

A. Georges Bank cod

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Additional information and details concerning Georges Bank cod can be found in the Appendix of the GARM III report (NEFSC 2008).

1.0 Background

This stock was last assessed and peer reviewed in August 2005 (O'Brien *et al.* 2006). The assessment was conducted using VPA with landings only, i.e. discards and recreational landings were not included in the catch at age. For terminal year 2004, total commercial landings were 4,583 mt and fully recruited F (ages 4-8, unweighted average) was estimated to be 0.24, the lowest F in the time series (1978-2004). Spawning stock biomass was 22,564 mt in 2004, 30% higher than the time series low in 1994. Since 1991, recruiting year classes had all been below the long term average (14 million age 1 fish) with the 2000 and 2001 year classes being the lowest in the time series. The 2003 year class, however, was estimated to be above average (21 million age 1 fish). The NEFSC spring and autumn bottom trawl survey indices continued to remain near record low values. The most recent above average autumn recruitment index of age 1 fish had occurred in 1988.

In 2002, biological reference points (BRPs) were developed for Georges Bank cod (NEFSC 2002) based on landings only, using a Beverton-Holt stock-recruit relationship with an assumed prior for the unfished recruitment. The BRPs were:

$$\begin{aligned}F_{MSY} &= 0.18, \\MSY &= 35,200 \text{ mt and} \\SSB_{MSY} &= 217,000 \text{ mt.}\end{aligned}$$

This assessment, with terminal year 2007, includes USA and Canadian commercial landings and discards, and USA recreational landings in the catch at age as recommended by the GARM II panel (Mayo and Terceiro 2005).

2.0 Fishery

Georges Bank Atlantic cod is a transboundary stock that is harvested by both USA and Canadian fishing fleets. USA cod landings are generally highest in the second calendar quarter (April-June) and are taken predominantly from the western part of Georges Bank (statistical areas (SA) 521-522, 525-526, 537-539, and Subarea 6) throughout the year (Figure A1). The majority of the landings from the eastern part of Georges Bank (SA 561-562) are taken in the first and second calendar quarter (January to June). USA landings are taken primarily by otter trawl gear and gill net gear. Since 1994, the Canadian fishery for Georges Bank cod has been open from June-December, and since 2005, June to the following February. Landings are taken primarily by long line and otter trawl.

Commercial Landings

Total commercial landings of GB cod taken by USA and Canadian fleets, and Distant Water Fleets (DWF) are available from 1893-2007 (Fig. A2a) and total catch is available from 1960-2007 (Table A1, Fig. A2b). USA commercial landings from 1994 to 2007 have been revised using the allocation scheme described at the GARM III data meeting. Total commercial landings of Georges Bank cod were 4,786 mt in 2007, a 26% increase from 2005. The USA accounted for 77% of the total landings and Canada the remaining 23%.

Commercial Discards

Atlantic cod discarded in the USA Georges Bank otter trawl, gillnet, and scallop fisheries were estimated using the NEFSC Observer data from 1989-2007. A ratio of discarded cod to total kept of all species (d:k) was estimated on a trip basis. Total discards (mt) were estimated from the product of d:k and total commercial landings (Table A2). Discards at age were estimated annually by applying combined survey and commercial age-length keys to observer length frequency data. Estimates of discards from 1978-1988 were hindcasted using a survey filter method (O'Brien and Esteves 2001, Mayo *et al.* 1992, see GARM III BRP WP 4.5). Canadian discards from groundfish and scallop fisheries were estimated from 1997-2007.

In 2007, the USA fishery discarded 1,040 mt and the Canadian scallop fleet discarded 124 mt. There were no discards in the Canadian 2007 groundfish fishery due to 100% observer coverage. Discards accounted for 22% of total USA catch and 10% of total Canadian catch in 2007 (Table A1, Fig. A2b).

Recreational Landings

USA recreational landings of Georges Bank cod were re-estimated using revised data provided by NOAA MRFSS from 1981-2007 (Table A3). The number of length samples taken in the recreational fishery is insufficient to be used in estimating the landings at age, however, a review of available samples indicated a length range similar to that in the NEFSC survey. A combined commercial and survey age-length key, and autumn survey length frequencies were applied to number of fish landed to obtain the landings at age. Recreational landings represent between 2-15% of the total USA catch of cod during 1981-2007. In 2007, recreational landings represented 0.17% of the total USA cod catch (Table A1, Fig A2b).

Total Catch

Total combined USA and Canadian catch of Georges Bank cod was 5,957 mt in 2007, a 29% increase from 4,411 mt caught in 2006. USA catches accounted for 79% and Canadian catches accounted for 21% of the total catch. Total discards accounted for 20% of the catch (Table A1, Figure A2b).

Sampling intensity

The numbers of samples taken to characterize the length and age composition of the USA and Canadian commercial cod landings from Georges Bank are summarized in Tables A4 and A5. In the USA fishery, sampling intensity has been relatively high since 2003, ranging between one sample per 7 mt to 1 sample per 98 mt (Table A5). In the Canadian fishery, sampling since 2003 has ranged between one sample per 3 mt to one sample per 18 mt. The average number of fish measured per sample was 102 in the USA fishery and 283 in the Canadian fishery during 2007 (Table A5).

Catch at age

Numbers (000s), weight (mt), mean weight (kg) and mean length (cm) of fish, at age, for the USA commercial landings, USA commercial discards, USA recreational landings, Canadian commercial landings, and Canadian commercial discards at age are presented in Tables A6-A10. Total catch at age in numbers (000s), weight (mt), mean weight (kg), and mean length (cm) are presented in Table A11. USA landings at age for eastern GB (SA 561-562) and western GB (SA 521,522,525,526,537-539 and SubArea 6) were estimated separately for 1978-2007 (App. A. Table A1) and then combined as shown in Table A6.

3.0 Research Bottom Trawl Surveys

Biomass and abundance indices

NEFSC spring and autumn survey biomass and abundance indices generally declined from the mid-1970s to the mid-1990s. Since about 1990 the indices have fluctuated without trend and continue to remain below the long term average (Table A12, Fig. A4-A5). The DFO abundance indices show an overall decline since 1990 (Fig. A5)

Catch at age for NEFSC spring and autumn surveys and DFO spring survey are presented in Table A13-A15 and Fig. A6-A8.

The recruitment indices for age 1 from the NEFSC 2007 autumn bottom trawl survey indicate that the last above average year class occurred in 1988. The 1999, 2001, 2003, and 2005 year classes, although below average, are stronger than the very weak 2000, 2002, and 2004 year classes (Fig. A9). The Canadian 2008 spring survey indices of abundance indicate that the 2003 year class was above average as both one and two year old fish (Fig. A10).

Maturity ogives

Logistic regression analysis was used to estimate female maturity ogives from NEFSC spring research survey data for 1970- 2008. The number of samples taken each year, by sex, over the time series is not consistently high and does not allow for reliable annual estimates, so the data was smoothed by using a 5-year moving average. For example, the 1990 ogive was estimated by combining data from 1988-1992 and estimating one ogive, and then the 1991 ogive was estimated by combining data from 1989-1993 and so forth, for the time series. This means that the first year, 1970, only has three years of data (1970, 1971, and 1972) and the last year, 2007, has only 4 years of data (2005, 2006, 2007 and 2008). Confidence limits for proportion mature at age were estimated at the 95% level using the approximate variance for large samples (Ashton 1972, O'Brien et al. 1993) and inverse 95% confidence limits for A_{50} (median age at maturity) were estimated within the SAS PROBIT procedure (SAS) (Figure A11).

Mean Length and Weight

Mean length and weight at age were estimated from the NEFSC autumn research bottom trawl surveys, 1970-2007. Mean weights at age were estimated using an historical length-weight equation prior to 1992. Annual length-weight parameters were estimated using data collected on autumn NEFSC surveys from 1992-2007. No trend is apparent in the younger ages, but ages 3-5 show a possible declining trend since the mid-1990s in both length and weight (Fig. A12). Length and weight trend together suggesting there is no change in condition for Georges Bank cod.

4.0 Assessment

In this VPA assessment, fully recruited F shifts from age 4, as seen in previous assessments, to fully recruited F at age 5. This is due, in part, to increases in minimum mesh size requirements to 6.5 inch square or diamond mesh that were invoked in May 2002. Prior to 2002, mesh requirements had been 6.5 inch square or 6.0 inch diamond mesh, since 1999.

VPA Input data and Analyses

The ADAPT calibration method (Parrack 1986, Gavaris 1986, and Conser and Powers 1990) was used to derive estimates of instantaneous fishing mortality in 2007 and beginning year stock sizes in 2008. A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the precision of fishing mortality and spawning stock biomass. A retrospective analysis was performed for terminal year fishing mortality, spawning stock biomass, and age 1 recruitment.

The base ADAPT formulation provided stock size estimates for ages 1-8 in 2008 and corresponding F estimates for ages 1-7 in 2007. Assuming full recruitment at age 5, the F on age 9 in the terminal year was estimated as the average of the F on ages 5-8. The F on age 9 in all years prior to the terminal year was derived from weighted estimates of Z for ages 5-8. For all years, the F on age 9 was applied to the 10+ age group. Spawning stock size estimates were estimated with female maturity ogives (5-year moving window) derived from NEFSC spring research survey data for 1978- 2008 as described above.

The catch at age (Table A11) includes combined USA and Canadian landings and discards, and USA recreational landings from 1978-2007 (Tables A6-A10) for age 1-10+. Swept-area estimates used to calibrate the VPA, estimated from indices of abundance, included the NEFSC 1978-2008 spring survey indices for ages 1-8 (Table A13), the NEFSC 1977-2006 autumn survey indices for ages 0-5 (Table A14) and the Canadian 1986-1992 and 1995-2007 spring survey indices for ages 1-8 (Table A15). The NEFSC spring survey was dis-aggregated into two series based on the use of the Yankee #36 or #41 trawls. The NEFSC employed the #41 trawl during 1973 to 1981. The spring indices were split into a series from 1978-1981 for the #41 trawl and a series from 1982-2005 for the #36 trawl. The autumn survey indices were shifted forward one age and one year to match cohorts in the spring survey in the subsequent year. Two formulations of the VPA were conducted and presented below. The Base Model was formulated as described above. The Split Model was also formulated as described above, however, the surveys were split between 1994 and 1995.

VPA Diagnostics – Base Model

The ADAPT calibration results for estimates of terminal year stock size and catchability (q) estimates, with corresponding standard error and coefficients of variation (CVs) are presented in Table A16a. Stock size estimates were more precise for ages 2-8, (CVs ranging from 0.27 - 0.31) than for age 1 (CV=0.48). Catchability estimates at age for the NEFSC spring and autumn surveys (Yankee #36 trawl) were similar with relatively low CVs (0.07-0.31), however, the spring survey (Yankee #41 trawl) was not as precise, particularly for ages 1, 7, and 8 (0.37-0.76). The precision of DFO (Division of Fisheries and Oceans, Canada) survey q estimates were similar to NEFSC spring and autumn surveys (Yankee #36 trawl), however, the q's estimates were larger than 1 for ages 6-8. For all surveys, q increases with age and approaches a 'flat-top', with error bars overlapping for the older ages (Fig. A13).

The residuals (observed – predicted), presented in App.A Fig. A1. indicated a pattern of negative residuals in the early years of the time series and positive residuals in the latter part of the time series for age 3-7 in the NEFSC spring survey and for ages 4-8 in the DFO survey . The NEFSC autumn residuals show no persistent pattern (App.A Fig. A1).

VPA Diagnostics – Split Model

The ADAPT calibration results for estimates of terminal year stock size and catchability (q) estimates, with corresponding standard error and coefficients of variation (CVs) are presented in Table A16b. Stock size estimates were more precise for ages 2-8, (CVs ranging from 0.27 - 0.39) than for age 1 (CV=0.45). Comparison of precision estimates of catchability at age, pre- and post- split, generally show higher CVs for the post-split indices (Table 16b). The q estimates for post-split indices were higher than pre-split for all surveys. Estimates of q increased with age and approached a ‘flat-top’, with error bars overlapping for the older ages (Fig. A13b).

The residuals (observed – predicted) are presented in App.A Fig. A2. The NEFSC spring pre-split surveys indicated either no pattern or a pattern of positive to negative residuals over time, however, in the post-split surveys there were no persistent patterns, except for age 2. The DFO pre-split surveys showed a pattern of negative to positive residuals over time, however, in the post-split surveys there were not persistent patterns. The NEFSC autumn residuals show no persistent pattern in either the pre- or post-split surveys.

VPA Assessment Results – Base Model

Fully recruited fishing mortality (unweighted, ages 5-8) was estimated at 0.14 in 2007 (Table A17a, Figure A14, App.A Table A2), a 52% decline from 2006, and the lowest F in the time series. Spawning stock biomass in 2007 was estimated at 25,377 mt, a 25% increase from 2006 (Table A17a, Figure A15, App A Table A2). Recruitment (millions of age 1 fish) of the 2003 year class (13.5 million age 1 fish) is estimated to be similar to the 1998 year class (12.4 million age 1 fish) (Table A17, Fig.A15. App.A. Table A2). The 2002 year class (2.0 million age 1 fish) and the 2000 year class (2.8 million age 1 fish) and are the lowest in the time series. The last above average year class (1990) occurred almost 2 decades ago. Stock mean weights at age show no trend for ages 1-3, however, since about 1987 there appears to be an overall general decline in weight, with some fluctuation, for ages 4-8 (App. A. Fig. A3).

VPA Assessment Results – Split Model

Fully recruited fishing mortality (unweighted, ages 5-8) was estimated at 0.30 in 2007 (Table A17b, Figure A14, App.A Table A3), a 42% decline from 2006, and the second lowest F in the time series. Spawning stock biomass in 2007 was estimated at 17,672 mt, a 23% increase from 2006 (Table A17b, Figure A15, App. A Table A3). Recruitment (millions of age 1 fish) of the 2003 year class (10.8 million age 1 fish) is estimated to be similar to the 1998 year class (12.2 million age 1 fish) (Table A17b, Fig.A15. App.A. Table A3). The 2002 year class (2.3 million age 1 fish) and the 2004 year class (2.5 million age 1 fish) and are the lowest in the time series. The last above average year class (1990) occurred almost 2 decades ago.

Precision of F and Stock Biomass Estimates – Base Model

A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the uncertainty associated with the estimate of F and SSB from the final VPA. One thousand bootstrap iterations were performed to estimate standard errors, CVs, and bias for age 1-8 stock

size estimates at the start of 2008 and age 1-10+ F estimates in 2007.

Base Model

The bootstrap results (Table A18a) indicate that stock sizes were well estimated for ages 3-8 with CVs varying between 0.26-0.31, however, age 1 (CV=0.73) and age 2 (CV=0.40) were not as well estimated. The fully recruited F for ages 5-8 was well estimated with CVs ranging between 0.17 and 0.29, with the exception of age 7 (CV=0.34). There is an 80% probability that the average F in 2007 is between 0.12 and 0.18 (Figure A16a). There is an 80% probability that SSB in 2008 is between 21,956 mt and 30,777 mt (Figure A16a).

Split Model

The bootstrap results (Table A18b) indicate that stock sizes were well estimated for ages 3-8 with CVs varying between 0.28-0.38, however, age 1 (CV=0.89), age 2 (CV=0.43), and age 8 (CV=0.42) were not as well estimated. The fully recruited F for ages 5-8 was well estimated with CVs ranging between 0.21 and 0.33, with the exception of age 1 (CV=0.41) and age 7 (CV=0.34). There is an 80% probability that the average F in 2007 is between 0.24 and 0.41 (Figure A16b). There is an 80% probability that SSB in 2008 is between 14,956 mt and 21,655 mt (Figure A16b).

Back-calculated partial recruitment

Back-calculated partial recruitment (PR) at age from VPA was averaged over 3 time periods corresponding to changes in management: 1980-1993, 1994-2001, and 2002-2007. Within a time period, the PR was scaled to the highest averaged PR value at age. –All three PRs vectors appear to be flat topped for both the Base Model and the Split Model. The shift from fully recruited F on age 4 during 1980-1993 to age 5 during 1994-2001 and 2002-2007 is evident (Figure A17a-A17b).

Retrospective Analysis

A retrospective analysis was performed to evaluate how well the current ADAPT calibration would have estimated F, SSB, and recruits at age 1 for seven years prior to the terminal year, 2007. Mohn's rho, calculated as the average of the 'tips' or terminal year values of each retrospective run, was calculated within each analysis.

Base Model

There is a retrospective pattern of estimating F values lower than the terminal year F ($\rho = -0.51$, Fig. A18a) and a corresponding pattern of estimating higher values of SSB relative to the terminal year SSB ($\rho=0.36$, Fig. A18b). The retrospective analysis in recruits at age 1 indicate that recruits are estimated at higher values relative to the terminal year ($\rho=0.54$). There are three high estimates in 2002, 2003, and 2004 (Fig. A18c). The 2002 and 2004 are the lowest estimated year classes in the time series, and the 2003 year class is the largest estimated since 1991.

Split Model

Although no distinct mechanism (e.g. change in reporting and sampling systems, closed areas, life-history or environmental effect) is apparent as to why the surveys should be split in the mid-1990s, the result is a weaker retrospective pattern, as seen in some of the other GARM

stocks (GB yellowtail flounder, witch flounder). The pattern of estimating F values lower than the terminal year F is moderate ($\rho = -0.14$), however, only one year (2002) is estimated as higher than the terminal year (Figure A19a). The corresponding pattern of estimating higher values of SSB relative to the terminal year SSB ($\rho=0.13$) is also moderate with an almost even split of higher and lower values relative to the terminal year (Figure A19b). The retrospective analysis in recruits at age 1 indicate that recruits are estimated at higher values relative to the terminal year ($\rho=0.92$), almost twice as high as the Base Model. There are three high estimates in 2002, 2003, and 2004 (Fig. A19c).

Sensitivity analysis

Prior to selecting a final model, two sensitivity analyses were conducted. The first analysis was conducted to address the GARM Model Meeting Panel's request to explore the partial recruitment of older ages in recent years. Using the Base Model formulation, the F on the oldest true age (9) was estimated differently in each run by varying the ages used to calculate an average F, which was then set as the F for both ages 9 and 10+. Six runs were made with F on the oldest age estimated as the average of ages 5-6, 5-7, 5-8, 6-7, 6-8, and 7-8.

Estimates of the scaled back-calculated partial recruitment show that for all age group averages, a flat-top PR persists (App.A. Fig. A4a). The F on age 9 for each age group, shows that the average that includes the youngest and oldest ages have the more extreme F values. (App.A. Fig. A4b). Comparing the average F for ages 5-8 from all six runs indicates very little difference between the runs (App.A. Fig. A4c).

The second sensitivity analysis applied the same VPA formulation used by the Transboundary Resources Assessment Committees' (TRAC) Eastern GB cod assessment, which assesses a subset of the stock as a management unit. This VPA formulation used a catch at age from 1 to 9, with no plus group, for the entire GB cod stock. In addition to estimating stock size for ages 1-9 in the terminal year, the oldest age (9) was also estimated for the six years prior to the terminal year, to 2000. This formulation is referred to as 'around-the-corner'. The retrospective pattern of fishing mortality shows lower estimates relative to the terminal year ($\rho=0.25$), however, there are some extreme high values in the mid-1990s (App. A. Fig. A5a). SSB shows a retrospective pattern of both higher and lower values relative to the terminal year ($\rho= 0.06$, App. A. Fig. A5b). The retrospective pattern in recruitment shows higher values relative to the TY in recent years ($\rho = 0.51$), but a mixed pattern prior to 2003 (App. A. Fig. A5c).

A comparison of the sensitivity run and the Base and Split Models is presented in Table A19. The Split VPA estimates lower stock size and higher F relative to the Base VPA. The Around the Corner VPA estimates higher stock size, particularly at older ages, and lower F on the older ages. The residual plots for 'around the corner' are presented in App. A. Figs A6.

The August GARM III Review Panel chose the **SPLIT MODEL** as the model to proceed with for determining stock status, primarily based on the lower retrospective pattern in F and SSB compared to the BASE MODEL.

5.0 Biological Reference Points

Yield per Recruit Analysis

A yield per recruit (YPR) analysis was conducted to provide an estimate of $F_{40\%}$ using the methods of Thompson and Bell (1934). Input data for catch and stock weights (ages 1-10+)

were derived from an average of the most recent five years (2003-2007). The partial recruitment (PR) was based on a normalized arithmetic mean of 2003-2007 fishing mortality from the VPA and the maturity ogive was estimated as a 5 year moving average as described above for 2004-2008 (Table A20).

Yield per Recruit Analysis- BASE MODEL

The estimated biological reference points of $F_{0.1}=0.22$, $F_{max} = 0.50$ and $F_{40\%} = 0.25$ (Fig. A20) are higher than those estimated by the Working Group on Re-Evaluation of Biological Reference Points: $F_{0.1}=0.17$, $F_{max} = 0.33$, and $F_{40\%} = 0.17$ (NEFSC 2002) Non-parametric estimates of MSY and SSB_{MSY} were estimated using the 31-year time series mean recruitment (13.8 million age 1 fish), Y/R (1.3592) and SSB/R (6.5116) as:

BASE MODEL

$F_{40\%} = 0.25$

MSY = 18,794

$SSB_{MSY} = 90,105$.

Yield per Recruit Analysis- SPLIT MODEL

Applying the same methods and data input described above, a YPR analysis was conducted based on the Split Model. Non-parametric estimates of MSY and SSB_{MSY} were estimated using the 31-year time series mean recruitment (14.1million age 1 fish), Y/R (1.3437) and SSB/R (6.5257) as:

SPLIT MODEL

$F_{40\%} = 0.25$

MSY = 19,194

$SSB_{MSY} = 91,806$.

Yield per Recruit Analysis - Stochastic MSY estimates

The GARM III BRP Panel selected the non-parametric YPR analysis as the basis for the estimation of BRPs for Georges Bank Atlantic cod. Stochastic projections using the same input data as the YPR were run out to 100 years with $F_{MSY} = 0.25$. Recruitment was estimated from a cumulative distribution function of 14 estimates of age 1 fish associated with $SSB > 50,000$ mt. The breakpoint of 50,000 mt was based on evidence of reduced recruitment productivity at biomasses below this value. The projection provided the following non-parametric biomass reference points:

BASE MODEL

$F_{40\%} = 0.25$

MSY = 29,445 mt

$SSB_{MSY} = 139,458$ mt.

SPLIT MODEL

$F_{40\%} = 0.25$

MSY = 31,159 mt

$SSB_{MSY} = 148,084$ mt.

The August GARM III Review Panel chose the **SPLIT MODEL** as the model to proceed

with for determining stock status, primarily based on the lower retrospective pattern in F and SSB compared to the BASE MODEL. The **SPLIT MODEL** stochastic MSY estimates bolded above are the final accepted BRP estimates.

6.0 Projections

Short term, 2-year stochastic projections were performed to estimate landings and SSB during 2008-2009. The input values for mean catch and stock weights, PR, and maturity are the same as described above for the YPR analysis. Recruitment was estimated from a cumulative distribution function of 14 estimates of age 1 fish associated with SSB > 50,000 mt from the **SPLIT MODEL**. Catch in 2008 was assumed equal to catch in 2007. The projections were run under three F scenarios: F_{07} , $F_{MSY}=F_{40\%}$, and $F_{REBUILD}$. The rebuilding plan for Georges Bank cod requires that the stock reach SSB_{MSY} by 2026. The $F_{REBUILD}$ was estimated in a separate medium term projection out to 2026 using the same input data as above. Under an $F_{REBUILD} = 0.186$ the stock is projected to rebuild to about $SSB_{MSY} = 148,084$ mt with a 50% probability by 2026.

The results of the **SPLIT MODEL** short term projections (Table A21) indicate that under all three scenarios catch is projected to decrease and SSB is projected to increase in 2009, relative to 2008.

7.0 Summary

The GARM Review Panel chose the **SPLIT MODEL** as the final model. The Georges Bank Atlantic cod stock is overfished and overfishing is occurring (Fig. A21). Fishing mortality (unweighted, ages 5-8) in 2007 was estimated to be about 0.30, the second lowest F in the time series. SSB was estimated at 17,672 mt in 2007, about 12% of SSB_{MSY} . The last year class that was above the time series average (14.1 million age 1 fish) occurred almost 2 decades ago in 1990. The 2003 year class (10.8 million age 1 fish) is near average and will be fully recruited to the fishery during 2008.

In this assessment, the VPA formulation was similar to previous assessments, however, fully recruited F shifted from ages 4-8 to ages 5-8, due in part to increases in mesh size since 2002.

Sources of uncertainty

- 1) the estimation of discards, particularly those hindcasted from 1978-1988,
- 2) the estimation of recreational landings, with very few length samples available,

8.0 Panel Discussion / Comments

Conclusions

The Panel concluded that the retrospective pattern in this assessment was substantial enough to warrant modifying the VPA by including a split in the survey time series in 1995. This modified assessment was accepted as Final by the Panel and was the best available estimate of stock status, as well as sufficient for management advice.

The Panel also noted that short term projections should utilize recruitment estimates from the VPA bifurcated at 50,000 MT of spawning biomass; to more appropriately reflect recruitment under current stock conditions. This approach was found to be appropriate basis for estimating F rebuild.

It was noted that the US/Canada TRAC assessment used a different formulation from that considered here. These formulations will need to be reconciled for the development of transboundary advice at a later date.

Research Recommendations

The Panel recommended that historical data be used to hindcast recruitment estimates as far back in time as possible for use in the estimation of reference points and projections.

Continued exploration of retrospective pattern and methods to account for it are critical for this stock.

9.0 References

- Ashton WD. The logit transformation with special reference to its uses in bioassay. 88. 72. London, Griffin and Co.
- Conser RJ, Powers JE. 1990. Extensions of the ADAPT VPA tuning method designed to facilitate assessment work on tuna and swordfish stocks. Int Comm Conserv Atlantic Tunas. Coll Vol Sci Pap. 32: p 461-467.
- Efron B. 1982. The jackknife, the bootstrap and other resampling plans. Phila Soc Ind Appl Math. 34: 92 p.
- Gavaris S. 1988. An adaptive framework for the estimation of population size. CAFSAC Res. Doc 88/29: 12 p.
- Mayo RK, O'Brien L, Buxton N. 1992. Discard Estimates of American plaice *Hippoglossoides platessoides* in the Gulf of Maine Northern shrimp fishery and the Gulf of Maine-Georges Bank Large-Mesh otter trawl fishery. Appendix to CRD-92-07 Res Doc SAW 14/3; 40 p. 92.
- Mayo RK, Terceiro M. eds. 2005. Assessment of 19 Northeast groundfish stocks through 2004. 2005 Groundfish Assessment Review Meeting (GARM). 2005. Woods Hole, MA. August 15-1. NEFSC Ref Doc. 05-13; 508 p.
- NEFSC 2002. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. NEFSC Ref Doc. 02-04; 254 p.
- O'Brien L, Esteves 2001. Update Assessment of American plaice in the Gulf of Maine - Georges Bank Region for 2000. NEFSC Ref Doc. 01-02; 114 p.
- O'Brien L, Burnett J, Mayo RK. 1993. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Tech Rep NMFS 113: 66
- O'Brien L, Shepherd N, Col L. 2006. Assessment of the Georges Bank Atlantic cod stock for 2005. NEFSC Ref Doc. 06-10; 148 p.
- Parrack ML. 1986. A method of analyzing catches and abundance indices from a fishery. Int Comm Conserv Atlantic Tunas. Coll Vol Sci Pap. 24: p 209-221.
- SAS /STAT User's Guide . www.technion.ac.il/docs/sas/.
- Thompson WF, Bell FH. 1934. Biological statistics of the Pacific halibut fishery. (2) effect of changes in intensity upon total yield and yield per unit of gear. Rep Inter Fish Comm. 8: 49 p.

Table A1. Commercial catch (metric tons, live) of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1960-2007.

Year	USA				Country			USSR	Spain	Poland	Other	Total Landings	Total Catch
	Landings	Discards	Rec.	Total USA	Landings	Discards	Total Canada						
1960	10834	-	-	10834	19	-	19	-	-	-	-	10853	10853
1961	14453	-	-	14453	223	-	223	55	-	-	-	14731	14731
1962	15637	-	-	15637	2404	-	2404	5302	-	143	-	23486	23486
1963	14139	-	-	14139	7832	-	7832	5217	-	-	1	27189	27189
1964	12325	-	-	12325	7108	-	7108	5428	18	48	238	25165	25165
1965	11410	-	-	11410	10598	-	10598	14415	59	1851	-	38333	38333
1966	11990	-	-	11990	15601	-	15601	16830	8375	269	69	53134	53134
1967	13157	-	-	13157	8232	-	8232	511	14730	-	122	36752	36752
1968	15279	-	-	15279	9127	-	9127	1459	14622	2611	38	43136	43136
1969	16782	-	-	16782	5997	-	5997	646	13597	798	119	37939	37939
1970	14899	-	-	14899	2583	-	2583	364	6874	784	148	25652	25652
1971	16178	-	-	16178	2979	-	2979	1270	7460	256	36	28179	28179
1972	13406	-	-	13406	2545	-	2545	1878	6704	271	255	25059	25059
1973	16202	-	-	16202	3220	-	3220	2977	5980	430	114	28923	28923
1974	18377	-	-	18377	1374	-	1374	476	6370	566	168	27331	27331
1975	16017	-	-	16017	1847	-	1847	2403	4044	481	216	25008	25008
1976	14906	-	-	14906	2328	-	2328	933	1633	90	36	19926	19926
1977	21138	-	-	21138	6173	-	6173	54	2	-	-	27367	27367
1978	26579	298	-	26877	8783	-	8783	-	-	-	-	35362	35659
1979	32645	537	-	33182	5979	-	5979	-	-	-	-	38624	39161
1980	40053	569	-	40622	8060	-	8060	-	-	-	-	48113	48682
1981	33849	1033	4162	39043	8496	-	8496	-	-	-	-	42345	47539
1982	39333	985	2955	43274	17816	-	17816	-	-	-	-	57149	61090
1983	36756	656	3865	41277	12132	-	12132	-	-	-	-	48888	53409
1984	32915	98	994	34007	5758	-	5758	-	-	-	-	38673	39765
1985	26828	349	4678	31856	10442	-	10442	-	-	-	-	37270	42298
1986	17490	457	425	18372	8503	-	8503	-	-	-	-	25993	26876
1987	19035	266	970	20271	11842	-	11842	-	-	-	-	30877	32113
1988	26310	323	2587	29220	12757	-	12757	-	-	-	-	39067	41977
1989	25056	866	507	26429	7912	-	7912	-	-	-	-	32967	34340
1990	28110	618	1339	30067	14345	-	14345	-	-	-	-	42455	44412
1991	24219	476	657	25352	13457	-	13457	-	-	-	-	37676	38809
1992	16899	766	350	18014	11669	-	11669	-	-	-	-	28569	29684
1993	14590	376	1127	16093	8527	-	8527	-	-	-	-	23117	24620
1994	9737	199	544	10479	5276	-	5276	-	-	-	-	15013	15755
1995	7028	116	826	7970	1099	-	1099	-	-	-	-	8127	9069
1996	7259	139	367	7765	1912	42	1954	-	-	-	-	9171	9719
1997	7545	127	715	8388	2917	479	3396	-	-	-	-	10462	11785
1998	7044	132	434	7609	1908	372	2280	-	-	-	-	8952	9889
1999	8319	132	387	8839	1825	328	2153	-	-	-	-	10144	10992
2000	7612	204	309	8125	1585	62	1647	-	-	-	-	9196	9772
2001	10746	374	205	11325	2144	117	2261	-	-	-	-	12889	13586
2002	9470	311	237	10018	1275	76	1351	-	-	-	-	10745	11369
2003	6856	335	203	7394	1316	191	1507	-	-	-	-	8172	8901
2004	3507	178	345	4029	1111	98	1209	-	-	-	-	4618	5238
2005	2754	541	243	3538	630	233	863	-	-	-	-	3384	4401
2006	2694	387	79	3159	1097	355	1452	-	-	-	-	3790	4611
2007	3678	1040	8	4725	1,108	124	1232	-	-	-	-	4,786	5957

Table A2. Discards of Atlantic cod in Georges Bank large mesh otter trawl and gill net fisheries, 1989-2007. Total includes discards from other gear.

Year	GB large mesh trawl			GB gillnet trawl			Scallop			Total	
	mt	cv	# trips	mt	cv	# trips	mt	cv	# trips	mt	cv
1989	730.0899	0.26	26	0	0	0	0	0	0	865.7	0.22
1990	524.9838	0.33	25	0	0	0	0	0	0	617.9	0.55
1991	425.0898	0.48	28	0	0	0	0	0	0	475.6	0.44
1992	270.63	0.48	29	0	0	0	0	0	0	765.6	0.25
1993	292.9039	0.29	25	0	0	0	0	0	0	375.9	0.23
1994	60.7842	0.41	25	76.1732	0.24	55	0	0	0	198.6	0.27
1995	54.66082	0.47	41	53.73666	0.35	86	0.4	0.68	0	115.7	0.29
1996	17.29	0.55	19	90.91845	0.85	88	27.3	0.50	14	139.0	0.47
1997	21.43163	0.29	27	75.29152	0.47	69	27.4	0.49	13	127.5	0.29
1998	11.00901	0.54	9	62.04998	0.00	194	49.5	0.43	17	131.5	0.40
1999	49.84209	0.48	20	43.28701	0.31	82	32.0	0.44	21	132.5	0.26
2000	110.8575	0.66	20	78.3508	0.33	168	4.2	0.15	26	204.1	0.38
2001	317.7702	0.64	33	39.33952	0.17	115	8.0	0.29	252	374.5	0.55
2002	84.59817	0.27	68	66.86346	0.24	52	5.4	0.42	16	311.4	0.26
2003	249.8549	0.28	147	45.08271	0.21	240	5.8	0.27	22	334.8	0.23
2004	113.6096	0.27	209	32.99943	0.16	451	1.0	0.33	23	178.1	0.19
2005	478.0872	0.12	702	5.66546	0.11	168	2.9	0.32	80	541.4	0.11
2006	334.9372	0.19	363	10.79936	0.13	217	6.4	0.17	80	386.9	0.32
2007	953.2067	0.15	370	16.00482	0.14	423	5.4	0.22	110	1039.6	0.15

Table A3. Estimated numbers (000s) and weight (mt,live) of Atlantic cod caught by marine recreational fishers from the Georges Bank and South stock during 1981-2007. The data has been revised by MRFSS since GARM II and includes new site registers.

Year	Catch		Landed	
	Numbers 000s	Weight* mt	Numbers 000s	Weight* mt
1981	1740.5	3841.4	1684.4	3717.6
1982	1548.2	6820.1	1495.1	6586.1
1983	1839.8	5501.8	1676.1	5012.4
1984	483.0	1293.8	452.7	1212.6
1985	1980.9	8498.9	1890.7	8111.6
1986	357.4	924.1	295.1	763.0
1987	503.2	960.7	461.5	881.1
1988	1362.2	3993.1	1132.0	3318.1
1989	560.1	1865.5	393.0	1309.1
1990	583.7	1438.0	455.2	1121.6
1991	465.9	1838.9	373.1	1472.6
1992	289.8	639.1	204.2	450.4
1993	1176.3	2886.0	761.9	1869.4
1994	603.2	1879.5	288.9	900.2
1995	798.7	2033.4	510.7	1300.3
1996	247.6	802.5	149.7	485.1
1997	543.8	1378.9	328.2	832.0
1998	581.6	1633.1	271.2	761.5
1999	233.4	793.4	126.2	429.2
2000	581.0	1409.3	288.3	699.2
2001	168.6	376.5	99.3	221.7
2002	146.5	442.4	93.1	281.1
2003	162.4	711.6	94.2	412.9
2004	245.2	470.2	130.1	249.5
2005	511.2	1237.5	141.8	343.3
2006	79.4	316.9	39.6	158.2
2007	24.8	83.1	3.9	13.0

* Weight as estimated by MRFSS, re-estimated in assessment

Table A4. USA sampling of commercial Atlantic cod landings, by market category, for the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978- 2007.

Year	Number of Samples, by Market Category & Quarter															Annual Sampling Intensity			
	Scrod					Market					Large					No. of Tons Landed/Sampled			
	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Scrd	Mkt	Lge	Σ
1978	17	15	6	3	41	9	12	13	9	43	1	0	1	2	4	69	374	1922	302
1979	2	5	14	8	29	6	19	11	8	44	2	0	4	1	7	88	407	1742	408
1980	7	10	13	4	34	12	14	5	1	32	3	0	0	0	3	136	588	5546	580
1981	4	10	11	3	28	6	9	10	2	27	2	0	0	0	2	149	634	6283	594
1982	5	9	32	9	55	6	20	27	13	66	8	8	9	5	30	156	279	410	260
1983	4	12	17	10	43	12	19	22	14	67	2	15	16	3	36	185	291	259	252
1984	6	8	8	7	29	8	15	8	11	42	18	5	3	3	29	138	441	358	329
1985	6	7	16	5	34	11	11	12	8	42	4	8	7	5	24	201	299	310	268
1986	6	7	7	6	26	8	10	10	11	39	6	5	10	8	29	142	215	186	186
1987	7	8	6	8	29	6	8	9	10	33	6	6	4	2	18	240	220	267	238
1988	8	6	7	5	26	13	7	9	9	38	4	4	3	1	12	283	331	532	346
1989	2	7	9	9	27	7	8	8	7	30	3	4	1	1	9	210	450	660	380
1990	8	9	10	4	31	10	13	9	8	40	4	4	4	0	12	295	315	538	340
1991	6	11	7	5	29	12	13	8	8	41	4	6	3	5	18	158	293	423	275
1992	6	7	7	10	30	8	10	6	9	33	5	5	3	1	14	149	215	377	219
1993	5	16	7	6	34	10	10	7	9	36	6	1	3	2	12	126	173	339	178
1994	3	9	8	2	22	5	11	7	4	27	1	4	3	1	9	92	187	290	167
1995	2	3	13	2	20	2	4	10	2	18	0	1	0	1	2	83	181	880	167
1996	6	2	12	3	23	5	6	11	6	28	0	2	1	1	4	59	143	400	127
1997	3	11	3	10	27	5	16	9	9	39	3	6	0	5	14	50	105	148	93
1998	3	7	23	5	38	10	10	15	3	38	1	2	1	0	3	44	92	573	87
1999	5	3	10	3	21	7	14	10	7	38	2	5	2	0	9	80	118	205	120
2000	21	19	16	27	83	20	14	13	16	63	2	2	2	2	8	18	72	192	49
2001	11	9	13	3	36	9	10	8	10	37	6	12	6	10	34	72	163	55	98
2002	5	7	7	1	20	8	10	11	6	35	14	8	6	3	31	80	153	63	107
2003	4	8	6	10	28	7	16	10	6	39	5	11	10	4	30	21	113	52	69
2004	8	11	4	10	33	14	6	8	13	41	25	13	2	11	51	8	53	20	28
2005	6	13	4	5	28	5	11	12	8	36	7	11	7	7	32	7	51	22	28
2006	11	16	8	14	49	13	15	10	13	51	25	28	7	18	78	6	37	6	15
2007	8	4	5	4	21	10	8	6	4	28	9	10	6	7	32	22	98	14	45

Table A5. USA and Canadian sampling of commercial Atlantic cod landings from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 - 2007.

Year	USA				Canada			
	Length Samples		Age Samples		Length Samples		Age Samples	
	No.	# Fish Measured	No.	# Fish Aged	No.	# Fish Measured	No.	# Fish Aged
1978	88	6841	76	1463	29	7684	29	1308
1979	80	6973	79	1647	13	3991	12	656
1980	69	4990	67	1119	10	2784	10	536
1981	57	4304	57	1231	17	4147	16	842
1982	151	11970	147	2579	17	4756	8	858
1983	146	12544	138	2945	15	3822	14	604
1984	100	8721	100	2431	7	1889	7	385
1985	100	8366	100	2321	29	7644	20	1062
1986	94	7515	94	2222	19	5745	19	888
1987	80	6395	79	1704	33	9477	33	1288
1988	76	6483	76	1576	40	11709	40	1984
1989	66	5547	66	1350	32	8716	32	1561
1990	83	7158	83	1700	40	9901	40	2012
1991	88	7708	88	1865	45	10873	45	1782
1992	77	6549	77	1631	48	10878	48	1906
1993	82	6636	82	1598	51	12158	51	2146
1994	58	4688	54	1064	104	25845	101	1268
1995	40	2879	40	778	36	11598	36	548
1996	55	4600	54	1080	129	26663	129	879
1997	80	6638	80	1581	118	31882	38	1244
1998	80	7076	81	1545	139	26549	139	1720
1999	68	5987	67	1503	84	24954	84	918
2000	154	12421	154	3043	107	20782	107	1436
2001	108	8389	108	2421	108	18190	108	1509
2002	86	6400	86	2179	91	18974	91	1264
2003	92	6116	90	2135	94	20199	94	1070
2004	125	8749	107	2755	127	17859	127	1370
2005	98	4705	86	1681	136	21942	136	1483
2006	178	9431	2798	163	258	43259	258	1455
2007	81	8291	76	2432	494	139816	494	1672

Table A6. Commercial landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Landings in Numbers (000's) at Age</u>											
1978	0	291	6012	1767	687	102	185	11	30	4	9088
1979	48	1542	611	3809	903	395	142	295	9	32	7785
1980	102	3092	4761	328	2045	858	386	59	125	4	11760
1981	39	2853	3725	2016	171	902	295	90	135	43	10269
1982	428	7565	2817	1750	1228	130	447	95	50	59	14568
1983	88	3461	5638	1374	881	658	85	155	56	82	12477
1984	70	1342	3275	2864	571	422	374	39	145	84	9186
1985	126	4159	1636	1032	1343	314	191	154	16	75	9045
1986	134	1142	3194	467	375	390	56	50	44	24	5877
1987	19	4873	814	1380	204	163	154	34	21	18	7679
1988	0	1679	5492	695	1059	149	88	90	17	24	9293
1989	0	1649	2633	3291	254	352	49	28	23	3	8283
1990	0	4647	3313	1279	1401	126	122	16	9	8	10920
1991	43	1164	2842	1841	830	562	65	42	12	6	7406
1992	1	2307	1333	761	939	256	177	19	15	3	5811
1993	0	769	3118	608	288	283	83	71	16	3	5238
1994	0.0	226	1108	1345	201	59	96	29	14	4	3081
1995	0.0	341	1007	570	310	28	19	19	5	1	2300
1996	0.0	211	753	947	191	137	8	9	10	0	2266
1997	0.0	399	539	674	566	75	60	11	6	3	2331
1998	8.2	693	979	349	259	190	24	8	2	0	2511
1999	0.0	256	1664	607	211	86	113	15	2.0	0.2	2953
2000	9	722	628	866	206	58	30	29	2	0	2550
2001	1	508	2301	616	457	111	34	15	11	1	4054
2002	0	32	1001	1293	310	285	68	13	8	5	3015
2003	0	74	279	650	707	117	95	17	4	2	1946
2004	0	30	272	153	228	158	34	26	6	3	911
2005	0	22	96	358	100	77	55	8	4	2	721
2006	0	12	440	129	185	29	14	13	2	2	825
2007		129	168	771	44	62	5	4	2	1	1186

Table A6 - continued. Commercial landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978- 2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Landings in Weight (Tons) at Age</u>											
1978	0	377	14847	6355	2804	546	1229	76	304	41	26579
1979	42	2202	1262	16766	4550	2886	1373	3042	89	435	32645
1980	84	4610	11660	1236	11661	5825	3244	566	1112	54	40053
1981	41	4285	8895	7035	847	6534	2558	893	1960	801	33849
1982	283	10616	7596	6543	6604	864	4299	959	667	902	39333
1983	94	5119	13773	4792	4312	4282	722	1668	645	1,350	36756
1984	72	2151	8080	10435	2887	2823	3279	396	1614	1178	32915
1985	118	5857	3475	4051	6910	2009	1563	1603	194	1048	26828
1986	126	1638	7325	1606	2036	2796	508	510	594	351	17490
1987	16	6849	2014	5556	1147	1290	1309	338	240	275	19035
1988		2533	12755	2313	5556	1021	733	851	201	347	26310
1989		2750	5861	11937	1288	2274	406	262	241	37	25056
1990		7087	7638	4488	6723	782	1013	175	101	102	28110
1991	50	1799	6990	6616	4246	3412	498	383	137	88	24219
1992	1	3423	3094	2961	4202	1571	1251	174	165	59	16899
1993	0	1171	6787	2020	1526	1625	638	629	150	43	14590
1994		306	2306	4594	965	427	670	261	140	67	9737
1995		511	2006	2152	1627	231	175	234	66	27	7028
1996	0	320	1820	3021	910	900	79	94	113	2	7259
1997		628	1260	2377	2219	429	447	83	68	34	7545
1998	4.4	1020	2204	1241	1241	1059	192	57	23	2	7044
1999		394	3528	1997	988	504	759	127	22	2	8319
2000	10	1227	1536	3034	978	341	225	242	18	0.2	7612
2001	0	781	5197	1809	1908	599	220	117	101	13	10746
2002		60	2166	3846	1225	1485	439	105	80	63	9470
2003		152	663	1945	2785	570	560	123	37	22	6856
2004		61	744	507	921	791	195	197	56	34	3507
2005		41	246	1226	410	386	313	65	40	29	2754
2006		24	1,110	464	748	138	89	89	14	18	2694
2007		263	423	2,469	175	269	30	27	17	6	3678

Table A6 - continued. Commercial landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978- 2007.

Year	Age										Mean
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Landings Mean Weight (kg) at Age</u>											
1978	0.582	1.297	2.470	3.597	4.078	5.331	6.651	7.086	10.139	11.288	2.925
1979	0.868	1.428	2.065	4.402	5.041	7.309	9.702	10.310	9.874	13.568	4.194
1980	0.824	1.491	2.450	3.766	5.703	6.789	8.403	9.517	8.918	12.946	3.406
1981	1.071	1.502	2.388	3.489	4.958	7.247	8.662	9.881	14.572	18.590	3.296
1982	0.661	1.403	2.697	3.738	5.378	6.624	9.625	10.108	13.254	15.415	2.700
1983	1.066	1.479	2.442	3.487	4.895	6.506	8.544	10.774	11.586	16.505	2.945
1984	1.026	1.603	2.468	3.643	5.056	6.689	8.759	10.099	11.168	14.101	3.583
1985	0.935	1.408	2.124	3.926	5.147	6.406	8.190	10.423	12.459	14.012	2.966
1986	0.945	1.434	2.293	3.440	5.434	7.160	9.020	10.099	13.347	14.863	2.976
1987	0.857	1.406	2.474	4.027	5.634	7.910	8.507	9.888	11.670	14.828	2.479
1988	0.000	1.508	2.322	3.329	5.245	6.853	8.350	9.452	11.541	14.755	2.831
1989	0.000	1.668	2.226	3.627	5.066	6.454	8.260	9.348	10.640	10.811	3.025
1990	0.000	1.525	2.305	3.509	4.799	6.200	8.317	11.255	11.547	12.581	2.574
1991	1.174	1.546	2.460	3.594	5.116	6.073	7.667	9.080	11.005	14.979	3.270
1992	1.016	1.484	2.321	3.893	4.477	6.127	7.070	9.323	10.818	17.028	2.908
1993	0.866	1.523	2.177	3.323	5.303	5.741	7.671	8.813	9.617	15.320	2.785
1994	0.000	1.354	2.081	3.415	4.809	7.280	6.983	9.174	9.972	18.039	3.160
1995	0.000	1.499	1.992	3.773	5.253	8.397	9.268	12.303	12.152	19.118	3.056
1996	0.000	1.517	2.418	3.192	4.755	6.555	10.069	10.166	11.114	9.283	3.203
1997	0.000	1.577	2.337	3.529	3.919	5.727	7.473	7.856	11.241	12.006	3.236
1998	0.536	1.473	2.250	3.558	4.799	5.581	7.884	7.587	12.382	10.299	2.804
1999	0.000	1.542	2.119	3.291	4.686	5.851	6.739	8.700	10.792	10.671	2.817
2000	1.177	1.699	2.447	3.504	4.755	5.853	7.488	8.271	7.890	10.789	2.985
2001	0.727	1.539	2.258	2.938	4.174	5.407	6.479	7.785	9.334	10.907	2.650
2002	0.000	1.834	2.165	2.974	3.948	5.221	6.510	8.076	9.425	12.166	3.141
2003	0.000	2.048	2.378	2.992	3.937	4.879	5.927	7.079	8.708	10.994	3.524
2004	0.000	2.020	2.735	3.306	4.037	4.998	5.673	7.655	8.668	11.827	3.847
2005	0.000	1.811	2.569	3.426	4.118	5.033	5.737	8.174	9.189	12.260	3.821
2006	0.000	2.080	2.524	3.594	4.048	4.706	6.129	7.039	8.013	10.197	3.264
2007	0.000	2.080	2.524	3.594	4.048	4.706	6.129	7.039	8.013	8.441	3.387

Table A6 - continued. Commercial landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978- 2007.

Year	Age										Mean
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Landings Mean Length (cm) at Age</u>											
1978	39.0	50.2	61.5	69.2	71.6	78.8	85.3	87.7	97.7	100.7	64.2
1979	44.3	51.9	57.7	74.2	77.9	88.2	97.8	99.6	98.5	108.8	71.0
1980	43.3	52.5	61.3	70.9	81.4	86.6	92.5	95.1	94.5	107.7	66.0
1981	47.4	52.4	60.9	69.0	77.7	88.3	94.0	97.9	111.7	120.7	64.9
1982	39.7	51.6	63.2	70.1	79.6	85.3	97.1	98.5	107.9	113.1	60.5
1983	47.5	52.5	61.4	68.6	77.1	84.9	93.1	100.6	103.0	116.0	63.2
1984	46.9	53.7	61.7	70.1	78.0	86.0	94.0	98.6	102.0	109.5	67.7
1985	45.4	51.6	58.5	72.0	78.7	84.7	91.8	99.7	105.5	109.7	62.5
1986	45.6	51.7	60.2	68.1	79.6	88.0	95.0	98.6	108.1	111.8	63.2
1987	44.2	51.6	61.6	72.5	81.3	91.3	93.1	97.9	103.4	111.7	59.4
1988		53.0	60.6	67.4	78.9	86.5	92.4	96.4	102.8	111.3	63.1
1989		54.7	59.8	69.9	77.9	84.2	91.3	96.6	100.6	101.3	64.8
1990		53.2	60.2	68.9	76.4	83.1	91.8	102.2	103.3	106.4	61.1
1991	49.0	53.3	61.7	69.3	78.1	82.5	89.5	93.3	100.8	111.3	66.1
1992	46.8	52.7	60.9	72.1	75.5	83.5	88.7	96.3	102.8	119.1	63.6
1993	45.0	53.0	59.7	68.5	79.9	82.1	91.7	95.7	98.5	112.2	63.2
1994		51.3	58.6	69.0	77.7	89.2	89.0	97.6	100.0	121.4	66.0
1995		52.7	57.9	71.0	80.8	93.3	97.6	106.5	106.8	121.9	64.8
1996		53.1	61.5	67.5	76.9	87.2	96.9	100.9	103.0	99.0	66.5
1997		53.6	60.9	69.6	72.2	83.3	91.2	92.5	104.6	107.2	66.7
1998	38.1	52.4	60.3	70.8	78.5	82.9	93.1	92.0	107.8	102.3	63.5
1999		53.4	59.3	69.0	77.9	83.8	88.3	95.7	102.5	103.6	64.2
2000	48.9	54.8	62.1	70.1	77.6	83.6	90.8	94.6	93.7		65.2
2001	42.0	53.1	60.3	65.8	74.0	81.2	86.4	91.9	98.4	103.3	62.8
2002		56.4	59.4	66.4	72.8	80.0	86.3	92.6	97.6	107.2	66.6
2003		58.3	61.4	66.5	73.1	78.3	84.0	89.1	94.9	103.2	69.7
2004		58.2	64.0	68.9	73.9	79.5	82.9	92.0	95.5	106.2	71.6
2005		56.1	63.0	69.6	74.7	79.7	83.1	93.9	96.9	106.7	71.6
2006		58.7	62.3	70.6	73.8	77.4	85.0	89.0	90.8	100.4	67.6
2007	0.0	58.7	62.3	70.6	73.8	77.4	85.0	89.0	90.8	92.0	66.9

Table A7. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Discards in Numbers (000's) at Age</u>											
1978	150	65	120	9	8	0	0	0	0	0	352
1979	231	330	15	13	2	0	0	0	0	0	591
1980	237	371	73	3	0	0	0	0	0	0	683
1981	578	529	62	0	0	0	0	0	0	0	1169
1982	206	676	54	21	0	0	0	0	0	0	957
1983	171	378	103	3	0	0	0	0	0	0	655
1984	58	87	11	0	0	0	0	0	0	0	156
1985	12	289	14	0	0	0	0	0	0	0	315
1986	439	168	35	17	0	0	0	0	0	0	661
1987	16	190	54	5	1	0	0	0	0	0	266
1988	76	206	70	8	0	0	0	0	0	0	360
1989	715	521	89	5	0	0	0	0	0	0	1331
1990	43	444	119	12	4	0	0	0	0	0	623
1991	89	247	52	18	4	3	0	1	0	0	414
1992	91	607	23	8	7	2	2	0	0	0	740
1993	18	273	65	2	2	2	0	1	0	0	363
1994	46.6	135	30	6	1	0	0	0	0	0	219
1995	11.7	70	33	3	1	0	0	0	0	0	119
1996	34.7	29	19	10	2	1	0	0	0	0	96
1997	57.1	54	13	6	4	0	0	0	0	0	134
1998	15.9	25	16	6	3	1	0	0	0	0	69
1999	37.3	45	32	5	0	0	0	0	0.0	0.0	120
2000	13	67	22	17	3	1	0	0	0	0	123
2001	7	179	103	9	7	2	0	0	0	0	307
2002	25	66	116	25	5	0	0	0	0	0	237
2003	10	92	38	36	14	2	1	0	0	0	193
2004	20	30	70	4	4	2	0	0	0	0	129
2005	8	241	61	49	5	3	2	0	0	0	370
2006	19	36	195	10	12	1	0	0	0	0	273
2007	10	364	184	119	5	7	0	0	0	0	689

Table A7 - continued. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Commercial Discards in Weight (Tons) at Age</u>											
1978	86	60	129	12	9	0	0	0	0	0	298
1979	152	349	18	16	3	0	0	0	0	0	537
1980	135	337	93	4	0	0	0	0	0	0	569
1981	374	581	78	0	0	0	0	0	0	0	1033
1982	139	757	64	26	0	0	0	0	0	0	985
1983	116	417	118	5	0	0	0	0	0	0	656
1984	27	61	9	0	0	0	0	0	0	0	98
1985	6	324	20	0	0	0	0	0	0	0	349
1986	285	117	37	18	0	0	0	0	0	0	457
1987	10	186	63	6	2	0	0	0	0	0	266
1988	47	185	83	9	0	0	0	0	0	0	323
1989	292	456	99	15	1	2	0	0	0	0	865
1990	23	412	140	24	17	1	0	0	0	0	618
1991	60	251	69	43	24	18	1	9	0	0	476
1992	62	567	36	26	44	15	13	0	1	0	766
1993	7	251	74	8	12	14	4	5	1	0	376
1994	21	117	40	16	2	1	1	0	0	0	199
1995	5	61	36	12	2	0	0	0	0	0	116
1996	17	25	37	40	13	8	.	0	0	0	139
1997	31	50	23	14	9	0	0	0	0	0	127
1998	9.6	26	42	24	14	7	1	0	8	0	131
1999	19.1	36	58	17	2	0	0	0	0	0	132
2000	7	65	48	62	17	4	1	0	0	0	204
2001	6	152	129	28	43	12	3	2	1	0	374
2002	13	71	175	44	7	1	0	0	0	0	311
2003	6	103	66	87	53	9	7	2	0	0	335
2004	7	34	100	10	13	9	2	1	0	0	178
2005	4	245	106	138	18	16	11	3	1	0	541
2006	8	37	288	23	27	2	1	1	0	1	387
2007	4	453	267	278	14	20	2	1	1	0	1040

Table A7 - continued. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of USA commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Age											
Year	1	2	3	4	5	6	7	8	9	10+	Average
<u>USA Commercial Discards Mean Weight (kg) at Age</u>											
1978	0.577	0.927	1.076	1.386	1.111	0.000	0.000	0.000	0.000	0.000	0.845
1979	0.658	1.059	1.185	1.209	1.242	0.000	0.000	0.000	0.000	0.000	0.909
1980	0.567	0.910	1.276	1.484	0.000	0.000	0.000	0.000	0.000	0.000	0.832
1981	0.648	1.097	1.257	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.883
1982	0.675	1.119	1.184	1.261	0.000	0.000	0.000	0.000	0.000	0.000	1.030
1983	0.677	1.104	1.148	1.484	0.000	0.000	0.000	0.000	0.000	0.000	1.001
1984	0.474	0.699	0.835	1.484	0.000	0.000	0.000	0.000	0.000	0.000	0.627
1985	0.474	1.119	1.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.108
1986	0.648	0.694	1.049	1.059	0.000	0.000	0.000	0.000	0.000	0.000	0.692
1987	0.610	0.980	1.177	1.028	1.484	0.000	0.000	0.000	0.000	0.000	1.000
1988	0.615	0.900	1.178	1.093	0.000	0.000	0.000	0.000	0.000	0.000	0.898
1989	0.408	0.874	1.114	3.114	5.035	6.119	6.193	6.974	0.000	0.000	0.650
1990	0.524	0.929	1.181	1.964	3.875	4.159	4.536	6.273	0.000	0.000	0.993
1991	0.676	1.015	1.332	2.446	5.868	6.615	5.989	13.874	0.000	0.000	1.149
1992	0.685	0.934	1.579	3.263	5.997	7.374	8.146	8.107	9.389	0.000	1.035
1993	0.387	0.916	1.137	4.400	7.288	7.648	8.614	8.866	9.465	6.735	1.036
1994	0.441	0.867	1.355	2.656	4.480	6.420	6.356	6.974	0.000	0.000	0.909
1995	0.402	0.866	1.089	3.698	4.614	4.639	4.109	0.000	0.000	0.000	0.977
1996	0.499	0.874	1.886	3.856	5.526	6.628	0.000	0.000	5.213	0.000	1.440
1997	0.549	0.927	1.812	2.297	2.193	2.831	3.319	0.000	0.000	0.000	0.951
1998	0.603	1.011	2.590	3.910	4.583	5.176	6.309	7.987	16.634	0.000	1.916
1999	0.512	0.804	1.785	3.200	3.536	3.767	4.124	0.000	0.000	0.000	1.101
2000	0.542	0.964	2.231	3.555	4.882	5.383	6.052	5.608	0.000	0.000	1.654
2001	0.805	0.851	1.256	3.169	5.719	6.456	7.211	6.998	7.323	0.000	1.220
2002	0.522	1.083	1.502	1.735	1.622	4.044	4.215	3.780	5.213	0.000	1.313
2003	0.647	1.117	1.733	2.421	3.861	4.801	6.287	10.006	9.444	11.374	1.732
2004	0.359	1.154	1.439	2.777	3.786	4.865	5.792	8.059	7.990	10.056	1.383
2005	0.431	1.018	1.720	2.799	3.954	4.666	6.119	9.771	10.247	10.770	1.462
2006	0.431	1.010	1.480	2.276	2.199	3.125	5.130	7.728	3.713	16.153	1.418
2007	0.433	1.244	1.452	2.339	2.923	2.757	4.236	7.213	7.656	5.974	1.508

Table A8. Recreational landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from Georges Bank and South (NAFO Division 5Z and Subarea 6), 1981-2007.

Year	Age										Total	
	1	2	3	4	5	6	7	8	9	10+		
<u>USA Recreational Landings in Numbers (000's) at Age</u>												
1978												0
1979												0
1980												0
1981	601	382	341	163	12	122	35	22	0	7	1684	
1982	136	929	202	109	68	3	38	7	3	0	1495	
1983	340	599	507	91	74	34	0	3	0	28	1676	
1984	153	92	82	88	12	15	4	1	4	2	453	
1985	34	849	388	275	258	44	31	5	3	4	1891	
1986	176	46	49	7	6	7	0	1	3	1	295	
1987	55	297	46	44	4	8	6	0	1	2	462	
1988	239	238	476	51	100	7	3	18	0	0	1132	
1989	176	124	29	51	6	5	1	0	0	0	393	
1990	22	131	166	54	65	9	6	1	0	2	455	
1991	135	59	86	60	23	8	2	0	0	0	373	
1992	30	110	32	11	10	4	2	1	0	0	199	
1993	277	241	177	21	15	7	3	0	10	3	755	
1994	45.8	113	66	43	11	5	3	1	1	0	288	
1995	20.6	203	226	32	18	4	1	0	0	0	503	
1996	29.1	22	47	36	8	7	0	0	0	0	150	
1997	66.5	123	42	48	37	4	5	0	0	0	326	
1998	39.2	128	62	18	12	5	0	1	0	0	265	
1999	9.0	17	34	36	16	5	5	0	1.9	0.0	124	
2000	92	121	29	29	8	2	0	0	0	0	280	
2001	4	23	55	6	9	1	0	0	0	0	98	
2002	9	11	25	37	5	5	1	0	0	0	93	
2003	7	29	16	19	16	2	2	0	0	0	92	
2004	30	6	28	22	21	14	3	4	0	0	129	
2005	3	76	16	32	7	3	3	0	0	0	141	
2006	9.3	5.0	14.2	2.7	6.0	1.3	1.1	0.3	0.1	0.0	40	
2007	0.5	1.1	0.3	1.4	0.2	0.4	0.1	0.0	0.0	0.0	4	

Table A8 continued. Recreational landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from Georges Bank and South (NAFO Division 5Z and Subarea 6), 1981-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Recreational Landings in Weight (Tons) at Age</u>											
1978	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0
1981	299	572	879	664	55	1096	302	206	0	90	4162
1982	73	1335	437	320	311	16	366	63	35	0	2955
1983	189	822	1509	333	340	195	0	24	0	454	3865
1984	52	70	249	346	55	106	34	9	44	29	994
1985	15	1116	834	848	1160	293	273	49	38	52	4678
1986	93	34	104	23	39	53	1	10	42	25	425
1987	25	463	120	188	22	58	48	0	5	40	970
1988	105	230	1153	196	593	41	23	246	0	0	2587
1989	96	130	62	157	24	23	9	2	6	0	507
1990	10	165	437	216	358	61	40	10	4	38	1339
1991	61	67	242	184	73	23	8	0	0	0	657
1992	15	140	74	40	42	21	13	4	0	0	350
1993	74	191	432	74	65	48	34	0	175	34	1127
1994	23	109	159	164	46	19	7	8	8	0	544
1995	8	250	375	88	90	12	4	0	0	0	826
1996	13	31	113	112	46	50	1	2	0	0	367
1997	34	159	112	175	170	19	45	1	0	0	715
1998	25.2	164	130	51	41	20	0	3	0	0	434
1999	5.2	21	79	145	72	27	21	1	16	0	387
2000	27	105	53	88	31	5	1	0	0	0	309
2001	1	34	115	21	29	4	1	0	0	0	205
2002	3	13	59	113	19	25	4	0	0	0	237
2003	4	31	34	56	59	6	13	1	0	0	203
2004	10	7	55	73	79	65	24	25	3	4	345
2005	2	70	29	82	33	12	14	2	0	0	243
2006	3.7	3.8	24.7	6.6	18.8	4.5	14.6	1.6	0.3	0.0	79
2007	0.1	0.8	0.4	3.0	0.9	1.9	0.3	0.1	0.0	0.0	8

Table A8 continued. Recreational landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from Georges Bank and South (NAFO Division 5Z and Subarea 6), 1981-2007.

Year	Age										Average
	1	2	3	4	5	6	7	8	9	10+	
<u>USA Recreational Landings Mean Weight (kg) at Age</u>											
1978											
1979											
1980											
1981	0.497	1.497	2.580	4.070	4.608	8.963	8.720	9.583	0.000	12.351	2.471
1982	0.537	1.437	2.163	2.921	4.591	5.839	9.512	9.342	10.619	0.000	1.977
1983	0.557	1.372	2.973	3.671	4.623	5.701	0.000	7.181	0.000	16.211	2.306
1984	0.342	0.756	3.052	3.943	4.600	6.959	8.629	13.780	9.824	13.029	2.194
1985	0.453	1.315	2.152	3.078	4.497	6.675	8.684	10.084	11.956	13.353	2.474
1986	0.527	0.747	2.134	3.343	7.017	7.701	6.959	11.624	16.623	21.883	1.442
1987	0.457	1.558	2.614	4.283	5.587	7.414	7.516	0.000	9.095	26.331	2.100
1988	0.440	0.968	2.420	3.802	5.916	6.059	9.095	13.737	0.000	0.000	2.285
1989	0.543	1.042	2.119	3.093	4.052	5.052	7.178	8.255	11.590	0.000	1.291
1990	0.448	1.267	2.631	4.030	5.515	6.636	7.126	9.990	9.095	17.518	2.943
1991	0.451	1.137	2.818	3.063	3.138	3.021	3.780	0.000	0.000	0.000	1.762
1992	0.513	1.267	2.356	3.738	4.189	5.595	5.568	7.469	0.000	0.000	1.756
1993	0.268	0.794	2.437	3.493	4.289	7.261	9.990	0.000	17.072	9.990	1.492
1994	0.495	0.965	2.434	3.832	4.068	4.086	2.405	14.559	14.559	0.000	1.892
1995	0.393	1.234	1.659	2.715	5.051	3.274	6.051	0.000	0.000	0.000	1.642
1996	0.454	1.399	2.380	3.160	5.936	6.775	2.898	5.415	0.000	0.000	2.455
1997	0.509	1.287	2.693	3.630	4.608	4.952	8.582	4.281	0.000	0.000	2.195
1998	0.642	1.285	2.074	2.907	3.458	3.954	0.000	4.814	0.000	0.000	1.638
1999	0.584	1.203	2.303	4.016	4.568	5.376	4.686	3.780	8.529	0.000	3.121
2000	0.291	0.864	1.861	3.023	4.028	2.818	4.826	0.000	0.000	0.000	1.102
2001	0.255	1.500	2.090	3.265	3.392	4.348	5.621	0.000	0.000	0.000	2.099
2002	0.400	1.189	2.336	3.096	3.942	4.747	5.521	0.000	0.000	0.000	2.562
2003	0.557	1.059	2.173	2.876	3.667	2.766	5.486	5.415	0.000	0.000	2.207
2004	0.316	1.190	1.988	3.267	3.837	4.637	7.081	5.941	7.469	10.301	2.663
2005	0.507	0.918	1.777	2.549	4.452	4.137	4.124	6.735	0.000	0.000	1.714
2006	0.397	0.753	1.733	2.431	3.141	3.447	13.837	5.137	4.281	0.000	1.963
2007	0.289	0.794	1.400	2.132	4.657	5.329	4.652	6.051	0.000	0.000	1.943

Table A9. Landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Canadian Commercial Landings in Numbers (000's) at Age</u>											
1978	2	61	1977	654	201	76	56	12	12	7	3058
1979	0	371	328	763	302	55	18	9	4	3	1853
1980	1	776	1122	214	420	125	32	11	14	10	2725
1981	2	146	611	506	135	382	87	51	21	16	1957
1982	6	1287	1362	1108	744	164	222	97	21	26	5037
1983	27	744	2505	1212	201	54	10	17	12	3	4785
1984	0	26	118	376	341	123	72	19	18	39	1132
1985	4	2147	904	383	497	139	45	38	9	11	4177
1986	19	238	1298	369	145	218	29	19	9	3	2347
1987	14	2596	602	741	91	79	117	22	15	6	4283
1988	10	229	2330	320	416	68	60	110	29	29	3601
1989	0	314	281	908	123	177	31	23	37	18	1912
1990	7	340	1776	619	802	95	102	8	14	30	3793
1991	11	493	512	1242	585	516	74	47	15	20	3515
1992	70	1784	899	291	544	186	175	25	21	7	4002
1993	4	252	1069	594	171	244	91	69	17	15	2526
1994	2	140	340	594	213	34	47	22	16	2	1410
1995	0	39	164	64	54	10	2	1	1	0	335
1996	1	25	163	269	52	36	9	2	1	0	558
1997	3	90	129	251	230	60	26	7	4	1	801
1998	0	58	202	97	91	74	13	7	3	2	547
1999	1	30	236	170	48	28	23	7	1	3	547
2000	0	30	59	231	93	25	15	9	2	1	465
2001	0.1	10	197	114	210	61	18	9	3	0	622
2002	0	3	38	150	42	75	14	5	2	1	330
2003	0.2	5	67	80	141	28	38	9	2	1	371
2004	0	3	60	64	54	73	18	19	4	0	295
2005	0	6	12	83	24	18	21	8	4	1	178
2006	0	3	113	44	125	32	14	14	2	1	348
2007	0	17	29	236	19	57	10	6	6	0	380

Table A9 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Canadian Commercial Landings in Weight (Tons) at Age</u>											
1978	1	84	4816	1911	788	470	371	122	113	107	8783
1979		509	525	2842	1398	342	169	105	47	42	5979
1980	1	1042	2722	692	2099	809	228	133	177	157	8060
1981	2	199	1433	1779	704	2638	801	497	220	224	8496
1982	4	1858	3165	4228	3860	1074	2028	914	266	418	17816
1983	24	1084	5519	3854	876	335	80	176	147	37	12132
1984		38	292	1427	1620	743	622	202	195	620	5758
1985	3	3019	1775	1388	2370	895	368	369	94	160	10442
1986	14	374	3734	1458	811	1565	250	180	89	28	8503
1987	9	4185	1556	3302	557	596	1113	243	189	93	11842
1988	8	296	5867	1249	2378	455	555	1177	334	437	12757
1989		411	662	3771	673	1207	231	247	432	276	7912
1990	6	616	5021	2290	4187	632	875	90	183	445	14345
1991	12	866	1425	4281	2593	2885	527	451	127	291	13457
1992	80	2769	2301	1038	2492	1101	1245	241	265	138	11669
1993	3	392	2488	1851	768	1429	638	623	153	183	8527
1994	2	203	817	2270	1023	243	370	196	128	23	5276
1995		57	409	241	286	63	22	10	10	0	1099
1996	1	38	384	898	272	229	62	17	11	0	1912
1997	3	138	292	821	979	351	213	60	47	13	2917
1998		86	480	310	389	431	91	58	33	30	1908
1999	1	47	540	600	200	177	156	56	9	41	1825
2000	0	44	126	710	393	123	93	66	17	13	1585
2001	0	15	445	338	840	312	94	72	28	0	2144
2002		4	86	461	181	379	94	41	18	11	1275
2003	0.1	7	142	213	529	122	216	62	15	9	1316
2004	0	4	122	182	182	333	97	138	37	17	1111
2005		7	21	210	89	89	108	60	34	12	630
2006	0	3	212	108	435	148	87	80	13	11	1097
2007	0	21	52	579	63	239	63	44	42	4	1107

Table A9 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Canadian Commercial Landings Mean Weight (kg) at Age</u>											
1978	0.707	1.376	2.436	2.922	3.918	6.187	6.625	10.148	9.429	15.262	2.872
1979	0.000	1.371	1.601	3.725	4.630	6.222	9.365	11.638	11.699	14.064	3.227
1980	0.567	1.343	2.426	3.235	4.997	6.468	7.119	12.135	12.652	15.721	2.958
1981	0.839	1.362	2.345	3.516	5.216	6.905	9.204	9.747	10.465	13.993	4.341
1982	0.652	1.444	2.324	3.816	5.188	6.550	9.137	9.418	12.667	16.092	3.537
1983	0.904	1.457	2.203	3.180	4.357	6.203	8.042	10.368	12.222	12.270	2.535
1984	0.000	1.477	2.473	3.794	4.751	6.043	8.633	10.622	10.807	15.897	5.087
1985	0.686	1.406	1.964	3.625	4.768	6.440	8.181	9.718	10.499	14.537	2.500
1986	0.723	1.572	2.877	3.952	5.592	7.179	8.612	9.453	9.934	9.437	3.623
1987	0.661	1.612	2.584	4.456	6.125	7.540	9.510	11.031	12.629	15.444	2.765
1988	0.786	1.294	2.518	3.904	5.716	6.694	9.251	10.700	11.531	15.065	3.543
1989	0.000	1.310	2.356	4.153	5.471	6.820	7.459	10.757	11.680	15.356	4.138
1990	0.831	1.812	2.827	3.699	5.221	6.657	8.582	11.227	13.080	14.821	3.782
1991	1.051	1.756	2.783	3.447	4.432	5.591	7.116	9.604	8.457	14.550	3.828
1992	1.148	1.552	2.559	3.568	4.581	5.921	7.112	9.626	12.603	19.714	2.916
1993	0.872	1.557	2.327	3.116	4.489	5.858	7.006	9.035	8.974	12.173	3.376
1994	0.906	1.453	2.404	3.822	4.805	7.141	7.869	8.914	7.970	11.637	3.742
1995	0.906	1.472	2.495	3.759	5.298	6.313	10.903	10.181	10.175		3.279
1996	1.034	1.538	2.358	3.337	5.237	6.358	6.916	8.455	10.594		3.427
1997	0.954	1.536	2.264	3.269	4.257	5.855	8.190	8.546	11.825	12.688	3.641
1998	0.626	1.484	2.375	3.195	4.274	5.828	6.991	8.298	10.984	14.840	3.487
1999	0.799	1.554	2.288	3.527	4.162	6.304	6.768	8.003	9.390	13.572	3.336
2000	0.866	1.458	2.128	3.075	4.230	4.923	6.200	7.344	8.254	12.863	3.408
2001	0.880	1.468	2.261	2.963	4.001	5.119	5.219	7.967	9.218		3.446
2002	0.551	1.421	2.265	3.073	4.301	5.054	6.721	8.277	8.790	10.755	3.863
2003	0.524	1.344	2.119	2.658	3.755	4.363	5.693	6.902	7.610	9.391	3.546
2004	0.704	1.360	2.011	2.827	3.391	4.561	5.517	7.354	9.040	10.328	3.714
2005	0.000	1.248	1.676	2.517	3.766	4.842	5.215	7.114	8.407	9.796	3.539
2006	0.048	1.102	1.872	2.430	3.493	4.564	6.340	5.917	7.321	7.646	3.156
2007	0.000	1.234	1.819	2.456	3.260	4.224	6.318	7.008	7.016	10.121	2.916

Table A10. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Canadian Commercial Discards in Numbers (000's) at Age</u>											
1978	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1979	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1980	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1981	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1982	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1990	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1991	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1992	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1993	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1994	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1995	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
1996	0.07	1.24	3.77	8.41	2.80	2.01	0.77	0.13	0.17	0.05	19
1997	0.32	19.43	27.20	41.70	45.74	8.81	3.26	1.11	0.09	0.06	148
1998	0.02	14.66	50.09	24.84	21.38	14.88	2.81	0.86	0.28	0.71	131
1999	0.44	8.71	55.11	34.36	11.58	6.57	3.56	0.39	0.17	0.16	121
2000	0.06	2.62	4.06	12.93	5.88	2.42	0.90	0.45	0.02	0.04	29
2001	0.26	0.94	11.41	6.43	15.46	5.82	2.26	1.45	0.96	0.24	45
2002	0.04	0.41	2.49	11.28	3.69	6.51	2.37	0.77	0.15	0.26	28
2003	0.22	0.35	4.48	15.11	32.20	7.28	6.36	1.57	0.24	0.00	68
2004	0.35	0.96	4.34	16.48	7.39	5.95	2.54	0.39	0.74	0.12	39
2005	0.75	18.90	16.00	55.80	9.18	4.86	4.78	1.07	0.36	0.06	112
2006	4.70	14.17	81.24	22.18	38.65	7.06	1.85	1.79	0.21	0.18	172
2007	0.14	14.83	14.48	48.80	3.80	3.51	0.20	0.07	0.06	0.00	86

Table A10 - continued. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total	
	1	2	3	4	5	6	7	8	9	10+		
<u>Canadian Commercial Discards in Weight (Tons) at Age</u>												
1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
1996	0.01	0.70	4.76	15.03	8.13	7.78	3.35	0.63	0.89	0.29		42
1997	0.29	27.18	58.04	128.85	183.58	47.02	24.65	8.94	0.48	0.36		479
1998	0.02	19.24	108.09	67.43	78.89	72.05	14.48	5.66	2.43	4.07		372
1999	0.34	12.40	117.57	102.09	41.01	30.44	18.73	2.94	1.26	1.54		328
2000	0.01	1.47	5.12	23.09	17.05	9.36	3.87	2.22	0.11	0.18		62
2001	0.03	0.53	14.40	11.49	44.86	22.52	9.78	7.13	5.12	1.04		117
2002	0.01	0.23	3.14	20.15	10.69	25.22	10.25	3.79	0.78	1.62		76
2003	0.03	0.20	5.66	26.99	93.42	28.21	27.48	7.76	1.30	0.00		191
2004	0.05	0.54	5.48	29.43	21.43	23.03	10.97	1.92	3.95	0.74		98
2005	0.09	14.06	22.90	119.13	27.88	20.19	20.14	5.42	2.74	0.43		233
2006	0.64	7.64	129.95	46.36	118.36	28.35	10.90	9.99	1.37	1.45		355
2007	0.02	9.91	15.09	79.45	7.90	9.91	0.92	0.44	0.33	0.00		124

Table A10 - continued. Discards at age (thousands of fish; metric tons) and mean weight (kg) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Age											
Year	1	2	3	4	5	6	7	8	9	10+	Average
<u>Canadian Commercial Discards Mean Weight (kg) at Age</u>											
1978	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1979	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1980	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1981	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1982	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1983	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1984	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1985	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1986	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1987	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1988	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1990	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1991	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1992	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1993	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1994	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1995	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
1996	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	5.912	2.140
1997	0.907	1.399	2.134	3.090	4.014	5.339	7.561	8.049	5.353	5.913	3.245
1998	0.629	1.312	2.158	2.714	3.691	4.843	5.144	6.585	8.728	5.741	2.852
1999	0.773	1.424	2.133	2.971	3.542	4.633	5.257	7.576	7.380	9.472	2.712
2000	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	5.159	2.128
2001	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	4.327	2.585
2002	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	6.232	2.713
2003	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	0.000	2.817
2004	0.128	0.562	1.262	1.786	2.901	3.872	4.322	4.934	5.353	6.392	2.485
2005	0.120	0.744	1.431	2.135	3.039	4.158	4.211	5.069	7.635	7.608	2.085
2006	0.135	0.539	1.600	2.090	3.063	4.013	5.902	5.586	6.520	8.014	2.064
2007	0.161	0.669	1.042	1.628	2.080	2.821	4.670	6.636	5.277	0.000	1.444

Table A11. Catch at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Catch in Numbers (000's) at Age</u>											
1978	152	417	8109	2430	897	178	241	23	42	11	12499
1979	279	2243	954	4585	1207	450	160	304	13	35	10229
1980	340	4239	5955	545	2465	983	418	70	139	14	15168
1981	1219	3911	4738	2685	318	1406	417	163	156	66	15079
1982	775	10457	4434	2988	2040	297	707	199	75	85	22057
1983	626	5182	8753	2680	1155	746	95	175	68	113	19593
1984	281	1548	3486	3328	924	560	450	59	167	125	10928
1985	176	7444	2942	1690	2098	496	267	197	28	90	15428
1986	768	1594	4576	860	525	615	86	70	56	28	9179
1987	104	7956	1515	2170	300	250	277	56	36	26	12691
1988	325	2352	8368	1074	1576	224	150	218	46	53	14386
1989	891	2609	3033	4254	383	534	81	51	60	21	11919
1990	72	5561	5373	1964	2272	231	229	25	23	40	15791
1991	270	1938	3486	3159	1442	1088	141	90	27	26	11667
1992	138	4448	2273	1066	1496	447	355	44	36	10	10313
1993	299	1535	4429	1225	475	536	178	141	43	21	8883
1994	91	605	1541	1987	426	98	146	51	31	6	4981
1995	32	649	1427	670	382	41	21	20	6	1	3251
1996	65	287	987	1270	256	184	18	12	11	0	3089
1997	126	684	749	1021	883	148	94	19	10	4	3738
1998	63	919	1310	494	386	285	40	16	6	3	3522
1999	46	354	2020	852	287	126	144	22	5	3	3859
2000	113	942	741	1156	316	88	46	39	4	1	3446
2001	12	720	2667	752	699	180	55	26	15	1	5126
2002	22	83	1129	1505	363	371	85	19	11	6	3594
2003	17	199	403	800	910	156	142	28	7	3	2665
2004	50	69	434	260	314	253	58	49	12	5	1505
2005	12	355	199	577	144	106	85	18	9	4	1509
2006	31	67	827	207	365	71	31	28	4	3	1635
2007	11	526	395	1176	72	129	16	10	9	1	2345

Table A11 - continued. Catch at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Year	Age										Total
	1	2	3	4	5	6	7	8	9	10+	
<u>Catch in Weight (Tons) at Age</u>											
1978	88	522	19793	8279	3600	1016	1600	197	418	149	35661
1979	194	3060	1804	19625	5951	3227	1542	3147	135	476	39162
1980	219	5990	14476	1933	13759	6634	3473	699	1289	212	48684
1981	716	5636	11284	9478	1607	10268	3661	1597	2180	1,116	47543
1982	499	14564	11262	11116	10775	1954	6694	1935	967	1,321	61088
1983	423	7442	20916	8984	5527	4812	803	1867	792	1,838	53404
1984	152	2320	8631	12207	4562	3672	3934	607	1852	1828	39766
1985	142	10313	6105	6287	10441	3197	2204	2022	326	1260	42298
1986	518	2163	11201	3106	2886	4414	759	700	724	405	26876
1987	60	11683	3753	9052	1728	1944	2470	580	435	406	32112
1988	160	3244	19856	3766	8527	1517	1311	2274	536	784	41976
1989	387	3747	6685	15879	1987	3506	646	511	679	312	34339
1990	38	8282	13235	7018	11285	1477	1928	275	289	586	44413
1991	183	2983	8726	11124	6935	6338	1034	842	264	381	38810
1992	159	6899	5505	4067	6780	2708	2522	418	431	196	29686
1993	85	2005	9781	3953	2369	3117	1313	1258	479	260	24620
1994	45	736	3323	7044	2037	690	1049	466	275	89	15754
1995	13	879	2825	2492	2007	306	200	244	75	27	9068
1996	32	414	2359	4086	1249	1194	145	113	124	2	9718
1997	68	1002	1745	3516	3560	847	730	153	116	47	11784
1998	39.1	1316	2963	1693	1763	1590	298	124	66	36	9888
1999	25.5	510	4321	2861	1302	738	955	187	48	44	10991
2000	44	1442	1768	3917	1437	482	324	311	34	13.0	9771
2001	7	983	5899	2208	2865	950	328	198	134	13	13584
2002	16	149	2490	4483	1443	1915	548	150	98	76	11368
2003	10	293	911	2328	3520	735	824	195	54	31	8901
2004	17	106	1027	801	1218	1221	329	363	101	56	5238
2005	5	377	424	1775	579	522	467	135	79	42	4404
2006	12	75	1,764	647	1,347	321	202	182	28	31	4610
2007	4	747	758	3,408	261	539	96	72	60	10	5956

Table A11 - continued. Catch at age (thousands of fish; metric tons) and mean weight (kg) at age of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2007.

Age											
Year	1	2	3	4	5	6	7	8	9	10+	Mean
<u>Catch Mean Weight (kg) at Age</u>											
1978	0.579	1.251	2.441	3.407	4.014	5.696	6.645	8.708	9.936	13.887	2.853
1979	0.694	1.364	1.892	4.280	4.931	7.176	9.664	10.350	10.438	13.611	3.829
1980	0.644	1.413	2.431	3.546	5.583	6.748	8.305	9.926	9.295	14.900	3.210
1981	0.587	1.441	2.381	3.529	5.055	7.303	8.780	9.800	14.018	16.799	3.153
1982	0.643	1.393	2.540	3.720	5.282	6.576	9.466	9.745	12.972	15.623	2.770
1983	0.676	1.436	2.389	3.352	4.784	6.447	8.491	10.667	11.699	16.319	2.726
1984	0.540	1.499	2.476	3.668	4.937	6.554	8.738	10.309	11.093	14.643	3.639
1985	0.806	1.385	2.075	3.720	4.977	6.439	8.247	10.279	11.765	14.047	2.742
1986	0.674	1.357	2.448	3.611	5.494	7.173	8.877	9.944	12.947	14.562	2.928
1987	0.582	1.468	2.476	4.171	5.768	7.777	8.908	10.336	12.027	15.642	2.530
1988	0.492	1.379	2.373	3.506	5.412	6.781	8.722	10.433	11.535	14.926	2.918
1989	0.435	1.436	2.204	3.732	5.181	6.563	7.937	9.976	11.287	14.651	2.881
1990	0.531	1.489	2.463	3.573	4.967	6.402	8.404	11.191	12.425	14.512	2.813
1991	0.658	1.520	2.499	3.520	4.809	5.825	7.318	9.388	9.615	14.649	3.315
1992	0.830	1.435	2.408	3.798	4.520	6.043	7.085	9.472	11.841	18.836	2.761
1993	0.284	1.306	2.208	3.227	4.984	5.820	7.378	8.922	11.135	12.228	2.772
1994	0.477	1.198	2.153	3.544	4.787	7.074	7.176	9.116	9.003	15.762	3.153
1995	0.396	1.347	1.977	3.721	5.249	7.430	9.327	12.197	11.841	19.118	2.785
1996	0.487	1.442	2.391	3.218	4.875	6.496	8.101	9.699	10.974	8.621	3.145
1997	0.539	1.463	2.328	3.445	4.033	5.734	7.734	8.090	11.420	12.087	3.151
1998	0.619	1.432	2.261	3.425	4.571	5.576	7.399	7.753	11.825	12.310	2.807
1999	0.534	1.431	2.137	3.355	4.543	5.867	6.641	8.406	9.562	13.201	2.844
2000	0.388	1.529	2.386	3.388	4.550	5.472	6.996	8.013	8.049	12.597	2.834
2001	0.601	1.365	2.212	2.937	4.101	5.265	5.980	7.681	9.043	9.737	2.650
2002	0.490	1.316	2.105	2.957	3.949	5.156	6.475	8.000	9.248	11.708	3.070
2003	0.602	1.458	2.254	2.907	3.866	4.710	5.789	6.918	8.251	10.448	3.334
2004	0.332	1.533	2.364	3.080	3.883	4.824	5.651	7.371	8.552	11.100	3.480
2005	0.431	1.035	2.102	3.068	4.003	4.925	5.467	7.497	8.786	11.370	2.891
2006	0.379	1.079	2.093	3.107	3.679	4.535	6.462	6.394	7.519	9.074	2.781
2007	0.423	1.420	1.917	2.899	3.627	4.173	5.932	6.957	6.922	9.070	2.540

Table A12. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod in NEFSC offshore spring and autumn research vessel bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2008. [1,2,3].

Year	Spring		Autumn	
	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	4.37	17.8
1964	-	-	2.79	11.4
1965	-	-	4.25	11.8
1966	-	-	4.90	8.1
1967	-	-	10.33	13.6
1968	4.73	12.7	3.31	8.6
1969	4.63	17.8	2.24	8.0
1970	4.34	15.8	5.12	12.6
1971	3.39	14.3	3.19	9.8
1972	9.16	19.3	13.09	22.9
1973	57.81	94.5	12.28	30.9
1974	14.74	36.4	3.49	8.2
1975	6.89	26.1	6.41	14.1
1976	7.06	18.6	10.43	17.7
1977	6.19	15.3	5.44	12.5
1978	12.31	31.2	8.59	23.3
1979	5.00	16.2	5.95	16.5
1980	7.68	24.1	2.91	6.7
1981	10.44	26.1	9.20	20.3
1982	32.96	101.9	3.34	6.1
1983	7.70	23.5	4.14	6.1
1984	4.08	15.3	4.73	10.0
1985	7.03	21.7	2.31	3.1
1986	5.04	16.7	2.99	3.7
1987	3.24	9.9	2.33	4.4
1988	5.87	13.5	3.07	5.6
1989	4.80	10.9	4.84	4.7
1990	4.79	11.7	4.78	11.5
1991	4.31	8.9	0.96	1.4
1992	2.67	7.4	1.72	3.0
1993	2.40	7.0	2.15	2.2
1994	0.95	1.2	1.82	3.3
1995	3.29	8.4	3.62	5.6
1996	2.70	7.5	1.10	2.7
1997	2.32	5.2	0.87	1.9
1998	4.36	11.7	1.87	2.8
1999	2.15	4.7	1.02	3.0
2000	3.57	8.2	1.31	1.4
2001	1.86	5.5	1.05	2.1
2002	2.08	5.0	4.70	11.3
2003	1.98	4.2	1.25	2.1
2004	5.38	14.3	4.21	5.9
2005	1.96	4.5	1.02	1.6
2006	3.17	6.1	1.44	2.7
2007	3.37	5.1	0.59	1.1
2008	3.57	4.3		
Mean 1963-2008	6.9	17.4	4.0	8.5

[1] During 1963-1984, BMV oval doors used in spring and autumn surveys; since 1985, Portuguese polyvalent doors used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents.

Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFC 1991).

[2] Spring surveys during 1980-1982, 1989-1991 and 1994 and autumn surveys during 1977-1981, 1989-1991, and 1993 were accomplished with the R/V Delaware II; in all other years, the surveys were accomplished using the R/V Albatross IV. Adjustments have been made to the R/V Delaware II catch per tow data to standardize these to R/V Albatross IV equivalents.

Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFC 1991)

[3] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a 36 Yankee' trawl. No adjustments have been made to the catch per tow data for these gear differences.

Table A13. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore spring bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2008.

Year	AGE											No./tow	
	0	1	2	3	4	5	6	7	8	9	10+		
SPRING													
1968	0.513	0.136	1.615	0.825	0.665	0.385	0.246	0.140	0.083	0.056	0.058		4.722
1969	0.000	0.123	0.546	1.780	0.888	0.451	0.326	0.215	0.128	0.072	0.112		4.641
1970	0.000	0.338	0.804	0.430	1.241	0.162	0.844	0.263	0.058	0.056	0.147		4.342
1971	0.000	0.206	0.860	0.438	0.254	0.570	0.114	0.324	0.365	0.128	0.132		3.391
1972	0.056	3.000	1.838	2.732	0.445	0.166	0.323	0.084	0.285	0.071	0.158		9.159
1973	0.056	0.546	42.258	6.344	6.387	0.657	0.515	0.367	0.058	0.217	0.404		57.808
1974	0.000	0.444	4.558	5.971	0.761	1.988	0.442	0.100	0.265	0.064	0.144		14.735
1975	0.000	0.064	0.327	2.092	2.941	0.377	0.744	0.084	0.115	0.147	0.000		6.890
1976	0.111	1.298	1.955	0.915	0.661	1.607	0.153	0.261	0.029	0.000	0.068		7.058
1977	0.000	0.044	3.389	1.084	0.553	0.267	0.717	0.052	0.066	0.000	0.021		6.193
1978	3.312	0.372	0.192	5.531	0.972	0.778	0.142	0.712	0.065	0.141	0.096		12.312
1979	0.108	0.428	1.298	0.275	1.852	0.547	0.236	0.084	0.139	0.013	0.022		5.000
1980	0.105	0.031	2.217	2.690	0.212	1.705	0.374	0.186	0.031	0.030	0.096		7.676
1981	0.301	2.302	1.852	2.811	1.685	0.106	0.879	0.258	0.132	0.000	0.113		10.438
1982	0.169	0.508	5.435	9.502	8.324	6.208	0.293	1.866	0.369	0.082	0.203		32.958
1983	0.081	0.332	1.952	3.017	0.796	0.697	0.443	0.027	0.219	0.000	0.138		7.701
1984	0.000	0.402	0.431	0.761	1.238	0.422	0.400	0.209	0.000	0.215	0.000		4.078
1985	0.244	0.111	2.653	0.663	1.110	1.412	0.265	0.192	0.180	0.037	0.161		7.029
1986	0.092	0.872	0.409	1.844	0.365	0.540	0.618	0.062	0.125	0.101	0.015		5.044
1987	0.000	0.020	1.613	0.378	0.763	0.062	0.179	0.136	0.033	0.027	0.025		3.235
1988	0.180	0.720	0.609	3.150	0.409	0.644	0.064	0.037	0.049	0.000	0.007		5.868
1989	0.000	0.310	1.410	0.666	1.583	0.235	0.351	0.051	0.040	0.055	0.093		4.794
1990	0.042	0.173	0.922	1.737	0.674	0.912	0.130	0.143	0.013	0.016	0.027		4.790
1991	0.195	1.027	0.528	0.689	0.929	0.479	0.328	0.054	0.041	0.000	0.045		4.313
1992	0.000	0.123	1.252	0.468	0.168	0.273	0.142	0.159	0.020	0.037	0.028		2.670
1993	0.110	0.009	0.399	1.306	0.205	0.090	0.138	0.029	0.034	0.021	0.055		2.396
1994	0.030	0.125	0.272	0.200	0.217	0.033	0.006	0.044	0.000	0.019	0.000		0.945
1995	0.482	0.050	0.382	0.854	0.534	0.599	0.107	0.234	0.028	0.022	0.000		3.290
1996	0.000	0.073	0.214	0.736	1.247	0.174	0.209	0.028	0.018	0.000	0.000		2.699
1997	0.302	0.291	0.437	0.170	0.489	0.422	0.050	0.134	0.020	0.000	0.000		2.315
1998	0.018	0.111	0.665	1.298	0.848	0.755	0.533	0.102	0.031	0.000	0.000		4.360
1999	0.067	0.212	0.291	0.609	0.510	0.238	0.119	0.064	0.031	0.007	0.000		2.148
2000	0.053	0.221	0.807	0.830	1.141	0.370	0.102	0.026	0.020	0.000	0.000		3.569
2001	0.000	0.061	0.235	0.794	0.160	0.383	0.177	0.023	0.018	0.012	0.000		1.862
2002	0.018	0.065	0.093	0.383	0.993	0.239	0.225	0.039	0.000	0.000	0.028		2.083
2003	0.000	0.016	0.213	0.271	0.623	0.696	0.064	0.080	0.012	0.000	0.000		1.975
2004	0.000	0.637	0.058	0.579	1.407	1.354	0.893	0.179	0.261	0.013	0.000		5.380
2005	0.0614	0.0119	0.4838	0.1378	0.631	0.2744	0.2053	0.1274	0.0298	0			1.9628
2006	0.0127	0.1786	0.231	1.3059	0.3319	0.7234	0.2128	0.1213	0.0539	0	0		3.1715
2007	0.000	0.125	0.639	0.3756	1.7937	0.1809	0.2092	0.0309	0.0181	0	0		3.3724
2008	0.1312	0.6326	0.8316	0.5785	0.3513	0.9606	0.0378	0.045	0	0	0		3.5686
average	0.263	0.408	1.123	1.640	1.155	0.711	0.306	0.180	0.094	0.066	0.096		6.877

Table A14. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2007.

Year	AGE											No./tow
	0	1	2	3	4	5	6	7	8	9	10+	
AUTUMN												
1963	0.019	0.719	0.778	0.920	0.897	0.354	0.326	0.175	0.103	0.014	0.069	4.374
1964	0.009	0.640	0.699	0.588	0.538	0.145	0.136	0.062	0.050	0.030	0.083	2.980
1965	0.173	1.299	0.998	0.707	0.484	0.167	0.179	0.112	0.081	0.023	0.023	4.246
1966	1.025	1.693	1.000	0.515	0.264	0.100	0.095	0.062	0.039	0.002	0.017	4.812
1967	0.072	7.596	1.334	0.523	0.406	0.133	0.133	0.055	0.051	0.012	0.070	10.385
1968	0.070	0.314	1.611	0.783	0.271	0.073	0.067	0.027	0.023	0.008	0.048	3.295
1969	0.000	0.343	0.622	0.626	0.331	0.094	0.061	0.019	0.023	0.022	0.059	2.200
1970	0.434	1.699	1.361	0.532	0.696	0.153	0.000	0.033	0.055	0.055	0.098	5.116
1971	0.400	0.602	0.617	0.408	0.310	0.478	0.164	0.042	0.090	0.000	0.075	3.186
1972	0.948	7.473	1.191	1.841	0.399	0.241	0.568	0.116	0.204	0.021	0.084	13.085
1973	0.203	1.748	6.060	1.164	2.039	0.210	0.225	0.175	0.062	0.137	0.253	12.276
1974	0.461	0.410	0.667	1.509	0.161	0.089	0.112	0.000	0.059	0.021	0.000	3.489
1975	2.377	0.992	0.421	0.628	1.682	0.111	0.156	0.000	0.000	0.000	0.037	6.406
1976	0.000	6.144	2.073	0.762	0.275	0.738	0.054	0.269	0.037	0.052	0.021	10.425
1977	0.152	0.237	3.434	0.691	0.253	0.173	0.394	0.007	0.027	0.000	0.077	5.444
1978	0.395	1.845	0.391	4.058	0.964	0.336	0.165	0.343	0.050	0.030	0.014	8.590
1979	0.115	1.625	1.677	0.162	1.687	0.321	0.184	0.031	0.113	0.010	0.025	5.948
1980	0.280	0.820	0.564	0.774	0.053	0.265	0.057	0.067	0.027	0.000	0.000	2.905
1981	0.261	3.525	2.250	1.559	0.589	0.054	0.579	0.057	0.064	0.018	0.083	9.039
1982	0.362	0.577	1.910	0.242	0.068	0.115	0.000	0.031	0.033	0.000	0.000	3.337
1983	1.283	0.850	1.089	0.740	0.069	0.033	0.004	0.010	0.015	0.000	0.044	4.136
1984	0.179	1.909	0.682	0.929	0.825	0.024	0.059	0.039	0.000	0.039	0.044	4.728
1985	1.002	0.181	0.843	0.067	0.106	0.077	0.028	0.000	0.000	0.000	0.003	2.306
1986	0.076	2.279	1.029	0.329	0.008	0.049	0.073	0.016	0.000	0.007	0.022	2.987
1987	0.204	0.414	1.353	0.108	0.200	0.028	0.012	0.000	0.000	0.000	0.007	2.325
1988	0.550	0.875	0.437	0.904	0.060	0.194	0.000	0.011	0.039	0.000	0.000	3.069
1989	0.251	2.798	1.046	0.161	0.507	0.055	0.015	0.007	0.000	0.000	0.000	4.841
1990	0.157	0.364	1.624	1.814	0.412	0.286	0.069	0.022	0.011	0.000	0.022	4.781
1991	0.041	0.408	0.175	0.274	0.031	0.029	0.000	0.000	0.000	0.000	0.000	0.957
1992	0.035	0.412	0.949	0.174	0.100	0.044	0.010	0.000	0.000	0.000	0.000	1.724
1993	0.178	0.970	0.532	0.383	0.017	0.025	0.022	0.000	0.000	0.022	0.000	2.149
1994	0.067	0.406	0.664	0.433	0.153	0.068	0.021	0.000	0.006	0.000	0.000	1.819
1995	0.160	0.245	1.811	1.249	0.087	0.054	0.011	0.000	0.000	0.000	0.000	3.616
1996	0.022	0.240	0.196	0.414	0.143	0.060	0.027	0.000	0.000	0.000	0.000	1.101
1997	0.006	0.236	0.321	0.109	0.129	0.049	0.009	0.007	0.000	0.000	0.000	0.867
1998	0.070	0.336	1.026	0.352	0.041	0.035	0.004	0.000	0.004	0.000	0.000	1.867
1999	0.070	0.140	0.154	0.310	0.255	0.087	0.000	0.000	0.000	0.000	0.000	1.016
2000	0.020	0.571	0.538	0.071	0.079	0.031	0.000	0.000	0.000	0.000	0.000	1.308
2001	0.028	0.047	0.381	0.459	0.059	0.055	0.008	0.008	0.000	0.000	0.000	1.045
2002	0.234	0.478	0.707	1.396	1.627	0.118	0.131	0.012	0.000	0.000	0.000	4.703
2003	0.327	0.166	0.309	0.201	0.156	0.082	0.000	0.007	0.000	0.000	0.000	1.248
2004	1.685	0.745	0.136	0.710	0.252	0.322	0.252	0.065	0.020	0.000	0.000	4.210
2005	0.052	0.055	0.579	0.129	0.176	0.026	0.000	0.007	0.000	0.000	0.000	1.024
2006	0.099	0.433	0.162	0.514	0.034	0.125	0.015	0.038	0.010	0.010	0.000	1.438
2007	0.075	0.115	0.207	0.050	0.130	0.006	0.007	0.000	0.000	0.000	0.000	
average	0.340	1.244	1.016	0.695	0.400	0.140	0.120	0.060	0.050	0.028	0.056	4.109

Table A15. Stratified mean catch per tow at age (numbers) of Atlantic cod in Canadian spring bottom trawl survey, 1986-2008.

Year	AGE										No./ tow
	1	2	3	4	5	6	7	8	9	10+	
SPRING											
1986	0.60	2.27	2.81	0.37	0.65	0.44	0.26	0.04	0.07	0.03	7.54
1987	0.25	2.13	0.93	1.09	0.34	0.12	0.22	0.08	0.03	0.07	5.26
1988	0.28	1.01	4.66	0.58	1.02	0.13	0.08	0.17	0.04	0.07	8.04
1989	1.63	2.78	1.38	2.85	0.36	0.42	0.05	0.10	0.12	0.06	9.75
1990	0.42	2.44	3.78	2.08	3.87	0.42	0.93	0.12	0.12	0.35	14.53
1991	1.18	1.16	1.84	2.15	1.05	1.31	0.16	0.22	0.03	0.09	9.19
1992	0.11	2.86	1.77	0.80	0.98	0.60	0.43	0.12	0.07	0.02	7.76
*1993	0.05	0.60	2.83	1.04	0.62	1.23	0.44	0.42	0.07	0.12	7.42
*1994	0.02	0.80	0.89	1.65	0.60	0.23	0.45	0.11	0.15	0.04	4.94
1995	0.07	0.67	1.50	0.86	0.60	0.19	0.04	0.05	0.02	0.02	4.02
1996	0.14	0.49	2.31	4.02	1.09	0.79	0.33	0.08	0.11	0.03	9.39
1997	0.32	0.53	0.55	1.25	1.23	0.27	0.06	0.03	0.02	0.01	4.27
1998	0.01	0.67	0.95	0.35	0.35	0.28	0.07	0.02	0.00	0.02	2.72
1999	0.33	0.32	1.49	1.09	0.41	0.26	0.15	0.01	0.02	0.01	4.09
2000	0.10	0.44	1.05	3.92	1.71	0.78	0.40	0.24	0.01	0.03	8.68
2001	0.00	0.06	0.64	0.42	1.11	0.52	0.26	0.17	0.16	0.06	3.40
2002	0.01	0.09	0.57	2.05	0.68	1.22	0.40	0.17	0.05	0.08	5.32
2003	0.00	0.02	0.30	0.65	1.21	0.32	0.34	0.16	0.01	0.00	3.01
2004	0.54	0.10	0.39	0.42	0.45	0.39	0.07	0.12	0.02	0.01	2.50
**2005	0.02	1.34	0.47	2.91	1.13	0.51	0.41	0.01	0.05	0.01	6.86
2006	0.00	0.04	1.41	0.66	1.63	0.70	0.20	0.18	0.08	0.05	4.95
2007	0.14	0.52	0.94	2.94	0.39	0.60	0.10	0.08	0.04	0.00	5.75
2008	0.01	0.32	0.90	0.59	2.18	0.14	0.28	0.03	0.00	0.01	4.47
average	0.27	0.94	1.49	1.51	1.03	0.52	0.27	0.12	0.06	0.05	6.41
* not used in VPA calibration; entire Bank not surveyed											
**R/V Teleost (R/V Needler indices not used since entire GB not surveyed)											
R/V Needler'05	0.05	2.04	2.78	14.18	3.42	1.59	1.45	0.12	0.15	0.02	25.80

Table A16a. Selected VPA diagnostics, including predicted beginning year stock numbers for ages 1-8 and catchability estimates of each survey index, with standard error and CV for the Georges Bank Atlantic cod stock for the **BASE MODEL**.

Levenburg-Marquardt Algorithm Completed 7 Iterations
Residual Sum of Squares = 383.740

Number of Residuals = 595
Number of Parameters = 8
Degrees of Freedom = 587
Mean Squared Residual = 0.653730
Standard Deviation = 0.808536

Number of Years = 30
Number of Ages = 10
First Year = 1978
Youngest Age = 1
Oldest True Age = 9

Number of Survey Indices Available = 30
Number of Survey Indices Used in Estimate = 30
VPA Classic Method - Auto Estimated Q's

Stock Numbers Predicted in Terminal Year Plus One (2008)
Age Stock Predicted Std. Error CV

Age	Stock Predicted	Std. Error	CV
1	5158.350	0.246246E+04	0.477374E+00
2	5777.533	0.195206E+04	0.337870E+00
3	4312.780	0.134212E+04	0.311197E+00
4	1201.636	0.348563E+03	0.290074E+00
5	4150.462	0.112909E+04	0.272039E+00
6	348.414	0.977986E+02	0.280697E+00
7	566.199	0.170298E+03	0.300775E+00
8	218.540	0.684464E+02	0.313198E+00

Catchability Values for Each Survey Used in Estimate
INDEX Catchability Std. Error CV

INDEX	Catchability	Std. Error	CV
1	0.219439E-01	0.434391E-02	0.197955E+00
2	0.919973E-01	0.727614E-02	0.790908E-01
3	0.186189E+00	0.193080E-01	0.103701E+00
4	0.316089E+00	0.450858E-01	0.142637E+00
5	0.402164E+00	0.624872E-01	0.155377E+00
6	0.408966E+00	0.614000E-01	0.150135E+00
7	0.427224E+00	0.771050E-01	0.180479E+00
8	0.517786E+00	0.835569E-01	0.161374E+00
9	0.141338E-01	0.106855E-01	0.756029E+00
10	0.899870E-01	0.208708E-01	0.231931E+00
11	0.198731E+00	0.467107E-01	0.235044E+00
12	0.177261E+00	0.223604E-01	0.126144E+00
13	0.216299E+00	0.540535E-01	0.249901E+00
14	0.207689E+00	0.355707E-01	0.171269E+00
15	0.300243E+00	0.112587E+00	0.374986E+00
16	0.291472E+00	0.165071E+00	0.566335E+00
17	0.209249E-01	0.562393E-02	0.268767E+00
18	0.981470E-01	0.209510E-01	0.213466E+00
19	0.327191E+00	0.335557E-01	0.102557E+00
20	0.615292E+00	0.779107E-01	0.126624E+00
21	0.949463E+00	0.112662E+00	0.118658E+00
22	0.112928E+01	0.189453E+00	0.167763E+00
23	0.121718E+01	0.235660E+00	0.193612E+00
24	0.128152E+01	0.264935E+00	0.206735E+00
25	0.172164E-01	0.366082E-02	0.212636E+00
26	0.746671E-01	0.874968E-02	0.117182E+00
27	0.131211E+00	0.152631E-01	0.116325E+00
28	0.158575E+00	0.229384E-01	0.144654E+00
29	0.122922E+00	0.223467E-01	0.181795E+00
30	0.143092E+00	0.233551E-01	0.163218E+00

Table A16b. Selected VPA diagnostics, including predicted beginning year stock numbers for ages 1-8 and catchability estimates of each survey index, with standard error and CV for the Georges Bank Atlantic cod stock for the **SPLIT MODEL**.

Levenburg-Marquardt Algorithm Completed 9 Iterations
 Residual Sum of Squares = 323.853

Number of Residuals = 595
 Number of Parameters = 8
 Degrees of Freedom = 587
 Mean Squared Residual = 0.551709
 Standard Deviation = 0.742771

Number of Years = 30
 Number of Ages = 10
 First Year = 1978
 Youngest Age = 1
 Oldest True Age = 9

Number of Survey Indices Available = 52
 Number of Survey Indices Used in Estimate = 52

VPA Classic Method - Auto Estimated Q's

Stock Numbers Predicted in Terminal Year Plus One (2008)

Age	Stock Predicted	Std. Error	CV
1	4874.666	0.218662E+04	0.448568E+00
2	5751.749	0.182760E+04	0.317747E+00
3	3851.720	0.113398E+04	0.294410E+00
4	970.307	0.274066E+03	0.282453E+00
5	2929.571	0.803594E+03	0.274304E+00
6	157.359	0.498832E+02	0.317002E+00
7	237.651	0.866388E+02	0.364564E+00
8	80.692	0.313443E+02	0.388442E+00

Catchability Values for Each Survey Used in Estimate

INDEX	Catchability	Std. Error	CV
1	0.178394E-01	0.601117E-02	0.336960E+00
2	0.918544E-01	0.111156E-01	0.121014E+00
3	0.168705E+00	0.303091E-01	0.179657E+00
4	0.215614E+00	0.433017E-01	0.200829E+00
5	0.264241E+00	0.594130E-01	0.224844E+00
6	0.278657E+00	0.523770E-01	0.187962E+00
7	0.297561E+00	0.527492E-01	0.177272E+00
8	0.363074E+00	0.710421E-01	0.195668E+00
9	0.292985E-01	0.628344E-02	0.214463E+00
10	0.101150E+00	0.921209E-02	0.910737E-01
11	0.225276E+00	0.256921E-01	0.114047E+00
12	0.506259E+00	0.867519E-01	0.171359E+00
13	0.688799E+00	0.113946E+00	0.165426E+00
14	0.701770E+00	0.122594E+00	0.174693E+00
15	0.723118E+00	0.181470E+00	0.250954E+00
16	0.816798E+00	0.174300E+00	0.213394E+00
17	0.141338E-01	0.106855E-01	0.756029E+00
18	0.899870E-01	0.208708E-01	0.231931E+00
19	0.198731E+00	0.467107E-01	0.235044E+00
20	0.177261E+00	0.223604E-01	0.126144E+00
21	0.216299E+00	0.540535E-01	0.249901E+00
22	0.207689E+00	0.355707E-01	0.171269E+00
23	0.300243E+00	0.112587E+00	0.374986E+00
24	0.291472E+00	0.165071E+00	0.566335E+00
25	0.358799E-01	0.115005E-01	0.320529E+00
26	0.187587E+00	0.396148E-01	0.211181E+00
27	0.324684E+00	0.370155E-01	0.114005E+00
28	0.372132E+00	0.475039E-01	0.127653E+00
29	0.580779E+00	0.710335E-01	0.122307E+00
30	0.555873E+00	0.114979E+00	0.206844E+00

Table A16b continued. Selected VPA diagnostics, including predicted beginning year stock numbers for ages 1-8 and catchability estimates of each survey index, with standard error and CV for the Georges Bank Atlantic cod stock for the **SPLIT MODEL**.

31	0.730017E+00	0.211842E+00	0.290188E+00
32	0.644843E-03	0.171054E-03	0.265264E+00
33	0.158633E-01	0.567279E-02	0.357605E+00
34	0.779414E-01	0.200113E-01	0.256748E+00
35	0.362628E+00	0.527704E-01	0.145522E+00
36	0.888325E+00	0.130864E+00	0.147315E+00
37	0.140774E+01	0.199374E+00	0.141627E+00
38	0.193422E+01	0.294172E+00	0.152088E+00
39	0.190133E+01	0.391504E+00	0.205911E+00
40	0.127804E-02	0.320091E-03	0.250454E+00
41	0.163752E-01	0.327145E-02	0.199780E+00
42	0.811005E-01	0.114794E-01	0.141545E+00
43	0.119082E+00	0.179800E-01	0.150989E+00
44	0.126944E+00	0.225861E-01	0.177922E+00
45	0.886514E-01	0.215241E-01	0.242795E+00
46	0.104097E+00	0.162056E-01	0.155678E+00
47	0.201548E-01	0.859432E-02	0.426415E+00
48	0.741493E-01	0.152083E-01	0.205104E+00
49	0.162972E+00	0.301554E-01	0.185035E+00
50	0.233271E+00	0.520419E-01	0.223096E+00
51	0.211986E+00	0.510959E-01	0.241035E+00
52	0.253043E+00	0.646169E-01	0.255360E+00

Table A17a . **BASE MODEL** estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and female percent mature (5-year moving window) of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2007.

Stock Numbers (Jan 1) in thousands

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	28705	25943	22914	45891	19863	11305	29021	9615	44505	17898	24854	17849	10204	19796	7470
2	4707	23365	20988	18453	36471	15562	8691	23506	7713	35744	14560	20056	13809	8290	15956
3	25333	3478	17107	13370	11591	20473	8096	5723	12569	4881	22111	9803	14070	6330	5023
4	7660	13468	1991	8669	6701	5520	8936	3512	2063	6191	2637	10610	5305	6709	2076
5	2967	4093	6916	1141	4688	2817	2128	4336	1367	920	3124	1198	4880	2584	2671
6	1264	1624	2267	3454	649	2015	1273	916	1678	649	484	1153	637	1967	833
7	1212	874	926	978	1570	266	982	541	308	823	308	197	467	315	642
8	82	776	572	385	428	654	133	402	205	176	425	118	88	178	132
9	174	47	363	405	169	173	378	56	153	105	93	154	51	50	66
10+	44	127	37	173	192	288	283	182	76	75	105	54	88	47	19
Total	72148	73793	74082	92919	82323	59073	59920	48789	70638	67462	68702	61191	49599	46266	34887

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Age																
1	9873	6318	3928	6690	10672	4976	12399	6159	2858	5338	1983	13523	2945	7178	7068	5158
2	5943	7814	5088	3187	5419	8623	4017	10108	4940	2330	4340	1608	11026	2400	5847	5778
3	8749	3487	5843	3577	2350	3819	6231	2967	7425	3396	1805	3372	1254	8698	1902	4313
4	2070	3214	1476	3500	2043	1252	1952	3289	1764	3690	1721	1115	2369	845	6362	1202
5	745	607	868	610	1728	762	582	836	1656	772	1665	694	679	1420	505	4150
6	853	189	121	369	270	628	280	221	402	731	306	553	288	426	834	348
7	283	223	68	62	138	90	259	117	102	168	268	111	226	141	285	566
8	209	74	53	36	35	30	37	84	54	35	62	92	39	109	87	219
9	68	46	15	26	19	12	10	11	34	22	12	26	32	16	64	62
10+	34	9	3	1	7	6	7	3	3	13	5	11	13	14	9	52
Total	28827	21980	17463	18057	22681	20196	25776	23796	19240	16495	12167	21104	18871	21247	22962	21848

Fishing Mortality

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	0.01	0.01	0.02	0.03	0.04	0.06	0.01	0.02	0.02	0.01	0.015	0.057	0.008	0.016	0.029
2	0.10	0.11	0.25	0.27	0.38	0.45	0.22	0.43	0.26	0.28	0.196	0.154	0.58	0.301	0.401
3	0.43	0.36	0.48	0.49	0.54	0.63	0.64	0.82	0.51	0.42	0.534	0.414	0.541	0.915	0.686
4	0.43	0.47	0.36	0.41	0.67	0.75	0.52	0.74	0.61	0.48	0.589	0.577	0.519	0.721	0.824
5	0.40	0.39	0.49	0.36	0.64	0.59	0.64	0.75	0.54	0.44	0.797	0.432	0.709	0.932	0.942
6	0.17	0.36	0.64	0.59	0.69	0.52	0.65	0.89	0.51	0.55	0.701	0.704	0.504	0.919	0.88
7	0.25	0.22	0.68	0.63	0.68	0.49	0.69	0.77	0.36	0.46	0.759	0.602	0.766	0.673	0.922
8	0.36	0.56	0.15	0.62	0.71	0.35	0.66	0.76	0.47	0.43	0.818	0.642	0.365	0.798	0.457
9	0.31	0.36	0.54	0.54	0.66	0.56	0.66	0.77	0.51	0.48	0.782	0.559	0.689	0.908	0.926
10+	0.31	0.36	0.54	0.54	0.66	0.56	0.66	0.77	0.51	0.48	0.782	0.559	0.689	0.908	0.926
F 5-8	0.29	0.38	0.49	0.55	0.68	0.49	0.66	0.79	0.47	0.47	0.77	0.59	0.59	0.83	0.80

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.02	0.00	0.01	0.01	0.00	0.00	0.01	0.00
2	0.33	0.09	0.15	0.10	0.15	0.12	0.10	0.11	0.17	0.05	0.05	0.05	0.04	0.03	0.10
3	0.80	0.66	0.31	0.36	0.43	0.47	0.44	0.32	0.50	0.48	0.28	0.15	0.19	0.11	0.26
4	1.03	1.11	0.68	0.51	0.79	0.56	0.65	0.49	0.63	0.60	0.71	0.30	0.31	0.32	0.23
5	1.17	1.41	0.66	0.61	0.81	0.80	0.77	0.53	0.62	0.73	0.90	0.68	0.27	0.33	0.17
6	1.14	0.83	0.47	0.78	0.90	0.68	0.67	0.57	0.67	0.81	0.81	0.69	0.52	0.20	0.19
7	1.14	1.23	0.43	0.38	1.34	0.67	0.92	0.57	0.87	0.80	0.87	0.84	0.53	0.28	0.06
8	1.30	1.38	0.53	0.43	0.89	0.88	1.03	0.70	0.73	0.87	0.69	0.87	0.69	0.34	0.14
9	1.15	1.24	0.62	0.65	0.85	0.74	0.78	0.54	0.64	0.77	0.89	0.70	0.37	0.30	0.14
10+	1.15	1.24	0.62	0.65	0.85	0.74	0.78	0.54	0.64	0.77	0.89	0.70	0.37	0.30	0.14
F 5-8	1.19	1.21	0.52	0.55	0.99	0.76	0.85	0.59	0.72	0.80	0.82	0.77	0.50	0.29	0.14

Table A17a. continued. **BASE MODEL** estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and female percent mature (5-year moving window) of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2007.

SSB at start of spawning season

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	836	853	856	1516	656	393	1230	1035	3133	1306	1725	803	371	1107	428
2	1503	6701	7328	6250	10785	5499	3999	10813	4333	19363	7815	9691	4488	3631	6593
3	31517	3803	21975	17270	15480	27649	11557	7748	18717	7186	32866	14041	19881	9025	7376
4	18567	37396	4512	22002	16572	13464	22981	9017	4886	17298	6676	27186	12810	16603	5337
5	7977	15051	29814	4352	17410	10409	7522	15813	5460	3771	12571	4596	18059	8870	8808
6	5197	7938	11369	19342	3223	10432	6181	4308	8903	3748	2606	5910	3262	8779	3750
7	5990	6042	6175	6557	11284	1769	6347	3385	2121	5890	2161	1262	2952	1863	3422
8	594	5667	5289	3026	3402	5999	1076	3240	1659	1514	3457	956	756	1336	982
9	1489	407	3145	4219	1655	1627	3567	525	1570	1023	866	1468	488	432	572
10+	565	1575	489	2566	2600	4135	3591	2170	984	1051	1336	701	1107	577	292
Total	74235	85433	90951	87101	83067	81375	68051	58056	51766	62150	72080	66616	64174	52224	37561

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	52	69	32	91	340	176	265	86	90	103	29	172	47	68	67
2	2434	1779	1923	1099	2459	4018	1833	4424	1689	854	1161	563	2236	551	1509
3	12256	4661	7924	5554	3644	5839	9115	4727	11300	4523	2410	4898	1749	10208	2254
4	4703	7228	3604	7847	4925	3112	4622	7893	4028	8181	3585	2649	5741	1942	14448
5	2579	1823	3246	2267	5257	2560	1955	2892	5387	2253	4683	2013	2205	4365	1592
6	3498	945	646	1830	1188	2568	1255	970	1701	2844	1115	2057	1118	1696	3062
7	1510	1136	495	437	758	505	1307	660	490	831	1224	483	1030	733	1413
8	1294	465	441	309	235	192	241	528	342	203	358	504	221	590	552
9	559	328	138	258	169	97	74	80	253	155	82	170	232	111	400
10+	327	106	55	5	75	63	77	29	25	132	47	104	136	120	79
Total	29212	18540	18503	19697	19050	19130	20744	22290	25305	20078	14694	13613	14714	20385	25377

Percent mature (females)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	8	7	9	9	8	8	13	18	16	20	25	20	12	13	9
2	33	34	38	38	36	41	49	59	58	59	64	61	46	53	47
3	75	78	79	79	79	85	87	91	91	89	90	91	85	89	89
4	95	96	96	96	96	98	98	99	99	98	98	98	97	98	99
5	99	99	99	99	99	100	100	100	100	100	100	100	100	100	100
6+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	4	4	4	5	10	9	7	7	8	7	4	7	6	5	4
2	43	41	50	48	57	56	51	51	50	43	33	38	36	35	37
3	93	92	96	95	94	94	93	94	93	88	84	83	83	84	89
4	100	100	100	100	99	100	99	100	99	99	98	98	98	98	99
5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table A17b. **SPLIT MODEL** estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and female percent mature (5-year moving window) of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2007.

Stock Numbers (Jan 1) in thousands

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	28705	25943	22914	45891	19863	11305	29021	9615	44505	17898	24854	17849	10204	19796	7470
2	4707	23365	20988	18453	36471	15562	8691	23506	7713	35744	14560	20056	13809	8290	15956
3	25333	3478	17107	13370	11591	20473	8096	5723	12569	4881	22111	9803	14070	6330	5023
4	7660	13468	1991	8669	6701	5520	8936	3512	2063	6191	2637	10610	5305	6709	2076
5	2967	4093	6916	1141	4688	2817	2128	4336	1367	920	3124	1198	4880	2584	2671
6	1264	1624	2267	3454	649	2015	1273	916	1678	649	484	1153	637	1967	833
7	1212	874	926	978	1570	266	982	541	308	823	308	197	467	315	642
8	82	776	572	385	428	654	133	402	205	176	425	118	88	178	132
9	174	47	363	405	169	173	378	56	153	105	93	154	51	50	66
10+	44	127	37	173	192	288	283	182	76	75	105	54	88	47	19
Total	72148	73793	74082	92919	82323	59073	59920	48789	70638	67462	68702	61191	49599	46266	34886

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Age																
1	9871	6316	3925	6675	10621	4944	12234	5977	2295	4239	1461	10802	2523	6490	7037	4875
2	5943	7812	5086	3185	5407	8581	3991	9973	4791	1868	3441	1181	8798	2054	5284	5752
3	8749	3487	5841	3575	2348	3809	6197	2946	7315	3274	1428	2635	904	6874	1619	3852
4	2070	3214	1475	3498	2041	1250	1944	3261	1746	3600	1621	806	1767	559	4869	970
5	745	607	868	610	1727	761	581	830	1634	758	1591	613	427	928	271	2930
6	853	189	121	369	270	627	279	220	397	713	294	493	223	220	432	157
7	283	223	68	62	138	90	258	116	102	164	253	102	179	88	116	238
8	209	74	53	36	35	30	37	84	54	34	59	80	32	70	44	81
9	68	46	15	26	19	12	10	11	34	21	11	23	22	10	32	26
10+	34	9	3	1	7	6	7	3	3	13	5	10	9	9	5	22
Total	28824	21975	17456	18037	22614	20110	25540	23421	18370	14685	10164	16745	14882	17301	19708	18902

Fishing Mortality

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	0.01	0.01	0.02	0.03	0.04	0.06	0.01	0.02	0.02	0.01	0.015	0.057	0.008	0.016	0.029
2	0.10	0.11	0.25	0.27	0.38	0.45	0.22	0.43	0.26	0.28	0.196	0.154	0.58	0.301	0.401
3	0.43	0.36	0.48	0.49	0.54	0.63	0.64	0.82	0.51	0.42	0.534	0.414	0.541	0.915	0.686
4	0.43	0.47	0.36	0.41	0.67	0.75	0.52	0.74	0.61	0.48	0.589	0.577	0.519	0.721	0.824
5	0.40	0.39	0.49	0.36	0.64	0.59	0.64	0.75	0.54	0.44	0.797	0.432	0.709	0.932	0.942
6	0.17	0.36	0.64	0.59	0.69	0.52	0.65	0.89	0.51	0.55	0.701	0.704	0.504	0.919	0.88
7	0.25	0.22	0.68	0.63	0.68	0.49	0.69	0.77	0.36	0.46	0.759	0.602	0.766	0.673	0.922
8	0.36	0.56	0.15	0.62	0.71	0.35	0.66	0.76	0.47	0.43	0.818	0.642	0.365	0.798	0.457
9	0.31	0.36	0.54	0.54	0.66	0.56	0.66	0.77	0.51	0.48	0.782	0.559	0.689	0.908	0.926
10+	0.31	0.36	0.54	0.54	0.66	0.56	0.66	0.77	0.51	0.48	0.782	0.559	0.689	0.908	0.926
F 5-8	0.29	0.38	0.49	0.55	0.68	0.49	0.66	0.79	0.47	0.47	0.77	0.59	0.59	0.83	0.80

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00
2	0.33	0.09	0.15	0.10	0.15	0.13	0.10	0.11	0.18	0.07	0.07	0.07	0.05	0.04	0.12
3	0.80	0.66	0.31	0.36	0.43	0.47	0.44	0.32	0.51	0.50	0.37	0.20	0.28	0.14	0.31
4	1.03	1.11	0.68	0.51	0.79	0.57	0.65	0.49	0.63	0.62	0.77	0.44	0.44	0.52	0.31
5	1.17	1.41	0.66	0.61	0.81	0.80	0.77	0.54	0.63	0.75	0.97	0.81	0.46	0.56	0.34
6	1.14	0.83	0.47	0.78	0.90	0.69	0.68	0.57	0.69	0.84	0.86	0.82	0.73	0.44	0.40
7	1.14	1.23	0.43	0.38	1.34	0.67	0.93	0.57	0.88	0.83	0.95	0.97	0.74	0.49	0.17
8	1.30	1.38	0.53	0.43	0.89	0.88	1.03	0.71	0.74	0.90	0.74	1.10	0.95	0.59	0.30
9	1.15	1.24	0.62	0.65	0.85	0.74	0.78	0.55	0.65	0.79	0.95	0.83	0.59	0.54	0.30
10+	1.15	1.24	0.62	0.65	0.85	0.74	0.78	0.55	0.65	0.79	0.95	0.83	0.59	0.54	0.30
F 5-8	1.19	1.21	0.52	0.55	0.99	0.76	0.85	0.60	0.73	0.83	0.88	0.92	0.72	0.52	0.30

Table A17b continued. **SPLIT MODEL** estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and female percent mature (5-year moving window) of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2007.

SSB at start of spawning season

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	836	853	856	1516	656	393	1230	1035	3133	1306	1725	803	371	1107	428
2	1503	6701	7328	6250	10785	5499	3999	10813	4333	19363	7815	9691	4488	3631	6593
3	31517	3803	21975	17270	15480	27649	11557	7748	18717	7186	32866	14041	19881	9025	7376
4	18567	37396	4512	22002	16572	13464	22981	9017	4886	17298	6676	27186	12810	16603	5337
5	7977	15051	29814	4352	17410	10409	7522	15813	5460	3771	12571	4596	18059	8870	8808
6	5197	7938	11369	19342	3223	10432	6181	4308	8903	3748	2606	5910	3262	8779	3750
7	5990	6042	6175	6557	11284	1769	6347	3385	2121	5890	2161	1262	2952	1863	3422
8	594	5667	5289	3026	3402	5999	1076	3240	1659	1514	3457	956	756	1336	982
9	1489	407	3145	4219	1655	1627	3567	525	1570	1023	866	1468	488	432	572
10+	565	1575	489	2566	2600	4135	3591	2170	984	1051	1336	701	1107	577	292
Total	74235	85433	90951	87101	83067	81375	68051	58056	51766	62150	72080	66616	64173	52224	37560
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	52	69	32	90	338	175	261	83	72	81	21	137	40	61	66
2	2434	1779	1922	1098	2453	3998	1821	4364	1636	683	918	412	1781	471	1361
3	12256	4661	7922	5551	3641	5823	9061	4691	11114	4344	1878	3798	1243	8025	1902
4	4703	7228	3604	7844	4921	3107	4601	7819	3982	7954	3342	1872	4188	1241	10909
5	2579	1823	3246	2267	5253	2556	1950	2867	5303	2205	4426	1740	1341	2744	831
6	3498	944	645	1829	1187	2564	1251	965	1675	2757	1064	1799	833	842	1532
7	1510	1136	494	437	758	504	1302	656	485	805	1140	434	784	440	568
8	1294	465	441	309	234	192	240	524	338	198	335	422	171	363	270
9	559	328	138	258	169	97	74	79	250	151	77	148	155	67	195
10+	327	106	55	5	75	63	77	29	25	128	44	91	91	72	39
Total	29211	18538	18499	19689	19030	19078	20637	22078	24880	19308	13246	10852	10627	14325	17672

Percent mature (females)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Age															
1	8	7	9	9	8	8	13	18	16	20	25	20	12	13	9
2	33	34	38	38	36	41	49	59	58	59	64	61	46	53	47
3	75	78	79	79	79	85	87	91	91	89	90	91	85	89	89
4	95	96	96	96	96	98	98	99	99	98	98	98	97	98	99
5	99	99	99	99	99	100	100	100	100	100	100	100	100	100	100
6+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Age															
1	4	4	4	5	10	9	7	7	8	7	4	7	6	5	4
2	43	41	50	48	57	56	51	51	50	43	33	38	36	35	37
3	93	92	96	95	94	94	93	94	93	88	84	83	83	84	89
4	100	100	100	100	99	100	99	100	99	99	98	98	98	98	99
5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
6+	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table A18a. **BASE MODEL** uncertainty measures of predicted stock size in 2008 (A) and fishing mortality in 2007 (B) for ages 1-10 from 1000 bootstrap replications.

A. Stock Size 2008

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
N 1	5158.	6533.	4768.	0.7298
N 2	5778.	6266.	2534.	0.4044
N 3	4313.	4506.	1340.	0.2974
N 4	1202.	1248.	338.	0.2705
N 5	4150.	4291.	1102.	0.2569
N 6	348.	366.	102.	0.2794
N 7	566.	591.	173.	0.2934
N 8	219.	225.	71.	0.3143

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
N 1	1375.	157.	26.6579	3783.	1.2603
N 2	489.	82.	8.4565	5289.	0.4792
N 3	194.	43.	4.4871	4119.	0.3254
N 4	47.	11.	3.8994	1155.	0.2925
N 5	141.	35.	3.3966	4009.	0.2749
N 6	17.	3.	4.9691	331.	0.3086
N 7	24.	6.	4.3101	542.	0.3198
N 8	6.	2.	2.8435	212.	0.3327

	LOWER 80. % CI	UPPER 80. % CI
N 1	2262.	12026.
N 2	3513.	9413.
N 3	2952.	6223.
N 4	873.	1747.
N 5	3037.	5708.
N 6	248.	498.
N 7	378.	829.
N 8	139.	320.

Table A18a continued. **BASE MODEL** Uncertainty measures of predicted stock size in 2008 (A) and fishing mortality in 2007 (B) for ages 1-10 from 1000 bootstrap replications.

B. Fishing Mortality (2007)

Bootstrap Output Variable: Fishing Mortality (2007)

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
AGE 1	0.0017	0.0018	0.000684	0.3877
AGE 2	0.1044	0.1080	0.030238	0.2801
AGE 3	0.2591	0.2646	0.061457	0.2323
AGE 4	0.2271	0.2321	0.053591	0.2309
AGE 5	0.1705	0.1738	0.044442	0.2557
AGE 6	0.1869	0.1939	0.056194	0.2898
AGE 7	0.0647	0.0694	0.023411	0.3371
AGE 8	0.1407	0.1457	0.025088	0.1721
AGE 9	0.1407	0.1457	0.025088	0.1721
AGE 10	0.1407	0.1457	0.025088	0.1721

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AGE 1	0.000109	0.000022	6.6054	0.0015	0.4425
AGE 2	0.003606	0.000963	3.4554	0.1008	0.3001
AGE 3	0.005418	0.001951	2.0909	0.2537	0.2422
AGE 4	0.005021	0.001702	2.2111	0.2221	0.2413
AGE 5	0.003348	0.001409	1.9636	0.1671	0.2659
AGE 6	0.007042	0.001791	3.7681	0.1798	0.3125
AGE 7	0.004697	0.000755	7.2536	0.0601	0.3898
AGE 8	0.005029	0.000809	3.5739	0.1357	0.1849
AGE 9	0.005029	0.000809	3.5739	0.1357	0.1849
AGE 10	0.005029	0.000809	3.5739	0.1357	0.1849

	LOWER 80. % CI	UPPER 80. % CI
AGE 1	0.001016	0.002715
AGE 2	0.073390	0.148701
AGE 3	0.185377	0.341005
AGE 4	0.170090	0.298353
AGE 5	0.121952	0.231915
AGE 6	0.131244	0.266855
AGE 7	0.044370	0.099813
AGE 8	0.116780	0.180193
AGE 9	0.116780	0.180193
AGE 10	0.116780	0.180193

Table A18b. **SPLIT MODEL** Uncertainty measures of predicted stock size in 2008 (A) and fishing mortality in 2007 (B) for ages 1-10 from 1000 bootstrap replications.

A. Stock Size 2008

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
N 1	4875.	6694.	5979.	0.8932
N 2	5752.	6358.	2707.	0.4257
N 3	3852.	4065.	1293.	0.3181
N 4	970.	1003.	303.	0.3015
N 5	2930.	3019.	841.	0.2787
N 6	157.	165.	50.	0.3014
N 7	238.	251.	96.	0.3835
N 8	81.	85.	36.	0.4197

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
N 1	1819.	198.	37.3120	3056.	1.9565
N 2	606.	88.	10.5393	5146.	0.5260
N 3	214.	41.	5.5481	3638.	0.3555
N 4	33.	10.	3.4200	937.	0.3228
N 5	89.	27.	3.0394	2841.	0.2961
N 6	7.	2.	4.6315	150.	0.3306
N 7	13.	3.	5.5863	224.	0.4289
N 8	4.	1.	5.4608	76.	0.4682

	LOWER 80. % CI	UPPER 80. % CI
N 1	1954.	13428.
N 2	3484.	9918.
N 3	2596.	5739.
N 4	653.	1395.
N 5	2031.	4074.
N 6	108.	229.
N 7	138.	379.
N 8	44.	130.

Table A18b continued. **SPLIT MODEL** Uncertainty measures of predicted stock size in 2008 (A) and fishing mortality in 2007 (B) for ages 1-10 from 1000 bootstrap replications.

B. Fishing Mortality (2007)

	NLLS Estimate	Bootstrap Mean	Bootstrap Std Error	C.V. For NLLS Soln.
AGE 1	0.0017	0.0018	0.000727	0.4096
AGE 2	0.1161	0.1200	0.034663	0.2889
AGE 3	0.3119	0.3232	0.081705	0.2528
AGE 4	0.3080	0.3172	0.074404	0.2345
AGE 5	0.3439	0.3520	0.086883	0.2468
AGE 6	0.3973	0.4208	0.140749	0.3345
AGE 7	0.1662	0.1848	0.079164	0.4283
AGE 8	0.3025	0.3192	0.065865	0.2063
AGE 9	0.3025	0.3192	0.065865	0.2063
AGE 10	0.3025	0.3192	0.065865	0.2063

	Bias Estimate	Bias Std. Error	Per Cent Bias	NLLS Estimate Corrected For Bias	C.V. For Corrected Estimate
AGE 1	0.000111	0.000023	6.6776	0.0016	0.4682
AGE 2	0.003842	0.001103	3.3082	0.1123	0.3087
AGE 3	0.011255	0.002608	3.6084	0.3006	0.2718
AGE 4	0.009239	0.002371	2.9997	0.2988	0.2490
AGE 5	0.008150	0.002760	2.3699	0.3357	0.2588
AGE 6	0.023443	0.004512	5.8998	0.3739	0.3764
AGE 7	0.018574	0.002571	11.1729	0.1477	0.5361
AGE 8	0.016722	0.002149	5.5282	0.2858	0.2305
AGE 9	0.016722	0.002149	5.5282	0.2858	0.2305
AGE 10	0.016722	0.002149	5.5282	0.2858	0.2305

	LOWER 80. % CI	UPPER 80. % CI
AGE 1	0.000962	0.002744
AGE 2	0.079354	0.167325
AGE 3	0.226352	0.433711
AGE 4	0.230071	0.417925
AGE 5	0.248083	0.468221
AGE 6	0.267313	0.606938
AGE 7	0.105918	0.284319
AGE 8	0.241887	0.406217
AGE 9	0.241887	0.406217
AGE 10	0.241887	0.406217

Table A19. Comparison of Mohn's rho for fishing mortality (F), spawning stock biomass (SSB) and recruitment at age 1, and VPA predicted stock size at age (stk pred) with standard error (std err) and coefficient of variation (cv) and F at age, with average fishing mortality for ages 5-8 (F5-8) for three VPA model formulations. All three VPAs use catch at age with different numbers at age for 2004 compared to final VPA run.

Base					Base Split Surveys					Round the Corner				
Mohn's rho					Mohn's rho					Mohn's rho				
F					F					F				
SSB					SSB					SSB				
Recruits					Recruits					Recruits				
age	stk pred	std err	cv	F	age	stk pred	std err	cv	F	age	stk pred	std err	cv	F
1	5183.3	2468.6	0.48	0	1	4956.4	2221.2	0.45	0.00	1	5440.4	2496.6	0.46	0.00
2	5806.7	1957.3	0.34	0.1	2	5849.3	1856.8	0.32	0.11	2	6090.9	1978.8	0.32	0.10
3	4336.7	1345.9	0.31	0.26	3	3923.7	1152.7	0.29	0.31	3	4567.7	1362.7	0.30	0.24
4	1209.6	349.7	0.29	0.17	4	992.5	279.0	0.28	0.30	4	1296.1	357.8	0.28	0.21
5	4179.6	1132.9	0.27	0.19	5	3005.4	819.1	0.27	0.34	5	4607.1	1185.5	0.26	0.18
6	345.1	97.0	0.28	0.07	6	160.5	50.7	0.32	0.39	6	333.8	94.1	0.28	0.20
7	554.4	168.0	0.30	0.14	7	239.6	87.2	0.36	0.17	7	540.3	168.4	0.31	0.06
8	205.4	66.1	0.32	0.14	8	77.4	30.6	0.39	0.30	8	256.7	76.6	0.30	0.03
9	61.0				9	27.0				9	286.5	90.6	0.32	0.03
10	51.0				10	22.0								
F5-8				0.14	F5-8				0.30	F5-8				0.11

Table A20. Input data for yield-per-recruit and projection analysis. Selectivity and mean weight estimated as an average of 2003-2007 data, and proportion mature estimated from a five-year moving average, 2004-2008.

Age	VPA selectivity	Stock weight	Catch weight	Spawning stock weight	Proportion mature
1	0.01	0.255	0.433	0.255	0.05
2	0.11	0.761	1.305	0.761	0.35
3	0.40	1.657	2.146	1.657	0.84
4	0.74	2.564	3.012	2.564	0.98
5	1.00	3.394	3.812	3.394	1.00
6	1.00	4.237	4.633	4.237	1.00
7	1.00	5.317	5.860	5.317	1.00
8	1.00	6.470	7.027	6.470	1.00
9	1.00	7.605	8.006	7.605	1.00
10	1.00	10.213	10.213	10.213	1.00

Table A21. Projection results of catch and spawning stock biomass in 2009 using catch in 2008=2007 for 3 fishing mortality (F) scenarios: $F_{STATUS\ QUO}$, F_{MSY} , and $F_{REBUILD}$.

	Year	Catch mt	SSB mt	F
F status quo 0.30	2007	5,957	17,672	0.30
	2008	5,957	21,242	0.36
	2009	5,754	25,008	0.30
Fmsy 0.25	2007	5,957	17,672	0.30
	2008	5,957	21,242	0.36
	2009	4,885	25,155	0.25
Frebuild 0.186	2007	5,957	17,672	0.30
	2008	5,957	21,242	0.36
	2009	3,722	25,360	0.186

Atlantic Cod Assessment Area

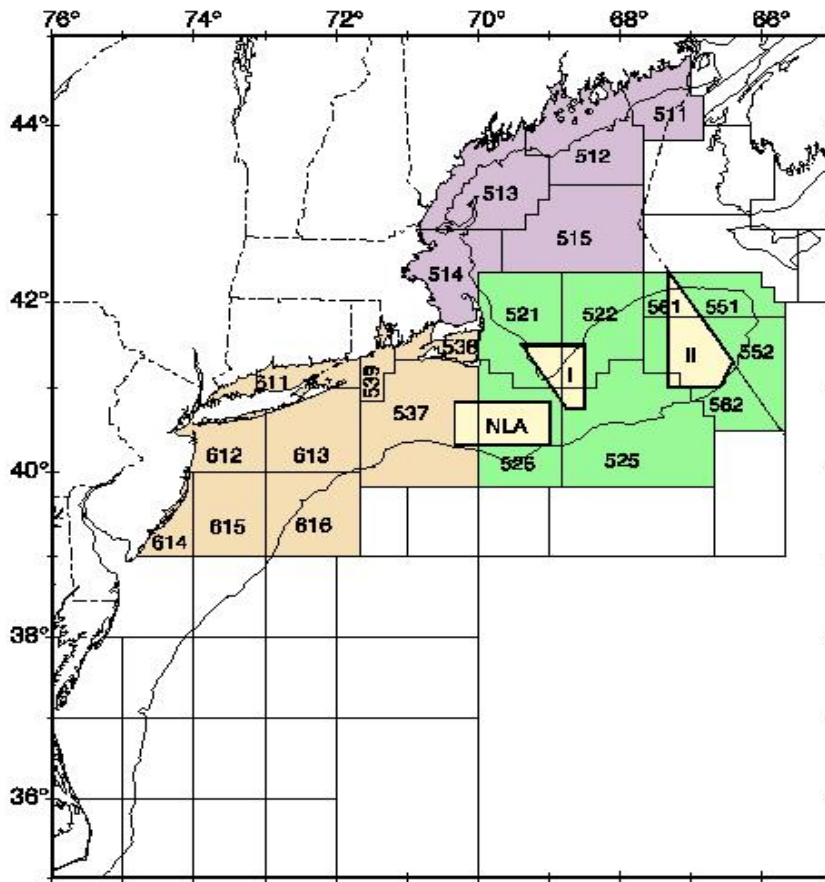


Figure A1. Stock area of Georges Bank cod as defined by Northwest Atlantic Fisheries Organization (NAFO) statistical areas: 521-526, 551-552, 561-562, 537-539, and Subarea 6.

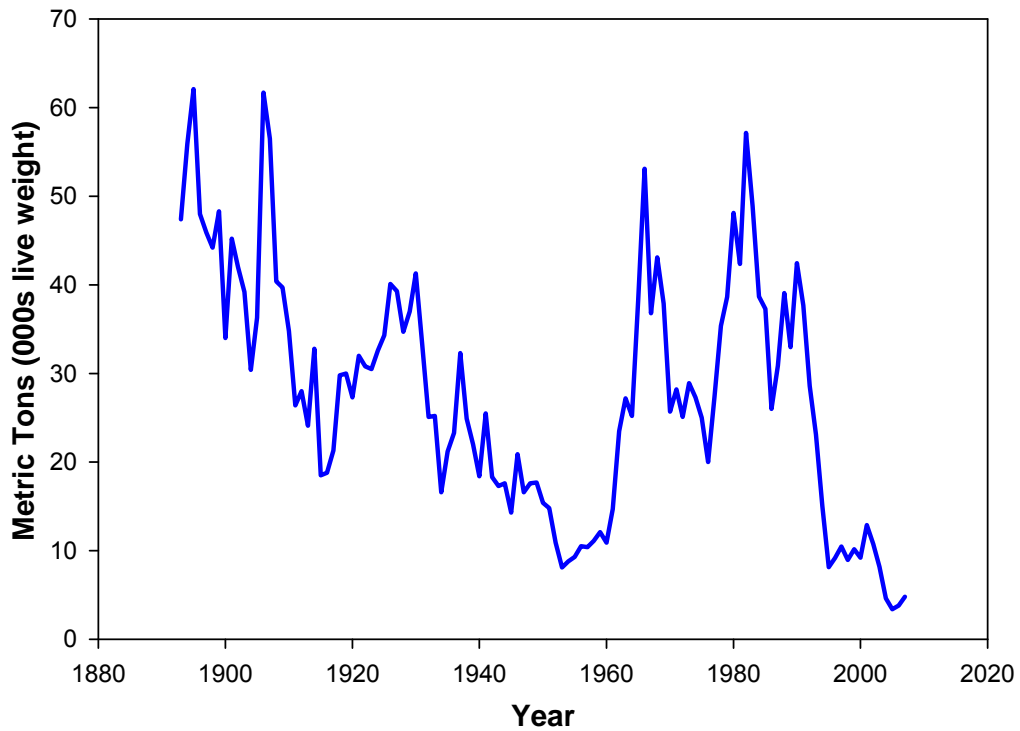


Figure A2a. Total commercial landings of Georges Bank Atlantic cod (NAFO Div. 5Z and SubArea 6, 1893-2007).

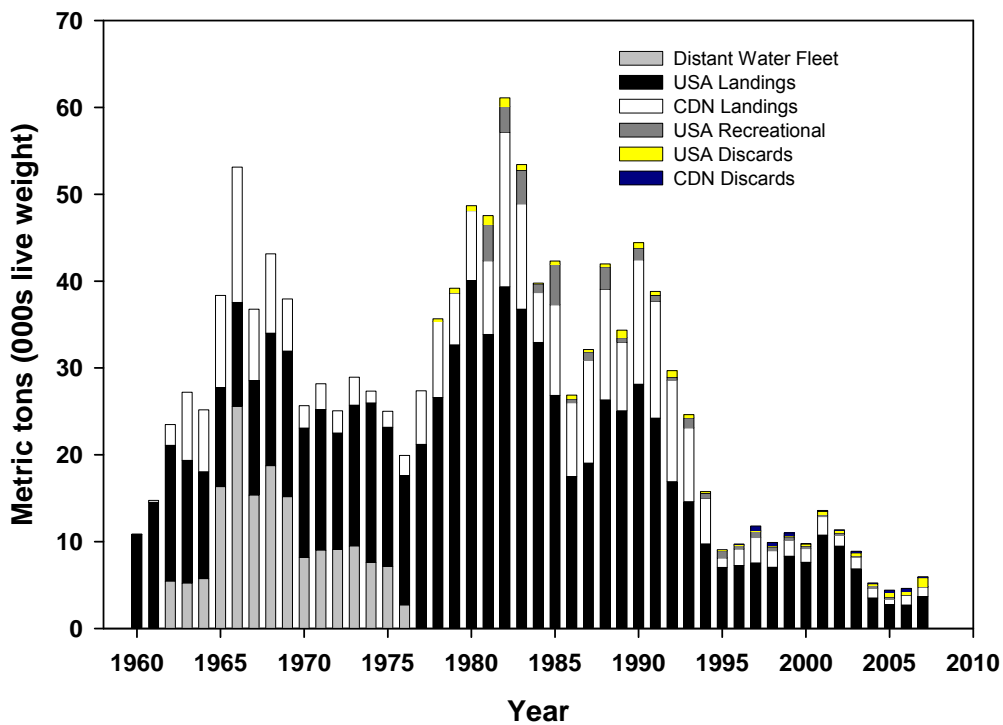


Figure A2b. Total catch of Georges Bank Atlantic cod including USA commercial landings, discards, and recreational landings and Canadian landings and discards, 1960-2007.

Georges Bank Cod Catch at Age

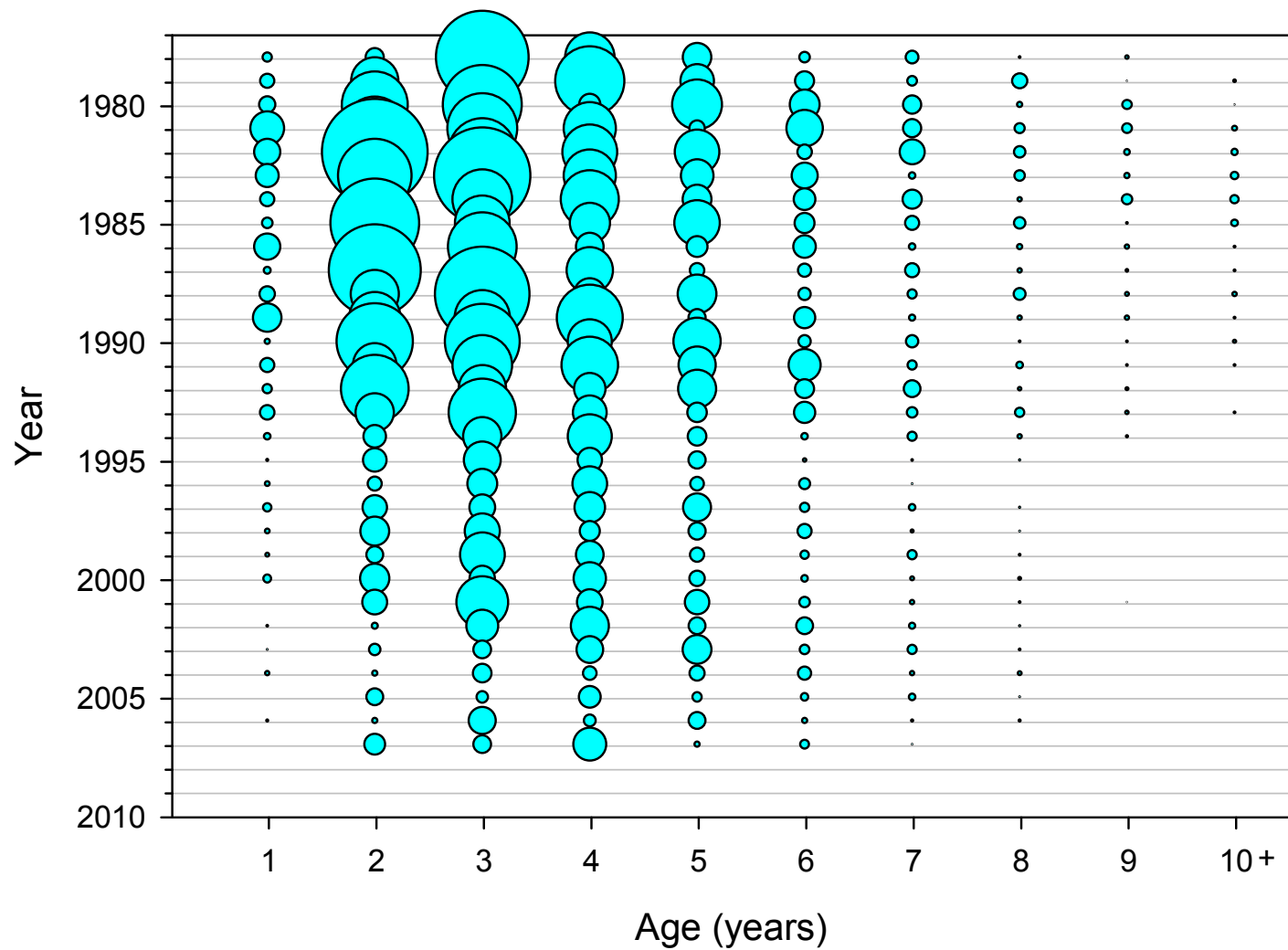


Figure A3. Total catch at age (000s of fish) of combined USA and Canadian commercial landings and discards and USArecreational landings for Georges Bank cod, 1978-2007.

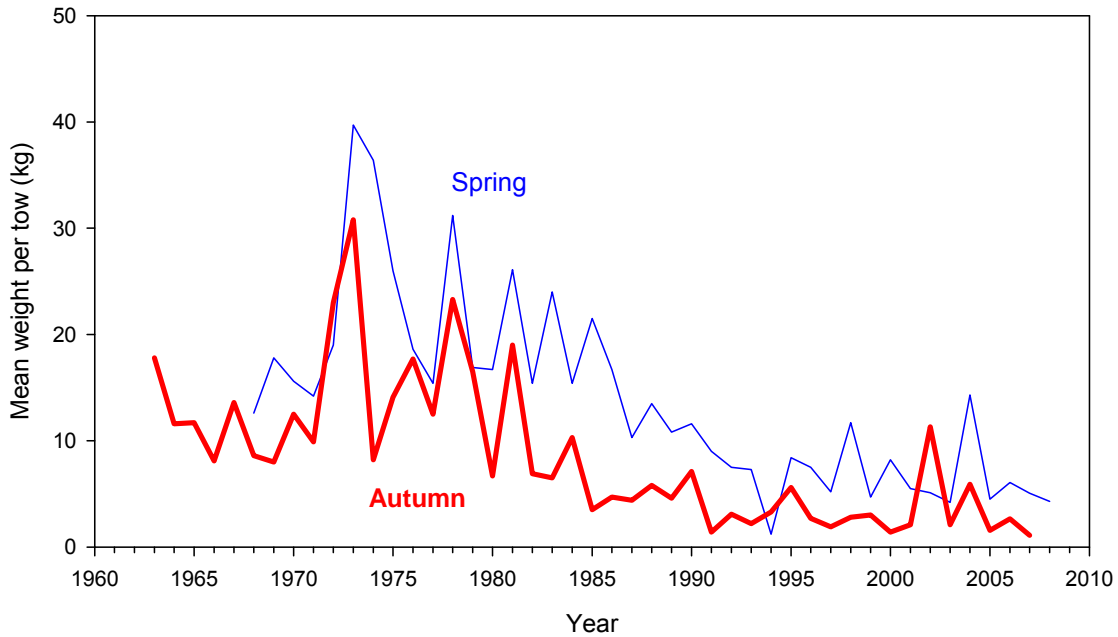


Figure A4. Standardized stratified mean catch per tow (kg) of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys on Georges Bank, 1963-2008.

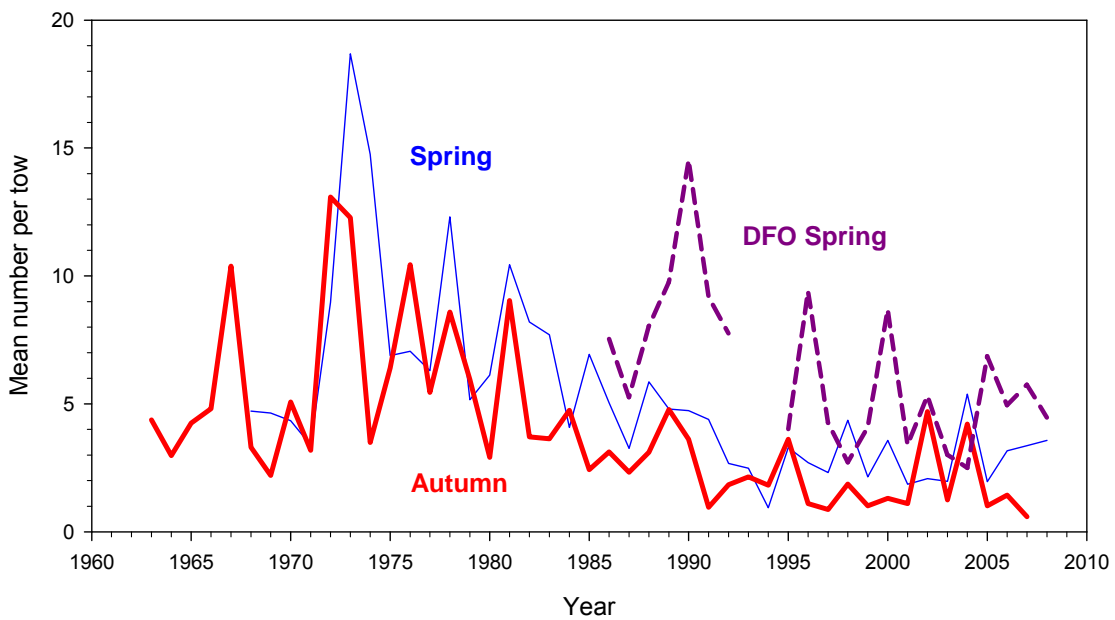


Figure A5. Standardized stratified mean number per tow of Atlantic cod in NEFSC and DFO spring and NEFSC autumn research vessel bottom trawl surveys on Georges Bank, 1963-2008.

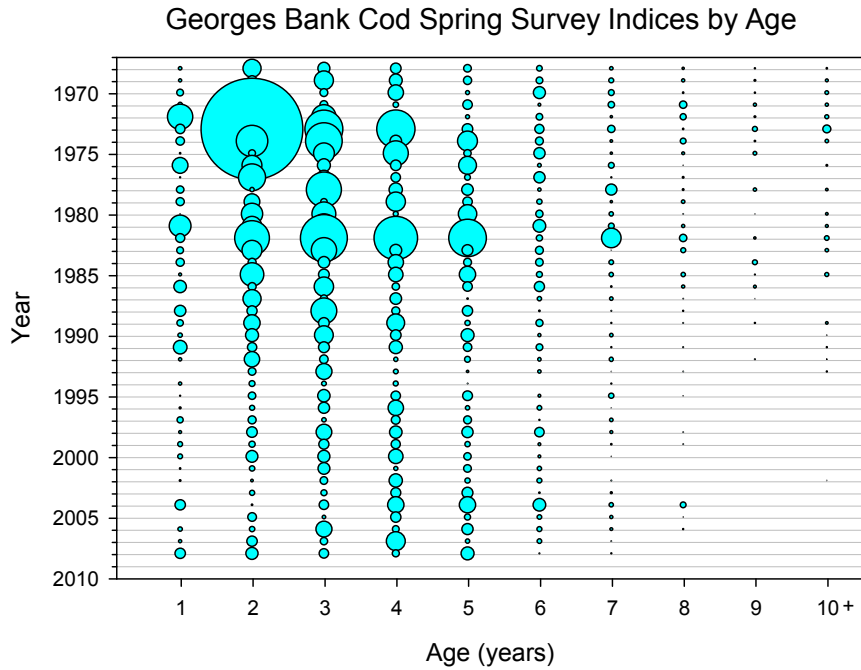


Figure A6. Standardized stratified mean catch per tow at age (numbers) of Georges Bank cod in NEFSC spring bottom trawl surveys, 1968-2008.

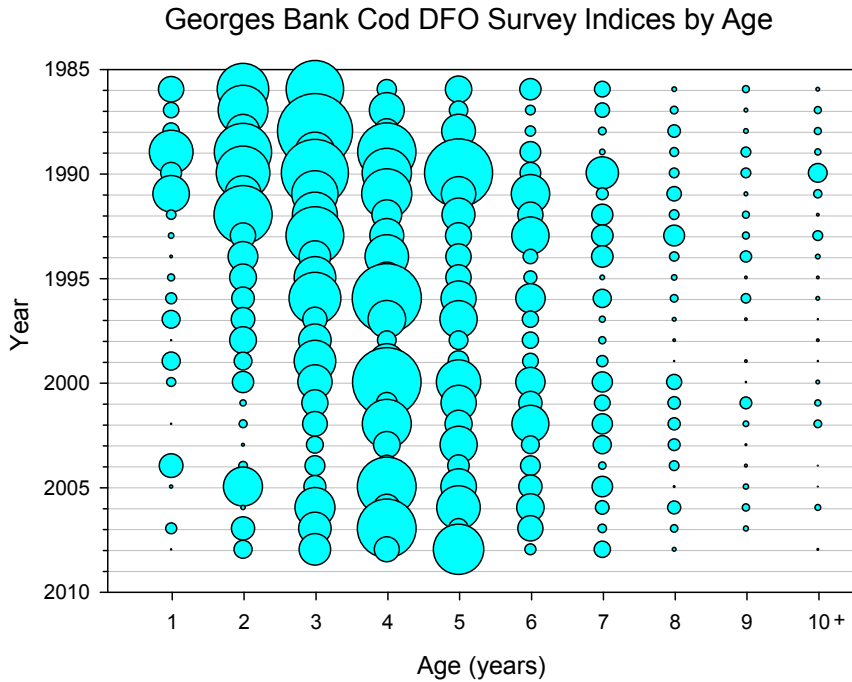


Figure A7. Standardized stratified mean catch per tow at age (numbers) of Georges Bank cod in the DFO spring bottom trawl surveys, 1986-2008.

Georges Bank Cod Autumn Survey Indices by Age

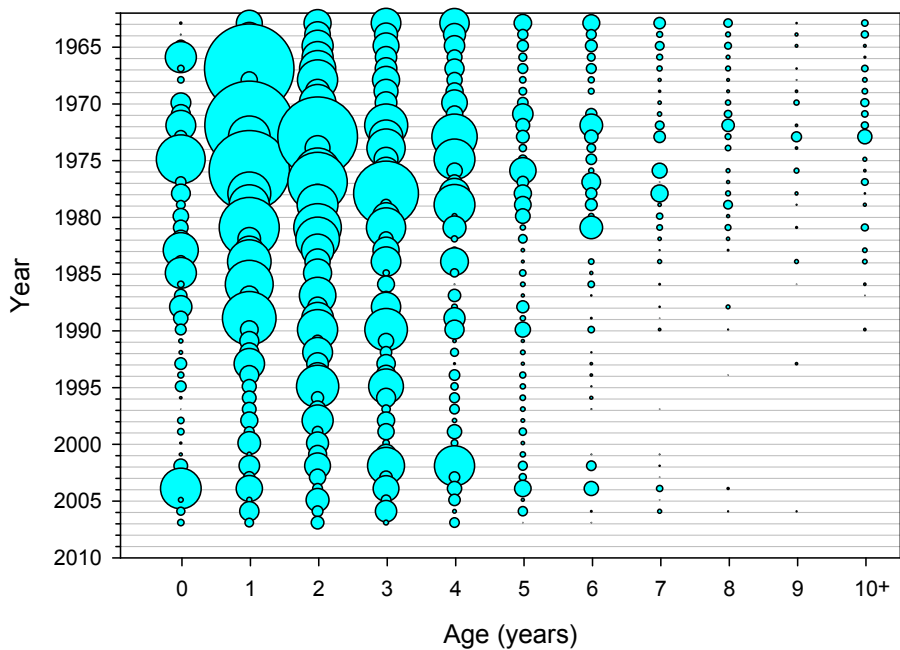


Figure A8. Standardized stratified mean catch per tow at age (numbers) of Georges Bank cod in NEFSC autumn bottom trawl surveys, 1963-2007.

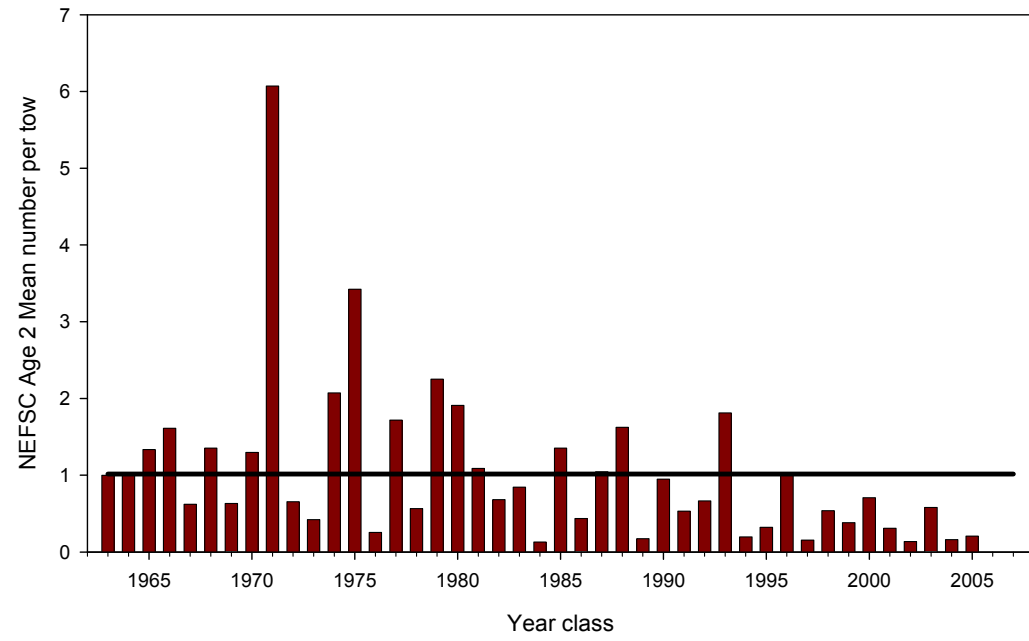
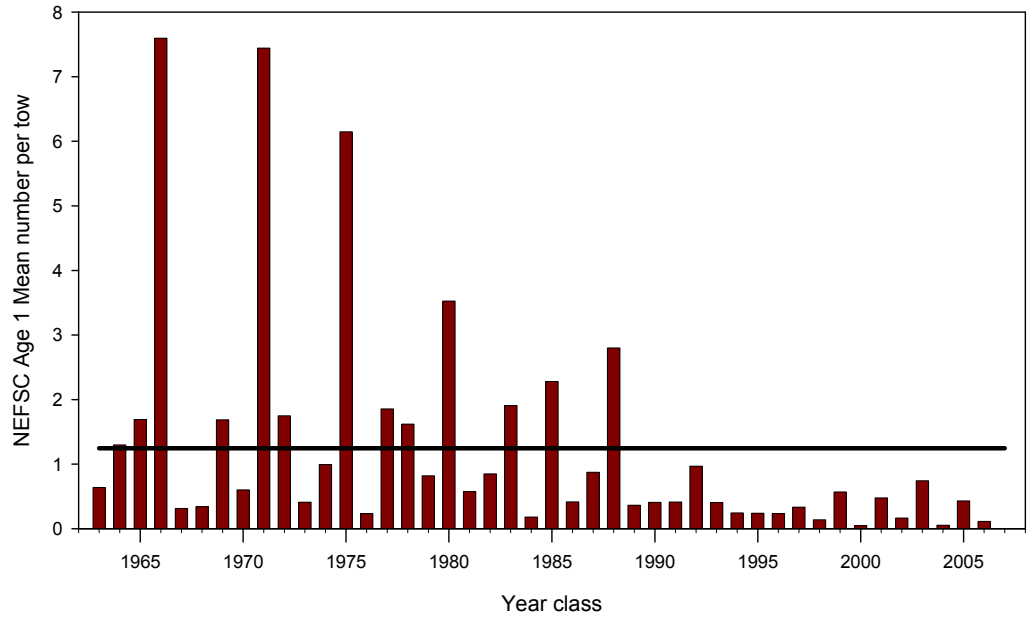


Figure A9. Relative year class strength of age 1 and age 2 Georges Bank cod based on standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trawl surveys, 1963-2007. Horizontal line represents the time series average.

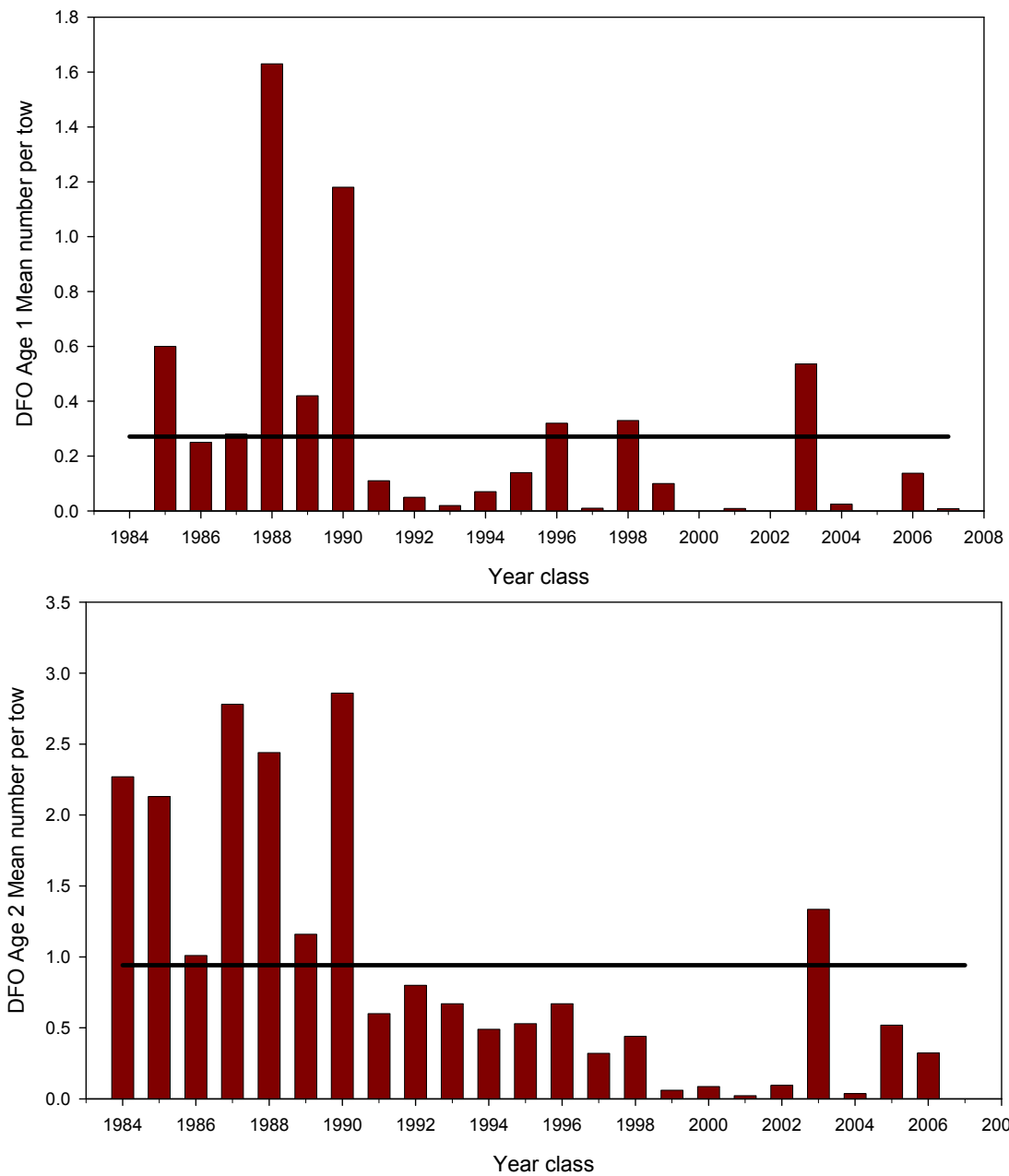
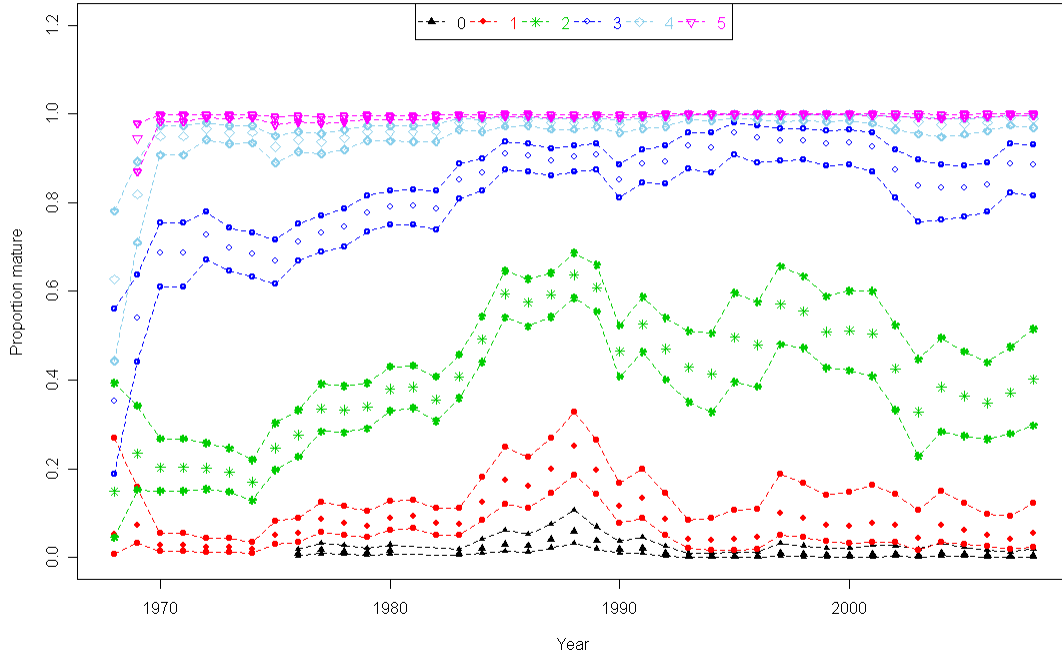
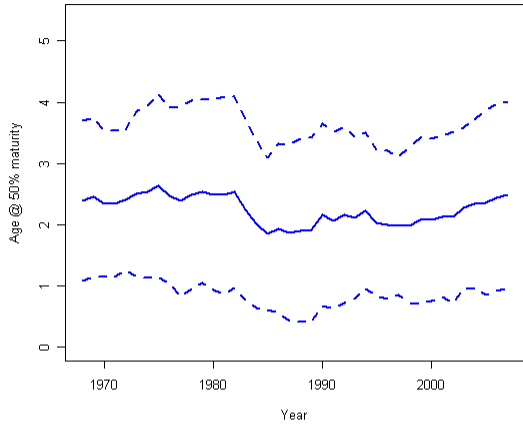


Figure A10. Relative year class strength of age 1 and age 2 Georges Bank cod based on catch (number) per tow indices from DFO spring research vessel bottom trawl surveys, 1986-2007. Horizontal line represents the time series average.

FEMALE Cod Georges Bank maturity at age w/ 95% CI



MALE Cod at 50% maturity (5 yr window)



FEMALE Cod at 50% maturity (5 yr window)

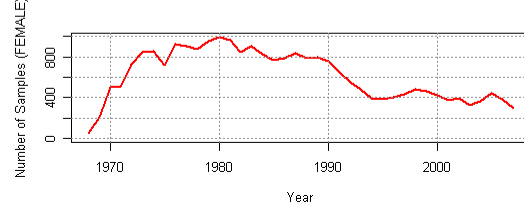
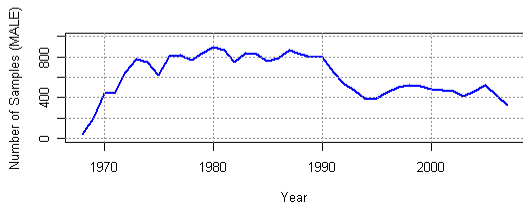
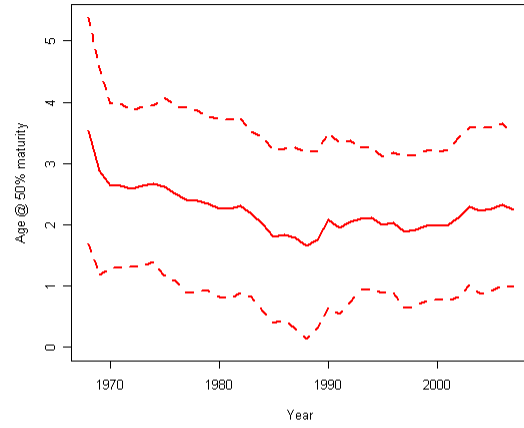


Figure A11. Proportion mature at age with 95% confidence intervals for female Georges Bank cod using a 5-year moving window for ages 1-5 (upper panel), median age at maturity (A50) for males (middle left panel) and females (middle right panel) with 95% confidence intervals, and number of samples in the combined 5-year moving average for males (lower left panel) and females (lower right panel).

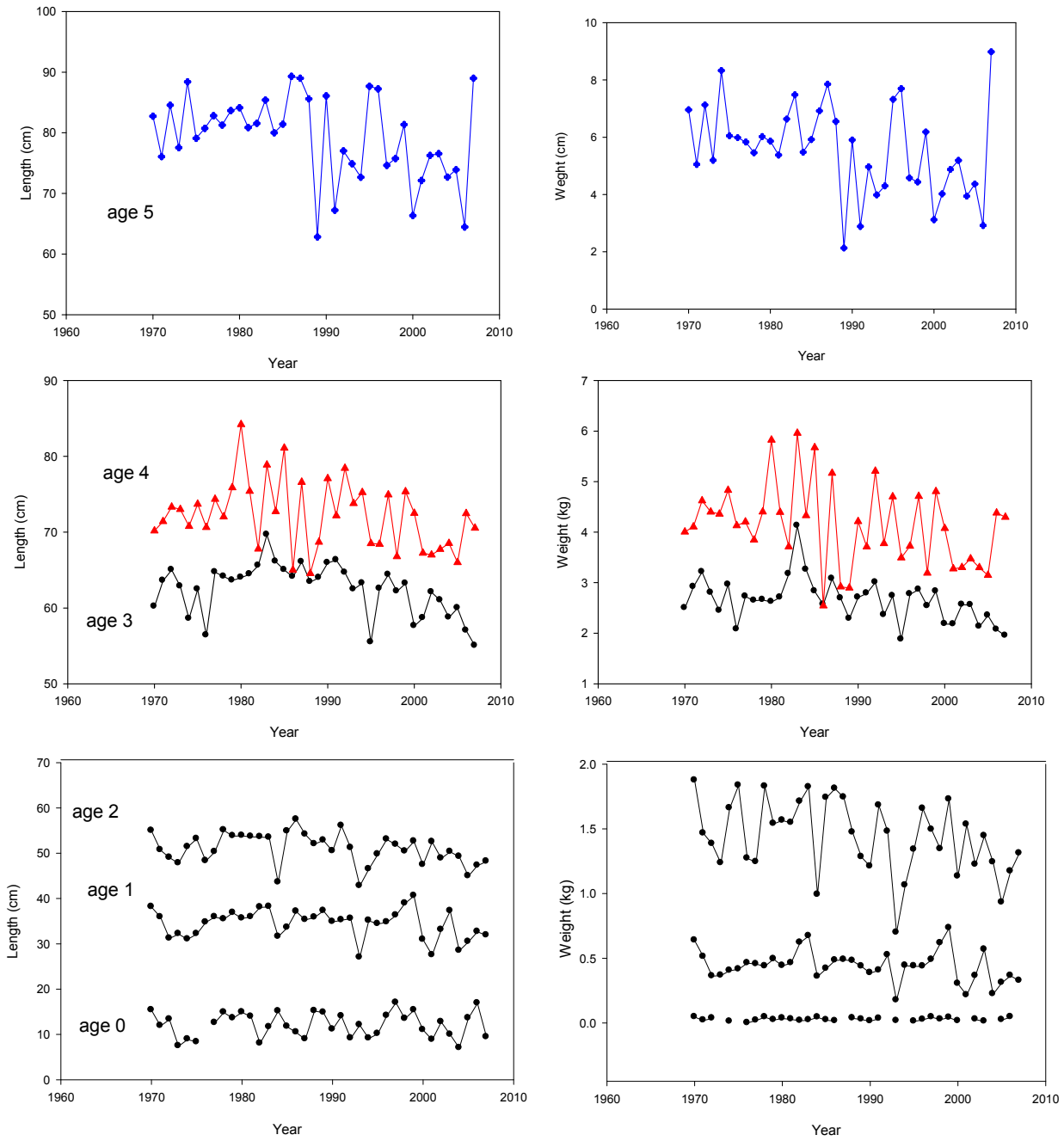


Figure A12. Mean length (left panels) and mean weight (right panels) at ages 0-5 for Georges Bank cod from autumn NEFSC surveys, 1970-2007.

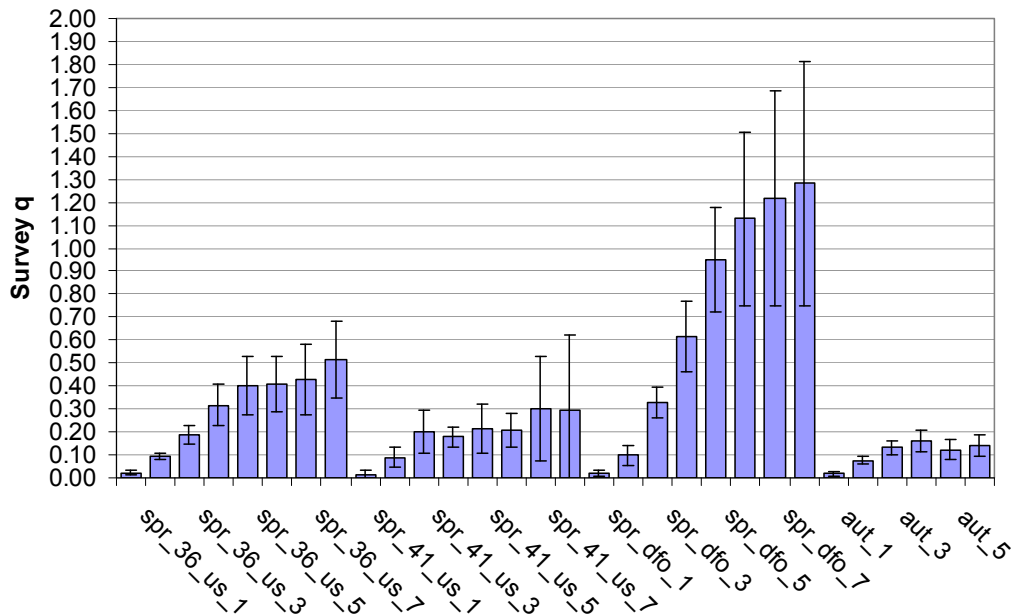


Figure A13a. **BASE MODEL** survey catchability (q) estimates based on swept area estimates of Georges Bank cod in NEFSC and DFO spring and autumn research bottom trawl surveys.

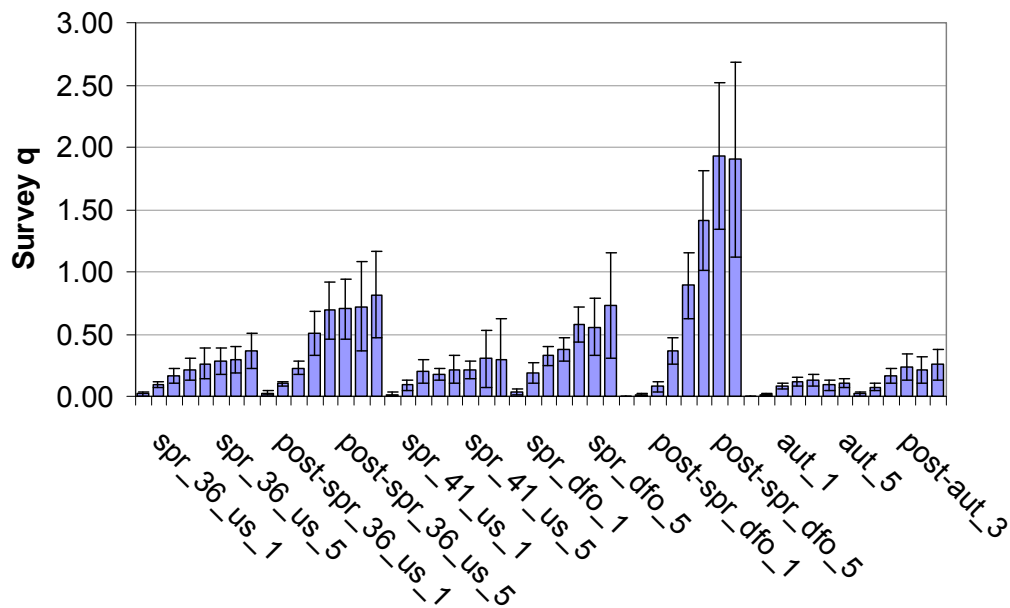


Figure A13b. **SPLIT MODEL** survey catchability (q) estimates based on swept area estimates of Georges Bank cod in NEFSC and DFO spring and autumn research bottom trawl surveys.

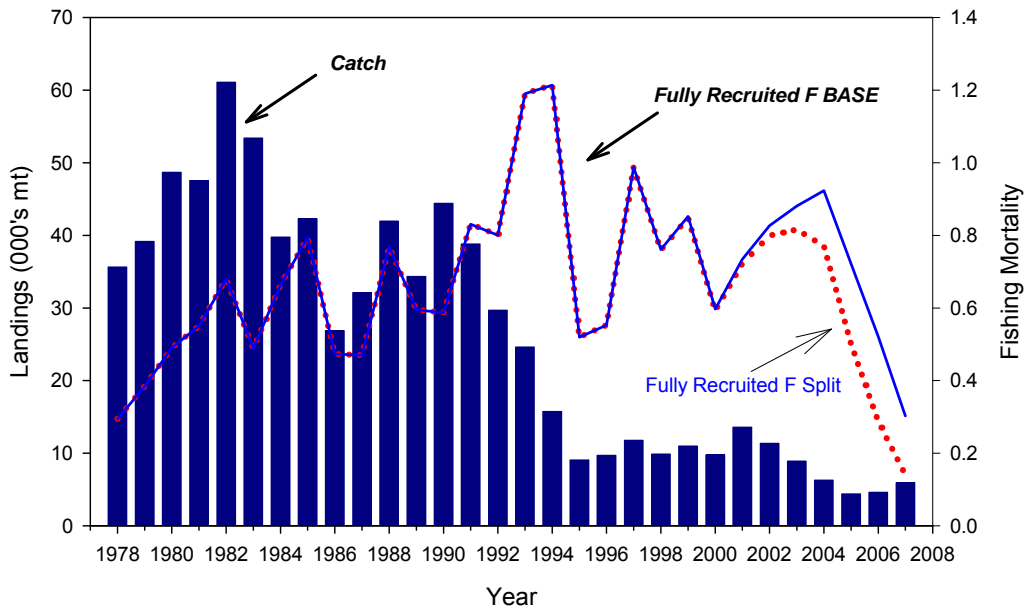


Figure A14. Trends in total catch and fishing mortality (ages 5-8) for Georges Bank cod, 1978-2007.

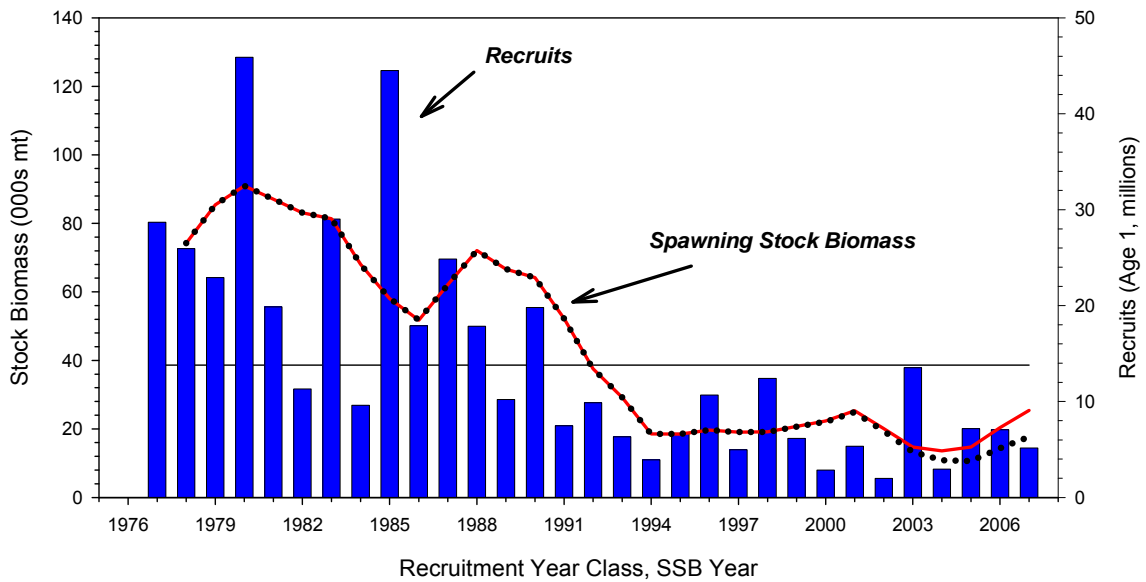


Figure A15. Trends in stock biomass and recruitment for Georges Bank Atlantic cod, 1978-2007. Horizontal line is the average recruitment for the time series. SSB Base =solid line, SSB Split = dotted line.

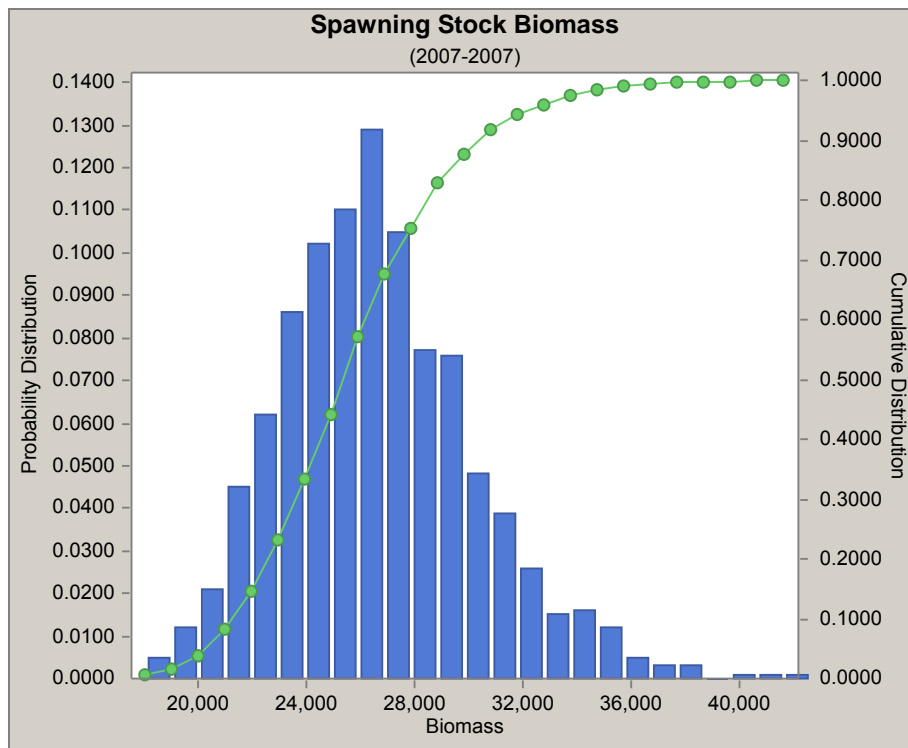
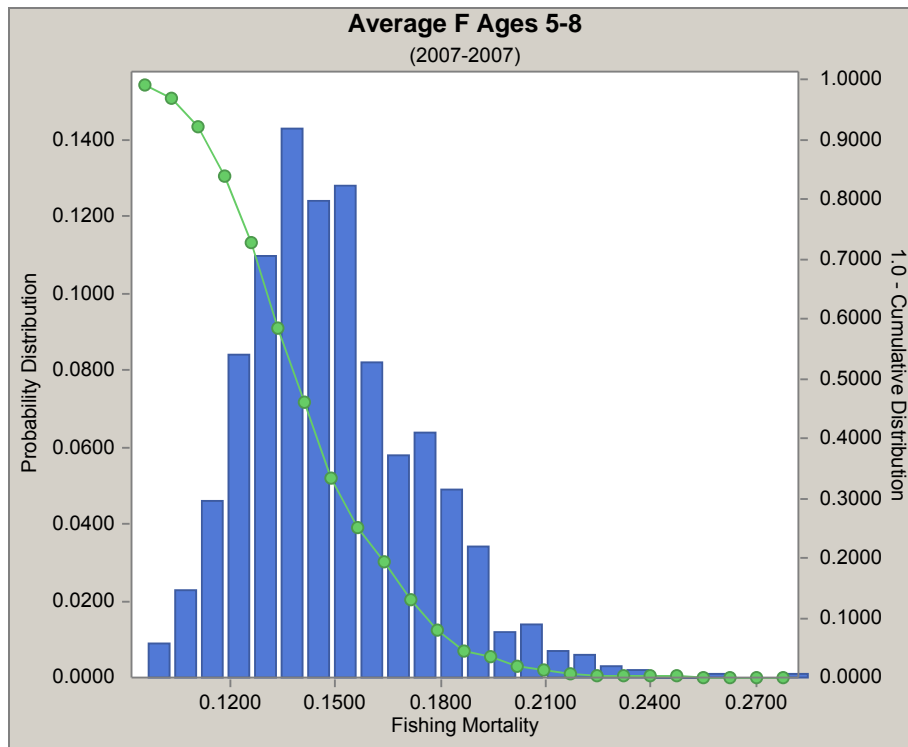


Figure A16a. **BASE MODEL** precision of the estimates of the instantaneous rate of fishing (F) on the fully recruited ages(5-8) and spawning stock biomass at the beginning of the spawning season for Georges Bank Atlantic cod, 2007. Bar height indicates the frequency of values within that range. The solid line is the cumulative probability that F is greater than, or SSB is less than, any selected value on X- axis.

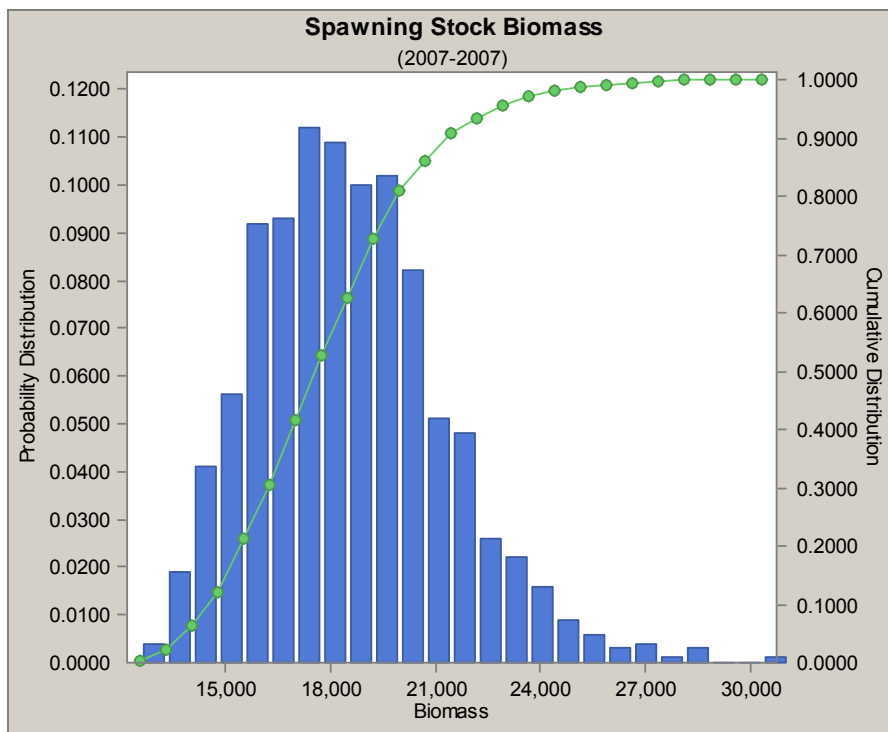
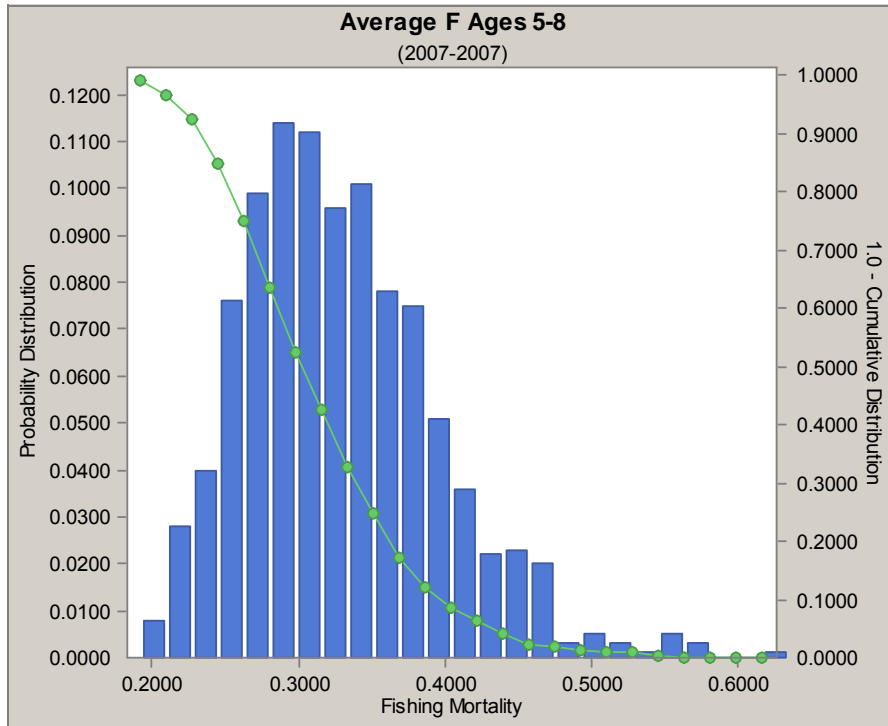


Figure A16b. **SPLIT MODEL** precision of the estimates of the instantaneous rate of fishing (F) on the fully recruited ages(5-8) and spawning stock biomass at the beginning of the spawning season for Georges Bank Atlantic cod, 2007. Bar height indicates the frequency of values within that range. The solid line is the cumulative probability that F is greater than, or SSB is less than, any selected value on X- axis.

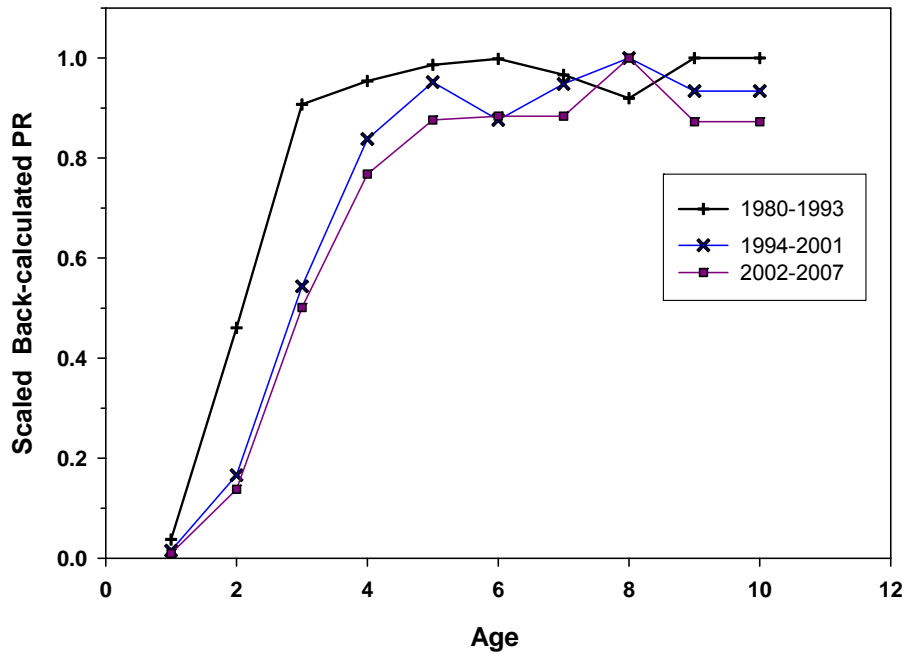


Figure A17a. **BASE MODEL** Scaled back-calculated partial recruitment (PR) from VPA for time periods 1980-1993, 1994-2001, and 2002-2007 for Georges Bank Atlantic cod.

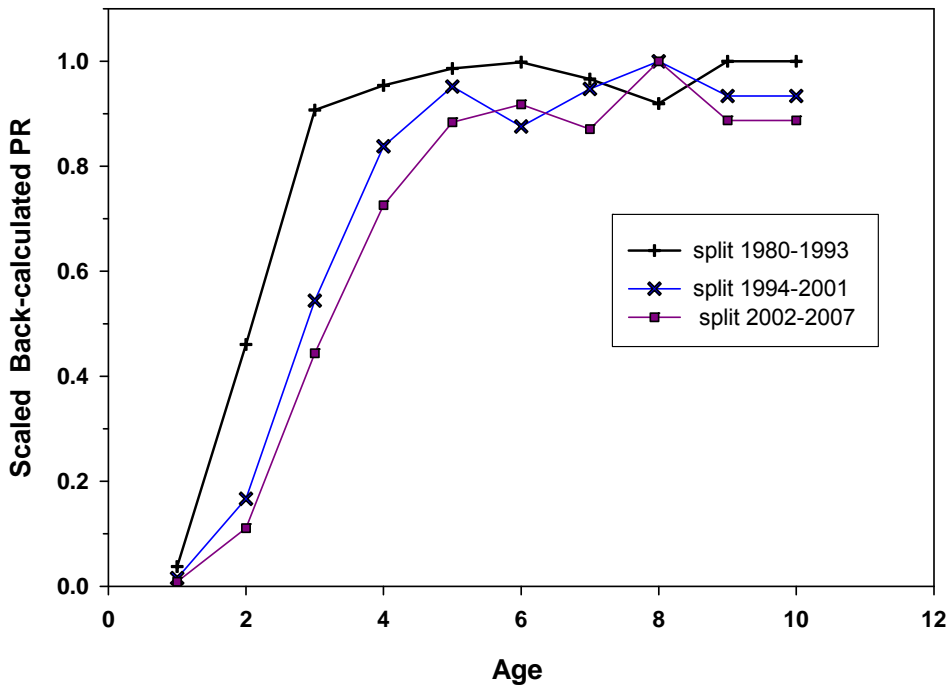


Figure A17b. **SPLIT MODEL** scaled back-calculated partial recruitment (PR) from VPA for time periods 1980-1993, 1994-2001, and 2002-2007 for Georges Bank Atlantic cod.

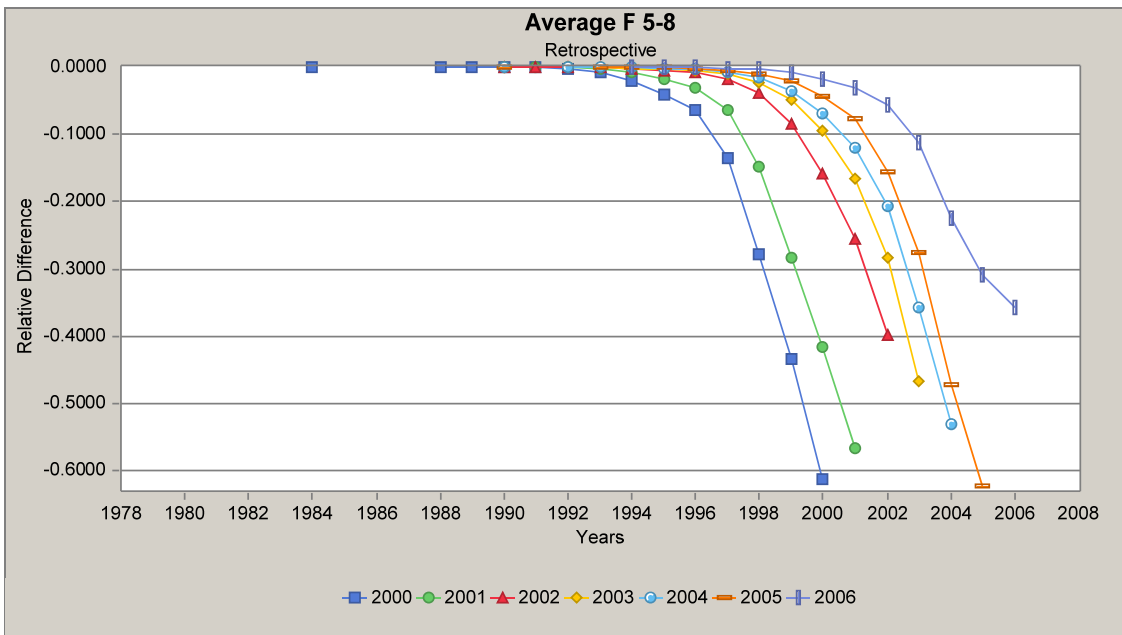


Figure A18a. **BASE MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = -0.50$) of Georges Bank Atlantic cod fishing mortality (ages 5-8, unweighted), based on ADAPT VPA, 2000-2007.

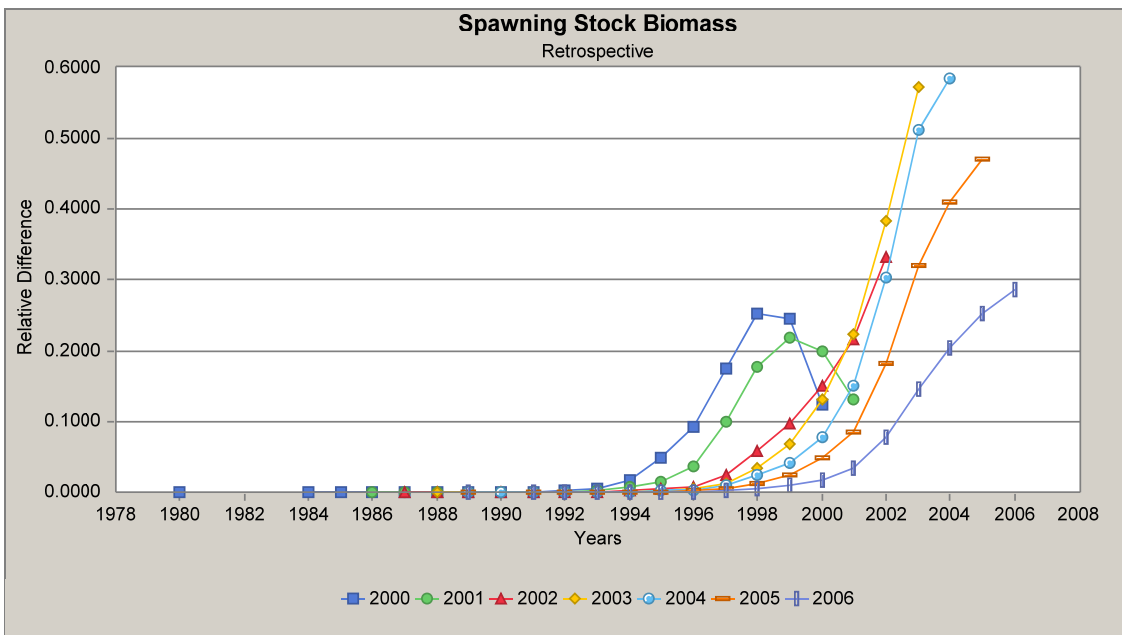


Figure A18b. **BASE MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = 0.36$) of Georges Bank Atlantic cod spawning stock biomass based on ADAPT VPA, 2000-2007.

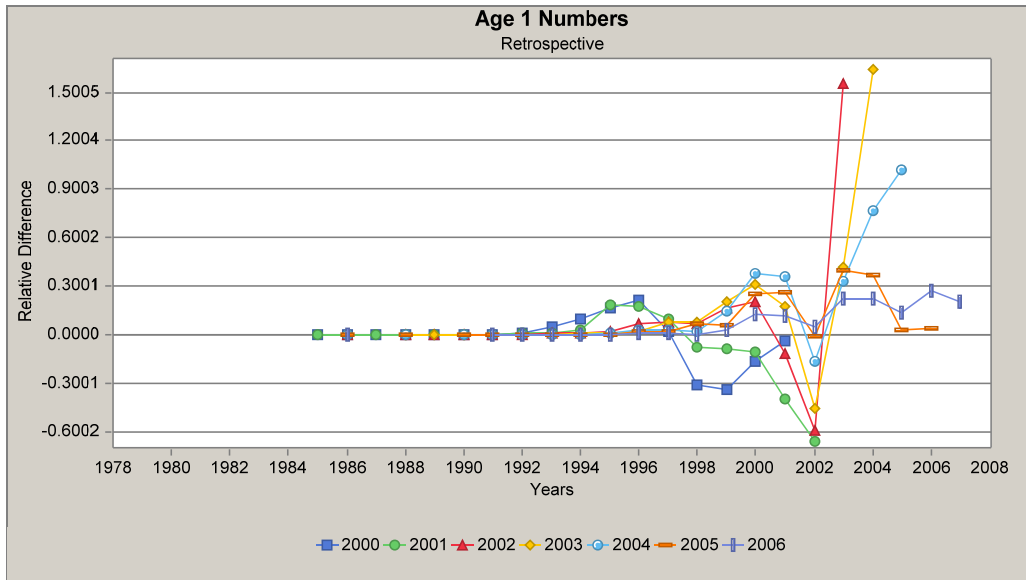


Figure A18c. **BASE MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = 0.54$) of Georges Bank Atlantic cod age 1 recruitment based on ADAPT VPA , 2000-2007.

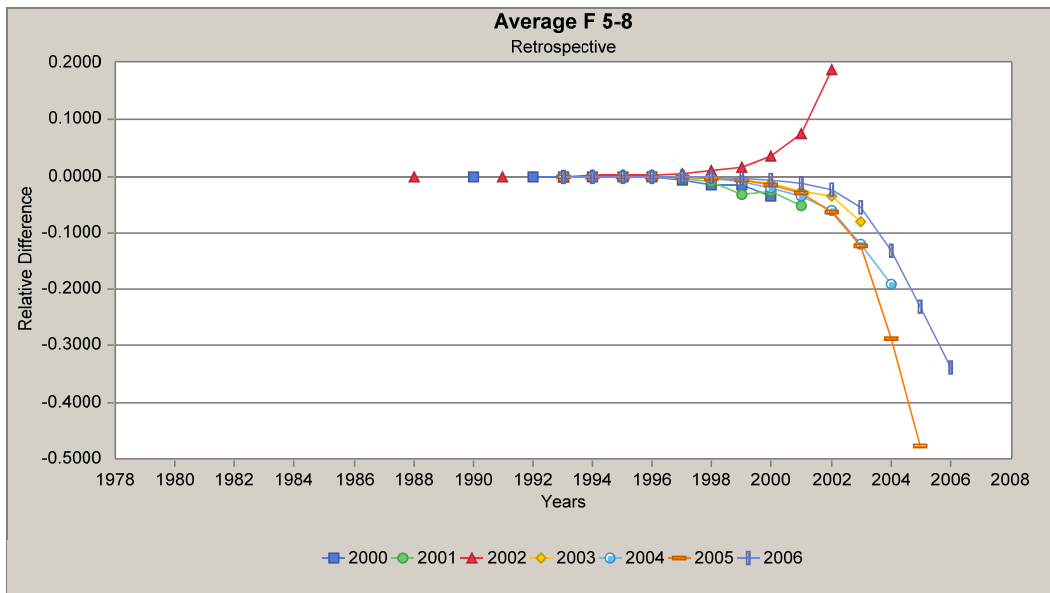


Figure A19a. **SPLIT MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = -0.14$) of Georges Bank Atlantic cod fishing mortality (ages 5-8, unweighted), based on ADAPT VPA, 2000-2007.

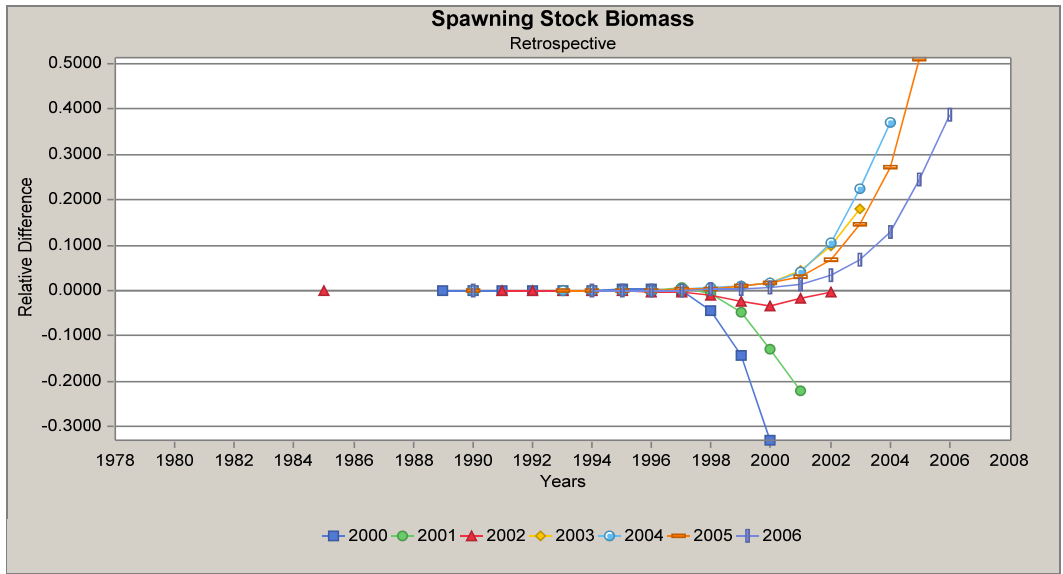


Figure A19b. **SPLIT MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = 0.13$) of Georges Bank Atlantic cod spawning stock biomass based on ADAPT VPA, 2000-2007

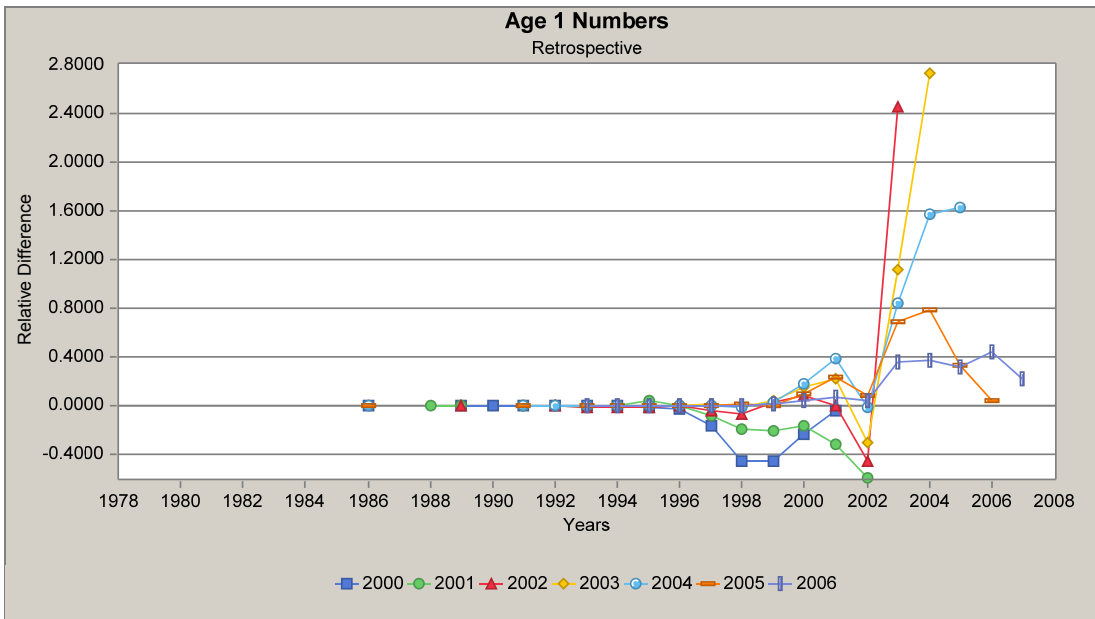


Figure A19c. **SPLIT MODEL** retrospective analysis of relative difference to terminal year 2007 ($\rho = 0.93$) of Georges Bank Atlantic cod age 1 recruitment based on ADAPT VPA, 2000-2007.



Figure A20. BASE MODEL Yield- and Spawning Stock Biomass per-recruit analysis for Georges Bank Atlantic cod . $F_{0.1} = 0.22$, $F_{max} = 0.50$ and $F_{40\%} = 0.25$.

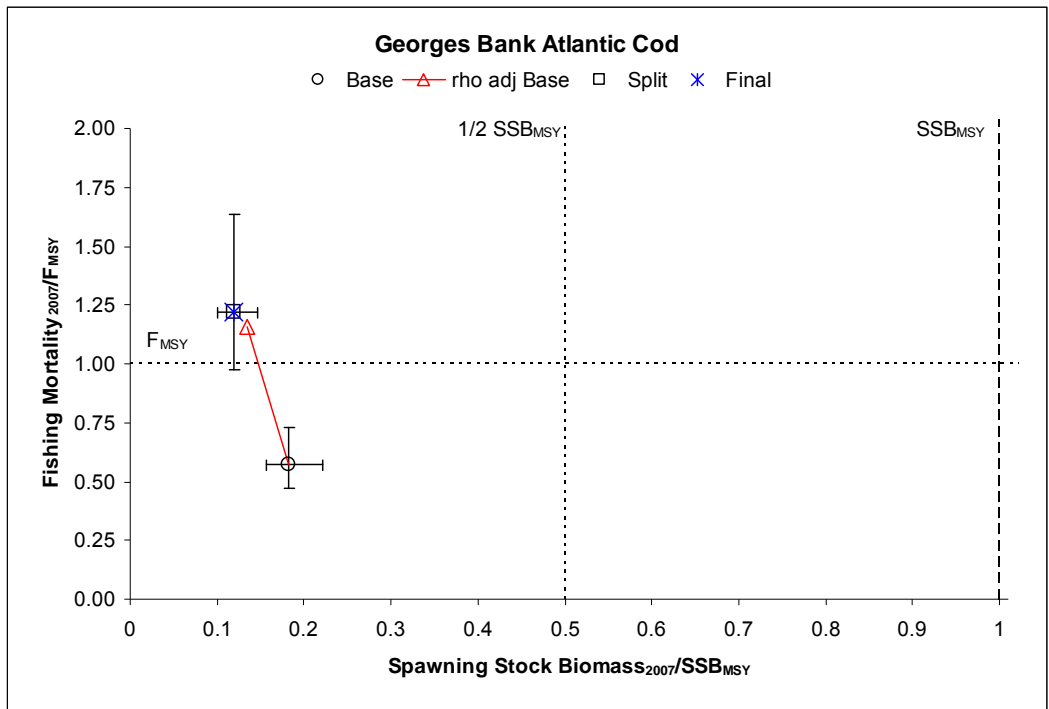


Figure A21. Status of 2007 fishing mortality (F) and spawning stock biomass (SSB) of Georges Bank Atlantic cod to F_{MSY} and SSB_{MSY} .