DFO Atlantic Fisheries
Research Document 96/101

MPO Pêches de l'Atlantique
Document de recherche 96/101

Assessment of Cod in Division 4X in 1996

by

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ABSTRACT

Landings of cod from Division 4X have fluctuated since 1948 between 35,500t and the 1995 value of 8,800t. The quota for 1996 was increased to 11,000t, 4,100t of which was landed by the end of June. Landings in 1995 and the first half of 1996 were dominated by the 1992 year class. The summer survey results indicate that abundance of 4X cod continued to increase in 1996, and suggest that the 1992 year class is particularly strong. Abundance at ages greater than 6, however, remains low, and the 1993 year-class (age 3) appears to be weak. The initial indications are that the 1994 year-class is also below average.

The adaptive framework was used to calibrate the sequential population analysis with the research survey results. The analysis was conducted using catch at age data for half-year intervals, including the first half of 1996. Beginning of year biomass for ages 3 and older continued to increase in 1996 from the historic low recorded in 1994, and will also increase for the beginning of 1997. The 1992 year-class is estimated to be the second strongest during the period examined (1977-1994). Fishing mortality in 1995 is the lowest in the time series, approaching $F_{0.1}$.

The projected $F_{0.1}$ yield for 1997 is 10,200t. The beginning of year 1997 biomass for ages 3 and older should reach 58,000t; about the middle of the range of 30,000t to 70,000t that has been observed since 1980. Although the biomass is expected to increase, the age range which is sustaining the fishery remains quite restricted. An increase in the abundance of older age classes is required to reduce the dependency of this fishery on recruitment.

RÉSUMÉ

Les débarquements de morue de la division 4X fluctuent : ils sont passés de 35 500 t en 1948 à 8 800 t en 1995. En 1996, le quota a été monté à 11 000 t, dont 4 100 avaient été débarquées à la fin de juin. Les débarquements de 1995 et de la première moitié de 1996 étaient dominés par la classe de 1992. Les résultats du relevé estival indiquent que l'abondance de la morue de 4X a continué à croître en 1996, et permettent de penser que la classe de 1992 est particulièrement forte. L'abondance des poissons de plus de 6 ans reste toutefois basse, et la classe de 1993 (âge 3) semble faible. Selon les premières indications, la classe de 1994 serait au-dessous de la moyenne.

Nous avons utilisé le cadre adaptatif pour calibrer l'analyse séquentielle de population en fonction des résultats des relevés scientifiques. L'analyse a eu recours à des données sur les captures selon l'âge pour des intervalles d'une demi-année, y compris la première moitié de 1996. Au début de l'année, la biomasse des âges 3 et plus a continué à s'accroître en 1996 par rapport au plancher de 1994, et va aussi augmenter au début de 1997. On estime que la classe de 1992 est la deuxième parmi les plus fortes pendant la période examinée (1977-1994). En 1995, la mortalité par pêche est la plus basse de la série chronologique, et s'approche de $F_{0,1}$.

La production prévue à $F_{0,1}$ pour 1997 se chiffre à 10 200 t. La biomasse, au début de l'année 1997, pour les âges 3 et plus, devrait atteindre 58 000 t, soit à peu près le milieu de la plage de 30 000 à 70 000 t qui est observée depuis 1980. Bien qu'on prévoie une augmentation de la biomasse, la fourchette d'âge qui alimente la pêche demeure très restreinte. Une augmentation de l'abondance des classes plus âgées est nécessaire si l'on veut réduire la dépendance de cette pêche à l'égard du recrutement.

BRIEF HISTORY OF FISHERY AND ASSESSMENT

Prior to 1963, the cod fishery in Division 4X (including the Canadian portion of Division 5Y; Fig. 1) was primarily an inshore fishery. The majority of fishing was done by Canadians, hand-lining and long-lining from small vessels. Between 1957 and 1962, 82-87% of landings were 'inshore', with the remainder split between Canadian and U.S. vessels fishing Brown's and LaHave banks (Halliday, 1971). Landings showed a slow decline between 1948 and 1958 from 20,000t to 12,000t (Fig. 2). This decline was attributed primarily to decreases in effort (as fishing was directed more for haddock) but also to declining abundance (Beverton and Hodder, 1962). Foreign and Canadian otter trawlers (OT) began fishing for cod on Browns and LaHave banks in 1962. Due to the increased exploitation on the offshore banks, almost exclusively by OT, landings increased rapidly after 1962, to a maximum of about 35,500 t in 1968.

In 1970, landings dropped by 10,000t. This reduction came almost entirely from Canadian and foreign OT landings, while landings by longline (LL) and handline (HL) were largely unaffected. There was no quota for cod in 4X at this time, however, due to the mixed species nature of the groundfish fishery in this area, management measures implemented to regulate fishing on one species inevitably influences others. The large reduction in cod landings in 1970 has been linked to reductions in effort in the groundfish fishery due to the institution of quotas for haddock and the closure of Brown's Bank to fishing for March and April, both of which occurred in 1970.

The 4X area was recognized as including a number of separate cod spawning stocks whose distributional boundaries were unclear, thus, it was felt to be inappropriate to assess it as a unit stock. Assessments were conducted for the offshore (primarily Browns and LaHave Banks) which was thought to be a discrete stock, and TACs were set for this area starting in 1975. These TACs, however, are thought to have had limited impact on landings due to misreporting to the inshore area, where no TAC was in place (Gagne et al, 1983).

Landings throughout much of the 1970s remained in the region of 20-24,000t, increasing to 31,000t by 1980. This increase occurred in conjunction with an 80% increases in the 4X haddock quota. As a result of this rapid increase in landings to near historically high levels, a TAC was imposed for 4X cod for the first time in 1982. The TAC was set at 30,000t (a level selected to prevent landings from exceeding the maximum landings observed in the early 1980s), and held at this level for 4 years. It had little influence on the landings as a whole, which declined from 32,000t to 21,000t between 1982 and 1985. Aside from the <65ft draggers, no quota group met its allocation from 1983 to 1985 (Campana and Simon, 1986).

The year 1985 also marked the first year in which 4X cod was treated as a single stock for assessment purposes. This step was taken partly because of changes in fishing practices, and partly because mixing between inshore and offshore stocks appeared to be more extensive than had previously been thought. It was not considered possible to separate landings reliably between inshore and offshore areas. This was not a requirement for logbook records, and the increasing range of much of the fleet made the apportioning of landings to inshore or offshore based on tonnage class unreliable. Furthermore, tagging data suggested there may be mixing between inshore and offshore stocks, as well as among inshore spawning groups. It was felt that an

assessment which grouped all of 4X would be acceptable due to the mixing occurring among spawning groups, and the mixed nature of the fishery (Campana and Simon, 1985).

With the imposition of more stringent quotas for 4X cod in 1986, there were suggestions that unreported landings and misreporting by species had become serious problems, particularly in 1987 and 1988 (Campana and Simon, 1987; Campana and Hamel, 1990). Reported landings since 1989 are considered more accurate due to increased enforcement, and the institution of mandatory weigh-outs in 1990 (Campana and Hamel, 1992; Gavaris, 1993).

Reported landings remained around 20,000t from 1985-1989, then increased to 28,000t in 1991, and subsequently fell to a low of 9,000t in 1995. The recent reductions in landings are a reflection of the total allowable catch, which declined from 26,000t in 1992 to 9,000t in 1995. The 1996 quota is 11,000t, 4,100t of which were landed by July 1.

DESCRIPTION OF FISHERY

The fishery in 4X takes place year round, with catches peaking in June and July (Table 1), and is prosecuted primarily by tonnage classes 2 and 3 otter trawlers, and by tonnage classes 1 and 2 long liners and handliners (Table 2). The proportion of landings from the winter-spring fishery, prosecuted predominantly by the otter trawl fleet, has declined in recent years. The distribution of landings has also shifted to the west in recent years, with landings from 4Xmno declining to a greater degree than in other areas (Table 3).

During meetings with industry representatives, dragger fishermen commented that declines in the winter-spring fishery reflect introduction of individual quota (cod quota is saved to use as bycatch when pursuing other fisheries through the year); traditionally, this was a period of high catch rates for the dragger fishery during which "steak" (large) cod were caught.

Recent changes in gear (increases in minimum hook and mesh sizes, change from diamond to square mesh) were expected to reduce the catch of small cod; however, discarding of small fish in 1995 led to gear closures in two areas in the vicinity of La Have and Roseway Banks due to high proportions of undersized fish (<43 cm) in catches monitored at sea. Port samplers indicate that discarding has also occurred in 1996.

CATCH AND WEIGHT AT AGE

The 1995 catch at age was based on 65 samples while 36 are available for the first half of 1996 (Table 4). Samples were aggregated by area, quarter and gear type. Aggregated by area was done to account for growth differences between the Bay of Fundy (4Xqrs5Yb) and southwest Scotian Shelf (4Xmnop) and the disproportionately low number of samples taken from the Bay of Fundy in many years. Landings in 4Xu (unspecified area) were apportioned to Bay of Fundy and Scotian Shelf for each statistical district according to known area landings by gear type and tonnage class for that statistical district and quarter. Landings reported from 5Y from 1983 to 1986 for each statistical district were divided between Scotian Shelf and Bay of Fundy according to the same

protocol. Misreporting to 5Y from 4X was identified as a problem in these years in past 4X cod assessments (Campana and Simon, 1987; 1988).

The seasonal length-weight parameters used in deriving catch numbers at age (Table 4) were those from Campana and Hamel (1992). These parameters were calculated as seasonal averages over the years for which seasonal survey information were available, and have been used since 1985 when seasonal surveys in 4X were discontinued.

In 1995, the 1992 year-class (age 3) dominated longline catches, while otter trawl landings were spread more evenly among ages 3-5 (Table 5). Landings of cod over age 5 have declined in recent years (Table 6) and in 1995 the proportions of landed weight comprised by these ages were below their long term averages (Fig. 3). The proportions of 3 year-olds, which accounted for over 50% of the numbers landed, was high in comparison with the long term mean (Fig. 4). Landings for most ages were well predicted by the previous assessment (Fig. 5); however, landings of the weak 1989 year-class (age 6) were greater than expected.

In the first half of 1996 landings were dominated by the strong 1992 year-class (age 4: Fig. 6). This year class accounts for 60% of the cod landings by number; a much greater proportion of the catch than usual (Fig. 7), and constitutes a higher proportion of the catch than predicted (Fig. 8). Catches for other ages are reasonably well predicted, aside from age 5 which is lower than expected. Landings of ages 2 and 3 will likely increase in proportion to other ages in the second half of the year as these fish grow into the fishery.

Weights at age for commercial landings from the Scotian Shelf display no persistent trends (Table 7), however a trend of increasing weight at age, particularly for ages 4-6, was noted for the Bay of Fundy in the 1995 assessment. An examination of length at age data from the summer survey did not detect any trend, and weights at age from the fishery in 1995 dropped to levels more consistent with the long term mean.

Commercial catch at age data from 1980 to 1996 were used in this assessment. While previous assessments have included landings data from before 1980 (Campana, 1992), inconsistencies in F's among cohorts within a year, variation in the weights at age, and unusual patterns in catch curves led to the exclusion of the catch at age for the period 1948-1970 in the 1993 assessment (Gavaris, 1993). Furthermore, commercial sampling prior to 1980 was very low, particularly west of Browns Bank (Bay of Fundy), and it has been concluded that the catch history could not be reliably reconstructed from commercial samples during this period (Clark, 1995).

ABUNDANCE INDICES

Annual stratified random surveys have been conducted in 4X during summer since 1970. As in the 4X cod assessments for 1994 (Clark et. al., 1995a) and 1995 (Clark et. al., 1995b), the sequential population analysis (SPA) for this assessment used survey information collected since 1983, when the RV Alfred Needler became the standard survey vessel. Uncertainties in relative fishing power between different survey vessels could have contributed to the residual patterns observed in past assessments (predominantly positive since 1983 and negative before 1983).

Furthermore, excluding data prior to 1983 eliminated the retrospective pattern which plagued previous assessments (see Gavaris et al., 1994). Based on these considerations, the present assessment was conducted using survey data from 1983-1996.

The 1996 survey showed a distribution of cod similar to that from the previous year (Fig. 9). Catches were good on and around Browns Bank, and throughout the Bay of Fundy. To the east, cod were caught in strata 470 and 471 for the first time since 1992. Catch per tow increased in both the Scotian Shelf and Bay of Fundy areas in 1996 (Fig. 10), reaching levels not seen since 1990. Thus, the expansion of distribution and improved catch per tow apparent in the 1995 survey appears to be continuing. Catch per tow is also higher in 1996 than any year between 1971 and 1982. However, due to the changes in survey vessels in 1982 and 1983, it is not clear that the generally higher catch per tow observed in years when the survey was conducted using the Alfred Needler, is indicative of higher population levels. When survey biomass indices are compared with VPA biomass estimates it appears that the ATC and LH provide a relative underestimate of the population biomass (Fig. 10b).

Due to problems with computer software, data on fish length was lost for 6 sets from the 1996 survey in 4X; however, set details (location, depth, distance) and number of fish caught by species were retained, as were the otoliths collected. For cod, otoliths were taken for all but 2 of the 27 fish caught in these 6 tows. The 2 fish from which otoliths were not taken were both caught in set 31. Ages are available for the remaining 17 fish for this set: 3 at age 2, 11 at age 4, and 3 at age 6. Catch at age information is thus available for 5 of the sets, and if it is assumed that the two fish for which otoliths were not collected from set 31 were also 4 year olds, then the catch at age can be determined for all 6 of these sets.

Following the completion of the summer groundfish survey in 4VW, 4 of these stations were resampled, and this information is also available for analysis. These sets were made approximately 3 to 4 weeks after the initial sets at these locations, thus it is likely that the distribution of fish within the survey area would have changed. In addition, these sets were made 2 weeks later than any sets during previous 4X summer surveys. Including the resampled stations gives a dramatically different survey result (Table 8). Version "a" of the 1996 index includes sets from the first survey only, including those sets for which length data were not available. In 1996b are included all the sets included in 1996a, plus the 4 resampled sets. The difference between these versions is attributable to one of the resampled sets, in which 595 Kg of cod was caught, the second largest survey set recorded in 4X.

Survey results have identified the 1988 (age 8 in 1996) and 1989 (age 7 in 1996) year-classes as below average and the 1992 year-class as well above average. The 1993 year class (age 3 in 1996) appears below average, and the initial indication given by this survey is that the 1994 year-class is also below average.

The age 2 survey index used in the calibration includes sets at depths <50 fathoms, excluding stratum 490 (St. Mary's Bay). When stratum 490 was removed from the analyses, relative error and bias were reduced in population estimates, and the magnitude of the residuals also decreased (Clark et al., 1995a).

The second annual 4X ITQ groundfish survey was conducted in July, 1996 using commercial trawlers under the auspices of the ITQ Committee. The survey employs a fixed station design (although 35 additional stations were occupied in 1996), and involves three vessels using balloon trawls with a 1/2 in. codend liner and rockhopper ground gear. The 4X area was divided into blocks of 100 nm^2 and blocks were selected for sampling prior to sailing. The selection of the exact station location within a block was made by the skipper, allowing them scope to identify a suitable location for trawling (O'Boyle et al., 1995). Once coordinates for the sampling location are determined, the location is fixed for subsequent years, eliminating the flexibility which was present in initial selection. Two of the three vessels (the Carmelle and the S and P) switched from a 300 to 280 balloon trawl between the first and second year to match what was in use on the Little T.J, however, the skippers felt this was a minor change and should not effect the catch for these vessels. Calibration among vessels may be difficult, and the changes in gear and protocol for station selection between years could influence results, however guarded comparisons can be made between years for the 105 stations which were sampled by the same vessel in each year (Appendix I). Very little cod was caught in the sets added for 1996.

Catch weights for the ITQ survey were higher for 1996 in the Bay of Fundy, and also in the vicinity of Roseway and Baccaro Banks, however, fewer large catches were made on German Bank (Fig. 11). The mean weight per tow declined for two of the three vessels in 1996, as did the overall mean for the 105 tows. This change is due primarily to one large tow (set 31, Little T. J., 1995). If the set in with the largest catch is excluded for each year, a slight increase in catch per tow is seen for 1996 (Appendix I). If log catch numbers are compared, a similar slight increase is exhibited for 1996.

The length frequency of the ITQ survey catch for 1996 on the Scotian Shelf (including only those sets made within Needler strata 470 - 481) peaks sharply at 40-43 cm. This is similar to the 1995 ITQ survey, differing only in the magnitude of the peak (Fig 12). These results contrast with the Needler survey which peaked sharply at 45 cm in 1995, unlike the ITQ survey, and peaks in 1996 at 52 and 58 cm, showing the progression of the 1992 year-class (Fig. 13). The 1992 year-class does not appear dominant in the ITQ survey in either 1995 or 1996.

The 1996 ITQ survey results for the Bay of Fundy (including only those sets made within Needler strata 484 - 495) show a and a large peak centred on 40cm and a doubling in the abundance of fish in the 60-70 cm range in 1996 when compared to the results from 1995 (Fig 12). This contrasts with the results from the Needler survey, where the catch per tow in the 65-70 cm range (corresponding to the 1992 year-class) is quadruple what was seen in 1995, and is higher than the peak for the same cohort in 1995 at 50cm (Fig 13). The peak in catch per tow at 40 cm (1994 year-class) in the Needler survey is much lower than the catches made at larger sizes, in contrast to the ITQ survey where the highest catches come at this length. The relatively high numbers of small fish caught in the ITQ survey may reflect the differences in gear used in the two surveys. The ITQ survey, unlike the Alfred Needler, uses rock-hopper ground gear. This gear is more effective at catching small cod, since there is no avenue for escape below the foot gear. Thus, we would expect proportionally greater numbers of small fish to be caught in the ITQ survey. Both surveys show higher numbers of fish in this length range in 1996 than in 1995, but it is difficult to determine at this stage in the ITQ survey development if the two surveys are picking up different signals about the size of this recruiting year-class.

In comparing catches between years at the 105 repeated stations, no obvious geographical pattern is discernible in number caught; stations where catch increased seem to be randomly assorted with those where catch decreased (Fig. 14).

ESTIMATION OF STOCK PARAMETERS

The adaptive framework (Gavaris 1988) was used to calibrate the sequential population analysis with the research survey results using the following data :

$C_{a,t}$ = catch for ages a=1, 2,..., 11 during the half year time periods beginning at t=1980,1980.5,1981,1981.5,...,1996

$I_{a,t}$ = Canadian summer survey abundance index for ages a=2, 3,...,10 observed during time t=1983.5,1984.5,...,1996.5 (excluding 1988.5 for ages 3 and 4).

The summer survey results were compared to mid-year population abundance. Data from ages 3 and 4 from the 1988 summer survey were excluded from the analysis because catchability at these ages appeared to be anomalously high. These data were influential and their inclusion affected population estimates. Estimates obtained when these data were excluded were considered more appropriate (Gavaris, 1993, Clark et al, 1995a).

Statistical error in the survey data was assumed to be independent and identically distributed after taking logarithms and the error in the catch at age was assumed negligible. Natural mortality, M, was assumed constant and equal to 0.2 and the fishing mortality rate, F, for age 11 was assumed equal to the average for ages 8, 9 and 10 in the same year.

A model formulation using ln population abundances at the middle of 1996 (t = 1996.5) as parameters was employed. Define the model parameters

$\phi_{a,1996.5}$ = ln population abundance for ages a = 2, 3,...,12, (age 1 abundance assumed equal to the long-term geometric mean recruitment 1985-94), and

κ_a = calibration constants for Canadian summer survey for ages a = 2,3,...,10

ADAPT was used to solve for the parameters by minimizing the objective function

$$Q_{a,t}(\phi,\kappa) = \sum_{a,t} (q_{a,t}(\phi,\kappa))^2 = \sum_{a,t} (\ln(I_{a,t}) - \ln(\kappa_a N_{a,t}(\phi)))^2$$

where the population abundance $N_{a,t}$, is taken at the corresponding time, t, to the survey. Since the sequential population analysis was conducted using half year catch at age data, the abundance at the mid-year time, t = y+0.5, is directly available.

For t = 1996.5, the population abundances are obtained directly from the parameter estimates,

$$N_{a,1996.5} = \exp[\phi_{a,1996.5}]$$

For all other years, y = 1980 to 1995, the population abundance was computed using the virtual population analysis algorithm which incorporates the exponential decay model

$$N_{a,t} = N_{a+\Delta t,y+\Delta t} \exp[(F_{a,t}+M)\Delta t]$$

where the fishing mortality for ages 1 to 10 is obtained by solving the catch equation using a Newton-Raphson algorithm,

$$N_{a,t} = C_{a,t}(F_{a,t} + M)\Delta t / F_{a,t}\Delta t(1 - \exp[-(F_{a,t} + M)\Delta t])$$

Analytical approximations of variance and bias for population abundance estimates and corresponding projected yield were derived following Gavaris (1993).

ASSESSMENT RESULTS

Results are presented for the two possible 1996 survey indices presented in Table 8. The relative error and bias indicate the degree of uncertainty in the estimates of population abundance (Table 9), reflecting the magnitude of the residuals (Fig. 15). For each cohort, the terminal population abundance estimates from the integrated model were adjusted for bias and used to construct the history of stock status (Tables 10 - 12).

Mean squared residual is lower for version 'a' (Table 9). This pattern is apparent in the residual plots (Fig. 15), where for version 'b', the residuals are generally larger, and for 1996 they are positive for all ages except age 7. For version 'a', the 1996 survey values do not present this anomalous pattern; residuals are generally quite small, and not all positive.

Both options show a similar trend of population growth Table 10), and indicate that the 1992 year class is the largest in the time series; they differ, however, in their estimates of current population size. Of the options presented for a survey index for 1996, version 'a' seems to be the most appropriate.

Version 'a' uses only data from the initial survey, in keeping with the standard survey design. The mean squared residual is lowest for this option, and the 1996 residuals show no strong pattern. Also, the less pronounced increase in survey index from 1995 is more in keeping with what was seen in the ITQ survey.

Version 'b' shows a strong trend towards positive residuals in 1996, suggesting the survey is anomalously high. This version also results in a doubling of the survey index from 1995, in sharp contrast from what is indicated by the ITQ survey. This option does benefit from including all available survey information from 1996, but it is strongly influenced by a single set.

Close correspondence occurred between the survey indices, scaled by the calibration constants, and results from the sequential population analysis (version 'a'), though for age 2 the correspondence was lower (Fig. 16). The results indicate that the 1992 year class is the second strongest in the time series, slightly stronger than 1980, 1985 and 1987 year-classes and of similar magnitude to the 1977 year class (Fig. 17). The 1992 year-class appears as a positive residual at both ages 3 and 4 and constituted a larger proportion of the overall catch than predicted in 1995 and 1996 to date, suggesting either that it is being targeted in the fishery, or that it may indeed be somewhat stronger than is currently estimated. The 1993 and 1994 year-classes appear to be well below average.

The beginning of year population biomass for ages 3 and older (spawning stock biomass) showed a strong increase for 1996, after declining rapidly from a peak in 1990 to the lowest levels in the time series in 1993 and 1994 (Table 11 and Fig. 18), and for the beginning of 1997 increases again to the level seen in 1990, primarily due to growth by the 1992 cohort.

The total fishing mortality rate for ages 4 and older has fluctuated around 0.6, lower generally, in the first half of the year, and higher in the last half (Table 12 and Fig. 19). F increased rapidly after 1989, peaking at 1.5 in the last half of 1992 (1.1 for the year), and has declined since then. This has approached and exceeded thrice $F_{0.1}$ and has likely resulted in lost yield due to capture of fish before their full growth potential has been realized. In the first half of 1996, F dropped below 0.2; although it is projected to rise to 0.3 in the second half, this represents a marked reduction in fishing mortality, and is close to $F_{0.1}$ for the whole of 1996.

PROGNOSIS

Yield projections indicated that the point estimates for projected yield were biased upward by about 10% and had a standard error of about 25% of the mean. As with population abundance estimates, the simple adjustment for bias was considered more appropriate than using the biased point estimate. The incoming year-classes were assumed to be equal to the long term geometric mean (Table 13). Average partial recruitment values from the last 5 years of 0.0, 0.06, 0.42, and 0.76 respectively for ages 1-4 were used in the projections.

Assuming the remainder of the 11,000t TAC for 1996 is landed (6,870t remain for the last half of 1996), the resulting fully recruited fishing mortality will be about 0.21 for the year. The projected yield for 1997 at $F_{0.1}$ is 10,200t. If an $F_{0.1}$ harvest strategy is followed, the beginning of year 1998 biomass for ages 3 and older will reach 67,000t, an increase of 9,000t from 1997. This increase in population biomass, however, is due largely to the entry of the 1995 year class. This year-class is unestimated, and thus assigned the geometric mean recruitment (Table 13) of 16.5 million at age 1; almost double the estimated recruitment for the 1994 year-class. The increase in age 4+ biomass is a more modest 3,000t, from 51,000t to 54,000t (Fig. 20).

Though not all uncertainties and biases can be incorporated, the statistical precision of the abundance estimate was approximated, and used to evaluate the risk that specific catch levels in 1997 would exceed $F_{0.1}$, or result in a decline in age 4+ biomass from 1997 to 1998. At a yield of

10,200t, which corresponds to a 50% risk of exceeding $F_{0.1}$, there is a 20% chance that 4+ population biomass will not increase for 1998; this probability increases to 50% at a yield of 13,500t (Fig. 21). Using the higher possible survey index to estimate population abundance would result in an $F_{0.1}$ yield projection for 1997 of 12,400t. If the lower population estimate is appropriate, a yield of 12,400t would increase the risk of exceeding $F_{0.1}$ for 1997 to almost 100%, and the risk of a decline in age 4+ biomass from 1997 to 1998 to 40%.

Beginning of year biomass for ages 4 and older has fluctuated between about 19,000t and 60,000t since 1980. Stock biomass is now increasing from the record low seen in 1994, and, at the current levels of fishing mortality, should continue to increase through 1997, due to the strong 1992 year-class. The age range which is sustaining the fishery, however, remains quite restricted, and recruitment of the 1993 and 1994 year-classes appears to be poor. This stock appears to be in the midst of recovery, however some building in the size of older age classes is required to reduce the dependence of this fishery on recruitment.

ACKNOWLEDGMENTS

I would like to thank D. Lyon and G. Donaldson for their efforts in sampling commercial landings, and for sharing their insights on the fishery. Thanks also to those members of the fishing industry who took the time to meet with us and discuss their experiences in the fishery. The assistance of P. Perley and S. Gavaris with the preparation of figures for this document is also appreciated .

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Table 1. Nominal catch (t) of 4X cod by month

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1980	706	2188	1704	2485	3317	5316	3433	3346	2603	2876	1547	1756	31277
1981	1649	2451	2529	1533	2881	4093	3845	4067	2253	3119	1728	1373	31521
1982	757	2390	2569	1491	3415	5109	4734	3258	3540	2890	1244	1737	33134
1983	1713	1654	1648	1888	2743	5713	4554	2832	3183	1787	1037	719	29471
1984	1798	2021	752	817	1796	3471	3688	4567	2773	1668	1201	976	25528
1985	779	1699	956	1268	1974	2586	3199	2650	2737	1801	787	1063	21499
1986	904	1633	1775	1450	1437	1939	2739	1995	2576	1714	771	1107	20040
1987	1208	1837	1242	1059	1870	2778	2663	1821	1679	1403	910	535	19005
1988	2104	1531	535	939	1620	2931	3104	2122	2524	1441	636	1050	20537
1989	2150	2347	1362	1707	1292	3562	1830	1772	1535	1278	637	413	19885
1990	2619	2027	707	778	1560	3104	3751	3123	2598	1689	1158	790	23904
1991	2023	2651	993	1666	2322	3167	3963	2881	2967	2208	1650	1258	27749
1992	2088	1740	1297	1502	1685	3622	3366	2803	2625	2353	1478	1521	26080
1993	657	903	994	996	1617	2312	2834	2221	1804	1048	562	78	16026
1994	734	972	547	847	824	1771	2246	1503	1267	1154	726	454	13045
1995	610	229	317	827	574	1236	1771	774	1071	521	276	561	8767
1996	501	326	446	530	791	1543							4137

Table 2. Nominal catch of 4X cod by gear and tonnage class.

	Otter Trawl					Gill Net		Long Line			Hand		
Year	0&1	2	3	4	5+	0&1	2&3	0&1	2	3+	Line	Misc.	Total
1980	1322	2769	4284	1042	2037	2683	61	8356	2360	898	4198	1267	31277
1981	1165	3086	2989	416	1131	2871	114	10302	2555	1235	5174	483	31521
1982	879	3159	4493	563	2217	3154	214	9120	3465	1087	4299	484	33134
1983	638	4735	6306	518	1118	2180	235	5747	2757	883	3750	604	29471
1984	964	4198	5904	302	1513	1248	220	3916	2825	980	3005	453	25528
1985	523	3954	5562	90	1185	1837	161	2617	1740	635	2755	440	21499
1986	573	3663	5123	224	974	1453	196	2479	1918	576	2490	371	20040
1987	312	2645	3504	531	929	1968	241	3075	2175	499	2670	456	19005
1988	454	3966	3542	160	467	903	444	3528	3149	672	3081	171	20537
1989	409	3933	4184	67	713	1254	475	2915	2167	623	2937	208	19885
1990	505	3668	3577	268	170	1933	692	4201	2967	849	4871	203	23904
1991	355	4598	5805	298	751	2225	619	4712	3679	842	3737	128	27749
1992	238	4494	5711	143	726	1811	586	4455	3574	719	3517	106	26080
1993	176	2778	3598	68	241	1387	523	2768	1693	310	2439	45	16026
1994	132	2022	2343	138	82	993	421	2837	1412	231	2367	67	13045
1995	100	1387	1619	112	75	470	507	1632	959	182	1706	18	8767
1996*	21	751	1219	86	80	97	122	568	312	35	846		4137

* January 1 - June 30.

Table 3. Nominal catch of 4X and 5Y cod by unit area.

	4Xm	4Xn	4Xo	4Xp	4Xq	4Xr	4Xs	4Xu	5Y	Foreign	Total
1980	5205	3325	9899	1561	3571	4684	2278	47	166	541	31277
1981	4767	2114	12097	1830	2413	5072	2031	419	599	179	31521
1982	5255	2922	10451	2079	3715	4571	2009	538	1349	245	33134
1983	3437	1690	8537	2497	3160	3787	1674	1826	2543	320	29471
1984	2255	2251	6192	1655	2244	2959	1414	3583	2698	277	25528
1985	3006	1199	5438	1026	1999	2301	1511	3608	1364	47	21499
1986	2914	1762	4670	544	1754	1802	1500	4469	557	68	20040
1987	2676	1611	4777	1131	1240	858	1207	5116	360	29	19005
1988	1502	1086	5458	1271	1124	850	1103	7990	142	11	20537
1989	1370	1019	5506	2820	1360	1112	915	5267	478	38	19885
1990	1846	764	7915	1746	2238	1721	1722	5404	326	222	23904
1991	2552	1584	8963	2440	2763	4243	2560	2246	307	91	27749
1992	1523	1818	10347	1455	2919	3352	1503	2876	278	9	26080
1993	1364	1646	4845	1436	1959	2428	1399	760	189		16026
1994	828	561	4414	1128	1662	1883	892	1540	137		13045
1995	293	696	1737	1586	1306	1032	510	1528	79		8767
1996*	104	269	946	664	820	869	215	216	34		4137

January 1 - June 30.

Table 4a. Construction of Age-length keys for 4X cod for 1995.

Area	Fundy (4Xqrs5Y)				Shelf (4Xmnop)			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
No. Samples	7	6	2	2	12	9	7	6
No. Aged	228	310	118	107	494	285	261	309
Landings (t)	365	1291	1350	412	791	1346	2265	948

Table 4b. Construction of length frequencies for 4X cod for 1995, and age-length keys against which they are matched.

Gear	Quarter	Area	a	b	Number of samples	Number Measured	Landings (t)	ALK used
OT	1	Fundy	0.0081	3.0503	7	1746	365	Fundy Q1
LL					0		0	
GN					0		0	
Ot	1	Shelf			10	1975	428	Shelf Q1
LL					4	1170	363	
GN					0		0	
OT	2	Fundy	0.0084	3.041	6	1569	817	Fundy Q2
LL					2	530	334	
GN					0	GN Q3 F#	140	
OT	2	Shelf			2	251	132	Shelf Q2
LL					8	1537	912	
GN					2	510	302	
OT	3	Fundy	0.0087	3.0233	3	528	755	Fundy Q3
LL					0	OT Q3 F#	239	
GN					1	210	356	
OT	3	Shelf			0	191*	117	Shelf Q3
LL					9	1997	1992	
GN					1	308**	156	
OT	4	Fundy	0.0063	3.1152	2	475	351	Fundy Q4
LL					0	OT Q4 F#	41	
GN					0	GN Q3 F#	20	
OT	4	Shelf			2	275	347	Shelf Q4
LL					7	1919	598	
GN					0	GN Q3 S#	3	

*One sample from June combined with one from October

**One sample from June was combined with the one September sample

LF substituted due to absence of commercial sampling for this gear/area/quarter combination.

Table 4c. Construction of Age-length keys for 4X cod for 1996.

Area	Fundy (4Xqrs5Y)				Shelf (4Xmnop)			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
No. Samples	5	4			5	8		
No. Aged	144	188			203	361		
Landings (t)	652	1346			621	1518		

Table 4d. Construction of length frequencies for 4X cod for 1996, and age-length keys against which they are matched.

Gear	Quarter	Area	a	b	Number of samples	Number Measured	Landings (t)	ALK used
OT	1	Fundy	0.0081	3.0503	5	1166	640	Fundy Q1
LL					0	OT Q1 F#	12	
GN					0		0	
Ot	1	Shelf			3	719	411	Shelf Q1
LL					4	805	210	
GN					0		0	
OT	2	Fundy	0.0084	3.041	5	1099	858	Fundy Q2
LL					1	275	415	
GN					0	GN Q2 S#	71	
OT	2	Shelf			4	1050	248	Shelf Q2
LL					12	2397	1123	
GN					2	454	147	

LF substituted due to absence of commercial sampling for this gear/area/quarter combination.

Table 5a. Landed numbers of 4X cod at age by gear type for 1995.

Age	1	2	3	4	5	6	7	8	9	10	11	12
LL+HL	0	128	1553	683	283	64	14	13	4	2	0	0
OT	0	6	543	325	222	44	11	19	4	3	1	0
GN	0	0	49	72	77	23	2	9	3	1	0	0

Table 5b. Landed numbers of 4X cod at age by gear type for 1996 (Jan. - July).

Age	1	2	3	4	5	6	7	8	9	10	11	12
LL+HL	0	2	185	514	73	41	7	4	2	2	1	0
OT	0	3	100	459	90	51	6	4	5	1	0	0
GN	0	0	1	18	15	13	1	1	1	0	0	0

Table 6. Catch at age (number in thousands) for cod in Division 4X.

Age	1	2	3	4	5	6	7	8	9	10	11	12	1+	2+	3+	4+
1980*	0	101	2517	1079	914	655	279	178	58	28	17	12	5838	5838	5737	3220
1980.5	0	737	3538	1279	827	480	163	83	32	31	2	5	7178	7178	6441	2904
1981	0	154	1612	2123	773	563	344	144	121	49	29	9	5919	5919	5765	4153
1981.5	0	664	2258	2142	1071	482	243	154	63	26	11	10	7124	7124	6460	4202
1982	0	378	1471	2162	1612	514	228	142	72	54	22	4	6658	6658	6280	4809
1982.5	0	526	1414	2252	1448	398	165	137	74	32	19	22	6486	6486	5960	4546
1983	0	156	1665	1255	1075	790	272	109	72	58	22	7	5483	5483	5327	3662
1983.5	9	875	2025	1177	982	415	187	95	48	18	14	3	5846	5837	4962	2938
1984	0	33	860	1312	913	461	256	85	43	31	12	10	4016	4016	3983	3123
1984.5	33	884	1533	1769	1017	504	209	91	20	18	17	8	6103	6070	5186	3653
1985	0	47	468	678	976	590	266	98	41	20	13	5	3201	3201	3154	2686
1985.5	0	664	1206	891	1348	694	248	96	30	33	5	2	5218	5218	4554	3348
1986	0	80	1120	767	438	539	257	96	59	11	10	7	3383	3383	3304	2184
1986.5	0	171	1669	1174	556	469	151	105	34	38	14	14	4394	4394	4224	2555
1987	0	94	280	1019	729	319	315	167	78	41	20	8	3069	3069	2976	2695
1987.5	0	767	622	1035	358	205	196	69	62	24	13	2	3352	3352	2585	1963
1988	0	67	1704	500	812	353	106	117	34	34	8	4	3738	3738	3672	1968
1988.5	0	337	1813	1159	741	303	72	75	51	19	20	1	4590	4590	4254	2441
1989	7	444	1653	2286	476	413	145	59	38	11	9	9	5549	5542	5099	3446
1989.5	11	212	908	1370	156	148	18	20	22	8	1	1	2874	2864	2652	1744
1990	0	33	1227	1242	1303	175	158	33	14	16	7	7	4215	4215	4182	2955
1990.5	0	111	1637	1563	1159	322	120	44	26	23	7	8	5019	5019	4908	3272
1991	2	79	631	2688	791	654	74	65	14	6	10	4	5017	5016	4937	4306
1991.5	0	313	904	2404	986	710	141	91	18	10	18	11	5605	5605	5292	4388
1992	0	64	991	810	1849	479	353	32	26	12	3	2	4621	4621	4558	3567
1992.5	0	688	2401	1067	1427	400	160	30	24	4	5	2	6207	6207	5519	3119
1993	0	13	1777	1002	381	388	89	39	5	4	4	0	3702	3702	3689	1913
1993.5	0	868	1713	1044	279	284	97	51	9	10	1	0	4355	4355	3487	1773
1994	0	122	1164	1197	383	89	75	13	7	0	0	0	3051	3051	2929	1765
1994.5	0	353	1116	1036	504	106	105	29	11	0	2	0	3263	3263	2910	1793
1995	0	6	641	528	367	72	19	25	6	2	0	0	1666	1666	1660	1019
1995.5	0	129	1505	553	215	58	9	15	5	3	0	0	2492	2492	2363	858
1996	0	5	286	992	178	104	14	9	7	3	1	0	1599	1599	1594	1308

* 1983 = first half of year; 1983.5 = second half of year.

Table 7. Mean weight at age (kg) of cod from commercial landinds in two sub-areas of Division 4X.

		1	2	3	4	5	6	7	8	9	10	11	12
	1983		0.76	1.22	1.81	2.50	3.93	6.09	8.22	10.76	11.83	12.22	16.59
	1984		0.96	1.30	1.69	2.34	3.37	4.68	6.83	8.60	11.06	13.21	14.03
	1985		0.60	1.07	1.47	2.00	3.06	4.55	6.70	6.89	9.00	14.16	15.66
	1986		0.78	1.13	1.63	2.21	3.47	4.69	7.15	8.83	8.81	13.11	13.10
	1987		1.23	1.40	1.83	2.61	3.46	4.99	7.33	8.36	10.66	11.80	15.85
Scotian	1988		0.94	1.30	1.90	2.69	3.98	5.23	8.06	9.88	10.93	13.05	16.04
Shelf	1989	0.78	1.23	1.57	2.21	2.75	3.96	4.88	7.86	9.46	11.95	15.04	14.81
	1990		0.82	1.29	1.97	2.86	3.72	5.59	8.10	10.46	11.93	14.12	15.24
	1991		0.76	1.13	1.73	2.50	3.54	5.08	6.44	9.44	11.19	13.73	15.74
	1992		0.78	1.14	1.63	2.58	3.58	4.44	6.50	8.37	12.10	14.50	19.15
	1993		0.68	1.25	1.62	2.24	3.44	4.67	7.01	9.13	10.97	18.08	
	1994		0.76	1.04	1.92	2.41	3.15	4.97	5.21	9.28	15.98	13.56	
	1995		0.86	1.23	1.72	3.26	4.09	4.69	7.23	9.18	13.33	16.33	
	Mean	0.78	0.86	1.23	1.78	2.53	3.60	4.96	7.13	9.13	11.52	14.07	15.62
	1983	0.38	0.86	1.48	2.18	3.30	4.88	6.38	8.62	9.92	12.19	14.23	20.63
	1984	0.39	0.93	1.62	2.48	3.52	4.67	6.98	7.94	12.10	13.45	4.75	
	1985	0.37	0.84	1.48	2.26	3.43	4.53	6.54	9.45	11.46	15.12	18.23	19.52
	1986	0.37	0.80	1.41	2.33	4.30	6.24	7.36	8.18	9.50	14.25	7.99	11.98
	1987		0.84	1.57	2.56	4.17	5.33	7.04	7.92	7.94	14.31	18.56	
Bay of	1988		0.86	1.46	2.24	4.09	5.36	8.99	10.14	8.89	14.69		
Fundy	1989	0.33	0.76	1.52	2.59	3.60	6.33	7.25	10.32	10.55	14.57		11.66
	1990		1.05	1.69	2.69	3.77	4.37	7.31	8.15	11.32	11.95	12.75	14.74
	1991	0.82	1.04	1.88	2.91	4.26	6.77	8.75	11.02	13.60	14.17	15.10	17.93
	1992		1.18	1.73	2.73	4.49	6.51	8.78	9.93	13.13	14.55	11.10	
	1993		0.90	1.74	2.86	4.74	6.09	7.58	9.18	14.32	16.75	13.85	
	1994		0.98	1.75	3.19	5.72	7.96	9.31	11.61	11.56	-	17.46	
	1995		1.29	1.91	2.78	4.38	6.01	7.76	9.84	12.49	8.57	14.32	
	Mean	0.44	0.95	1.63	2.60	4.14	5.77	7.69	9.41	11.29	13.71	13.49	16.08

Table 8. Summer groundfish survey indices for cod in Division 4X.

Age	2	3	4	5	6	7	8	9	10
1983	223	4226	2369	1480	946	389	0	77	37
1984	1385	3390	2362	1820	688	482	63	58	25
1985	1139	4331	1527	1451	766	483	267	165	13
1986	258	2920	1226	314	549	448	217	97	19
1987	1158	618	1180	528	260	245	304	75	40
1988	564			1776	496	210	244	91	38
1989	1073	3420	2549	420	489	108	27	82	37
1990	110	5523	2463	2321	240	414	80	42	0
1991	390	1131	3086	1094	751	128	116	19	21
1992	874	1569	681	1710	471	460	124	85	0
1993	350	2518	925	129	265	52	61	0	6
1994	711	2739	1605	449	36	195	88	70	0
1995	350	4779	1477	598	274	94	91	34	42
1996a	323	2048	5527	880	753	148	0	56	15
1996b	323	2422	7651	1579	1086	180	0	241	15

1996a uses version 'a' of survey indices, 1996b uses version 'b' of survey indices; see text p. 5.

Table 9a. Statistical properties of estimates for population abundance and survey calibration constants for cod in Division 4X (1996 survey index version 'a' used in assessment).

	Population abundance					July survey calibration constants				
Age	Par. est.	Std. err.	Rel. err.	Bias	Rel. bias	Par. est.	Std. err.	Rel. err.	Bias	Rel. bias
2	7669	3798	0.5	965	0.13	0.038	0.005	0.138	0	0.006
3	6845	2520	0.37	465	0.07	0.245	0.034	0.138	0.002	0.007
4	13004	4354	0.33	674	0.05	0.245	0.034	0.137	0.002	0.007
5	3088	1085	0.35	159	0.05	0.245	0.032	0.132	0.002	0.007
6	1965	698	0.36	103	0.05	0.268	0.035	0.133	0.002	0.006
7	414	156	0.38	26	0.06	0.371	0.05	0.136	0.003	0.008
8	66	44	0.66	9	0.13	0.388	0.056	0.143	0.003	0.009
9	130	49	0.38	8	0.06	0.402	0.057	0.141	0.004	0.011
10	52	19	0.36	3	0.05	0.266	0.041	0.154	0.004	0.014
11	85	31	0.36	5	0.05					
Mean squared residuals = 0.22596										

Table 9b. Statistical properties of estimates for population abundance and survey calibration constants for cod in Division 4X (1996 survey index version 'b' used in assessment).

	Population abundance					July survey calibration constants				
Age	Par. est.	Std. err.	Rel. err.	Bias	Rel. bias	Par. est.	Std. err.	Rel. err.	Bias	Rel. bias
2	7969	4077	0.51	1070	0.13	0.037	0.005	0.143	0	0.007
3	7738	2928	0.38	558	0.07	0.239	0.034	0.143	0.002	0.007
4	15288	5182	0.34	826	0.05	0.242	0.034	0.142	0.002	0.007
5	4067	1393	0.34	206	0.05	0.246	0.033	0.136	0.002	0.007
6	2367	834	0.35	124	0.05	0.266	0.036	0.137	0.002	0.007
7	469	179	0.38	30	0.06	0.362	0.051	0.14	0.003	0.009
8	68	46	0.67	10	0.14	0.369	0.055	0.148	0.004	0.01
9	258	90	0.35	13	0.05	0.426	0.062	0.145	0.005	0.011
10	52	19	0.37	3	0.06	0.265	0.042	0.16	0.004	0.015
11	85	32	0.38	5	0.06					
Mean squared residuals = 0.241106										

Table 10a. Estimated bias adjusted population numbers (000s) at the beginning and middle of year for codin Division 4X.
(1996 survey index version 'a' used in assessment)

Age	1	2	3	4	5	6	7	8	9	10	11	12	1+	2+	3+	4+
1980*	22743	23296	22580	8637	4909	2946	1486	825	348	168	33	0	87971	65228	41932	19352
1980.5	20579	20983	18041	6790	3574	2045	1079	578	259	125	14	0	74067	53488	32505	14464
1981	26107	18620	18286	12963	4928	2448	1394	822	444	204	83	10	86309	60202	41582	23296
1981.5	23623	16702	15014	9713	3726	1681	935	607	288	138	48	0	72475	48852	32150	17136
1982	14079	21375	14482	11440	6755	2355	1064	615	404	200	100	33	72902	58823	37448	22966
1982.5	12739	18981	11706	8297	4581	1642	745	422	297	130	69	0	59609	46870	27889	16183
1983	13914	11527	16675	9248	5371	2771	1109	518	252	199	87	44	61715	47801	36274	19599
1983.5	12590	10282	13506	7176	3839	1758	745	365	160	125	58	0	50604	38014	27732	14226
1984	17471	11383	8472	10297	5375	2541	1197	497	240	99	96	39	57707	40236	28853	20381
1984.5	15809	10269	6848	8071	3996	1862	839	369	176	61	75	0	48375	32566	22297	15449
1985	9521	14273	8451	4741	5624	2651	1206	561	247	141	38	52	47506	37985	23712	15261
1985.5	8615	12870	7202	3646	4162	1838	839	415	185	109	22	0	39903	31288	18418	11216
1986	27608	7795	11014	5372	2453	2487	1005	523	284	139	67	15	58762	31154	23359	12345
1986.5	24980	6977	8902	4132	1804	1738	665	383	201	115	52	0	49949	24969	17992	9090
1987	18943	22603	6151	6470	2625	1105	1127	458	247	149	68	34	59980	41037	18434	12283
1987.5	17140	20363	5299	4887	1683	698	721	256	149	96	42	0	51334	34194	13831	8532
1988	27925	15509	17696	4204	3440	1183	437	467	166	77	64	26	71194	43269	27760	10064
1988.5	25267	13970	14392	3329	2342	736	295	311	118	38	50	0	60848	35581	21611	7219
1989	9733	22863	12320	11301	1914	1416	379	199	211	59	16	26	60437	50704	27841	15521
1989.5	8801	20265	9578	8056	1280	890	205	124	155	43	6	0	49403	40602	20337	10759
1990	15291	7953	18136	7804	5988	1010	664	168	93	119	31	5	57262	41971	34018	15882
1990.5	13835	7165	15243	5881	4180	747	451	121	71	93	21	0	47808	33973	26808	11565
1991	18812	12519	6378	12238	3839	2683	372	294	67	40	63	13	57318	38506	25987	19609
1991.5	17020	11253	5171	8520	2722	1807	265	204	48	30	47	0	47087	30067	18814	13643
1992	14803	15400	9885	3820	5429	1528	962	107	99	26	18	26	52103	37300	21900	12015
1992.5	13395	13874	8003	2687	3160	929	536	66	65	12	13	0	42740	29345	15471	7468
1993	30997	12120	11748	4486	1164	1307	385	298	24	32	7	6	62574	31577	19457	7709
1993.5	28047	10955	8943	3108	692	814	264	232	17	25	3	0	53100	25053	14098	5155
1994	11157	25378	9087	6466	1823	362	468	147	162	7	14	2	55073	43916	18538	9451
1994.5	10095	22847	7116	4713	1286	243	352	120	140	7	12	0	46931	36836	13989	6873
1995	9056	9135	20337	5379	3281	686	119	219	82	116	6	10	48426	39370	30235	9898
1995.5	8194	8260	17793	4365	2620	552	90	174	68	103	5	0	42224	34030	25770	7977
1996	16357	7414	7351	14669	3425	2167	444	73	142	57	90	4	52193	35836	28422	21071
1996.5	14800	6704	6380	12330	2929	1862	388	57	122	49	81	0	45702	30902	24198	17818

* 1980 = first half of year; 1980.5 = second half of year.

Table 10b. Estimated bias adjusted population numbers (000s) at the beginning and middle of year for cod in Division 4X.
(1996 survey index version 'b' used in assessment)

Age	1	2	3	4	5	6	7	8	9	10	11	12	1+	2+	3+	4+
1980*	22744	23296	22581	8637	4909	2946	1486	825	348	168	33	0	87973	65229	41933	19352
1980.5	20580	20983	18041	6790	3574	2045	1079	578	259	125	14	0	74068	53488	32505	14464
1981	26110	18621	18286	12963	4928	2448	1394	822	444	204	83	10	86313	60203	41582	23296
1981.5	23626	16703	15014	9713	3726	1681	935	607	288	138	48	0	72479	48853	32150	17136
1982	14082	21377	14482	11440	6755	2355	1064	615	404	200	100	33	72907	58825	37448	22966
1982.5	12742	18983	11706	8297	4581	1643	746	422	297	130	69	0	59616	46874	27891	16185
1983	13916	11529	16676	9249	5371	2771	1109	518	252	199	87	44	61721	47805	36276	19600
1983.5	12591	10284	13508	7176	3839	1758	745	365	160	125	58	0	50609	38018	27734	14226
1984	17475	11385	8474	10299	5375	2542	1197	497	240	99	96	39	57718	40243	28858	20384
1984.5	15812	10270	6850	8072	3997	1862	839	369	176	61	75	0	48383	32571	22301	15451
1985	9532	14276	8452	4743	5625	2651	1206	561	247	141	38	52	47524	37992	23716	15264
1985.5	8625	12873	7203	3648	4163	1838	839	415	185	109	22	0	39920	31295	18422	11219
1986	27604	7804	11017	5373	2455	2488	1006	524	284	139	67	15	58776	31172	23368	12351
1986.5	24977	6985	8904	4133	1805	1739	665	383	201	115	52	0	49959	24982	17997	9093
1987	18943	22600	6158	6472	2625	1106	1128	458	247	149	68	34	59988	41045	18445	12287
1987.5	17140	20360	5306	4888	1684	699	722	256	149	96	42	0	51342	34202	13842	8536
1988	28603	15509	17693	4210	3441	1184	438	467	167	77	64	26	71879	43276	27767	10074
1988.5	25881	13970	14390	3335	2343	736	296	312	118	38	50	0	61469	35588	21618	7228
1989	9739	23418	12320	11299	1919	1418	379	199	211	59	16	26	61003	51264	27846	15526
1989.5	8806	20768	9579	8054	1284	891	206	125	155	43	6	0	49917	41111	20343	10764
1990	15479	7958	18590	7804	5986	1014	665	169	94	120	31	5	57915	42436	34478	15888
1990.5	14006	7169	15655	5881	4179	751	452	121	71	94	22	0	48401	34395	27226	11571
1991	19959	12674	6381	12610	3839	2682	375	295	68	40	63	13	58999	39040	26366	19985
1991.5	18058	11393	5174	8857	2722	1806	268	204	48	31	47	0	48608	30550	19157	13983
1992	17097	16339	10011	3823	5733	1529	961	110	99	26	19	26	55773	38676	22337	12326
1992.5	15470	14724	8117	2690	3435	929	535	69	65	12	14	0	46060	30590	15866	7749
1993	35289	13998	12517	4589	1166	1554	385	297	26	33	7	7	69868	34579	20581	8064
1993.5	31931	12654	9639	3202	694	1038	264	232	19	26	3	0	59702	27771	15117	5478
1994	12476	28893	10625	7095	1908	364	670	147	161	9	14	2	62364	49888	20995	10370
1994.5	11288	26027	8507	5282	1362	245	535	120	139	8	13	0	53526	42238	16211	7704
1995	9319	10214	23214	6637	3796	755	121	384	82	115	7	10	54654	45335	35121	11907
1995.5	8432	9237	20396	5504	3086	614	91	323	68	102	6	0	47859	39427	30190	9794
1996	16357	7630	8235	17024	4455	2588	500	74	278	57	89	5	57292	40935	33305	25070
1996.5	14800	6899	7180	14461	3861	2243	439	59	245	49	80	0	50316	35516	28617	21437

* 1980 = first half of year; 1980.5 = second half of year.

Table 11a. Estimated population biomass (000 t) at the beginning of the year for cod in Division 4X (1996 survey index version 'a' used in assessment).

Age	1	2	3	4	5	6	7	8	9	10	11	12	1+	2+	3+	4+
1980	10462	16540	25064	14597	11536	9840	6850	5066	3048	1971	447	0	105421	94959	78419	53355
1981	12009	13220	20297	21907	11581	8176	6426	5047	3889	2393	1125	157	106230	94221	81000	60703
1982	6476	15176	16075	19334	15874	7866	4905	3776	3539	2346	1356	518	97242	90765	75589	59514
1983	6400	8184	18509	15629	12622	9255	5112	3181	2208	2334	1180	691	85306	78905	70721	52212
1984	8037	8082	9404	17402	12631	8487	5518	3052	2102	1161	1302	613	77791	69754	61672	52268
1985	4380	10134	9381	8012	13216	8854	5560	3445	2164	1654	515	817	68131	63752	53618	44237
1986	12700	5534	12226	9079	5765	8307	4633	3211	2488	1630	909	236	66716	54017	48482	36257
1987	8714	16048	6828	10934	6169	3691	5195	2812	2164	1748	922	534	65759	57045	40997	34169
1988	12846	11011	19643	7105	8084	3951	2015	2867	1454	903	868	408	71155	58310	47298	27656
1989	4477	16233	13675	19099	4498	4729	1747	1222	1848	692	217	408	68846	64369	48136	34461
1990	7034	5647	20131	13189	14072	3373	3061	1032	815	1396	420	79	70247	63214	57567	37436
1991	8654	8888	7080	20682	9022	8961	1715	1805	587	469	854	204	68921	60268	51379	44300
1992	6809	10934	10972	6456	12758	5104	4435	657	867	305	244	408	59950	53140	42206	31234
1993	14259	8605	13040	7581	2735	4365	1775	1830	210	375	95	94	54966	40707	32102	19061
1994	5132	18018	10087	10928	4284	1209	2157	903	1419	82	190	31	54440	49308	31290	21203
1995	4166	6486	22574	9091	7710	2291	549	1345	718	1361	81	157	56528	52363	45877	23303
1996	7524	5264	8160	24791	8049	7238	2047	448	1244	669	1220	63	66716	59192	53928	45768

Table 11b. Estimated population biomass (000 t) at the beginning of the year for cod in Division 4X (1996 survey index version 'b' used in assessment).

Age	1	2	3	4	5	6	7	8	9	10	11	12	1+	2+	3+	4+
1980	10462	16540	25065	14597	11536	9840	6850	5066	3048	1971	447	0	105422	94960	78420	53355
1981	12011	13221	20297	21907	11581	8176	6426	5047	3889	2393	1125	157	106232	94221	81000	60703
1982	6478	15178	16075	19334	15874	7866	4905	3776	3539	2346	1356	518	97245	90767	75589	59514
1983	6401	8186	18510	15631	12622	9255	5112	3181	2208	2334	1180	691	85311	78910	70724	52214
1984	8039	8083	9406	17405	12631	8490	5518	3052	2102	1161	1302	613	77803	69764	61681	52275
1985	4385	10136	9382	8016	13219	8854	5560	3445	2164	1654	515	817	68145	63760	53625	44243
1986	12698	5541	12229	9080	5769	8310	4638	3217	2488	1630	909	236	66745	54047	48506	36277
1987	8714	16046	6835	10938	6169	3694	5200	2812	2164	1748	922	534	65776	57062	41016	34180
1988	13157	11011	19639	7115	8086	3955	2019	2867	1463	903	868	408	71493	58335	47324	27685
1989	4480	16627	13675	19095	4510	4736	1747	1222	1848	692	217	408	69258	64778	48151	34476
1990	7120	5650	20635	13189	14067	3387	3066	1038	823	1408	420	79	70881	63761	58111	37476
1991	9181	8999	7083	21311	9022	8958	1729	1811	596	469	854	204	70216	61035	52037	44954
1992	7865	11601	11112	6461	13473	5107	4430	675	867	305	258	408	62562	54697	43096	31984
1993	16233	9939	13894	7755	2740	5190	1775	1824	228	387	95	110	60169	43936	33998	20104
1994	5739	20514	11794	11991	4484	1216	3089	903	1410	106	190	31	61465	55726	35212	23419
1995	4287	7252	25768	11217	8921	2522	558	2358	718	1349	95	157	65200	60913	53661	27894
1996	7524	5417	9141	28771	10469	8644	2305	454	2435	669	1207	79	77115	69591	64173	55032

Table 12a. Estimated bias adjusted fishing mortality for cod in Division 4X (1996 survey index version 'a' used in assessment).

Age	1	2	3	4	5	6	7	8	9	10	11
1980*	0.00	0.01	0.25	0.28	0.44	0.53	0.44	0.51	0.39	0.39	1.50
1980.5	0.00	0.08	0.46	0.44	0.56	0.57	0.35	0.33	0.28	0.61	0.41
1981	0.00	0.02	0.19	0.38	0.36	0.55	0.60	0.41	0.67	0.58	0.89
1981.5	0.00	0.09	0.34	0.53	0.72	0.72	0.64	0.62	0.53	0.45	0.53
1982	0.00	0.04	0.23	0.44	0.58	0.52	0.51	0.55	0.41	0.66	0.54
1982.5	0.00	0.06	0.27	0.67	0.81	0.59	0.53	0.83	0.60	0.60	0.68
1983	0.00	0.03	0.22	0.31	0.47	0.71	0.60	0.50	0.71	0.73	0.63
1983.5	0.00	0.19	0.34	0.38	0.63	0.57	0.61	0.64	0.76	0.32	0.57
1984	0.00	0.01	0.23	0.29	0.39	0.42	0.51	0.40	0.42	0.78	0.29
1984.5	0.00	0.19	0.54	0.52	0.62	0.67	0.61	0.60	0.25	0.75	0.53
1985	0.00	0.01	0.12	0.33	0.40	0.53	0.53	0.40	0.39	0.32	0.90
1985.5	0.00	0.11	0.39	0.59	0.83	1.01	0.74	0.56	0.37	0.77	0.57
1986	0.00	0.02	0.23	0.33	0.42	0.52	0.63	0.43	0.50	0.18	0.32
1986.5	0.00	0.05	0.44	0.71	0.78	0.67	0.55	0.68	0.39	0.86	0.64
1987	0.00	0.01	0.10	0.36	0.69	0.72	0.69	0.97	0.81	0.69	0.74
1987.5	0.00	0.08	0.26	0.50	0.51	0.74	0.67	0.66	1.13	0.62	0.81
1988	0.00	0.01	0.21	0.27	0.57	0.75	0.59	0.61	0.49	1.23	0.27
1988.5	0.00	0.05	0.28	0.91	0.81	1.13	0.59	0.58	1.19	1.50	1.09
1989	0.00	0.04	0.30	0.48	0.61	0.73	1.03	0.74	0.42	0.45	1.71
1989.5	0.00	0.02	0.21	0.39	0.27	0.38	0.20	0.38	0.32	0.44	0.38
1990	0.00	0.01	0.15	0.37	0.52	0.40	0.58	0.47	0.34	0.29	0.54
1990.5	0.00	0.03	0.24	0.65	0.69	1.20	0.66	0.97	0.96	0.59	0.84
1991	0.00	0.01	0.22	0.52	0.49	0.59	0.47	0.53	0.49	0.35	0.38
1991.5	0.00	0.06	0.41	0.70	0.95	1.06	1.61	1.25	1.00	0.82	1.02
1992	0.00	0.01	0.22	0.50	0.88	0.80	0.97	0.76	0.64	1.35	0.41
1992.5	0.00	0.13	0.96	1.47	1.57	1.56	0.98	1.82	1.18	0.82	1.27
1993	0.00	0.00	0.35	0.53	0.84	0.75	0.56	0.30	0.47	0.30	1.69
1993.5	0.00	0.17	0.45	0.87	1.10	0.91	0.97	0.52	1.50	1.00	1.00
1994	0.00	0.01	0.29	0.43	0.50	0.60	0.37	0.20	0.10	0.00	0.03
1994.5	0.00	0.03	0.36	0.52	1.06	1.22	0.75	0.57	0.17	0.17	0.30
1995	0.00	0.00	0.07	0.22	0.25	0.24	0.37	0.26	0.16	0.05	0.16
1995.5	0.00	0.03	0.19	0.29	0.18	0.24	0.22	0.20	0.15	0.06	0.13
1996	0.00	0.00	0.08	0.15	0.11	0.10	0.07	0.27	0.11	0.11	0.02

* 1980 = first half of year; 1980.5 = second half of year.

Table 12b. Estimated bias adjusted fishing mortality for cod in Division 4X (1996 survey index version 'b' used in assessment).

Age	1	2	3	4	5	6	7	8	9	10	11
1980*	0.00	0.01	0.25	0.28	0.44	0.53	0.44	0.51	0.39	0.39	1.50
1980.5	0.00	0.08	0.46	0.44	0.56	0.57	0.35	0.33	0.28	0.61	0.41
1981	0.00	0.02	0.19	0.38	0.36	0.55	0.60	0.41	0.67	0.58	0.89
1981.5	0.00	0.09	0.34	0.53	0.72	0.72	0.64	0.62	0.53	0.45	0.53
1982	0.00	0.04	0.23	0.44	0.58	0.52	0.51	0.55	0.41	0.66	0.54
1982.5	0.00	0.06	0.27	0.67	0.81	0.59	0.53	0.83	0.60	0.60	0.68
1983	0.00	0.03	0.22	0.31	0.47	0.71	0.60	0.50	0.71	0.73	0.63
1983.5	0.00	0.19	0.34	0.38	0.63	0.57	0.61	0.64	0.76	0.32	0.57
1984	0.00	0.01	0.23	0.29	0.39	0.42	0.51	0.40	0.42	0.78	0.29
1984.5	0.00	0.19	0.54	0.52	0.62	0.67	0.61	0.60	0.25	0.75	0.53
1985	0.00	0.01	0.12	0.33	0.40	0.53	0.53	0.40	0.39	0.32	0.90
1985.5	0.00	0.11	0.39	0.59	0.83	1.01	0.74	0.56	0.37	0.77	0.57
1986	0.00	0.02	0.23	0.33	0.42	0.52	0.63	0.43	0.50	0.18	0.32
1986.5	0.00	0.05	0.44	0.71	0.78	0.67	0.55	0.68	0.39	0.86	0.64
1987	0.00	0.01	0.10	0.36	0.69	0.72	0.69	0.96	0.81	0.69	0.74
1987.5	0.00	0.08	0.26	0.50	0.51	0.74	0.67	0.66	1.13	0.62	0.80
1988	0.00	0.01	0.21	0.27	0.57	0.75	0.59	0.61	0.48	1.22	0.27
1988.5	0.00	0.05	0.28	0.91	0.81	1.13	0.59	0.58	1.19	1.49	1.09
1989	0.00	0.04	0.30	0.48	0.60	0.73	1.02	0.74	0.42	0.45	1.70
1989.5	0.00	0.02	0.21	0.39	0.27	0.38	0.20	0.38	0.32	0.43	0.38
1990	0.00	0.01	0.14	0.37	0.52	0.40	0.58	0.47	0.34	0.29	0.54
1990.5	0.00	0.03	0.23	0.65	0.69	1.19	0.65	0.96	0.95	0.59	0.83
1991	0.00	0.01	0.22	0.51	0.49	0.59	0.47	0.53	0.49	0.34	0.38
1991.5	0.00	0.06	0.41	0.67	0.95	1.06	1.58	1.25	0.99	0.80	1.01
1992	0.00	0.01	0.22	0.50	0.82	0.80	0.97	0.74	0.64	1.33	0.40
1992.5	0.00	0.13	0.94	1.47	1.39	1.56	0.98	1.72	1.17	0.80	1.23
1993	0.00	0.00	0.32	0.52	0.84	0.61	0.56	0.30	0.42	0.30	1.62
1993.5	0.00	0.15	0.41	0.84	1.09	0.68	0.97	0.52	1.29	0.97	0.92
1994	0.00	0.01	0.25	0.39	0.47	0.59	0.25	0.20	0.10	0.00	0.03
1994.5	0.00	0.03	0.30	0.46	0.98	1.21	0.46	0.57	0.18	0.13	0.29
1995	0.00	0.00	0.06	0.17	0.21	0.21	0.36	0.14	0.16	0.05	0.13
1995.5	0.00	0.03	0.16	0.22	0.15	0.21	0.22	0.10	0.15	0.06	0.10
1996	0.00	0.00	0.07	0.13	0.09	0.09	0.06	0.27	0.06	0.11	0.02

* 1980 = first half of year; 1980.5 = second half of year.

Table 13. Projections for cod in Division 4X.

	Age	Beg. yr. wt.		Mid-yr. wt.		catch 1996.5			catch 1997			population '97		population '98	
		1997	1997	1997	1997	num.	biom.	F	F	num.	biom	num	biom	num	biom
	1	0.38	0.28	0.48	0.38	0	0	0.00	0.00	0	0	16500	4620	16500	4620
	2	0.89	0.71	0.9	0.89	96	86	0.03	0.01	121	108	13392	9508	13509	9591
	3	1.4	1.11	1.47	1.4	444	652	0.15	0.08	437	612	5974	6631	10855	12049
	4	2.07	1.69	2.16	2.07	1423	3077	0.26	0.15	686	1419	5351	9043	4497	7600
A	5	2.82	2.35	3.11	2.82	393	1222	0.30	0.20	1616	4558	9805	23042	3763	8843
	6	3.88	3.34	4.11	3.88	250	1027	0.30	0.20	375	1456	2277	7605	6573	21954
	7	5.48	4.61	5.88	5.48	52	306	0.30	0.20	239	1307	1447	6671	1526	7035
	8	7.22	6.14	7.68	7.22	8	59	0.30	0.20	50	359	302	1854	970	5956
	9	10.4	8.76	11.16	10.4	16	183	0.30	0.20	7	77	45	394	202	1770
	10	12.89	11.73	13.47	12.89	7	89	0.30	0.20	16	202	95	1114	30	352
	11	14.83	13.56	15.66	14.83	11	169	0.30	0.20	6	93	38	515	64	868
	12	16.42	15.71		16.42							63	990	26	408
	1+					2700	6870			3553	10191	55289	71988	58515	81045
	2+					2700	6870			3553	10191	38789	67368	42015	76425
	3+					2604	6784			3432	10083	25397	57860	28506	66834
	4+					2160	6132			2995	9471	19423	51229	17651	54785
	1	0.38	0.28	0.48	0.38	0	0	0.00	0.00	0	0	16500	4620	16500	4620
	2	0.89	0.71	0.9	0.89	81	73	0.03	0.01	121	108	13392	9508	13509	9591
	3	1.4	1.11	1.47	1.4	411	604	0.12	0.08	451	631	6165	6843	10855	12049
	4	2.07	1.69	2.16	2.07	1379	2981	0.21	0.15	782	1619	6106	10319	4641	7843
B	5	2.82	2.35	3.11	2.82	429	1333	0.25	0.20	1941	5474	11775	27671	4294	10091
	6	3.88	3.34	4.11	3.88	249	1025	0.25	0.20	509	1974	3086	10307	7893	26363
	7	5.48	4.61	5.88	5.48	49	287	0.25	0.20	295	1619	1792	8261	2069	9538
	8	7.22	6.14	7.68	7.22	7	50	0.25	0.20	58	418	351	2155	1202	7380
	9	10.4	8.76	11.16	10.4	27	304	0.25	0.20	8	80	47	412	235	2059
	10	12.89	11.73	13.47	12.89	5	74	0.25	0.20	32	416	196	2299	31	364
	11	14.83	13.56	15.66	14.83	9	139	0.25	0.20	6	96	39	529	131	1776
	12	16.42	15.71		16.42							64	1005	26	408
	1+					2646	6870			4203	12435	59513	83930	61386	92082
	2+					2646	6870			4203	12435	43013	79310	44886	87462
	3+					2565	6797			4082	12327	29621	69802	31377	77871
	4+					2154	6193			3631	11696	23456	62959	20522	65822

* A and B refer to version of 1996 survey indices used in the assessment.

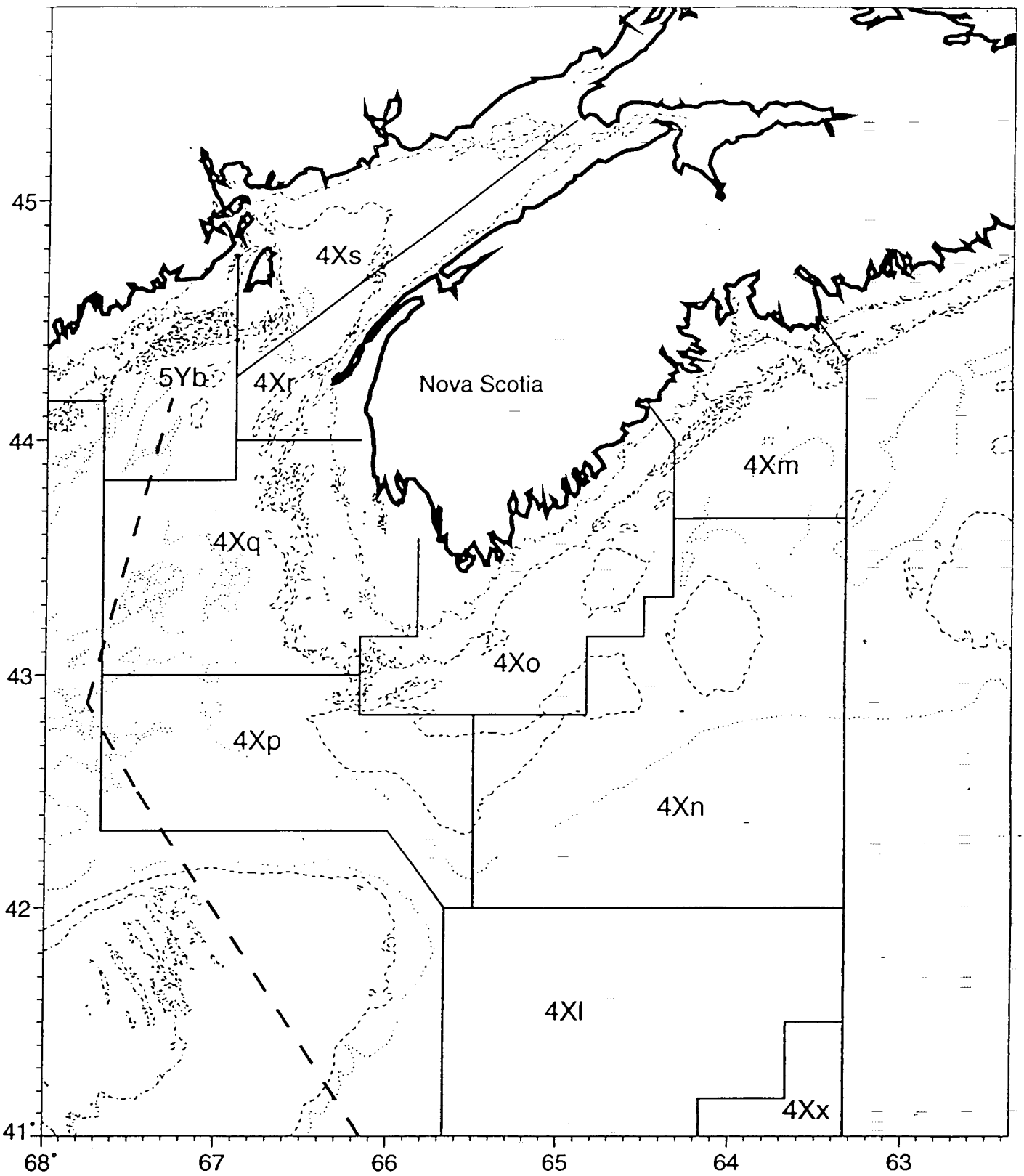


Fig. 1. Canadian fisheries statistical unit areas in NAFO Division 4X.

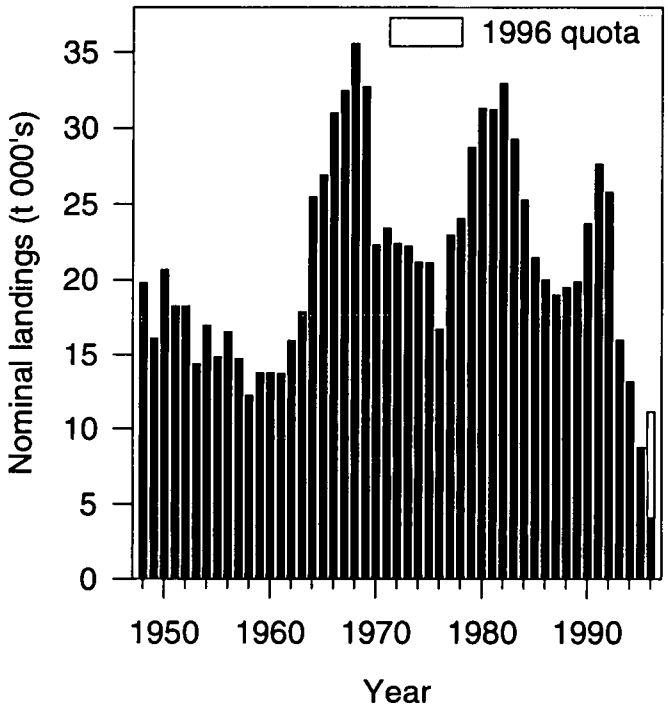


Fig. 2. Nominal landings of cod in Division 4X including catches by Canada in Division 5Y. For 1995, quota and mid-year landings shown.

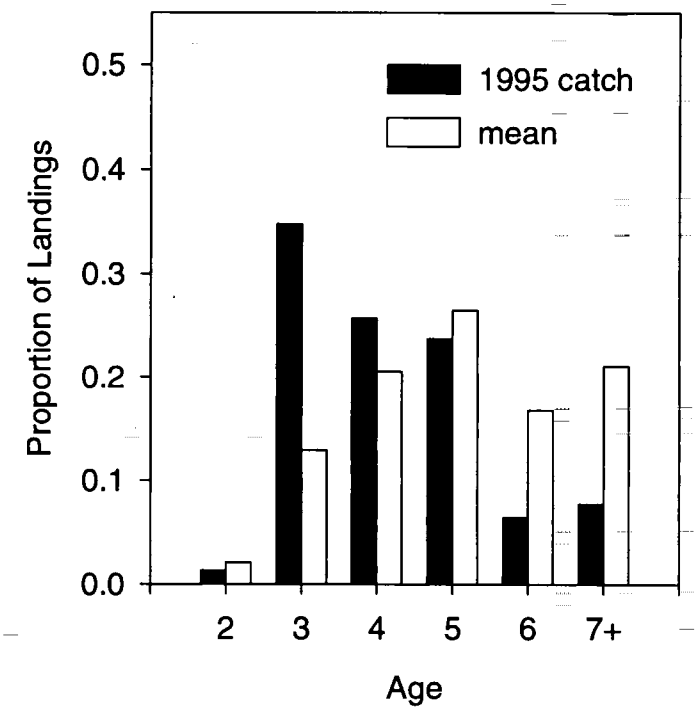


Fig. 3. Division 4X cod catch by weight proportioned by age for 1995 compared to mean for 1983-1995.

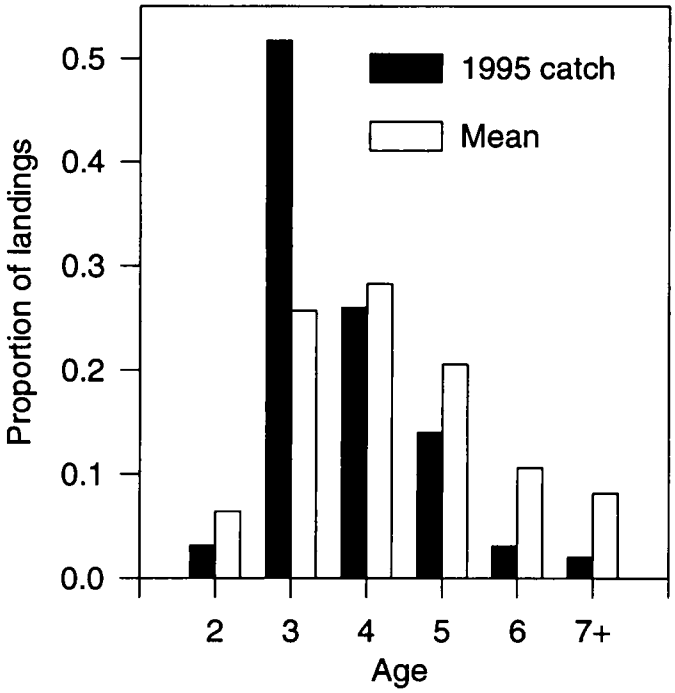


Fig. 4. 4X cod catch by number for 1995 proportioned by age compared to mean for 1983-1994.

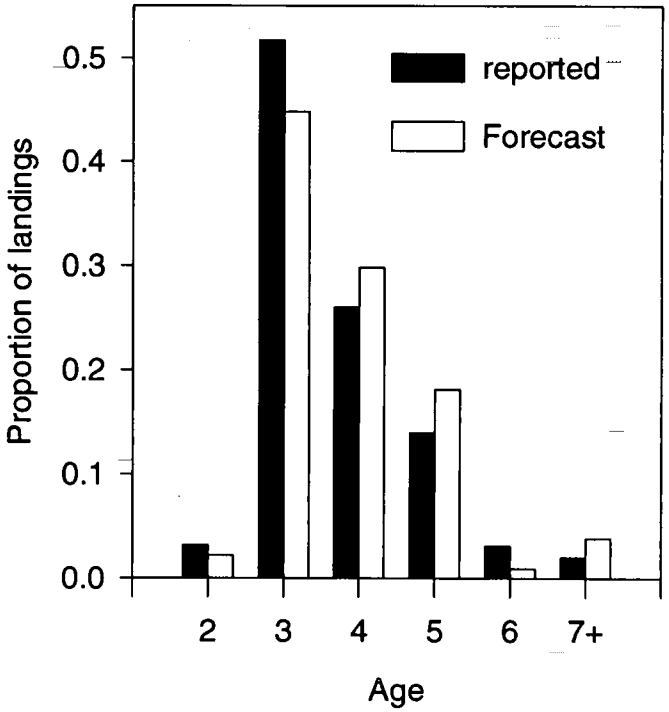


Fig. 5. Reported and forecast landings of cod in Division 4X for 1995 proportioned by age.

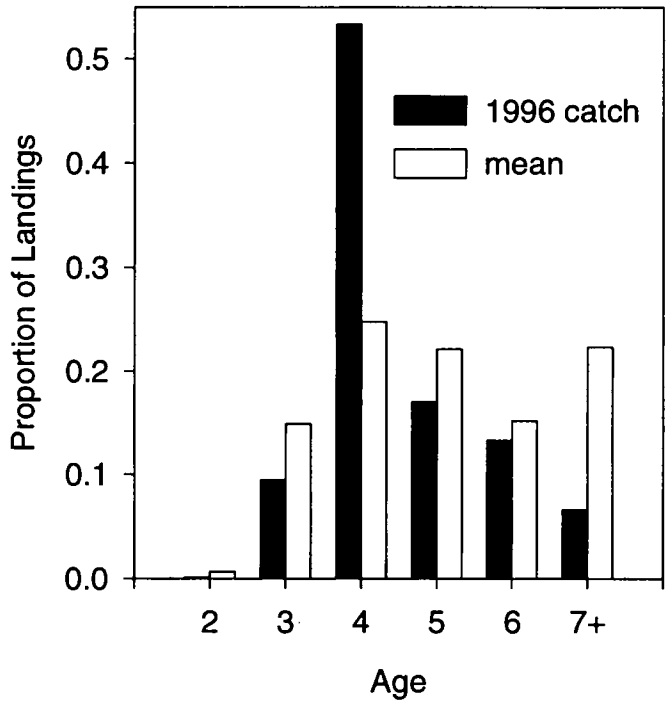


Fig. 6. Division 4X cod catch by weight proportioned by age for 1996 compared to mean for 1983-1995 (Jan. - July).

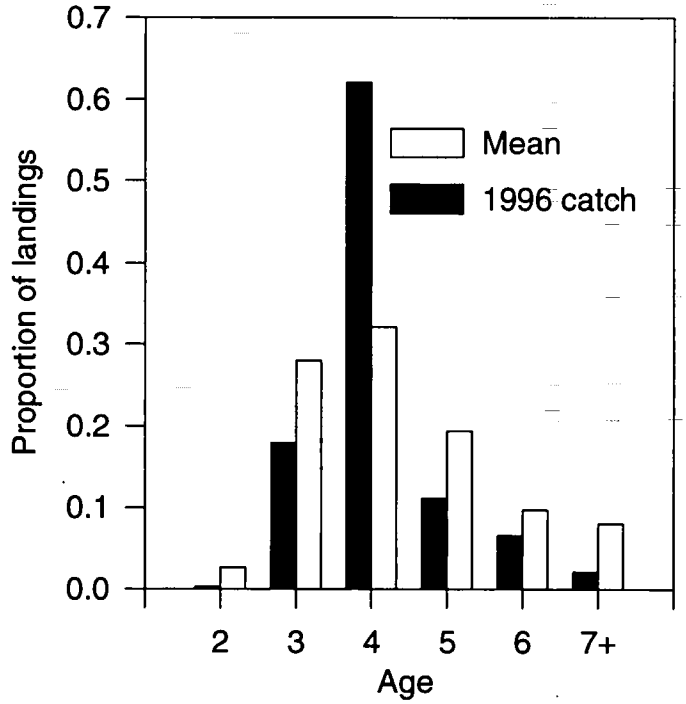


Fig. 7. 4X cod catch by number for 1996 proportioned by age compared to mean for 1990 -1995 (January - July).

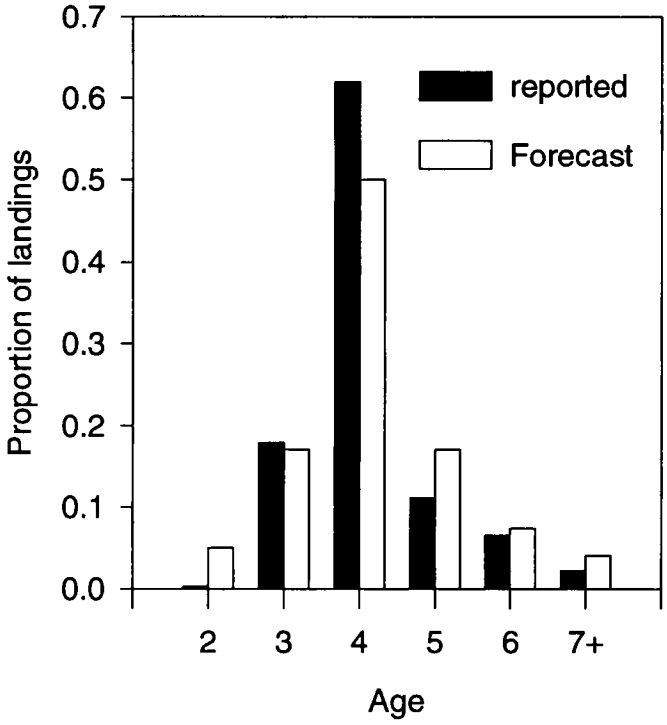
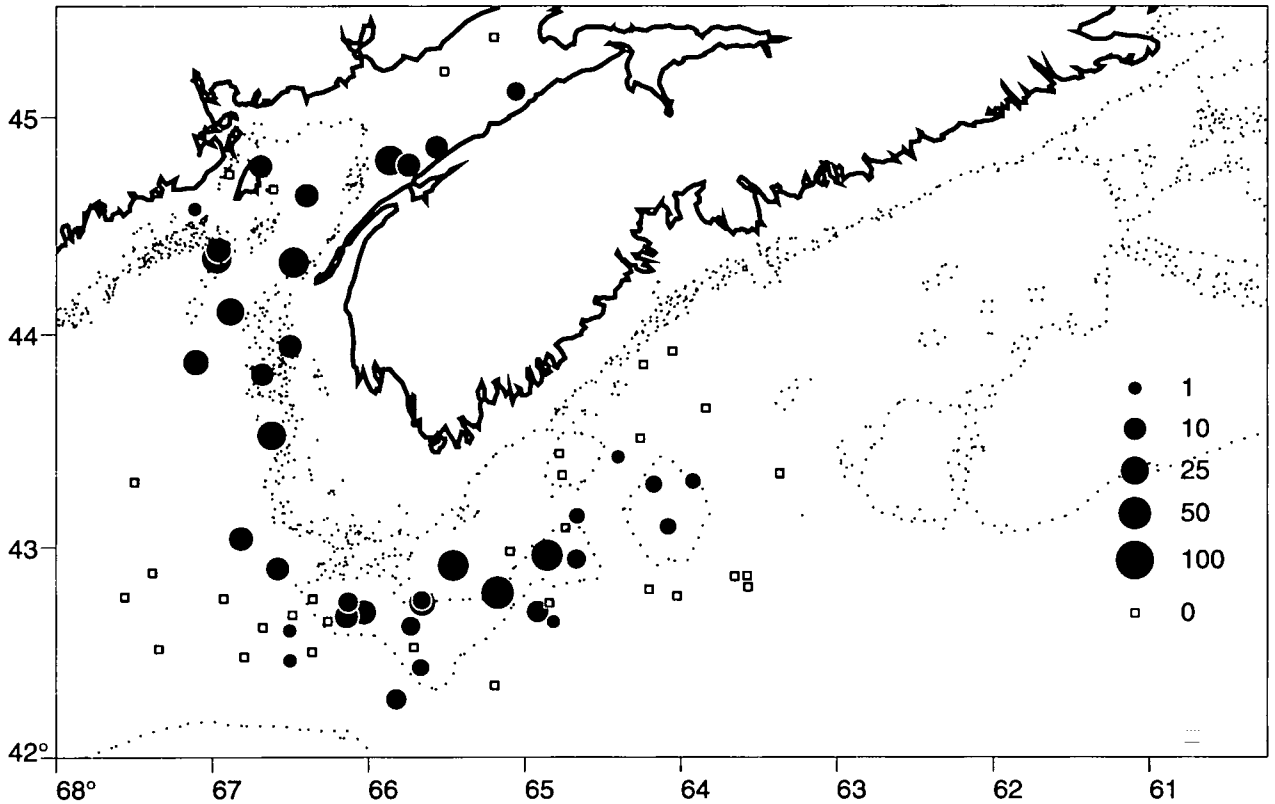


Fig. 8. Reported and forecast landings of cod in Division 4X for 1996 proportioned by age.



Summer Groundfish Survey 4X Cod Biomass (kg/tow) July 1993

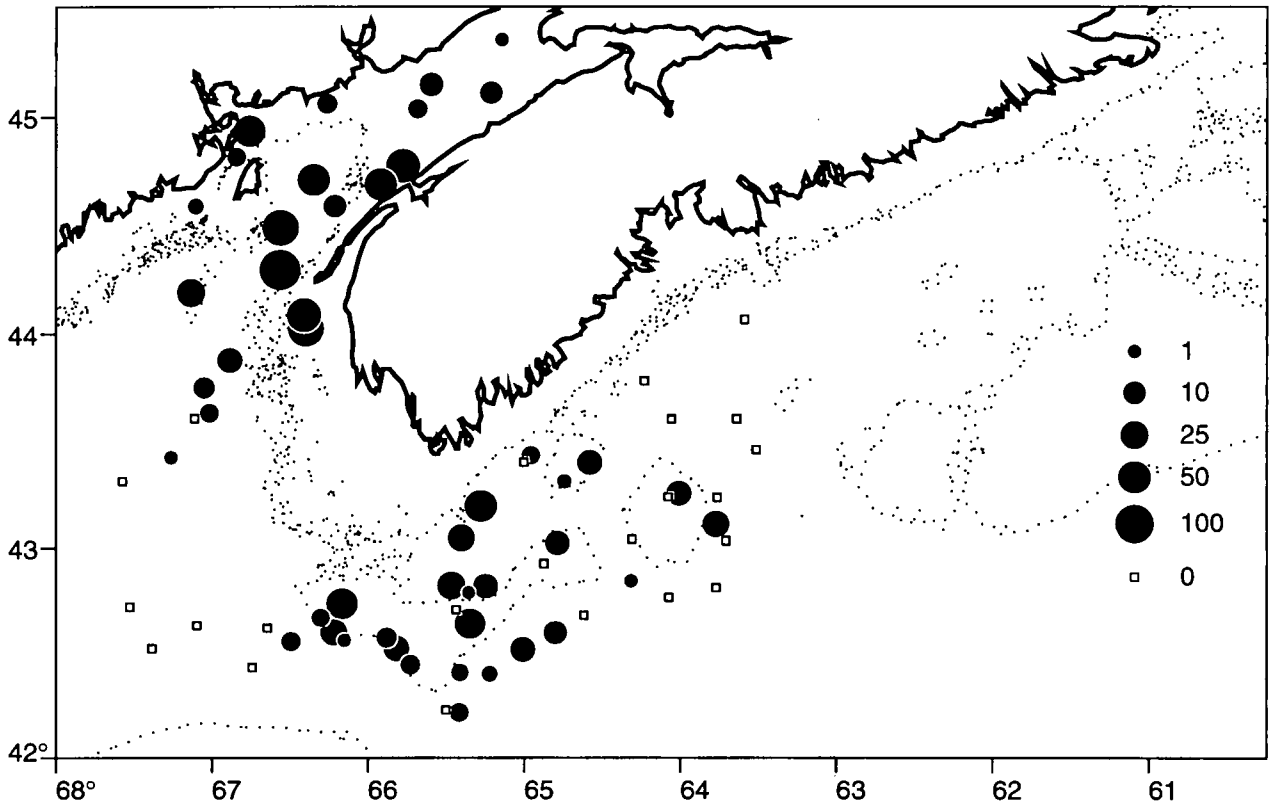
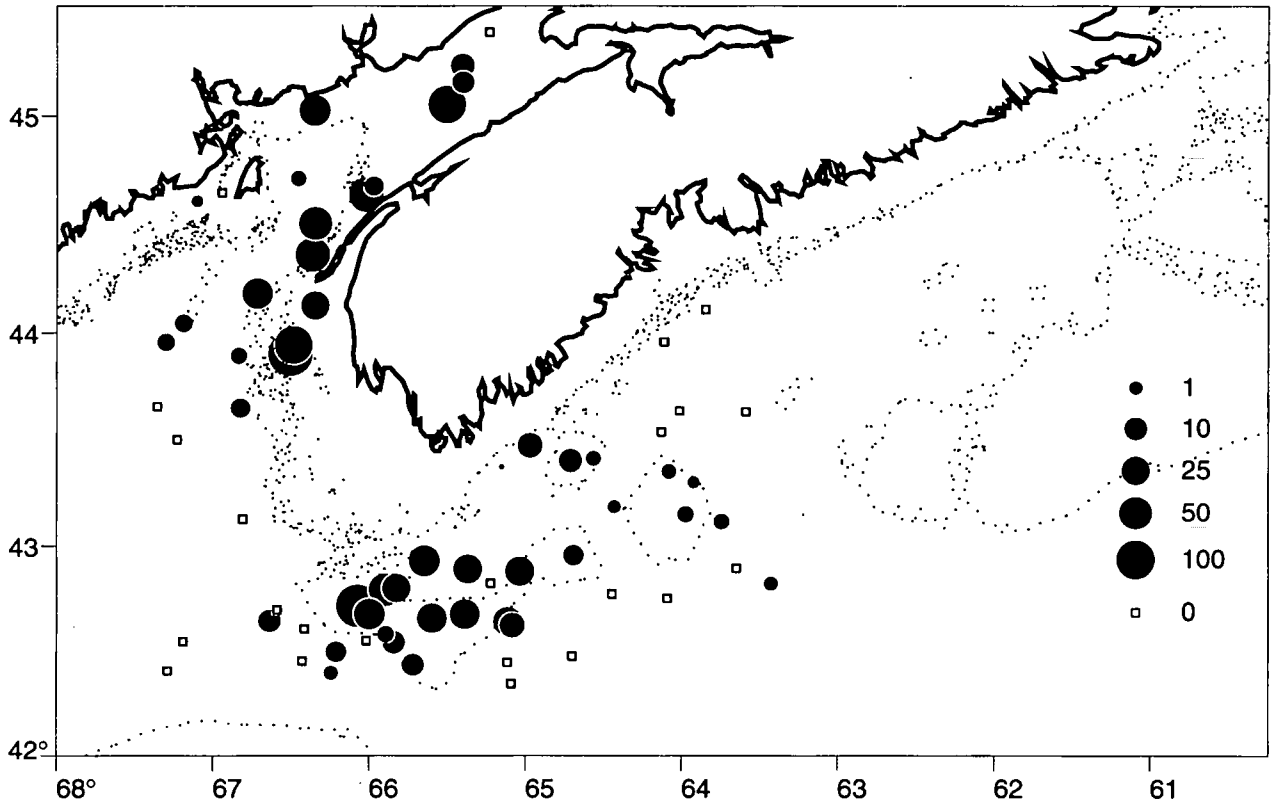


Fig. 9. Groundfish Survey 4X Cod Biomass (kg/tow) July 1994



Summer Groundfish Survey 4X Cod Biomass (kg/tow) July 1995

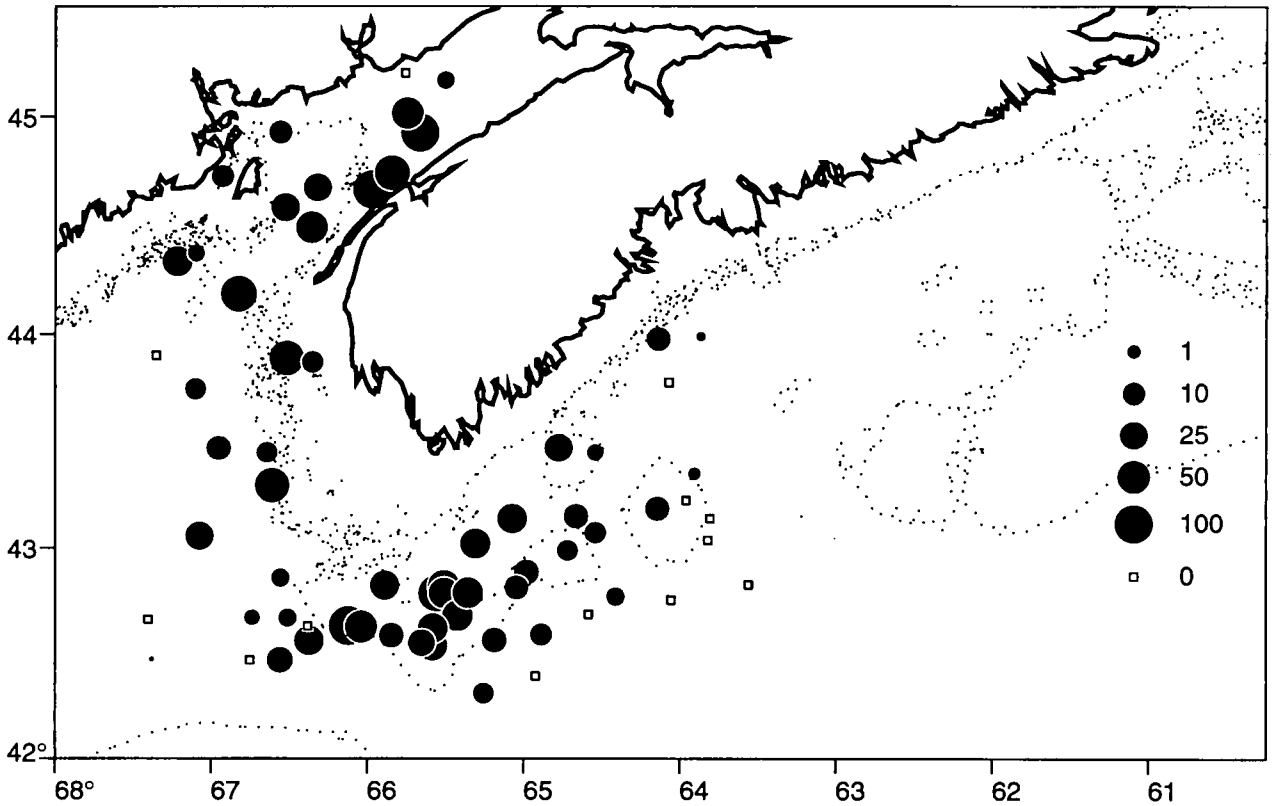


Fig. 9(cont.) Groundfish Survey 4X Cod Biomass (kg/tow) July 1996

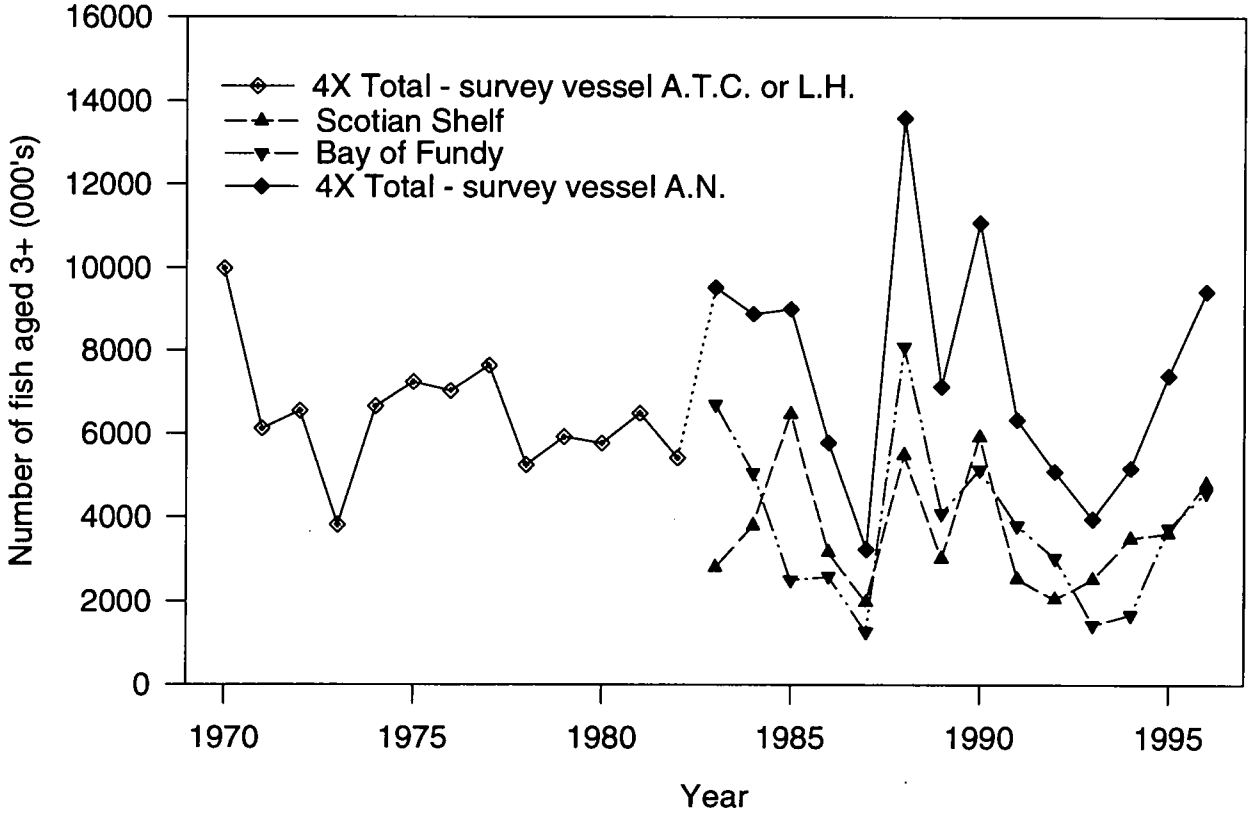


Fig 10. Summer groundfish survey indices for 4X cod by region.

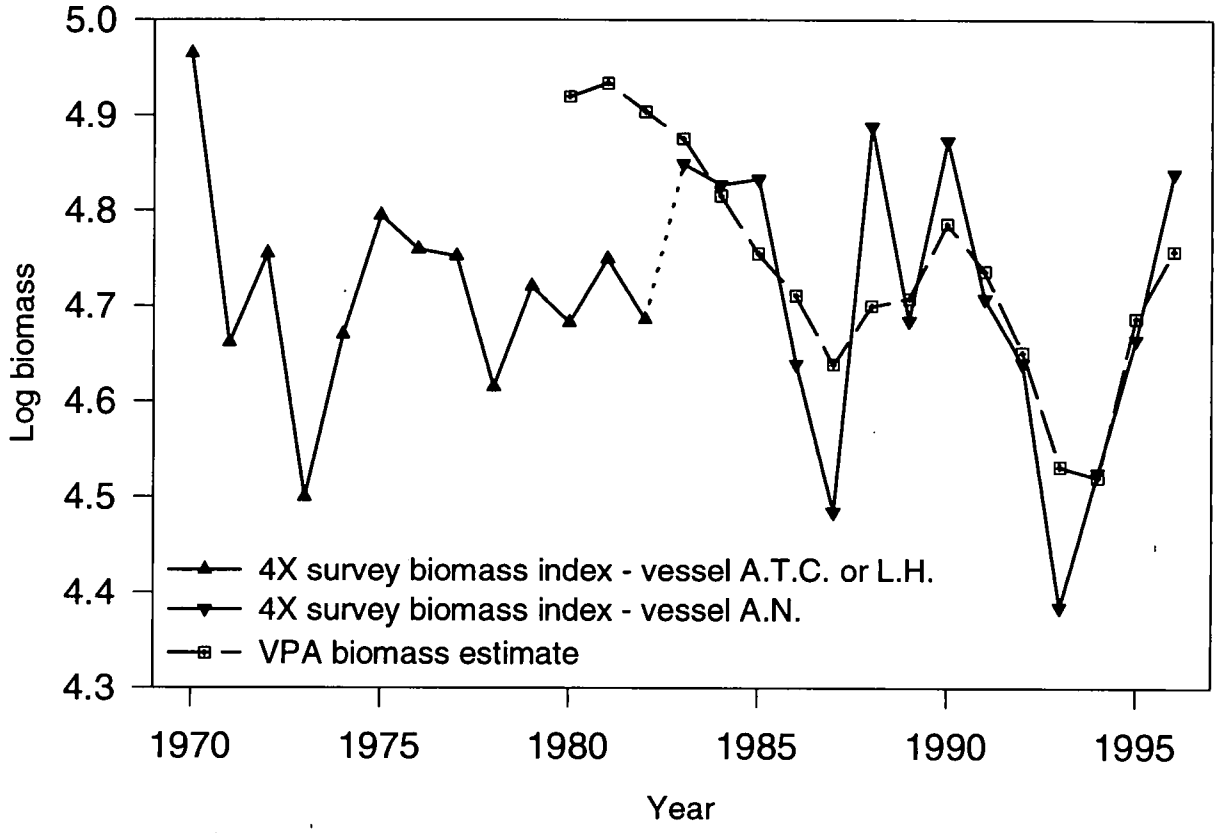


Fig. 10b. Comparison of survey biomass indices and VPA biomass estimate.

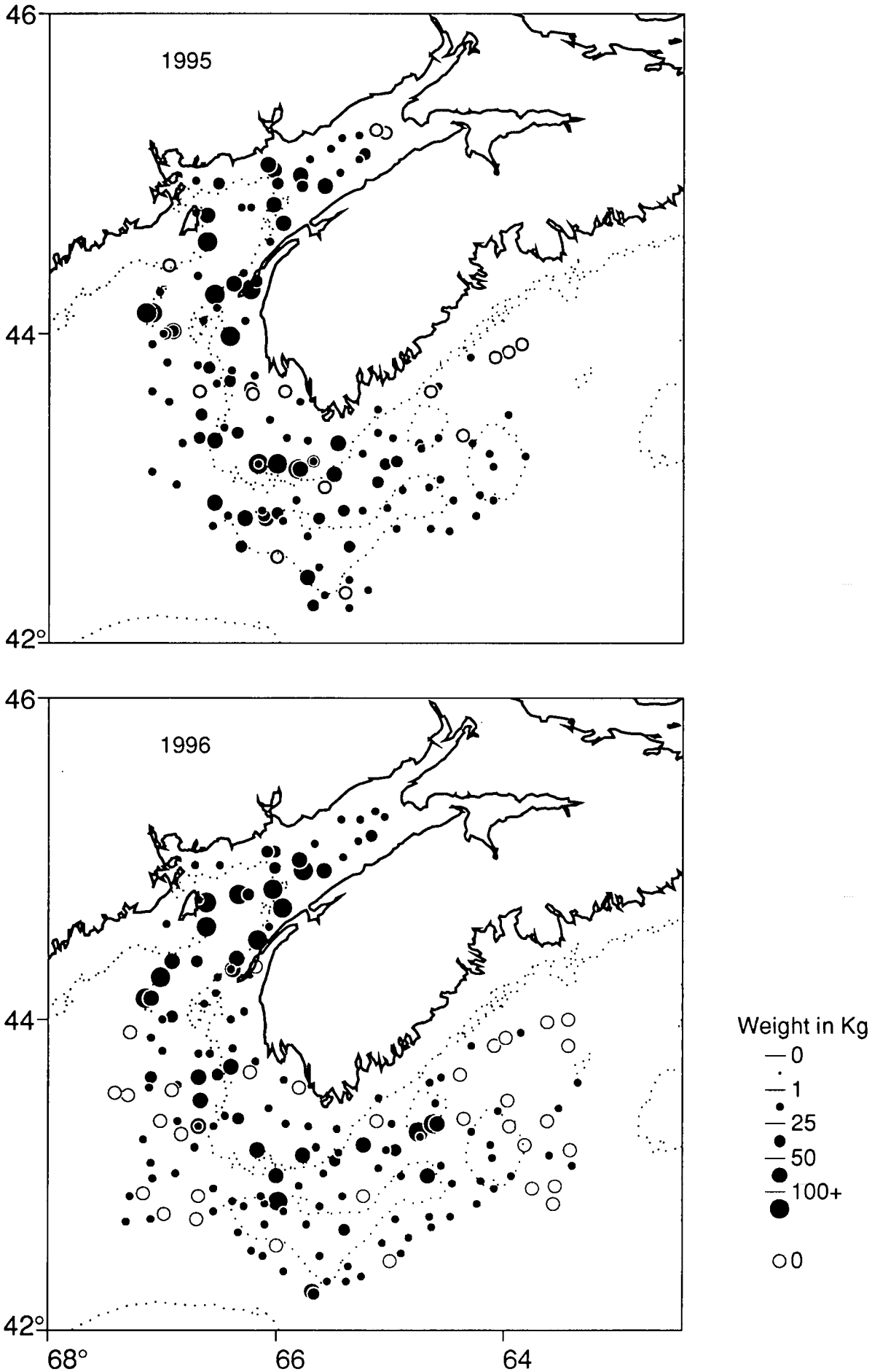
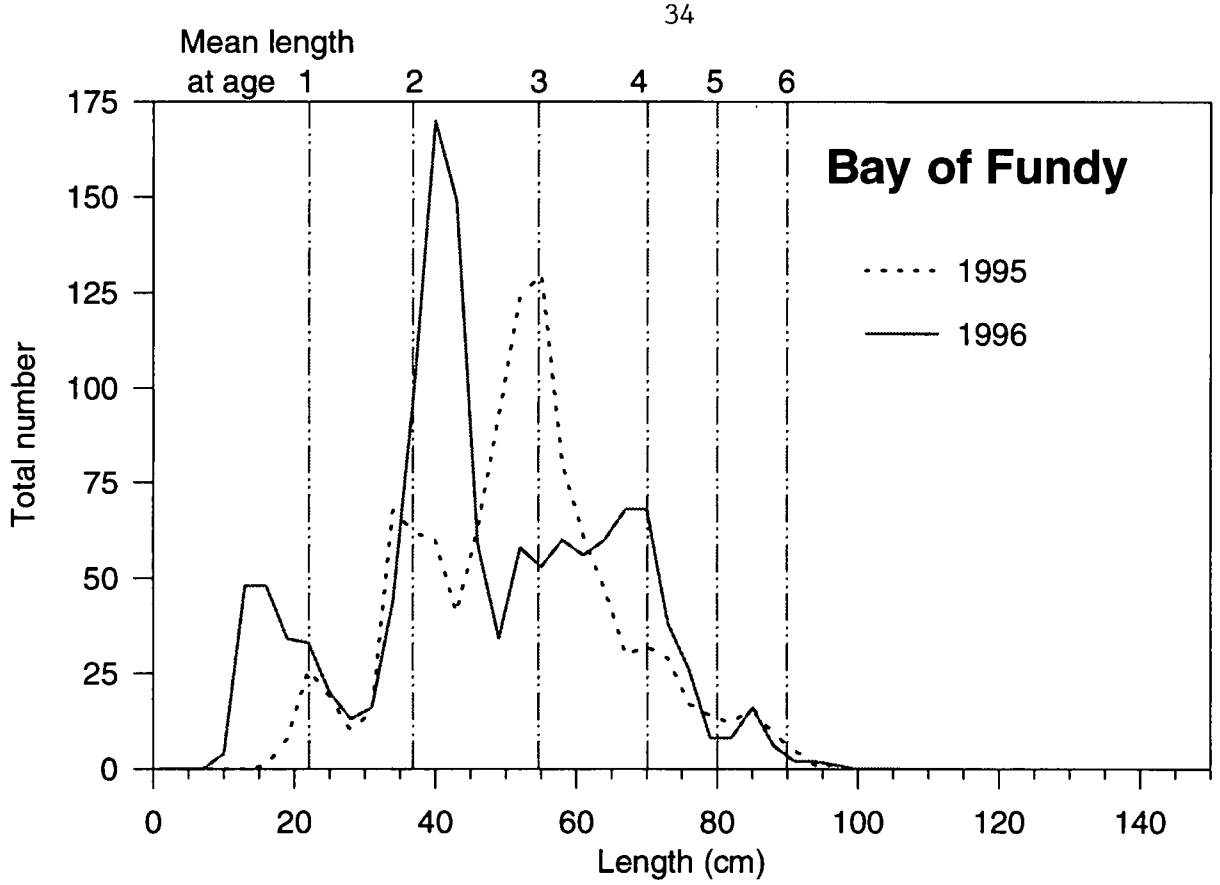


Fig.11 4X Cod from 1995/1996 ITQ Survey



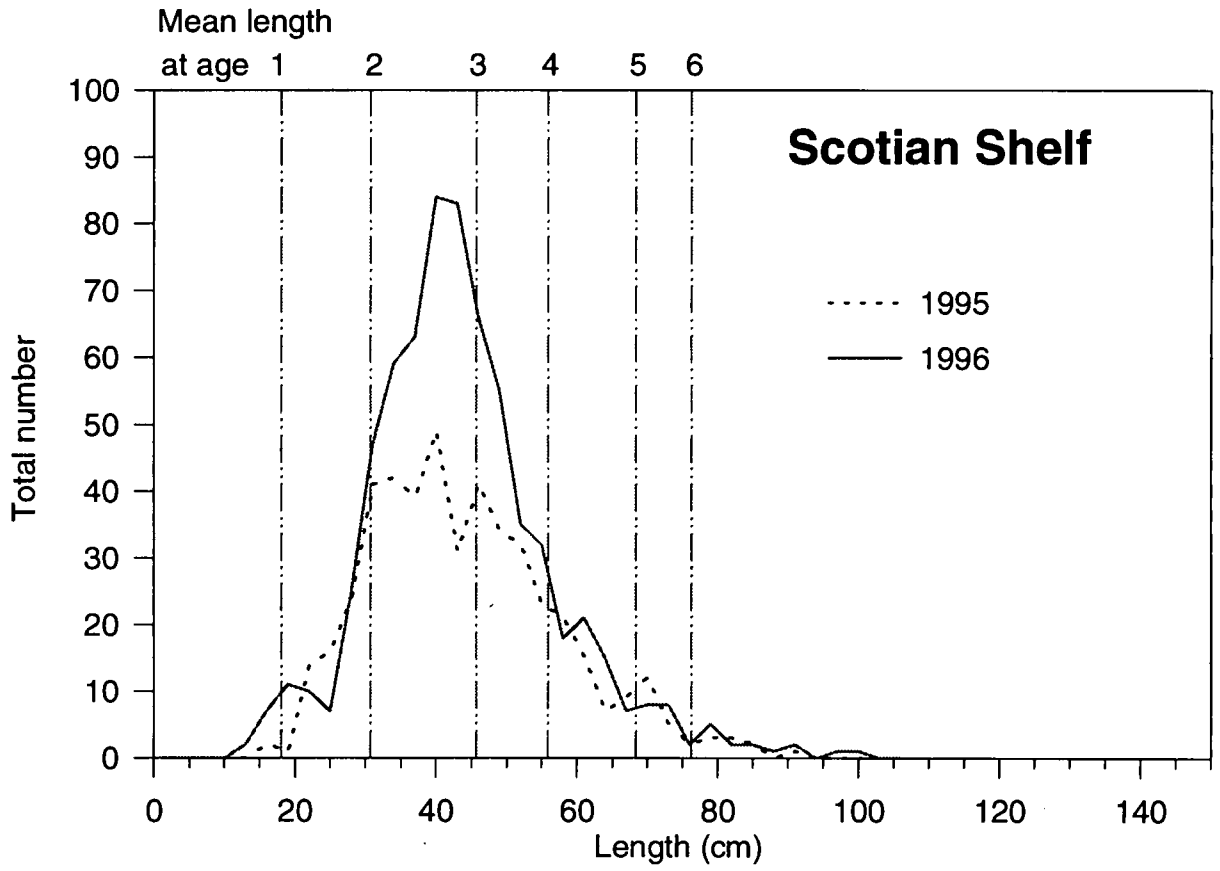
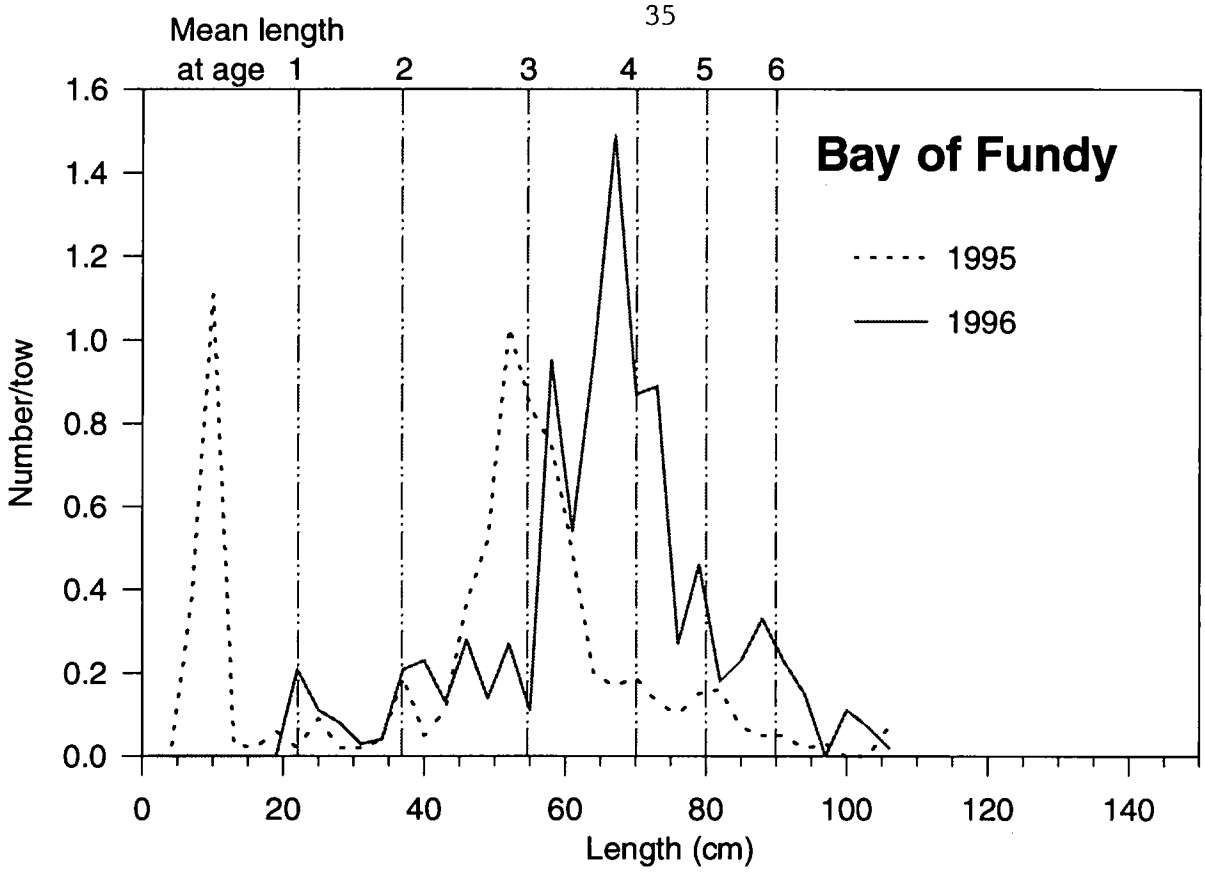


Fig 12. Length frequencies for cod from ITQ surveys in Division 4X.



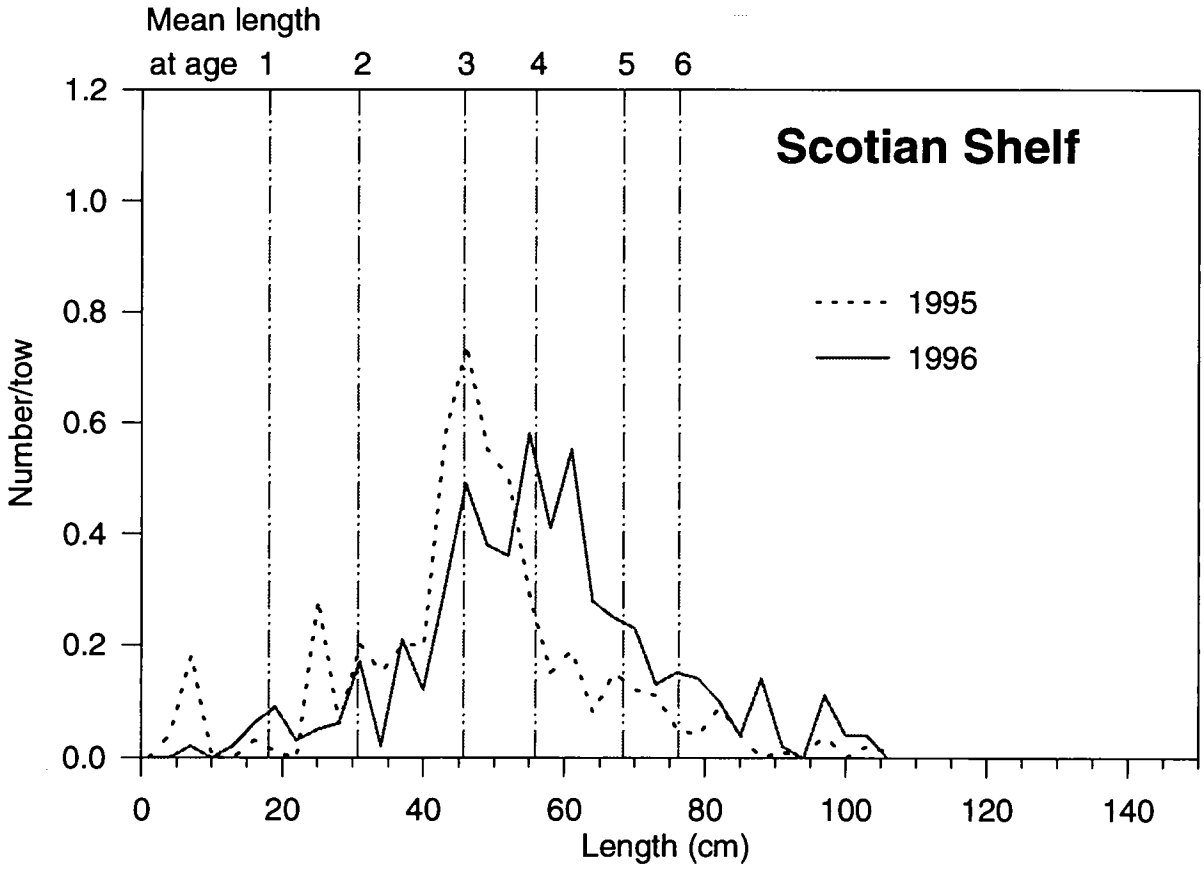


Fig 13. Length frequencies from summer RV groundfish surveys in Division 4X.

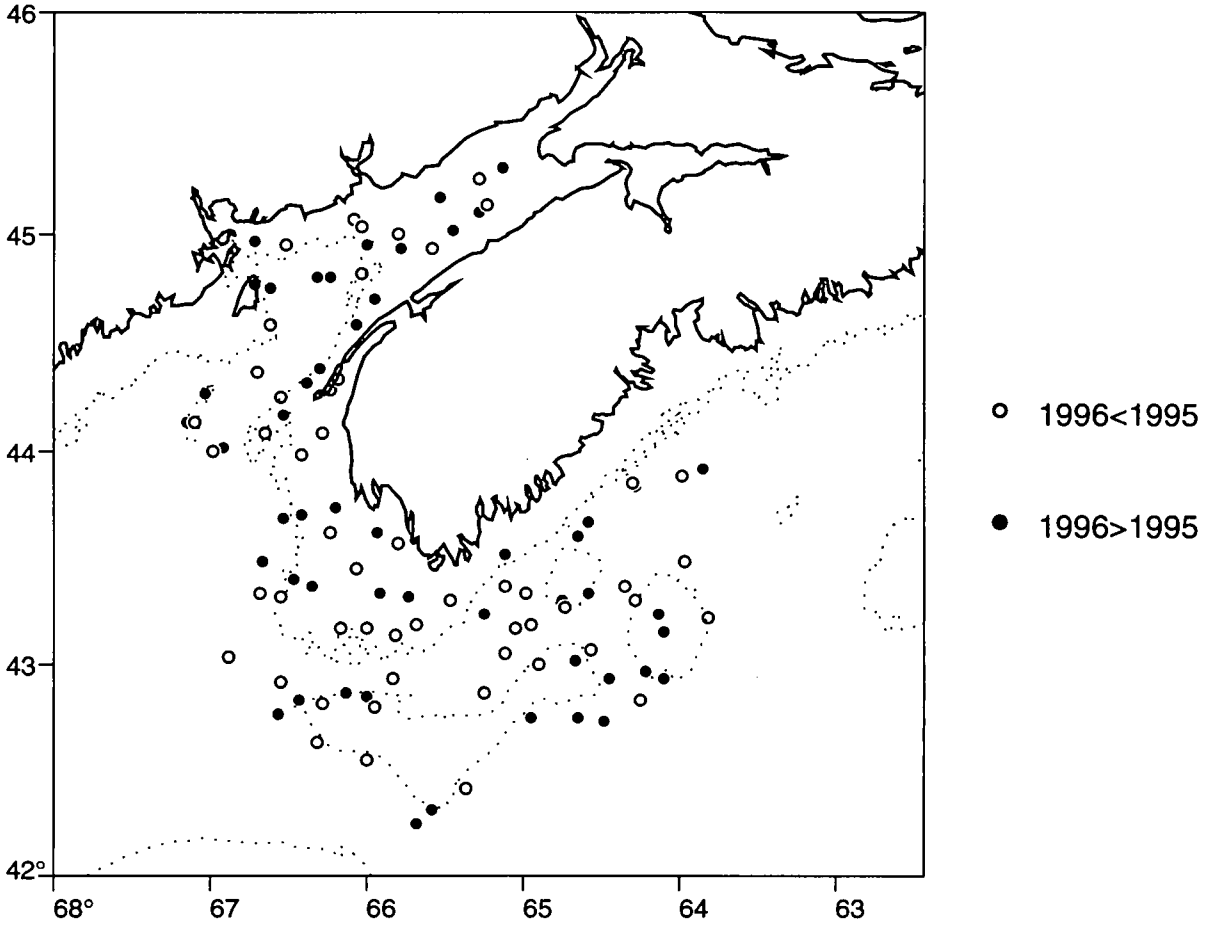


Fig. 14. Comparison of ITQ survey cod catches at repeated stations.

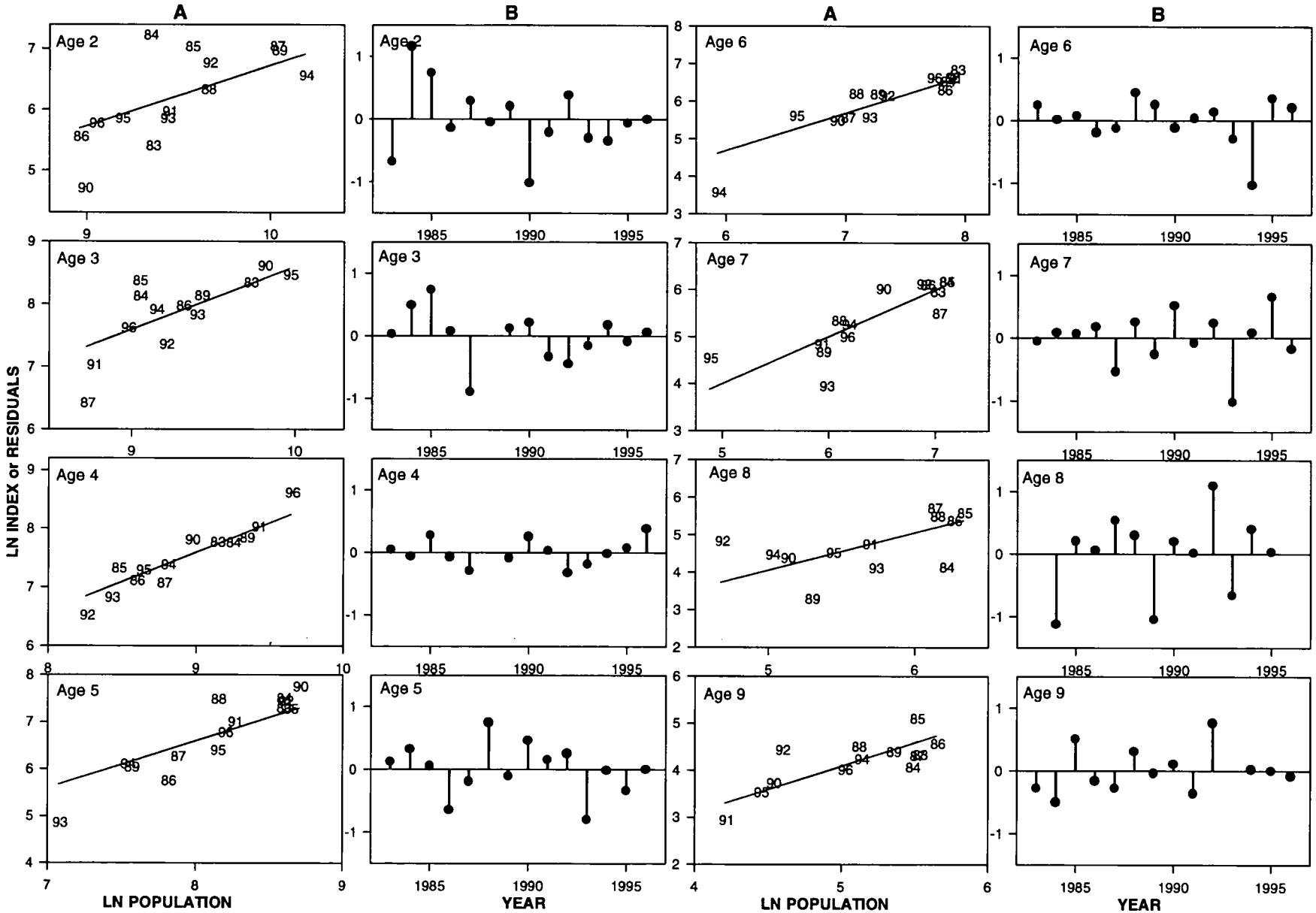


Fig. 15a. Age by age plots of A) the observed and predicted ln abundance index versus ln population numbers, and B) residuals plotted against year for cod in Division 4X and the Canadian portion of 5Y (1996 survey index version 'a' used in assessment).

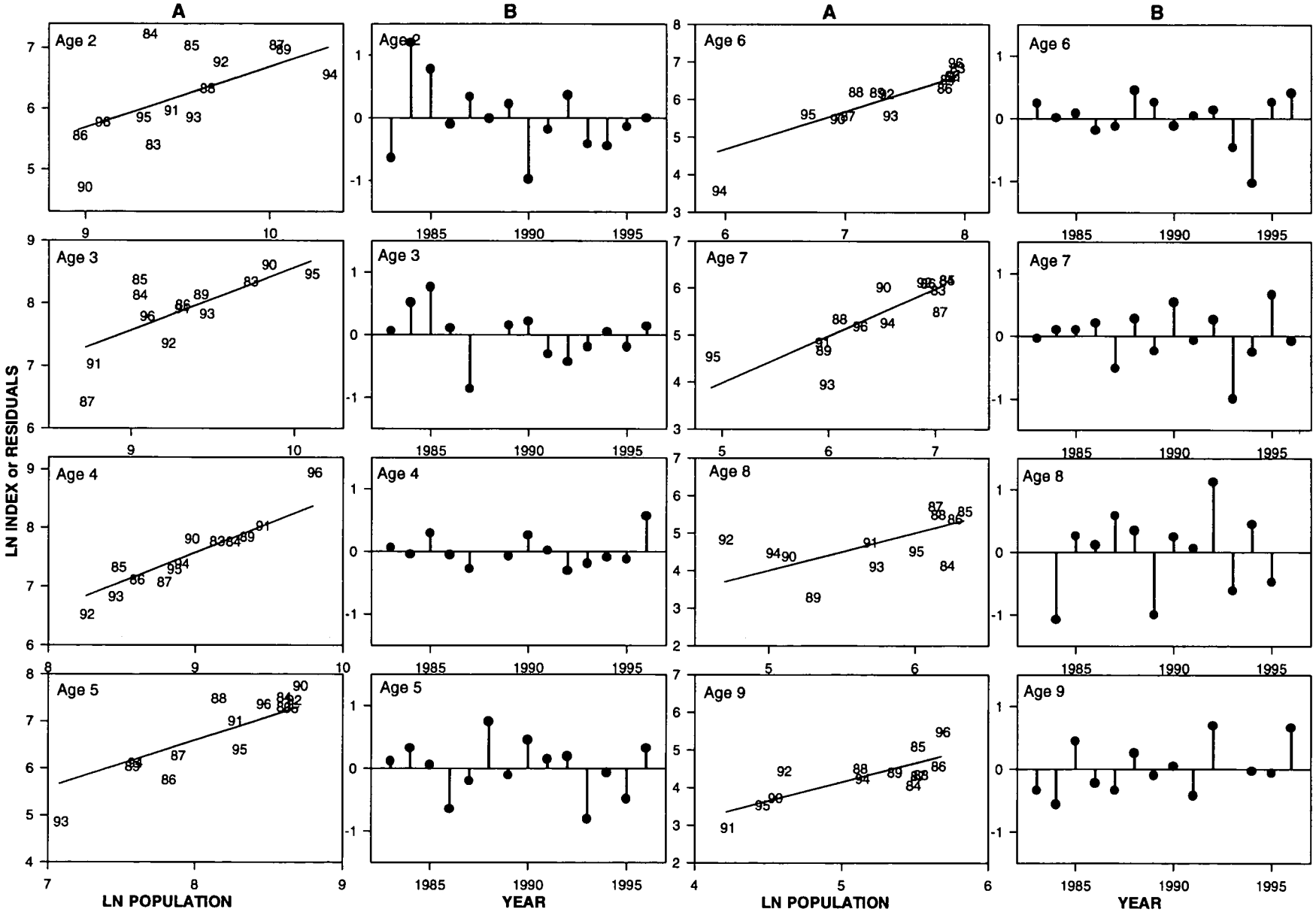


Fig. 15b. Age by age plots of A) the observed and predicted ln abundance index versus ln population numbers, and B) residuals plotted against year for cod in unit area 4X and the Canadian portion of 5Y (1996 survey index version 'b' used in assessment).

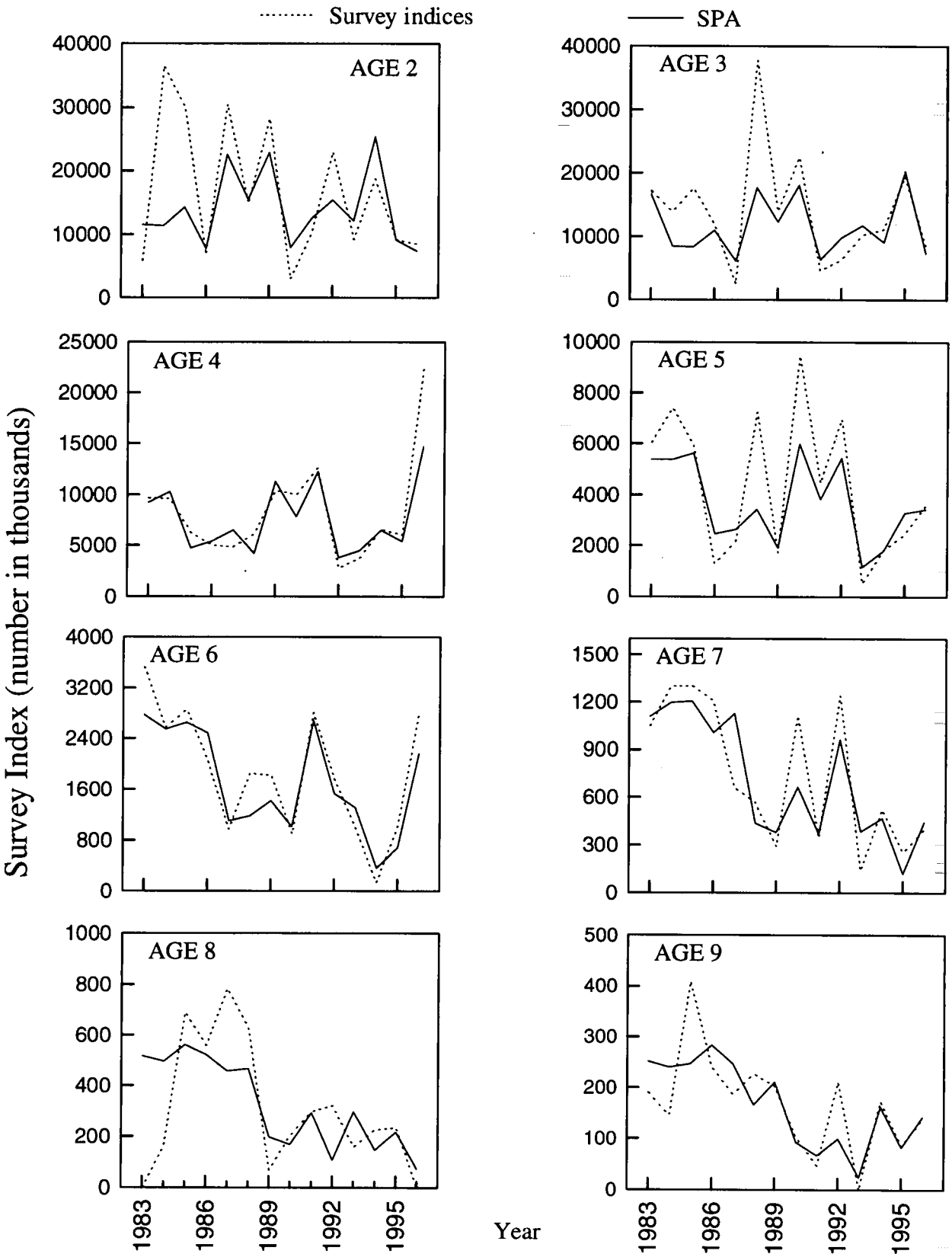


Figure 16. Mid-year population numbers from sequential population analysis (SPA) and research survey indices (adjusted by calibration constants) for cod in Division 4X.

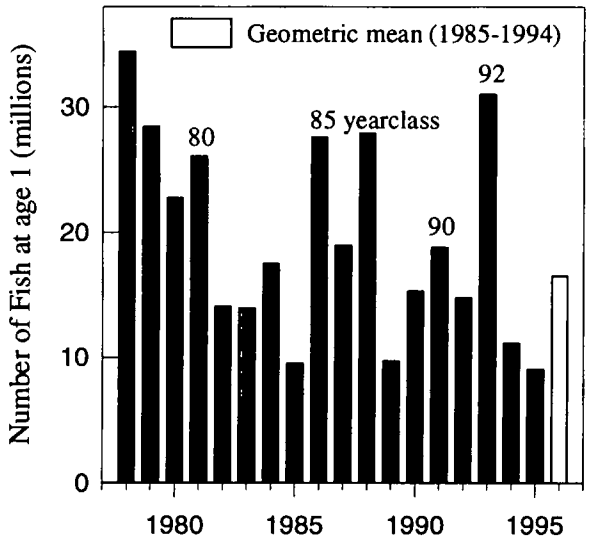


Fig. 17. Recruitment (age 1) for cod in Division 4X.

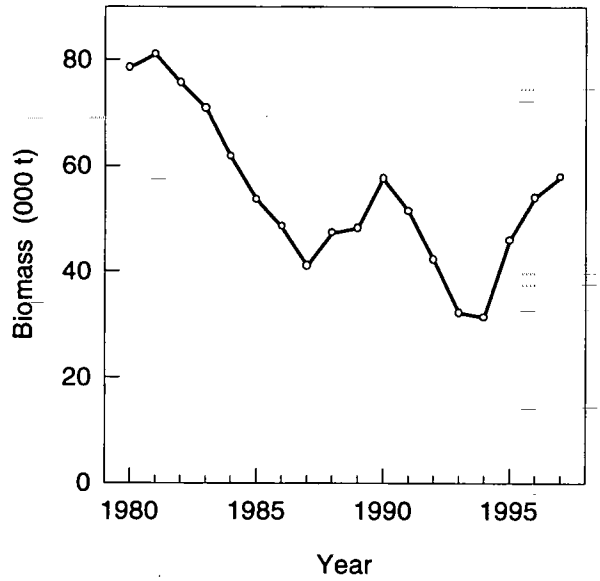


Fig. 18. Beginning of year biomass (3+) for cod in in Division 4X.

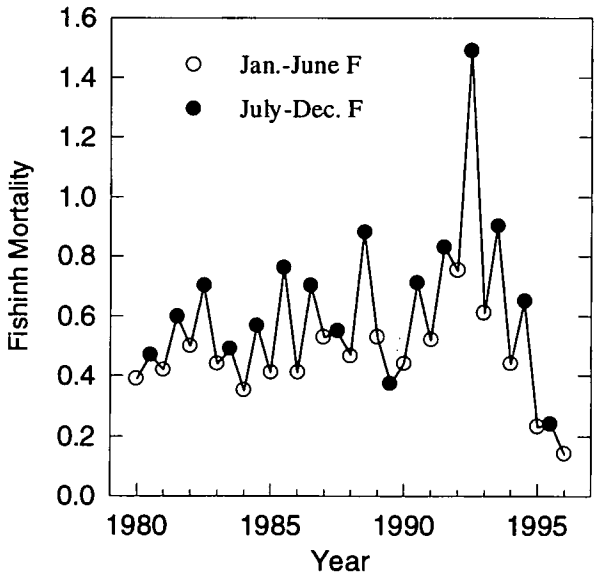


Fig. 19. Fishing mortality (4+) for cod in Division 4X.

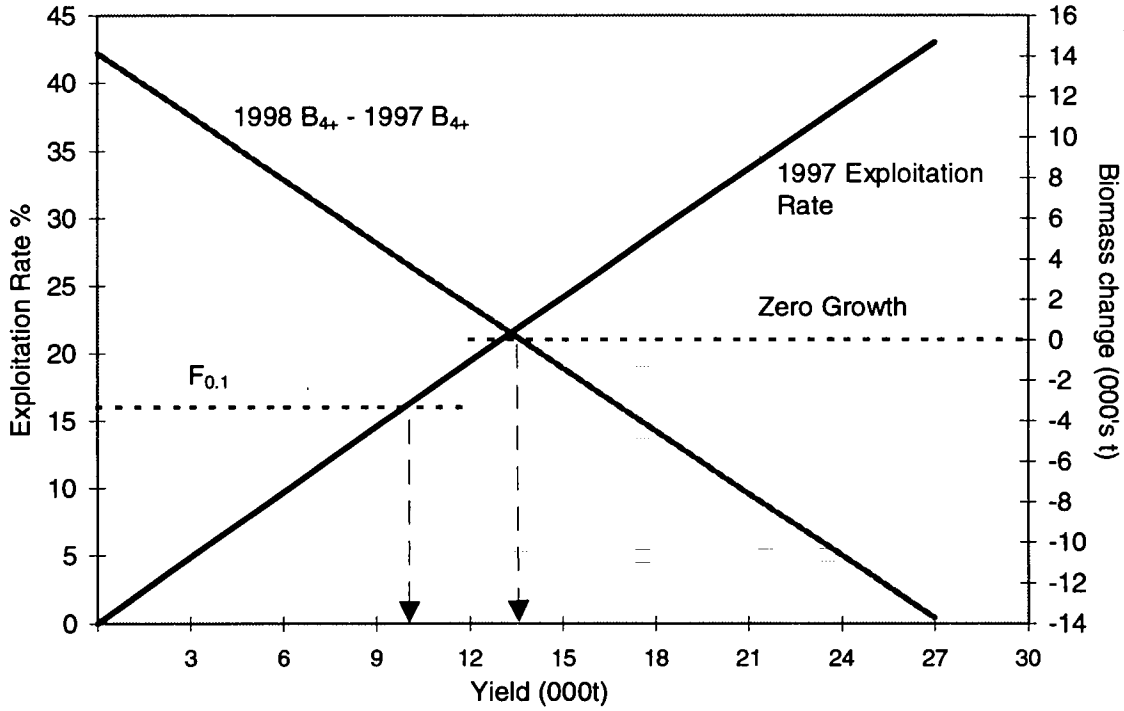


Figure 20. Projected 4X cod yield in 1997 and beginning of year biomass (age 4+) in 1998.

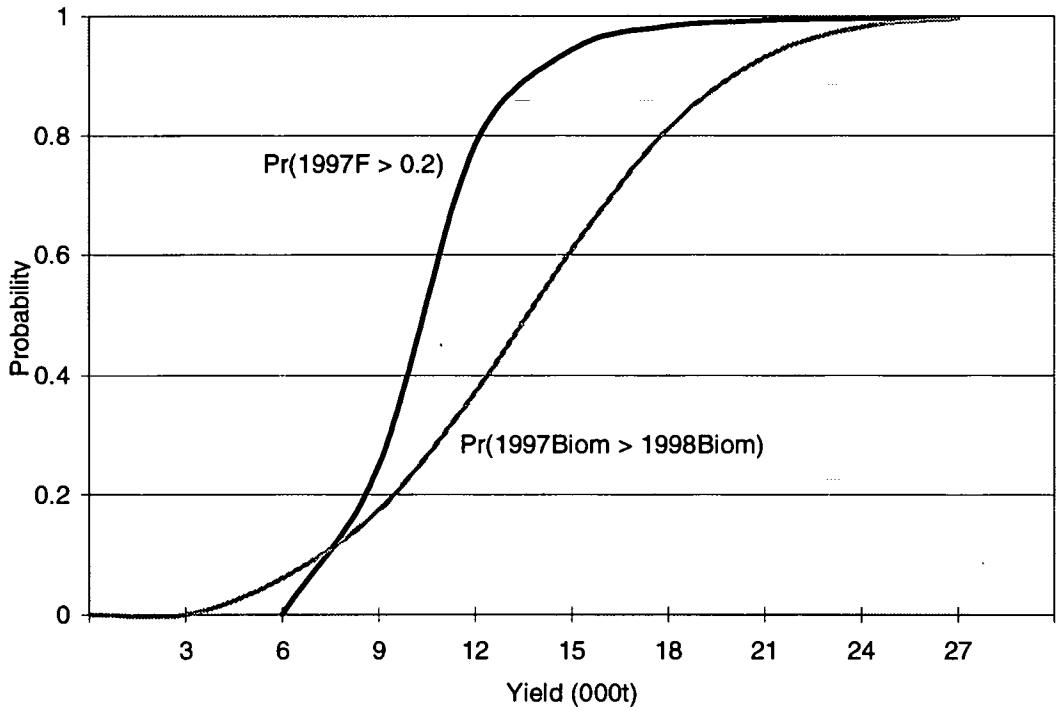


Fig. 21. Influence of yield for 4X cod in 1997 on the probability of exceeding $F_{0.1}$ and of ages 4+ biomass increasing.

Appendix I. Comparison of ITQ survey results for 4X cod in 1995 and 1996.

Block #		1995	Catch		1996	Catch		Log values			
	Vessel	setno	weight	number	setno	weight	number	wt95	wt96	num95	num96
2	Little T. J.	22	4	8	39	19	26	0.70	1.30	0.95	1.43
3	Little T. J.	21	37	11	43	4	1	1.58	0.70	1.08	0.30
4	Little T. J.	4	63	20	46	37	12	1.81	1.58	1.32	1.11
5	Little T. J.	3	91	36	45	43	21	1.96	1.64	1.57	1.34
6	Little T. J.	15	85	46	47	60	33	1.93	1.79	1.67	1.53
7	Little T. J.	6	16	7	48	19	6	1.23	1.30	0.90	0.85
8	Little T. J.	7	0	0	49	2	5	0.00	0.48	0.00	0.78
9	Little T. J.	8	7	4	50	5	17	0.90	0.78	0.70	1.26
10	Little T. J.	9	0	0	51	13	32	0.00	1.15	0.00	1.52
18	Little T. J.	10	0	0	52	1	54	0.00	0.30	0.00	1.74
19	Little T. J.	11	30	18	53	25	10	1.49	1.41	1.28	1.04
20	Little T. J.	12	13	8	54	23	9	1.15	1.38	0.95	1.00
21	Little T. J.	13	3	2	55	18	7	0.60	1.28	0.48	0.90
22	Little T. J.	14	50	21	56	92	40	1.71	1.97	1.34	1.61
23	Little T. J.	16	25	15	57	107	43	1.41	2.03	1.20	1.64
24	Little T. J.	17	28	16	44	37	21	1.46	1.58	1.23	1.34
25	Little T. J.	18	15	5	58	126	38	1.20	2.10	0.78	1.59
26	Little T. J.	24	51	13	41	135	19	1.72	2.13	1.15	1.30
27	Little T. J.	23	4	6	40	12	5	0.70	1.11	0.85	0.78
31	Little T. J.	25	1923	2668	42	441	251	3.28	2.65	3.43	2.40
32	Little T. J.	19	7	3	59	38	15	0.90	1.59	0.60	1.20
33	Little T. J.	28	24	14	62	8	9	1.40	0.95	1.18	1.00
34	Little T. J.	20	65	39	60	314	277	1.82	2.50	1.60	2.44
35	Little T. J.	29	78	30	61	123	50	1.90	2.09	1.49	1.71
36	Little T. J.	26	90	63	25	90	40	1.96	1.96	1.81	1.61
37	Little T. J.	27	20	19	24	80	16	1.32	1.91	1.30	1.23
38	Little T. J.	35	229	181	27	7	4	2.36	0.90	2.26	0.70
39	Little T. J.	34	24	8	37	32	14	1.40	1.52	0.95	1.18
40	Little T. J.	33	0	0	36	64	21	0.00	1.81	0.00	1.34
41	Little T. J.	32	24	26	35	250	263	1.40	2.40	1.43	2.42
42	Little T. J.	31	140	89	34	132	67	2.15	2.12	1.95	1.83
43	Little T. J.	30	266	113	33	59	33	2.43	1.78	2.06	1.53
44	Little T. J.	1	27	18	31	32	9	1.45	1.52	1.28	1.00
45	Little T. J.	36	9	10	28	6	8	1.00	0.85	1.04	0.95
46	Little T. J.	40	186	213	29	1	1	2.27	0.30	2.33	0.30
47	Little T. J.	39	17	10	22	6	4	1.26	0.85	1.04	0.70
48	Little T. J.	38	205	140	21	12	6	2.31	1.11	2.15	0.85
49	Little T. J.	37	17	8	23	16	6	1.26	1.23	0.95	0.85
50	Little T. J.	2	25	11	32	14	5	1.41	1.18	1.08	0.78
Mean	Little T. J.		99.95	99.974		64.18	38.41	1.41	1.47	1.22	1.26
Median	Little T. J.		25	14		32	16				
Block #	Vessel	setno	weight	number	setno	weight	number	wt95	wt96	num95	num96
57	Carmelle	8	1	2	8	2	2	0.30	0.48	0.48	0.48
58	Carmelle	30	0	0	42	1	3	0.00	0.30	0.00	0.60
59	Carmelle	31	4	7	43	0	0	0.70	0.00	0.90	0.00
60	Carmelle	11	0	0	41	0	0	0.00	0.00	0.00	0.00

61	Carmelle	12	26	7	7	71	15	1.43	1.86	0.90	1.20
62	Carmelle	13	3	3	6	27	9	0.60	1.45	0.60	1.00
70	Carmelle	17	46	13	1	70	24	1.67	1.85	1.15	1.40
71	Carmelle	24	19	15	5	23	1	1.30	1.38	1.20	0.30
72	Carmelle	25	27	13	9	41	20	1.45	1.62	1.15	1.32
73	Carmelle	29	2	4	44	1	5	0.48	0.30	0.70	0.78
74	Carmelle	32	1	7	45	14	9	0.30	1.18	0.90	1.00
75	Carmelle	43	1	1	55	8	7	0.30	0.95	0.30	0.90
76	Carmelle	49	30	31	54	24	26	1.49	1.40	1.51	1.43
77	Carmelle	48	108	102	46	56	76	2.04	1.76	2.01	1.89
78	Carmelle	28	112	55	11	66	44	2.05	1.83	1.75	1.65
79	Carmelle	27	113	97	10	72	69	2.06	1.86	1.99	1.85
80	Carmelle	23	55	45	4	7	2	1.75	0.90	1.66	0.48
81	Carmelle	18	49	20	2	10	4	1.70	1.04	1.32	0.70
90	Carmelle	21	12	9	16	7	5	1.11	0.90	1.00	0.78
92	Carmelle	22	51	20	14	9	5	1.72	1.00	1.32	0.78
93	Carmelle	39	4	2	13	7	5	0.70	0.90	0.48	0.78
94	Carmelle	33	1	1	12	13	2	0.30	1.15	0.30	0.48
95	Carmelle	42	20	8	47	1	2	1.32	0.30	0.95	0.48
98	Carmelle	35	17	31	37	6	12	1.26	0.85	1.51	1.11
99	Carmelle	34	38	45	38	132	134	1.59	2.12	1.66	2.13
101	Carmelle	40	79	64	40	7	7	1.90	0.90	1.81	0.90
102	Carmelle	38	1	3	24	5	6	0.30	0.78	0.60	0.85
113	Carmelle	37	27	15	25	18	10	1.45	1.28	1.20	1.04
114	Carmelle	36	0	0	28	0	0	0.00	0.00	0.00	0.00
117	Carmelle	45	4	3	32	4	4	0.70	0.70	0.60	0.70
126	Carmelle	44	35	33	30	50	25	1.56	1.71	1.53	1.41
Mean	Carmelle		28.58	21.161		24.26	17.194	1.08	1.06	1.02	0.92
Median	Carmelle		19	9		9	6				

Block #	Vessel	setno	weight	number	setno	weight	number	wt95	wt96	num95	num96
129	S. & P	8	14	14	34	10	9	1.18	1.04	1.18	1.00
139	S & P	20	2	2	56			0.48	0.00	0.48	0.00
140	S & P	46	14	10	56	15	11	1.18	1.20	1.04	1.08
141	S & P	45	1	1	49	11	4	0.30	1.08	0.30	0.70
142	S & P	43	11	12	48	12	7	1.08	1.11	1.11	0.90
143	S & P	42	18	36	47	1	1	1.28	0.30	1.57	0.30
145	S & P	41	14	10	46	15	2	1.18	1.20	1.04	0.48
152	S & P	33	3	9	28	16	15	0.60	1.23	1.00	1.20
153	S & P	40	1	2	45	4	5	0.30	0.70	0.48	0.78
154	S & P	44	3	4	44	10	6	0.60	1.04	0.70	0.85
155	S & P	23	1	4	42	60	32	0.30	1.79	0.70	1.52
156	S & P	22	5	8	41	1	1	0.78	0.30	0.95	0.30
157	S & P	19	28	17	40	9	3	1.46	1.00	1.26	0.60
158	S & P	2	2	2	58	57	14	0.48	1.76	0.48	1.18
161	S & P	18	31	11	38	8	4	1.51	0.95	1.08	0.70
162	S & P	17	29	10	37	25	4	1.48	1.41	1.04	0.70
163	S & P	25	13	7	36	5	3	1.15	0.78	0.90	0.60
164	S & P	24	2	3	43	1	1	0.48	0.30	0.60	0.30
165	S & P	32	1	2	29	8	8	0.30	0.95	0.48	0.95
166	S & P	39	4	10	30	0	0	0.70	0.00	1.04	0.00