



SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1986

An Assessment Update of the Cod Stock in NAFO Divisions 3NO

by

C. A. Bishop and J. W. Baird

Science Branch, Department of Fisheries and Oceans
P. O. Box 5667, St. John's, Newfoundland, Canada A1C 5X1

INTRODUCTION

The data presented in this document, in most cases, represents an update of that presented previously (NAFO Scientific Council Meeting June 1986 - See NAFO SCS Doc. 86/35). The methods and sources of data collection are the same and are not presented here in detail. Some tables are repeated for reference purposes but otherwise only new information will be presented.

Nominal catch and catch at age

Cod catches from Div. 3NO since 1977, along with corresponding TAC's, are as follows:

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
TAC ('000 t)	30	15	25	26	26	17 ^b	17 ^b	26	33	33
Catch ('000 t)	18	15	28	20	24	32	29	27 ^a	35 ^a	

^aProvisional.

^bExcluded expected catches by Spain.

Landings by country for Div. 3NO are shown in Table 1 while Table 2 indicates catch information available by country, month, and year for 1986 for the period January to June. Canadian landings for 1986 were obtained from the Department of Fisheries and Oceans Canada while that for other countries was obtained from estimates provided by Canadian surveillance personnel. The age composition for this first half catch, along with average weights and lengths at age (Table 4) was estimated using sampling data indicated in Table 3.

Survey data

Biomass estimates from Canadian research surveys by strata (Fig. 1) are shown in Tables 5 and 6 with mean number and mean weight per tow values in Table 7. Biomass estimates for Div. 30 originally presented in SCS Doc. 86/35, were based on preliminary data and were incorrectly calculated. The corrected data were substantially different from original estimates. Total biomass in both divisions showed a substantial increase from 1982 to 1984 with the stock biomass being somewhat stable from 1984 to 1986.

Estimates of abundance for non-sampled strata were once again obtained using analysis of variance of the ln catch per tow after the inclusion of 1986 survey data. Survey abundance estimates for the non-sampled strata for Div. 3N and 3O are shown in Tables 8 and 9. Mean number per tow estimates have declined since 1984 in Div. 3N but, have generally increased in recent years in Div. 3O with the exception of 1985. Mean number per tow estimates (Tables 10 and 11) show that the 1981 and 1982 year-classes were most abundant in 1986 and that there were significant numbers of fish of ages 10 and older in the population.

Recruitment index

Mean number per tow data from Canadian and USSR surveys were combined to provide a recruitment index for the stock using indices reported for ages 2 and 3 for year-classes 1974 to 1984. Data from the Canadian surveys was that obtained from mean number per tow data which had been adjusted for unsampled strata (Table 11) while that for the USSR surveys (year-classes 1974-82) was obtained from NAFO SCS Doc. 83/V1/16 and other unpublished data. Preliminary analyses indicated significant relationships between year-class abundances at age 2 and 3 within and between countries and as such combination was considered appropriate. Indices used (Table 12A) were first averaged over common year-classes (1974-79) and a new index obtained by scaling each to the average for the common year-classes. The arithmetic means of these scaled values (Table 12B) were used as a recruitment index. The relationship between this index and age 3 population abundance from a cohort at $F_t = 0.35$ (NAFO SCR Doc. 86/35) for year-classes from 1974-79 was significant with an $r^2 = 0.75$ but with a large positive intercept (Fig. 2).

Catch-effort data-

Catch and effort data from Canadian otter trawlers during the period January to June was added to that previously used for the period 1977-85 and analyzed using a multiplicative model (Table 13). Catch rates generally increased from 1977 to 1982-1983 (Table 14; Fig. 3) but have since declined.

Fishing mortality in 1985

In the previous assessment, attempts to determine F in 1985 from the relationship between average exploitable biomass (from cohort analysis) and catch-rate index were not successful mainly because of the small number of data points. It was stated that the discriminating power of a short data series could be significantly influenced by changes in the parameters and inclusion of additional years.

Data available since that time are not considered sufficient to permit new cohort analyses. The catch at age matrix for the January to June period was derived from landings of only 6361 t whereas landings will probably be in excess of 40,000 t. The catch rate data was similarly available for only the January to June period. The analysis using a multiplicative model does account for seasonality based on previous data and the catch rate index obtained indicated a general decline from 1982 to 1986.

The following relationships were considered with regard to surveys, CPUE, and cohort abundance and biomass to determine F in 1985. These were:

1. Age 5+ survey abundance vs age 5+ cohort abundance.
2. Age 5+ survey abundance vs age 5+ cohort abundance (without 1984).
3. Age 6+ survey abundance vs age 6+ cohort abundance.
4. Age 6+ survey abundance vs age 6+ cohort abundance (without 1984).
5. Total survey biomass vs cohort 3+ mid-year biomass.
6. Total survey biomass vs cohort 3+ mid-year biomass (without 1984).
7. CPUE vs cohort exploitable biomass.

Significant regression relationships were observed only for (4) and (5). In (4) the only significant relationship occurred at $F_t = 0.25$ (Table 15) for the range considered. R^2 was highest at this level but the residual in the last year was high and positive.

In (5) for a range of F 's from 0.25 to 0.50 (Table 16) all were significant except at 0.50. Highest R^2 occurred at lowest F but residuals were once again highest and positive at this F value.

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	5,084	8,999	1,145	3,261	871	19,360
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	29,818
1984 ^a	8,722	13,580	1,071	3,306	431	27,120
1985 ^a	18,406	12,405	601	3,446	149	34,694

^aProvisional.

Table 2. Cod landings from NAFO Division 3N0 by the Canadian fleet from January 1 to June 30, 1986 with estimated for foreign fleets as obtained by Canadian surveillance.

	Can-N OT	Can-M	Total
3N			
J	8	2	10
F	10		10
M	15	4	19
A	116	1	117
M	754	76	830
J	1025	163	1188
Total	1928	246	2173
30			
J	361	139	500
F	636	295	931
M	712	331	1043
A	240	271	511
M	237	215	452
J	479 ^a	272	751
Total	2665	1523	4188
			6361
Foreign: (to July 21)			
Portugal			1235
Spain			4044
USSR			10
Korea			11
Mexico/Chile			329
Panama			1392
USA			7
Cayman Islands			51
Total Foreign			7109

^aIncludes 5 t line trawl.

Table 3. Commercial sampling for NAFO Divisions 3N0 cod from January to June 1986.

Qtr.	Gear	Country	Div.	No. aged	Month	No. meas.	Landings country/mo.	Total
1	OT	CAN(N)	30	403	Feb.	891	636	1431
					Mar.	814	712	1043
						403	1705	2474
2	OT	CAN(N)	3N	181	Apr.	114	116	156
					May	646	754	830
					June	157	1025	1188
			30	Apr.	301	240	511	
				May	378	237	1203	
					181	1596	3888	
Total			584		3301	6362		

Table 4. Estimated average weight, average length, and catch numbers at age for the Canada-Newfoundland cod fishery in NAFO Divs. 3N0 during the first half of 1986.

AGE	AVERAGE		CATCH		
	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
4	0.839	46.000		0.36	1.06
5	1.286	52.476	667	84.86	0.13
6	1.840	58.801	622	91.84	0.15
7	2.937	68.419	137	38.68	0.28
8	4.999	81.120	145	18.53	0.13
9	6.621	88.975	74	11.63	0.16
10	8.555	96.983	79	10.29	0.13
11	9.097	98.627	137	13.64	0.10
12	9.640	100.566	53	7.86	0.15
13	10.969	105.028	17	3.63	0.21
14	13.586	113.173	10	1.44	0.14
15	10.245	101.689	3	2.59	0.75
16	16.628	121.000		0.21	1.03
17	17.152	121.087	1	0.29	0.56
18	16.628	121.000		0.21	1.03

Table 5. Biomass estimates (MT) by stratum from survey cruises in Div. 3N

Strata	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
357			1383				29		52	332	135	92	0	2102	259
358		1061	1772				383		483	1054	229	236	182	122	547
359		312	258			660	147		190	478	208	13	71	0	134
360		1966			306	1950	4040	2182	1416	1738	3743	1238	7877	9161	1945
361	2909	4525	2525	350	3246	2618	5894	8203	2666	4173		8125	12838	29220	50957
362	2127	9695	4222	2233	306	1666	6836	6621	1632	5847	8701	3708	40764	16509	19686
373	8159	3423	1855	2362		1031	1750	4300	1838	857	4578	6647	17916	2446	2897
374	901	702	273	0	135		1248	1324	479	0	146	2369	8335	877	769
375	3270	9977	1042	955	10601		5429	3598	369	3229	29835	5943	2404	18475	14586
376		1892	806		383	77	9672	102	868	855	2208	2	1049	391	1883
377		550	14	83	283		1380	130	22	287	428	22	29	13	54
378	530	4146	404	632			687	90	281	939	104	303	133	470	256
379			1828	915			50	0	601	178	53	179	129	324	365
380	9	322	1317	206			52		232	57	25		224	847	135
381	480	1429	2386	359	122		2677	393	196	427	533	2186	478	1544	747
382	142	2458	9	69		42	948	2215	220	285	182	36	0	16	61
383	231	1479	1	16		44	324	1564	146	0	430	5	294	0	0
Total	18357	43935	20096	7781	15381	8088	41546	30722	11692	20736	51538	31104	92725	82515	95280
Upper limit	35959	58509	29260	13257	35224	13399	61360	37915	16334	28150	120675	46068	123845	108355	162513
Lower limit	755	29362	10931	2304	-4462	2776	21732	23529	7051	13322	-17600	16141	61605	56674	28046

Table 6. Biomass estimates (MT) by stratum from survey cruises in Division 30.

Strata	1973	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
329	211		6422	180	2008	357	18	487	373	560	840	304
330	9291	475	287	593	2218	3753	470	3371	123	3626	4642	2130
331	288	729	454		342	150	609		38	2630	3423	685
332		830	351	940	4525	2266	9		3474	2358	13471	2499
333		525	82	0	2	0	28		153	0	147	232
334			6	0	6	0	43		8	0	570	3481
335	22		3		0	0	10		11	0	0	126
336	29	0	0	136	3	1	286		104	0	34	45
337	78	1906	32	630	614	23	133		610	434	1203	8497
338	4298	5563	1876	6953	1334	5729	1795		5659	29905	7485	14405
339	1547	40		249	1475			505	610	1087	359	29
340		2029	2690	298	966	3718	386	4294	2849	6827	5431	5796
351	3092	1562	2684	8141	4334	47954	5629	6621	4498	43455	23490	38217
352	3075	426	1429	6120	3961	10008	5625		6236	34168	29692	15071
353	3265	77	2	262	84	1573	2		472	0	6083	951
354	439		38	8		34	273	44	125	489	219	180
355	76	0	4			24	367	32	135	0	135	12
356	11					12	49	9		0	0	32
Total	25681	14161	16360	24261	20646	76966	15733	15363	25478	125339	97223	92699
Upper Limit	35514	58392	65071	38015	34853	133278	24517	25164	33764	169942	126100	136099
Lower Limit	15848	30070	-32350	10508	6442	20645	6950	5561	17191	80736	68346	49299

Table 7. Mean number and weight of cod per standard tow from research vessel surveys in NAFO Div. 3N, 3O, and 3NO.

Div.	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
<u>Mean Number per tow</u>															
3N	44.60	33.33	12.17	8.91	17.10	10.30	32.37	25.00	5.59	11.28	18.38	15.54	40.01	24.96	10.34
3O			10.48		10.31	12.63	18.93	16.93	46.36	8.52	8.62	21.86	36.36	15.84	33.72
3NO			12.46		13.23	11.61	25.70	20.78	26.28	9.85	14.60	18.77	38.03	20.24	22.44
<u>Mean Weight per tow</u>															
3N	24.51	34.05	18.03	8.91	17.57	8.24	33.32	25.98	9.34	16.56	46.30	25.01	74.05	65.90	76.09
3O			25.19		12.17	12.63	19.42	15.93	57.28	12.17	22.32	19.13	93.8	72.35	68.98
3NO			21.40		14.48	10.71	26.36	20.72	32.74	14.29	37.00	21.92	84.01	69.24	72.41

Table 8. Cod abundance (000's) from stratified-random cruises in Div. 3I. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
0-30	375	1593	5076	3826	398	1435	6616	(1681)	7474	4329	263	508	10583	1578	1746	3184	912
	376	1499	(1250)	788	37	(869)	1294	113	3601	225	225	113	225	33	7933	48	177
31-50	360	2992	(4158)	1516	(2712)	(2888)	2302	3425	4211	1011	1273	2695	523	2118	5680	3005	552
	361	1853	5747	5796	835	904	3623	723	5610	4764	1166	1808	(3851)	4961	3283	10293	3310
	362	2520	2484	11823	984	1466	431	1021	5030	7440	757	1203	3859	1608	18971	4385	2391
	373	2520	18897	3831	142	426	(1444)	76	946	5959	327	331	1892	1509	8160	770	675
	374	931	1563	175	175	1	140	(561)	1607	1817	297	1	163	1677	2893	175	47
	383	674	74	1644	51	25	(119)	17	320	1493	34	1	118	25	34	1	1
51-100	359	421	(765)	822	622	(532)	(430)	4709	1359	(1015)	549	2133	611	126	95	0	1264
	377	100	(713)	1066	143	613	413	(278)	2800	105	73	490	1146	278	56	105	23
	382	647	425	4347	16	130	(342)	24	2639	1943	243	255	146	194	0	134	12
101-150	358	225	(608)	861	4189	(423)	(341)	(236)	262	(804)	431	1993	135	1343	380	448	760
	378	139	619	3673	459	1683	(1206)	(835)	657	120	400	1445	193	1236	318	2181	433
	381	182	1195	779	861	79	156	(389)	3267	364	155	379	779	1851	301	2391	1312
151-200	357	164	(498)	(1056)	1157	(346)	(280)	(194)	12	(660)	49	336	37	382	0	2381	137
	379	106	(695)	(1473)	1802	785	(390)	(270)	24	0	671	408	40	322	175	525	801
	380	116	17	118	641	70	(192)	(133)	22	(453)	96	26	15	(282)	83	788	136
Total		16682	44784	43591	15222	12673	19719	14684	40641	32500	7009	14125	24314	19604	50108	31264	12943
Estimated mean no. per tow			35.76	34.81	12.16	10.12	15.75	11.73	32.45	25.95	5.60	11.28	19.42	15.66	40.02	24.97	10.34

Table 9. Cod abundance (000's) from stratified-random cruises in Div. 30. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	1973	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
31-50	330	2089	2144	419	679	889	1071	3674	1411	941	359	1921	1461	823
	331	456	34	49	624	(244)	240	205	1284	(184)	377	993	548	214
	338	1898	2451	4987	3230	9047	1311	2666	1681	(2801)	4103	10116	2391	2976
	340	1716		215	4164	258	708	1730	386	859	2340	2998	2733	2576
	351	2520	2837	936	615	4843	2535	39981	1513	3689	8701	18538	4413	32509
	352	2580	3409	1290	1791	5965	4648	3486	2113	(3563)	3486	11814	4859	2988
	353	1282	224	705	48	320	1732	4388	48	(253)	257	1	674	165
51-100	329	1721	129	(437)	3682	172	1731	1012	65	129	753	775	501	501
	332	1047	(554)	1729	367	1729	7309	2613	118	(632)	5678	236	1839	458
	337	948	735	688	356	249	320	516	48	(290)	285	142	939	882
	339	585	220	22	(434)	(353)	329	1361	(337)	198	2448	1054	88	29
	354	474	261	(337)	712	36	(356)	729	2075	107	107	142	261	178
101-150	333	151	(28)	958	85	0	4	0	6	(32)	60	0	17	53
	336	121	9	0	0	141	5	2	95	(22)	41	0	9	45
	355	103	19	0	4	(103)	(109)	19	128	19	151	0	398	12
151-200	334	92	(36)	(54)	7	0	2	0	21	(40)	3	0	152	856
	335	58	7	(7)	1	(7)	0	0	3	(5)	4	0	0	40
	356	61	2	(9)	(11)	(9)	(9)	5	18	2	(15)	0	0	9
Total		17902	13719	12841	16810	24364	22419	62387	11349	13766	29167	48630	21283	45316
Estimated mean no. per tow.			10.21	9.56	12.51	18.13	16.68	46.46	8.45	10.24	21.71	36.19	15.84	33.72

Table 10. Mean number of cod at age and per standard tow from research vessel surveys in NAFO Divisions 3NO.

# Sets	1971 ^a	1972 ^a	1973	1974 ^a	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
Age															
1	0.0	0.01	0.07	0.05	0.46	0.58	0.01	0.55	3.09	0.01	0.35	1.56	0.01	0.01	.02
2	4.18	1.17	2.64	1.39	3.16	3.89	2.35	0.71	0.93	5.39	0.38	9.37	3.28	0.41	.70
3	42.14	9.01	2.69	4.97	4.70	2.89	9.71	7.07	2.33	1.38	5.39	1.18	6.20	4.47	.71
4	5.80	19.28	1.88	0.89	2.64	1.83	6.29	8.17	9.25	0.67	1.58	3.54	9.90	6.05	7.71
5	4.43	1.72	2.48	0.44	0.59	1.66	4.63	2.48	7.84	1.07	1.83	.60	5.29	2.41	6.46
6	1.06	.71	0.50	0.38	0.31	0.26	1.54	0.96	1.76	0.44	2.32	.47	5.60	.88	1.62
7	1.08	.58	0.28	0.14	0.60	0.07	0.49	0.61	0.52	0.21	1.13	.78	1.87	.97	.68
8	0.48	.41	0.20	0.04	0.25	0.13	0.22	0.04	0.26	0.18	0.50	.58	1.00	.73	.65
9	0.24	.30	0.22	0.01	0.25	0.06	0.10	0.01	0.10	0.18	0.53	.26	1.81	.88	.50
10	0.03	.17	0.13	0.07	0.08	0.07	0.10	0.03	0.02	0.09	0.24	.16	1.57	1.34	.74
11	0.08	.08	0.06	0.03	0.01	0.02	0.01	0.04	0.06	0.05	0.04	.07	.86	.98	1.20
12	0.14	.05	0.09		0.02		0.04	0	0	0.07	0.14	.05	.32	.49	.65
13			0.14		0.01		0.09	0.04	0.04	0.03	0.06	.01	.11	.24	.36
14+	0.47	.36	0.50	0.15	0.15	0.05	0.12	0.01	0.10	0.12	0.17	.14	.22	.39	.52
Mean no. per tow	60.13	33.85	11.89	8.56	13.23	11.51	25.70	20.72	26.30	9.89	14.66	18.76	38.03	20.24	22.42
Upper Limit	117.35	51.51	15.47	12.50	25.93	17.94	33.96	31.81	47.18	12.85	23.61	25.28	47.82	24.06	44.11
Lower Limit	2.93	16.10	8.33	4.62	0.52	5.09	17.45	9.90	5.49	6.91	5.70	12.24	28.25	16.42	0.74

^aSurvey 3N only.

Table 11. Mean number of cod at age and per standard tow from research vessel surveys in HAFO Divisions 3H0 (includes estimates for non sampled strata).

No. sets	1971 ^a 45	1972 ^a 45	1973 94	1974 ^a 37	1975 58	1976 78	1977 88	1978 88	1979 172	1980 140	1981 77	1982 136	1984 116	1985 178	1986 203	
Age																
1	0.0	0.01	0.07	0.06	0.44	0.61	0.01	0.56	3.11	0.01	0.35	1.56	0.01	0.01	0.02	
2	2.49	1.20	2.48	1.64	3.00	4.10	2.29	0.72	0.94	5.35	0.38	9.37	3.28	0.41	0.70	
3	25.06	9.27	2.52	5.88	4.46	3.05	9.46	7.22	2.35	1.37	5.40	1.18	6.20	4.47	0.71	
4	3.45	19.83	1.76	1.05	2.50	1.93	6.13	8.34	9.31	0.67	1.58	3.54	9.91	6.05	7.71	
5	2.63	1.77	2.33	0.52	0.56	1.75	4.51	2.53	7.89	1.06	1.83	0.60	5.29	2.41	6.46	
6	0.63	0.73	0.47	0.45	0.29	0.27	1.50	0.98	1.77	0.44	2.32	0.47	5.60	0.88	1.62	
7	0.64	0.60	0.26	0.17	0.57	0.07	0.48	0.62	0.52	0.21	1.13	0.78	1.87	0.97	0.68	
8	0.29	0.42	0.19	0.05	0.24	0.14	0.21	0.04	0.26	0.18	0.50	0.58	1.00	0.73	0.65	
9	0.14	0.31	0.21	0.01	0.24	0.06	0.10	0.01	0.10	0.18	0.53	0.26	1.81	0.88	0.50	
10	0.02	0.17	0.12	0.08	0.08	0.07	0.10	0.03	0.02	0.09	0.24	0.16	1.57	1.34	0.74	
11	0.05	0.08	0.06	0.04	0.01	0.02	0.01	0.04	0.06	0.05	0.04	0.07	0.86	0.98	1.20	
12	0.08	0.05	0.08		0.02		0.04	0.0	0.0	0.07	0.14	0.05	0.32	0.49	0.65	
13			0.13		0.01		0.09	0.04	0.04	0.03	0.06	0.01	0.11	0.24	0.36	
14+	0.28	0.37	0.47	0.18	0.14	0.05	0.12	0.01	0.10	0.12	0.17	0.14	0.22	0.39	0.52	
Mean no. per tow	35.76	34.81	11.15	10.12	12.55	12.13	25.04	21.15	26.47	9.82	14.67	18.79	38.04	20.24	22.42	

^aSurvey in 3H1 only.

Table 12. A. Mean numbers per tow at ages 2 and 3 from Canadian and USSR surveys along with cohort abundance ($F_t = 0.35$; NAFO SCR Doc. 86/35) for the same year-classes. B. Relationship of a recruitment index (average of indices obtained by dividing numbers per tow by average for common years) to cohort abundance.

Year-class	Canadian		USSR		Cohort age 3 abundance $\times 10^{-6}$ ($F_t = 0.35$)
	Age 2	Age 3	Age 2	Age 3	
A.					
1974	4.10	9.46	96	222	45
1975	2.29	7.22	97	67	35
1976	0.72	2.35	7	26	15
1977	0.94	1.37	8	25	18
1978	5.35	5.40	44	50	32
1979	0.38	1.18	5	21	30
1980	9.37	-	85	55	
1981	-	6.20	27	123	
1982	3.28	4.47	68		
1983	0.41	0.71			
1984	0.70				
Ave. 1974-79 year-classes	2.3	4.5	42.8	68.5	
					Recruitment index (Ave. Can. + USSR indices)
B.					
1974	1.78	2.10	2.24	3.24	2.34
1975	1.00	1.60	2.27	0.99	1.46
1976	0.31	0.52	0.16	0.38	0.34
1977	0.41	0.30	0.19	0.36	0.32
1978	2.33	1.20	1.03	0.73	1.32
1979	0.17	0.26	0.12	0.31	0.22
1980	4.07	-	1.99	0.80	2.29
1981	-	1.38	0.63	1.80	1.27
1982	1.43	0.99	1.59		1.34
1983	0.18	0.16			0.17
1984	0.30				0.30

Cohort age 3 numbers vs recruitment index

$$r^2 = 0.75$$

$$a = 11.37$$

$$b = 17.80$$

Table 13. Regression coefficients and the analysis of variance from regression of ln catch rate for cod in Divisions 3NO from 1977 to 1986 using Canadian otter trawl data. (Data for 1986 from January to June only.)

Country	Gear	ln power	Month	ln power
Can N	OT 4	0.000	May	
			June	-0.945
Can N	OT 5	0.134	July	
			Oct.	
Can M	OT 4	0.432	Aug.	-0.803
			Sept.	
Can M	OT 5	0.585	Mar.	-0.602
			Apr.	
			Feb.	-0.445
			Nov.	
Div. 3H and 3O		0.000	Dec.	-0.251
			Jan.	0.000

Table 14. Catch rate index for cod in NAFO Division 3NO using otter trawl data from 1977 to 1986. (Data for 1986 from January to June.)

Year	Catch rate		Catch	Effort
	Mean	S.E.		
1977	1.216	0.259	17604	14474
1978	1.014	0.175	14718	14521
1979	1.410	0.230	27940	19810
1980	1.122	0.211	19990	17812
1981	1.444	0.264	24344	16861
1982	1.826	0.309	31605	17309
1983	1.739	0.255	28818	16572
1984	1.468	0.231	27120	18475
1985	1.505	0.246	41284	27429
1986	1.237	0.208	33000	26667

Table 15. Relationship of survey age 6+ abundance with cohort age 6+ abundance for a range of fully recruited F's. (1984 value omitted.)

	0.25	0.30	0.35	0.40	0.45	0.50
Slope	4191	3310	2789	2317	1949	1655
Intercept	3404	5044	5072	5953	6638	7187
r ²	0.60	0.54	0.49	0.43	0.36	0.30
81 Res.	-1080	620	1556	2469	3181	3751
82 Res.	7662	6719	6214	5711	5321	5010
83 Res.	2883	1526	770	42	-525	-980

Table 16. Relationship of total survey biomass with cohort 3+ mid-year biomass at a range of fully recruited F's.

	0.25	0.30	0.35	0.40	0.45	0.50
Slope	2389	1823	1457	1154	918	729
Intercept	58539	66387	66297	70512	73796	76430
r ²	0.71	0.67	0.64	0.59	0.52	0.44
82 Res.	62864	52347	43759	38142	33783	30302
84 Res.	-1545	1656	3189	4915	6269	7364
85 Res.	19182	10738	5822	1281	-2267	-5120

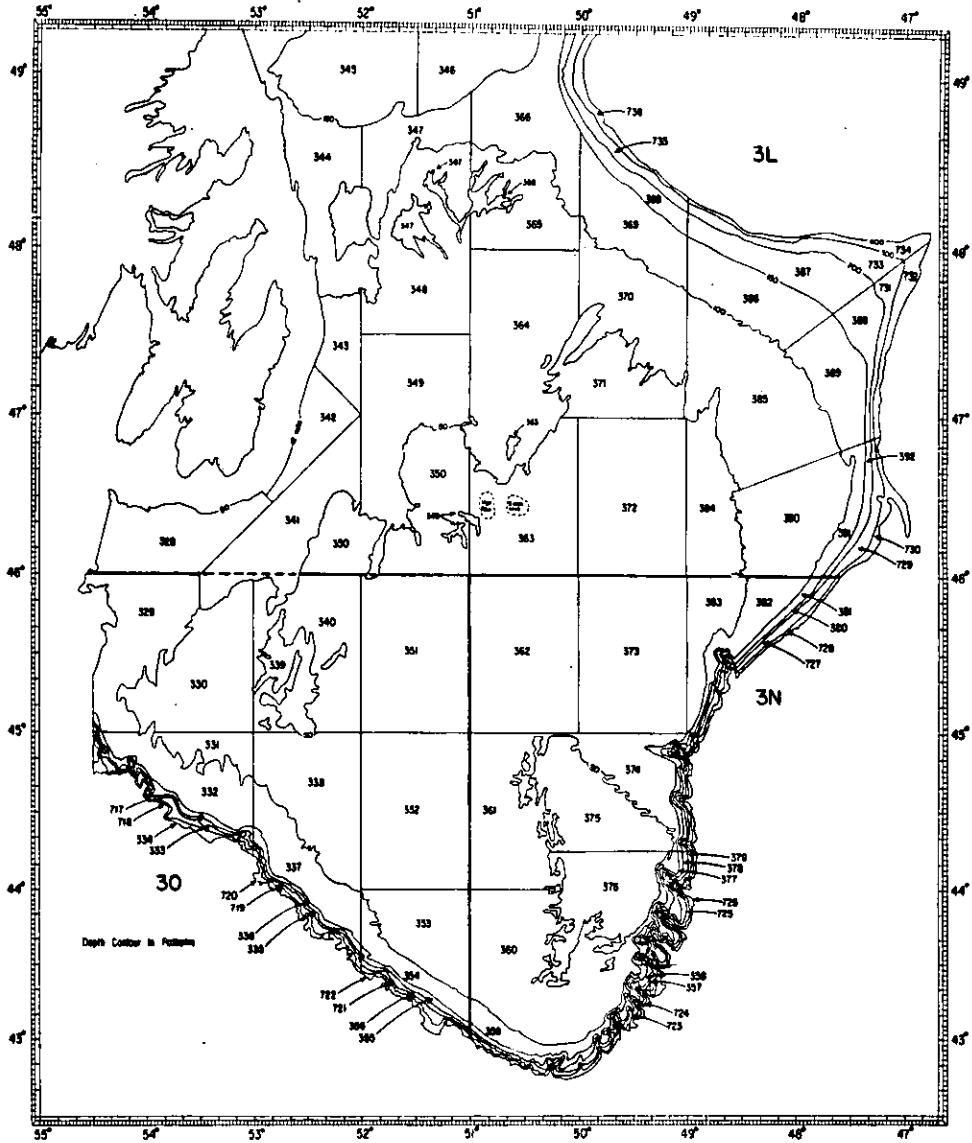


Fig. 1. Stratification scheme for NAFO Divisions 3LNO.

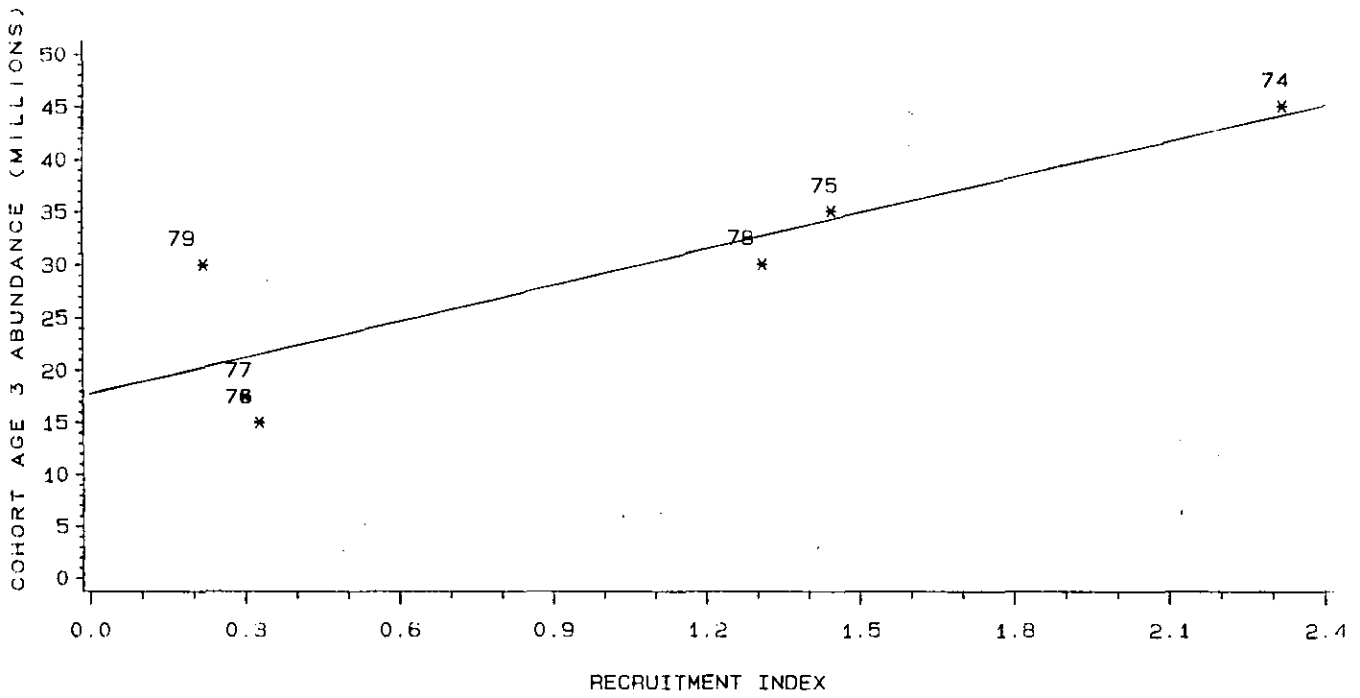


FIG 2. RELATIONSHIP OF RECRUITMENT INDEX TO COHORT AGE 3 ABUNDANCE FOR THE 1974-79 YEAR-CLASSES FOR COD IN DIVISIONS 3NO.

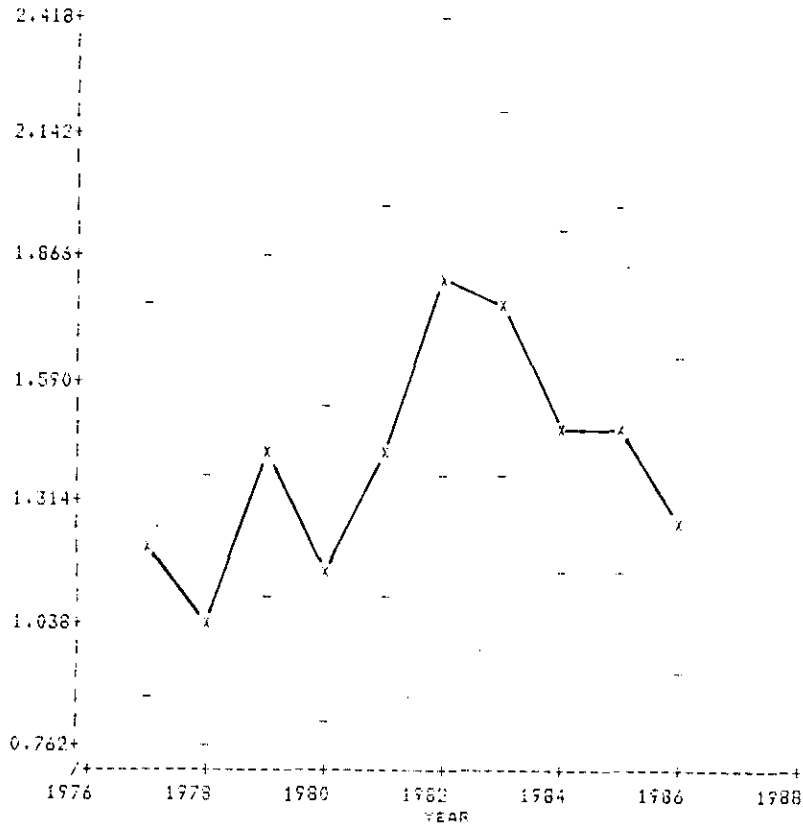


Fig. 3. Catch rate index with approximate 90% confidence interval for cod in Div. 3NO using Canadian otter trawl data from 1977 to 1986 (January to June 1986).

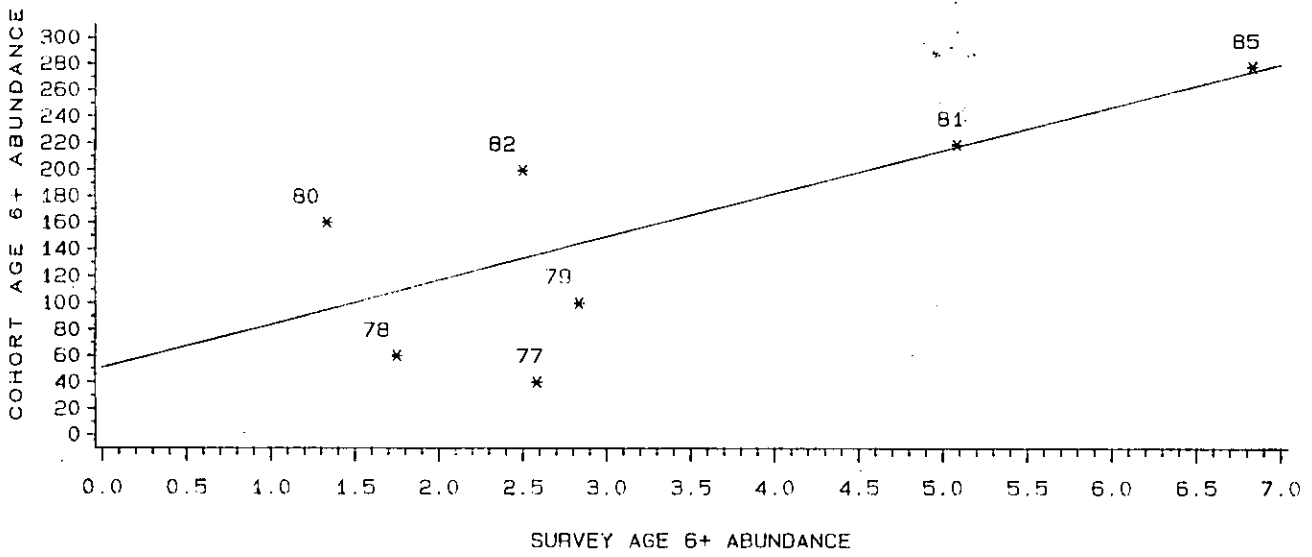


FIG 4. RELATIONSHIP OF AGE 6+ SURVEY ABUNDANCE TO AGE 6+ COHORT ABUNDANCE FOR NAFO DIV. 3NO COD FOR THE PERIOD 1977-85 (EXCLUDING 1984) USING TERMINAL F=0.30.

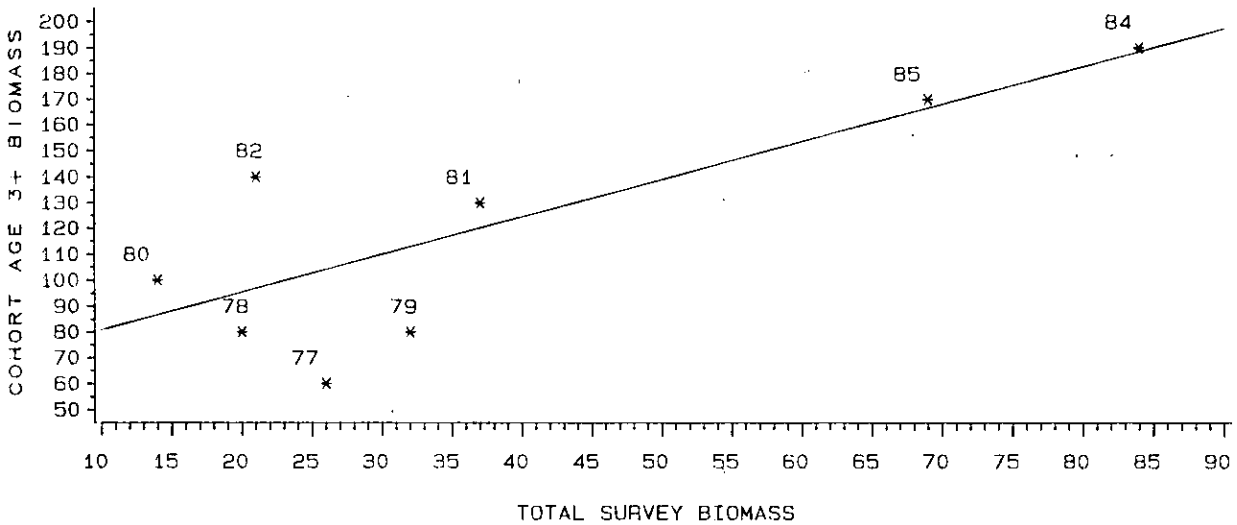


FIG 5. RELATIONSHIP OF TOTAL SURVEY BIOMASS TO COHORT AGE 3+ BIOMASS FOR DIV. 3NO COD FOR THE PERIOD 1977-85 USING TERMINAL F=0.30.