Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 98/136

Secrétariat canadien pour l'évaluation des stocks
Document de recherche 98/136

Assessment of 4X Haddock in 1997 and the first half of 1998

P.C.F. Hurley, G.A.P. Black, P.A. Comeau, R.K. Mohn and K. Zwanenburg.

Marine Fish Division
Maritimes Region, Science Branch
Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia, B2Y 4A2

ISSN 1480-4883
Ottawa, 1998
Canada

Abstract

Landings of 4X haddock in 1997 were 6,527t against a TAC of 6,700t. The TAC for 1998 is 8,100t and landings in the first half of the year were 3,597t. Mean length in mobile gear landings remained about the same in 1997 as in 1996, but decreased slightly to 49.6cm during the first half of 1998 due to small fish encountered in 4Xn in March. Mean length in fixed gear landings increased slightly in 1997 and again in the first half of 1998 to 50.4cm. Abundance in the summer research vessel survey decreased to about the long-term mean in 1998. Mean number per tow of small haddock (less than 43cm) decreased but was still above the long-term mean; however the catch rate of market-size haddock remained below the long-term mean. Results of a resource abundance survey conducted by the ITQ fleet in cooperation with DFO Science for the fourth year in 1998 compare well with the research vessel survey results; however the industry surveys indicate that abundance and size composition trends in the inshore area off southwest Nova Scotia, not covered by the research vessel, differ from trends in the traditional survey strata. An index of abundance, which included the inshore area, was generated from the industry surveys and was incorporated into the assessment. Both the 1993 and 1994 year-classes are estimated to be strong and have resulted in an increase in spawning stock biomass from a low of 21,000t in 1994 to about 30,000t in 1998. It was demonstrated that there is still a strong tendency to over-estimate large year-classes, even at age 6, and the estimates of the 1993 and 1994 year-classes were adjusted downward in the projection. The $F_{0.1}$ yield in 1999 would be 9,000t. Spawning stock biomass would peak at 36,000t in 1999 and decrease to 34,000t at the beginning of 2000.

Résumé

En 1997, les débarquements d'aiglefin en 4X s'élevaient à 6 527 t pour un TPA de 6 700 t. En 1998, le TPA était de 8 100 t et les captures au cours du premier semestre ont été de 3 597 t. La taille moyenne des poissons débarqués de bateaux à engins mobiles en 1997 demeurait sensiblement la même qu'en 1996; cependant elle diminuait légèrement à 49,6 cm au cours de la première moitié de 1998, en raison de la petite taille des poissons observés en 4Xn en mars. La taille moyenne des poissons débarqués de bateaux à engins fixes a augmenté légèrement en 1997 puis au cours du premier semestre de 1998, où elle atteignait 50,4 cm. Selon les relevés de recherche d'été, il y a eu en 1998 une baisse de l'abondance, qui se serait située aux environs de la moyenne à long terme. Pour ce qui est du petit aiglefin, (moins de 43 cm) le nombre moyen par trait de chalut a diminué, quoi qu'il restait supérieur à la moyenne à long terme, alors que le taux de capture de poissons de taille commerciale est demeuré sous la moyenne à long terme. En 1998, pour une quatrième année, les résultats du relevé d'abondance mené par la flottille des QI en collaboration avec les scientifiques du MPO ont été comparables à ceux du relevé estival du bateau de recherche. Par contre, en ce qui a trait aux tendances relatives à l'abondance et à la courbe de distribution de la taille, les résultats des relevés de l'industrie, effectués dans les zones côtières du sud-ouest de la Nouvelle-Écosse non couvertes par le bateau de recherche, ne concordent pas avec les résultats des strates traditionnelles de relevés. À partir des données des relevés de l'industrie, un indice d'abondance qui inclut la zone côtière a été établi puis intégré à l'évaluation. On estime importantes les classes d'âge de 1993 et 1994, qui seraient responsables de l'augmentation de la biomasse des stocks de géniteurs, laquelle est passée de 21 000 t à 30 000 t environ entre 1994 et 1998. Cependant, il a été établi qu'on a une forte tendance à surestimer l'ampleur des classes d'âge abondantes, et ce, même à 6 ans, de sorte qu'on a revu à la baisse les prévisions associées aux classes d'âge correspondant à 1993 et 1994. Ainsi, le rendement $F_{0,1}$ pour 1999 serait de 9000 t, et la biomasse des géniteurs devrait culminer à 36 000 t en 1999 puis redescendre à 34 000 t au début de l'an 2000.

Introduction

This document contains an evaluation of the NAFO Division 4X haddock stock for the 1997 fishing year and the first half of 1998. In stock assessments since 1974, haddock caught in unit area 4Xs (Figure 1) have been excluded from the assessment because they were believed to be part of the 5Y stock (Halliday 1974). Hurley et al. (in prep) re-evaluated this stock definition and concluded that haddock landings over the assessment period 1970-98 from 4Xs and from 5Y by Canadian fishermen were most likely haddock from the 4X stock and should be included in the assessment. This revised stock definition was followed in this assessment.

It has been shown that haddock in the Bay of Fundy area grow faster than haddock on the Scotian Shelf in 4X. As a result, haddock landings from 4Xmnop and 4Xqr have been handled separately in the past and separate age/length keys were used for the two areas, designated as Scotian Shelf and Bay of Fundy stock components respectively. Haddock landings from 4Xs and 5Y were included in the Bay of Fundy stock component in this assessment. Similarly haddock catches from the research vessel survey strata 470-481 and 482-491,495 have been handled separately, as Scotian Shelf and Bay of Fundy components in the past. Haddock catches from research vessel survey strata 492-494 were included in the Bay of Fundy component in this assessment (Figure 2).

In a previous assessment of this stock (Frank et al. 1990), it was concluded that problems with the catch-at-age and/or the ADAPT formulation needed to be resolved before the results of Sequential Population Analysis (SPA) could be used as the basis for harvest level advice. In 1992, it was determined that a bias was present in haddock ageing data for this stock in recent years. Criteria for ageing haddock otoliths for this stock were redefined and revised ageing data were available for research vessel survey samples for the 1996 assessment. These revised research vessel survey ageing data were used together with length composition data from commercial samples to construct a commercial catch-at-age for the 1996 assessment (Hurley et al. 1996). For the assessment last year (Hurley et al. 1997), revised ageing data were available for commercial samples from 1988-97 for construction of a commercial catch-at-age; however revised ageing data were not available for commercial samples from 1985-87, and revised ageing data from research vessel survey from 1985-87 were used together with length composition data from commercial samples. Exploitation levels in the 1980s produced by that assessment were lower than in previous assessments and were considered to be inconsistent with effort trends over the same period. It was felt that these exploitation levels were a result of the multi-year research vessel age/length key used to produce the catch-at-age for 1985-87. Revised ageing data were available for commercial samples from 1985-87 for this assessment. Revised ageing data for earlier years are not available as a different technique (cracking vs. sectioning the otoliths) was employed for age determinations prior to 1985; however a comparison of ageing data obtained from cracking and from sectioning of 4VW haddock otoliths produced similar results and suggested that ageing criteria prior to 1985 were acceptable (pers comm J. Simon and K. Frank).

This assessment included the research vessel survey data in the current year 1998, together with commercial landings data for the first half of the year and commercial samples of those landings, to determine stock status in the current year and to make yield projections for 1999. The results of an industry survey conducted in 1995-98 were also used in the assessment.

Description of the Fishery

Nominal Catches

The long-term (1948-97) reported annual landings of haddock in NAFO Division 4X average about 19,000t. Landings exceeded 30,000t during the mid- to late 1960s and again during the early 1980s (Table 1 and 2, Figure 3). Landings declined subsequently and have been below the long-term average since 1984. Landings reached 6,800t in 1989 when it was recommended that the fishery be maintained at the lowest possible level and the mobile gear fishery was closed in mid-season. Landings increased from 1989 to 10,530t in 1992 under a Management Plan that called for a by-catch fishery only. A TAC of 6,000t was implemented in 1993 and landings in that year were 6,968t. Landings in 1994 were 4,406t, the lowest level observed in recent history, under a quota of 4,500t and stringent fishing plans. Quotas for 4X haddock have increased slightly in the past several years. The TAC in 1997 was 6,700t and total reported landings were 6,527t (Table 2). The 1998 TAC is 8,100t and 3,597t were landed in the first half of the year.

The by-catch of 4X haddock in the foreign silver hake fishery has been less than 50t (Table 3). The co-ordinates of the Small Mesh Gear Box were re-defined in 1994, resulting in a shift in the Box to the east and to deeper water. This change and the introduction of grates have resulted in an overall reduction in the groundfish by-catch in this fishery. The 4X haddock by-catch has been less than 10t since and was negligible in 1998.

The domestic fishery was dominated by the mobile gear sector between 1977 and 1989 (Table 3). Between 1990 and 1994, the fixed gear sector took a larger proportion of the landings; however the proportion taken by the mobile gear sector has increased since and was 66% in 1997.

Inshore mobile gear (<65ft) landings were 4,214t in 1997 (Table 3) while landings by the offshore mobile gear fleet were 64t. Fixed gear landings (longline and handline) were 2,158t while gillnet landings remain low, at 56t. The mobile gear sector indicated that haddock was largely a bycatch species in 1997; directing for cod and pollock would catch their haddock allocation. The fixed gear sector reported they were avoiding haddock in 1997, due to the low haddock quota, but also because of small haddock. There was a delay in the start of the fishery and landings were down in the first two quarters.

Mobile gear sector haddock landings in the first quarter of 1998 were twice those of 1997, and the highest they had been since 1989 (Table 4). This was a result of directed fishing for haddock off the back of Browns Bank and along the edge in February, March and early April (Figure 4 and 5). Landings in May and June were more similar to previous years. The fixed gear groups generally started late again in 1998. Landings in the first two quarters were more similar to 1996.

The proportion of mobile gear sector haddock landings from 4Xs and 5Y has been increasing in recent years and reached 652t in 1997. This trend was responsible for the request that the exclusion of these landings from the assessment be re-evaluated. Preliminary data suggest the proportion of landings from these areas will be lower in 1998 (Figure 5).

Allocations and Management Actions

Quota allocations and management actions for 4X haddock in recent years have been quite complicated and are described in detail by Annand and Hansen (1994, 1995, 1996, 1997) for 1993 to 1996 respectively and in previous assessment documents for this stock. Since 1995, all fleets have been required to submit Conservation Harvesting Plans prior to fishing. Dockside monitoring continued to be the predominant method for collection of landings and effort data. The mobile gear ITQ fleet and the offshore and midshore EA fleets continued with 100% weighout of all landings while the generalist fleet was subject to 50% weighout. The fixed gear <65' were placed under a minimum of 20% weighout distributed on a random basis. The spawning closure on Browns Bank was in place for all groundfish gears February 1 to June 15. Small fish protocols have been in place since 1994 and resulted in the closure of Roseway Bank to fixed gear for two weeks in August in 1997 due to high catches of small cod and haddock. The mobile gear sector encountered large numbers of small haddock in deep water to the southeast of Browns Bank in March 1998, which resulted in a small fish closure. Browns Bank was closed to all gear sectors in late June 1998 due to small haddock.

In 1996, the fixed gear <45' adopted a community structure for quota groups and were eventually divided into seven geographic management boards. The fixed gear 45-65' operated independently of the fixed gear <45'. Within the community quota framework, the practice that started in 1996 of either equal shares or sharing arrangements based on catch history within community groups was much more widespread in 1997 and continued in 1998. Quota allocations, closures and trip limits were managed within the Management Boards. Although the overall haddock quota increased in 1997, the end of a sharing arrangement between the mobile and fixed gear sectors resulted in an 11% decrease in the fixed gear haddock allocation in 1997.

Additional Information about the Fishery

During consultation meetings, most fishermen indicated they felt haddock abundance was good throughout most of the stock area, but not in the eastern portion of 4X. Roseway Bank and "the Gully", between Browns and Georges Banks, were mentioned as hotspots. It was observed that haddock were generally small. Haddock taken by handlines were still small in 1998 but fish size had improved over last year. The fixed gear sector reported that they were able to avoid small fish, in comparison to the last couple of years. It was felt that discarding of small haddock in the longline fleet was reduced in 1997 and had improved further in 1998. It was thought that misreporting, associated with the introduction of community quotas in 1995 and 1996, was also reduced. The mobile gear sector encountered large numbers of small haddock in deep water to the southeast of Browns Bank in March, which resulted in a small fish closure. This concentration of fish was considered unusual.

Data

Size and Age Composition of the Catch

The size composition of 4X haddock landings from 1990-97 is shown in Figure 6. There has been a increase in the mean length of mobile gear landings from 48.3cm in 1990 since the introduction of square mesh and ITQs in the early 1990s; however mean length in mobile gear landings dropped from 54.7cm in 1995 to 51.6cm in 1996 and remained about the same in 1997 at 51.7cm. Mean length in fixed gear landings decreased from 54.1cm in 1990 to 49.4cm in 1993 and has remained relatively stable since. Mean length of mobile gear landings in the first half of 1998 dropped substantially to 49.6cm, relative to 1997 (Figure 7).

Criteria for ageing haddock otoliths for this stock were redefined. Details can be obtained from Campana (1995) and Hurley et al. (1996). In the assessment last year, revised ageing data were not available for commercial samples from 1985-87 and age/length keys from research vessel survey samples were used to construct the catch-at-age from the commercial catch-at-length data for these years. Exploitation levels in the 1980s produced by that assessment were much lower than in previous assessments and were considered to be inconsistent with effort trends over that same period. It was felt that this was likely a result of the use of age/length keys from the research vessel surveys.

Revised ageing data are now available for these commercial samples and a catch-at-age was constructed for 1985-87 using the gear and quarter stratifications shown in Tables 6-8). The resulting catch-at-age is shown in Table 9. A comparison to the catch-at-age used for these years in the assessment last year shows substantial differences. Repeating that SPA using the revised catch-at-age for these years resulted in fishing mortality levels more in line with previous assessments and with effort trends in the early 1980s, but had little effect on the rest of the assessment (Figure 8).

As a routine check, an inter-reader comparison was conducted using a subset of otoliths read for this assessment. Otoliths were selected from the 1985 and 1986 commercial samples and from the 1998 research vessel survey. A pairwise comparison of ages from the primary and secondary agers showed high precision and little bias, with an overall coefficient of variation of 3.7 and 5.95 for the commercial and survey samples respectively (Figure 9). Although there was a slight bias at older ages in the survey otoliths, the sample size at those ages was small and the results were considered acceptable.

Commercial sampling data were used to construct a catch-at-age for 1997 and the first half of 1998 as in previous assessments. The gear and quarter stratifications used are shown in Tables 10 and 11. In several cases, insufficient otoliths were collected from longline samples and otter trawl age/length keys were used to construct catch-at-age from longline length frequencies. The resulting catch-at-age is shown in Table 12.

The 1993 year-class is predominant in the 1997 and the 1998 half-year catch-at-age, but the 1994 year-class also made a significant contribution to the 1998 half-year catch (Table 13, Figure 10). A comparison of the predicted and actual catch-at-age for 1997 shows that the proportion of age 5 is lower than predicted, while the proportion at ages 6 and 7 is higher. In the first half of 1998, the proportion of age 4 (the 1994 year-class) in the catch-at-age is much lower than predicted and age 5 (the 1993 year-class) is also lower. The proportion at older ages is higher, particularly at ages 7 and 8; however it must be remembered that this is a half-year catch-at-age while the prediction was based on a full year of fishing.

Commercial weight-at-age data from 1970-98 showed no consistent trends over the recent period (Table 14, Figure 11). Weights were generally higher during the mid-1970s to the mid-1980s. The 1998 values are for the half-year and are lower than values for the last two to three years, which are for the full year.

Commercial Catch Rates

Commercial catch rates have not been considered a reliable index of haddock abundance in 4X due to the high and variable levels of misreporting, particularly in the mid-1980s, and the extent of management changes in the recent period.

Research Vessel Surveys

A summer groundfish research vessel survey of the Scotian Shelf and Bay of Fundy has been conducted in July since 1970. The stratification scheme used in this stratified random survey design has not changed and is shown in Figure 2. The vessel conversion

factor of 1.2 was used for the *A.T. Cameron* surveys (Fanning 1985), as usual. Mean number per tow by stratum for 4X haddock are shown in Table 15.

Mean number per tow of 4X haddock in the summer research vessel survey decreased from a high level of 83 fish per tow in 1995 to 46 in 1998, about the same as the long-term mean of 45 (Figure 12). Mean weight per tow decreased from a high of 56kg in 1996 to 27 in 1998, relative to a long-term mean of 36kg. The mean number per tow of small (<43cm) haddock decreased from 80 to 38, but was still above the long-term mean of 32 fish while the catch of market-size haddock remained at 9, the same as 1997, well below the long-term mean of 16 fish per tow.

Haddock abundance in the survey was high on Browns Bank (stratum 480) and above average on Roseway and LaHave Banks (strata 474 and 473) but low elsewhere in the Shelf strata (Table 15, Figure 13). Abundance has been decreasing since 1996 in both the Shelf and the Bay of Fundy strata. The abundance of market-size haddock was below average on the Scotian Shelf, with few above 50cm, but market-size haddock were above average in abundance in the Bay of Fundy (Table 16 and 17, Figure 14 and 15).

The 1998 research vessel survey indicates that the 1993 and 1994 year-classes are above average in abundance but not to the same extent as previous surveys (Table 18, Figure 16). The 1995 and 1996 year-classes appear relatively weak but the 1997 year-class may be average.

Biological Indices

Mean length-at-age of haddock caught in the Scotian Shelf strata of the summer research vessel survey decreased in the late 1970s, particularly at older ages, but then recovered somewhat in the late 1980s. Mean length-at-age has subsequently decreased since 1995 (Table 19, Figure 17). The long-term trend in mean length-at-age did not occur in haddock in the Bay of Fundy strata; however the recent decrease is evident there also (Table 20, Figure 18). Mean weight-at-age of haddock in the research vessel survey shows a similar trend (Table 21, Figure 19).

Condition is the relative weight of the fish for their length (i.e. their plumpness). An index of condition, the predicted weight of a haddock at a given length, was calculated from the annual length/weight relationship from the summer research vessel surveys. Indices were calculated for 35 and 50cm (Table 22, Figure 20). While these indices were variable, they indicated that condition has decreased since the late 1980s to low levels in the 1990s. Low condition is one indicator of poor health; however the cause of low condition in this stock is uncertain and the significance of this low condition is unknown.

Oceanographic Conditions

Oceanographic conditions in 1998 showed a substantial change. Near-bottom temperatures in almost all research vessel survey strata in NAFO Division 4X were below their long-term means and many established new low levels (Table 23). Temperatures in the 2-4°C range were widespread in the eastern portion of 4X (Losier et al., 1999). These conditions are associated with an increased transport of Labrador Slope Water (Drinkwater et al., 1998). The impact on haddock in 4X is not yet understood.

Joint industry/DFO Survey

The ITQ fleet in co-operation with DFO Science has conducted a trawl survey of the 4X area since 1995 during July, the same time that the DFO research vessel *Alfred Needler* conducts the annual summer groundfish survey. The ITQ survey was designed to cover the entire 4X area, including the inshore area off southwest Nova Scotia that the *Alfred Needler* is unable to survey. This inshore area has become a major fishing area for the mobile gear sector in recent years, and as much as 20% of 4X haddock landings by mobile gear have been caught in this area.

This survey has been conducted by three draggers (<65 ft) equipped with standardised gear with the same size codend liner as the research vessel. A fixed station design, based upon the research vessel survey strata, is used and standardised tows are made. Sampling of catches is conducted by Fisheries Observers and length frequency samples are taken for cod, haddock, pollock, winter flounder and redfish. Further details are summarised in O'Boyle et al. (1995). Results of the 1995-97 surveys were reported in detail by Hurley et al. (1996, 1997).

Survey coverage was increased to 187 standardised fishing sets in 1998, with the addition of 8 tows in eastern 4X, and now covers most of the 4X area (Figure 21). There were 29 tows in the area inshore of the traditional research vessel strata.

Catch rates by stratum from the two surveys in 1998 are compared in Tables 24 and 25. As in previous years, catch rates were generally but not always higher in the ITQ survey. Catch rates in the inshore area were high. There were also differences in the size compositions between the two surveys, and between the inshore area and the adjacent strata (481,485,490) (Figure 22).

Arithmetic mean catch rate trends calculated for ITQ survey tows in the Scotian Shelf (470-481) and Bay of Fundy (482-495) stratum groups were comparable to trends from the research vessel survey (Figure 23 and 24). Trends for the inshore area were different from those in the traditional survey strata.

GIS potential mapping techniques were used to develop annual estimates of trawlable biomass in 4X from the ITQ surveys (Figure 25). Mapping parameters were 4km for the

inner radius of influence and 30km for the outer radius of influence for each data point. A maximum of 10 nearest neighbours within the inner radius was used to calculate the surface elevation and an exponential decay (0.2) was used to determine the distance-weighted influence of the surface height over the outer radius of influence. The survey stratum boundaries, the NAFO Division 4X boundaries and the 200m contour on the seaward edge of the continental shelf were used to limit the estimates. The proportion inshore was calculated by subtraction of the biomass in the survey strata from the 4X total (Table 26). These showed a small decrease overall since 1996 but an increase in the inshore area over the same period.

Catch numbers-at-length for the three areas from the ITQ surveys (Table 27) were converted to numbers-at-age using the age/length keys from the research vessel surveys (Table 28). The age/length keys for the Bay of Fundy strata were used to convert the inshore catches. The numbers-at-age were converted to estimates of total abundance by weighting them by the biomass estimates for each of the areas. The resulting combined catch-at-age was also used as an index of haddock abundance.

Estimation of Parameters and Assessment Results

A traditional age-based SPA was conducted using the ADAPT framework (Gavaris 1988). The model used is as follows:

Parameters:

Survey numbers at mid-year $N_{i,1998}$ $i = 2\text{-}7$

Calibration coefficients $q_{1,i}$ i = ages 2-7 for July RV survey

$q_{2,i}$ i = ages 2-7 for ITQ survey

Structure Imposed:

Error in catch assumed negligible

Partial selection fixed for ages 1 and 8-10 in 1998

F on oldest age (10) set as average F of ages 2-7 adjusted by the relative selectivity of age 10 in 1998

No intercepts were fitted

M = 0.2 for all ages

Input:

$C_{i,t}$ $i = 1\text{-}10$; $t = 1970$ to 1998 - catch-at-age for entire year (half year for 1998)

$J_{i,t}$ $i = 2\text{-}7$; $t = 1970$ to 1998 - July RV survey index

$ITQ_{i,t}$ $i = 2\text{-}7$; $t = 1985$ to 1998 - ITQ survey index

Objective function:

Minimise $\{ \sum\sum (\ln J_{i,t} - \ln q_{1,i} N_{i,t})^2 \} + \{ \sum\sum (\ln ITQ_{i,t} - \ln q_{2,i} N_{i,t})^2 \}$

Summary:

Number of observations: 174 for July RV (6 ages by 29 years)
24 for ITQ (6 ages by 4 years)

Number of parameters: 18

6 ln Ns estimated by NLLS, 12 qs algebraically

age	1	2	3	4	5	6	7	8	9	10
selectivity	.0001	.033	.118	.453	.884	.972	1.00	1.00	1.00	1.00

The minimisation technique used was a non-linear least squares (NLLS) gradient technique (the Marquardt algorithm). The NLLS technique is a compiled version of ADAPT written in ACON.

The SPA input data, commercial catch numbers-at-age, research vessel survey stratified mean numbers-at-age per tow, and ITQ survey total numbers-at-age, are shown in Table 29 and the resulting estimates of fishing mortality, population numbers and biomass, and residuals are shown in Table 30 and Figure 26. Also shown in Table 30 are summary statistics of the overall fit of the model and the bootstrap bias correction results based on 1000 replicates. The research vessel survey calibration coefficients had CVs of 11% and bias of less than 1%. The ITQ survey calibration coefficients had CVs in the range of 31-35% and larger bias also; however this is due largely to the short time series.

As with previous assessments of this resource, the residuals show some strong year effects, with positive residuals in all ages in some years and negative residuals at all ages in other years (Figure 26); however these patterns are less extreme than in previous assessments (Hurley et al. 1996). The inclusion of the ITQ survey improved the overall fit, relative to an SPA using the research vessel survey alone, and reduced the effect of the 1996 survey resulting in slightly lower population numbers.

Past assessments of this resource have shown a strong retrospective pattern, where exploitation is under-estimated and population abundance is over-estimated in the current year, relative to when additional data are available in subsequent years. The retrospective pattern in this assessment is relatively good (Figure 27).

As noted earlier, the use of revised ageing data for 1985-87 in this assessment has resulted in much higher estimates of fishing mortality during the early 1980s than did the previous assessment. These levels are much more in line with effort trends during that period. Estimates of total mortality calculated from research vessel survey were comparable with fishing mortalities from the SPA (Figure 28).

The exploitation rate on ages 5-7 has been higher than the target since the early 1970s (Figure 29). Exploitation decreased from approximately 50% in the early 1980s to close to the target level through the late 1980s and early 1990s and dropped below the target in 1994 and 1995. If the TAC of 8,100t is reached in 1998, the exploitation level will be at about the target level (20%, $F_{0.1}$=0.25).

Spawning stock biomass calculated using the maturity ogive of Waiwood and Buzeta (1989) has been decreasing since 1980 and reached a low of 21,000t in 1994 (Figure 30). Spawning stock biomass has increased to 34,000t in 1998 as the 1993 and 1994 year-classes mature. Except for the 1987 and 1988 year-classes, recruitment of the 1983-92 year-classes was below average (Figure 30). Both the research vessel survey and the ITQ survey indicate the 1993 and 1994 year-classes to be very strong. The retrospective pattern evident in the last three years of this analysis has reduced the apparent size of these year-classes, but they are still estimated to be well above average and among the strongest year-classes. The 1995 year-class is below average and the 1996 year-class is slightly above average. There appears to be no relationship between spawning stock biomass and recruitment over the biomass range observed (Figure 30).

In the two previous assessments (Hurley et al. 1996, 1997), it was shown that a significant retrospective effect exists between observations of large year-classes at early ages and subsequent estimates. This analysis indicates there is still a tendency to over-estimate large year-classes, even at age 6 (Figure 31). While this may be due to discarding or higher natural mortality on large year-classes, it may also be an artifact of ageing error. A Gompertz function fit through contemporaneous vs. converged estimates of abundance at age from retrospective SPAs suggest the 1993 and 1994 year-classes be reduced from 39 and 49 million at age 1, as indicated by this SPA, to 29 and 34 million at age 1 respectively. The 1992 and 1995 year-classes would essentially be unaffected. If these year-class adjustments are made, then spawning stock biomass has only increased to 28,000t in 1998. The level of exploitation in 1997 and 1998 will increase slightly.

Outlook

Given the recent recruitment history of this resource, the apparent lack of a relationship between spawning stock biomass and recruitment, and that the only strong recruitment in recent years occurred when both spawning stock biomass and fish condition were at low levels, it was felt that using geometric mean recruitment from 1983 to 1992 of 12 million for the 1996 and subsequent year-classes would be appropriate for projections. An age 1 recruitment of 29 and 34 million was used for the 1993 and 1994 year-classes respectively, reduced from the SPA estimate due to the tendency to over-estimate the size of large year-classes.

It was noted that there were significant differences between the research vessel survey and commercial weights-at-age. It was felt that while the research vessel survey weights-at-age would be appropriate to calculate population biomass, it would be more appropriate to use commercial weights-at-age to calculate yields. The mean of the last three years was used in both cases.

The projected yield at the target exploitation rate (20%, $F_{0.1}$=0.25) in 1999 would be 9,000t. Of this projected yield, 67% will come from the 1993 and 1994 year-classes.

Spawning stock biomass would peak at 36,000t in 1999 and decrease to 34,000t at the beginning of 2000.

Year	F	Yield (t)	Population Biomass (t)	Spawning Biomass (t)
1998	.24	8100	42232	34119
1999	.25	8958	42382	35806
2000	.25	8219	39640	33957

Risk analysis indicates that at a yield of 9,000t, which corresponds to a 50% risk of exceeding $F_{0.1}$, the spawning stock biomass has a 98% probability of decreasing for 2000 (Figure 32). This probability of spawning stock biomass decreasing for 2000 decreases to 50% at a yield of 6,100t (Figure 33).

With the reduction in the estimated strength of the 1993 and 1994 year-classes in this assessment, the outlook is not as optimistic as last year. Spawning stock biomass will not increase to the level predicted last year.

The SPA indicated that the 1996 year-class was average in strength; however this estimate is relatively uncertain, as there is only a single estimate in the calibration block. The decision to use an age 1 recruitment of 12 million for the 1996 year-class has little impact on the 1999 $F_{0.1}$ yield, as this year-class would only be partially recruited to the fishery. Using the value of 26 million from the SPA would only increase the 1996 yield by 200t if unadjusted and by only 100t if year-class size was adjusted downward using Gompertz fit. The impact on subsequent years would be more substantial as those fish grow and recruit of the fishery.

The projected yield was calculated using commercial weights-at-age. These do not show the decreasing trend in recent years that are evident in the research vessel survey weights-at-age. If the commercial weights-at-age used are overestimated, then potential yield will be overestimated. If there were a shift in the proportion of landings from the Bay of Fundy to the Scotian Shelf where growth is slower, this would also result in potential yield being overestimated.

Acknowledgments

The authors wish to thank the participants of the cod, haddock and flounder assessment working group for their contributions and in particular Steve Campana for chairing the working group. We would also like to thank Don Clark for reviewing the manuscript.

References

Campana, S.E. 1995. Expert age determination of 4VW and 4X haddock otoliths by national and international laboratories. DFO Atl. Fish. Res. Doc. 95/120: 19p.

Drinkwater, K.F., D.B. Mountain and A. Herman. 1998. Recent changes in the hydrography of the Scotian Shelf and Gulf of Maine - a return to conditions of the 1960s? NAFO SCR Doc. 98/37, 16 p.

Fanning, L.P. 1985. Intercalibration of research vessel survey results obtained by different vessels. CAFSAC Res. Doc. 85/3: 43p.

Frank, K.T., P.C.F. Hurley, and J. Simon. 1990. Assessment of 4X haddock in 1989. CAFSAC Res. Doc. 90/58: 48p.

Gavaris, S. 1988. An adaptive framework for the estimation of population size. CAFSAC Res. Doc. 88/29: 12p.

Halliday, R.G. 1974. Current status of the ICNAF Div. 4X haddock stock. ICNAF Res. Doc. 74/91: 24p.

Hurley, P.C.F., G.A.P. Black, R. Mohn, and P. Comeau. 1996. Assessment of 4X haddock in 1995. DFO Atl. Fish. Res. Doc. 96/30: 66p.

Hurley, P.C.F., G.A.P. Black, R. Mohn, and P. Comeau. 1997. Assessment of 4X haddock in 1996 and the first half of 1997. DFO Atl. Fish. Res. Doc. 97/108: 101p.

Hurley, P.C.F., P. Comeau, L. Van Eeckhaut and W.T. Stobo. (in prep). Revision of the stock definition of the 4X haddock stock.

Losier, R., F. Page, P. McCurdy, M. Ringuette, and J. McRuer. 1999. Overview of 1998 Hydrographic Sampling Effort and Near-Bottom Water Temperature and Salinity Conditions During the Canadian Research Vessel Groundfish Summer Surveys Conducted on the Scotian Shelf and in the Bay of Fundy (4VWX). DFO Atl. Fish. Res. Doc. 99/76.

O'Boyle, R. [Ed.], D. Beanlands, P. Fanning, J. Hunt, P. Hurley, T. Lambert, J. Simon, and K. Zwanenburg. 1995. An overview of joint Science/Industry surveys on the Scotian Shelf, Bay of Fundy, and Georges Bank. DFO Atl. Fish. Res. Doc. 95/133: 34p.

O'Boyle, R.N., K. Frank, and J. Simon. 1989. An evaluation of the population dynamics of 4X haddock during 1962-88 with yield projected to 1990. CAFSAC Res. Doc. 89/58: 59p.

Waiwood, K.G., and M.-I. Buzeta. 1989. Reproductive biology of southwest Scotian Shelf haddock (*Melanogrammus aeglefinus*). Can. J. Fish. Aquat. Sci. 46 (Suppl. 1): 153-170.

Table 1. Reported nominal catch (t rounded) and TAC of haddock from NAFO Division 4X.

	Catch	TAC
1960	15800	
1961	17918	
1962	18032	
1963	24461	
1964	36049	
1965	29166	
1966	43349	
1967	37896	
1968	32602	
1969	30703	
1970	18072	18000
1971	17592	18000
1972	13483	9000
1973	13106	9000
1974	13378	0
1975	18298	15000
1976	17498	15000
1977	21281	15000
1978	27323	21500
1979	25193	26000
1980	29210	28000
1981	31475	27850
1982	25729	32000
1983	27405	32000
1984	21156	32000
1985	16131	15000
1986	15555	15000
1987	13780	15000
1988	11272	12400
1989	6800	4600
1990	7556	4600
1991	9826	0
1992	10530	0
1993	6968	6000
1994	4406	4500
1995	5669	6000
1996	6245	6500
1997	6527	6700
1998*	3597	8100

* - Landings to June 30, 1998

Table 2. Reported nominal catch (t rounded) of haddock from NAFO Division 4X (Canandian landings include 5Y) 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	16050 (26)	-	1638	2	370	12	18072	18000
1971	16493 (29)	-	654	97	347	1	17592	18000
1972	12593 (36)	-	409	10	470	1	13483	9000
1973	12687 (30)	-	265	14	134	6	13106	9000
1974	12586 (25)	-	660	35	97	-	13378	-
1975	16139 (56)	-	2111	39	7	2	18298	15000
1976	16426 (45)	-	972	-	95	5	17498	15000
1977	19619 (79)	-	1648	2	-	12	21281	15000
1978	26045 (62)	114	1135	2	-	27	27323	21500
1979	24837 (49)	268	70	3	-	15	25193	26000
1980	28807 (56)	71	257	38	-	37	29210	28000
1981	30877 (82)	117	466	-	-	15	31475	27850
1982	24843 (92)	28	854	-	-	4	25729	32000
1983	26843 (119)	44	494	17	-	7	27405	32000
1984	20927 (97)	23	206	-	-	-	21156	32000
1985	16105 (86)	-	25	-	-	1	16131	15000
1986	15507 (78)	-	38	10	-	-	15555	15000
1987	13763 (82)	-	17	-	-	-	13780	15000
1988	11217 (79)	-	2	53	-	-	11272	12400
1989	6794 (43)	-	1	5	-	-	6800	4600
1990	7504 (71)	-	32	17[2]	-	3[2]	7556	4600
1991	9772 (81)	13	-	38[2]	-	3[2]	9826	-
1992	10508 (89)	5[1]	-	-	-	17[2]	10530	-
1993	6947 (86)	-	-	-	-	21[2]	6968	6000
1994	4405 (68)	-	-	-	-	1[2]	4406	4500
1995	5660 (78)	-	-	-	-	9[2]	5669	6000
1996	6237 (84)	-	-	-	-	8[2]	6245	6500
1997	6519 (87)					8[2]	6527	6700
1998*	3596 (49)					1[2]	3597	8100

1 = NAFO Circular Letters 2 = Observer Program Data * = 1998 Data only for quarters 1 and 2

Table 3. Reported nominal catch (t round) of haddock from NAFO Division 4X 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												Total
	TC 1-3						TC 4+						
	MG (OT)		FG (LL)[1]		Misc.[2]		MG (OT)		FG (LL)		Misc.		
1970	5510	(1377)	3393		492		6503	(296)	113		0		16012
1971	4744	(949)	3598	(1199)	260		7712	(367)	94		0		16407
1972	2929	(732)	4472	(447)	357		4742	(216)	63		8		12570
1973	1930	(322)	6124	(680)	285		4228	(282)	70		0		12637
1974	4119	(515)	6391	(533)	200		1623	(325)	56		0		12388
1975	6186	(326)	5194	(577)	246		4408	(157)	26		0		16059
1976	4393	(1098)	5312	(885)	432	(216)	6117	(185)	46		33		16333
1977	6238	(1040)	4329	(481)	529		8246	(129)	117		134		19593
1978	9694		6817	(568)	906	(453)	7473	(156)	97		416		25404
1979	10555	(5278)	5133	(395)	515	(515)	8272	(251)	56		48		24580
1980	13471	(1225)	6926	(385)	1079	(360)	7046	(294)	82		0		28604
1981	14991	(333)	7861	(302)	967	(322)	6475	(809)	70		0		30364
1982	12120	(252)	7599	(345)	842	(70)	2972	(297)	32		0		23565
1983	12964	(231)	8548	(225)	751	(75)	2562	(197)	15		0		24840
1984	12097	(212)	6778	(226)	193	(193)	613	(77)	0		0		19682
1985	10292	(181)	4367	(182)	134		520	(104)	1		0		15314
1986	9630	(201)	5345	(184)	99		209	(209)	0		0		15282
1987	8103	(180)	4856	(270)	212	(19)	502	(84)	0		0		13673
1988	7174	(133)	3442	(156)	93	(93)	377	(189)	0		0		11085
1989	3731	(133)	2686	(244)	194		90	(22)	0		0		6701
1990	3322	(79)	3785	(135)	278	(278)	110		0		0		7495
1991	4171	(97)	5127	(151)	258	(258)	206	(69)	0		0		9761
1992	3462	(74)	6560	(177)	217	(109)	258	(86)	0		2		10500
1993	2620	(61)	4091	(136)	100	(14)	123	(31)	0		0		6935
1994	2068	(63)	2177	(84)	48		97	(48)	0		0		4391
1995	3035	(65)	2420	(81)	69		105	(105)	0		2		5631
1996	3593	(86)	2351	(59)	50	(50)	151	(151)	0		0		6145
1997	4214	(73)	2158	(94)	56	(56)	64	(13)	0		0		6493
1998*	2949	(82)	568	(52)	10		32	(32)	0		0		3559

1 = Includes Handline 2 = Gillnets (set, drift), traps, unspecified. * = 1997 Data only for quarters 1 and 2

Table 4. Reported nominal catch (t round) of haddock from NAFO Division 4X (excluding unit area 4Xs and 5Y) by gear type, tonnage class, area and quarter, 1985 - 1998. Only first 2 quarters included for 1998.

		OTB				LL		MISC		
		mnop		qr		mnop	qr	mnop	qr	
		1-3	4+	1-3	4+	1-3	1-3	1-3	1-3	Total
1985	1	2702	522	138	0	1926	11	12	0	
	2	2391	21	1226	0	345	46	105	29	
	3	230	17	2212	13	822	59	455	52	
	4	89	17	738	0	815	3	41	4	15041
1986	1	2568	147	157	0	1964	5	0	0	
	2	830	20	1317	0	329	32	0	0	
	3	794	14	2284	1	1719	62	0	0	
	4	642	27	609	0	1451	13	0	0	14985
1987	1	3026	219	108	0	2161	26	31	0	
	2	1965	163	667	5	366	58	40	1	
	3	442	42	1271	3	1201	42	85	0	
	4	89	69	384	0	995	5	74	0	13538
1988	1	2203	77	81	0	1368	19	25	0	
	2	1476	222	763	16	176	29	22	5	
	3	1126	17	688	4	1075	29	45	2	
	4	612	40	125	0	650	7	19	0	10921
1989	1	2121	34	143	0	916	9	36	0	
	2	501	8	587	3	216	59	55	1	
	3	46	2	253	0	1023	36	65	1	
	4	2	42	3	0	440	0	64	0	6666
1990	1	1341	42	93	1	1267	8	20	0	
	2	229	16	723	0	256	11	9	56	
	3	125	16	427	1	1447	29	115	53	
	4	128	25	117	1	707	6	27	1	7297
1991	1	792	37	71	4	1800	20	10	0	
	2	305	64	766	3	451	46	27	5	
	3	200	20	627	4	1702	140	168	17	
	4	865	34	435	17	929	29	48	0	9636
1992	1	1006	92	76	0	1698	17	43	0	
	2	410	116	563	0	707	105	22	3	
	3	197	8	534	7	2240	256	66	51	
	4	264	8	315	14	1368	77	55	11	10329
1993	1	598	49	62	2	1009	13	0	0	
	2	388	49	503	4	671	220	18	5	
	3	155	3	436	11	1822	209	54	6	
	4	130	5	236	0	138	2	12	1	6811
1994	1	239	19	231	2	331	0	0	0	
	2	194	7	362	1	535	61	5	3	
	3	87	2	399	0	923	90	23	7	
	4	144	48	300	16	233	2	8	0	4272
1995	1	798	74	258	1	301	0	0	0	
	2	109	2	357	7	369	125	3	4	
	3	70	4	446	0	1054	38	43	13	
	4	456	9	383	1	447	29	0	1	5402
1996	1	696	111	317	1	203	9	0	0	
	2	233	4	352	1	405	63	4	1	
	3	111	3	423	5	788	85	31	5	
	4	352	16	697	3	734	27	1	1	5682
1997	1	716	19	332	1	220	1	0	0	
	2	363	2	379	1	160	37	4	1	
	3	220	1	644	4	915	54	38	4	
	4	324	16	614	13	723	30	6	0	5842
1998	1	1958	27	249	0	221	3	0	0	
	2	562	4	179	1	309	35	9	1	
	3									
	4									3559

Table 5a. Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y (data from NAFO data files).

		4XL	4XM	4XN	4XO	4XP	4XQ	4XR	4XS	4XU	5Y	Total
Mobile	1970	0	136	2847	1439	4442	693	2098	340	18	38	12051
	1971	0	60	4260	1445	3833	740	1897	216	4	85	12541
	1972	0	60	1841	1511	1659	869	1627	104	0	23	7693
	1973	0	41	2589	1088	543	589	1203	67	38	49	6207
	1974	0	65	475	688	395	872	3129	118	0	198	5940
	1975	0	123	2232	2134	1702	1609	2327	68	398	79	10673
	1976	0	114	4218	1920	870	1237	2107	28	15	92	10602
	1977	0	141	4370	3098	3204	1154	1421	31	1066	26	14510
	1978	0	244	4580	3392	4109	2030	2009	95	707	641	17808
	1979	0	271	6491	3766	2592	3030	1950	281	447	257	19084
	1980	0	314	6547	4163	2220	3736	2986	362	189	203	20720
	1981	36	233	8419	3828	2051	3069	3277	183	370	497	21963
	1982	0	121	4034	3194	779	3262	2905	317	479	1259	16350
	1983	0	45	3039	3534	1651	3118	2327	362	1448	1998	17523
	1984	7	56	2164	1906	2105	2586	1458	206	2222	1244	13955
Gillnet	1970	0	83	0	5	0	0	0	0	0	0	89
	1971	0	54	0	23	0	0	0	0	0	0	78
	1972	0	43	0	15	0	0	1	0	0	0	59
	1973	0	104	0	30	0	0	9	0	0	0	143
	1974	0	129	0	19	0	0	2	0	0	0	150
	1975	0	0	0	6	0	0	0	0	172	0	178
	1976	0	120	9	259	0	0	0	0	0	0	389
	1977	0	0	1	11	1	0	0	0	324	0	337
	1978	0	162	61	344	0	0	0	2	1	0	571
	1979	0	94	8	296	0	2	1	0	0	0	400
	1980	0	334	0	457	0	2	3	5	0	0	801
	1981	0	302	5	535	0	0	0	12	3	0	856
	1982	0	226	1	569	0	0	1	15	6	19	836
	1983	0	152	0	485	0	2	1	17	5	4	667
	1984	0	45	0	123	0	4	0	13	2	1	189
Longline	1970	0	43	192	1856	280	31	464	100	0	0	2967
	1971	0	65	401	1901	374	136	232	124	3	0	3236
	1972	0	87	329	2847	256	210	237	71	0	0	4038
	1973	0	90	722	3906	585	225	160	33	96	1	5819
	1974	0	148	700	4402	409	320	184	25	0	0	6187
	1975	0	26	740	336	341	181	3	0	3317	0	4944
	1976	0	85	825	3018	433	171	87	6	19	0	4644
	1977	0	39	843	379	416	100	0	0	2258	0	4036
	1978	0	131	1206	3475	870	273	66	5	26	0	6054
	1979	0	334	925	2582	262	184	59	3	3	0	4351
	1980	3	551	1383	2991	402	256	114	8	16	0	5725
	1981	2	878	1260	3562	937	118	111	12	127	17	7024
	1982	0	905	960	3580	956	211	68	16	61	1	6758
	1983	4	910	1098	3989	1163	186	128	12	297	1	7786
	1984	0	738	864	2332	1226	70	94	7	974	0	6305
Handline	1970	0	27	0	458	0	6	35	12	0	0	539
	1971	0	46	0	393	0	7	9	1	0	0	455
	1972	0	17	0	458	0	2	16	4	0	0	497
	1973	0	23	0	332	0	10	11	1	0	0	376
	1974	0	16	0	217	0	10	14	2	0	0	259
	1975	0	0	0	0	0	0	0	0	276	0	276
	1976	0	90	0	612	0	5	7	0	0	0	715
	1977	0	0	0	0	0	0	0	0	410	0	410
	1978	0	70	2	740	0	34	13	0	0	0	861
	1979	0	62	0	701	0	55	17	3	0	0	838
	1980	0	206	0	1017	0	3	52	6	0	0	1283
	1981	0	122	0	751	0	16	33	2	0	0	924
	1982	0	132	0	697	0	22	22	1	1	0	875
	1983	0	38	0	673	0	10	54	2	1	0	778
	1984	0	8	0	381	15	35	34	1	0	0	474
Total	1970	0	488	3040	3937	4722	731	2624	452	18	38	16050
	1971	0	346	4662	3799	4207	904	2142	340	7	85	16493
	1972	0	349	2170	4964	1923	1082	1902	179	0	23	12593
	1973	0	327	3310	5410	1129	824	1401	101	134	50	12687
	1974	0	371	1175	5361	804	1203	3330	145	0	198	12586
	1975	0	149	2972	2476	2044	1790	2330	68	4230	79	16139
	1976	0	419	5080	5837	1303	1416	2206	39	33	92	16426
	1977	0	181	5294	3527	3638	1254	1421	32	4245	26	19619
	1978	0	615	6029	8311	5064	2353	2095	103	834	641	26045
	1979	0	771	7424	7448	2854	3313	2028	293	450	257	24837
	1980	3	1427	7930	8726	2621	4144	3158	389	205	203	28807
	1981	38	1542	9684	8773	2988	3209	3422	209	500	513	30878
	1982	0	1386	4995	8057	1735	3502	2995	349	547	1278	24844
	1983	4	1149	4137	8698	2814	3379	2512	395	1751	2003	26843
	1984	7	847	3029	4747	3346	2695	1586	227	3199	1245	20928

Table 5b. Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y. (from ZIF)

		4XL	4XM	4XN	4XO	4XP	4XQ	4XR	4XS	4XU	5Y	Total
Mobile	1985	0	144	1455	1949	1401	1930	1330	277	2326	791	11602
	1986	1	295	1624	1329	538	2254	910	198	2690	224	10062
	1987	0	132	2194	1059	901	1221	210	63	2823	83	8687
	1988	0	269	1007	728	963	559	107	22	3896	97	7648
	1989	0	41	733	454	1047	566	207	12	761	89	3909
	1990	0	35	468	533	738	886	223	5	543	7	3439
	1991	0	16	786	851	645	1153	739	87	93	11	4382
	1992	0	32	939	735	427	912	604	51	21	6	3727
	1993	0	7	503	500	355	925	296	108	50	12	2755
	1994	0	3	187	445	104	999	311	112	2	14	2178
	1995	0	7	222	275	1018	975	477	157	8	28	3168
	1996	0	10	541	214	758	995	800	413	14	92	3836
	1997	1	11	407	173	1063	860	1121	627	14	25	4303
	1998	0	18	188	49	596	298	132	32	0	5	1317
Gillnet	1985	0	29	0	67	0	0	1	12	4	0	113
	1986	0	31	0	47	0	0	1	7	1	1	88
	1987	0	95	0	90	2	0	1	18	3	6	215
	1988	0	40	2	26	3	0	2	1	8	0	81
	1989	0	96	0	47	0	2	0	2	10	0	158
	1990	0	82	1	74	3	75	31	1	11	0	278
	1991	0	79	2	144	5	12	2	3	10	0	257
	1992	0	79	5	42	1	53	3	7	23	1	215
	1993	0	21	3	46	6	8	3	1	12	1	100
	1994	0	4	0	21	3	4	3	0	11	1	48
	1995	0	5	4	20	7	11	3	3	16	0	69
	1996	0	10	1	17	6	4	1	7	3	0	50
	1997	0	5	0	12	29	4	1	2	4	1	57
	1998	0	0	1	0	8	1	0	0	1	0	11
Longline	1985	0	493	485	1545	528	33	86	6	858	0	4034
	1986	0	856	432	1924	486	11	61	6	1100	0	4875
	1987	10	552	286	1798	391	54	33	2	1445	2	4572
	1988	0	359	403	791	247	30	18	21	1446	35	3350
	1989	0	256	219	861	277	28	9	1	814	4	2469
	1990	0	275	229	1309	368	30	3	8	1168	1	3391
	1991	0	409	561	1809	801	97	45	1	863	0	4588
	1992	0	133	458	2276	319	98	181	2	2119	1	5587
	1993	0	113	1129	994	400	178	202	1	211	0	3227
	1994	0	50	175	663	171	10	39	0	470	0	1578
	1995	0	82	672	616	435	149	13	3	200	0	2171
	1996	0	68	556	678	351	84	66	6	243	0	2053
	1997	0	73	616	490	380	61	30	8	391	0	2049
	1998	0	13	274	61	121	29	4	0	45	0	547
Handline	1985	0	23	0	294	0	11	6	0	0	0	334
	1986	0	17	0	426	0	15	10	1	0	0	469
	1987	0	33	0	236	4	8	4	1	0	0	286
	1988	0	5	0	111	0	2	4	2	3	0	126
	1989	0	4	0	193	0	4	12	0	8	0	221
	1990	0	3	0	376	0	8	3	0	6	0	396
	1991	0	11	0	460	0	30	29	0	9	0	539
	1992	0	13	0	844	1	40	74	0	2	0	974
	1993	0	3	7	775	27	14	32	3	3	0	865
	1994	0	1	2	486	21	75	11	0	4	0	600
	1995	0	0	2	140	13	3	0	0	91	0	250
	1996	0	2	5	248	13	14	3	1	13	0	298
	1997	0	1	1	72	5	6	2	0	23	0	109
	1998	0	0	0	15	1	1	0	0	4	0	21
Total	1985	0	699	1941	3861	1928	1974	1426	295	3191	791	16105
	1986	1	1203	2055	3732	1023	2280	982	212	3794	225	15507
	1987	10	814	2481	3183	1297	1283	249	84	4271	90	13763
	1988	0	673	1412	1656	1212	597	131	46	5358	132	11217
	1989	0	432	952	1557	1324	599	228	15	1593	92	6794
	1990	0	396	698	2292	1108	999	259	14	1729	9	7504
	1991	0	515	1349	3264	1452	1292	816	91	975	12	9766
	1992	0	259	1402	3898	749	1104	862	60	2166	8	10508
	1993	0	144	1642	2316	788	1124	533	112	276	13	6947
	1994	0	58	365	1618	298	1088	364	113	487	15	4405
	1995	0	95	900	1052	1473	1139	493	164	316	28	5660
	1996	0	89	1103	1158	1127	1097	870	427	274	92	6237
	1997	1	90	1025	746	1477	931	1154	638	431	25	6518
	1998	0	31	2163	124	725	330	136	50	0	5	3564

Table 6. Summary of commercial sampling for the 4X haddock fishery in 1985. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	2676.48 (250 - 2825)	510.53 (-)	169.23 (31 - 260)	0 (-)
2	2252.26 (386 - 5068)	18.60 (-)	1446.18 (79 - 960)	0 (-)
3	365.00 (12 - 205)	6.02 (-)	2140.94 (180 -1125)	11.81 (-)
4	203.65 (24 - 215)	25.10 (-)	595.00 (117 -2159)	0 (-)

Longline/Handline

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	1921.85 (222 - 1697)	1.09 (-)	14.81 (-)	0 (-)
2	364.25 (92 -1050)	0 (-)	65.77 (-)	0 (-)
3	1076.43 (110 -1632)	0.05 (-)	77.73 (-)	0 (-)
4	834.96 (109 -1216)	0 (-)	3.78 (-)	0 (-)

Miscellaneous*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	8.43 (-)	0 (-)	0 (-)	0 (-)
2	4.61 (-)	0 (-)	2.97 (-)	0 (-)
3	93.45 (-)	0 (-)	1.56 (-)	0 (-)
4	11.00 (-)	0 (-)	0 (-)	0 (-)

* - Longline samples applied to miscellaneous landings

Table 7. Summary of commercial sampling for the 4X haddock fishery in 1986. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	2625.46 (269 - 4175)	202.37 (-)	151.85 (26 - 240)	0 (-)
2	830.85 (107 - 1796)	24.61 (-)	1314.21 (146 -2501)	0 (-)
3	835.71 (72 - 761)	19.89 (-)	2270.80 (143 -1192)	1.38 (-)
4	640.07 (31 - 225)	42.17 (-)	601.11 (27 - 494)	0 (-)

Longline/Handline

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	1851.64 (189 - 2474)	0 (-)	5.13 (-)	0 (-)
2	317.83 (105 -1002)	0 (-)	31.71 (-)	0 (-)
3	1637.10 (163 -2463)	0 (-)	62.40 (-)	0 (-)
4	1417.94 (130 -1152)	0 (-)	12.42 (-)	0 (-)

Miscellaneous*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	5.07 (-)	0 (-)	0 (-)	0 (-)
2	8.78 (-)	0 (-)	0 (-)	0 (-)
3	48.66 (-)	0 (-)	0 (-)	0 (-)
4	29.08 (-)	0 (-)	0.61 (-)	0 (-)

* - Longline samples applied to miscellaneous landings

Table 8. Summary of commercial sampling for the 4X haddock fishery in 1987. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	2975.60 (293 - 5433)	297.88 (-)	104.82 (-)	0 (-)
2	1915.57 (84 - 3174)	235.94 (-)	648.11 (55 -1132)	7.84 (-)
3	436.72 (-)	69.33 (-)	1249.65 (124 -1801)	5.22 (-)
4	79.88 (-)	140.77 (-)	330.16 (-)	0 (-)

Longline/Handline

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	2160.69 (151 - 1797)	0.31 (-)	25.81 (-)	0 (-)
2	365.52 (89 - 711)	0 (-)	58.11 (-)	0 (-)
3	1200.67 (142 - 733)	0 (-)	42.32 (-)	0 (-)
4	995.14 (86 - 699)	0 (-)	4.59 (-)	0 (-)

Miscellaneous*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	6.91 (-)	0 (-)	0 (-)	0 (-)
2	33.90 (-)	0 (-)	0.64 (-)	0 (-)
3	83.18 (-)	0 (-)	0.47 (-)	0 (-)
4	69.10 (-)	0.03 (-)	0 (-)	0 (-)

* - Longline samples applied to miscellaneous landings

Table 9. Comparison of catch-at-age from this assessment and last year's assessment.

Catch-at-age from this assessment (CAA98)

Age	1985	1986	1987
1	0	0	0
2	180	278	83
3	1721	1095	975
4	2225	4649	2941
5	4425	3927	4517
6	1456	1499	2078
7	496	224	291
8	132	98	58
9	48	36	7
10	16	30	9
1-10	10699	11834	10960

Catch-at-age from 1997 assessment (CAA97)

Age	1985	1986	1987
1	0	0	0
2	160	52	28
3	2013	1184	274
4	906	3286	1490
5	4886	2946	3848
6	1559	2774	2718
7	744	875	1331
8	378	337	352
9	228	132	74
10	124	115	131
1-10	10998	11701	10246

Percent Difference (CAA97/CAA98)

Age	1985	1986	1987
1	0	0	0
2	0	2	1
3	-3	-1	7
4	12	12	14
5	-4	8	7
6	-1	-11	-6
7	-2	-6	-10
8	-2	-2	-3
9	-2	-1	-1
10	-1	-1	-1
1-10	-3	1	7

Table 10. Summary of commercial sampling for the 4X haddock fishery in 1997. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	716.14 (207 - 2199)	19.27 (69 - 630)	332.23 (162 - 1279)	1.44 (0 - 0)
2	362.67 (27 - 1162)	1.91 (25 - 199)	378.78 (205 - 1700)	0.90 (0 - 0)
3	220.02 (25 - 202)	1.23 (0 - 0)	644.26 (148 - 1702)	3.83 (0 - 0)
4	324.44 (278 - 2144)	15.58 (29 - 200)	613.60 (173 - 1720)	12.50 (0 - 0)

Longline/Handline*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	220.46 (0 - 0)	0 (0 - 0)	0.52 (0 - 0)	0 (0 - 0)
2	159.54 (28 - 1679)	0 (0 - 0)	36.23 (0 - 0)	0 (0 - 0)
3	915.06 (0 - 1885)	0 (0 - 0)	53.76 (0 - 0)	0 (0 - 0)
4	723.38 (104 - 1360)	0 (0 - 0)	30.40 (0 - 0)	0 (0 - 0)

Miscellaneous*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
2	4.34 (0 - 0)	0 (0 - 0)	0.69 (0 - 0)	0 (0 - 0)
3	38.41 (0 - 0)	0 (0 - 0)	4.25 (0 - 0)	0 (0 - 0)
4	6.10 (0 - 0)	0 (0 - 0)	0.30 (0 - 0)	0 (0 - 0)

* - Longline Length Frequencies applied to Otter Trawl Age-Length Keys

Table 11. Summary of commercial sampling for the 4X haddock fishery in 1998. Tonnes landed is followed by the number of fish aged and measured in parenthesis. The boxes represent the aggregation used in age-length key formation.

Otter Trawls

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	1958.4 (399 - 3794)	26.66 (0 - 0)	249.28 (134 - 930)	0.47 (0 - 0)
2	561.81 (229 - 1450)	3.69 (26 - 211)	179.43 (0 - 1334)	1.43 (0 - 0)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

Longline/Handline*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	220.61 (27 - 455)	0 (0 - 0)	3.00 (0 - 0)	0 (0 - 0)
2	308.70 (62 - 1026)	0 (0 - 0)	35.48 (34 - 692)	0 (0 - 0)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

Miscellaneous*

Quarter	4Xmnop TC1-3	4Xmnop TC4+	4Xqr TC1-3	4Xqr TC4+
1	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
2	9.24 (0 - 0)	0 (0 - 0)	1.03 (0 - 0)	0 (0 - 0)
3	(-)	(-)	(-)	(-)
4	(-)	(-)	(-)	(-)

* - Longline Length Frequencies applied to Otter Trawl Age-Length Keys

Table 12. 4X haddock commercial catch-at-age (000's). (1998 for quarters 1 and 2 only)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	45	0	30	82	15	1	6	10	0	0	54	1	0	0	3
2	1930	2059	31	2057	1693	1520	786	2075	99	73	289	1169	553	72	884
3	942	2072	3349	64	3955	3586	1507	2945	4228	1585	3392	2295	4370	4244	1381
4	1498	914	1780	2412	185	4539	3569	1639	7811	7419	3265	6277	2441	6449	5199
5	367	1255	485	1025	1419	492	3333	3012	2213	3697	5380	4578	4507	3964	3629
6	440	511	645	439	485	1119	337	2770	3010	1168	3794	3394	1712	2320	2374
7	4245	97	85	585	157	258	901	361	1035	1306	508	1294	1446	820	955
8	1715	3204	42	247	209	187	126	352	185	272	560	396	341	335	350
9	157	1074	1199	249	138	49	78	91	188	65	170	332	185	181	109
10	91	204	555	541	253	39	69	70	15	52	32	110	92	96	78
11	135	77	25	52	484	171	25	16	15	11	22	16	50	64	40
12	21	103	202	6	24	229	78	7	8	0	3	25	18	22	20
13	22	77	60	16	6	11	73	31	6	3	3	5	9	2	5
14	0	2	36	0	0	0	4	46	10	3	2	3	5	11	3
15	0	0	0	0	0	3	1	0	15	0	0	1	0	3	3
16	0	0	0	0	0	0	0	0	10	4	5	2	0	2	0

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0	0	1	13	13	0	3	8	22	10	3	0	0	0
2	228	294	92	214	190	403	52	145	139	98	99	37	11	6
3	2105	1153	1046	512	497	1422	1304	242	709	368	757	809	517	55
4	2455	4871	3034	1016	499	394	2351	2527	520	632	694	993	1672	392
5	4658	4021	4593	896	936	358	580	2287	1828	327	617	682	1007	859
6	1508	1512	2102	1968	310	472	246	227	1070	971	238	428	454	599
7	509	226	298	871	720	391	310	247	170	269	449	355	269	319
8	136	98	66	894	460	654	200	331	106	24	421	439	138	195
9	51	36	16	372	504	277	310	237	73	17	162	355	110	87
10	16	31	19	209	255	204	280	240	46	13	24	130	94	108
11	7	11	17	146	57	61	142	132	58	20	26	17	35	44
12	4	6	12	49	81	48	169	152	51	15	18	1	4	13
13	2	3	13	44	30	9	71	36	12	7	11	3	2	2
14	4	4	14	22	12	9	13	15	7	1	11	1	0	3
15	0	0	15	7	4	2	4	2	1	0	3	1	0	3
16	0	0	16	4	0	1	4	2	0	1	2	2	1	1

Table 13. 4X haddock catch numbers-at-age from projection in last year's assessment and the actual catch-at-age.

Predicted catch (000s)

Age	1997	%	1998	%
1	0	0	0	0
2	66	1	58	1
3	784	15	169	3
4	1931	36	2048	33
5	1655	31	2359	38
6	393	7	1069	17
7	125	2	234	4
8	138	3	72	1
9	151	3	79	1
10	157	3	87	1
1+	5400	100	6175	100

Actual catch (000s)

Age	1997	%	1998	%
1	0	0	0	0
2	9	0	6	0
3	469	12	54	2
4	1447	37	385	15
5	901	23	845	32
6	417	11	593	22
7	255	7	318	12
8	131	3	194	7
9	105	3	86	3
10	91	2	107	4
11	34	1	44	2
12	4	0	12	0
13	1	0	2	0
14	0	0	3	0
15	0	0	3	0
16	1	0	1	0
17	0	0	0	0
1+	3866	100	2655	100

Note: 1998 actual catch Jan. - June only.

Table 14. 4X haddock commercial weight-at-age (kg). (1998 for quarters 1 and 2 only)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.290	0.290	0.290	0.270	0.180	0.230	0.230	0.280	0.290	0.290	0.160	0.230			0.250
2	0.570	0.500	0.450	0.510	0.460	0.520	0.520	0.460	0.440	0.510	0.522	0.593	0.493	0.394	0.527
3	0.900	0.960	0.900	0.750	0.820	0.820	0.810	0.710	0.870	0.870	0.882	0.877	0.907	0.758	0.785
4	1.050	1.250	1.350	1.250	1.100	1.200	1.190	1.220	1.330	1.330	1.326	1.260	1.294	1.141	1.069
5	1.160	1.400	1.600	1.800	1.700	1.550	1.600	1.720	1.850	1.840	1.777	1.721	1.653	1.714	1.411
6	1.430	1.500	1.750	2.000	2.300	2.250	2.100	2.200	2.330	2.360	2.355	2.219	2.130	2.146	1.932
7	1.650	1.750	1.900	2.200	2.500	2.850	2.950	2.940	2.700	2.830	2.906	2.654	2.577	2.607	2.287
8	1.950	1.950	2.100	2.300	2.600	3.000	3.500	3.300	3.390	3.300	3.278	3.134	2.947	2.869	2.683
9	2.300	2.300	2.300	2.500	2.800	3.200	3.600	3.570	3.770	4.030	3.811	3.608	3.470	3.108	3.054
10	2.820	2.650	2.800	2.700	2.950	3.450	3.800	3.770	4.170	4.150	4.332	3.688	4.033	3.550	3.431
11	2.800	3.250	3.000	3.300	3.200	3.500	4.100	3.690	4.030	4.960	4.200	4.546	3.946	3.630	3.841
12	2.850	3.000	3.700	3.400	3.800	3.700	4.000	3.940	3.620	6.000	4.963	4.823	4.033	3.780	4.114
13	3.600	3.000	3.300	4.200	3.900	4.400	4.200	3.910	4.630	5.680	5.711	4.680	4.908	4.064	4.000
14															
15															
16															

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1				0.439			0.550	0.671			0.161			
2	0.573	0.522	0.615	0.848	0.810	0.666	1.159	0.790	0.796	0.872	0.773	0.906	0.827	0.414
3	0.830	0.728	0.779	1.085	1.085	1.073	1.104	1.026	0.972	1.139	1.074	1.011	1.030	0.743
4	1.071	1.022	1.005	1.179	1.232	1.431	1.440	1.232	1.129	1.312	1.369	1.217	1.289	1.165
5	1.408	1.380	1.328	1.469	1.350	1.809	1.833	1.572	1.392	1.483	1.597	1.396	1.561	1.436
6	1.966	1.838	1.796	1.522	1.511	1.740	2.016	1.956	1.734	1.793	1.730	1.598	1.869	1.576
7	2.442	2.506	2.472	1.683	1.690	2.001	2.088	1.887	2.132	2.080	1.976	1.614	2.048	1.760
8	2.920	2.775	3.123	1.794	1.672	2.050	2.234	1.963	2.098	2.493	2.013	1.860	2.069	1.773
9	3.501	3.396	4.061	2.031	1.815	2.108	2.240	2.158	2.365	2.101	2.355	2.136	2.199	2.014
10	3.313	3.493	3.309	2.256	1.882	2.351	2.228	2.167	2.242	2.775	2.286	2.042	2.357	2.146
11	4.029	3.299	4.150	2.373	2.256	2.316	2.274	2.100	2.377	2.204	2.584	2.750	2.648	2.493
12	4.424	3.331	4.775	2.570	2.379	2.613	2.339	1.968	2.148	2.381	2.305	3.373	2.550	1.986
13	5.468	4.286	5.173	2.329	2.490	2.373	2.327	2.660	2.521	2.899	2.623	3.027	3.072	4.424
14	5.595	4.804	5.827	3.302	2.713	3.126	2.654	2.919	2.887	4.510	2.902	3.271	4.481	4.793
15				3.767	3.135	3.204	3.421	3.218	4.777	4.308	3.095	3.490		
16			7.526	4.754	6.052	4.546	3.787	5.541	5.628	2.486	3.224	3.286	3.674	3.605

Table 15. 4X haddock mean numbers per standard tow by stratum from the 1970-98 summer Research Vessel survey (with vessel conversion 1970-81)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
470	3.94	0.58	5.68	5.13	0.41	4.20	0.70	273.93	5.75	38.25	3.28	6.09	0.00	36.34	12.58
471	0.00	0.00	2.47	0.00	0.00	0.55	0.00	0.44	0.46	0.55	2.92	2.86	4.89	3.89	0.46
472	13.72	37.80	15.86	12.56	28.86	49.18	35.25	14.92	10.53	32.55	248.91	192.03	141.20	39.75	49.03
473	89.87	9.98	82.22	51.92	53.90	11.50	113.46	170.97	26.39	81.26	31.42	10.60	135.88	34.22	60.70
474	55.73	25.61	28.96	39.50	75.43	97.01	76.85	26.00	103.58	303.43	27.18	119.46	135.37	58.27	0.00
475	78.14	53.88	21.97	57.63	105.68	27.13	137.04	36.58	81.00	77.82	71.20	46.08	48.50	53.94	254.51
476	0.00	84.58	12.38	0.00	41.53	39.53	1.31	1055.25	53.78	0.00	23.10	14.84	5.50	62.34	8.75
477	45.40	34.13	24.52	31.91	132.00	25.24	66.94	31.07	45.54	44.47	35.92	53.20	94.15	86.99	150.81
478	1.75	1.75	0.70	0.58	2.52	3.21	10.50	4.68	6.15	2.52	1.75	0.67	2.94	17.14	16.73
480	100.65	242.10	98.74	132.80	264.49	179.52	64.13	631.56	192.55	88.73	224.06	180.81	73.74	93.29	172.05
481	63.26	30.89	31.69	183.36	273.08	49.72	56.51	30.81	72.98	85.20	169.64	35.11	170.30	41.82	70.77
482	2.33	3.32	0.00	0.00	5.83	3.06	4.69	9.75	8.40	20.54	14.75	9.92	23.33	8.58	20.90
483	2.53	0.00	4.08	0.00	1.85	2.10	30.33	9.96	1.75	11.05	23.50	32.23	70.04	5.66	33.42
484	0.00	0.53	0.00	0.37	0.35	0.39	6.11	0.41	0.58	14.87	2.33	1.67	6.04	1.28	4.12
485	52.16	11.78	3.11	31.92	9.29	12.00	14.77	34.48	13.88	10.87	65.92	15.01	24.85	11.29	26.44
490	30.43	56.87	0.53	70.77	324.45	48.12	109.15	189.51	63.48	384.72	311.15	1479.70	485.53	234.97	773.65
491	4.16	0.00	11.39	3.92	21.05	3.01	2.58	21.30	11.52	5.21	15.37	15.48	30.46	32.01	29.26
492	1.22	21.00	6.74	4.81	19.83	7.78	25.55	16.21	7.68	28.29	5.64	21.31	103.64	18.56	1.24
493	2.42	0.95	1.56	4.37	0.74	6.15	4.42	6.56	10.57	0.41	1.58	3.09	1.65	0.39	36.04
494	0.00	1.40	5.75	7.45	16.16	6.03	3.49	16.57	4.86	17.29	1.85	3.21	5.04	0.00	5.56
495	16.80	13.56	9.33	4.00	20.19	1.73	4.87	33.92	48.00	31.46	6.75	8.68	38.59	14.84	3.09

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1970-97
470	0.97	41.18	6.61	6.46	3.19	1.54	0.00	0.97	0.49	0.00	2.11	5.68	16.49	8.09	17.23
471	0.00	0.51	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.01	0.00	1.01	0.86
472	73.40	73.09	28.21	34.73	47.23	17.47	19.11	7.89	7.32	14.77	42.50	74.95	30.98	7.25	49.78
473	189.10	174.07	80.29	12.01	12.32	41.51	92.36	5.83	0.46	47.42	210.78	352.79	101.04	199.85	81.58
474	134.50	52.61	3.15	1.54	1.80	31.11	6.32	6.69	8.26	8.16	8.15	41.32	107.22	92.83	56.54
475	100.85	159.04	14.13	13.90	22.10	54.47	22.48	16.04	8.75	125.37	164.81	175.06	46.38	47.18	74.09
476	369.87	22.39	25.03	9.10	9.21	5.30	8.51	11.67	2.83	14.82	51.60	52.17	72.14	25.26	73.48
477	92.13	120.41	43.99	59.48	42.02	24.37	38.58	39.23	12.84	56.47	248.00	86.51	60.13	120.74	65.23
478	20.42	9.48	25.39	11.32	0.00	13.83	0.00	4.88	3.40	14.39	5.30	22.14	5.90	3.09	7.50
480	117.45	97.60	52.78	84.96	175.59	251.54	316.69	200.96	71.76	173.09	274.90	226.30	341.80	322.51	183.02
481	18.68	168.47	31.93	25.72	29.26	18.03	40.43	25.32	41.43	41.01	145.58	102.30	71.88	58.67	75.90
482	1.46	2.06	31.63	22.73	18.19	39.56	20.86	1.50	7.29	19.23	18.65	138.92	25.17	10.82	17.24
483	14.58	13.00	11.48	20.59	1.54	36.84	41.78	4.03	3.83	0.50	3.54	1.96	17.23	4.46	14.27
484	2.94	0.69	0.00	1.37	0.97	0.97	0.00	0.00	0.70	0.65	3.03	5.17	2.91	3.01	2.09
485	80.44	35.57	2.97	9.68	1.86	13.13	87.06	20.51	8.40	1.69	78.02	94.92	4.35	34.48	27.73
490	160.56	31.56	44.66	128.41	129.52	174.02	79.27	104.55	18.53	412.74	541.72	336.00	267.88	139.75	249.73
491	16.34	3.09	1.03	0.26	0.00	0.67	1.30	3.56	4.80	22.25	63.99	9.09	44.53	10.16	13.49
492	5.04	1.97	2.63	5.33	0.31	0.00	0.39	8.21	0.00	7.00	6.02	4.69	37.18	67.20	13.15
493	2.31	35.48	13.65	0.00	0.00	0.00	0.00	1.56	0.00	0.00	1.12	0.62	24.29	1.63	5.71
494	3.50	26.49	0.00	0.70	0.00	0.00	2.92	0.58	0.00	6.00	25.43	300.70	0.00	17.83	16.46
495	5.22	0.00	0.00	0.98	0.00	18.05	0.00	0.00	0.00	4.93	55.27	16.99	48.84	21.23	14.50

Table 16. 4X haddock (Scotian Shelf strata 470-481) stratified mean numbers-at-length per standard tow from 1970-98 summer Research Vessel surveys.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.22	0.01	0.00	0.00	0.00	0.00
6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.19	0.03	0.24	0.27	0.20	0.11
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.02	0.00	0.41	0.01	0.74	0.21	0.29	0.43
10.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	0.12	0.00	0.00	0.02
12.5	0.05	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.10	0.00	0.00	0.12	0.43	0.08	0.00
14.5	0.12	0.02	0.20	0.03	0.14	0.00	0.00	0.00	0.66	0.06	2.45	3.87	3.24	0.75	0.23
16.5	0.31	0.03	0.94	0.20	0.35	0.38	0.35	0.43	2.24	0.30	5.16	12.87	7.94	3.90	1.96
18.5	1.67	0.00	2.58	1.91	2.57	1.71	2.13	1.66	3.62	1.04	8.10	6.71	7.71	4.39	2.65
20.5	4.35	0.09	3.76	4.46	8.62	3.65	3.73	2.74	3.12	1.29	12.54	1.18	8.78	1.15	2.11
22.5	2.49	0.15	1.44	4.49	5.68	3.08	1.42	3.20	1.15	0.31	7.47	0.13	7.66	1.17	2.42
24.5	1.23	0.76	0.61	1.79	1.29	1.94	0.75	2.42	0.22	0.90	2.56	0.78	8.42	1.18	4.26
26.5	0.05	3.90	0.20	3.85	1.48	0.98	0.74	1.53	0.11	2.39	0.63	0.69	6.21	1.12	3.36
28.5	0.60	6.36	0.02	9.20	5.53	1.06	1.39	3.43	0.92	4.21	0.98	1.58	4.16	1.45	3.47
30.5	0.92	5.54	0.05	12.90	14.07	1.45	1.86	5.44	1.76	3.47	1.66	2.08	2.46	2.42	2.81
32.5	1.95	2.59	0.17	4.72	12.90	1.65	1.81	12.22	1.97	2.74	1.62	1.18	1.60	4.23	1.90
34.5	2.96	0.90	0.60	2.62	7.62	1.01	1.30	18.30	2.13	2.16	1.68	0.61	1.25	4.50	2.44
36.5	1.32	0.83	1.27	0.50	8.54	1.44	1.47	17.02	1.74	0.90	3.23	0.57	0.90	3.25	3.76
38.5	0.98	1.18	1.32	0.25	9.07	0.79	1.11	24.30	2.50	0.61	5.15	0.37	2.01	1.80	5.15
40.5	1.18	1.71	1.30	0.21	9.03	2.72	0.69	25.35	4.05	0.87	3.52	0.56	2.22	1.45	5.44
42.5	1.14	1.75	0.98	0.20	5.81	3.87	1.32	28.16	5.85	1.70	2.43	2.41	1.26	1.75	5.02
44.5	0.92	1.95	0.46	0.66	2.56	2.05	1.06	30.32	2.74	2.09	2.43	3.09	0.96	1.23	3.89
46.5	1.21	1.84	0.65	0.58	1.58	2.30	2.19	17.89	1.64	3.09	2.31	3.37	1.60	1.40	2.35
48.5	1.39	2.06	0.68	1.35	0.57	3.08	2.58	16.82	1.76	3.50	2.27	3.55	1.52	1.27	2.15
50.5	1.57	1.79	0.99	1.11	1.24	2.11	3.12	11.86	1.65	2.84	4.75	2.14	2.79	2.51	1.27
52.5	1.19	3.42	1.23	1.05	1.23	1.51	3.31	5.63	1.66	2.69	4.43	1.56	1.60	1.82	1.38
54.5	1.05	2.84	1.17	1.02	1.86	0.74	1.35	10.45	1.56	1.77	5.39	2.45	1.65	1.92	1.16
56.5	1.34	3.33	0.99	0.61	1.41	0.91	1.05	7.25	1.59	1.83	4.21	1.72	1.43	1.15	0.96
58.5	0.89	2.06	1.15	0.66	1.63	0.63	0.63	6.55	2.24	1.48	3.42	1.96	0.62	1.09	0.67
60.5	0.67	1.47	0.70	0.68	0.78	0.59	0.68	1.61	0.92	1.59	2.26	0.99	0.41	0.73	0.66
62.5	0.54	0.74	0.81	0.49	0.78	0.56	0.42	1.73	0.75	1.01	1.64	0.99	0.36	0.39	0.43
64.5	0.55	0.33	0.40	0.29	0.77	1.24	0.21	0.78	0.31	0.54	1.50	0.42	0.18	0.44	0.00
66.5	0.26	0.31	0.18	0.35	0.62	0.12	0.22	2.25	0.15	0.40	0.75	0.28	0.16	0.28	0.03
68.5	0.21	0.23	0.09	0.12	0.16	0.42	0.16	0.28	0.09	0.14	0.72	0.09	0.01	0.06	0.05
70.5	0.07	0.05	0.02	0.03	0.01	0.05	0.01	0.06	0.03	0.06	0.41	0.05	0.07	0.08	0.00
72.5	0.02	0.19	0.02	0.00	0.00	0.18	0.03	0.13	0.00	0.01	0.09	0.03	0.00	0.00	0.01
74.5	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.06	0.00	0.00	0.00	0.07	0.00	0.02	0.00
76.5	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00
78.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.02	0.00
80.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sum	33.23	48.43	24.94	56.32	107.91	42.24	37.20	259.92	49.33	46.92	95.79	59.54	80.09	49.49	62.54

Table 16 continued. 4X haddock (Scotian Shelf strata 470-481) stratified mean numbers-at-length per standard tow from 1970-98 summer Research Vessel surveys.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1970-97
0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.01
6.5	0.00	0.19	0.00	0.12	0.00	0.00	0.00	0.02	0.02	0.23	0.00	0.31	0.06	0.10	0.07
8.5	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.02	1.74	0.04	0.92	0.06	0.08	0.18
10.5	0.00	0.00	0.03	0.00	0.01	0.00	0.00	0.00	0.00	1.12	0.00	2.20	0.05	0.39	0.13
12.5	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.35	0.29	0.00	0.01	0.06
14.5	0.31	0.07	0.02	0.07	0.03	0.00	0.00	0.23	0.00	0.00	6.01	0.41	0.00	1.02	0.68
16.5	2.00	1.43	0.36	2.18	0.90	0.00	0.38	1.17	0.02	0.12	18.13	3.42	0.27	4.85	2.42
18.5	4.93	2.97	0.34	3.88	2.51	0.00	2.37	1.92	0.68	1.08	24.37	4.06	2.10	6.93	3.56
20.5	3.81	1.05	0.77	1.78	3.87	0.07	2.26	0.87	2.47	4.84	11.87	1.96	2.73	3.51	3.57
22.5	3.41	0.77	0.13	0.23	2.24	0.07	1.45	0.42	3.03	6.63	3.91	5.00	2.65	1.43	2.58
24.5	2.12	2.09	0.09	0.03	0.74	0.24	0.71	0.27	1.65	3.55	1.85	9.40	1.91	0.72	1.92
26.5	1.99	3.30	0.33	0.10	1.23	0.85	0.14	0.53	0.40	1.00	2.03	9.67	2.36	3.03	1.83
28.5	5.94	3.58	0.69	0.22	2.61	2.71	0.18	1.22	0.36	0.40	5.55	6.12	4.52	4.43	2.80
30.5	5.18	4.80	0.65	0.49	3.16	4.00	0.24	1.04	0.47	1.21	6.87	4.17	7.97	4.20	3.54
32.5	6.47	5.22	0.91	0.56	3.40	2.93	0.25	0.81	0.44	2.18	4.65	3.27	10.92	4.32	3.40
34.5	8.09	6.32	1.38	0.63	1.70	1.81	0.71	0.34	0.31	1.98	2.79	3.76	7.96	5.64	3.14
36.5	6.14	7.31	2.24	0.55	0.83	1.71	2.11	0.54	0.40	1.14	1.90	5.40	5.60	6.73	2.95
38.5	8.15	6.91	2.21	0.90	0.51	2.91	4.06	0.61	0.37	0.62	1.95	4.98	4.12	5.30	3.39
40.5	7.67	6.11	2.61	1.29	0.78	3.86	4.56	1.41	0.73	1.00	2.90	3.30	4.90	3.66	3.62
42.5	9.11	6.50	2.26	2.32	0.81	2.52	4.06	2.57	0.55	0.82	1.77	3.04	3.91	2.71	3.71
44.5	8.53	5.57	2.76	3.31	1.17	1.45	3.74	3.46	0.64	1.03	1.31	2.61	2.45	2.53	3.37
46.5	6.69	5.09	2.65	2.30	1.42	1.15	4.56	3.24	1.00	1.15	1.48	1.96	1.54	1.36	2.79
48.5	3.22	4.12	2.21	2.04	1.59	1.08	3.58	2.44	0.62	1.11	1.57	1.31	1.37	0.73	2.53
50.5	3.57	3.57	1.58	1.70	1.33	1.24	2.34	2.01	1.10	1.23	1.16	1.53	1.00	0.37	2.33
52.5	1.92	1.64	1.49	0.85	1.05	0.87	1.95	1.42	0.55	0.95	1.09	1.18	0.59	0.36	1.76
54.5	1.34	1.93	1.00	0.67	0.46	0.76	1.43	0.75	0.39	0.61	0.97	0.82	0.46	0.27	1.71
56.5	1.05	1.01	0.61	0.17	0.32	0.40	0.71	0.55	0.31	0.30	0.77	0.39	0.19	0.16	1.31
58.5	0.98	0.91	0.24	0.19	0.15	0.26	0.56	0.20	0.17	0.19	0.11	0.24	0.19	0.12	1.07
60.5	0.65	0.44	0.23	0.16	0.05	0.07	0.37	0.11	0.17	0.17	0.03	0.14	0.05	0.08	0.62
62.5	0.23	0.06	0.15	0.08	0.02	0.08	0.10	0.12	0.13	0.00	0.10	0.04	0.05	0.04	0.46
64.5	0.06	0.13	0.07	0.00	0.03	0.07	0.09	0.02	0.02	0.02	0.00	0.01	0.00	0.01	0.30
66.5	0.10	0.14	0.02	0.04	0.02	0.01	0.00	0.04	0.04	0.00	0.04	0.00	0.00	0.01	0.24
68.5	0.00	0.06	0.04	0.01	0.00	0.00	0.02	0.01	0.02	0.00	0.04	0.00	0.00	0.00	0.11
70.5	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
72.5	0.00	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
74.5	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
76.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78.5	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sum	103.66	83.46	28.12	26.89	32.94	31.14	42.94	28.36	17.11	36.53	105.61	81.95	69.99	65.11	62.23

Table 17. 4X Haddock (Bay of Fundy strata 482-495) stratified mean numbers-at-length per standard tow from 1970-1998 summer Research Vessel surveys.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.04	0.00
8.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.10	0.00
10.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.5	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.66	0.04	0.00	0.00
18.5	0.00	0.00	0.00	0.00	0.07	0.12	0.09	0.09	0.08	0.15	0.04	5.54	0.02	0.26	0.00
20.5	0.08	0.00	0.00	0.00	1.29	0.03	0.20	0.12	0.02	0.24	0.24	14.08	0.25	0.36	0.35
22.5	0.04	0.00	0.00	0.00	1.28	0.04	0.49	0.45	0.02	0.19	0.44	13.33	0.45	0.98	1.54
24.5	0.04	0.00	0.00	0.10	0.41	0.11	0.73	0.21	0.00	0.13	0.53	8.52	0.71	0.69	3.38
26.5	0.00	0.05	0.00	0.66	0.17	0.05	0.29	0.23	0.00	0.13	0.22	3.36	1.61	0.33	2.30
28.5	0.00	0.00	0.00	0.91	0.37	0.00	0.42	0.21	0.00	0.31	0.12	3.79	2.42	0.39	2.46
30.5	0.00	0.12	0.00	1.67	1.16	0.02	0.48	0.24	0.02	1.44	0.53	6.13	3.87	0.31	6.10
32.5	0.08	0.14	0.00	1.69	1.36	0.06	1.01	0.42	0.07	2.07	1.60	6.67	4.86	0.56	10.57
34.5	0.04	0.08	0.00	1.54	1.65	0.37	1.25	0.80	0.27	3.60	2.08	8.79	3.89	1.20	8.86
36.5	0.12	0.12	0.00	0.39	1.43	0.43	1.36	1.31	0.49	2.45	2.50	7.93	3.05	1.33	3.72
38.5	0.00	0.16	0.00	0.05	2.10	0.33	0.87	1.98	0.56	1.72	1.84	7.40	2.26	1.51	2.51
40.5	0.14	0.17	0.10	0.12	4.48	0.22	0.33	1.86	0.73	1.85	2.20	3.52	2.43	1.54	1.90
42.5	0.25	0.53	0.03	0.00	4.24	0.15	0.41	1.59	0.68	1.45	3.05	1.51	2.27	1.82	2.29
44.5	0.35	0.56	0.13	0.07	2.87	0.54	1.03	1.65	0.85	2.61	2.96	0.99	2.61	1.74	2.89
46.5	0.88	0.23	0.14	0.00	2.23	0.57	0.76	1.40	1.02	2.15	2.25	1.45	1.76	1.70	2.45
48.5	1.24	0.64	0.09	0.13	1.23	0.84	0.76	1.45	0.89	2.23	1.98	1.78	2.69	1.16	2.41
50.5	1.71	0.63	0.09	0.41	0.57	0.98	1.23	1.55	1.51	2.00	2.17	1.41	2.59	1.53	2.12
52.5	1.70	0.72	0.23	0.63	0.27	0.40	0.89	1.14	1.27	1.05	2.32	1.07	2.25	0.80	1.45
54.5	1.96	0.57	0.17	0.39	0.30	0.76	0.81	2.01	1.21	2.00	2.02	0.66	2.66	0.85	1.12
56.5	1.33	0.72	0.23	0.46	0.00	0.07	1.24	1.62	1.00	1.75	2.27	1.03	2.12	0.83	1.35
58.5	0.55	1.18	0.16	0.63	0.21	0.02	0.78	1.18	0.68	2.05	1.51	0.68	2.35	0.84	1.42
60.5	0.57	0.76	0.45	0.41	0.32	0.42	0.33	1.28	0.65	1.68	1.30	0.74	2.04	0.68	0.65
62.5	0.52	1.04	0.38	0.60	0.32	0.08	0.63	1.48	0.33	1.11	1.23	1.65	2.11	0.52	0.42
64.5	0.46	0.71	0.48	0.44	0.31	0.35	0.13	0.72	0.22	1.49	0.72	0.85	1.87	0.34	0.49
66.5	0.41	0.07	0.32	0.25	0.08	0.00	0.14	0.37	0.11	1.37	0.44	0.70	1.51	0.38	0.64
68.5	0.25	0.14	0.05	0.18	0.29	0.29	0.20	0.36	0.13	0.51	0.25	0.50	1.03	0.20	0.24
70.5	0.10	0.10	0.06	0.03	0.02	0.21	0.24	0.47	0.15	0.49	0.15	0.41	0.99	0.19	0.18
72.5	0.03	0.00	0.07	0.00	0.08	0.05	0.02	0.06	0.08	0.94	0.00	0.14	0.99	0.16	0.18
74.5	0.00	0.03	0.03	0.00	0.07	0.00	0.00	0.05	0.12	0.19	0.03	0.23	0.48	0.10	0.00
76.5	0.00	0.03	0.02	0.00	0.04	0.04	0.05	0.13	0.02	0.13	0.00	0.19	0.17	0.16	0.00
78.5	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.11	0.00	0.04	0.05	0.00	0.18	0.04	0.00
80.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
82.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
84.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86.5	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sum	12.85	9.57	3.35	11.75	29.21	7.55	17.15	26.51	13.19	39.55	37.16	105.72	58.56	23.74	63.95

Table 17 continued. 4X Haddock (Bay of Fundy strata 482-495) stratified mean numbers-at-length per standard tow from 1970-1998 summer Research Vessel surveys.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1970-97
0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.02	0.00
6.5	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.53	0.19	0.05	0.00	0.48	0.03
8.5	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.02	0.00	1.13	0.13	0.20	0.08	1.64	0.07
10.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.54	0.00	0.53	0.03
12.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
14.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.01
16.5	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	1.80	0.00	0.04	0.02	0.10
18.5	0.00	0.00	0.00	0.06	0.15	0.00	0.01	0.07	0.02	0.18	6.33	0.02	0.48	0.08	0.49
20.5	0.08	0.02	0.03	0.42	0.31	0.00	0.05	0.16	0.05	0.16	5.41	0.02	1.90	0.15	0.92
22.5	0.35	0.05	0.18	0.78	0.25	0.00	0.16	0.26	0.14	3.95	3.36	0.13	3.57	0.15	1.16
24.5	0.24	0.02	0.22	1.38	0.31	0.00	0.19	0.25	0.00	8.85	0.82	0.63	3.59	0.03	1.15
26.5	0.26	0.03	0.16	1.28	0.07	0.00	0.06	0.05	0.00	5.99	0.23	1.29	1.30	0.06	0.72
28.5	0.06	0.02	0.09	0.80	0.21	0.02	0.02	0.02	0.00	1.70	0.69	3.24	0.25	0.22	0.66
30.5	0.13	0.00	0.03	0.46	0.42	0.18	0.00	0.00	0.00	0.58	2.51	3.69	0.59	0.51	1.10
32.5	0.98	0.05	0.07	0.41	0.56	0.48	0.02	0.16	0.05	0.41	4.12	2.63	0.89	1.19	1.50
34.5	1.10	0.22	0.08	0.17	0.82	1.64	0.02	0.09	0.03	0.83	5.69	1.79	1.25	1.00	1.72
36.5	2.09	0.24	0.28	0.30	1.31	2.54	0.08	0.28	0.05	1.24	5.52	2.25	1.95	0.72	1.60
38.5	2.33	0.35	0.68	0.52	1.29	1.65	0.20	0.06	0.11	1.12	3.25	3.68	2.04	0.56	1.45
40.5	3.73	0.39	0.53	0.57	0.99	1.08	0.49	0.07	0.18	0.39	2.48	5.61	2.18	0.79	1.44
42.5	2.51	0.57	0.29	0.43	0.42	1.01	0.79	0.02	0.27	0.18	2.80	5.90	1.67	1.23	1.33
44.5	3.25	1.51	0.46	0.37	0.14	1.25	1.18	0.27	0.29	0.25	2.71	5.61	1.98	1.70	1.47
46.5	2.40	0.95	0.27	0.37	0.22	1.01	3.06	0.23	0.12	0.33	3.62	4.20	2.26	2.09	1.36
48.5	1.38	1.44	0.26	0.25	0.61	0.67	2.51	0.28	0.23	0.35	1.66	4.23	1.69	2.12	1.25
50.5	1.12	1.45	0.88	0.72	0.14	1.35	2.83	0.45	0.27	0.46	1.59	4.04	1.39	2.63	1.33
52.5	0.72	1.40	0.91	0.70	0.52	1.01	2.51	1.33	0.24	0.47	1.53	3.98	1.07	1.89	1.16
54.5	0.74	1.19	0.81	1.01	0.55	1.27	3.35	1.50	0.30	0.32	0.84	3.37	0.92	2.02	1.20
56.5	0.88	0.60	0.76	0.82	0.48	1.27	2.40	1.90	0.73	0.35	0.98	2.98	0.78	1.85	1.10
58.5	0.45	0.59	0.78	0.57	0.52	0.94	1.59	1.13	0.44	0.19	0.91	2.86	0.64	1.17	0.92
60.5	0.83	0.25	0.23	0.65	0.28	0.73	1.03	1.00	0.23	0.35	0.45	1.85	0.51	0.54	0.74
62.5	0.62	0.22	0.14	0.47	0.29	1.10	0.92	0.78	0.08	0.28	0.39	1.35	0.18	0.47	0.69
64.5	0.69	0.14	0.07	0.35	0.04	0.67	0.34	0.62	0.18	0.34	0.20	0.74	0.13	0.17	0.50
66.5	0.46	0.31	0.21	0.23	0.03	0.67	0.43	0.27	0.13	0.33	0.21	0.61	0.08	0.14	0.38
68.5	0.08	0.08	0.04	0.22	0.07	0.19	0.29	0.34	0.03	0.20	0.18	0.25	0.06	0.17	0.24
70.5	0.26	0.02	0.05	0.11	0.01	0.16	0.17	0.07	0.00	0.22	0.14	0.13	0.05	0.03	0.19
72.5	0.23	0.05	0.03	0.05	0.00	0.05	0.11	0.06	0.00	0.11	0.00	0.00	0.05	0.00	0.13
74.5	0.00	0.05	0.00	0.09	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.06
76.5	0.00	0.00	0.03	0.03	0.00	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
78.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
80.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
82.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
84.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sum	27.94	12.30	8.55	14.58	11.05	21.37	24.82	11.76	4.17	32.06	60.92	67.92	33.59	26.38	28.24

Table 18. 4X haddock stratified mean numbers-at-age per standard tow from the 1970-98 summer Research Vessel survey strata 470-495.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.47	0.03	0.54	0.14	0.32	0.27
1	5.21	0.10	4.72	5.79	10.31	6.02	4.98	5.77	5.54	1.84	19.84	32.96	11.70	6.11	3.75
2	4.17	10.08	0.21	20.57	20.72	3.24	5.86	36.36	4.73	12.40	6.32	25.43	25.10	4.04	21.44
3	1.23	4.38	3.04	0.66	29.86	4.83	3.77	56.66	10.95	7.46	13.92	6.15	11.91	12.89	10.99
4	2.31	1.94	1.38	2.89	0.91	7.17	3.94	16.13	3.74	9.45	7.16	8.43	4.73	5.70	16.56
5	0.93	2.70	0.81	1.36	3.74	0.37	6.65	15.62	1.55	4.78	11.12	3.43	7.69	3.36	5.20
6	2.14	1.28	0.90	0.48	0.84	1.62	0.58	8.61	2.98	2.00	4.29	3.80	3.14	2.12	2.66
7	5.51	1.99	0.59	0.70	0.49	0.41	0.72	1.17	1.18	2.99	1.55	1.21	3.43	0.87	1.28
8	0.78	5.49	0.92	0.52	0.59	0.31	0.13	1.41	0.08	1.29	1.17	0.16	0.59	0.31	0.54
9	0.31	0.71	1.44	0.34	0.32	0.13	0.07	0.16	0.00	0.22	0.59	0.30	0.38	0.29	0.36
10	0.30	0.08	0.05	0.57	0.23	0.11	0.02	0.14	0.00	0.10	0.23	0.18	0.21	0.21	0.08
11	0.07	0.04	0.01	0.02	0.35	0.34	0.01	0.02	0.04	0.00	0.03	0.08	0.14	0.17	0.03
12	0.02	0.10	0.00	0.00	0.00	0.26	0.14	0.15	0.03	0.00	0.00	0.04	0.00	0.05	0.03
13	0.00	0.00	0.01	0.01	0.00	0.00	0.10	0.08	0.02	0.00	0.00	0.00	0.00	0.05	0.04
14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.09	0.06	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.18	0.03	0.06	0.05	0.11	0.05	0.03
total	22.98	28.89	14.09	33.91	68.35	24.80	27.12	142.58	31.16	43.21	66.31	82.76	69.27	36.54	63.25

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1970-97
0	0.00	0.14	0.00	0.06	0.00	0.17	0.00	0.00	0.00	2.55	0.18	2.00	0.12	1.63	0.25
1	6.31	3.44	1.20	6.44	5.39	0.07	3.86	2.81	4.17	19.09	41.81	4.53	9.02	8.98	8.31
2	8.68	8.54	1.38	1.92	8.79	9.56	1.24	2.24	0.95	5.34	22.41	24.17	5.30	6.94	10.76
3	20.81	6.75	2.45	0.91	1.76	8.60	11.36	0.88	1.57	1.98	10.63	22.71	19.25	4.26	10.30
4	9.54	13.55	3.03	1.90	0.82	1.58	10.37	6.92	0.60	1.78	3.77	11.56	11.62	12.52	6.05
5	13.15	5.30	3.67	2.65	1.66	1.28	2.18	4.92	1.72	0.36	1.71	4.67	3.60	6.74	4.15
6	3.38	5.66	2.57	2.81	0.71	1.42	1.20	0.94	1.04	1.75	0.70	1.54	1.50	1.72	2.24
7	1.68	2.02	1.85	1.34	1.47	1.29	1.08	0.35	0.17	1.02	1.43	1.07	0.55	1.39	1.41
8	1.06	1.04	0.81	1.05	0.52	1.08	0.90	0.36	0.13	0.14	0.37	1.50	0.17	0.91	0.84
9	0.59	0.59	0.23	0.65	0.44	0.45	0.67	0.26	0.05	0.05	0.09	0.37	0.28	0.25	0.37
10	0.22	0.34	0.29	0.36	0.13	0.37	0.79	0.19	0.04	0.08	0.00	0.30	0.18	0.16	0.21
11	0.06	0.06	0.06	0.12	0.10	0.18	0.08	0.04	0.09	0.01	0.00	0.12	0.02	0.11	0.08
12	0.03	0.10	0.01	0.01	0.08	0.08	0.08	0.02	0.02	0.05	0.02	0.02	0.01	0.01	0.05
13	0.03	0.06	0.00	0.00	0.00	0.05	0.02	0.00	0.03	0.09	0.00	0.07	0.00	0.00	0.02
14	0.04	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unknown	0.03	0.10	0.70	0.48	0.05	0.02	0.00	0.09	0.02	0.00	0.02	0.27	0.04	0.01	0.09
total	65.60	47.69	18.28	20.70	21.93	26.23	33.83	20.02	10.61	34.28	83.15	74.90	51.69	45.64	45.15

Table 19. 4X haddock (Scotian Shelf strata 470-481) mean length-at-age (cm) from the 1970 –98 summer Research Vessel survey.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1970		20.96	33.80	40.99	45.04	49.74	52.43	56.42	60.49	62.19	67.34	67.98	60.50					
1971		20.64	29.19	40.69	46.38	51.05	52.76	54.68	57.63	62.90	69.52	69.44	71.97					
1972		19.95	26.92	38.96	48.23	52.62	55.75	56.09	59.66	62.16	64.44	68.50	76.50					
1973		21.25	29.88	34.85	48.39	53.37	58.82	59.16	60.62	61.76	63.84	67.65						
1974		20.84	30.94	38.84	44.27	53.84	58.16	61.34	62.42	63.06	62.22	66.46						
1975		21.92	31.51	40.64	47.80	54.15	58.19	63.63	64.69	65.60	69.66	68.37	67.10					
1976		20.54	31.10	38.35	47.93	51.64	57.38	61.62	60.50				64.50	66.50				
1977	8.50	21.67	34.66	42.19	47.61	53.38	55.80	63.00	64.92	69.90	64.50		66.98	70.50	66.40			
1978		18.96	33.01	41.76	48.59	53.62	57.35	60.67				62.50						
1979	7.30	19.51	29.58	36.41	47.20	52.27	58.19	60.74	62.14	69.25						68.50		
1980	6.50	19.84	31.68	38.99	47.85	53.42	57.10	61.36	62.93	66.45	67.49	70.50						
1981	8.29	16.93	29.69	40.78	46.86	53.28	57.55	60.06	64.72	66.11	67.96	70.50						
1982	6.50	17.72	24.11	35.99	45.69	50.46	55.74	58.99	63.02	68.09		66.50						
1983	7.69	17.64	25.47	34.32	44.55	52.06	55.30	60.18	61.15	62.97	63.17	61.39	73.82	70.50				
1984	8.18	17.81	24.48	31.97	40.15	47.38	54.24	57.09	59.40	61.79								
1985		19.12	28.65	33.67	40.57	44.51	48.73	53.86	56.18	57.12	60.86				66.50			
1986	6.50	19.42	29.77	36.33	38.73	44.62	47.47	50.34	54.18	57.87	58.44	64.82	67.02	60.50				
1987		19.27	29.62	36.66	40.86	43.63	46.96	50.31	51.70	54.19	56.22	58.50						
1988	6.50	18.50	31.88	38.88	42.05	45.84	45.86	47.99	50.24	51.33	51.35	59.16	62.50					
1989	10.50	20.27	30.77	40.27	41.90	47.10	50.18	49.61	50.47	51.61	54.69	55.48	50.90		66.50			
1990		21.53	30.60	39.78	44.67	49.67	50.44	50.12	51.92	54.35	49.48	58.03	54.04		66.50			
1991		20.49	34.47	40.31	46.54	49.90	54.95	54.72	54.55	52.31	49.91	63.26	58.37		68.50			64.50
1992		18.93	30.12	39.41	45.13	48.93	54.37	56.02	53.15	52.46	62.35	58.50	62.50	68.50				
1993		22.11	31.61	39.62	45.87	49.29	53.61	54.55	54.38	51.03	58.03	53.61	56.50	56.37	74.50			
1994	9.08	22.32	32.90	39.28	45.45	48.09	49.54	51.86	55.45	53.29	54.50	58.50	51.48	52.01				
1995	8.50	18.24	30.29	39.23	45.85	49.36	50.86	53.18	56.27	60.34			54.50					
1996	9.76	17.82	26.33	36.37	42.73	45.67	50.56	52.38	52.77	56.08	49.89	58.50	59.55	52.50				
1997	8.32	20.76	27.69	32.69	39.72	45.29	46.60	50.38	54.24	53.96	53.97	60.35	62.50					
1998	9.55	18.62	27.97	33.57	36.92	42.15	46.17	49.18	53.36	51.98	54.53	57.82	54.50					
1970-97	8.01	19.82	30.03	38.15	44.88	49.79	53.39	56.08	57.77	59.54	59.99	63.11	62.29	62.17	68.15	68.50		64.50

Table 20. 4X haddock (Bay of Fundy strata 482/495) mean length-at-age (cm) from the 1970-98 summer Research Vessel survey.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1970		22.00	34.83	41.52	47.06	50.01	51.47	56.02	58.91	58.67	62.72	68.50					
1971			32.89	44.56	49.76	53.21	54.31	55.82	60.92	63.24	74.50		73.36				
1972		16.50		44.32	51.22	54.80	57.60	59.64	61.80	64.23	72.94			78.50			
1973		24.50	31.51	39.78	52.58	57.78	61.75	61.63	60.91	65.17	63.88			70.50			
1974		22.00	32.39	42.48	49.31	59.75	63.90	61.08	65.64	62.84	66.61	69.58					
1975		22.20	36.67	46.20	51.07	54.50	65.65				64.50	65.71	66.73				
1976		23.28	33.90	43.29	49.80	55.67	62.50	68.24	66.50	65.69	66.50	72.50	67.68	71.67			
1977		23.61	38.35	46.77	52.65	57.93	60.96	67.35	67.18	69.67	65.58	66.50	76.50	73.18	74.13		
1978		19.63	37.76	46.68	53.02	56.75	59.30	62.75	66.17				68.50	72.50	73.15	70.30	
1979	6.50	21.34	34.56	44.31	52.64	59.13	62.75	65.09	67.75	72.40	69.07				72.50	73.93	
1980		22.84	34.59	42.92	51.27	57.22	62.90	63.36	63.83	68.03							
1981		21.62	33.30	41.61	50.12	59.33	63.33	66.20	62.50	69.31	74.85	72.50	74.50				
1982		22.13	31.70	41.06	50.26	55.95	61.65	65.43	68.52	68.83	74.56	75.93					
1983	8.28	22.61	33.24	42.23	49.93	57.14	61.70	64.40	66.53	66.74	70.41	73.25	66.50	76.50			
1984		24.06	31.69	36.54	46.32	52.26	57.59	61.71	63.45	66.78	69.43	70.50	72.50	66.50			
1985		23.97	36.07	42.83	47.16	52.73	61.87	63.94	64.71	63.69	67.13	62.73	66.50	66.50	70.50		
1986	6.50	23.70	36.70	45.26	50.28	52.23	57.05	58.11	56.50	64.42	63.47		64.88	62.50			
1987		25.24	37.93	46.35	51.88	54.19	62.27	61.44	58.53	65.73	70.50	66.50	76.50		65.86		
1988		24.93	37.18	47.12	50.97	54.99	57.01	63.92	59.62	66.84	62.13						
1989		21.85	35.53	41.18	49.67	52.55	55.95	57.45	53.91	62.50	62.50	63.27					
1990	8.50		36.95	46.19	53.60	55.55	58.62	59.93	63.87	65.02	63.75	65.54	62.50	67.98			
1991		23.93	43.56	47.09	53.35	54.75	61.49	62.50	63.98	65.57	58.21	70.50	70.50	70.50			
1992		22.37	35.05	34.50	53.05	58.73	58.74	62.80	61.07	67.55	60.79	72.50					
1993		21.71	38.24	45.62	51.85	55.94	59.41	61.93	60.50			66.35					
1994	8.05	25.02	36.33	47.22	54.51	70.50	62.47	64.44	67.62					70.50			
1995	7.33	20.02	34.93	45.17	51.44	57.74	59.92	61.90	62.83	70.50							
1996	8.09	21.15	30.30	42.15	51.43	56.45	57.96	60.32	61.55	64.53	67.19	58.50		82.50			
1997	8.50	23.04	30.77	39.07	46.47	53.56	58.49	59.44	71.81	71.83							58.50
1998	8.54	21.00	33.54	40.40	45.70	50.24	55.84	56.92	59.63	60.77		64.50					
1970-97	7.72	22.51	35.07	43.36	50.81	56.12	59.95	62.11	63.23	66.24	66.87	68.29	69.78	71.53	71.23	72.12	58.50

Table 21. 4X haddock mean weight-at-age (kg) from the 1970-98 summer Research Vessel survey strata 470-495.

	1970	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	0.079	0.083	0.076	0.098	0.091	0.100	0.089	0.104	0.064	0.077	0.081	0.086	0.056	0.061	0.094
2	0.380	0.246	0.196	0.286	0.307	0.360	0.343	0.451	0.408	0.340	0.402	0.388	0.214	0.232	0.277
3	0.722	0.739	0.652	0.483	0.673	0.746	0.654	0.807	0.876	0.747	0.737	0.769	0.632	0.525	0.431
4	1.027	1.071	1.279	1.318	0.988	1.230	1.161	1.200	1.429	1.327	1.288	1.156	1.270	1.045	0.781
5	1.358	1.402	1.634	1.782	1.740	1.724	1.545	1.721	1.861	1.761	1.770	1.836	1.669	1.563	1.231
6	1.560	1.556	1.971	2.300	2.278	2.299	2.039	1.988	2.183	2.408	2.108	2.350	2.323	1.880	1.811
7	1.984	1.722	2.020	2.354	2.513	2.859	2.598	2.838	2.633	2.737	2.475	2.725	2.882	2.391	2.139
8	2.397	2.141	2.470	2.433	2.700	3.012	2.414	3.066	3.390	3.159	2.679	2.931	3.433	2.720	2.438
9	2.551	2.653	2.851	2.721	2.740	3.147	2.875	3.797		4.151	3.186	3.391	3.572	2.851	2.999
10	3.227	3.751	3.756	2.823	2.839	3.461	2.981	3.074		3.729	3.297	4.259	4.605	3.184	3.588

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1970-97
1	0.074	0.066	0.100	0.096	0.083	0.108	0.086	0.078	0.103	0.140	0.062	0.054	0.113	0.061	0.086
2	0.306	0.262	0.353	0.438	0.342	0.414	0.566	0.308	0.353	0.410	0.345	0.203	0.225	0.259	0.334
3	0.518	0.580	0.554	0.681	0.711	0.800	0.816	0.628	0.746	0.815	0.787	0.648	0.414	0.395	0.675
4	0.700	0.731	0.940	0.981	0.862	1.301	1.298	1.117	1.061	1.223	1.144	1.183	0.770	0.600	1.103
5	0.969	0.959	1.140	1.343	1.248	1.720	1.483	1.631	1.375	1.315	1.452	1.432	1.172	1.057	1.494
6	1.342	1.164	1.123	1.310	1.495	1.806	2.091	1.988	1.758	1.596	1.550	1.675	1.340	1.436	1.832
7	1.965	1.399	1.438	1.558	1.500	2.079	2.128	2.179	1.903	1.858	1.795	1.873	1.627	1.681	2.149
8	1.998	1.656	1.650	1.623	1.509	2.145	2.050	1.710	1.823	2.327	2.127	1.952	2.050	2.040	2.357
9	1.933	2.277	2.091	1.860	1.536	2.370	1.857	1.798	1.317	1.529	2.863	2.502	1.885	1.852	2.567
10	2.530	2.312	1.949	1.782	1.852	1.604	1.655	2.397	1.949	1.637		2.371	1.579	1.622	2.777

Table 22. 4X haddock length-weight relationship from the summer Research Vessel survey strata 470-495 and predicted weight at lengths of 35 and 50 cm.

Years	Cases	Intercept	s.e.	Alpha	Beta	s.e.	Corr	35	50
1970	1362	-5.63605	0.03493	3.57E-06	3.2868	0.00955	0.99431	0.424	1.369
1971	1054	-4.97928	0.04244	6.88E-06	3.10434	0.01139	0.99299	0.427	1.293
1972	1014	-5.06497	0.03575	6.31E-06	3.1431	0.00956	0.99535	0.450	1.381
1973	886	-4.78574	0.03419	8.35E-06	3.06445	0.00936	0.9959	0.450	1.343
1974	1543	-4.93482	0.03099	7.19E-06	3.10137	0.00848	0.99429	0.442	1.337
1975	764	-5.09557	0.04714	6.12E-06	3.14458	0.01261	0.99393	0.439	1.348
1976	1258	-4.92984	0.0357	7.23E-06	3.09033	0.0098	0.99374	0.427	1.286
1977	1190	-4.93255	0.03553	7.21E-06	3.10346	0.00941	0.99458	0.446	1.351
1978	1100	-5.17424	0.04085	5.66E-06	3.17445	0.01089	0.9936	0.451	1.400
1979	1245	-4.94251	0.03652	7.14E-06	3.10425	0.00964	0.99406	0.443	1.341
1980	1109	-4.6544	0.0382	9.52E-06	3.03049	0.01011	0.9939	0.455	1.341
1981	804	-5.14458	0.04721	5.83E-06	3.15376	0.01233	0.99393	0.432	1.330
1982	932	-4.8914	0.03988	7.51E-06	3.09176	0.01066	0.99452	0.446	1.344
1983	866	-5.25021	0.04929	5.25E-06	3.16576	0.0131	0.99268	0.406	1.254
1984	980	-4.95148	0.04331	7.07E-06	3.09815	0.01168	0.99313	0.430	1.298
1985	861	-4.72363	0.0479	8.88E-06	3.03262	0.01289	0.99233	0.428	1.261
1986	840	-5.20822	0.05405	5.47E-06	3.16458	0.01451	0.9913	0.421	1.302
1987	696	-4.75034	0.06457	8.65E-06	3.05082	0.0171	0.98928	0.444	1.319
1988	658	-5.04213	0.04981	6.46E-06	3.12857	0.0133	0.99413	0.437	1.335
1989	627	-4.86996	0.05006	7.67E-06	3.07914	0.01384	0.99375	0.436	1.307
1990	821	-4.5281	0.05275	1.08E-05	3.00099	0.01399	0.99122	0.465	1.355
1991	818	-4.86745	0.04161	7.69E-06	3.07442	0.011	0.99482	0.430	1.287
1992	655	-4.50558	0.04152	1.10E-05	2.98416	0.01115	0.99547	0.448	1.298
1993	540	-4.75433	0.04337	8.61E-06	3.03736	0.01179	0.99597	0.422	1.246
1994	982	-4.73518	0.02275	8.78E-06	3.03636	0.00653	0.99774	0.428	1.265
1995	1208	-4.75282	0.02276	8.63E-06	3.03378	0.00644	0.99729	0.417	1.231
1996	1253	-4.78469	0.02479	8.36E-06	3.04446	0.00694	0.99677	0.420	1.243
1997	1108	-4.6392	0.03129	9.67E-06	3.01232	0.00867	0.99545	0.433	1.268
1998	1024	-4.74856	0.02871	8.66E-06	3.03646	0.00807	0.99641	0.423	1.249
1970-97				8.82E-06	3.032676			0.436	1.312

Table 23. Mean bottom temperatures (C), longterm mean and minimum, by stratum and stratified mean bottom temperature from the 1970-98 summer Research Vessel survey.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
470	7.71	7.42	8.55	6.03	9.70	8.37	9.12	6.71	8.37	5.87	7.81	7.72	6.64	7.32	4.88
471	8.40	8.83	8.78	9.81	9.72	9.32	9.29	9.63	8.44	9.19	9.42	9.04	8.51	9.10	8.81
472	7.41	6.93	7.50	9.45	11.50	6.78	7.87	9.69	8.95	7.70	6.17	7.27	6.68	6.66	8.56
473	3.27	2.72	3.84	3.40	5.33	12.59	5.63	6.36	3.16	3.55	4.77	2.50	3.90	2.54	3.11
474	3.99	3.19	3.99	3.24	4.55	3.45	3.58	3.04	3.88	3.79	5.60	2.76	4.55	4.21	
475	4.08	3.58	4.17	4.40	4.66	3.30	7.03	4.41	4.26	5.12	5.59	3.85	4.99	3.49	4.68
476	6.36	4.67	5.65	7.20	5.71	5.09	7.54	7.31	6.20	6.16	5.74	5.57	6.68	7.26	6.31
477	7.37	7.20	8.36	7.87	7.96	4.11	8.15	6.92	5.51	5.87	6.95	7.62	4.45	5.68	6.70
478	7.32	6.52	8.36	8.17	8.57	9.16	7.36	9.31	9.00	7.75	9.10	7.20	7.86	8.13	8.78
480	5.54	6.52	6.22	8.79	7.98	7.57	9.30	5.34	6.14	5.82	6.59	5.78	8.55	5.74	8.58
481	5.75	7.54	6.17	8.51	8.03	6.87	9.89	6.55	7.25	9.11	6.99	6.91	9.94	7.02	9.20
482	7.02	8.66	8.24	7.32	9.08	7.72	8.55	7.91	7.03	9.14	7.48	7.69	8.56	8.65	9.38
483	6.81	7.41	8.06	7.47	8.26	7.81	8.22	7.51	7.17	8.19	7.63	7.64	6.79	8.71	7.60
484	6.86	7.66	7.07	9.70	7.99	7.02	8.73	6.71	6.38	7.09	7.92	6.89	7.60	7.18	9.14
485	6.42	6.94	7.19	8.08	7.74	6.61	9.47	6.29	6.84	8.37	7.33	6.60	7.21	6.95	8.02
490	7.21	7.45	7.43	9.04	7.94	7.27	10.28	7.19	6.84	8.85	8.16	7.96	8.58	8.17	8.90
491	6.48	6.71	6.75	7.60	7.18	6.66	9.14	6.47	6.43	7.22	7.55	6.83	7.11	7.00	7.42
492	6.73	6.79	6.96	7.17	7.20	6.56	8.66	6.24	6.25	7.11	6.56	6.98	7.76	6.75	7.29
493	6.72	6.80	6.56	8.22	7.64	6.58	9.46	7.25	7.32	7.33	8.35	7.75	8.36	7.56	8.36
494	9.03	9.41	8.42	9.61	9.01	8.39	10.69	9.64	9.31	10.53	9.98	10.09	10.05	10.08	9.53
495	7.72	7.99	7.77	9.10	8.53	8.44	10.29	8.45	8.21	9.29	9.66	8.37	9.27	9.97	9.71
Strat. Mean	6.79	7.10	7.17	8.18	8.13	6.95	8.82	7.21	6.97	7.57	7.37	7.08	7.58	7.25	8.03

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Mean 1970-97	Min 1970-97
470	9.63	2.46	6.48	7.65	8.26	8.58	5.06	6.14	7.70	10.08	6.69	7.40	4.07	4.36	7.23	2.46
471	10.01	10.12	9.44	8.34	8.61	8.96	8.40	9.08	9.44	10.07	10.03	10.09	9.52	6.88	9.23	8.34
472	8.72	8.64	6.10	7.02	8.09	8.14	8.21	9.64	7.80	9.81	8.90	5.22	8.86	4.46	8.01	5.22
473	5.16	5.06	2.40	2.45	3.66	3.93	2.60	2.32	2.23	3.59	3.28	4.00	1.82	1.50	3.90	1.82
474	3.27	4.95	3.08	2.26	2.99	4.35	2.44	2.01	2.42	3.67	2.14	2.69	3.94	2.04	3.48	2.01
475		4.46	3.20	3.75	4.74	4.39	3.11	5.33	2.99	5.55	3.62	3.18	7.16	2.98	4.41	2.99
476	7.37	6.99	4.68	4.47	5.46	4.83	4.50	4.58	6.56	4.91	4.91	4.74	4.63	4.10	5.79	4.47
477		5.89	6.01	4.96	7.74	7.03	5.01	10.12	6.42	6.50	5.75	5.51	7.36	4.06	6.63	4.11
478		8.25	7.14	7.98	6.34	8.98	7.80	8.24	8.69	8.21	8.94	8.84	8.22	6.38	8.16	6.34
480		7.60	4.86	7.17	6.70	6.53	5.20	4.05	6.29	7.73	4.85	4.77	7.65	4.52	6.59	4.05
481		8.75	6.41	6.42	7.56	7.31	5.90	6.94	7.87	8.88	7.60	5.77	8.58	5.13	7.55	5.75
482	8.27	8.22	7.81	7.38	6.99	8.19	8.64	8.36	9.15	8.53	7.57	8.00	8.08	7.09	8.13	6.99
483		8.10	7.55	7.23	7.01	8.34	8.54	8.27	8.68	8.48	8.24	8.09	7.76	6.05	7.84	6.79
484	8.40	7.54	7.92	7.87	7.18	7.60	7.95	6.84	7.61	8.74	8.17	8.54	7.64	6.13	7.71	6.38
485	8.27	7.24	7.94	7.27	7.21	7.95	7.07	6.39	6.88	9.03	6.97	7.56	7.32	6.06	7.40	6.29
490	8.14	8.74	7.65	7.93	8.29	8.20	8.07	6.35	7.20	9.33	7.48	7.39	8.32	7.95	8.01	6.35
491	7.10	7.73	5.71	6.88	7.08	7.40	6.97	5.30	6.49	8.47	6.83	6.76	7.16	6.59	7.02	5.30
492	7.03	7.38	6.03	7.28	6.90	6.60	6.82	5.52	6.54	8.84	7.02	7.20	7.23	6.60	6.98	5.52
493	7.26	7.67	6.71	10.05	7.45	7.81	7.38	5.89	6.88	8.64	7.34	7.06	7.67	7.60	7.57	5.89
494	8.63	8.84	8.82	11.03	10.20	8.83	8.50	6.97	8.46	10.29	8.95	8.41	9.68	8.75	9.34	6.97
495	8.03	9.42	7.82	8.73	8.91	8.59	8.94	7.14	8.55	10.11	7.95	8.04	8.40	8.15	8.69	7.14
Strat. Mean	8.13	7.55	6.76	7.03	7.31	7.44	6.82	6.89	7.36	8.42	7.21	6.90	7.42	5.70	7.41	6.76

Table 24. Mean number of haddock per standard tow by stratum from the Research Vessel Survey July 6 - 17, 1998 and the ITQ Survey, July 1 - 11, 1998.

	RV Survey			ITQ Survey		
Stratum	Sets	Mean	St. Dev	Sets	Mean	St. Dev.
470	2	8.09	11.44	9	14.28	24.35
471	2	1.01	1.43	2	1.09	0.00
472	4	7.25	6.94	13	38.63	24.94
473	2	199.85	50.70	2	124.72	0.77
474	2	92.83	64.65	4	342.85	362.03
475	2	47.18	15.77	1	72.98	
476	4	25.26	33.70	15	65.22	106.82
477	5	120.74	85.91	11	90.53	50.33
478	2	3.09	4.37			
480	8	322.51	414.16	6	299.97	308.72
481	9	58.67	56.71	19	79.02	85.63
482	3	10.82	8.80	7	15.69	25.62
483	2	4.46	0.49			
484	3	3.01	2.65	10	3.43	3.17
485	3	34.48	20.20	17	64.57	109.97
490	4	139.75	97.30	10	247.83	252.95
491	3	10.16	4.03	6	39.86	36.82
492	3	56.00	88.48	10	19.91	36.39
493	3	1.35	1.54	5	1.55	3.47
494	2	14.86	13.52	4	1.94	2.24
495	2	21.23	7.53	7	39.52	79.59
Inshore				29	185.54	376.15

Table 25. Mean weight of haddock per standard tow by stratum from the Research Vessel Survey July 6 - 17, 1998 and the ITQ Survey, July 1 - 11, 1998.

	RV Survey			ITQ Survey		
Stratum	Sets	Mean	St. Dev	Sets	Mean	St. Dev.
470	2	5.26	7.44	9	9.08	15.49
471	2	0.55	0.77	2	1.09	0.00
472	4	4.19	6.00	13	21.12	15.93
473	2	115.90	48.95	2	83.87	12.32
474	2	60.71	53.24	4	184.63	191.84
475	2	33.91	10.92	1	42.48	
476	4	11.76	15.86	15	16.71	22.63
477	5	37.73	17.69	11	32.84	18.17
478	2	3.28	4.64			
480	8	110.67	112.50	6	106.29	106.87
481	9	23.63	24.91	19	27.65	25.08
482	3	17.52	15.28	7	10.05	15.23
483	2	13.41	5.61			
484	3	5.11	5.82	10	5.33	4.93
485	3	35.81	34.05	17	51.51	74.55
490	4	101.23	59.13	10	180.73	154.38
491	3	14.97	7.24	6	49.34	40.47
492	3	92.92	143.59	10	19.52	30.05
493	3	0.01	1.54	5	2.59	5.78
494	2	9.97	12.90	4	2.91	4.14
495	2	10.28	0.75	7	47.83	90.53
Inshore				29	75.86	151.15

Table 26. ITQ Survey GIS haddock biomass (t) estimates by area using potential mapping.

Biomass (t)

	1995	1996	1997	1998
Shelf	39104	43053	34903	31409
BoF	29801	31911	31392	24253
inshore	21394	14202	13536	18610
total	90299	89166	79831	74273

Proportion (%)

	1995	1996	1997	1998
Shelf	43	48	44	42
BoF	33	36	39	33
inshore	24	16	17	25
total	100	100	100	100

Number of Sets

	1995	1996	1997	1998
Shelf	60	83	81	80
BoF	53	73	73	76
inshore	23	21	22	23
total	136	177	176	179

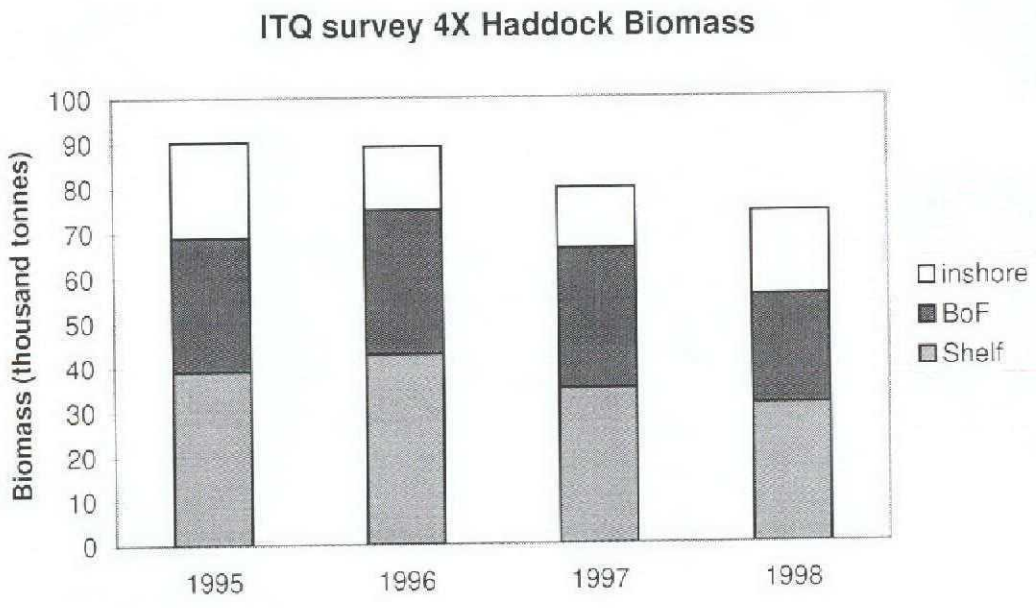


Table 27. 4X haddock total numbers-at-length (000's) from the ITQ Survey by year and area.

	1995			1996			1997			1998		
strata	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore	Shelf 470-481	Fundy 482-495	Inshore
0.5	0	0	0	0	0	0	0	0	0	0	0	0
2.5	0	0	0	0	0	0	0	0	0	0	0	0
4.5	0	0	0	0	0	0	0	0	0	0	0	0
6.5	0	0	0	2	5	0	1	0	0	1	0	0
8.5	1	0	0	34	71	10	2	0	0	0	2	3
10.5	7	0	0	46	94	17	0	0	0	19	1	2
12.5	23	1	10	5	11	0	1	0	0	24	1	10
14.5	597	19	176	40	83	9	1	4	4	187	1	39
16.5	2658	60	684	283	581	13	48	18	23	625	27	89
18.5	4023	164	1014	602	1236	60	369	87	68	860	80	138
20.5	2378	292	1077	428	905	117	818	258	133	423	120	167
22.5	742	160	591	476	1019	166	456	282	132	100	71	168
24.5	251	75	211	1119	2421	412	292	270	63	116	26	66
26.5	207	46	146	1399	3225	529	335	178	78	455	49	270
28.5	572	44	328	993	2469	405	475	67	122	700	118	627
30.5	1098	204	974	526	1440	254	884	176	183	619	277	710
32.5	1160	466	1319	265	756	117	1147	328	271	635	415	648
34.5	634	639	1186	430	1042	109	903	567	289	806	348	581
36.5	328	550	817	831	1932	170	556	663	210	883	264	532
38.5	457	297	437	842	2014	205	541	522	123	707	259	409
40.5	406	161	277	579	1562	193	592	637	142	508	403	350
42.5	295	188	234	388	1199	127	493	533	157	408	440	211
44.5	171	186	177	311	1040	90	376	517	149	331	451	134
46.5	197	182	93	235	804	65	240	477	127	163	343	45
48.5	131	124	57	168	552	41	135	374	94	86	274	27
50.5	114	86	45	121	427	17	89	295	55	76	164	31
52.5	82	56	41	96	326	14	66	209	24	32	108	2
54.5	87	59	45	63	195	15	49	107	26	28	85	2
56.5	60	34	42	53	168	9	22	66	11	15	37	8
58.5	36	28	29	34	112	2	20	27	3	7	30	0
60.5	13	26	16	16	61	6	9	23	1	1	18	0
62.5	11	22	11	8	29	1	4	10	0	2	15	0
64.5	1	16	2	8	27	3	3	9	0	1	11	0
66.5	1	8	1	1	5	0	1	7	0	2	5	1
68.5	0	3	2	0	1	1	0	0	0	0	4	0
70.5	1	3	1	1	9	0	0	6	0	0	3	0
72.5	0	2	0	0	0	0	0	0	0	0	1	0
74.5	0	3	0	0	0	0	0	0	0	0	0	0
76.5	0	1	1	0	0	0	0	0	0	0	0	0
78.5	0	0	0	0	0	0	0	0	0	0	0	0
80.5	0	0	0	0	0	0	0	0	0	0	0	0

Table 28. 4X haddock ITQ Survey total numbers-at-age (000's) (A) unadjusted, (B) adjusted using GIS biomass estimates.

A.

	Scotian Shelf RV Strata (470-481)				Bay of Fundy RV Strata (482-495)				Inshore				RV Strata (470-495)				Total All Sets			
	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998
0	8	88	3	44	0	0	0	3	0	27	0	6	8	88	3	48	8	115	3	53
1	10546	1181	1596	2184	822	22	1080	326	3956	123	532	678	11368	1204	2675	2511	15324	1327	3207	3188
2	3637	4715	1196	1538	2239	1797	411	1526	5088	2098	345	3396	5876	6512	1607	3064	10964	8610	1952	6460
3	1510	2499	3222	1114	798	2106	2851	320	756	869	1057	348	2308	4604	6073	1434	3064	5474	7129	1782
4	478	1125	1860	2663	193	648	1872	1266	145	109	472	689	671	1774	3733	3929	816	1883	4205	4618
5	231	557	595	788	59	123	382	803	50	16	74	172	290	679	977	1590	340	695	1052	1763
6	101	137	252	188	23	32	68	69	14	4	8	3	124	169	320	257	138	173	328	260
7	176	112	75	106	48	19	47	68	23	4	3	5	223	130	122	174	247	134	125	178
8	43	141	29	40	14	22	0	52	10	3	0	4	57	163	29	92	67	166	29	96
9	5	23	55	29	5	7	3	11	1	0	0	0	9	31	58	39	10	31	58	39
10	1	31	37	31	3	5	0	1	0	0	0	0	4	35	37	32	4	35	37	32
11	0	3	4	8	0	3	0	6	0	0	0	0	0	7	4	14	0	7	4	14
12	3	7	5	3	0	0	0	0	0	0	0	0	3	7	5	3	3	7	5	3
13	0	6	1	0	0	0	0	0	1	0	0	0	0	6	1	0	1	6	1	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0
16	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	4	0

B.

	Scotian Shelf RV Strata (470-481)				Bay of Fundy RV Strata (482-495)				Inshore				RV Strata (470-495)				Total All Sets			
	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998
0	86	901	28	396	0	0	0	22	0	282	0	47	86	901	28	418	86	1183	28	465
1	118945	12113	13577	19499	9972	190	6692	2163	25830	1276	5066	5800	128918	12303	20269	21663	154748	13579	25335	27463
2	41023	48339	10177	13728	27150	15395	2548	10120	33221	21685	3282	29063	68173	63734	12725	23848	101394	85419	16007	52910
3	17027	25620	27407	9941	9679	18036	17674	2123	4939	8982	10062	2978	26706	43656	45081	12064	31644	52638	55143	15043
4	5396	11538	15828	23775	2336	5555	11607	8393	945	1124	4494	5898	7732	17093	27435	32168	8677	18217	31929	38066
5	2607	5706	5064	7032	715	1051	2368	5321	325	165	709	1474	3321	6757	7432	12353	3647	6922	8141	13828
6	1135	1401	2145	1677	279	276	419	457	92	42	80	29	1414	1677	2564	2134	1506	1720	2645	2164
7	1981	1145	640	943	578	159	290	451	153	41	33	40	2559	1305	930	1394	2712	1346	963	1434
8	483	1450	248	358	171	184	0	346	63	34	0	33	653	1634	248	704	716	1668	248	737
9	51	241	464	256	57	62	19	70	5	3	0	1	108	303	483	326	113	306	483	328
10	12	314	313	275	41	39	0	9	0	0	0	0	53	353	313	283	53	353	313	283
11	0	34	32	72	0	29	0	38	0	2	0	0	0	63	32	110	0	64	32	110
12	39	67	40	25	0	0	0	0	0	0	0	0	39	67	40	25	39	67	40	25
13	0	62	10	0	0	0	0	0	7	0	0	0	0	62	10	0	7	62	10	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	11	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	11	0	0
16	0	0	0	0	0	0	21	0	0	0	3	0	0	0	21	0	0	0	24	0

Table 29. SPA Input Data

A. Catch Numbers-at-Age (000's)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0	0	42	152	1	37	18	2	0	0	16	1	0	0	2
2	1088	809	22	3114	713	2198	1306	1289	77	83	164	1210	526	70	763
3	747	1660	3490	114	4783	4617	1657	3137	3453	1184	2497	2268	3895	3621	1195
4	1549	809	1871	2274	318	5220	4295	2026	7221	6862	3071	6369	2648	6020	5046
5	391	1460	517	1080	1829	490	3712	3204	2156	3970	5527	4300	4954	4104	3708
6	541	415	656	533	523	1115	437	2891	2916	1094	3573	3272	1823	2454	2583
7	4679	71	91	607	194	250	813	361	1071	1272	538	1191	1560	1033	1022
8	1922	3404	58	326	277	174	155	390	141	269	636	366	364	434	367
9	137	1047	1185	262	191	63	72	107	110	58	173	331	196	206	119
10	99	167	520	621	277	32	96	72	27	70	35	99	101	131	83
1-10	11153	9841	8452	9085	9106	14196	12562	13480	17172	14863	16230	19407	16067	18074	14887

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0	0	0	13	13	0	3	8	22	10	3	0	0	0
2	228	297	91	214	190	403	52	141	139	98	99	37	13	6
3	2105	1157	1045	512	497	1422	1304	243	709	369	757	809	526	55
4	2455	4879	3032	1016	499	394	2351	2523	520	632	694	993	1676	392
5	4658	4023	4590	896	936	358	580	2290	1828	327	617	682	1008	859
6	1508	1514	2098	1968	310	472	246	229	1070	971	238	428	455	599
7	509	226	292	871	720	391	310	247	170	269	449	355	269	319
8	136	98	59	894	460	654	200	331	106	24	421	439	138	195
9	51	36	7	372	504	277	310	237	73	17	162	355	110	87
10	16	31	9	209	255	204	280	240	46	13	24	130	94	108
•1-10	11667	12262	11223	6965	4384	4575	5637	6490	4684	2731	3462	4229	4289	2620

B. Research Vessel Survey Stratified Mean Numbers-at-Age per Tow

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	5.85	0.12	5.28	6.50	11.58	6.77	5.59	6.42	6.22	2.07	22.28	37.02	13.13	6.86	4.20
2	4.68	11.32	0.23	22.97	23.10	3.46	5.72	40.46	5.32	13.93	7.09	27.88	28.17	4.54	22.13
3	1.38	4.91	3.34	0.73	32.10	5.25	3.93	63.39	11.89	8.12	15.56	7.50	13.03	14.41	13.63
4	2.60	2.11	1.47	3.15	0.97	7.67	4.13	17.86	3.95	10.18	8.03	9.02	4.66	6.19	18.08
5	1.05	2.89	0.88	1.50	4.14	0.41	7.10	17.17	1.71	4.97	12.25	3.41	7.45	3.50	5.83
6	2.40	1.37	0.98	0.54	0.94	1.75	0.65	9.54	3.27	1.87	4.78	3.72	2.54	2.30	3.11
7	5.98	2.06	0.64	0.71	0.55	0.46	0.79	1.28	1.28	3.06	1.74	1.29	2.14	0.95	1.38
8	0.91	5.32	0.99	0.49	0.64	0.35	0.15	1.54	0.00	1.04	1.29	0.18	0.31	0.29	0.58
9	0.35	0.69	1.30	0.30	0.36	0.14	0.05	0.16	0.00	0.22	0.63	0.35	0.19	0.27	0.41
10	0.35	0.09	0.04	0.51	0.26	0.11	0.02	0.16	0.00	0.09	0.26	0.20	0.06	0.15	0.09
1-10	25.55	30.88	15.15	37.40	74.64	26.37	28.13	157.98	33.64	45.55	73.91	90.57	71.68	39.46	69.44

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	7.04	3.87	1.35	7.20	6.05	0.08	4.33	3.11	4.68	21.45	46.93	5.09	10.14	10.09
2	9.41	9.59	1.55	2.10	9.88	10.74	1.45	2.52	1.07	5.90	24.82	26.63	5.94	7.76
3	23.30	7.40	2.74	1.03	1.98	9.66	12.83	0.99	1.77	2.05	11.60	21.40	20.82	4.76
4	10.66	14.05	3.46	2.14	0.93	1.78	11.48	7.60	0.67	1.92	4.23	11.37	11.78	13.37
5	14.87	5.79	3.87	2.93	1.86	1.44	2.40	5.41	1.93	0.37	1.87	5.05	3.62	5.98
6	3.80	6.25	2.86	3.09	0.79	1.60	1.35	0.91	1.17	1.85	0.80	1.67	1.56	1.39
7	1.93	2.25	1.96	1.49	1.65	1.45	1.19	0.39	0.19	1.14	1.53	1.16	0.57	1.01
8	1.14	1.17	0.83	1.09	0.59	1.22	1.01	0.39	0.14	0.15	0.42	1.63	0.19	0.59
9	0.66	0.68	0.24	0.71	0.49	0.51	0.76	0.30	0.06	0.05	0.10	0.40	0.32	0.23
10	0.24	0.36	0.31	0.40	0.14	0.41	0.91	0.21	0.05	0.09	0.00	0.34	0.20	0.18
1-10	73.05	51.41	19.17	22.18	24.36	28.89	37.71	21.83	11.73	34.97	92.30	74.74	55.14	45.36

Table 29. SPA Input Data (cont.)

C. ITQ Survey Total Numbers-at-Age

Age	1995	1996	1997	1998
1	154747905	13579064	25335208	27462656
2	101394484	85418948	16006652	52910448
3	31644320	52638048	55142687	15042582
4	8676922	18217200	31928727	38066293
5	3646530	6922473	8140970	13827674
6	1506238	1719703	2644796	2163713
7	2711567	1346150	963118	1433699
8	716447	1667737	247598	736988
9	112825	306193	483147	327661
10	52735	353048	313187	283472
1-10	305209977	182168569	141206095	152255189

Table 30. SPA Results

A. Biomass (t)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	1151	275	2578	1746	1360	2289	2879	1213	2170	931	1447	1677	1964	1198	464
2	3293	2935	642	5756	6304	3639	7580	8742	5174	4991	4828	6230	5034	3362	4633
3	3435	4721	6611	1263	12786	13932	7021	17008	21721	11314	13828	12410	13705	10023	7617
4	6745	3577	5630	9601	2249	17772	18293	9167	25375	27137	15406	18791	16031	15550	13578
5	3181	5857	3438	4603	9725	3104	15535	17255	9921	20324	22065	15502	15147	15336	11589
6	4839	2470	4447	3217	3060	7206	2820	10284	13752	7376	13290	13841	9009	7875	8746
7	28018	3572	1801	3441	2106	1965	4743	2010	5008	7751	4547	5787	6755	4530	2846
8	13945	16029	3547	1660	1912	1489	1063	2407	1108	2374	3912	2796	2750	1999	1542
9	1849	8252	8122	3515	822	1080	841	578	0	618	1366	1830	1680	1273	547
10	991	1842	5467	4594	2426	269	756	503	0	0	304	723	782	835	471
1-10	67446	49529	42283	39394	42750	52746	61532	69167	84228	82815	80994	79587	72857	61981	52033
SSB	58649	42435	33743	29036	27737	35185	42234	47195	58506	62415	61391	59149	53424	46805	38643

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	591	229	259	1143	1197	285	539	413	557	2003	4410	434	685	0
2	2249	1293	727	1557	3548	3570	1554	1521	1234	2552	6980	4541	1143	3625
3	10792	4486	2795	1871	3291	8296	8952	3039	3607	3198	5726	12252	9598	2527
4	10238	13181	5665	3731	2039	4212	11921	10912	3227	5271	4392	7301	14469	13273
5	11132	10683	11980	3975	3568	2103	4486	10840	8768	3268	5258	3963	6237	13761
6	6441	6650	7301	8054	2956	2692	2066	3639	6820	6130	2812	4168	2656	4443
7	3619	3751	4860	5108	5068	2516	2040	1429	2972	4210	4247	2380	2973	1739
8	491	2003	3095	4295	3639	4140	1681	1090	646	2308	3308	3085	1612	2243
9	415	152	1526	2829	2356	2888	2590	933	252	282	2261	2264	1827	1069
10	137	233	54	1285	1829	1203	1981	1649	343	105	0	1486	959	1190
1-10	46103	42662	38262	33847	29491	31904	37809	35465	28426	29329	39392	41875	42158	43870
SSB	33964	34181	32716	28499	22426	22881	27812	28109	22806	21463	24272	28853	31159	27792

B. Fishing Mortality

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.10	0.04	0.00	0.09	0.02	0.13	0.04	0.03	0.00	0.00	0.01	0.04	0.02	0.00	0.02
3	0.15	0.23	0.27	0.03	0.20	0.19	0.14	0.11	0.12	0.07	0.11	0.12	0.17	0.14	0.06
4	0.25	0.25	0.44	0.28	0.11	0.35	0.28	0.24	0.41	0.36	0.24	0.42	0.20	0.43	0.31
5	0.19	0.40	0.25	0.50	0.38	0.26	0.45	0.34	0.44	0.42	0.55	0.64	0.70	0.54	0.51
6	0.20	0.31	0.32	0.44	0.48	0.42	0.39	0.79	0.61	0.43	0.85	0.76	0.62	0.94	0.80
7	0.43	0.04	0.10	0.55	0.28	0.44	0.62	0.65	0.78	0.59	0.38	0.79	1.09	0.90	1.59
8	0.43	0.66	0.04	0.66	0.52	0.44	0.55	0.70	0.57	0.45	0.67	0.49	0.59	1.12	1.01
9	0.19	0.44	0.51	0.24	1.09	0.21	0.32	0.97	0.43	0.50	0.59	0.92	0.54	0.82	1.15
10	0.39	0.37	0.40	0.54	0.43	0.52	0.55	0.63	0.68	0.54	0.62	0.80	0.81	0.85	0.95
5-7	0.28	0.25	0.22	0.49	0.38	0.37	0.49	0.59	0.61	0.48	0.60	0.73	0.80	0.79	0.97

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.04	0.02	0.03	0.01	0.02	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00
3	0.09	0.13	0.17	0.16	0.10	0.10	0.10	0.05	0.11	0.07	0.09	0.04	0.02	0.01
4	0.16	0.29	0.57	0.25	0.23	0.10	0.25	0.28	0.16	0.14	0.18	0.16	0.09	0.02
5	0.51	0.42	0.49	0.33	0.39	0.26	0.22	0.42	0.34	0.14	0.19	0.28	0.24	0.06
6	0.40	0.31	0.40	0.40	0.18	0.34	0.29	0.13	0.35	0.30	0.14	0.19	0.30	0.20
7	0.35	0.10	0.09	0.29	0.25	0.36	0.40	0.53	0.13	0.14	0.22	0.33	0.18	0.34
8	1.01	0.10	0.03	0.43	0.24	0.38	0.32	1.02	0.45	0.02	0.33	0.35	0.20	0.18
9	0.35	0.82	0.01	0.29	0.47	0.22	0.31	0.77	0.65	0.12	0.23	0.51	0.14	0.18
10	0.44	0.37	0.50	0.42	0.33	0.35	0.37	0.41	0.32	0.23	0.24	0.29	0.24	0.18
5-7	0.42	0.27	0.33	0.34	0.27	0.32	0.30	0.36	0.27	0.19	0.18	0.27	0.24	0.20

Table 30. SPA Results (cont.)

C. Population Numbers (000's)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	25717	6152	47728	44560	24555	50032	53315	30679	41323	33520	42939	45320	36028	43532	16196
2	12083	21055	5037	39039	36345	20103	40929	43634	25116	33832	27444	35141	37104	29497	35641
3	5794	8908	16507	4104	29144	29111	14470	32328	34558	20493	27624	22320	27676	29903	24087
4	7674	4068	5791	10357	3256	19533	19656	10347	23630	25169	15707	20358	16222	19134	21205
5	2507	4881	2598	3049	6422	2379	11269	12207	6639	12812	14397	10080	10905	10885	10218
6	3259	1699	2675	1659	1519	3603	1504	5868	7095	3485	6898	6786	4362	4446	5198
7	14670	2179	1016	1597	876	770	1941	835	2189	3171	1863	2415	2596	1922	1419
8	6121	7777	1720	749	758	541	405	853	357	823	1445	1038	899	714	639
9	879	3272	3287	1356	318	371	286	191	345	165	431	607	519	407	192
10	339	595	1732	1619	873	88	247	169	59	183	82	196	198	248	147
1-10	79042	60587	88092	108088	104066	126530	144022	137111	141310	133653	138829	144262	136509	140687	114942

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	11346	5815	9088	23930	23534	7675	11419	9092	15194	38800	49446	12664	25883	12062
2	13258	9289	4761	7440	19581	19256	6283	9346	7437	12420	31758	40481	10368	21191
3	28490	10649	7336	3816	5898	15860	15402	5098	7524	5962	10079	25912	33109	8477
4	18639	21420	7672	5061	2661	4380	11698	11430	3954	5518	4548	7567	20483	26631
5	12796	13039	13123	3538	3225	1727	3230	7450	7075	2767	3946	3096	5297	15254
6	5011	6262	7035	6591	2086	1793	1089	2119	4028	4138	1969	2673	1917	3425
7	1919	2738	3756	3861	3615	1427	1041	669	1528	2330	2509	1397	1801	1158
8	237	1111	2037	2811	2374	2308	814	571	324	1097	1664	1648	822	1231
9	191	71	820	1615	1492	1527	1298	486	168	169	876	981	953	549
10	50	110	26	666	985	766	1000	782	183	72	123	570	482	680
1-10	91937	70504	55655	59329	65451	56718	53274	47044	47415	73273	106919	96990	101115	90657

Table 30. SPA Results (cont.)

Residuals

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	0.08	0.38	-2.11	0.49	0.53	-0.71	-0.98	0.91	-0.58	0.09	-0.38	0.76	0.70	-0.90	0.51
3	-0.58	0.30	-0.68	-0.95	0.97	-0.84	-0.46	1.50	-0.24	-0.13	0.25	-0.26	0.11	0.11	0.22
4	-0.28	0.15	-0.45	-0.37	-0.49	-0.07	-0.74	1.35	-0.89	-0.04	0.13	0.09	-0.47	-0.22	0.68
5	-0.31	0.16	-0.48	0.04	0.24	-1.15	0.26	1.00	-0.64	-0.25	0.62	-0.26	0.48	-0.37	0.19
6	0.14	0.29	-0.50	-0.54	0.12	-0.16	-0.29	1.27	-0.10	-0.05	0.45	0.17	0.14	0.21	0.27
7	-0.44	0.17	-0.19	-0.29	-0.09	-0.05	-0.33	1.01	0.13	0.51	0.36	0.04	0.65	0.03	1.11
2	0.00	0.00	0.00	0.00	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	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	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg 2-7	-0.12	0.12	-0.37	-0.13	0.11	-0.25	-0.21	0.59	-0.19	0.01	0.12	0.05	0.13	-0.09	0.25

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	0.64	1.02	-0.14	-0.28	0.29	0.39	-0.50	-0.35	-0.96	0.19	0.76	0.09	0.12	-0.07
3	0.61	0.47	-0.12	-0.46	-0.28	0.32	0.63	-0.86	-0.64	-0.27	0.91	0.63	-0.16	-0.11
4	0.19	0.41	0.20	-0.06	-0.26	-0.19	0.78	0.41	-1.04	-0.34	0.69	1.11	0.20	-0.49
5	0.90	-0.12	-0.48	0.46	0.13	0.42	0.28	0.37	-0.66	-1.49	-0.21	1.09	0.16	-0.37
6	0.28	0.50	-0.35	-0.20	-0.55	0.41	0.70	-0.46	-0.72	-0.32	-0.52	-0.06	0.28	-0.42
7	0.41	0.07	-0.39	-0.58	-0.43	0.43	0.57	-0.03	-1.82	-0.44	-0.18	0.19	-0.87	0.44
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	-0.34	-0.49	0.26
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.20	-0.51	-0.28
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.40	0.01	-0.63
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.37	0.58	0.14	-0.36
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.11	-0.26	0.58	-0.20
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.04	-0.64	0.50
Avg 2-7	0.25	0.20	-0.11	-0.09	-0.09	0.15	0.20	-0.08	-0.49	-0.22	0.21	0.31	-0.10	-0.14

Mean Square of the Residuals = 0.334406

Param	Est.	CV	Bias
1	9.88241	0.450884	
2	8.92738	0.323847	
3	10.0887	0.269663	
4	9.47611	0.254898	
5	7.84752	0.286814	
6	6.58458	0.314047	
7	0.00043819	0.112789	-0.551904
8	0.000540351	0.111238	-0.54762
9	0.000592331	0.110712	-0.564771
10	0.000716379	0.110912	-0.605156
11	0.000820027	0.111634	-0.670709
12	0.000919824	0.112285	-0.745926
13	2.52117	0.348918	-5.80232
14	2.38625	0.326401	-4.91265
15	2.1433	0.314863	-4.44147
16	1.65341	0.315936	-4.81646
17	1.0639	0.324741	-5.56045
18	1.27349	0.335778	-6.47749

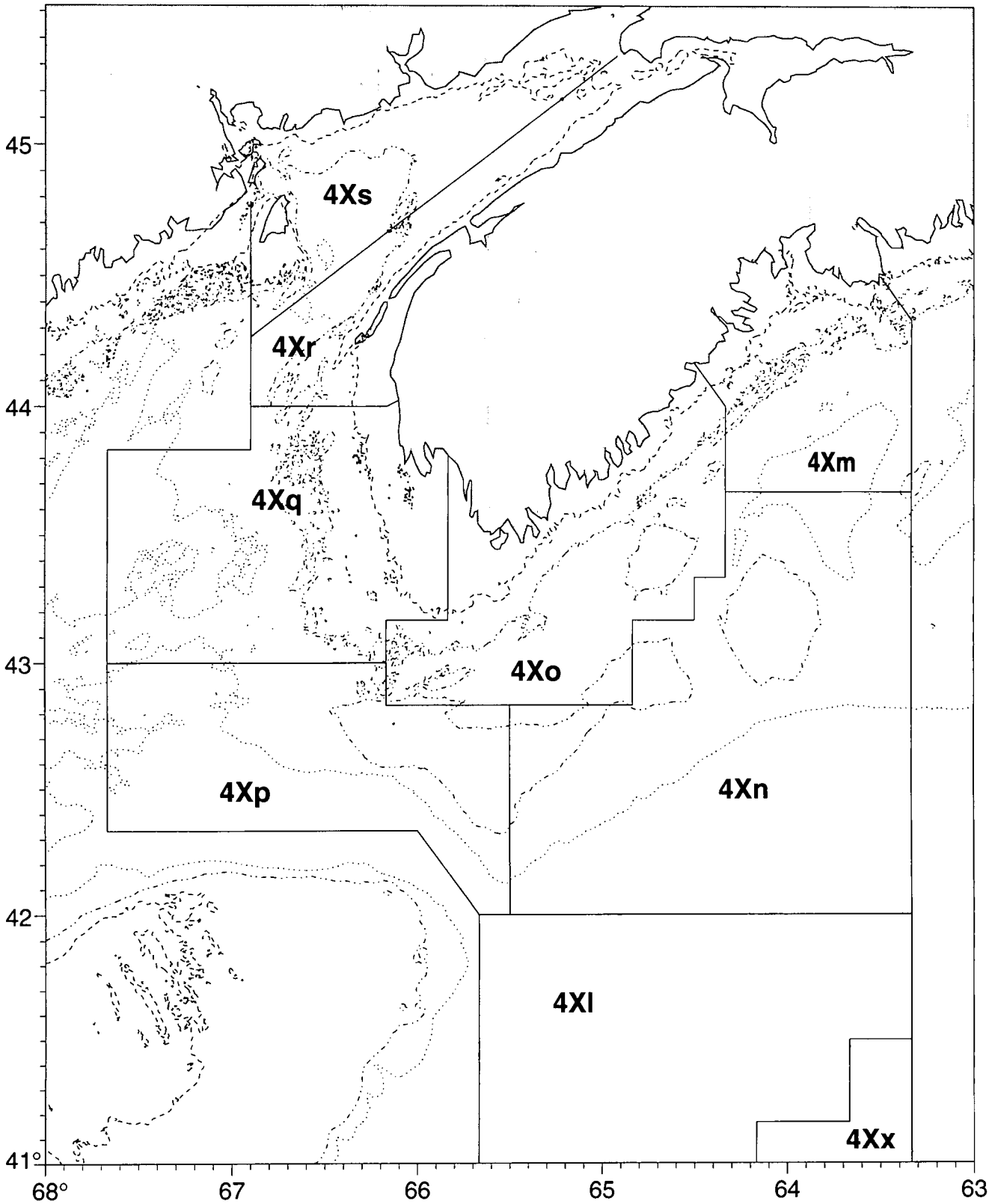


Figure 1. Unit areas in NAFO Division 4X.

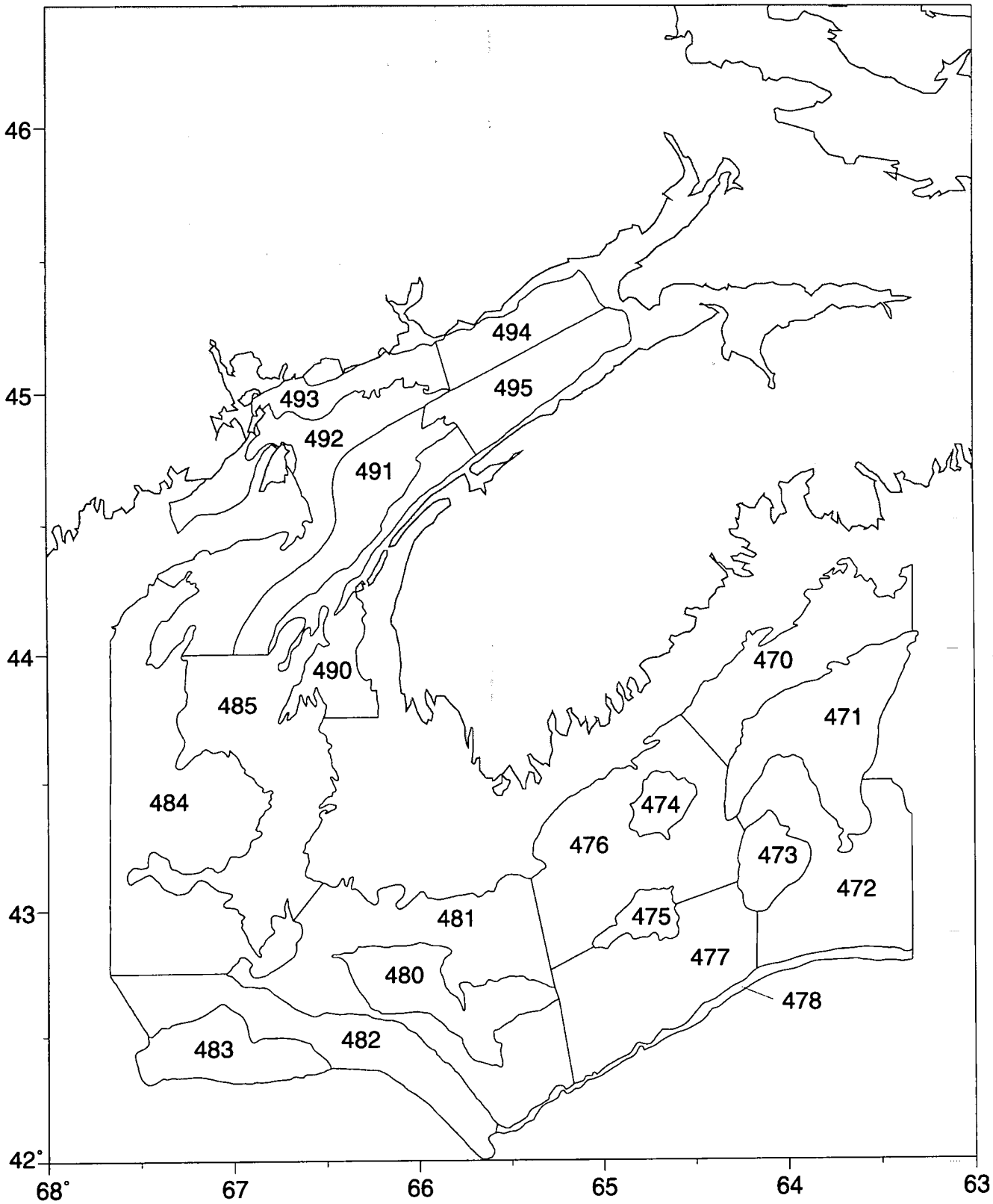


Figure 2. Research vessel survey strata in NAFO Division 4x.

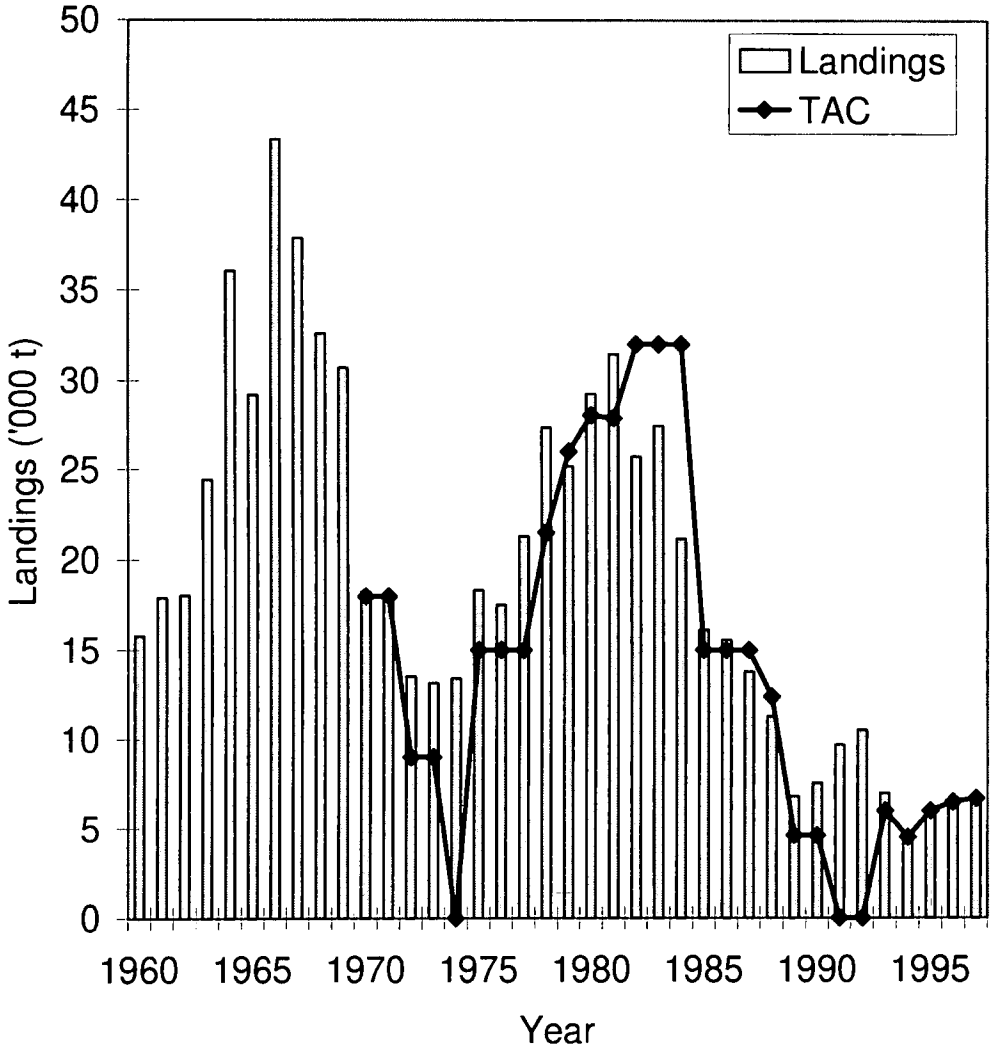


Figure 3. Long-term trends in 4X haddock landings, and TACs. Canadian landings in 5Y are included.

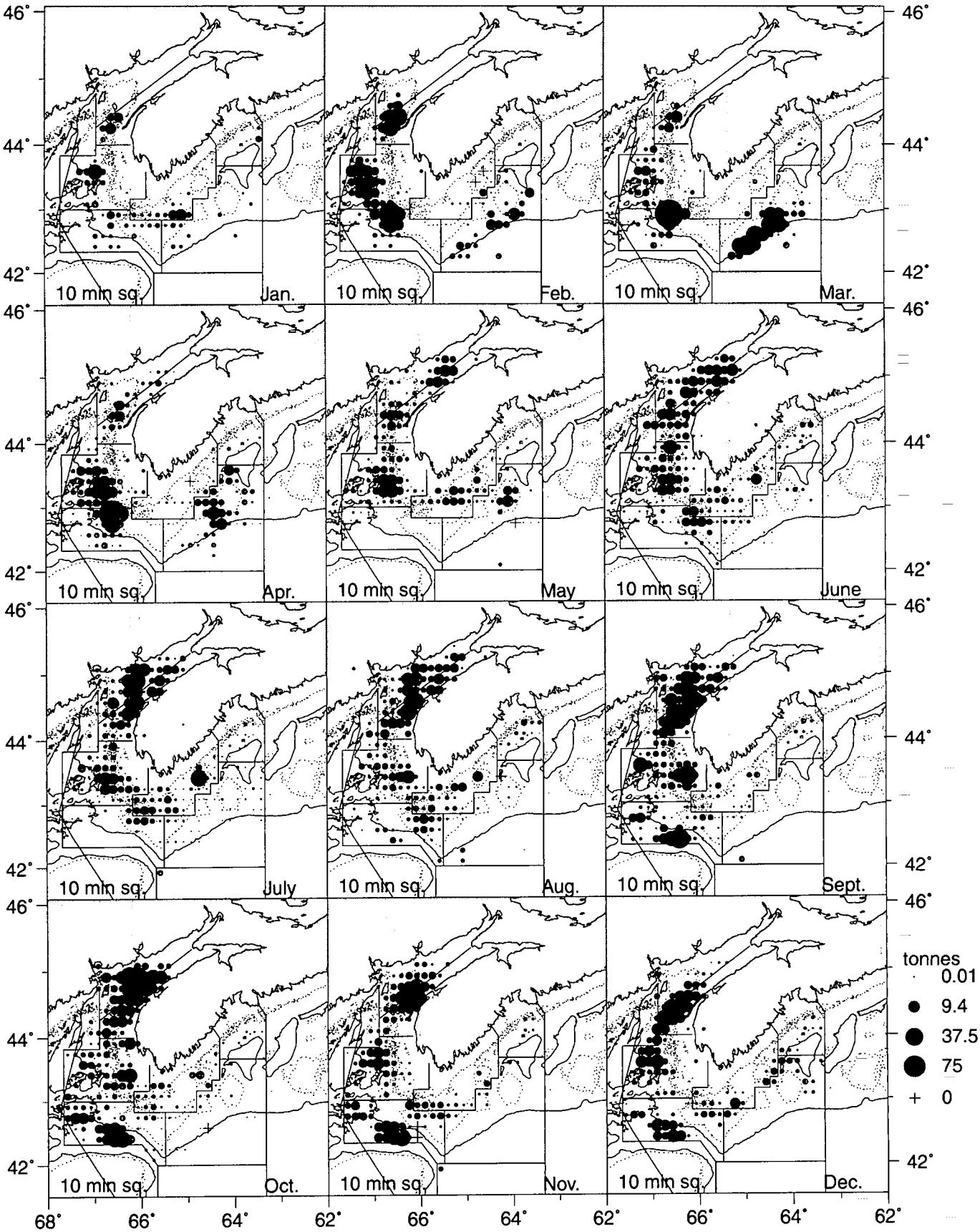


Figure 4a. Haddock catches (t) by stern trawls in NAFO Divisions 4X+5Y by month in 1997, aggregated by 10x10 minute squares.

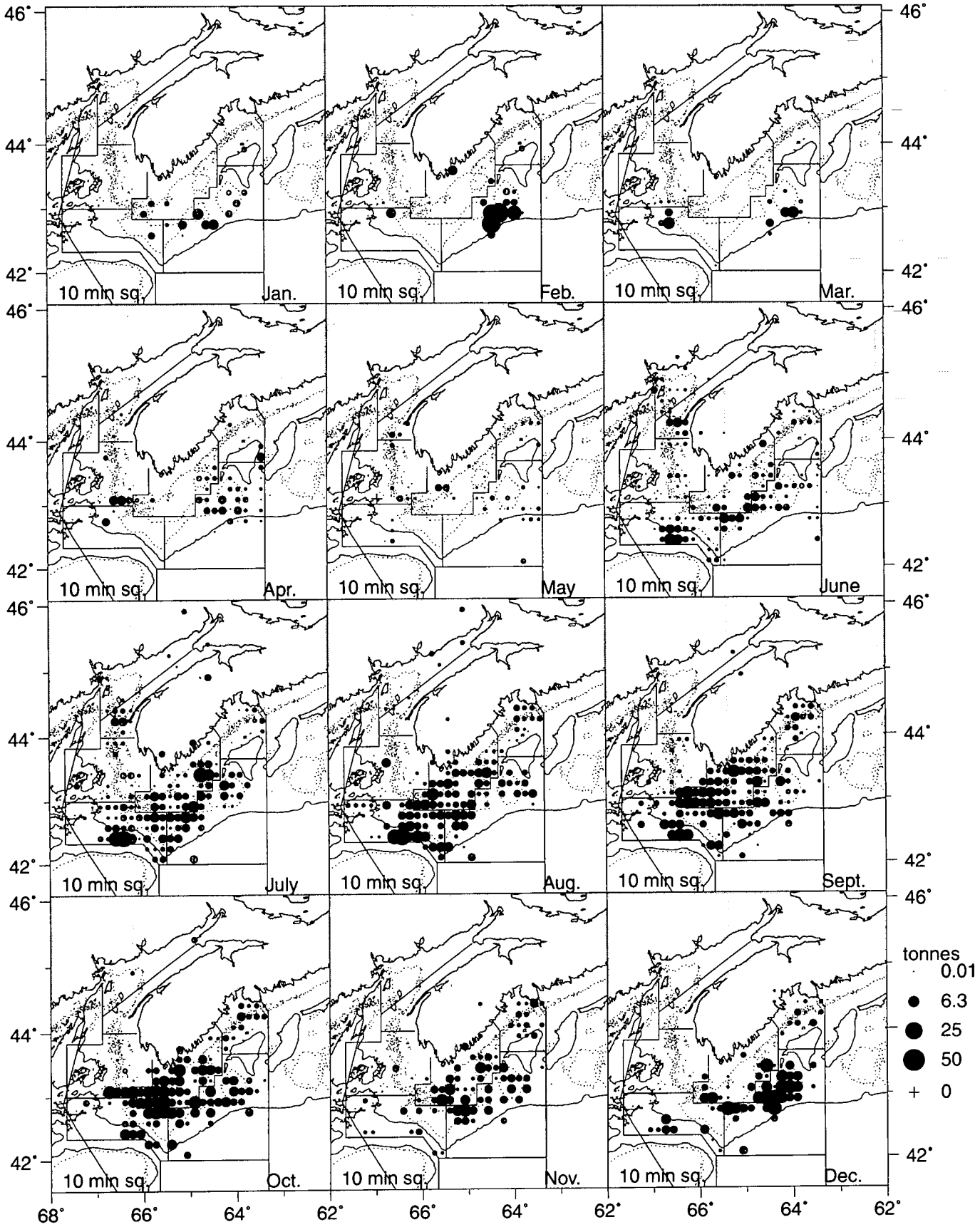


Figure 4b. Haddock catches (t) by longlines in NAFO Divisions 4X+5Y by month in 1997, aggregated by 10x10 minute squares.

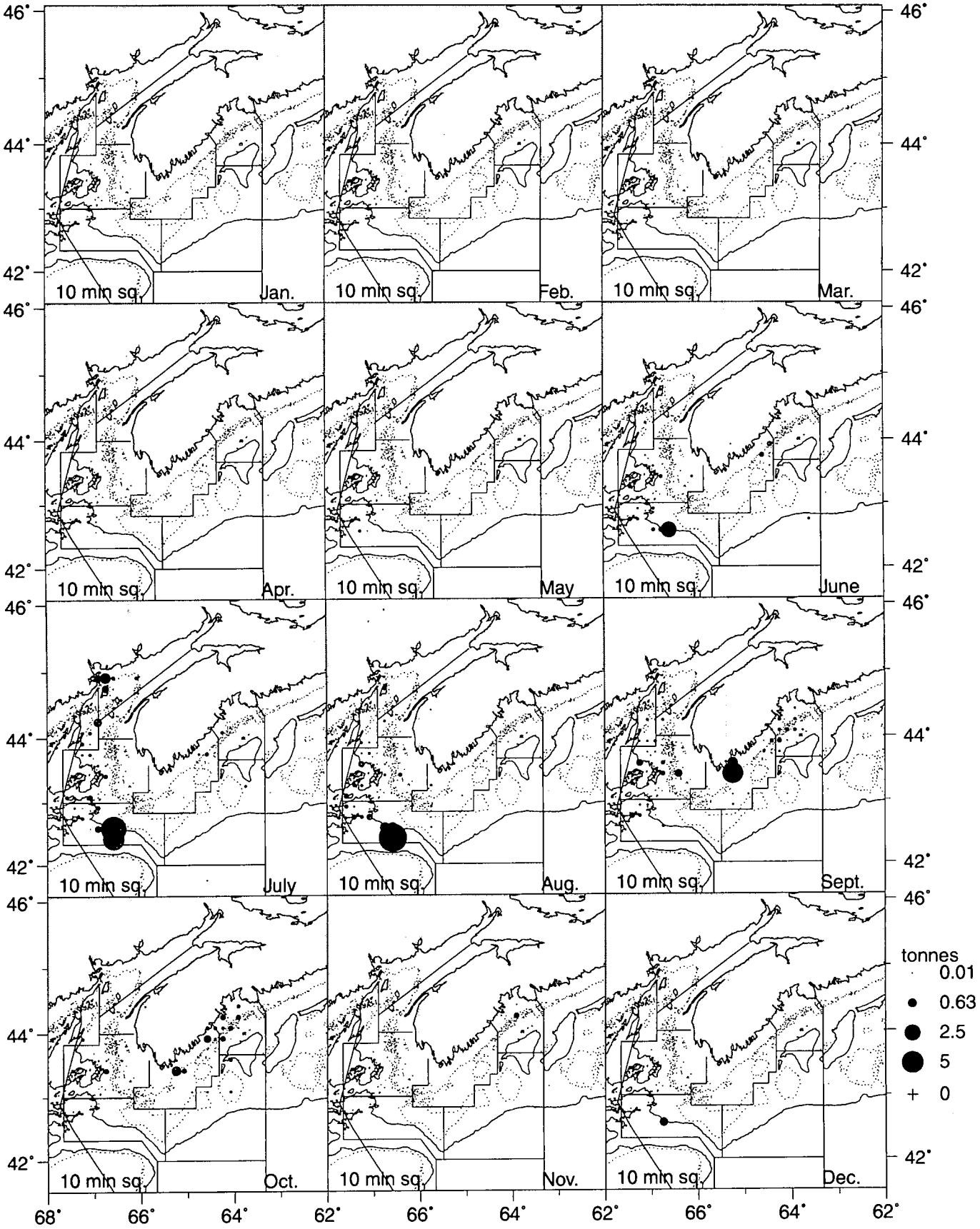


Figure 4c. Haddock catches (t) by gillnets in NAFO Divisions 4X+5Y by month in 1997, aggregated by 10x10 minute squares.

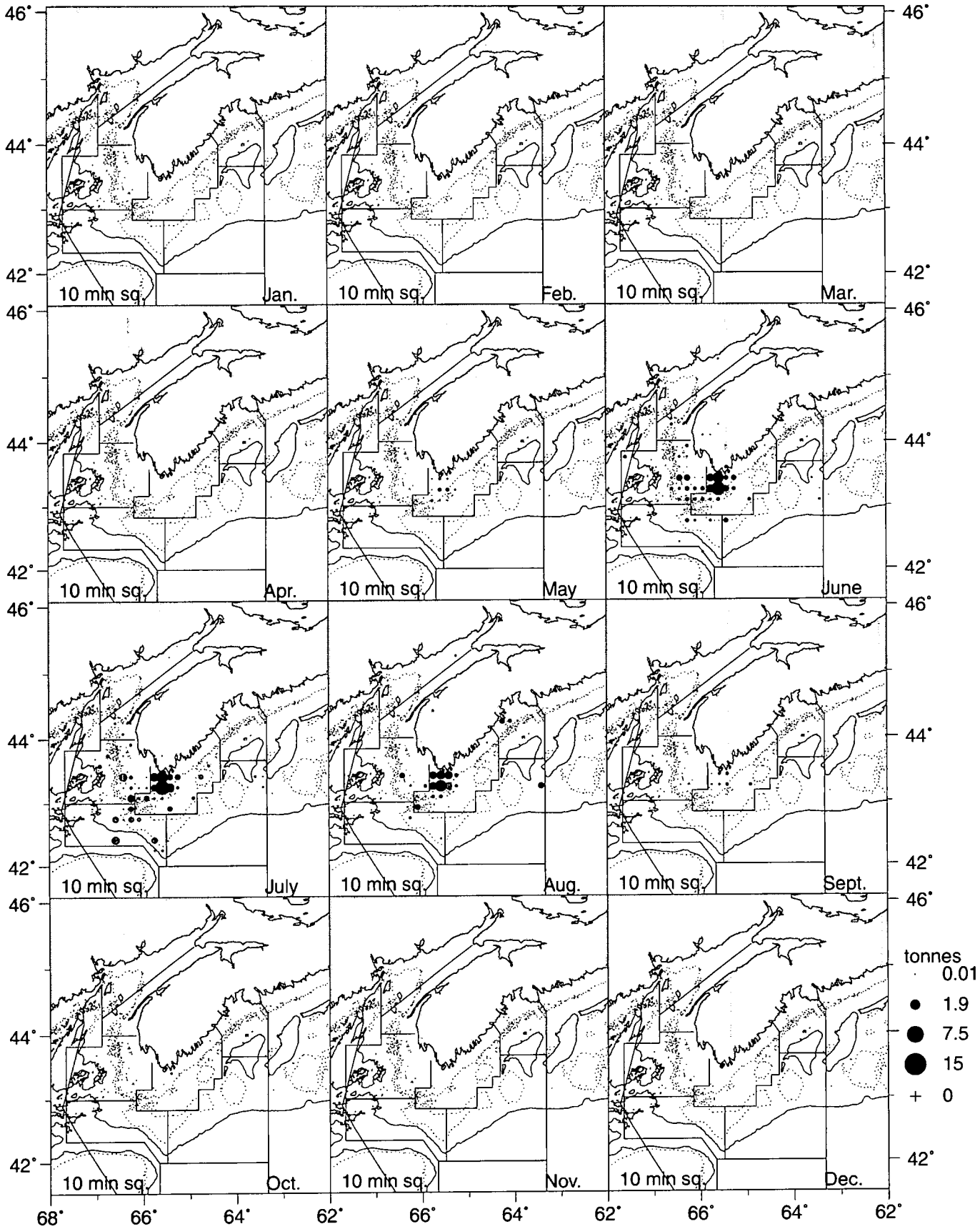


Figure 4d. Haddock catches (t) by handlines in NAFO Divisions 4X+5Y by month in 1997, aggregated by 10x10 minute squares.

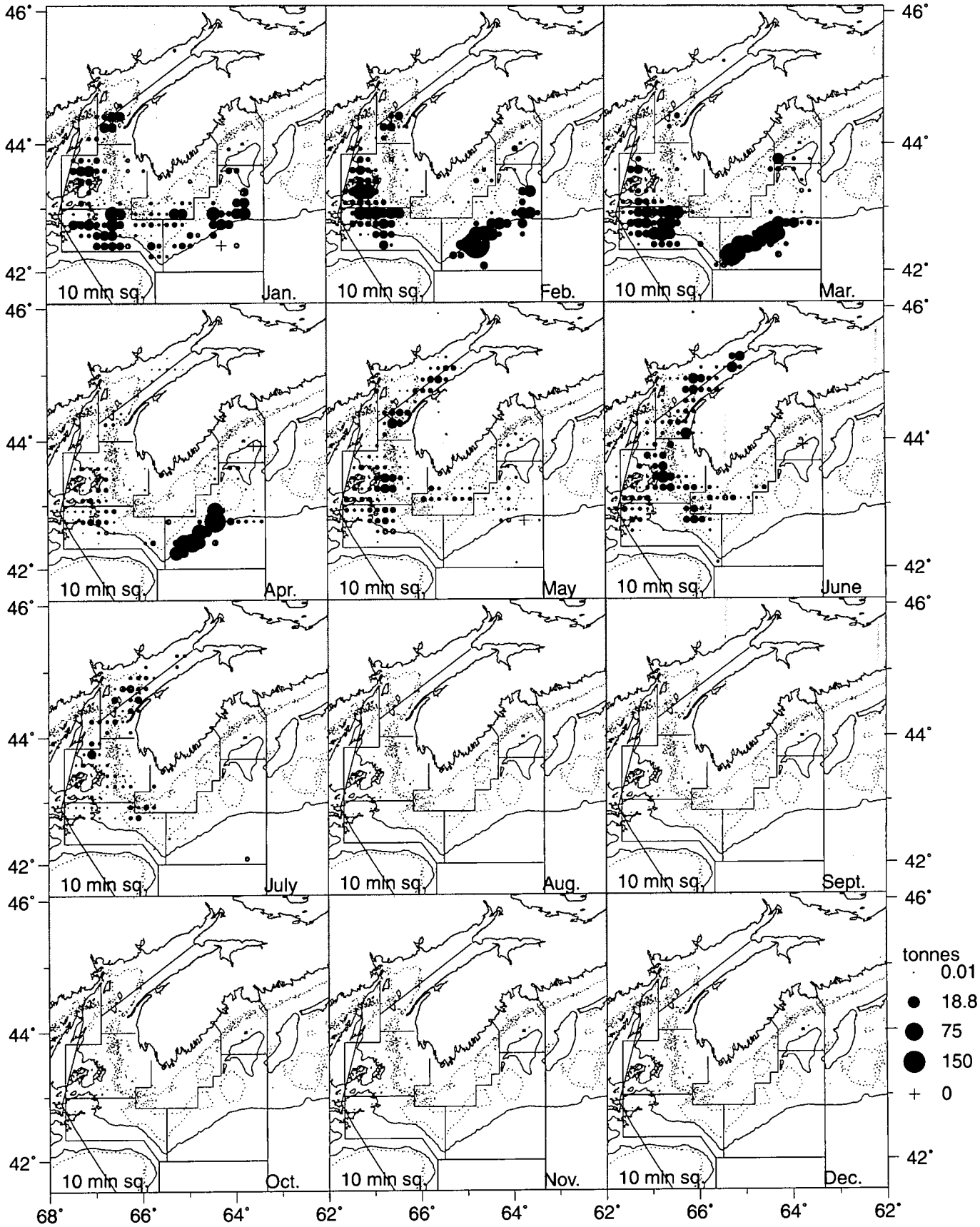


Figure 5a. Haddock catches (t) by stern trawls in NAFO Divisions 4X+5Y by month in 1998 (to early July only), aggregated by 10x10 minute squares.

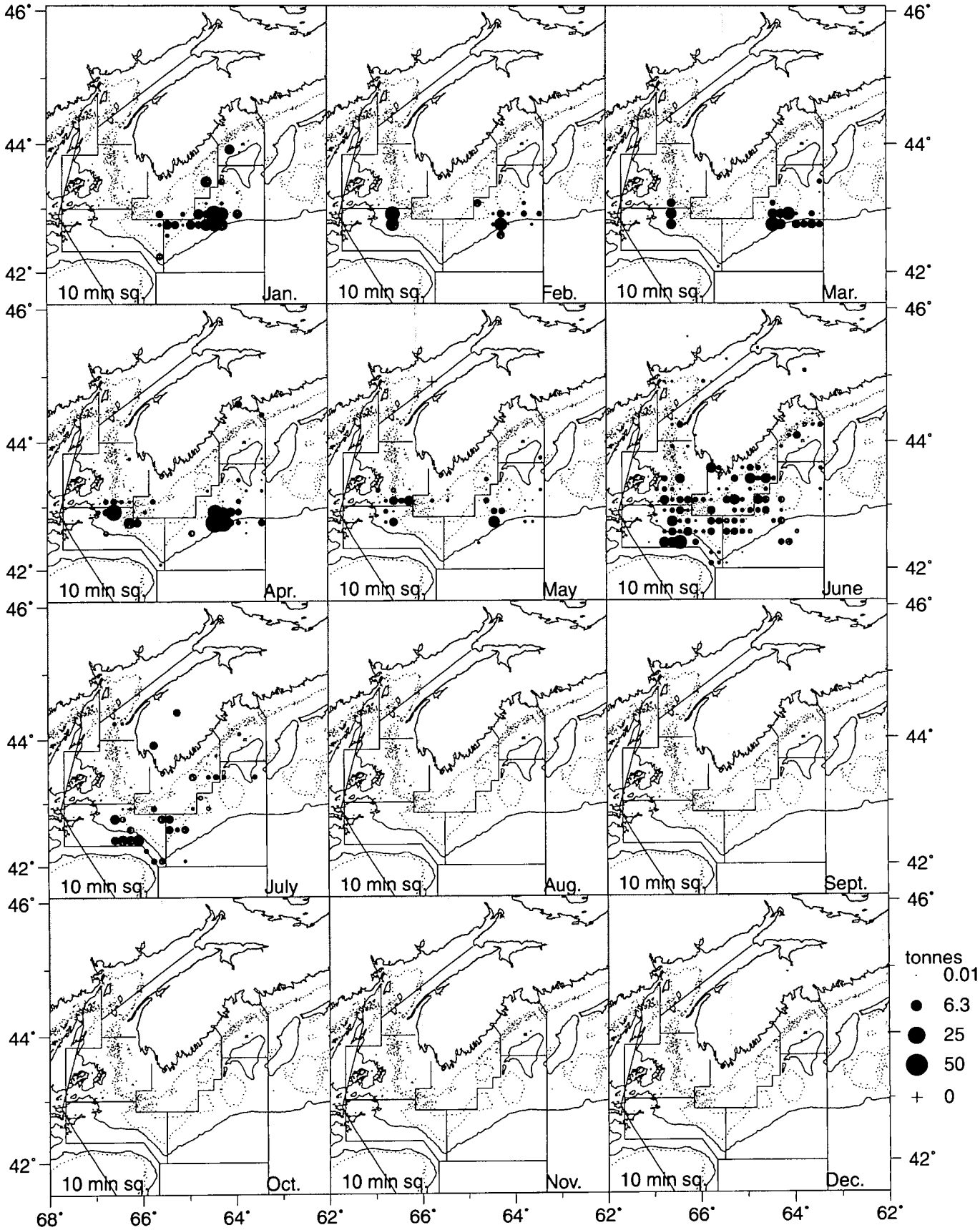


Figure 5b. Haddock catches (t) by longlines in NAFO Divisions 4X+5Y by month in 1998 (to early July only), aggregated by 10x10 minute squares.

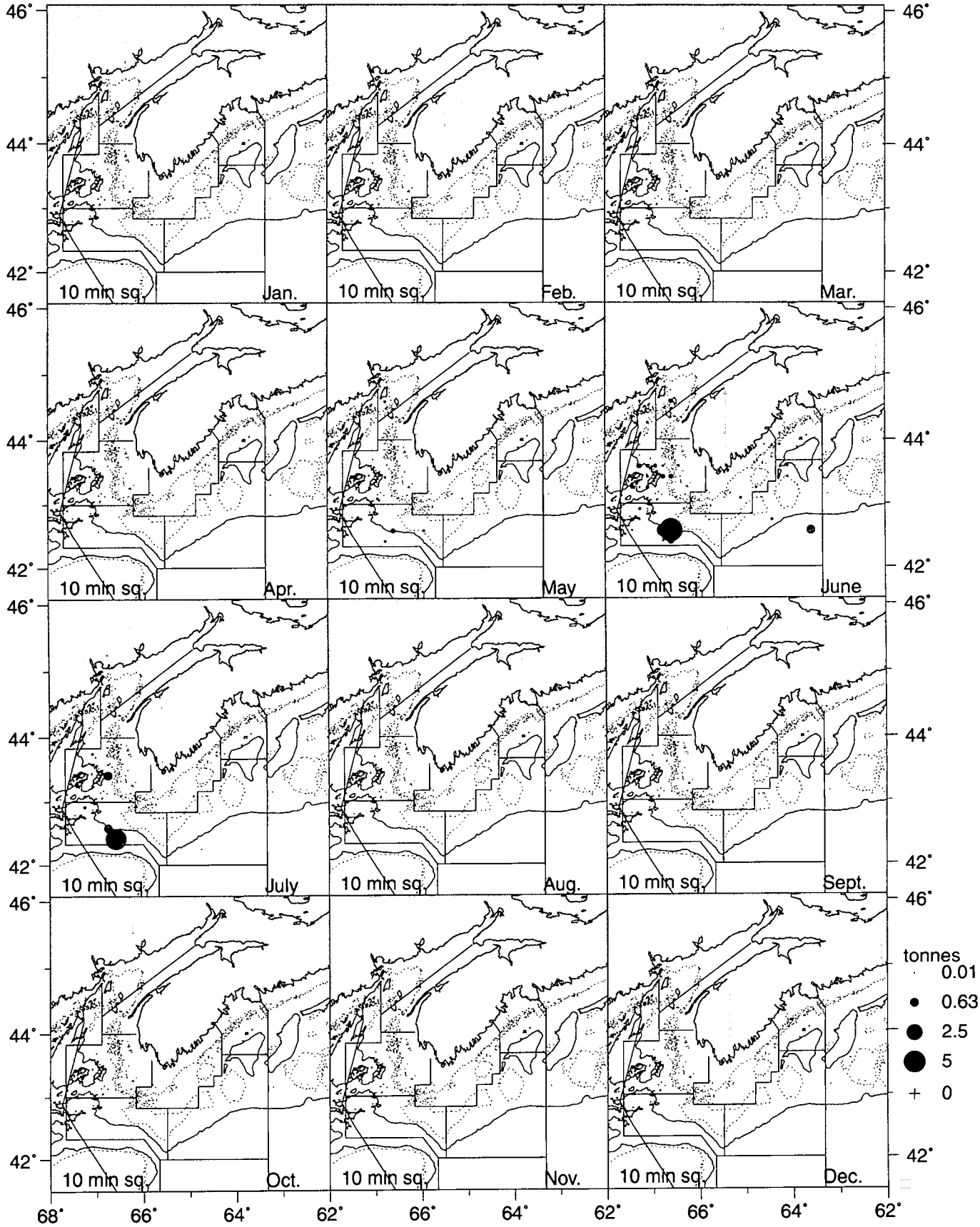


Figure 5c. Haddock catches (t) by gillnets in NAFO Divisions 4X+5Y by month in 1998 (to early July only), aggregated by 10x10 minute squares.

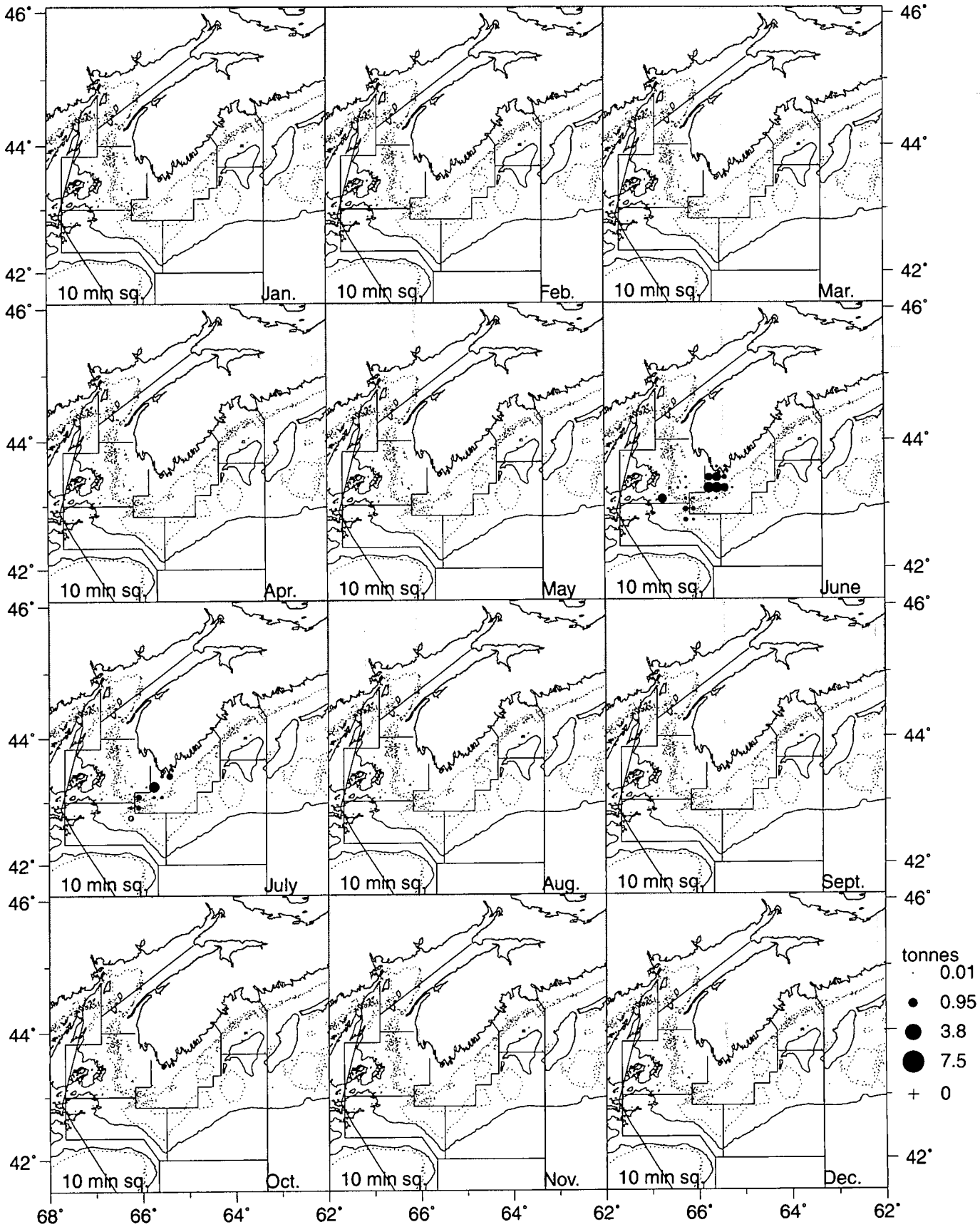


Figure 5d. Haddock catches (t) by handlines in NAFO Divisions 4X+5Y by month in 1998 (to early July only), aggregated by 10x10 minute squares.

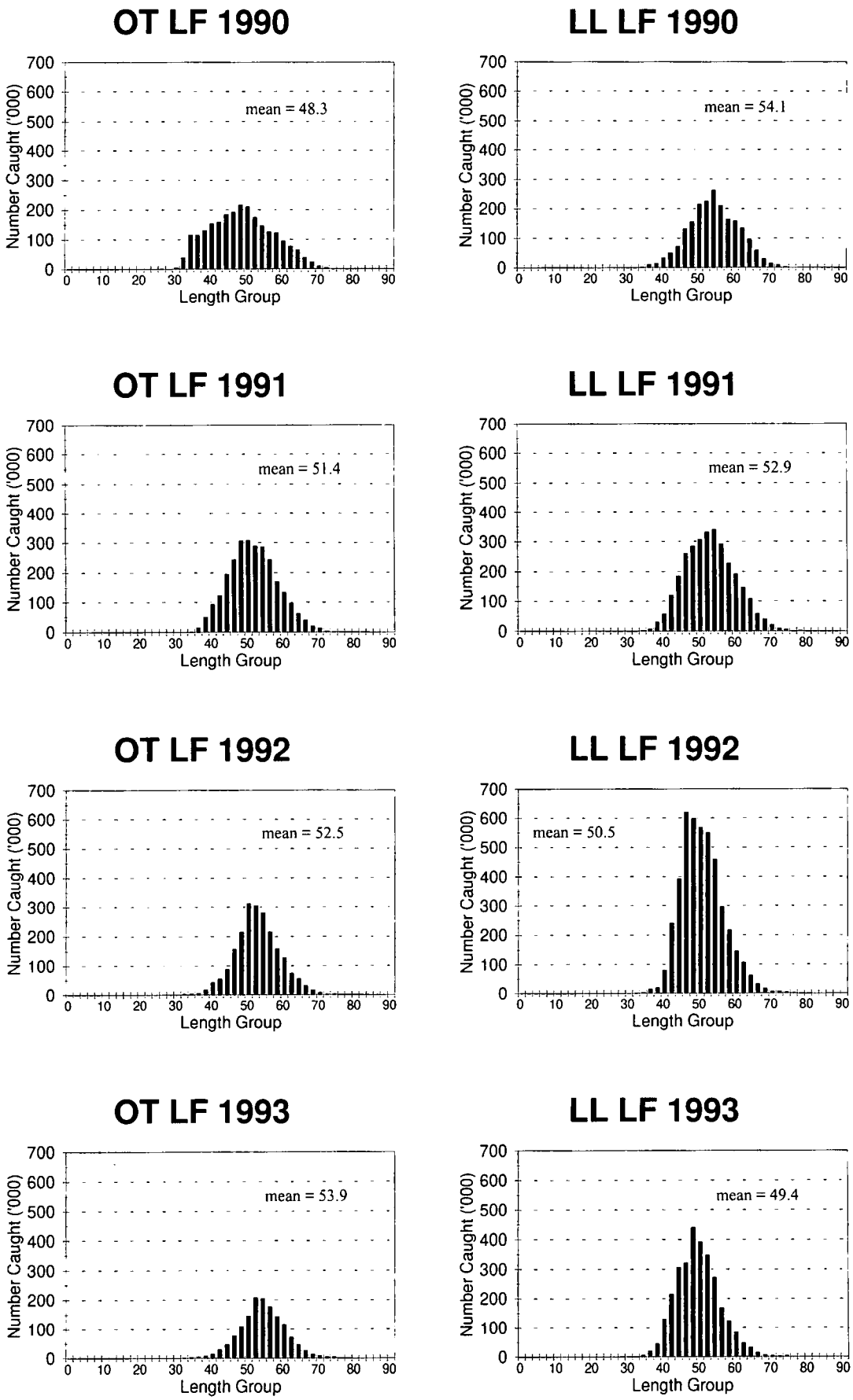


Figure 6a. Catch-at-length (cm) for 4X haddock, 1990-1993, for the otter trawl and longline gear sectors.

lf_gear.wb1

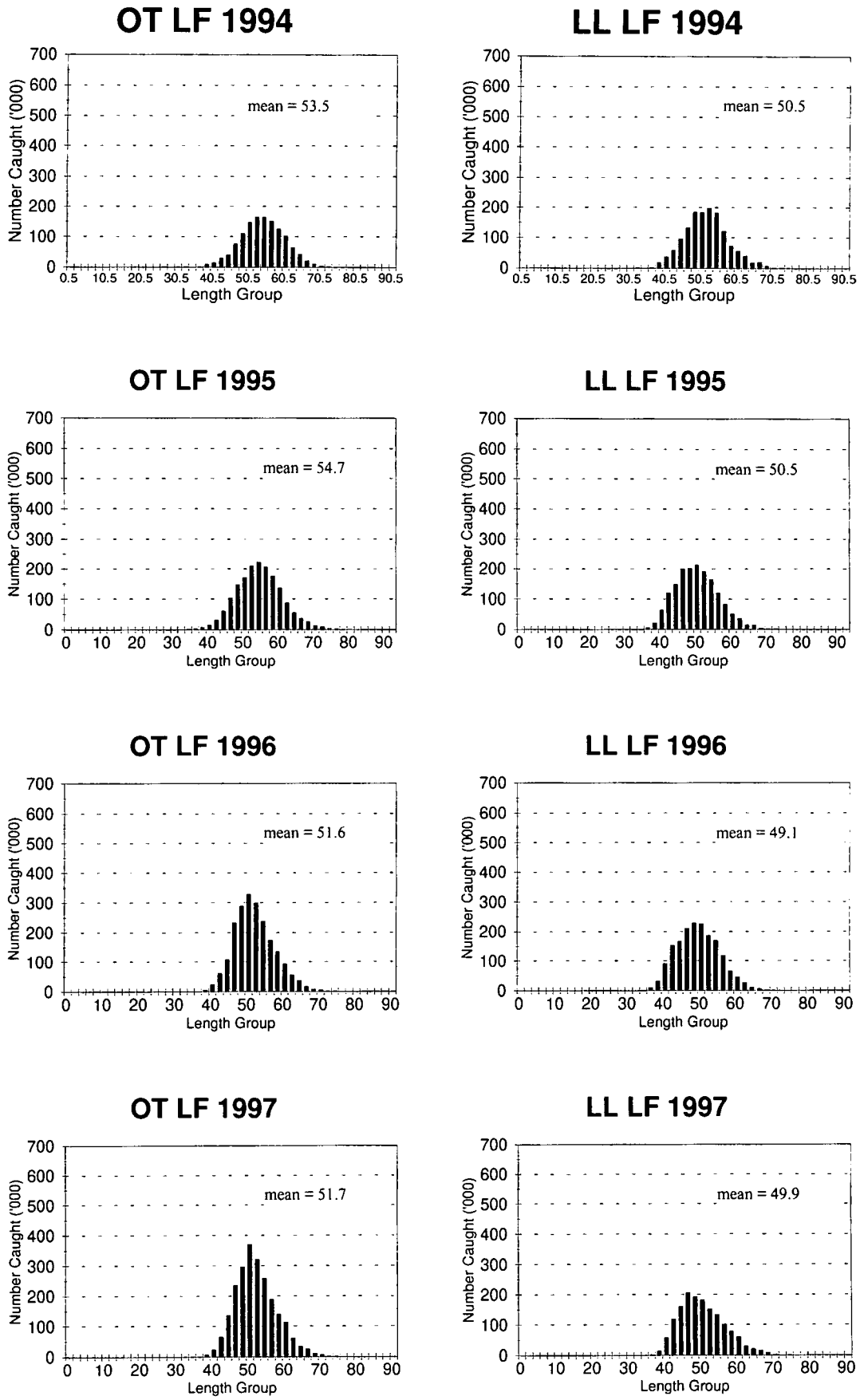
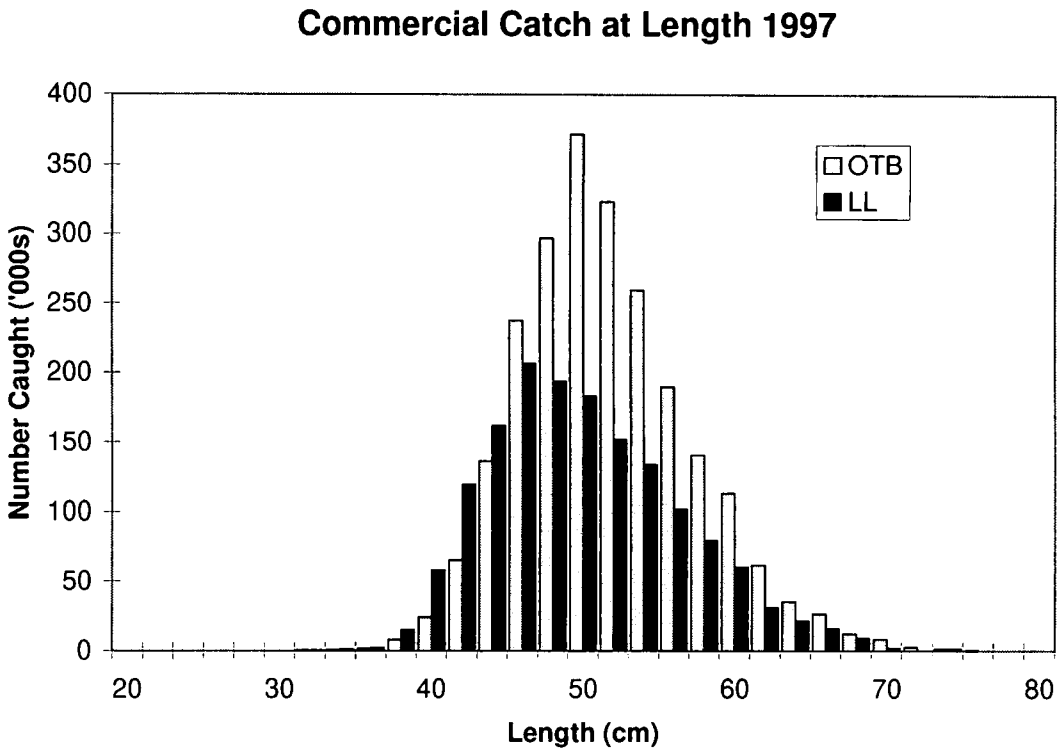


Figure 6b. Catch-at-length (cm) for 4X haddock, 1994-1997, for the otter trawl and longline gear sectors.

ll_gear.wb1



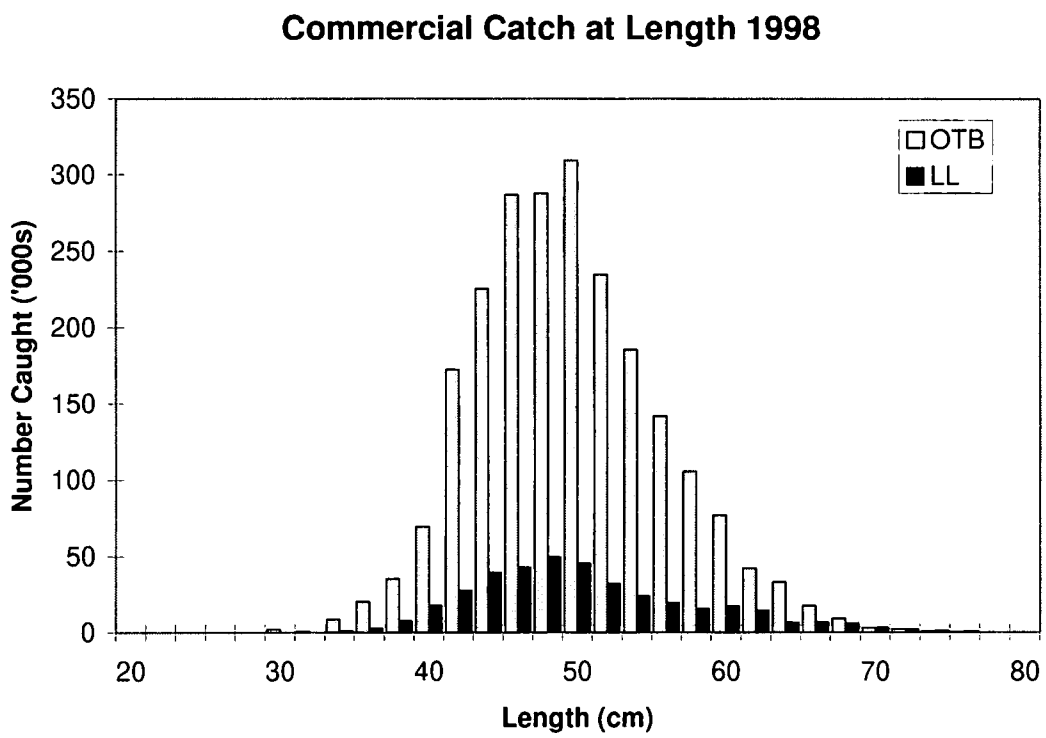
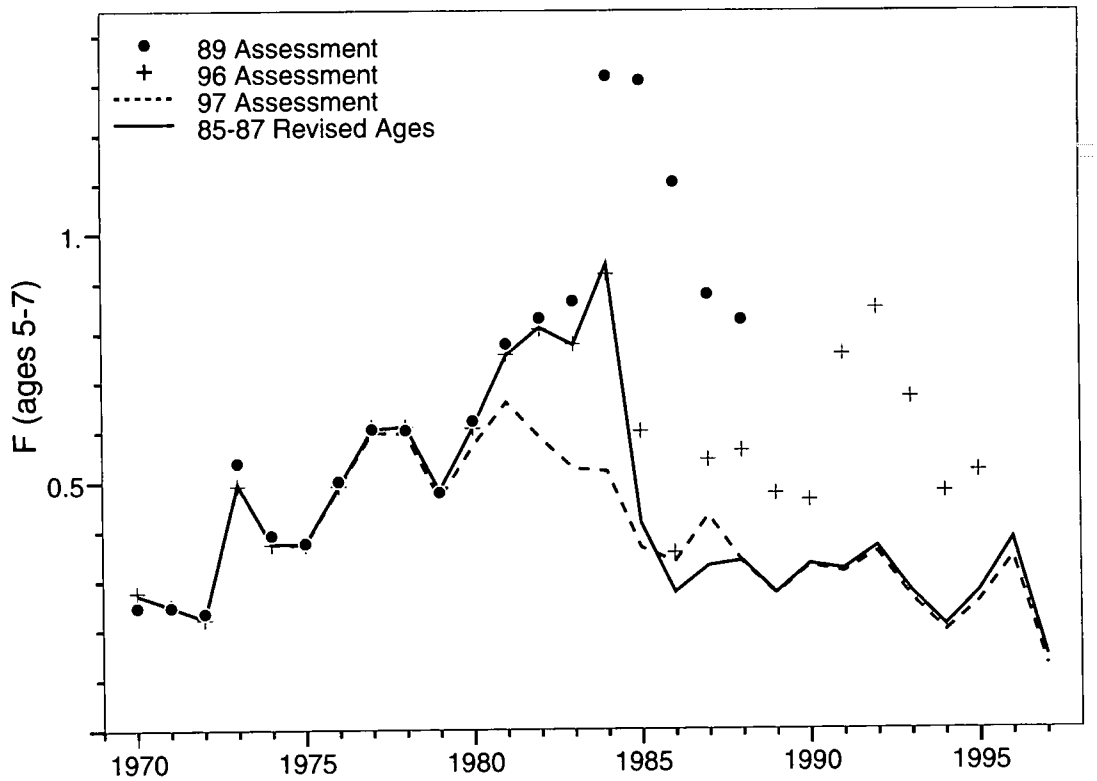


Figure 7. 4X haddock catch-at-length for otter trawl and longline gear sectors for 1997 and the first half of 1998.



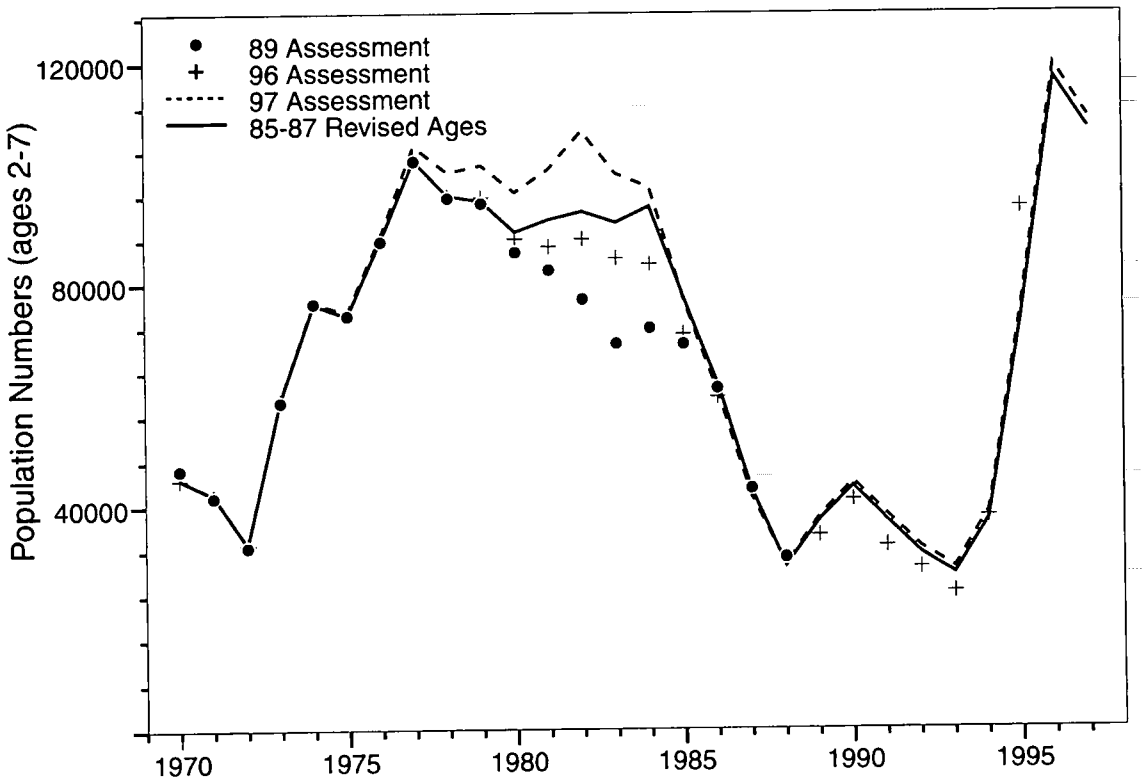


Figure 8. A comparison of results from last year's assessment using revised ageing data for 1985-87 and previous assessments.

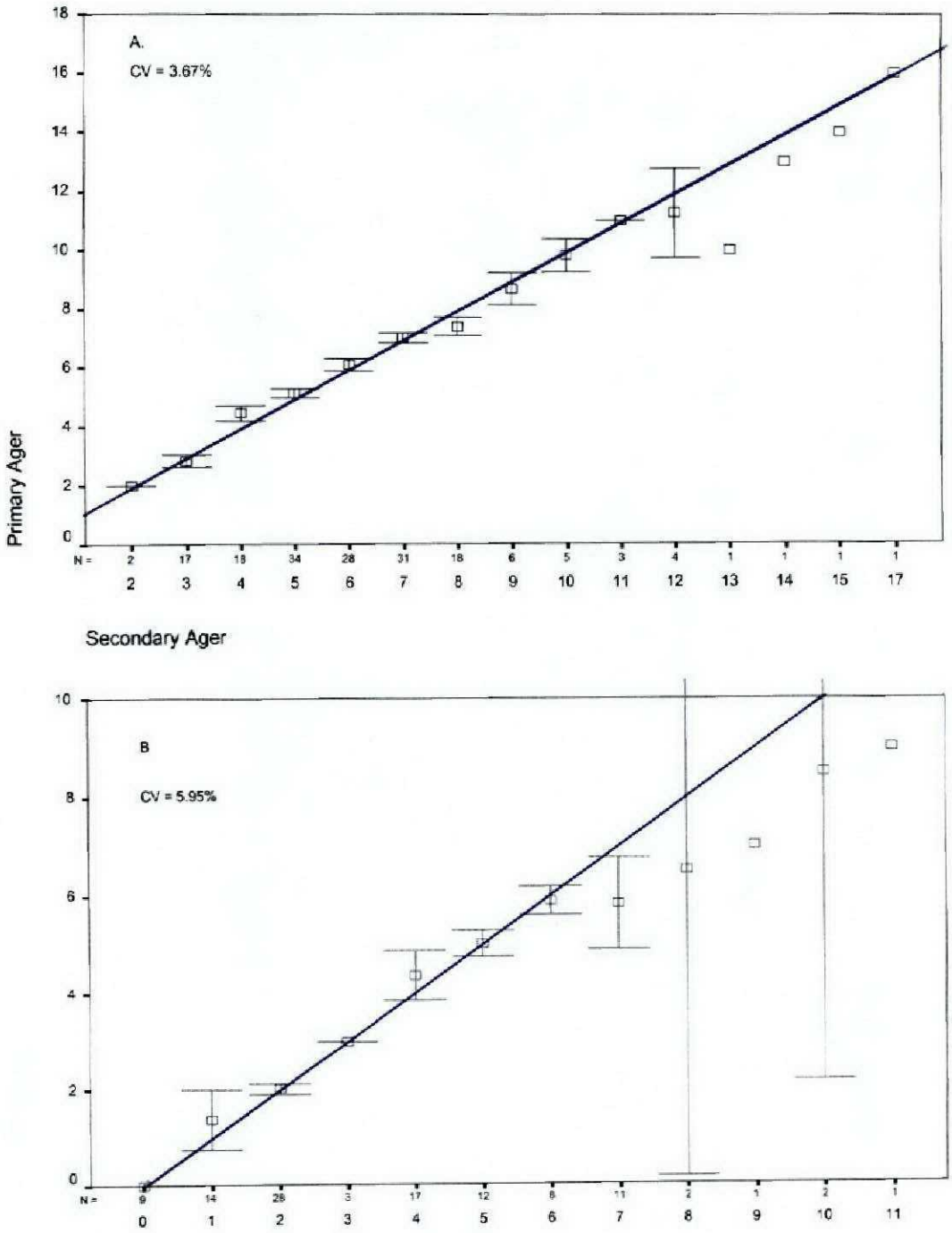
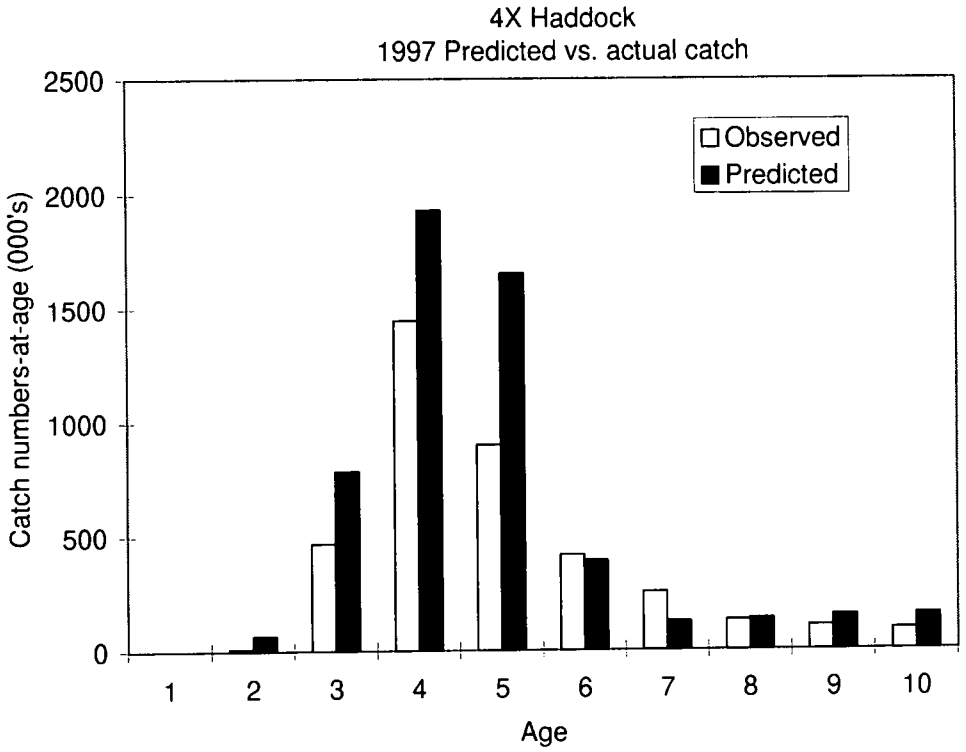


Figure 9. Age bias plots of pairwise age comparisons of revised 4X haddock ages for commercial (A) and research vessel (B) samples. Bars represent 95% confidence interval around each category. The line represents the 1:1 line. Sample size is indicated above the x-axis labels.



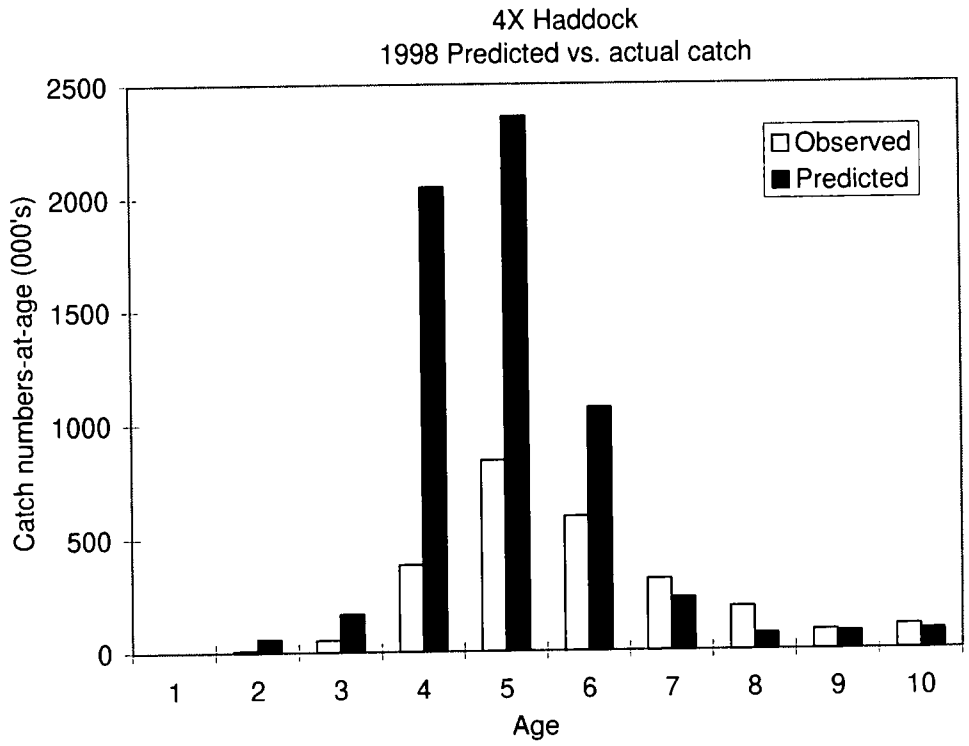


Figure 10. 4X haddock predicted and actual catch numbers-at-age (000's). Catch for 1998 only includes January - June.

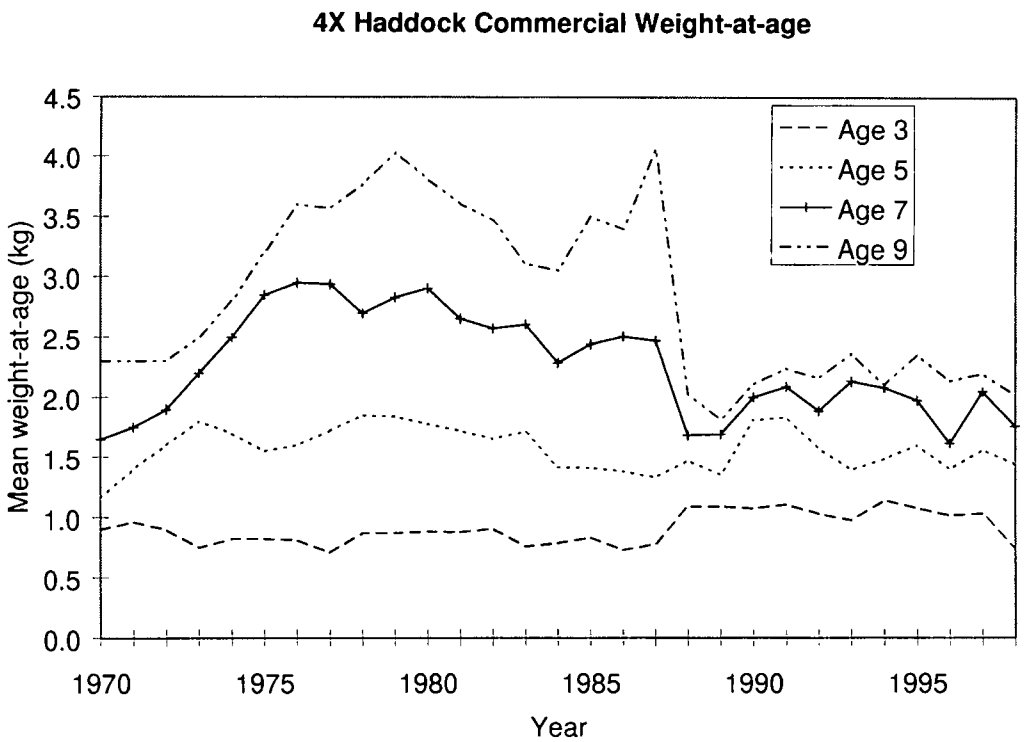


Figure 11. 4X haddock commercial mean weight-at-age (kg).

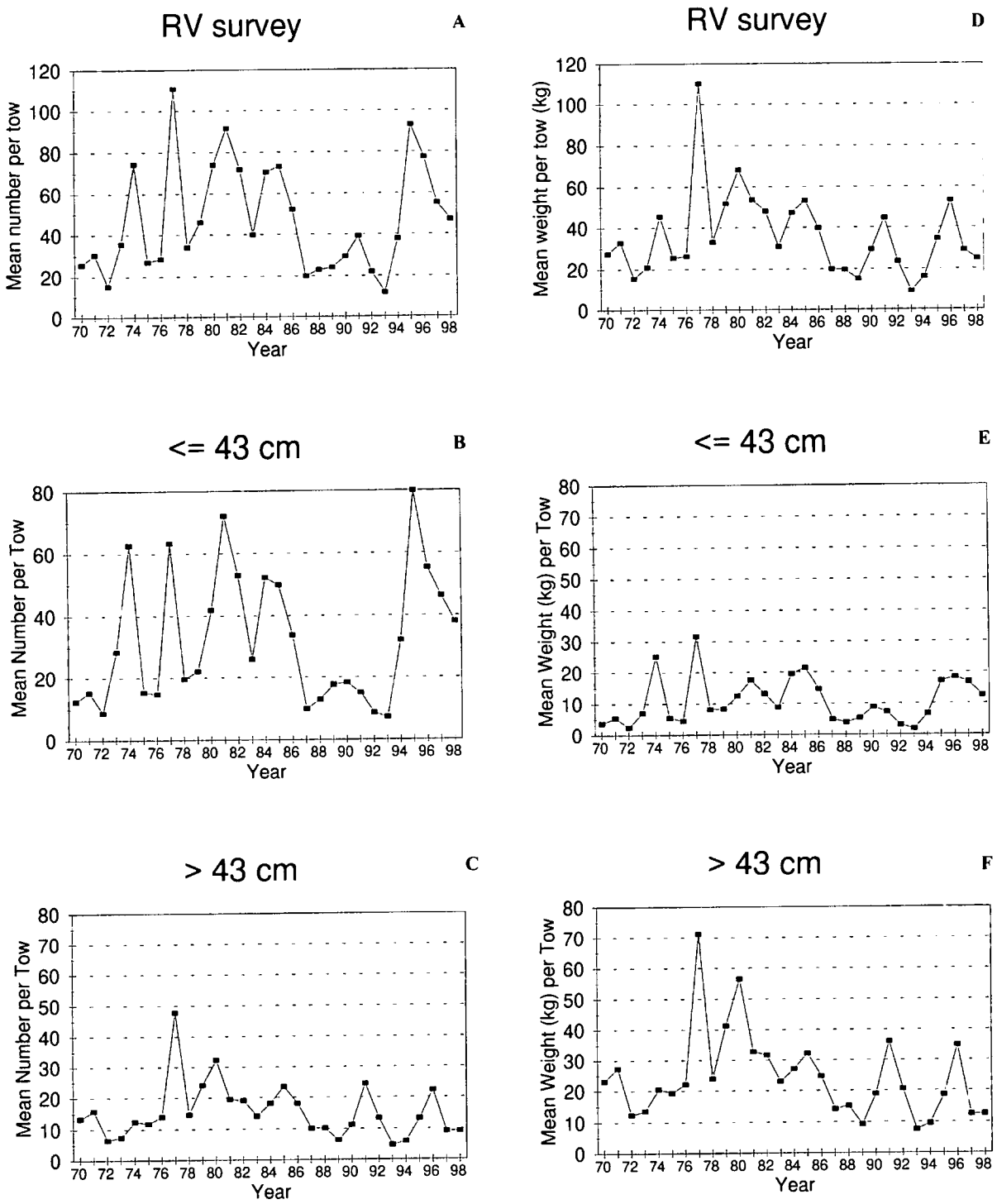


Figure 12. Summer RV survey, mean catch rate of haddock from 4X during 1970-1998 for (a) all lengths combined (nos./tow), (b) lengths <=43 (nos./tow), (c) lengths >43cm (nos./tow), (d) all lengths combined (wt/tow), (e) lengths <=43cm (wt/tow) and (f) lengths >43cm (wt/tow).

nptplot.wb1

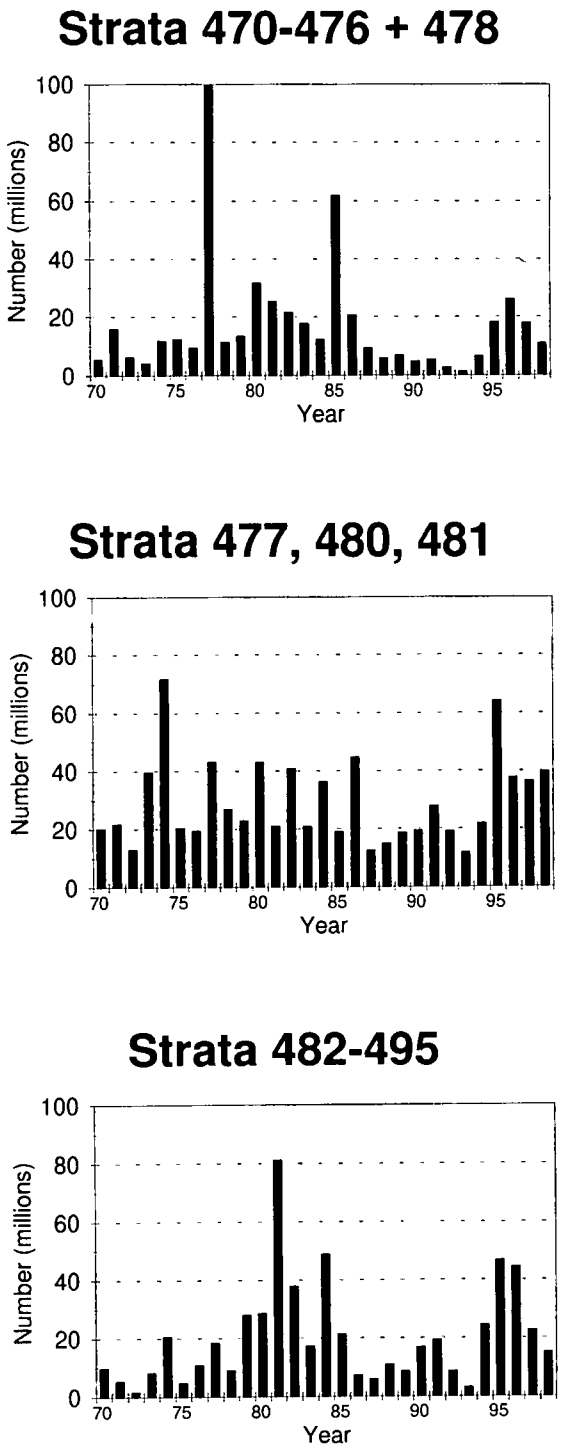


Figure 13. 4X haddock summer RV survey stratified numbers by stratum grouping.

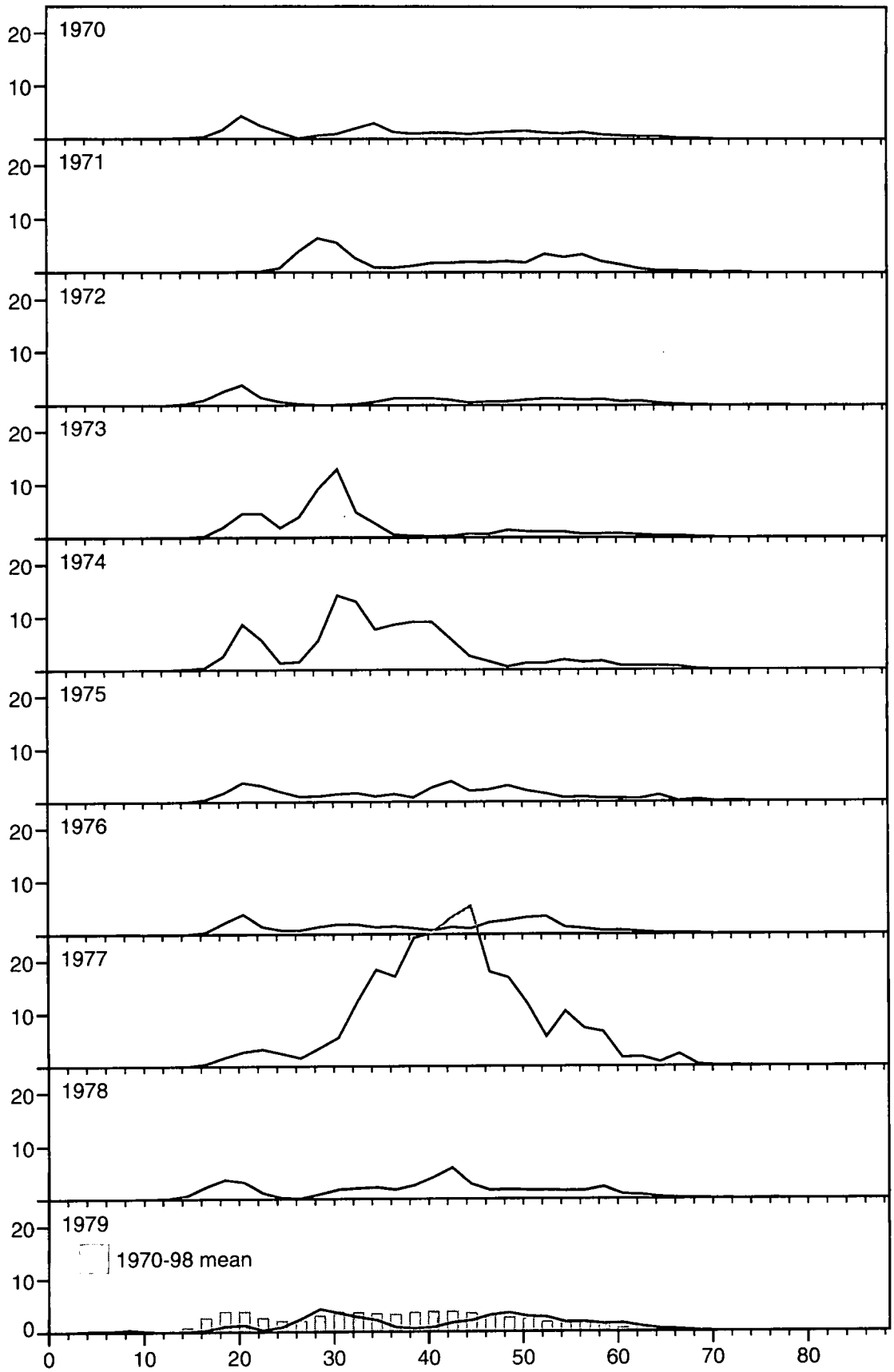


Figure 14a. 4X haddock mean numbers-at-length per tow for Scotian Shelf strata from summer research vessel surveys, 1970-79 (bars represent the long term mean).

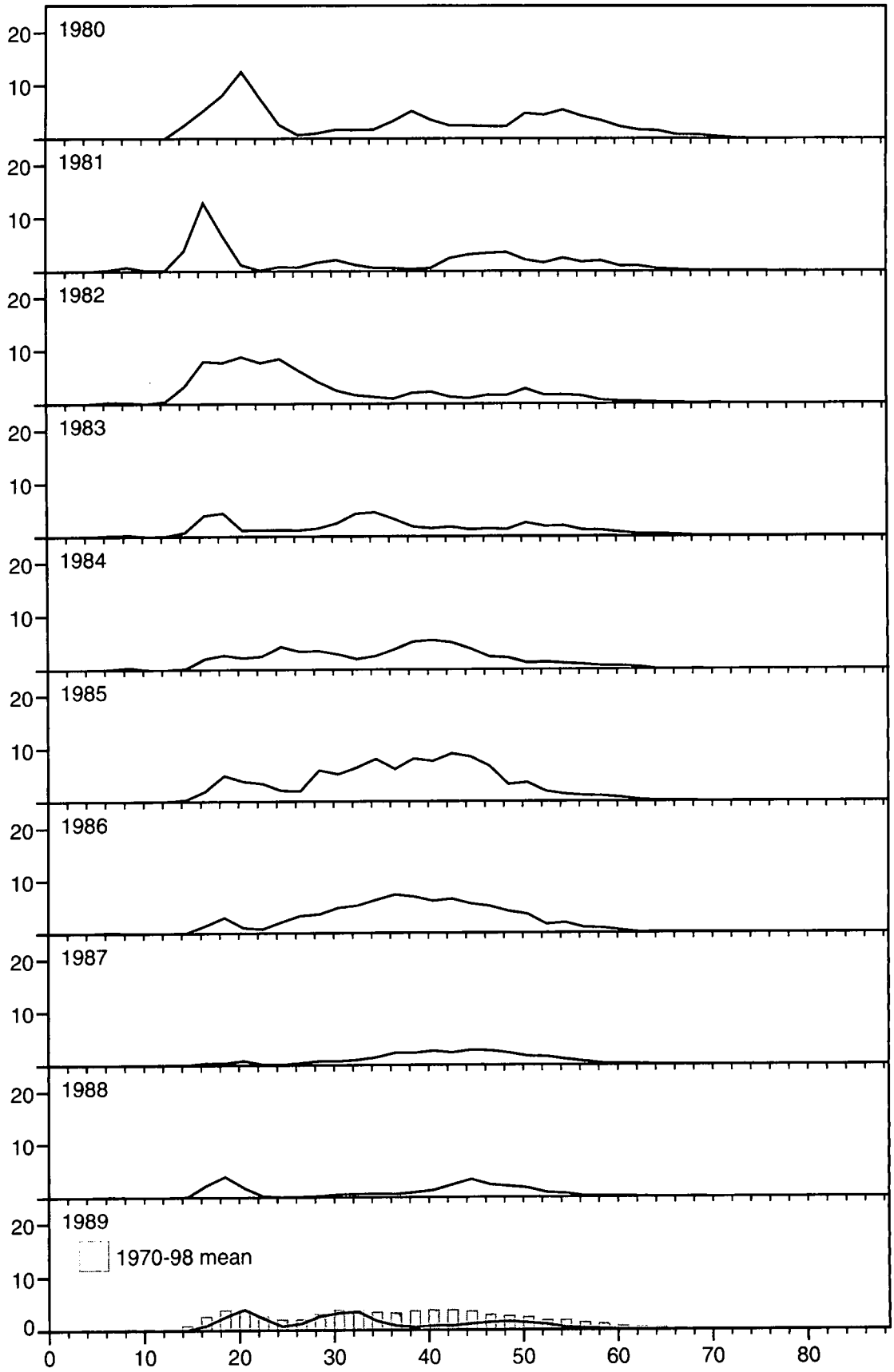


Figure 14b. 4X haddock mean numbers-at-length per tow for Scotian Shelf strata from summer research vessel surveys, 1980-89 (bars represent the long term mean).

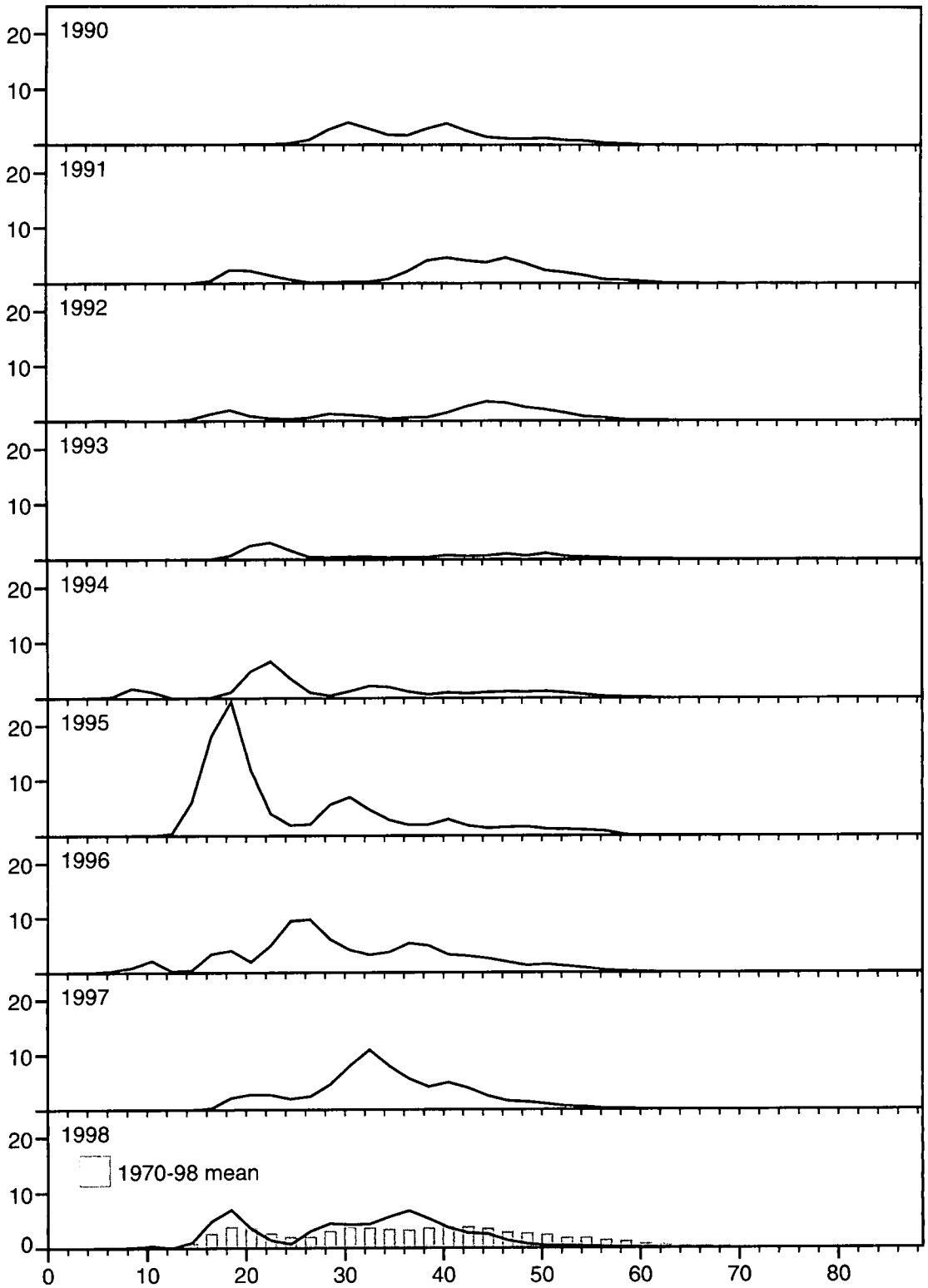


Figure 14c. 4X haddock mean numbers-at-length per tow for Scotian Shelf strata from summer research vessel surveys, 1990-98 (bars represent the long term mean).

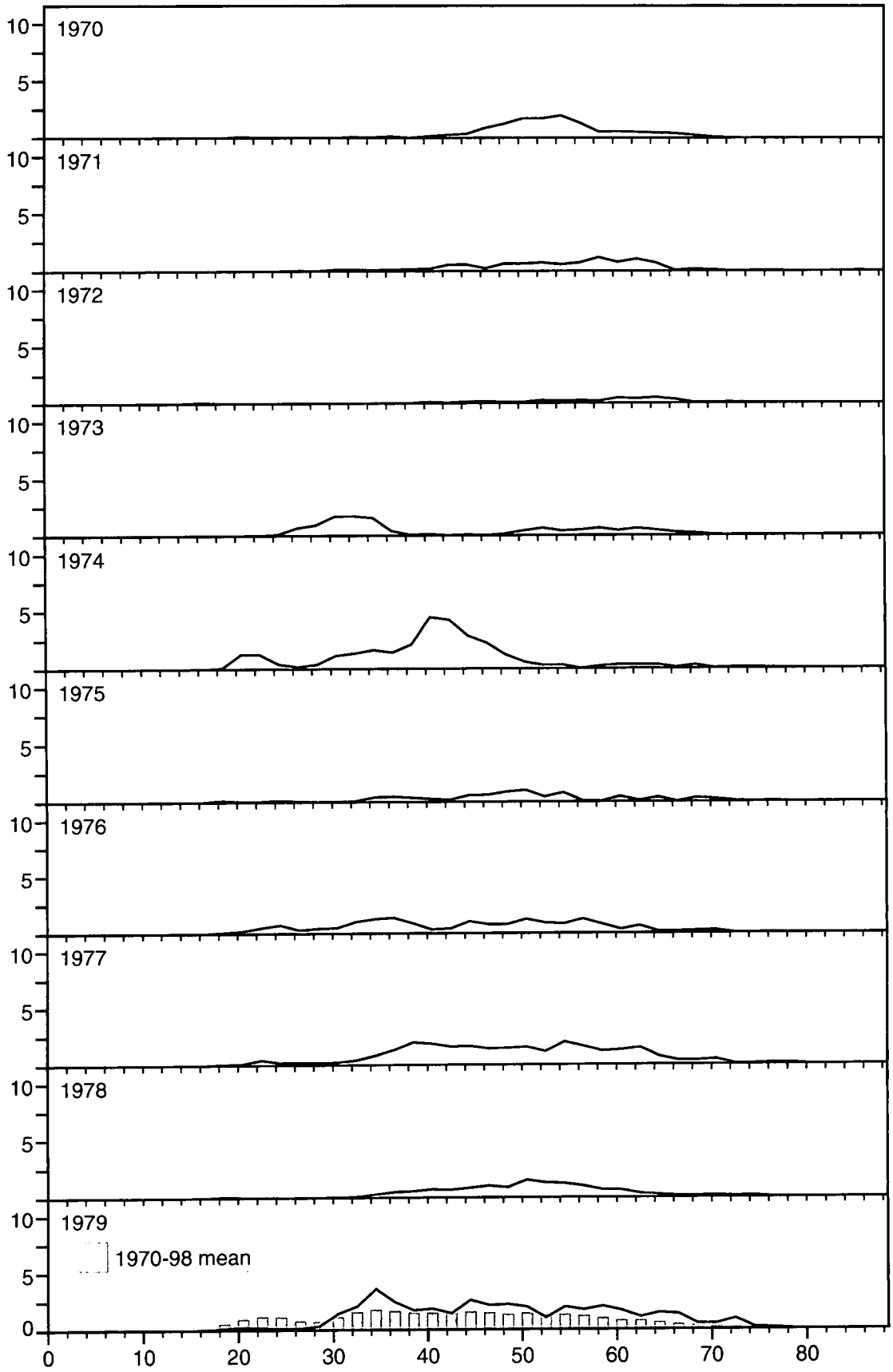


Figure 15a. 4X haddock mean numbers-at-length per tow for Bay of Fundy strata from summer research vessel surveys, 1970-79 (bars represent the long term mean).

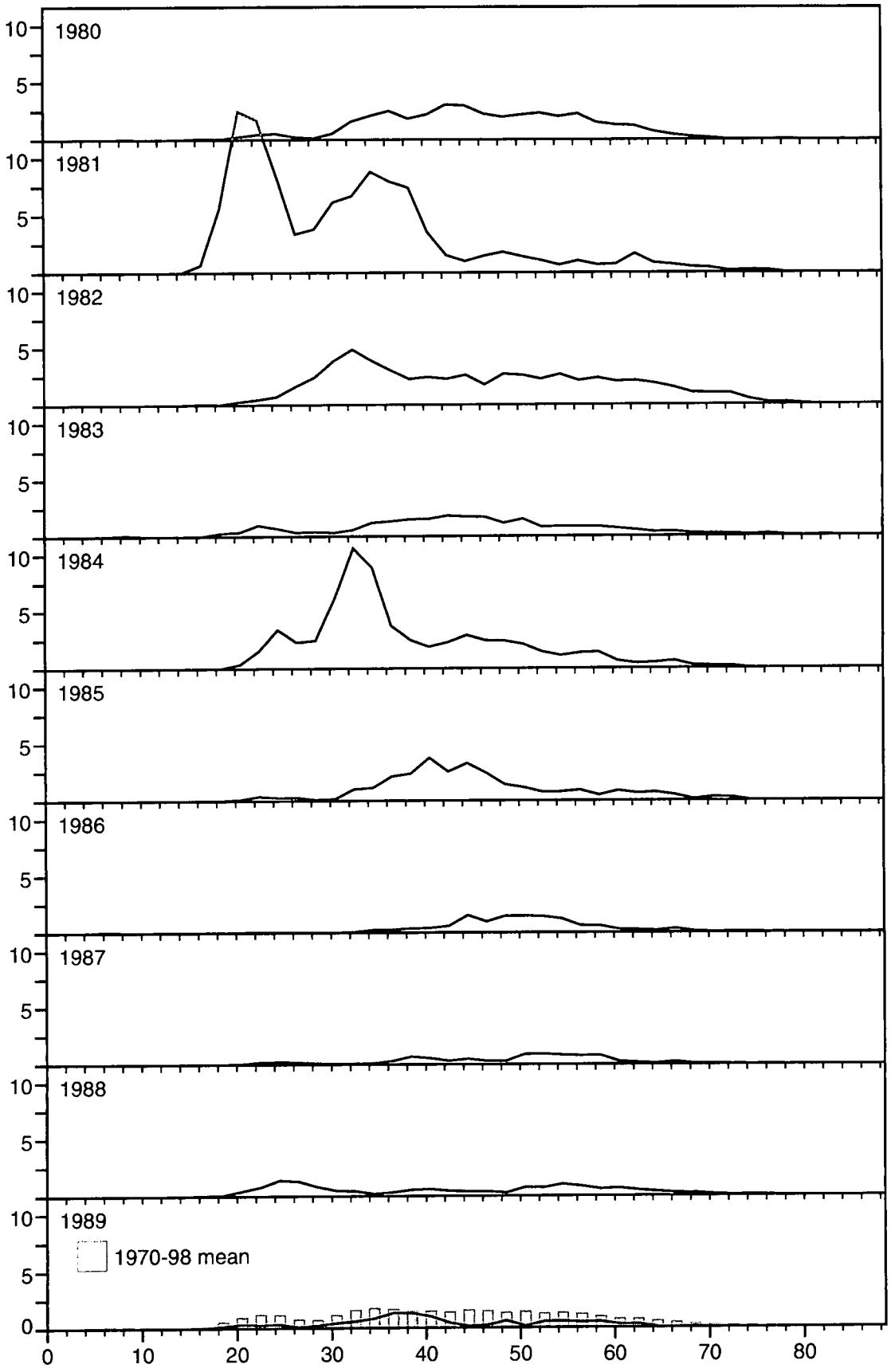


Figure 15b. 4X haddock mean numbers-at-length per tow for Bay of Fundy strata from summer research vessel surveys, 1980-89 (bars represent the long term mean).

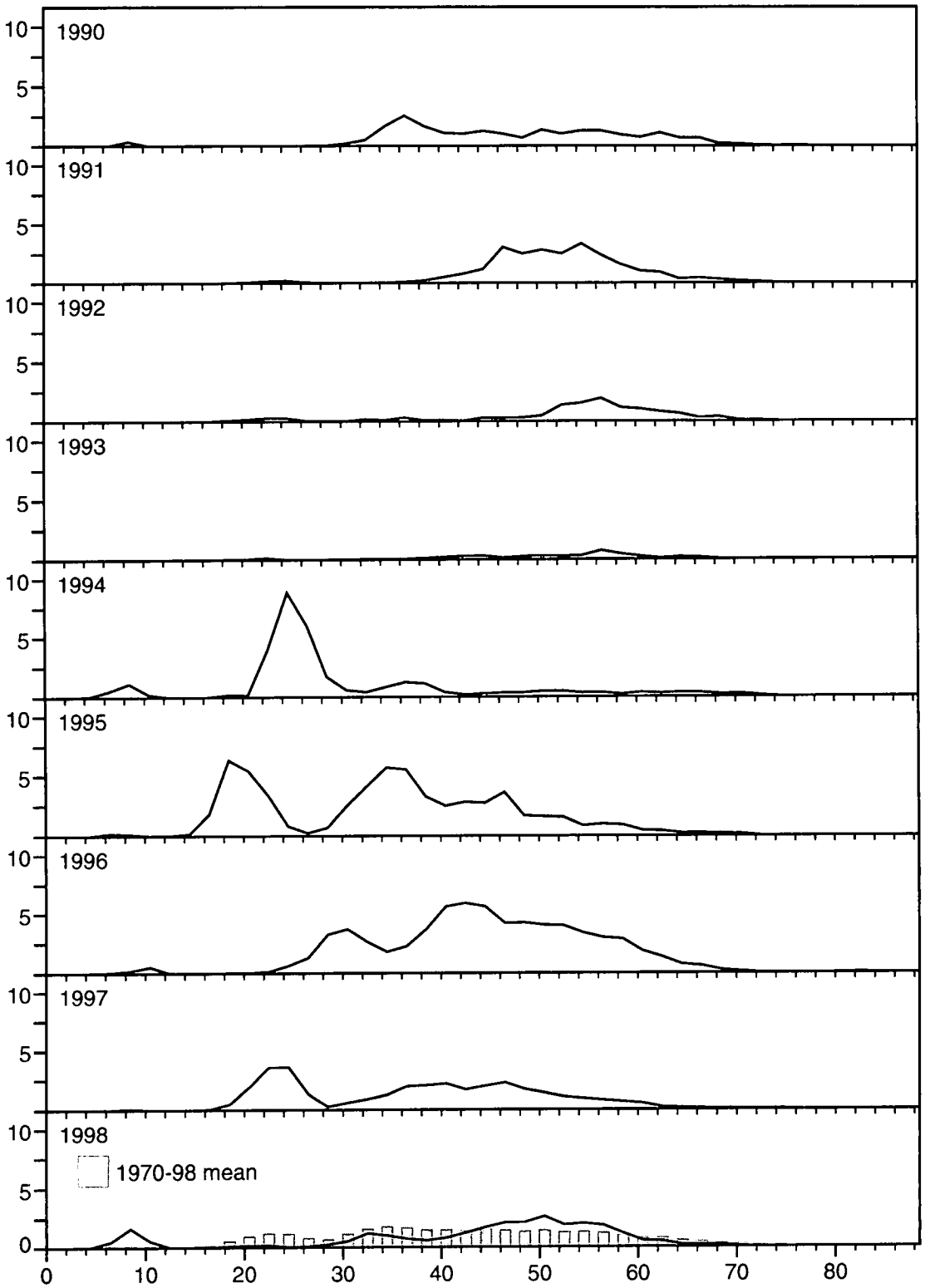
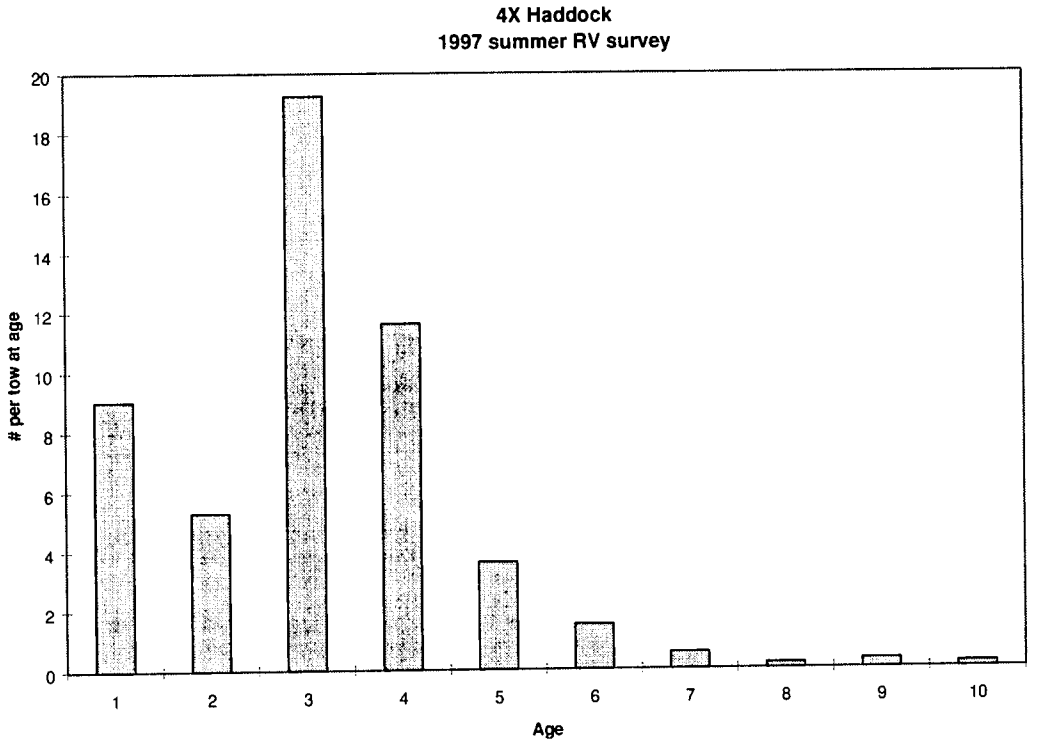


Figure 15c. 4X haddock mean numbers-at-length per tow for Bay of Fundy strata from summer research vessel surveys, 1990-98 (bars represent the long term mean).



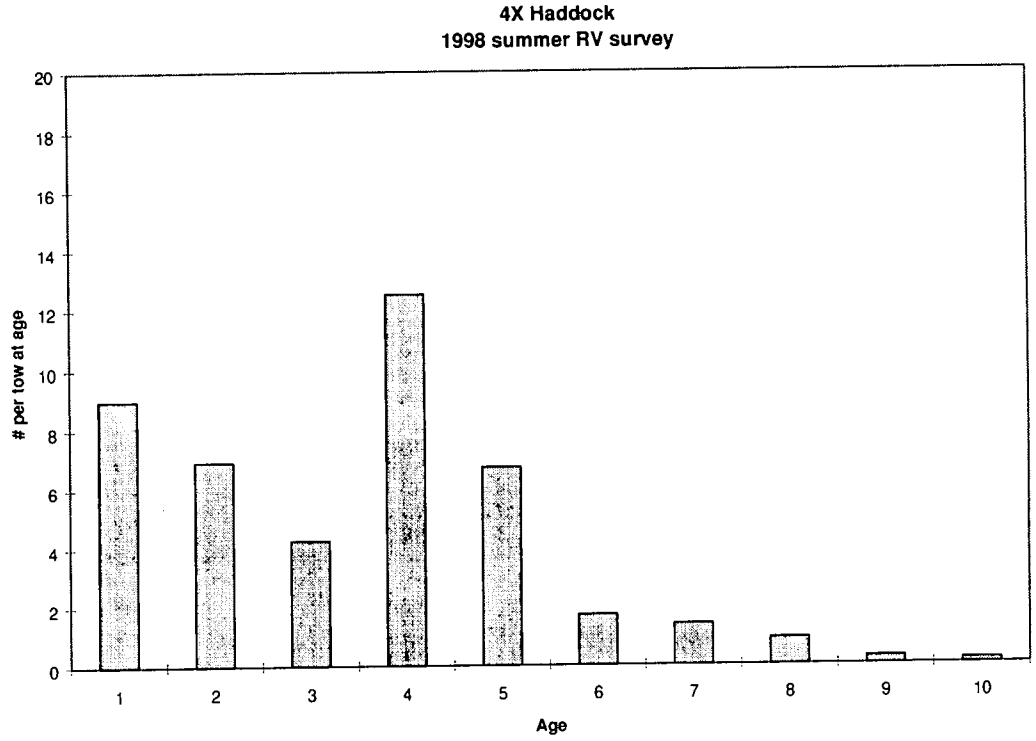


Figure 16. 4X haddock mean numbers-at-age per tow from summer research vessel surveys, 1997 and 1998.

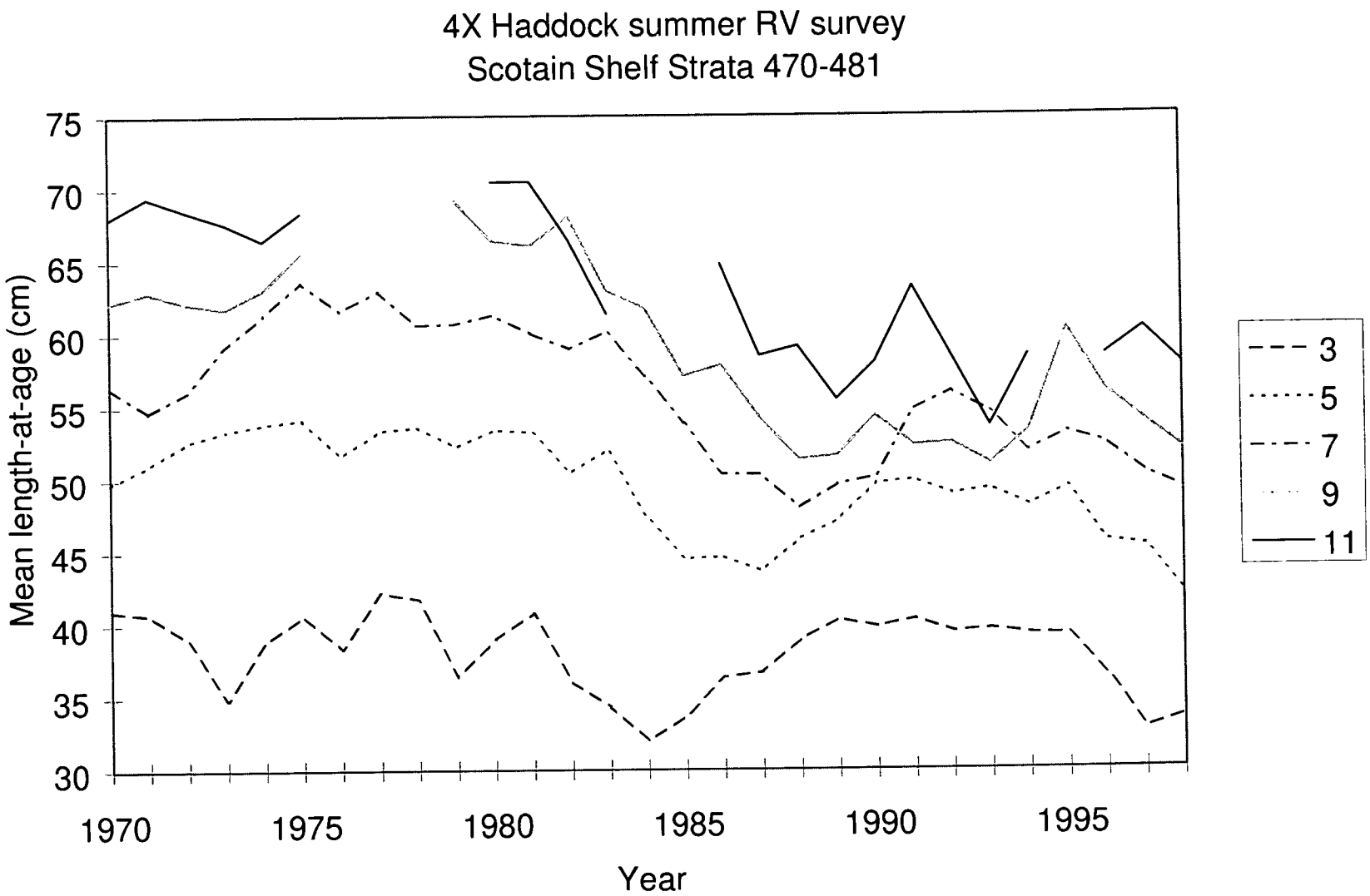


Figure 17. 4X haddock mean length-at-age (cm) for Scotian Shelf strata from summer research vessel surveys, 1970-98.

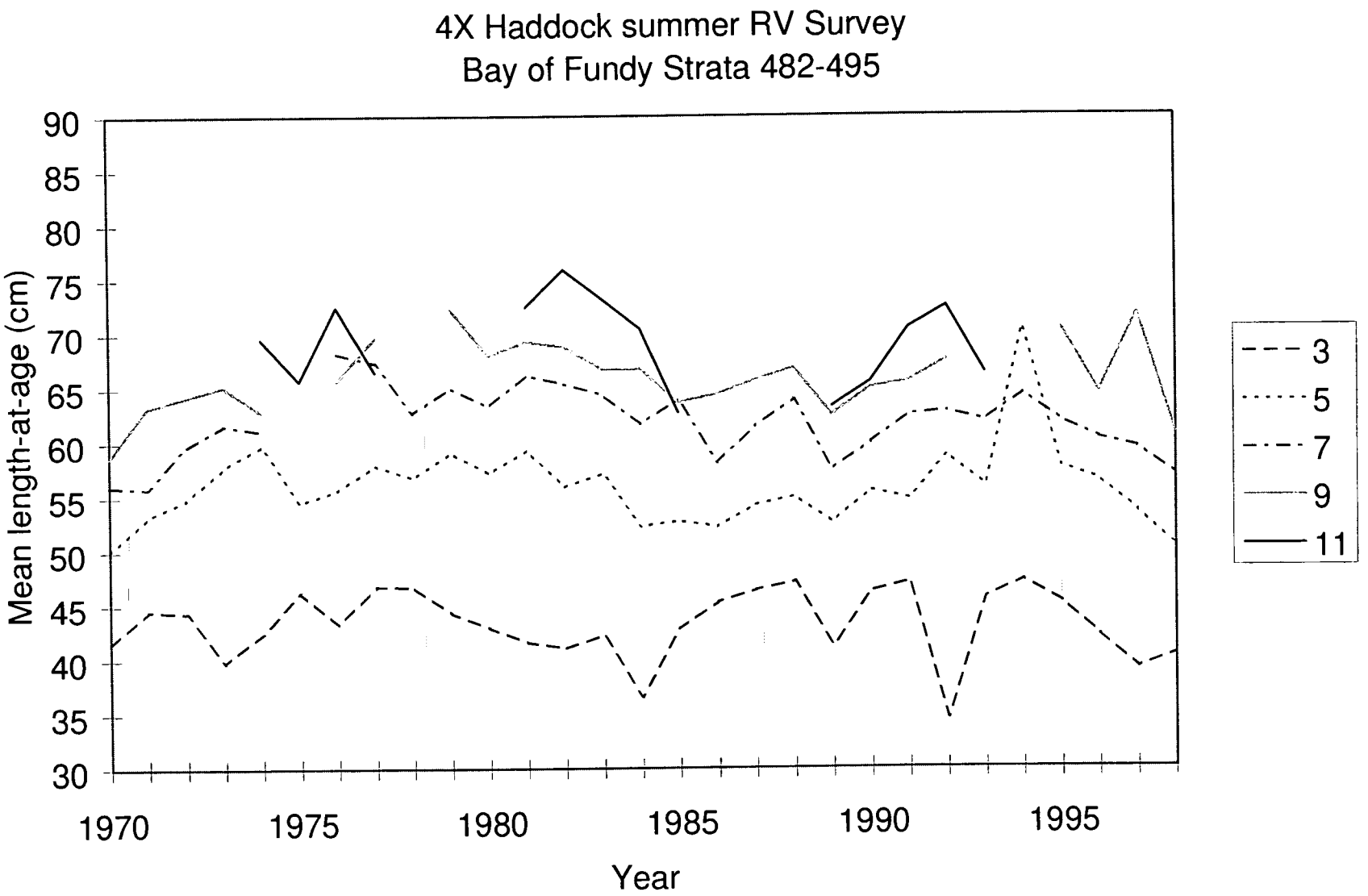


Figure 18. 4X haddock mean length-at-age (cm) for Bay of Fundy strata from summer research vessel surveys, 1970-98.

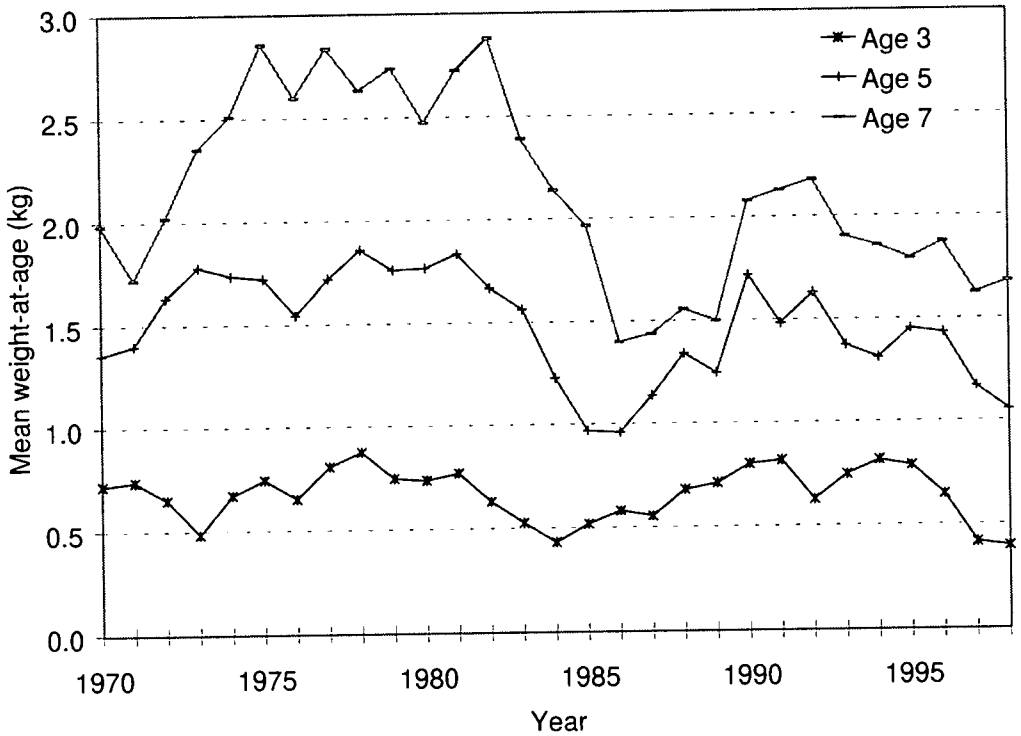


Figure 19. 4X haddock mean weight-at-age (kg) from summer research vessel surveys, 1970-98.

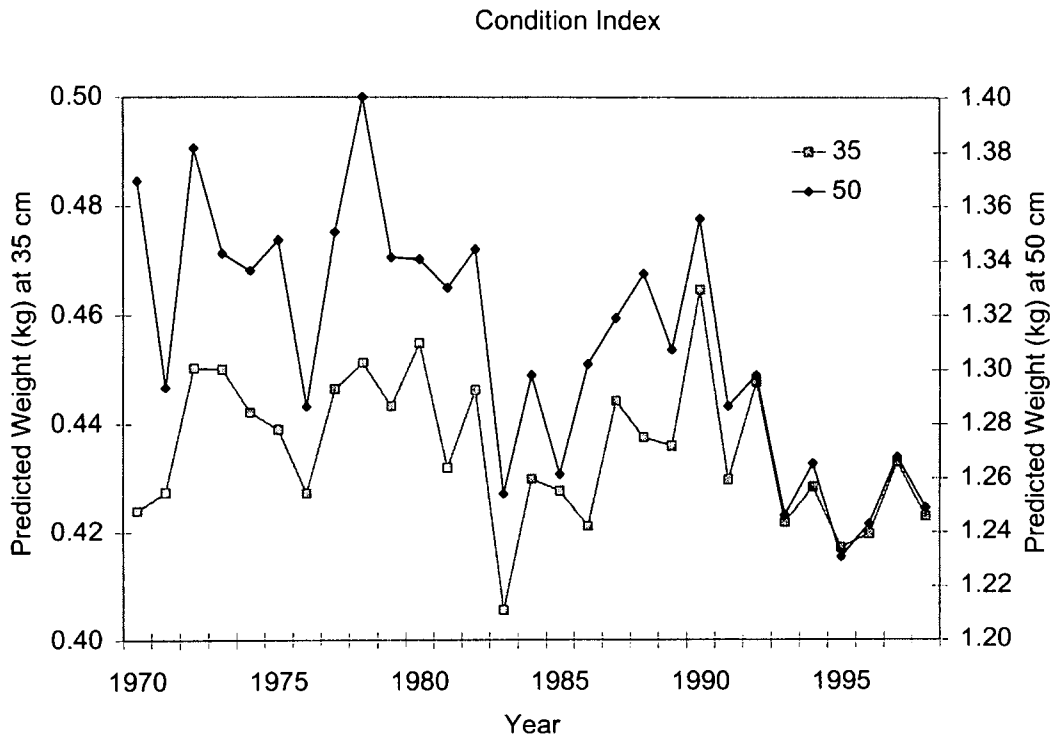


Figure 20. 4X haddock predicted weights (kg) at lengths of 35 and 50cm from summer research vessel surveys, 1970-98.

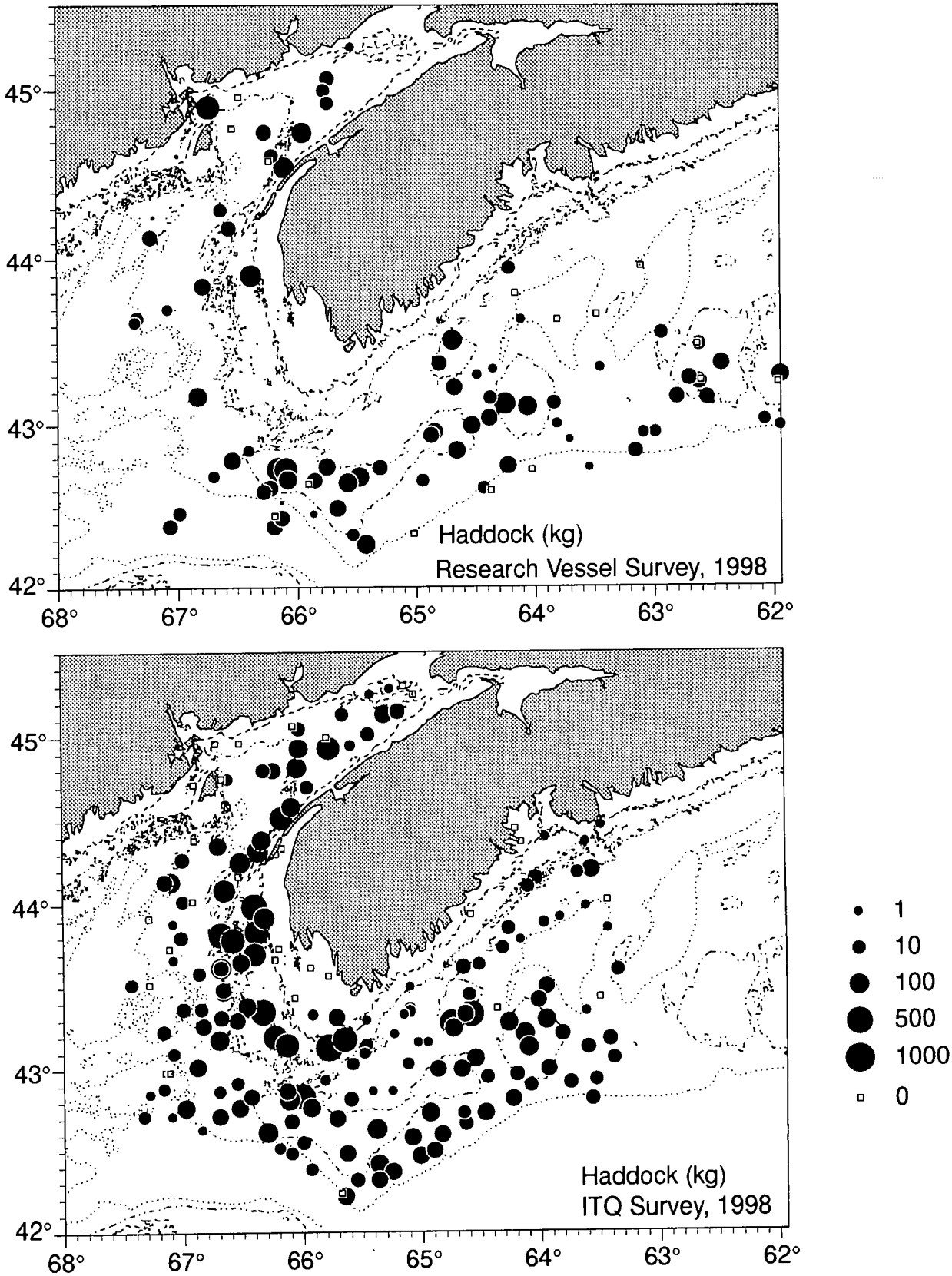


Figure 21. 4X haddock catches (kg) per standard tow in the 1998 summer research vessel and ITQ surveys.

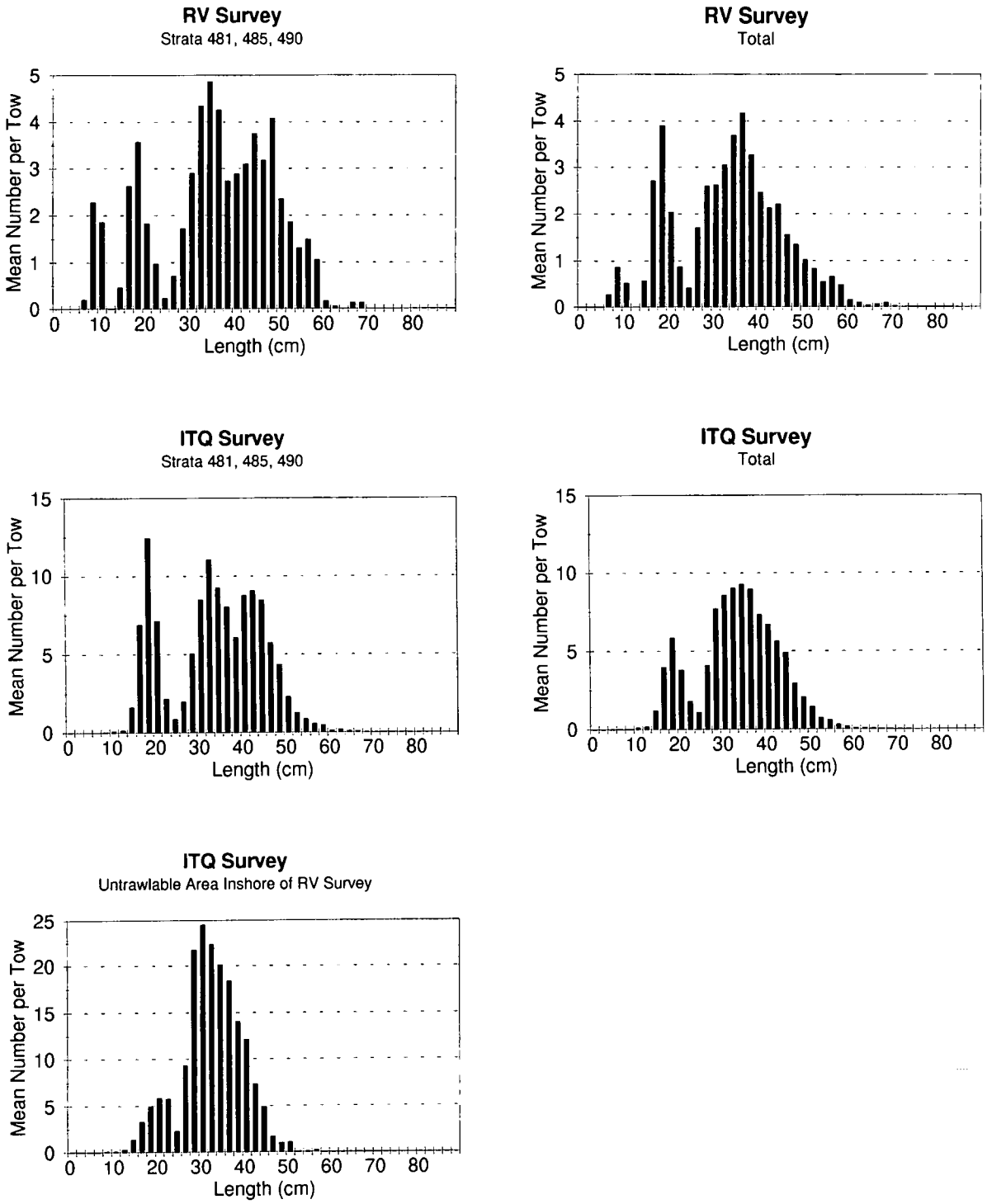


Figure 22. 4X haddock length frequency distributions from the 1998 summer research vessel and ITQ surveys, for the total survey area, for strata 481, 485, and 490, and for the area inshore of the research vessel survey strata.

lffig98.wb1

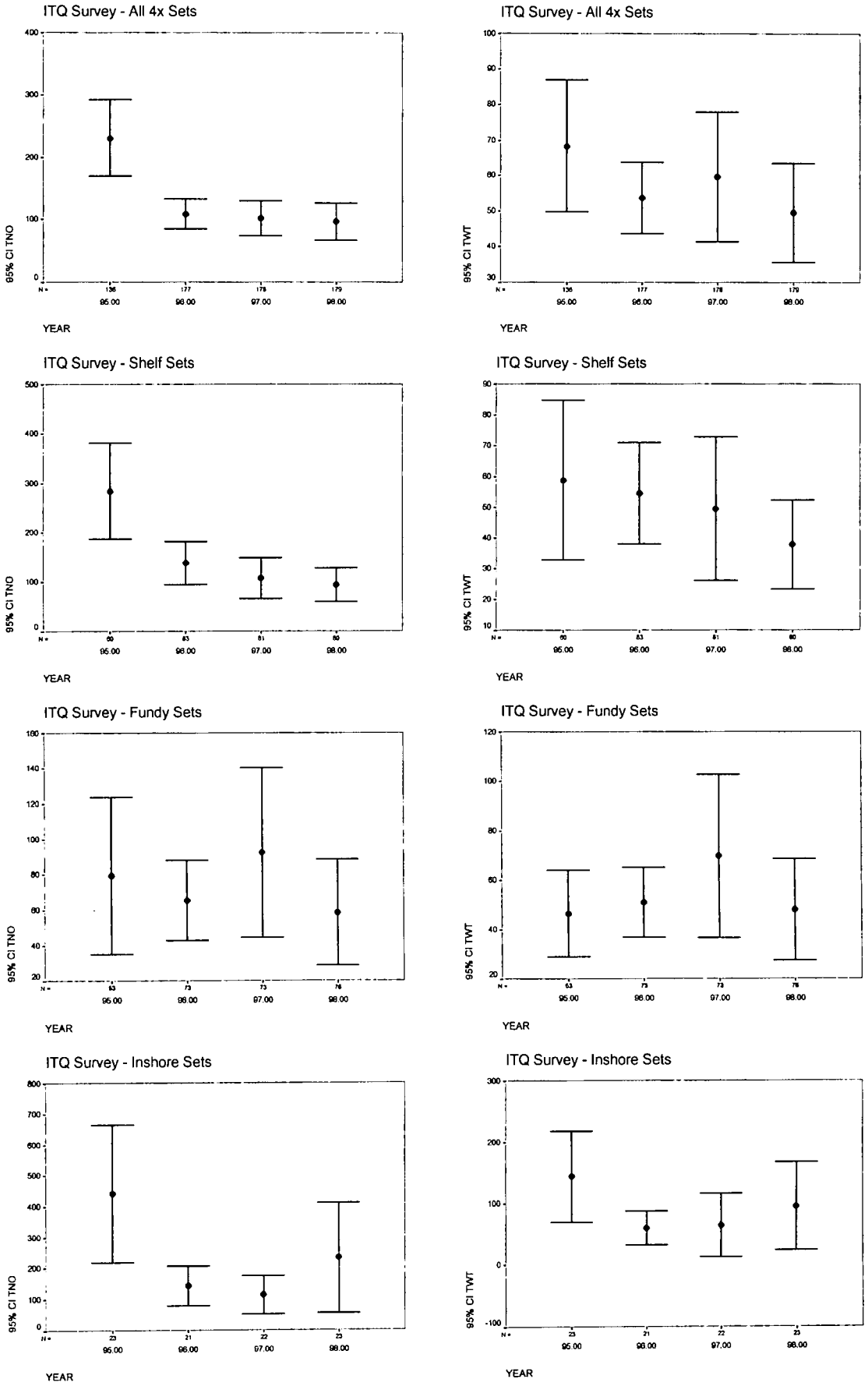


Figure 23. 4X haddock mean catch rates, #/tow on left and kg/tow on right for all sets, for Scotian Shelf strata, for Bay of Fundy strata, and for the area inshore of the research survey strata from the ITQ surveys, 1995-98.

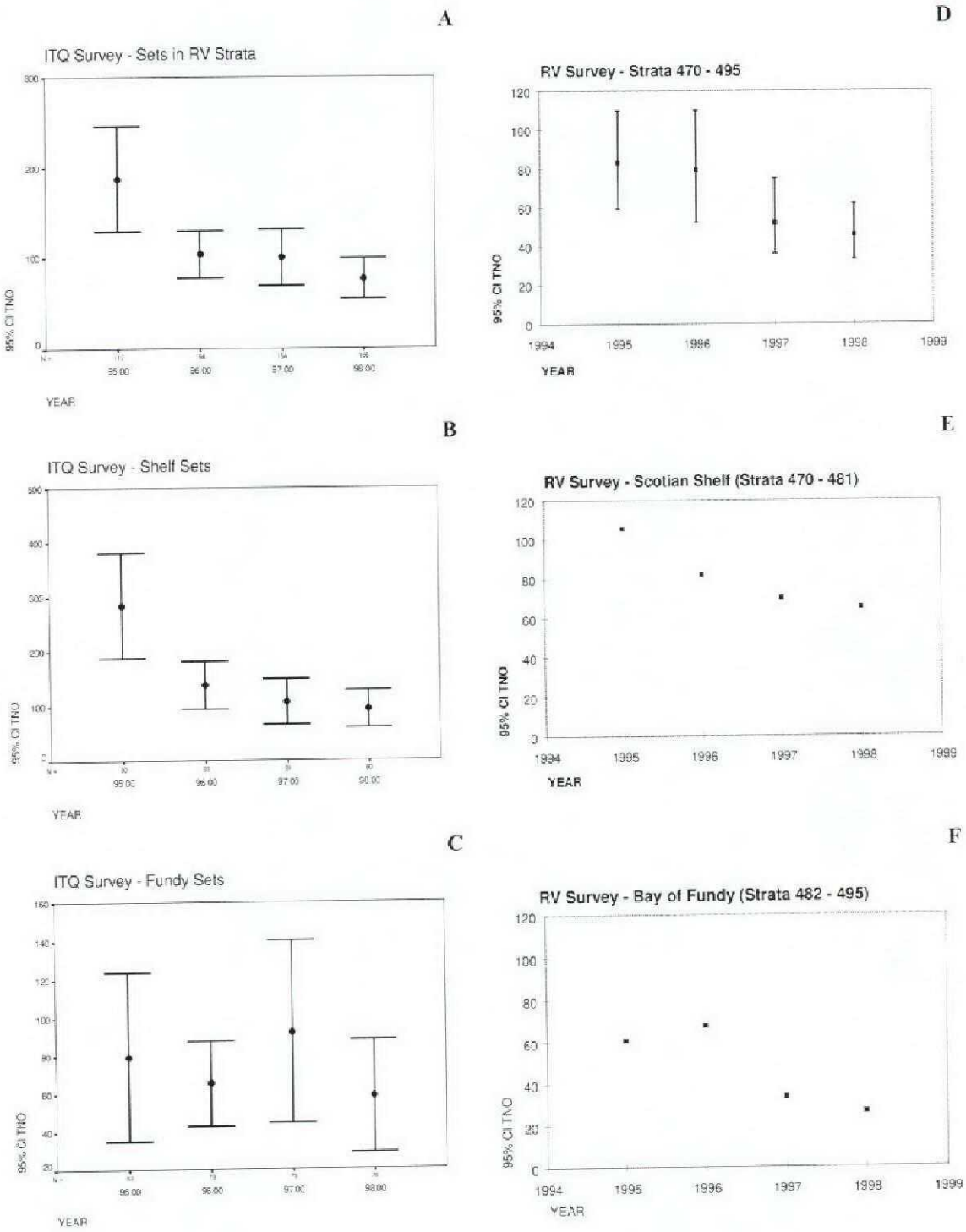


Figure 24. 4X haddock mean catch rates (#/tow), from the ITQ surveys on the left and research vessel surveys on the right, 1995-98 for: (A) and (D) all survey strata; (B) and (E) Scotian Shelf strata; (C) and (F) Bay of Fundy strata.

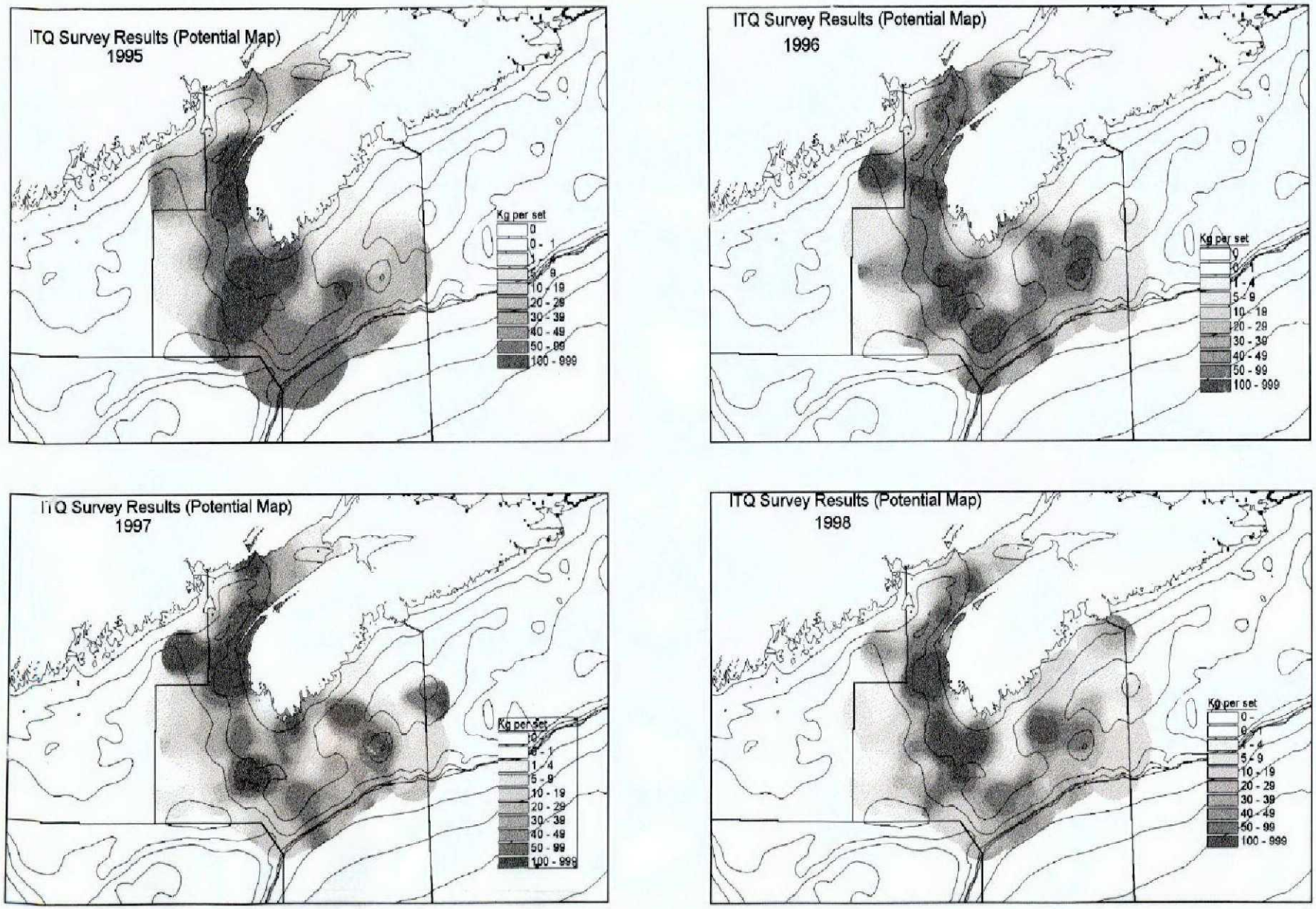


Figure 25. 4X haddock biomass distributions from industry surveys, 1995-98 generated using SPANS.

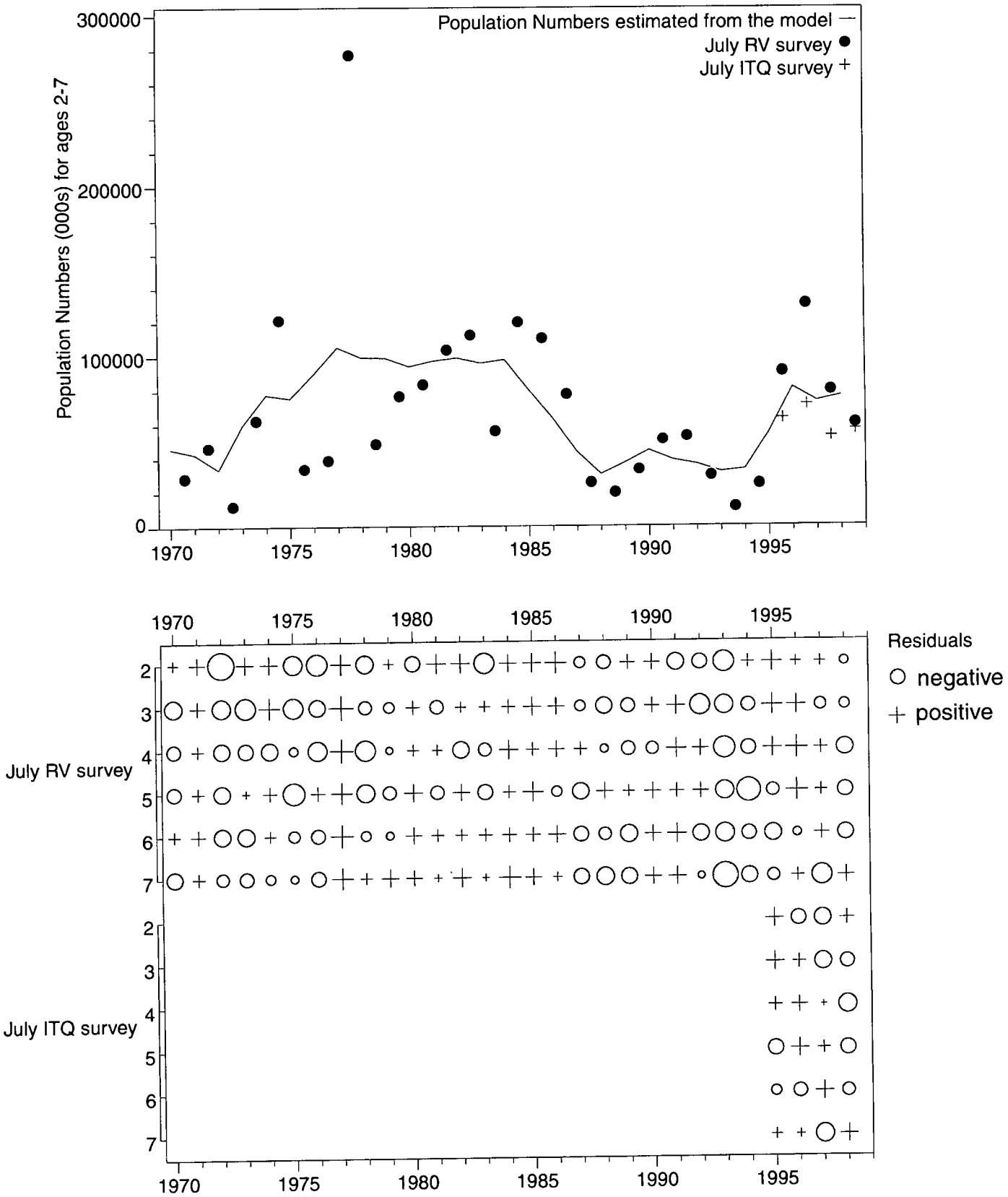


Figure 26. SPA results: (above) population numbers (ages 2-7) estimated from the model and the q-adjusted survey indices; (below) expanding symbol plot of residuals at age.

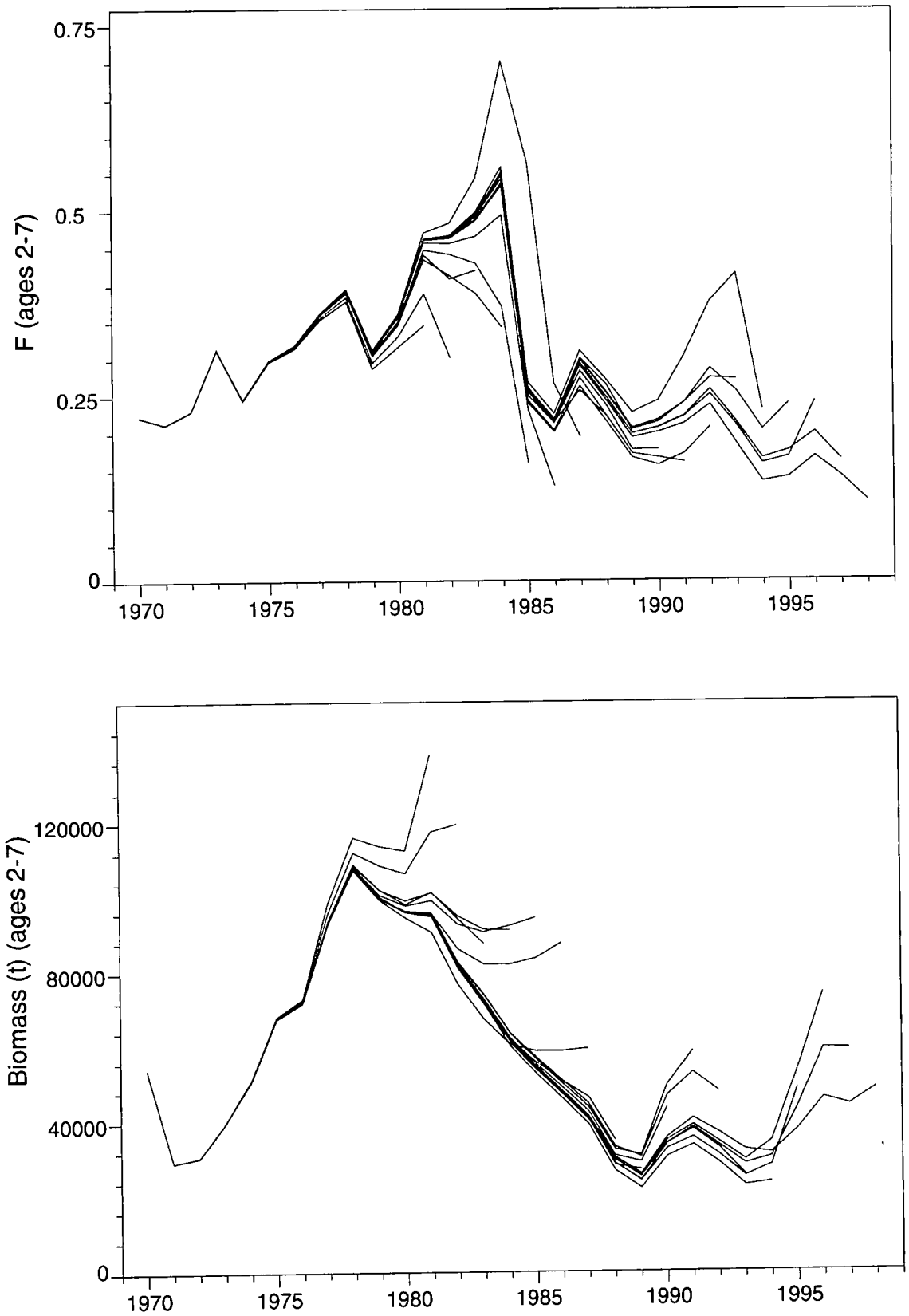


Figure 27. Retrospective analysis of SPA results.

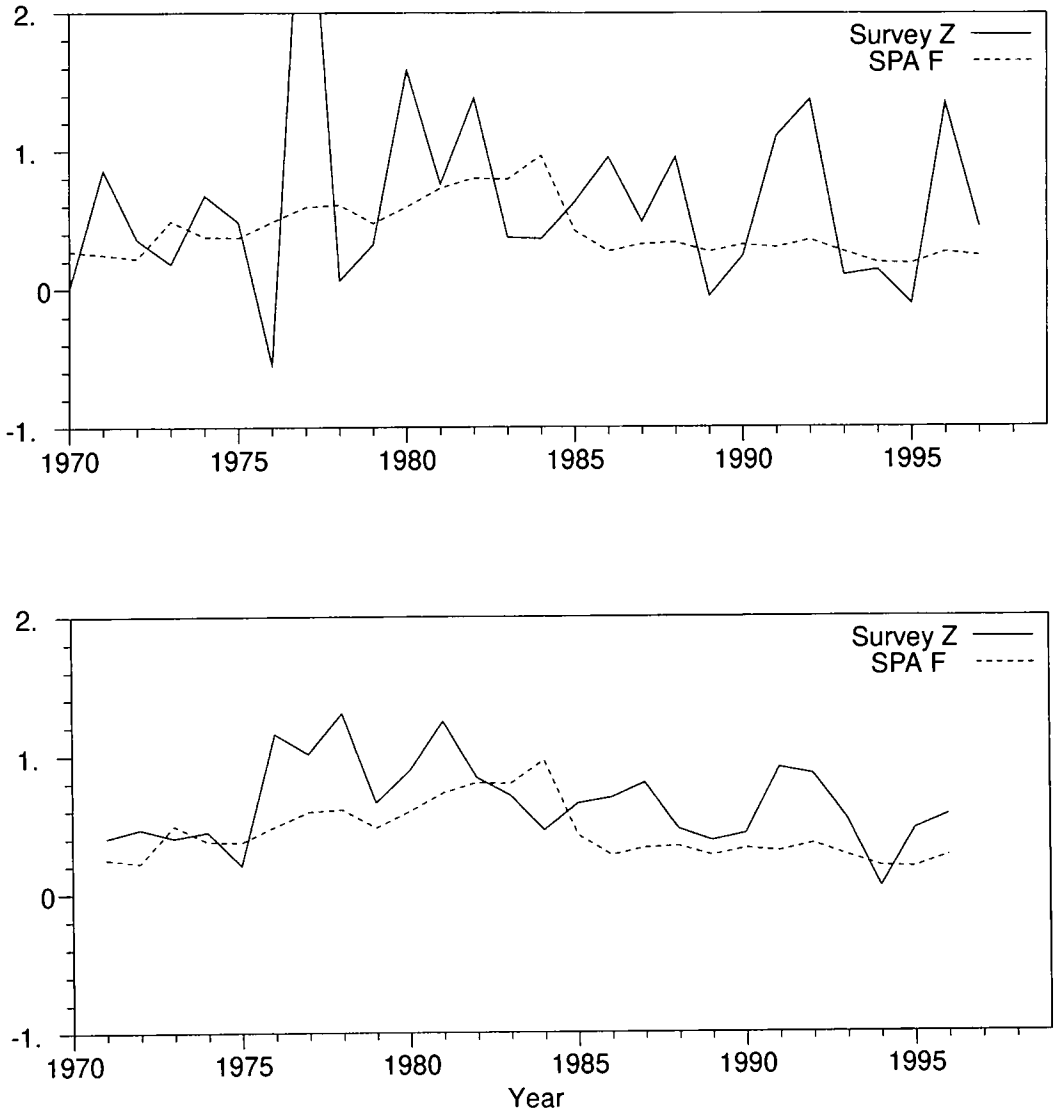


Figure 28. A comparison of total mortalities (Z) calculated from the summer research vessel survey and fishing mortalitles from the SPA for fully recruited ages (5-7). Three year running means in the lower panel.

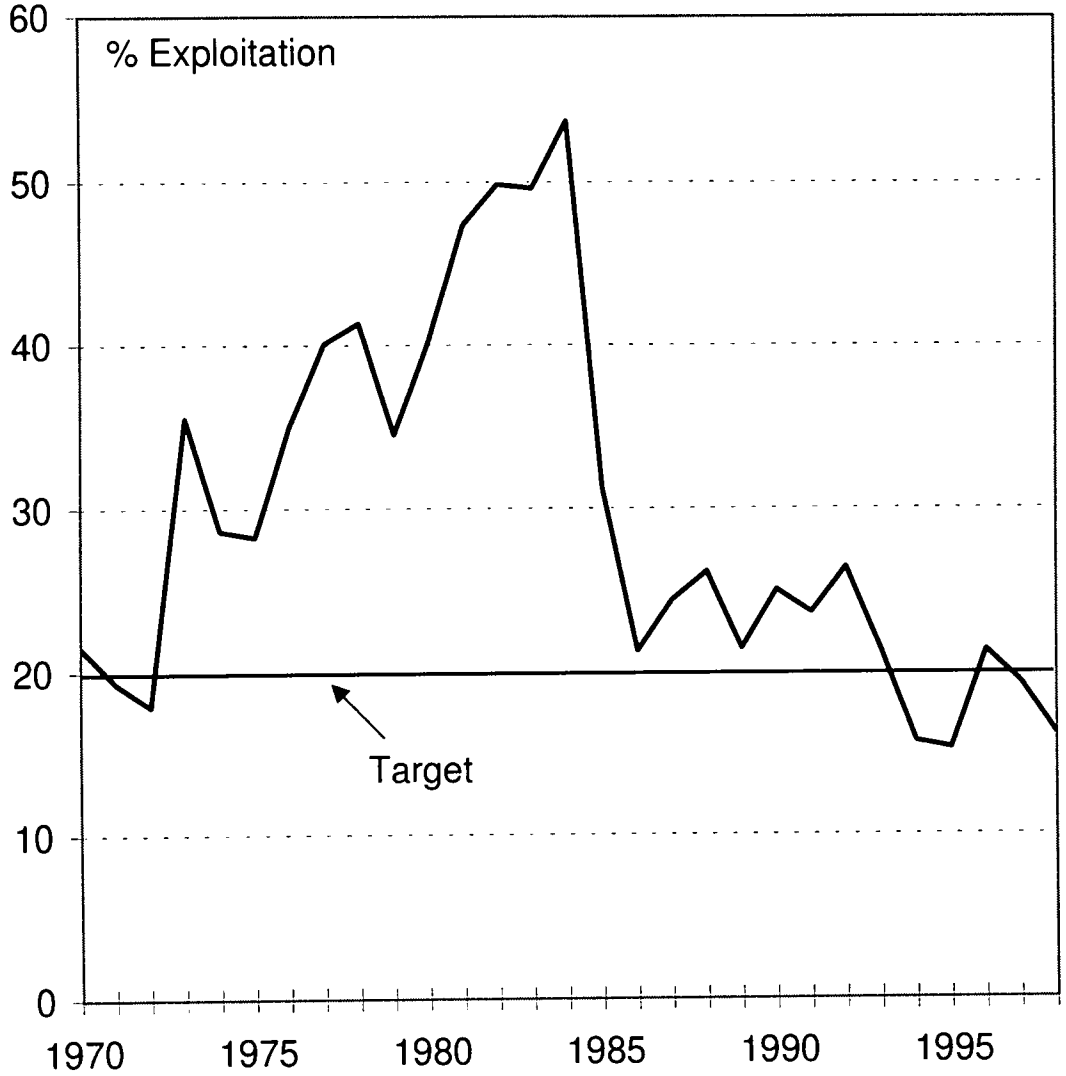


Figure 29. Exploitation level (%) for 4X haddock 1970-98 from this assessment (note 1998 value is from half-year landings).

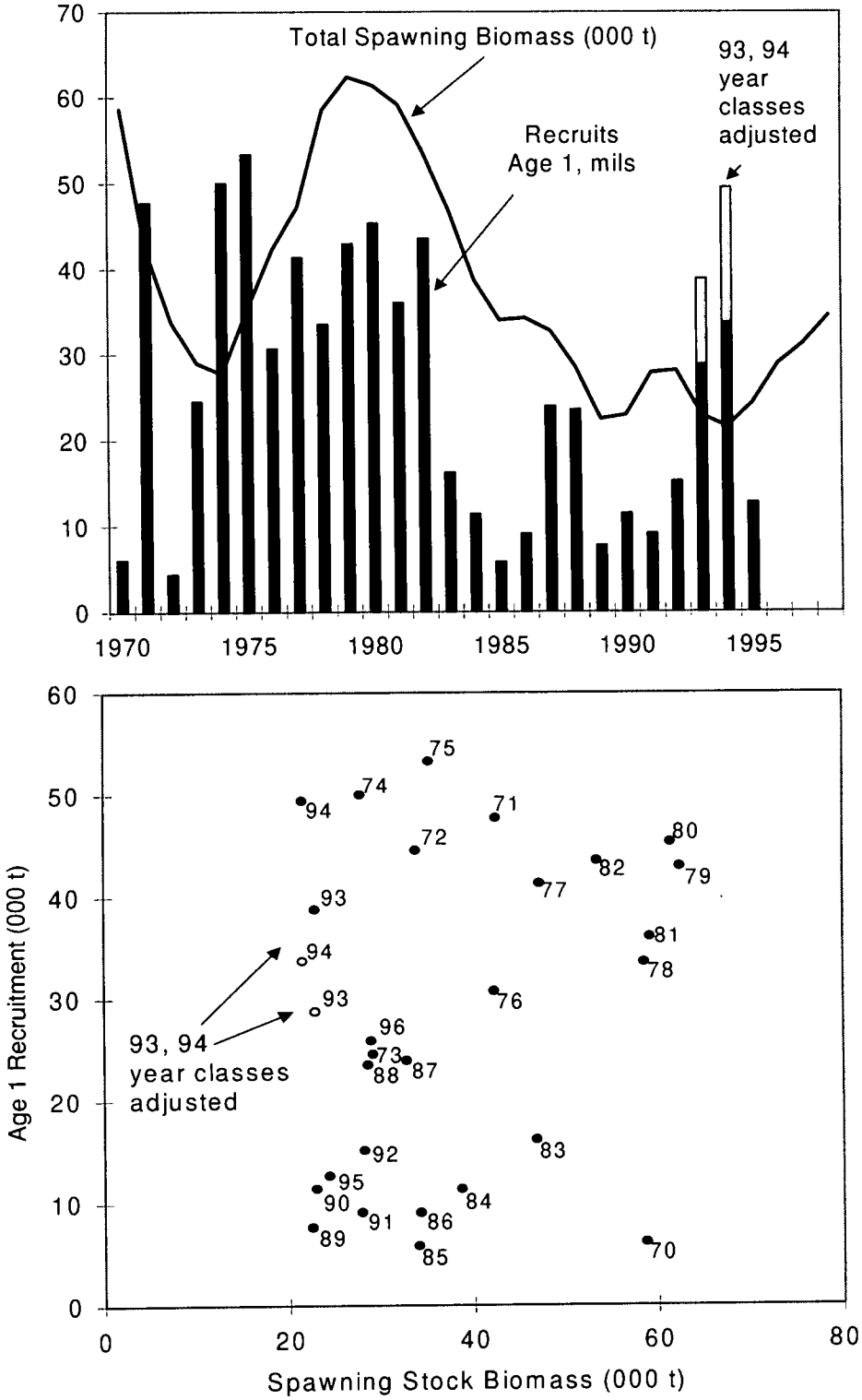


Figure 30. Spawning stock biomass and age 1 recruitment in the subsequent year from this assessment. Labels in lower panel are year-class.

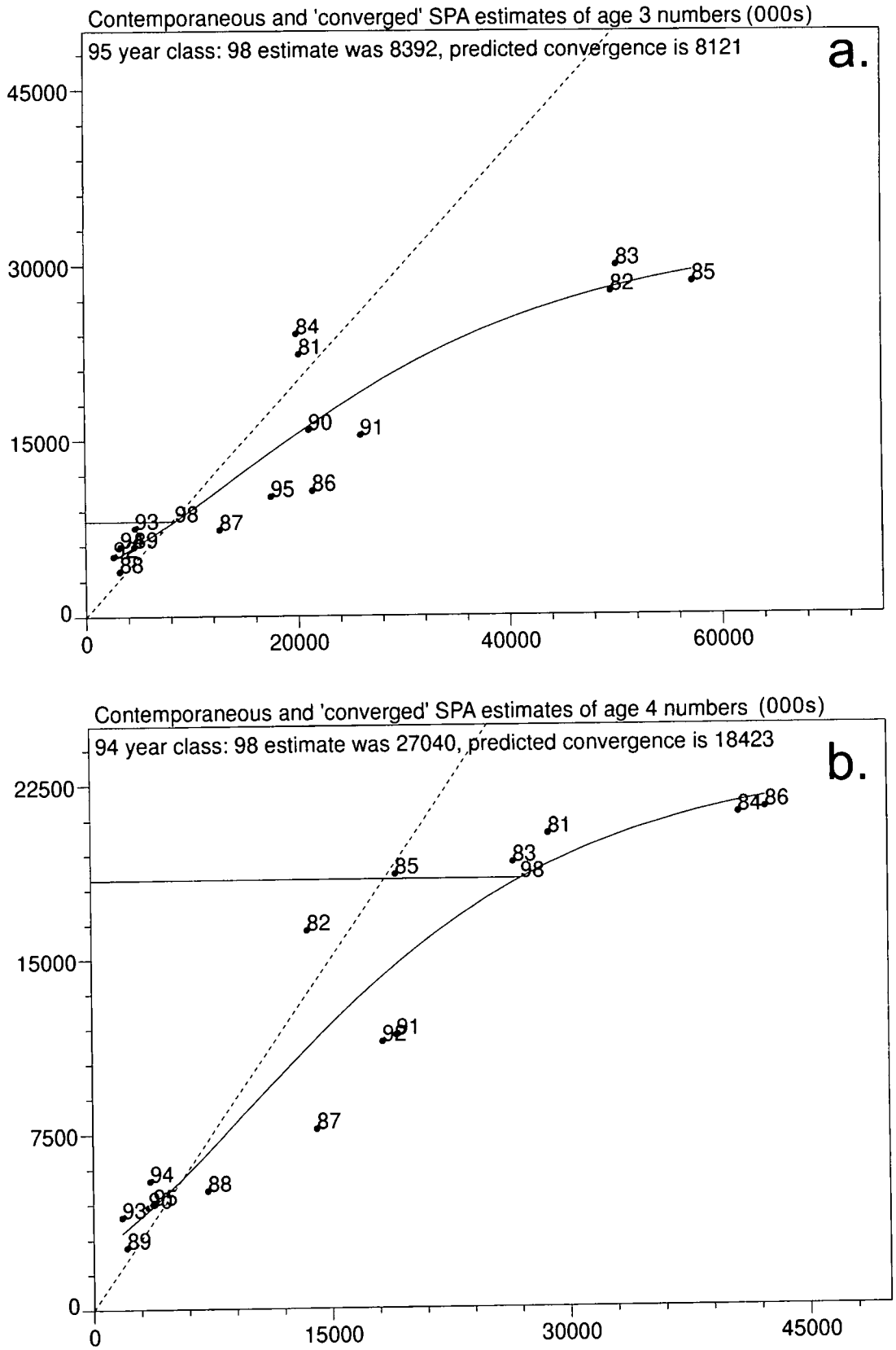
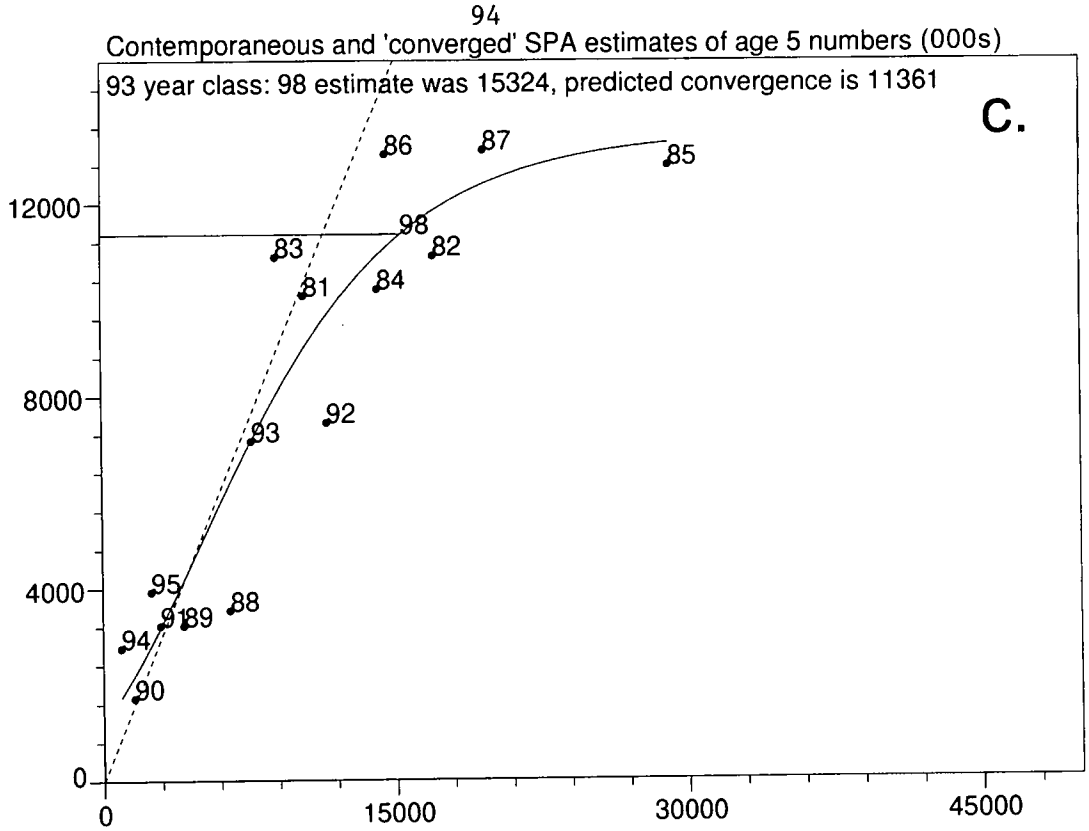


Figure 31. Contemperaneous and converged SPA estimates of (a.) age 3 and (b.) age 4 population numbers. The solid line is a Gompertz fit and the dashed line is unit slope. The number denotes year.



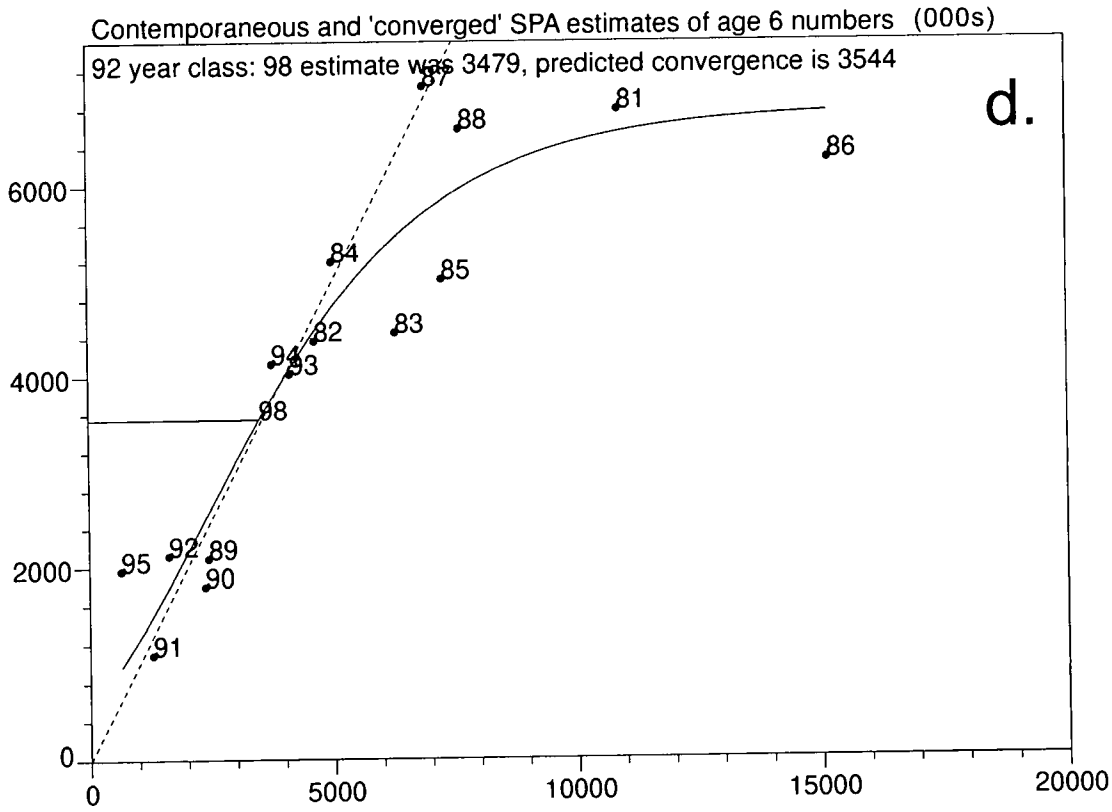


Figure 31 (cont.) Contemperaneous and converged SPA estimates of (c.) age 5 and (d.) age 6 population numbers. The solid line is a Gompertz fit and the dashed line is unit slope. The number denotes year.

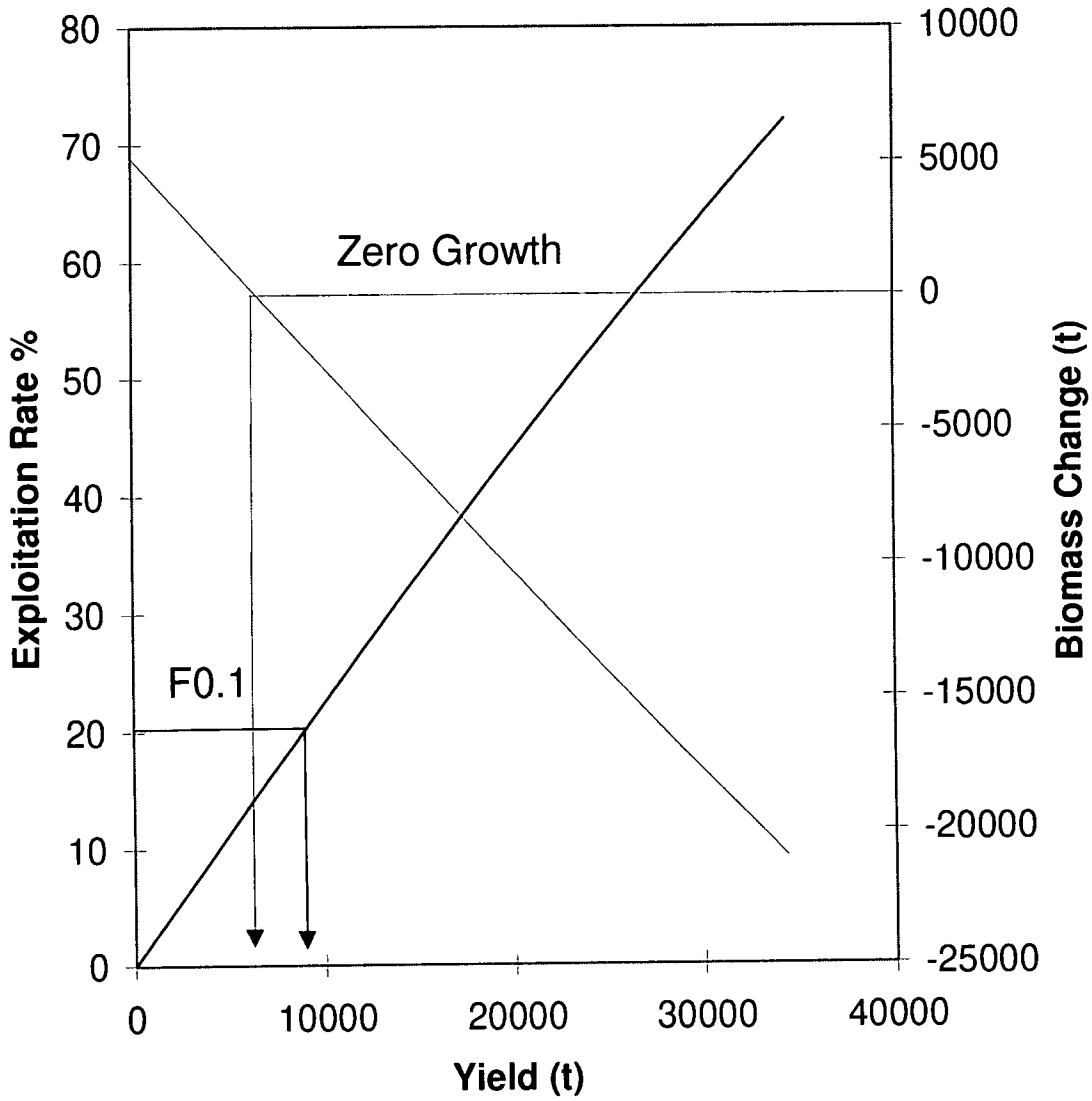


Figure 32. 4X haddock projection showing trajectories of exploitation rate and change in spawning stock biomass at various levels of yield in 1999.

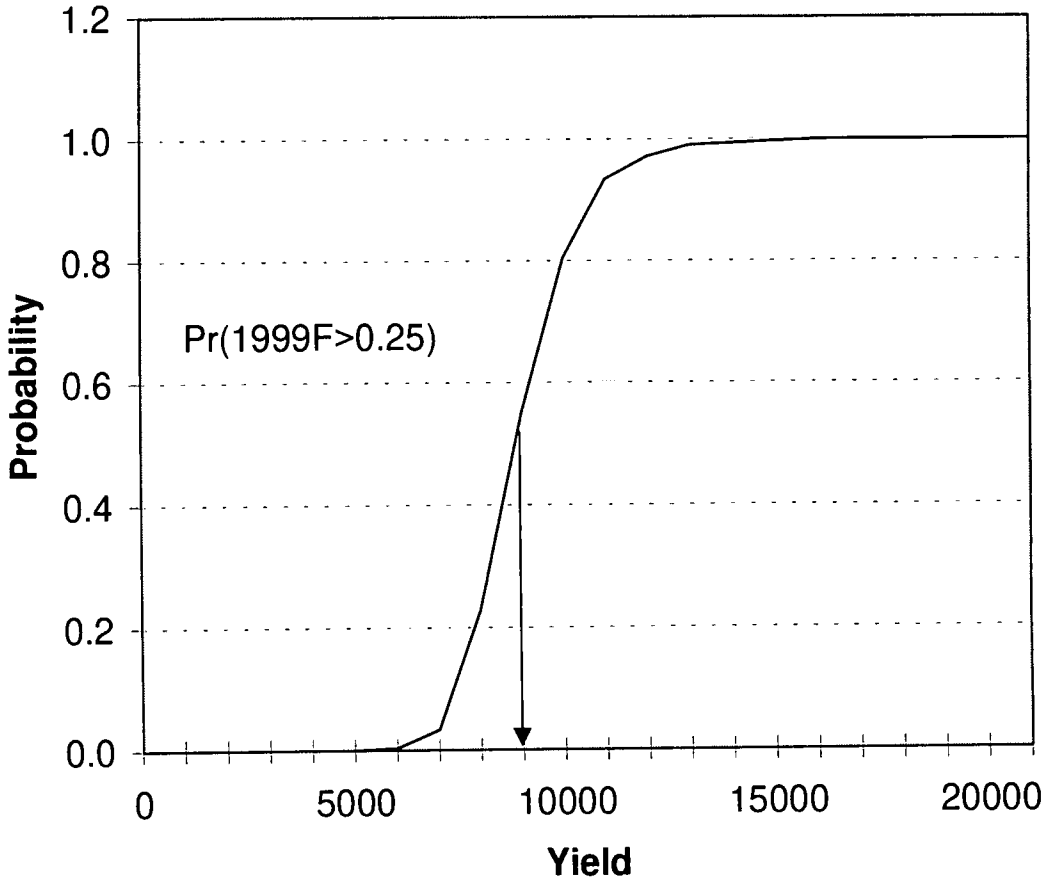


Figure 33. Probability that $F_{0.1}$ will be exceeded at various levels of yield in 1999 from 4X haddock projections.