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Assessment of the Georges Bank Atlantic Cod Stock for 1997

by

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ABSTRACT

This report presents an updated and revised analytical assessment of the status of the Georges Bank cod (*Gadus morhua*) stock (NAFO Division 5Z and Statistical Area 6) for the period 1978-1996 based on analysis of USA and Canadian commercial landings and effort data and research vessel survey data through 1996. Estimates of 1996 fishing mortality and spawning stock biomass, and 1997 stock size and the precision of the fishing mortality and spawning stock biomass estimates are presented. A retrospective analysis of the VPA for Georges Bank cod is also presented. Short-term forecasts of landings in 1997 and 1998 and the resulting 1998 and 1999 spawning stock biomass are given based on assumed status quo 1997 fishing mortalities.

Total commercial landings of Georges Bank cod in 1996 were estimated at 8,900 mt, slightly higher than the 7,800 mt landed in 1995. The USA fleet landed 79% of the total landings, a 4% increase from 1995. Landings for 1995 and 1996 are the lowest in the time series (1893-1996), and represent a decrease of about 80% from the mid-1980's. Commercial landings per standardized unit effort declined steadily from 1982 to 1987, gradually increased until 1990, and then declined steadily to the lowest estimated values in 1994-1996. Fishery independent bottom trawl surveys, conducted by the Northeast Fisheries Science Center, show a similar decline in both biomass and numbers of cod since 1982. The 1995 and 1996 indices remain near record-low values. Recent recruitment indices of age 1 cod are among the lowest in the time series.

Spawning stock biomass generally declined from about 90,000 mt in the early 1980's to a record low of 31,000 mt in 1994 and increased to 41,000 mt in 1996. Fishing mortality doubled between 1979 and 1985, increased to a record high of 1.07 (61% exploitation rate) in 1994 and then reached a 1978-1996 record-low of 0.18 (15% exploitation rate) in 1996. At the current level of exploitation, landings are expected to remain low in 1997 at about 7,800 mt and spawning stock biomass is projected to increase to about 50,000 mt in 1998. This increase in spawning stock biomass, however, is dependent upon the growth of current year classes, since the recruiting 1994, 1995, and 1996 year classes are the lowest on record.

INTRODUCTION

Atlantic cod (*Gadus morhua*) are distributed in the Northwest Atlantic from West Greenland south, nearly to Cape Hatteras, North Carolina (Bigelow and Schroeder 1953). Within the New England area, four distinct stocks are recognized (Wise 1963): Georges Bank, Gulf of Maine, Southern New England and the South Channel, and the New Jersey coastal cod. Atlantic cod commonly attain lengths up to 130 cm and weights up to 25-35 kg. Maximum ages are in excess of 20 years, although fish ages 2-5 are most commonly caught by the commercial fishery. Sexual maturity is attained between the ages of 2 and 4 (O'Brien 1990). The spawning season for Atlantic cod, an iteroparous spawner, is from November to May with peak spawning on Georges Bank occurring during February and March (Smith 1983).

Atlantic cod in the Georges Bank area have been commercially exploited since the 17th century. Reliable landings statistics are available since 1893. Historically, the Georges Bank fishery (NAFO Div. 5Z and Subarea 6) can be separated into five periods (Serchuk and Wigley 1992: Figure 1) (1) 1893-1914, when high landings (> 40,000 tons) in 1895 and 1906-07 were followed by about 10 years of sharply-reduced landings; (2) 1915-1940, when annual landings fluctuated between 20,000 - 30,000 tons, and when cod was generally taken as a by-catch in the Georges Bank haddock fishery; (3) 1940-1960, when landings declined, reaching a record-low of 8,100 tons in 1953. Declines in this period reflect a reduction in fishing activity during World War II and redirection of remaining fleet effort towards the more abundant haddock resource; (4) 1960-1976, when Canadian and distant-water fleet fisheries for Georges Bank cod developed. Large increases in fishing effort for cod during this period resulted in a five-fold increase in annual landings between 1960 and 1966 (11,000 to 53,000 tons) but landings sharply declined afterward reaching only 20,000 tons in 1976; (5) 1977 onward, after the implementation of extended fisheries jurisdiction by both the USA and Canada. Total landings of Georges Bank cod doubled between 1977 and 1982 (27,000 to 57,000 tons), declined to 26,000 tons in 1986, but increased to 42,500 tons in 1990 (Table 1). Commercial landings declined to 15,200 tons in 1994, and declined further in 1995 (7,800 tons) and 1996 (8,900 tons) after a year round closure to areas on the USA side of the Georges Bank boundary with Canada was implemented in December 1994 and Canadian TACs were reduced. Since October 1984, when the International Court of Justice delimited a maritime boundary between the USA and Canada in the Gulf of Maine/Georges Bank region, fishing activity by each country has been restricted to its own waters on Georges Bank.

This report presents an updated and revised analytical assessment of the Georges Bank cod stock (NAFO Division 5Z and Statistical Area 6) for the period 1978-1996 based on analysis of commercial landings and effort data and research vessel survey data through 1996. An analytical assessment of this stock was first conducted by the USA in 1986 by Serchuk and Wigley (1986) and most recently in 1994 by Serchuk *et al.* (1994). Analytical assessments of the component of the Georges Bank cod stock in Canadian waters (Unit Areas 5Zj and 5Zm) were first conducted in 1990 (Hunt 1990) by CAFSAC (Canadian Atlantic Fisheries Scientific Advisory Committee) and are currently conducted under the the Canadian Regional Assessment

Process (RAP; Hunt and Buzeta 1996, 1997).

THE FISHERY

Commercial Landings

The methodology for collecting and processing the commercial fishery and landings data has been revised since the last assessment. Prior to 1994, information of the catch quantity, by market category, was derived from reports of landings transactions submitted voluntarily by processors and dealers. More detailed data on fishing effort and location of fishing activity were obtained for a subset of trips from personal interviews of fishing captains conducted by port agents in the major ports of the Northeast. Information acquired from the interview was used to augment the total catch information obtained from the dealer.

In 1994, a mandatory reporting system was initiated requiring anyone fishing for or purchasing regulated groundfish in the Northeast to submit either vessel trip reports (logbooks) or dealer reports, respectively (Power *et al.* 1997 WP). Information on fishing effort (number of hauls, average haul time) and catch location were now obtained from logbooks submitted to NMFS by vessel captains instead of personal interviews. Estimates of total catch by species and market category were derived from mandatory dealer reports submitted on a trip basis to NMFS. Catches by market category were allocated to stock based on a matched subset of trips between the dealer and logbook databases. Both databases were stratified by calendar quarter, port group and gear group to form a pool of observations from which proportion of catch, by stock, could be allocated to market category with the matched subset. The cross products of the market category by stock proportions derived from the matched subset were employed to compute the total catch by stock, market category, calendar quarter, port group, and gear group in the full dealer database. The USA landings for Atlantic cod for 1994-1996 were derived for Eastern Georges Bank (statistical area 560, 561, 562, 551, 552) and Western Georges Bank (statistical area 520-526,530,537-539,600-639) using the proration methodology described above (Wigley *et al.* 1997 WP, DeLong *et al.* 1997 WP).

Total commercial landings of Georges Bank cod in 1996 were estimated to be 8,900 mt, 13% higher than in 1995 (Table 1, Figure 1). USA landings were 79% (7,000 mt) of the total. The Canadian fleet landed the remaining 21% (1,900 mt). The 1996 USA landings were 4% higher than the 1995 landings, and the 1996 Canadian landings were 71% higher than in 1995.

Otter trawl landings accounted for a little more than half (53%) of the total 1996 landings. Although USA otter trawl landings declined in 1996, they still continued to account for the majority (58%) of the landings (Table 2). In the Canadian fishery the otter trawl and longline fisheries accounted for 35% and 52%, respectively, of the cod landings (Hunt and Buzeta 1997). During 1978-1994 otter trawl gear accounted for 84% of the USA landings and 58% of the

Canadian landings. The USA cod landings from Georges Bank continue to be dominated by 'market' size category cod in both weight (57%) and number (54%) in 1996 (Table 3). Historically, 'market' cod have accounted for 40-60% of the landings. The percentage of 'scrod' cod landed, by number, declined by about half from 1995 to 1996.

Commercial Discards

Preliminary estimates of discards from otter trawl and gill net trips were derived for 1989-1996 using the Sea Sampling Data Base. Discard ratios were estimated as the amount (lbs) of cod discarded to the amount kept. Discard ratios are presented in Table 4 for each quarter for catch taken in the western part (statistical areas 521, 522, 525, 526) and the eastern part (statistical areas 561, 562) of Georges Bank. In the large mesh otter trawl fishery, ratios ranged from 0 to 0.10, with less discarding occurring in the eastern part. In the gill net fishery, discard ratios ranged from 0 to 0.19, but were predominantly less than .10. The highest discard ratio was during the first quarter, but this was also associated with a smaller number of sampled tows. Discard estimates were not included in the assessment, however, due primarily to the lack of data for 1978-1988. Further analysis of the sea sampling data will be undertaken to determine how well the samples represent the fishery, and to examine discarding by other gears.

Recreational Catches

Methods for estimation of recreational catch surveyed in the Marine Recreational Fishery Statistics Surveys (MRFSS) have recently been revised for 1981-1995 (Gray *et al.* 1994). Catch estimates for Georges Bank cod (Table 5) are now slightly lower than reported in the previous assessment (Serchuk *et al.* 1994). An evaluation of the national saltwater angling surveys and the MRFSS and a description of historic trends in recreational cod catches are provided by Serchuk *et al.* (1993). The total cod caught during 1979-1996 by recreational fisherman ranged from 500 mt to 9,000 mt, accounting for 1-19% of the total landings. Recreational landings in 1996 were 800 mt, representing 6.3% of the total cod landings.

Recreational catches have not been included in the final assessment analysis since a number of problems still remain in estimating the quantity and size/age composition of the recreational catch, by stock (Recreational Fisheries Statistics Working Group 1992). Among these are: (1) lack of recreational catch estimates in January and February when some party boats in Massachusetts, Rhode Island, and New York land Georges Bank cod; (2) inability to properly categorize catches of long-range trips (e.g., to Georges Bank) that are being made in increasing numbers by party boats, from Maine to New York; (3) catch estimates for the Georges Bank stock that are imprecise [i.e., relatively large CVs], and (4) length frequency sampling intensity, particularly for the Georges Bank stock, that is low and probably insufficient to accurately characterize the size composition of the catch. Moreover, length frequency sampling is opportunistic and thus samples are not distributed in proportion to the catch, by time, fishing mode, or state of landing.

Sampling Intensity

Commercial Landings

The numbers of samples taken for the length and age composition of the USA and Canadian commercial cod fishery for the Georges Bank region are summarized in Table 6. The average number of fish in each length sample is about 80 for the USA and about 250 for Canada . The USA length frequency sampling averaged 1 sample per 471 mt from 1978-1981 and improved to 1 sample per 281 mt from 1982-1992. Sampling intensity during 1993-1996 was high with an average of 1 sample per 160 mt. During 1978-1985, Canadian sampling intensity averaged 1 sample per 615 mt and improved to 1 sample per 310 mt during 1986-1992. Sampling intensity improved markedly during 1993-1996 to 1 sample per 52 mt. The high sampling intensity for both the USA and Canadian fishery is attributed to the decrease in landings rather than an increase in numbers of samples taken.

The USA sampling intensity in 1995 and 1996 (1 sample per 167 tons and 1 sample per 127 tons, respectively) was the most intense since 1978, however, the number of samples for each market category, per quarter, was the poorest since 1981, particularly for the large market category (Table 7). The distribution of sampling by market category (scrod: 42%, market: 51%, large: 7%) approximated the distribution of the 1996 landings in number, by market category.

Recreational Catch

Biological sampling of recreational landings include only length measurements. Since 1981 the number of fish measured represent less than 0.1% of the total number of fish landed (Table 8). During 1981-1996, the number of fish measured ranged from 0.01% to 0.06% of the total number landed. In 1996, 0.04% of the fish landed were sampled.

Commercial Catch at Age

The age composition of the 1978-1993 USA landings was estimated, by market category, from monthly length frequency and age samples, and pooled by calendar quarter. Landed mean weights were estimated by applying the cod length-weight equation:

$$\ln \text{Weight}_{(\text{kg,live})} = -11.7231 + 3.0521 \ln \text{Length}_{(\text{cm})},$$

to the quarterly length frequency samples, by market category. Numbers landed, by quarter, were estimated by dividing the mean weight values into the quarterly landings, by market category, and prorating the total numbers by the corresponding market category sample length frequency. Quarterly age-length keys were then applied to the numbers at length, to estimate numbers at age. Annual estimates of catch-at-age were obtained by summing values over market category and quarter (Table 9). Derivation of catch by quarter, rather than by month, was performed since not

all months had at least two length frequency samples per market category (i.e., minimum desired for monthly catch estimates).

The age composition of the 1994-1996 USA landings was also estimated, by market category, from monthly length frequency and age samples, but were pooled semi-annually, due to insufficient samples for some quarters. The consistency in the estimation of the catch at age from 1978-1993 was maintained by dis-aggregating the 1994-1996 landings into an eastern component (SA 561-562) and western component (SA 521, 522, 525, 526). The age composition of the USA landings from the Eastern component was estimated by applying USA length frequency and combined USA and Canadian age samples, while the age composition of the USA landings from the Western component was estimated by applying USA length frequency and age samples only. In 1995 and 1996, the age composition of the large market category was determined on an annual basis due to insufficient samples. The catch-at-age was then derived as described above for the 1978-1993 landings. The Eastern and Western components were then pooled to obtain the age composition for USA Georges Bank cod landings for 1993-1996. The USA Eastern component was used in the Canadian assessment of cod in area 5Zj,m (Hunt and Buzeta 1997).

Canadian landings-at-age data (Table 10) from the Eastern component (5Zj,m) for 1978-1993 were taken from Hunt and Buzeta (1994) and data for 1994-1996 were provided by Hunt (pers. comm.). Canadian and USA data were combined to produce a total landings-at-age matrix for 1978-1996 (Table 11). The proportions of the total landings accounted for by the USA and Canada are also indicated in Table 11.

Total commercial landings in 1996 were dominated by the 1992 and 1993 year classes (Table 12). These two cohorts, combined, accounted for 78% of the landings by number and 72% by weight. The 1992 year class dominated both the USA landings (44% by number; 47% by weight) and the Canadian landings (48% by number; 47% by weight) in 1996. The 1993 cohort accounted for the second highest landings in number and weight in both the USA fishery (34% and 26%, respectively) and the Canadian fishery (29% and 20% , respectively).

Commercial Mean Weights at Age

Mean weights at age for ages 1-10+ are summarized for USA, Canadian, and total landings in Tables 9-11. There do not appear to be consistent trends in the mean weight by age during the 19 year time series. In the USA landings, age three fish in 1994 and 1995 had the lowest mean weight at age on record, but in 1996 were about average. The mean weight of age 7 fish was at a record high in 1995 and 1996. The same patterns were not seen in the Canadian landings, however, the age 8 fish in 1996 and the age 9 fish in 1994 had the lowest mean weight on record. These anomalous weights in the older fish in recent years may be due to poorer sampling in recent years and the decreasing abundance of these ages in the population. Beginning year stock mean weights at age, derived from catch mean weights at age (Rivard 1980), are presented in Table 13.

Recreational Catch at Age

A landings-at-age matrix for 1981-1996 was derived for recreational data using methodology similar to that used for the commercial catch. Preliminary investigation of the pooled 1981-1996 data indicated that length frequencies were similar between modes (i.e party boat, charter boat, etc.) and that on a semi-annual basis, more larger fish were caught in the latter half of the year. However, since sampling data was insufficient by mode and wave (two month intervals), the data were pooled on an annual basis.

The age composition of the 1981-1996 recreational landings was estimated from annual recreational length frequency data and commercial age-length data augmented by research survey age-length data for fish < 40 cm. The total number of fish landed was prorated by the annual length frequency to estimate number of fish landed at length, then the augmented age-length keys were applied to estimate numbers at age (Table 14). Mean weights were estimated by applying the cod length-weight equation, described above, to the estimated number at length (Table 14). The data are not stratified by market category.

Throughout the 1981-1996 time series, recreational landings at age have been dominated by ages 2 and 3 which is similar to the USA commercial landings at age where ages 2, 3, and 4 are dominant. The strong 1980, 1983, and 1985 year classes are represented in the catch at age up to ages 4 and 5. The 1988 year class, however, is only well represented at ages 2 and 3, similar to the weaker 1992 year class.

Recreational Mean Weights at Age

The mean weights at age for the recreational landings for ages 1-10+ are summarized in Table 14 for 1981-1996. There are no significant trends over the 16 year time series and the mean weights at age have a range of values similar to the USA commercial mean weights at age. In 1994 and 1995, age 3 fish had a record low mean weight, which was also noted in the USA commercial mean weight at age 3. The variability in the mean weight of older fish, with an anomalous low mean weight for age 9 in 1996, is most likely due to the poor sampling of the older age fish.

STOCK ABUNDANCE AND BIOMASS INDICES

Commercial Catch Rates

USA commercial landings per unit effort (LPUE) were derived for all interviewed otter trawl trips landing cod from Georges Bank and South. Indices were estimated for all ton class 2-4 vessels from 1964-1996 that landed any amount of cod. Standardized fishing effort and LPUE were also

estimated based on a five factor general linear main effects model that included year, area, tonnage class, quarter, and depth (Table 15) using methodology similar to Mayo *et al.* (1994). Standards chosen for the analysis were year 1978, area 521, quarter 2, depth 3, and tonnage class 33. Model coefficients were re-transformed to the linear scale after correcting for bias (Granger and Newbold 1977). Standardized effort was calculated by multiplying nominal effort by the re-transformed coefficients for area, quarter, tonnage class, and depth. Total standardized (raised) effort was then derived by dividing total USA landings by the standardized LPUE (Table 16).

Nominal LPUE and standardized LPUE exhibit similar trends, and since 1985 are approximately equivalent (Table 16, Figure 2). Standardized LPUE peaked in 1980 at 2.9 mt/day fished and declined steadily from 1982 to 1987. LPUE remained relatively stable from 1988-1990, and then declined to a record low by 1995. LPUE is estimated to be about 0.4 mt/ day fished in 1996. Standardized or raised effort and nominal effort have similar trends in general, although effort trends did diverge in both 1991 and 1994 (Figure 3). Raised effort more than doubled from 1978 to 1985, declined in 1986 and then increased to historic high levels until 1993. Average standardized effort declined during 1994-1996 by about 23% from 1993.

Under the current management restrictions of days at sea (DAS), greater mesh sizes, and closed areas, imposed in December of 1994, and the use of mandatory logbooks to collect effort data , implemented in May 1994, and other management measures, the 1994-1996 effort data may no longer be equivalent to the historic 1978-1993 effort series. Additionally, the effort estimates for 1994-1996 were derived from unaudited data. The LPUE series was, therefore, not used as an index of abundance in the subsequent calibration of the VPA. Analyzes to explore the effect of the closed areas on estimation of LPUE were undertaken and are presented in Appendix 1. Hunt and Buzeta (1997) reported a 50% decline in total effort in all Canadian fleet sectors in 1995, and consider the current catch rates to be biased due to the reduced total allowable catch (TAC) and bycatch limitations imposed since 1995.

Research Vessel Survey Indices

USA Surveys

NEFSC spring and autumn research bottom trawl surveys have been conducted off the Northeast coast of the USA since 1968, and 1963, respectively (Azarovitz 1981). Indices of abundance (stratified mean number per tow) and biomass (stratified mean weight (kg) per tow) were estimated from both the spring and autumn bottom trawl surveys for Georges Bank cod during 1963-1996 (Table 17). The indices were adjusted for differences in fishing power of the *Albatross IV* and the *Delaware II,* and for differences between catchability of BMV and polyvalent doors, introduced in 1985. The fishing power coefficients of 0.79 and 0.67 and the door conversion coefficients of 1.56 and 1.62 were applied to abundance and biomass indices, respectively (NEFSC 1991). Unstandardized and standardized catch per tow at age, in number, for NEFSC spring and autumn surveys are presented in Appendix 2: Tables 1-2.

NEFSC spring and autumn catch per tow indices for both biomass and abundance show similar trends, throughout the time series (Table 17, Figures 4-5). Survey biomass indices were stable between 1963-1971, then increased to a record high in 1973. Georges Bank cod biomass then generally declined over the next two decades, reaching record low biomass levels between 1991-1994, increasing in 1995, but again declining in 1996. Survey abundance indices for ages 1 and 2 indicate above average recruitment for the 1966, 1971, 1975, 1977, 1979, 1980, 1983, 1985, 1988, and 1993 year classes (Figure 6). The indices for an above average year class, however, have been declining over time, particularly noticeable in the age 1 index (Figure 6).

Canadian Surveys

Canadian research bottom trawl surveys have been conducted on Georges Bank during the spring since 1986. Indices of abundance for Canadian surveys are summarized as stratified mean number per tow from 1986-1997 (Appendix 2: Table 3). In 1993 and 1994, the Canadian research survey did not sample the western part of Georges Bank (Canadian strata 5Z5 - 5Z7), therefore these data were not used in the calibration of the VPA. Survey abundance indices indicated a steady decline in total numbers of cod from 1990 to 1995, then an increase in 1996, dominated by the 1994 year class at age 4, followed by a decline in 1997.

MORTALITY

Natural Mortality

Instantaneous natural mortality (M) of Georges Bank cod is assumed to be 0.2, the conventional value of M used for all Northwest Atlantic cod stocks (Paloheimo and Koehler 1968; Pinhorn 1975; Minet 1978).

Total Mortality

Pooled estimates of instantaneous total mortality (Z) were estimated for eight time periods from both spring and autumn catch per tow indices (Table 18). Estimates were derived as the ln ratio of 3+/4+ indices in the autumn and 4+/5+ indices in the spring (Appendix 2: Table 2). Different age groups were used so that Z values for identical year classes could be derived over the same time periods. Estimates in the spring are less than in the autumn in all time periods except 1973-1976.

Total mortality decreased from a high of 0.73 during 1964-1967 to a record low of 0.34 during 1968-1972, then increased and remained stable between 0.56-68 during 1973-1984. Total mortality then reached a record high of 1.10 during 1985-1987, declined to 0.6 during 1988-1990, and then increased to 1.04 during 1991-1995.

ESTIMATES OF STOCK SIZE AND FISHING MORTALITY

Virtual Population Analysis Calibration

The ADAPT calibration method (Parrack 1986, Gavaris 1988, Conser and Powers 1990) was used to derive estimates of fishing mortality in 1996 and beginning year stock sizes in 1997. The catch-at-age used in the VPA consisted of combined USA and Canadian commercial landings from 1978-1996 for ages 1-9 with a 10+ age group. The indices of abundance used to calibrate the VPA included both the NEFSC 1978-1996 spring research survey abundance indices for ages 1-8 and the Canadian 1986-1997 spring research survey abundance indices for ages 1-8, and the NEFSC 1977-1996 autumn research survey catch at ages 0-6. The autumn survey indices were lagged forward one age and one year to match cohorts in the subsequent year.

The final ADAPT formulation provided stock size estimates for ages 1-8 in 1997 and corresponding F estimates for ages 1-7 in 1996. Assuming full recruitment at age 4, the F on ages 8 and 9 in the terminal year was estimated as the average of the F on ages 4 through 8. The F on age 9 in all years prior to the terminal year was derived from weighted estimates of Z for ages 4 through 9. For all years, the F on age 9 was applied to the 10+ age group. Spawning stock estimates were derived by applying pooled maturity ogives for 1978-1981,1982-1985,1986-1996 (Table 19) derived from O'Brien (1990).

The final ADAPT calibration results are presented in Appendix 3 for estimates of F, stock size, and SSB at age. Estimates of stock size were more precise for ages 2-8 with CVs ranging from 0.27 (ages 3,4) to 0.33 (ages 2,8) than for age 1 (CV=0.52). The residual patterns for the tuning indices did not show any strong trends for the three surveys, although USA spring age 3 and Canadian spring age 4 did exhibit a possible trend over time (Figure 7). The natural log of the observed survey indices, standardized to the mean, are presented in Figure 8.

Fishing mortality (ages 4-8, unweighted) in 1996 was estimated at 0.18, a decline of 51% from 1995 (Table 19, Figure 9). The 1996 estimate of SSB was 41,200 mt, a 20% increase from the 1995 estimate (34,000 mt) which was the second lowest in the time series (Table 19, Figure 10).

Since 1978 recruitment has ranged from 4 million (1994 year class) to 43 million (1985 year class). With the exception of the slightly above average 1990 year class, recruitment since 1989 has been at record low values. The 1994, 1995, and 1996 year classes are the poorest of the 20 year time series (Table 19, Figure 10).

In addition to the final ADAPT calibration, two other ADAPT formulations were performed: (1) to evaluate the effect of adding recreational landings (1981-1996) to the total catch at age matrix, and (2) to evaluate the effect of the including the commercial indices of abundance, LPUE (1978-1996), as a calibration index.

A base ADAPT run was made with the same formulation as the final ADAPT described above, except that 1978-1980 were eliminated from the catch at age and then a second calibration was performed that included the recreational catch at age, 1981-1996. Differences between the two calibrations (Run 28 vs. Run 24) were minimal (Table 20, Figure 11). Stock sizes were slightly higher with the addition of the recreational landings (Figure 11) and the CV's were similar for each age compared to the base run. Fishing mortality and spawning stock biomass estimates were essentially the same between the two calibrations (Figure 11). Estimates of stock size, fishing mortality, and SSB for the ADAPT run 24 with the commercial plus recreational catch at age is presented in Table 21.

The effect of including the LPUE series as a calibration index was to estimate lower stock sizes in 1997, and increase the fishing mortality in 1996 (Table 20: Run 34) when compared to the final ADAPT formulation (Table 20: Run 29). Stock sizes are estimated more precisely, with lower CVs, in the ADAPT formulation with the LPUE series. Uncertainty associated with the 1994-1996 LPUE indices, however, precludes the acceptance of this ADAPT formulation.

Precision Estimates of F and SSB

A conditional non-parametric bootstrap procedure (Efron 1982) was used to evaluate the uncertainty associated with the estimates of fishing mortality and spawning stock biomass from the final VPA. One thousand bootstrap iterations were performed to estimate standard errors, coefficients of variation (CVs) and bias for age 1-8 stock size estimates at the start of 1997, the catchability (q) for each index of abundance used in calibrating the VPA, and the age 1-7 F's in 1996 (Appendix 4).

The bootstrap results indicate that stock sizes were well estimated for age 2-8 with coefficients of variation (CVs) varying between 0.28-0.36. Age 1 stock size was not well estimated (CV=0.77). The CVs for the catchability coefficients for all indices ranged between 0.15-0.23. The fully recruited F for ages 4+ was reasonably well estimated (CV=0.15) with a point estimate of 0.184, slightly higher than the VPA estimate of 0.178 (Appendix 4). The distribution of the 1996 F estimates, derived from bootstrapping, ranged from 0.12 to 0.30 (Figure 12). The cumulative probability curve shows that there is an 80% probability that the F in 1996 is between 0.16 and 0.23 (Figure 12).

The bootstrap mean for the spawning stock biomass (42,420 mt) was reasonably well estimated with a CV of 0.11, and is slightly higher than the VPA estimate (41,140 mt). The distribution of the 1996 spawning stock biomass estimates, derived from bootstrapping, ranged from 30,000 mt to 66,000 mt (Figure 13). The cumulative probability curve shows that there is an 80% probability that the 1996 SSB is between 37,000 mt and 47,000 mt (Figure 13).

Retrospective Analysis

A retrospective analysis was performed to evaluate how well the current ADAPT calibration would have estimated spawning stock biomass, fishing mortality, and recruits at age 1 for the six years prior to the current assessment, 1990-1995. Convergence of the estimates generally occurs after about three years (Figures 14-16). With the exception of 1996, the retrospective analysis indicates a pattern of closely estimating or underestimating the recruits at age 1 (Figure 14) . Estimates of spawning stock biomass (SSB) show no trend over time. The 1995 and 1994 SSB is slightly over-estimated and under-estimated, respectively, and the 1993 SSB is underestimated to a greater extent. SSB estimates for 1992-1990 are very close to the 1996 estimates (Figure 15).

Estimates of fishing mortality (F) do not show a consistent trend over the six-year period (Figure 16). Fishing mortality in 1995, 1994, and 1990 were underestimated, and the F was overestimated in 1993, 1992, and 1991. The very high overestimation of F in 1993 and the underestimation of F in 1994 may be influenced by the lack of 1993-1994 Canadian survey indices in the calibration. The actual ADAPT formulation employed for the 1994 assessment had Canadian survey (5Z j,m) indices derived for the eastern portion of the survey only (Serchuk *et al.* 1994) which contrasts with the indices used in the current formulation that were derived using all the Georges Bank strata. The fishing mortality in the previous assessment was estimated to be 0.91 for 1994 (Serchuk *et al.* 1994).

BIOLOGICAL REFERENCE POINTS

Yield and Spawning Stock Biomass per Recruit

Yield, total stock biomass, and spawning stock biomass per recruit were estimated using methodology of Thompson and Bell (1934). The estimates were derived based on arithmetic means of the 1994-1996 catch mean weight at age and stock mean weight at age (Tables 11 and 13) and the 1986-1996 maturity ogive. A partial recruitment (PR) vector was calculated as the geometric mean of the 1994-1996 F estimates from the final VPA (Table 19). The final exploitation pattern was derived by dividing the PR by the geometric mean of the unweighted F for ages 4-8 and smoothed by applying full exploitation at ages 4 and older. The exploitation pattern of:

Age 1: 0.0003, Age 2: 0.1318, Age 3: 0.5316, Ages 4+: 1.000

reflects a decrease in the exploitation at age compared to the previous assessment (Serchuk *et al.* 1994). Input values for the yield-per-recruit analysis are provided in Table 22, and results of the analysis are provided in Table 22 and Figure 17. The resulting biological reference points were $F_{0.1}$=.17 and $F_{20\%}$=.43. Spawning stock biomass (ages 3+) and recruitment (age 1) data for 1978-1996 are presented in Figure 18. The most recent recruits (1992-1995) are in the lower left quadrant of the plot.

PROJECTIONS

Short-term, three year deterministic projections were performed to estimate landings and SSB in 1997, 1998, and 1999 under the F scenarios of $F_{96} = 0.18$, $F_{0.1} = 0.17$, and $F_{20\%}=0.43$. Data input were the same as described in the yield per recruit analysis (Table 23). In addition, recruitment in 1997 was set at 4.6 million fish as estimated by the ADAPT formulation and the recruitment for 1998 and 1999 was derived as the geometric mean of the 1990-1996 year classes at age one (Table 19).

Under a status quo F of 0.18 and 4.6 million recruits, landings are projected to be 7,800 mt in 1997, increase 6% to 8,400 mt in 1998, and increase again to 8,900 mt in 1999 (Table 23, Figure 19). SSB also increases in each of the three years to 55,000 mt by 1999, a 35% increase from 1996. Fishing at $F_{20\%}= 0.43$, landings will increase to 18,000 mt in 1998, then decline in 1998 to 15,600 mt. SSB at $F_{20\%}$ will initially increase 16% from 1996 (41,000 mt) to 1998 (49,000 mt), but then will decline in 1999 (44,600 mt). Projections for $F_{0.1} = 0.17$ give similar results as status quo F = 0.18 (Table 23).

CONCLUSIONS

The Georges Bank cod stock is at a low biomass level and is fully exploited relative to rebuilding F levels. Biomass indices derived from research surveys indicate that the stock remains near the 30-year record-low value. Fishing mortality declined from record-high levels in 1993 and 1994 (1.05, 1.07) to a record-low in 1996 (F=0.18) that is nearly equal to $F_{0.1}=0.17$. Spawning stock biomass declined from about 90,000 mt in the early 1980's, reached a record-low (31,300 mt) in 1994, and remains near record-low size (41,100 mt) in 1996. Recruiting year classes continue to decline in size with the most recent year classes (1994, 1995, 1996) being the lowest on record.

Accounting for the estimation uncertainty associated with the 1996 SSB (41,100 mt) and F (0.18) estimates, there is an 80% probability that the 1996 SSB is between 37,000 mt and 47,000 mt and there is an 80% probability that the F in 1996 is between 0.16 and 0.23.

At the present level of exploitation (15%), and constant recruitment of 4.6 million, the SSB is expected to increase each year through 1999. If recruitment is poorer, increases in SSB may not be realized. Maintaining this level of exploitation, given average recruitment, presents an opportunity for re-building the Georges Bank cod stock.

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Table 1. Commercial landings (metric tons, live) of Atlantic cod from Georges Bank and South (Division 5Z and Subarea 6), 1960 - 1996.

	Country						
Year	USA	Canada	USSR	Spain	Poland	Other	Total
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	8411	-	-	-	-	25901
1987	19035	11845	-	-	-	-	30880
1988	26310	12932	-	-	-	-	39242
1989	25097	8001	-	-	-	-	33098
1990	28193	14310	-	-	-	-	42503
1991	24175	13455	-	-	-	-	37630
1992	16855	11712	-	-	-	-	28567
1993	14594	8519	-	-	-	-	23113
1994	9893	5276					15169
1995	6759	1100					7859
1996	7020	1885					8905

Table 2. Distribution of USA commercial landings (metric tons, live) of Atlantic cod from Georges Bank (Area 5Ze), by gear type, 1965 - 1996. The percentage of total USA commercial landings of Atlantic cod from Georges Bank, by gear type, is also presented for each year. Data only reflect Georges Bank cod landings that could be identified by gear type.

	Landings (metric tons, live)						Percentage of Annual Landings					
Year	Otter Trawl	Sink Gill Net	Line Trawl	Handline	Other Gear	Total	Otter Trawl	Sink Gill Net	Line Trawl	Handline	Other Gear	Total
1965	10251	0	582	505	9	11347	90.3	-	5.1	4.5	0.1	100.0
1966	10206	0	787	757	19	11769	86.7	-	6.7	6.4	0.2	100.0
1967	10915	0	894	704	9	12522	87.2	-	7.1	5.6	0.1	100.0
1968	12084	0	936	524	<1	13544	89.2	-	6.9	3.9	-	100.0
1969	13194	0	1371	387	<1	14952	88.2	-	9.2	2.6	-	100.0
1970	11270	0	1676	404	<1	13350	84.4	-	12.6	3.0	-	100.0
1971	12436	0	2334	230	2	15002	82.9	-	15.6	1.5	-	100.0
1972	10179	0	2071	217	10	12477	81.6	-	16.6	1.7	0.1	100.0
1973	12431	3	2185	206	21	14846	83.7	-	14.7	1.4	0.2	100.0
1974	14078	3	2548	11	9	16649	84.6	-	15.3	0.1	-	100.0
1975	12069	0	2435	84	4	14592	82.7	-	16.7	0.6	-	100.0
1976	12257	4	1519	153	5	13938	88.0	-	10.9	1.1	-	100.0
1977	18529	30	912	83	22	19576	94.7	0.2	4.7	0.4	0.1	100.0
1978	20862	81	1569	1180	59	23751	87.8	0.3	6.6	5.0	0.3	100.0
1979	26562	620	2707	860	159	30908	85.9	2.0	8.8	2.8	0.5	100.0
1980	32479	4491	1102	0	273	38345	84.7	11.7	2.9	-	0.7	100.0
1981	27694	3515	120	584	197	32110	86.2	10.9	0.4	1.8	0.6	100.0
1982	33371	2935	385	624	210	37525	88.9	7.8	1.0	1.7	0.6	100.0
1983	30981	1812	831	441	81	34146	90.7	5.3	2.4	1.3	0.3	100.0
1984	26161	2573	366	753	197	30050	87.1	8.6	1.2	2.5	0.6	100.0
1985	21444	2482	436	284	163	24809	86.4	10.0	1.8	1.1	0.7	100.0
1986	13576	1679	692	305	95	16347	83.0	10.3	4.2	1.9	0.6	100.0
1987	13711	1522	1636	222	71	17162	79.9	8.9	9.5	1.3	0.4	100.0
1988	20296	1864	1950	232	116	24458	83.0	7.6	8.0	0.9	0.5	100.0
1989	17946	3150	1583	119	91	22889	78.4	13.8	6.9	0.5	0.4	100.0
1990	21707[1]	2316	1252	395	133	25803	84.1	9.0	4.9	1.5	0.5	100.0
1991	17892[2]	2171	1919	286	180	22448	79.7	9.7	8.5	1.3	0.8	100.0
1992	11696[3]	1747	1709	186	114	15452	75.7	11.3	11.1	1.2	0.7	100.0
1993	10893[4]	1321	1316	62	78	13670	79.7	9.7	9.6	0.4	0.6	100.0
1994	7139	1318	1372	-[5]	21	9850	72.5	13.4	13.9	-	0.2	100.0
1995	3780	1300	1660	-[5]	18	6758	55.9	19.2	24.6	-	0.3	100.0
1996	4047	1552	1413	-[5]	6	7018	57.7	22.1	20.1	-	0.1	100.0

[1] Includes 849 tons taken by pair-trawl (Note: 1990 was the first year that pair-trawl landings exceeded a few tons)
[2] Includes 1068 tons taken by pair-trawl
[3] Includes 1149 tons taken by pair-trawl
[4] Includes 1352 tons taken by pair-trawl
[5] Handline included with line trawl

Table 3. Percentage, by weight and number of fish landed, of USA commercial Atlantic cod landings from Georges Bank and South (NAFO Division 5Z and Statistical Area 6), by market category, 1964 - 1996. Percent values, by number, are only available from 1978 onwards.

	Percentage by Weight				Percentage by Number			
Year	Large	Market	Scrod	Total [a]	Large	Market	Scrod	Total [a]
1964	45	47	8	100	-	-	-	-
1965	56	40	3	100	-	-	-	-
1966	53	37	10	100	-	-	-	-
1967	41	42	16	100	-	-	-	-
1968	34	46	19	100	-	-	-	-
1969	27	57	16	100	-	-	-	-
1970	30	62	8	100	-	-	-	-
1971	40	51	9	100	-	-	-	-
1972	37	53	10	100	-	-	-	-
1973	24	40	36	100	-	-	-	-
1974	24	59	17	100	-	-	-	-
1975	28	62	10	100	-	-	-	-
1976	34	48	18	100	-	-	-	-
1977	26	39	34	100	-	-	-	-
1978	29	60	11	100	14	64	22	100
1979	37	55	8	100	20	57	23	100
1980	42	47	11	100	20	53	27	100
1981	37	51	12	100	13	56	31	100
1982	31	47	22	100	10	42	48	100
1983	25	53	22	100	9	48	43	100
1984	32	56	12	100	13	60	27	100
1985	28	47	25	100	10	35	55	100
1986	31	48	21	100	11	46	43	100
1987	25	38	37	100	8	27	65	100
1988	24	48	28	100	9	43	48	100
1989	24	54	22	100	10	49	41	100
1990	23	45	32	100	9	36	55	100
1991	31	50	19	100	14	49	37	100
1992	31	42	27	100	12	37	51	100
1993	28	43	29	100	10	39	51	100
1994	27	52	21	100	11	49	40	100
1995	26	49	25	100	11	40	49	100
1996	23	57	20	100	12	54	24	100

[a] Includes landings of 'mixed' cod.

Table 4. Estimates of the discard ratios(discard weight/kept weight) of Georges Bank Atlantic cod in the otter trawl and gill net fisheries, by quarter, in the western part (Statistical Area 521, 522, 525, 526) and the eastern part (Statistical Area 561, 562) of Georges Bank, 1989-1996. Number of tows are in parentheses.

Otter trawl

Year	West	East	West	East	West	East	West	East
1989	0.029 (127)	0.018 (16)	0.054 (239)	0.027 (100)	0.073 (222)	0.043 (16)	0.057 (151)	0.030 (27)
1990	0.100(175)	0.012 (63)	0.074 (130)	0.008 (20)	0.027 (116)	0.002 (14)	0.020 (172)	0.026 (35)
1991	0.005 (187)	0.016 (81)	0.032 (173)	0.027 (1)	0.020 (167)	-	0.075 (220)	-
1992	0.012 (121)	0.022 (120)	0.009 (108)	0.001 (21)	0.053 (67)	-	0.018 (90)	0.061 (31)
1993	0.022 (46)	0.017 (18)	0.004 (49)	0.021 (222)	0.088 (74)	-	0.030 (123)	0.015 (15)
1994	0.008 (172)	0.003 (114)	0.043 (36)	0.005 (172)	0.000 (13)	0.003 (43)	0.004 (49)	0.000 (10)
1995	0.004 (244)	0.002 (38)	0.032 (217)	0.001 (38)	0.010 (114)	0.000 (8)	0.012 (106)	0.001 (28)
1996	0.012 (113)	0.007 (30)	0.001 (180)	0.000 (126)	-	-	-	-

Gill Net

Year	West	East	West	East	West	East	West	East
1989	-	-	0.001 (3)	-	0.011 (58)	-	0.067 (36)	-
1990	0.017 (8)	-	0.017 (37)	-	0.069 (17)	-	0.142 (21)	-
1991	0.115 (4)	-	0.011 (227)	-	0.033 (509)	-	0.099 (129)	-
1992	0.033 (29)	-	0.046 (340)	0.030 (18)	0.028 (257)	-	0.043 (198)	-
1993	0.059 (84)	-	0.074 (140)	0.064 (5)	0.007 (9)	0.003 (5)	0.056 (197)	-
1994	0.118 (90)	-	-	-	0.043 (24)	-	0.070 (110)	-
1995	0.193 (52)	-	0.028 (67)	-	0.029 (70)	-	0.081 (61)	-
1996	0.017 (32)	-	0.080 (25)	-	0.146 (6)	-	0.034 (24)	-

Table 5. Estimated number (000's) and weight (metric tons, live) of Atlantic cod caught by marine recreational fishermen from the Georges Bank stock in 1960, 1965, 1970, 1974, and 1979 - 1996.[1]

Year	Total Cod Caught		Total Cod Retained (excluding those caught and released)			
	No. of Cod (000's)	Wt. of Cod (mt)	No. of Cod (000's)	Wt. of Cod (mt)	Mean Weight (kg)	Percent of Total Landings
1960	Not Estimated		Not Estimated		-----	-----
1965	Not Estimated		Not Estimated		-----	-----
1970	Not Estimated		Not Estimated		-----	-----
1974	Not Estimated		Not Estimated		-----	-----
1979	393	580	393	580	1.476	1.5
1980	186	471	133	270	2.523	1.0
1981	1749	6265	1695	6074	3.161	12.5
1982	1650	4582	1600	4444	1.022	7.2
1983	1885	5994	1709	5435	2.860	10.0
1984	499	1385	464	1289	2.603	3.2
1985	2144	9075	2054	8693	3.619	18.9
1986	354	1060	291	872	2.311	3.3
1987	472	797	434	734	2.539	2.3
1988	1321	4368	1102	3643	3.096	8.5
1989	567	1979	404	1411	3.517	4.1
1990	586	989	463	782	2.728	1.8
1991	485	1908	333	1308	3.356	3.4
1992	265	556	193	405	2.046	1.4
1993	1106	2856	755	1948	1.864	7.8
1994	437	1458	303	1010	2.140	6.2
1995	742	2080	471	1320	2.272	14.4
1996	235	817	174	603	3.059	6.3

[1] From 1979-1993 Marine Recreational Fishery Statistics Survey expanded catch estimates, 1981 to present estimated from new MRFSS methodology (1 January 1997).

Table 6. USA and Canadian sampling of commercial Atlantic cod landings from the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

	USA				Canada			
	Length Samples		Age Samples		Length Samples		Age Samples	
Year	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

Table 7. USA sampling of commercial Atlantic cod landings, by market category, for the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

	Number of Samples, by Market Category & Quarter															Annual Sampling Intensity			
	Scrod					Market					Large					No. of Tons Landed/Sample			
Year	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

Table 8. Sampling of recreational Atlantic cod landings from the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6), 1981 - 1996, and the number of combined commercial and NEFSC research survey age samples applied to recreational length samples.

	Lengths			Ages
Year	Number Landed (000's)	Number Measured	Percent Measured	Number
1981	1695	341	0.02	1494
1982	1600	111	0.01	3226
1983	1709	337	0.02	3673
1984	464	223	0.05	2778
1985	2054	155	0.01	2628
1986	291	148	0.05	2589
1987	434	259	0.06	2066
1988	1102	183	0.02	2160
1989	404	212	0.05	1750
1990	463	214	0.05	2183
1991	333	142	0.04	2158
1992	193	122	0.06	1871
1993	755	138	0.02	1831
1994	303	176	0.06	1291
1995	471	157	0.03	1018
1996	174	71	0.04	1312

Table 9. 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 cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
				USA Commercial Landings in Numbers (000's) at Age							
1978	-	331	5731	1636	625	53	288	35	28	8	8735
1979	34	1618	572	4107	910	403	59	244	-	45	7992
1980	88	3002	4707	286	1888	951	413	76	153	-	11564
1981	25	3060	3613	1960	101	1026	330	72	109	46	10342
1982	325	7855	2466	1682	1258	117	452	116	50	57	14378
1983	81	3542	5557	1244	854	722	85	218	88	62	12453
1984	81	1281	3305	2961	500	393	386	25	153	82	9167
1985	130	4280	1539	985	1388	273	173	165	12	86	9031
1986	137	1091	3290	432	337	412	58	53	38	26	5874
1987	12	4878	804	1380	188	173	153	41	23	18	7670
1988	-	1345	5662	688	1076	175	100	86	21	18	9171
1989	-	1770	2638	3237	207	362	51	20	13	-	8298
1990	-	4603	3273	1265	1465	134	143	28	3	8	10922
1991	41	1032	2731	2040	873	572	52	23	8	3	7375
1992	-	2387	1268	746	936	217	133	9	12	3	5711
1993	-	781	3178	521	269	228	68	74	15	2	5136
1994	0.1	258	1186	1232	181	62	90	24	22	4	3059
1995	-	354	895	629	237	35	24	14	1	1	2190
1996	0.1	183	744	971	190	88	6	0.4	3	-	2185
				USA Commercial Landings in Weight (Tons) at Age							
1978	-	430	14159	6041	2794	276	2168	274	356	81	26579
1979	30	2462	1411	17662	4525	2943	541	2507	-	564	32645
1980	74	4475	11663	1141	10937	6375	3504	657	1227	-	40053
1981	22	4592	8528	6644	524	7532	2773	716	1628	890	33849
1982	249	10960	7032	6465	6856	755	4281	1200	624	911	39333
1983	80	5303	13647	4271	4015	4628	679	2244	975	914	36756
1984	85	2099	8096	10650	2655	2655	3456	246	1739	1234	32915
1985	118	6094	3320	3930	7219	1746	1397	1707	148	1149	26828
1986	131	1586	7498	1475	1892	2964	528	537	507	372	17490
1987	10	6888	1953	5581	1063	1349	1306	392	242	251	19035
1988	-	2098	12981	2288	5677	1157	848	776	226	259	26310
1989	-	2958	5964	11861	1106	2403	439	209	157	-	25097
1990	-	7094	7411	4346	6902	817	1193	297	35	98	28193
1991	47	1615	6840	6943	4362	3526	406	285	96	55	24175
1992	-	3663	3040	2949	4470	1379	1070	93	137	54	16855
1993	-	1192	7081	1865	1417	1581	560	692	166	40	14594
1994	-	378	2491	4407	868	473	726	234	236	79	9893
1995	-	515	1810	2412	1314	267	253	161	9	20	6759
1996	-	275	1823	3303	915	593	64	3	45	-	7020
				USA Commercial Landings Mean Weight (kg) at Age							
1978	-	1.298	2.470	3.692	4.473	5.199	7.522	7.924	12.794	10.125	3.043
1979	0.889	1.522	2.464	4.301	4.974	7.309	9.127	10.264	-	12.533	4.085
1980	0.839	1.490	2.478	3.992	5.792	6.703	8.489	8.648	8.046	-	3.464
1981	0.885	1.501	2.360	3.389	5.209	7.339	8.397	9.988	14.884	19.348	3.274
1982	0.767	1.395	2.852	3.845	5.449	6.457	9.473	10.297	12.434	15.982	2.736
1983	0.993	1.497	2.456	3.434	4.703	6.407	7.955	10.280	11.091	14.742	2.952
1984	1.053	1.638	2.450	3.597	5.308	6.751	8.960	9.710	11.361	15.049	3.590
1985	0.914	1.424	2.157	3.989	5.201	6.398	8.075	10.355	12.107	13.360	2.971
1986	0.957	1.454	2.279	3.414	5.608	7.198	9.066	10.135	13.339	14.308	2.978
1987	0.801	1.412	2.429	4.043	5.657	7.811	8.520	9.466	10.621	13.944	2.482
1988	-	1.559	2.293	3.326	5.278	6.629	8.487	9.067	10.606	14.389	2.869
1989	-	1.672	2.260	3.664	5.351	6.632	8.686	10.673	11.622	-	3.025
1990	-	1.541	2.264	3.436	4.712	6.103	8.366	10.482	10.246	12.250	2.581
1991	1.131	1.566	2.504	3.403	4.955	6.161	7.829	12.392	11.991	20.861	3.278
1992	-	1.535	2.397	3.951	4.775	6.359	8.035	10.457	11.107	17.418	2.951
1993	-	1.526	2.228	3.580	5.271	6.936	8.185	9.386	10.520	21.211	2.841
1994	0.900	1.463	2.101	3.577	4.804	7.591	8.089	9.786	10.980	19.055	3.234
1995	-	1.453	2.022	3.837	5.535	7.679	10.701	11.761	10.678	14.953	3.088
1996	-	1.503	2.451	3.400	4.825	6.727	10.497	8.346	13.836	-	3.212

Table 9 continued. 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 cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
					USA Commercial Landings Mean Length (cm) at Age						
1978	-	50.2	61.5	69.8	73.7	79.3	89.3	91.3	107.1	101.0	64.9
1979	44.7	52.9	61.0	73.9	77.5	88.2	95.3	99.4	-	106.1	70.9
1980	43.9	52.6	61.6	72.4	81.9	86.3	92.9	92.2	91.2	-	66.5
1981	44.6	52.3	60.4	68.5	78.4	88.7	93.1	98.2	112.8	123.2	64.6
1982	42.3	51.4	64.4	70.8	79.9	84.1	96.5	99.2	105.5	114.9	60.7
1983	46.3	52.7	61.5	68.1	75.9	84.5	90.7	99.1	101.5	111.7	63.3
1984	47.2	54.1	61.5	69.8	79.3	86.5	94.8	97.5	102.5	112.0	67.7
1985	45.1	51.8	58.6	72.4	79.0	84.5	91.4	99.4	104.7	107.9	62.5
1986	45.8	52.0	60.1	67.6	81.1	88.2	95.2	98.7	108.2	109.8	63.2
1987	43.3	51.7	61.3	72.7	81.6	90.9	93.2	96.6	100.1	110.1	59.4
1988	-	53.6	60.3	67.6	79.2	85.5	92.7	94.8	100.1	109.6	63.4
1989	-	54.7	60.1	70.0	79.3	85.3	94.2	100.4	103.6	-	64.8
1990	-	53.4	59.8	68.6	76.1	82.7	92.2	99.7	99.3	106.0	61.1
1991	48.4	53.5	62.1	68.0	77.5	82.8	90.0	106.1	105.7	125.8	66.3
1992	-	53.1	61.0	71.7	75.9	83.5	91.1	99.3	101.8	118.2	63.3
1993	-	53.1	59.8	69.4	78.4	87.0	91.7	96.1	99.8	126.0	63.0
1994	45.0	52.4	58.7	69.5	76.4	89.4	91.3	97.4	101.4	122.1	65.7
1995	-	52.4	57.8	71.0	81.0	89.9	100.9	104.3	100.9	113.0	64.6
1996	46.0	53.0	61.6	68.4	76.7	86.4	99.4	92.1	109.8	-	66.4

Table 10. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
				CAN Commercial Landings in Numbers (000's) at Age							
1978	2	62	2017	667	205	78	57	12	12	7	3119
1979	-	371	328	763	302	55	18	9	4	3	1853
1980	1	775	1121	214	420	125	32	11	14	10	2723
1981	2	145	608	504	134	380	87	51	21	16	1948
1982	6	1283	1358	1105	742	164	221	97	21	26	5023
1983	27	744	2506	1212	201	54	10	17	12	3	4786
1984	-	26	118	375	340	123	72	19	18	39	1130
1985	4	2146	904	383	497	139	45	38	9	11	4176
1986	19	235	1283	365	143	215	29	19	9	3	2320
1987	14	2595	602	741	91	79	117	22	15	6	4282
1988	10	232	2360	324	421	69	61	111	29	29	3646
1989	-	318	284	918	124	179	31	23	37	18	1932
1990	7	339	1769	617	799	95	102	8	14	30	3780
1991	11	493	512	1241	585	516	74	47	15	20	3514
1992	70	1790	902	292	546	187	176	25	21	7	4016
1993	4	252	1068	594	171	244	91	69	17	15	2525
1994	2	140	340	593	213	34	47	22	16	2	1409
1995	0.1	38	162	63	53	10	2	1	1	-	331
1996	0.6	24	159	262	51	35	9	2	1	0.2	545
				CAN Commercial Landings in Weight (Tons) at Age							
1978	1	85	4913	1949	803	483	378	122	113	107	8778
1979	-	509	525	2842	1398	342	169	105	47	42	5978
1980	1	1041	2720	692	2099	809	228	133	177	157	8063
1981	2	197	1426	1772	699	2624	801	497	220	224	8499
1982	4	1853	3156	4217	3849	1074	2019	914	266	418	17824
1983	24	1084	5521	3854	876	335	80	176	147	37	12130
1984	-	38	292	1423	1615	743	622	202	195	620	5763
1985	3	3017	1775	1388	2370	895	368	369	94	160	10443
1986	14	369	3691	1442	800	1543	250	180	89	28	8411
1987	9	4183	1556	3302	557	596	1113	243	189	93	11845
1988	8	300	5942	1265	2406	462	564	1188	334	437	12932
1989	-	417	669	3812	678	1221	231	247	432	276	8011
1990	5	615	5001	2283	4173	631	876	85	187	454	14310
1991	12	866	1425	4278	2593	2885	527	451	127	291	13455
1992	80	2778	2308	1042	2501	1107	1252	241	265	138	11712
1993	3	393	2485	1852	767	1431	635	623	150	180	8519
1994	2	203	817	2266	1023	243	370	196	128	23	5272
1995	0.1	56	405	237	281	60	20	14	12	-	1085
1996	1	37	376	875	268	224	62	18	14	2	1877
				CAN Commercial Landings Mean Weight (kg) at Age							
1978	0.707	1.376	2.436	2.922	3.918	6.187	6.625	10.148	9.429	15.262	2.814
1979	-	1.371	1.601	3.725	4.630	6.222	9.365	11.638	11.699	14.064	3.226
1980	0.567	1.343	2.426	3.235	4.997	6.468	7.119	12.135	12.652	15.721	2.961
1981	0.839	1.362	2.345	3.516	5.216	6.905	9.204	9.747	10.465	13.993	4.363
1982	0.652	1.444	2.324	3.816	5.188	6.550	9.137	9.418	12.667	16.092	3.548
1983	0.904	1.457	2.203	3.180	4.357	6.203	8.042	10.368	12.222	12.270	2.534
1984	-	1.477	2.473	3.794	4.751	6.043	8.633	10.622	10.807	15.897	5.100
1985	0.686	1.406	1.964	3.625	4.768	6.440	8.181	9.718	10.499	14.537	2.501
1986	0.723	1.572	2.877	3.952	5.592	7.179	8.612	9.453	9.934	9.437	3.625
1987	0.661	1.612	2.584	4.456	6.125	7.540	9.510	11.031	12.629	15.444	2.766
1988	0.786	1.294	2.518	3.904	5.716	6.694	9.251	10.700	11.531	15.065	3.547
1989	-	1.310	2.356	4.153	5.471	6.820	7.459	10.757	11.680	15.356	4.141
1990	0.831	1.812	2.827	3.699	5.221	6.657	8.582	11.227	13.080	14.821	3.786
1991	1.051	1.756	2.783	3.447	4.432	5.591	7.116	9.604	8.457	14.550	3.829
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	3.374
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	-	3.284
1996	1.034	1.538	2.358	3.337	5.237	6.358	6.916	8.455	10.594	12.002	3.443

Table 10 continued. Landings at age (thousands of fish; metric tons) and mean weight (kg) and mean length (cm) at age of Canadian commercial landings of Atlantic cod from the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total
	CAN Commercial Landings Mean Length (cm) at Age										
1978	39.5	48.9	59.0	63.3	69.6	81.2	82.5	98.3	94.7	112.8	61.8
1979	-	49.3	51.9	69.3	74.8	82.2	95.2	103.2	103.4	110.4	64.1
1980	36.6	48.9	59.5	66.2	76.4	83.6	86.6	104.7	105.7	114.6	61.7
1981	41.8	49.1	59.1	68.1	78.0	86.1	94.8	96.6	97.5	108.9	70.6
1982	38.3	50.1	58.9	70.0	77.8	84.4	94.9	95.2	106.4	115.3	65.5
1983	42.9	50.4	57.9	65.8	73.0	82.9	90.9	99.0	105.1	105.0	59.9
1984	-	50.7	60.4	70.0	75.7	82.3	92.3	100.1	100.8	114.5	75.6
1985	39.0	49.8	55.7	68.7	75.3	83.8	91.1	96.3	99.0	110.8	58.1
1986	39.6	51.7	63.5	71.0	79.6	86.8	92.8	95.9	96.3	96.1	67.2
1987	38.5	52.1	61.0	73.6	82.3	88.4	96.1	101.2	106.3	114.4	60.1
1988	40.8	48.3	60.5	70.4	80.2	84.8	95.2	99.9	102.5	112.2	65.8
1989	-	48.6	59.1	71.9	79.0	85.1	87.7	100.3	103.1	113.3	69.4
1990	41.7	54.3	63.1	69.0	77.6	84.0	92.0	102.0	107.4	112.1	68.2
1991	45.1	53.7	62.6	67.2	73.3	78.8	86.2	96.1	90.6	112.1	68.4
1992	46.2	51.4	60.6	67.7	73.8	80.6	85.4	94.8	105.8	115.1	61.1
1993	42.2	51.4	58.9	64.9	72.9	80.4	85.5	94.1	92.4	104.5	65.0
1994	43.0	50.3	59.6	69.8	75.3	85.9	89.4	93.0	88.6	102.6	67.9
1995	43.0	50.6	60.4	69.5	78.3	83.1	100.9	98.4	97.8	-	65.0
1996	44.9	51.3	59.3	66.6	77.7	83.3	84.7	90.8	99.9	104.6	66.4

Table 11. 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 cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

Year	Age 1	2	3	4	5	6	7	8	9	10+	Total	% of Total Landings USA	Canada
Total Commercial Landings in Numbers (000's) at Age													
1978	2	393	7748	2303	830	131	345	47	40	15	11854	73.7	26.3
1979	34	1989	900	4870	1212	458	77	253	4	48	9845	81.2	18.8
1980	89	3777	5828	500	2308	1076	445	87	167	10	14287	80.9	19.1
1981	27	3205	4221	2464	235	1406	417	123	130	62	12290	84.1	15.9
1982	331	9138	3824	2787	2000	281	673	213	71	83	19401	74.1	25.9
1983	108	4286	8063	2456	1055	776	95	235	100	65	17239	72.2	27.8
1984	81	1307	3423	3336	840	516	458	44	171	121	10297	89.0	11.0
1985	134	6426	2443	1368	1885	412	218	203	21	97	13207	68.4	31.6
1986	156	1326	4573	797	480	627	87	72	47	29	8194	71.7	28.3
1987	26	7473	1406	2121	279	252	270	63	38	24	11952	64.2	35.8
1988	10	1577	8022	1012	1497	244	161	197	50	47	12817	71.6	28.4
1989	-	2088	2922	4155	331	541	82	43	50	18	10230	81.1	18.9
1990	7	4942	5042	1882	2264	229	245	36	17	38	14702	74.3	25.7
1991	52	1525	3243	3281	1458	1088	126	70	23	23	10889	67.7	32.3
1992	70	4177	2170	1038	1482	404	309	34	33	10	9727	58.7	41.3
1993	4	1033	4246	1115	440	472	159	143	32	17	7661	67.0	33.0
1994	2	398	1526	1825	394	96	137	46	38	6	4468	68.5	31.5
1995	0.1	392	1058	692	290	44	26	15	2	1	2520	86.9	13.1
1996	0.7	207	903	1234	241	123	15	3	5	0.2	2731	80.0	20.0
Total Commercial Landings in Weight (Tons) at Age													
1978	1	515	18890	7990	3597	757	2549	395	465	198	35357	75.2	24.8
1979	30	2970	1936	20504	5923	3288	711	2611	44	606	38623	84.5	15.5
1980	75	5516	14382	1833	13036	7184	3735	793	1408	154	48116	83.2	16.8
1981	24	4789	9953	8416	1224	10156	3575	1212	1848	1151	42348	79.9	20.1
1982	253	12812	10187	10681	10705	1827	6303	2110	891	1388	57157	68.8	31.2
1983	105	6387	19167	8126	4891	4963	763	2418	1120	946	48886	75.2	24.8
1984	85	2137	8389	12074	4271	3401	4078	447	1938	1858	38678	85.1	14.9
1985	121	9111	5095	5319	9588	2644	1765	2073	246	1309	37271	72.0	28.0
1986	145	1955	11189	2917	2692	4505	776	717	596	409	25901	67.5	32.5
1987	19	11071	3509	8882	1619	1945	2416	633	426	360	30880	61.6	38.4
1988	8	2399	18923	3552	8085	1618	1412	1960	566	719	39242	67.0	33.0
1989	-	3375	6633	15673	1783	3625	669	455	588	298	33098	75.8	24.2
1990	5	7709	12412	6629	11075	1448	2069	382	222	552	42503	66.3	33.7
1991	59	2481	8265	11221	6955	6411	933	736	223	346	37630	64.2	35.8
1992	80	6441	5348	3991	6971	2486	2322	334	402	192	28567	59.0	41.0
1993	3	1585	9566	3717	2184	3012	1195	1315	316	220	23113	63.1	36.9
1994	2	581	3308	6673	1892	716	1095	430	364	103	15165	65.2	34.8
1995	0.1	577	2215	2649	1595	327	273	174	20	20	7851	86.1	13.9
1996	0.6	311	2199	4178	1183	817	127	21	59	2	8898	78.9	21.1
Total Commercial Landings Mean Weight (kg) at Age													
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		

Table 11 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 cod stock (NAFO Division 5Z and Statistical Area 6), 1978 - 1996.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Total
	Total Commercial Landings Mean Length (cm) at Age										
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	-	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

Table 12. Summary of USA and Canadian 1996 commercial landings of Atlantic cod from the Georges Bank and South cod stock (NAFO Division 5Z and Statistical Area 6).

Age	USA Catch at Age				Canadian Catch at Age				Total 1996 Catch at Age			
	Catch in Numbers (000's)	% of USA Total	Catch in Weight (mt)	% of USA Total	Catch in Numbers (000's)	% of CAN Total	Catch in Weight (mt)	% of CAN Total	Catch in Numbers (000's)	% of Total	Catch in Weight (mt)	% of Total
1	-	-	-	-	1	0.1	1	0.0	1	0.0	0.6	0.0
2	183	8.4	275	3.9	24	4.4	37	2.0	207	7.6	311	3.5
3	744	34.1	1823	26.0	159	29.2	376	20.0	903	33.1	2199	24.7
4	971	44.4	3303	47.0	262	48.1	875	46.6	1234	45.2	4178	46.9
5	190	8.7	915	13.0	51	9.4	268	14.3	241	8.8	1183	13.3
6	88	4.0	593	8.5	35	6.5	224	12.0	123	4.5	817	9.2
7	6	0.3	64	0.9	9	1.6	62	3.3	15	0.6	127	1.4
8	-	-	3	-	2	0.4	18	0.9	3	0.1	21	0.2
9	3	0.1	45	0.6	1	0.2	14	0.8	5	0.2	59	0.7
10+	-	-	-	-	0.2	0.0	2	0.1	0.2	0.0	2	0.0
Total	2185	100.0	7021	100.0	545	100.0	1876	100.0	2731	100.0	8898	100.0
	Mean Weight Per Fish (kg)		3.212		Mean Weight Per Fish (kg)		3.443		Mean Weight Per Fish (kg)		3.258	

Table 13. Mean weight at age (kg) at the beginning of the year (January 1) for Georges Bank and South cod stock (NAFO Division 5Z and Subarea 6), 1978 - 1996. Values derived from landings mean weights-at-age using the procedures described by Rivard (1980).

	Year																			
Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.486	0.694	0.625	0.700	0.548	0.748	0.907	0.711	0.736	0.502	0.548	0.583	0.594	0.947	0.993	0.573	0.711	0.702	0.666	0.675
2	1.023	1.028	1.139	1.118	1.112	1.068	1.260	1.222	1.157	1.173	1.050	1.127	1.123	1.163	1.311	1.327	1.128	1.154	1.168	1.168
3	1.881	1.678	1.920	1.855	1.996	1.826	1.911	1.847	1.863	1.918	1.869	1.857	1.995	1.994	2.002	1.864	1.824	1.748	1.893	1.944
4	2.922	3.219	2.808	2.903	3.007	2.969	2.933	3.087	2.763	3.201	2.960	2.983	2.827	2.902	3.129	2.866	2.870	2.882	2.664	3.133
5	3.370	4.118	4.876	4.373	4.275	4.216	4.101	4.291	4.667	4.611	4.755	4.353	4.296	4.098	4.011	4.369	4.001	4.482	4.337	4.307
6	4.594	5.579	5.712	6.386	5.826	5.849	5.525	5.709	6.048	6.579	6.214	6.013	5.846	5.368	5.418	5.478	6.076	5.956	6.031	5.563
7	6.235	7.290	7.760	7.562	8.223	7.201	7.547	7.300	7.561	8.022	8.234	7.393	7.524	6.850	6.651	6.799	7.149	8.924	7.861	7.271
8	7.235	8.721	9.136	9.108	9.207	9.814	8.970	9.549	8.978	9.448	9.454	9.699	9.357	9.432	8.542	8.319	8.388	9.648	9.509	8.910
9	10.004	9.967	9.325	11.349	11.119	10.541	10.783	10.741	11.396	10.660	10.563	10.793	11.612	10.156	11.263	9.772	9.454	9.862	12.234	7.488
10+	13.200	12.625	15.400	18.565	16.723	14.554	15.356	13.494	14.104	15.000	15.298	17.111	14.526	15.373	19.025	13.236	16.658	14.953	12.002	12.002

Table 14. Landings at age (thousands of fish;metric tons) and mean weight (kg) at age of total recreational landings of Atlantic cod from the Georges Bank and south cod stock (NAFO Divison 5Z and Statistical Area 6), 1981-1996.

Total Recreational Landings in Numbers (000's) at Age

Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	97	671	574	217	7	77	26	11	10	5	1695
1982	115	982	275	115	77	5	24	5	2	0.2	1600
1983	139	409	711	174	144	100	12	14	4	2.31	1709
1984	19	92	141	126	27	27	20	1	6	4.81	464
1985	70	563	266	305	507	128	94	88	4	29.203	2054
1986	21	48	122	18	28	37	7	6	3	1.644	292
1987	6	225	72	82	7	11	17	6	5	2.9	434
1988	29	190	637	86	115	18	11	12	2	2	1102
1989	11	132	104	117	13	21	3	1	2	0	404
1990	1	165	158	44	68	10	14	2	0.4	1	463
1991	2	51	151	74	26	19	4	5	0.3	0.1	332
1992	31	97	32	13	13	3	3	0.4	0.1	0	193
1993	10	228	441	45	11	15	2	2	1		755
1994	4	85	122	68	11	4	6	1	0.6	2	304
1995	1	154	230	67	17	1	1	0	0	0	471
1996	2	27	76	53	8	6	0	2	0.1	0	174

Total Recreational Landings in Weight (tons) at Age

Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	38.617	962.48	1235	787.43	35.354	558.3	238.86	136.49	82.274	12	4086.81
1982	73.232	1282.9	723.85	410.39	466.89	33.122	218.36	49.137	16.701	1.951	3276.53
1983	82.325	555.99	2158.8	772.76	769.31	635.95	92.893	132.12	39.129	30.21	5269.49
1984	18.749	136.98	368.44	534.52	154.47	181.36	161.67	11.629	66.868	85.477	1720.16
1985	53.553	652.66	781.06	1426.9	3049.2	969.41	839.5	918.49	52.589	330.057	9073.42
1986	15.249	74.825	315.15	87.807	198.5	300.55	62.551	53.58	29.972	17.876	1156.06
1987	3.153	387.59	196.17	303.49	39.617	98.908	181.1	75.076	55.036	36.378	1376.52
1988	14.292	249.76	1602.5	280.21	582.88	116.49	84.756	125.42	23.931	30.371	3110.61
1989	6.284	194.4	242.39	505.29	75.959	140.04	34.792	14.153	19.822	0	1233.13
1990	0.494	240.07	353.56	166.62	386.2	73.676	123.99	17.86	3.935	11.887	1378.29
1991	1.95	88.352	388.83	237.53	132.39	133.12	50.311	56.408	2.881	0.786	1092.56
1992	9.859	126.15	82.329	48.228	53.047	26.139	26.222	4.306	1.417	0	377.70
1993	2.942	263.17	938.08	134.47	57.993	71.749	14.387	16.222	4.81		1503.82
1994	2.409	107.06	237	252.72	56.52	31.591	43.609	9.04	5.92	10	755.87
1995	0.453	216.06	450.83	226.74	101.85	8.661	10.222	0	0	0	1014.82
1996	1.141	42.939	190.55	185.01	37.987	50.358	0	9	0.448		517.43

Table 14. continued. Landings at age (thousands of fish;metric tons) and mean weight (kg) at age of total recreational landings of Atlantic cod from the Georges Bank and south cod stock (NAFO Divison 5Z and Statistical Area 6), 1981-1996.

Total Recreational Landings Mean Weight at Age

Year	1	2	3	4	5	6	7	8	9	10+	Total
1981	0.397	1.434	2.154	3.625	5.366	7.223	9.039	12.552	13.78	12	67.57
1982	0.637	1.307	2.628	3.574	6.02	7.151	9.112	9.42	9.485	8.255	57.59
1983	0.594	1.359	3.037	4.434	5.355	6.357	7.661	9.547	9.428	13.08064	60.85
1984	1.002	1.495	2.603	4.258	5.66	6.677	8.137	8.744	10.91	17.77035	67.26
1985	0.357	1.159	2.937	4.685	6.012	7.581	8.911	10.49	11.907	11.29424	65.33
1986	0.711	1.574	2.584	4.785	6.984	8.227	9.017	9.639	11.333	10.8684	65.72
1987	0.515	1.721	2.718	3.719	5.486	9.178	10.701	11.57	11.941	12.70652	70.26
1988	0.501	1.313	2.514	3.255	5.075	6.527	7.932	10.648	11.15	12.595	61.51
1989	0.568	1.469	2.34	4.322	6.012	6.773	9.932	11.163	9.387	0	51.97
1990	0.819	1.453	2.232	3.798	5.709	7.652	8.825	8.808	9.095	10.301	58.69
1991	0.915	1.719	2.577	3.219	5.042	6.907	11.598	12.227	10.906	9.387	64.50
1992	0.319	1.296	2.584	3.749	3.952	7.65	9.876	11.641	10.301	0	51.37
1993	0.307	1.152	2.126	3.012	5.278	4.789	6.663	7.01	7.499	0	37.84
1994	0.615	1.258	1.941	3.728	5.303	7.381	7.742	7.948	9.185	10	55.10
1995	0.466	1.408	1.962	3.376	5.973	6.88	8.001	0	0	0	28.07
1996	0.582	1.602	2.504	3.509	4.865	8.335	0	9	5.213	0	35.61

Table 15. General linear model (GLM) analysis of LPUE of Georges Bank cod for interviewed trips landing cod during 1978-1993 as a function of year, area, quarter, tonnage class and depth with no interaction.

General Linear Models Procedure

Dependent Variable: LNCPUEDF

Source	DF	Sum of Squares	Mean Square	F Value	> F
Model	28	31732.79388553	1133.31406734	735.46	0.0001
Error	54356	83760.33125977	1.54095834		
Corrected Total	54384	115493.12514529			

R-Square	C.V.	Root MSE	LNCPUEDF Mean
0.274759	-549.0211	1.24135343	-0.22610303

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	15	12685.54117665	845.70274511	548.82	0.0001
AREA	5	5241.16957276	1048.23391455	680.25	0.0001
QTR	3	4097.78364005	1365.92788002	886.41	0.0001
TC2	3	6023.47684536	2007.82561512	1302.97	0.0001
DEPTH	2	3684.82265071	1842.41132535	1195.63	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	15	15953.77293165	1063.58486211	690.21	0.0001
AREA	5	7615.39757423	1523.07951485	988.40	0.0001
QTR	3	3159.27477519	1053.09159173	683.40	0.0001
TC2	3	6322.64153966	2107.54717989	1367.69	0.0001
DEPTH	2	3684.82265071	1842.41132535	1195.63	0.0001

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT		0.760997649 B	26.75	0.0001	0.02844571	
AREA	522	-0.444577000 B	-29.48	0.0001	0.01507858	0.641168
	523	-0.010785910 B	-0.53	0.5968	0.02038704	0.989478
	524	-0.735978983 B	-41.37	0.0001	0.01778914	0.479112
	525	-0.843403568 B	-36.88	0.0001	0.02286656	0.430356
	526	-1.194326116 B	-60.80	0.0001	0.01964379	0.302966
	521	0.000000000 B	.	.	.	1.000000
QTR	1	-0.057274522 B	-3.86	0.0001	0.01482597	0.944439
	3	-0.621223632 B	-41.41	0.0001	0.01500215	0.537347
	4	-0.417172723 B	-26.54	0.0001	0.01571823	0.658989
	2	0.000000000 B	.	.	.	1.000000
Tonclass	31	-0.793757151 B	-32.66	0.0001	0.02430028	0.452276
	32	-0.540370836 B	-33.92	0.0001	0.01593153	0.582606
	41	0.433927651 B	33.67	0.0001	0.01288832	1.543435
	33	0.000000000 B	.	.	.	1.000000
DEPTHCD	1	0.731465629 B	48.11	0.0001	0.01520442	2.078364
	2	0.373888353 B	24.87	0.0001	0.01503558	1.453539
	3	0.000000000 B	.	.	.	1.000000

Table 16. Georges Bank cod landings (mt), nominal and standardized effort (days fished) and landings per day fished (LPUE), USA only.

Year	USA Landings Used in GLM (mt)	Nominal		Standardized		
		Effort	LPUE	Effort	LPUE	Raised Effort[1]
1978	15776	7980	1.977	5937	2.657	10003
1979	20584	9406	2.188	7720	2.666	12244
1980	25213	10080	2.501	8525	2.958	13543
1981	18339	9089	2.018	8130	2.256	15005
1982	23289	10045	2.319	8833	2.607	15087
1983	22072	11668	1.892	10561	2.090	17587
1984	19669	14641	1.343	12632	1.557	21140
1985	18012	16447	1.095	15045	1.197	22408
1986	11572	12520	0.924	11956	0.968	18072
1987	12731	14945	0.852	13942	0.913	20846
1988	19010	17769	1.070	17099	1.112	23666
1989	15557	15834	0.983	15581	0.998	25136
1990	18358	15882	1.156	15007	1.223	23047
1991	14173	14857	0.954	15085	0.940	25730
1992	8786	13606	0.646	12989	0.676	24919
1993	7749	12958	0.598	12883	0.602	24262
1994	3939	7397	0.532	6834	0.576	17166
1995	1951	6564	0.297	6166	0.316	21365
1996	2242	6200	0.362	5687	0.394	17806

[1] Derived as total landings/ standardized LPUE.

Table 17. 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 - 1996. [a,b,c]

	Spring		Autumn	
Year	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	4.37	17.8
1964	-	-	2.98	11.6
1965	-	-	4.25	11.7
1966	-	-	4.81	8.1
1967	-	-	10.38	13.6
1968	4.72	12.6	3.30	8.6
1969	4.64	17.8	2.20	8.0
1970	4.34	15.6	5.07	12.5
1971	3.39	14.2	3.19	9.9
1972	8.97	19.0	13.09	23.0
1973	18.68 [d]	39.7 [d]	12.28	30.8
1974	14.75	36.4	3.49	8.2
1975	6.89	26.0	6.41	14.1
1976	7.06	18.6	10.44	17.7
1977	6.30	15.4	5.45	12.5
1978	12.31	31.2	8.59	23.3
1979	5.16	16.9	5.95	16.5
1980	6.12	16.7	2.91	6.7
1981	10.44	26.1	9.04	19.0
1982	8.20 [e]	15.4 [e]	3.71	6.9
1983	7.70	24.0	3.64	6.5
1984	4.08	15.4	4.75	10.3
1985	6.94	21.5	2.43	3.5
1986	5.04	16.7	3.12	4.7
1987	3.26	10.3	2.33	4.4
1988	5.86	13.5	3.11	5.8
1989	4.80	10.8	4.78	4.6
1990	4.74	11.6	3.62 [f]	7.1 [f]
1991	4.39	9.0	0.96	1.4
1992	2.67	7.5	1.84	3.1
1993	2.48	7.3	2.15	2.2
1994	0.94	1.2	1.82	3.3
1995	3.29	8.4	3.62	5.6
1996	2.70	7.5	1.10	2.7

[a] During 1963-1984, BMV oval doors were used in spring and autumn surveys; since 1985, Portuguese polyvalent doors have been 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).

[b] 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).

[c] 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.

[d] Excludes unusually high catch of 1894 cod (2558 kg) at Station 230 (Strata tow 20-4).
[e] Excludes unusually high catch of 1032 cod (4096 kg) at Station 323 (Strata tow 16-7).
[f] Excludes unusually high catch of 111 cod (504 kg) at Station 205 (Strata tow 23-4).

Table 18. Estimates of instantaneous total mortality (Z) and fishing mortality (F)[1] for the Georges Bank cod stock for eight time-periods, 1964 - 1995, derived from NEFSC offshore spring and autumn bottom trawl survey data.[2]

Time Period	Spring Z	Spring F	Autumn Z	Autumn F	Geometric Mean Z	Geometric Mean F
1964-1967	-	-	0.73	0.53	0.73	0.53
1968-1972	0.34	0.14	0.35	0.15	0.34	0.14
1973-1976	0.70	0.50	0.56	0.36	0.63	0.43
1977-1981	0.47	0.27	0.67	0.47	0.56	0.36
1982-1984	0.42	0.22	1.12	0.92	0.68	0.48
1985-1987	0.84	0.64	1.45	1.25	1.10	0.90
1988-1990	0.60	0.40	0.60	0.40	0.60	0.40
1991-1995	0.68	0.44	1.58	1.38	1.04	0.84

[1] Instantaneous natural mortality (M) assumed to be 0.20.

[2] Estimates derived from:

Georges Bank spring: ln (Σ age 4+ for years i to j/ Σ age 5+ for years i+1 to j+1).
Georges Bank autumn: ln (Σ age 3+ for years i-1 to j-1/ Σ age 4+ for years i to j).

Table 19. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (mt) of Georges Bank cod, estimat from virtual population analysis (VPA) calibrated using the commercial catch at age ADAPT formulation and the percent mature at age, 1978-1996.

Stock Numbers (Jan 1) in thousands

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	27714	23514	20106	41396	17472	9617	27395	8694	42851	16397	23550	15656	9725	19832	8717	12015	10652	3962	6072	4562
2	4268	22688	19221	16381	33868	14005	7776	22356	6997	34942	13401	19272	12818	7956	16190	7074	9833	8719	3243	4971
3	25526	3139	16776	12319	10511	19460	7588	5184	12489	4529	21846	9545	13889	6023	5134	9476	4857	7690	6784	2468
4	7947	13888	1756	8462	6267	5146	8637	3116	2034	6087	2436	10628	5171	6810	1997	2240	3916	2596	5339	4737
5	2878	4422	6964	985	4698	2609	1991	4053	1313	944	3065	1078	4942	2530	2606	696	825	1555	1499	3255
6	1124	1605	2524	3614	594	2037	1181	870	1612	641	520	1155	583	1997	753	793	171	319	1011	1009
7	1434	802	900	1093	1686	232	966	500	339	753	297	205	456	270	651	251	222	54	221	716
8	67	862	587	334	518	772	104	376	212	199	372	97	94	152	107	253	61	58	20	168
9	146	12	477	402	162	231	419	45	124	109	106	126	41	44	61	57	78	9	34	14
10	54	148	28	190	187	148	293	206	76	68	98	45	90	44	18	30	12	4	1	24
1 +	71159	71081	69338	85174	75962	54257	56350	45400	68048	64668	65691	57808	47809	45659	36235	32884	30629	24966	24226	21925

Fishing Mortality

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.000	0.002	0.005	0.001	0.021	0.013	0.003	0.017	0.004	0.002	0.001	0.000	0.001	0.003	0.009	0.000	0.000	0.000	0.000
2	0.107	0.102	0.245	0.244	0.354	0.413	0.206	0.382	0.235	0.270	0.139	0.128	0.555	0.238	0.336	0.176	0.046	0.051	0.073
3	0.409	0.381	0.484	0.476	0.514	0.612	0.690	0.736	0.519	0.420	0.521	0.413	0.513	0.904	0.629	0.684	0.427	0.165	0.159
4	0.386	0.490	0.378	0.388	0.676	0.750	0.557	0.664	0.568	0.486	0.615	0.566	0.515	0.760	0.854	0.799	0.724	0.349	0.295
5	0.384	0.361	0.456	0.306	0.636	0.592	0.628	0.722	0.518	0.396	0.776	0.414	0.706	1.013	0.990	1.200	0.750	0.231	0.196
6	0.138	0.379	0.637	0.562	0.740	0.547	0.659	0.741	0.562	0.570	0.730	0.729	0.569	0.921	0.900	1.072	0.964	0.165	0.144
7	0.309	0.112	0.791	0.548	0.582	0.603	0.743	0.657	0.333	0.505	0.917	0.583	0.901	0.723	0.744	1.209	1.144	0.769	0.078
8	1.485	0.392	0.179	0.523	0.607	0.410	0.632	0.908	0.470	0.430	0.880	0.672	0.552	0.714	0.431	0.978	1.771	0.337	0.178
9	0.361	0.438	0.490	0.442	0.662	0.651	0.599	0.720	0.541	0.488	0.736	0.575	0.622	0.855	0.917	0.964	0.774	0.300	0.178
10	0.361	0.438	0.490	0.442	0.662	0.651	0.599	0.720	0.541	0.488	0.736	0.575	0.622	0.855	0.917	0.964	0.774	0.300	0.178
mn4-8	0.540	0.347	0.488	0.465	0.648	0.580	0.644	0.738	0.490	0.477	0.784	0.593	0.648	0.826	0.784	1.052	1.071	0.370	0.178

Table 19 continued. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (mt) of Georges Bank cod, estimated from virtual population analysis (VPA) calibrated using the commercial catch at age ADAPT formulation and the percent mature at age, 1978-1996.

SSB at the start of the spawning season - males and females (mt)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	913	1104	850	1960	1200	903	3124	775	7009	1830	2871	2029	1285	4175	1923	1802	1685	619	899
2	1410	7539	6913	5783	16139	6345	4304	11652	4817	24256	8514	13166	8126	5504	12421	5643	6813	6178	2318
3	33845	3729	22417	15929	15643	26062	10501	6880	18780	7129	32953	14563	22393	9091	8147	13871	7261	11513	11005
4	20220	38256	4297	21379	15793	12650	21660	8077	4845	17031	6167	27345	12716	16500	5137	5326	9445	6689	12834
5	8798	16585	30443	3958	17474	9639	7112	14912	5437	3941	12386	4237	18252	8472	8573	2407	2818	6487	6087
6	4882	8130	12541	20323	2957	10521	5656	4245	8589	3707	2769	5947	3000	8894	3394	3514	858	1788	5756
7	8215	5550	5918	7296	12173	1460	6227	3166	2348	5370	2027	1331	2855	1588	3698	1347	1269	407	1661
8	367	6810	5034	2696	4165	6841	811	2986	1705	1694	2938	814	774	1228	826	1731	370	511	181
9	1331	112	3963	4097	1561	2113	3956	417	1251	1033	958	1198	411	377	568	460	626	77	389
10	653	1681	388	3168	2710	1873	3941	2385	945	910	1287	676	1135	561	286	325	172	58	15
Total	80633	89497	92765	86591	89815	78406	67291	55495	55728	66901	72870	71308	70948	56390	44973	36426	31317	34327	41145

Percent Mature (females)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	7	7	7	7	13	13	13	13	23	23	23	23	23	23	23	23	23	23	23
2	34	34	34	34	47	47	47	47	64	64	64	64	64	64	64	64	64	64	64
3	78	78	78	78	84	84	84	84	91	91	91	91	91	91	91	91	91	91	91
4	96	96	96	96	97	97	97	97	98	98	98	98	98	98	98	98	98	98	98
5	100	100	100	100	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	100	100	100	100
7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 20. Parameter estimates of stock size, with standard error, t-statistic, and CV, and estimates of terminal year fishing mortality (F) in 1996 from trial ADAPT calibrations for Georges Bank cod (CAA = catch at age).

Run 28: Commercial CAA only with Survey indices,1981-1996

Age	Stock size Estimate	Standard Error	T-Statistic	CV	F in 1996
1	1583.23	1120.09	1.41348	0.71	1 0.0001
2	5137.87	1835.88	2.79859	0.36	2 0.0725
3	2492.37	717.158	3.47535	0.29	3 0.1555
4	4855.03	1358.44	3.57398	0.28	4 0.2823
5	3423.14	1001.33	3.4186	0.29	5 0.1703
6	1174.21	360.193	3.25994	0.31	6 0.0955
7	1110 44	355.228	3.12599	0.32	7 0.0576
8	228.835	77.9414	2.93599	0.34	8 0.1514

Run 24: Commercial CAA plus Recreational CAA with Survey indices,1981-1996

Age	Stock size Estimate	Standard Error	T-Statistic	CV	F in 1996
1	1678.74	1166.5	1.43913	0.69	0.0004
2	5431.83	1906.7	2.84882	0.35	0.0777
3	2621.37	744.08	3.52297	0.28	0.1610
4	5070.64	1411.03	3.59357	0.28	0.2892
5	3472.65	1012.76	3.4289	0.29	0.1724
6	1197.45	365.311	3.2779	0.31	0.0960
7	1158.25	364.67	3.17615	0.31	0.0541
8	244.341	81.0993	3.01287	0.33	0.1529

Run 34: Commercial CAA with Survey and LPUE indices, 1978-1996

Age	Stock size Estimate	Standard Error	T-Statistic	CV	F in 1996
1	4417.72	2161.05	2.04424	0.49	0.0001
2	4799.7	1483.78	3.23477	0.31	0.0843
3	2128.3	519.951	4.09326	0.24	0.2058
4	3576.52	852.665	4.19453	0.24	0.3743
5	2459.7	629.914	3.90481	0.26	0.2310
6	839.019	218.623	3.83775	0.26	0.1840
7	551.039	153.492	3.59001	0.28	0.0938
8	137.995	40.3922	3.41636	0.29	0.2208

Run 29: Final ADAPT , Commercial CAA with Survey indices only , 1978-1996

Age	Stock size	Standard	T-Statistic	CV	F in 1996
1	4562.38	2361.03	1.93237	0.52	0.0001
2	4970.84	1626.21	3.05671	0.33	0.0731
3	2468.17	673.624	3.66402	0.27	0.1591
4	4737.34	1264.46	3.74652	0.27	0.2950
5	3254.73	918.155	3.54486	0.28	0.1956
6	1009.26	300.895	3.35419	0.30	0.1444
7	716.321	232.355	3.08288	0.32	0.0778
8	167.648	55.5617	3.01732	0.33	0.1782

Table 21. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (mt) of Georges Bank cod, estimated from virtual population analysis (VPA) and calibrated using the commercial plus recreational catch at age ADAPT formulation, 1981-1996.

Stock Numbers (Jan 1) in thousands

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	45755	19148	10464	28969	9230	44783	17012	24298	16285	10280	22357	9927	13111	11597	4228	6637	1679
2	18203	37349	15274	8344	23628	7372	36505	13899	19858	13323	8409	18255	8036	10722	9489	3460	5432
3	13701	11396	21421	8257	5565	13021	4793	22922	9781	14250	6287	5459	11079	5438	8341	7275	2621
4	9250	6879	5621	9599	3535	2105	6412	2587	10932	5270	6962	2076	2477	4830	2961	5664	5071
5	1030	5147	3006	2223	4727	1381	986	3257	1124	5085	2572	2664	749	978	2241	1738	3473
6	3844	624	2335	1376	1035	1706	671	549	1208	609	2053	763	828	205	434	1557	1197
7	1149	1805	252	1119	636	359	796	311	212	480	283	679	256	238	77	315	1158
8	362	540	847	110	484	238	209	392	99	97	159	114	274	64	65	39	244
9	435	175	245	468	49	133	124	109	132	41	45	62	62	93	10	40	27
10	207	197	157	329	245	80	77	101	45	92	44	18	31	19	5	2	29
1 +	93936	83261	59623	60795	49134	71178	67585	68424	59676	49527	49170	40018	36904	34184	27853	26727	20932

Fishing Mortality

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.003	0.026	0.026	0.004	0.025	0.004	0.002	0.002	0.001	0.001	0.003	0.011	0.001	0.001	0.000	0.000
2	0.268	0.356	0.415	0.205	0.396	0.231	0.265	0.151	0.132	0.551	0.232	0.299	0.191	0.051	0.066	0.078
3	0.489	0.507	0.603	0.648	0.772	0.508	0.417	0.540	0.418	0.516	0.908	0.590	0.630	0.408	0.187	0.161
4	0.386	0.628	0.728	0.509	0.740	0.558	0.478	0.633	0.565	0.517	0.761	0.820	0.729	0.568	0.333	0.289
5	0.301	0.591	0.581	0.564	0.819	0.522	0.386	0.792	0.413	0.707	1.015	0.968	1.095	0.612	0.164	0.172
6	0.556	0.706	0.536	0.573	0.859	0.563	0.568	0.750	0.722	0.568	0.906	0.891	1.049	0.774	0.122	0.096
7	0.555	0.556	0.632	0.639	0.782	0.342	0.509	0.944	0.585	0.907	0.710	0.708	1.185	1.094	0.487	0.054
8	0.526	0.591	0.393	0.602	1.094	0.450	0.455	0.891	0.674	0.569	0.738	0.407	0.879	1.661	0.294	0.153
9	0.439	0.618	0.634	0.541	0.823	0.539	0.482	0.754	0.574	0.625	0.853	0.888	0.889	0.613	0.251	0.153
10	0.439	0.618	0.634	0.541	0.823	0.539	0.482	0.754	0.574	0.625	0.853	0.888	0.889	0.613	0.251	0.153
mn4-8	0.465	0.614	0.574	0.577	0.859	0.487	0.479	0.802	0.592	0.654	0.826	0.759	0.988	0.942	0.280	0.153

Table 21 continued. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (mt) of Georges Bank cod, estimated from virtual population analysis (VPA) and calibrated using the commercial plus recreational catch at age ADAPT formulation, 1981-1996.

SSB at the start of the spawning season - males and females (mt)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	935	1235	679	3282	579	7004	1758	1853	1243	1353	4669	1538	784	1286	275	733
2	6346	13387	6741	4071	12140	4525	25063	8506	11555	7074	5823	14017	5513	5374	5910	1853
3	17369	16913	28960	11477	7466	19483	7575	34627	14808	22866	9475	8730	16290	7939	12220	11739
4	22082	17363	14018	24618	9229	5141	17942	6525	28254	12972	16833	5372	5949	11926	7582	13560
5	4422	19381	11216	8129	17494	5858	4136	13070	4415	18862	8619	8783	2638	3418	9479	7045
6	21505	3132	12106	6749	5068	9295	3925	2907	6215	3153	9203	3451	3668	1060	2454	9014
7	8118	13080	1581	7327	4000	2533	5727	2120	1380	3009	1684	3896	1383	1363	613	2372
8	2923	4363	7514	859	3730	1945	1782	3111	829	796	1290	886	1904	393	578	352
9	4679	1712	2239	4452	447	1337	1185	984	1246	418	381	587	504	767	91	456
10	3356	2874	1977	4498	2682	991	1015	1306	677	1152	564	293	347	250	69	18
Total	91734	93439	87029	75463	62834	58113	70105	75010	70623	71656	58540	47553	38979	33775	39271	47144

Percent Mature (females)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	7	13	13	13	13	23	23	23	23	23	23	23	23	23	23	23
2	34	47	47	47	47	64	64	64	64	64	64	64	64	64	64	64
3	78	84	84	84	84	91	91	91	91	91	91	91	91	91	91	91
4	96	97	97	97	97	98	98	98	98	98	98	98	98	98	98	98
5	100	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	100
7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 22. Yield and SSB per Recruit results for Georges Bank cod.

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   The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
    PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992
              ---------------------------------------
            Run Date: 15- 4-1997;  Time: 14:13:47.46
 Cod Georges Bank - 1997
```

Proportion of F before spawning: .1667
Proportion of M before spawning: .1667
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 10
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file: ==> GBYPR.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Stock
1	.0003	1.0000	.2300	.942	.749
2	.1318	1.0000	.6400	1.502	1.217
3	.5316	1.0000	.9100	2.283	1.866
4	1.0000	1.0000	.9800	3.609	2.882
5	1.0000	1.0000	1.0000	4.975	4.240
6	1.0000	1.0000	1.0000	6.794	5.791
7	1.0000	1.0000	1.0000	8.423	7.476
8	1.0000	1.0000	1.0000	9.697	8.881
9	1.0000	1.0000	1.0000	10.944	10.510
10+	1.0000	1.0000	1.0000	15.174	15.170

Summary of Yield per Recruit Analysis for: Cod Georges Bank - 1997

```
 Slope of the Yield/Recruit Curve at F=0.00: -->   25.9796
   F level at slope=1/10 of the above slope (F0.1): ----->    .171
     Yield/Recruit corresponding to F0.1: ----->    1.6986
   F level to produce Maximum Yield/Recruit (Fmax): ----->    .338
     Yield/Recruit corresponding to Fmax: ----->    1.8521
   F level at 20 % of Max Spawning Potential (F20): ----->    .430
     SSB/Recruit corresponding to F20: -------->    5.4030
```

Listing of Yield per Recruit Results for:
Cod Georges Bank - 1997

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.000	.00000	.00000	5.5167	29.0106	4.2370	27.0151	100.00
	.050	.12691	.92642	4.8847	21.4678	3.6042	19.5677	72.43
	.100	.21200	1.39391	4.4617	16.8132	3.1803	14.9893	55.49
	.150	.27320	1.63661	4.1582	13.7367	2.8759	11.9744	44.32
F0.1	.171	.29372	1.69856	4.0565	12.7662	2.7740	11.0257	40.81
	.200	.31945	1.76168	3.9293	11.5986	2.6462	9.8862	36.60
	.250	.35572	1.82252	3.7502	10.0533	2.4664	8.3818	31.03
	.300	.38501	1.84738	3.6059	8.9003	2.3214	7.2625	26.88
Fmax	.338	.40400	1.85208	3.5126	8.2015	2.2275	6.5859	24.38
	.350	.40921	1.85184	3.4870	8.0167	2.2018	6.4071	23.72
	.400	.42959	1.84472	3.3872	7.3239	2.1013	5.7380	21.24
F20%	.430	.44039	1.83711	3.3344	6.9764	2.0481	5.4030	20.00
	.450	.44702	1.83118	3.3020	6.7699	2.0154	5.2040	19.26
	.500	.46214	1.81423	3.2284	6.3189	1.9411	4.7703	17.66
	.550	.47539	1.79568	3.1640	5.9461	1.8761	4.4123	16.33
	.600	.48714	1.77660	3.1071	5.6337	1.8186	4.1127	15.22
	.650	.49763	1.75762	3.0564	5.3686	1.7673	3.8589	14.28
	.700	.50708	1.73910	3.0108	5.1411	1.7212	3.6414	13.48
	.750	.51565	1.72125	2.9696	4.9440	1.6795	3.4531	12.78
	.800	.52346	1.70417	2.9322	4.7716	1.6415	3.2886	12.17
	.850	.53063	1.68789	2.8979	4.6196	1.6067	3.1438	11.64
	.900	.53723	1.67243	2.8664	4.4846	1.5747	3.0152	11.16
	.950	.54335	1.65775	2.8373	4.3639	1.5451	2.9004	10.74
	1.000	.54903	1.64384	2.8103	4.2553	1.5177	2.7971	10.35

Table 23. Summary of short-term deterministic projections for Georges Bank cod. Recruitment was based on the geometric mean of the 1990-1996 year classes at age 1.

Input for Projections:

Number of Years: 3; Initial Year: 1997; Final Year: 1999
Number of Ages : 10; Age at Recruitment: 1; Last Age: 10
Natural Mortality is assumed Constant over time at: .200
Proportion of F before spawning: .1667
Proportion of M before spawning: .1667
Last age is a PLUS group.

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Average Weights Stock
1	.0003	1.0000	.2300	.942	.749
2	.1318	1.0000	.6400	1.502	1.217
3	.5316	1.0000	.9100	2.283	1.866
4	1.0000	1.0000	.9800	3.609	2.882
5	1.0000	1.0000	1.0000	4.975	4.240
6	1.0000	1.0000	1.0000	6.794	5.791
7	1.0000	1.0000	1.0000	8.423	7.476
8	1.0000	1.0000	1.0000	9.697	8.881
9	1.0000	1.0000	1.0000	10.944	10.510
10+	1.0000	1.0000	1.0000	15.174	15.170

SSB in 1996 was estimated at 41145 mt
Landings in 1996 were estimated at 8,896 t
F(4-9, unweighted) in 1996 was estimated at 0.18

Projection results:

Year	F	Lndngs	SSB	F	Lndngs	SSB	F	Lndngs	SSB
1997	0.18	7862	46380	0.18	7862	46380	0.18	7862	46380
1998	0.18	8370	50874	0.43	17944	49074	0.17	7941	50948
1999	0.18	8939	55375	0.43	15598	44642	0.17	8552	55868

Table 24. Stochastic medium-term projections of spawning stock biomass (mt), recruitment (age 1, thousands) and landings (mt) for Georges Bank cod, assuming F=0.17. Probability of SSB> the 70,000 mt threshold is given, along with the lower and upper quartiles and the median of bootstrap simulations.

	- Spawning Biomass -				- Recruitment -			- Landings -		
Year	L-25	Median	U-75	Probability	L-25	Median	U-75	L-25	Median	U-75
1997	43,826	47,460	51,253	0.000	9,053	12,708	17,986	6,982	7,679	8,283
1998	49,655	53,660	58,245	0.009	10,031	13,998	19,545	7,565	8,160	8,873
1999	57,116	62,400	68,454	0.200	11,113	15,418	21,896	8,296	8,962	9,738
2000	67,320	74,885	83,495	0.666	12,750	17,518	24,548	9,287	10,208	11,314
2001	79,861	90,054	101,804	0.925	14,671	19,928	27,936	11,165	12,627	14,381
2002	95,378	108,905	124,278	0.991	16,781	22,480	31,219	13,534	15,502	17,783
2003	112,311	129,154	148,598	0.999	19,054	25,276	34,851	16,136	18,624	21,554
2004	130,335	150,290	174,047	1.000	21,606	28,056	37,986	18,821	21,912	25,465
2005	150,436	174,092	202,207	1.000	23,953	30,893	41,187	21,917	25,508	29,733
2006	172,172	199,878	232,636	1.000	26,853	34,428	45,651	25,222	29,387	34,366

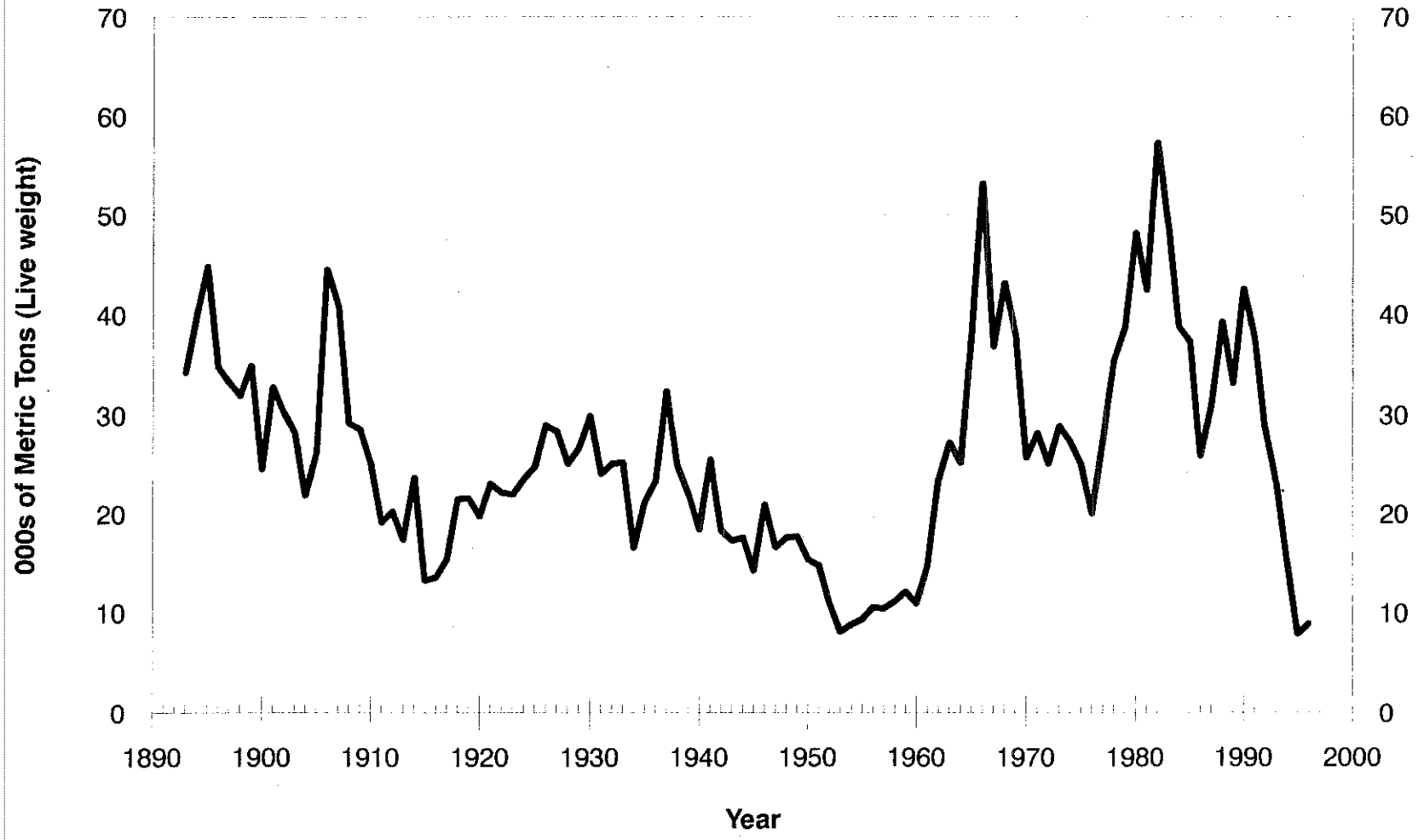


Figure 1. Total commercial landings of Georges Bank cod (Division 5Zand 6), 1893-1996.

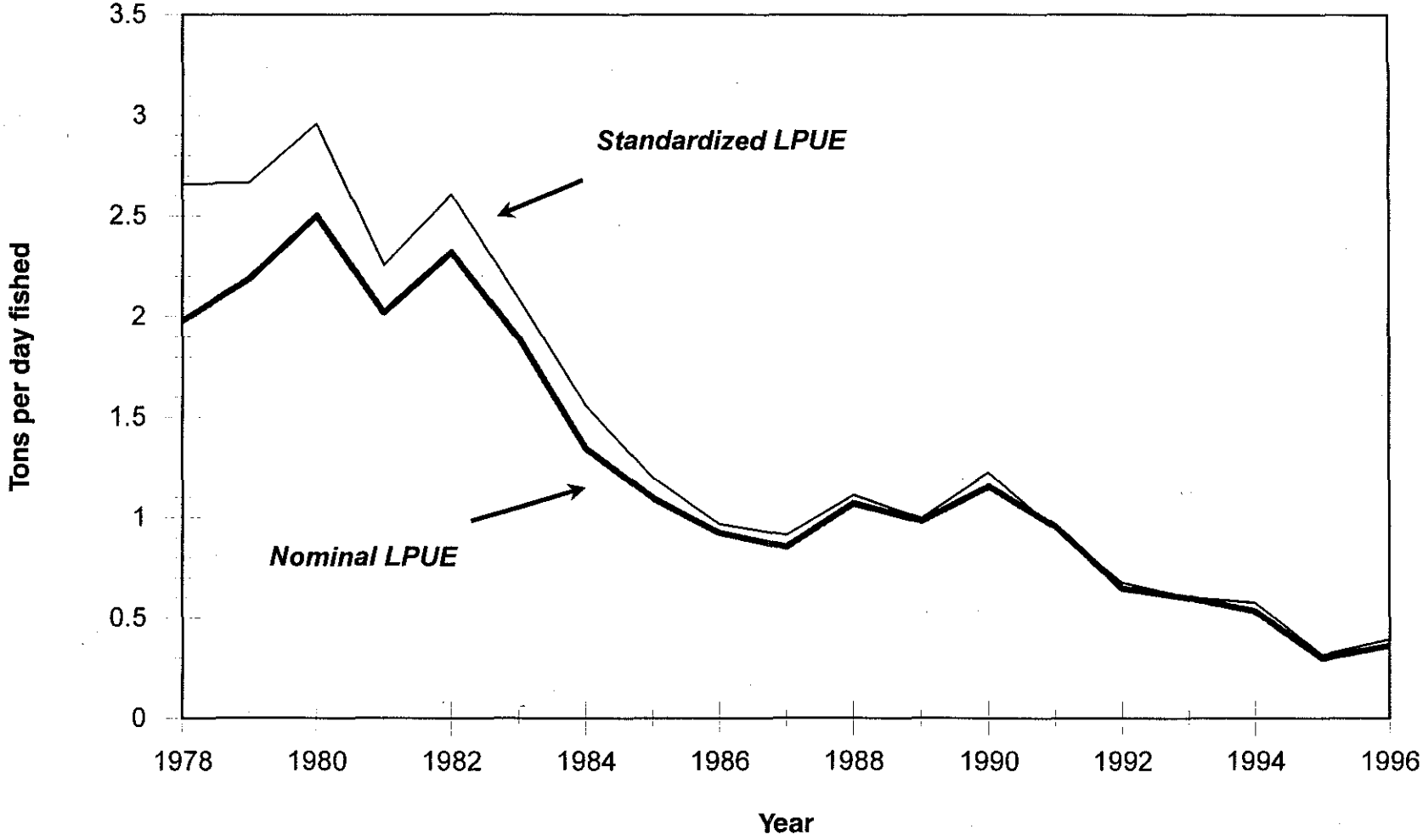


Figure 2. Trends in USA LPUE (landings per day fished) of Georges Bank cod, 1978-1996. Nominal LPUE is based on all otter trawl trips landing cod. Standardized LPUE is derived from a GLM incorporating year, tonnage class, area, quarter, and depth.

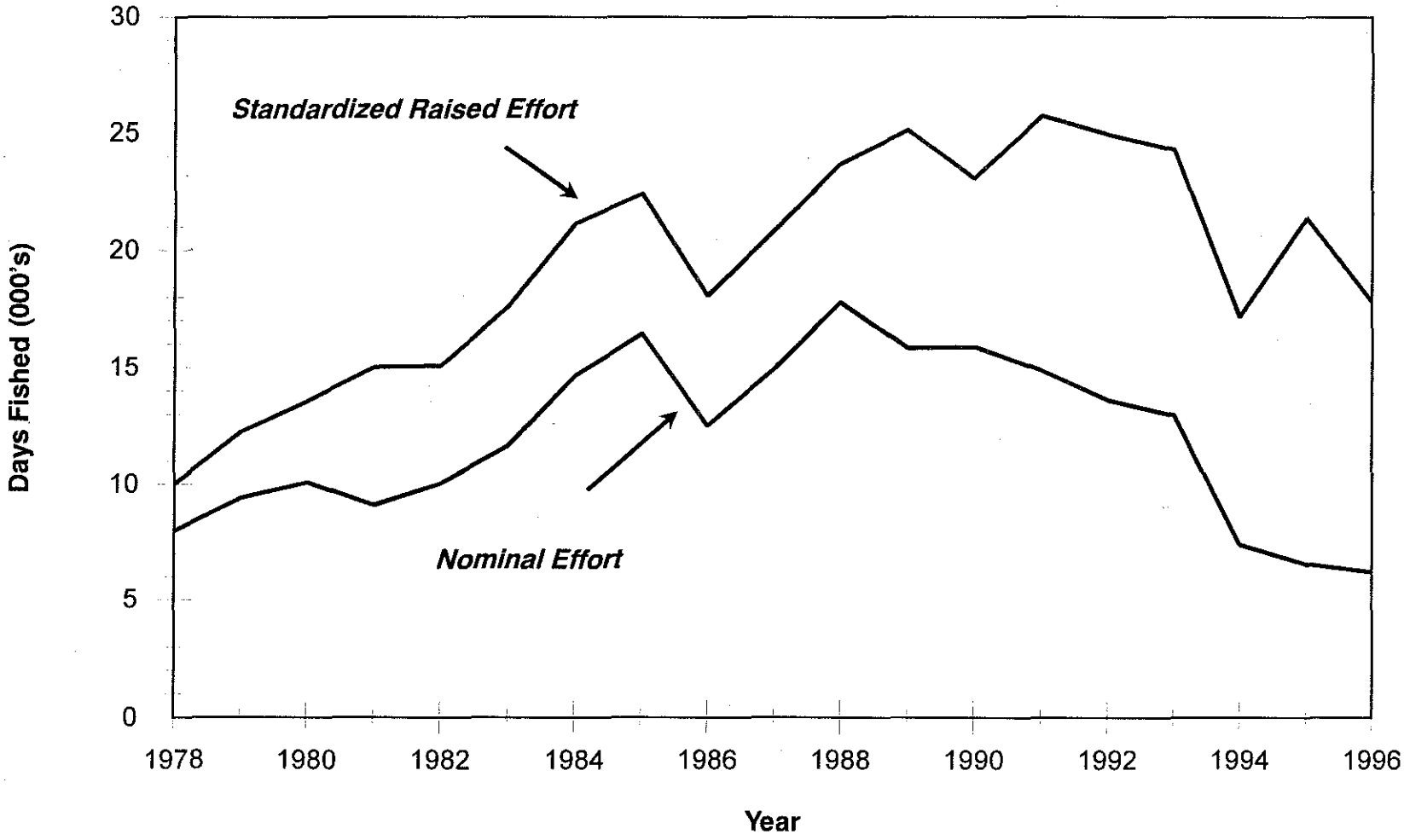


Figure 3. Trends in USA fishing effort (days fished) on Georges Bank, 1978-1996. Nominal effort based on all otter trawl trips landing cod. Standardized-raised effort derived from a GLM incorporating year, tonnage class, area, quarter, and depth.

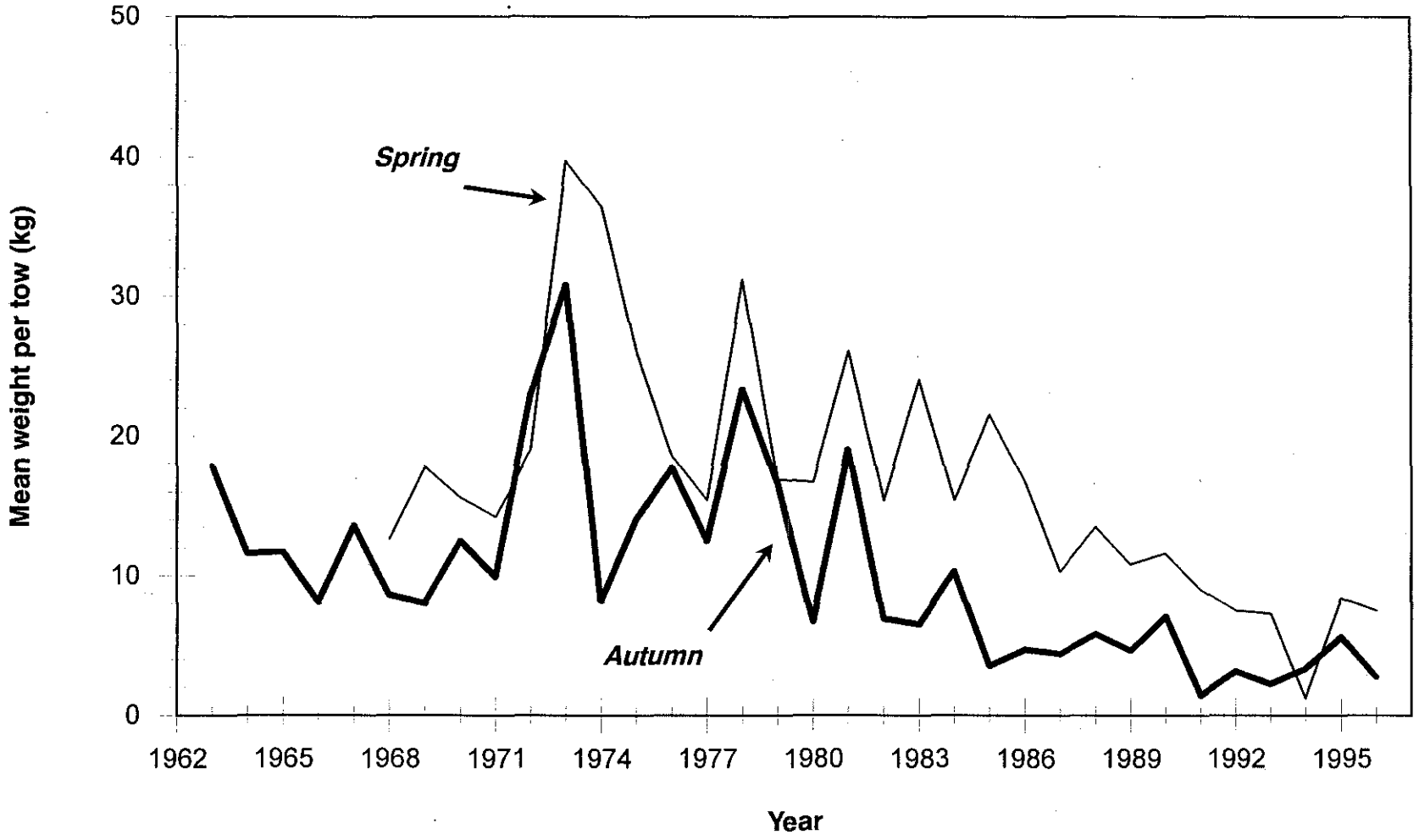


Figure 4. Standardized stratified mean catch per tow (kg) of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys on Georges Bank, 1963-1996.

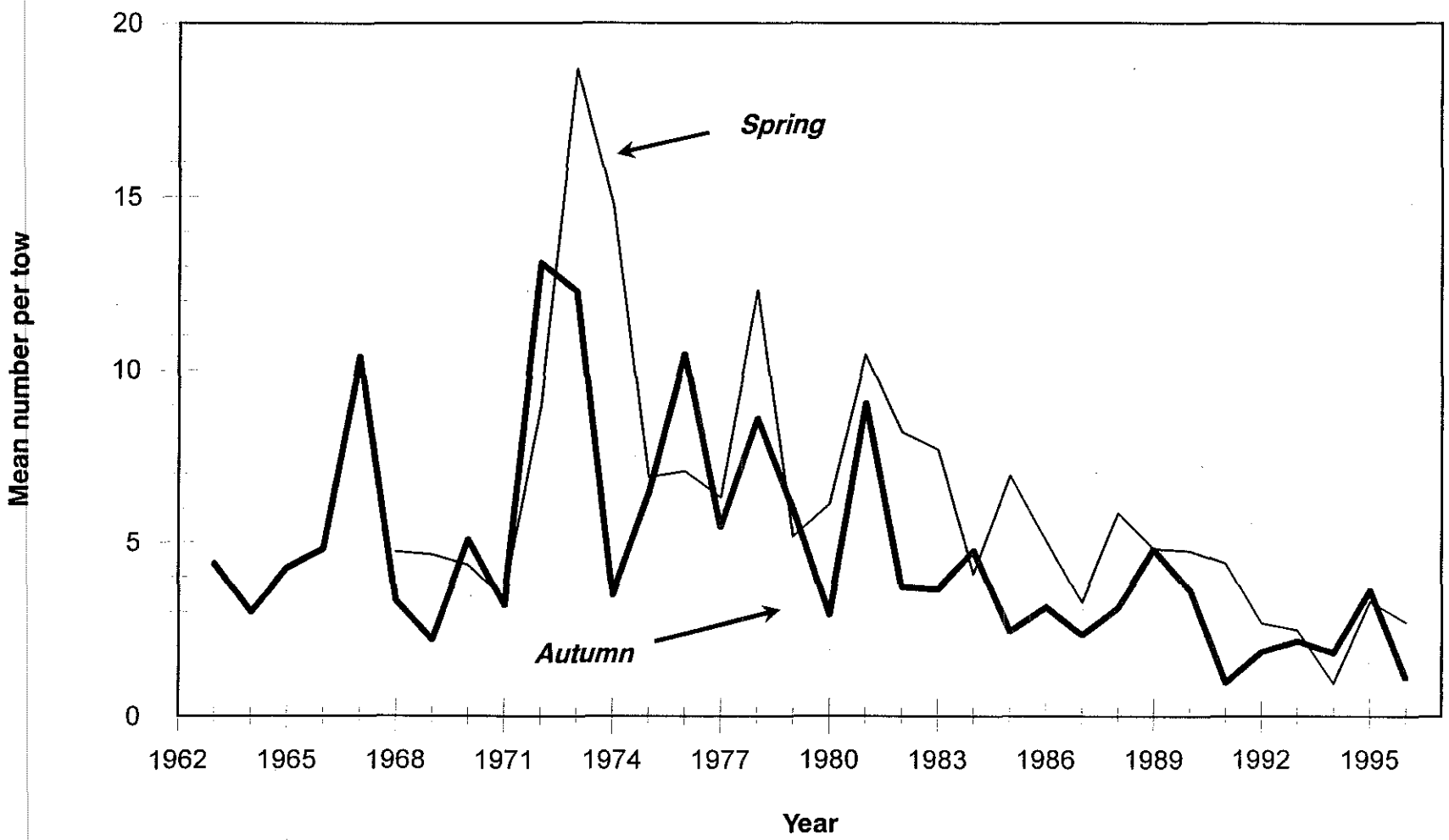


Figure 5. Standardized stratified mean number per tow of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys on Georges Bank, 1963 -1996.

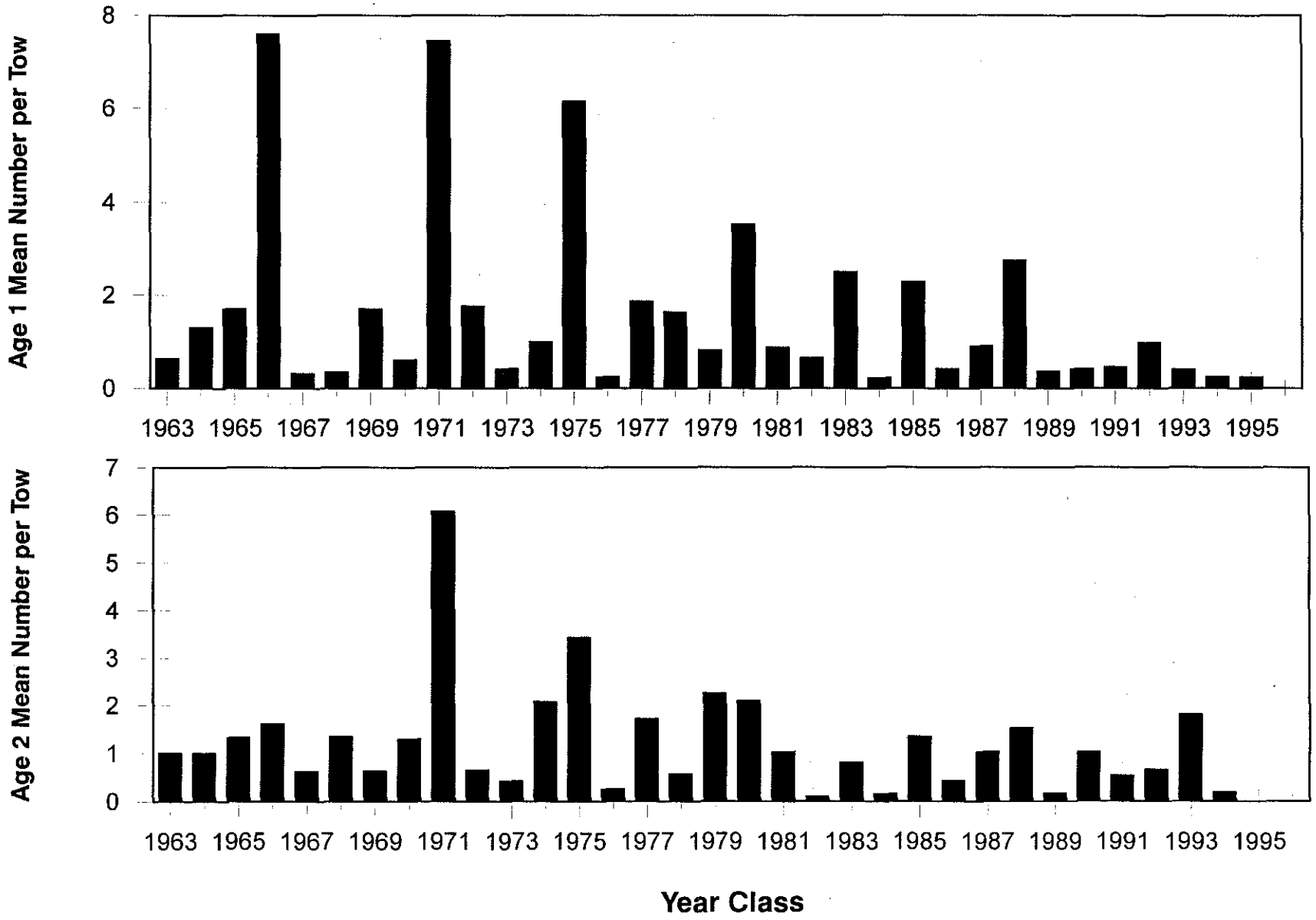


Figure 6. Relative year class strengths of Georges Bank cod age 1 and age 2 based on standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trawl surveys, 1963-1996.

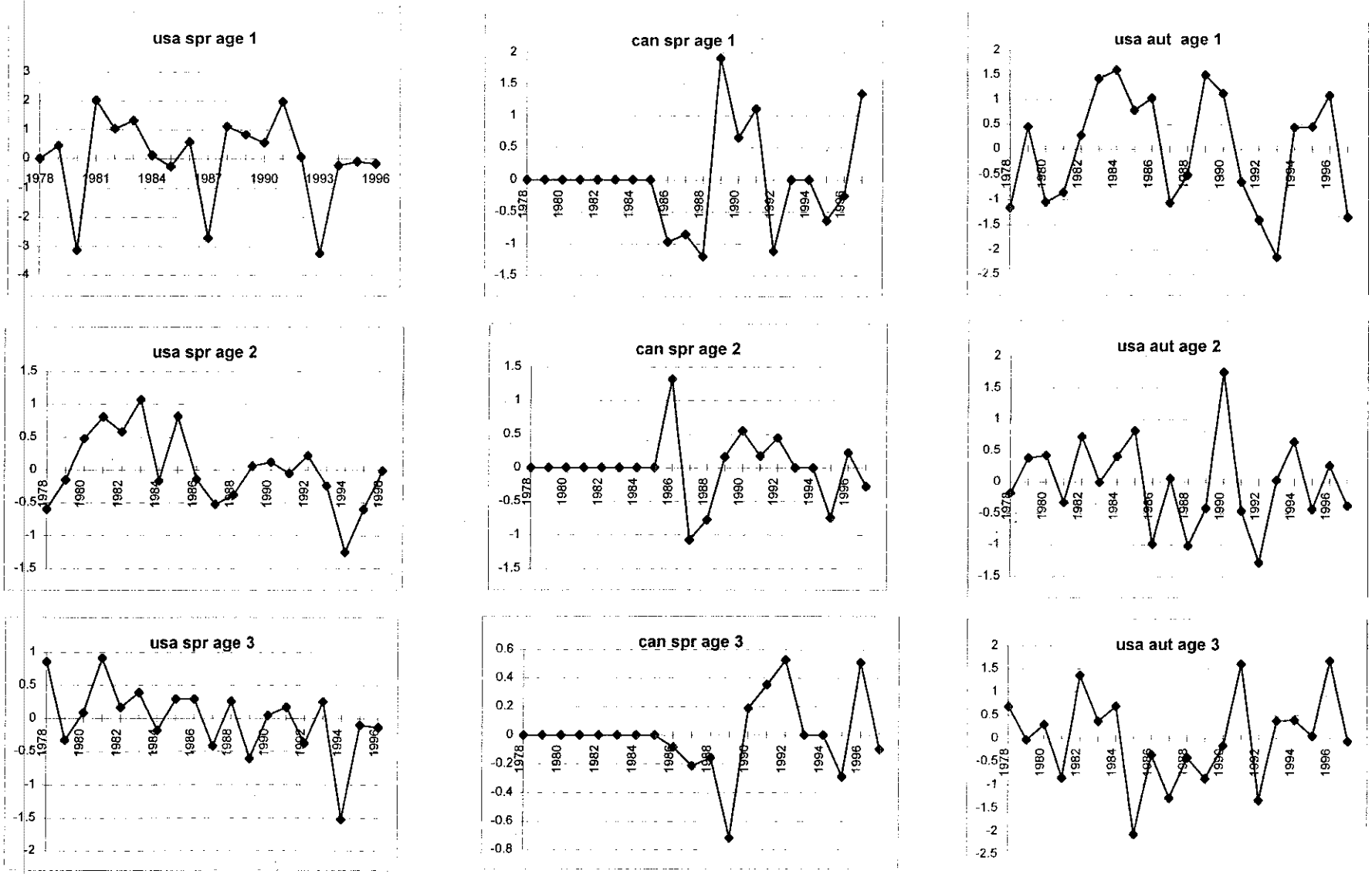


Figure 7. Residual plots (expected -observed) for ages 1-8 for the USA spring and Canadian spring abundance indicies, and ages 1-6 for the USA autumn research survey indices.

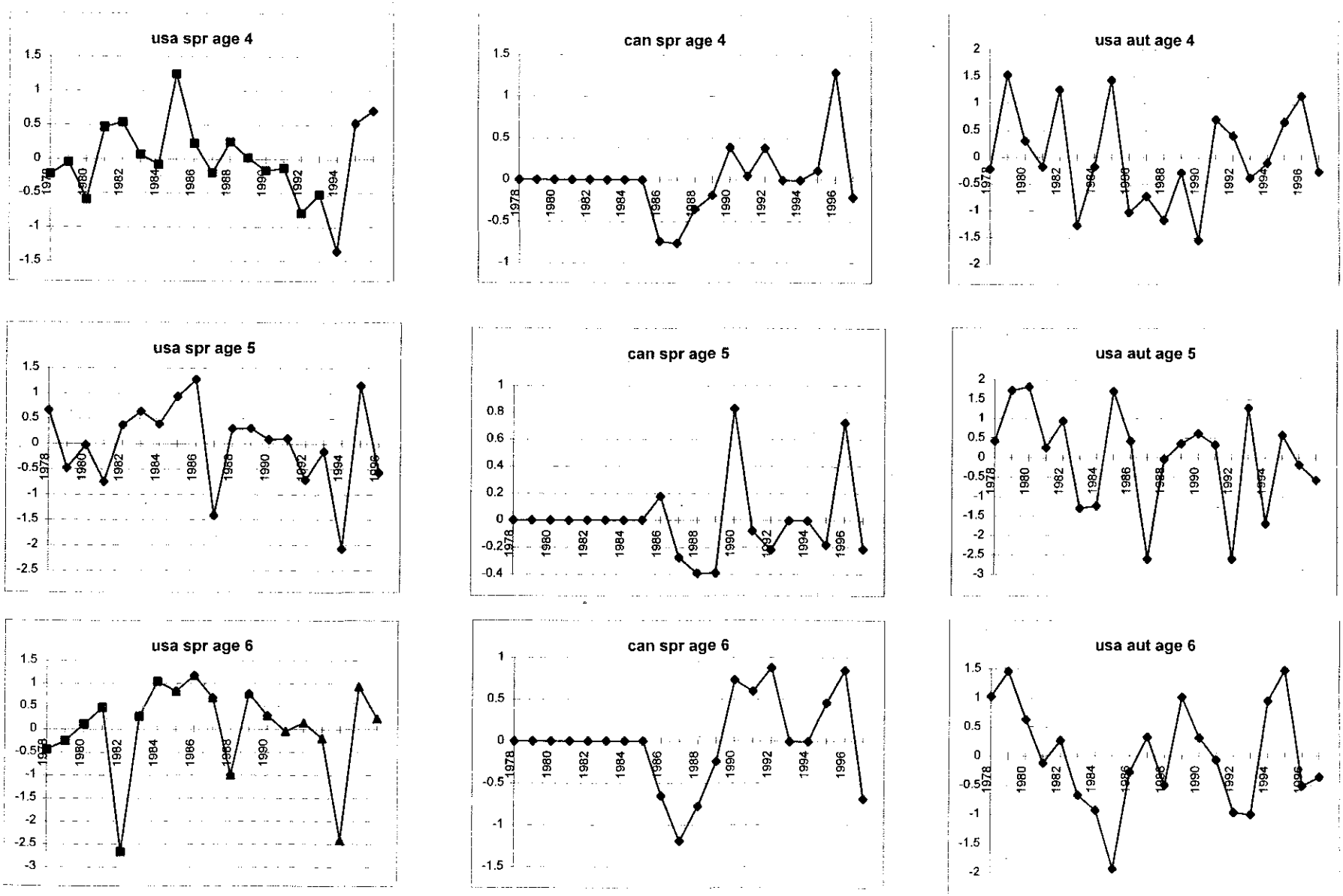
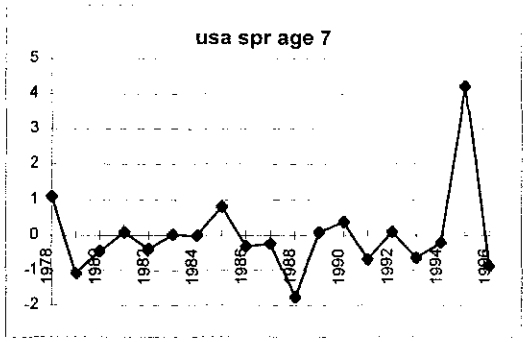
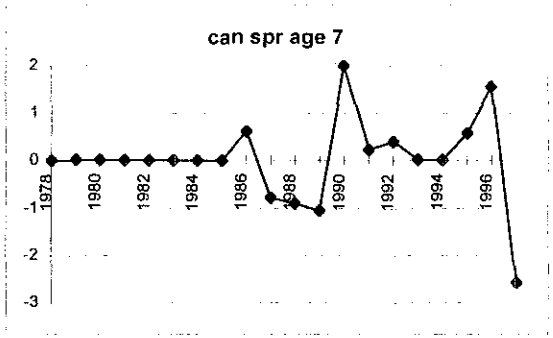
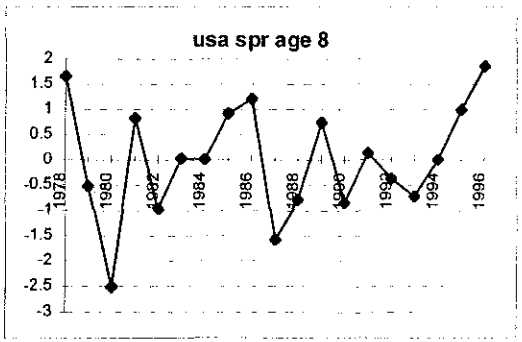


Figure 7 continued. Residual plots (expected -observed) for ages 1-8 for the USA spring and Canadian spring abundance indicies, and ages 1-6 for the USA autumn







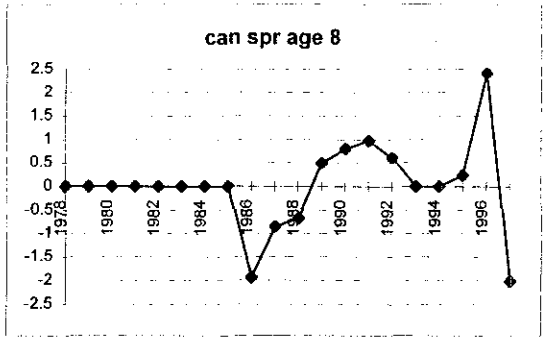


Figure 7 continued. Residual plots (expected -observed) for ages 1-8 for the USA spring and Canadian spring abundance indicies, and ages 1-6 for the USA autumn , research survey indices.

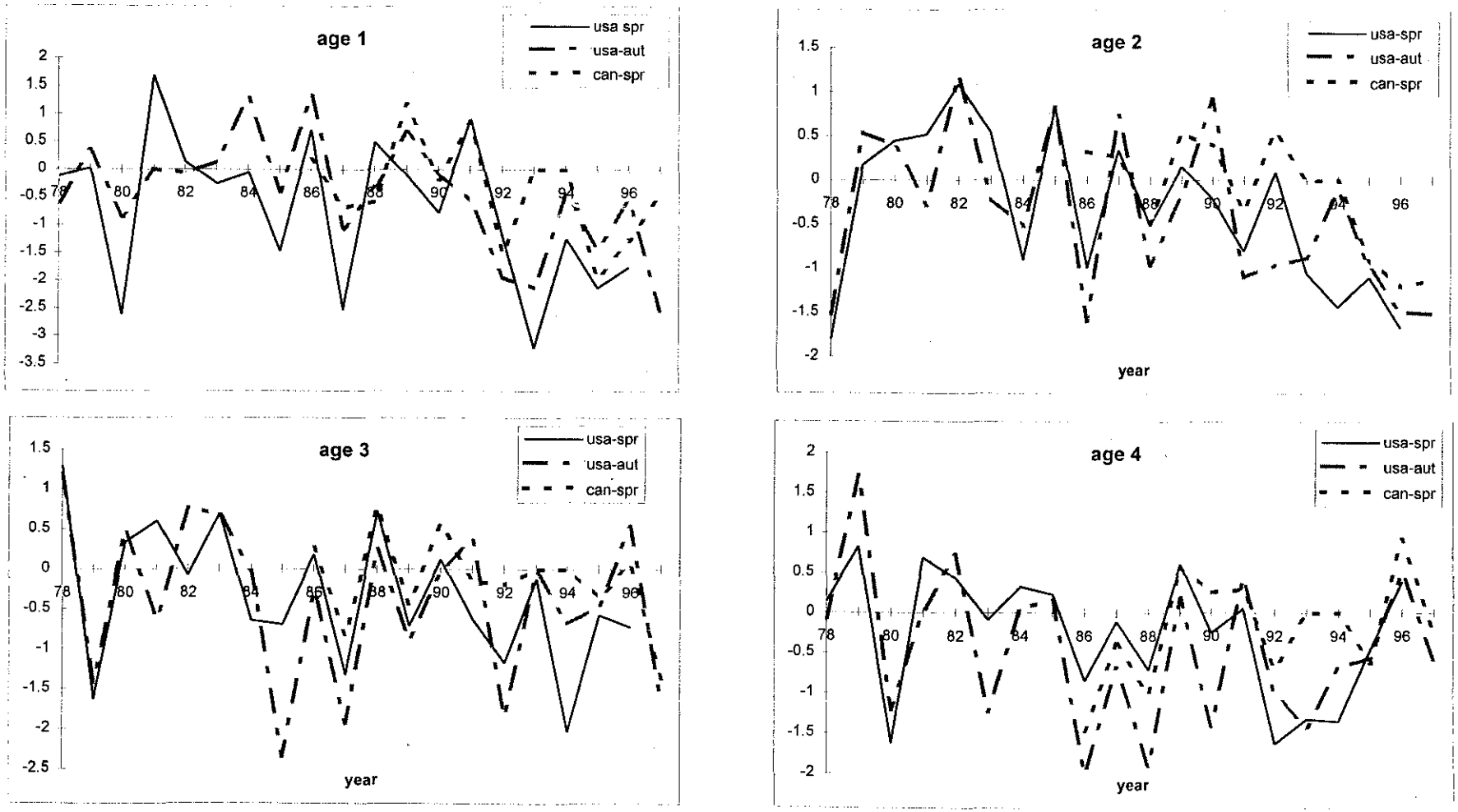
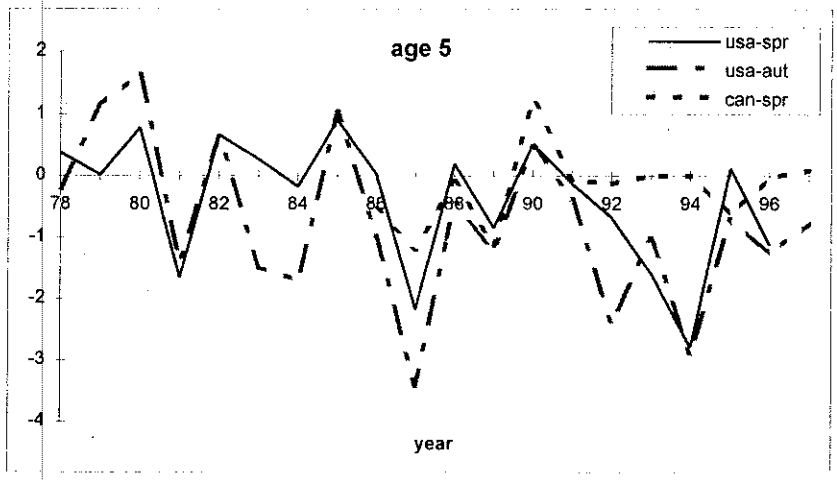
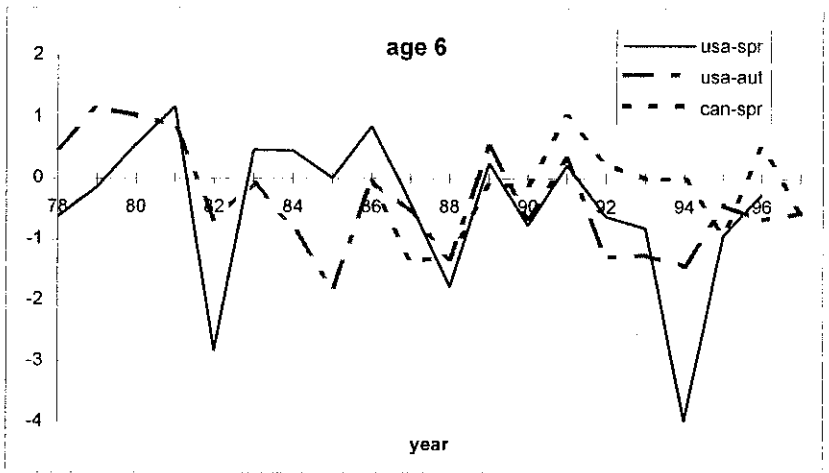
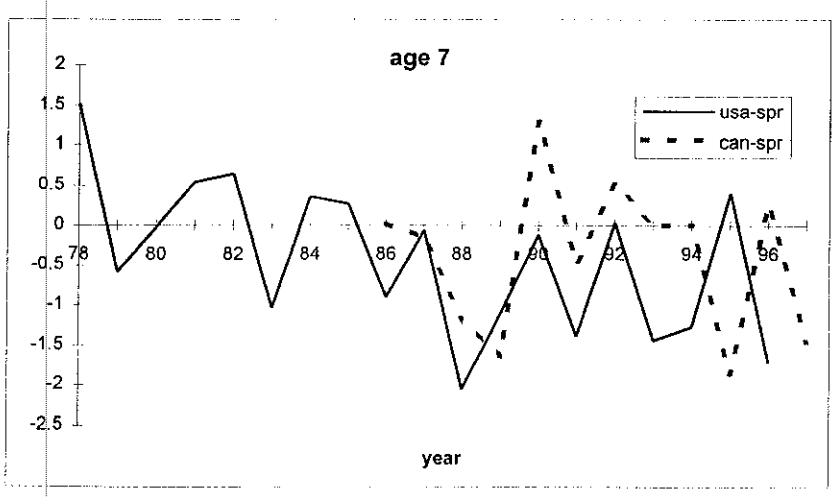


Figure 8. Natural log of the observed survey indices, standardized to the mean, for the USA spring and autumn survey and the Canadian spring survey.







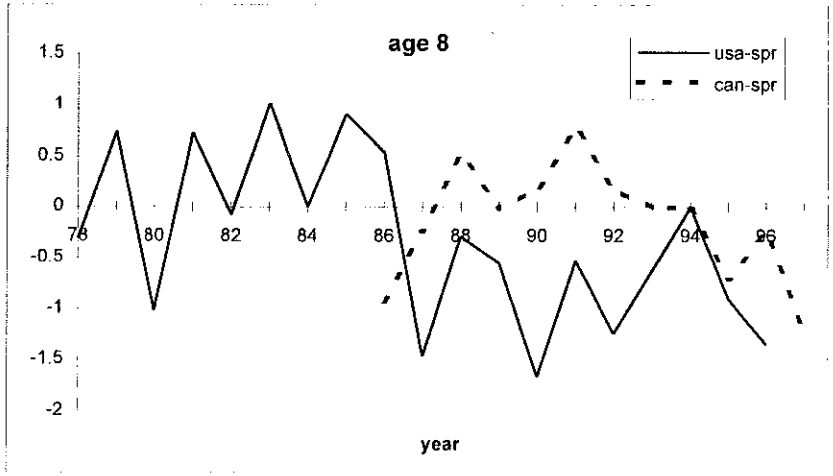


Figure 8 continued. Natural log of the observed survey indices, standardized to the mean, for the USA spring and autumn survey and the Canadian spring survey

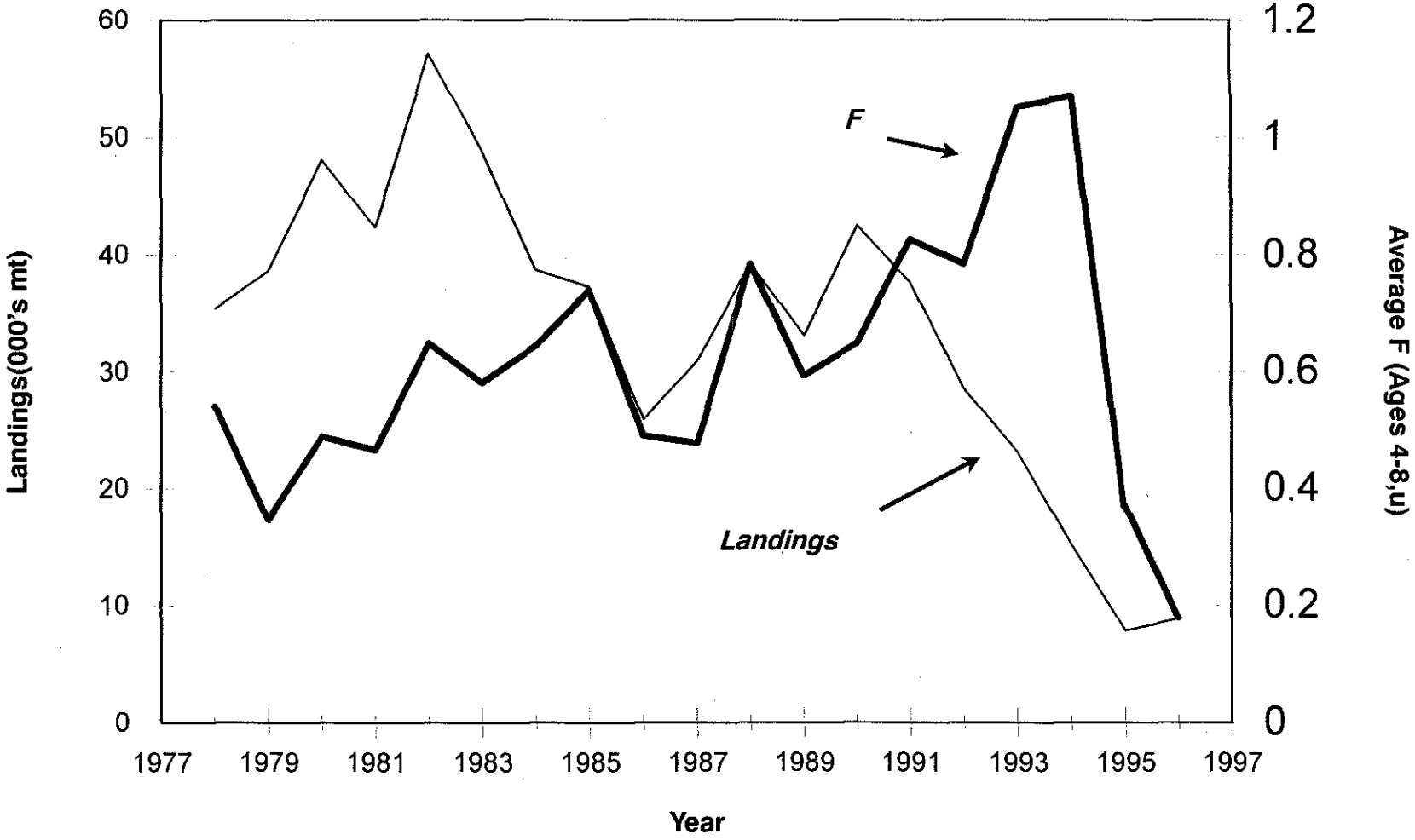


Figure 9. Trends in total commercial landings and fishing mortality for Georges Bank cod, 1978-1996.

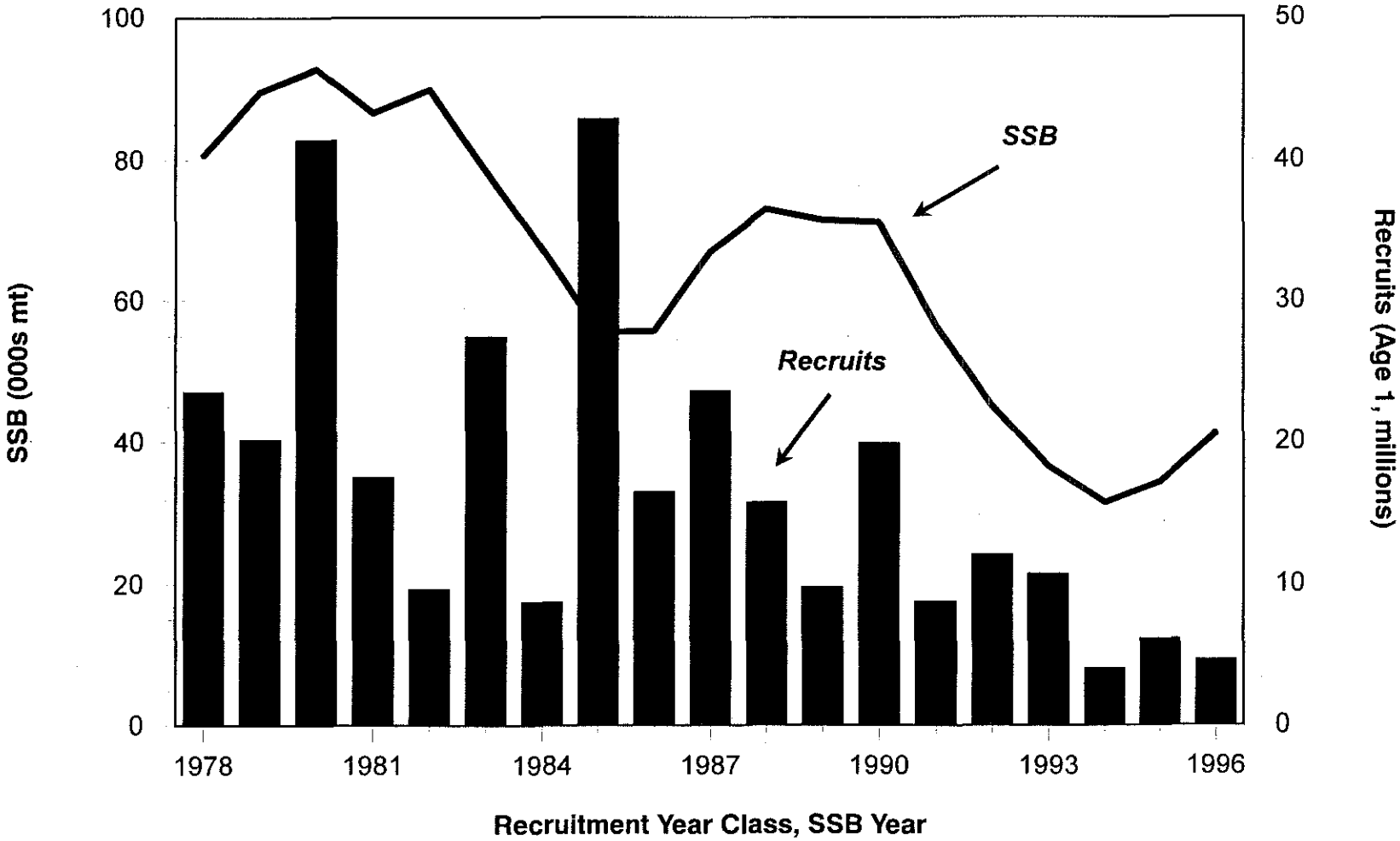
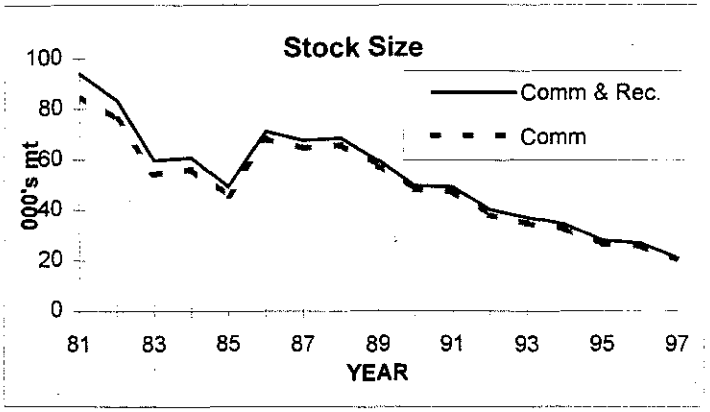
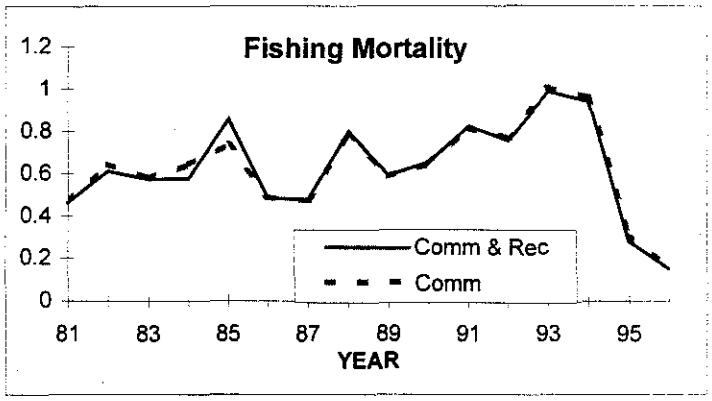


Figure 10. Trends in spawning stock biomass and recruitment for Georges Bank cod, 1978-1996.





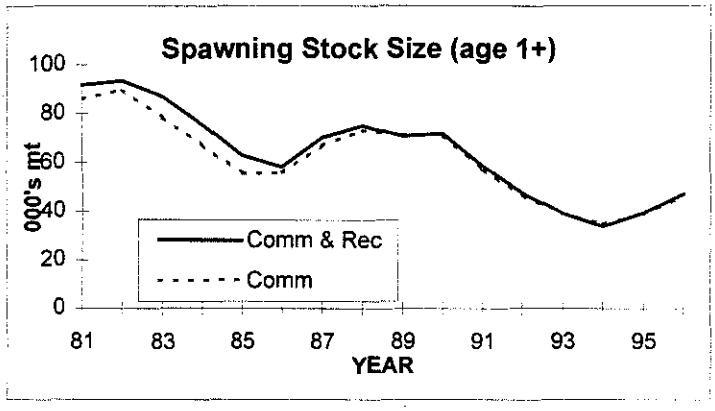


Figure 11. Estimates of stock size at age 1, fishing mortality and spawning stock stock size (age 1+) for ADAPT runs with commercial & recreational catch at age (Run 24) and a commercial only catch at age (Run 28).

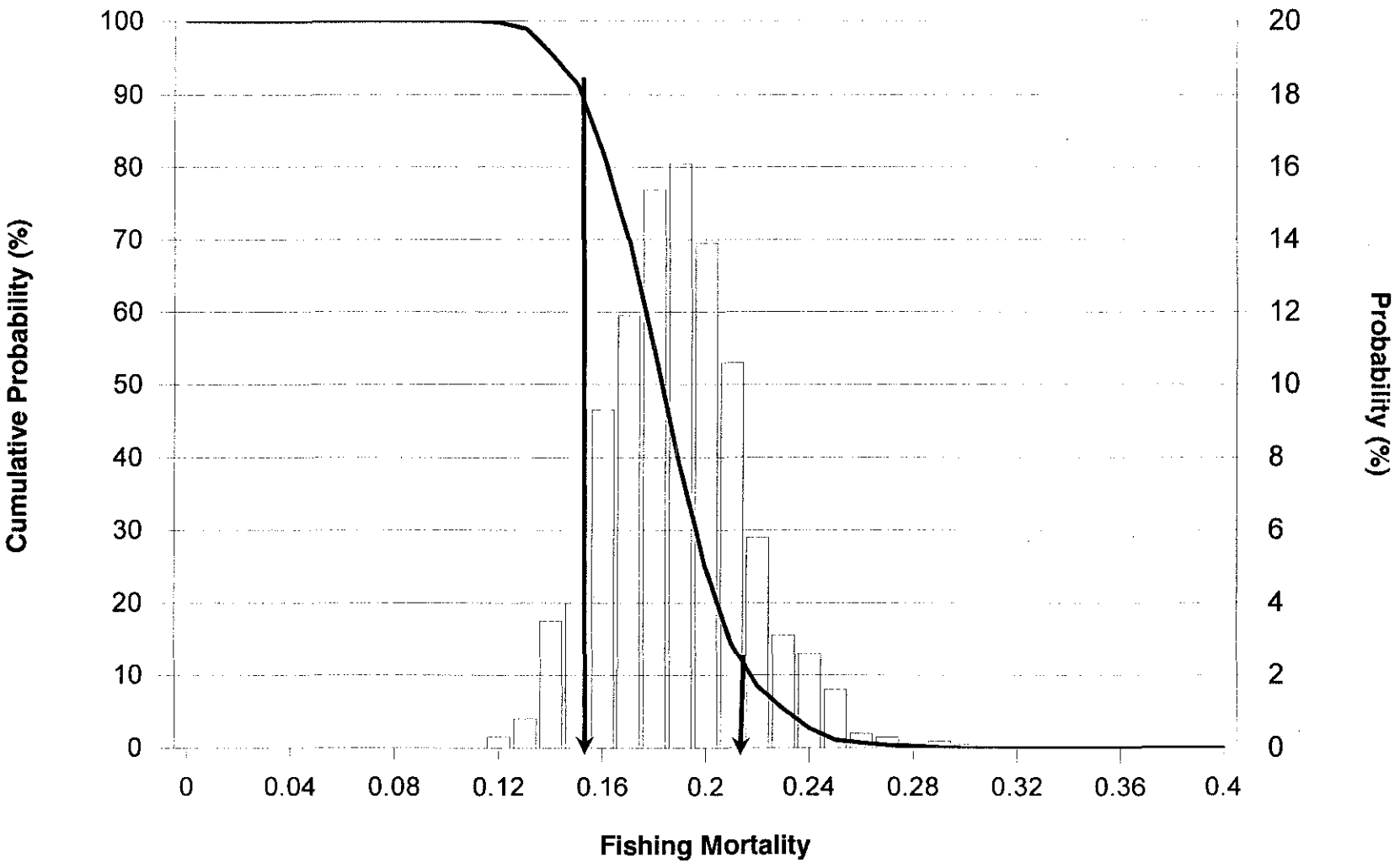


Figure 12. Precision of the estimates of the instantaneous rate of fishing (F) on the fully recruited ages (4+) in 1996 for Georges Bank cod. The bar height indicates the probability of values within that range. The solid line gives the probability that F is greater than any selected value on the X-axis.

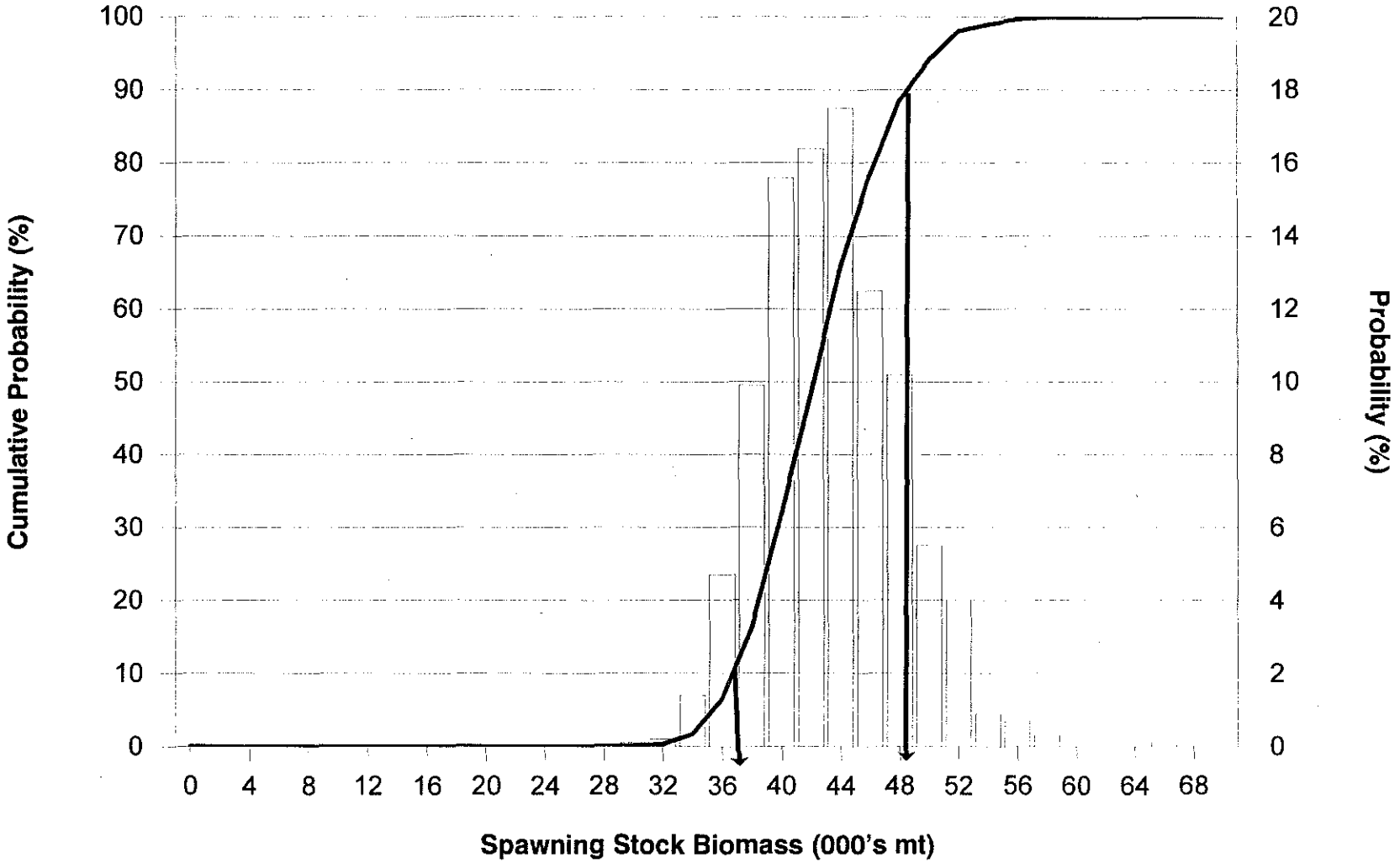


Figure 13. Precision of the estimates of spawning stock biomass (SSB) at the beginning of the spawning season for Georges Bank cod, 1996. The bar height indicates the probability of values within that range. The solid line gives the probability that SSB is less than any selected value on the X-axis.

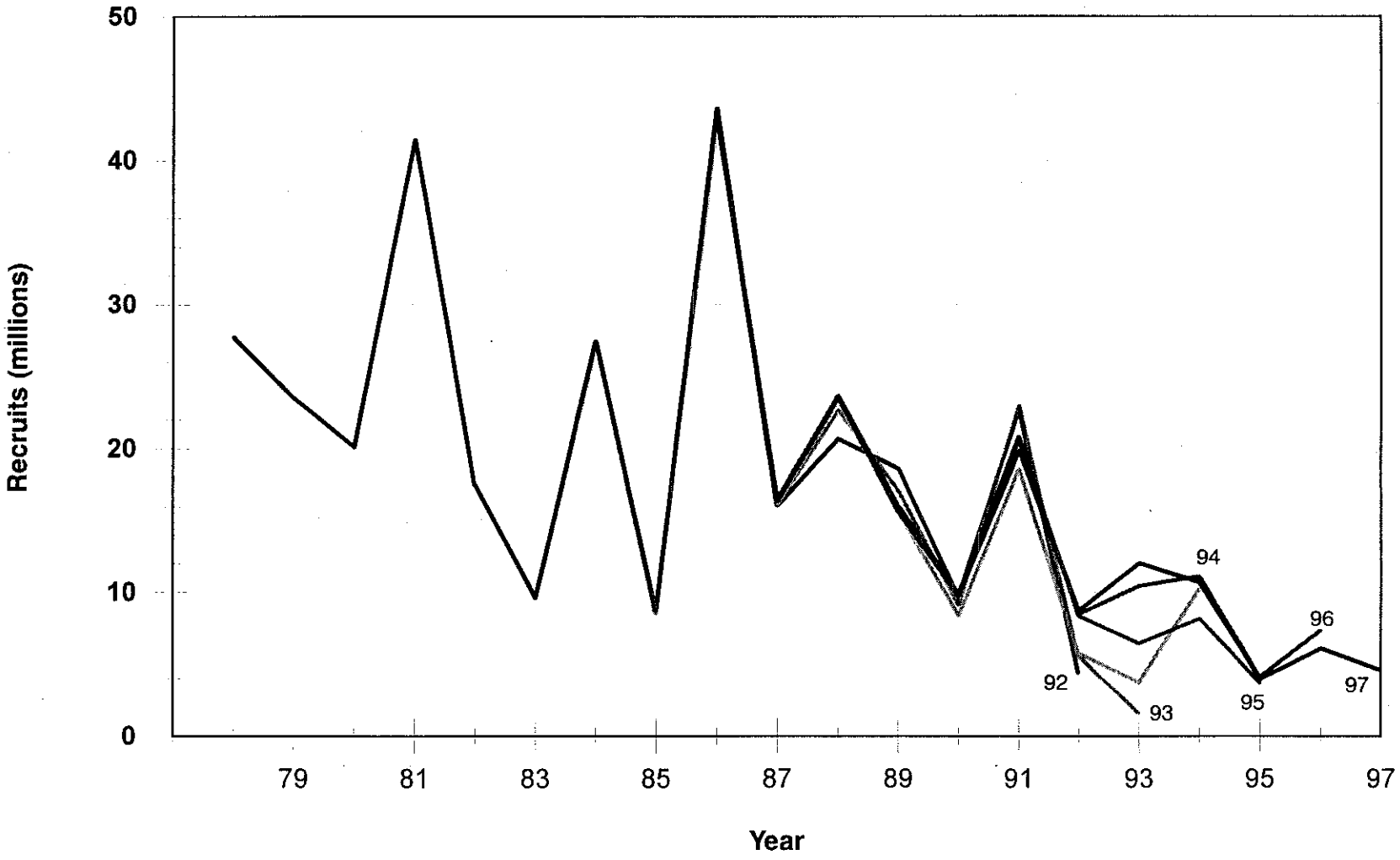


Figure 14. Retrospective analysis of Georges Bank cod VPA based on the final ADAPT formulation for recruits at age 1, 1996-1990.

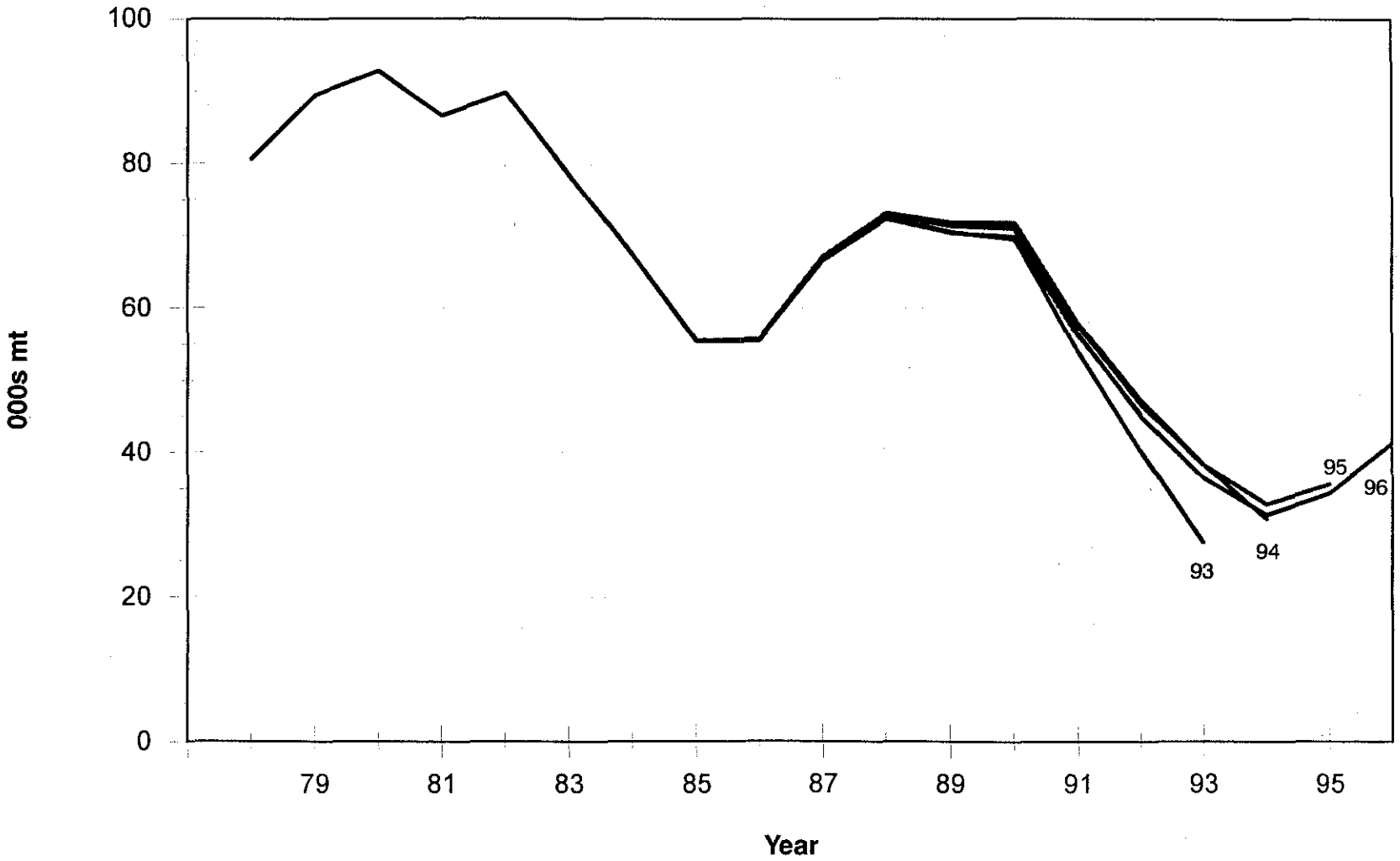


Figure 15. Retrospective analysis of Georges Bank cod VPA based on the final ADAPT formulation for spawning stock biomass, 1996-1990.

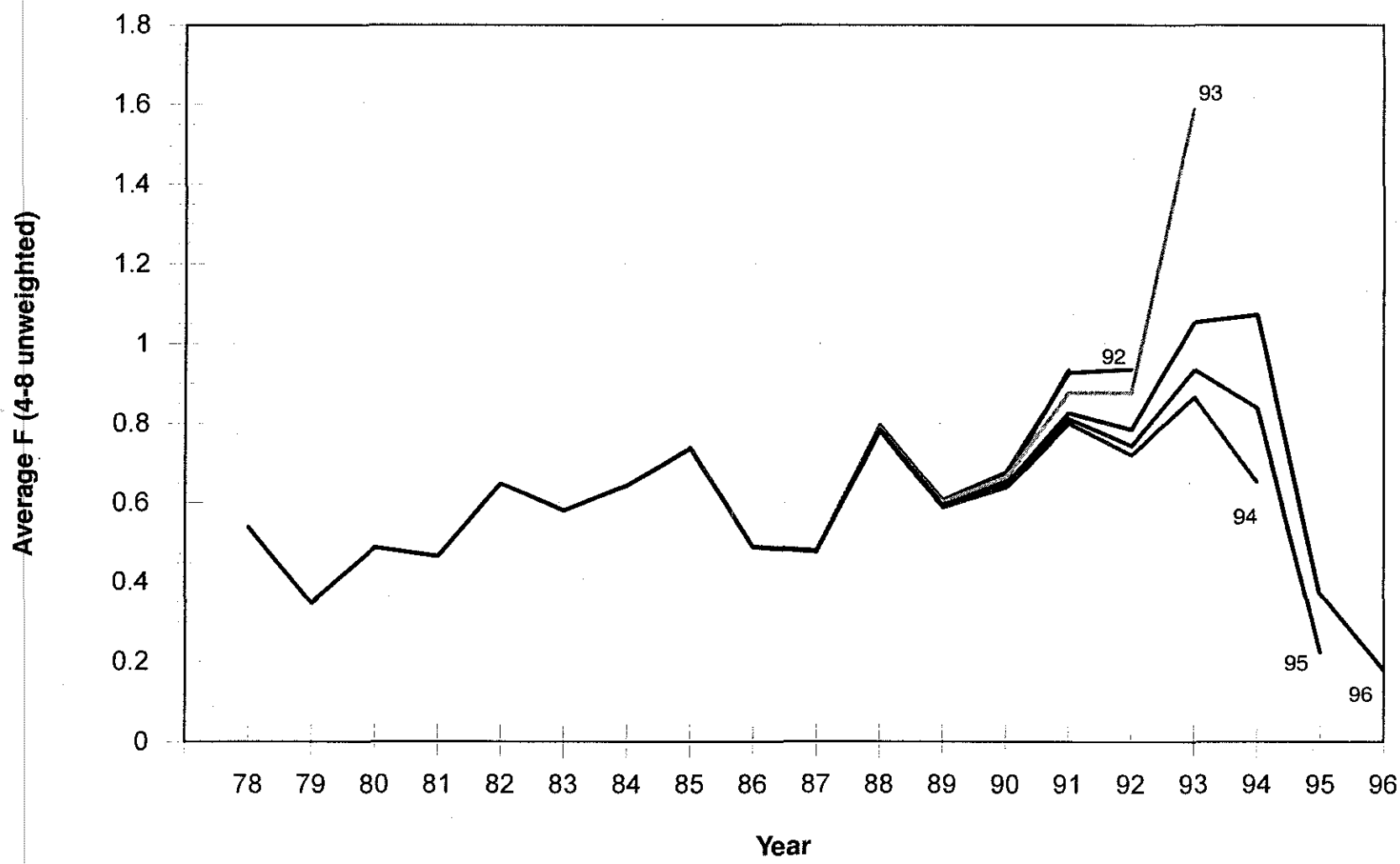


Figure 16. Retrospective analysis of Georges Bank cod VPA based on the final ADAPT formulation for fishing mortality (average F, ages 4-8, unweighted), 1996-1990.

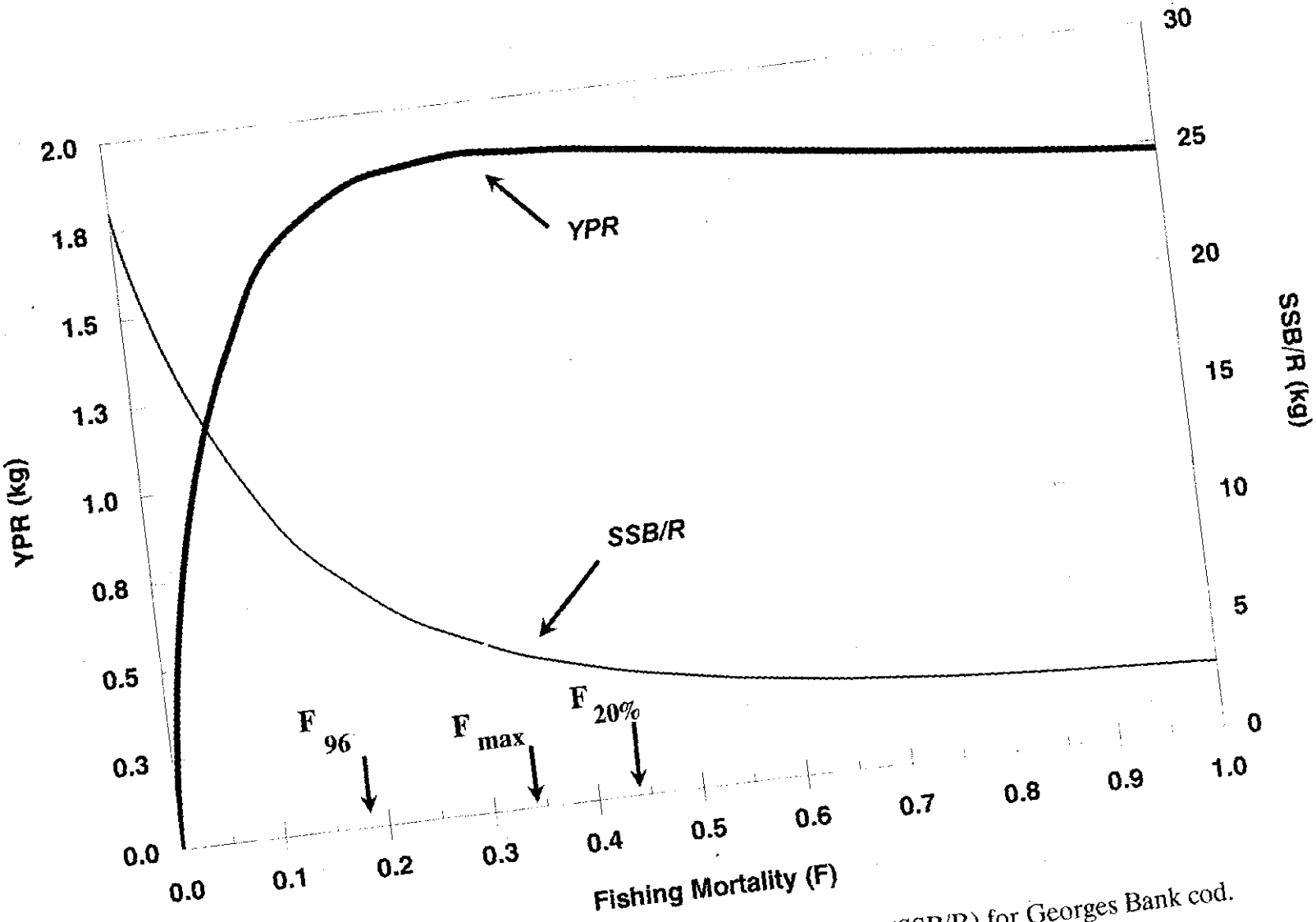


Figure 17. Yield per recruit (YPR) and spawning stock per recruit (SSB/R) for Georges Bank cod.

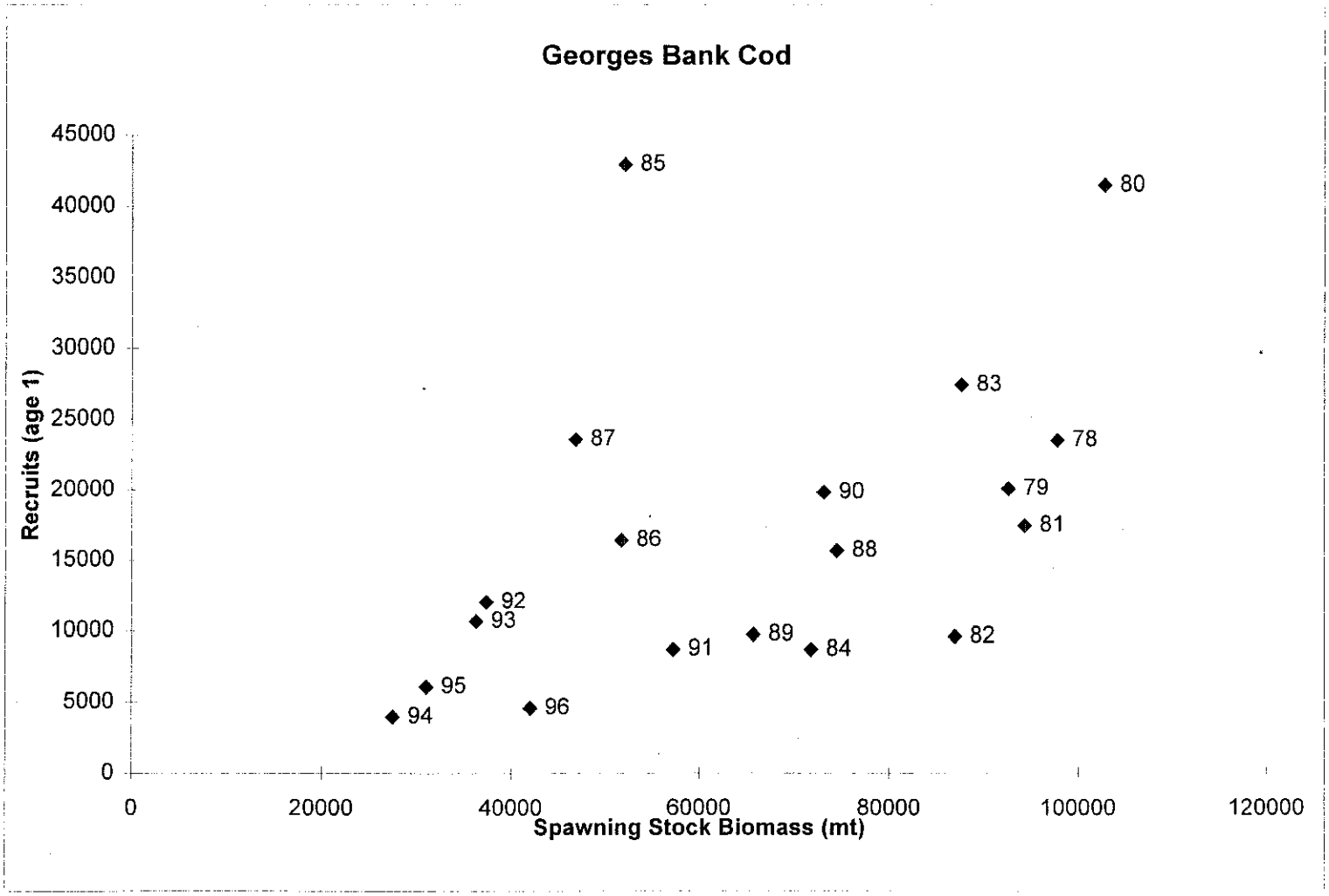


Figure 18. Spawning stock biomass (ages 3+) and recruits (age 1) for 1978-1996.

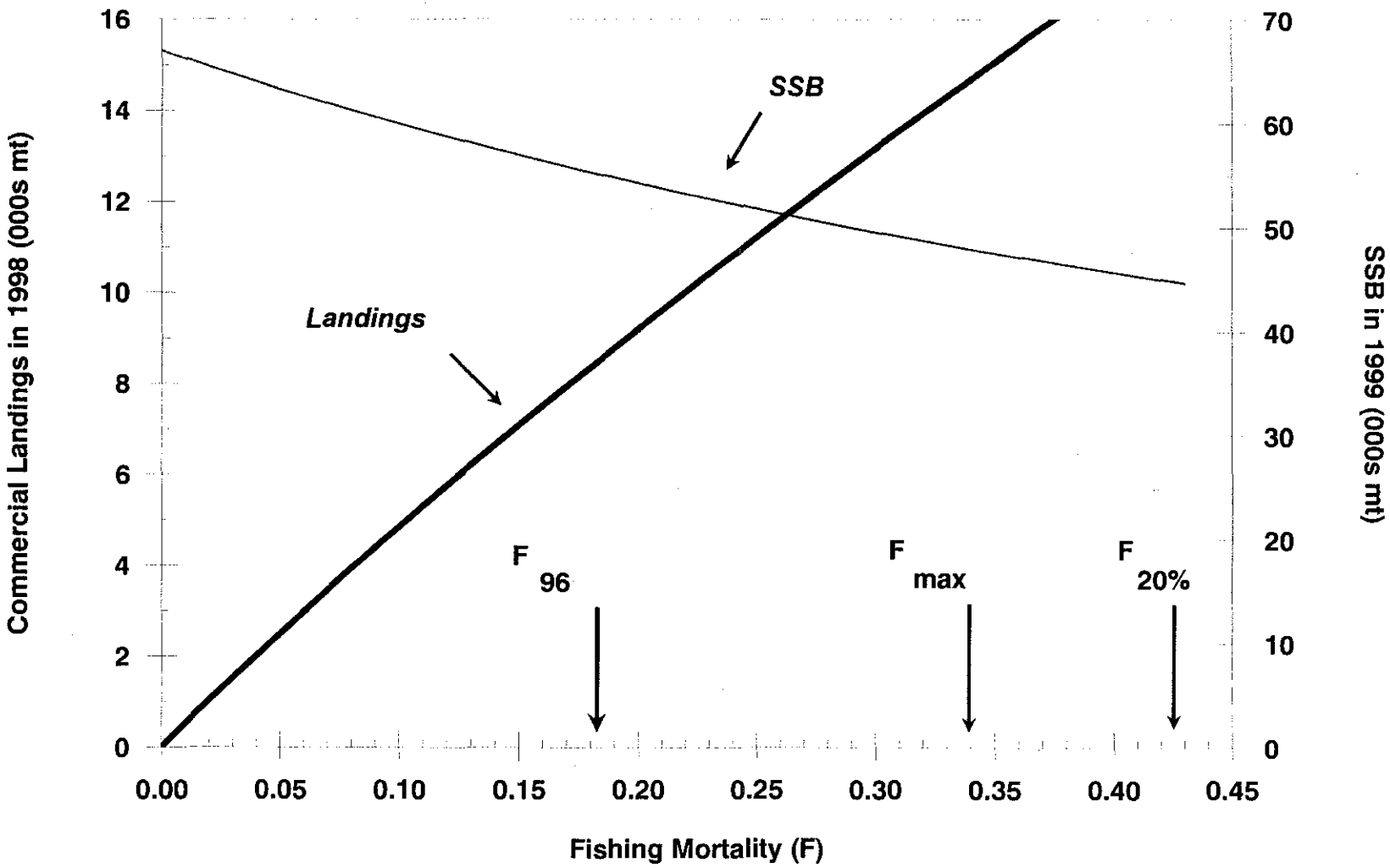


Figure 19. Predicted landings in 1998 and spawning stock biomasses in 1999 of Georges Bank cod over a range of fishing mortalities in 1998 from F = 0. 0 to F = 0.45.

APPENDIX 1

A Preliminary Analysis of Georges Bank Cod Abundance Indices in the "Open Area", and Closed Areas I and II.

A Preliminary Analysis of Georges Bank Cod Abundance Indices in the "Open Area", and Closed Areas I and II.

With the complete closure of Areas I and II on Georges Bank and the Nantucket Lightship Area since December 1994, landings per unit effort (LPUE) estimated for 1994-1996 may no longer be proportional to stock abundance and may not be equivalent to the previous time series of LPUE (1978-1993) of Atlantic cod. An analysis using research survey data was undertaken to explore the relative magnitude of the abundance indices between the closed and open areas and a second analysis using the commercial data was conducted to compare the effect of the current area closures on the standardized LPUE.

Research Survey Data

Abundance indices (mean number and mean weight per tow) for Atlantic cod from the spring (1968-1996) and autumn (1963-1996) bottom trawl surveys were estimated based on being in the 'open' Area, closed Area I , closed Area II , or the closed Nantucket Lightship Area. Each survey station was assigned to either the open area or to one of the three closed areas based on the beginning latitude and longitude position of the trawl haul and was also assigned to a survey strata. In some cases, however, survey strata included open and closed areas, for example, strata 19 included the open area, Area I , and Area II (Appendix 1: Figure 1). For any stratum that occurred in more than one area, the stratum was reallocated into a smaller stratum within each area, stratum area in nautical miles was re-estimated, and the 'new' stratum was then used in the analysis. This is not post-stratification but does provide a method to derive stratified mean estimates within each area. Stratified mean catch per tow in both numbers and weight (kg) was estimated as well as the variance of the mean (Cochran 1977) for the open Area, closed Area I, closed Area II, and the Nantucket Lightship Area. Ratios of the abundance indices in the closed area to the abundance in the open area were derived for spring and autumn and are presented in Appendix 1, Figures 2-5 for Area I and Area II.

Seasonally, the abundance and biomass indices of cod in Area I are consistent between the spring and autumn surveys relative to the open area (Appendix 1: Figures 2 - 5). The indices were variable and similar in trend to the open area prior to 1982, and show an increasing trend in the recent years for both spring and autumn surveys. In Area II, however, cod do not appear to be as available to the survey gear in the autumn as in the spring, relative to the open area (Appendix 1: Figures 2 - 5). The trend of higher biomass and abundance in Area II relative to the open Area during 1970-1981 and the increasing trend during 1982-1996 in the spring (Appendix 1: Figure 2-3) is not apparent in the autumn (Appendix 1: Figures 4 and 5).

The estimated mean individual fish weights (mean biomass/mean number) are variable and show no trend in the spring or autumn (Figures 6-7) over the time series. There is a tendency, although not consistent throughout the time series, of a higher mean weight of fish in Area I compared to Area II and the open area.

Commercial

Current area closures, implemented in December of 1994, were simulated throughout the 1978-1996 time series to determine the historic magnitude of LPUE within the closed areas and the effect of the closed areas on trends in LPUE. All interviewed otter trawl trips landing cod from Georges Bank and South from 1978-1996 were assigned to either the open area or closed Area I or II, or the closed Nantucket Lightship Area, according to the recorded latitude and longitude position of the fishing trip. Indices were estimated for all ton class 2-4 vessels from 1978-1996 that landed any amount of cod. Commercial catch and effort data from 1994-1996 were unaudited for the fields of interest so, as a 'preliminary' audit, obvious outliers were eliminated for latitude, longitude, average number of tows, and number of soak hours. Days fished were calculated for 1994-1996 as (number of hauls x soak hours)/ 24. In spite of this , there was still the possibility of estimating erroneous LPUE values, therefore, the data was ultimately not used in the final VPA.

Standardized fishing effort and LPUE were then estimated based on three general linear main effects models (GLM), using methodology similar to Mayo *et al.* (1994), to investigate the effect of the closed area on the standardized LPUE. The model was run with 1978-1993 data , and the 1994-1996 standardized fishing effort and LPUE were estimated by applying the re-transformed model coefficients.

The first model was a four factor GLM with year, tonnage class, quarter, and depth. The second model included statistical area as a fifth factor, and the third model included a close/open area variable as a fifth factor. Standards chosen for the analysis were year 1978, statistical area 521, quarter 2, depth zone 3, tonnage class 33, and open area 0. Model coefficients were retransformed to the linear scale after correcting for bias (Granger and Newbold 1977). Standardized effort was calculated by multiplying nominal effort by the re-transformed coefficients for statistical area, quarter, tonnage class, depth, and close/open area factor. Total raised effort was then derived by dividing total USA landings by the standardized LPUE.

Standardized LPUE for the five factor GLM with statistical area indicates a declining trend since 1982. The four factor model, with no area included, had the same trend but at a lower magnitude (Appendix 1: Figure 8, lower panel). The GLM with the close/open area factor tracked the four factor (no-area) GLM almost exactly, except in 1994. Similar patterns are observed in the raised effort, where the four factor (no area) model is very similar to the close/open model, with the exception of 1994 (Figure 8, upper panel). The five factor model, with statistical area, follows the same trend with a lower magnitude.

These results indicate that the close/open area factor has no substantial effect on the standardized LPUE, and the addition of the statistical area increases the absolute magnitude. The 1994 point may be influenced by the change in the manner of collection of catch effort data in that year. Prior to 1994, effort data was collected by port agents during personal interview with the vessel captains, and the most recent effort data is taken from mandatory logbooks. Effort data was unaudited for 1994-1996.

The current 1994-1996 effort data may not be consistent with the historical effort data because of the change in the manner of collecting information (i.e. personal interviews vs. mandatory logbooks). Further work needs to be done to characterize the post-1994 effort data before the data is included with the historic LPUE series.

Summary

The survey analysis suggests that seasonal movement of cod may influence the abundance indices in the closed area relative to the open area, during the autumn. These results may be more indicative of spatial differences between the eastern and western part of the Bank, rather than differences between open area and closed areas. The GLM indicated no effect of the closed area on historical levels of LPUE. Re-examination of the data on a different spatial scale (east vs. west) for both research and commercial data may provide further insight.

Since 1985 the stock has been fished in the east by the Canadian fishery and to the west by the USA fishery. The temporal component of the survey that coincides with the decline of LPUE in 1982 suggests that fishing mortality may be influencing changes in the stock. Partitioning the total fishing mortality on the stock into an eastern and western partial F may clarify how spatial trends in the stock may be influenced by trends in partial F.

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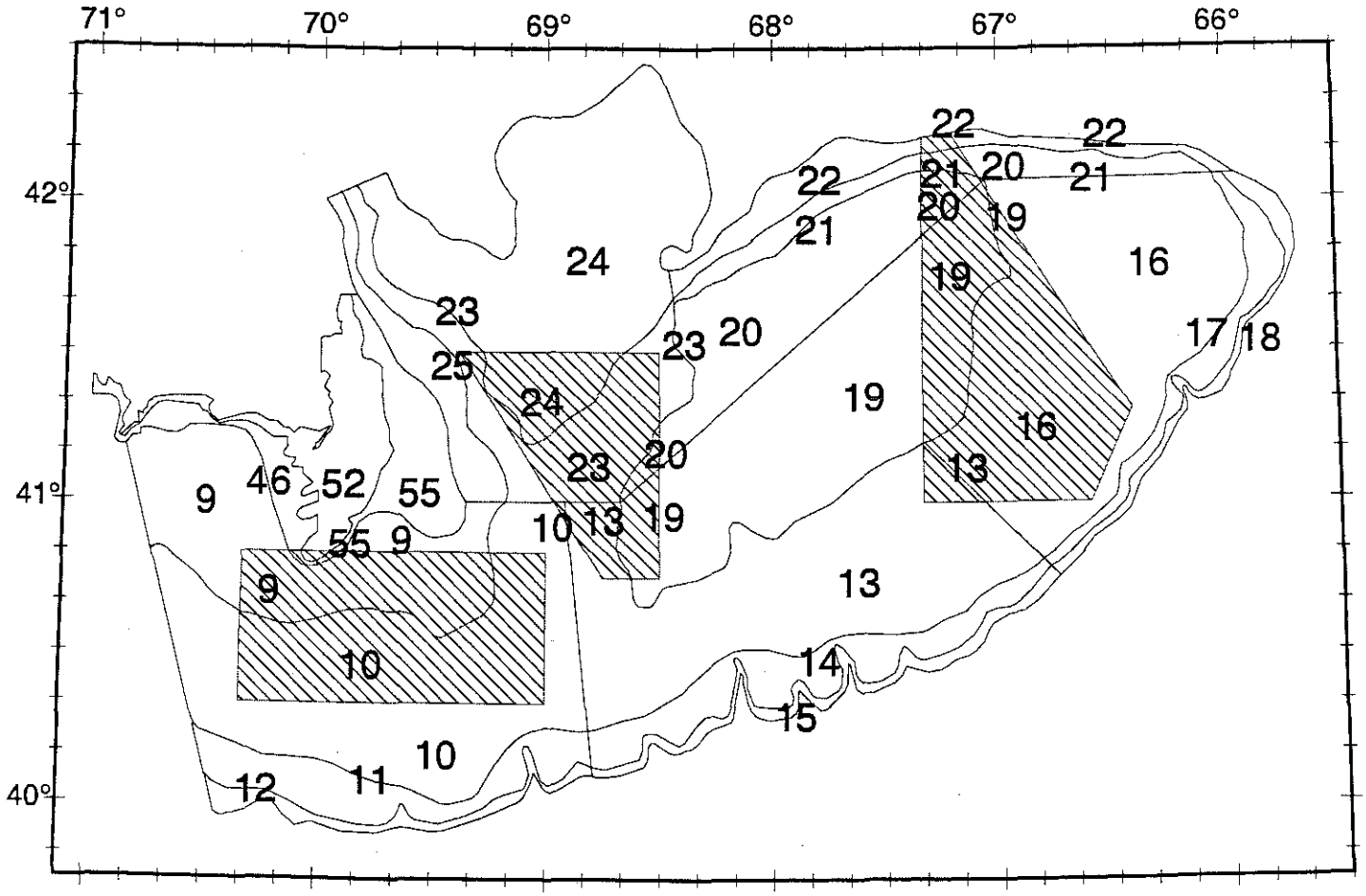
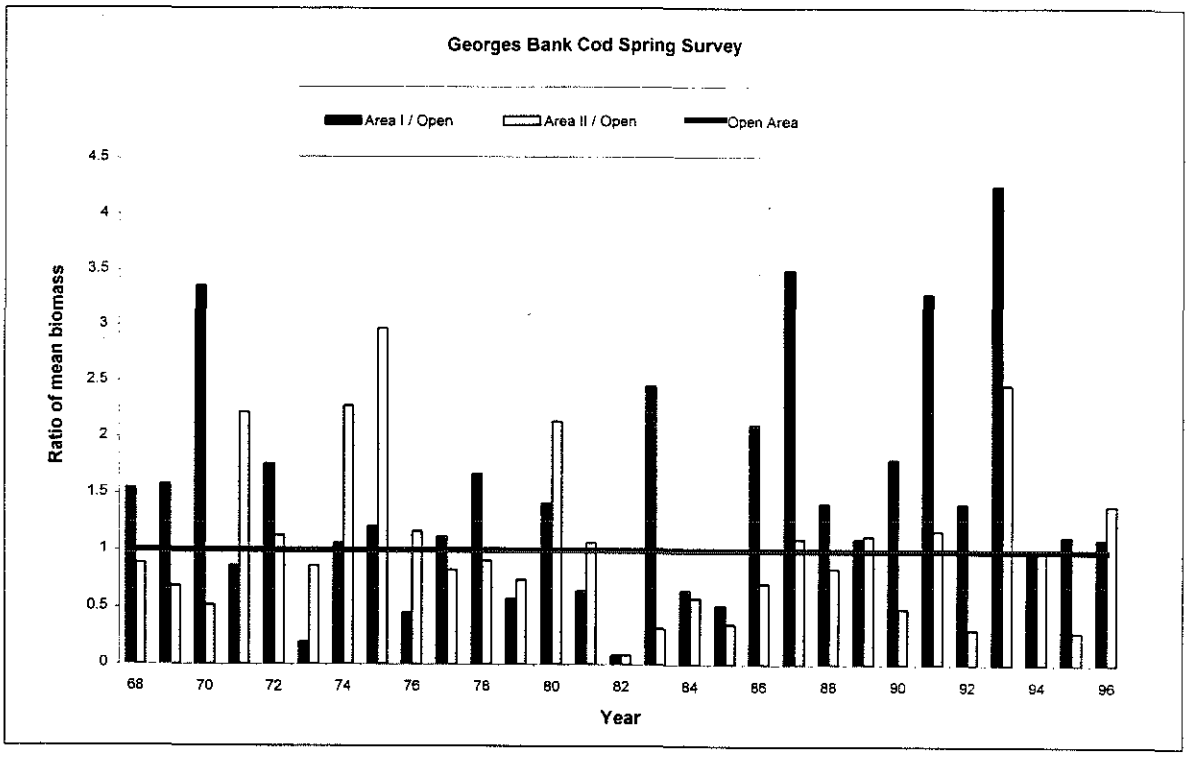
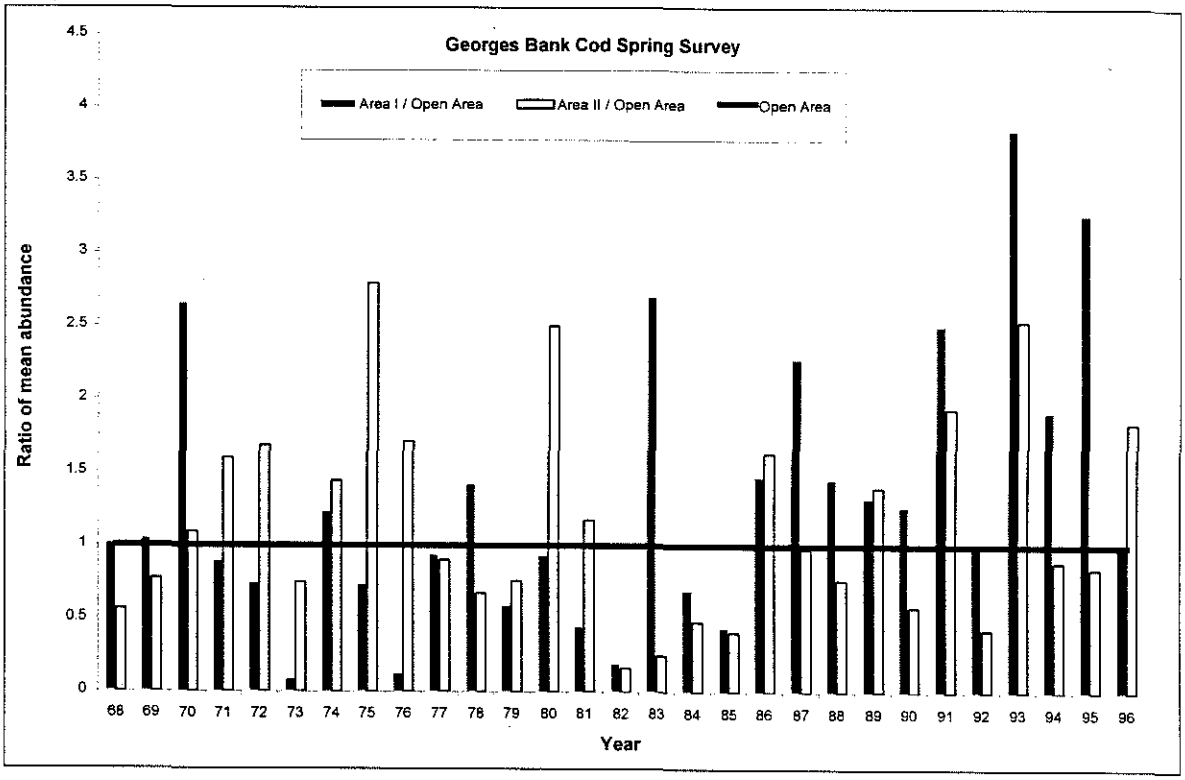
Mayo, R.K. T.E. Helser, L. O'Brien, K.A. Sosebee, B.F. Figuerido, and D. Hayes. 1994. Estimation of standardized otter trawl effort, landings per unit effort, and landings at age for Gulf of Maine and Georges Bank cod. NEFSC Ref. Doc. 94-12, 17 p.



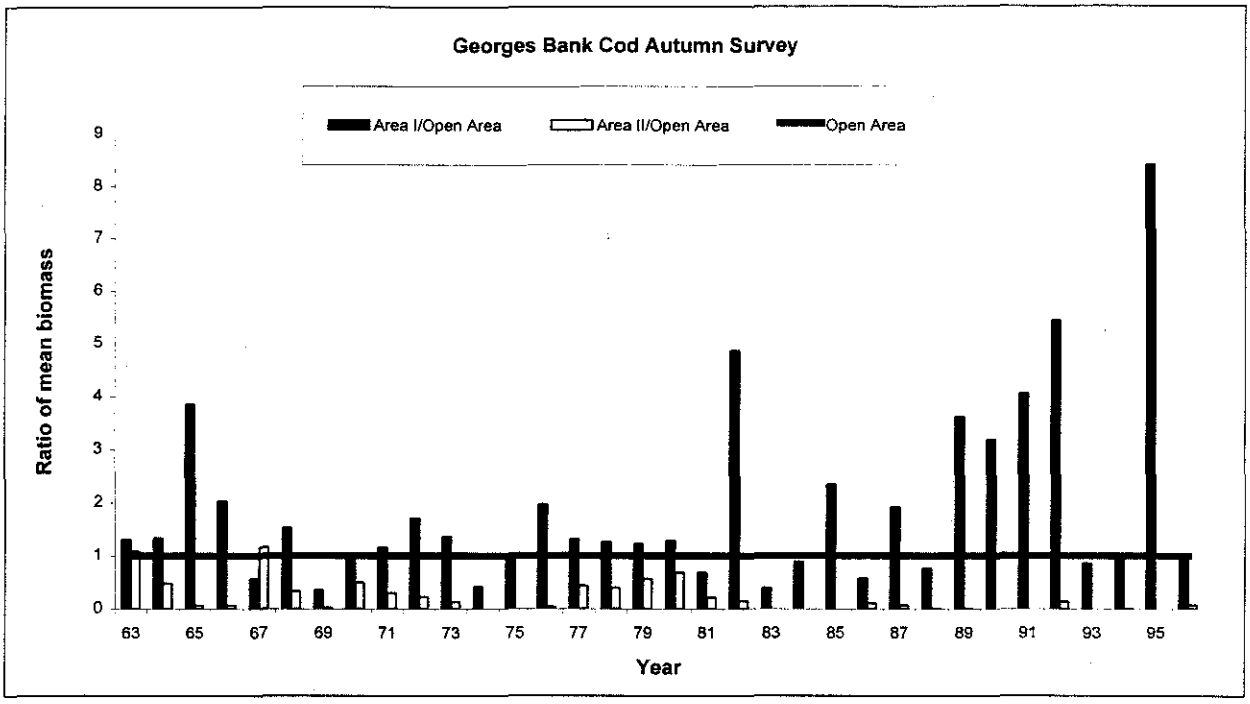
Appendix 1: Figure 1. NEFSC survey strata for the Georges Bank area, with the Nantucket Lightship closed area, Area I, and Area II (from west to east).



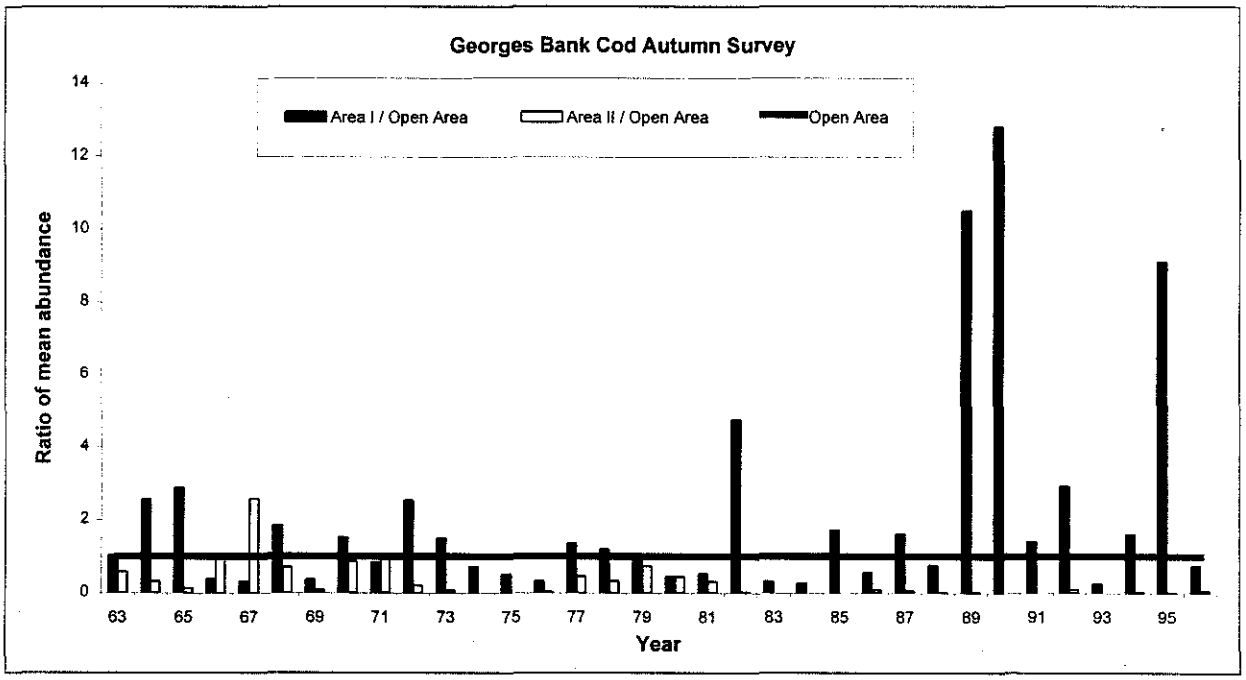
Appendix 1:Figure 2. Ratio of stratified mean weight per tow (kg) of Georges Bank cod in NEFSC spring research vessel trawl survey in Area I and Area II to the stratified mean weight per tow in the open area, 1968-1996.



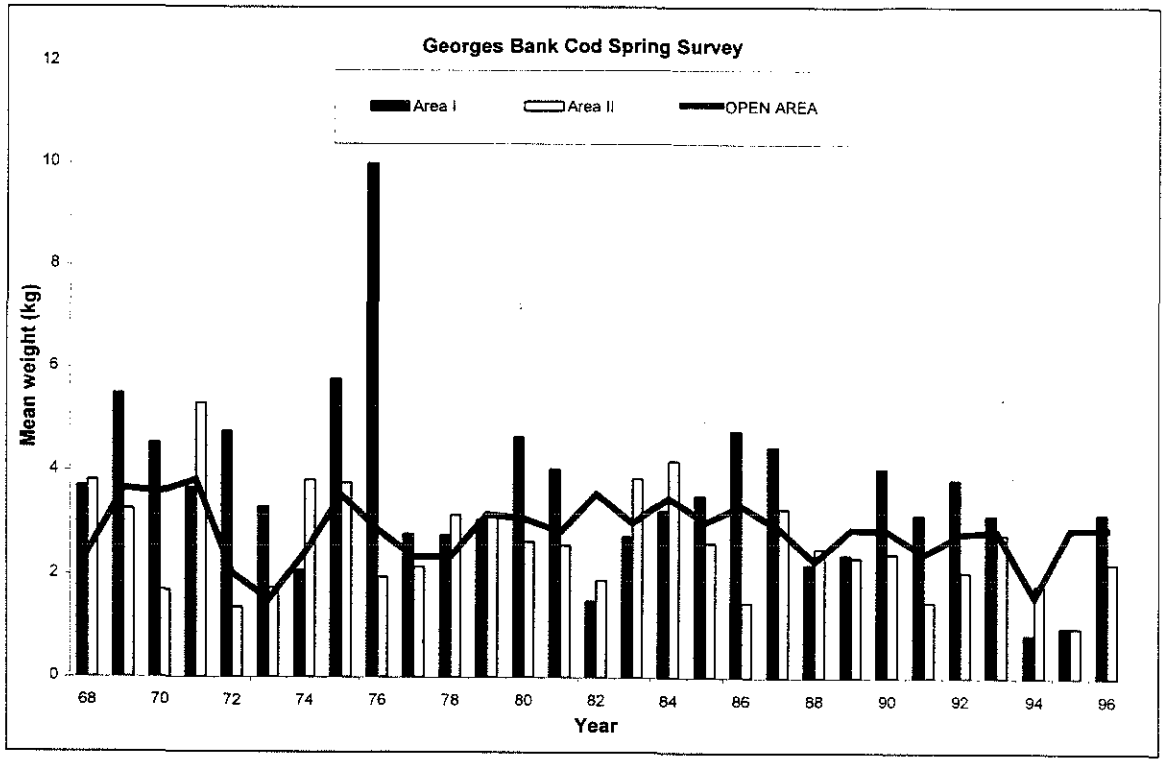
Appendix 1: Figure 3. Ratio of stratified mean number per tow (kg) of Georges Bank cod in NEFSC spring research vessel trawl survey in Area I and Area II to the stratified mean number per tow in the open area, 1968-1996.



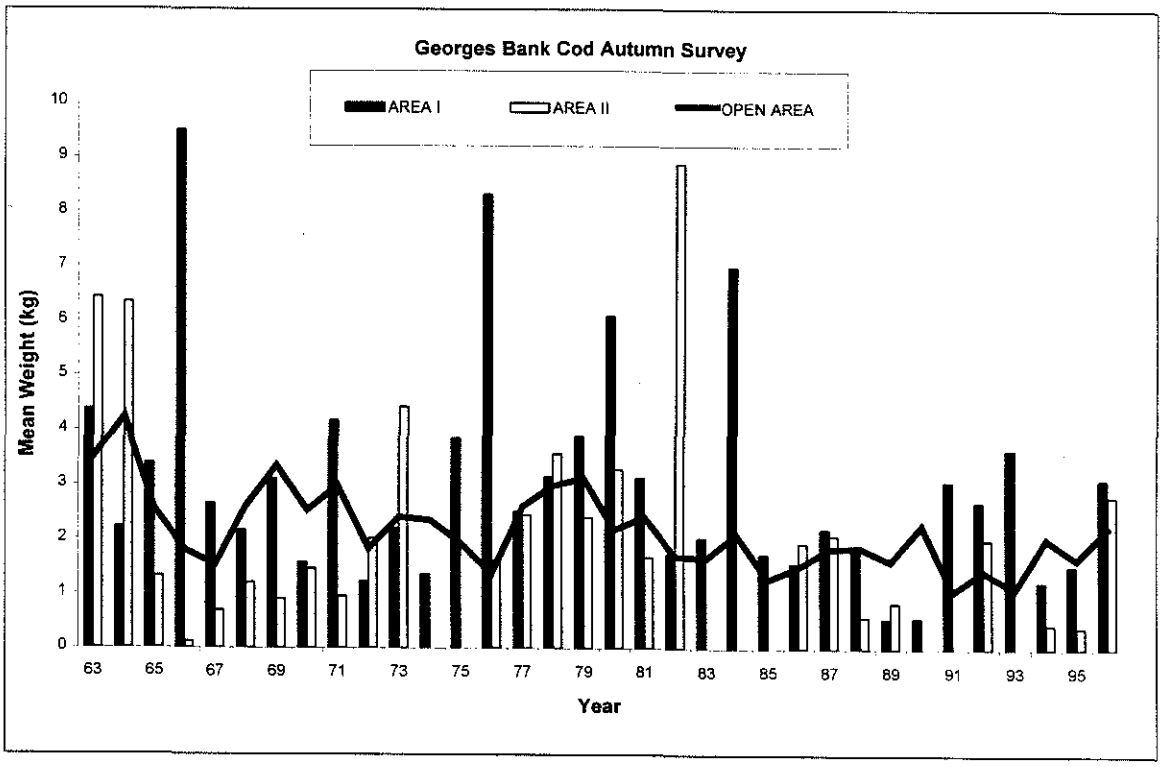
Appendix 1:Figure 4. Ratio of stratified mean weight per tow (kg) of Georges Bank cod in NEFSC autumn research vessel trawl survey in Area I and Area II to the stratified mean weight per tow in the open area, 1968-1996.



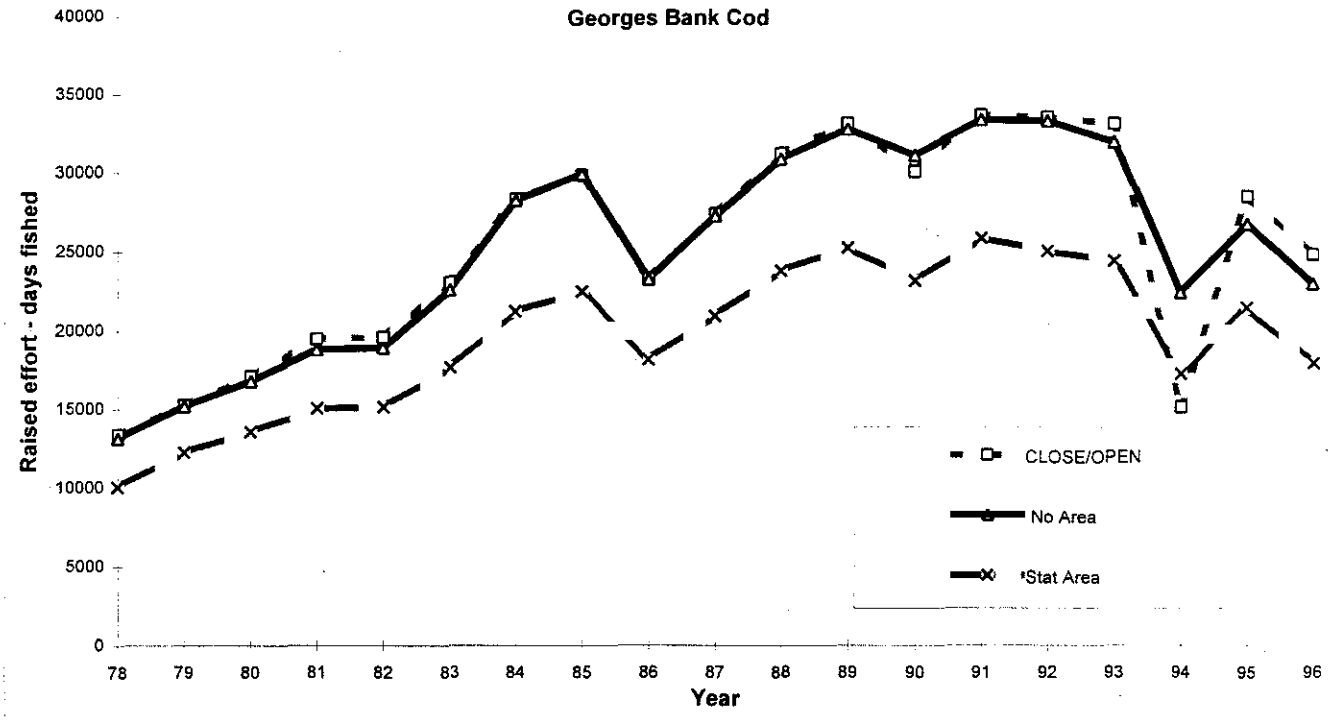
Appendix 1: Figure 5. Ratio of stratified mean number per tow (kg) of Georges Bank cod in NEFSC autumn research vessel trawl survey in Area I and Area II to the stratified mean number per tow in the Open Area, 1968-1996.

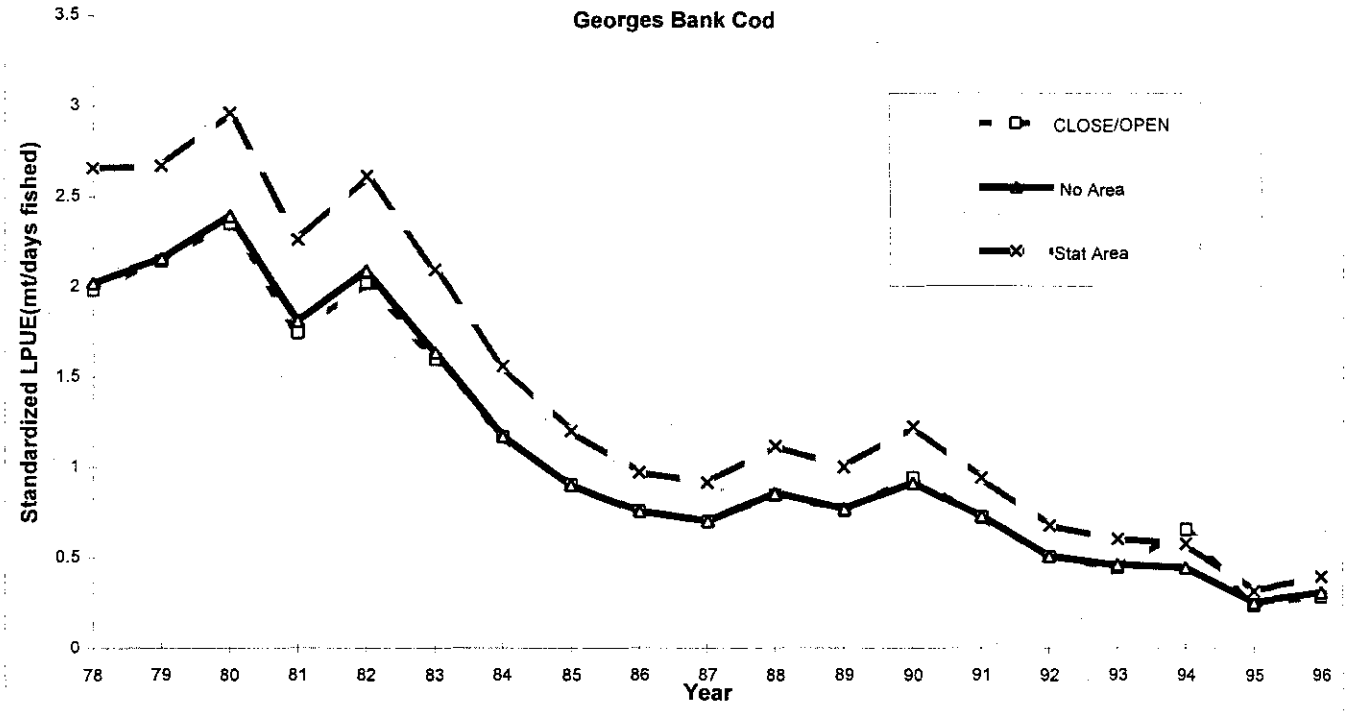


Appendix 1: Figure 6. Mean weight of Georges Bank cod from NEFSC spring research surveys in Area I, Area II and the open area, 1968-1996.



Appendix 1: Figure 7. Mean weight of Georges Bank cod from NEFSC autumn research surveys in Area I, Area II and the open area, 1968-1996.





Appendix Figure 8. Standardized landings per unit effort (LPUE) and raised effort derived from three general linear models: 1) five factor model including a closed or open factor, 2) four factor model, excluding area, and 3) a five factor model including statistical area.

APPENDIX 2

Age-specific bottom trawl survey abundance indices for Georges Bank Cod.

Table 1. Stratified mean catch per tow at age (numbers) and mean weight per tow (kg) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank (Strata 13-25), 1963-1996.

Table 2. 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 - 1996.

Table 3. Stratified mean catch per tow at age (numbers) of Atlantic cod in Canadian spring bottom trawl surveys on Eastern Georges Bank, 1986 - 1996.

Appendix 2:Table 1. Stratified mean catch per tow at age (numbers) and mean weight per tow (kg) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank, 1963-1996. [a]

Year	Age Group 0	1	2	3	4	5	6	7	8	9	10+	Totals 0+	1+	2+	3+	4+	5+	Stratified Mean Wt (kg) Per Tow
Spring																		
1968	0.329	0.087	1.035	0.529	0.426	0.247	0.158	0.090	0.053	0.036	0.037	3.027	2.698	2.611	1.576	1.047	0.621	7.80
1969	0.000	0.079	0.350	1.141	0.569	0.289	0.209	0.138	0.082	0.046	0.072	2.975	2.975	2.896	2.546	1.405	0.836	11.00
1970	0.000	0.244	0.522	0.308	0.830	0.104	0.420	0.176	0.039	0.087	0.053	2.783	2.783	2.539	2.017	1.709	0.879	9.70
1971	0.000	0.133	0.525	0.322	0.143	0.375	0.091	0.225	0.195	0.051	0.112	2.172	2.172	2.039	1.514	1.192	1.049	8.80
1972	0.036	1.860	1.175	1.693	0.327	0.076	0.208	0.078	0.141	0.074	0.080	5.748	5.712	3.852	2.677	0.984	0.657	11.70
1973 [d]	0.036	0.334	7.464	1.403	1.628	0.273	0.201	0.227	0.032	0.130	0.249	11.977	11.941	11.607	4.143	2.740	1.112	24.50
1974	0.000	0.286	2.921	3.828	0.488	1.284	0.282	0.065	0.165	0.022	0.112	9.453	9.453	9.167	6.246	2.418	1.930	22.50
1975	0.000	0.041	0.242	1.309	1.982	0.167	0.440	0.083	0.060	0.069	0.025	4.418	4.418	4.377	4.135	2.826	0.844	16.10
1976	0.071	0.834	1.232	0.605	0.443	1.008	0.105	0.168	0.023	0.000	0.035	4.524	4.453	3.619	2.387	1.782	1.339	11.50
1977	0.000	0.018	2.261	0.692	0.335	0.179	0.466	0.033	0.042	0.000	0.013	4.039	4.039	4.021	1.760	1.068	0.733	9.50
1978	2.123	0.241	0.120	3.545	0.621	0.499	0.092	0.457	0.033	0.091	0.070	7.892	5.769	5.528	5.408	1.863	1.242	19.30
1979	0.070	0.279	0.871	0.191	1.226	0.347	0.150	0.056	0.093	0.008	0.014	3.305	3.235	2.956	2.085	1.894	0.668	10.50
1980	0.067	0.025	1.452	1.723	0.134	0.950	0.383	0.123	0.020	0.019	0.071	4.967	4.900	4.875	3.423	1.700	1.566	15.30
1981	0.244	1.869	1.555	2.255	1.353	0.081	0.706	0.218	0.117	0.000	0.069	8.467	8.223	6.354	4.799	2.544	1.191	24.00
1982 [e]	0.120	0.396	2.755	1.141	1.051	0.843	0.013	0.242	0.052	0.013	0.028	6.654	6.534	6.138	3.383	2.242	1.191	14.20
1983	0.052	0.211	1.261	1.954	0.491	0.447	0.276	0.035	0.123	0.000	0.087	4.937	4.885	4.674	3.413	1.459	0.968	14.80
1984	0.000	0.258	0.296	0.511	0.744	0.286	0.272	0.143	0.000	0.100	0.005	2.615	2.615	2.357	2.061	1.550	0.806	9.50
1985	0.244	0.098	2.633	0.757	1.058	1.328	0.270	0.203	0.172	0.025	0.150	6.938	6.694	6.596	3.963	3.206	2.148	21.50
1986	0.092	0.871	0.423	1.824	0.360	0.545	0.633	0.063	0.119	0.095	0.015	5.040	4.948	4.077	3.654	1.830	1.470	16.70
1987	0.000	0.034	1.612	0.403	0.752	0.060	0.179	0.147	0.016	0.027	0.025	3.255	3.255	3.221	1.609	1.206	0.454	10.30
1988	0.180	0.700	0.684	3.115	0.413	0.645	0.045	0.020	0.052	0.000	0.007	5.861	5.681	4.981	4.297	1.182	0.769	13.40
1989	0.000	0.481	1.689	0.940	1.939	0.288	0.436	0.064	0.050	0.102	0.085	6.074	6.074	5.593	3.904	2.964	1.025	16.10
1990	0.052	0.246	1.172	2.161	0.827	1.134	0.158	0.176	0.016	0.020	0.034	5.996	5.944	5.698	4.526	2.365	1.538	17.30
1991	0.247	1.352	0.647	1.022	1.118	0.587	0.425	0.049	0.052	0.000	0.057	5.556	5.309	3.957	3.310	2.288	1.170	13.43
1992	0.000	0.123	1.255	0.470	0.163	0.270	0.144	0.161	0.020	0.037	0.028	2.671	2.671	2.548	1.293	0.823	0.660	7.46
1993	0.115	0.017	0.398	1.347	0.222	0.107	0.120	0.037	0.037	0.021	0.055	2.476	2.361	2.344	1.946	0.599	0.377	6.96
1994	0.037	0.156	0.345	0.253	0.274	0.042	0.007	0.056	0.000	0.024	0.000	1.196	1.159	1.003	0.658	0.405	0.131	1.81
1995	0.482	0.050	0.382	0.854	0.534	0.599	0.107	0.234	0.028	0.022	0.000	3.292	2.810	2.760	2.378	1.524	0.990	8.37
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	2.699	2.626	2.412	1.676	0.429	7.50

[a] 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.

[d] Excludes unusually high catch of 1894 cod (2558 kg) at Station 230 (Strata tow 20-4).

[e] Excludes unusually high catch of 1032 cod (4096 kg) at Station 323 (Strata tow 16-7).

Appendix 2:Table 1 (Continued). Stratified mean catch per tow at age (numbers) and mean weight per tow (kg) of Atlantic cod in NEFSC offshore spring and autumn bottom trawl surveys on Georges Bank, 1963-1996. [a,b]

	Age Group											Totals						Stratified Mean Wt (kg)
Year	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+	Per Tow
Autumn																		
1963	0.012	0.461	0.499	0.590	0.575	0.227	0.209	0.112	0.066	0.009	0.044	2.804	2.792	2.331	1.832	1.242	0.667	11.00
1964	0.006	0.410	0.448	0.377	0.345	0.093	0.087	0.040	0.032	0.019	0.053	1.910	1.904	1.494	1.046	0.669	0.324	7.10
1965	0.111	0.833	0.640	0.453	0.310	0.107	0.115	0.072	0.052	0.015	0.015	2.723	2.612	1.779	1.139	0.686	0.376	7.20
1966	0.657	1.085	0.641	0.330	0.169	0.064	0.061	0.040	0.025	0.001	0.011	3.084	2.427	1.342	0.701	0.371	0.202	5.00
1967	0.046	4.869	0.855	0.335	0.260	0.085	0.085	0.035	0.033	0.008	0.045	6.656	6.610	1.741	0.886	0.551	0.291	8.40
1968	0.045	0.201	1.033	0.502	0.174	0.047	0.043	0.017	0.015	0.005	0.031	2.113	2.068	1.867	0.834	0.332	0.158	5.30
1969	0.000	0.220	0.399	0.401	0.212	0.060	0.039	0.012	0.015	0.014	0.038	1.410	1.410	1.190	0.791	0.390	0.178	5.00
1970	0.265	1.082	0.867	0.336	0.445	0.098	0.000	0.021	0.035	0.035	0.063	3.247	2.982	1.900	1.033	0.697	0.252	7.70
1971	0.256	0.386	0.405	0.250	0.193	0.305	0.117	0.027	0.057	0.000	0.048	2.044	1.788	1.402	0.997	0.747	0.554	6.10
1972	0.607	4.771	0.830	1.135	0.256	0.156	0.366	0.070	0.131	0.014	0.053	8.389	7.782	3.011	2.181	1.046	0.790	14.20
1973	0.130	1.121	3.891	0.758	1.290	0.135	0.145	0.112	0.040	0.089	0.161	7.872	7.742	6.621	2.730	1.972	0.682	19.00
1974	0.296	0.262	0.419	0.975	0.105	0.073	0.066	0.000	0.044	0.000	0.000	2.240	1.944	1.682	1.263	0.288	0.183	5.10
1975	1.524	0.637	0.270	0.400	1.080	0.072	0.100	0.000	0.000	0.000	0.024	4.107	2.583	1.946	1.676	1.276	0.196	8.70
1976	0.000	3.941	1.328	0.489	0.178	0.474	0.035	0.173	0.025	0.034	0.013	6.690	6.690	2.749	1.421	0.932	0.754	10.90
1977	0.123	0.192	2.778	0.570	0.204	0.141	0.321	0.006	0.022	0.000	0.063	4.420	4.297	4.105	1.327	0.757	0.553	11.50
1978	0.321	1.505	0.207	3.392	0.782	0.272	0.134	0.279	0.041	0.024	0.011	6.968	6.647	5.142	4.935	1.543	0.761	21.50
1979	0.096	1.314	1.393	0.182	1.309	0.240	0.146	0.029	0.093	0.006	0.018	4.826	4.730	3.416	2.023	1.841	0.532	15.20
1980	0.227	0.664	0.458	0.628	0.062	0.204	0.043	0.054	0.020	0.000	0.000	2.360	2.133	1.469	1.011	0.383	0.321	6.20
1981	0.212	2.860	1.826	1.265	0.478	0.044	0.470	0.046	0.052	0.015	0.067	7.335	7.123	4.263	2.437	1.172	0.694	17.50
1982	0.205	0.561	1.342	0.141	0.044	0.062	0.000	0.010	0.000	0.000	0.014	2.379	2.174	1.613	0.271	0.130	0.086	4.30
1983	0.661	0.415	0.655	0.510	0.035	0.030	0.002	0.000	0.008	0.000	0.015	2.331	1.670	1.255	0.600	0.090	0.055	4.00
1984	0.119	1.600	0.065	0.568	0.558	0.011	0.040	0.025	0.004	0.025	0.028	3.043	2.924	1.324	1.259	0.691	0.133	6.30
1985	1.084	0.220	0.803	0.103	0.115	0.101	0.000	0.000	0.004	0.000	0.000	2.430	1.346	1.126	0.323	0.220	0.105	3.50
1986	0.096	2.280	0.153	0.382	0.010	0.061	0.090	0.016	0.000	0.008	0.028	3.124	3.028	0.748	0.595	0.213	0.203	4.70
1987	0.204	0.414	1.353	0.112	0.195	0.028	0.012	0.000	0.000	0.007	0.000	2.325	2.121	1.707	0.354	0.242	0.047	4.40
1988	0.549	0.903	0.433	0.909	0.091	0.178	0.000	0.011	0.039	0.000	0.000	3.113	2.564	1.661	1.228	0.319	0.228	5.80
1989	0.332	3.466	1.304	0.232	0.632	0.070	0.010	0.005	0.000	0.000	0.000	6.051	5.719	2.253	0.949	0.717	0.085	6.90
1990 [f]	0.197	0.458	1.942	1.473	0.265	0.184	0.015	0.016	0.000	0.000	0.028	4.578	4.381	3.923	1.981	0.508	0.243	10.60
1991	0.051	0.525	0.213	0.351	0.035	0.037	0.000	0.000	0.000	0.000	0.000	1.212	1.161	0.636	0.423	0.072	0.037	2.09
1992	0.033	0.454	1.024	0.180	0.112	0.030	0.010	0.000	0.000	0.000	0.000	1.843	1.810	1.356	0.332	0.152	0.040	3.10
1993	0.226	1.228	0.673	0.484	0.021	0.032	0.028	0.000	0.000	0.028	0.000	2.720	2.494	1.266	0.593	0.109	0.088	3.25
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	1.752	1.346	0.682	0.529	0.376	3.26
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	3.456	3.211	1.401	0.152	0.065	5.63
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	1.079	0.840	0.644	0.229	0.086	2.71

[f] Excludes unusually high catch of 111 cod (504 kg) at Station 205 (Strata tow 23-4).

Appendix 2:Table 2. 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 - 1996. [a,b,c]

	Age Group											Totals					
Year	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+
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	4.209	4.073	2.459	1.633	0.969
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	4.641	4.518	3.972	2.192	1.304
1970	0.000	0.381	0.814	0.480	1.295	0.162	0.655	0.275	0.061	0.136	0.083	4.341	4.341	3.961	3.147	2.666	1.371
1971	0.000	0.207	0.819	0.502	0.223	0.585	0.142	0.351	0.304	0.080	0.175	3.388	3.388	3.181	2.362	1.860	1.636
1972	0.056	2.902	1.833	2.641	0.510	0.119	0.324	0.122	0.220	0.115	0.125	8.967	8.911	6.009	4.176	1.535	1.025
1973 [d]	0.056	0.521	11.644	2.189	2.540	0.426	0.314	0.354	0.050	0.203	0.388	18.684	18.628	18.107	6.463	4.274	1.735
1974	0.000	0.446	4.557	5.972	0.761	2.003	0.440	0.101	0.257	0.034	0.175	14.747	14.747	14.301	9.744	3.772	3.011
1975	0.000	0.064	0.378	2.042	3.092	0.261	0.686	0.129	0.094	0.108	0.039	6.892	6.892	6.828	6.451	4.409	1.317
1976	0.111	1.301	1.922	0.944	0.691	1.572	0.164	0.262	0.036	0.000	0.055	7.057	6.947	5.646	3.724	2.780	2.089
1977	0.000	0.028	3.527	1.080	0.523	0.279	0.727	0.051	0.066	0.000	0.020	6.301	6.301	6.273	2.746	1.666	1.143
1978	3.312	0.376	0.187	5.530	0.969	0.778	0.144	0.713	0.051	0.142	0.109	12.312	9.000	8.624	8.436	2.906	1.938
1979	0.109	0.435	1.359	0.298	1.913	0.541	0.234	0.087	0.145	0.012	0.022	5.156	5.047	4.611	3.253	2.955	1.042
1980	0.083	0.031	1.790	2.124	0.165	1.171	0.472	0.152	0.025	0.024	0.088	6.122	6.039	6.008	4.219	2.095	1.930
1981	0.301	2.303	1.916	2.779	1.667	0.100	0.870	0.269	0.144	0.000	0.085	10.435	10.134	7.831	5.914	3.135	1.468
1982 [e]	0.148	0.488	3.395	1.406	1.295	1.039	0.016	0.298	0.064	0.016	0.035	8.200	8.053	7.564	4.169	2.763	1.468
1983	0.081	0.329	1.967	3.048	0.766	0.697	0.431	0.055	0.192	0.000	0.136	7.702	7.621	7.291	5.324	2.276	1.510
1984	0.000	0.402	0.462	0.797	1.161	0.446	0.424	0.223	0.000	0.156	0.008	4.079	4.079	3.677	3.215	2.418	1.257
1985	0.244	0.098	2.633	0.757	1.058	1.328	0.270	0.203	0.172	0.025	0.150	6.938	6.694	6.596	3.963	3.206	2.148
1986	0.092	0.871	0.423	1.824	0.360	0.545	0.633	0.063	0.119	0.095	0.015	5.040	4.948	4.077	3.654	1.830	1.470
1987	0.000	0.034	1.612	0.403	0.752	0.060	0.179	0.147	0.016	0.027	0.025	3.255	3.255	3.221	1.609	1.206	0.454
1988	0.180	0.700	0.684	3.115	0.413	0.645	0.045	0.020	0.052	0.000	0.007	5.861	5.681	4.981	4.297	1.182	0.769
1989	0.000	0.380	1.334	0.743	1.532	0.228	0.344	0.051	0.040	0.081	0.067	4.798	4.798	4.418	3.084	2.342	0.810
1990	0.041	0.194	0.926	1.707	0.653	0.896	0.125	0.139	0.013	0.016	0.027	4.736	4.695	4.501	3.575	1.868	1.215
1991	0.195	1.068	0.511	0.807	0.883	0.464	0.336	0.039	0.041	0.000	0.045	4.389	4.194	3.126	2.615	1.808	0.925
1992	0.000	0.123	1.255	0.470	0.163	0.270	0.144	0.161	0.020	0.037	0.028	2.671	2.671	2.548	1.293	0.823	0.660
1993	0.115	0.017	0.398	1.347	0.222	0.107	0.120	0.037	0.037	0.021	0.055	2.476	2.361	2.344	1.946	0.599	0.377
1994	0.029	0.123	0.273	0.199	0.216	0.033	0.005	0.044	0.000	0.019	0.000	0.943	0.914	0.791	0.518	0.318	0.102
1995	0.482	0.050	0.382	0.854	0.534	0.599	0.107	0.234	0.028	0.022	0.000	3.292	2.810	2.760	2.378	1.524	0.990
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	2.699	2.626	2.412	1.676	0.429

[a] 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.

[b] During 1963-1984, BMV oval doors were used in spring and autumn surveys; since 1985, Portuguese polyvalent doors have been 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 (NEFSC 1991).

[c] 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 (NEFSC 1991).

[d] Excludes unusually high catch of 1894 cod (2558 kg) at Station 230 (Strata tow 20-4).

[e] Excludes unusually high catch of 1032 cod (4096 kg) at Station 323 (Strata tow 16-7).

Appendix 2:Table 2 (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 - 1996. [b,c]

	Age Group											Totals					
Year	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+
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	4.356	3.636	2.858	1.938	1.041
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	2.970	2.331	1.632	1.044	0.505
1965	0.173	1.299	0.998	0.707	0.484	0.167	0.179	0.112	0.081	0.023	0.023	4.248	4.075	2.775	1.777	1.070	0.587
1966	1.025	1.693	1.000	0.515	0.264	0.100	0.095	0.062	0.039	0.002	0.017	4.811	3.786	2.094	1.094	0.579	0.315
1967	0.072	7.596	1.334	0.523	0.406	0.133	0.133	0.055	0.051	0.012	0.070	10.383	10.312	2.716	1.382	0.860	0.454
1968	0.070	0.314	1.611	0.783	0.271	0.073	0.067	0.027	0.023	0.008	0.048	3.296	3.226	2.913	1.301	0.518	0.246
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	2.200	1.856	1.234	0.608	0.278
1970	0.413	1.688	1.353	0.524	0.694	0.153	0.000	0.033	0.055	0.055	0.098	5.065	4.652	2.964	1.611	1.087	0.393
1971	0.399	0.602	0.632	0.390	0.301	0.476	0.183	0.042	0.089	0.000	0.075	3.189	2.789	2.187	1.555	1.165	0.864
1972	0.947	7.443	1.295	1.771	0.399	0.243	0.571	0.109	0.204	0.022	0.083	13.087	12.140	4.697	3.402	1.632	1.232
1973	0.203	1.749	6.070	1.182	2.012	0.211	0.226	0.175	0.062	0.139	0.251	12.280	12.078	10.329	4.259	3.076	1.064
1974	0.462	0.409	0.654	1.521	0.164	0.114	0.103	0.000	0.069	0.000	0.000	3.494	3.033	2.624	1.970	0.449	0.285
1975	2.377	0.994	0.421	0.624	1.685	0.112	0.156	0.000	0.000	0.000	0.037	6.407	4.029	3.036	2.615	1.991	0.306
1976	0.000	6.148	2.072	0.763	0.278	0.739	0.055	0.270	0.039	0.053	0.020	10.436	10.436	4.288	2.217	1.454	1.176
1977	0.152	0.237	3.424	0.702	0.251	0.174	0.396	0.007	0.027	0.000	0.078	5.447	5.296	5.059	1.635	0.933	0.682
1978	0.396	1.855	0.255	4.180	0.964	0.335	0.165	0.344	0.051	0.030	0.014	8.587	8.192	6.337	6.082	1.902	0.938
1979	0.118	1.619	1.717	0.224	1.613	0.296	0.180	0.036	0.115	0.007	0.022	5.948	5.829	4.210	2.493	2.269	0.656
1980	0.280	0.818	0.564	0.774	0.076	0.251	0.053	0.067	0.025	0.000	0.000	2.908	2.629	1.810	1.246	0.472	0.396
1981	0.261	3.525	2.250	1.559	0.589	0.054	0.579	0.057	0.064	0.018	0.083	9.040	8.778	5.254	3.003	1.444	0.855
1982	0.320	0.875	2.094	0.220	0.069	0.097	0.000	0.016	0.000	0.000	0.022	3.711	3.391	2.516	0.423	0.203	0.134
1983	1.031	0.647	1.022	0.796	0.055	0.047	0.003	0.000	0.012	0.000	0.023	3.636	2.605	1.958	0.936	0.140	0.086
1984	0.186	2.496	0.101	0.886	0.870	0.017	0.062	0.039	0.006	0.039	0.044	4.747	4.561	2.065	1.964	1.078	0.207
1985	1.084	0.220	0.803	0.103	0.115	0.101	0.000	0.000	0.004	0.000	0.000	2.430	1.346	1.126	0.323	0.220	0.105
1986	0.096	2.280	0.153	0.382	0.010	0.061	0.090	0.016	0.000	0.008	0.028	3.124	3.028	0.748	0.595	0.213	0.203
1987	0.204	0.414	1.353	0.112	0.195	0.028	0.012	0.000	0.000	0.007	0.000	2.325	2.121	1.707	0.354	0.242	0.047
1988	0.549	0.903	0.433	0.909	0.091	0.178	0.000	0.011	0.039	0.000	0.000	3.113	2.564	1.661	1.228	0.319	0.228
1989	0.262	2.738	1.030	0.183	0.499	0.055	0.008	0.004	0.000	0.000	0.000	4.780	4.518	1.780	0.750	0.566	0.067
1990 [f]	0.156	0.362	1.534	1.164	0.209	0.145	0.012	0.013	0.000	0.000	0.022	3.617	3.460	3.098	1.564	0.401	0.192
1991	0.040	0.415	0.168	0.277	0.028	0.029	0.000	0.000	0.000	0.000	0.000	0.957	0.917	0.502	0.334	0.057	0.029
1992	0.033	0.454	1.024	0.180	0.112	0.030	0.010	0.000	0.000	0.000	0.000	1.843	1.810	1.356	0.332	0.152	0.040
1993	0.179	0.970	0.532	0.382	0.017	0.025	0.022	0.000	0.000	0.022	0.000	2.149	1.970	1.000	0.468	0.086	0.070
1994	0.067	0.406	0.664	0.433	0.153	0.068	0.021	0.000	0.006	0.000	0.000	1.818	1.751	1.345	0.681	0.248	0.095
1995	0.160	0.245	1.811	1.249	0.087	0.054	0.011	0.000	0.000	0.000	0.000	3.617	3.457	3.212	1.401	0.152	0.065
1996	0.022	0.240	0.196	0.414	0.143	0.060	0.027	0.000	0.000	0.000	0.000	1.102	1.080	0.840	0.644	0.230	0.087

[b] During 1963-1984, BMV oval doors were used in spring and autumn surveys; since 1985, Portuguese polyvalent doors have been 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 (NEFSC 1991).

[c] 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 (NEFSC 1991).

[f] Excludes unusually high catch of 111 cod (504 kg) at Station 205 (Strata tow 23-4).

Appendix 2:Table 3. Stratified mean catch per tow at age (numbers) of Atlantic cod in Canadian spring bottom trawl surveys on Eastern Georges Bank, 1986 - 1996.

	Age Group										Totals				
Year	1	2	3	4	5	6	7	8	9	10+	1+	2+	3+	4+	5+
1986	0.60	2.27	2.81	0.37	0.65	0.44	0.26	0.04	0.07	0.03	7.54	6.94	4.67	1.86	1.49
1987	0.25	2.13	0.93	1.09	0.34	0.12	0.22	0.08	0.03	0.07	5.26	5.01	2.88	1.95	0.86
1988	0.28	1.01	4.66	0.58	1.02	0.13	0.08	0.17	0.04	0.07	8.04	7.76	6.75	2.09	1.51
1989	1.63	2.78	1.38	2.85	0.36	0.42	0.05	0.10	0.12	0.06	9.75	8.12	5.34	3.96	1.11
1990	0.42	2.44	3.78	2.08	3.87	0.42	0.93	0.12	0.12	0.35	14.55	14.11	11.67	7.89	5.81
1991	1.18	1.16	1.84	2.15	1.05	1.31	0.16	0.22	0.03	0.09	9.19	8.01	6.85	5.01	2.86
1992	0.11	2.86	1.77	0.80	0.98	0.60	0.43	0.12	0.07	0.02	7.76	7.65	4.79	3.02	2.22
1993	0.05	0.60	2.83	1.04	0.62	1.23	0.44	0.42	0.07	0.12	7.42	7.37	6.77	3.94	2.90
1994	0.02	0.80	0.89	1.65	0.60	0.23	0.45	0.11	0.15	0.04	4.94	4.92	4.12	3.23	1.58
1995	0.07	0.67	1.50	0.86	0.60	0.19	0.04	0.05	0.02	0.02	4.02	3.95	3.28	1.78	0.92
1996	0.14	0.49	2.31	4.02	1.09	0.79	0.33	0.08	0.11	0.03	9.39	9.25	8.76	6.45	2.43
1997	0.32	0.53	0.55	1.25	1.23	0.27	0.06	0.03	0.02	0.01	4.27	3.95	3.42	2.87	1.62

APPENDIX 3

Full Listing of ADAPT VPA Calibration Output and Diagnostics for Georges Bank Cod.

ADAPT Run Number 29 1997 4 8 12 22 7
COD: GEORGES BANK STOCK
GBCOD97_NOCPUE

Output option selected for input parameters: full
Output option selected for results: full

INPUT PARAMETERS AND OPTIONS SELECTED

Natural mortality is 0.2

Oldest age (not in the plus group) is 9

For all yrs prior to the terminal year (1996), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 9: 4 5 6 7 8 9
This method for estimating F on the oldest age is generally used
when a flat-topped partial recruitment curve is thought to be
characteristic of the stock.

F for age 10+ is then calculated from the following
ratios of F[age 10+] to F[age 9]

1978	1.0000
1979	1.0000
1980	1.0000
1981	1.0000
1982	1.0000
1983	1.0000
1984	1.0000
1985	1.0000
1986	1.0000
1987	1.0000
1988	1.0000
1989	1.0000
1990	1.0000
1991	1.0000
1992	1.0000
1993	1.0000
1994	1.0000
1995	1.0000
1996	1.0000

Stock size of the 10+ group is then calculated
using the following method: CATCHEQ

Partial recruitment estimate for 1996

1	0.0027
2	0.3340
3	0.8209
4	1.0000
5	1.0000
6	1.0000
7	1.0000
8	1.0000
9	1.0000

Objective function is SUM w*(LOG(OBS) - LOG(PRED))**2

Indices normalized (by dividing by mean observed value)
before tuning to VPA stocksizes

The residuals for years prior to the terminal year are downweighted
using the following algorithm: NONE

Biomass estimates (other than SSB) reflect mean stock sizes.
SSB calculated as in the NEFSC projection program
(see note below SSB table for description of the algorithm).

Initial estimates of parameters for the Marquardt algorithm
and lower and upper bounds on the parameter estimates:

Par.	Initial Est	Lower Bnd	Upper Bnd
N 1	2.0000000E3	1.0000000E0	1.0000000E6
N 2	9.0000000E3	1.0000000E0	1.0000000E6
N 3	4.0000000E3	1.0000000E0	1.0000000E6
N 4	5.0000000E3	1.0000000E0	1.0000000E6
N 5	2.0000000E3	1.0000000E0	1.0000000E6
N 6	2.0000000E3	1.0000000E0	1.0000000E6
N 7	2.0000000E3	1.0000000E0	1.0000000E6
N 8	1.0000000E3	1.0000000E0	1.0000000E6
qRV SPR 1	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 2	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 3	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 4	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 5	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 6	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 7	1.0000000E-4	0.0000000E0	1.0000000E0
qRV SPR 8	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 1	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 2	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 3	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 4	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 5	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 6	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 7	1.0000000E-4	0.0000000E0	1.0000000E0
qRV CAN 8	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 1	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 2	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 3	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 4	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 5	1.0000000E-4	0.0000000E0	1.0000000E0
qRV FAL 6	1.0000000E-4	0.0000000E0	1.0000000E0

The following indices of abundance are available:

1	RV SPR 1
2	RV SPR 2
3	RV SPR 3
4	RV SPR 4
5	RV SPR 5
6	RV SPR 6
7	RV SPR 7
8	RV SPR 8
9	RV CAN 1
10	RV CAN 2
11	RV CAN 3
12	RV CAN 4
13	RV CAN 5
14	RV CAN 6
15	RV CAN 7
16	RV CAN 8
17	RV AUT 1
18	RV FAL 1
19	RV FAL 2
20	RV FAL 3
21	RV FAL 4
22	RV FAL 5
23	RV FAL 6

Indices that will be used in this run are: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 1
5 16 18 19 20 21 22 23

Obs Indices (before transformation) by index & yr; with index means

	1978	1979	1980	1981	1982	1983	1984
1	0.376	0.435	0.031	2.303	0.488	0.329	0.402
2	0.187	1.359	1.789	1.916	3.395	1.967	0.462
3	5.530	0.298	2.123	2.779	1.406	3.048	0.797
4	0.969	1.913	0.165	1.667	1.295	0.766	1.161
5	0.778	0.541	1.171	0.100	1.039	0.697	0.446
6	0.144	0.234	0.472	0.870	0.016	0.431	0.424
7	0.713	0.087	0.152	0.269	0.298	0.055	0.223
8	0.051	0.145	0.025	0.144	0.064	0.192	0.000
9	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
10	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
11	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
12	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
13	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
14	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
15	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
16	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
18	0.152	0.396	0.118	0.280	0.261	0.320	1.031
19	0.237	1.855	1.619	0.818	3.525	0.875	0.647
20	3.424	0.255	1.717	0.564	2.250	2.094	1.022
21	0.702	4.180	0.224	0.774	1.559	0.220	0.796
22	0.251	0.964	1.613	0.076	0.589	0.069	0.055
23	0.174	0.335	0.296	0.251	0.054	0.097	0.047

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.098	0.871	0.034	0.700	0.380	0.194	1.068	0.123	0.017
2	2.633	0.423	1.612	0.684	1.334	0.926	0.511	1.255	0.398
3	0.757	1.824	0.403	3.115	0.743	1.707	0.807	0.470	1.347
4	1.058	0.360	0.752	0.413	1.532	0.653	0.883	0.163	0.222
5	1.328	0.545	0.060	0.645	0.228	0.896	0.465	0.270	0.107
6	0.270	0.633	0.179	0.045	0.344	0.125	0.336	0.144	0.120
7	0.203	0.063	0.147	0.020	0.051	0.139	0.039	0.161	0.037
8	0.172	0.119	0.016	0.052	0.040	0.013	0.040	0.020	0.037
9	-999.000	0.600	0.250	0.280	1.630	0.420	1.180	0.110	-999.000
10	-999.000	2.270	2.130	1.010	2.780	2.440	1.160	2.860	-999.000
11	-999.000	2.810	0.930	4.660	1.380	3.780	1.840	1.770	-999.000
12	-999.000	0.370	1.090	0.580	2.850	2.080	2.150	0.800	-999.000
13	-999.000	0.650	0.340	1.020	0.360	3.870	1.050	0.980	-999.000
14	-999.000	0.440	0.120	0.130	0.420	0.420	1.310	0.600	-999.000
15	-999.000	0.260	0.220	0.080	0.050	0.930	0.160	0.430	-999.000
16	-999.000	0.040	0.080	0.170	0.100	0.120	0.220	0.120	-999.000
18	0.186	1.084	0.096	0.204	0.549	0.262	0.156	0.040	0.033
19	2.496	0.220	2.280	0.414	0.903	2.738	0.362	0.415	0.454
20	0.101	0.803	0.153	1.353	0.433	1.030	1.534	0.168	1.024
21	0.886	0.103	0.382	0.112	0.909	0.183	1.164	0.277	0.180
22	0.870	0.115	0.010	0.195	0.091	0.499	0.209	0.028	0.112
23	0.017	0.101	0.061	0.028	0.178	0.055	0.145	0.029	0.030

	1994	1995	1996	1997*******	
1	0.123	0.050	0.073	-999.000	0.426
2	0.273	0.382	0.214	-999.000	1.143
3	0.200	0.854	0.736	-999.000	1.523
4	0.216	0.534	1.247	-999.000	0.840
5	0.033	0.599	0.174	-999.000	0.533
6	0.006	0.107	0.209	-999.000	0.269
7	0.044	0.234	0.028	-999.000	0.156
8	0.000	0.028	0.018	-999.000	0.069
9	-999.000	0.070	0.140	0.320	0.500
10	-999.000	0.670	0.490	0.530	1.634
11	-999.000	1.500	2.310	0.550	2.153
12	-999.000	0.860	4.020	1.250	1.605
13	-999.000	0.600	1.090	1.230	1.119
14	-999.000	0.190	0.790	0.270	0.469

15	-999.000	0.040	0.330	0.060	0.256
16	-999.000	0.050	0.080	0.030	0.101
18	0.179	0.067	0.160	0.022	0.280
19	0.970	0.406	0.245	0.240	1.086
20	0.532	0.664	1.811	0.196	1.056
21	0.382	0.433	1.249	0.414	0.757
22	0.017	0.153	0.087	0.143	0.307
23	0.025	0.068	0.054	0.060	0.105

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00
9	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
10	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
11	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
12	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
13	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
14	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
15	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
16	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00
18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
8	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	-99.00
9	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
16	1.00	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00
18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Negative weights in the above table indicate missing values

DOWNWEIGHTS BY YEAR (delta)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

	1	2	3	4	5	6	7	8	9	10
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	11	12	13	14	15	16	18	19	20	21
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	22	23
	1.0000	1.0000

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
9	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
10	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
11	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
12	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
13	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
14	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
15	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
16	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
10	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
11	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
12	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
13	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
14	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
15	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000

16 ■	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
18 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
21 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
22 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	1994	1995	1996	1997
1 ■	1.0000	1.0000	1.0000	-99.0000
2 ■	1.0000	1.0000	1.0000	-99.0000
3 ■	1.0000	1.0000	1.0000	-99.0000
4 ■	1.0000	1.0000	1.0000	-99.0000
5 ■	1.0000	1.0000	1.0000	-99.0000
6 ■	1.0000	1.0000	1.0000	-99.0000
7 ■	1.0000	1.0000	1.0000	-99.0000
8 ■	-99.0000	1.0000	1.0000	-99.0000
9 ■	-99.0000	1.0000	1.0000	1.0000
10 ■	-99.0000	1.0000	1.0000	1.0000
11 ■	-99.0000	1.0000	1.0000	1.0000
12 ■	-99.0000	1.0000	1.0000	1.0000
13 ■	-99.0000	1.0000	1.0000	1.0000
14 ■	-99.0000	1.0000	1.0000	1.0000
15 ■	-99.0000	1.0000	1.0000	1.0000
16 ■	-99.0000	1.0000	1.0000	1.0000
18 ■	1.0000	1.0000	1.0000	1.0000
19 ■	1.0000	1.0000	1.0000	1.0000
20 ■	1.0000	1.0000	1.0000	1.0000
21 ■	1.0000	1.0000	1.0000	1.0000
22 ■	1.0000	1.0000	1.0000	1.0000
23 ■	1.0000	1.0000	1.0000	1.0000

Negative weights in the above table indicate missing values

CATCH AT AGE (millions) - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984
1 ■	2.000	34.000	89.000	27.000	331.000	108.000	81.000
2 ■	393.000	1989.000	3777.000	3205.000	9138.000	4286.000	1307.000
3 ■	7748.000	900.000	5828.000	4221.000	3824.000	8063.000	3423.000
4 ■	2303.000	4870.000	500.000	2464.000	2787.000	2456.000	3336.000
5 ■	830.000	1212.000	2308.000	235.000	2000.000	1055.000	840.000
6 ■	131.000	458.000	1076.000	1406.000	281.000	776.000	516.000
7 ■	345.000	77.000	445.000	417.000	673.000	95.000	458.000
8 ■	47.000	253.000	87.000	123.000	213.000	235.000	44.000
9 ■	40.000	4.000	167.000	130.000	71.000	100.000	171.000
10 ■	15.000	48.000	10.000	62.000	83.000	65.000	121.000
1+■	11854.000	9845.000	14287.000	12290.000	19401.000	17239.000	10297.000

	1985	1986	1987	1988	1989	1990	1991
1 ■	134.000	156.000	26.000	10.000	0.001	7.000	52.000
2 ■	6426.000	1326.000	7473.000	1577.000	2088.000	4942.000	1525.000
3 ■	2443.000	4573.000	1406.000	8022.000	2922.000	5042.000	3243.000
4 ■	1368.000	797.000	2121.000	1012.000	4155.000	1882.000	3281.000
5 ■	1885.000	480.000	279.000	1497.000	331.000	2264.000	1458.000
6 ■	412.000	627.000	252.000	244.000	541.000	229.000	1088.000
7 ■	218.000	87.000	270.000	161.000	82.000	245.000	126.000
8 ■	203.000	72.000	63.000	197.000	43.000	36.000	70.000
9 ■	21.000	47.000	38.000	50.000	50.000	17.000	23.000
10 ■	97.000	29.000	24.000	47.000	18.000	38.000	23.000
1+■	13207.000	8194.000	11952.000	12817.000	10230.001	14702.000	10889.000

	1992	1993	1994	1995	1996
1	70.000	4.000	2.000	0.100	0.700
2	4177.000	1033.000	398.000	392.000	207.000
3	2170.000	4246.000	1526.000	1058.000	903.000
4	1038.000	1115.000	1825.000	692.000	1234.000
5	1482.000	440.000	394.000	290.000	241.000
6	404.000	472.000	96.000	44.000	123.000
7	309.000	159.000	137.000	26.000	15.000
8	34.000	143.000	46.000	15.000	3.000
9	33.000	32.000	38.000	2.000	5.000
10	10.000	17.000	6.000	1.000	0.200
1+	9727.000	7661.000	4468.000	2520.100	2731.900

CAA summary for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983	1984
2	11797.000	9759.000	14021.000	12071.000	18916.000	16966.000	9924.000
3	11404.000	7770.000	10244.000	8866.000	9778.000	12680.000	8617.000
4	3656.000	6870.000	4416.000	4645.000	5954.000	4617.000	5194.000
5	1353.000	2000.000	3916.000	2181.000	3167.000	2161.000	1858.000
6	523.000	788.000	1608.000	1946.000	1167.000	1106.000	1018.000

	1985	1986	1987	1988	1989	1990	1991
2	12955.000	7962.000	11864.000	12710.000	10162.000	14640.000	10791.000
3	6529.000	6636.000	4391.000	11133.000	8074.000	9698.000	9266.000
4	4086.000	2063.000	2985.000	3111.000	5152.000	4656.000	6023.000
5	2718.000	1266.000	864.000	2099.000	997.000	2774.000	2742.000
6	833.000	786.000	585.000	602.000	666.000	510.000	1284.000

	1992	1993	1994	1995	1996
2	9614.000	7608.000	4422.000	2517.000	2726.000
3	5437.000	6575.000	4024.000	2125.000	2519.000
4	3267.000	2329.000	2498.000	1067.000	1616.000
5	2229.000	1214.000	673.000	375.000	382.000
6	747.000	774.000	279.000	85.000	141.000

WT AT AGE (MID-YR) in kg. - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.707	0.889	0.836	0.882	0.765	0.971	1.053	0.907	0.929
2	1.310	1.494	1.460	1.495	1.402	1.490	1.635	1.418	1.475
3	2.461	2.149	2.468	2.358	2.664	2.377	2.451	2.086	2.447
4	3.469	4.211	3.668	3.415	3.834	3.309	3.619	3.887	3.660
5	4.336	4.888	5.647	5.213	5.352	4.637	5.083	5.087	5.603
6	5.787	7.178	6.676	7.222	6.511	6.393	6.582	6.412	7.191
7	7.374	9.183	8.390	8.565	9.363	7.964	8.909	8.097	8.915
8	8.492	10.313	9.089	9.888	9.897	10.286	10.104	10.236	9.955
9	11.785	11.699	8.432	14.170	12.503	11.227	11.303	11.418	12.687
10	13.200	12.625	15.400	18.565	16.723	14.554	15.356	13.494	14.104

	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.726	0.786	0.809	0.831	1.114	1.148	0.872	0.906	0.906
2	1.481	1.520	1.617	1.560	1.627	1.542	1.534	1.459	1.471
3	2.495	2.359	2.269	2.462	2.548	2.464	2.253	2.168	2.095
4	4.187	3.511	3.772	3.522	3.420	3.843	3.333	3.657	3.830
5	5.810	5.401	5.396	4.892	4.769	4.704	4.967	4.804	5.492
6	7.726	6.647	6.694	6.333	5.891	6.156	6.379	7.432	7.384
7	8.949	8.776	8.222	8.456	7.410	7.509	7.510	8.013	10.715
8	10.013	9.987	10.718	10.648	10.520	9.846	9.217	9.368	11.617
9	11.414	11.143	11.665	12.580	9.686	12.059	9.699	9.698	10.382
10	15.000	15.298	17.111	14.526	15.373	19.025	13.236	16.658	14.953

	1996
1	0.882
2	1.507
3	2.435
4	3.387
5	4.912
6	6.622
7	8.369
8	8.438
9	12.883
10	12.002

WT AT AGE (JAN 1) in kg. - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	0.486	0.694	0.625	0.700	0.548	0.748	0.907	0.711	0.736
2	1.023	1.028	1.139	1.118	1.112	1.068	1.260	1.222	1.157
3	1.881	1.678	1.920	1.855	1.996	1.826	1.911	1.847	1.863
4	2.922	3.219	2.808	2.903	3.007	2.969	2.933	3.087	2.763
5	3.370	4.118	4.876	4.373	4.275	4.216	4.101	4.291	4.667
6	4.594	5.579	5.712	6.386	5.826	5.849	5.525	5.709	6.048
7	6.235	7.290	7.760	7.562	8.223	7.201	7.547	7.300	7.561
8	7.235	8.721	9.136	9.108	9.207	9.814	8.970	9.549	8.978
9	10.004	9.967	9.325	11.349	11.119	10.541	10.783	10.741	11.396
10	13.200	12.625	15.400	18.565	16.723	14.554	15.356	13.494	14.104

	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.502	0.548	0.583	0.594	0.947	0.993	0.674	0.711	0.702
2	1.173	1.050	1.127	1.123	1.163	1.311	1.327	1.128	1.154
3	1.918	1.869	1.857	1.995	1.994	2.002	1.864	1.824	1.748
4	3.201	2.960	2.983	2.827	2.902	3.129	2.866	2.870	2.882
5	4.611	4.755	4.353	4.296	4.098	4.011	4.369	4.001	4.482
6	6.579	6.214	6.013	5.846	5.368	5.418	5.478	6.076	5.956
7	8.022	8.234	7.393	7.524	6.850	6.651	6.799	7.149	8.924
8	9.448	9.454	9.699	9.357	9.432	8.542	8.319	8.388	9.648
9	10.660	10.563	10.793	11.612	10.156	11.263	9.772	9.454	9.862
10	15.000	15.298	17.111	14.526	15.373	19.025	13.236	16.658	14.953

	1996	1997
1	0.666	0.675
2	1.168	1.168
3	1.893	1.944
4	2.664	3.133
5	4.337	4.307
6	6.031	5.563
7	7.861	7.271
8	9.509	8.910
9	12.234	7.488
10	12.002	12.002

Weights at age at the start of the spawning season are assumed to be the same as the Jan1 weight at age estimates.

PERCENT MATURE (females) - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	7	7	7	7	13	13	13	13	23	23	23	23	23	23	23
2	34	34	34	34	47	47	47	47	64	64	64	64	64	64	64
3	78	78	78	78	84	84	84	84	91	91	91	91	91	91	91
4	96	96	96	96	97	97	97	97	98	98	98	98	98	98	98
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
7	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

	1993	1994	1995	1996
1	23	23	23	23
2	64	64	64	64
3	91	91	91	91
4	98	98	98	98
5	100	100	100	100
6	100	100	100	100
7	100	100	100	100
8	100	100	100	100
9	100	100	100	100
10	100	100	100	100

SEX RATIO (Percent Female) - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
5	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
7	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
8	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
9	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
10	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

	1993	1994	1995	1996
1	50	50	50	50
2	50	50	50	50
3	50	50	50	50
4	50	50	50	50
5	50	50	50	50
6	50	50	50	50
7	50	50	50	50
8	50	50	50	50
9	50	50	50	50
10	50	50	50	50

BEGIN MARQUARDT ALGORITHM

LAMBDA 1.00000E-2
RSS 1.04207E3
NPHI 1.04207E3

par
2.00000E3 9.00000E3 4.00000E3 5.00000E3 2.00000E3 2.
00000E3 2.00000E3 1.00000E3 1.00000E-4 1.00000E-4 1
.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4
1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4
1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4
1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4

LAMBDA 1.00000E-1
RSS 8.91363E2
NPHI 8.91363E2

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par
   2.15820E3      8.43487E3      3.79628E3      4.95996E3      2.13465E3      1.
      84674E3      1.80251E3      8.33192E2      8.88241E-5     9.47955E-5     9
      .77737E-5    1.05532E-4     1.11954E-4     1.18744E-4     1.27113E-4
      1.35649E-4   9.44795E-5     9.80441E-5     1.01293E-4     1.06519E-4
       1.13710E-4    1.22453E-4     1.29900E-4     1.42641E-4     9.19928E-5
        9.47208E-5    9.78278E-5     1.03491E-4     1.07787E-4     1.19944E-4


LAMBDA         1.00000E0
RSS            7.66269E2
NPHI           7.66269E2

par
   2.31199E3      7.96778E3      3.62603E3      4.92799E3      2.26455E3      1.
      72503E3      1.64634E3      7.08531E2      7.99645E-5     9.03412E-5     9
      .57621E-5    1.10669E-4     1.23890E-4     1.38739E-4     1.58207E-4
      1.79423E-4   8.97276E-5     9.62292E-5     1.02366E-4     1.12668E-4
       1.27619E-4    1.47126E-4     1.64939E-4     1.97882E-4     8.53896E-5
        9.02064E-5    9.58619E-5     1.06635E-4     1.15238E-4     1.41434E-4


LAMBDA         1.00000E1
RSS            6.69510E2
NPHI           6.69510E2

par
   2.44303E3      7.58702E3      3.48738E3      4.90415E3      2.40519E3      1.
      65194E3      1.55575E3      6.33975E2      7.32680E-5     8.66892E-5     9
      .39576E-5    1.14852E-4     1.34490E-4     1.57833E-4     1.90225E-4
      2.27687E-4   8.58188E-5     9.45496E-5     1.03056E-4     1.17841E-4
       1.40068E-4    1.70908E-4     2.01210E-4     2.61398E-4     8.02299E-5
        8.65101E-5    9.40934E-5     1.09056E-4     1.21473E-4     1.62092E-4


LAMBDA         1.00000E0
RSS            3.71634E2
NPHI           3.71634E2

par
   2.90184E3      5.10668E3      2.58828E3      4.63635E3      3.73690E3      1.
      67963E3      1.67334E3      5.75885E2      4.13526E-5     6.77969E-5     8
      .34888E-5    1.33488E-4     1.86848E-4     2.60869E-4     3.78418E-4
      5.33021E-4   6.55120E-5     8.37587E-5     1.04679E-4     1.43088E-4
       2.02415E-4    2.94191E-4     4.07567E-4     6.69168E-4     5.52832E-5
        6.72698E-5    8.36761E-5     1.18675E-4     1.49810E-4     2.73537E-4


LAMBDA         1.00000E-1
RSS            2.36141E2
NPHI           2.36141E2

par
   4.04252E3      4.90168E3      2.45020E3      4.73562E3      3.81996E3      1.
      03657E3      6.73492E2      2.19132E1      3.16669E-5     5.81911E-5     7
      .82438E-5    1.61384E-4     2.77118E-4     4.71424E-4     8.46501E-4
      1.44261E-3   5.55158E-5     7.98202E-5     1.09735E-4     1.77802E-4
       3.16621E-4    5.86386E-4     9.74524E-4     2.09198E-3     4.37374E-5
        5.77829E-5    7.86949E-5     1.34225E-4     1.96028E-4     5.10067E-4


LAMBDA         1.00000E-2
RSS            1.65608E2
NPHI           1.65608E2

par
   4.47873E3      4.91372E3      2.43549E3      4.66060E3      2.55807E3      8.
      71730E2      6.40394E2      8.26087E1      3.25083E-5     5.90033E-5     7
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      .93520E-5     1.71932E-4     3.23268E-4     6.26190E-4     1.31388E-3
      2.67073E-3    5.56422E-5     7.97982E-5     1.12974E-4     1.93518E-4
       3.94187E-4    8.76474E-4     1.65315E-3     4.40949E-3     4.45503E-5
        5.85357E-5    7.97763E-5     1.40431E-4     2.18716E-4     6.99213E-4


LAMBDA        1.00000E-3
RSS           1.56390E2
NPHI          1.56390E2

par
   4.55194E3      4.96118E3      2.46311E3      4.72607E3      3.17202E3      9.
      78860E2      6.88595E2      1.51959E2      3.21723E-5     5.84036E-5     7
      .84953E-5     1.69808E-4     3.22544E-4     6.45287E-4     1.47639E-3
      3.40143E-3    5.50819E-5     7.92536E-5     1.11144E-4     1.90502E-4
       3.92925E-4    9.19437E-4     1.94184E-3     6.55391E-3     4.40788E-5
        5.79417E-5    7.89132E-5     1.38547E-4     2.15136E-4     7.25200E-4


LAMBDA        1.00000E-4
RSS           1.56149E2
NPHI          1.56149E2

par
   4.56191E3      4.97031E3      2.46782E3      4.73635E3      3.24080E3      1.
      00780E3      7.14017E2      1.69067E2      3.21228E-5     5.83190E-5     7
      .83690E-5     1.69412E-4     3.21359E-4     6.45020E-4     1.49131E-3
      3.50824E-3    5.49457E-5     7.91229E-5     1.10964E-4     1.90111E-4
       3.91202E-4    9.16960E-4     1.97364E-3     7.21924E-3     4.40100E-5
        5.78569E-5    7.87855E-5     1.38228E-4     2.14449E-4     7.24227E-4


LAMBDA        1.00000E-5
RSS           1.56148E2
NPHI          1.56148E2

par
   4.56238E3      4.97084E3      2.46817E3      4.73734E3      3.25473E3      1.
      00926E3      7.16321E2      1.67648E2      3.21177E-5     5.83101E-5     7
      .83570E-5     1.69384E-4     3.21381E-4     6.45266E-4     1.49224E-3
      3.50923E-3    5.49434E-5     7.91221E-5     1.10941E-4     1.90035E-4
       3.90935E-4    9.17553E-4     1.97559E-3     7.26009E-3     4.40032E-5
        5.78482E-5    7.87734E-5     1.38206E-4     2.14417E-4     7.24452E-4
RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001
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RESULTS

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES 156.148492
ORTHOGONALITY OFFSET..... 0.010275
MEAN SQUARE RESIDUALS 0.487964

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 1	4.56238E3	2.36103E3	1.93237E0	0.52
N 2	4.97084E3	1.62621E3	3.05671E0	0.33
N 3	2.46817E3	6.73624E2	3.66402E0	0.27
N 4	4.73734E3	1.26446E3	3.74652E0	0.27
N 5	3.25473E3	9.18155E2	3.54486E0	0.28
N 6	1.00926E3	3.00895E2	3.35419E0	0.30
N 7	7.16321E2	2.32355E2	3.08288E0	0.32
N 8	1.67648E2	5.55617E1	3.01732E0	0.33
qRV SPR 1	3.21177E-5	5.25452E-6	6.11240E0	0.16
qRV SPR 2	5.83101E-5	9.47642E-6	6.15318E0	0.16
qRV SPR 3	7.83570E-5	1.26941E-5	6.17268E0	0.16
qRV SPR 4	1.69384E-4	2.74236E-5	6.17660E0	0.16
qRV SPR 5	3.21381E-4	5.21642E-5	6.16094E0	0.16
qRV SPR 6	6.45266E-4	1.04933E-4	6.14932E0	0.16
qRV SPR 7	1.49224E-3	2.42058E-4	6.16478E0	0.16
qRV SPR 8	3.50923E-3	6.00011E-4	5.84860E0	0.17
qRV CAN 1	5.49434E-5	1.27986E-5	4.29292E0	0.23
qRV CAN 2	7.91221E-5	1.79969E-5	4.39644E0	0.23
qRV CAN 3	1.10941E-4	2.50644E-5	4.42623E0	0.23
qRV CAN 4	1.90035E-4	4.28613E-5	4.43372E0	0.23
qRV CAN 5	3.90935E-4	8.85659E-5	4.41406E0	0.23
qRV CAN 6	9.17553E-4	2.09225E-4	4.38548E0	0.23
qRV CAN 7	1.97559E-3	4.50480E-4	4.38552E0	0.23
qRV CAN 8	7.26009E-3	1.64899E-3	4.40275E0	0.23
qRV FAL 1	4.40032E-5	7.11630E-6	6.18345E0	0.16
qRV FAL 2	5.78482E-5	9.21746E-6	6.27594E0	0.16
qRV FAL 3	7.87734E-5	1.24893E-5	6.30726E0	0.16
qRV FAL 4	1.38206E-4	2.18926E-5	6.31290E0	0.16
qRV FAL 5	2.14417E-4	3.40574E-5	6.29575E0	0.16
qRV FAL 6	7.24452E-4	1.15431E-4	6.27607E0	0.16

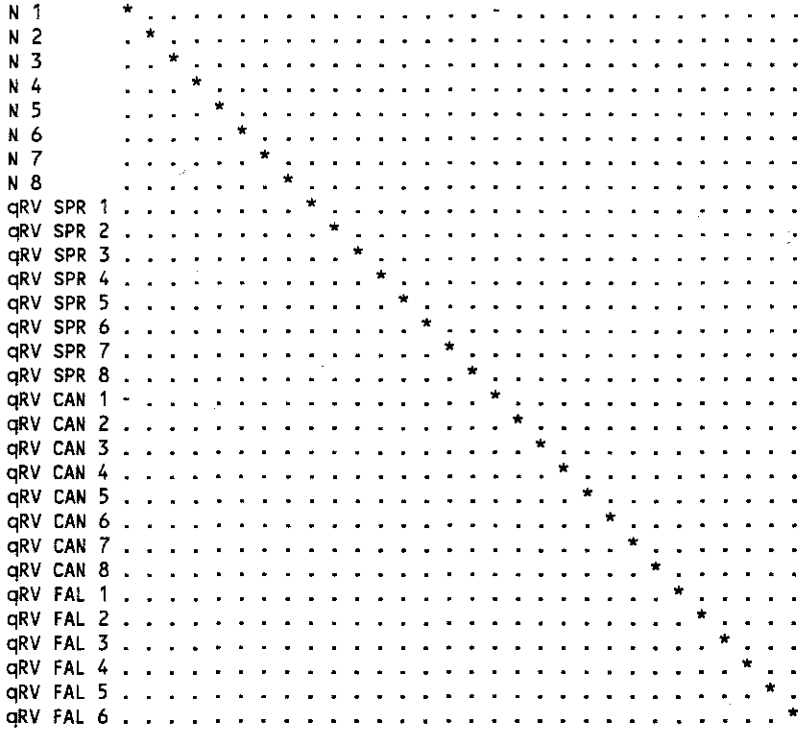
CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qRV SPR 1	1.36867E-5	2.23917E-6	0.16
qRV SPR 2	6.66602E-5	1.08335E-5	0.16
qRV SPR 3	1.19368E-4	1.93382E-5	0.16
qRV SPR 4	1.42361E-4	2.30485E-5	0.16
qRV SPR 5	1.71209E-4	2.77894E-5	0.16
qRV SPR 6	1.73476E-4	2.82106E-5	0.16
qRV SPR 7	2.32632E-4	3.77356E-5	0.16
qRV SPR 8	2.42713E-4	4.14994E-5	0.17
qRV CAN 1	2.74717E-5	6.39930E-6	0.23
qRV CAN 2	1.29286E-4	2.94069E-5	0.23
qRV CAN 3	2.38855E-4	5.39637E-5	0.23
qRV CAN 4	3.05006E-4	6.87924E-5	0.23
qRV CAN 5	4.37457E-4	9.91053E-5	0.23
qRV CAN 6	4.30332E-4	9.81266E-5	0.23
qRV CAN 7	5.05750E-4	1.15323E-4	0.23
qRV CAN 8	7.33269E-4	1.66548E-4	0.23
qRV FAL 1	1.23113E-5	1.99102E-6	0.16
qRV FAL 2	6.28206E-5	1.00098E-5	0.16
qRV FAL 3	8.32172E-5	1.31939E-5	0.16
qRV FAL 4	1.04554E-4	1.65620E-5	0.16
qRV FAL 5	6.58866E-5	1.04653E-5	0.16
qRV FAL 6	7.62935E-5	1.21562E-5	0.16

CORRELATION BETWEEN PARAMETERS ESTIMATED

1.00	0.05	0.04	0.02	0.01	0.02	0.01	0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.24	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.17	-0.01	-0.01	-0.00	-0.00	-0.00
0.05	1.00	0.06	0.04	0.02	0.02	0.01	0.01	-0.12	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.16	-0.16	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.12	-0.11	-0.01	-0.01	-0.00	-0.00
0.04	0.06	1.00	0.06	0.04	0.02	0.01	0.01	-0.10	-0.09	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.13	-0.13	-0.13	-0.01	-0.01	-0.01	-0.00	-0.01	-0.10	-0.09	-0.09	-0.01	-0.01	-0.00
0.02	0.04	0.06	1.00	0.05	0.03	0.01	0.01	-0.08	-0.08	-0.08	-0.01	-0.00	-0.00	-0.00	-0.01	-0.02	-0.11	-0.11	-0.13	-0.01	-0.01	-0.01	-0.01	-0.08	-0.08	-0.08	-0.09	-0.01	-0.01
0.01	0.02	0.04	0.05	1.00	0.01	0.01	0.01	-0.07	-0.06	-0.06	-0.07	-0.00	-0.01	-0.02	-0.06	-0.01	-0.01	-0.09	-0.10	-0.13	-0.00	-0.02	-0.07	-0.06	-0.06	-0.06	-0.07	-0.09	-0.01
0.02	0.02	0.02	0.03	0.01	1.00	0.04	0.04	-0.04	-0.04	-0.04	-0.06	-0.09	-0.01	-0.02	-0.05	-0.05	-0.01	-0.01	-0.08	-0.12	-0.14	-0.03	-0.06	-0.04	-0.04	-0.04	-0.06	-0.09	-0.11
0.01	0.01	0.01	0.01	0.01	0.04	1.00	0.07	-0.02	-0.02	-0.02	-0.04	-0.08	-0.10	-0.03	-0.05	-0.03	-0.02	-0.01	-0.01	-0.11	-0.14	-0.17	-0.06	-0.02	-0.02	-0.02	-0.04	-0.08	-0.11
0.01	0.01	0.01	0.01	0.01	0.04	0.07	1.00	-0.01	-0.01	-0.01	-0.02	-0.05	-0.10	-0.11	-0.03	-0.02	-0.02	-0.02	-0.01	-0.02	-0.13	-0.16	-0.19	-0.01	-0.01	-0.02	-0.03	-0.05	-0.10
-0.01	-0.1	-0.1	-0.08	-0.07	-0.04	-0.02	-0.01	1.00	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.03	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.03	0.03	0.02	0.01	0.01	0.01
-0.01	-0.01	-0.09	-0.08	-0.06	-0.04	-0.02	-0.01	0.02	1.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01
-0.00	-0.01	-0.01	-0.08	-0.06	-0.04	-0.02	-0.01	0.01	0.01	1.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
-0.00	-0.00	-0.00	-0.01	-0.07	-0.06	-0.04	-0.02	0.01	0.01	0.01	1.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
-0.00	-0.00	-0.00	-0.00	-0.00	-0.09	-0.08	-0.05	0.01	0.01	0.01	0.01	1.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02
-0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.10	-0.10	0.00	0.00	0.00	0.01	0.01	1.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.02	0.00	0.00	0.00	0.01	0.01	0.02
-0.00	-0.00	-0.00	-0.00	-0.02	-0.02	-0.03	-0.11	0.00	0.00	0.00	0.01	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.02
-0.00	-0.00	-0.00	-0.01	-0.06	-0.05	-0.05	-0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.00	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
-0.24	-0.16	-0.13	-0.02	-0.01	-0.05	-0.03	-0.02	0.03	0.01	0.00	0.00	0.01	0.00	0.00	0.00	1.00	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.07	0.03	0.02	0.01	0.01	0.01
-0.01	-0.16	-0.13	-0.11	-0.01	-0.01	-0.02	-0.02	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.04	1.00	0.03	0.01	0.01	0.01	0.01	0.01	0.04	0.03	0.02	0.01	0.00	0.00
-0.01	-0.01	-0.13	-0.11	-0.09	-0.01	-0.01	-0.02	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.03	1.00	0.02	0.01	0.00	0.01	0.01	0.03	0.02	0.02	0.02	0.01	0.00
-0.00	-0.01	-0.01	-0.13	-0.10	-0.08	-0.01	-0.01	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02	1.00	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01
-0.00	-0.01	-0.01	-0.01	-0.13	-0.12	-0.11	-0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	1.00	0.03	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.02
-0.00	-0.01	-0.01	-0.01	-0.00	-0.14	-0.14	-0.13	0.01	0.01	0.01	0.02	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.03	1.00	0.04	0.04	0.01	0.01	0.01	0.02	0.03	0.04
-0.00	-0.00	-0.00	-0.01	-0.02	-0.03	-0.17	-0.16	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.04	1.00	0.04	0.01	0.01	0.01	0.01	0.02	0.03
-0.00	-0.00	-0.01	-0.01	-0.07	-0.06	-0.06	-0.19	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.04	1.00	0.01	0.01	0.01	0.01	0.02	0.03
-0.17	-0.12	-0.10	-0.08	-0.06	-0.04	-0.02	-0.01	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01	1.00	0.03	0.02	0.01	0.01	0.01
-0.01	-0.11	-0.09	-0.08	-0.06	-0.04	-0.02	-0.01	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.03	1.00	0.02	0.01	0.01	0.01
-0.01	-0.01	-0.09	-0.08	-0.06	-0.04	-0.02	-0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	1.00	0.01	0.01	0.01
-0.00	-0.01	-0.01	-0.09	-0.07	-0.06	-0.04	-0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	1.00	0.02	0.01
-0.00	-0.00	-0.01	-0.01	-0.09	-0.09	-0.08	-0.05	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.02	1.00	0.02
-0.00	-0.00	-0.00	-0.01	-0.01	-0.11	-0.11	-0.10	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.02	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.02	1.00

CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

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SYMBOLS:  =  LARGE NEGATIVE CORRELATION     whenever  -1 <= R <  -L
          -  MODERATE NEGATIVE CORRELATION  whenever  -L <= R <  -M
          .  SMALL CORRELATION              whenever  -M <= R <= +M
          +  MODERATE POSITIVE CORRELATION  whenever  +M <  R <= +L
          *  LARGE POSITIVE CORRELATION     whenever  +L <  R <= +1

Where R is the estimated correlation, M is 0.2 and L is 0.5
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SUMMMARY OF RESIDUALS

Index 1 RV SPR 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.1253	-0.1164	1.0000	-0.0089	-0.0127	27713.831
1979	0.0211	-0.2808	1.0000	0.3019	0.4322	23513.743
1980	-2.6269	-0.4373	1.0000	-2.1896	-3.1345	20105.840
1981	1.6874	0.2848	1.0000	1.4025	2.0078	41395.733
1982	0.1356	-0.5778	1.0000	0.7134	1.0212	17471.811
1983	-0.2582	-1.1748	1.0000	0.9166	1.3122	9616.908
1984	-0.0571	-0.1280	1.0000	0.0708	0.1014	27395.410
1985	-1.4698	-1.2757	1.0000	-0.1941	-0.2778	8694.003
1986	0.7149	0.3194	1.0000	0.3955	0.5662	42850.891
1987	-2.5284	-0.6413	1.0000	-1.8871	-2.7015	16396.521
1988	0.4963	-0.2792	1.0000	0.7755	1.1102	23550.222
1989	-0.1146	-0.6875	1.0000	0.5728	0.8200	15656.476
1990	-0.7852	-1.1636	1.0000	0.3784	0.5417	9725.482
1991	0.9188	-0.4510	1.0000	1.3699	1.9610	19832.465
1992	-1.2426	-1.2730	1.0000	0.0304	0.0436	8717.450
1993	-3.2216	-0.9522	1.0000	-2.2693	-3.2487	12014.521
1994	-1.2406	-1.0726	1.0000	-0.1681	-0.2406	10652.152
1995	-2.1427	-2.0617	1.0000	-0.0811	-0.1160	3961.614

1996	-1.7643	-1.6346	1.0000	-0.1297	-0.1856	6072.171

Partial variance for this index is 1.140471

Index 2 RV SPR 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-1.8094	-1.3908	1.0000	-0.4186	-0.5993	4268.132
1979	0.1727	0.2799	1.0000	-0.1071	-0.1534	22688.356
1980	0.4481	0.1140	1.0000	0.3341	0.4782	19220.660
1981	0.5166	-0.0459	1.0000	0.5625	0.8052	16380.739
1982	1.0885	0.6805	1.0000	0.4081	0.5842	33867.529
1983	0.5428	-0.2026	1.0000	0.7453	1.0669	14005.208
1984	-0.9065	-0.7909	1.0000	-0.1156	-0.1655	7775.936
1985	0.8343	0.2651	1.0000	0.5692	0.8148	22356.173
1986	-0.9942	-0.8965	1.0000	-0.0977	-0.1398	6996.800
1987	0.3436	0.7117	1.0000	-0.3681	-0.5269	34942.188
1988	-0.5136	-0.2467	1.0000	-0.2670	-0.3822	13400.810
1989	0.1546	0.1167	1.0000	0.0379	0.0542	19272.242
1990	-0.2108	-0.2911	1.0000	0.0803	0.1149	12818.437
1991	-0.8050	-0.7680	1.0000	-0.0369	-0.0529	7956.217
1992	0.0933	-0.0576	1.0000	0.1509	0.2160	16190.397
1993	-1.0551	-0.8856	1.0000	-0.1696	-0.2427	7073.906
1994	-1.4338	-0.5562	1.0000	-0.8775	-1.2562	9833.039
1995	-1.0962	-0.6764	1.0000	-0.4197	-0.6009	8719.435
1996	-1.6756	-1.6654	1.0000	-0.0103	-0.0147	3243.405

Partial variance for this index is 0.164286

Index 3 RV SPR 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	1.2893	0.6932	1.0000	0.5961	0.8533	25526.278
1979	-1.6317	-1.4026	1.0000	-0.2291	-0.3280	3138.850
1980	0.3321	0.2735	1.0000	0.0586	0.0839	16775.933
1981	0.6012	-0.0353	1.0000	0.6365	0.9112	12318.975
1982	-0.0801	-0.1940	1.0000	0.1139	0.1631	10511.411
1983	0.6936	0.4219	1.0000	0.2717	0.3890	19459.983
1984	-0.6476	-0.5199	1.0000	-0.1278	-0.1829	7588.361
1985	-0.6993	-0.9009	1.0000	0.2016	0.2886	5183.775
1986	0.1801	-0.0216	1.0000	0.2017	0.2888	12489.201
1987	-1.3298	-1.0360	1.0000	-0.2937	-0.4205	4528.681
1988	0.7153	0.5376	1.0000	0.1777	0.2544	21846.394
1989	-0.7185	-0.2905	1.0000	-0.4280	-0.6128	9544.727
1990	0.1139	0.0847	1.0000	0.0293	0.0419	13889.477
1991	-0.6359	-0.7509	1.0000	0.1150	0.1646	6023.142
1992	-1.1760	-0.9106	1.0000	-0.2654	-0.3799	5134.122
1993	-0.1231	-0.2977	1.0000	0.1747	0.2500	9476.070
1994	-2.0310	-0.9661	1.0000	-1.0650	-1.5245	4856.927
1995	-0.5788	-0.5065	1.0000	-0.0723	-0.1035	7690.486
1996	-0.7275	-0.6319	1.0000	-0.0956	-0.1368	6784.173

Partial variance for this index is 0.145462

Index 4 RV SPR 4
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	0.1421	0.2972	1.0000	-0.1551	-0.2221	7946.749
1979	0.8222	0.8555	1.0000	-0.0332	-0.0476	13888.469

1980	-1.6271	-1.2128	1.0000	-0.4143	-0.5931	1755.519
1981	0.6851	0.3600	1.0000	0.3251	0.4655	8461.580
1982	0.4325	0.0597	1.0000	0.3729	0.5338	6266.605
1983	-0.0928	-0.1374	1.0000	0.0446	0.0638	5145.917
1984	0.3228	0.3804	1.0000	-0.0577	-0.0826	8636.783
1985	0.2302	-0.6392	1.0000	0.8694	1.2445	3115.566
1986	-0.8478	-1.0658	1.0000	0.2179	0.3120	2033.598
1987	-0.1112	0.0306	1.0000	-0.1419	-0.2031	6087.472
1988	-0.7105	-0.8854	1.0000	0.1749	0.2504	2435.569
1989	0.6003	0.5879	1.0000	0.0124	0.0177	10627.708
1990	-0.2531	-0.1326	1.0000	-0.1205	-0.1725	5170.627
1991	0.0496	0.1427	1.0000	-0.0931	-0.1333	6809.552
1992	-1.6402	-1.0840	1.0000	-0.5562	-0.7963	1996.944
1993	-1.3313	-0.9691	1.0000	-0.3622	-0.5184	2239.967
1994	-1.3565	-0.4104	1.0000	-0.9461	-1.3544	3916.411
1995	-0.4536	-0.8217	1.0000	0.3682	0.5270	2595.734
1996	0.3945	-0.1005	1.0000	0.4951	0.7087	5339.119

Partial variance for this index is 0.172404

Index 5 RV SPR 5
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	0.3793	-0.0782	1.0000	0.4574	0.6548	2877.644
1979	0.0160	0.3516	1.0000	-0.3356	-0.4804	4422.407
1980	0.7874	0.8057	1.0000	-0.0183	-0.0261	6964.358
1981	-1.6746	-1.1504	1.0000	-0.5242	-0.7505	984.879
1982	0.6679	0.4121	1.0000	0.2559	0.3663	4698.236
1983	0.2692	-0.1762	1.0000	0.4454	0.6377	2608.880
1984	-0.1773	-0.4466	1.0000	0.2692	0.3854	1990.840
1985	0.9134	0.2642	1.0000	0.6492	0.9293	4052.662
1986	0.0228	-0.8628	1.0000	0.8856	1.2678	1312.992
1987	-2.1837	-1.1930	1.0000	-0.9907	-1.4183	943.814
1988	0.1912	-0.0151	1.0000	0.2064	0.2954	3064.840
1989	-0.8508	-1.0597	1.0000	0.2089	0.2990	1078.380
1990	0.5198	0.4626	1.0000	0.0572	0.0819	4941.632
1991	-0.1370	-0.2067	1.0000	0.0697	0.0998	2530.447
1992	-0.6796	-0.1772	1.0000	-0.5024	-0.7193	2606.418
1993	-1.6052	-1.4979	1.0000	-0.1073	-0.1536	695.738
1994	-2.7761	-1.3275	1.0000	-1.4486	-2.0738	825.036
1995	0.1173	-0.6936	1.0000	0.8108	1.1607	1555.157
1996	-1.1190	-0.7303	1.0000	-0.3887	-0.5564	1499.059

Partial variance for this index is 0.362083

Index 6 RV SPR 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.6277	-0.3209	1.0000	-0.3068	-0.4392	1124.370
1979	-0.1388	0.0350	1.0000	-0.1738	-0.2489	1605.001
1980	0.5629	0.4878	1.0000	0.0751	0.1075	2524.098
1981	1.1744	0.8466	1.0000	0.3278	0.4693	3613.569
1982	-2.8202	-0.9595	1.0000	-1.8608	-2.6638	593.714
1983	0.4710	0.2733	1.0000	0.1976	0.2829	2036.916
1984	0.4564	-0.2714	1.0000	0.7278	1.0418	1181.367
1985	0.0043	-0.5775	1.0000	0.5818	0.8328	869.898
1986	0.8563	0.0396	1.0000	0.8167	1.1691	1612.421
1987	-0.4067	-0.8833	1.0000	0.4766	0.6823	640.665
1988	-1.7875	-1.0915	1.0000	-0.6960	-0.9963	520.280
1989	0.2478	-0.2942	1.0000	0.5420	0.7759	1154.737
1990	-0.7673	-0.9770	1.0000	0.2097	0.3002	583.401
1991	0.2222	0.2537	1.0000	-0.0315	-0.0451	1997.314

1992	-0.6243	-0.7224	1.0000	0.0981	0.1405	752.502
1993	-0.8066	-0.6700	1.0000	-0.1366	-0.1955	792.985
1994	-3.8839	-2.2013	1.0000	-1.6826	-2.4088	171.494
1995	-0.9213	-1.5807	1.0000	0.6594	0.9440	318.976
1996	-0.2518	-0.4273	1.0000	0.1755	0.2512	1010.852

Partial variance for this index is 0.547141

Index 7 RV SPR 7
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	1.5202	0.7608	1.0000	0.7594	1.0871	1434.102
1979	-0.5791	0.1797	1.0000	-0.7588	-1.0863	802.022
1980	-0.0280	0.2945	1.0000	-0.3226	-0.4618	899.648
1981	0.5443	0.4892	1.0000	0.0551	0.0789	1092.951
1982	0.6487	0.9228	1.0000	-0.2741	-0.3924	1686.339
1983	-1.0491	-1.0615	1.0000	0.0123	0.0176	231.832
1984	0.3583	0.3652	1.0000	-0.0068	-0.0098	965.532
1985	0.2640	-0.2922	1.0000	0.5562	0.7963	500.325
1986	-0.9060	-0.6802	1.0000	-0.2258	-0.3232	339.420
1987	-0.0587	0.1163	1.0000	-0.1751	-0.2506	752.805
1988	-2.0534	-0.8154	1.0000	-1.2381	-1.7723	296.513
1989	-1.1260	-1.1835	1.0000	0.0575	0.0824	205.189
1990	-0.1144	-0.3852	1.0000	0.2708	0.3876	455.902
1991	-1.3931	-0.9074	1.0000	-0.4857	-0.6952	270.441
1992	0.0322	-0.0293	1.0000	0.0615	0.0880	650.800
1993	-1.4383	-0.9839	1.0000	-0.4544	-0.6505	250.542
1994	-1.2596	-1.1041	1.0000	-0.1555	-0.2226	222.158
1995	0.4061	-2.5270	1.0000	2.9331	4.1989	53.543
1996	-1.7170	-1.1078	1.0000	-0.6092	-0.8721	221.343

Partial variance for this index is 0.724642

Index 8 RV SPR 8
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.2953	-1.4454	1.0000	1.1501	1.6464	67.154
1979	0.7408	1.1069	1.0000	-0.3661	-0.5240	861.974
1980	-1.0318	0.7226	1.0000	-1.7544	-2.5115	586.968
1981	0.7347	0.1585	1.0000	0.5761	0.8247	333.917
1982	-0.0763	0.5967	1.0000	-0.6730	-0.9634	517.516
1983	1.0204	0.9962	1.0000	0.0241	0.0346	771.702
1985	0.9110	0.2775	1.0000	0.6335	0.9069	376.095
1986	0.5426	-0.2940	1.0000	0.8366	1.1977	212.377
1987	-1.4639	-0.3582	1.0000	-1.1057	-1.5829	199.172
1988	-0.2852	0.2666	1.0000	-0.5519	-0.7900	372.039
1989	-0.5602	-1.0768	1.0000	0.5166	0.7395	97.086
1990	-1.6996	-1.1112	1.0000	-0.5884	-0.8423	93.798
1991	-0.5404	-0.6313	1.0000	0.0909	0.1301	151.576
1992	-1.2408	-0.9757	1.0000	-0.2650	-0.3794	107.409
1993	-0.6256	-0.1180	1.0000	-0.5075	-0.7265	253.235
1995	-0.9043	-1.5932	1.0000	0.6889	0.9862	57.925
1996	-1.3461	-2.6412	1.0000	1.2951	1.8539	20.311

Partial variance for this index is 0.706648

Index 9 RV CAN 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize

1986	0.1823	0.8563	1.0000	-0.6740	-0.9648	42850.891
1987	-0.6931	-0.1044	1.0000	-0.5888	-0.8428	16396.521
1988	-0.5798	0.2577	1.0000	-0.8375	-1.1989	23550.222
1989	1.1817	-0.1506	1.0000	1.3323	1.9072	15656.476
1990	-0.1744	-0.6267	1.0000	0.4523	0.6476	9725.482
1991	0.8587	0.0859	1.0000	0.7728	1.1063	19832.465
1992	-1.5141	-0.7361	1.0000	-0.7780	-1.1137	8717.450
1995	-1.9661	-1.5248	1.0000	-0.4413	-0.6318	3961.614
1996	-1.2730	-1.0977	1.0000	-0.1752	-0.2508	6072.171
1997	-0.4463	-1.3836	1.0000	0.9373	1.3418	4562.377

Partial variance for this index is 0.670239

Index 10 RV CAN 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	0.3287	-0.5913	1.0000	0.9201	1.3171	6996.800
1987	0.2651	1.0169	1.0000	-0.7518	-1.0763	34942.188
1988	-0.4811	0.0586	1.0000	-0.5396	-0.7725	13400.810
1989	0.5314	0.4219	1.0000	0.1095	0.1568	19272.242
1990	0.4010	0.0141	1.0000	0.3868	0.5538	12818.437
1991	-0.3426	-0.4628	1.0000	0.1202	0.1721	7956.217
1992	0.5598	0.2477	1.0000	0.3121	0.4468	16190.397
1995	-0.8915	-0.3712	1.0000	-0.5203	-0.7448	8719.435
1996	-1.2044	-1.3601	1.0000	0.1558	0.2230	3243.405
1997	-1.1259	-0.9332	1.0000	-0.1927	-0.2759	4970.840

Partial variance for this index is 0.267313

Index 11 RV CAN 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	0.2663	0.3261	1.0000	-0.0598	-0.0856	12489.201
1987	-0.8394	-0.6883	1.0000	-0.1511	-0.2163	4528.681
1988	0.7722	0.8853	1.0000	-0.1131	-0.1619	21846.394
1989	-0.4448	0.0572	1.0000	-0.5020	-0.7186	9544.727
1990	0.5629	0.4324	1.0000	0.1305	0.1868	13889.477
1991	-0.1571	-0.4032	1.0000	0.2461	0.3522	6023.142
1992	-0.1959	-0.5629	1.0000	0.3670	0.5253	5134.122
1995	-0.3614	-0.1588	1.0000	-0.2026	-0.2901	7690.486
1996	0.0704	-0.2842	1.0000	0.3546	0.5076	6784.173
1997	-1.3647	-1.2953	1.0000	-0.0694	-0.0994	2468.174

Partial variance for this index is 0.078162

Index 12 RV CAN 4
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-1.4674	-0.9507	1.0000	-0.5166	-0.7396	2033.598
1987	-0.3869	0.1457	1.0000	-0.5326	-0.7625	6087.472
1988	-1.0179	-0.7704	1.0000	-0.2475	-0.3543	2435.569
1989	0.5742	0.7029	1.0000	-0.1287	-0.1843	10627.708
1990	0.2592	-0.0176	1.0000	0.2768	0.3962	5170.627
1991	0.2923	0.2578	1.0000	0.0346	0.0495	6809.552
1992	-0.6963	-0.9689	1.0000	0.2727	0.3903	1996.944
1995	-0.6239	-0.7067	1.0000	0.0827	0.1184	2595.734
1996	0.9182	0.0145	1.0000	0.9036	1.2936	5339.119
1997	-0.2500	-0.1051	1.0000	-0.1449	-0.2074	4737.343

Partial variance for this index is 0.188158

Index 13 RV CAN 5
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-0.5432	-0.6669	1.0000	0.1237	0.1771	1312.992
1987	-1.1912	-0.9970	1.0000	-0.1942	-0.2780	943.814
1988	-0.0926	0.1808	1.0000	-0.2734	-0.3914	3064.840
1989	-1.1341	-0.8638	1.0000	-0.2703	-0.3870	1078.380
1990	1.2408	0.6585	1.0000	0.5823	0.8336	4941.632
1991	-0.0636	-0.0108	1.0000	-0.0528	-0.0756	2530.447
1992	-0.1326	0.0188	1.0000	-0.1514	-0.2167	2606.418
1995	-0.6233	-0.4976	1.0000	-0.1256	-0.1798	1555.157
1996	-0.0263	-0.5344	1.0000	0.5081	0.7274	1499.059
1997	0.0946	0.2409	1.0000	-0.1463	-0.2095	3254.732

Partial variance for this index is 0.099701

Index 14 RV CAN 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-0.0638	0.3917	1.0000	-0.4555	-0.6521	1612.421
1987	-1.3631	-0.5313	1.0000	-0.8318	-1.1908	640.665
1988	-1.2831	-0.7394	1.0000	-0.5436	-0.7782	520.280
1989	-0.1103	0.0578	1.0000	-0.1682	-0.2408	1154.737
1990	-0.1103	-0.6249	1.0000	0.5146	0.7366	583.401
1991	1.0272	0.6058	1.0000	0.4214	0.6033	1997.314
1992	0.2463	-0.3704	1.0000	0.6167	0.8829	752.502
1995	-0.9036	-1.2287	1.0000	0.3251	0.4654	318.976
1996	0.5214	-0.0753	1.0000	0.5967	0.8542	1010.852
1997	-0.5522	-0.0768	1.0000	-0.4754	-0.6805	1009.260

Partial variance for this index is 0.316529

Index 15 RV CAN 7
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	0.0155	-0.3997	1.0000	0.4152	0.5943	339.420
1987	-0.1515	0.3969	1.0000	-0.5485	-0.7852	752.805
1988	-1.1632	-0.5348	1.0000	-0.6284	-0.8995	296.513
1989	-1.6332	-0.9030	1.0000	-0.7302	-1.0453	205.189
1990	1.2900	-0.1046	1.0000	1.3946	1.9965	455.902
1991	-0.4700	-0.6268	1.0000	0.1568	0.2245	270.441
1992	0.5186	0.2513	1.0000	0.2673	0.3826	650.800
1995	-1.8563	-2.2464	1.0000	0.3901	0.5585	53.543
1996	0.2539	-0.8272	1.0000	1.0811	1.5476	221.343
1997	-1.4508	0.3472	1.0000	-1.7981	-2.5740	716.321

Partial variance for this index is 0.925875

Index 16 RV CAN 8
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1986	-0.9262	0.4330	1.0000	-1.3592	-1.9458	212.377
1987	-0.2331	0.3688	1.0000	-0.6019	-0.8617	199.172
1988	0.5207	0.9936	1.0000	-0.4730	-0.6771	372.039

1989	-0.0100	-0.3498	1.0000	0.3398	0.4865	97.086
1990	0.1724	-0.3842	1.0000	0.5566	0.7968	93.798
1991	0.7785	0.0957	1.0000	0.6828	0.9774	151.576
1992	0.1724	-0.2487	1.0000	0.4211	0.6028	107.409
1995	-0.7031	-0.8662	1.0000	0.1631	0.2335	57.925
1996	-0.2331	-1.9142	1.0000	1.6811	2.4066	20.311
1997	-1.2139	0.1965	1.0000	-1.4104	-2.0191	167.648

Partial variance for this index is 0.966176

Index 18 RV FAL 1
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.6129	0.1984	1.0000	-0.8113	-1.1614	27713.831
1979	0.3464	0.0341	1.0000	0.3123	0.4471	23513.743
1980	-0.8607	-0.1225	1.0000	-0.7382	-1.0568	20105.840
1981	-0.0001	0.5997	1.0000	-0.5998	-0.8586	41395.733
1982	-0.0685	-0.2629	1.0000	0.1944	0.2784	17471.811
1983	0.1337	-0.8600	1.0000	0.9937	1.4225	9616.908
1984	1.3044	0.1869	1.0000	1.1175	1.5998	27395.410
1985	-0.4102	-0.9609	1.0000	0.5507	0.7883	8694.003
1986	1.3544	0.6342	1.0000	0.7202	1.0310	42850.891
1987	-1.0697	-0.3264	1.0000	-0.7432	-1.0640	16396.521
1988	-0.3159	0.0356	1.0000	-0.3515	-0.5032	23550.222
1989	0.6741	-0.3726	1.0000	1.0467	1.4984	15656.476
1990	-0.0646	-0.8487	1.0000	0.7841	1.1225	9725.482
1991	-0.5815	-0.1362	1.0000	-0.4453	-0.6375	19832.465
1992	-1.9379	-0.9582	1.0000	-0.9797	-1.4026	8717.450
1993	-2.1375	-0.6374	1.0000	-1.5001	-2.1475	12014.521
1994	-0.4492	-0.7577	1.0000	0.3085	0.4417	10652.152
1995	-1.4293	-1.7468	1.0000	0.3175	0.4545	3961.614
1996	-0.5588	-1.3198	1.0000	0.7609	1.0893	6072.171
1997	-2.5430	-1.6056	1.0000	-0.9373	-1.3418	4562.377

Partial variance for this index is 0.654902

Index 19 RV FAL 2
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-1.5238	-1.3988	1.0000	-0.1250	-0.1789	4268.132
1979	0.5353	0.2719	1.0000	0.2634	0.3770	22688.356
1980	0.3996	0.1061	1.0000	0.2935	0.4202	19220.660
1981	-0.2830	-0.0538	1.0000	-0.2291	-0.3280	16380.739
1982	1.1773	0.6725	1.0000	0.5048	0.7226	33867.529
1983	-0.2158	-0.2105	1.0000	-0.0053	-0.0076	14005.208
1984	-0.5173	-0.7989	1.0000	0.2816	0.4032	7775.936
1985	0.8322	0.2572	1.0000	0.5751	0.8232	22356.173
1986	-1.5966	-0.9045	1.0000	-0.6921	-0.9908	6996.800
1987	0.7417	0.7038	1.0000	0.0380	0.0543	34942.188
1988	-0.9644	-0.2546	1.0000	-0.7097	-1.0160	13400.810
1989	-0.1845	0.1087	1.0000	-0.2932	-0.4198	19272.242
1990	0.9248	-0.2990	1.0000	1.2239	1.7520	12818.437
1991	-1.0991	-0.7760	1.0000	-0.3231	-0.4625	7956.217
1992	-0.9625	-0.0655	1.0000	-0.8970	-1.2841	16190.397
1993	-0.8721	-0.8935	1.0000	0.0214	0.0306	7073.906
1994	-0.1128	-0.5642	1.0000	0.4514	0.6462	9833.039
1995	-0.9839	-0.6844	1.0000	-0.2995	-0.4287	8719.435
1996	-1.4890	-1.6733	1.0000	0.1844	0.2639	3243.405
1997	-1.5096	-1.2463	1.0000	-0.2632	-0.3768	4970.840

Partial variance for this index is 0.255562

Index 20 RV FAL 3
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	1.1758	0.6985	1.0000	0.4773	0.6833	25526.278
1979	-1.4210	-1.3973	1.0000	-0.0236	-0.0338	3138.850
1980	0.4855	0.2788	1.0000	0.2068	0.2960	16775.933
1981	-0.6268	-0.0300	1.0000	-0.5968	-0.8543	12318.975
1982	0.7562	-0.1887	1.0000	0.9449	1.3527	10511.411
1983	0.6840	0.4272	1.0000	0.2568	0.3676	19459.983
1984	-0.0333	-0.5146	1.0000	0.4813	0.6889	7588.361
1985	-2.3436	-0.8956	1.0000	-1.4479	-2.0728	5183.775
1986	-0.2743	-0.0163	1.0000	-0.2580	-0.3693	12489.201
1987	-1.9322	-1.0307	1.0000	-0.9014	-1.2905	4528.681
1988	0.2474	0.5429	1.0000	-0.2954	-0.4229	21846.394
1989	-0.8919	-0.2852	1.0000	-0.6067	-0.8685	9544.727
1990	-0.0252	0.0900	1.0000	-0.1151	-0.1648	13889.477
1991	0.3731	-0.7456	1.0000	1.1187	1.6015	6023.142
1992	-1.8371	-0.9053	1.0000	-0.9318	-1.3339	5134.122
1993	-0.0312	-0.2924	1.0000	0.2612	0.3740	9476.070
1994	-0.6866	-0.9608	1.0000	0.2742	0.3925	4856.927
1995	-0.4644	-0.5012	1.0000	0.0368	0.0527	7690.486
1996	0.5390	-0.6266	1.0000	1.1656	1.6686	6784.173
1997	-1.6845	-1.6377	1.0000	-0.0468	-0.0670	2468.174

Partial variance for this index is 0.476872

Index 21 RV FAL 4
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.0741	0.0937	1.0000	-0.1679	-0.2403	7946.749
1979	1.7094	0.6520	1.0000	1.0574	1.5137	13888.469
1980	-1.2157	-1.4162	1.0000	0.2005	0.2870	1755.519
1981	0.0228	0.1565	1.0000	-0.1337	-0.1915	8461.580
1982	0.7231	-0.1438	1.0000	0.8669	1.2409	6266.605
1983	-1.2353	-0.3408	1.0000	-0.8945	-1.2805	5145.917
1984	0.0504	0.1770	1.0000	-0.1266	-0.1813	8636.783
1985	0.1581	-0.8426	1.0000	1.0007	1.4325	3115.566
1986	-1.9940	-1.2692	1.0000	-0.7248	-1.0376	2033.598
1987	-0.6833	-0.1728	1.0000	-0.5105	-0.7308	6087.472
1988	-1.9102	-1.0888	1.0000	-0.8214	-1.1759	2435.569
1989	0.1836	0.3845	1.0000	-0.2008	-0.2875	10627.708
1990	-1.4177	-0.3360	1.0000	-1.0817	-1.5485	5170.627
1991	0.4306	-0.0607	1.0000	0.4913	0.7033	6809.552
1992	-1.0037	-1.2874	1.0000	0.2837	0.4062	1996.944
1993	-1.4358	-1.1726	1.0000	-0.2632	-0.3768	2239.967
1994	-0.6824	-0.6138	1.0000	-0.0685	-0.0981	3916.411
1995	-0.5580	-1.0251	1.0000	0.4672	0.6688	2595.734
1996	0.5014	-0.3040	1.0000	0.8053	1.1529	5339.119
1997	-0.6029	-0.4235	1.0000	-0.1793	-0.2567	4737.343

Partial variance for this index is 0.415265

Index 22 RV FAL 5
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	-0.2007	-0.4829	1.0000	0.2822	0.4039	2877.644
1979	1.1431	-0.0531	1.0000	1.1962	1.7124	4422.407
1980	1.6582	0.4010	1.0000	1.2572	1.7998	6964.358
1981	-1.3917	-1.5551	1.0000	0.1634	0.2339	984.879
1982	0.6508	0.0074	1.0000	0.6435	0.9211	4698.236

1983	-1.4989	-0.5809	1.0000	-0.9180	-1.3141	2608.880
1984	-1.7277	-0.8513	1.0000	-0.8765	-1.2547	1990.840
1985	1.0413	-0.1405	1.0000	1.1817	1.6917	4052.662
1986	-0.9828	-1.2675	1.0000	0.2847	0.4075	1312.992
1987	-3.4252	-1.5977	1.0000	-1.8275	-2.6162	943.814
1988	-0.4548	-0.4198	1.0000	-0.0349	-0.0500	3064.840
1989	-1.2169	-1.4644	1.0000	0.2475	0.3543	1078.380
1990	0.4854	0.0579	1.0000	0.4275	0.6120	4941.632
1991	-0.3875	-0.6114	1.0000	0.2239	0.3205	2530.447
1992	-2.4081	-0.5819	1.0000	-1.8263	-2.6144	2606.418
1993	-1.0093	-1.9026	1.0000	0.8933	1.2789	695.738
1994	-2.9190	-1.7322	1.0000	-1.1868	-1.6990	825.036
1995	-0.6973	-1.0983	1.0000	0.4009	0.5739	1555.157
1996	-1.2619	-1.1350	1.0000	-0.1269	-0.1816	1499.059
1997	-0.7649	-0.3597	1.0000	-0.4052	-0.5801	3254.732

Partial variance for this index is 0.865966

Index 23 RV FAL 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1978	0.5008	-0.2051	1.0000	0.7059	1.0105	1124.370
1979	1.1578	0.1508	1.0000	1.0071	1.4416	1605.001
1980	1.0327	0.6035	1.0000	0.4291	0.6143	2524.098
1981	0.8702	0.9624	1.0000	-0.0922	-0.1320	3613.569
1982	-0.6638	-0.8437	1.0000	0.1799	0.2576	593.714
1983	-0.0851	0.3891	1.0000	-0.4742	-0.6788	2036.916
1984	-0.8110	-0.1557	1.0000	-0.6554	-0.9382	1181.367
1985	-1.8143	-0.4617	1.0000	-1.3526	-1.9364	869.898
1986	-0.0418	0.1554	1.0000	-0.1972	-0.2823	1612.421
1987	-0.5461	-0.7676	1.0000	0.2215	0.3171	640.665
1988	-1.3247	-0.9757	1.0000	-0.3490	-0.4996	520.280
1989	0.5249	-0.1785	1.0000	0.7033	1.0068	1154.737
1990	-0.6442	-0.8612	1.0000	0.2171	0.3107	583.401
1991	0.3223	0.3695	1.0000	-0.0472	-0.0675	1997.314
1992	-1.2817	-0.6067	1.0000	-0.6750	-0.9664	752.502
1993	-1.2557	-0.5543	1.0000	-0.7014	-1.0041	792.985
1994	-1.4269	-2.0855	1.0000	0.6586	0.9429	171.494
1995	-0.4374	-1.4650	1.0000	1.0276	1.4710	318.976
1996	-0.6679	-0.3115	1.0000	-0.3564	-0.5102	1010.852
1997	-0.5626	-0.3131	1.0000	-0.2495	-0.3571	1009.260

Partial variance for this index is 0.407906

Standardized residuals by index & yr; with row/column/grand means

	1978	1979	1980	1981	1982	1983	1984
1	-0.0127	0.4322	-3.1345	2.0078	1.0212	1.3122	0.1014
2	-0.5993	-0.1534	0.4782	0.8052	0.5842	1.0669	-0.1655
3	0.8533	-0.3280	0.0839	0.9112	0.1631	0.3890	-0.1829
4	-0.2221	-0.0476	-0.5931	0.4655	0.5338	0.0638	-0.0826
5	0.6548	-0.4804	-0.0261	-0.7505	0.3663	0.6377	0.3854
6	-0.4392	-0.2489	0.1075	0.4693	-2.6638	0.2829	1.0418
7	1.0871	-1.0863	-0.4618	0.0789	-0.3924	0.0176	-0.0098
8	1.6464	-0.5240	-2.5115	0.8247	-0.9634	0.0346	-99.0000
9	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
10	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
11	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
12	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
13	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
14	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
15	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
16	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
18	-1.1614	0.4471	-1.0568	-0.8586	0.2784	1.4225	1.5998
19	-0.1789	0.3770	0.4202	-0.3280	0.7226	-0.0076	0.4032
20	0.6833	-0.0338	0.2960	-0.8543	1.3527	0.3676	0.6889
21	-0.2403	1.5137	0.2870	-0.1915	1.2409	-1.2805	-0.1813
22	0.4039	1.7124	1.7998	0.2339	0.9211	-1.3141	-1.2547
23	1.0105	1.4416	0.6143	-0.1320	0.2576	-0.6788	-0.9382
**	0.2490	0.2158	-0.2641	0.1915	0.2445	0.1653	0.1081

	1985	1986	1987	1988	1989	1990	1991	1992
1	-0.2778	0.5662	-2.7015	1.1102	0.8200	0.5417	1.9610	0.0436
2	0.8148	-0.1398	-0.5269	-0.3822	0.0542	0.1149	-0.0529	0.2160
3	0.2886	0.2888	-0.4205	0.2544	-0.6128	0.0419	0.1646	-0.3799
4	1.2445	0.3120	-0.2031	0.2504	0.0177	-0.1725	-0.1333	-0.7963
5	0.9293	1.2678	-1.4183	0.2954	0.2990	0.0819	0.0998	-0.7193
6	0.8328	1.1691	0.6823	-0.9963	0.7759	0.3002	-0.0451	0.1405
7	0.7963	-0.3232	-0.2506	-1.7723	0.0824	0.3876	-0.6952	0.0880
8	0.9069	1.1977	-1.5829	-0.7900	0.7395	-0.8423	0.1301	-0.3794
9	-99.0000	-0.9648	-0.8428	-1.1989	1.9072	0.6476	1.1063	-1.1137
10	-99.0000	1.3171	-1.0763	-0.7725	0.1568	0.5538	0.1721	0.4468
11	-99.0000	-0.0856	-0.2163	-0.1619	-0.7186	0.1868	0.3522	0.5253
12	-99.0000	-0.7396	-0.7625	-0.3543	-0.1843	0.3962	0.0495	0.3903
13	-99.0000	0.1771	-0.2780	-0.3914	-0.3870	0.8336	-0.0756	-0.2167
14	-99.0000	-0.6521	-1.1908	-0.7782	-0.2408	0.7366	0.6033	0.8829
15	-99.0000	0.5943	-0.7852	-0.8995	-1.0453	1.9965	0.2245	0.3826
16	-99.0000	-1.9458	-0.8617	-0.6771	0.4865	0.7968	0.9774	0.6028
18	0.7883	1.0310	-1.0640	-0.5032	1.4984	1.1225	-0.6375	-1.4026
19	0.8232	-0.9908	0.0543	-1.0160	-0.4198	1.7520	-0.4625	-1.2841
20	-2.0728	-0.3693	-1.2905	-0.4229	-0.8685	-0.1648	1.6015	-1.3339
21	1.4325	-1.0376	-0.7308	-1.1759	-0.2875	-1.5485	0.7033	0.4062
22	1.6917	0.4075	-2.6162	-0.0500	0.3543	0.6120	0.3205	-2.6144
23	-1.9364	-0.2823	0.3171	-0.4996	1.0068	0.3107	-0.0675	-0.9664
**	0.4473	0.0363	-0.8075	-0.4969	0.1561	0.3948	0.2862	-0.3219

	1993	1994	1995	1996	1997********	
1	-3.2487	-0.2406	-0.1160	-0.1856	-99.0000	0.0000
2	-0.2427	-1.2562	-0.6009	-0.0147	-99.0000	0.0000
3	0.2500	-1.5245	-0.1035	-0.1368	-99.0000	0.0000
4	-0.5184	-1.3544	0.5270	0.7087	-99.0000	0.0000
5	-0.1536	-2.0738	1.1607	-0.5564	-99.0000	-0.0000
6	-0.1955	-2.4088	0.9440	0.2512	-99.0000	0.0000
7	-0.6505	-0.2226	4.1989	-0.8721	-99.0000	0.0000
8	-0.7265	-99.0000	0.9862	1.8539	-99.0000	-0.0000
9	-99.0000	-99.0000	-0.6318	-0.2508	1.3418	0.0000
10	-99.0000	-99.0000	-0.7448	0.2230	-0.2759	-0.0000
11	-99.0000	-99.0000	-0.2901	0.5076	-0.0994	0.0000
12	-99.0000	-99.0000	0.1184	1.2936	-0.2074	0.0000

13 ■	-99.0000	-99.0000	-0.1798	0.7274	-0.2095	0.0000
14 ■	-99.0000	-99.0000	0.4654	0.8542	-0.6805	0.0000
15 ■	-99.0000	-99.0000	0.5585	1.5476	-2.5740	0.0000
16 ■	-99.0000	-99.0000	0.2335	2.4066	-2.0191	-0.0000
18 ■	-2.1475	0.4417	0.4545	1.0893	-1.3418	0.0000
19 ■	0.0306	0.6462	-0.4287	0.2639	-0.3768	0.0000
20 ■	0.3740	0.3925	0.0527	1.6686	-0.0670	0.0000
21 ■	-0.3768	-0.0981	0.6688	1.1529	-0.2567	0.0000
22 ■	1.2789	-1.6990	0.5739	-0.1816	-0.5801	0.0000
23 ■	-1.0041	0.9429	1.4710	-0.5102	-0.3571	0.0000
** ■	-0.5236	-0.6504	0.4236	0.5382	-0.5503	0.0000

-99 in the above table indicates a missing value

Percent of total sum of squares by index & yr; with row/column sums

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 ■	0.00	0.06	3.07	1.26	0.33	0.54	0.00	0.02	0.10	2.28
2 ■	0.11	0.01	0.07	0.20	0.11	0.36	0.01	0.21	0.01	0.09
3 ■	0.23	0.03	0.00	0.26	0.01	0.05	0.01	0.03	0.03	0.06
4 ■	0.02	0.00	0.11	0.07	0.09	0.00	0.00	0.48	0.03	0.01
5 ■	0.13	0.07	0.00	0.18	0.04	0.13	0.05	0.27	0.50	0.63
6 ■	0.06	0.02	0.00	0.07	2.22	0.03	0.34	0.22	0.43	0.15
7 ■	0.37	0.37	0.07	0.00	0.05	0.00	0.00	0.20	0.03	0.02
8 ■	0.85	0.09	1.97	0.21	0.29	0.00	-99.00	0.26	0.45	0.78
9 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.29	0.22
10 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.54	0.36
11 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.00	0.01
12 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.17	0.18
13 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.01	0.02
14 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.13	0.44
15 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	0.11	0.19
16 ■	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	1.18	0.23
18 ■	0.42	0.06	0.35	0.23	0.02	0.63	0.80	0.19	0.33	0.35
19 ■	0.01	0.04	0.06	0.03	0.16	0.00	0.05	0.21	0.31	0.00
20 ■	0.15	0.00	0.03	0.23	0.57	0.04	0.15	1.34	0.04	0.52
21 ■	0.02	0.72	0.03	0.01	0.48	0.51	0.01	0.64	0.34	0.17
22 ■	0.05	0.92	1.01	0.02	0.27	0.54	0.49	0.89	0.05	2.14
23 ■	0.32	0.65	0.12	0.01	0.02	0.14	0.28	1.17	0.02	0.03
** ■	2.73	3.04	6.88	2.77	4.65	2.97	2.19	6.14	5.11	8.90

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*******	
1 ■	0.39	0.21	0.09	1.20	0.00	3.30	0.02	0.00	0.01	-99.00	12.88
2 ■	0.05	0.00	0.00	0.00	0.01	0.02	0.49	0.11	0.00	-99.00	1.86
3 ■	0.02	0.12	0.00	0.01	0.05	0.02	0.73	0.00	0.01	-99.00	1.64
4 ■	0.02	0.00	0.01	0.01	0.20	0.08	0.57	0.09	0.16	-99.00	1.95
5 ■	0.03	0.03	0.00	0.00	0.16	0.01	1.34	0.42	0.10	-99.00	4.09
6 ■	0.31	0.19	0.03	0.00	0.01	0.01	1.81	0.28	0.02	-99.00	6.18
7 ■	0.98	0.00	0.05	0.15	0.00	0.13	0.02	5.51	0.24	-99.00	8.18
8 ■	0.20	0.17	0.22	0.01	0.04	0.16	-99.00	0.30	1.07	-99.00	7.08
9 ■	0.45	1.14	0.13	0.38	0.39	-99.00	-99.00	0.12	0.02	0.56	3.71
10 ■	0.19	0.01	0.10	0.01	0.06	-99.00	-99.00	0.17	0.02	0.02	1.48
11 ■	0.01	0.16	0.01	0.04	0.09	-99.00	-99.00	0.03	0.08	0.00	0.43
12 ■	0.04	0.01	0.05	0.00	0.05	-99.00	-99.00	0.00	0.52	0.01	1.04
13 ■	0.05	0.05	0.22	0.00	0.01	-99.00	-99.00	0.01	0.17	0.01	0.55
14 ■	0.19	0.02	0.17	0.11	0.24	-99.00	-99.00	0.07	0.23	0.14	1.75
15 ■	0.25	0.34	1.25	0.02	0.05	-99.00	-99.00	0.10	0.75	2.07	5.12
16 ■	0.14	0.07	0.20	0.30	0.11	-99.00	-99.00	0.02	1.81	1.27	5.34
18 ■	0.08	0.70	0.39	0.13	0.61	1.44	0.06	0.06	0.37	0.56	7.82
19 ■	0.32	0.06	0.96	0.07	0.52	0.00	0.13	0.06	0.02	0.04	3.05
20 ■	0.06	0.24	0.01	0.80	0.56	0.04	0.05	0.00	0.87	0.00	5.69
21 ■	0.43	0.03	0.75	0.15	0.05	0.04	0.00	0.14	0.42	0.02	4.96
22 ■	0.00	0.04	0.12	0.03	2.14	0.51	0.90	0.10	0.01	0.11	10.34
23 ■	0.08	0.32	0.03	0.00	0.29	0.32	0.28	0.68	0.08	0.04	4.87
** ■	4.27	3.89	4.78	3.42	5.64	6.09	6.41	8.28	6.96	4.88	100.00

Partial variance (and proportion of total) by index

	1	2	3	4	5	6
**	1.14047086	0.16428647	0.14546236	0.17240381	0.36208260	0.54714062
**	0.10808347	0.01556958	0.01378560	0.01633887	0.03431490	0.05185302

	7	8	9	10	11	12
**	0.72464178	0.70664751	0.67023859	0.26731344	0.07816167	0.18815784
**	0.06867497	0.06696963	0.06351913	0.02533354	0.00740745	0.01783189

	13	14	15	16	18	19
**	0.09970088	0.31652866	0.92587529	0.96617554	0.65490163	0.25556228
**	0.00944874	0.02999771	0.08774605	0.09156534	0.06206563	0.02421987

	20	21	22	23**********	
**	0.47687213	0.41526471	0.86596594	0.40790571	10.55176033
**	0.04519361	0.03935502	0.08206839	0.03865760	1.00000000

STOCK NUMBERS (Jan 1) in millions - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983
1	27713.831	23513.743	20105.840	41395.733	17471.811	9616.908
2	4268.132	22688.356	19220.660	16380.739	33867.529	14005.208
3	25526.278	3138.850	16775.933	12318.975	10511.411	19459.983
4	7946.749	13888.469	1755.519	8461.580	6266.605	5145.917
5	2877.644	4422.407	6964.358	984.879	4698.236	2608.880
6	1124.370	1605.001	2524.098	3613.569	593.714	2036.916
7	1434.102	802.022	899.648	1092.951	1686.339	231.832
8	67.154	861.974	586.968	333.917	517.516	771.702
9	146.042	12.454	476.801	401.848	162.093	230.976
10	54.349	148.119	28.273	189.934	187.121	148.284
1+	71158.651	71081.395	69338.099	85174.126	75962.375	54256.606

	1984	1985	1986	1987	1988	1989
1	27395.410	8694.003	42850.891	16396.521	23550.222	15656.476
2	7775.936	22356.173	6996.800	34942.188	13400.810	19272.242
3	7588.361	5183.775	12489.201	4528.681	21846.394	9544.727
4	8636.783	3115.566	2033.598	6087.472	2435.569	10627.708
5	1990.840	4052.662	1312.992	943.814	3064.840	1078.380
6	1181.367	869.898	1612.421	640.665	520.280	1154.737
7	965.532	500.325	339.420	752.805	296.513	205.189
8	103.849	376.095	212.377	199.172	372.039	97.086
9	419.179	45.211	124.239	108.731	106.064	126.347
10	293.203	206.029	75.848	68.007	98.336	44.980
1+	56350.460	45399.739	68047.786	64668.056	65691.067	57807.871

	1990	1991	1992	1993	1994	1995
1	9725.482	19832.465	8717.450	12014.521	10652.152	3961.614
2	12818.437	7956.217	16190.397	7073.906	9833.039	8719.435
3	13889.477	6023.142	5134.122	9476.070	4856.927	7690.486
4	5170.627	6809.552	1996.944	2239.967	3916.411	2595.734
5	4941.632	2530.447	2606.418	695.738	825.036	1555.157
6	583.401	1997.314	752.502	792.985	171.494	318.976
7	455.902	270.441	650.800	250.542	222.158	53.543
8	93.798	151.576	107.409	253.235	61.257	57.925
9	40.579	44.221	60.761	57.174	77.939	8.531
10	89.631	43.533	18.108	29.850	12.131	4.237
1+	47808.966	45658.908	36234.911	32883.989	30628.544	24965.639

	1996	1997
1	6072.171	4562.377
2	3243.405	4970.840
3	6784.173	2468.174
4	5339.119	4737.343
5	1499.059	3254.732
6	1010.852	1009.260
7	221.343	716.321
8	20.311	167.648
9	33.852	13.915
10	1.348	24.115
1+	24225.636	21924.726

Summaries for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983
2	43244.429	47407.079	48727.184	43186.610	58141.350	44260.439
3	38976.297	24718.723	29506.524	26805.871	24273.820	30255.231
4	13450.019	21579.873	12730.591	14486.896	13762.409	10795.247
5	5503.270	7691.404	10975.072	6025.316	7495.805	5649.330
6	2625.626	3268.997	4010.713	5040.438	2797.568	3040.450

	1984	1985	1986	1987	1988	1989
2	28242.667	36454.495	24996.809	48094.797	41936.445	41980.069
3	20466.731	14098.322	18000.009	13152.609	28535.634	22707.827
4	12878.370	8914.547	5510.808	8623.928	6689.241	13163.100
5	4241.587	5798.981	3477.209	2536.457	4253.672	2535.391
6	2250.747	1746.319	2164.217	1592.643	1188.832	1457.012

	1990	1991	1992	1993	1994	1995
2	37953.274	25738.689	27438.592	20782.443	19886.322	20991.256
3	25134.837	17782.472	11248.195	13708.538	10053.283	12271.821
4	11245.360	11759.330	6114.072	4232.467	5196.356	4581.335
5	6074.733	4949.778	4117.128	1992.501	1279.945	1985.602
6	1133.101	2419.331	1510.710	1296.762	454.910	430.444

	1996	1997
2	18118.264	17324.318
3	14874.859	12353.478
4	8090.686	9885.304
5	2751.566	5147.961
6	1252.507	1893.229

FISHING MORTALITY - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.0001	0.0016	0.0049	0.0007	0.0212	0.0125	0.0033	0.0172	0.0040	0.0018
2	0.1073	0.1019	0.2448	0.2436	0.3541	0.4128	0.2055	0.3822	0.2350	0.2697
3	0.4086	0.3811	0.4844	0.4759	0.5143	0.6123	0.6902	0.7357	0.5186	0.4203
4	0.3861	0.4903	0.3780	0.3883	0.6763	0.7496	0.5567	0.6641	0.5676	0.4862
5	0.3838	0.3608	0.4561	0.3061	0.6358	0.5922	0.6279	0.7216	0.5176	0.3956
6	0.1378	0.3789	0.6370	0.5621	0.7404	0.5465	0.6592	0.7411	0.5617	0.5704
7	0.3091	0.1122	0.7911	0.5476	0.5817	0.6031	0.7428	0.6569	0.3331	0.5048
8	1.4850	0.3921	0.1789	0.5227	0.6067	0.4103	0.6316	0.9076	0.4695	0.4301
9	0.3605	0.4384	0.4895	0.4424	0.6618	0.6510	0.5994	0.7202	0.5414	0.4882
10	0.3605	0.4384	0.4895	0.4424	0.6618	0.6510	0.5994	0.7202	0.5414	0.4882

	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.0005	0.0000	0.0008	0.0029	0.0089	0.0004	0.0002	0.0000	0.0001
2	0.1393	0.1275	0.5553	0.2380	0.3356	0.1760	0.0458	0.0510	0.0731
3	0.5206	0.4130	0.5128	0.9040	0.6294	0.6836	0.4265	0.1649	0.1591
4	0.6147	0.5658	0.5146	0.7603	0.8544	0.7988	0.7236	0.3490	0.2950
5	0.7761	0.4143	0.7059	1.0127	0.9899	1.2004	0.7503	0.2308	0.1956
6	0.7304	0.7294	0.5688	0.9214	0.8998	1.0724	0.9641	0.1654	0.1444
7	0.9165	0.5828	0.9012	0.7234	0.7439	1.2085	1.1442	0.7693	0.0778
8	0.8800	0.6723	0.5519	0.7141	0.4305	0.9784	1.7714	0.3371	0.1782
9	0.7360	0.5751	0.6217	0.8552	0.9169	0.9638	0.7740	0.2999	0.1782
10	0.7360	0.5751	0.6217	0.8552	0.9169	0.9638	0.7740	0.2999	0.1782

Avg F for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.4597	0.3167	0.4529	0.4352	0.5870	0.5610	0.5877	0.6871	0.4576	0.4396
3	0.5184	0.3526	0.4876	0.4671	0.6259	0.5857	0.6514	0.7379	0.4947	0.4679
4	0.5404	0.3468	0.4882	0.4654	0.6482	0.5804	0.6436	0.7383	0.4899	0.4774
5	0.5789	0.3110	0.5158	0.4846	0.6411	0.5380	0.6654	0.7568	0.4704	0.4752
6	0.6440	0.2944	0.5357	0.5442	0.6429	0.5200	0.6779	0.7686	0.4547	0.5018

	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.6539	0.5007	0.6158	0.7534	0.6977	0.8740	0.8323	0.2954	0.1605
3	0.7397	0.5629	0.6259	0.8393	0.7580	0.9904	0.9634	0.3361	0.1750
4	0.7835	0.5929	0.6485	0.8264	0.7837	1.0517	1.0707	0.3703	0.1782
5	0.8258	0.5997	0.6820	0.8429	0.7660	1.1149	1.1575	0.3757	0.1490
6	0.8423	0.6615	0.6740	0.7863	0.6914	1.0864	1.2932	0.4239	0.1335

Avg F (weighted by N) for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.3644	0.2731	0.3919	0.3762	0.4533	0.5574	0.5118	0.5121	0.4430	0.3221
3	0.3926	0.4303	0.4877	0.4572	0.5918	0.6243	0.6282	0.7180	0.5239	0.4613
4	0.3621	0.4375	0.4921	0.4412	0.6510	0.6459	0.5916	0.7076	0.5357	0.4829
5	0.3275	0.3422	0.5103	0.5155	0.6299	0.5513	0.6629	0.7310	0.5171	0.4749
6	0.2658	0.3169	0.6045	0.5564	0.6200	0.5163	0.6938	0.7529	0.5168	0.5219

	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.4315	0.3308	0.5582	0.6692	0.5161	0.5653	0.3270	0.1473	0.1850
3	0.5687	0.5033	0.5596	0.8620	0.7757	0.7662	0.6021	0.2157	0.2094
4	0.7258	0.5688	0.6175	0.8406	0.8985	0.9511	0.7661	0.3009	0.2515
5	0.7894	0.5813	0.7050	0.9509	0.9200	1.1223	0.8962	0.2379	0.1672
6	0.8236	0.7049	0.7012	0.8862	0.7993	1.0804	1.1608	0.2636	0.1332

Avg F (wt by catch) for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	0.3908	0.3742	0.4310	0.4061	0.4804	0.5747	0.5768	0.5523	0.4772	0.3418
3	0.4006	0.4439	0.4996	0.4648	0.5985	0.6294	0.6331	0.7197	0.5255	0.4645
4	0.3835	0.4521	0.5196	0.4546	0.6525	0.6593	0.5954	0.7101	0.5409	0.4854
5	0.3792	0.3593	0.5377	0.5295	0.6316	0.5565	0.6650	0.7333	0.5240	0.4832
6	0.3719	0.3571	0.6549	0.5565	0.6245	0.5224	0.6956	0.7597	0.5279	0.5250

	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	0.5255	0.4362	0.5647	0.7793	0.5960	0.7021	0.5916	0.2127	0.2162
3	0.5802	0.5160	0.5695	0.8684	0.7960	0.7847	0.6456	0.2425	0.2280
4	0.7339	0.5744	0.6309	0.8492	0.9066	0.9691	0.7794	0.3194	0.2664
5	0.7913	0.6103	0.7098	0.9556	0.9309	1.1256	0.9308	0.2647	0.1744
6	0.8291	0.7076	0.7273	0.8906	0.8139	1.0830	1.1856	0.3804	0.1381

BACKCALCULATED PARTIAL RECRUITMENT

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.00	0.00	0.01	0.00	0.03	0.02	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01
2	0.07	0.21	0.31	0.43	0.48	0.55	0.28	0.42	0.41	0.47	0.15	0.17	0.62	0.24	0.34
3	0.28	0.78	0.61	0.85	0.69	0.82	0.93	0.81	0.91	0.74	0.57	0.57	0.57	0.89	0.64
4	0.26	1.00	0.48	0.69	0.91	1.00	0.75	0.73	1.00	0.85	0.67	0.78	0.57	0.75	0.86
5	0.26	0.74	0.58	0.54	0.86	0.79	0.85	0.80	0.91	0.69	0.85	0.57	0.78	1.00	1.00
6	0.09	0.77	0.81	1.00	1.00	0.73	0.89	0.82	0.99	1.00	0.80	1.00	0.63	0.91	0.91
7	0.21	0.23	1.00	0.97	0.79	0.80	1.00	0.72	0.59	0.88	1.00	0.80	1.00	0.71	0.75
8	1.00	0.80	0.23	0.93	0.82	0.55	0.85	1.00	0.83	0.75	0.96	0.92	0.61	0.71	0.43
9	0.24	0.89	0.62	0.79	0.89	0.87	0.81	0.79	0.95	0.86	0.80	0.79	0.69	0.84	0.93
10	0.24	0.89	0.62	0.79	0.89	0.87	0.81	0.79	0.95	0.86	0.80	0.79	0.69	0.84	0.93

	1993	1994	1995	1996
1	0.00	0.00	0.00	0.00
2	0.15	0.03	0.07	0.25
3	0.57	0.24	0.21	0.54
4	0.66	0.41	0.45	1.00
5	0.99	0.42	0.30	0.66
6	0.89	0.54	0.22	0.49
7	1.00	0.65	1.00	0.26
8	0.81	1.00	0.44	0.60
9	0.80	0.44	0.39	0.60
10	0.80	0.44	0.39	0.60

MEAN BIOMASS (MT)

	1978	1979	1980	1981	1982	1983
1	17757.972	18931.368	15198.252	33080.110	11991.124	8412.596
2	4813.746	29257.929	22651.621	19778.539	36454.624	15601.973
3	47056.060	5115.848	29981.797	21114.604	20011.927	31670.313
4	20860.577	42241.628	4890.488	21843.879	16003.079	10993.717
5	9451.406	16545.877	28839.556	4028.962	17042.633	8355.176
6	5521.597	8746.299	11414.946	18262.431	2505.586	9175.134
7	8287.426	6326.259	4789.051	6592.596	10955.051	1269.192
8	275.685	6708.522	4440.673	2350.827	3515.296	5941.424
9	1317.529	107.689	2904.741	4201.184	1358.297	1746.075
10	549.180	1382.158	314.586	2601.589	2097.268	1453.149
1+	115891.178	135363.576	125425.712	133854.721	121934.885	94618.749

	1984	1985	1986	1987	1988	1989
1	26104.384	7087.941	36010.050	10779.890	16773.093	11479.862
2	10451.739	24030.316	8368.482	41295.639	17273.186	26574.104
3	12314.943	7022.636	21798.420	8419.688	36727.635	16190.726
4	21925.325	8108.537	5195.987	18442.244	5848.742	28008.292
5	6881.872	13468.971	5249.825	4131.783	10568.821	4347.601
6	5217.386	3614.162	8115.549	3451.279	2250.999	5033.626
7	5569.670	2720.890	2345.494	4834.616	1567.559	1169.992
8	712.459	2327.477	1541.180	1479.530	2272.034	694.267
9	3262.229	337.472	1113.053	897.219	767.452	1025.541
10	3100.041	1817.483	755.420	737.475	976.856	535.546
1+	95540.047	70535.885	90493.459	94469.363	95026.376	95059.557

	1990	1991	1992	1993	1994	1995
1	7322.160	19996.179	9031.414	9493.795	8746.134	3253.034
2	14035.489	10481.916	19328.889	9044.637	12719.455	11343.430
3	24453.772	9292.424	8597.526	14176.094	7824.389	13499.039
4	13012.510	14968.215	4742.541	4721.681	9349.409	7650.314
5	15899.908	6991.578	7168.830	1859.379	2558.229	6939.281
6	2577.943	7073.857	2809.720	2861.729	753.062	1972.955
7	2336.904	1308.266	3162.796	1009.219	978.992	367.354
8	702.041	1045.106	784.424	1371.112	250.554	520.632
9	348.091	264.605	441.320	327.682	483.027	69.700
10	887.799	413.430	207.500	233.466	129.132	49.861
1+	81576.617	71835.576	56274.959	45098.794	43792.382	45665.600

	1996
1	4853.779
2	4277.115
3	13878.612
4	14263.681
5	6081.321
6	5662.802
7	1617.340
8	142.705
9	363.133
10	13.469
1+	51153.957

Summaries for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983
2	96266.497	114942.361	107008.134	93971.838	106488.196	83006.930
3	91452.751	85684.432	84356.512	74193.299	70033.572	67404.956
4	44396.690	80568.584	54374.715	53078.694	50021.645	35734.643
5	23536.113	38326.956	49484.227	31234.815	34018.566	24740.926
6	14084.707	21781.079	20644.671	27205.854	16975.933	16385.750

	1984	1985	1986	1987	1988	1989
2	63073.393	61292.989	52614.936	82054.779	76508.975	82018.609
3	52621.654	37262.673	44246.454	40759.140	59235.789	55444.505
4	40306.711	30240.037	22448.034	32339.452	22508.154	39253.778
5	18381.386	22131.500	17252.047	13897.209	16659.413	11245.486
6	11499.514	8662.529	12002.222	9765.426	6090.592	6897.885

	1990	1991	1992	1993	1994	1995
2	73018.567	51161.362	46594.726	35043.850	34434.089	42293.005
3	58983.078	40679.446	27265.837	25999.213	21714.634	30949.575
4	34529.306	31387.022	18668.311	11823.119	13890.245	17450.536
5	21516.796	16418.806	13925.770	7101.438	4540.836	9800.222
6	5616.888	9427.229	6756.940	5242.060	1982.608	2860.941

	1996
2	45923.575
3	41646.460
4	27767.848
5	13504.167
6	7422.846

CATCH BIOMASS (MT)

	1978	1979	1980	1981	1982	1983
1	1.416	30.277	74.534	23.854	253.727	105.065
2	516.610	2981.574	5546.137	4818.938	12908.454	6440.707
3	19229.437	1949.608	14523.464	10048.568	10291.290	19392.685
4	8053.826	20709.104	1848.611	8483.043	10823.100	8241.407
5	3627.901	5969.761	13153.993	1233.351	10834.861	4948.344
6	761.105	3313.763	7271.344	10265.972	1855.092	5014.331
7	2561.383	709.593	3788.674	3610.087	6372.736	765.423
8	409.379	2630.588	794.422	1228.829	2132.828	2437.763
9	475.019	47.216	1421.965	1858.745	898.945	1136.707
10	198.000	606.000	154.000	1151.030	1388.009	946.010
1+	35834.076	38947.483	48577.144	42722.416	57759.043	49428.442

	1984	1985	1986	1987	1988	1989
1	85.440	121.776	145.175	18.908	7.873	0.001
2	2147.835	9185.303	1966.779	11135.743	2406.610	3389.111
3	8499.832	5166.742	11305.348	3538.377	19119.351	6686.689
4	12204.868	5384.897	2949.413	8967.310	3595.343	15846.221
5	4321.371	9719.714	2717.084	1634.377	8202.701	1801.382
6	3439.139	2678.598	4558.384	1968.662	1644.211	3671.279
7	4137.358	1787.338	781.205	2440.556	1436.664	681.859
8	449.981	2112.507	723.557	636.390	1999.321	466.785
9	1955.287	243.041	602.653	437.979	564.876	589.799
10	1858.076	1308.918	409.016	360.000	719.006	307.998
1+	39099.186	37708.834	26158.615	31138.302	39695.956	33441.123

	1990	1991	1992	1993	1994	1995	1996
1	5.827	58.027	80.506	3.494	1.815	0.091	0.618
2	7793.562	2495.165	6487.715	1591.918	582.094	578.084	312.850
3	12540.022	8400.268	5411.695	9690.695	3337.390	2226.305	2208.309
4	6696.211	11381.075	4052.026	3771.628	6765.221	2670.199	4207.084
5	11223.621	7080.705	7096.620	2232.046	1919.465	1601.467	1189.629
6	1466.390	6517.547	2528.120	3068.960	725.999	326.334	817.827
7	2106.001	946.415	2352.754	1219.684	1120.202	282.604	125.907
8	387.486	746.349	337.723	1341.476	443.832	175.525	25.431
9	216.425	226.299	404.632	315.816	373.862	20.902	64.714
10	551.988	353.579	190.250	225.012	99.948	14.953	2.400
1+	42987.533	38205.429	28942.041	23460.730	15369.827	7896.466	8954.771

Summaries for ages 2 8 3 8 4 8 5 8 6 8

	1978	1979	1980	1981	1982	1983
2	35159.640	38263.990	46926.644	39688.787	55218.362	47240.660
3	34643.030	35282.416	41380.508	34869.849	42309.907	40799.954
4	15413.593	33332.808	26857.043	24821.282	32018.617	21407.268
5	7359.767	12623.704	25008.432	16338.239	21195.517	13165.861
6	3731.866	6653.944	11854.440	15104.888	10360.656	8217.518

	1984	1985	1986	1987	1988	1989
2	35200.383	36035.100	25001.771	30321.415	38404.201	32543.326
3	33052.549	26849.797	23034.991	19185.671	35997.591	29154.215
4	24552.717	21683.055	11729.643	15647.295	16878.240	22467.526
5	12347.849	16298.158	8780.230	6679.985	13282.897	6621.305
6	8026.477	6578.443	6063.146	5045.609	5080.196	4819.923

	1990	1991	1992	1993	1994	1995	1996
2	42213.293	37567.523	28266.652	22916.408	14894.202	7860.519	8887.039
3	34419.731	35072.359	21778.938	21324.490	14312.108	7282.435	8574.189
4	21879.709	26672.091	16367.243	11633.795	10974.719	5056.130	6365.880
5	15183.498	15291.016	12315.218	7862.167	4209.498	2385.931	2158.795
6	3959.877	8210.311	5218.597	5630.121	2290.033	784.464	969.166

SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)

	1978	1979	1980	1981	1982	1983
1	912.564	1104.081	850.305	1960.428	1199.966	902.953
2	1410.121	7538.933	6913.041	5782.527	16138.933	6345.202
3	33844.848	3728.634	22417.132	15928.835	15642.925	26061.546
4	20219.540	38256.199	4296.988	21379.424	15792.817	12650.233
5	8798.335	16585.411	30442.642	3958.218	17473.606	9639.231
6	4882.457	8130.416	12541.040	20323.465	2957.086	10520.545
7	8214.614	5550.162	5918.367	7296.237	12172.711	1460.236
8	366.885	6810.363	5034.238	2696.191	4165.185	6840.639
9	1330.661	111.601	3963.464	4097.268	1561.106	2112.708
10	653.404	1681.209	388.132	3168.022	2710.468	1872.694
1+	80633.430	89497.008	92765.349	86590.615	89814.804	78405.987

	1984	1985	1986	1987	1988	1989
1	3123.987	775.273	7009.104	1829.601	2870.703	2029.098
2	4303.899	11651.864	4817.091	24255.688	8514.026	13166.369
3	10501.323	6880.148	18780.384	7129.190	32953.043	14563.475
4	21659.731	8076.614	4845.234	17031.387	6167.284	27344.893
5	7112.214	14912.205	5436.643	3940.926	12385.916	4236.886
6	5655.632	4245.118	8589.348	3707.175	2768.709	5946.768
7	6226.943	3166.336	2348.021	5369.558	2026.930	1331.324
8	810.978	2985.985	1705.384	1694.152	2937.693	814.152
9	3955.925	416.553	1251.189	1033.415	958.482	1198.416
10	3940.712	2384.797	945.388	909.540	1287.011	676.358
1+	67291.344	55494.893	55727.784	66900.632	72869.797	71307.740

	1990	1991	1992	1993	1994	1995
1	1284.724	4175.425	1923.059	1801.671	1684.833	619.091
2	8125.910	5503.865	12420.611	5642.884	6813.356	6178.313
3	22393.472	9090.777	8146.523	13871.486	7260.825	11513.186
4	12715.883	16499.674	5136.788	5325.942	9444.776	6689.090
5	18252.221	8472.399	8573.215	2406.810	2817.686	6486.565
6	3000.184	8894.088	3394.299	3513.632	858.171	1787.523
7	2854.787	1588.305	3698.269	1347.026	1269.456	406.515
8	774.243	1227.550	825.904	1731.003	369.895	511.004
9	410.872	376.651	568.108	460.193	626.439	77.404
10	1135.303	561.282	285.984	325.421	171.786	58.292
1+	70947.597	56390.017	44972.762	36426.066	31317.222	34326.983

	1996
1	899.290
2	2317.539
3	11005.132
4	12834.011
5	6087.034
6	5755.891
7	1661.242
8	181.333
9	388.834
10	15.188
1+	41145.495

The above SSBs by age (a) and year (y) are calculated following the algorithm used in the NEFSC projection program, i.e.

$$SSB(a,y) = W(a,y) \times P(a,y) \times N(a,y) \times \exp[-Z(a,y)]$$

where $Z(a,y) = 0.1667 \times M(a,y) + 0.1667 \times F(a,y)$
N(a,y) - Jan 1 stock size estimates (males & females)
P(a,y) - proportion mature (generally females)
W(a,y) - weight at age at the beginning of the spawning season

The W(a,y) are assumed to be the same as the Jan1 weight at age estimates (see "WT AT AGE" table in input section).
Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

MEAN STOCK NUMBERS (millions) - GBCOD97_NOCPUE

	1978	1979	1980	1981	1982	1983
1	25117.358	21295.127	18179.727	37505.793	15674.672	8663.847
2	3674.615	19583.620	15514.809	13229.792	26001.872	10471.123
3	19120.707	2380.571	12148.216	8954.455	7511.985	13323.649
4	6013.427	10031.258	1333.285	6396.451	4173.990	3322.368
5	2179.752	3384.999	5107.058	772.868	3184.348	1801.849
6	954.138	1218.487	1709.848	2528.722	384.823	1435.184
7	1123.871	688.910	570.805	769.713	1170.036	159.366
8	32.464	650.492	488.577	237.745	355.188	577.622
9	111.797	9.205	344.490	296.484	108.638	155.525
10	41.605	109.478	20.428	140.134	125.412	99.845
1+	58369.734	59352.148	55417.242	70832.159	58690.965	40010.380

	1984	1985	1986	1987	1988	1989
1	24790.489	7814.709	38762.164	14848.334	21339.813	14190.187
2	6392.501	16946.626	5673.547	27883.618	11363.938	16434.202
3	5024.456	3366.556	8908.222	3374.624	15569.154	7135.622
4	6058.393	2086.066	1419.669	4404.644	1665.834	7425.316
5	1353.900	2647.724	936.967	711.150	1956.827	805.708
6	792.675	563.656	1128.570	446.710	338.649	751.961
7	625.173	336.037	263.095	540.241	178.619	142.300
8	70.513	227.381	154.815	147.761	227.499	64.776
9	288.616	29.556	87.732	78.607	68.873	87.916
10	201.878	134.688	53.561	49.165	63.855	31.298
1+	45598.594	34153.000	57388.341	52484.854	52773.061	47069.287

	1990	1991	1992	1993	1994	1995
1	8811.264	17949.891	7867.085	10887.380	9653.570	3590.546
2	8997.108	6442.481	12534.947	5896.113	8717.926	7711.374
3	9932.482	3646.948	3489.256	6292.097	3609.035	6443.455
4	3694.637	4376.671	1234.073	1416.646	2556.579	1997.471
5	3250.186	1466.047	1523.986	374.346	532.521	1263.525
6	407.065	1200.790	456.420	448.617	101.327	267.193
7	276.360	176.554	421.201	134.383	122.176	34.284
8	65.932	99.345	79.669	148.759	26.746	44.816
9	27.670	27.318	36.597	33.785	49.807	6.714
10	61.118	26.893	10.907	17.639	7.752	3.335
1+	35523.822	35412.939	27654.140	25649.765	25377.438	21362.713

	1996
1	5503.151
2	2838.166
3	5699.635
4	4211.302
5	1238.054
6	855.150
7	193.254
8	16.912
9	28.187
10	1.122
1+	20584.933

Time stamp at end of run 1997 4 8 12 23 38

APPENDIX 4

Precision Estimates of 1996 Fishing Mortality and Spawning Stock Biomass for Georges Bank Cod.

BOOTSTRAP RESULTS FOR GBCOD97_NOCPUE Timestamp 1997 4 15 9 45 50
COD: GEORGES BANK STOCK

SEED FOR THE RANDOM NUMBER GENERATOR: 74747
MAIN LOOP LIMIT IN MARQUARDT ALGORITHM: 50
NUMBER OF BOOTSTRAP REPLICATIONS ATTEMPTED: 1000
NUMBER FOR WHICH NLLS CONVERGED: 1000
Results from the converged replications are used for computing the statistics that follow. Other replications are ignored.

Appendix 4: Table 1.
BOOTSTRAP OUTPUT VARIABLE: N_hat
Age-specific stocksizes (on Jan 1, 1997) estimated by NLLS

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1	4.562E3	5.285E3	2.943E3	0.65
2	4.971E3	5.177E3	1.714E3	0.34
3	2.468E3	2.549E3	6.596E2	0.27
4	4.737E3	4.884E3	1.191E3	0.25
5	3.252E3	3.363E3	8.916E2	0.27
6	1.009E3	1.048E3	2.896E2	0.29
7	7.164E2	7.512E2	2.382E2	0.33
8	1.679E2	1.777E2	5.582E1	0.33

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	7.231E2	9.306E1	15.85	3.839E3	0.77
2	2.059E2	5.419E1	4.14	4.765E3	0.36
3	8.104E1	2.086E1	3.28	2.387E3	0.28
4	1.472E2	3.766E1	3.11	4.590E3	0.26
5	1.106E2	2.819E1	3.40	3.142E3	0.28
6	3.836E1	9.159E0	3.80	9.710E2	0.30
7	3.483E1	7.534E0	4.86	6.816E2	0.35
8	9.763E0	1.765E0	5.81	1.582E2	0.35

Appendix 4: Table 2.
BOOTSTRAP OUTPUT VARIABLE: q_unscaled
Catchability estimates (q) for each index of abundance used in the ADAPT run. Note that these q's have been re-scaled to original units.

FLEET	ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR ADAPT SOLN
qRV spr 1	1.369E-5	1.389E-5	2.216E-6	0.16
qRV spr 2	6.666E-5	6.762E-5	1.024E-5	0.15
qRV spr 3	1.194E-4	1.203E-4	1.962E-5	0.16
qRV spr 4	1.424E-4	1.440E-4	2.204E-5	0.15
qRV spr 5	1.712E-4	1.724E-4	2.676E-5	0.16
qRV spr 6	1.735E-4	1.753E-4	2.769E-5	0.16
qRV spr 7	2.326E-4	2.334E-4	3.578E-5	0.15
qRV spr 8	2.427E-4	2.481E-4	4.070E-5	0.17
qRV CAN 1	2.747E-5	2.827E-5	6.544E-6	0.24
qRV CAN 2	1.293E-4	1.330E-4	2.866E-5	0.22
qRV CAN 3	2.389E-4	2.418E-4	5.178E-5	0.22
qRV CAN 4	3.050E-4	3.115E-4	7.011E-5	0.23
qRV CAN 5	4.375E-4	4.482E-4	9.454E-5	0.22
qRV CAN 6	4.303E-4	4.433E-4	9.605E-5	0.22
qRV CAN 7	5.057E-4	5.186E-4	1.152E-4	0.23
qRV CAN 8	7.331E-4	7.497E-4	1.613E-4	0.22
qRV FAL 1	1.231E-5	1.251E-5	1.939E-6	0.16
qRV FAL 2	6.282E-5	6.322E-5	9.627E-6	0.15
qRV FAL 3	8.322E-5	8.471E-5	1.313E-5	0.16
qRV FAL 4	1.046E-4	1.058E-4	1.565E-5	0.15
qRV FAL 5	6.589E-5	6.633E-5	9.781E-6	0.15
qRV FAL 6	7.629E-5	7.696E-5	1.134E-5	0.15

FLEET	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
qRV spr 1	2.068E-7	7.007E-8	1.51	1.348E-5	0.16
qRV spr 2	9.550E-7	3.238E-7	1.43	6.571E-5	0.16
qRV spr 3	8.897E-7	6.203E-7	0.75	1.185E-4	0.17
qRV spr 4	1.651E-6	6.969E-7	1.16	1.407E-4	0.16
qRV spr 5	1.191E-6	8.462E-7	0.70	1.700E-4	0.16
qRV spr 6	1.880E-6	8.758E-7	1.08	1.716E-4	0.16
qRV spr 7	8.348E-7	1.131E-6	0.36	2.318E-4	0.15
qRV spr 8	5.396E-6	1.287E-6	2.22	2.373E-4	0.17
qRV CAN 1	7.938E-7	2.069E-7	2.89	2.668E-5	0.25
qRV CAN 2	3.695E-6	9.062E-7	2.86	1.256E-4	0.23
qRV CAN 3	2.934E-6	1.637E-6	1.23	2.359E-4	0.22
qRV CAN 4	6.524E-6	2.217E-6	2.14	2.985E-4	0.23
qRV CAN 5	1.068E-5	2.990E-6	2.44	4.268E-4	0.22
qRV CAN 6	1.306E-5	3.037E-6	3.04	4.172E-4	0.23
qRV CAN 7	1.289E-5	3.644E-6	2.55	4.928E-4	0.23
qRV CAN 8	1.653E-5	5.101E-6	2.26	7.166E-4	0.23
qRV FAL 1	1.935E-7	6.132E-8	1.57	1.212E-5	0.16
qRV FAL 2	3.959E-7	3.044E-7	0.63	6.243E-5	0.15
qRV FAL 3	1.489E-6	4.153E-7	1.79	8.173E-5	0.16
qRV FAL 4	1.234E-6	4.949E-7	1.18	1.033E-4	0.15
qRV FAL 5	4.425E-7	3.093E-7	0.67	6.544E-5	0.15
qRV FAL 6	6.731E-7	3.586E-7	0.88	7.561E-5	0.15

Appendix 4: Table 3
BOOTSTRAP OUTPUT VARIABLE: F_t
Full vector of age-specific terminal F's (in 1996)

AGE	ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR ADAPT SOLN
1	1.274E-4	1.365E-4	5.989E-5	0.47
2	7.315E-2	7.539E-2	1.919E-2	0.26
3	1.591E-1	1.628E-1	3.806E-2	0.24
4	2.951E-1	3.022E-1	7.046E-2	0.24
5	1.956E-1	2.017E-1	5.339E-2	0.27
6	1.444E-1	1.509E-1	4.709E-2	0.33
7	7.772E-2	8.081E-2	2.630E-2	0.34
8	1.782E-1	1.839E-1	2.631E-2	0.15
9	1.782E-1	1.839E-1	2.631E-2	0.15
10+	1.782E-1	1.839E-1	2.631E-2	0.15

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	9.133E-6	1.894E-6	7.17	1.183E-4	0.51
2	2.243E-3	6.068E-4	3.07	7.090E-2	0.27
3	3.695E-3	1.204E-3	2.32	1.554E-1	0.24
4	7.068E-3	2.228E-3	2.39	2.881E-1	0.24
5	6.084E-3	1.688E-3	3.11	1.895E-1	0.28
6	6.491E-3	1.489E-3	4.50	1.379E-1	0.34
7	3.087E-3	8.316E-4	3.97	7.464E-2	0.35
8	5.683E-3	8.320E-4	3.19	1.725E-1	0.15
9	5.683E-3	8.320E-4	3.19	1.725E-1	0.15
10+	5.683E-3	8.320E-4	3.19	1.725E-1	0.15

Appendix 4: Table 4.
BOOTSTRAP OUTPUT VARIABLE: F_full_t
Fully-recruited F in the terminal year (1996)

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR ADAPT SOLN
1.782E-1	1.839E-1	2.631E-2	0.15

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
5.683E-3	8.320E-4	3.19	1.725E-1	0.15

Appendix 4: Table 5.
BOOTSTRAP OUTPUT VARIABLE: SSB_spawn_t
SSB (males & females) at start of spawning season (1996)

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR ADAPT SOLN
4.114E4	4.242E4	4.554E3	0.11

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.276E3	1.440E2	3.10	3.987E4	0.11