

Assessment of 4VWX-5-6 Pollock

by

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INTRODUCTION

The pollock (Pollachius virens) fishery on the Scotian Shelf and Gulf of Maine has been recently increasing in commercial importance. Since the early 1970's there seem to have been an increase in fishing effort directed on pollock, accompanied by a raise in landings. This is attributed to the application of restrictive legislation on the cod and haddock fishery, as well as a decline in abundance of some groundfish stocks, which happened during the same period of time (application of low TACs on cod and haddock catch, closure of the haddock fishery of Browns Bank in March, April and May, decrease in flatfish abundance on the Scotian Shelf, etc).

There is some evidence to suggest that the pollock of the Scotian Shelf and Gulf of Maine area is constituted by more than one spawning stock (Steele, 1963, Kohler, 1968); however, the information presently available is not adequate to provide a basis for stock delineation. Consequently, the pollock of ICNAF Div. 4VWX, subarea 5 and 6 has been until now considered and managed as a single stock.

The pollock fishery was completely unmanaged before 1973, when a total allowable catch of 50,000 tons was applied to the area covering the Scotian Shelf to Georges Bank (ICNAF Div. 4X-5). The TAC was then revised to 55,000 tons in 1974 for ICNAF Div. 4VWX-5 and finally lowered to 30,000 tons in 1977. Since the USA withdrawal from ICNAF in 1977, no management plan has been developed for the American fishery, (Clark, Burns & Hayden, 1978), allowing for an increase in commercial landings.

COMMERCIAL LANDINGS

Between 1960 and 1968, total landings of pollock in ICNAF Div. 4VWX-5-6 decreased from 40,386 tons to 22,849 tons, resulting from a decline in both Canadian and American landings (Tables 1 and 2,

Figure 1). The catch then slowly increased to reach a maximum reported catch of 45,297 tons in 1978.

Canada is the main harvester in this fishery, followed by the USA (Figure 2). However, the two fisheries differ in seasonal and geographical pattern. Canadian catches reach their peak in the summer months, although high landings have been recorded in December (Table 3). Traditionally the American fishery was concentrated in the fall, during the spawning season, but since 1977 high catches have been recorded throughout the year. Up to 90% of the Canadian catch is reported in ICNAF area 4X, while 60% of the American catch is recorded in ICNAF area 5Y (Figure 3).

The main gears involved in the Canadian fishery are trawlers and gillnets (Table 4). Among them stern trawlers of 500-999.9 GT report the largest catch (Table 5). The American fishery is also dominated by trawlers, although gillnetting has increased from 7% of total landings in 1970 to 37% in 1977 (Clark, Burns and Hayden, 1978).

Catches from other countries were highest during the 1965-1975 period, but are no longer of importance, and represent less than 3% of the total landings.

#### AGE COMPOSITION OF THE COMMERCIAL CATCH

Samples of the landed catch from the Canadian trawler fleet are available as far back as 1948 (Tables 6a, 6b, 6c and 6d). However, sampling previous to 1973 did not provide either a good seasonal coverage or sufficient age-length keys to allow reliable estimation of the age composition of the catch. Weight at ages derived from trawler samples from 1972 to 1978 are presented in Table 7.

In the USA, samples from the commercial catch have been taken since 1973 but are solely constituted of length frequencies until 1977 (Clark, pers. comm.).

Samples taken aboard other countries commercial vessels are scarce and do not, until now, provide satisfactory information on the foreign catch composition.

The catch composition was thus determined by applying the Canadian samples to Canadian and foreign countries (other than USA) landings, from 1973 to 1978. Trawler, gillnet and trap samples were applied to their respective catches. American landings were broken down into numbers at age using the American samples whenever possible, and the Canadian samples when American data were not available.

Removals at age and catch composition for all countries, for Canada and the USA are given in Tables 8a and 8b. Two strong year-classes, the 1969 year-class present mainly in the Canadian catch, and the 1971 year-class, more obvious in the American catch, supported

most of the fishery from 1973 to 1975. Since then, there was no evidence for the presence of an outstanding year-class in the fished population, and fish between the age of 3 and 6 years old constitute most of the catch.

## POPULATION ABUNDANCE INDICES

### Research Survey Catch Rates

Groundfish surveys have been run yearly by Canada (summer survey, since 1970), and by the USA (spring survey, since 1968, fall survey, since 1963). These surveys provide three indices of population abundance for the area covering the Scotian Shelf, Georges Bank and Gulf of Maine area.

In the Canadian survey, which covers the Scotian Shelf (ICNAF Div. 4VWX), the total number of fish per tow remains fairly constant from 1972 to 1979, except for the 1977 cruise (Tables 9 & 10, Figure 4). The sudden increase in catch rate for that year could be due to a greater availability of the fish rather than to an abundance change. Consequently, it was decided to use as an estimate of 1977 catch rate an average of the 1976 and 1978 values (2.76, 2.66). To do so, the 1977 catch composition was first calculated, and then multiplied by the average total number per tow for 1976 and 1978 (2.71). The resulting catch rates are shown in Table 9.

The American survey, conducted in the Georges Bank and Gulf of Maine area (ICNAF area 4X, 5Y and 5Ze) (Tables 10, 11, and 12, Figure 4) agrees with the Canadian survey data in showing a general decline of catch rates between 1973 and 1975. After that year the variation in the data among the three surveys is too great to allow identification of a clear trend in population abundance.

By adding the survey catch rates of a cohort at age 2-3, the relative strength of a year-class should become apparent. In the Canadian survey (Figure 5), there are three outstanding year-classes: the 1968, the 1971 and the 1969 year-class (in order of importance). In the American surveys, only the 1971 year-class shows up clearly. Although the surveys results do not compare rigorously, they all indicate a higher recruitment in the early 1970's than in the most recent years, which is confirmed by the commercial catch composition. However, the presence in 1979 of 0-age group fish in the Canadian survey could be an indication that a strong year-class will be coming through.

### Commercial Catch Rates

Commercial catch rates as population abundance indices have been calculated from 1972 to 1978 (Table 10 and Figure 4). The Chikuni method (Chikuni, 1976) of estimating a yearly catch rate has been applied to the Canadian catch and effort data of trawlers: trawler of 500-999.9 GT

were chosen because they land the highest proportion of the trawlers catch. The index was determined for the months of June, July and August, considering that on the average both catch and effort are maximum during these months (Figure 6). Also, restricting the time of the year allows one to compensate for the variability of catch rates due to availability of the fish, rather than real population changes. Other commercial indices include trips with 50% or more of total catch being pollock, and all trips directed on groundfish species.

All the commercial catch rates, except one, show a general decline of fish abundance from 1973 to 1976, followed by a drastic increase to a peak in 1977, with a return to slightly lower value in 1978 (Figure 4). A similar decrease in catch rates between 1973 and 1975 was also observed in the research surveys. As stated earlier, the high catch rates obtained in 1977 could be due to a higher availability of pollock rather than to an increase in abundance.

#### Mortality Rates

An estimate of the instantaneous natural mortality rate ( $M$ ) for pollock of the Scotian Shelf, Georges Bank area is not available. Consequently, a rate of 0.2 was assumed throughout the present analysis.

Total mortality coefficients ( $Z$ ) were calculated using the research catch rates and the commercial removals at age with effort values derived from the Canadian commercial catch rates. The  $Z$  values calculated with the summer and spring survey data (Table 9 and 12) fluctuate too much to indicate any clear trend in mortality. The mortality rates estimated with the fall survey data (Table 11) increase from 1975 to 1978 (from -1.71 to 1.32), which disagree with the descending trend in mortality shown by most of the commercial data (Table 13 and 14). Average values for mortality rate between 1976 - 1978 would be  $Z=0.65$ , from research surveys data, and  $Z=0.41$ , from commercial data. Assuming a natural mortality rate of 0.2, this would imply that the fishing mortality level was between  $F=.21$  and  $F=.45$  for the past three years.

#### COHORT ANALYSIS

Runs of cohort analysis were executed using the catch at age from 1973 to 1978, and a natural mortality coefficient of 0.2. For each run the fully recruited  $F$  values (age 5+) weighted on population numbers, were regressed on effort values. This effort was generated by dividing the landings with the Canadian research catch rates (age 5+ in weight). The best relationship was obtained ( $R^2=.92$ ) for a starting terminal  $F=.265$  (Table 15 and Figure 7).

Population numbers at age 5+ estimated by cohort analysis were then regressed on the Canadian research survey catch rates (at age 5+)

in no/tow giving an  $R^2=0.83$  (Figure 8).

The partial recruitment for ages 3 and 4 was obtained by adjusting the cohort table until the highest correlation ( $R^2=0.84$ ) was found between population estimates at age 2-3 and Canadian research cruise catch rates (in no/tow) for the same ages (Figure 9). The high intercept of the slope could be explained by the unavailability of young pollock to the research gear: fish of one and two years old were found to stay in inshore waters (Mavor, 1918, Mironova, 1961, Mironova, 1964 and Steele, 1963), and we suspect that part of the three years old remains in inshore areas (three years old fish are present in commercial samples of the inshore fixed gear catch). However one cannot exclude the possibility that the distribution behavior of the young fish could be related to their abundance; in years of strong recruitment the distribution would stretch offshore, making the fish more available to the research gear. The partial recruitment resulting from the analysis is shown in Figure 10.

#### YIELD PER RECRUIT

The Thompson-Bell yield per recruit relationship gave an  $F_{0.1}=0.221$ , using the mean weight at age of 1977-1978, the partial recruitment observed in 1978, and a natural mortality rate of 0.20 (Table 17).

#### PROJECTION OF FUTURE CATCH

Projections of future catches of pollock were done for a constant fishing mortality rate of  $F=0.221$  or a TAC of 40,000 tons. The partial recruitment of 1978 and the mean weight at age for 1977-1978 (using gillnets, traps, and trawler weight) were assumed with an age 2 recruitment value of  $44,355 \times 10^3$  fish. This value was calculated by taking the geometric mean of the population estimates at age 2 for 1974 to 1976.

The results of the projection are shown in Table 18.

These projections imply that fishing at  $F_{0.1}=0.221$  in 1980 will yield a catch approximately 40,000 tons. Because of misreporting problems, the results of this analysis should be interpreted with caution. However, reported landings for the last 20 years have averaged around 35,000 tons and have been close to 40,000 tons for the last six years. Available data and analysis suggest that present stock size is within the range that yielded those historical catches.

## References

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Table 1. Pollock landings (t round fresh) by country for Division 4VWX, Subarea 5 and Statistical area 6, 1960-79.

Year	Canada	Fed. Rep. Germany	Germ. Dem. Rep.	Japan	Spain	USSR	United Kingdom	USA	Other	TOTAL <sup>b</sup>
1960 <sup>a</sup>	29,470	-	-	-	783	-	-	10,132	1	40,386
1961	26,323	-	-	-	982	-	-	10,265	1	37,571
1962	31,721	-	-	-	-	-	-	7,391	-	39,112
1963	28,999	126	-	-	-	906	28	6,653	-	36,712
1964	30,007	208	-	-	-	4,603	374	6,006	55	41,253
1965	27,316	71	-	-	1361	2,667	11	5,303	-	36,729
1966	18,271	-	-	-	2384	9,865	12	3,791	-	34,323
1967	17,567	-	9	-	1779	644	1	3,312	-	23,317
1968	18,062	-	-	-	1128	372	-	3,280	7	22,849
1969	15,968	1188	2195	-	1515	227	-	3,943	7	25,043
1970	10,753	3233	4710	40	532	527	-	3,976	-	23,771
1971	11,757	633	6849	15	912	2216	-	4,890	3	27,275
1972	18,022	475	4816	8	616	3495	4	5,729	54	33,219
1973	26,990	1124	948	1570	3113	3092	-	6,303	36	43,176
1974	24,975	149	2	40	1500	2348	48	8,726	14	37,302
1975	26,548	236	96	-	709	2004	-	9,318	124	39,035
1976	23,568	994	24	-	303	1466	-	10,863	390	37,608
1977	24,654	368	-	1	2	268	-	13,056	53	38,402
1978 <sup>c</sup>	26,900	-	-	18	-	494	-	17,711	174	45,297
1979 <sup>c</sup>	27,000	-	-	2	-	1000	-	11,000	49	39,050

<sup>a</sup> catches for 1960-65 from ICNAF Statistical Bulletins, vol. 10-26.

<sup>b</sup> Includes unallocated catch

<sup>c</sup> Provisional

Table 2. Pollock landings (T, round fresh) for Divs. 4VWX, Subarea 5, and Statistical Area 6, 1960-79.

YEAR	4Vn	4Vs	4W	4X	TOTAL 4VWX	5Y	5Ze	5Zw	TOTAL 5Z	5NK	TOTAL SA 5	SA 6	TOTAL
1960	691	811	8354	20132	29988	6545	-	-	3834	18	10397	-	40385
61	811	1053	13167	14321	29352	5017	-	-	3177	25	8219	-	37571
62	554	738	12045	19624	32961	2560	-	-	3576	15	6151	-	39112
63	400	274	9152	20645	30471	2168	-	-	3947	10	6125	116	36712
64	337	137	12488	19283	32245	1754	-	-	7250	-	9004	4	41253
1965	147	1058	13134	13390	27729	1933	-	-	7065	-	8998	2	36729
66	226	562	11040	12648	24476	953	-	-	8846	-	9799	48	34323
67	147	510	5836	8290	14783	1728	-	-	6790	14	8532	2	23319
68	256	757	5954	10656	17623	1416	3724	82	3806	-	5222	4	22849
69	91	209	3938	10983	15221	4635	5025	162	5187	-	9822	-	25043
1970	130	519	2952	8194	11795	6281	5157	123	5280	-	11561	415	23771
71	214	317	1802	9739	12072	7016	7096	142	7238	58	14312	891	27275
72	102	495	3419	16190	20206	6419	6519	51	6570	-	12989	24	33219
73	170	834	5871	23225	30100	5202	6235	1618	7853	-	13055	21	43176
74	68	239	4740	20362	25409	6106	6233	5	6238	-	12344	49	37802
1975	179	620	5697	18668	25164	6015	7848	3	7851	-	13866	5	39035
76	52	1050	3424	19700	24226	6441	6915	11	6926	12	13379	3	37608
77	166	1181	6082	14700	22129	8278	7846	79	7925	36	16239	34	38402
78 <sup>a</sup>	97	2833	4911	15160	23001	12237	9942	16	9958	91	22286	10	45297
79 <sup>b</sup>	-	-	-	-	20044	424	-	-	2337	-	-	-	22805

<sup>a</sup> provisional

<sup>b</sup> not including USA and NF landings.



Table 3. Pollock landings (t round fish) by months and country for Division 4VWX - Sub. 5.

Year	Jan	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	TOTAL <sup>a</sup>
<u>CANADA</u>													
1972	204	993	296	930	1004	3084	3718	1192	1755	2188	2191	467	18022
1973	498	981	1521	2922	2135	4785	3239	3403	2331	2181	1955	1039	26990
1974	288	187	869	1012	1986	3730	5073	2206	2202	1634	2461	3327	24975
1975	333	230	475	2021	1524	2920	2736	3691	2312	2833	2993	4480	26543
1976	297	263	445	1498	2604	4270	3814	2327	2347	1669	1413	2621	23568
1977	1062	1748	2271	1859	1006	2202	2097	2003	2304	1333	2309	4459	24653
1978 <sup>b</sup>	1591	3471	1951	2138	3538	2887	2864	1271	1173	916	749	4351	26900
1979 <sup>b</sup>	896	1453	1514	1926	2597	4691	4571	3062	1207	296	-	-	22213
<u>USA</u>													
1972	455	318	228	229	200	394	329	294	314	488	1082	1397	5728
1973	419	313	311	406	331	418	335	302	262	573	1111	1519	6300
1974	946	558	508	650	479	388	644	570	480	661	1097	1385	8726
1975	740	721	486	594	477	924	684	743	765	598	1108	1061	9314
1976	706	658	501	665	936	1035	985	800	1125	669	813	1305	10861
1977	1017	661	460	817	1061	1038	1350	1149	933	924	1188	1709	13049
1978 <sup>b</sup>	889	1062	1038	1390	1150	1345	992	1594	930	1250	2663	2621	17711
1979 <sup>b</sup>	1195	435	508	754	1294	1307	1259	1709	1397	-	-	-	9858
<u>OTHERS</u>													
1972	599	481	440	686	538	627	867	270	183	47	385	4278	9445
1973	513	1808	442	966	48	812	117	367	700	407	1996	1689	9865
1974	42	567	165	132	751	235	612	463	412	228	176	268	4051
1975	154	382	311	129	645	339	234	51	195	156	327	245	3168
1976	33	129	273	312	228	265	257	275	659	543	113	89	3176
1977	-	2	84	43	398	96	11	17	5	8	2	-	666
1978 <sup>bc</sup>	-	-	-	10	117	215	200	142	1	1	-	-	686
1979 <sup>bc</sup>	-	-	-	15	179	329	306	217	2	2	-	-	1050
<u>TOTALS</u>													
1972	1258	1792	964	1845	1742	4105	4914	1756	2252	2723	3658	6142	33195
1973	1430	3102	2274	4294	2514	6015	3691	5072	3293	3161	5062	4247	43155
1974	1276	1312	1542	1794	3216	4353	6329	3239	3094	2523	3734	4980	37752
1975	1227	1333	1272	2744	2646	4183	3654	4485	3272	3587	4428	5786	39030
1976	1036	1050	1219	2475	3768	5571	5070	3402	4131	2881	2339	4015	47605
1977	2079	2411	2815	2719	2465	3336	3458	3169	3242	2261	3499	6168	38366
1978 <sup>b</sup>	2389	4337	3013	3461	4990	4191	3706	2814	2037	2114	3369	6723	45297
1979 <sup>b</sup>	2091	1888	2022	2695	4070	6327	6136	4988	2606	298	-	-	33121

<sup>a</sup> includes NK months of the year

<sup>b</sup> provisional

<sup>c</sup> landings by months prorated

Table 4. Catch of Pollock in metric tons by fishing gear (and corresponding percentage of total catch) from Canadian fishery, ICNAF area 4VWX-5, 1972-78.

YEAR	TRAWLERS			TOTAL	GILLNET	OTHERS	TOTAL
	SIDE	STERN	MIDWATER				
1972	6845 (43%)	9090 (57%)	-	15935 (88%)	484 (3%)	1603 (9%)	18022 (100%)
1973	11224 (48%)	11980 (52%)	16 (<1%)	23220 (86%)	501 (2%)	3268 (12%)	26989 (100%)
1974	6878 (34%)	13571 (66%)	6 (<1%)	20455 (82%)	2211 (9%)	2309 (9%)	24975 (100%)
1975	4062 (20%)	16155 (80%)	1 (<1%)	20218 (76%)	4146 (16%)	2184 (8%)	26548 (100%)
1976	3047 (19%)	12834 (81%)	17 (<1%)	15898 (68%)	5060 (21%)	2610 (11%)	23568 (100%)
1977	2337 (12%)	17454 (88%)	42 (<1%)	19833 (80%)	2866 (12%)	1954 (8%)	24653 (100%)
1978 <sup>a</sup>	2149 (11%)	17057 (86%)	697 (3)%	19903 (78%)	4190 (17%)	1268 (5%)	25361 (100%)
1979 <sup>ab</sup>	2660 (15%)	15374 (85%)	97 (<1%)	18131 (83%)	1351 (6%)	2273 (11%)	21755 (100%)

<sup>a</sup> provisional

<sup>b</sup> Maritime only

Table 5. Catch of Pollock in metric tons by vessel size for Canadian stern trawlers (and corresponding percentage of total catch), 1972-78, ICNAF area 4VWX-5.

Year	0-24.9		25-49.9		50-149.9		150-499.9		500-999.9		TOTAL	
1972	78	(1%)	432	(5%)	1377	(15%)	1032	(11%)	6171	(68%)	9090	(100%)
1973	4	(<1%)	2031	(17%)	4247	(36%)	889	(7%)	4809	(40%)	11980	(100%)
1974	5	(<1%)	788	(6%)	2167	(16%)	1136	(8%)	9475	(70%)	13571	(100%)
1975			568	(3%)	2482	(15%)	897	(6%)	12208	(76%)	16155	(100%)
1976	22	(<1%)	679	(5%)	2998	(24%)	387	(3%)	8748	(68%)	12834	(100%)
1977	11	(<1%)	778	(5%)	2445	(14%)	355	(2%)	13865	(79%)	17454	(100%)
1978 <sup>a</sup>	-		756	(5%)	2712	(16%)	458	(3%)	13114	(77%)	17057 <sup>b</sup>	(100%)
1979 <sup>c</sup>												

<sup>a</sup> provisional

<sup>b</sup> includes NK tonnage and tonnage over 2000 tons.

<sup>c</sup> data not available

Table 6a. Canadian commercial samples available for pollock in ICNAF area 4V and Subarea 5, since 1948<sup>a</sup>.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
						4V						
<u>1949</u>												
LDV	-	0/100	-	-	-	-	-	-	-	-	-	-
<u>1962</u>												
OTB1	-	-	-	-	40/200	-	-	-	-	-	-	-
FIX	-	-	-	-	-	-	50/179	-	-	-	-	-
<u>1976</u>												
OTB2	-	-	-	-	-	-	-	-	29/269	-	-	-
<u>1977</u>												
OTB2	-	-	-	-	-	-	-	30/298	28/200	-	-	-
<u>1978</u>												
OTB2	-	-	41/1226	-	104/931	-	38/314	-	-	35/300	-	-
						5ZE, 5Y						
<u>1967</u>												
OTB1	-	0/116	-	-	-	-	-	-	-	-	-	-
<u>1971</u>												
OTB2	-	-	-	-	-	-	-	-	-	34/259	-	-
<u>1974</u>												
OTB2	-	-	-	-	-	-	-	-	-	59/606	-	-
<u>1975</u>												
OTB2	-	-	-	-	-	-	-	48/329	-	92/522	52/323	-
OTB1	-	-	-	32/115 <sup>1</sup>	-	-	30/229	-	-	42/182	-	-
<u>1976</u>												
OTB2	-	-	-	-	-	78/544	-	31/325	-	-	-	-
<u>1977</u>												
OTB2	39/205	123/655	-	-	-	-	38/219	-	-	-	-	-
<u>1978</u>												
OTB2	-	154/1375	-	-	26/192	-	-	-	-	-	-	-
OTB1	-	-	-	-	-	-	-	-	-	22/266	-	-

<sup>a</sup>The first number represents the number of fish aged and the second is the number of fish measured.

The gear code is the same as the one used by ICNAF.

Table 6b. Canadian commercial samples available for pollock in ICNAF area 4W, since 1948<sup>a</sup>.

Year	4W											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1948												
OTB1	-	0/100	0/100	0/100	-	-	-	-	-	-	-	-
1949												
OTB1	-	0/200	-	-	-	-	-	-	-	-	-	-
1950												
OTB1	-	0/100	0/100	-	-	-	-	-	-	-	-	-
1961												
OTB1	-	-	-	-	-	-	-	-	-	-	0/107	-
1962												
OTB1	-	-	58/116	-	-	-	-	-	-	-	131/22	70/107
1963												
OTB1	-	-	-	-	-	-	-	-	-	-	0/292	0/204
1964												
OTB1	-	-	-	-	0/546	-	-	-	-	-	-	-
1965												
OTB1	-	-	-	-	46/218	-	-	-	-	0/312	-	-
1966												
OTB1	-	-	-	-	-	-	-	-	-	-	0/279	-
1967												
OTB2	-	-	-	-	-	-	0/262	0/218	-	0/179	-	-
1968												
OTB1	-	-	-	-	-	0/265	-	-	-	-	-	-
1969												
OTB2	-	0/202	-	-	-	-	-	-	-	-	-	-
1970												
OTB2	0/241	-	-	-	-	-	-	-	-	-	-	-
OTB1	0/559	-	-	55/166	-	-	-	-	-	-	-	-
1973												
OTB1	-	-	-	-	-	-	-	-	-	71/470	151/843	54/251
1974												
OTB1	-	-	-	-	-	50/217	-	48/309	-	-	-	38/207
1975												
OTB2	-	-	-	44/243	-	-	-	-	-	-	40/249	27/247
OTB1	34/209	-	-	-	43/311	-	-	-	-	-	-	-
1976												
OTB2	-	-	-	58/285	-	-	-	-	-	-	-	47/217
OTB1	-	-	-	-	-	-	51/200	-	40/270	-	-	-
1977												
OTB2	-	-	44/44	-	-	-	-	49/303	38/200	-	43/330	47/215
OTB1	-	47/200	-	-	-	59/300	47/299	103/597	102/559	48/300	47/304	56/297
1978												
OTB2	34/203	38/305	23/279	37/319	-	-	-	-	-	-	-	-
OTB1	45/241	-	85/454	-	-	44/214	-	-	-	-	-	-
FIX	-	-	-	-	-	46/1059	-	-	-	-	-	-

<sup>a</sup>The first number represents the number of fish aged and the second number is the number of fish measured.  
The gear code is the same one used by ICNAF.

Table 6c. Canadian commercial samples available for pollock in ICNAF division 4X since 1948a.

Year	4X											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1962												
OTB1	-	-	-	-	98/182	-	-	-	-	33/114	-	-
1963												
OTB1	-	-	-	-	-	0/485	-	-	0/150	-	0/126	-
1964												
OTB1	-	-	-	-	-	-	-	-	-	0/279	-	-
1965												
OTB1	-	-	-	-	-	-	-	-	0/147	-	-	-
1966												
OTB1	-	-	-	-	-	0/96	-	-	-	-	-	-
1967												
OTB1	-	-	-	-	-	-	0/152	-	-	-	-	-
1968												
OTB1	-	-	-	0/392	-	-	-	0/230	-	0/247	-	-
1969												
OTB1	-	-	-	-	-	-	0/183	-	-	0/270	0/302	-
1970												
OTB2	0/300	-	-	-	-	39/145	-	-	-	30/132	-	-
OTB1	0.306	-	-	-	-	35/141	64/197	-	34/185	-	-	-
1971												
OTB2	-	-	-	-	-	-	-	25/60	-	-	-	-
OTB1	-	-	-	-	179/418	34/139	33/183	26/53	-	-	-	-
1972												
OTB2	-	-	-	-	-	37/239	-	-	-	-	23/237	-
OTB1	-	-	-	33/112	26/119	-	-	-	-	26/197	63/360	-
1973												
OTB2	-	-	-	-	30/153	-	-	-	-	35/192	-	-
OTB1	-	44/152	83/432	-	40/156	80/418	-	0/232	38/212	-	26/124	-
1974												
OTB2	-	-	-	0/69	36/216	-	-	-	91/456	38/292	-	76/532
OTB1	-	-	42/189	111/625	91/370	49/245	59/208	49/230	27/201	25/485	23/262	-
1975												
GN	-	-	-	-	-	-	-	-	32/224	-	-	-
OTB2	-	-	-	41/239	37/260	80/289	-	36/159	-	-	-	-
OTB1	66/518	-	-	61/333	70/339	115/575	52/200	24/204	-	-	-	-
1976												
GN	-	-	-	-	-	-	28/247	35/198	-	-	-	-
OTB2	45/231	-	-	-	28/248	115/919	63/570	-	73/404	-	44/204	-
OTB1	-	47/364	32/211	74/339	-	33/228	28/28	47/200	-	-	62/430	40/177
1977												
GN	-	-	-	-	30/256	-	-	-	-	-	-	-
OTB2	-	79/496	286/1478	75/473	-	-	-	-	49/400	-	43/205	-
OTB1	42/240	109/514	74/554	75/419	-	-	-	79/494	26/170	76/533	-	-
1978												
GN	-	-	-	-	-	35/323	-	28/183	25/195	25/61	-	-
OTB2	-	-	92/457	66/481	32/232	37/303	56/406	-	-	-	-	27/245
OTB1	-	65/358	35/268	-	104/884	-	70/472	-	-	-	-	-

<sup>a</sup>The first number represents the number of fish aged and the second number is the number of fish measured.  
The gear code is the same as the one used by ICNAF.

Table 6d. Canadian commercial samples available for pollock in mixed areas of ICNAF divisions 4VWX-5, since 1948<sup>a</sup>.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
<u>1975</u>						<u>4V-4X</u>						
OTB	-	-	-	-	-	-	-	-	-	38/211	-	-
<u>1976</u>						<u>4V-4W</u>						
OTB2	-	-	-	-	-	-	-	-	-	-	81/549	-
<u>1978</u>												
OTB1	-	-	-	-	-	-	43/261	-	-	-	-	-
<u>1972</u>						<u>4X-5Z</u>						
<u>1973</u>												
OTB	-	-	-	-	-	-	-	-	-	66/493	-	-
<u>1974</u>												
OTB2	-	-	-	-	-	-	-	-	-	-	-	-
OTB1	-	-	-	-	-	-	-	-	53/756	30/378	-	-
<u>1975</u>												
OTB2	-	-	-	-	-	-	-	27/362	-	-	-	36/225
<u>1976</u>												
OTB2	-	-	-	-	-	-	-	38/331	-	-	-	-
<u>1977</u>												
OTB2	-	152/853	47/292	-	-	76/499	-	-	-	-	-	41/268
<u>1978</u>												
OTB2	-	67/637	50/628	-	36/303	21/311	-	-	-	-	-	-
OTB1	-	-	-	-	-	35/302	24/393	-	-	-	-	-
<u>1975</u>						<u>4W-5Z</u>						
<u>1976</u>												
OTB	-	-	-	-	-	-	-	-	-	41/289	-	-
<u>1978</u>												
OTB2	-	82/630	-	-	-	-	-	-	-	-	-	-
<u>1973</u>						<u>4W-4X</u>						
<u>1974</u>												
OTB1	-	-	-	40/258	-	-	-	-	-	-	-	-
<u>1975</u>												
OTB2	-	-	-	-	-	-	-	-	-	-	-	-
OTB1	-	-	-	79/472	-	-	-	-	35/201	-	-	44/325
<u>1976</u>												
OTB2	-	-	-	-	-	37/218	-	-	-	40/207	-	-
OTB1	-	-	-	-	-	41/212	-	-	-	-	-	-
<u>1977</u>												
OTB2	-	-	96/499	46/200	-	-	-	-	-	-	-	48/301
OTB1	-	-	-	42/300	-	-	-	-	-	36/300	41/261	-
<u>1978</u>												
OTB2	-	-	70/623	43/314	-	68/595	-	-	-	-	-	-
<u>1974</u>						<u>4W-4X-5Z</u>						
<u>1975</u>												
OTB1	-	-	-	-	-	-	-	-	-	80/568	-	-
<u>1977</u>												
OTB2	-	-	-	-	-	-	-	-	-	-	-	45/254
<u>1978</u>												
OTB2	85/566	38/300	34/662	-	-	-	-	-	-	-	-	-
<u>1978</u>						<u>4V-4W-4X</u>						
OTB2	-	-	-	-	-	-	27/326	-	-	-	-	-
OTB1	-	-	-	-	-	-	42/275	-	-	-	-	-
<u>1978</u>						<u>4V-4X-5Z</u>						
OTB2	-	-	-	-	48/307	-	-	-	-	-	-	-

<sup>a</sup>The first number represents the number of fish aged and the second number is the number of fish measured.  
The gear code is the same as the one used by ICNAF.

Table 7. Commercial weight at age (kg) for Pollock caught by trawlers in ICNAF area 4VWX-5

AGE	1972	1973	1974	1975	1976	1977	1978
1	-	-	-	-	-	-	-
2	1.10	0.78	0.81	0.89	0.81	0.93	0.86
3	2.18	1.58	1.44	1.47	1.55	1.10	1.07
4	3.39	2.38	2.18	2.10	2.20	1.55	1.57
5	4.36	3.12	3.07	2.97	2.97	2.45	2.24
6	5.17	3.67	4.10	3.95	3.76	3.35	3.32
7	5.94	4.42	5.10	5.00	4.51	4.34	4.13
8	6.37	4.96	6.11	6.24	5.18	5.63	5.44
9	6.76	5.70	6.68	7.07	6.14	6.38	6.52
10	7.39	5.64	7.27	7.29	7.64	7.22	7.08
11	6.67	7.40	8.01	7.83	7.66	8.32	7.97
12	7.65	7.59	8.65	8.88	7.26	9.11	8.76
13	7.65	-	7.34	8.80	8.00	8.63	9.21
14	9.51	-	8.68	10.92	7.82	9.54	8.88
15	-	-	-	9.29	8.78	10.19	10.17
16	12.79	-	-	-	7.82	10.76	10.17



Table 8a. Removals at age and age composition (% of total number) for pollock in ICNAF areas 4VWX-5 and 6, 1973 - 1978, all countries.

Removals at Age							Age Composition						
AGE	1973	1974	1975	1976	1977	1978	AGE	1973	1974	1975	1976	1977	1978
2	1856	617	372	514	174	153	2	11	3	2	4	1	1
3	1595	7281	3346	2952	2708	3189	3	10	43	20	21	18	18
4	5684	2899	8435	3583	4457	5630	4	34	17	51	25	39	31
5	4341	3626	1890	4453	2431	4390	5	26	21	11	32	17	24
6	1049	1327	1655	1233	2822	1762	6	6	8	10	9	19	10
7	795	511	555	960	1063	1872	7	5	3	3	7	7	10
8	363	415	137	258	558	577	8	2	2	1	2	4	3
9	457	112	55	28	159	259	9	3	1	*	*	1	1
10	421	123	70	32	73	118	10	3	1	1	*	1	1
11	79	103	46	34	40	84	11	*	*	*	*	*	*
12	28	40	24	25	58	23	12	*	*	*	*	*	*
13+	3	16	14	46	192	120	13+	*	*	*	*	1	1

\* <1%

Table 8b. Removals at age and age composition (% of total number) for Pollock in ICNAF areas 4WX-5 and 6, 1973-1978, for USA and Canada and other countries.

Age	REMOVALS AT AGE						AGE COMPOSITION						
	U.S.A.						U.S.A.						
	1973	1974	1975	1976	1977	1978	AGE	1973	1974	1975	1976	1977	1978
2	1959	314	141	122	24	49	2	43	5	3	3	1	1
3	578	2864	1056	803	474	892	3	13	48	23	20	11	15
4	1218	1091	2602	1029	1429	1494	4	26	18	56	26	34	25
5	460	1200	320	1212	691	1379	5	10	20	7	30	17	24
6	155	180	258	373	711	569	6	3	3	6	9	17	10
7	106	115	123	323	288	737	7	2	2	3	8	7	13
8	74	96	42	104	210	266	8	2	2	1	3	5	4
9	26	28	21	11	84	163	9	1	1	*	*	2	3
10	15	32	28	7	52	100	10	*	1	1	*	1	2
11	-	14	17	17	16	57	11	-	*	*	*	1	1
12	-	21	7	16	44	18	12	-	*	*	*	1	*
13+	-	-	3	2	141	94	13+	-	*	*	*	3	2
	CANADA AND OTHER COUNTRIES						CANADA AND OTHER COUNTRIES						
2	197	303	231	392	150	104	2	2	3	2	4	1	1
3	1017	4417	2290	2149	2233	2297	3	8	40	19	21	21	19
4	9770	1808	5832	2554	3029	4136	4	36	16	49	25	29	33
5	3881	2425	1570	3240	1750	3016	5	31	22	13	32	17	24
6	894	1147	1397	860	2111	1193	6	7	10	12	9	20	10
7	689	397	432	638	775	1135	7	6	4	4	6	7	9
8	289	318	96	155	348	311	8	2	3	1	2	3	3
9	431	84	34	18	75	96	9	3	1	*	*	1	1
10	406	92	42	25	21	18	10	3	*	*	*	*	*
11	79	89	30	17	24	27	11	1	1	*	*	*	*
12	28	19	17	9	14	5	12	1	*	*	*	*	*
13+	3	16	11	44	51	26	13+	*	*	*	1	1	*

\* < 1%

Table 9. Stratified mean catch per tow at age (number) and total mortality coefficient (Z) calculated for pollock in Canadian summer bottom trawl surveys in Division 4VWX, 1970 - 1979.

AGE	1970	1971	1972	1973	1974	1975	1976	1977 <sup>a</sup>	1977 <sup>b</sup>	1978	1979
0	-	-	-	-	-	-	-	-	-	-	.033
1	.007	-	.019	-	.007	-	-	-	-	-	-
2	1.785	.731	.093	.402	.042	.006	.031	.261	.113	.048	-
3	.430	.609	.199	.374	.942	.018	.199	.781	.337	.151	.104
4	.267	.169	1.249	1.136	.233	.327	.571	.984	.425	.540	.665
5	.194	.039	.383	.418	.286	.276	1.003	2.029	.876	.803	.763
6	.192	.018	.111	.067	.186	.369	.241	1.425	.615	.334	.553
7	.154	.032	.032	.015	.211	.055	.415	.204	.088	.311	.236
8	.099	.011	.055	.038	.093	.099	.153	.360	.155	.398	.136
9	.021	.007	.048	.058	.085	.034	.032	.118	.051	.050	.009
10	-	.022	.036	.002	.052	.004	.034	.062	.027	.002	.035
11	.048	-	.012	.026	.129	.008	.011	.034	.015	-	-
12	.013	-	.006	.011	.046	-	.023	.016	.007	.016	-
13+	-	-	.025	-	-	-	.028	-	-	.007	-
Nk	.027	-	.010	-	-	-	.014	.004	.002	.004	.053
TOTAL	3.238	1.638	2.267	2.547	2.312	1.196	2.755	6.278	2.712	2.664	2.587
Z <sup>c</sup>	2.08	-0.92	1.18	-0.23	0.65	-0.10	-0.13		1.650	.633	
Z <sup>d</sup>								.711	.492		

a actual data

b transformed data: real age composition x average of 1976 - 1978: 2.709

c calculated as  $\ln \left( \frac{\sum \text{age 5 and older}}{\sum \text{age 6 and older}} \right)$

d Z value calculated using the transformed data

Table 10 Pollock research and commercial catch per unit of effort in ICNAF area 4VWX-5

	1972	1973	1974	1975	1976	1977	1978	1979
<u>RESEARCH CRUISES</u>								
Canadian summer bottom trawl (No/tow)	2.27	2.55	2.31	1.20	2.76	6.28	2.66	2.59
American autumn <sup>a</sup> bottom trawl (No/tow)	2.2	1.6	0.9	0.7	3.7	1.9	1.0	
American spring <sup>a</sup> bottom trawl (No/tow)	7.0	5.0	2.4	1.7	1.8	1.6	2.6	1.1
<u>COMMERCIAL</u>								
<u>Canadian stern trawl 150-499.9 GT</u>								
CPUE for 50% or more of the total catch (t/hr.)	0.52	0.70	0.51	0.48	0.47	0.50	0.25	
<u>Canadian stern trawl 500-999.9 GT</u>								
CPUE for 50% or more of total catch (t/hr.)	0.78	0.67	0.67	0.69	0.55	1.05	0.85	
CPUE <sup>b</sup> at 75% of total catch (t/hr.)	0.79	0.94	0.55	0.66	0.37	0.97	0.87	
CPUE for total groundfish effort (t/hr.)	0.16	0.18	0.32	0.35	0.22	0.76		
<u>American Otter trawl</u>								
CPUE for 50% or more of total catch 0 - 50 G.T. (t/hr.)	0.35	0.48	0.37	0.22	0.19	0.29	0.30	
51-500 G.T. (t/hr.)	0.32	0.33	0.32	0.26	0.27	0.34	0.30	

<sup>a</sup> for ICNAF Divisions 5Y, 5Ze and 4X.

<sup>b</sup> calculated with the Chikuni method.

Table 11. Stratified mean catch per tow at age (nos) for pollock in Albatross IV autumn bottom trawl survey cruises in Division 4X and 5Y (Strata 13-42)

AGE	1970	1971	1972	1973	1974	1975	1976 <sup>a</sup>	1977	1978 <sup>a</sup>
0	0.01	0.03	0.00	0.00	0.00	0.02	0.00	0.00	0.00
1	0.15	0.14	0.58	0.04	0.00	0.28	0.04	0.06	0.03
2	0.06	0.24	1.02	0.88	0.10	0.07	0.04	0.05	0.19
3	0.03	0.07	0.56	0.13	0.34	0.05	0.22	0.03	0.04
4	0.10	0.01	0.08	0.22	0.28	0.13	0.82	0.32	0.04
5	0.10	0.08	0.09	0.15	0.16	0.06	2.41	0.53	0.09
6	0.10	0.12	0.11	0.16	0.12	0.06	0.70	0.47	0.09
7	0.05	0.05	0.07	0.11	0.11	0.08	0.45	0.28	0.15
8	0.06	0.10	0.07	0.07	0.02	0.06	0.21	0.14	0.08
9	0.01	0.03	0.06	0.00	0.03	0.02	0.07	0.11	0.06
10	0.03	0.01	0.03	0.18	0.00	0.01	0.01	0.02	0.04
11	0.01	0.01	0.03	0.02	0.04	0.01	0.01	0.00	0.03
12	0.00	0.02	0.03	0.01	0.00	0.00	0.04	0.03	0.02
13	0.04	0.02	0.02	0.05	0.00	0.01	0.09	0.00	0.02
14+	0.05	0.08	0.07	0.07	0.03	0.03	0.30	0.15	0.08
$\Sigma$	0.78	1.01	2.82	2.10	1.23	0.89	5.41	2.19	0.96
$Z^b$	-0.02	0.06	-0.14	0.85	0.60	-1.71	1.27	1.32	

a do not include strata 41 and 42

b  $Z$  calculated as  $\ln \left\{ \frac{\Sigma \text{age 5 and older}}{\Sigma \text{age 6 and older}} \right\}$

Table 12. Stratified mean catch per tow in numbers at age for pollock in USA spring bottom trawl surveys, Georges Bank to Scotian Shelf (strata 13 - 42), 1973 - 1979.

AGE	1973	1974	1975	1976	1977	1978	1979
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.01	0.03	0.02	0.20	0.14	0.00	0.10
2	3.62	0.09	0.33	0.14	0.38	0.21	0.07
3	0.62	0.48	0.20	0.13	0.23	0.40	0.06
4	0.15	0.25	0.34	0.15	0.06	0.56	0.12
5	0.13	0.39	0.08	0.26	0.16	0.65	0.07
6	0.04	0.50	0.09	0.14	0.32	0.20	0.17
7	0.02	0.10	0.10	0.17	0.13	0.14	0.09
8	0.10	0.04	0.08	0.17	0.11	0.10	0.17
9	0.03	0.00	0.05	0.11	0.02	0.07	0.07
10	0.11	0.01	0.06	0.02	0.02	0.08	0.04
11	0.02	0.13	0.02	0.04	0.01	0.06	0.03
12	0.01	0.01	0.08	0.05	0.00	0.01	0.02
13+	0.09	0.32	0.21	0.20	0.04	0.06	0.04
$\Sigma$	4.95	2.35	1.66	1.78	1.62	2.54	1.05
$Z^a$	-.702	.777	-.156	.579	.117	.777	

<sup>a</sup>  $Z$  calculated as in  $\left\{ \frac{\Sigma \text{ age 5 and older}}{\Sigma \text{ age 6 and older}} \right\}$

Table 13 Total mortality coefficients ( $Z$ ) for pollock calculated from the commercial catch at age data and effort estimated with Chikuni abundance index and CPUE for catches with more than 50% of pollock.

Age	1973-74	1974-75	1975-76	1976-77	1977-78
	<u>Chikuni for stern trawler 500 - 999.9 gt</u>				
2 - 3	-0.964	-1.843	-1.524	-2.611	-2.631
3 - 4	-0.195	-0.299	0.478	-1.361	-0.455
4 - 5	0.852	0.276	1.186	-0.561	0.292
5 - 6	1.588	0.632	0.974	-0.493	0.599
6 - 7	1.122	0.720	1.092	-0.801	0.688
7 - 8	1.053	1.164	1.313	-0.407	0.888
8 - 9	1.579	1.869	2.135	-0.465	1.045
9 - 10	1.715	0.318	1.089	-1.908	0.575
10 - 11	1.811	0.831	1.269	-1.172	0.137
11 - 12	1.083	1.305	1.157	-1.483	0.831
$\bar{Z}^a$	1.422	0.977	1.290	-0.961	0.680
<u>Catches with more than 50% of pollock for stern trawlers 500 - 999.9 gt.</u>					
2 - 3	-1.500	-1.688	-1.882	-2.287	-2.532
3 - 4	-0.750	-0.144	0.121	-1.038	-0.355
4 - 5	0.317	0.430	0.828	-0.238	0.392
5 - 6	1.052	0.787	0.617	-0.170	0.698
6 - 7	0.586	0.874	0.734	-0.477	0.787
7 - 8	0.517	1.319	0.956	-0.083	0.987
8 - 9	1.043	2.024	1.777	-0.142	1.144
9 - 10	1.180	0.473	0.731	-1.594	0.675
10 - 11	1.275	0.986	0.912	-0.849	0.236
11 - 12	0.548	1.459	0.799	-1.160	0.930
$\bar{Z}^a$	0.886	1.132	0.932	-0.638	0.780
<u>Catches with more than 50% of pollock for stern trawlers 150 - 499.9 gt.</u>					
2 - 3	-1.183	-1.598	-2.088	-1.703	-2.050
3 - 4	-0.414	-0.054	-0.085	-0.453	0.126
4 - 5	0.633	0.521	0.623	0.347	0.873
5 - 6	1.369	0.877	0.411	0.415	1.180
6 - 7	0.903	0.964	0.528	0.107	1.269
7 - 8	0.834	1.409	0.750	0.502	1.469
8 - 9	1.360	2.114	1.572	0.443	1.626
9 - 10	1.496	0.563	0.525	-0.999	1.156
10 - 11	1.592	1.076	0.706	-0.264	0.718
11 - 12	0.864	1.549	0.594	-0.575	1.412
$\bar{Z}^a$	1.203	1.222	0.727	-0.053	1.261

<sup>a</sup>  $\bar{Z}$  calculated for ages 5 - 6 to 11 - 12.

Table 14 . Total mortality coefficient (Z) for pollock calculated as 3 years running average from commercial CPUE

Age	1973-74-75	1974-75-76	1975-76-77	1976-77-78
<u>Chikuni for stern trawlers 500 - 999.9 gt</u>				
5 - 7	1.377	0.769	0.123	0.069
6 - 8	1.132	0.878	0.464	0.026
7 - 9	1.209	1.324	0.599	0.209
8 - 10	1.219	1.722	0.200	0.041
9 - 11	1.519	0.617	-0.063	-0.489
10 - 12	1.722	0.919	-0.171	-0.092
$\bar{Z}$	1.363	1.038	0.192	-0.039
<u>Catches with more than 50% of pollock for stern trawlers 500 - 999.9 gt.</u>				
5 - 7	1.003	0.770	0.088	0.237
6 - 8	0.792	0.898	0.391	0.166
7 - 9	0.861	1.400	0.514	0.376
8 - 10	0.860	1.755	0.163	0.213
9 - 11	1.131	0.619	-0.081	-0.395
10 - 12	1.312	0.932	-0.183	0.024
$\bar{Z}$	0.993	1.062	0.149	0.103
<u>Catches with more than 50% of pollock for stern trawlers 150 - 499.9 gt.</u>				
5 - 7	1.273	0.761	0.279	0.674
6 - 8	1.025	0.900	0.518	0.541
7 - 9	1.081	1.439	0.641	0.795
8 - 10	1.137	1.763	0.448	0.666
9 - 11	1.405	0.612	0.156	-0.084
10 - 12	1.584	0.930	0.086	0.352
$\bar{Z}$	1.206	1.001	0.138	0.394



Table 15. Population number and fishing mortality of 4VWX Sub-area 5 - 6 Pollock from cohort analysis, assuming a natural mortality  $M = 0.2$

AGE	POPULATION NUMBERS ( $\times 10^{-3}$ )					
	1973	1974	1975	1976	1977	1978
2	65706	34505	49490	45943	45277	49732
3	21291	52116	27692	40182	37150	36912
4	20533	15988	36081	19645	30227	27966
5	9928	11668	10467	21909	12842	20715
6	3388	4200	6272	6859	13908	8314
7	1987	1825	2238	3637	4500	8833
8	1362	908	1032	1330	2109	2723
9	973	787	368	721	856	1222
10	774	383	543	251	565	557
11	242	253	203	381	177	396
12	68	127	114	124	281	109
TOTAL	126253	122760	134498	140983	147893	157479
FISHING MORTALITY						
AGE	1973	1974	1975	1976	1977	1978
2	0.032	0.020	0.008	0.012	0.004	0.003
3	0.086	0.168	0.143	0.085	0.084	0.100
4	0.365	0.224	0.299	0.225	0.178	0.250
5	0.660	0.421	0.223	0.254	0.235	0.265
6	0.419	0.429	0.345	0.221	0.254	0.265
7	0.584	0.370	0.320	0.345	0.303	0.265
8	0.349	0.704	0.159	0.241	0.346	0.265
9	0.732	0.171	0.181	0.044	0.230	0.265
10	0.919	0.438	0.154	0.152	0.154	0.265
11	0.447	0.599	0.289	0.104	0.288	0.265
12	0.598	0.424	0.264	0.250	0.257	0.265

Table 16 . Yield per recruit for 4VWX-5-6 Pollock using the 1978 partial recruitment from cohort analysis and a natural mortality rate  $M = 0.2$

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.030	0.08332	0.306	3.675	1.000
	0.060	0.15230	0.535	3.515	0.874
	0.090	0.20984	0.706	3.364	0.768
	0.120	0.25820	0.832	3.222	0.679
	0.150	0.29918	0.924	3.089	0.604
	0.180	0.33417	0.991	2.966	0.539
	0.210	0.36427	1.039	2.851	0.485
F0.1---	0.221	0.37473	1.054	2.812	0.467
	0.240	0.39038	1.072	2.745	0.437
	0.270	0.41319	1.094	2.647	0.397
	0.300	0.43326	1.107	2.556	0.362
	0.330	0.45105	1.115	2.472	0.331
	0.360	0.46691	1.118	2.395	0.304
FMAX---	0.374	0.47361	1.119	2.362	0.293
	0.390	0.48115	1.118	2.323	0.281
	0.420	0.49401	1.115	2.257	0.260
	0.450	0.50568	1.111	2.197	0.242
	0.480	0.51632	1.105	2.140	0.226
	0.510	0.52608	1.099	2.088	0.211
	0.540	0.53506	1.092	2.040	0.198
	0.570	0.54336	1.084	1.996	0.186
	0.600	0.55106	1.077	1.955	0.176

Table 17. Projection of future catch of pollock in ICNAF Div. 4VWX and Subarea 5 and 6; using 1978 partial recruitment.

Rec at age 2 =  $44,355 \times 10^3$  fish.

$F_{0.1} = 0.2210$

YEAR	POP NUMBERS	POP BIOMASS	CATCH NUMBERS	CATCH BIOMASS	F
1978	157481	273431	18057	43131.15	0.2653
1979	156972	286694	15802	39498.55	0.2210
1980	158481	301784	16515	42682.34	0.2210

TAC = 40,000 t

1978	157481	273431	18057	43131.15	0.2653
1979	156972	286694	16005	40000.12	0.2241
1980	158300	301190	15479	40000.09	0.2063

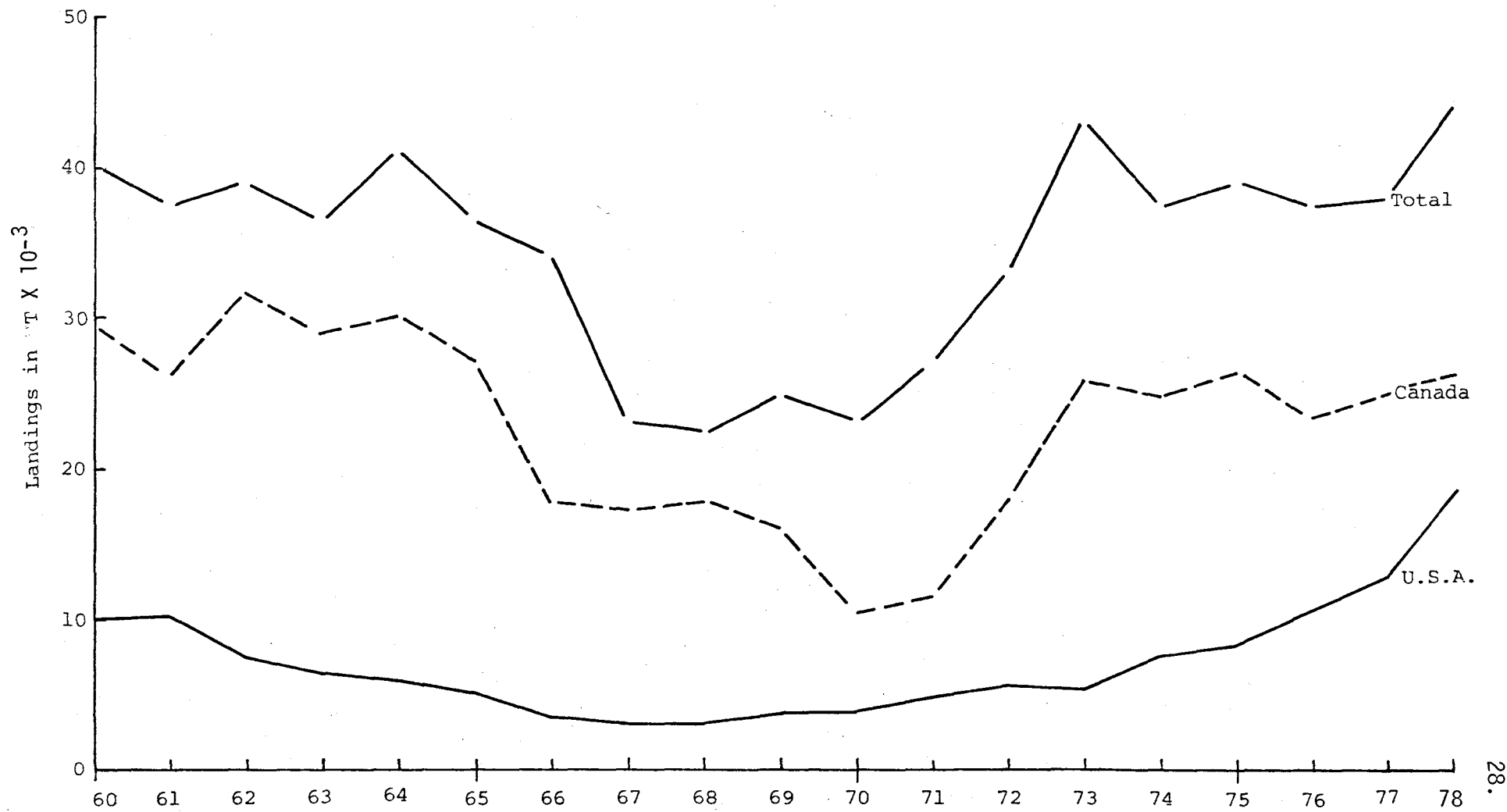


Figure 1 Pollock landings for Division 4VWX subarea 5 and statistical area 6  
1960-78.

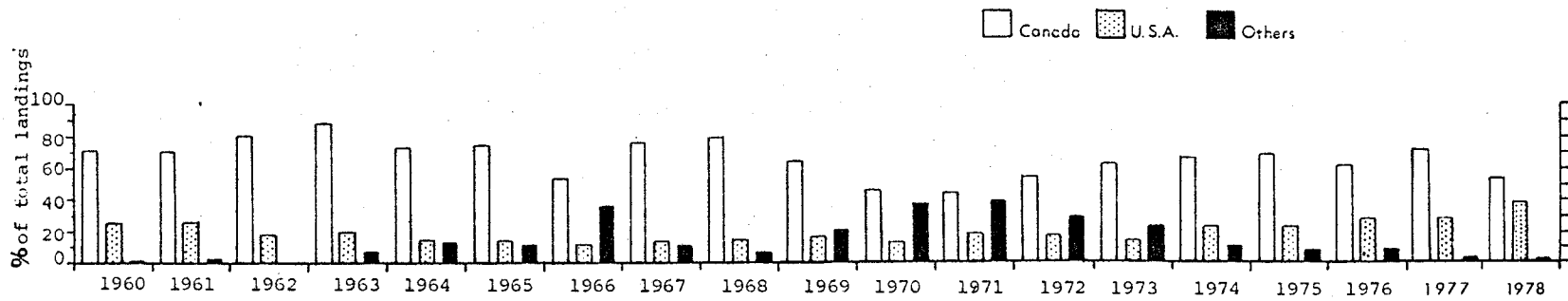


Figure 2. Percentage of total landings of pollock for Canada, U.S.A., and other countries in Div. 4VWX, subarea 5, 1960-78.

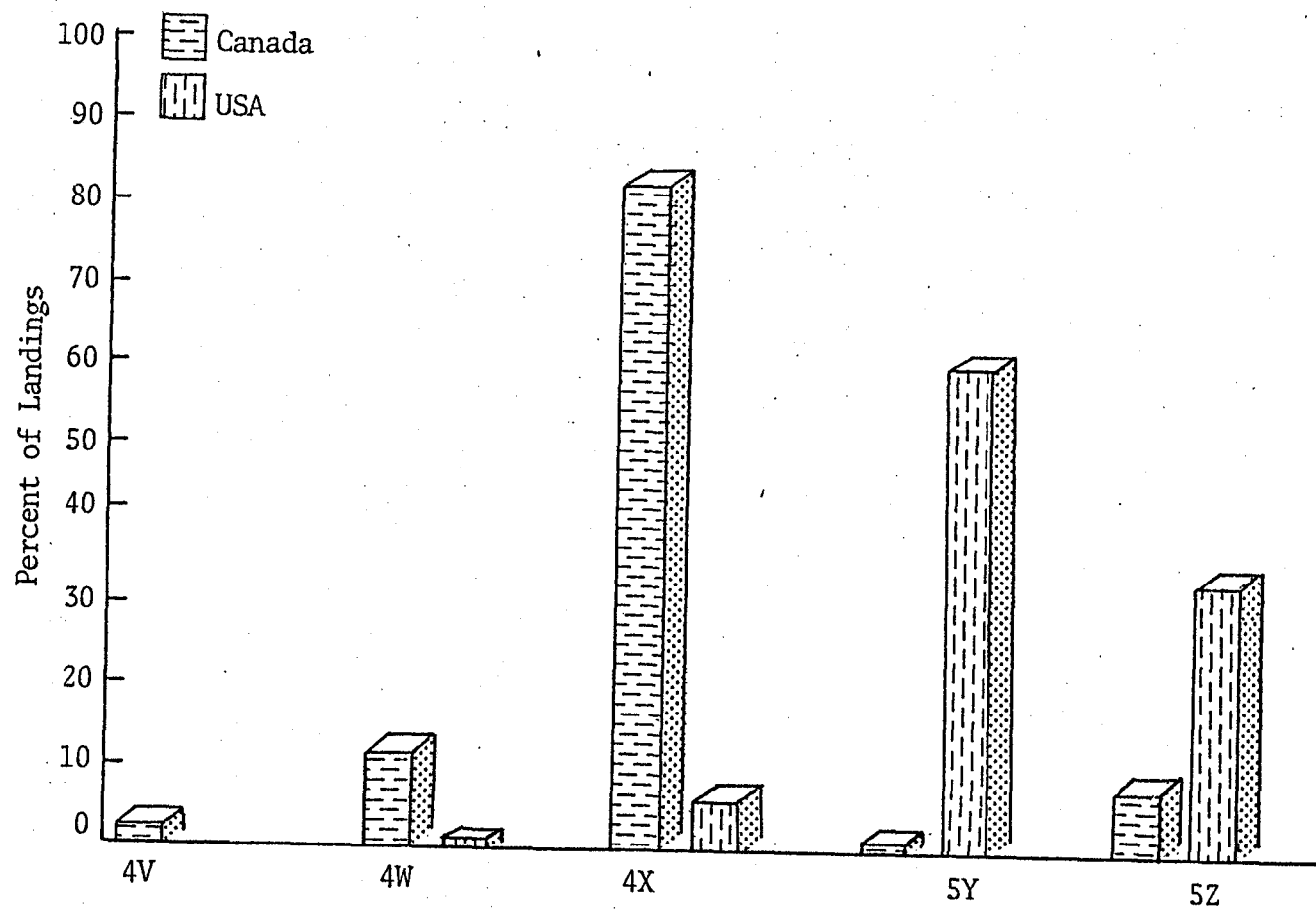


Figure 3. Distribution of pollock catches by Canada and USA in ICNAF areas 4 & 5 from 1972-1977.

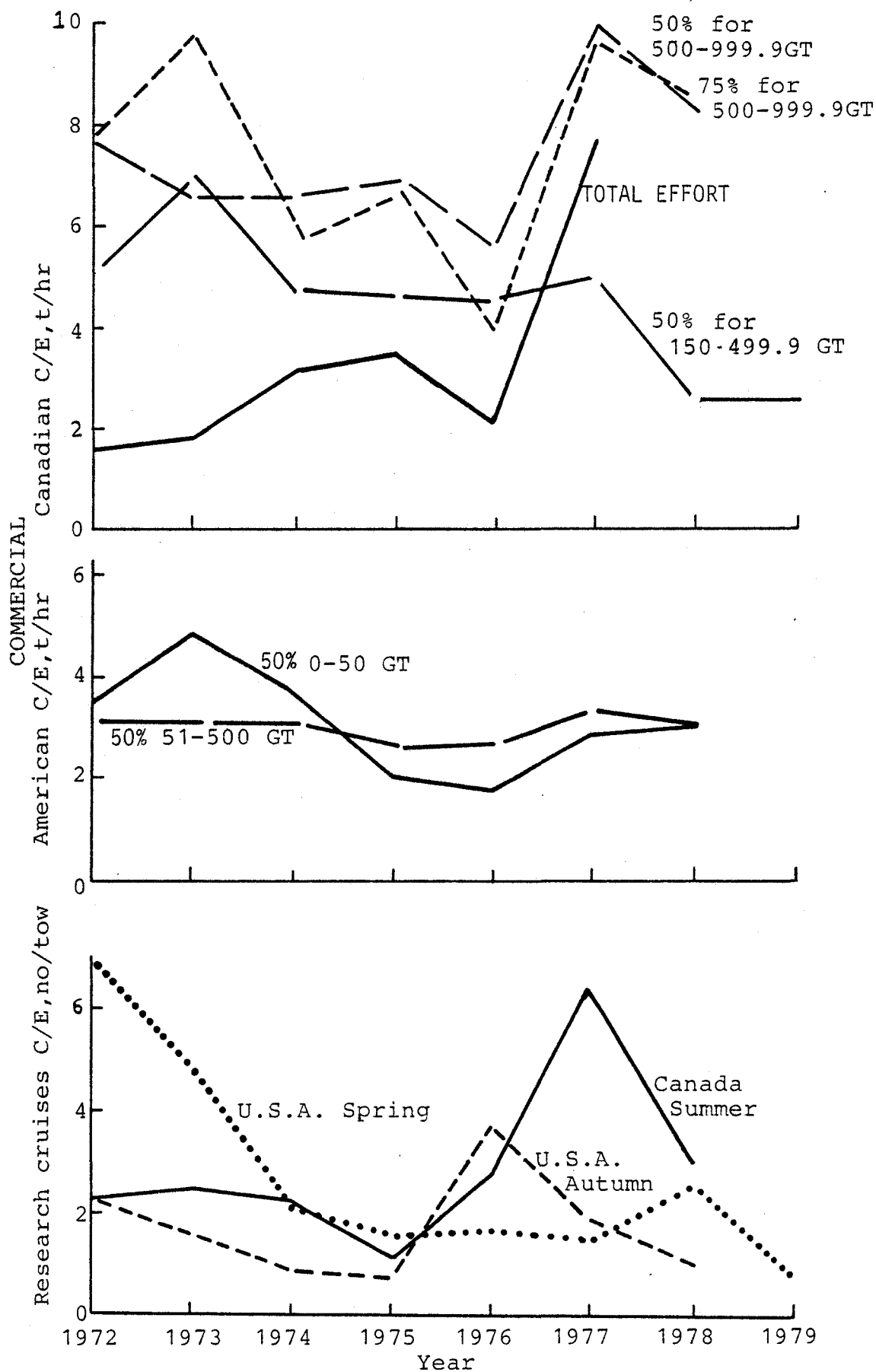


Figure 4. Abundance indices for pollock from Canadian and American research and commercial data, ICNAF area 4VWX-5, 1970-79.

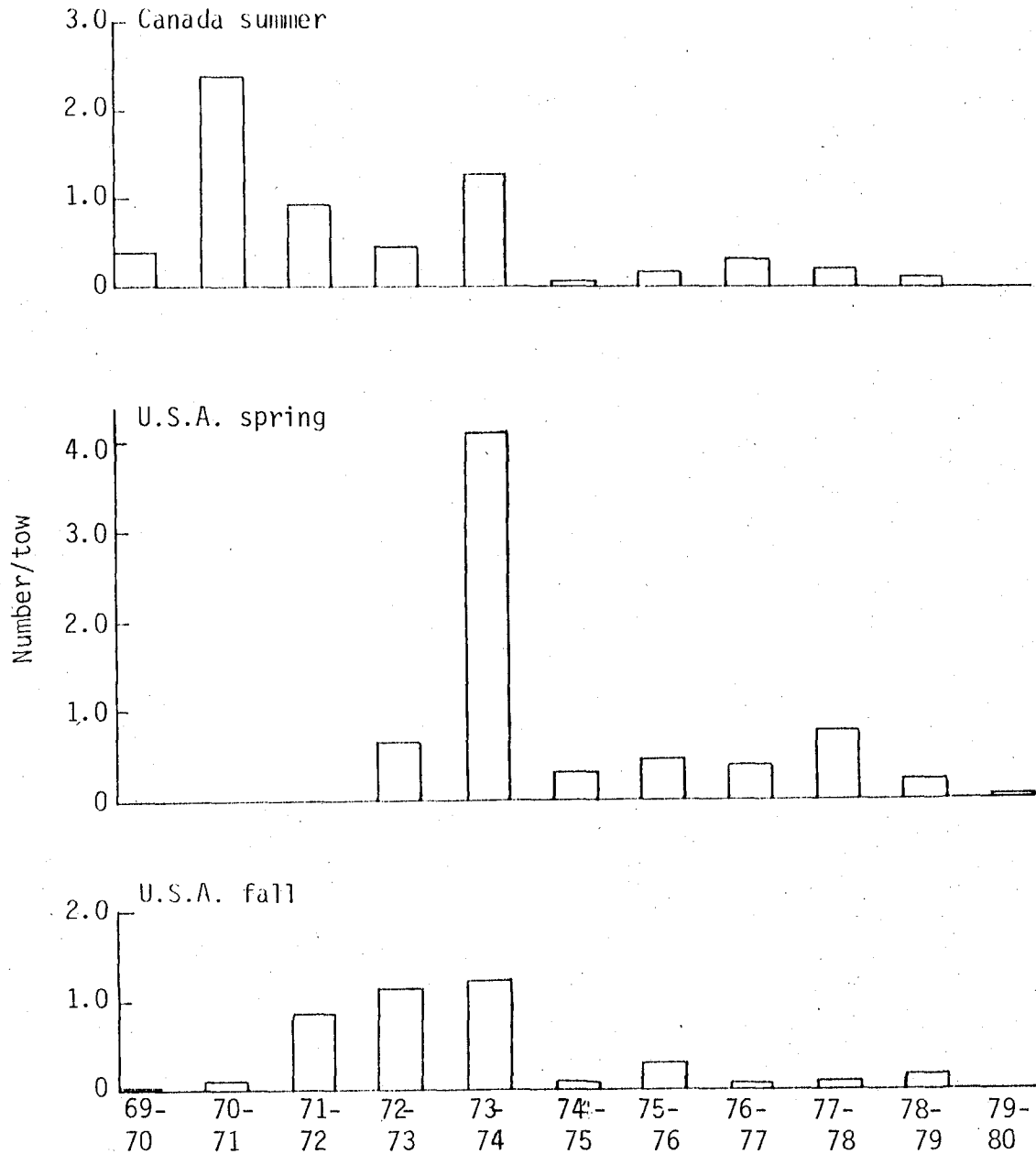


Figure 5. Research catch rates at age 2 + 3 for the Canadian and American surveys from 1970-1980.



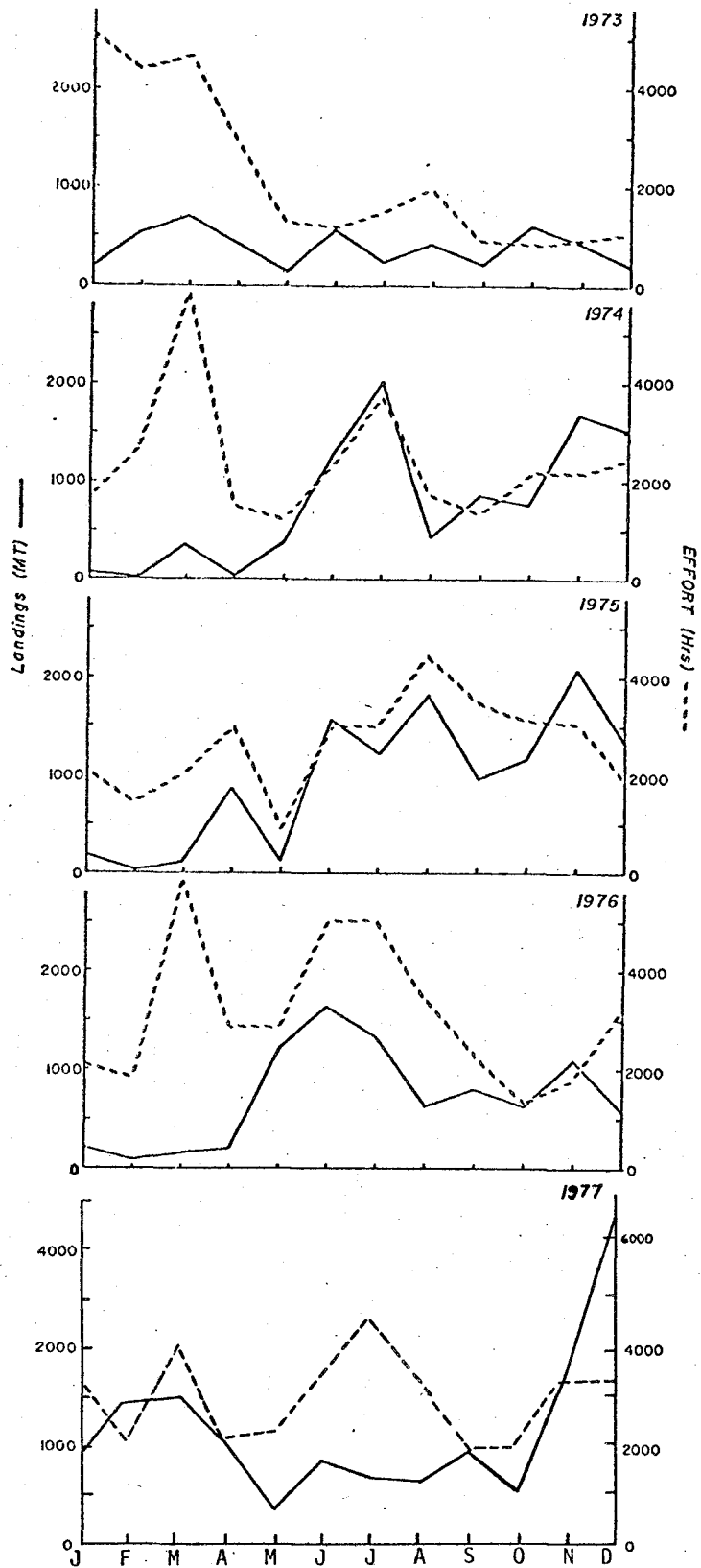


Figure 6. Landings of pollock (mt), and corresponding effort (hrs) for Canadian (MQ) stern trawl of 501-900 gross tons in Div. 4VWX-subarea 5, 1973-77.

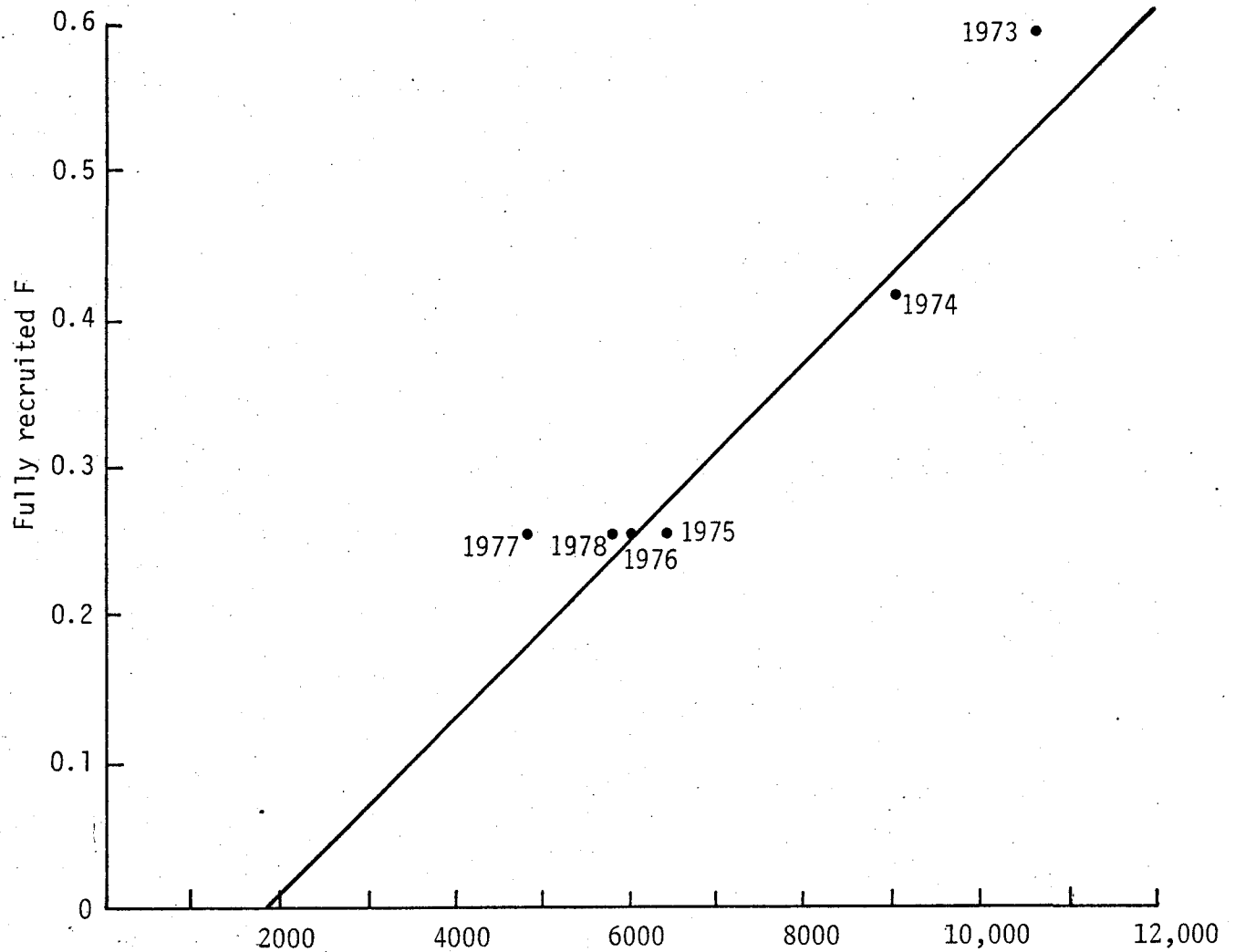


Figure 7. GM regression of weighted fully recruited F from cohort analysis and research effort (landings ÷ CPUE).  $R^2 = .92$  intercept at -0.098.

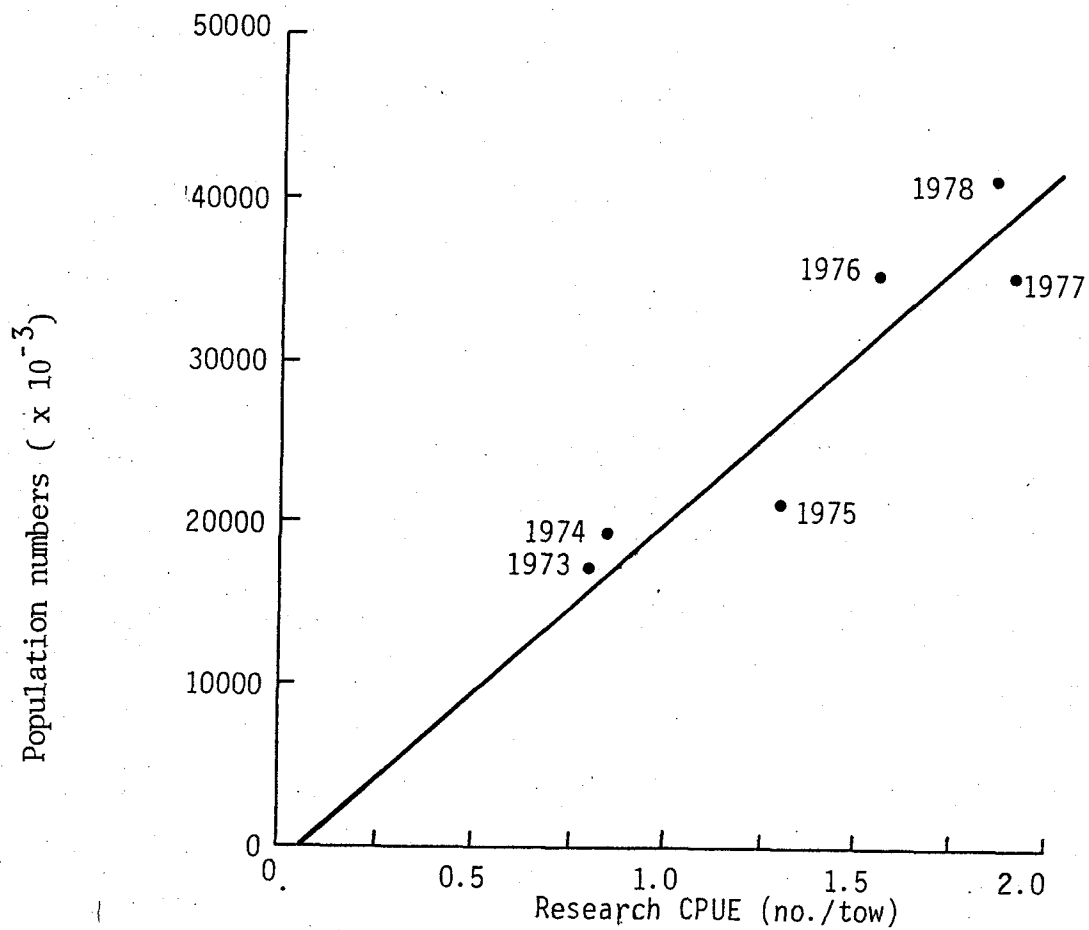


Figure 8. GM regression of population numbers from cohort analysis (age 5+) and CPUE in number/tow (age 5+) from Canadian summer cruise data.  $R^2 = .83$  intercept at -543.74.

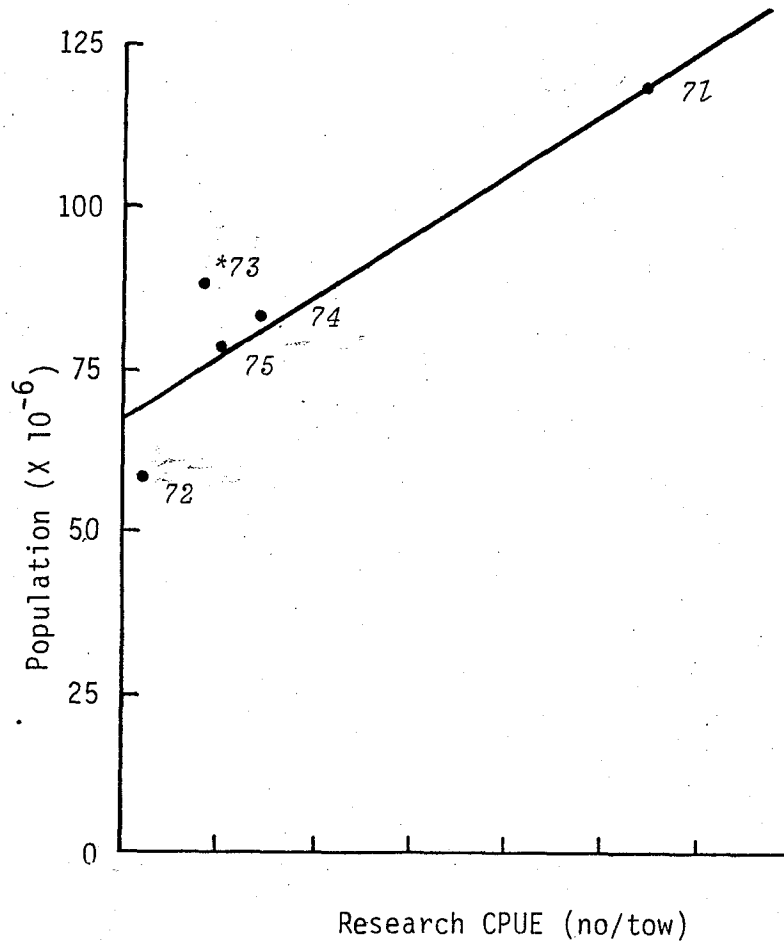


Figure 9. GM regression of population numbers from cohort (age 2+3) and CPUE in numbers/tow (age 2+3) from Canadian summer research cruise data.  $R^2=0.84$ . intercept at 69465. (\* year class).

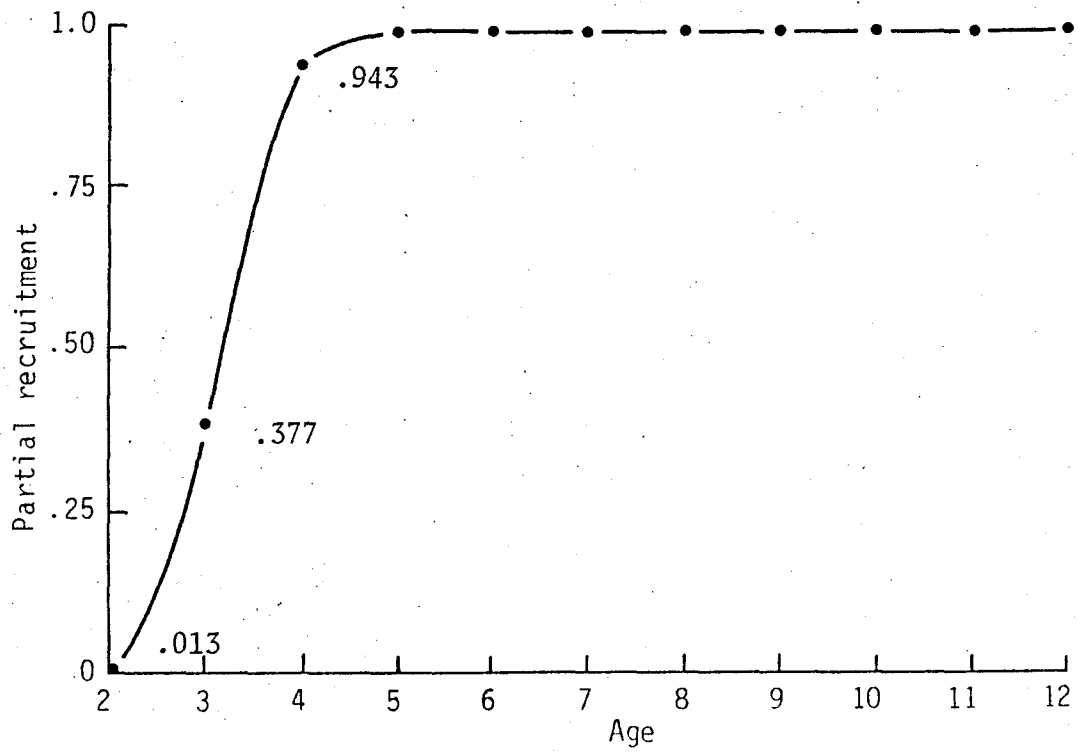


Figure 10. Partial recruitment for Pollock in 1978 from cohort analysis.