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An evaluation of the population dynamics of 4X haddock during 1962-87 with yield projected to 1988.

by

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Abstract

This evaluation of the 4X haddock population is similar to that conducted last year. The calibration models are virtually identical. Only the input data have changed. In this regard the two assessments are very different, with the 1987 survey data providing a pessimistic view of resource status. The 1986 fully recruited fishing mortality is estimated to be 0.513 with a comparable level (0.549) generated by the 15,000 t TAC in 1987. Total stock biomass is currently about 60,000 t, reaching the low levels observed in the early 1970's. Poor recruiting 1984 - 86 year-classes are expected to push this biomass and consequent yield even lower over the next 3 to 5 years. The resource is currently suffering from growth overfishing and recruitment overfishing is highly likely. Resource projections to 1988 indicate an $F_{0.1}$ yield of 8204 t while the 50 percent rule level is 12,384 t. Given market pressure, these levels will likely be exceeded.

Résumé

La présente évaluation de la population d'aiglefin 4X est similaire à celle effectuée l'an dernier. Les modèles d'étalonnage sont pratiquement identiques. Seules les données d'entrée ont changé. A cet égard, les deux évaluations sont très différentes, les données du relevé de 1987 donnant une vue pessimiste de l'état de la ressource. On estimte à 0,513 la mortalité par pêche du poisson entièrement recruté en 1986 et le TPA de 15 000 t pour 1987 donne un niveau comparable (0,549). Actuellement, la biomasse totale du stock est d'environ 60 000 t, retombant ainsi aux bas niveaux observés au début des années 70. On prévoit que le faible recrutement des classes de 1984 à 1986 va encore faire baisser la biomasse, et partant, le rendement, au cours des 3 à 5 prochaines années. La ressource souffre actuellement d'une surpêche au détriment de la croissance et il est très probable que la surpêche nuise au recrutment. Les prévisions pour la ressource jusque 1988 donnent un rendement à $F_{0,1}$ de 8 204 t tandis que le niveau avec la règle de 50 pour cent est de 12 384 t. Compte tenu de la pression du marché, ces niveaux seront probablement dépassés.

Introduction

Sequential Population Analysis (SPA) has been used to provide estimates of the size of the haddock population in NAFO Division 4X since 1974. These analyses have been calibrated using groundfish survey data. Since 1980, US survey sampling in NAFO Division 4X was restricted to those strata covering Brown's Bank. Commercial catch rate indices have also been used, although their utility has been limited by problems in data quality. Consequently, in recent years, the Canadian summer bottom trawl survey data have been used exclusively to calibrate the SPA.

The survey data have been treated in various ways to account for the presence of sets with unusually large catches. In particular, these sets have been either removed or a Winsorizing technique employed to reduce their disproportionate impact on estimates of central tendency. O'Boyle and Wallace (1986) investigated the use of the delta distribution (Pennington, 1983) on this data set. The Statistics, Sampling and Survey Subcommittee (SSSS) of CAFSAC investigated the uses of this distribution and concluded that at low sample sizes (n 4), the delta mean was very sensitive to the assumption that the population was indeed following the delta distribution. It stated that the arithmetic mean was not as sensitive to these assumptions and recommended its use unless the form of the distribution could be determined. Given the low sampling rates in the Canadian summer bottom trawl survey, the use of the arithmetic mean is preferred and was used in this assessment.

Tuning of the SPA has been effected using a variety of procedures. Initial efforts used geometric mean regressions between SPA abundance and the survey index, generally aggregated across age groups. More recently, age by age tuning has been conducted, using as criteria, maximization of the correlation coefficient (r) and attainment of a zero origin for the age specific calibration plots. Mohn (1983) showed that examination of the residuals of the last point would provide a more appropriate criterion. However, this places a lot of weight on the accuracy of the current year's data. To circumvent this problem, Doubleday (1981) had earlier used a combination of age-by-age relationships and examination of cohort-by-cohort fits to these relationships to establish current year fishing mortality, in a procedure called "Survivor". This procedure was used during 1981 - 86 to supplement the age-by-age tuned cohort analysis. In 1985, the principle of the examination of cohort-specific residuals was incorporated into the calibration of the cohort analysis. This procedure has remained unchanged since then although the underlying form of the calibration model (linear or curvilinear; additive or multiplicative errors) has been modified. Use of the survivor method was discontinued in this assessment.

The 1962 - 87 stock size was calculated and compared to estimates made by O'Boyle and Wallace (1986). Yield at $F_{0.1}$ and F_{50} (50% rule) was predicted for 1988.

Trends in Reported Landings

Annual Trends

The long-term (1930-1983) average annual catch for 4X haddock is about 20,000 t. This level has rarely been maintained for long periods. Prior to the mid-1960's, Canadian and US fishing vessels landed 15,000-20,000 t annually. In 1965-66, the Canadian offshore fleet expanded rapidly and displaced US fishing effort. As well, landings by the USSR substantially increased. This caused a rapid increase in reported landings, to levels never before attained by the resource (Figure 1). Much of this yield was supported by the 1963 year class, which has been shown (O'Boyle and Wallace, 1986) to be an order of magnitude larger than the average long term recruitment level.

Recruitment during the late 1960's was below average and could not support the high exploitation rates. ICNAF, the contemporary management body, was concerned with this situation and as a result imposed in 1970, the first quotas ever used by an international fisheries management organization. At the same time, the spawning grounds were closed to fishing during the spawning season.

Landings decreased in the early 1970's to levels above those seen prior to 1960. They remained low until 1975, just prior to extension of Canada's 200 mile limit in 1977. After this, landings increased rapidly, due to a recovery in the stocks as well as expansion of fleet size, fueled by federal and provincial vessel loan programs. A peak in catch was reached in 1981 and has declined to the 15,000 t level observed in 1985-86 (Table 1).

During the 1977-81 period, when fleet size was expanding and the TAC's were restrictive, misreporting and discarding became a significant problem. Reports of this occurring are based on discussions with fishermen and protection officers and have not been quantified. No estimate of misreporting and/or discarding are incorporated into this assessment.

The recent regulatory history of the stock is given in tables 2a and 2b. The quotas have been applied increasingly to smaller and smaller fleet units. In 1986-87, the allocation to mobile gear less than 65 ft. was also split by season. Table 2b illustrates that under the same allocation system, the 1987 fishery was slightly ahead of that of 1986.

Canadian Fishery by Gear Type, Tonnage Class and Unit Area

During the mid-1960's, activity by the mobile gear greater than 100 ft. represented the predominant amount of fishing effort directed on the resource. This fleet restricted its fishing effort to unit areas 4Xm-p (Figure 2), leaving the Bay of Fundy to the smaller draggers. The large vessel fleet substantially reduced its fishing operations in 4X in 1984 (Table 3), because of declining catch rates. As stated earlier, the mobile gear fleet less than 65 ft. increased in size during 1977-81 and became the dominant gear component by 1980 (Table 3).

This fleet operates throughout 4X but particularly in unit areas 4Xq-r during the latter part of the year. In 1986-87, this fleet increased its operations in 4VW, again due to declining catch rates in 4X.

The fixed gear, mostly longliner, fleet operates in unit areas 4Xm-p. Effort by this fleet has not changed dramatically. In recent years, there have been reports of large concentrations of dogfish which would tend to lower the catch rates of this fleet. This problem has decreased somewhat in 1986-87.

Age Composition of the Commercial Catch

Sampling Intensity

Since 1970, sampling for this resource has been generally good (Table 3). Prior to 1981, however, sampling was weighted heavily toward the offshore fleet and consequently sampling of inshore fleet catches was scanty. Since that time, sampling has been excellent with rates of one sample per 200-300 t landed attained. Sampling has been particularly good since 1985.

Construction of 1962-87 Catch-at-age

Construction of the catch-at-age matrix prior to 1978 is discussed by O'Boyle (1981). No adjustment has been made for the USSR catches in the mid-1960's. The length frequency of these landings was assumed to be the same as that for Canada. This is probably an inappropriate assumption and efforts are presently underway to rectify this. However, this should be kept in mind when analyzing the present data set for recruitment studies.

Construction of the 1978-85 catch at age is discussed by O'Boyle and Wallace (1986). The 1986 catch at age was constructed using the sampling stratum-sample availability table given in Table 4a. That for the first half of 1987 is given in Table 4b. This is in keeping with the practice followed since 1982.

For 1979-86, only Canadian sampling was used as no foreign sampling data were available. No correction for discarding and/or misreporting has been applied.

Trends in age composition

The catch and weight at age for 1962-86 are given in Table 5a. The pulse of the 1963 year-class through the fishery during the late 1960's is particularly evident. In recent years, no one year-class has supported the fishery. In 1986, the 1980-82 year-classes have been the dominant contributors. In 1987 (Table 5b), it is the 1981-83 year-classes that contribute the most to the landings. Consistently ages 4-6 have contributed the most numbers and biomass to the reported landings.

The 1986 observed catch-at-age contained substantially more younger fish than that projected by O'Boyle and Wallace (1986) (Table 6, Figure 3). The difference is particularly striking for the 1982 year-class which showed up stronger than expected.

The 1986 weights at age compare favourably to the long term (1962-86) average for the fishery (Figure 4). Certainly the recent declining trend in weights appears to have stopped.

An indication of the level of exploitation sustained by a resource can be obtained from examining trends in the average size and age of a fish in the catch. These parameters fluctuate dramatically due to recruitment pulses into the population. Nevertheless, the long term average level of these parameters is related to the exploitation rate. Trends in the 1962-86 estimates for average weight and age are given in Figure 5, along with the levels expected in populations exploited at $F_{0.1}$ and F_{max}. Since 1973, the average age in the catch has not reached above that expected for an F_{max} exploited stock. The average age has been stable around 4.75 since 1977. The average weight has also been generally below the F_{max} level and has exhibited a declining trend since 1982. These trends suggest high exploitation rates in the 4X haddock fishery.

Stock Abundance Trends

Commercial Catch Rates

Commercial catch rate indices were developed for various fleet sectors operating in 4X on a time and space basis (Table 7). Only trips where the main species was defined as being haddock were used. The catch rate was calculated as:

$$U_t = \frac{\Sigma \; Y_t}{\Sigma \; f_t} \qquad (1)$$

where U_t is the catch rate in year t

Y_t is the catch biomass in year t for trips where effort has been reported and where haddock comprised the largest proportion of the catch for the trip (main species).

f_t is the effort in year t for trips where effort has been reported and where haddock comprised the largest proportion of the catch for the trip (main species).

A multiplicative model (Gavaris, 1980) incorporating all gears was not employed since the assumption of equivalent partial recruitment to all gears would be violated. Age structured multiplicative models (O'Boyle et al, 1984) are a possibility which remains to be explored.

Trends in the various catch rate series are provided in figures 6, 7 and 8. Those for the tonnage class 2-3 draggers all show a declining trend since 1979.

The catch rates for the tonnage class 4-5 vessels are relatively smooth in the first quarter but erratic in the second quarter. The latter trend is understandable given that the commercial fishing for this gear sector is exploited predominately in the first and fourth quarter of the year. The first quarter catch rates in 1986-87 dramatically increase to levels never before seen in the fishery. Examination of the raw data disclosed that information for only one trip (Cape John during 4 February - 5 March 1986) was present on the file. The trip had been particularly successful but fishing in 4X was discontinued for other fleet operation reasons. Although an investigation of the 1987 data was not undertaken it is likely that a similar event occurred. For this reason the 1986-87 catch rates cannot be compared to the historical time series.

The longliner catch rates (Figure 8) have been decreasing since 1984. Before then, the catch rates had been very erratic.

Three catch rate series for 1970-87 were chosen for further examination. All are reflective of catch rates at the time and location of most importance to their fleet specific fishery. The three are: 1) otter trawlers, TC 2-3, 1st quarter, 4Xm-p, 2) otter trawlers , TC 2-3, 3rd quarter, 4Xq-r and 3) otter trawlers, TC 4-5, 1st quarter, 4Xm-p. These catch rates were partitioned among age group using the port sampling data used to construct the catch at age matrix. The catch at age for these three fisheries is provided in Table 8, while the resulting catch rates, by age groups 2-5 (partially recruited) and 6-9 (fully recruited) are shown in Figure 9 and Table 9.

The spring fisheries show dramatic declines in the age 2-5 population since 1980. The trends in the older animals are not as clear.

Groundfish Bottom Trawl Surveys

Standardized Canadian summer bottom trawl surveys have been conducted in 4X since 1970. The vessel used during 1970-81 was the A. T. Cameron. In 1982 the Lady Hammond was used and in 1983 and 1984, the Alfred Needler was used. In the 1983 and 1984 assessments, discussion of conversion factors was extensive. In 1985, a conversion factor of 1.22 x ATC = LH = AN was used. The SSS Subcommittee of CAFSAC met to decide the appropriate conversion factors and recommended that the A. T. Cameron values be adjusted upward by a factor of 1.2 ie. 1.2 x ATC = LH = AN. This was done here.

The arithmetic parameters for the summer survey data are given in Table 10.

Age 0+ abundance increased during 1977-80 and has declined gradually since. Age 2-5 abundance appears to have undergone a gradual increase since 1977 with a small decline in 1986 and a sharp decline in 1987. Age 6-9 abundance has gradually declined since 1977 (Figure 10).

Two recruitment trends were developed using the survey data set. These were calculated by first standardizing the age 1, 2 and 3 catch rates to the age specific 1970-87 average. Then the age 1 and 3 estimates on a cohort by cohort basis were averaged. The same was done for ages 2 and 3. The indices (Table 11, Figure 11) show a strong 1980 and 1982 year-class with relatively weak recruitment occurring in 1985 and 1986.

Sequential Population Analysis Methodology

The Calibration Data

The discrepancy between the survey and commercial catch rates noted in the last two assessments was once again observed. The former is providing a relatively more optimistic view of resource status compared to the latter. The survey series represents an unbiased but variable view of abundance. The commercial catch rate series represents a biased but relatively stable view of abundance. The latter series also suffers from the misreporting/discarding problems mentioned earlier. In addition, the fleets operating in 4X direct their operations in a multi-species fashion, making interpretation of catch rates even more problematical. For these reasons the previous practice of calibrating the SPA with survey data alone was continued.

The Calibration Model

As in O'Boyle and Wallace (1986) the following model was used as a basis of calibration:

$$U_{a,t} = (\alpha_a + q_a N_{a,t}) \cdot \varepsilon_{a,t} \qquad (2)$$

where $U_{a,t}$ is the survey catch numbers per tow at age a in year t

α_a is the age a intercept for the relationship.

q_a is the age a catchability of the survey or slope of the relationship.

$N_{a,t}$ is the mid-year age a, year t SPA abundance estimate.

$\varepsilon_{\hat{a},t}$ is the error in the age a, year t estimate of the survey numbers per tow derived from the relationship.

The error term is assumed to be multiplicative rather than additive, based on analysis of the variance distribution in the data sets made by O'Boyle and Wallace (1986). Homogeneity of the variance is obtained through a log transform.

The survey catch rate was chosen as the dependent variable based on the observation that the variance in this data set is considerably higher than that in the catch at age data set (O'Boyle and Wallace, 1986).

The formulation requires use of a nonlinear least squares procedure. The algorithm used was a method of linearization which is based on the Newton-Raphson numerical technique (Draper and Smith, 1966).

The Calibration Methodology

The software used in calibration is given in Annex 1. The function AUTOSPANONLR is the main routine which calls INPUT for inputting all the basic matrices. ITERCOHORT (which calls PARTIAL), INTERFACERES and NONLR (which call TAYLOR and FCUM) represent the main calibration routines. The output are controlled by PLOTRESRVSPA (which calls PRINTRVSPA) and OUTPUT.

An initial run of SPA is conducted and equation 2 fit to the age 2 to 7 data, on an age by age basis, for the 1970-83 period. The 1984-87 data are not used for it is strongly influenced by the SPA input assumptions. The residuals for ages 2-7, 1970-87 are calculated using the age specific relationships. Starting at age 7, the 1987 fishing mortality which minimizes the sum of squares of the residuals along the 1980 cohort is chosen for the final 1987 exploitation rate. This fishing mortality is applied to ages 8 to 13+, thus implicitly assuming a flat-topped partial recruitment ogive. Once the age 7 estimate is obtained, the analysis is repeated for age 6 and the fishing mortality which minimizes the sum of squares of the 1981 year-class selected. This continues in a sequential manner for all ages down to age 2. This procedure is identical to that described by O'Boyle and Wallace (1986).

The age 12 and 13+ fishing mortality was calculated as

$$F = \frac{\sum_{a=1}^{13+} C_{a,t}}{\sum_{a=1}^{13+} \bar{N}_{a,t} \cdot PR_{a,t}} \qquad (3)$$

where $PR_{a,t}$, the partial recruitment pattern in year t is calculated by dividing the mean F for ages 7 through 10 into that for age 1 to 13+ on a year by year basis.

As in the previous assessment, the 1987 first half of the year catch at age was estimated and included in the catch-at-age matrix to allow use of the 1987 survey data. No age 2 haddock were caught in the commercial fishery in the first half of 1987 (Table 5b). Consequently, the 1987 age 2 SPA could not be used to define the fishing mortality in that year on that age group. Nevertheless the age 2 relationship was used to define residuals for use in calibration of the older year-classes.

Results and Discussion

Model fit

The population and fishing mortality matrices for 1962-87 along with the calibration diagnostics are given in Tables 12 and 13 and Figure 12. The 1987 fishing mortalities are for only the first half of 1987, expressed in terms of a full year.

The fit of the model to the data is not as good as in O'Boyle and Wallace (1986). The correlation coefficients (r) are low, as indicated by the scatter of points around the regression lines (Figure 12a). Trends in the residuals with ln observed x or ln predicted y are not evident, indicating that the model choice is appropriate. However, the fit of the 1980-82 year classes is poor, with residuals being high at young ages (2-5) and low at older ages (6+). The model is unable to fit the high survey catch rates observed for these year classes at age 4. The predicted 1985-87 abundance for ages 5 and 6 is opposite in trend to that observed in the survey data. Nevertheless, this is the best fit of the model to the data, given the calibration technique.

Population Trends

Trends in age one beginning of year numbers (Figure 13a, Table 14) show that recruitment in recent years has dropped below the long term (1962-86) geometric mean of 28641 x 10^3. Recent year-class strengths are ranked as:

Year-Class	Numbers at age one ($\times 10^{-6}$)	Ranking
1980	36.9	strong
1981	29.1	above average
1982	50.5	strong
1983	27.8	above average
1984	19.5	weak
1985	20.0	weak

The estimates for the 1980, 1981 and 1984 year-classes are substantially lower than those of O'Boyle and Wallace (1986). The 1982 year-class continues to be estimated at approximately 50 x 10^6 fish.

Mid-year population biomass (Figure 13b, Table 15) shows an increase to above 90,000 t during 1971-79 followed by a decline to 60,000 t by 1987. This year's evaluation of population biomass is substantially more pessimistic than that given by O'Boyle and Wallace (1986).

Finally, the fully recruited fishing mortality (Figure 13c, Table 15) shows exploitation well in excess of the $F_{0.1}$ level and for most years since 1977 in excess of F_{max}. It is evident that this resource is being subjected to growth overfishing.

Yield Projections to 1988

Yield was projected to 1988 assuming two different fishing mortality scenarios in 1987. The first assumed $F_{0.1}$ or 0.25 while the second used the 50 percent rule, which states that the exploitation rate should be half way between the current F (0.55) and the $F_{0.1}$ level (0.25). This provides an F of 0.40 in 1988.

The projection input conditions are given in Table 16. The beginning of 1987 population numbers for ages 3-13+ were taken directly from the SPA. The age 1 and 2 estimates of 20,000 and 16375 x 10^3 respectively were based upon examination of the age 1 + 2 survey recruitment index in relation to the SPA age one numbers. The 1985 and 1986 recruitment indices were the third and second lowest observed in the time series, behind the 1970 year-class. The next highest recruitment occurs at about 20,000 x 10^3 fish. Until more information is available on the strength of the 1985 and 1986 year-classes, it was felt that the figure of 20,000 x 10^3 at age 1 for these two year-classes would represent a conservative estimate of year-class strength. For the 1985 year-class, this provided an estimate of 16375 x 10^3 at age 2.

The weights at age used for projection were the 1984-86 average. The partial recruitment is also the annual average for this period. The annual vectors before averaging were calculated assuming full recruitment at ages 6 and 7 and adjusting all PR values above one to one. This and the weight at age vector are given in Table 16.

Natural mortality was assumed to be 0.2. The size of the 1987 year-class at age one was assumed to be the geometric mean of 1962-86 or 28641 x 10^3.

The projection results are given in Table 17. Yield in 1988 at $F_{0.1}$ is 8204 t and 12,384 t at F_{50}. This level of harvesting is not significantly different from that presented by O'Boyle and Wallace (1986) and further emphasizes the poor state of the resource.

Concluding Remarks

The assessment presented here assumes that the survey data are tracking population abundance. The high fishing mortalities observed recently appear to be more in line with what is observed in the commercial catch rate series. If the 1988 survey indicates the same low stock size observed in the 1987 survey, then reasons will have to be found to explain why the survey data indicated high stock size relative to the commercial data for the 1980-85 period.

Whatever the trend in abundance historically, it is evident that the resource is currently at a very low level, almost as low as that observed in the early 1970's. The resource is being growth overfished but it is difficult to establish if recruitment overfishing is occurring as well.

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Annex I

Software used in calibration of 1987 Division 4X haddock assessment.

```
      ∇AUTOSPANONLR[⎕]∇
      ∇AUTOSPANONLR
[1]    INPUT
[2]    'AGES TO CALIBRATE'
[3]    APR←⎕
[4]    ROWS←AG⍳APR
[5]    RCOUNT←(¯1↑ROWS)+1
[6]   S5:FCOUNT←0
[7]    RCOUNT←RCOUNT-1
[8]    →(RCOUNT<ROWS[2])/S4
[9]    FVECT←0.01 0.05 0.1 0.5 1 1.1 1.2
[10]   →(RCOUNT=4)/S10
[11]   →(RCOUNT=3)/S12
[12]   →S11
[13]  S10:FVECT←0.0001 0.0005 0.001 0.005 ,FVECT
[14]   →S11
[15]  S12:FVECT←0.0001 0.0005 0.001 0.005 0.01 0.05 0.1
[16]  S11:ALLRESID←(⍴FVECT)⍴0
[17]  S2:FCOUNT←FCOUNT+1
[18]   →(FCOUNT>⍴FVECT)/S3
[19]   →(RCOUNT≠¯1↑ROWS)/S6
[20]   FI←PR×FVECT[FCOUNT]
[21]   →S7
[22]  S6:FI[RCOUNT]←FVECT[FCOUNT]
[23]  S7:ITERCOHORT
[24]   INTERFACERES
[25]   (RVCPUENOS[ROWS+1;]×1000)NONLR SPA
[26]   ALLRESID[FCOUNT]←MAT[RCOUNT-(ROWS[1]-1);3]
[27]   →S2
[28]  S3:FVECT←FVECT[(ALLRESID⍳⌊/ALLRESID)-1],FVECT[(ALLRESID⍳⌊/ALLRESID)+1]
[29]   FVECT
[30]   →(((FVECT[2]-FVECT[1])÷FVECT[2])≤0.01)/S9
[31]   FVECT←+\FVECT[1],10⍴(FVECT[2]-FVECT[1])÷10
[32]   FCOUNT←0
[33]   ALLRESID←(⍴FVECT)⍴0
[34]   →S2
[35]  S9:→(RCOUNT≠¯1↑ROWS)/S8
[36]   FI←PR×(FVECT[1]+FVECT[2])÷2
[37]   →S5
[38]  S8:FI[RCOUNT]←(FVECT[1]+FVECT[2])÷2
[39]   →S5
[40]  S4:ITERCOHORT
[41]   INTERFACERES
[42]   (RVCPUENOS[ROWS+1;]×1000) NONLR SPA
[43]   ' '
[44]   'TABLES AND PLOTS ?'
[45]   PLOTANS←⍞
[46]   →(PLOTANS='N')/0
[47]   ' '
[48]   OUTPUT RESID
[49]   ' '
[50]   TIT←'POPULATION NUMBERS (000S)'
[51]   AG←⍳13
[52]   YR←1961+⍳¯1↑⍴POP
[53]   0 OUT POP,[1]+/[1]POP
[54]   TIT←'FISHING MORTALITY'
[55]   F[;J]←F[;J]×2
[56]   3 OUT F
[57]   ' '
[58]   RESID PLOTRESRVSPA (RVCPUENOS[ROWS+1;]×1000)
      ∇
```

```
∇INPUT[⎕]∇
∇INPUT;NAM;X;M
 NAM←⎕NL 2
 NUM←1
ER0:⎕←'NAME OF CATCH MATRIX?.....'
 →(∨/NAM∧.=X←(¯1↑⍴NAM)↑(' '≠X)/X←,⍞)/OK1
 →ER0,0⍴⎕←'NAMED MATRIX DOES NOT EXIST, RE-ENTER '
OK1:→(2=⍴⍴CATCH←⍎X)/OK2
 →ER0,0⍴⎕←((' '≠X)/X),' IS NOT A MATRIX.'
OK2:→(∧/0≤,CATCH)/ER1
 →0,0⍴⎕←'NEGATIVE VALUES IN CATCH MATRIX.'
ER1:'FIRST YEAR AND YOUNGEST AGE GROUP?'
 →(∧/(X=⌈X),(0≤2↑X),2=⍴X←,⎕)/OK3
 →ER1,0⍴⎕←'MUST BE 2 NON-NEGATIVE INTEGERS, RE-ENTER '
OK3:YR←(¯1+X[1])+⍳J←(⍴CATCH)[2]
 AG←(¯1+X[2])+⍳I←(⍴CATCH)[1]
ER2:'NATURAL MORTALITY?'
 →(∨/(1,I)=⍴M←,⎕)/OK4
 →ER2,0⍴⎕←'EITHER 1 OR ',(⍕I),' NUMBERS, RE-ENTER '
OK4:→(∧/M>0)/OK5
 →ER2,0⍴⎕←'MORTALITIES MUST BE POSITIVE, RE-ENTER '
OK5:MORT←⍉((J,I)⍴M)
 F←(I,J)⍴0
ER3:'STARTING PR VALUES FOR LAST YEAR (',(⍕¯1↑YR),')?'
 →(∨/(1,I)=⍴PR←,⎕)/OK6
 →ER3,0⍴⎕←'EITHER 1 OR ',(⍕I),' NUMBERS, RE-ENTER '
OK6:→(∧/PR>0)/OK7
 →ER3,0⍴⎕←'PARTIAL RECRUITMENT VALUES MUST BE POSITIVE, RE-ENTER '
OK7:'ASSUMED AGES OF FULL RECRUITMENT (USED IN CALCULATION OF PR MATRIX) ?'
 AGE←AG⍳⎕
 'PRESENCE OR ABSENCE OF PLUS GROUP (P/A)?'
 →('A'≠ANS←⍞)/0
 NUM←0
∇
```

```
∇ITERCOHORT[⎕]∇
∇ITERCOHORT;FC;ITER;Y;X;FCNEW;DIFF1
 FC←(¯1↑⍴CATCH)⍴(¯1↑FI)
 FC[J]←FC[J]×0.5
 MORT[;J]←0.1
 ITER←0
OK9:I←⍴FI
 F[;J]←I⍴FI×0.5
 F[I;]←J⍴FC
 ITER←ITER+1
 →(ITER≥11)/0
 POP←(I,J)⍴0
 POP[;J]←((,CATCH[;J])×(,F[;J])+(,MORT[;J]))÷(,F[;J])×1-⋆-(,F[;J])+(,MORT[;J])
 POP[I;]←((,CATCH[I;])×(,F[I;])+(,MORT[I;]))÷(,F[I;])×1-⋆-(,F[I;])+(,MORT[I;])
 →(ANS='A')/SK1
 I←I-1
 POP[I;]←((,CATCH[I;])×FC+(,MORT[I;]))÷FC×1-⋆-FC+(,MORT[I;])
 F[I;]←J⍴FC
SK1:Y←J-1
AA:X←MORT[⍳I-1;Y]
 POP[⍳I-1;Y]←(CATCH[⍳I-1;Y]×⋆X÷2)+(POP[1↓⍳I;Y+1]×⋆X)
 →(1≤Y←Y-1)/AA
 F[⍳I-1;⍳J-1]←(⍟(¯1 ¯1↓POP[⍳((1↑⍴POP)-NUM);])÷1 1↓POP[⍳((1↑⍴POP)-NUM);])-¯1 ¯1↓MORT[⍳((1↑⍴POP)-NUM);]
 PARTIAL
 FCNEW←(+/[1]CATCH)÷(+/[1]POP×PART×(1-⋆-(F+MORT))÷(F+MORT))
 DIFF1←|FCNEW-FC
 FC←(¯1↓FCNEW),¯1↑FC
 →((⌈/¯1↓DIFF1)>0.001)/OK9
∇
```

```
∇PARTIAL[⎕]∇
∇PARTIAL
 PART←F÷((⍴F)⍴((+/[1]F[AGE;])÷⍴AGE))
 PART←((PART<1)×PART)+(PART≥1)
∇
```

```
∇INTERFACERES[⎕]∇
∇INTERFACERES
 POPNB←POP×⋆-(F+0.2)×0.5
 POPNB←POPNB[;0+⍳¯1↑⍴POP]
 SPA←POPNB[ROWS;]
∇
```

```
     ∇NONLR[⎕]∇
     ∇YIN NONLR XIN;FLAG;Y;X;YM;XM;SDEVY2;SDEVX2;SDEVXY
[1]   FLAG←0
[2]   Y←0 ¯1↓YIN
[3]   X←0 ¯1↓XIN
[4]  S1:YM←(+/[2]Y)÷¯1↑⍴Y
[5]   XM←(+/[2]X)÷¯1↑⍴X
[6]   SDEVY2←+/[2]((Y-⍉(⌽⍴Y)⍴YM)*2)
[7]   SDEVX2←+/[2]((X-⍉(⌽⍴X)⍴XM)*2)
[8]   SDEVXY←+/[2](Y-⍉(⌽⍴Y)⍴YM)×(X-⍉(⌽⍴X)⍴XM)
[9]   →(FLAG=1)/S2
[10]  RPART←SDEVXY÷(SDEVX2×SDEVY2)*0.5
[11]  Y TAYLOR X
[12]  A←⍉(⌽⍴XIN)⍴O[1;;1]
[13]  B←⍉(⌽⍴XIN)⍴O[2;;1]
[14]  FLAG←1
[15]  X←XIN
[16]  Y←YIN
[17]  →S1
[18] S2:RALL←SDEVXY÷(SDEVX2×SDEVY2)*0.5
[19]  PREDY←A+B×XIN
[20]  RESID←(⍉YIN)-⍉(A+B×XIN)
[21]  ZCUM←FCUM RESID*2
[22]  MAT←⍉(8,⍴A[;1])⍴A[;1],B[;1],RPART,RALL,(,(2,⍴A[;1])⍴0),(+/[2](RESID*2)),(⌽,(1,-(1↑⍴YIN))↑ZCUM)
     ∇

     ∇TAYLOR[⎕]∇
     ∇Y TAYLOR X;ITER;Z;YY;BB;FLAG2;DEV
[1]   O←(2,⍴X)⍴0
[2]   O[1;;]←0.5
[3]   O[2;;]←0.0001
[4]   ITER←0
[5]  S3:ITER←ITER+1
[6]   →(ITER>50)/0
[7]   Z←(2,⍴X)⍴0
[8]   YY←(⍉Y)-⍉(O[1;;]+O[2;;]×X)
[9]   Z[1;;]←1÷(O[1;;]+O[2;;]×X)
[10]  Z[2;;]←X÷(O[1;;]+O[2;;]×X)
[11]  BB←(2,1↑⍴X)⍴0
[12]  FLAG2←0
[13] S5:FLAG2←FLAG2+1
[14]  →(FLAG2>(1↑⍴X))/S6
[15]  BB[;FLAG2]←(⍉YY[FLAG2;])⌹(⍉Z[;FLAG2;])
[16]  →S5
[17] S6:DEV←BB÷O[;;1]
[18]  O[1;;]←O[1;;]+⍉(⌽⍴X)⍴BB[1;]
[19]  O[2;;]←O[2;;]+⍉(⌽⍴X)⍴BB[2;]
[20]  →(⌈(|,DEV)≥9.9999999999997E¯6)/S3
     ∇

     ∇FCUM[⎕]∇
     ∇Y←FCUM X;I
[1]   Y←X
[2]   →(1=I←(⍴X)[2])/0
[3]  LP1:Y[;I-1]←Y[;I-1]+(1↓Y[;I]),0
[4]   →(1<I←I-1)/LP1
     ∇
```

```
∇OUTPUT[⎕]∇
∇OUTPUT RESID
 ⎕←(UNAFION RESID)
 '        A           B            R(PART)        R(ALL)           INTERVALS             AGE RESID      CCH RESID
 '------------------------------------------------------------------------------------------------------------'
 ' '
 16 7⍕MAT
 ' '
 ' '
 TIT←'STANDARDIZED RESIDUALS ((OBS−PRED)/SER) MATRIX'
 AG←ROWS
 YR←1953−⍳¯1↑⍴SPA
 3 OUT RESID
 ' '
 ' '
∇

∇PLOTRESRVSPA[⎕]∇
∇RESID PLOTRESRVSPA INDEX
 ITER←1
 YR←1959+⍳¯1↑⍴INDEX
S1:'AGE ';ITER+1;' PLOTS '
 DATA←INDEX[ITER;]AND PREDY[ITER;]VS SPA[ITER;]
 DATALN←(⍟INDEX[ITER;])AND(⍟PREDY[ITER;])VS(⍟SPA[ITER;])
 ⍝→S2
 'SURVEY NO, PER TOW VS SPA NUMBERS'
 ' '
 DY←'SURVEY NO, PER TOW'
 DX←'SPA NUMBERS'
 ' '
 40 60 PLOT DATA
 ' '
 ' '
 'LN SURVEY NO, PER TOW VS LN SPA NUMBERS'
 ' '
 DY←'LN SURVEY NO PER TOW'
 DX←'LN SPA NUMBERS'
 ' '
 40 60 PLOT DATALN
 ' '
 ' '
 'TREND IN POPULATION ABUNDANCE OVER TIME'
 ' '
 DY←'ABUNDANCE'
 DX←'YEAR'
 40 60 PLOT INDEX[ITER;]AND PREDY[ITER;]VS YR
S2:' '
 ' '
 →S3
 'TREND IN LNK OVER TIME'
 ' '
 DY←'LNK'
 DX←'YEAR'
 40 60 PLOT LNKOBS[ITER;]AND LNK[ITER;]VS YR
 ' '
 'TREND IN K OVER TIME'
 ' '
 DY←'K'
 40 60 PLOT(*LNKOBS[ITER;])AND(*LNK[ITER;])VS YR
 ' '
S3:' '
 'TREND IN  LN RESIDUAL OVER TIME'
 ' '
 DY←'LN RESIDUAL'
 DX←'YEAR'
 40 60 PLOT(RESID[ITER;])AND((⍴YR)⍴0)VS YR
 ' '
 'TREND IN LN RESIDUAL VS PREDICTED   LN Y'
 ' '
 DX←'PREDICTED  LN Y'
 40 60 PLOT RESID[ITER;]AND((⍴PREDY[ITER;])⍴0)VS⍟PREDY[ITER;]
 ' '
 'TREND IN LN RESIDUAL VS OBSERVED   LN N'
 ' '
 DX←'OBSERVED  LN N'
 40 60 PLOT RESID[ITER;]AND((⍴SPA[ITER;])⍴0)VS⍟SPA[ITER;]
 YR PRINTRVSPA DATA
 ' '
 ' '
 ITER←ITER+1
 →(ITER=(1↑⍴INDEX)+1)/0
 →S1
∇

∇PRINTRVSPA[⎕]∇
∇Z←INDEX PRINTRVSPA DATA;⎕PP;NOP;RANK;FMT;FS;LBLS;I
 ⍝ PRINT DATA ARRAY USED FOR PLOTS
 ⍝ DATA←→ARRAY SUITABLE FOR USE WITH THE"PLOT"FUNCTION
 ⍝ (INDEX)←→DEFAULT IS ⍳¯1↑⍴DATA
 ⎕PP←4
 N←¯1+1↑⍴DATA
 FS←(N⍴E3),(N,2)⍴' '
 FS←¯3⌽FS
 LBLS←(10↑' INDEX'),[1](10↑' CARRIER'),[1]FS
 LBLS←LBLS,[1]10↑' RANK'
 Z←((2 2+⍴DATA),10)⍴' '
 'SUMMARY OF DATA FROM PLOT'
 '------- -- ---- ---- ----'
 ''
 'CARRIER VARIABLE; POPULATION NOS'
 'RESPONSE VARIABLE(S); SURVEY - O:OBSERVED, +:PREDICTED'
 ''
 ⍎(0=⎕NC'INDEX')/'INDEX←⍳¯1↑⍴DATA'
 RANK←INDEX[⍋DATA[1;]]
 Z[1;;]←(2 10⍴20↑LBLS[1;]),[1](¯2↑(⍴DATA),10)⍴⍕(¯2↑(⍴DATA),1)⍴INDEX
 I←1
LP:Z[I+1;;]←(2 10⍴20↑LBLS[1+I;]),[1](¯2↑(⍴DATA),10)⍴⍕(¯2↑(⍴DATA),1)⍴DATA[I;]
 →((1↑⍴DATA)≥I←I+1)/LP
 Z[I+1;;]←(2 10⍴20↑LBLS[1+I;]),[1](¯2↑(⍴DATA),10)⍴⍕(¯2↑(⍴DATA),1)⍴RANK
 Z←(1 10×⌽2+⍴DATA)⍴,2 1 3⍉Z
∇
```

Table 1. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit area 4Xs) by country. The numbers in brackets represent the number of commercial samples collected in that year.

YEAR	CANADA (MQ)	CANADA (Nfld)	USA	USSR	SPAIN	OTHER	TOTAL	TAC
1970	15560 (26)	-	1638	2	370	12	17582	18000
1971	16067 (29)	-	654	97	347	1	17166	18000
1972	12391 (36)	-	409	10	470	1	13281	9000
1973	12535 (30)	-	265	14	134	6	12954	9000
1974	12243 (25)	-	660	35	97	-	13035	-
1975	15985 (56)	-	2111	39	7	2	18144	15000
1976	16293 (45)	-	972	-	95	5	17365	15000
1977	19555 (79)	-	1648	2	-	12	21217	15000
1978	25299 (62)	114	1135	2	-	27	26577	21500
1979	24275 (49)	268	70	3	-	15	24631	26000
1980	28209 (56)	71	257	38	-	37	28612	28000
1981	30148 (82)	117	466	-	-	15	30746	27850
1982	23201 (92)	28	854	-	-	4	24087	32000
1983	24428 (119)	44	494	17	-	7	24990	32000
1984	19402 (97)	23	206	-	-	-	19631	32000
1985	14901 (86)	-	25[2]	-	-	1	14927	15000
1986	14984 (78)	-	40[3]	10[3]	-	-	15034	15000
1987[1]	8583 (56)	-	-	-	-	-	8583	15000

Long-term averages:

1930 - 60 = 16854 t
1961 - 83 = 24217 t
1930 - 83 = 20127 t

1. 1 January - 30 June 1986

2. NAFO SCS DOC 86/22.

3. NAFO SCS DOC 87/20.

Table 2a. Recent Canadian fishery allocations and the respective reported catch (t) of 4X haddock. Information from Atlantic Quota Reports.

Year	Report Date	Fleet	Allocation	Reported[1] Catch	%	CLOSURE DATES
1976		All Vessels	13300	15715	118	
1977		All Vessels	13400	20220	151	
1978		All Vessels	21500	25518	119	
1979		vessels ≤<125'	17500	17949	103	
		vessels > 125'	8500	6471	76	
		Total	26000	24420		
1980		vessels < 125'	22500	23585	105	
		vessels ≥ 125'	5500	5095	93	
		Total	28000	28680		
1981	31/12	vessels < 125'	22350	25102	112	24/10 - 31/12
		vessels > 125'	5500	5380	98	02/02 - 31/12
		Total	27850	30482		
1982	31/12	FG.<< 65'	8850	8168	92	
		MG. < 65'	15000	12909	86	
		FG. 65-100'	100	124	124	23/05 - 31/12
		MG. 65-100'	1000	567	57	
		MG. > 100'	7050	2829	40	
		Total	32000	24597		
1983	31/12	FG. < 65'	9050	9179	104	
		MG. ≤ 65'	15000	12991	87	
		FG. 65-100'	100	108	108	12/04 - 31/12
		MG. 65-100'	800	177	18	
		MG. > 100'	7050	2438	35	
		Total	32000	24893		
1984	31/12	FG. < 65'	8850	6958	79	
		MG. < 65'	15000	12359	82	
		FG. 65-100'	100	3	3	
		MG. 65-100'	1000	44	4	
		MG. > 100'	7050	648	9	
		Total	32000	20012		
1985	31/12	FG. < 65'	4000	4496	112	16/11 - 31/12
		MG. < 65'	10000	10214	102	13/08 - 31/12
		FG. 65-100'	100	1	1	
		MG. 65-100'	100	61	61	
		MG. > 100'	800	541	68	
		Total	15000	15313		

Table 2a. (Continued)

Year	Report Date	Fleet	Allocation	Reported[1] Catch	%	CLOSURE DATES
1986	31/12	FG. ≤ 65'	5000	5446	109	
		MG. < 65' 1/1-30/4	2700			13/03
		1/5-31/8	4000			18/07
		1/9-31/12	2300	9202	102	
		FG. 65-100'	100	0	0	
		MG. 65-100'	100	118	118	15/02 , 15/11
		MG. > 100'	800	680	85	
		Total	15000	15446		
1987	26/09	FG. < 65'	5000	2944	59	
		MG. < 65' 1/1-30/4	2700			
		1/5-31/8	4000			
		1/9-31/12	2300	6299	70	
		FG. 65-100	100	49	49	
		MG. 65-100	100	118	118	
		MG. > 100	800	449	56	
		Total	15000	9859	66	

[1] These figures are based on hail information and thus are unofficial and not comparable to those in Table 1.

Table 2b. Trends in reported catch from Atlantic Quota Report to third week in April during 1982-87.

Fleet	1982	1983	1984	1985	1986	1987
FG < 65'	5146	4918	4397	2486	2631	2944
MG < 65'	8162	9057	8463	7457	5694	6299
FG 65-100'	119	171	2	1	0	49
MG 65-100'	451	185	33	46	110	118
MG > 100'	2179	2171	468	543	117	449

Table 3. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit areas 4Xs) landed in the Maritimes split by tonnage class and gear type. The numbers in brackets represent the mean weight landed per age/size sample collected.

Year	Tonnage Class 1 - 3 MG	Tonnage Class 1 - 3 FG	Tonnage Class 4+ MG	Tonnage Class 4+ FG	Total
1970	4894 (979)	4049	6500 (295)	114	15559
71	4289 (715)	3973 (1006)	7712 (454)	93	16067
72	2741 (914)	4837 (1491)	4750 (238)	63	12391
73	1822 (304)	6415 (635)	4228 (302)	70	12535
74	3949 (790)	6615 (1120)	1623 (325)	56	12243
75	6091 (338)	5465 (1163)	4409 (457)	26	15991
76	4348 (1087)	5750 (1345)	6144 (486)	52	16294
77	6185 (1031)	4878 (490)	8345 (130)	152	19560
78	9213 (9213)	7904 (1083)	8093 (169)	92	25302
79	9870 (4935)	5727 (1076)	8634 (262)	56	24287
1980	13050 (1266)	8038 (932)	7045 (310)	82	28215
81	14769 (348)	8840 (540)	6475 (950)	70	30156
82	11614 (235)	8597 (470)	2972 (309)	32	23216
83	12315 (209)	9580 (438)	2538 (181)	15	24446
84	11744 (202)	7102 (1008)	609 (87)	0	19455
85	9727 (171)	4724 (168)	566 (113)	1	15018
86	9201 (192)	5575 (192)	209 (209)	1	14985
87[1]	5650 (145)	2555 (213)	377 (75)	0	

1. 1 January - 30 June 1987.

Table 4a. Summary of commercial sampling for the haddock fishery in 1986. The tons landed is followed by sampling information in parentheses. The first number represents the number of fish measured and the second the number of otoliths read. The boxes represent the aggregation used in age-length key formation.

Mobile Gear

Quarter	4Xm-p TC 1-3	4Xm-p TC 4+	4Xq-r TC 1-3	4Xq-r TC 4+
1	2568 (4136-271)	147 (289-31)	157 (240-26)	0
2	830 (2025-144)	20	1317 (2501-146)	0
3	794 (761-72)	14	2284 (1192-143)	1
4	642 (225-31)	27	609 (494-27)	0

Fixed Gear

Quarter	4Xm-p TC 1-3	4Xm-p TC 4+	4Xq-r TC 1-3	4Xq-r TC 4+
1	1964 (2474-189)	-	5	-
2	329 (1002-105)	-	32	-
3	1719 (2463-163)	-	62	-
4	1451 (1152-130)	-	13	-

Table 4b. Summary of commercial sampling for the haddock fishery in 1987. The tons landed is followed by sampling information in parentheses. The first number represents the number of fish measured and the second the number of otoliths read. The boxes represent the aggregation used in age-length key formation.

Mobile Gear

Quarter	4Xm-p TC 1-3	4Xm-p TC 4+	4Xq-r TC 1-3	4Xq-r TC 4+
1	3058 (4749-266)	219 (1121-77)	78	-
2	2061 (3174-84)	158	453 (1132-55)	-
3	-	-	-	-
4	-	-	-	-

Fixed Gear

Quarter	4Xm-p TC 1-3	4Xm-p TC 4+	4Xq-r TC 1-3	4Xq-r TC 4+
1	2210 (1797-151)	-	7	-
2	299 (711-89)	-	39	-
3	-	-	-	-
4	-	-	-	-

Table 5a. Landing numbers (A), Weight (B), Percent by Number (C) and Percent by Weight (D) of NAFO Division 4X (excluding 4Xs) Haddock.

A.

LANDINGS AT AGE (000S) OF HADDOCK CAUGHT IN UNIT AREAS 4XM-4XR

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0	0	0	0	0	0	0	0	0	0	41	150	1	37	18	2	0	0	16	1	0	0	2	0	0
2	137	715	155	79	217	22	665	10	1055	788	22	3077	694	2175	1296	1285	75	81	161	1102	491	64	708	198	290
3	4324	2013	1272	3038	16341	313	297	2016	724	1617	3434	113	4653	4568	1644	3126	3354	1155	2445	2215	3637	3274	1100	1756	1170
4	1418	7165	4266	1981	9776	20380	1164	1968	1502	788	1641	2247	309	3164	4261	2019	7914	6709	3008	6219	2474	3476	4680	2261	4878
5	1778	3087	9337	3153	3167	9148	17448	1621	379	1422	509	1067	1779	485	3662	3193	2094	3881	5413	4199	4623	3733	3439	4516	3723
6	1708	1647	3018	3409	2149	1037	4684	11243	524	404	645	527	509	1103	434	2881	2232	1070	3499	3193	1763	2232	2376	1463	1476
7	1646	1415	1492	1973	3747	735	713	3220	4536	69	70	600	189	247	307	360	1040	1244	327	1163	1457	740	748	464	246
8	773	593	1370	1000	640	1052	516	455	1062	3316	37	322	269	172	154	369	137	263	623	337	340	375	340	132	116
9	645	478	612	743	409	187	672	249	133	1020	1166	259	166	62	71	107	107	57	187	323	153	137	110	53	40
10	252	132	416	288	424	102	190	174	56	163	312	614	269	32	95	72	26	68	34	97	94	119	77	16	28
11	205	113	297	293	82	90	131	172	175	131	26	55	352	165	39	23	5	11	21	14	45	67	36	6	9
12	34	59	136	114	62	23	63	74	27	146	193	13	24	229	103	3	6	1	3	23	16	25	20	1	4
13	100	42	36	113	54	61	69	65	37	105	92	6	4	11	137	87	48	18	10	9	14	25	12	1	2

B.

MEAN WEIGHT (KG) AT AGE OF HADDOCK CAUGHT IN UNIT AREAS 4XM-4XR

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.290	0.290	0.270	0.270	0.290	0.270	0.290	0.290	0.290	0.290	0.290	0.270	0.180	0.230	0.230	0.280	0.290	0.290	0.160	0.240	0.000	0.000	0.250	0.000	0.000
2	0.330	0.500	0.500	0.260	0.310	0.320	0.370	0.560	0.570	0.500	0.450	0.310	0.460	0.520	0.520	0.460	0.440	0.510	0.522	0.593	0.493	0.394	0.327	0.333	0.523
3	0.750	0.780	0.750	0.650	0.670	0.620	0.620	0.750	0.900	0.760	0.700	0.750	0.820	0.820	0.810	0.710	0.870	0.870	0.882	0.887	0.707	0.753	0.785	0.757	0.726
4	1.150	1.050	1.000	1.000	0.850	0.850	0.900	0.800	1.050	1.250	1.350	1.250	1.100	1.200	1.190	1.220	1.330	1.330	1.376	1.260	1.274	1.141	1.069	1.043	1.050
5	1.400	1.450	1.390	1.200	1.230	1.050	1.100	1.130	1.160	1.400	1.600	1.300	1.700	1.550	1.600	1.720	1.350	1.340	1.777	1.721	1.653	1.714	1.411	1.372	1.377
6	1.600	1.700	1.700	1.560	1.500	1.450	1.300	1.330	1.430	1.500	1.750	2.000	2.300	2.250	2.100	2.200	2.330	2.360	2.335	2.219	2.130	2.146	1.722	1.742	1.867
7	1.700	1.850	1.750	1.730	1.800	1.600	1.700	1.600	1.650	1.770	1.900	2.200	2.300	2.850	2.750	2.540	2.700	2.830	2.706	2.634	2.577	2.607	2.287	2.460	2.480
8	2.120	2.350	2.040	2.200	2.180	2.050	2.050	2.000	1.950	1.950	2.100	2.300	2.600	3.000	3.300	3.300	3.330	3.300	3.278	3.134	2.947	2.867	2.883	2.901	2.615
9	1.900	2.250	2.300	2.310	2.300	2.360	2.300	2.450	2.300	2.300	2.300	2.300	2.800	3.200	3.600	3.570	3.770	4.030	3.611	3.608	3.470	3.103	3.054	3.341	3.379
10	2.400	2.200	2.400	2.530	2.500	2.700	2.520	2.500	2.520	2.650	2.800	2.700	2.950	3.450	3.800	3.770	4.170	4.130	4.332	3.680	4.033	3.330	3.431	3.244	3.540
11	2.580	2.700	2.420	2.500	2.750	2.700	3.000	2.700	2.300	3.230	3.000	3.300	3.200	3.500	4.100	3.690	4.030	4.960	4.200	4.346	3.746	3.630	3.841	4.162	3.037
12	2.790	3.200	3.000	2.700	2.600	2.690	2.700	3.300	2.650	3.000	3.700	3.400	3.600	3.700	4.000	3.940	3.620	6.000	4.763	4.323	4.033	3.780	4.114	4.300	3.110
13	3.970	3.750	3.610	3.330	3.000	3.300	3.750	3.060	3.600	3.000	3.300	4.200	3.700	4.400	4.200	3.910	4.630	3.680	5.711	4.680	4.708	4.064	4.000	3.700	4.410

C.

LANDINGS PERCENT BY NUMBERS

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	4	1	0	1	0	2	0	10	8	0	34	7	15	10	9	0	1	1	6	3	0	0	2	2
3	34	12	6	17	47	2	1	7	7	16	40	1	49	32	13	23	20	3	15	12	24	20	3	16	10
4	11	41	19	11	25	61	4	9	14	8	21	25	3	36	33	15	42	46	19	33	16	33	34	20	37
5	13	16	42	17	8	27	56	8	3	14	6	12	19	3	29	24	13	27	34	22	31	23	25	41	34
6	13	7	13	30	5	3	16	53	3	4	7	6	5	8	3	21	17	7	22	17	11	13	17	13	13
7	12	8	7	11	10	2	3	15	41	1	1	7	2	2	6	3	6	7	3	6	10	6	7	4	2
8	7	8	6	6	2	2	2	2	17	33	1	4	3	1	1	3	1	2	4	2	2	2	2	1	1
9	5	3	3	4	1	1	3	1	1	10	14	3	2	0	1	1	1	0	1	2	1	1	1	0	0
10	2	1	2	2	1	0	1	1	1	2	6	7	3	0	1	1	0	0	0	1	1	1	1	0	0
11	2	1	1	1	0	0	0	1	2	2	0	1	6	1	0	0	0	0	0	0	0	0	0	0	0
12	0	0	1	1	0	0	0	0	0	1	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0
13	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0

D.

LANDINGS PERCENT BY WEIGHT

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	2	0	0	0	0	1	0	4	2	0	13	2	7	4	3	0	0	0	2	1	0	2	1	1
3	15	7	3	8	31	1	1	5	4	10	24	1	29	22	7	11	11	4	6	6	14	10	4	10	6
4	9	33	13	8	21	52	3	6	10	5	17	23	3	36	27	12	33	36	14	25	13	25	25	16	31
5	13	20	36	15	10	29	60	7	5	12	6	16	23	4	32	27	14	29	34	23	32	26	25	42	36
6	14	12	16	33	8	4	19	53	5	4	7	9	7	14	5	31	25	10	27	23	15	19	24	17	13
7	19	11	9	15	17	4	4	10	46	1	1	11	4	4	13	5	10	14	5	10	16	10	11	8	4
8	11	6	9	8	5	6	3	3	22	40	1	6	5	3	3	6	2	4	7	4	4	5	3	3	2
9	5	5	5	7	5	1	5	2	2	14	21	5	4	1	1	2	2	1	2	4	3	2	2	1	1
10	5	1	3	3	1	1	2	2	2	3	11	14	6	1	2	1	0	1	1	1	2	2	1	0	1
11	3	1	2	2	1	1	1	2	3	4	1	2	14	3	1	0	0	0	0	0	1	1	1	0	0
12	1	1	2	1	0	0	1	1	0	3	5	0	1	5	2	0	0	0	0	0	0	0	0	0	0
13	2	1	0	1	1	1	1	1	1	2	2	0	0	0	4	2	1	0.	0	0	0	0	0	0	0

Table 5b. Landings numbers, weight, percent numbers, and percent weight at age of NAFO Division 4X (excluding 4Xs) haddock for the first half of 1987.

Age	Numbers x 10^3	S^2	C.V.	Weight (kg)	% by Number	% by Weight
1	0	0	0	-	0	0
2	0	0	0	-	0	0
3	420	2139.500	0.110	.626	6.32	3.07
4	1783	13921.800	0.066	.912	26.85	18.98
5	2762	18472.900	0.049	1.284	41.59	41.37
6	1419	10085.000	0.071	1.742	21.37	28.85
7	206	1010.100	0.154	2.453	3.10	5.90
8	45	130.800	0.250	2.960	.68	1.55
9	2	1.000	0.500	4.095	.03	0.10
10	2	-	-	4.410	.03	0.10
11	2	2.000	0.707	3.030	.03	0.07
12	0	-	-	-	0	0
13+	0	-	-	-	0	0

Table 6. Comparison of 1986 projected catch numbers with that observed in the 1986 fishery.

Age	Observed No.	Observed %	Projected No.	Projected %
1	0	0	1	0
2	290	2	172	2
3	1170	10	644	6
4	4378	38	2116	21
5	3923	34	4090	40
6	1476	13	2329	23
7	246	2	555	5
8	116	1	154	2
9	40	-	37	1
10	28	-	19	0
11	9	-	9	0
12	4	-	7	0
13+	2	-	3	0
No. (000's)	11682	100.00	10136	100.00
Catch (t)	15043		15000	

Table 7. Commercial catch rates (tons per unit effort) of 4X haddock for various fleet sectors. For otter trawlers the unit of effort is in hours fishing; for longliners, the unit of effort is in thousands of lines fished. QTR is the year quarter. Below the quarter is indicated the unit areas of capture (see Figure 2).

	OTB-2 (TC 2-3)			OTB-2 (TC 4-5)		LL (TC 2-3)		
	QTR1	QTR2	QTR3	QTR1	QTR2	QTR1	QTR2	QTR3
Year	MNOP	MNOP	QR	MNOP	MNOP	MNOP	MNOP	MNOP
1968	.279	.362	.665	.531	.373	3.161	7.029	-
69	-	.273	.576	.635	.563	14.997	-	-
1970	.064	.374	.155	.332	.650	10.261	-	-
71	.190	.369	.078	.282	.380	11.424	11.970	8.022
72	.099	.286	.094	.308	.390	16.789	4.822	7.413
73	-	.308	.564	.290	.231	15.824	4.076	23.208
74	.257	.142	.092	.335	.315	15.783	10.305	7.099
75	-	.298	.221	.424	.411	13.865	12.424	6.430
76	.362	.204	.205	.433	.352	15.204	9.197	6.647
77	.509	.349	.299	.479	.451	15.782	9.041	14.355
78	.428	.690	.247	.551	.646	17.214	14.147	7.877
79	.522	.461	.210	.895	.491	17.819	9.683	8.088
1980	.559	.329	.217	.827	.236	13.665	10.974	9.609
81	.462	.442	.289	.880	.889	15.011	8.184	8.743
82	.351	.231	.253	.642	.477	13.485	8.780	7.990
83	.287	.265	.180	.605	.380	13.985	10.883	8.951
84	.256	.259	.182	.413	.493	15.343	11.131	7.049
85	.283	.266	.125	.474	.389	13.345	9.883	5.882
86	.230	.142	.189	.923	-	11.083	6.365	7.260
87	.249	.213	-	1.490	-	12.685	5.848	-

Table 8. Landings at age of 4X haddock by gear sector in 1st and 3rd quarter.

LANDINGS AT AGE (000S) OF 4X HADDOCK REPORTED BY OTB, TC1-3 IN FIRST QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	0	0	0	0	0	0	1	0	0	0	4	0	0	2	0	0	0
3	29	32	23	0	5	1	9	43	171	37	34	103	65	62	13	75	17	33
4	57	16	18	2	1	5	56	58	335	378	150	790	144	391	296	252	560	529
5	20	17	6	1	10	2	50	144	83	197	346	627	457	426	366	1115	924	1262
6	16	8	7	0	5	2	8	112	87	41	200	561	161	217	491	316	429	488
7	114	0	1	0	0	0	10	11	50	31	39	188	99	91	142	89	36	59
8	40	46	0	0	0	0	2	14	10	10	16	26	11	19	51	8	28	6
9	1	16	9	0	1	0	1	2	4	1	8	35	9	16	5	16	3	0
10	3	3	2	0	0	0	1	1	0	0	0	14	2	7	15	0	3	0
11	2	2	0	0	2	0	0	1	0	0	0	2	1	3	4	0	2	0
12	0	2	0	0	0	0	1	0	0	0	0	3	2	1	3	0	0	0
13	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0
14	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

LANDINGS AT AGE (000S) OF 4X HADDOCK REPORTED BY OTB, TC4-5 IN FIRST QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	7	2	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0
3	103	504	605	12	61	30	118	260	364	154	87	122	67	184	0	33	1	2
4	214	245	476	976	16	123	750	333	715	1557	381	712	128	721	60	108	32	38
5	77	271	149	471	128	36	673	874	178	812	078	1116	488	374	70	200	53	90
6	61	127	172	201	67	43	104	676	185	169	509	381	175	212	52	45	25	35
7	429	0	31	172	2	9	141	70	106	128	100	222	172	44	32	13	2	4
8	149	716	12	27	0	4	21	86	21	41	41	24	30	16	7	2	2	0
9	5	245	221	51	7	1	18	11	9	3	20	9	6	6	2	2	0	0
10	13	42	48	116	4	0	13	9	0	2	1	6	8	5	2	0	0	0
11	6	34	8	5	20	1	4	6	0	1	0	0	0	3	0	0	0	0
12	1	30	12	2	3	1	7	2	0	0	0	0	0	0	0	0	0	0
13	3	9	6	0	0	0	10	3	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	11	0	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

LANDINGS AT AGE (000S) OF 4X HADDOCK REPORTED BY OTB, TC1-3 IN THIRD QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	18	0	0	41	10	0	5	6	0	0	33	0	0	0	2	0	0
2	620	373	21	1010	1026	1126	473	913	6	12	150	652	338	21	457	166	131
3	137	122	838	18	1212	1164	289	375	336	314	1148	673	1439	857	575	646	321
4	91	40	42	64	2	438	294	58	717	791	603	730	418	517	1166	618	952
5	20	40	3	31	23	2	180	17	177	60	311	335	486	232	356	345	437
6	12	0	8	5	7	3	17	10	139	147	206	233	87	213	162	60	44
7	155	2	0	1	0	0	11	6	29	93	18	51	65	53	59	12	1
8	48	201	0	0	0	0	0	0	8	0	27	35	9	19	7	3	0
9	4	22	10	6	0	0	0	0	3	3	9	25	9	12	8	1	0
10	3	1	10	2	0	0	0	0	1	0	0	10	1	16	7	0	0
11	12	0	0	0	9	0	0	0	0	0	0	0	4	14	3	0	0
12	1	5	0	0	0	0	1	0	0	0	0	0	0	6	0	0	0
13	3	9	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Table 9. Catch rate (no. per hour fished) at age for Canadian otter trawlers fishing 4X haddock in unit areas MNOP (A and B) and QR (C) in the 1st and 3rd quarters during 1970-86.

A.

CATCH RATES (NO PER HR) AT AGE FOR OTB, TC2-3 IN FIRST QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.327	0.000	0.000	0.000	0.000	0.000	0.000	0.806	0.000	0.000	0.000	0.519	0.000	0.000	0.227	0.000	0.000	0.000
3	4.746	27.839	27.085	0.000	31.997	23.957	16.927	34.675	73.789	20.185	15.135	13.361	14.999	8.777	1.473	7.933	1.525	2.689
4	9.328	13.919	21.197	95.699	6.399	119.784	105.336	46.771	144.558	206.214	66.771	102.475	33.229	55.353	33.540	26.655	50.222	43.106
5	3.273	14.789	7.066	47.849	63.994	47.913	94.041	116.122	35.816	107.471	154.019	81.331	105.455	60.308	41.472	117.936	82.866	102.835
6	2.619	6.960	8.243	0.000	31.997	47.913	15.047	90.317	37.542	22.367	89.028	72.770	37.151	30.720	55.636	33.424	38.473	39.765
7	18.657	0.000	1.173	0.000	0.000	0.000	18.808	8.870	21.576	16.912	17.361	24.386	22.845	12.883	16.090	9.414	3.229	4.808
8	6.546	40.018	0.000	0.000	0.000	0.000	3.762	11.290	4.315	5.455	7.122	3.373	2.538	2.690	5.779	0.846	2.511	0.489
9	0.164	13.919	10.598	0.000	6.399	0.000	1.881	1.613	1.726	0.546	3.561	4.540	2.077	2.265	0.567	1.692	0.269	0.000
10	0.491	2.610	2.355	0.000	0.000	0.000	1.881	0.806	0.000	0.000	0.000	1.816	0.462	0.991	1.700	0.000	0.269	0.000
11	0.327	1.740	0.000	0.000	12.799	0.000	0.000	0.806	0.000	0.000	0.000	0.259	0.231	0.425	0.453	0.000	0.179	0.000
12	0.000	1.740	0.000	0.000	0.000	0.000	1.881	0.000	0.000	0.000	0.000	0.389	0.462	0.142	0.340	0.000	0.000	0.000
13	0.164	0.870	0.000	0.000	0.000	0.000	1.881	0.806	0.000	0.000	0.000	0.130	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.613	0.000	0.000	0.000	0.130	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

B.

CATCH RATE (NO PER HR) AT AGE FOR OTB, TC4-5, IN FIRST QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	1.577	0.167	0.000	0.000	0.000	0.000	0.169	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	24.324	42.109	83.397	1.112	39.441	38.195	19.931	32.499	94.621	34.839	22.476	32.868	25.677	52.872	0.000	30.393	6.273	13.769
4	48.199	20.470	65.615	90.477	10.345	156.559	126.679	44.123	186.255	352.236	78.427	191.817	49.055	207.177	83.960	99.470	200.720	261.609
5	17.342	22.642	20.401	43.663	82.762	45.834	113.673	109.243	46.368	183.696	226.822	300.658	187.022	113.215	97.954	184.203	332.443	619.600
6	13.739	10.611	23.709	18.633	43.321	54.746	17.566	84.496	48.192	38.232	131.475	102.644	67.067	60.918	72.765	41.446	156.813	240.956
7	96.622	0.000	4.273	15.945	1.293	11.458	23.316	8.750	27.613	28.957	25.834	59.808	65.918	12.643	44.779	11.973	12.545	27.536
8	33.559	59.822	1.654	2.503	0.000	5.093	3.547	10.750	5.470	9.275	10.592	6.466	11.497	4.598	9.795	1.642	12.545	0.000
9	1.126	20.470	30.464	4.728	4.526	1.273	3.040	1.375	2.344	0.679	5.167	2.425	2.299	1.724	2.799	1.642	0.000	0.000
10	2.929	3.507	6.617	10.733	2.586	0.000	2.196	1.125	0.000	0.452	0.258	1.616	3.066	1.437	2.799	0.000	0.000	0.000
11	1.351	2.841	1.103	0.464	12.932	1.273	0.676	0.750	0.000	0.226	0.000	0.000	0.000	0.862	0.000	0.000	0.000	0.000
12	0.225	2.507	1.654	0.185	1.940	1.273	1.182	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.676	0.752	0.827	0.000	0.000	0.000	1.687	0.375	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.375	0.000	0.000	0.258	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.226	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

C.

CATCH RATE (NO PER HR) AT AGE FOR OTB, TC2-3 IN THIRD QUARTER

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	2.340	0.000	0.000	28.702	0.542	0.000	0.364	1.325	0.000	0.000	2.154	0.000	0.000	0.000	0.111	0.000	0.000
2	80.588	26.309	2.136	707.056	55.598	110.564	62.796	201.673	0.683	1.138	9.791	49.394	23.918	1.387	25.290	9.696	10.664
3	17.807	8.605	85.247	12.601	65.678	114.295	38.368	82.834	36.238	29.766	74.937	50.585	101.827	56.596	31.820	49.427	26.622
4	11.828	2.621	4.273	44.804	0.106	43.008	39.032	12.812	81.596	74.984	39.361	55.303	29.579	34.142	64.524	36.106	78.753
5	2.600	2.621	0.814	21.702	1.246	0.196	23.697	3.755	20.143	5.688	20.301	25.377	34.390	15.321	19.760	20.156	36.242
6	1.560	0.000	0.814	3.500	0.379	0.295	2.257	2.209	15.819	13.935	13.447	17.651	6.156	14.066	8.965	3.505	3.849
7	20.147	0.141	0.000	0.700	0.000	0.000	1.460	1.325	3.300	8.816	1.175	3.864	4.600	3.500	3.265	0.701	0.083
8	6.239	14.177	0.000	0.000	0.000	0.000	0.000	0.000	0.910	0.000	1.762	2.652	0.637	1.255	0.387	0.175	0.000
9	0.520	1.552	1.017	4.200	0.000	0.000	0.000	0.000	0.341	0.284	0.587	1.894	0.637	0.792	0.443	0.058	0.000
10	0.390	0.071	1.017	1.400	0.000	0.000	0.000	0.000	0.114	0.000	0.000	0.758	0.071	1.057	0.387	0.000	0.000
11	1.560	0.000	0.000	0.000	0.488	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.283	0.925	0.166	0.000	0.000
12	0.130	0.353	0.000	0.000	0.000	0.000	0.133	0.000	0.000	0.000	0.000	0.000	0.000	0.396	0.000	0.000	0.000
13	0.390	0.635	0.000	0.000	0.000	0.000	0.664	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 10.

A. CANADIAN SUMMER SURVEY - STRATIFIED AR, MEAN CATCH (NUMBERS) PER STANDARD TOW

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.000	0.000	0.000	0.000	0.000	0.000	0.069	0.025	0.012	0.323	0.027	0.678	0.271	0.349	0.307	0.000	0.121	0.000
1	5.899	0.117	5.900	4.449	11.520	6.970	6.425	6.401	6.325	1.748	21.946	41.014	13.062	6.858	4.684	6.637	3.867	0.943
2	4.733	11.146	0.262	12.362	23.111	3.744	6.119	33.567	4.998	13.428	6.860	28.791	28.713	4.538	23.382	6.777	8.807	0.897
3	1.404	4.716	3.258	0.395	31.740	4.876	3.866	38.796	10.347	10.040	15.326	6.878	12.815	14.449	12.381	24.828	10.013	3.613
4	2.597	2.061	1.350	2.435	0.988	7.952	4.228	11.334	3.059	10.680	8.036	8.772	4.687	5.828	17.671	19.104	17.077	6.632
5	1.118	2.926	0.865	1.174	4.115	0.427	7.362	11.511	1.301	4.987	12.741	3.155	6.654	3.558	5.537	11.710	10.304	3.233
6	2.640	1.384	0.904	0.368	0.913	1.945	0.574	6.650	2.540	1.978	4.354	3.467	2.614	2.351	3.176	3.087	2.833	1.771
7	5.787	2.087	0.613	0.559	0.506	0.531	0.679	0.789	1.101	3.061	1.683	1.157	2.504	0.962	1.564	0.952	0.618	0.442
8	0.795	3.210	0.879	0.414	0.345	0.422	0.127	1.031	0.029	1.162	1.312	0.250	0.333	0.322	0.557	0.095	0.258	0.003
9	0.337	0.759	1.239	0.267	0.330	0.176	0.024	0.143	0.000	0.248	0.637	0.464	0.166	0.272	0.444	0.000	0.067	0.000
10	0.279	0.093	0.043	0.395	0.255	0.110	0.037	0.129	0.000	0.030	0.245	0.232	0.060	0.209	0.080	0.040	0.017	0.000
11	0.085	0.045	0.006	0.007	0.343	0.301	0.000	0.015	0.031	0.000	0.043	0.142	0.038	0.090	0.033	0.000	0.017	0.000
12	0.029	0.061	0.005	0.000	0.000	0.269	0.254	0.069	0.039	0.000	0.000	0.036	0.000	0.069	0.030	0.030	0.000	0.000
13+	0.000	0.000	0.000	0.015	0.000	0.000	0.109	0.279	0.196	0.165	0.050	0.005	0.000	0.070	0.041	0.034	0.078	0.457

B. CANADIAN SUMMER SURVEY - STRATIFIED AR, VARIANCE OF CATCH (NUMBERS) PER STANDARD TOW

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.062	0.001	0.213	0.071	0.055	0.015	0.000	0.003	0.000
1	2.213	0.003	6.800	6.661	43.245	7.915	2.533	3.345	4.953	0.803	197.133	567.615	26.343	5.087	4.632	2.913	0.223	0.062
2	1.943	8.016	0.017	18.737	67.114	1.190	1.940	148.700	2.414	2.480	8.243	159.086	66.925	2.648	125.709	1.776	5.964	0.135
3	0.109	2.058	0.565	0.014	100.788	2.012	0.319	572.094	9.398	0.647	34.920	11.160	11.735	19.349	20.303	68.860	6.822	0.711
4	0.584	0.436	0.068	0.335	0.070	4.723	0.474	46.062	0.650	5.615	6.252	2.531	1.130	1.050	36.622	76.795	14.160	1.323
5	0.200	1.006	0.022	0.066	1.119	0.019	1.313	26.053	0.147	1.735	14.898	0.218	1.841	0.322	1.982	15.721	3.353	0.689
6	1.136	0.236	0.022	0.008	0.073	0.327	0.006	6.602	0.648	0.243	1.530	0.264	0.204	0.122	0.395	0.257	0.405	0.071
7	3.667	0.624	0.010	0.017	0.020	0.032	0.008	0.034	0.082	0.598	0.149	0.050	0.260	0.021	0.090	0.038	0.046	0.016
8	0.084	3.065	0.024	0.013	0.024	0.019	0.000	0.135	0.000	0.073	0.054	0.004	0.007	0.004	0.010	0.001	0.008	0.000
9	0.016	0.068	0.046	0.008	0.009	0.005	0.000	0.001	0.000	0.012	0.018	0.017	0.003	0.005	0.009	0.000	0.002	0.000
10	0.017	0.003	0.000	0.016	0.005	0.004	0.000	0.002	0.000	0.000	0.003	0.012	0.001	0.003	0.001	0.000	0.000	0.000
11	0.001	0.000	0.000	0.000	0.005	0.011	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.001	0.000	0.000	0.000	0.007	0.008	0.002	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
13+	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.005	0.003	0.002	0.000	0.000	0.001	0.000	0.001	0.004	0.128

C. CANADIAN SUMMER SURVEY - COEFFICIENTS OF VARIATION IN AR, MEAN CATCH (NUMBERS) PER STANDARD TOW

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0	0.000	0.000	0.000	0.000	0.000	0.000	0.794	0.000	0.000	0.476	1.090	0.604	0.983	0.672	0.399	0.000	0.453	0.000
1	0.252	0.468	0.442	0.580	0.571	0.404	0.248	0.286	0.352	0.513	0.640	0.581	0.393	0.329	0.459	0.257	0.123	0.264
2	0.295	0.255	0.498	0.352	0.354	0.291	0.228	0.364	0.311	0.117	0.419	0.438	0.285	0.359	0.480	0.178	0.277	0.410
3	0.235	0.304	0.265	0.300	0.316	0.291	0.146	0.617	0.296	0.080	0.386	0.486	0.267	0.304	0.364	0.327	0.261	0.233
4	0.294	0.338	0.193	0.238	0.268	0.273	0.163	0.599	0.264	0.222	0.311	0.181	0.227	0.176	0.342	0.459	0.220	0.173
5	0.400	0.343	0.168	0.219	0.257	0.323	0.152	0.443	0.295	0.279	0.303	0.148	0.204	0.159	0.254	0.339	0.178	0.159
6	0.404	0.351	0.164	0.231	0.296	0.294	0.135	0.386	0.317	0.249	0.284	0.148	0.173	0.149	0.198	0.164	0.225	0.170
7	0.331	0.379	0.163	0.233	0.279	0.337	0.132	0.295	0.260	0.253	0.229	0.193	0.204	0.151	0.193	0.205	0.347	0.226
8	0.365	0.336	0.172	0.275	0.284	0.327	0.000	0.356	0.000	0.240	0.177	0.253	0.281	0.196	0.180	0.333	0.347	0.000
9	0.375	0.344	0.173	0.335	0.287	0.402	0.000	0.221	0.000	0.442	0.204	0.201	0.330	0.242	0.214	0.000	0.648	0.000
10	0.467	0.389	0.000	0.320	0.277	0.575	0.000	0.347	0.000	0.000	0.224	0.472	0.527	0.262	0.395	0.000	0.000	0.000
11	0.372	0.000	0.000	0.000	0.206	0.348	0.000	0.000	0.000	0.000	0.000	0.386	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.518	0.000	0.000	0.000	0.311	0.352	0.648	0.000	0.000	0.000	0.000	0.000	0.458	0.000	0.000	0.000	0.000
13+	0.000	0.000	0.000	0.000	0.000	0.000	0.290	0.227	0.361	0.332	0.894	0.000	0.000	0.452	0.000	0.930	0.811	0.783

Table 11. Recruitment indices for 4X haddock calculated from summer groundfish survey data set.

Year-Class	Age 1 + 2 Index	Age 2 + 3 Index
1968	-	0.394
1969	0.793	0.590
1970	0.017	0.028
1971	0.844	1.863
1972	1.195	1.145
1973	0.822	0.318
1974	0.653	1.913
1975	1.733	1.804
1976	0.575	0.633
1977	0.912	1.201
1978	0.379	0.573
1979	2.442	1.716
1980	3.548	1.783
1981	0.943	0.715
1982	1.346	2.012
1983	0.547	0.704
1984	0.743	0.512
1985	0.261	-
1986*	0.110	-

* Based on age one numbers per tow only.

Table 12. Cohort Analysis calibrated with survey catch per tow using Survey-SPA relationship assuming multiplicative error.

POPULATION NUMBERS (000S)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	24986	91666	201009	16140	10074	17381	8063	14464	25294	6217	47285	44143	23719	48563	51606	29091	39147	27536	33950	36880	29147	50519	27011	19497		
2	32402	20457	75050	164572	13215	8248	14230	6601	11842	20709	5090	38677	36006	19418	39727	42235	23816	32051	22544	27781	30194	23864	41362	22768	15963	
3	39711	26402	16104	61306	134677	10621	6733	11049	5396	8741	16242	4147	28862	28851	13930	31353	33417	19431	26167	18312	21676	24277	19480	33224	18461	12307
4	19226	44793	19795	12034	47444	93669	8230	5244	7222	3762	5693	10191	3293	19436	19488	9918	22841	24324	14861	19212	12988	14454	16875	14946	25431	14056
5	11566	14461	30173	12329	8060	29980	58249	5685	2513	4554	2367	2996	6310	2417	11240	12100	6293	12354	13845	9446	10102	8395	6879	9598	10191	16659
6	9567	7861	9046	16255	7241	3733	16268	31902	3188	1714	2442	1478	1487	3557	1540	5871	7017	3258	6603	6437	3934	4083	3496	2520	3772	4794
7	4687	6288	4944	4676	8414	3984	2116	9081	15946	2136	1038	1415	733	757	1914	863	2200	3183	1699	2240	2379	1630	1324	694	739	1752
8	3144	2347	3867	2698	2043	3490	2597	1088	4521	8951	1686	768	616	429	396	837	385	860	1480	914	782	630	525	226	148	383
9	1895	1694	1385	1927	1304	912	1912	1657	479	2016	4328	1329	338	261	196	185	333	191	466	648	425	332	158	122	65	17
10	1049	968	954	580	903	697	578	958	1132	272	728	2489	854	100	158	96	55	176	105	229	238	183	103	30	52	17
11	536	649	655	405	214	356	479	301	608	840	75	132	1482	455	60	43	13	21	83	55	100	110	42	15	10	17
12	202	253	429	268	148	96	210	273	91	340	524	38	59	714	224	14	14	3	7	49	33	41	28	2	6	0
13	316	185	92	265	200	337	208	201	125	244	250	17	10	34	341	147	115	51	25	19	28	41	17	2	3	0
	169288	210024	363503	293453	233937	173513	119952	88504	78356	60496	87748	107820	103788	125001	140819	132758	135647	123439	121836	122222	112027	128609	118118	103643	163551	123330

9/ 7/87

FISHING MORTALITY

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.000	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000		
2	0.005	0.039	0.002	0.000	0.018	0.003	0.053	0.002	0.104	0.043	0.005	0.092	0.022	0.132	0.037	0.034	0.003	0.003	0.008	0.048	0.018	0.003	0.019	0.010	0.020	
3	0.087	0.088	0.091	0.056	0.163	0.055	0.050	0.225	0.161	0.229	0.266	0.031	0.196	0.192	0.140	0.117	0.118	0.068	0.109	0.144	0.205	0.162	0.065	0.067	0.073	0.070
4	0.085	0.195	0.274	0.201	0.259	0.275	0.170	0.536	0.261	0.263	0.442	0.279	0.109	0.348	0.277	0.255	0.415	0.364	0.253	0.443	0.236	0.542	0.365	0.183	0.211	0.286
5	0.186	0.269	0.419	0.332	0.570	0.411	0.402	0.379	0.182	0.423	0.271	0.500	0.373	0.251	0.449	0.345	0.438	0.426	0.566	0.676	0.706	0.676	0.804	0.734	0.554	0.377
6	0.220	0.264	0.460	0.458	0.397	0.368	0.383	0.493	0.200	0.302	0.345	0.501	0.475	0.420	0.373	0.782	0.591	0.451	0.881	0.795	0.651	0.927	1.417	1.026	0.567	0.742
7	0.492	0.286	0.406	0.628	0.678	0.228	0.466	0.497	0.377	0.036	0.101	0.632	0.335	0.447	0.627	0.613	0.739	0.566	0.420	0.853	1.129	0.963	1.568	1.343	0.459	0.263
8	0.419	0.328	0.497	0.527	0.606	0.404	0.249	0.621	0.608	0.527	0.038	0.622	0.659	0.585	0.561	0.721	0.500	0.412	0.626	0.565	0.655	1.182	1.259	1.043	1.966	0.263
9	0.472	0.374	0.670	0.557	0.426	0.257	0.492	0.182	0.367	0.019	0.353	0.243	0.938	0.305	0.513	1.019	0.438	0.400	0.512	0.800	0.645	0.973	1.465	0.656	1.143	0.263
10	0.280	0.191	0.657	0.796	0.731	0.176	0.452	0.253	0.098	1.009	1.504	0.318	0.428	0.396	1.098	1.767	0.745	0.557	0.443	0.632	0.572	1.273	1.756	0.897	0.915	0.263
11	0.550	0.214	0.695	0.808	0.605	0.328	0.360	0.997	0.382	0.272	0.484	0.614	0.530	0.511	1.283	0.894	1.352	0.847	0.330	0.329	0.691	1.179	2.987	0.610	29.895	0.263
12	0.426	0.296	0.558	0.626	0.613	0.306	0.414	0.472	0.394	0.633	0.516	0.473	0.593	0.433	0.698	1.024	0.608	0.486	0.578	0.727	0.768	1.088	1.498	0.991	1.118	0.263
13	0.426	0.296	0.558	0.626	0.613	0.306	0.414	0.472	0.394	0.633	0.516	0.473	0.593	0.433	0.698	1.024	0.608	0.486	0.578	0.727	0.768	1.088	1.498	0.991	1.118	0.263

Table 13. Summary of diagnostics for final SPA calibration run

A. Regression Diagnostics

Age	a	q_a (x 10^3)	R (1970-84)	R (1970-87)
2	-2.242	0.545	0.620	-
3	-2.071	0.687	0.680	0.725
4	0.003	0.469	0.581	0.568
5	-1.089	0.958	0.878	0.629
6	-0.593	1.125	0.740	0.588
7	0.145	0.798	0.896	0.879

B. ln Residuals (obs-Pred)

	YEAR																	
AGE	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.359	0.359	-0.007	-0.257	0.410	-0.586	-1.022	0.610	-0.641	-0.009	-0.253	0.949	0.830	-0.741	0.263	-0.277	0.461	-3.662
3	0.317	0.531	-0.730	-0.166	0.805	-1.070	-0.439	0.867	-0.526	0.045	0.140	-0.214	0.240	0.200	0.250	0.328	0.108	-0.464
4	-0.044	0.370	-0.373	-0.441	-0.311	0.134	-0.535	1.112	-0.949	0.214	0.365	0.291	-0.048	0.215	1.082	1.190	0.563	0.177
5	0.219	0.330	0.232	0.231	0.177	-0.574	0.122	0.398	-0.914	-0.416	0.471	0.409	0.274	-0.141	0.647	0.919	0.609	-0.847
6	0.120	0.422	-0.505	-0.398	0.419	-0.186	-0.209	0.656	-0.620	-0.037	0.154	-0.094	0.128	0.151	1.008	1.187	0.209	-0.670
7	-0.514	0.230	-0.335	-0.465	-0.157	-0.091	-0.531	0.264	-0.121	0.489	0.391	-0.037	0.803	0.073	0.984	0.865	0.082	-1.101

Table 14. Comparison of numbers (mil.) at age 1 generated by CAFSAC assessments since 1977.

Assessment	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
O'Boyle unpublished assessment #1 1977	30.8	7.0	60.4	49.3	28.9	33.4	-	-	-	-	-	-	-	-	-	-	-	-
O'Boyle unpublished assessment #2 1978	20.8	7.0	60.2	35.3	14.6	26.9	44.8	-	-	-	-	-	-	-	-	-	-	-
Res. Doc. 78/19	33.0	10.8	75.0	56.4	34.7	43.5	83.0	29.4	-	-	-	-	-	-	-	-	-	-
Res. Doc. 80/2	26.4	7.2	50.3	53.3	28.9	56.2	73.5	41.3	50.3	-	-	-	-	-	-	-	-	-
Res. Doc. 81/24	25.4	6.5	48.6	47.2	26.2	50.6	81.8	42.0	76.1	45.3	100.0	-	-	-	-	-	-	-
Res. Doc. 82/53	25.5	6.1	47.9	46.3	25.0	54.1	63.0	39.0	61.9	31.8	97.0	91.9	-	-	-	-	-	-
Res. Doc. 83/73	25.4	6.4	47.74	44.6	24.6	50.1	59.4	33.5	57.0	28.2	88.0	75.5	30.7	-	-	-	-	-
Res. Doc. 84/100	25.3	6.3	47.4	44.5	24.2	49.0	52.6	30.2	41.3	28.1	37.9	39.4	24.5	20.0	-	-	-	-
Res. Doc. 85/109	25.3	6.3	47.4	44.4	24.0	49.1	52.1	30.2	41.8	33.9	39.8	58.5	28.6	48.6	12.3	-	-	-
Res. Doc. 86/98	25.3	6.2	47.3	44.2	23.7	48.8	52.1	29.6	39.9	29.4	37.9	48.3	37.5	50.2	23.2	27.4	18.7	-
Present Document (Log)	25.3	6.2	47.3	44.1	23.7	48.6	51.6	29.1	39.1	27.5	34.1	36.9	29.1	50.5	27.8	19.5	20.0	20.0

Table 15. Comparison of population parameters generated by O'Boyle and Wallace (1986) and the current assessment.

Year	Mid-year Population Biomass (kt)		Fully Recruited ages (7-10) Fishing Mortality*	
	1986	1987	1986	1987
1970	59.6	59.6	0.394	0.394
71	49.9	49.9	0.633	0.633
72	53.2	53.2	0.516	0.516
73	58.0	58.0	0.473	0.473
74	60.1	60.0	0.592	0.593
75	71.3	71.2	0.433	0.433
76	79.7	79.4	0.697	0.698
77	81.9	81.4	1.021	1.024
78	93.3	92.4	0.603	0.608
79	94.6	92.9	0.480	0.486
80	88.3	85.6	0.567	0.578
81	87.1	80.5	0.702	0.727
82	84.7	73.4	0.713	0.768
83	80.2	67.4	0.932	1.088
84	78.3	64.1	0.916	1.498
85	81.0	64.7	0.422	0.991
86	80.6	62.4	0.387	0.513
87	-	60.3	-	0.549

* ages 6-7 for 1986 only

Table 16. 1987 population conditions used for projection purposes

Age	Beg. of year Numbers at age (000's)	Weight at age (kg) (1984-86)	Partial Recruitment (1984-86)
1	20000	0.250	0.0001
2	16375	0.534	0.020
3	12807	0.766	0.081
4	14056	1.054	0.270
5	16859	1.400	0.719
6	4794	1.914	1.000
7	1752	2.409	1.000
8	383	2.733	1.000
9	17	3.265	1.000
10	17	3.405	1.000
11	17	3.680	1.000
12	0	3.841	1.000
13	0	4.703	1.000

$M = 0.2$
$F_{0.1} = 0.25$

Age one recruitment (1962-86 geometric mean) = 28641×10^3

Table 17. Catch projection results using input data given in Table 16.

Year	Mid-year 1+ Population Biomass (t)	1+ Catch Biomass (t)	Fully Recruited Fishing Mortality
1987	61708	15000	0.549
1988 ($F_{0.1}$)	65448	8204	0.25
1988 (F_{50})	63246	12384	0.40

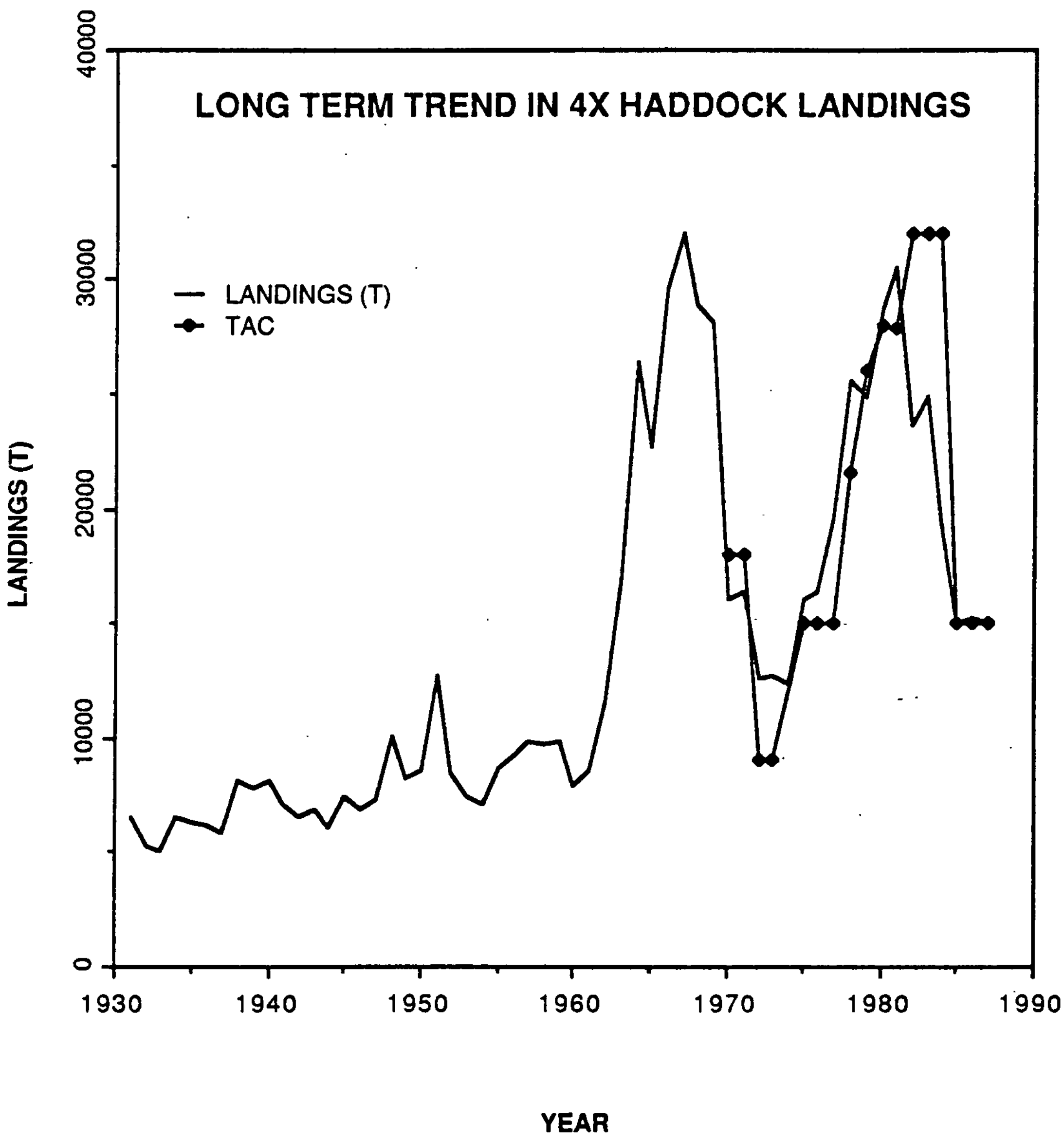


Figure 1. Long-term trends in 4X haddock landings, along with annual TAC since 1970.

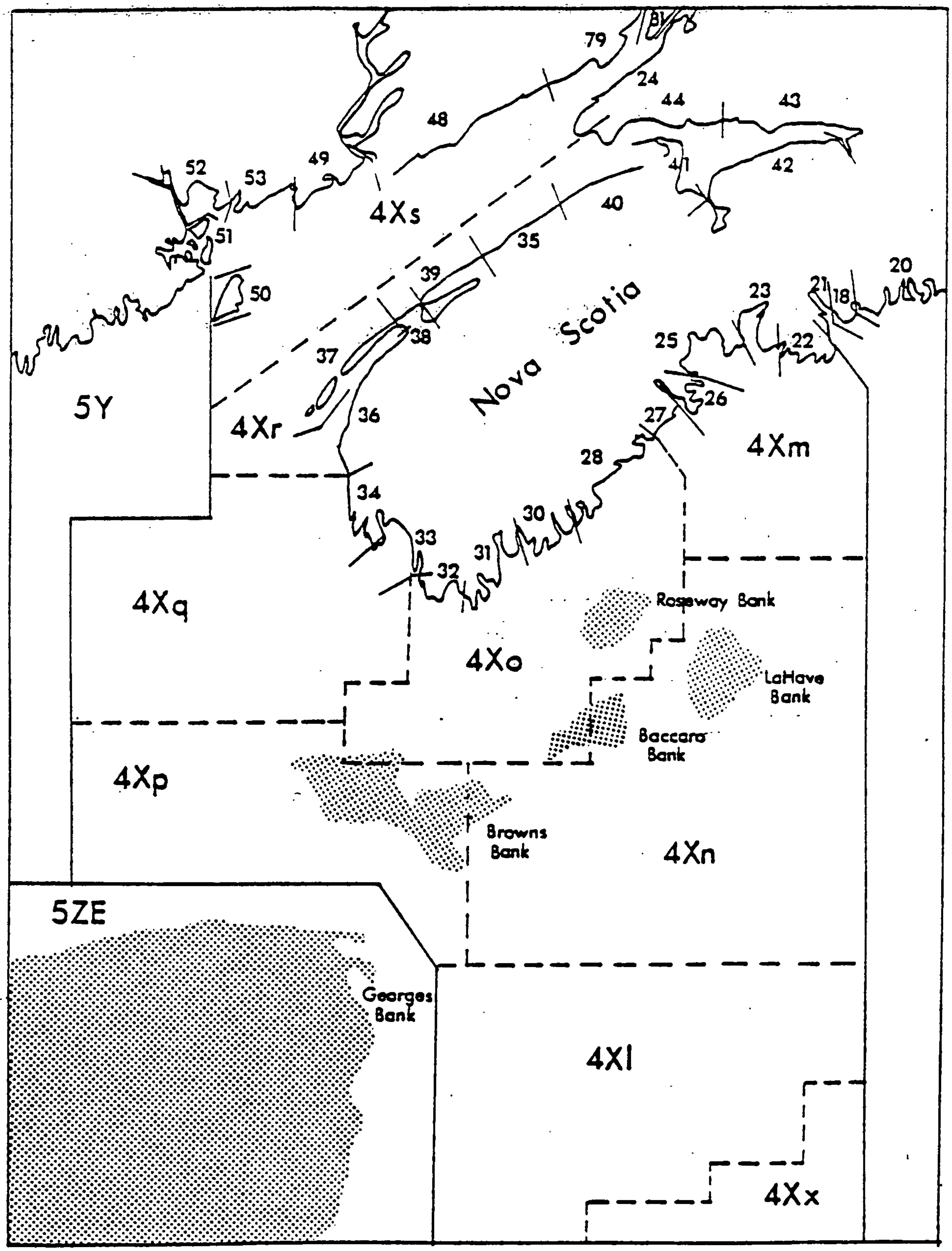


Figure 2. Canadian fisheries statistical unit areas in NAFO Division 4X

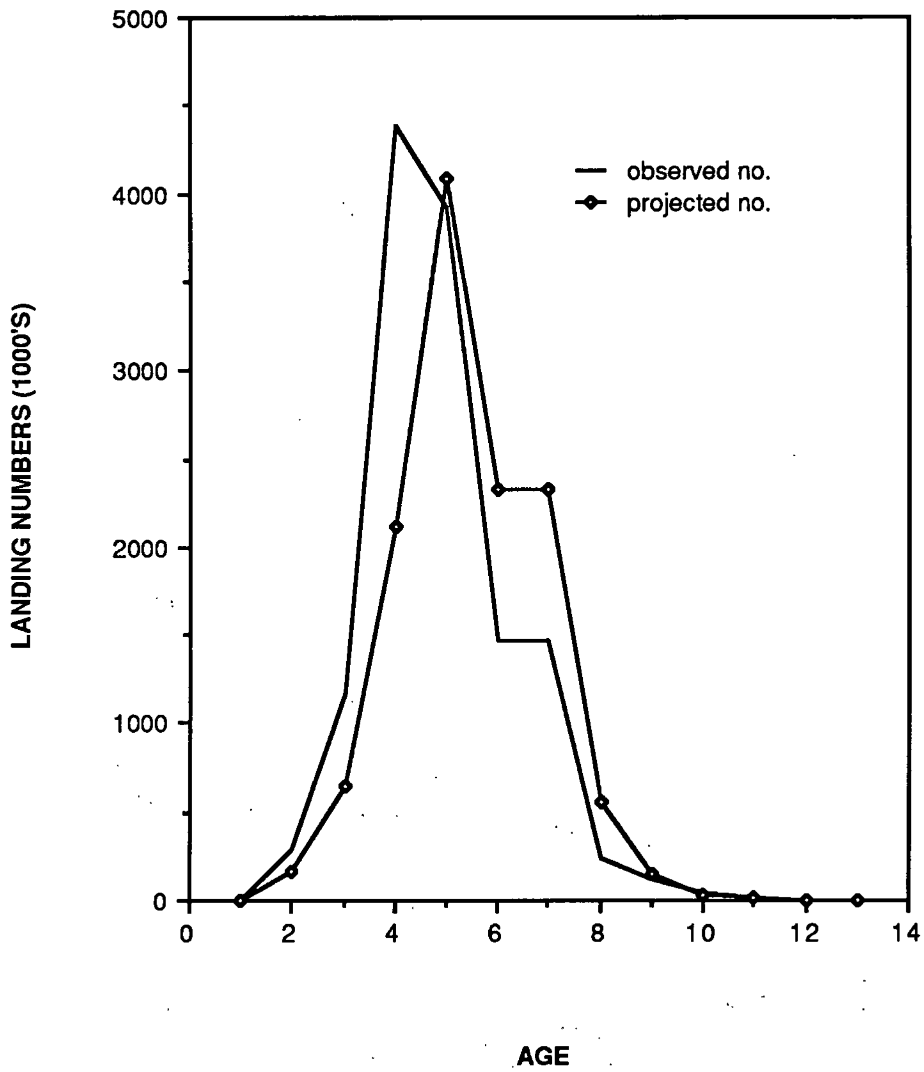


Figure 3. Catch numbers (000's) at age for 4X haddock. Comparison of observed 1986 catch at age (—) with that projected, using 15,000 t in 1986, by O'Boyle and Wallace, 1986 (-o-).

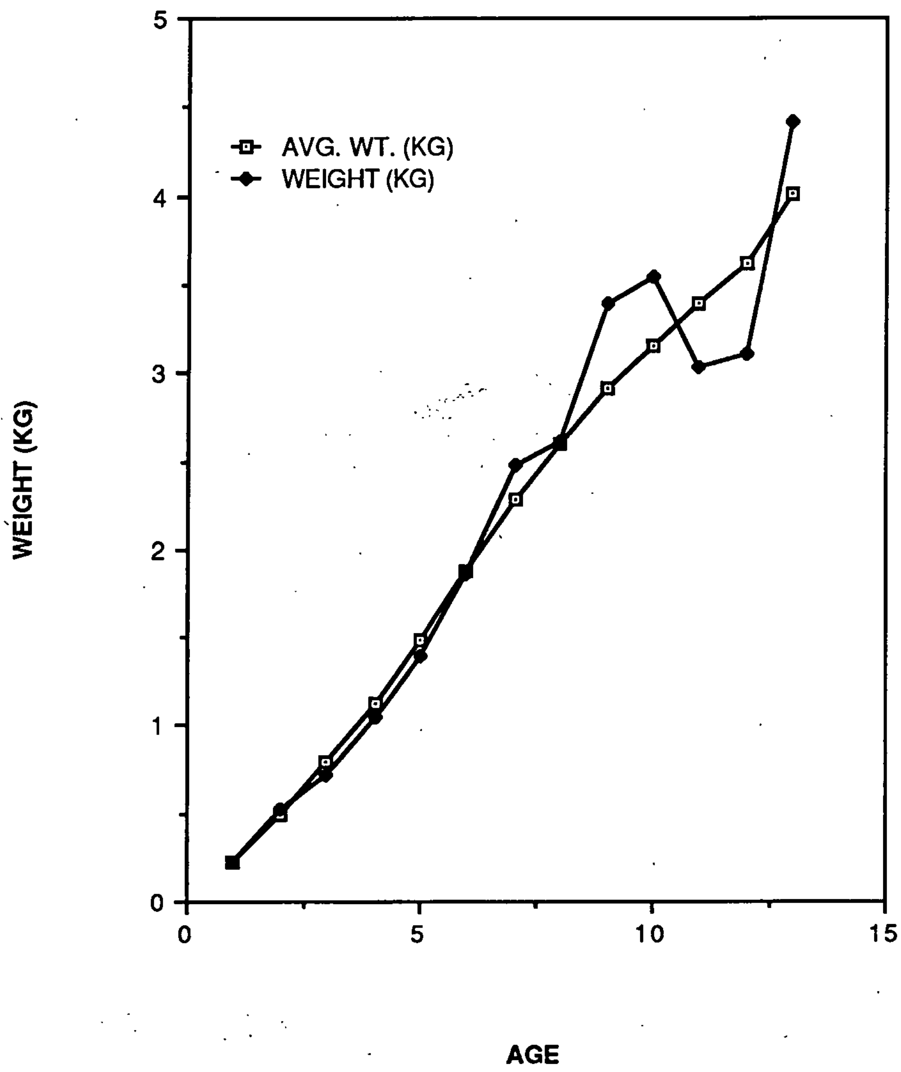
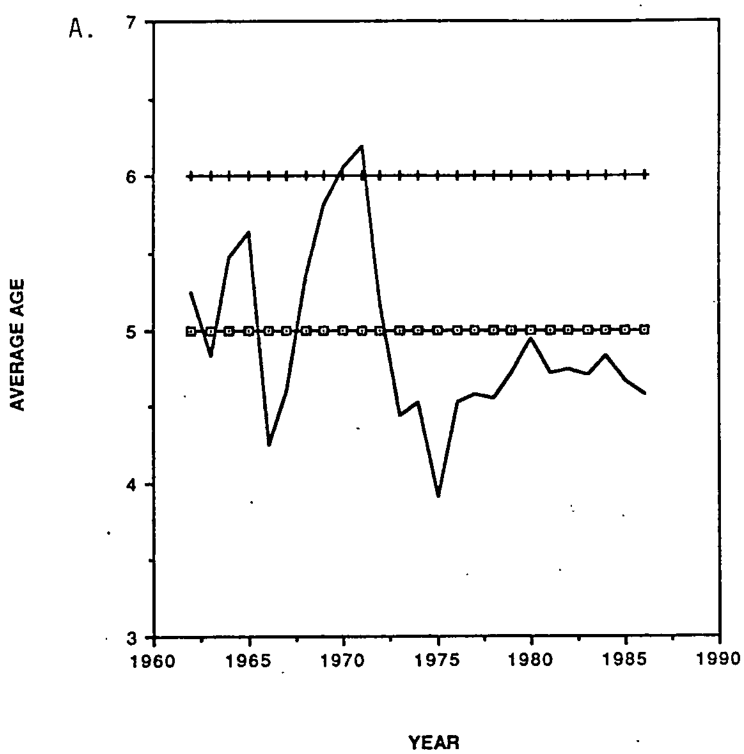


Figure 4. Weight at age (kg) of haddock in commercial catch samples in NAFO Division 4X, 1962-1986. Weights at age for 1986 (-■-) and mean weights at age for 1962-86 (-□-)

A.



B.

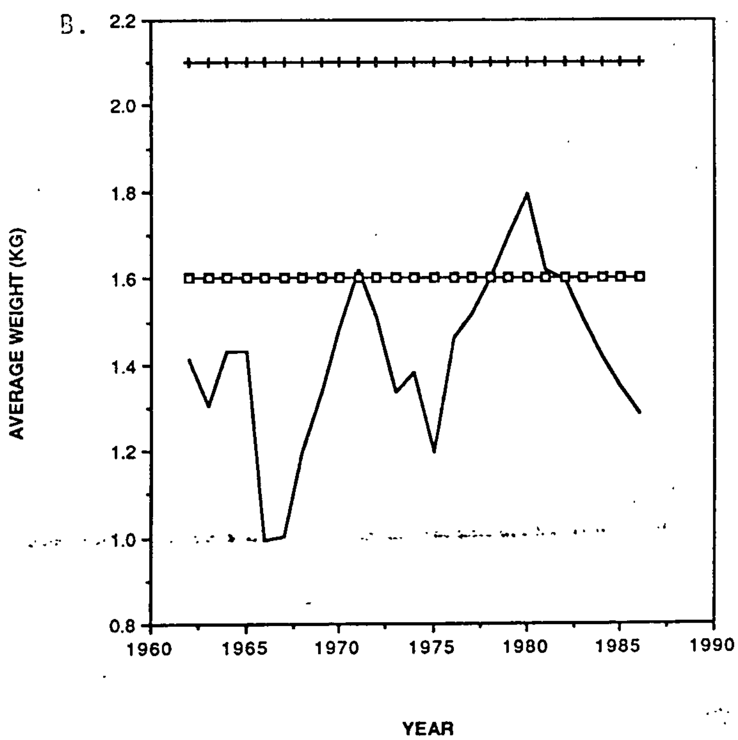


Figure 5. Age-size characteristics of landings of 4X haddock.

A. Average age of 4X haddock in landings.
B. Average weight (kg) of 4X haddock in landings.

Top and bottom line in each figure indicates levels of these parameters in populations harvested at $F_{0.1}$ and F_{max} respectively.

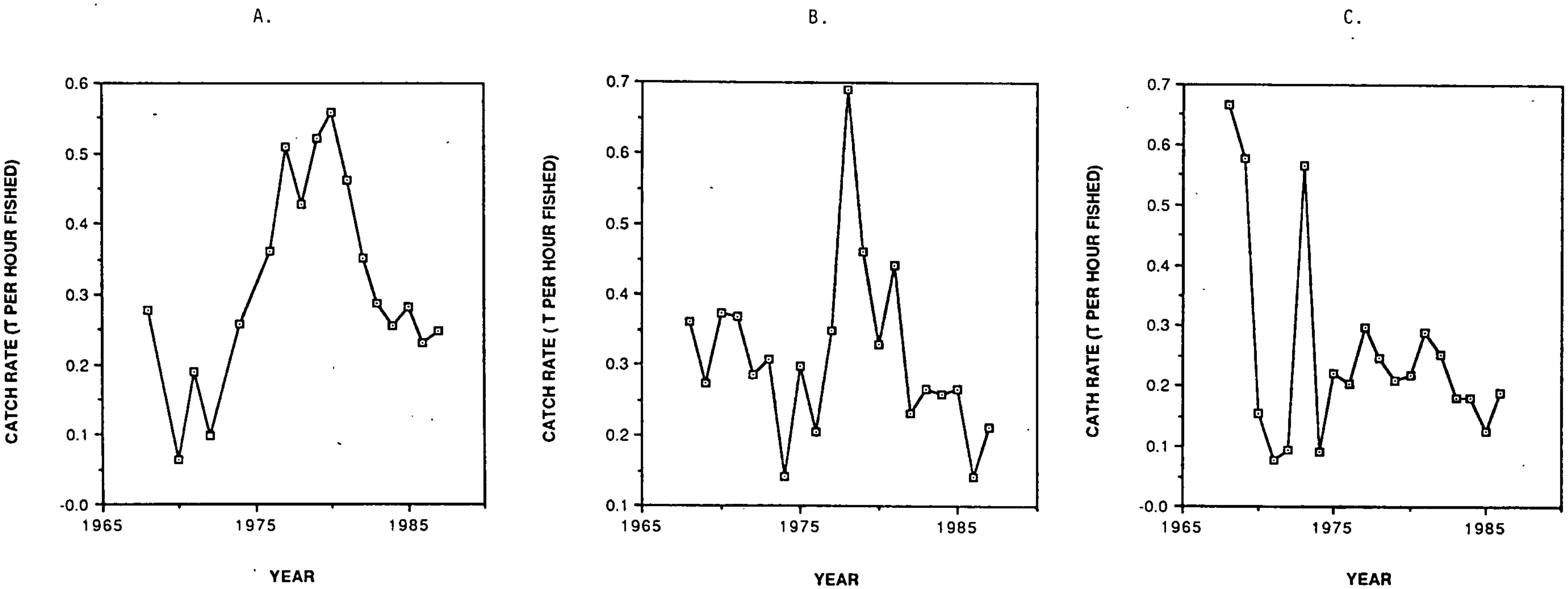
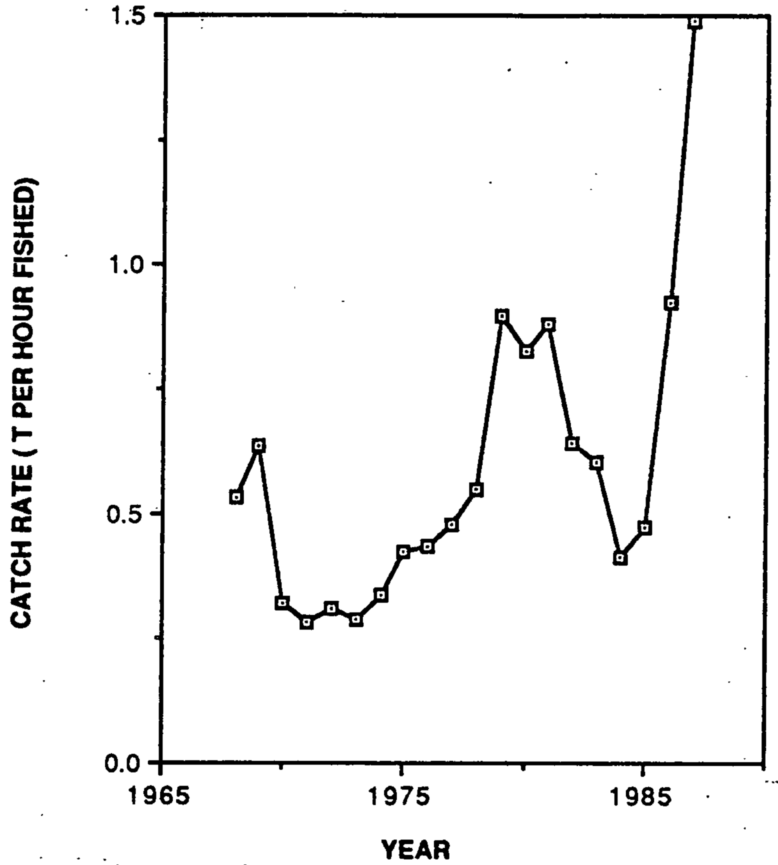


Figure 6. Trends in catch rates (t per hour fished) of haddock by otter trawlers, TC 2-3, fishing in 1st quarter, 4X MNOP (A), 2nd quarter, 4X MNOP (B), and third quarter, 4X OR (C).

A.



B.

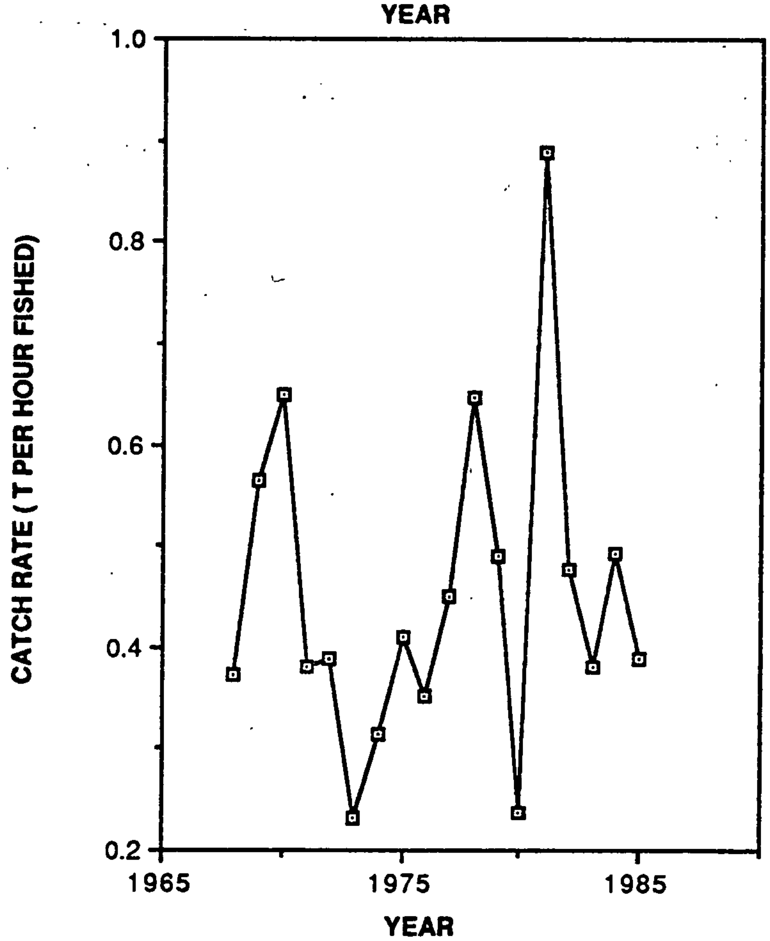


Figure 7. Trends in catch rates (t per hour fished) of haddock by otter trawlers, TC 4-5, fishing in 4X MNOP (A) during 1st and 2nd quarter.

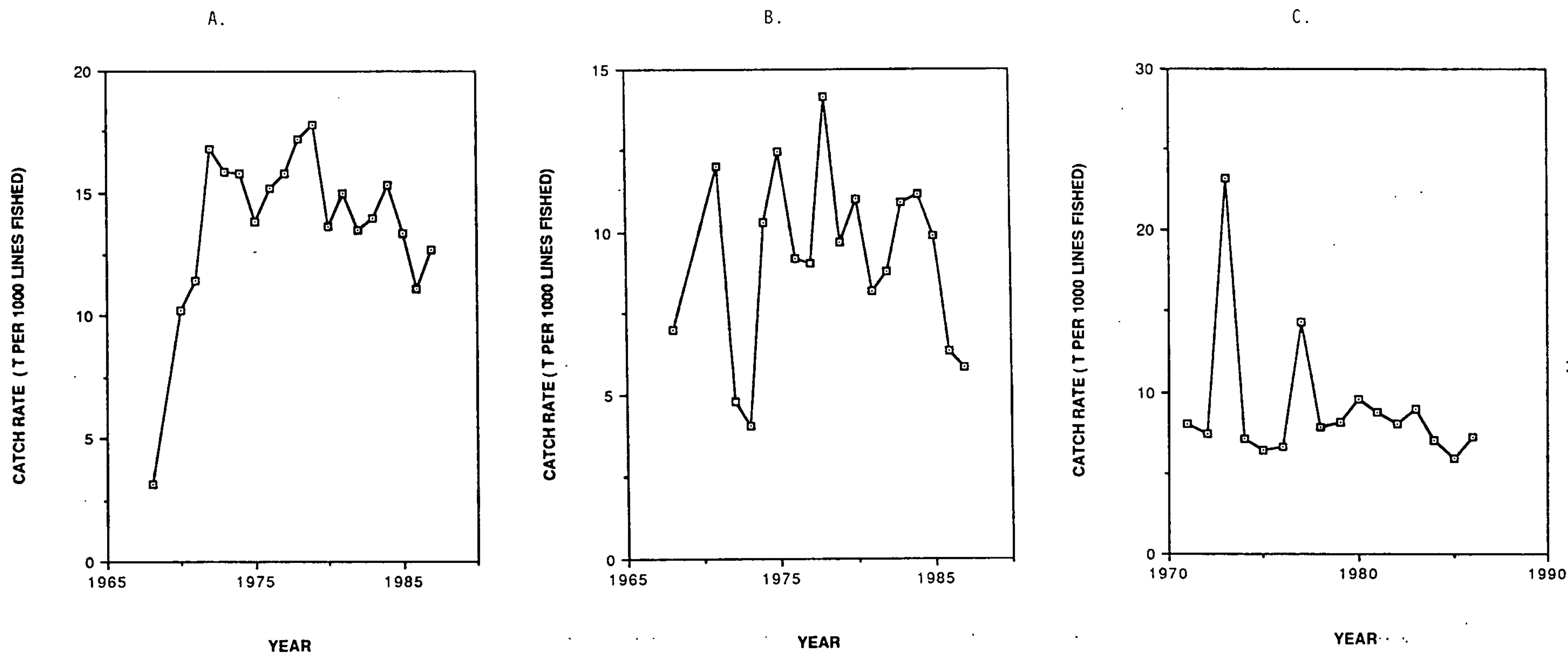


Figure 8. Trends in catch rates (t per thousands of lines fished) of haddock by longliners, TC 2-3, fishing in 4X MNOP during 1st (A), 2nd (B) and 3rd (C) quarters.

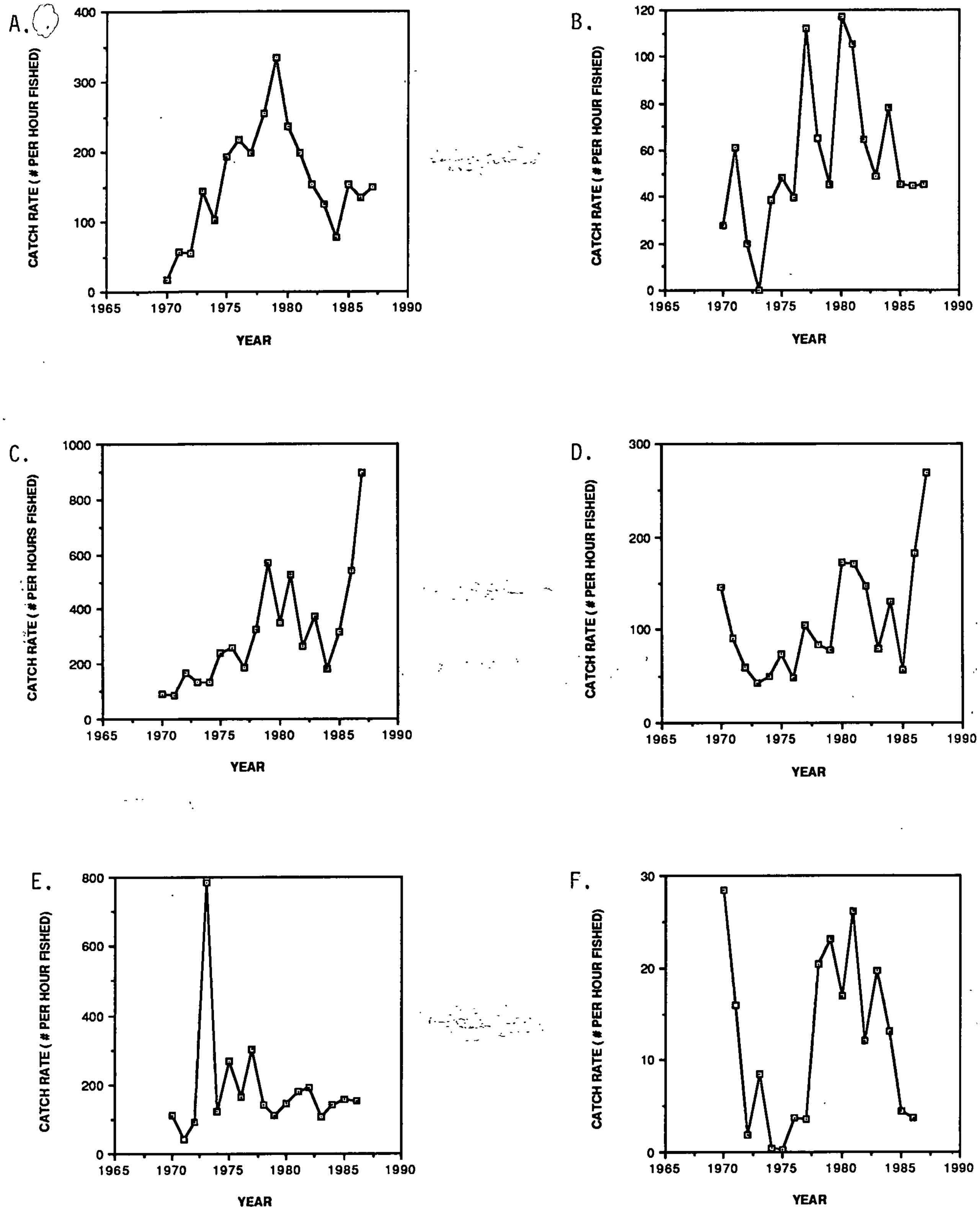


Figure 9. Trends in catch rates (no. per hour fished) of haddock for ages 2-5 (A,C,E) and age 6-9 (B,D,F) by otter trawlers.

A-B: TC 2-3, 1st quarter, 4X MNOP.
C-D: TC 4-5, 1st quarter, 4X MNOP.
E-F: TC 2-3, 3rd quarter, 4X QR.

A.

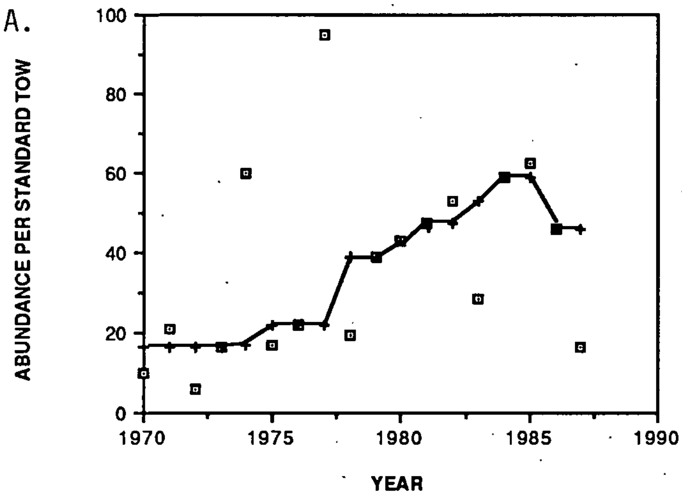
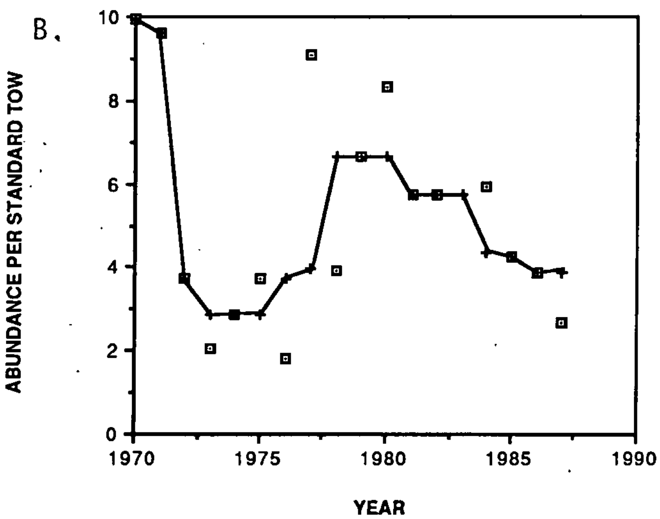
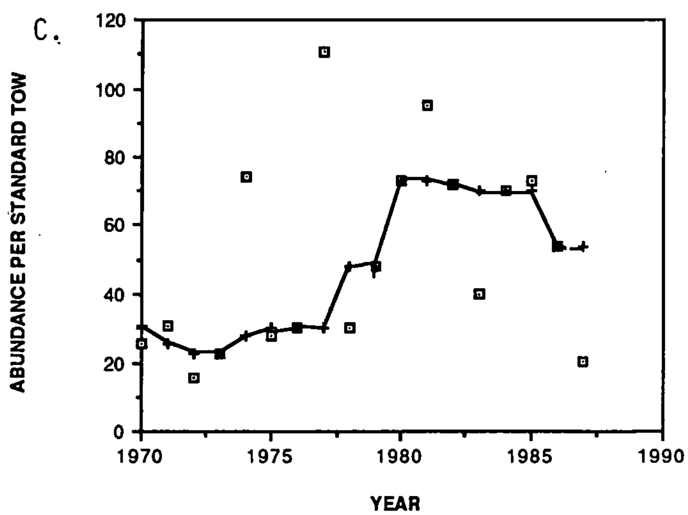


Figure 10. Survey arithmetic mean catch rates (#/tow) of haddock from 4X during 1970-87 for ages 2-5 (A), 6-9 (B) and all age groups combined (C). The solid line in each figure indicates the trend in the median smoothed estimates.

B.



C.



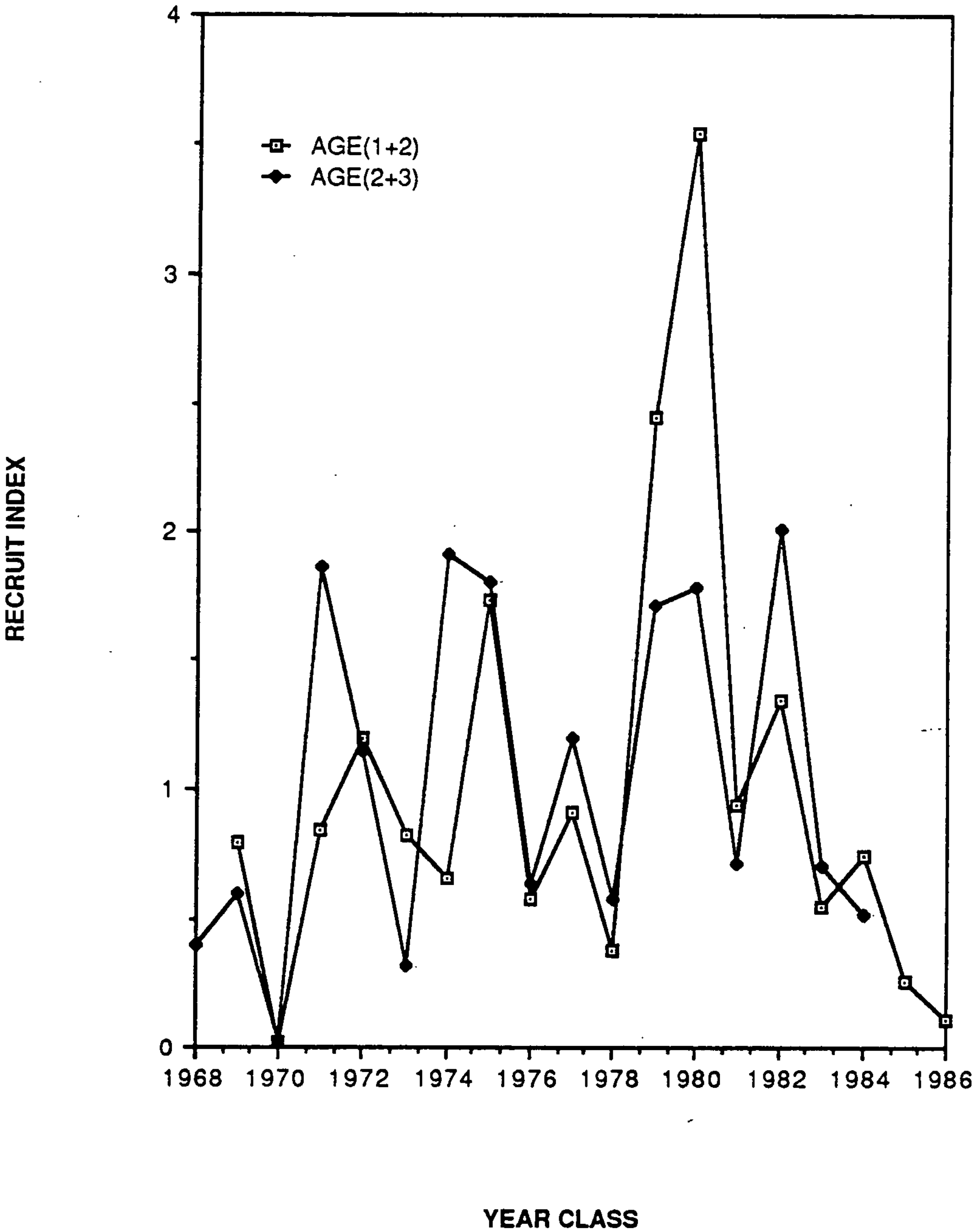


Figure 11. Trend in age 1 + 2 and age 2 + 3 recruitment indices derived from Canadian summer survey data set.

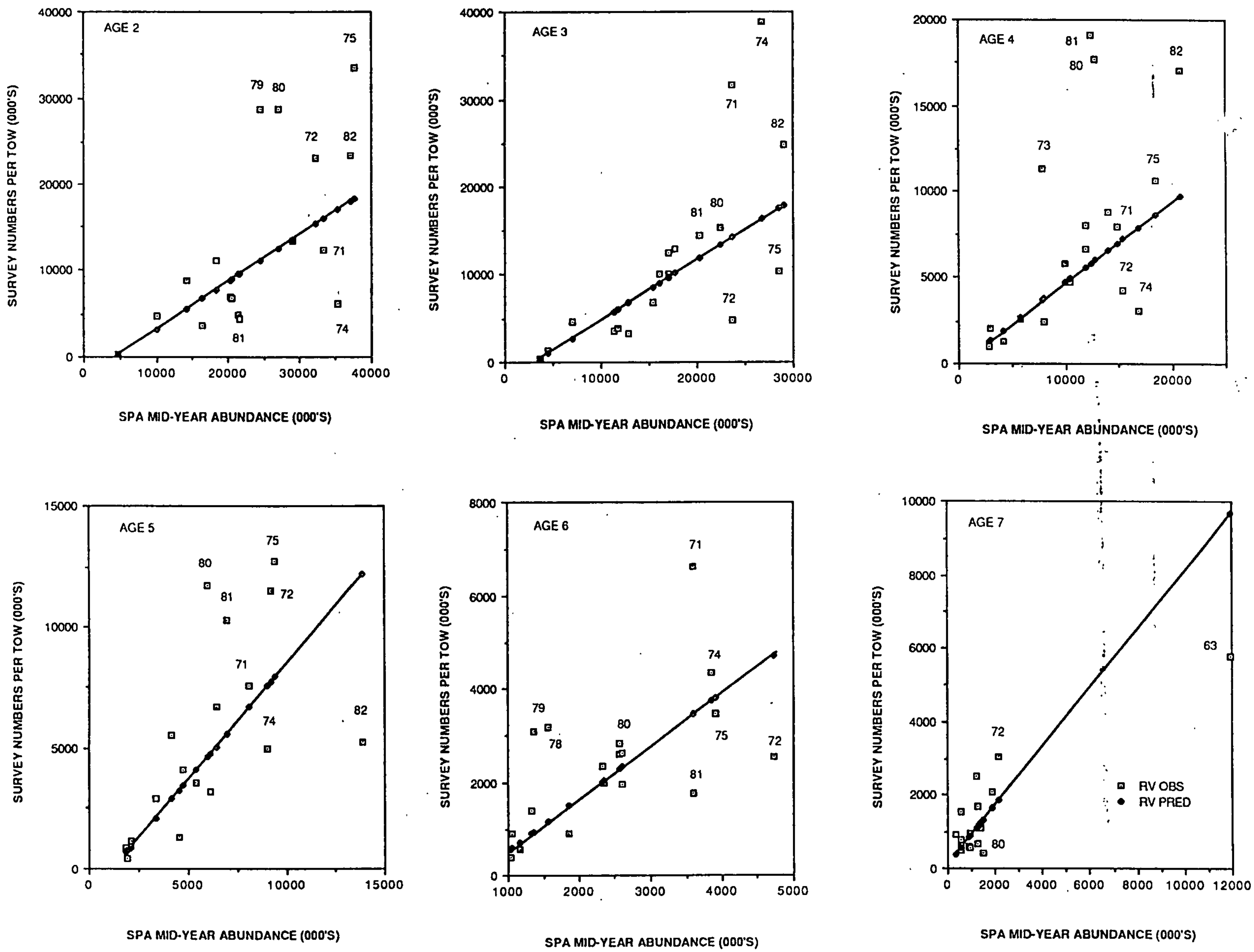


Figure 12a. Relationships by age between survey numbers per tow and SPA mid-year numbers from cohort analysis calibrated with equation 2 in text. Solid line is predicted relationship. Number beside point indicates year-class.

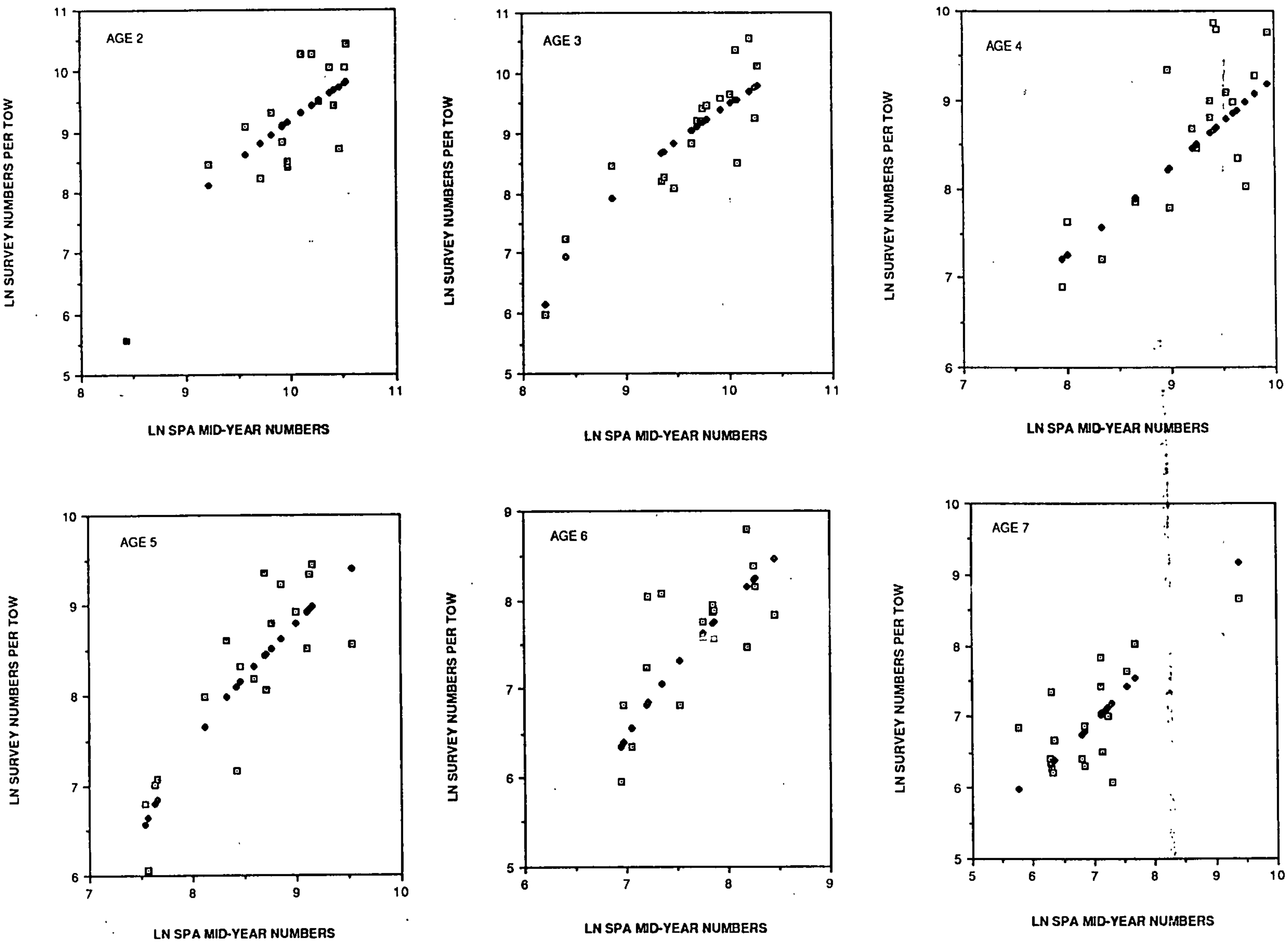


Figure 12b. Relationships by age between LN survey numbers per tow and LN SPA mid-year numbers from cohort analysis calibrated with equation 2 in text. Solid line is predicted relationship.

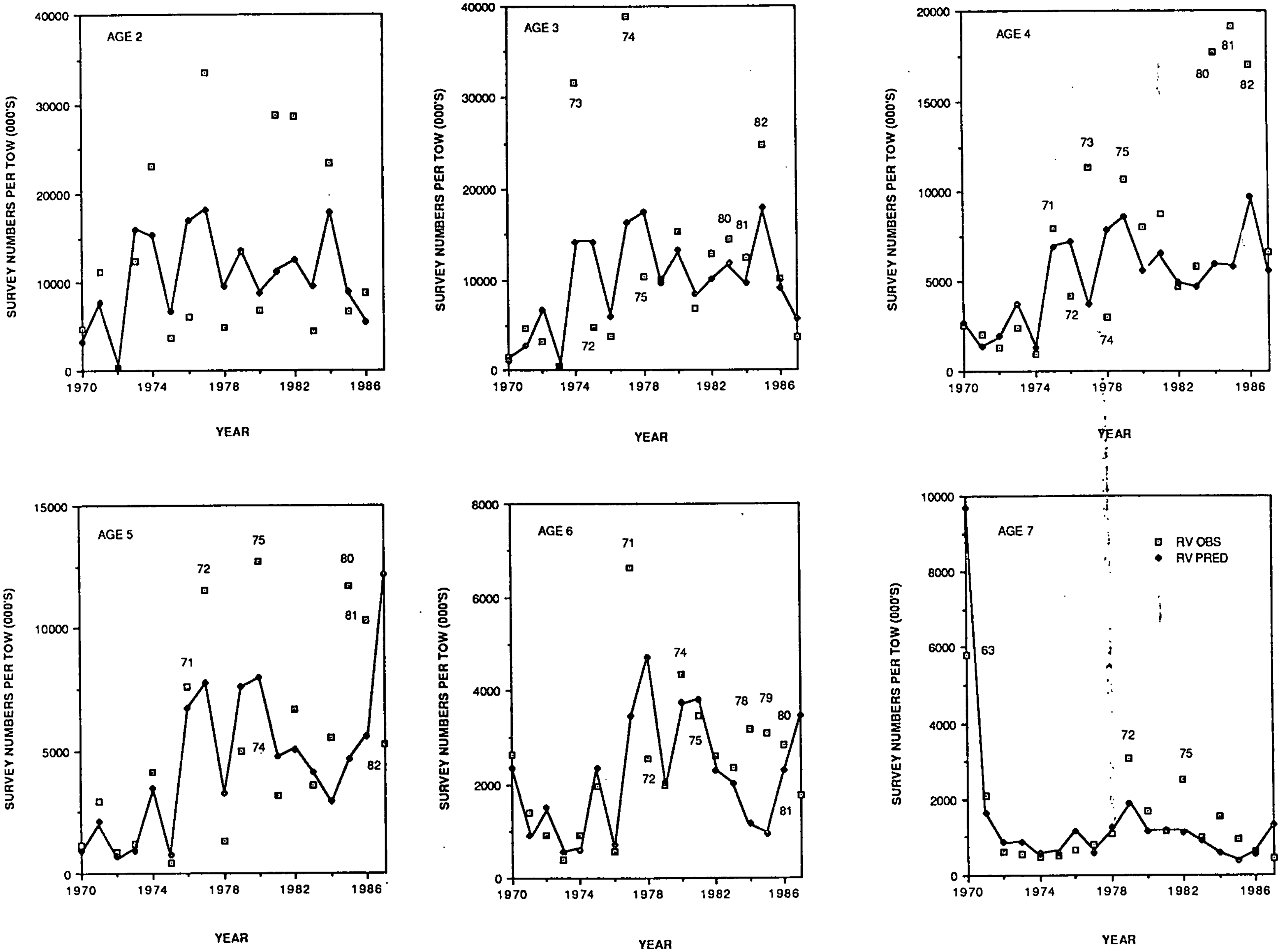


Figure 12c. Trend in age-specific predicted (solid line) and observed survey numbers per tow derived from cohort analysis calibrated using equation 2 in text. Number beside point indicates year-class.

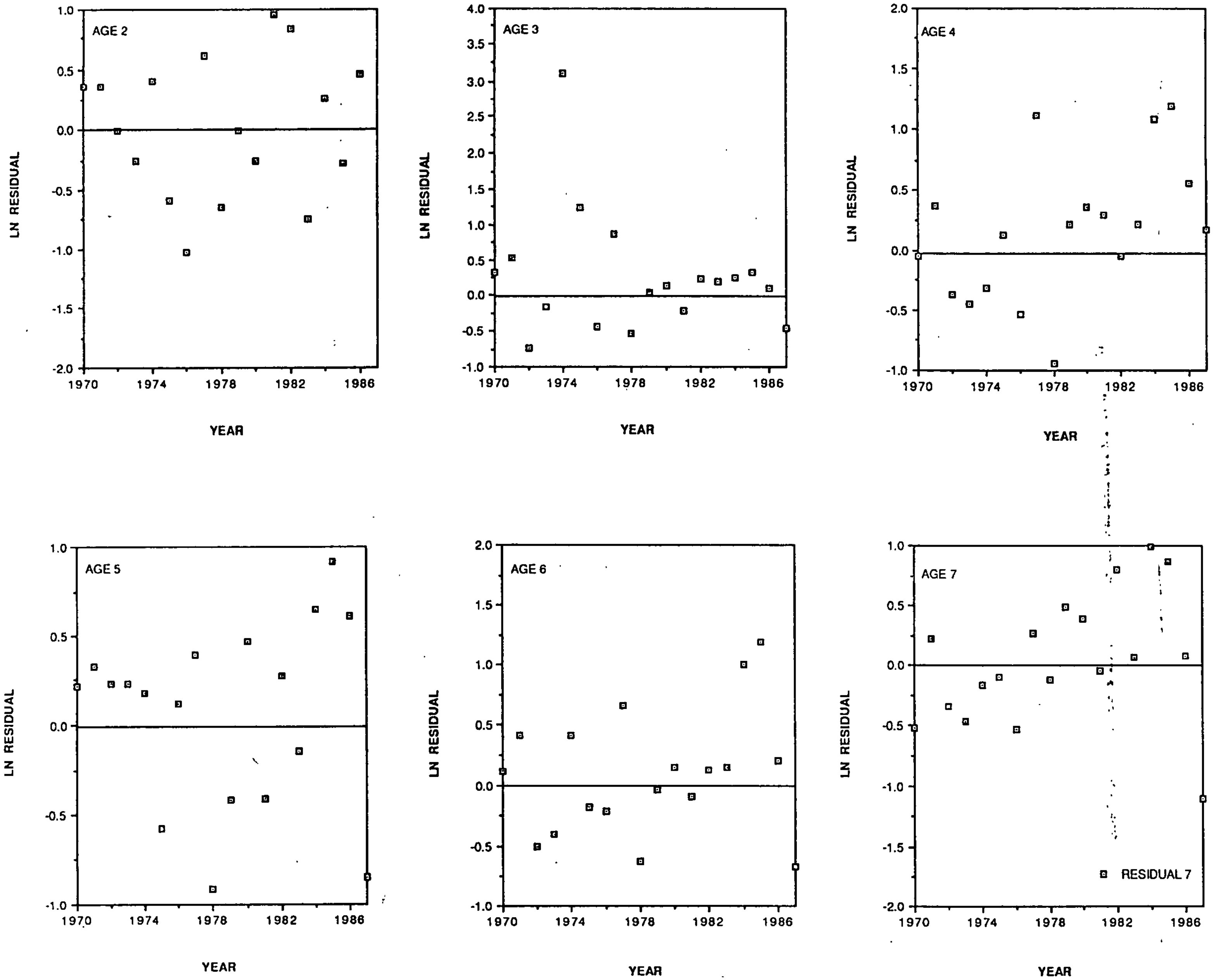


Figure 12d. Trend in LN residuals with time for age-by-age relationships of cohort analysis calibrated using equation 2 in text.

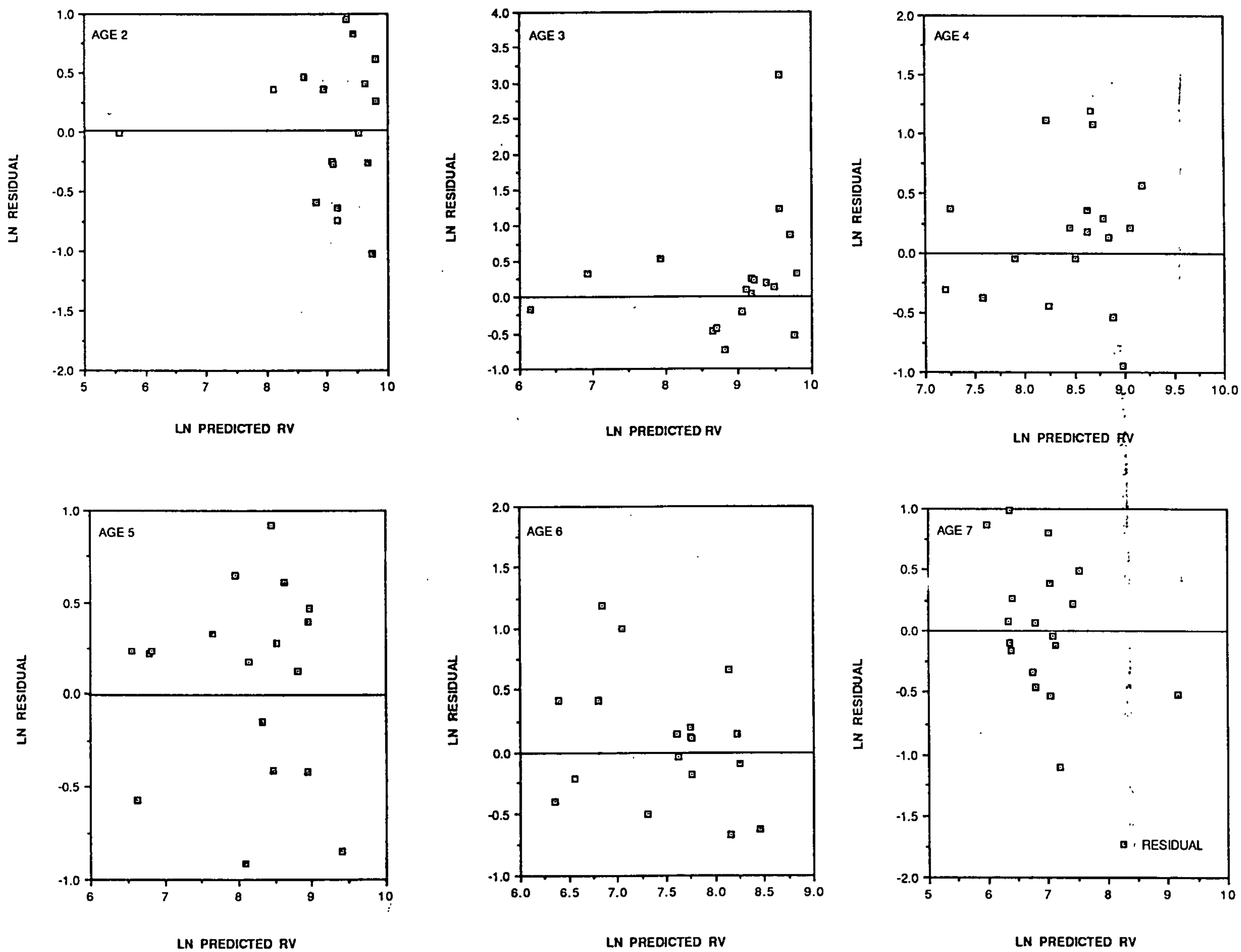


Figure 12e. Relationships by age between LN residuals and LN predicted survey numbers per tow for calibration equation 2 given in text.

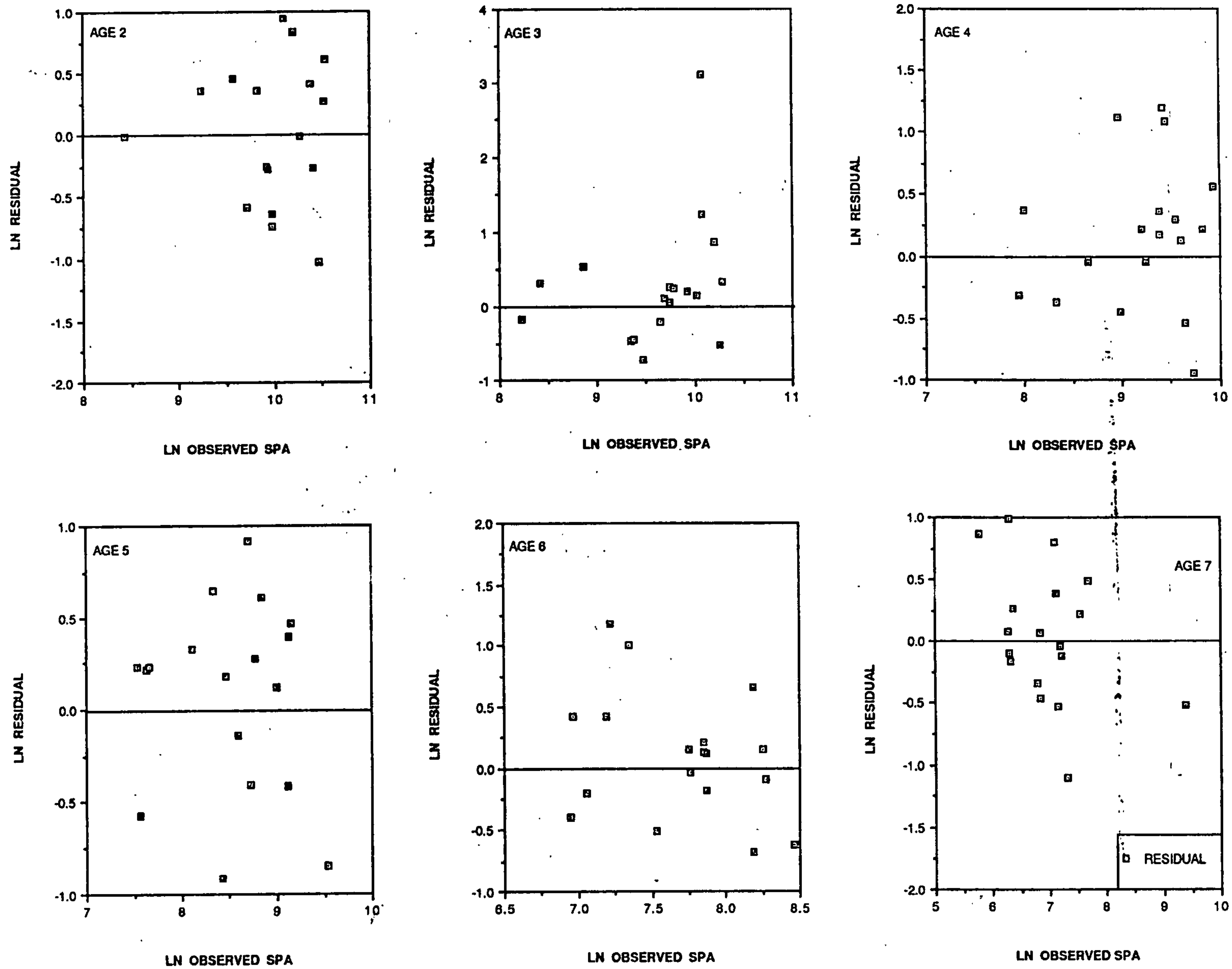


Figure 12f. Relationship by age between LN residuals and LN observed survey numbers per tow for calibration equation 2 given in text.

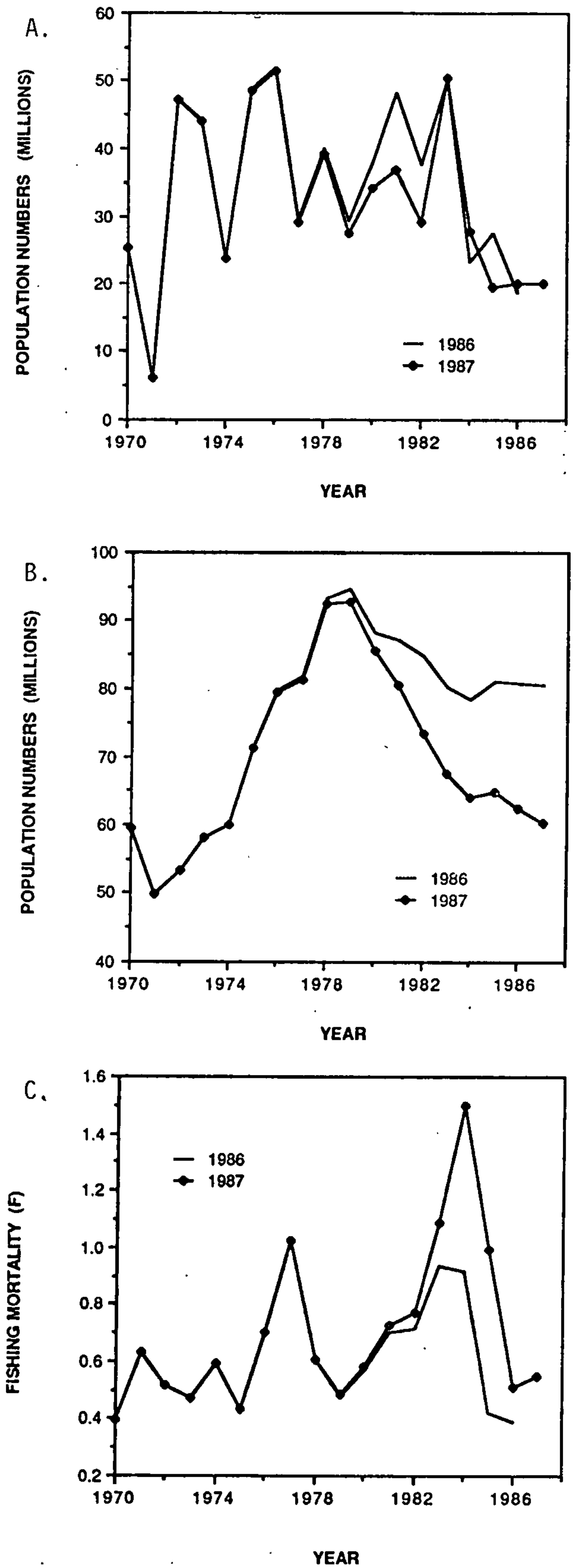


Figure 13. Trends in age one population numbers (A), mid-year population biomass (B), and fully recruited fishing mortality (C) of the 4X haddock resource. All figures show the results of the current assessment (1987) in comparison to that of last year (1986).