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Research Document 2002/098 | **Document de recherche 2002/098**

Assessment of the Status of Div. 4X/5Y Haddock in 2002

Évaluation de l'état du stock d'aiglefin des divisions 4X5Y en 2002

P.C.F. Hurley, G.A.P. Black, J.E. Simon, R.K. Mohn, and P.A. Comeau

Marine Fish Division
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS B2Y 4A2

ISSN 1480-4883

Canada

Abstract

The quota for 4X/5Y haddock has remained at 8,100t for the last 5 years and reported landings have been close to the quota each year. Abundance has been increasing since the early 1990s and is presently high. Production has been decreasing since the late 1970s and is presently low. Size-at-age, growth rate and fish condition are all at or near the lowest observed. Exploitation rate for ages 5-7 decreased from approximately 50% in the early 1980s but dropped below 20% (which corresponds to the currently used $F_{0.1}$=0.25) in 1994 to the present. Partial recruitment has changed in recent years and fully recruited ages have changed from 5-7 to 8-10. Exploitation on fully recruited ages in the 2002 fishing year will be below $F_{0.1}$ if the TAC is not exceeded. The 1998 yearclass is estimated to be the largest observed in the time series, and the 1999 yearclass is estimated to be very strong. These yearclasses may be overestimated by a factor of 2, due to the retrospective pattern. Spawning stock biomass (ages 4+) is estimated to increase to a high in 2003 and then decrease unless further strong recruitment occurs. Projected yield at $F_{0.1}$ in the 2003 fishing year ranges from 9,000-15,000t depending upon the weights-at-age used to calculate yields. Emphasis should be on how the potential yield from the current good recruitment should be utilized over time, and on the implications of that decision for 4X cod conservation as a result of the mixed fishery problem.

Résumé

Le quota d'aiglefin de 4X5Y est demeuré inchangé à 8 100 t pour les cinq dernières années et les débarquements déclarés se rapprochaient du quota chaque année. L'abondance, à la hausse depuis le début des années 1990, est présentement élevée, mais la production, à la baisse depuis la fin des années 1970, est faible en ce moment. La taille selon l'âge, le taux de croissance et la condition du poisson se situent tous à, ou près des plus faibles niveaux observés. Le taux d'exploitation des âges 5 à 7, qui se situait à environ 50 % au début des années 1980, est tombé à moins de 20 % (ce qui correspond au $F_{0.1}$ = 0,25 utilisé en ce moment) en 1994, niveau où il se situe maintenant. Le taux de recrutement partiel a changé dans les dernières années, les âges pleinement recrutés ayant passé de 5 à 7 ans à 8 à 10 ans. Le taux d'exploitation des âges pleinement recrutés pendant la saison de pêche 2002 sera inférieur à $F_{0.1}$ si le TAC n'est pas dépassé. Selon les estimations, la classe d'âge de 1998 sera la plus abondante de la série temporelle et celle de 1999 sera très abondante. Il se peut que ces classes d'âge soient surestimées par un facteur de 2, à cause du profil rétrospectif. La biomasse du stock reproducteur (âges 4+) devrait atteindre un pic en 2003, pour ensuite diminuer, à moins d'un recrutement en force. Le rendement prévu de la pêche à $F_{0.1}$ en 2003 varie entre 9 000 t et 15 000 t, selon le poids à l'âge utilisé pour calculer le rendement. L'accent devrait être mis sur la manière d'utiliser au fil du temps le rendement potentiel provenant du bon recrutement actuel ainsi que sur les répercussions de cette décision pour la conservation de la morue de 4X à la lumière du problème de la pêche mixte.

Introduction

This document contains an evaluation of the haddock stock on the Southern Scotian Shelf and Bay of Fundy (NAFO Division 4X). As in previous assessments of this stock (Hurley et al. 1998, 1999), haddock caught by Canadian fishermen in NAFO Division 5Y are included in the management unit. Haddock in the Bay of Fundy area grow faster than haddock on the southern Scotian Shelf. As a result, haddock landings from 4Xmnop and 4Xqrs/5Y are handled separately and separate age/length keys are used for the two areas, designated as Scotian Shelf and Bay of Fundy stock components respectively (Figure 1). Similarly haddock catches from the research vessel survey strata 470-481 and 482-495 are handled separately, as Scotian Shelf and Bay of Fundy components (Figure 2). In 1999, the fishing year was changed from January to December to April to March. The TAC of 8,100t established for the 12-month fishery in 1999 was extended to 9,800t for the 15-month period ending March 31, 2000, based on the proportion of landings in the first quarter of the year over the last 10 years. The fishing year since then has been April 1 to March 31. The TAC has remained at 8,100t for the 2000/01, 2001/02 and 2002/03 fishing years.

The last full assessment of this stock was conducted in 1999 (Hurley et al. 1999) with annual updates in 2000 and 2001 (DFO 2000,2001). This assessment includes the research vessel survey data in the current year 2002, 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 the fishing year 2003/4. The results of an industry survey conducted in 1996-2002 were also used in the assessment.

Description of the Fishery

The long-term (1948-2001) reported annual landings of haddock in NAFO Division 4X/5Y average about 18,000t. 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. The TAC in 1998 was 8,100t and total reported landings were 7,843t (Table 2). The 1999 TAC was set at 8,100t and was subsequently changed to 9,800t for a 15 month period ending March 31, 2000, based on proration from the average first quarter landings over the last decade. This 15-month quota was necessary to change the fishing year to an April 1 starting date. The TAC has remained at 8,100t for the last 3 years and reported landings have been close to the TAC.

The 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 increased since and was 73% in 2001.

Details about the management history of the fishery can be obtained from Hansen and Annand (1994, 1995, 1996, 1997) and Hurley et al. (1996, 1997, 1998, 1999). Several recent changes to the management of this fishery have had a significant impact on the timing of the fishery. As a result of the change to an April-March fishing year in 1999, landings in the first quarter of 2000 and 2001 were the highest since 1992 (Table 4, Figure 4 and 5). Landings in the first quarter of 2002 were also high. Both the fixed gear and mobile gear sectors indicate this is due primarily to the ability to direct for haddock with a minimal bycatch of cod at that time of year. This situation has been necessitated by the low quotas for cod in the last 3 years. The introduction of sharing arrangements in the fixed gear sector, as a result of Community Management Boards, has also contributed to this change.

The change in timing of the fishery has resulted in a change in the distribution of catches. The proportion of catches coming from 4Xn and 4Xp has been increasing in recent years (Table 4, Figure 4 and 5). While the increase in 4Xn is largely result of the increase in the winter fishery, the increases in changes in 4Xp likely reflects directing for larger haddock in deeper water.

The 2002 fishing year is progressing much like the previous two years. Although most fishermen are attempting to avoid catching cod, 70% of the overall cod quota had been landed by October 24th, while only 56% of the haddock quota had been landed.

Reports from industry indicate that haddock abundance has been good throughout the stock area in recent years although there were reports of changes in inshore distribution. Catches of small fish have been prevalent, particularly in eastern 4X. Port samples indicate that the proportion of fish <43cm in landings from 4Xmnop by quarter and gear type was as high as 23%. Reports indicate that discarding and misreporting of 4X/5Y haddock have been minimal in recent years.

Data

Age Composition of the Catch

Port samples of landings were used to construct a catch-at-age for 1999, 2000, 2001 and the first half of 2002 as in previous assessments of this resource. The age composition was derived by application of age/length keys to length frequencies, stratified by quarter and gear. Due to differences in growth rates between haddock on the Scotian Shelf and in the Bay of Fundy, landings are separated into 4Xmnop and 4Xqrs5Y and separate age/length keys were used, whenever possible. Seasonal length/weight parameters derived by O'Boyle et al. (1983) were used. When insufficient samples are available to satisfy this stratification, length frequencies may need to be aggregated and a common age/length key applied. In some cases, a key from one gear, quarter or area may have to be applied to another where no otoliths are available. The gear and quarter aggregations are shown in Tables 5-8.

The resulting catch-at-age is shown in Table 9 and the catch-at-age as proportion is shown in Table 10 and Figure 5. One can see the 1993 and 1994 yearclasses recruit to the fishery at age 2 and 3 and become dominant in the fishery in 1997-1999 when they made up more than 50% of landings by number in those years. These two yearclasses still made up 33% of landings by number in 2001 and the impact of these two yearclasses can be seen through to 2002. The 1998 yearclass made up 5% of landings by number at age 2 and 22% at age 3. In the 2002 half year catch at age, the 1998 yearclass made up 36% of the landings by number.

As a routine check, the primary ager read the 4X haddock otolith reference collection. A pair-wise comparison of ages showed high precision and little bias, with an overall coefficient of variation of 2.2% (Figure 6). The results were considered acceptable.

Mean weights-at-age in the commercial landings have been variable with a modest decline since the early 1990s. The age 5 weight-at-age in recent years is similar to that since 1970, but ages 7 and older are very low compared to the 1970s and early-1980s (Table 11, Figure 7).

In 1984/1985, there was a change in the methodology used to determine ages in this resource from "crack and burn" to "thin section" (this change in methodology is not restricted to 4X haddock). Concerns have been expressed that the decreases in size-at-age observed in that period may be due to changes in the methodology, not to changes in growth rate, and this needs to be investigated.

Research Vessel Surveys

A summer groundfish research 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 is shown in Figure 2. The vessel conversion factor of 1.2 was used for the *A.T. Cameron* surveys (Fanning 1985). Catches from the 2000-2002 surveys are shown in Figure 8. Mean number per tow by stratum is shown in Table 12.

Mean number per tow of 4X haddock in 2002 declined from the high levels of the past several years but were still well above the long-term mean (Figure 9). Mean weight per tow also decreased in 2002 but was still above the long-term mean. These decreases were more pronounced in the Scotian Shelf strata (Figure 10).

A comparison of haddock ages by the primary and secondary agers showed good precision and little bias, with coefficients of variation of 3.5 and 3.4 for the 2000 and 2001 surveys respectively (Figure 11). Although there was a bias at older ages, the sample size at those ages was small and the results were considered acceptable.

Mean numbers-at-age per standard tow for the 1970-2002 summer RV surveys are shown in Table 13 and the age composition of the surveys from 1995-2002 are shown in Figure 12.

The above average 1993 and 1994 yearclasses are apparent. The 1998 and 1999 yearclasses are very strong and 2000 yearclass is also above average.

The weight per tow of ages 4+ in the RV survey, as a proxy for spawning stock biomass, was used as an indicator of abundance. Abundance has shown an increasing trend since 1993 and was above average above the long-term average in 2002 (Figure 13).

The catch per tow of ages 2 and 3 in the RV survey, adjusted by the calibration coefficients from the SPA, was used as an indicator of recruitment. Recruitment was below average from 1983 to 1992, with the exception of the 1987 and 1988 yearclasses. The 1993 and 1994 yearclasses were above average. The 1998 yearclass is the largest in the RV survey series and the 1999 yearclass is the third largest (Figure 13).

The age structure of a population reflects the quality of the population abundance. In general, a broader range of ages is more likely to represent a healthy stock. Several means of expressing this were explored, in particular the number of ages between the 10^{th} and 90^{th} percentiles in the RV survey in a year and the number of above average ages 4-10 in a year in the RV survey (Figure 14). The latter was used as an indicator of population age structure. This indicator has been increasing since 1995 and all ages were above average in 2002. This may not be the best indicator of age structure because it is insensitive to the relative contribution of older ages with the age distribution, which are thought to have a higher reproductive potential. Further work is required in this area.

Several indices can provide insight into the distributional properties of abundance. The proportion of annual survey sets where a species occurs (non-zero sets) is a measure of the area occupied by the species. The area occupied in the RV survey by haddock 43cm and greater in length (approximates ages 4+, as this calculation cannot presently be done using age data) has shown an increasing trend since the late 1980s and is near the high levels seen in the late 1970s and early 1980s (Figure 15). The area occupied by haddock 26-42cm (approximates ages 2 and 3) has shown an increasing trend since the late 1980s and is at the highest level observed in the series.

The average catch rate in the annual survey sets where a species occurs is a measure of the local density of the species. Local density in the RV survey of haddock 43cm and greater has shown an increasing trend since the early 1990s and about average in 2002 (Figure 15). The local density in the RV survey of haddock 26-42cm has been increasing since the early 1990s and is at the highest level observed in the series.

Mean lengths-at-age of haddock in 4X in the RV survey decreased through the mid- to late 1980s (Table 14, Figure 16). Some recovery occurred in the late 1980s and early 1990s, but not to the sizes of the earlier period. Mean lengths-at-age have been decreasing since the early to mid 1990s, particularly at older ages. Mean weights-at-age show similar trends (Table 15, Figure 16). Many ages are below the long-term mean length and weight and some are at the smallest size observed in the RV series. A comparison of weights-at-age from the commercial fishery and from the RV survey, show similar trends at ages 7 and 9, but some differences at age 5 in the recent period and different trends at age 3, suggesting that age 3 is

not fully recruited to the fishery and that age 5 has become less so in the last 5 years (Figure 17).

The instantaneous annual growth rate (G) calculated for length at ages 2-7 shows a long-term decreasing trend since the mid-1970s but shows some sign of stabilizing in the last few years (Figure 18). This was used as an indicator of production.

The predicted weight of a haddock at a length of 50cm is considered an index of fish condition, of relative weight at length (i.e. plumpness). This index declined through the late 1980s and early 1990s and after showing some improvement, has decreased to lowest level observed (Figure 19). Fulton's K, also an index of fish condition, shows a similar trend (Figure 19). For cod, low levels of Fulton's K have been related to poor reproductive success, and to post-spawning mortality at very low levels. Similar experiments have not been conducted for haddock. It would appear that the levels observed here for haddock have not affected reproductive success. However, poor condition does reflect low productivity. This index was used as an indicator of production.

Total mortality (Z) estimated for ages 5-7 (historically fully recruited) from the RV surveys were relatively stable in recent years with an implied fishing mortality of about $F_{0.1}$ (assuming natural mortality of 0.2) (Figure 20). Relative fishing mortality calculated from commercial catches and RV survey biomass for ages 5-7 showed an increasing trend through the 1970s to a maximum in the early 1980s, followed by a decreasing trend. Relative F increased 1992-1994, but decreased in 1995 and has remained relatively stable since (Figure 20).

Industry Survey

The mobile gear <65 ft (ITQ) fleet has conducted a joint resource survey with DFO since the summer of 1995. The survey is conducted in July, the same time that the DFO research vessel survey is conducted, by 3 draggers (<65 ft) equipped with standardized gear with the same size codend liner as used in the RV survey. A fixed station design, based on the RV survey strata, is used and standardized tows are made. The survey is designed to cover the entire 4X area, included the large inshore area off southwest Nova Scotia not covered by the RV survey. Further details are summarized in O'Boyle et al. 1995 and Hurley et al. 1999. Due to changes in the survey design between 1995, the first year of the survey, and subsequent years, the 1995 survey was not used in the time series here.

Haddock catches in the 2001 and 2002 ITQ surveys are shown in Figure 21. As with the RV survey, haddock catches are widespread throughout most of 4X, with the exception of the inshore areas off southwest Nova Scotia and in eastern 4X. Mean number and weight per tow trends and mean number-at-age per tow are shown in Table 16. Both mean number and mean weight per tow were stable 1996-1998, then increased 1999-2001 and decreased in 2002. Haddock age composition from the ITQ survey is shown in Figure 22. The 1993 and 1994 yearclasses were also above average in this survey. The 1998, 1999 and 2000

yearclasses were all strong , but catches of these yearclasses were considerably lower in 2002.

Mean weight per tow of ages 4+ from this survey was also used as an indicator of abundance and has shown an increased trend since 1996 (Figure 23). As with the RV survey, the catch per tow of ages 2 and 3 in the ITQ survey, adjusted by the calibration coefficients for this survey from the SPA, was used as an indicator of recruitment (Figure 23).

Estimation of Stock Parameters and Results

A traditional age-based Sequential Population Analysis (SPA) using the ADAPT framework (Gavaris 1988) was used to produce estimates of population abundance in numbers. The SPA model used is as follows:

Parameters:

Population numbers at mid-year $N_{i,2002}$ i = 2-10
Calibration coefficients $q_{1,i}$ i = ages 2-10 for July RV survey
$q_{2,i}$ i = ages 2-10 for ITQ survey

Structure Imposed:

Error in catch assumed negligible
Partial recruitment fixed for age 1 in 2002
F on oldest age (10) set as average F of ages 8-9 adjusted by the partial recruitment of age 10 in 2002
No intercepts were fitted
M = 0.2 for all ages

Input:

$C_{i,t}$ i = 1-10; t = 1970 to 2002 - catch-at-age for entire year (half year for 2002)
$J_{i,t}$ i = 2-10; t = 1970 to 2002 - July RV survey index
$ITQ_{i,t}$ i = 2-10; t = 1996 to 2002 - 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: 297 for July RV (9 ages by 33 years)
63 for ITQ (9 ages by 7 years)
Number of parameters: 27, 9 ln Ns estimated by NLLS, 18 qs algebraically

age	1	2	3	4	5	6	7	8	9	10
partial recruitment	.0001	.004	.055	.205	.503	.814	.918	1.00	1.00	1.00

The SPA inputs, commercial catch numbers-at-age, RV survey stratified mean numbers-at-age per tow, and ITQ survey mean numbers-at-age per tow, are shown in Tables 9, 13 and 16 respectively. Residuals from the model fit and summary statistics of overall fit of the model are shown in Table 17 and Figure 24. The resulting estimates of population numbers and biomass, and fishing mortality are shown in Table 18. As with previous assessments of this resource, the residuals show some strong year effects, with positive residuals at all ages in some years and negative residuals at all ages in other years.

Recruitment from 1983-92 was below average, although the 1987 and 1988 yearclasses were near-average in strength (Figure 25). Both the 1993 and 1994 yearclasses were above average. The 1997 yearclass was average and the 1998 yearclass is estimated to be the strongest in the time series. The model suggests that the 1999 yearclass is also very strong and that the 2000 yearclass is above average.

Spawning stock biomass (ages 4+) decreased from a peak in 1979 and reached a low of 19,000t in 1990 (Figure 25). The above average 1993 and 1994 yearclasses resulted in spawning stock biomass increasing to 41,000t in 1998. The average 1997 yearclass and the large 1998 yearclass are estimated to increase spawning stock biomass to 63,000t in 2002.

There appears to be no relationship between spawning stock biomass and recruitment over the biomass range observed (Figure 26).

The exploitation rate on ages 5-7 (historically fully recruited) increased from the 1970s to approximately 50% in the early 1980s (Figure 25). It declined to close to $F_{0.1}$ (20% exploitation, currently used value of $F_{0.1} = 0.25$) in the late 1980s and dropped below $F_{0.1}$ in 1994. Exploitation rate on ages 5-7 dropped again in 2000 and 2001. Partial recruitment has changed in recent years and fully recruited ages changed from 5-7 to 8-10. The exploitation rate on older ages has remained high at about 22% in those years.

Estimates of total mortality calculated from the RV surveys were comparable with fishing mortality estimates from the SPA (Figure 27). This implies that there has not been an increase in natural mortality in this resource, as has been the case with a number other groundfish stocks on the Scotian Shelf recently.

Past assessments of this resource have exhibited 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 pattern of exploitation estimates in this case is variable and does not show a consistent over- or under-estimation (Figure 28). The biomass estimates do exhibit a consistent pattern of over-estimation of population abundance in the most recent year, particularly when strong yearclasses occur. Retrospective estimates of yearclass size indicate that early estimates of large yearclasses may be over-estimated by a factor of at least 2 and that this pattern of over-estimation can persist at older ages (Figure 29).

Projected yield and spawning stock biomass were calculated using recent mean weights-at-age. Weights-at-age in this resource have been declining since the mid- 1990s. If this trend continues, then yield and spawning stock biomass will be over-estimated. A shift in the proportion of landings from the Bay of Fundy to the Scotian Shelf, where growth is considerably slower, would also result in yield being over-estimated.

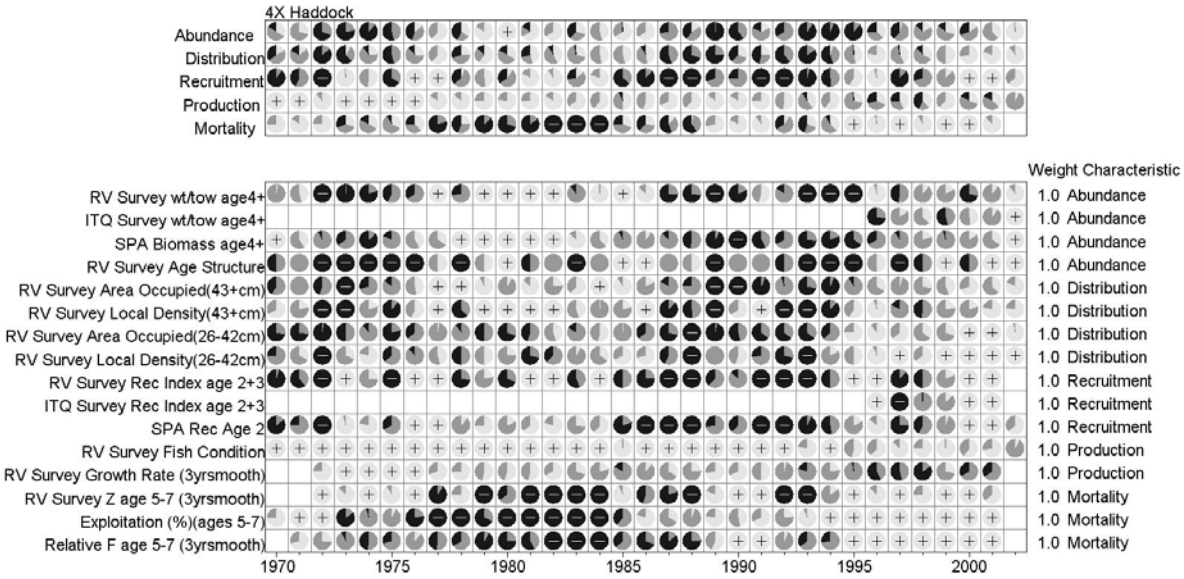
In 1984/1985, there was a change in the methodology used to determine ages in the resource from "crack and burn" to "thin section" (this change in methodology is not restricted just to 4X haddock). Concerns have been expressed that the decreases in size-at-age observed in that period may be due to changes in the methodology, not to changes in growth rate, and this needs to be investigated. This would not just effect estimates of size-at-age, but also estimates of spawning stock biomass and exploitation rates during that period.

Traffic Light Analysis

Considerable effort has gone into development of the Traffic Light Method for use in fishery management planning (see Halliday et al. 2001 and RAP 2000, 2001a, 2001b, 2001c for details).

The Traffic Light table summarises the indicators of stock status shown above. This table shows the annual values of each indicator as a combination of three lights depending on whether they are among the best values for that indicator, among the worst or in between. For indicators such as stock biomass and recruitment, high values are good and have a green light + and low values are bad and have a red light −. However, for indicators such as mortality, high values are bad and are assigned a red light whereas low values are good and receive a green light. Intermediate values (midpoint between red and green) are yellow ●. A value between red and yellow is expressed as a pie with increasing amounts of red in the pie as the value approaches the red threshold or cut point. Similarly, a value between the midpoint and the green cut point becomes increasingly green in the pie as the green cut point is approached. Empty cells in the table indicate no observation for that year. Uncertainties about the appropriate cut point resulted in a broad yellow zone.

In the traffic light analysis, indicators are summarised into groups, which emphasise specific aspects of the resource. These groupings are called characteristics; abundance, distribution, recruitment, production, and mortality. The following outlook is cast in terms of these characteristics.



See Appendix 1 for a description of the traffic light indicators, the boundary points, and the weights and rationales for these.

Contact the primary author for a colour copy of the Traffic Light Table.

Outlook

Indicators of abundance (RV Survey wt/tow ages 4+, ITQ Survey wt/tow ages 4+, SPA Biomass ages 4+, RV Survey Age Structure) all show increasing trends in the most recent period and all indicate that the 2002 value is above average. The large increase in 2002 4+ biomass is a result of the 1998 yearclass.

Indicators of recruitment (RV Survey Recruitment Index ages 2+3, ITQ Survey Recruitment Index ages 2+3, SPA Recruitment age 2) all show that the 1998 yearclass is the strongest observed in the survey/SPA time series. The 1999 yearclass is also very strong and the 2000 yearclass may be above average. The 1993 and 1994 yearclasses were above average.

The distribution indicators (RV Survey Area Occupied 43+cm, RV Survey Local Density 43+cm, RV Survey Area Occupied 26-42cm, RV Survey Local Density 26-42cm) show that fish at lengths that approximate the spawning stock are near the widest area occupied observed and the local density is about average. The area occupied by fish at lengths that approximate recruits is at the widest observed and the local density is also at the highest.

The indicators of production (RV Survey Growth Rate, RV Survey Fish Condition) have been decreasing since the late 1970s to early 1980s and are at or near the lowest levels observed.

The indicators of mortality (RV Survey Total Mortality ages 5-7, SPA Exploitation ages 5-7, Relative Fishing Mortality ages 5-7) show that mortality has been low in recent years. It should be noted though that fully recruited ages have changed from 5-7 to 8-10 in recent years and F on these ages continues to be high.

Projected yield was calculated using the recent partial recruitment pattern. While the very strong incoming 1998 and 1999 yearclasses may result in an increase in the partial recruitment to the fishery at ages 4 and 5 in 2003, the extent of this is uncertain. Therefore the projected yield was calculated using the 1999-2001 average partial recruitment. Weights-at-age in the fishery are currently larger than those indicated for the population by the research vessel survey. Projected yield was calculated using recent weights-at-age from the fishery, but also using weights-at-age from the research vessel survey to approximate the anticipated increased contribution of catch from the Scotian Shelf stock area, if quotas and catches increase significantly. Projections using the survey weights-at-age are considered a lower bound and results closer to those using recently observed fishery weights-at-age are more likely. The table below shows projected yield at F=0.25 (currently used for $F_{0.1}$) for the 2003 fishing year and the spawning stock biomass (ages 4+) at the beginning of the 2003 fishing year.

This analysis indicates that landings of 8,100t (TAC) in the 2002 fishing year will result in an exploitation rate below $F_{0.1}$.

Weight-at-age	2003 SSB (t)	2003 Yield (t)
high	79,000	15,000
low	77,000	9,000

If fished at $F_{0.1}$, spawning stock biomass is estimated to increase to a high in 2003 and then decrease subsequently, unless further strong recruitment occurs.

It is possible to estimate the uncertainties from the model regarding stock size and then use these in a risk analysis. The risk plot incorporates the discrepancy between the accepted model and the data. Other uncertainties not considered in this risk analysis include errors in the model and model formulations, changes in fishing practices, and environmental effects on survivorship. The spawning stock biomass is currently near historically high levels; therefore a change in spawning stock biomass in not an immediate concern. Accordingly the risk analysis is done only to measure if we are keeping fishing mortality at a moderate level. The steepness of the curves indicates that the risk analysis results are relatively robust to estimation error for abundance but the distance between them indicates they are sensitive to assumptions of fishery weights-at-age (Figure 30).

Given the retrospective pattern observed in this resource in the past when strong yearclasses were present, this assessment likely over-estimates biomass.

Although we have observed high recruitment and recruits that are widely distributed at high local density, the spawners exhibit low growth rate, below average size-at-age, and lower condition. It is uncertain how this will impact future production.

In summary, high exploitation in the early 1980s, despite good recruitment, led to declines in spawning stock biomass. Although exploitation decreased to near $F_{0.1}$ in the late 1980s, declining production and poor recruitment resulted in further declines in spawning stock biomass. Improved recruitment and low exploitation in the early 1990s started stock rebuilding. Continued low exploitation since 1994 and the above average 1993 and 1994 yearclasses have allowed spawning stock biomass to continue to rebuild. The very strong 1998 and 1999 yearclasses are expected to continue this trend.

The resource is rebuilding, due to record high levels of recruitment and low recent exploitation levels. Spawning stock biomass is near the high levels of the late 1970s/early 1980s and is projected to exceed these levels in 2003 but will decrease unless further strong recruitment occurs. Thus emphasis should be on how the potential yield from the current good recruitment is to be utilized over time, and on the implications of that decision for 4X cod conservation as a result of the mixed fishery problem.

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

Year	Annual Catch	TAC	Fishing Year** 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	7843	8100		
1999	6621	8100	9291	9800
2000	6961		7761	8100
2001	8466		7411	8100
2002*	3937		1524	8100

* - Landings to June 30th,2002

** Fishing year in 1999 was extended to Mar 31,2000. TAC prorated upwards. Subsequent fishing years begin on April 1.

Table 2. Reported nominal catch (t) of haddock from NAFO Div. 4X (Canadian 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	172	-	32	7556	4600
1991	9772	(81)	13	-	382	-	32	9826	-
1992	10508	(89)	51	-	-	-	172	10530	-
1993	6947	(86)	-	-	-	-	212	6968	6000
1994	4405	(68)	-	-	-	-	12	4406	4500
1995	5660	(78)	-	-	-	-	92	5669	6000
1996	6237	(84)	-	-	-	-	82	6245	6500
1997	6519	(87)	-	-	-	-	82	6527	6700
1998	7842	(86)	-	-	-	-	12	7843	8100
1999	6621	(74)	-	-	-	-	-	6621	8100
2000	6961	(91)	-	-	0	-	-	6961	8100
2001	8466	(100)	-	-	-	-	-	8466	8100
2002*	3937	(54)	-	-	-	-	-	3937	8100

* = 2002 Data only until June 30th

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

	Tonnage Class									
	TC 1-3						TC 4+			
Year	MG (OT)		FG (LL)[1]		Misc [2]		MG (OT)		FG (LL)	Misc.	Total
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	5154	(99)	2558	(80)	50		80	(40)	0	0	7842
1999	4475	(73)	1995	(249)	31	(31)	120	(17)	0	0	6621
2000	4129	(59)	2699	(159)	28	(14)	105	(35)	0	0	6961
2001	6128	(96)	2229	(64)	21	(11)	88	(88)	0	0	8466
2002	3373	(82)	522	(65)	6	(6)	35	(12)	0	0	3936

1 = Includes Handline

2 = Gillnets (set, drift), traps, unspecified.

* = 2002 Data only until June 30

Table 4a. Reported landings by month and gear type from NAFO Divisions 4X and 5Y (from ZIF) 2002 data to June 30

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mobile	1985	331	2598	439	792	1067	1924	1306	856	1046	713	240	290	11602
	1986	421	1806	754	364	1021	900	871	688	1852	938	206	242	10062
	1987	448	1192	1739	520	1207	1142	549	293	1009	473	75	40	8687
	1988	1312	1037	109	555	756	1185	670	117	1103	469	89	248	7648
	1989	614	1062	667	289	193	735	171	83	47	15	9	24	3909
	1990	720	794	77	244	379	361	315	113	154	95	100	87	3439
	1991	280	508	122	159	449	589	440	195	280	235	319	811	4388
	1992	578	414	225	97	353	659	450	137	197	161	163	293	3727
	1993	259	232	223	107	396	467	320	166	209	163	147	67	2755
	1994	112	244	137	155	227	195	234	141	202	160	121	252	2178
	1995	246	375	518	117	182	185	207	188	269	292	188	402	3168
	1996	197	450	481	270	203	141	267	275	364	414	453	319	3836
	1997	78	457	539	399	176	249	337	277	559	502	420	311	4303
	1998	319	885	1033	511	99	170	320	304	492	259	340	504	5235
	1999	476	494	229	241	296	305	349	589	733	283	291	308	4595
	2000	518	826	549	123	288	217	341	316	414	282	226	133	4234
	2001	1049	502	1258	296	386	269	301	475	722	331	397	230	6216
	2002	780	598	621	538	347	526							3410
Gillnet	1985	0	0	2	1	1	2	16	43	36	10	0	1	113
	1986	0	1	0	0	1	7	18	16	15	25	3	2	88
	1987	2	1	4	7	15	17	32	24	44	58	12	0	215
	1988	1	1	3	1	1	11	14	14	18	13	4	1	82
	1989	0	0	0	12	2	13	10	15	41	35	25	4	158
	1990	6	5	6	0	13	51	66	31	72	23	4	0	278
	1991	0	0	2	5	5	20	18	63	98	41	2	1	257
	1992	4	1	0	5	5	10	26	29	69	64	3	0	215
	1993	0	0	1	2	4	18	11	14	36	12	1	0	100
	1994	0	0	0	1	1	5	10	7	13	9	1	0	48
	1995	0	0	0	1	0	6	10	2	49	1	0	0	69
	1996	0	0	0	0	1	4	12	9	22	2	0	0	50
	1997	0	0	0	0	0	4	8	23	15	6	0	1	58
	1998	0	0	0	0	0	10	16	7	9	6	1	1	50
	1999	0	0	0	0	0	6	6	5	7	4	2		31
	2000	0	0	1	0	0	2	6	5	4	8	0	0	28
	2001	0	0	0	0	0	1	5	5	5	2	0	0	21
	2002	0	0	1	1	1	3							7
Longline	1985	457	1300	185	207	91	99	159	291	448	357	190	271	4056
	1986	438	1107	316	117	84	102	186	429	713	621	418	356	4888
	1987	718	1126	342	66	138	180	291	367	361	516	259	210	4575
	1988	807	485	104	81	50	83	177	367	538	288	128	254	3362
	1989	382	385	168	69	47	115	229	357	325	266	110	54	2506
	1990	645	463	205	48	33	107	265	382	555	270	202	216	3391
	1991	777	851	193	77	87	236	444	481	524	427	262	229	4589
	1992	937	638	140	127	243	330	506	570	717	507	349	529	5592
	1993	102	691	227	205	275	223	294	608	471	84	45	2	3228
	1994	292	36	2	53	41	236	352	158	180	116	98	16	1580
	1995	293	11	0	112	126	162	363	372	230	197	68	238	2173
	1996	199	13	0	12	64	260	267	249	215	280	254	240	2053
	1997	31	157	33	40	16	102	254	344	323	357	178	232	2066
	1998	99	54	71	139	32	152	352	316	507	378	161	201	2461
	1999	55	32	23	27	27	102	335	377	372	299	202	104	1955
	2000	126	302	347	22	37	149	411	422	370	319	118	49	2670
	2001	321	101	237	47	27	116	297	355	215	295	147	62	2219
	2002	199	64	149	29	13	62							515
Handline	1985	1	0	0	0	4	35	118	101	54	15	5	0	334
	1986	0	0	0	0	3	50	188	120	72	29	7	0	469
	1987	0	0	0	0	3	41	88	94	44	10	2	3	286
	1988	0	0	0	0	0	10	15	32	38	21	9	1	126
	1989	0	0	0	1	3	43	75	48	31	15	4	1	221
	1990	0	0	0	0	3	77	93	114	82	20	4	2	396
	1991	1	1	0	1	2	97	184	138	77	39	1	0	539
	1992	0	0	0	0	5	132	315	290	143	70	14	4	974
	1993	0	0	0	2	2	189	284	297	81	9	2	0	865
	1994	0	0	0	0	9	256	242	61	26	5	1	0	600
	1995	0	0	0	0	7	91	117	9	23	3	0	0	250
	1996	0	0	0	0	4	134	113	44	0	2	0	0	298
	1997	0	0	0	0	1	40	43	21	3	3	0	0	110
	1998	0	0	0	0	0	22	56	27	34	1	0	0	141
	1999	0	0	0	0	1	6	25	5	1	1	0	0	40
	2000	0	0	0	0	0	15	11	2	0	0	0	0	29
	2001	0	0	0	0	0	3	2	5	0	0	0	0	10
	2002	0	0	0	0	0	4							4
Total	1985	789	3898	626	1000	1164	2060	1599	1291	1585	1096	436	562	16105
	1986	859	2913	1071	481	1109	1059	1262	1254	2652	1613	635	599	15507
	1987	1168	2320	2085	594	1363	1381	961	777	1458	1057	347	253	13763
	1988	2119	1523	216	637	808	1289	876	529	1697	790	231	503	11217
	1989	996	1447	836	371	245	906	485	504	444	330	147	83	6794
	1990	1371	1262	288	293	429	597	739	640	864	408	309	305	7504
	1991	1057	1361	318	241	542	942	1086	877	978	742	585	1042	9772
	1992	1519	1052	366	228	606	1131	1297	1027	1127	801	529	825	10508
	1993	361	924	452	316	676	897	909	1085	797	267	195	69	6947
	1994	404	280	139	209	278	692	838	366	421	289	220	268	4405
	1995	539	387	518	230	314	445	697	570	572	492	256	640	5660
	1996	396	463	481	282	273	539	659	578	602	699	707	559	6237
	1997	109	614	572	439	194	395	642	664	899	867	598	544	6538
	1998	419	939	1103	650	132	354	743	654	1042	645	503	705	7887
	1999	531	526	252	269	324	420	716	976	1114	587	495	412	6621
	2000	644	1129	897	146	325	383	769	745	788	609	344	182	6961
	2001	1371	603	1496	343	413	389	606	840	942	628	545	292	8466
	2002	980	662	771	568	361	595							3936

Table 4b. Reported landings by unit area and gear type from NAFO Divisions 4X and 5Y (from ZIF) 2002 data to June 30

		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	25	1954	108	867	803	1013	404	4	56	5234
	1999	0	21	825	143	1402	932	709	516	6	41	4595
	2000	0	16	1157	93	1141	941	468	387	0	30	4234
	2001	0	22	1790	181	1702	980	762	727	2	50	6216
	2002	0	0	1129	191	560	482	809	214	2	22	3409
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	7	1	6	22	8	2	2	2	1	51
	1999	0	7	0	3	9	5	1	4	1	1	31
	2000	0	5	0	1	10	4	1	6	0	0	28
	2001	0	7	0	1	2	6	1	3	1	0	21
	2002	0	1	0	0	2	3	0	0	0	0	6
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	7	109	583	652	805	124	20	6	112	3	2421
	1999	0	150	321	678	708	31	22	2	43	1	1955
	2000	0	202	903	752	636	44	40	3	89	1	2670
	2001	0	199	930	478	474	35	29	5	70	1	2219
	2002	0	26	392	52	18	7	17	1	3	1	517
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	1	1	111	2	8	0	0	14	0	137
	1999	0	1	1	25	1	8	2	0	1	0	40
	2000	0	1	0	9	5	9	3	0	2	0	29
	2001	0	0	0	7	1	1	0	0	0	0	10
	2002	0	0	0	3	0	1	0	0	0	0	4
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	7	142	2539	877	1696	943	1035	412	132	60	7843
	1999	0	180	1147	848	2120	976	733	522	51	42	6621
	2000	0	224	2060	856	1791	998	512	396	92	32	6961
	2001	0	228	2720	667	2179	1022	792	735	72	51	8466
	2002	0	27	1521	246	580	493	826	215	5	23	3936

Table 5. Summary of commercial samples for the Div. 4X haddock fishery for 1999.

Otter Trawls

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	992 (4624-476)	69 (1124-125)	139 (848-115)	1
2	299 (1300-160)	1	537 (1678-236)	4 (220-28)
3	658 (1802-184)	20	987 (904-97)	7
4	343 (835-90)	10	520 (1204-117)	9

Longline/handline/Misc

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	108 (220-0)	-	-	-
2	136	-	28	-
3	1084 (1031-56)	-	32	-
4	601 (410-32)	-	6	-

Miscellaneous

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	-	-	-	-
2	5	-	2	-
3	10	-	9	-
4	5	-	1	-

Values are tonnes landed followed by the number of fish measured and number of fish aged in parentheses. The boxes represent the aggregation used in age-length key formation.

Table 6. Summary of commercial samples for the Div. 4X haddock fishery for 2000.

Otter Trawls

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	1482 (3803-520)	73 (646- 47)	325 (1816-191)	14
2	175 (1591-125)	1	446 (1445-139)	6
3	392 (1683-197)	8	668 (1855-265)	3
4	276 (1507-165)	-	365 (1301-156)	-

Longline/handline

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	762 (1065 - 112)	-	12	-
2	179 (506- 25)	-	44 (210 - 23)	-
3	1100 (820 - 91)	-	116	-
4	468 (923 - 109)	-	18	-

Miscellaneous

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	2 (153 -27)	-	-	-
2	1	-	2	-
3	7	-	9	-
4	7 (178 - 0)	-	1	-

Values are tonnes landed followed by the number of fish measured and number of fish aged in parentheses. The boxes represent the aggregation used in age-length key formation.

Table 7. Summary of commercial samples for the Div. 4X haddock fishery for 2001.

Otter Trawls

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	2076(2681-314)	61(218-25)	656(2300-275)	17
2	384(2060-196)	1	565(2356-282)	-
3	764(2244-189)	1	734(1118-128)	-
4	402(1927-141)	7	548(685-59)	-

Longline/handline

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	658(1801-178)	-	-	-
2	155 (835-25)	-	38 (865-31)	-
3	843 (1744-140)	-	31	-
4	499 (2189-182)	-	6	-

Miscellaneous

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	1(86-20)	-	1	-
2	1	-	1	-
3	8	-	8(42-17)	-
4	1	-	1	-

Values are tonnes landed followed by the number of fish measured and number of fish aged in parentheses. The boxes represent the aggregation used in age-length key formation.

Table 8. Summary of commercial samples for the Div. 4X haddock fishery for 2002.

Otter Trawls

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	1323 (4032-423)	12 (199-23)	641 (1593-160)	23 (400-43)
2	544 (1196-106)	-	865 (2671-254)	-

Longline/handline

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	410 (1649-153)	-	2	-
2	85 (235-0)	-	25	-

Miscellaneous

	4Xmnop		4Xqrs5Y	
Quarter	TC 1-3	TC 4+	TC 1-3	TC 4+
1	1	-	1	-
2	1	-	3 (99-0)	-

Values are tonnes landed followed by the number of fish measured and number of fish aged in parentheses. The boxes represent the aggregation used in age-length key formation.

Table 9. 4X haddock commercial catch-at-age (000's).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	42	152	1	37	18	2	0	0	16	1	0	0	2	0
2	1088	809	22	3114	713	2198	1306	1289	77	83	164	1210	526	70	763	228
3	747	1660	3490	114	4783	4617	1657	3137	3453	1184	2497	2268	3895	3621	1195	2105
4	1549	809	1871	2274	318	5220	4295	2026	7221	6862	3071	6369	2648	6020	5046	2455
5	391	1460	517	1080	1829	490	3712	3204	2156	3970	5527	4300	4954	4104	3708	4658
6	541	415	656	533	523	1115	437	2891	2916	1094	3573	3272	1823	2454	2583	1508
7	4679	71	91	607	194	250	813	361	1071	1272	538	1191	1560	1033	1022	509
8	1922	3404	58	326	277	174	155	390	141	269	636	366	364	434	367	136
9	137	1047	1185	262	191	63	72	107	110	58	173	331	196	206	119	51
10	99	167	520	621	277	32	96	72	27	70	35	99	101	131	83	16
11	181	186	26	56	567	167	39	23	9	11	21	14	48	76	39	7
12	28	150	196	13	25	231	104	8	6	1	3	24	17	27	22	4
13	38	108	93	6	4	11	158	87	49	18	10	9	15	27	13	2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	13	13	0	3	8	22	10	3	0	0	0	0	0	0	0
2	90	214	190	403	52	141	139	98	99	37	13	31	35	241	62	1
3	1043	512	497	1422	1304	243	709	368	757	809	526	149	433	423	1370	93
4	3030	1016	499	394	2351	2523	520	632	694	993	1676	1052	503	766	854	1137
5	4588	896	936	358	580	2290	1828	327	617	682	1008	1795	1168	578	713	344
6	2096	1968	310	472	246	229	1070	971	238	428	455	1137	882	1164	517	323
7	291	871	720	391	310	247	170	269	449	355	269	536	569	885	1133	300
8	58	894	460	654	200	331	106	24	421	439	138	329	244	527	885	512
9	7	372	504	277	310	237	73	17	162	355	110	181	55	210	396	299
10	9	209	255	204	280	240	46	13	24	130	94	192	47	108	156	116
11	6	146	57	61	142	132	58	20	26	17	35	140	58	32	28	53
12	0	49	81	48	169	152	51	15	18	1	4	31	26	8	18	11
13	0	44	30	9	71	36	12	7	11	3	2	6	5	14	12	2
14	0	22	12	9	13	15	7	1	11	1	0	8	0	4	18	1
15	0	7	4	2	4	2	1	0	3	1	0	5	0	3	4	0
16	0	4	0	1	4	2	0	1	2	2	1	1	0	0	0	0

* = 2002 Data only until June 30

Table 10. 4X haddock commercial catch-at-age (percent at age).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0	0	0.5	1.7	0.0	0.3	0.1	0.0	0	0	0.1	0.0	0	0	0.0	0
2	9.5	7.9	0.3	34.0	7.3	15.0	10.2	9.5	0.4	0.6	1.0	6.2	3.3	0.4	5.1	2.0
3	6.6	16.1	39.8	1.2	49.3	31.6	12.9	23.1	20.0	8.0	15.4	11.7	24.1	19.9	8.0	18.0
4	13.6	7.9	21.3	24.8	3.3	35.7	33.4	14.9	41.9	46.1	18.9	32.7	16.4	33.1	33.7	21.0
5	3.4	14.2	5.9	11.8	18.9	3.4	28.9	23.6	12.5	26.7	34.0	22.1	30.7	22.5	24.8	39.9
6	4.7	4.0	7.5	5.8	5.4	7.6	3.4	21.3	16.9	7.3	22.0	16.8	11.3	13.5	17.3	12.9
7	41.0	0.7	1.0	6.6	2.0	1.7	6.3	2.7	6.2	8.5	3.3	6.1	9.7	5.7	6.8	4.4
8	16.9	33.1	0.7	3.6	2.9	1.2	1.2	2.9	0.8	1.8	3.9	1.9	2.3	2.4	2.5	1.2
9	1.2	10.2	13.5	2.9	2.0	0.4	0.6	0.8	0.6	0.4	1.1	1.7	1.2	1.1	0.8	0.4
10	0.9	1.6	5.9	6.8	2.9	0.2	0.7	0.5	0.2	0.5	0.2	0.5	0.6	0.7	0.6	0.1
11	1.6	1.8	0.3	0.6	5.8	1.1	0.3	0.2	0.1	0.1	0.1	0.1	0.3	0.4	0.3	0.1
12	0.2	1.5	2.2	0.1	0.3	1.6	0.8	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0
13	0.3	1.0	1.1	0.1	0.0	0.1	1.2	0.6	0.3	0.1	0.1	0.0	0.1	0.1	0.1	0.0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0.2	0.3	0	0.0	0.1	0.5	0.4	0.1	0	0	0	0	0	0	0
2	0.8	3.0	4.2	8.6	0.9	2.1	2.9	3.5	2.8	0.9	0.3	0.6	0.9	4.9	1.0	0.0
3	9.3	7.1	10.9	30.2	21.6	3.6	14.7	13.3	21.4	19.0	12.1	2.7	10.8	8.5	22.2	2.9
4	27.0	14.0	10.9	8.4	38.9	37.0	10.8	22.8	19.6	23.3	38.7	18.8	12.5	15.4	13.9	35.6
5	40.9	12.4	20.5	7.6	9.6	33.5	38.0	11.8	17.5	16.0	23.3	32.1	29.0	11.6	11.6	10.8
6	18.7	27.2	6.8	10.0	4.1	3.4	22.2	35.0	6.7	10.1	10.5	20.3	21.9	23.4	8.4	10.1
7	2.6	12.0	15.8	8.3	5.1	3.6	3.5	9.7	12.7	8.3	6.2	9.6	14.1	17.8	18.4	9.4
8	0.5	12.4	10.1	13.9	3.3	4.8	2.2	0.9	11.9	10.3	3.2	5.9	6.1	10.6	14.4	16.0
9	0.1	5.1	11.0	5.9	5.1	3.5	1.5	0.6	4.6	8.3	2.5	3.2	1.4	4.2	6.4	9.4
10	0.1	2.9	5.6	4.3	4.6	3.5	1.0	0.5	0.7	3.1	2.2	3.4	1.2	2.2	2.5	3.6
11	0.1	2.0	1.2	1.3	2.4	1.9	1.2	0.7	0.7	0.4	0.8	2.5	1.4	0.6	0.5	1.7
12	0	0.7	1.8	1.0	2.8	2.2	1.1	0.5	0.5	0.0	0.1	0.6	0.6	0.2	0.3	0.4
13	0	0.6	0.7	0.2	1.2	0.5	0.2	0.3	0.3	0.1	0.0	0.1	0.1	0.3	0.2	0.1
14	0	0.3	0.3	0.2	0.2	0.2	0.1	0.0	0.3	0.0	0	0.1	0.0	0.1	0.3	0.0
15	0	0.1	0.1	0.0	0.1	0.0	0.0	0	0.1	0.0	0	0.1	0.0	0.1	0.1	0.0
16	0	0.1	0	0.0	0.1	0.0	0	0.0	0.1	0.0	0.0	0.0	0	0	0	0

* = 2002 Data only until June 30

Table 11. 4X Haddock commercial weight-at-age (kg).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.29	0.29	0.29	0.27	0.18	0.23	0.23	0.28	0.29	0.29	0.16	0.23			0.25	
2	0.57	0.5	0.45	0.51	0.46	0.52	0.52	0.46	0.44	0.51	0.522	0.593	0.493	0.394	0.527	0.573
3	0.9	0.96	0.9	0.75	0.82	0.82	0.81	0.71	0.87	0.87	0.882	0.877	0.907	0.758	0.785	0.83
4	1.05	1.25	1.35	1.25	1.1	1.2	1.19	1.22	1.33	1.33	1.326	1.26	1.294	1.141	1.069	1.071
5	1.16	1.4	1.6	1.8	1.7	1.55	1.6	1.72	1.85	1.84	1.777	1.721	1.653	1.714	1.411	1.408
6	1.43	1.5	1.75	2	2.3	2.25	2.1	2.2	2.33	2.36	2.355	2.219	2.13	2.146	1.932	1.966
7	1.65	1.75	1.9	2.2	2.5	2.85	2.95	2.94	2.7	2.83	2.906	2.654	2.577	2.607	2.287	2.442
8	1.95	1.95	2.1	2.3	2.6	3	3.5	3.3	3.39	3.3	3.278	3.134	2.947	2.869	2.683	2.92
9	2.3	2.3	2.3	2.5	2.8	3.2	3.6	3.57	3.77	4.03	3.811	3.608	3.47	3.108	3.054	3.501
10	2.82	2.65	2.8	2.7	2.95	3.45	3.8	3.77	4.17	4.15	4.332	3.688	4.033	3.55	3.431	3.313
11	2.8	3.25	3	3.3	3.2	3.5	4.1	3.69	4.03	4.96	4.2	4.546	3.946	3.63	3.841	4.029
12	2.85	3	3.7	3.4	3.8	3.7	4	3.94	3.62	6	4.963	4.823	4.033	3.78	4.114	4.424
13	3.6	3	3.3	4.2	3.9	4.4	4.2	3.91	4.63	5.68	5.711	4.68	4.908	4.064	4	5.468
14																5.595
15																
16																

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002*
1		0.439			0.55	0.671			0.161							
2	0.615	0.848	0.81	0.666	1.159	0.79	0.796	0.872	0.773	0.906	0.827	0.611	0.969	0.804	0.780	0.490
3	0.779	1.085	1.085	1.073	1.104	1.026	0.972	1.139	1.074	1.011	1.03	0.922	1.200	0.931	1.053	0.877
4	1.005	1.179	1.232	1.431	1.44	1.232	1.129	1.312	1.369	1.217	1.289	1.029	1.426	1.202	1.157	1.161
5	1.328	1.469	1.35	1.809	1.833	1.572	1.392	1.483	1.597	1.396	1.561	1.23	1.411	1.280	1.389	1.151
6	1.796	1.522	1.511	1.74	2.016	1.956	1.734	1.793	1.73	1.598	1.869	1.429	1.638	1.307	1.311	1.230
7	2.472	1.683	1.69	2.001	2.088	1.887	2.132	2.08	1.976	1.614	2.048	1.676	2.018	1.516	1.393	1.195
8	3.123	1.794	1.672	2.05	2.234	1.963	2.098	2.493	2.013	1.86	2.069	1.88	2.366	1.783	1.643	1.273
9	4.061	2.031	1.815	2.108	2.24	2.158	2.365	2.101	2.355	2.136	2.199	2.08	2.137	2.288	1.860	1.448
10	3.309	2.256	1.882	2.351	2.228	2.167	2.242	2.775	2.286	2.042	2.357	2.122	2.110	2.521	2.210	1.513
11	4.15	2.373	2.256	2.316	2.274	2.1	2.377	2.204	2.584	2.75	2.648	2.433	2.869	2.161	2.382	1.736
12	4.775	2.57	2.379	2.613	2.339	1.968	2.148	2.381	2.305	3.373	2.55	2.939	2.503	3.118	2.747	1.855
13	5.173	2.329	2.49	2.373	2.327	2.66	2.521	2.899	2.623	3.027	3.072	3.537	2.361	2.818	2.699	2.753
14	5.827	3.302	2.713	3.126	2.654	2.919	2.887	4.51	2.902	3.271	4.481	3.604	5.700	3.546	1.788	4.342
15		3.767	3.135	3.204	3.421	3.218	4.777	4.308	3.095	3.49		2.348	5.184	2.576	3.167	4.065
16	7.526	4.754	6.052	4.546	3.787	5.541	5.628	2.486	3.224	3.286	3.674	3.081				

Table 12. 4X haddock mean numbers per standard tow by stratum from the 1970-2002 summer RV survey.

	trawlable units	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
470	77962	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	0.97
471	85080	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	0.00
472	105842	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	73.40
473	22456	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	189.10
474	13643	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	134.50
475	13220	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	100.85
476	125248	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	369.87
477	104401	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	92.13
478	19745	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	20.42
480	55506	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	117.45
481	158890	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	18.68
482	88301	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	1.46
483	45082	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	14.58
484	191855	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	2.94
485	134061	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	80.44
490	50930	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	160.56
491	58217	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	16.34
492	92029	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	5.04
493	45167	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	2.31
494	35337	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	3.50
495	49489	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	5.22
470-481	781993	33.23	48.42	24.94	56.33	107.20	42.24	37.20	259.73	49.33	46.84	95.82	59.54	80.09	49.49	63.65	103.70
482-495	790468	12.85	9.58	3.35	11.75	29.21	7.55	17.16	26.51	13.19	39.61	37.16	105.72	58.54	23.75	63.96	27.95
Total	1572461	22.98	28.90	14.09	33.91	67.99	24.80	27.12	142.49	31.16	43.20	66.34	82.75	69.26	36.55	63.81	65.62

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1970-2002
470	6.61	6.46	3.19	1.54	0.00	0.97	0.49	0.00	2.11	5.68	16.49	8.09	0.97	2.08	99.64	3.44	18.08
471	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	1.01	0.00	1.01	5.34	0.00	182.22	0.50	6.46
472	28.21	34.73	47.23	17.47	19.11	7.89	7.32	14.77	42.50	74.95	30.98	7.25	194.46	41.45	78.14	27.93	52.82
473	80.29	12.01	12.32	41.51	92.36	5.83	0.46	47.42	210.78	352.79	101.04	199.85	85.43	66.13	75.46	155.32	86.86
474	3.15	1.54	1.80	31.11	6.32	6.69	8.26	8.16	8.15	41.32	107.22	92.83	58.35	128.46	15.56	574.19	74.32
475	14.13	13.90	22.10	54.47	22.48	16.04	8.75	125.37	164.81	175.06	46.38	47.18	65.12	267.81	153.13	171.72	84.23
476	25.03	9.10	9.21	5.30	8.51	11.67	2.83	14.82	51.60	52.17	72.14	25.26	19.05	32.62	175.65	133.00	74.03
477	43.99	59.48	42.02	24.37	38.58	39.23	12.84	56.47	248.00	86.51	60.13	120.74	213.79	279.37	304.24	141.85	87.47
478	25.39	11.32	0.00	13.83	0.00	4.88	3.40	14.39	5.30	22.14	5.90	3.09	6.14	35.14	18.65	53.90	9.91
480	52.78	84.96	175.59	251.54	316.69	200.96	71.76	173.09	274.90	226.30	341.80	322.51	1022.21	964.38	448.81	298.95	247.92
481	31.93	25.72	29.26	18.03	40.43	25.32	41.43	41.01	145.58	102.30	71.88	58.67	274.05	130.46	326.67	176.67	93.69
482	31.63	22.73	18.19	39.56	20.86	1.50	7.29	19.23	18.65	138.92	25.17	10.82	19.44	48.93	8.48	24.83	18.03
483	11.48	20.59	1.54	36.84	41.78	4.03	3.83	0.50	3.54	1.96	17.23	4.46	4.22	4.97	13.76	15.99	13.42
484	0.00	1.37	0.97	0.97	0.00	0.00	0.70	0.65	3.03	5.17	2.91	3.01	3.73	8.55	23.14	6.04	3.12
485	2.97	9.68	1.86	13.13	87.06	20.51	8.40	1.69	78.02	94.92	4.35	34.48	84.82	219.97	10.63	98.90	37.13
490	44.66	128.41	129.52	174.02	79.27	104.55	18.53	412.74	541.72	336.00	267.88	139.75	62.71	137.85	219.26	87.83	231.51
491	1.03	0.26	0.00	0.67	1.30	3.56	4.80	22.25	63.99	9.09	44.53	10.16	38.49	64.99	132.13	50.37	20.42
492	2.63	5.33	0.31	0.00	0.39	8.21	0.00	7.00	6.02	4.69	37.18	67.20	7.05	4.99	6.61	13.28	14.16
493	13.65	0.00	0.00	0.00	0.00	1.56	0.00	0.00	1.12	0.62	24.29	1.63	5.90	14.70	25.74	4.97	6.45
494	0.00	0.70	0.00	0.00	2.92	0.58	0.00	6.00	25.43	300.70	0.00	17.83	29.51	139.30	7.41	36.51	20.96
495	0.00	0.98	0.00	18.05	0.00	0.00	0.00	4.93	55.27	16.99	48.84	21.23	61.06	52.01	7.41	80.04	19.03
470-481	28.12	26.89	32.96	31.14	42.94	28.36	17.11	36.53	105.6	81.94	69.99	65.11	191.56	152.85	212.82	120.28	75.32
482-495	8.55	14.58	11.05	21.37	24.83	11.77	4.17	32.06	60.91	67.92	33.6	26.38	30.88	69.7	36.04	39.77	30.11
Total	18.28	20.7	21.95	26.23	33.83	20.02	10.61	34.28	83.14	74.89	51.7	45.64	110.78	111.05	123.95	79.80	52.60

Table 13. 4X haddock mean numbers-at-age per standard tow from the 1970-2002 summer RV survey.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
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	0.00	0.14
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	6.31	3.44
2	4.17	10.08	0.21	20.57	20.71	3.24	5.86	36.36	4.73	12.40	6.32	25.43	25.10	4.04	21.44	8.68	8.54
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	20.81	6.75
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	9.54	13.55
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	13.15	5.30
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	3.38	5.66
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	1.68	2.02
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	1.06	1.04
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	0.59	0.59
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	0.22	0.34
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	0.06	0.06
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	0.03	0.10
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	0.03	0.06
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	0.04	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	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	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	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	0.03	0.10
4X total	22.98	28.89	14.09	33.91	68.35	24.80	27.12	142.59	31.16	43.21	66.31	82.76	69.27	36.54	63.25	65.60	47.69
SS total	33.23	48.43	24.94	56.32	107.20	42.24	37.20	259.73	49.33	46.83	95.83	59.54	80.09	49.49	62.54	103.70	83.72
BoF total	12.85	9.57	3.35	11.75	29.21	7.55	17.15	26.51	13.19	39.61	37.17	105.72	58.54	23.75	63.96	27.95	12.30

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1970-01
0	0.00	0.06	0.00	0.17	0.00	0.00	0.00	2.55	0.18	2.00	0.12	1.63	24.78	24.79	4.32	0.01	1.95
1	1.20	6.44	5.39	0.07	3.86	2.81	4.17	19.09	41.81	4.53	9.02	8.98	32.51	24.61	27.74	3.81	10.21
2	1.38	1.92	8.79	9.56	1.24	2.24	0.95	5.34	22.41	24.17	5.30	6.94	18.43	40.10	28.72	15.27	12.36
3	2.45	0.91	1.76	8.60	11.36	0.88	1.57	1.98	10.63	22.71	19.25	4.26	8.71	6.19	37.22	20.80	10.77
4	3.03	1.90	0.82	1.58	10.37	6.92	0.60	1.78	3.77	11.56	11.62	12.52	5.84	4.29	10.91	23.00	6.35
5	3.67	2.65	1.66	1.28	2.18	4.92	1.72	0.36	1.71	4.67	3.60	6.74	9.92	3.48	4.15	5.48	4.39
6	2.55	2.81	0.71	1.42	1.20	0.94	1.04	1.75	0.70	1.54	1.50	1.72	5.53	4.81	1.98	2.87	2.40
7	1.86	1.34	1.47	1.29	1.06	0.35	0.17	1.02	1.43	1.07	0.55	1.39	2.72	1.71	5.06	2.09	1.57
8	0.81	1.05	0.52	1.08	0.91	0.36	0.13	0.14	0.37	1.50	0.17	0.91	1.05	0.68	1.95	3.18	0.88
9	0.24	0.65	0.44	0.45	0.67	0.26	0.05	0.05	0.09	0.37	0.28	0.25	0.79	0.30	1.08	1.71	0.40
10	0.29	0.36	0.13	0.37	0.80	0.19	0.04	0.08	0.00	0.30	0.18	0.16	0.17	0.06	0.73	0.91	0.22
11	0.07	0.12	0.10	0.18	0.08	0.04	0.09	0.01	0.00	0.12	0.02	0.11	0.17	0.02	0.08	0.62	0.08
12	0.01	0.01	0.08	0.08	0.08	0.02	0.02	0.05	0.02	0.02	0.01	0.01	0.11	0.01	0.00	0.03	0.05
13	0.00	0.00	0.00	0.05	0.02	0.00	0.03	0.09	0.00	0.07	0.00	0.00	0.04	0.00	0.03	0.04	0.02
14	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	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	0.00	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	0.04	0.00	0.00	0.00	0.00	0.00	0.00
17	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	0.00	0.00	0.00	0.00
unknown	0.70	0.48	0.05	0.02	0.00	0.09	0.02	0.00	0.02	0.27	0.04	0.01	0.00	0.01	0.00	0.01	0.08
4X total	18.28	20.70	21.93	26.23	33.83	20.02	10.61	34.28	83.14	74.90	51.69	45.64	110.79	111.06	123.97	79.81	51.74
SS total	28.12	26.89	32.96	31.14	42.94	28.36	17.11	36.52	105.60	81.94	69.99	65.11	191.56	152.85	212.82	120.27	73.88
BoF total	8.55	14.58	11.05	21.37	24.83	11.77	4.17	32.06	60.91	67.92	33.60	26.38	30.88	69.70	36.04	39.78	29.81

Table 14. 4X Haddock summer RV survey strata 470-495 - mean length-at-age (cm).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0								8.5		7.3	6.5	8.3	6.5	7.8	8.2		6.5
1	21.0	20.6	19.9	21.3	21.0	21.9	21.0	21.9	19.0	19.9	20.0	19.9	17.9	18.7	20.5	19.5	19.5
2	33.8	29.3	26.9	30.2	31.1	32.6	32.3	35.1	33.8	32.0	33.3	32.8	26.9	28.2	29.4	30.8	30.1
3	41.1	41.6	39.3	35.7	40.0	41.4	40.0	42.4	43.0	41.0	40.8	41.4	38.8	37.1	34.5	36.6	38.2
4	45.7	47.0	48.7	49.6	45.3	48.5	48.4	48.1	50.2	49.6	49.3	47.8	48.8	46.7	42.2	41.2	41.0
5	49.9	51.3	52.8	54.8	54.4	54.2	53.1	54.1	54.7	54.4	54.8	55.3	53.5	53.5	49.1	45.7	45.4
6	52.0	53.1	56.0	59.5	59.3	59.3	58.1	56.6	57.7	60.2	58.1	59.9	59.6	56.8	55.8	50.7	48.3
7	56.2	54.9	56.5	60.1	61.3	63.6	62.8	63.6	61.2	62.8	61.4	62.8	63.9	61.4	58.9	57.5	51.2
8	59.6	58.7	60.2	60.7	62.7	64.7	61.3	65.2	66.2	65.6	63.2	64.3	67.7	63.7	61.4	58.1	54.2
9	60.5	63.0	63.1	63.0	63.0	65.6	65.7	69.8		71.6	67.1	67.5	68.7	64.8	65.5	57.8	59.8
10	65.1	70.5	69.1	63.9	63.6	67.5	66.5	65.2		69.1	67.5	72.8	74.6	66.9	69.4	62.9	60.1
11	68.2	69.4	68.5	67.7	68.0	67.0	72.5	66.5	62.5		70.5	72.3	74.9	67.6	70.5	62.7	64.8
12	60.5	72.9	76.5			66.8	66.9	69.0	68.5			74.5		70.8	72.5	66.5	65.5
13			78.5	70.5			69.7	72.9	72.5					75.0	66.5	66.5	61.1
14								69.8	73.2	72.5						68.7	
15									70.3	72.9							
16																	
17																	

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1970-01
0		6.5	10.5	8.5				8.7	7.5	9.7	8.4	8.7	9.7	10.0	9.0	6.5	8.3
1	21.0	20.9	20.4	21.5	20.7	19.4	22.1	23.8	18.6	17.8	22.1	18.7	21.7	22.3	20.6	19.9	20.5
2	31.9	34.6	32.0	33.1	37.5	30.8	32.7	34.2	32.6	27.4	28.1	29.5	25.8	33.7	28.7	27.6	31.3
3	37.5	40.1	40.7	41.6	42.7	39.3	41.8	42.7	42.8	39.9	34.2	34.2	37.1	37.9	37.2	34.0	39.5
4	44.1	44.9	43.4	48.8	49.7	47.2	47.3	48.9	48.6	48.6	42.1	38.9	38.6	43.8	39.4	39.8	46.0
5	47.1	49.6	49.0	53.8	52.1	53.4	51.5	49.9	52.5	51.7	48.4	46.7	42.5	42.7	45.1	41.4	50.8
6	47.2	49.1	52.0	54.7	58.3	57.3	55.9	53.2	53.6	54.8	50.3	51.7	45.1	45.6	45.4	45.5	54.2
7	51.3	51.6	52.0	57.2	58.4	59.1	57.4	56.0	56.3	56.8	54.0	54.6	47.7	50.0	46.7	46.5	57.2
8	53.6	52.9	52.1	57.7	57.9	54.7	56.6	60.4	59.7	57.6	57.9	58.4	49.8	52.0	49.1	46.6	59.0
9	58.0	54.8	52.7	59.8	55.8	55.2	51.0	53.3	65.6	62.5	56.5	56.4	50.0	56.4	51.6	48.9	60.5
10	56.8	54.4	56.0	52.3	53.9	61.1	58.0	54.5		60.5	54.0	54.5	55.3	61.5	46.9	49.1	61.8
11	61.7	59.2	60.9	60.7	66.3	64.2	58.3	58.5		58.5	60.4	60.4	55.6	56.5	53.9	41.6	64.3
12	76.5	62.5	50.9	58.1	61.0	62.5	56.5	51.5	54.5	59.6	62.5	54.5	55.1	62.5		59.6	63.8
13				68.0	70.5	68.5	56.4	57.8		69.3			51.4		52.5	61.1	66.3
14	65.9		66.5	66.5	68.5		74.5						68.5		74.5		69.9
15																	71.6
16											58.5						58.5
17					64.5												64.5

Table 15. 4X Haddock summer RV survey strata 470-495 - mean weight-at-age (kg).

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
0																	
1	0.080	0.102	0.078	0.092	0.087	0.102	0.090	0.103	0.067	0.082	0.073	0.075	0.047	0.040	0.083	0.073	0.053
2	0.392	0.248	0.203	0.296	0.309	0.369	0.367	0.463	0.413	0.345	0.440	0.401	0.223	0.241	0.290	0.331	0.285
3	0.761	0.762	0.661	0.510	0.708	0.759	0.695	0.838	0.900	0.781	0.793	0.864	0.678	0.550	0.465	0.549	0.603
4	1.078	1.083	1.303	1.347	1.012	1.266	1.160	1.258	1.465	1.369	1.309	1.201	1.310	1.103	0.836	0.728	0.776
5	1.384	1.424	1.633	1.816	1.716	1.800	1.523	1.771	1.951	1.757	1.752	1.864	1.697	1.586	1.273	1.010	1.017
6	1.607	1.618	1.991	2.374	2.218	2.271	1.926	2.009	2.260	2.383	2.111	2.312	2.325	1.886	1.847	1.380	1.178
7	2.033	1.721	2.145	2.396	2.516	2.828	2.411	2.870	2.640	2.709	2.496	2.761	2.869	2.383	2.073	2.023	1.431
8	2.337	2.181	2.501	2.464	2.679	3.013	2.384	2.917	3.422	3.368	2.712	3.109	3.341	2.665	2.447	1.977	1.693
9	2.384	2.590	2.897	2.717	2.784	3.251	2.685	4.021		4.034	3.451	3.308	3.446	2.818	2.830	1.936	2.173
10	2.951	4.073	3.966	2.885	2.817	3.169	2.600	2.972		3.477	3.319	3.970	4.212	3.176	3.769	2.483	2.200
11	3.631	3.516	3.700	3.386	3.408	3.314	3.500	3.500	2.600		3.400	3.811	4.468	3.146	2.350	2.635	2.803
12	2.225	4.738	4.600			3.326	3.056	3.531	4.200			4.000		3.690	3.500	3.200	2.836
13			6.200	4.000			3.374	3.631	3.900					4.366	2.300	3.100	2.119
14								3.693	4.195	3.600						3.036	
15									4.237	4.721							
16																	
17																	

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1970-01
0								0.007	0.005	0.010	0.005	0.007	0.009	0.010	0.007	0.003	0.008
1	0.093	0.092	0.089	0.109	0.083	0.082	0.098	0.139	0.063	0.053	0.114	0.065	0.104	0.108	0.087	0.078	0.085
2	0.342	0.520	0.356	0.424	0.600	0.307	0.366	0.423	0.353	0.210	0.231	0.261	0.188	0.393	0.235	0.209	0.338
3	0.581	0.689	0.747	0.819	0.839	0.624	0.770	0.865	0.829	0.680	0.428	0.409	0.540	0.569	0.542	0.396	0.682
4	0.968	0.987	0.911	1.338	1.331	1.141	1.109	1.234	1.157	1.210	0.793	0.621	0.606	0.888	0.642	0.635	1.079
5	1.154	1.348	1.292	1.690	1.503	1.666	1.394	1.341	1.436	1.450	1.187	1.069	0.820	0.802	0.925	0.711	1.439
6	1.139	1.384	1.510	1.879	2.083	2.010	1.777	1.657	1.536	1.780	1.392	1.448	0.966	1.013	0.933	0.915	1.756
7	1.436	1.654	1.543	2.132	2.064	2.299	1.941	1.926	1.793	1.878	1.648	1.790	1.171	1.332	1.040	0.980	2.061
8	1.660	1.645	1.612	2.187	2.123	1.761	1.859	2.319	2.197	1.898	1.902	2.136	1.314	1.574	1.211	0.993	2.269
9	2.090	1.989	1.555	2.531	2.005	2.004	1.396	1.567	2.648	2.503	1.895	2.024	1.373	1.991	1.424	1.147	2.462
10	1.816	1.903	1.799	1.644	1.679	2.537	2.226	1.705		2.454	1.535	1.581	1.890	2.458	1.143	1.167	2.614
11	2.328	2.203	2.310	2.450	3.511	2.786	2.191	2.195		2.233	2.045	2.171	1.809	1.858	1.644	0.905	2.830
12	6.000	2.900	1.310	2.479	2.564	2.760	1.995	1.274	1.510	2.019	1.358	1.465	1.642	2.200		1.887	2.861
13				3.513	3.555	3.500	1.682	2.179		3.879			1.347		1.450	2.430	3.182
14	2.870		2.400	3.300	3.400		4.540						3.260		3.810		3.464
15																	4.479
16											2.054						2.054
17					2.945												2.945

Table 16. 4X haddock mean number at age per tow, mean number per tow and mean weight per tow from the ITQ survey.

	1996	1997	1998	1999	2000	2001	2002	AVG
0	0.5	0.0	0.3	3.6	5.4	0.6	0.0	1.5
1	6.9	14.7	14.9	98.8	75.7	58.9	17.3	41.0
2	41.3	9.5	29.3	39.7	75.7	54.5	29.3	39.9
3	25.1	33.1	8.3	18.2	12.0	56.5	30.4	26.2
4	9.0	19.4	21.5	7.1	8.5	13.5	29.9	15.6
5	3.5	5.0	8.0	11.1	7.2	5.0	6.5	6.6
6	0.9	1.6	1.2	4.6	8.1	2.1	3.0	3.1
7	0.7	0.6	0.8	2.1	2.6	5.3	2.2	2.0
8	0.8	0.2	0.4	0.6	1.0	1.9	3.0	1.1
9	0.2	0.3	0.2	0.5	0.3	1.0	1.6	0.6
10	0.2	0.2	0.2	0.1	0.1	0.7	0.9	0.3
11	0.0	0.0	0.1	0.1	0.0	0.1	0.8	0.2
12	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
unk	0.2	0.1	0.3	0.5	2.1	0.6	0.5	0.6
total	89.3	84.7	85.5	187.1	198.7	200.7	125.4	138.8

N sets	173	177	190	185	188	187	183	
Number per tow	89.2	84.7	85.5	187.3	195.3	201.5	125.6	138.4
Weight per tow	44.2	47.9	40.2	53.9	65.5	77.5	54.2	54.8

Table 17. SPA results - Residuals

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
2	0.01	0.30	-2.16	0.43	0.46	-0.74	-0.91	0.85	-0.71	-0.04
3	-0.60	0.26	-0.70	-0.97	0.98	-0.85	-0.43	1.46	-0.25	-0.19
4	-0.36	0.14	-0.47	-0.40	-0.49	-0.08	-0.74	1.30	-0.89	-0.06
5	-0.37	0.17	-0.44	0.02	0.22	-1.16	0.29	0.99	-0.65	-0.20
6	0.37	0.31	-0.49	-0.48	0.12	-0.11	-0.27	1.28	-0.08	0.14
7	-0.39	0.54	-0.18	-0.22	0.00	-0.06	-0.30	1.06	0.15	0.59
8	-1.52	0.50	0.17	0.43	0.44	0.29	-0.39	1.35	-0.68	1.14
9	-0.21	-1.08	-0.11	-0.41	0.90	-0.58	-0.59	0.70	0.00	1.03
10	0.38	-0.94	-3.19	-0.32	-0.03	0.63	-1.86	0.93	0.00	0.07
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
Ave 2-10	-0.15	0.01	-0.42	-0.11	0.14	-0.15	-0.29	0.55	-0.17	0.14

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	-0.45	0.73	0.64	-0.95	0.57	0.62	0.90	-0.19	-0.24	0.17
3	0.15	-0.39	0.11	0.09	0.11	0.63	0.48	-0.22	-0.48	-0.23
4	0.00	0.00	-0.41	-0.22	0.66	0.16	0.49	0.15	-0.19	-0.30
5	0.60	-0.27	0.46	-0.32	0.22	0.90	-0.08	-0.34	0.49	0.01
6	0.45	0.29	0.28	-0.07	0.22	0.36	0.57	-0.29	-0.01	-0.47
7	0.38	0.05	1.17	-0.34	0.23	0.37	0.18	-0.26	-0.48	-0.19
8	0.58	-1.11	0.28	0.03	0.05	0.80	0.44	-0.32	-0.18	-0.80
9	1.03	0.10	0.45	0.34	1.08	0.59	0.54	-0.77	-0.13	-0.37
10	1.85	0.66	0.60	0.75	-0.13	1.18	0.39	0.13	0.12	-1.13
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
Ave 2-10	0.26	0.00	0.20	-0.04	0.17	0.31	0.22	-0.12	-0.06	-0.18

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	0.34	-0.65	-0.36	-1.39	-0.12	0.92	0.51	0.24	0.24	0.79
3	0.24	0.60	-0.94	-0.62	-0.59	0.63	0.99	0.31	0.06	0.51
4	-0.15	0.68	0.39	-1.14	-0.29	0.22	0.88	0.49	-0.01	0.50
5	0.44	0.41	0.29	-0.65	-1.47	-0.12	0.62	-0.11	0.15	-0.14
6	0.27	0.76	-0.14	-0.82	-0.21	-0.57	0.09	-0.24	-0.52	0.21
7	0.53	0.39	0.08	-1.60	-0.54	-0.05	0.19	-0.64	0.02	0.28
8	0.27	0.89	0.19	-0.05	-1.36	-1.00	0.65	-1.07	0.53	0.34
9	-0.50	0.47	0.49	-1.12	-0.52	-1.42	-0.46	-0.59	-0.18	0.81
10	0.13	0.67	0.11	-0.53	-0.21	0.00	0.37	-0.67	-0.61	-0.06
2	0	0	0	0	0	0	0.01	-0.21	0.64	0.53
3	0	0	0	0	0	0	0.34	0.11	-0.02	0.50
4	0	0	0	0	0	0	0.04	0.41	-0.06	0.11
5	0	0	0	0	0	0	0.05	-0.06	0.04	-0.31
6	0	0	0	0	0	0	-0.19	0.08	-0.62	0.29
7	0	0	0	0	0	0	0.01	-0.30	-0.28	0.27
8	0	0	0	0	0	0	0.30	-0.63	-0.02	0.06
9	0	0	0	0	0	0	-0.89	-0.34	-0.22	0.54
10	0	0	0	0	0	0	0.03	-0.51	-0.32	-0.53
Ave 2-10	0.09	0.23	0.01	-0.44	-0.30	-0.08	0.20	-0.21	-0.07	0.26

Age	2000	2001	2002
2	0.15	0.29	-0.24
3	-0.26	0.11	0.00
4	-0.05	0.43	-0.26
5	0.12	0.06	-0.15
6	-0.69	-0.20	-0.08
7	-0.69	-0.43	0.15
8	-0.50	0.06	-0.42
9	-0.45	0.52	0.44
10	-1.29	1.02	0.98
2	-0.25	-0.10	-0.62
3	-0.34	-0.22	-0.37
4	0.04	0.05	-0.59
5	0.57	-0.03	-0.26
6	0.09	0.12	0.23
7	-0.02	-0.14	0.45
8	0.17	0.31	-0.20
9	-0.27	0.63	0.55
10	-0.72	1.04	1.03
Ave 2-10	-0.24	0.20	0.03

Mean Square of the Residuals = 0.364781

	Est. Param	CV	Bias
1	10.3498	0.451424	-0.02013
2	10.6555	0.321857	-0.01947
3	10.7682	0.269986	-0.01192
4	9.36049	0.242782	-0.00458
5	8.68895	0.234021	0.0126
6	8.04806	0.232502	0.032957
7	8.82439	0.220007	0.030783
8	7.79099	0.253963	0.073917
9	6.48612	0.278497	0.130079

Table 18a. SPA results - Population Numbers (000s)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	25931	6199	48001	45063	24733	50508	53828	32683	44025	33900
2	12185	21230	5075	39262	36757	20249	41319	44054	26757	36045
3	5728	8992	16650	4136	29328	29449	14590	32647	34902	21837
4	7861	4014	5860	10474	3283	19684	19933	10446	23891	25451
5	2619	5034	2554	3105	6518	2400	11392	12434	6719	13026
6	2723	1790	2801	1623	1565	3681	1522	5968	7281	3550
7	15119	1740	1090	1699	847	808	2005	850	2271	3322
8	7374	8144	1360	810	842	518	435	906	370	890
9	750	4299	3588	1061	368	439	266	216	389	175
10	442	490	2572	1865	632	129	302	153	80	219
1-10	80731	61932	89552	109099	104872	127864	145592	140357	146684	138415

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	42491	45139	35683	41749	16036	12076	5759	8562	25507	23699
2	27755	34774	36956	29215	34181	13127	9887	4715	7010	20872
3	29436	22575	27376	29781	23855	27295	10541	7829	3779	5546
4	16807	21841	16431	18889	21106	18450	20442	7587	5466	2631
5	14629	10982	12119	11056	10018	12714	12884	12329	3470	3556
6	7073	6976	5100	5440	5339	4847	6195	6910	5943	2031
7	1917	2558	2751	2526	2233	2034	2604	3704	3761	3085
8	1569	1083	1016	841	1134	904	1205	1927	2769	2291
9	485	709	555	503	295	596	617	898	1525	1458
10	91	241	281	277	225	134	442	472	729	912
1-10	142252	146877	138268	140276	114423	92177	70576	54934	59960	66080

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	8332	11312	13553	21140	34043	46179	16827	22845	31504	100607
2	19391	6821	9259	11089	17288	27863	37806	13777	18704	25793
3	16916	15511	5538	7453	8953	14066	22722	30919	11268	15285
4	4091	12563	11520	4314	5461	6997	10831	17872	24838	9091
5	1702	2993	8159	7149	3062	3899	5101	7969	13115	19384
6	2064	1070	1926	4608	4199	2211	2634	3559	5612	9114
7	1382	1263	653	1369	2804	2559	1595	1769	2502	3566
8	1874	778	754	311	967	2053	1689	984	1205	1564
9	1460	943	456	318	159	770	1300	986	681	689
10	738	944	491	159	194	115	484	743	707	394
1-10	57950	54199	52308	57909	77129	106711	100988	101423	110138	185486

Age	2000	2001	2002
1	71138	42207	15816
2	82370	58243	34556
3	21086	67221	47629
4	12123	16881	53796
5	6988	9232	13048
6	14814	5198	6913
7	6664	11075	3788
8	2405	4655	8042
9	1059	1492	3010
10	514	677	863
1-10	219160	216881	187463

Table 18b. SPA results - Fishing Mortaity

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	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
3	0.16	0.23	0.26	0.03	0.20	0.19	0.13	0.11	0.12	0.06
4	0.25	0.25	0.44	0.27	0.11	0.35	0.27	0.24	0.41	0.35
5	0.18	0.39	0.25	0.49	0.37	0.26	0.45	0.34	0.44	0.41
6	0.25	0.30	0.30	0.45	0.46	0.41	0.38	0.77	0.58	0.42
7	0.42	0.05	0.10	0.50	0.29	0.42	0.59	0.63	0.74	0.55
8	0.34	0.62	0.05	0.59	0.45	0.46	0.50	0.65	0.55	0.41
9	0.23	0.31	0.45	0.32	0.85	0.17	0.35	0.79	0.37	0.46
10	0.28	0.47	0.25	0.45	0.65	0.32	0.43	0.72	0.46	0.43
5-7	0.28	0.24	0.22	0.48	0.37	0.36	0.47	0.58	0.59	0.46

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.01	0.04	0.02	0.00	0.02	0.02	0.03	0.02	0.03	0.01
3	0.10	0.12	0.17	0.14	0.06	0.09	0.13	0.16	0.16	0.10
4	0.23	0.39	0.20	0.43	0.31	0.16	0.31	0.58	0.23	0.24
5	0.54	0.57	0.60	0.53	0.53	0.52	0.42	0.53	0.34	0.34
6	0.82	0.73	0.50	0.69	0.77	0.42	0.31	0.41	0.46	0.18
7	0.37	0.72	0.99	0.60	0.70	0.32	0.10	0.09	0.30	0.30
8	0.59	0.47	0.50	0.85	0.44	0.18	0.09	0.03	0.44	0.25
9	0.50	0.73	0.49	0.60	0.59	0.10	0.07	0.01	0.31	0.48
10	0.55	0.60	0.50	0.72	0.52	0.14	0.08	0.02	0.38	0.37
5-7	0.58	0.67	0.70	0.61	0.67	0.42	0.28	0.34	0.36	0.28

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3	0.10	0.10	0.05	0.11	0.05	0.06	0.04	0.02	0.01	0.03
4	0.11	0.23	0.28	0.14	0.14	0.12	0.11	0.11	0.05	0.06
5	0.26	0.24	0.37	0.33	0.13	0.19	0.16	0.15	0.16	0.07
6	0.29	0.29	0.14	0.30	0.30	0.13	0.20	0.15	0.25	0.11
7	0.37	0.32	0.54	0.15	0.11	0.22	0.28	0.18	0.27	0.19
8	0.49	0.33	0.66	0.47	0.03	0.26	0.34	0.17	0.36	0.19
9	0.24	0.45	0.86	0.29	0.13	0.26	0.36	0.13	0.35	0.09
10	0.36	0.39	0.76	0.38	0.08	0.26	0.35	0.15	0.35	0.14
5-7	0.31	0.28	0.35	0.26	0.18	0.18	0.21	0.16	0.23	0.13

Age	2000	2001	2002*
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.02	0.02	0.00
4	0.07	0.06	0.02
5	0.10	0.09	0.03
6	0.09	0.12	0.05
7	0.16	0.12	0.09
8	0.28	0.24	0.07
9	0.25	0.35	0.11
10	0.26	0.29	0.15
5-7	0.12	0.11	0.06

* 2002 landings to June 30 only

Table 18c. SPA results - Biomass (t)

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	1178	282	3471	1804	1242	2134	2895	1297	2265	1001
2	3426	2990	730	5966	6197	3628	7994	8993	5519	5480
3	3654	4914	6741	1331	13426	14262	7388	18105	22530	12402
4	7373	3644	5839	9883	2358	18635	18704	9767	26471	28251
5	3352	6238	3397	4776	9909	3239	15819	17821	10526	20899
6	4228	2679	4716	3196	3140	7267	2833	10440	14566	7655
7	29675	2893	2031	3712	2070	2023	4692	1999	5229	8221
8	16371	17149	2822	1863	2134	1426	1130	2403	1158	2654
9	1368	10575	9019	2766	965	1295	758	669	1885	650
10	1221	1528	8243	5393	1747	382	879	432	288	1158
1-10	71846	52892	47008	40689	43188	54291	63091	71926	90437	88371
4+	63588	44706	36067	31589	22323	34267	44815	43531	60123	69488

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	1504	1406	1552	867	238	502	213	179	1003	1108
2	5272	5950	4779	3109	3681	2176	1426	635	1542	3777
3	15397	13919	14274	10430	7986	10891	4709	3186	1834	3457
4	16994	21315	17480	16335	14312	10735	13343	5797	4139	2084
5	22655	17154	17301	15937	11871	11683	11086	11667	3964	4015
6	13621	14040	10618	9731	9138	6424	6757	7437	7511	2897
7	4675	6175	7084	5946	4415	3931	3659	4817	5162	4508
8	4253	3016	3087	2324	2737	1829	2229	2970	4256	3741
9	1654	2125	1817	1543	811	1297	1278	1688	2772	2332
10	332	891	1050	917	734	356	912	938	1453	1726
1-10	86358	85989	79043	67139	55924	49824	45613	39315	33636	29646
4+	64184	64716	58437	52733	44018	36255	39264	35314	29257	21303

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	340	526	585	821	1606	4028	581	580	2374	3845
2	3767	1744	1478	1921	3520	6172	4348	1524	3226	2851
3	9134	9252	3389	3624	5038	8329	11133	9270	3463	5738
4	4090	13117	11271	3589	5323	7000	10848	13124	12805	4526
5	2112	4244	12149	9016	3734	5190	6607	9551	12076	13832
6	3216	2007	3347	7928	6381	3173	4211	5057	7358	9261
7	2480	2487	1430	2705	5188	4411	2708	3030	3950	4644
8	3443	1654	1437	644	2052	4222	3116	1860	2261	2398
9	2948	1974	940	498	271	1909	3047	1869	1336	1180
10	1180	1947	1108	335	299	207	1234	1456	1224	770
1-10	32710	38953	37133	31079	33412	44641	47832	47320	50074	49047
4+	19469	27430	31682	24715	23248	26112	31771	35947	41010	36611

Age	2000	2001	2002
1	3806	3090	0
2	16653	9279	4660
3	6896	31024	14530
4	8395	10203	31560
5	4871	8367	8816
6	13501	4496	6360
7	7559	11368	3622
8	3265	5912	8173
9	1714	2234	3548
10	945	1022	1113
1-10	67604	86995	82381
4+	40250	43602	63192

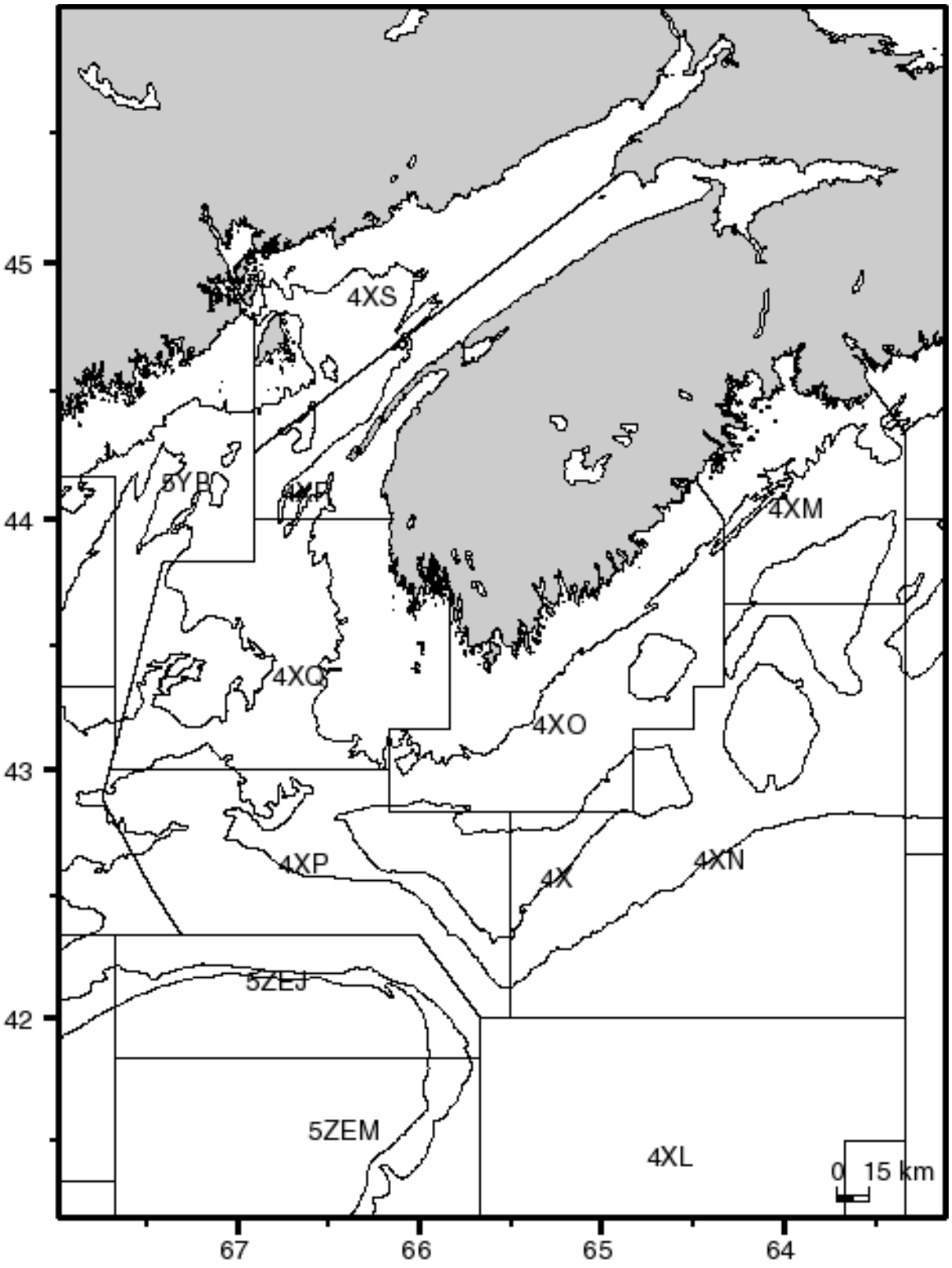


Figure 1. Statistical unit areas in Div. 4X, 5Y and 5Z.

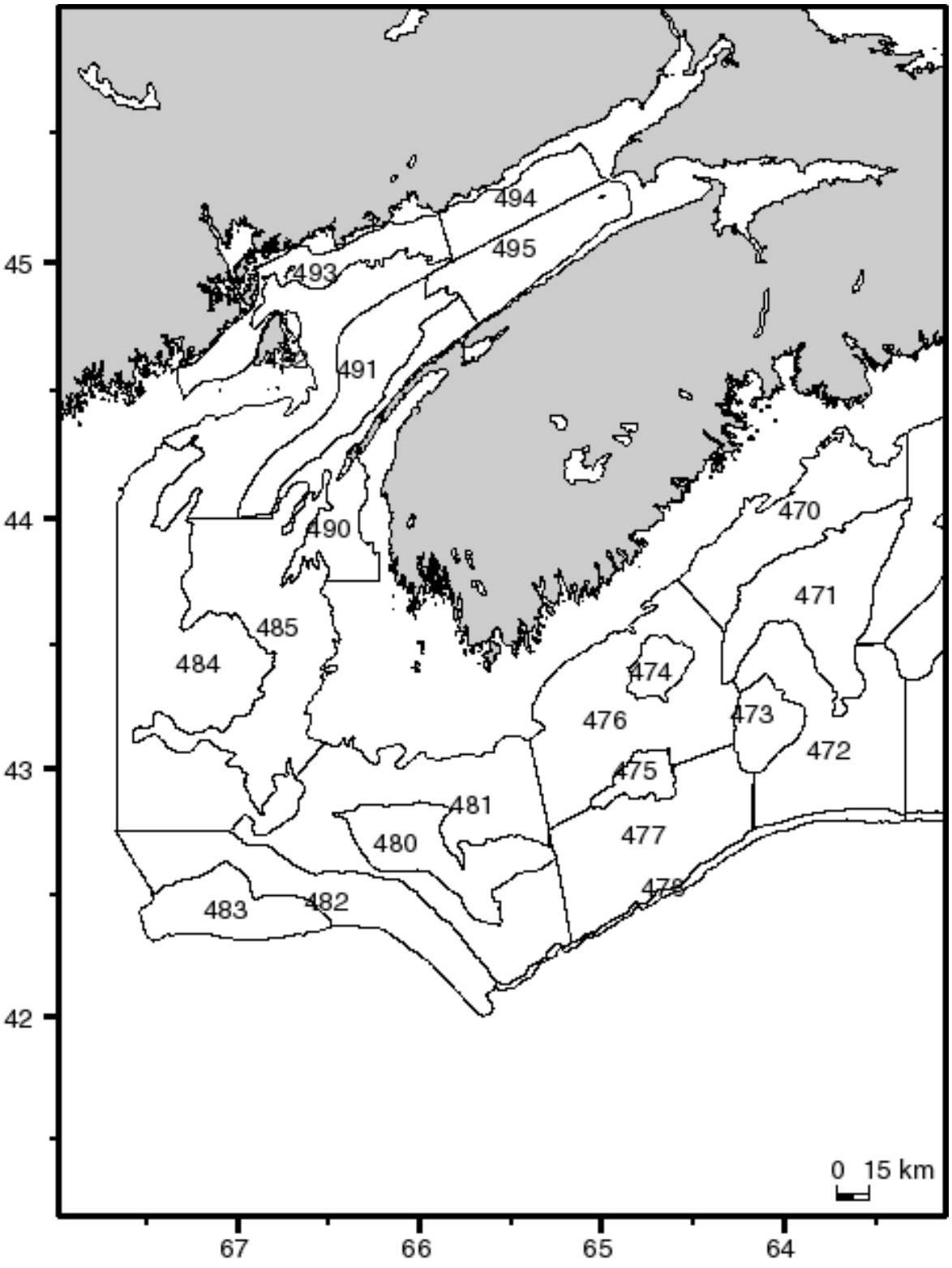


Figure 2. Stratification scheme for the summer RV survey in Div. 4X.

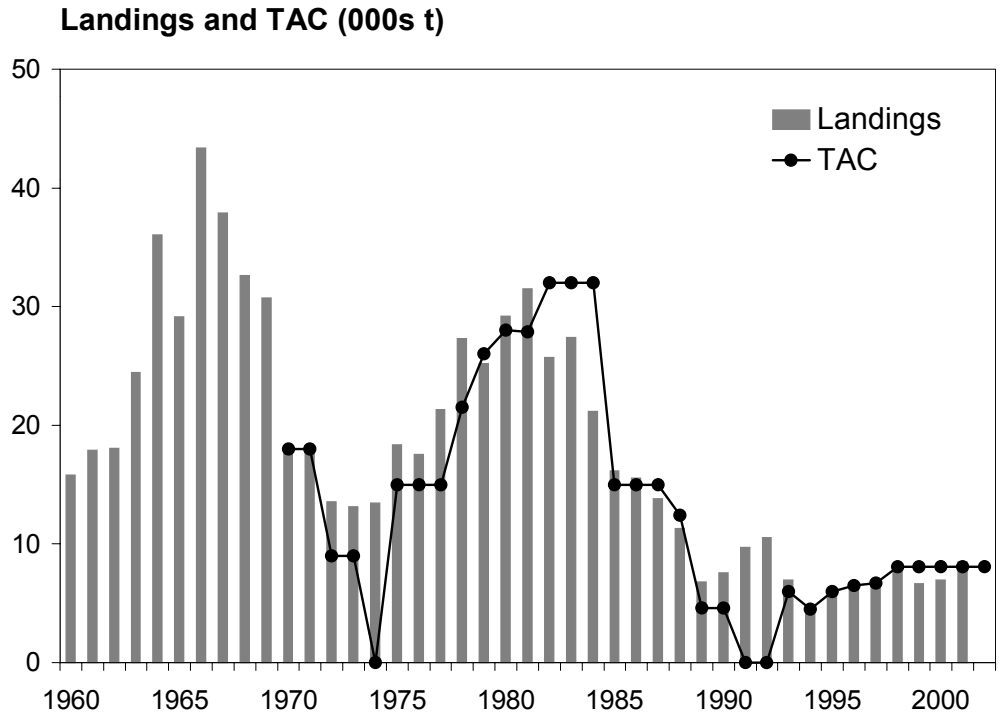


Figure 3. Long-term trends in 4X/5Y haddock landings and TACs.

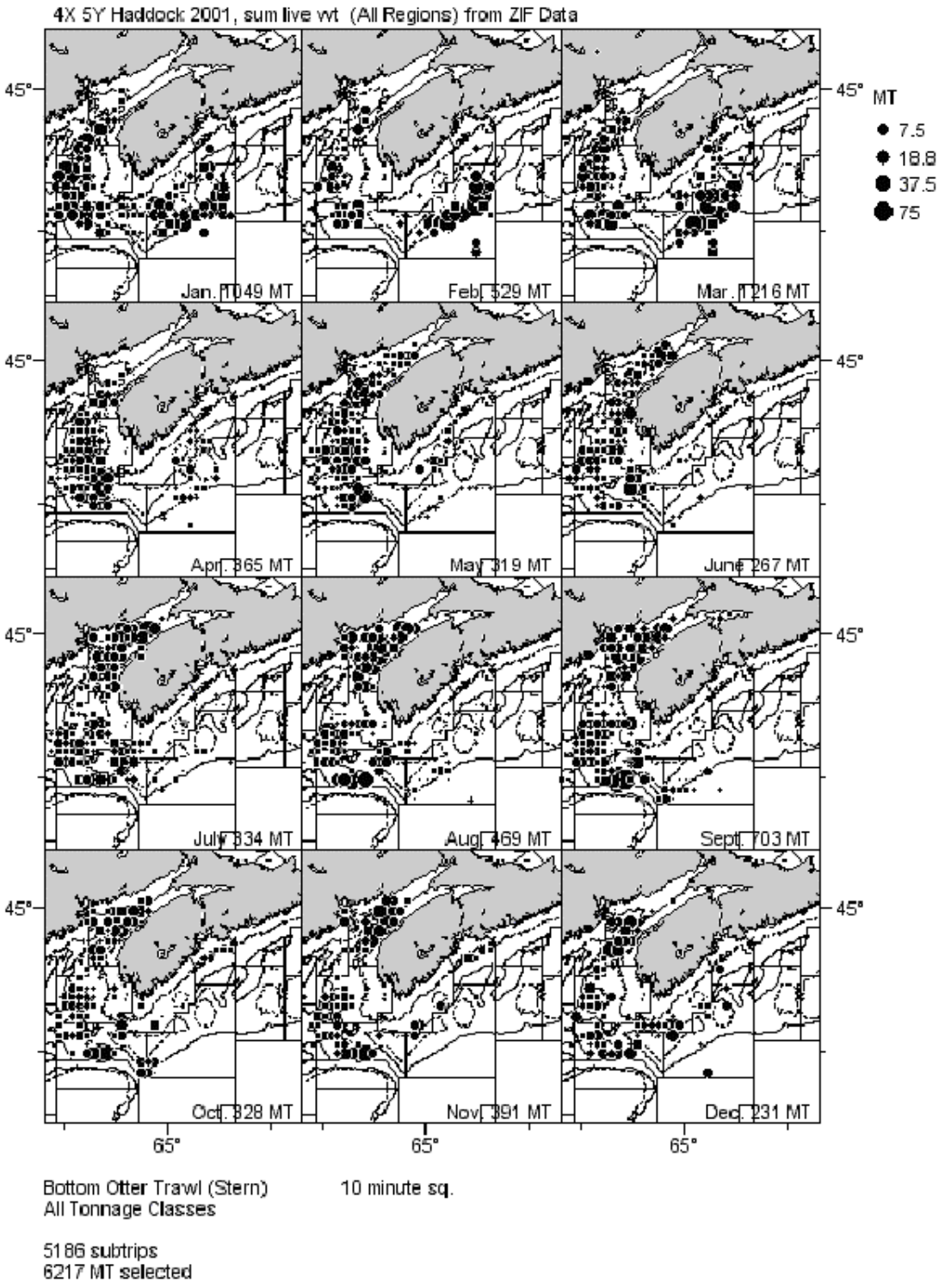


Figure 4a. Haddock catches by stern trawls in NAFO Div. 4X/5Y by month in 2001, aggregated by 10x10 minute squares (where catch position was reported).

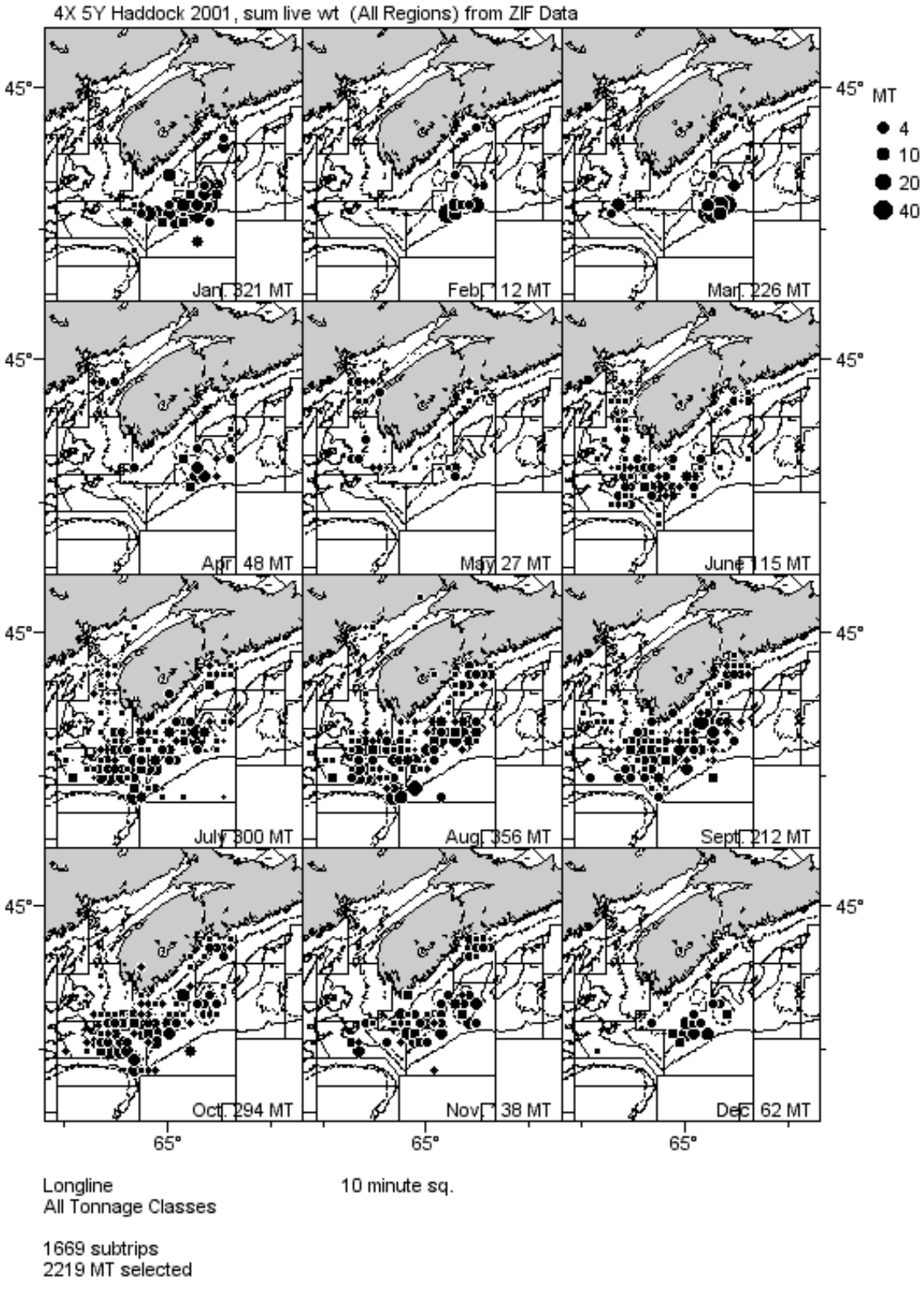


Figure 4b. Haddock catches by longlines in NAFO Div. 4X/5Y by month in 2001, aggregated by 10x10 minute squares (where catch position was reported).

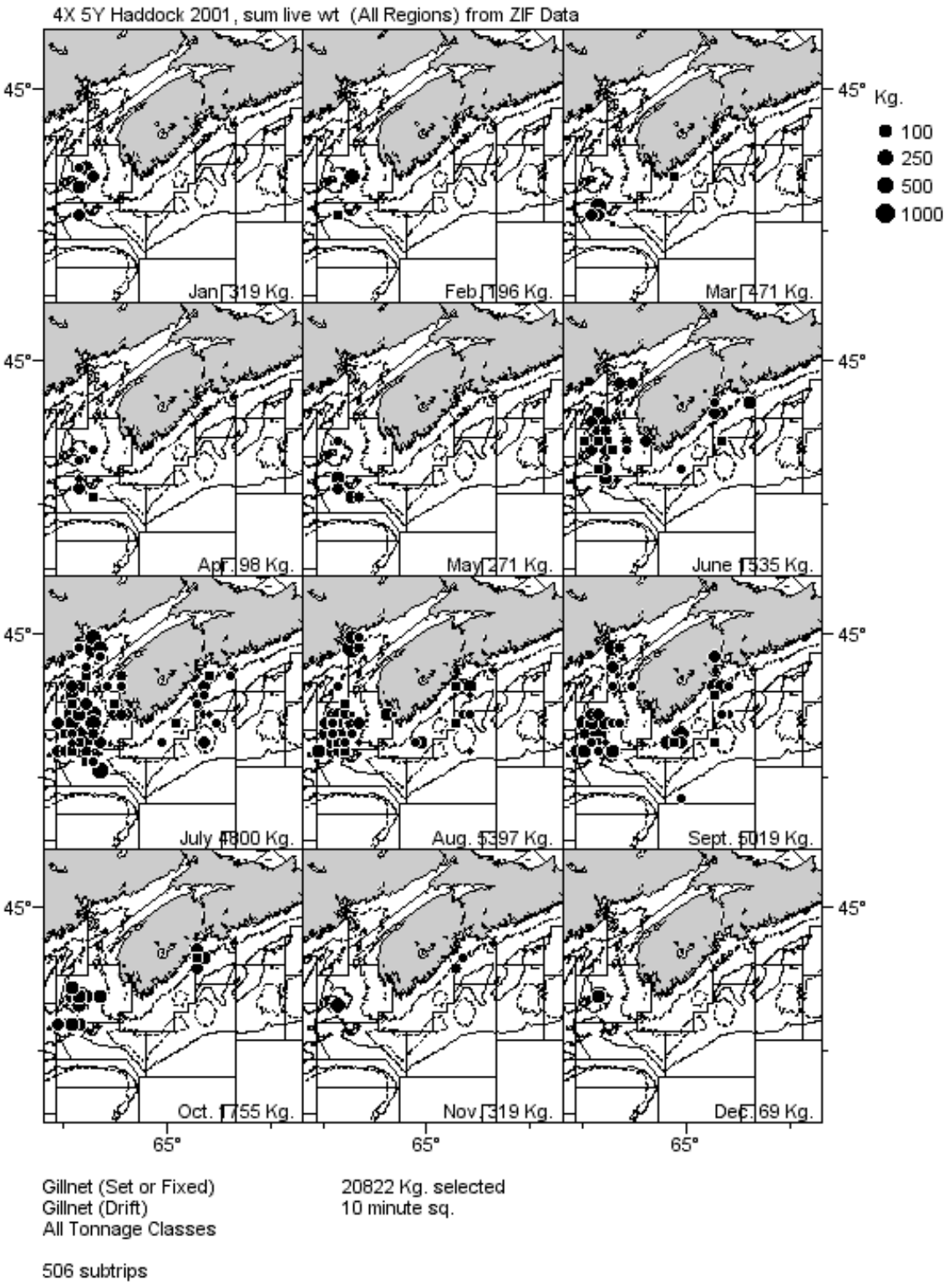


Figure 4c. Haddock catches by gillnets in NAFO Div. 4X/5Y by month in 2001, aggregated by 10x10 minute squares (where catch position was reported).

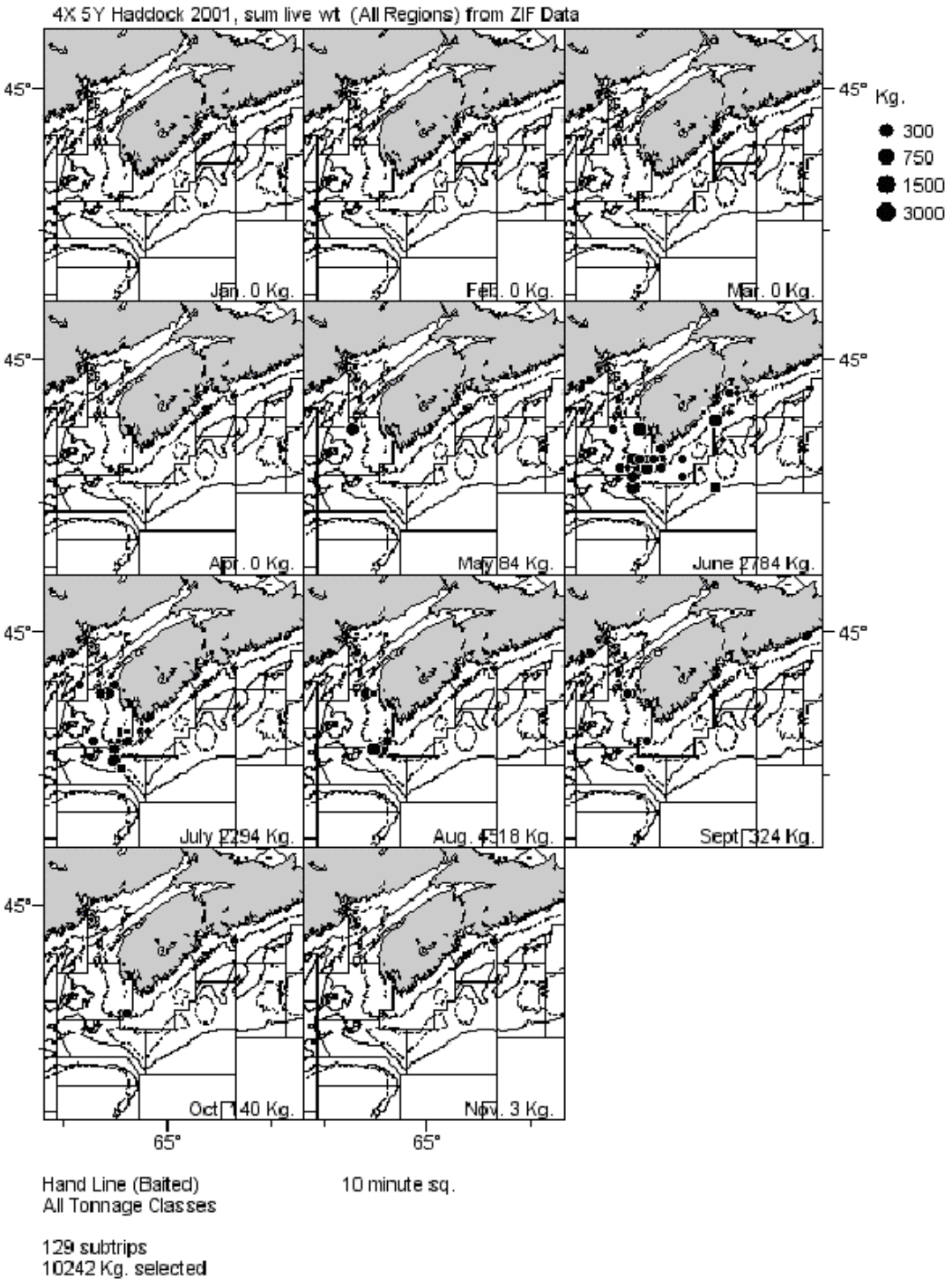


Figure 4d. Haddock catches by handlines in NAFO Div. 4X/5Y by month in 2001, aggregated by 10x10 minute squares (where catch position was reported).

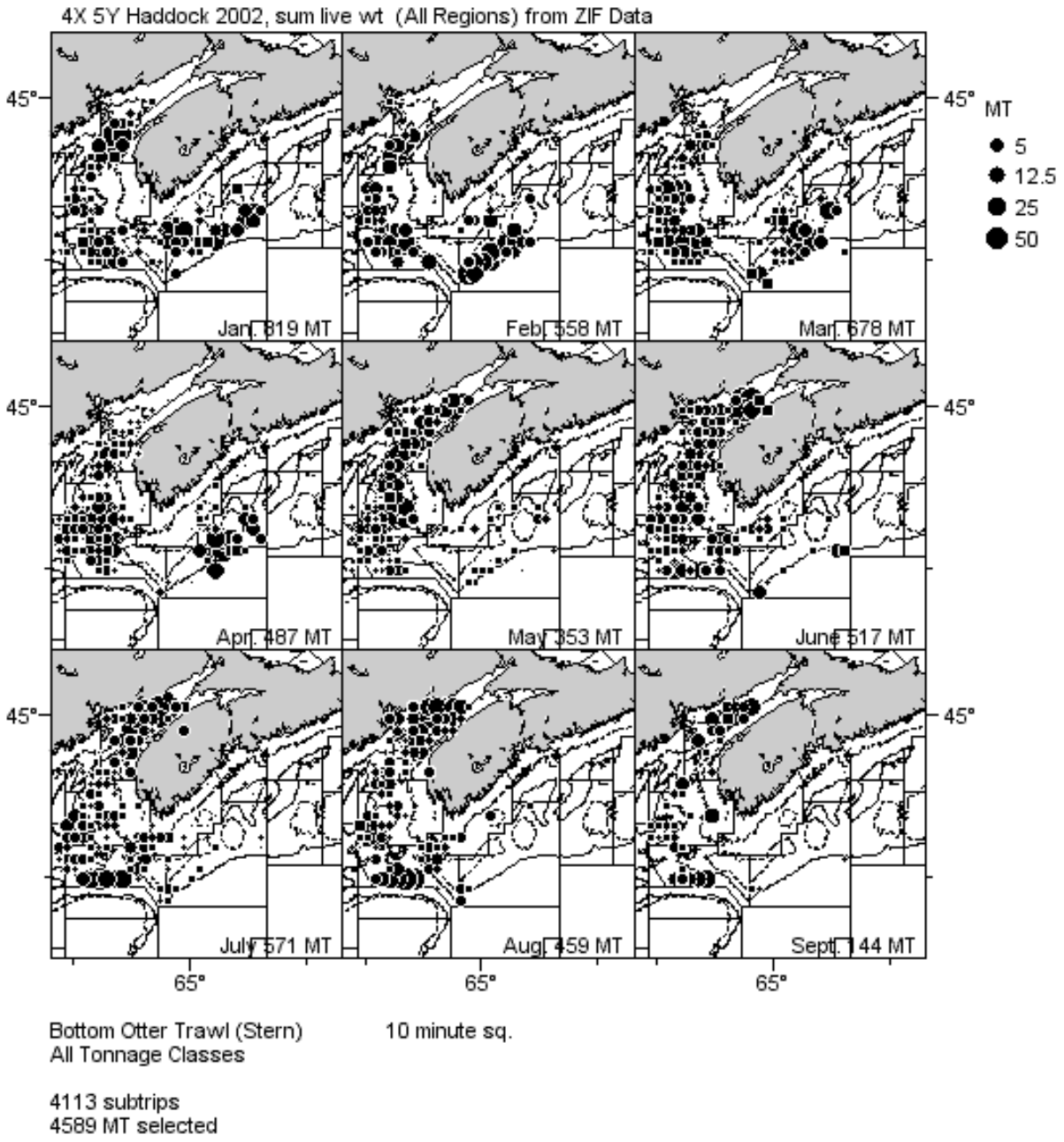


Figure 5a. Haddock catches by stern trawls in NAFO Div. 4X/5Y by month in 2002, aggregated by 10x10 minute squares (where catch position was reported).

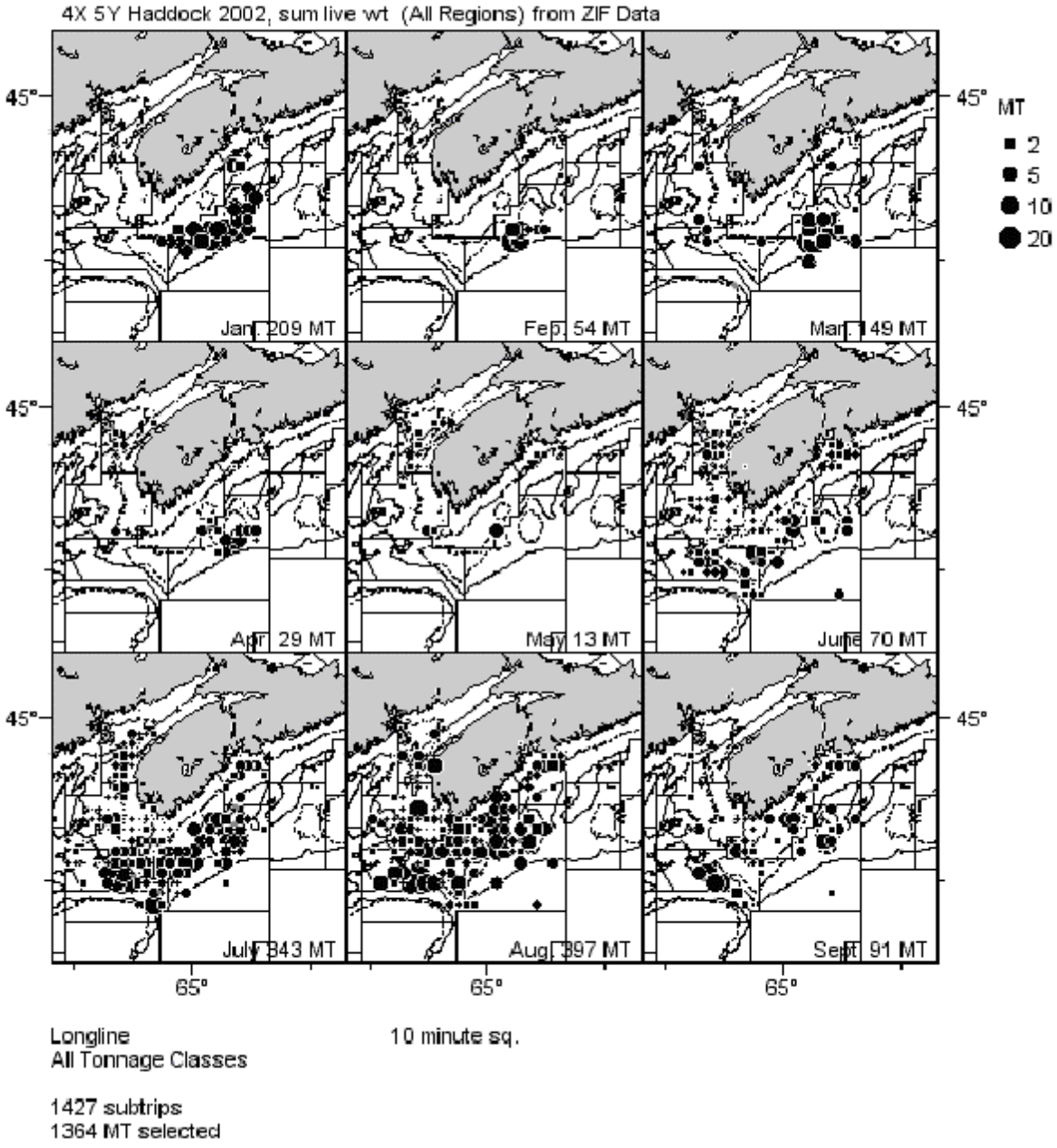


Figure 5b. Haddock catches by longlines in NAFO Div. 4X/5Y by month in 2002, aggregated by 10x10 minute squares (where catch position was reported).

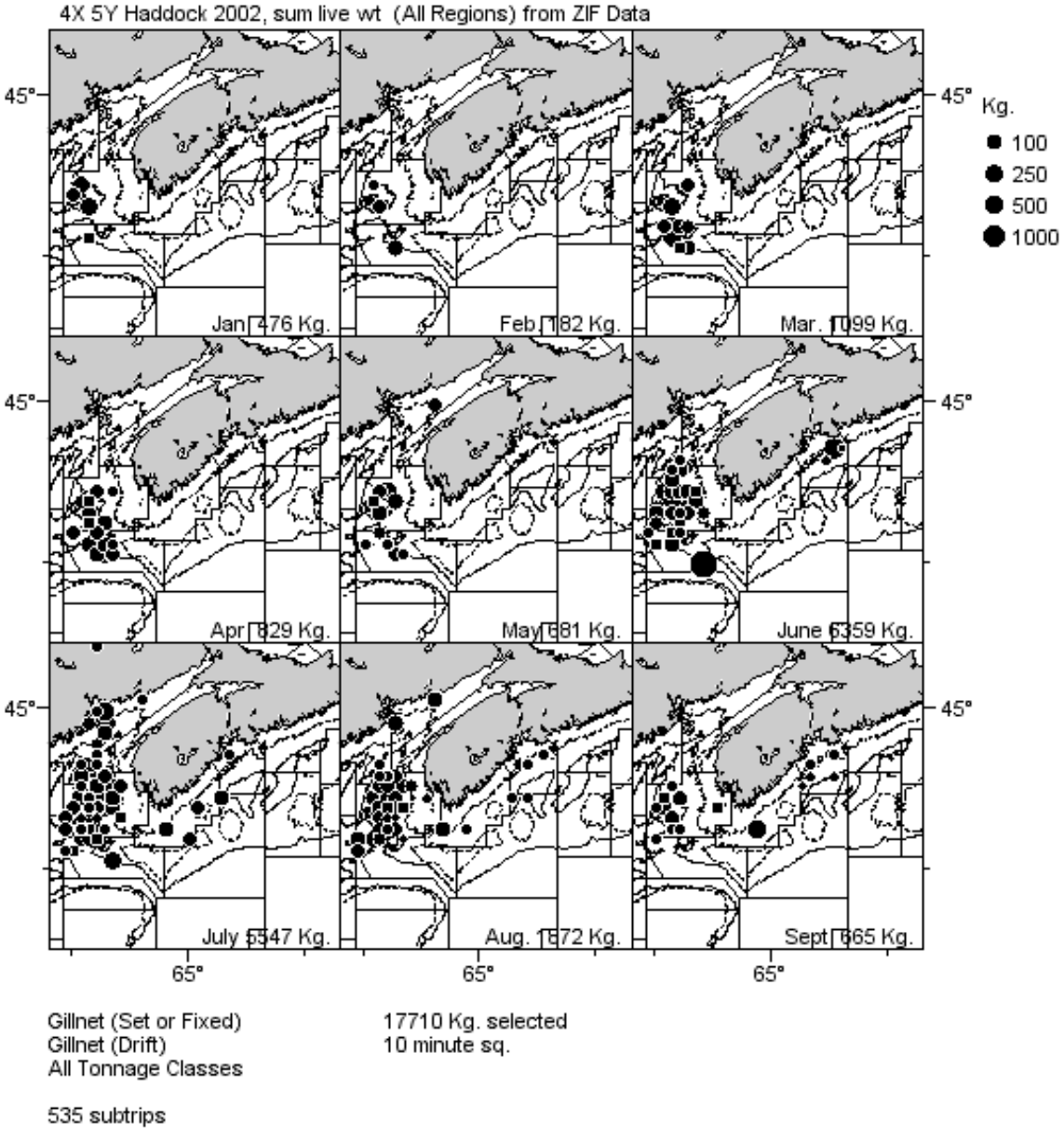


Figure 5c. Haddock catches by gillnets in NAFO Div. 4X/5Y by month in 2002, aggregated by 10x10 minute squares (where catch position was reported).

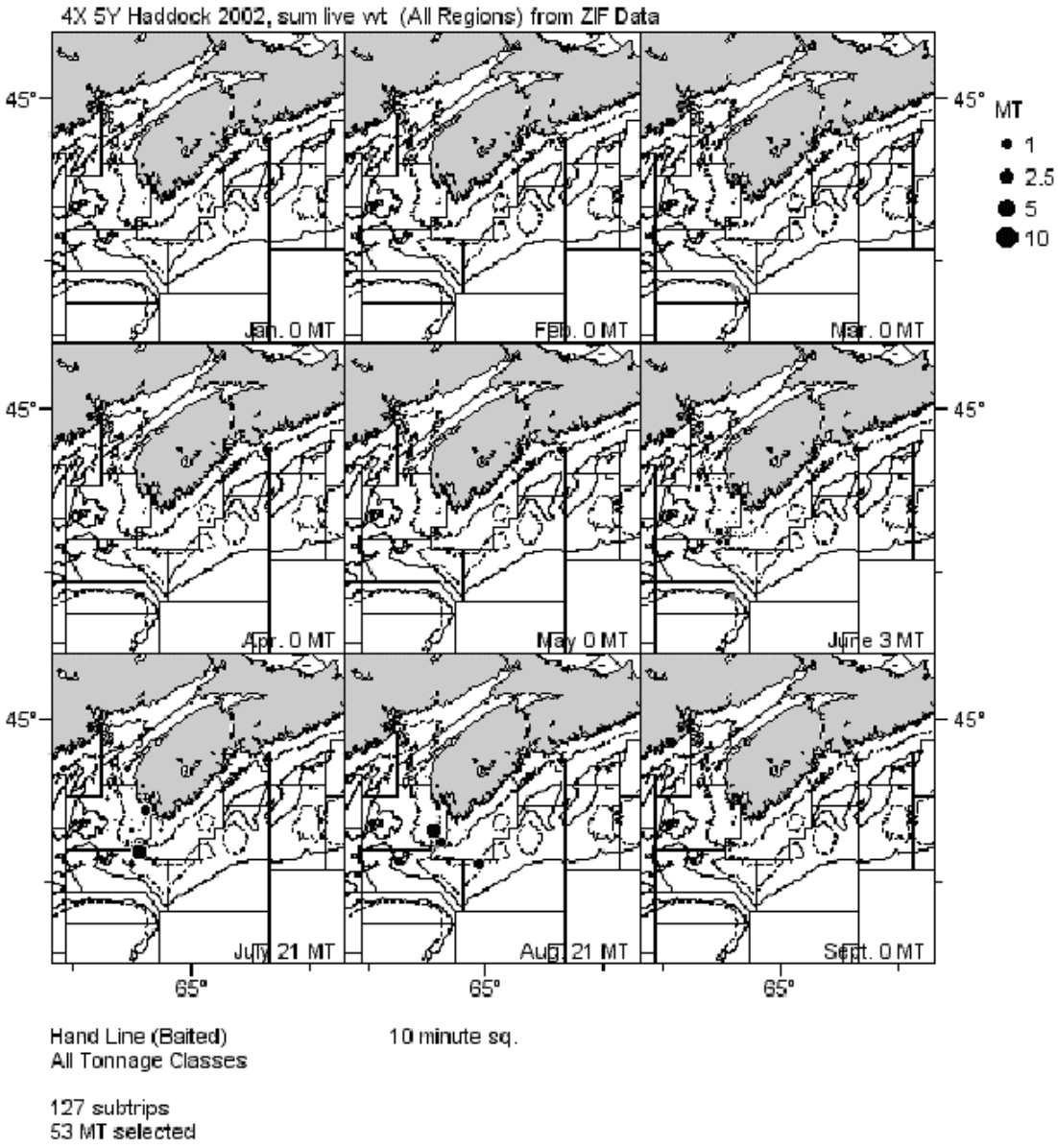
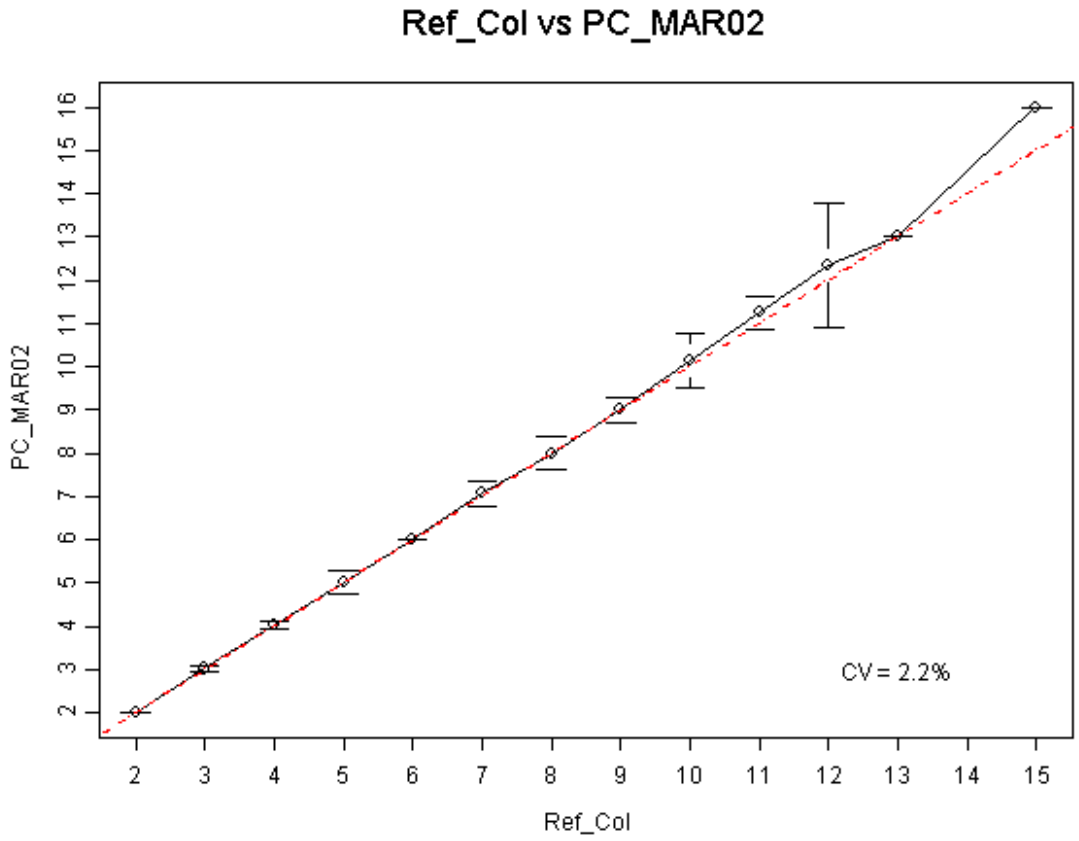


Figure 5d. Haddock catches by handlines in NAFO Div. 4X/5Y by month in 2002, aggregated by 10x10 minute squares (where catch position was reported).



PC_MAR02

Ref_Col	2	3	4	5	6	7	8	9	10	11	12	13	16	Total
2	3	0	0	0	0	0	0	0	0	0	0	0	0	3
3	2	48	3	0	0	0	0	0	0	0	0	0	0	53
4	0	4	67	6	0	0	0	0	0	0	0	0	0	77
5	0	0	1	10	1	0	0	0	0	0	0	0	0	12
6	0	0	0	0	2	0	0	0	0	0	0	0	0	2
7	0	0	0	0	1	10	2	0	0	0	0	0	0	13
8	0	0	0	0	0	2	8	2	0	0	0	0	0	12
9	0	0	0	0	0	0	1	9	1	0	0	0	0	11
10	0	0	0	0	0	0	0	1	4	2	0	0	0	7
11	0	0	0	0	0	0	0	0	0	6	2	0	0	8
12	0	0	0	0	0	0	0	0	0	0	2	1	0	3
13	0	0	0	0	0	0	0	0	0	0	0	1	0	1
15	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	5	52	71	16	4	12	11	12	5	8	4	2	1	203

Figure 6. Comparison of ages read by the primary ager against the haddock reference collection in March 2002.

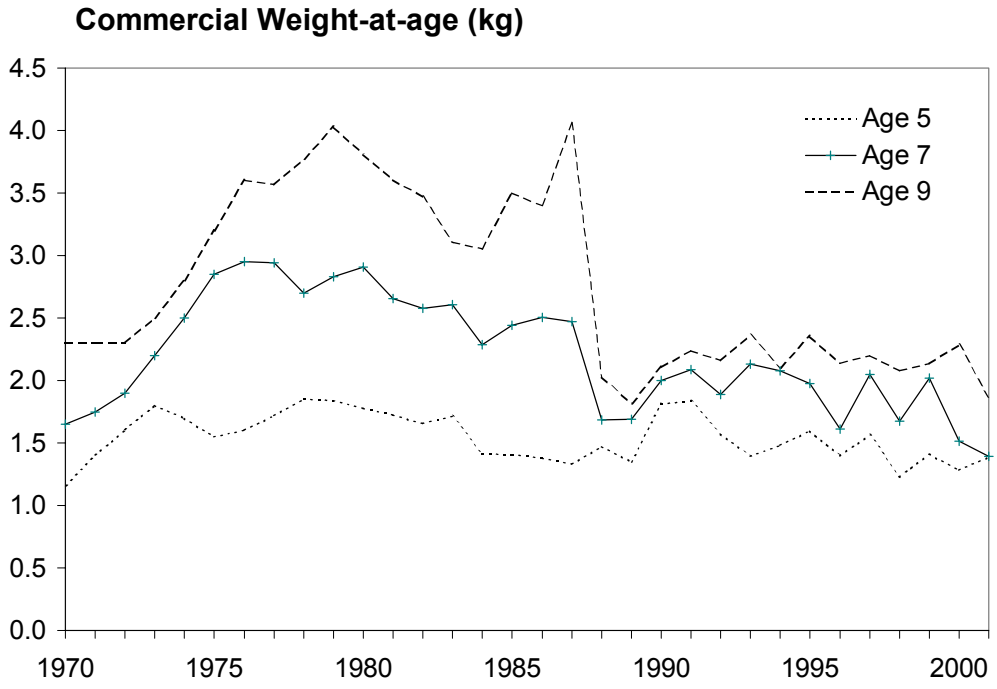


Figure 7. 4X haddock commercial mean weight-at-age (kg).

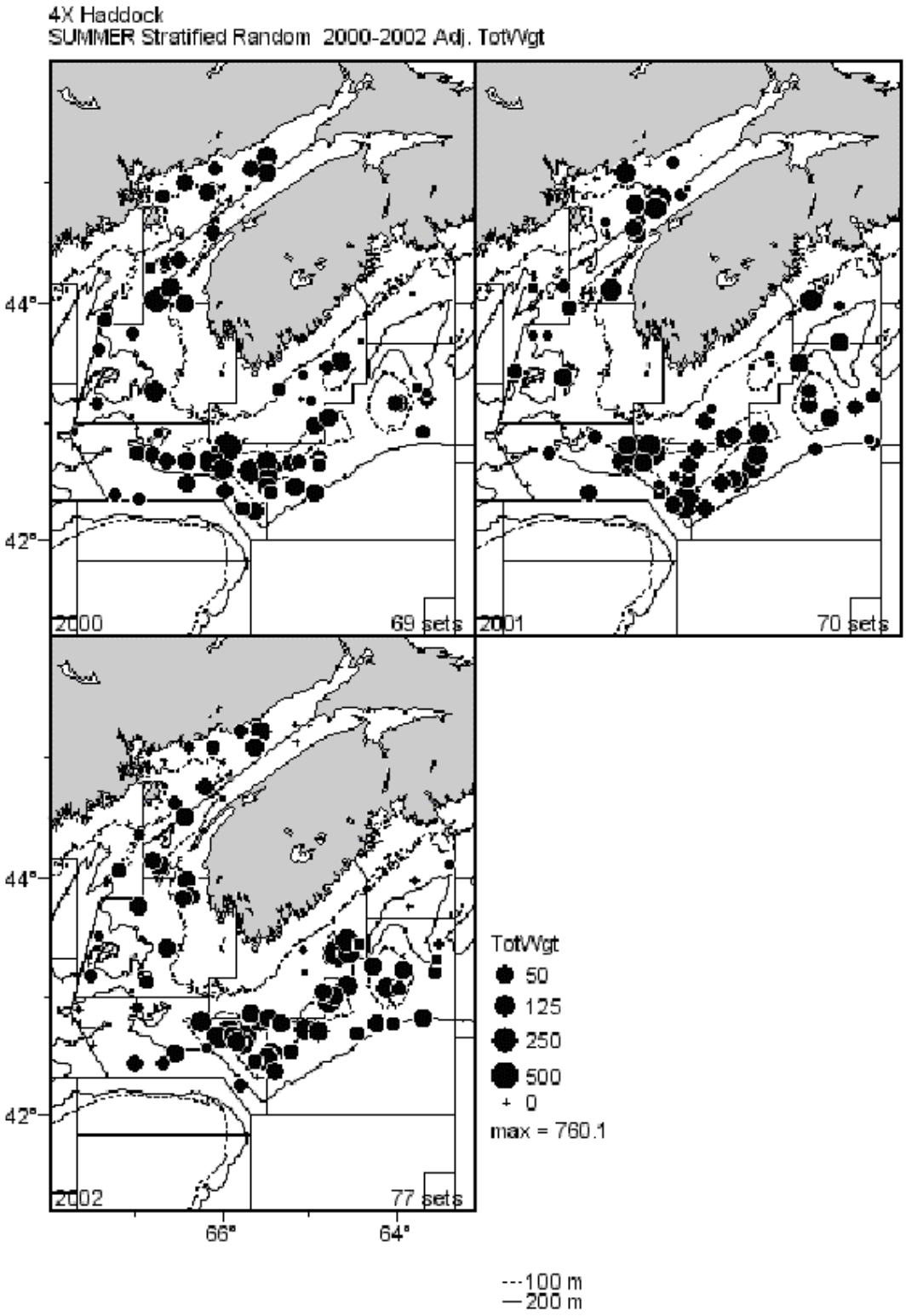


Figure 8. 4X haddock catches (kg) per standard tow from the 2000-2002 summer RV survey.

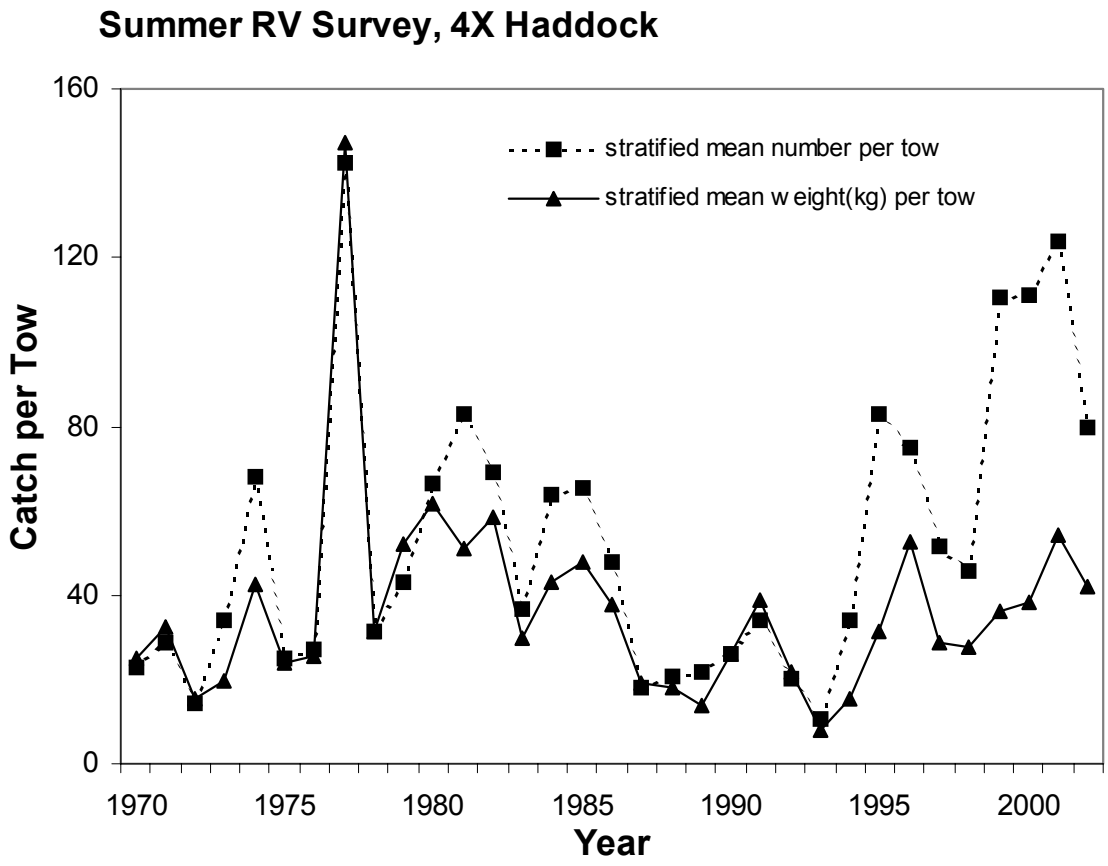


Figure 9. 4X haddock mean number and mean weight per tow from the summer RV survey, 1970-2002.

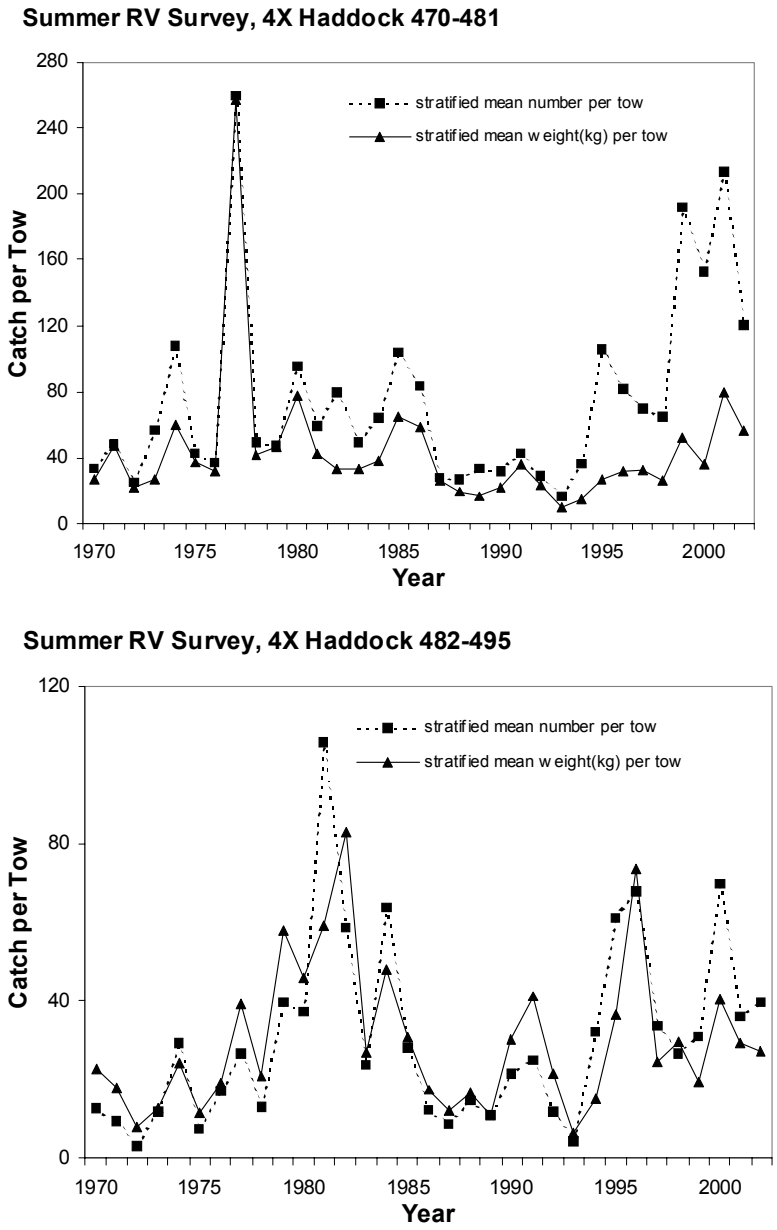
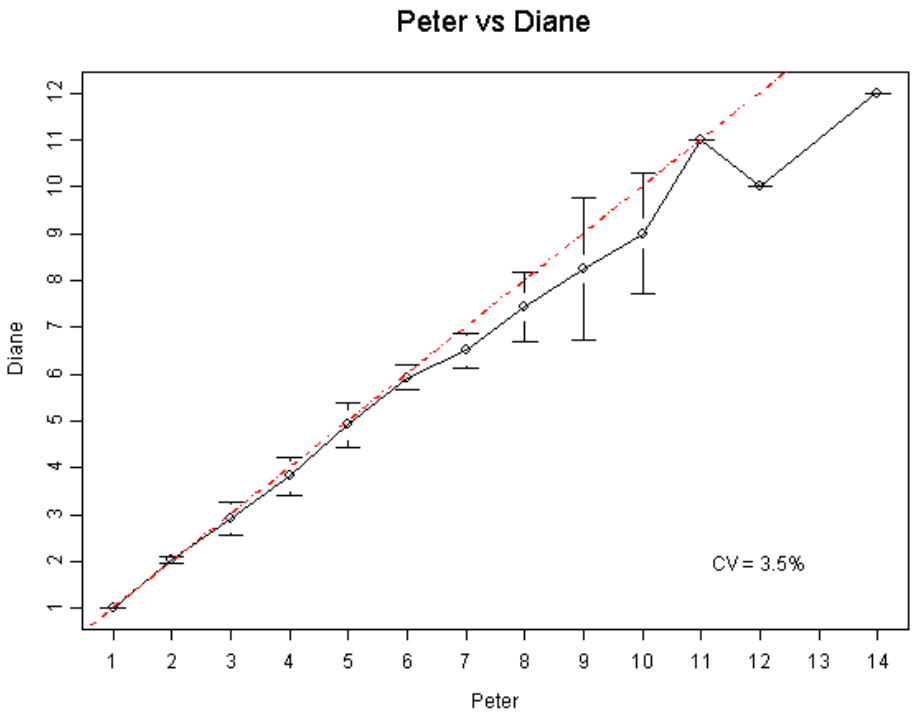
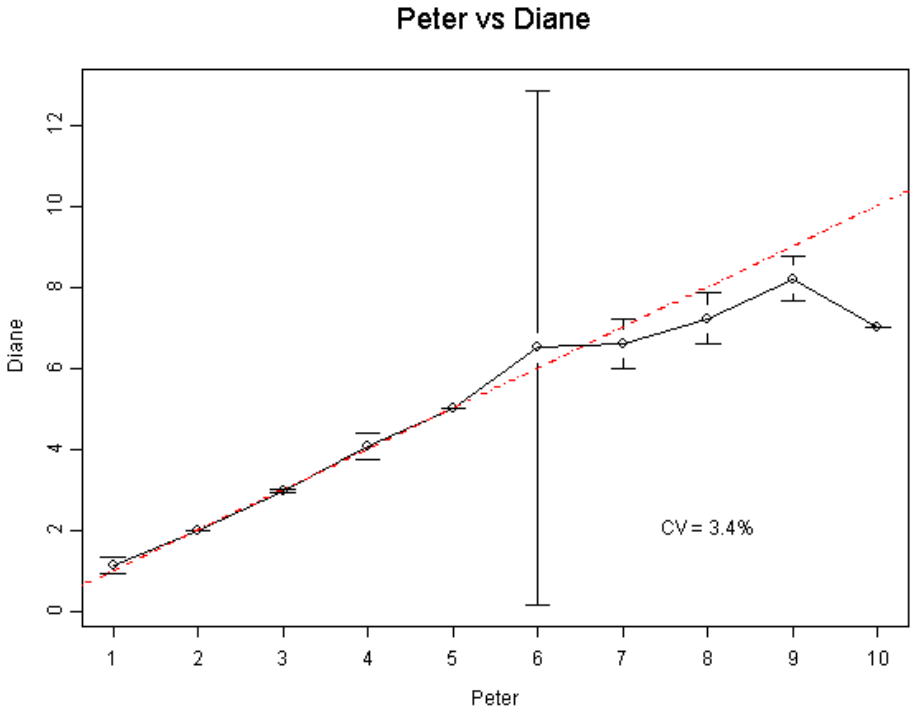


Figure 10. 4X haddock mean number and mean weight per tow from the summer RV survey on the Scotian Shelf (strata 470-481) and Bay of Fundy (strata 482-495).



RV 2000



RV 2001

Figure 11. Comparison of haddock ages by the primary and secondary agers from the summer RV survey in Div. 4X.

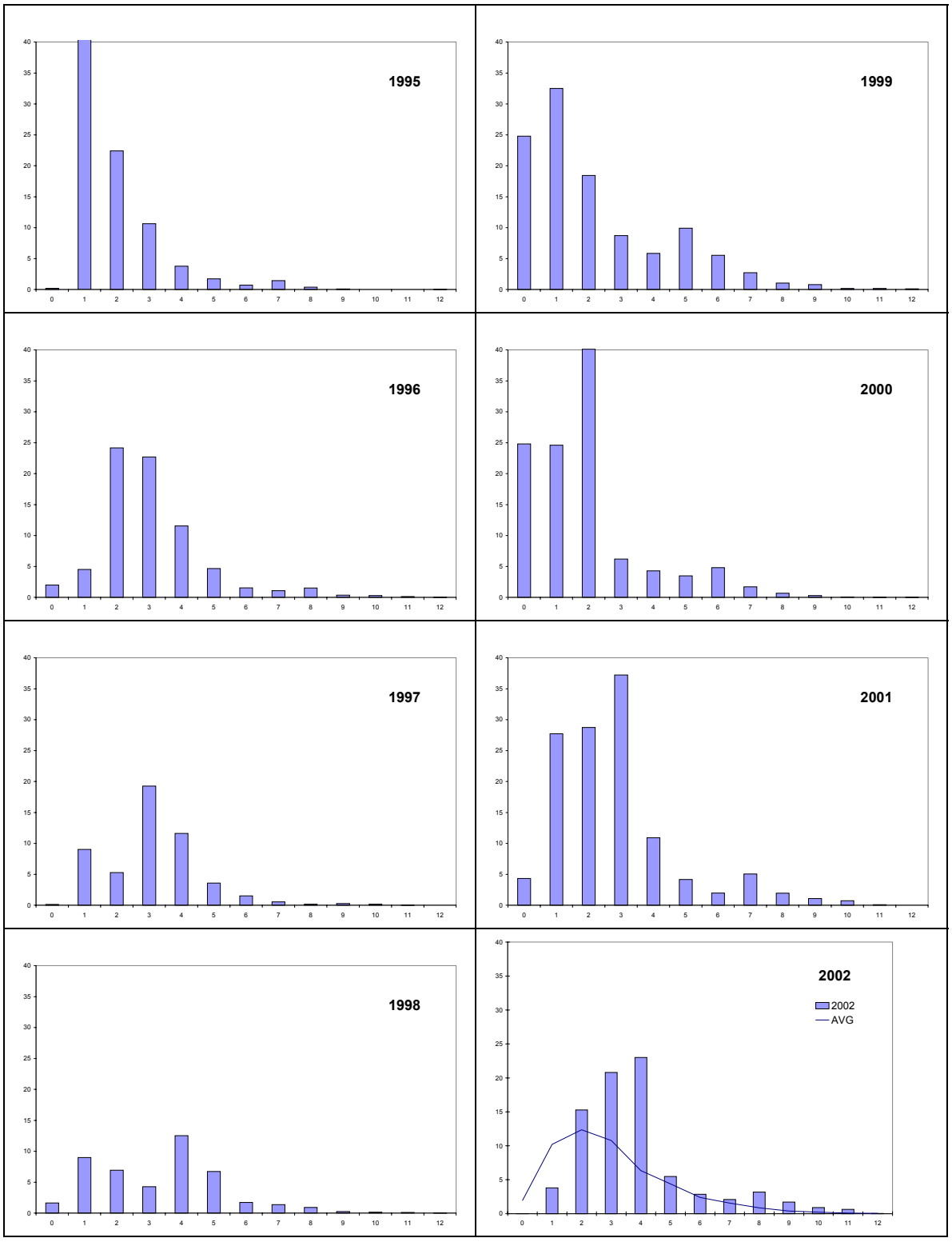


Figure 12. Age composition of 4X haddock in summer RV survey, 1995-2002.

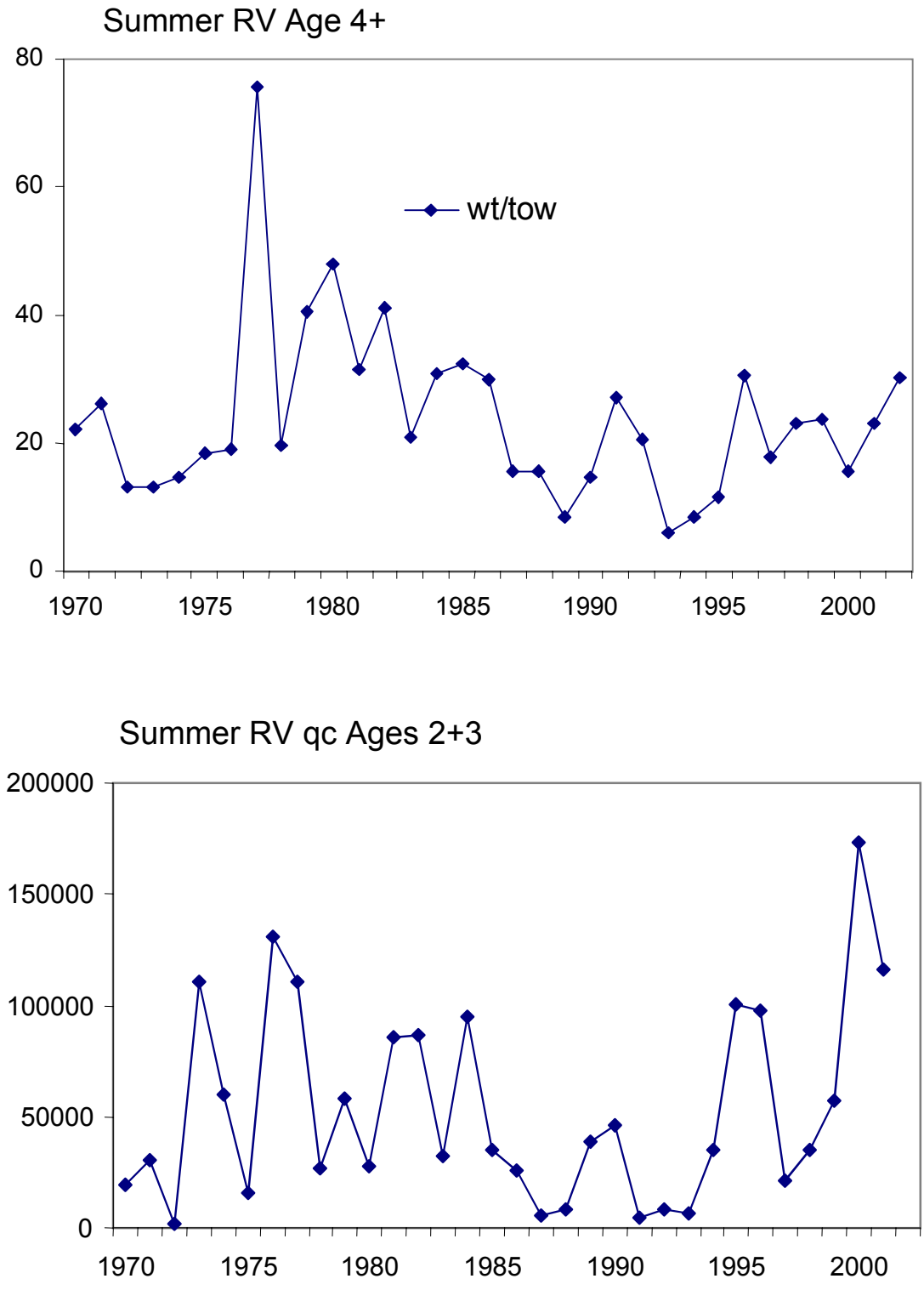
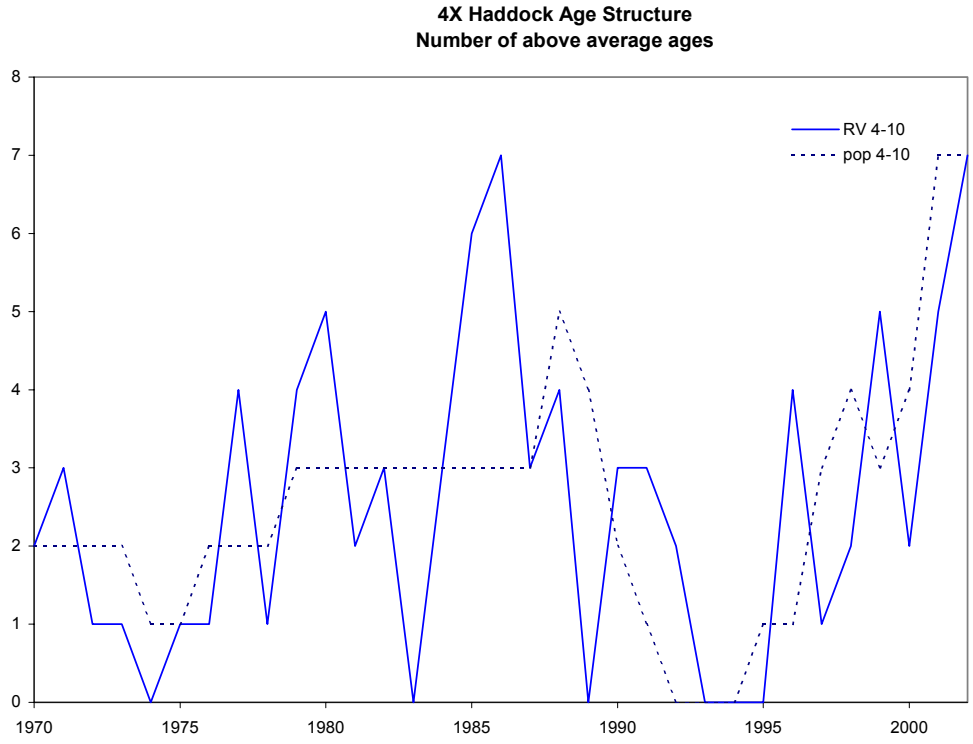


Figure 13. Weight per tow of ages 4+ in the RV survey (upper) and q-adjusted catch per tow of ages 2 and 3.



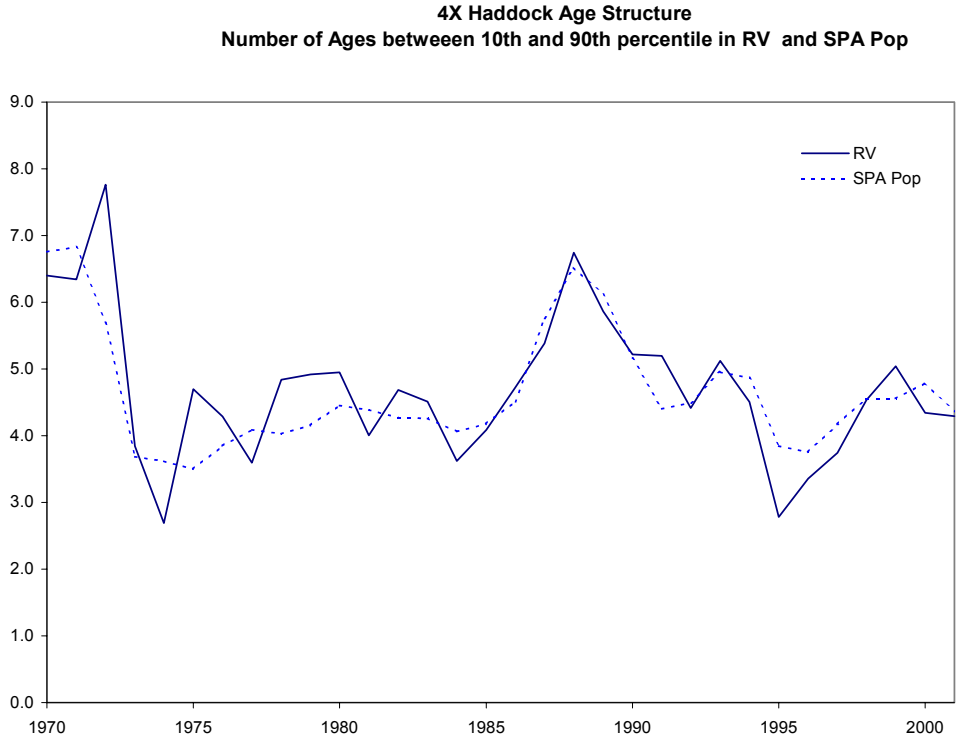
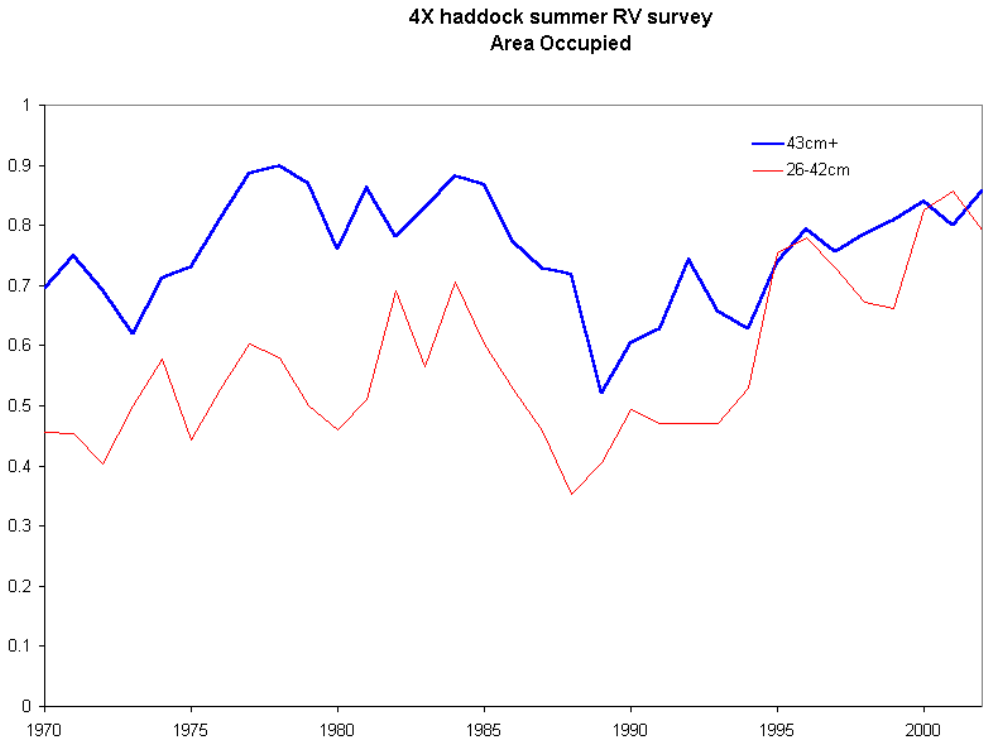


Figure 14. 4X haddock age structure indicators calculated from RV survey and SPA.



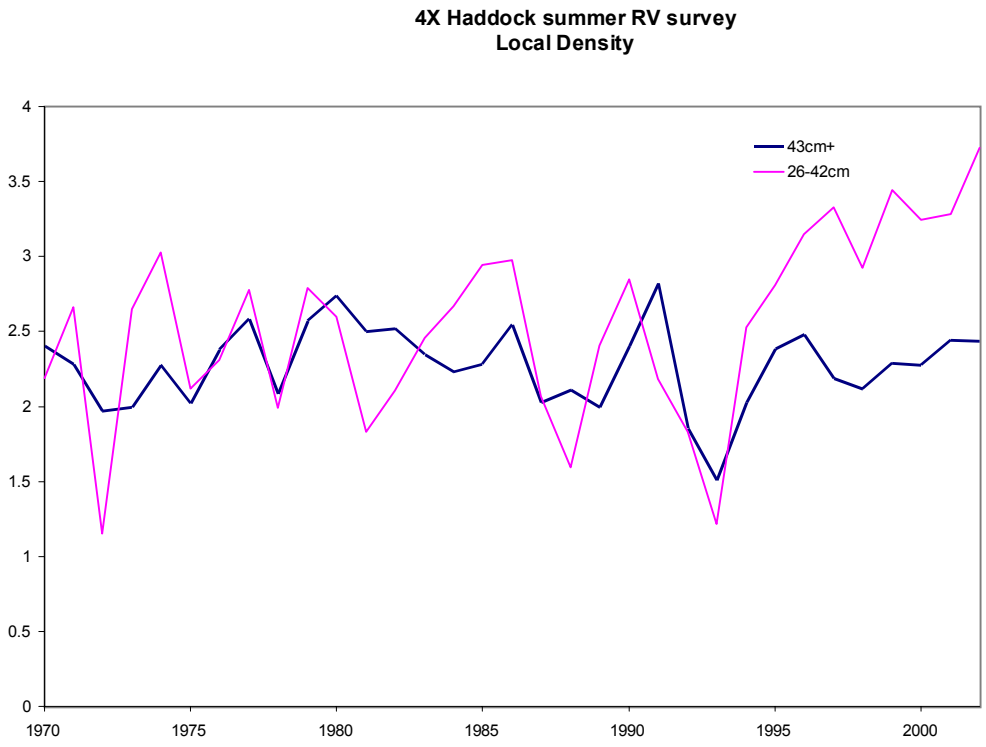


Figure 15. Distribution indices for 4X haddock in the RV survey, 26-42cm and 43cm+.

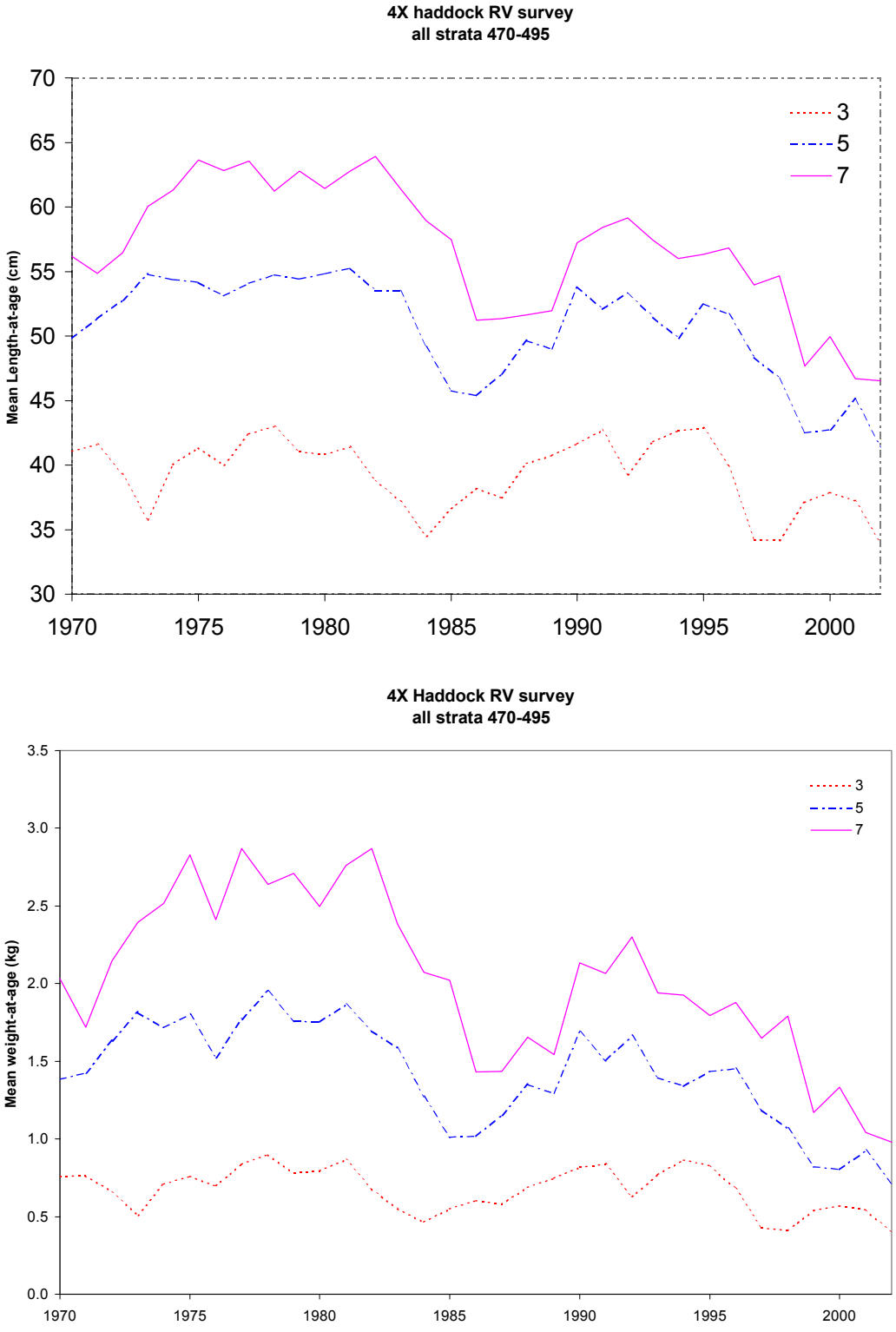


Figure 16. Mean lengtht-at-age (upper) and mean weight-at-age (lower) from the RV survey (all strata 470-495).

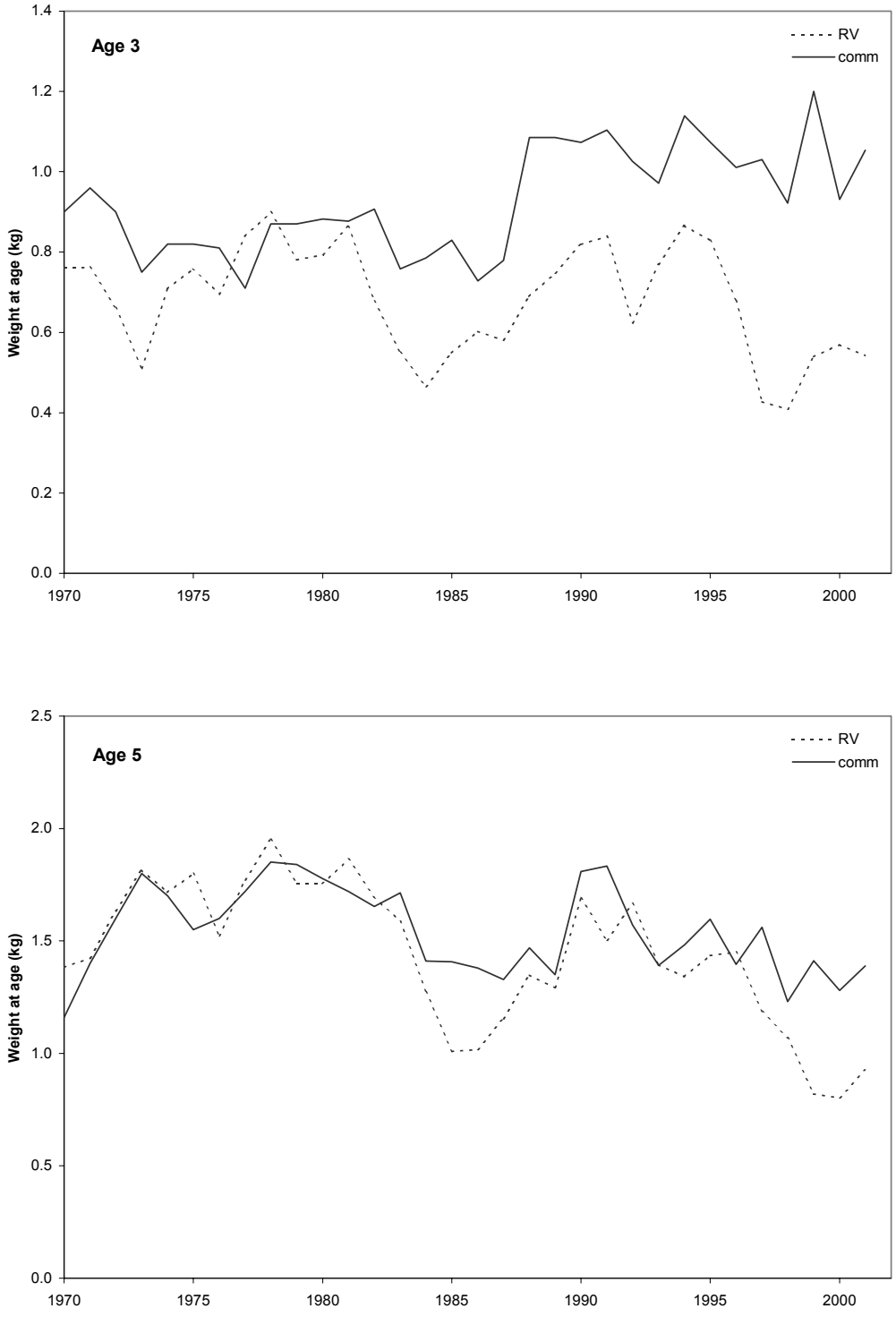


Figure 17a. Comparison of 4X haddock weight-at-age from RV survey and commercial fishery.

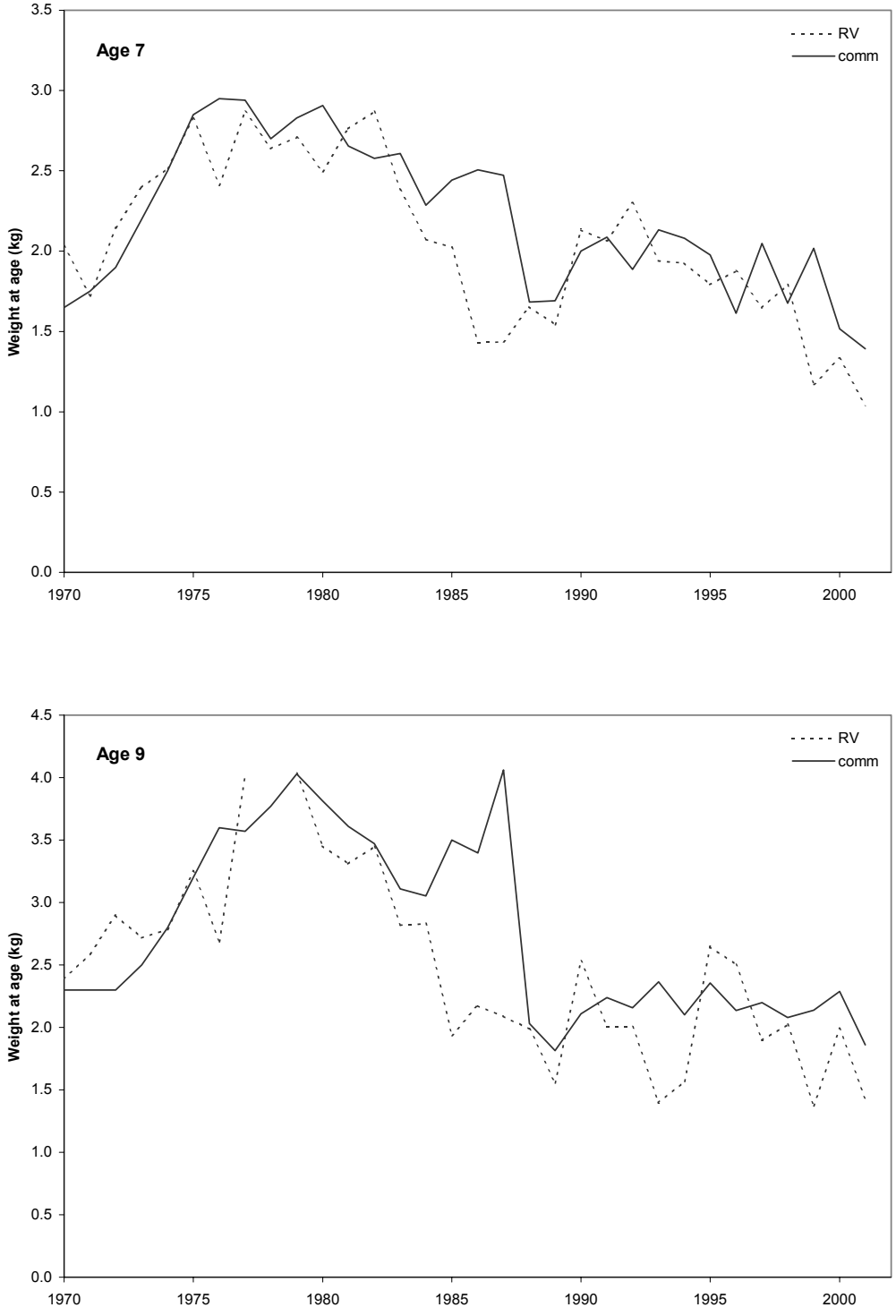


Figure 17b. Comparison of 4X haddock weight-at-age from RV survey and commercial fishery.

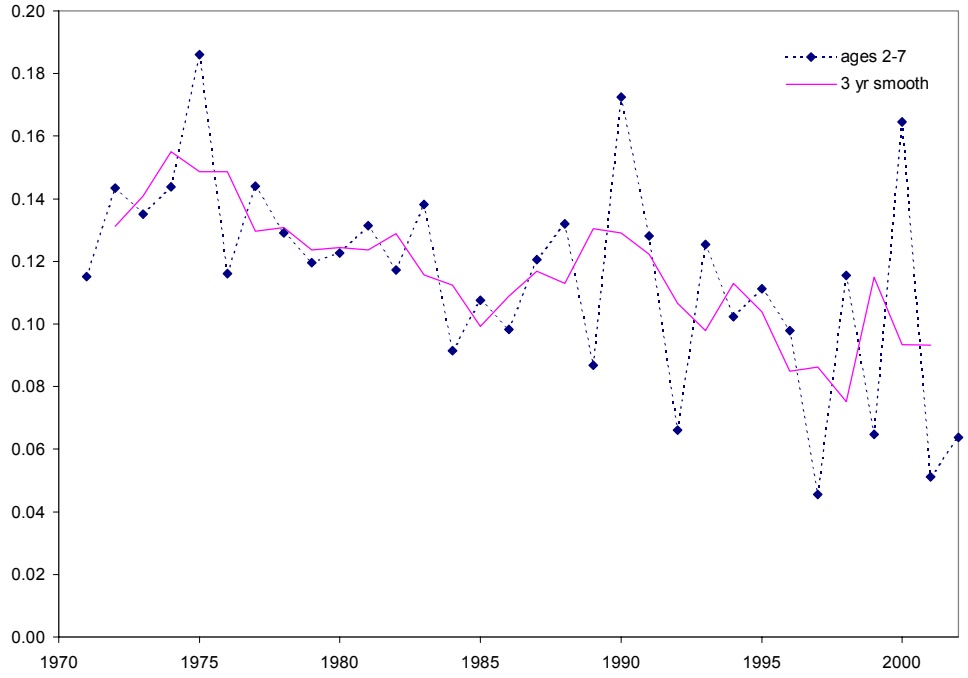
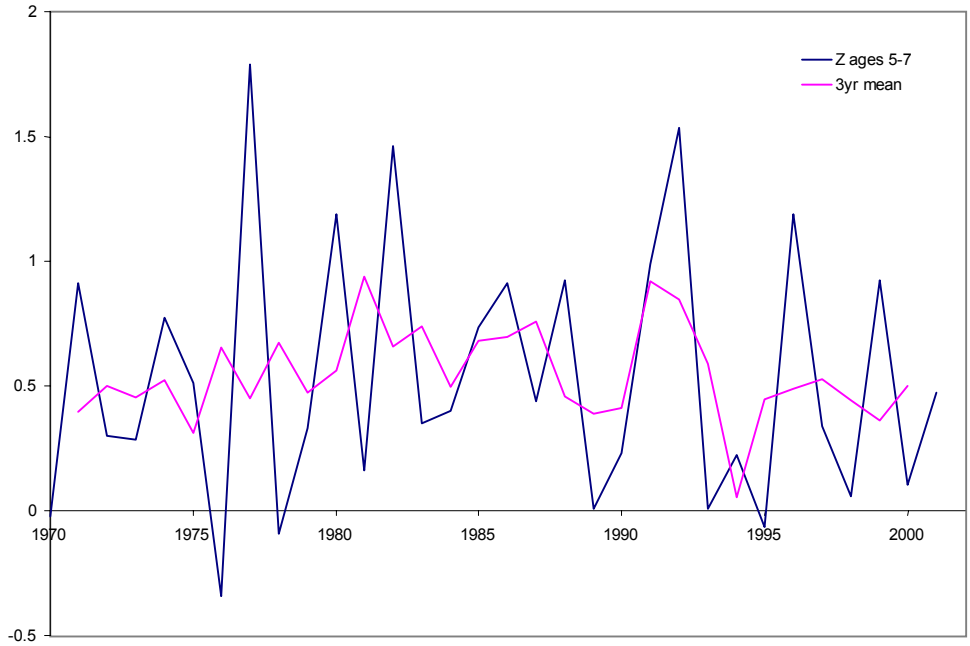


Figure 18. 4X haddock instantaneous growth rate (G) calculated using length at ages 2-7 from the RV survey.

Figure 19. 4X haddock condition indices calculated from the RV survey (all strata 470-495), predicted weight at 50cm (upper) and Fulton's K (lower).



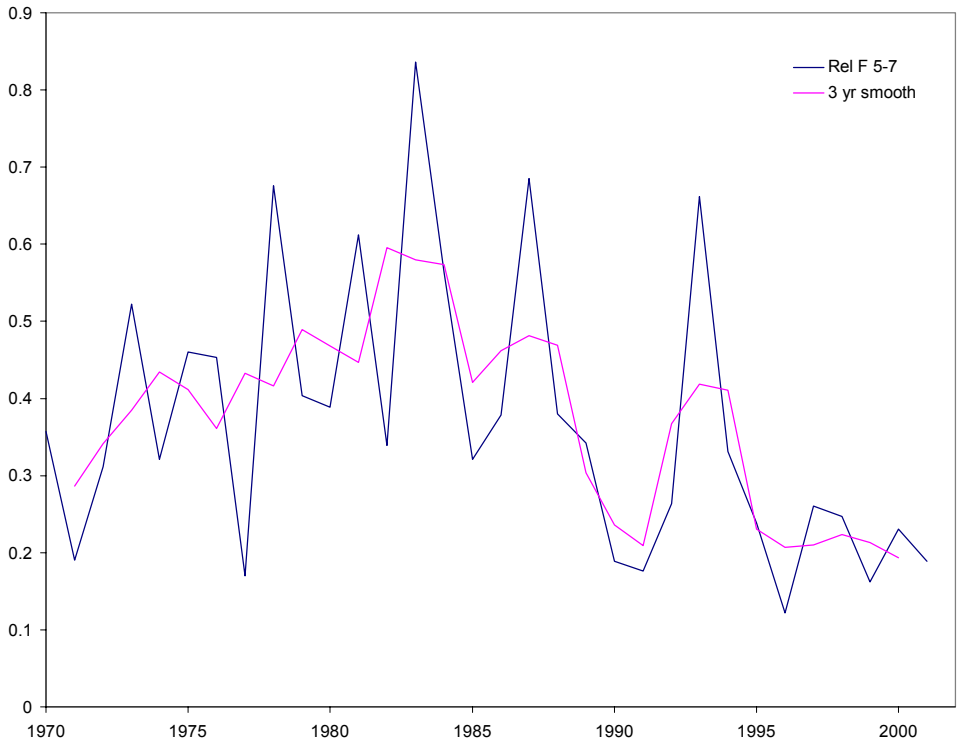


Figure 20. 4X haddock total mortality (Z) estimates ages 5-7 calculated from the RV survey (upper) and relative F ages 5-7 (lower).

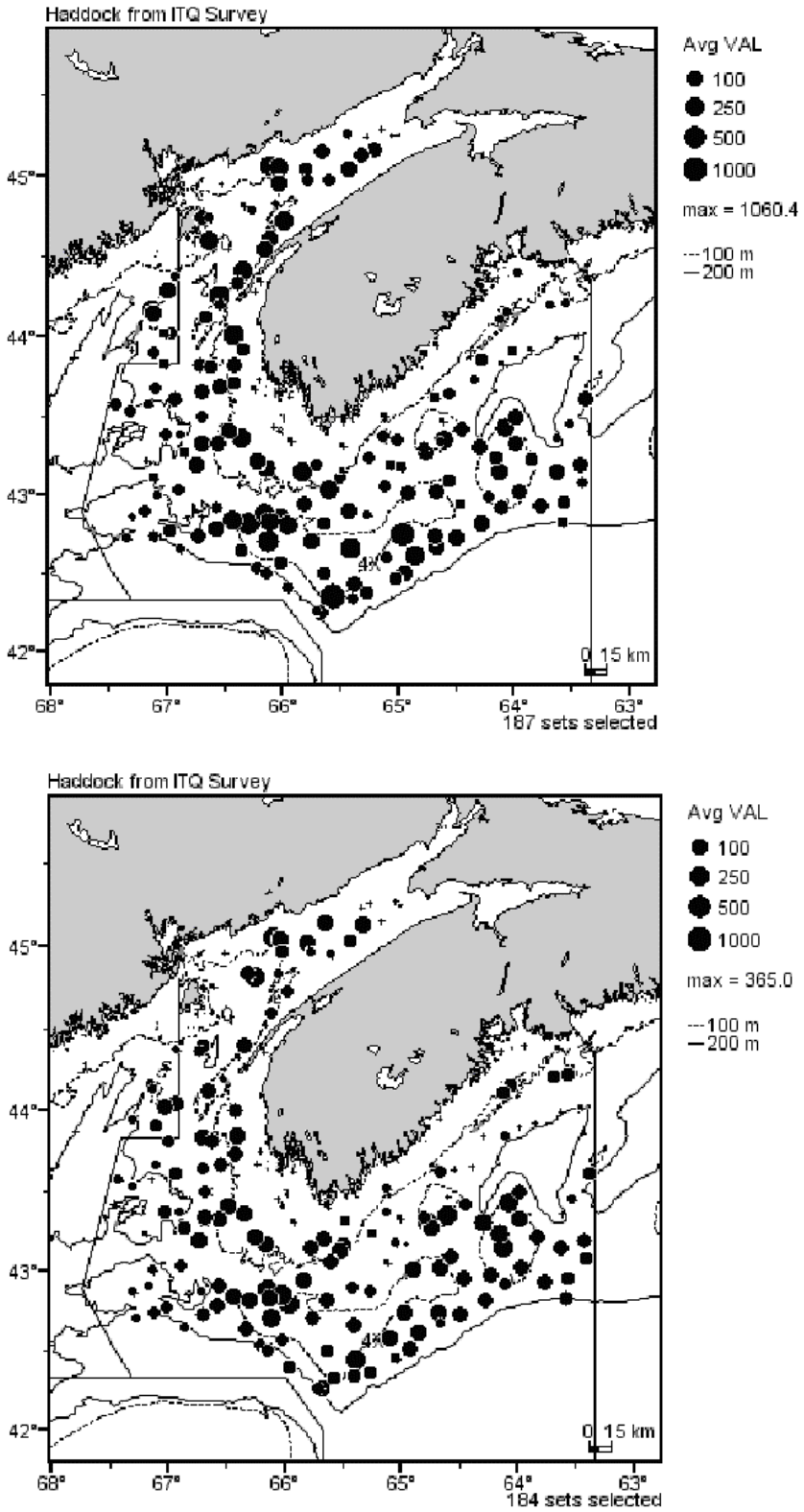


Figure 21. Haddock catches (kg) per standard tow from the 2001 and 2002 ITQ survey.

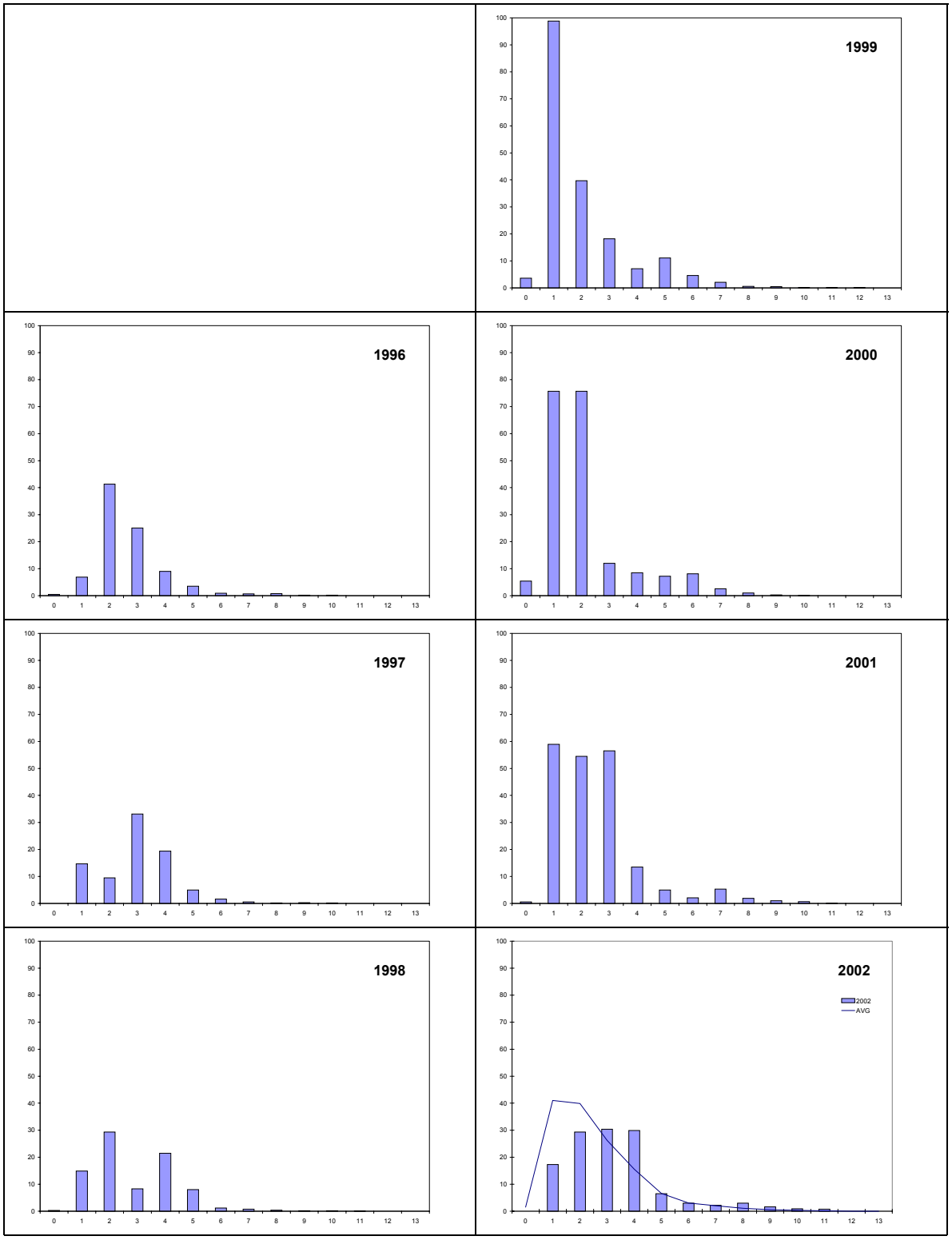
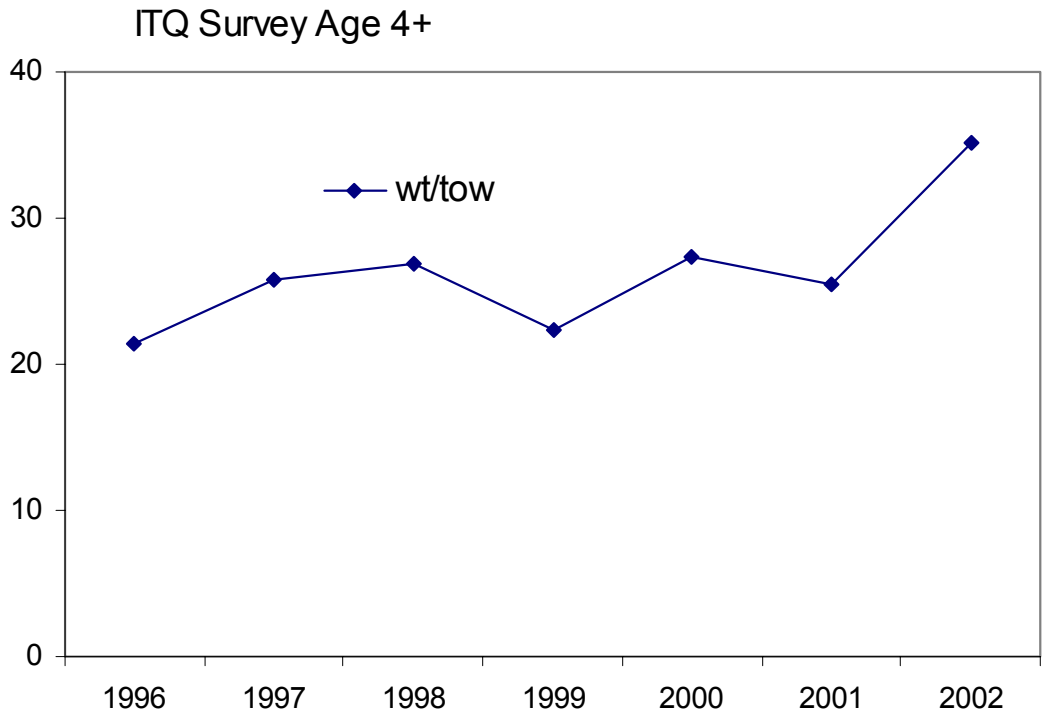


Figure 22. 4X haddock age composition from ITQ survey, 1996-2002.



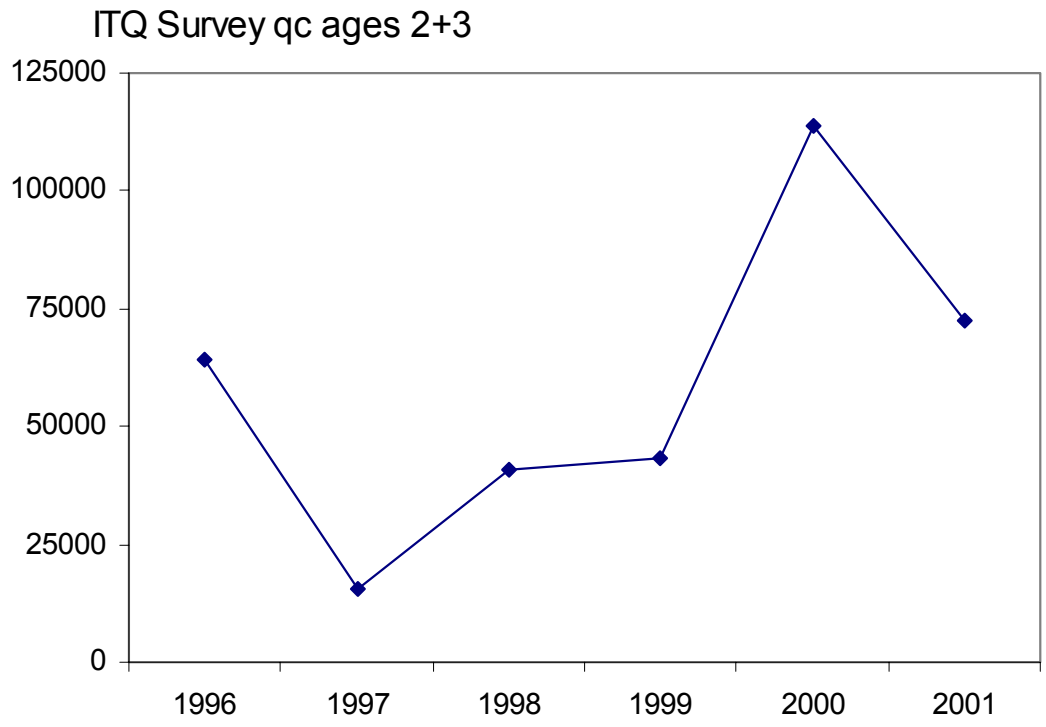


Figure 23. Weight per tow of ages 4+ in the ITQ survey (upper) and q-adjusted catch per tow of ages 2 and 3.

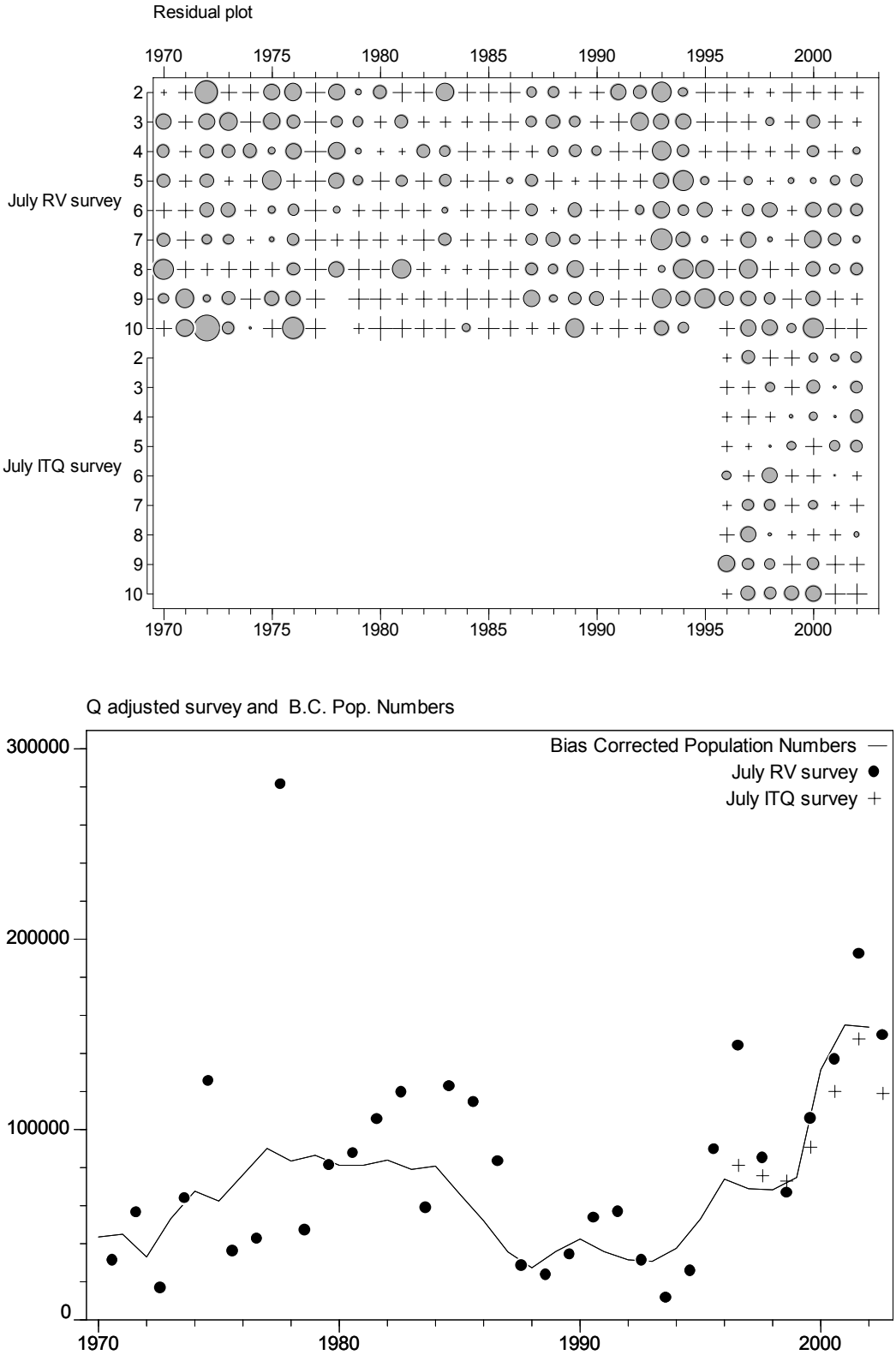


Figure 24. Residuals at age (upper) and population numbers (2-10) estimated from the model and the q-adjusted survey indices (lower).

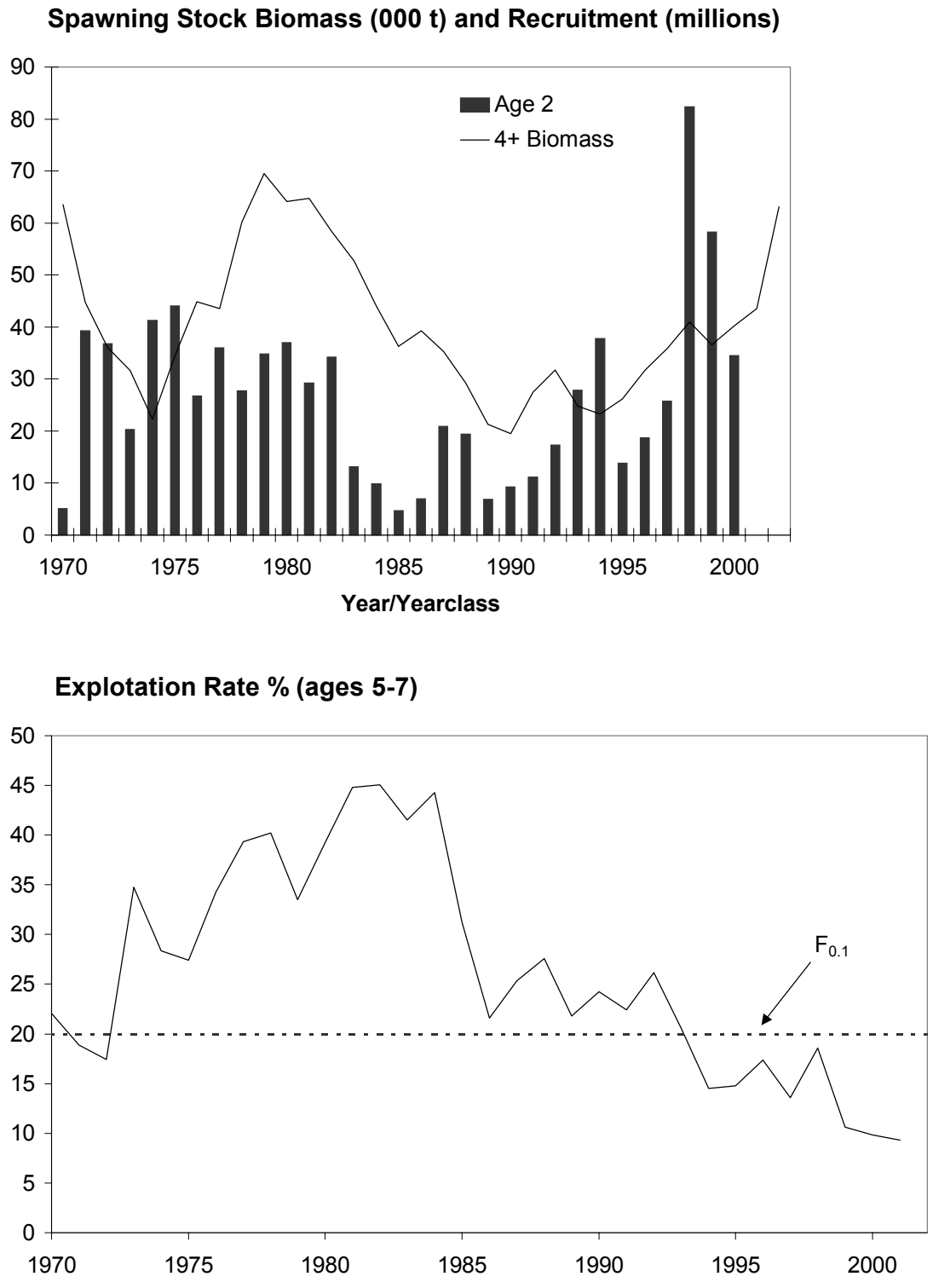


Figure 25. Spawning stock biomass and age 1 recruitment in the subsequent year from the SPA.

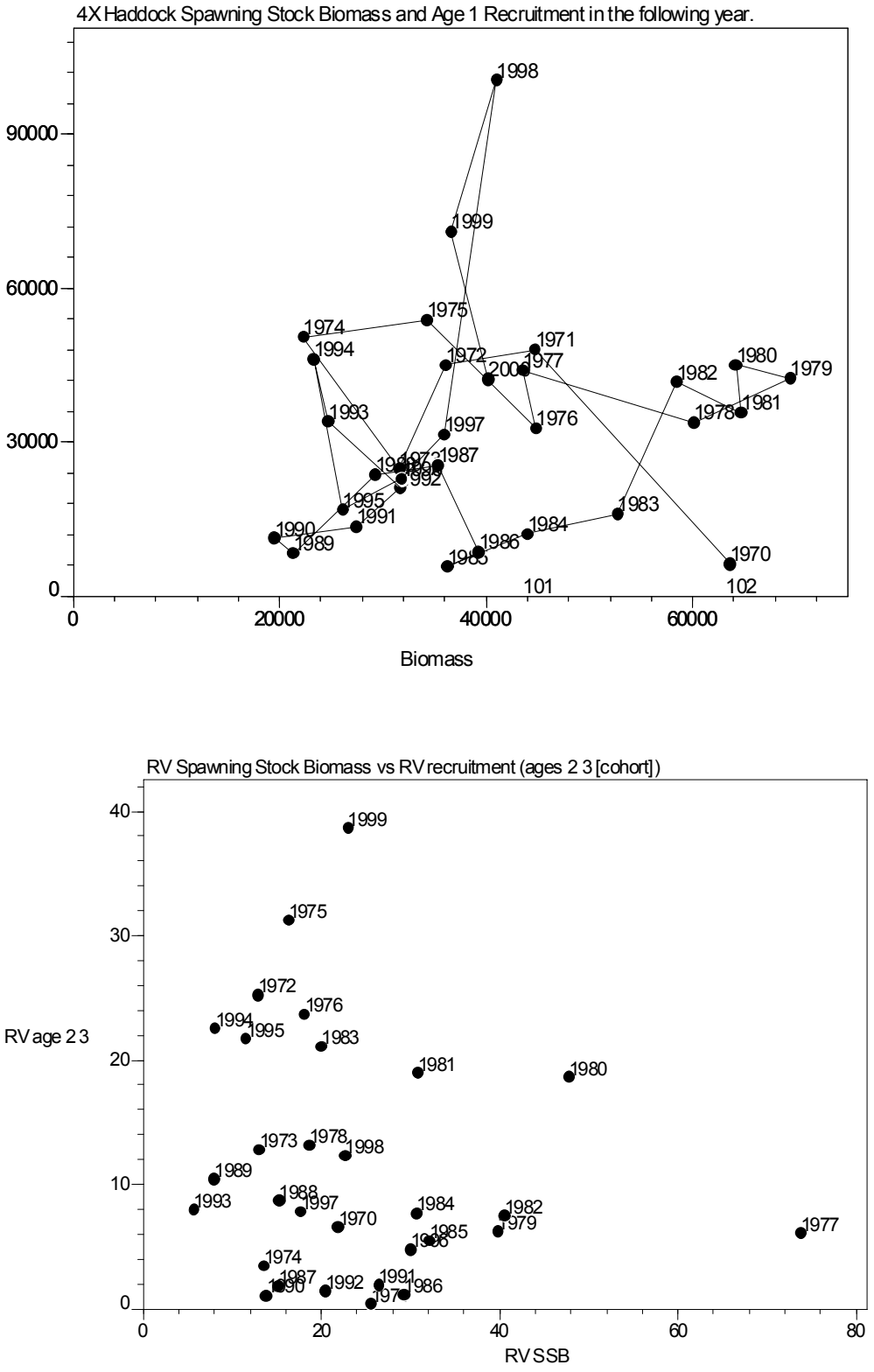


Figure 26. Spawning stock biomass and age 1 recruitment in the subsequent year from the SPA (upper) and RV survey age 4+ and RV survey ages 2+3. Labels are yearclass.

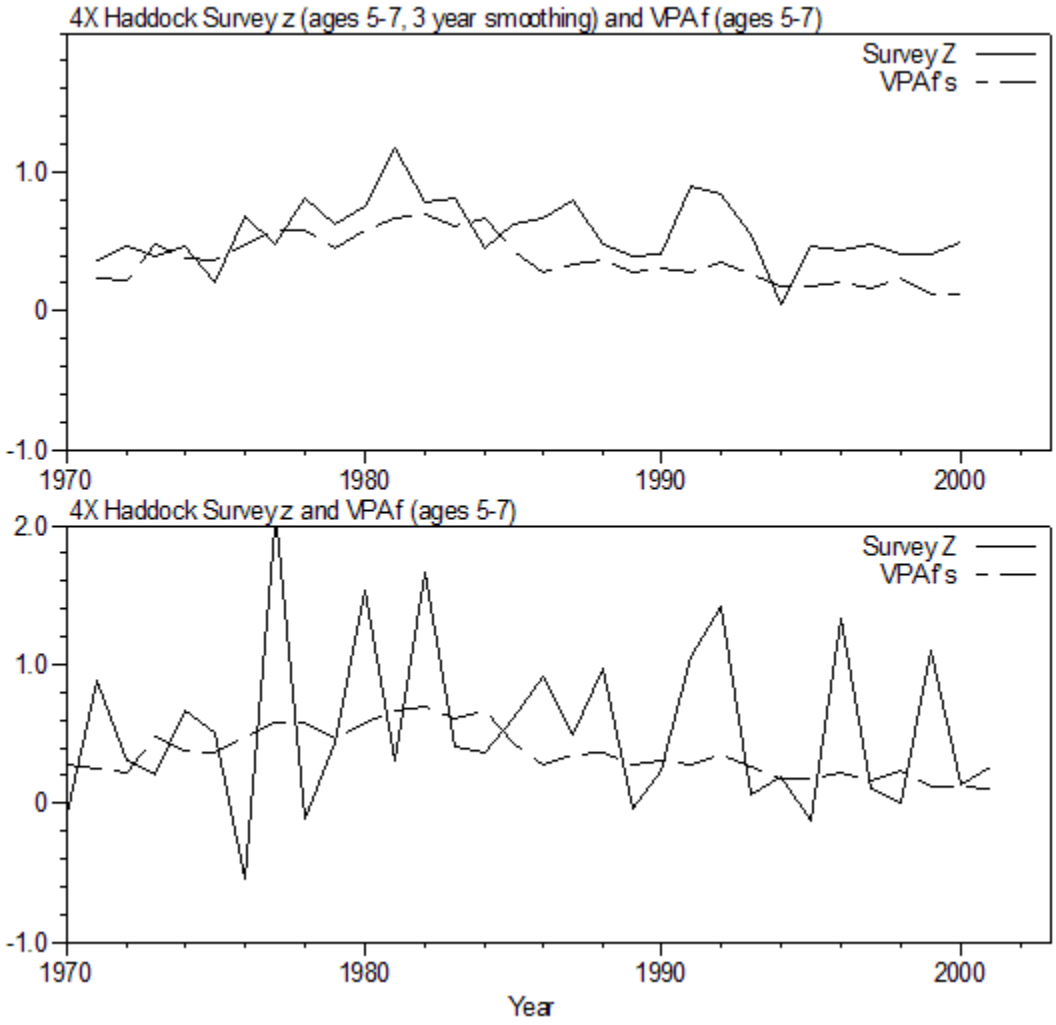


Figure 27. Comparison of total mortalities (Z) calculated from the RV survey and fishing mortalities (F) from the SPA for ages 5-7. Three year running means of RV Zs in the upper panel.

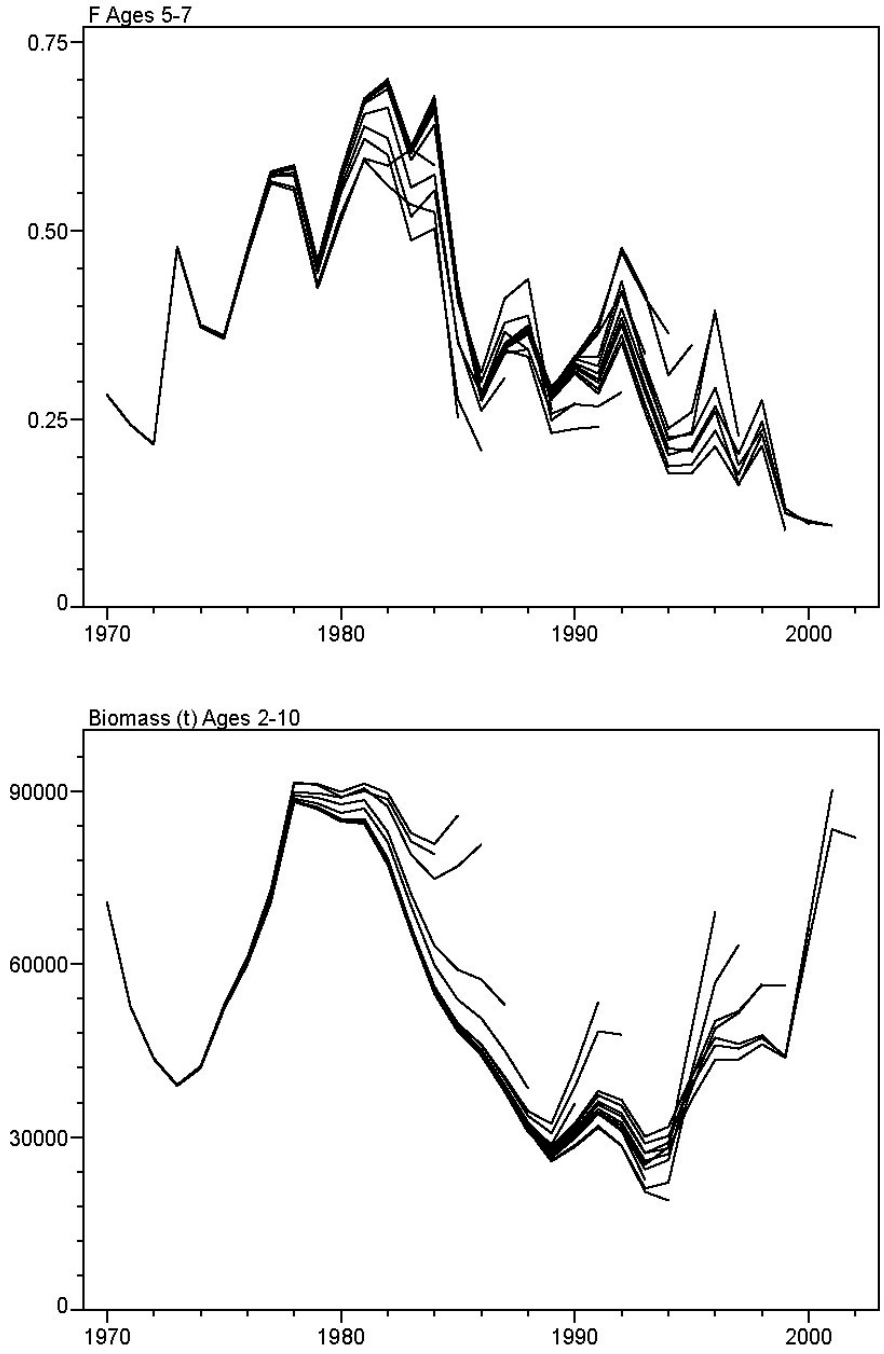


Figure 28. Retrospective pattern.

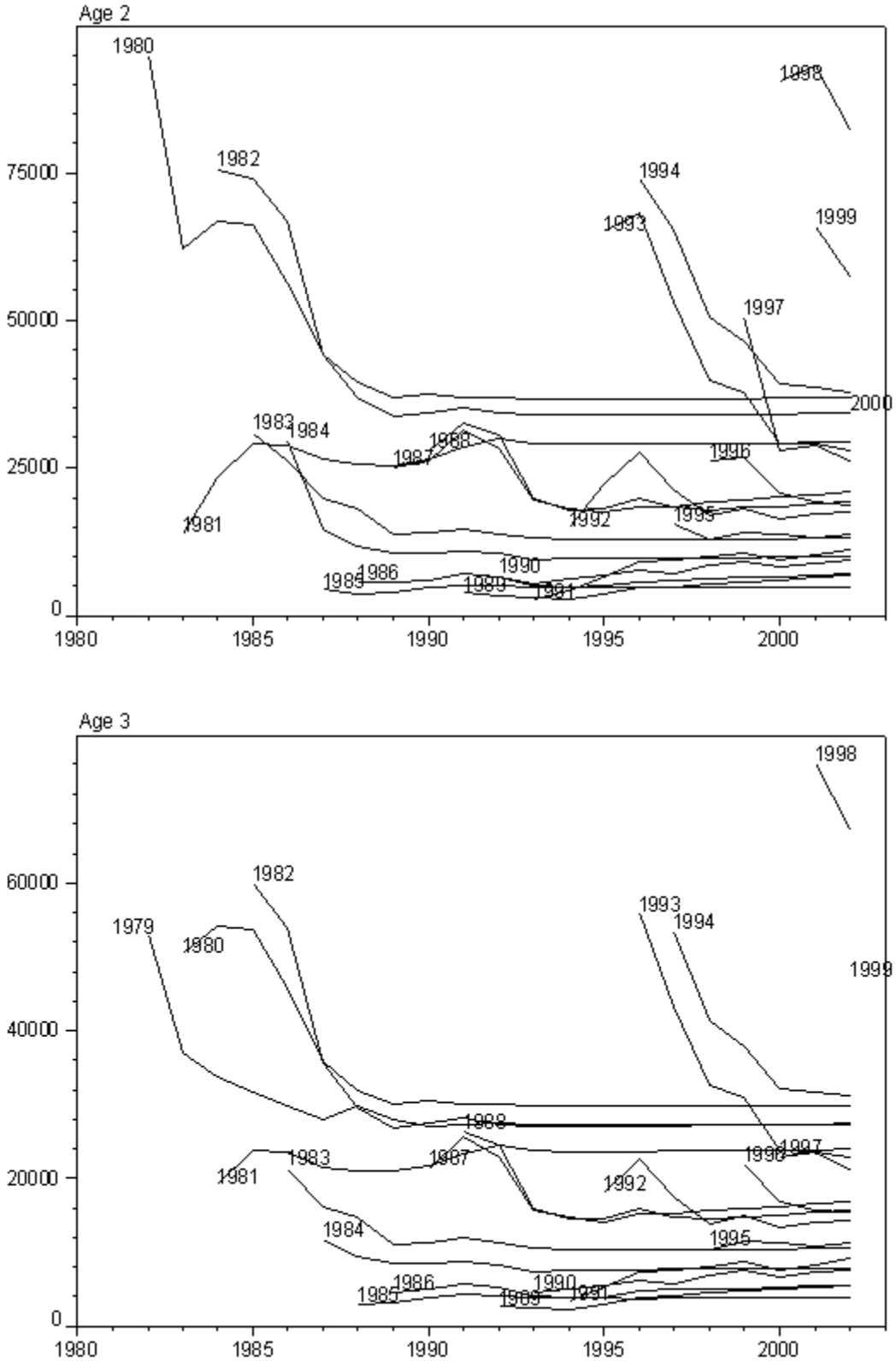


Figure 29a. Retrospective estimates of yearclass size at ages 2 and 3.

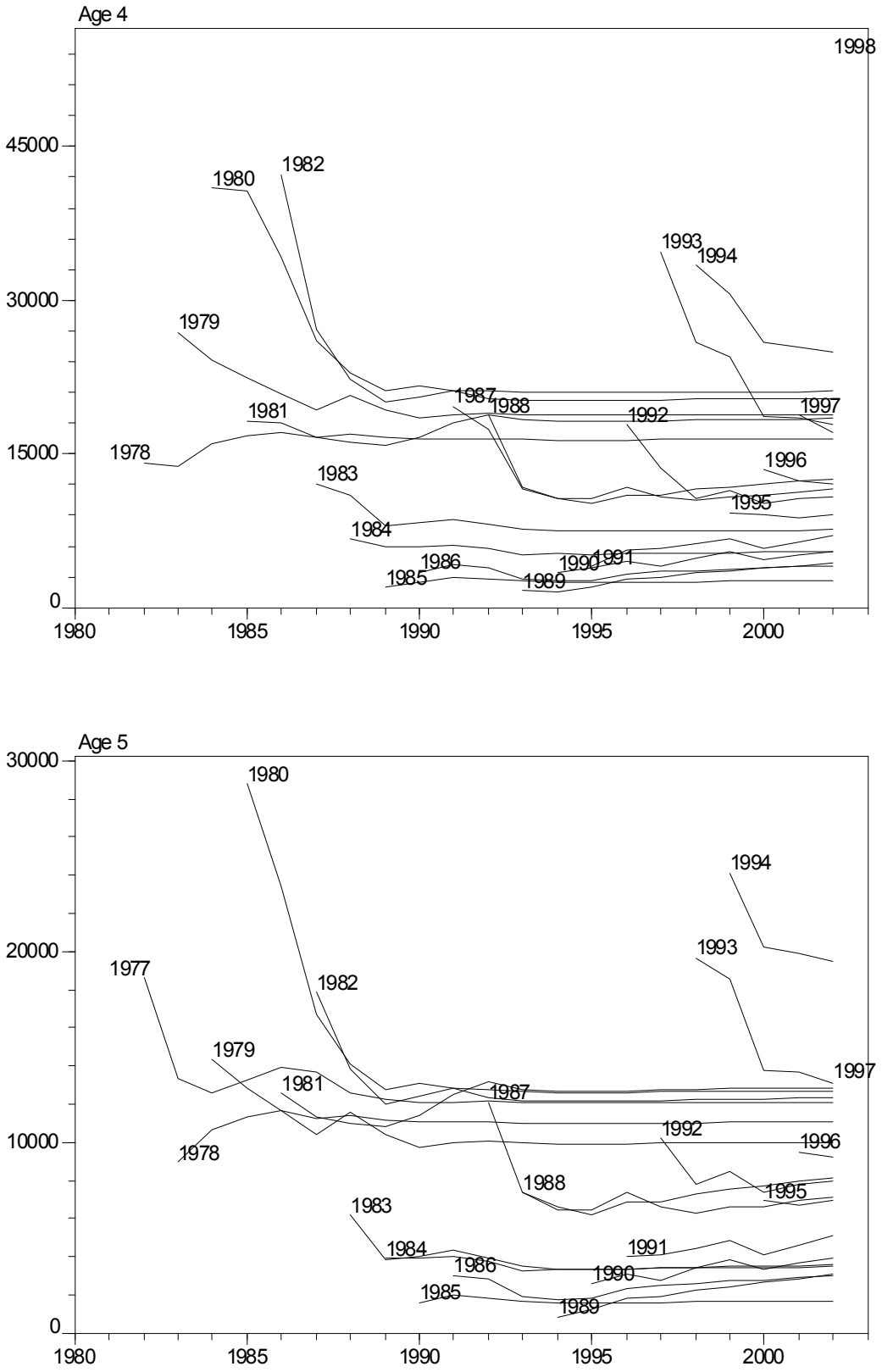


Figure 29b. Retrospective estimates of yearclass size at ages 4 and 5.

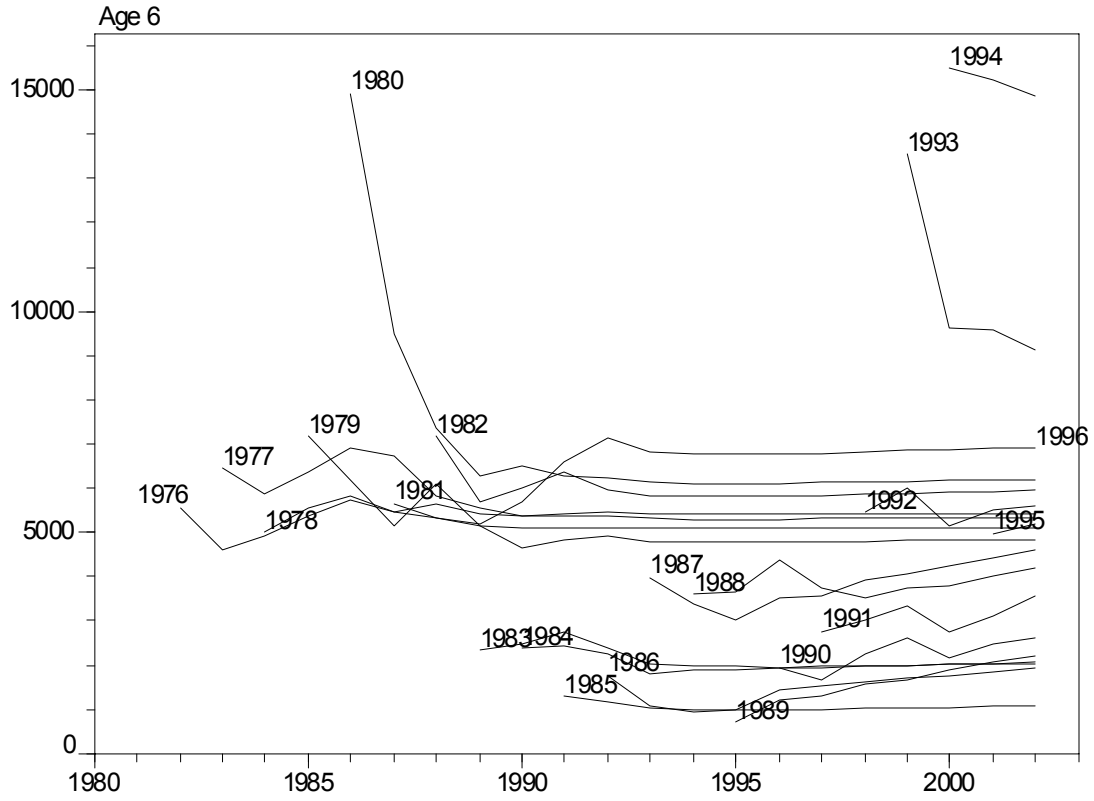


Figure 29c. Retrospective estimates of yearclass size at age6.

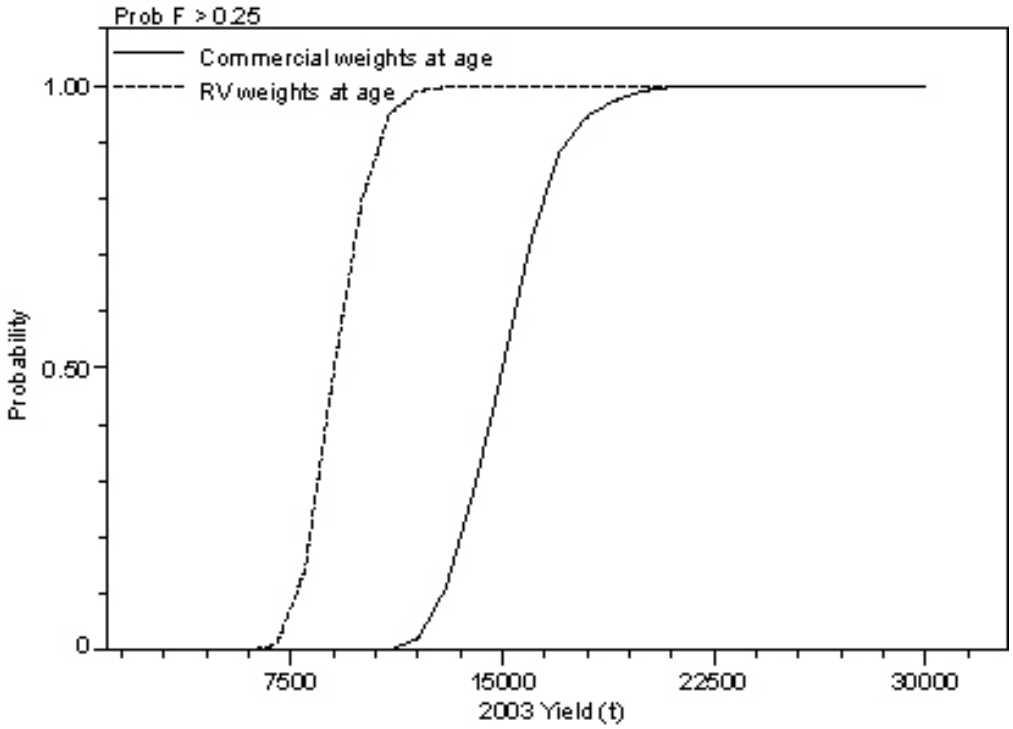


Figure 30. Risk plot – probability that $F_{0.1}$ will be exceeded at various levels of yield, calculated using recent commercial weights-at-age and RV weights-at-age.

Appendix 1. Description of traffic light indicators, boundary points, weights and rationales for 4X/5Y haddock.

The traffic light approach provides a framework that allows us to incorporate multiple indices of stock status and other relevant indicators. Colour boundaries corresponding to good and bad periods can be established qualitatively for some indicators, but remain problematic for others. For most indicators, the history of the index is short relative to the ecological and evolutionary history of the fish populations or of the ecosystems within which they occur. In the absence of quantitative information to specify colour boundaries they have been established by a process of deliberation, where the weight of expert opinion is used to determine the most reasonable estimates. These represent the best available estimates; however all are subject to improvement through ongoing research.

The time period 1970-2002 was used to establish colour boundaries for the 4X/5Y haddock stock status indicators. During this period, abundance of the stock was relatively high during the late 1970s and early 1980s, and relatively low during the late 1980s and early 1990s. Recruitment was relatively good during the mid-1970s through to the early 1980s, but was poor from the mid-1980s to the mid-1990s. Production in terms of growth in the population has decreased throughout the period. Mortality rates were high from the mid-1970s to the mid- to late 1980s. Colour boundaries were set to correspond to these general trends.

Indicator	Green Boundary	Red Boundary	Characteristic	Weight
RV Survey wt per tow ages 4+ (kg)	31: Consistent with highs observed in late 70s/early 80s	13: Consistent with lows observed in late 80s/early 90s	Abundance	1
ITQ Survey wt per tow ages 4+ (kg)	30: This is a short time series and thus its true range is uncertain. The boundaries were set to be consistent with those for SPA 4+ biomass	20: This is a short time series and thus its true range is uncertain. The boundaries were set to be consistent with those for SPA 4+ biomass	Abundance	1
SPA Biomass ages 4+ (t)	55000: Consistent with highs observed in late 70s/early 80s	20000: Consistent with lows observed in late 80s/early 90s	Abundance	1
RV Survey Age Structure –above average ages 4-10	5: Consistent with highs observed in late 70s/early 80s	1: Consistent with lows observed in late 80s/early 90s	Abundance	1
RV Survey Area Occupied 43+cm	0.88: Consistent with highs observed in late 70s/early 80s	0.62: Consistent with lows observed in late 80s/early 90s	Distribution	1
RV Survey Local Density 43+cm	2.5: Consistent with highest observed	2: Consistent with lowest observed	Distribution	1
RV Survey Area Occupied (26-42cm)	0.8: Consistent with highest observed	0.4: Consistent with lowest observed	Distribution	1
RV Survey Local Density (26-42cm)	3.2: Consistent with highest observed	1.6: Consistent with lowest observed	Distribution	1
RV Survey Recruitment Index ages 2+3	87,000: Set to be consistent with those of SPA age 2 recruitment	18,000: Set to be consistent with those of SPA age 2 recruitment	Recruitment	1
ITQ Survey Recruitment Index ages 2+3	62,000: Set to be consistent with those of SPA age 2 recruitment	26,000: Set to be consistent with those of SPA age 2 recruitment	Recruitment	1
SPA Recruitment age 2	40,000,000: Consistent with highs observed in late 70s/early 80s	10,000,000: Consistent with lows observed in late 80s/early 90s	Recruitment	1
RV Survey Fish Condition (Fulton's K)	1.02: It is unlikely that K values in the range observed were low enough to have affected reproductive success or mortality, but they do reflect reductions in production	0.90: It is unlikely that K values in the range observed were low enough to have affected reproductive success or mortality, but they do reflect reductions in production	Production	1
RV Survey Growth (G)	0.14: Consistent with highest	0.07: Consistent with lowest	Production	1

ages 2-7 3yr smooth	observed	observed		
RV Survey Total Mortality (Z) ages 5-7 3yr smooth	0.45: Based on $F_{0.1}$ limit + M (0.2)	0.70: Twice $F_{0.1}$ limit + M (0.2)	Mortality	1
Exploitation (%) (ages 5-7)	20: Moderate F level ($F_{0.1}$)	36: Twice $F_{0.1}$ limit	Mortality	1
Relative Fishing Mortality (Ages 5-7) 3yr smooth	0.25: $F_{0.1}$ limit	0.50: Twice $F_{0.1}$ limit	Mortality	1