Northwest Atlantic Fisheries Organization

Serial No. N1149

NAFO SCR Doc. 86/35

SCIENTIFIC COUNCIL MEETING - JUNE 1986

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

by

C. A. Bishop and J. W. Baird

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

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]	

[a]Provisional.

[b]Excluded expected catches by Spain.

Landings by country for Div. 3NO since 1953 are shown in Table 1, while Table 2 indicates catch information available by country, month, and gear for 1985. Canadian landings were obtained from the Department of Fisheries and Oceans, Canada, while that for other countries was obtained from NAFO circular letters and/or FLASH records. Sampling data used to obtain catch at age from the commercial catch in 1985 (Table 3) were obtained by the Commercial Sampling and Foreign Cooperative Research units of the Department of Fisheries and Oceans.

The total estimated catch-at-age, along with average weights and lengths-at-age, are shown in Table 4. Average weights-at-age were determined by applying a length-weight relationship (log weight = 3.0849 log length - 5.2106 to the length frequencies and age length keys. The calculated total catch weight was within 2% of the total reported and estimated catch. The dominant year-classes in the fishery were those from 1978 to 1980.

Survey data

Stratified random research vessel surveys have been conducted in Div. 3NO since 1971, with the exception of 1983 as well as those in Div. 3O for 1971-72 and 1974. Surveys from 1971 to 1982 were conducted by the research vessel A. T. CAMERON, those for 1984 and 1985 by the A. NEEDLER, and that for 1986 by the W. TEMPLEMAN. Biomass estimates from these surveys by strata are shown in Tables 5 and 6 with mean number and weight per tow values in Tables 7 and 8. Biomass in Div. 3N has generally increased since 1980, being somewhat stable since 1984. In Div. 3O the biomass estimates increased dramatically from 1982 to 1984 but declined in 1986 to a level approximately one-half that in 1985.

Survey coverage was incomplete mainly in the earlier years as well as for Div. 3O in 1981. Estimates of abundance for the non-sampled strata were obtained using analysis of variance of the ln catch per tow as described in NAFO SCR Doc. 84/VI/53. Tables 9 and 10 show survey abundance estimates from Div. 3N and 3O respectively with estimated values for strata which were not surveyed. Abundance in both divisions increased to 1984 but have declined substantially in 1986.

Estimates of mean number of cod per standard tow at age (Table 11) from the 1985 survey indicate that year-classes from 1980 to 1982 were dominant while that for 1975 was also still relatively abundant.

* Further assessment of this stock is given in the Appendix

Catch-effort data

Catch and effort data for 1959-84 was obtained from NAFO statistical bulletins while that for the Canadian otter trawl fleet in 1985 was provided by the Department of Fisheries and Oceans, Canada. As in the past catch rates from the otter trawl and pair trawl fisheries were analyzed separately because of differences in their seasonal pattern. Estimated weights (log catch x effort) were applied in a weighted regression for the multiplicative model with data less than 10 t or 10 hours being excluded from the analysis. The results of analysis using the multiplicative model for both gear categories are shown in Tables 12-15 and Fig. 1-2. The catch rate indices for both gears were combined and averaged as done in previous assessments for this stock (NAFO SCR Doc. 85/39). The indices for each gear were averaged over the period 1959-75 after scaling each to its respective mean for that period. The catch rate indices for 1976-85 were those from the Canadian OT fleet which were also scaled by their 1959-75 mean. The combined catch rate index is indicated in Table 16. The rationale for the separation of the two time series and the periods used have been discussed in previous assessments. In 1985 the Canadian catch represented over 50% of the total reported catch.

Cohort analysis

Catch and average weight at age data from the commercial fishery over the period 1959-85 (Table 17) were used in a preliminary cohort analysis. Assessments conducted since 1981 have used average weights at age for the earlier years and those obtained from commercial sampling for years beginning in 1977. One constant average weight was used for the 1959-65 and another for that from 1966 to 1976. The latter values were the average of those from 1977 to 1980. In an effort to improve this data base, the period from 1972 to 1976 was reanalyzed and average weights for each of these years was determined. The average for this time period (1972-76) was used as the average weight by year for the period 1966-71. The new and old average weights at age matrices are shown in Tables 17 and 18 with sum of products analysis for each in Table 19. The partial recruitment estimate and fishing mortality occurring on the last age group (12) was that used in the 1985 assessment. A cohort analysis at $F_t = 0.20$, the level estimated for 1984 during the 1985 assessment, suggest that partial selections and F values on the last age (fully recruited - ages 6-10) were reasonably well estimated. The results of this cohort analysis is presented (Tables 20-22) for illustration only as tuning was not attempted until all necessary data was available and parameters accepted.

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	28,818
1984[a]	8,722	13,580	1071	3306	431	27,120
1985[a]	18,046	12,405	601	3,446	149	34,694

[a]Provisional.

Table 2. Cod landing (t) from NAFO Divisions 3NO by country, month, and division in 1985.

Month	CanN OT	CanN LL	Can(M)	Spain[a]	Port (GN)	USSR[a]	Cuba	USA	Total
Jan.				60		216			276
Feb.	65			44		1528			1637
Mar.	17			1269		1033	16		2335
Apr.	70			455		488	50	4	1067
May	1442	28	19	1509		158		11	3167
June	1202		114	2498	97			8	3919
July	580		314	1000	97			28	2019
Aug.	684	7	130	850				2	1673
Sept.	286	12	455	1596				1	2350
Oct.	599	11	46	1462				10	2128
Nov.	1613		1329	746				1	3689
Dec.	78		84	916		23		18	1119
	6636	58	2491	12405	194	3446	66	83	25379
					30				
Jan.			31						31
Feb.	962		9						971
Mar.	1649		31				28		1708
Apr.	1898		26				19		1943
May	939		320		118				1377
June	338	21	215		82				656
July	34	137	603		42				816
Aug.	20	1	482		88				591
Sept.	62	5	102		71				240
Oct.	57	12	281						350
Nov.	101		147						248
Dec.	50		328		6				384
	6110	176	2575		407		47		9315
									34694

[a] 3NO.

Table 3. Commercial sampling for NAFO Divisions 3NO cod in 1985.

Qtr.	Gear	Country	Div.	No. aged	Month	No. meas.	Landings Country/mo.	Total
1	OT	Can(N)	3Ø	587	Feb.	1131	962	2915
		USSR	3N	55	Feb.	102	1528	
		Can(N)	3Ø		Mar.	2090	1649	4043
				642		3323		6958
2	OT	Can(N)	3Ø	983	Apr.	2020	1898	3010
		"	"		May	898	939	4426
		"	3N		May	1267	1442	
		"	"		June	578	1898	4396
				983		4763		11832
3	OT	Can(N)	3N	339	July	538	580	2696
		"	"		Aug.	269	684	2176
		"	"		Sept.	213	286	2519
				339		1020		7391
4	OT	Can(N)	3N	442	Oct.	246	599	2478
		"	"		Nov.	976	1613	5434
		"	3Ø		Nov.	204	101	
				442		1426		7912
2	GN	Port	3Ø	439[a]	May	520	118	118
		"	3N		June	1373	97	97
		"	3Ø		June	951	82	82
						2844		297
3	GN	Port	3N	439[a]	July	261	97	139
		"	3Ø		Aug.	231	88	165
						492		304
Total				2845		13868		34694

[a]Combined 2nd and 3rd quarter age/length key.

Table 4. Estimated catch, average weight, and average length at age, along with associated variances for the commercial cod fishery in NAFO Div. 3NO during 1985.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
4	0.984	48.134	709	83.96	0.12
5	1.419	54.106	3435	133.12	0.04
6	1.948	59.694	2051	113.46	0.06
7	3.120	69.708	2010	80.58	0.04
8	4.689	79.300	832	50.21	0.06
9	6.512	88.334	502	34.80	0.07
10	8.301	95.611	660	36.31	0.05
11	9.048	98.267	335	26.01	0.08
12	11.063	104.960	128	15.75	0.12
13	12.067	107.512	41	8.38	0.20
14	11.754	107.249	25	7.42	0.30
15	16.212	119.474	7	2.71	0.37
16	15.553	118.161	6	2.74	0.49
17	17.271	122.229	5	3.04	0.67
18	14.441	115.514	1	0.70	0.70
19					
20	20.056	128.446			0.02
21	16.628	121.000	1	0.56	1.04
22	27.285	142.000			0.02
23	20.751	130.000			0.02

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	265
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	1635
361	2909	4525	2525	350	3246	2618	5894	8203	2666	4173		8125	12838	29220	48871
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	2896
374	501	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	1835
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	515			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	92842
Upper limit	35959	58509	29260	13257	35224	13399	61360	37915	16334	28150	120675	46068	123845	108355	
Lower limit	755	29362	10931	2304	-4462	2776	21732	23529	7051	13322	-17600	16141	61605	56674	

Table 6. Biomass estimates (MT) by stratum from survey cruises in Division 3O.

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	9251	475	287	593	2218	3753	470	3371	123	3626	4642	2139
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	124
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	4508
351	3092	1562	2684	8141	4334	47954	5629	6621	4498	43455	23490	13370
352	3075	426	1429	6120	3961	10008	5625		6236	34168	29692	1915
353	3265	77	2	262	84	1573	2		472	0	6083	488
354	439		38	8		34	273	44	125	489	219	53
355	76	0	4			24	367	32	135	0	135	58
356	11					12	49	9		0	0	
Total	25681	14161	16360	24261	20646	76966	15733	15363	25478	125339	97223	52832
Upper Limit	35514	58392	65071	38015	34853	133278	24517	25164	33764	169942	126100	
Lower Limit	15848	30070	-32350	10508	6442	20645	6950	5561	17191	80736	68346	

Table 7. Mean number and weight of cod per standard tow from research vessel surveys in NAFO Div. 3N, 30, and 3NO.

Div.	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985
	Mean Number per tow													
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
30			10.48		10.31	12.63	18.93	16.93	46.36	8.52	8.62	21.86	36.36	15.84
3NO			12.46		13.23	11.61	25.70	20.78	26.28	9.85	14.60	18.77	38.03	20.24
	Mean Weight per tow													
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
30			25.19		12.17	12.63	19.42	15.93	57.28	12.17	22.32	19.13	93.80	72.35
3NO			1.40		14.48	10.71	26.36	20.72	32.74	14.29	37.00	21.92	84.01	69.24

Table 8. Mean number of cod at age and per standard tow from research vessel surveys in NAFO Divisions 3NO.

# 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
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
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
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
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
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	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
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
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
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
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
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
12	0.14	.05	0.09		0.02		0.04	0	0	0.07	0.14	.05	.32	.49
13			0.14		0.01		0.09	0.04	0.04	0.03	0.06	.01	.11	.24
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
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
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
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

[a]Survey 3N only.

Table 9. Cod abundance (000's) from stratified-random cruises in Division 3N. Numbers in brackets are estimates for non-sampled strata.

Depth range (fath)	Strata	Area	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986[a]
0-30	375	1593	5076	3826	398	1435	6616	(1671)	7474	4329	263	508	10583	1578	1746	3184	912
	376	1499	(1262)	788	37	(885)	1294	113	3601	225	225	113	225	33	7933	48	176
31-50	360	2992	(4228)	1516	(2830)	(2962)	2302	3425	4211	1011	1273	2695	523	2118	5680	3005	552
	361	1853	5747	5796	835	904	3623	723	5610	4764	1166	1808	(3697)	4961	3283	10293	3310
	362	2520	2484	11823	984	1466	431	1021	5830	7440	757	1203	3859	1608	18971	4385	2391
	373	2520	18897	3831	142	426	(1395)	76	946	5959	327	331	1892	1589	8160	770	675
	374	931	1563	175	175	1	140	(569)	1607	1817	297	1	163	1677	2893	175	46
	383	674	74	1644	51	25	(115)	17	320	1493	34	1	118	25	34	1	0
51-100	359	421	(667)	822	622	(468)	(366)	4709	1359	(875)	549	2133	611	126	95	0	1264
	377	100	(789)	1066	143	613	413	(305)	2800	105	73	490	1146	278	56	105	23
	382	647	425	4347	16	130	(360)	24	2639	1943	243	255	146	194	0	134	12
101-150	358	225	(557)	861	4189	(391)	(305)	(215)	262	(729)	431	1993	135	1343	380	448	760
	378	139	619	3673	459	1683	(1171)	(824)	657	120	400	1445	193	1236	318	2181	433
	381	182	1195	779	861	79	156	(372)	3267	364	155	379	779	1851	301	2391	1312
151-200	357	164	(485)	(1026)	1157	(340)	(266)	(187)	12	(635)	49	336	37	382	0	2831	135
	379	106	(605)	(1280)	1802	785	(331)	(233)	24	0	671	408	40	322	175	525	801
	380	116	17	118	641	70	(179)	(126)	22	(429)	96	26	15	(276)	83	788	136
Total		16682	44690	43371	15342	12663	19463	14610	40641	32238	7009	14125	24162	19597	50108	31264	12938
Estimated mean no. per tow			35.69	34.63	12.25	10.11	15.54	11.67	32.45	25.74	5.60	11.28	19.29	15.65	40.02	24.97	10.33

[a]The 1986 data was not used in regressions to estimate missing strata.

Table 10. Cod abundance (000's) from stratified-random cruises in Division 3Ø. 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[a]
31-50	330	2089	2144	419	679	889	1071	3674	1411	941	359	1921	1461	819
	331	456	34	49	624	(250)	240	205	1284	(175)	377	993	548	214
	338	1898	2451	4987	3230	9047	1311	2666	1681	(2593)	4103	10116	2391	2959
	340	1716	(605)	215	4164	258	708	1730	386	859	2340	2898	2733	2003
	351	2520	2837	936	615	4843	2535	39981	1513	3689	8701	18538	4413	2919
	352	2580	3409	1290	1791	5965	4648	3486	2113	(3325)	3486	11814	4859	331
	353	1282	224	705	48	320	1732	4388	48	(239)	257	1	674	481
51-100	329	1721	129	(443)	3682	172	1731	1012	65	129	753	775	501	501
	332	1047	(632)	1729	367	1729	7309	2613	118	(649)	5678	236	1839	458
	337	948	735	688	356	249	320	516	48	(257)	285	142	939	882
	339	585	220	22	(466)	(379)	329	1361	(363)	198	2448	1054	88	29
	354	474	261	(345)	712	36	(387)	729	2075	107	107	142	261	53
101-150	333	151	(26)	958	85	0	4	0	6	(26)	60	0	17	53
	336	121	9	0	0	141	5	2	95	(18)	41	0	9	45
	355	103	19	0	4	(104)	(113)	19	128	19	151	0	398	15
151-200	334	92	(14)	(20)	7	0	2	0	21	(14)	3	0	152	856
	335	58	7	(5)	1	(6)	0	0	3	(4)	4	0	0	39
	356	61	2	(8)	(10)	(8)	(9)	5	18	2	(14)	0	0	
Total		17902	13758	12819	16841	24396	22454	62387	11376	13244	29167	48630	21283	12657
Estimated mean no. per tow			10.24	9.54	12.53	18.15	16.71	46.43	8.47	9.86	21.71	36.19	15.84	9.45

[a]The 1986 data was not used in regressons to estimate missing strata.

Table 11. Mean number of cod at age and per standard tow from research vessel surveys in NAFO Divisions 3NO.

# 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
Age														
1	0	0.01	.07	.06	.43	.61	.01	.56	3.14	.01	.34	1.56	0.01	0.01
2	2.48	1.20	2.49	1.64	2.97	4.10	2.29	.72	.95	5.36	.37	9.38	3.28	0.41
3	25.01	9.22	2.54	5.87	4.42	3.04	9.46	7.19	2.37	1.37	5.30	1.18	6.20	4.47
4	3.44	19.72	1.77	1.05	2.48	1.93	6.13	8.31	9.40	.67	1.55	3.54	9.90	6.05
5	2.63	1.76	2.34	.52	.55	1.75	4.51	2.52	7.97	1.06	1.80	.60	5.29	2.41
6	.63	.73	.47	.45	.29	.27	1.50	.98	1.79	.44	2.28	.47	5.60	.88
7	.64	.59	.26	.17	.56	.07	.48	.62	.53	.21	1.11	.78	1.87	.97
8	.28	.42	.19	.05	.23	.14	.21	.04	.26	.18	.49	.58	1.00	.73
9	.14	.31	.21	.01	.23	.06	.10	.01	.10	.18	.52	.26	1.81	.88
10	.02	.17	.12	.08	.08	.07	.10	.03	.02	.09	.24	.16	1.57	1.34
11	0.05	.08	.06	.04	.01	.02	.01	.04	.06	.05	.04	.07	.86	.98
12	.08	.05	.08		.02		.04	0	0	.07	.14	.05	.32	.49
13			.13		.01		.09	.04	.04	.03	.06	.01	.11	.24
14+	.28	.37	.47	.18	.14	.05	.12	.01	.10	.12	.17	.14	.22	.39
Mean no. per tow	35.69	34.63	11.21	10.11	12.43	12.12	25.05	21.07	26.74	9.83	14.41	18.79	38.04	20.24

[a]Survey 3N only.

Table 12. Regression coefficients and the analysis of variance from the regression of ln catch rate for cod in Divisions 3NO from 1959 to 1985 using otter trawl data.

Country	Gear	ln Power	Month	ln Power
Can N	OT 4	-0.629	Oct.	-0.893
Can N	OT 5	-0.482	May	
			June	
Can M	OT 4	-0.256	July	-0.621
			Aug.	
Can M	OT 5	-0.047	Sept.	
Esp.	OT 6	0.000	Mar.	
			Apr.	-0.535
PRT	OT 6	0.098	Nov.	
			Dec.	-0.208
			Feb.	-0.180
Div. 3N and 30		0.000		
			Jan.	0.000

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.604
MULTIPLE R SQUARED.....0.364

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	7.313E1	7.313E1	
REGRESSION	36	7.460E1	2.072E0	8.183
TYPE 1	5	3.227E1	6.454E0	25.487
TYPE 2	5	1.931E1	3.863E0	15.256
TYPE 3	0	0.000E0	1.000E0	3.949
TYPE 4	26	2.873E1	1.105E0	4.364
RESIDUALS	514	1.302E2	2.532E-1	
TOTAL	551	2.779E2		

Table 13. Regression coefficients and the analysis of variance from the regression of ln catch rate for cod in Divisions 3NO from 1959 to 1984 using Spanish pair trawl data.

Gear	ln Power	Month	ln Power
PT 4	0.000	Feb.	
		Mar.	-0.121
PT 5	0.357	Apr.	
PT 6		Sept.	-0.044
		Oct.	0.000
		Jan.	
Div. 3N and 30	0.000	May	
		Aug.	0.137
		Nov.	
		June	
		July	0.331
		Dec.	

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....0.825
MULTIPLE R SQUARED.....0.681

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	8.920E0	8.920E0	
REGRESSION	30	2.045E2	6.815E0	45.313
TYPE 1	1	1.052E1	1.052E1	69.919
TYPE 2	4	1.915E1	4.787E0	31.830
TYPE 3	25	1.888E2	7.552E0	50.214
RESIDUALS	637	9.581E1	1.504E-1	
TOTAL	668	3.092E2		

Table 14. Catch rate indices for cod in NAFO Div. 3NO using otter trawl data from 1959-85.

YEAR	TOTAL CATCH	CATCH RATE MEAN	S.E.	EFFORT
1959	62459	0.959	0.152	65096
1960	79677	0.845	0.151	94296
1961	72724	0.947	0.184	76805
1962	34948	1.211	0.214	28852
1963	69742	1.626	0.276	42896
1964	64461	1.217	0.207	52982
1965	99187	1.204	0.208	82405
1966	108919	1.326	0.184	82168
1967	226784	1.684	0.259	134648
1968	165512	0.860	0.126	192528
1969	117705	0.907	0.140	129812
1970	111561	0.880	0.156	126766
1971	126296	0.717	0.117	176129
1972	103374	0.965	0.185	107079
1973	80429	0.508	0.139	158461
1974	73389	0.790	0.238	92906
1975	44174	0.907	0.188	48725
1976	24283	0.868	0.175	27981
1977	17604	0.910	0.178	19344
1978	14718	0.943	0.141	15604
1979	27940	1.222	0.165	22865
1980	19990	0.990	0.170	20187
1981	24344	1.228	0.201	19830
1982	31605	1.483	0.213	21311
1983	28818	1.593	0.206	18086
1984	27120	1.339	0.184	20253
1985	34694	1.251	0.175	27729

AVERAGE C.V. FOR THE MEAN:0.174

Table 15. Catch rate indices for cod in NAFO Div. 3NO using Spanish pair trawl data from 1959 to 1984.

YEAR	TOTAL CATCH	CATCH RATE MEAN	S.E.	EFFORT
1959	62459	0.838	0.108	74533
1960	79677	1.001	0.129	79588
1961	72724	0.956	0.117	76070
1962	34948	0.783	0.103	44621
1963	69742	1.506	0.203	46315
1964	64461	1.342	0.168	48018
1965	99187	1.463	0.186	67813
1966	108919	1.408	0.182	77344
1967	226784	1.411	0.179	160699
1968	165512	1.336	0.171	123854
1969	117705	1.208	0.151	97452
1970	111561	1.218	0.152	91578
1971	126296	1.194	0.148	105813
1972	103374	0.812	0.095	127322
1973	80429	0.587	0.070	136988
1974	73389	0.550	0.068	133439
1975	44174	0.511	0.072	86522
1976	24283	0.789	0.103	30783
1977	17604	0.335	0.046	52530
1978	14718	0.112	0.015	131522
1979	27940	0.876	0.136	31901
1980	19990	0.315	0.044	63517
1981	24344	0.598	0.083	40682
1982	31605	0.434	0.058	72815
1983	28818	0.624	0.087	46165
1984	27120	1.054	0.143	25721

AVERAGE C.V. FOR THE MEAN:0.131

Table 16. Catch rate index from a combination of OT and PT indices.

Year	Index	Year	Index
1959	.86	1972	0.85
1960	.88	1973	0.52
1961	.91	1974	0.64
1962	.95	1975	0.68
1963	1.50	1976	0.84
1964	1.22	1977	0.88
1965	1.27	1978	0.91
1966	1.30	1979	1.18
1967	1.48	1980	0.96
1968	1.04	1981	1.19
1969	1.00	1982	1.44
1970	1.00	1983	1.54
1971	.91	1984	1.30
		1985	1.21

Table 17. Catch numbers (X 10^{-3}) and average weight (kg) at age from the commercial cod fishery in Div. 3NO over the period 1959-85.

CATCH AT AGE

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
3	1711	1846	812	1026	313	6202	1013	753	20086	16359	8154	2105	950	69	10058	6425
4	13036	6503	4400	3882	5757	15555	7611	18413	62442	56775	12924	19703	26900	19797	27600	9501
5	5068	22050	11696	2206	11210	19496	7619	19681	50317	48608	26949	10799	30300	12289	15098	10907
6	6025	3095	15258	1581	4849	7919	13258	11795	18517	18485	11191	9481	11700	13432	5989	10872
7	3935	2377	2014	3594	1935	2273	9861	8486	4774	6337	2089	3646	3500	5883	1971	2247
8	1392	2504	1672	773	3840	1109	4827	4467	4651	1592	1393	1635	2500	1686	972	2147
9	757	583	847	668	1165	788	1081	1829	236	505	518	541	500	285	707	1015
10	926	387	196	433	608	328	1248	1694	180	178	292	149	200	216	243	676
11	1220	898	25	226	322	37	163	122	71	90	134	227	100	78	137	428
12	103	242	245	216	208	112	141	57	45	45	202	90	50	74	116	257
3+	34173	40485	37165	14605	30207	53819	46822	67297	161319	148974	63846	48376	76700	53809	62891	44475
4+	32462	38639	36353	13579	29894	47617	45809	66544	141233	132615	55692	46271	75750	53740	52833	38050
5+	19426	32136	31953	9697	24137	32062	38198	48131	78791	75840	42768	26568	48850	33943	25233	28549
6+	14358	10086	20257	7491	12927	12566	30579	28450	28474	27232	15819	15769	18550	21654	10135	17642

AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	671	4054	607	920	72	280	478	305	1179	49	1
4	8781	7534	2469	4337	3827	1138	1032	1978	647	768	709
5	3528	5945	2531	2518	9208	3789	1194	1591	1893	1127	3435
6	2505	1084	1500	818	2784	2057	2173	1012	1204	1984	2051
7	3057	211	572	354	883	665	1805	1528	686	1004	2010
8	1059	238	177	102	265	185	543	1492	1152	558	832
9	921	44	209	58	58	75	182	595	774	704	502
10	461	37	65	51	17	27	89	211	238	430	660
11	252	13	41	8	12	7	39	162	81	86	335
12	152	9	25	5	7	13	12	27	41	40	128
3+	21387	19169	8196	9171	17133	8236	7547	8901	7895	6750	10663
4+	20716	15115	7589	8251	17061	7956	7069	8596	6716	6701	10662
5+	11935	7581	5120	3914	13234	6818	6037	6618	6069	5933	9953
6+	8407	1636	2589	1396	4026	3029	4843	5027	4176	4806	6518

AVERAGE WEIGHT AT AGE

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
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	0.54	0.57	0.42	0.38
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	0.97	1.00	0.73	0.89
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	1.44	1.43	1.20	1.28
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	2.08	2.19	1.96	2.13
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	2.89	3.63	2.86	3.14
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	3.56	4.63	4.67	4.16
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	5.95	6.25	7.32	5.53
10	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	7.95	9.56	5.46	6.74
11	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	8.32	11.17	8.40	5.27
12	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	10.14	13.99	7.51	7.09

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	0.50	0.57	0.72	0.65	0.71	0.90	0.94	0.85	0.79	0.79
4	0.91	1.00	1.05	0.98	1.04	1.27	1.17	1.17	1.15	0.98
5	1.41	1.48	1.55	1.39	1.69	1.84	1.50	1.87	1.51	1.42
6	2.33	2.48	2.25	2.09	2.50	2.69	2.20	2.63	2.26	1.95
7	3.25	3.51	3.74	2.87	3.69	3.55	3.83	3.80	3.04	3.11
8	4.03	4.74	4.61	3.70	5.49	5.33	5.26	5.20	4.05	4.69
9	6.67	7.17	6.19	4.75	7.98	7.13	7.49	6.27	5.76	6.50
10	8.74	8.81	7.23	7.15	9.22	9.10	8.80	8.08	7.22	8.30
11	9.14	11.70	9.48	7.98	10.60	9.01	9.82	8.99	8.92	9.05
12	12.49	11.47	12.87	10.11	12.61	10.15	12.28	11.01	12.61	11.07

Table 18. Average weight (kg) at age data for cod in Div. 3NO used in previous assessments.

AVERAGE WEIGHT AT AGE

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
3	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
4	0.82	0.82	0.82	0.82	0.82	0.82	0.82	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
5	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
6	1.95	1.95	1.95	1.95	1.95	1.95	1.95	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
7	2.82	2.82	2.82	2.82	2.82	2.82	2.82	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
8	3.39	3.39	3.39	3.39	3.39	3.39	3.39	4.64	4.64	4.64	4.64	4.64	4.64	4.64	4.64	4.64	4.64
9	3.98	3.98	3.98	3.98	3.98	3.98	3.98	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52
10	4.68	4.68	4.68	4.68	4.68	4.68	4.68	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10
11	5.25	5.25	5.25	5.25	5.25	5.25	5.25	9.94	9.94	9.94	9.94	9.94	9.94	9.94	9.94	9.94	9.94
12	6.17	6.17	6.17	6.17	6.17	6.17	6.17	11.77	11.77	11.77	11.77	11.77	11.77	11.77	11.77	11.77	11.77

AGE	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	0.66	0.57	0.72	0.65	0.71	0.90	0.94	0.85	0.79
4	1.02	1.00	1.05	0.98	1.04	1.27	1.17	1.17	1.15
5	1.53	1.48	1.55	1.39	1.69	1.84	1.50	1.87	1.51
6	2.33	2.48	2.25	2.09	2.50	2.69	2.20	2.63	2.28
7	3.45	3.51	3.74	2.87	3.69	3.55	3.83	3.80	3.04
8	4.64	4.74	4.61	3.70	5.49	5.33	5.26	5.20	4.05
9	6.52	7.17	6.19	4.75	7.98	7.13	7.49	6.27	5.76
10	8.10	8.81	7.23	7.15	9.22	9.10	8.80	8.08	7.22
11	9.94	11.70	9.48	7.98	10.60	9.01	9.82	8.99	8.92
12	11.77	11.47	12.87	10.11	12.61	10.15	12.28	11.01	12.61

Table 19. Sum of product analysis for cod in Div. 3NO using average weights from previous assessments (1) and those from a new matrix (2).

Year	Reported Catch	Sum of Products(1)	Sum of Products(2)	% Diff(1)	% Diff(2)
1959	64,370	59,695	-	-7.3	-
1960	79,677	65,236	-	-18.1	-
1961	72,724	65,601	-	-9.8	-
1962	34,984	29,414	-	-15.9	-
1963	69,742	57,251	-	-17.9	-
1964	64,461	70,898	-	+10.0	-
1965	99,187	98,084	-	-1.1	-
1966	108,919	154,406	140,604	+41.8	+29.1
1967	226,784	239,360	212,002	+5.6	-6.5
1968	165,511	221,556	196,648	+33.9	+18.8
1969	117,705	108,994	97,073	-7.4	-17.5
1970	111,561	88,315	79,436	-20.8	-28.8
1971	126,296	131,822	118,260	+4.4	-6.4
1972	103,374	103,711	92,691	+0.3	-10.3
1973	80,429	92,460	89,589	+15.0	+11.4
1974	73,389	93,038	77,131	+26.8	+5.1
1975	44,174	50,127	42,532	+13.5	-3.7
1976	24,283	24,636	22,284	+1.5	-8.2
1977	17,604	15,965	-	-9.3	-
1978	14,718	13,622	-	-7.4	-
1979	27,941	26,493	-	-5.2	-
1980	19,360	17,483	-	-9.7	-
1981	24,344	21,666	-	-11.0	-
1982	31,605	29,150	-	-7.8	-
1983	28,818	25,018	-	-13.2	-
1984	27,120	20,890	-	-23.0	-
1985	34,694	-	32,916	-	-5.1

Table 20. Population numbers ($X10^{-3}$) of Div. 3NO cod from a cohort analysis at F_t=0.20.

POPULATION NUMBERS

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967
3	53623	52379	81956	107685	78128	111687	162347	210082	183210
4	93903	42354	41214	66365	87237	63682	85830	132002	171319
5	19549	65086	28793	29762	50823	66214	38064	63385	91413
6	16663	11419	33336	12990	22371	31467	36571	24270	34087
7	12142	8191	6549	13487	9205	13928	18597	17945	9198
8	4723	6380	4555	3539	7790	5786	9347	6304	7014
9	3308	2607	2958	2217	2198	2904	3733	3285	1119
10	3100	2024	1607	1655	1210	746	1664	2079	1034
11	2327	1701	1307	1139	963	441	314	233	169
12	311	801	580	1047	728	497	328	109	81
3+	209648	192942	202854	239887	260653	297352	356795	459694	498645
4+	156026	140563	120898	132202	182526	185665	194448	249612	315434
5+	62123	98209	79684	65837	95289	121982	108618	117610	144116
6+	42574	33123	50892	36075	44466	55768	70554	54225	52702

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	100563	127855	80313	84468	62208	35192	36964	22984	29256
4	131825	67531	97301	63850	68297	50869	19712	24450	18211
5	83764	56557	43596	61835	27936	38004	16675	7542	12072
6	29314	24598	21921	25922	23210	11753	17454	3783	2982
7	11153	7274	10013	9368	10637	6849	4203	4452	831
8	3211	3398	4066	4899	4503	3385	3824	1408	879
9	1534	1189	1521	1849	1749	2161	1892	1188	195
10	703	799	504	756	1062	1174	1130	631	139
11	684	414	390	278	438	674	741	313	99
12	74	479	218	114	137	288	428	220	29
3+	362826	290094	259843	253340	200176	150349	103022	66971	64693
4+	262263	162239	179530	168872	137968	115157	66058	43987	35437
5+	130438	94708	82229	105022	69671	64287	46346	19537	17226
6+	46673	38150	38633	43187	41735	26284	29672	11995	5154

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	49604	42844	19097	22940	37452	34983	69359	30376	111
4	20285	40063	34246	15570	18528	30231	28366	55720	24826
5	8093	14374	28876	24575	11718	14236	22961	22639	44924
6	4505	4335	9490	15310	16692	8513	10216	17086	17515
7	1461	2331	2809	5250	10674	11700	6055	7274	12194
8	489	679	1588	1501	3697	7106	8197	4336	5047
9	504	240	463	1060	1062	2536	4468	5668	3045
10	119	224	144	327	800	705	1538	2957	4004
11	81	39	137	103	243	575	386	1043	2032
12	70	29	25	101	78	164	324	243	777
3+	85210	105158	96875	86738	100944	110748	151868	147343	114475
4+	35606	62314	77779	63798	63492	75764	82509	116967	114364
5+	15321	22251	43533	48228	44964	45533	54143	61247	89539
6+	7229	7877	14657	23653	33246	31298	31182	38609	44614

Table 21. Mid-year (average) population biomass (t X 10^{-3}) of Div. 3NO cod from a cohort analysis at F_t=0.20.

POPULATION BIOMASS (AVERAGE)

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967
3	20062	19561	31032	40783	29677	41241	61594	91220	74933
4	64465	28814	28846	47764	62519	40819	60714	99421	110128
5	18902	59317	24818	32363	50468	62418	38314	63762	73712
6	23263	17081	42773	21429	34744	47718	51017	33243	43931
7	25250	17474	13792	29270	20765	32389	32044	36770	17977
8	12073	15092	11007	9546	16786	15882	19651	12627	15178
9	10401	8228	8931	6619	5348	8863	11246	12347	5673
10	10908	7670	6363	5983	3566	2335	3409	5851	6514
11	7513	5468	6153	4819	3701	2002	1018	1217	974
12	1409	3714	2442	5186	3413	2433	1370	697	495
3+	194247	182419	176157	203762	230987	256100	280378	357156	349516
4+	174185	162858	145124	162979	201310	214859	218784	265936	274582
5+	109720	134045	116279	115216	138791	174040	158070	166515	164454
6+	90818	74727	91461	82852	88323	111622	119756	102753	90742

AGE	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	39818	53704	34446	36526	30428	15224	12716	7792	12249
4	80051	49224	70410	39102	50129	30658	9247	15610	11352
5	65185	49334	45896	53214	26915	37765	10429	6291	10824
6	33841	34727	31599	36721	27883	16079	18653	4148	4968
7	20618	17428	22606	20987	18305	18841	7310	6916	2096
8	8567	9831	11844	12875	11358	11884	10530	2551	2719
9	7145	5060	6939	8997	8562	9939	8405	2706	1027
10	4197	4386	2923	4480	6781	8997	3476	1937	938
11	4866	2586	1898	1687	2977	6047	3602	627	763
12	429	3347	1536	785	850	2798	1829	784	266
3+	264719	229627	230099	215376	184207	158232	86198	49362	47201
4+	224901	175923	195651	178850	153779	143008	73482	41570	34953
5+	144850	126699	125241	139747	103650	112351	64235	25960	23600
6+	79664	77365	79346	86533	76735	74585	53806	19670	12776

AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	25458	27637	11228	14665	30341	29666	52947	21731	79
4	17160	35873	28561	14095	20685	30922	29712	57648	21713
5	8909	18233	29719	34442	18456	18172	37174	30151	55428
6	8182	7914	14969	32132	37790	15871	22781	33066	28982
7	3581	7240	5991	16341	31130	37705	19561	18523	31256
8	1659	2601	4834	6965	16416	29903	35646	14794	19510
9	2477	1165	1858	7376	6210	14943	22953	27579	16315
10	633	1280	875	2609	6200	4658	10299	17805	27390
11	590	297	945	950	1810	4295	2776	8059	15159
12	573	305	190	1078	655	1658	3009	2522	7085
3+	69224	102544	99169	130655	169693	187794	236858	231877	222917
4+	43765	74908	87941	115989	139352	158129	183911	210146	222838
5+	26606	39034	59381	101894	118667	127206	154199	152498	201124
6+	17696	20801	29662	67452	100210	109034	117025	122347	145696

Table 22. Fishing mortalities for Div. 3NO cod from a cohort analysis at F_t=0.20.

FISHING MORTALITY

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	0.036	0.040	0.011	0.011	0.004	0.063	0.007	0.004	0.129	0.198	0.073
4	0.167	0.186	0.126	0.067	0.076	0.315	0.103	0.167	0.516	0.646	0.238
5	0.338	0.469	0.596	0.085	0.279	0.394	0.250	0.420	0.937	1.025	0.748
6	0.510	0.356	0.705	0.144	0.274	0.326	0.512	0.770	0.917	1.194	0.699
7	0.443	0.387	0.415	0.349	0.264	0.199	0.882	0.739	0.852	0.989	0.382
8	0.394	0.569	0.520	0.276	0.787	0.238	0.846	1.529	1.320	0.794	0.604
9	0.292	0.284	0.380	0.405	0.881	0.357	0.386	0.955	0.265	0.452	0.657
10	0.401	0.237	0.145	0.341	0.810	0.666	1.764	2.310	0.214	0.328	0.517
11	0.866	0.876	0.021	0.248	0.461	0.097	0.854	0.862	0.624	0.157	0.442
12	0.451	0.402	0.619	0.257	0.376	0.284	0.635	0.837	0.931	1.074	0.618

AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	0.029	0.013	0.001	0.380	0.213	0.033	0.166	0.014	0.024	0.004	0.014
4	0.253	0.627	0.386	0.915	0.761	0.506	0.611	0.144	0.127	0.132	0.084
5	0.320	0.780	0.666	0.578	1.283	0.728	0.786	0.424	0.215	0.435	0.187
6	0.650	0.691	1.020	0.828	1.166	1.316	0.514	0.459	0.234	0.392	0.161
7	0.515	0.533	0.945	0.383	0.894	1.422	0.330	0.567	0.184	0.427	0.151
8	0.588	0.830	0.534	0.382	0.969	1.779	0.355	0.511	0.182	0.204	0.146
9	0.499	0.355	0.199	0.449	0.899	1.943	0.288	0.612	0.310	0.149	0.081
10	0.395	0.346	0.255	0.260	1.082	1.649	0.347	0.919	0.290	0.140	0.096
11	1.031	0.506	0.219	0.255	1.016	2.195	0.156	0.826	0.257	0.102	0.078
12	0.600	0.652	0.883	0.580	1.055	1.374	0.423	0.500	0.211	0.372	0.152

AGE	1981	1982	1983	1984	1985
3	0.014	0.010	0.019	0.002	0.010
4	0.064	0.075	0.026	0.015	0.032
5	0.119	0.132	0.096	0.057	0.088
6	0.155	0.141	0.140	0.137	0.138
7	0.207	0.156	0.134	0.166	0.200
8	0.177	0.264	0.169	0.153	0.200
9	0.210	0.300	0.213	0.148	0.200
10	0.131	0.402	0.188	0.175	0.200
11	0.195	0.373	0.264	0.096	0.200
12	0.186	0.200	0.150	0.200	0.200

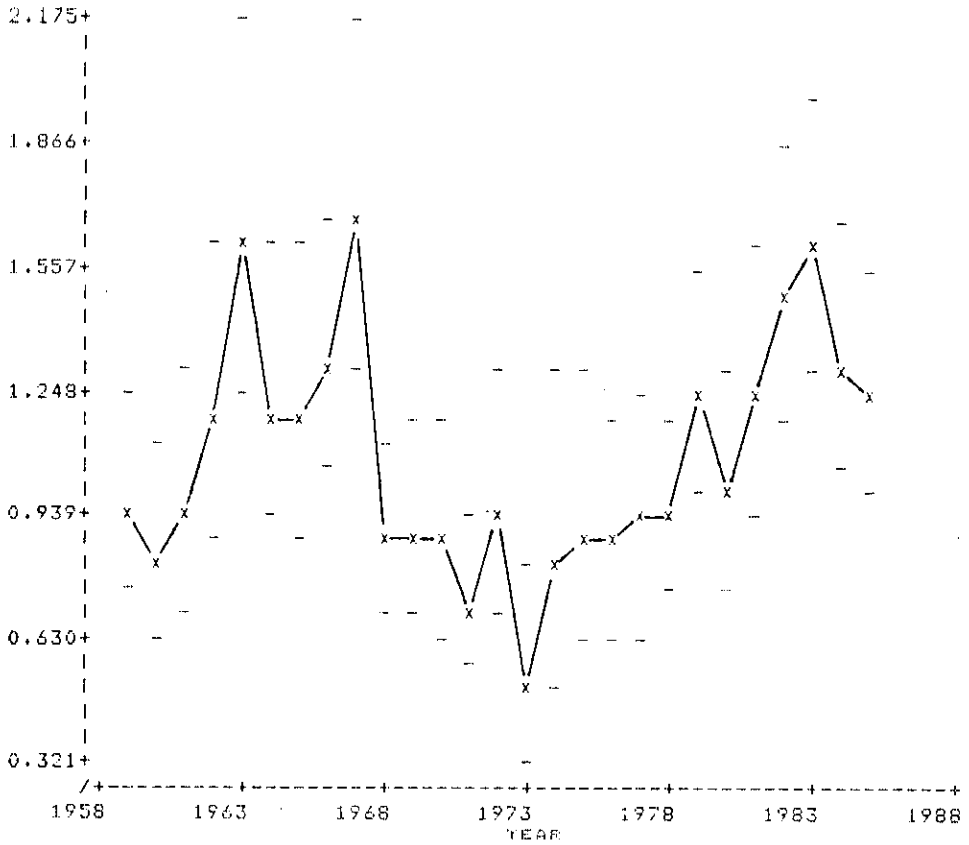

Fig.1. Catch rate index with approximate 90% confidence interval for cod in Div. 3NO using otter trawl from 1959 to 1985.

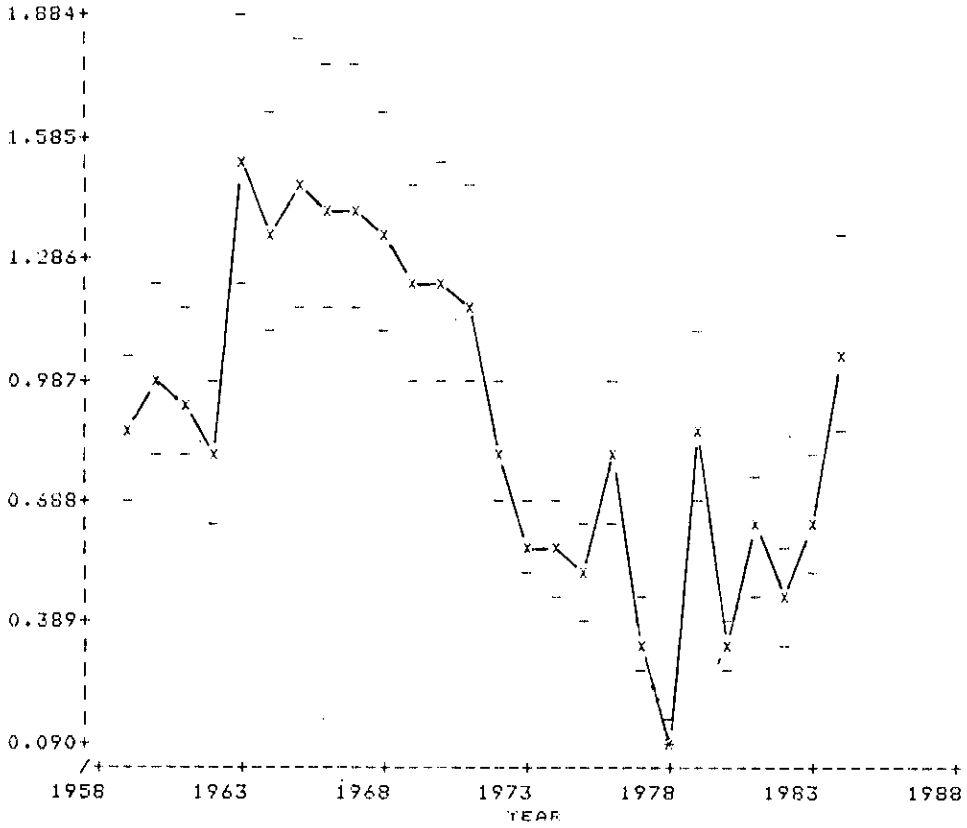

Fig. 2. Catch rate index with approximate 90% confidence interval for cod in Div. 3NO using Spanish pair trawl data from 1959 to 1984.

APPENDIX

A sum of products analysis using commercial catch and average weight at age indicated a substantial discrepancy in 1984 (-23%). It was determined that estimates of removals at age by the Spanish fleet had been underestimated and as such these were adjusted so as to provide closer agreement (Table 1).

Sampling data from Spanish observers were used to estimate catch at age for Spain in 1985 (Table 2) and these, along with average weights at age, were included in the assessment replacing the 1985 data previously used.

Catch rate indices were claculated using data from the Canadian otter trawl fishery from 1977 to 1985. The results of this analysis are shown in Tables 3 and 4 and Fig. 1. A comparison of these catch rates with those used in the 1985 assessment (Fig. 2) indicated a similar pattern in the earlier years with more variation since 1980.

The relationship of average exploitable biomass and catch rate index for the 1977-85 period was used to estimate fishing mortality in 1985. Based on the pattern of residuals in the last 3 years (Table 5 and Fig. 2), F in 1985 was estimated at 0.45. A comparison of ratios of cohort exploitable biomass and commercial catch rates over the 1977-80 and 81-85 periods (Table 5) indicated that F in 1985 approximated 0.50. Tables 6-8 show the results of a cohort analysis at $F_t = 0.45$.

Table 1. Catch at age for cod in Div. 3NO during 1984 adjusted for discrepancies in sum of products.

Age	Can. Av. Wt.	Catch by Spain 1984	Adjusted Spanish Catch	Total All Countries
3	0.79	15	23	58
4	1.15	407	625	1000
5	1.51	486	747	1411
6	2.28	545	837	2324
7	3.04	359	552	1220
8	4.05	284	436	720
9	5.76	375	576	918
10	7.22	211	324	551
11	8.92	24	52	106
12	12.61	23	35	42
#		2763	4207	
wt.		13520	13520	27120
S.O.P.		8720	13779	25990
%		64	102	96

Table 2. Catch and weights at age of cod in Div. 3NO for 1985, including Spanish sampling and adjusted for non-reporting countries.

Age	Can. No.	Can. Av. Wt.	Spain No.	Spain Av. Wt.	Total No.	Total Av. Wt.	Total # All Countries
3			45	0.48	45	0.48	54
4	519	0.95	1876	.84	2395	0.86	2850
5	2273	1.39	2823	1.35	5096	1.37	6064
6	1348	1.89	1160	2.23	2508	2.05	2984
7	1271	3.11	818	3.47	2089	3.25	2486
8	528	4.71	140	4.43	668	4.65	795
9	327	6.59	59	6.77	386	6.62	459
10	422	8.27	28	9.12	450	8.32	535
11	213	9.00	8	13.02	221	9.15	262
12	83	11.13			83	11.13	99
	6909		6248		13157		16588
	22289		12405		34694		41284

* Includes non-member non-reporting countries estimates from Canadian surveillance (4,770t).

Discrepancy between reported and calculated catch = 3.9%.

Table 3. Regression coefficients and the analysis of variance from the regression of ln. catch rate for cod in Div. 3NO from 1977 to 1985 using Canadian otter trawl data.

Country	Gear	ln power	Month	ln power
Can.N	OT 4	0.000	May July	-0.988
Can.N	OT 5	0.150	Aug. Sept.	-0.898
Can. M	OT 4	0.382	March April	-0.715
Can.M	OT 5	0.585	Feb. Nov. Dec. Jan.	-0.556 -0.346 0.000
Div. 3N and 30		0.000	June Oct.	-1.059

Table 4. Catch rate index for cod in NAFO Div. 3NO using otter trawl data from 1977 to 1985.

Year	Total catch	Catch rate Mean	S.E.	Effort
1977	17604	1.322	0.300	13320
1978	14718	1.150	0.216	12793
1979	27940	1.585	0.282	17629
1980	19990	1.251	0.252	15981
1981	24344	1.559	0.304	15618
1982	31605	2.027	0.374	15592
1983	28818	1.914	0.307	15057
1984	27120	1.622	0.279	16716
1985	41284	1.656	0.296	24926

Average c.v. for the mean: 0.187

Table 5 . Relationships of C.P.U.E. with exploitable biomass along with ratios of average C.P.U.E. and biomass for the periods 1981-85 and 1977-80 for cod in Div. 3NO.

		F_t=0.40		F_t=0.45		F_t= 0.50	
Year	CPUE	Obs.	Res.	Obs.	Res.	Obs.	Res.
1977	1.322	28	-42	28	-40	28	-39
1978	1.150	65	3	65	3	65	4
1979	1.585	66	-14	66	-11	65	-9
1980	1.251	95	28	94	28	93	28
1981	1.559	93	14	92	16	91	17
1982	2.027	93	-3	91	-1	89	2
1983	1.914	93	1	89	1	86	2
1984	1.622	75	-6	70	-8	66	-10
1985	1.656	101	19	90	11	82	5
	r^2	0.23		0.20		0.17	
	slope	39		33		29	
	intercept	18		24		28	
1981-85 / 1977-80	1.32	1.43		1.37		1.32	

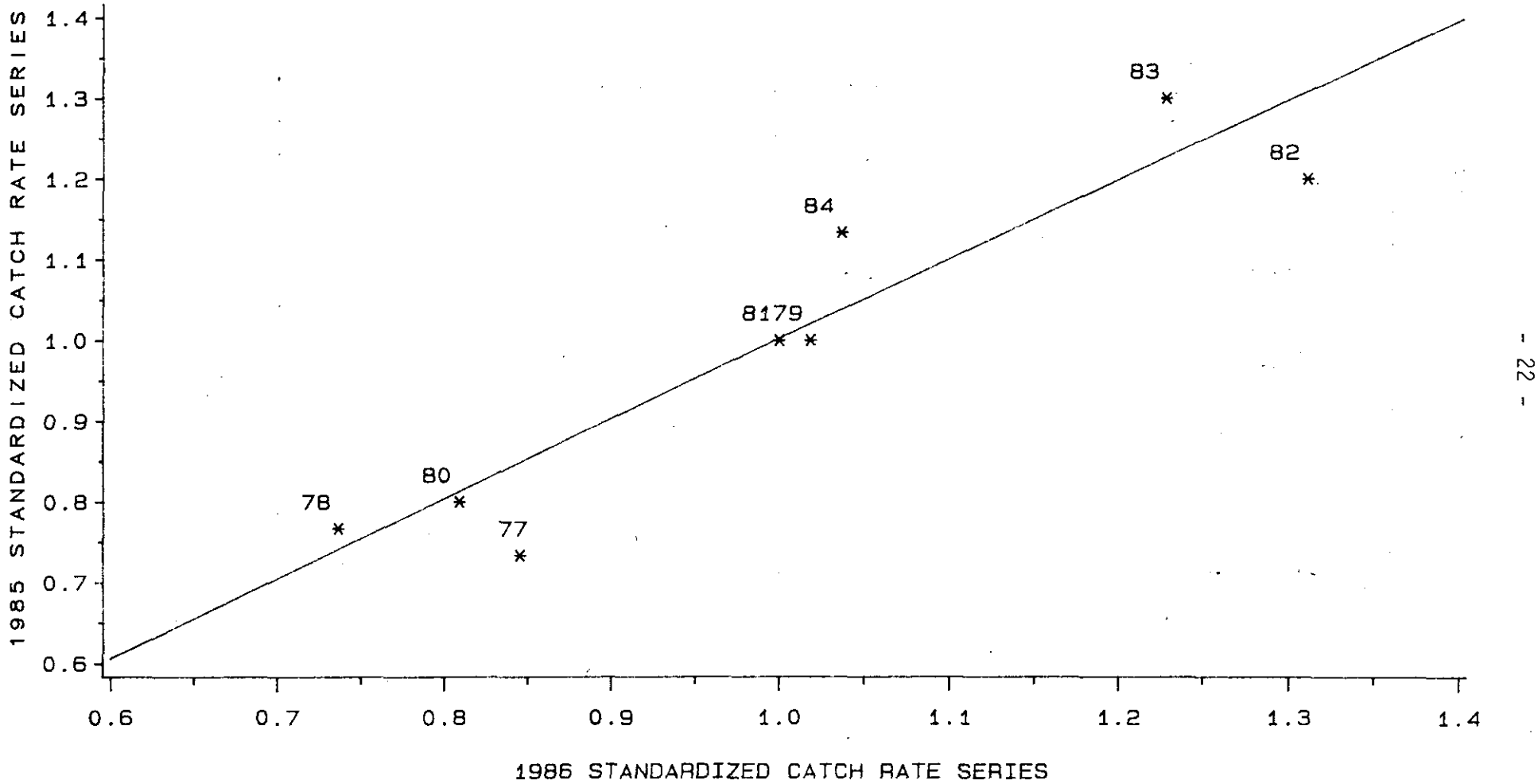

FIG 1. COMPARISON OF THE STANDARDIZED CATCH RATE INDICES CALCULATED DURING THE 1985 AND 1986 ASSESSMENTS FOR THE PERIOD 1977-1984.

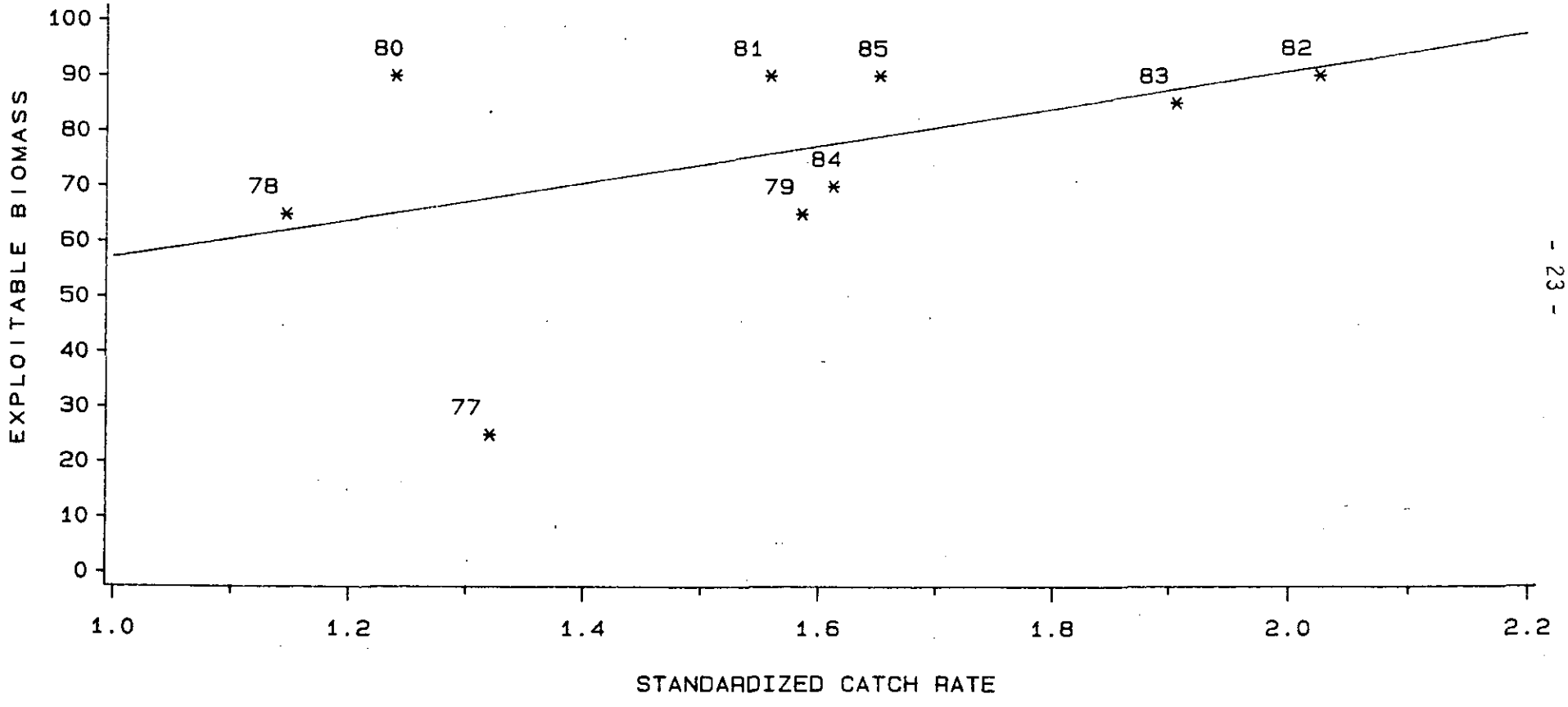

FIG 2. STANDARDIZED CATCH RATE VERSUS AVERAGE EXPLOITABLE BIOMASS USING TERMINAL FISHING MORTALITY = 0.45 FOR THE PERIOD 1977-1985.

Table 6. Population numbers ($X10^{-3}$) of Div. 3NO cod from a cohort analysis at F_t = 0.45.

POPULATION NUMBERS

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
3	53692	53177	82106	107737	78248	112327	162551	209999	183235	100491	127842	80314	84379	62086
4	93896	42411	41867	66488	87279	63781	86354	132169	171251	131845	67473	97290	63851	68224
5	19534	65082	28839	30297	50923	66249	38145	63814	91550	83709	56574	43548	61826	27936
6	16517	11408	33333	13028	22809	31549	36600	24336	34438	29426	24553	21934	25883	23203
7	12484	6072	6539	13485	9236	14287	18665	17969	9252	11441	7366	9976	9379	10605
8	4371	6661	4458	3532	7788	5811	9640	6359	7033	3256	3633	4140	4869	4512
9	2898	2319	3187	2137	2192	2902	3754	3525	1164	1550	1225	1714	1911	1724
10	3360	1686	1371	1843	1145	741	1663	2096	1231	740	612	534	914	1112
11	2258	1913	1032	946	1117	367	310	232	165	845	445	401	303	567
12	329	745	754	822	570	623	284	106	60	66	610	243	123	157
3+	209342	193474	203487	240314	261308	298658	357964	460604	499418	363388	290532	260094	253437	200126
4+	155651	140278	121380	132577	183060	186331	195414	250605	316183	262897	162690	179781	169058	138040
5+	61753	97867	79513	66089	95780	122549	109060	118437	144932	131051	95217	82490	105207	69816
6+	42218	32805	50674	35792	44857	56300	70915	54623	53382	47342	38643	38942	43380	41880

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	34893	36194	22508	26893	44002	33930	14078	16282	27720	25077	50307	40744	2677
4	50767	19467	23819	17821	18350	35477	26963	11461	13077	22263	20272	40131	33306
5	37944	16593	7341	11556	7723	12789	25121	18613	8354	9773	10497	16012	31243
6	11753	17405	3716	2618	4062	4074	8173	12236	11810	5757	6502	11745	11033
7	6843	4203	4413	773	1327	1985	2595	4189	8157	7703	3799	4283	7513
8	3359	3819	1408	847	444	569	1305	1326	2820	5045	4224	2490	2403
9	2169	1871	1184	195	478	204	373	829	918	1824	2780	2989	1387
10	1154	1136	613	136	120	202	114	253	611	587	955	1576	1617
11	715	725	318	85	78	39	119	78	103	419	290	566	792
12	394	461	206	33	58	27	25	87	58	114	177	164	368
3+	149792	101874	65527	61159	76711	87315	78887	65353	73715	70585	106523	120690	93838
4+	115099	65680	43019	34266	32709	55385	64809	49071	45995	53487	56216	79946	91161
5+	64330	46213	19200	16446	14360	19909	37846	37610	32918	31225	35944	39825	57855
6+	26386	29620	11858	4889	6586	7099	12725	18997	24564	21452	25507	23813	25712

Table 7. Mid-year average population biomass (t X 10^{-3}) of Div. 3NO cod from a cohort analysis at F_t = 0.45.

POPULATION BIOMASS (AVERAGE)

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
3	20088	19865	31090	40803	29723	41484	61671	91184	74744	37787	53698	34449	36488	30368
4	64462	28056	29322	47856	62551	40093	61103	90557	110072	80068	49176	70401	39183	50064
5	18986	59313	24872	32970	50583	62458	38407	54294	73891	65111	40355	45837	53203	26916
6	23000	17060	42767	21496	35522	47865	51068	33378	44660	34005	34635	31626	36642	27868
7	26140	17165	13767	29263	20845	33308	32229	36041	18142	21508	17693	22498	21020	18214
8	10976	15976	10700	9522	16777	15960	20606	12802	15263	8746	10754	12138	12752	11388
9	8911	7180	9768	6327	5323	8856	11322	13825	5935	7237	5277	8066	9353	8447
10	12024	6239	5360	6767	3271	2312	3401	6032	7890	4458	4476	3133	5588	7145
11	7162	6535	4846	3894	4444	1747	997	1207	1084	6103	2822	1986	1078	3954
12	1513	3393	3436	3920	2516	3141	1115	663	485	542	4597	1772	868	1042
3+	193160	181582	175937	202837	231558	258026	281917	359863	352366	267646	232486	231705	216074	185406
4+	173072	161718	144848	162034	201835	216542	220246	268679	277623	229859	178787	197457	180407	155037
5+	108610	132862	115516	114179	139284	175648	159145	169122	167351	147791	129611	127056	141304	104973
6+	89725	73549	90644	81209	88701	113190	120738	104828	93459	82680	80256	81219	88101	78058

AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	15067	12422	7628	11175	22564	21832	8271	10381	22402	21243	38269	29151	1896
4	30560	9077	15090	11020	15403	31502	22080	10219	14408	22467	21128	41259	28212
5	37686	10327	6047	10128	8474	15997	24099	25273	12836	12091	26105	20864	36799
6	16080	18556	3998	4613	7214	7379	12474	25147	25854	10365	14048	21596	17959
7	18821	7310	6782	1933	3141	6064	5425	12781	22992	23737	11775	9888	17181
8	11773	10508	2552	2598	1462	2139	3880	6092	12201	17993	20159	7635	8286
9	9982	8252	2679	1028	2297	957	1469	5698	5279	10056	13302	12864	6030
10	8819	3509	1801	912	635	1136	679	1992	4631	3706	6009	8226	9868
11	6465	3463	661	644	560	276	816	713	1315	2838	1786	4102	5269
12	4161	2075	682	312	448	280	191	911	468	1105	1736	1605	2993
3+	159415	85502	47920	44363	62197	87583	88184	77207	122307	127702	154518	157189	135093
4+	144348	73079	40292	33188	39633	65751	71913	66826	99984	106459	116249	128038	133197
5+	113788	64003	25202	22168	24231	34249	49833	56607	85576	83992	95121	86779	104985
6+	76102	53676	19155	12040	15756	18252	24034	53334	72740	71900	69016	65915	68186

Table 8. Fishing mortalities for Div. 3NO cod from a cohort analysis at F_t = 0.45.

FISHING MORTALITY

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.036	0.037	0.011	0.011	0.004	0.003	0.007	0.004	0.129	0.170	0.073	0.029	0.013	0.001	0.384
4	0.167	0.186	0.123	0.067	0.076	0.314	0.102	0.167	0.516	0.646	0.238	0.253	0.627	0.387	0.718
5	0.338	0.467	0.575	0.084	0.279	0.393	0.249	0.417	0.935	1.027	0.747	0.320	0.700	0.666	0.579
6	0.516	0.356	0.705	0.144	0.268	0.325	0.511	0.767	0.902	1.185	0.701	0.650	0.692	1.021	0.828
7	0.428	0.394	0.416	0.349	0.283	0.193	0.877	0.738	0.845	0.747	0.376	0.517	0.532	0.950	0.383
8	0.434	0.537	0.535	0.277	0.787	0.237	0.806	1.498	1.312	0.777	0.551	0.573	0.830	0.533	0.385
9	0.341	0.325	0.348	0.424	0.805	0.357	0.383	0.852	0.254	0.446	0.630	0.429	0.341	0.202	0.447
10	0.363	0.292	0.172	0.301	0.884	0.672	1.769	2.239	0.176	0.309	0.507	0.369	0.277	0.242	0.265
11	0.909	0.731	0.027	0.307	0.383	0.112	0.872	0.869	0.560	0.125	0.405	0.934	0.455	0.165	0.238
12	0.420	0.440	0.440	0.340	0.510	0.220	0.780	0.880	0.950	0.850	0.450	0.520	0.590	0.720	0.390

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
3	0.218	0.034	0.102	0.015	0.030	0.006	0.019	0.019	0.014	0.026	0.002	0.023
4	0.775	0.523	0.630	0.161	0.145	0.171	0.116	0.091	0.103	0.036	0.028	0.009
5	1.296	0.757	0.841	0.446	0.245	0.519	0.255	0.172	0.190	0.136	0.102	0.234
6	1.172	1.367	0.554	0.521	0.251	0.471	0.266	0.227	0.216	0.227	0.247	0.324
7	0.894	1.451	0.358	0.647	0.220	0.472	0.193	0.280	0.247	0.223	0.378	0.450
8	0.971	1.778	0.372	0.581	0.221	0.254	0.167	0.239	0.396	0.299	0.385	0.450
9	0.915	1.963	0.287	0.661	0.378	0.188	0.105	0.247	0.447	0.368	0.415	0.450
10	1.072	1.777	0.357	0.917	0.327	0.180	0.125	0.176	0.506	0.322	0.408	0.450
11	1.058	2.077	0.185	0.870	0.256	0.118	0.104	0.269	0.557	0.369	0.232	0.450
12	0.930	1.580	0.360	0.640	0.230	0.370	0.180	0.260	0.300	0.260	0.330	0.450