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Assessment 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

Nominal catch and catch at age

Cod catches from Div. 3NO since 1978, along with corresponding TAC's, are as follows:

	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>
TAC ('000 t)	15	25	26	26	17 ^b	17 ^b	26	33	33	33
Catch ('000 t)	15	28	20	24	32	29	27	35 ^a	51 ^a	

^aProvisional.

^bExcluded expected catches by Spain.

Catches by country for Div. 3NO since 1953 as well as those for country, month, and gear in 1986 are shown in Tables 1 and 2 respectively. Catch statistics for 1986 for Canada were obtained from the Department of Fisheries and Oceans, Canada, while those for other countries were obtained from NAFO Circular Letters, the NAFO Secretariat and/or FLASH records. Catches from 1981 to 1985 averaged approximately 30,000 t but have increased since 1984. Preliminary data suggest a substantial increase from 1984 to 1985. Sampling data available (Table 3) was almost entirely from the Canadian fishery and was obtained by the Canadian Port Sampling and Observer Program Sampling units of the Department of Fisheries and Oceans.

This data was used to estimate the catch and average lengths and weights at age (Table 4) for all catches reported by month (Table 2). No sampling was available from the remaining catch (32,133 t). Average weights-at-age were determined by applying a length-weight relationship ($\log \text{ weight} = 3.0849 \log \text{ length} - 5.2106$) to length frequencies and age length keys. The calculated catch was within 4% of the reported catch. Dominant year-classes were those from 1980-82.

Survey data

In the most recent assessment of this stock (Bishop and Baird, 1986) Canadian survey data were presented for surveys conducted from 1971 to 1986. For reference purposes data from these surveys are presented again in Tables 5-11. Preliminary results from the spring 1987 surveys in terms of total biomass and abundance are shown in Tables 5 and 6.

Total biomass estimates from Canadian surveys showed a substantial increase in both divisions from 1982 to 1984. Biomass was somewhat stable from 1984 to 1986 but indicated an increase in 1987 particularly in Div. 30. Approximately 85% of the biomass in 1987 in Div. 30 was from 4 strata, namely 329, 340, 351, and 352 (Fig. 1). This pattern of biomass distribution is not inconsistent with that occurring in past surveys (Table 6) with the exception of the large estimates in Strata 329 and 340.

* See Appendix (page 13) for additional information.

Commercial catch-effort data

Catch and effort data for 1977-85 was obtained from NAFO statistical bulletins while that for the Canadian otter trawl fleet for 1986 was provided by the Department of Fisheries and Oceans, Canada. Catch rates from the otter trawl and pair trawl fisheries were analyzed separately because of differences in their seasonal patterns (Tables 12, 13). Plots of residuals indicated that data with greater catch and effort were less variable, therefore, estimated weights calculated according to Judge et al. (1980, p. 132) were applied in a weighted regression of the multiplicative model. To reduce the possible effect of truncation and rounding errors data with less than 10 t catch or 10 hours effort were excluded from the analysis. In previous assessments of this stock catch rates were analyzed from 1959 to the present. It was considered to be more appropriate and reliable to use data from 1977 to the present because this was the period when not only were catch rates thought to be better estimated, but reported catches were considered more reliable and biological sampling was more extensive. Canadian otter trawl catch rates (Table 14, Fig. 2) have increased from 1977 to 1982 and have subsequently declined. Spanish pair trawl catch rates (Table 15, Fig. 3), although quite variable have generally increased from 1977 to 1984 with a decline in 1985.

References

- Bishop, C. A., and J. W. Baird, 1986. An assessment update of the cod stock in NAFO Divisions 3NO, NAFO SCR Doc. 86/124. Ser. No. N1253. 14 p.
- Judge, C. C., W. E. Griffiths, R. C. Hills, and T. C. Lee. 1980. The theory and practice of econometrics. John Wiley and Sons, New York. 793 p.

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	8,705	13,590	1,071	3,306	431	27,103
1985 ^a	18,406	12,405	601	3,446	4,849	39,394
1986 ^a	17,204	23,395	6,890	1,181	2,802	51,472

^aProvisional.

Table 2. Cod landings (t) from NAFO Divisions 3N0 by country and month in 1986.

Mo.	3N						30			3N0										
	Can(N)			Can(M)			France (SP)	Can(N)		Can(M)		Can(Q)	Cuba	USSR	USA	Japan	Panama	Port	Spain	Other
	OT	GN	LL	OT	LL		OT	LL	OT	LL										
J	8			2			361		139				400	12						
F	10			4			685		295				97	21						
M	15						698		328	3			246	17						
A	113				1		239		286	5		2	182	19						
M	754	61			95		238		53	139	15			27						
J	1092	19	135	223	33	185	540		151	119	122			44						
J	1133	46		182	247		177	7	81	76				65						
A	1003	134		45	135		58	21		130				11						
S	1285	11		65	189		36	11	9	242				29						
O	1448						80	12		3				70	1					
N	595			6			566		124				1	62						
D	270			30			730		1036				1	56						
UK																				
	7726	19	387	557	700	185	4408	51	2502	717	137	2	1181	433	1	1180	6890	23062	1001	
Total 3N0 = 51472 t																				

Table 3. Commercial sampling for NAFO Div. 3N0 cod in 1986.

Quarter	Gear	Country	Div.	# Aged	Month	# Meas.	Country/Month	Total
1	OT	Can(N)	30	403	Feb .	891	685	1504
		"	"		Mar .	814	698	1044
		Other	"					793
				403		1705		3341
2	OT	Can(N)	3N	75	Apr	114	113	114
		"	"		May	646	754	910
		"	"		June	157	1092	1502
		"	30	181	Apr.	301	239	530
		"	"		May	378	238	1377
		France(SP)	3N	167	June	1585	185	185
Other	"					274		
				423		3181	4892	
3	OT	Can(N)	3N	404	Jul.	180	1133	1608
		"	"		Aug.	438	1003	1317
		"	"		Sept.	371	1285	1550
		"	30	95	Jul.	2050	177	848
		Other	"					191
				499		3039	5428	
4	OT	Can(N)	3N	396	Oct.	1229	1448	1448
		"	"		Nov.	309	595	901
		"	30	130	Nov.	636	566	2551
		Other	"					191
				526		2174	5091	
Total				1851		10099	18752	

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 1986. (Data for Spain and Portugal not included.)

AGE	AVERAGE		CATCH		
	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
3	0.330	34.000	33	33.04	1.01
4	0.833	45.084	1061	79.17	0.07
5	1.361	53.332	2292	119.60	0.05
6	1.874	59.178	1976	107.12	0.05
7	2.845	67.599	536	45.74	0.09
8	4.253	76.534	446	31.20	0.07
9	6.022	86.202	198	15.70	0.08
10	8.368	96.145	168	13.76	0.08
11	9.022	98.096	247	16.01	0.06
12	9.661	100.492	115	11.22	0.10
13	10.891	103.866	54	8.27	0.15
14	12.399	109.193	17	4.28	0.26
15	12.616	109.176	6	2.18	0.39
16	11.989	107.958	5	2.56	0.50
17	14.510	115.110	2	1.46	0.59
18	16.628	121.000		0.28	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	1987
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	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	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	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	95280	123743
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	1987
329	211		6422	180	2008	357	18	487	373	560	840	304	
330	9251	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	281189
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. 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
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	5830	7440	757	1203	3859	1608	18971	4385	2391
	373	2520	18897	3831	142	426	(1444)	76	946	5959	327	331	1892	1589	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. 3O. 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	2898	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
45	45	94	37	58	78	88	88	172	140	77	130	116	178	203	
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	16.47	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 NAFO Divisions 3NO (includes estimates for non sampled strata).

No. sets	1971 ^a	1972 ^a	1973	1974 ^a	1975	1976	1977	1978	1979	1980	1981	1982	1984	1985	1986
45	45	94	37	58	78	88	88	172	140	77	136	116	178	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 3N only.

Table 12. Regression coefficients and analysis of variance from the regression of ln catch rate for cod in Divisions 3N0 from 1977-86 using otter trawl data.

Country/Gear	ln Power	Month	ln Power
Can-N OT-4	0.000	Jan.	0.000
Can-N OT-5	0.137	Feb.	-0.384
Can-M OT-4	0.404	Mar.	-0.562
Can-M OT-5	0.576	Apr.	-0.608
		May	-0.880
		June	-0.930
<u>Division</u>	<u>ln Power</u>	July	-0.828
3N	0.000	Aug.	-0.756
30	0.055	Sept.	-0.821
		Oct.	-0.941
		Nov.	-0.432
		Dec.	-0.257

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.643
 MULTIPLE R SQUARED..... 0.413

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.440E1	3.440E1	
REGRESSION	24	4.540E1	1.891E0	8.594
TYPE 1	3	1.168E1	3.893E0	17.686
TYPE 2	11	1.924E1	1.749E0	7.946
TYPE 3	1	1.402E-1	1.402E-1	0.637
TYPE 4	9	8.027E0	8.919E-1	4.052
RESIDUALS	293	6.449E1	2.201E-1	
TOTAL	318	1.443E2		

Table 13. Regression coefficients and analysis of variance from the regression of ln catch rate for cod in Div. 3N0 from 1977 to 1985 using Spanish pair trawl data.

Gear	ln Power	Month	ln Power
PT-4	0.000	Jan.	0.000
PT-5	0.138	Feb.	0.252
PT-6	0.498	Mar.	-0.176
		Apr.	-0.167
		May	0.172
		June	0.412
		July	0.453
Division	ln Power	Aug.	0.271
3N	0.000	Sept.	-0.008
30	0.244	Oct.	0.046
		Nov.	0.072
		Dec.	0.409

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R,..... 0.812
 MULTIPLE R SQUARED,.... 0.659

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	8.642E1	8.642E1	
REGRESSION	22	1.039E2	4.720E0	16.264
TYPE 1	2	1.955E0	9.777E ⁻¹	3.369
TYPE 2	11	8.230E0	7.482E ⁻¹	2.576
TYPE 3	1	1.280E0	1.280E0	4.412
TYPE 4	8	8.150E1	1.019E1	35.102
RESIDUALS	185	5.369E1	2.902E ⁻¹	
TOTAL	208	2.440E2		

Table 14. Catch rate index for cod in NAFO Div. 3NO using Canadian otter trawl data for the period 1977-86.

PREDICTED CATCH RATE

YEAR	LN TRANSFORM		RETRANSFORMED		CATCH	EFFORT
	MEAN	S.E.	MEAN	S.E.		
1977	-0.8569	0.0293	0.467	0.079	17604	37685
1978	-1.0130	0.0147	0.403	0.049	14718	36562
1979	-0.6909	0.0113	0.556	0.059	27941	50214
1980	-0.9038	0.0212	0.448	0.065	19360	43261
1981	-0.6783	0.0201	0.561	0.079	24344	43392
1982	-0.4461	0.0122	0.710	0.078	31605	44485
1983	-0.4834	0.0119	0.685	0.075	28818	42097
1984	-0.6588	0.0133	0.574	0.066	27103	47217
1985	-0.6231	0.0129	0.595	0.067	34694	58306
1986	-0.7587	0.0112	0.520	0.055	50885	97858

Table 15. Catch rate index for cod in NAFO Div. 3NO using Spanish pair trawl data for the period 1977-85.

PREDICTED CATCH RATE

YEAR	LN TRANSFORM		RETRANSFORMED		CATCH	EFFORT
	MEAN	S.E.	MEAN	S.E.		
1977	-0.7274	0.0232	0.553	0.084	17604	31860
1978	-1.8950	0.0202	0.172	0.024	14718	85478
1979	0.2139	0.0334	1.409	0.256	27941	19828
1980	-0.9561	0.0224	0.440	0.066	19360	44023
1981	-0.1443	0.0229	0.990	0.149	24344	24585
1982	-0.3947	0.0208	0.772	0.111	31605	40959
1983	-0.1538	0.0229	0.981	0.148	28818	29383
1984	0.4157	0.0210	1.735	0.251	27103	15621
1985	-0.1067	0.0214	1.029	0.150	34694	33721

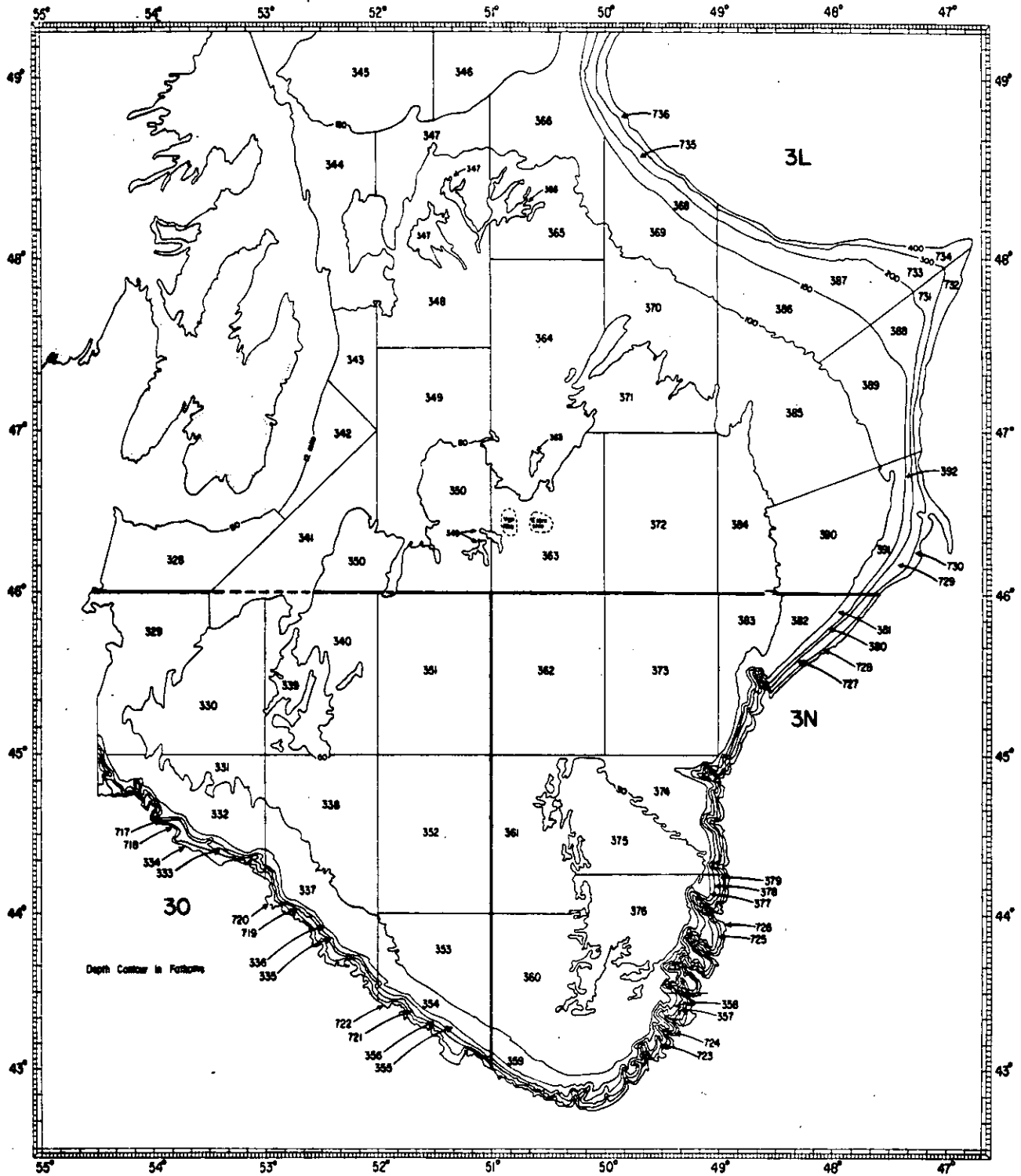


Fig. 1. Stratification scheme for NAFO Div. 3LNO.

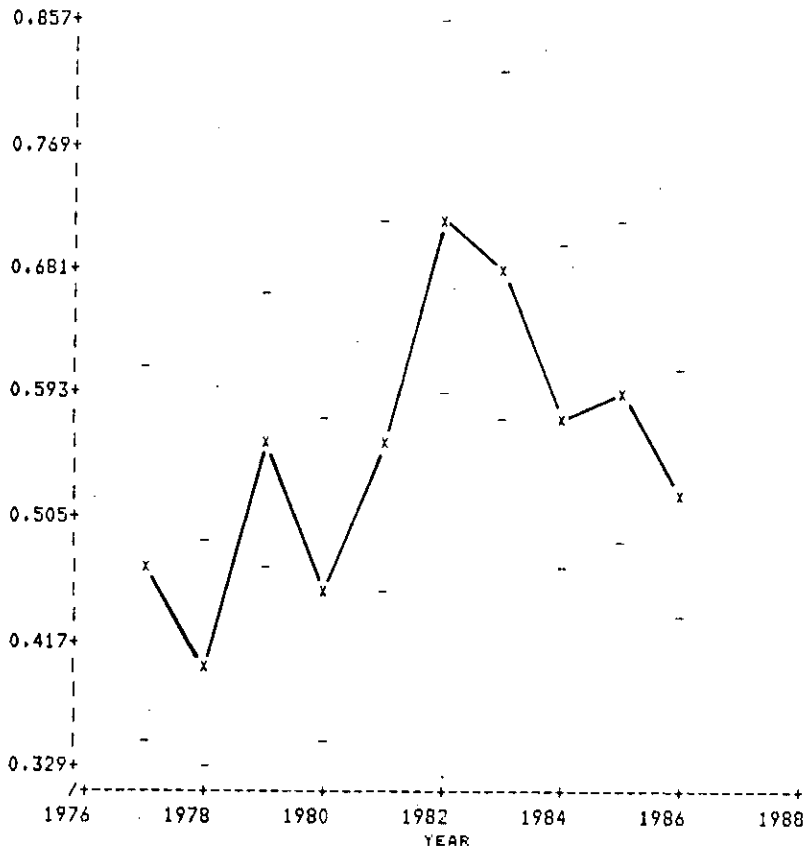


Fig. 2. Catch rate index with approximate 90% confidence interval for Div. 3N0 cod using Canadian otter trawl data for the period 1977-86.

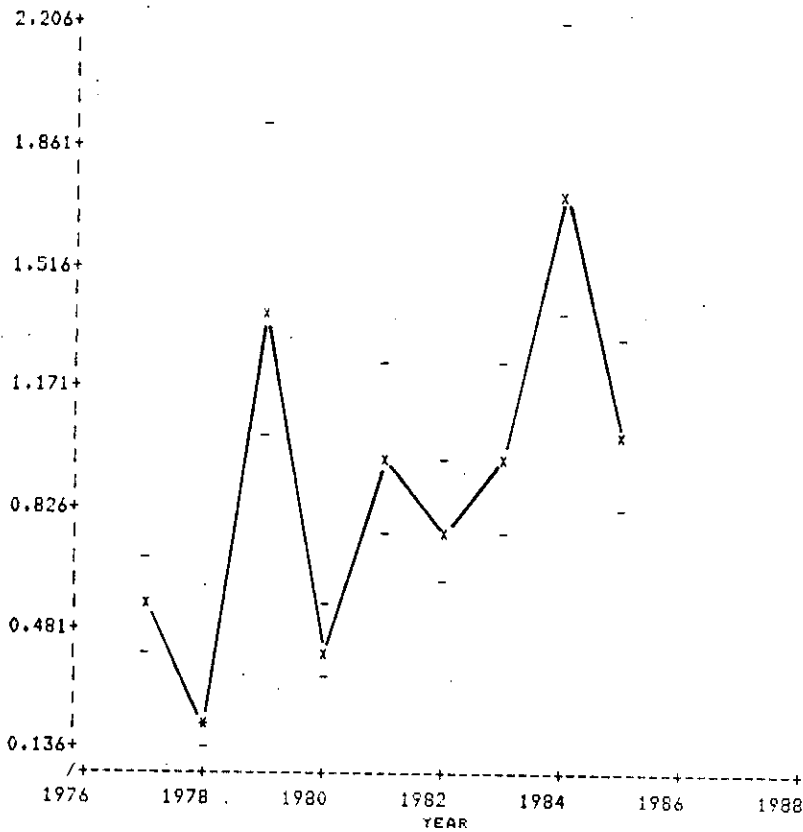


Fig. 3. Catch rate index with approximate 90% confidence interval for Div. 3N0 cod using Spanish pair trawl data for the period 1977-85.

Appendix. Further Information on Assessment of the Cod Stock in Div. 3N0

Catch-at-age

Catch and average weights-at-age for the Spanish fishery for cod in Div. 3N0 were combined with Canadian estimates and the total catch-at-age was adjusted for catches for which no sampling data were available (Table 1). The calculated catch (catch-age-age X average weights) was 91% of the reported catch. Catch and average weights-at-age for the period 1959-86 are presented in Tables 2 and 3 respectively. Catch-rate indices for each of otter trawl and pair trawl were derived using a multiplicative model using data for the 1977-86 and 1977-85 periods respectively. Pair-trawl catch-rates derived from official Spanish statistics for the 1982-86 period indicated the same trends for overlapping years as the pair-trawl index estimated from the multiplicative analysis (Table 4). The 1986 index reported by Spain was adjusted by the ratio of catch rates in both series for these overlapping years and appended to the 1977-85 pair-trawl catch-rate series. In the time period considered, the two fisheries (Canadian otter trawl and Spanish pair trawl) have generally occurred in separate areas. The Canadian otter-trawl fleet has fished mainly inside the Canadian 200-mile fishery zone while the Spanish pair-trawl fleet has fished outside the zone. Catch-rate indices for the two gears were combined after weighting each to an estimate of the geographical area inside (80%) and outside (20%) the zone. The combined index (Table 5) showed a general increase in catch rates from 1977 to 1984 with declines in both 1985 and 1986.

Cohort analysis

Catch and average weight-at-age data from the commercial fishery over the 1959-86 period were used in cohort analyses. Natural mortality was estimated at 0.20, fishing mortality for the oldest age group (12) was set at the level for fully recruited ages (7-10) and input partial recruitment was as shown below.

Fishing mortality in 1986

Partial recruitment in 1986 was estimated by iteration as an average over the 1981-84 period (Table 6). The values are as follows:

Age (years)	3	4	5	6	7	8	9	10	11	12
Partial recruitment	0.06	0.24	0.54	0.76	1.00	1.00	1.00	1.00	1.00	1.00

Average exploitable biomass from cohort analyses over a range of fully recruited fishing mortalities in 1986 were compared with the combined otter-trawl and pair-trawl catch-rate index using a least squares regression relationship. The analysis indicated that there were no significant relationships (Fig. 1).

The relationship between Canadian survey abundance at ages 6+ and cohort numbers at age 6+ for the 1977-86 period over a range of fully recruited F_s were significant and calibration in terms of placing the intercept near the origin suggested a fully recruited F in 1986 of 0.20 (Table 7, Fig. 2). Survey data for 1984 were not included in the relationship. Abundance estimated from this survey were higher than the others in the series and was not reflected by a correspondingly high cohort abundance. The age structure from the survey was also not consistent with those from surveys in 1982 and 1985.

Recruitment

With an average partial recruitment vector, age 3 cohort abundance ($F_{86} = 0.20$) in 1984-86 (1981-83 year-classes) were estimated to be 106, 82 and 14 millions respectively. From the relationship between Canadian survey mean-number-per-tow at age 3 and cohort age 3 abundance (average) for the 1977-82 period, cohort age 3 abundance for these year-classes was predicted at 33, 29 and 20 million fish respectively (Table 8a, Fig. 3). The partial recruitment vector used for 1986 was adjusted (Table 8b) to reconcile predicted year-class strengths and the estimated fully recruited fishing mortality in 1986. Using this method, the best estimates obtained for these year-classes were 62, 37 and 21 millions respectively. Adjusted partial recruitment was used in the final cohort analysis (Table 9).

Table 1. Catch-at-age and average weights of cod in Div. 3NO during 1986.

Age (yr)	Age compositions					Average weight(kg)		
	Spain		Canada	Sub-	Total	Spain	Canada	Spain +
	PT	Total	SCR 87/53	total	3NO	total	SCR 87/53	Canada*
2	1	2	-	2	2	-	-	-
3	57	94	33	127	155	0.41	0.33	0.39
4	769	1269	1061	2330	2836	1.15	0.83	1.00
5	1784	2945	2292	5237	6375	1.63	1.36	1.65
6	971	1603	1976	3579	4357	2.50	1.87	2.15
7	424	700	536	1236	1505	3.99	2.85	3.50
8	208	343	446	789	960	6.97	4.25	5.43
9	163	269	198	467	568	9.37	6.02	7.95
10	93	154	168	322	392	11.28	8.37	9.76
11	39	64	247	311	379	13.33	9.02	9.91
12	4	7	115	122	149	13.83	9.66	9.90
13	1	2	54	56	68	-	-	-
No.	4514	7451	7126	14578	17746	Reported catch = 51,287		
Catch	14180	23395	18752	42147	51287	Calculated catch = 46,836		
w (kg)	3.14	3.14	2.63	2.89	2.89	Difference = 91%		

* Weighted by numbers-at-age.

Table 2. Catch-at-age for Div. 3NO cod for the period 1959-86.

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	6593	4400	3882	5757	15555	7611	18413	62442	56775	12924	19703	26900	19797	27600	9501
5	5868	22050	11696	2206	11210	19496	7619	19681	58317	43608	26949	10799	30380	12289	15098	10987
6	6025	3095	15258	1581	4849	7919	13258	11795	18517	18485	11191	9481	11700	13432	5969	10872
7	3935	2377	2014	3594	1935	2273	9861	8486	4774	6337	2089	3646	3500	5883	1971	2247
8	1392	2584	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	146974	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	75640	42766	26568	48850	33943	25233	28549
6+	14358	10086	20257	7491	12927	12566	30579	28450	28474	27232	15819	15769	18558	21654	10135	17642
AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986				
3	671	4054	607	920	72	280	478	305	1179	58	54	155				
4	3781	7534	2469	4337	3827	1138	1032	1978	647	1040	2850	2836				
5	3528	5945	2531	2518	9208	3789	1194	1591	1893	1411	6064	6375				
6	2505	1084	1500	818	2784	2057	2173	1012	1204	2324	2984	4357				
7	3857	211	572	354	883	665	1805	1528	686	1220	2486	1505				
8	1059	238	177	102	265	185	543	1492	1152	720	795	960				
9	921	44	209	58	58	75	182	595	774	918	459	568				
10	461	37	65	51	17	27	89	211	238	551	535	392				
11	252	13	41	8	12	7	39	162	81	106	262	379				
12	152	9	25	5	7	13	12	27	41	42	99	149				
3+	21387	19169	8196	9171	17133	8236	7547	8901	7895	8350	16588	17676				
4+	20716	15115	7589	8251	17061	7956	7069	8596	6716	8292	16534	17521				
5+	11935	7581	5120	3914	13234	6818	6037	6618	6069	7292	13684	14685				
6+	8407	1636	2589	1396	4026	3029	4843	5827	4130	5021	7620	9210				

Table 3. Average weights-at-age for Div. 3NO cod for the period 1959-86.

AGE	AVERAGE WEIGHT IN KG																
	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	1986
3	0.50	0.57	0.72	0.65	0.71	0.90	0.94	0.85	0.79	0.48	0.39
4	0.91	1.00	1.05	0.98	1.04	1.27	1.17	1.17	1.15	0.86	1.00
5	1.41	1.48	1.55	1.39	1.69	1.84	1.50	1.87	1.51	1.37	1.65
6	2.33	2.48	2.25	2.89	2.50	2.69	2.20	2.63	2.28	2.05	2.15
7	3.25	3.51	3.74	2.87	3.69	3.55	3.83	3.90	3.04	3.25	3.50
8	4.03	4.74	4.61	3.70	5.49	5.33	5.26	5.20	4.05	4.65	5.43
9	6.67	7.17	6.19	4.75	7.98	7.13	7.49	6.27	5.76	6.62	7.95
10	8.74	8.81	7.23	7.15	9.22	9.10	8.80	8.08	7.22	8.32	9.76
11	9.14	11.70	9.48	7.98	10.60	9.01	9.82	8.99	8.92	9.15	9.91
12	12.49	11.47	12.87	10.11	12.61	10.15	12.28	11.01	12.61	11.13	9.90

Table 4. Estimation of "standardized" catch rate for Spanish pair trawl in 1986.

Year	Standardized catch rate	Pair Trawl catch rates (SCS 87/13)	
1982	0.77	0.52	
1983	0.98	0.70	
1984	1.74	1.05	
1985	1.03	0.58	
1986	(0.75)	0.47	

Ratio of standardized to unadjusted catch rates for 1982 - 85 = 1.586

Table 5. Catch rate index estimated by averaging Canadian otter trawl and Spanish pair trawl catch rates.

Year	Standardized catch rates		Normalized catch rates		Weighted average OT+PT
	OT	PT	OT	PT	
1977	0.47	0.55	0.85	0.62	0.80
1978	0.40	0.17	0.72	0.19	0.61
1979	0.56	1.41	1.01	1.60	1.13
1980	0.45	0.44	0.81	0.50	0.75
1981	0.56	0.99	1.01	1.12	1.03
1982	0.71	0.77	1.28	0.87	1.20
1983	0.69	0.98	1.25	1.11	1.22
1984	0.57	1.74	1.03	1.97	1.22
1985	0.60	1.03	1.09	1.17	1.11
1986	0.52	0.75	0.94	0.85	0.92
Average	0.55	0.88			

Table 6. Annual partial recruitment values for Div. 3NO cod for the period 1959-86.

SELECTIVITY COEFFICIENTS

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	0.09	0.09	0.03	0.03	0.01	0.28	0.01	0.00	0.14	0.23	0.16	0.06	0.02	0.00	0.97
4	0.40	0.42	0.28	0.19	0.15	1.00	0.13	0.19	0.54	0.76	0.53	0.49	1.00	0.53	1.00
5	0.81	1.00	1.00	0.24	0.55	1.00	0.32	0.47	0.99	1.00	1.00	0.61	1.00	0.92	1.00
6	1.00	0.81	1.00	0.42	0.53	1.00	0.65	0.97	0.95	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	0.23	0.02	0.51	0.02	0.12	0.01	0.08	0.07	0.05	0.10	0.00	0.00	0.06
4	0.83	0.33	1.00	0.26	0.66	0.42	0.49	0.27	0.37	0.17	0.09	0.14	0.24
5	1.00	0.47	1.00	0.71	1.00	1.00	1.00	0.47	0.55	0.64	0.43	0.59	0.54
6	1.00	0.86	1.00	0.80	1.00	1.00	1.00	0.72	0.54	0.77	0.98	1.00	0.76
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 7. Relationship of Canadian survey age 6+ numbers with cohort age 6+ (average) abundance for the period 1977-86.

Year	Survey Age 6+	Ft = 0.15		Ft = 0.20		Ft = 0.25	
		Obs.	Resid.	Obs.	Resid.	Obs.	Resid.
1977	2.64	4.7	-10.8	4.7	-9.6	4.7	-8.9
1978	1.78	5.9	-3.2	5.9	-3.8	5.9	-4.2
1979	2.87	9.5	-7.7	9.5	-6.0	9.5	-5.0
1980	1.36	16.2	10.2	16.2	8.7	16.2	7.8
1981	5.13	25.5	-8.5	23.8	-3.8	22.8	-0.9
1982	2.54	26.3	11.6	23.5	9.7	21.8	8.6
1983	-	-	-	-	-	-	-
1984	13.25	-	-	-	-	-	-
1985	6.89	37.9	-9.2	30.1	-6.8	25.5	-5.4
1986	6.82	64.0	17.5	48.1	11.6	38.6	8.0

1977-86	r ²	0.68	0.66	0.62
(ex.1984)	slope	7.43	5.33	4.07
	intercept	-4.14	0.22	2.83

1977-86	r ²	0.36	0.363	0.360
(inc.1984)	slope	3.00	2.21	1.74
	intercept	10.48	10.51	10.52

Table 8. a) Relationship of survey abundance (age 3) with cohort numbers age 3 (average) for the period 1977-82 along with predicted values for 1984-86.

Year	Survey Abundance Age 3	Cohort Numbers Age 3 (Ave.)	Cohort Numbers Age 3 (Ave.)
1977	9.46	42.3	
1978	7.22	36.9	
1979	2.35	18.8	
1980	1.37	21.2	
1981	5.40	29.6	
1982	1.18	26.9	
1983	-		
1984	6.20	(33.4)	55.8
1985	4.47	(29.2)	33.2
1986	0.71	(20.1)	19.4
r ²	0.84		(estimates from adjusted partial selection)
slope	2.43		
intercept	18.37		

Table 8. b) Partial recruitment vector adjusted to give cohort age 3 numbers described above.

Age (yr)	3	4	5	6	7	8	9	10	11	12
Partial recruitment	0.04	0.55	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 9: Results of cohort analysis for Div. 3NO cod using Ft = 0.20. (Population numbers, average population biomass, fishing mortality).

AGE	POPULATION NUMBERS													
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
3	53690	53182	82102	107739	78245	112305	162557	205999	183237	100502	127856	80329	84447	62128
4	93899	42410	41872	66485	87281	63778	86336	132174	171252	131847	67462	97302	63063	68280
5	19533	65082	28836	30300	50921	66251	30142	63799	21554	83709	56575	43555	61836	27947
6	16514	11407	33333	13028	22812	31547	36601	24334	34426	29430	24553	21936	25809	23211
7	12460	8069	6539	13485	9236	14209	10663	17970	9251	11431	7369	9976	9381	10609
8	4372	6641	4455	3531	7789	5811	9642	6358	7034	3254	3625	4143	4869	4513
9	2886	2320	3171	2135	2192	2902	3754	3527	1163	1550	1224	1767	1913	1724
10	3368	1678	1372	1830	1143	740	1663	2075	1233	739	812	533	908	1114
11	2261	1919	1024	946	1106	386	309	232	183	846	444	401	302	563
12	331	748	759	816	570	614	283	106	80	85	611	242	123	157
3+	209315	193456	203465	240295	261294	298623	357950	460594	499412	363394	290552	260124	253530	200244
4+	153624	140274	121363	132555	183049	186318	195393	250595	316175	262892	162695	179796	169083	138116
5+	61725	97664	79491	66070	95768	122540	109057	118421	144923	131044	95213	82494	105220	69836
6+	42192	32731	30653	35770	44847	56290	70915	54322	53369	47335	38638	38738	43384	41890
AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	35060	36713	23681	27591	46983	41179	20800	23580	32945	29865	60812	61606	36682	21460
4	50803	19604	24244	18290	18921	37917	32882	16965	19052	26540	24176	48722	50386	29984
5	37990	16621	7454	11904	8158	13257	27119	23459	12860	14665	19940	19208	30906	38674
6	11761	17442	3739	2910	4367	4389	8576	13672	15778	9448	10567	14612	14449	26432
7	6849	4210	4443	794	1402	2218	2853	4502	9496	10952	6820	7562	9661	9130
8	3363	3824	1414	872	460	630	1496	1537	3084	6141	7584	4963	5087	5824
9	2170	1874	1188	199	498	216	424	985	1091	2034	3678	5167	3412	3446
10	1154	1137	616	140	123	219	124	294	739	720	1127	2311	3400	2378
11	716	725	319	87	81	42	133	87	217	524	406	707	1394	2299
12	390	462	206	33	60	29	27	98	64	142	283	259	483	904
3+	150257	102612	66704	62821	81052	100096	94435	85378	95325	101040	135391	185117	164139	140530
4+	115196	65899	43623	35230	34069	58918	73634	61798	62386	71175	74579	103511	127457	119071
5+	64393	46295	19379	16940	15148	21001	40753	44833	43329	44635	50403	54789	77071	69066
6+	26403	29674	11925	5035	6991	7743	13633	21375	30469	29970	30464	35581	38085	50413

Table 9. (continued)

POPULATION BIOMASS (AVERAGE)														
AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
3	20088	19867	31088	40804	29721	41476	61674	91184	74945	35791	53705	34455	36517	30389
4	64462	28855	29235	47853	62552	40891	61090	99562	110072	80070	49184	70410	39113	50113
5	18885	59313	24871	32974	50580	62460	38404	64276	73897	65112	49357	45845	53215	26929
6	22993	17059	42768	21455	35528	47861	51070	33374	44634	34093	34636	31629	36654	27884
7	26076	17157	13766	29265	20843	33315	32224	36844	18137	21477	17703	22498	21023	18228
8	10779	15913	10492	9520	16780	15958	20412	13376	15266	3740	10722	12143	12753	11391
9	8847	7184	9709	6319	5322	8857	11321	13825	5928	7240	5270	8026	9366	8448
10	12055	6197	5363	6729	3264	2311	3402	6028	7900	4452	4481	3126	5550	7157
11	7180	6565	4807	3897	4391	1741	995	1208	1081	6112	2816	1990	1872	3920
12	1524	3410	3464	3882	2519	3091	1109	661	487	540	4605	1766	871	1036
3+	193109	181520	175863	202739	231501	257960	281901	359347	352349	267627	232473	231895	218933	185495
4+	173021	161653	144775	161935	201780	216485	220227	268663	277404	227836	178773	197440	180416	155106
5+	108559	132798	115440	114082	139227	175594	159138	169101	167331	147766	129590	127029	141303	104593
6+	89675	73485	90569	81108	88647	113134	120734	104826	93434	82654	80233	81184	88087	78064
AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
3	15155	12621	7825	11492	24104	26550	12231	15077	26664	25305	46363	44088	15946	7556
4	30594	9172	15441	11420	15922	33828	27347	15410	21287	27007	25268	50224	33074	25782
5	37747	10362	6184	10598	8998	16658	27468	32727	20362	10756	32048	25241	44255	52594
6	16097	18631	4049	4812	7867	8023	13212	28865	35557	17738	23619	27545	23753	46838
7	18843	7329	6885	1988	3388	6857	6106	13833	27325	35101	22201	18979	24914	26337
8	11789	10532	2579	2690	1529	2398	4524	7144	13447	25274	32750	16763	19592	26044
9	9986	8275	2709	1056	2435	1028	1687	6830	6399	11505	18446	24317	18959	22578
10	8820	3513	1822	940	666	1246	746	2338	5689	4852	7279	13096	23409	19130
11	6480	3464	664	662	593	324	915	795	1592	3839	2936	5246	10350	18779
12	4114	2084	683	317	467	307	214	1039	532	1415	2595	2693	4320	7375
3+	159625	85982	48840	45975	55969	97220	94451	124056	158858	170793	213505	228192	223573	253034
4+	144470	73362	41015	34483	41865	70670	82219	108979	132193	145408	167143	184104	207627	245477
5+	113376	64190	25574	23063	25944	36842	54372	93569	110705	118481	141875	133379	139553	219896
6+	76129	53828	19390	12465	16946	20184	27404	60842	90542	99725	109827	108639	125296	167102

FISHING MORTALITY

AGE	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	0.036	0.039	0.011	0.011	0.004	0.063	0.007	0.004	0.129	0.198	0.073	0.029	0.013	0.001	0.381	0.215	0.033	0.177
4	0.167	0.186	0.123	0.067	0.076	0.314	0.103	0.167	0.516	0.646	0.238	0.253	0.626	0.386	0.917	0.767	0.511	0.607
5	0.338	0.469	0.595	0.084	0.279	0.393	0.249	0.417	0.935	1.027	0.747	0.320	0.780	0.665	0.578	1.292	0.740	0.803
6	0.516	0.356	0.705	0.144	0.268	0.325	0.511	0.767	0.803	1.185	0.701	0.649	0.692	1.020	0.827	1.168	1.349	0.530
7	0.429	0.394	0.416	0.349	0.263	0.193	0.377	0.738	0.845	0.949	0.376	0.517	0.532	0.949	0.383	0.691	1.429	0.347
8	0.434	0.539	0.536	0.277	0.787	0.237	0.806	1.498	1.312	0.778	0.553	0.573	0.638	0.532	0.385	0.969	1.759	0.359
9	0.342	0.325	0.350	0.424	0.885	0.357	0.383	0.851	0.254	0.446	0.631	0.431	0.341	0.202	0.447	0.913	1.941	0.280
10	0.362	0.294	0.172	0.303	0.886	0.673	1.768	2.240	0.176	0.310	0.506	0.369	0.279	0.241	0.265	1.071	1.756	0.346
11	0.907	0.728	0.027	0.307	0.388	0.112	0.874	0.868	0.562	0.125	0.406	0.962	0.456	0.166	0.237	1.058	2.067	0.180
12	0.417	0.438	0.436	0.343	0.509	0.224	0.784	0.883	0.947	0.854	0.449	0.522	0.580	0.724	0.394	0.926	1.579	0.355
AGE	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986								
3	0.014	0.025	0.004	0.013	0.016	0.011	0.022	0.001	0.002	0.008								
4	0.156	0.135	0.138	0.077	0.062	0.086	0.030	0.023	0.065	0.110								
5	0.420	0.236	0.470	0.197	0.108	0.128	0.111	0.085	0.189	0.200								
6	0.477	0.231	0.444	0.179	0.165	0.126	0.135	0.193	0.259	0.200								
7	0.600	0.194	0.419	0.178	0.236	0.167	0.118	0.196	0.327	0.200								
8	0.555	0.197	0.218	0.143	0.216	0.313	0.184	0.175	0.190	0.200								
9	0.623	0.352	0.164	0.088	0.204	0.391	0.265	0.219	0.181	0.200								
10	0.873	0.298	0.164	0.107	0.143	0.366	0.266	0.306	0.191	0.200								
11	0.822	0.235	0.105	0.074	0.222	0.418	0.249	0.181	0.233	0.200								
12	0.614	0.209	0.330	0.158	0.229	0.234	0.174	0.197	0.255	0.200								

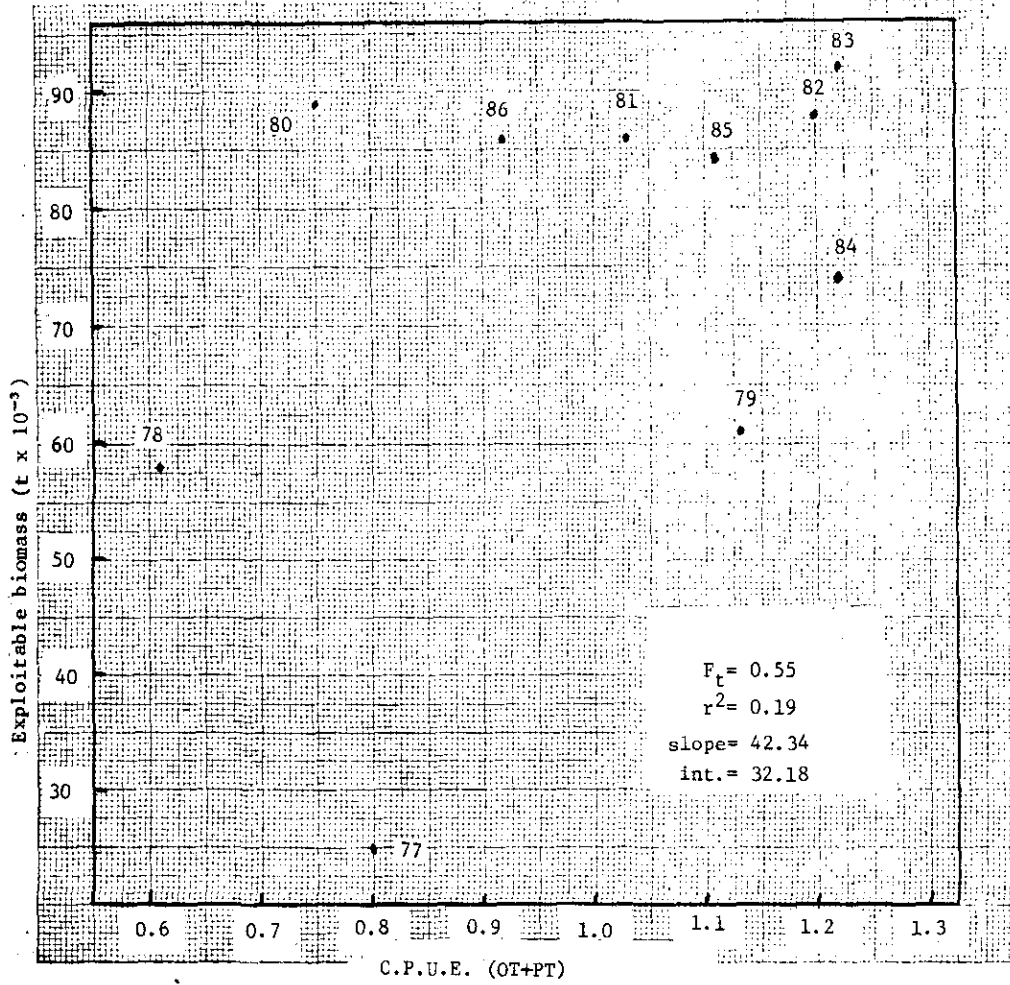


Fig. 1. Relationship of commercial C.P.U.E. (OT+PT) with cohort exploitable biomass.

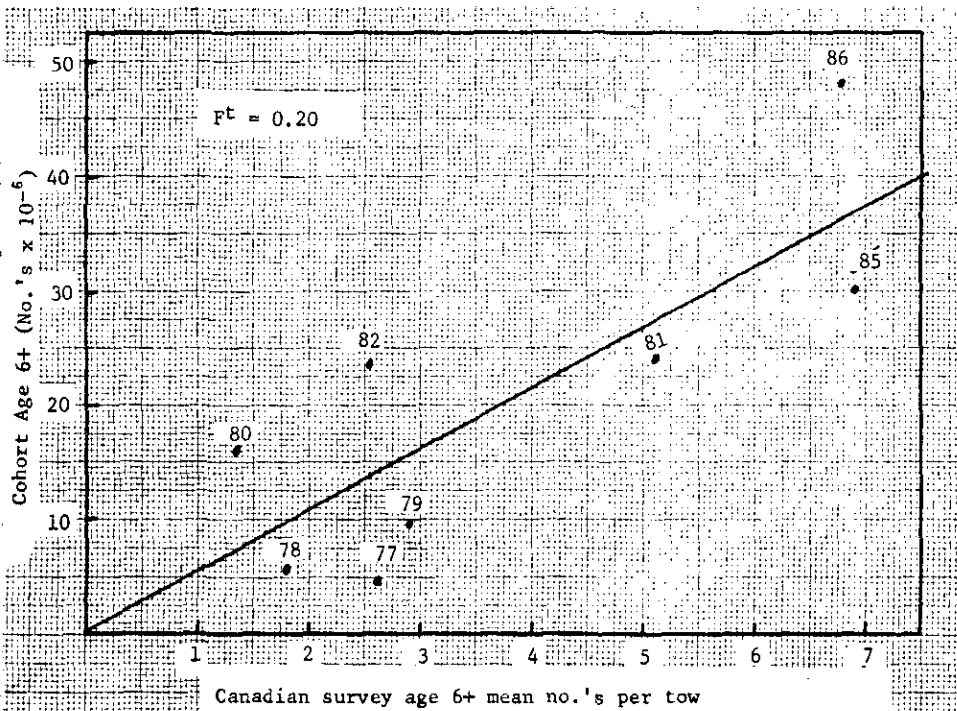


Fig. 2. Relationship of survey abundance and cohort numbers for ages 6+.

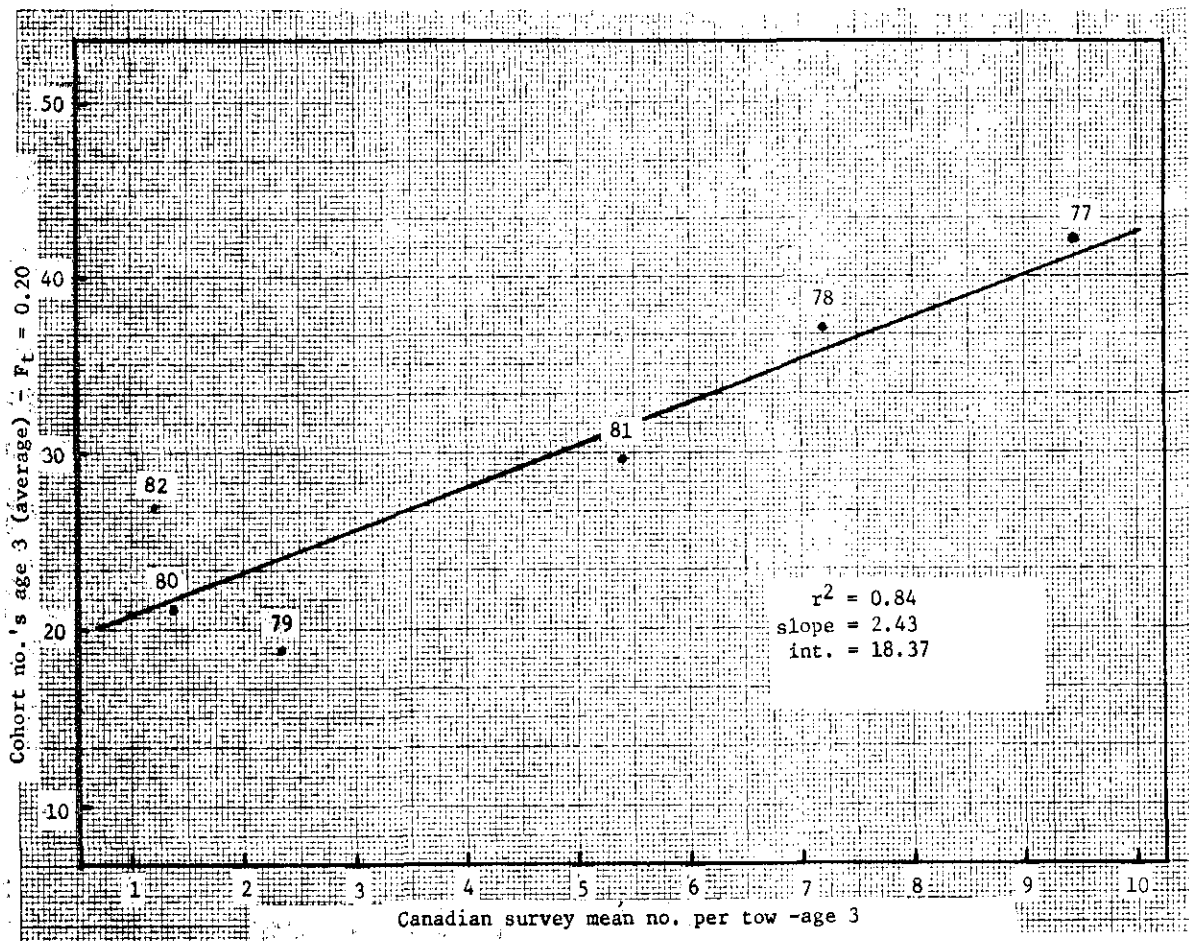


Fig. 3. Relationship of survey and cohort numbers at age 3.