

1979 Assessment of Cod in Divisions 4T  
and 4Vn (Jan-Apr)

by

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Introduction

Catches from this stock reached an all time recorded high of 110 thousand t in 1956 apparently as a result of the reaction of the cod biomass to the destruction of pelagic stock biomass by epizootic disease. From that point catches declined to 41 thousand t in 1967. However reported catches then climbed to about 60 thousand t per year in the early 1970's primarily due to an increase in interest in the 4Vn winter fishery by foreign countries and large Canadian otter trawlers. With dropping catch rates and decline in numbers estimated from research tows, there was an indication that the population was being exploited at fishing mortalities above sustainable levels. In 1974 quotas were first applied to this stock and, reported catches subsequently dropped to a low of 22 thousand t in 1977. In 1978, catch-per-unit-efforts of various fleet components increased very substantially and were at 12 year highs with unprecedented numbers of cod found on the fall research cruise. These improvements appear to result from improved recruitment from three year-classes, those of 1973, 1974 and 1975.

Figure 1 shows the catch from 1965 by Canada and by all countries by Division. Tables 1 and 2 present the same data and Tables 3-5 show the Canadian nominal catch for 1976-1978 broken down by gear and Division.

Catch per unit effort

The population estimates from the fall cruises on the E.E. Prince are given in Table 6. Also shown in Figure 2 are 4+, 5+, and 6+ estimates. After declining slowly until 1975 the estimates have shown a large increase in the past 3 years predominantly due to large

estimates for the 1973, 1974 and 1975 year-classes. First indications are that the 1976 and 1977 year-classes are also better than those before 1973. The 1975 year-class was the largest seen at age 1 and age 2 and second largest at age 3. Mortalities estimated by looking at fully recruited age groups indicate that  $F$  was high through the middle 70's but has been declining recently.

Commercial catch per unit efforts were considered for Canadian otter trawl tonnage classes 2, 3, 4 and 5. These four tonnage classes have taken varying amounts of the Canadian catch but the total has usually been around 50 percent (Figure 3). Tonnage class 5 has increased in importance over the years at the expense of the smaller vessels but its share dropped in 1977 after all large non-Gulf based vessels were excluded from 4T. The figures for 1978 may be misleading since the Quebec catch is not included and it is mainly tonnage class 2. To estimate the CPUE for each tonnage class, the directed catch and effort were taken for a three month period that usually accounted for the majority of the catch. For tonnage classes 2 and 3 this was May, June and July - for tonnage classes 4 and 5 - December, January and February these series are shown in Figure 4. For the latter two tonnage classes, each pair of figures was averaged to yield a figure for the middle year; for example the 1965-66 and 1966-67 figures were averaged to get a 1966 CPUE. The resulting series are given in Table 7. The lack of data from Quebec for 1978 probably affects the tonnage class 2 point most since most of the otter trawler effort from that province is in that class. The Maritime catch by tonnage class 2 for 1978 was only 97 t with only 18 t in May, June and July on which the CPUE is based.

Table 8 shows correlations between the CPUE series and the research 4+ estimates. Tonnage class 2 and 3 and the research data appear to agree. Since age 4 fish are only partially recruited and the 4+ research numbers are up in 1978 because of a high catch of four year olds, the research 4+ estimate for 1978 should show a greater increase than the CPUE index. Since the TC2 figure may be unrepresentative in 1978 (and possibly low), the research 4+ and TC2 series will diverge in 1978. Because of this regressions on the TC2 series were run with and without 1978. Because of the noted agreement, it was decided to produce a combined TC2-TC3 index. This was produced by dividing each series by the 1970 value so they were comparable and then taking an average weighted by catch. The series is derived in Table 7 and shown in Figure 5. The correlation coefficient between this index and the research 4+ estimates is 0.83 with the 1978 point and 0.87 without. There are a number of reasons why the TC4 and TC5 series may not correlate with the others or each other. These gears fished in 4T and 4Vn primarily when fish were not available elsewhere. The fish they catch from this stock is highly infected with codworm (*Phocanema decipiens*) and is not readily accepted by processors if other fish are available. Thus the amount of directed fishing will not be controlled by the catch rate in this stock alone and this may affect the calculated CPUE. In many stocks on the Scotian Shelf it has been noted that the CPUE of TC4 shows little variation and no correlation with research cruise estimates and other CPUE series. This may be partly

due to change in gear and fleet composition but may also be due to a fishing strategy that alters species and area over a fairly wide area to maintain a desired catch rate.

The foreign component in this fishery has changed markedly over the years. The foreign catch has tended to be of smaller fish and there may have been a high level of underreporting of this catch. As well as this the gear pattern in the Canadian fishery has varied due to changing regulations. Hence it was felt that it was impossible to develop an average effort index that adequately reflected the fishery and could be used to adjust fishing mortalities.

#### Removals at age

Samples of the commercial catch of otter trawls, seiners, gillnets and handlines were available. These were weighted by the catch by area and third of year to obtain an estimate of catch at age for 1978. The 1977 and 1976 figures were revised in a similar fashion to account for differences between preliminary and final nominal catch figures. The rest of the catch-at-age table was taken from Lett (1978). The catch-at-age data are given in Table 9. The same weighting of samples yielded average weights at age. These were smoothed using a Von Bertalanffy equation ( $R^2=.94$ ) and the results are given in Table 10.

#### Cohort Analysis

A cohort analysis was performed on the catch-at-age data assuming  $M=0.2$  and with terminal  $F$  and the selectivity pattern adjusted so that the analysis agreed with the research and commercial catch-per-unit-effort and the research data information on the strength of the recruiting age classes. The relative strength of each year-class at ages 1, 2 and 3 in the research cruise estimates was averaged to provide an index of the year-class size to correlate with estimates of numbers of three year olds from the cohort analysis. This index is shown in Table 12.

The partial recruitment used in the final cohort run was derived by comparing recruitment estimates and cohort numbers at age 3 in earlier runs. For the final run the correlation coefficient without the 1978 point was 0.84 and the intercept was 14723 (about 20% of the level of the average number of three year olds). This comparison is plotted in Figure 6. This selectivity pattern was compared with the ratios of catch to research population estimates at age (Table 13). For younger ages the agreement was good. For older ages the ratios levelled off in most years but in the last they were variable and may indicate a drop in partial recruitment at older ages. This difference took place above age 9 and thus could not have a strong impact on the analysis. The partial recruitment and weights at age used in the analysis are given in Table 10.

Table 11 shows the numbers at age and fishing mortalities estimated from the cohort analysis. Table 12 gives other results of the analysis along with a number of comparisons with other data. These comparisons are plotted in Figure 6. There is good agreement between fishable biomass (numbers x p.r. x weight) and index of CPUE of tonnage classes 2 and 3 and between 4+ cohort and research estimates of numbers. Also regressions without the 1978 points predict points close to the observed values. The recruitment index agrees well with the estimated numbers at age 3 without the 1978 point. However this regression predicts over 300 million fish at age 3 in 1978, this number is well beyond the range of the predictive regression. For projections the 1975 year-class was set at 150 million at age 3, on a par with the largest previous year-class in the analysis. This regression also predicted over 100 million fish at age 3 in 1979 and 1980.

### Yield per recruitment

A Thompson-Bell yield analysis was carried out on the weights and partial recruitments of Table 10. This gave a yield per recruit of 0.722 kg at  $F_{0.1}$  of 0.20 and 0.767 kg at  $F_{max}$  of 0.35.

### Projections

Projections were made from the numbers estimated in the cohort analysis. The average recruitment between 1967 and 1974 was about 70 million. The numbers at age three input into the projections were 150 million in 1978, 100 million in 1979 and 1980 and 70 million thereafter. The 1978 figure, as noted, may be quite conservative and this will have to be investigated carefully for next year's assessment since the 1980-84 catches will depend heavily on the 1975 year-class if it is as big as the research data predicts. Since this year-class will reach maximum biomass in 1981 or 1982, there is no loss in yield if a conservative estimate of its size is taken now. Projections were run with  $F=F_{0.1}$  after 1979, one with  $F_{0.1}$  in 1979 and one at the TAC set for 1979 (Table 14). These indicate that the improved recruitment will allow the stock to support an increased catch over the next few years and that the 1979 TAC could be raised to 49 thousand tons. Indications are that the last 5 year-classes are better than the average of the past 15. Long-term catch levels will depend on whether this is short-term phenomenon or is a permanent change possibly due to changes in the structure of the fishery.

### Acknowledgements

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References

- P.F. Lett, 1978. A multispecies simulation for the management of the southern Gulf of St. Lawrence cod stock. CAFSAC Res. Doc. 78/21.

Table 1. 4T-Vn (winter) Cod: Nominal Catch (t) all gears, all countries.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
<u>4T</u>															
Canada	45453	37227	32918	37467	40624	42616	40644	39987	24833	19121	24570	15935	19536	31315	
<u>Total</u>	46471	38248	34245	37910	40905	43410	40669	42096	25756	28579	28853	17600	19536	31315	
<u>% Canada</u>	97.81	97.33	96.12	98.83	99.31	98.17	99.94	94.99	96.42	66.91	85.16	90.54	100	100	
<u>4VN (Winter)</u>															
Canada	10888	10438	2866	6214	5449	4732	6916	7130	8790	9882	6878	11744	2428	9068	
<u>Total</u>	16556	16603	7069	8641	6914	21049	15706	23195	23852	18676	12378	15179	2683	9068	
<u>% Canada</u>	65.76	62.87	40.54	71.91	78.81	22.48	44.03	30.74	36.85	52.91	55.57	77.37	90.50	100	
<u>4T + 4VN (winter)</u>															
Canada	56341	47665	35784	43681	46073	47348	47560	47117	33623	29003	31448	27679	21964	40383	
<u>Total</u>	63027	54851	41314	46551	47819	64459	56375	65291	49608	47255	41231	32779	22219	43636 <sup>1</sup>	
<u>% Canada</u>	89.39	86.90	86.61	93.83	96.35	73.45	84.36	72.16	67.78	61.38	76.27	84.44	98.85	92.55	
										63000	50000	30000	15000	38000	36000

<sup>1</sup> includes 3253 foreign catch reported only as 4T-Vn (winter).

Table 2a. Nominal Cod Catch (t) by countries in Div. 4T

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Canada	45453	37227	32918	37467	40624	42616	40644	39987	24833	19121	24570	15935	19536	31315
Denmark								672	212	86				
France	912	1009	481	302	259	520	2	495	265	1664	2170	1459		
Norway										686				
Portugal	67					148		366	446	7022	805	206		
Spain	39	12	811	141	22	126	23	576			1308			
U.S.A.			35											
<b>Total</b>	<b>46471</b>	<b>38248</b>	<b>34245</b>	<b>37910</b>	<b>40905</b>	<b>43410</b>	<b>40669</b>	<b>42096</b>	<b>25756</b>	<b>28579</b>	<b>28853</b>	<b>17600</b>	<b>19536</b>	<b>31315</b>
											4T + 4VN	FRANCE		<u>3253</u>
												TOTAL		34568

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Table 2b: Nominal Cod Catch (t) by countries in Div. 4VN (Jan - Apr.)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Canada	10888	10438	2866	6214	5449	4732	6916	7130	8790	9882	6878	11744	2428	9068
France	1260	3726	1398	226	120	2450	624	7606	8647	4567	3368	1407	255	
Norway	-	128	-	-	-	-	-	-	-	15	-	-	-	
Portugal	1325	138	85	25	307	2326	126	2579	2555	1752	-	170	-	
Spain	2923	2173	2470	2176	1038	11540	8040	5724	3860	2227	2132	1858	-	
FRG	-	-	-	-	-	1	-	-	-	233	-	-	-	
USA	-	-	-	-	-	-	-	73	-	-	-	-	-	
UK	160	-	223	-	-	-	-	82	-	-	-	-	-	
USSR	-	-	9	-	-	-	-	-	-	-	-	-	-	
Poland	-	-	-	-	-	-	-	1	-	-	-	-	-	
Other	-	-	18	-	-	-	-	-	-	-	-	-	-	
TOTAL	16556	16603	7069	8641	6914	21049	15706	23195	23852	18676	12378	15179	2683	9068



Table 3a. 1976 Nominal catches (t) for Canadian cod fishery in 4T by month and gear.

Catch	J	F	M	A	M	J	J	A	S	O	N	D	Total Catch
Fixed Gill Nets				10	283	1107	1214	847	658	295	35		4449
Handlines					62	156	367	279	187	107	11		1169
Misc.					1	81	204	126	100	55	10		577
Side O.T.	1073	243		464	1641	477	806	427	560	269	71	33	6064
Stern O.T.	777	36	10	837	313	18	7	47	33	11	44		2133
OTB unsp.					9	1		5	11		9		35
Longlines					1	1	15	11	6	11	1		46
Danish Seine				6	200	127	224	120	146	60	37	10	930
Scottish Seine					86	91	49	122	50	6	3		407
Midwater	40				66					11			117
Pair Seine								3					3
Uncovered pound nets			4			1							5
<b>Total Canada</b>	<b>1890</b>	<b>279</b>	<b>14</b>	<b>1317</b>	<b>2662</b>	<b>2060</b>	<b>2886</b>	<b>1987</b>	<b>1751</b>	<b>825</b>	<b>221</b>	<b>43</b>	<b>15935</b>

Table 3b. 1976 Nominal catches (t) for Canadian - cod fishery in 4VN from Jan - April by gear.

Catch	January	February	March	April	Total
Side OT	2125	1816	308	215	4464
Stern OT	2060	1449	2598	522	6629
Longline				9	9
Danish Seine	7			7	14
Midwater	2		574	52	628
Total Canada	4194	3265	3480	805	11744

Table 4 a 1977 Nominal catches (t) for Canadian cod fishery in 4T by month and gear

Catch	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total Catch
Fixed gill net	-	-	-	5	443	1116	1608	1508	875	265	111	-	5931
Handlines	-	-	-	-	37	199	303	224	154	97	95	5	1114
Misc	-	-	-	-	112	185	168	139	105	133	70	-	912
Side O.T.	-	-	-	148	1450	949	989	905	471	1086	1294	52	7344
Stern O.T.	-	-	11	20	332	18	35	32	57	133	188	8	834
OTB unspec.	-	-	-	-	22	1	5	5	9	48	19	-	109
Longlines	-	-	-	-	-	11	78	25	15	17	41	17	204
Purse Seine	-	-	-	-	-	1	1	-	-	-	-	-	2
Danish Seine	-	-	-	-	311	273	311	418	371	318	694	7	2703
Scot. Seine	-	-	-	-	41	32	83	35	47	13	82	14	347
Midwater	-	-	-	-	-	-	1	2	-	-	-	-	3
Pair Seine	-	-	-	-	-	-	2	-	-	-	-	-	2
Uncovered pound nets	-	-	-	-	2	10	12	-	-	-	-	-	24
Covered pots & fyke nets	-	-	-	-	-	-	-	-	-	4	-	-	4
Dredges	-	-	-	-	-	-	-	3	-	-	-	-	3
Total Can	-	-	11	173	2750	2795	3596	3296	2104	2114	2594	103	19536

Table 4b. 1977 Nominal catches (t) for Canadian Cod fishery in  
4VN from January - April by gear

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Catch	Jan	Feb	Mar	Apr	Total
Side O.T.	402	399	23	51	875
Stern O.T.	417	443	675	7	1542
Longline	-	-	-	3	3
Danish Seine	-	-	-	6	6
Midwater	-	-	2	-	2
Total Can.	819	842	700	67	2428

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Table 5a: 1978 Nominal catches (t) for Canadian fishery in 4T by month and gear.

Catch	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
Traps	-	-	-	-	5	6	7	6	-	-	1	-	25
Drift Nets	-	-	-	-	-	1	13	-	5	-	-	-	19
Fixed Gill Nets	-	-	-	-	151	306	846	716	291	136	32	-	2478
Handlines	-	-	-	-	12	106	95	94	105	132	106	4	654
Misc	-	-	-	-	9	20	60	61	69	86	31	-	336
Unspec	-	-	-	-	4	20	29	7	29	19	-	-	108
Shrimp Trawl	-	-	-	-	8	-	2	27	-	1	27	-	65
Side OT	95	-	-	392	1929	186	509	94	148	347	91	-	3791
Stem OT	68	-	1	26	352	17	42	12	30	209	51	-	808
Longlines	-	-	-	17	16	7	20	26	23	10	3	-	122
Purse Seine	-	-	-	-	-	3	-	-	-	-	-	-	3
Danish Seine	-	-	-	21	989	540	433	566	337	263	381	213	3743
Scottish Seine	-	-	-	70	332	25	78	3	2	21	16	-	547
Midwater	-	-	-	-	-	-	-	-	-	-	-	-	-
Pair Seine	-	-	-	-	-	6	-	-	-	-	-	-	6
Scal. Drag.	-	-	-	-	-	-	5	-	-	-	-	-	5
Quebec catch (no gear break-down available)	-	-	-	763	4817	2816	3078	2773	1964	2119	275	-	18605
<b>TOTAL</b>	<b>163</b>	<b>-</b>	<b>1</b>	<b>1289</b>	<b>8624</b>	<b>4059</b>	<b>5217</b>	<b>4385</b>	<b>3003</b>	<b>3343</b>	<b>1014</b>	<b>217</b>	<b>31315</b>

Table 5b: 1978 Nominal catches (t) for Canadian cod fishery in 4VN from Jan - Apr by gear.

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Catch	Jan	Feb	March	April	Total
Side O.T.	3382	1130	28	27	4567
Stern O.T.	1324	2737	4	14	4079
Longline	4	-	-	-	4
Danish Seine	-	-	-	-	-
Midwater	82	336	-	-	418
Tot. Canada	4792	4203	32	41	9068

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TABLE 6. 4TVn (Winter) Cod: Fall Research Cruise Population Estimates

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978
0	-	-	-	43	-	-	-	21	
1	42	118	1478	146	160	806	5998	1089	2365
2	6887	1148	4193	9511	4671	10983	14844	20481	9707
3	15069	12508	9196	18806	20431	8263	64245	29976	43924
4	14551	15132	24553	8727	14375	12506	16128	25203	47326
5	17996	14336	10173	13741	5517	10501	10833	10088	26747
6	16184	11229	8455	6597	6621	3677	4554	5325	8140
7	4849	6979	5756	4607	2934	2636	1206	3000	4593
8	2078	1727	3335	3527	2171	1768	894	1289	1569
9	1793	354	643	2234	2011	819	502	969	627
10	358	381	469	611	855	598	475	614	784
11	584	219	406	145	339	712	417	492	910
12	467	127	128	462	198	168	124	400	110
13+	944	331	158	228	435	91	147	481	300
UK	213	91	-	122	19	-	62	103	-
Total	82017	64682	68943	69506	60737	53529	120428	99531	147102
4+	59804	50815	54076	40879	35456	33476	35280	47681	91106
5+	45253	35683	29523	32152	21081	20970	19152	22658	43780
6+	27257	21347	19350	18411	15564	10469	8319	12570	17033
Z <sub>4+/5+</sub>	.52	.54	.52	.66	.53	.56	.44	.09	
Z <sub>5+/6+</sub>	.75	.61	.47	.73	.70	.92	.42	.29	

Table 7. 4TVn (Winter) Cod: Catch per unit effort, Canadian Otter trawlers.

	Directed trips-May, TC2(t/hr)	June, July TC3(t/hr)	Directed trips-Dec-Feb TC4(T/hr)	TC5(t/hr)	Catch (t) TC2	TC3	TC2/TC3 CPUE Index
1967	.16	.22	.85	.26	7234	4292	.76
1968	.14	.24	.86	(.56)	7420	6389	.76
1969	.23	.31	.86	(.56)	6992	6441	1.09
1970	.23	.26	.76	.82	8534	6525	1.00
1971	.18	.26	.82	.79	6922	6263	.89
1972	.17	.28	.85	.93	5611	6749	.93
1973	.12	.17	.67	.94	4044	3158	.59
1974	.08	.09	.74	.80	2527	1875	.35
1975	.12	.20	.88	.95	3292	3772	.66
1976	.08	.15	.76	.98	2134	1526	.45
1977	.13	.19	.94	1.47	3582	3857	.65
1978	.13	.29	1.29	2.09	97	2781	1.09

<sup>1</sup> CPUE base on Maritime Region data only.

<sup>2</sup> Smoothed estimate base on 1967-68 and 1969-70 points.

<sup>3</sup> Index is TC2 and TC3 CPUE's relative to 1970 weighted by-catch to that tonnage class.



Table 8.

Correlations Between OTB CPUE's and Research Cruise Numbers at age estimates

	CPUE 3	CPUE 4	CPUE 5	RES 4+
CPUE2 (including 1978)	0.78	0.11	-0.37	0.38
CPUE2 (not including 1978)	0.89	0.21	-0.38	0.92
CPUE3	-	0.51	-0.01	0.74
CPUE4	-	-	0.43	0.53
CPUE5	-	-	-	0.66

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Table 9. CATCH AT AGE 4TVN(WINTER) COD

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	700	310	327	26	2	1541	378	1229	2379	335	633	476
4	7068	8140	4936	3395	2476	14294	4396	3170	9902	3744	3065	11300
5	5503	8086	12530	14972	7313	11326	11878	3862	6096	8820	3721	12302
6	4586	4674	3571	11925	8941	7193	5982	9851	2350	6710	3039	5723
7	3040	2916	2516	4194	6127	8479	4492	3631	3173	1454	1660	3117
8	1735	1276	2136	1905	2567	5128	3455	2188	1250	1136	429	1178
9	407	753	917	1444	1237	1370	2204	2081	1033	420	306	233
10	1021	434	785	727	554	719	740	1186	738	216	233	246
11	901	899	212	569	156	452	380	300	571	126	126	83
12	383	698	283	360	432	127	130	178	113	134	55	75
13	171	259	292	239	42	92	63	74	47	41	64	26
14	82	139	55	139	103	34	35	26	40	16	12	8
15	23	65	21	30	144	72	14	4	5	8	4	6

Table 10. 4 TVn (winter) Cod: Inputs to analysis

Age	Weight at age (kg)	Partial Recruitment
3	0.34	0.02
4	0.66	0.40
5	1.10	0.75
6	1.62	1.0
7	2.22	1.0
8	2.86	1.0
9	3.53	1.0
10	4.22	1.0
11	4.90	1.0
12	5.60	1.0
13	6.22	1.0
14	6.83	1.0
15	7.42	1.0

Table 11. Cohort analysis results with M=0.2 and partial recruitment as in Table 10.

		POPULATION NUMBERS (in thousands)											
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	1	105215	93885	56810	51404	76013	27444	48249	<b>69844</b>	<b>65617</b>	122573	160454	105291
4	1	48809	85509	76586	46216	42063	62233	21075	39161	56071	51570	100051	130796
5	1	28271	33566	62643	58237	34767	32198	38018	13277	29194	36948	38834	79142
6	1	19323	18167	20165	39951	34133	21847	16113	20379	7376	18386	22270	28428
7	1	9224	11671	10645	13278	21919	19856	11379	7779	7771	3913	8982	15483
8	1	6874	4801	6917	6439	7076	12401	8584	5251	3084	3491	1888	5851
9	1	2428	4058	2776	3730	3548	3471	5513	3902	2320	1394	1831	1157
10	1	4010	1619	2641	1443	1747	1785	1602	2520	1312	965	761	1222
11	1	3542	2359	933	1452	524	929	811	642	990	406	594	412
12	1	993	2085	1118	572	674	288	352	320	254	294	219	373
13	1	495	466	1075	659	143	161	121	171	101	106	119	129
14	1	372	250	147	616	324	79	49	42	73	40	50	40
15	1	84	230	79	71	379	172	34	8	11	23	19	30
		229639	258667	242536	224069	223309	182864	151899	163296	174173	240108	336071	368354

FISHING MORTALITY

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	1	0.007	0.004	0.006	0.001	0.000	0.064	0.009	0.020	0.041	0.003	0.004	0.005
4	1	0.174	0.111	0.074	0.085	0.067	0.293	0.262	0.094	0.217	0.084	0.034	0.100
5	1	0.242	0.310	0.250	0.334	0.265	0.492	0.424	0.388	0.262	0.306	0.112	0.188
6	1	0.304	0.335	0.218	0.400	0.342	0.452	0.528	0.764	0.434	0.516	0.163	0.250
7	1	0.453	0.323	0.303	0.429	0.370	0.639	0.573	0.725	0.600	0.529	0.228	0.250
8	1	0.327	0.348	0.417	0.396	0.512	0.611	0.588	0.617	0.594	0.446	0.289	0.250
9	1	0.205	0.229	0.454	0.558	0.487	0.573	0.583	0.890	0.678	0.405	0.204	0.250
10	1	0.330	0.351	0.398	0.813	0.431	0.589	0.714	0.734	0.972	0.284	0.413	0.250
11	1	0.330	0.547	0.289	0.567	0.399	0.771	0.729	0.726	1.015	0.420	0.267	0.250
12	1	0.556	0.462	0.328	1.188	1.232	0.669	0.525	0.952	0.675	0.701	0.326	0.250
13	1	0.481	0.952	0.357	0.512	0.393	0.998	0.860	0.653	0.720	0.558	0.899	0.250
14	1	0.279	0.951	0.532	0.287	0.433	0.647	1.587	1.161	0.938	0.577	0.311	0.250
15	1	0.358	0.370	0.314	0.621	0.538	0.612	0.602	0.767	0.710	0.472	0.270	0.250

Table 12. Results of cohort analysis

Year	Fishable Biomass(t)	F(Fully recruited)	4+ Numbers (thousands)	Recruitment Index of 3 year olds
1967	162926	0.34	-	
1968	170590	0.35	-	
1969	188281	0.30	-	
1970	211504	0.43	172665	.073
1971	196536	0.39	147296	.075
1972	186805	0.56	155420	.021
1973	146566	0.57	103651	.052
1974	117809	0.75	93452	.116
1975	98502	0.60	108556	.038
1976	107064	0.50	117535	.156
1977	135957	0.20	175616	.136
1978	212220	0.25	263063	.325
1978 (Predicted)	206973	-	266303	
1979				.110
1980				.194

Correlations

	with 1978		without 1978	
	R	intercept	R	intercept
Biomass and CPUE 23	0.89	47377	0.86	48994
4+ Cohort & Research	0.96	9289	0.86	7107
Recruitment & Research Index	-	-	0.84	14723

Table 13. Catch at age divided by research abundance estimates.

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AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978
3	0.002	0.000	0.168	0.020	0.060	0.288	0.005	0.021	0.011
4	0.233	0.164	0.582	0.504	0.221	0.792	0.232	0.122	0.239
5	0.832	0.510	1.113	0.864	0.700	0.581	0.814	0.369	0.460
6	0.737	0.796	0.851	0.907	1.488	0.639	1.473	0.571	0.703
7	0.865	0.878	1.473	0.975	1.238	1.204	1.206	0.553	0.679
8	0.917	1.486	1.538	0.980	1.008	0.707	1.271	0.333	0.751
9	0.805	3.494	2.131	0.987	1.035	1.261	0.837	0.316	0.372
10	2.031	1.454	1.533	1.211	1.387	1.234	0.455	0.379	0.314
11	0.974	0.712	1.113	2.621	0.885	0.802	0.302	0.256	0.091
12	0.771	3.402	0.992	0.281	0.899	0.673	1.081	0.137	0.682

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Table 14. Projections of 4TVn (Winter) cod population and catch

- recruitment  $1.5 \times 10^8$  - 1978  
 $1.0 \times 10^8$  - 1979-80  
 $0.7 \times 10^8$  - 1981-87

- F at  $F_{0.1} = 0.20$  after 1979

(a) 1979 - Catch = 36000 t(TAC)

Year	Population (3+)		Catch		Fully Recruited F
	Numbers $\times 10^{-6}$	Biomass $\times 10^{-3}$	Numbers $\times 10^{-6}$	Biomass $\times 10^{-3}$	
1978	413	336	35	44	0.25
1979	407	400	26	36	0.14
1980	409	472	40	63	0.20
1981	369	497	39	70	0.20
1982	337	500	36	73	0.20
1983	313	491	33	72	0.20
1984	296	475	30	69	0.20
1985	285	458	29	66	0.20
1986	277	440	27	63	0.20
1987	272	422	26	60	0.20

(b) 1979 - F =  $F_{0.1} = 0.20$

Year	Population (3+)		Catch		Fully Recruited F
	Numbers $\times 10^{-6}$	Biomass $\times 10^{-3}$	Numbers $\times 10^{-6}$	Biomass $\times 10^{-3}$	
1978	413	336	35	44	0.25
1979	407	400	36	49	0.20
1980	401	456	39	61	0.20
1981	363	483	39	68	0.20
1982	333	488	36	71	0.20
1983	310	482	33	70	0.20
1984	294	467	30	68	0.20
1985	284	452	28	65	0.20
1986	276	435	27	63	0.20
1987	271	419	26	60	0.20

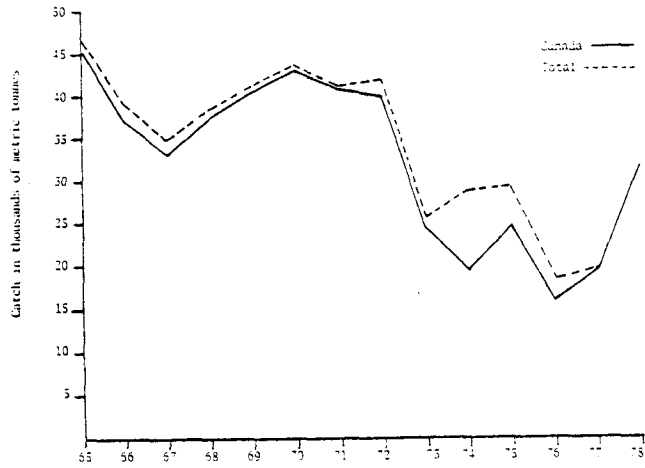


Figure 1a: Cod Catch 1965-1978 in 4T.  
\* Foreign not included for 1978.

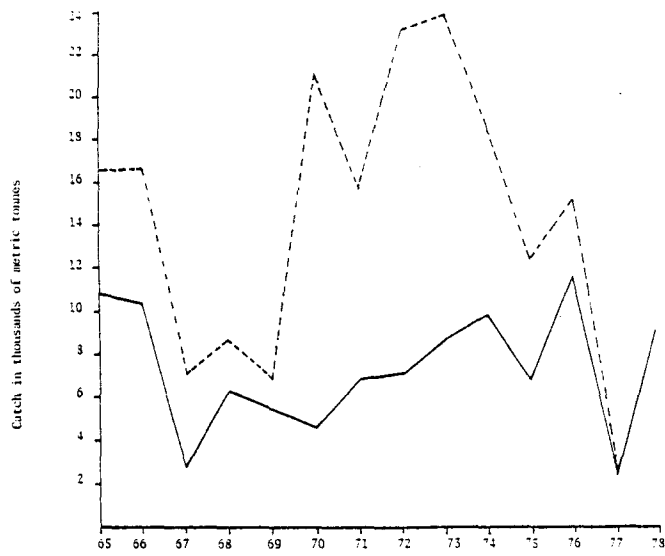


Figure 1b: Cod catch 1965 - 1978 in 4N (winter).  
\* Foreign not included for 1978.

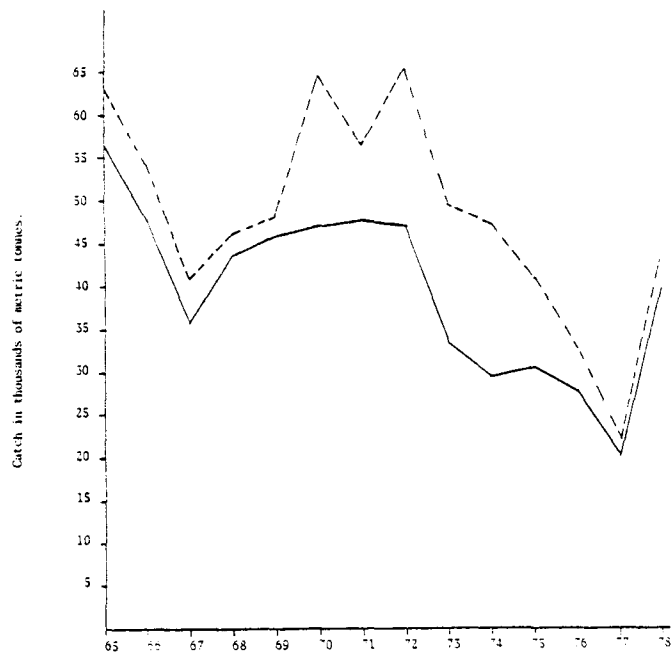


Figure 1c: Cod catch 1965-1978 in 4T and 4N (winter).

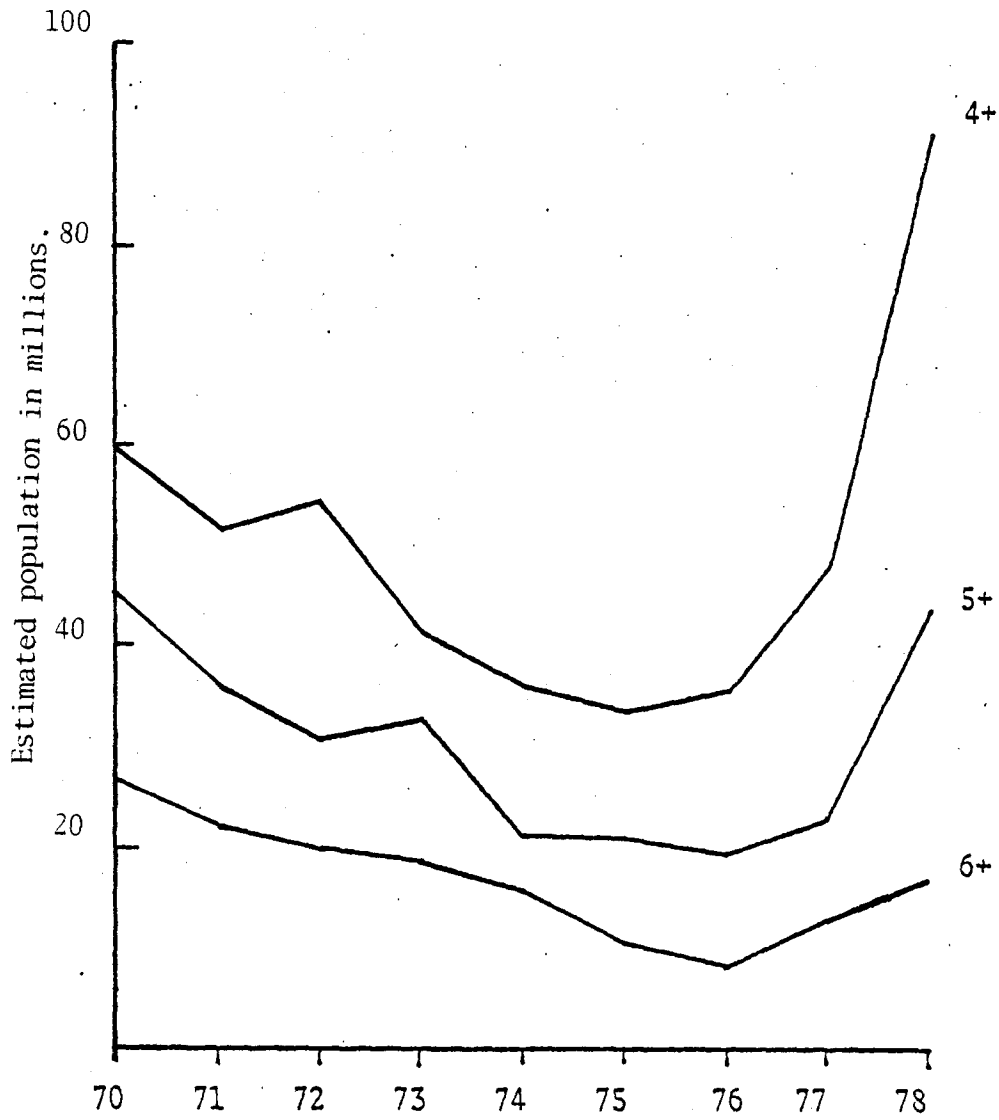


Figure 2. Population estimates of cod from fall research cruises.



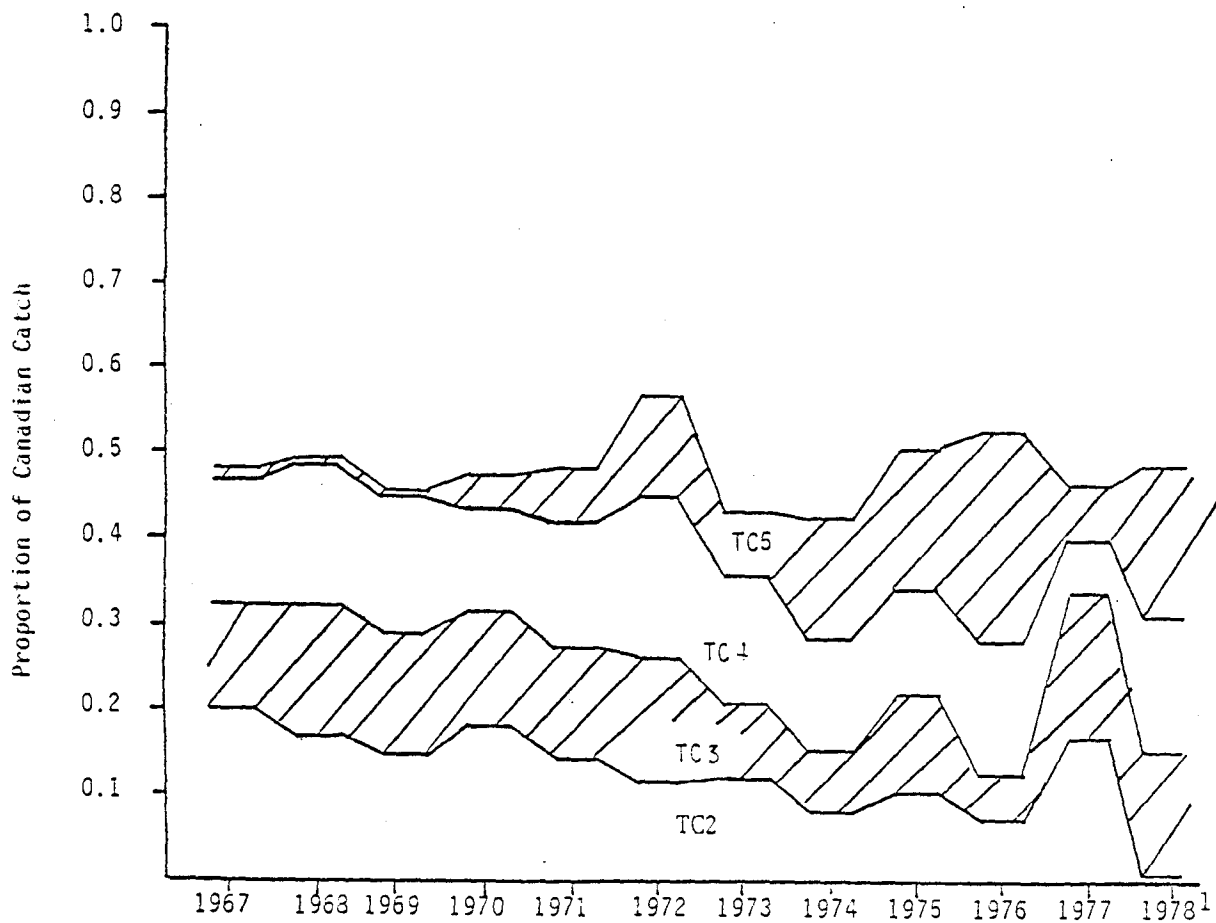


Figure 3. 4TVN (winter) Cod porportion of catch caught by OTB tonnage classes 2,3,4 and 5.

<sup>1</sup> Canada - Maritimes only.

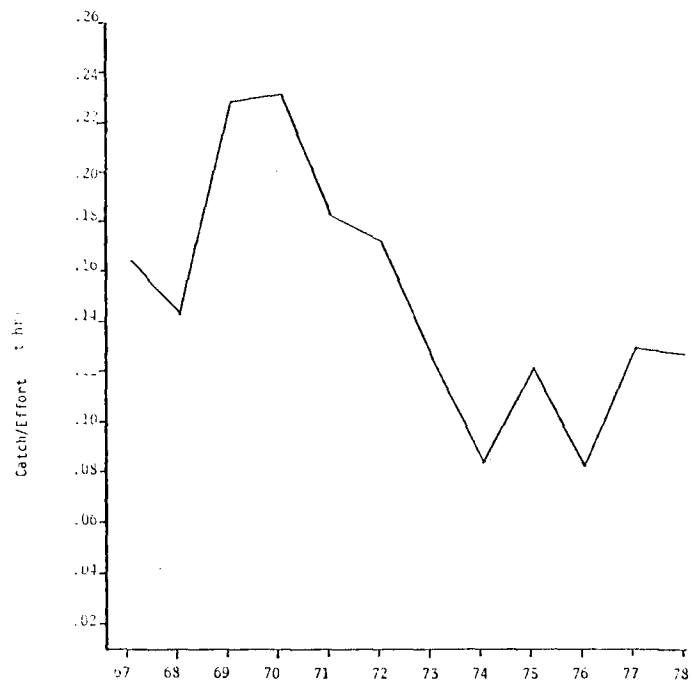


Figure 4a. Cod CPUE to OTB TC2 in 4TVN (winter). Directed catch, May, June, and July.

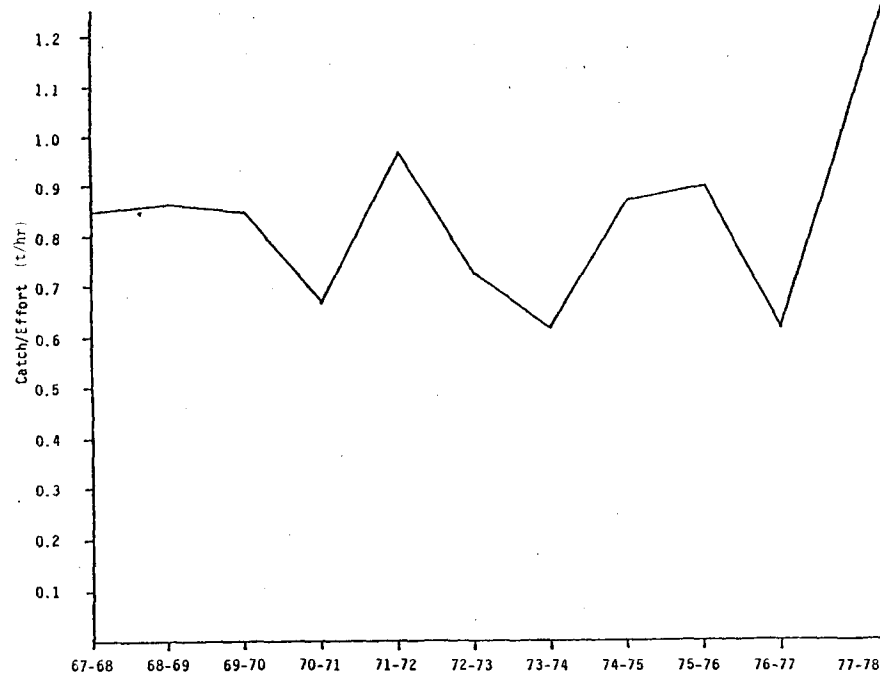


Figure 4c. Cod CPUE to OTB TC4 in 4TVN (winter) directed catch, Dec., Jan. and Feb.



Figure 4b. Cod CPUE to OTB TC3 in 4TVN (winter). Directed catch, May, June and July.

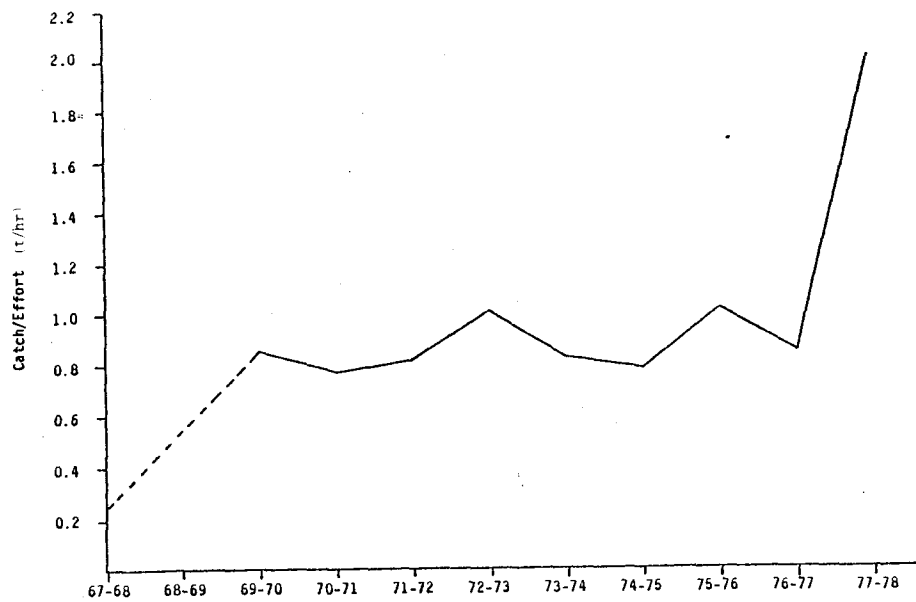


Figure 4d. Cod CPUE to OTB TC5 in 4TVN (winter) directed catch, Dec., Jan., and Feb.

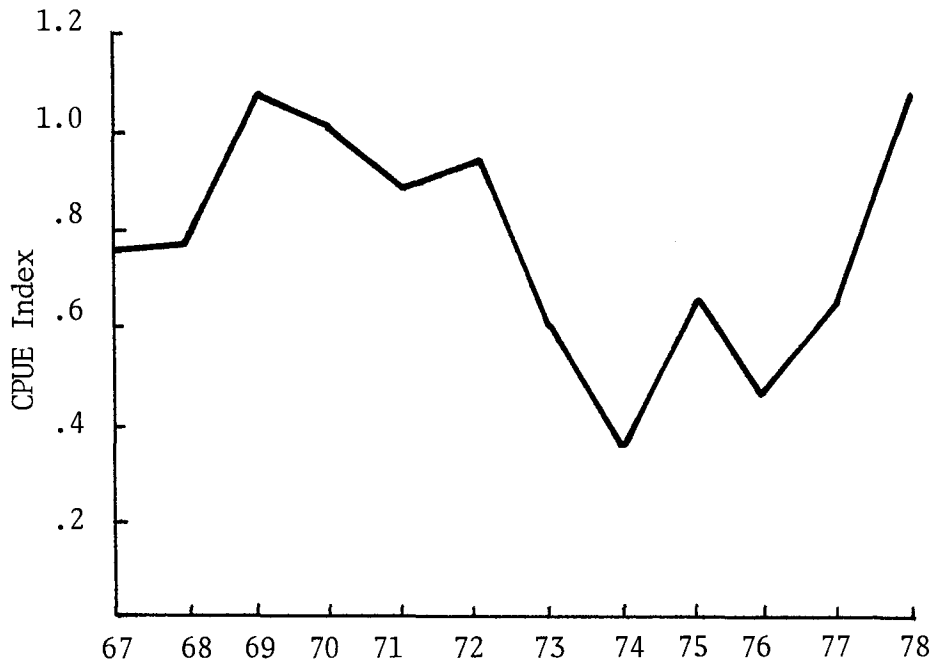


Figure 5. Combined OTB2 and OTB3 CPUE index.

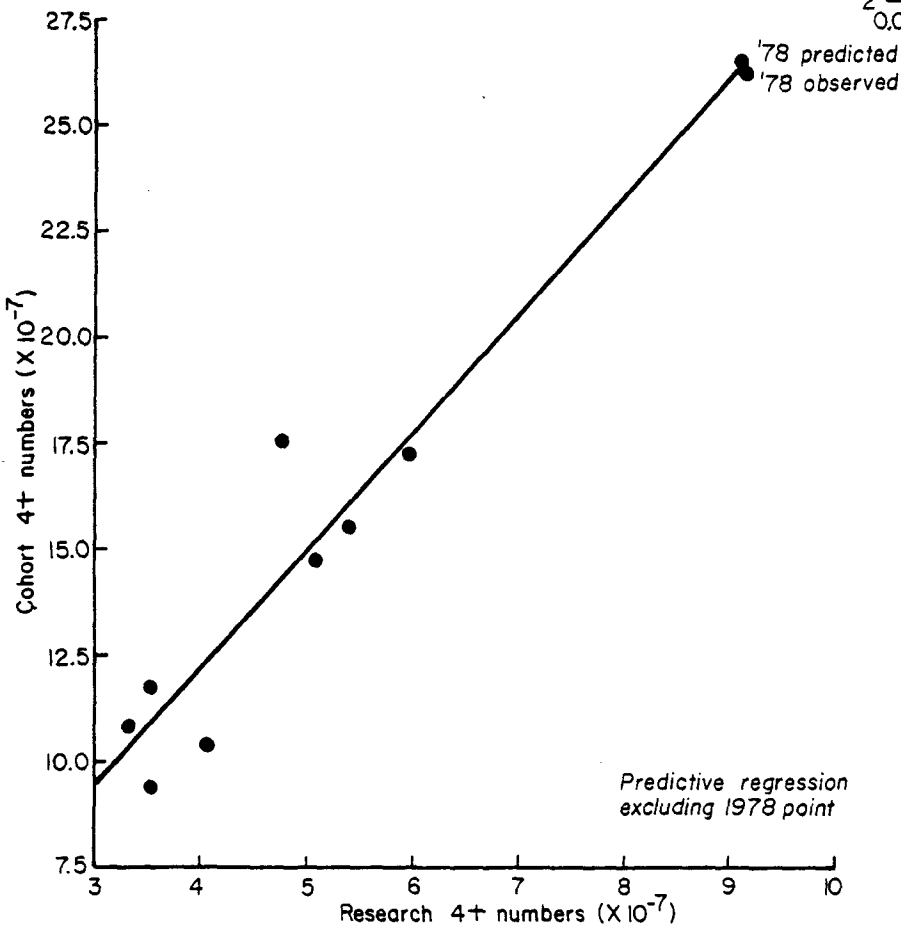
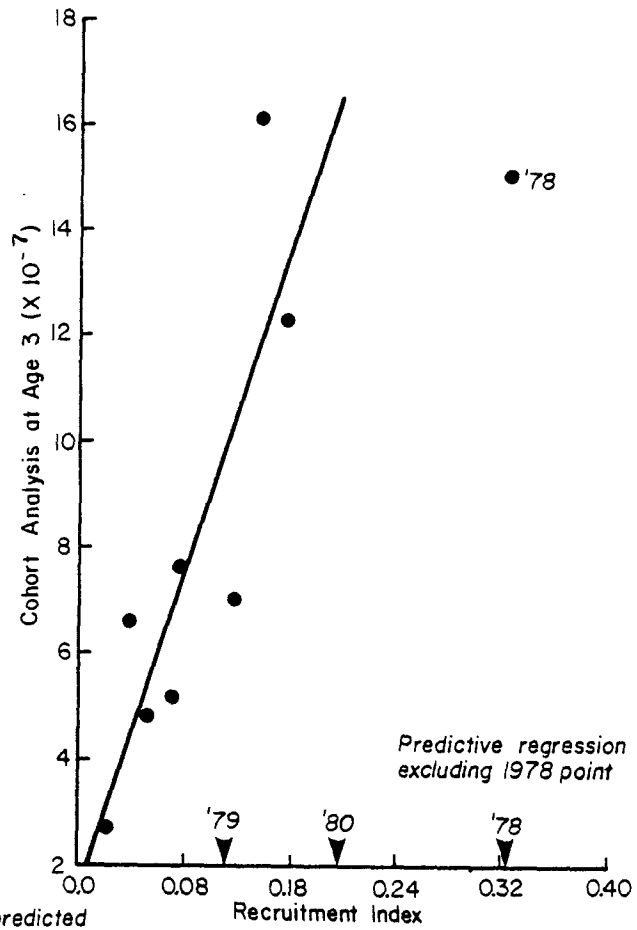
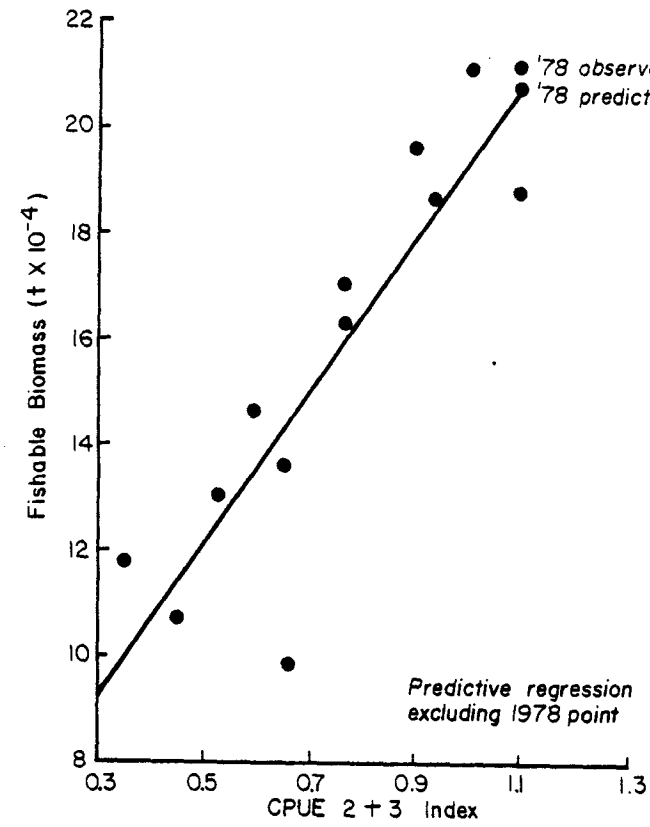


Figure 6. Results of Cohort Analysis vs. Other Data