

A. Georges Bank Atlantic Cod by L. O'Brien , N. J. Munroe, L. Col

1.0 Background

This stock was last assessed and peer reviewed in October 2002 (O'Brien *et al.* 2002). Landings were 12,769 mt in 2001 and fully recruited F (ages 4-8, unweighted average) was estimated to be 0.38 in 2001, the second lowest F in the time series (1978-2000). Spawning stock biomass was 29,170 mt in 2001 and continued the increasing trend from the record low estimate of 17,375 mt in 1995. Since 1991, recruiting year classes have all been below the long term average and the 2000 and 2001 year classes were the lowest in the time series. The NEFSC spring and autumn bottom trawl survey indices continued to remain near record low values. Autumn recruitment indices for age 2 fish from the 1994 through 1998 year classes were all below the time series (1963-2000) average. The most recent above average autumn recruitment index occurred in 1993.

The current assessment presented here is considered an update and the methodology has remained the same as in the 2002 assessment (O'Brien *et al.* 2002).

2.0 Fishery

Total commercial landings of Georges Bank cod (Table A1, Figure A1) decreased 20% in 2002 to 10,274 mt, 22% in 2003 to 7,963 mt, and 42% in 2004 to a record-low 4,583 mt. USA landings decreased 67% (3,471mt) and Canadian landings decreased 48% (1,112mt) in 2004 relative to 2001 landings (Table A1). Recreational landings were estimated at 346 mt in 2004, an 11% increase from 2003.

USA landings were dominated in weight by age 4 in 2002, and by age 5 in 2003 and 2004. Canadian landings were dominated in weight by the 1998 year class at age 4 in 2002, at age 5 in 2003 and at age 6 in 2004.

3.0 Research Surveys

NEFSC spring and autumn survey biomass and abundance indices have fluctuated during 2002 to 2005, but continue to remain below the long term average (Table A2, Figure A2-A3). The recruitment indices for age 1 from the NEFSC 2004 autumn bottom trawl survey indicate that the 2003 year class, while below average, is still the strongest since 1992 (Table A3, Fig.A4). The age 0 index is not generally used as an indicator of year class strength, however, the 2004 index is well above average and the highest since the 1975 year class. The Canadian 2004 spring survey index of abundance for age 1 indicated that the 2003 year class was above average (Table A3, Figure A5). The 2005 Canadian indices are not representative since the survey did not cover all of the Georges Bank strata.

4.0 Assessment

Input data and Analyses

The current assessment is an update assessment and employs the same VPA formulation as in the 2001 assessment (O'Brien *et al.* 2002). A slight variation from the previous assessment is that the number of surveys available as tuning indices in the terminal year is decreased from three to two since the DFO 2005 spring survey did not sample the entire Georges Bank strata due to mechanical problems.

Catch at age (1-10+) has been updated with total 2004 landings (USA and Canadian). The USA commercial port sampling for this stock has increased from 1 sample per 104 mt landed in 2002, to 1 sample per 68 mt landed in 2003, and 1 sample per 27 mt in 2004. Samples were well distributed between quarters, so that quarterly catch at age by market category could be estimated without pooling (Table A4). Spatial coverage was poor for eastern Georges Bank (SA 561, 562), as it has been for several years. As in the last assessment, additional length samples from western Georges Bank and combined US and Canadian age samples from eastern Georges Bank were applied to characterize the landings from eastern Georges Bank. The catch at age includes total landings from both the USA and Canadian fisheries (Table A5).

Discards at age were estimated using the Observer Database from 1989-2004. A discard to kept ratio was applied to landings to estimate total discards (mt), and total discards at length were estimated from sampled length frequencies of observed tows. The age composition of the discarded length frequency was estimated using a combination of commercial data for all ages and research survey data for ages 1-3 only.

Research survey indices have been estimated for the 2002-2005 NEFSC and 2002-2004 Canadian Department of Fisheries and Oceans (DFO) spring (ages 1-8) bottom trawl surveys and the NEFSC 2002-2004 autumn (ages 1-6) bottom trawl survey (Table A3). The ADAPT calibration method (Parrack 1986), (Gavaris 1988), (Conser and J.E. Powers. 1990) was used to derive estimates of instantaneous fishing mortality and beginning year stock sizes in 2004. 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.

Assessment results

Fully recruited fishing mortality (ages 4-8) was estimated at 0.24 in 2004 (Table A6, Figure A6). Spawning stock biomass in 2004 was estimated at 22,564 mt, a 25% decrease from 2001 but a 23% increase from the record low in 1995 (Table A6, Figure A7). Recruitment (millions of age 1 fish) of the 2004 year class (10.4 million) is estimated to be similar to the 1998 year class (12.8 million) (Table A6, Figure A7). Recruitment of the 2003 year class (21.2 million) is the first year class estimated above the long-term average (1977-2003) of 14.7 million fish. The survival ratio of recruit/SSB was above average for the 2003 and 2004 year classes (Figure A8).

VPA Diagnostics

Stock size estimates for ages 1-8 were well estimated with CVs ranging from 0.29 to 0.57 (Appendix A2). The distribution of F estimates from the bootstrap analysis ranged from 0.14 to 0.31 with an 80% probability that F in 2004 was between 0.17 and 0.26. The distribution of SSB estimates from the bootstrap analysis ranged from 16,721 mt to 30,137 mt with an 80% probability that SSB in 2004 was between 19,704 mt to 27,122 mt.

The strong retrospective pattern present in the previous assessment (O'Brien *et al.* 2002) with this model formulation is not as evident for the most current years (Figure A9). The terminal year estimates of fishing mortality were the same for 2004 and 2003, but are then less than the converged estimates from 1994-2002. SSB estimates were similar for 2000-2004, but are greater than converged estimates from 1994-1999. The pattern in the terminal year estimates of recruits are generally less than converged estimates.

Sensitivity Analyses

Analyses were conducted to determine the sensitivity of fishing mortality and spawning stock biomass estimates to the addition of discards to the catch at age. Differences in F are minimal with F being slightly higher, and SSB slightly lower than the base run estimates when discards are included in the catch at age.

5.0 Biological Reference Points

Biological reference points were established for Georges Bank cod based on a Beverton-Holt stock recruit model (NEFSC 2002.) as:

$MSY = 35,236$ mt

$SSB_{MSY} = 216,780$ mt and

$F_{MSY} = 0.175$

In 2004, spawning stock biomass was estimated at 22,564 mt, about 10% of the target SSB_{MSY} . The stock is considered to be overfished. F was estimated at 0.24, therefore overfishing is occurring on this stock.

6.0 Summary

Georges Bank Atlantic cod are overfished and overfishing is occurring. Fishing mortality has been steadily declining since 1997, except for a slight increase in 2001, and is currently at the lowest exploitation in the time series. Spawning stock biomass reached a record low in 1995 and slowly increased, primarily due to growth, until 2001. Since 2001, however, SSB has been declining. The 2002-2004 F trajectory is less than that projected for A13 and the SSB is slightly higher than the A13 projection (Figure A10). Catch during 2002-2004 was also less than the A13 projection.

The 1999 and 1998 year class accounts for the majority of the US catch and the 1998 year class

accounts for the majority of the Canadian catch in 2004. The 1998 (12.8 million age 1 fish) year class, while below the long term average (14.7 million age 1 fish), represents the strongest year class since the last above-average year class that occurred in 1990 (17.8 million age1 fish). The 2000, 2001, and 2002 year classes are among the lowest in the time series. The 2003 (21.2 million age 1 fish) year class is the first above average year class since the 1990 and will enter the fishery during 2005.

The NEFSC and DFO survey biomass and abundance indices fluctuated during 2002 to 2005, however, all the indices continue to remain below the long term average. The most recent NEFSC surveys indicate that the 2003 year class may be similar in size to the 1998 year class, and the DFO spring survey indicates that the year class is above average.

The lack of strong recruitment in the last decade suggests that recovery of this stock will be largely dependent on reducing fishing mortality in the near term and husbanding the strong 2003 year class, and potentially the 2004 year class, to increase SSB.

7.0 Sources of Uncertainty

Landings data for 1994-2004 are derived by proration and are provisional.

Estimation of eastern Georges Bank landings are derived on small number of samples supplemented by western length frequency and Canadian age data. Increased sampling of landings in statistical areas 561-562 would be an improvement.

The 2004 NMFS fall survey index for age 0 may be optimistic.

8.0 Panel Discussion

The NMFS fall 2004 survey had the highest age 0 index since the 1975 year class. The panel discussed whether the high number of age 0 cod in 2004 was a sampling artifact. An examination of catch locations indicated that age 0 cod were caught in multiple tows in 2004, but were highly localized. Additionally, the NMFS spring survey age 1 and age 2 indices in 2005 were lower than the fall 2004 age 0 and age 1 indices respectively, indicating a possible year effect. The panel decided to not use the age 1 index for 2005 in the projections based on the uncertainty of the index. Concern was also expressed that the mean weight and number per tow at age generally increased in 2004 over all ages. It was recommended that confidence intervals be examined for NMFS survey indices.

Lower abundance indices were observed in the Canadian DFO spring 2005 survey; however there is uncertainty in these data due to incomplete surveying and vessel changes. It was noted that a conversion factor needs to be calculated between the Canadian R/V Needler and R/V Teleost in order to use the Canadian spring 2005 indices. At the present time it was concluded that the 2005 Canadian survey will not be used in the VPA input for 2004.

In recent years, there has been a decline in mean weight at age of older fish in commercial fishery catches. It was discussed whether this could be due to small sample sizes of older ages in

the U.S. commercial data, however the decline was consistent over all older ages. Mean weight at age has also been declining for older fish in the Canadian surveys, indicating possible lower productivity in the stock for recent years.

The recommendation was made that discards and recreational catches be included in future catch at age input data to account for all removals. For this assessment, discards and recreational catches were not included in order to be consistent with 2002 reference points, however, a sensitivity run with discards was presented which did not show substantial differences from the base run.

The mean F is currently estimated as an average of ages 4-8, however, since 1994 the landings of age groups 7 and 8 have declined. The panel discussed that an F averaged over ages 4-6 may be more representative of the current age structure of the landings.

The panel noted that trends in partial recruitment need to be examined since this could change the estimation of reference points. A three year average was agreed to be sufficient for the present time since the projections are only going to be made over a four-year period.

Projection Determination:

Recruitment at age 1 in 2005 will be estimated from the stock recruitment relationship. Mean weights at age will be averaged over the last three years in order to account for declining mean weights at age in older ages. Maturity ogive and partial recruitment will be averaged over the last three years as well.

Research Recommendations:

Examine variances of NMFS survey mean weights and mean numbers per tow by year, especially for 2004.

Include discards and recreational catches in the catch at age.

Examine changes in partial recruitment and explore the effect of estimating average F for age groups 4-6 compared to the current average F for ages 4-8.

9.0 References

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Table A1. Commercial landings (metric tons, live) of Atlantic cod from the Georges Bank and South (NAFO Division 5Z and Subarea 6) stock, 1960–2004 (* = Provisional data).

| Year | Country | | | | | | Total |
|------|---------|--------|-------|-------|--------|-------|-------|
| | USA | Canada | USSR | Spain | Poland | Other | |
| 1960 | 10834 | 19 | - | - | - | - | 10853 |
| 1961 | 14453 | 223 | 55 | - | - | - | 14731 |
| 1962 | 15637 | 2404 | 5302 | - | 143 | - | 23486 |
| 1963 | 14139 | 7832 | 5217 | - | - | 1 | 27189 |
| 1964 | 12325 | 7108 | 5428 | 18 | 48 | 238 | 25165 |
| 1965 | 11410 | 10598 | 14415 | 59 | 1851 | - | 38333 |
| 1966 | 11990 | 15601 | 16830 | 8375 | 269 | 69 | 53134 |
| 1967 | 13157 | 8232 | 511 | 14730 | - | 122 | 36752 |
| 1968 | 15279 | 9127 | 1459 | 14622 | 2611 | 38 | 43136 |
| 1969 | 16782 | 5997 | 646 | 13597 | 798 | 119 | 37939 |
| 1970 | 14899 | 2583 | 364 | 6874 | 784 | 148 | 25652 |
| 1971 | 16178 | 2979 | 1270 | 7460 | 256 | 36 | 28179 |
| 1972 | 13406 | 2545 | 1878 | 6704 | 271 | 255 | 25059 |
| 1973 | 16202 | 3220 | 2977 | 5980 | 430 | 114 | 28923 |
| 1974 | 18377 | 1374 | 476 | 6370 | 566 | 168 | 27331 |
| 1975 | 16017 | 1847 | 2403 | 4044 | 481 | 216 | 25008 |
| 1976 | 14906 | 2328 | 933 | 1633 | 90 | 36 | 19926 |
| 1977 | 21138 | 6173 | 54 | 2 | - | - | 27367 |
| 1978 | 26579 | 8778 | - | - | - | - | 35357 |
| 1979 | 32645 | 5978 | - | - | - | - | 38623 |
| 1980 | 40053 | 8063 | - | - | - | - | 48116 |
| 1981 | 33849 | 8499 | - | - | - | - | 42348 |
| 1982 | 39333 | 17824 | - | - | - | - | 57157 |
| 1983 | 36756 | 12130 | - | - | - | - | 48886 |
| 1984 | 32915 | 5763 | - | - | - | - | 38678 |
| 1985 | 26828 | 10443 | - | - | - | - | 37271 |
| 1986 | 17490 | 8504 | - | - | - | - | 25901 |
| 1987 | 19035 | 11844 | - | - | - | - | 30880 |
| 1988 | 26310 | 12741 | - | - | - | - | 39242 |
| 1989 | 25097 | 7895 | - | - | - | - | 33098 |
| 1990 | 28193 | 14364 | - | - | - | - | 42503 |
| 1991 | 24175 | 13462 | - | - | - | - | 37630 |
| 1992 | 16855 | 11673 | - | - | - | - | 28567 |
| 1993 | 14594 | 8524 | - | - | - | - | 23113 |
| 1994 | 9893 | 5278 | - | - | - | - | 15169 |
| 1995 | 6759 | 1100 | - | - | - | - | 7859 |
| 1996 | 7020 | 1926 | - | - | - | - | 8905 |
| 1997 | 7537 | 2919 | - | - | - | - | 10435 |
| 1998 | 6959 | 1908 | - | - | - | - | 8832 |
| 1999 | 8061 | 1819 | - | - | - | - | 9880 |
| 2000 | 7617 | 1572 | - | - | - | - | 9189 |
| 2001 | 10635 | 2143 | - | - | - | - | 12778 |
| 2002 | 8998 | 1276 | - | - | - | - | 10274 |
| 2003 | 6646 | 1317 | - | - | - | - | 7963 |
| 2004 | 3471 | 1112 | - | - | - | - | 4583 |

Table A2. 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 - 2005. [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 | | |
| 1963-2004 Average | 7.3 | 18.7 | 4.30 | 9.0 |

[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 A3. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2005.

| 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 |
| average | 0.289 | 0.427 | 2.297 | 1.752 | 1.196 | 0.730 | 0.321 | 0.190 | 0.099 | 0.066 | 0.096 | 7.294 |

Table A3 continued. Standardized (for vessel and door changes) stratified mean catch per tow at age (numbers) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963 - 2004.

| 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 | 0.129 | 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 | 1.6853 | 0.7448 | 0.1358 | 0.7101 | 0.252 | 0.3215 | 0.2524 | 0.0647 | 0.0195 | 0.000 | 0.000 | 4.186 |
| average | 0.360 | 1.318 | 1.066 | 0.728 | 0.421 | 0.146 | 0.126 | 0.063 | 0.051 | 0.029 | 0.056 | 4.364 |

Table A3 continued. Stratified mean catch per tow at age (numbers) of Atlantic cod in Canadian spring bottom trawl survey

| 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 | 0.05 | 2.04 | 2.78 | 14.18 | 3.42 | 1.59 | 1.45 | 0.12 | 0.15 | 0.02 | 25.80 |
| average | 0.31 | 1.07 | 1.67 | 2.09 | 1.09 | 0.58 | 0.33 | 0.13 | 0.06 | 0.06 | 6.41 |

* R/V Needler indices not included in VPA calibration (entire GB not surveyed)

| | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|------|
| 2005 | | | | | | | | | | | |
| R/V Teleost | 0.02 | 1.34 | 0.47 | 2.91 | 1.13 | 0.51 | 0.41 | 0.01 | 0.05 | 0.01 | 6.86 |

Table A4. USA sampling of commercial Atlantic cod landings, by market category, for the Georges Bank and South cod stock (NAFO Division 5Z and Subarea 6), 1978 - 2004.

| Year | Number of Samples, by Market Category & Quarter | | | | | | | | | | | | | Annual Sampling Intensity | | | | | |
|------|---|----|----|----|--------|----|----|----|-------|----|----|----|----|---------------------------|-----|-----|-----|------|-----|
| | Scrod | | | | Market | | | | Large | | | | | Scrd | Mkt | Lge | Σ | | |
| | Q1 | Q2 | Q3 | Q4 | Σ | Q1 | Q2 | Q3 | Q4 | Σ | Q1 | Q2 | Q3 | | | | | Q4 | 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 | 94 |
| 1998 | 3 | 7 | 23 | 5 | 38 | 10 | 10 | 15 | 3 | 38 | 1 | 2 | 1 | 0 | 3 | 44 | 92 | 573 | 88 |
| 1999 | 5 | 3 | 10 | 3 | 21 | 7 | 14 | 10 | 7 | 38 | 2 | 5 | 2 | 0 | 9 | 80 | 118 | 205 | 118 |
| 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 | 104 |
| 2003 | 4 | 8 | 6 | 10 | 28 | 7 | 16 | 10 | 6 | 39 | 5 | 11 | 10 | 4 | 30 | 21 | 113 | 52 | 68 |
| 2004 | 8 | 11 | 4 | 10 | 33 | 13 | 9 | 7 | 14 | 43 | 24 | 12 | 2 | 11 | 49 | 8 | 50 | 20 | 27 |

Table A5. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2004.

| Year | Age | | | | | | | | | | Total | % of Total Landings | |
|------|---|------|------|------|------|------|-----|-----|-----|-----|-------|---------------------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | | USA | Canada |
| | Total Commercial Landings in Numbers (000's) at Age | | | | | | | | | | | | |
| 1978 | 2 | 392 | 7708 | 2290 | 826 | 129 | 344 | 47 | 40 | 15 | 11793 | 74.1 | 26.4 |
| 1979 | 34 | 1989 | 900 | 4870 | 1212 | 458 | 77 | 253 | 4 | 48 | 9845 | 81.2 | 18.8 |
| 1980 | 89 | 3778 | 5829 | 500 | 2308 | 1076 | 445 | 87 | 167 | 10 | 14289 | 80.9 | 19.1 |
| 1981 | 27 | 3206 | 4224 | 2466 | 236 | 1408 | 417 | 123 | 130 | 62 | 12299 | 84.1 | 15.8 |
| 1982 | 331 | 9142 | 3828 | 2790 | 2002 | 281 | 674 | 213 | 71 | 83 | 19416 | 74.1 | 25.9 |
| 1983 | 108 | 4286 | 8062 | 2456 | 1055 | 776 | 95 | 235 | 100 | 65 | 17237 | 72.2 | 27.8 |
| 1984 | 81 | 1307 | 3423 | 3337 | 841 | 516 | 458 | 44 | 171 | 121 | 10300 | 89.0 | 11.0 |
| 1985 | 134 | 6427 | 2443 | 1368 | 1885 | 412 | 218 | 203 | 21 | 97 | 13209 | 68.4 | 31.6 |
| 1986 | 156 | 1329 | 4588 | 801 | 482 | 630 | 87 | 72 | 47 | 29 | 8221 | 71.5 | 28.2 |
| 1987 | 26 | 7474 | 1406 | 2121 | 279 | 252 | 270 | 63 | 38 | 24 | 11953 | 64.2 | 35.8 |
| 1988 | 10 | 1574 | 7992 | 1008 | 1492 | 243 | 160 | 196 | 50 | 47 | 12770 | 71.8 | 28.6 |
| 1989 | 0 | 2084 | 2919 | 4145 | 330 | 539 | 82 | 43 | 50 | 18 | 10209 | 81.3 | 18.9 |
| 1990 | 7 | 4943 | 5049 | 1884 | 2267 | 229 | 245 | 36 | 17 | 38 | 14716 | 74.2 | 25.7 |
| 1991 | 52 | 1525 | 3243 | 3282 | 1458 | 1088 | 126 | 70 | 23 | 23 | 10891 | 67.7 | 32.3 |
| 1992 | 70 | 4171 | 2167 | 1037 | 1480 | 403 | 308 | 34 | 33 | 10 | 9714 | 58.8 | 41.3 |
| 1993 | 4 | 1033 | 4247 | 1115 | 440 | 472 | 159 | 143 | 32 | 17 | 7662 | 67.0 | 33.0 |
| 1994 | 2 | 398 | 1526 | 1826 | 394 | 96 | 137 | 46 | 38 | 6 | 4470 | 68.4 | 31.5 |
| 1995 | 0 | 393 | 1059 | 693 | 291 | 45 | 26 | 15 | 2 | 1 | 2525 | 86.7 | 13.1 |
| 1996 | 1 | 208 | 907 | 1240 | 242 | 124 | 15 | 2 | 4 | 0 | 2743 | 79.7 | 19.9 |
| 1997 | 3 | 517 | 640 | 884 | 795 | 132 | 84 | 15 | 10 | 4 | 3084 | 74.0 | 25.8 |
| 1998 | 0 | 740 | 1191 | 424 | 326 | 239 | 39 | 13 | 7 | 5 | 2984 | 81.7 | 18.0 |
| 1999 | 1 | 286 | 1926 | 706 | 201 | 97 | 119 | 17 | 2 | 3 | 3359 | 83.7 | 16.3 |
| 2000 | 14 | 752 | 687 | 1062 | 284 | 75 | 42 | 37 | 4 | 1 | 2958 | 84.5 | 15.5 |
| 2001 | 0 | 685 | 2382 | 643 | 597 | 166 | 45 | 22 | 11 | 2 | 4554 | 86.4 | 13.6 |
| 2002 | 0 | 51 | 967 | 1347 | 318 | 331 | 67 | 17 | 8 | 5 | 3111 | 89.4 | 10.6 |
| 2003 | 0.2 | 71 | 371 | 754 | 751 | 124 | 122 | 23 | 6 | 3 | 2226 | 83.3 | 16.7 |
| 2004 | 0 | 31 | 319 | 222 | 264 | 230 | 49 | 41 | 10 | 4 | 1170 | 74.7 | 25.3 |

Table A5 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2004.

| Year | Age | | | | | | | | | | | % of Total Landings | |
|------|--|-------|-------|-------|-------|-------|------|------|------|------|-------|---------------------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | Total | USA | Canada |
| | <u>Total Commercial Landings in Weight (Tons) at Age</u> | | | | | | | | | | | | |
| 1978 | 1 | 513 | 18975 | 7952 | 3581 | 750 | 2539 | 394 | 467 | 186 | 35357 | 75.2 | 24.8 |
| 1979 | 30 | 2971 | 1936 | 20504 | 5923 | 3285 | 710 | 2612 | 47 | 606 | 38623 | 84.5 | 15.5 |
| 1980 | 75 | 5517 | 14385 | 1834 | 13038 | 7185 | 3732 | 790 | 1404 | 157 | 48116 | 83.2 | 16.8 |
| 1981 | 24 | 4790 | 9960 | 8424 | 1226 | 10167 | 3578 | 1215 | 1849 | 1115 | 42348 | 79.9 | 20.1 |
| 1982 | 253 | 12819 | 10198 | 10695 | 10717 | 1832 | 6306 | 2117 | 891 | 1330 | 57157 | 68.8 | 31.2 |
| 1983 | 104 | 6387 | 19166 | 8124 | 4891 | 4963 | 759 | 2420 | 1122 | 951 | 48886 | 75.2 | 24.8 |
| 1984 | 85 | 2137 | 8389 | 12076 | 4274 | 3400 | 4079 | 448 | 1934 | 1855 | 38678 | 85.1 | 14.9 |
| 1985 | 121 | 9112 | 5096 | 5319 | 9590 | 2641 | 1765 | 2076 | 242 | 1309 | 37271 | 72.0 | 28.0 |
| 1986 | 145 | 1959 | 11232 | 2934 | 2701 | 4525 | 781 | 719 | 597 | 400 | 25994 | 67.3 | 32.4 |
| 1987 | 19 | 11072 | 3509 | 8884 | 1620 | 1945 | 2419 | 635 | 431 | 344 | 30879 | 61.6 | 38.4 |
| 1988 | 8 | 2394 | 18847 | 3537 | 8052 | 1613 | 1405 | 1949 | 556 | 690 | 39051 | 67.4 | 33.1 |
| 1989 | 0 | 3370 | 6626 | 15631 | 1777 | 3611 | 667 | 453 | 584 | 273 | 32992 | 76.1 | 24.3 |
| 1990 | 5 | 7711 | 12431 | 6638 | 11091 | 1450 | 2072 | 382 | 223 | 554 | 42557 | 66.2 | 33.6 |
| 1991 | 59 | 2481 | 8266 | 11223 | 6956 | 6413 | 933 | 736 | 223 | 346 | 37637 | 64.2 | 35.7 |
| 1992 | 80 | 6432 | 5340 | 3988 | 6963 | 2482 | 2318 | 333 | 401 | 192 | 28528 | 59.1 | 41.1 |
| 1993 | 3 | 1585 | 9567 | 3718 | 2184 | 3013 | 1195 | 1315 | 316 | 220 | 23118 | 63.1 | 36.9 |
| 1994 | 2 | 581 | 3309 | 6676 | 1892 | 716 | 1096 | 430 | 364 | 102 | 15171 | 65.2 | 34.8 |
| 1995 | 0 | 572 | 2221 | 2652 | 1599 | 328 | 273 | 175 | 21 | 20 | 7859 | 86.0 | 13.8 |
| 1996 | 1 | 313 | 2209 | 4201 | 1190 | 823 | 128 | 21 | 59 | 2 | 8946 | 78.5 | 21.0 |
| 1997 | 3 | 817 | 1484 | 3120 | 3263 | 792 | 676 | 135 | 112 | 53 | 10456 | 72.1 | 27.7 |
| 1998 | 0 | 1098 | 2743 | 1483 | 1539 | 1417 | 325 | 118 | 82 | 61 | 8867 | 78.5 | 21.1 |
| 1999 | 1 | 446 | 4283 | 2437 | 986 | 622 | 874 | 160 | 26 | 45 | 9880 | 81.6 | 18.4 |
| 2000 | 13 | 1275 | 1690 | 3752 | 1345 | 436 | 317 | 322 | 30 | 8 | 9189 | 82.9 | 17.1 |
| 2001 | 0 | 1036 | 5594 | 2029 | 2604 | 915 | 284 | 183 | 110 | 18 | 12778 | 83.2 | 16.8 |
| 2002 | 0 | 91 | 2189 | 4134 | 1364 | 1771 | 453 | 141 | 74 | 57 | 10274 | 87.6 | 12.4 |
| 2003 | 0.1 | 138 | 874 | 2287 | 3029 | 615 | 754 | 186 | 51 | 28 | 7963 | 83.5 | 16.5 |
| 2004 | 0 | 60 | 826 | 707 | 1082 | 1157 | 291 | 322 | 90 | 51 | 4583 | 75.7 | 24.3 |

Table A5- continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978-2004.

| Year | Age | | | | | | | | | | Mean |
|------|--|-------|-------|-------|-------|-------|--------|--------|--------|--------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | |
| | <u>Total Commercial Landings Mean Weight (kg) at Age</u> | | | | | | | | | | |
| 1978 | 0.707 | 1.310 | 2.461 | 3.469 | 4.336 | 5.787 | 7.374 | 8.492 | 11.785 | 13.200 | 2.983 |
| 1979 | 0.889 | 1.494 | 2.149 | 4.211 | 4.888 | 7.178 | 9.183 | 10.313 | 11.699 | 12.625 | 3.923 |
| 1980 | 0.836 | 1.460 | 2.468 | 3.668 | 5.647 | 6.676 | 8.390 | 9.089 | 8.432 | 15.400 | 3.368 |
| 1981 | 0.882 | 1.495 | 2.358 | 3.415 | 5.213 | 7.222 | 8.565 | 9.888 | 14.170 | 18.565 | 3.446 |
| 1982 | 0.765 | 1.402 | 2.664 | 3.834 | 5.352 | 6.511 | 9.363 | 9.897 | 12.503 | 16.723 | 2.946 |
| 1983 | 0.971 | 1.490 | 2.377 | 3.309 | 4.637 | 6.393 | 7.964 | 10.286 | 11.227 | 14.554 | 2.836 |
| 1984 | 1.053 | 1.635 | 2.451 | 3.619 | 5.083 | 6.582 | 8.909 | 10.104 | 11.303 | 15.356 | 3.756 |
| 1985 | 0.907 | 1.418 | 2.086 | 3.887 | 5.087 | 6.412 | 8.097 | 10.236 | 11.418 | 13.494 | 2.822 |
| 1986 | 0.929 | 1.475 | 2.447 | 3.660 | 5.603 | 7.191 | 8.915 | 9.955 | 12.687 | 14.104 | 3.161 |
| 1987 | 0.726 | 1.481 | 2.495 | 4.187 | 5.810 | 7.726 | 8.949 | 10.013 | 11.414 | 15.000 | 2.584 |
| 1988 | 0.786 | 1.520 | 2.359 | 3.511 | 5.401 | 6.647 | 8.776 | 9.987 | 11.143 | 15.298 | 3.062 |
| 1989 | - | 1.617 | 2.269 | 3.772 | 5.396 | 6.694 | 8.222 | 10.718 | 11.665 | 17.111 | 3.235 |
| 1990 | 0.831 | 1.560 | 2.462 | 3.522 | 4.892 | 6.333 | 8.456 | 10.648 | 12.580 | 14.526 | 2.891 |
| 1991 | 1.114 | 1.627 | 2.548 | 3.420 | 4.769 | 5.891 | 7.410 | 10.520 | 9.686 | 15.373 | 3.456 |
| 1992 | 1.148 | 1.542 | 2.464 | 3.843 | 4.704 | 6.156 | 7.509 | 9.846 | 12.059 | 19.025 | 2.937 |
| 1993 | 0.872 | 1.534 | 2.253 | 3.333 | 4.967 | 6.379 | 7.510 | 9.217 | 9.699 | 13.236 | 3.017 |
| 1994 | 0.906 | 1.459 | 2.168 | 3.657 | 4.804 | 7.432 | 8.013 | 9.368 | 9.698 | 16.659 | 3.394 |
| 1995 | 0.906 | 1.471 | 2.095 | 3.830 | 5.492 | 7.384 | 10.715 | 11.617 | 10.383 | 14.953 | 3.087 |
| 1996 | 0.882 | 1.507 | 2.435 | 3.387 | 4.912 | 6.622 | 8.369 | 8.438 | 12.883 | 12.002 | 3.212 |
| 1997 | 0.954 | 1.577 | 2.321 | 3.532 | 4.103 | 6.019 | 8.050 | 8.631 | 11.870 | 12.795 | 3.390 |
| 1998 | 0.579 | 1.483 | 2.302 | 3.497 | 4.735 | 5.934 | 8.185 | 8.610 | 12.684 | 14.606 | 2.969 |
| 1999 | 0.830 | 1.565 | 2.223 | 3.452 | 4.891 | 6.422 | 7.341 | 9.685 | 12.153 | 13.735 | 2.941 |
| 2000 | 0.956 | 1.696 | 2.461 | 3.533 | 4.731 | 5.797 | 7.530 | 8.596 | 8.817 | 12.831 | 3.107 |
| 2001 | 0.880 | 1.516 | 2.349 | 3.157 | 4.356 | 5.516 | 6.323 | 8.178 | 9.766 | 11.951 | 2.806 |
| 2002 | 0.551 | 1.768 | 2.265 | 3.068 | 4.290 | 5.345 | 6.759 | 8.428 | 9.711 | 12.127 | 3.303 |
| 2003 | 0.524 | 1.941 | 2.353 | 3.034 | 4.031 | 4.954 | 6.178 | 7.924 | 9.239 | 10.793 | 3.577 |
| 2004 | 0.704 | 1.950 | 2.586 | 3.192 | 4.090 | 5.032 | 5.945 | 7.838 | 9.273 | 12.219 | 3.920 |

Table A5 - continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Georges Bank and South stock (NAFO Division 5Z and Subarea 6), 1978 - 2004.

| Year | Age | | | | | | | | | | | Mean |
|------|------|------|------|------|------|------|-------|-------|-------|-------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | | |
| 1978 | 39.5 | 50.0 | 60.8 | 67.9 | 72.7 | 80.4 | 80.2 | 93.1 | 103.4 | 106.5 | 64.1 | |
| 1979 | 44.7 | 52.2 | 57.7 | 73.2 | 76.8 | 87.5 | 95.3 | 99.5 | 103.4 | 106.4 | 69.6 | |
| 1980 | 43.8 | 51.8 | 61.2 | 69.7 | 80.9 | 86.0 | 92.4 | 93.8 | 92.4 | 114.6 | 65.6 | |
| 1981 | 44.4 | 52.2 | 60.2 | 68.4 | 78.2 | 88.0 | 93.5 | 97.5 | 110.3 | 119.5 | 65.6 | |
| 1982 | 42.2 | 51.2 | 62.4 | 70.5 | 79.1 | 84.3 | 96.0 | 97.4 | 105.8 | 115.0 | 61.9 | |
| 1983 | 45.5 | 52.3 | 60.4 | 67.0 | 75.3 | 84.4 | 90.7 | 99.1 | 101.9 | 111.4 | 62.4 | |
| 1984 | 47.2 | 54.0 | 61.5 | 69.8 | 77.8 | 85.5 | 94.4 | 98.6 | 102.3 | 112.8 | 68.6 | |
| 1985 | 44.9 | 51.1 | 57.5 | 71.4 | 78.0 | 84.3 | 91.3 | 98.8 | 102.3 | 108.2 | 61.1 | |
| 1986 | 45.0 | 51.9 | 61.1 | 69.2 | 80.7 | 87.7 | 94.4 | 98.0 | 105.9 | 108.4 | 64.3 | |
| 1987 | 40.7 | 51.8 | 61.2 | 73.0 | 81.8 | 90.1 | 94.5 | 98.2 | 102.5 | 111.2 | 59.7 | |
| 1988 | 40.8 | 52.8 | 60.4 | 68.5 | 79.5 | 85.3 | 93.6 | 97.7 | 101.5 | 111.2 | 64.1 | |
| 1989 | 0.0 | 53.8 | 60.0 | 70.4 | 79.2 | 85.2 | 91.7 | 100.3 | 103.2 | 113.3 | 65.7 | |
| 1990 | 41.7 | 53.5 | 61.0 | 68.7 | 76.6 | 83.2 | 92.1 | 100.2 | 106.0 | 110.8 | 62.9 | |
| 1991 | 47.7 | 53.6 | 62.2 | 67.7 | 75.8 | 80.9 | 87.8 | 99.4 | 95.9 | 113.9 | 67.0 | |
| 1992 | 46.2 | 52.4 | 60.8 | 70.6 | 75.1 | 82.2 | 87.9 | 96.0 | 104.3 | 116.0 | 62.4 | |
| 1993 | 42.2 | 52.7 | 59.6 | 67.0 | 76.3 | 83.6 | 88.2 | 95.1 | 95.9 | 107.0 | 63.0 | |
| 1994 | 43.1 | 51.7 | 58.9 | 69.6 | 75.8 | 88.2 | 90.7 | 95.3 | 95.9 | 115.8 | 65.8 | |
| 1995 | 43.0 | 50.6 | 58.2 | 70.9 | 80.5 | 88.5 | 100.9 | 103.8 | 99.1 | 113.0 | 64.6 | |
| 1996 | 45.1 | 52.7 | 61.2 | 68.0 | 76.9 | 85.5 | 90.7 | 91.0 | 106.9 | 104.6 | 66.4 | |
| 1997 | 43.7 | 53.4 | 60.2 | 68.8 | 72.1 | 82.3 | 91.2 | 93.1 | 104.2 | 106.5 | 66.7 | |
| 1998 | 37.8 | 52.4 | 60.1 | 68.8 | 76.0 | 82.2 | 91.4 | 93.1 | 106.4 | 111.9 | 61.7 | |
| 1999 | 41.5 | 53.4 | 59.6 | 68.6 | 76.9 | 84.1 | 88.5 | 96.6 | 103.4 | 109.0 | 64.0 | |
| 2000 | 45.4 | 54.9 | 61.8 | 69.4 | 76.3 | 81.5 | 89.2 | 93.7 | 93.8 | 107.9 | 65.4 | |
| 2001 | 43.0 | 53.1 | 60.8 | 66.7 | 74.1 | 80.2 | 83.6 | 91.4 | 97.5 | 103.6 | 63.4 | |
| 2002 | 37.0 | 55.8 | 60.1 | 66.2 | 73.8 | 79.3 | 85.6 | 92.0 | 96.5 | 104.2 | 67.0 | |
| 2003 | 36.5 | 57.4 | 61.0 | 66.1 | 72.4 | 77.2 | 83.4 | 90.8 | 95.5 | 100.3 | 69.0 | |
| 2004 | 40.1 | 57.6 | 62.7 | 67.1 | 72.8 | 77.9 | 82.3 | 90.5 | 95.5 | 104.8 | 70.9 | |

Table A6. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2004.

| | | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|--|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Stock Numbers (Jan 1) in thousands | | | | | | | | | | | | | | | |
| Age | | | | | | | | | | | | | | | |
| 1 | | 27713 | 23513 | 20104 | 41392 | 17471 | 9615 | 27391 | 8669 | 42747 | 16376 | 23446 | 15673 | 9184 | 17849 |
| 2 | | 4268 | 22688 | 19220 | 16380 | 33865 | 14004 | 7774 | 22353 | 6977 | 34857 | 13384 | 19187 | 12832 | 7513 |
| 3 | | 25526 | 3139 | 16776 | 12319 | 10510 | 19458 | 7588 | 5182 | 12486 | 4512 | 21777 | 9531 | 13819 | 6034 |
| 4 | | 7947 | 13888 | 1755 | 8461 | 6266 | 5145 | 8635 | 3115 | 2032 | 6085 | 2422 | 10571 | 5159 | 6752 |
| 5 | | 2878 | 4422 | 6964 | 985 | 4698 | 2609 | 1990 | 4051 | 1312 | 943 | 3063 | 1067 | 4895 | 2521 |
| 6 | | 1124 | 1605 | 2524 | 3613 | 594 | 2037 | 1181 | 869 | 1611 | 640 | 519 | 1153 | 574 | 1959 |
| 7 | | 1434 | 802 | 900 | 1093 | 1686 | 232 | 965 | 500 | 339 | 752 | 296 | 205 | 455 | 263 |
| 8 | | 67 | 862 | 587 | 334 | 517 | 772 | 104 | 376 | 212 | 199 | 371 | 97 | 93 | 151 |
| 9 | | 146 | 12 | 477 | 402 | 162 | 231 | 419 | 45 | 124 | 109 | 106 | 126 | 40 | 44 |
| 10+ | | 55 | 149 | 29 | 192 | 189 | 150 | 297 | 209 | 77 | 69 | 99 | 45 | 90 | 44 |
| Total | | 71158 | 71082 | 69336 | 85171 | 75959 | 54252 | 56344 | 45370 | 67918 | 64541 | 65483 | 57654 | 47142 | 43129 |
| | | | | | | | | | | | | | | | |
| Age | | | | | | | | | | | | | | | |
| 1 | | 6641 | 8183 | 5252 | 3248 | 5928 | 10096 | 4577 | 12809 | 7928 | 3436 | 3352 | 2283 | 21220 | 10398 |
| 2 | | 14566 | 5374 | 6696 | 4298 | 2659 | 4852 | 8263 | 3747 | 10486 | 6478 | 2813 | 2745 | 1869 | 17373 |
| 3 | | 4771 | 8147 | 3465 | 5122 | 3165 | 1990 | 3505 | 6097 | 2810 | 7904 | 4684 | 2257 | 2183 | 1502 |
| 4 | | 2006 | 1943 | 2828 | 1456 | 3236 | 1774 | 1051 | 1795 | 3248 | 1679 | 4316 | 2960 | 1512 | 1499 |
| 5 | | 2559 | 703 | 582 | 664 | 566 | 1533 | 655 | 478 | 831 | 1698 | 793 | 2315 | 1741 | 1037 |
| 6 | | 745 | 755 | 178 | 120 | 281 | 245 | 537 | 243 | 209 | 423 | 850 | 361 | 1216 | 1187 |
| 7 | | 620 | 244 | 191 | 58 | 58 | 119 | 82 | 225 | 111 | 103 | 196 | 397 | 184 | 787 |
| 8 | | 101 | 228 | 56 | 32 | 24 | 34 | 21 | 32 | 77 | 53 | 44 | 100 | 214 | 106 |
| 9 | | 60 | 52 | 57 | 4 | 13 | 17 | 13 | 5 | 12 | 29 | 24 | 21 | 61 | 139 |
| 10+ | | 18 | 28 | 9 | 2 | 0 | 2 | 9 | 7 | 3 | 5 | 15 | 10 | 21 | 53 |
| Total | | 32088 | 25656 | 19313 | 15005 | 15930 | 20662 | 18714 | 25438 | 25713 | 21810 | 17087 | 13448 | 30220 | 34081 |

Table A6 - continued
Fishing Mortality

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Age | | | | | | | | | | | | | | |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.11 | 0.10 | 0.24 | 0.24 | 0.35 | 0.41 | 0.21 | 0.38 | 0.24 | 0.27 | 0.14 | 0.13 | 0.55 | 0.25 |
| 3 | 0.41 | 0.38 | 0.48 | 0.48 | 0.51 | 0.61 | 0.69 | 0.74 | 0.52 | 0.42 | 0.52 | 0.41 | 0.52 | 0.90 |
| 4 | 0.39 | 0.49 | 0.38 | 0.39 | 0.68 | 0.75 | 0.56 | 0.66 | 0.57 | 0.49 | 0.62 | 0.57 | 0.52 | 0.77 |
| 5 | 0.38 | 0.36 | 0.46 | 0.31 | 0.64 | 0.59 | 0.63 | 0.72 | 0.52 | 0.40 | 0.78 | 0.42 | 0.72 | 1.02 |
| 6 | 0.14 | 0.38 | 0.64 | 0.56 | 0.74 | 0.55 | 0.66 | 0.74 | 0.56 | 0.57 | 0.73 | 0.73 | 0.58 | 0.95 |
| 7 | 0.31 | 0.11 | 0.79 | 0.55 | 0.58 | 0.60 | 0.74 | 0.66 | 0.33 | 0.51 | 0.92 | 0.59 | 0.91 | 0.75 |
| 8 | 1.48 | 0.39 | 0.18 | 0.52 | 0.61 | 0.41 | 0.63 | 0.91 | 0.47 | 0.43 | 0.88 | 0.68 | 0.56 | 0.72 |
| 9 | 0.36 | 0.43 | 0.48 | 0.44 | 0.65 | 0.64 | 0.59 | 0.71 | 0.53 | 0.48 | 0.72 | 0.57 | 0.62 | 0.85 |
| 10+ | 0.36 | 0.43 | 0.48 | 0.44 | 0.65 | 0.64 | 0.59 | 0.71 | 0.53 | 0.48 | 0.72 | 0.57 | 0.62 | 0.85 |
| Total | 0.54 | 0.35 | 0.49 | 0.47 | 0.65 | 0.58 | 0.64 | 0.74 | 0.49 | 0.48 | 0.79 | 0.60 | 0.65 | 0.84 |
| | | | | | | | | | | | | | | |
| Age | | | | | | | | | | | | | | |
| 1 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.38 | 0.24 | 0.07 | 0.11 | 0.09 | 0.13 | 0.10 | 0.09 | 0.08 | 0.12 | 0.02 | 0.03 | 0.02 | 0.02 |
| 3 | 0.70 | 0.86 | 0.67 | 0.26 | 0.38 | 0.44 | 0.47 | 0.43 | 0.31 | 0.41 | 0.26 | 0.20 | 0.18 | 0.18 |
| 4 | 0.85 | 1.01 | 1.25 | 0.74 | 0.55 | 0.80 | 0.59 | 0.57 | 0.45 | 0.55 | 0.42 | 0.33 | 0.18 | 0.18 |
| 5 | 1.02 | 1.18 | 1.38 | 0.66 | 0.64 | 0.85 | 0.79 | 0.63 | 0.47 | 0.49 | 0.59 | 0.44 | 0.18 | 0.18 |
| 6 | 0.91 | 1.18 | 0.91 | 0.52 | 0.66 | 0.89 | 0.67 | 0.58 | 0.50 | 0.57 | 0.56 | 0.48 | 0.23 | 0.23 |
| 7 | 0.80 | 1.27 | 1.58 | 0.68 | 0.34 | 1.52 | 0.74 | 0.88 | 0.54 | 0.66 | 0.47 | 0.42 | 0.35 | 0.35 |
| 8 | 0.46 | 1.18 | 2.37 | 0.72 | 0.15 | 0.73 | 1.29 | 0.80 | 0.76 | 0.61 | 0.56 | 0.29 | 0.24 | 0.24 |
| 9 | 0.91 | 1.09 | 1.27 | 0.71 | 0.56 | 0.84 | 0.67 | 0.61 | 0.46 | 0.53 | 0.46 | 0.39 | 0.24 | 0.24 |
| 10+ | 0.91 | 1.09 | 1.27 | 0.71 | 0.56 | 0.84 | 0.67 | 0.61 | 0.46 | 0.53 | 0.46 | 0.39 | 0.24 | 0.24 |
| Total | 0.81 | 1.16 | 1.50 | 0.67 | 0.47 | 0.96 | 0.82 | 0.69 | 0.55 | 0.58 | 0.52 | 0.39 | 0.24 | 0.24 |

Table A6 continued. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F), spawning stock biomass (mt), and percent mature of Georges Bank cod, estimated from virtual population analysis (VPA), calibrated using the commercial catch at age ADAPT formulation, 1978-2004.

| SSB at start of spawning season | | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|--|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Age | | | | | | | | | | | | | | | |
| 1 | | 913 | 1104 | 850 | 1960 | 1200 | 903 | 3123 | 773 | 8512 | 2224 | 3479 | 2473 | 633 | 1961 |
| 2 | | 1410 | 7539 | 6913 | 5782 | 16137 | 6344 | 4303 | 11650 | 5027 | 25329 | 8902 | 13721 | 6610 | 4211 |
| 3 | | 33845 | 3729 | 22417 | 15928 | 15642 | 26058 | 10500 | 6878 | 18776 | 7101 | 32836 | 14540 | 22024 | 9011 |
| 4 | | 20219 | 38255 | 4297 | 21379 | 15793 | 12648 | 21655 | 8075 | 4842 | 17024 | 6128 | 27180 | 12814 | 16501 |
| 5 | | 8798 | 16585 | 30442 | 3958 | 17473 | 9639 | 7110 | 14906 | 5434 | 3937 | 12377 | 4189 | 18051 | 8432 |
| 6 | | 4882 | 8130 | 12541 | 20322 | 2957 | 10520 | 5655 | 4242 | 8582 | 3704 | 2764 | 5937 | 2947 | 8681 |
| 7 | | 8215 | 5550 | 5918 | 7296 | 12172 | 1460 | 6226 | 3166 | 2345 | 5361 | 2024 | 1327 | 2845 | 1537 |
| 8 | | 367 | 6810 | 5034 | 2696 | 4165 | 6840 | 811 | 2985 | 1705 | 1691 | 2930 | 811 | 769 | 1218 |
| 9 | | 1331 | 112 | 3967 | 4100 | 1564 | 2116 | 3961 | 417 | 1252 | 1034 | 958 | 1193 | 409 | 373 |
| 10+ | | 659 | 1698 | 392 | 3199 | 2750 | 1899 | 3992 | 2422 | 956 | 919 | 1304 | 681 | 1143 | 565 |
| Total | | 80639 | 89512 | 92771 | 86621 | 89852 | 78426 | 67335 | 55513 | 57432 | 68324 | 73700 | 72053 | 68245 | 52490 |
| Age | | | | | | | | | | | | | | | |
| 1 | | 764 | 640 | 72 | 44 | 76 | 971 | 203 | 935 | 175 | 62 | 29 | 42 | 705 | |
| 2 | | 9011 | 3447 | 2817 | 1839 | 1155 | 3090 | 5325 | 1938 | 5222 | 3251 | 1488 | 929 | 619 | |
| 3 | | 7401 | 11456 | 5195 | 7881 | 5166 | 3078 | 5495 | 9169 | 4808 | 13550 | 7638 | 3402 | 3633 | |
| 4 | | 5218 | 4508 | 6375 | 3584 | 7612 | 4406 | 2625 | 4450 | 8169 | 4129 | 10444 | 6818 | 3743 | |
| 5 | | 8375 | 2442 | 1788 | 2578 | 2136 | 4798 | 2271 | 1721 | 3000 | 5938 | 2559 | 7313 | 5756 | |
| 6 | | 3351 | 3286 | 896 | 632 | 1469 | 1112 | 2292 | 1177 | 990 | 1901 | 3614 | 1488 | 5093 | |
| 7 | | 3488 | 1300 | 1013 | 451 | 418 | 652 | 494 | 1241 | 685 | 543 | 1071 | 2056 | 911 | |
| 8 | | 775 | 1504 | 307 | 266 | 219 | 248 | 139 | 242 | 518 | 364 | 283 | 674 | 1383 | |
| 9 | | 561 | 411 | 422 | 37 | 137 | 145 | 121 | 43 | 96 | 237 | 188 | 165 | 483 | |
| 10+ | | 287 | 296 | 117 | 28 | 0 | 21 | 113 | 87 | 34 | 56 | 160 | 100 | 237 | |
| Total | | 39229 | 29289 | 19003 | 17340 | 18387 | 18521 | 19078 | 21003 | 23697 | 30033 | 27474 | 22987 | 22564 | |

Table A6 continued

Percent mature (females)

| Age | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1 | 7 | 7 | 7 | 7 | 13 | 13 | 13 | 13 | 28 | 28 | 28 | 28 | 12 | 12 |
| 2 | 34 | 34 | 34 | 34 | 47 | 47 | 47 | 47 | 67 | 67 | 67 | 67 | 52 | 52 |
| 3 | 78 | 78 | 78 | 78 | 84 | 84 | 84 | 84 | 91 | 91 | 91 | 91 | 90 | 90 |
| 4 | 96 | 96 | 96 | 96 | 97 | 97 | 97 | 97 | 98 | 98 | 98 | 98 | 99 | 99 |
| 5+ | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| Age | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1 | 12 | 12 | 12 | 2 | 2 | 2 | 13 | 13 | 13 | 3 | 3 | 7 | 7 |
| 2 | 52 | 52 | 52 | 39 | 39 | 39 | 57 | 57 | 57 | 44 | 44 | 34 | 34 |
| 3 | 90 | 90 | 90 | 95 | 95 | 95 | 92 | 92 | 92 | 95 | 95 | 79 | 79 |
| 4 | 99 | 99 | 99 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 96 | 96 |
| 5+ | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

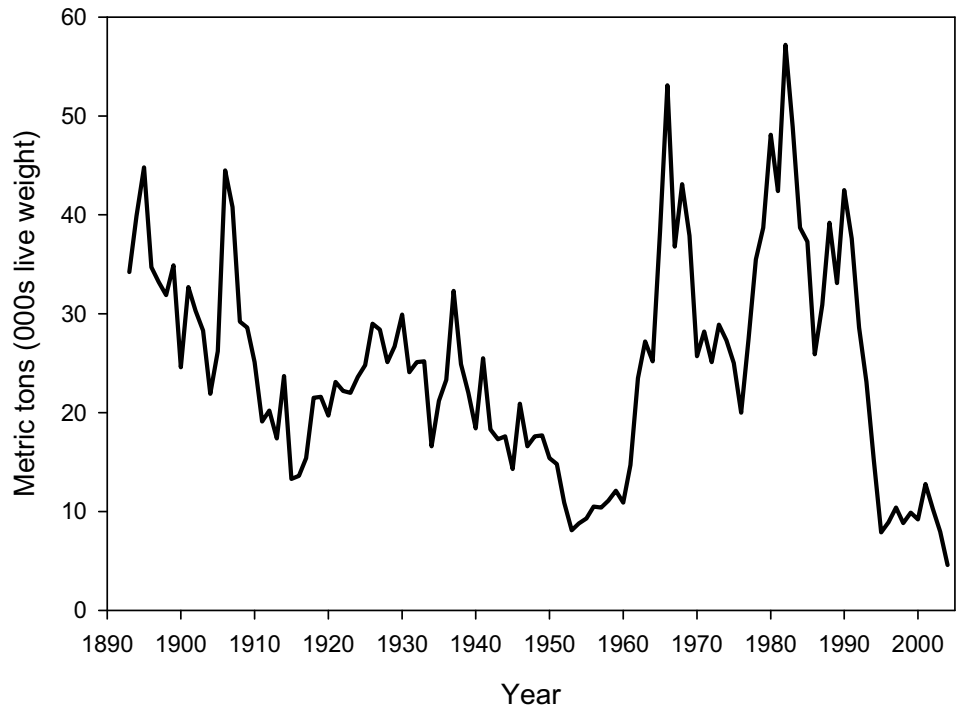


Figure A1a. Total commercial landings of Georges Bank cod (NAFO Division 5Z ans Subarea 6), 1893-2004.

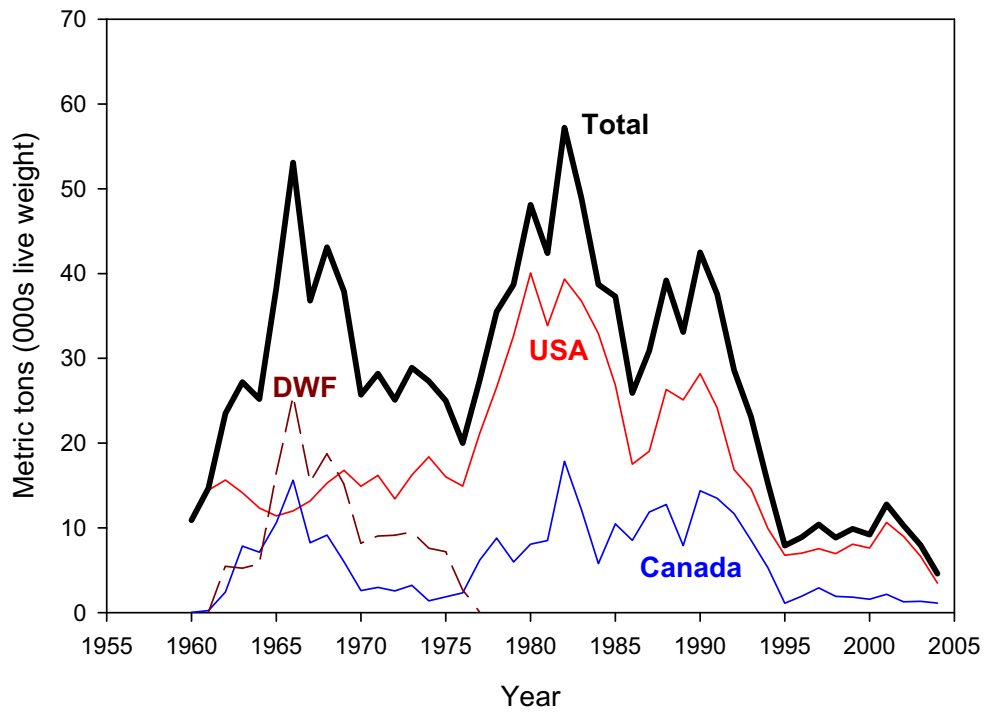


Figure A1b. Total commercial landings of Georges Bank cod (NAFO Division 5Z ans Subarea 6), 1960-2004.

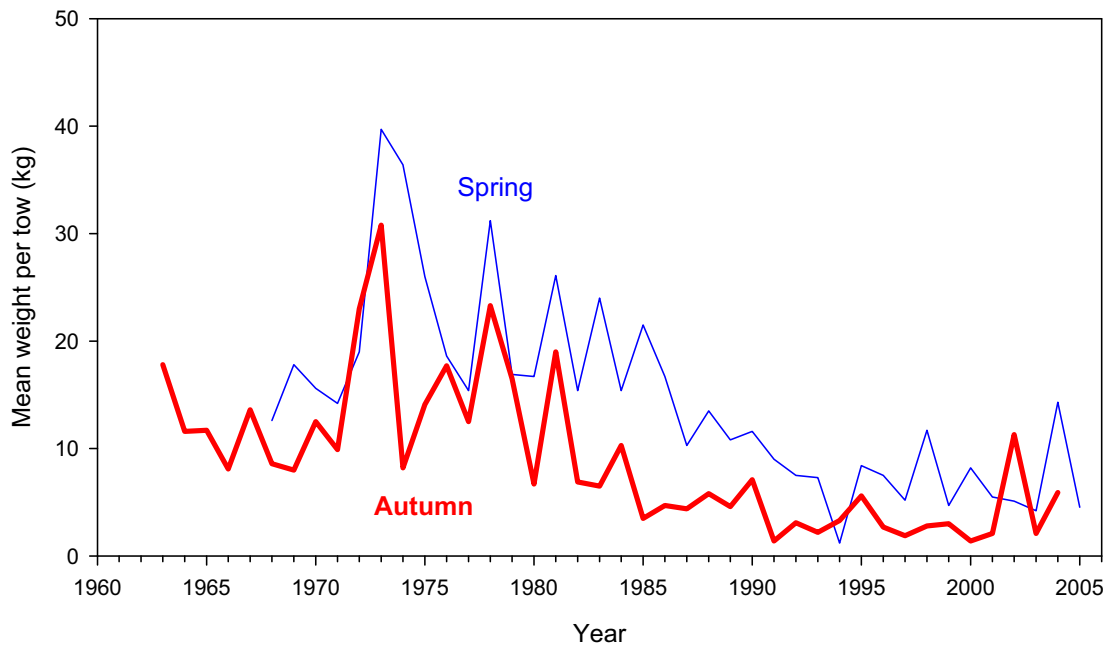


Figure A2. Standardized stratified mean catch per tow (kg) of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys on Georges Bank, 1963-2005.

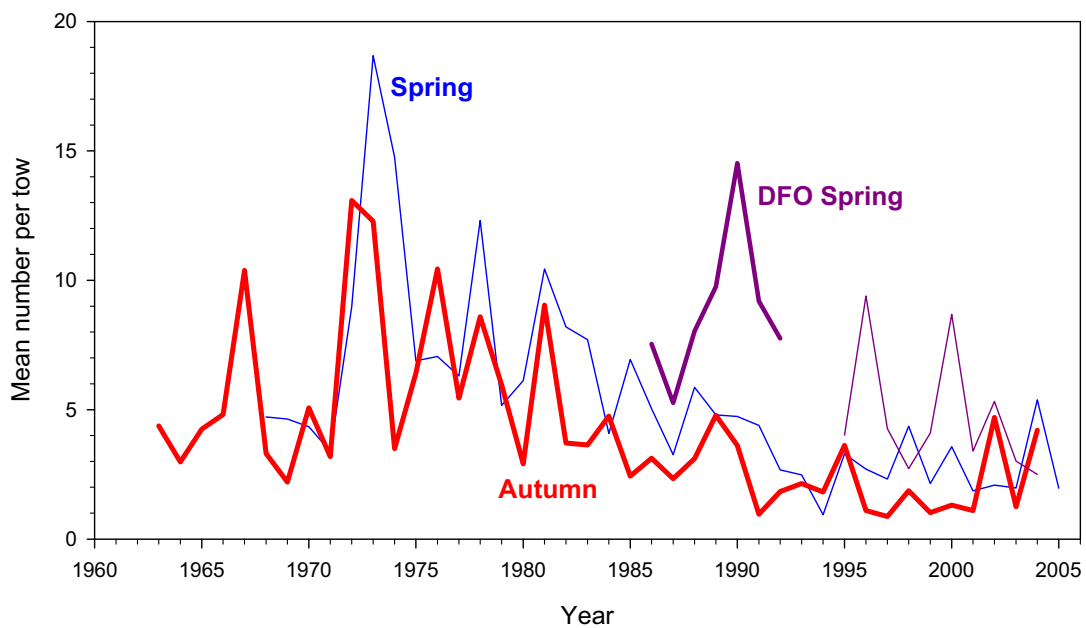


Figure A3. Standardized stratified mean number per tow of Atlantic cod in NEFSC and DFO spring and NEFSC autumn research vessel bottom trawl surveys on Georges Bank, 1963-2005.

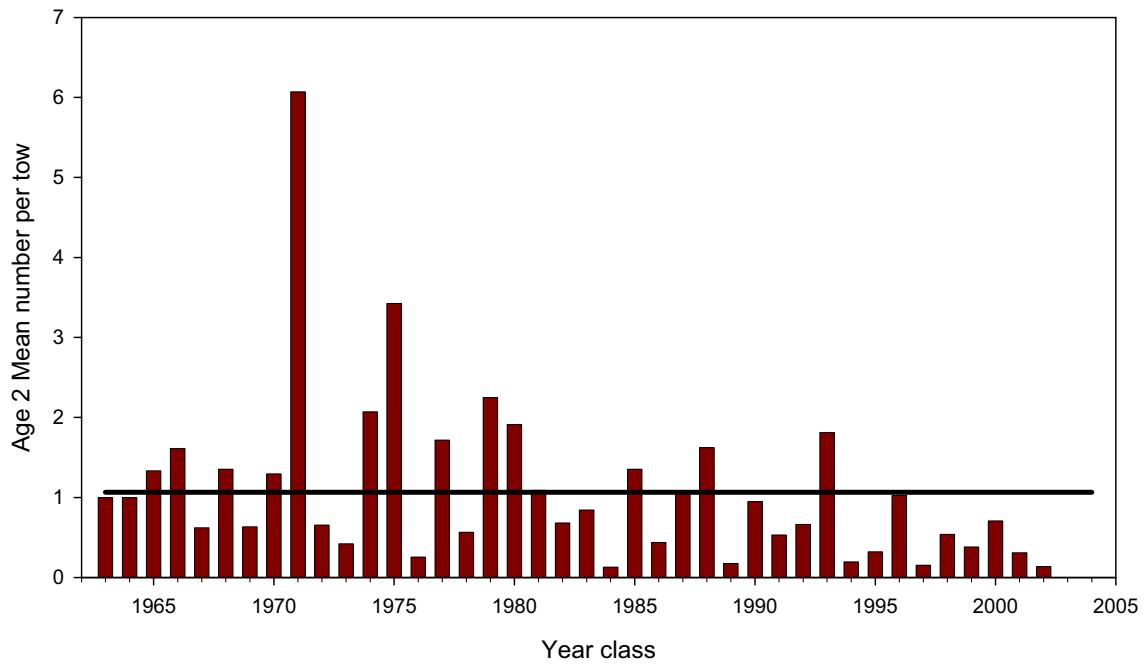
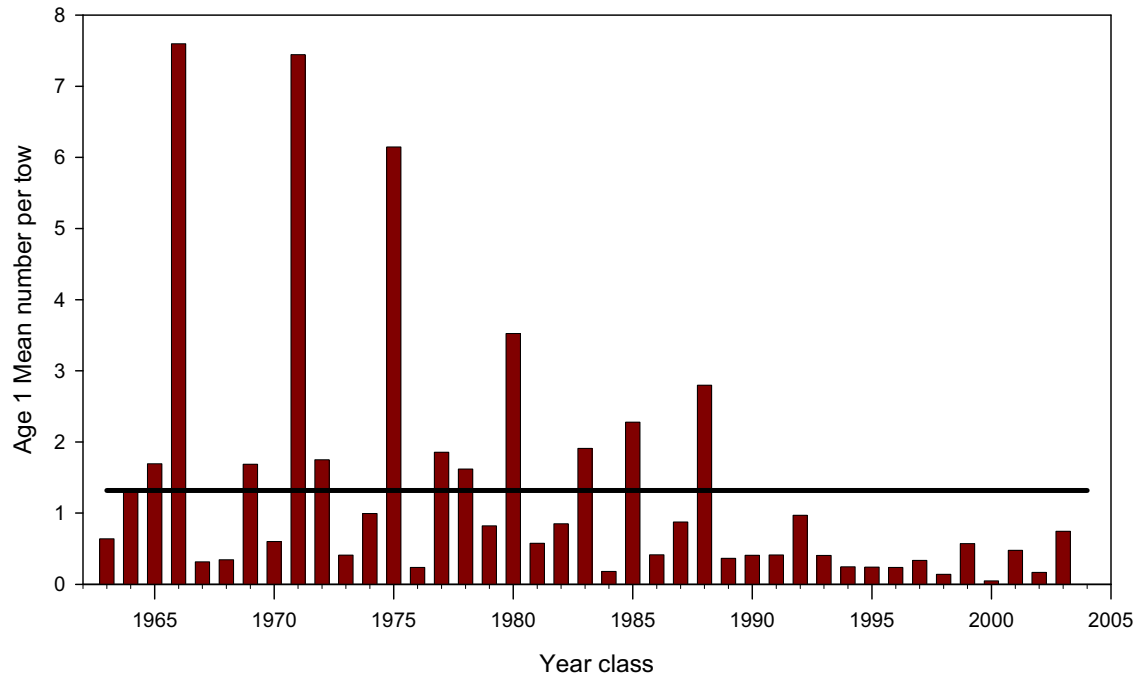


Figure A4. Relative year class strength of age 1 and age 2 Georges Bank cod based on standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trawl surveys, 1963-2004. Horizontal line represents the time series average.

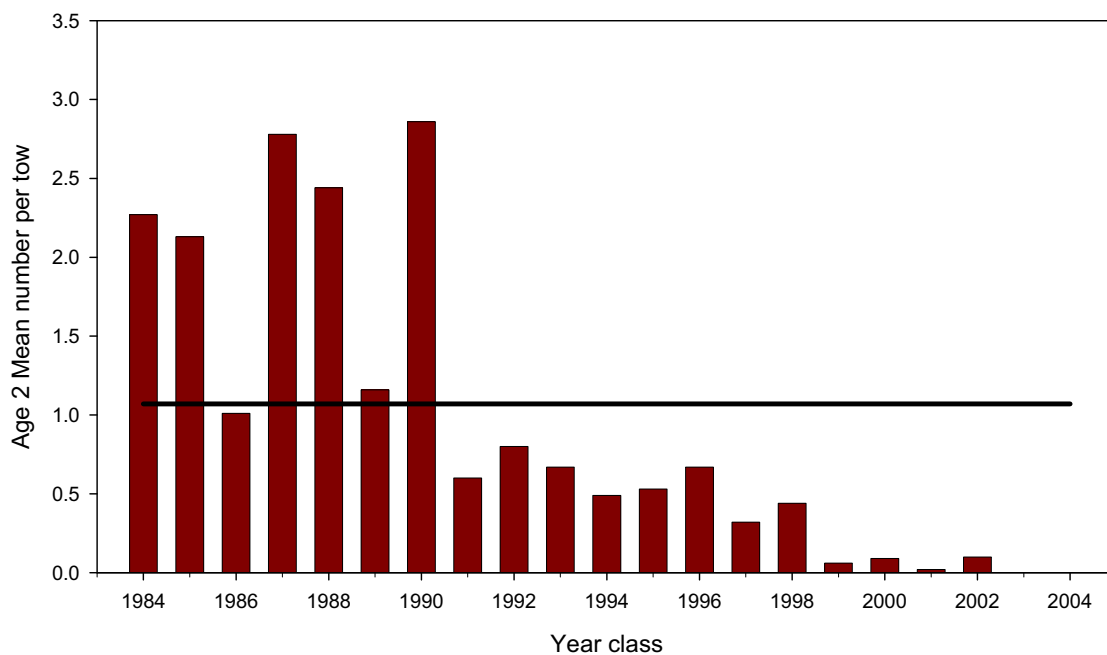
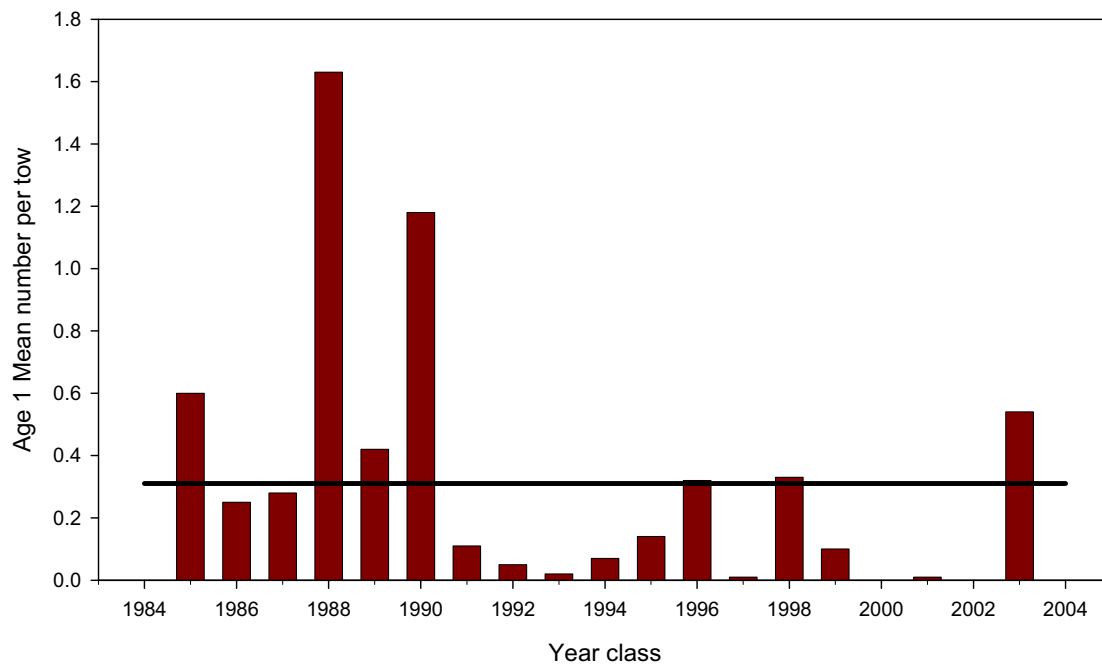


Figure A5. Relative year class strength of age 1 and age 2 Georges Bank cod based on standardized catch (number) per tow indices from DFO spring research vessel bottom trawl surveys, 1986-2004. Horizontal line represents the time series average.

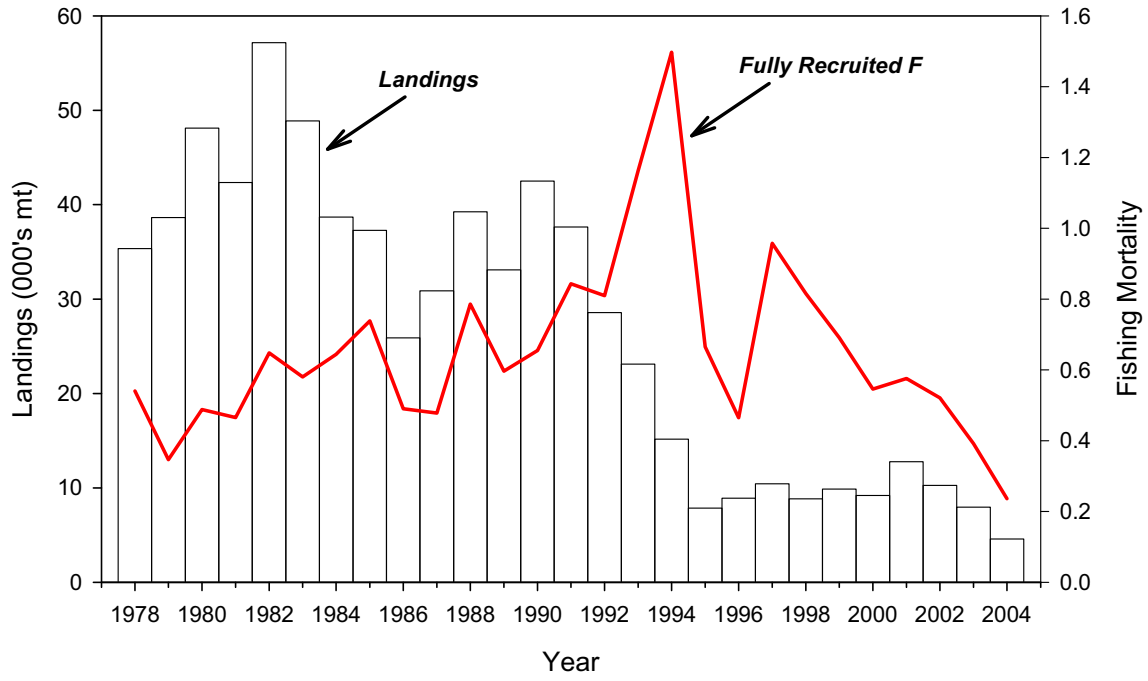


Figure A6. Trends in total commercial landings and fishing mortality for Georges Bank cod, 1978-2005.

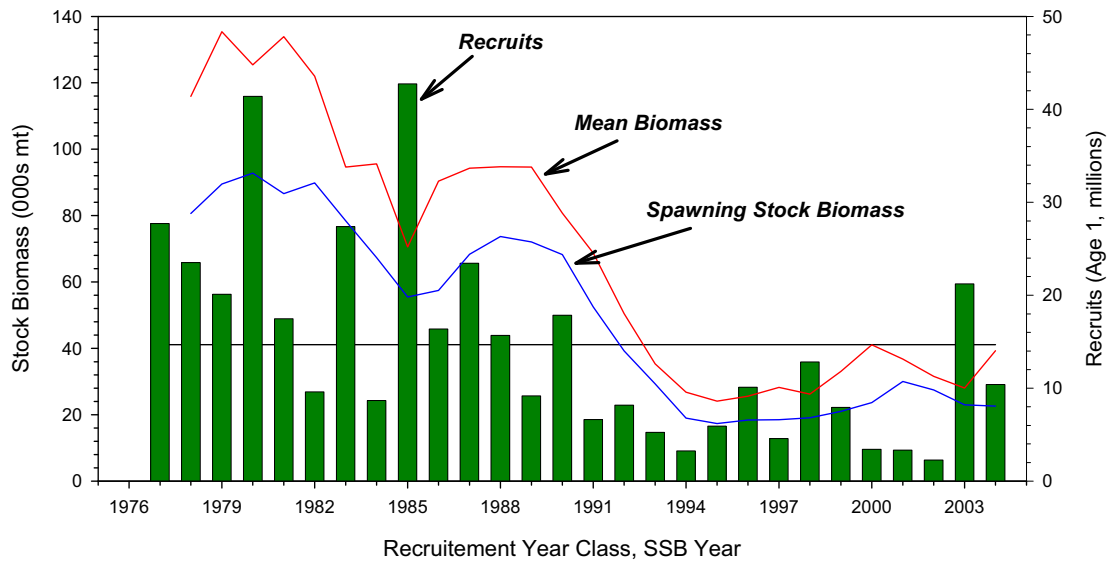


Figure A7. Trends in stock biomass and recruitment for Georges Bank Atlantic cod, 1978-2004. Horizontal line is the average recruitment for the time series.

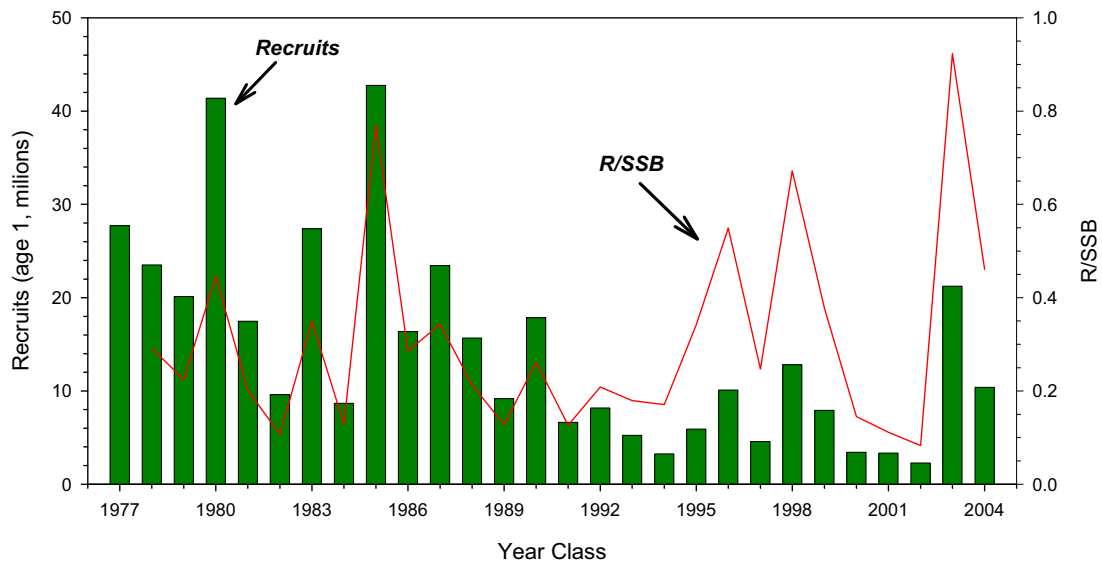


Figure A8. Trends in recruitment and recruitment/SSB survival ratio for Georges Bank cod, 1978-2004.

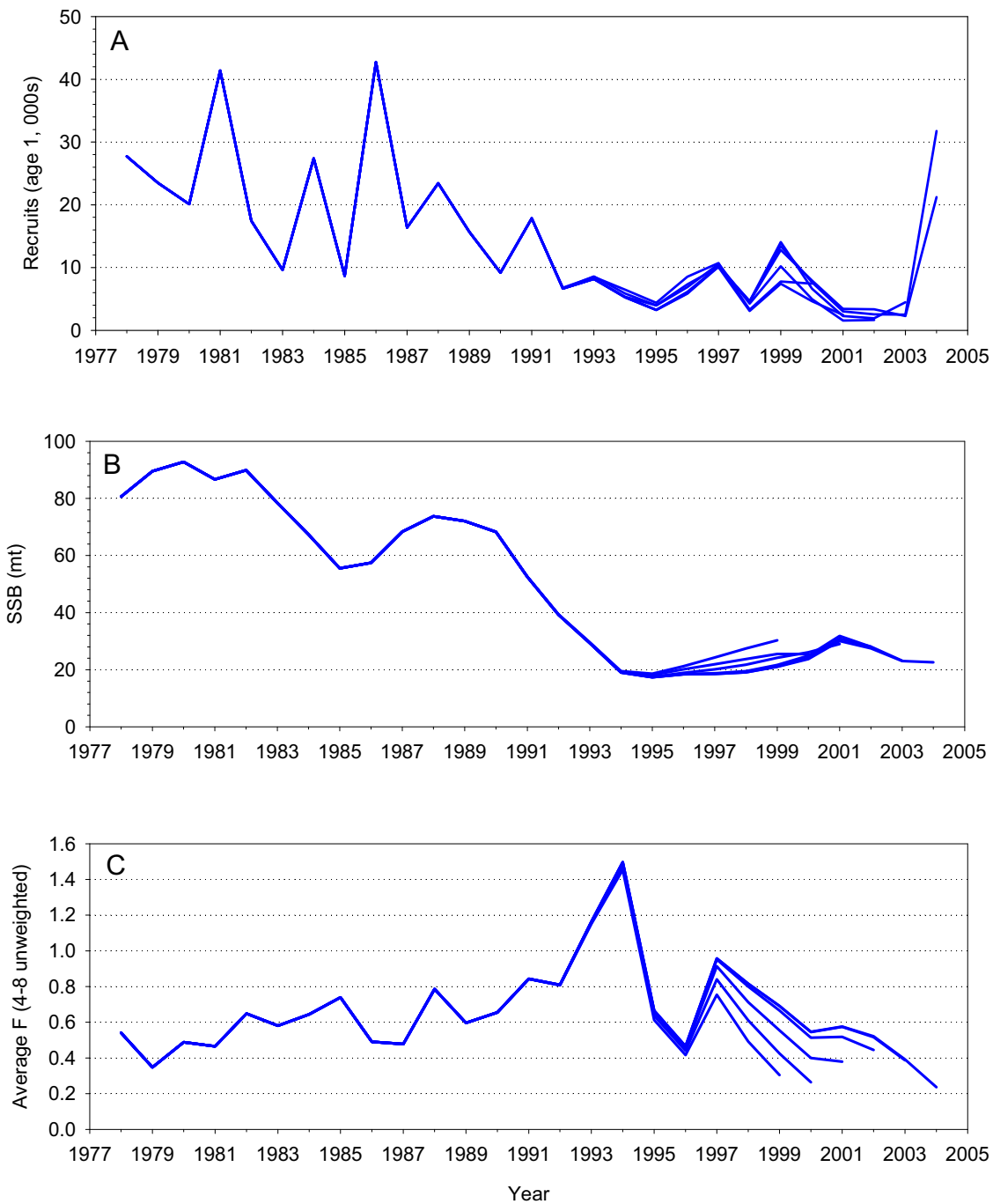
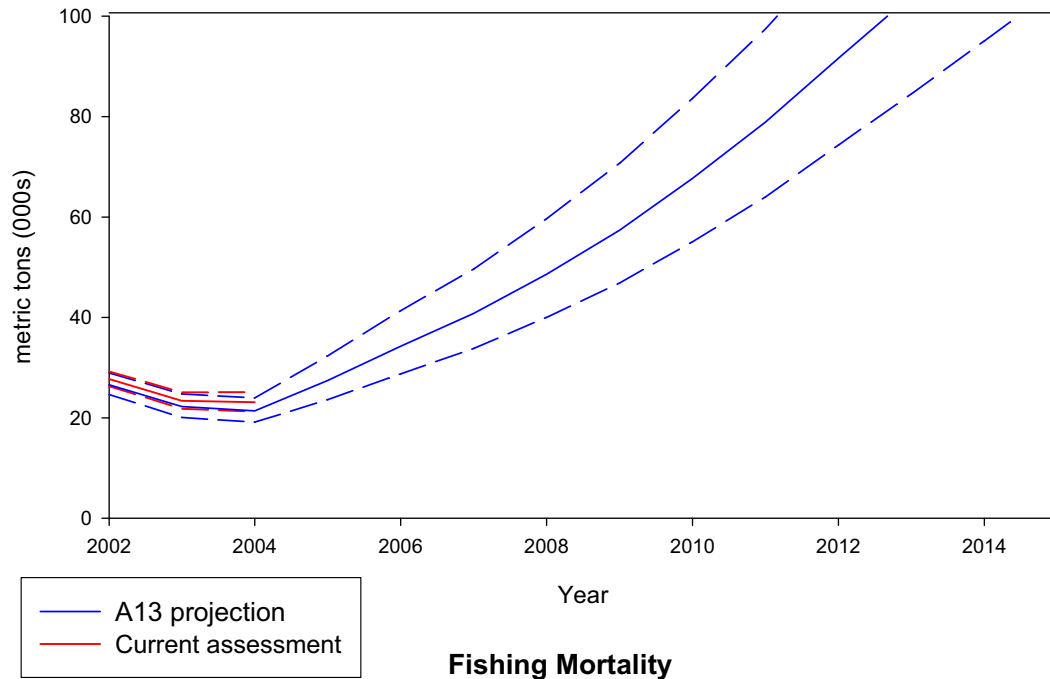


Figure A9. Retrospective analysis of Georges Bank cod recruits at age 1(A), spawning stock biomass (B), and fishing mortality (C) (average F, aged 4-8, unweighted), based on the final ADAPT VPA formulation, 2004-1995.

GB Cod Spawning Stock Biomass



Fishing Mortality

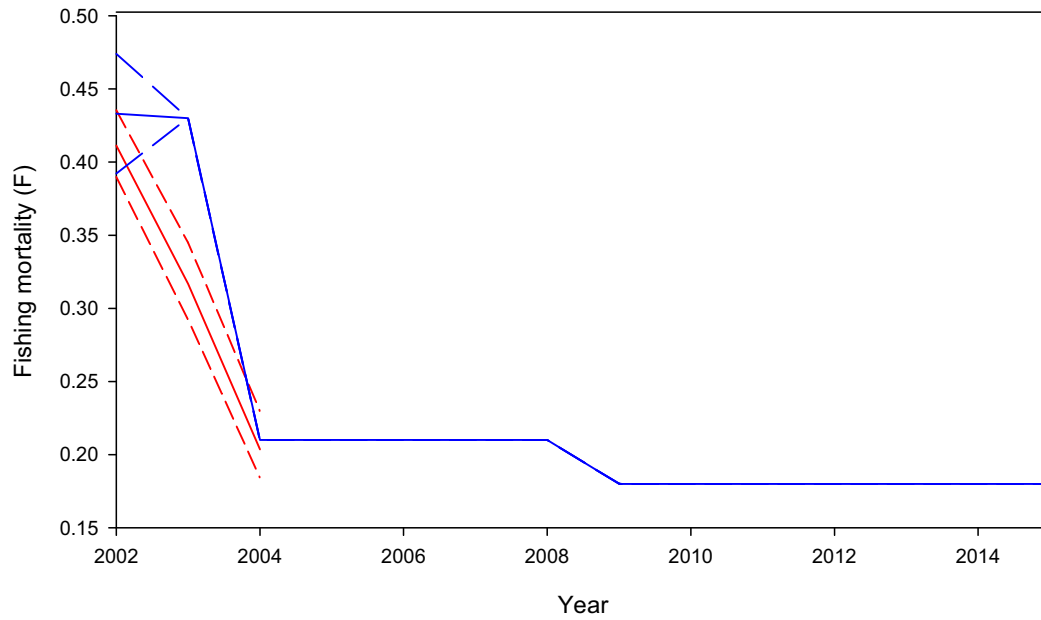


Figure A10. Comparison of A13 projections and current assessment bootstrap estimates of spawning stock biomass (SSB) and fishing mortality (F), 2002-2004.