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An Assessment of the Cod Stock in NAFO Divisions 3NO

by

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Nominal catch and catch at age

Between the years 1953-92, the highest catch of cod in NAFO Divisions 3NO occurred during 1967 with approximately 227,000 tonnes taken. The lowest catch of 12,561 tonnes occurred during 1992 (Table 1, Figure 1). Prior to 1992, the lowest catch had been in 1978. Several times during the past 15 years the catches have been in excess of the TAC. However, the catch for 1992 marks the first time since 1981 that the TAC has not been exceeded.

Canadian landings by month and division are presented in Table 2. The Canadian fishery occurs throughout the year with peak landings during June and July. During 1992, 83% of the Canadian catch was taken from Division 3O. The catches by other countries, primarily Spain and Portugal, occur in the NAFO Regulatory Area, mainly in Division 3N.

Over the past several years, catches from the Regulatory Area have been those reported by contracting parties combined with estimates from Canadian surveillance authorities. During 1992 surveillance estimates included an additional 2450 tonnes of cod in Divisions 3NO taken by countries fishing in the Regulatory Area. These estimates are incorporated into this assessment.

Sampling data available for the Canadian fishery in 1992 (Table 3), obtained from Canadian port samplers and offshore observers, were used to adjust monthly catches by Canada. In total 13,325 cod were measured for length and 1,276 were aged during 1992. Catch, average weight and average length at age for the 1992 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 most abundant yearclasses in the Canadian fishery during 1992 were the 1981 (age 11) and the 1986 (age 6). The 1985 and 1986 yearclasses had dominated catches from the previous two years.

Catch at age data for the Portuguese fleet fishing in the Regulatory Area were obtained from national research reports (NAFO SCS Doc 93/15). There was no cod sampling in Div. 3NO by Spain in 1992. Spanish catches as well as those estimated from the Regulatory Area were adjusted to catch at age using the sampling from the Portuguese otter trawl fleet. This indicated that the 1989 year class (age 3) was dominant in the otter trawl fisheries in the Regulatory Area (Table 5). It is estimated that in excess of 4.5 million cod were taken in these fisheries. This year class also dominates the 1991 catch in the Regulatory Area with an estimated six million fish taken. The 1981 yearclass, age 11 in 1992 dominated the Portuguese gillnet fishery.

Catch at age and mean weights at age for the 1959-1992 period are presented in Tables 6 and 7 respectively. During recent years the 1981 and 1982 yearclasses have been abundant in the Division 3NO cod catches. Only the 1981 yearclass is still well represented in the 1992 catch. The most abundant yearclasses in 1992 were the 1988 and 1989 or age 3 and 4. This is the second consecutive year that fish as young as these have dominated the catch. These young, small cod were taken in trawl fisheries by Spain, Portugal and non-contracting parties in the Regulatory Area. There does not appear to be any discernable trends in mean weights at age in recent years with the 1992 values somewhat lower but within the range of those recently observed.

Commercial catch and effort

Catch and effort from the Canadian otter trawl fishery was analyzed using a multiplicative model (Gavaris, 1980). Annual catch rates were standardized by country/gear/tonnage class, NAFO division, and month. The

model accounted for nearly 49% 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. There was a sharp decline from 1990 to 1991 with the 1991 value almost half the next lowest value in the 15 year time series. The 1992 value was again lower and now represents the lowest index in the time series.

Although it had been determined that catch rates are not suitable for quantitative calibrations of SPA they are still used to provide a general description of the status of this resource.

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 3.

Biomass estimates for these surveys are presented in Tables 13-14 and in Figure 4. Biomass for Divisions 3N and 3O combined increased gradually from the early 1970's to the early 1980's with a sharp increase between 1982 and 1984. Since 1984 biomass has been declining steadily, with the exception of what appears to be an anomalously high 1987 estimate. The increase in 1987 was caused by a large increase in Division 3O. Preliminary estimates of the Division 3NO total biomass in 1993 increased to about 74000 tonnes, up from 44000 and 58000 in 1992 and 1991 respectively.

Abundance estimates are shown in Tables 11-12 and Figure 5. Trends in Division 3NO cod abundance are similar to those observed for biomass with a large value again occurring in 1987, caused mainly by a high estimate for Division 3O. While the abundances estimated for the 1988 to 1992 period are all among the lowest observed in the Canadian time series of RV abundance for this stock, the 1993 estimate is up considerably. This increase appears to be represented by the 1989 and 1990 year classes.

Age composition data for 1971 to 1992 are presented in Table 15. The age structure for the 1993 survey was not available in time for the current meeting. The dominant age in the 1992 survey was age 3 (the 1989 yearclass) with about 69% of the total abundance occurring at this age. The yearclasses from 1983 to 1988 (ages 4 to 9 in 1992) are among the lowest observed in the time series.

An additional stratified random survey has been conducted by Canada during the fall from 1990 to 1992. The results of these surveys are presented in Tables 16 and 17. Biomass and abundance are down considerably in Division 3O relative to 1990 and 1991 surveys. Biomass estimates in 3N are below the 1991 and 1992 estimates while abundance estimates are higher. This reflects increased numbers of young fish present in the fall surveys in 3N. The age composition from the 1992 survey also indicates that the 1989 yearclass was strong.

Distribution plots of the numbers cod caught per tow during spring surveys from 1979-1992 (excluding 1983-84 where no surveys occurred) are presented in Figures 9-11. Some inter-annual variability can be observed for the years 1979 to 1982. This is followed by constant catches per tow in the mid-eighties to 1990 and low numbers per tow in 1991 and 1992. The last two years are also characterized by one or two very large tows per survey in each year.

Estimation of stock parameters

ADAPT Calibration

The adaptive framework (Gavaris 1988) 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 (1992). The formulation used with ADAPT is described as follows:

Parameters estimated by ADAPT:

- Yearclass estimates
  $N_{i,1992}$ $\quad i = 3$ to 11

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

- $C_{i,t}$ $\quad i = 3$ to 12 $\quad t =$ 1977-92
- $RV(Can)_{i,t}$ $\quad i = 3$ to 11 $\quad t =$ 1977-82, 1984-92
- $RV(USSR)_{i,t}$ $\quad i = 3$ to 11 $\quad t =$ 1977-91

Objective function

- Minimize

$$\sum_{yr}\sum_{age}\{obs(\ln RV(Can)_{i,t})-pred(\ln RV(Can)_{i,t})\}^2 + \sum_{yr}\sum_{age}\{obs(\ln RV(USSR)_{i,t})-pred(\ln RV(USSR)_{i,t})\}^2$$

Summary

- Number of observations = 270
- Number of parameters estimated = 27

The coefficients of variation (CV's) on the age 4 to 11 abundance estimates were in the range of 40% to 50%, while that on age 3 was higher at 91% (Table 19). All research vessel catchabilities were estimated with CV's between 25% and 30%. Residuals indicate that both the Canadian and Soviet survey indices contain several year effects, both negative and positive (Table 20), although they are less pronounced in recent years. The high CV's on most abundance estimates and the patterns observed in the residuals suggest some uncertainty with the results of this analysis. This could be the result of highly variable survey indices as well as poorly estimated removals at age.

Laurec-Shepherd Calibration

An analysis using the Laurec-Shepherd (LS) technique was also conducted using Canadian RV data only from 1984 to 1992 as a survey was not conducted in 1983. A survey was not conducted by Russia in 1992 and consequently this RV index could not be combined with the Canadian RV in a L/S calibration. Most of the structure and data were the same as included in the ADAPT analysis except that the mean of the previous five ages (7-11) was used instead of ages 7-10. The catchabilities at each age showed no discernable trend in recent years (Table 22). Standard errors on catchabilities were large for most ages suggesting a poor fit of the model to the data.

Assessment Results

The results of the two analyses indicate that in 1992 fishing mortalities on most ages were high and that the L/S F's were higher than those for ADAPT.

The L/S analysis was conducted on a shorter data set (CAN RV 1984-92) and the resulting SE estimates for q were large. It was concluded that the results from ADAPT, which included data from both RV indices and for a longer time period, provided the better estimate of F and subsequent stock size.

The results of a cohort analysis using estimates from ADAPT are shown in Tables 23-25 and Figures 6-8.

From 1978 to 1986 F's were less than 0.2 and from 1987 to 1991 were in the range of 0.2 to 0.4. The 1992 mean F for ages 7 to 10 was estimated to be 0.47 (Table 23, Figure 6), although F's on younger ages (4-6) were higher.

Beginning of the year population biomass for ages 3 and older increased in the early 1960's and peaked at about 450,000 tons in 1967 (Table 24, Figure 7). A subsequent decline followed and the estimate for 1976 was 70,000 tons. Biomass again increased and reached 290,000 tonnes in 1984. Another decline occurred in recent years and the age 3+ beginning of the year biomass for 1992 is estimated to be approximately 68,000 tons the lowest estimate since 1976.

Age 3 population estimates from the sequential population analysis are presented in Table 25 and Figure 8. The highest recruitment levels 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 1991 (1983-1988 yearclasses) the lowest in the time series, averaging below 10 million fish. There appears to be some strength in the 1989 yearclass with approximately 35 million fish estimated for this cohort. The geometric mean recruitment for the period of the calibration analyses (1977-92) is about 20 million fish.

References

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

Year	Canada	Spain	Portugal	Russia	Others	Total
1953	39884	12633	7919		5761	66197
1954	17392	88674	24045		4650	134761
1955	6053	64987	27711		15605	114356
1956	5363	42624	15505		1390	64882
1957	9641	51990	21740		6819	90190
1958	4812	29436	11608		2195	48051
1959	3687	39994	17730	48	2911	64370
1960	3408	33972	14347	24204	3746	79677
1961	5428	32284	9059	22854	3099	72724
1962	3235	17413	3653	7971	2712	34984
1963	5079	37632	10004	10184	6843	69742
1964	2882	37185	8095	9510	6789	64461
1965	4229	64652	1692	17166	11448	99187
1966	6501	52533	5070	39023	5792	108919
1967	3446	77948	9703	118845	16842	226784
1968	3287	69752	6752	78820	6900	165511
1969	3664	71160	4940	29173	8768	117705
1970	4771	67034	3185	28338	8233	111561
1971	2311	89915	6589	19307	8174	126296
1972	1736	76324	11537	12198	1579	103374
1973	1832	42403	7759	27849	586	80429
1974	1360	38338	6602	26911	178	73389
1975	1189	16616	5560	20785	24	44174
1976	2065	9880	2620	8992	726	24283
1977	2532	8827	1742	4041	462	17604
1978	6246	5813	641	1819	199	14718
1979	9938	13782	1140	2446	545	27851
1980	5589	8999	1145	3261	997	19991
1981	6096	13299	1091	3187	671	24344
1982	10185	14361	2466	3985	608	31605
1983	11374	12320	1109	3238	778	28819
1984	8705	13590	1071	3306	431	27103
1985	18179	13682	608	3968	462	36899
1986	18035	23395	6890	1181	1144	50645
1987	18652	15788	4108	764	2307	41619
1988	19727	15889	3927	2973	634	43150
1989	13433	17904	913	108	857	33215
1990*	10620	4678	2145	18	11385	28846
1991*	12056	3976	1061	–	12296	29389
1992*	7684	1927	448	51	2450	12561**

* Provisional

** Includes Surveillance Estimates and NAFO Scientific Council Estimates

Table 2. Cod landings (t) from NAFO Divisions 3NO by Canada in 1992 by month.

3N	Can/N						Can/M				3O	Can/N				Can/m					
	OT	DS	SSc	GN	LL	JG	OT	DS	SSc	LL	OT	DS	SS	GN	LL	OT	DS	SS	GN	LL	Totals
J											2			12		59				51	124
F										0	94					205				103	402
M			0				1				438	0	30	101		96		16		62	744
A	6				15		0				163	24	31	64	84	56		15		150	609
M		11	14				1			29	35	0	2	94	117	95				258	656
J	5	2	0				9		2	39	1093	41	47	11		70		55		110	1484
J	8	3	21	12			14	0		49	716	20	51	27	0	73	1	10		19	1023
A	35	5	6	28	6	0	12	1		112	385	0		27	0	2	0			9	628
S	95	1	10		9	1	22	1	0	207	186	1	3		1	2	0	0		50	588
O	36	6	26	88	4	0	0	0		105	19	1	1	189	0	7	0			19	503
N							13			29	128	1	3	189		2				22	388
D							0			10	190	9	29	119		56			118	4	535
Total	185	28	77	128	35	1	72	3	2	580	3448	97	197	833	202	723	1	96	118	857	7684

Table 3. Commercial sampling by Canada in NAFO Divisions 3NO During 1992.

						Landings (Tonnes)	
			No.		No.		Total
Quarter	Gear	Division	Aged	Month	Measured	Month	(3NO)
1	OT	3O	101	Jan		2	61
				Feb	220	94	299
				Mar		438	535
2	OT		222	Apr		163	225
				May		35	131
				Jun	907	1093	1177
3	OT		561	Jul	1795	716	811
				Aug	919	385	434
				Sep	450	186	305
4	OT		112	Oct		19	62
				Nov	248	128	143
				Dec*		190	246
1-4		3O	996		4539		4429
1	SS	3O	33	Mar	157	30	46
2	SS		120	Apr	249	31	46
	SS			Dec*			280
1-4		3O	153		406		372
3	GN	3N	74	Aug	173	28	55
				Dec*			73
1-4		3N	74		173		128
2	GN	3O	53	Jun	230	11	11
				Dec*			940
1-4		3O	53		230		951
3	LL	3N	a	Jul	188	49	49
				Aug	2061	118	118
				Sept	1799	216	216
4				Oct	309		148
1-4		3N			4357		614
1	LL	3O	b	Jan	588	51	
				Mar	484	62	216
2				Apr	910	234	
				Jun	612	110	719
3				Aug	418	9	79
				Sep	548	51	
				Oct	60	45	45
1-4					3620		1059
1-4	ALL	3NO	1276	Apr	13325		7684**

* Includes landings for months where no sampling occurred.

** Includes 129 tonnes from Danish seine fishery

a. A/L keys were used from OT qtr's 3 and 4

b. A/L keys were used from OT qtr's 1 to 4.

Table 4. Catch, average weight and length at age for the cod fishery by Canada in Divisions 3NO during 1992.

Age	Average Wt (Kg)	L. (cm)	Catch Mean	Std. Err	C.V.
3	0.575	40.56	21	3.6	0.17
4	1.015	48.63	25	4.86	0.2
5	1.322	52.89	34	4.94	0.15
6	2.351	63.57	112	7.7	0.07
7	3.197	70.24	75	6.32	0.08
8	5.195	82.30	42	6.28	0.15
9	6.215	87.46	66	7.43	0.11
10	7.872	94.42	94	7.77	0.08
11	8.607	97.15	123	8.78	0.07
12	10.66	103.81	78	6.2	0.08
13	12.7	110.12	56	4.97	0.09
14	13.49	112.16	49	4.84	0.1
15	15.4	117.21	27	3.02	0.11
16	16.18	119.38	21	2.63	0.13
17	16.41	119.89	9	1.61	0.18
18	16.23	118.64	5	1.22	0.27
19	16.24	119.54	1	0.69	0.52

Table 5. Catch and average weight at age of cod from the fisheries in NAFO Divisions 3NO during 1992.

Age	Canada OT		LL		All Gears		Spain		Portugal		Other		Total Number	Total Weight
	Number	Wt (Kg)	Number	Wt (Kg)	Number	Wt (Kg)	Number	Wt (Kg)	Number	Wt (Kg)	Number	Wt (Kg)		
2							35	0.25	4	0.25	44	0.25	83	0.25
3	21	0.58			21	0.58	1091	0.33	192	0.33	2404	0.33	4529	0.33
4	25	1.02	2	1.21	27	1.03	734	0.64	75	0.64	933	0.64	1796	0.65
5	34	1.32	15	1.28	49	1.31	332	1.04	34	1.04	422	1.04	826	1.07
6	112	2.35	32	1.93	144	2.26	198	1.65	22	1.74	290	1.65	756	1.88
7	75	3.2	19	2.95	94	3.15	59	2.6	7	2.74	75	2.6	329	2.92
8	42	5.2	10	5.12	52	5.18	5	3.39	1	3.39	6	3.39	116	5.00
9	66	6.22	17	5.46	83	6.06	7	2.76	1	6.15	8	2.76	182	5.79
10	94	7.87	19	7.27	113	7.77	6	4.6	1	8.34	8	4.6	261	7.59
11	123	8.61	22	8.33	145	8.57			8	9.91			298	8.69
12	78	10.66	19	10.56	97	10.64			3	10.61			197	10.64
13	56	12.7	16	12.94	72	12.75	2	13	1	12.95	2	13	149	12.76
14	49	13.49	12	13.6	61	13.51			1	13.32			123	13.51
15	27	15.4	6	15.56	33	15.43			1	14.32			69	15.41
16	21	16.18	5	16.69	26	16.28							52	16.28
17	9	16.41	2	16.63	11	16.45							22	16.45
18	5	16.23	1	15.6	6	16.12							12	16.12
19	1	16.24			1	16.24							2	16.24
20+														
Numb	836		197		1035		3267		351		4152		5860	
Weigh	6009		1674		7683		1928		448		2450		12561	
Av. W	7.17		8.50		7.42		0.59		1.28		0.59		1.28	

TABLE 6. CATCH AT AGE FOR DIV. 3NO COD, 1959-92

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	1711	1846	812	1026	313	6202	1013	753	20086	16359	8154	2105
4	13036	6503	4400	3882	5757	15555	7611	18413	62442	56775	12924	19703
5	5068	22050	11696	2206	11210	19496	7619	19681	50317	48608	26949	10799
6	6025	3095	15258	1581	4849	7919	13258	11795	18517	18485	11191	9481
7	3935	2377	2014	3594	1935	2273	9861	8486	4774	6337	2089	3646
8	1392	2504	1672	773	3840	1109	4827	4467	4651	1592	1393	1635
9	757	583	847	668	1165	788	1081	1829	236	505	518	541
10	926	387	196	433	608	328	1248	1694	180	178	292	149
11	1220	898	25	226	322	37	163	122	71	90	134	227
12	103	242	245	216	208	112	141	57	45	45	202	90
13	1128	1409	392	846	473	56	276	183	335	51	574	1472
3+	35301	41894	37557	15451	30680	53875	47098	67480	161654	149025	64420	49848
4+	33590	40048	36745	14425	30367	47673	46085	66727	141568	132666	56266	47743
5+	20554	33545	32345	10543	24610	32118	38474	48314	79126	75891	43342	28040
6+	15486	11495	20649	8337	13400	12622	30855	28633	28809	27283	16393	17241

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	950	69	10058	6425	671	4054	607	920	72	266	505	305	1179	58
4	26900	19797	27600	9501	8781	7534	2469	4337	3827	1055	1091	1978	647	1000
5	30300	12289	15098	10907	3528	5945	2531	2518	9208	3812	1262	1591	1893	1411
6	11700	13432	5989	10872	2505	1084	1500	818	2784	2275	2297	1012	1204	2324
7	3500	5883	1971	2247	3057	211	572	354	883	761	1902	1528	686	1220
8	2500	1686	972	2147	1059	238	177	102	265	222	574	1492	1152	720
9	500	285	707	1015	921	44	209	58	58	92	192	595	774	918
10	200	216	243	676	461	37	65	51	17	31	94	211	238	551
11	100	78	137	428	252	13	41	8	12	8	41	162	81	106
12	50	74	116	257	152	9	25	5	7	13	13	27	41	42
13	700	350	173	881	396	17	36	21	16	2	32	52	36	70
3+	77400	54159	63064	45356	21783	19186	8232	9192	17149	8537	8003	8953	7931	8420
4+	76450	54090	53006	38931	21112	15132	7625	8272	17077	8271	7498	8648	6752	8362
5+	49550	34293	25406	29430	12331	7598	5156	3935	13250	7216	6407	6670	6105	7362
6+	19250	22004	10308	18523	8803	1653	2625	1417	4042	3404	5145	5079	4212	5951

	1985	1986	1987	1988	1989	1990	1991	1992
3	57	153	516	277	1917	1064	1103	4529
4	2953	2865	422	318	2182	4505	673	1796
5	6203	6423	3491	1527	1502	4341	995	886
6	3036	4370	3445	6347	1260	895	544	756
7	2519	1512	1213	3955	1887	422	282	329
8	797	948	653	1009	1284	721	368	116
9	459	558	845	567	485	581	568	182
10	533	373	494	425	233	439	502	241
11	261	349	398	249	168	150	383	298
12	97	135	404	142	100	83	202	197
13	71	86	188	298	285	106	337	427
3+	16986	17772	12069	15114	11303	13307	5957	9757
4+	16929	17619	11553	14837	9386	12243	4854	5228
5+	13976	14754	11131	14519	7204	7738	4181	3432
6+	7773	8331	7640	12992	5702	3397	3186	2546

TABLE 7. WEIGHT AT AGE FOR DIV. 3NO COD, 1959-92

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
3	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.48	0.48	0.48	0.48	0.48	0.48
4	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.90	0.90	0.90	0.90	0.90	0.90
5	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.35	1.35	1.35	1.35	1.35	1.35
6	1.95	1.95	1.95	1.95	1.95	1.95	1.95	2.14	2.14	2.14	2.14	2.14	2.14
7	2.82	2.82	2.82	2.82	2.82	2.82	2.82	3.16	3.16	3.16	3.16	3.16	3.16
8	3.39	3.39	3.39	3.39	3.39	3.39	3.39	4.21	4.21	4.21	4.21	4.21	4.21
9	3.98	3.98	3.98	3.98	3.98	3.98	3.98	6.34	6.34	6.34	6.34	6.34	6.34
0	4.68	4.68	4.68	4.68	4.68	4.68	4.68	7.69	7.69	7.69	7.69	7.69	7.69
1	5.25	5.25	5.25	5.25	5.25	5.25	5.25	8.46	8.46	8.46	8.46	8.46	8.46
2	6.17	6.17	6.17	6.17	6.17	6.17	6.17	10.24	10.24	10.24	10.24	10.24	10.24
3	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
3+	44.23	44.23	44.23	44.23	44.23	44.23	44.23	58.47	58.47	58.47	58.47	58.47	58.47
4+	43.81	43.81	43.81	43.81	43.81	43.81	43.81	57.99	57.99	57.99	57.99	57.99	57.99
5+	42.99	42.99	42.99	42.99	42.99	42.99	42.99	57.09	57.09	57.09	57.09	57.09	57.09
6+	41.74	41.74	41.74	41.74	41.74	41.74	41.74	55.74	55.74	55.74	55.74	55.74	55.74

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	0.54	0.57	0.42	0.38	0.50	0.57	0.72	0.65	0.71	0.90	0.94	0.85	0.79
4	0.97	1.00	0.73	0.89	0.91	1.00	1.05	0.98	1.04	1.27	1.17	1.17	1.13
5	1.44	1.43	1.20	1.28	1.41	1.48	1.55	1.39	1.69	1.84	1.50	1.87	1.51
6	2.08	2.19	1.96	2.13	2.33	2.48	2.25	2.09	2.50	2.69	2.20	2.63	2.28
7	2.89	3.63	2.86	3.14	3.25	3.51	3.74	2.87	3.69	3.55	3.83	3.80	3.04
8	3.56	4.63	4.67	4.16	4.03	4.74	4.61	3.70	5.49	5.33	5.26	5.20	4.05
9	5.95	6.25	7.32	5.53	6.67	7.17	6.19	4.75	7.98	7.13	7.49	6.27	5.76
0	7.95	9.56	5.46	6.74	8.74	8.81	7.23	7.15	9.22	9.10	8.80	8.08	7.22
1	8.32	11.17	8.40	5.27	9.14	11.70	9.48	7.98	10.60	9.01	9.82	8.99	8.92
2	10.14	13.99	7.51	7.09	12.49	11.47	12.87	10.11	12.61	10.15	12.28	11.01	12.61
3	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50	13.50
3+	57.34	67.92	54.03	50.11	62.97	66.43	63.19	55.17	69.03	64.47	66.79	63.37	60.83
4+	56.80	67.35	53.61	49.73	62.47	65.86	62.47	54.52	68.32	63.57	65.85	62.52	60.04
5+	55.83	66.35	52.88	48.84	61.56	64.86	61.42	53.54	67.28	62.30	64.68	61.35	58.89
6+	54.39	64.92	51.68	47.56	60.15	63.38	59.87	52.15	65.59	60.46	63.18	59.48	57.38

	1985	1986	1987	1988	1989	1990	1991	1992
3	0.48	0.39	0.49	0.74	0.51	0.55	0.55	0.33
4	0.86	1.01	0.82	1.00	0.97	1.01	0.85	0.65
5	1.37	1.52	1.30	1.38	1.60	1.46	1.59	1.07
6	2.05	2.16	1.83	1.79	2.24	2.51	2.30	1.88
7	3.25	3.49	2.89	2.23	3.27	2.73	3.83	2.92
8	4.65	5.41	4.76	3.77	4.61	4.14	5.56	5.00
9	6.62	7.95	7.26	5.12	7.08	5.02	7.53	5.79
0	8.32	9.82	8.95	6.88	8.31	8.37	9.04	7.59
1	9.15	9.94	9.85	9.37	9.47	9.29	11.98	8.60
2	11.13	9.88	12.59	11.07	12.25	11.25	13.98	10.64
3	13.50	13.50	13.50	13.50	13.50	11.91	13.60	14.12
3+	61.38	65.07	64.24	56.85	63.81	58.24	70.81	58.59
4+	60.90	64.68	63.75	56.11	63.30	57.69	70.26	58.26
5+	60.04	63.67	62.93	55.11	62.33	56.68	69.41	57.61
6+	58.67	62.15	61.63	53.73	60.73	55.22	67.82	56.54

Table 8. Analysis of variance for the regression of LN catch rate of cod for Canadian otter trawlers in NAFO Divisions 3NO.

Regression of Multiplicative Model

Multiple R	0.698
Multiple R Squared	0.487

Analysis of Variance

Source of Variation	DF	Sums of Squares	Mean Squares	F-Value
Intercept	1	19.2	19.2	
Regression	30	21.09	0.703	15.688
Type 1	3	3.501	1.167	26.04
Type 2	1	0.07394	0.07394	1.65
Type 3	11	7.547	0.6861	15.312
Type 4	15	6.845	0.4564	10.184
Residuals	495	22.18	0.04481	
Totals	526	62.47		

Table 9. Regression coefficients from the regression of LN catch rate of Canadian Otter trawlers for cod in NAFO Divisions 3NO.

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3124	INTERCEPT	0.030	0.220	526
2	34				
3	1				
4	77				
1	3125	1	0.085	0.064	252
	27124	2	0.374	0.096	59
	27125	3	0.546	0.076	111
2	35	4	-0.069	0.053	351
3	2	5	-0.241	0.146	36
	3	6	-0.449	0.139	41
	4	7	-0.653	0.136	45
	5	8	-0.971	0.132	60
	6	9	-0.928	0.134	58
	7	10	-0.859	0.141	45
	8	11	-0.793	0.146	37
	9	12	-0.911	0.150	31
	10	13	-0.825	0.140	43
	11	14	-0.408	0.133	54
	12	15	-0.203	0.134	54
4	78	16	-0.201	0.192	35
	79	17	0.096	0.188	43
	80	18	-0.102	0.215	18
	81	19	0.153	0.209	19
	82	20	0.391	0.188	33
	83	21	0.338	0.188	39
	84	22	0.134	0.190	38
	85	23	0.161	0.186	39
	86	24	0.041	0.184	44
	87	25	0.025	0.182	49
	88	26	0.065	0.183	42
	89	27	0.022	0.187	35
	90	28	0.017	0.189	33
	91	29	-0.665	0.193	29
	92	30	-0.787	0.203	20

TABLE 10. CATCH RATE INDEX OF CANADIAN OTTER TRAWLERS FOR COD IN DIV 3NO.

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1977	0.0296	0.0482	1.028	0.223	2532	2462
1978	-0.1715	0.0280	0.849	0.141	6246	7353
1979	0.1255	0.0249	1.145	0.180	9938	8679
1980	-0.0728	0.0371	0.933	0.178	5589	5988
1981	0.1821	0.0341	1.206	0.221	6096	5054
1982	0.4203	0.0264	1.536	0.248	10185	6629
1983	0.3673	0.0224	1.460	0.217	11374	7789
1984	0.1638	0.0259	1.189	0.190	8705	7320
1985	0.1907	0.0243	1.223	0.190	18179	14870
1986	0.0703	0.0231	1.085	0.164	18035	16628
1987	0.0544	0.0220	1.068	0.158	18652	17464
1988	0.0943	0.0233	1.111	0.169	19727	17760
1989	0.0521	0.0247	1.064	0.166	13514	12700
1990	0.0468	0.0255	1.058	0.168	10620	10037
1991	-0.6359	0.0274	0.534	0.088	12056	22572
1992	-0.7576	0.0337	0.471	0.086	7684	16301

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.166

Table 11. Abundance (000's) from stratified random spring surveys 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	AN 27 1984	AN 43 1985	WT 47 1986	WT 58 1987	WT 70 1988	WT 82 1989	WT 94+95 1990	WT 105-106 1991	WT[a] 119-120 1992	WT 136-137 1993
31-50	330	2089	2143	418	680	889	1072	3674	1411	941	358	1921	1461	824	3763	993	342	949	86	16	39
	331	456	34	49	624	(185)	240	205	1284	(134)	377	993	548	214	650	240	137	(186)	34	17	0
	338	1898	2451	4987	3229	9047	1311	2666	1681	(1797)	4103	10116	2390	2976	5303	1781	3818	1371	1382	855	356
	340	1716	(979)	215	4165	258	708	1730	386	859	2340	2898	2734	2576	55431	1178	615	873	186	26	64
	351	2520	2837	936	615	4843	2535	39982	1513	3689	8701	18538	4413	32509	28753	2913	1470	2033	315	151	57
	352	2580	3409	1289	1791	5965	4648	2292	2113	(2264)	3486	11814	4859	2988	12097	8821	3769	4320	1439	775	360
	353	1282	225	706	48	321	1732	4388	48	(207)	257	0	674	165	1700	1674	385	529	69	192	144
51-100	329	1721	129	(380)	3682	172	1731	1012	65	129	754	775	501	501	42933	2233	388	1200	1608	48	108
	332	1047	(1031)	1729	367	1729	7309	2613	118	(814)	5678	236	1839	458	2546	1297	393	1556	19059	1305	49886
	337	948	735	688	356	249	320	516	47	(234)	285	142	939	882	451	249	1281	285	939	1583	37573
	339	585	220	22	(109)	(129)	329	1361	(60)	198	2459	1054	88	29	278	102	15	132	44	44	22
	354	474	261	(105)	712	36	(230)	729	2076	107	107	142	261	178	1975	160	36	53	368	71	267
101-150	333	151	(19)	958	85	0	4	0	6	(14)	60	0	17	53	340	0	283	74	193	130	176
	336	121	9	0	0	141	5	2	95	(4)	27	0	9	45	9	5	5	59	27	763	132
	355	103	19	0	4	(18)	(24)	19	128	19	151	0	398	12	54	12	178	50	97	27	66
151-200	334	92	(11)	(7)	7	0	2	0	21	(8)	3	0	152	856	14	70	52	235	483	173	414
	335	58	7	(0)	1	(0)	0	0	3	(0)	4	0	0	40	4	7	4	26	4	131	253
	356	61	2	(1)	(2)	(3)	(4)	5	18	2	48	0	0	9	2	30	37	40	44	135	131
31-50		12541	12078	8600	11152	21508	12246	54937	8436	9891	19622	46280	17079	42252	107697	17600	10536	10261	3511	2032	1020
51-100		4775	2376	2934	5226	2315	9919	6231	2366	1482	9283	2349	3628	2048	48183	4041	2113	3226	22018	3051	87856
101-150		375	47	958	89	159	33	21	229	37	238	0	424	110	403	17	466	183	317	920	374
151-200		211	20	8	10	3	6	5	42	10	55	0	152	905	20	107	93	301	531	439	778
201-300		245	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2347	6369	752
301-400		309	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	102	46
Mean #/tow			10.80	9.30	12.26	17.85	16.52	45.54	8.24	8.50	21.73	36.19	15.84	33.72	116.31	16.20	9.83	10.40	19.63	9.32	
Adjusted total			14518	12500	16476	23983	22204	61193	11073	11419	29199	48628	21283	45316	156302	21764	13204	13978	26375	12914	90826
Unadjusted total			12481	11996	16365	23648	21946	61195	11013	5943	29198	48628	21282	45315	156304	21764	13206	13786	26375	12914	
Upper limit			16978	72778	36380	38899	54753	115076	18404	11743	45492	63225	27522	101321	237824	28720	19586	17170	72880	92671	
Lower limit			7983	-48786	-3649	8397	-10861	7314	3621	144	12904	34031	15043	-10690	74784	14808	6827	10401	-20130	-66842	

[a]1992 data are not used to adjust for missing strata; strata > 200 fathoms are not included in means + totals.

Table 12. Cod abundance (000's) from stratified random spring surveys in Division 3N. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	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	WT* 119-120 1992	WT 136-137 1993
0-30	375	1593	3826	399	1435	6617	(811)	7474	4329	263	508	10583	1578	1746	3184	912	2167	1116	1674	1226	60	80	34
	376	1499	788	38	(128)	1294	113	3601	225	225	113	225	32	7933	48	177	2813	375	113	177	48	0	0
31-50	360	2992	1516	(420)	(544)	2302	3425	4211	1011	1273	2695	524	2118	5679	3004	553	1198	1422	165	569	56	112	0
	361	1853	5796	835	904	3624	723	5610	4764	1165	1808	(3111)	4961	3283	10293	3310	10484	2841	1904	2380	817	35	247
	362	2520	11823	984	1466	431	1021	5830	7440	757	1204	3859	1608	18970	4385	2392	43871	1702	2605	3443	170	32	57
	373	2520	3831	142	426	(1137)	76	946	5959	327	331	1892	1589	8161	769	676	4307	1097	822	227	52	0	0
	374	931	175	175	0	140	(101)	1607	1817	297	0	163	1677	2893	175	47	266	363	28	210	14	14	0
	383	674	1644	51	25	(80)	17	320	1493	34	0	118	25	34	0	0	422	51	84	25	34	0	0
51-100	359	421	822	622	(152)	(367)	4709	1359	(745)	561	2133	611	126	95	0	1264	332	269	95	47	32	47	190
	377	100	1066	143	613	413	(46)	2800	105	73	490	1146	278	56	105	23	758	0	19	0	0	0	8
	382	647	4347	16	130	(150)	24	2639	1943	243	255	146	194	0	134	12	16	24	81	130	0	0	0
101-150	358	225	861	4189	(260)	(604)	(280)	262	(1209)	439	1993	135	1343	380	448	760	1478	549	709	456	59	1478	709
	378	139	3673	459	1683	(409)	(190)	657	120	403	1445	193	1236	318	2181	433	151	157	198	172	122	172	89
	381	182	779	861	79	156	(173)	3267	364	155	379	779	1851	200	2391	1312	68	191	102	273	55	7	0
151-200	357	164	(254)	1157	(43)	(105)	(46)	12	(216)	49	336	37	382	0	2831	137	(253)	6	18	123	148	302	8
	379	106	(295)	1802	785	(124)	(56)	24	0	671	408	40	322	175	525	801	4	8	44	139	406	1126	26
	380	116	118	641	70	(122)	(55)	22	(246)	96	26	15	(121)	83	788	136	313	226	118	270	300	57	4127
0-30		3092	4614	437	1563	7911	924	11075	4554	488	621	10808	1610	9679	3232	1089	4980	1491	1787	1403	108	80	34
31-50		11490	24785	2607	3365	7714	5361	18524	22484	3853	6038	9667	11978	39020	18626	6978	60548	7476	5608	6854	1143	193	304
51-100		1168	6235	781	895	930	4779	6798	2793	877	2878	1903	598	151	239	1299	1106	293	195	177	32	47	198
101-150		546	5313	5509	2022	1169	643	4186	1693	997	3818	1107	4430	898	5020	2505	1697	897	1009	901	236	1657	796
151-200		386	667	3600	858	351	157	48	462	816	770	92	825	258	4144	1074	570	240	180	532	854	1485	4161
201-300		420	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	539	1982	138
301-400		352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	14	5
Mean #/tow			33.23	10.33	6.98	14.43	9.48	32.45	25.54	5.60	11.28	18.82	15.53	40.02	24.97	10.34	55.02	8.30	7.01	7.88	1.90	3.94	
Adjusted total			41612	12930	8741	18073	11867	40640	31985	7008	14124	23574	19444	50107	31262	12943	68902	10397	8772	9866	2372	5132	5637
Unadjusted total			41062	12511	7615	14976	10108	40641	29569	7030	14125	20464	19321	50006	31260	12943	68649	10399	8778	9867	2372	5132	
Upper limit			60525	19420	10765	25131	25080	58111	38156	9512	18899	38028	24878	72633	39382	18459	94509	12770	11226	11844	3550	11869	
Lower limit			21600	5602	4465	4821	-4864	23171	20982	4547	9351	2900	13765	27378	23139	7427	42788	8028	6330	7890	1193	-1604	

*1992 data are not used to adjust for missing strata; strata > 200 fathoms are not included in means or totals.

Table 13. Biomass (MT) from random stratified cruises in Division 3Ø. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	207-209 Area	ATC 233 1973	ATC 245 1975	ATC 263 1976	ATC 277 1977	ATC 289+291 1978	ATC 303 1979	ATC 318-319 1980	ATC 327-328 1981	ATC 27 1982	AN 43 1984	AN 47 1985	WT 58 1986	WT 70 1987	WT 82 1988	WT 94+95 1989	WT 105-106 1990	WT 119-120 1991	WT[a] 136 1992	WT 1993
31-50	330	2089	8986	474	287	592	2218	3753	470	3371	123	3626	4642	2136	5654	2767	1713	2262	90	2	11
	331	456	279	728	454	(183)	342	150	609	(410)	38	2630	3423	685	804	1224	183	(848)	98	97	0
	338	1898	4174	5558	1874	6947	1334	5729	1795	(5873)	5659	29905	7485	14405	9838	9124	14874	5475	6271	8466	2959
	340	1716	(2043)	2028	2688	298	966	3718	386	4294	2849	6827	5431	5796	77479	12421	2977	6338	70	4	979
	351	2520	3003	1561	2681	8134	4334	47954	5629	6621	4498	43255	23490	38217	66032	15852	11619	16567	3890	1128	696
	352	2580	2986	425	1428	6114	3961	6235	5625	(9618)	6236	34168	29692	15071	49765	57457	34373	28930	16762	9958	4879
	353	1282	3172	77	2	262	84	1573	2	(541)	472	0	6083	951	9610	626	2371	3544	688	972	2222
51-100	329	1721	205	(221)	6417	180	2008	357	19	517	396	594	840	304	45335	9436	682	1611	1627	10	17
	332	1047	(1579)	829	351	939	4525	2266	9	(2068)	3474	2358	13471	2499	9808	8681	1369	8728	4097	960	30014
	337	948	75	1904	32	629	614	23	133	(623)	610	434	1203	8497	2674	382	2787	1997	2373	17045	19121
	339	585	1086	40	(44)	(70)	249	1475	(31)	505	610	1087	359	29	354	233	146	103	3	7	3
	354	474	427	(35)	38	8	(83)	34	273	44	125	489	219	180	2179	530	25	317	2312	39	540
101-150	333	151	(36)	524	82	0	2	0	28	(49)	153	0	147	232	1057	0	1040	225	500	53	916
	336	121	28	0	0	136	3	1	286	(15)	70	0	34	45	17	18	23	191	40	438	147
	355	103	74	0	4	(9)	(12)	24	367	32	135	0	135	12	114	19	195	96	86	3	58
151-200	334	92	(21)	(6)	6	0	6	0	43	(28)	8	0	570	3481	59	248	136	425	776	514	781
	335	58	22	(0)	3	(0)	0	0	10	(2)	11	0	0	126	18	39	7	63	2	44	2088
	356	61	10	(0)	(0)	(2)	(3)	12	49	9	166	0	0	32	7	102	74	142	11	43	154
31-50			12541	24643	10851	9414	22530	13239	69112	14516	30728	19875	120411	80246	77261	219182	99471	68110	63964	27869	20627
51-100			4775	3372	3029	6882	1826	7479	4155	481	3757	5215	4962	16092	11509	60350	19262	5009	12756	10412	18061
101-150			375	138	524	86	145	16	25	681	96	358	0	316	289	1188	37	1258	512	626	494
151-200			211	53	6	9	2	9	12	102	31	185	0	570	3639	84	389	217	630	789	603
201-300			245	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11868	1516
301-400			309	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	41
Mean wt./tow			20.99	10.72	12.20	18.23	15.44	54.55	11.73	25.76	19.08	93.30	72.35	68.98	208.97	88.67	55.51	57.84	37.22	29.84	
Adjusted total			28204	14411	16391	24502	20743	73302	15768	34619	25633	125375	97224	92698	280808	119156	74594	77863	39696	41342	66874
Unadjusted total			24527	14148	16346	24238	20647	73304	15735	15393	25632	125373	97223	92699	280807	119157	74595	77016	39697	41342	
Upper limit			35742	87352	89006	38369	35818	135612	24518	25204	33925	169977	126100	136099	382599	179304	134314	101143	55540	91139	
Lower limit			13312	-59055	-56313	10108	5477	10995	6951	5582	17338	80769	68346	49299	179014	59009	14876	52888	23854	-8454	

[a]1992 data are not used to adjust for missing strata; strata > 200 fathoms are not included in totals or means.

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

Depth range (fath)	Strata	Area	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	WT[a] 119-120 1992	WT 136-137 1993
0-30	375	1593	9691	1012	955	10591	(2148)	5424	3598	369	3229	29835	5943	2404	18475	14585	8034	16512	20104	10230	1141	1391	678
	376	1499	1837	783	(174)	383	77	9663	102	868	855	2208	2	1049	391	1883	2876	4454	745	2745	751	0	0
31-50	360	2992	1910	(919)	(382)	305	1948	4037	2182	1416	1738	3743	1238	7877	9161	1945	1282	494	1202	9486	581	842	1
	361	1853	4395	2453	350	3243	2616	5889	8203	2666	4173	(12196)	8125	12838	29220	50957	27584	15887	12722	20240	11883	278	2144
	362	2520	9416	4101	2231	306	1664	6830	6621	1632	5847	8701	3708	40764	16509	19686	69852	12714	16464	24747	2361	446	835
	373	2520	3325	1802	2359	(758)	1030	1749	4300	1838	857	4578	6647	17916	2446	2897	6788	5959	6090	3441	392	0	0
	374	931	681	266	0	135	(227)	1247	1324	479	0	146	2369	8335	877	769	1058	4032	489	3296	361	3	0
	383	674	1572	1	17	(14)	46	338	1564	146	0	430	5	295	0	0	818	71	335	326	113	0	0
51-100	359	421	303	251	(6)	(7)	659	147	(76)	190	478	208	13	71	0	134	43	44	21	6	15	3	51
	377	100	535	14	83	283	(14)	1379	130	22	287	428	22	29	13	54	328	0	9	0	0	0	1
	382	647	2032	7	59	(10)	44	991	2215	220	285	182	36	0	16	61	12	7	419	40	0	0	0
101-150	358	225	1030	1721	(64)	(69)	(111)	383	(300)	483	1054	229	236	182	122	547	1803	229	486	159	56	284	450
	378	139	4028	393	631	(49)	(78)	686	90	281	939	104	303	133	470	256	73	96	81	62	82	62	68
	381	182	883	1475	228	128	(146)	2797	393	196	427	533	2186	319	1544	747	82	270	39	212	232	1	0
151-200	357	164	(104)	1343	(13)	(14)	(25)	29	(74)	52	332	135	92	0	2102	259	(142)	18	22	62	59	158	17
	379	106	(107)	1776	515	(16)	(27)	50	0	601	178	53	179	129	324	365	4	15	22	61	204	633	60
	380	116	273	1116	180	(30)	(49)	55	(135)	232	57	25	(86)	224	847	135	454	181	176	180	110	56	3061
0-30		3092	11528	1795	1127	10974	2225	15087	3700	1237	4084	32043	5945	3453	18866	16468	10910	20966	20849	12975	1892	1391	678
31-50		11490	21299	9542	5339	4761	7531	20090	24194	8177	12615	29784	22092	88025	58213	76254	107382	39157	37302	61536	15691	1569	2980
51-100		1168	2870	272	148	300	717	2517	2421	432	1050	818	71	100	29	249	383	51	449	46	15	3	52
101-150		546	5941	3589	923	246	335	3866	783	960	2420	866	2725	634	2136	1550	1958	595	606	433	370	347	518
151-200		386	484	4235	708	60	101	134	209	885	567	213	357	353	3273	759	600	214	220	303	373	847	3138
201-300		420	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	351	802	58
301-400		352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	5	4
Mean wt./tow			33.64	15.52	6.58	13.05	8.71	33.30	25.00	9.34	16.56	50.90	24.91	73.92	65.90	76.09	96.81	48.70	47.46	60.13	14.65	3.79	
Adjusted total			42123	19433	8245	16340	10911	41698	31307	11694	20737	63734	31196	92564	82515	95278	121233	60981	59425	75294	18340	4940	7428
Unadjusted total			41912	18513	7607	15372	8084	41695	30722	11692	20736	51538	31104	92566	82515	95280	121091	60982	59425	75293	18342	4940	
Upper limit			57120	27613	13059	36966	13775	62035	38492	16493	28150	120670	46068	123679	108356	162514	159883	80483	81925	98258	33620	7761	
Lower limit			26704	9413	2155	-6222	2393	21355	22952	6891	13322	-17595	16141	61452	56675	28046	82300	41481	36925	52329	3064	2120	

[a]1992 data are not used to adjust for missing strata; strata > 200 fathoms are not included in means + totals.

Table 15. 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	0.01	0.06	0.04	0.41	0.55	0.01	0.56	3	0.01	0.33
2	2.57	1.15	2.35	1.13	2.84	3.67	2.3	0.72	0.9	5.32	0.35
3	25.88	8.84	2.39	4.05	4.22	2.73	9.5	7.18	2.27	1.36	5.02
4	3.56	18.94	1.67	0.73	2.37	1.73	6.16	8.29	8.99	0.66	1.47
5	2.72	1.69	2.21	0.36	0.53	1.57	4.53	2.52	7.62	1.06	1.71
6	0.65	0.7	0.44	0.31	0.28	0.25	1.51	0.97	1.71	0.43	2.16
7	0.66	0.57	0.25	0.11	0.54	0.07	0.48	0.62	0.51	0.21	1.05
8	0.29	0.4	0.18	0.03	0.22	0.12	0.22	0.04	0.25	0.18	0.47
9	0.15	0.29	0.2	0.01	0.22	0.06	0.1	0.01	0.1	0.18	0.49
10	0.02	0.17	0.12	0.06	0.07	0.07	0.1	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	0.02	0	0.04	0	0	0.07	0.13
13	0	0	0.12	0	0.01	0	0.09	0.04	0.04	0.03	0.06
14	0.29	0.35	0.44	0.12	0.13	0.05	0.12	0.01	0.1	0.12	0.16
1+	36.93	33.24	10.56	6.97	11.87	10.89	25.17	21.03	25.57	9.77	13.66
2+	36.93	33.23	10.5	6.93	11.46	10.34	25.16	20.47	22.57	9.76	13.33
3+	34.36	32.08	8.15	5.8	8.62	6.67	22.86	19.75	21.67	4.44	12.98
4+	8.48	23.24	5.76	1.75	4.4	3.94	13.36	12.57	19.4	3.08	7.96
5+	4.92	4.3	4.09	1.02	2.03	2.21	7.2	4.28	10.41	2.42	6.49
6+	2.2	2.61	1.88	0.66	1.5	0.64	2.67	1.76	2.79	1.36	4.78

	1982	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1.4	0.01	0.01	0.02	0.21	0.01	0.02	0.04	0.02	0
2	8.4	3.29	0.41	0.68	2.73	1.68	0.25	0.47	6.3	0.65
3	1.06	6.21	4.5	0.69	2.8	2.23	1.89	0.95	1.24	4.42
4	3.17	9.92	6.09	7.54	9.18	0.46	1.09	1.34	0.6	0.17
5	0.54	5.3	2.43	6.32	34.3	0.41	0.28	1.09	0.41	0.1
6	0.42	5.61	0.89	1.58	20.91	1.07	0.3	0.24	0.18	0.13
7	0.7	1.87	0.98	0.67	8.2	1.18	0.68	0.47	0.13	0.05
8	0.52	1	0.74	0.64	1.75	0.78	0.62	0.61	0.17	0.03
9	0.23	1.81	0.89	0.49	1.91	0.82	0.44	0.73	0.34	0.11
10	0.14	1.57	1.35	0.72	0.68	0.87	0.48	0.51	0.22	0.13
11	0.06	0.86	0.99	1.17	0.76	0.44	0.64	0.42	0.18	0.16
12	0.04	0.32	0.49	0.64	0.7	0.55	0.42	0.41	0.11	0.17
13	0.01	0.11	0.24	0.35	0.8	0.79	0.33	0.22	0.15	0.15
14	0.13	0.22	0.39	0.51	0.76	1.25	1	1.65	0.72	0.13
1+	16.82	38.1	20.4	22.02	85.69	12.54	8.44	9.15	10.77	6.4
2+	15.42	38.09	20.39	22	85.48	12.53	8.42	9.11	10.75	6.4
3+	7.02	34.8	19.98	21.32	82.75	10.85	8.17	8.64	4.45	5.75
4+	5.96	28.59	15.48	20.63	79.95	8.62	6.28	7.69	3.21	1.33
5+	2.79	18.67	9.39	13.09	70.77	8.16	5.19	6.35	2.61	1.16
6+	2.25	13.37	6.96	6.77	36.47	7.75	4.91	5.26	2.2	1.06

Table 16. Biomass (t) and Abundance (000's) of cod from autumn stratified random surveys in Division 3O.

Depth			Biomass			Abundance		
Range	Strata	Area	1990	1991	1992	1990	1991	1992
31–50	330	2089	2465	681	876	1625	745	902
	331	456	1	232	83	11	377	68
	338	1898	6639	3771	1533	3437	1311	249
	340	1716	1697	3520	2839	644	1520	2222
	351	2520	7031	9922	1296	4634	5334	662
	352	2580	11930	18064	1960	3060	4532	613
	353	1282	2666	7	0	674	24	0
51–100	329	1721	683	496	9	215	129	43
	332	1047	345	4	85	196	39	79
	337	948	1301	46	174	213	36	108
	339	585	618	0	40	73	0	22
	354	474	2	0	319	36	0	249
101–150	333	151	4	0	6	6	0	6
	336	121	16	0	0	3	0	0
	355	103		15	6		66	116
151–200	334	92	8	0	0	7	0	0
	335	58	5	4	0	4	2	0
	356	61		4	0		2	0
31–50		12541	32429	36197	8587	14085	13843	4716
51–100		4775	2949	546	627	733	204	501
101–150		375	20	15	12	9	66	122
151–200		211	13	8	0	11	4	0
Total			35411	36766	9226	14838	14117	5339
Upper			47985	51619	14078	21022	19938	8452
Lower			22833	21918	4376	8657	8295	2014

Table 17. Biomass (t) and Abundance (000's) of cod from autumn stratified random surveys in Division 3N.

Depth Range	Strata	Area	Biomass 1990	Biomass 1991	Biomass 1992	Abundance 1990	Abundance 1991	Abundance 1992
0–30	375	1593	21899	38662		1814	11988	
	376	1499	2089	14770	22566	1067	28265	47484
31–50	360	2992	3727	1611	1817	1492	842	861
	361	1853	14530	8568	4456	1913	2156	2956
	362	2520	4180	21096	6986	2218	7623	7756
	373	2520	4897	16186	1660	447	3247	378
	374	931	1129	3356		196	2097	
	383	674	40	34		84	67	
51–100	359	421	1	0	35	16	0	63
	377	100	36		74	49		101
	382	647	47	10	27	49	32	49
101–150	358	225	130	95	607	127	160	988
	378	139	116	158	103	110	261	151
	381	182		0			0	
151–200	357	164	128	64	37	111	68	43
	379	106	140		93	156		119
	380	116		13			48	
0–30		3092	23988	53432	22566	2881	40253	47484
31–50		11490	28503	50851	14919	6350	16032	11951
51–100		1168	84	10	136	114	32	213
101–150		546	246	253	710	237	421	1139
151–200		386	268	77	130	167	116	162
Total			53089	104623	38461	9749	56854	60949
Upper			96410	164110	110465	13724	113966	226427
Lower			9760	45134	−33545	5768	256	−104530

Table 18. Mean No./Tow at age for Div. 3NO combined from Fall Research Vessel surveys

Age	1990	1991	1992
1	0.92	0.51	0.01
2	1.25	14.98	5.71
3	0.95	1.92	17.89
4	2.32	1.47	2.4
5	1.37	2.55	0.95
6	0.46	1.36	0.6
7	0.31	0.41	0.18
8	0.29	0.4	0.04
9	0.24	0.68	0.05
10	0.29	0.46	0.06
11	0.13	0.51	0
12	0.1	0.37	0.05
13	0.14	0.31	0.11
14+	0.77	1.07	0.2
Mean	9.55	26.99	28.26
Upper	12.34	48.96	98.93
Lower	6.76	5.02	−42.42

Table 19. Results from ADAPT for Div. 3NO cod using Canadian and Russian Surveys: Estimated parameters with associated CVs

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.009478
MEAN SQUARE RESIDUALS 0.890830

PARAMETER	AGE	ESTIMATE	STD. ERR.	T-STAT	C.V.
NUMBERS					
	3	38445	34906	1.101	0.908
	4	3007	1242	2.421	0.413
	5	1278	442	2.892	0.346
	6	1830	890	2.057	0.486
	7	696	311	2.234	0.448
	8	302	150	2.008	0.498
	9	653	321	2.033	0.492
	10	1258	648	1.941	0.515
	11	1340	670	1.998	0.501
INDEX 1: RV1					
	3	1.37E-4	3.51E-5	3.895	0.257
	4	1.83E-4	4.66E-5	3.932	0.254
	5	1.85E-4	4.80E-5	3.857	0.259
	6	1.49E-4	3.87E-5	3.851	0.260
	7	1.54E-4	4.10E-5	3.748	0.267
	8	1.35E-4	3.68E-5	3.669	0.273
	9	1.50E-4	4.14E-5	3.623	0.276
	10	1.69E-4	4.68E-5	3.602	0.278
	11	1.76E-4	4.85E-5	3.625	0.276
INDEX 2: RV2					
	3	3.53E-4	8.77E-5	4.028	0.248
	4	3.27E-4	8.12E-5	4.027	0.248
	5	3.01E-4	7.56E-5	3.983	0.251
	6	2.72E-4	6.92E-5	3.924	0.255
	7	2.34E-4	6.11E-5	3.835	0.261
	8	2.00E-4	5.29E-5	3.771	0.265
	9	2.11E-4	5.65E-5	3.732	0.268
	10	2.27E-4	6.09E-5	3.735	0.268
	11	2.39E-4	6.33E-5	3.775	0.265

RV1 - Canadian Survey
RV2 - Russian Survey

Table 20. Results from ADAPT for Div. 3NO cod using Canadian and Russian Surveys: Residuals.

LOG RESIDUALS FROM RV1

5/ 6/

	1977	1978	1979	1980	1981	1982	1984	1985	1986	198
3	0.346	-0.121	-0.268	-0.824	0.240	-1.181	0.085	0.000	-0.578	1.25
4	0.470	0.180	0.061	-1.560	-0.803	-0.259	0.608	0.019	0.480	1.94
5	1.086	-0.092	0.532	-1.795	-0.344	-1.530	0.610	-0.441	0.435	2.33
6	0.604	0.195	0.167	-1.652	-0.560	-1.223	1.175	-0.571	-0.116	2.31
7	0.533	0.066	-0.094	-1.574	-0.432	-1.435	0.576	-0.131	-0.433	1.95
8	0.648	-1.407	-0.404	-0.642	-0.313	-0.611	0.362	0.146	0.049	1.05
9	-0.430	-2.158	-0.368	-0.595	0.570	-0.762	0.105	0.465	0.001	1.49
0	0.716	-1.376	-1.357	-0.324	-0.233	-0.454	1.017	-0.034	0.476	0.61
1	-1.267	0.130	-0.520	-0.237	-0.976	-1.251	1.005	0.847	0.045	0.85

	1988	1989	1990	1991	1992
3	0.337	0.238	-0.398	0.877	0.000
4	-0.565	-0.326	0.289	-0.023	-0.518
5	-0.778	-0.569	0.649	-0.093	-0.010
6	-0.294	-0.296	0.364	0.214	-0.325
7	-0.014	-0.053	0.689	0.620	-0.278
8	0.121	0.074	0.516	0.331	0.081
9	0.553	-0.204	0.599	0.322	0.409
0	1.063	0.230	0.197	-0.266	-0.265
1	0.538	1.091	0.348	-0.473	-0.139

UM OF RV RESIDUALS : 0.0006301334816 MEAN RESIDUAL : 0.00000466765542

LOG RESIDUALS FROM RV2

5/ 6/

	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	0.281	-0.129	-0.700	-0.801	-0.436	0.116	-0.057	0.818	1.710
4	0.647	0.308	-1.379	-0.849	-0.333	0.339	0.354	0.958	1.553
5	1.104	0.879	-0.761	-1.380	-0.721	0.927	0.432	0.983	1.883
6	0.902	1.008	-0.634	-0.629	-1.749	0.376	1.056	0.625	1.491
7	1.434	0.594	-0.057	-0.239	-1.128	-0.583	0.683	0.779	1.372
8	1.568	0.893	-0.338	0.337	-0.858	-1.959	-0.365	0.556	1.090
9	0.350	0.483	0.013	-0.411	-0.674	0.536	0.623	-0.735	0.427
0	0.439	-0.485	0.675	0.189	-1.336	0.833	0.512	0.043	-0.450
1	0.750	3.026	-0.288	0.162	-0.296	0.006	0.544	-0.762	0.042

	1986	1987	1988	1989	1990	1991
3	1.355	0.012	0.559	-0.816	-2.213	0.301
4	1.611	-0.847	-1.066	-0.994	-1.091	0.790
5	1.250	-1.683	-1.987	-1.385	-0.838	1.299
6	1.145	-1.322	-1.651	-1.295	-0.409	1.086
7	1.079	-0.790	-1.515	-1.000	-1.271	0.640
8	1.544	-0.124	-0.945	-0.528	-1.691	0.822
9	1.293	0.285	-0.287	-1.326	-1.733	1.157
0	0.763	0.342	0.205	-1.631	-1.047	0.948
1	-0.933	0.137	-0.158	-1.067	-1.384	0.221

RV1 – Canadian Survey
RV2 – Russian Survey

Table 21. Results from ADAPT for Div. 3NO cod using Canadian and Russian Surveys: Population numbers and fishing mortality.

POPULATION NUMBERS (000S)

	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	54676	65979	23969	25228	32213	28019	41731	46137	36430
4	24600	44215	53187	19559	20414	25916	22664	33099	37721
5	10628	17907	32276	40083	15059	15727	19429	17970	26195
6	6990	6411	12383	18094	29368	11187	11436	14194	13436
7	2363	4366	4509	7619	12755	21966	8244	8274	9518
8	1027	1417	3254	2892	5549	8722	16602	6129	5670
9	1230	680	1068	2425	2167	4024	5791	12550	4366
10	351	818	504	822	1902	1601	2756	4041	9444
11	242	229	624	398	645	1472	1120	2041	2810
12	300	161	180	500	318	491	1059	843	1575
3+	102407	142184	131954	117619	120391	119125	130831	145279	147166

	1986	1987	1988	1989	1990	1991	1992
3	10087	6784	13032	13136	12043	4822	38293
4	29775	8120	5088	10419	9020	8897	2950
5	28212	21785	6266	3878	6556	3309	1246
6	15834	17286	14677	3749	1816	1440	1809
7	8253	9009	11035	6274	1929	677	686
8	5514	5389	6279	5456	3429	1198	299
9	3921	3656	3822	4228	3305	2155	648
10	3160	2705	2229	2616	3022	2181	1250
11	7250	2249	1768	1440	1931	2077	1331
12	2064	5620	1481	1222	1027	1445	1354
3+	114069	82605	65677	52417	44078	28199	49866

FISHING MORTALITY

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
3	0.012	0.016	0.003	0.012	0.017	0.012	0.032	0.001	0.002	0.017	0.088	0.024
4	0.118	0.115	0.083	0.061	0.061	0.088	0.032	0.034	0.090	0.112	0.059	0.072
5	0.305	0.169	0.379	0.111	0.097	0.119	0.114	0.091	0.303	0.290	0.195	0.314
6	0.271	0.152	0.286	0.150	0.090	0.105	0.124	0.200	0.287	0.364	0.249	0.650
7	0.311	0.094	0.244	0.117	0.180	0.080	0.096	0.178	0.346	0.226	0.161	0.504
8	0.211	0.083	0.094	0.089	0.121	0.210	0.080	0.139	0.169	0.211	0.144	0.196
9	0.208	0.099	0.062	0.043	0.103	0.178	0.160	0.084	0.124	0.171	0.295	0.179
10	0.229	0.071	0.038	0.043	0.056	0.157	0.100	0.163	0.064	0.140	0.225	0.237
11	0.207	0.039	0.021	0.022	0.073	0.130	0.083	0.059	0.108	0.055	0.218	0.169
12	0.096	0.035	0.044	0.029	0.046	0.063	0.044	0.056	0.070	0.075	0.083	0.112

	1989	1990	1991	1992
3	0.176	0.103	0.291	0.139
4	0.263	0.803	1.766	1.079
5	0.559	1.316	0.404	1.454
6	0.464	0.787	0.541	0.610
7	0.404	0.277	0.617	0.739
8	0.301	0.264	0.415	0.552
9	0.136	0.216	0.344	0.368
10	0.104	0.175	0.294	0.238
11	0.138	0.090	0.228	0.282
12	0.094	0.093	0.167	0.174

Table 22. Results of Laurec-Shepard calibration analysis for cod in Div. 3NO.

VPA Version 3.0 (HSDOS)
Cod in Divisions 3NO

Disaggregated Qs
Log transformation
No trend in Q (mean used)

Terminal Fs estimated using Laurec-Shepherd
Regression weights
, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Oldest age F = .400*average of 5 younger ages.

Fishing mortalities

Age,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
3,	.002,	.002,	.018,	.092,	.025,	.199,	.108,	.398,	.194
4,	.038,	.098,	.122,	.062,	.075,	.281,	.979,	1.894,	2.806
5,	.098,	.341,	.318,	.215,	.330,	.590,	1.491,	.599,	2.404
6,	.208,	.315,	.429,	.282,	.751,	.499,	.873,	.760,	1.394
7,	.190,	.365,	.256,	.202,	.605,	.524,	.309,	.770,	1.763
8,	.146,	.183,	.227,	.167,	.257,	.402,	.389,	.484,	.872
9,	.094,	.131,	.188,	.324,	.214,	.189,	.320,	.608,	.472
10,	.155,	.072,	.149,	.253,	.268,	.128,	.261,	.505,	.569
11,	.057,	.102,	.062,	.235,	.196,	.161,	.114,	.382,	.644
12,	.051,	.068,	.071,	.095,	.123,	.112,	.111,	.220,	.346

Log catchability residuals
Fleet : CANADIAN RV

Age ,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
3 ,	-.16,	-.24,	-.86,	.97,	.07,	.04,	-.67,	.86,	.00
4 ,	.34,	-.27,	.19,	1.62,	-.90,	-.64,	.09,	-.44,	.00
5 ,	.31,	-.71,	.14,	2.05,	-1.12,	-.90,	.32,	-.09,	.00
6 ,	.74,	-.95,	-.43,	1.96,	-.64,	-.70,	-.02,	.05,	.00
7 ,	.08,	-.64,	-.86,	1.63,	-.39,	-.35,	.25,	.28,	.00
8 ,	-.10,	-.28,	-.39,	.69,	-.13,	-.15,	.38,	-.01,	.00
9 ,	-.43,	-.12,	-.55,	.94,	.08,	-.51,	.34,	.24,	.00
10 ,	.37,	-.52,	-.06,	.13,	.58,	-.15,	-.01,	-.33,	.00
11 ,	.30,	.12,	-.51,	.26,	.00,	.57,	-.08,	-.66,	.00

SUMMARY STATISTICS FOR AGE 3

Fleet , Pred. , SE(q), Partial, Raised,	SLOPE ,	SE ,	INTRCPT, SE
, q , , F , F ,	,	Slope ,	, Intrcpt
1 , -13.18 , .642, .0002 , .1937,	.5686-01,	.8136-01,	-13.179, .203

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.194	.642	0.000	.642	0.000

SUMMARY STATISTICS FOR AGE 4

Fleet , Pred. , SE(q), Partial, Raised,	SLOPE ,	SE ,	INTRCPT, SE
, q , , F , F ,	,	Slope ,	, Intrcpt
1 , -12.84 , .771, .0003 , 2.8055,	-.7236-01,	.9716-01,	-12.839, .244

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
2.806	.771	0.000	.771	0.000

SUMMARY STATISTICS FOR AGE 5

Fleet , Pred. , SE(q), Partial, Raised,	SLOPE ,	SE ,	INTRCPT, SE
, q , , F , F ,	,	Slope ,	, Intrcpt
1 , -12.82 , .987, .0003 , 2.4037,	-.3316-01,	.1296+00,	-12.817, .312

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio

Table 22. (cont)

SUMMARY STATISTICS FOR AGE 6

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.94	.943	.0002	1.3943	-.300E-01	.123E+00	-12.941	.298

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.394	.943	0.000	.943	0.000

SUMMARY STATISTICS FOR AGE 7

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.83	.765	.0003	1.7632	.443E-01	.988E-01	-12.830	.242

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
1.763	.765	0.000	.765	0.000

SUMMARY STATISTICS FOR AGE 8

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-13.00	.352	.0002	.8724	.323E-01	.445E-01	-13.002	.111

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.872	.352	0.000	.352	0.000

SUMMARY STATISTICS FOR AGE 9

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.77	.504	.0003	.4724	.524E-01	.629E-01	-12.766	.159

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.472	.504	0.000	.504	0.000

SUMMARY STATISTICS FOR AGE 10

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.69	.351	.0003	.5693	-.179E-01	.455E-01	-12.694	.111

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.569	.351	0.000	.351	0.000

SUMMARY STATISTICS FOR AGE 11

Fleet	Pred. q	SE(q)	Partial F	Raised F	SLOPE	SE Slope	INTRCPT	SE Intrcpt
1	-12.58	.408	.0003	.6438	-.390E-01	.513E-01	-12.575	.129

Fbar	SIGMA(int.)	SIGMA(ext.)	SIGMA(overall)	Variance ratio
.644	.408	0.000	.408	0.000

Table 22. (cont)

Traditional vpa Terminal Fs estimated using Laurec-Shepherd

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,
AGE						
3,	.0122,	.0166,	.0034,	.0123,	.0181,	.0130,
4,	.1164,	.1132,	.0886,	.0637,	.0639,	.0912,
5,	.2938,	.1668,	.3704,	.1196,	.1009,	.1248,
6,	.2615,	.1452,	.2806,	.1459,	.0982,	.1098,
7,	.2973,	.0904,	.2304,	.1148,	.1748,	.0875,
8,	.1927,	.0787,	.0904,	.0831,	.1188,	.2020,
9,	.1764,	.0891,	.0586,	.0410,	.0960,	.1739,
10,	.1860,	.0593,	.0340,	.0402,	.0536,	.1452,
11,	.1691,	.0313,	.0177,	.0201,	.0685,	.1231,
12,	.0817,	.0279,	.0346,	.0240,	.0410,	.0587,
FBAR 5-10,	.2346,	.1049,	.1774,	.0908,	.1071,	.1405,

Table 8 Fishing mortality (F) at age

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	FBAR 90-92
AGE											
3,	.0350,	.0015,	.0019,	.0177,	.0916,	.0253,	.1990,	.1080,	.3981,	.1937,	.2333,
4,	.0346,	.0376,	.0980,	.1224,	.0619,	.0750,	.2814,	.9785,	1.8941,	2.8055,	1.8927,
5,	.1183,	.0983,	.3410,	.3182,	.2150,	.3299,	.5898,	1.4906,	.5991,	2.4037,	1.4978,
6,	.1511,	.2082,	.3153,	.4295,	.2818,	.7510,	.4990,	.8727,	.7603,	1.3943,	1.0091,
7,	.1010,	.1902,	.3647,	.2558,	.2016,	.6051,	.5240,	.3086,	.7703,	1.7632,	.9474,
8,	.0880,	.1463,	.1830,	.2266,	.1672,	.2571,	.4017,	.3888,	.4844,	.8724,	.5819,
9,	.1531,	.0938,	.1309,	.1884,	.3236,	.2142,	.1891,	.3196,	.6082,	.4724,	.4667,
10,	.0975,	.1553,	.0723,	.1495,	.2535,	.2678,	.1279,	.2612,	.5045,	.5693,	.4450,
11,	.0762,	.0574,	.1024,	.0619,	.2355,	.1957,	.1608,	.1135,	.3818,	.6438,	.3797,
12,	.0414,	.0514,	.0683,	.0706,	.0945,	.1232,	.1123,	.1113,	.2199,	.3457,	.2257,
FBAR 5-10,	.1148,	.1487,	.2345,	.2613,	.2404,	.4042,	.3886,	.6069,	.6211,	1.2459,	

Table 10 Stock number at age (start of year) Numbers*10-3

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,
3,	55167,	61735,	23109,	24028,	31101,	25981,
4,	24745,	44618,	49713,	18855,	19432,	25007,
5,	10915,	18033,	32620,	37250,	14485,	14925,
6,	7161,	6661,	12496,	18440,	27061,	10722,
7,	2442,	4514,	4716,	7728,	13047,	20084,
8,	1110,	1485,	3376,	3067,	5641,	8969,
9,	1422,	750,	1124,	2525,	2311,	4101,
10,	421,	976,	562,	868,	1984,	1719,
11,	290,	286,	753,	444,	683,	1540,
12,	351,	200,	227,	605,	357,	522,
TOTAL,	104023,	139259,	128697,	113811,	116102,	113569,

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	GMST 77-89	AMST 77-89
3,	37784,	42626,	33508,	9632,	6492,	12238,	11681,	11449,	3681,	28288,	0,	23682,	28852,
4,	20996,	29871,	34847,	27382,	7748,	4849,	9770,	7838,	8414,	2024,	19082,	20465,	24449,
5,	18690,	16606,	23555,	25867,	19836,	5962,	3683,	6037,	2412,	1036,	100,	15932,	18648,
6,	10786,	13595,	12323,	13712,	15407,	13098,	3510,	1672,	1113,	1085,	77,	11416,	12690,
7,	7866,	7745,	9039,	7361,	7307,	9517,	5061,	1745,	572,	426,	220,	7240,	8187,
8,	15065,	5821,	5243,	5139,	4667,	4890,	4254,	2453,	1049,	217,	60,	4547,	5287,
9,	6000,	11295,	4117,	3575,	3354,	3233,	3096,	2331,	1362,	529,	74,	2885,	3408,
10,	2822,	4215,	8420,	2957,	2424,	1987,	2136,	2098,	1386,	607,	270,	1800,	2422,
11,	1217,	2095,	2955,	6413,	2085,	1540,	1244,	1539,	1323,	685,	281,	1142,	1657,
12,	1115,	923,	1620,	2184,	4935,	1349,	1037,	868,	1125,	739,	295,	708,	1187,
TOTAL,	122340,	134794,	135624,	104221,	74254,	58663,	45473,	38029,	22437,	35637,	20459,		

Table 22. (cont)

Table 11 Spawning stock number at age (spawning time) Numbers*10-3

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,
3,	55167,	61735,	23109,	24028,	31101,	25981,
4,	24745,	44618,	49713,	18855,	19432,	25007,
5,	10915,	18033,	32620,	37250,	14485,	14925,
6,	7161,	6661,	12496,	18440,	27061,	10722,
7,	2442,	4514,	4716,	7728,	13047,	20084,
8,	1110,	1485,	3376,	3067,	5641,	8969,
9,	1422,	750,	1124,	2525,	2311,	4101,
10,	421,	976,	562,	868,	1984,	1719,
11,	290,	286,	753,	444,	683,	1540,
12,	351,	200,	227,	605,	357,	522,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,
3,	31445,	44449,	15021,	17060,	27991,	24422,
4,	24745,	46849,	48719,	19610,	24679,	29258,
5,	16154,	27952,	45342,	62953,	26653,	22388,
6,	17759,	14987,	26117,	46100,	72794,	23587,
7,	8571,	16881,	13536,	28516,	46318,	76922,
8,	5263,	6847,	12492,	16837,	30066,	47178,
9,	10193,	4641,	5339,	20151,	16476,	30715,
10,	3711,	7054,	4015,	8002,	18058,	15125,
11,	3392,	2715,	6007,	4711,	6150,	15121,
12,	4026,	2579,	2297,	7635,	3620,	6408,
TOTALBIO,	125259,	174954,	178886,	231573,	272804,	291125,

Table 12 Stock biomass at age (start of year) Tonnes

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
3,	32117,	33675,	16084,	3756,	3181,	9056,	5957,	6297,	2025,	9335,
4,	24565,	34351,	29968,	27656,	6353,	4849,	9476,	7916,	7152,	1316,
5,	34950,	25075,	32268,	39318,	25787,	8228,	5894,	8814,	3835,	1109,
6,	28366,	30998,	25262,	29618,	28194,	23446,	7862,	4197,	2561,	2039,
7,	29889,	23546,	29377,	25690,	21117,	21222,	16549,	4763,	2191,	1244,
8,	78339,	23576,	24379,	27800,	22214,	18436,	19612,	10157,	5833,	1084,
9,	37620,	65061,	27255,	28418,	24351,	16551,	21921,	11701,	10253,	3064,
10,	22798,	30433,	70053,	29039,	21696,	13670,	17752,	17562,	12533,	4606,
11,	10941,	18692,	27034,	63742,	20537,	14433,	11785,	14297,	15850,	5894,
12,	12272,	11643,	18030,	21574,	62136,	14932,	12702,	9760,	15724,	7868,
TOTALBIO,	311859,	297048,	299718,	296612,	235565,	144823,	129511,	95465,	77956,	37559,

Table 23. Fishing mortality matrix for cod in Div. 3NO, 1959-92.

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	0.035	0.034	0.011	0.010	0.004	0.061	0.007	0.004	0.128	0.195	0.073	0.029
4	0.165	0.181	0.107	0.064	0.075	0.303	0.098	0.163	0.510	0.641	0.233	0.251
5	0.330	0.462	0.570	0.072	0.264	0.386	0.238	0.395	0.896	1.001	0.736	0.312
6	0.475	0.345	0.686	0.136	0.223	0.302	0.496	0.711	0.814	1.051	0.662	0.630
7	0.381	0.347	0.396	0.334	0.245	0.155	0.770	0.696	0.718	0.746	0.297	0.468
8	0.321	0.446	0.440	0.258	0.727	0.216	0.568	1.027	1.120	0.558	0.353	0.401
9	0.165	0.216	0.265	0.314	0.782	0.312	0.339	0.437	0.123	0.320	0.352	0.225
10	0.195	0.119	0.104	0.210	0.529	0.524	1.234	1.475	0.068	0.128	0.310	0.161
11	0.366	0.294	0.010	0.168	0.238	0.053	0.542	0.343	0.189	0.044	0.135	0.423
12	0.106	0.113	0.120	0.112	0.228	0.121	0.291	0.364	0.203	0.175	0.131	0.125
13	0.106	0.113	0.120	0.112	0.228	0.121	0.291	0.364	0.203	0.175	0.131	0.125
7-10	0.265	0.282	0.301	0.279	0.571	0.302	0.728	0.909	0.507	0.438	0.328	0.313

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	0.012	0.001	0.355	0.188	0.028	0.139	0.012	0.016	0.003	0.012	0.017	0.012
4	0.616	0.373	0.882	0.677	0.423	0.496	0.118	0.115	0.083	0.061	0.061	0.088
5	0.770	0.645	0.547	1.148	0.578	0.571	0.305	0.169	0.379	0.111	0.097	0.119
6	0.663	0.988	0.775	1.021	0.926	0.347	0.271	0.152	0.286	0.150	0.090	0.105
7	0.503	0.861	0.360	0.770	0.943	0.171	0.311	0.094	0.244	0.117	0.180	0.080
8	0.693	0.486	0.322	0.858	1.101	0.161	0.211	0.083	0.094	0.089	0.121	0.210
9	0.203	0.150	0.387	0.663	1.244	0.107	0.208	0.099	0.062	0.043	0.103	0.178
10	0.121	0.127	0.184	0.801	0.738	0.129	0.229	0.071	0.038	0.043	0.056	0.157
11	0.154	0.063	0.111	0.571	0.820	0.038	0.207	0.039	0.021	0.022	0.073	0.130
12	0.152	0.162	0.125	0.309	0.403	0.057	0.096	0.035	0.044	0.029	0.046	0.063
13	0.152	0.162	0.125	0.309	0.403	0.057	0.096	0.035	0.044	0.029	0.046	0.063
7-10	0.380	0.406	0.313	0.773	1.006	0.142	0.240	0.087	0.110	0.073	0.115	0.156

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	0.032	0.001	0.002	0.017	0.088	0.024	0.176	0.354	0.291	0.139		
4	0.032	0.034	0.090	0.112	0.059	0.072	0.263	0.803	0.398	1.079		
5	0.114	0.091	0.303	0.290	0.195	0.314	0.559	1.316	0.404	1.454		
6	0.124	0.200	0.287	0.364	0.249	0.650	0.464	0.787	0.541	0.610		
7	0.096	0.178	0.346	0.226	0.161	0.504	0.404	0.277	0.617	0.739		
8	0.080	0.139	0.169	0.211	0.144	0.196	0.301	0.264	0.415	0.552		
9	0.160	0.084	0.123	0.171	0.295	0.179	0.136	0.216	0.344	0.368		
10	0.100	0.163	0.064	0.140	0.225	0.237	0.104	0.175	0.293	0.238		
11	0.083	0.059	0.108	0.055	0.218	0.169	0.138	0.090	0.228	0.282		
12	0.044	0.056	0.070	0.075	0.083	0.112	0.094	0.093	0.167	0.174		
13	0.044	0.056	0.070	0.075	0.083	0.112	0.094	0.093	0.167	0.174		
7-10	0.109	0.141	0.176	0.187	0.206	0.279	0.236	0.233	0.417	0.474		

Table 24. Population biomass at the beginning of the year (tonnes) for cod in Div. 3NO, 1959-92.

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	16511	18127	25718	32807	24175	34952	48191	74128	64443	35687	45030	28439
4	62593	25672	28203	40976	52277	38760	52968	82433	113996	37498	45328	64652
5	19937	66510	30038	35507	53883	68008	40108	69946	103378	93403	62886	48988
6	28530	18310	52982	21476	41787	52316	58481	42015	62445	53406	43414	38117
7	35305	20983	15933	32761	23027	41052	47482	46367	26786	34629	23387	28035
8	17515	23752	16040	11595	25370	19486	38027	26532	27845	15020	18873	19981
9	20204	12192	14782	10045	8708	11919	15265	26486	11656	10534	9971	15370
10	25558	16512	9471	10935	7069	3838	8406	13424	21069	11393	8455	7750
11	21305	19326	13785	8023	8336	3917	2136	2918	3669	18629	9485	5871
12	4696	14225	13528	12819	6372	6171	3488	1503	2509	2867	16838	7830
13	22136	27651	7693	16602	9282	1099	5416	3591	8468	1289	14509	37208
3+	274290	263259	228171	233545	260287	281516	319970	389343	446263	364357	298176	302241
4+	257779	245132	202454	200738	236112	246564	271779	315216	381819	328670	253145	273802
5+	195186	219459	174251	159762	183835	207805	218811	232782	267824	241172	207818	209150
6+	175249	152950	144212	124255	129952	139797	178703	162836	164446	147768	144931	160162
7+	146719	134640	91231	102779	88165	87481	120221	120821	102001	94362	101517	122044

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	29539	25468	18600	12033	6692	12085	22964	40910	12225	13371	25449	23539
4	42649	47784	38008	13881	17177	12571	17467	34047	44680	16040	19394	26695
5	68611	32565	46751	19419	8621	16922	12328	22205	39056	51711	20783	21704
6	45374	39733	21838	31356	7336	7066	13073	11669	22289	33656	62558	22489
7	25425	28052	19826	11564	13728	3911	6759	13317	11453	21182	38013	70517
8	20181	16211	14276	16971	6051	6286	4024	5697	12107	11484	24585	37683
9	15523	11323	11500	13467	7264	2517	6619	3687	4998	13167	13568	25433
10	13573	14241	12036	7914	6852	2345	2694	5891	3355	5441	16205	12678
11	6248	11288	13628	9740	2668	2999	2454	2091	4741	3464	5875	13912
12	3633	5032	11704	9715	3881	1456	3083	1983	1763	5013	3301	5164
13	17694	8847	4351	26019	8571	357	1005	562	453	50	898	1309
3+	288448	240544	212517	172079	88840	68515	92470	142059	157120	174578	230630	261122
4+	258910	215077	193917	160046	82148	56431	69506	101149	144894	161207	205181	237584
5+	216261	167293	155910	146165	64971	43859	52039	67102	100215	145167	185786	210888
6+	147650	134728	109159	126745	56350	26937	39711	44897	61159	93457	165003	189185
7+	102276	94995	87321	95389	49015	19872	26638	33229	38870	59801	102445	166696

Table 24. (Continued)

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	30464	35067	12022	2724	2307	8471	4729	1735	2459	6000		
4	23800	32769	30934	20842	4630	3561	8856	6494	1541	1770		
5	28756	23904	33006	32164	25053	6644	4886	7802	4202	1184		
6	22759	29242	23651	27235	28871	22456	6600	3632	2635	3128		
7	23827	23416	25892	22041	22524	22295	15182	4768	2098	1778		
8	74050	24027	21321	23105	21993	20720	17519	12619	4674	1309		
9	33244	68655	22620	23843	22929	18883	21858	15904	12025	3676		
10	21445	27199	65362	25469	22836	15762	17060	23274	14114	9454		
11	9954	17331	22848	65911	22114	16197	11627	16977	20795	11746		
12	11011	8983	15691	19636	62896	15469	13092	10605	16480	15290		
13	997	1834	1992	2266	4667	8352	7486	2752	8960	12895		
3+	280307	292426	275338	265235	240820	158812	128895	106561	89983	68231		
4+	249843	257359	263316	262510	238513	150341	124166	104826	87524	62231		
5+	226043	224590	232382	241668	233884	146780	115310	98332	85983	60461		
6+	197286	200687	199376	209504	208831	140136	110424	90531	81782	59277		
7+	174527	171445	175725	182270	179960	117679	103824	86899	79147	56149		

Table 25. Population numbers at the beginning of the year (000s) for cod in Div. 3NO, 1959-92.

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	197(
3	55037	60425	85726	109356	80585	116507	166176	211794	184123	101963	128658	81253
4	94838	43513	47801	69451	88605	65694	89776	135137	172721	132573	68678	97958
5	19937	65851	29741	35155	53349	67334	39711	66616	93980	84912	57169	44535
6	17611	11737	33963	13767	26787	33536	37488	25619	36732	31415	25538	22422
7	13737	8967	6809	14000	9841	17543	20291	18696	10302	13319	8995	10783
8	5596	7687	5191	3752	8211	6306	12307	7690	7629	4115	5171	5474
9	5505	3322	4028	2737	2373	3248	4160	5708	2255	2038	1929	2973
10	5782	3822	2192	2531	1636	888	1946	2427	3019	1632	1211	1110
11	4402	3896	2779	1618	1681	790	431	464	455	2308	1175	727
12	1126	2500	2377	2253	1120	1085	613	205	269	308	1809	841
13	2425	3029	843	1818	1017	120	593	393	720	110	1234	3164
3+	225996	214749	221450	256439	275203	313051	373491	474750	512205	374693	301566	271241
4+	170959	154324	135724	147083	194619	196544	207315	262956	328081	272730	172908	189987
5+	76121	110811	87923	77632	106014	130850	117539	127819	155360	140157	104230	92029
6+	56185	44960	58182	42477	52664	63516	77828	61203	61380	55245	47061	47494
7+	38573	33223	24219	28710	25878	29980	40340	35585	24648	23830	21523	25072

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	86878	63669	37200	41493	26766	34528	54677	65983	23971	25229	32214	28022
4	64620	70270	52065	21356	28158	21307	24601	44217	53190	19561	20415	25918
5	62373	28566	39619	17654	8888	15109	10628	17907	32277	40086	15060	15727
6	26691	23650	12268	18776	4585	4084	6991	6411	12383	18095	29370	11188
7	9779	11266	7210	4625	5535	1487	2363	4366	4509	7619	12756	21968
8	5529	4839	3901	4119	1754	1766	1027	1417	3254	2893	5550	8723
9	3002	2265	2436	2314	1430	478	1230	680	1068	2425	2167	4024
10	1944	2006	1596	1355	976	337	351	818	505	822	1902	1601
11	774	1411	1447	1087	498	382	243	229	624	398	645	1472
12	390	543	1085	1061	503	180	301	162	180	500	318	491
13	1505	752	372	1894	851	37	77	45	34	4	69	112
3+	263486	209238	159199	115734	79944	79694	102489	142237	131996	117630	120467	119246
4+	176608	145569	121999	74241	53178	45166	47812	76253	108025	92401	88253	91224
5+	111988	75299	69934	52885	25019	23859	23211	32036	54835	72841	67837	65306
6+	49614	46733	30315	35231	16131	8750	12583	14129	22557	32755	52777	49579
7+	22924	23082	18046	16455	11547	4666	5592	7718	10174	14660	23407	38391

Table 25. (Continued)

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	41731	46141	36430	10089	6785	13032	13135	3944	4822	20000		
4	22667	33100	37724	29775	8122	5088	10419	9020	2266	2950		
5	19430	17973	26195	28214	21785	6268	3878	6556	3308	1246		
6	11437	14195	13438	15834	17288	14677	3750	1816	1440	1808		
7	8245	8274	9519	8255	9010	11037	6274	1930	677	686		
8	16603	6129	5671	5514	5391	6279	5458	3429	1198	299		
9	5792	12551	4367	3921	3657	3823	4228	3307	2155	648		
10	2756	4041	9445	3160	2706	2229	2617	3023	2181	1251		
11	1120	2041	2810	7251	2250	1768	1441	1931	2077	1332		
12	1059	843	1575	2065	5621	1482	1222	1028	1446	1354		
13	77	150	153	185	404	641	613	228	724	918		
3+	130917	145440	147327	114263	83017	66323	53033	36210	22295	32493		
4+	89185	99299	110897	104174	76232	53291	39898	32267	17473	12493		
5+	66518	66199	73173	74399	68110	48204	29479	23247	15207	9543		
6+	47088	48227	46978	46185	46325	41936	25602	16691	11899	8296		
7+	35652	34032	33540	30351	29037	27258	21852	14875	10459	6488		

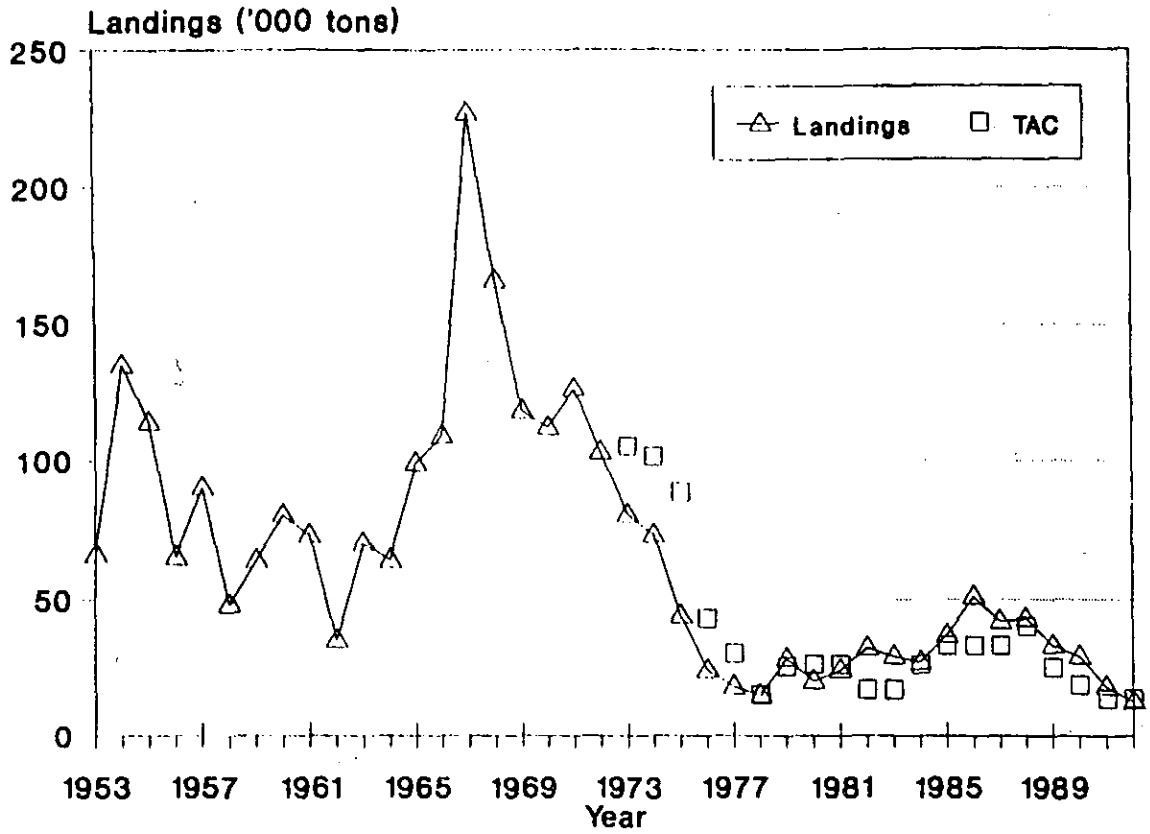

Figure 1. Landings of cod in NAFO Divisions 3NO for the period 1953-92.

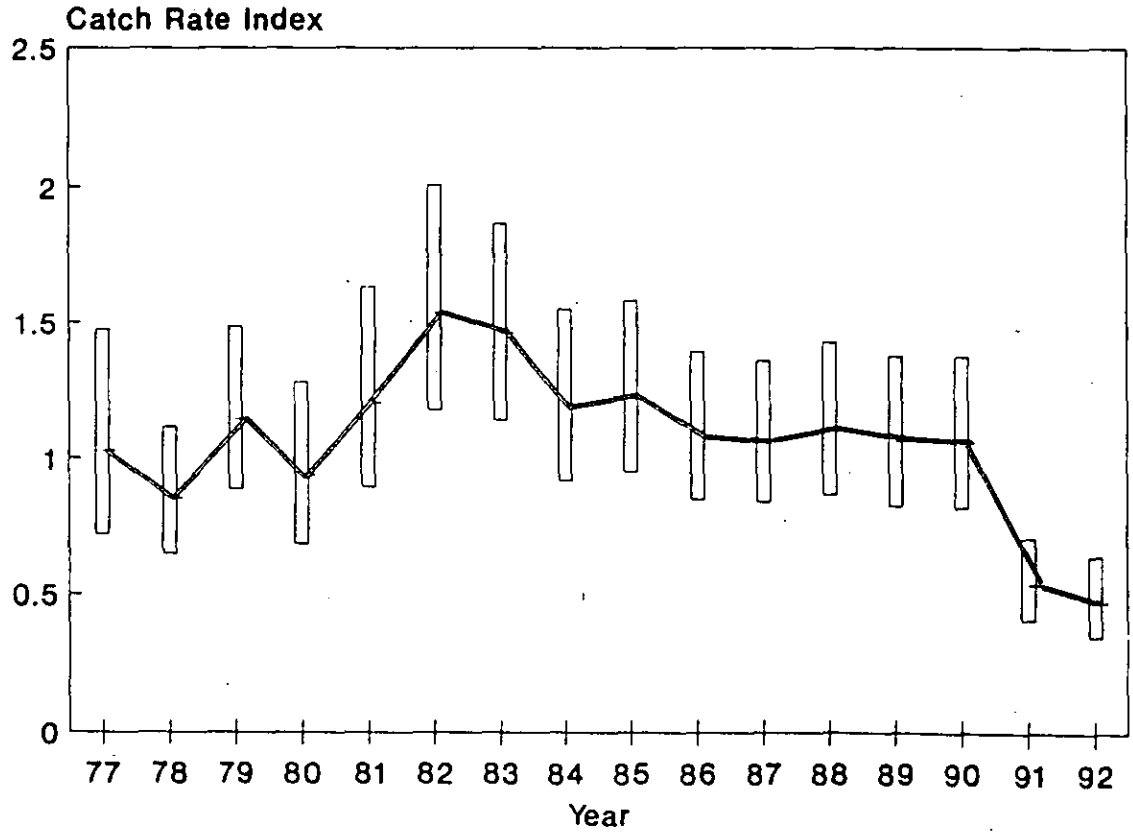

Fig 2. Catch rate index for cod in Div. 3NO by Canadian otter trawls.

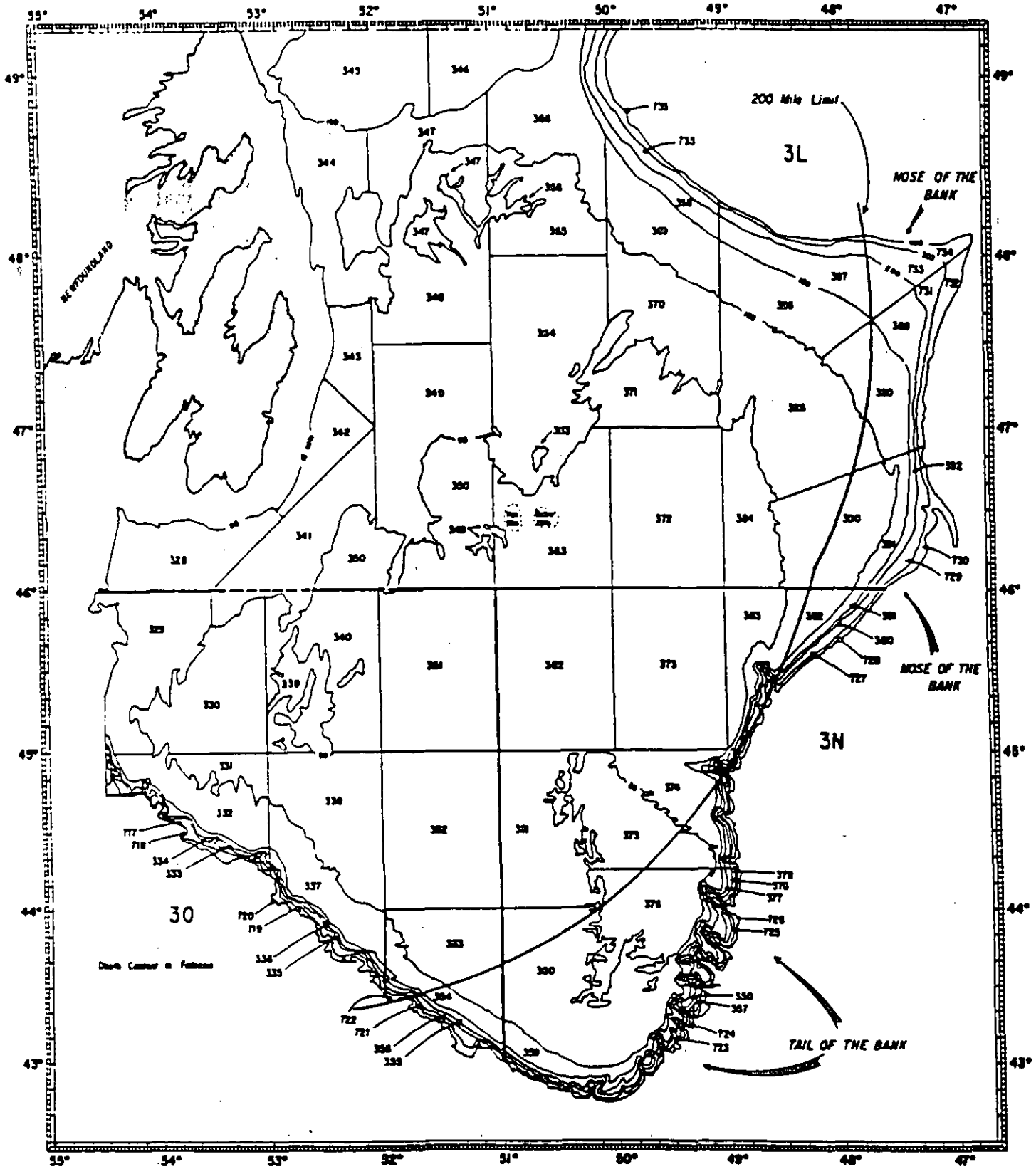

Figure 3. Stratification scheme for NAFO Divisions 3LNO showing the Canadian 200-mile limit.

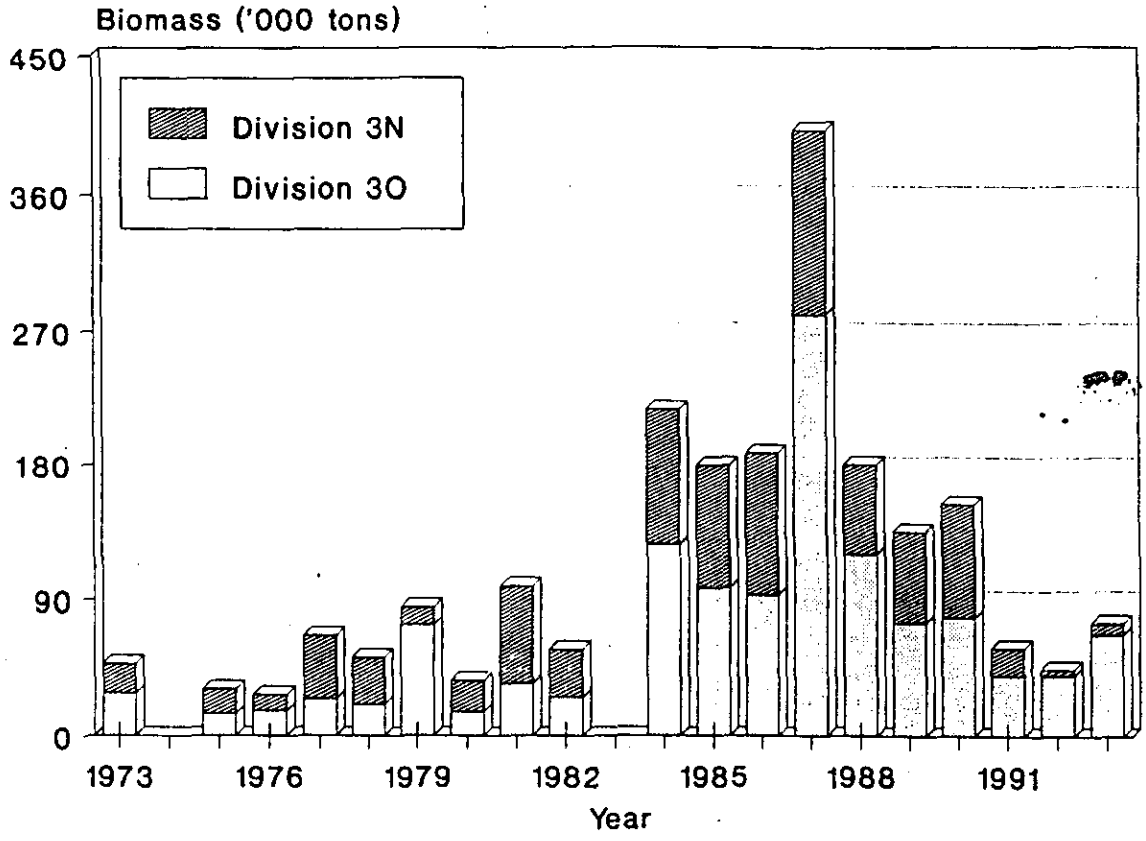

Figure 4. Cod in Divisions 3NO:
RV biomass from Canadian surveys.

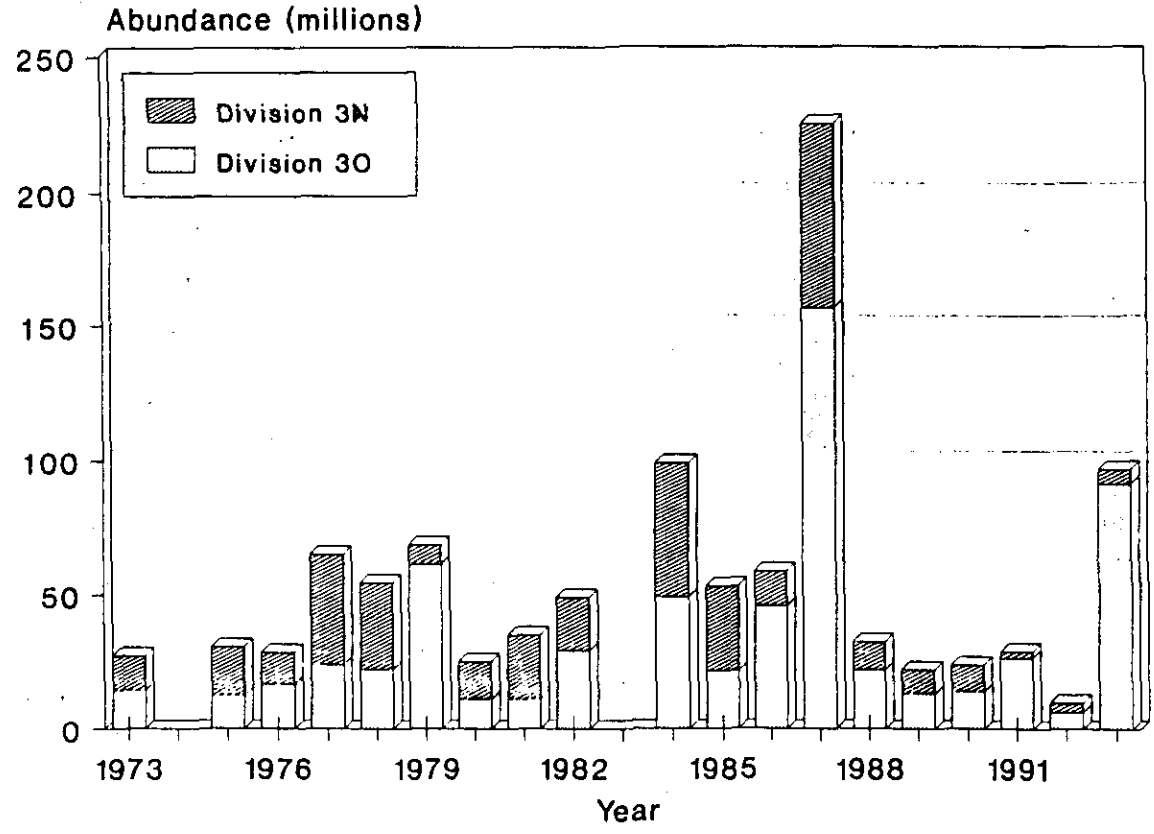

Figure 5. Cod in Divisions 3NO:
RV abundance from Canadian surveys.

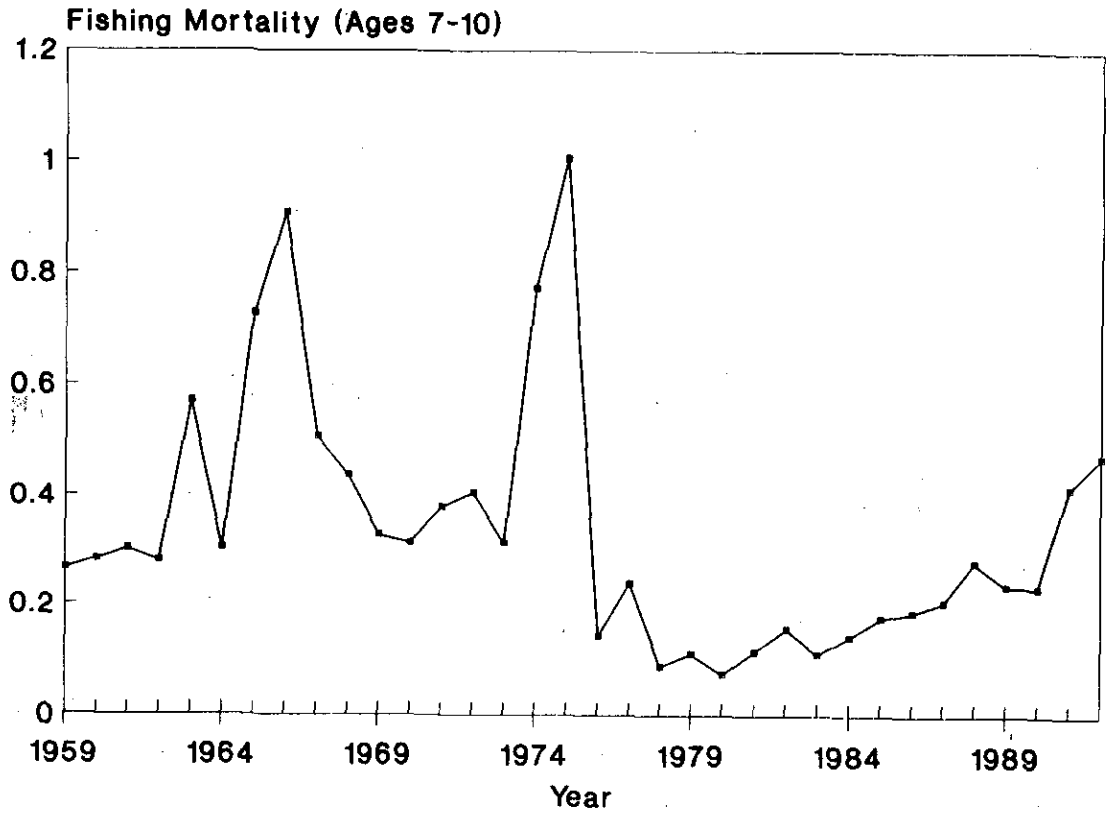

Fig 6. Trends in fishing mortality (ages 7-10) for cod in Div. 3NO.

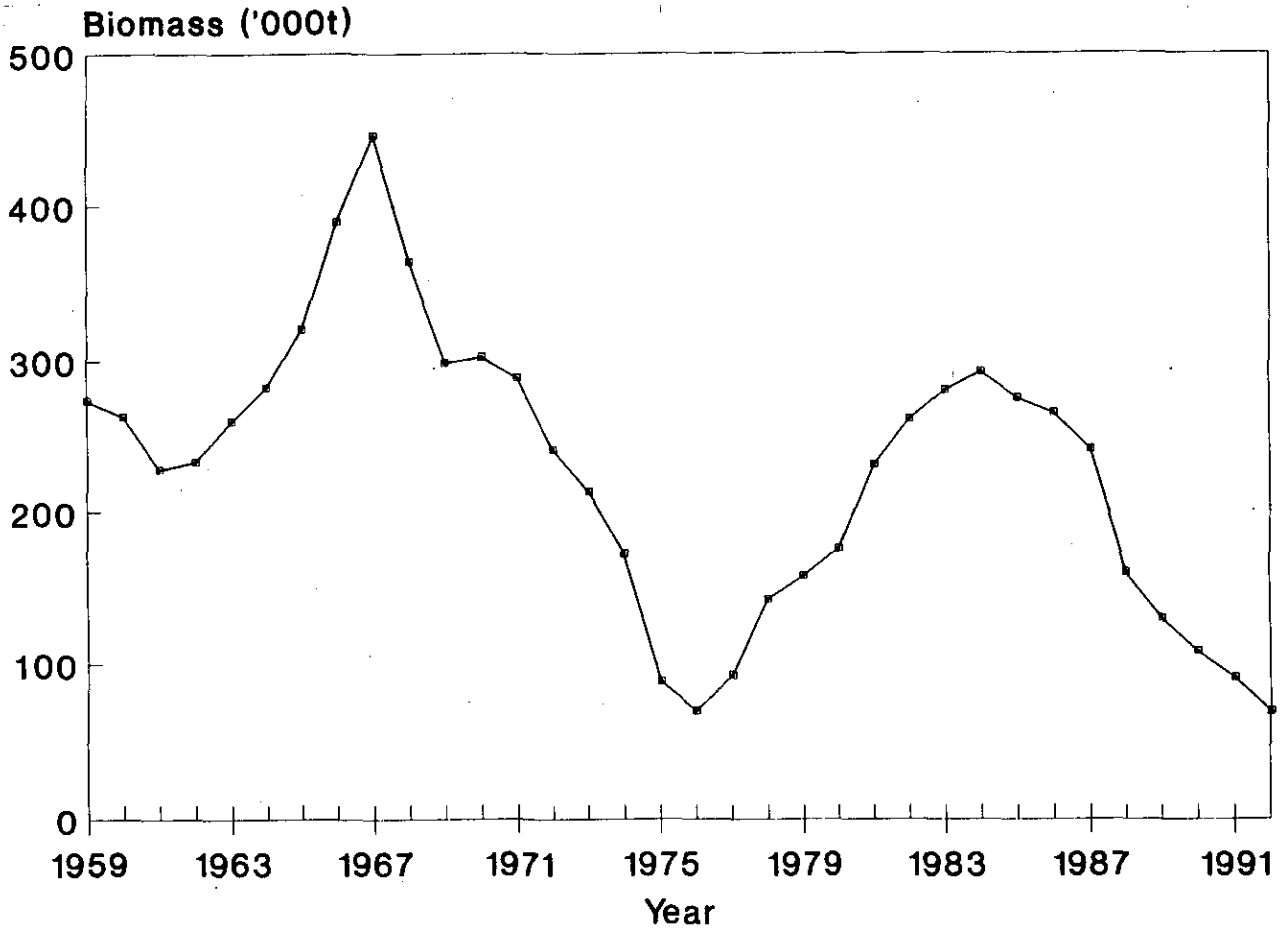

Fig 7. January 1 population biomass for cod in Division 3NO.

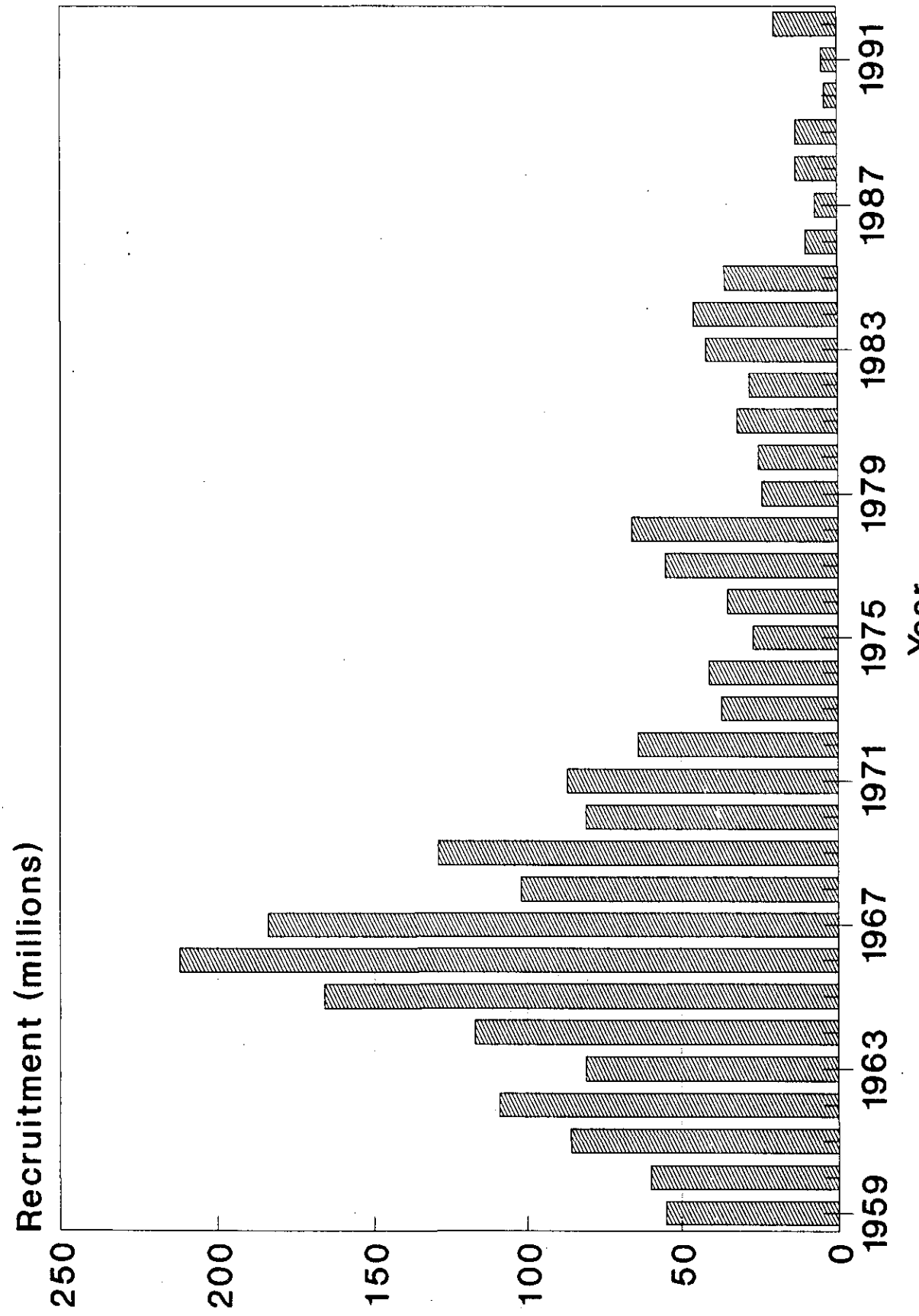

Fig. 8. Age 3 population numbers for cod in Div. 3NO, 1959-92.

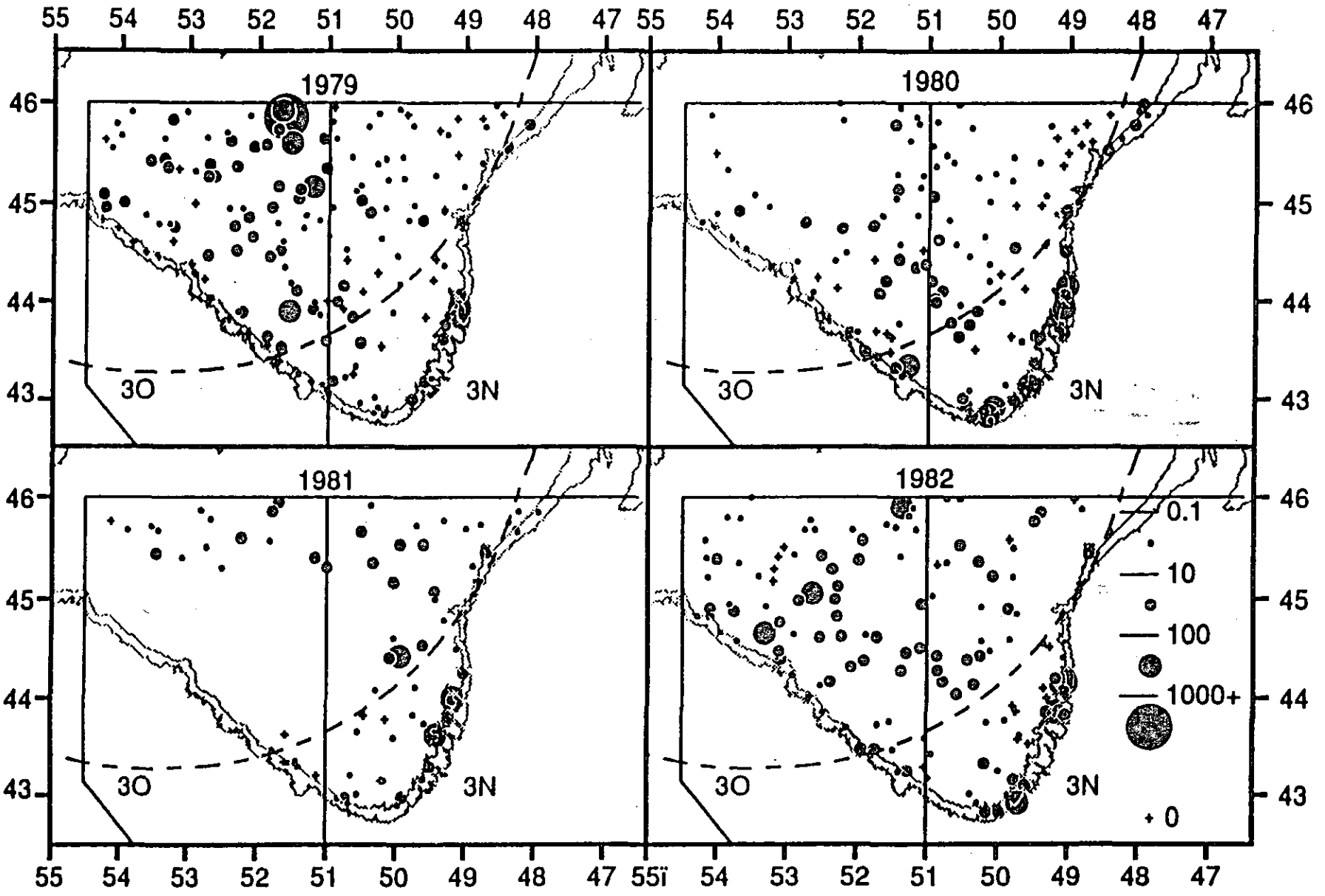

Figure 9. Cod distribution 1979-82 from Spring 3NO RV Surveys, Numbers per tow.

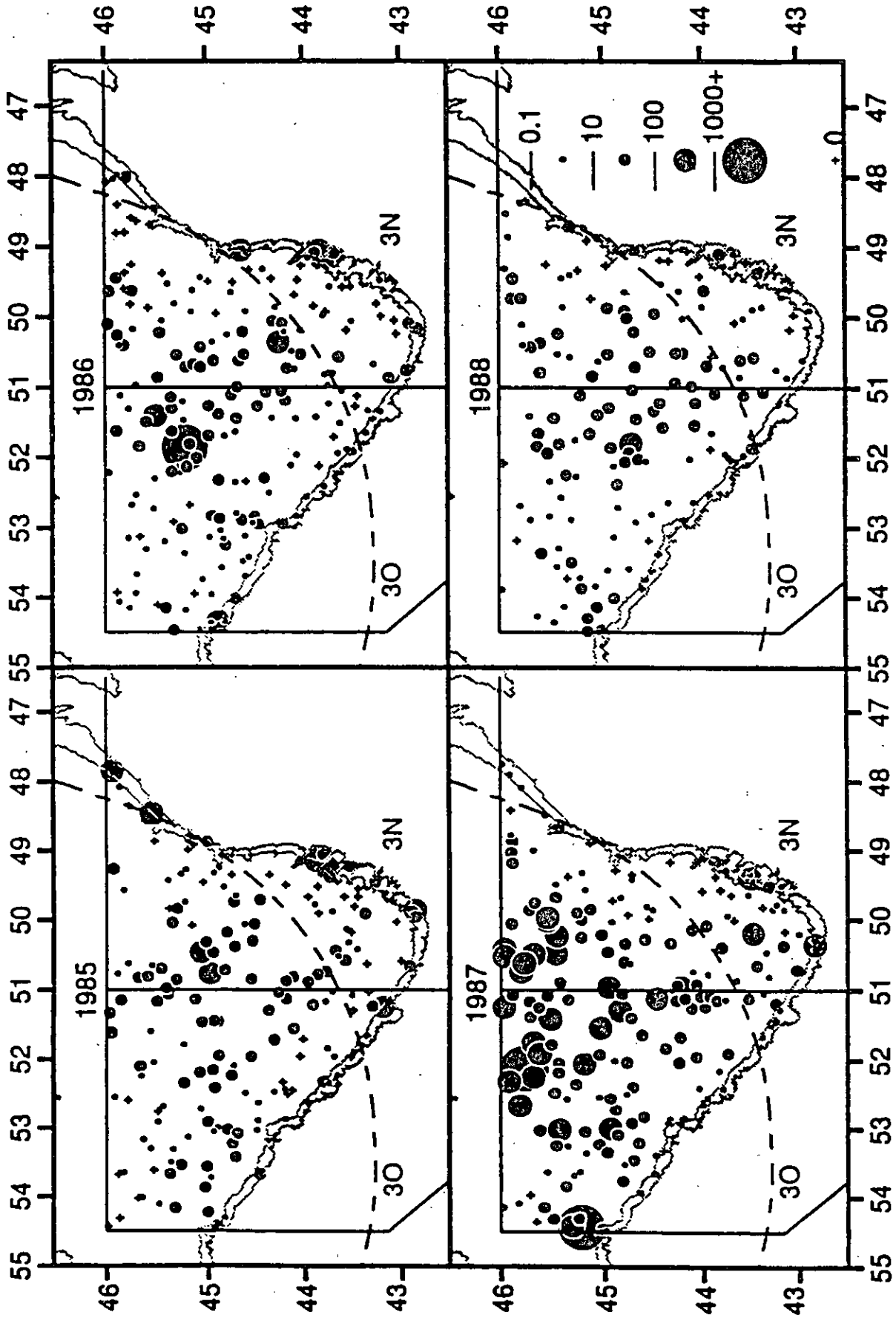

Figure 10. Cod distribution 1985-88 from Spring 3NO RV Surveys, Numbers per tow.

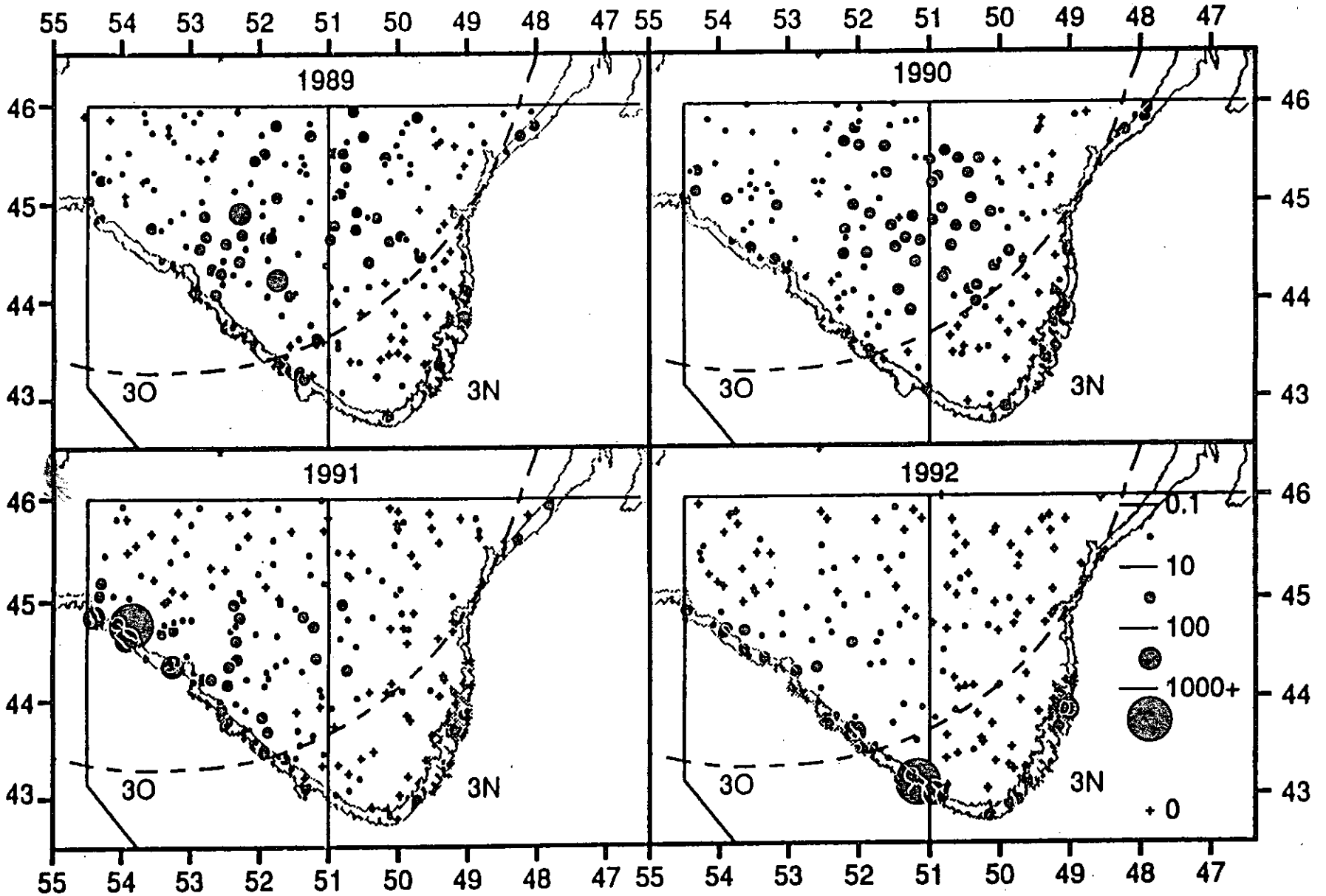

Figure 11. Cod distribution 1989-92 from Spring 3NO RV Surveys, Numbers per tow.