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Assessment of 4VsW cod to 2002.

Bilan de l'état du stock de morue de 4VsW en 2002.

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ABSTRACT

The last complete assessment of 4VsW cod included data to 1997. This assessment includes new information from 1998 to 2002 as well as a new treatment of research survey data. There has been no commercial fishery since 1993 however the cod stock has continued to decline. The lack of catch makes sequential population analysis relatively uninformative and the research survey data has been used as the primary source of information on recent trends. The July RV data has been adjusted to account for estimated catchability at length by the survey gear however it is apparent that the existing estimates are only partially effective in this regard.

The spring survey series was used to re-estimate the maturity schedule. The new estimates indicate that the age of 50% maturity has fallen to 3 years old. Mortality remains high in spite of the closed fishery and, while seals may be a factor for younger age groups, there is no clear explanation for the high adult mortality. The 1999 yearclass index is the largest since 1990 but is still below the long-term average. Since the closure of the fishery in 1993 the surplus production has averaged –2000 t/yr, i.e. the SSB has been declining steadily for 10 years without fishing. The population biomass has declined to very low levels and the SSB is currently estimated to be less than 5,000 t, a 97% decline from the peak in 1984. Biological reference points for spawning stock biomass limits were derived for three methods of stock size estimation. All three methods estimate the current SSB to be below the lowest applicable reference point value. The bottom line is that, in spite of 10 years with virtually no fishery and a return to normal environmental conditions, the cod in 4VsW are continuing to decline. There is no evidence that this will change any time soon.

RÉSUMÉ

La dernière évaluation détaillée de la morue de 4VsW incluait des données allant jusqu'à 1997. La présente évaluation inclut de nouveaux renseignements couvrant la période 1998-2000, ainsi qu'un nouveau traitement des données de relevés de recherche. Malgré que la pêche commerciale soit fermée depuis 1993, le stock a continué à décliner. L'absence de prises rendant l'analyse séquentielle de population relativement peu utile, les données de relevé de recherche ont été utilisées comme source principale de renseignements sur les tendances récentes. Les données issues des relevés de NR de juillet ont été rajustées afin de tenir compte du potentiel de capture estimé de la morue selon la longueur par l'engin de relevé; il semble toutefois évident que les estimations existantes ne sont que partiellement efficaces à cet égard.

On a utilisé la série de données de relevés de printemps pour faire une nouvelle estimation de la chronologie de la maturité. Selon cette estimation, l'âge à lequel 50 % des morues atteignent la maturité a chuté à 3 ans. Le taux de mortalité

demeure élevé malgré la fermeture de la pêche et, bien que la prédation exercée par les phoques puisse être un facteur dans le cas des groupes d'âge plus jeunes, on ne peut pas facilement l'expliquer dans le cas des adultes. L'indice d'abondance de la classe d'âge 1999 est le plus élevé depuis 1990, mais il reste inférieur à la moyenne à long terme. Depuis la fermeture de la pêche en 1993, la production excédentaire a atteint en moyenne – 2000 t/an, c'est-à-dire que la BSS a diminué progressivement au cours des dix dernières années malgré la fermeture de la pêche. La biomasse de la population a diminué et se situe à un niveau très bas, tandis que la BSS estimative se chiffre actuellement à moins de 5 000 t, ce qui représente une baisse de 97 % par rapport au pic observé en 1984.

On a établi les points de référence biologiques pour les limites de la BSS d'après trois méthodes d'estimation de la taille du stock. D'après celles-ci, la BSS actuelle se situe au-dessous de la plus faible valeur des points de référence applicables. Le résultat, c'est que malgré le fait que le stock n'a quasiment pas été pêché pendant 10 ans et que les conditions environnementales sont redevenues normales, le stock de morue de 4VsW continue à décliner. Rien n'indique que cette situation va changer dans un avenir rapproché.

Introduction

The most recent stock assessment of cod in NAFO Divs. 4VsW (Mohn *et al.* 1998) was completed in early 1998 and considered data up to the end of 1997. There have been annual updates provided in Stock Status Reports (SSR A3-35, DFO 1999 to DFO 2002).

Comprising the northeastern portion of the Scotian Shelf, 4VsW has traditionally been fished for cod by large offshore trawlers with smaller vessels taking less than 25% of the total catch. Reported landings during the period 1958 to 1992 ranged from 10,000 to 80,000 metric tonnes annually, averageing close to 50,000t. Due to the very depleted status of the stock the directed fishery for 4VsW cod was closed in September 1993 and has remained so since that time.

The removals since the closure have been taken as strictly regulated bycatch in other fisheries operating in the area or, since 1996, during the commercial index part of the 4VsW Sentinel Program. The reported landings (Table 1; Figure 1) from 1994 to 1999 averaged about 310t. but have been less than 160t in 2000-2002. Unlike the years when there was a directed fishery, half or more of the catch in each year since the closure has been taken by longliners (Table 2). This is primarily due to lack of quota for target species for mobile gear in 4VsW in recent years, i.e. the haddock fishery is closed and pollock are scarce in 4VsW.

Data

Catch at age

Construction of a catch at age has been hampered by a lack of commercial or observer samples (Table 3). Given that there is no directed fishery, cod landings are small, scattered and unpredictable. The complete catch at age, including 1970-1997 from (Mohn *et al.* 1998) is given in Table 4. The 4VsW catch at age was adjusted for the amount estimated to be from 4TVn cod in the years 1986-92 (Mohn and MacEachern 1993; Mohn and MacEachern 1994) however this has not been required in subsequent years due to the moratorium on cod fishing. The catch at age for 1998 to 2002 was constructed using all available samples in a single key for each year. While this is not ideal there is insufficient sampling to partition the age-length keys and the catches themselves are small (<200 t). As with the catch at age itself, the commercial mean weights at age (Table 5, Figure 2) are poorly estimated since the fishery moratorium in 1993. The weights had begun to increase slightly in the mid-1990's but have declined again at most ages and continue to be very low. Changes in the comercial weights at age are confounded with changes in the dominance of the gears catching the cod. Prior to the moratorium, trawlers accounted for 50-70% of the landings while since 1993 they have accounted for 10-40%. Also the change from a directed species to a bycatch species has altered the distribution and timing of the little catch there has been.

Seal Predation Removals

In the last assessment seal predation removals were treated as an additional source of mortality, by addition of the seal catch at age to the commercial catch at age. Seal predation removals of 4VsW cod, for the period 1970 to 1997, were estimated following the approach of (Mohn and Bowen 1996) Although three models of predation interaction were previously considered (Figure 3) only the one denoted 'constrained', which was used as the basis of the previous assessment, is used here.

The potential impact of seal predation is considered here based on the same population growth and total consumption assumptions as in the previous assessment. There is no indication that the growth of the grey seal population has changed from the 11% *per annum* used in the last assessment and thus the total food consumption by grey seals is now estimated to be about 310,000t. in 2002. The proportion of cod in the seal diet has been re-estimated for recent years based on Quantitative Fatty Acid Signature Analysis (QFASA) (Iverson *et al.* (in review)). Lipids in

marine organisms are characterized by their diversity (> 60 types) of fatty acids which originate in various unicellular phytoplankton and seaweeds. Unlike proteins that are readily broken down during digestion, dietary fatty acids pass into the circulation intact and deposited in animal tissue with little modification. The pattern of prey fatty acids can be thought of as a prey signature that is deposited within the blubber of marine mammals in a predictable way. Fatty acids stored in blubber represent the integration of feeding over periods of weeks to perhaps months depending on the rate and degree of lipid storage. This means that the diets determined from fatty acids should not be biased by where the samples are collected. Quantitative fatty acid signature analysis (QFASA) determines the diet by comparing the fatty acids in potential prey with that found in a small sample of the seal's blubber. This comparison is done with a computer program that selects the mixture of different prey that most closely matches the pattern of fatty acids found in the seal's blubber. Research is underway to estimate the diets of over 450 grey seals sampled between 1993 and 2000. Preliminary results indicate that capelin and sandlance are dominant prey in the diets. Cod is occurring at only trace levels on average i.e. less than 1% (W.D. Bowen, pers. comm.) suggesting that the proportion of cod in grey seal diets, based on faecal samples from Sable Island, was too high for the population as a whole. Thus for the period since 1993 the proportion of cod in the seal diet is estimated at or below 1%. This is considerably less than the 2.5-4% estimated for the period 1993-1997 in the last assessment ('constrained model' in Mohn *et al.*, 1998). Assuming a constant 1% cod in the seal diet since 1993 results in an estimate of 3100t of cod consumed by grey seals in 2002 (Table 6, Figure 3).

The QFASA technique does not provide age composition estimates comparable to those obtained from analysis of fish otoliths and other hard parts in the seal diet (Table 6). Based on the cod size/age composition information from the otoliths ages 1 and 2 make up over 50% by weight (90% by numbers) of cod in the seals diet although ages up to 8 are included.

Survey Indices of Abundance

There are now three useful indices of abundance for this stock (Figure 4). The July RV series runs from 1970 to 2002 without exception (Table 7). The March RV series runs from 1979 to 2002 however several years were missed (Table 8). The newest survey series is the 4VsW Sentinel Survey which has been conducted in Sept.-Oct. for 1995-2002 (Table 9). All three surveys use stratified random survey designs although there are some differences in the stratification schemes employed. The 2002 values of the three indices of abundance are the lowest (March RV and Sentinel) or second lowest (July RV) values in their respective time series.

For a number of years the assessments of this stock have applied a conversion factor to the July RV results for the AT Cameron survey series (1970-1981) and Lady Hammond (1982) to adjust them to the Alfred Needler equivalents. This factor was estimated based on the idea of allowing a step to occur in the survey catchability estimates in the ADAPT model formulation. Research on this approach (Mohn 1999) clearly identified a break in the series in 1982, consistent with the first vessel change (AT Cameron to Lady Hammond). This approach estimates the conversion factor to be 1.70 and this was used in this assessment. This estimate is close to the swept volume ratio of the two gears used (1.90) but is is quite different from the 0.8 obtained in the comparative fishing experiment (Fanning 1985). No conversions are required for the March RV or Sentinel surveys.

The 4VsW Sentinel Survey has been conducted by commercial longliners in Sept.-Oct. each year since 1995. The set locations are randomly generated, using the summer RV stratification scheme. Three additional strata are surveyed between the inshore limit of the RV strata (~50 fm contour) and approximately the 19 m (10 fm) contour. Each set consists of 1500 hooks (all #12 circle hooks, baited with frozen mackerel) fished inside a 3 nautical mile circle centered on the selected point. Stratified estimates of mean catch per set and size composition are available.

The trawl survey data are generally used only to produce relative indices of abundance as the absolute catchability, even for a species as well studied as cod, is not well estimated. Research vessel survey results can be used to estimate population totals (Table 10a) however these are

underestimates sometimes refered to as 'trawlable' numbers at age. When population dynamic models are fitted they usually include estimating the age-specific coefficients of catchability (*q's*) applicable to the single stock in question. A meta-analysis of 47 stock assessment estimates of *q*-at-age (Harley *et al.* 2001; Harley and Myers 2001) has been used to estimate several synthetic length-specific catchability (*q*-at-length) curves appropriate to different body forms and seasons. The curves were estimated based on *q*-at-length implied by the reported estimates of *q*- at-age. The 'Summer/Fall Cod' curve (Figure 5) has been applied to the July RV stratified total length compositions and then converted to age compositions using the regular annual survey age-length keys. The resulting *q*-corrected survey total numbers at age (Table 10b) are a reasonable proxy for total population estimates. Conversion to *q*-at-length ensures that changes in growth, which may alter *q* -at-age, are accounted properly. Comparison of trawlable and *q*-corrected estimates (Figure 6) shows that the q-corrected numbers are about double the trawlable estimates. The notable exceptions are in 1983, 1992 and 1999-2001. In these cases there were large catches of ages 0 and/or 1 which have very low catchability and large influence on the *q*-adjusted estimates. The exception is the high value in 2001 which is driven by 2 year olds.

Survey Distribution

Maps of the spatial distribution of survey catches are aggregated in 15' squares. Years are grouped in 5 year blocks for the July RV (Figure 7), 5 or 4 year blocks for the March RV (Figure 8) and 4 year blocks for the September Sentinel (Figure 9). The year blocks were selected to be as consistent as possible given the differences in the data series. It was previously documented that the cod distribution had contracted prior to the moratorium. In the July survey what is apparent now is that there has been a further contraction, as well as depletion, in the years since the moratorium (Figure 7, bottom 2 panels). The March survey shows the same general pattern (Figure 8, bottom 2 panels cf upper panels). The Sentinel survey only began in 1995, during the moratorium, but even in it there is an apparent contraction of the cod distribution (Figure 9).

There are several statistics proposed as indices of spatial distribution. These include the stratified area occupied as a measure of prevalence, and the stratified mean of the non-zero catches as a measure of local density (Figure 10). These statistics require careful interpretation but have been used in a number of RAP SSR's (e.g. DFO 2002) as indices of spatial extent. Prevalence is the likelihood of encountering cod at all on a given set. The stratified area occupied index sums over all strata the stratum area weighted by the prevalence of cod in the stratum. Local density is indicative of the size of individual cod aggregations where they occur. The mean of the non-zero catches is essentially the average local density. The July survey time series (Figure 10, left panel) indicates a period of stability up to the mid-1980's followed by a slow decline to the early 1990's for both these indicators. There was an abrupt decline by 1993 and both indicators have varied but remained low since then. The March survey indicators (Figure 10, right panel) are consistent with the July except for the 2002 point for stratified area occupied which is near average in March but the lowest ever in July.

Survey Length, Weight and Condition

The growth and condition of fish differs between 4Vs and 4W. The mean length at age (Table 11, Figure 11) has varied over years as well as differing between divisions. Mean lengths were higher in the period from the mid-70's to the mid-80's and have generally declined since then. The difference in mean length between 4Vs and 4W has increased in recent years with 4Vs fish larger than those in 4W. This must be interpreted carefully as it comes from very small sample sizes in 4Vs. The bulk of the survey catches are taken in 4W (>85% of numbers since 1999) and those sizes are more representative of the population as a whole.

Mean lengths at age in recent years (2000-2002) show an interesting pattern with age. In 4W average lengths for ages 3 to 7 are 83-91% of the longterm mean while age 2 is about 95% and age 1 is above average. The same pattern holds in 4Vs although the mean lengths at age are all closer to the long-term means with age 2 is near average and age 1 is 15% above average.

Fish condition is estimated from survey length and weight data. Allometric parameters are estimated for each year over the range of available sizes for each division. Condition can be expressed as relative measure simply using the predicted weight at a fixed length (60 cm for 4VsW cod) over time. These numbers are hard to relate to the condition expressed in most laboratory studies as Fulton's K ($K=100*W/L^3$). For comparisons the predicted weights are converted to a comparable measure to Fulton's K (a pseudo-K) (Figure 12) by substituting the prediction length cubed (i.e. 60^3 cm). Overall condition has been improving in 4VsW since the mid-1990's, more so in 4W than 4Vs.

Mean weights at age (Table 12) are compared between a combined 4VsW estimate based on the stratified survey length frequencies (Table 12a) and q-corrected length frequencies by division (Table 12 b) in Figure 13. The difference in mean weights between the methods is generally minor although the q-corrected weights are used subsequently for consistency with the RV numbers.

Mean weights at age (Figure 14) show a similar pattern with age as the mean lengths. The youngest (age 1) recent average is equal to the long-term mean. At age 2 the mean weight is about 80% of the long-term mean. Ages 3 to 8 (with the exception of 6) all average about 65% of the long-term mean. Thus, although early ages appear to be experiencing average growth this falls off very quickly and reduced size at age continues to be a factor in this stock.

Maturity

Previous assessments (Mohn *et al.* 1998) have used biomass at ages 5+ as a proxy for the spawning stock biomass. The basis for this assumption is difficult to establish but it was used for a number of earlier assessments. It is consistent with earlier work (Fleming 1960) showed the age of 50% maturity was in the range 5.5 to 7.5 for Newfoundland stocks in the period 1947-50. Also, in the Gulf of St. Lawrence there were no mature fish younger than 4 years observed based on sampling in 1955-56(Powles 1958). Estimates of age at 50% maturity in (Trippel *et al.* 1997)suggests mean age may have been about 4 in the late 1970's.

Age and length at maturity was estimated from March RV survey data available for most years from 1979 to 2002. Macroscopic maturity stages are assigned for the length stratified sample of fish being examined in detail. All the stages of gonad maturation other than 'immature' (excluding 'unknown') are included as mature in the analysis. Ogives fitted to the proportions mature at length in 5 year blocks (Figure 15) show a considerable reduction in the length at 50% mature. Annual estimates of the ogives are variable (Figure 16) showing a sharp drop in the length at 50% mature about 1994 in 4Vs while it is more gradual in 4W. In both cases, since 1995, the length at 50% maturity has been at or near the minimum observed.

The age at 50% maturity (Figure 16) was estimated by linear interpolation of the length of 50% maturity on the mean lengths at age. The change in age at 50% mature appears to have been less than for length, remaining variable but without trend up to about 1995. In both 4Vs and 4W the mean age at 50% maturity was about 3.5 years and dropped after 1995 to about 3.0. Although difficult to characterise the changes because of the high variability of annual estimates it appears to be more of a discontinuity in 1995 than a trend in age at maturity. Based on these estimates, three maturity ogives for estimating SSB will be used.

Maturity ogives for computing 4VsW cod SSB

	Ages 0-2	Age 3	Age 4	Age 5+
prior to 1979	0.0	0.0	0.5	1.0
1979-1994	0.0	0.25	0.75	1.0
after 1994	0.0	0.5	1.0	1.0

Stock Assessment

Spawning Stock and Recruitment

The use of *q*-correction scales the relative survey numbers to an underlying total population size to which the mean weights at age and maturity ogives can be applied to obtain a survey estimate of SSB (Table 13). The survey SSB and age 5+ biomass are compared to corresponding estimates of yearclass size (mean of q-corrected estimates of age 1 and 2) in Figure 17. The stock reproductive potential concept (Trippel E.A. 1999) suggests that first-time spawners, and small spawners in general, are likely to contribute disproportionately fewer viable larvae than would be expected based simply on biomass. The proportion of the SSB from repeat spawners in each year, based on the maturity schedule discussed above, has declined in the last two years to the lowest proportions on record (Figure 18, upper panel). In addition to spawning experience, stock reproductive potential considers spawner size. The proportion of age 5+ spawners in the SSB (Figure 18, lower panel) provides an index of larger, experienced spawners since by age 5 all, or at least the vast majority, are likely to be larger, repeat spawners. There has been a steady decline in the proportion of 5+ biomass in the SSB since about 1990 (with the sole exception of 2000). In 2002 it is the lowest in the time series at 16% while historically it was >50% and often about 75%. Currently the stock is more dependent on first-time and small spawners than it has ever been before.

The stock-recruit plot (Figure 19) highlights the recent yearclasses (1994-2000) since the moratorium which are all close to the origin, i.e. 0. The recruits/spawner (Figure 20) shows that several recent yearclasses have been at or above the average. The high recruitment productivity of the 1999 yeaclass does appear to be real as it has shown up strongly above average at ages 0 and 2. The recruitment productivity of the 1997 yearclass is questionable however as it comes from a single strong estimate at age 2 and corresponds to a very low estimate of SSB. In spite of the various caveats, it seems likely that at least one or more recent yearclasses have been more productive (i.e. higher R/SSB) than those from 1983 to 1996.

Survey Estimates of Total Mortality

Estimates of total mortality (Z) between ages along cohorts were computed on an annual basis (Table 14). The means of two age groups (ages 2-4 and age 5-8) are representative of the trends in the younger and older parts of the stock respectively (Figure 21). The Z's appear to have been increasing more or less continuously since the mid-1980's (ages 5-8) or late 1980's (ages 2-4). Although the younger group would not likely have been targetted in the fishery, the older group was the main part of the catch. In spite of that, neither age group shows a noticeable decrease in Z with the closure of the fishery in late 1993.

The Z since 1993 can be taken as an estimate of natural mortality (M) as the fishery catches have been negligible and indeed F is almost inestimable with SPA. The M (=Z) on the older ages has been about 1.0 and increasing. Although Z on the younger age group is lower, about 0.5, it is an underestimate due to changing catchability with age (see below) and is also increasing.

Mean Z at age over years (below) suggest that the *q*-correction applied is insuffficient for the younger ages. The first time periods correspond to the years of AT Cameron surveys. The remaining two periods are both A Needler. The period 1983-92 was prior to the moratorium while the final period is since then. The apparent 'dome' in the Z's probably corresponds to a residual increase in *q* with age despite the corrections. This is consistent with the fact that the almost all *q*'s at age used in the original meta-analysis were estimated with an assumption of constant M at all ages (and in many cases M=0.2). This has little effect on estimates of spawning stock or fishable stock however it has a significant effect on estimates of recruitment and mortality at younger ages. These effects would exist in the original assessments and are simply re-expressed here.

	Age									
Z's over years	1	2	3	4	5	6	7	8	9	10
Mean 1970-1981	-0.718	0.103	0.505	0.663	0.864	0.765	0.808	0.883	0.562	0.614
Mean 1983-1992	-0.540	0.214	0.462	0.615	0.813	0.826	1.042	1.161	1.479	0.296
Mean 1993-2001	-0.921	0.055	0.817	1.263	1.671	1.080	1.171	1.845		

Relative F

The relative fishing mortality is computed as the ratio of the catch numbers at age over the q-corrected July RV numbers at age (Figure 22). If the RV q-corrections were completely accurate these mortality estimates would be absolute estimates of fishing mortality although still affected by the high variability in the RV estimates. Given the bias in the q-corrections noted above the estimates for the younger age group are overestimates of the actual F.

Surplus Production

Surplus production, that available to harvest, is estimated from the change in biomass between years plus the catch in the given year. Following the approach of Mohn and Simon (2002) for 4TVW haddock, the surplus production is calculated for 4VsW cod in the years since 1990 (Figure 23). In addition to surplus production from the *q*-corrected survey biomass estimates reported above (length-corrected in Fig 23), two other estimates have been made. In both cases, adjustments for RV catchability are made using age-specific *q*'s estimated from two recent assessment models (MFM and FMF in Fig 23, see section on comparison with other studies below). The surplus production estimates from all estimates have agreed quite closely. After the closure of the fishery in 1993 the surplus production has averaged –2000 t/yr, i.e. the SSB has been declining steadily for 10 years without fishing.

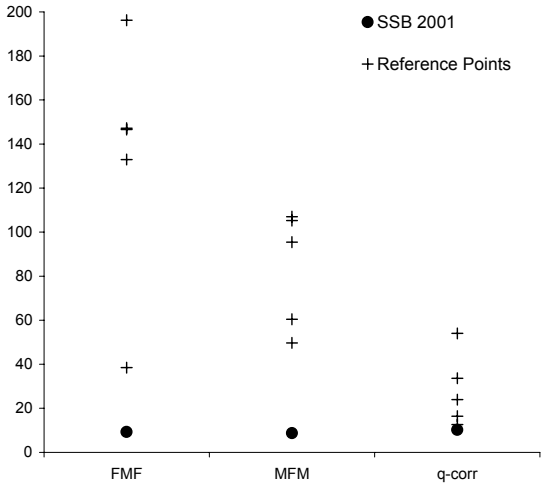
Reference Points

DFO recently completed a workshop to set biological reference points for gadoid species (Rivard and Rice, 2002). The five reference points for SSB identified were:

- $B_{recover}$, the lowest biomass from which the stock has recovered readily (bmin);
- NP_{50}, the SSB corresponding to 50% of the maximum recruitment predicted by a non-parametric S-R curve (np50);
- RK_{50} the SSB (left-hand limb) corresponding to 50% of the maximum value of a Ricker curve (rk50);
- BH_{50}, the SSB corresponding to the recruitment at 50% of the asymptotic value of a Beverton-Holt curve (bh50);
- $Sb_{50/90}$ (Serabrykov) which is the intersection of the 50^{th} percentile of the recruitment and the replacement line above 90% of the S-R points (ser9050);

The stock-recruit information is available from the q-corrected RV data in this assessment as well as from two recent assessment models (MFM and FMF in Fig 24, see section on comparison with other studies below). The five reference points were compared for each source of assessment data (text table and figure below). The ranges varied widely, both within and between data sources, from 13kt to 196kt. For all three data sources the current SSB is below the lowest reference point value (Ser9050 in each case).

	FMF	MFM	q-corr
SSB in 2001	9.34	8.7	10.22
Bmin	132.93	60.44	16.42
Ser9050	38.43	49.72	12.59
np50	196.23	95.45	53.99
bh50	146.55	105.26	33.67
rk50	147.16	106.98	23.94



Comparison with Other Studies

The previous assessment of this stock (Mohn *et al.* 1998) (refered to as MFM) included SPA estimates of SSB, recruitment and F. There was also an alternative model formulation published (Fu *et al.* 2001)(referred to as FMF) which included the same basic estimates but also included age-structured estimates of natural mortality. The results from these two assessments are compared with the corresponding results in this assessment.

Spawning Stock Biomass

The SSB trajectories (Figure 25) differ substantially in the historical part of each series although all are in agreement that since 1993 the SSB has been at or near the lowest values in the respective series. The SSB was calculated from the *q*-corrected RV population biomass under two maturity schedules, the new maturities presented in this assessment and the previous assumption of age 5+ biomass as a proxy. This allows comparison with the MFM and FMF under the same maturity assumption. There is an important difference in the current assessment which indicates that the SSB began to decline several years earlier than the MFM or FMF models.

Fishing Mortality

Fishing mortality is compared between the current assessment and the same two earlier models (Figure 26). Comparisons over ages 5-7 (primary ages in the fishery) shows good agreement between the three assessments although the RV relative F shows a spikier pattern. The differences are largest in the early 1970's, a period for which the catch data has been questioned in the past. When the F's over ages 5+ are considered there is a large discrepancy between the RV relative F estimates and the other two assessments. The relative F shows a very high mortality, presumably on ages greater than 7, in the late 1980's. This corresponds to the period of discrepancy between MFM and FMF assessments and this assessment in SSB as well.

Stock-Recruit

The three different stock recruit datasets are plotted in Figure 27. The distribution of points is quite different in each case although the range of values is similar and all agree that current values are near the origin.

The three methods of estimating the stock status parameters have several significant points of disagreement about the history of the stock however they are very consistent regarding the current status. The SSB has declined steadily since the late 1980's. The SSB is at or near the lowest value in the time series and has been so for more than 5 years. Recent fishing mortality has been very low, probably too low to estimate, since the closure of the fisheries in 1993. As a result, whatever

role fishing played in creating the collapse of this stock, the continued decline of 4VsW cod since 1994 is not a direct effect of fishing. Finally, the stock-recruit data for recent years are all concentrated near the origin with no appearance of compensatory recruitment.

Synopsis of the decline and collapse of 4VsW cod.

By the late 1980's and early 1990's the cod stock in 4VsW was severely depleted by more than 20 years of almost continuous overfishing. The fishing mortality due to the reported catches likely significantly under-estimates the total mortality from fishing, especially on younger ages i.e. those of little or no commercial value. At the same time the natural (predation) mortality, also concentrated on the younger ages, may have been increasing as the grey seal population became larger.

Another factor which existed in the area was an extended period of below normal water temperatures from 1986 to 1999 (Drinkwater et al. 2002). Low temperature may have caused decreased egg and larval survival by a variety of mechanisms. It may also have responsible for observed reduction in the physiological condition of the spawners. Low condition may in turn either reduce spawning success or induce post-spawning mortality.

Yearclasses since the early 1980's, with few exceptions, have been below average to negligible in abundance to begin with and have been subject to increasing mortality rates over time. As the poor yearclasses reached the ages at the core of the fishery catch (e.g. ages 4-7) the fishery had to fish harder and take a greater fraction of older fish than they had before in an effort to take their quotas. These effects were exacerbated by the reductions in condition and growth observed after the mid-1980's. As a result the biomass of large, older cod was severely depleted and is now lower than ever before and still declining. There are at least three reasons to consider that the age characteristics of the spawning stock may be as important as the spawning stock biomass itself. The stock reproductive potential metric has been proposed as an improvement over the simple spawning stock biomass(Trippel E.A. 1999). This is because it explicitly incorporates the results of studies on reproductive biology which have shown that size, experience and condition are all vitally important in determining the reproductive contribution of a spawner. The conclusion is that one 10 kilogram spawner is vastly more valuable than ten 1 kilogram spawners.

The argument has been made that cod is an evolutionarily long-lived species reaching very large sizes (Longhurst 1998). The depletion by fishing of large, older fish (ages 10-20+) had left the population in a precarious state, incapable of outlasting a prolonged period of poor recruitment and rebuilding rapidly when conditions ameliorated. This is given some weight by the fact that, in the time since it was written in 1998 the environmental conditions have returned to average, or even above average temperatures, but there has been no detectable resurgence in cod abundance. Large size and longevity are the means of coping with highly uncertain recruitement success due to environmental variation.

Another argument has been made about the possiblility that cultivation effects (Walters and Kitchell 2001) may be important for cod. The heavy predation of adult cod on a wide range of forage species may be important to prevent those same forage species from preying heavily on early life stages of cod. Evidence of this has been detected in the southern Gulf of St. Lawrence cod stock (Swain and Sinclair 2000). Large adult cod may play a major role in ensuring that the ecosystem is conducive to the growth and survival of their own young.

The bottom line is that, in spite of 10 years with virtually no fishery and a recent return to normal environmental conditions, the cod in 4VsW are continuing to decline. There is no evidence that this will change any time soon.

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Table 1. 4VsW cod nominal catches by country and NAFO Divisions.

YEAR	CANADA	FRANCE	PORTUGAL	SPAIN	USSR	OTHERS	TOTAL	SUBDIV. 4Vs	DIV. 4W	TAC
1958	17938	4577	1095	14857	-	124	38591	23790	14801	
1959	20069	16378	8384	19999	-	1196	66026	47063	18963	
1960	18389	1018	1720	29391	-	126	50644	27689	22956	
1961	19697	3252	2321	40884	113	42	66309	34237	32072	
1962	17579	2645	341	42146	2383	60	65154	26350	38804	
1963	13144	72	617	44528	9505	307	68173	27566	40607	
1964	14330	1010	-	39690	7133	1094	63257	25496	37761	
1965	23104	536	88	39280	7856	122	70986	36713	34273	
1966	17690	1494	-	43157	5473	711	68525	27177	41348	
1967	18464	77	102	33934	1068	513	54158	26607	27551	
1968	24888	225	-	50418	4865	32	80428	48781	31647	
1969	14188	217	-	32305	2783	672	50165	22316	27849	
1970	11818	420	296	41926	2521	453	57434	28639	28795	
1971	17064	4	18	30864	4506	107	52563	24128	28435	
1972	19987	495	856	28542	4646	7119	61645	36533	25112	
1973	15929	922	849	30883	2918	2592	54093	23401	30692	60500
1974	10700	35	1464	27384	3097	1061	43741	19611	24130	60000
1975	9939	1867	546	15611	3042	1512	32517	11694	20823	60000
1976	9567	697	-	11090	1018	2035	24407	11553	12854	30000
1977	9890	68	-	-	97	335	10390	2873	7517	7000
1978	24642	437	-	57	218	51	25405	10357	15048	7000
1979	39219	18	-	2	683	108	40030	15393	24637	30000
1980	48821	17	5	5	338	66	49252	31378	17874	45000
1981	53053	-	-	-	630	35	53718	32107	21611	50000
1982	55675	-	-	-	45	34	55754	40110	15644	55600
1983	50898	-	1230	-	190	62	52380	33170	19210	64000
1984	52104	-	303	-	110	29	52546	42578	9968	55000
1985	56553	-	870	-	21	11	57455	48189	9266	55000
1986	51467	-	-	-	28	34	51529	44028	7501	48000
1987	45430	-	-	-	25	48	45503	39755	5748	44000
1988	38215	-	-	-	106	35	38356	33729	4627	38000
1989	36619	-	-	-	84	40	36743	29378	7365	35200
1990	34172	-	-	-	150	81	34403	26274	8129	35200
1991	32804	-	-	-	195	69	33068	24600	8468	35200
1992	29835	-	-	-	-	57	29892	21351	8541	35200
1993	3281	-	-	-	-	13	3294	2163	1131	11000
1994	355	-	-	-	-	-	355	170	185	0
1995	283	-	-	-	-	-	283	184	99	0
1996	306	-	-	-	-	1	307	158	149	0
1997	327	-	-	-	-	-	327	110	217	0
1998	274	-	-	-	-	-	274	110	164	0
1999	297 [1]	-	-	-	-	-	297 [1]	209 [1]	88 [1]	0
2000	157 [1]	-	-	-	-	-	157 [1]	90 [1]	67 [1]	0
2001	149 [1]	-	-	-	-	-	149 [1]	91 [1]	57 [1]	0
2002	83 [1]	-	-	-	-	-	83 [1]	27 [1]	56 [1]	0

[1] Preliminary Catch Statistics (ZIFF)

Table 2. Canadian catch of 4VsW cod by gear and (sub) Division (from NAFO).

	4Vs					4W					4VsW				
YEAR	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL
1964	2056	42	2	.	2100	7324	708	88	4110	12230	9380	750	90	4110	14330
1965	7366	84	22	.	7472	10290	1416	159	3767	15632	17656	1500	181	3767	23104
1966	6374	143	14	.	6531	6614	1472	38	3035	11159	12988	1615	52	3035	17690
1967	6735	99	27	.	6861	6460	2405	71	2667	11603	13195	2504	98	2667	18464
1968	9501	48	18	.	9567	8360	2970	89	3902	15321	17861	3018	107	3902	24888
1969	3540	43	7	.	3590	4695	3567	13	2323	10598	8235	3610	20	2323	14188
1970	3054	21	1	.	3076	3602	3817	62	1261	8742	6656	3838	63	1261	11818
1971	5827	40	.	.	5867	4768	4819	26	1584	11197	10595	4859	26	1584	17064
1972	9856	115	4	.	9975	4732	3793	7	1480	10012	14588	3908	11	1480	19987
1973	6392	82	3	.	6477	4723	3748	20	961	9452	11115	3830	23	961	15929
1974	4644	56	.	.	4700	1335	2969	5	1691	6000	5979	3025	5	1691	10700
1975	1824	63	.	.	1887	3566	3185	11	1290	8052	5390	3248	11	1290	9939
1976	3755	42	.	.	3797	937	2913	14	1906	5770	4692	2955	14	1906	9567
1977	2751	50	4	.	2805	1873	3487	68	1657	7085	4624	3537	72	1657	9890
1978	9561	294	19	.	9874	7997	4552	839	1380	14768	17558	4846	858	1380	24642
1979	14853	438	86	.	15377	13784	5825	3245	988	23842	28637	6263	3331	988	39219
1980	28941	2116	321	.	31378	6298	6588	3440	1117	17443	35239	8704	3761	1117	48821
1981	27662	4274	171	.	32107	9148	8229	2433	1136	20946	36810	12503	2604	1136	53053
1982	32247	7069	794	.	40110	6352	6655	1943	615	15565	38599	13724	2737	615	55675
1983	26817	4475	671	.	31963	11280	5052	1936	667	18935	38097	9527	2607	667	50898
1984	37290	4123	879	.	42292	3683	3512	2144	473	9812	40973	7635	3023	473	52104
1985	39098	7449	718	44	47309	3746	3386	1229	883	9244	42844	10835	1947	927	56553
1986	35482	8277	237	.	43996	2728	3075	600	1068	7471	38210	11352	837	1068	51467
1987	33139	6276	311	11	39737	1748	2666	538	741	5693	34887	8942	849	752	45430
1988	26959	6077	612	56	33704	1124	2163	382	842	4511	28083	8240	994	898	38215
1989	22608	6324	400	40	29372	3332	2983	323	609	7247	25940	9307	723	649	36619
1990	22218	3825	224	4	26271	2839	4080	530	452	7901	25057	7905	754	456	34172
1991	20529	3838	229	.	24596	3579	3675	371	583	8208	24108	7513	600	583	32804
1992	17908	3279	164	.	21351	3579	4179	505	221	8484	21487	7458	669	221	29835
1993	1109	999	55	.	2163	158	817	87	56	1118	1267	1816	142	56	3281
1994	128	40	2	.	170	29	146	.	10	185	157	186	2	10	355
1995	108	56	.	20	184	11	79	.	9	99	119	135	.	29	283
1996	85	72	.	1	158	11	132	.	5	148	96	204	.	6	306
1997	34	63	.	13	110	14	173	.	30	217	48	236	.	43	327
1998	16	89	.	5	110	7	136	.	21	164	23	225	.	26	274
1999[1]	61	148	.	.	209	3	77	.	8	88	64	225	.	8	297
2000[1]	48	42	.	.	90	2	62	.	3	67	50	104	.	3	157
2001[1]	49	42	.	.	91	3	49	.	5	57	53	91	.	5	148
2002[1]	12	15	.	.	27	5	48	.	2	55	17	63	.	2	82

[1] Preliminary Catch Statistics (ZIFF)

Table 3. Summary of commercial sampling available for 4VsW cod since the last assessment.

Year	Catch (t.)	Samples	Lengths	Ages
1997	328	4	760	182
1998	274	13	2298	416
1999	297	17	4309	510
2000	157	6	1052	116
2001	149	9	1524	260
2002	83	4	718	-

Table 4. Commercial catch at age for 4VsW cod adjusted for estimated 4TVn component in 1986-92.

	Age																		
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1+	3+	6+
1970	1293	8631	8886	14802	13673	4539	1942	759	236	72	137	56	9	12	4	4	55055	45131	7770
1971	1984	12824	9643	5125	6612	5128	3419	1963	704	367	159	173	156	80	40	52	48429	33621	12241
1972	2046	15865	11801	11989	7384	6527	3308	1880	347	466	68	8	36	0	3	7	61735	43824	12650
1973	1218	10221	8001	5803	9634	3324	3370	4732	1684	389	551	8	21	21	18	47	49042	37603	14165
1974	1273	7321	13324	11695	6854	2247	669	1008	196	153	13	2	0	0	0	0	44755	36161	4288
1975	1538	8571	7402	3163	4788	3297	2943	623	497	686	172	123	41	6	6	19	33875	23766	8413
1976	513	2866	2860	4707	3900	2085	1287	447	136	53	12	47	0	4	0	2	18919	15540	4073
1977	1	23	532	1229	1591	845	490	199	118	33	42	44	11	3	2	6	5169	5145	1793
1978	34	94	1168	4078	4817	2582	767	247	107	75	31	27	28	10	1	2	14068	13940	3877
1979	12	93	1762	6559	9525	5056	1210	377	76	23	10	4	3	0	0	0	24710	24605	6759
1980	31	92	1765	4873	6937	6177	3050	1121	313	92	50	26	4	0	1	7	24539	24416	10841
1981	3	258	3200	9136	7281	4651	2957	1421	397	135	69	32	22	2	5	2	29571	29310	9693
1982	3	138	2473	7667	10123	3681	2568	1315	679	318	153	65	54	55	19	19	29330	29189	8926
1983	0	6	3507	8679	7484	6278	1905	1012	625	224	149	52	24	15	6	11	29977	29971	10301
1984	0	1	430	5778	9101	5678	3829	1250	544	290	153	63	34	17	8	5	27181	27180	11871
1985	0	4	156	2253	8151	7523	4284	2430	1063	452	284	173	68	20	17	15	26893	26889	16329
1986	0	3	124	4089	7098	7584	3368	1358	922	339	189	81	66	11	19	18	25269	25266	13955
1987	0	0	30	815	5400	5367	5465	2636	928	492	220	122	61	11	14	12	21573	21573	15328
1988	0	8	185	1507	2008	3920	3496	2782	1454	471	260	152	64	9	10	11	16337	16329	12629
1989	0	7	671	2544	4066	3133	3316	1244	1354	484	202	38	29	15	58	35	17196	17189	9908
1990	0	0	291	2264	3889	2577	1606	2936	891	1051	323	135	55	15	14	13	16060	16060	9616
1991	0	1	274	3237	6295	3589	608	629	327	61	432	69	65	10	6	5	15608	15607	5801
1992	0	2	568	2404	8232	5897	1690	652	185	285	84	108	33	7	6	7	20160	20158	8954
1993	0	0	32	427	605	758	513	129	44	8	7	4	2	1	0	0	2530	2530	1466
1994	0	0	0	4	68	29	72	15	5	1	0	0	0	0	0	0	194	194	122
1995	0	0	6	14	45	51	21	18	8	2	0	0	0	0	0	0	165	165	100
1996	0	0	36	87	53	31	17	5	1.3	1.2	0.1	0	0	0	0	0	232	232	56
1997	0	1	4	18	44	20	22	23	11	5	3	2	0	1	0	0	154	153	88
1998	0	0	2	20	44	40	19	15	9	2	3	2	0	0	0	0	157	157	91
1999	0	0	1	20	54	46	41	14	5	4	3	1	0	0	0	0	191	191	115
2000	0	0	5	7	26	46	20	6	0	2	0	0	0	0	0	0	114	114	75
2001	0	0	5	22	19	25	12	4	2	0	0	0	0	0	0	0	89	89	43
2002																			

Table 5. 4VsW cod weights at age from commercial landings.

	Age															
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1971	50	195	488	1,071	1,446	1,800	2,280	3,500	4,870	5,700	5,700	8,740	6,770	5,920	9,270	6,030
1972	70	396	803	1,112	1,400	1,840	2,290	2,880	4,820	4,560	7,570	11,560	6,310	.	14,490	8,730
1973	90	252	740	955	1,176	1,640	2,290	2,280	2,640	4,270	3,850	9,480	7,050	9,060	10,980	9,610
1974	130	314	684	1,184	1,736	2,170	2,590	2,470	3,240	3,620	4,870	9,580	.	.	.	.
1975	90	280	585	892	1,368	1,880	2,340	2,940	3,690	3,720	4,790	5,460	8,240	12,100	12,780	8,130
1976	80	260	549	1,041	1,499	2,260	3,330	4,370	4,850	5,570	7,390	3,380	14,230	11,540	22,970	15,500
1977	140	280	730	1,106	1,722	2,400	3,150	4,470	4,040	5,290	4,730	4,920	6,570	8,850	10,520	12,270
1978	68	470	932	1,207	1,627	2,330	3,390	4,760	5,340	6,190	7,910	8,570	9,610	10,300	8,370	12,040
1979	50	416	681	957	1,563	2,300	3,080	3,720	4,900	6,390	7,250	10,110	13,950	10,260	11,970	12,890
1980	70	511	795	1,155	1,595	2,220	3,100	4,260	5,380	6,960	7,420	10,010	8,750	10,530	13,970	17,800
1981	80	536	789	1,122	1,681	2,120	2,960	3,900	5,690	7,020	7,680	9,450	12,050	8,480	9,800	17,770
1982	100	551	773	1,037	1,530	2,330	2,730	3,990	5,340	6,840	8,530	8,880	10,900	10,430	13,340	14,920
1983	70	393	772	1,041	1,528	2,130	3,090	3,550	4,380	5,790	6,840	9,160	10,640	11,730	14,070	13,550
1984	.	540	740	1,060	1,500	2,060	2,690	3,640	4,030	5,190	7,090	8,440	9,280	10,580	12,630	13,210
1985	.	680	710	1,030	1,450	1,970	2,380	3,100	3,840	5,030	6,320	6,130	9,880	11,120	11,120	14,490
1986	.	270	680	950	1,260	1,650	2,380	2,740	3,670	4,990	5,300	6,870	10,180	9,570	11,890	14,520
1987	.	.	480	930	1,280	1,540	1,870	2,610	3,580	4,310	6,490	6,320	7,230	11,680	12,690	13,190
1988	.	350	630	970	1,260	1,730	1,920	2,370	2,790	3,670	4,920	7,060	7,650	11,170	12,160	14,760
1989	.	290	770	1,010	1,280	1,560	2,190	2,210	2,500	3,930	5,100	5,160	8,550	12,280	7,870	15,380
1990	.	.	760	1,000	1,230	1,400	1,680	2,270	2,180	2,170	4,380	6,190	8,490	12,330	10,380	11,410
1991	.	460	770	880	1,140	1,460	1,570	1,960	2,370	2,290	2,890	3,530	4,140	12,980	9,180	10,750
1992	.	190	630	790	1,010	1,310	1,760	1,840	1,960	2,720	2,490	2,600	5,670	13,530	12,830	12,970
1993	.	.	570	860	1,050	1,390	1,790	2,210	4,050	3,710	7,750	4,780	11,020	13,440	14,270	16,010
1994	.	.	690	1,280	1,530	1,830	1,800	2,120	2,700	2,850	.	.	.	.	.	.
1995	.	.	690	870	1,250	1,690	2,060	2,340	3,080	4,280	.	8,090	.	.	.	.
1996	.	.	662	926	1,414	1,859	2,478	2,669	3,488	4,409	7,387	.	.	.	.	.
1997	.	460	512	840	1,082	1,913	2,074	3,223	4,073	4,412	5,624	5,214	6,187	5,530	10,281	.
1998	.	.	1,032	1,123	1,416	1,527	1,864	2,085	3,529	3,261	3,647	2,489	9,721	10,062	8,421	.
1999	.	.	759	952	1,144	1,584	1,738	2,146	2,643	3,107	3,216	3,405	3,938	7,231	.	.
2000	.	.	958	1,146	1,168	1,328	1,687	1,938	2,762	2,182	.	10,779	.	.	.	.
2001	.	407	897	1,146	1,426	1,545	1,981	2,315	2,241	3,176	.	.	.	.	.	.

Table 6. Estimated seal consumption of 4VsW cod in numbers at age and total biomass under the constrained Lotka-Volterra model of seal predation on cod. The fractions refer to the fraction of the seals total diet biomass being taken as cod. (Taken from Mohn *et al.*, 1998)

	Age									
Year	1	2	3	4	5	6	7	8	Biomass (tonnes)	Fraction in Seal diet
1970	2620	1186	379	194	96	58	35	21	1292	0.127
1971	1796	859	316	179	101	61	37	23	1127	0.101
1972	2140	1061	422	219	110	67	41	25	1336	0.108
1973	2382	1186	476	229	103	63	38	23	1393	0.102
1974	3580	1554	438	209	93	56	34	21	1487	0.099
1975	6956	2662	417	204	95	57	35	21	2001	0.123
1976	5251	2180	521	236	95	58	35	21	1843	0.102
1977	4712	2215	782	343	129	78	47	29	2202	0.111
1978	8301	3549	948	454	201	122	74	45	3308	0.15
1979	7399	3326	1043	512	237	144	87	53	3450	0.141
1980	7657	3604	1276	610	270	164	99	60	3899	0.144
1981	10514	4817	1592	751	325	197	120	73	4954	0.166
1982	12722	5818	1914	895	382	232	141	85	5921	0.18
1983	13207	6314	2319	1070	445	270	164	99	6735	0.186
1984	13211	6236	2223	1089	503	305	185	112	6944	0.171
1985	14650	6916	2465	1228	583	354	215	130	7830	0.172
1986	17879	7951	2416	1250	627	380	231	140	8512	0.167
1987	22535	9168	2009	1093	587	356	216	131	8613	0.151
1988	24950	10255	2351	1195	585	355	215	131	9328	0.146
1989	21806	9779	3045	1433	619	375	228	138	9721	0.136
1990	12150	6787	3320	1507	607	368	223	135	8437	0.106
1991	13030	5776	1738	928	487	295	179	109	6334	0.071
1992	12182	4874	987	592	355	215	130	79	4750	0.048
1993	10639	4220	818	407	193	117	71	43	3494	0.031
1994	13420	5121	785	414	213	129	78	48	4001	0.032
1995	15063	5485	563	358	227	138	84	51	4104	0.029
1996	17114	6184	582	337	195	118	72	43	4272	0.027
1997	18205	6525	554	335	203	123	75	45	4457	0.025

Extrapolated seal consumption based on 11% population growth and 1% cod in the seal diet (see text)

Year	Total seal Consumption	Cod consumed (t)
1970	10206	
1971	11198	
1972	12357	
1973	13683	
1974	15032	
1975	16294	
1976	18135	
1977	19944	
1978	22119	
1979	24548	
1980	27103	
1981	29889	
1982	32992	
1983	36341	
1984	40738	
1985	45587	
1986	51032	
1987	57087	
1988	63833	
1989	71421	
1990	79913	
1991	89437	
1992	100095	
1993	112016	1120
1994	125373	1254
1995	140325	1403
1996	157079	1571
1997	175849	1758
1998	196951	1970
1999	220585	2206
2000	247055	2471
2001	276702	2767
2002	309906	3099

Table 7. 4VsW Cod July RV stratified mean catch per tow. Years 1970-81 are adjusted by a factor of 1.70 based on NLLS-estimated change in catchability.

	Age																	Totals		
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unk	Age 0+	Age 3+	Age 6+
1970	0.06	0.89	10.06	3.53	5.49	2.72	0.89	1.06	0.34	0.06	0.15	0.17	0.06	0.11	.	.	.	25.62	14.59	2.85
1971	0.02	0.94	4.68	21.74	4.89	9.64	3.53	2.11	0.89	0.38	0.04	0.09	0.04	0.13	.	.	.	49.12	43.49	7.21
1972	.	3.79	5.89	7.25	19.23	3.55	3.66	0.98	0.34	0.30	0.09	.	.	.	.	.	.	45.08	35.40	5.36
1973	.	3.91	26.79	42.10	34.19	13.70	1.13	1.77	0.55	0.26	0.32	0.11	.	.	0.13	0.02	.	124.97	94.27	4.28
1974	0.53	3.15	20.10	11.77	3.45	1.23	1.36	0.23	0.28	0.13	0.11	0.04	0.04	.	.	0.04	.	42.46	18.68	2.23
1975	0.04	2.02	5.17	8.00	3.74	1.83	0.40	0.49	0.13	0.26	0.02	.	0.04	.	.	.	.	22.15	14.91	1.34
1976	.	1.43	7.87	8.98	5.53	3.51	0.68	0.32	0.55	.	0.38	0.04	.	0.09	.	.	.	29.38	20.08	2.06
1977	.	0.45	5.85	14.83	9.64	6.00	2.64	0.57	0.38	0.09	.	0.06	0.04	.	.	.	.	40.55	34.25	3.79
1978	0.11	1.87	7.98	19.06	20.85	5.77	2.13	0.53	0.11	0.06	0.04	.	.	.	.	.	0.04	58.55	48.59	2.91
1979	0.62	0.74	6.47	9.79	10.13	11.02	5.51	1.64	0.62	0.26	0.04	0.02	.	0.02	.	.	.	46.87	39.04	8.11
1980	0.02	0.43	4.28	11.30	6.25	10.59	7.38	2.91	0.79	0.21	0.17	0.06	.	.	.	.	.	44.40	39.68	11.53
1981	0.04	2.83	7.77	11.77	17.96	6.85	4.91	2.53	0.94	0.30	0.34	0.09	0.02	0.02	.	0.02	.	56.38	45.74	9.17
1982	.	0.91	78.68	65.75	22.96	5.15	2.79	1.50	0.64	0.14	0.15	0.08	.	.	.	.	.	178.74	99.15	5.29
1983	0.02	13.72	13.31	44.47	19.25	9.88	4.42	0.99	0.55	0.14	0.08	0.04	0.02	0.02	.	.	.	106.91	79.86	6.26
1984	0.07	0.41	7.27	12.82	19.09	12.94	6.01	4.13	0.41	0.33	0.10	0.23	0.01	0.01	0.01	.	.	63.84	56.09	11.24
1985	.	1.29	1.68	7.88	9.56	9.32	5.12	2.56	1.01	0.48	0.11	0.11	0.07	.	.	0.01	.	39.20	36.23	9.47
1986	0.03	0.36	1.32	1.53	6.16	3.89	3.26	1.15	0.55	0.24	0.15	0.04	.	0.02	.	.	.	18.70	16.99	5.41
1987	0.04	0.64	1.51	4.97	4.83	8.86	3.61	2.71	1.47	0.34	0.02	0.08	0.04	0.01	.	0.03	.	29.16	26.97	8.31
1988	0.07	0.06	4.70	7.29	5.89	3.27	3.41	1.95	0.98	0.22	0.05	0.12	0.02	.	0.02	.	.	28.05	23.22	6.77
1989	0.03	0.25	8.86	7.38	5.01	3.47	1.35	2.00	0.47	0.32	0.01	.	0.02	0.01	.	.	.	29.18	20.04	4.18
1990	.	0.13	5.06	18.22	8.64	3.83	1.41	0.60	0.29	0.11	0.07	.	.	.	.	.	.	38.35	33.16	2.47
1991	.	0.47	1.82	3.38	6.97	4.91	1.63	0.43	0.19	0.24	0.07	0.05	0.02	.	.	.	.	20.17	17.88	2.63
1992	.	1.69	5.02	6.60	4.08	2.59	0.88	0.15	0.07	0.04	0.02	.	.	.	0.01	.	.	21.14	14.44	1.16
1993	0.01	0.09	1.00	6.36	7.18	5.66	3.16	1.10	0.27	0.00	0.02	.	.	.	.	.	.	24.85	23.75	4.55
1994	0.06	0.11	1.30	2.81	2.39	1.11	0.49	0.51	0.06	0.04	0.04	0.02	.	.	.	.	.	8.93	7.46	1.16
1995	0.21	0.18	0.66	2.39	2.41	1.91	0.77	0.42	0.49	0.07	.	.	.	.	.	.	.	9.52	8.46	1.75
1996	0.01	0.42	2.14	1.62	0.92	0.65	0.35	0.10	0.05	0.01	0.01	.	.	.	.	.	.	6.28	3.71	0.52
1997	.	0.05	0.59	0.85	0.61	0.23	0.02	0.08	0.04	.	.	.	.	.	.	.	0.12	2.61	1.97	0.27
1998	0.07	0.19	0.54	2.21	3.53	1.33	0.35	0.25	0.08	.	.	0.01	.	.	.	.	.	8.56	7.76	0.69
1999	1.50	0.18	2.24	2.82	3.13	1.53	0.38	0.03	0.09	0.02	.	0.03	.	.	.	.	.	11.95	8.03	0.55
2000	0.65	0.22	0.49	1.10	0.60	0.54	0.29	0.13	0.04	0.01	0.02	.	.	.	.	.	0.24	4.33	2.97	0.73
2001	0.04	0.23	5.21	3.78	1.40	0.42	0.13	0.07	0.05	.	0.02	.	.	.	.	.	.	11.35	5.87	0.27
2002	0.02	0.29	0.76	1.83	0.85	0.17	0.02	.	.	.	.	.	0.01	.	.	.	.	3.95	2.88	0.03

Table 8. 4VsW Cod Spring RV mean catch per tow

	Age																	Totals		
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unk	0+	3+	6+
1979	.	0.26	2.12	0.89	0.6	1.37	1.02	0.47	0.29	0.07	0.1	0.08	0.02	0.03	0.01	0.01	.	7.34	4.96	2.10
1980	.	0.86	2.71	2.04	1.67	2.52	2.90	1.43	0.3	0.06	0.03	0.01	.	0.01	.	.	.	14.54	10.97	4.74
1981	.	8.25	3.80	5.29	7.79	4.87	5.76	3.20	1.53	0.18	0.14	0.03	0.02	.	.	.	.	40.86	28.81	10.86
1982	.	2.65	22.22	17.91	11.84	7.24	1.99	1.36	1.08	0.28	0.14	0.06	0.03	0.01	.	0.01	0.01	66.83	41.96	4.97
1983	.	0.85	3.17	42.14	25.52	4.96	5.85	1.32	0.62	0.29	0.1	0.04	0.04	0.01	0.04	.	.	84.95	80.93	8.31
1984	.	0.22	1.49	1.85	9.37	6.21	2.92	2.53	0.77	0.5	0.2	0.02	0.09	.	0.01	.	0.02	26.20	24.49	7.06
1985	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1986	.	0.19	10.88	19.44	23.58	11.67	13.13	6.27	1.34	0.73	0.28	0.04	0.05	0.01	0.01	.	0.01	87.63	76.56	21.87
1987	.	0.35	0.92	2.87	4.50	10.14	4.82	3.32	1.2	0.24	0.1	0.04	0.03	0.03	0.01	.	.	28.57	27.30	9.79
1988	.	0.60	7.96	9.49	4.26	4.32	4.88	1.43	1.87	0.46	0.19	0.18	0.04	0.02	.	0.03	.	35.73	27.17	9.10
1989	.	0.58	17.96	10.40	4.23	4.80	1.68	0.70	0.22	0.25	0.05	0.03	0.02	.	0.01	0.02	.	40.95	22.41	2.98
1990	.	0.12	1.60	5.08	2.56	0.86	0.31	0.19	0.36	0.13	0.12	0.04	0.03	0.01	.	.	.	11.41	9.69	1.19
1991	.	0.02	3.50	12.15	21.92	5.09	1.49	0.35	0.02	0.1	.	0.01	0	0.02	0.01	.	.	44.68	41.16	2.00
1992	.	0.07	0.52	0.25	0.25	0.49	0.31	0.11	0.05	0.02	.	0.01	0.03	0.01	.	.	.	2.12	1.53	0.54
1993	.	0.03	2.86	5.62	3.83	2.43	1.08	0.16	0.08	0.01	.	.	.	.	.	.	.	16.10	13.21	1.33
1994	.	0.10	0.16	0.30	0.83	0.46	0.68	0.33	0.26	0.03	0.02	.	.	.	.	.	.	3.17	2.91	1.32
1995	.	0.23	0.39	0.63	1.19	2.05	0.48	0.25	0.12	0.002	0.01	.	.	.	.	.	.	5.35	4.73	0.86
1996	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1997	.	0.16	6.88	17.08	13.56	4.70	3.88	1.03	0.68	0.36	0.32	.	.	.	.	.	.	48.64	41.60	6.27
1998	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1999	.	0.68	0.70	1.08	2.67	2.03	0.59	0.09	0.01	.	.	.	.	.	0.01	.	0.01	7.87	6.49	0.71
2000	.	0.79	1.44	2.11	0.29	0.24	0.07	0.05	0.02	.	.	0.01	.	.	.	.	0.09	5.11	2.88	0.24
2001	.	0.08	1.66	1.80	1.00	0.19	0.07	0.06	0.01	0.01	.	.	.	.	.	.	.	4.88	3.14	0.15
2002	0.01	0.30	0.29	0.48	0.41	0.04	0.01	0.03	0.01	0.01	0.01	.	.	.	.	.	0.02	1.62	1.02	0.09

Table 9. Length composition of 4VsW Sentinel Survey (stratified mean catch per set).

	Year							
Length	1995	1996	1997	1998	1999	2000	2001	2002
25	0.02	.	.	0.02	0.00	0.00	0.00	.
28	0.03	0.01	.	0.04	0.00	0.00	0.01	0.01
31	0.21	0.04	0.08	0.03	0.03	0.04	0.03	0.03
34	0.68	0.18	0.29	0.17	0.17	0.15	0.13	0.04
37	1.68	0.81	0.57	0.68	0.40	0.46	0.33	0.31
40	2.81	1.87	1.07	1.35	0.71	1.04	0.66	0.68
43	2.86	2.80	1.34	2.26	1.01	1.46	0.93	0.98
46	2.56	3.09	1.36	2.33	1.26	1.46	0.84	0.84
49	1.98	2.98	1.24	2.65	1.29	1.34	0.83	1.05
52	1.48	2.25	1.01	2.42	1.33	1.03	0.78	0.86
55	1.33	2.06	0.98	1.70	1.21	0.58	0.35	0.65
58	0.79	1.25	0.78	1.16	0.76	0.47	0.26	0.48
61	0.57	0.98	0.58	0.74	0.60	0.29	0.23	0.23
64	0.38	0.50	0.50	0.57	0.43	0.34	0.16	0.27
67	0.21	0.37	0.27	0.25	0.32	0.15	0.11	0.14
70	0.24	0.23	0.15	0.21	0.25	0.08	0.08	0.10
73	0.14	0.15	0.08	0.24	0.23	0.06	0.11	0.12
76	0.07	0.09	0.08	0.03	0.04	0.05	0.02	0.05
79	0.04	0.04	0.05	0.04	0.14	0.02	0.01	0.03
82	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01
85	0.00	0.01	0.01	0.00	0.02	0.01	0.00	.
88	.	0.00	0.01	0.01	0.00	.	.	0.01
91	0.01	.	.	0.00	.	0.01	.	.
94	.	.	0.00	.	.	.	.	.
97	.	.	.	0.00	.	0.00	.	.
M	M	M	M	M	M	M	M	M
121	.	.	.	.	.	.	.	0.01
SUM	18.12	19.72	10.47	16.92	10.21	9.04	5.89	6.86

Table 10a. 4VsW Cod July RV trawlable population numbers (000's). Years 1970-81 are adjusted by a factor of 1.70 based on NLLS-estimated change in catchability.

	Age																	Totals		
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unk	Age 0+	Age 3+	Age 6+
1970	152	2,129	23,975	8,414	13,077	6,488	2,129	2,534	811	152	355	406	152	253	.	.	.	61,028	34,772	6,792
1971	51	2,230	11,151	51,803	11,658	22,962	8,414	5,018	2,129	912	101	203	101	304	.	.	.	117,038	103,606	17,183
1972	.	9,022	14,041	17,285	45,822	8,465	8,718	2,332	811	710	203	.	.	.	.	.	.	107,408	84,345	12,773
1973	.	9,327	63,816	100,311	81,455	32,643	2,686	4,207	1,318	608	760	253	.	.	304	51	.	297,740	224,598	10,188
1974	1,267	7,502	47,900	28,030	8,211	2,940	3,244	558	659	304	253	101	101	.	.	101	.	101,173	44,504	5,322
1975	101	4,815	12,317	19,059	8,921	4,359	963	1,166	304	608	51	.	101	.	.	.	.	52,766	35,532	3,193
1976	.	3,396	18,754	21,390	13,179	8,363	1,622	760	1,318	.	912	101	.	203	.	.	.	70,000	47,849	4,917
1977	.	1,064	13,939	35,329	22,962	14,294	6,285	1,369	912	203	.	152	101	.	.	.	.	96,611	81,607	9,022
1978	253	4,461	19,008	45,416	49,674	13,736	5,069	1,267	253	152	101	.	.	.	.	.	101	139,493	115,771	6,944
1979	1,470	1,774	15,409	23,316	24,127	26,256	13,128	3,903	1,470	608	101	51	.	51	.	.	.	111,665	93,012	19,312
1980	51	1,014	10,188	26,915	14,902	25,243	17,589	6,944	1,875	507	406	152	.	.	.	.	.	105,786	94,533	27,473
1981	101	6,741	18,501	28,030	42,781	16,321	11,709	6,032	2,230	710	811	203	51	51	.	51	.	134,323	108,979	21,846
1982	.	2,174	187,444	156,650	54,708	12,270	6,641	3,574	1,519	328	357	179	.	.	.	.	.	425,843	236,226	12,598
1983	48	32,688	31,711	105,950	45,863	23,539	10,531	2,359	1,310	334	191	95	48	48	.	.	.	254,714	190,267	14,914
1984	167	977	17,321	30,544	45,482	30,830	14,319	9,840	977	786	238	548	24	24	24	.	.	152,099	133,635	26,779
1985	.	3,073	4,003	18,774	22,777	22,205	12,198	6,099	2,406	1,144	262	262	167	.	.	24	.	93,394	86,318	22,562
1986	71	858	3,145	3,645	14,676	9,268	7,767	2,740	1,310	572	357	95	.	48	.	.	.	44,553	40,479	12,889
1987	95	1,525	3,598	11,841	11,508	21,109	8,601	6,457	3,502	810	48	191	95	24	.	71	.	69,474	64,256	19,799
1988	167	143	11,198	17,368	14,033	7,791	8,124	4,646	2,335	524	119	286	48	.	48	.	.	66,829	55,322	16,130
1989	71	596	21,109	17,583	11,936	8,267	3,216	4,765	1,120	762	24	.	48	24	.	.	.	69,522	47,745	9,959
1990	.	305	12,063	43,414	20,575	9,118	3,355	1,432	686	253	169	.	.	.	.	.	.	91,369	79,002	5,894
1991	.	1,131	4,339	8,048	16,599	11,694	3,887	1,023	445	563	173	129	37	.	.	.	.	48,067	42,597	6,256
1992	.	4,023	11,953	15,719	9,724	6,182	2,107	347	174	85	41	.	.	.	20	.	.	50,373	34,398	2,774
1993	24	213	2,392	15,142	17,095	13,497	7,523	2,625	640	12	39	.	.	.	.	.	.	59,202	56,573	10,839
1994	144	270	3,090	6,694	5,689	2,641	1,159	1,211	144	91	98	54	.	.	.	.	.	21,286	17,782	2,758
1995	507	430	1,582	5,698	5,748	4,549	1,824	1,003	1,171	168	.	.	.	.	.	.	.	22,681	20,162	4,166
1996	21	1,006	5,107	3,868	2,181	1,547	834	243	128	14	22	.	.	.	.	.	.	14,971	8,836	1,240
1997	.	131	1,398	2,030	1,460	552	48	199	105	.	.	.	.	.	.	.	297	6,221	4,692	649
1998	167	453	1,287	5,265	8,410	3,169	834	596	191	.	.	24	.	.	.	.	.	20,394	18,488	1,644
1999	3,574	429	5,337	6,719	7,457	3,645	905	71	214	48	.	71	.	.	.	.	.	28,471	19,132	1,310
2000	1,549	524	1,167	2,621	1,430	1,287	691	310	95	24	48	.	.	.	.	.	572	10,316	7,076	1,739
2001	95	548	12,413	9,006	3,336	1,001	310	167	119	.	48	.	.	.	.	.	.	27,041	13,985	643
2002	48	691	1,811	4,360	2,025	405	48	.	.	.	.	.	24	.	.	.	.	9,411	6,862	71

Table 10b. 4VsW Cod July RV q-corrected population numbers (000's). Years 1970-81 are adjusted by a factor of 1.70 based on NLLS-estimated change in catchability.

	Age																Totals			Mean catch per tow		
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Age 0+	Age 3+	Age 6+	Age 0+	Age 3+	Age 6+
1970	6,939	25,759	114,307	14,312	16,504	7,555	2,535	2,834	915	160	376	430	155	274	.	.	193,055	46,051	7,680	81.03	19.33	3.22
1971	2,130	40,828	73,097	124,899	15,615	27,132	9,544	5,558	2,327	984	108	212	89	320	.	.	302,844	186,789	19,142	127.11	78.40	8.03
1972	.	108,934	49,213	27,725	65,062	10,009	9,764	2,630	863	758	250	.	.	.	.	.	275,207	117,061	14,265	115.51	49.13	5.99
1973	.	89,022	254,369	176,855	105,445	38,557	2,958	4,683	1,408	679	786	254	.	.	310	41	675,369	331,978	11,120	283.47	139.34	4.67
1974	61,764	57,114	154,535	53,673	10,901	3,384	3,597	580	718	349	249	97	90	.	.	87	347,137	73,724	5,767	145.70	30.94	2.42
1975	4,243	46,448	48,653	35,819	12,095	5,093	1,038	1,245	329	628	29	.	105	.	.	.	155,723	56,379	3,372	65.36	23.66	1.42
1976	.	35,476	74,801	47,089	18,006	9,796	1,825	833	1,398	.	953	131	.	217	.	.	190,525	80,248	5,357	79.97	33.68	2.25
1977	.	7,447	51,645	60,803	29,806	16,104	6,821	1,421	948	222	.	148	96	.	.	.	175,461	116,369	9,655	73.65	48.84	4.05
1978	13,019	53,728	47,825	72,708	61,618	15,428	5,446	1,392	284	138	121	.	.	.	.	.	271,708	157,136	7,382	114.04	65.95	3.10
1979	72,552	34,828	63,398	49,886	32,377	31,146	14,516	4,193	1,548	631	127	69	7	29	.	.	305,306	134,529	21,120	128.15	56.47	8.86
1980	4,181	14,781	38,500	49,176	19,787	29,267	19,159	7,447	2,002	518	404	142	.	.	.	.	185,365	127,903	29,672	77.80	53.68	12.45
1981	7,053	74,878	63,719	48,055	53,480	18,403	12,802	6,692	2,346	769	864	224	38	38	.	38	289,398	143,747	23,809	121.47	60.33	9.99
1982	500	35,340	411,213	227,260	60,477	12,603	7,071	3,809	1,630	361	365	197	.	.	14	.	760,841	313,787	13,448	319.34	131.70	5.64
1983	3,028	401,658	152,955	215,351	59,790	27,997	11,581	2,572	1,393	340	190	97	46	46	.	.	877,045	319,405	16,266	368.12	134.06	6.83
1984	6,251	12,030	67,178	57,621	61,905	35,584	15,993	10,776	1,037	848	250	593	15	15	22	.	270,119	184,659	29,550	113.38	77.51	12.40
1985	.	45,562	32,327	46,069	35,187	27,817	13,945	6,769	2,596	1,234	290	279	172	.	.	33	212,278	134,389	25,317	89.10	56.41	10.63
1986	2,756	10,320	13,804	8,341	21,256	11,205	8,820	2,992	1,400	620	389	89	.	57	.	.	82,048	55,168	14,366	34.44	23.16	6.03
1987	6,712	30,748	23,246	27,113	17,925	26,030	9,897	7,235	3,889	876	61	200	109	24	.	65	154,129	93,423	22,355	64.69	39.21	9.38
1988	9,105	1,818	46,927	43,435	23,420	9,408	9,393	5,257	2,525	564	130	292	40	.	45	.	152,360	94,509	18,246	63.95	39.67	7.66
1989	4,248	8,023	74,377	37,276	17,959	10,415	3,878	5,199	1,221	837	32	8	47	19	.	.	163,540	76,893	11,243	68.64	32.27	4.72
1990	289	5,545	49,775	110,326	33,533	11,985	4,017	1,656	735	271	182	.	.	.	.	.	218,315	162,706	6,862	91.63	68.29	2.88
1991	.	41,032	19,487	19,370	26,013	14,496	4,414	1,130	479	479	176	137	30	.	.	.	127,245	66,725	6,846	53.41	28.01	2.87
1992	.	55,958	101,887	46,837	22,655	9,248	2,900	411	197	92	43	.	.	.	22	.	240,251	82,406	3,665	100.84	34.59	1.54
1993	1,000	5,891	11,932	44,525	29,985	19,416	10,323	3,292	816	12	42	.	.	.	.	.	127,233	108,411	14,485	53.40	45.50	6.08
1994	6,215	3,333	14,211	19,253	11,744	3,991	1,478	1,376	160	98	104	57	.	.	.	.	62,021	38,262	3,274	26.03	16.06	1.37
1995	27,338	5,732	7,987	15,326	11,236	7,583	2,519	1,223	1,344	202	.	.	.	.	.	.	80,491	39,433	5,289	33.78	16.55	2.22
1996	908	13,043	20,743	10,447	4,325	2,282	1,141	286	148	14	24	.	.	.	.	.	53,361	18,667	1,614	22.40	7.84	0.68
1997	837	1,089	6,922	5,133	2,914	910	293	312	90	31	.	.	.	.	.	.	18,530	9,683	726	7.78	4.06	0.30
1998	11,089	6,543	7,616	11,882	13,707	3,402	680	906	145	.	.	31	.	.	.	.	56,001	30,753	1,763	23.51	12.91	0.74
1999	202,004	5,796	22,355	18,587	12,861	5,889	1,013	136	258	49	.	78	.	.	.	.	269,026	38,870	1,533	112.92	16.31	0.64
2000	99,105	5,615	6,200	6,539	2,582	1,622	843	338	117	36	39	.	.	.	.	.	123,036	12,116	1,373	51.64	5.09	0.58
2001	6,380	7,423	68,275	33,618	7,569	1,331	368	211	140	.	45	.	.	.	.	.	125,361	43,283	764	52.62	18.17	0.32
2002	.	6,574	8,545	11,109	3,813	732	58	.	.	.	.	.	18	.	.	.	30,849	15,730	76	12.95	6.60	0.03

Table 11. Mean length at age in 4Vs and 4W cod from July RV surveys.

SubDivision 4Vs

	Age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1970	7.00	16.58	25.59	36.16	48.03	53.64	59.19	63.92	65.06	97.00	82.00	70.05	.	73.49	.	.
1971	.	.	27.93	34.41	44.36	52.08	56.03	56.60	63.21	70.00	70.00	.	.	67.00	.	.
1972	.	21.42	30.86	41.60	44.09	51.97	56.56	57.20	64.08	89.81	59.89	.	.	.	.	.
1973	.	21.19	30.12	38.80	46.42	52.72	65.44	66.89	62.40	82.00	.	79.39	.	.	.	82.00
1974	.	20.22	28.80	37.43	47.43	54.03	58.67	62.49	68.66	68.29	82.96	97.00	.	.	.	115.00
1975	.	20.24	31.48	40.09	46.75	53.87	60.64	67.04	70.35	75.73	88.00	.	.	.	.	.
1976	.	19.23	28.55	35.18	44.82	56.17	64.57	71.60	70.04	.	81.26	.	.	100.00	.	.
1977	.	24.72	27.84	39.47	47.72	56.56	65.61	72.06	81.79	82.13	.	83.70	.	.	.	.
1978	.	20.30	35.34	42.31	48.95	57.71	67.84	75.52	79.00	85.00	88.00	.	.	.	.	.
1979	.	14.09	30.13	36.61	46.66	53.61	63.13	75.27	84.39	88.77	97.00	93.53	112.00	94.00	.	.
1980	.	15.20	25.30	40.69	47.61	55.45	63.84	71.64	78.31	98.88	96.89	105.19	.	.	.	.
1981	.	18.86	33.68	39.98	50.61	57.76	63.17	71.25	84.58	91.94	100.83	100.00	112.00	109.00	.	115.00
1982	.	12.79	29.24	36.06	44.13	55.48	62.56	65.99	71.90	81.64	86.89	96.49	.	.	103.00	.
1983	.	16.20	23.79	38.08	48.11	54.58	62.55	71.36	72.99	84.81	78.93	100.27	109.00	109.00	.	.
1984	.	17.81	29.00	38.81	47.11	55.68	59.26	62.77	76.23	67.73	72.01	100.47	115.00	91.00	109.00	.
1985	.	17.97	26.04	34.60	42.75	49.77	56.48	61.33	68.20	72.29	77.31	92.93	71.24	.	.	133.00
1986	10.00	13.00	23.94	35.09	44.47	51.24	56.17	61.46	64.38	74.88	83.12	92.54	.	106.00	.	.
1987	.	14.19	27.05	35.51	43.03	50.91	55.01	58.63	62.40	67.91	77.98	87.95	95.05	112.00	.	113.63
1988	7.00	.	27.32	34.13	39.32	52.41	55.61	57.53	64.36	68.97	84.00	86.83	91.00	.	106.13	.
1989	.	25.00	27.87	34.84	43.65	49.23	53.96	61.89	65.42	63.46	91.70	106.00	107.26	100.00	.	.
1990	10.00	14.29	28.41	32.85	40.23	51.15	55.15	65.15	71.01	69.84	70.77	.	.	.	.	.
1991	.	19.00	26.30	34.50	41.28	48.73	56.30	61.27	70.95	75.27	73.33	88.31	103.00	.	.	.
1992	.	.	28.34	34.19	42.11	49.24	56.15	54.52	64.68	66.55	94.00	.	.	.	94.00	.
1993	.	12.32	26.39	32.74	41.88	49.27	51.82	56.27	78.61	.	.	.	.	.	.	.
1994	.	17.50	26.73	32.96	39.86	47.40	52.64	59.63	67.51	64.55	82.00	97.00	.	.	.	.
1995	7.80	17.21	27.61	32.92	42.66	46.24	50.84	54.33	57.82	51.92	.	.	.	.	.	.
1996	10.00	24.93	30.61	33.77	40.59	51.10	52.95	56.07	59.52	79.00	58.00	.	.	.	.	.
1997	.	25.00	27.80	35.22	38.31	44.26	49.00	59.77	67.00	.	.	.	.	.	.	.
1998	13.00	19.00	28.62	38.50	44.80	49.40	48.88	52.29	65.64	.	.	73.00	.	.	.	.
1999	.	16.16	26.88	33.30	38.96	47.03	50.54	59.74	63.27	64.00	.	70.81	.	.	.	.
2000	7.00	22.10	26.04	34.34	42.71	47.97	56.02	60.73	60.06	.	82.00	.	.	.	.	.
2001	4.00	19.00	28.38	36.46	41.94	48.47	53.24	54.14	55.46	.	.	.	.	.	.	.
2002	.	22.73	29.69	34.31	41.42	46.28	61.95	.	.	.	.	.	58.00	.	.	.

Division 4W

	Age															
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1970	10.00	19.76	33.55	44.99	52.80	61.75	71.35	77.92	79.54	79.00	83.42	.	112.00	.	.	.
1971	7.00	15.77	22.61	35.15	51.33	55.64	59.44	67.70	69.17	73.11	.	67.00	100.00	.	.	.
1972	.	19.21	28.50	41.12	54.58	60.07	67.51	82.00	79.00	98.00	.	.	.	.	.	.
1973	.	21.18	28.46	39.55	47.86	51.94	60.60	57.83	69.38	61.00	95.74	.	.	.	97.00	.
1974	8.77	24.00	31.13	38.08	47.58	55.56	64.75	75.64	74.36	63.40	73.00	.	88.00	.	.	.
1975	10.00	21.11	27.41	36.58	45.98	55.74	66.74	80.03		88.08	.	.	100.00	.	.	.
1976	.	20.63	28.42	36.34	46.25	51.94	59.82	69.20		.	.	88.00	.	.	.	.
1977	.	22.74	30.72	40.38	47.57	58.83	64.11	71.42	85.02	.	.	.	76.00	.	.	.
1978	9.38	18.98	33.44	41.31	50.24	57.74	66.47	67.19	79.30	100.00	118.00	.	.	.	.	.
1979	8.76	14.74	27.22	36.01	45.97	51.90	59.77	67.81	74.96	69.39	.	.	.	.	.	.
1980	7.09	17.46	30.71	38.27	45.78	51.78	58.07	61.64	81.26	71.17	.	.	.	.	.	.
1981	7.27	19.86	25.83	40.06	46.70	54.60	57.18	60.88	64.56	80.54	79.00	94.00	.	.	.	.
1982	7.00	17.63	30.97	36.07	41.35	49.15	55.21	60.23	65.68	64.31	.	.	.	.	.	.
1983	7.00	19.34	26.44	36.90	46.80	51.37	58.07	61.41	61.42	64.00	.	.	.	.	.	.
1984	10.76	21.01	26.44	35.47	43.29	52.59	56.56	59.35	65.29	72.77	70.00	68.50	.	.	.	.
1985	.	17.58	21.14	33.61	41.02	49.11	54.24	59.73	66.42	77.73	.	88.00	100.00	.	.	.
1986	10.00	18.79	27.72	35.21	41.13	53.31	59.53	63.29	71.71	74.87	72.55	.	.	.	.	.
1987	7.00	14.72	22.80	34.74	40.82	47.05	52.47	58.10	58.25	97.00	.	.	.	.	.	.
1988	8.97	18.29	28.77	33.97	41.29	50.23	55.56	58.28	61.10	59.73	.	.	.	.	.	.
1989	7.00	17.11	29.98	36.84	42.77	50.44	51.06	75.57	74.11	85.00	.	.	.	.	.	.
1990	.	19.67	28.47	35.51	41.60	46.79	54.36	54.62	63.92	.	.	.	.	.	.	.
1991	.	10.20	28.17	34.09	40.14	45.23	47.19	50.58	55.27	.	.	55.00	.	.	.	.
1992	.	18.23	21.71	31.66	34.23	42.47	44.25	52.47	50.36	94.00	.	.	.	.	.	.
1993	7.00	13.71	26.54	32.00	39.38	43.90	45.15	49.28	50.34	94.00	70.00	.	.	.	.	.
1994	9.74	22.10	27.80	32.10	36.00	40.16	45.61	48.13	52.00	.	73.00	.	.	.	.	.
1995	8.02	18.43	25.63	33.04	36.95	39.59	40.80	45.34	45.39	49.00	.	.	.	.	.	.
1996	.	17.99	25.78	32.63	36.77	43.40	44.94	50.59	54.14	.	.	.	.	.	.	.
1997	10.00	23.49	25.71	32.86	36.40	43.44	49.15	54.14	49.00	49.00	.	.	.	.	.	.
1998	5.87	17.85	24.02	33.81	38.11	44.26	49.95	65.92	57.17	.	.	.	.	.	.	.
1999	7.57	22.00	28.79	32.47	38.81	42.33	48.24	.		58.00	.	.	.	.	.	.
2000	7.00	19.32	25.96	33.66	38.95	44.89	49.84	49.59		85.00	.	.	.	.	.	.
2001	7.55	18.07	25.41	27.96	33.34	41.45	51.19	52.00	64.00	.	76.00	.	.	.	.	.
2002	.	20.65	26.66	33.44	36.87	38.24	.	.	.	.	.	.	.	.	.	.

Table 12a. July RV survey mean weights at age for 4VsW cod (VDC).

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1970	79	250	958	1,259	1,695	2,366	3,314	3,284	5,466	5,501	4,004	12,300	3,042	
1971	43	186	469	1,087	1,441	1,755	1,952	2,627	3,561	2,700	2,600	11,000	3,100	
1972	64	307	809	905	1,628	1,823	2,023	2,901	7,668	2,428				
1973	102	274	664	1,084	1,342	2,141	2,120	2,581	2,123	7,487	4,891			10,500
1974	131	320	572	1,130	1,489	2,066	3,415	3,336	2,751	3,867	8,300	5,500		
1975	82	241	456	884	1,280	1,800	2,150	3,157	4,717	5,950		10,000		
1976	79	273	523	1,039	1,552	2,460	3,432	3,449		5,958	4,900		11,250	
1977	150	316	690	1,141	1,956	2,809	3,892	5,457	5,166		6,383	5,000		
1978	72	423	746	1,264	1,950	3,106	3,254	5,190	6,738	12,733				
1979	18	239	466	959	1,459	2,342	4,042	5,762	6,077	8,850	9,043	14,200	8,800	
1980	55	313	609	985	1,513	2,243	2,915	4,800	7,419	8,243	10,731			
1981	90	349	653	1,224	1,789	2,100	2,874	4,333	6,374	8,595	9,060	11,000	11,000	
1982	49	297	512	779	1,421	2,148	2,554	3,095	4,275	6,239	7,514			9,300
1983	69	253	534	1,012	1,436	2,153	2,979	3,259	4,846	4,728	10,969	13,000	14,000	
1984	82	282	585	972	1,539	1,867	2,227	4,172	3,032	3,382	7,331	14,000	6,000	11,500
1985	42	146	427	764	1,184	1,690	2,162	2,996	3,786	4,254	7,109	4,028		
1986	67	250	472	784	1,223	1,672	2,104	2,715	4,076	4,950	7,014		9,600	
1987	28	169	469	763	1,272	1,533	1,794	2,213	3,430	4,071	6,328	8,074	17,200	
1988	66	228	413	744	1,364	1,647	1,839	2,371	3,173	5,400	6,573	7,350		13,137
1989	69	287	518	804	1,269	1,441	2,347	2,732	2,743	7,308	9,900	11,577	8,300	
1990	26	222	400	728	1,097	1,605	1,928	3,278	2,989	3,558				
1991	15	224	438	699	1,013	1,386	1,746	2,073	4,247	4,109	5,418	10,000		
1992	53	114	344	503	818	1,068	1,563	2,396	5,436	8,230				8,490
1993	19	194	331	602	834	946	1,274	1,704	9,000	1,750				
1994	68	213	338	510	772	1,050	1,847	2,231	2,156	4,482	7,150			
1995	66	214	361	520	683	1,058	1,327	1,628	1,317					
1996	70	244	395	628	867	1,009	1,505	1,817	3,750	1,624				
1997	122	212	449	717	1,020	1,500	1,857	1,958	915					
1998	58	180	473	824	1,040	1,180	1,576	2,289			3,704			
1999	77	246	331	568	813	1,181	2,015	2,358	2,329		3,725			
2000	82	186	416	666	905	1,449	1,674	1,988	6,300	4,960				
2001	60	162	345	650	902	1,341	1,553	1,637		5,498				
2002	85	226	411	595	823	2,021						1,530		

Table 12b. July RV survey mean weights at age for 4VsW cod based on q-corrected size composition.

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1970	65	189	741	1,213	1,738	2,525	3,658	3,714	6,122	6,504	3,487	14,940	4,046	.
1971	38	131	395	1,026	1,424	1,793	2,152	2,736	3,751	3,261	2,851	9,728	2,851	.
1972	63	254	698	857	1,593	1,850	2,013	2,896	8,639	2,547	.	.	.	.
1973	94	236	616	1,076	1,377	2,231	2,203	3,055	2,369	8,423	4,843	.	.	8,743
1974	107	275	522	1,075	1,625	2,223	3,775	3,666	3,043	4,518	9,649	7,101	.	.
1975	87	235	566	1,005	1,687	2,517	3,702	3,821	5,501	7,095	.	10,546	.	.
1976	78	228	461	977	1,531	2,355	3,637	3,651	.	5,803	7,237	.	10,800	.
1977	135	262	646	1,096	1,960	2,745	3,732	5,826	5,618	.	5,980	4,362	.	.
1978	66	377	699	1,237	1,908	2,945	3,280	5,110	7,105	13,357	.	.	.	.
1979	28	196	426	926	1,398	2,302	3,982	6,122	6,502	9,884	8,998	15,736	8,929	.
1980	58	256	569	965	1,488	2,234	2,875	4,593	7,338	7,975	10,101	.	.	.
1981	81	280	626	1,167	1,764	2,127	2,831	4,298	6,447	8,583	8,225	12,424	11,475	.
1982	48	275	449	701	1,352	2,147	2,587	3,357	4,283	6,044	7,967	.	.	9,639
1983	70	191	489	979	1,361	2,115	2,981	3,293	4,617	4,705	9,212	11,623	11,623	.
1984	66	234	531	931	1,534	1,846	2,257	3,784	3,035	3,320	7,453	13,532	6,746	11,539
1985	51	104	379	706	1,141	1,641	2,144	2,967	3,768	4,359	7,080	4,479	.	.
1986	61	193	395	774	1,232	1,655	2,174	2,692	3,943	4,919	7,237	.	10,931	.
1987	35	133	409	701	1,219	1,530	1,883	2,333	3,221	4,563	6,381	8,169	12,690	.
1988	63	217	379	657	1,255	1,636	1,827	2,499	3,026	5,467	6,266	6,836	.	10,835
1989	52	244	449	751	1,182	1,431	2,415	2,880	2,705	7,834	11,815	12,326	9,858	.
1990	39	215	366	663	1,032	1,545	1,792	3,307	3,290	3,429	.	.	.	.
1991	14	200	386	644	970	1,321	1,641	1,966	4,280	3,973	5,759	9,792	.	.
1992	55	97	297	405	775	995	1,478	2,152	5,296	7,524	.	.	.	7,524
1993	20	174	302	570	792	886	1,186	1,468	7,472	3,080	.	.	.	.
1994	62	183	301	451	730	1,087	1,812	2,393	2,352	4,162	7,960	.	.	.
1995	54	166	327	488	628	975	1,291	1,673	1,197	.	.	.	.	.
1996	55	209	336	522	803	974	1,454	1,781	4,899	1,859	.	.	.	.
1997	119	168	376	551	886	1,274	1,961	2,314	1,107	.	.	.	.	.
1998	50	142	422	765	1,071	1,155	1,495	2,256	.	.	3,778	.	.	.
1999	58	217	313	537	743	1,150	2,040	2,386	2,247	.	3,413	.	.	.
2000	71	156	359	613	898	1,477	1,717	2,113	5,934	5,307	.	.	.	.
2001	52	149	255	462	843	1,487	1,539	1,724	.	4,440	.	.	.	.
2002	79	179	356	524	790	2,311		.	.	.	.	1,875	.	.

Table 13. Spawning stock biomass estimated from q-corrected survey numbers and updated (see text) maturity ogives.

4VsW	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	SSB	Age 5+
1970	.	.	.	.	5,889.9	7,725.6	3,764.8	6,098.4	2,000.0	575.8	1,439.8	882.4	1,361.0	651.7	.	.	.	.	.	30,389.5	24,499.6
1971	.	.	.	.	4,713.6	22,730.1	10,065.7	7,037.3	3,745.2	2,171.5	207.7	355.6	510.8	536.5	.	.	.	.	.	52,074.1	47,360.5
1972	.	.	.	.	16,397.2	9,376.7	10,623.2	3,114.6	1,470.4	3,849.6	374.4	.	.	.	.	.	.	.	.	45,206.0	28,808.7
1973	.	.	.	.	33,362.8	31,227.2	3,881.3	6,068.6	2,529.8	946.7	3,896.7	724.4	.	.	1,596.6	127.5	.	.	.	84,361.6	50,998.8
1974	.	.	.	.	3,446.7	3,234.7	4,703.8	1,289.2	1,548.7	625.3	660.5	548.1	375.1	.	.	843.0	.	.	.	17,275.1	13,828.4
1975	.	.	.	.	3,573.7	5,054.6	1,536.4	2,710.6	738.5	2,033.2	119.5	.	648.5	.	.	.	.	.	.	16,415.0	12,841.3
1976	.	.	.	.	5,176.4	8,820.8	2,527.8	1,781.8	3,002.4	.	3,253.2	556.6	.	1,380.2	.	.	.	.	.	26,499.3	21,322.9
1977	.	.	.	.	9,604.0	18,565.2	11,012.7	3,119.6	3,247.9	733.9	.	519.0	246.2	.	.	.	.	.	.	47,048.4	37,444.4
1978	.	.	.	.	22,412.8	17,318.3	9,434.7	2,686.6	853.5	576.1	951.8	.	.	.	.	.	1,225.6	.	689.1	56,148.6	33,735.7
1979	.	.	.	3,121.7	13,222.5	25,616.6	19,659.0	9,822.2	5,573.1	2,412.6	738.8	363.5	66.9	153.3	.	.	.	.	.	80,750.2	64,405.9
1980	.	.	.	4,112.7	8,425.1	25,619.7	25,181.8	12,596.6	5,408.8	2,234.7	1,897.1	841.2	.	.	.	.	.	.	.	86,317.6	73,779.8
1981	.	.	.	4,423.4	27,540.3	19,090.6	16,019.7	11,143.6	5,929.7	2,914.9	4,364.2	1,083.2	275.9	254.8	.	298.1	.	.	.	93,338.3	61,374.6
1982	.	.	.	25,531.8	31,816.2	17,042.8	15,182.1	9,852.6	5,472.8	1,544.3	2,205.5	1,572.4	.	.	138.5	.	.	.	.	110,359.0	53,010.9
1983	.	.	.	26,300.1	43,908.8	38,095.4	24,489.8	7,667.5	4,586.7	1,571.4	894.5	896.3	536.5	536.5	.	.	.	.	.	149,483.5	79,274.5
1984	.	.	.	7,645.7	43,207.6	54,583.1	29,523.6	24,318.7	3,925.1	2,573.0	831.3	4,420.1	203.6	103.4	256.5	.	.	.	.	171,591.6	120,738.4
1985	.	.	.	4,359.9	18,631.8	31,739.8	22,879.8	14,509.5	7,701.6	4,647.7	1,262.6	1,974.2	769.5	.	.	710.8	.	.	.	109,187.1	86,195.4
1986	.	.	.	823.0	12,346.4	13,808.1	14,600.5	6,506.0	3,767.6	2,445.6	1,912.5	644.2	.	620.8	.	.	.	.	.	57,474.8	44,305.4
1987	.	.	.	2,773.8	9,422.6	31,717.5	15,144.7	13,620.5	9,071.0	2,821.8	277.3	1,277.5	887.5	298.3	.	876.5	.	.	.	88,189.0	75,992.6
1988	.	.	.	4,111.1	11,545.2	11,809.7	15,368.4	9,602.9	6,309.6	1,705.6	710.4	1,832.1	275.9	.	485.0	.	.	.	.	63,756.0	48,099.7
1989	.	.	.	4,182.3	10,120.4	12,311.9	5,550.9	12,556.2	3,516.4	2,265.5	252.5	96.9	584.2	192.1	.	.	.	.	.	51,629.1	37,326.5
1990	.	.	.	10,085.1	16,678.3	12,371.0	6,207.7	2,967.8	2,431.3	892.7	623.1	.	.	.	.	.	.	.	.	52,257.2	25,493.8
1991	.	.	.	1,870.3	12,569.6	14,063.1	5,831.6	1,855.2	942.0	2,050.7	700.1	787.0	293.7	.	.	.	.	.	.	40,963.3	26,523.4
1992	.	.	.	3,473.8	6,883.4	7,164.8	2,885.0	607.9	424.0	486.1	324.3	.	.	.	162.2	.	.	.	.	22,411.6	12,054.4
1993	.	.	.	3,363.8	12,828.4	15,375.2	9,141.8	3,903.2	1,198.1	92.8	128.0	.	.	.	.	.	.	.	.	46,031.4	29,839.2
1994	.	.	.	1,446.7	3,969.2	2,912.8	1,607.4	2,492.4	383.1	230.8	433.6	457.3	.	.	.	.	.	.	.	13,933.2	8,517.3
1995	.	.	.	2,501.9	5,487.5	4,760.1	2,454.5	1,579.1	2,248.3	242.3	.	.	.	.	.	.	.	.	.	19,273.7	11,284.2
1996	.	.	.	1,756.8	2,259.6	1,832.1	1,111.3	415.7	263.9	71.0	45.0	.	.	.	.	.	.	.	.	7,755.5	3,739.1
1997	.	.	.	965.7	1,606.7	806.7	374.0	612.7	207.2	33.9	.	.	.	.	.	.	.	.	.	4,607.0	2,034.5
1998	.	.	.	2,508.5	10,480.8	3,644.7	785.8	1,354.6	328.0	.	.	115.8	.	.	.	.	.	.	.	19,218.1	6,228.8
1999	.	.	.	2,908.7	6,904.0	4,377.3	1,165.1	277.2	615.2	109.1	.	264.6	.	.	.	.	.	.	.	16,621.3	6,808.5
2000	.	.	.	1,172.2	1,582.8	1,455.8	1,245.4	580.3	248.0	211.2	205.9	.	.	.	.	.	.	.	.	6,701.6	3,946.6
2001	.	.	.	4,291.0	3,493.5	1,122.6	547.6	325.1	240.9	.	200.8	.	.	.	.	.	.	.	.	10,221.4	2,436.9
2002	.	.	.	1,979.4	1,996.9	578.5	134.8	.	.	.	.	.	32.9	.	.	.	.	.	.	4,722.5	746.1

Table 14. RV Z's calculated from q-corrected RV numbers

	Age													
Year	0	1	2	3	4	5	6	7	8	9	10	Ages 2-4	Ages 5-8	Ages5-8/6-9
1970		-1.043	-0.089	-0.087	-0.497	-0.234	-0.785	0.197	-0.072	0.390	0.574	-0.224	-0.223	-0.285494
1971		-0.187	0.969	0.652	0.445	1.022	1.289	1.863	1.122	1.371	.	0.689	1.324	1.156713
1972		-0.848	-1.279	-1.336	0.523	1.219	0.735	0.625	0.239	-0.038	-0.017	-0.697	0.705	0.872041
1973		-0.552	1.556	2.787	3.439	2.372	1.628	1.875	1.394	1.006	2.097	2.594	1.817	2.205702
1974		0.160	1.462	1.490	0.761	1.182	1.061	0.569	0.134	2.501	.	1.238	0.737	0.938449
1975		-0.476	0.033	0.688	0.211	1.026	0.220	-0.116	.	-0.417	-1.519	0.310	0.377	0.641571
1976		-0.376	0.207	0.457	0.112	0.362	0.250	-0.129	1.840	.	1.866	0.259	0.581	0.386414
1977		-1.860	-0.342	-0.013	0.659	1.084	1.589	1.610	1.928	0.606	.	0.101	1.553	1.248131
1978		-0.166	-0.042	0.809	0.682	0.061	0.261	-0.106	-0.798	0.081	0.567	0.483	-0.145	0.076612
1979		-0.100	0.254	0.925	0.101	0.486	0.667	0.739	1.095	0.445	-0.108	0.427	0.747	0.568046
1980		-1.461	-0.222	-0.084	0.073	0.827	1.052	1.155	0.957	-0.513	0.591	-0.078	0.998	0.940004
1981		-1.703	-1.272	-0.230	1.445	0.956	1.212	1.412	1.873	0.745	1.477	-0.019	1.363	1.139938
1982		-1.465	0.647	1.335	0.770	0.085	1.011	1.006	1.566	0.640	1.322	0.917	0.917	0.457953
1983		1.788	0.976	1.247	0.519	0.560	0.072	0.908	0.496	0.307	-1.138	0.914	0.509	0.418455
1984		-0.988	0.377	0.493	0.800	0.937	0.860	1.424	-0.173	1.074	-0.108	0.557	0.762	0.948875
1985		1.194	1.355	0.774	1.144	1.149	1.539	1.576	1.431	1.155	1.180	1.091	1.424	1.307341
1986		-0.812	-0.675	-0.765	-0.203	0.124	0.198	-0.262	0.469	2.323	0.664	-0.548	0.132	0.108927
1987		-0.423	-0.625	0.146	0.645	1.019	0.633	1.053	1.931	1.908	-1.571	0.055	1.159	0.975493
1988		-3.711	0.230	0.883	0.810	0.886	0.591	1.460	1.104	2.862	2.762	0.641	1.010	0.870091
1989		-1.825	-0.394	0.106	0.404	0.953	0.851	1.956	1.504	1.528	.	0.039	1.316	1.131679
1990		-1.257	0.944	1.445	0.839	0.999	1.268	1.240	0.428	0.432	0.285	1.076	0.984	1.039781
1991		-0.910	-0.877	-0.157	1.034	1.609	2.373	1.747	1.652	2.408	.	0.000	1.845	1.74026
1992		1.545	0.828	0.446	0.154	-0.110	-0.127	-0.685	2.764	0.792	.	0.476	0.461	-0.12413
1993		-0.881	-0.478	1.333	2.017	2.575	2.015	3.024	2.118	-2.126	-0.323	0.957	2.433	2.386557
1994		-0.874	-0.075	0.539	0.437	0.460	0.189	0.023	-0.235	.	.	0.300	0.109	0.281067
1995		-1.286	-0.268	1.265	1.594	1.894	2.176	2.111	4.530	2.123	.	0.864	2.678	2.075591
1996		0.634	1.396	1.277	1.559	2.051	1.295	1.161	1.577	.	.	1.411	1.521	1.669935
1997		-1.945	-0.540	-0.982	-0.155	0.291	-1.127	0.765	.	.	.	-0.559	-0.024	-0.075752
1998		-1.229	-0.892	-0.079	0.845	1.212	1.610	1.257	1.097	.	.	-0.042	1.294	1.260784
1999		-0.067	1.229	1.974	2.071	1.943	1.098	0.147	1.980	0.224	.	1.758	1.292	1.698848
2000		-2.498	-1.691	-0.146	0.663	1.482	1.385	0.883	.	-0.240	.	-0.391	1.250	1.401299
2001		-0.141	1.816	2.177	2.336	3.128	.	.	.	.	.	2.109	3.128	3.559771
Mean 1970-1981		-0.718	0.103	0.505	0.663	0.864	0.765	0.808	0.883	0.562	0.614			
Mean 1983-1992		-0.540	0.214	0.462	0.615	0.813	0.826	1.042	1.161	1.479	0.296			
Mean 1992-2001		-0.921	0.055	0.817	1.263	1.671	1.080	1.171	1.845	-0.005	-0.323			

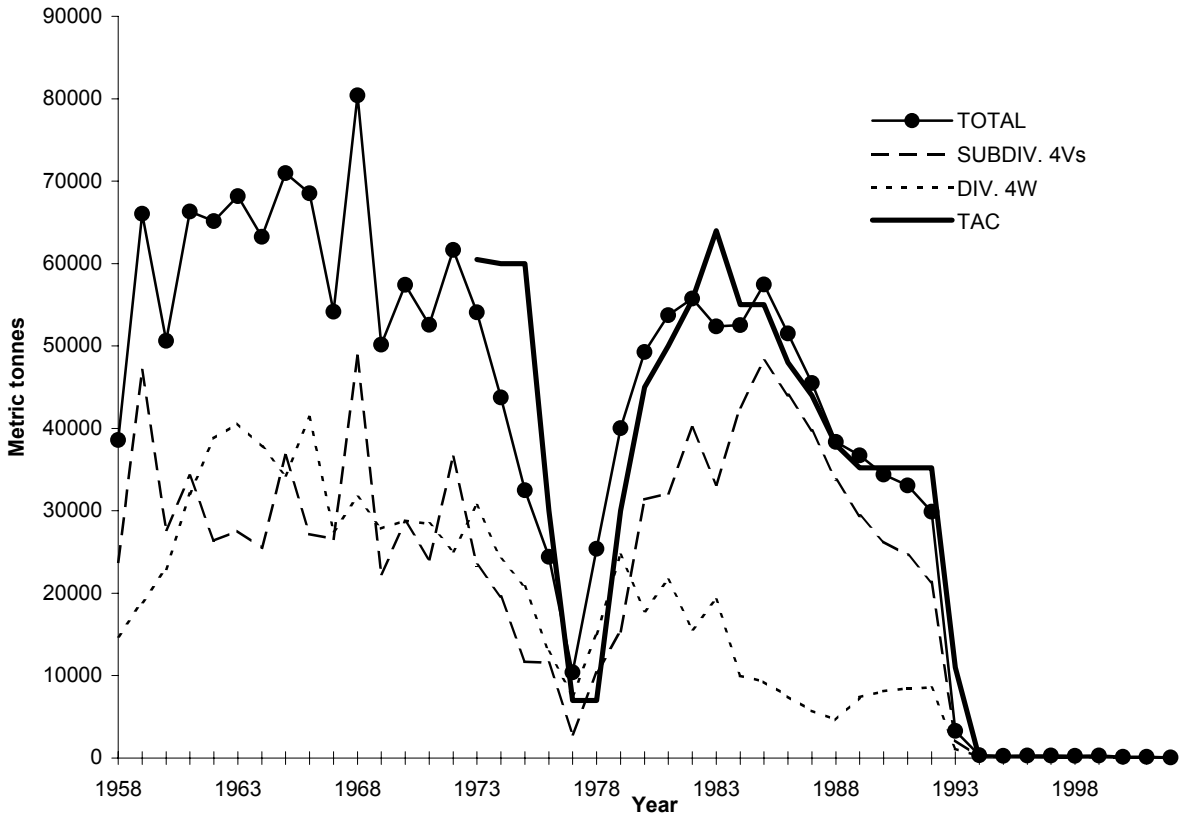


Figure 1. Nominal landings and TAC for 4VsW cod

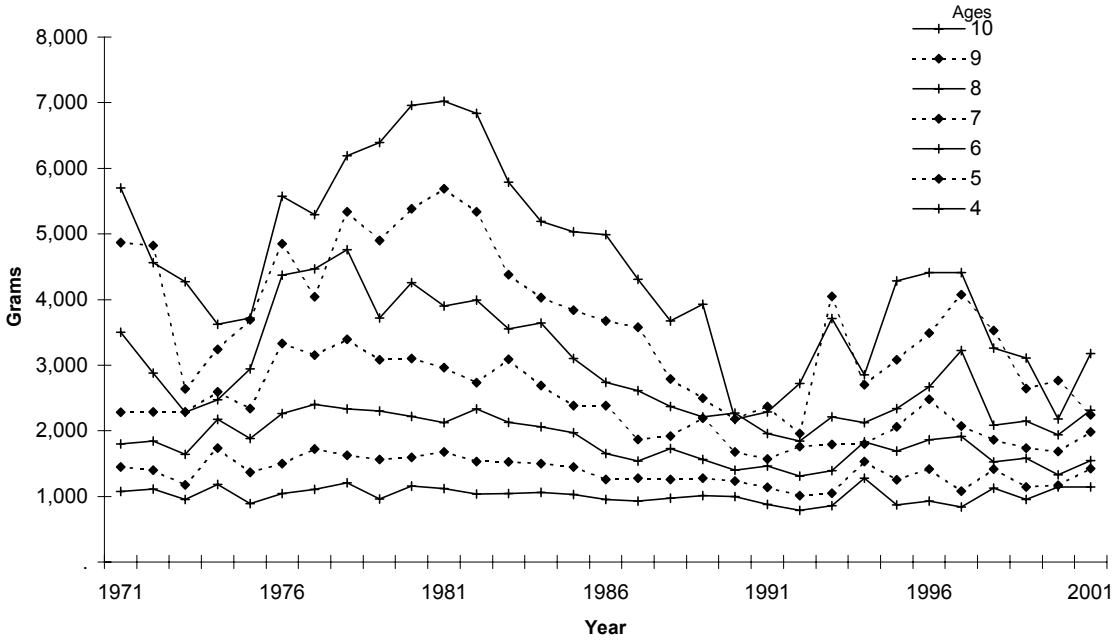


Figure 2. 4VsW cod mean weights at age from commercial landings

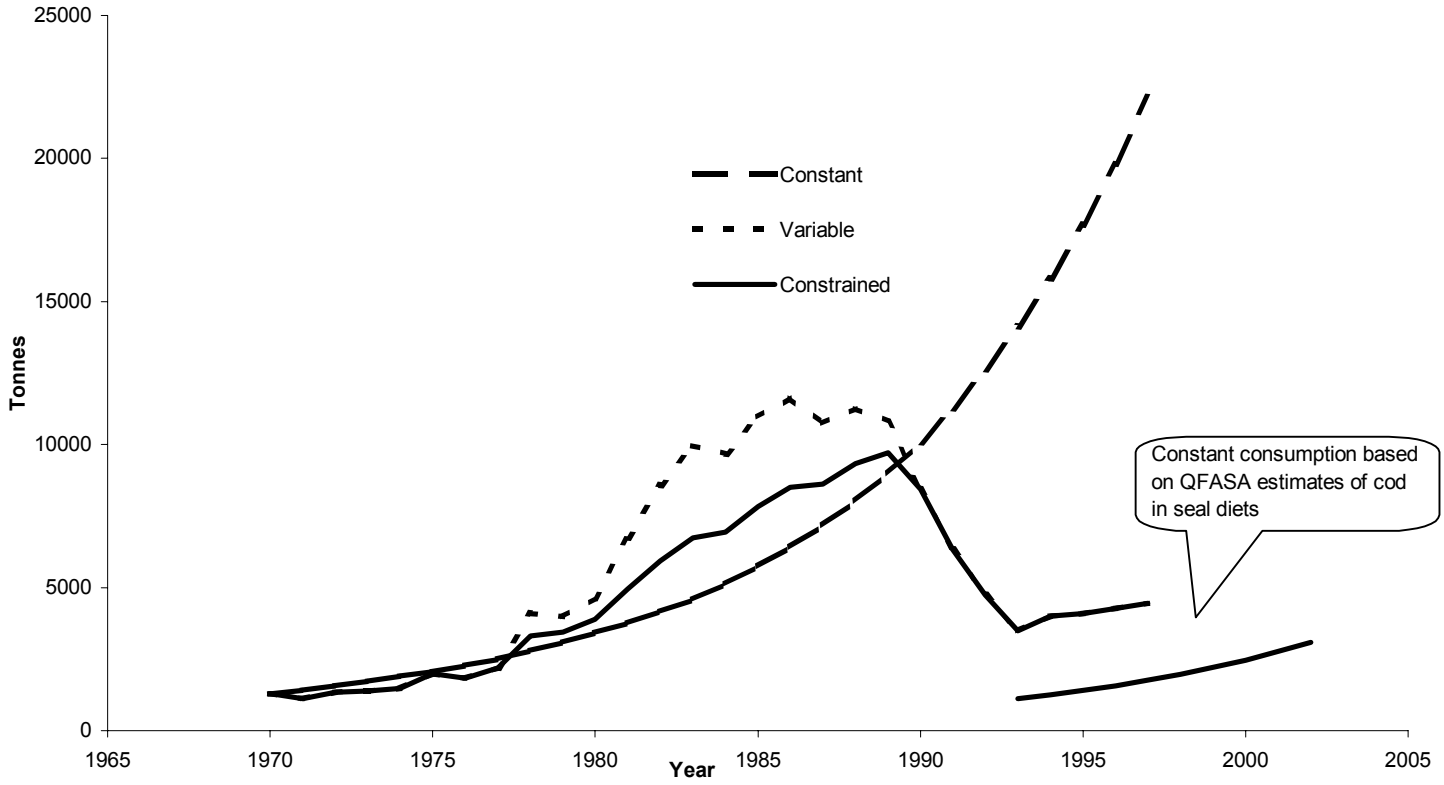


Figure 3. Biomass of 4VsW cod consumed by grey seals under three models of predation

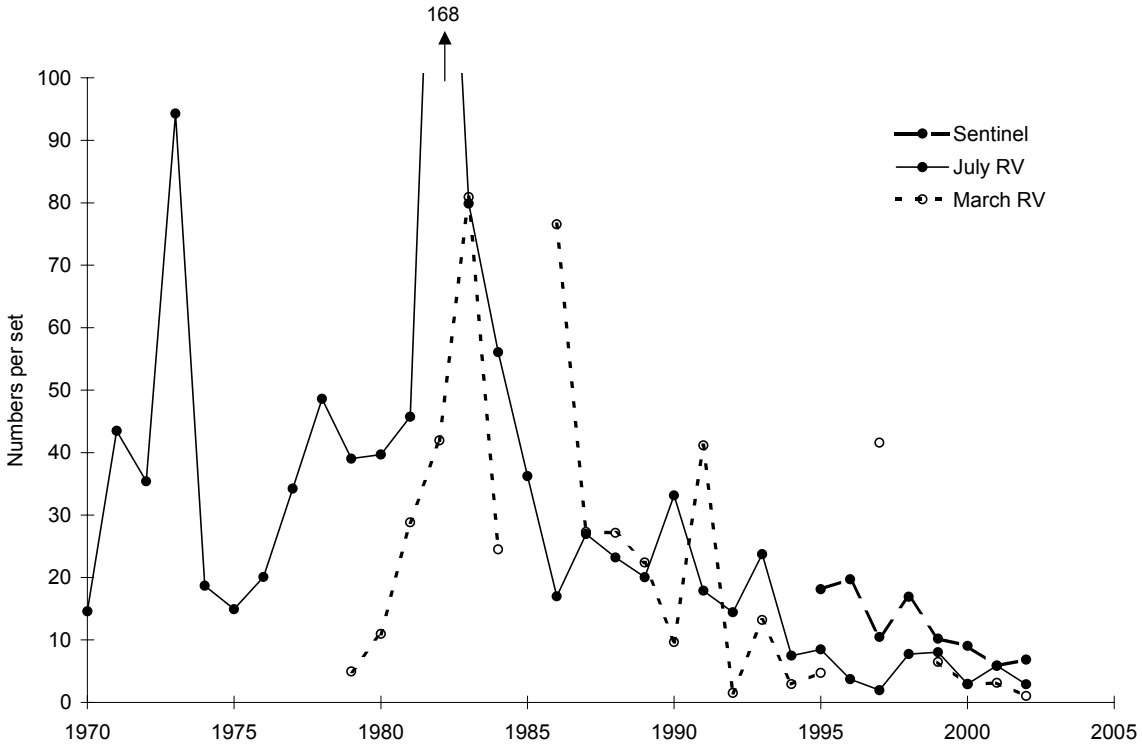


Figure 4. Survey indices of abundance of 4VsW cod (RV ages 3+, Sentinel 34+ cm)

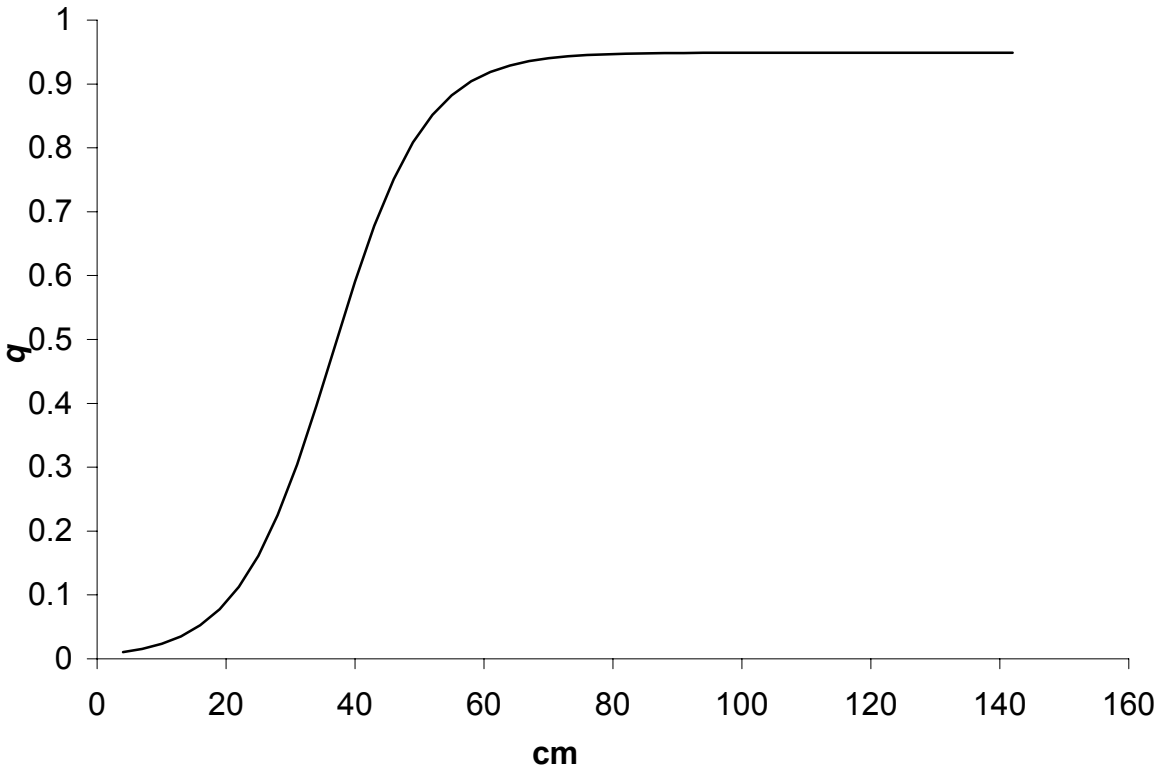


Figure 5. Catchability (*q*) curve applied to July RV length frequencies

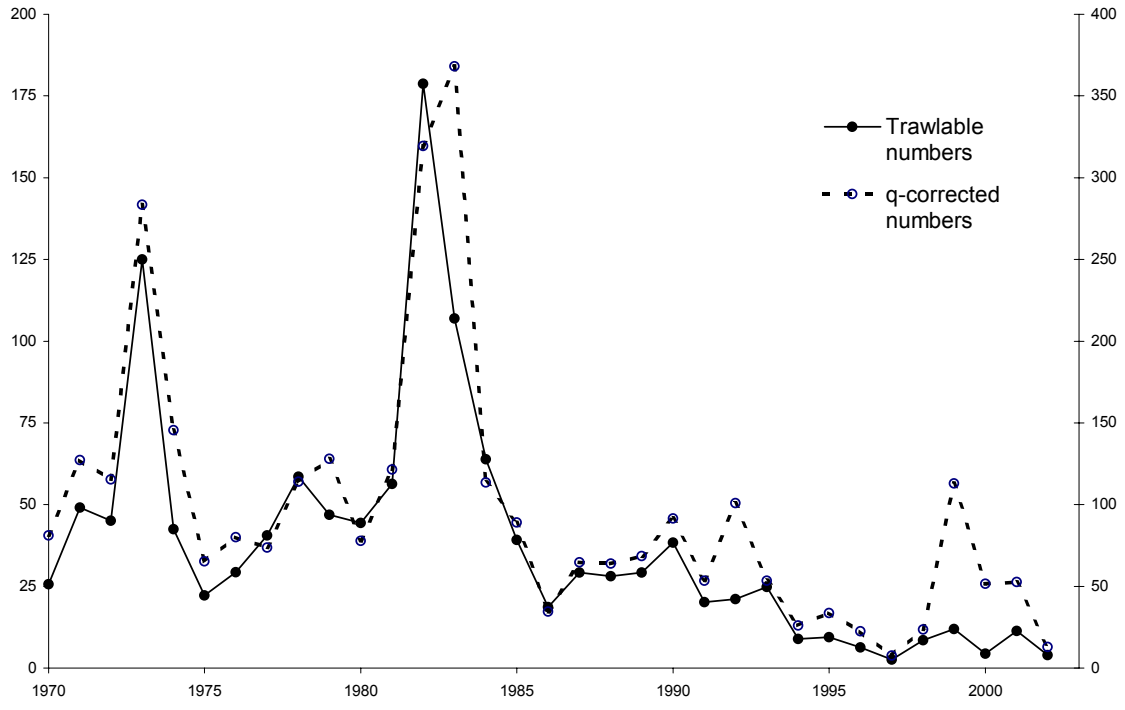


Figure 6. Trawlable (left axis) and q-corrected (right axis) estimates of 4VsW cod population numbers (millions) from July RV surveys.

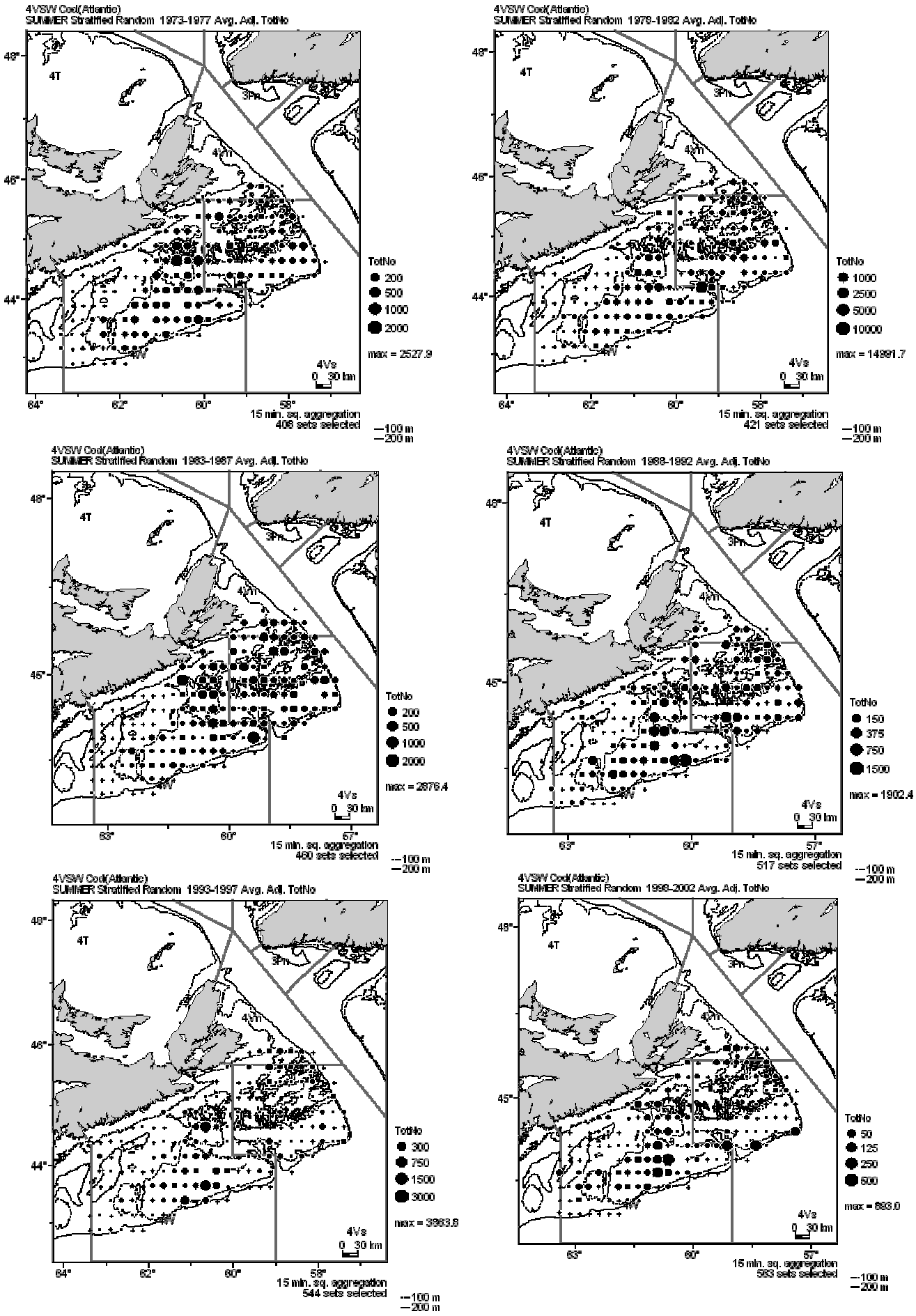


Figure 7. July RV distribution aggregated by 5 year blocks

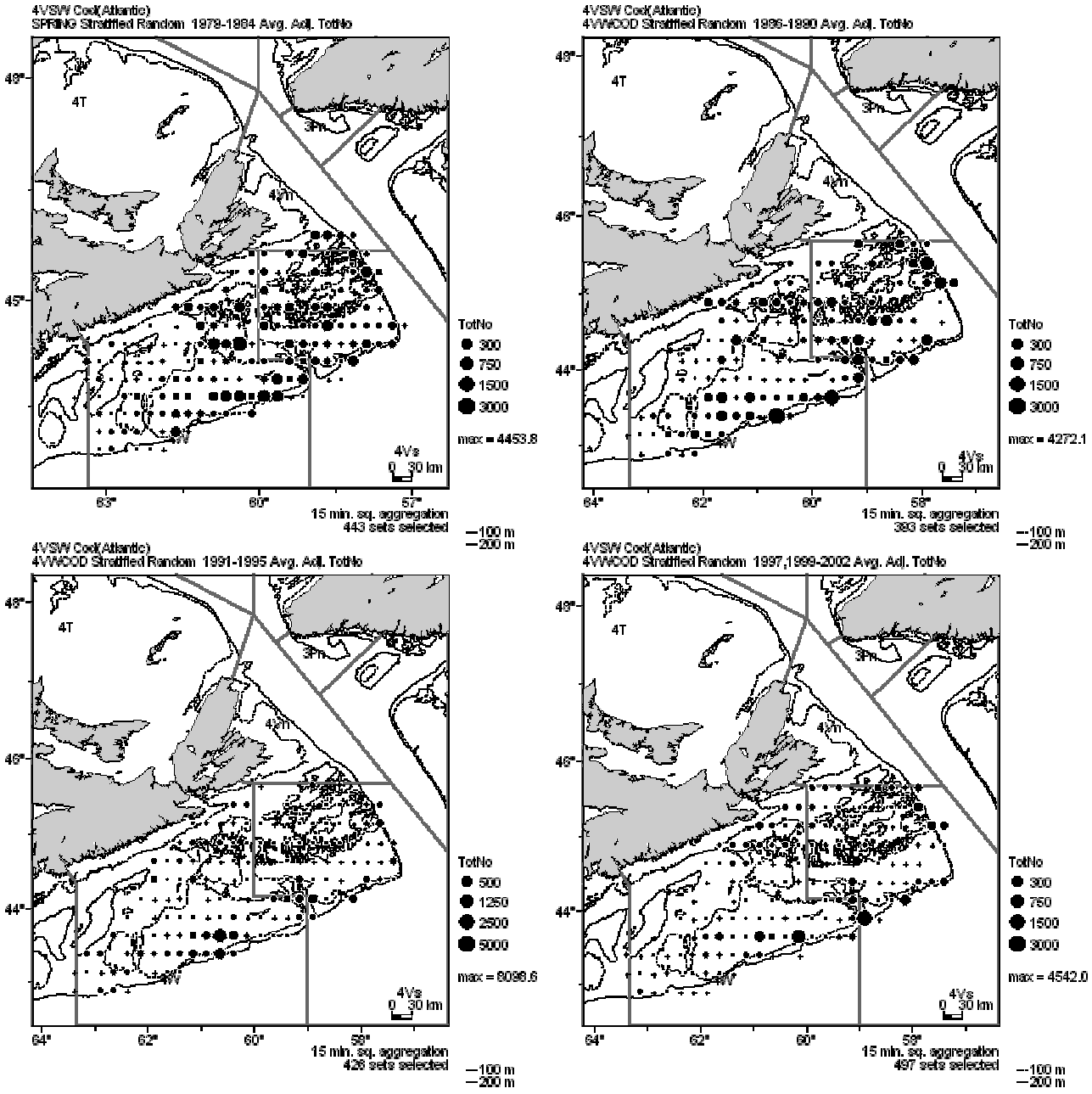


Figure 8. March RV distribution aggregated by 5 year (approx.) blocks

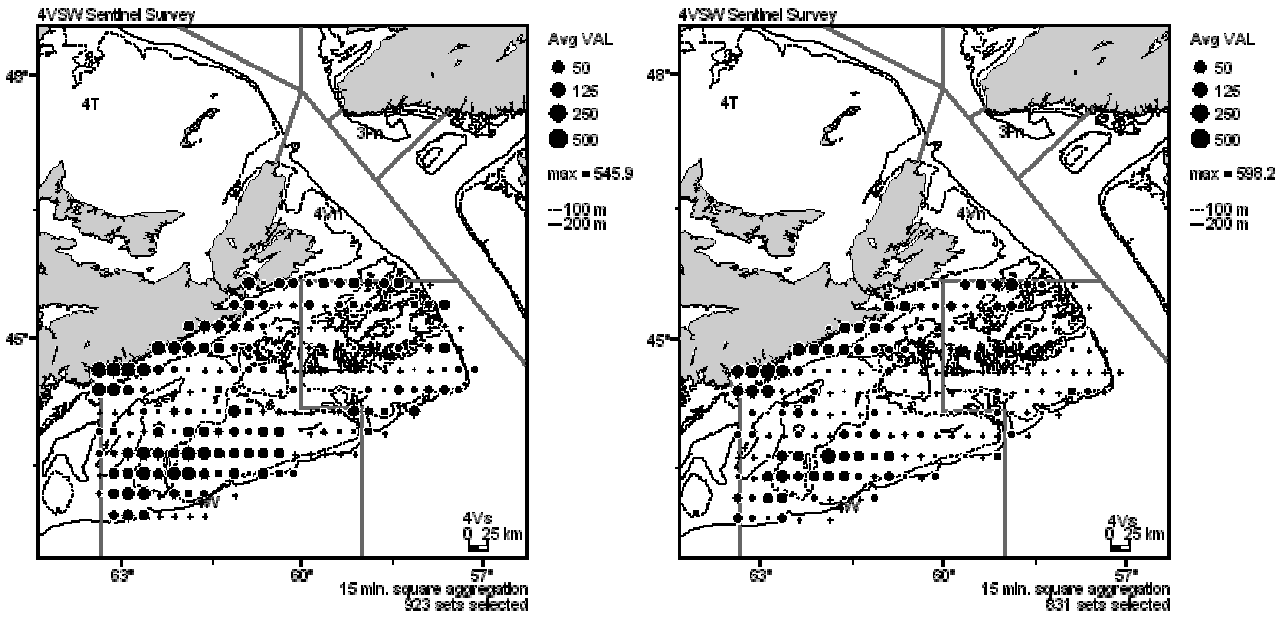


Figure 9. September (Sentinel Survey) distribution aggregated by 4 year blocks

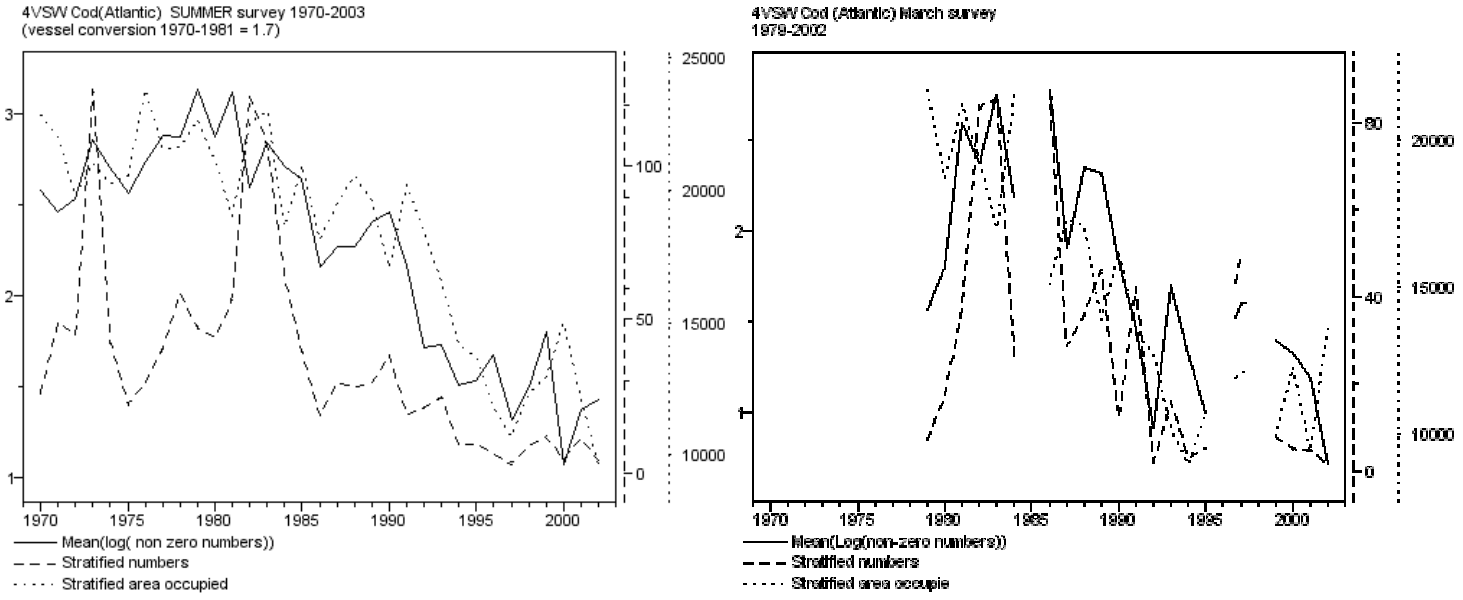


Figure 10. Indices of spatial distribution for 4VsW cod from July RV surveys (left) and March (right)

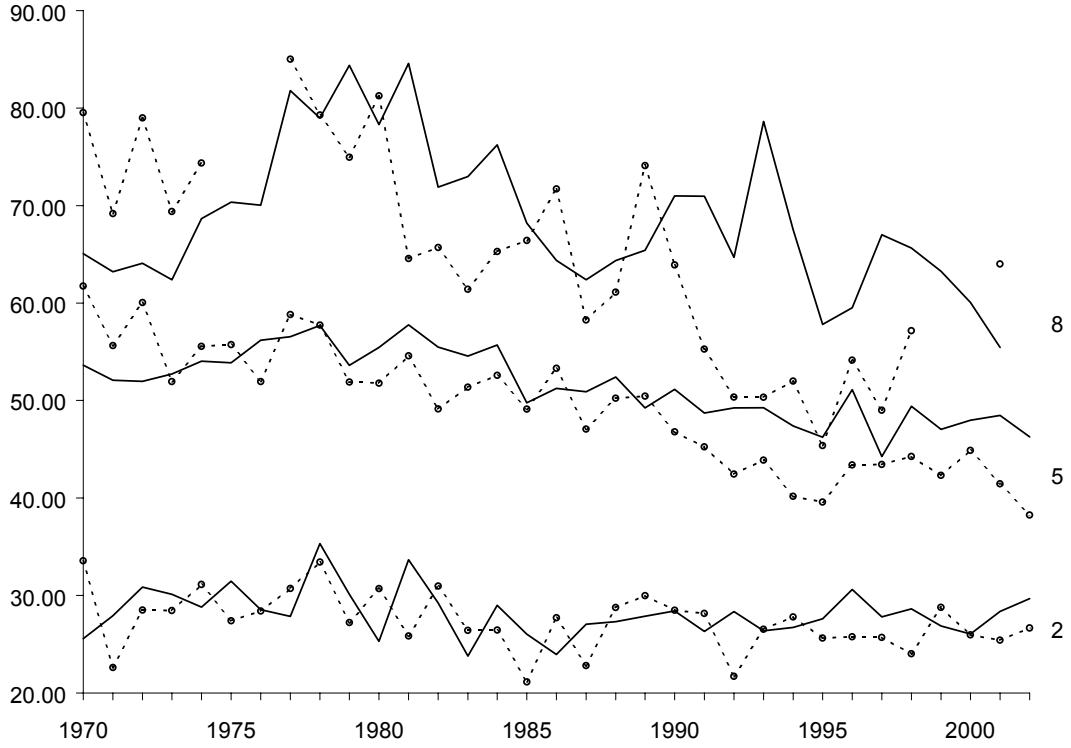


Figure 11. Mean length (cm) of cod at selected ages (age 2, age 5 and age 8) in 4VS (solid) and 4W (dashed).

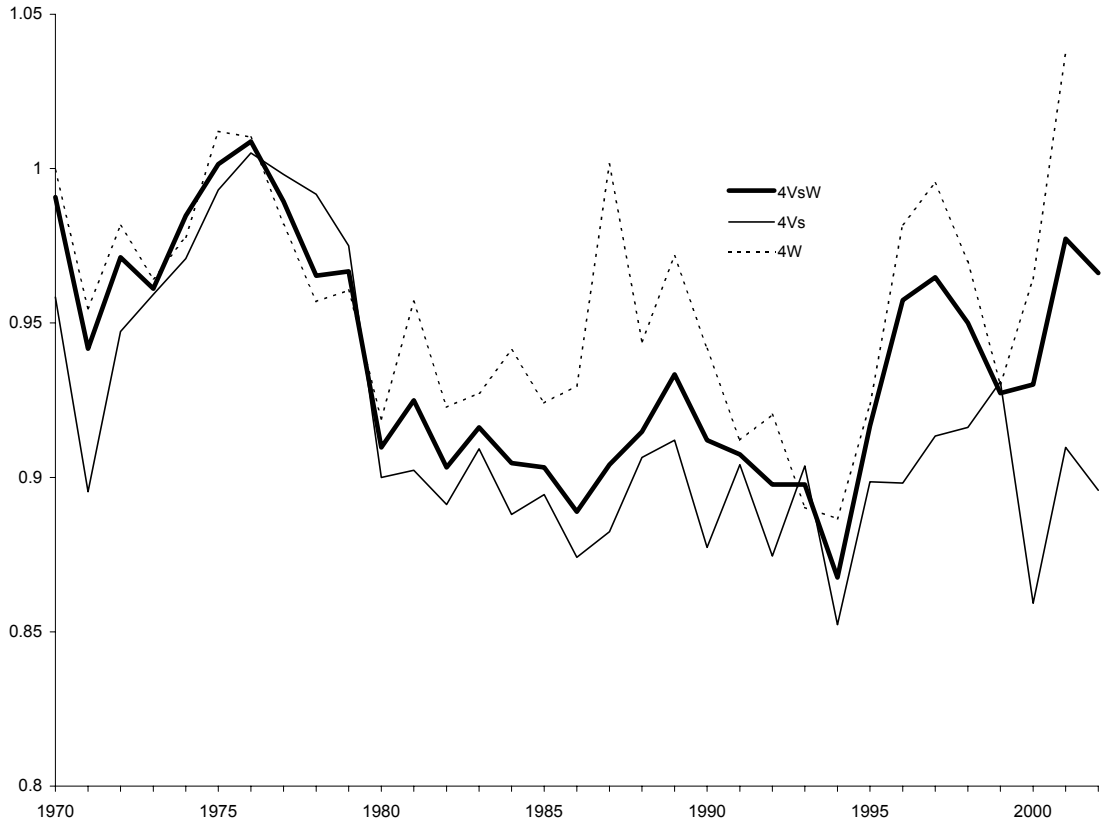


Figure 12. Fish condition (pseudo-Fultons K) based on length-weight regressions by division

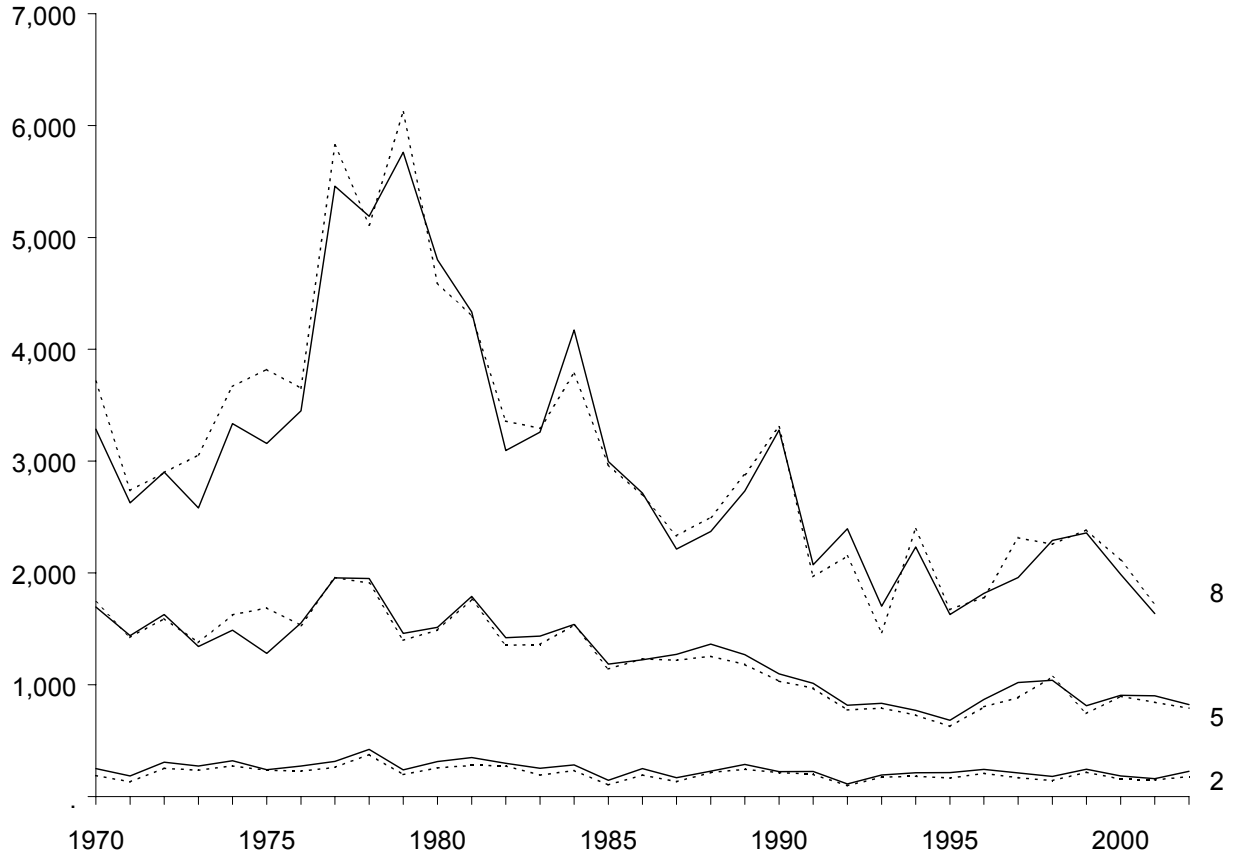


Figure 13. Mean weight of cod at selected ages (age 2, age 5 and age 8) in 4VsW. Weights from trawlable length frequencies (solid) are compared to those from q-corrected length frequencies (dashed).

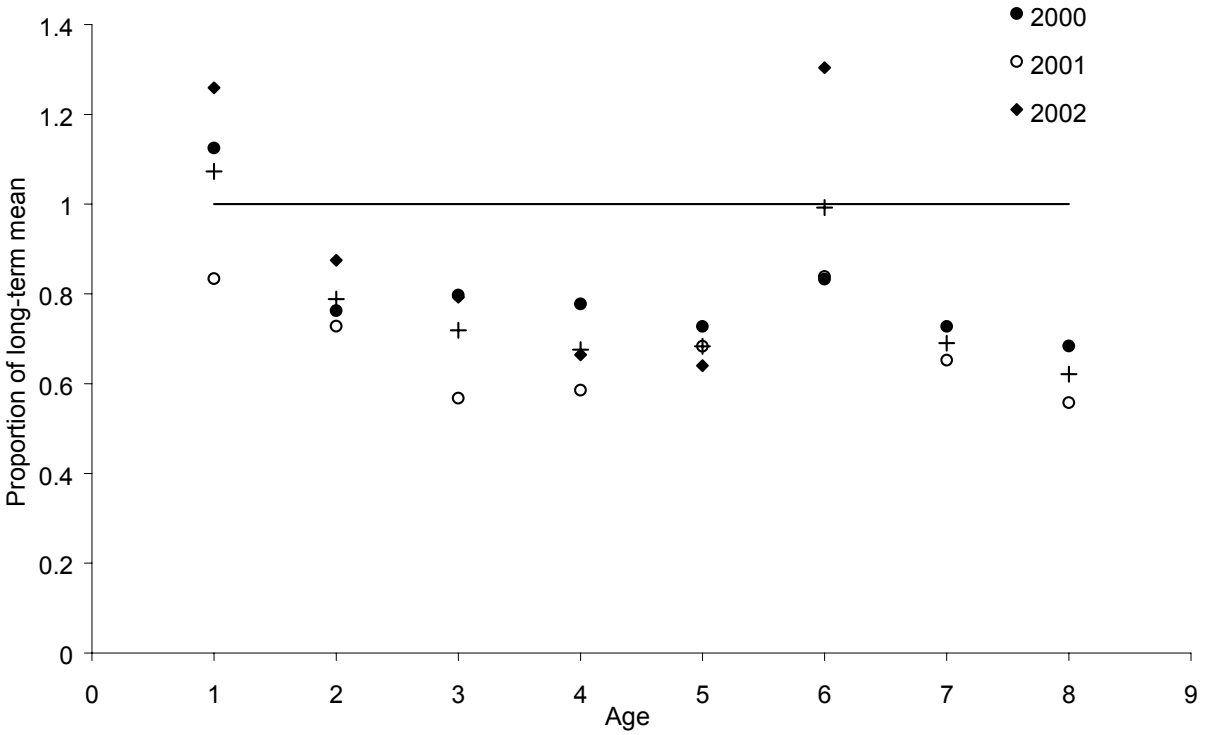


Figure 14. Ratio of recent mean weights at age with the long-term mean.

Figure 15 A

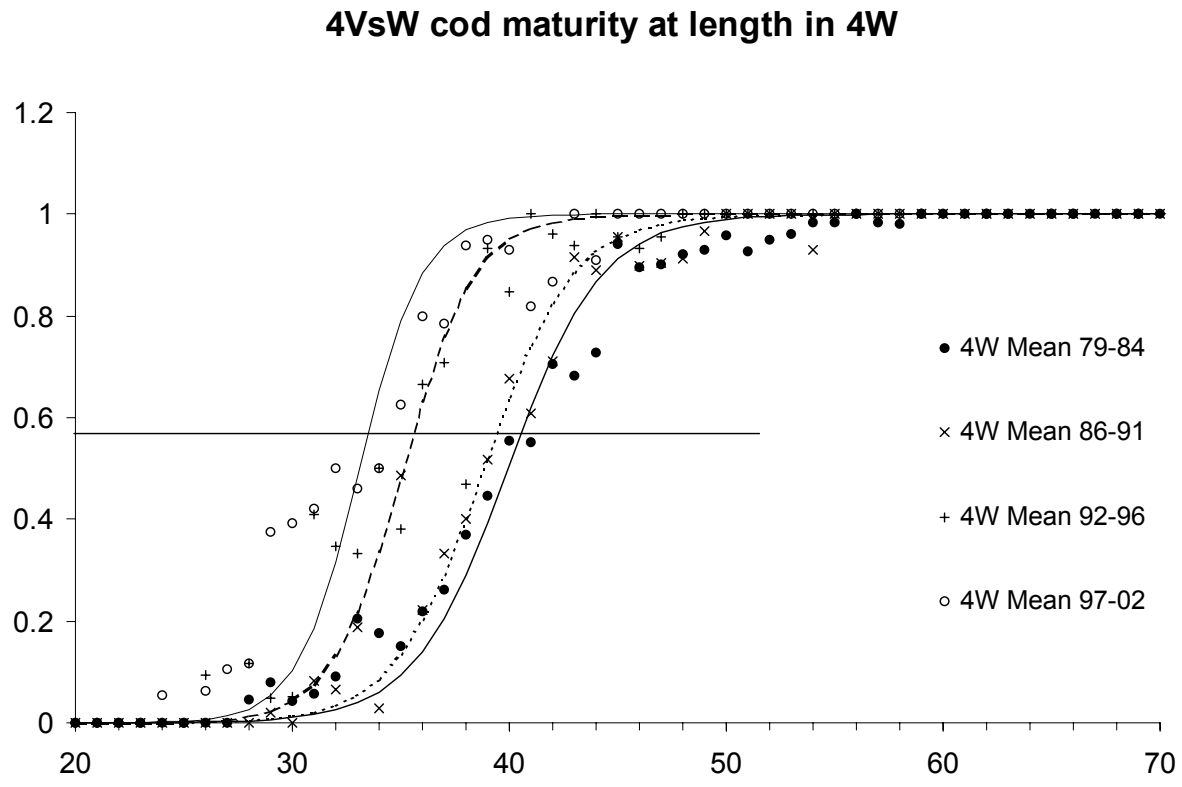


Figure 15 B

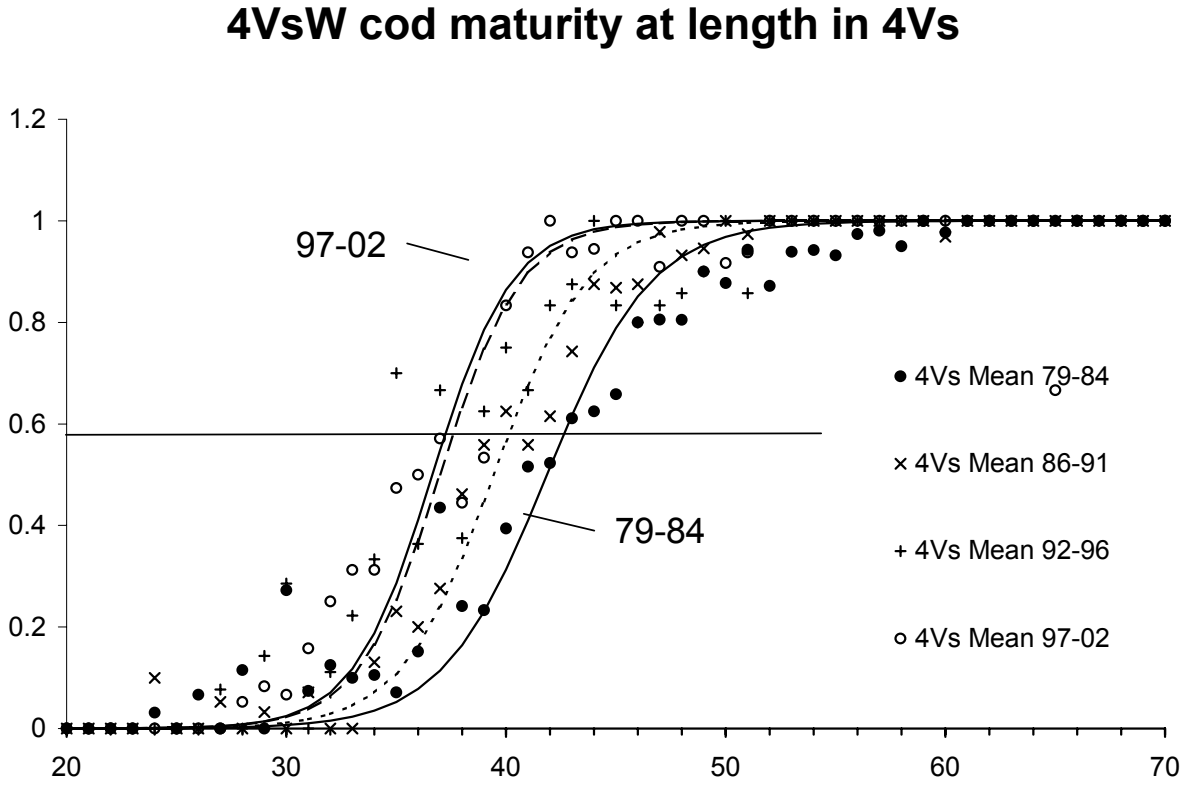


Figure 15. Maturity ogives for 4VsW cod from March RV survey data.

Figure 16 A

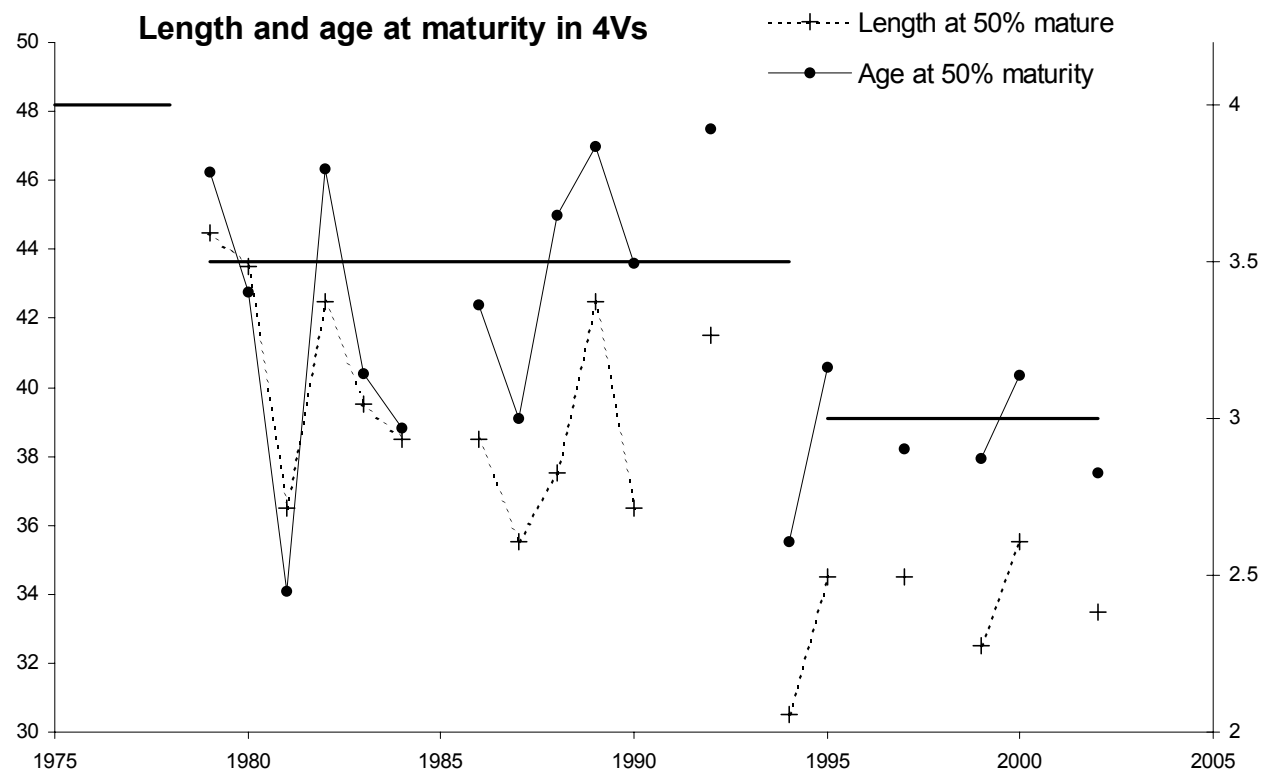


Figure 16 B

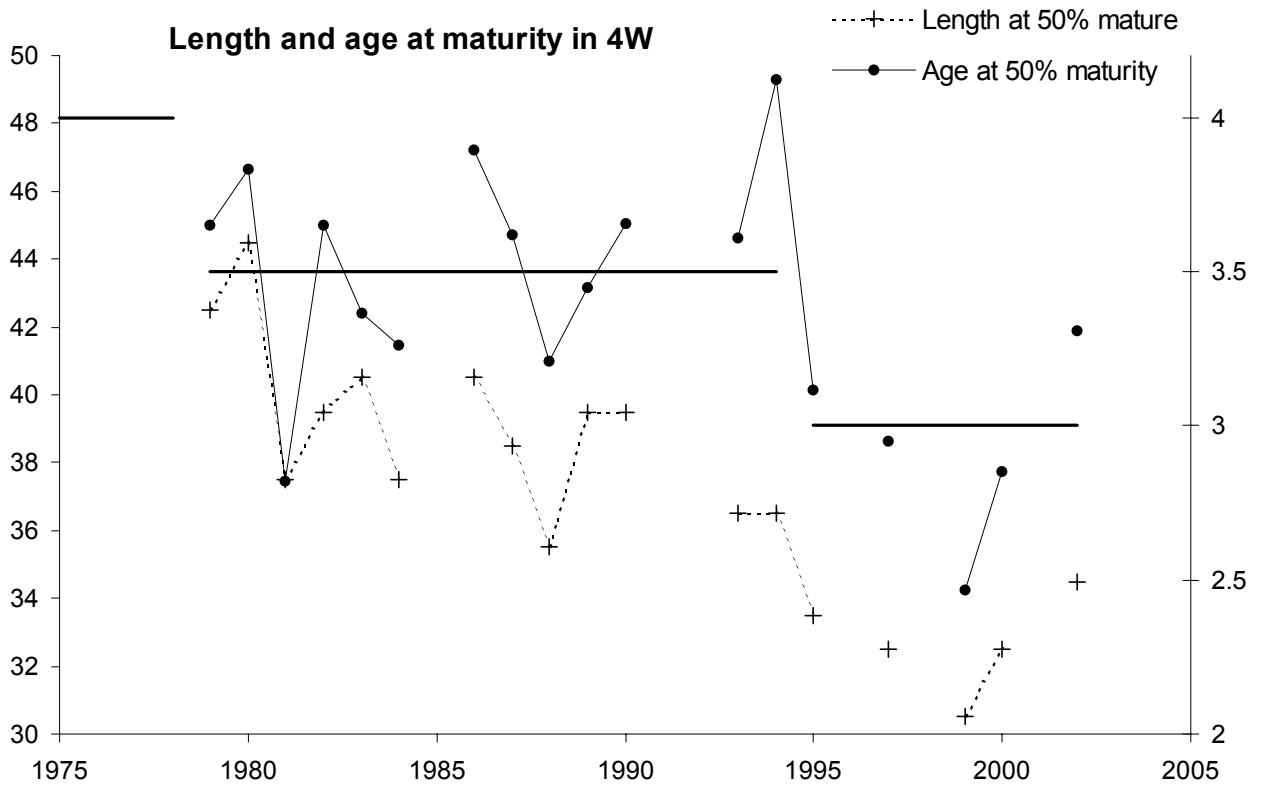


Figure 16. Mean length and age at 50% maturity based on March RV survey data in 4VsW cod.

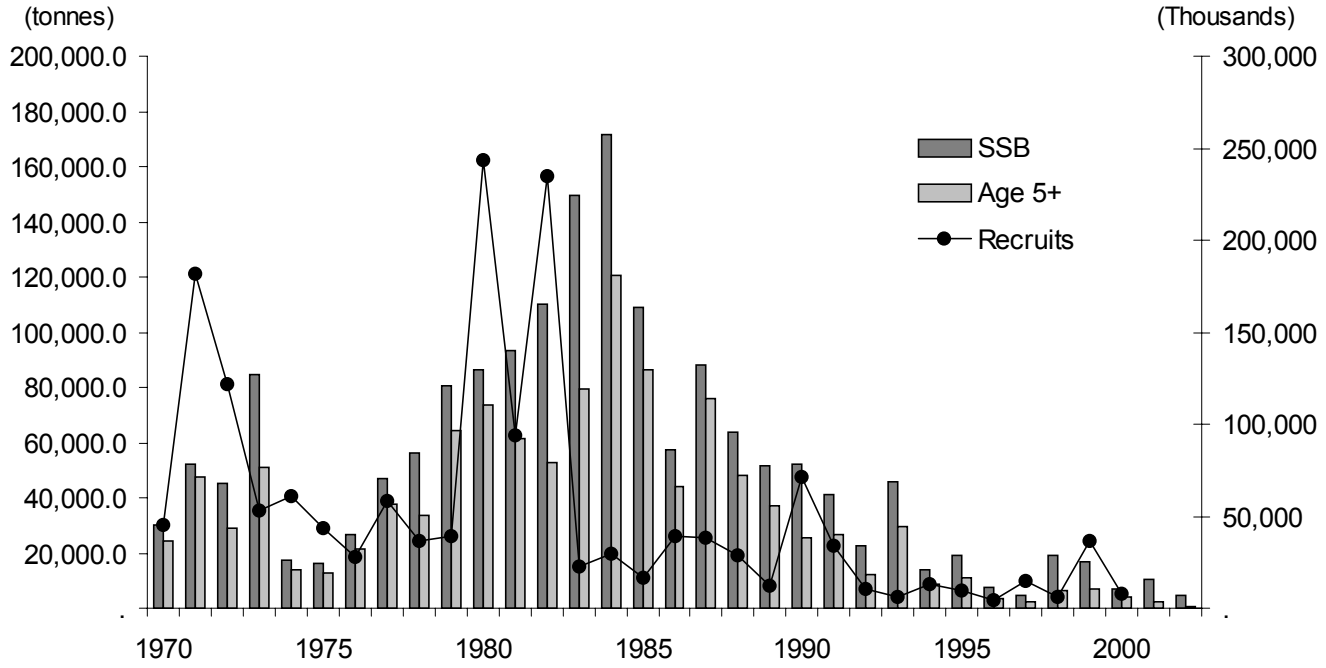


Figure 17. July RV survey estimate (q-corrected) of spawning stock biomass and recruitment (yearclass at age 1&2) in 4VsW cod.

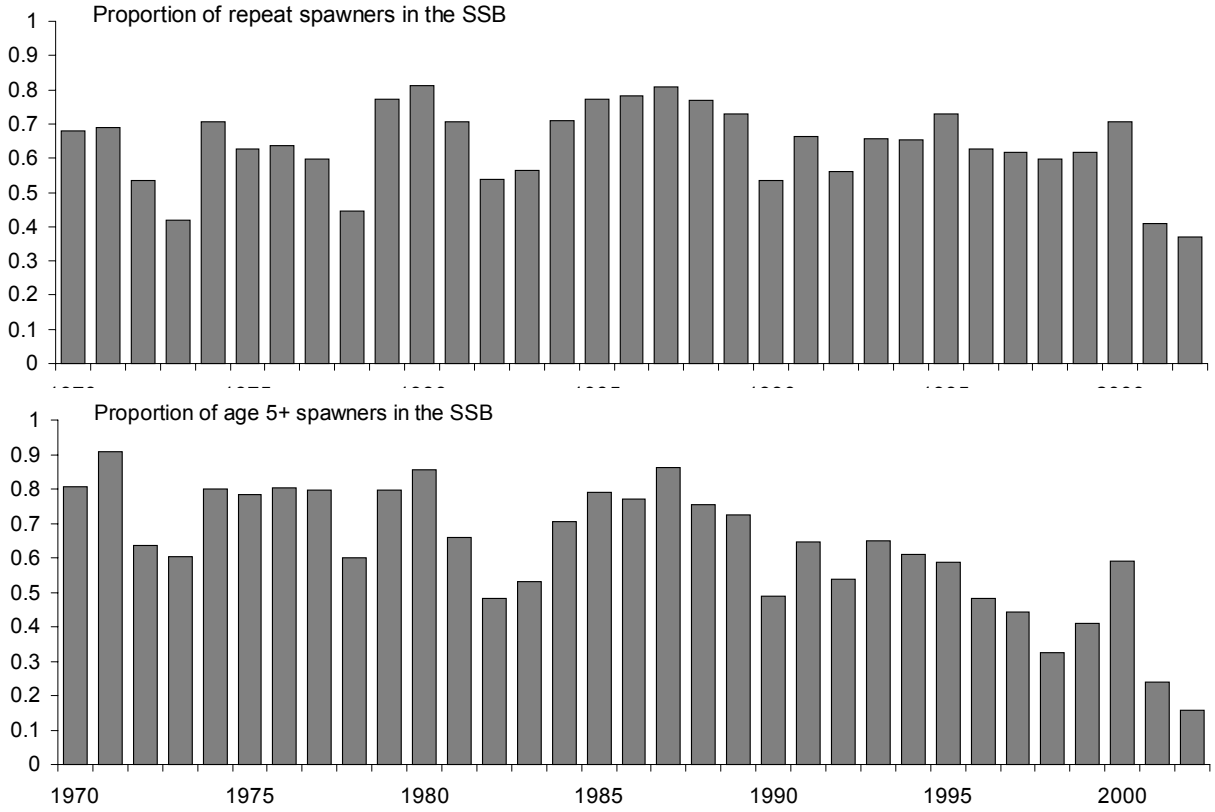


Figure 18. Proportion of SSB in the age 5+ biomass (i.e. known repeat spawners).

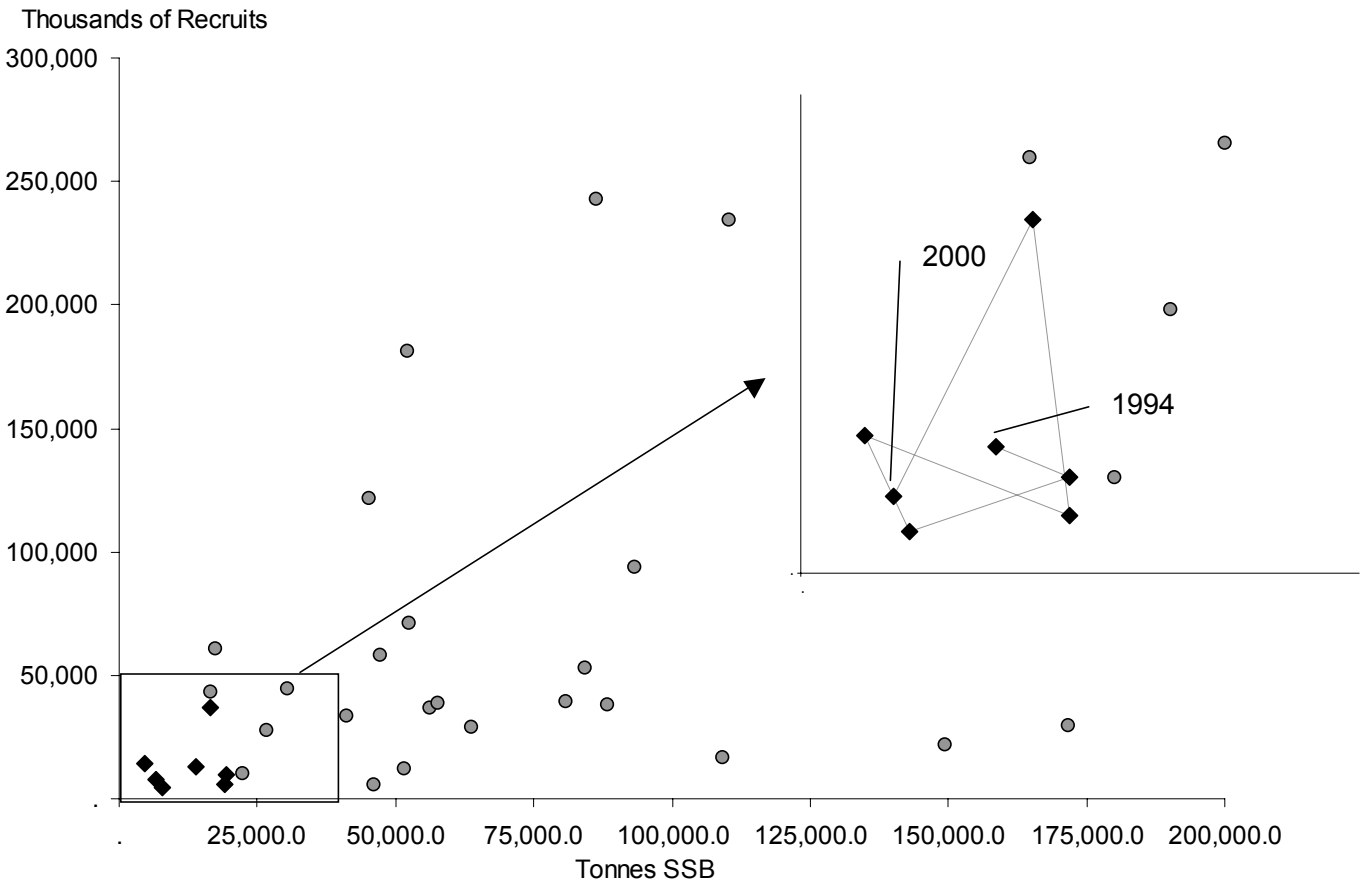


Figure 19. Stock-recruit plot of q-corrected July RV estimates (inset expands corner near origin). Period prior to the moratorium (1970-1993 yearclasses) have grey circles while the moratorium (1994-2000 yearclasses) have black diamonds.

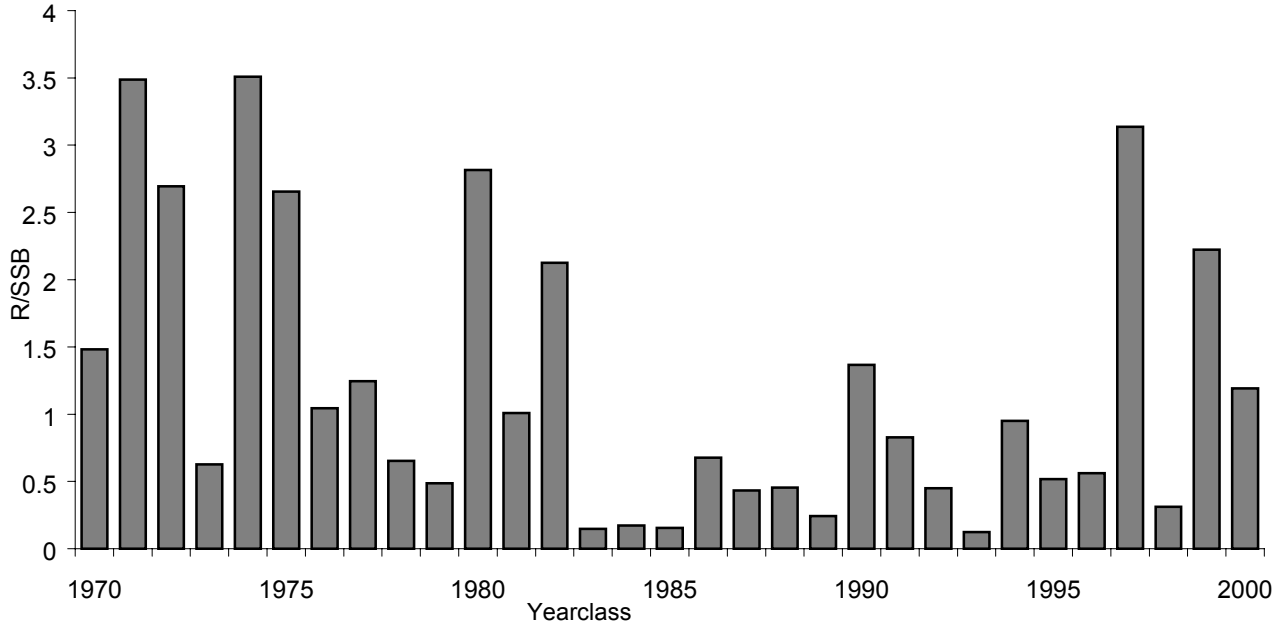


Figure 20. July RV survey Recruits (thousands) per SSB (tonnes) based on mean q-corrected yearclass size at ages 1&2 for 4VsW cod

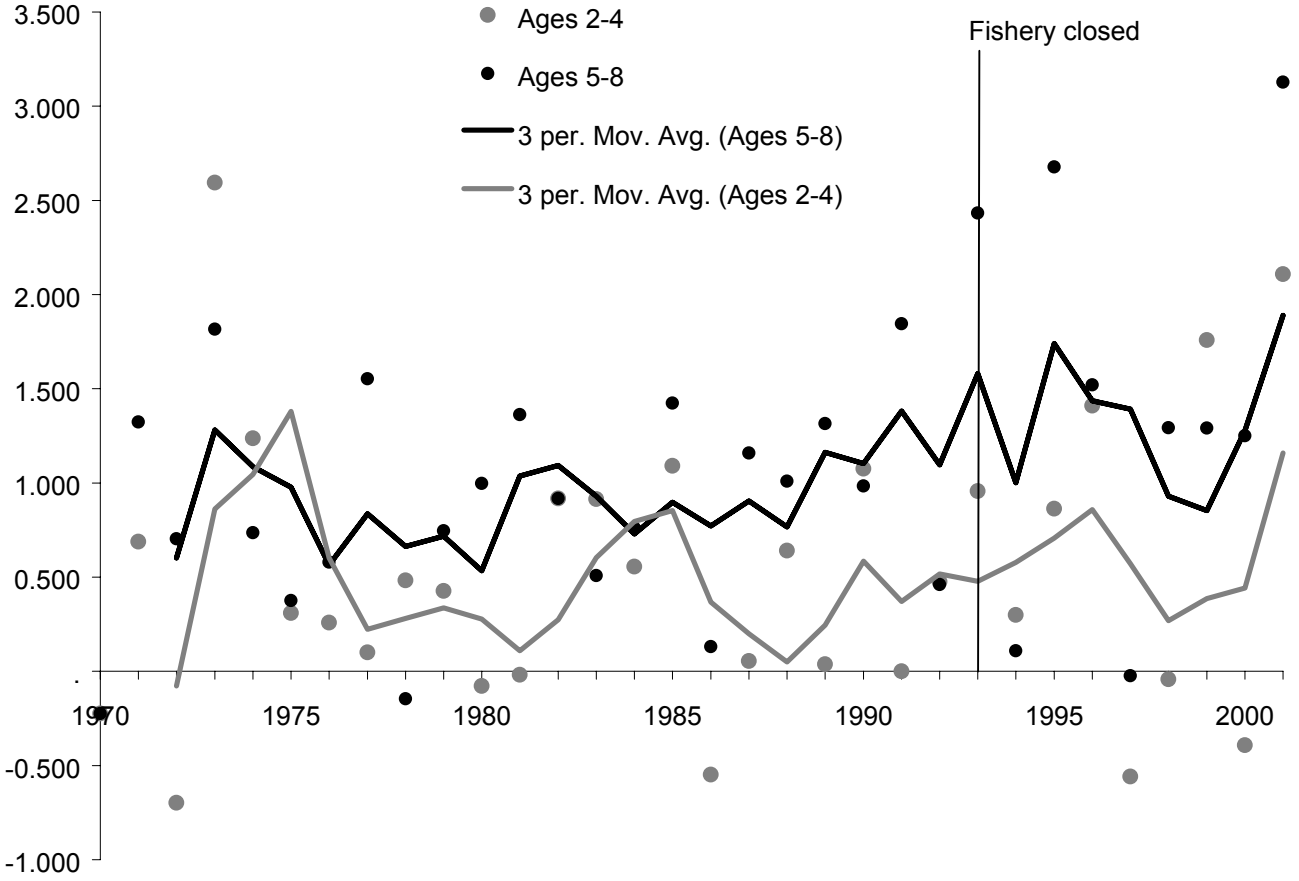


Figure 21. Estimates of total mortality (Z) from q-corrected July RV survey population numbers at age. Ages 2-4 refers to the mean Z between ages 2-4 and ages 3-5 the following year. The lines are 3-year running means.

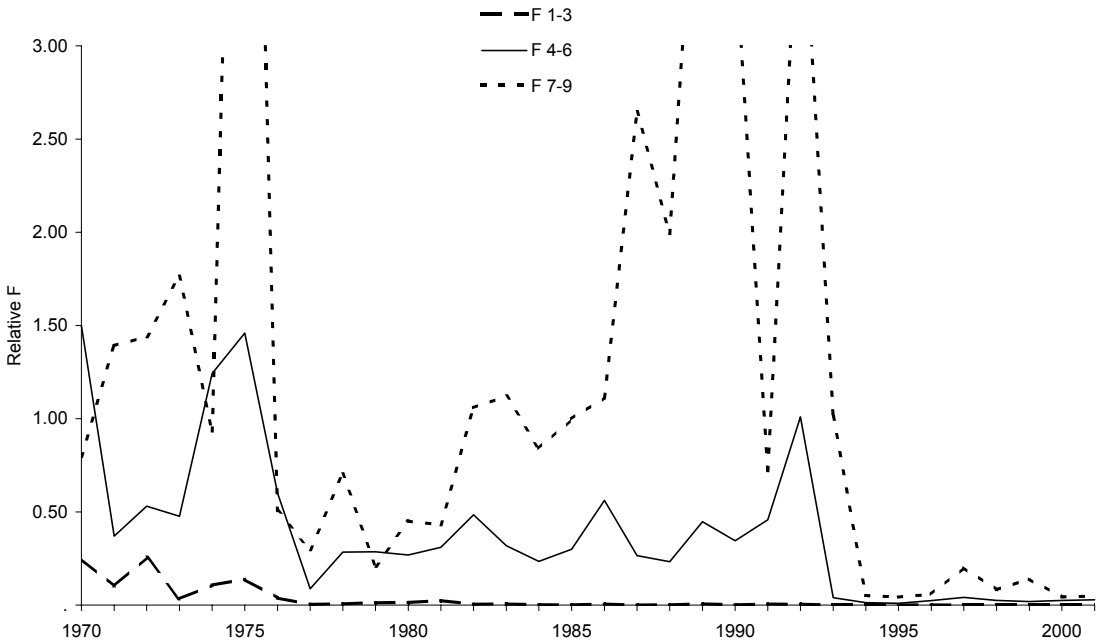


Figure 22. Relative fishing mortality (ratio of catch numbers at age to q-corrected RV survey numbers at age) for 4VsW cod for selected age groups.

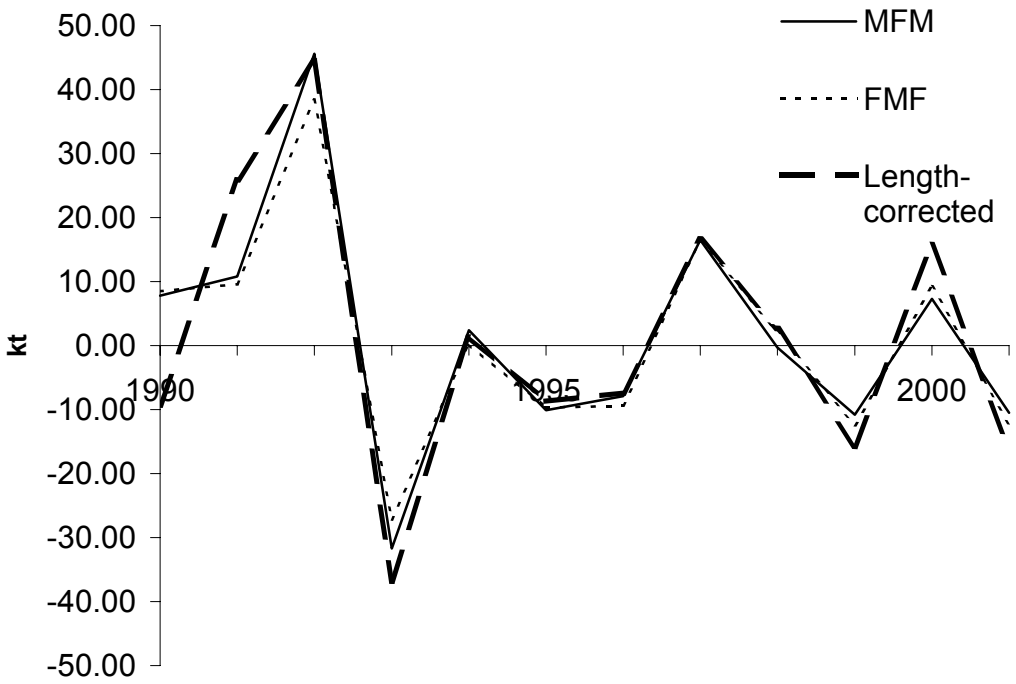


Figure 23. Surplus production estimates from summer RV biomass with *q*-corrections derived from age-by-age estimates for 4VsW cod assessments. The solid lines are based on q's from the 1998 asssessment (MFM) and the dotted are from Fu *et al.* (2001) (FMF). The dashed line is from the length-specific *q*-correction in this assessment.The average annual surplus production since 1993 is –2,000 t/yr.

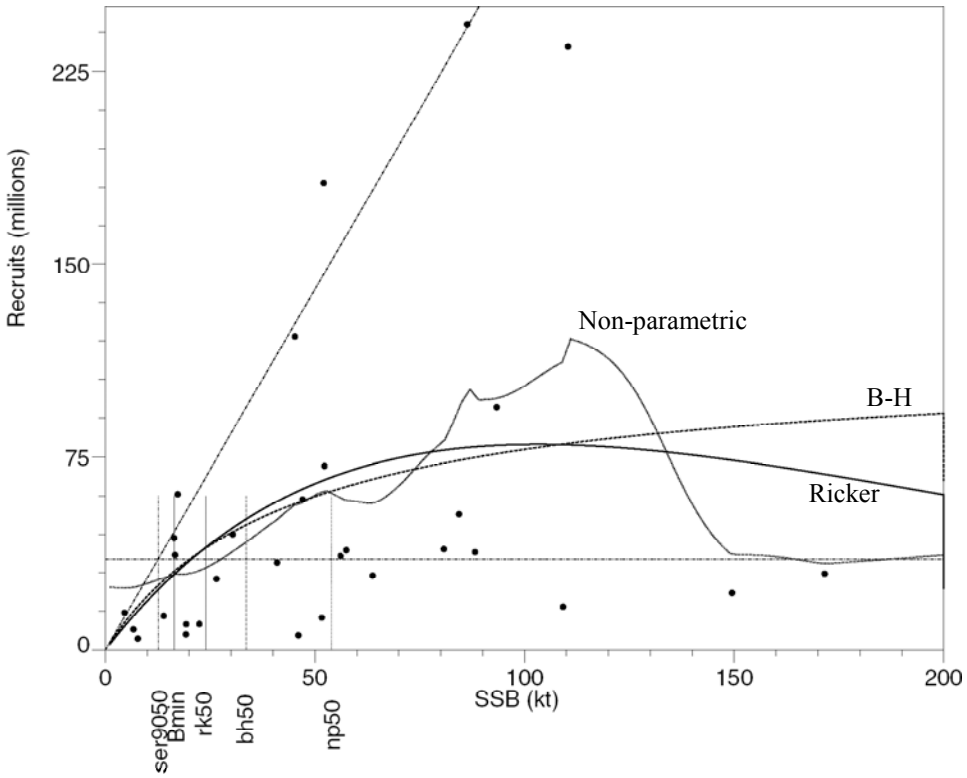


Figure 24a. Estimates of 4VsW cod biomass reference points based on results of DFO Gadoid reference point workshop. See text for list of reference point definitions. Stock and recruit estimates from from the length-specific *q*-corrected RV data in this assessment

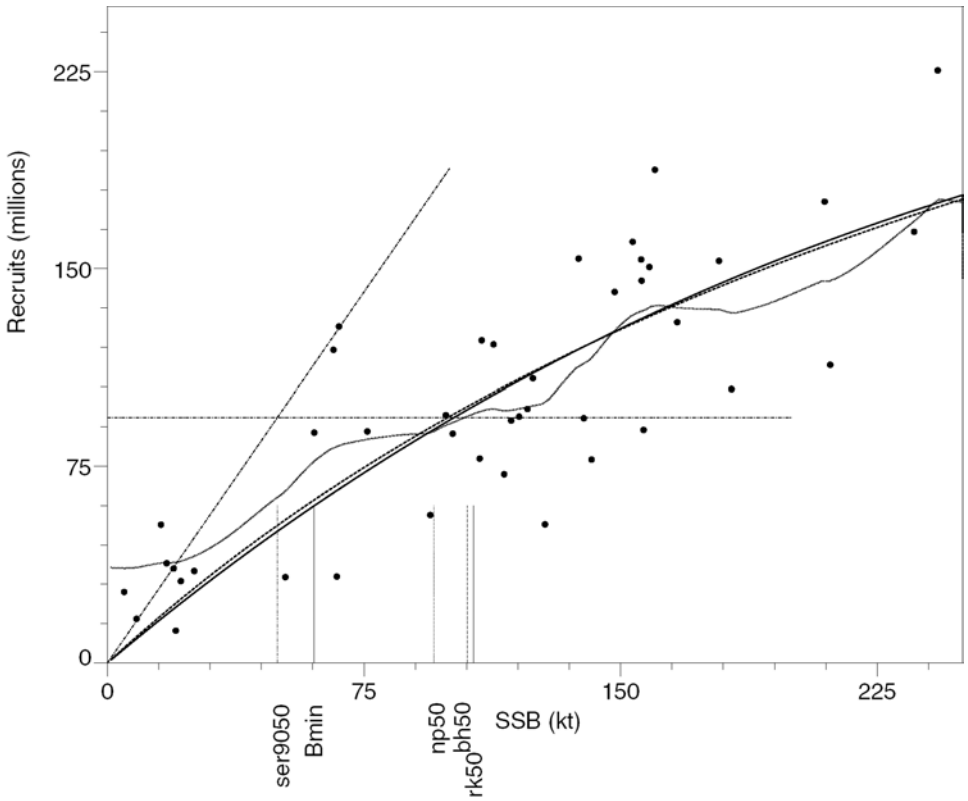


Figure 24b. Estimates of 4VsW cod biomass reference points based on results of DFO Gadoid reference point workshop. See text for list of reference point definitions. Stock and recruit estimates are updated from the 1998 asssessment (MFM).

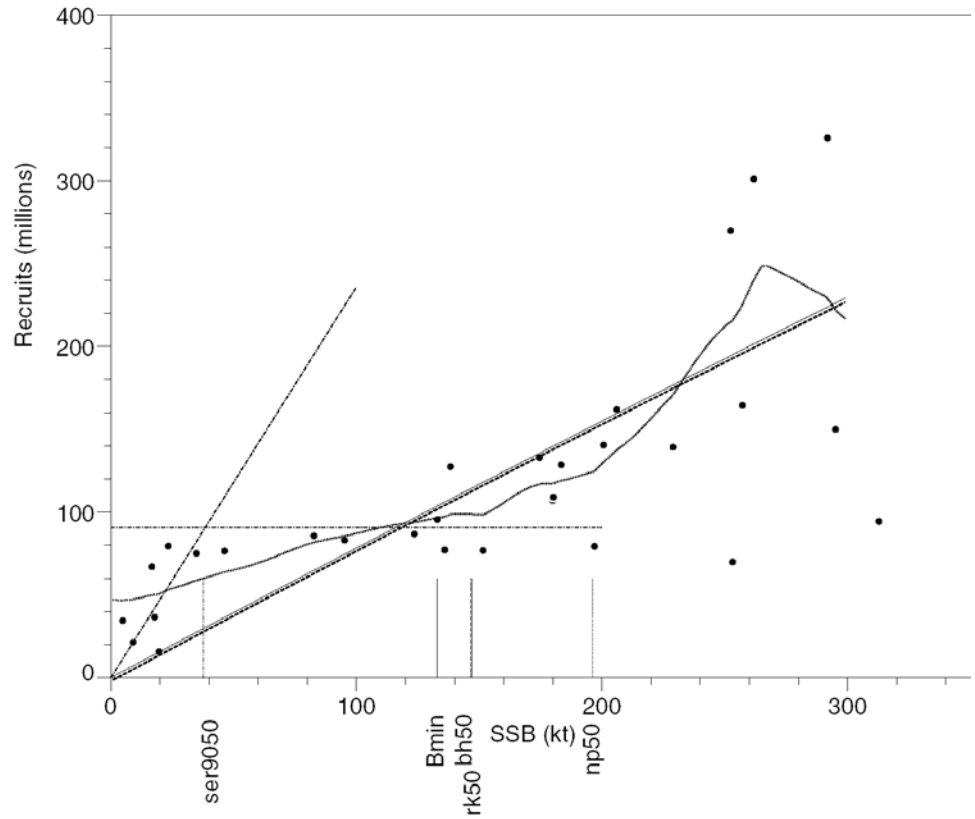


Figure 24c. Estimates of 4VsW cod biomass reference points based on results of DFO Gadoid reference point workshop. See text for list of reference point definitions. Stock and recruit estimates are from Fu *et al.* (2001) (FMF).

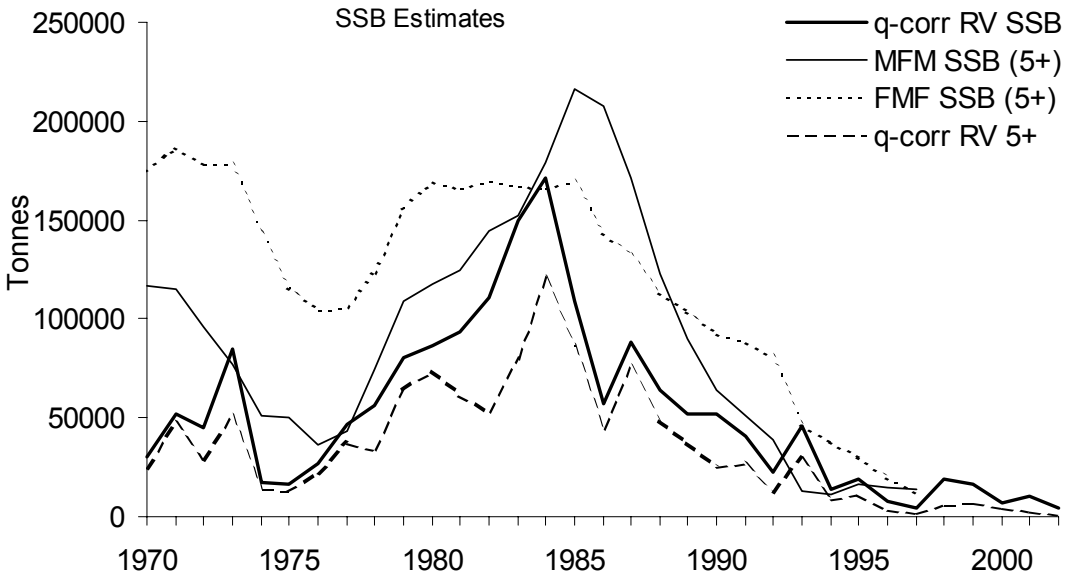


Figure 25. Comparison of SSB trajectories estimated for 4VsW cod from different models. The q-corr RV SSB was computed with the RV data and new maturity schedule in this assessment. MFM referes to the results in the previous assessment (Mohn *et al.*, 1998). FMF refers to results in Fu *et al.* (2001). The q-corr RV 5+ uses the old maturity assumption (i.e. age 5+).

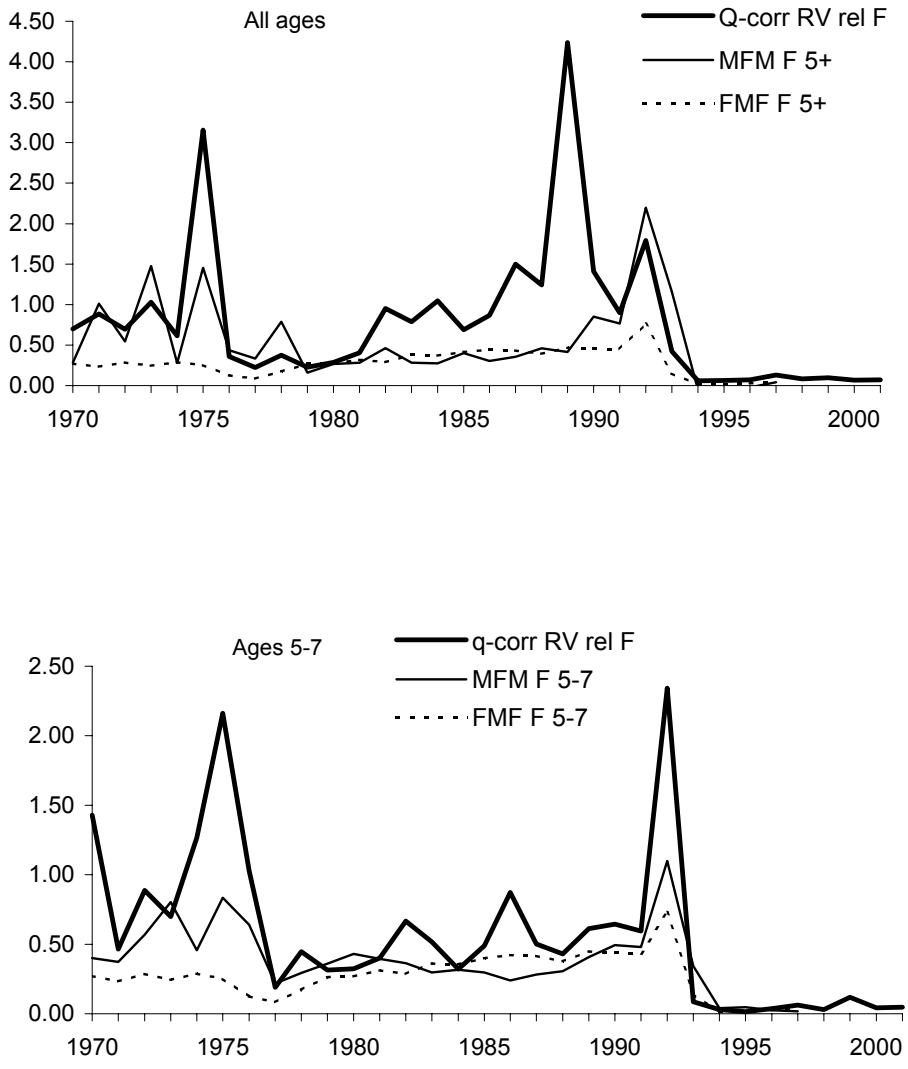
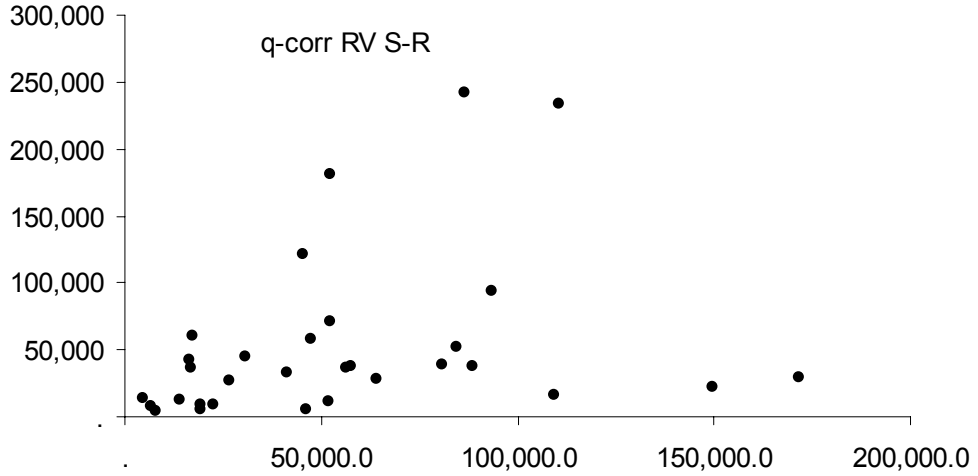
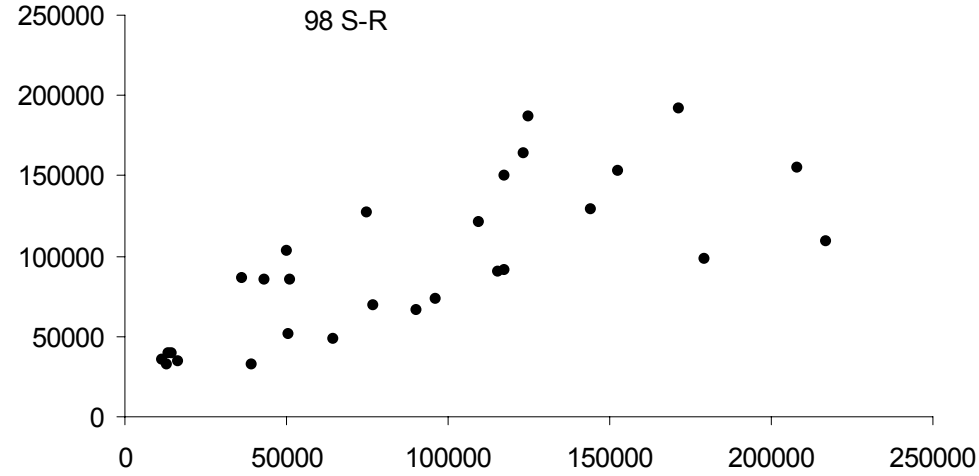


Figure 26. Comparisons for fishing mortality estimates for 4VsW cod from different models. Sources as for Figure 25.





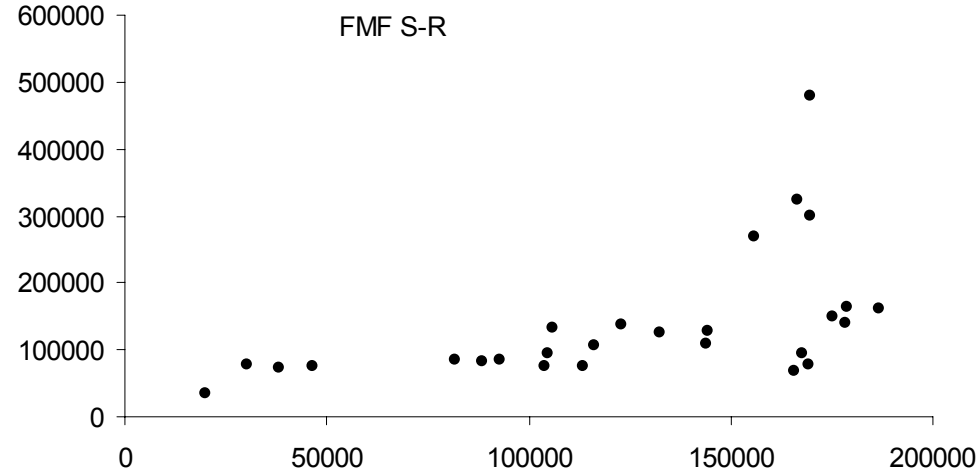


Figure 27. Comparisons stock-recruit plots for 4VsW cod from different models. Sources as for Figure 25.