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Assessment of the Eastern Scotian Shelf (4VW) Haddock Stock with Projections to 1982

by

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Abstract

Research surveys and commercial catch rates both indicate that this stock has increased dramatically in recent years and is now at the highest level since the surveys began in 1970. Three strong year classes (1975, 1976, 1977) have been providing substantial recruitment which will continue into 1982. Projections indicate that the 1981 TAC of 23,000 mt should be retained for 1982.

Résumé

Les relevés par navire de recherche et les taux de capture commerciaux indiquent que ce stock a augmenté de façon dramatique ces dernières années. Il est présentement à son plus haut niveau depuis le début des relevés en 1970. Trois abondantes classes d'âges (1975, 1976, 1977) ont donné un recrutement substantiel, qui se poursuivra en 1982. D'après les prévisions, le TPA pour 1982 devrait être maintenu au niveau de 1981, soit 23,000 tm.

Introduction

The haddock (*Melanogrammus aeglefinus* (L.)) population on the Scotian Shelf is separated into two major stocks, one occupying ICNAF Division 4X and the other centered in Division 4VW with some seasonal migration into 4T (Needler 1930 ; McCracken 1956, 1963; Halliday and McCracken 1970). Nominal catches of haddock from Divisions 4TVW for the period 1954 through 1964 ranged from 22,000 mt to 30,000 mt except for a catch of 38,000 mt in 1959 (Table 1). Following a catch of 56,000 mt in 1965 this fishery declined to a minimum catch of 1,360 mt in 1976 (Figure 1). Recent allocations and reported catches for ICNAF Division 4VW are presented in Table 2. Catches in Division 4T have been well below 1,000 mt during this period, and are not subject to quota restrictions.

The major fluctuations in nominal catches are largely determined by the otter trawl fleet. Nominal catches by longliners increased during the 1970's when stock size was lowest, with the highest and third highest catches of the past two decades reported in 1978 and 1979 (Table 3).

Catches by foreign vessels dominated the fishery in the mid-1960's and have continued to play a significant role. The majority of these foreign catches were bycatches to fisheries directed at other species. The bulk (43,000 mt) of the 1965 peak catch was taken by the USSR in connection with their small-mesh silver hake fishery. Bycatches from this fishery have continued to the present, but under increasingly strict control. Although the reported bycatches have been small in recent years, they represent substantial numbers of one and two year old haddock due to the small mesh size.

The distribution of catches in space and time has undergone marked changes. Prior to 1965 approximately 1/3 of the catches were taken in 4T and 4V. This fraction has been much smaller in recent years, paralleling changes in distribution shown by the research surveys (Table 1, Table 12) (Scott 1976, MS 1980). Under quota regulation the Canadian bottom trawl fishery has changed from primarily a spring fishing season to one in which the peak periods are February-June and November-December (Table 4, Figure 2). Seasonal patterns of the Canadian longliner fishery have changed over the past two decades from predominantly a spring and fall fishery to a summer fishery (Table 5, Figure 2b). Thus although the 1981 TAC is within the historical range of 22,000 to 30,000 mt, it will not be comparable in terms of its composition by area or month.

This assessment relies heavily on the summer research surveys. Thus it was found necessary to make a special study of the sources of variation in population estimates obtained from these surveys. These results, while preliminary in nature, show that the variance of survey estimates is an increasing function of abundance, and that the predominant source of variation is large sets of young haddock occurring during the periods 0400 to 0800 and 1600 to 2000. While these observations suggest that survey estimates of total population biomass should be quite reliable, they also indicate that very high variances are associated with survey estimates for the strength of incoming year classes.

Commercial Removals

The breakdown of commercial removals into numbers at age for this stock is complicated by the lack of sampling for haddock removals associated with the USSR directed fishery for silver hake. For this assessment past practices for estimating the removals by the small mesh fishery were continued. However, the discovery of a less than satisfactory fit of an allometric relation between length and weight for the 1980 summer groundfish survey led to the adoption of new parameters for this relationship for the period 1970 - 1979, necessitating a revision of the catch at age matrix for 1970 - 1979 (the years 1978, 1979 would have been revised in any case to reflect the final NAFO removal statistics). A further change in the calculation for 1980 was the separation of the bottom trawl landings into spring (January - June) and fall (July - December) components to reflect the recent change in seasonal distribution of landings. This change was not warranted for the period 1976 - 1979 due to the small numbers of samples from the small total landings in this period.

Overall commercial removals at age were determined separately for three major groups: Canadian bottom trawls (OTB), other Canadian gears (mainly longlines (LL)), and small mesh foreign removals. Once total removals (MT) were determined for each category a table of numbers at age (Table 8a) was calculated using standard procedures, vis:

1) a length-weight relation was obtained from the appropriate summer groundfish survey.

2) for Canadian removals the relevant commercial samples were combined and a table of the length-frequency at each age computed. From this table an average weight at age is determined using the relationship with length. Knowing the age composition and mean weight at age it is possible to determine numbers at age in a given removal. These calculations are performed in the AGE-LENGTH system which resides on the central computer at BIO.

3) for small-mesh removals the age composition is assumed to resemble that of the summer research vessel survey for the year in question. The accuracy of this method is questionable as the research surveys employ different gear with different coverage in space and time, but no better method has been proposed.

Age composition by numbers and by weight for removals are presented in Table 10a.

In view of the serious questions regarding the accuracy of these methods it was considered important to attempt to obtain an independent check on the results. While the possibilities are limited, the results of the checks that have been performed are given on the following page.

Length-Weight Relations

It has been customary, for this stock, to obtain a relationship between length and weight from the summer research vessel surveys. An allometric relationship

$$W=AL^B \tag{1}$$

where W is the (round) weight (kg) and L the fork length (cm) is fit to the data by linear regression after taking logarithms. No correction for bias is applied when the parameter A is calculated from the regression estimate of log A. The accuracy of the resulting fit can be checked by comparing average weights for each length group to the predicted value given by (1). For the summer 1980 survey this comparison shows a major systematic trend in the residuals with a tendency to overestimate the weight of fish in the middle size range (30 - 55 cm) corresponding roughly to ages 3 - 6 in the removals (Figure 4).

The most likely explanation for the trend in Figure 4 is that the sampled population is not homogeneous. A variety of mechanisms may be postulated to explain the lack of homogeneity, including higher fishing mortality on rapidly growing members of a year class and density dependence of growth, but it will require a considerable effort to determine which mechanism is responsible.

The actual values of the parameters used in the assessment are presented in Table 8b. Although the individual values vary substantially from year to year, the resulting curves are quite similar for the predominant length classes. This is a common property of fitted allometric curves and is due to a high correlation between the two parameters (Gould 1966). The limited available data do not permit an analysis of seasonal variation in the length-weight relation. It would, in principle, be preferable to apply different relationships to the spring and fall fisheries, but this would required a change in the priorities given the analysis of the spring and fall research survey data so that the data would be available more quickly.

Small Mesh Removals

Estimates of small mesh removals for the period 1971 - 1977 were taken from Waldron (MS 1980). These estimates are based on an adjustment to the nominal catches of haddock by the USSR using by-catch rates obtained from the International Observer Program in 1977 and 1979. Estimates for 1970 and 1978 - 79 (using final NAFO statistics) were calculated using the same procedure (Table 6). For 1980 an estimate of haddock by-catches in directed fisheries for silver hake and squid by 8 foreign countries were provided by the International Observer Program (Table 7).

No information about the composition of haddock by-catches was available, so it was necessary to assume an age composition similar to that of the research surveys. As discussed by Waldron (MS 1980), the adjusted removals for 1970 - 1977 are likely to be underestimates. Althought the tonnages are generally small, these removals are believed to include considerable numbers of young fish. Estimates of recruitment from sequential population analysis will consequently be unreliable.

Comparisons of Average Weight Estimates

It was not possible to resolve all the questions concerning the appropriate length-weight relationship to be used in estimating removals at age. This relationship is used to determine average weights of fish in the removals. The average weight obtained using the length-weight relationship should, in principle, agree closely with the average obtained by dividing the combined sample weight by the number of fish sampled. Table 9 presents the results of this comparison together with the removals at age used in the previous assessment. The revised estimates for removals in Table 8 are somewhat higher than in previous years, due to the use of different parameters in the length-weight relationship. There is good overall agreement between the average weight used to estimate numbers removed for Table 8 and the average weight of fish sampled (Table 9a).

The largest discrepancy in the table occurred for the fall component of the OTB fishery in 1980. Since the summer is a period of intense feeding for haddock it is reasonable to expect changes in condition factor between the spring and fall fishing seasons to produce fish which are heavier at a given length. Thus the parameters of the length-weight relation from a summer research survey may not be suitable. Further investigation of this hypothesis is required when data from the fall research survey series become available. The 1980 estimates are based on provisional statistics and hence are subject to revision in next year's assessment.

Research Vessel Surveys

Research vessel surveys have been conducted using the A.T. Cameron in NAFO area 4VW each summer since 1970. In 1978 additional fall and spring surveys were instituted using the Lady Hammond. Data are available from 11 summer surveys and the surveys in November, 1978 and March 1979. Catch numbers and biomass remained low for the years 1970 - 1976 and have increased in recent years (Tables 12, 13). This increase appears to be confined to the area of Western Bank in NAFO Division 4W (Scott 1976, 1980 unpublished).

The variability associated with research survey estimates of abundance must be taken into account when attempting to use survey results, particularily as the variation increases more rapidly than the estimated abundance (Table 12). Figure 5 presents the relationship between the weighted mean catch per standard tow $W_h \bar{y}_h$, and the corresponding weighted variance, $W_h^2 \; S_h^2 / n_h$, in the last four years (this notation is explained in Appendix 1). In 1980, for example, strata 63 and 55 contributed respectively 48 and 17% of the overall mean, and 74 and 19% of the overall variance. Within a year there are differences among strata (Figure 6). Within each strata the catches are seldom homogeneous. In 4VW extraordinary sets occur between 4:00 and 8:00 and between 16:00 and 20:00 (Figure 7).

Our overall impression of abundance may be largely influenced by whether the survey happens to hit one, two, or three large sets, which may in turn depend on the time of day that certain strata are sampled. Preliminary examination of these extraordinary sets indicates that they are predominantly small fish. Colton (1965) has suggested that daily vertical migrations of young haddock may cause differences between day and night sets. The data presented here suggest a different pattern. In May, 1981 a special cruise by the Lady Hammond was conducted on Emerald Bank. A total of 15 tows were taken at 3 hour intervals in an area of high stock density. For haddock of less than 23 cm fork length a pronounced bimodal pattern with peaks in the morning and evening was observed (Figure 8). There was no clear pattern in catches of larger fish. These data confirm the patterns found in the research survey data and suggest that the effect will be primarily in the younger age groups. Thus while estimates of fishable biomass from the surveys should be influenced only slightly by diurnal patterns, these may be responsible for much of the variance in recruitment indices obtained from the surveys.

There are references in the literature to differences between night time and day time catches in haddock and other groundfish species (Woodhead 1961; Parish et al 1963). These references indicate a pattern consistent with that found in 4X haddock (Figure 7b), but the pattern observed in 4VW haddock (Figure 7a, Figure 8) has not been reported for other haddock stocks. Thus the inability of the research surveys to predict recruitment in 4VW haddock may not carry over to other areas and stocks.

Recruitment

Recruitment in haddock is notoriously variable and generally year class strength has a bimodal distribution (Hennemuth et al. 1981). Catch projections in haddock are sensitive to assumptions about year class strength, except when there are a number of strong year classes entering together. The research surveys are commonly used to provide an indication of recruitment as an aid to projections. However, even when spring and fall data are considered, it is difficult to quantify the size of incoming year classes. Examination of Figure 9 shows that while the 1978 year class is clearly very poor, there is no discernible difference between the 1975 - 77 year classes. Only with many years of data is it possible to recognize that the 1974 year class was weak. This apparent weakness may have been due to high fishing mortalities from small mesh gear.

The high catch rates for small (<23 cm) haddock obtained in the 1981 special cruise of the Lady Hammond indicate that the 1980 year class is strong. This observation is supported by high by-catch rates for small haddock reported by the International Observer Program in June, 1981.

Weights at Age

Mean weights at age for the population are required for projections and in order to make comparisons of population biomass obtained from sequential population analysis and from research surveys. Because commercial gear will tend to select the larger fish at a given age, mean weight at age for the population will not, in general, be the same as that in the removals. However, since projections require mean weights in the removals, estimates of mean weight at age should generally follow commercial patterns. For this assessment the mean lengths at age in the commercial removals were used as a basis for fitting a von Bertalanfly growth curve

$$L = L\infty \left(1 - e^{k(t_0 - t)}\right) \qquad (2)$$

using (weighted by $\frac{1}{\text{sample size}}$) nonlinear regression. The weighting is required to reduce the influence of high variances associated with larger fish due to the small sample sizes. Separate growth curves were obtained for each category of removal (e.g., OTB, LL, and small mesh) and converted to weight at age using the appropriate allometric relationship. These relationships were then evaluated at various ages and combined to obtain the table of weights at age (Table 15). To determine how representative these weights were for the population a comparison was made between the observed total biomass from the research surveys and an estimate of biomass obtained by applying the mean weights at age to the research survey population estimates. While there is evidently some bias present (Figure 10), the overall accuracy of this procedure was adequate for comparisons between survey biomass estimates and estimates obtained by sequential population analysis.

Sequential Population Analysis

Traditional sequential population analysis depends heavily on the stabilization of numbers towards the early years of a cohort as cumulative fishing mortality increases to overcome the potential pitfalls of:

- subjectivity, particularly with regard to partial recruitment patterns sought when adjusting terminal f's,
- the types of adjustments made, and the
- excess of parameters over the number of data points when calibrating against catch rates for age aggregated data.

Calibration of sequential population analysis against catch rate data (such as that provided by the research vessel surveys) presents major technical difficulties. Research vessel survey estimates for the 4VW stock indicate that abundance has increased substantially in the past few years. The variance of these estimates increases roughly as the square of abundance, so that a regression line need not pass near points where abundance is large. Since most of the recent increase in population is concentrated in the younger ages, and since small fish are expected to be more available to the research gear, it is desirable to calibrate younger ages separately, using a regression model which allows for errors in both dependent and independent variables.

The SURVIVOR method (Doubleday MS 1980) implemented by Rivard (1980) (Appendix 2) overcomes some of the central difficulties to calibrating SPA against catch rate data. It seeks calibration constants of the form

$$N(I,J) = K(I)\ A(I,J) \qquad (3)$$

where N is SPA abundance for age I in year J, A is a catch rate, and K the slope which is determined by regression of Log N against Log A. A separate value of K may be obtained for each age in a "calibration block". Typically one finds that K levels off above a certain age. This allows several ages to be combined to compute a fully recruited calibration constant. In 4VW haddock the age at which K levels off was determined from trial runs to be 4. This reflects the application of research survey age composition for small mesh fisheries and is lower than the value obtained in 4X haddock. As the importance of small mesh removals is decreasing, this age may need to be revised upwards in the future.

Any new technique must be thoroughly tested before it can form the basis of an assessment. Thus we will present the results both of a conventional sequential population analysis and an analysis based on the "SURVIVOR" method. Fortunately the two methods agree closely. The "SURVIVOR" method will be discussed first as it may be unfamiliar to the reader.

Calibration

The results obtained from the SURVIVOR program will depend on the calibration block that is chosen. Because the program uses a logarithmic transformation it is necessary to exclude ages in which commercial or research catches are zero. This limited the range of ages which could be used to 2 - 8, so conventional procedures were used to extend the analysis to older ages.

Preliminary trials showed that the best results were obtained using a calibration block restricted to ages 2 - 5 and that the magnitude and variance of the calibration constants increased as the block size was decreased by removing the most recent year from the block (Table 16). With a block including 1970 - 1977 the largest coefficient of variation for estimated survivors in 1980 was associated with an outlier at age 7. When this point is ignored the greatest variability is associated with age 2.

High variability is expected at age 2 in both commercial removals (due to inability to adequately account for small mesh removals) and in the research survey abundance index (due to diurnal variation in catchability of young haddock in 4VW). The coefficients of variation became excessive when block size was restricted to years prior to 1977. Thus a calibration block based on ages 2 - 5 and the years 1970 - 1977 was chosen as the best compromise between the coefficients of variation in K for 1980 and loss of the stabilizing effect of sequential population analysis. The results are presented in Table 17.

Extension to Older Ages

Initial guesses for F values in the last year were obtained from the estimated survivors by solving the cohort formula for fishing mortality as a function of catches and survivors in the last year. It was assumed that partial recruitment would be sigmoidal. This was consistent with the results of the SURVIVOR program.

F values for the oldest ages were calculated by the usual iterative procedure based on cohort analysis in which new values were obtained as the average over three fully recruited ages. This algorithm converged in two or three iterations and produced similar patterns for various choices of the fully recruited ages. The results are presented in Table 18.

This extension allows comparison with other indices of abundance, but does not alter the conditions in the final year. The relationship (3) between cohort and research numbers is also maintained without a change in the value of K (Figure 11).

Conventional Sequential Population Analysis

A conventional sequential population analysis was performed starting with the same partial recruitment as the previous year's assessment. Fine tuning was based on a comparison of research 1+2 numbers to sequential population analysis age 1 and research to sequential 3+ numbers. It was found necessary to adjust the partial recruitment at age 3 from 0.18 to 0.2 to obtain a good relationship between the generated population and research indices. The best overall relationships were obtained using a terminal F of 0.25 (Figure 12). In comparison, the "SURVIVOR" based method yielded a terminal F of 0.55.

The ability of the relationships used to discriminate between different choices of input parameters was poor despite the fact that the points used in the regression are distributed fairly evenly over the observed range of abundances. This was due to the presence of three strong year classes which make up the recent increases in abundance. By adjusting the relative strengths of these year classes it was possible to obtain good relationships over a wide range of terminal F values.

Reconciliation

The two approaches used to determine a 1980 fishing mortality produce different results. This is seen clearly by considering 2+ biomass (Figure 13). The traditional SPA produces the best agreement for the most recent year, while the "SURVIVOR" based estimates are consistently low, but better reflect the overall pattern. In essence, the traditional method relies heavily on the most recent year's survey. Examination of the population matrix for the traditional SPA (Table 19) shows that the 1977 year class is considerably larger than any other in the series. This may be an overestimate. However, it is also possible that underestimates of small mesh removals during the early part of the decade have produced an unrealistic view of year class strength in the early 1970's. Because research survey data are highly variable at these ages it is, however, unwarranted to conclude that the 1977 year class is exceptional on the basis of the large stratified mean catch per tow at age 1 in 1978.

It is possible to adjust the "SURVIVOR" based results to correct for the apparent bias by multiplying the population in 1974 - 1980 by a correction factor equal to the geometric mean of the ratio of survey to SPA 2+ biomass, which yields an estimate for the 2+ biomass in 1980 of 113,000 mt (Table 20). This correction factor can be interpreted as an average factor which would have to be applied to the catch matrix for 1974 - 1980 to eliminate the bias evident in Figure 13.

Projections

The 4VW haddock stock is still in a state of flux, making it impossible to determine equilibrium conditions of weight at age, maximum age, and partial recruitment. Two options are available:

1) use historical partial recruitment and make a (subjective) adjustment to compensate for the reduction in small mesh removals, or

2) use a partial recruitment based on more recent data with the understanding that a large uncertainty is associated with the values so obtained due to lack of convergence of the sequential population analysis. Previous assessments have used an age range of 2 - 11; under equilibrium conditions a range of 2 - 15 would be more appropriate.

In order to determine the effect that the indicated changes would have, projections were made using both the historical data and a revised partial recruitment with reflects the recent changes in the fishery. The weights at age for both projections were calculated as the average of the 1978 - 1980 values.

The change in mean weight at age from that used in the previous assessment was minor, and $F_{0.1}$ remained at 0.3 using this historical partial recruitment (Table 21). A change to the age range 2 - 15 produced only a modest reduction in $F_{0.1}$ to 0.28.

Projections were carried out using the input parameters shown in Table 21. In view of the uncertainties associated with the revised partial recruitment it was decided to bracket the answer that would be obtained using a correction factor of 1.3 by applying factors of 1.2 and 1.4 to the 1980 population of Table 19. No attempt was made to estimate the number of fish at ages 12 - 15, so the projections are marginally lower than would be obtained using all ages. It was decided to leave the 1980 removals at their reported level as the increased quota in 1980 would be expected to reduce the level of misreporting below the 1974 - 1980 average.

Considering the major differences in the input parameters it is encouraging that the projections are all consistent with a TAC of 23,000 mt. While it is too soon to say precisely what the equilibrium conditions for this stock will be, these results suggest that the transition to equilibrium conditions will not require major changes in quota advice. It should be noted that the main source of differences between these projections is the sizes of the 1975 - 1977 year classes. While it is difficult to fix the size of any one year class with precision, the fact that recruitment occurs over a period of several years allows an overestimate of one year class to be compensated by an underestimate in an adjacent year.

Discussion

The 4VW haddock stock has responded dramatically to the imposition of quota restrictions and by-catch regulation of small mesh fisheries. While there is qualitative agreement between commercial catch rates (Table 11) and the research vessel surveys for the fishable stock, (Figure 3), the surveys provide the only means of estimating recruitment. Unfortunately it was shown that the surveys do not provide quantitative measures of recruitment. Not only are they influenced by diurnal changes in availability of young fish, but the uncertainties over small mesh removals in the early 1970's make calibration of the surveys chancy.

The 1982 projected catches are determined essentially by the strengths of the 1975 - 1977 year classes, and thus are subject to errors resulting from our inability to accurately estimate year class strength. For this assessment the presence of three strong year classes provides some protection from errors in estimating the strength of a single year class. This happy situation is not likely to persist, and it is therefore essential to develop improved methods for determining year class size. In this stock the utility of historical data is seriously reduced by the uncertainties over commercial removals. Thus it may be some time before a recruitment index can be calibrated against sequential population analysis.

In the face of these uncertainties it is very encouraging to find that radically different approaches to the analysis lead to essentially identical results. There is every reason to expect the quality of the data, particularly that related to commercial removals, to be better for the 1980's than the 1970's when removals are almost certainly underestimated.

There is no doubt that the 4VW haddock stock is presently at the highest level since 1970. It remains to be seen, however, whether the stock will return to its historical distribution as biomass approaches the level prevalent in the 1950's. Growth rates, as indicated by mean weight at age (Table 15), appear to be higher now than in the early 1970's. If these are not an artifact of higher fishing mortality on the larger fish at a given age then increased stock biomass should be accompanied by a decline in growth rates. Thus this stock may remain in a state of flux for some years to come.

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Appendix 1. Standard Notation for use in Groundfish Research Trawl Surveys

L = number of strata sampled

N_h = total number of sample units in the hth stratum

n_h = total number of units sampled in the hth stratum ($h = 1, 2, \ldots, L_h$)

$N = \sum_{h=1}^{L} N_h$ = total number of sample units in survey

$n = \sum_{h=1}^{L} n_h$ = total number of observations in survey

$W_h = \frac{N_h}{N}$ = stratum weight

$f_h = \frac{n_h}{N_h}$ = sampling fraction in the hth stratum

y_{hi} = ith observation in the hth stratum ($1 = 1, 2, \ldots, n_h$)

$\bar{y}_h = \sum_{i=1}^{n_h} y_{h_i}/n_h$ = sample mean in the hth stratum

$s^2{}_h = \sum_{i=1}^{n_n} (y_{hi} - \bar{y}_h)^2/n_h$ = sample variance in the hth stratum

$\bar{y}_{st} = \sum_{h=1}^{L} W_h \bar{y}_h$ = estimate of the population mean per unit (i.e. stratified mean catch per tow).

$\widehat{Var}(\bar{y}_{st})$ or $s^2(\bar{y}_{st}) = \frac{1}{N^2} \sum_{h=1}^{L} N_h^2 \frac{s_h^2}{n_h}$ = estimate of the variance of the stratified mean

A parametric value of the variance of an estimator may be denoted either by Greek letters, i.e.,

σ^2_{st} , or by the following convention VAR $(\bar{y}_{st})$

Appendix 2. SURVIVOR

The "SURVIVOR" program used in this document differs from that originally described by Rivard (1980) in two ways:

1) the original program contained an error in the loop which computes integrated catch. The result of this error was that the final term in the summation was omitted in the original program.

2) the calculation of residuals was changed to agree with its formula in Rivard (1980). The original program introduced a small bias in mean of the residuals. This had no effect on the calculation of estimated survivors, but could influence the interpretation of the results, particularly the effect of changing the calibration block.

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Table 1. Nominal catches (mt) of eastern Scotian Shelf haddock (4TVW) by NAFO Division and country, as reported by NAFO.

Year	4T Canada	4T USA	4T USSR	4T Spain	4T Other	4Vn[3] Canada	4Vn USA	4Vn USSR	4Vn Spain	4Vn Other	4Vs Canada	4Vs USA	4Vs USSR	4Vs Spain	4Vs Other	4W Canada	4W USA	4W USSR	4W Spain	4W Other	All Areas & Countries	(2)
1953	4742					3546										9357					17645	
1954	5918	1044			40	5549	405		1058	24						12323	1956		17		28334	
1955	3101	31				3339	450		1183	13						12777	1217				22111	
1956	2861					4899	147		1350	12						18273	1661		354		29557	
1957	1740	1				5869	120		747	9						19960	1533		132		30111	
1958	2599			151		3166	71		1343	6						17572	427		1593		26928	
1959	2996	1		64		1594	159		69		3456	111		2870		21156	4804		640		37920	
1960	2041					1317	6		97		1187	18		3926	1	20093	127		1024		29837	
1961	1297			273	2	1055	1		47	1	846			1526	7	22277	23	151	1441	16	28963	
1962	1132			10		1097	1		5	2	1235			1076		15566	51	2567	3224		25966	
1963	1019			46		1213	1	6	64		1061	1		2828	195	11002	60	3295	4915	866	26572	
1964	461			1		958			59	52	677	11		2057	2	9810	42	4391	2884	1889	23294	
1965	432			3	3	402			53	84	1201			1806	47	7007	8	42876	1500	96	55518	
1966	149			1		311		516	30		1494			940	9	8259	19	9985	1885	51	23649	
1967	112			9		203		95	26	31	898			839	9	7180	5	459	1046		10912	
1968	144				4	127			70	6	1128		59	1702	23	8392		195	1458	10	13318	
1969	167				3	245				112	726			631	66	8270		235	864	1	11320	
1970	160					395	2		75	1	620		34	830	16	4754	574	636	1332		9429	
1971	151					466			215	1	1133		11	1114		7940	497	464	1477		13469	
1972	60					362	3		136	19	421		3	599	37	2096	70	103	737	102	4748	
1973	21				2	286			76	164	233			431	9	2830	173	76	95	18	4414	
1974	17				14	161			3	1	147		30	174	196	907	6	102	521	78	2357	(0)
1975	35				2	67			15	4	107	1		48	2	1393	20	52	63	59	1868	(0)
1976	12					40				1	52	1	9		1	1198	31	15			1360	(2000)
1977	8					189				8	144				1	2845	1	14		38	3248	(2000)
1978	18					119				3	441		3		38	4949	82	139		109	5901	(2000)
(1)1979	59					194				11	650				3	2339		104		73	3433	(2000)
(1)1980	270					181					1836					12444		247		30	15008	(15000)
1981																						(23000)

(1) Provisional 4/81
(2) Quotas
(3) Catches for 1953-58 are for 4Vn and 4Vs combined.

Table 2. Recent fishery allocations and the respective reported catch for 4VW haddock. (Metric Tons)

Year	Vessel Size	Allocation	Reported Catch	% of Allocation
1975	all vessels	-	-	-
1976	all vessels	1,250	1,263[1]	101
1977	all vessels	1,700	3,086[1]	182
1978	all vessels	1,700*	4,459[1]	262
1979	all vessels	1,700*	2,915[1]	171
1980	> 125 ft.	11,500	10,522[2]	91
	< 125 ft.	3,400	2,105[2]	62
1981	> 125 ft.	16,000	11,915[3]	74
	< 125 ft.	4,500	542[3]	12

* Closed Fisheries

[1] Maritimes and Quebec

[2] Maritimes

[3] Atlantic Quota Report - 29 April 1981

Table 3. Nominal catches (mt) of eastern Scotian Shelf haddock in 4V and 4W (4TVW) by gear type for Canada (M,Q & Nfld.) as reported by NAFO.

Year	Otter Trawler	Longliner	Danish Seiner	Miscellaneous	Total
1960	20835	1077	23	696	22631
1961	22060	448	52	1377	23937
1962	16453	665	76	705	17899
1963	11943	511	147	526	13127
1964	10679	70	62	874	11685
1965	8033	352	66	160	8611
1966	10222	233	19	130	10604
1967	7855	126	25	573	8579
1968	8819	296	16	364	9495
1969	8603	289	30	341	9263
1970	5056	479	20	262	5817
1971	8709	538	77	179	9503
1972	2141	528	76	138	2883
1973	2459	628	28	232	3347
1974	543	493	17	162	1215
1975	593	873	10	82	1558
1976	383	657	10	75	1125
1977	2198	729	26	170	3123
1978	4009	1069	67	364	5509
1979	1745	1232	64	142	3183
1980[1]	13073	899	169	320	14535

[1]Preliminary

Table 4. Nominal catches (mt) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) otter trawlers, as reported to NAFO

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1960	578	3372	4827	1328	1177	597	1427	1678	1543	1199	1665	1442	20833
1961	1387	2761	5029	6605	1389	324	508	489	859	927	1022	488	21788
1962	626	1863	4749	2401	1164	615	954	1079	1015	739	654	449	16308
1963	664	236	388	4444	1357	645	844	1079	1004	434	659	237	11991
1964	406	1531	1473	1557	1155	378	688	1082	804	359	342	638	10413
1965	347	819	1005	1114	986	350	1563	644	109	206	338	363	7844
1966	369	463	3301	1821	2151	264	247	138	136	63	262	101	9316
1967	198	294	4038	800	258	85	263	237	100	526	661	187	7647
1968	254	546	3302	782	730	901	602	114	317	391	650	408	8997
1969	888	1183	3108	1472	852	183	132	106	61	117	81	349	8532
1970	425	480	1436	1459	141	86	398	110	74	78	115	227	5029
1971	408	772	4740	1946	147	225	47	39	16	20	32	200	8592
1972	103	90	1022	280	105	221	19	56	26	18	49	128	2117
1973	93	155	1218	313	150	282	4	2	23	16	32	107	2395
1974	45	78	58	20	24	103	18	43	35	28	30	40	522
1975	25	71	68	124	65	20	85	9	40	34	20	27	588
1976	15	1	18	39	76	102	4	32	17	22	13	42	381
1977	44	90	79	57	217	37	49	114	184	180	297	796	2144
1978	118	151	669	1121	193	25	124	113	58	62	226	66	2926
1979	26	76	157	43	357	136	120	112	45	110	193	268	1643
1980[1]	107	1165	2391	1099	316	486	744	676	411	1108	1444	1466	11413

[1]Preliminary

Table 5. Nominal catches (mt) of eastern Scotian Shelf haddock in 4V and 4W by month by Canadian (MQ) longliners, as reported to NAFO

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1960	50	122	76	66	18	-	133	80	172	25	190	145	1077
1961	3	36	23	35	6	1	8	13	63	64	159	81	492
1962	13	1	74	2	7	6	25	33	67	145	206	86	665
1963	25	3	4	49	9	17	26	30	49	85	68	52	417
1964	3	-	3	5	3	-	-	-	-	23	12	22	71
1965	17	41	27	65	23	10	5	23	28	39	53	21	352
1966	-	24	71	11	-	-	7	12	9	52	30	17	233
1967	3	1	19	10	-	3	7	5	15	29	25	9	126
1968	10	19	17	42	10	10	12	42	42	49	38	6	297
1969	1	1	8	8	4	9	25	56	39	68	53	17	289
1970	19	4	43	22	12	12	25	57	120	110	40	15	479
1971	-	14	12	33	18	26	94	61	106	107	38	29	538
1972	-	-	3	9	17	26	102	88	73	111	81	18	528
1973	1	6	115	149	47	40	39	62	56	78	59	17	669
1974	10	4	16	20	27	44	74	78	59	71	63	27	493
1975	31	37	69	78	93	81	74	138	88	105	57	24	875
1976	20	36	93	113	71	56	106	85	72	70	57	17	796
1977	15	33	55	36	42	86	65	92	72	116	100	34	746
1978	31	63	78	104	121	116	175	166	105	53	49	8	1069
1979	5	18	123	109	129	110	148	215	142	94	109	30	1232
1980[1]	4	2	36	98	103	111	125	189	98	89	32	12	899

[1]Preliminary

Table 6. Derivation of adjusted nominal catches (mt) of eastern Scotian Shelf haddock (4TVW) for 1971-79 by USSR, as determined by International Observer Program.

Year 1	Nominal Catch of 4VW S. Hake in directed S. Hake fishery[1] 2	Nominal Catch of 4VW Haddock in directed S. Hake fishery[1] 3	Nominal Catch of 4VW Haddock in all USSR fisheries[1] 4	Estimated Catch of 4VW Haddock in S. Hake directed fishery[2] 5	Adjusted Catch of 4VW Haddock in all USSR fisheries (Colums (4-3) + 5)
1970	164013	670	670	1230	1230
1971	122413	279	475	918	1114
1972	107969	102	106	810	814
1973	268511	76	76	2014	2014
1974	81181	91	132	609	650
1975	95298	52	52	715	715
1976	70054	18	24	525	531
1977	20145	10	14	121	125
1978	41243	132	142	371	381
1979[3]	43936	?	104	395	395

[1] As reported to NAFO

[2] As estimated from Observer Program

[3] Reported in NAFO STATLANT Output, March 1981.

Table 7. Derivation of adjusted nominal catch (mt) of eastern Scotian Shelf haddock (4TVW) for 1980 by foreign countries, as determined by International Observer Program.

Country	Directed Species	Nominal Catch of 4VW Haddock in all fisheries[1]	Nominal Catch of 4VW Haddock in all fisheries[2]	Nominal Catch of 4VW Haddock in directed fisheries[3]	Nominal Catch of Directed species[3]	Nominal Catch of Directed species[2]	Ratio (5 ÷ 6)	Estimated bycatch of 4VW Haddock in directed fishery (8 x 7)
1	2	3	4	5	6	7	8	
Bulgaria	S. H.	-	3.22	2.07	516.4	687.4	0.004	2.75
Cuba	S. H.	20	19.27	14.60	1105.7	2110.6	0.013	27.44
France	Sq.	-	0.41	1.13	366.9	364.0	0.003	1.09
Japan	Sq.	10	5.84	29.16	8115.8	15835.7	0.004	63.34
Poland	Sq.	-	-	-	488.5	488.8	-	-
Portugal	Sq.	-	1.88	3.60	931.3	1646.7	0.004	6.59
Spain	Sq.	-	1.44	1.07	869.3	4817.0	0.001	4.82
USSR	S. H.	247	161.6	202.90	22990.1	38450.2	0.009	346.05
Total		277	193.7	254.53	-	-	-	452.08

[1] As reported to NAFO

[2] As reported to FLASH

[3] As reported to International Observer Program

Table 8a. *REMOVALS AT AGE ('000) FOR THE 4VW HADDOCK STOCK (REV.)* 2/ 7/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	348	309	295	329	38	386	294	37	141	1	41
2	132	681	207	1132	224	55	613	149	165	146	6
3	675	849	600	545	948	404	144	986	860	472	2365
4	1718	2126	718	1359	240	736	191	413	2234	1196	4275
5	1407	2651	911	806	449	272	244	542	434	669	3134
6	1381	1177	675	703	291	183	144	245	725	156	1663
7	1196	918	339	325	109	63	102	94	211	142	259
8	390	1150	186	155	44	30	29	56	62	14	122
9	91	270	155	69	8	8	6	14	24	6	38
10	38	38	10	102	14	4	7	8	9	4	12
11	18	20	18	2	12	1	2	5	2	2	8

Table 8b. Parameters used to calculate removals at age

PERIOD	A	B	RESEARCH SURVEY	
1970-1975	0.00885	3.039	Summer	1975
1976	0.00553	3.160	"	1976
1977	0.00909	3.041	"	1977
1978	0.00580	3.152	"	1978
1979	0.00640	3.126	"	1979
1980	0.00369	3.268	"	1980

Table 9a. Check on average weights used to calculate removals at age for Table 8.

Period		Gear	Sample Wt. (kg round)[1]	Number in Sample[1]	Average Weight (kg round) (A) of Sample	(B) Determined Using Length-Weight Relation	Ratio A/B
Jan-June	'80	OTB	9,152	6,668	1.37	1.406	0.98
July-Dec	'80	OTB	9,062	7,104	1.28	1.098	1.16
Jan-Dec	'80	LL	2,497	1,538	1.62	1.638	0.99
Jan-Dec	'79	OTB	3,084	2,169	1.42	1.380	1.03
"	'79	LL	4,105	2,766	1.48	1.448	1.02
"	'78	OTB	9,547	7,688	1.24	1.282	0.97
"	'78	LL	2,127	1,289	1.65	1.638	1.01
"	'77	OTB	5,857	4,506	1.30	1.236	1.05
"	'76	OTB	1,429	1,727	0.83	0.799	1.04
"	'75	OTB	1,480	1,273	1.16	1.254	0.93
"	'74	OTB	435	364	1.20	1.183	1.01
"	'73	OTB	2,613	1,898	1.38	1.364	1.01
"	'72	OTB	2,686	1,868	1.44	1.482	0.97
"	'71	OTB	10,040	7,245	1.39	1.477	0.94
"	'70	OTB	3,119	2,172	1.44	1.378	1.04

[1] excludes samples for which no weight was recorded

Table 9b. *PREVIOUS[1] REMOVALS AT AGE ('000) FOR THE 4VW HADDOCK STOCK* 2/ 7/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	231	179	453	290	26	318	348	36	105	1
2	85	430	100	1048	216	36	484	127	182	198
3	443	586	447	439	624	319	124	832	565	567
4	1069	1490	505	1050	158	572	195	363	1432	1322
5	886	1890	619	638	269	218	253	430	299	650
6	888	835	429	560	200	140	140	201	499	125
7	768	647	225	240	71	49	122	66	143	98
8	238	818	124	127	27	23	27	38	42	7
9	53	194	101	48	7	6	6	12	19	4
10	22	26	11	75	8	3	8	7	6	1
11	10	14	11	1	8	1	7	6	5	1

[1] CAFSAC Res. Doc. 80/61

Table 10a. Percent age composition (numbers) for commercial removals.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	5	3	7	6	2	18	16	1	3	0	0
2	2	7	5	20	9	3	34	6	3	5	0
3	9	8	15	10	40	19	8	39	18	17	20
4	23	21	17	25	10	34	11	16	46	43	36
5	19	26	22	15	19	13	13	21	9	24	26
6	19	12	16	13	12	9	8	10	15	6	14
7	16	9	8	6	5	3	6	4	4	5	2
8	5	11	5	3	2	1	2	2	1	1	1
9	1	3	4	1	0	0	0	1	0	0	0
10	1	0	0	2	1	0	0	0	0	0	0
11	0	0	0	0	1	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	2	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0

Table 10b. Percent age composition (round weight) of removals.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	9	1	0	0	0
3	3	3	5	4	19	11	6	27	8	7	11
4	15	14	13	25	10	42	11	16	41	38	29
5	18	26	24	22	28	21	23	26	12	31	30
6	23	14	23	20	24	13	23	15	25	10	22
7	25	14	14	14	10	7	18	7	9	11	4
8	10	20	9	6	5	4	6	5	3	1	2
9	2	6	9	3	1	1	1	1	1	1	1
10	1	1	0	6	2	0	2	1	1	0	0
11	1	1	1	0	1	0	1	1	0	0	0
12	1	1	0	0	0	0	1	1	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0

Table 11. Catch rates (mt/hr fishing) exhibited by Canadian otter trawl fishery (side and stern) during the February-June period from 1970 to the present.

Year	Tonnage Class 3	Tonnage Class 4	Tonnage Class 5
1970	0.349	0.366	0.475
1971	0.158	0.332	0.497
1972	0.143	0.245	0.311
1973	-	0.212	0.364
1974	-	0.201	0.240
1975	0.124	0.275	0.298
1976	0.080	0.318	0.191
1977	0.188	0.228	0.413
1978	0.413	0.665	0.737
1979	0.189	0.492	0.484
1980	0.450	0.863	1.690

Table 12a. Catch (number of fish) per standard tow by groundfish surveys in 4VW

A - mean for all 27 strata
B - excluding strata with only one set

MONTH	YEAR	STRATIFIED MEAN CATCH PER STANDARD TOW A	B	STRATIFIED ESTIMATE OF THE VARIANCE OF B	(n)
June	1970	8.87	8.91	6.12	26
June	1971	8.00	8.00	6.18	27
June	1972	4.41	4.41	1.39	27
June	1973	3.71	3.71	1.13	27
June	1974	6.16	6.36	7.18	26
June	1975	8.90	8.90	8.59	27
June	1976	8.80	9.50	7.74	25
June	1977	25.87	25.99	56.08	26
June	1978	37.75	37.91	209.48	26
Nov.	1978	47.30[1]	-	-	-
June	1979	28.91	28.91	78.82	27
March	1979	18.56[1]	-	-	-
June	1980	37.74	37.71	128.69	27

[1] Corrected for differences in fishing power, for area 4VsW (strata 43-66)

Table 12b. Catch (kg) per standard tow by summer groundfish survey in 4VW

AREA
(Strata)

YEAR	4Vn 40-42	4Vs 43-46	4Vs 47-52	4V[1] 50-52	4W 53-66	4VW[2] 40-66
1970	2.38	-	15.13	5.11	10.59	8.03
1971	0.00	0.19	1.50	0.52	9.01	5.18
1972	0.00	1.92	2.63	1.67	4.16	3.04
1973	0.15	0.13	0.90	0.36	5.07	2.94
1974	0.00	-	1.54	0.44	9.09	5.19
1975	0.37	0.00	2.57	0.83	12.33	7.14
1976	1.64	-	2.57	1.13	8.07	4.94
1977	3.08	0.17	7.28	2.90	28.86	17.15
1978	0.87	-	0.03	0.21	40.38	22.26
1979	0.11	0.16	0.97	0.38	40.18	22.22
1980	0.50	0.60	2.39	1.09	60.01	33.43

[1] 4V = 0.2367 x 4Vn + 0.4758 (43-46) + 0.2875 (47-52)

[2] 4VW = 0.4512 x 4V + 0.5488 x 4W

GROUNDFISH SURVEY STRATIFIED MEAN CATCH PER TOW
4VW HADDOCK SUMMER SURVEY
FOR YEARS 1970 - 1980, *AGES* 0-11, 12+,*UK*
VESSEL: A.T. CAMERON

Table 13. *4VW HADDOCK R.V. SURVEY STRATIFIED MEAN CATCH PER TOW* 19/ 4/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	0.09	0.05	0.01	0.00	0.19	0.06	0.25	0.21	0.00	1.24	1.20
1	2.27	1.44	1.10	0.48	0.30	3.85	2.74	5.01	8.25	0.07	2.93
2	0.84	3.02	0.74	1.59	1.79	0.55	3.01	9.49	9.23	7.61	0.23
3	1.53	1.00	1.08	0.48	2.42	1.60	0.42	7.49	12.34	8.28	12.40
4	1.70	1.32	0.49	0.45	0.44	1.43	0.82	1.02	6.93	8.61	11.60
5	0.82	0.52	0.41	0.16	0.45	0.37	0.79	1.62	0.43	2.41	7.21
6	0.52	0.30	0.31	0.33	0.23	0.68	0.18	0.60	0.41	0.31	1.74
7	0.58	0.14	0.12	0.07	0.17	0.17	0.19	0.17	0.10	0.25	0.28
8	0.30	0.21	0.06	0.08	0.07	0.07	0.05	0.10	0.01	0.08	0.10
9	0.13	0.01	0.03	0.03	0.04	0.04	0.01	0.00	0.00	0.00	0.02
10	0.03	0.00	0.02	0.04	0.03	0.04	0.01	0.06	0.01	0.03	0.00
11	0.03	0.00	0.00	0.00	0.03	0.00	0.01	0.01	0.01	0.02	0.00
12+	0.04	0.00	0.00	0.00	0.00	0.02	0.05	0.02	0.00	0.01	0.00
UK	0.00	0.00	0.04	0.00	0.01	0.01	0.27	0.08	0.03	0.00	0.04

Table 14 . *PERCENT AGE COMPOSITION OF RESEARCH SURVEY CATCHES (NOS.)* 6/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	25.94	18.06	25.25	12.95	5.09	43.71	33.27	19.62	21.87	0.27
2	9.66	38.04	17.05	42.93	29.96	6.20	36.54	37.13	24.45	27.50
3	17.51	12.53	24.79	12.89	40.53	18.15	5.14	29.30	32.72	29.93
4	19.48	16.56	11.22	12.12	7.39	16.24	10.00	3.98	18.38	31.09
5	9.32	6.58	9.35	4.44	7.61	4.25	9.57	6.33	1.13	8.72
6	5.98	3.71	7.02	8.88	3.78	7.76	2.13	2.34	1.08	1.13
7	6.64	1.73	2.81	1.85	2.82	1.97	2.33	0.67	0.28	0.89
8	3.38	2.64	1.39	2.22	1.13	0.81	0.60	0.39	0.03	0.30
9	1.43	0.14	0.76	0.74	0.64	0.44	0.13	0.00	0.00	0.00
10	0.31	0.00	0.38	0.98	0.50	0.48	0.13	0.22	0.03	0.12
11	0.34	0.00	0.00	0.00	0.54	0.00	0.13	0.02	0.04	0.06

	1980
1	8.02
2	0.63
3	33.97
4	31.79
5	19.75
6	4.77
7	0.76
8	0.27
9	0.05
10	0.00
11	0.00

Table 15a. 4VW haddock weight-at-age (kg) as derived from the Canadian commercial sampling - both mid-year (a) and beginning of year (b) estimates.

ESTIMATED WEIGHT AT AGE 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.15	0.15	0.15	0.15	0.15	0.15	0.09	0.13	0.08	0.11	0.08
2	0.41	0.41	0.41	0.41	0.41	0.41	0.34	0.56	0.31	0.32	0.33
3	0.66	0.69	0.72	0.72	0.65	0.81	0.67	0.91	0.68	0.72	0.69
4	0.92	0.99	1.05	1.03	1.17	1.23	1.16	1.21	1.09	1.15	1.02
5	1.23	1.30	1.40	1.38	1.60	1.58	1.58	1.51	1.54	1.60	1.42
6	1.56	1.65	1.77	1.84	2.05	1.99	2.07	1.88	2.00	2.04	1.88
7	1.98	2.01	2.18	2.17	2.52	2.45	2.44	2.31	2.45	2.46	2.36
8	2.41	2.34	2.51	2.61	2.88	2.89	2.77	2.68	2.81	2.83	2.90
9	2.85	2.66	2.93	2.96	3.13	3.25	3.13	3.07	3.26	3.22	3.48
10	3.32	3.05	3.25	3.19	3.39	3.27	3.36	3.45	3.85	3.49	4.01
11	3.74	3.32	3.45	2.94	3.59	4.62	3.74	3.86	4.25	3.77	4.83
12	4.09	3.66	-	3.65	-	3.67	3.80	4.17	-	3.70	5.92
13	4.78	3.92	3.82	4.76	3.82	4.69	3.70	4.27	3.68	4.26	-
14	5.37	4.47	-	5.15	-	-	-	-	5.42	4.48	-
15	-	4.30	-	-	-	-	-	-	-	3.64	-
16	-	-	-	-	-	-	-	-	-	-	-

Table 15b.

ESTIMATED WEIGHT AT AGE AT BEGINNING OF THE YEAR 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	
1	0.07	0.07	0.07	0.07	0.07	0.07	0.03	0.06	0.03	0.05	0.03	0.03
2	0.27	0.27	0.26	0.26	0.26	0.26	0.21	0.43	0.18	0.20	0.22	0.22
3	0.52	0.54	0.55	0.55	0.46	0.63	0.49	0.78	0.51	0.55	0.55	0.55
4	0.77	0.83	0.87	0.86	0.94	1.03	0.94	1.07	0.88	0.95	0.83	0.83
5	1.06	1.13	1.21	1.19	1.36	1.36	1.36	1.34	1.31	1.38	1.20	1.20
6	1.38	1.48	1.59	1.65	1.82	1.77	1.86	1.69	1.78	1.82	1.63	1.63
7	1.79	1.83	1.99	1.99	2.32	2.24	2.24	2.10	2.23	2.25	2.11	2.11
8	2.20	2.17	2.32	2.42	2.71	2.68	2.61	2.49	2.62	2.64	2.64	2.64
9	2.64	2.49	2.75	2.78	2.99	3.03	2.97	2.88	3.07	3.04	3.21	3.21
10	3.10	2.88	3.10	3.04	3.28	3.15	3.23	3.26	3.64	3.33	3.74	3.74
11	3.53	3.17	3.30	2.86	3.50	4.33	3.60	3.68	4.05	3.63	4.51	4.51
12	3.89	3.51	-	3.52	-	3.58	3.69	4.00	-	3.59	5.56	5.56
13	4.55	3.78	3.75	4.56	3.75	4.52	3.64	4.13	3.62	4.16	-	-
14	5.10	4.33	-	4.96	-	-	-	-	5.26	4.39	-	-
15	-	4.19	-	-	-	-	-	-	-	4.56	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-

Table 16. Summary of SURVIVOR Runs

Ages First-Last	First Year	Calibration Block Final Year	Calibration Block Oldest Year	Full Recruitment Age	Final K for Age 6	Residuals Mean	Residuals SD	CV in Last Year min. - max.	Outliers Year	Outliers Age
						0.0386	0.4389	39.44 - 74.12		
2-8	1970	1977	5	4	3406	0.0386*	0.4389*	39.44 - 74.12*	1973	5
									1975	6
									1977	7
2-8	1970	1978	5	4	3188	0.0306	0.4404	37.46 - 71.26	1973	5
									1975	6
									1977	7
2-8	1970	1979	5	4	3237	0.0435	0.4395	36.38 - 68.08	1973	5
									1975	6
									1977	7

* Second run with same parameters using estimated SURVIVORS of first run as initial data

Table 17. Results of 'SURVIVOR' calibration block 1970 through 1977, ages 2 through 5

FINAL ITERATION (2)

POPULATION NUMBERS 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	5066	5949	2449	5413	5487	3608	20255	48120	43528	41182	1062
3	6610	3687	4292	1657	3494	4204	2862	15850	38924	35342	32528
4	6045	4109	2312	2609	1008	2102	3177	2085	11489	30929	26698
5	3187	2947	2016	1200	1338	592	1288	2261	1322	8126	23316
6	2250	1444	951	924	498	815	300	833	1273	821	5574
7	2149	811	514	333	402	252	540	138	476	662	482
8	1008	698	180	202	112	268	166	371	44	292	423

ESTIMATED SURVIVORS 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	0	2479	274	778	1068	0	1641	17392	21465	23746	958
3	0	108	181	34	2003	849	0	9833	23073	18140	39465
4	0	380	0	0	211	1382	173	999	11602	18406	33723
5	0	0	0	0	412	348	950	1938	395	4319	20721
6	0	0	136	348	299	1226	191	987	397	494	4572
7	0	0	37	6	355	387	394	341	168	452	733
8	727	100	97	180	187	206	139	279	4	247	248

RMS=0.4232309835

ESTIMATED SURVIVORS FOR AGE 8 (WEIGHTED)

YEAR	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(o/o)
1970	727	374380	612	84.17
1971	84	157727	397	472.95
1972	74	11826	109	147.09
1973	109	15369	124	113.94
1974	80	7412	86	106.98
1975	228	14471	120	52.77
1976	136	6474	80	59.12
1977	309	22279	149	48.31
1978	10	502	22	223.63
1979	258	14142	119	46.18
1980	325	28132	168	51.67

ESTIMATED SURVIVORS FOR 1980 (WEIGHTED)

AGE	SURVIVORS	VARIANCE	STANDARD ERROR	C.V.(o/o)
2	958	414877	644	67.26
3	28306	214922813	14660	51.79
4	22122	104081035	10202	46.12
5	19605	59787873	7732	39.44
6	4252	4421260	2103	49.46
7	313	53786	232	74.12
8	325	28132	168	51.67

FINAL ESTIMATION FOR K

AGE	K	LN(K)	VAR(LN(K)	STANDARD ERROR	D.F
2	4600.67	8.3363	0.1954	0.1563	3
3	3617.08	8.0818	0.2233	0.1671	3
4	3405.65	8.0355	0.1954	0.1105	15
5	3405.65	8.0355	0.1954	0.1105	15
6	3405.65	8.0355	0.1954	0.1105	15
7	3405.65	8.0355	0.1954	0.1105	15
8	3405.65	8.0355	0.1954	0.1105	15

Table 17. (continued)

RESIDUALS (MODIFIED CALCULATION) 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	¯0.3627	0.7519	0.2357	0.2043	0.3057	¯0.4610	¯0.4790	¯0.1949	¯0.1229	¯0.2596	¯0.0977
3	¯0.2882	¯0.1349	¯0.2054	¯0.0695	0.8049	0.2066	¯0.7378	0.4243	0.0254	¯0.2767	0.2098
4	¯0.1385	¯0.0108	¯0.4258	¯0.6314	0.3007	0.7423	¯0.2227	0.4106	0.6225	¯0.1515	0.2945
5	¯0.2351	¯0.6015	¯0.4713	¯0.8589	0.0462	0.6674	0.6359	0.7929	¯0.0001	¯0.0866	¯0.0462
6	¯0.3311	¯0.4602	¯0.0063	0.0962	0.3339	0.9520	0.5937	0.7965	¯0.0083	0.1624	¯0.0362
7	¯0.1809	¯0.6441	¯0.3081	¯0.4552	0.2568	0.7546	0.0950	1.3427	¯0.3905	0.1335	0.5771
8	¯0.0977	¯0.0721	0.0364	0.2325	0.6212	¯0.1945	¯0.0815	¯0.1896	¯0.2496	¯0.1389	¯0.3205

MEAN OF RESIDUALS=0.03855540169
STANDARD DEVIATION OF RESIDUALS=0.4389019591

OUTLIERS OF RESIDUALS 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	¯0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 17. (continued)

ANALYSIS OF VARIANCE

SOURCE		B	STAND ERROR OF B
CONSTANT		0.038	
AGE	3	0.041	0.177
	4	0.152	0.187
	5	0.098	0.204
	6	0.336	0.226
	7	0.280	0.251
	8	0.108	0.257
YEAR	1971	0.038	0.223
	1972	-0.029	0.231
	1973	-0.179	0.243
	1974	0.382	0.259
	1975	0.363	0.279
	1976	-0.093	0.302
	1977	0.399	0.328
	1978	-0.123	0.355
	1979	-0.177	0.382
	1980	0.011	0.362
YRCLASS	1963	-0.378	0.393
	1964	-0.595	0.347
	1965	-0.394	0.314
	1966	-0.392	0.289
	1967	-0.405	0.271
	1968	-0.363	0.251
	1969	-0.192	0.266
	1970	0.117	0.272
	1971	0.114	0.282
	1972	-0.165	0.289
	1973	-0.261	0.314
	1974	-0.078	0.342
	1975	-0.230	0.375
	1976	-0.041	0.412
	1977	0.000	0.461

SUMMARY OF ANALYSIS OF VARIANCE

SOURCE	SS	DF	MS	F
CONSTANT	0.1115	1		
AGE	0.65135	6	0.1086	0.647
YEAR	4.23016	10	0.4230	2.522
YRCLASS	2.04282	16	0.1277	0.761
RESIDUALS	7.71590	44	0.1754	
TOTAL	14.75174	77		

Table 18. Results of 'Cohort' for 'survivor' - derived starting F values

POPULATION NUMBERS 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	5297	5940	2949	5923	5456	4003	22659	53216	48147	45559	1185
3	6973	4218	4248	2227	3825	4265	3228	17997	43435	39270	37168
4	7463	5098	2685	2935	1330	2274	3126	2512	13842	34784	31724
5	4069	4555	2250	1549	1173	872	1195	2387	1683	9312	27396
6	3253	2058	1330	1018	539	555	468	758	1464	985	7018
7	3386	1413	620	479	198	179	288	253	399	542	665
8	817	1691	327	201	98	63	89	144	122	136	315
9	202	316	344	99	25	40	24	47	67	44	98
10	79	83	14	141	18	13	26	14	26	33	31
11	43	31	33	2	23	2	7	15	5	13	23
2+	31582	25403	14801	14574	12685	12265	31111	77343	109189	130678	105625
3+	26285	19463	11852	8651	7229	8262	8451	24126	61042	85119	104440
4+	19311	15245	7604	6424	3404	3997	5223	6129	17607	45848	67272
5+	11848	10147	4919	3489	2074	1724	2097	3617	3765	11065	35547

FISHING MORTALITY 4/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
2	0.028	0.135	0.081	0.237	0.046	0.015	0.030	0.003	0.004	0.004	0.006
3	0.113	0.252	0.170	0.315	0.320	0.111	0.051	0.062	0.022	0.013	0.073
4	0.294	0.618	0.350	0.717	0.222	0.443	0.070	0.200	0.196	0.039	0.160
5	0.481	1.031	0.593	0.855	0.550	0.422	0.256	0.289	0.336	0.083	0.135
6	0.634	0.999	0.822	1.439	0.905	0.455	0.415	0.442	0.793	0.192	0.301
7	0.495	1.264	0.926	1.389	0.944	0.499	0.495	0.530	0.877	0.342	0.554
8	0.749	1.393	0.996	1.886	0.681	0.745	0.442	0.567	0.818	0.124	0.550
9	0.690	2.895	0.691	1.486	0.444	0.251	0.326	0.387	0.510	0.151	0.550
10	0.747	0.706	1.632	1.624	1.901	0.437	0.357	0.959	0.480	0.138	0.550
11	0.626	1.219	0.915	1.571	0.843	0.566	0.451	0.513	0.830	0.219	0.469
7+	0.555	1.458	0.890	1.544	0.880	0.515	0.466	0.540	0.809	0.282	0.551

Table 19. Results of traditional sequential population analysis

POPULATION NUMBERS ('000) 6/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	7782	4128	8015	8213	6999	31497	54131	67792	80173	652	4546
2	5469	6057	3101	6295	6427	5696	25438	44052	55471	65512	533
3	7016	4358	4342	2350	4130	5060	4614	20272	35932	45265	53504
4	7507	5133	2800	3012	1431	2523	3777	3647	15705	28640	36632
5	4103	4591	2278	1642	1236	954	1398	2919	2612	10836	22366
6	3261	2087	1360	1040	616	605	535	923	1899	1744	8266
7	3398	1420	643	502	215	241	329	307	534	898	1287
8	821	1700	332	219	116	77	139	176	166	247	606
9	207	319	351	102	39	55	35	87	93	79	189
10	79	87	16	147	21	24	37	23	59	54	60
11	46	30	37	3	27	4	16	24	12	40	40
	39691	29910	23274	23526	21256	46733	90449	140223	192654	153967	128026

FISHING MORTALITY 6/ 5/81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0.051	0.086	0.042	0.045	0.006	0.014	0.006	0.001	0.002	0.002	0.010
2	0.027	0.133	0.077	0.222	0.039	0.011	0.027	0.004	0.003	0.002	0.012
3	0.113	0.243	0.166	0.296	0.293	0.092	0.035	0.055	0.027	0.012	0.050
4	0.292	0.613	0.333	0.691	0.205	0.390	0.058	0.134	0.171	0.047	0.138
5	0.476	1.017	0.584	0.781	0.515	0.379	0.215	0.230	0.204	0.071	0.167
6	0.632	0.977	0.796	1.376	0.740	0.409	0.356	0.348	0.549	0.104	0.250
7	0.493	1.253	0.877	1.262	0.834	0.351	0.423	0.415	0.573	0.193	0.250
8	0.746	1.377	0.976	1.534	0.548	0.572	0.266	0.439	0.536	0.067	0.250
9	0.666	2.770	0.674	1.397	0.290	0.195	0.215	0.196	0.352	0.087	0.250
10	0.758	0.656	1.474	1.497	1.544	0.219	0.241	0.507	0.190	0.099	0.250
11	0.580	1.238	0.817	1.222	0.669	0.360	0.254	0.325	0.368	0.096	0.250
	0.253	0.574	0.250	0.365	0.150	0.058	0.023	0.022	0.031	0.021	0.110

Table 20. Correction of bias in 'survivor' based population biomass estimates

YEAR	RESEARCH SURVEY	2+ BIOMASS (MT) 'SURVIVOR' BASED SPA	RATIO SURVEY/SPA
1974	16,151	8,102	1.99
1975	18,833	8,662	2.17
1976	14,057	14,133	0.995
1977	47,950	38,165	1.26
1978	63,710	56,585	1.13
1979	65,152	79,652	0.82
1980	100,416	88,036	1.14
		geometric mean ratio:	1.28
		corrected SPA estimated of 1980 2+ biomass:	113,000

Table 21 Input conditions and results of projections

AGE	WEIGHT	PR	TRADITIONAL 1980 POPULATION (NUMBERS x 10^{-3})	PR	'SURVIVOR' DERIVED 1980 POPULATION (NUMBERS x 10^{-3}) 1.2X	1.4X
1	0.1	0.04	4,546	-	-	-
2	0.379	0.05	533	0.007	1,422	1,659
3	0.752	0.18	53,504	0.05	44,602	52,035
4	1.118	0.55	36,632	0.2	38,069	44,414
5	1.516	0.67	22,366	0.3	32,875	38,354
6	1.951	1	8,266	0.7	8,422	9,825
7	2.395	1	1,287	1	798	931
8	2.806	1	606	1	378	441
9	3.256	1	189	1	118	137
10	3.699	1	60	1	37	43
11	4.175	1	40	1	28	32
12	4.597	-	-	1	0	0
13	4.07	-	-	1	0	0
14	4.95	-	-	1	0	0
15	4.64	-	-	1	0	0
	$F_{0.1}$		0.30		0.28	
	F_{MAX}		0.56		0.84	
PROJECTED CATCHES (10^{-3} mt)						
	1981 (QUOTA)		23		23	23
	1982 ($F_{0.1}$)		24		20	24
	1983 ($F_{0.1}$)		22		21	26

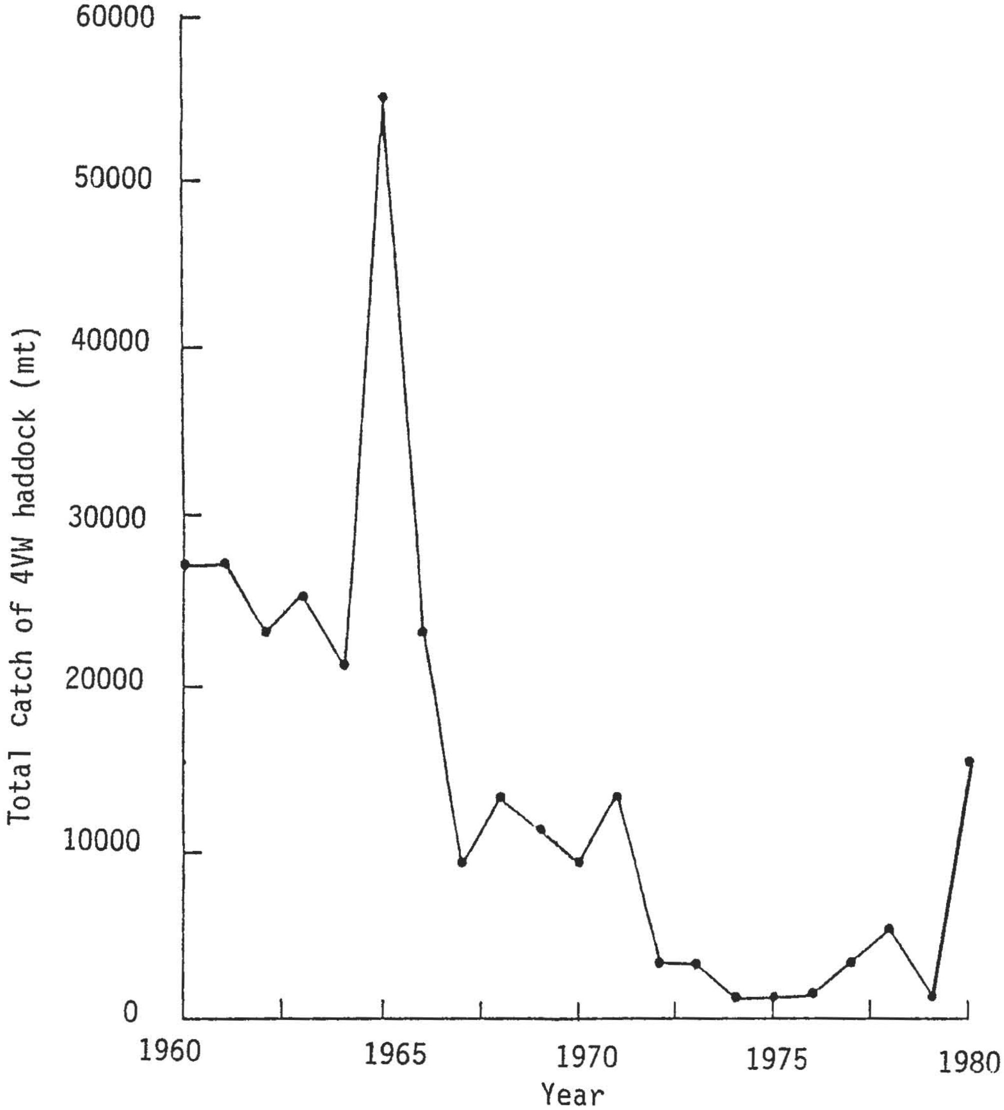


Figure 1. Nominal catches of Div. 4VW haddock (mt) value for 1980 is preliminary.

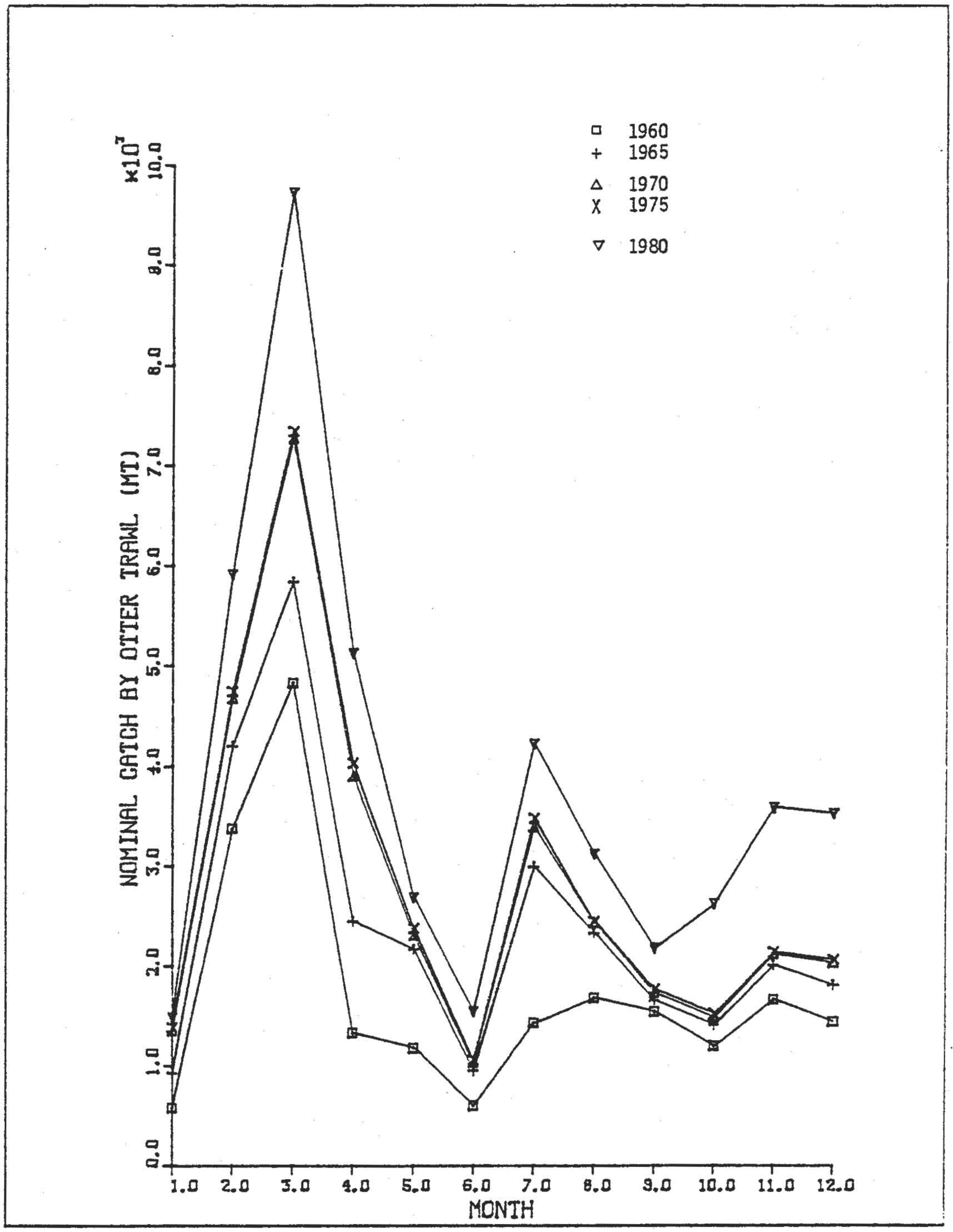


Figure 2a. Seasonal Distribution of 4VW Haddock landings by the otter trawler fleet since 1960. Each year is cumulated with the previously indicated years.

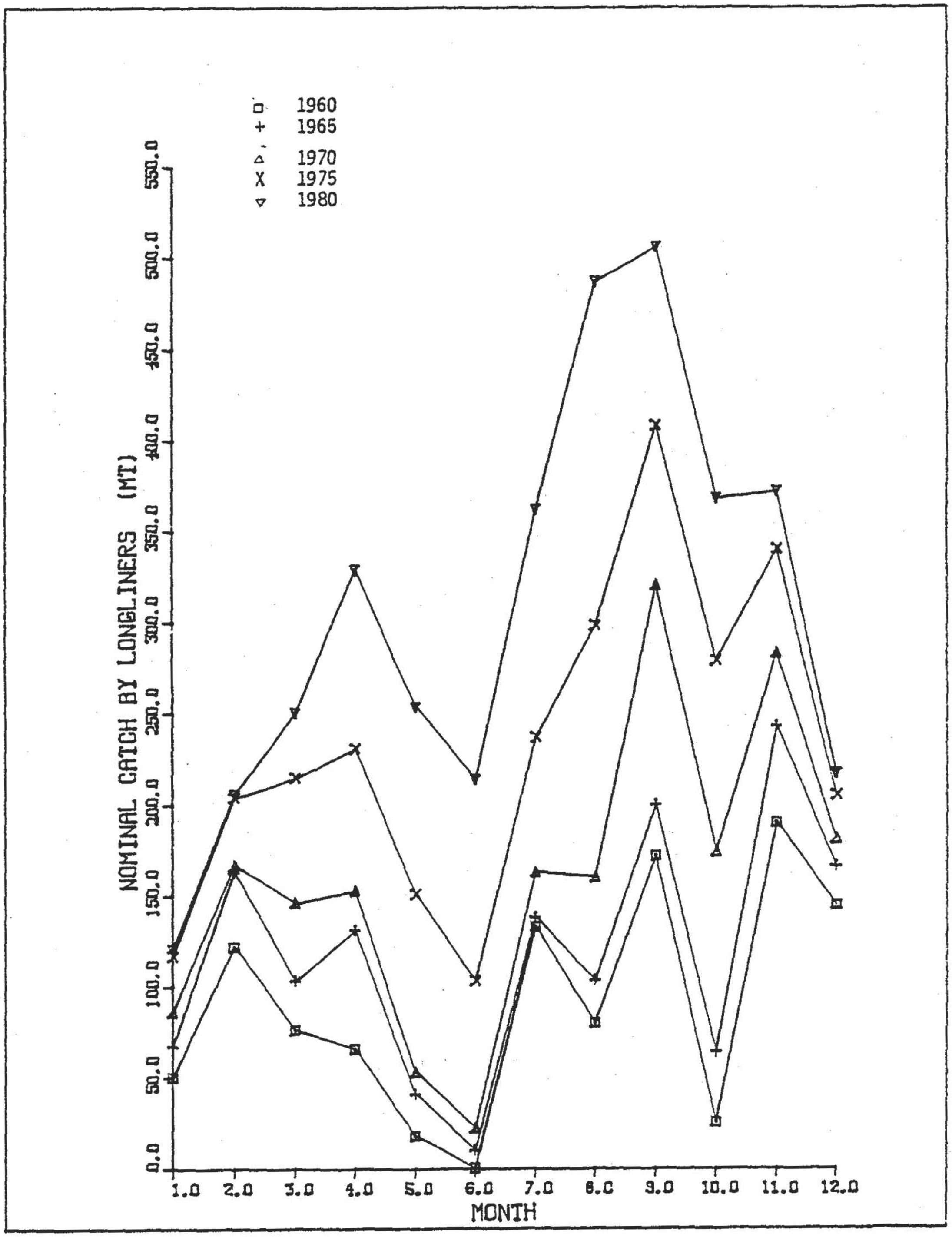


Figure 2b. Seasonal Distribution of 4VW Haddock landings by the longliner fleet since 1960. Each year is cumulated with the previously indicated years.

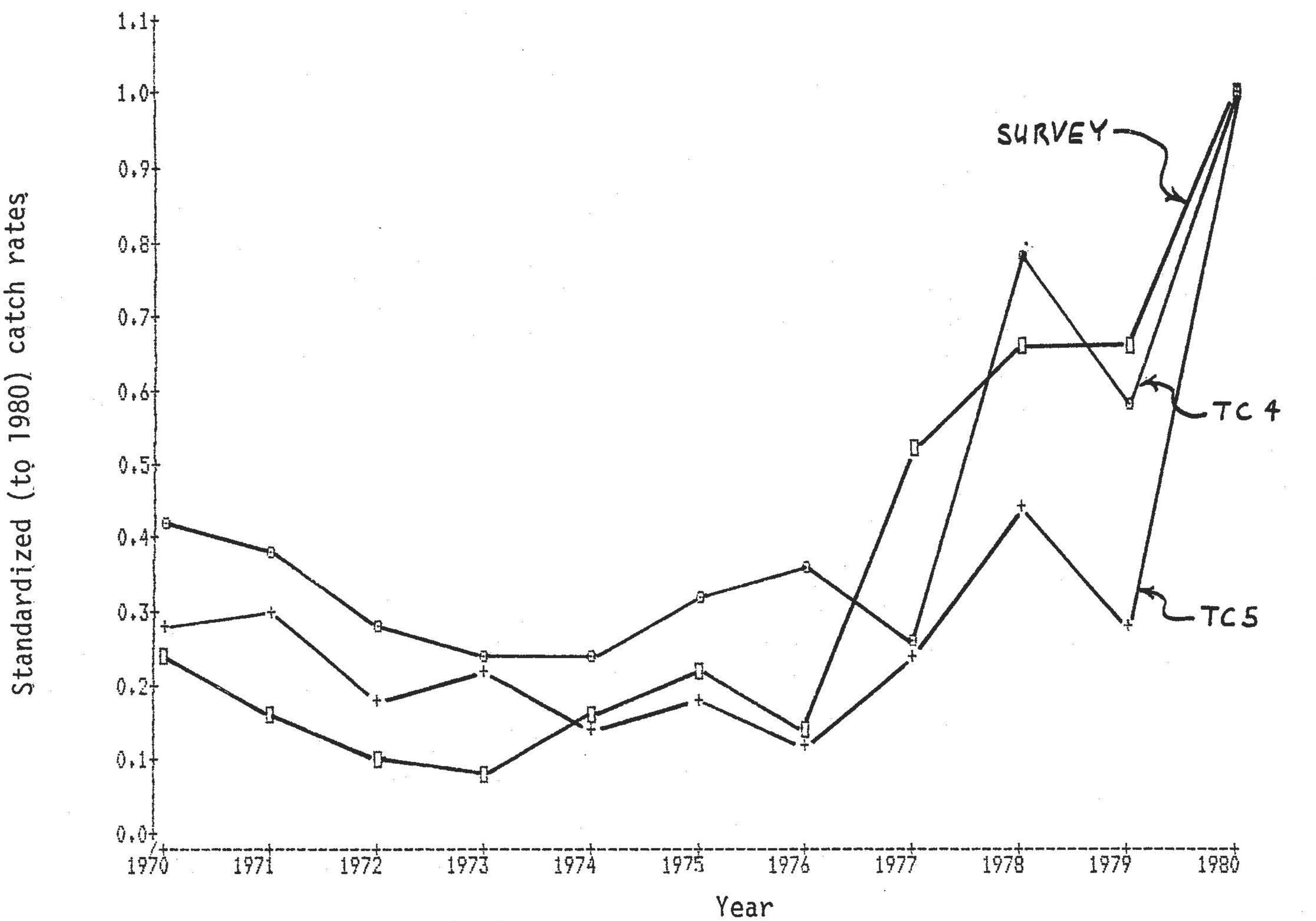


Figure 3. 1970-1980 trends in standardized (to 1980) catch rates (weight/time) in Canadian Otter Trawler fishery (TC 4 and TC 5) and Canadian Summer Bottom Trawl Survey

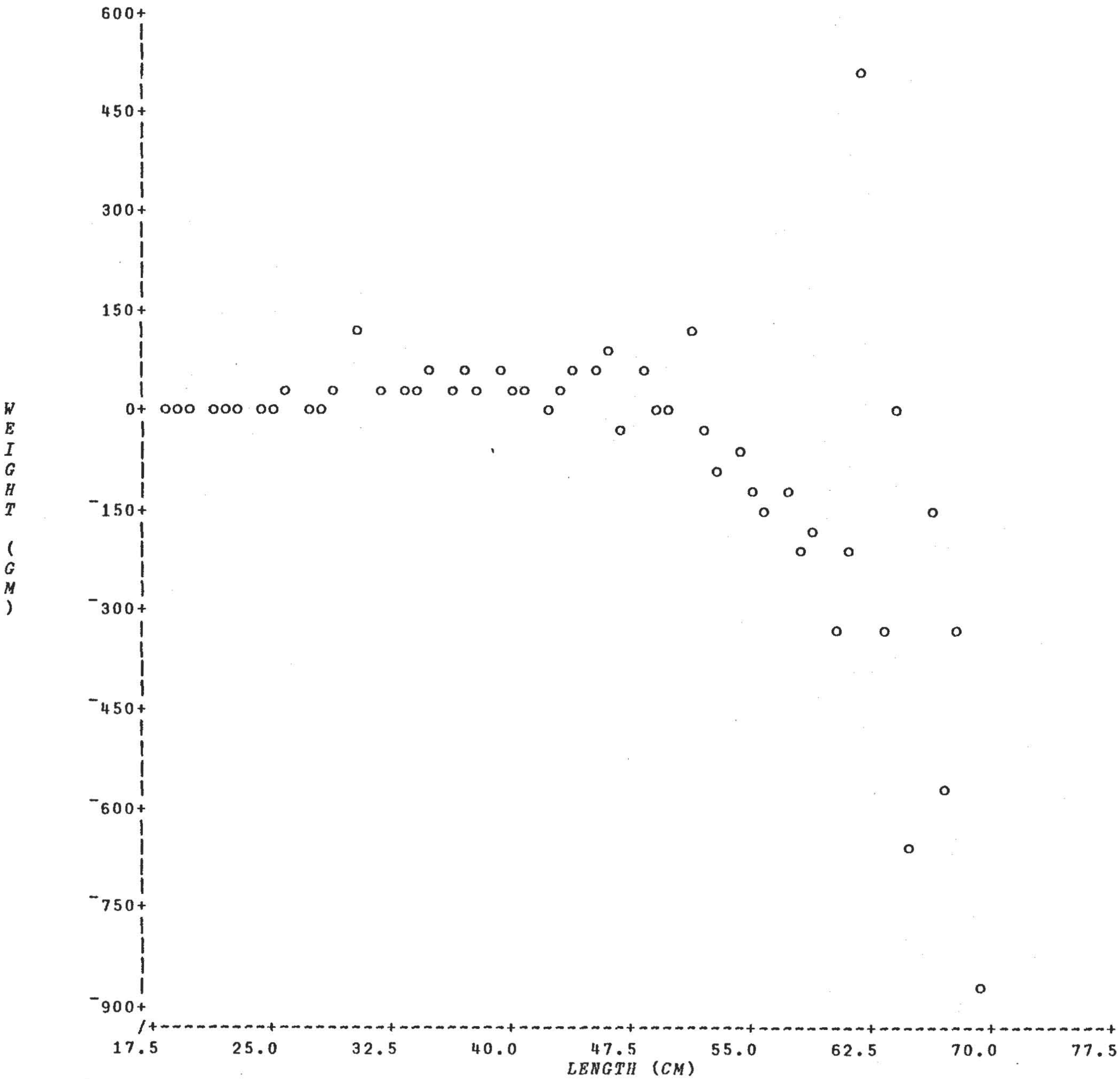
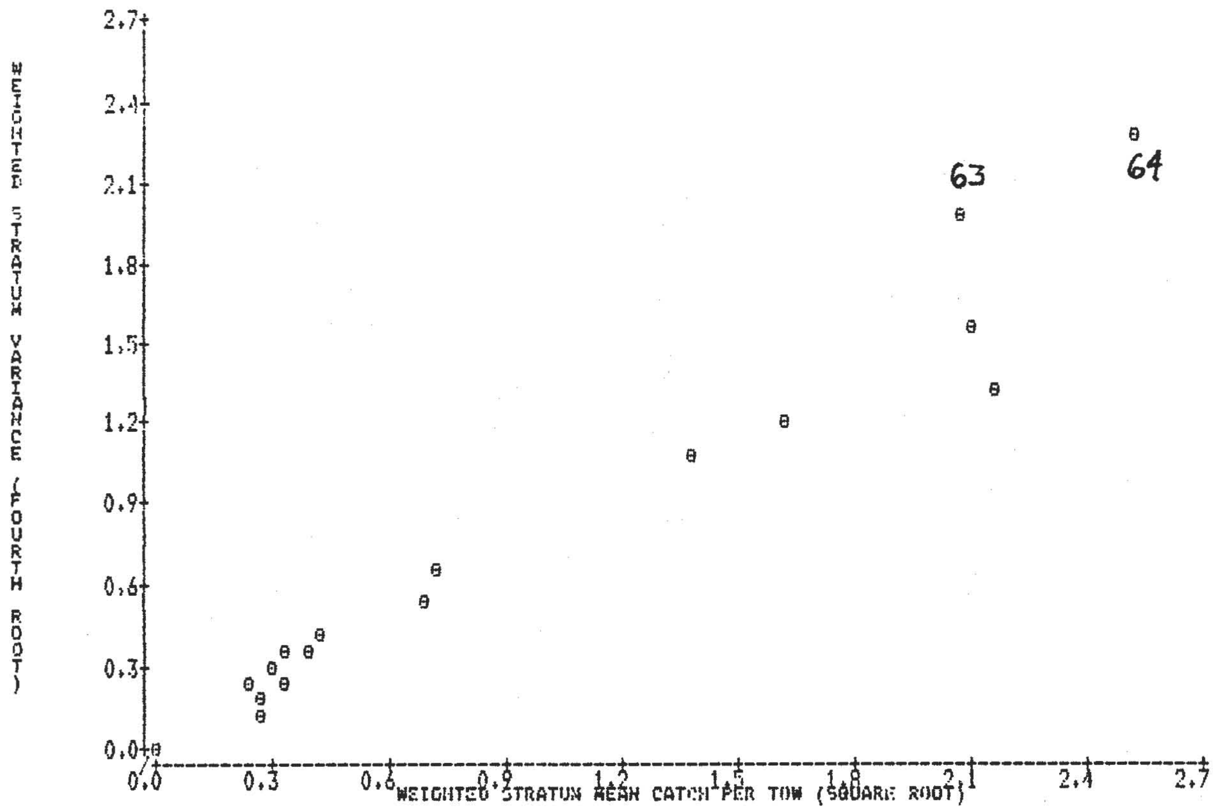


Figure 4. *RESIDUALS = OBSERVED - PREDICTED WEIGHTS FOR 4VW HADDOCK, JULY* 1980, *A306-A307*

Figure 5a.

RELATION OF WEIGHTED STRATUM VARIANCE TO WEIGHTED STRATUM MEAN
CATCH PER STANDARD TOW, FOR 1977

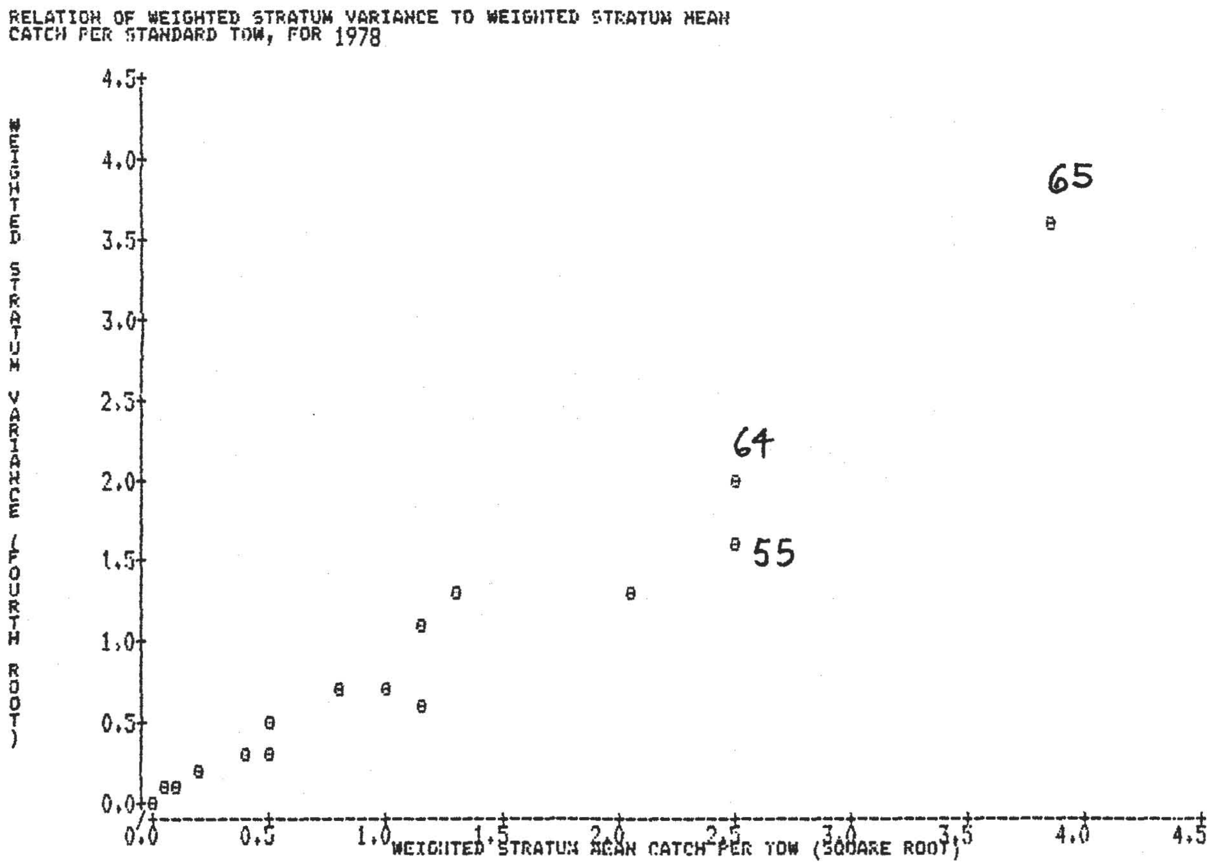


RESULTS OF GROUNDFISH SURVEY FOR 1977
NUMBER OF STRATA INCLUDED IS 26

STRATUM	YBAR	SSQ	WEIGHTED YBAR	WEIGHTED SSQ
40	0.00	0.0E0	0.0E0	0.0E0
41	0.00	0.0E0	0.0E0	0.0E0
42	2.02	8.5E0	8.4E-2	8.9E-3
43	0.00	0.0E0	0.0E0	0.0E0
44	0.83	1.2E0	1.0E-1	4.8E-3
45	0.00	0.0E0	0.0E0	0.0E0
46	0.00	0.0E0	0.0E0	0.0E0
47	10.02	2.1E2	5.3E-1	1.9E-1
48	2.43	2.4E1	1.1E-1	1.3E-2
49	0.00	0.0E0	0.0E0	0.0E0
50	5.33	3.0E1	7.1E-2	1.5E-3
52	0.00	0.0E0	0.0E0	0.0E0
53	0.00	0.0E0	0.0E0	0.0E0
54	2.88	4.5E1	2.5E-2	3.8E-3
55	64.75	9.2E3	4.1E0	2.0E0
56	16.11	5.3E3	4.9E-1	8.2E-2
57	5.93	9.3E1	1.5E-1	2.1E-2
58	3.13	2.4E0	6.6E-2	3.6E-4
59	45.93	1.1E3	3.6E0	2.8E0
60	3.88	3.0E1	1.7E-1	2.8E-2
61	0.00	0.0E0	0.0E0	0.0E0
62	27.24	1.9E3	1.9E0	1.4E0
63	450.58	3.5E5	4.3E0	1.4E1
64	152.89	7.9E4	2.3E0	2.2E1
65	34.33	1.2E3	3.2E0	2.2E0
66	0.00	0.0E0	0.0E0	0.0E0

STRATIFIED MEAN CATCH PER TOW: 25.9882384
STRATIFIED ESTIMATE OF THE VARIANCE: 56.08469491

Figure 5b.



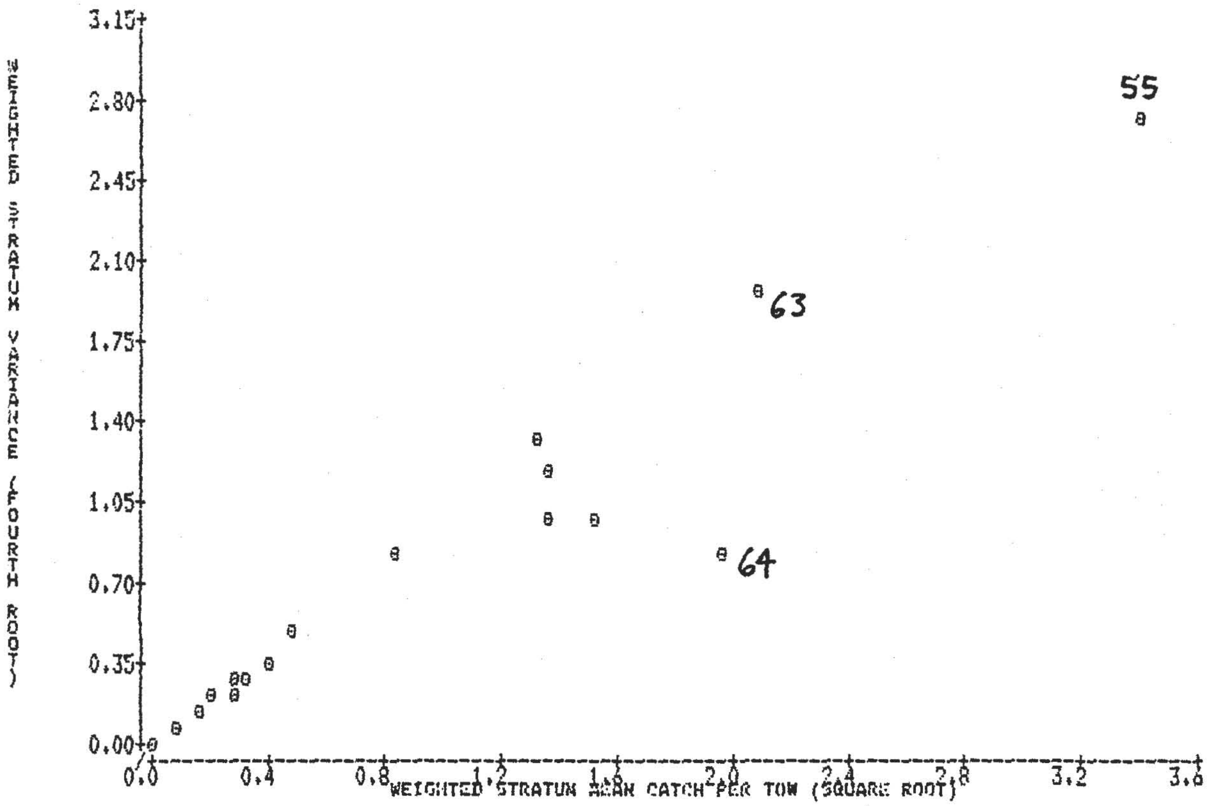
RESULTS OF GROUNDFISH SURVEY FOR 1978
NUMBER OF STRATA INCLUDED IS 26

STRATUM	YBAR	SSQ	WEIGHTED YBAR	WEIGHTED SSQ
40	0.00	0.0E0	0.0E0	0.0E0
41	1.92	9.4E0	4.7E-2	2.2E-3
42	0.00	0.0E0	0.0E0	0.0E0
43	0.00	0.0E0	0.0E0	0.0E0
44	0.00	0.0E0	0.0E0	0.0E0
45	0.00	0.0E0	0.0E0	0.0E0
46	0.00	0.0E0	0.0E0	0.0E0
47	0.00	0.0E0	0.0E0	0.0E0
48	0.00	0.0E0	0.0E0	0.0E0
50	0.32	3.2E-1	3.9E-3	1.6E-5
51	0.00	0.0E0	0.0E0	0.0E0
52	0.00	0.0E0	0.0E0	0.0E0
53	0.00	0.0E0	0.0E0	0.0E0
54	19.43	8.9E2	2.9E-1	6.9E-2
55	93.21	8.9E3	6.3E0	9.5E0
56	32.09	1.5E3	9.8E-1	2.3E-1
57	158.59	9.5E3	4.1E0	3.2E0
58	62.25	9.4E3	1.3E0	1.4E0
59	8.47	1.3E3	6.5E-1	3.1E-1
60	39.88	2.9E3	1.2E0	1.2E0
61	3.39	1.8E1	1.3E-1	1.5E-2
62	19.37	1.5E2	1.3E0	1.8E-1
63	28.80	1.3E2	2.6E-1	9.3E-3
64	148.04	5.1E4	6.2E0	1.7E1
65	192.43	1.5E5	9.9E1	1.8E2
66	1.09	2.4E0	7.9E-3	6.2E-5

STRATIFIED MEAN CATCH PER TOW: 37.90553336
STRATIFIED ESTIMATE OF THE VARIANCE: 209.4848535

Figure 5c.

RELATION OF WEIGHTED STRATUM VARIANCE TO WEIGHTED STRATUM MEAN CATCH PER STANDARD TOW, FOR 1979



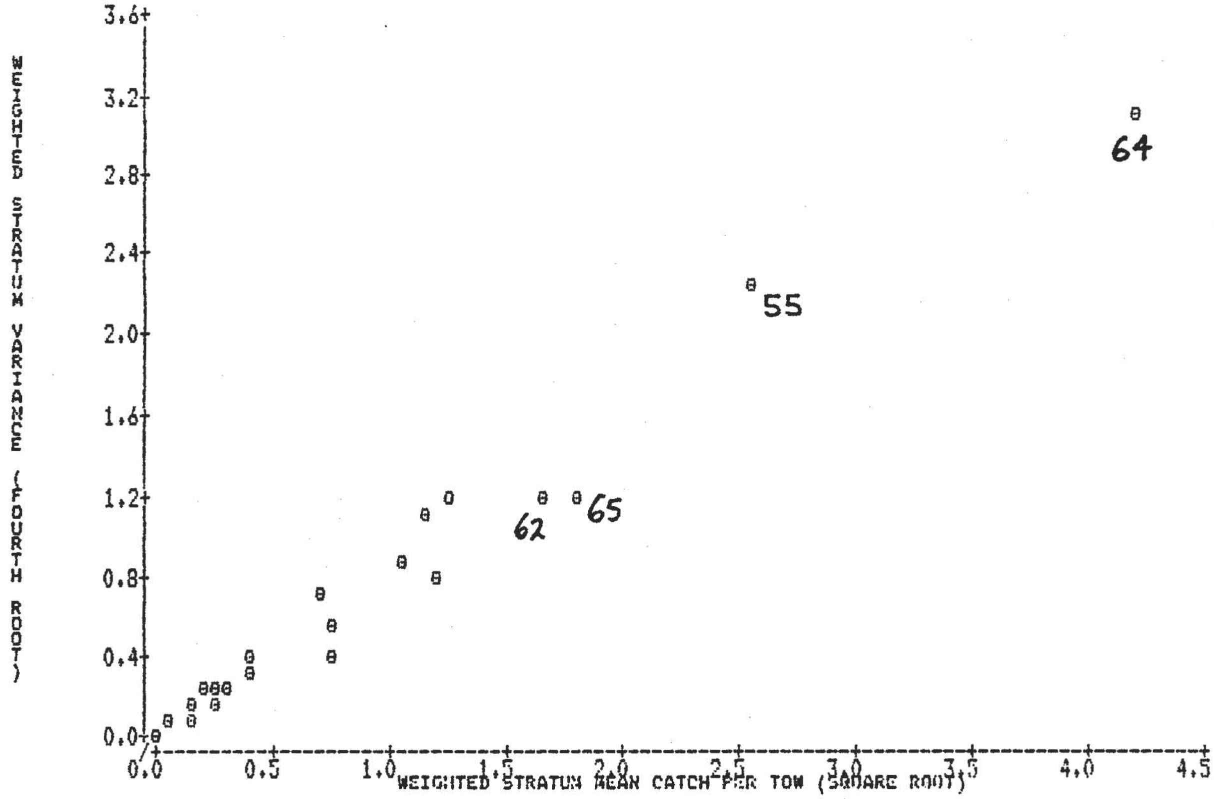
RESULTS OF GROUNDFISH SURVEY FOR 1979
NUMBER OF STRATA INCLUDED IS 27

STRATUM	YBAR	SSQ	WEIGHTED YBAR	WEIGHTED SSQ
40	0.00	0.0E0	0.0E0	0.0E0
41	0.63	7.9E0	2.3E-2	3.1E-4
42	0.00	0.0E0	0.0E0	0.0E0
43	0.00	0.0E0	0.0E0	0.0E0
44	0.35	1.2E0	8.9E-2	4.7E-3
45	0.00	0.0E0	0.0E0	0.0E0
46	0.00	0.0E0	0.0E0	0.0E0
47	0.10	8.0E-2	9.4E-3	5.9E-5
48	0.00	0.0E0	0.0E0	0.0E0
49	1.94	5.4E0	7.3E-3	5.8E-5
50	0.78	1.0E3	6.1E-2	5.0E-3
51	0.00	0.0E0	0.0E0	0.0E0
52	3.08	1.9E1	3.4E-2	1.1E-3
53	0.00	0.0E0	0.0E0	0.0E0
54	3.90	3.4E1	8.9E-2	3.1E-3
55	172.33	8.7E4	1.2E1	5.8E1
56	58.63	2.0E4	1.8E0	3.0E0
57	3.83	9.4E1	1.7E-1	2.1E-2
58	88.33	1.3E4	1.3E0	1.9E0
59	2.29	2.1E3	7.3E-1	5.3E-1
60	5.23	5.5E1	2.3E-1	5.0E-2
61	0.00	0.0E0	0.0E0	0.0E0
62	33.48	8.1E2	3.4E0	1.0E0
63	443.75	3.2E5	4.3E0	1.5E1
64	33.83	1.2E3	3.7E0	4.2E-1
65	24.04	7.4E2	1.8E0	8.3E-1
66	0.00	0.0E0	0.0E0	0.0E0

STRATIFIED MEAN CATCH PER TOW: 28.90506015
STRATIFIED ESTIMATE OF THE VARIANCE: 78.81898442

Figure 5d.

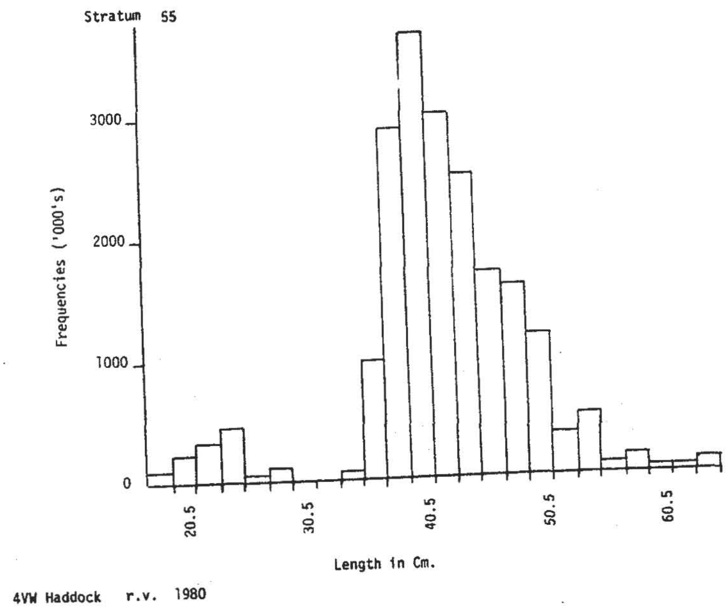
RELATION OF WEIGHTED STRATUM VARIANCE TO WEIGHTED STRATUM MEAN CATCH PER STANDARD TOW, FOR 1980



RESULTS OF GROUNDFISH SURVEY FOR 1980
NUMBER OF STRATA INCLUDED IS 27

STRATUM	YBAR	SSQ	WEIGHTED YBAR	WEIGHTED SSQ
40	0.00	0.0E0	0.0E0	0.0E0
41	0.78	4.0E0	5.3E-2	1.3E-3
42	0.82	2.8E-1	2.8E-2	2.0E-4
43	1.22	5.9E0	5.1E-2	2.9E-3
44	0.51	1.1E0	6.4E-2	4.1E-3
45	0.00	0.0E0	0.0E0	0.0E0
46	0.00	0.0E0	0.0E0	0.0E0
47	1.92	3.2E0	8.7E-2	3.1E-3
48	11.05	4.2E2	5.1E-1	2.2E-1
49	4.88	4.7E1	2.2E-2	4.9E-4
50	3.88	4.8E1	1.9E-2	2.4E-3
51	0.42	3.5E-1	2.0E-3	3.8E-8
52	13.52	3.7E2	1.3E-1	3.2E-2
53	0.00	0.0E0	0.0E0	0.0E0
54	10.90	2.8E1	1.7E-1	8.8E-3
55	94.88	3.8E4	9.3E0	3.5E1
56	31.55	3.2E4	5.6E0	1.8E0
57	31.77	5.1E1	5.9E-1	1.7E-2
58	63.41	1.2E4	1.3E0	1.7E0
59	3.48	3.1E1	3.5E-1	7.2E-2
60	24.94	7.1E2	1.1E0	6.5E-1
61	0.40	0.0E0	0.0E0	0.0E0
62	10.27	9.4E3	2.2E0	1.8E0
63	153.58	8.2E3	1.5E0	3.8E1
64	428.59	2.8E5	1.8E1	9.5E1
65	42.01	1.8E3	3.2E0	2.0E0
66	0.00	0.0E0	0.0E0	0.0E0

STRATIFIED MEAN CATCH PER TOW: 37.70856481
STRATIFIED ESTIMATE OF THE VARIANCE: 128.6948986



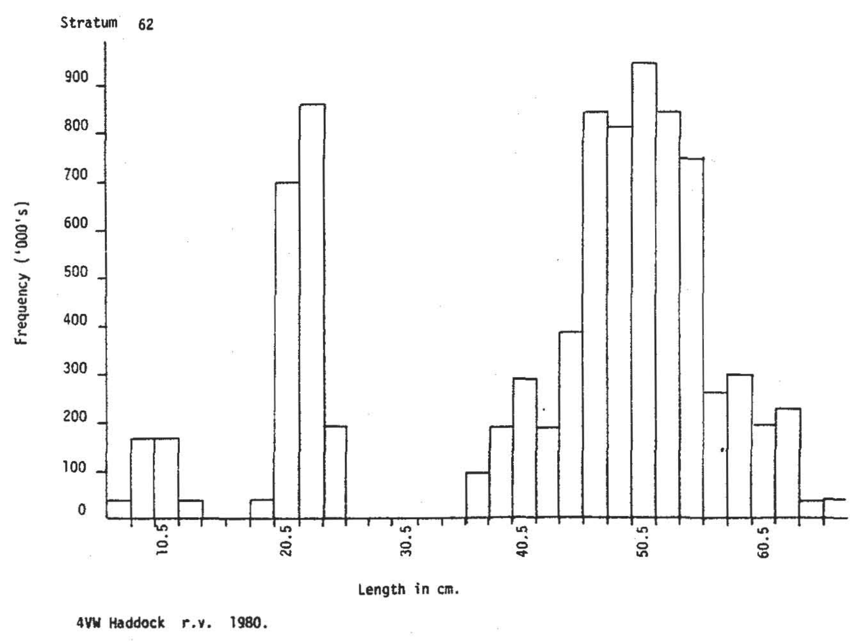
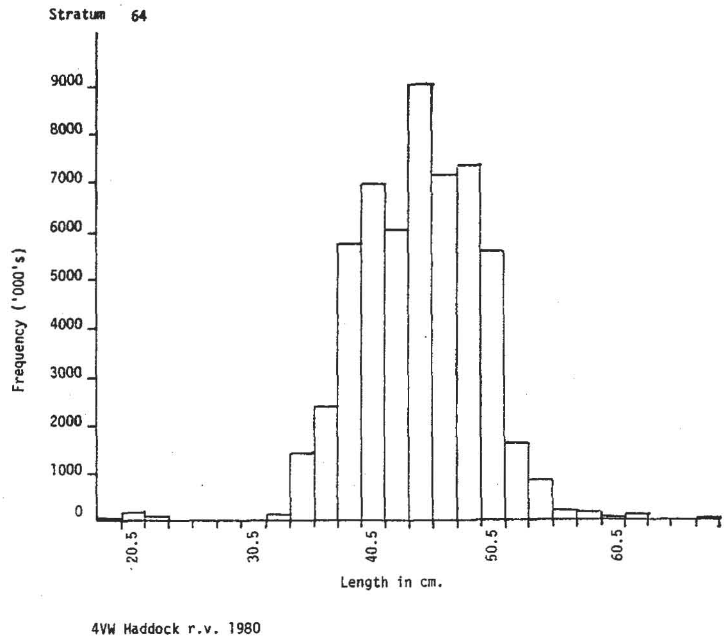


Figure 6. Length-frequencies for four dominant strata in summer 1980 survey



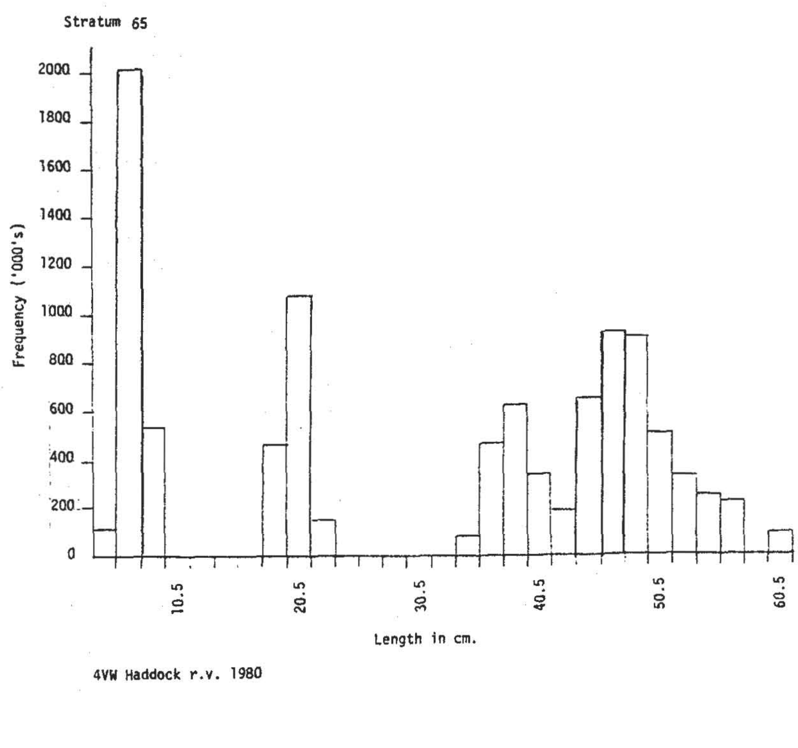


Figure 6 (continued). Length-frequencies for four dominant strata in summer 1980 survey

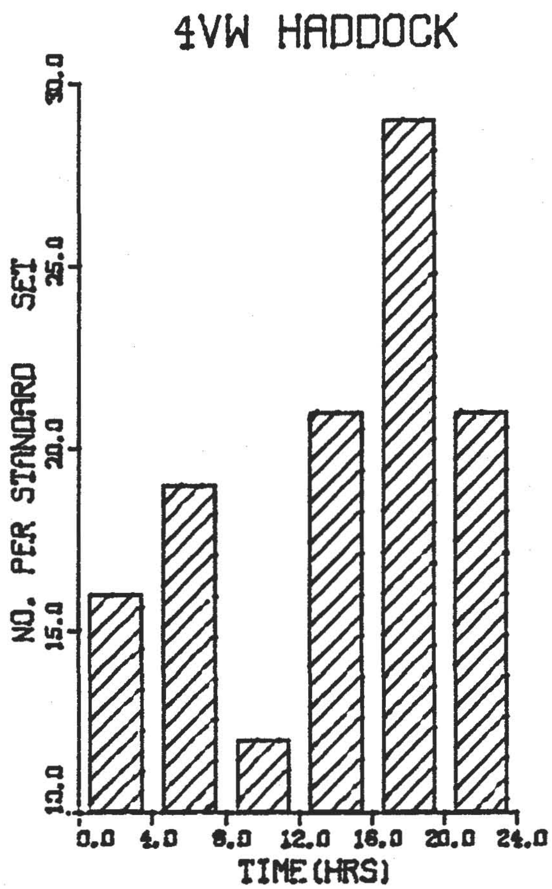


Figure 7a. Diurnal variation in Canadian summer bottom trawl survey average catch rates (numbers per standard tow) of 4VW haddock during 1970-80.

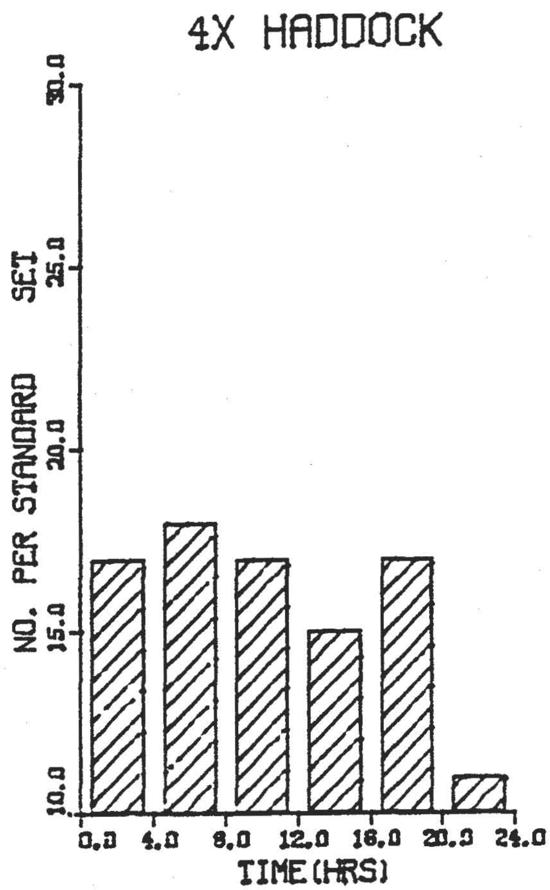


Figure 7b. Diurnal variation in Canadian summer bottom trawl survey average catch rates (numbers per standard tow) of 4X haddock during 1970-80.

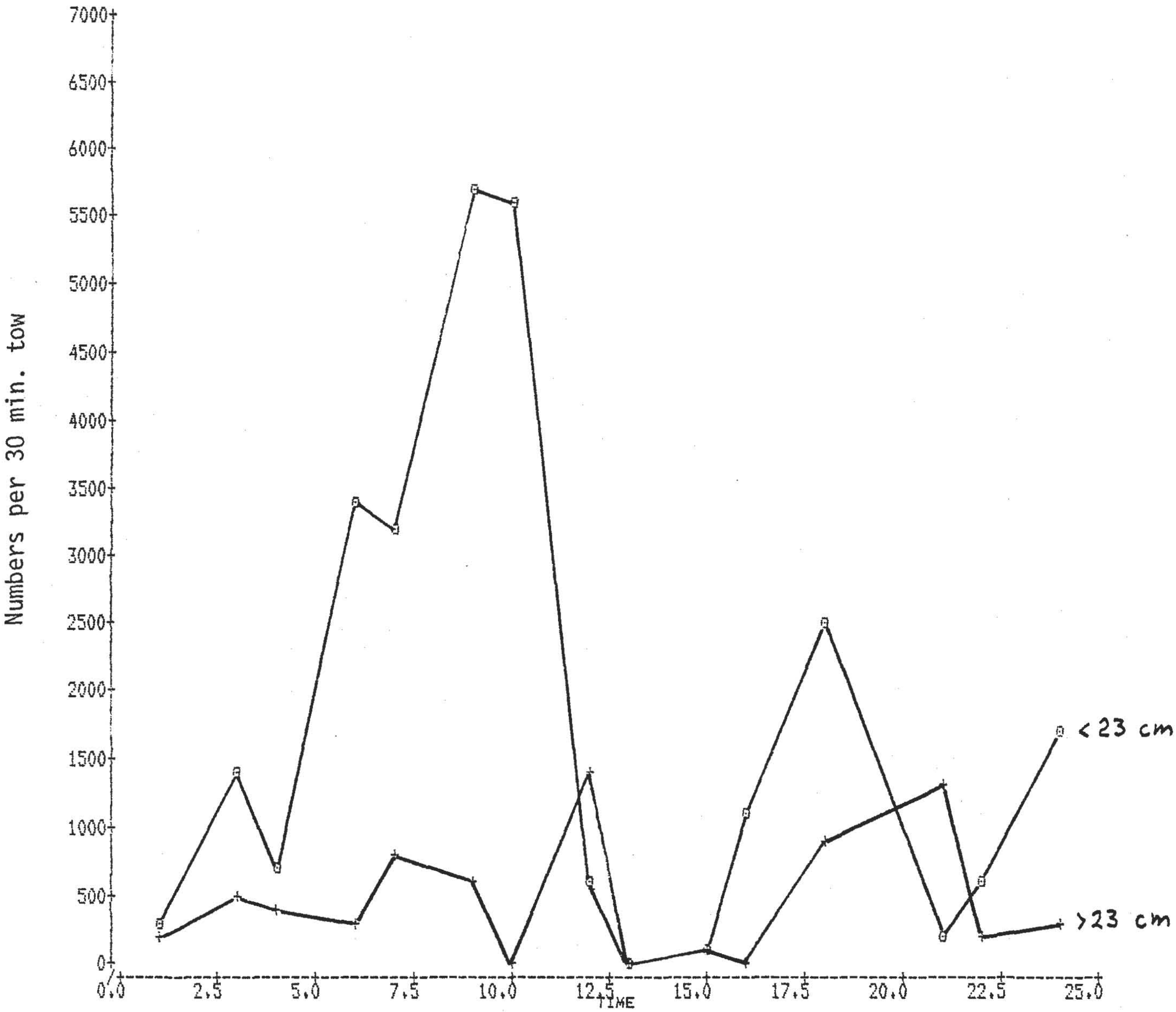


Figure 8. Numbers of haddock per 30 min. tow for two length groups: small (<23 cm) and large (>23 cm) on a special cruise conducted in May, 1981

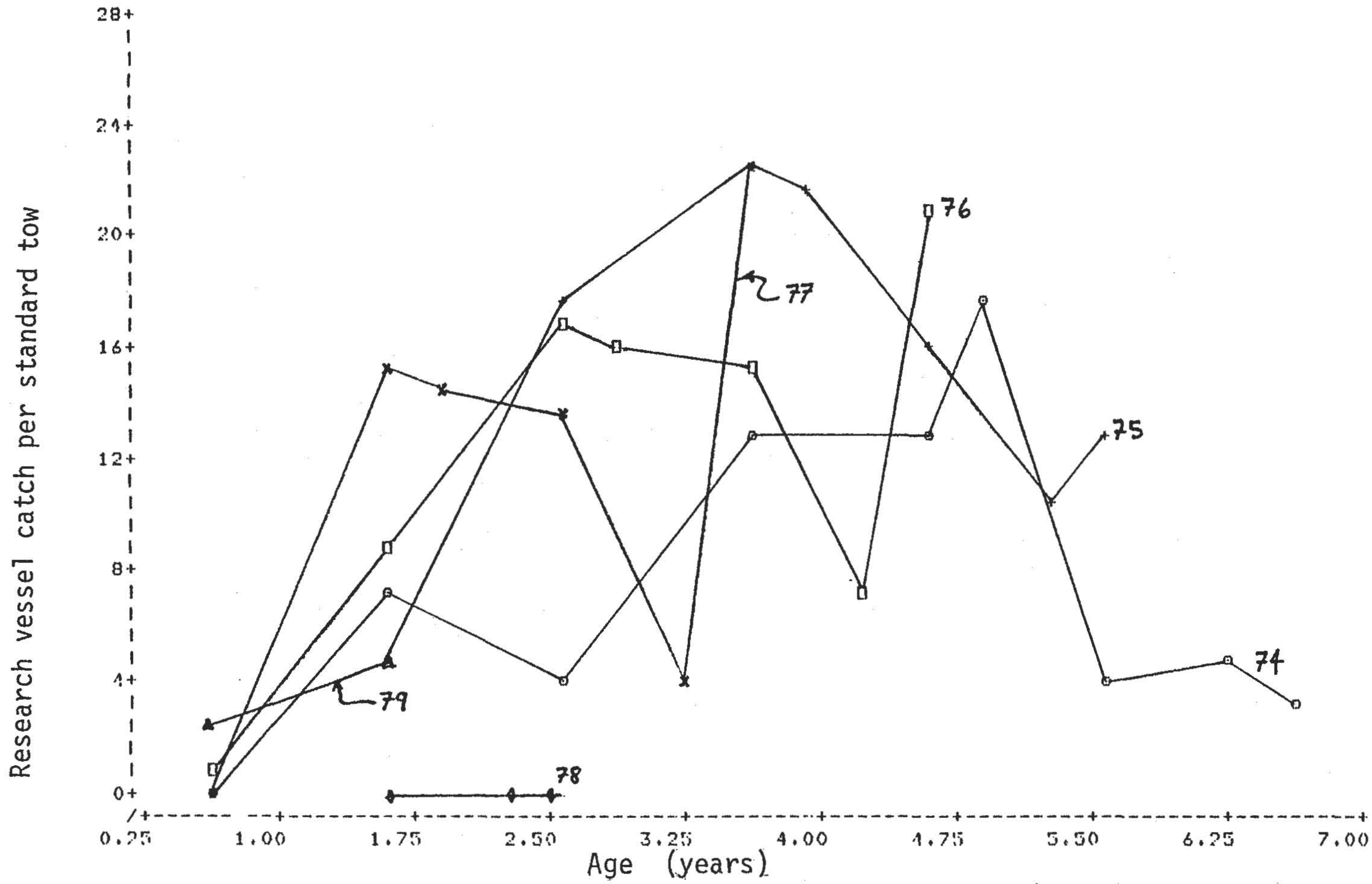
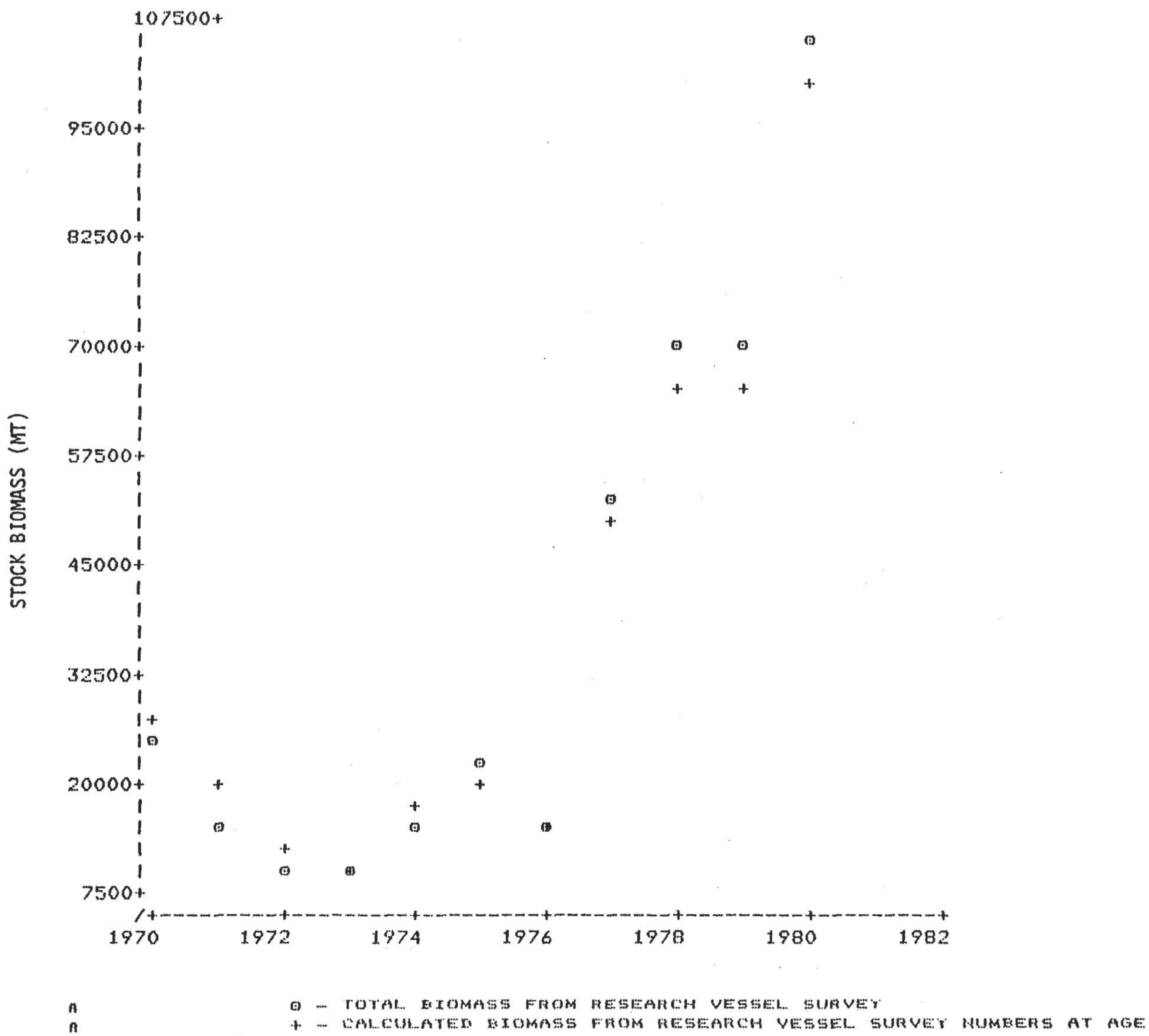


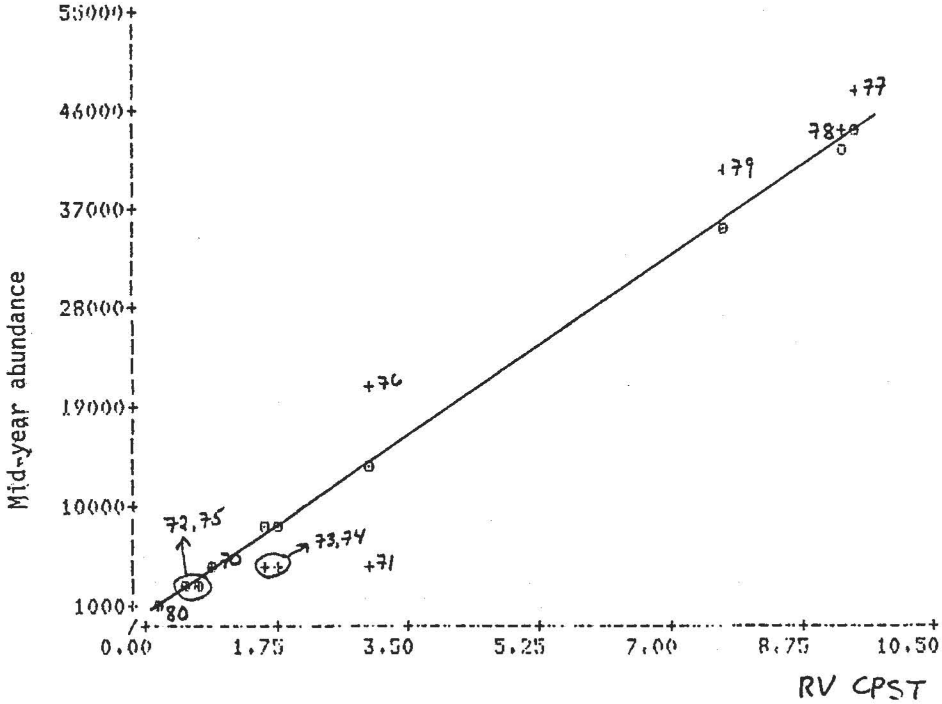
Figure 9. Year class size as determined from summer, spring and fall research surveys. (A correction factor of was applied to spring and fall surveys.)



o-	28451	19122	11724	9750	16291	20613	14818	50039	65820	65176	101129
+-	25094	16187	9500	9187	16219	22312	15437	53594	69562	69437	104469

Figure 10. Comparison of observed and calculated biomass for the 4VW haddock stock.

Mid-year abundance from cohort vs. corrected research catch per standard tow for age 2. Sample correlation 0.9765730531



Mid-year abundance from cohort vs. corrected research catch per standard tow for ages 3. Sample correlation: 0.9526485655

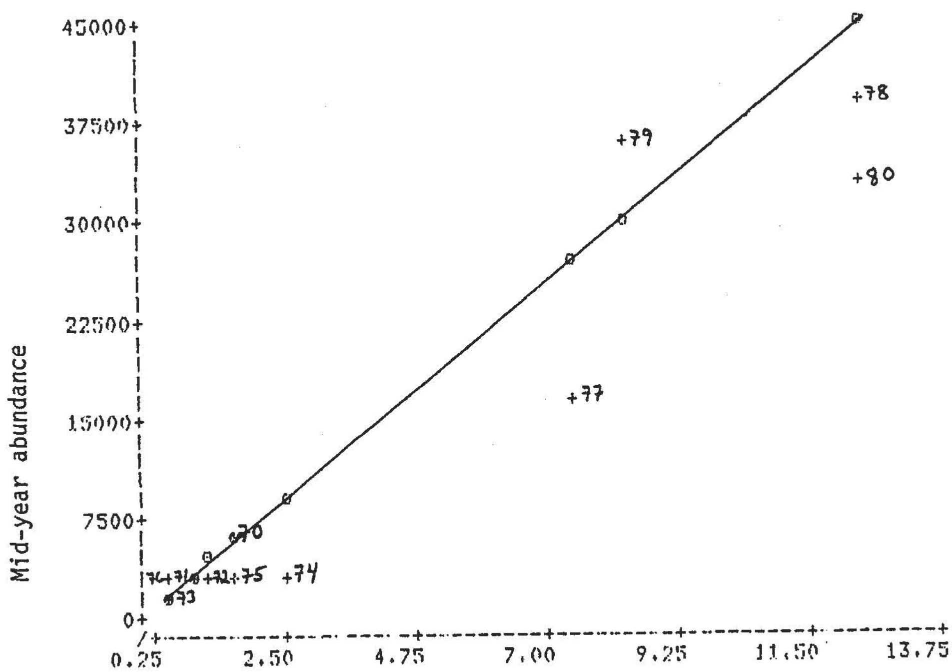
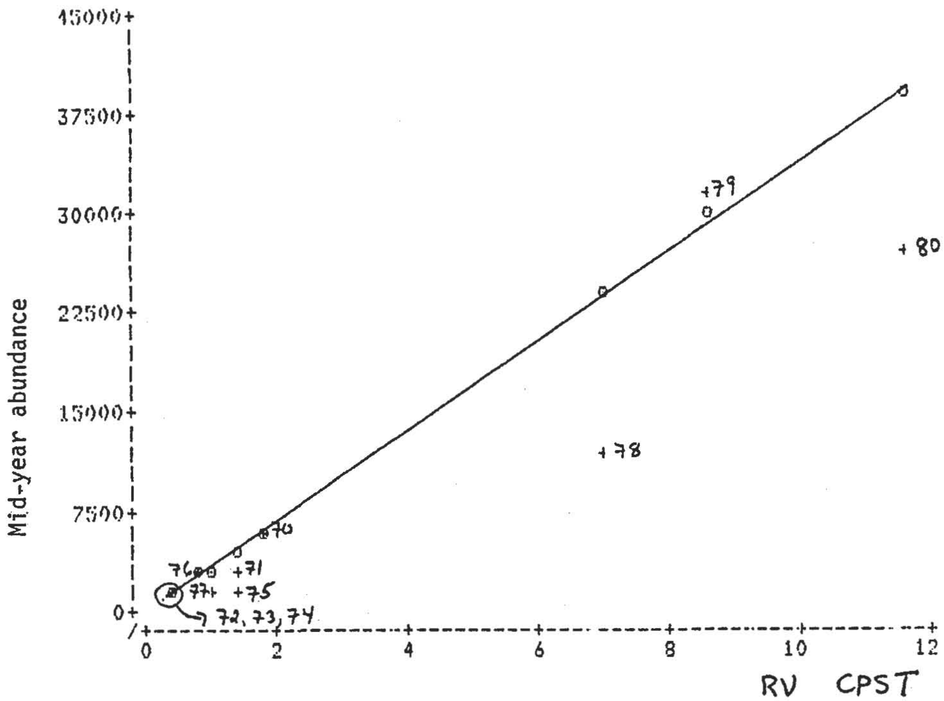


Figure 11. Mid-year abundance from 'SURVIVOR' based cohort versus summer research survey catch (numbers) per standard tow for ages 2-8.

Mid-year abundance from cohort vs. corrected research catch per standard tow for age 4. Sample correlation: 0.9376787959



Mid-year abundance from cohort vs. corrected research catch per standard tow for age 5. Sample correlation: 0.9840161934

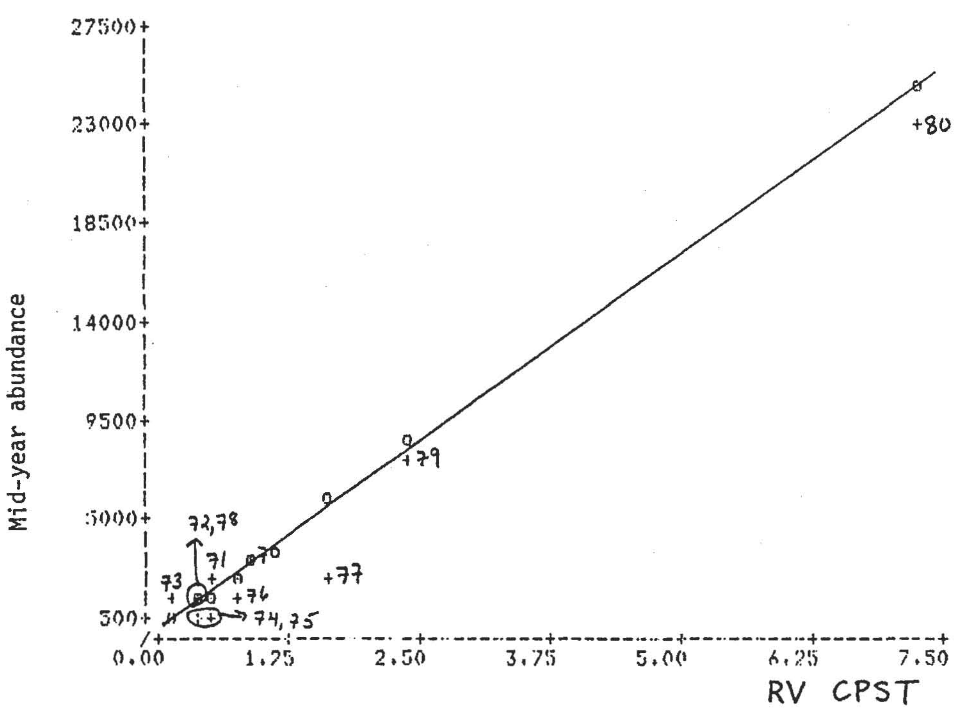
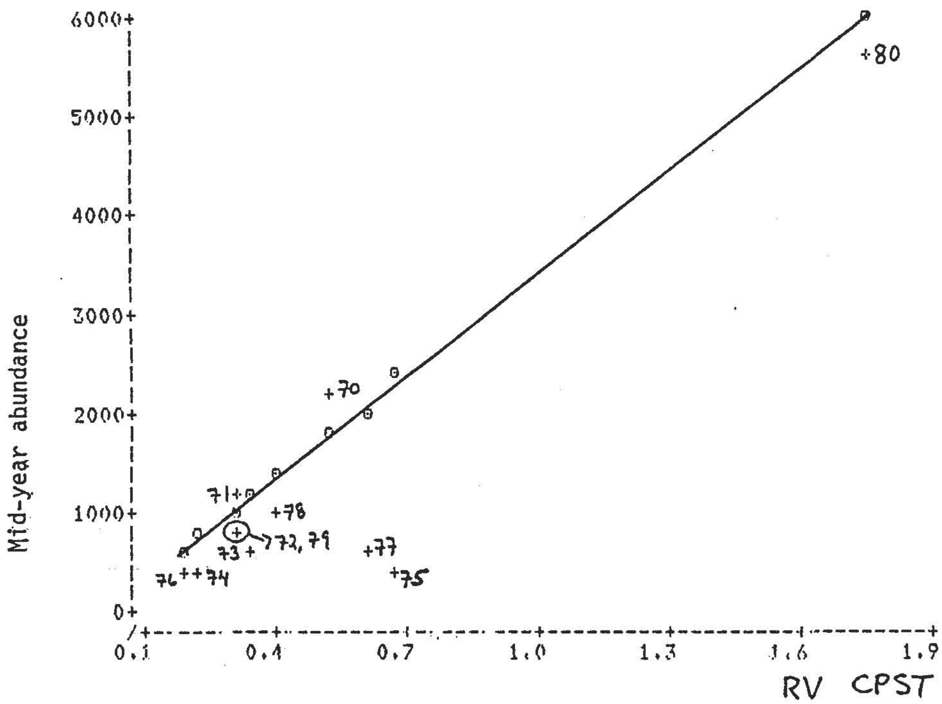


Figure 11. (continued)

Mid-year abundance from cohort vs. corrected research catch per standard tow for age 6. Sample correlation: 0.8996033258



Mid-year abundance from cohort vs. corrected research catch per standard tow for age 7. Sample correlation: 0.8863754831

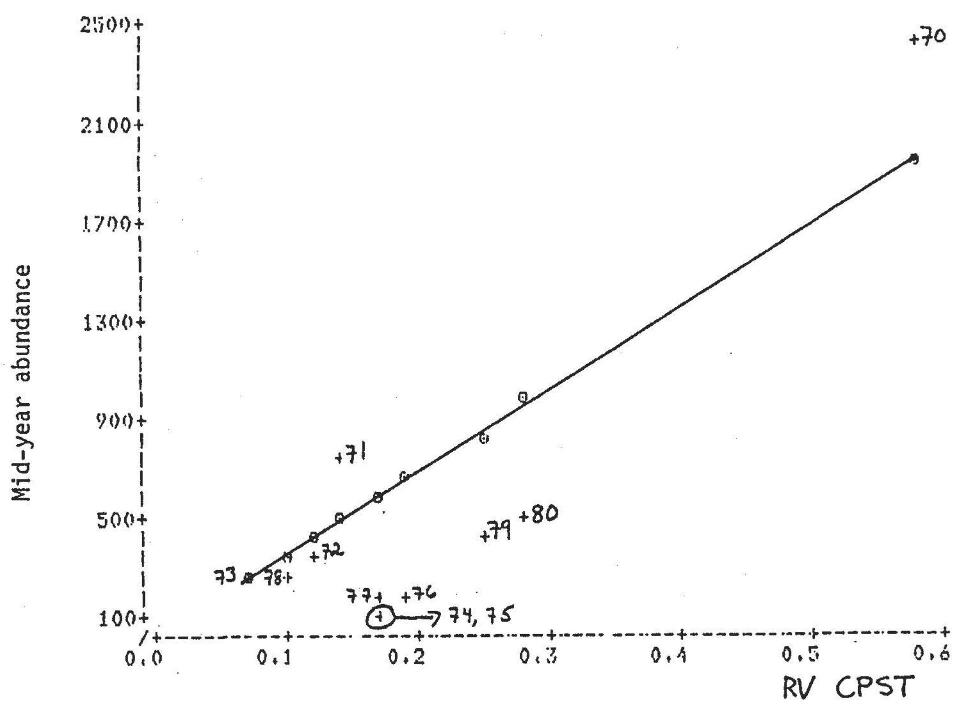


Figure 11. (continued)

Mid-year abundance from cohort vs. corrected research catch per standard tow for age 8.   Sample correlation: 0.8182336253

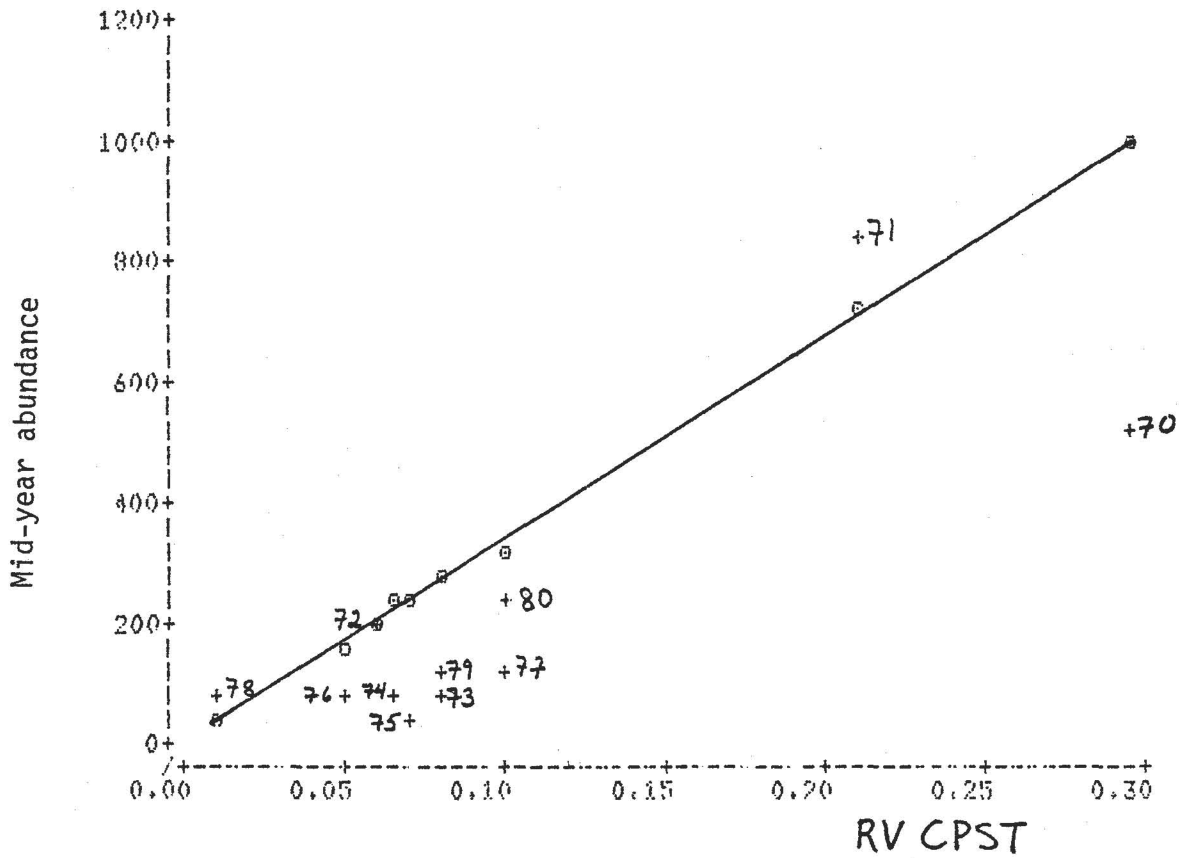
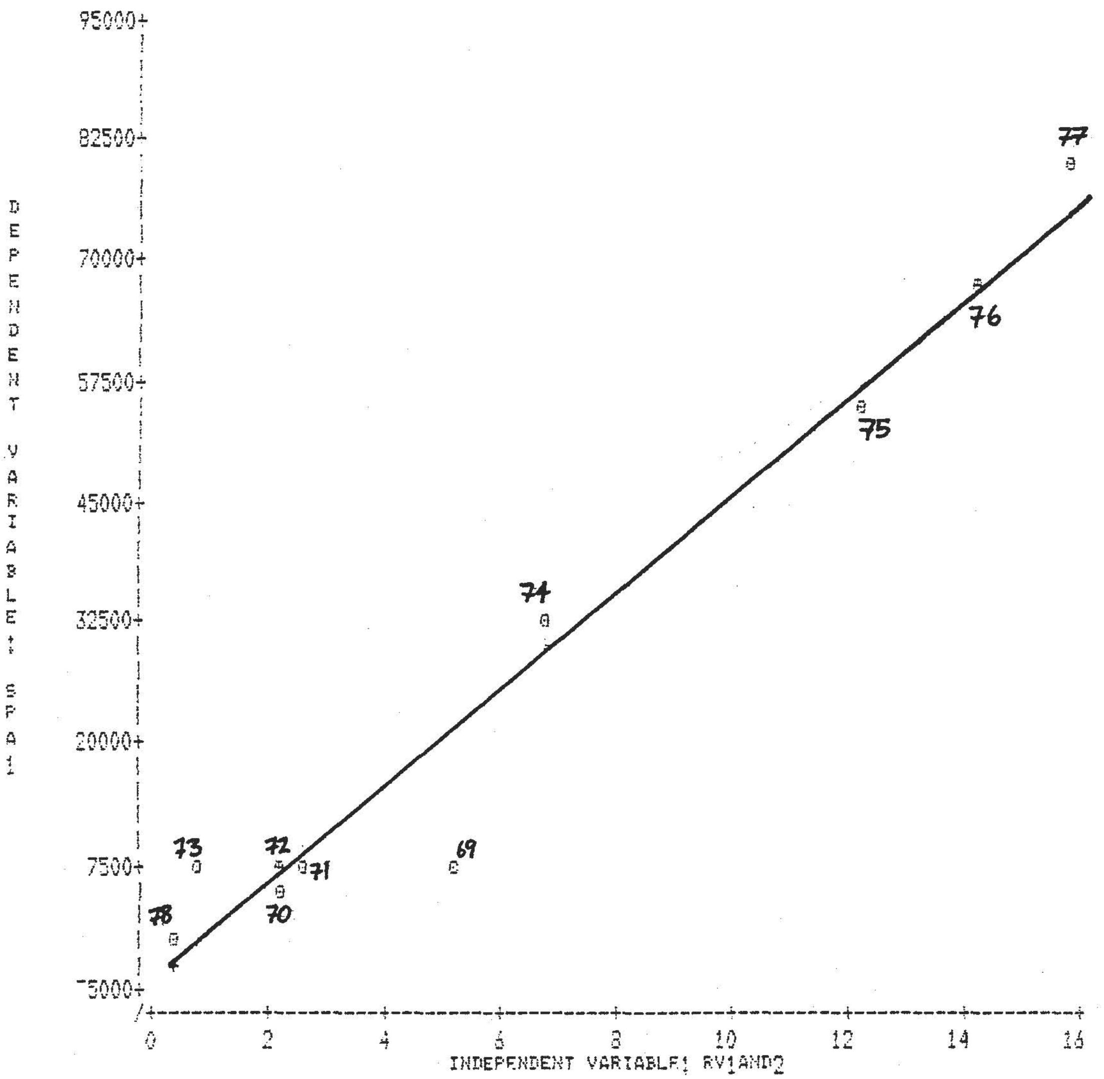


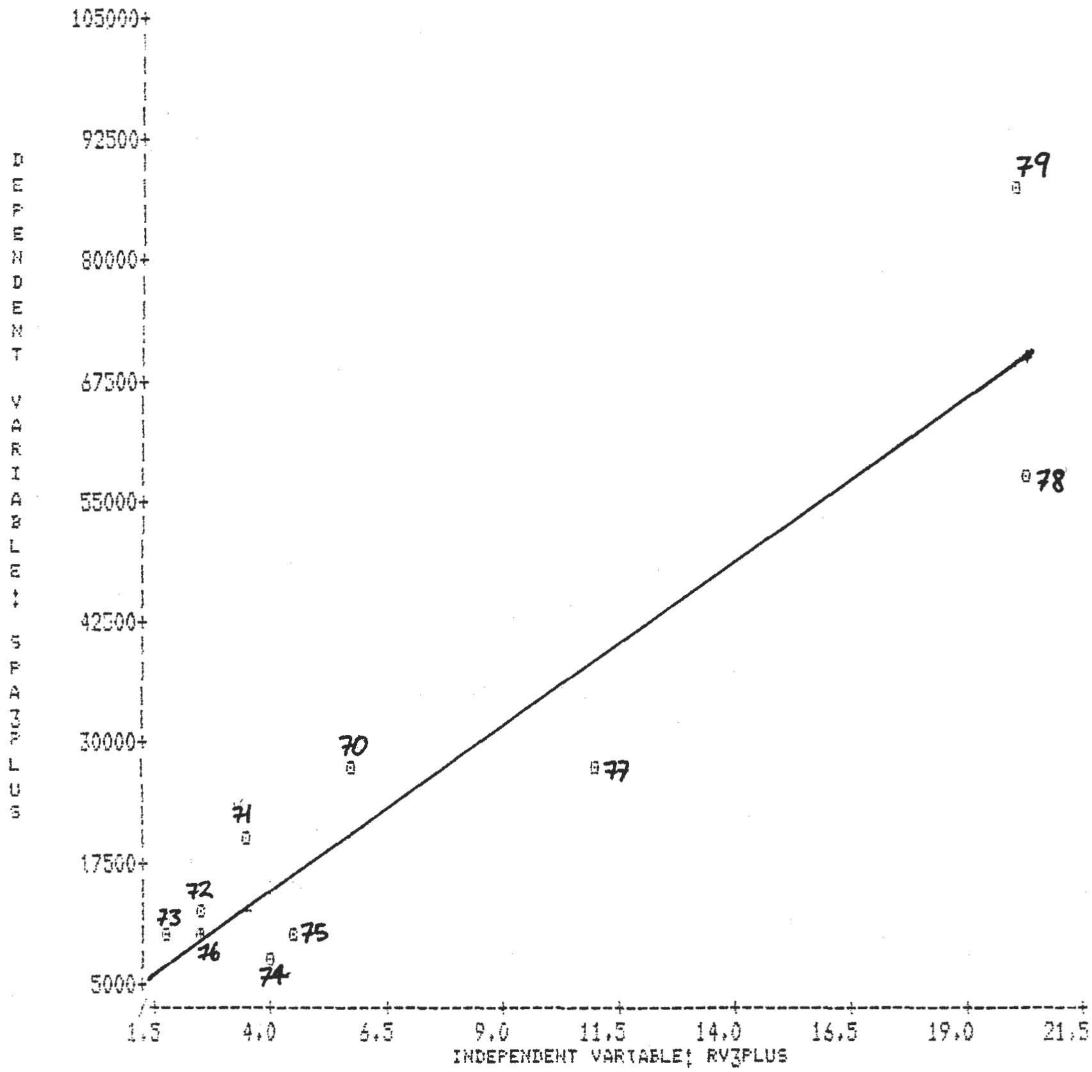
Figure 11. (continued)



YEAR_CLASS	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
RV1AND2	5.29	2.18	2.69	2.27	0.85	6.86	12.23	14.24	15.86	0.30
SPA1	7782	4128	8015	8213	6999	31497	54131	67792	80173	652
PREDICTED	21983	6369	8930	6821	¯308	29865	56825	66916	75049	¯3069

SAMPLE CORRELATION: 0.98006978
SLOPE: 5020.453538
INTERCEPT: ¯4575.186859

Figure 12a. Comparison of calculated age 1 numbers ('000) with research 1 + 2 catch per standard tow for the 4VW haddock stocks, with least squares regression line (GM regression line was similar).



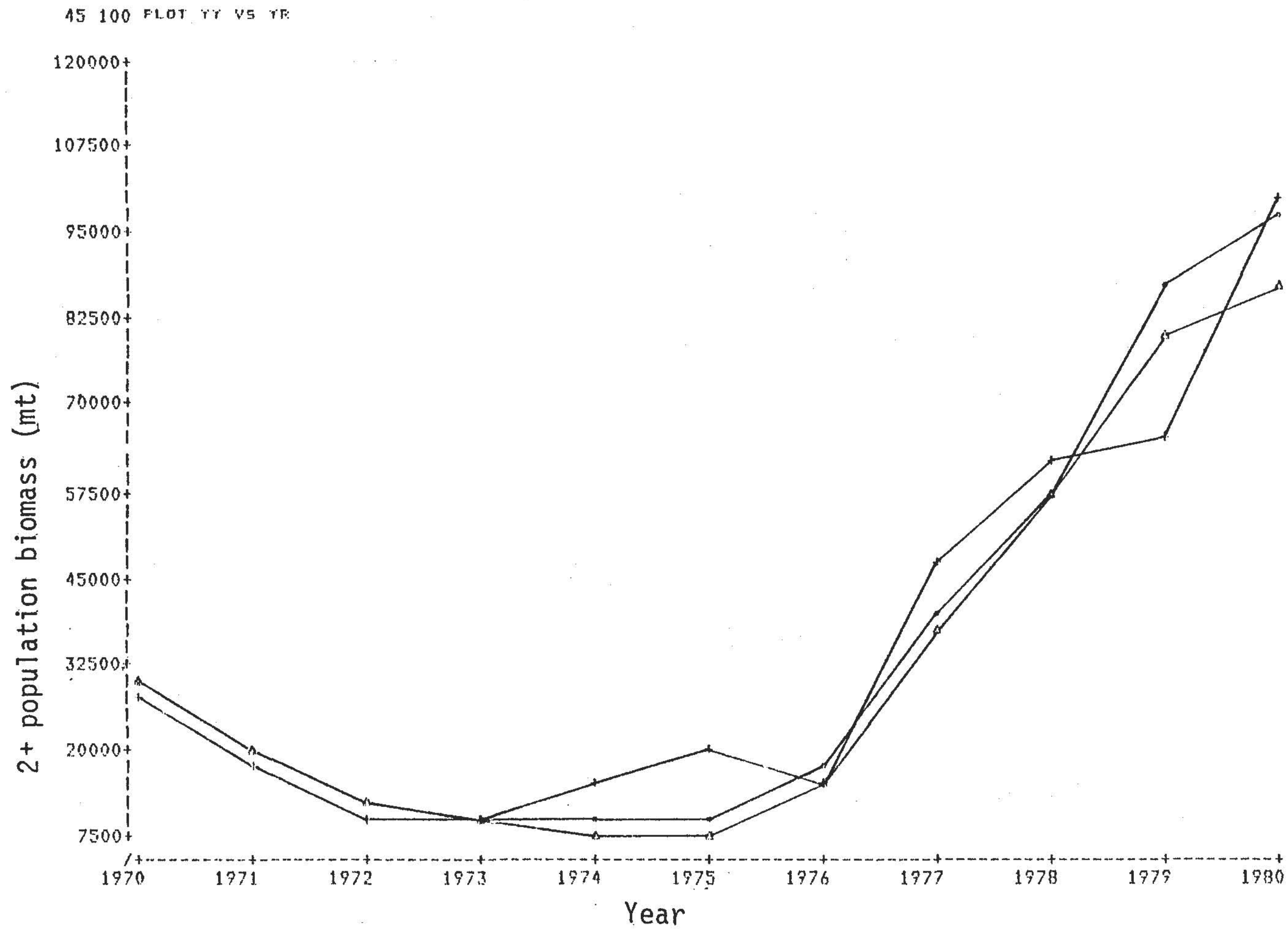
YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
RV3PLUS	5.64	3.50	2.52	1.64	3.88	4.40	2.48	11.07	20.24	19.99
SPA3PLUS	26440	19725	12159	9018	7830	9514	10879	28378	57010	87803
PREDICTED	20409	13109	9766	6765	14405	16179	9630	38930	70208	69355

SAMPLE CORRELATION: 0.9319329587
SLOPE: 3410.908215
INTERCEPT: 1170.995689

Figure 12b. Comparison of calculated 3+ numbers ('000) with research catch per standard tow for the 4VW haddock stock, with least squares regression line (GM regression line was similar).

FIGURE 13. POPULATION BIOMASS TRENDS IN THE 4VW HADDOCK STOCK, 1970-1980

+ - SUMMER RESEARCH SURVEY (ESTIMATED WEIGHTS)
o - TRADITIONAL SEQUENTIAL POPULATION ANALYSIS
Δ - ''SURVIVOR'' -BASED SEQUENTIAL POPULATION ANALYSIS



B 0+ YY

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
o	30668	20157	12826	9728	9018	10438	16969	39108	58633	87480	98658
+	27400	18458	11216	9527	16151	18833	14057	47950	63710	65152	100416
Δ	30527	19955	12543	9251	8102	8662	14133	38165	56585	79652	88036