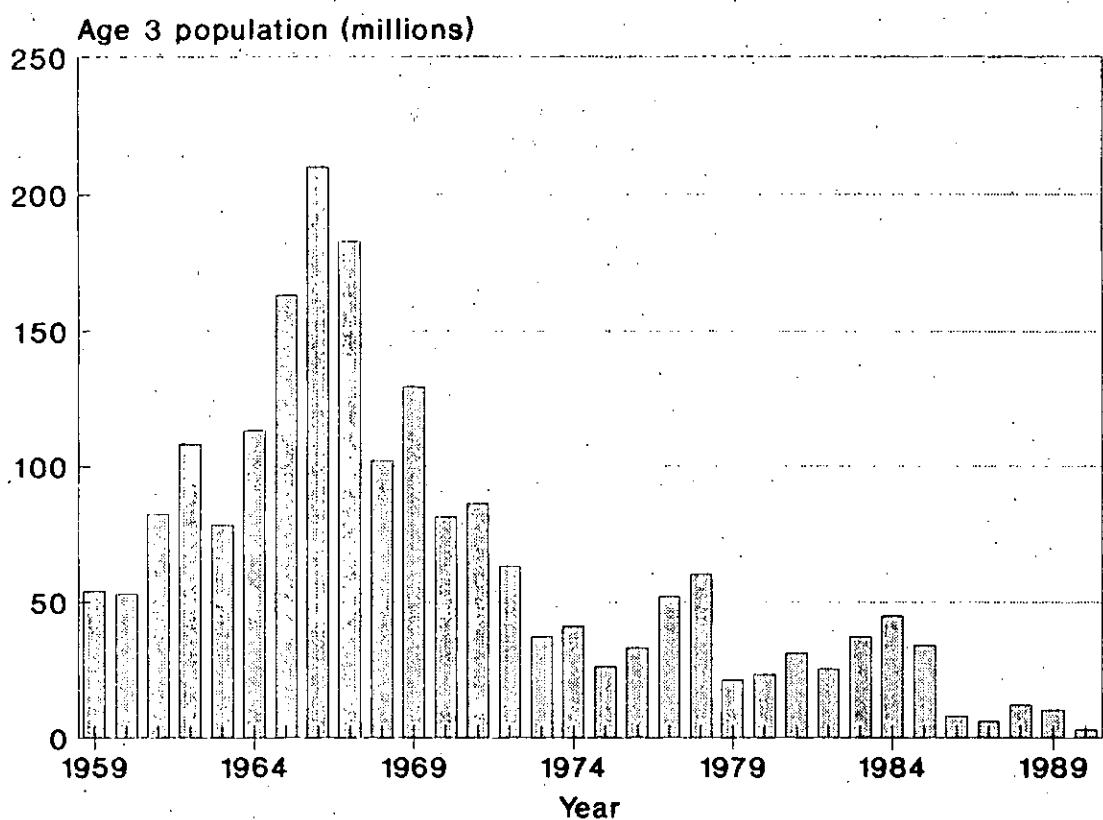
Fig 11. Age 3 population numbers
for cod in Div. 3NO.