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CAFSAC RESEARCH DOCUMENT 80/2

ICNAF Division 4X Haddock
January 1980 Status Report

by

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INTRODUCTION

From the early 1930's to the early 1960's, reported landings of the ICNAF Division 4X haddock stock fluctuated between 10-20,000 metric tons (t) annually (Figure 1). These landings were split equally between Canada and the U.S. During this period, the major part of Canada's catches was landed by longliners while the U.S. landings were almost wholly reported by otter trawlers. In 1963, the USSR first entered the fishery, reporting a catch of 400 t (Table 1). Their involvement in the fishery increased until 1966, when they reported catches of 10,065 t. However, subsequent to this, they did not undertake directed fishing on 4X haddock. During the same period, the Canadian otter trawl fleet expanded rapidly, with a particularly large increase in the number of vessels in the tonnage class 4 category. As well tonnage class 5 vessels entered the Canadian fishery (Table III, Figure 3) for the first time in 1966.

The increased effort in the fishery resulted in peak reported total landings from the stock of 37116 t in 1966. Catches remained close to or above 30,000 t until 1969. The high exploitation rates generated during the late 1960's provoked dramatic declines in stock abundance which in turn resulted in the establishment of a TAC and restricted fishing area regulations in 1970.

In both 1970 and 1971, the TAC was set at 18,000 t. No bottom trawling was allowed on Brown's Bank during March-May. In the following two years, the TAC was reduced to 9,000 t with similar area restrictions. In 1974, 4X was closed to directed fishing on haddock altogether and managed through by-catch regulations. Limitations on total haddock landed per fishing trip were continued in 1975 in an attempt to control exploitation rates. These have continued in varying forms to the present. Since 1976 the offshore fleet allocation has been divided into sub-annual quotas in an effort to regulate fishing pressure throughout the year. By 1975 and 1976, discards were becoming an increasingly important problem. In 1977 and 1978, the TACs were overrun by considerable margins (Table 1) despite all the regulations.

Belzile (1978) estimated that in the springs of 1977 and 1978, the offshore fleet encountered large by-catches of haddock, particularly while fishing for pollock, and discarded approximately 10% of the total catch. No reports on discard patterns in 1979 are as yet available.

Since 1975, misreporting of haddock by species (particularly by the inshore fleet) and by area (particularly by the offshore fleet) has become increasingly evident. No data exists which can provide estimates on the level of these catches.

The trends in the fishery since 1975 suggest that the fisherman have had a difficult time staying within the established TACs, particularly in 1977 and 1978. Consequently the catches shown in Table I, II, and III are most likely conservative, although by how much is impossible to determine.

Commercial catch age composition

Previous analysis (Halliday and McCracken, 1970; McCracken; 1956, 1960) has indicated that catches reported from Unit Area 4Xs are likely from the ICNAF Division 5Y haddock stock. These landings were therefore excluded from the present assessment.

The age composition of landings from the ICNAF Division 4X haddock stock were constructed for the 1962-79 period. It has been observed (Hennemuth et al., 1964) that Unit Area 4Xr haddock landings have a substantially different size and age composition from those reported from 4Xmnopq. Consequently, sampling data from these two areas were applied separately to the respective catches in construction of the removals at age table.

Canadian commercial samples were applied to Canadian landings whenever possible. Generally, otter trawl samples were applied to landings reported by otter trawlers, danish seiners and shrimp trawlers. Longline samples were applied to combined longline and gillnet landings.

USA landings compositions for 1962-64 were taken from Schultz and Halliday (MS 1969) while from 1965 to the present, Canadian samples were applied to USA landings. This should not introduce major errors since landings from both countries have been similar in age composition (Hennemuth et al., 1964) and USA landings have been only a small proportion of total reported catch during the 1965-79 period.

No commercial samples for the 1962-76 period are available for the USSR and Spanish landings. The age composition of these catches was assumed to be the same as that of Canada.

The 1979 removals at age were based on samples taken during January-October as the November-December samples were not available at the time of the assessment.

The generated removals at age are given in Table IV and the percent age composition, by numbers and weight, are given in Table V. These numbers do not include any correction for discarding as the age structure of the discarded and misreported catches is not well known. During the early 1960's, the 1959 and 1960 year-classes supported the fishery. In the subsequent years of high exploitation rates, the 1962 and very large 1963 year-classes supported the fishery. The latter remained an important component of the landings until 1972. During the mid 1970's, when the stock appeared to be recovering, the 1969 and 1971 year-classes contributed significantly to the landings. Since 1977, the 1974 and 1975 year-classes have become increasingly important to the fishery. In 1979, they contributed 27 and 33% by weight respectively to the landings.

The weights at age derived from the commercial samples are given in Table VI. For 1979, weights for ages 10-13+ appear anamolous and may have been due to bad sampling. For these ages, the means of the weights for the equivalent ages in 1977 and 1978 were used in all subsequent analyses.

Stock abundance trends

Four independent sets of data were analysed to discern patterns in abundance from the early 1960's to the present. These consisted of both research (Canada and U.S.) and commercial (Canada and U.S.) data sets.

Canadian summer bottom trawl survey

Since 1970, Canada has been carrying out a standardized groundfish survey on the Scotian Shelf during July-August. The stratified mean catch (in numbers) per standard tow for haddock caught in 4X (strata 70-91 and 95, (Figure 4b)) during this survey are given in Table VII. There is a considerable amount of variation in these data which has yet to be explained. In 1974 and 1977, for instance haddock appeared particularly available to the research gear.

The breakdown and ranking of catch rates by strata is given in Tables VIII + IX respectively. It is evident from this that during July, haddock concentrate primarily on Brown's Bank and secondarily in the Roseway Bank areas. Concentrations are sometimes, as in 1979, observed just in the mouth of the Bay of Fundy.

To facilitate elucidation of trends in abundance, a 3 year running average was applied to the total kg/tow (Table VII) information. The 1970 and 1979 estimates were the straight average figures of the first and last two years of the series. These data are given in Table XIII and illustrated in 5a. The survey indicates that the stock has undergone a continuous increase in abundance since 1971-1972. A sharp decline was observed in 1979 although this could be an artifact caused by the variability in the data.

U.S. fall bottom trawl survey

The NMFS, Wood's Hole has been running a standardized bottom trawl survey on the east coast since 1963. The strata sampled in Division 4X (strata 31-34, 41, 42) are given in Figure 4a. The catch in numbers at age per tow for these strata (Table X) exhibits considerably less variation than those of the Canadian survey. As observed during the Canadian survey, haddock appear to have been exceptionally available in 1977, although it is not quite so obvious in this series. The difference in the two data bases warrants further investigation.

The breakdown of catch rates by strata (Table XII) show that significant amounts of haddock were caught in strata 41 and 42, during the 1965, 1968, 1969, 1973, 1974 and 1975 surveys. This agrees with the Canadian survey data. In 1963, 1964, 1976, 1978 and 1979, these two strata were not sampled. The catch in numbers at age per tow were calculated with these strata removed to generate a consistent series of abundance indices (Table XI). Examination of kg/tow data smoothed over three years (Table XIII and Figure 5a) shows that removal of strata 41 and 42 considerably raises the catch rates in 1965-1969 and 1977-1979. Therefore catch rates with strata 41 and 42 removed were used in all subsequent analyses.

During the 1970-79 period, the U.S. and Canadian smoothed series agree quite well although the former exhibits a much faster rate of stock increase during 1975-1978.

Canadian commercial catch per unit effort

Catches by otter trawlers of tonnage class 4 have consistently contributed significantly to the total reported landings (Tables II and III).

Brown's Bank has been closed to directed fishing on haddock during March-May since 1970. Thus only catch-effort statistics for the July-October period were analysed.

The averaged monthly otter trawler (T.C.4) catch rates where haddock represented more than 50% of the total reported catch are given in Table XIII and illustrated in Figure 5b.

As observed in the research data, the series reflects a rapid increase in stock size since 1973. No data as yet are available for 1979.

U.S. Commercial catch per unit effort

This series, provided by NMFS, Wood's Hole (Table XIII) ends in 1977 due to trip limitations on U.S. vessels. It agreeds very well with the trends observed in the U.S. survey data during 1963-1973 (Figure 5b).

Comparison of abundance indices

Agreement among the various indices for the 1970-1978 period is very good (Table XIV), the lowest correlation coefficient being 0.90. All indices show that the stock was at its highest level of abundance during the early 1960's and subsequently underwent gradual decline to reach a minimum in 1971-1973. Since then the abundance has rapidly increased reaching a present stock level approximately equivalent to that observed during the early 1960's.

In an effort to use all available information, combined abundance estimates for the Canadian and U.S. research data were developed for ages 2+ and 5+ for use in cohort analysis. First, the catch (in numbers) at age per tow for each survey (Tables VII and XI) was smoothed to reduce the variation due to availability. This was done by applying the observed age composition to the 3 year smoothed average total catch per tow. Next, the age 2+ and 5+ numbers per tow were calculated for each data base and normalized to the 1970 estimate (Table XV). The correlation of age 2+ numbers per tow is low while that for ages 5+ is much higher (Figure 6). In both cases, a straight average of the two surveys normalized indices would be the best overall indicator of abundance trends. Consequently for 1963-1969, the normalized U.S. estimates were taken as representative of population trends while subsequent to that, the mean of the Canadian and U.S. normalized indices was used.

A year-class strength index was developed from the research surveys for use in adjustment of cohort analysis. Each series was examined to discern the earliest age that could be used as an indicator of year-class strength. For the Canadian survey, this proved to be age 2 (Figure 7) while for the U.S. survey, it was age 1 (Figure 8). Correlation between the two indices was very high (Figure 9) with only the 1972 year-class being underestimated in the U.S. survey relative to the Canadian survey. The 1971 year-class appeared to be the strongest in recent years, followed by those (in order of size) of 1975, 1977, 1976, 1969, 1974, 1968, 1973 and finally 1970. Both survey indices were then normalized to the size of the 1968 year-class and a combined index taken as the average of the two (Table XVI).

COHORT ANALYSIS

Calculation of the fishing mortality on the oldest age groups

The spring 1978 assessment (O'Boyle, 1978) provided an initial estimate of the partial recruitment pattern in the fishery. It showed that haddock entered the fishery in significant amounts at age 2, were fully recruited by age 6 and then gradually became less available to the fishery as they grew older. This reduction in partial recruitment in ages 7 to 12 can be partly explained by the presence of longliners in the fishery. In contrast to otter trawlers, their fishing power drops off with age of the fish. In this assessment, the partial recruitment for age 12 was estimated to be 0.60. The first cohort analysis was run using the age 12 fishing mortalities from the spring 1978 assessment. The weighted (on population numbers) F for ages 6-8 (i.e. fully recruited ages) was calculated for each year and multiplied by 0.60 to obtain a new estimate of F at age 12 for that year. This new estimate was entered as the Terminal F and another cohort analysis executed. After 5 iterations, the terminal F values stablized. The iterated stable estimates were taken as final.

Calculation of fully recruited fishing mortality (F_r) in 1979

Optimization of the relationship between the cohort analysis age 6+ numbers in year t+1 and the age 5+ combined research survey index in year t (Table XV) was used to calibrate age 6+ population sizes the final years of the cohort analysis.

The relationship between cohort analysis 3+ biomass and Canadian otter trawl catch per unit effort (adjusted to beginning of the year) as well as between cohort analysis weighted fishing mortality (on 3+ numbers) and effective effort derived from the Canadian commercial CPUE index, provided supportive evidence for the reliability of the derived trends.

The results are illustrated in Figure 10. An F_r of 0.33 in 1979 and F's at age 12 of 0.33 and 0.19 in 1977 and 1978 respectively provided the best correlations for the lines. The fact that all three relationships show the latest years of the cohort analysis in line with the long-term trends, is evidence that the fully recruited population sizes for 1976-1979 are being accurately estimated.

Calculation of 1974-1978 year-class strength

Optimization of the relationship between cohort analysis numbers at age 1 and the normalized combined research survey year-class strength index (Table XVI) was used to evaluate age 1 recruitment in the 1974-1978 period. This was done through adjustment to the partial recruitments for ages 1 to 5.

The relationship between cohort analysis age 3+ numbers in year t+1 and normalized research survey age 2+ catches per tow (Table XV) in year t confirmed the cohort analysis estimates.

The results are shown in Figure 11. The estimated size of the 1973 year-class was fairly close to the line, suggesting the partial recruitment of age 6 in 1979 was correct. The 1974 year-class size was being overestimated while that of 1975 was right on the line. In order to bring the size of the 1974 year-class onto the line, the F at age 5 in 1979 would have to be almost doubled, which seems improbable. It may be here that the research data are in error. For this assessment the 1973 and 1974 year-class were taken as fully recruited in 1979.

The sizes of the 1976 and 1977 year-classes at age 1 were predicted from the relationship given in Figure 11a and projected to 1979 to provide terminal F's and subsequently partial recruitments.

The size of the 1978 year-class at age 1 was determined through examination of the Canadian research survey data. This year-class was virtually absent from four cruises (fall 1978, spring, summer and fall 1979). As well, the smoothed catch rate of age 1 in 1979 is only 22% of the mean of those for the 1974-1977 year-classes. This percentage was applied to the 1975-77 age 1 recruitment estimates to arrive at a size of 12.17×10^{-6} for the 1978 year-class at age 1. This is the weakest year-class since 1970 and is more typical of recruitment observed in the mid to late 1960's.

The final cohort analysis results are provided in Table XVII. They show that the recent rapid increase in stock size was due to consistently strong recruitment to the fishery since 1972. Compared to the historical average, the sizes of the 1971-1977 year-classes are quite high.

Catch Projections

The partial recruitment pattern for 1979 (Table XVIII, Figure 12) differs from the spring 1978 assessment estimate in that haddock now appear to be fully recruited to the fishery one year earlier. A yield per recruit calculated with the 1979 partial recruitment, the mean weights at age for 1977 to 1979 and a natural mortality of 0.2 provided an $F_{0.1}$ of 0.33 and an F_{max} of 0.64. This indicates that the stock is presently being fished at $F_{0.1}$.

A catch projection was carried out to the end of 1980 using the input values provided in Table XVIII. The fishing mortality was set at $F_{0.1}$ and the 1980 recruitment at age 1 was taken as the geometric mean of the cohort analysis estimates for the 1972-78 period (48.88×10^{6}).

The projection results are given below:

	1979	1980
Age 1+ Numbers ($x10^{-6}$)	146.6	154.9
Age 1+ Biomass ($x10^{-3}$ t)	155.3	159.4
Catch Numbers ($x10^{-6}$)	15.8	16.3
Catch Biomass ($x10^{-3}$ t)	25.3	27.9

These results imply an $F_{0.1}$ catch of 28000 t in 1980 which is not significantly different from the $F_{0.1}$ catch level determined during the last assessment (26,000 t). These catch levels are comparable to the long-term estimated potential yield from this stock. However, if the 1978 year-class is as weak as the research surveys tend to indicate, then yields in 1982-83 will be expected to fall below the long-term estimates although it is too early to predict the degree of decline.

A complicating factor is the presence of high discard and misreporting rates in this fishery. The exact effects of these on the cohort analysis are hard to determine. However, in general, the addition of more catch to the end years of Table IV will result in higher population sizes being estimated for the same inputted terminal F values. These may or may not cause dramatic changes in the relationships between the cohort analysis estimates and the research survey abundance indices. If they do, higher terminal F's will be required to bring the relationships back in line. Thus the population size remains the same, but is being exploited in excess of $F_{0.1}$. Just how much of a change results from addition of discards to the present analysis depends on its absolute amount and size composition, both of which are unknown.

In conclusion, the catch projection given here is representative of what is known about the fishery but must be interpreted with caution due to the recent high discarding and misreporting practices.

References

Belzile, L. 1978. Report on the discarding of fish in the Canadian offshore fishery in ICNAF Subareas 4 and 5 ICNAF Res. Doc. 78/VI/83.

Halliday, R. & F. McCracken. (1970). Movement of haddock tagged off Digby, Nova Scotia. ICNAF Res. Bull. 7: 8-14.

Hennemuth, R.C., M.D. Grosslein & F.D. McCracken. (1964). Abundance, age composition of landings and total mortality of haddock caught off southern Nova Scotia, 1956-1961. ICNAF Res. Bull. 1: 43-73.

O'Boyle, R.N. 1978. ICNAF Division 4X haddock--spring 1978 status report CAFSAC Research Document 78/19.

McCracken, F. (1956). Cod and haddock tagging off Lockeport, Nova Scotia. Fish. Res. Bd. Canada, Atlantic Prog. Rept. 64: 10-15.

McCracken, F. (1960). Studies on haddock in the Passamaquoddy region. J. Fish. Res. Bd. Can. 17: 175-180.

Schultz, R.L. & R.G. Halliday, MS (1969). Abundance, age composition and survival of haddock from southern Nova Scotia grounds 1962-68. ICNAF Res. Doc. 69/86, Serial No. 2252.

Table I. ICNAF Division 4Xm-r Haddock Nominal Catches (metric tons round) by Country

* - Provisional (May, 1979) ** - Projected (December, 1979)

YEAR	CANADA (Ma)	CANADA (Nfld)	USA	USSR	SPAIN	JAPAN	OTHER	TOTAL	QUOTA
1962	10118		5761					15879	
1963	14385		6397	400			28	21210	
1964	24468	12	7612	1108			40	33240	
1965	20562		2455	2582				25599	
1966	25492	23	1393	10065	143			37116	
1967	29098	46	2937	199	78			32358	
1968	27277		2858	335	116		36	30622	
1969	27419		1707		478		19	29623	
1970	15561		1639	2	370	12		17584	18000
1971	16064		656	97	347	1		17165	18000
1972	12394		411	10	470		1	13286	9000
1973	12580		268	14	134	6		13002	9000
1974	12434		662	35	97			13228	0
1975	16509		2109	39	7		2	18666	15000
1976	16338		972		95		5	17410	15000
1977	19537		1649	2			12	21200	15000
*1978	25270	114	1175	2		8	11	26580	21500
**1979	25000	278	50	8		10		25346	26000

Table II. Catch of 4X Haddock in Metric Tons by Fishing Gear for Canadian (Maritimes & Quebec) Fishery 1962 - 1979

YEAR	OTTER TRAWL SIDE & STERN	LONGLINE	MISCELLANEOUS GEARS	TOTAL
1962	7813	3724	-	11537
1963	12063	4700	-	16763
1964	20532	5799	-	26331
1965	18048	4692	-	22740
1966	25800	3720	-	29520
1967	28696	3108	162	31966
1968	25515	2997	325	28837
1969	24333	3302	439	28074
1970	11750	3907	355	16012
1971	12152	3940	312	16404
1972	7639	4048	883	12570
1973	6123	5853	704	12680
1974	5688	6211	535	12434
1975	10567	4944	548	16059
1976	10505	4642	1191	16338
1977	14464	4032	1097	19593
1978	16924	6084	2356	25364
1979	18785	4696	1519	25000

Table III. Catch of 4X Haddock in Metric Tons by Vessel Size for Canadian (Maritimes & Quebec) Side and Stern Otter Trawlers 1962 - 1979

YEAR	VESSEL SIZE (TONS)					TOTAL
	0-50	51-150	151-500	500+	NK	
1962	5224	1973	432	-	184	7813
1963	5926	3230	2863	-	44	12063
1964	3118	3964	13450	-	-	20532
1965	4605	4182	9261	-	-	18048
1966	8872	9094	7648	186		25800
1967	7479	7983	11085	2149	-	28696
1968	4753	6938	10552	3272	-	25515
1969	2619	4144	9791	7779	-	24333
1970	2050	3165	3703	2832	-	11750
1971	1715	2714	4773	2950	-	12152
1972	1196	1688	2811	1944	-	7639
1973	919	971	2569	1664	-	6123
1974	2165	1895	1072	556	-	5688
1975	2742	3419	2413	1993	-	10567
1976	1778	2598	3029	3100	-	10505
1977	2672	3543	3627	4622	-	14464
1978	4410	4930	3583	4001	-	16924
1979	-------------- not available -------------------					

Table IV. Catch at Age (Numbers x 10^{-3}) of Haddock from 4Xm-r (excludes discards)

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	-	-	-	-	-	-	-	-	-	-	41	150	1	37	18	2	0	0
2	139	713	155	70	219	22	665	10	1055	788	22	3077	694	2175	1296	1285	72	97
3	4524	2013	1272	3038	18341	515	297	2016	724	1617	3434	113	4553	4568	1644	3125	3367	1729
4	1415	7185	4286	1981	9795	20380	1164	1968	1502	788	1841	2247	309	5164	4261	2019	7410	6723
5	1778	3087	9337	3153	3167	9148	17448	1621	379	1422	509	1067	1779	485	3682	3193	2103	3897
6	1708	1649	3018	5409	2149	1039	4684	11243	524	404	645	527	509	1103	434	2881	2624	1308
7	1648	1415	1492	1973	3747	735	713	3220	4536	69	90	600	189	247	307	360	955	1487
8	973	593	1370	1000	840	1052	518	455	1863	3316	57	322	259	172	154	389	125	377
9	645	478	612	745	409	187	672	249	133	1020	1166	259	186	62	71	107	86	73
10	232	152	416	288	424	102	190	194	96	163	512	614	269	32	95	72	25	59
11	205	113	297	203	88	90	131	172	175	181	26	55	552	165	39	23	5	14
12	64	59	168	114	62	23	55	94	27	146	193	13	24	229	103	8	6	0
13+	100	43	36	113	84	81	89	69	37	105	92	6	4	11	157	87	35	13
Total	13431	17500	22459	18087	39326	33374	26636	21311	11051	10019	8628	9050	9438	14450	12761	13552	16813	15777
Estimated Landings	18949	22806	32172	25910	39116	33494	31903	28435	16414	16235	13054	12095	13030	17318	18651	20557	25200	25377
Reported Landings	15879	21210	33240	25599	37116	32358	30622	29623	17584	17165	13286	13003	13228	18666	17410	21200	26580	25346

Table V . Composition of Commercial Catch for 4X Haddock Fishery

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
A. PER CENT BY NUMBER:																		
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	1.66	0.01	0.26	0.14	0.01	0.00	0.00
2	1.03	4.07	0.69	0.39	0.56	0.07	2.50	0.05	9.55	7.78	0.25	34.00	7.35	15.05	10.16	9.48	0.43	0.60
3	33.68	11.50	5.66	16.80	46.64	1.54	1.12	9.46	6.55	16.14	39.80	1.25	49.30	31.61	12.88	23.07	20.03	10.96
4	10.54	41.06	19.08	10.95	24.91	61.07	4.37	9.23	13.59	7.87	21.34	24.83	3.27	35.74	33.39	14.90	44.07	42.61
5	13.24	17.64	41.57	17.43	8.05	27.41	65.51	7.61	3.43	14.20	5.90	11.79	18.85	3.36	28.85	23.56	12.51	24.70
6	12.72	9.42	13.44	29.91	5.46	3.11	17.59	52.76	4.74	4.03	7.48	5.82	5.39	7.63	3.40	21.26	15.61	8.29
7	12.27	8.09	6.64	10.91	9.53	2.20	2.68	15.11	41.05	0.69	1.04	6.63	2.00	1.71	6.32	2.66	5.68	9.43
8	7.24	3.39	6.10	5.53	2.14	3.15	1.94	2.14	16.86	33.10	0.66	3.56	2.85	1.19	1.21	2.87	0.74	2.39
9	4.80	2.73	2.72	4.12	1.04	0.56	2.52	1.17	1.20	10.18	13.51	2.86	1.97	0.43	0.56	0.79	0.51	0.46
10	1.73	0.87	1.85	1.59	1.08	0.31	0.71	0.91	0.87	1.63	5.93	6.78	2.85	0.22	0.74	0.53	0.15	0.37
11	1.53	0.65	1.32	1.12	0.22	0.27	0.49	0.81	1.58	1.81	0.30	0.61	5.85	1.14	0.31	0.17	0.03	0.09
12	0.48	0.34	0.75	0.63	0.16	0.07	0.24	0.44	0.24	1.46	2.24	0.14	0.25	1.58	0.81	0.06	0.04	0.00
13+	0.74	0.25	0.16	0.62	0.21	0.24	0.33	0.32	0.33	1.05	1.07	0.07	0.04	0.08	1.23	0.64	0.21	0.08
B. PER CENT BY WEIGHT																		
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.33	0.00	0.05	0.02	0.00	0.00	0.00
2	0.41	1.56	0.24	0.10	0.17	0.02	0.77	0.02	3.66	2.43	0.08	12.97	2.45	6.53	3.61	2.88	0.13	0.24
3	17.91	6.89	2.97	7.62	31.42	0.95	0.58	5.32	3.97	9.56	23.68	0.70	29.28	21.63	7.14	10.80	11.89	5.59
4	8.59	33.08	13.32	7.65	21.29	51.72	3.28	6.09	9.61	6.07	19.04	23.22	2.61	35.78	27.19	11.98	37.35	32.59
5	13.14	19.63	37.73	14.60	9.96	28.68	60.16	6.56	2.68	12.26	6.24	15.88	23.21	4.34	31.59	26.72	14.27	26.72
6	14.42	12.29	15.95	32.57	8.24	4.50	19.09	53.38	4.57	3.73	8.65	8.71	8.99	14.33	4.89	30.83	22.39	11.70
7	19.13	11.48	9.04	14.85	17.24	3.95	3.80	18.12	45.60	0.74	1.31	10.91	3.63	4.06	12.76	5.15	10.04	15.94
8	10.89	6.11	8.69	8.49	4.68	6.44	3.33	3.20	22.13	39.83	0.92	6.12	5.37	2.98	2.89	6.24	1.62	4.61
9	6.47	4.72	4.76	6.61	2.61	1.32	4.84	2.15	1.86	14.45	20.54	5.35	4.00	1.15	1.37	1.86	1.23	1.10
10	2.94	1.47	3.10	2.92	2.71	0.82	1.50	1.71	1.65	2.66	10.98	13.71	6.09	0.64	1.94	1.32	0.37	0.97
11	3.09	1.34	2.23	1.96	0.62	0.73	1.23	1.63	2.99	3.62	0.60	1.50	13.56	3.33	0.86	0.41	0.08	0.27
12	0.91	0.83	1.57	1.19	0.41	0.20	0.59	1.09	0.47	2.70	5.47	0.37	0.70	4.89	2.21	0.15	0.09	0.00
13+	2.11	0.61	0.40	1.44	0.64	0.68	0.82	0.74	0.81	1.94	2.33	0.21	0.12	0.28	3.54	1.65	0.54	0.28

Table VI. Mean Weights at Age (kg) for 4X Haddock Stock Derived from Commercial Statistics

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	.56	.27	.18	.23	.23	.28	.28	(0.29)
2	.56	.50	.50	.36	.31	.32	.37	.56	.57	.50	.45	.51	.46	.52	.52	.46	.44	0.62
3	.75	.78	.75	.65	.67	.62	.62	.75	.90	.96	.90	.75	.82	.82	.81	.71	.89	0.82
4	1.15	1.05	1.00	1.00	.85	.85	.9	.88	1.05	1.25	1.35	1.25	1.10	1.20	1.19	1.22	1.27	1.23
5	1.40	1.45	1.30	1.20	1.23	1.05	1.10	1.15	1.16	1.40	1.60	1.80	1.70	1.55	1.60	1.72	1.71	1.74
6	1.60	1.70	1.70	1.56	1.50	1.45	1.30	1.35	1.43	1.50	1.75	2.00	2.30	2.25	2.10	2.20	2.15	2.27
7	2.20	1.85	1.95	1.95	1.80	1.80	1.70	1.60	1.65	1.75	1.90	2.20	2.50	2.85	2.95	2.94	2.65	2.72
8	2.12	2.35	2.04	2.20	2.18	2.05	2.05	2.00	1.95	1.95	2.10	2.30	2.60	3.00	3.50	3.30	3.27	3.10
9	1.90	2.25	2.50	2.30	2.50	2.36	2.30	2.45	2.30	2.30	2.30	2.50	2.80	3.20	3.60	3.57	3.61	3.83
10	2.40	2.20	2.40	2.63	2.50	2.70	2.52	2.50	2.82	2.65	2.80	2.70	2.95	3.80	3.80	3.77	3.77	4.16
11	2.86	2.70	2.42	2.50	2.75	2.70	3.00	2.70	2.80	3.25	3.00	3.30	3.20	3.50	4.10	3.69	3.79	4.97
12	2.70	3.20	3.00	2.70	2.60	2.89	2.90	3.30	2.85	3.00	3.70	3.40	3.80	3.70	4.00	3.94	3.76	5.23
13+	3.99	3.25	3.61	3.30	3.00	2.80	2.95	3.06	3.60	3.00	3.20	4.20	3.90	4.40	4.20	3.91	3.91	5.48

Weights in parenthesis are estimates, based on 1972-1978 data.

Table VII. Stratified Mean Catch (in numbers) per standard tow of Haddock Caught during Canadian Summer Bottom Trawl Survey (strata 70-91, 95)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	-	-	-	-	-	-	-	0.007	-	0.352
1	4.872	0.099	4.404	4.976	8.153	5.518	4.617	5.278	5.391	1.636
2	3.921	9.263	0.195	19.053	17.942	3.466	5.272	20.246	4.660	11.528
3	1.148	3.933	2.732	0.479	21.220	4.383	3.394	13.077	9.544	6.605
4	2.167	1.729	1.160	2.466	0.768	6.013	3.405	3.868	2.870	7.919
5	0.881	2.489	0.761	1.131	3.578	0.394	6.175	5.557	1.400	4.009
6	1.982	1.131	0.825	0.423	0.775	1.417	0.467	3.456	2.615	1.605
7	5.073	1.746	0.543	0.569	0.438	0.510	0.553	0.466	0.988	2.524
8	0.704	4.424	0.808	0.429	0.505	0.287	0.101	0.558	0.025	0.949
9	0.293	0.504	1.106	0.287	0.268	0.136	0.026	0.121	0	0.208
10	0.258	0.078	0.037	0.371	0.202	0.043	0.033	0.095	0	0.026
11	0.069	0.035	0.005	0.018	0.287	0.246	0.008	0.008	0.035	0
12	0.017	0.053	0.004	0.008	-	0.153	0.284	0.216	0.130	0.099
NK	-	-	0.066	-	-	-	0.074	0.007	0.088	0.121
TOTAL	21.385	25.484	12.646	30.210	54.136	22.566	24.409	52.960	27.746	37.581
2+	16.513	25.385	8.242	25.234	45.983	17.048	19.792	47.675	22.355	35.593
5+	9.277	10.460	4.155	3.236	6.053	3.186	7.721	10.484	5.281	9.541
Total kg/tow	20.71	26.96	12.98	16.86	36.61	20.00	20.94	83.01	25.05	42.26

Table VIII Strata Breakdown of Mean Catch (Numbers and kg) per Standard Tow of Haddock caught during Canadian Summer Bottom Trawl Survey

STRATA		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
70-81	Num/Tow	27.69	39.71	20.77	45.17	91.92	35.32	31.85	145.24	40.00	38.92
	Kg/Tow	22.66	39.37	19.41	22.22	53.22	30.64	25.88	136.13	32.81	38.62
82-84	Num/Tow	0.82	1.01	0.47	0.14	1.71	1.13	8.57	3.56	2.39	13.23
	Kg/Tow	1.37	1.77	1.42	0.00	2.81	2.45	14.94	8.71	4.57	35.00
85, 90-92	Num/Tow	22.12	15.93	4.29	21.27	51.62	12.31	22.60	38.81	16.08	61.46
	Kg/Tow	35.68	30.07	9.61	22.68	40.32	18.00	19.25	55.63	26.88	70.76
93-95	Num/Tow	6.03	4.89	4.71	4.22	10.28	3.70	3.61	16.41	19.39	4.43
	Kg/Tow	18.81	7.37	11.88	(11.80)[1]	11.72	5.04	4.52	20.02	24.93	8.78

[1] Interpolated between 1972 and 1974.

Table IX. Strata Ranking of Haddock Catches (Numbers per Tow) from Canadian Summer Bottom Trawl Survey
1 - highest catch rate; 2 - second highest catch rate......5 - fifth highest catch rate, etc.

STRATA	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
70								2		
71										
72						4				
73	2		2	4			2	3		5
74	5		4		4	2	4		2	2
75	3	4		5	3		1		4	
76		2			5	3				
77		5	5				5			
78										
79										
80	1	1	1	2	2	1		1	1	3
81	4		3	1	1				3	4
82										
83										
84										
85										
90		3		3		5	3	5	5	1
91								4		
92										
93										
94										
95										

Table X Stratified Mean Catch (in numbers) per Standard Tow of Haddock caught during U. S. Fall Bottom Trawl Survey (Strata 31-42)

AGE	1963*	1964*	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*	1977	1978*	1979*
0	79.39	0.21	0.44	0.70	0.08	2.05	10.22	0.10	12.59	8.19	1.82	4.10	9.58	11.71	12.06	6.08	
1	48.68	14.21	6.07	1.18	3.37	0.91	4.13	4.31	0.02	20.59	8.89	1.79	6.93	13.66	8.98	9.85	
2	15.67	10.96	26.10	1.51	1.25	2.64	0.77	2.14	5.76	0.18	12.31	5.25	3.42	4.43	18.13	11.93	
3	14.03	3.58	9.87	22.31	2.44	1.09	2.16	0.67	1.60	4.31	0.16	5.39	4.51	1.92	9.63	14.45	
4	19.62	4.62	3.55	7.42	22.09	0.37	0.31	1.27	0.57	1.26	3.48	0.14	5.33	2.38	2.44	5.61	
5	7.64	7.37	3.18	2.23	4.04	8.41	0.08	0.20	0.98	0.32	0.83	1.54	0	3.66	3.49	2.43	
6	3.29	2.18	4.13	1.57	0.92	2.97	2.91	0.71	0.19	0.54	0.11	0.47	0.74	0	3.82	3.14	
7	1.52	0.63	1.25	2.28	0.83	0.33	1.22	2.43	0.11	0.14	0.35	0.05	0.29	0.08	0.19	0.43	
8	1.21	0.75	0.30	0.84	0.40	0.42	0.13	0.81	2.51	0.07	0.12	0.23	0.18	0.02	0.12	0	
9	0.33	0.34	0.40	0.55	0.14	0.52	0.33	0.25	0.83	1.17	0.24	0.03	0.07	0	0.14	0.12	
10	0.42	0	0	0	0	0	0.19	0.15	0.19	0.22	0.83	0.04	0.02	0.02	0	0.07	
11	0.05	0	0	0	0	0	0.05	0.14	0.23	0.04	0.08	1.09	0.05	0	0.05	0	
12	0.08	0	0	0	0	0	0	0.04	0	0.08	0	0.18	0.03	0.25	0.02	0	
13	0	0	0	0	0	0	0	0.02	0	0.01	0	0	0.07	0.03	0.02	0	
14	0	0	0	0	0	0	0	0	0	0	0	0.12	0.01	0	0.04	0.05	
TOTAL	191.92	44.89	55.29	40.61	35.63	19.75	22.57	13.26	25.69	37.12	29.24	20.47	31.28	38.69	59.14	54.18	83.16
Ages 2+	63.86	30.43	48.78	38.71	32.11	16.75	8.15	8.83	13.07	8.34	18.51	14.59	14.77	13.29	38.09	38.23	-
Ages 5+	14.54	11.27	9.26	7.47	6.33	12.65	4.91	4.75	5.04	2.59	2.56	3.80	1.46	4.56	7.89	6.24	-
Total Kg/tow	67.91	31.43	30.59	33.49	27.11	19.10	12.79	14.53	17.05	17.10	18.94	17.21	18.29	21.94	48.73	53.59	53.43

* Strata 41 and 42 not sampled.

Table X I. Stratified Mean Catch (in numbers) per Standard Tow of Haddock Caught During U. S. Fall Bottom Trawl Survey (Strata 31-34)

AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
0	79.39	0.21	1.53	1.12	0.13	3.55	10.27	0.13	20.46	7.74	1.12	3.70	7.10	11.71	12.55	6.08	
1	48.68	14.21	2.46	1.83	6.29	1.72	4.66	4.88	0.06	34.03	3.85	2.77	4.42	13.66	16.16	9.85	
2	15.67	10.96	24.99	2.88	2.44	4.60	0.52	2.51	8.61	0.12	16.12	6.72	2.91	4.43	29.46	11.93	
3	14.03	3.58	10.67	39.85	3.89	1.62	2.17	0.41	2.30	5.32	0.16	7.54	1.96	1.92	13.33	14.45	
4	19.62	4.62	3.67	12.82	31.64	0.49	0.32	1.16	0.31	1.54	1.95	-	5.07	2.38	3.99	5.61	
5	7.64	7.37	2.95	4.08	4.57	12.83	0.04	0.25	1.07	0.18	0.35	0.87	-	3.66	4.27	2.43	
6	3.29	2.18	3.99	2.30	0.98	4.13	3.09	0.81	0.16	0.60	0.16	0.36	0.35	-	6.02	3.14	
7	1.52	0.63	1.24	3.80	1.07	0.53	1.42	3.09	0.11	0.17	0.16	0.13	0.23	0.58	0.14	0.43	
8	1.21	0.75	0.19	1.55	0.47	0.73	0.17	1.29	3.70	0.14	0.08	0.14	0.14	0.02	0.09	-	
9	0.33	0.34	0.37	0.90	0.17	0.71	0.62	0.34	1.54	1.83	0.30	0.07	0.12	-	0.10	0.12	
10	0.42	-	-	-	-	-	0.36	0.34	0.28	0.36	1.07	0.07	-	0.02	-	0.07	
11	0.05	-	-	-	-	-	0.10	0.16	0.41	-	0.12	2.02	0.03	-	0.09	-	
12	0.08	-	-	-	-	-	-	0.06	-	0.20	-	0.27	0.05	0.25	-	-	
13	-	-	-	-	-	-	-	0.05	-	-	-	-	0.04	0.03	-	-	
14	-	-	-	-	-	-	-	-	-	-	-	0.12	-	-	0.10	0.05	
TOTAL	191.92	44.89	52.07	71.15	51.63	30.92	23.74	15.48	39.01	52.22	25.48	24.78	22.42	38.69	86.30	54.18	83.16
AGES 2+	63.86	30.43	48.07	68.18	45.23	25.64	8.81	10.47	18.49	10.46	20.47	18.31	10.90	13.29	57.59	38.23	-
AGES 5+	14.54	11.27	8.74	12.63	7.26	18.93	5.80	6.39	7.27	3.48	2.24	4.05	0.96	4.56	10.81	6.24	-
TOTAL kg/tow	67.91	31.43	31.82	58.65	34.91	28.53	14.59	17.66	24.10	24.45	17.27	20.74	13.86	21.94	75.29	53.59	53.43

Table XII Strata Breakdown of Mean Catch (Numbers) per Standard Tow of Haddock Caught During U. S. Fall Bottom Trawl Survey

Strata	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
31	210.8	25.5	23.8	23.5	57.8	23.2	19.0	19.3	27.7	46.6	18.0	27.6	22.3	41.4	90.8	53.3
32	204.2	29.0	30.4	118.4	45.0	83.4	80.0	20.2	63.8	98.2	28.2	36.5	54.8	117.0	232.2	62.8
33	182.0	96.3	156.5	203.3	95.0	47.5	27.7	24.8	84.5	109.3	81.3	33.5	25.5	45.0	91.7	101.5
34	172.2	46.3	39.2	39.8	26.4	11.6	6.0	5.2	19.7	13.8	5.2	13.2	5.3	3.2	24.8	28.8
41	-	-	58.3	6.0	15.0	2.7	19.0	10.1	9.1	17.8	31.5	11.8	35.4	-	28.7	-
42	-	-	64.0	1.0	31.5	34.8	36.0	15.0	18.7	32.2	47.2	40.0	75.3	-	21.5	-

Table XIII Indices of Abundance for 4X Haddock Stock

YEAR	RESEARCH SURVEYS			COMMERCIAL STATISTICS	
	Canadian Summer kg/tow Strata 70-95 (smoothed over 3 years)	U.S. Fall kg/tow Strata 31-42 (smoothed over 3 years)	U.S. Fall kg/tow Strata 31-34 (smoothed over 3 years)	Canadian Otter Trawlers 151-500 G.T. mt/hr (50%)	U.S. Otter Trawlers 151-500 G.T. mt/hr
1963		49.67 (2)	49.67		0.271
1964		43.31 (2)	43.72		0.313
1965		31.84	40.63		0.271
1966		30.40	41.79		0.196
1967		27.57	40.70		0.225
1968		19.67	35.43	0.285	0.188
1969		15.47	20.26	0.204	0.142
1970	23.84	14.79	18.78	0.170	0.133
1971	20.22	16.23	22.07	0.170	0.104
1972	18.93	17.70	21.97	0.168	0.138
1973	22.15	17.75	20.82	0.149	0.104
1974	24.49	18.15	17.29	0.165	-
1975	25.85	19.15	18.85	0.243	0.242
1976	41.32	29.65 (2)	37.03	0.310	0.217
1977	43.00	41.42	50.27	0.286	0.321
1978	50.11	51.92 (2)	60.77	0.386	(3)
1979	33.65	53.51 (2)	53.51	(1)	(3)

1. Not available
2. Strata 41 and 42 not sampled.
3. Not calculated due to 10% trip limitation on U. S. vessels.

Table XIV. Correlation Matrix of Abundance Estimates of 4X Haddock Stock for the 1970-78 Period

	Canadian Summer Research Survey	U.S. FALL RESEARCH SURVEYS		Canadian O.T. CPUE
		Strata 31-34	Strata 31-42	
Canadian Summer Research Survey	1	0.95	0.94	0.95
U.S. Fall Research Surveys Strata 31-34	-	1	0.99	0.92
U.S. Fall Research Surveys Strata 31-42	-	-	1	0.90
Canadian O.T. CPUE	-	-	-	1

Table XV Abundance estimates from Canadian summer and U. S. fall bottom trawl surveys

YEAR	AGE 2+ NUMBERS PER TOW					AGE 5+ NUMBERS PER TOW				
	Smoothed Numbers/Tow		Normalized to 1970		Combined Survey Index	Smoothed Numbers/Tow		Normalized to 1970		Combined Survey Index
	U.S.	Canada	U.S.	Canada		U.S.	Canada	U.S.	Canada	
1963	47.15	-	3.75	-	3.75	12.91	-	1.99	-	1.99
1964	47.45	-	3.77	-	3.77	11.52	-	1.78	-	1.78
1965	48.89	-	3.88	-	3.88	10.88	-	1.68	-	1.68
1966	53.83	-	4.28	-	4.28	9.54	-	1.47	-	1.47
1967	46.35	-	3.68	-	3.68	12.94	-	1.99	-	1.99
1968	26.56	-	2.11	-	2.11	10.66	-	1.64	-	1.64
1969	14.97	-	1.19	-	1.19	10.37	-	1.60	-	1.60
1970	12.59	20.95	1.00	1.00	1.00	6.49	9.87	1.00	1.00	1.00
1971	13.14	16.74	1.04	0.80	0.92	5.71	7.99	0.88	0.81	0.85
1972	16.47	19.64	1.31	0.94	1.13	4.33	5.97	0.67	0.61	0.64
1973	16.41	26.51	1.30	1.27	1.29	3.26	4.50	0.50	0.46	0.48
1974	16.56	29.42	1.32	1.40	1.36	2.42	4.16	0.37	0.42	0.40
1975	14.17	27.63	1.13	1.32	1.23	3.19	5.68	0.49	0.58	0.54
1976	27.26	28.20	2.17	1.35	1.76	5.44	7.16	0.84	0.73	0.79
1977	36.37	30.00	2.89	1.43	2.16	7.20	7.89	1.11	0.80	0.96
1978	47.91	35.24	3.81	1.68	2.75	8.53	8.47	1.31	0.86	1.09

Table XVI. Year-class strength indices from Canadian summer and U. S. fall bottom trawl surveys

Year-Class	U.S. Fall Surveys Smoothed Age 1 Number/Tow	Canadian Summer Surveys Smoothed Age 2 Number/Tow	U.S. Fall Survey Normalized to 1970	Canadian Summer Survey Normalized to 1970	Combined Index
1962	30.03	-	6.54	-	6.54
1963	30.50	-	6.65	-	6.65
1964	2.65	-	0.58	-	0.58
1965	1.50	-	0.33	-	0.33
1966	6.24	-	1.36	-	1.36
1967	1.97	-	0.43	-	0.43
1968	4.59	4.30	1.00	1.00	1.00
1969	8.22	7.22	1.79	1.68	1.74
1970	0.05	0.35	0.01	0.08	0.05
1971	25.34	20.40	5.52	4.75	5.14
1972	5.17	11.81	1.13	2.75	1.94
1973	2.71	5.18	0.59	1.20	0.90
1974	5.64	7.18	1.23	1.67	1.45
1975	17.36	13.41	3.78	3.12	3.45
1976	11.18	6.61	2.44	1.54	1.99
1977	13.56	10.03	2.95	2.33	2.64

Table XVII Population numbers (x 10^{-3}) and instantaneous fishing mortalities of cohort analysis.

POPULATION NUMBERS 9/ 1/80

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	25100	92178	205781	18962	10234	17589	8067	14898	26436	7169	50301	53352	28948	56167	73480	41293	50339	0
2	44907	20550	75469	168479	15525	8379	14401	6605	12197	21644	5870	41146	43545	23700	45952	60144	33806	41214
3	62844	36641	16180	61648	137876	12513	6840	11188	5398	9032	17008	4786	30903	35024	17436	36450	48079	27613
4	19547	47359	28178	12096	47724	96288	9779	5332	7336	3765	5931	10818	3816	21091	24542	12787	27014	36317
5	12162	14723	32273	19192	8111	30210	60393	6953	2585	4647	2369	3190	6824	2845	12596	16238	8643	15413
6	10259	8349	9261	17974	12860	3775	16456	33658	4226	1773	2518	1479	1647	3977	1890	6981	10405	5173
7	5011	6854	5343	4852	9822	8584	2151	9235	17384	2986	1086	1478	734	888	2258	1155	3109	6145
8	3576	2611	4331	3025	2187	4651	6363	1116	4647	10128	2382	808	667	430	503	1119	620	1681
9	2379	2048	1601	2307	1572	1030	2856	4741	502	2119	5292	1899	370	303	197	273	564	394
10	1643	1364	1244	757	1214	917	674	1730	3656	290	812	3278	1320	135	192	97	126	384
11	781	1135	979	642	359	611	658	380	1241	2907	90	202	2128	837	81	71	14	81
12	429	454	827	533	342	215	418	420	156	858	2216	50	115	1243	536	31	37	7
	188638	234266	381468	310468	247827	184761	129057	96256	85764	67318	95876	122486	121018	146639	179663	176638	182756	134422

FISHING MORTALITY 9/ 1/80

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.001	0.000	0.000	0.000	0.000
2	0.003	0.039	0.002	0.000	0.016	0.003	0.052	0.002	0.100	0.041	0.004	0.086	0.018	0.107	0.032	0.024	0.002	0.003
3	0.083	0.063	0.091	0.056	0.159	0.047	0.049	0.222	0.160	0.220	0.252	0.026	0.182	0.156	0.110	0.100	0.081	0.071
4	0.083	0.184	0.184	0.200	0.257	0.266	0.141	0.524	0.257	0.263	0.420	0.261	0.094	0.316	0.213	0.192	0.361	0.227
5	0.176	0.264	0.385	0.200	0.565	0.407	0.385	0.298	0.177	0.413	0.271	0.461	0.340	0.209	0.390	0.245	0.313	0.325
6	0.203	0.246	0.447	0.404	0.204	0.363	0.378	0.461	0.147	0.290	0.333	0.500	0.418	0.366	0.293	0.609	0.327	0.325
7	0.452	0.259	0.369	0.597	0.548	0.099	0.456	0.487	0.340	0.026	0.096	0.595	0.335	0.368	0.502	0.422	0.415	0.309
8	0.358	0.289	0.430	0.455	0.553	0.288	0.094	0.599	0.585	0.449	0.027	0.581	0.590	0.583	0.413	0.485	0.252	0.283
9	0.356	0.298	0.549	0.442	0.339	0.224	0.301	0.060	0.347	0.759	0.279	0.163	0.811	0.256	0.510	0.569	0.185	0.227
10	0.170	0.131	0.461	0.545	0.488	0.131	0.373	0.132	0.029	0.969	1.193	0.232	0.255	0.305	0.792	1.732	0.247	0.185
	0.343	0.117	0.408	0.430	0.316	0.178	0.248	0.693	0.169	0.071	0.383	0.359	0.338	0.246	0.756	0.442	0.502	0.211
	0.179	0.154	0.253	0.268	0.222	0.126	0.187	0.282	0.212	0.207	0.101	0.333	0.260	0.226	0.237	0.330	0.194	0.173
	0.086	0.091	0.077	0.075	0.200	0.231	0.270	0.301	0.166	0.196	0.117	0.093	0.097	0.122	0.088	0.097	0.117	0.146

Table XVIII Parameters used in yield per recruit calculation and catch projections

Age	Partial Recruitment	Weight kg. ($\bar{x}$ of 1977-79)	Population Numbers ($x10^{-3}$) in 1979	Catch Numbers ($x10^{-3}$) in 1979
1	0.0001	0.283	12170	0
2	0.008	0.507	41214	97
3	0.220	0.807	27613	1729
4	0.700	1.240	36317	6723
5	1.000	1.723	15413	3897
6	1.000	2.207	5173	1308
7	0.950	2.770	6145	1487
8	0.870	3.223	1681	377
9	0.700	3.590	394	73
10	0.570	3.770	384	59
11	0.650	3.740	81	14
12	0.540	3.850	7	1

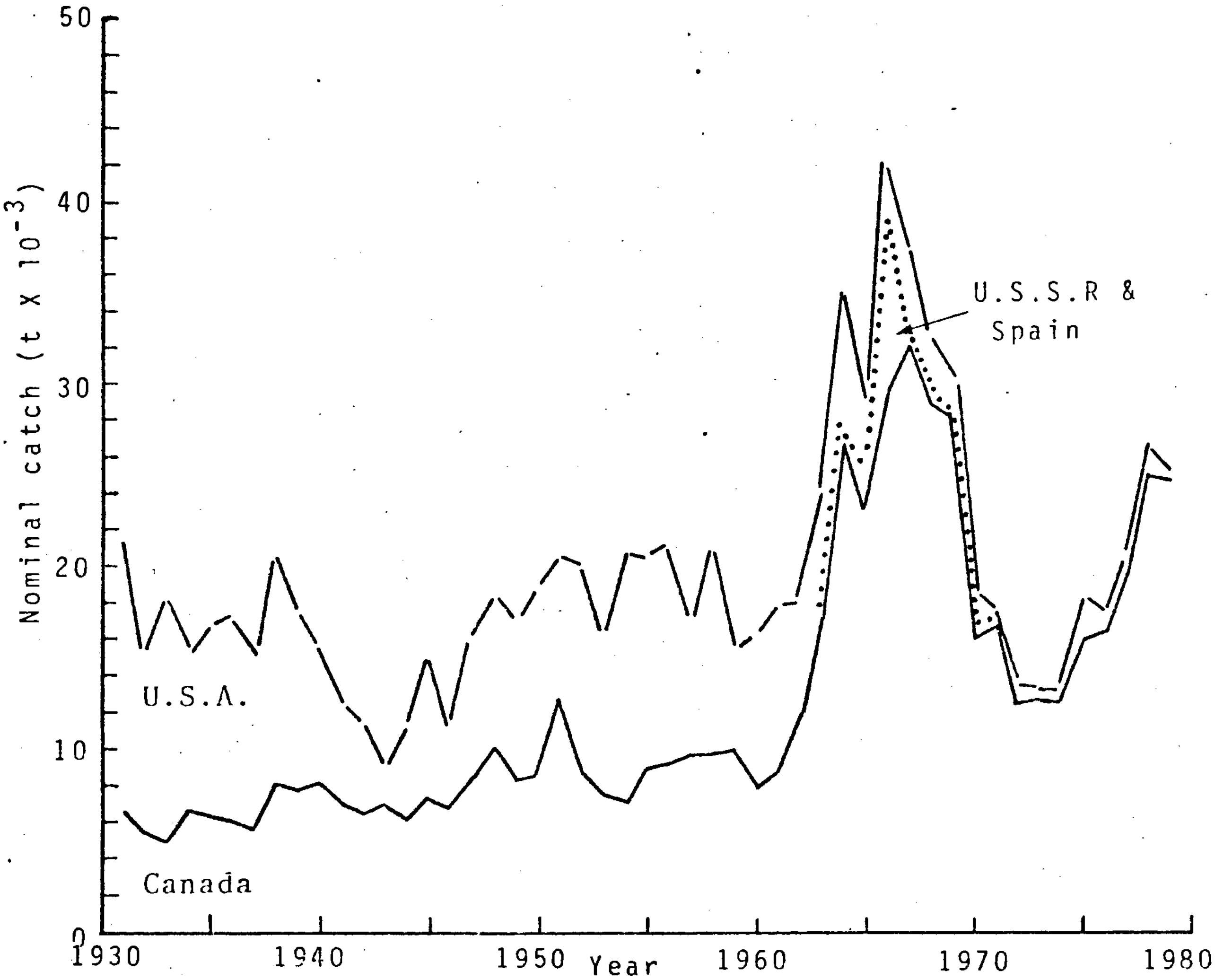


Fig. I. ICNAF Division 4X Haddock--reported nominal catches(t X 10^{-3}) 1931-1979

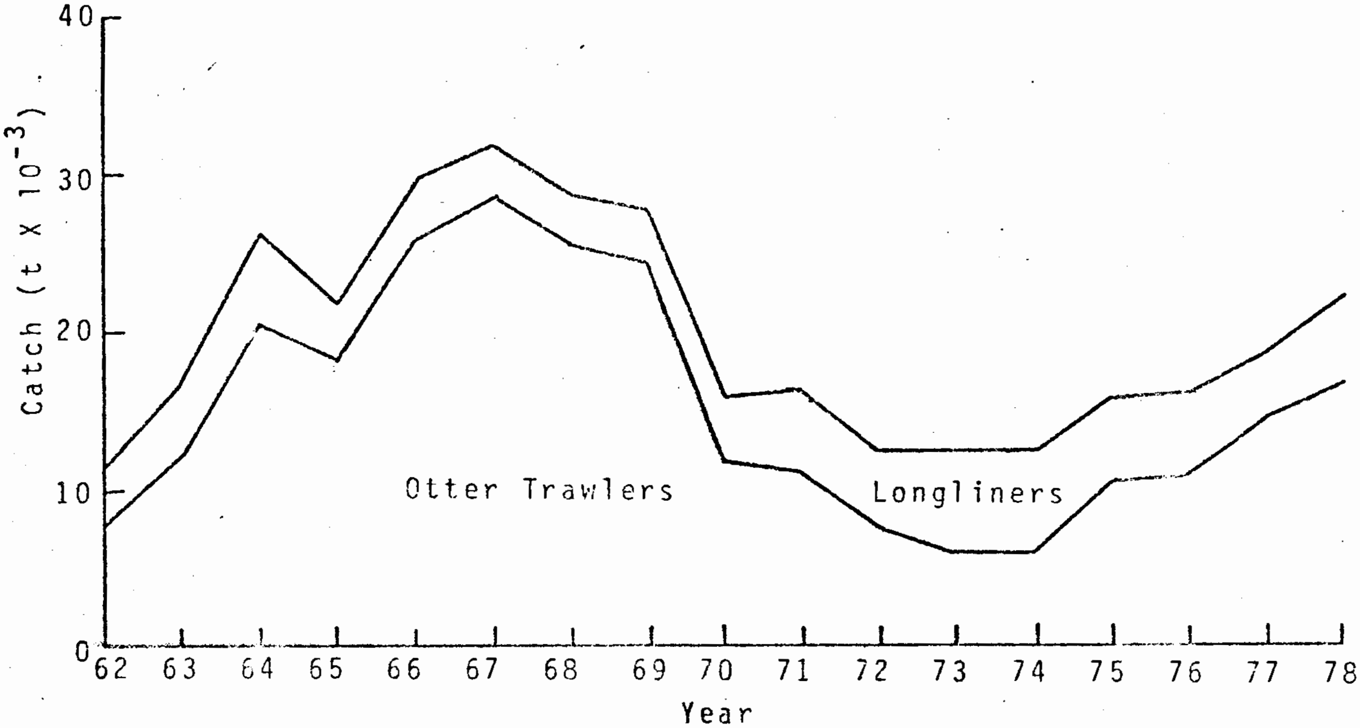


Fig.2. Reported Catch (t X 10^{-3}) of 4X Haddock by Canadian fishery.

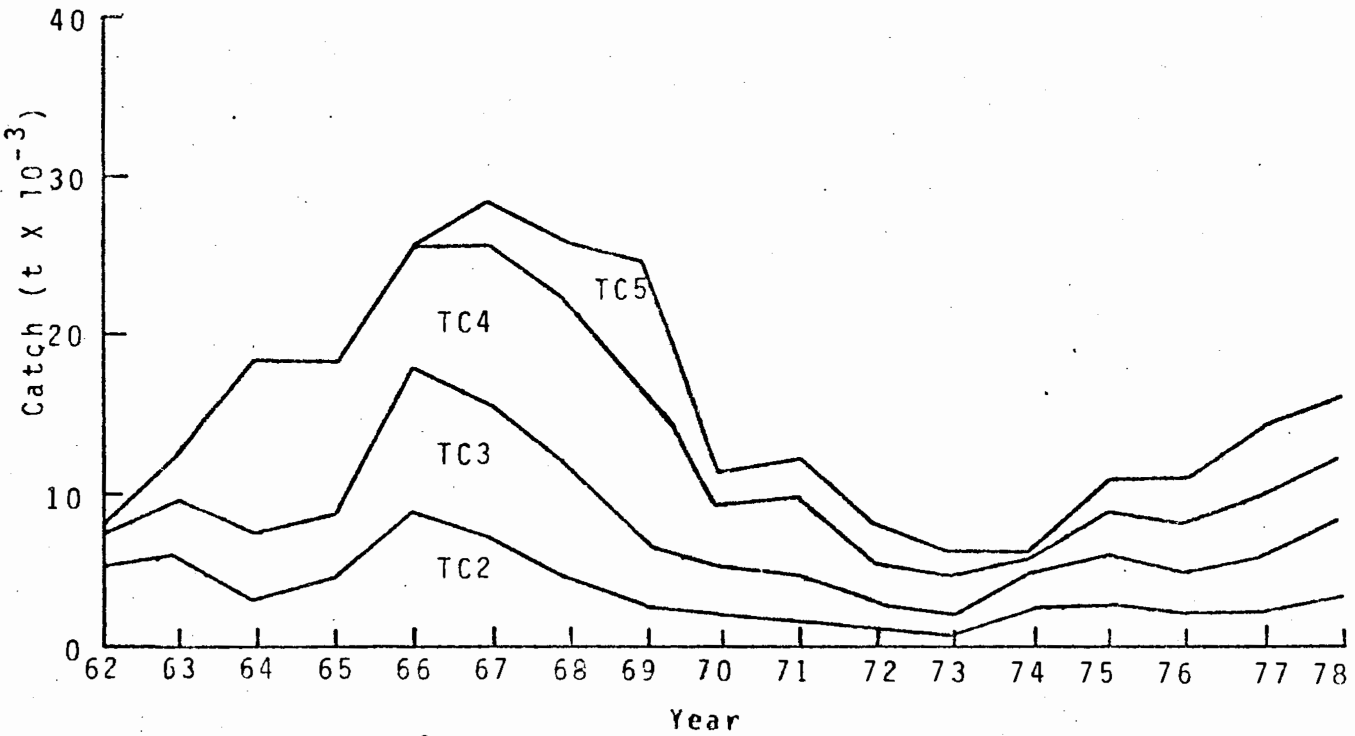
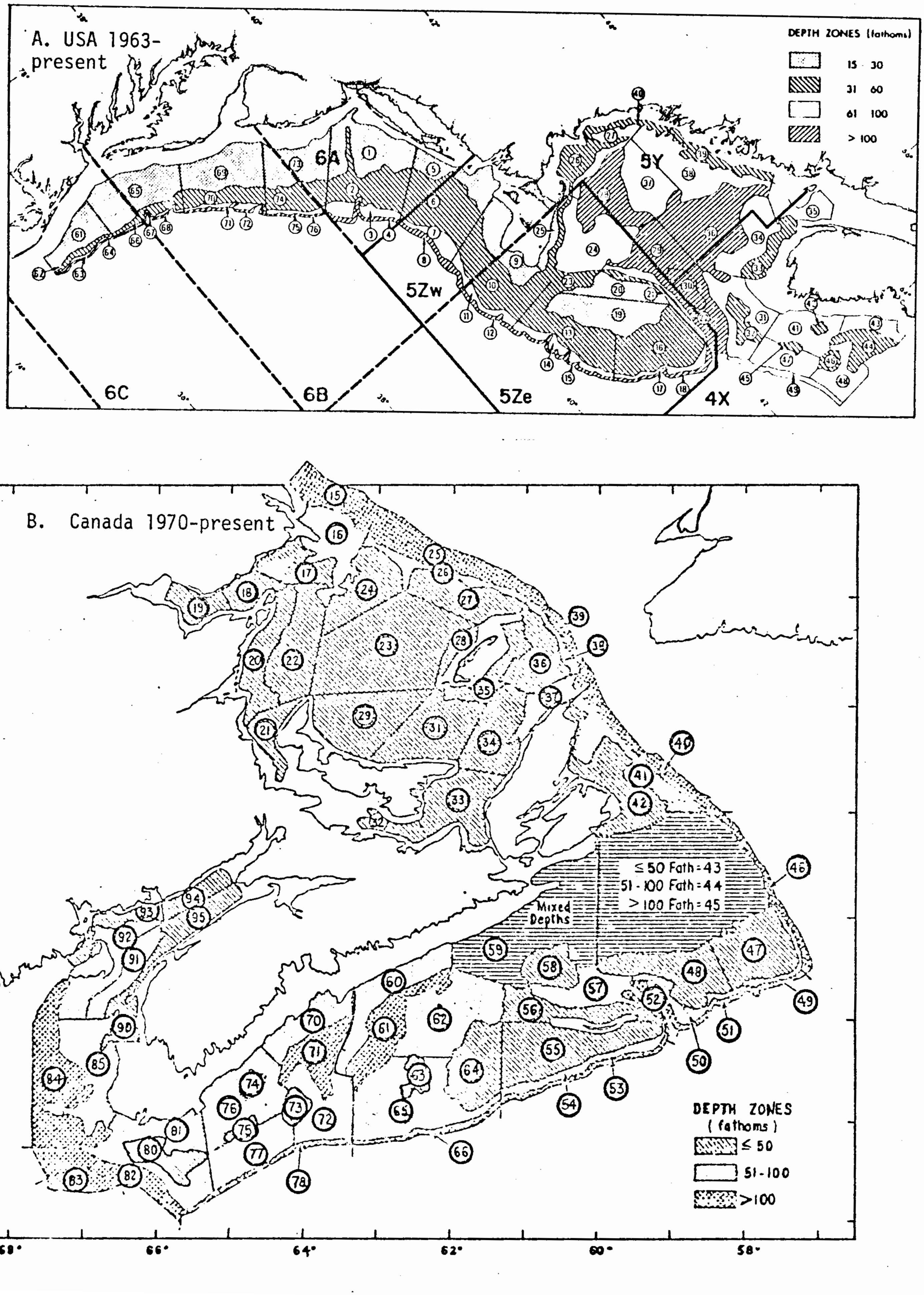


Fig.3. Catch (t X 10^{-3}) of 4X Haddock by Canadian Otter Trawl Fleet.

Figure 4. Stratification schemes used for Canadian summer and U.S.A. fall bottom trawl surveys.



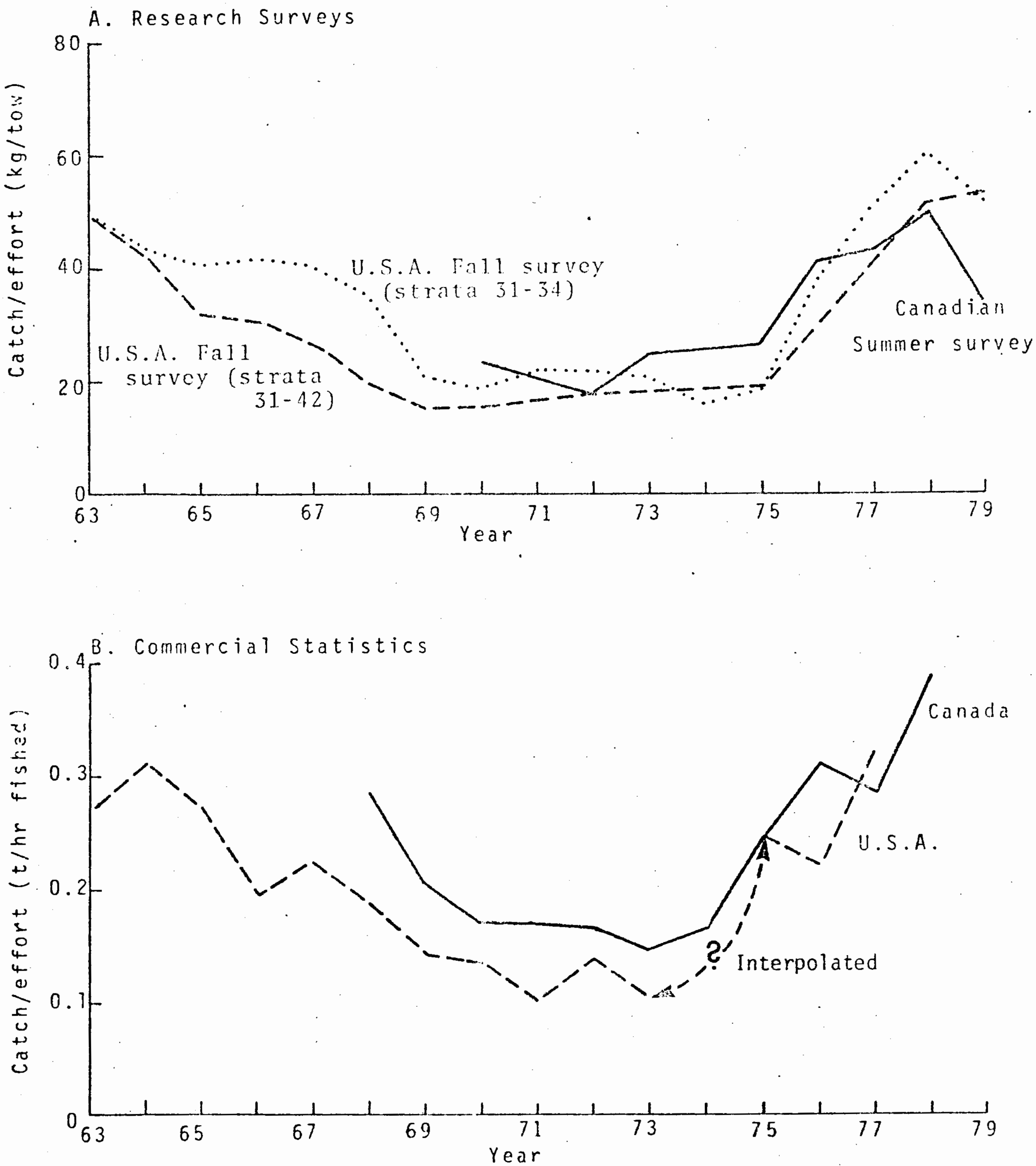


Figure 5 Catch per unit effort indices for 4X Haddock stock.

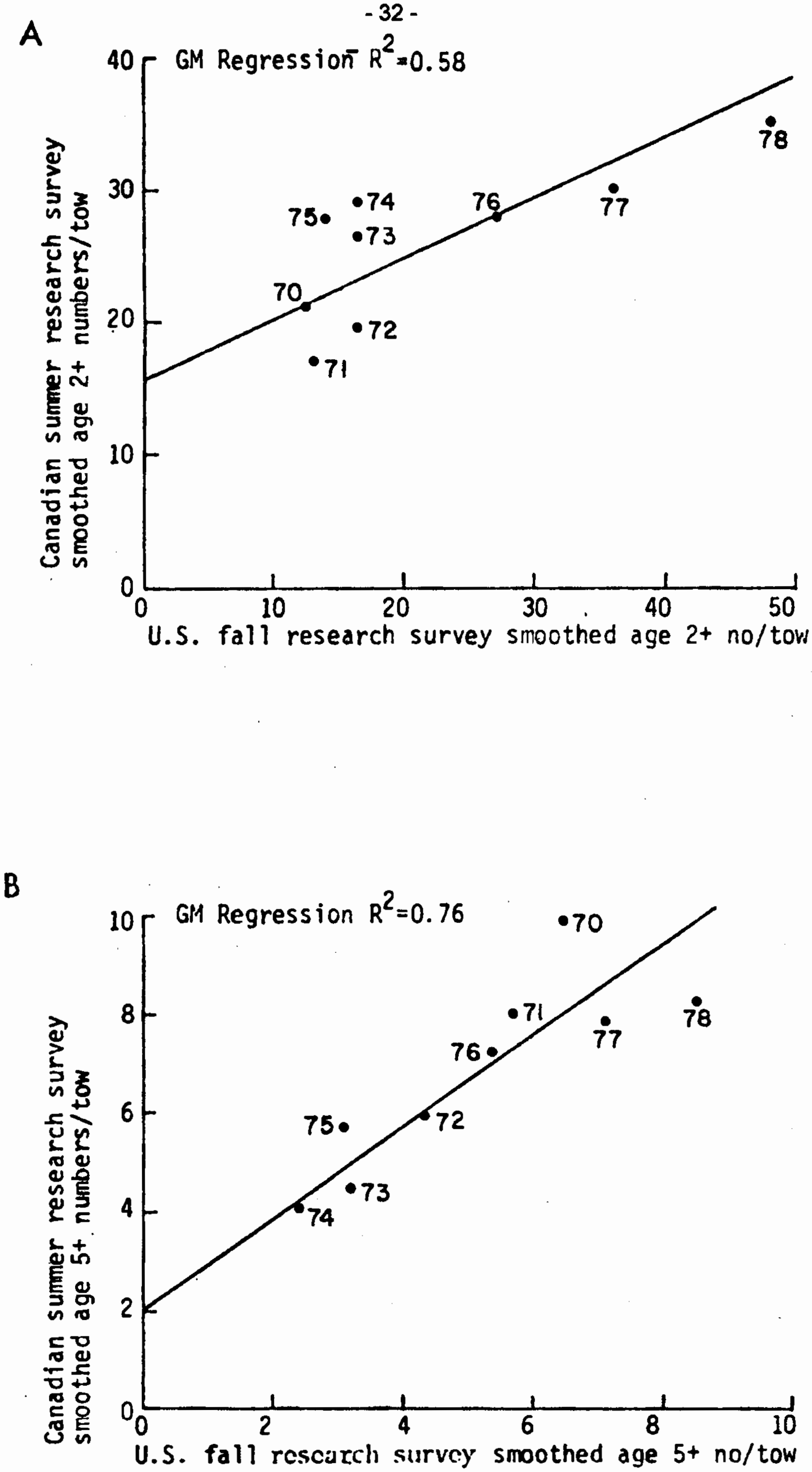


Figure 6. Relationship between abundance estimates from Canadian summer and U.S. fall Bottom trawl surveys.

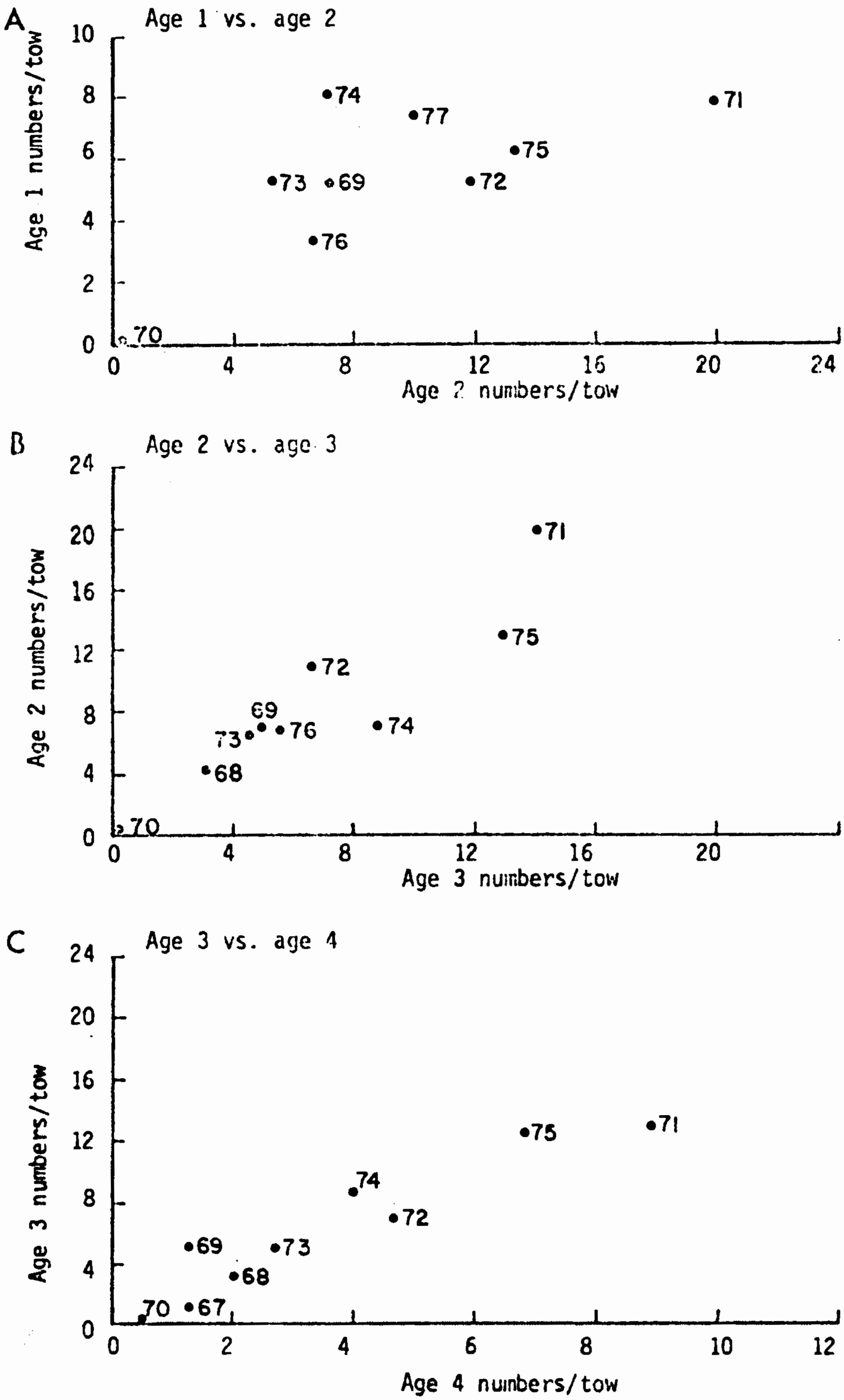


Figure 7. Relationships among numbers per tow (smoothed) of ages 1,2,3,and 4 for Canadian summer bottom trawl survey.

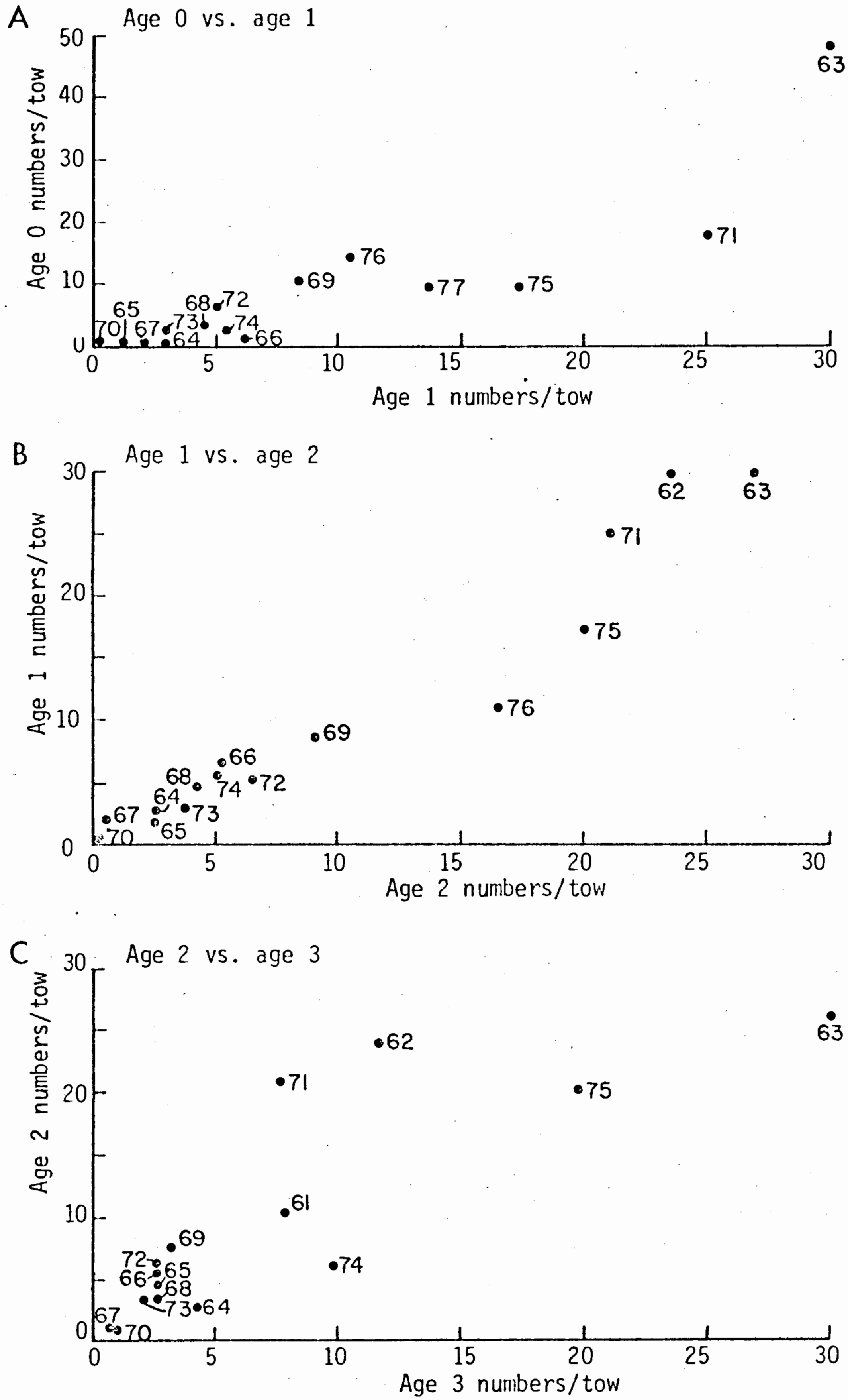


Figure 8. Relationship among numbers per tow (smoothed) of age 0,1,2, and 3 for U.S. fall bottom trawl survey.

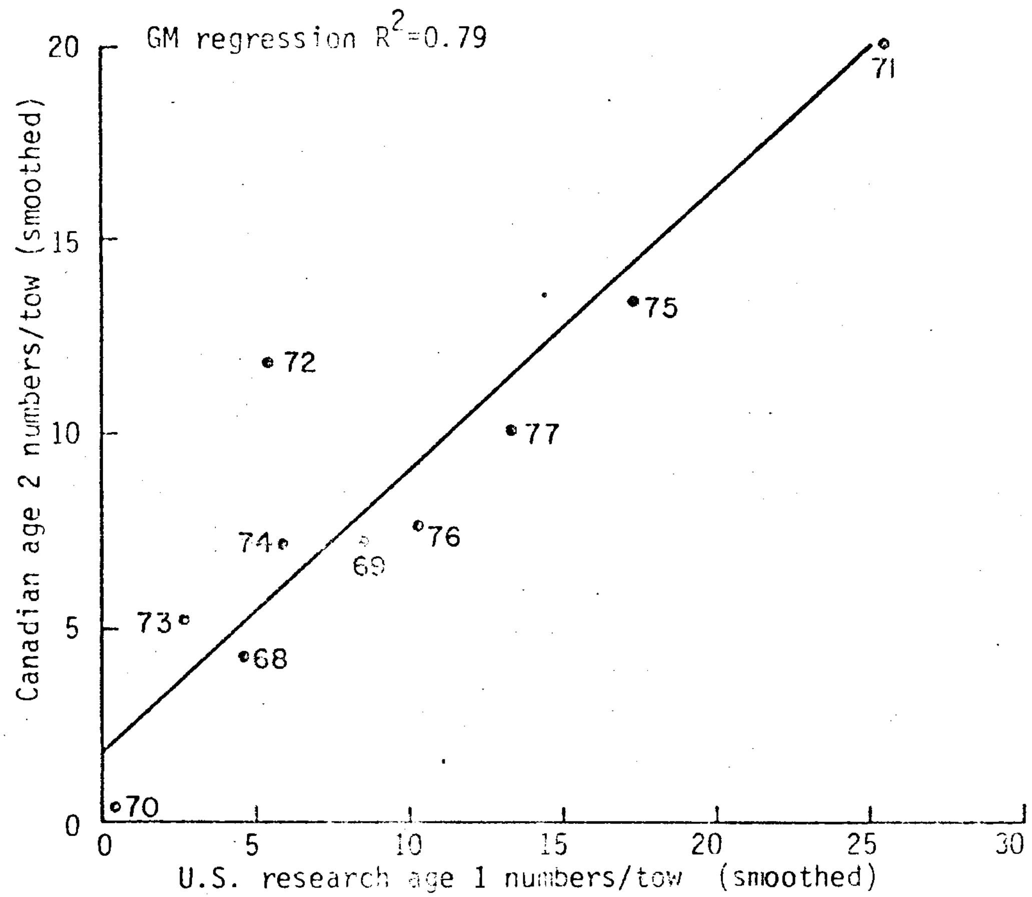


Figure 9. Relationship between chosen year-class strength indices from Canadian and U.S. research surveys.

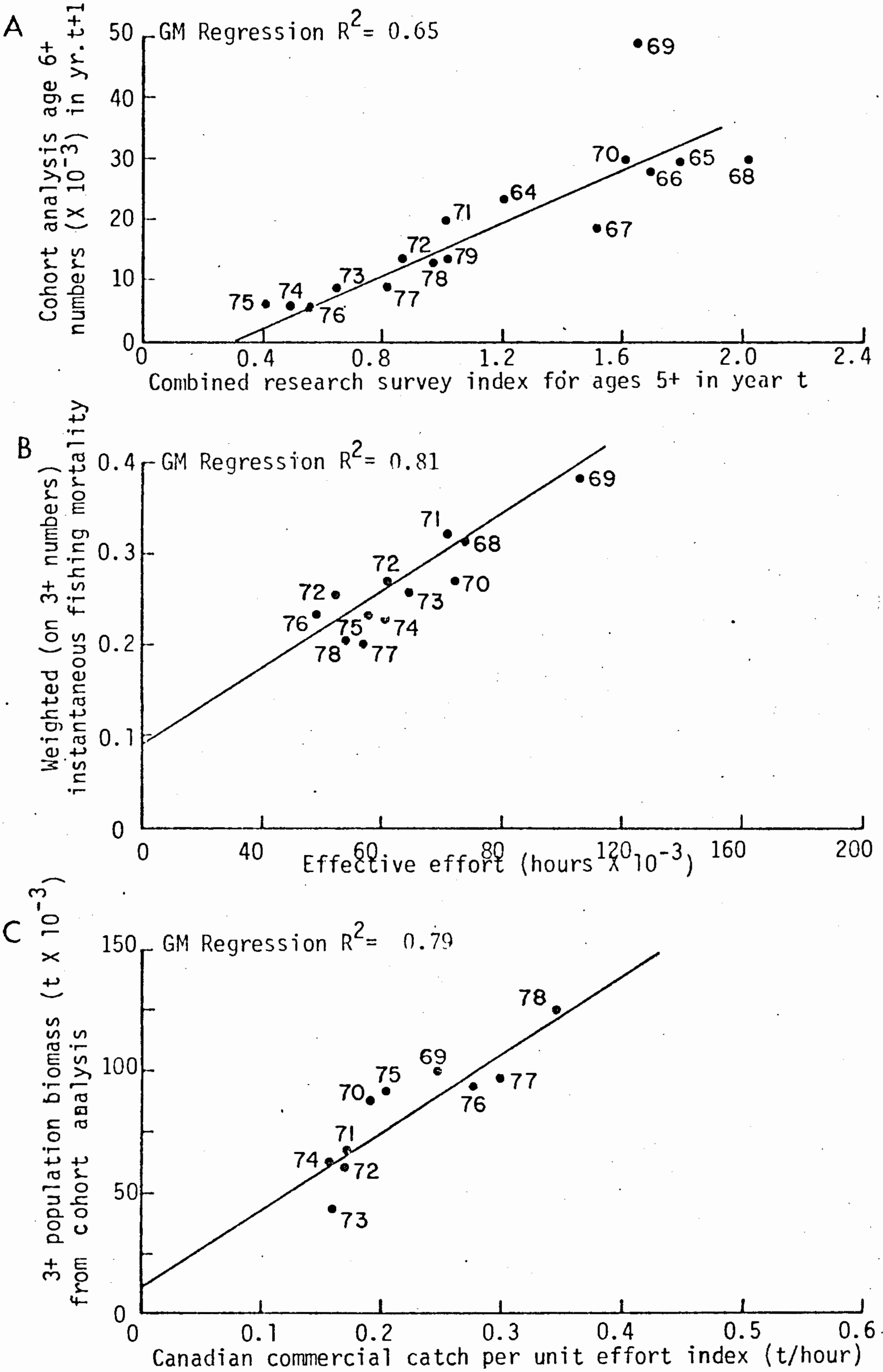
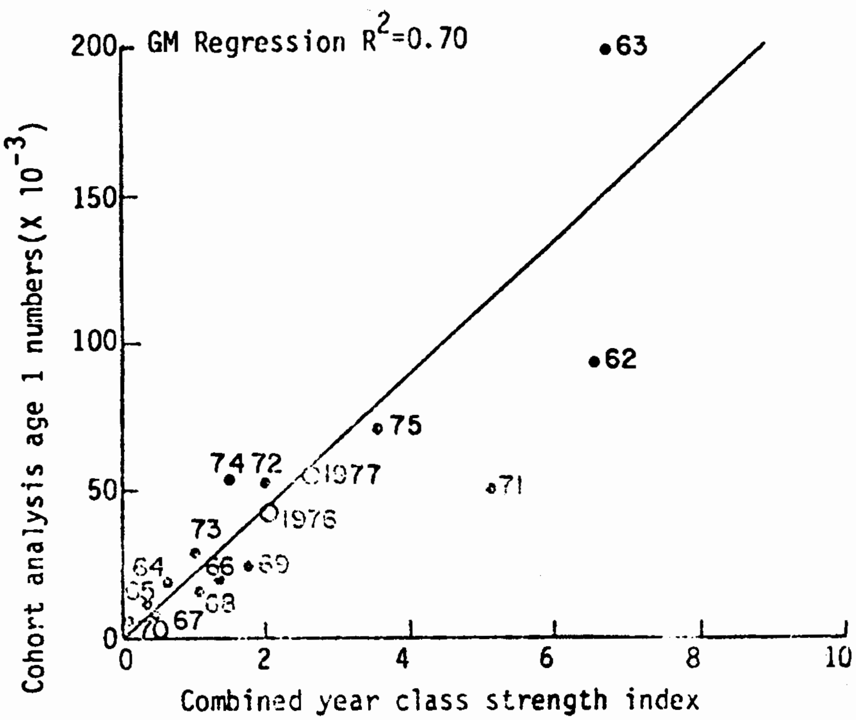
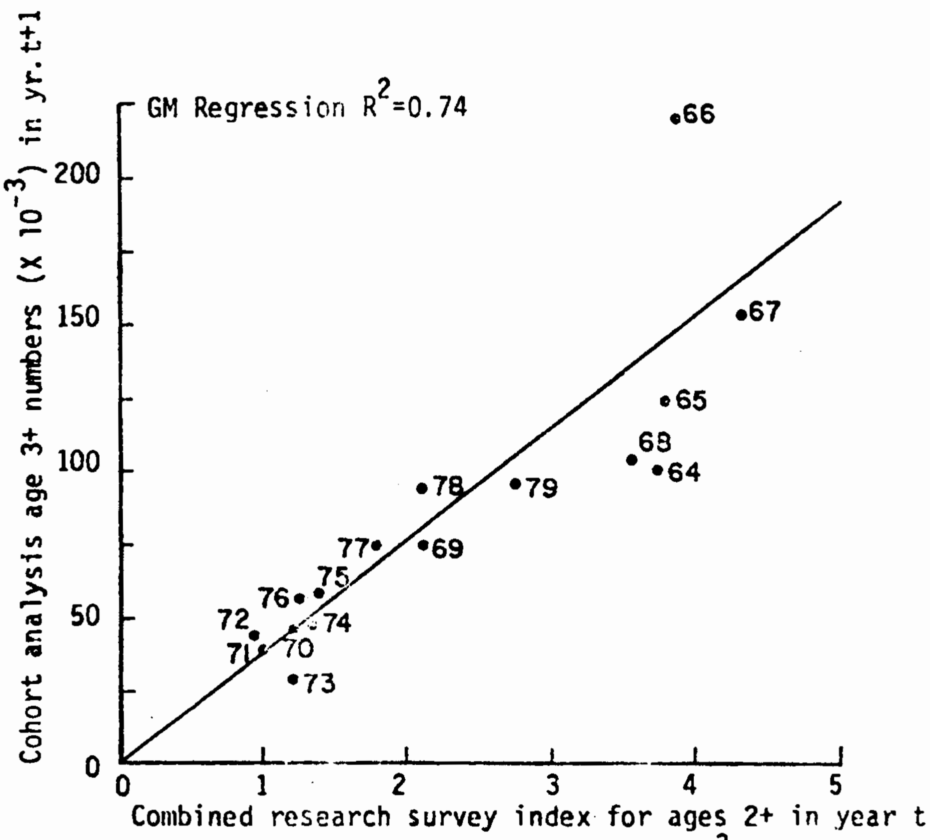


Figure 10. Relationships used to adjust recruited population in cohort analysis.



A Relationship between cohort analysis age 1 numbers (X 10^{-3}) and combined research survey year-class strength index. Numbers indicate year-class.



B. Relationship between cohort analysis age 3+ numbers (X 10^{-3}) in year t+1 and combined research survey index for ages 2+ in year t.

Figure 11. Relationships used to adjust partially recruited population in cohort analysis.

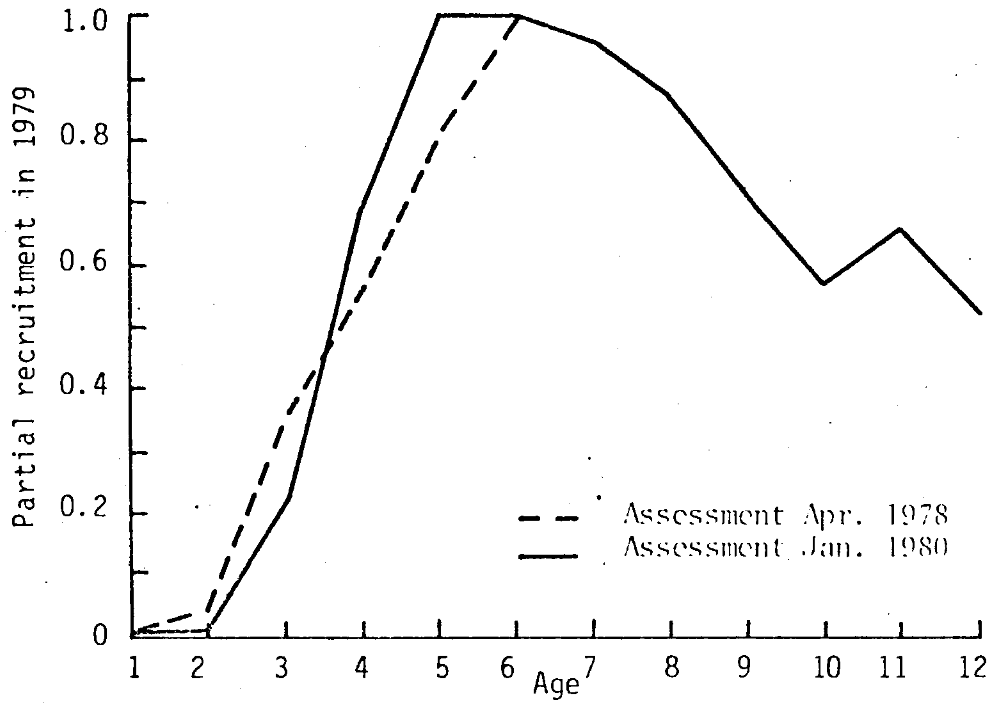


Figure 12. Final partial recruitment pattern used in yield per recruit calculations and catch projections.

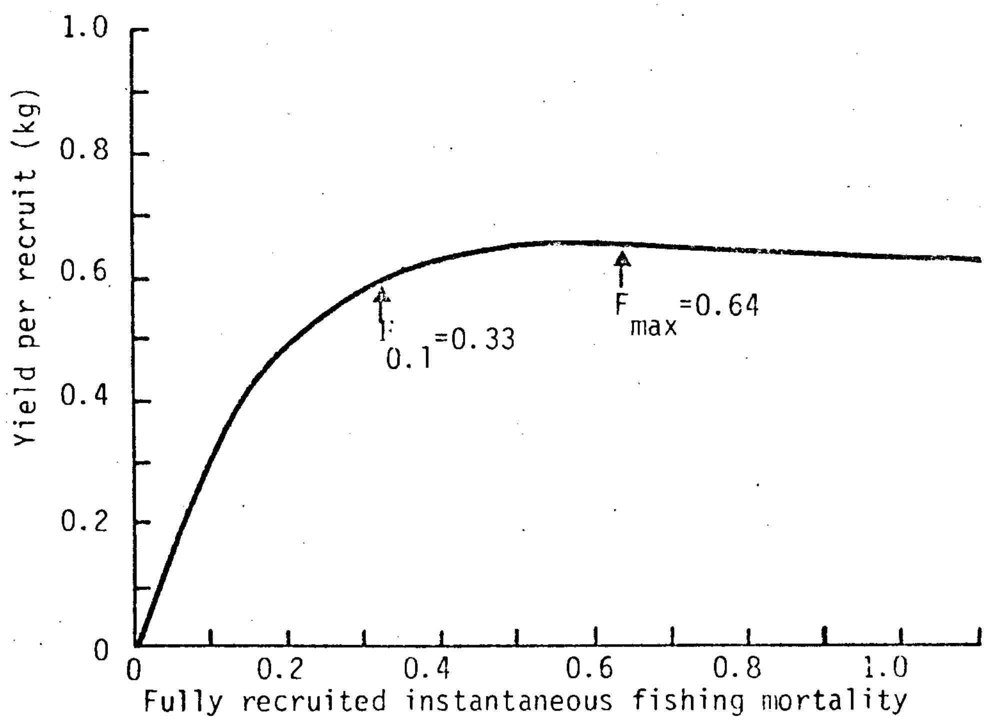


Figure 13. Yield per recruit curve for presently derived partial recruitment pattern.