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Stock Assessment of Georges Bank Yellowtail Flounder for 1997

by

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ABSTRACT

Biomass of the Georges Bank yellowtail flounder stock remains low relative to historic levels, but is increasing. Instantaneous fishing mortality rate (F) is currently at very low levels (F_{96}=0.10) at low levels of fishing mortality (F). Virtual populations analysis (VPA) of 1973-1996 catch at age, calibrated with research survey abundance indices estimated that spawning stock biomass (SSB) was greater than 21,000 mt and several stong year classes were produced in the early 1970s. Intense F (F>1.0) decreased SSB rapidly in the early 1980s to less than 4,000 mt from 1984 to 1988 resulting in poor recruitment. Moderate recruitment and reduced F have produced recent increases in spawning biomass to 11,700 mt in 1996. A biomass dynamics model of 1963-1996 landings, calibrated with survey indices, suggests that stock size was greater than 45,000 mt in the 1960s, decreased to approximately 4,000 mt in the late 1980s, and increased to 13,700 mt in 1996. Current biomass remains well below the level which would produce maximum sustainable yield. Projections from both assessment models indicate that landings and stock biomass will continue to increase if F remains low.

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INTRODUCTION

Yellowtail flounder, *Limanda ferruginea,* inhabit the continental shelf of the northwest Atlantic from Labrador to Chesapeake Bay. Off the U.S. coast, commercially important concentrations are found on Georges Bank, off southern New England, and off Cape Cod, generally at depths between 37 and 73 m (20 to 40 fathoms). Yellowtail grow to 55 cm total length (Bigelow and Schroeder, 1953), but high rates of fishing mortality have greatly reduced the average size and age of fish in the stocks. Yellowtail appear to be relatively sedentary, although seasonal movements have been reported (Royce et al. 1959). Spawning occurs during spring and summer, peaking in May. Larvae are pelagic for a month or more, then develop demersal form and settle to the bottom.

Tagging observations, larval distribution, and geographic patterns of landings and survey data indicate relatively discrete stocks on Georges Bank, in Southern New England waters, and off Cape Cod. Tag returns suggest that stock mixing is rare (Royce et al. 1959, Lux 1963). Concentrations of pelagic larvae are discontinuously distributed among the three geographic areas (Georges Bank, Cape Cod and southern New England), but larval mixing occurs among stocks in some years (Silverman 1983). Despite vertical movement of larvae, which limits horizontal drift (Smith et al. 1978), U.S. and Canadian portions of Georges Bank are considered a single larval retention area (Sinclair 1986). Survey catches from Georges Bank are significantly correlated with those from southern New England waters, but not with those off Cape Cod. The Georges Bank yellowtail stock is defined as the entire Bank, east of the Great South Channel (statistical reporting areas 522, 525, 551, 552, 561, and 562; Figure 1).

Over the past 25 years, the fishery for yellowtail flounder has been managed under several regimes. From 1971 to 1976, national quotas were allocated by the International Commission for Northwest Atlantic Fisheries. Minimum mesh size, area closures, and trip limits were imposed through the New England Fishery Management Council's Atlantic Groundfish Fishery Management Plan from 1977 to 1982. In 1982, the Council adopted an Interim Groundfish Plan, which established a minimum size limit of 28 cm (11 in). In 1986, the Council's Multispecies Fishery Management Plan increased the minimum legal size to 30 cm (12 in), increased minimum mesh size to 140 mm (5.5 in for most of Georges Bank fisheries), and imposed seasonal closures. Amendment #4 to the Plan further increased the minimum legal size to 33 cm (13 in) in 1989. Amendments #5, #6, and #7 (1994-1996), limited days at sea, closed areas year-round, further increased minimum mesh size to 142 mm (6 in diamond or square) and imposed trip limits for groundfish bycatch in the sea scallop fishery. In 1994, the Canadian government began quota management of the Georges Bank yellowtail resource.

The Georges Bank yellowtail stock has been assessed for the last four decades using various models for estimating abundance and mortality from catch and survey data. Results have shown that the instantaneous rate of fishing mortality (F) has exceeded the level of maximum yield-per-recruit (F_{max}) since the late 1950s (Brown and Hennemuth 1971, Pentilla and Brown 1973, Sissenwine et al. 1978, Clark et al. 1981, Collie and Sissenwine 1983, McBride and Clark 1983, McBride 1989). Virtual population analysis (VPA) calibrated with survey indices of abundance (Conser et al. 1991, Rago et al. 1994) confirmed that F consistently and significantly exceeded all relevant overfishing reference points. The 1994 assessment showed that the stock had collapsed and F needed to be substantially reduced to rebuild spawning stock biomass (SSB) (NEFSC 1994a). An updated analysis of combined U.S. and Canadian catch and survey indices confirmed historical patterns of stock abundance and F, and indicated that F decreased in 1995 (Gavaris et al. 1996). Projections based on updated landings and survey information suggested that F decreased and SSB was increasing (NEFMC 1996). The present stock assessment is an updated and revised VPA-based assessment of U.S. and Canadian catch, supplemented with a surplus production analysis.

DATA AND METHODS

Commercial Landings

U.S. commercial landings of yellowtail flounder were derived from dealer weighout reports. Previous to 1994, landings were allocated to statistical area, month, and gear type according to interview data collected by port agents (Burns et al. 1983). From 1994 to 1996, U.S. dealer landings were allocated to stock area using fishing vessel logbook data, by fishing gear, port, and season (Wigley, et al. 1997). Canadian landings reported in Gavaris et al. (1996) were revised and updated from reported yellowtail trawl landings and prorated unclassified flounder landings.

The Georges Bank yellowtail stock has been exploited since the late 1930s (Table 1, Figure 2). Landings, which have been predominantly taken by the U.S. fleet, gradually increased to 7,300 mt in 1949, decreased in the early 1950s to 1,600 mt in 1956, and increased again in the late 1950s. Annual landings averaged 16,300 mt during 1962-1976, with some taken by distant water fleets. No foreign landings of yellowtail have occurred since 1975. U.S. landings declined to approximately 6,000 mt between 1978 and 1981. Strong recruitment and intense fishing effort produced greater than 10,500 mt in 1982 and 1983. In every year since 1985, landings have been 3,000 mt or less. Landings fell to a low of 1,100 mt in 1989, averaged 2,200 from 1990 to 1994 and dropped to record lows of 200 and 800 mt in 1995 and 1996. For the first time on record, the majority of Georges Bank yellowtail yield was landed by Canadian fishermen in 1995. The Canadian fishery for yellowtail was negligible before 1989, landed less than 100 mt 1989-1992, and increased to yield 2,100 mt in 1994. In 1995 and 1996, Canada set a total allowable catch of 400 mt, and estimated landings were under 500 mt.

Otter trawls are the principal fishing gear used to catch yellowtail flounder, but scallop dredges and sink gillnets contribute some landings. In recent years, otter trawls caught greater than 95% of total landings from the Georges Bank stock, dredges caught 2-5% of annual totals, and gillnet landings were less than 0.1%. Current levels of recreational and 'distant water' foreign fishing are negligible.

Previous stock assessments of Georges Bank yellowtail used port samples of length and age distribution by market category, quarter and statistical area to estimate landings at age (Conser et al. 1991, Rago et al. 1994). For the present assessment, 1994-1996 landings by statistical area were not available, and the frequency of port sampling was not adequate for quarterly estimates. Landings at age for 1994-1996 were estimated by half-year for the entire stock. The weighted sum of port samples (by market category) was supplemented with samples collected at sea, and thus not culled into market categories (Table 2). As in previous U.S. assessments, sample length frequencies were expanded to total landings at size using the ratio of landings to sample weight (predicted from length-weight relationships by sex and season; Lux 1969b), and portioned to age using pooled-sex age-length keys. Commercial age-length keys were derived from pooled port samples and sea samples. Age distributions for lengths not represented in commercial age samples, were derived from survey observations. Estimates of U.S. landings at age and mean weight at age of landed yellowtail are presented in Tables 3 and 4.

Discard Estimates

Discarding of small yellowtail has been an important source of mortality in the Georges Bank yellowtail fishery due to intense fishing pressure, discrepancies between minimum size limits and gear selectivity, and recently imposed groundfish trip limits for the scallop dredge fishery. Previous assessments estimated age-specific discard rates using selection ogives fit to multiple data sources: discard ratios from trip interviews, sea sampling, and survey length distributions (Conser et al. 1991, Rago et al. 1994). The 18th Northeast Regional Stock Assessment Review Committee recommended the intensification of sea sampling coverage of this and other fisheries to allow direct estimation of discards for all seasons of the fishery (NEFSC 1994b).

Sea sampling coverage has increased since 1993. The number of sampled trips which observed yellowtail catches from Georges Bank was 22 in 1994, 16 in 1995, and 18 in 1996. Ratios of discard to kept weights recorded by observers varied considerably over time and among gear types. Semi-annual estimates of discard to kept ranged from 2-17% for trawl trips and 79-326% for scallop dredge trips. All sampled trawl trips used 152 mm (6 in) mesh. Total discards ($D_{t,g}$) by half-year (t) and gear-type (g) were estimated by the product of total landings ($K_{t,g}$) and the ratio ($R_{t,g}$) of mean discards per trip (d_i) to mean landings per trip (k_i) for all sampled trips ($n_{t,g}$) in half-year t using gear-type g according to Cochran (1977) (Table 5):

$$R_{t,g} = [(\sum d_{i,t,g})/n_{t,g}] \,/\, [(\sum k_{i,t,g})/n_{t,g})] = (\sum d_{i,t,g}) \,/\, (\sum k_{i,t,g}) \qquad (1)$$

$$D_{t,g} = K_{t,g}\,\mathrm{R}_{t,g} \qquad (2)$$

Sample variance of ratio estimates of total discards within half-year and gear types [Var($D_{t,g}$)] was estimated:

$$\mathrm{Var}(D_{t,g}) = \{[N_{t,g}^{\,2}\,(1-n_{t,g}/N_{t,g})]/[n_{t,g}(n_{t,g}-1)]\}\sum(d_{i,t,g} - R_{t,g}k_{i,t,g})^2 \qquad (3)$$

where $N_{t,g}$ is the total number of trips in half-year t with gear type g (estimated from landings by half-year and gear and logbook catch per trip for trips which caught yellowtail in the stock area; Table 6), $d_{i,t,g}$ indicates weight of yellowtail discards from trip i, and $k_{i,t,g}$ indicates weight of landed yellowtail from trip i. Annual discard ratios for 1994-1996 were 14%, 18% and 7% and total discard estimates were 215 mt, 52 mt, and 50mt, respectively. There were too few trips in many half-year/gear strata (n=0-14) for precise estimates.

Discard ratios were alternatively derived from vessel trip reports (VTRs) reported directly by fishermen (Table 6). All trip logs that had a valid statistical area and reported discards of any species were included in the analysis. Landings of the subset of trips which met these criteria had similar spatial-temporal patterns, gear distributions, and target species as landings from all trips in the database with valid statistical area (DeLong et al. 1997). Similar to sea sampling indications, discard ratios from VTRs varied among half-year and gear groups: trawl fishermen reported 4-10% of yellowtail were discarded, and dredge fishermen reported 57-284% discards. Annual discard ratios for 1994-1996 from logbooks were approximately 10% each year, and total discard estimates were 158 mt, 30 mt, and 71 mt, respectively. Total discards from the dredge fishery were comparable in magnitude to those from the trawl fishery because of higher discard ratios from dredges. Comparison of discard rates from VTRs and sea sampling suggests that logbook estimates are not significantly underestimated (Figure 3). Estimates of total discards for 1994-1996 were based on logbook data, because the larger number of trips are more likely to represent the entire fishery.

Sea sampling length observations were used to characterize the age composition of discards for 1994-1996 by gear and half-year, except for trawl discards July-December 1996 and first half-year dredge discards, when there were too few samples (Table 7). The length distribution of the 11 mt of trawl discards in the second half of 1996 was approximated using the fall survey length frequency, 1994-1996 retention at size (approximated by the ratios at length of cumulative size distributions from the fishery and surveys; NEFSC 1995), and 1994-1996 discard ratios at size. Pooled January-June 1994 and 1996 samples were used to characterize the 17, 1, and 8 mt of dredge discards from the first halves of 1994, 1995, and 1996, respectively. The dredge fishery discarded a much wider range of sizes than the trawl fishery, resulting from less selective gear and groundfish trip limits (200 lb). Sea-sampled ages were supplemented with age-at-length observations from port samples for larger sizes. Estimated discards at age and mean weight of 1994-1996 discards are presented in Table 8.

A limited number of sea samples suggests that discarding by Canadian trawlers and dredge fishermen was relatively small before 1996 (Gavaris et al. 1996). In 1996, 11 mt of yellowtail was discarded from the Canadian scallop fishery and is included in estimates of total Canadian catch at age (Table 9). The total catch at age used for virtual population analysis is presented in Table 10. A description of concerns about the reliability of recent estimates of catch at age is included in the Discussion section below.

<u>Stock Abundance and Biomass Indices</u>

NEFSC spring and autumn bottom trawl survey catches (strata 13-21, Figure 4), NEFSC scallop survey catches (strata 54-74, Figure 5), and Canadian bottom trawl survey catches (strata 5Z1-5Z4, Figure 6) were used to estimate relative stock biomass and relative abundance at age for Georges Bank yellowtail (Tables 11-14). Standardization coefficients, which compensate for survey door, vessel, and net changes in NEFSC groundfish surveys (1.22 for old doors, 0.85 for the Delaware II, and 1.76 for the 'yankee 41' net; Rago et al. 1994) were applied to the catch of each tow. Abundance and biomass indices from NEFSC groundfish surveys have generally declined steadily and significantly since 1963 (Tables 11 and 12, Figure 7). Several large year classes have temporarily interrupted the overall rate of decline but the general trend has persisted. Between 1963 and 1969, autumn survey indices averaged 26 fish per tow; in the last six years the average was less than 4 yellowtail per tow. Declines in average weight per tow suggest that current biomass levels are about 10% of levels observed in the 1960s. However, there are indications of increasing stock levels in the last two years.

Scallop survey indices of yellowtail abundance at age were evaluated in the previous assessment of Georges Bank yellowtail, but were not used to calibrate the VPA, because they were not well correlated to population estimates (Rago et al. 1994). However, strata near the U.S./Canada interjurisdictional boundary were inadvertently omitted from previous analyses. The current assessment includes all strata on Georges Bank (54-74, including post-1985 3-digit strata [621, 622, 631, 632, 651, 652, 661, 662]), except for strata 56, 57, and 73, because they have not been sampled since 1988. Revised scallop survey indices were delta transformed (Pennington 1986), because there is a high proportion of tows with no yellowtail catch. The scallop survey index decreased in the 1980s but increased to above-average catches in the last four years (Table 13, Figure 8).

The Canadian spring survey has been conducted since 1987. The Canadian yellowtail index generally increased to peak catches in 1996 (Table 14, Figure 9). Preliminary estimates from the 1997 Canadian survey are even greater than those in 1996 (47 yellowtail per tow).

The NEFSC winter survey use a gear specifically designed to catch a wide size-range of flatfishes. Unfortunately, geographic strata on Georges Bank which are important to measure stock abundance of yellowtail have not been consistently sampled over the survey time series. Therefore, there a times series of standard survey strata on Georges Bank from the winter survey is not currently available.

Correspondence among survey indices was assessed using correlations among logged observations within ages (Rago et al. 1994; Table 15). Normalized indices of catch per tow at age are illustrated in Figure 10. VPA estimates of abundance from Rago et al. (1994) and Gavaris et al. (1996) were also included in correlation analyses. The strongest correlation among age-2+ indices of abundance was between the NEFSC spring and fall surveys (r=0.6). The Canadian survey and scallop survey age-2+ indices were moderately correlated with spring and fall NEFSC indices (r=0.2-0.6). The strongest correlations among age-1 indices were between the scallop index and the other NEFSC indices (r=0.7 with spring and r=0.8 with fall). The age-1 index from the Canadian survey was not well correlated with other age-1 indices (r<0.2). The NEFSC age-2 spring index was strongly correlated with NEFSC fall (r=0.8) and the Canadian index (r=0.7). The scallop age-2 index was moderately correlated with other NEFSC indices (r=0.5 with spring and r=0.6 with fall). Spring and fall NEFSC indices of age-3 abundance were strongly correlated (r=0.8), and correlations were moderate to strong among all other age-3 indices. Spring and fall NEFSC indices of age-4 abundance were also strongly correlated (r=0.8), and correlations were moderate to strong among all other age-4 indices. Correlations among age-5+ aggregate indices were considerably lower than those for younger ages. In summary, there is moderate to strong correlation among abundance indices at age (except for the Canadian age-1 index), and the strongest correlations were among age-3 and age-4 indices.

Virtual Population Analysis

Abundace estimates for ages 1-6+, 1973-1996, was calibrated using ADAPT (Gavaris 1988), which estimated age 2-5 survivors in 1997 and survey catchability coefficients (*q*) using nonlinear least squares according to agreement of survey indices with abundance estimates. The instantaneous rate of natural mortality (M) was assumed to be 0.2 based on tag returns (Lux 1969a) and relationships of Z to effort (Brown and Hennemuth 1971). Observations of a few 14-year-old yellowtail from historical NEFSC surveys suggest that M is approximately 0.2. Yellowtail older than 4 years were assumed to be fully-recruited to estimate F for ages 5 and 6+ for all years in the VPA. Eighteen series of survey indices were used in the VPA calibration (all except age-1 from the Canadian survey):

Tuning Indices for VPA Calibration

Survey	**age-1**	**age-2**	**age-3**	**age-4**	**age-5+**
NEFSC Spring	**X**	**X**	**X**	**X**	**X**
Scallop	**X**	**X**	**X**	**X** (4+)	
NEFSC Fall	**X**	**X**	**X**	**X**	**X**
Canada		**X**	**X**	**X**	**X**

The Canadian age-1 index was excluded, because it was not well correlated to other indices. An age-4+ index was derived from the scallop survey, because the survey gear rarely catches older yellowtail. The NEFSC spring survey and the Canadian survey were used to indicate abundance at the beginning of the year, and the scallop and fall surveys were used as indices of mid-year abundance.

As recommended by the 18th SARC, percent of mature fish at age was based on observations from the NEFSC spring survey within periods of similar stock biomass [1973-1991 from Almeida and Burnett (1997); 1992-1996 from spring survey observations]: age-2 were 42%-49% mature in years of moderate to high stock biomass (1973-1983), increased to 93% at low stock biomass (1984-1991), and decreased to 52% during stock rebuilding (1992-1996).

The mean residual for VPA calibration was 0.77 (Appendix A). Approximate coefficients of variation (CVs) for abundance estimates ranged 22-53%, and decreased with age. Estimates of *q* for each index were relatively precise (CV=18-23%). There were no high correlations among parameter estimates ($|r|<0.15$). Although the model generally fit the data well, there were some patterns in survey residuals (Figures 11a-11d): several indices had trended residuals (e.g., NEFSC spring ages 1, 4, and 5+; scallop age-3; fall age-2), there were correlated errors (i.e., all surveys had some years when residuals for all ages were negative or all were positive), and there were two statistical outliers (i.e., the absolute standardized residual was >3).

The pattern of catchability estimates from the scallop survey may indicate a problem with the assumed age composition. Estimates of q were 0.03, 0.02, 0.04, and 0.05 for ages 1, 2, 3, and 4+. Applying age-length keys from the fall survey (which has different size-selectivity) may inflate the apparent catchability of age-1 fish in the scallop survey.

Variance and model bias of estimates were assessed using bootstrap analysis of the VPA calibration. Two hundred bootstrap realizations were performed by randomly resampling survey residuals. Bootstrapped abundance estimates had only slightly greater CVs than the least squares approximations reported above. Bootstrap-derived Fs were estimated with similar precision to abundance estimates: CVs were high at age-1 (CV = 77%) but decreased with age (CV=22% for ages 4-6). Bootstrap analysis indicates that SSB in 1997 was well estimated (CV=16%). On average, bootstrap analyses indicate that results from the VPA calibration are insensitive to the effects of minor statistical problems (i.e., trended residuals, correlated errors, and outliers).

Bootstrap estimates of bias were relatively low (1-7% for abundance estimates, 4% for F_{4+}, and 3% for SSB), which are substantial improvements from the previous assessment. Bias corrected estimates are presented in Tables A1-A3. However, there are several difficulties in completely correcting for bias (NEFSC 1997). Therefore, bias correction was not incorporated into stochastic projections.

Consistency of VPA estimates was assessed using retrospective analysis (Sinclair et al. 1990). The number of retrospective comparisons was limited by the length of the Canadian survey time series. Retrospective ADAPT runs were made by iteratively truncating the terminal year of catch and survey data back to a terminal year of 1991 (when the Canadian survey had five years of data).

Short-term projections of landings and SSB incorporated uncertainty in VPA estimates using the 200 bootstrap estimates of age 2-6+ 1997 abundance. Projections through 1999 were simulated for each of the 200 abundance estimates by randomly sampling point estimates of 1973-1996 age-1 abundance 100 times (totaling 20,000 simulated trajectories). Projections assumed geometric mean partial recruitment 1994-1996, mean discard ratios at age 1994-1996, mean weight of landings at age 1994-1996, and proportion mature at age from 1992-1996 survey observations.

Medium-term forecasts (i.e., 10 year) incorporated a Beverton-Holt (1957) spawning stock-recruit relationship with lognormally distributed error to simulate 1997-2006 recruitment (Overholtz et al. 1997). Similar to short-term projections, medium-term forecasts assumed geometric mean partial recruitment 1994-1996, mean discard ratios at age 1994-1996, mean weight of landings at age 1994-1996, and proportion mature at age from 1992-1996 survey observations.

Biomass Dynamics Model

The 18th SARC concluded that age-based assessments of Georges Bank yellowtail flounder have been complicated by the truncated age structure and poor characterization of catch at age, and exploration of alternative assessment methods was recommended (NEFSC 1994b). A nonequilibrium surplus production model incorporating covariates (ASPIC; Prager 1994, 1995) was implemented using total catch and survey indices of stock biomass from 1963 to 1996. Estimates of initial biomass (B_I), maximum sustainable yield (MSY), intrinsic rate of increase (r), and catchability of each survey (q) were estimated using nonlinear least squares of survey residuals. The fall survey catch per unit effort (CPUE) contributed to the total sum of squares as a series of observed effort (E=CPUE/C); the NEFSC and Canadian spring surveys contributed as independent biomass indices at the beginning of the year. The NEFSC scallop survey does not measure weights and was not included as a biomass index.

Correlations among survey biomass indices were moderate to strong (r= 0.5, 0.7, and 0.8) (Appendix B). Most of the variance in survey indices was explained by the simple biomass dynamics model (R^2= 0.69, 0.56, and 0.71). There were some temporal patterns of survey residuals, but the overall magnitude of the residuals appears small (Figure 12). Effort residuals from the fall survey significantly increased over time, indicating that the model was predicting greater biomass than observed from the survey. Biomass estimates for the first two to five years of the analysis (1963 to 1964-66) are imprecise and are not generally considered reliable (Prager 1994, 1995).

Survey residuals were randomly resampled 500 times to estimate precision and model bias. Bootstrap analysis showed that B_I, MSY, and r were very well estimated (the relative interquartile ranges were <9%), and survey q's were slightly more variable (relative IQRs=7%-18%). Bootstrap calculations of K, B_{MSY}, and F_{MSY} were stable (relative IQRs=1-8%), but ratios of current conditions to MSY conditions (F_{96}/F_{MSY} and B_{97}/B_{MSY}) were less precise (relative IQRs=22-31%). Yield in 1997 was projected using the current biomass estimate and the expected rate of change at the current biomass and assumed levels of F. Estimates of bias were less than 7% for all estimates in the production model.

RESULTS

Virtual Population Analysis

The analysis indicated that stock abundance of Georges Bank yellowtail was greater than 100 million in the early 1970s and the population was supported by several strong year-classes (Table 16; Appendix A). Stock levels rapidly declined in the early 1980s due to poor recruitment and extremely high F, and remained low through the 1980s. Total stock abundance gradually increased from 18 million in 1987 to the current level, which is less than half of 1973 abundance. Age-4+ F averaged 1.2 from 1973 to 1994, was greater than 0.9 each year until 1995, and decreased from 1.7 in 1994 to 0.1 in 1996 (Figure 13, Table 17).

The estimated time series of recruitment is dominated by four strong year classes of greater than 50 million at age-1 (1973, 1974, 1977, and 1980 year classes; Figure 14, Table 16). All other cohorts produced since 1973 were less than 25 million at age-1. The 1991 to 1995 cohorts were moderately abundant, but the 1995 cohort was the weakest since 1986. Information on the strength of the 1995 year class is equivocal. The VPA indicated poor recruitment, but the 1997 Canadian survey caught an abundance of yellowtail at a mode of 25 cm (presumably age-2).

Spawning biomass was 21,000 mt in 1973, declined to less than 4,000 mt from 1984-1988, fluctuated below 6,000 mt from 1989 to 1994, and increased to 11,700 mt in 1996 (Figure 14, Table 18). The relationship between SSB and recruitment is variable (Figure 15): the four strong cohorts in the time series were produced when SSB exceeded 7,500 mt. When SSB was greater than 10,000 mt, three of six cohorts were strong. When SSB was 7,500 to 10,000 mt one of five cohorts were strong, and when SSB was less than 7,500 mt, no strong year classes were produced.

The distribution of bootstrap estimates of fully-recruited F suggests that there is an 80% chance that F_{96} was between 0.08 and 0.14, and there is nearly 0% probability that F_{96} exceeded $F_{0.1}$ (0.25; Conser et al. 1991) (Figure 16). There is 80% probability that SSB_{96} was between 9,800 and 14,600 mt, and there is a 12% chance that SSB_{96} was below the rebuilding threshold (10,000 mt; NEFMC 1996; Figure 17).

Although some retrospective differences were substantial, there were no patterns of positive or negative inconsistency. Initial estimates of abundance of the 1990 and 1993 cohorts were much greater than revised estimates, presumably resulting from imprecise discard estimates. Abundance estimates in penultimate years were relatively consistent. Fully-recruited F estimates were more consistent than retrospective recruitment estimates, and SSB estimates were very consistent.

Sensitivity analyses were performed to explore two aspects of the VPA calibration. The accuracy of age-1 discards in 1992 and 1993 were suspect, because the retention model used to estimate them had no age-1 landings information (Rago et al. 1994). Age-1 indices for 1992 and 1993 were removed from VPA calibration to examine sensitivity of estimates to discard inaccuracies in those years. The other aspect of VPA tuning which was explored was log transformation of NEFSC groundfish surveys for VPA calibration, because survey catches are skewed and indices are sensitive to rare large catches. Results from the four permutations of alternative ADAPT runs were very similar (Table 19). All catch data and untransformed survey data were used in the accepted run (Tables 16-18), because results were not sensitive to log transformation or excluding 1992 and 1993 age-1 from the calibration.

Age-based projections suggest that, at $F_{0.1}$, landings and SSB will continue to increase in the next three years (Figures 19 and 20). At status-quo F (0.10), landings decrease to approximately 1,200 mt in 1997, then increase to 1,400 mt in 1998, and 1,600 mt in 1999; SSB increases to approximately 13,000 mt in 1997, 16,000 mt in 1998 and 19,000 mt by 1999 (Table 20). Fishing at $F_{0.1}$ (0.25), produces landings which increase to 2,700 mt in 1997, 2,800 mt in 1998 and 2,900 mt in 1999; SSB increases to 13,000 in 1997, 14,000 mt in 1998 and 15,000 in 1999 (Table 20).

An alternative age-based projection was performed to examine sensitivity to using 1994-1996 average conditions. A projection was made using 1996 mean weights, which were greater than 1994-1996 averages, and 1996 partial recruitment, which was greater at ages 1-3. The sensitivity analysis showed that, if 1996 partial recruitment and mean weight at age remain constant, projected 1997 landings will increase to approximately 3,300 mt at $F_{0.1}$.

Medium-term forecasts used expected recruitment from the Beverton-Holt equation presented in Figure 15. The median, lower 25th, and upper 75th percentiles of projected spawning biomass, recruitment (age 1) and landings are given in Tables 21 and 22 and Figure 21 for fishing mortality rate scenarios of F=0.25, and 0.10, respectively.

Under the assumption that F=0.10, landings increase from 1,400 mt in 1998 to 5,500 mt, while spawning biomass increases from 17,500 mt in 1998 to 71,600 mt in 2006, and median recruitment improves from 31.1 to 59.8 million fish (Table 20). For the $F_{0.1}$=0.25 scenario, landings rise steadily from 2,800 mt in 1998 to 8,400 mt in 2006, while spawning biomass improves from 14,900 mt to 46,200 mt and recruitment from 29.1 to 47.2 million during 1998-2006 (Table 21). For all years of the medium-term simulations there is a 100% probability that spawning biomass exceeds the 10,000 mt threshold.

Biomass Dynamics Model

Patterns of stock biomass and F from VPA and the surplus production model were similar (Figure 22, Table 23; Appendix B). The biomass dynamics model indicated that a maximum sustainable yield of 12,800 mt can be produced by the Georges Bank yellowtail stock at a stock biomass of 37,500 mt (B_{MSY}) and F on total biomass ($F_{1+,wb}$) of 0.3 (F_{MSY}). Stock biomass was greater than 45,000 mt in the late 1960s. However, after 1967, F exceeded F_{MSY}, and biomass began to decline. Fishing mortality continued to exceeded F_{MSY} until 1994. By 1971, biomass was reduced to less than B_{MSY}, and continued declining to approximately 4,000 mt in the late 1980s. In 1995, F sharply decreased, and in 1996 biomass began to increase. However, in 1996, biomass was only 29% of B_{MSY}. Yield, F, and biomass trajectories illustrate that stock biomass and yield have had delayed responses to changes in F (Figure 23).

Projections of 1997 catch from the production model indicate that, at the current level of F, landings will increase to approximately 2,000 mt. Projection results differ between VPA and the surplus production model, because age-based projections used estimated abundance at age and assume average 1994-1996 stock conditions (partial recruitment, mean weight, maturation) and the production model projections assume that population growth is a function of current biomass and assumed F levels (Figure 24). At relatively low biomass and low F, the production model assumes a rapid growth rate in 1997.

An exploratory ASPIC analysis was performed which included historical catch and landings-per-unit-effort as an index of biomass from 1943-1966 (Lux 1964, 1969a). The model did not fit the data well, using several starting values for biomass and model formulations, but the results suggested that stock biomass exceeded 60,000 mt before 1963 (Figure 25). Estimates of MSY, *r*, *K*, and *q*'s were not sensitive to extending the time series, including the LPUE series, attempting several starting values of B_l, and changing the model formulation.

Biological Reference Points

Conser et al. (1991) estimated biological reference points using yield and spawning stock biomass per recruit. The analyses were revised with 1994-1996 estimates of mean weight, partial recruitment, and maturity at age. $F_{0.1}$ was estimated as 0.24, F_{max} was 0.61, and $F_{20\%}$ was 0.64. However, as discussed below, there were considerable sources of uncertainty in recent estimates of mean weight and partial recruitment at age, and reference points reported here should be considered provisional. Yield-per-recruit results from the previous analysis ($F_{0.1}$=0.25, F_{max}=0.63; Conser et al 1991) may still be applicable to the current fishery, because the assumed conditions (e.g., mean weights, exploitation pattern) appear to be similar to current conditions.

DISCUSSION

Estimates of catch at age are based on few commercial samples in recent years. Mean weight at age substantially increased in 1996 and there was a discrepancy between U.S. age-length keys and patterns in the Canadian catch at length. Abrupt changes in length distribution at age and mean weight at age are documented throughout the VPA time series in both commercial and survey databases for this stock, even in years when sampling was more comprehensive. Therefore, the increase in size at age in 1996 may be a realistic change rather than the result of poor sampling. Visual inspection of catch at length by sex from Canadian commercial samples indicates that the 1992 year class dominated 1995 and 1996 landings. The NEFSC spring survey also indicated an abundance of age-4 fish in 1996. However, age-4 yellowtail did not predominate NEFSC fall survey catches or U.S. commercial catches. Fall survey age samples were used to characterize the age distribution of most of the Canadian catch, because it is mainly a late-summer to fall fishery. The result was that many of the large fish, which were presumably age-4, were categorized as age-3. The VPA estimated that the 1992 year-class was only slightly above average at age-1, but it experienced relatively low mortality and was the most abundant age-5 cohort in the series. In summary, fall survey ages may not accurately characterize Canadian landings. Estimation of catch at age is complicated by changing spatial patterns of fishing and low levels of sampling, particularly in 1994 and 1995. Despite the potential for inaccuracies in estimates of catch at age, ADAPT residuals do not indicate a large disagreement between survey and commercial catch at age in recent years.

The implications of sexually dimorphic growth on estimates of catch at age is not clear. Canadian commercial samples show distinct length modes for each sex. However, this pattern is not observed in U.S. samples. Commercial age-length keys from the U.S. fishery do not indicate substantial differences in patterns of length at age by sex. Although Canadian landings are from a relatively restricted segment of the stock's range, there was no simple explanation for the different patterns of length composition by sex between the two fisheries. As noted above, length at age by sex are not available from the Canadian fishery (U.S. survey ages are used for Canadian catch at age estimates). Canadian catch at age was estimated with both pooled-sex keys and separate-sex keys (Neilson et al. 1997). Similar age compositions were obtained from the two methods in 1993 and 1994, but more substantial differences were found in 1995. At present, only landings and the Canadian survey can be estimated by sex; discards and other calibration indices can not, because U.S. sea sampling data and survey data are not collected by sex.

Each assessment model (VPA and surplus production) fits the data reasonably well and has strengths and weaknesses. Both models show that F is low and the stock is rebuilding, current stock levels are far below historic levels, and the stock is capable of quick response to reduced F. The VPA should generate more informative projections, but the age structure in the current year may be imprecisely estimated. The biomass dynamics approach combines the processes of growth and recruitment in a simplified model, but assuming the expected population growth rate may risk overestimating 1997 yield. A clear benefit of the production model is the ability to use the entire survey time series, whereas the VPA can not due to problems in reconstructing the fishery catch at age prior to 1973.

Some realizations of of the ten year projections suggest that SSB will exceed the stock's carrying capacity. Stock rebuilding may be modeled more realistically if compensatory growth and maturity and abundance of older ages are incorporated into projections. The biomass dynamics model may be a useful tool to evaluate long-term harvest strategies, because compensatory population growth is a central feature of the simple model.

Results from surplus production modeling strongly suggest that stock biomass is far below the level which would produce MSY (37,500 mt). Therefore, the basis of the 10,000 mt SSB rebuilding threshold should be re-examined.

CONCLUSIONS

Biomass of the Georges Bank yellowtail flounder stock remains low relative to historic levels, but is increasing, with current F below the $F_{0.1}$ reference point. Recent increases in SSB are due to moderate recruitment and improved survival. Stock biomass in 1996 was 29% of the biomass which would produce MSY. The spawning stock in 1996 was 11,700 mt, and there is a 12% chance that SSB is below the rebuilding threshold of 10,000 mt. There is only slight probability that current F (age-4+ F_{96}=0.10) exceeded the rebuilding reference point (age 4+ $F_{0.1}$=0.25). Current F on total stock biomass (age 1+ F_{96}=0.09) is similarly much less than F_{MSY}. Age-1 recruitment was approximately the long-term average from 1991 to 1994, but declined in 1995 and 1996. The 1995 year class appears to be the weakest since 1986. Projections from both models suggest that, at F_{96}, landings and SSB will continue to increase.

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Table 1. Georges Bank yellowtail flounder landings (thousand mt) from statistical areas 522, 525, 551, 552, 561, 562.

Year	U.S.	Canada	Foreign	Total
1935	0.3	0.0	0.0	0.3
1936	0.3	0.0	0.0	0.3
1937	0.3	0.0	0.0	0.3
1938	0.3	0.0	0.0	0.3
1939	0.4	0.0	0.0	0.4
1940	0.6	0.0	0.0	0.6
1941	0.9	0.0	0.0	0.9
1942	1.6	0.0	0.0	1.6
1943	1.3	0.0	0.0	1.3
1944	1.7	0.0	0.0	1.7
1945	1.4	0.0	0.0	1.4
1946	0.9	0.0	0.0	0.9
1947	2.3	0.0	0.0	2.3
1948	5.7	0.0	0.0	5.7
1949	7.3	0.0	0.0	7.3
1950	3.9	0.0	0.0	3.9
1951	4.3	0.0	0.0	4.3
1952	3.7	0.0	0.0	3.7
1953	2.9	0.0	0.0	2.9
1954	2.9	0.0	0.0	2.9
1955	2.9	0.0	0.0	2.9
1956	1.6	0.0	0.0	1.6
1957	2.3	0.0	0.0	2.3
1958	4.5	0.0	0.0	4.5
1959	4.1	0.0	0.0	4.1
1960	4.4	0.0	0.0	4.4
1961	4.2	0.0	0.0	4.2
1962	7.7	0.0	0.0	7.7
1963	11.0	0.0	0.1	11.1
1964	14.9	0.0	0.0	14.9
1965	14.2	0.0	0.8	15.0
1966	11.3	0.0	0.3	11.6
1967	8.4	0.0	1.4	9.8
1968	12.8	0.0	1.8	14.6
1969	15.9	0.0	2.4	18.3
1970	15.5	0.0	0.3	15.8
1971	11.9	0.0	0.5	12.4
1972	14.2	0.0	2.2	16.4
1973	15.9	0.0	0.3	16.2
1974	14.6	0.0	1.0	15.6
1975	13.2	0.0	0.1	13.3
1976	11.3	0.0	0.0	11.3
1977	9.4	0.0	0.0	9.4
1978	4.5	0.0	0.0	4.5
1979	5.5	0.0	0.0	5.5
1980	6.5	0.0	0.0	6.5
1981	6.2	0.0	0.0	6.2
1982	10.6	0.0	0.0	10.6
1983	11.3	0.0	0.0	11.3
1984	5.8	0.0	0.0	5.8
1985	2.5	0.0	0.0	2.5
1986	3.0	0.0	0.0	3.0
1987	2.7	0.0	0.0	2.7
1988	1.9	0.0	0.0	1.9
1989	1.1	<0.1	0.0	1.1
1990	2.7	<0.1	0.0	2.7
1991	1.8	<0.1	0.0	1.8
1992	2.8	<0.1	0.0	2.8
1993	2.1	0.8	0.0	2.9
1994	1.6	2.1	0.0	3.7
1995	0.3	0.5	0.0	0.8
1996	0.8	0.5	0.0	1.3

Table 2. Sample sizes (number of trips, fish measured, and fish aged) for estimation of U.S. landings at age of Georges Bank yellowtail flounder, 1994-1996.

		market	Port Samples			Sea Samples			Survey	Landings
year	months	size	trips	lengths	ages	trips	lengths	ages	ages*	(mt)
1994	Jan-Jun	small	1	95						75.5
		large	1	93						122.4
		all	1	188	53	14	400	0	4	197.9
1994	Jul-Dec	small	7	847						633.1
		large	7	596						757.5
		all	7	1,443	353	8	2,150	73	4	1390.6
1995	Jan-Jun	small	2	235						64.7
		large	4	345						95.9
		all	4	580	166	11	611	43	3	160.6
1995	Jul-Dec	small	0	0						67.7
		large	1	81						63.8
		all	1	81	23	5	89	0	22	131.5
1996	Jan-Jun	small	2	250						158.8
		large	3	254						362.1
		all	3	504	146	15	415	65	2	520.9
1996	Jul-Dec	small	3	382						116.8
		large	3	274						113.6
		all	3	656	173	3	106	9	0	230.4

* used for commercial length samples with no corresponding age samples.

Table 3. U.S.A. landings at age (thousands) of Georges Bank yellowtail flounder (1973-1990 from Conser et al. 1991; 1991-1993 from Rago et al. 1994).

	Age								
Year	1	2	3	4	5	6	7	8+	Total
1973	0	3,837	13,076	9,274	3,743	1,259	278	81	31,548
1974	180	6,297	7,818	7,397	3,544	852	452	173	26,713
1975	427	16,851	6,943	3,391	2,084	671	313	164	30,844
1976	43	19,320	5,085	1,347	532	434	287	147	27,195
1977	31	6,616	9,805	1,721	394	221	129	124	19,041
1978	0	2,140	3,970	1,660	459	102	37	35	8,403
1979	17	6,804	3,396	1,242	550	141	79	52	12,281
1980	0	2,371	8,696	1,419	321	85	4	10	12,906
1981	6	479	5,267	4,555	796	122	4	0	11,229
1982	217	13,132	7,061	3,245	1,031	62	19	3	24,770
1983	239	7,667	16,016	2,316	625	109	10	8	26,990
1984	244	1,913	4,266	4,734	1,592	257	47	17	13,070
1985	371	3,335	816	652	410	60	5	0	5,649
1986	90	5,733	978	347	161	52	16	8	7,385
1987	15	1,819	2,730	761	132	39	32	41	5,569
1988	0	1,650	1,181	624	165	15	20	3	3,658
1989	0	1,337	664	262	68	11	8	0	2,350
1990	0	735	4,582	738	105	17	3	0	6,180
1991	0	27	867	2,256	289	56	4	0	3,499
1992	0	3,183	1,891	1,176	502	20	7	0	6,779
1993	0	375	1,538	1,392	287	65	4	1	3,662
1994	0	129	2,614	853	253	40	8	1	3,897
1995	0	12	272	281	70	3	11	3	651
1996	0	161	751	482	144	5	5	1	1,550
mean	78	4,413	4,595	2,172	761	196	74	36	12,326

Table 4. Mean weight (kg) at age of U.S.A. landings of Georges Bank yellowtail flounder.

	Age								
Year	1	2	3	4	5	6	7	8+	All
1973	0.198	0.375	0.464	0.527	0.603	0.689	1.067	1.136	0.504
1974	0.200	0.378	0.500	0.609	0.680	0.725	0.906	1.249	0.542
1975	0.211	0.340	0.492	0.554	0.618	0.687	0.688	0.649	0.427
1976	0.185	0.339	0.545	0.636	0.741	0.814	0.852	0.866	0.416
1977	0.197	0.364	0.527	0.634	0.782	0.865	1.036	1.013	0.495
1978	0.182	0.337	0.513	0.684	0.793	0.899	0.930	0.948	0.526
1979	0.139	0.356	0.462	0.649	0.728	0.835	1.003	0.882	0.443
1980	0.138	0.354	0.495	0.656	0.813	1.054	1.256	1.214	0.499
1981	0.091	0.389	0.493	0.603	0.707	0.798	0.832	1.044	0.552
1982	0.213	0.313	0.487	0.650	0.748	1.052	1.024	1.311	0.426
1983	0.215	0.296	0.440	0.604	0.736	0.952	1.018	0.987	0.420
1984	0.208	0.240	0.378	0.500	0.642	0.738	0.944	1.047	0.441
1985	0.236	0.363	0.497	0.647	0.733	0.819	0.732	1.044	0.439
1986	0.234	0.343	0.540	0.664	0.823	0.864	0.956	1.140	0.399
1987	0.212	0.338	0.523	0.666	0.680	0.938	0.793	0.788	0.491
1988		0.351	0.557	0.688	0.855	1.054	0.873	1.385	0.504
1989		0.355	0.543	0.725	0.883	1.026	1.254	1.044	0.471
1990		0.337	0.419	0.588	0.699	0.807	1.230	1.044	0.436
1991		0.270	0.383	0.484	0.728	0.820	1.306	1.044	0.484
1992		0.341	0.381	0.528	0.648	1.203	1.125	1.044	0.411
1993		0.316	0.390	0.510	0.562	0.858	1.263	1.044	0.451
1994		0.300	0.355	0.473	0.629	0.787	0.896	1.166	0.403
1995		0.309	0.379	0.465	0.583	0.778	0.785	0.531	0.446
1996		0.321	0.417	0.569	0.726	0.926	1.031	1.209	0.488
mean	0.191	0.334	0.466	0.596	0.714	0.874	0.992	1.035	0.463

Table 5. Estimated discards of Georges Bank yellowtail flounder from sea sampling observations.

	1994					1995					1996				
	Jan-Jun		Jul-Dec		annual	Jan-Jun		Jul-Dec		annual	Jan-Jun		Jul-Dec		annual
	trawl	dredge*	trawl	dredge*	total	trawl	dredge*	trawl	dredge*	total	trawl	dredge	trawl	dredge	total
total landings (mt)	168	0	1,381	40	1,588	160	0	123	9	292	519	3	223	7	751
trips with discard	14	0	4	4	22	11	0	3	2	16	12	3	1	2	18
total kept (mt)	10.71		10.30	0.04		2.06		0.91	0.03		13.00	0.02	0.05	0.06	
total discard (mt)	0.24		0.61	0.12		0.31		0.16	0.02		0.61	0.03	0.00	0.10	
discard/kept	0.02		0.06	3.26		0.15		0.17	0.79		0.05	1.23	0.05	1.59	
Expanded estimates															
total trips	505		587	109	1,201	294		216	86	596	446	34	340	80	899
total discards (mt)	4		82	129	215	24		21	7	52	24	3	11	11	50
sum of squares	0.002					0.013					0.034				
Variance of est.	2.86					9.71					50.23				
Std. Err. of est.	1.69					3.12					7.09				
CV of est.	0.44					0.13					0.29				

* there were no dredge logbooks with discards data for the 1st half of 1994-95; landings from those cells were added to landings for 2nd halves.

Table 6. Estimated discards of Georges Bank yellowtail flounder from logbook data, using all trips with discard of any species.

	1994					1995					1996				
	Jan-Jun		Jul-Dec		annual	Jan-Jun		Jul-Dec		annual	Jan-Jun		Jul-Dec		annual
	trawl	dredge	trawl	dredge	sum	trawl	dredge	trawl	dredge	sum	trawl	dredge	trawl	dredge	sum
total landings (mt)	168.3	29.9	1380.6	9.7	1588.5	159.9	0.6	123.4	8.5	292.3	518.7	2.8	222.8	7.0	751.3
trips with logbooks	134	36	423	61	654	286	5	217	59	567	381	37	292	58	768
total kept (mt)	44.64	4.47	994.22	5.43		155.73	0.56	123.83	6.08		442.65	3.04	191.59	5.12	
kept/trip	0.33	0.12	2.35	0.09		0.54	0.11	0.57	0.10		1.16	0.08	0.66	0.09	
trips with discard	55	16	143	18	232	64	2	34	22	122	93	19	93	20	225
total kept (mt)	19.35	2.73	326.90	1.12		37.79	0.32	9.42	1.39		106.81	1.68	62.69	1.26	
total discard (mt)	1.96	1.55	25.47	1.91		1.40	0.29	0.63	2.47		6.61	4.77	3.22	3.49	
discard/kept	0.10	0.57	0.08	1.70		0.04	0.93	0.07	1.78		0.06	2.84	0.05	2.78	
Expanded estimates															
total trips	505	241	587	109	1,442	294	5	216	83	597	446	34	340	80	899
total discards (mt)	17	17	108	16	141	6	1	8	15	24	32	8	11	20	39
sum of squares	1.18	0.61	41.33	0.66		0.03	0.02	0.03	0.69		2.77	2.32	0.78	1.72	
Variance of est.	90.08	137.60	531.28	21.13		0.55	0.14	1.22	7.54		51.09	3.36	7.58	21.39	
Std. Err. of est.	9.49	11.73	23.05	4.60		0.74	0.38	1.10	2.75		7.15	1.83	2.75	4.63	
CV of est.	0.56	0.69	0.21	0.28		0.13	0.72	0.13	0.18		0.22	0.23	0.24	0.24	

Table 7. Samples sizes (number of trips, fish measured, and fish aged) for estimation of discards at age of Georges Bank yellowtail flounder, 1994-1996.

year	months	gear	Sea trips	Samples lengths	Commercial ages	Survey ages	Discards (mt)
1994	Jan-Jun	trawl	14	104			17
		dredge	0	0			17
		all	14	104	48	124	34
1994	Jul-Dec	trawl	4	1,421			108
		dredge	4	63			16
		all	8	1,484	402	7	124
1995	Jan-Jun	trawl	11	176			6
		dredge	0	0			1
		all	11	176	179	44	7
1995	Jul-Dec	trawl	3	55			8
		dredge	2	25			15
		all	5	80	15	48	23
1996	Jan-Jun	trawl	12	212			32
		dredge	3	13			8
		all	15	225	189	22	40
1996	Jul-Dec	trawl	1	4			11
		dredge	2	152			20
		all	3	156	174	20	31

Table 8. Estimated discards at age (thousands) of from the U.S. Georges Bank yellowtail flounder fishery (1973-1990 from Conser et al. 1991; 1991-1993 from Rago et al. 1994), and mean weight at age of discards 1994-1996.

Discards

	Age								
Year	1	2	3	4	5	6	7	8+	Total
1973	347	1,053	167	2	0	0	0	0	1,569
1974	1,963	2,674	86	1	0	0	0	0	4,724
1975	3,945	8,433	114	1	0	0	0	0	12,493
1976	572	11,692	61	0	0	0	0	0	12,325
1977	299	1,964	112	0	0	0	0	0	2,375
1978	9,659	965	64	0	0	0	0	0	10,688
1979	216	2,701	49	0	0	0	0	0	2,966
1980	309	1,201	125	0	0	0	0	0	1,635
1981	49	250	84	1	0	0	0	0	384
1982	1,846	4,359	61	1	0	0	0	0	6,267
1983	457	22	0	0	0	0	0	0	479
1984	184	4	0	0	0	0	0	0	188
1985	279	10	0	0	0	0	0	0	289
1986	68	38	0	0	0	0	0	0	106
1987	125	834	21	0	0	0	0	0	980
1988	483	717	10	0	0	0	0	0	1,210
1989	185	179	4	0	0	0	0	0	368
1990	219	1,196	1,541	62	2	0	0	0	3,020
1991	412	27	355	174	4	0	0	0	972
1992	2,389	5,176	636	93	8	0	0	0	8,302
1993	5,189	549	512	99	4	0	0	0	6,353
1994	1	317	238	17	3	0	0	0	577
1995	14	45	47	7	0	0	0	0	136
1996	49	115	103	6	0	0	0	0	273
mean	1,219	1,856	183	19	1	0	0	0	3,278

Mean Weight (kg)

	Age								
Year	1	2	3	4	5	6	7	8+	All
1994	0.130	0.238	0.287	0.417	0.512	0.622			0.265
1995	0.155	0.233	0.283	0.357	0.496	0.593		0.531	0.255
1996	0.137	0.266	0.312	0.418					0.263
mean	0.141	0.247	0.294	0.398	0.513	0.607			0.261

Table 9. Estimated Canadian catch at age (thousands) of Georges Bank yellowtail flounder (from Neilson et al. 1997).

	Age								
Year	1	2	3	4	5	6	7	8+	Total
1993	5	85	727	901	27	0	5	0	1,750
1994	70	415	2,890	1,701	654	59	29	0	5,818
1995	0	100	576	427	66	10	0	0	1,179
1996	1	107	655	229	22	4	0	0	1,018
mean	19	177	1,212	815	192	18	9	0	2,441

Table 10. Total catch at age (thousands) of Georges Bank yellowtail flounder (1973-1990 from Conser et al. 1991; 1991-1993 from Rago et al. 1994).

	Age								
Year	1	2	3	4	5	6	7	8+	Total
1973	347	4,890	13,243	9,276	3,743	1,259	278	81	33,117
1974	2,143	8,971	7,904	7,398	3,544	852	452	173	31,437
1975	4,372	25,284	7,057	3,392	2,084	671	313	164	43,337
1976	615	31,012	5,146	1,347	532	434	287	147	39,520
1977	330	8,580	9,917	1,721	394	221	129	124	21,416
1978	9,659	3,105	4,034	1,660	459	102	37	35	19,091
1979	233	9,505	3,445	1,242	550	141	79	52	15,247
1980	309	3,572	8,821	1,419	321	85	4	10	14,541
1981	55	729	5,351	4,556	796	122	4	0	11,613
1982	2,063	17,491	7,122	3,246	1,031	62	19	3	31,037
1983	696	7,689	16,016	2,316	625	109	10	8	27,469
1984	428	1,917	4,266	4,734	1,592	257	47	17	13,258
1985	650	3,345	816	652	410	60	5	0	5,938
1986	158	5,771	978	347	161	52	16	8	7,491
1987	140	2,653	2,751	761	132	39	32	41	6,549
1988	483	2,367	1,191	624	165	15	20	3	4,868
1989	185	1,516	668	262	68	11	8	0	2,718
1990	219	1,931	6,123	800	107	17	3	0	9,200
1991	412	54	1,222	2,430	293	56	4	0	4,471
1992	2,389	8,359	2,527	1,269	510	20	7	0	15,081
1993	5,194	1,009	2,777	2,392	318	65	9	1	11,765
1994	71	861	5,742	2,571	910	99	37	1	10,291
1995	14	157	895	715	137	13	11	4	1,966
1996	50	383	1,509	716	167	9	5	1	2,841
mean	1,301	6,298	4,980	2,327	794	199	76	36	16,011

Table 11. NEFSC spring trawl survey mean catch per tow of Georges Bank yellowtail flounder (strata13-21; standardized for vessel, door, and gear changes).

	Age									biomass
Year	1	2	3	4	5	6	7	8+	Total	(kg)
1968	0.149	3.364	3.579	0.316	0.084	0.160	0.127	0.000	7.779	2.813
1969	1.015	9.406	11.119	3.096	1.423	0.454	0.188	0.057	26.758	11.170
1970	0.093	4.485	6.030	2.422	0.570	0.121	0.190	0.000	13.911	5.312
1971	0.791	3.335	4.620	3.754	0.759	0.227	0.050	0.029	13.564	4.607
1972	0.138	7.136	7.198	3.514	1.094	0.046	0.122	0.000	19.247	6.450
1973	1.931	3.266	2.368	1.063	0.410	0.173	0.023	0.020	9.254	2.938
1974	0.316	2.224	1.842	1.256	0.346	0.187	0.085	0.009	6.265	2.719
1975	0.420	2.939	0.860	0.298	0.208	0.068	0.000	0.013	4.806	1.676
1976	1.034	4.368	1.247	0.311	0.196	0.026	0.048	0.037	7.268	2.273
1977	0.000	0.671	1.125	0.384	0.074	0.013	0.000	0.000	2.267	0.999
1978	0.936	0.798	0.507	0.219	0.026	0.000	0.008	0.000	2.494	0.742
1979	0.279	1.933	0.385	0.328	0.059	0.046	0.041	0.000	3.072	1.227
1980	0.057	4.644	5.761	0.473	0.057	0.037	0.000	0.000	11.030	4.456
1981	0.012	1.027	1.779	0.721	0.205	0.061	0.000	0.026	3.830	1.960
1982	0.045	3.742	1.122	1.016	0.455	0.065	0.000	0.026	6.472	2.500
1983	0.000	1.865	2.728	0.531	0.123	0.092	0.061	0.092	5.492	2.642
1984	0.000	0.093	0.809	0.885	0.834	0.244	0.000	0.000	2.865	1.646
1985	0.110	2.198	0.262	0.282	0.148	0.000	0.000	0.000	3.000	0.988
1986	0.027	1.806	0.291	0.056	0.137	0.055	0.000	0.000	2.372	0.847
1987	0.000	0.128	0.112	0.133	0.053	0.055	0.000	0.000	0.480	0.329
1988	0.078	0.275	0.366	0.242	0.199	0.027	0.000	0.000	1.187	0.566
1989	0.047	0.424	0.740	0.290	0.061	0.022	0.022	0.000	1.605	0.729
1990	0.000	0.065	1.108	0.393	0.139	0.012	0.045	0.000	1.762	0.699
1991	0.435	0.000	0.254	0.675	0.274	0.020	0.000	0.000	1.659	0.631
1992	0.000	2.010	1.945	0.598	0.189	0.000	0.000	0.000	4.742	1.566
1993	0.046	0.290	0.500	0.317	0.027	0.000	0.000	0.000	1.180	0.482
1994	0.000	0.621	0.638	0.357	0.145	0.043	0.000	0.000	1.804	0.660
1995	0.040	1.180	4.810	1.490	0.640	0.010	0.000	0.000	8.170	2.579
1996	0.030	0.990	2.630	2.700	0.610	0.060	0.000	0.000	7.020	2.853
mean	0.277	2.251	2.301	0.970	0.329	0.080	0.035	0.011	6.254	2.381

Table 12. NEFSC autumn trawl survey mean catch per tow of Georges Bank yellowtail flounder (strata13-21; standardized for vessel, door, and gear changes).

	Age										biomass
Year	0	1	2	3	4	5	6	7	8+	Total	(kg)
1963	0.000	14.722	7.896	11.226	1.858	0.495	0.281	0.034	0.233	36.746	12.788
1964	0.000	1.721	9.723	7.370	5.998	2.690	0.383	0.095	0.028	28.007	13.623
1965	0.014	1.138	5.579	5.466	3.860	1.803	0.162	0.284	0.038	18.345	9.104
1966	1.177	8.772	4.776	2.070	0.837	0.092	0.051	0.000	0.000	17.775	3.988
1967	0.106	9.137	9.313	2.699	1.007	0.309	0.076	0.061	0.000	22.708	7.575
1968	0.000	11.782	11.946	5.758	0.766	0.944	0.059	0.000	0.000	31.254	10.536
1969	0.135	8.106	10.381	5.855	1.662	0.553	0.149	0.182	0.000	27.023	9.279
1970	1.048	4.610	5.133	3.144	1.952	0.451	0.063	0.017	0.000	16.417	4.979
1971	0.025	3.627	6.949	4.904	2.248	0.551	0.234	0.024	0.024	18.586	6.365
1972	0.785	2.424	6.525	4.824	2.095	0.672	0.279	0.000	0.000	17.604	6.328
1973	0.094	2.494	5.497	5.104	2.944	1.216	0.416	0.171	0.031	17.996	6.602
1974	1.030	4.623	2.854	1.524	1.060	0.460	0.249	0.131	0.000	12.133	3.733
1975	0.361	4.625	2.511	0.877	0.572	0.334	0.033	0.000	0.031	9.420	2.365
1976	0.000	0.336	1.929	0.475	0.117	0.122	0.033	0.000	0.067	3.078	1.533
1977	0.000	0.928	2.161	1.649	0.618	0.113	0.056	0.036	0.016	5.614	2.829
1978	0.037	4.729	1.272	0.773	0.406	0.139	0.011	0.000	0.024	7.443	2.383
1979	0.018	1.312	1.999	0.316	0.122	0.138	0.038	0.064	0.007	4.041	1.520
1980	0.078	0.761	5.086	6.050	0.678	0.217	0.162	0.006	0.033	13.217	6.722
1981	0.000	1.584	2.333	1.630	0.500	0.121	0.083	0.013	0.000	6.345	2.621
1982	0.000	2.424	2.185	1.590	0.423	0.089	0.000	0.000	0.000	6.711	2.270
1983	0.000	0.109	2.284	1.914	0.473	0.068	0.012	0.000	0.038	4.898	2.131
1984	0.012	0.661	0.400	0.306	2.428	0.090	0.029	0.000	0.018	3.944	0.593
1985	0.010	1.350	0.560	0.160	0.040	0.080	0.000	0.000	0.000	2.200	0.709
1986	0.000	0.280	1.110	0.350	0.070	0.000	0.000	0.000	0.000	1.810	0.820
1987	0.000	0.113	0.390	0.396	0.053	0.079	0.000	0.000	0.000	1.031	0.509
1988	0.011	0.019	0.213	0.102	0.031	0.000	0.000	0.000	0.000	0.376	0.171
1989	0.027	0.248	1.992	0.774	0.069	0.066	0.000	0.000	0.000	3.176	0.977
1990	0.147	0.000	0.326	1.517	0.280	0.014	0.000	0.000	0.000	2.284	0.725
1991	0.000	2.100	0.275	0.439	0.358	0.000	0.000	0.000	0.000	3.172	0.730
1992	0.000	0.151	0.396	0.712	0.162	0.144	0.027	0.000	0.000	1.592	0.576
1993	0.000	0.842	0.136	0.587	0.536	0.000	0.000	0.000	0.000	2.101	0.545
1994	0.010	1.200	0.220	0.980	0.710	0.260	0.030	0.030	0.000	3.440	0.897
1995	0.070	0.280	0.120	0.350	0.280	0.050	0.010	0.000	0.000	1.160	0.354
1996	0.000	0.140	0.350	1.870	0.450	0.070	0.000	0.000	0.000	2.880	1.303
mean	0.153	2.863	3.377	2.464	1.049	0.366	0.086	0.034	0.017	10.427	3.770

Table 13. NEFSC scallop survey mean number per tow of Georges Bank yellowtail flounder (strata 54, 55, 58-72, 74; delta transformed).

	Age									
Year	0	1	2	3	4	5	6	7	8	Total
1982	0.000	0.509	0.542	0.215	0.085	0.018	0.000	0.000	0.000	1.369
1983	0.000	0.276	0.549	0.464	0.095	0.041	0.010	0.010	0.000	1.446
1984	0.000	0.377	0.125	0.064	0.104	0.011	0.019	0.000	0.000	0.700
1985	0.000	0.662	0.079	0.003	0.015	0.000	0.000	0.000	0.000	0.758
1986	0.000	0.197	0.072	0.006	0.004	0.000	0.000	0.000	0.000	0.279
1987	0.006	0.104	0.151	0.136	0.010	0.014	0.008	0.000	0.000	0.424
1988	0.000	0.118	0.052	0.072	0.022	0.000	0.000	0.000	0.000	0.263
1989	0.000	0.194	0.458	0.233	0.065	0.000	0.000	0.000	0.000	0.951
1990	0.000	0.108	0.063	0.392	0.089	0.000	0.000	0.000	0.000	0.652
1991	0.068	2.434	0.030	0.147	0.146	0.000	0.000	0.000	0.000	2.758
1992	0.008	0.204	0.221	0.126	0.011	0.004	0.000	0.000	0.000	0.566
1993	0.150	1.295	0.100	0.333	0.300	0.027	0.011	0.000	0.000	2.066
1994	0.018	1.606	0.126	0.585	0.334	0.114	0.021	0.001	0.000	2.788
1995	0.021	0.697	0.333	1.008	0.554	0.019	0.046	0.013	0.000	2.670
1996	0.000	0.562	0.563	1.414	0.251	0.104	0.094	0.000	0.000	2.988
mean	0.271	0.623	0.231	0.347	0.139	0.024	0.014	0.002	0.000	1.379

Table 14. Canadian spring trawl survey mean number per tow of Georges Bank yellowtail flounder.

	Age						
Year	1	2	3	4	5	6	Total
1987	0.08	0.12	0.74	2.58	0.56	0.02	4.02
1988	0.04	0.67	1.81	0.80	0.67	0.01	3.96
1989	0.08	0.76	0.91	0.29	0.04	0.01	2.01
1990	0.05	1.92	4.04	1.07	0.40	0.01	7.44
1991	0.14	0.61	1.86	2.93	0.82	0.00	6.22
1992	0.10	10.06	4.59	1.14	0.29	0.00	16.08
1993	0.32	2.63	6.32	2.45	0.21	0.02	11.63
1994	0.00	6.38	3.46	2.63	0.86	0.19	13.52
1995	0.17	1.17	4.55	2.16	0.95	0.07	8.90
1996	0.53	5.62	8.23	7.16	1.36	0.17	22.54
mean	0.15	2.99	3.65	2.32	0.62	0.05	9.63

Table 15. Correlations among log transformed survey indices of abundance for Georges Bank yellowtail flounder (SAW-18: abundance estimates from Rago et al. 1994; RAP-96: abundance estimates from Gavaris et al. 1996).

Age-2+	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	1.00					
RAP-96	0.97	1.00				
Fall	0.73	0.72	1.00			
Spring	0.40	0.22	0.59	1.00		
Canada	0.36	0.44	0.26	0.42	1.00	
Scallop	0.24	0.27	0.46	0.19	0.53	1.00

Age-1	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	-----					
RAP-96	-----	-----				
Fall	-----	-----	1.00			
Spring	-----	-----	0.22	1.00		
Canada	-----	-----	0.03	-0.04	1.00	
Scallop	-----	-----	0.69	0.77	0.20	1.00

Age-2	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	1.00					
RAP-96	0.98	1.00				
Fall	0.72	0.69	1.00			
Spring	0.80	0.72	0.79	1.00		
Canada	0.49	0.30	-0.04	0.73	1.00	
Scallop	0.78	0.38	0.63	0.50	0.24	1.00

Age-3	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	1.00					
RAP-96	0.96	1.00				
Fall	0.71	0.67	1.00			
Spring	0.78	0.64	0.84	1.00		
Canada	0.48	0.68	0.52	0.62	1.00	
Scallop	0.47	0.36	0.56	0.71	0.67	1.00

Age-4	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	1.00					
RAP-96	0.95	1.00				
Fall	0.80	0.80	1.00			
Spring	0.84	0.45	0.82	1.00		
Canada	0.75	0.74	0.73	0.62	1.00	
Scallop	0.33	0.37	0.51	0.54	0.47	1.00

Age-5+	SAW-18	RAP-96	Fall	Spring	Canada	Scallop
SAW-18	1.00					
RAP-96	0.81	1.00				
Fall	0.64	0.38	1.00			
Spring	0.19	0.13	0.69	1.00		
Canada	-0.10	0.07	0.25	0.76	1.00	
Scallop	-0.11	-0.01	0.51	0.32	0.76	1.00

Table 16. Estimates of beginning year stock size (millions of fish) for Georges Bank yellowtail flounder derived from virtual population analysis.

	Age						
Year	1	2	3	4	5	6+	Total
1973	28,290	23,279	28,937	16,960	6,729	2,859	107,054
1974	50,265	22,848	14,635	11,709	5,492	2,240	107,189
1975	68,516	39,214	10,589	4,830	2,893	1,551	127,593
1976	22,919	52,140	9,228	2,284	885	1,417	88,873
1977	15,760	18,208	14,628	2,899	651	768	52,914
1978	50,823	12,605	7,144	3,003	816	304	74,695
1979	23,375	32,871	7,510	2,199	957	465	67,377
1980	22,099	18,927	18,312	3,032	677	206	63,253
1981	61,066	17,814	12,264	7,011	1,198	185	99,538
1982	21,627	49,947	13,925	5,199	1,618	129	92,445
1983	5,819	15,840	25,067	4,957	1,319	264	53,266
1984	8,620	4,134	6,011	6,031	1,962	382	27,140
1985	14,595	6,670	1,650	1,062	654	102	24,733
1986	6,661	11,361	2,435	613	279	129	21,478
1987	7,030	5,311	4,080	1,108	188	155	17,872
1988	19,371	5,629	1,947	851	219	49	28,066
1989	8,584	15,423	2,467	517	132	36	27,159
1990	12,026	6,861	11,255	1,415	186	34	31,777
1991	22,800	9,648	3,870	3,675	435	87	40,515
1992	19,085	18,295	7,850	2,063	811	42	48,146
1993	23,038	13,464	7,415	4,141	541	125	48,724
1994	22,130	14,162	10,111	3,558	1,226	179	51,366
1995	16,190	18,054	10,816	3,082	587	119	48,848
1996	7,240	13,243	14,639	8,046	1,877	168	45,213
1997	----------	5,882	10,496	10,620	5,939	1,509	----------
mean	22,317	18,073	10,291	4,435	1,531	444	53,674
min	5,819	4,134	1,650	517	132	34	17,872
max	68,516	52,140	25,067	11,709	5,939	2,240	127,593

Table 17. Estimates of instantaneous fishing mortality (F) for Georges Bank yellowtail flounder derived from virtual population analysis.

	Age						mean
Year	1	2	3	4	5	6+	age-4+
1973	0.014	0.264	0.705	0.928	0.954	0.954	0.945
1974	0.048	0.569	0.909	1.198	1.249	1.249	1.232
1975	0.073	1.247	1.334	1.497	1.591	1.591	1.559
1976	0.030	1.071	0.958	1.055	1.091	1.091	1.079
1977	0.023	0.736	1.383	1.068	1.105	1.105	1.092
1978	0.236	0.318	0.978	0.944	0.971	0.971	0.962
1979	0.011	0.385	0.707	0.978	1.009	1.009	0.999
1980	0.016	0.234	0.760	0.729	0.743	0.743	0.738
1981	0.001	0.046	0.658	1.266	1.325	1.325	1.305
1982	0.111	0.489	0.833	1.172	1.219	1.219	1.203
1983	0.142	0.769	1.225	0.727	0.741	0.741	0.736
1984	0.056	0.718	1.533	2.022	2.269	2.269	2.186
1985	0.050	0.808	0.790	1.137	1.179	1.179	1.165
1986	0.026	0.824	0.587	0.982	1.014	1.014	1.003
1987	0.022	0.803	1.367	1.421	1.053	1.053	1.176
1988	0.028	0.625	1.126	1.664	1.792	1.792	1.749
1989	0.024	0.115	0.356	0.822	0.842	0.842	0.835
1990	0.020	0.373	0.919	0.980	1.010	1.010	1.000
1991	0.020	0.006	0.429	1.311	1.376	1.376	1.354
1992	0.149	0.703	0.440	1.138	1.183	1.183	1.168
1993	0.287	0.086	0.534	1.017	1.050	1.050	1.039
1994	0.004	0.070	0.988	1.602	1.718	1.718	1.679
1995	0.001	0.010	0.096	0.296	0.299	0.299	0.298
1996	0.008	0.032	0.121	0.104	0.104	0.104	0.104
mean	0.058	0.471	0.822	1.086	1.116	1.120	1.109
min	0.001	0.006	0.096	0.104	0.104	0.104	0.104
max	0.287	1.247	1.533	2.022	2.269	2.269	2.186

Table 18. Estimates of spawning stock biomass (mt) for Georges Bank yellowtail flounder derived from virtual population analysis.

	Age						
Year	1	2	3	4	5	6+	Total
1973	0	3,022	8,933	5,531	2,509	1,372	21,368
1974	0	2,821	4,518	3,982	2,042	1,031	14,394
1975	0	3,283	2,694	1,319	848	501	8,646
1976	0	4,684	3,042	861	383	691	9,661
1977	0	2,020	3,906	1,084	296	424	7,729
1978	0	1,541	2,198	1,275	397	171	5,582
1979	0	4,127	2,330	874	421	251	8,001
1980	0	2,516	5,954	1,351	371	150	10,342
1981	0	3,064	4,186	2,295	449	78	10,072
1982	0	5,748	4,366	1,908	670	75	12,767
1983	0	1,534	6,031	2,035	656	171	10,427
1984	0	629	1,103	1,195	450	107	3,485
1985	0	1,480	543	394	270	46	2,732
1986	0	2,365	947	249	139	71	3,770
1987	0	1,099	1,110	376	63	64	2,712
1988	0	1,303	624	269	82	21	2,299
1989	0	4,465	1,063	245	76	26	5,875
1990	0	1,694	2,958	509	79	18	5,257
1991	0	2,223	1,140	948	164	38	4,513
1992	0	2,227	2,291	624	295	28	5,464
1993	0	1,964	1,831	1,272	180	68	5,314
1994	0	1,824	1,868	777	347	66	4,878
1995	0	2,472	3,073	1,139	277	81	7,017
1996	0	1,902	4,518	3,948	1,199	145	11,706
mean	0	2,500	2,968	1,436	528	237	7,667
min	0	629	543	245	63	18	2,299
max	0	5,748	8,933	5,531	2,509	1,372	21,368

Table 19. Summary of results from sensitivity ADAPT runs for Georges Bank yellowtail flounder.

Settings	run 275	run 277	run 279*	run 280
retransformed NEFSC S&F	Y	Y	N	N
92,93 age-1 in tuning	Y	N	Y	N
Diagnostics				
total sum of squares	824.48	816.68	820.57	811.31
residual sum of squares	249.45	245.05	233.70	228.65
~R squared	0.70	0.70	0.72	0.72
mean squared residuals	0.82	0.81	0.77	0.76
CV n2	0.54	0.54	0.53	0.53
CV n3	0.37	0.37	0.35	0.35
CV n4	0.34	0.34	0.32	0.32
CV n5	0.24	0.25	0.23	0.22
min CVq	0.19	0.19	0.18	0.18
max CVq	0.29	0.29	0.28	0.28
parameters correlated	0	0	0	0
residual series trended	Y	Y	Y	Y
standardized residuals >3	3	3	2	2
survey-years with year effect	18	18	18	18
max partial variance (%)	14	14	13	13
Results				
97 n2	5.959	5.667	5.882	5.552
97 n3	9.941	9.728	10.496	10.241
97 n4	9.765	9.678	10.620	10.522
97 n5	5.703	5.893	5.939	6.205
97 n6+	1.449	1.498	1.509	1.577
97 n2+	32.817	32.464	34.446	34.097
96 F1	0.0076	0.0080	0.0077	0.0081
96 F2	0.0343	0.0350	0.0325	0.0333
96 F3	0.1309	0.1320	0.1209	0.1220
96 F4+	0.1076	0.1043	0.1035	0.0993
96 mean Biomass	13.275	13.321	14.049	14.137
96 SSB	11.048	11.131	11.706	11.787

* accepted run.

Table 20. Stochastic short-term projections of spawning stock biomass (mt), recruitment (age 1, thousands) and landings (mt) for Georges Bank yellowtail flounder, assuming F=0.01 and F=0.25. Probability of SSB> the 10,000 mt threshold is given, along with the lower and upper quartiles and the median of bootstrap simulations.

F_{96}=0.10

	- Spawning Biomass -				- Recruitment -			- Landings -		
Year	L-25	Median	U-75	Probability	L-25	Median	U-75	L-25	Median	U-75
1997	12,026	13,344	14,796	1.000	8,620	19,371	23,038	1,038	1,174	1,333
1998	14,663	16,048	17,648	1.000	8,620	21,627	23,375	1,269	1,401	1,564
1999	17,162	18,937	21,206	1.000	8,620	19,371	23,038	1,465	1,595	1,777

$F_{0.1}$=0.25

	- Spawning Biomass -				- Recruitment -			- Landings -		
Year	L-25	Median	U-75	Probability	L-25	Median	U-75	L-25	Median	U-75
1997	11,442	12,665	14,061	1.000	8,620	19,371	23,038	2,339	2,655	3,014
1998	12,577	13,826	15,189	1.000	8,620	21,627	23,375	2,544	2,812	3,132
1999	13,771	15,190	17,136	1.000	8,620	19,371	23,038	2,706	2,939	3,255

Table 21. Stochastic medium-term projections of spawning stock biomass (mt), recruitment (age 1, thousands) and landings (mt) for Georges Bank yellowtail flounder, assuming F=0.10. Probability of SSB> the 10,000 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	13,732	15,383	17,315	1.000	19,074	29,238	44,109	1,000	1,131	1,284
1998	15,926	17,491	19,395	1.000	20,506	31,144	47,332	1,227	1,356	1,513
1999	19,464	21,488	23,872	1.000	22,627	34,497	52,805	1,429	1,559	1,736
2000	23,848	27,212	31,606	1.000	25,170	37,692	57,209	1,739	1,944	2,191
2001	28,896	33,985	40,328	1.000	27,913	40,836	61,704	2,098	2,432	2,862
2002	34,936	41,516	49,632	1.000	31,218	44,559	65,978	2,576	3,041	3,613
2003	41,181	49,263	59,220	1.000	34,652	48,691	71,824	3,092	3,693	4,441
2004	47,258	56,735	68,378	1.000	37,896	52,390	75,554	3,592	4,315	5,202
2005	53,424	64,214	77,259	1.000	41,254	56,125	80,094	4,087	4,919	5,932
2006	59,583	71,637	86,078	1.000	44,489	59,775	84,021	4,595	5,539	6,654

Table 22. Stochastic medium-term projections of spawning stock biomass (mt), recruitment (age 1, thousands) and landings (mt) for Georges Bank yellowtail flounder, assuming F=0.25. Probability of SSB> the 10,000 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	13,016	14,621	16,428	1.000	18,570	28,649	43,613	2,339	2,655	3,014
1998	13,641	14,930	16,616	1.000	18,977	29,069	43,884	2,546	2,815	3,136
1999	15,712	17,362	19,341	1.000	20,460	31,061	47,403	2,730	2,970	3,295
2000	18,452	21,417	25,274	1.000	22,422	34,336	52,408	3,179	3,574	4,097
2001	21,602	25,929	31,188	1.000	24,680	37,033	56,303	3,698	4,385	5,252
2002	25,168	30,260	36,722	1.000	26,562	39,007	59,149	4,373	5,258	6,335
2003	28,588	34,707	42,272	1.000	28,539	41,798	62,702	5,065	6,118	7,445
2004	31,914	38,819	47,409	1.000	29,973	43,315	64,511	5,674	6,910	8,440
2005	34,969	42,746	52,037	1.000	31,966	45,367	67,721	6,295	7,661	9,366
2006	37,915	46,230	56,207	1.000	33,324	47,190	69,570	6,860	8,385	10,206

Table 23. Estimates of instantaneous fishing mortality (mean F_{age-1+}) and mean biomass (mt) for Georges Bank yellowtail flounder derived from biomass dynamics analysis calibrated using the ASPIC procedure, 1963-1996.

Year	F	Biomass
1963	0.215	51,690
1964	0.300	49,720
1965	0.322	46,520
1966	0.255	45,460
1967	0.209	46,880
1968	0.314	46,510
1969	0.434	42,190
1970	0.417	37,920
1971	0.338	36,680
1972	0.471	34,850
1973	0.525	31,030
1974	0.576	27,140
1975	0.713	22,470
1976	0.845	17,040
1977	0.760	13,140
1978	0.514	12,230
1979	0.476	13,120
1980	0.488	14,120
1981	0.403	15,610
1982	0.831	14,460
1983	1.229	9,256
1984	1.097	5,313
1985	0.596	4,274
1986	0.718	4,204
1987	0.776	3,790
1988	0.593	3,645
1989	0.258	4,557
1990	0.662	5,383
1991	0.343	6,125
1992	0.712	6,695
1993	0.625	6,379
1994	0.604	6,423
1995	0.094	8,469
1996	0.095	13,740
mean	0.569	16,095
min	0.094	3,645
max	1.229	46,510

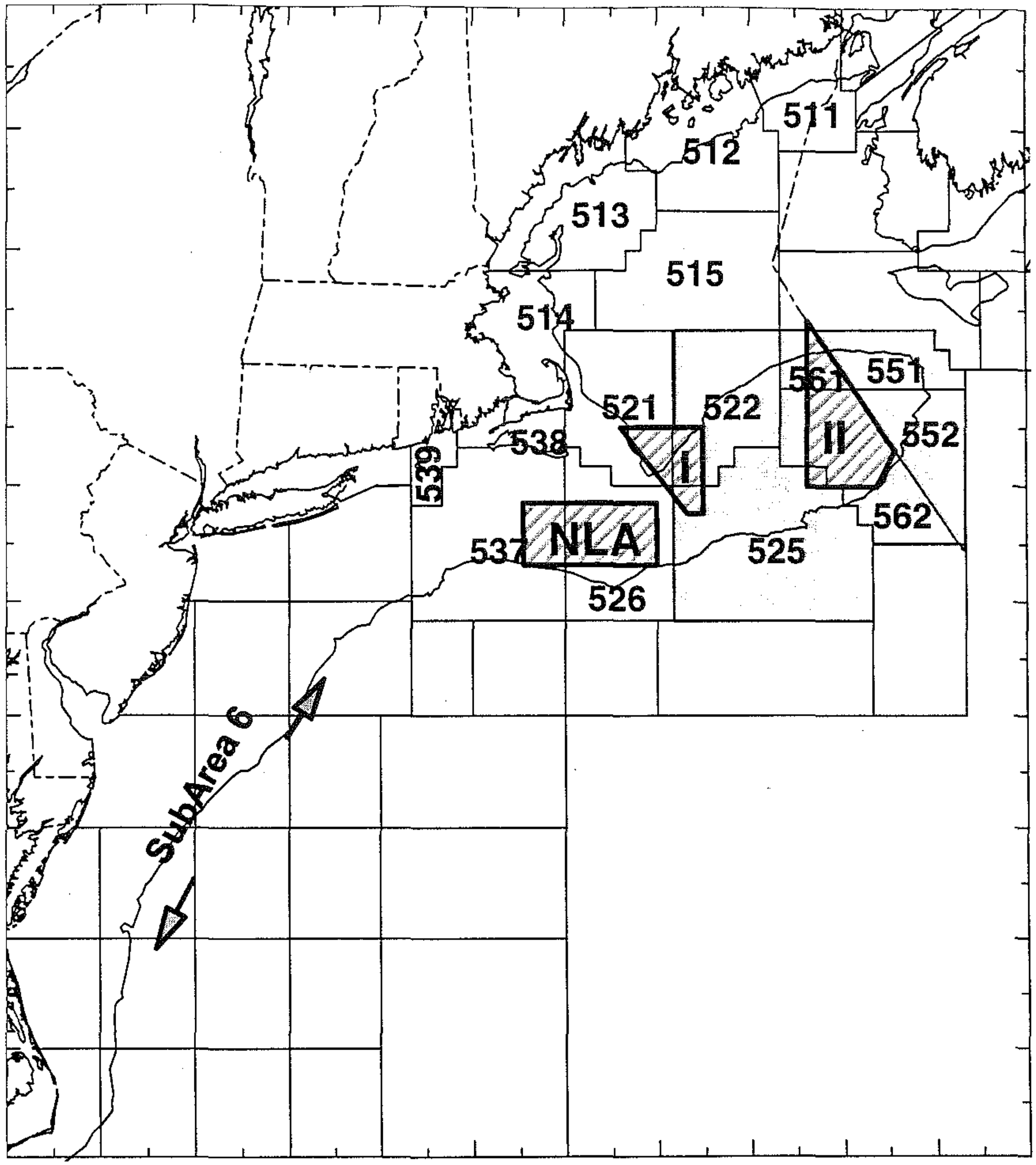


Figure 1. Statistical reporting areas for Georges Bank yellowtail flounder. Catches from shaded areas are included in the analyses. Areas I, II, and the Nantucket lightship area are closed to fishing.

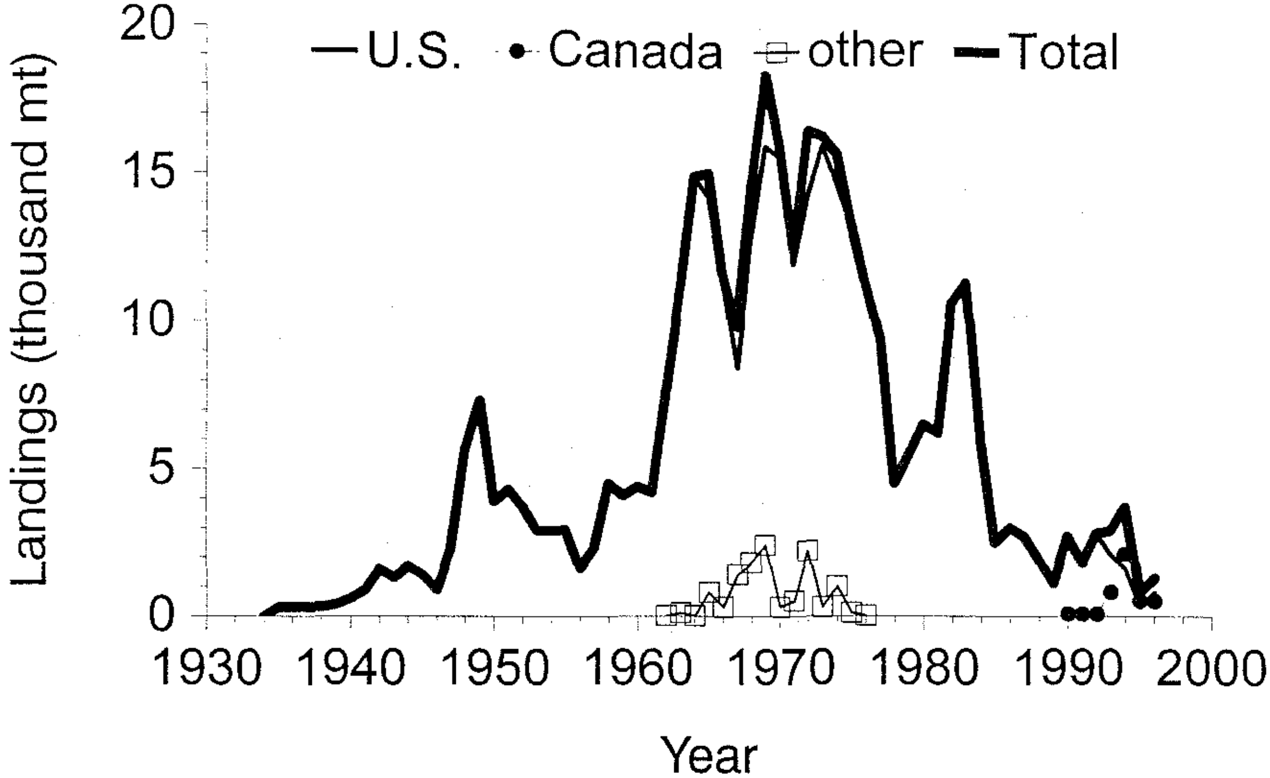


Figure 2. Landings of Georges Bank yellowtail flounder.

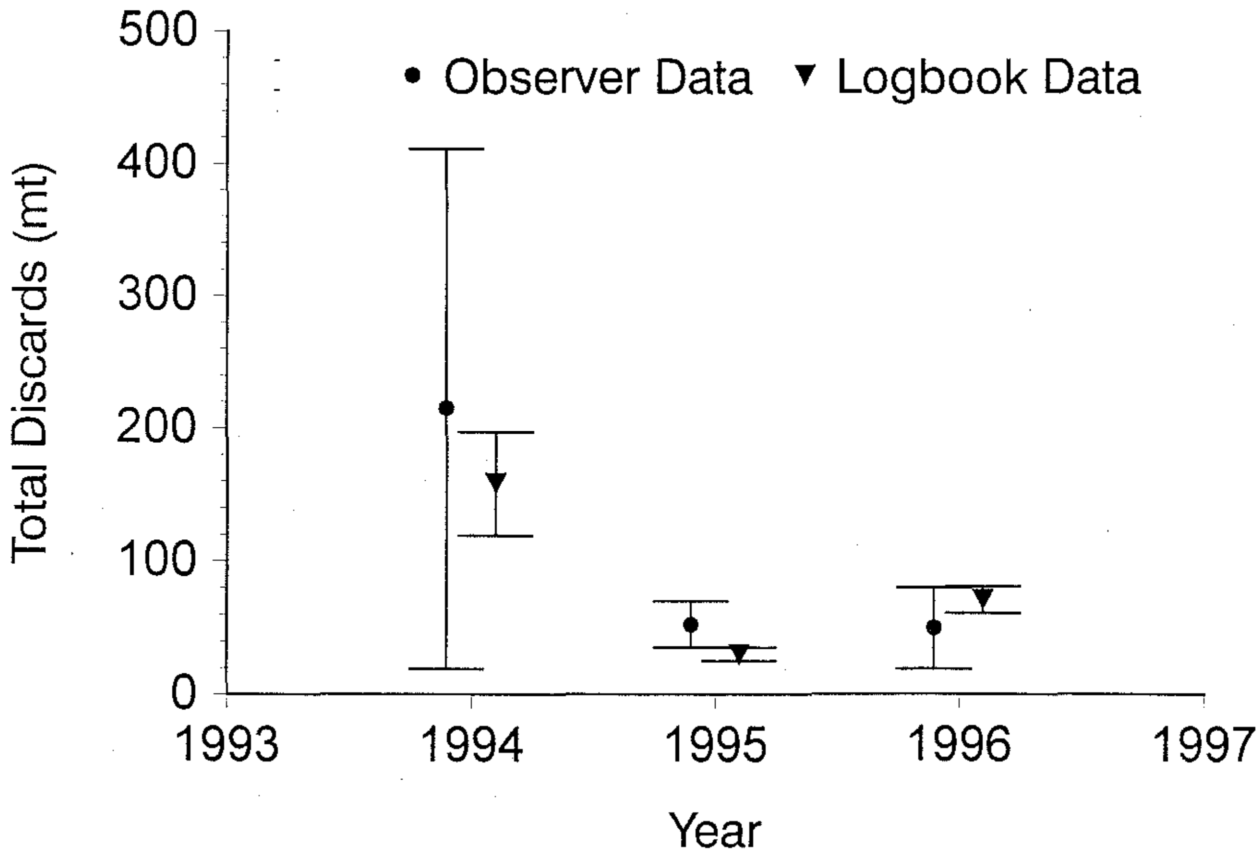


Figure 3. Estimates of total discards (above) and discard ratios (below) for Georges Bank yellowtail flounder with 95% confidence intervals.

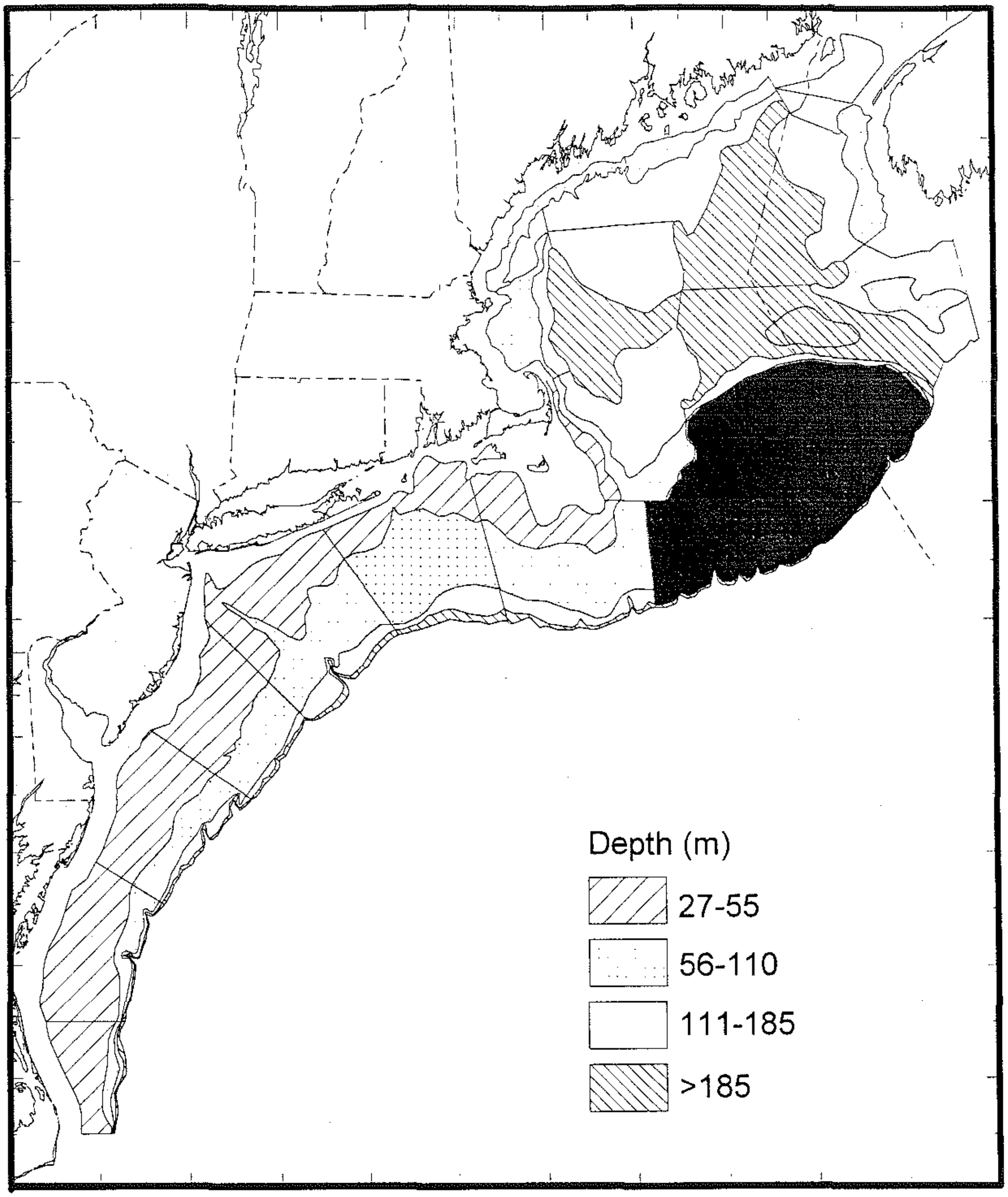


Figure 4. NEFSC groundfish survey strata. Strata 13-21 (shaded) are included in the Georges Bank yellowtail flounder assessment.

Figure 5. NEFSC scallop survey strata. Shaded strata (54, 55, 58-72, 74) are included in the Georges Bank yellowtail flounder assessment.

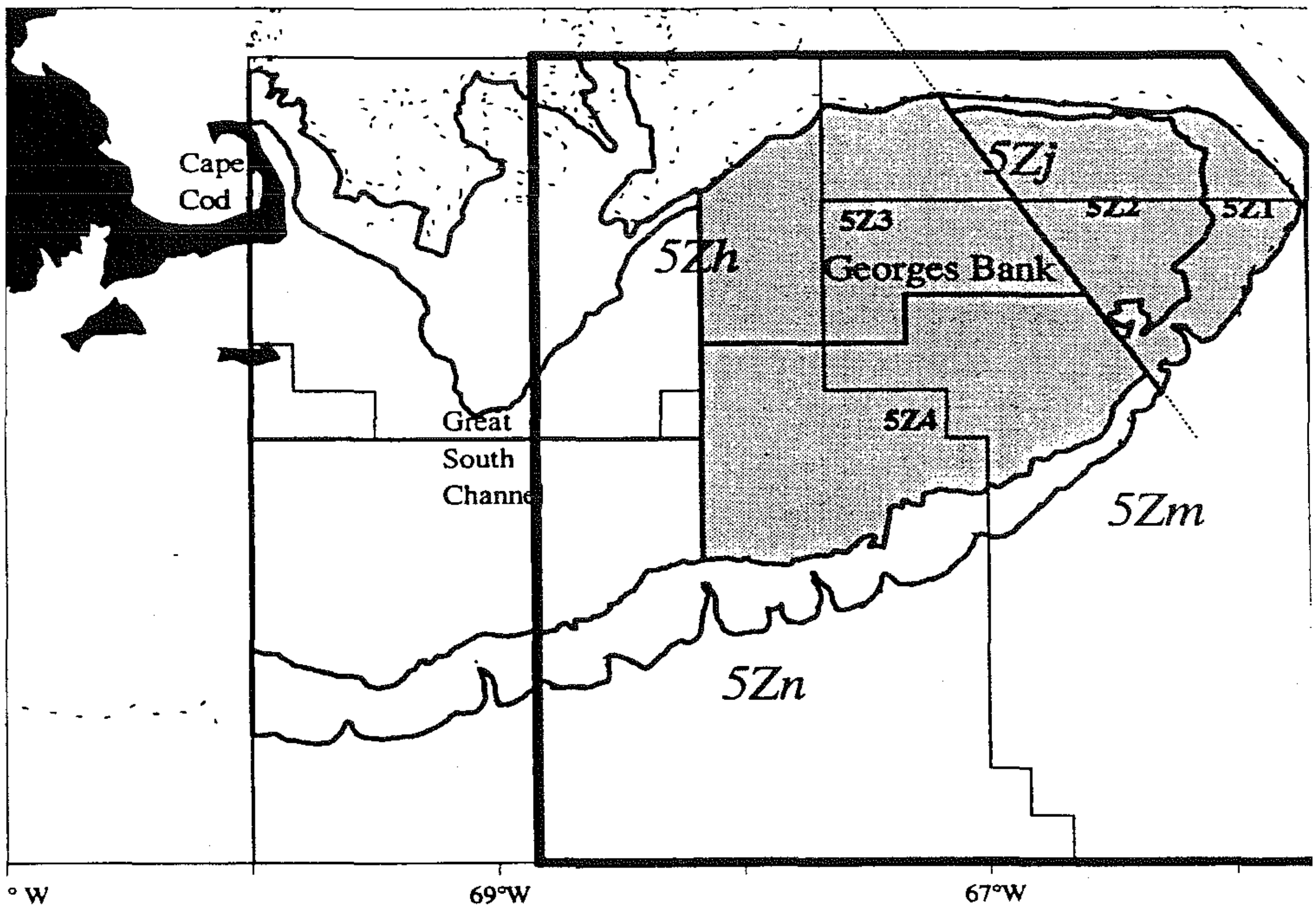
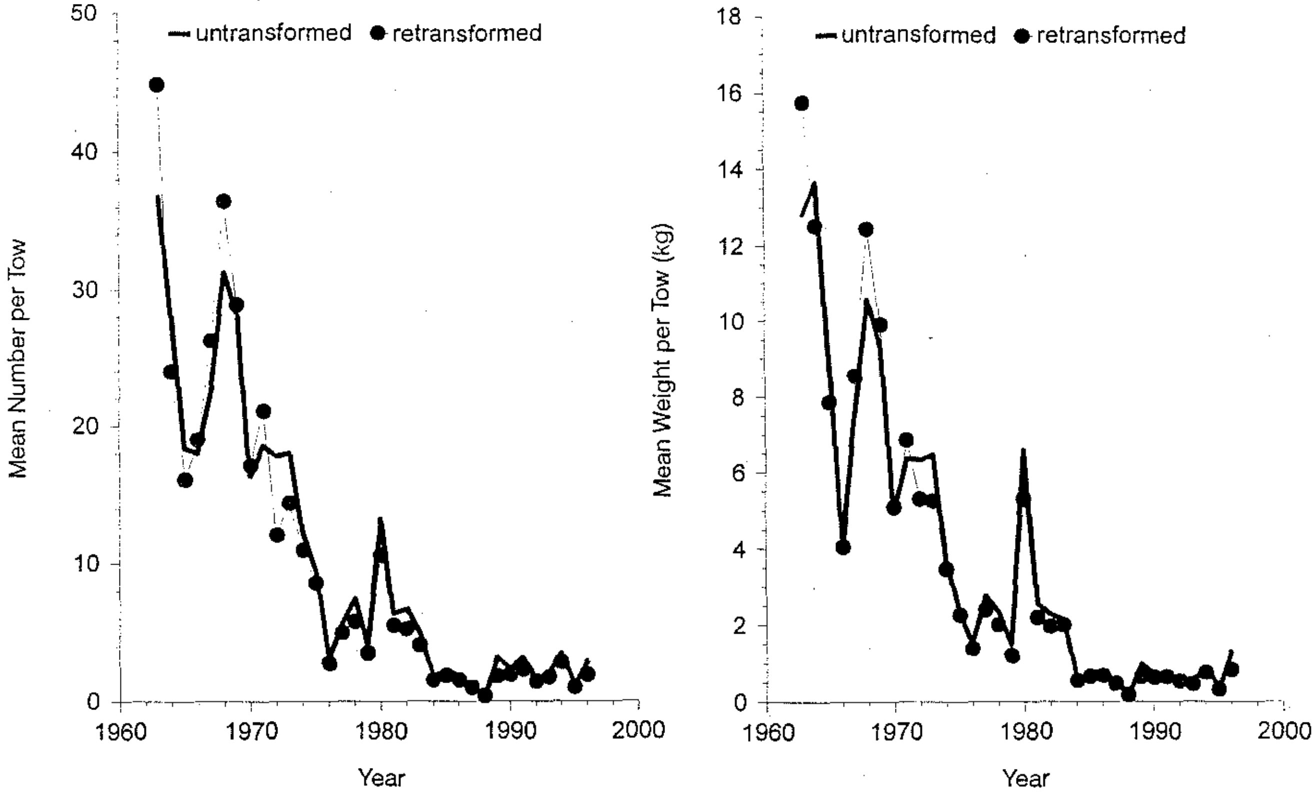


Figure 6.. Canada DFO groundfish survey strata. Shaded strata are included in the Georges Bank yellowtail flounder assessment (from Gavaris et al. 1996).

Fall Survey



Spring Survey

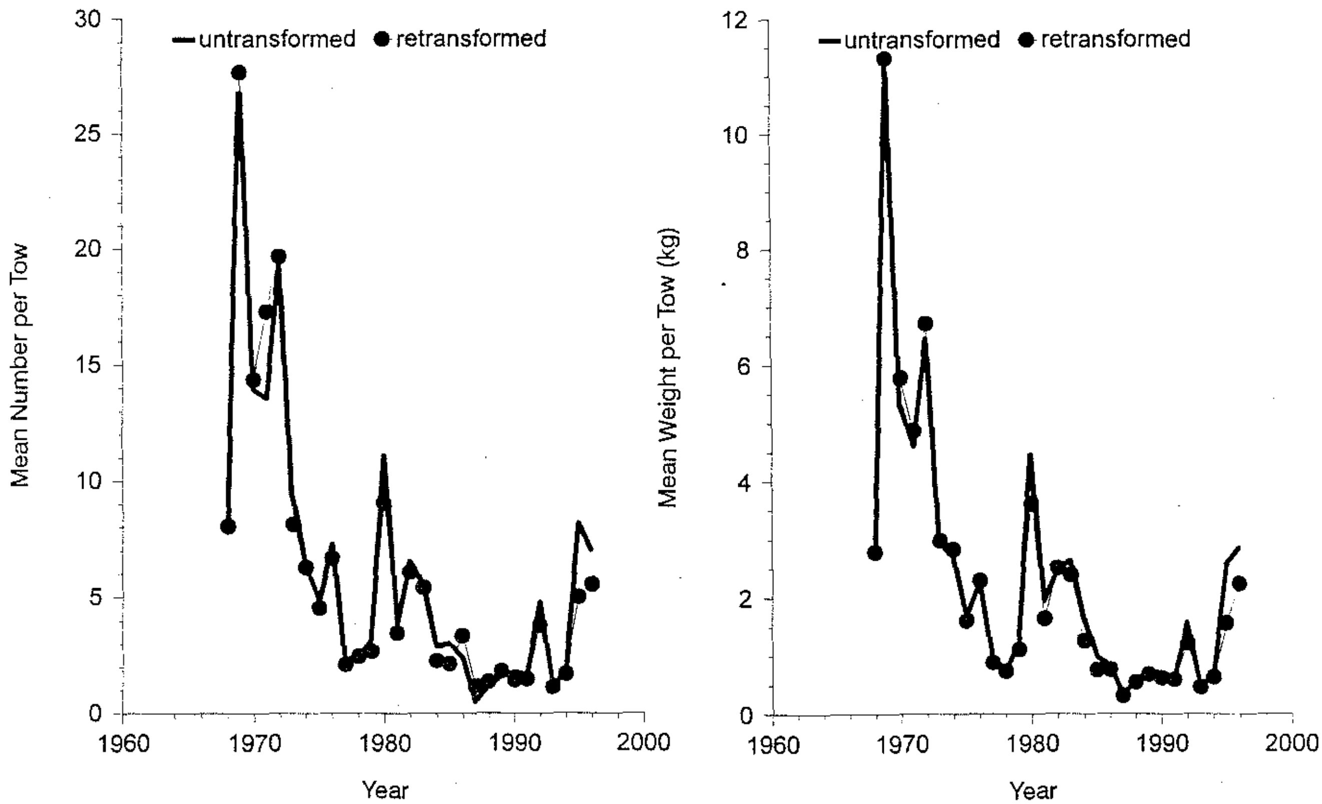


Figure 7. NEFSC spring and fall survey catches of Georges Bank yellowtail flounder.

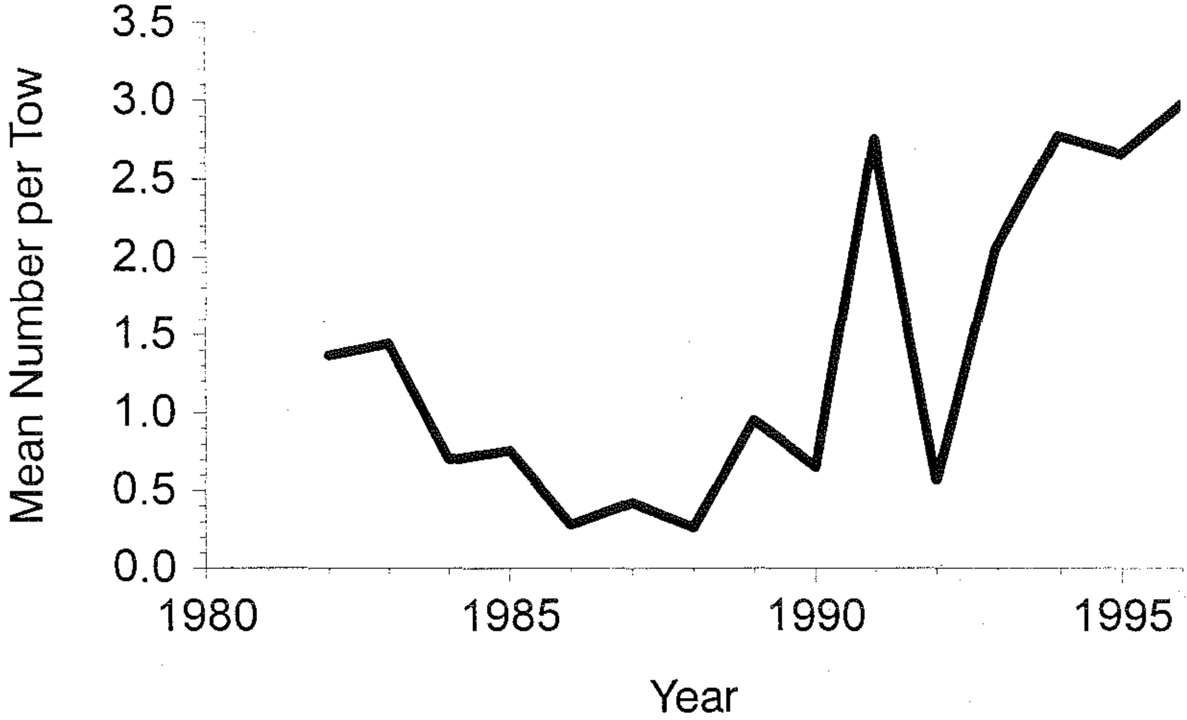


Figure 8. NEFSC scallop survey catches of Georges Bank yellowtail flounder.

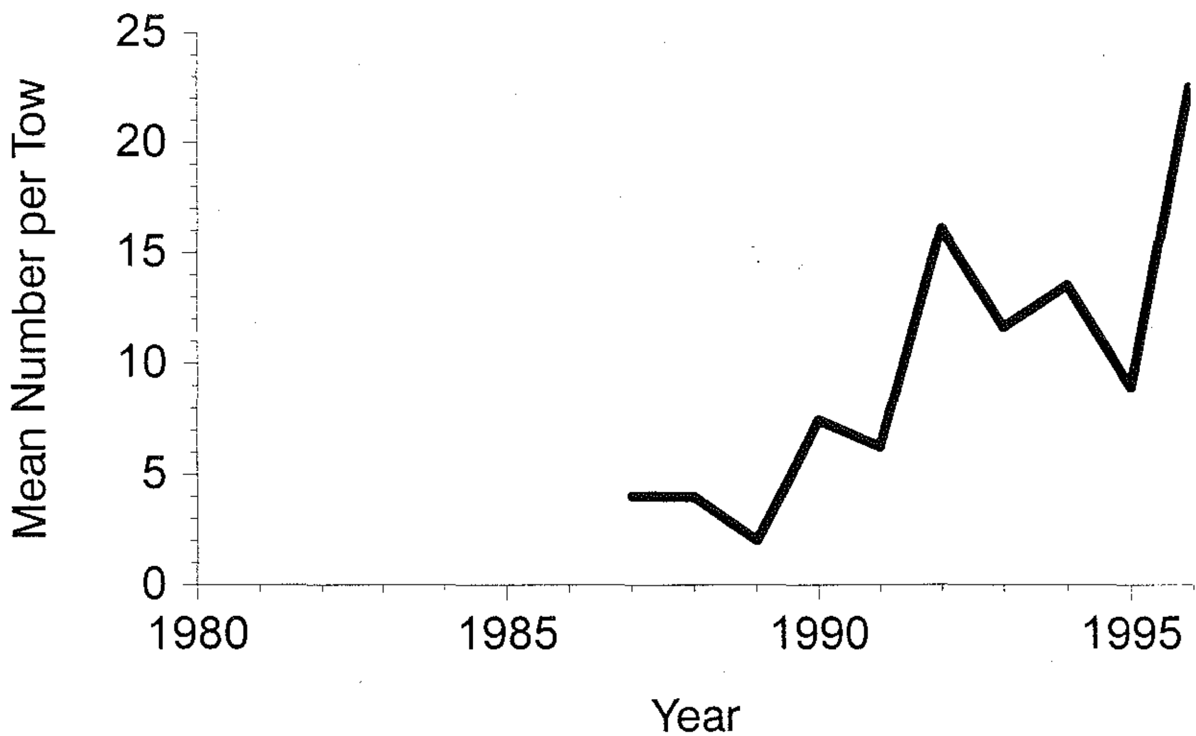


Figure 9. Canadian trawl survey catches of Georges Bank yellowtail flounder.

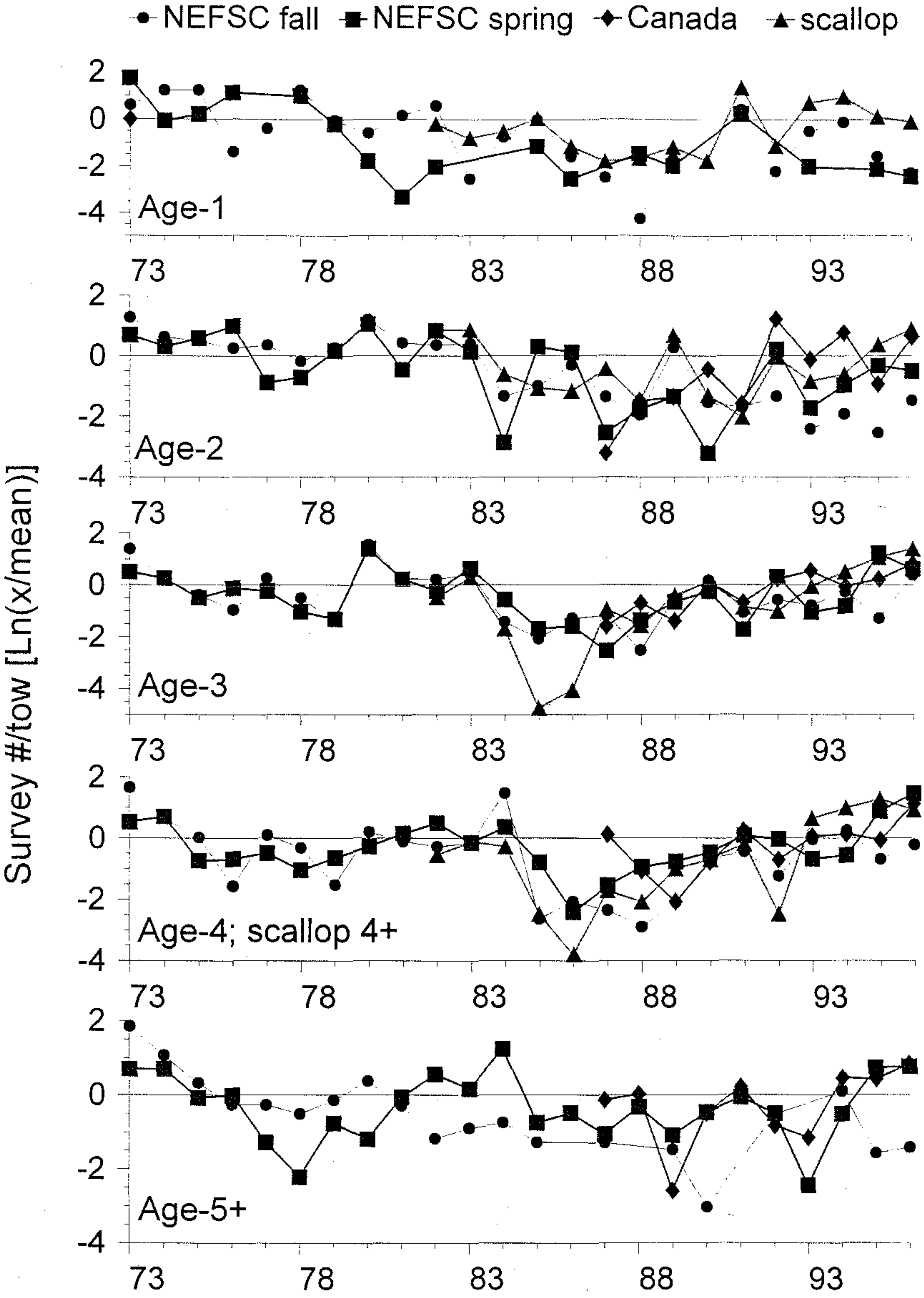


Figure 10. Survey indices of abundance for Georges Bank yellowtail flounder by age.

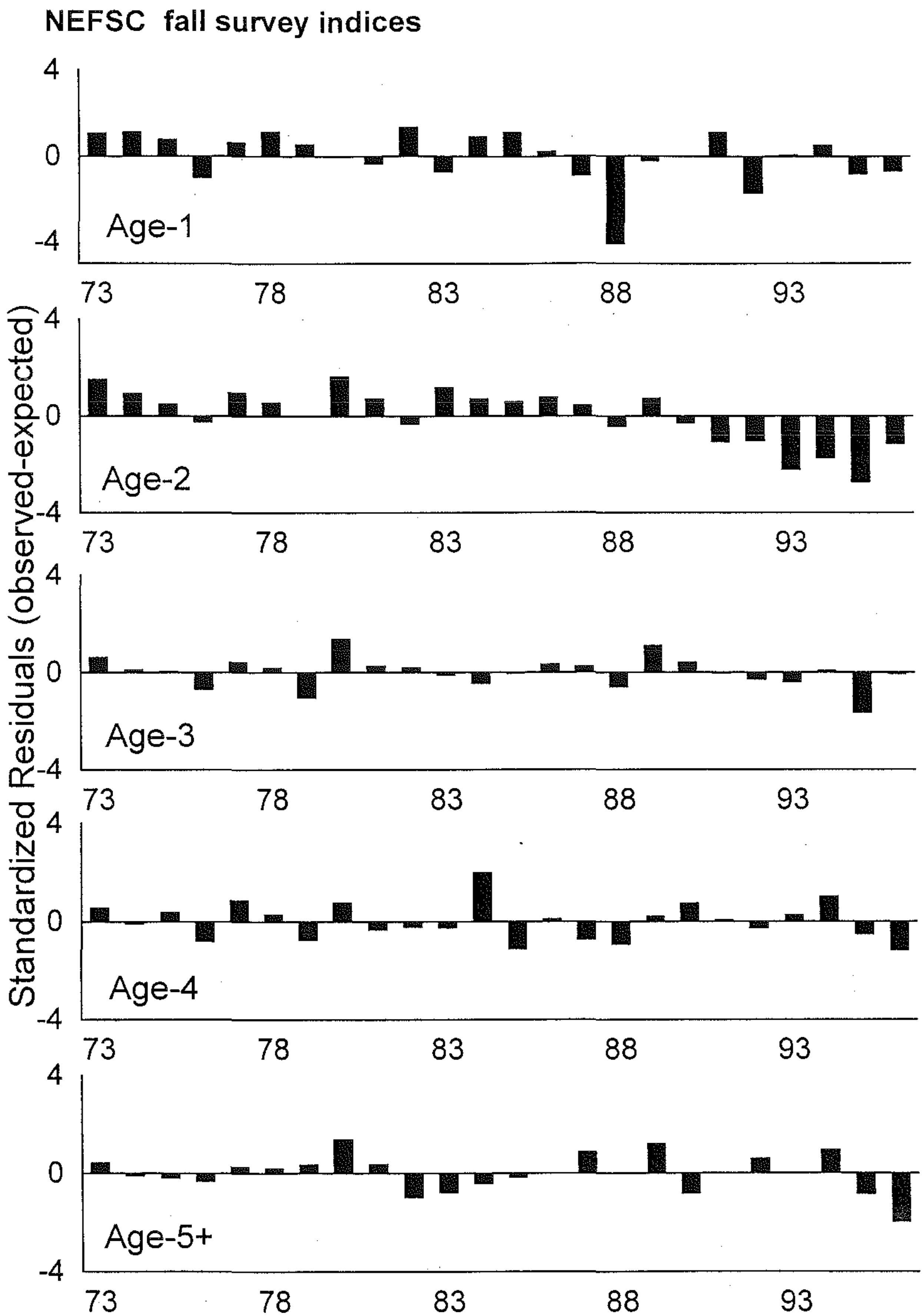


Figure 11a. ADAPT residuals for VPA calibration of Georges Bank yellowtail flounder.

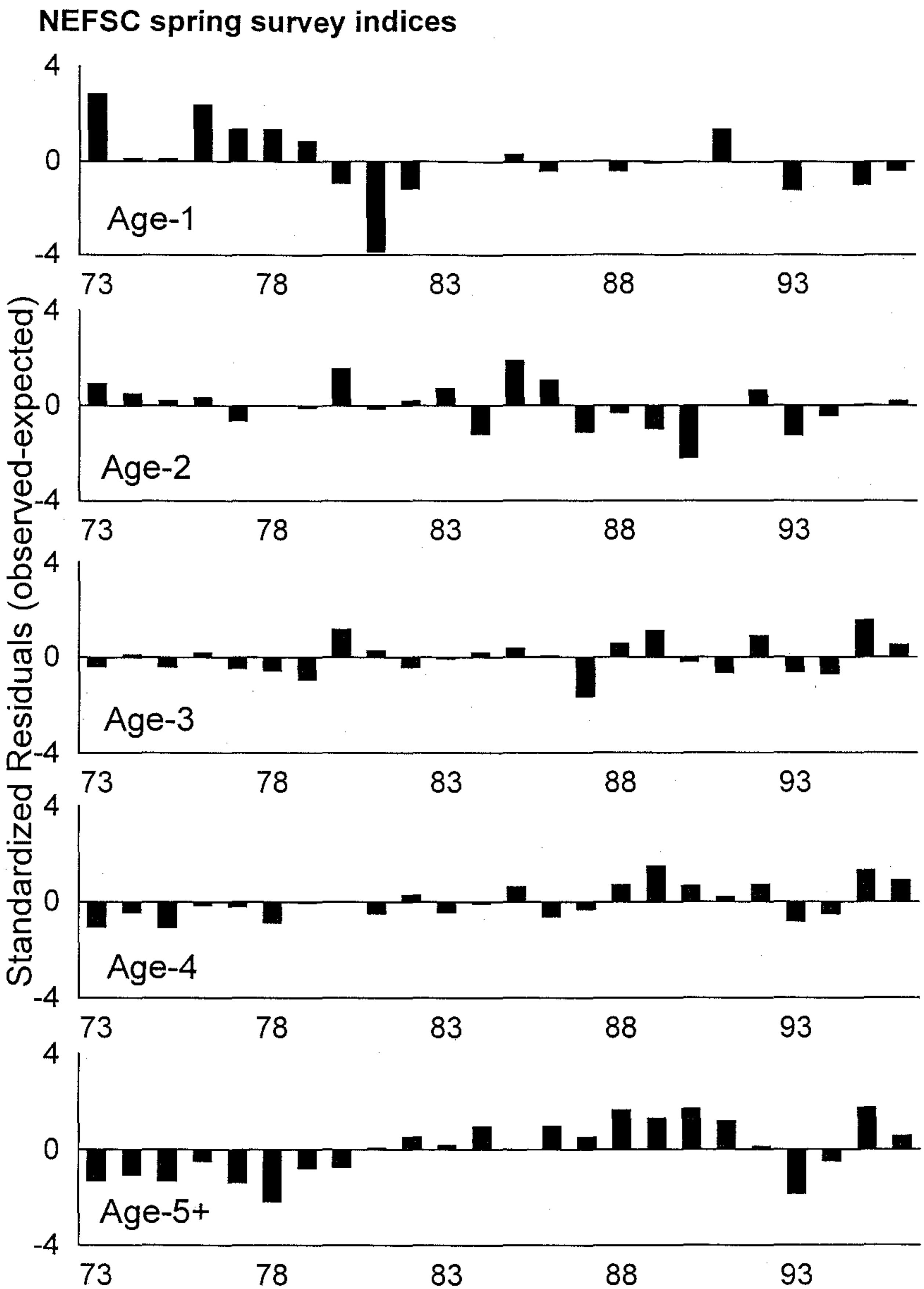


Figure 11b. ADAPT residuals for VPA calibration of Georges Bank yellowtail flounder.

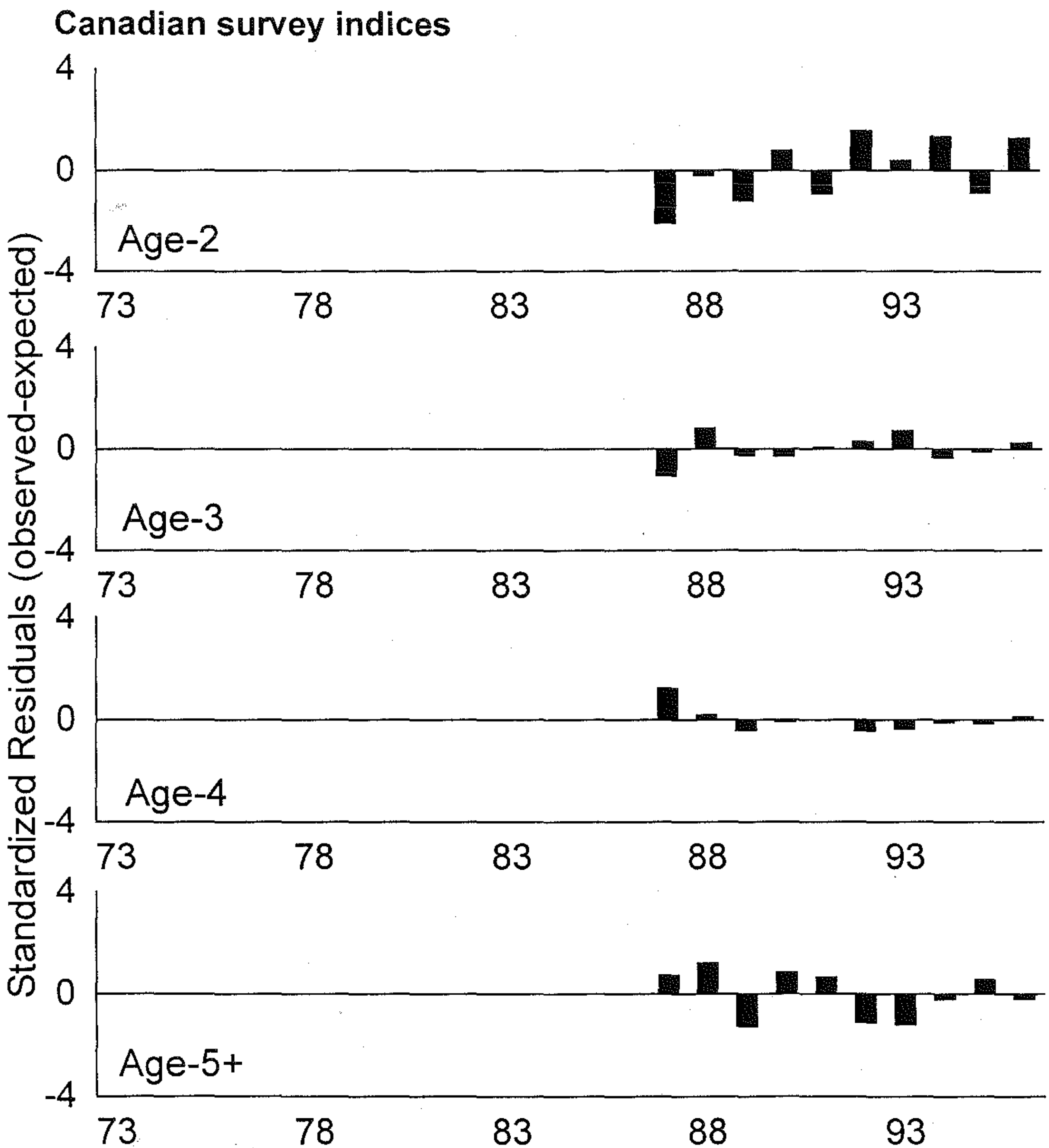


Figure 11c. ADAPT residuals for VPA calibration of Georges Bank yellowtail flounder.

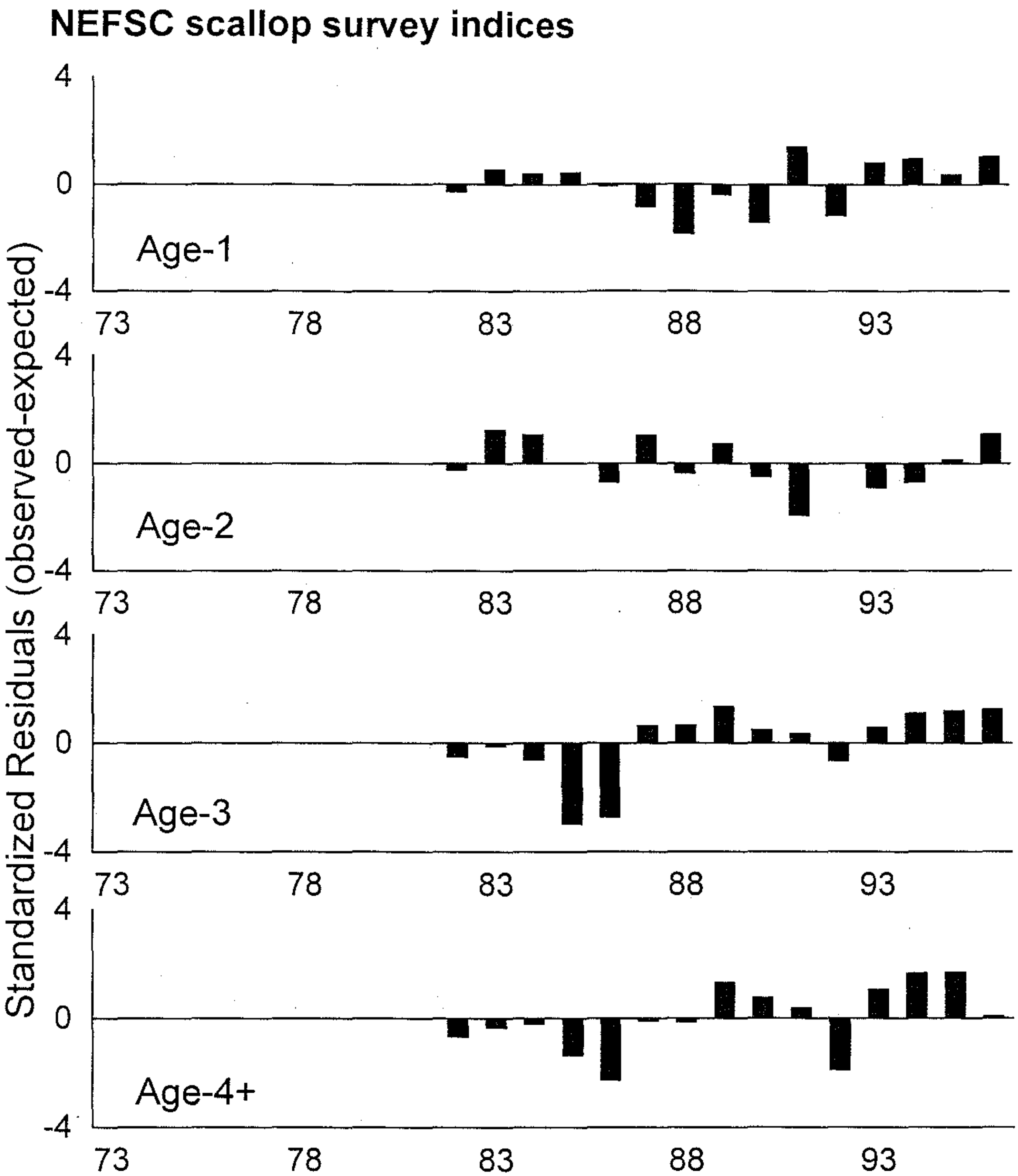


Figure 11d. ADAPT residuals for VPA calibration of Georges Bank yellowtail flounder.

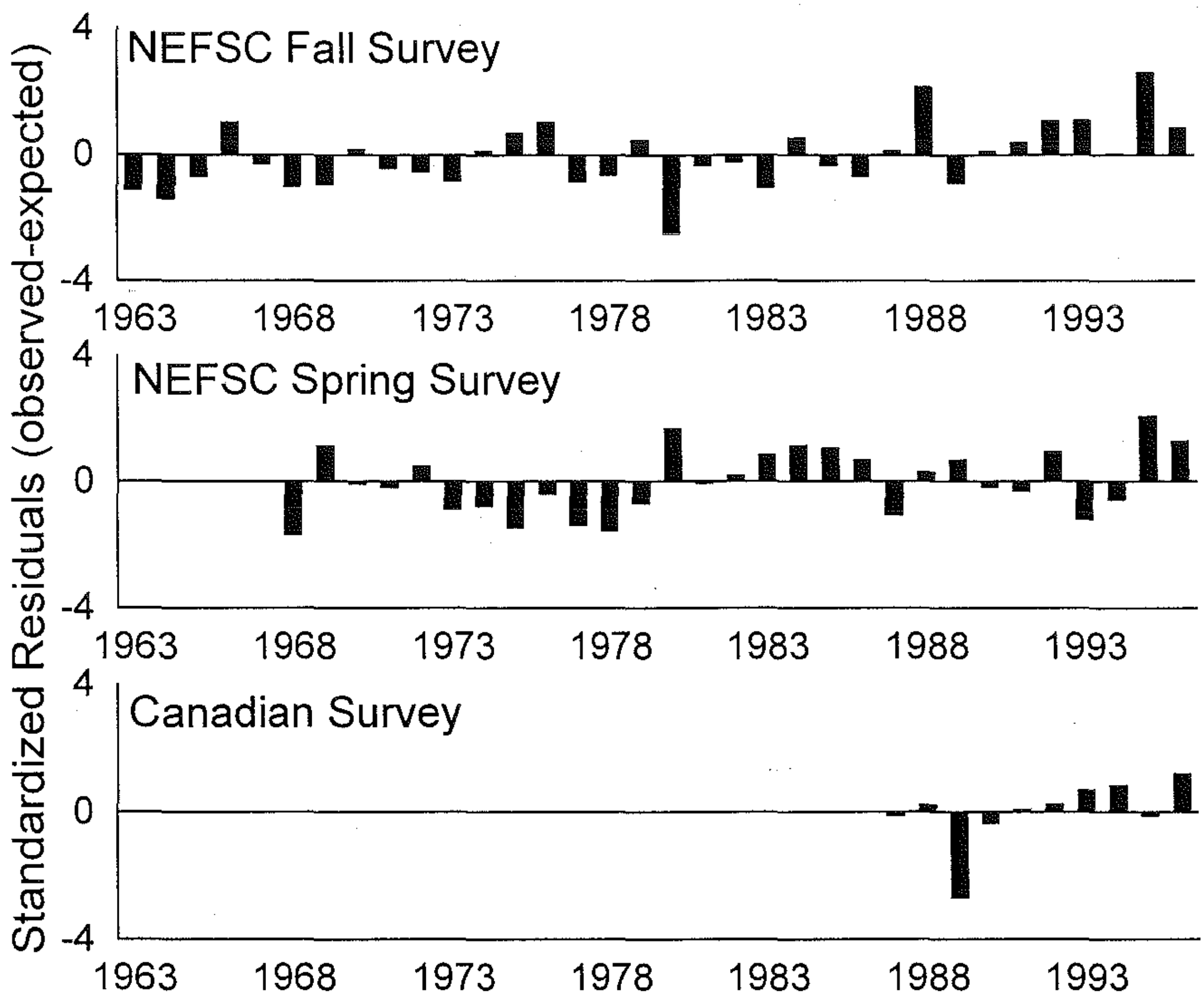


Figure 12. ASPIC residuals for production model calibration of Georges Bank yellowtail flounder.

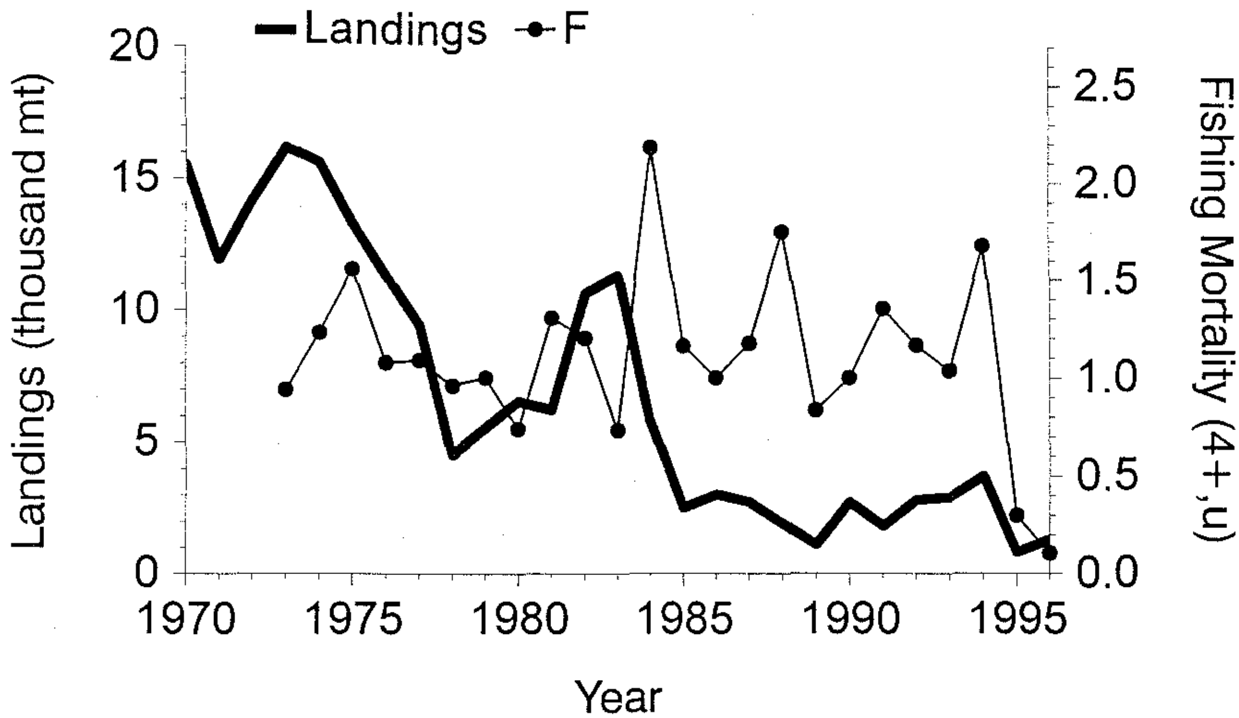


Figure 13. Instantaneous rate of fishing mortality (F[4+,u]) and total landings of Georges Bank yellowtail flounder.

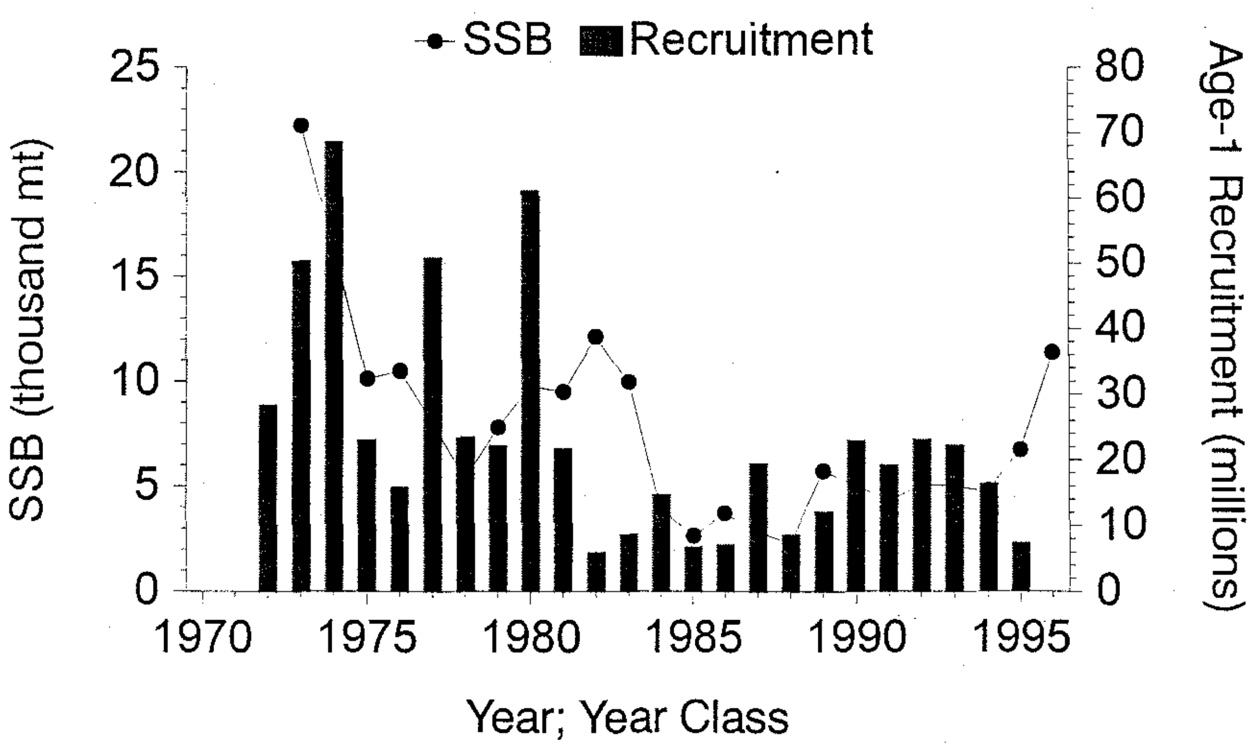


Figure 14. Spawning stock biomass and age-1 recruitment of Georges Bank yellowtail flounder.

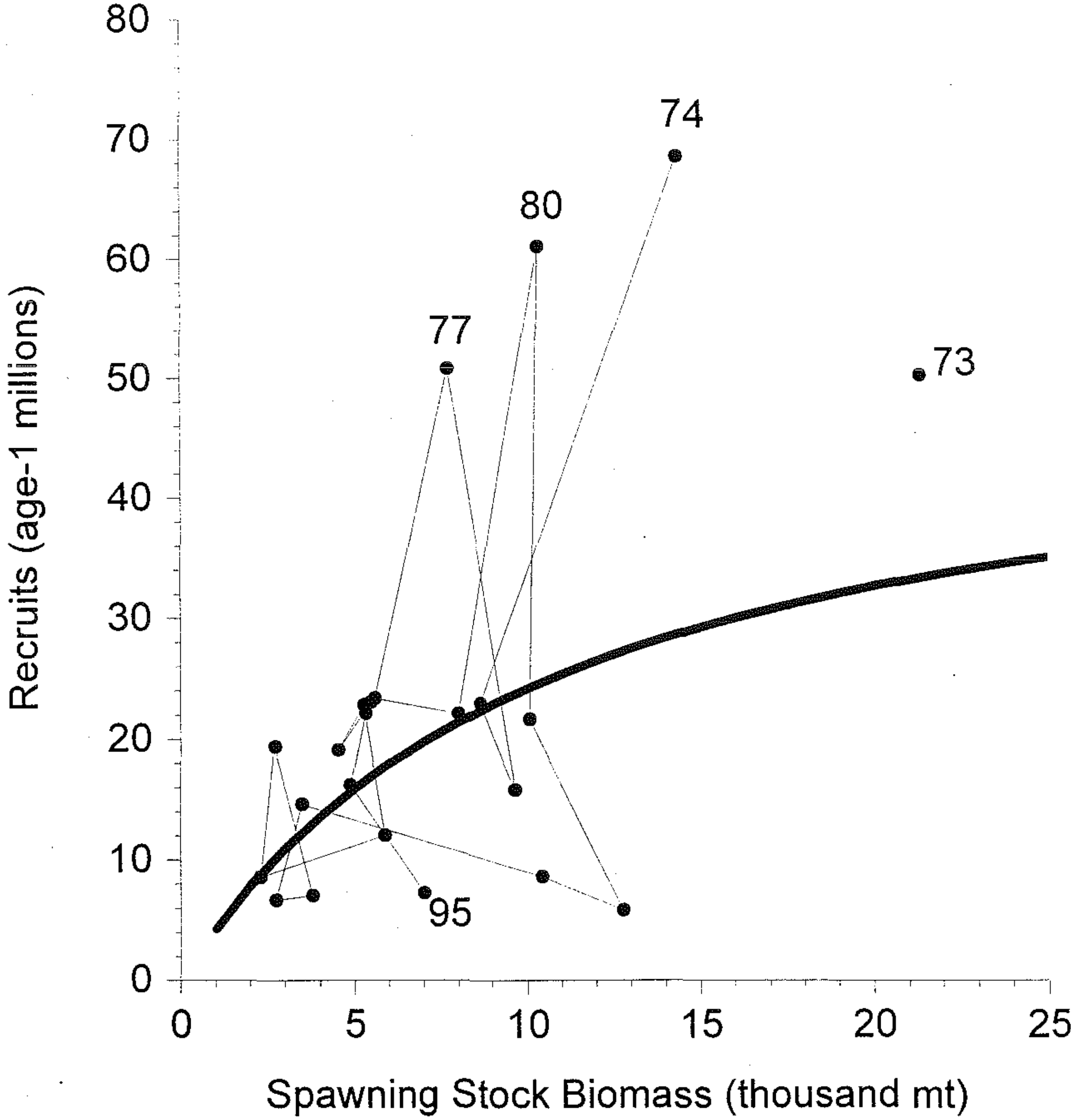


Figure 15. Spawning stock-recruitment relationship for Georges Bank yellowtail flounder. Data labels indicate year-class. Fitted Beverton-Holt relationship from Overholtz et al. 1997: R=50090xSSB/(10737+SSB).

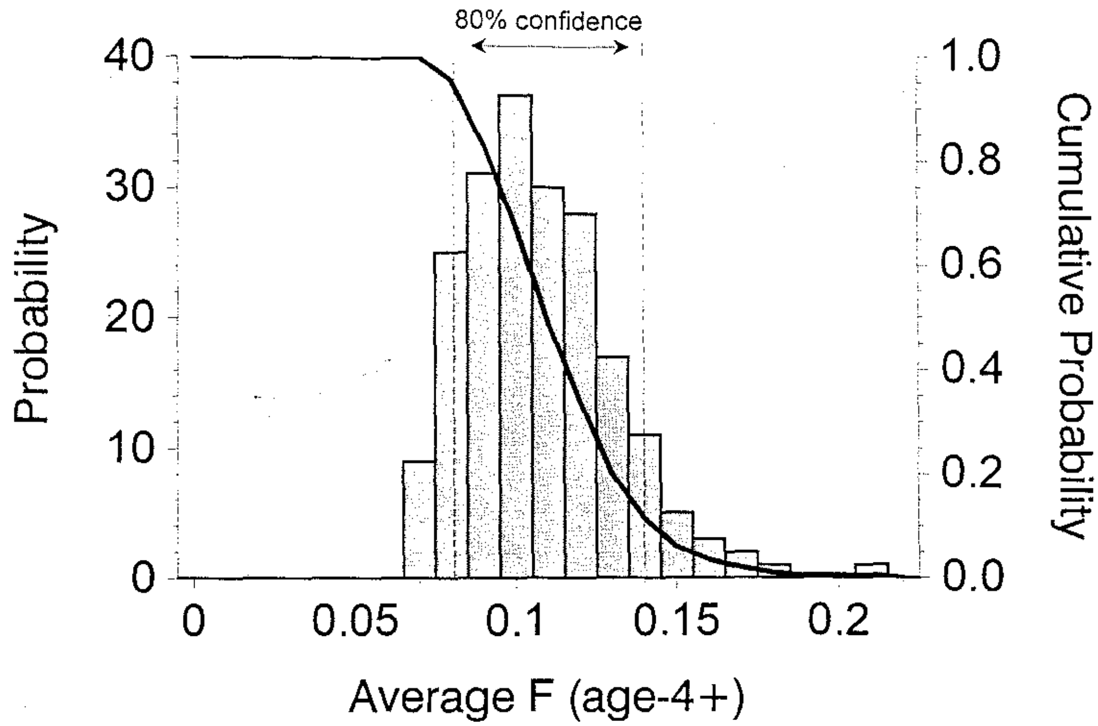


Figure 16. Distribution of bootstrap estimates of instantaneous fishing mortality for Georges Bank yellowtail flounder in 1996.

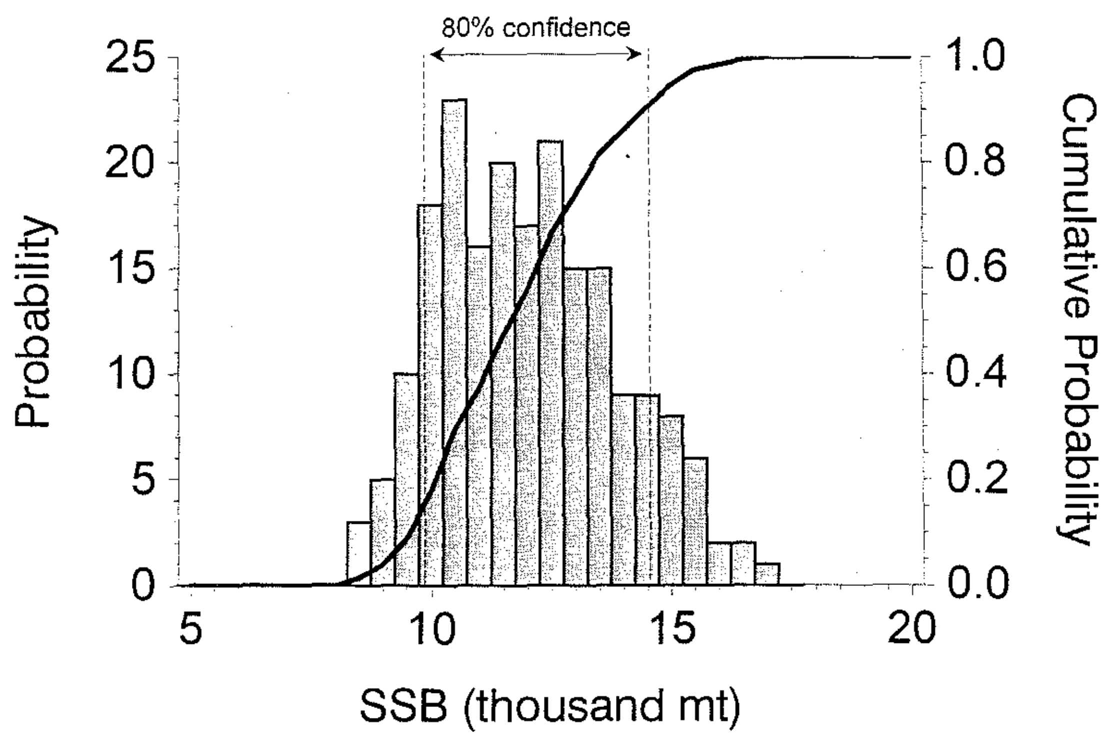


Figure 17. Distribution of bootstrap estimates of spawning stock biomass of Georges Bank yellowtail flounder in 1996.

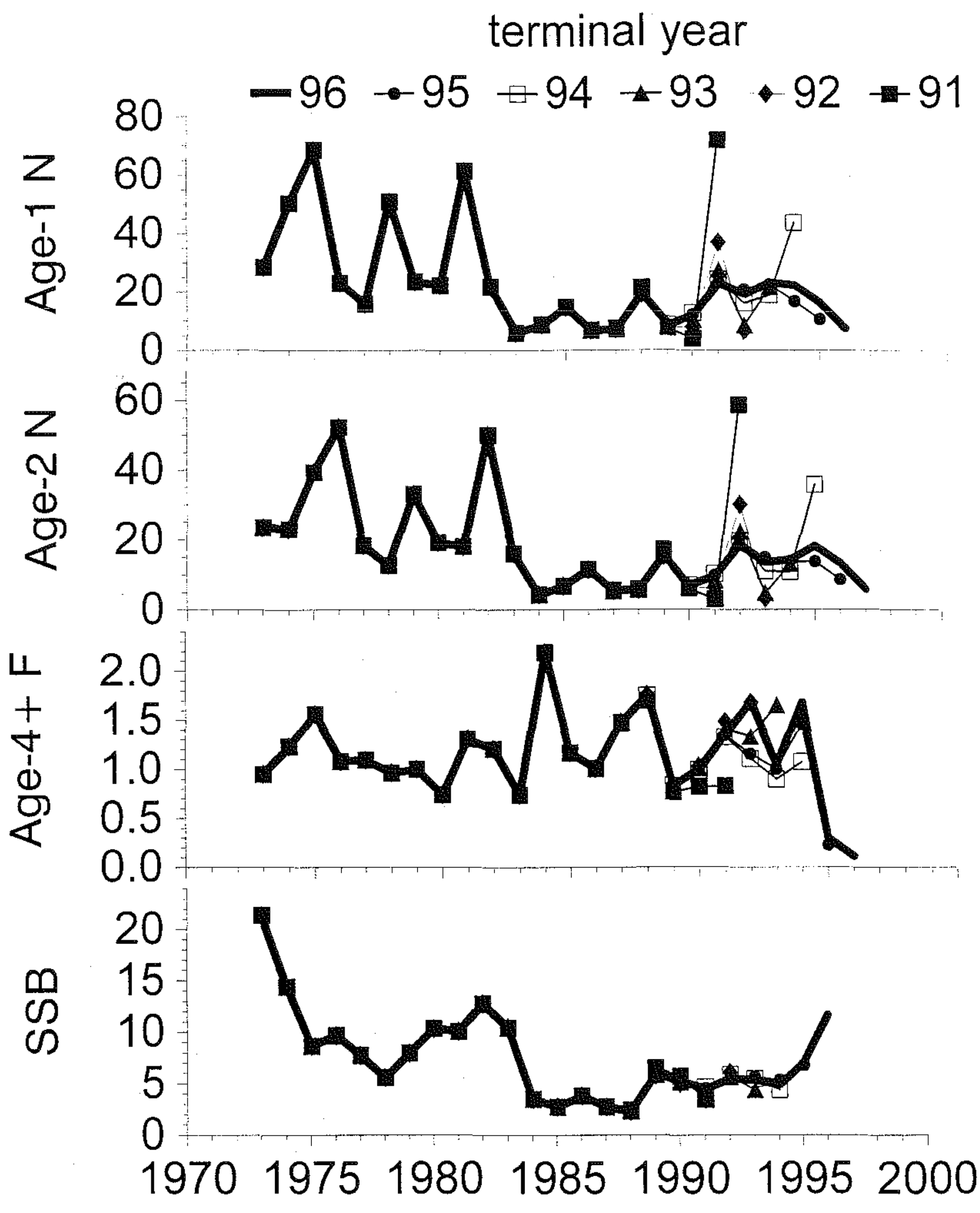


Figure 18. Retrospective analysis of VPA estimates of age-1 abundance, age-2 abundance (millions), fully-recruited F and SSB (thousand mt) of Georges Bank yellowtail flounder.

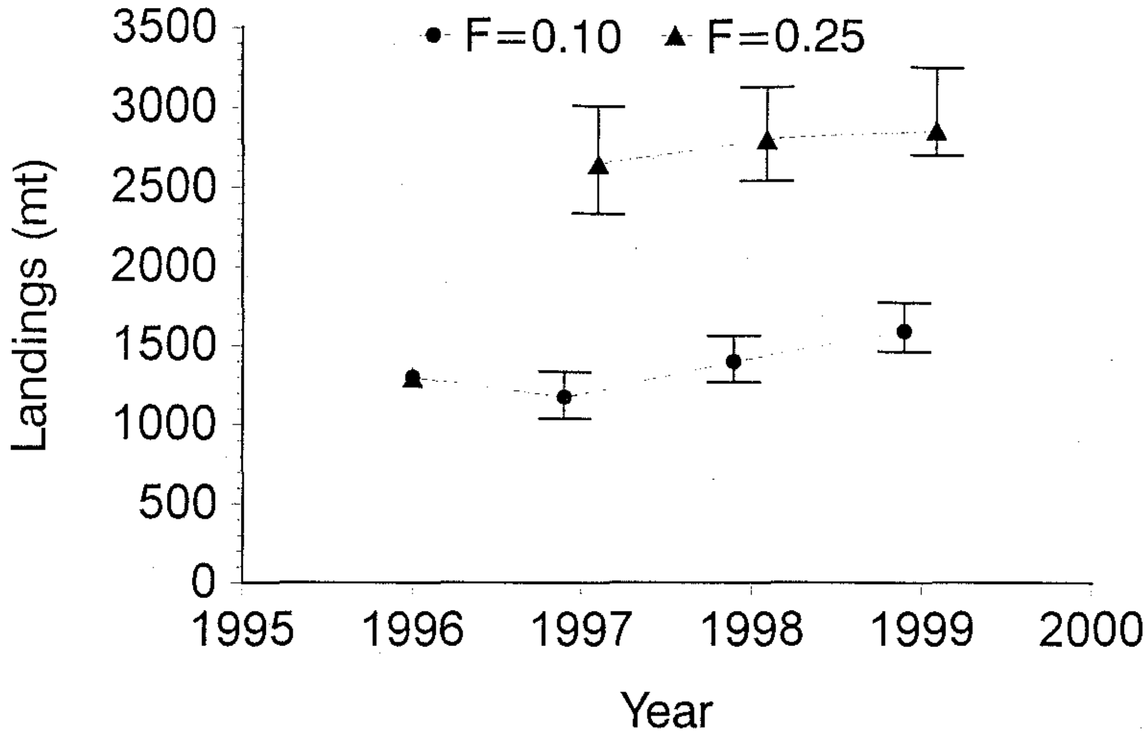


Figure 19. Stochastic short-term projections and interquartile range of Georges Bank yellowtail flounder landings at status quo F (F96) and F0.1.

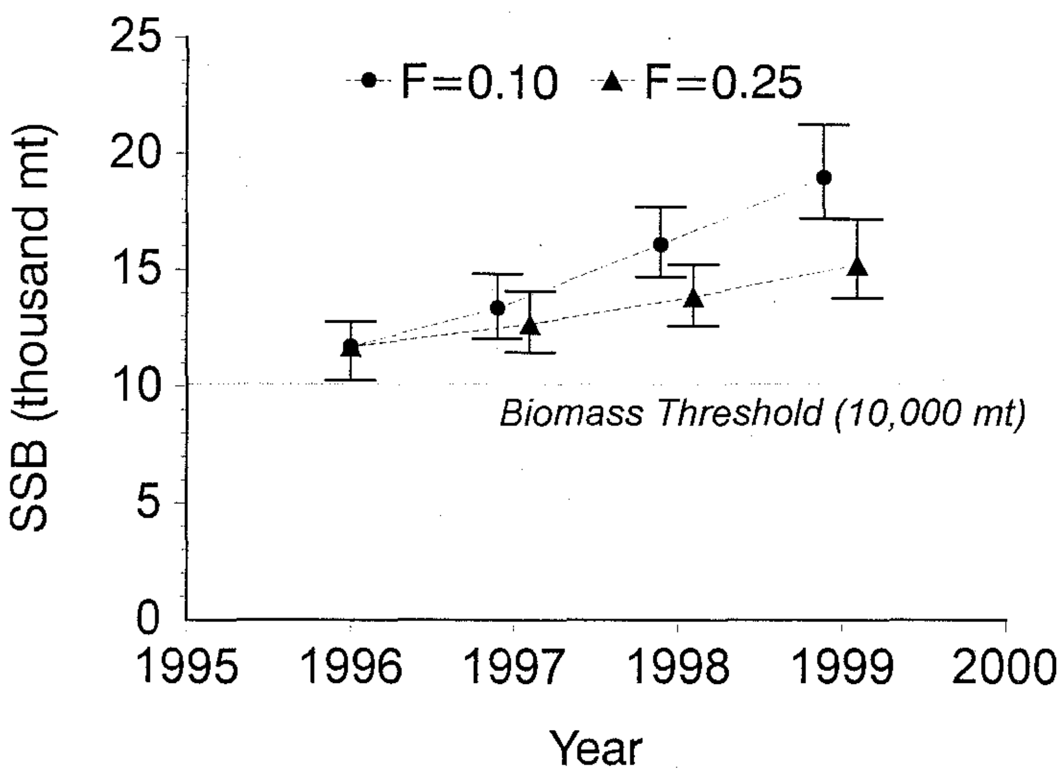


Figure 20. Stochastic short-term projections and interquartile range of Georges Bank yellowtail flounder spawning stock biomass at status quo F (F96=0.10) and F0.1(0.25).

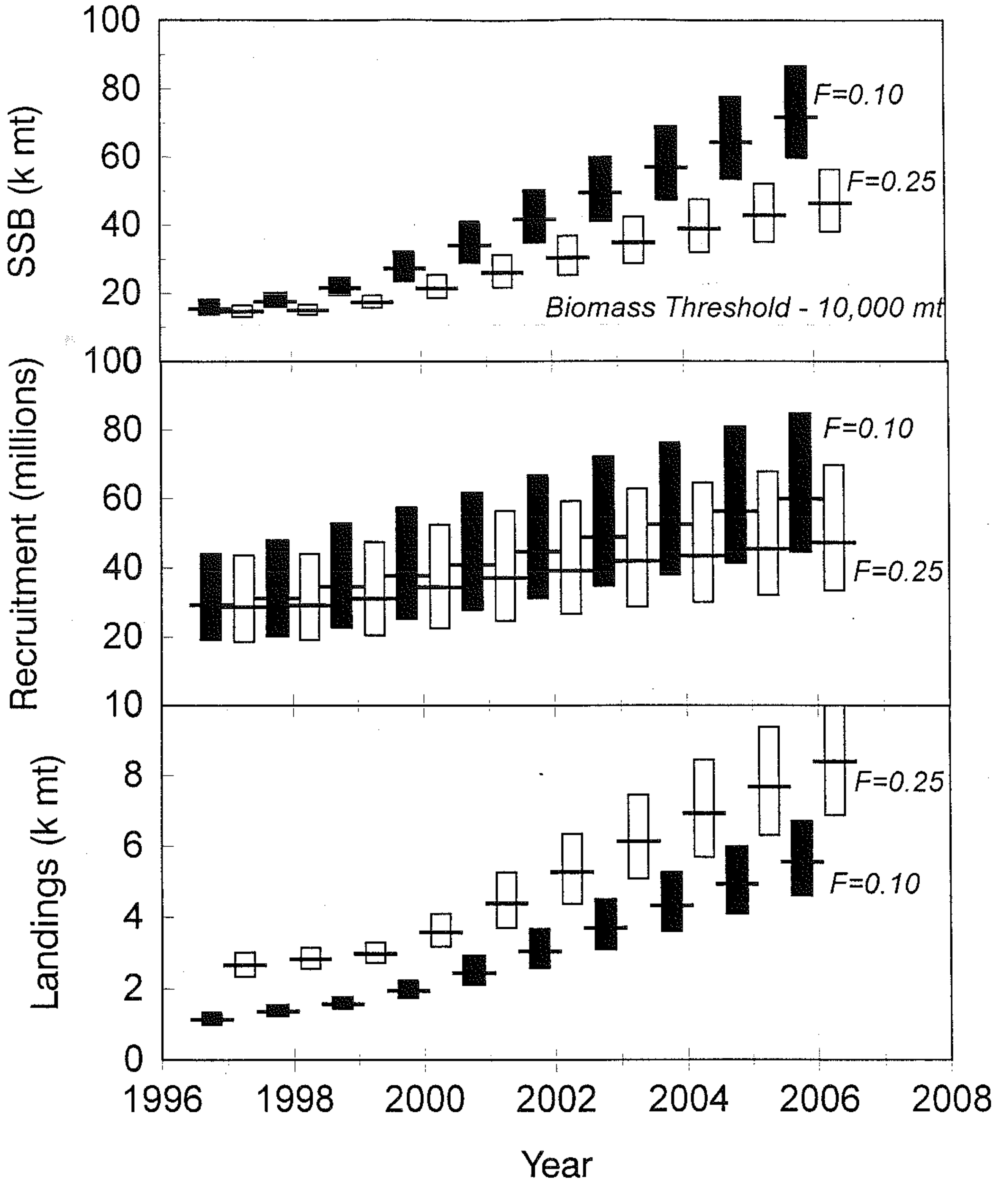


Figure 21. Stochastic medium-term projections and interquartile range of Georges Bank yellowtail flounder spawning stock biomass at status quo F (F96=0.10) and F0. (0.25).

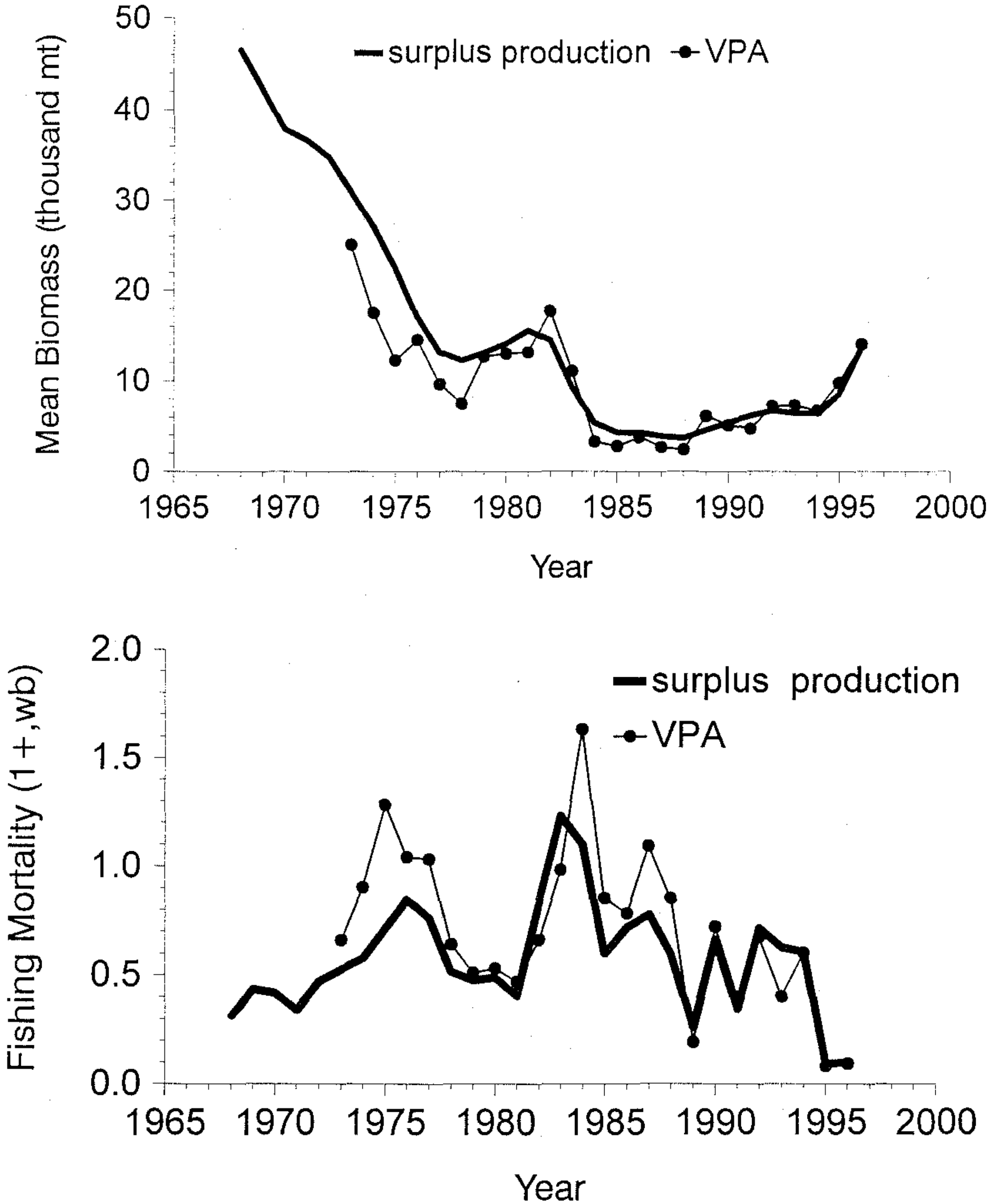


Figure 22. Comparison of results from VPA and surplus production modeling o f Georges Bank yellowtail flounder landings at various levels of fishing mortality.

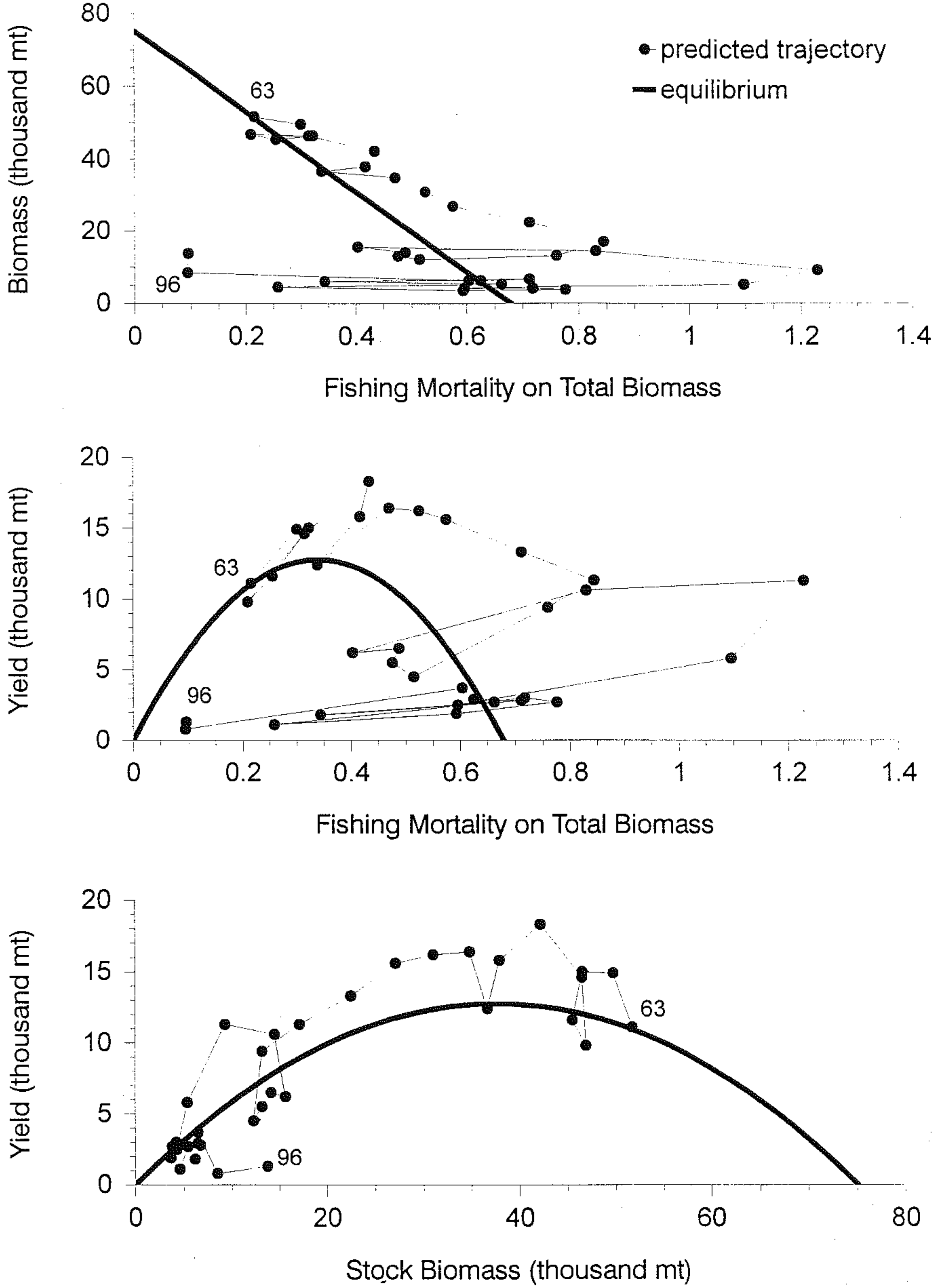


Figure 23. Biomass dynamics of Georges Bank yellowtail flounder.

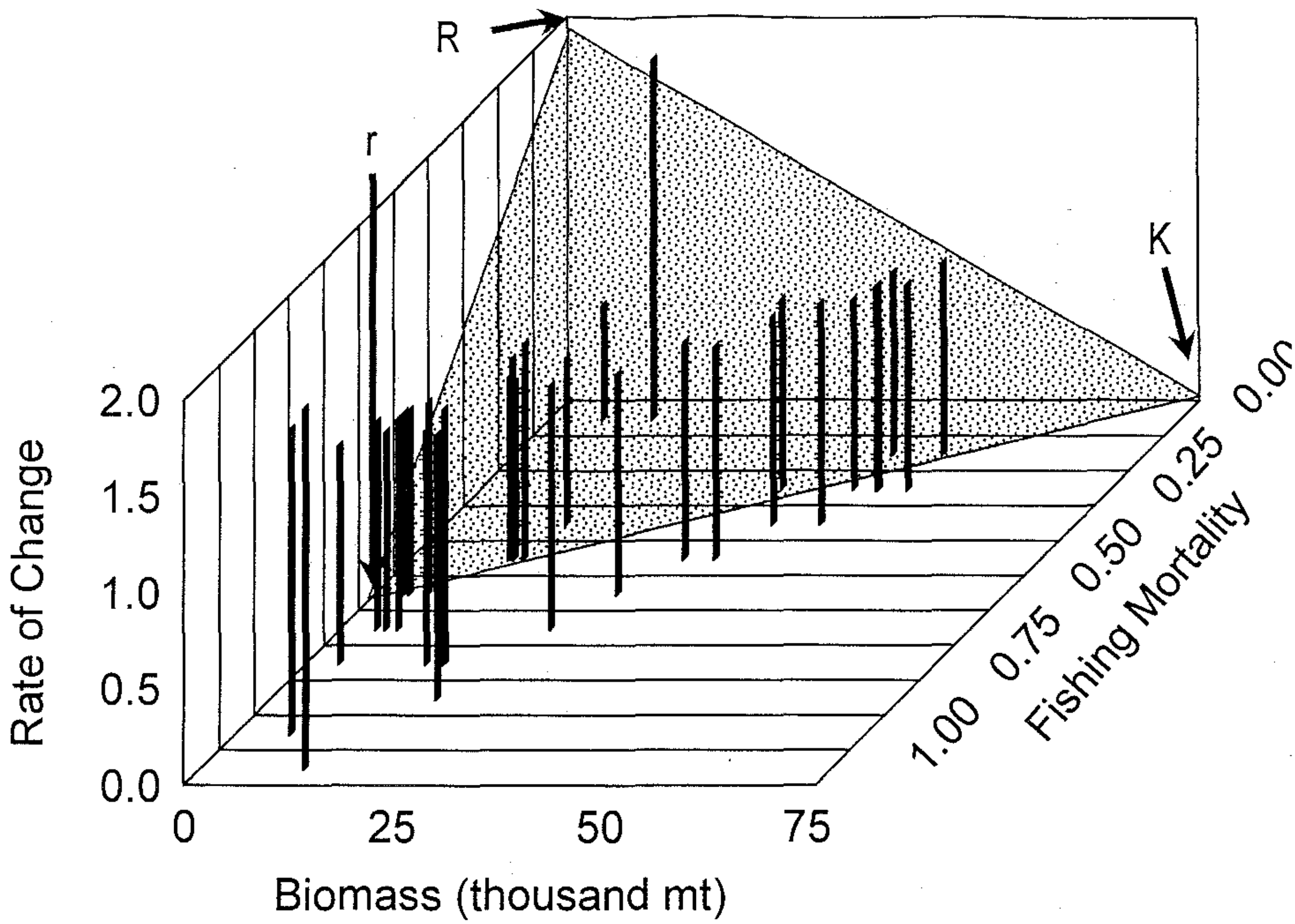


Figure 24. Expected population growth rate of Georges Bank yellowtail flounder as a function of biomass and F.

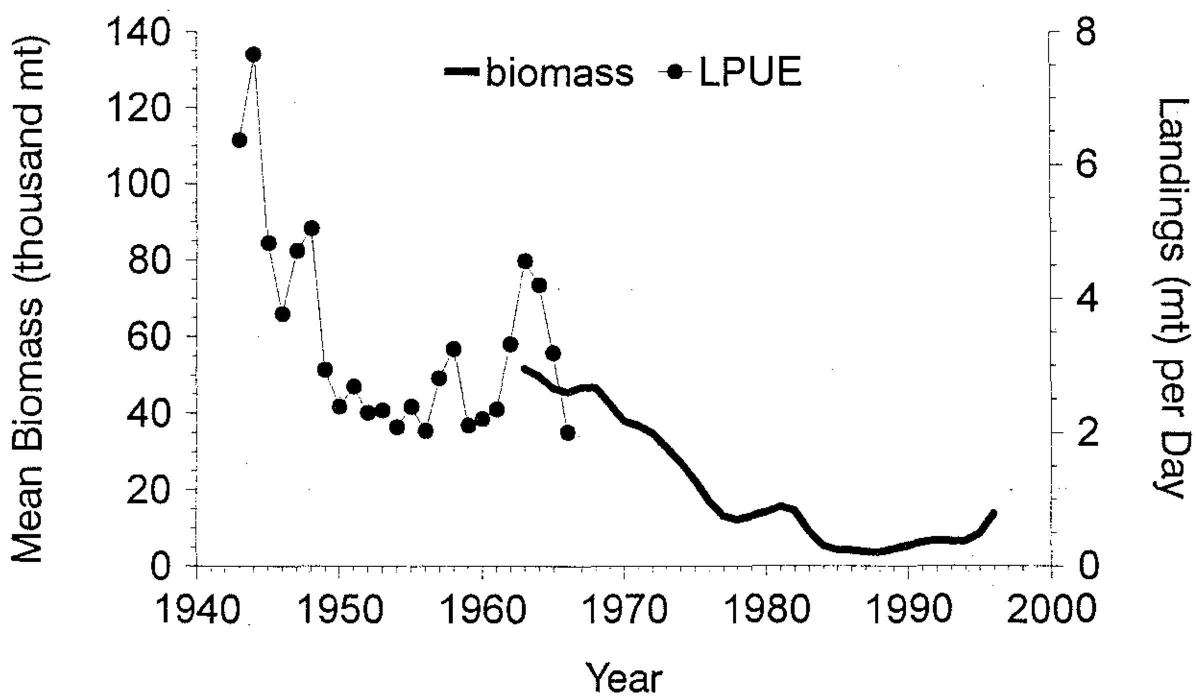


Figure 25. Estimated biomass of Georges Bank yellowtail flounder and historical estimates of landings per unit effort (Lux 1964, 1969a).

APPENDIX A: VIRTUAL POPULATION ANALYSIS

```
ADAPT          Run Number 285            1997 4 16 15 20 46
YELLOWTAIL FLOUNDER - GEORGES BANK STOCK 1973-1996 Age 1-8
GB96_7

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 5

For all yrs prior to the terminal year (1996), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 5:    4 5
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 6+ is then calculated from the following
ratios of F[age 6+] to F[age 5]
      1973    1.0000
      1974    1.0000
      1975    1.0000
      1976    1.0000
      1977    1.0000
      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 6+ group is then calculated
using the following method:  CATCHEQ

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 2	5.0000000E0	0.0000000E0	1.0000000E6
N 3	5.0000000E0	0.0000000E0	1.0000000E6
N 4	5.0000000E-1	0.0000000E0	1.0000000E6
N 5	5.0000000E-1	0.0000000E0	1.0000000E6
qSPR AGE1	1.0000000E-1	0.0000000E0	1.0000000E2
qSPR AGE2	1.0000000E-1	0.0000000E0	1.0000000E2
qSPR AGE3	1.0000000E-1	0.0000000E0	1.0000000E2
qSPR AGE4	1.0000000E-1	0.0000000E0	1.0000000E2
qSPR 5+	1.0000000E-1	0.0000000E0	1.0000000E2
qSCAL AG1	1.0000000E-1	0.0000000E0	1.0000000E2
qSCAL AG2	1.0000000E-1	0.0000000E0	1.0000000E2
qSCAL AG3	1.0000000E-1	0.0000000E0	1.0000000E2
qSCAL 4+	1.0000000E-1	0.0000000E0	1.0000000E2
qFALL AG1	1.0000000E-1	0.0000000E0	1.0000000E2
qFALL AG2	1.0000000E-1	0.0000000E0	1.0000000E2
qFALL AG3	1.0000000E-1	0.0000000E0	1.0000000E2
qFALL AG4	1.0000000E-1	0.0000000E0	1.0000000E2
qFAL AG5+	1.0000000E-1	0.0000000E0	1.0000000E2
qCAN AGE2	1.0000000E-1	0.0000000E0	1.0000000E2
qCAN AGE3	1.0000000E-1	0.0000000E0	1.0000000E2
qCAN AGE4	1.0000000E-1	0.0000000E0	1.0000000E2
qCAN 5+	1.0000000E-1	0.0000000E0	1.0000000E2

The following indices of abundance are available:

1	SPR AGE1
2	SPR AGE2
3	SPR AGE3
4	SPR AGE4
5	SPR AGE5
6	SPR AGE6
7	SPR 5+
8	SCAL AG1
9	SCAL AG2
10	SCAL AG3
11	SCAL 4+
12	FALL AG1
13	FALL AG2
14	FALL AG3
15	FALL AG4
16	FALL AG5
17	FALL AG6
18	FAL AG5+
19	CAN AGE1
20	CAN AGE2
21	CAN AGE3
22	CAN AGE4
23	CAN AGE5
24	CAN AGE6
25	CAN 5+

Indices that will be used in this run are: 1 2 3 4 7 8 9 10 11 12 13 14 15 18
20 21 22 25

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

	1973	1974	1975	1976	1977	1978
1	1.931	0.316	0.420	1.034	0.000	0.936
2	3.266	2.224	2.939	4.368	0.671	0.798
3	2.368	1.842	0.860	1.247	1.125	0.507
4	1.063	1.256	0.298	0.311	0.384	0.219
7	0.626	0.627	0.289	0.307	0.087	0.034
8	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
9	-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
11	-4995.000	-4995.000	-4995.000	-4995.000	-4995.000	-4995.000
12	2.494	4.623	4.625	0.336	0.928	4.729
13	5.497	2.854	2.511	1.929	2.161	1.272
14	5.104	1.524	0.877	0.475	1.649	0.773
15	2.944	1.060	0.572	0.117	0.618	0.406
18	1.834	0.840	0.398	0.222	0.221	0.174
20	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
21	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
22	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
25	-3996.000	-3996.000	-3996.000	-3996.000	-3996.000	-3996.000

	1979	1980	1981	1982	1983	1984
1	0.279	0.057	0.012	0.045	0.000	0.000
2	1.933	4.644	1.027	3.742	1.865	0.093
3	0.385	5.761	1.779	1.122	2.728	0.809
4	0.328	0.473	0.721	1.016	0.531	0.885
7	0.146	0.094	0.292	0.546	0.368	1.078
8	-999.000	-999.000	-999.000	0.509	0.276	0.377
9	-999.000	-999.000	-999.000	0.542	0.549	0.125
10	-999.000	-999.000	-999.000	0.215	0.464	0.064
11	-4995.000	-4995.000	-4995.000	0.103	0.156	0.134
12	1.312	0.761	1.584	2.424	0.109	0.661
13	1.999	5.086	2.333	2.185	2.284	0.400
14	0.316	6.050	1.630	1.590	1.914	0.306
15	0.122	0.678	0.500	0.423	0.473	2.428
18	0.247	0.418	0.217	0.089	0.118	0.137
20	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
21	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
22	-999.000	-999.000	-999.000	-999.000	-999.000	-999.000
25	-3996.000	-3996.000	-3996.000	-3996.000	-3996.000	-3996.000

	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.110	0.027	0.000	0.078	0.047	0.000	0.435	0.000	0.046
2	2.198	1.806	0.128	0.275	0.424	0.065	0.000	2.010	0.290
3	0.262	0.291	0.112	0.366	0.740	1.108	0.254	1.945	0.500
4	0.282	0.056	0.133	0.242	0.290	0.393	0.675	0.598	0.317
7	0.148	0.192	0.108	0.226	0.105	0.196	0.294	0.189	0.027
8	0.662	0.197	0.104	0.118	0.194	0.108	2.434	0.204	1.295
9	0.079	0.072	0.151	0.052	0.458	0.063	0.030	0.221	0.100
10	0.003	0.006	0.136	0.072	0.233	0.392	0.147	0.126	0.333
11	0.015	0.004	0.032	0.022	0.065	0.089	0.146	0.015	0.338
12	1.350	0.280	0.113	0.019	0.248	0.000	2.100	0.151	0.842
13	0.560	1.110	0.390	0.213	1.992	0.326	0.275	0.396	0.136
14	0.160	0.350	0.396	0.102	0.774	1.517	0.439	0.712	0.587
15	0.040	0.070	0.053	0.031	0.069	0.280	0.358	0.162	0.536
18	0.080	0.000	0.079	0.000	0.066	0.014	0.000	0.171	0.000
20	-999.000	-999.000	0.120	0.670	0.760	1.920	0.610	10.060	2.630
21	-999.000	-999.000	0.740	1.810	0.910	4.040	1.860	4.590	6.320
22	-999.000	-999.000	2.580	0.800	0.290	1.070	2.930	1.140	2.450
25	-3996.000	-3996.000	0.580	0.680	0.050	0.410	0.820	0.290	0.210

	1994	1995	1996	1997*******	
1	0.000	0.040	0.030	-999.000	0.344
2	0.621	1.180	0.990	-999.000	1.633
3	0.638	4.810	2.630	-999.000	1.425
4	0.357	1.490	2.700	-999.000	0.626
7	0.188	0.650	0.670	-3996.000	0.312
8	1.606	0.697	0.562	-999.000	0.623
9	0.126	0.333	0.563	-999.000	0.231
10	0.585	1.008	1.414	-999.000	0.347
11	0.470	0.632	0.449	-4995.000	0.178
12	1.200	0.280	0.140	-999.000	1.361
13	0.220	0.120	0.350	-999.000	1.525
14	0.980	0.350	1.870	-999.000	1.269
15	0.710	0.280	0.450	-999.000	0.557
18	0.320	0.060	0.070	-3996.000	0.289
20	6.380	1.170	5.620	-999.000	2.994
21	3.460	4.550	8.230	-999.000	3.651
22	2.630	2.160	7.160	-999.000	2.321
25	1.050	1.020	1.530	-3996.000	0.664

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	1.00	1.00	1.00	1.00	-99.00	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
3	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
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
9	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
10	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
11	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	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
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	1.00	-99.00	-99.00	1.00	1.00	-99.00	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
3	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
7	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	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	1.00	1.00	1.00	1.00	-99.00	1.00	-99.00	1.00	1.00
20	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	1.00	1.00	1.00	1.00

	1991	1992	1993	1994	1995	1996	1997
1	1.00	-99.00	1.00	-99.00	1.00	1.00	-99.00
2	-99.00	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	-99.00
4	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	-99.00
8	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
9	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
10	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
11	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
12	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
13	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
14	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
15	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
18	-99.00	1.00	-99.00	1.00	1.00	1.00	-99.00
20	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
21	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
22	1.00	1.00	1.00	1.00	1.00	1.00	-99.00
25	1.00	1.00	1.00	1.00	1.00	1.00	-99.00

Negative weights in the above table indicate missing values

DOWNWEIGHTS BY YEAR (delta)

1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

1993	1994	1995	1996	1997
1.0000	1.0000	1.0000	1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

1	2	3	4	7	8	9	10	11	12
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

13	14	15	18	20	21	22	25
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - GB96_7

	1973	1974	1975	1976	1977	1978	1979
1	1.0000	1.0000	1.0000	1.0000	-99.0000	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
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-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	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000

	1980	1981	1982	1983	1984	1985	1986
1	1.0000	1.0000	1.0000	-99.0000	-99.0000	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
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	-99.0000	-99.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000

	1987	1988	1989	1990	1991	1992	1993
1	-99.0000	1.0000	1.0000	-99.0000	1.0000	-99.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	-99.0000	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
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	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	-99.0000	1.0000	1.0000	-99.0000	1.0000	-99.0000
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
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	1994	1995	1996	1997
1	-99.0000	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
7	1.0000	1.0000	1.0000	-99.0000
8	1.0000	1.0000	1.0000	-99.0000
9	1.0000	1.0000	1.0000	-99.0000
10	1.0000	1.0000	1.0000	-99.0000
11	1.0000	1.0000	1.0000	-99.0000
12	1.0000	1.0000	1.0000	-99.0000
13	1.0000	1.0000	1.0000	-99.0000
14	1.0000	1.0000	1.0000	-99.0000
15	1.0000	1.0000	1.0000	-99.0000
18	1.0000	1.0000	1.0000	-99.0000
20	1.0000	1.0000	1.0000	-99.0000
21	1.0000	1.0000	1.0000	-99.0000
22	1.0000	1.0000	1.0000	-99.0000
25	1.0000	1.0000	1.0000	-99.0000

Negative weights in the above table indicate missing values

CATCH AT AGE (millions) - GB96_7

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.347	2.143	4.372	0.615	0.330	9.659	0.233	0.309	0.055
2	4.890	8.971	25.284	31.012	8.580	3.105	9.505	3.572	0.729
3	13.243	7.904	7.057	5.146	9.917	4.034	3.445	8.821	5.351
4	9.276	7.398	3.392	1.347	1.721	1.660	1.242	1.419	4.556
5	3.743	3.544	2.084	0.532	0.394	0.459	0.550	0.321	0.796
6	1.618	1.477	1.148	0.868	0.474	0.174	0.272	0.099	0.126
1+	33.117	31.437	43.337	39.520	21.416	19.091	15.247	14.541	11.613

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	2.063	0.696	0.428	0.650	0.158	0.140	0.483	0.185	0.219	0.412
2	17.491	7.689	1.917	3.345	5.771	2.653	2.367	1.516	1.931	0.054
3	7.122	16.016	4.266	0.816	0.978	2.751	1.191	0.668	6.123	1.222
4	3.246	2.316	4.734	0.652	0.347	0.761	0.624	0.262	0.800	2.429
5	1.031	0.625	1.592	0.410	0.161	0.132	0.165	0.068	0.107	0.294
6	0.084	0.127	0.321	0.065	0.076	0.112	0.038	0.019	0.020	0.060
1+	31.037	27.469	13.258	5.938	7.491	6.549	4.868	2.718	9.200	4.471

	1992	1993	1994	1995	1996
1	2.389	5.194	0.071	0.014	0.050
2	8.359	1.009	0.861	0.157	0.383
3	2.527	2.777	5.742	0.895	1.509
4	1.269	2.392	2.571	0.715	0.716
5	0.509	0.318	0.910	0.137	0.167
6	0.027	0.075	0.137	0.028	0.015
1+	15.080	11.765	10.292	1.946	2.840

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

	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	32.770	29.294	38.965	38.905	21.086	9.432	15.014	14.232	11.558
3	27.880	20.323	13.681	7.893	12.506	6.327	5.509	10.660	10.829
4	14.637	12.419	6.624	2.747	2.589	2.293	2.064	1.839	5.478
5	5.361	5.021	3.232	1.400	0.868	0.633	0.822	0.420	0.922

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	28.974	26.773	12.830	5.288	7.333	6.409	4.385	2.533	8.981	4.059
3	11.483	19.084	10.913	1.943	1.562	3.756	2.018	1.017	7.050	4.005
4	4.361	3.068	6.647	1.127	0.584	1.005	0.827	0.349	0.927	2.783
5	1.115	0.752	1.913	0.475	0.237	0.244	0.203	0.087	0.127	0.354

	1992	1993	1994	1995	1996
2	12.691	6.571	10.221	1.932	2.790
3	4.332	5.562	9.360	1.775	2.407
4	1.805	2.785	3.618	0.880	0.898
5	0.536	0.393	1.047	0.165	0.182

WT AT AGE (MID-YR) in kg. - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 ■	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
2 ■	0.375	0.378	0.340	0.339	0.364	0.337	0.356	0.354	0.389	0.313	0.296	0.240
3 ■	0.464	0.500	0.492	0.545	0.527	0.513	0.462	0.495	0.493	0.487	0.440	0.378
4 ■	0.527	0.609	0.554	0.636	0.634	0.684	0.649	0.656	0.603	0.650	0.604	0.500
5 ■	0.603	0.680	0.618	0.741	0.782	0.793	0.728	0.813	0.707	0.748	0.736	0.642
6 ■	0.776	0.842	0.682	0.835	0.950	0.915	0.893	1.078	0.799	1.055	0.959	0.785

■	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
2 ■	0.363	0.343	0.338	0.351	0.355	0.337	0.270	0.341	0.316	0.277	0.285	0.304
3 ■	0.497	0.540	0.523	0.557	0.543	0.419	0.383	0.381	0.390	0.352	0.373	0.410
4 ■	0.647	0.664	0.666	0.688	0.725	0.588	0.484	0.528	0.510	0.472	0.464	0.568
5 ■	0.733	0.823	0.680	0.855	0.883	0.699	0.728	0.648	0.562	0.629	0.582	0.725
6 ■	0.812	0.912	0.842	0.985	1.122	0.871	0.852	1.183	0.909	0.818	0.836	0.980

WT AT AGE (JAN 1) in kg. - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 ■	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
2 ■	0.325	0.061	0.058	0.058	0.060	0.058	0.060	0.059	0.062	0.056	0.054	0.049
3 ■	0.405	0.433	0.431	0.430	0.423	0.432	0.395	0.420	0.418	0.435	0.371	0.334
4 ■	0.464	0.532	0.526	0.559	0.588	0.600	0.577	0.551	0.546	0.566	0.542	0.469
5 ■	0.564	0.599	0.613	0.641	0.705	0.709	0.706	0.726	0.681	0.672	0.692	0.623
6 ■	0.776	0.842	0.682	0.835	0.950	0.915	0.893	1.078	0.799	1.055	0.959	0.785

■	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
2 ■	0.060	0.059	0.058	0.059	0.060	0.058	0.052	0.058	0.056	0.053	0.053	0.055
3 ■	0.345	0.443	0.424	0.434	0.437	0.386	0.359	0.321	0.365	0.334	0.321	0.342
4 ■	0.495	0.574	0.600	0.600	0.635	0.565	0.450	0.450	0.441	0.429	0.404	0.460
5 ■	0.605	0.730	0.672	0.755	0.779	0.712	0.654	0.560	0.545	0.566	0.524	0.580
6 ■	0.812	0.912	0.842	0.985	1.122	0.871	0.852	1.183	0.909	0.818	0.836	0.980

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

PERCENT MATURE (females) - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 ■	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 ■	42	45	45	45	45	45	45	45	49	49	49	93	93	93	93
3 ■	97	98	98	98	98	98	98	98	99	99	99	100	100	100	100
4 ■	99	100	100	100	100	100	100	100	100	100	100	100	100	100	100
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

■	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0	0	0	0	0	0	0	0	0
2 ■	93	93	93	93	52	52	52	52	52
3 ■	100	100	100	100	100	86	86	86	86
4 ■	100	100	100	100	100	100	98	98	98
5 ■	100	100	100	100	100	100	100	100	100
6 ■	100	100	100	100	100	100	100	100	100

SEX RATIO (Percent Female) - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
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

■	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	50	50	50	50	50	50	50	50	50
2 ■	50	50	50	50	50	50	50	50	50
3 ■	50	50	50	50	50	50	50	50	50
4 ■	50	50	50	50	50	50	50	50	50
5 ■	50	50	50	50	50	50	50	50	50
6 ■	50	50	50	50	50	50	50	50	50

BEGIN MARQUARDT ALGORITHM

```
LAMBDA        1.00000E-2
RSS           8.20569E2
NPHI          8.20569E2

par
   5.00000E0       5.00000E0       5.00000E-1      5.00000E-1      1.00000E-1      1.
      00000E-1      1.00000E-1      1.00000E-1      1.00000E-1      1.00000E-1      1
      .00000E-1      1.00000E-1      1.00000E-1      1.00000E-1      1.00000E-1
      1.00000E-1      1.00000E-1      1.00000E-1      1.00000E-1      1.00000E-1
       1.00000E-1      1.00000E-1


LAMBDA        1.00000E-1
RSS           7.15469E2
NPHI          7.15469E2

par
   5.05681E0       5.34766E0       7.89283E-1      6.82851E-1      8.22756E-2      9.
      09233E-2      9.82183E-2      1.09372E-1      1.18987E-1      9.48363E-2      9
      .84163E-2      1.00881E-1      1.10258E-1      8.67694E-2      9.39340E-2
      1.02093E-1      1.11857E-1      1.20638E-1      9.34772E-2      1.03272E-1
       1.13173E-1      1.26808E-1


LAMBDA        1.00000E0
RSS           6.29250E2
NPHI          6.29250E2

par
   5.10819E0       5.68294E0       1.12033E0       8.86015E-1      6.93874E-2      8.
      35043E-2      9.65526E-2      1.18476E-1      1.39232E-1      9.03341E-2      9
      .68581E-2      1.01760E-1      1.20361E-1      7.65352E-2      8.87704E-2
      1.04055E-1      1.23734E-1      1.43036E-1      8.78218E-2      1.06021E-1
       1.26354E-1      1.57278E-1
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LAMBDA        1.00000E1
RSS           5.63117E2
NPHI          5.63117E2

par
   5.11071E0      5.94361E0      1.44740E0      1.09592E0      6.05415E-2     7.
      79331E-2      9.52093E-2     1.26648E-1     1.58966E-1     8.69035E-2     9
      .56608E-2      1.02706E-1     1.29594E-1     6.91837E-2     8.47883E-2
      1.05846E-1      1.34701E-1     1.65265E-1     8.35287E-2     1.08381E-1
       1.38553E-1      1.88832E-1

LAMBDA        1.00000E0
RSS           3.38168E2
NPHI          3.38168E2

par
   4.16254E0      6.44112E0      3.18488E0      2.56796E0      2.32955E-2     5.
      38658E-2      9.03049E-2     1.71894E-1     2.74127E-1     7.39226E-2     9
      .33674E-2      1.12040E-1     1.83276E-1     3.78696E-2     6.78257E-2
      1.17894E-1      1.97067E-1     2.98289E-1     6.76872E-2     1.25129E-1
       2.09490E-1      3.85073E-1

LAMBDA        1.00000E-1
RSS           2.43959E2
NPHI          2.43959E2

par
   5.29532E0      9.06095E0      7.07789E0      4.80705E0      1.63918E-2     3.
      83407E-2      8.16851E-2     2.29674E-1     4.89231E-1     5.66649E-2     8
      .18656E-2      1.11463E-1     2.51416E-1     2.49666E-2     5.26726E-2
      1.23984E-1      2.86546E-1     5.59688E-1     4.72802E-2     1.28808E-1
       3.08108E-1      8.29959E-1

LAMBDA        1.00000E-2
RSS           2.33885E2
NPHI          2.33885E2

par
   5.84734E0      1.03844E1      1.00348E1      5.85308E0      1.66083E-2     3.
      87641E-2      8.05765E-2     2.46271E-1     6.22665E-1     5.57707E-2     7
      .98974E-2      1.10028E-1     2.72115E-1     2.56315E-2     5.24273E-2
      1.23784E-1      3.20056E-1     7.40611E-1     4.71568E-2     1.26302E-1
       3.43755E-1      1.22913E0

LAMBDA        1.00000E-3
RSS           2.33695E2
NPHI          2.33695E2

par
   5.88220E0      1.04960E1      1.06121E1      5.94035E0      1.66042E-2     3.
      87543E-2      8.05583E-2     2.46950E-1     6.43184E-1     5.57303E-2     7
      .98669E-2      1.10027E-1     2.73095E-1     2.56304E-2     5.24084E-2
      1.23781E-1      3.22273E-1     7.73947E-1     4.71141E-2     1.26238E-1
       3.46011E-1      1.34071E0

LAMBDA        1.00000E-4
RSS           2.33695E2
NPHI          2.33695E2
par
   5.88200E0      1.04958E1      1.06203E1      5.93942E0      1.66044E-2     3.
      87552E-2      8.05602E-2     2.46952E-1     6.43452E-1     5.57324E-2     7
      .98700E-2      1.10032E-1     2.73100E-1     2.56310E-2     5.24097E-2
      1.23784E-1      3.22278E-1     7.74589E-1     4.71168E-2     1.26245E-1
       3.46021E-1      1.34550E0
```

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

RESULTS

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES 233.694770
ORTHOGONALITY OFFSET......... 0.004180
MEAN SQUARE RESIDUALS 0.766212

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 2	5.88200E0	3.09914E0	1.89794E0	0.53
N 3	1.04958E1	3.71297E0	2.82680E0	0.35
N 4	1.06203E1	3.42569E0	3.10019E0	0.32
N 5	5.93942E0	1.36482E0	4.35181E0	0.23
qSPR AGE1	1.66044E-2	3.60063E-3	4.61151E0	0.22
qSPR AGE2	3.87552E-2	7.16474E-3	5.40916E0	0.18
qSPR AGE3	8.05602E-2	1.45312E-2	5.54395E0	0.18
qSPR AGE4	2.46952E-1	4.45458E-2	5.54378E0	0.18
qSPR 5+	6.43452E-1	1.16077E-1	5.54332E0	0.18
qSCAL AG1	5.57324E-2	1.29675E-2	4.29786E0	0.23
qSCAL AG2	7.98700E-2	1.83722E-2	4.34732E0	0.23
qSCAL AG3	1.10032E-1	2.52227E-2	4.36241E0	0.23
qSCAL 4+	2.73100E-1	6.27140E-2	4.35469E0	0.23
qFALL AG1	2.56310E-2	4.77419E-3	5.36866E0	0.19
qFALL AG2	5.24097E-2	9.48611E-3	5.52488E0	0.18
qFALL AG3	1.23784E-1	2.23560E-2	5.53696E0	0.18
qFALL AG4	3.22278E-1	5.82644E-2	5.53130E0	0.18
qFAL AG5+	7.74589E-1	1.53559E-1	5.04424E0	0.20
qCAN AGE2	4.71168E-2	1.33464E-2	3.53031E0	0.28
qCAN AGE3	1.26245E-1	3.54978E-2	3.55642E0	0.28
qCAN AGE4	3.46021E-1	9.73017E-2	3.55616E0	0.28
qCAN 5+	1.34550E0	3.78431E-1	3.55547E0	0.28

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qSPR AGE1	5.70702E-3	1.23756E-3	0.22
qSPR AGE2	6.32839E-2	1.16994E-2	0.18
qSPR AGE3	1.14761E-1	2.07003E-2	0.18
qSPR AGE4	1.54530E-1	2.78745E-2	0.18
qSPR 5+	2.00730E-1	3.62112E-2	0.18
qSCAL AG1	3.47139E-2	8.07701E-3	0.23
qSCAL AG2	1.84446E-2	4.24276E-3	0.23
qSCAL AG3	3.81297E-2	8.74051E-3	0.23
qSCAL 4+	4.86118E-2	1.11631E-2	0.23
qFALL AG1	3.48905E-2	6.49891E-3	0.19
qFALL AG2	7.99225E-2	1.44659E-2	0.18
qFALL AG3	1.57026E-1	2.83596E-2	0.18
qFALL AG4	1.79670E-1	3.24824E-2	0.18
qFAL AG5+	2.23662E-1	4.43401E-2	0.20
qCAN AGE2	1.41068E-1	3.99590E-2	0.28
qCAN AGE3	4.60921E-1	1.29602E-1	0.28
qCAN AGE4	8.03115E-1	2.25837E-1	0.28
qCAN 5+	8.93413E-1	2.51278E-1	0.28

```
CORRELATION BETWEEN PARAMETERS ESTIMATED
  1.00  0.04  0.02  0.02 -0.15 -0.01 -0.00 -0.00 -0.00 -0.16 -0.01 -0.00 -0.00 -
      0.13 -0.01 -0.00 -0.00 -0.00 -0.01 -0.00 -0.00 -0.00
  0.04  1.00  0.05  0.05 -0.10 -0.09 -0.01 -0.00 -0.00 -0.11 -0.11 -0.01 -0.01 -
      0.09 -0.09 -0.01 -0.01 -0.01 -0.13 -0.01 -0.01 -0.01
  0.02  0.05  1.00  0.06 -0.01 -0.07 -0.07 -0.01 -0.01 -0.09 -0.09 -0.09 -0.01 -
      0.08 -0.07 -0.07 -0.01 -0.01 -0.11 -0.11 -0.01 -0.01
  0.02  0.05  0.06  1.00 -0.05 -0.06 -0.07 -0.09 -0.10 -0.08 -0.09 -0.10 -0.15 -
      0.05 -0.07 -0.08 -0.12 -0.12 -0.10 -0.10 -0.15 -0.15
 -0.15 -0.10 -0.01 -0.05  1.00  0.01  0.00  0.00  0.00  0.04  0.01  0.01  0.01
      0.03  0.01  0.00  0.01  0.01  0.02  0.01  0.01  0.01
 -0.01 -0.09 -0.07 -0.06  0.01  1.00  0.01  0.01  0.01  0.02  0.02  0.01  0.01
      0.02  0.02  0.01  0.01  0.01  0.02  0.01  0.01  0.01
 -0.00 -0.01 -0.07 -0.07  0.00  0.01  1.00  0.01  0.01  0.01  0.01  0.01  0.01
      0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
 -0.00 -0.00 -0.01 -0.09  0.00  0.01  0.01  1.00  0.01  0.01  0.01  0.01  0.01
      0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
 -0.00 -0.00 -0.01 -0.10  0.00  0.01  0.01  0.01  1.00  0.01  0.01  0.01  0.01
      0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
 -0.16 -0.11 -0.09 -0.08  0.04  0.02  0.01  0.01  0.01  1.00  0.02  0.02  0.01
      0.04  0.02  0.01  0.01  0.01  0.03  0.02  0.01  0.01
 -0.01 -0.11 -0.09 -0.09  0.01  0.02  0.01  0.01  0.01  0.02  1.00  0.02  0.01
      0.02  0.02  0.01  0.01  0.01  0.03  0.02  0.01  0.01
 -0.00 -0.01 -0.09 -0.10  0.01  0.01  0.01  0.01  0.01  0.02  0.02  1.00  0.02
      0.01  0.01  0.01  0.01  0.01  0.02  0.02  0.01  0.02
 -0.00 -0.01 -0.01 -0.15  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.02  1.00
      0.01  0.01  0.01  0.02  0.02  0.01  0.02  0.02  0.02
 -0.13 -0.09 -0.08 -0.05  0.03  0.02  0.01  0.01  0.01  0.04  0.02  0.01  0.01
      1.00  0.02  0.01  0.01  0.01  0.02  0.01  0.01  0.01
 -0.01 -0.09 -0.07 -0.07  0.01  0.02  0.01  0.01  0.01  0.02  0.02  0.01  0.01
      0.02  1.00  0.01  0.01  0.01  0.02  0.01  0.01  0.01
 -0.00 -0.01 -0.07 -0.08  0.00  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01
      0.01  0.01  1.00  0.01  0.01  0.02  0.02  0.01  0.01
 -0.00 -0.01 -0.01 -0.12  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.02
      0.01  0.01  0.01  1.00  0.01  0.01  0.01  0.02  0.02
 -0.00 -0.01 -0.01 -0.12  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.02
      0.01  0.01  0.01  0.01  1.00  0.01  0.01  0.02  0.02
 -0.01 -0.13 -0.11 -0.10  0.02  0.02  0.01  0.01  0.01  0.03  0.03  0.02  0.01
      0.02  0.02  0.02  0.01  0.01  1.00  0.02  0.01  0.01
 -0.00 -0.01 -0.11 -0.10  0.01  0.01  0.01  0.01  0.01  0.02  0.02  0.02  0.02
      0.01  0.01  0.02  0.01  0.01  0.02  1.00  0.02  0.02
 -0.00 -0.01 -0.01 -0.15  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.02
      0.01  0.01  0.01  0.02  0.02  0.01  0.02  1.00  0.02
 -0.00 -0.01 -0.01 -0.15  0.01  0.01  0.01  0.01  0.01  0.01  0.01  0.02  0.02
      0.01  0.01  0.01  0.02  0.02  0.01  0.02  0.02  1.00
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CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)
N 2          * . . . . . . . . . . . . . . . . . . . . .
N 3          . * . . . . . . . . . . . . . . . . . . . .
N 4          . . * . . . . . . . . . . . . . . . . . . .
N 5          . . . * . . . . . . . . . . . . . . . . . .
qSPR AGE1    . . . . * . . . . . . . . . . . . . . . . .
qSPR AGE2    . . . . . * . . . . . . . . . . . . . . . .
qSPR AGE3    . . . . . . * . . . . . . . . . . . . . . .
qSPR AGE4    . . . . . . . * . . . . . . . . . . . . . .
qSPR  5+     . . . . . . . . * . . . . . . . . . . . . .
qSCAL AG1    . . . . . . . . . * . . . . . . . . . . . .
qSCAL AG2    . . . . . . . . . . * . . . . . . . . . . .
qSCAL AG3    . . . . . . . . . . . * . . . . . . . . . .
qSCAL 4+     . . . . . . . . . . . . * . . . . . . . . .
qFALL AG1    . . . . . . . . . . . . . * . . . . . . . .
qFALL AG2    . . . . . . . . . . . . . . * . . . . . . .
qFALL AG3    . . . . . . . . . . . . . . . * . . . . . .
qFALL AG4    . . . . . . . . . . . . . . . . * . . . . .
qFAL AG5+    . . . . . . . . . . . . . . . . . * . . . .
qCAN AGE2    . . . . . . . . . . . . . . . . . . * . . .
qCAN AGE3    . . . . . . . . . . . . . . . . . . . * . .
qCAN AGE4    . . . . . . . . . . . . . . . . . . . . * .
qCAN  5+     . . . . . . . . . . . . . . . . . . . . . *
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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

SUMMMARY OF RESIDUALS

Index 1 SPR AGE1
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
1973	1.7260	-0.7556	1.0000	2.4816	2.8350	28.290
1974	-0.0840	-0.1808	1.0000	0.0967	0.1105	50.265
1975	0.2005	0.1290	1.0000	0.0715	0.0817	68.516
1976	1.1014	-0.9661	1.0000	2.0675	2.3620	22.919
1978	1.0018	-0.1697	1.0000	1.1716	1.3384	50.823
1979	-0.2086	-0.9464	1.0000	0.7379	0.8429	23.375
1980	-1.7967	-1.0026	1.0000	-0.7942	-0.9073	22.099
1981	-3.3549	0.0139	1.0000	-3.3688	-3.8485	61.066
1982	-2.0331	-1.0242	1.0000	-1.0090	-1.1527	21.627
1985	-1.1393	-1.4174	1.0000	0.2781	0.3177	14.595
1986	-2.5439	-2.2018	1.0000	-0.3421	-0.3908	6.661
1988	-1.4831	-1.1343	1.0000	-0.3488	-0.3985	19.371
1989	-1.9896	-1.9482	1.0000	-0.0415	-0.0474	8.584
1991	0.2356	-0.9713	1.0000	1.2069	1.3788	22.800
1993	-2.0111	-0.9609	1.0000	-1.0502	-1.1998	23.038
1995	-2.1509	-1.3137	1.0000	-0.8372	-0.9565	16.190
1996	-2.4386	-2.1185	1.0000	-0.3201	-0.3656	7.240

Partial variance for this index is 1.840711

Index 2 SPR AGE2
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
1973	0.6932	-0.1029	1.0000	0.7961	0.9095	23.279
1974	0.3089	-0.1216	1.0000	0.4306	0.4919	22.848
1975	0.5877	0.4186	1.0000	0.1692	0.1932	39.214
1976	0.9839	0.7034	1.0000	0.2805	0.3204	52.140
1977	-0.8894	-0.3486	1.0000	-0.5407	-0.6177	18.208
1978	-0.7160	-0.7164	1.0000	0.0004	0.0005	12.605
1979	0.1687	0.2421	1.0000	-0.0734	-0.0838	32.871
1980	1.0452	-0.3099	1.0000	1.3551	1.5481	18.927
1981	-0.4637	-0.3705	1.0000	-0.0932	-0.1065	17.814
1982	0.8293	0.6605	1.0000	0.1688	0.1928	49.947
1983	0.1329	-0.4880	1.0000	0.6208	0.7093	15.840
1984	-2.8655	-1.8312	1.0000	-1.0343	-1.1816	4.134
1985	0.2972	-1.3528	1.0000	1.6500	1.8850	6.670
1986	0.1007	-0.8203	1.0000	0.9211	1.0522	11.361
1987	-2.5461	-1.5808	1.0000	-0.9653	-1.1028	5.311
1988	-1.7813	-1.5226	1.0000	-0.2588	-0.2956	5.629
1989	-1.3484	-0.5146	1.0000	-0.8337	-0.9525	15.423
1990	-3.2237	-1.3247	1.0000	-1.8991	-2.1695	6.861
1992	0.2078	-0.3439	1.0000	0.5517	0.6302	18.295
1993	-1.7282	-0.6505	1.0000	-1.0778	-1.2313	13.464
1994	-0.9668	-0.5999	1.0000	-0.3669	-0.4191	14.162
1995	-0.3249	-0.3571	1.0000	0.0323	0.0369	18.054
1996	-0.5004	-0.6670	1.0000	0.1666	0.1903	13.243

Partial variance for this index is 0.691233

Index 3 SPR AGE3
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
1973	0.5082	0.8464	1.0000	-0.3382	-0.3864	28.937
1974	0.2570	0.1646	1.0000	0.0924	0.1055	14.635
1975	-0.5047	-0.1589	1.0000	-0.3457	-0.3950	10.589
1976	-0.1331	-0.2965	1.0000	0.1634	0.1867	9.228
1977	-0.2361	0.1642	1.0000	-0.4003	-0.4573	14.628
1978	-1.0331	-0.5525	1.0000	-0.4806	-0.5491	7.144
1979	-1.3084	-0.5025	1.0000	-0.8059	-0.9206	7.510
1980	1.3973	0.3888	1.0000	1.0085	1.1521	18.312
1981	0.2222	-0.0121	1.0000	0.2343	0.2677	12.264
1982	-0.2387	0.1149	1.0000	-0.3537	-0.4040	13.925
1983	0.6497	0.7028	1.0000	-0.0531	-0.0606	25.067
1984	-0.5658	-0.7251	1.0000	0.1593	0.1820	6.011
1985	-1.6933	-2.0179	1.0000	0.3247	0.3709	1.650
1986	-1.5883	-1.6290	1.0000	0.0407	0.0465	2.435
1987	-2.5431	-1.1127	1.0000	-1.4304	-1.6341	4.080
1988	-1.3590	-1.8523	1.0000	0.4933	0.5636	1.947
1989	-0.6550	-1.6158	1.0000	0.9609	1.0977	2.467
1990	-0.2513	-0.0979	1.0000	-0.1534	-0.1752	11.255
1991	-1.7243	-1.1655	1.0000	-0.5587	-0.6383	3.870
1992	0.3114	-0.4582	1.0000	0.7696	0.8792	7.850
1993	-1.0470	-0.5153	1.0000	-0.5317	-0.6075	7.415
1994	-0.8033	-0.2052	1.0000	-0.5981	-0.6833	10.111
1995	1.2168	-0.1377	1.0000	1.3546	1.5475	10.816
1996	0.6131	0.1650	1.0000	0.4482	0.5120	14.639

Partial variance for this index is 0.415264

Index 4 SPR AGE4
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
1973	0.5299	1.4323	1.0000	-0.9024	-1.0309	16.960
1974	0.6967	1.0618	1.0000	-0.3651	-0.4171	11.709
1975	-0.7419	0.1763	1.0000	-0.9181	-1.0489	4.830
1976	-0.6992	-0.5726	1.0000	-0.1265	-0.1446	2.284
1977	-0.4883	-0.3342	1.0000	-0.1541	-0.1761	2.899
1978	-1.0499	-0.2989	1.0000	-0.7510	-0.8579	3.003
1979	-0.6459	-0.6106	1.0000	-0.0353	-0.0404	2.199
1980	-0.2799	-0.2895	1.0000	0.0096	0.0110	3.032
1981	0.1417	0.5489	1.0000	-0.4072	-0.4652	7.011
1982	0.4847	0.2499	1.0000	0.2348	0.2682	5.199
1983	-0.1642	0.2021	1.0000	-0.3663	-0.4185	4.957
1984	0.3466	0.3984	1.0000	-0.0517	-0.0591	6.031
1985	-0.7970	-1.3387	1.0000	0.5417	0.6188	1.062
1986	-2.4136	-1.8886	1.0000	-0.5250	-0.5998	0.613
1987	-1.5486	-1.2957	1.0000	-0.2529	-0.2889	1.108
1988	-0.9500	-1.5600	1.0000	0.6099	0.6968	0.851
1989	-0.7691	-2.0589	1.0000	1.2898	1.4735	0.517
1990	-0.4651	-1.0513	1.0000	0.5862	0.6696	1.415
1991	0.0758	-0.0971	1.0000	0.1728	0.1974	3.675
1992	-0.0454	-0.6746	1.0000	0.6292	0.7188	2.063
1993	-0.6800	0.0223	1.0000	-0.7023	-0.8024	4.141
1994	-0.5612	-0.1294	1.0000	-0.4319	-0.4934	3.558
1995	0.8676	-0.2729	1.0000	1.1405	1.3029	3.082
1996	1.4621	0.6866	1.0000	0.7755	0.8859	8.046

Partial variance for this index is 0.385169

Index 7 SPR 5+
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1973	0.6965	1.8197	1.0000	-1.1232	-1.2832	9.589
1974	0.6981	1.6045	1.0000	-0.9064	-1.0355	7.732
1975	-0.0764	1.0506	1.0000	-1.1270	-1.2876	4.444
1976	-0.0160	0.3928	1.0000	-0.4088	-0.4671	2.302
1977	-1.2770	-0.0907	1.0000	-1.1863	-1.3552	1.419
1978	-2.2165	-0.3272	1.0000	-1.8893	-2.1584	1.120
1979	-0.7593	-0.0893	1.0000	-0.6700	-0.7654	1.421
1980	-1.1996	-0.5662	1.0000	-0.6334	-0.7236	0.882
1981	-0.0661	-0.1163	1.0000	0.0502	0.0573	1.384
1982	0.5597	0.1168	1.0000	0.4430	0.5061	1.747
1983	0.1652	0.0190	1.0000	0.1462	0.1670	1.584
1984	1.2400	0.4110	1.0000	0.8290	0.9471	2.344
1985	-0.7457	-0.7207	1.0000	-0.0250	-0.0285	0.756
1986	-0.4854	-1.3357	1.0000	0.8503	0.9714	0.409
1987	-1.0607	-1.5117	1.0000	0.4509	0.5152	0.343
1988	-0.3223	-1.7587	1.0000	1.4364	1.6409	0.268
1989	-1.0889	-2.2220	1.0000	1.1331	1.2945	0.168
1990	-0.4648	-1.9545	1.0000	1.4897	1.7019	0.220
1991	-0.0593	-1.0921	1.0000	1.0328	1.1799	0.521
1992	-0.5011	-0.5999	1.0000	0.0988	0.1129	0.853
1993	-2.4470	-0.8479	1.0000	-1.5991	-1.8268	0.666
1994	-0.5064	-0.1009	1.0000	-0.4056	-0.4633	1.405
1995	0.7341	-0.7893	1.0000	1.5234	1.7403	0.706
1996	0.7644	0.2743	1.0000	0.4901	0.5599	2.045

Partial variance for this index is 1.014455

Index 8 SCAL AG1
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 1
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.2019	0.0351	1.0000	-0.2370	-0.2707	18.584
1983	-0.8139	-1.2922	1.0000	0.4782	0.5464	4.928
1984	-0.5021	-0.8586	1.0000	0.3565	0.4072	7.604
1985	0.0609	-0.3292	1.0000	0.3901	0.4457	12.910
1986	-1.1511	-1.1021	1.0000	-0.0490	-0.0560	5.960
1987	-1.7899	-1.0461	1.0000	-0.7438	-0.8498	6.303
1988	-1.6636	-0.0352	1.0000	-1.6284	-1.8604	17.322
1989	-1.1665	-0.8472	1.0000	-0.3192	-0.3647	7.690
1990	-1.7522	-0.5083	1.0000	-1.2439	-1.4211	10.793
1991	1.3630	0.1315	1.0000	1.2314	1.4068	20.465
1992	-1.1162	-0.1076	1.0000	-1.0086	-1.1522	16.112
1993	0.7319	0.0165	1.0000	0.7154	0.8173	18.242
1994	0.9472	0.1097	1.0000	0.8375	0.9568	20.023
1995	0.1125	-0.2016	1.0000	0.3140	0.3587	14.667
1996	-0.1028	-1.0097	1.0000	0.9068	1.0360	6.537

Partial variance for this index is 0.732247

Index 9 SCAL AG2
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.8531	1.0586	1.0000	-0.2055	-0.2348	36.089
1983	0.8660	-0.2104	1.0000	1.0764	1.2297	10.144
1984	-0.6138	-1.5324	1.0000	0.9186	1.0494	2.705
1985	-1.0727	-1.0917	1.0000	0.0190	0.0217	4.203
1986	-1.1655	-0.5659	1.0000	-0.5995	-0.6849	7.109
1987	-0.4248	-1.3177	1.0000	0.8928	1.0200	3.352
1988	-1.4909	-1.1838	1.0000	-0.3071	-0.3509	3.833
1989	0.6847	0.0551	1.0000	0.6296	0.7193	13.230
1990	-1.2990	-0.8742	1.0000	-0.4248	-0.4853	5.223
1991	-2.0409	-0.3619	1.0000	-1.6790	-1.9181	8.718
1992	-0.0440	-0.0386	1.0000	-0.0054	-0.0062	12.047
1993	-0.8370	-0.0671	1.0000	-0.7698	-0.8795	11.707
1994	-0.6058	-0.0085	1.0000	-0.5973	-0.6824	12.414
1995	0.3660	0.2630	1.0000	0.1030	0.1177	16.287
1996	0.8912	-0.0579	1.0000	0.9490	1.0842	11.816

Partial variance for this index is 0.620754

Index 10 SCAL AG3
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.4773	-0.0457	1.0000	-0.4316	-0.4931	8.682
1983	0.2919	0.3854	1.0000	-0.0935	-0.1068	13.362
1984	-1.6891	-1.1580	1.0000	-0.5311	-0.6068	2.855
1985	-4.7494	-2.1610	1.0000	-2.5884	-2.9570	1.047
1986	-4.0562	-1.6850	1.0000	-2.3712	-2.7089	1.685
1987	-0.9353	-1.4843	1.0000	0.5490	0.6272	2.060
1988	-1.5713	-2.1316	1.0000	0.5603	0.6401	1.078
1989	-0.3969	-1.5691	1.0000	1.1721	1.3391	1.893
1990	0.1233	-0.2941	1.0000	0.4174	0.4769	6.772
1991	-0.8575	-1.1519	1.0000	0.2944	0.3363	2.872
1992	-1.0117	-0.4493	1.0000	-0.5624	-0.6425	5.799
1993	-0.0398	-0.5483	1.0000	0.5084	0.5809	5.253
1994	0.5236	-0.4292	1.0000	0.9529	1.0886	5.916
1995	1.0677	0.0298	1.0000	1.0380	1.1858	9.363
1996	1.4062	0.3205	1.0000	1.0857	1.2403	12.523

Partial variance for this index is 1.363667

Index 11 SCAL 4+
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 4 5 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.5471	0.0271	1.0000	-0.5742	-0.6560	3.762
1983	-0.1319	0.1508	1.0000	-0.2828	-0.3230	4.258
1984	-0.2839	-0.1071	1.0000	-0.1769	-0.2021	3.290
1985	-2.4737	-1.3020	1.0000	-1.1718	-1.3387	0.996
1986	-3.7955	-1.8157	1.0000	-1.9798	-2.2617	0.596
1987	-1.7160	-1.6364	1.0000	-0.0796	-0.0910	0.713
1988	-2.0907	-1.9872	1.0000	-0.1036	-0.1183	0.502
1989	-1.0074	-2.1459	1.0000	1.1385	1.3006	0.428
1990	-0.6931	-1.3404	1.0000	0.6473	0.7395	0.958
1991	-0.1982	-0.5289	1.0000	0.3307	0.3778	2.158
1992	-2.4737	-0.8288	1.0000	-1.6449	-1.8792	1.599
1993	0.6413	-0.2775	1.0000	0.9187	1.0496	2.774
1994	0.9709	-0.4766	1.0000	1.4476	1.6537	2.273
1995	1.2671	-0.2041	1.0000	1.4712	1.6808	2.986
1996	0.9252	0.8657	1.0000	0.0595	0.0680	8.703

Partial variance for this index is 1.116891

Index 12 FALL AG1
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
1973	0.6055	-0.3214	1.0000	0.9269	1.0589	28.290
1974	1.2226	0.2534	1.0000	0.9693	1.1073	50.265
1975	1.2231	0.5631	1.0000	0.6599	0.7539	68.516
1976	-1.3991	-0.5320	1.0000	-0.8671	-0.9906	22.919
1977	-0.3831	-0.9065	1.0000	0.5233	0.5979	15.760
1978	1.2453	0.2644	1.0000	0.9809	1.1206	50.823
1979	-0.0369	-0.5123	1.0000	0.4754	0.5432	23.375
1980	-0.5815	-0.5684	1.0000	-0.0131	-0.0150	22.099
1981	0.1515	0.4480	1.0000	-0.2965	-0.3387	61.066
1982	0.5770	-0.5900	1.0000	1.1670	1.3332	21.627
1983	-2.5248	-1.9029	1.0000	-0.6219	-0.7105	5.819
1984	-0.7224	-1.5098	1.0000	0.7874	0.8996	8.620
1985	-0.0083	-0.9833	1.0000	0.9750	1.1139	14.595
1986	-1.5814	-1.7677	1.0000	0.1863	0.2129	6.661
1987	-2.4888	-1.7138	1.0000	-0.7750	-0.8854	7.030
1988	-4.2717	-0.7002	1.0000	-3.5716	-4.0802	19.371
1989	-1.7027	-1.5140	1.0000	-0.1887	-0.2156	8.584
1991	0.4335	-0.5372	1.0000	0.9707	1.1089	22.800
1992	-2.1989	-0.7150	1.0000	-1.4839	-1.6952	19.085
1993	-0.4804	-0.5268	1.0000	0.0464	0.0530	23.038
1994	-0.1261	-0.5670	1.0000	0.4409	0.5037	22.130
1995	-1.5814	-0.8795	1.0000	-0.7018	-0.8018	16.190
1996	-2.2745	-1.6844	1.0000	-0.5901	-0.6742	7.240

Partial variance for this index is 1.169271

Index 13 FALL AG2
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 2
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1973	1.2822	-0.0242	1.0000	1.3065	1.4925	18.624
1974	0.6268	-0.1798	1.0000	0.8066	0.9214	15.940
1975	0.4987	0.0827	1.0000	0.4160	0.4752	20.726
1976	0.2350	0.4362	1.0000	-0.2012	-0.2298	29.514
1977	0.3486	-0.4784	1.0000	0.8270	0.9448	11.826
1978	-0.1814	-0.6624	1.0000	0.4810	0.5495	9.839
1979	0.2707	0.2656	1.0000	0.0051	0.0058	24.886
1980	1.2045	-0.2172	1.0000	1.4217	1.6242	15.355
1981	0.4252	-0.1893	1.0000	0.6145	0.7020	15.790
1982	0.3596	0.6373	1.0000	-0.2777	-0.3172	36.089
1983	0.4040	-0.6318	1.0000	1.0357	1.1832	10.144
1984	-1.3383	-1.9537	1.0000	0.6155	0.7031	2.705
1985	-1.0018	-1.5130	1.0000	0.5112	0.5840	4.203
1986	-0.3176	-0.9872	1.0000	0.6696	0.7650	7.109
1987	-1.3636	-1.7390	1.0000	0.3754	0.4289	3.352
1988	-1.9684	-1.6051	1.0000	-0.3634	-0.4151	3.833
1989	0.2672	-0.3662	1.0000	0.6334	0.7236	13.230
1990	-1.5428	-1.2955	1.0000	-0.2473	-0.2825	5.223
1991	-1.7130	-0.7833	1.0000	-0.9297	-1.0621	8.718
1992	-1.3483	-0.4599	1.0000	-0.8884	-1.0150	12.047
1993	-2.4171	-0.4884	1.0000	-1.9286	-2.2033	11.707
1994	-1.9361	-0.4298	1.0000	-1.5063	-1.7208	12.414
1995	-2.5422	-0.1583	1.0000	-2.3839	-2.7235	16.287
1996	-1.4718	-0.4792	1.0000	-0.9926	-1.1340	11.816

Partial variance for this index is 1.017189

Index 14 FALL AG3
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 3
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1973	1.3922	0.8574	1.0000	0.5347	0.6109	19.042
1974	0.1835	0.0906	1.0000	0.0929	0.1061	8.845
1975	-0.3691	-0.4002	1.0000	0.0310	0.0355	5.414
1976	-0.9823	-0.3906	1.0000	-0.5917	-0.6759	5.466
1977	0.2623	-0.0956	1.0000	0.3579	0.4088	7.342
1978	-0.4953	-0.6549	1.0000	0.1596	0.1823	4.197
1979	-1.3899	-0.4925	1.0000	-0.8974	-1.0252	4.937
1980	1.5622	0.3764	1.0000	1.1858	1.3547	11.771
1981	0.2507	0.0188	1.0000	0.2319	0.2649	8.232
1982	0.2259	0.0721	1.0000	0.1538	0.1757	8.682
1983	0.4113	0.5032	1.0000	-0.0919	-0.1050	13.362
1984	-1.4220	-1.0402	1.0000	-0.3818	-0.4362	2.855
1985	-2.0704	-2.0432	1.0000	-0.0272	-0.0311	1.047
1986	-1.2877	-1.5673	1.0000	0.2796	0.3194	1.685
1987	-1.1642	-1.3666	1.0000	0.2023	0.2312	2.060
1988	-2.5207	-2.0138	1.0000	-0.5068	-0.5790	1.078
1989	-0.4941	-1.4513	1.0000	0.9573	1.0936	1.893
1990	0.1789	-0.1764	1.0000	0.3552	0.4058	6.772
1991	-1.0611	-1.0342	1.0000	-0.0270	-0.0308	2.872
1992	-0.5775	-0.3315	1.0000	-0.2460	-0.2811	5.799
1993	-0.7706	-0.4305	1.0000	-0.3401	-0.3885	5.253
1994	-0.2581	-0.3115	1.0000	0.0534	0.0610	5.916
1995	-1.2877	0.1475	1.0000	-1.4352	-1.6396	9.363
1996	0.3881	0.4383	1.0000	-0.0502	-0.0574	12.523

Partial variance for this index is 0.303083

Index 15 FALL AG4
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 4
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1973	1.6641	1.1872	1.0000	0.4769	0.5448	10.171
1974	0.6426	0.7091	1.0000	-0.0665	-0.0760	6.306
1975	0.0257	-0.2887	1.0000	0.3143	0.3591	2.325
1976	-1.5613	-0.8691	1.0000	-0.6922	-0.7908	1.301
1977	0.1030	-0.6356	1.0000	0.7386	0.8438	1.643
1978	-0.3171	-0.5507	1.0000	0.2336	0.2668	1.789
1979	-1.5194	-0.8765	1.0000	-0.6429	-0.7345	1.292
1980	0.1957	-0.4517	1.0000	0.6474	0.7396	1.975
1981	-0.1089	0.1699	1.0000	-0.2788	-0.3185	3.678
1982	-0.2761	-0.0923	1.0000	-0.1838	-0.2099	2.829
1983	-0.1644	0.0406	1.0000	-0.2050	-0.2342	3.232
1984	1.4714	-0.2482	1.0000	1.7196	1.9645	2.421
1985	-2.6346	-1.6670	1.0000	-0.9676	-1.1054	0.586
1986	-2.0750	-2.1564	1.0000	0.0814	0.0930	0.359
1987	-2.3532	-1.7334	1.0000	-0.6198	-0.7081	0.548
1988	-2.8895	-2.0845	1.0000	-0.8049	-0.9196	0.386
1989	-2.0894	-2.2605	1.0000	0.1711	0.1955	0.324
1990	-0.6887	-1.3178	1.0000	0.6291	0.7187	0.831
1991	-0.4429	-0.4930	1.0000	0.0501	0.0572	1.895
1992	-1.2359	-1.0043	1.0000	-0.2316	-0.2645	1.137
1993	-0.0393	-0.2592	1.0000	0.2198	0.2511	2.395
1994	0.2418	-0.6325	1.0000	0.8743	0.9988	1.649
1995	-0.6887	-0.2445	1.0000	-0.4441	-0.5074	2.430
1996	-0.2142	0.8049	1.0000	-1.0191	-1.1642	6.939

Partial variance for this index is 0.432771

Index 18 FAL AG5+
Index is tuned to the sum of mean full stock sizes (in number)
for ages: 5 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1973	1.8487	1.4831	1.0000	0.3656	0.4176	5.689
1974	1.0678	1.1516	1.0000	-0.0837	-0.0957	4.084
1975	0.3209	0.4709	1.0000	-0.1501	-0.1714	2.068
1976	-0.2629	0.0013	1.0000	-0.2641	-0.3018	1.293
1977	-0.2674	-0.4876	1.0000	0.2202	0.2515	0.793
1978	-0.5065	-0.6709	1.0000	0.1644	0.1878	0.660
1979	-0.1562	-0.4480	1.0000	0.2919	0.3334	0.825
1980	0.3699	-0.8155	1.0000	1.1854	1.3542	0.571
1981	-0.2857	-0.5983	1.0000	0.3126	0.3571	0.710
1982	-1.1769	-0.3246	1.0000	-0.8523	-0.9737	0.933
1983	-0.8949	-0.2295	1.0000	-0.6654	-0.7601	1.026
1984	-0.7456	-0.3957	1.0000	-0.3499	-0.3997	0.869
1985	-1.2835	-1.1468	1.0000	-0.1367	-0.1562	0.410
1987	-1.2961	-2.0598	1.0000	0.7637	0.8725	0.165
1989	-1.4759	-2.5125	1.0000	1.0366	1.1843	0.105
1990	-3.0265	-2.3138	1.0000	-0.7127	-0.8142	0.128
1992	-0.5239	-1.0276	1.0000	0.5037	0.5755	0.462
1994	0.1028	-0.7254	1.0000	0.8282	0.9462	0.625
1995	-1.5712	-0.8427	1.0000	-0.7285	-0.8323	0.556
1996	-1.4171	0.3118	1.0000	-1.7289	-1.9751	1.763

Partial variance for this index is 0.523592

Index 20 CAN AGE2
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
1987	-3.2169	-1.3854	1.0000	-1.8314	-2.0923	5.311
1988	-1.4971	-1.3272	1.0000	-0.1699	-0.1941	5.629
1989	-1.3710	-0.3193	1.0000	-1.0518	-1.2016	15.423
1990	-0.4443	-1.1293	1.0000	0.6850	0.7826	6.861
1991	-1.5909	-0.7884	1.0000	-0.8025	-0.9168	9.648
1992	1.2120	-0.1485	1.0000	1.3605	1.5542	18.295
1993	-0.1296	-0.4551	1.0000	0.3255	0.3718	13.464
1994	0.7566	-0.4045	1.0000	1.1611	1.3264	14.162
1995	-0.9396	-0.1618	1.0000	-0.7779	-0.8886	18.054
1996	0.6297	-0.4717	1.0000	1.1014	1.2582	13.243

Partial variance for this index is 1.221902

Index 21 CAN AGE3
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
1987	-1.5961	-0.6635	1.0000	-0.9326	-1.0654	4.080
1988	-0.7017	-1.4031	1.0000	0.7014	0.8013	1.947
1989	-1.3893	-1.1666	1.0000	-0.2227	-0.2544	2.467
1990	0.1012	0.3513	1.0000	-0.2501	-0.2857	11.255
1991	-0.6744	-0.7163	1.0000	0.0419	0.0479	3.870
1992	0.2289	-0.0090	1.0000	0.2379	0.2718	7.850
1993	0.5487	-0.0660	1.0000	0.6148	0.7023	7.415
1994	-0.0537	0.2441	1.0000	-0.2978	-0.3402	10.111
1995	0.2201	0.3115	1.0000	-0.0914	-0.1044	10.816
1996	0.8128	0.6142	1.0000	0.1986	0.2269	14.639

Partial variance for this index is 0.233152

Index 22 CAN AGE4
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
1987	0.1058	-0.9584	1.0000	1.0642	1.2158	1.108
1988	-1.0651	-1.2226	1.0000	0.1575	0.1799	0.851
1989	-2.0799	-1.7216	1.0000	-0.3583	-0.4093	0.517
1990	-0.7743	-0.7140	1.0000	-0.0603	-0.0689	1.415
1991	0.2330	0.2402	1.0000	-0.0072	-0.0083	3.675
1992	-0.7110	-0.3373	1.0000	-0.3737	-0.4269	2.063
1993	0.0541	0.3596	1.0000	-0.3055	-0.3490	4.141
1994	0.1250	0.2079	1.0000	-0.0830	-0.0948	3.558
1995	-0.0719	0.0644	1.0000	-0.1363	-0.1557	3.082
1996	1.1265	1.0239	1.0000	0.1026	0.1172	8.046

Partial variance for this index is 0.177546

Index 25 CAN 5+
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 5 6
SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1987	-0.1353	-0.7740	1.0000	0.6388	0.7297	0.343
1988	0.0238	-1.0210	1.0000	1.0449	1.1937	0.268
1989	-2.5863	-1.4844	1.0000	-1.1019	-1.2588	0.168
1990	-0.4821	-1.2168	1.0000	0.7347	0.8393	0.220
1991	0.2110	-0.3544	1.0000	0.5654	0.6459	0.521
1992	-0.8284	0.1377	1.0000	-0.9661	-1.1037	0.853
1993	-1.1512	-0.1103	1.0000	-1.0409	-1.1892	0.666
1994	0.4583	0.6368	1.0000	-0.1785	-0.2040	1.405
1995	0.4293	-0.0516	1.0000	0.4809	0.5494	0.706
1996	0.8347	1.0120	1.0000	-0.1772	-0.2025	2.045

Partial variance for this index is 0.670426

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

■	1973	1974	1975	1976	1977	1978	1979
1 ■	2.8350	0.1105	0.0817	2.3620	-99.0000	1.3384	0.8429
2 ■	0.9095	0.4919	0.1932	0.3204	-0.6177	0.0005	-0.0838
3 ■	-0.3864	0.1055	-0.3950	0.1867	-0.4573	-0.5491	-0.9206
4 ■	-1.0309	-0.4171	-1.0489	-0.1446	-0.1761	-0.8579	-0.0404
7 ■	-1.2832	-1.0355	-1.2876	-0.4671	-1.3552	-2.1584	-0.7654
8 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-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 ■	1.0589	1.1073	0.7539	-0.9906	0.5979	1.1206	0.5432
13 ■	1.4925	0.9214	0.4752	-0.2298	0.9448	0.5495	0.0058
14 ■	0.6109	0.1061	0.0355	-0.6759	0.4088	0.1823	-1.0252
15 ■	0.5448	-0.0760	0.3591	-0.7908	0.8438	0.2668	-0.7345
18 ■	0.4176	-0.0957	-0.1714	-0.3018	0.2515	0.1878	0.3334
20 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25 ■	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
** ■	0.5169	0.1219	-0.1004	-0.0731	0.0489	0.0081	-0.1845

■	1980	1981	1982	1983	1984	1985	1986
1	-0.9073	-3.8485	-1.1527	-99.0000	-99.0000	0.3177	-0.3908
2	1.5481	-0.1065	0.1928	0.7093	-1.1816	1.8850	1.0522
3	1.1521	0.2677	-0.4040	-0.0606	0.1820	0.3709	0.0465
4	0.0110	-0.4652	0.2682	-0.4185	-0.0591	0.6188	-0.5998
7	-0.7236	0.0573	0.5061	0.1670	0.9471	-0.0285	0.9714
8	-99.0000	-99.0000	-0.2707	0.5464	0.4072	0.4457	-0.0560
9	-99.0000	-99.0000	-0.2348	1.2297	1.0494	0.0217	-0.6849
10	-99.0000	-99.0000	-0.4931	-0.1068	-0.6068	-2.9570	-2.7089
11	-99.0000	-99.0000	-0.6560	-0.3230	-0.2021	-1.3387	-2.2617
12	-0.0150	-0.3387	1.3332	-0.7105	0.8996	1.1139	0.2129
13	1.6242	0.7020	-0.3172	1.1832	0.7031	0.5840	0.7650
14	1.3547	0.2649	0.1757	-0.1050	-0.4362	-0.0311	0.3194
15	0.7396	-0.3185	-0.2099	-0.2342	1.9645	-1.1054	0.0930
18	1.3542	0.3571	-0.9737	-0.7601	-0.3997	-0.1562	-99.0000
20	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
21	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
22	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
25	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
**	0.6138	-0.3428	-0.1597	0.0859	0.2513	-0.0185	-0.2494

■	1987	1988	1989	1990	1991	1992	1993
1	-99.0000	-0.3985	-0.0474	-99.0000	1.3788	-99.0000	-1.1998
2	-1.1028	-0.2956	-0.9525	-2.1695	-99.0000	0.6302	-1.2313
3	-1.6341	0.5636	1.0977	-0.1752	-0.6383	0.8792	-0.6075
4	-0.2889	0.6968	1.4735	0.6696	0.1974	0.7188	-0.8024
7	0.5152	1.6409	1.2945	1.7019	1.1799	0.1129	-1.8268
8	-0.8498	-1.8604	-0.3647	-1.4211	1.4068	-1.1522	0.8173
9	1.0200	-0.3509	0.7193	-0.4853	-1.9181	-0.0062	-0.8795
10	0.6272	0.6401	1.3391	0.4769	0.3363	-0.6425	0.5809
11	-0.0910	-0.1183	1.3006	0.7395	0.3778	-1.8792	1.0496
12	-0.8854	-4.0802	-0.2156	-99.0000	1.1089	-1.6952	0.0530
13	0.4289	-0.4151	0.7236	-0.2825	-1.0621	-1.0150	-2.2033
14	0.2312	-0.5790	1.0936	0.4058	-0.0308	-0.2811	-0.3885
15	-0.7081	-0.9196	0.1955	0.7187	0.0572	-0.2645	0.2511
18	0.8725	-99.0000	1.1843	-0.8142	-99.0000	0.5755	-99.0000
20	-2.0923	-0.1941	-1.2016	0.7826	-0.9168	1.5542	0.3718
21	-1.0654	0.8013	-0.2544	-0.2857	0.0479	0.2718	0.7023
22	1.2158	0.1799	-0.4093	-0.0689	-0.0083	-0.4269	-0.3490
25	0.7297	1.1937	-1.2588	0.8393	0.6459	-1.1037	-1.1892
**	-0.1810	-0.2056	0.3176	0.0395	0.1352	-0.2191	-0.4030

■	1994	1995	1996	1997	********
1	-99.0000	-0.9565	-0.3656	-99.0000	-0.0000
2	-0.4191	0.0369	0.1903	-99.0000	-0.0000
3	-0.6833	1.5475	0.5120	-99.0000	-0.0000
4	-0.4934	1.3029	0.8859	-99.0000	0.0000
7	-0.4633	1.7403	0.5599	-99.0000	-0.0000
8	0.9568	0.3587	1.0360	-99.0000	-0.0000
9	-0.6824	0.1177	1.0842	-99.0000	-0.0000
10	1.0886	1.1858	1.2403	-99.0000	-0.0000
11	1.6537	1.6808	0.0680	-99.0000	-0.0000
12	0.5037	-0.8018	-0.6742	-99.0000	-0.0000
13	-1.7208	-2.7235	-1.1340	-99.0000	-0.0000
14	0.0610	-1.6396	-0.0574	-99.0000	-0.0000
15	0.9988	-0.5074	-1.1642	-99.0000	-0.0000
18	0.9462	-0.8323	-1.9751	-99.0000	-0.0000
20	1.3264	-0.8886	1.2582	-99.0000	-0.0000
21	-0.3402	-0.1044	0.2269	-99.0000	-0.0000
22	-0.0948	-0.1557	0.1172	-99.0000	-0.0000
25	-0.2040	0.5494	-0.2025	-99.0000	-0.0000
**	0.1432	-0.0050	0.0892	1.0000	-0.0000

-99 in the above table indicates a missing value

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

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	2.64	0.00	0.00	1.83	-99.00	0.59	0.23	0.27	4.86
2	0.27	0.08	0.01	0.03	0.13	0.00	0.00	0.79	0.00
3	0.05	0.00	0.05	0.01	0.07	0.10	0.28	0.44	0.02
4	0.35	0.06	0.36	0.01	0.01	0.24	0.00	0.00	0.07
7	0.54	0.35	0.54	0.07	0.60	1.53	0.19	0.17	0.00
8	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
9	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
10	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
11	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
12	0.37	0.40	0.19	0.32	0.12	0.41	0.10	0.00	0.04
13	0.73	0.28	0.07	0.02	0.29	0.10	0.00	0.86	0.16
14	0.12	0.00	0.00	0.15	0.05	0.01	0.34	0.60	0.02
15	0.10	0.00	0.04	0.21	0.23	0.02	0.18	0.18	0.03
18	0.06	0.00	0.01	0.03	0.02	0.01	0.04	0.60	0.04
20	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
21	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
22	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
**	5.22	1.18	1.28	2.68	1.52	3.01	1.36	3.91	5.25

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.44	-99.00	-99.00	0.03	0.05	-99.00	0.05	0.00	-99.00
2	0.01	0.16	0.46	1.16	0.36	0.40	0.03	0.30	1.54
3	0.05	0.00	0.01	0.05	0.00	0.88	0.10	0.40	0.01
4	0.02	0.06	0.00	0.13	0.12	0.03	0.16	0.71	0.15
7	0.08	0.01	0.29	0.00	0.31	0.09	0.88	0.55	0.95
8	0.02	0.10	0.05	0.07	0.00	0.24	1.13	0.04	0.66
9	0.02	0.50	0.36	0.00	0.15	0.34	0.04	0.17	0.08
10	0.08	0.00	0.12	2.87	2.41	0.13	0.13	0.59	0.07
11	0.14	0.03	0.01	0.59	1.68	0.00	0.00	0.55	0.18
12	0.58	0.17	0.27	0.41	0.01	0.26	5.46	0.02	-99.00
13	0.03	0.46	0.16	0.11	0.19	0.06	0.06	0.17	0.03
14	0.01	0.00	0.06	0.00	0.03	0.02	0.11	0.39	0.05
15	0.01	0.02	1.27	0.40	0.00	0.16	0.28	0.01	0.17
18	0.31	0.19	0.05	0.01	-99.00	0.25	-99.00	0.46	0.22
20	-99.00	-99.00	-99.00	-99.00	-99.00	1.44	0.01	0.47	0.20
21	-99.00	-99.00	-99.00	-99.00	-99.00	0.37	0.21	0.02	0.03
22	-99.00	-99.00	-99.00	-99.00	-99.00	0.48	0.01	0.05	0.00
25	-99.00	-99.00	-99.00	-99.00	-99.00	0.17	0.47	0.52	0.23
**	1.82	1.70	3.12	5.82	5.32	5.31	9.14	5.43	4.57

	1991	1992	1993	1994	1995	1996	1997	*******
1	0.62	-99.00	0.47	-99.00	0.30	0.04	-99.00	12.43
2	-99.00	0.13	0.50	0.06	0.00	0.01	-99.00	6.44
3	0.13	0.25	0.12	0.15	0.79	0.09	-99.00	4.05
4	0.01	0.17	0.21	0.08	0.56	0.26	-99.00	3.75
7	0.46	0.00	1.09	0.07	0.99	0.10	-99.00	9.89
8	0.65	0.44	0.22	0.30	0.04	0.35	-99.00	4.32
9	1.21	0.00	0.25	0.15	0.00	0.39	-99.00	3.66
10	0.04	0.14	0.11	0.39	0.46	0.50	-99.00	8.04
11	0.05	1.16	0.36	0.90	0.93	0.00	-99.00	6.58
12	0.40	0.94	0.00	0.08	0.21	0.15	-99.00	10.90
13	0.37	0.34	1.59	0.97	2.43	0.42	-99.00	9.91
14	0.00	0.03	0.05	0.00	0.88	0.00	-99.00	2.95
15	0.00	0.02	0.02	0.33	0.08	0.44	-99.00	4.22
18	-99.00	0.11	-99.00	0.29	0.23	1.28	-99.00	4.21
20	0.28	0.79	0.05	0.58	0.26	0.52	-99.00	4.59
21	0.00	0.02	0.16	0.04	0.00	0.02	-99.00	0.88
22	0.00	0.06	0.04	0.00	0.01	0.00	-99.00	0.67
25	0.14	0.40	0.46	0.01	0.10	0.01	-99.00	2.52
**	4.35	5.00	5.71	4.41	8.27	4.59	0.00	100.00

-99 in the above table indicates a missing value

Partial variance (and proportion of total) by index

■	1	2	3	4	7	8
** ■	1.84071084	0.69123341	0.41526434	0.38516865	1.01445529	0.73224696
** ■	0.13214648	0.04962434	0.02981224	0.02765164	0.07282876	0.05256874

■	9	10	11	12	13	14
** ■	0.62075351	1.36366680	1.11689085	1.16927072	1.01718925	0.30308306
** ■	0.04456452	0.09789901	0.08018272	0.08394312	0.07302504	0.02175864

■	15	18	20	21	22	25
** ■	0.43277070	0.52359202	1.22190172	0.23315172	0.17754554	0.67042642
** ■	0.03106904	0.03758920	0.08772155	0.01673820	0.01274617	0.04813059

■	*************
** ■	13.92932180
** ■	1.00000000

STOCK NUMBERS (Jan 1) in millions - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981
1 ■	28.290	50.265	68.516	22.919	15.760	50.823	23.375	22.099	61.066
2 ■	23.279	22.848	39.214	52.140	18.208	12.605	32.871	18.927	17.814
3 ■	28.937	14.635	10.589	9.228	14.628	7.144	7.510	18.312	12.264
4 ■	16.960	11.709	4.830	2.284	2.899	3.003	2.199	3.032	7.011
5 ■	6.729	5.492	2.893	0.885	0.651	0.816	0.957	0.677	1.198
6 ■	2.859	2.240	1.551	1.417	0.768	0.304	0.465	0.206	0.185
1+■	107.055	107.189	127.593	88.873	52.914	74.695	67.376	63.252	99.538

■	1982	1983	1984	1985	1986	1987	1988	1989	1990
1 ■	21.627	5.819	8.620	14.595	6.661	7.030	19.371	8.584	12.026
2 ■	49.947	15.840	4.134	6.670	11.361	5.311	5.629	15.423	6.861
3 ■	13.925	25.067	6.011	1.650	2.435	4.080	1.947	2.467	11.255
4 ■	5.199	4.957	6.031	1.062	0.613	1.108	0.851	0.517	1.415
5 ■	1.618	1.319	1.962	0.654	0.279	0.188	0.219	0.132	0.186
6 ■	0.129	0.264	0.382	0.102	0.129	0.155	0.049	0.036	0.034
1+■	92.445	53.266	27.141	24.733	21.478	17.871	28.066	27.159	31.777

■	1991	1992	1993	1994	1995	1996	1997
1 ■	22.800	19.085	23.038	22.130	16.190	7.240	0.000
2 ■	9.648	18.295	13.464	14.162	18.054	13.243	5.882
3 ■	3.870	7.850	7.415	10.111	10.816	14.639	10.496
4 ■	3.675	2.063	4.141	3.558	3.082	8.046	10.620
5 ■	0.435	0.811	0.541	1.226	0.587	1.877	5.939
6 ■	0.087	0.042	0.125	0.179	0.119	0.168	1.509
1+■	40.514	48.146	48.724	51.366	48.849	45.212	34.447

Summaries for ages 2 6 3 6 4 6 5 6

■	1973	1974	1975	1976	1977	1978	1979	1980	1981
2 ■	78.765	56.924	59.077	65.954	37.155	23.872	44.001	41.153	38.472
3 ■	55.486	34.076	19.863	13.814	18.946	11.268	11.130	22.226	20.658
4 ■	26.549	19.441	9.274	4.586	4.318	4.124	3.620	3.914	8.394
5 ■	9.589	7.732	4.444	2.302	1.419	1.120	1.421	0.882	1.384

■	1982	1983	1984	1985	1986	1987	1988	1989	1990
2 ■	70.818	47.447	18.521	10.138	14.817	10.841	8.695	18.575	19.751
3 ■	20.871	31.607	14.387	3.468	3.456	5.531	3.066	3.152	12.891
4 ■	6.946	6.540	8.375	1.818	1.021	1.451	1.119	0.685	1.635
5 ■	1.747	1.584	2.344	0.756	0.409	0.343	0.268	0.168	0.220

■	1991	1992	1993	1994	1995	1996	1997
2 ■	17.714	29.060	25.685	29.236	32.658	37.973	34.447
3 ■	8.066	10.766	12.221	15.074	14.604	24.730	28.565
4 ■	4.196	2.916	4.806	4.963	3.788	10.090	18.069
5 ■	0.521	0.853	0.666	1.405	0.706	2.045	7.449

FISHING MORTALITY - GB96_7

■	1973	1974	1975	1976	1977	1978	1979	1980	1981
1 ■	0.0136	0.0483	0.0731	0.0301	0.0234	0.2358	0.0111	0.0156	0.0010
2 ■	0.2642	0.5690	1.2468	1.0710	0.7356	0.3178	0.3850	0.2339	0.0463
3 ■	0.7048	0.9085	1.3339	0.9579	1.3833	0.9783	0.7072	0.7601	0.6582
4 ■	0.9275	1.1982	1.4967	1.0549	1.0673	0.9439	0.9788	0.7283	1.2665
5 ■	0.9538	1.2487	1.5907	1.0911	1.1047	0.9713	1.0088	0.7432	1.3251
6 ■	0.9538	1.2487	1.5907	1.0911	1.1047	0.9713	1.0088	0.7432	1.3251

■	1982	1983	1984	1985	1986	1987	1988	1989	1990
1 ■	0.1114	0.1418	0.0564	0.0505	0.0266	0.0223	0.0279	0.0241	0.0203
2 ■	0.4894	0.7689	0.7184	0.8079	0.8242	0.8032	0.6250	0.1150	0.3726
3 ■	0.8330	1.2246	1.5338	0.7908	0.5869	1.3674	1.1268	0.3556	0.9193
4 ■	1.1712	0.7265	2.0211	1.1355	0.9835	1.4224	1.6629	0.8219	0.9802
5 ■	1.2187	0.7413	2.2686	1.1793	1.0138	1.5034	1.7921	0.8415	1.0103
6 ■	1.2187	0.7413	2.2686	1.1793	1.0138	1.5034	1.7921	0.8415	1.0103

■	1991	1992	1993	1994	1995	1996
1 ■	0.0202	0.1489	0.2866	0.0036	0.0010	0.0077
2 ■	0.0062	0.7031	0.0865	0.0696	0.0097	0.0325
3 ■	0.4292	0.4397	0.5343	0.9879	0.0959	0.1209
4 ■	1.3112	1.1392	1.0173	1.6024	0.2962	0.1035
5 ■	1.3757	1.1834	1.0504	1.7177	0.2985	0.1035
6 ■	1.3757	1.1834	1.0504	1.7177	0.2985	0.1035

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

	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.7608	1.0346	1.4518	1.0532	1.0791	0.8365	0.8177	0.6417	0.9243
3	0.8849	1.1510	1.5030	1.0488	1.1650	0.9662	0.9259	0.7437	1.1437
4	0.9450	1.2319	1.5594	1.0790	1.0922	0.9622	0.9988	0.7382	1.3056
5	0.9538	1.2487	1.5907	1.0911	1.1047	0.9713	1.0088	0.7432	1.3251

	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.9862	0.8405	1.7621	1.0185	0.8844	1.3200	1.3998	0.5951	0.8585
3	1.1104	0.8584	2.0230	1.0712	0.8995	1.4492	1.5935	0.7152	0.9800
4	1.2029	0.7363	2.1861	1.1647	1.0037	1.4764	1.7490	0.8350	1.0002
5	1.2187	0.7413	2.2686	1.1793	1.0138	1.5034	1.7921	0.8415	1.0103

	1991	1992	1993	1994	1995	1996
2	0.8996	0.9298	0.7478	1.2191	0.1998	0.0928
3	1.1229	0.9864	0.9131	1.5064	0.2473	0.1079
4	1.3542	1.1687	1.0394	1.6793	0.2977	0.1035
5	1.3757	1.1834	1.0504	1.7177	0.2985	0.1035

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

	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.6528	0.8781	1.3087	1.0553	1.0306	0.6249	0.4898	0.5154	0.5097
3	0.8159	1.0853	1.4309	0.9961	1.3141	0.9684	0.7993	0.7551	0.9093
4	0.9370	1.2183	1.5418	1.0731	1.0796	0.9513	0.9906	0.7317	1.2762
5	0.9538	1.2487	1.5907	1.0911	1.1047	0.9713	1.0088	0.7432	1.3251

	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.6250	1.0043	1.6035	0.8671	0.7970	1.1010	0.8749	0.1732	0.7348
3	0.9495	1.1223	1.8578	0.9810	0.7077	1.3869	1.3337	0.4580	0.9276
4	1.1832	0.7301	2.0904	1.1537	0.9956	1.4415	1.6938	0.8267	0.9842
5	1.2187	0.7413	2.2686	1.1793	1.0138	1.5034	1.7921	0.8415	1.0103

	1991	1992	1993	1994	1995	1996
2	0.4097	0.6770	0.3908	0.6529	0.0715	0.0855
3	0.8922	0.6326	0.7261	1.2010	0.1480	0.1138
4	1.3192	1.1521	1.0219	1.6351	0.2966	0.1035
5	1.3757	1.1834	1.0504	1.7177	0.2985	0.1035

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

	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	0.7428	0.9360	1.3128	1.0562	1.0825	0.7543	0.5422	0.6244	0.9126
3	0.8267	1.0980	1.4349	0.9981	1.3205	0.9686	0.8134	0.7552	0.9709
4	0.9371	1.2186	1.5426	1.0734	1.0799	0.9515	0.9907	0.7317	1.2764
5	0.9538	1.2487	1.5907	1.0911	1.1047	0.9713	1.0088	0.7432	1.3251

	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0.6783	1.0371	1.7013	0.8790	0.8062	1.1456	0.9630	0.2765	0.8085
3	0.9661	1.1451	1.8740	1.0014	0.7398	1.3874	1.3595	0.5173	0.9279
4	1.1834	0.7301	2.0923	1.1539	0.9958	1.4421	1.6946	0.8268	0.9843
5	1.2187	0.7413	2.2686	1.1793	1.0138	1.5034	1.7921	0.8415	1.0103

	1991	1992	1993	1994	1995	1996
2	1.0339	0.7146	0.6722	1.1399	0.1803	0.1032
3	1.0478	0.7366	0.7785	1.2383	0.1954	0.1144
4	1.3194	1.1523	1.0220	1.6358	0.2966	0.1035
5	1.3757	1.1834	1.0504	1.7177	0.2985	0.1035

BACKCALCULATED PARTIAL RECRUITMENT

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0.01	0.04	0.05	0.03	0.02	0.24	0.01	0.02	0.00	0.09	0.12	0.02	0.04	0.03	0.01
2	0.28	0.46	0.78	0.98	0.53	0.32	0.38	0.31	0.03	0.40	0.63	0.32	0.69	0.81	0.53
3	0.74	0.73	0.84	0.88	1.00	1.00	0.70	1.00	0.50	0.68	1.00	0.68	0.67	0.58	0.91
4	0.97	0.96	0.94	0.97	0.77	0.96	0.97	0.96	0.96	0.96	0.59	0.89	0.96	0.97	0.95
5	1.00	1.00	1.00	1.00	0.80	0.99	1.00	0.98	1.00	1.00	0.61	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	0.80	0.99	1.00	0.98	1.00	1.00	0.61	1.00	1.00	1.00	1.00

	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.02	0.03	0.02	0.01	0.13	0.27	0.00	0.00	0.06
2	0.35	0.14	0.37	0.00	0.59	0.08	0.04	0.03	0.27
3	0.63	0.42	0.91	0.31	0.37	0.51	0.58	0.32	1.00
4	0.93	0.98	0.97	0.95	0.96	0.97	0.93	0.99	0.86
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86

MEAN BIOMASS (1000s MT)

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	0.255	0.445	0.600	0.205	0.141	0.412	0.211	0.199	0.553
2	6.984	6.025	7.047	10.005	4.305	3.316	8.859	5.436	6.142
3	8.835	4.422	2.664	2.979	3.869	2.153	2.281	5.827	4.059
4	5.360	3.840	1.288	0.828	1.042	1.224	0.838	1.296	2.218
5	2.408	1.973	0.832	0.368	0.284	0.381	0.404	0.356	0.435
6	1.317	0.996	0.492	0.665	0.408	0.164	0.241	0.144	0.076
1+	25.159	17.701	12.922	15.049	10.049	7.650	12.834	13.256	13.482

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.186	0.049	0.076	0.129	0.060	0.063	0.173	0.077	0.108	0.205
2	11.296	3.003	0.649	1.526	2.439	1.133	1.345	4.697	1.760	2.354
3	4.228	5.879	1.079	0.520	0.910	1.077	0.601	1.028	2.838	1.100
4	1.839	1.952	1.210	0.379	0.238	0.365	0.265	0.235	0.488	0.917
5	0.646	0.629	0.467	0.260	0.133	0.061	0.081	0.072	0.075	0.159
6	0.073	0.164	0.111	0.045	0.068	0.063	0.021	0.025	0.017	0.037
1+	18.268	11.677	3.593	2.859	3.848	2.763	2.487	6.134	5.287	4.772

	1992	1993	1994	1995	1996
1	0.161	0.182	0.200	0.147	0.065
2	4.108	3.700	3.439	4.642	3.592
3	2.209	2.048	2.083	3.492	5.134
4	0.600	1.221	0.778	1.127	3.942
5	0.285	0.173	0.343	0.269	1.173
6	0.027	0.065	0.065	0.078	0.142
1+	7.390	7.390	6.908	9.756	14.049

Summaries for ages 2 6 3 6 4 6 5 6

	1973	1974	1975	1976	1977	1978	1979	1980	1981
2	24.904	17.256	12.323	14.845	9.908	7.238	12.623	13.058	12.929
3	17.920	11.231	5.276	4.839	5.603	3.922	3.764	7.622	6.787
4	9.085	6.808	2.612	1.860	1.734	1.769	1.483	1.795	2.728
5	3.725	2.968	1.324	1.033	0.692	0.545	0.645	0.500	0.511

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	18.082	11.627	3.517	2.730	3.789	2.700	2.313	6.057	5.179	4.568
3	6.786	8.625	2.868	1.204	1.350	1.566	0.968	1.360	3.419	2.214
4	2.558	2.745	1.789	0.684	0.440	0.489	0.367	0.332	0.581	1.114
5	0.719	0.794	0.578	0.305	0.201	0.124	0.102	0.098	0.093	0.197

	1992	1993	1994	1995	1996
2	7.229	7.208	6.708	9.609	13.983
3	3.121	3.508	3.269	4.967	10.391
4	0.912	1.459	1.186	1.475	5.257
5	0.312	0.238	0.408	0.347	1.315

CATCH BIOMASS (1000s MT)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.003	0.021	0.044	0.006	0.003	0.097	0.002	0.003	0.001	0.021
2	1.845	3.429	8.786	10.716	3.166	1.054	3.411	1.272	0.284	5.528
3	6.227	4.018	3.553	2.854	5.352	2.106	1.613	4.429	2.671	3.522
4	4.971	4.601	1.928	0.873	1.112	1.155	0.820	0.944	2.809	2.154
5	2.296	2.463	1.323	0.402	0.314	0.370	0.408	0.265	0.576	0.788
6	1.256	1.243	0.783	0.725	0.450	0.159	0.243	0.107	0.101	0.089
1+	16.599	15.776	16.417	15.575	10.399	4.942	6.497	7.018	6.441	12.101

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.007	0.004	0.007	0.002	0.001	0.005	0.002	0.002	0.004	0.024
2	2.309	0.466	1.232	2.010	0.910	0.841	0.540	0.656	0.015	2.888
3	7.200	1.655	0.412	0.534	1.473	0.677	0.365	2.609	0.472	0.971
4	1.418	2.446	0.430	0.235	0.519	0.441	0.193	0.479	1.203	0.684
5	0.466	1.060	0.307	0.135	0.092	0.145	0.061	0.076	0.219	0.337
6	0.122	0.252	0.053	0.069	0.094	0.037	0.021	0.017	0.051	0.032
1+	11.522	5.884	2.441	2.984	3.090	2.147	1.183	3.839	1.964	4.936

	1993	1994	1995	1996
1	0.052	0.001	0.000	0.001
2	0.320	0.239	0.045	0.117
3	1.094	2.057	0.335	0.621
4	1.242	1.247	0.334	0.408
5	0.182	0.589	0.080	0.121
6	0.068	0.112	0.023	0.015
1+	2.959	4.245	0.818	1.282

Summaries for ages 2 6 3 6 4 6 5 6

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
2	16.596	15.754	16.373	15.569	10.396	4.845	6.495	7.015	6.441	12.081
3	14.751	12.325	7.587	4.854	7.229	3.791	3.084	5.744	6.156	6.552
4	8.524	8.308	4.034	2.000	1.877	1.685	1.471	1.315	3.485	3.030
5	3.552	3.706	2.106	1.127	0.765	0.530	0.651	0.371	0.677	0.876

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	11.515	5.879	2.434	2.983	3.089	2.142	1.181	3.837	1.960	4.912
3	9.206	5.413	1.202	0.973	2.179	1.301	0.641	3.181	1.945	2.024
4	2.006	3.758	0.790	0.439	0.706	0.624	0.275	0.572	1.473	1.052
5	0.588	1.312	0.360	0.204	0.186	0.183	0.082	0.094	0.270	0.369

	1993	1994	1995	1996
2	2.907	4.245	0.817	1.282
3	2.587	4.005	0.773	1.165
4	1.493	1.948	0.438	0.544
5	0.250	0.701	0.104	0.136

SSB AT THE START OF THE SPAWNING SEASON - males & females (1000s MT)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	3.022	2.821	3.283	4.684	2.020	1.541	4.127	2.516	3.064	5.748
3	8.933	4.518	2.694	3.042	3.906	2.198	2.330	5.954	4.186	4.365
4	5.531	3.982	1.319	0.861	1.084	1.275	0.873	1.351	2.295	1.908
5	2.509	2.042	0.848	0.383	0.296	0.397	0.421	0.371	0.449	0.670
6	1.372	1.031	0.501	0.691	0.424	0.171	0.251	0.150	0.078	0.075
1+	21.368	14.394	8.646	9.661	7.729	5.582	8.001	10.342	10.072	12.767

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	1.534	0.629	1.480	2.365	1.099	1.303	4.465	1.694	2.223	2.227
3	6.031	1.103	0.543	0.947	1.110	0.624	1.063	2.958	1.140	2.291
4	2.035	1.195	0.394	0.248	0.375	0.269	0.245	0.509	0.948	0.623
5	0.656	0.450	0.270	0.139	0.063	0.082	0.076	0.079	0.164	0.295
6	0.171	0.107	0.046	0.071	0.064	0.021	0.026	0.018	0.038	0.028
1+	10.427	3.485	2.732	3.770	2.712	2.299	5.875	5.257	4.513	5.464

	1993	1994	1995	1996
1	0.000	0.000	0.000	0.000
2	1.964	1.823	2.452	1.900
3	1.831	1.866	3.067	4.516
4	1.272	0.777	1.140	3.946
5	0.180	0.347	0.277	1.199
6	0.068	0.066	0.081	0.145
1+	5.314	4.878	7.017	11.706

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 $Z(a,y) = 0.4167 \times M(a,y) + 0.4167 \times F(a,y)$
$N(a,y)$ - 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 mid-year weight at age estimates (see "WT AT AGE" table in input section).

MEAN STOCK NUMBERS (millions) - GB96_7

	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	25.472	44.511	59.956	20.473	14.123	41.197	21.073	19.879	55.321
2	18.624	15.940	20.726	29.514	11.826	9.839	24.886	15.355	15.790
3	19.042	8.845	5.414	5.466	7.342	4.197	4.937	11.771	8.232
4	10.171	6.306	2.325	1.301	1.643	1.789	1.292	1.975	3.678
5	3.993	2.901	1.346	0.497	0.364	0.481	0.555	0.438	0.615
6	1.696	1.183	0.722	0.796	0.429	0.179	0.270	0.133	0.095
1+	78.997	79.686	90.489	58.047	35.728	57.681	53.011	49.552	83.730
2+	53.525	35.174	30.533	37.574	21.604	16.484	31.939	29.672	28.409

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	18.584	4.928	7.604	12.910	5.960	6.303	17.322	7.690	10.793
2	36.089	10.144	2.705	4.203	7.109	3.352	3.833	13.230	5.223
3	8.682	13.362	2.855	1.047	1.685	2.060	1.078	1.893	6.772
4	2.829	3.232	2.421	0.586	0.359	0.548	0.386	0.324	0.831
5	0.864	0.855	0.728	0.355	0.162	0.090	0.095	0.082	0.108
6	0.069	0.171	0.141	0.055	0.075	0.074	0.021	0.023	0.020
1+	67.117	32.692	16.453	19.156	15.351	12.429	22.735	23.241	23.747
2+	48.533	27.764	8.849	6.246	9.391	6.125	5.413	15.551	12.954

	1991	1992	1993	1994	1995	1996
1	20.465	16.112	18.242	20.023	14.667	6.537
2	8.718	12.047	11.707	12.414	16.287	11.816
3	2.872	5.799	5.253	5.916	9.363	12.523
4	1.895	1.137	2.395	1.649	2.430	6.939
5	0.219	0.439	0.308	0.545	0.462	1.619
6	0.044	0.023	0.071	0.080	0.094	0.145
1+	34.213	35.556	37.976	40.627	43.303	39.579
2+	13.748	19.444	19.734	20.604	28.635	33.042

Time stamp at end of run 1997 4 16 15 21 25

BOOTSTRAP RESULTS FOR GB96_7   Timestamp 1997 4 9 15 28 40
YELLOWTAIL FLOUNDER - GEORGES BANK STOCK 1973-1996 Age 1-8

SEED FOR THE RANDOM NUMBER GENERATOR: 74747
MAIN LOOP LIMIT IN MARQUARDT ALGORITHM: 50
NUMBER OF BOOTSTRAP REPLICATIONS ATTEMPTED: 200
NUMBER FOR WHICH NLLS CONVERGED: 200
Results from the converged replications are used for computing the statistics that follow. Other replications are ignored.

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

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
5.882E0	6.273E0	2.692E0	0.46
1.050E1	1.124E1	4.056E0	0.39
1.062E1	1.109E1	3.381E0	0.32
5.939E0	5.979E0	1.266E0	0.21

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
3.905E-1	1.904E-1	6.64	5.491E0	0.49
7.466E-1	2.868E-1	7.11	9.749E0	0.42
4.677E-1	2.390E-1	4.40	1.015E1	0.33
3.919E-2	8.952E-2	0.66	5.900E0	0.21

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.

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
5.707E-3	5.970E-3	1.213E-3	0.21
6.328E-2	6.349E-2	1.141E-2	0.18
1.148E-1	1.166E-1	2.133E-2	0.19
1.545E-1	1.559E-1	2.582E-2	0.17
2.007E-1	2.055E-1	3.432E-2	0.17
3.471E-2	3.572E-2	7.656E-3	0.22
1.844E-2	1.893E-2	3.867E-3	0.21
3.813E-2	3.884E-2	7.999E-3	0.21
4.861E-2	5.069E-2	1.171E-2	0.24
3.489E-2	3.606E-2	6.589E-3	0.19
7.992E-2	8.070E-2	1.393E-2	0.17
1.570E-1	1.573E-1	2.803E-2	0.18
1.797E-1	1.825E-1	3.213E-2	0.18
2.237E-1	2.243E-1	4.273E-2	0.19
1.411E-1	1.482E-1	3.809E-2	0.27
4.609E-1	4.734E-1	1.177E-1	0.26
8.031E-1	8.504E-1	2.257E-1	0.28
8.934E-1	9.373E-1	2.384E-1	0.27

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
2.630E-4	8.574E-5	4.61	5.444E-3	0.22
2.016E-4	8.069E-4	0.32	6.308E-2	0.18
1.793E-3	1.508E-3	1.56	1.130E-1	0.19
1.325E-3	1.825E-3	0.86	1.532E-1	0.17
4.756E-3	2.427E-3	2.37	1.960E-1	0.18
1.009E-3	5.413E-4	2.91	3.370E-2	0.23
4.839E-4	2.734E-4	2.62	1.796E-2	0.22
7.149E-4	5.656E-4	1.87	3.741E-2	0.21
2.082E-3	8.278E-4	4.28	4.653E-2	0.25
1.173E-3	4.659E-4	3.36	3.372E-2	0.20
7.786E-4	9.851E-4	0.97	7.914E-2	0.18
2.571E-4	1.982E-3	0.16	1.568E-1	0.18
2.782E-3	2.272E-3	1.55	1.769E-1	0.18
6.734E-4	3.021E-3	0.30	2.230E-1	0.19
7.169E-3	2.694E-3	5.08	1.339E-1	0.28
1.247E-2	8.326E-3	2.71	4.484E-1	0.26
4.732E-2	1.596E-2	5.89	7.558E-1	0.30
4.387E-2	1.686E-2	4.91	8.495E-1	0.28

BOOTSTRAP OUTPUT VARIABLE: N_t1
Full vector of age-specific stocksizes on Jan 1, 1997

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1.837E1	1.835E1	5.013E-1	0.03
5.882E0	6.273E0	2.692E0	0.46
1.050E1	1.124E1	4.056E0	0.39
1.062E1	1.109E1	3.381E0	0.32
5.939E0	5.979E0	1.266E0	0.21
1.509E0	1.519E0	3.218E-1	0.21

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
-1.494E-2	3.544E-2	-0.08	1.838E1	0.03
3.905E-1	1.904E-1	6.64	5.491E0	0.49
7.466E-1	2.868E-1	7.11	9.749E0	0.42
4.677E-1	2.390E-1	4.40	1.015E1	0.33
3.919E-2	8.952E-2	0.66	5.900E0	0.21
9.961E-3	2.275E-2	0.66	1.499E0	0.21

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

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
7.662E-3	9.063E-3	5.879E-3	0.77
3.248E-2	3.432E-2	1.298E-2	0.40
1.209E-1	1.260E-1	3.651E-2	0.30
1.035E-1	1.073E-1	2.277E-2	0.22
1.035E-1	1.073E-1	2.277E-2	0.22
1.035E-1	1.073E-1	2.277E-2	0.22

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.401E-3	4.157E-4	18.29	6.261E-3	0.94
1.839E-3	9.181E-4	5.66	3.065E-2	0.42
5.056E-3	2.581E-3	4.18	1.159E-1	0.32
3.744E-3	1.610E-3	3.62	9.979E-2	0.23
3.744E-3	1.610E-3	3.62	9.979E-2	0.23
3.744E-3	1.610E-3	3.62	9.979E-2	0.23

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

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1.035E-1	1.073E-1	2.277E-2	0.22

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
3.744E-3	1.610E-3	3.62	9.979E-2	0.23

BOOTSTRAP OUTPUT VARIABLE: PR_t
Partial recruitment vector in the terminal year (1996)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
6.335E-2	7.101E-2	5.152E-2	0.81
2.686E-1	2.652E-1	1.157E-1	0.43
1.000E0	9.259E-1	1.256E-1	0.13
8.560E-1	8.205E-1	1.901E-1	0.22
8.560E-1	8.205E-1	1.901E-1	0.22
8.560E-1	8.205E-1	1.901E-1	0.22

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
7.664E-3	3.643E-3	12.10	5.569E-2	0.93
-3.355E-3	8.180E-3	-1.25	2.719E-1	0.43
-7.408E-2	8.882E-3	-7.41	1.074E0	0.12
-3.550E-2	1.344E-2	-4.15	8.915E-1	0.21
-3.550E-2	1.344E-2	-4.15	8.915E-1	0.21
-3.550E-2	1.344E-2	-4.15	8.915E-1	0.21

BOOTSTRAP OUTPUT VARIABLE: PR_mean
Average partial recruitment over 1994-1996

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
7.487E-3	7.505E-3	1.788E-3	0.24
7.060E-2	6.886E-2	9.080E-3	0.13
5.696E-1	5.540E-1	2.589E-2	0.05
9.254E-1	9.056E-1	7.476E-2	0.08
9.495E-1	9.298E-1	7.848E-2	0.08
9.495E-1	9.298E-1	7.848E-2	0.08

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.785E-5	1.265E-4	0.24	7.469E-3	0.24
-1.741E-3	6.420E-4	-2.47	7.234E-2	0.13
-1.561E-2	1.831E-3	-2.74	5.852E-1	0.04
-1.975E-2	5.286E-3	-2.13	9.451E-1	0.08
-1.969E-2	5.549E-3	-2.07	9.692E-1	0.08
-1.969E-2	5.549E-3	-2.07	9.692E-1	0.08

BOOTSTRAP OUTPUT VARIABLE: B_mean_t
Mean stock biomass during the terminal year (1996)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1.405E1	1.455E1	2.313E0	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
5.003E-1	1.635E-1	3.56	1.355E1	0.17

BOOTSTRAP OUTPUT VARIABLE: SSBæf_mean_t
Mean female SSB during the terminal year (1996)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
5.731E0	5.903E0	8.997E-1	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.726E-1	6.362E-2	3.01	5.558E0	0.16

BOOTSTRAP OUTPUT VARIABLE: SSB_spawn_t
SSB (males & females) at start of spawning season (1996)

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1.171E1	1.206E1	1.827E0	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
3.502E-1	1.292E-1	2.99	1.136E1	0.16

Table B1. Bias-corrected abundance estimates of Georges Bank yellowtail flounder (thousands).

	AGE						
YEAR	1	2	3	4	5	6+	TOTAL
1973	27,797	23,179	28,998	16,229	5,610	2,597	104,410
1974	49,173	22,445	14,579	11,913	5,039	2,221	105,370
1975	66,845	38,325	10,349	4,900	3,191	1,705	125,315
1976	22,282	50,784	8,994	2,234	1,014	1,534	86,842
1977	15,061	17,688	14,054	2,789	633	765	50,990
1978	49,634	12,033	6,826	2,751	756	287	72,287
1979	22,464	31,946	7,062	2,005	778	408	64,663
1980	21,458	18,181	17,625	2,709	540	177	60,690
1981	59,681	17,289	11,672	6,565	953	162	96,322
1982	21,161	48,813	13,497	4,777	1,349	116	89,713
1983	5,695	15,465	24,294	4,706	1,041	231	51,432
1984	8,453	4,035	5,805	5,711	1,787	371	26,162
1985	14,280	6,535	1,593	994	539	91	24,032
1986	6,601	11,105	2,369	577	236	118	21,006
1987	6,753	5,262	3,949	1,065	164	146	17,339
1988	18,763	5,403	1,942	803	200	47	27,158
1989	8,359	14,925	2,308	533	110	34	26,269
1990	11,390	6,677	10,853	1,290	203	35	30,448
1991	21,710	9,128	3,733	3,440	347	76	38,434
1992	18,857	17,402	7,424	1,961	671	38	46,353
1993	22,901	13,286	6,788	3,813	481	116	47,385
1994	21,263	14,080	9,968	3,074	1,001	155	49,541
1995	15,075	17,345	10,751	3,056	272	71	46,570
1996	6,762	12,330	14,059	7,995	1,860	172	43,178
1997	-----	5,491	9,749	10,150	5,900	1,499	-----
MEAN	21,697	17,566	9,970	4,242	1,387	441	51,979
MIN	5,695	4,035	1,593	533	110	34	17,339
MAX	66,845	50,784	24,294	11,913	5,900	2,221	125,315

Table B2. Bias-corrected fishing mortality estimates for Georges Bank yellowtail flounder.

	AGE					
YEAR	1	2	3	4	5	6+
1973	0.014	0.264	0.690	0.970	1.277	1.124
1974	0.049	0.574	0.890	1.117	1.421	1.269
1975	0.075	1.250	1.333	1.375	1.226	1.301
1976	0.031	1.085	0.971	1.061	0.846	0.954
1977	0.024	0.752	1.431	1.105	1.123	1.114
1978	0.241	0.333	1.025	1.063	1.074	1.069
1979	0.012	0.395	0.758	1.112	1.436	1.274
1980	0.016	0.243	0.788	0.844	1.036	0.940
1981	0.001	0.048	0.693	1.382	2.212	1.797
1982	0.114	0.498	0.854	1.324	1.718	1.521
1983	0.144	0.780	1.248	0.768	1.053	0.911
1984	0.057	0.730	1.565	2.161	2.857	2.509
1985	0.051	0.815	0.816	1.237	1.699	1.468
1986	0.027	0.834	0.600	1.057	1.333	1.195
1987	0.023	0.796	1.393	1.471	1.972	1.722
1988	0.029	0.650	1.092	1.791	2.123	1.957
1989	0.025	0.119	0.382	0.766	1.114	0.940
1990	0.021	0.381	0.949	1.114	0.852	0.983
1991	0.021	0.007	0.444	1.434	2.310	1.872
1992	0.150	0.741	0.466	1.205	1.695	1.450
1993	0.286	0.087	0.592	1.138	1.254	1.196
1994	0.004	0.070	0.982	2.226	3.189	2.708
1995	0.001	0.010	0.096	0.297	0.796	0.547
1996	0.008	0.035	0.126	0.104	0.104	0.104
MEAN	0.059	0.479	0.841	1.172	1.488	1.330
MIN	0.001	0.007	0.096	0.104	0.104	0.104
MAX	0.286	1.250	1.565	2.226	3.189	2.708

Table B3. Bias-corrected estimates of SSB (mt) for Georges Bank yellowtail flounder.

	AGE						
YEAR	1	2	3	4	5	6+	TOTAL
1973	0	3,009	9,007	5,200	1,828	3,159	22,203
1974	0	2,765	4,536	4,191	1,744	3,110	16,345
1975	0	3,205	2,634	1,408	1,089	1,782	10,118
1976	0	4,535	2,949	840	486	1,677	10,488
1977	0	1,949	3,679	1,027	285	1,067	8,006
1978	0	1,461	2,060	1,112	353	379	5,364
1979	0	3,994	2,145	753	286	610	7,789
1980	0	2,408	5,664	1,150	262	270	9,755
1981	0	2,972	3,927	2,048	247	299	9,492
1982	0	5,597	4,194	1,645	454	230	12,120
1983	0	1,491	5,788	1,899	455	316	9,949
1984	0	611	1,052	1,068	321	881	3,933
1985	0	1,445	518	353	179	138	2,634
1986	0	2,302	917	227	103	173	3,721
1987	0	1,092	1,063	354	45	258	2,812
1988	0	1,238	631	241	65	104	2,279
1989	0	4,314	983	258	56	56	5,668
1990	0	1,643	2,817	439	92	40	5,030
1991	0	2,103	1,093	843	89	156	4,283
1992	0	2,085	2,143	577	197	84	5,086
1993	0	1,937	1,637	1,114	147	164	4,999
1994	0	1,814	1,846	518	153	441	4,772
1995	0	2,374	3,054	1,129	105	68	6,730
1996	0	1,769	4,330	3,922	1,189	162	11,372
MEAN	0	2,421	2,861	1,346	426	651	7,706
MIN	0	611	518	227	45	40	2,279
MAX	0	5,597	9,007	5,200	1,828	3,159	22,203

APPENDIX B: BIOMASS DYNAMICS MODEL

Georges Bank Yellowtail -- ASPIC 3.6x -- Three Indices Extended Series

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ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.64)

FIT Mode

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CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	34	Number of bootstrap trials:	0
Number of data series:	3	Lower bound on MSY:	1.000E+00
Objective function computed:	in EFFORT	Upper bound on MSY:	5.000E+01
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	1.000E-01
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	1.000E+01
Relative conv. criterion (effort):	1.000E-04	Random number seed:	1964285
Maximum F allowed in fitting:	5.000	Monte Carlo search trials:	50000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

		1	2	3
1	USA Fall Survey	1.000 34		
2	USA Spring Survey	0.755 29	1.000 29	
3	Canadian Survey	0.547 10	0.662 10	1.000 10

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title		Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1)	SSE in yield	0.000E+00					
Loss(0)	Penalty for B1R > 2	0.000E+00	1	N/A	1.000E+00	N/A	
Loss(1)	USA Fall Survey	7.842E+00	34	2.451E-01	1.000E+00	9.748E-01	0.692
Loss(2)	USA Spring Survey	7.646E+00	29	2.832E-01	1.000E+00	8.436E-01	0.564
Loss(3)	Canadian Survey	1.242E+00	10	1.552E-01	1.000E+00	1.539E+00	0.706

TOTAL OBJECTIVE FUNCTION: 1.67295690E+01

Number of restarts required for convergence: 86
Est. B-ratio coverage index (0 worst, 2 best): 1.2842
Est. B-ratio nearness index (0 worst, 1 best): 1.0000

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1963	1.379E+00	1.548E+00	1	1
MSY	Maximum sustainable yield	1.275E+01	1.110E+01	1	1
r	Intrinsic rate of increase	6.791E-01	6.600E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	USA Fall Survey	1.421E-01	1.229E-01	1	1
q(2)	USA Spring Survey	1.359E-01	1.274E-01	1	1
q(3)	Canadian Survey	3.274E-01	3.020E-01	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	1.275E+01	Kr/4	
K	Maximum stock biomass	7.511E+01		
Bmsy	Stock biomass at MSY	3.755E+01	K/2	
Fmsy	Fishing mortality at MSY	3.396E-01	r/2	
F(0.1)	Management benchmark	3.056E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	1.263E+01	0.99*MSY	
B-ratio	Ratio of B(1997) to Bmsy	4.541E-01		
F-ratio	Ratio of F(1996) to Fmsy	2.800E-01		
Y-ratio	Proportion of MSY avail in 1997	7.020E-01	2*Br-Br^2	Ye(1997) = 8.952E+00
....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	USA Fall Survey	2.389E+00	r/2q(1)	f(0.1) = 2.150E+00

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1963	0.215	5.178E+01	5.169E+01	1.110E+01	1.110E+01	1.095E+01	6.324E-01	1.379E+00
2	1964	0.300	5.162E+01	4.972E+01	1.490E+01	1.490E+01	1.140E+01	8.825E-01	1.375E+00
3	1965	0.322	4.813E+01	4.652E+01	1.500E+01	1.500E+01	1.202E+01	9.496E-01	1.281E+00
4	1966	0.255	4.515E+01	4.546E+01	1.160E+01	1.160E+01	1.219E+01	7.515E-01	1.202E+00
5	1967	0.209	4.573E+01	4.688E+01	9.800E+00	9.800E+00	1.196E+01	6.156E-01	1.218E+00
6	1968	0.314	4.790E+01	4.651E+01	1.460E+01	1.460E+01	1.202E+01	9.245E-01	1.275E+00
7	1969	0.434	4.532E+01	4.219E+01	1.830E+01	1.830E+01	1.253E+01	1.277E+00	1.207E+00
8	1970	0.417	3.955E+01	3.792E+01	1.580E+01	1.580E+01	1.274E+01	1.227E+00	1.053E+00
9	1971	0.338	3.650E+01	3.668E+01	1.240E+01	1.240E+01	1.275E+01	9.956E-01	9.718E-01
10	1972	0.471	3.684E+01	3.485E+01	1.640E+01	1.640E+01	1.268E+01	1.386E+00	9.810E-01
11	1973	0.525	3.312E+01	3.103E+01	1.628E+01	1.628E+01	1.236E+01	1.545E+00	8.819E-01
12	1974	0.576	2.920E+01	2.714E+01	1.562E+01	1.562E+01	1.176E+01	1.695E+00	7.774E-01
13	1975	0.713	2.534E+01	2.247E+01	1.601E+01	1.601E+01	1.067E+01	2.099E+00	6.747E-01
14	1976	0.845	2.000E+01	1.704E+01	1.440E+01	1.440E+01	8.925E+00	2.489E+00	5.325E-01
15	1977	0.760	1.452E+01	1.314E+01	9.985E+00	9.985E+00	7.356E+00	2.239E+00	3.866E-01
16	1978	0.514	1.189E+01	1.223E+01	6.284E+00	6.284E+00	6.952E+00	1.513E+00	3.166E-01
17	1979	0.476	1.256E+01	1.312E+01	6.241E+00	6.241E+00	7.352E+00	1.401E+00	3.344E-01
18	1980	0.488	1.367E+01	1.412E+01	6.896E+00	6.896E+00	7.787E+00	1.438E+00	3.640E-01
19	1981	0.403	1.456E+01	1.561E+01	6.299E+00	6.299E+00	8.395E+00	1.188E+00	3.877E-01
20	1982	0.831	1.666E+01	1.446E+01	1.203E+01	1.203E+01	7.919E+00	2.448E+00	4.436E-01
21	1983	1.229	1.255E+01	9.256E+00	1.138E+01	1.138E+01	5.486E+00	3.620E+00	3.342E-01
22	1984	1.097	6.660E+00	5.313E+00	5.830E+00	5.830E+00	3.349E+00	3.231E+00	1.773E-01
23	1985	0.596	4.179E+00	4.274E+00	2.546E+00	2.546E+00	2.738E+00	1.754E+00	1.113E-01
24	1986	0.718	4.370E+00	4.204E+00	3.020E+00	3.020E+00	2.695E+00	2.116E+00	1.164E-01
25	1987	0.776	4.045E+00	3.790E+00	2.940E+00	2.940E+00	2.444E+00	2.284E+00	1.077E-01
26	1988	0.593	3.549E+00	3.645E+00	2.163E+00	2.163E+00	2.355E+00	1.747E+00	9.450E-02
27	1989	0.258	3.741E+00	4.557E+00	1.176E+00	1.176E+00	2.905E+00	7.600E-01	9.962E-02
28	1990	0.662	5.470E+00	5.383E+00	3.565E+00	3.565E+00	3.394E+00	1.950E+00	1.457E-01
29	1991	0.343	5.299E+00	6.125E+00	2.101E+00	2.101E+00	3.818E+00	1.010E+00	1.411E-01
30	1992	0.712	7.016E+00	6.695E+00	4.768E+00	4.768E+00	4.141E+00	2.097E+00	1.868E-01
31	1993	0.625	6.389E+00	6.379E+00	3.985E+00	3.985E+00	3.964E+00	1.840E+00	1.701E-01
32	1994	0.604	6.369E+00	6.423E+00	3.881E+00	3.881E+00	3.989E+00	1.779E+00	1.696E-01
33	1995	0.094	6.477E+00	8.469E+00	7.990E-01	7.990E-01	5.089E+00	2.778E-01	1.725E-01
34	1996	0.095	1.077E+01	1.374E+01	1.306E+00	1.306E+00	7.593E+00	2.800E-01	2.867E-01
35	1997		1.705E+01						4.541E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) USA Fall Survey

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed yield	Model yield	Resid in log effort	Resid in yield
1	1963	8.680E-01	1.511E+00	0.2147	1.110E+01	1.110E+01	-0.55428	0.000E+00
2	1964	1.094E+00	2.109E+00	0.2997	1.490E+01	1.490E+01	-0.65639	0.000E+00
3	1965	1.648E+00	2.269E+00	0.3225	1.500E+01	1.500E+01	-0.32001	0.000E+00
4	1966	2.909E+00	1.796E+00	0.2552	1.160E+01	1.160E+01	0.48242	0.000E+00
5	1967	1.294E+00	1.471E+00	0.2090	9.800E+00	9.800E+00	-0.12830	0.000E+00
6	1968	1.386E+00	2.209E+00	0.3139	1.460E+01	1.460E+01	-0.46632	0.000E+00
7	1969	1.972E+00	3.052E+00	0.4338	1.830E+01	1.830E+01	-0.43669	0.000E+00
8	1970	3.173E+00	2.932E+00	0.4167	1.580E+01	1.580E+01	0.07908	0.000E+00
9	1971	1.948E+00	2.379E+00	0.3381	1.240E+01	1.240E+01	-0.19970	0.000E+00
10	1972	2.592E+00	3.311E+00	0.4706	1.640E+01	1.640E+01	-0.24504	0.000E+00
11	1973	2.521E+00	3.692E+00	0.5247	1.628E+01	1.628E+01	-0.38145	0.000E+00
12	1974	4.271E+00	4.049E+00	0.5755	1.562E+01	1.562E+01	0.05336	0.000E+00
13	1975	6.912E+00	5.014E+00	0.7127	1.601E+01	1.601E+01	0.32088	0.000E+00
14	1976	9.589E+00	5.946E+00	0.8451	1.440E+01	1.440E+01	0.47779	0.000E+00
15	1977	3.603E+00	5.349E+00	0.7601	9.985E+00	9.985E+00	-0.39495	0.000E+00
16	1978	2.691E+00	3.616E+00	0.5139	6.284E+00	6.284E+00	-0.29537	0.000E+00
17	1979	4.191E+00	3.348E+00	0.4758	6.241E+00	6.241E+00	0.22476	0.000E+00
18	1980	1.047E+00	3.436E+00	0.4883	6.896E+00	6.896E+00	-1.18824	0.000E+00
19	1981	2.454E+00	2.839E+00	0.4035	6.299E+00	6.299E+00	-0.14588	0.000E+00
20	1982	5.297E+00	5.850E+00	0.8314	1.203E+01	1.203E+01	-0.09924	0.000E+00
21	1983	5.339E+00	8.649E+00	1.2292	1.138E+01	1.138E+01	-0.48238	0.000E+00
22	1984	9.831E+00	7.720E+00	1.0972	5.830E+00	5.830E+00	0.24168	0.000E+00
23	1985	3.592E+00	4.192E+00	0.5958	2.546E+00	2.546E+00	-0.15458	0.000E+00
24	1986	3.684E+00	5.055E+00	0.7184	3.020E+00	3.020E+00	-0.31653	0.000E+00
25	1987	5.776E+00	5.458E+00	0.7757	2.940E+00	2.940E+00	0.05657	0.000E+00
26	1988	1.265E+01	4.175E+00	0.5934	2.163E+00	2.163E+00	1.10829	0.000E+00
27	1989	1.204E+00	1.816E+00	0.2581	1.176E+00	1.176E+00	-0.41116	0.000E+00
28	1990	4.918E+00	4.660E+00	0.6623	3.565E+00	3.565E+00	0.05375	0.000E+00
29	1991	2.878E+00	2.414E+00	0.3430	2.101E+00	2.101E+00	0.17600	0.000E+00
30	1992	8.277E+00	5.011E+00	0.7122	4.768E+00	4.768E+00	0.50184	0.000E+00
31	1993	7.311E+00	4.395E+00	0.6247	3.985E+00	3.985E+00	0.50888	0.000E+00
32	1994	4.327E+00	4.251E+00	0.6042	3.881E+00	3.881E+00	0.01757	0.000E+00
33	1995	2.257E+00	6.639E-01	0.0943	7.990E-01	7.990E-01	1.22375	0.000E+00
34	1996	1.002E+00	6.690E-01	0.0951	1.306E+00	1.306E+00	0.40424	0.000E+00

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) USA Spring Survey

Data type I0: Start-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
6	1968	1.000E+00	1.000E+00	0.0	2.813E+00	6.510E+00	-0.83905	-3.697E+00
7	1969	1.000E+00	1.000E+00	0.0	1.117E+01	6.160E+00	0.59523	5.010E+00
8	1970	1.000E+00	1.000E+00	0.0	5.312E+00	5.376E+00	-0.01195	-6.385E-02
9	1971	1.000E+00	1.000E+00	0.0	4.607E+00	4.961E+00	-0.07394	-3.535E-01
10	1972	1.000E+00	1.000E+00	0.0	6.450E+00	5.007E+00	0.25315	1.443E+00
11	1973	1.000E+00	1.000E+00	0.0	2.938E+00	4.501E+00	-0.42664	-1.563E+00
12	1974	1.000E+00	1.000E+00	0.0	2.719E+00	3.968E+00	-0.37806	-1.249E+00
13	1975	1.000E+00	1.000E+00	0.0	1.676E+00	3.444E+00	-0.72014	-1.768E+00
14	1976	1.000E+00	1.000E+00	0.0	2.273E+00	2.718E+00	-0.17875	-4.449E-01
15	1977	1.000E+00	1.000E+00	0.0	9.990E-01	1.973E+00	-0.68081	-9.745E-01
16	1978	1.000E+00	1.000E+00	0.0	7.420E-01	1.616E+00	-0.77844	-8.741E-01
17	1979	1.000E+00	1.000E+00	0.0	1.227E+00	1.707E+00	-0.33014	-4.800E-01
18	1980	1.000E+00	1.000E+00	0.0	4.456E+00	1.858E+00	0.87475	2.598E+00
19	1981	1.000E+00	1.000E+00	0.0	1.960E+00	1.979E+00	-0.00970	-1.910E-02
20	1982	1.000E+00	1.000E+00	0.0	2.500E+00	2.264E+00	0.09914	2.360E-01
21	1983	1.000E+00	1.000E+00	0.0	2.642E+00	1.706E+00	0.43743	9.361E-01
22	1984	1.000E+00	1.000E+00	0.0	1.646E+00	9.052E-01	0.59794	7.408E-01
23	1985	1.000E+00	1.000E+00	0.0	9.880E-01	5.680E-01	0.55364	4.200E-01
24	1986	1.000E+00	1.000E+00	0.0	8.470E-01	5.939E-01	0.35494	2.531E-01
25	1987	1.000E+00	1.000E+00	0.0	3.290E-01	5.498E-01	-0.51341	-2.208E-01
26	1988	1.000E+00	1.000E+00	0.0	5.660E-01	4.824E-01	0.15992	8.365E-02
27	1989	1.000E+00	1.000E+00	0.0	7.290E-01	5.085E-01	0.36021	2.205E-01
28	1990	1.000E+00	1.000E+00	0.0	6.990E-01	7.435E-01	-0.06168	-4.447E-02
29	1991	1.000E+00	1.000E+00	0.0	6.310E-01	7.202E-01	-0.13216	-8.915E-02
30	1992	1.000E+00	1.000E+00	0.0	1.566E+00	9.536E-01	0.49606	6.124E-01
31	1993	1.000E+00	1.000E+00	0.0	4.820E-01	8.684E-01	-0.58873	-3.864E-01
32	1994	1.000E+00	1.000E+00	0.0	6.600E-01	8.656E-01	-0.27123	-2.056E-01
33	1995	1.000E+00	1.000E+00	0.0	2.579E+00	8.804E-01	1.07482	1.699E+00
34	1996	1.000E+00	1.000E+00	0.0	2.853E+00	1.463E+00	0.66756	1.390E+00

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) Canadian Survey

Data type I0: Start-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
25	1987	1.000E+00	1.000E+00	0.0	1.264E+00	1.324E+00	-0.04646	-6.011E-02
26	1988	1.000E+00	1.000E+00	0.0	1.235E+00	1.162E+00	0.06112	7.322E-02
27	1989	1.000E+00	1.000E+00	0.0	4.710E-01	1.225E+00	-0.95564	-7.538E-01
28	1990	1.000E+00	1.000E+00	0.0	1.578E+00	1.791E+00	-0.12644	-2.127E-01
29	1991	1.000E+00	1.000E+00	0.0	1.759E+00	1.735E+00	0.01401	2.446E-02
30	1992	1.000E+00	1.000E+00	0.0	2.475E+00	2.297E+00	0.07474	1.782E-01
31	1993	1.000E+00	1.000E+00	0.0	2.642E+00	2.092E+00	0.23359	5.504E-01
32	1994	1.000E+00	1.000E+00	0.0	2.753E+00	2.085E+00	0.27795	6.681E-01
33	1995	1.000E+00	1.000E+00	0.0	2.027E+00	2.120E+00	-0.04506	-9.342E-02
34	1996	1.000E+00	1.000E+00	0.0	5.304E+00	3.525E+00	0.40862	1.779E+00

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.64)

RESULTS OF BOOTSTRAPPED ANALYSIS

Param name	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
B1ratio	1.366E+00	1.379E+00	0.94%	9.224E-01	1.460E+00	1.313E+00	1.395E+00	8.111E-02	0.059
K	7.508E+01	7.511E+01	0.03%	7.091E+01	8.822E+01	7.338E+01	7.812E+01	4.739E+00	0.063
r	6.798E-01	6.791E-01	-0.10%	5.456E-01	7.278E-01	6.428E-01	6.981E-01	5.529E-02	0.081
q(1)	1.445E-01	1.421E-01	-1.66%	1.322E-01	1.205E+00	1.407E-01	1.511E-01	1.042E-02	0.072
q(2)	1.409E-01	1.359E-01	-3.53%	1.249E-01	1.450E+00	1.336E-01	1.528E-01	1.923E-02	0.136
q(3)	3.367E-01	3.274E-01	-2.79%	2.678E-01	1.748E+00	3.137E-01	3.735E-01	5.971E-02	0.177
MSY	1.276E+01	1.275E+01	-0.04%	1.185E+01	1.291E+01	1.264E+01	1.282E+01	1.809E-01	0.014
Ye(1997)	8.988E+00	8.952E+00	-0.40%	6.815E+00	1.067E+01	7.925E+00	9.912E+00	1.987E+00	0.221
Bmsy	3.754E+01	3.755E+01	0.03%	3.545E+01	4.411E+01	3.669E+01	3.906E+01	2.369E+00	0.063
Fmsy	3.399E-01	3.396E-01	-0.10%	2.728E-01	3.639E-01	3.214E-01	3.491E-01	2.765E-02	0.081
fmsy(1)	2.347E+00	2.389E+00	1.79%	2.075E+00	2.508E+00	2.221E+00	2.414E+00	1.933E-01	0.082
fmsy(2)	2.441E+00	2.498E+00	2.36%	1.983E+00	2.679E+00	2.287E+00	2.555E+00	2.677E-01	0.110
fmsy(3)	1.009E+00	1.037E+00	2.82%	8.159E-01	1.184E+00	9.177E-01	1.080E+00	1.623E-01	0.161
F(0.1)	3.059E-01	3.056E-01	-0.09%	2.455E-01	3.275E-01	2.893E-01	3.141E-01	2.488E-02	0.081
Y(0.1)	1.263E+01	1.263E+01	-0.04%	1.174E+01	1.278E+01	1.252E+01	1.270E+01	1.791E-01	0.014
B-ratio	4.490E-01	4.541E-01	1.13%	3.221E-01	5.847E-01	3.857E-01	5.244E-01	1.387E-01	0.309
F-ratio	2.816E-01	2.800E-01	-0.56%	2.156E-01	3.925E-01	2.412E-01	3.311E-01	8.993E-02	0.319
Y-ratio	6.966E-01	7.020E-01	0.78%	5.405E-01	8.275E-01	6.226E-01	7.744E-01	1.518E-01	0.218
f0.1(1)	2.113E+00	2.150E+00	1.61%	1.867E+00	2.257E+00	1.999E+00	2.173E+00	1.740E-01	0.082
f0.1(2)	2.197E+00	2.249E+00	2.13%	1.784E+00	2.411E+00	2.058E+00	2.299E+00	2.409E-01	0.110
f0.1(3)	9.080E-01	9.336E-01	2.54%	7.343E-01	1.066E+00	8.259E-01	9.720E-01	1.461E-01	0.161
q2/q1	9.540E-01	9.563E-01	0.24%	8.424E-01	1.098E+00	8.882E-01	1.011E+00	1.232E-01	0.129
q3/q1	2.315E+00	2.303E+00	-0.49%	1.877E+00	2.757E+00	2.116E+00	2.521E+00	4.046E-01	0.175

NOTES ON BOOTSTRAPPED ESTIMATES:

- The bootstrapped results shown were computed from 500 trials.
- These results are conditional on the constraints placed upon MSY and r in the input file (ASPIC.INP).
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- The bias corrections used here are based on medians. This is an accepted statistical procedure, but may estimate nonzero bias for unbiased, skewed estimators.

Trials replaced for lack of convergence:	29
Trials replaced for MSY out-of-bounds:	15
Trials replaced for r out-of-bounds:	15
Residual-adjustment factor:	1.0438

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	aspic.bio
Name of output file (this file)	ytfsq.prj
Number of years of projections	1

Year	Input data	User data type
1997	1.000E+00	F:F(1996)

TABLE OF PROJECTED YIELDS

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1997	2.014E+00	2.000E+00	-0.69%	1.935E+00	3.970E+00	1.987E+00	2.046E+00	5.915E-02	0.029

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	5.149E+01	5.178E+01	0.55%	4.690E+01	7.377E+01	5.008E+01	5.332E+01	3.244E+00	0.063
1964	5.146E+01	5.162E+01	0.32%	4.825E+01	7.235E+01	5.027E+01	5.324E+01	2.966E+00	0.058
1965	4.800E+01	4.813E+01	0.25%	4.539E+01	6.537E+01	4.686E+01	4.977E+01	2.912E+00	0.061
1966	4.505E+01	4.515E+01	0.22%	4.263E+01	5.845E+01	4.395E+01	4.673E+01	2.780E+00	0.062
1967	4.564E+01	4.573E+01	0.20%	4.336E+01	5.782E+01	4.466E+01	4.728E+01	2.616E+00	0.057
1968	4.780E+01	4.790E+01	0.19%	4.546E+01	5.763E+01	4.678E+01	4.914E+01	2.360E+00	0.049
1969	4.525E+01	4.532E+01	0.15%	4.292E+01	5.421E+01	4.437E+01	4.680E+01	2.431E+00	0.054
1970	3.950E+01	3.955E+01	0.13%	3.743E+01	4.772E+01	3.870E+01	4.149E+01	2.782E+00	0.070
1971	3.646E+01	3.650E+01	0.09%	3.464E+01	4.388E+01	3.578E+01	3.832E+01	2.533E+00	0.069
1972	3.681E+01	3.684E+01	0.10%	3.519E+01	4.354E+01	3.619E+01	3.860E+01	2.414E+00	0.066
1973	3.308E+01	3.312E+01	0.12%	3.161E+01	3.888E+01	3.251E+01	3.455E+01	2.044E+00	0.062
1974	2.917E+01	2.920E+01	0.09%	2.780E+01	3.406E+01	2.863E+01	3.039E+01	1.761E+00	0.060
1975	2.532E+01	2.534E+01	0.06%	2.417E+01	2.959E+01	2.486E+01	2.641E+01	1.557E+00	0.061
1976	1.998E+01	2.000E+01	0.09%	1.900E+01	2.366E+01	1.959E+01	2.093E+01	1.339E+00	0.067
1977	1.450E+01	1.452E+01	0.12%	1.363E+01	1.780E+01	1.415E+01	1.532E+01	1.164E+00	0.080
1978	1.187E+01	1.189E+01	0.14%	1.102E+01	1.514E+01	1.153E+01	1.268E+01	1.152E+00	0.097
1979	1.254E+01	1.256E+01	0.14%	1.167E+01	1.575E+01	1.219E+01	1.335E+01	1.155E+00	0.092
1980	1.365E+01	1.367E+01	0.12%	1.279E+01	1.673E+01	1.331E+01	1.444E+01	1.127E+00	0.083
1981	1.455E+01	1.456E+01	0.11%	1.375E+01	1.733E+01	1.423E+01	1.526E+01	1.035E+00	0.071
1982	1.664E+01	1.666E+01	0.08%	1.600E+01	1.887E+01	1.639E+01	1.722E+01	8.303E-01	0.050
1983	1.254E+01	1.255E+01	0.08%	1.209E+01	1.409E+01	1.236E+01	1.292E+01	5.596E-01	0.045
1984	6.653E+00	6.660E+00	0.11%	6.339E+00	7.801E+00	6.523E+00	6.927E+00	4.039E-01	0.061
1985	4.173E+00	4.179E+00	0.15%	3.889E+00	5.220E+00	4.052E+00	4.404E+00	3.517E-01	0.084
1986	4.363E+00	4.370E+00	0.15%	4.084E+00	5.418E+00	4.247E+00	4.595E+00	3.476E-01	0.080
1987	4.036E+00	4.045E+00	0.23%	3.762E+00	5.120E+00	3.922E+00	4.247E+00	3.253E-01	0.081
1988	3.539E+00	3.549E+00	0.29%	3.242E+00	4.721E+00	3.421E+00	3.796E+00	3.745E-01	0.106
1989	3.725E+00	3.741E+00	0.43%	3.364E+00	4.986E+00	3.579E+00	3.975E+00	3.958E-01	0.106
1990	5.441E+00	5.470E+00	0.53%	4.993E+00	6.804E+00	5.267E+00	5.693E+00	4.259E-01	0.078
1991	5.256E+00	5.299E+00	0.81%	4.722E+00	6.544E+00	5.041E+00	5.473E+00	4.319E-01	0.082
1992	6.933E+00	7.016E+00	1.19%	3.663E+00	8.259E+00	6.682E+00	7.229E+00	5.462E-01	0.079
1993	6.225E+00	6.389E+00	2.65%	9.847E-01	7.447E+00	5.856E+00	6.737E+00	8.071E-01	0.130
1994	6.057E+00	6.369E+00	5.16%	8.636E-01	7.649E+00	5.436E+00	6.797E+00	1.206E+00	0.199
1995	6.005E+00	6.477E+00	7.87%	8.636E-01	8.251E+00	5.129E+00	7.075E+00	1.945E+00	0.324
1996	1.000E+01	1.077E+01	7.63%	9.701E-01	1.336E+01	8.582E+00	1.178E+01	3.202E+00	0.320
1997	1.626E+01	1.705E+01	4.89%	9.783E+00	2.097E+01	1.400E+01	1.884E+01	4.846E+00	0.298
1998	2.460E+01	2.529E+01	2.78%	1.749E+01	3.099E+01	2.154E+01	2.800E+01	6.457E+00	0.262

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

TRAJECTORY OF ABSOLUTE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1963	2.158E-01	2.147E-01	-0.51%	1.533E-01	2.320E-01	2.085E-01	2.216E-01	1.309E-02	0.061
1964	3.005E-01	2.997E-01	-0.27%	2.193E-01	3.189E-01	2.901E-01	3.081E-01	1.798E-02	0.060
1965	3.234E-01	3.225E-01	-0.28%	2.445E-01	3.418E-01	3.121E-01	3.314E-01	1.926E-02	0.060
1966	2.557E-01	2.552E-01	-0.22%	2.019E-01	2.699E-01	2.472E-01	2.620E-01	1.477E-02	0.058
1967	2.095E-01	2.090E-01	-0.21%	1.702E-01	2.205E-01	2.031E-01	2.140E-01	1.092E-02	0.052
1968	3.144E-01	3.139E-01	-0.16%	2.616E-01	3.312E-01	3.051E-01	3.211E-01	1.595E-02	0.051
1969	4.343E-01	4.338E-01	-0.12%	3.615E-01	4.579E-01	4.181E-01	4.433E-01	2.518E-02	0.058
1970	4.171E-01	4.167E-01	-0.11%	3.463E-01	4.398E-01	3.988E-01	4.257E-01	2.697E-02	0.065
1971	3.384E-01	3.381E-01	-0.11%	2.836E-01	3.548E-01	3.217E-01	3.444E-01	2.280E-02	0.067
1972	4.711E-01	4.706E-01	-0.11%	3.991E-01	4.930E-01	4.502E-01	4.793E-01	2.903E-02	0.062
1973	5.253E-01	5.247E-01	-0.12%	4.470E-01	5.503E-01	5.033E-01	5.350E-01	3.170E-02	0.060
1974	5.758E-01	5.755E-01	-0.06%	4.935E-01	6.043E-01	5.531E-01	5.869E-01	3.376E-02	0.059
1975	7.131E-01	7.127E-01	-0.07%	6.044E-01	7.478E-01	6.818E-01	7.266E-01	4.478E-02	0.063
1976	8.460E-01	8.451E-01	-0.11%	7.017E-01	8.948E-01	8.063E-01	8.649E-01	5.861E-02	0.069
1977	7.611E-01	7.601E-01	-0.13%	6.075E-01	8.147E-01	7.163E-01	7.819E-01	6.556E-02	0.086
1978	5.146E-01	5.139E-01	-0.14%	4.076E-01	5.539E-01	4.838E-01	5.297E-01	4.585E-02	0.089
1979	4.764E-01	4.758E-01	-0.13%	3.842E-01	5.102E-01	4.498E-01	4.893E-01	3.946E-02	0.083
1980	4.889E-01	4.883E-01	-0.12%	4.037E-01	5.194E-01	4.635E-01	5.005E-01	3.701E-02	0.076
1981	4.039E-01	4.035E-01	-0.09%	3.479E-01	4.235E-01	3.881E-01	4.114E-01	2.332E-02	0.058
1982	8.321E-01	8.314E-01	-0.08%	7.354E-01	8.643E-01	8.061E-01	8.448E-01	3.873E-02	0.047
1983	1.230E+00	1.229E+00	-0.09%	1.061E+00	1.281E+00	1.185E+00	1.250E+00	6.487E-02	0.053
1984	1.099E+00	1.097E+00	-0.14%	9.082E-01	1.165E+00	1.050E+00	1.126E+00	7.585E-02	0.069
1985	5.967E-01	5.958E-01	-0.15%	4.775E-01	6.374E-01	5.655E-01	6.135E-01	4.802E-02	0.080
1986	7.193E-01	7.184E-01	-0.12%	5.739E-01	7.707E-01	6.871E-01	7.406E-01	5.353E-02	0.074
1987	7.771E-01	7.757E-01	-0.19%	5.981E-01	8.414E-01	7.346E-01	8.019E-01	6.731E-02	0.087
1988	5.955E-01	5.934E-01	-0.36%	4.491E-01	6.546E-01	5.577E-01	6.187E-01	6.097E-02	0.102
1989	2.594E-01	2.581E-01	-0.50%	2.006E-01	2.845E-01	2.453E-01	2.687E-01	2.338E-02	0.090
1990	6.665E-01	6.623E-01	-0.63%	5.359E-01	7.366E-01	6.394E-01	6.919E-01	5.252E-02	0.079
1991	3.464E-01	3.430E-01	-0.97%	2.836E-01	3.822E-01	3.324E-01	3.599E-01	2.743E-02	0.079
1992	7.259E-01	7.122E-01	-1.90%	6.089E-01	3.198E+00	6.873E-01	7.604E-01	7.306E-02	0.101
1993	6.486E-01	6.247E-01	-3.69%	5.344E-01	5.000E+00	5.930E-01	7.106E-01	1.047E-01	0.161
1994	6.388E-01	6.042E-01	-5.42%	4.939E-01	1.831E+01	5.654E-01	7.307E-01	1.652E-01	0.259
1995	1.008E-01	9.435E-02	-6.38%	7.563E-02	5.000E+00	8.671E-02	1.179E-01	3.118E-02	0.309
1996	1.002E-01	9.508E-02	-5.13%	7.685E-02	5.000E+00	8.633E-02	1.170E-01	3.069E-02	0.306
1997	1.002E-01	9.508E-02	-5.13%	7.685E-02	5.000E+00	8.633E-02	1.170E-01	3.069E-02	0.306

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.