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Assessment of the Georges Bank Winter Flounder Stock, 1982-1997

by

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ABSTRACT

The current assessment represents the initial attempt to conduct an analytical assessment of the Georges Bank winter flounder stock. The Georges Bank population of winter flounder is a discrete offshore stock distributed in the shallower areas of the bank complex. The stock is exploited by both directed otter trawl fisheries and as bycatch in large and small mesh otter trawl and scallop dredge fisheries targeting other species. Recent management measures have been directed at other principal groundfish species or the entire groundfish complex, but management actions including seasonal and year round area closures, mesh size restrictions, effort controls, and retention restrictions on specific gear sectors likely have a significant effect on the Georges Bank winter flounder resource.

The Georges Bank winter flounder stock has been exploited by U.S., Canada, and distant water fleets historically, but the U.S. fishery has generated most of the reported landings since 1970. Landings during the 1970s and 1980s ranged between 2,000 and 4,000 mt, but declined to approximately 1,700 mt in 1993. Otter trawl gear accounts for greater than 95% of landings in most years, although the proportion of landings from the scallop dredge sector increased in the early 1990s. Discards are known to occur in both the otter trawl and scallop dredge fisheries. Although available data were inadequate to either estimate the magnitude of discards or characterize their size or age distribution, information from sea sampling observations indicates that discards are a relatively low proportion of the total catch in the otter trawl fishery.

Landings per unit effort indices for all trips landing winter flounder and directed trips declined between the mid-1970s and early 1990s. U.S. and Canadian research vessel survey indices are highly variable, but appear to indicate a significant decline in abundance and biomass between the early 1980s and early 1990s.

A Virtual Population Analysis calibrated with research vessel survey indices indicates strong year classes in 1980 (8.2 million), 1985 (6.6 million), 1987 (7.4 million), and 1994 (5.4 million) based on age 2 recruitment numbers. Spawning stock biomass declined from 8,300 mt in 1982 to 2,000 mt in 1994 and has increased to 3,500 mt in 1997. There is little apparent relationship between stock and recruitment. Age 2 recruitment from the 1995 and 1996 year classes is poor, and the 1996 year class (0.77 million) is the weakest in the time series. The average fishing mortality rate (ages 4-6, unweighted) increased from approximately 0.5 in 1982 to above 1.0 in 1984, and ranged between 0.66 and 1.36 in the mid-1980s to early 1990s. The fishing mortality rate declined to below 0.5 in 1994 and has ranged between 0.32 and 0.53 through 1997.

A yield per recruit analysis estimates $F_{0.1} = 0.21$ and $F_{max} = 0.42$, and an SSB per recruit analysis estimates $F_{20\%} = 0.47$. An unconstrained surplus production analysis estimates MSY as 3,100 mt and the stock biomass at MSY (B_{MSY})of 11,400 mt. The Sustainable Fishery Act (SFA) harvest control rule was re-estimated and at the current biomass proxy, the corresponding fully recruited threshold and target fishing mortality rates are 0.04 and 0.03, respectively. Relative to the SFA harvest control rule, the stock was in an overfished condition and overfishing was occurring ($F_{1998} = 0.34$). Short-term stochastic projections indicated that SSB will increase slightly (3%) between 1999 and 2000 if the stock is fished at $F_{20\%} = 0.47$ in 1999, and increase between 13% ($F_{1998} = 0.34$) and 44% ($F = 0.00$) if fished at lower levels.

INTRODUCTION

Georges Bank winter flounder (*Psueudopleuronectes americanus*) is a demersal flatfish species distributed in the Northwest Atlantic from Labrador to Georgia (Bigelow and Schroeder 1953, Klein-MacPhee 1978). Although primarily distribution in shallow inshore waters where estuarine habitat serves as important spawning and nursery areas, winter flounder are also distributed on some shallow offshore banks including Nantucket Shoals and Georges Bank principally in waters shallower than 80 m in depth. Adult winter flounder feed primarily on benthic invertebrates including annelids (predominately polychaetes), Cnidarids, and Anthoza (Langton and Bowman 1981). Principal predators include striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), goosefish (*Lophius americanus*), spiny dogfish (*Squalus acanthias*), and sea raven (*Hemitripterus americanus*) (Dickie and McCraken 1955, Grosslein and Azarovitz 1982). Spawning peaks on Georges Bank during March and April, as evidenced by the presence of spawning condition fish in the Northeast Fisheries Science Center (NEFSC) Spring research vessel bottom trawl survey and high densities of eggs and larvae detected by NEFSC icthyoplankton surveys.

Stock Structure

Evidence from tagging data, differences in life history characteristics, and meristic studies provide evidence for discrete stocks of winter flounder in the U.S. waters of the Northwest Atlantic. Winter flounder on Georges Bank have considerably higher growth rates than fish from inshore waters (Bigelow and Shroeder 1953, Lux 1973); and historically, the Georges Bank stock was considered as a separate species (*Psudopleuronectes dignabilis*; Kendall 1912). Meristic studies indicate that fin ray counts differ for fish from Georges Bank and inshore areas indicating further evidence for a discrete offshore stock of winter flounder on Georges Bank (Perlmutter 1947, Lux *et al.* 1970). Extensive tagging studies of winter flounder indicate little mixing of fish between Georges Bank and inshore areas (Coates *et al.* 1970, Howe and Coates 1975), providing further evidence for discrete stock structure (Pierce and Howe 1977).

For the purposes of this assessment, the Georges Bank stock was defined to include U.S. statistical areas 522-525, 551, 552, 561, and 562 (Figure 1) which corresponds approximately to NAFO subarea 5Zh,j,m&n. Corresponding survey data include NEFSC offshore survey strata 01130 to 01220. NEFSC offshore strata 01230 appears to include a mix of winter flounder from the Southern New England/Mid Atlantic stock complex and the Georges Bank stock, and therefore was not included in survey analyses for this assessment. Canadian survey strata include strata 5Z1 to 5Z8.

Fishery Description

Winter flounder, also known as blackback or lemon sole within the commercial fishery sector, are harvested primarily using otter trawl gear, and landings occur in both targeted landings and as bycatch in fisheries targeting other species. Bycatch landings and discards occur in trawl fisheries targeting other groundfish species and scallop dredge fisheries. Although recreational landings are a significant source of fishing mortality in inshore waters for the Southern New England stock complex, recreational landings from the Georges Bank stock are insignificant and are not included in this assessment.

Management History

Over the past 25 years, management of the commercial fishery for Georges Bank winter flounder has focused on minimum size limits and management measures (seasonal and year round area closures, mesh size regulations, effort control measures, and fleet capacity reduction programs) primarily intended to address management needs for other demersal species (Atlantic cod, haddock, and yellowtail flounder). Seasonal spawning closures of haddock spawning grounds, which increased in temporal and spatial coverage since their inception in 1970 (Clark 1976), have provided some measure of protection for the winter flounder stock.

Winter flounder was included in the New England Fishery Management Council's Atlantic Groundfish Fishery Management Plan (1977-1982). This initial plan established a minimum commercial size limit (11 inches, 28 cm), imposed minimum mesh sizes for trawls, and established spawning stock biomass per recruit targets. In 1982, the Council adopted an Interim Groundfish Plan, which established a minimum mesh size of 130 mm (5 1/8"). In 1983, the minimum mesh size was increased to 140 mm (5.5") In 1986, the Council's Multispecies Fishery Management Plan increased the minimum legal size to 30 cm (12 in) and imposed seasonal area closures. Amendments 5 and 7 (1994, 1996), established effort controls (days at sea limits), further increased minimum mesh size to 142 mm (6" diamond or square mesh), imposed trip limits for regulated groundfish bycatch in the sea scallop fishery, and prohibited small mesh fisheries from landing regulated groundfish. In December 1994, two large areas on Georges Bank were closed to fishing on a year round basis to protect overfished groundfish species. These areas include both the eastern and western edges of the distribution of winter flounder on the bank.

Amendment #9 to the Multispecies Fishery Management Plan was submitted in 1998 to revise the overfishing definition according to Sustainable Fisheries Act requirements. The Overfishing Definition Review Panel (Applegate *et al.* 1998) recommended an MSY based control rule derived from survey based proxies of MSY reference points. Biomass reference points were based on the U.S. NEFSC Autumn research vessel biomass index (stratified mean kg/tow) and fishing mortality reference points were based on an exploitation index (catch/U.S. NEFSC Autumn research vessel biomass index).

Georges Bank winter flounder was previously assessed in 1978 (Lange and Lux 1978) and 1986 (Gabriel and Foster 1986). These two assessments provided descriptive summaries of catch, effort, survey indices, and yield per recruit modeling. The current assessment represents the initial attempt to conduct an analytical assessment of the stock.

THE FISHERY

Commercial Landings

Before 1976, commercial landings of Georges Bank winter flounder were reported from the United States, Canada, and distant water fleets including the former Soviet Union. From 1964 to 1971, commercial landings increased, reaching a peak of 4,500 mt in 1972 (Figure 2, Table 1). Landings declined from 1971 to 1976, before increasing sharply to 3,600 mt in 1977. Commercial landings peaked between 1980 and 1984 (averaging 3,800 mt/year), but declined sharply beginning in 1985 (Figure 2). Landings trended downward after 1984, with the

exception of increased landings resulting from the strong 1984 year class in 1987 and 1988. Commercial landings in 1995 (760 mt) were the lowest recorded in the landings time series dating back to 1962.

Since the late 1960's, U.S. landings have been the dominate component of total commercial landings. Canadian landings have averaged 0.1% to 2.7% of total fishery landings since 1970. The Canadian industry's interest in the Georges Bank winter flounder resource has increased (S. Gavaris, personal communication), and reported Canadian landings in 1997 reached their highest reported levels since 1966 (Table 1).

Otter trawls have been the dominate gear accounting for greater than 98% of landings in the U.S. fishery through 1985 (Table 2). Since 1985, the proportion of landings taken by scallop dredges has increased steadily from less than 1% to approximately 7 to 8% by the early 1990s. It is unclear whether this trend represents increased retention rates by the scallopers, or improved reporting of non-target landings by the fleet. The proportion of winter flounder landings accounted for by scallop dredges declined from 1994 to 1997 in response to U.S. groundfish retention limits imposed in the scallop fishery. Tonnage class 3 (51-150 GRT) otter trawlers generally account for approximately 60% to 80% of U.S. landings, while tonnage class 4 (151-500 GRT) otter trawlers generally account for all but a few percent of the remaining U.S. landings (Table 3).

Commercial landings since 1982 are reported for 8 market categories (lemon sole, extra large, large, large/mixed, medium, small, peewee, and unclassified) based primarily on the individual fish size. Three categories (lemon sole, small, and large) comprised approximately 85% of the commercial landings from 1982 to 1997 (Table 4).

Commercial Discards

Commercial discarding occurs in the otter trawl and scallop gear sectors due to marketability (size and condition), minimum size limit regulations, and groundfish retention limits which prohibit groundfish retention in some small mesh fisheries and restrict retention in others (scallop fishery). Discard information is available from two primary sources, the sea sampling database which summarizes information collected by trained observers riding on commercial trips and the Vessel Trip Report (VTR) database which contains records of commercial operator reported discards.

Sea sampling data (available 1989 to 1997) represents the most reliable source of information available for estimating commercial discards. The total number of Georges Bank trips where winter flounder weights were collected ranged from 4 to 17 trips annually. Sea sampling of scallop dredge trips was limited with no more than 5 trips available annually where weights of landed and discarded winter flounder were sampled. Based on this limited amount of information, estimated total discards in the trawl gear sector ranged from 1.2 to 24.9 mt annually, representing 0.2 to 1.6% of otter trawl catch. Limited sampling of sea scallop trips precludes even preliminary estimates of discards for this fleet sector. However, limited sea sampled trips

occurring in 1995 to 1997 (eight trips) appear to indicate that discarding of winter flounder by this gear sector may have increased significantly in response to groundfish retention regulations.

Length frequency information available in the sea sampling database was examined to determine the feasibility of partitioning discard weight estimates into numbers at length. The number of discarded winter flounder measured annually by the Sea Sampling Program ranged from 70 in 1989 to none in 1997. Clearly, the number of discarded winter flounder measured was insufficient to characterize the overall length frequency distribution of the discarded portion of the catch. The number of discarded winter flounder measured in the scallop dredge gear sector was insignificant in every year except 1997, when 239 discarded winter flounder were measured in the second quarter and a total of 274 were measured across all quarters. Based on the limited data available to either estimate the magnitude of total discards or characterize their size distribution, we concluded that it would be inappropriate to generate estimates of discards based on an analysis of available sea sampling data.

Commercial operator reported discards in the VTR database (available 2nd Quarter of 1994 to 1997) represented the next best available source for estimating discards. Reporting rates in the VTR database are known to be incomplete because many operators fail to reliably report discards. To avoid problems associated with incomplete reporting, we estimated discard ratios using VTR data based on a subset of logbook records that reported at least 1 pound of discards for any species (DeLong *et al.* 1997, NEFSC 1997, Brown and Munroe 2000). By using this subset to characterize discard ratios, we made three basic assumptions: 1) it is highly unlikely that a groundfish trip could operate within the Georges Bank stock area without generating discards of some species, 2) trips that reported discards of some species reliably reported discards of winter flounder, and 3) the ratio of landed to discarded weight from this subset was representative of the discarding behavior of the entire fleet. Thus, the subset used to estimate discard ratios included 1) trips reporting both landings and discards of winter flounder, 2) trips reporting winter flounder discards but no landings, and 3) trips reporting winter flounder landings and discards for some other species.

For the otter trawl gear sector, the number of trips included in the discard ratio estimate ranged from 73 to 182 trips annually. Based on logbook reported discards, estimated total discards in the trawl gear sector ranged from 7.2 to 21.9 mt annually, representing 0.5 to 3.0% of otter trawl landings. Based on the number of scallop dredge trips reporting discards of winter flounder, it was clear that discard reporting rates for winter flounder are extremely low in this gear sector. From a regulatory standpoint, there are a number of disincentives to accurately reporting groundfish bycatch by scallop dredges. The limited number of trips reporting discards represent a significant source of uncertainty relative to the total fishery removals from the stock.

The third approach attempted to estimating discards involved using a combination of commercial sea sample data and research vessel survey data to estimate the total numbers discarded at length (following Mayo *et al.* 1992). Three significant weaknesses were encountered that precluded the use of this approach. First, the length frequency distribution from a research vessel survey is assumed to be representative of the size distribution of the winter flounder resource seasonally.

The limited number of strata and tows made on the U.S. NEFSC Spring and Autumn research vessel surveys produce limited numbers of winter flounder to characterize the length frequency distribution. For the period when the catch at age was produced for this assessment (1982 to 1997), the total number of winter flounder captured in representative tows during NEFSC Spring research vessel surveys ranged from 31 to 256 fish, and in 7 of the 17 years the total number of fish captured was less than 70 fish. For the U.S. NEFSC Autumn research vessel survey, the total number of winter flounder captured ranged from 12 to 320 fish, and in 8 of the 17 years the total number of fish captured was less than 70 fish. The low numbers of fish sampled result in an increased likelihood that there are some seasons when the U.S. NEFSC survey performs poorly in representing the length frequency distribution of the resource.

Second, the discard length frequency information available from sea sampling was limited resulting in a potentially poor determination of the discard selectivity ogive used in the analysis. One diagnostic for determining the performance of this estimation method is examination of the relationship between the research vessel bottom trawl survey number per tow discarded and the sea sample estimated number discarded. The expectation of is that this relationship will have a positive slope and that the correlation will be positive. The correlations between these estimated variables were weak, and in some cases negative, ranging from -0.1 to 0.7. This diagnostic indicates a significant problem with one of the inputs to this discard estimation procedure.

Third, if the number discarded at length could be reliably estimated, the number of age determinations for smaller size winter flounder from survey data is limited. While commercial age data could be used to augment age keys for older individuals, research vessel survey and sea sampling data are the only source of age determinations for sub-legal size fish. The number of survey ages available ranged as low as 12 determinations (U.S. NEFSC Autumn 1991 survey) when every winter flounder captured within the strata set was aged.

In summary, available survey, vessel trip record, and sea sampling data were insufficient to produce reliable estimates of the magnitude or age composition of winter flounder discards occurring in the Georges Bank otter trawl or scallop dredge fisheries. However, both the sea sampling and vessel trip record approaches produced consistent information concerning the magnitude of discards occurring in the otter trawl and scallop dredge fisheries. Both approaches produced low estimates of discards relative to landings (Sea Sample: 0.2% to 1.6%; VTR: 0.5 to 3.0%) for the otter trawl fishery.

In addition, both data sources appear to indicate that discarding increased in the scallop dredge fishery following the implementation of groundfish retention limits. The recent scallop dredge discards represent a significant source of uncertainty relative to the total fishery removals from this stock. However, an analysis of the spatial overlap of exploitable scallop resources and winter flounder distributions indicated little spatial overlap. Because of the uncertainty in both the underlying data and the performance of the discard estimation approaches, no commercial discards were included in the catch at age analyzed in this assessment.

Sampling Intensity of Commercial Landings

Although the U.S. commercial landings of Georges Bank winter flounder are reported for 8 market categories (lemon sole, extra large, large/mixed, large, medium, small, peewee, and unclassified), three categories (lemon sole, small, and large) comprised 85% of the commercial landings from 1982 to 1997 (Table 4). After comparing the length frequencies by market categories across years, other market categories including peewee (5.9%), medium (1.7%), extra large (0.6%) and large/mixed (0.2%) were combined with the small, large, and lemon sole market categories to estimate catch at age (see Table 5 for details). U.S. commercial length samples were aggregated by quarter and combined market categories and summarized in Table 5. Since 1982, annual sampling intensity by combined market category ranged from 36 to 902 mt of landings/sample. Sampling intensity has been lower for lemon sole than for small or large combined market categories, and sampling in all market categories deteriorated after 1992. Poor sampling intensity prior to 1982 precludes extension of the landings at age time series prior to 1982. There is no formal commercial sampling program for Canadian landings of Georges Bank winter flounder.

Landings at Age

Age composition of the 1982 to 1997 commercial landings from Georges Bank was estimated by applying commercial age-length keys to quarterly commercial numbers at length, aggregated by market category. In some instances, the landings at age analysis was pooled to half year, and in one case across three quarters of the calendar year (1993, quarters 2-4) because of insufficient length frequency sampling (Table 6). Mean weights at age were estimated by applying the length-weight equations to the quarterly length frequency samples by market category. Total numbers landed per quarter were estimated by applying the mean weights to the quarterly landings by market category and prorating according to the sample length frequency. Numbers at age were summed over market category for each quarter and annual estimates of landings at age were obtained by summing values over quarters. Landings from both the unclassified market category for U.S. landings and total reported Canadian landings were assumed to have the same age composition as the sampled U.S. landings, and the estimated landings at age was adjusted to incorporate these landings. The unsampled portion of landings generally accounted for less than 10% of the total landings at age.

Total estimated landings at age for 1982 to 1997 are summarized in Table 7A. Age 2 to 4 fish dominate landings in most years, and two relatively large year classes (1985, 1987) appear to track well through the landings at age matrix. Landings of age 1 fish are insignificant except in 1995 when almost 264,000 age 1 fish were estimated. Examination of the U.S. commercial samples indicated that large numbers of age 1 fish were present in multiple samples occurring in the third and fourth quarters of 1995. In addition, relatively large numbers of the 1994 cohort were landed as age 2 fish in 1996 and age 3 fish in 1997. Estimated landed weight (mt) of Georges Bank winter flounder by age and year is summarized in Table 7B.

Mean Weights at Age

Mean length and weight at age from the analysis of total landings at age are summarized in Tables 7C and 7D, respectively. Mean weights at age have remained relatively stable from 1982

to 1997, although poor sampling of older ages results in some variability in the estimated length and weight for ages 7 and older.

STOCK ABUNDANCE AND BIOMASS INDICES

U.S. Landings per Unit Effort (LPUE) Indices

Landings per unit effort (landings/days fished) were tabulated from the weighout database by tonnage class from 1964 to 1993 for all otter trawl trips landing winter flounder and for directed trips (trips with >= 50% winter flounder landings). Landings per unit effort indices for all trips and for directed winter flounder trips demonstrated similar trends with high levels of landings per unit effort in the 1980s, and declines in both indices to their lowest levels in the time period in the early 1990s (Figure 3).

U.S. NEFSC Research Vessel Bottom Trawl Survey

The Northeast Fisheries Science Center of the U.S. National Marine Fisheries Service has conducted a stratified random bottom trawl survey designed to assess the abundance and biomass of fish species along the continental shelf of the United States from the Scotian Shelf to Cape Hatteras since 1963 (Azarovitz 1981, Depres *et al.* 1988, Azarovitz *et al.* 1997). Two stratified random bottom trawl surveys, a spring survey (April 1968-1998) and an autumn survey (October 1963-1997) are used to estimate changes in abundance (stratified mean number/tow) and biomass (stratified mean weight (kg)/tow) of demersal fish species including winter flounder in the Georges Bank area. The indices for Georges Bank winter flounder include data from representative tows occurring in the NEFSC offshore strata 01130 to 01220. Significant changes in the catchability of winter flounder due to a door gear change in 1995 necessitated adjusting pre-1995 using door standardization coefficients (1.46 numbers, 1.39 weight; Forrester et al. 1997) estimated through fishing power experiments. These experiments indicated no significant differences in the catchability of winter flounder between the two research vessels (Delaware II and Albatross IV) during the survey time series.

Standardized, stratified abundance and biomass indices for Georges Bank winter flounder from the U.S. NEFSC Spring and Autumn research vessel Bottom Trawl surveys are shown in Table 8 and Figure 4. Abundance and biomass indices exhibit considerable variability but generally exhibit intermediate levels of abundance from the early 1960s to early 1980s, and declining levels of abundance since the mid-1980s (Figure 4). Both surveys have exhibited a declining trend over the final two years of the survey. The stratified mean length (cm) in both the U.S. NEFSC Spring and Autumn surveys exhibited a general declining trend between the mid 1960s and early 1990s, but the stratified mean length of winter flounder captured in the survey has increased over the past five years (Figure 5). Sharp single year declines in mean length generally correspond to the recruitment of above average year classes to the survey gear.

Stratified mean number at age for the U.S. NEFSC Spring and Autumn surveys is shown in Tables 9A and 9B, respectively. Although these indices are noisy, larger cohorts appear to track through the numbers at age matrix for the 1980, 1985, 1987, and 1994 cohorts.

Canadian Research Vessel Bottom Trawl Survey

The Department of Fisheries and Oceans, Canada has conducted a stratified random bottom trawl survey on Georges Bank since 1986. The Canadian survey, normally conducted during February or early March, occupies stations in both U.S. and Canadian waters. Station density is generally higher than on U.S. NEFSC surveys of Georges Bank. For the purposes of this assessment, stations occurring in strata 5Z1 to 5Z8 within the NAFO area 5Zh,j,m,n were included in the estimation of abundance indices. Weight data were collected, but were unavailable for estimating biomass indices (kg/tow). Stratified mean numbers/tow at length were available for winter flounder from 1987 to 1998. Biomass indices were generated by applying the U.S. survey length-weight regression relationship (Weight (kg) = 0.0000079099 * Length (cm) $^{3.1378}$) to the stratified mean numbers at length from the Canadian survey. Indices of abundance and biomass for the Canadian survey are summarized as stratified mean number/tow from 1986 to 1998 (Table 9C, Figure 4).

Winter flounder captured during the Canadian survey are counted and measured, but not aged. U.S. survey and commercial age keys were used to partition stratified mean numbers at length into stratified mean numbers at age. Sufficient age determinations were available from U.S. NEFSC Spring survey data to partition stratified mean numbers at length into numbers at age for fish smaller than 40 cm. U.S. commercial age keys from the first quarter of the corresponding year were applied for fish longer than 40 cm. The application of commercial age keys will provide unbiased estimates of catch at age if both the U.S. commercial fleet and the Canadian survey are sampling fish that grow at the same rate. Since the principal winter flounder habitat is located in U.S. waters and the Canadian survey samples across both U.S. and Canadian waters with primary catches occurring in U.S. waters, this assumption appears to be valid.

MORTALITY AND MATURATION

Natural Mortality

For this assessment, natural mortality was assumed to be constant and equal to 0.20 throughout the time series. The observation of maximum ages in the populations occasionally exceeding 15 years is consistent with this assumption of natural mortality.

Total Mortality

Estimates of instantaneous total mortality (Z) and fishing mortality (F, assuming natural mortality = 0.20) were estimated from the stratified number at age indices from the U.S. NEFSC Spring and Autumn surveys. Because of interannual variability in the survey indices, pooled estimates of mortality rates were estimated across running three year time periods from 1981 to 1997. Total mortality (Z) was estimated as the natural log of the ratio of ages 3+/4+ indices from the Autumn survey, and ages 4+/5+ indices from the spring survey. Mortality rates for both surveys exhibited similar patterns with relatively low mortality rates in the early 1980s, higher mortality rates in the mid-1980s to early 1990s, and lower mortality rates in the mid-1990s (Figure 6). The two surveys exhibit divergent trends in the most recent years (1993 to 1997), with the spring survey estimate high and increasing fishing mortality, while the Autumn survey estimates lower and decreasing fishing mortality (Figure 6).

Maturity

Maturation determinations for female winter flounder were collected on the NEFSC Spring research vessel survey from 1982 to 1997. The total number of maturation determinations annually is limited, particularly in terms of the number of determinations for ages 2 and 3 fish which determine the character of the maturation relationship at age. We used a logistic regression approach (O'Brien *et al* 1993) to estimate the proportion of females mature at age. Logistic equations for individual years were used to estimate age at 50% maturity for individual years. Age at 50% maturation for female winter flounder appeared to fluctuate without trend from 1982 to 1998 (Table 10). After attempts to pool across various time periods produced stable results, a logistic regression using the entire time series (1982 to 1998) was performed. Age at 50% maturity was estimated to be 1.83 years and the resulting maturity ogive (0.00 at age 1, 0.62 at age 2, 0.92 at age 3, 1.00 at age 4) was used in subsequent analyses (Table 10). O'Brien *et al* (1993) reported age at 50% maturation of 1.9 years and a similar estimated maturity ogive (0.03 at age 1, 0.62 at age 2, 0.99 at age 3, 1.00 at age 4) for data from 1985 to 1989.

ESTIMATES OF STOCK SIZE AND FISHING MORTALITY

Virtual Population Analysis Calibration

The ADAPT virtual population analysis (VPA) calibration method (Parrick 1986, Gavaris 1988, Conser and Powers 1990) was used to estimate terminal stock abundance at ages 2-6 and derive age specific estimates of fishing mortality in 1997 and stock sizes at the beginning of 1998. The catch at age in the VPA consisted of combined U.S. and Canadian landings during 1982 to 1997 for ages 1-6 with a 7+ age group. Indices available to calibrate the VPA included the U.S. NEFSC Spring research vessel survey catch (numbers) at age (ages 1 to 7), the Canadian Spring research vessel Survey catch (numbers) at age (ages 1 to 7), and the U.S. NEFSC Autumn research vessel survey catch (numbers) at age (ages 0 to 6) lagged forward one age and one year. Several VPA calibrations were completed and evaluated during the Southern Demersal Subcommittee and SAW/SARC meetings. A summary of these calibrations including key diagnostics and terminal year results are reported in Table 11.

The final accepted calibration (Run 15) estimated ages 2 to 6 and included the U.S. NEFSC Spring indices (ages 1 to 7), the Canadian Spring indices (ages 1 to 7), and the U.S. NEFSC Autumn indices (ages 1-6, lagged forward one age and one year). This calibration was successful in reducing the coefficients of variation on the youngest ages (2 and 3) and produced favorable diagnostics (Table 11, Appendix 1).

Virtual Population Analysis Results

The assessment results indicate that stock numbers exceeded 25 million in the early 1980s, gradually declined to reach a low level of approximately 8.8 million in 1993, increased to 13.6 million in 1995, and have again declined to 9.6 million fish in 1997 (Table 12). Age 2 recruitment was relatively stable throughout the time period, but larger 1980, 1985, 1987 and 1994 year classes exceed 5 million fish at age 2 (Table 12, Figure 7). Recent recruitment, as measured by the 1995 and 1996 year classes, has been the lowest in the time series (Figure 7). There appears to be little discernible relationship between stock and recruitment over the time period analyzed in this assessment (Figure 7).

Spawning stock biomass declined from levels exceeding 8,000 mt in the early 1980's to less than 2,000 mt in 1994, but increased to almost 3,700 mt in 1996 (Table 12, Figure 7). Spawning stock biomass declined slightly from almost 3,700 mt in 1996 to 3,500 mt in 1997. In the early 1980s, spawning stock biomass consisted of a wide range of ages and the youngest mature ages (2 and 3) comprised less than 40% of the total spawning stock biomass (Figure 8). The age structure of the spawning stock biomass became truncated in the mid 1980s to mid 1990s, when the youngest mature ages (2 and 3) comprised 45% to 75% of the spawning stock biomass. Some broadening of the age structure of spawning stock biomass is evident after 1994, but the age structure spawning component of the stock remains truncated relative to historical levels (Figure 8).

From the early 1980s to the early 1990s, fishing mortality rates ranged from approximately 0.5 to as high as 1.4. Fishing mortality rates declined sharply after 1993 and have fluctuated between 0.3 and 0.5 from 1994 to 1997 (Table 12). There is a reasonable level of agreement between VPA estimated fishing mortality rates and survey estimated rates of fishing mortality (Z estimates assuming m=0.2) throughout the time series (Figure 6). However, in the most recent three years, VPA estimates of fishing mortality correspond more closely with fishing mortality estimates from the Autumn survey. Patterns in fishing mortality appear to be reasonably well correlated with reported landings included in the assessment (Figure 9).

Precision Estimates of F and SSB

Uncertainty and potential bias estimates were assessed using a bootstrap analysis of the VPA calibration. One thousand bootstrap realizations were produced by randomly resampling survey residuals produced by the final ADAPT calibration. Bootstrap abundance indices had slightly larger CV's than the least squares estimates produced by the final ADAPT VPA calibration (Appendix 2). Estimates of bias on all ages were relatively low, ranging from 3.7% to 6.4%. Bias estimates for fully recruited F and spawning stock biomass were each below 3%.

The distribution of bootstrap realizations of spawning stock biomass indicates that there is an 80% chance that the 1997 estimate of SSB is between 3,100 and 4,200 mt (Figure 10). The distribution of bootstrap realizations of fishing mortality suggests that there is an 80% probability that F_{1997} is between 0.33 and 0.51 (Figure 10).

Retrospective Analysis

Retrospective analyses of the Georges Bank winter flounder VPA were performed from 1997 to 1990 by sequentially reanalyzing the ADAPT calibration after removing the terminal year of input data. Retrospective patterns for fishing mortality (Figure 11A) indicate a pattern of slightly overestimating average fishing mortality in the terminal year. The tendency was more pronounced in the terminal year 1992 and 1993 assessments. The retrospective patterns for spawning stock biomass (Figure 11B) indicate that there is a tendency in the most recent years to slightly overestimate spawning stock biomass in the terminal year. This pattern shifts before 1993 with a tendency to underestimate SSB in the terminal year estimates evident before 1993.

The retrospective patterns for age 2 recruitment (Figure 11C) indicate considerable variability in the performance of the terminal year estimation of stock numbers at age 2. Performance was

generally acceptable with a slight tendency to underestimate age 2 recruitment for most year classes. However, retrospective performance was particularly poor for the 1992 and 1994 year classes, where initial estimates were considerably higher than converged estimates of these year classes. Both of these year classes had estimated age 1 landings included in the catch at age, whereas landings at age from other year classes indicated no landings at age 1. This observation should be considered when evaluating the reliability of the terminal estimate of age 2 recruitment, which estimates that incoming age 2 recruitment is the weakest in the time series.

BIOLOGICAL REFERENCE POINTS

Yield and Spawning Stock Biomass per Recruit Analyses

Yield per recruit (Thompson and Bell 1934) and yield per recruit (Gabriel *et al.* 1989) analyses were conducted using the partial recruitment vector estimated from the calibrated VPA. Since major fishery management measures have been implemented beginning in 1994, 4-year (1994-1997) arithmetic mean weights and geometric mean partial recruitment were used as inputs in these analyses. The maturation schedule for Georges Bank winter flounder has been stable through time, so the long term estimate of the maturation schedule was used as an input. Results of the analysis indicate that $F_{0.1}$ is currently estimated to be 0.21, F_{max} is estimated to be 0.42, and $F_{20\%}$ is estimated to be 0.47 (Table 13, Figure 12).

SFA Overfishing Definitions

The Overfishing Definition Review Panel (Applegate *et al.* 1998) proposed an MSY based harvest control rule for Georges Bank winter flounder derived from survey based proxies of biomass and exploitation. The panel defined maximum sustainable yield as 2,700 mt, identified a threshold fishing mortality proxy (F_{MSY}) as a level of an exploitation index (catch/U.S. NEFSC Autumn survey biomass) of 0.98, and identified a target stock biomass proxy as the U.S. NEFSC Autumn survey biomass index value of 2.74. Further, target fishing mortality proxy was estimated to be 75% of the threshold proxy value, and stock biomass proxies were established as 50% of the target B_{MSY} proxy values. Figure 13 provides a graphic representation of the SFA overfishing definition.

A non-equilibrium surplus production analysis (ASPIC, Prager 1993, 1994) was completed using landings biomass and the U.S. NEFSC Spring, Canada spring, and U.S. NEFSC Autumn survey indices of stock biomass from 1963 to 1997 to provide perspective on historical stock levels and to provide information relative to SFA reference points (Appendix 3). Initial biomass, maximum sustainable yield, the intrinsic rate of increase and catchability (q) of the survey biomass indices were estimated by nonlinear least squares of the biomass index residuals.

The current surplus production model differed from the model used to construct the SFA harvest control rule in two respects. First, the catch input included foreign landings (primarily from the 1960s) that were not included in the surplus production model. Second, the strata set used to estimate the U.S. NEFSC Spring and Autumn indices included a larger strata set than the indices used to estimate the SFA harvest control rule. The two strata sets produced highly correlated survey indices, although the current survey indices are scaled lower than the previous indices.

Results of the surplus production analysis indicated a reasonable fit to the input data, and estimated trends in biomass were well matched with results from the Virtual Population Analysis (Figure 14, Appendices 1 and 3). A maximum sustainable biomass (MSY) of 3,100 mt was estimated to be produced by a biomass (B_{msy}) of 11,400 mt (Table 14). A time trajectory of results from the surplus production model indicates that yield has generally exceeded estimated surplus production for the past two decades (Figure 15).

The SFA harvest control rule was re-estimated in its original format based on a current NEFSC research vessel survey indices (revised strata set) and a revised surplus production model that incorporated the Canadian research vessel survey indices and foreign commercial landings in the 1960s and early 1970s. The target B_{MSY} proxy (U.S. NEFSC Autumn Survey biomass units) was estimated to be 2.730 (MSY/f_{msy}), and the threshold B_{MSY} proxy was estimated to be 50% of the B_{MSY} proxy. The threshold and target F_{msy} proxies (in exploitation index units) were estimated to be 1.125 (MSY Proxy / B_{msy} proxy) and 0.843 ($0.75*F_{threshold}$ proxy), respectively.

The revised harvest control rule is displayed graphically in Figure 13. For the latest time period for which data were available (1995-1997), the three year average of the U.S. NEFSC Autumn survey index (1.542) and the exploitation index (0.754) indicate that overfishing was occurring and that the stock was in an overfished condition relative to the harvest control rule. If the harvest control rule were applied for the 1999 fishing year, the corresponding threshold fishing mortality rate (fully recruited F) would be 0.04 and the target fishing mortality rate (fully recruited F) would be 0.03.

PROJECTIONS

Short Term Stochastic Projections

Short term deterministic projections were performed for 1998, 1999, and 2000. 1998 U.S. landings were assumed to be 964 mt based on the landings projections by the New England Fishery Management Council's Multispecies Monitoring Committee. Canadian landings in 1998 were assumed to be equal to 1997 landings. The projections were based on a partial recruitment vector estimated as the geometric mean of 1994 to 1997 F's at age from the final VPA calibration, 1994 to 1997 arithmetic mean stock and catch weights, and the long term (1982-1997) maturity schedule for Georges Bank winter flounder. Age 1 recruitment was estimated from the terminal year bootstrap realizations of the VPA in 1998, and recruitment in 1999 and 2000 was resampled from observed age 2 recruitment estimated by the ADAPT VPA calibration from 1982 to 1997 (Age Pro Model 3).

Projections were run at F = 0.00 (maximum stock rebuilding rate), $F_{target} = 0.03$ (management target associated with the revised SFA harvest control rule), $F_{threshold} = 0.04$ (management threshold associated with the revised SFA harvest control rule), $F_{0.1} = 0.21$ (commonly used yield per recruit reference point), $F_{1998} = 0.34$ (based on projected landings of 1,107 mt in 1998), and $F_{20\%} = 0.47$ (current New England Fishery Management Council overfishing definition) for years 1999 and 2000. Results for these reference points of F are presented in Table 15.

Projections at F = 0.00 in 1999/2000 provide a benchmark for the maximum projected stock rebuilding rate. For this level of fishing mortality (i.e., fishery closure), there would be no

projected landings. Age 1+ biomass is projected to increase 33% from 5,680 mt in 1999 to 7,552 mt in 2000. Spawning stock biomass is projected to increase from 44% from 3,735 mt in 1999 to 5,374 mt in 2000 (Table 15, Figure 16). Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 4,098 mt and 6,793 mt (Table 15).

Projections at $F_{target} = 0.03$ in 1999/2000 result in a 91% decline in landings from 1,107 mt in 1998 to 118 mt in 1999 (Table 15, Figure 16). Age 1+ biomass is projected to increase 31% from 5,619 mt in 1999 to 7,342 mt in 2000. Spawning stock biomass is projected to increase 41% from 3,716 mt in 1999 to 5,228 mt in 2000. Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 3,986 mt and 6,613 mt (Table 15).

Projections at $F_{threshold} = 0.04$ in 1999/2000 result in an 86% decline in landings from 1,107 mt in 1998 to 157 mt in 1999 (Table 15, Figure 16). Age 1+ biomass is projected to increase 30% from 5,600 mt in 1999 to 7,274 mt in 2000. Spawning stock biomass is projected to increase 40% from 3,709 mt in 1999 to 5,181 mt in 2000. Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 3,948 mt and 6,552 mt (Table 15).

Projections at $F_{0.1} = 0.21$ in 1999/2000 result in a 31% decline in landings from 1,107 mt in 1998 to 764 mt in 1999 (Table 15, Figure 16). Age 1+ biomass is projected to increase 18% from 5,279 mt in 1999 to 6,244 mt in 2000. Spawning stock biomass is projected to increase 24% from 3,597 mt in 1999 to 4,446 mt in 2000. Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 3,377 mt and 5,639 mt (Table 15).

Based on projected landings of 1,107 mt in 1998, the projected level of fishing mortality in 1998 is 0.34. Fishing at $F_{1998} = 0.34$ in 1999/2000, landings would increase by 6% from 1,107 mt in 1998 to 1,172 mt in 1999 (Table 15, Figure 16). Age 1+ biomass is projected to increase 11% from 5,050 mt in 1999 to 5,596 mt in 2000. Spawning stock biomass would increase 13% from 3,514 mt in 1999 to 3,967 mt in 2000. Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 3,004 mt and 5,046 mt (Table 15).

The overfishing definition previously established by the New England Fishery Management Council for Georges Bank winter flounder is $F_{20\%}$, which is currently estimated to be 0.47. Fishing at $F_{20\%} = 0.47$ in 1999/2000, landings would increase by 42% from 1,107 mt in 1998 to 1,575 mt in 1999 (Table 15, Figure 16). Age 1+ biomass is projected to increase 4% from 4,836 mt in 1999 to 5,042 mt in 2000. Spawning stock biomass is projected to increase 3% from 3,433 mt in 1999 to 3,550 mt in 2000. Accounting for some sources of uncertainty in the stock assessment, there is an 80% chance that SSB in 2000 would be between 2,676 mt and 4,529 mt.

CONCLUSIONS

The Georges Bank winter flounder stock is overexploited and at a low level of biomass. Fishing mortality rates were very high in the early 1990s (1990-1993 average F=0.74), but have declined since 1994. Spawning stock biomass levels and age composition have improved since 1993, but incoming recruitment, particularly the 1995 and 1996 year classes, is poor. Stock biomass in 1997 was at 60% of the biomass proxy specified in the SFA harvest control rule. Assuming a catch of 1,100 mt in 1998, the estimated level of SSB in 1998 is 3,300 mt and fully recruited F is projected to increase to 0.34. Relative to the SFA overfishing definition and control rule, the stock was in an overfished condition and overfishing was occurring.

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Table 1. Landings (mt) of Georges Bank winter flounder from 1962-1997 by statistical area and country.

	522-525 561-562	5Z (521-543)				5ZE (521-526, 541-543)				Included in
	U.S.	U.S.	Canada	USSR	Total	U.S.	Canada	USSR	Total	Assessment
1962		6996	26		7022					
1963		6911	120	19	7050					
1964	1371	12656	146		12802					1517
1965	1176	10479	199	312	10990					1687
1966	1877	13807	164	156	14127					2197
1967	1917	10815	83	349	11247					2349
1968	1570		57			4346	59	372	4777	1999
1969	2167		116			6380		235	6615	2518
1970	2615		61			7020	64	40	7124	2716
1971	3092		62			1400	65	1029	15094	4183
1972	2805		8			1026	8	1699	11973	4512
1973	2269		14			4387	14	693	5094	2976
1974	2124		12			4508	12	82	4602	2218
1975	2409		13			4833	13	515	5361	2937
1976	1877		15			3732	11	1	3744	1893
1977	3572		15			5954	15	7	5976	3594
1978	3185		65			6378	65		6443	3250
1979	3045		19			6293	19		6312	3064
1980	3931		44			9941	44		9985	3975
1981	3993		19			9711	19		9730	4012
1982	2961		19			7347	19		7366	2980
1983	3894		14			8014	14		8028	3908
1984	3927		4			7574	4		7578	3931
1985	2151		12			4758	11		4769	2163
1986	1762		25							1787
1987	2637		32							2669
1988	2804		55							2859
1989	1880		11							1891
1990	1898		55							1953
1991	1814		14							1828
1992	1822		27							1849
1993	1662		21							1683
1994	907		65							972
1995	706		54							760
1996	1265		71							1336
1997	1287		143							1430

Table 2. U.S. landings (mt) and percent of landings of Georges Bank winter flounder (U.S. statistical areas 522-525, 551-552, 561-562) by gear type from 1964 to 1993. U.S. general canvas landings are not included.

	Landings by Gear (mt)				Percent of Total Landings		
	Trawl	Scallop Dredge	Other	Total	Trawl	Scallop Dredge	Other
1964	1360.2	--	11.2	1371.4	99.2	--	0.8
1965	1175.1	--	0.8	1176.0	99.9	--	0.1
1966	1851.3	--	25.8	1877.1	98.6	--	1.4
1967	1915.5	--	1.8	1917.3	99.9	--	0.1
1968	1565.3	--	4.6	1569.9	99.7	--	0.3
1969	2165.0	--	1.8	2166.8	99.9	--	0.1
1970	2610.6	--	4.4	2615.0	99.8	--	0.2
1971	3086.9	--	4..8	3091.7	99.8	--	0.2
1972	2796.6	--	7.9	2804.5	99.7	--	0.3
1973	2265.2	--	3.5	2268.8	99.8	--	0.2
1974	2116.5	--	7.7	2124.2	99.6	--	0.4
1975	2386.6	--	22.6	2409.2	99.1	--	0.9
1976	1874.7	--	2.6	1877.3	99.9	--	0.1
1977	3570.4	--	1.6	3571.9	100.0	--	<0.1
1978	3166.5	17.9	1.1	3185.5	99.4	0.6	<0.1
1979	3019.8	24.9	0	3044.6	99.2	0.8	<0.1
1980	3887.9	42.5	0.3	3930.8	98.9	1.1	<0.1
1981	3935.3	53.5	3.7	3992.5	98.6	1.3	0.1
1982	2919.5	41.2	0.1	2960.8	98.6	1.4	<0.1
1983	3864.0	25.4	7.2	3896.6	99.2	0.7	0.2
1984	3899.9	18.5	11.1	3929.5	99.2	0.5	0.3
1985	2146.3	3.1	3.2	2152.6	99.7	0.1	0.1
1986	1724.3	36.0	2.3	1762.6	97.8	2.0	0.1
1987	2560.6	77.6	0	2638.5	97.0	2.9	<0.1
1988	2699.5	106.5	0	2805.9	96.2	3.8	<0.1
1989	1761.7	119.7	0.1	1881.4	93.6	6.4	<0.1
1990	1779.6	118.2	1.6	1899.4	93.7	6.2	0.1
1991	1673.7	141.2	0.8	1815.6	92.2	7.8	<0.1
1992	1677.8	136.4	8.7	1822.9	92.0	7.5	0.5
1993	1535.2	115.5	12.4	1663.1	92.3	6.9	0.7
1994*	909.4	52.9	9.4	971.7	93.6	5.4	1.0
1995*	713.1	37.0	10.0	760.2	93.8	4.9	1.3
1996*	1243.8	71.2	20.6	1335.7	93.1	5.3	1.5
1997*	1337.9	80.0	11.9	1429.8	93.6	5.6	0.8

* includes Canadian landings.

Table 3. U.S. landings (mt) of Georges Bank winter flounder by tonnage class (TC2 = 5-50 GRT, TC3 = 51-150 GRT, TC4 = 151-500 GRT) for otter trawl and scallop dredge landings.

	Weighout Landings (mt)							Percentage of Total Landings						
	Otter Trawl Ton Class			Scallop Dredge Ton Class			All Others	Otter Trawl Ton Class			Scallop Dredge Ton Class			All Others
Year	2	3	4	2	3	4		2	3	4	2	3	4	
1964	74.0	927.8	358.4	0.0	0.0	0.0	11.2	5.4	67.7	26.1	0.0	0.0	0.0	0.8
1965	81.4	694.3	399.4	0.0	0.0	0.0	0.9	6.9	59.0	34.0	0.0	0.0	0.0	0.1
1966	54.2	1188.7	630.0	0.0	0.0	0.0	4.2	2.9	63.3	33.6	0.0	0.0	0.0	0.2
1967	46.4	1074.1	794.9	0.0	0.0	0.0	1.8	2.4	56.0	41.5	0.0	0.0	0.0	0.1
1968	34.4	1039.5	491.4	0.0	0.0	0.0	4.6	2.2	66.2	31.3	0.0	0.0	0.0	0.3
1969	6.6	1542.2	616.2	0.0	0.0	0.0	1.8	0.3	71.2	28.4	0.0	0.0	0.0	0.1
1970	16.2	2003.8	590.6	0.0	0.0	0.0	4.4	0.6	76.6	22.6	0.0	0.0	0.0	0.2
1971	66.8	2282.4	737.6	0.0	0.0	0.0	4.8	2.2	73.8	23.9	0.0	0.0	0.0	0.2
1972	36.4	2233.1	527.1	0.0	0.0	0.0	7.9	1.3	79.6	18.8	0.0	0.0	0.0	0.3
1973	22.0	1726.5	516.7	0.0	0.0	0.0	3.5	1.0	76.1	22.8	0.0	0.0	0.0	0.2
1974	15.8	1532.3	568.4	0.0	0.0	0.0	7.7	0.7	72.1	26.8	0.0	0.0	0.0	0.4
1975	9.5	1855.2	544.6	0.0	0.0	0.0	0.0	0.4	77.0	22.6	0.0	0.0	0.0	0.0
1976	2.2	1487.4	386.1	0.0	0.0	0.0	1.6	0.1	79.2	20.6	0.0	0.0	0.0	0.1
1977	33.2	2901.3	636.4	0.0	0.0	0.0	1.1	0.9	81.2	17.8	0.0	0.0	0.0	<0.1
1978	10.5	2541.3	615.7	0.0	7.6	10.3	0.2	0.3	79.8	19.3	0.0	0.2	0.3	<0.1
1979	34.7	2436.1	548.8	0.0	18.1	6.8	0.2	1.1	80.0	18.0	0.0	0.6	0.2	<0.1
1980	70.3	3112.3	705.3	2.9	19.6	20.1	0.4	1.8	79.2	17.9	<0.1	0.5	0.5	<0.1
1981	26.3	3087.7	822.5	0.0	19.0	34.5	2.5	0.7	77.3	20.6	0.0	0.5	0.9	0.1
1982	29.2	2194.6	693.4	0.0	26.9	14.2	2.5	1.0	74.1	23.4	0.0	0.9	0.5	0.1
1983	10.7	2641.1	1218.7	0.0	4.7	20.7	0.8	0.3	67.8	31.3	0.0	0.1	0.5	<0.1
1984	10.3	2551.1	1349.2	0.0	8.2	10.2	0.4	0.3	64.9	34.3	0.0	0.2	0.3	<0.1
1985	4.1	1316.3	829.0	0.0	1.8	1.4	0.0	0.2	61.2	38.5	0	0.1	0.1	0.0
1986	0.0	1222.5	504.2	0.1	6.6	29.3	0.0	0	69.4	28.6	<0.1	0.4	1.7	0.0
1987	0.4	1899.5	660.7	0.0	14.5	63.5	0.0	<0.1	72.0	25.0	0	0.5	2.4	<0.1
1988	2.6	1917.9	778.9	0.1	29.2	77.2	0.0	0.1	68.4	27.8	<0.1	1.0	2.8	<0.1
1989	0.0	1250.5	511.2	0.1	24.4	95.3	0.1	0.0	66.5	27.2	<0.1	1.3	5.1	<0.1
1990	0.3	1256.6	524.1	0.0	27.6	90.6	0.1	<0.1	66.2	27.6	<0.1	1.5	4.8	<0.1
1991	4.5	1225.1	444.8	0.7	22.7	117.9	0.0	0.2	67.5	24.5	<0.1	1.2	6.5	<0.1
1992	0.6	1221.1	464.7	0.1	29.8	106.5	0.0	<0.1	67.0	25.5	<0.1	1.6	5.8	<0.1
1993	0.0	1145.5	402.1	0.0	26.7	88.8	0.0	<0.1	68.9	24.2	0	1.6	5.3	0.0

Table 4. U.S. landings (mt) of Georges Bank winter flounder (522-525, 551-552, 561-562) by market category from 1980 to 1997.

	Landings by Market Category (mt)								Landings by Market Category (percent)							
	1200 Unclassified	1201 Lemon Sole	1202 Large	1203 Small	1204 Extra Large	1205 Large/ Mixed	1206 Medium	1207 Peewee	1200 Unclassified	1201 Lemon Sole	1202 Large	1203 Small	1204 Extra Large	1205 Large/ Mixed	1206 Medium	1207 Peewee
1980	101	824	745	2257	0	0	0	0	2.6	21.0	19.0	57.4	0.0	0.0	0.0	0.0
1981	31	902	748	2310	0	0	0	0	0.8	22.6	18.7	57.9	0.0	0.0	0.0	0.0
1982	137	517	549	1666	33	10	47	1	4.6	17.5	18.5	56.3	1.1	0.3	1.6	<0.1
1983	68	1506	361	1758	160	25	14	1	1.7	38.6	9.3	45.1	4.1	0.6	0.4	<0.1
1984	154	370	2029	1231	6	4	28	108	3.9	9.4	51.6	31.3	0.2	0.1	0.7	2.7
1985	76	573	264	1076	110	46	2	3	3.5	26.6	12.3	50.0	5.1	2.1	0.1	0.1
1986	183	176	741	540	2	0	45	76	10.4	10.0	42.0	30.6	0.1	0.0	2.6	4.3
1987	118	241	1027	974	2	0	38	238	4.5	9.1	38.6	36.9	0.1	0.0	1.4	9.0
1988	149	164	995	1269	1	<1	34	194	5.3	5.8	35.5	45.2	<0.1	<0.1	1.2	6.9
1989	127	110	717	751	<1	<1	37	138	6.8	5.8	38.1	39.9	<0.1	<0.1	2.0	7.3
1990	112	71	629	882	<1	0	57	149	5.9	3.7	33.1	46.4	<0.1	0	3.0	7.8
1991	152	54	680	792	<1	0	46	92	8.4	3.0	37.5	43.6	<0.1	0	2.5	5.1
1992	151	64	673	767	<1	<1	26	140	8.3	3.5	36.9	42.1	<0.1	<0.1	1.4	7.7
1993	119	89	634	712	<1	<1	22	86	7.2	5.4	38.1	42.8	<0.1	0.1	1.3	5.2
1994	33	60	380	433	***	***	2	***	3.6	6.6	41.9	47.7	***	***	0.2	***
1995	70	40	245	351	***	***	<1	***	9.9	5.7	34.7	49.7	***	***	<0.1	***
1996	191	67	414	577	***	***	15	***	15.1	5.3	32.8	45.6	***	***	1.2	***
1997	424	45	453	215	0	1	91	58	32.9	3.5	35.2	16.7	0.0	<0.1	7.1	4.5

*** Prorated into other market categories.

Table 5. U.S. port sampling of commercial winter flounder landings of length composition and commercial ages from Georges Bank (Statistical Areas 522-525, 551-562), 1980-1997. Total number of samples does not include 14 unclassified (market category 1200) samples from 1980 (1), 1981 (2), 1982 (4), 1985 (1), 1986 (1), 1990 (4), and 1991 (1).

				Number of Samples by Market Category, Area and Quarter															Annual Sampling Intensity No. mt landed/sample		
				Lemon Sole (1201) Extra-Large (1204)					Large (1202) and Large/Mixed (1205) Blackback					Small (1203), Medium (1206), and Pee-Wee (1207) Blackback					1201 1204	1202 1205	1203 1206 1207
	Total Samples	Total Measured	Total Aged	Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Q1	Q2	Q3	Q4	Tot	Lemon	Large	Small
1980	8	863	226	0	0	1	0	1	2	2	1	0	5	1	0	1	0	2	445	217	-----
1981	1	268	77	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	355	-----	-----
1982	26	2900	739	0	1	6	2	9	0	1	6	3	10	0	1	5	1	7	26	71	190
1983	36	4493	874	0	3	2	1	6	2	5	6	2	15	2	3	9	1	15	37	42	84
1984	24	2855	593	0	1	3	1	5	3	3	4	3	13	1	2	0	3	6	135	111	48
1985	38	3927	827	1	2	5	1	9	2	4	9	1	16	2	3	7	1	13	50	28	75
1986	29	2822	563	1	1	0	3	5	2	3	3	2	10	1	6	3	4	14	178	67	144
1987	33	3108	618	2	1	1	2	6	4	3	3	1	11	5	3	4	4	16	87	51	131
1988	34	2959	693	2	2	1	2	7	4	3	3	1	11	4	4	4	4	16	86	61	111
1989	16	1470	280	1	1	0	0	2	3	2	0	1	6	1	3	3	1	8	412	124	282
1990	34	3469	737	0	0	0	1	1	3	3	4	3	13	6	7	3	4	20	902	58	116
1991	35	3137	698	1	1	1	1	4	6	6	2	2	16	6	3	3	3	15	129	37	114
1992	35	3034	688	1	2	1	1	5	5	4	3	3	15	6	5	3	1	15	301	36	118
1993	16	1435	338	1	2	0	1	4	3	2	0	0	5	1	5	0	1	7	93	408	195
1994	17	1345	330	0	1	1	1	3	1	2	2	1	6	1	3	3	1	8	20	64	54
1995	14	1137	274	1	1	0	2	4	1	0	0	3	4	2	1	0	3	6	10	17	104
1996	11	1064	236	0	2	1	1	4	0	2	1	1	4	0	1	1	1	3	17	104	192
1997	15	1155	225	0	0	0	1	1	1	0	1	0	2	3	2	1	5	11	45	227	33

Table 6. Data pooling procedures used to apply length frequency samples to landings by market category to estimate catch (numbers) at age of Georges Bank winter flounder from 1982 to 1997.

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Market Category Comments
1982	Pooled		X	X	1204 (Extra Large) pooled with 1201 Lemon Sole 1205 (Large/Mixed) pooled with 1202 (Large) 1206 (Medium) and 1207 (Peewee) pooled with 1203 (Small)
1983	Pooled		X	X	
1984	Pooled		Pooled		
1985	X	X	X	X	
1986	X	X	Pooled		
1987	X	X	X	X	
1988	X	X	X	X	
1989	X	X	Pooled		
1990	X	X	X	X	
1991	X	X	X	X	
1992	X	X	X	X	
1993	X	Pooled			
1994	Pooled		X	X	1201 (Lemon Sole) and 1204 (Extra Large) pooled with 1202 (Large) 1205 (Large/Mixed) pooled with 1202 (Large) 1206 (Medium) and 1207 (Peewee) pooled with 1203 (Small)
1995	X	X	Pooled		
1996	Pooled		X	X	
1997	X	X	Pooled		

Table 7A. Estimated landings at age (thousands) of Georges Bank winter flounder from 1982 to 1997.

	Age									
	1	2	3	4	5	6	7	8	9	10+
1982	---	352.8	1707.2	1047.9	510.5	258.0	116.6	101.2	30.4	32.8
1983	10.1	787.0	2901.5	1453.8	551.2	206.0	220.8	133.7	46.9	127.0
1984	---	281.7	570.0	1370.9	1408.2	635.0	302.7	230.4	169.3	217.4
1985	19.6	804.6	693.0	811.6	490.7	111.5	50.7	21.6	19.7	8.2
1986	---	664.8	1327.7	235.2	228.6	130.7	48.7	23.4	7.3	8.8
1987	---	1293.7	1681.3	898.9	133.2	88.6	40.3	35.1	25.0	20.6
1988	---	835.3	2773.6	842.6	197.1	89.6	46.1	23.8	6.9	16.5
1989	---	1380.8	1222.0	509.3	147.2	106.7	28.9	22.0	5.7	3.9
1990	---	294.9	2031.5	668.1	184.5	45.5	7.5	6.5	0.2	2.5
1991	---	592.6	1270.0	950.6	135.8	37.8	29.9	18.0	8.6	3.9
1992	---	796.4	756.1	727.4	468.1	92.2	32.2	14.6	10.8	3.6
1993	37.1	300.5	1143.2	450.8	319.6	163.1	20.7	13.4	5.4	7.4
1994	---	532.8	582.2	246.0	67.3	56.7	34.4	9.3	4.3	3.0
1995	263.7	679.1	266.8	188.4	75.6	18.9	13.5	3.5	2.7	0.5
1996	---	736.5	567.3	240.3	156.7	104.0	38.0	28.8	10.1	6.4
1997	---	479.9	1114.9	589.6	131.8	34.8	11.3	7.1	2.0	13.3

Table 7B. Estimated weight (mt) at age for Georges Bank winter flounder landed from 1982 to 1997.

	Age									
	1	2	3	4	5	6	7	8	9	10+
1982	---	99.6	760.6	817.5	531.4	317.0	160.5	164.2	61.1	68.1
1983	1.8	219.5	1308.2	971.4	495.3	204.0	252.5	168.5	69.1	217.6
1984	---	82.1	266.2	802.6	1048.5	566.2	317.8	272.1	221.4	353.7
1985	3.3	326.1	360.0	634.1	514.9	152.3	78.2	37.6	40.1	16.4
1986	---	264.4	809.7	182.5	235.2	155.6	68.9	37.0	12.7	20.5
1987	---	499.6	924.3	780.5	147.5	108.0	63.9	56.4	46.5	41.9
1988	---	292.4	1415.8	641.2	226.6	118.5	73.5	42.2	14.2	34.4
1989	---	498.1	565.1	421.7	158.8	142.2	44.0	39.6	12.2	9.5
1990	---	134.6	1035.2	505.4	183.1	60.9	14.9	12.4	0.5	6.0
1991	---	248.5	614.8	671.2	133.8	54.3	47.4	33.2	16.4	8.7
1992	---	309.9	373.2	541.3	424.7	109.6	42.8	24.1	16.8	6.2
1993	9.3	115.5	614.4	342.1	301.3	211.1	34.3	25.2	12.4	17.2
1994	---	201.0	318.0	218.0	75.3	75.9	51.6	17.3	8.2	6.4
1995	74.6	267.9	159.3	124.3	75.5	24.3	21.4	6.3	5.3	1.4
1996	---	304.2	348.2	217.1	171.7	150.0	60.1	51.4	20.0	12.9
1997	---	174.1	595.8	414.2	133.3	49.8	17.5	13.3	4.3	27.6

Table 7C. Estimated mean length (cm) at age for Georges Bank winter flounder from the commercial landings at age.

	Age									
	1	2	3	4	5	6	7	8	9	10+
1982	--	30.68	35.36	42.42	46.54	49.11	50.91	53.68	57.46	58.03
1983	26.67	30.53	35.49	40.29	44.40	45.78	47.88	49.40	52.00	54.51
1984	--	31.05	36.05	38.72	41.75	44.31	46.61	48.42	50.00	53.61
1985	26.07	34.12	36.74	42.27	46.62	50.72	52.72	54.85	57.61	57.50
1986	--	33.99	39.13	42.18	46.12	48.37	51.04	53.37	55.08	60.42
1987	--	33.72	37.77	43.88	47.44	48.70	53.17	53.34	56.02	57.67
1988	--	32.77	36.76	41.95	48.01	50.16	53.28	55.15	57.79	58.16
1989	--	32.95	35.45	43.16	46.86	50.32	52.52	55.52	58.64	61.33
1990	--	35.72	36.93	41.91	45.74	50.39	57.26	56.46	62.00	60.83
1991	--	34.65	36.06	40.85	45.69	51.67	53.27	56.00	56.35	59.56
1992	--	33.90	36.53	41.71	44.37	48.43	49.74	53.89	52.20	54.73
1993	29.66	33.68	37.57	41.80	44.74	49.83	54.10	56.30	60.05	60.23
1994	---	33.53	37.75	44.09	47.56	50.36	52.13	56.16	56.64	58.48
1995	30.80	33.94	38.93	40.05	45.41	49.35	52.23	55.52	56.88	63.00
1996	---	34.65	39.32	44.42	47.08	51.64	53.20	55.39	57.29	57.53
1997	---	33.19	37.42	40.90	45.75	51.51	52.96	56.36	59.00	58.25

Table 7D. Estimated mean weight (kg) at age for Georges Bank winter flounder from the commercial landings at age.

	Age									
	1	2	3	4	5	6	7	8	9	10+
1982	--	0.283	0.444	0.779	1.041	1.228	1.375	1.623	2.007	2.078
1983	0.181	0.279	0.451	0.668	0.899	0.991	1.144	1.261	1.475	1.713
1984	--	0.292	0.467	0.585	0.744	0.891	1.050	1.180	1.308	1.626
1985	0.168	0.405	0.522	0.782	1.050	1.366	1.541	1.743	2.035	2.011
1986	--	0.398	0.617	0.778	1.029	1.194	1.420	1.601	1.764	2.351
1987	--	0.385	0.549	0.868	1.107	1.217	1.582	1.605	1.861	2.038
1988	--	0.350	0.510	0.760	1.149	1.323	1.594	1.770	2.053	2.090
1989	--	0.359	0.459	0.826	1.076	1.332	1.522	1.804	2.131	2.450
1990	--	0.457	0.510	0.757	0.992	1.339	1.983	1.909	2.531	2.388
1991	--	0.418	0.479	0.702	0.985	1.438	1.582	1.853	1.897	2.250
1992	--	0.390	0.494	0.744	0.906	1.185	1.321	1.656	1.552	1.727
1993	0.250	0.384	0.537	0.758	0.941	1.294	1.657	1.880	2.299	2.324
1994	---	0.377	0.546	0.886	1.118	1.338	1.499	1.867	1.910	2.133
1995	0.283	0.394	0.597	0.660	0.999	1.287	1.582	1.798	1.941	2.662
1996	---	0.413	0.614	0.903	1.096	1.442	1.582	1.788	1.982	2.013
1997	---	0.363	0.534	0.702	1.011	1.429	1.555	1.879	2.167	2.092

Table 8. Standardized, stratified abundance (numbers) and biomass (weight) indices for Georges Bank winter flounder from the U.S. NEFSC Spring and Autumn, and Canadian Spring research vessel bottom trawl surveys (U.S. survey strata 01130-01220; Canadian survey strata 5Z1-5Z8). Canadian biomass indices were estimated using the stratified mean number at length and the U.S. survey length-weight regression coefficients. Door standardization coefficients of 1.46 (numbers) and 1.39 (weight) were applied to U.S. survey indices before 1985 to account for differences in catchability between survey doors (Forrester et al. 1997).

	U.S. NEFSC Spring Survey		**U.S. NEFSC Autumn Survey**		**Canada Spring Survey**	
	Number/tow	Weight (kg)/tow	Number/tow	Weight (kg)/tow	Number/tow	Weight (kg)/tow
1963			1.200	1.815		
1964			1.298	1.822		
1965			2.152	2.050		
1966			5.163	5.655		
1967	*Spring Survey initiated in 1968*		1.791	2.074		
1968	2.700	3.114	1.308	1.072		
1969	3.136	4.290	2.370	2.385		
1970	1.864	2.294	5.620	6.490		
1971	1.838	2.168	1.324	1.259		
1972	4.946	5.321	1.261	1.580		
1973	2.946	3.507	1.218	1.195		
1974	6.049	5.782	1.193	1.464		
1975	1.955	1.407	3.790	2.061		
1976	4.672	3.012	5.987	3.925		
1977	3.792	1.580	4.862	3.992		
1978	7.068	5.055	4.056	3.100		
1979	1.736	2.206	5.065	3.829		
1980	3.221	2.801	1.661	1.865		
1981	3.727	3.749	3.831	2.434		
1982	2.295	1.523	5.301	2.692		
1983	8.405	7.111	2.726	2.363		
1984	5.529	5.604	3.933	2.445		
1985	3.837	2.650	1.979	1.119		
1986	2.003	1.214	3.575	2.178	*Canadian Survey initiated in 1987*	
1987	2.803	1.247	0.762	0.889	3.73	2.83
1988	2.925	1.648	4.084	1.273	2.70	1.65
1989	1.299	0.757	1.560	1.051	3.48	1.88
1990	2.803	1.573	0.498	0.346	3.29	1.74
1991	2.403	1.319	0.268	0.136	1.43	0.97
1992	1.416	0.898	0.677	0.384	2.25	1.39
1993	1.018	0.570	1.166	0.663	2.78	1.45
1994	1.292	0.578	0.870	0.578	2.45	0.98
1995	2.613	1.489	2.357	1.337	3.10	1.17
1996	2.314	1.504	1.539	1.756	2.20	1.12
1997	1.610	1.192	1.744	1.534	2.80	1.77
1998	0.762	0.722	1.784	1.565	1.42	1.08

Table 9A. Stratified mean catch/tow (numbers) of Georges Bank winter flounder (NEFSC strata 01130-01220) in the U.S. NEFSC Spring research vessel bottom trawl survey. Indices have been corrected to account for changes in catchability due to changes in trawl doors.

Spring	Age										
Year	0	1	2	3	4	5	6	7	8	9	10+
1980	0.0000	0.1837	0.9630	0.6802	0.4244	0.5839	0.1930	0.0131	0.1448	0.0352	0.0000
1981	0.0000	0.1061	0.1891	1.3794	1.0334	0.2698	0.2045	0.4945	0.0266	0.0238	0.0000
1982	0.0000	0.0736	0.7878	0.3844	0.5957	0.1748	0.1497	0.0410	0.0175	0.0352	0.0352
1983	0.0000	0.0263	1.0262	3.1337	1.5819	0.6704	0.6969	0.5602	0.4195	0.1234	0.1669
1984	0.0000	0.0352	0.1418	1.9117	1.5371	0.4583	0.5456	0.4697	0.2622	0.0263	0.1418
1985	0.0000	0.0000	1.8507	0.6213	0.6285	0.3971	0.2206	0.0465	0.0241	0.0485	0.0000
1986	0.0000	0.2517	0.6618	0.7388	0.1159	0.1599	0.0748	0.0000	0.0000	0.0000	0.0000
1987	0.0000	0.1611	1.6488	0.5849	0.2939	0.0903	0.0000	0.0000	0.0240	0.0000	0.0000
1988	0.0000	0.0725	0.5354	1.4354	0.6799	0.1161	0.0412	0.0182	0.0000	0.0263	0.0000
1989	0.0000	0.0483	0.5312	0.2673	0.2258	0.1558	0.0180	0.0000	0.0526	0.0000	0.0000
1990	0.0000	0.1270	0.6108	1.5623	0.3320	0.0976	0.0733	0.0000	0.0000	0.0000	0.0000
1991	0.0000	0.2702	0.3446	0.8243	0.5802	0.2752	0.0361	0.0241	0.0000	0.0482	0.0000
1992	0.0000	0.0722	0.6000	0.2988	0.1391	0.1460	0.1094	0.0000	0.0240	0.0263	0.0000
1993	0.0000	0.1704	0.2727	0.3322	0.1540	0.0000	0.0463	0.0180	0.0241	0.0000	0.0000
1994	0.0000	0.1258	0.5753	0.4083	0.1021	0.0359	0.0443	0.0000	0.0000	0.0000	0.0000
1995	0.0000	0.1487	0.7817	1.2580	0.2935	0.1015	0.0292	0.0000	0.0000	0.0000	0.0000
1996	0.0000	0.0372	1.2191	0.4312	0.4888	0.0689	0.0263	0.0420	0.0000	0.0000	0.0000
1997	0.0000	0.0241	0.1923	0.5354	0.6689	0.1139	0.0241	0.0263	0.0000	0.0241	0.0000
1998	0.0000	0.0000	0.0233	0.1621	0.4265	0.1240	0.0000	0.0263	0.0000	0.0000	0.0000

Table 9B. Stratified mean catch/tow (numbers) of Georges Bank winter flounder (NEFSC strata 01130-01220) in the U.S. NEFSC Autumn research vessel bottom trawl survey. Indices have been corrected to account for changes in catchability due to changes in trawl doors.

Autumn	Age										
Year	0	1	2	3	4	5	6	7	8	9	10+
1980	0.0385	0.1218	0.4034	0.3881	0.2643	0.2251	0.1618	0.0000	0.0245	0.0077	0.0263
1981	0.0000	2.1322	0.5043	0.3922	0.4723	0.1313	0.0583	0.0701	0.0352	0.0175	0.0175
1982	0.2813	1.9636	2.1455	0.4383	0.3368	0.1216	0.0137	0.0000	0.0000	0.0000	0.0000
1983	0.0854	0.0689	0.5828	1.1333	0.4898	0.0572	0.1905	0.0842	0.0321	0.0000	0.0000
1984	0.2365	0.6602	0.9909	0.9156	0.8113	0.2304	0.0588	0.0139	0.0162	0.0000	0.0000
1985	0.1085	0.3235	0.9966	0.4172	0.0789	0.0270	0.0270	0.0000	0.0000	0.0000	0.0000
1986	0.2020	1.0945	1.5675	0.3660	0.2026	0.0479	0.0241	0.0232	0.0000	0.0000	0.0479
1987	0.0000	0.0526	0.2035	0.2181	0.1211	0.0000	0.0789	0.0611	0.0263	0.0000	0.0000
1988	0.0482	2.9253	0.6351	0.3860	0.0395	0.0000	0.0248	0.0248	0.0000	0.0000	0.0000
1989	0.0241	0.0963	1.0601	0.0722	0.1417	0.0725	0.0575	0.0094	0.0260	0.0000	0.0000
1990	0.0000	0.0840	0.0600	0.3026	0.0000	0.0510	0.0000	0.0000	0.0000	0.0000	0.0000
1991	0.1078	0.0456	0.0000	0.0620	0.0526	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1992	0.0000	0.0233	0.4610	0.1567	0.0094	0.0263	0.0000	0.0000	0.0000	0.0000	0.0000
1993	0.0000	0.5901	0.1316	0.2461	0.1723	0.0263	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.1648	0.4288	0.1582	0.0850	0.0331	0.0000	0.0000	0.0000	0.0000	0.0000
1995	0.0180	0.9675	0.8979	0.3596	0.0480	0.0478	0.0000	0.0000	0.0180	0.0000	0.0000
1996	0.0000	0.1226	0.3380	0.6241	0.2436	0.0550	0.0934	0.0620	0.0000	0.0000	0.0000
1997	0.0180	0.0782	0.6851	0.5741	0.2957	0.0615	0.0283	0.0031	0.0000	0.0000	0.0000

Table 9C. Stratified mean catch/tow (numbers) of Georges Bank winter flounder (DFO strata 5Z1-5Z8) in the Canadian Spring research vessel bottom trawl survey. Age keys were used from the corresponding U.S. NEFSC Spring survey for fish less than 40 cm, and from U.S. commercial age keys for fish greater than or equal to 40 cm. Commercial ages were unavailable for 1998 so only U.S. survey ages were used to partition the 1998 stratified mean length indices.

Autumn	Age										
Year	0	1	2	3	4	5	6	7	8	9	10+
1987	0.020	0.050	0.784	1.887	0.551	0.122	0.149	0.092	0.045	0.036	0.024
1988	0.000	0.786	1.256	0.234	0.258	0.083	0.033	0.019	0.011	0.026	0.000
1989	0.000	0.400	0.979	1.355	0.600	0.058	0.053	0.010	0.015	0.000	0.000
1990	0.000	0.150	0.753	1.983	0.250	0.113	0.017	0.005	0.005	0.000	0.000
1991	0.000	0.040	0.225	0.480	0.583	0.105	0..019	0.006	0.000	0.000	0.000
1992	0.000	0.020	0.610	1.018	0.323	0.191	0.038	0.018	0.001	0.002	0.013
1993	0.000	0.932	0.515	0.689	0.218	0.247	0.141	0.053	0.001	0.000	0.000
1994	0.000	0.007	1.600	0.562	0.202	0.055	0.011	0.014	0.010	0.000	0.000
1995	0.000	0.732	1.263	0.845	0.130	0.100	0.021	0.010	0.005	0.001	0.000
1996	0.000	0.301	0.932	0.414	0.323	0.117	0.053	0.029	0.019	0.007	0.003
1997	0.000	0.110	0.590	0.785	0.987	0.180	0.063	0.018	0.026	0.013	0.000
1998	0.002	0.080	0.120	0.492	0.526	0.132	0.011	0.015	0.000	0.000	0.000

Table 10. Proportion mature at age for female winter flounder sampled by the U.S. NEFSC Spring research vessel survey from 1982 to 1997. Logistic regression equations and age at 50% maturation are presented annually and for data pooled across the entire time series.

		Age					Logistic Regression Coefficients		
	N	1	2	3	4	5	a	b	A50
1982	23	0.00	0.44	1.00	1.00	1.00	18.30	9.04	2.02
1983	79	0.00	0.14	0.56	1.00	1.00	6.38	2.22	2.87
1984	54	0.00	0.80	1.00	0.93	0.93	17.70	9.54	1.85
1985	40	0.03	0.62	0.99	1.00	1.00	----	----	----
1986	39	0.00	1.00	1.00	1.00	1.00	19.83	13.59	1.46
1987	67	0.00	0.83	1.00	1.00	1.00	18.44	10.00	1.84
1988	42	0.00	0.13	0.95	1.00	1.00	11.88	4.96	2.39
1989	15	0.00	0.20	1.00	1.00	1.00	24.56	11.58	2.12
1990	43	0.00	0.44	1.00	1.00	1.00	23.80	11.79	2.02
1991	34	0.00	0.00	1.00	1.00	1.00	34.25	14.10	2.43
1992	31	0.00	0.54	0.78	1.00	1.00	3.28	1.64	2.00
1993	21	0.00	1.00	1.00	1.00	1.00	—	—	---
1994	30	0.00	0.79	0.86	1.00	1.00	3.49	2.16	1.62
1995	21	0.00	0.33	1.00	1.00	1.00	24.48	11.90	2.06
1996	43	0.00	0.76	1.00	1.00	1.00	18.23	9.70	1.88
1997	9	0.00	0.67		1.00	1.00	13.98	7.34	1.91
1998	10	0.00		1.00	1.00	1.00	—	—	---
1982-1998	**561**	**0.00**	**0.62**	**0.92**	**0.99**	**1.00**	**3.99**	**2.18**	**1.83**

Table 11. Virtual Population Analysis (VPA) run descriptions including a summary of diagnostics and results. Run 15 represents the final accepted VPA.

VPA Run #	Run 4	Run 9	Run 8	Run 11	* *Run 15**
Inputs					
Estimated Ages	1 to 6	2 to 6	2 to 6	2 to 6	2 to 6
Tuning Indices					
US Spring 1-7	Ages 1-7	Ages 1-7	Ages 1-7	Ages 1-7	Ages 1-7
US Spring 1-5+	No	No	No	Yes	No
US Autumn 1	Ages 1-7	Ages 1-7	Ages 2-7	Ages 2-7	Ages 2-7
US Autumn 2-5+	No	No	No	Yes	No
Canada Spring	---	---	---	---	Ages 1-7
Diagnostics					
Sum of squares	142.42	142.42	135.47	114.36	189.26
Mean squared	0.754	0.754	0.753	0.841	0.736
CV Age 1 Numbers	0.92	---	-----	-----	---
CV Age 2 Numbers	0.52	0.52	0.52	0.48	0.40
CV Age 3 Numbers	0.46	0.46	0.47	0.44	0.36
CV Age 4 Numbers	0.46	0.46	0.46	0.56	0.37
CV Age 5 Numbers	0.40	0.40	0.40	0.68	0.34
CV Age 6 Numbers	0.41	0.41	0.41	0.59	0.34
Min/Max CV q (US Spring)	0.22 - 0.28	0.22 - 0.28	0.22 - 0.28	0.23 - 0.24	0.21 - 0.28
Min/Max CV q (US Autumn)	0.22 - 0.29	0.22 - 0.29	0.22 - 0.27	0.23 - 0.24	0.21 - 0.26
Min/Max CV q (Canada Spring)	---	---	---	---	0.25 - 0.27
Stan. Residuals > 2	8	8	8	6	9
Maximum Partial Variance	2.026 US Autumn 7	2.010 US Autumn 7	2.016 US Autumn 7	2.081 US Autumn 2	2.421 Can Spring 1

Table 11 (Cont). Virtual Population Analysis (VPA) run descriptions including a summary of diagnostics and results. Run 15 represents the final accepted VPA.

VPA Run #	Run 4	Run 9	Run 8	Run 11	**Run 15**
Terminal Year Results					
Stock Numbers	5991	5124	5346	5970	5688
1998 Age 1 Numbers	867	-----	-----	-----	---
1998 Age 2 Numbers	551	551	556	1302	774
1998 Age 3 Numbers	992	992	1190	2048	1568
1998 Age 4 Numbers	2026	2026	2044	1769	2097
1998 Age 5 Numbers	1008	1008	1006	311	797
1998 Age 6 Numbers	397	397	400	467	330
1998 Age 7 Numbers	151	151	151	73	122
Fishing Mortality					
1997 Age 2 F	0.36	0.36	0.31	0.19	0.24
1997 Age 3 F	0.40	0.40	0.40	0.45	0.39
1997 Age 4 F	0.42	0.42	0.43	1.00	0.51
1997 Age 5 F	0.26	0.26	0.26	0.23	0.31
1997 Age 6 F	0.34	0.34	0.34	0.61	0.41
1997 Average F (4-6,u)	0.34	0.34	0.34	0.61	0.41
Biomass					
1997 Mean Biomass	3913	3913	4008	3762	3943
1997 Jan 1 Biomass	4551	4551	4629	4261	4519
1997 SSB	3702	3702	3749	3129	3536

Table 12. Stock numbers (thousands), fishing mortality, and spawning stock biomass (mt) at age of Georges Bank winter flounder estimated using an ADAPT calibration .

STOCK NUMBERS

	1982	1983	1984	1985	1986	1987	1988	1989
1	4627	2725	6089	5963	8027	5307	9002	5243
2	8236	3788	2222	4986	4864	6572	4345	7370
3	6532	6424	2389	1564	3354	3381	4210	2802
4	3382	3803	2634	1441	654	1545	1247	937
5	1263	1821	1799	916	445	322	451	258
6	762	572	992	198	306	158	143	191
7	822	1453	1406	175	204	211	146	106
1+	25624	20586	17532	15243	17854	17496	19545	16908

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	3327	4523	2441	2906	4813	6944	2987	946	00
2	4293	2724	3703	1998	2346	3940	5447	2445	774
3	4785	3248	1694	2311	1364	1439	2611	3793	1568
4	1188	2079	1510	703	858	590	936	1625	2097
5	307	368	842	578	167	480	313	549	797
6	78	84	179	266	184	76	324	114	330
7	28	133	117	75	164	81	258	110	122
1+	14005	13158	10485	8837	9896	13550	12876	9582	5688

FISHING MORTALITY

	1982	1983	1984	1985	1986	1987	1988	1989
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.05	0.26	0.15	0.20	0.16	0.25	0.24	0.23
3	0.34	0.69	0.31	0.67	0.58	0.80	1.30	0.66
4	0.42	0.55	0.86	0.97	0.51	1.03	1.37	0.92
5	0.59	0.41	2.00	0.90	0.84	0.61	0.66	0.99
6	0.47	0.51	1.23	0.97	0.64	0.97	1.17	0.96
7	0.47	0.51	1.23	0.97	0.64	0.97	1.17	0.96
4-6,u	0.49	0.49	1.36	0.95	0.66	0.87	1.07	0.96

	1990	1991	1992	1993	1994	1995	1996	1997
1	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00
2	0.08	0.28	0.27	0.18	0.29	0.21	0.16	0.24
3	0.63	0.57	0.68	0.79	0.64	0.23	0.27	0.39
4	0.97	0.70	0.76	1.23	0.38	0.44	0.33	0.51
5	1.09	0.52	0.95	0.94	0.59	0.19	0.81	0.31
6	1.03	0.69	0.84	1.13	0.42	0.32	0.44	0.41
7	1.03	0.69	0.84	1.13	0.42	0.32	0.44	0.41
4-6,u	1.03	0.64	0.85	1.10	0.46	0.32	0.53	0.41

Table 12 (Continued). Stock numbers (thousands), fishing mortality, and spawning stock biomass (mt) at age of Georges Bank winter flounder estimated using an ADAPT calibration .

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1982	1983	1984	1985	1986	1987	1988	1989
1	00	00	00	00	00	00	00	00
2	1083	505	295	814	726	1036	654	1127
3	1963	1765	717	471	1313	1192	1273	873
4	2172	1788	1096	688	360	879	589	487
5	1150	1350	816	577	324	254	380	184
6	754	504	667	158	289	140	132	188
7	1162	1689	1339	238	272	289	196	147
1+	8285	7601	4930	2947	3285	3790	3224	3006

	1990	1991	1992	1993	1994	1995	1996	1997
1	00	00	00	00	00	00	00	00
2	760	444	583	318	405	632	1074	373
3	1598	1205	595	797	486	576	1075	1457
4	556	1041	748	323	527	312	618	926
5	214	275	535	385	132	417	218	473
6	74	84	157	221	183	82	343	126
7	45	194	139	109	238	123	393	181
1+	3247	3243	2756	2152	1970	2143	3721	3536

Table 13. Yield per recruit and SSB per recruit analysis for Georges Bank winter flounder.

```
The NEFSC Yield and Stock Size per Recruit Program - PDBYPRC
 PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992
          ---------------------------------------
          Run Date: 11-12-1998;  Time: 15:58:51.70
GB WINTER FLOUNDER - 15 Year, No Plus Group

Proportion of F before spawning:  .2000
Proportion of M before spawning:  .2000
Natural Mortality is Constant at:  .200
Initial age is:  1; Last age is: 15
Last age is a TRUE Age;
Original age-specific PRs, Mats, and Mean Wts from file:
==> gbwinfl.dat
```

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Stock
1	.0000	1.0000	.0000	.221	.168
2	.5400	1.0000	.6200	.387	.300
3	.8600	1.0000	.9200	.573	.474
4	1.0000	1.0000	1.0000	.788	.670
5	1.0000	1.0000	1.0000	1.055	.917
6	1.0000	1.0000	1.0000	1.372	1.195
7	1.0000	1.0000	1.0000	1.521	1.428
8	1.0000	1.0000	1.0000	1.757	1.673
9	1.0000	1.0000	1.0000	1.894	1.827
10	1.0000	1.0000	1.0000	1.978	1.938
11	1.0000	1.0000	1.0000	2.080	2.024
12	1.0000	1.0000	1.0000	2.143	2.129
13	1.0000	1.0000	1.0000	2.204	2.165
14	1.0000	1.0000	1.0000	2.249	2.195
15	1.0000	1.0000	1.0000	2.265	2.251

```
Summary of Yield per Recruit Analysis for:
GB WINTER FLOUNDER - 15 Year, No Plus Group

Slope of the Yield/Recruit Curve at F=0.00: -->     4.1119
  F level at slope=1/10 of the above slope (F0.1): ----->     .209
    Yield/Recruit corresponding to F0.1: ----->      .3361
  F level to produce Maximum Yield/Recruit (Fmax): ----->     .420
    Yield/Recruit corresponding to Fmax: ----->      .3652
  F level at 20 % of Max Spawning Potential (F20): ----->     .472
    SSB/Recruit corresponding to F20: -------->      .8073
```

Table 13 (Cont). Yield per recruit and SSB per recruit analysis for Georges Bank winter flounder.

Listing of Yield per Recruit Results for:
GB WINTER FLOUNDER - 15 Year, No Plus Group

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.00	.00000	.00000	5.2420	4.4887	3.7252	4.0372	100.00
	.05	.14193	.15784	4.6694	3.5613	3.1478	3.1165	77.20
	.10	.24124	.24894	4.2444	2.9077	2.7205	2.4716	61.22
	.15	.31356	.30172	3.9207	2.4361	2.3959	2.0089	49.76
	.20	.36821	.33218	3.6682	2.0881	2.1430	1.6692	41.35
F0.1	.21	.37670	.33609	3.6284	2.0351	2.1032	1.6176	40.07
	.25	.41087	.34944	3.4668	1.8256	1.9416	1.4142	35.03
	.30	.44510	.35881	3.3030	1.6233	1.7779	1.2186	30.18
	.35	.47323	.36339	3.1673	1.4646	1.6424	1.0657	26.40
	.40	.49681	.36505	3.0531	1.3377	1.5285	.9439	23.38
Fmax	.42	.50538	.36517	3.0115	1.2931	1.4871	.9012	22.32
	.45	.51689	.36493	2.9557	1.2346	1.4314	.8453	20.94
F20%	.47	.52493	.36451	2.9168	1.1948	1.3926	.8073	20.00
	.50	.53424	.36374	2.8717	1.1497	1.3476	.7644	18.93
	.55	.54941	.36192	2.7983	1.0787	1.2746	.6970	17.26
	.60	.56280	.35973	2.7338	1.0188	1.2102	.6402	15.86
	.65	.57472	.35736	2.6764	.9675	1.1531	.5918	14.66
	.70	.58541	.35493	2.6251	.9233	1.1021	.5501	13.63
	.75	.59508	.35250	2.5790	.8848	1.0561	.5140	12.73
	.80	.60386	.35012	2.5372	.8510	1.0145	.4823	11.95
	.85	.61188	.34782	2.4992	.8212	.9766	.4545	11.26
	.90	.61924	.34561	2.4644	.7947	.9420	.4297	10.64
	.95	.62602	.34350	2.4325	.7709	.9102	.4076	10.10
	1.00	.63230	.34149	2.4030	.7495	.8808	.3877	9.60

Table 14. Results of an ASPIC surplus production model of Georges Bank winter flounder.

Georges Bank Winter Flounder -- ASPIC 3.6x -- Two Indices

Page 1
01 Dec 1997 at 22:27

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

FIT Mode

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	34	Number of bootstrap trials:	0
Number of data series:	2	Lower bound on MSY:	1.000E+00
Objective function computed:	in EFFORT	Upper bound on MSY:	5.000E+02
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 (lagged)	0.252 31	1.000 31	
3 Canadian Survey (lagged)	0.636 12	0.157 12	1.00 12

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	1.098E+01	34	3.433E-01	1.000E+00	5.345E-01	0.323
Loss(2)	USA Spring Survey (lagged)	7.131E+00	21	2.459E-01	1.000E+00	7.462E+00	0.273
Loss(3)	Canadian Survey (lagged)	6.169E-01	12	6.169E-02	1.000E+00	2.974E+00	0.509

TOTAL OBJECTIVE FUNCTION: 1.87327825E+01

Number of restarts required for convergence: 28
Est. B-ratio coverage index (0 worst, 2 best): 0.8027
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 1964	5.514E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	3.068E+00	2.500E+00	1	1
r	Intrinsic rate of increase	5.380E-01	4.000E-01	1	1
.....	Catchability coefficients by fishery:				
q(1)	USA Fall Survey	2.394E-01	2.410E-01	1	1
q(2)	USA Spring Survey (lagged)	3.125E-01	3.550E-01	1	1
q(3)	Canadian Survey (lagged)	3.881E-01	3.000E-01	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	3.068E+00	Kr/4	
K	Maximum stock biomass	2.281E+01		
Bmsy	Stock biomass at MSY	1.140E+01	K/2	
Fmsy	Fishing mortality at MSY	2.690E-01	r/2	
F(0.1)	Management benchmark	2.421E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	3.037E+00	0.99*MSY	
B-ratio	Ratio of B(1997) to Bmsy	3.756E-01		
F-ratio	Ratio of F(1996) to Fmsy	1.298E+00		
Y-ratio	Proportion of MSY avail in 1997	6.102E-01	2*Br-Br^2	Ye(1997) = 1.872E+00
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	USA Fall Survey	1.124E-01	r/2q(1)	f(0.1) = 1.011E-01

Table 15. Results of short-term stochastic projections of landings (mt) in the 1999 and spawning stock biomass (mt) in 2000 for Georges Bank winter flounder. Landings in 1998 were assumed to be 1,107 mt based on projections by the NEFMC Multispecies Monitoring Committee and assumed Canadian landings, resulting in a realized F of 0.34 in 1998. Projected landings and spawning stock biomass estimates are provided for the 10th, 50th, and 90th percentiles for various levels of fishing mortality in 1999 including current and proposed biological reference points.

	Landings (mt) in 1999			Total Stock Biomass (mt) in 2000			Spawning Stock Biomass (mt) in 2000		
Fishing Mortality	10%	50%	90%	10%	50%	90%	10%	50%	90%
0.00	0	0	0	5,863	7,552	9,423	4,098	5,374	6,793
0.03 (F_{target})	89	118	150	5,695	7,342	9,170	3,986	5,228	6,613
0.04 ($F_{threshold}$)	119	157	199	5,641	7,274	9,088	3,948	5,181	6,552
0.21 ($F_{0.1}$)	578	764	969	4,804	6,244	7,848	3,377	4,446	5,639
0.34 (F_{1998})	888	1,172	1,487	4,275	5,596	7,068	3,004	3,967	5,046
0.47 ($F_{20\%}$)	1,195	1,576	2,011	3,823	5,042	6,406	2,676	3,550	4,529

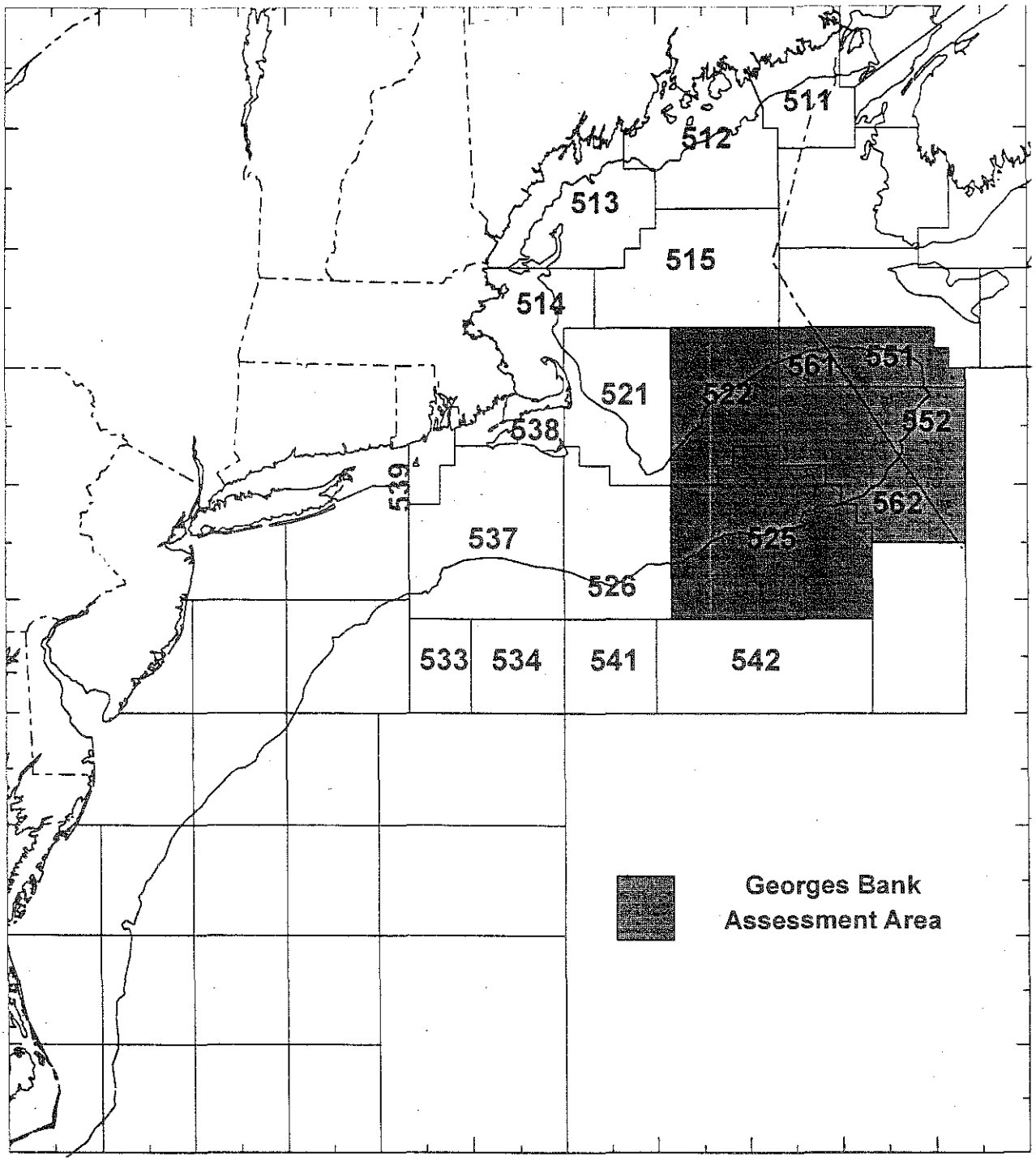


Figure 1. NEFSC statistical areas included in the Georges Bank winter flounder assessment.

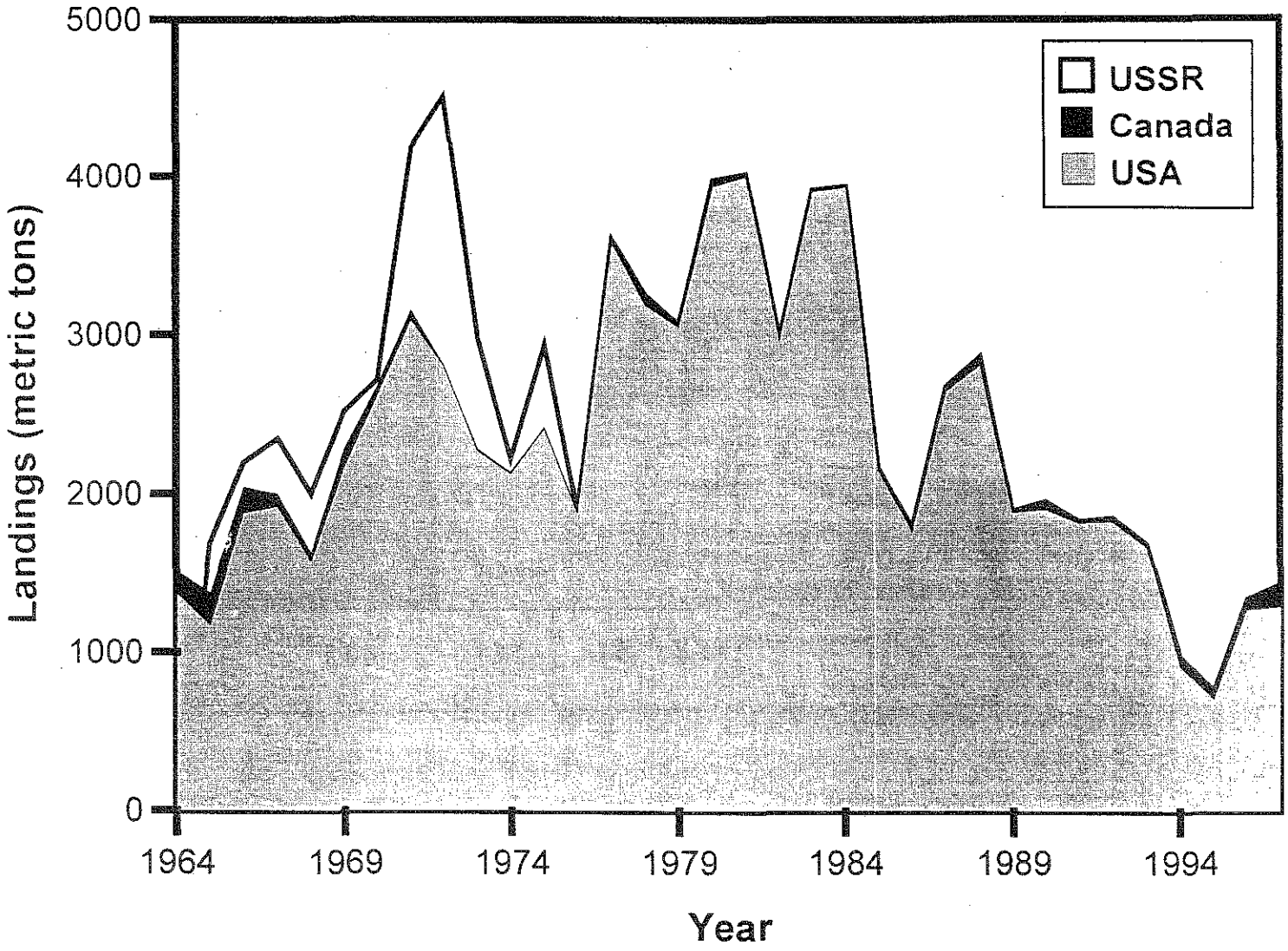


Figure 2. Total commercial landings (mt) of winter flounder from the Georges Bank stock (U.S. statistical areas 522-525, 551-562; NAFO areas 5Zh,j,m,n).

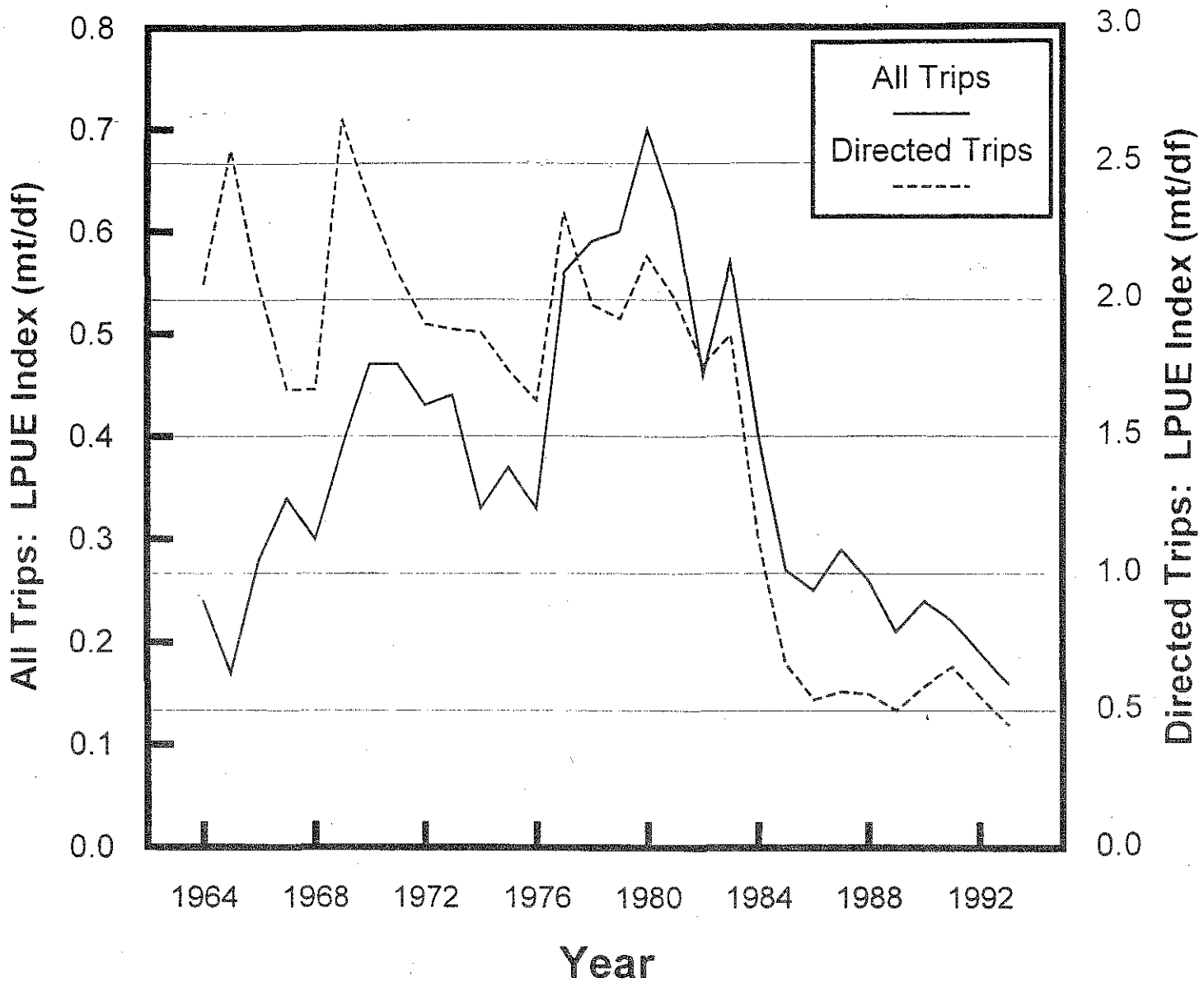


Figure 3. Unstandardized landings (mt) per unit effort (days fished) for all otter trawl trips landing winter flounder and for directed trips (trips where landings of winter flounder constitute 50% or more of the trip).

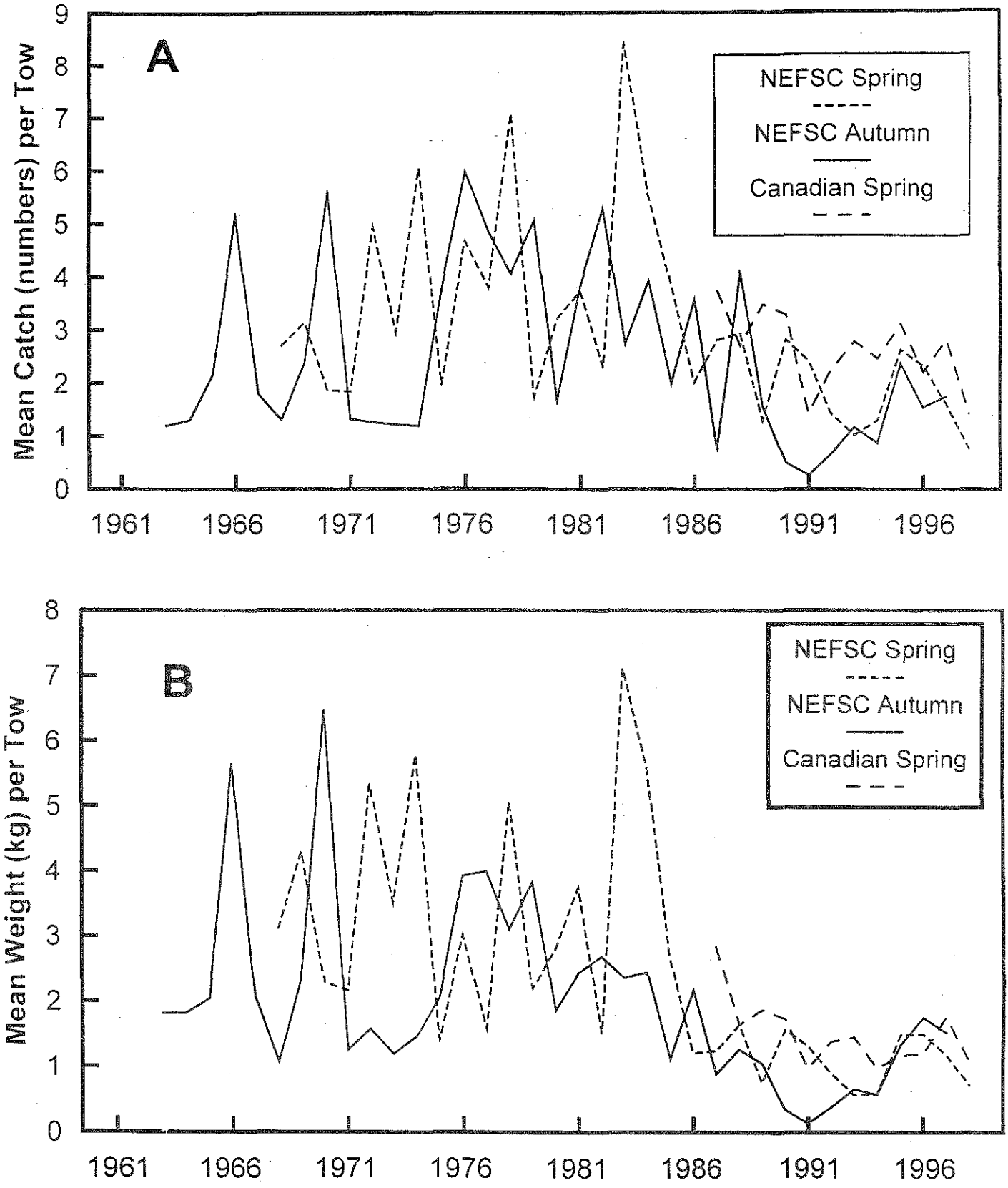


Figure 4. U.S. and Canadian research vessel bottom trawl survey abundance (number per tow; top panel) and biomass (kg per tow; bottom panel) for Georges Bank winter flounder, 1963-1998. Canadian weight per tow was estimated using the stratified mean number per tow at length and the U.S. survey length-weight regression equation.

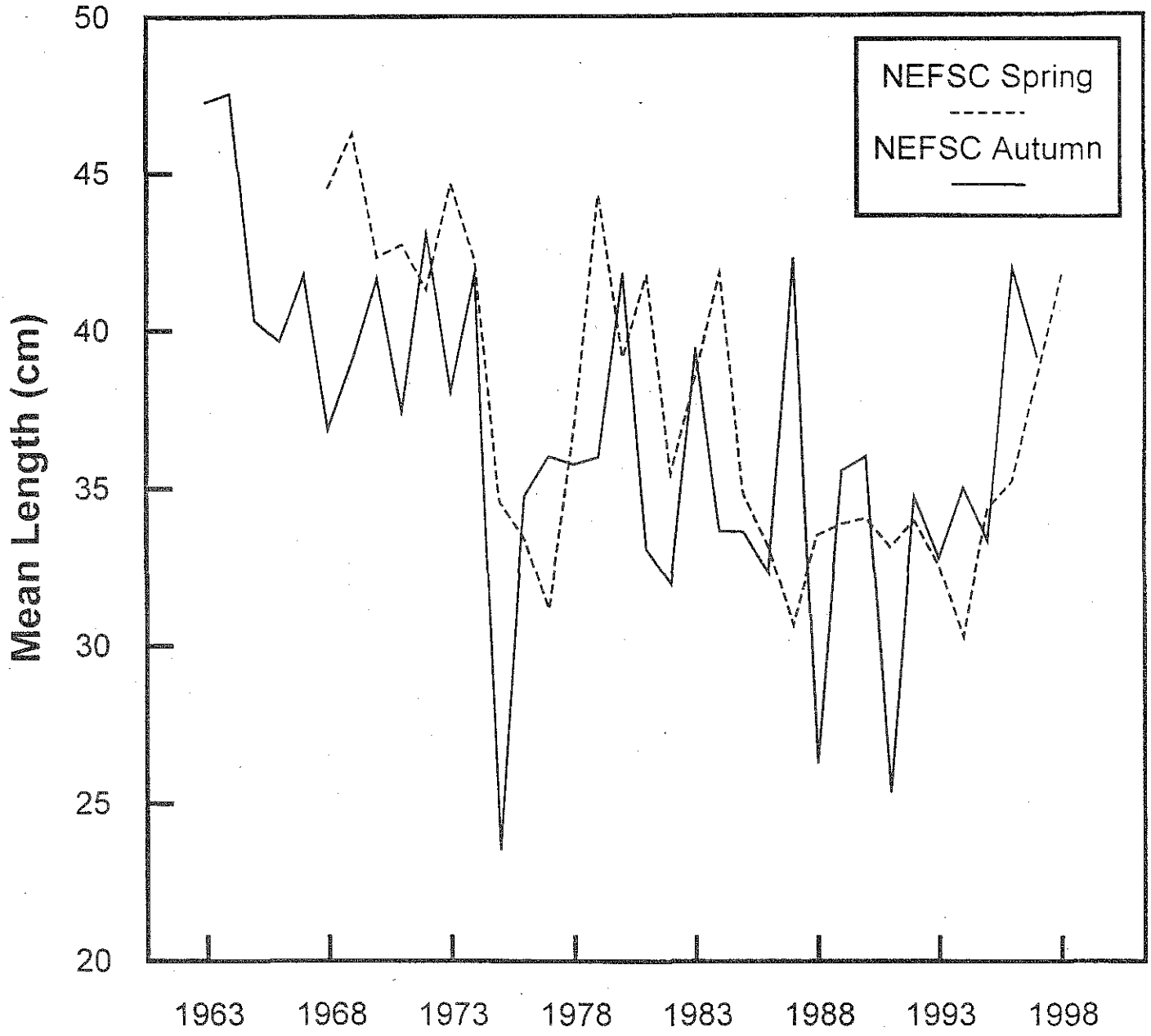


Figure 5. Stratified mean length of Georges Bank (NEFSC offshore strata 13-22) winter flounder from the NEFSC spring and autumn research vessel surveys.

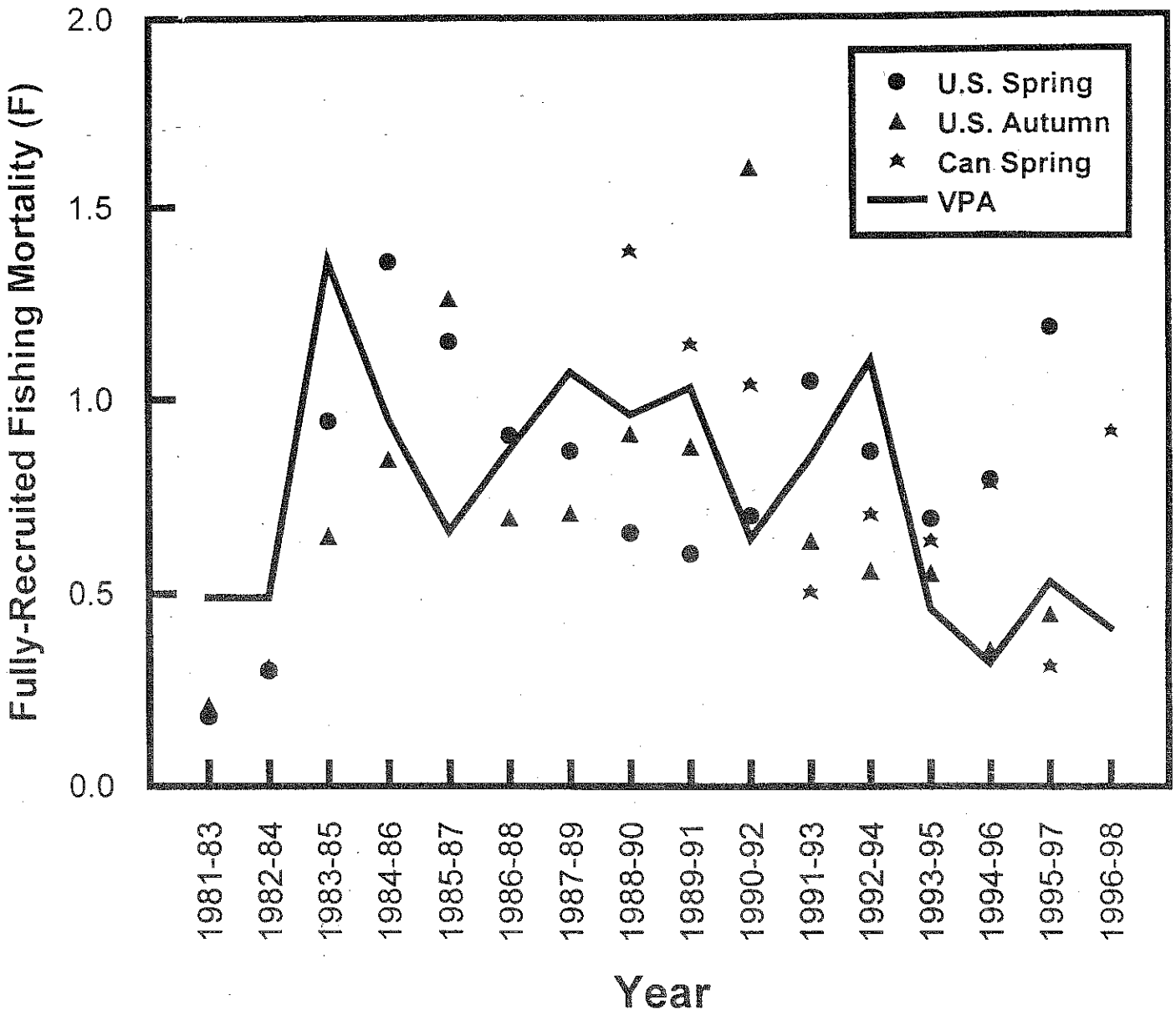
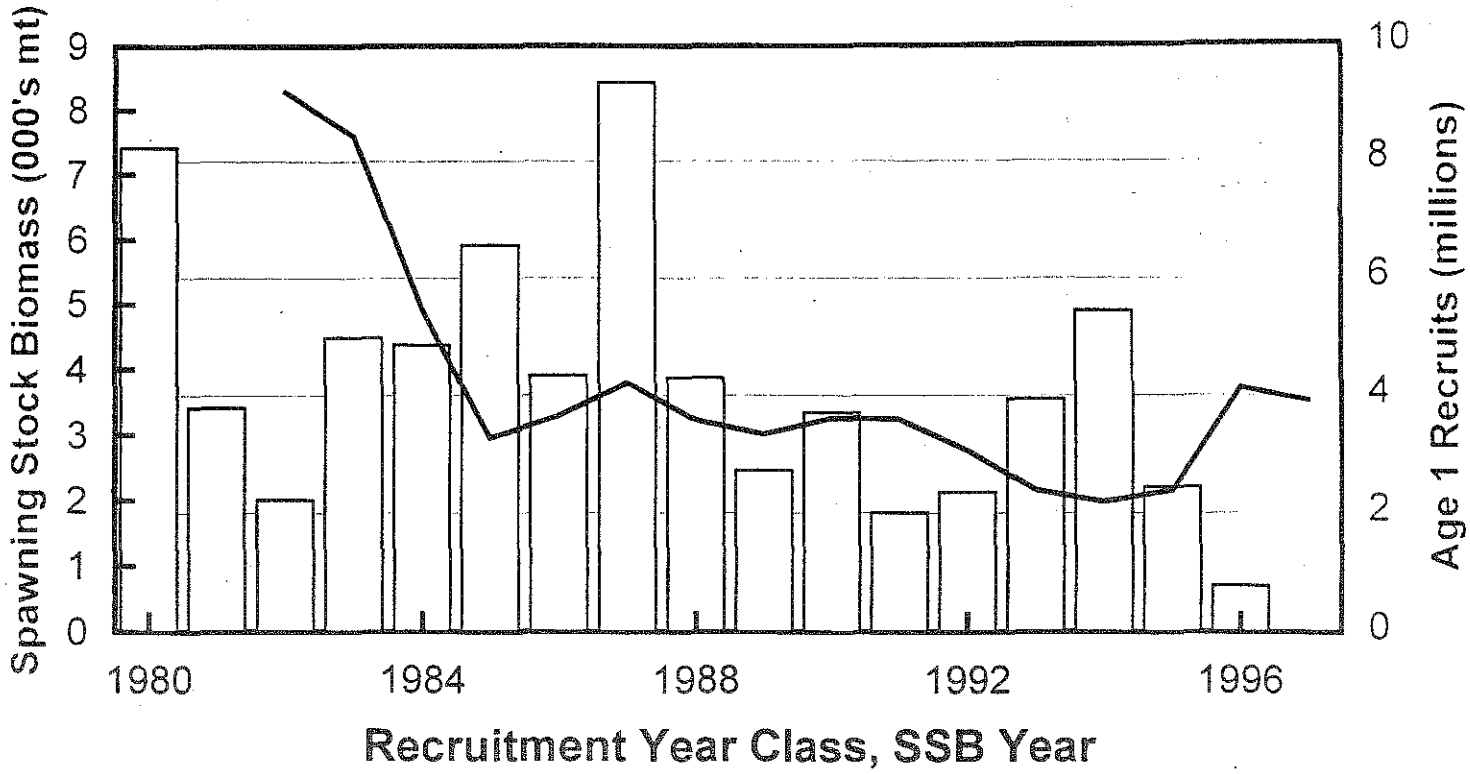


Figure 6. Comparison of estimated instantaneous fishing mortality rate estimated from NEFSC research vessel catch numbers at age with VPA estimates of average unweighted F for ages 4-6. The x-axis labels give the 3-year average used to generate the survey based estimates of F. The midpoint of this range (i.e., 1982 for the range 1981-83) corresponds to the VPA estimates of F.



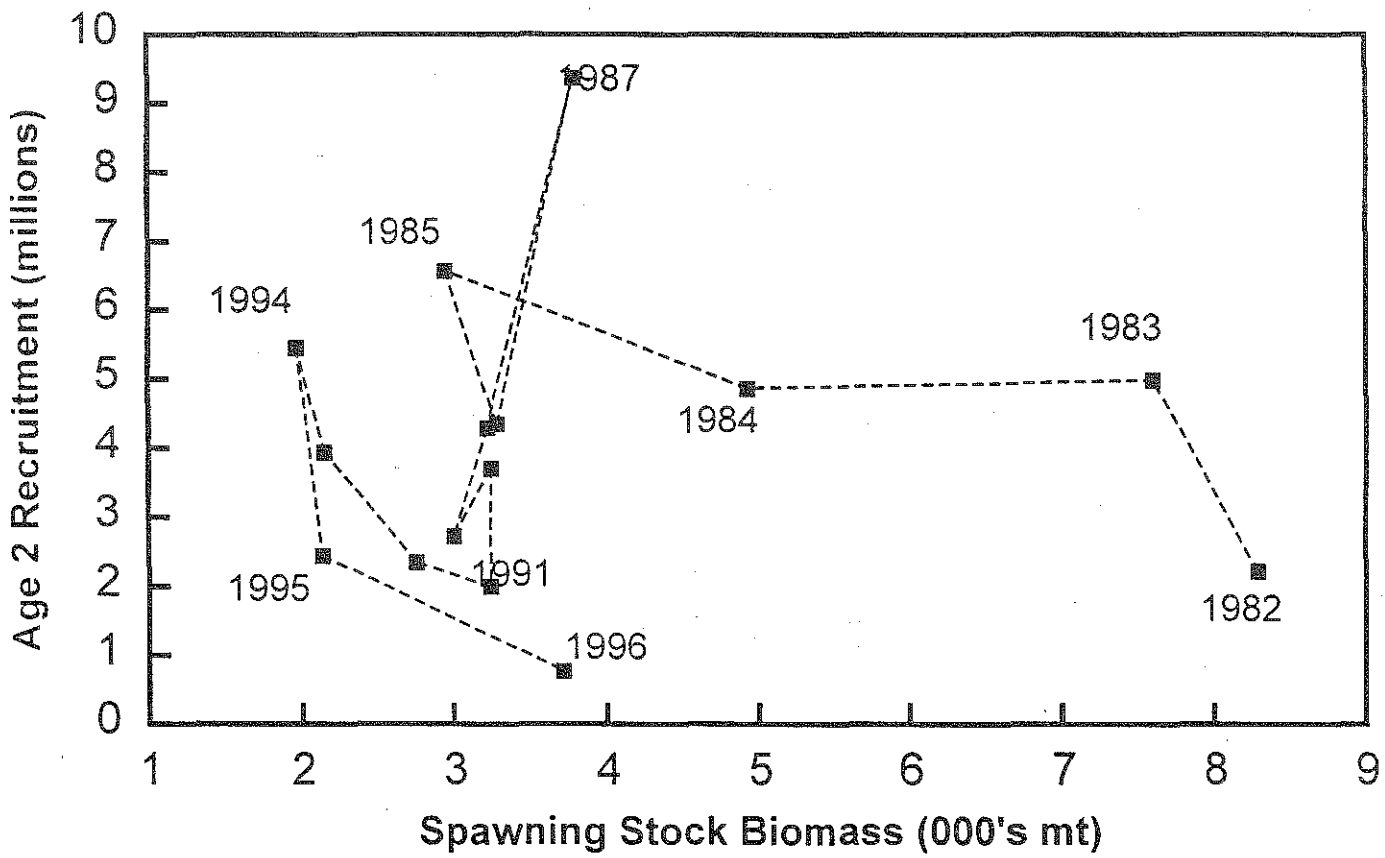


Figure 7. Trends in spawning stock biomass (line) and age 2 recruitment (bars) estimated from Virtual Population Analysis for Georges Bank winter flounder from 1980 to 1997.

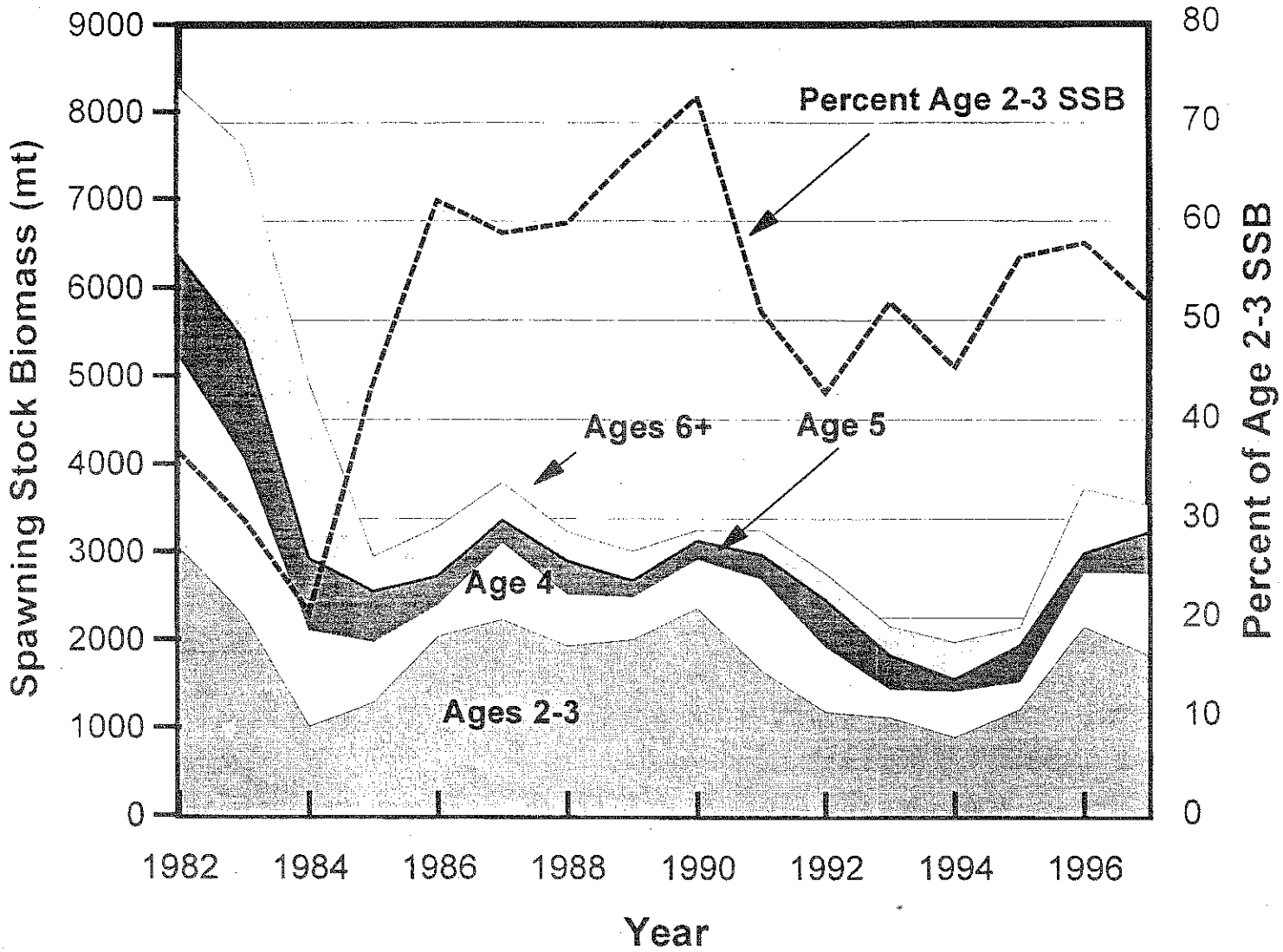


Figure 8. Age composition of the spawning stock biomass estimated from Virtual Population Analysis for Georges Bank winter flounder from 1982 to 1997.

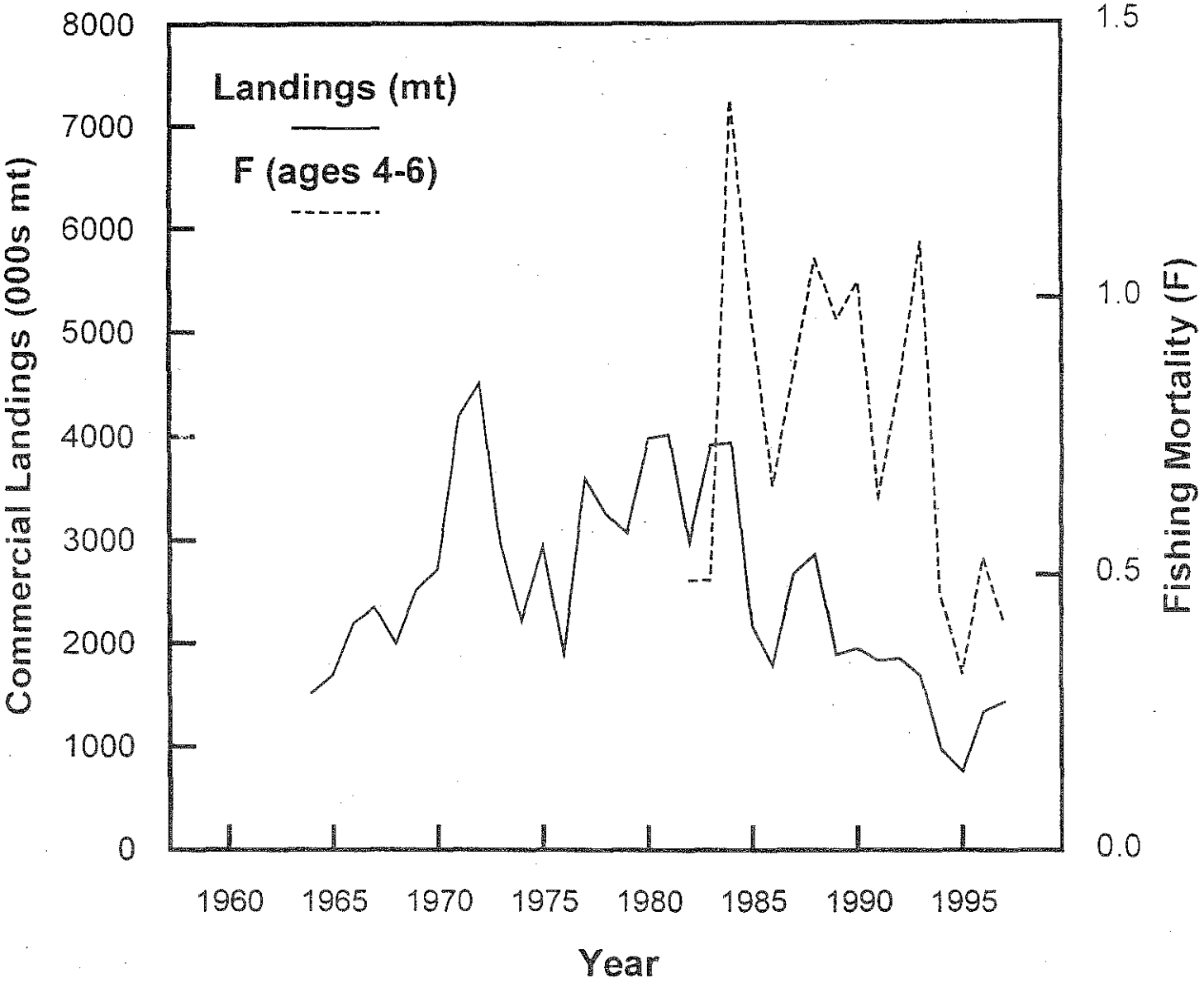


Figure 9. Trends in commercial landings (mt) and fully-recruited fishing mortality (F, ages 4-6, unweighted) estimated from Virtual Population Analysis for Georges Bank winter flounder from 1964 to 1997.

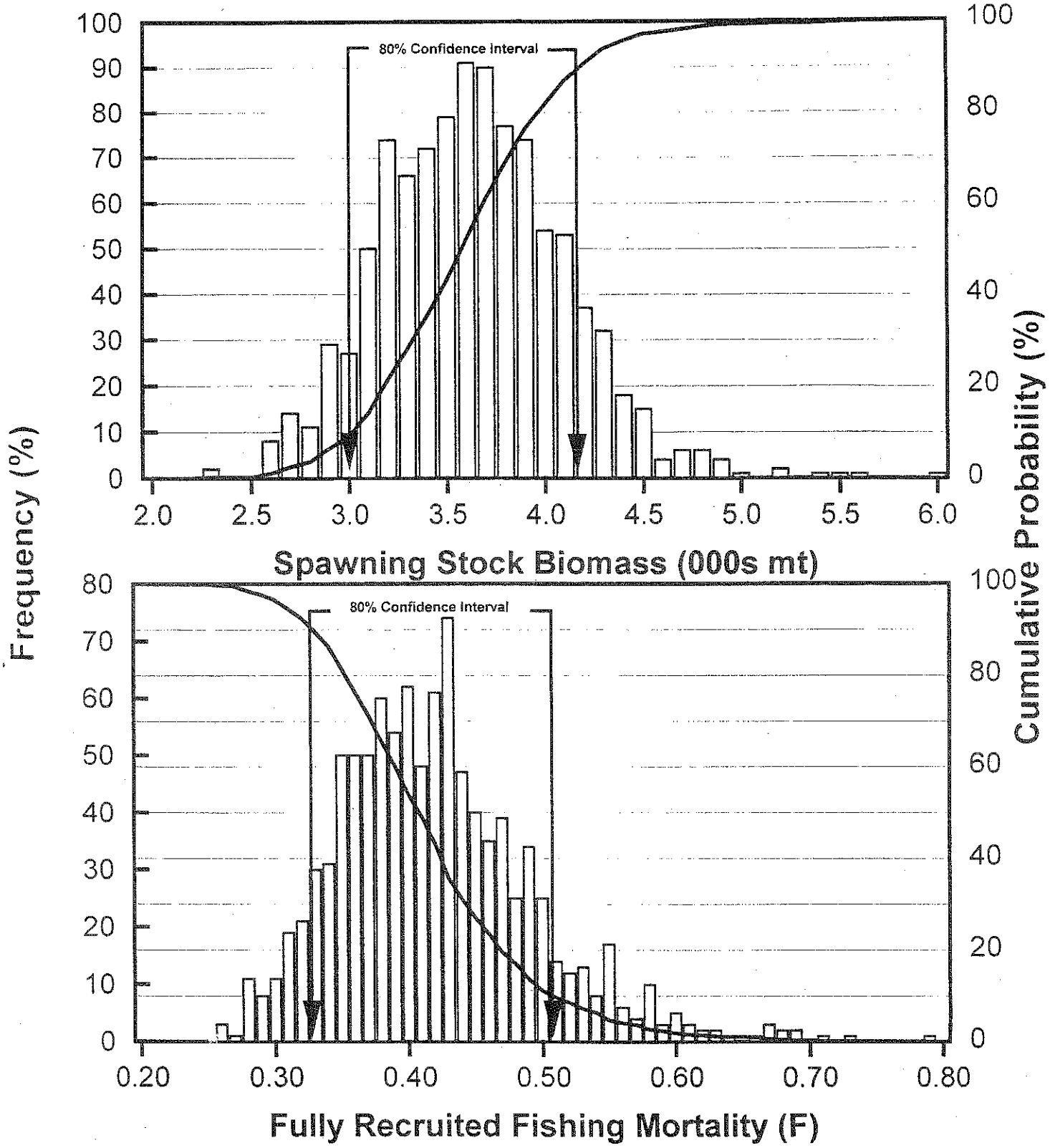


Figure 10. Precision of the estimates of spawning stock biomass (top panel) at the beginning of the spawning season (April 1) and instantaneous rate of fishing mortality (bottom panel) on the fully recruited ages (ages 4-6) in 1997 for Georges Bank winter flounder. The vertical bars display both the range of the estimator and the probability of individual values within the range. The solid line gives the probability of individual values within the range. The solid line gives the probability that F is greater than or SSB is less than the corresponding value on the X-axis. The solid arrows indicate the approximate 90% and 10% confidence levels for F and SSB. The precision estimates were derived from 1000 bootstrap replications of the final ADAPT VPA calibration.

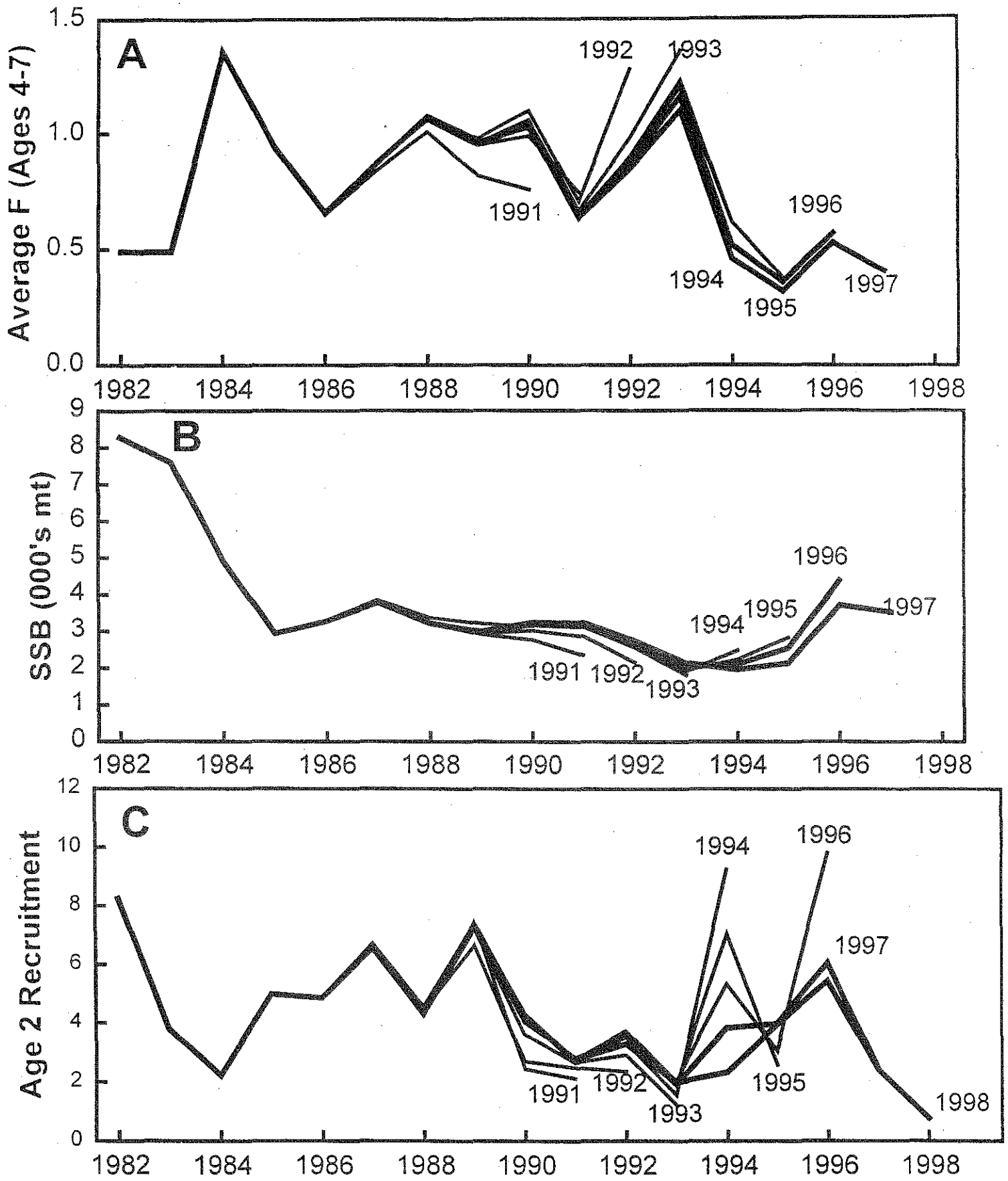


Figure 11. Retrospective analysis results of fishing mortality (Panel A) , spawning stock biomass (Panel B), and age 2 recruitment (Panel C) for the Georges Bank winter flounder assessment, 1997-1990.

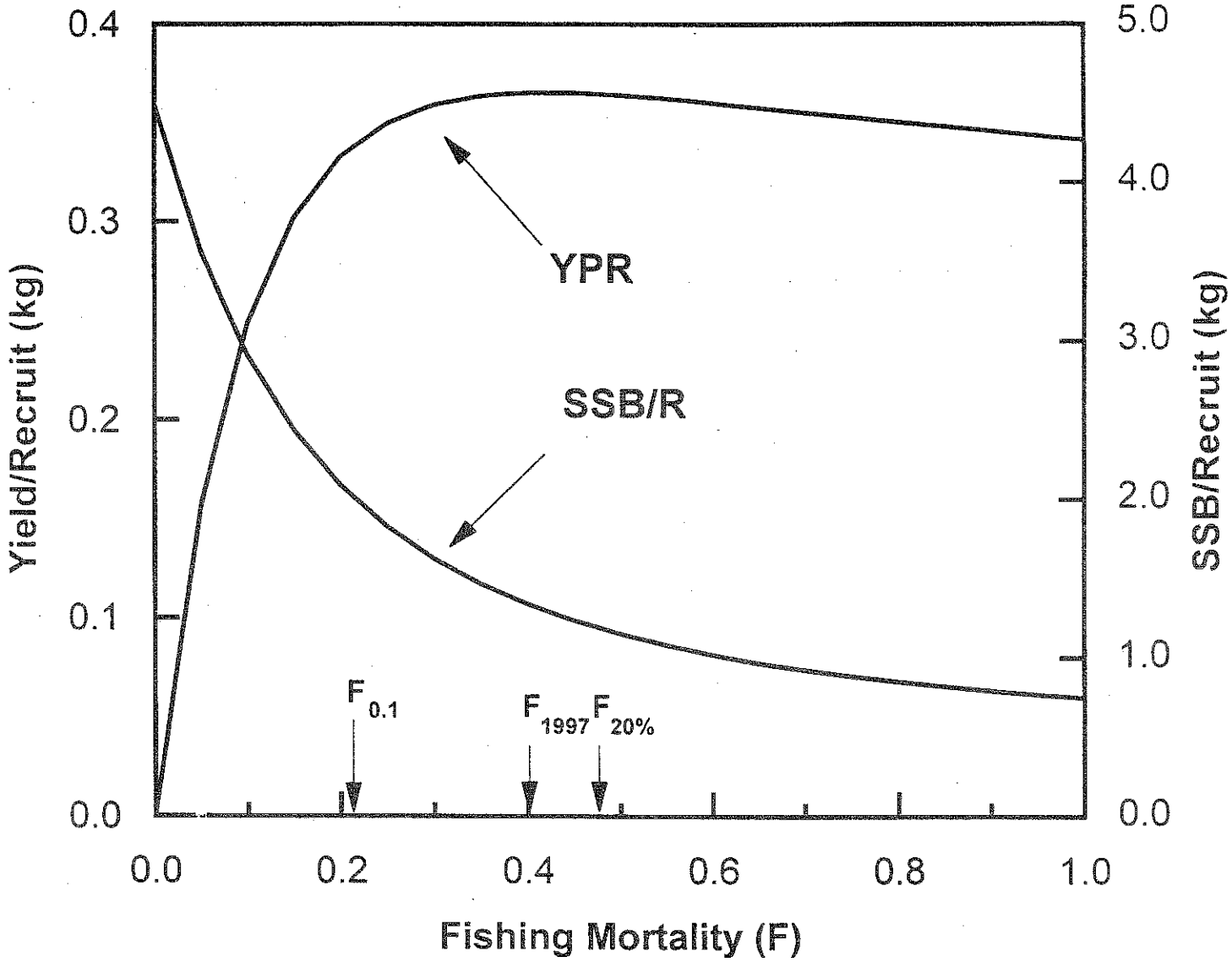


Figure 12. Yield (YPR) and spawning stock biomass (SSB/R) per recruit for Georges Bank winter flounder.

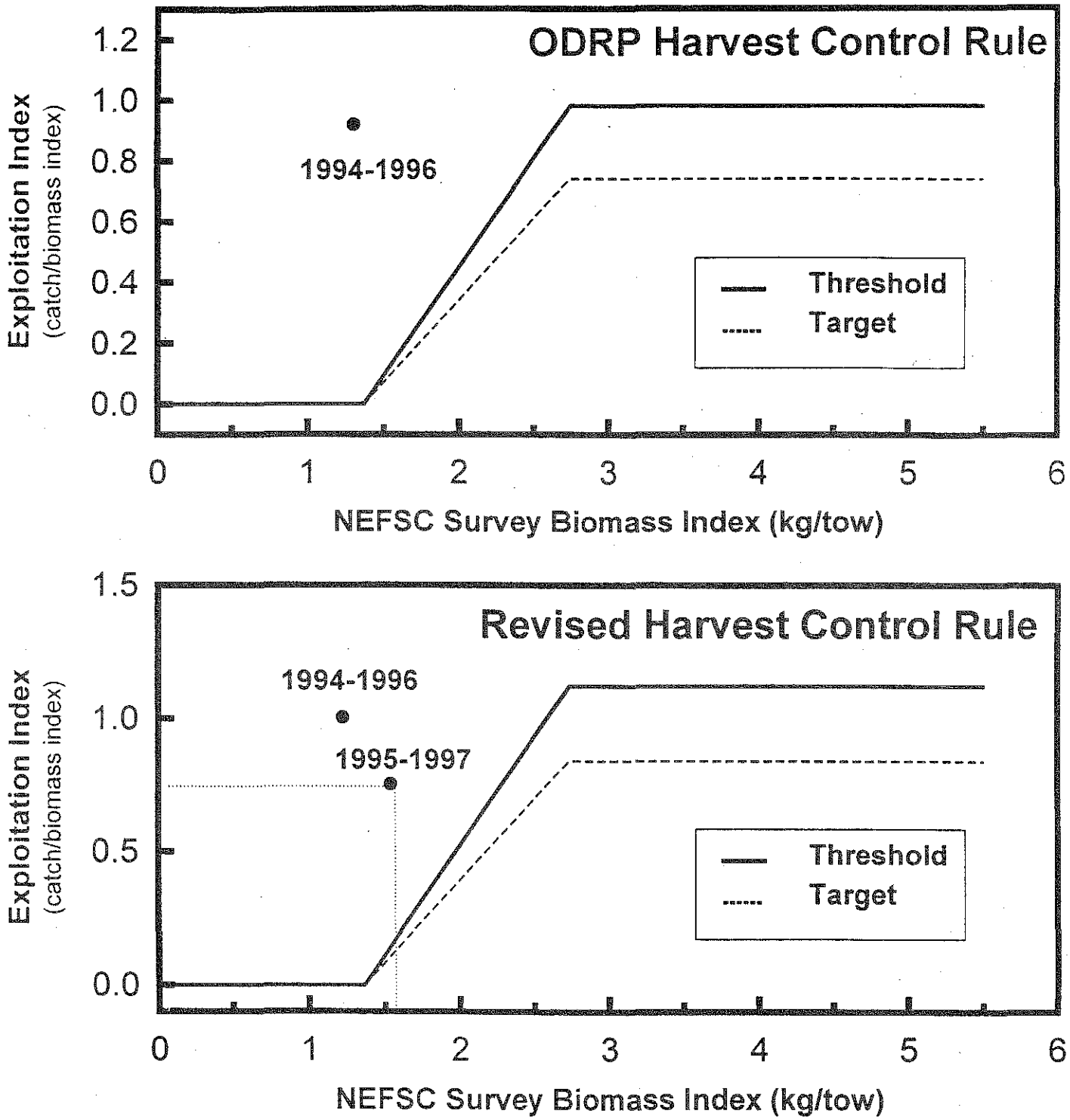


Figure 13. Proposed control rule for Georges Bank winter flounder based on survey equivalents of MSY-based reference points from the Overfishing Definition Review Panel report (Applegate et al. 1998).

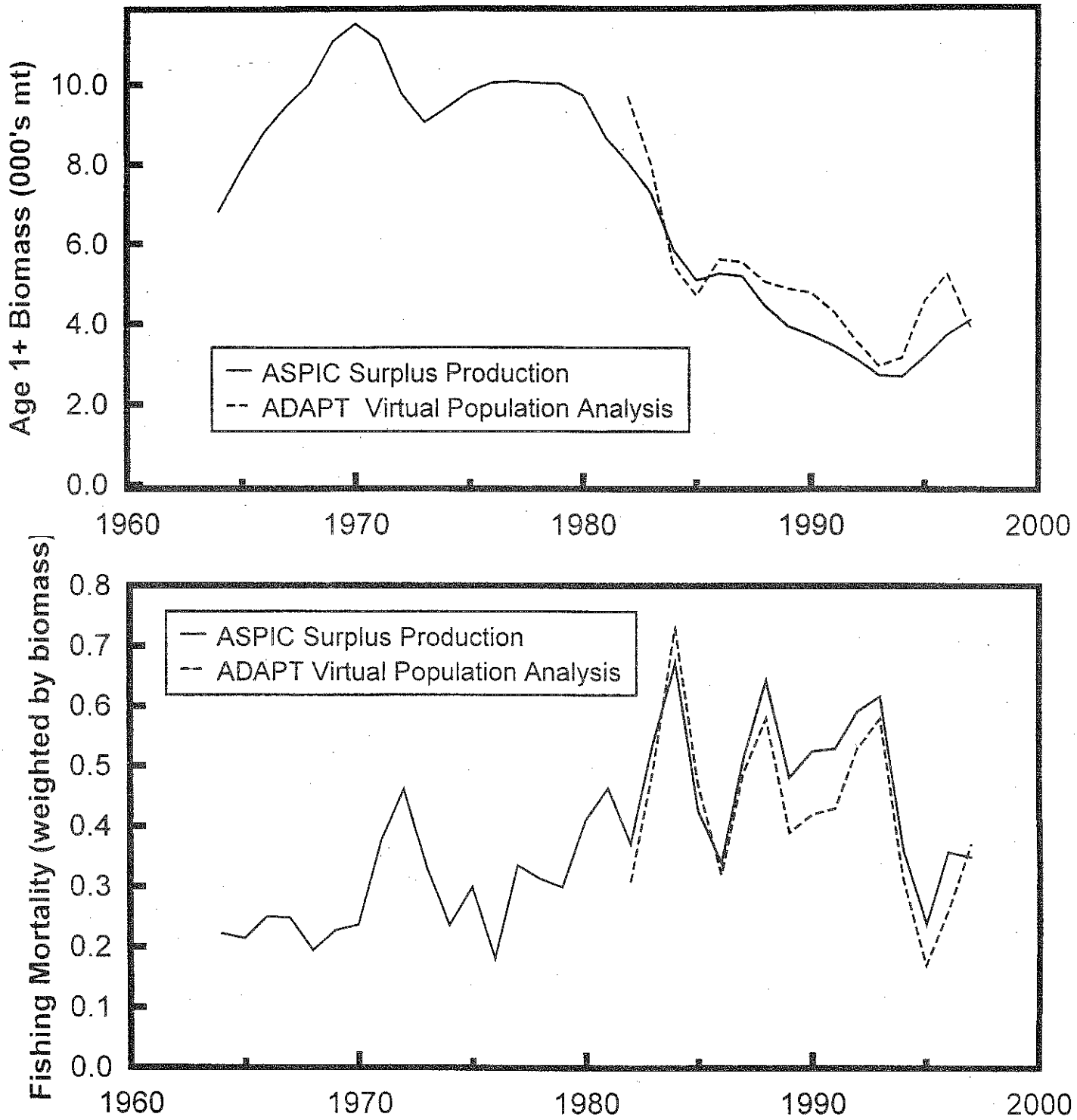


Figure 14. Comparison of estimated age 1+ biomass and fishing mortality (weighted by biomass) from an ASPIC surplus production model and an ADAPT virtual population analysis for Georges Bank winter flounder.

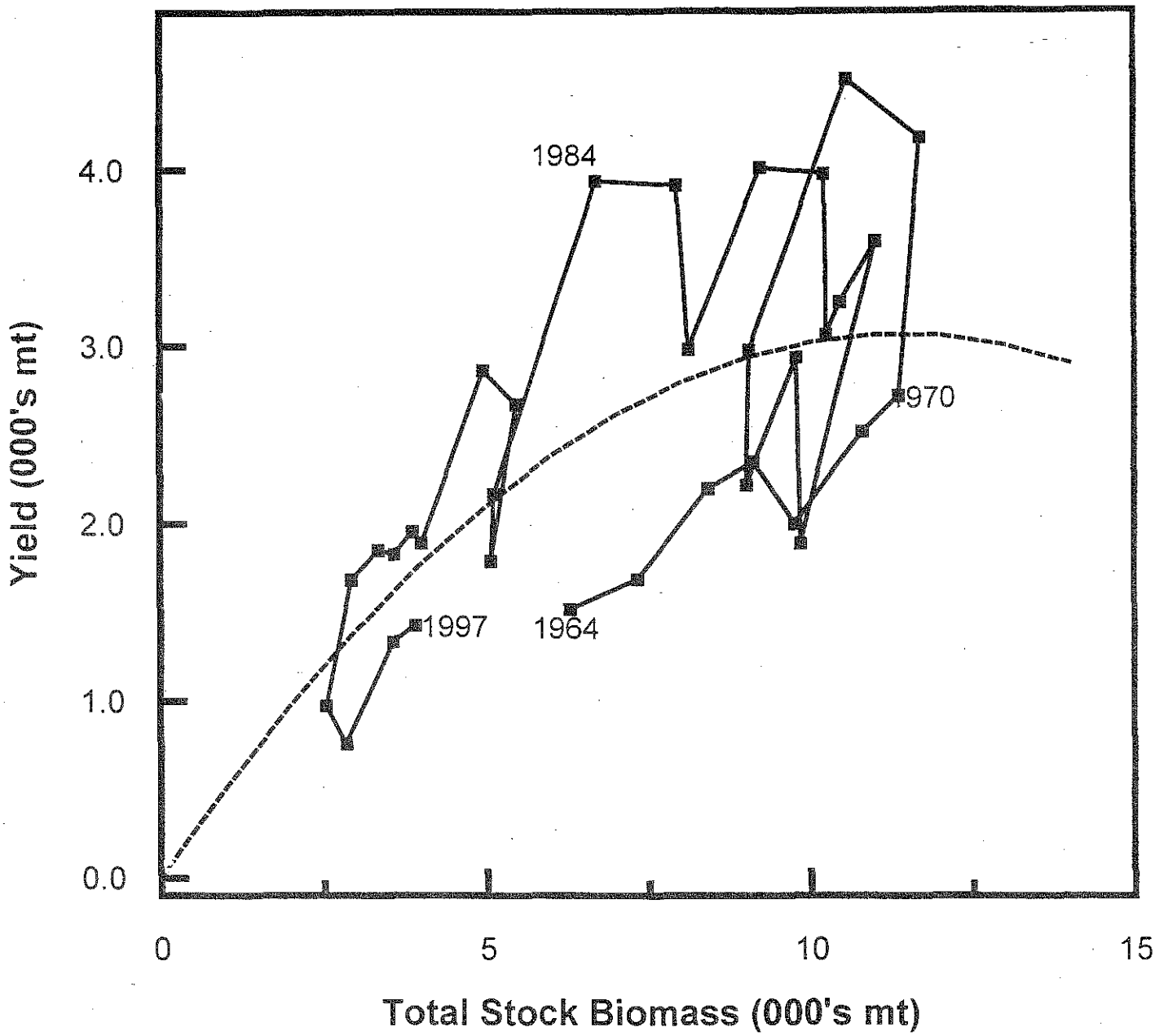


Figure 15. Time trajectory of fishery yield from the Georges Bank winter flounder stock relative to the surplus production curve estimated by ASPIC.

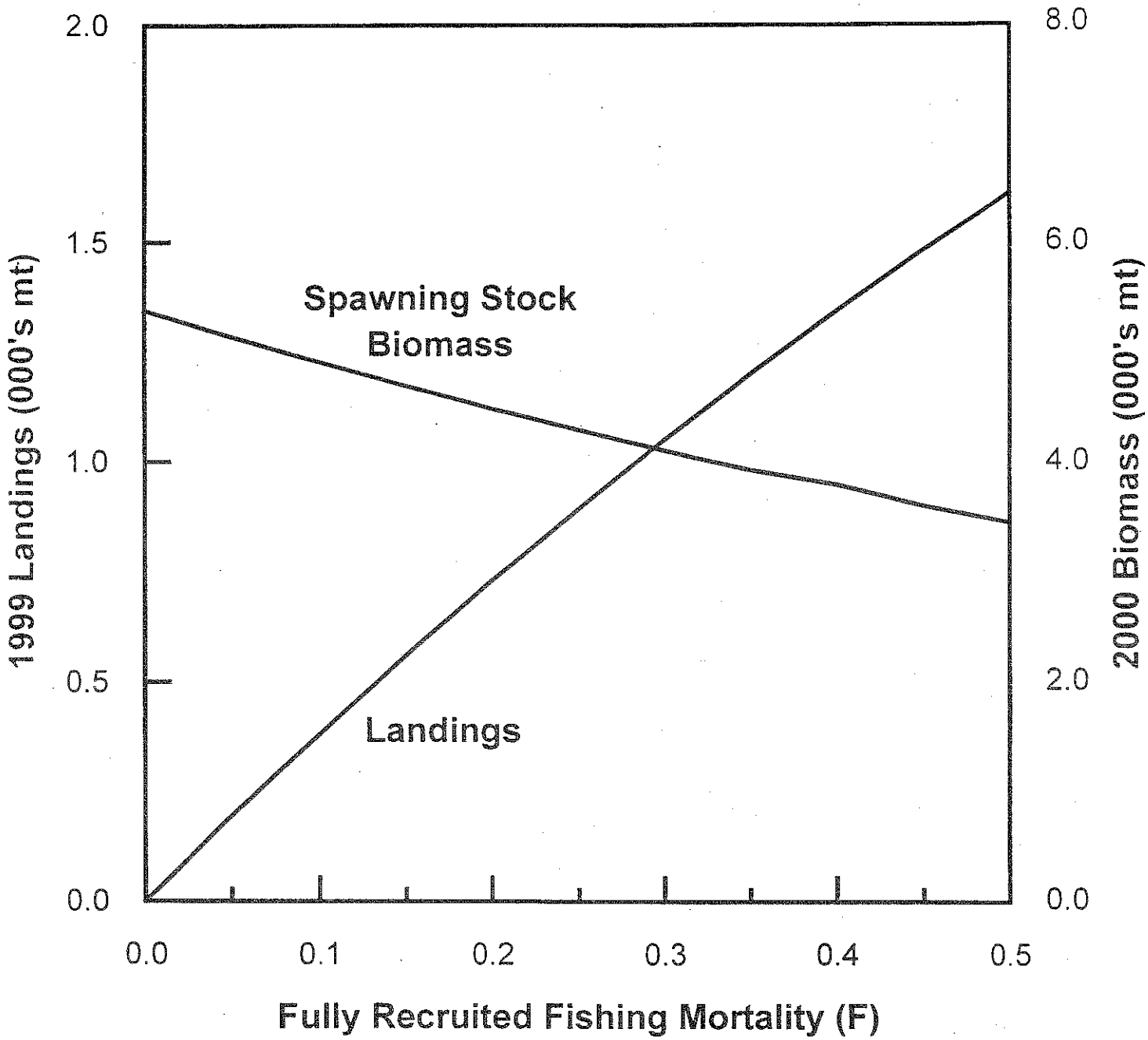


Figure 16. Results of short-term stochastic projections for the Georges Bank winter flounder stock. Projected landings of 1,107 mt assumed in 1998. Winter flounder landings in 1999 and spawning stock biomass in 2000 are shown as a function of fishing mortality in 2000.

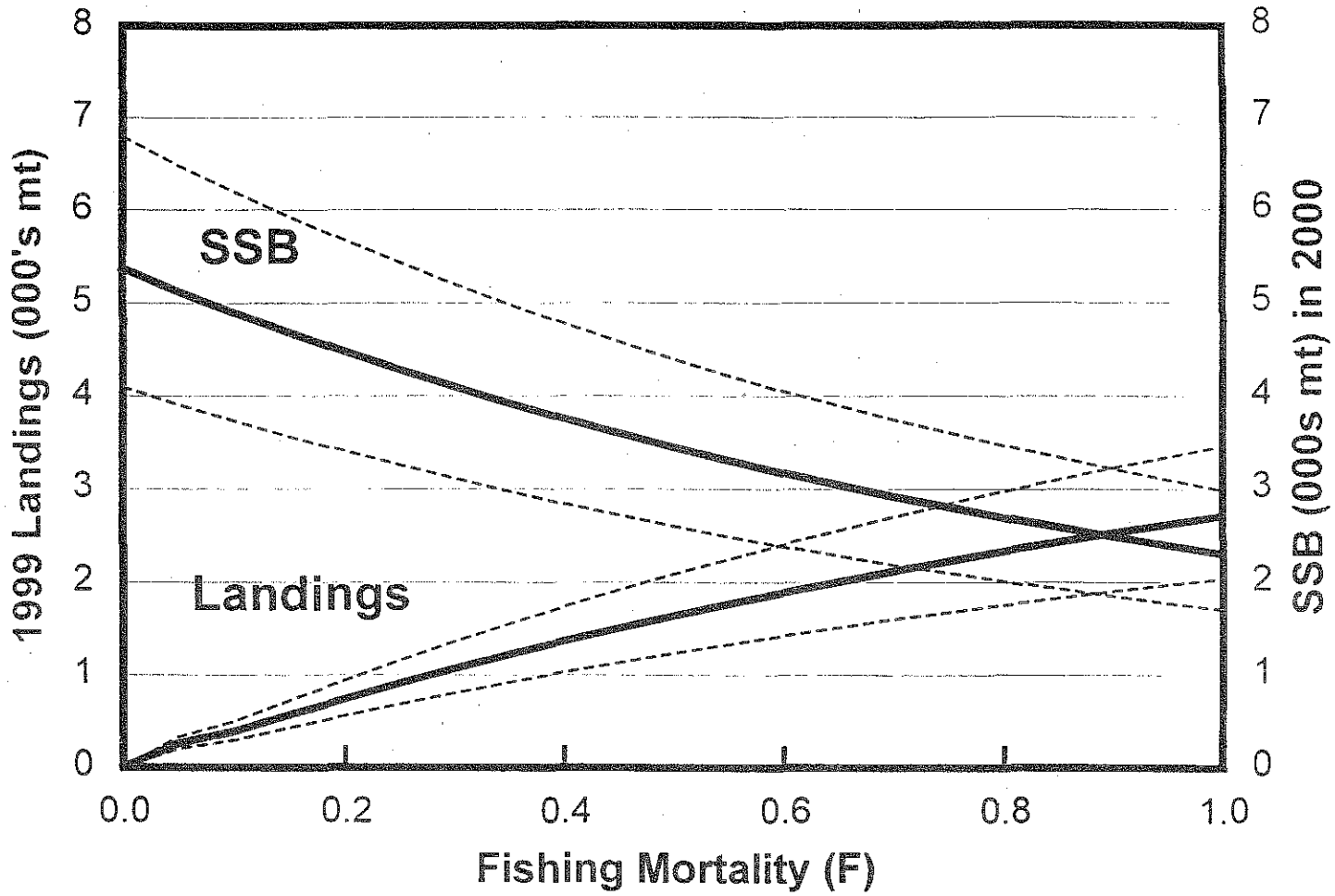


Figure 17. Results of short-term stochastic projections for the Georges Bank winter flounder stock. Projected landings of 964 mt assumed in 1998. Winter flounder landings in 1999 and spawning stock biomass in 2000 are shown as a function of fishing mortality in 1999. Dotted lines indicate 80% confidence intervals around each line.

Appendix 1. ADAPT VPA calibration for the Georges Bank winter flounder assessment.

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```
Woods Hole Assessment Toolbox  Georges Bank Winter Flounder 1982-1997  Run Number 15   11/15/98   3:09:38
Georges Bank Winter Flounder 1982-1997  1982 - 1998
Input Parameters and Options Selected
-------------------------------------
Natural mortality is  0.2
Oldest age (not in the plus group) is  6
For all years prior to the terminal year ( 1997 ), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age  6 : 4 5 6
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  7 + is then calculated from the following
ratios of F[age 7 +] to F[age 6 ]
```

```
Stock size of the  7 + group is then calculated using
the following method:  CATCH EQUATION
 Partial recruitment estimate for  1998
 1              0.01
 2              0.2
 3              0.6
 4              1
 5              1
 6              1
Objective function is Sum w*(LOG(OBS)-LOG(PRED))**2
 Indices normalized (by dividing by mean observed value)
before tuning to VPA stocksizes
Downweighting is not used
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            5.00E+04       1.00E-03       1.00E+06
N  3            1.00E+04       1.00E-03       1.00E+06
N  4            5.00E+03       1.00E-03       1.00E+06
N  5            2.50E+03       1.00E-03       1.00E+06
N  6            2.00E+03       1.00E-03       1.00E+06
q US_Sp1        1.00E-04       1.00E-08       1.00E+00
q US_Sp2        1.00E-04       1.00E-08       1.00E+00
q US_Sp3        1.00E-04       1.00E-08       1.00E+00
q US_Sp4        1.00E-04       1.00E-08       1.00E+00
q US_Sp5        1.00E-04       1.00E-08       1.00E+00
q US_Sp6        1.00E-04       1.00E-08       1.00E+00
q US_Sp7        1.00E-04       1.00E-08       1.00E+00
q US_A12        1.00E-04       1.00E-08       1.00E+00
q US_A23        1.00E-04       1.00E-08       1.00E+00
q US_A34        1.00E-04       1.00E-08       1.00E+00
q US_A45        1.00E-04       1.00E-08       1.00E+00
q US_A56        1.00E-04       1.00E-08       1.00E+00
q US_A67        1.00E-04       1.00E-08       1.00E+00

The following indices of abundance are available
 1              US_Sp1
 2              US_Sp2
 3              US_Sp3
 4              US_Sp4
 5              US_Sp5
 6              US_Sp6
 7              US_Sp7
 8              US_A01
 9              US_A12
 10             US_A23
 11             US_A34
 12             US_A45
 13             US_A56
 14             US_A67

 The Indices that will be used in this run are:
 1              US_Sp1   {US Spring Age 1}
 2              US_Sp2   {US Spring Age 2)
 3              US_Sp3   {US Spring Age 3)
 4              US_Sp4   {US Spring Age 4)
 5              US_Sp5   {US Spring Age 5)
 6              US_Sp6   {US Spring Age 6)
 7              US_Sp7   {US Spring Age 7)
 9              US_A12   {US Autumn Age 1, lagged forward to age 2 in the following year}
 10             US_A23   {US Autumn Age 2, lagged forward to age 3 in the following year)
 11             US_A34   {US Autumn Age 3, lagged forward to age 4 in the following year)
 12             US_A45   {US Autumn Age 4, lagged forward to age 5 in the following year)
 13             US_A56   {US Autumn Age 5, lagged forward to age 6 in the following year)
 14             US_A67   {US Autumn Age 6, lagged forward to age 7 in the following year)
```

Obs Indices (before transformation) by index and year; with Index means

	1982	1983	1984	1985	1986	1987	1988
US_Sp1	0.07	0.03	0.04	0.00	0.25	0.16	0.07
US_Sp2	0.79	1.03	0.14	1.85	0.66	1.65	0.54
US_Sp3	0.38	3.13	1.91	0.62	0.74	0.58	1.44
US_Sp4	0.60	1.58	1.54	0.63	0.12	0.29	0.68
US_Sp5	0.17	0.67	0.46	0.40	0.16	0.09	0.12
US_Sp6	0.15	0.70	0.55	0.22	0.07	0.00	0.04
US_Sp7	0.04	0.56	0.47	0.05	0.00	0.00	0.02
US_A12	2.13	1.96	0.07	0.66	0.32	1.09	0.05
US_A23	0.50	2.15	0.58	0.99	1.00	1.57	0.20
US_A34	0.39	0.44	1.13	0.92	0.42	0.37	0.22
US_A45	0.47	0.34	0.49	0.81	0.08	0.20	0.12
US_A56	0.13	0.12	0.06	0.23	0.03	0.05	0.00
US_A67	0.06	0.01	0.19	0.06	0.03	0.02	0.08

	1989	1990	1991	1992	1993	1994	1995
US_Sp1	0.05	0.13	0.27	0.07	0.17	0.13	0.15
US_Sp2	0.53	0.61	0.34	0.60	0.27	0.58	0.78
US_Sp3	0.27	1.56	0.82	0.30	0.33	0.41	1.26
US_Sp4	0.23	0.33	0.58	0.14	0.15	0.10	0.29
US_Sp5	0.16	0.10	0.28	0.15	0.00	0.04	0.10
US_Sp6	0.02	0.07	0.04	0.11	0.05	0.04	0.03
US_Sp7	0.00	0.00	0.02	0.00	0.02	0.00	0.00
US_A12	2.93	0.10	0.08	0.05	0.02	0.59	0.16
US_A23	0.64	1.06	0.06	0.00	0.46	0.13	0.43
US_A34	0.39	0.07	0.30	0.06	0.16	0.25	0.16
US_A45	0.04	0.14	0.00	0.05	0.01	0.17	0.09
US_A56	0.00	0.07	0.05	0.00	0.03	0.03	0.03
US_A67	0.02	0.06	0.00	0.00	0.00	0.00	0.00

	1996	1997	1998	Average
US_Sp1	0.04	0.02	0.00	0.110
US_Sp2	1.22	0.19	0.02	0.694
US_Sp3	0.43	0.54	0.16	0.876
US_Sp4	0.49	0.67	0.43	0.520
US_Sp5	0.07	0.11	0.12	0.199
US_Sp6	0.03	0.02	0.00	0.142
US_Sp7	0.04	0.03	0.03	0.127
US_A12	0.97	0.12	0.08	0.670
US_A23	0.90	0.34	0.69	0.731
US_A34	0.36	0.62	0.57	0.401
US_A45	0.05	0.24	0.30	0.225
US_A56	0.05	0.06	0.06	0.071
US_A67	0.00	0.09	0.03	0.060

Catch at age (thousands) - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	00	10	00	20	00	00	00
2	353	787	282	805	665	1294	835
3	1707	2902	570	693	1328	1681	2774
4	1048	1454	1371	812	235	899	843
5	511	551	1408	491	229	133	197
6	258	206	635	112	131	89	90
7	281	528	920	100	88	121	93
1+	4157	6438	5186	3031	2675	4217	4832

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	37	00	264
2	1381	295	593	796	301	533	679
3	1222	2032	1270	756	1143	582	267
4	509	668	951	727	451	246	188
5	147	185	136	468	320	67	76
6	107	46	38	92	163	57	19
7	61	17	60	61	47	51	20
1+	3427	3241	3047	2902	2461	1536	1513

	1996	1997
1	00	00
2	737	480
3	567	1115
4	240	590
5	157	132
6	104	35
7	83	34
1+	1888	2385

CAA Summary for ages 4 - 7

1982	1983	1984	1985	1986	1987	1988
2097	2739	4334	1514	683	1242	1223

1989	1990	1991	1992	1993	1994	1995
824	915	1185	1349	980	421	303

1996	1997
584	790

Weight at age (mid year) in kg - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	0.200	0.181	0.200	0.168	0.200	0.200	0.200
2	0.282	0.279	0.292	0.405	0.398	0.386	0.350
3	0.446	0.451	0.467	0.520	0.610	0.550	0.510
4	0.780	0.668	0.586	0.781	0.776	0.868	0.761
5	1.041	0.899	0.745	1.049	1.029	1.108	1.150
6	1.228	0.990	0.892	1.366	1.190	1.219	1.323
7	1.616	1.339	1.267	1.721	1.579	1.726	1.762

	1989	1990	1991	1992	1993	1994	1995
1	0.200	0.200	0.200	0.200	0.250	0.200	0.283
2	0.361	0.456	0.419	0.389	0.384	0.377	0.394
3	0.462	0.510	0.484	0.494	0.537	0.546	0.597
4	0.828	0.765	0.706	0.744	0.759	0.886	0.660
5	1.077	0.992	0.985	0.907	0.943	1.118	0.999
6	1.332	1.340	1.438	1.188	1.294	1.338	1.287
7	1.741	2.021	1.751	1.468	1.900	1.638	1.694

	1996	1997
1	0.200	0.200
2	0.413	0.363
3	0.614	0.534
4	0.903	0.702
5	1.096	1.011
6	1.442	1.429
7	1.735	1.872

January 1 Biomass Weights - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	0.169	0.143	0.141	0.109	0.144	0.151	0.149
2	0.223	0.236	0.230	0.285	0.259	0.278	0.265
3	0.364	0.357	0.361	0.390	0.497	0.468	0.444
4	0.727	0.546	0.514	0.604	0.635	0.728	0.647
5	1.067	0.837	0.705	0.784	0.896	0.927	0.999
6	1.131	1.015	0.895	1.009	1.117	1.120	1.211
7	1.616	1.339	1.267	1.721	1.579	1.726	1.762

	1989	1990	1991	1992	1993	1994	1995
1	0.132	0.138	0.143	0.144	0.204	0.142	0.234
2	0.269	0.302	0.289	0.279	0.277	0.307	0.281
3	0.402	0.429	0.470	0.455	0.457	0.458	0.474
4	0.650	0.591	0.600	0.600	0.612	0.690	0.600
5	0.905	0.906	0.863	0.800	0.838	0.921	0.941
6	1.238	1.201	1.194	1.082	1.083	1.123	1.200
7	1.741	2.021	1.751	1.468	1.900	1.638	1.694

	1996	1997
1	0.148	0.148
2	0.342	0.269
3	0.492	0.470
4	0.734	0.657
5	0.851	0.954
6	1.200	1.248
7	1.735	1.867

SSB Weights - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	0.169	0.143	0.141	0.109	0.144	0.151	0.149
2	0.223	0.236	0.230	0.285	0.259	0.278	0.265
3	0.364	0.357	0.361	0.390	0.497	0.468	0.444
4	0.727	0.546	0.514	0.604	0.635	0.728	0.647
5	1.067	0.837	0.705	0.784	0.896	0.927	0.999
6	1.131	1.015	0.895	1.009	1.117	1.120	1.211
7	1.616	1.339	1.267	1.721	1.579	1.726	1.762

	1989	1990	1991	1992	1993	1994	1995
1	0.132	0.138	0.143	0.144	0.204	0.142	0.234
2	0.269	0.302	0.289	0.279	0.277	0.307	0.281
3	0.402	0.429	0.470	0.455	0.457	0.458	0.474
4	0.650	0.591	0.600	0.600	0.612	0.690	0.600
5	0.905	0.906	0.863	0.800	0.838	0.921	0.941
6	1.238	1.201	1.194	1.082	1.083	1.123	1.200
7	1.741	2.021	1.751	1.468	1.900	1.638	1.694

	1996	1997
1	0.148	0.148
2	0.342	0.269
3	0.492	0.470
4	0.734	0.657
5	0.851	0.954
6	1.200	1.248
7	1.735	1.867

Computed (Rivard) from midyear weights: Jan 1 Weights - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	0.169	0.143	0.141	0.109	0.144	0.151	0.149
2	0.223	0.236	0.230	0.285	0.259	0.278	0.265
3	0.364	0.357	0.361	0.390	0.497	0.468	0.444
4	0.727	0.546	0.514	0.604	0.635	0.728	0.647
5	1.067	0.837	0.705	0.784	0.896	0.927	0.999
6	1.131	1.015	0.895	1.009	1.117	1.120	1.211
7	1.616	1.339	1.267	1.721	1.579	1.726	1.762

	1989	1990	1991	1992	1993	1994	1995
1	0.132	0.138	0.143	0.144	0.204	0.142	0.234
2	0.269	0.302	0.289	0.279	0.277	0.307	0.281
3	0.402	0.429	0.470	0.455	0.457	0.458	0.474
4	0.650	0.594	0.600	0.600	0.612	0.690	0.600
5	0.905	0.906	0.868	0.800	0.838	0.921	0.941
6	1.238	1.201	1.194	1.082	1.083	1.123	1.200
7	1.741	2.021	1.751	1.468	1.900	1.638	1.694

	1996	1997	1998
1	0.148	0.148	0.150
2	0.342	0.269	0.269
3	0.492	0.470	0.489
4	0.734	0.657	0.607
5	0.851	0.955	0.751
6	1.200	1.251	1.070
7	1.735	1.872	1.872

Percent Mature (females)- D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	00	00	00
2	62	62	62	62	62	62	62
3	92	92	92	92	92	92	92
4	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100

	1989	1990	1991	1992	1993	1994	1992
1	00	00	00	00	00	00	00
2	62	62	62	62	62	62	62
3	92	92	92	92	92	92	92
4	100	100	100	100	100	100	100
5	100	100	100	100	100	100	100
6	100	100	100	100	100	100	100
7	100	100	100	100	100	100	100

	1996	1997
1	00	00
2	62	62
3	92	92
4	100	100
5	100	100
6	100	100
7	100	100

pF is 0.2
pM is 0.2

Residual Sum of Squares from Marquardt Algorithm

Number 1	
RSS	901.31971201316
Lambda	1.00E-02
Number 2	
RSS	768.726781922027
Lambda	1.00E-03
Number 3	
RSS	659.875404495142
Lambda	1.00E-01
Number 4	
RSS	576.875058385801
Lambda	1.00E-02
Number 5	
RSS	536.386262695469
Lambda	1.00E+00
Number 6	
RSS	468.164292503494
Lambda	1.00E-01
Number 7	
RSS	438.624465455625
Lambda	1.00E+01
Number 8	
RSS	389.559887862789
Lambda	1.00E+00
Number 9	
RSS	270.440208557222
Lambda	1.00E+02
Number 10	
RSS	209.710853390405
Lambda	1.00E+01
Number 11	
RSS	145.538114640377
Lambda	1.00E+00
Number 12	
RSS	136.454179367638
Lambda	1.00E+02
Number 13	
RSS	135.48940240279
Lambda	1.00E+01
Number 14	
RSS	135.473860063072
Lambda	1.00E+00
Number 15	
RSS	135.473856845667
Lambda	1.00E-01

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 135.473856845667
Mean Square Residuals: 0.75263

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 2	5.56E+02	2.89E+02	1.92E+00	0.52
N 3	1.19E+03	5.65E+02	2.11E+00	0.47
N 4	2.04E+03	9.41E+02	2.17E+00	0.46
N 5	1.01E+03	3.99E+02	2.52E+00	0.40
N 6	4.00E+02	1.63E+02	2.45E+00	0.41
q US_Sp1	1.90E-04	4.40E-05	4.33E+00	0.23
q US_Sp2	2.00E-04	4.33E-05	4.62E+00	0.22
q US_Sp3	2.64E-04	5.69E-05	4.64E+00	0.22
q US_Sp4	5.22E-04	1.13E-04	4.64E+00	0.22
q US_Sp5	1.34E-03	2.99E-04	4.48E+00	0.22
q US_Sp6	2.27E-03	5.19E-04	4.37E+00	0.23
q US_Sp7	1.46E-03	4.13E-04	3.53E+00	0.28
q US_A12	1.08E-04	2.33E-05	4.62E+00	0.22
q US_A23	2.54E-04	5.65E-05	4.50E+00	0.22
q US_A34	5.50E-04	1.19E-04	4.64E+00	0.22
q US_A45	1.05E-03	2.34E-04	4.47E+00	0.22
q US_A56	3.35E-03	8.13E-04	4.12E+00	0.24
q US_A67	3.29E-03	8.75E-04	3.75E+00	0.27

Catchability Estimates in Original Units

	Estimate	Std.Err.	C.V.
q US_Sp1	2.09E-05	4.82E-06	0.23
q US_Sp2	1.39E-04	3.01E-05	0.22
q US_Sp3	2.31E-04	4.98E-05	0.22
q US_Sp4	2.72E-04	5.86E-05	0.22
q US_Sp5	2.67E-04	5.96E-05	0.22
q US_Sp6	3.24E-04	7.40E-05	0.23
q US_Sp7	1.86E-04	5.25E-05	0.28
q US_A12	7.22E-05	1.56E-05	0.22
q US_A23	1.85E-04	4.12E-05	0.22
q US_A34	2.21E-04	4.76E-05	0.22
q US_A45	2.36E-04	5.27E-05	0.22
q US_A56	2.36E-04	5.74E-05	0.24
q US_A67	1.96E-04	5.21E-05	0.27

Summary of Residuals

US_Sp
Tuned to: 1-Jan
For ages: 1

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.074	0.881	-0.398	-0.126	1	-0.272	-0.313	4627
1983	0.026	0.519	-1.427	-0.656	1	-0.772	-0.889	2725
1984	0.035	1.160	-1.136	0.148	1	-1.284	-1.480	6090
1985	0.000	0.000	0	0	1	0.000	0.000	00
1986	0.252	1.529	0.831	0.425	1	0.407	0.469	8028
1987	0.161	1.012	0.385	0.012	1	0.373	0.430	5311
1988	0.072	1.717	-0.413	0.540	1	-0.954	-1.099	9013
1989	0.048	1.004	-0.820	0.004	1	-0.823	-0.949	5270
1990	0.127	0.636	0.147	-0.452	1	0.600	0.691	3340
1991	0.270	0.878	0.902	-0.130	1	1.032	1.189	4612
1992	0.072	0.474	-0.418	-0.746	1	0.328	0.379	2490
1993	0.170	0.589	0.441	-0.529	1	0.970	1.118	3095
1994	0.126	1.005	0.138	0.005	1	0.132	0.153	5278
1995	0.149	1.304	0.305	0.266	1	0.039	0.045	6847
1996	0.037	0.461	-1.081	-0.773	1	-0.307	-0.354	2423
1997	0.024	0.129	-1.515	-2.046	1	0.531	0.612	679
1998	0.000	0.000	0	0	1	0.000	0.000	00

Partial Variance: 0.52

US_Sp
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.788	1.649	0.126	0.500	1	-0.374	-0.431	8236
1983	1.026	0.758	0.391	-0.276	1	0.667	0.769	3788
1984	0.142	0.445	-1.589	-0.810	1	-0.779	-0.897	2222
1985	1.851	0.998	0.980	-0.002	1	0.982	1.132	4986
1986	0.662	0.974	-0.048	-0.026	1	-0.022	-0.025	4865
1987	1.649	1.316	0.865	0.275	1	0.590	0.680	6573
1988	0.535	0.871	-0.260	-0.138	1	-0.121	-0.140	4349
1989	0.531	1.477	-0.268	0.390	1	-0.658	-0.759	7379
1990	0.611	0.864	-0.128	-0.146	1	0.018	0.021	4315
1991	0.345	0.547	-0.701	-0.602	1	-0.098	-0.113	2734
1992	0.600	0.756	-0.146	-0.280	1	0.134	0.154	3776
1993	0.273	0.408	-0.935	-0.896	1	-0.039	-0.044	2039
1994	0.575	0.501	-0.188	-0.692	1	0.504	0.581	2500
1995	0.782	0.865	0.119	-0.145	1	0.263	0.303	4322
1996	1.219	1.075	0.563	0.072	1	0.491	0.566	5368
1997	0.192	0.397	-1.284	-0.923	1	-0.360	-0.415	1984
1998	0.023	0.111	-3.394	-2.196	1	-1.199	-1.382	556

Partial Variance: 0.327

US_Sp
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.384	1.725	-0.824	0.545	1	-1.369	-1.578	6532
1983	3.134	1.696	1.275	0.528	1	0.746	0.860	6424
1984	1.912	0.631	0.781	-0.461	1	1.241	1.431	2389
1985	0.621	0.413	-0.343	-0.884	1	0.541	0.623	1564
1986	0.739	0.886	-0.170	-0.122	1	-0.049	-0.056	3354
1987	0.585	0.893	-0.404	-0.113	1	-0.290	-0.335	3381
1988	1.435	1.112	0.494	0.106	1	0.388	0.447	4211
1989	0.267	0.741	-1.187	-0.300	1	-0.886	-1.022	2805
1990	1.562	1.265	0.579	0.235	1	0.343	0.396	4792
1991	0.824	0.862	-0.061	-0.148	1	0.087	0.101	3266
1992	0.299	0.450	-1.075	-0.800	1	-0.276	-0.318	1702
1993	0.332	0.626	-0.970	-0.468	1	-0.501	-0.578	2371
1994	0.408	0.369	-0.763	-0.997	1	0.234	0.270	1397
1995	1.258	0.413	0.362	-0.884	1	1.246	1.436	1565
1996	0.431	0.772	-0.709	-0.259	1	-0.450	-0.519	2924
1997	0.535	0.984	-0.492	-0.016	1	-0.476	-0.549	3728
1998	0.162	0.314	-1.687	-1.158	1	-0.529	-0.610	1190

Partial Variance: 0.516

US_Sp
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.596	1.765	0.135	0.568	1	-0.433	-0.499	3382
1983	1.582	1.985	1.112	0.686	1	0.426	0.492	3803
1984	1.537	1.375	1.083	0.318	1	0.765	0.882	2634
1985	0.628	0.752	0.189	-0.285	1	0.474	0.547	1441
1986	0.116	0.341	-1.502	-1.075	1	-0.426	-0.491	654
1987	0.294	0.806	-0.571	-0.215	1	-0.356	-0.410	1545
1988	0.680	0.651	0.268	-0.429	1	0.697	0.804	1247
1989	0.226	0.489	-0.835	-0.714	1	-0.120	-0.138	938
1990	0.332	0.621	-0.449	-0.476	1	0.027	0.031	1190
1991	0.580	1.088	0.109	0.085	1	0.024	0.028	2085
1992	0.139	0.796	-1.319	-0.228	1	-1.091	-1.257	1525
1993	0.154	0.370	-1.217	-0.993	1	-0.224	-0.258	710
1994	0.102	0.473	-1.628	-0.748	1	-0.880	-1.015	907
1995	0.293	0.322	-0.572	-1.133	1	0.560	0.646	617
1996	0.489	0.543	-0.062	-0.611	1	0.549	0.632	1040
1997	0.669	0.981	0.251	-0.019	1	0.270	0.311	1880
1998	0.426	1.067	-0.199	0.065	1	-0.263	-0.303	2044

Partial Variance: 0.305

US_Sp
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.175	1.692	-0.130	0.526	1	-0.656	-0.757	1263
1983	0.670	2.440	1.214	0.892	1	0.322	0.371	1821
1984	0.458	2.410	0.834	0.880	1	-0.046	-0.053	1799
1985	0.397	1.227	0.690	0.205	1	0.485	0.559	916
1986	0.160	0.596	-0.219	-0.517	1	0.297	0.343	445
1987	0.090	0.432	-0.791	-0.839	1	0.048	0.056	322
1988	0.116	0.605	-0.539	-0.503	1	-0.037	-0.042	451
1989	0.156	0.346	-0.245	-1.060	1	0.815	0.939	259
1990	0.098	0.411	-0.713	-0.888	1	0.175	0.202	307
1991	0.275	0.496	0.324	-0.701	1	1.025	1.181	370
1992	0.146	1.135	-0.310	0.127	1	-0.437	-0.504	847
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.036	0.232	-1.713	-1.461	1	-0.252	-0.291	173
1995	0.102	0.697	-0.674	-0.361	1	-0.312	-0.360	520
1996	0.069	0.449	-1.061	-0.801	1	-0.260	-0.300	335
1997	0.114	0.850	-0.559	-0.163	1	-0.396	-0.456	634
1998	0.124	1.348	-0.474	0.299	1	-0.772	-0.890	1006

Partial Variance: 0.259

US_Sp
Tuned to: 1-Jan
For ages: 6

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.150	1.731	0.050	0.549	1	-0.499	-0.575	762
1983	0.697	1.300	1.588	0.262	1	1.326	1.528	572
1984	0.546	2.254	1.343	0.813	1	0.531	0.612	992
1985	0.221	0.451	0.438	-0.797	1	1.235	1.423	198
1986	0.075	0.695	-0.644	-0.364	1	-0.280	-0.323	306
1987	0.000	0.000	0	0	1	0.000	0.000	00
1988	0.041	0.326	-1.240	-1.121	1	-0.119	-0.137	143
1989	0.018	0.434	-2.068	-0.834	1	-1.234	-1.423	191
1990	0.073	0.178	-0.664	-1.724	1	1.060	1.222	78
1991	0.036	0.192	-1.372	-1.652	1	0.280	0.323	84
1992	0.109	0.409	-0.264	-0.893	1	0.630	0.726	180
1993	0.046	0.613	-1.123	-0.489	1	-0.635	-0.732	270
1994	0.044	0.441	-1.168	-0.820	1	-0.348	-0.401	194
1995	0.029	0.184	-1.584	-1.694	1	0.110	0.127	81
1996	0.026	0.812	-1.689	-0.209	1	-1.480	-1.706	357
1997	0.024	0.301	-1.776	-1.201	1	-0.575	-0.663	132
1998	0.000	0.000	0	0	1	0.000	0.000	00

Partial Variance: 0.741

US_Sp
Tuned to: 1-Jan
For ages: 7

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.041	1.199	-1.132	0.181	1	-1.314	-1.514	822
1983	0.560	2.119	1.482	0.751	1	0.731	0.843	1453
1984	0.470	2.051	1.306	0.718	1	0.588	0.677	1406
1985	0.046	0.255	-1.007	-1.365	1	0.358	0.413	175
1986	0.000	0.000	0	0	1	0.000	0.000	00
1987	0.000	0.000	0	0	1	0.000	0.000	00
1988	0.018	0.213	-1.945	-1.544	1	-0.400	-0.461	146
1989	0.000	0.000	0	0	1	0.000	0.000	00
1990	0.000	0.000	0	0	1	0.000	0.000	00
1991	0.024	0.194	-1.664	-1.640	1	-0.024	-0.028	133
1992	0.000	0.000	0	0	1	0.000	0.000	00
1993	0.018	0.111	-1.956	-2.198	1	0.242	0.279	76
1994	0.000	0.000	0	0	1	0.000	0.000	00
1995	0.000	0.000	0	0	1	0.000	0.000	00
1996	0.042	0.414	-1.108	-0.882	1	-0.227	-0.261	284
1997	0.026	0.186	-1.576	-1.684	1	0.108	0.124	127
1998	0.026	0.220	-1.576	-1.514	1	-0.062	-0.072	151

Partial Variance: 0.351

US_A1
Tuned to: 1-Jan
For ages: 2

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	2.132	0.887	1.157	-0.120	1	1.277	1.472	8236
1983	1.964	0.408	1.075	-0.897	1	1.972	2.273	3788
1984	0.069	0.239	-2.275	-1.430	1	-0.845	-0.974	2222
1985	0.660	0.537	-0.015	-0.622	1	0.607	0.700	4986
1986	0.324	0.524	-0.728	-0.647	1	-0.082	-0.094	4865
1987	1.095	0.708	0.490	-0.346	1	0.836	0.964	6573
1988	0.053	0.468	-2.545	-0.759	1	-1.786	-2.059	4349
1989	2.925	0.795	1.474	-0.230	1	1.704	1.964	7379
1990	0.096	0.465	-1.940	-0.767	1	-1.174	-1.353	4315
1991	0.084	0.294	-2.077	-1.223	1	-0.854	-0.984	2734
1992	0.046	0.407	-2.688	-0.900	1	-1.788	-2.061	3776
1993	0.023	0.220	-3.359	-1.516	1	-1.843	-2.124	2039
1994	0.590	0.269	-0.127	-1.312	1	1.185	1.366	2500
1995	0.165	0.465	-1.403	-0.765	1	-0.638	-0.735	4322
1996	0.968	0.578	0.367	-0.548	1	0.915	1.055	5368
1997	0.123	0.214	-1.699	-1.544	1	-0.155	-0.179	1984
1998	0.078	0.060	-2.148	-2.816	1	0.668	0.770	556

Partial Variance: 1.615

US_A2
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.504	1.659	-0.371	0.506	1	-0.877	-1.010	6532
1983	2.146	1.631	1.077	0.489	1	0.588	0.678	6424
1984	0.583	0.607	-0.226	-0.500	1	0.274	0.316	2389
1985	0.991	0.397	0.305	-0.923	1	1.228	1.416	1564
1986	0.997	0.852	0.311	-0.161	1	0.471	0.543	3354
1987	1.567	0.858	0.763	-0.153	1	0.916	1.056	3381
1988	0.203	1.069	-1.278	0.067	1	-1.345	-1.550	4211
1989	0.635	0.712	-0.140	-0.340	1	0.200	0.230	2805
1990	1.060	1.217	0.372	0.196	1	0.176	0.203	4792
1991	0.060	0.829	-2.499	-0.187	1	-2.312	-2.665	3266
1992	0.000	0.000	0	0	1	0.000	0.000	00
1993	0.461	0.602	-0.460	-0.507	1	0.047	0.054	2371
1994	0.132	0.355	-1.714	-1.036	1	-0.678	-0.781	1397
1995	0.429	0.397	-0.533	-0.923	1	0.390	0.450	1565
1996	0.898	0.742	0.206	-0.298	1	0.504	0.581	2924
1997	0.338	0.947	-0.771	-0.055	1	-0.716	-0.825	3728
1998	0.685	0.302	-0.064	-1.197	1	1.133	1.306	1190

Partial Variance: 0.934

US_A3
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.392	1.861	-0.023	0.621	1	-0.644	-0.742	3382
1983	0.438	2.093	0.088	0.738	1	-0.650	-0.750	3803
1984	1.133	1.449	1.038	0.371	1	0.667	0.769	2634
1985	0.916	0.793	0.825	-0.232	1	1.057	1.219	1441
1986	0.417	0.360	0.039	-1.022	1	1.061	1.223	654
1987	0.366	0.850	-0.092	-0.163	1	0.071	0.081	1545
1988	0.218	0.686	-0.610	-0.377	1	-0.233	-0.269	1247
1989	0.386	0.516	-0.039	-0.662	1	0.623	0.718	938
1990	0.072	0.655	-1.715	-0.423	1	-1.292	-1.489	1190
1991	0.303	1.147	-0.282	0.137	1	-0.420	-0.484	2085
1992	0.062	0.839	-1.868	-0.176	1	-1.692	-1.950	1525
1993	0.157	0.390	-0.940	-0.940	1	0.000	0.000	710
1994	0.246	0.499	-0.489	-0.695	1	0.206	0.238	907
1995	0.158	0.340	-0.931	-1.080	1	0.149	0.172	617
1996	0.360	0.572	-0.110	-0.558	1	0.449	0.517	1040
1997	0.624	1.035	0.442	0.034	1	0.408	0.470	1880
1998	0.574	1.124	0.358	0.117	1	0.241	0.278	2044

Partial Variance: 0.587

US_A4
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.472	1.324	0.741	0.280	1	0.461	0.531	1263
1983	0.337	1.908	0.403	0.646	1	-0.243	-0.280	1821
1984	0.490	1.885	0.778	0.634	1	0.144	0.166	1799
1985	0.811	0.960	1.282	-0.041	1	1.323	1.525	916
1986	0.079	0.466	-1.048	-0.763	1	-0.286	-0.329	445
1987	0.203	0.338	-0.105	-1.085	1	0.980	1.130	322
1988	0.121	0.473	-0.620	-0.749	1	0.129	0.149	451
1989	0.040	0.271	-1.740	-1.306	1	-0.434	-0.501	259
1990	0.142	0.322	-0.463	-1.134	1	0.672	0.774	307
1991	0.000	0.000	0	0	1	0.000	0.000	00
1992	0.053	0.888	-1.454	-0.119	1	-1.335	-1.538	847
1993	0.009	0.618	-3.176	-0.481	1	-2.695	-3.106	590
1994	0.172	0.181	-0.267	-1.707	1	1.440	1.659	173
1995	0.085	0.545	-0.974	-0.607	1	-0.366	-0.422	520
1996	0.048	0.351	-1.545	-1.047	1	-0.498	-0.574	335
1997	0.244	0.664	0.079	-0.409	1	0.488	0.563	634
1998	0.296	1.054	0.273	0.053	1	0.220	0.254	1006

Partial Variance: 1.062

US_A5
Tuned to: 1-Jan
For ages: 6

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.131	2.549	0.620	0.936	1	-0.316	-0.364	762
1983	0.122	1.915	0.543	0.649	1	-0.106	-0.122	572
1984	0.057	3.319	-0.211	1.200	1	-1.411	-1.626	992
1985	0.230	0.664	1.182	-0.410	1	1.592	1.835	198
1986	0.027	1.024	-0.962	0.024	1	-0.985	-1.136	306
1987	0.048	0.527	-0.388	-0.640	1	0.252	0.290	158
1988	0.000	0.000	0	0	1	0.000	0.000	00
1989	0.000	0.000	0	0	1	0.000	0.000	00
1990	0.072	0.263	0.026	-1.337	1	1.363	1.571	78
1991	0.051	0.282	-0.326	-1.265	1	0.939	1.083	84
1992	0.000	0.000	0	0	1	0.000	0.000	00
1993	0.026	0.903	-0.988	-0.101	1	-0.886	-1.022	270
1994	0.026	0.649	-0.988	-0.433	1	-0.555	-0.640	194
1995	0.033	0.271	-0.758	-1.307	1	0.549	0.633	81
1996	0.048	1.196	-0.391	0.179	1	-0.569	-0.656	357
1997	0.055	0.443	-0.250	-0.814	1	0.564	0.650	132
1998	0.061	1.338	-0.138	0.291	1	-0.430	-0.495	400

Partial Variance: 0.843

US_A6
Tuned to: 1-Jan
For ages: 7

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.058	2.700	-0.022	0.993	1	-1.015	-1.170	822
1983	0.014	4.773	-1.470	1.563	1	-3.033	-3.496	1453
1984	0.191	4.620	1.162	1.530	1	-0.368	-0.424	1406
1985	0.059	0.575	-0.013	-0.553	1	0.540	0.622	175
1986	0.027	0.670	-0.791	-0.400	1	-0.391	-0.451	204
1987	0.024	0.695	-0.905	-0.364	1	-0.541	-0.623	211
1988	0.079	0.481	0.281	-0.732	1	1.013	1.168	146
1989	0.025	0.350	-0.876	-1.050	1	0.174	0.200	107
1990	0.058	0.093	-0.035	-2.376	1	2.341	2.698	28
1991	0.000	0.000	0	0	1	0.000	0.000	00
1992	0.000	0.000	0	0	1	0.000	0.000	00
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.000	0.000	0	0	1	0.000	0.000	00
1995	0.000	0.000	0	0	1	0.000	0.000	00
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.093	0.418	0.450	-0.872	1	1.322	1.524	127
1998	0.028	0.495	-0.744	-0.702	1	-0.042	-0.048	151

Partial Variance: 2.016

Partial variance (and proportion of total) by index

0.52	0.327	0.516	0.305	0.259	0.741	0.351	1.615	0.934	0.587	1.062
0.843	2.016									
0.052	0.032	0.051	0.03	0.026	0.074	0.035	0.16	0.093	0.058	0.105
0.084	0.2									

Standardized residuals by index and year; with row/column/grand means

	1982	1983	1984	1985	1986	1987	1988
US_Sp1	-0.313	-0.889	-1.480	0.000	0.469	0.430	-1.099
US_Sp2	-0.431	0.769	-0.897	1.132	-0.025	0.680	-0.140
US_Sp3	-1.578	0.860	1.431	0.623	-0.056	-0.335	0.447
US_Sp4	-0.499	0.492	0.882	0.547	-0.491	-0.410	0.804
US_Sp5	-0.757	0.371	-0.053	0.559	0.343	0.056	-0.042
US_Sp6	-0.575	1.528	0.612	1.423	-0.323	0.000	-0.137
US_Sp7	-1.514	0.843	0.677	0.413	0.000	0.000	-0.461
US_A12	1.472	2.273	-0.974	0.700	-0.094	0.964	-2.059
US_A23	-1.010	0.678	0.316	1.416	0.543	1.056	-1.550
US_A34	-0.742	-0.750	0.769	1.219	1.223	0.081	-0.269
US_A45	0.531	-0.280	0.166	1.525	-0.329	1.130	0.149
US_A56	-0.364	-0.122	-1.626	1.835	-1.136	0.290	0.000
US_A67	-1.170	-3.496	-0.424	0.622	-0.451	-0.623	1.168
Col Avg	-0.535	0.175	-0.046	1.001	-0.027	0.302	-0.266

	1989	1990	1991	1992	1993	1994	1995
US_Sp1	-0.949	0.691	1.189	0.379	1.118	0.153	0.045
US_Sp2	-0.759	0.021	-0.113	0.154	-0.044	0.581	0.303
US_Sp3	-1.022	0.396	0.101	-0.318	-0.578	0.270	1.436
US_Sp4	-0.138	0.031	0.028	-1.257	-0.258	-1.015	0.646
US_Sp5	0.939	0.202	1.181	-0.504	0.000	-0.291	-0.360
US_Sp6	-1.423	1.222	0.323	0.726	-0.732	-0.401	0.127
US_Sp7	0.000	0.000	-0.028	0.000	0.279	0.000	0.000
US_A12	1.964	-1.353	-0.984	-2.061	-2.124	1.366	-0.735
US_A23	0.230	0.203	-2.665	0.000	0.054	-0.781	0.450
US_A34	0.718	-1.489	-0.484	-1.950	0.000	0.238	0.172
US_A45	-0.501	0.774	0.000	-1.538	-3.106	1.659	-0.422
US_A56	0.000	1.571	1.083	0.000	-1.022	-0.640	0.633
US_A67	0.200	2.698	0.000	0.000	0.000	0.000	0.000
Col Avg	-0.067	0.414	-0.034	-0.708	-0.583	0.104	0.209

	1996	1997	1998
US_Sp1	-0.354	0.612	0.000
US_Sp2	0.566	-0.415	-1.382
US_Sp3	-0.519	-0.549	-0.610
US_Sp4	0.632	0.311	-0.303
US_Sp5	-0.300	-0.456	-0.890
US_Sp6	-1.706	-0.663	0.000
US_Sp7	-0.261	0.124	-0.072
US_A12	1.055	-0.179	0.770
US_A23	0.581	-0.825	1.306
US_A34	0.517	0.470	0.278
US_A45	-0.574	0.563	0.254
US_A56	-0.656	0.650	-0.495
US_A67	0.000	1.524	-0.048
Col Avg	-0.085	0.090	-0.108

Percent of total sum of squares by index and year; with row/column sums

	1982	1983	1984	1985	1986	1987	1988
US_Sp1	0.055	0.440	1.217	0.000	0.122	0.103	0.671
US_Sp2	0.103	0.329	0.447	0.712	0.000	0.257	0.011
US_Sp3	1.383	0.411	1.137	0.216	0.002	0.062	0.111
US_Sp4	0.138	0.134	0.432	0.166	0.134	0.093	0.359
US_Sp5	0.318	0.077	0.002	0.174	0.065	0.002	0.001
US_Sp6	0.184	1.297	0.208	1.125	0.058	0.000	0.010
US_Sp7	1.274	0.395	0.255	0.095	0.000	0.000	0.118
US_A12	1.205	2.869	0.527	0.272	0.005	0.516	2.355
US_A23	0.567	0.255	0.055	1.113	0.164	0.619	1.335
US_A34	0.306	0.312	0.329	0.825	0.831	0.004	0.040
US_A45	0.157	0.044	0.015	1.292	0.060	0.709	0.012
US_A56	0.074	0.008	1.469	1.871	0.717	0.047	0.000
US_A67	0.760	6.789	0.100	0.215	0.113	0.216	0.758
++	6.523	13.360	6.193	8.077	2.271	2.628	5.782

	1989	1990	1991	1992	1993	1994	1995
US_Sp1	0.500	0.265	0.786	0.080	0.694	0.013	0.001
US_Sp2	0.320	0.000	0.007	0.013	0.001	0.187	0.051
US_Sp3	0.580	0.087	0.006	0.056	0.185	0.040	1.146
US_Sp4	0.011	0.001	0.000	0.878	0.037	0.572	0.232
US_Sp5	0.490	0.023	0.775	0.141	0.000	0.047	0.072
US_Sp6	1.125	0.829	0.058	0.293	0.297	0.089	0.009
US_Sp7	0.000	0.000	0.000	0.000	0.043	0.000	0.000
US_A12	2.142	1.017	0.538	2.359	2.507	1.036	0.300
US_A23	0.029	0.023	3.946	0.000	0.002	0.339	0.112
US_A34	0.286	1.233	0.130	2.113	0.000	0.031	0.016
US_A45	0.139	0.333	0.000	1.315	5.361	1.530	0.099
US_A56	0.000	1.371	0.651	0.000	0.580	0.228	0.222
US_A67	0.022	4.044	0.000	0.000	0.000	0.000	0.000
++	5.644	9.225	6.898	7.247	9.708	4.113	2.261

	1996	1997	1998	++
US_Sp1	0.070	0.208	0.000	5.225
US_Sp2	0.178	0.096	1.061	3.774
US_Sp3	0.149	0.168	0.207	5.946
US_Sp4	0.222	0.054	0.051	3.515
US_Sp5	0.050	0.116	0.440	2.792
US_Sp6	1.618	0.244	0.000	7.445
US_Sp7	0.038	0.009	0.003	2.230
US_A12	0.618	0.018	0.329	0.000
US_A23	0.188	0.378	0.947	18.614
US_A34	0.148	0.123	0.043	10.074
US_A45	0.183	0.176	0.036	6.771
US_A56	0.239	0.235	0.136	11.460
US_A67	0.000	1.290	0.001	7.848
++	3.702	3.113	3.254	100.000

STOCK NUMBERS (Jan 1) in thousands - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	4627	2725	6090	5963	8028	5311	9013
2	8236	3788	2222	4986	4865	6573	4349
3	6532	6424	2389	1564	3354	3381	4211
4	3382	3803	2634	1441	654	1545	1247
5	1263	1821	1799	916	445	322	451
6	762	572	992	198	306	158	143
7	822	1453	1406	175	204	211	146
1+	25624	20586	17532	15244	17855	17502	19560

	1989	1990	1991	1992	1993	1994	1995
1	5270	3340	4612	2490	3095	5278	6847
2	7379	4315	2734	3776	2039	2500	4322
3	2805	4792	3266	1702	2371	1397	1565
4	938	1190	2085	1525	710	907	617
5	259	307	370	847	590	173	520
6	191	78	84	180	270	194	81
7	107	28	133	118	76	173	86
1+	16948	14051	13285	10639	9151	10623	14038

	1996	1997	1998
1	2423	679	00
2	5368	1984	556
3	2924	3728	1190
4	1040	1880	2044
5	335	634	1006
6	357	132	400
7	284	127	151
1+	12730	9165	5346

FISHING MORTALITY - D:\What 1.8

	1982	1983	1984	1985	1986	1987	1988
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.05	0.26	0.15	0.20	0.16	0.25	0.24
3	0.34	0.69	0.31	0.67	0.58	0.80	1.30
4	0.42	0.55	0.86	0.97	0.51	1.03	1.37
5	0.59	0.41	2.00	0.90	0.84	0.61	0.66
6	0.47	0.51	1.23	0.97	0.64	0.97	1.17
7	0.47	0.51	1.23	0.97	0.64	0.97	1.17

	1989	1990	1991	1992	1993	1994	1995
1	0.00	0.00	0.00	0.00	0.01	0.00	0.04
2	0.23	0.08	0.27	0.27	0.18	0.27	0.19
3	0.66	0.63	0.56	0.67	0.76	0.62	0.21
4	0.92	0.97	0.70	0.75	1.21	0.36	0.41
5	0.99	1.09	0.52	0.94	0.91	0.56	0.18
6	0.96	1.02	0.68	0.83	1.10	0.39	0.30
7	0.96	1.02	0.68	0.83	1.10	0.39	0.30

	1996	1997
1	0.00	0.00
2	0.16	0.31
3	0.24	0.40
4	0.29	0.43
5	0.73	0.26
6	0.39	0.34
7	0.39	0.34

Average F for 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	0.49	0.49	1.36	0.95	0.66	0.87	1.07

	1989	1990	1991	1992	1993	1994	1995
4,6	0.96	1.03	0.63	0.84	1.07	0.44	0.30

	1996	1997
4,6	0.47	0.34

Average F weighted by N for 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	0.47	0.50	1.31	0.95	0.64	0.96	1.18

	1989	1990	1991	1992	1993	1994	1995
4,6	0.94	0.99	0.67	0.82	1.08	0.39	0.30

	1996	1997
4,6	0.40	0.38

Average F for weighted by Catch for 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	0.47	0.51	1.40	0.95	0.66	0.98	1.23

	1989	1990	1991	1992	1993	1994	1995
4,6	0.94	1.00	0.68	0.83	1.09	0.40	0.34

	1996	1997
4,6	0.45	0.39

Biomass Weighted F

1982	1983	1984	1985	1986	1987	1988
0.31	0.49	0.73	0.47	0.32	0.49	0.58

1989	1990	1991	1992	1993	1994	1995
0.39	0.42	0.43	0.52	0.56	0.29	0.16

1996	1997
0.24	0.36

BACKCALCULATED PARTIAL RECRUITMENT

	1982	1983	1984	1985	1986	1987	1988
1	0.00	0.01	0.00	0.00	0.00	0.00	0.00
2	0.08	0.38	0.08	0.20	0.20	0.24	0.17
3	0.58	1.00	0.15	0.69	0.69	0.77	0.95
4	0.71	0.79	0.43	1.00	0.60	1.00	1.00
5	1.00	0.59	1.00	0.92	1.00	0.59	0.48
6	0.79	0.73	0.61	1.00	0.76	0.94	0.85
7	0.79	0.73	0.61	1.00	0.76	0.94	0.85

	1989	1990	1991	1992	1993	1994	1995
1	0.00	0.00	0.00	0.00	0.01	0.00	0.11
2	0.23	0.07	0.39	0.28	0.15	0.44	0.46
3	0.66	0.58	0.80	0.72	0.63	1.00	0.51
4	0.92	0.89	1.00	0.79	1.00	0.58	1.00
5	1.00	1.00	0.74	1.00	0.75	0.91	0.43
6	0.97	0.94	0.98	0.88	0.91	0.63	0.73
7	0.97	0.94	0.98	0.88	0.91	0.63	0.73

	1996	1997
1	0.00	0.00
2	0.23	0.73
3	0.33	0.94
4	0.40	1.00
5	1.00	0.61
6	0.53	0.81
7	0.53	0.81

MEAN BIOMASS (using catch mean weights at age)

	1982	1983	1984	1985	1986	1987	1988
1	839	446	1104	906	1455	963	1634
2	2056	847	547	1667	1623	2048	1232
3	2250	1917	876	543	1424	1177	1111
4	1967	1788	953	662	364	771	478
5	908	1227	541	584	285	245	348
6	682	406	471	160	246	113	103
7	969	1395	948	178	218	215	140
1+	9671	8026	5439	4699	5615	5531	5047

	1989	1990	1991	1992	1993	1994	1995
1	955	605	836	451	697	957	1720
2	2163	1717	913	1175	652	753	1409
3	870	1659	1106	561	818	521	767
4	468	537	970	732	289	616	305
5	163	171	260	458	336	136	433
6	151	61	81	133	195	196	82
7	110	33	155	108	81	214	115
1+	4880	4784	4320	3618	3068	3393	4831

	1996	1997
1	439	123
2	1858	564
3	1451	1496
4	741	981
5	239	514
6	390	146
7	372	184
1+	5490	4008

Summaries for ages 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	3557	3421	1965	1405	895	1129	930

	1989	1990	1991	1992	1993	1994	1995
4,6	781	769	1311	1324	820	948	820

	1996	1997
4,6	1369	1641

Catch BIOMASS (using catch mean weights)

	1982	1983	1984	1985	1986	1987	1988
1	00	02	00	03	00	00	00
2	100	221	83	328	266	502	294
3	767	1326	268	365	819	939	1447
4	824	982	816	645	184	795	657
5	538	500	1084	523	239	149	230
6	320	206	579	155	157	110	121
7	454	708	1165	172	139	209	164
1+	3003	3943	3995	2192	1805	2704	2912

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	09	00	75
2	501	135	250	312	116	202	269
3	572	1049	621	378	623	322	160
4	429	520	680	549	350	220	125
5	161	187	135	432	306	76	76
6	145	62	55	111	215	77	25
7	105	34	106	90	89	84	34
1+	1913	1986	1847	1872	1708	980	764

	1996	1997
1	00	00
2	306	175
3	350	600
4	218	418
5	174	134
6	151	50
7	145	63
1+	1344	1441

Summaries for ages 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	1682	1687	2479	1323	581	1054	1007

	1989	1990	1991	1992	1993	1994	1995
4,6	735	769	870	1092	871	372	226

	1996	1997
4,6	544	602

Jan 1 BIOMASS (using Jan 1 mean weights)

	1982	1983	1984	1985	1986	1987	1988
1	782	390	859	650	1156	802	1343
2	1837	894	511	1421	1260	1827	1152
3	2378	2293	863	610	1667	1582	1870
4	2459	2077	1354	870	415	1125	807
5	1348	1524	1268	718	399	299	451
6	862	581	888	200	342	177	174
7	1328	1945	1782	301	322	365	258
1+	10993	9704	7524	4771	5561	6177	6054

	1989	1990	1991	1992	1993	1994	1995
1	696	461	660	359	631	750	1602
2	1985	1303	790	1054	565	768	1214
3	1127	2056	1535	775	1084	640	742
4	610	704	1251	915	434	626	370
5	234	278	319	678	495	160	489
6	237	94	101	195	292	218	97
7	186	57	233	173	145	283	146
1+	5074	4953	4889	4147	3646	3444	4661

	1996	1997
1	359	101
2	1836	534
3	1439	1752
4	763	1236
5	285	605
6	429	165
7	493	238
1+	5602	4629

Summaries for ages 4,6

	1982	1983	1984	1985	1986	1987	1988
4,6	4668	4181	3510	1788	1156	1600	1431

	1989	1990	1991	1992	1993	1994	1995
4,6	1080	1076	1671	1787	1221	1003	957

	1996	1997
4,6	1477	2006

SSB AT THE START OF THE SPAWNING SEASON -MALES AND FEMALES (MT) (using SSB mean weights)

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	00	00	00
2	979	457	267	735	656	936	591
3	2027	1823	741	487	1356	1231	1315
4	2172	1788	1096	688	360	879	589
5	1150	1350	816	577	324	254	380
6	754	504	667	158	289	140	132
7	1162	1689	1339	239	272	289	196
1+	8244	7610	4925	2883	3258	3729	3203

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	00	00	00
2	1020	690	403	538	293	391	629
3	902	1654	1252	618	849	516	649
4	488	557	1045	757	328	560	328
5	184	215	277	539	396	137	454
6	188	74	84	159	225	193	88
7	147	45	195	141	112	252	132
1+	2929	3234	3256	2750	2203	2050	2279

	1996	1997
1	00	00
2	956	270
3	1251	1476
4	691	1090
5	237	552
6	381	148
7	438	213
1+	3954	3749

Appendix 2. Results of 1000 bootstrap realizations of the ADAPT VPA calibration for Georges Bank winter flounder (Run 15).

The number of bootstraps: 1000
Bootstrap Output Variable: N hat

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
N 2	774	824	275	0.36
N 3	1568	1646	506	0.32
N 4	2097	2174	668	0.32
N 5	797	833	237	0.30
N 6	331	345	104	0.31

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
N 2	50	09	6.44	724	0.379705
N 3	78	16	4.98	1490	0.339505
N 4	77	21	3.69	2019	0.330816
N 5	36	08	4.53	761	0.311763
N 6	14	03	4.35	316	0.328189

Bootstrap Output Variable: Q_unscaled

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
q US_Sp1	0.0000204	0.0000206	0.0000042	0.20
q US_Sp2	0.0001362	0.0001373	0.0000243	0.18
q US_Sp3	0.0002308	0.0002343	0.0000406	0.18
q US_Sp4	0.0002772	0.0002818	0.0000550	0.20
q US_Sp5	0.0002765	0.0002812	0.0000529	0.19
q US_Sp6	0.0003320	0.0003356	0.0000633	0.19
q US_Sp7	0.0001947	0.0002021	0.0000494	0.25
q US_A12	0.0000707	0.0000712	0.0000123	0.17
q US_A23	0.0001850	0.0001877	0.0000359	0.19
q US_A34	0.0002254	0.0002295	0.0000437	0.19
q US_A45	0.0002447	0.0002515	0.0000482	0.20
q US_A56	0.0002462	0.0002501	0.0000535	0.22
q US_A67	0.0002023	0.0002088	0.0000474	0.23
q Can_Sp1	0.0000356	0.0000367	0.0000084	0.24
q Can_Sp2	0.0001994	0.0002038	0.0000443	0.22
q Can_Sp3	0.0002936	0.0002983	0.0000670	0.23
q Can_Sp4	0.0002987	0.0003032	0.0000669	0.22
q Can_Sp5	0.0002789	0.0002833	0.0000618	0.22
q Can_Sp6	0.0002246	0.0002318	0.0000502	0.22
q Can_Sp7	0.0001481	0.0001502	0.0000332	0.22

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
q US_Sp1	0.00000023	0.000000132	1.150	0.000020163	0.21
q US_Sp2	0.00000108	0.000000768	0.795	0.000135108	0.18
q US_Sp3	0.00000345	0.000001285	1.496	0.000227361	0.18
q US_Sp4	0.00000463	0.000001739	1.670	0.000272559	0.20
q US_Sp5	0.00000468	0.000001674	1.692	0.000271851	0.19
q US_Sp6	0.00000363	0.000002000	1.095	0.000328344	0.19
q US_Sp7	0.00000737	0.000001562	3.786	0.000187316	0.26
q US_A12	0.00000050	0.000000388	0.710	0.000070199	0.17
q US_A23	0.00000269	0.000001135	1.452	0.000182353	0.20
q US_A34	0.00000405	0.000001382	1.797	0.000221357	0.20
q US_A45	0.00000678	0.000001523	2.772	0.000237891	0.20
q US_A56	0.00000393	0.000001692	1.598	0.000242222	0.22
q US_A67	0.00000652	0.000001499	3.223	0.000195789	0.24
q Can_Sp1	0.00000102	0.000000266	2.847	0.000034633	0.24
q Can_Sp2	0.00000446	0.000001400	2.236	0.000194895	0.23
q Can_Sp3	0.00000470	0.000002118	1.600	0.000288887	0.23
q Can_Sp4	0.00000452	0.000002115	1.512	0.000294177	0.23
q Can_Sp5	0.00000445	0.000001956	1.596	0.000274437	0.23
q Can_Sp6	0.00000721	0.000001588	3.209	0.000217424	0.23
q Can_Sp7	0.00000210	0.000001049	1.417	0.000146005	0.23

Bootstrap Output Variable: N t1

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	4197.3	4211.7	137.8	0.0328
Age 2	774.3	824.2	275.1	0.3552
Age 3	1568.0	1646.0	505.8	0.3226
Age 4	2096.8	2174.1	668.1	0.3186
Age 5	796.9	832.9	237.2	0.2977
Age 6	330.6	345.0	103.8	0.3139
Age 7	121.7	122.8	25.5	0.2095

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	14.35	4.36	0.342	4182.95	0.03
Age 2	49.91	8.70	6.445	724.42	0.38
Age 3	78.03	16.00	4.976	1489.93	0.34
Age 4	77.31	21.13	3.687	2019.46	0.33
Age 5	36.06	7.50	4.526	760.79	0.31
Age 6	14.38	3.28	4.350	316.24	0.33
Age 7	1.09	0.81	0.895	120.60	0.21

Bootstrap Output Variable: F t

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0000	0.0000	0.0000	0.40
Age 2	0.2445	0.2531	0.0745	0.30
Age 3	0.3928	0.4077	0.1107	0.28
Age 4	0.5125	0.5213	0.1217	0.24
Age 5	0.3080	0.3181	0.0870	0.28
Age 6	0.4103	0.4197	0.0744	0.18
Age 7	0.4103	0.4197	0.0744	0.18

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	0.0000001	0.0000000	5.661	0.0000011	0.43
Age 2	0.0085851	0.0023565	3.512	0.2358821	0.32
Age 3	0.0148748	0.0035008	3.787	0.3779258	0.29
Age 4	0.0087768	0.0038491	1.712	0.5037450	0.24
Age 5	0.0101020	0.0027518	3.280	0.2979058	0.29
Age 6	0.0094394	0.0023538	2.301	0.4008254	0.19
Age 7	0.0094394	0.0023538	2.301	0.4008254	0.19

Bootstrap Output Variable: F full t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
0.4103	0.4197	0.0744	0.18

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
0.00944	0.00235	2.30	0.40083	0.19

Bootstrap Output Variable: PR t

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0000	0.0000	0.0000	0.43
Age 2	0.4770	0.4800	0.1638	0.34
Age 3	0.7664	0.7613	0.1867	0.24
Age 4	1.0000	0.9550	0.0990	0.10
Age 5	0.6010	0.6030	0.1874	0.31
Age 6	0.8005	0.7790	0.1025	0.13
Age 7	0.8005	0.7790	0.1025	0.13

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	0.00000	0.000000	2.51	0.00000222	0.44
Age 2	0.00305	0.005180	0.64	0.47393858	0.35
Age 3	-0.00507	0.005905	-0.66	0.77147689	0.24
Age 4	-0.04505	0.003129	-4.50	1.04504841	0.09
Age 5	0.00208	0.005926	0.35	0.59888341	0.31
Age 6	-0.02148	0.003242	-2.68	0.82196591	0.12
Age 7	-0.02148	0.003242	-2.68	0.82196591	0.12

Bootstrap Output Variable: PR mean

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0000	0.0000	0.0000	0.18
Age 2	0.3595	0.3546	0.0435	0.12
Age 3	0.5161	0.5074	0.0435	0.08
Age 4	0.7449	0.7307	0.0397	0.05
Age 5	0.6417	0.6359	0.0853	0.13
Age 6	0.6841	0.6756	0.0627	0.09
Age 7	0.6841	0.6756	0.0627	0.09

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	0.00000	0.0000003	-0.59	0.0000472	0.17
Age 2	-0.00498	0.0013752	-1.39	0.3645233	0.12
Age 3	-0.00873	0.0013771	-1.69	0.5248122	0.08
Age 4	-0.01421	0.0012565	-1.91	0.7590629	0.05
Age 5	-0.00579	0.0026959	-0.90	0.6475190	0.13
Age 6	-0.00855	0.0019829	-1.25	0.6926717	0.09
Age 7	-0.00855	0.0019829	-1.25	0.6926717	0.09

Bootstrap Output Variable: B mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
3943.5790	4076.4568	556.6180	0.14

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
132.8778	17.6018	3.37	3810.7012	0.15

Bootstrap Output Variable: SSB f mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
1500.6443	1741.9573	246.4637	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
241.313	7.794	16.08	1259.331	0.20

Bootstrap Output Variable: SSB spawn t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
3536.8613	3635.9209	464.4455	0.13

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
99.06	14.69	2.80	3437.80	0.14

Appendix C3. ASPIC Surplus Production Model of the Georges Bank winter flounder assessment. Q's were fixed using the results from the ADAPT VPA calibration.

Georges Bank Winter Flounder -- ASPIC 3.6x -- Two Indices

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ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.65)

FIT Mode

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National Marine Fisheries Service
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CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	34	Number of bootstrap trials:	0
Number of data series:	2	Lower bound on MSY:	1.000E+00
Objective function computed:	in EFFORT	Upper bound on MSY:	5.000E+02
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
1 USA Fall Survey	1.000 34	
2 USA Spring Survey	0.243 30	1.000 30

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	1.037E+01	34	3.241E-01	1.000E+00	8.767E-01	0.295
Loss(2) USA Spring Survey	6.980E+00	30	2.493E-01	1.000E+00	1.140E+00	0.237

TOTAL OBJECTIVE FUNCTION: 1.73500742E+01

Number of restarts required for convergence: 4
Est. B-ratio coverage index (0 worst, 2 best): 0.9673
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 1964	6.571E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	2.984E+00	2.500E+00	1	1
r	Intrinsic rate of increase	6.566E-01	4.000E-01	1	1
.....	Catchability coefficients by fishery:				
q(1)	USA Fall Survey	2.410E-01	2.410E-01	0	1
q(2)	USA Spring Survey	3.550E-01	3.550E-01	0	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	2.984E+00	Kr/4	
K	Maximum stock biomass	1.818E+01		
Bmsy	Stock biomass at MSY	9.088E+00	K/2	
Fmsy	Fishing mortality at MSY	3.283E-01	r/2	
F(0.1)	Management benchmark	2.955E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	2.954E+00	0.99*MSY	
B-ratio	Ratio of B(1998) to Bmsy	6.627E-01		
F-ratio	Ratio of F(1997) to Fmsy	7.945E-01		
Y-ratio	Proportion of MSY avail in 1998	8.862E-01	2*Br-Br^2	Ye(1998) = 2.644E+00
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	USA Fall Survey	1.362E+00	r/2q(1)	f(0.1) = 1.226E+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	1964	0.230	5.971E+00	6.595E+00	1.517E+00	1.517E+00	2.755E+00	7.006E-01	6.571E-01
2	1965	0.215	7.209E+00	7.840E+00	1.687E+00	1.687E+00	2.923E+00	6.554E-01	7.932E-01
3	1966	0.248	8.445E+00	8.851E+00	2.197E+00	2.197E+00	2.980E+00	7.560E-01	9.292E-01
4	1967	0.246	9.227E+00	9.555E+00	2.349E+00	2.349E+00	2.975E+00	7.488E-01	1.015E+00
5	1968	0.194	9.853E+00	1.034E+01	2.001E+00	2.001E+00	2.925E+00	5.896E-01	1.084E+00
6	1969	0.230	1.078E+01	1.096E+01	2.518E+00	2.518E+00	2.857E+00	7.000E-01	1.186E+00
7	1970	0.243	1.112E+01	1.117E+01	2.719E+00	2.719E+00	2.827E+00	7.412E-01	1.223E+00
8	1971	0.397	1.122E+01	1.053E+01	4.183E+00	4.183E+00	2.904E+00	1.210E+00	1.235E+00
9	1972	0.495	9.944E+00	9.113E+00	4.512E+00	4.512E+00	2.977E+00	1.508E+00	1.094E+00
10	1973	0.354	8.409E+00	8.404E+00	2.976E+00	2.976E+00	2.967E+00	1.079E+00	9.253E-01
11	1974	0.252	8.399E+00	8.795E+00	2.218E+00	2.218E+00	2.979E+00	7.682E-01	9.243E-01
12	1975	0.320	9.160E+00	9.185E+00	2.937E+00	2.937E+00	2.983E+00	9.739E-01	1.008E+00
13	1976	0.193	9.207E+00	9.766E+00	1.889E+00	1.889E+00	2.964E+00	5.892E-01	1.013E+00
14	1977	0.362	1.028E+01	9.940E+00	3.594E+00	3.594E+00	2.956E+00	1.101E+00	1.131E+00
15	1978	0.342	9.643E+00	9.499E+00	3.250E+00	3.250E+00	2.977E+00	1.042E+00	1.061E+00
16	1979	0.329	9.371E+00	9.327E+00	3.064E+00	3.064E+00	2.982E+00	1.001E+00	1.031E+00
17	1980	0.454	9.288E+00	8.753E+00	3.975E+00	3.975E+00	2.977E+00	1.383E+00	1.022E+00
18	1981	0.521	8.290E+00	7.701E+00	4.012E+00	4.012E+00	2.911E+00	1.587E+00	9.122E-01
19	1982	0.419	7.189E+00	7.117E+00	2.980E+00	2.980E+00	2.843E+00	1.275E+00	7.910E-01
20	1983	0.610	7.052E+00	6.416E+00	3.911E+00	3.911E+00	2.722E+00	1.857E+00	7.760E-01
21	1984	0.783	5.863E+00	5.023E+00	3.933E+00	3.933E+00	2.380E+00	2.385E+00	6.451E-01
22	1985	0.503	4.309E+00	4.305E+00	2.165E+00	2.165E+00	2.157E+00	1.532E+00	4.742E-01
23	1986	0.395	4.301E+00	4.525E+00	1.788E+00	1.788E+00	2.231E+00	1.203E+00	4.733E-01
24	1987	0.592	4.745E+00	4.513E+00	2.671E+00	2.671E+00	2.227E+00	1.803E+00	5.221E-01
25	1988	0.746	4.301E+00	3.836E+00	2.861E+00	2.861E+00	1.985E+00	2.272E+00	4.732E-01
26	1989	0.560	3.424E+00	3.381E+00	1.892E+00	1.892E+00	1.807E+00	1.704E+00	3.768E-01
27	1990	0.605	3.340E+00	3.232E+00	1.954E+00	1.954E+00	1.745E+00	1.842E+00	3.675E-01
28	1991	0.601	3.130E+00	3.045E+00	1.830E+00	1.830E+00	1.664E+00	1.830E+00	3.444E-01
29	1992	0.657	2.965E+00	2.816E+00	1.850E+00	1.850E+00	1.562E+00	2.001E+00	3.262E-01
30	1993	0.660	2.677E+00	2.551E+00	1.684E+00	1.684E+00	1.440E+00	2.011E+00	2.946E-01
31	1994	0.361	2.433E+00	2.696E+00	9.720E-01	9.720E-01	1.507E+00	1.098E+00	2.677E-01
32	1995	0.217	2.967E+00	3.496E+00	7.600E-01	7.600E-01	1.850E+00	6.622E-01	3.265E-01
33	1996	0.297	4.058E+00	4.497E+00	1.336E+00	1.336E+00	2.220E+00	9.048E-01	4.465E-01
34	1997	0.261	4.942E+00	5.482E+00	1.430E+00	1.430E+00	2.511E+00	7.945E-01	5.438E-01
35	1998		6.022E+00						6.627E-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	1964	8.326E-01	9.544E-01	0.2300	1.517E+00	1.517E+00	-0.13657	0.000E+00
2	1965	8.229E-01	8.929E-01	0.2152	1.687E+00	1.687E+00	-0.08161	0.000E+00
3	1966	3.885E-01	1.030E+00	0.2482	2.197E+00	2.197E+00	-0.97496	0.000E+00
4	1967	1.133E+00	1.020E+00	0.2458	2.349E+00	2.349E+00	0.10461	0.000E+00
5	1968	1.867E+00	8.032E-01	0.1936	2.001E+00	2.001E+00	0.84322	0.000E+00
6	1969	1.056E+00	9.536E-01	0.2298	2.518E+00	2.518E+00	0.10179	0.000E+00
7	1970	4.190E-01	1.010E+00	0.2433	2.719E+00	2.719E+00	-0.87970	0.000E+00
8	1971	3.322E+00	1.648E+00	0.3972	4.183E+00	4.183E+00	0.70099	0.000E+00
9	1972	2.856E+00	2.054E+00	0.4951	4.512E+00	4.512E+00	0.32931	0.000E+00
10	1973	2.490E+00	1.469E+00	0.3541	2.976E+00	2.976E+00	0.52758	0.000E+00
11	1974	1.515E+00	1.046E+00	0.2522	2.218E+00	2.218E+00	0.37000	0.000E+00
12	1975	1.425E+00	1.327E+00	0.3198	2.937E+00	2.937E+00	0.07139	0.000E+00
13	1976	4.813E-01	8.026E-01	0.1934	1.889E+00	1.889E+00	-0.51146	0.000E+00
14	1977	9.003E-01	1.500E+00	0.3616	3.594E+00	3.594E+00	-0.51070	0.000E+00
15	1978	1.048E+00	1.420E+00	0.3422	3.250E+00	3.250E+00	-0.30321	0.000E+00
16	1979	8.002E-01	1.363E+00	0.3285	3.064E+00	3.064E+00	-0.53263	0.000E+00
17	1980	2.131E+00	1.884E+00	0.4541	3.975E+00	3.975E+00	0.12323	0.000E+00
18	1981	1.648E+00	2.162E+00	0.5210	4.012E+00	4.012E+00	-0.27118	0.000E+00
19	1982	1.107E+00	1.737E+00	0.4187	2.980E+00	2.980E+00	-0.45074	0.000E+00
20	1983	1.655E+00	2.529E+00	0.6096	3.911E+00	3.911E+00	-0.42411	0.000E+00
21	1984	1.609E+00	3.249E+00	0.7830	3.933E+00	3.933E+00	-0.70303	0.000E+00
22	1985	1.935E+00	2.087E+00	0.5029	2.165E+00	2.165E+00	-0.07559	0.000E+00
23	1986	8.209E-01	1.639E+00	0.3951	1.788E+00	1.788E+00	-0.69166	0.000E+00
24	1987	3.004E+00	2.456E+00	0.5919	2.671E+00	2.671E+00	0.20163	0.000E+00
25	1988	2.247E+00	3.095E+00	0.7459	2.861E+00	2.861E+00	-0.31998	0.000E+00
26	1989	1.800E+00	2.322E+00	0.5596	1.892E+00	1.892E+00	-0.25455	0.000E+00
27	1990	5.647E+00	2.509E+00	0.6047	1.954E+00	1.954E+00	0.81134	0.000E+00
28	1991	1.346E+01	2.494E+00	0.6010	1.830E+00	1.830E+00	1.68565	0.000E+00
29	1992	4.818E+00	2.726E+00	0.6570	1.850E+00	1.850E+00	0.56941	0.000E+00
30	1993	2.540E+00	2.739E+00	0.6601	1.684E+00	1.684E+00	-0.07551	0.000E+00
31	1994	1.682E+00	1.496E+00	0.3606	9.720E-01	9.720E-01	0.11682	0.000E+00
32	1995	5.684E-01	9.021E-01	0.2174	7.600E-01	7.600E-01	-0.46187	0.000E+00
33	1996	7.608E-01	1.233E+00	0.2971	1.336E+00	1.336E+00	-0.48254	0.000E+00
34	1997	9.322E-01	1.082E+00	0.2609	1.430E+00	1.430E+00	-0.14935	0.000E+00

Georges Bank Winter Flounder -- ASPIC 3.6x -- Two Indices
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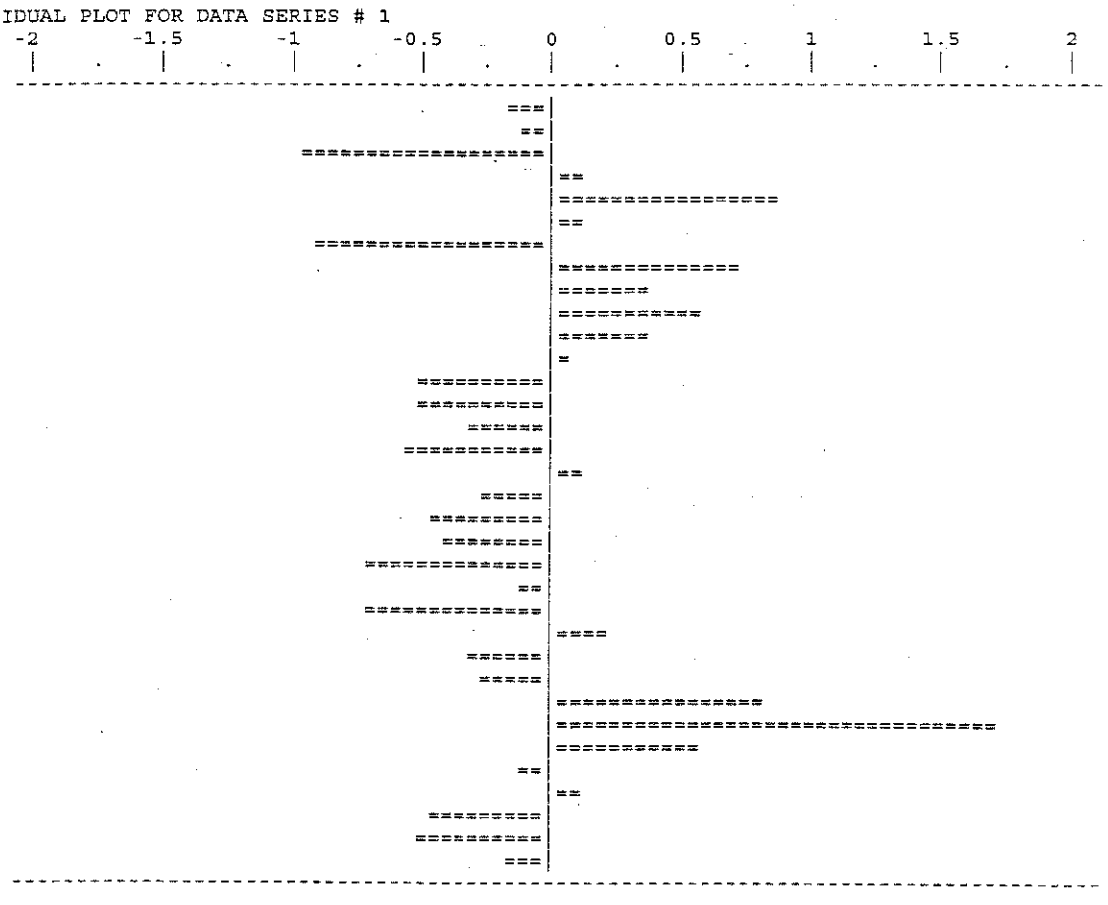
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

Year	Residual
1964	-0.1366
1965	-0.0816
1966	-0.9750
1967	0.1046
1968	0.8432
1969	0.1018
1970	-0.8797
1971	0.7010
1972	0.3293
1973	0.5276
1974	0.3700
1975	0.0714
1976	-0.5115
1977	-0.5107
1978	-0.3032
1979	-0.5326
1980	0.1232
1981	-0.2712
1982	-0.4507
1983	-0.4241
1984	-0.7030
1985	-0.0756
1986	-0.6917
1987	0.2016
1988	-0.3200
1989	-0.2546
1990	0.8113
1991	1.6856
1992	0.5694
1993	-0.0755
1994	0.1168
1995	-0.4619
1996	-0.4825
1997	-0.1494



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
1	1964	0.000E+00	0.000E+00	0.0	*	2.120E+00	0.00000	0.0
2	1965	0.000E+00	0.000E+00	0.0	*	2.559E+00	0.00000	0.0
3	1966	0.000E+00	0.000E+00	0.0	*	2.998E+00	0.00000	0.0
4	1967	0.000E+00	0.000E+00	0.0	*	3.276E+00	0.00000	0.0
5	1968	1.000E+00	1.000E+00	0.0	3.114E+00	3.498E+00	-0.11624	-3.839E-01
6	1969	1.000E+00	1.000E+00	0.0	4.290E+00	3.826E+00	0.11452	4.642E-01
7	1970	1.000E+00	1.000E+00	0.0	2.294E+00	3.946E+00	-0.54245	-1.652E+00
8	1971	1.000E+00	1.000E+00	0.0	2.168E+00	3.984E+00	-0.60857	-1.816E+00
9	1972	1.000E+00	1.000E+00	0.0	5.321E+00	3.530E+00	0.41032	1.791E+00
10	1973	1.000E+00	1.000E+00	0.0	3.507E+00	2.985E+00	0.16113	5.219E-01
11	1974	1.000E+00	1.000E+00	0.0	5.782E+00	2.982E+00	0.66222	2.800E+00
12	1975	1.000E+00	1.000E+00	0.0	1.407E+00	3.252E+00	-0.83779	-1.845E+00
13	1976	1.000E+00	1.000E+00	0.0	3.012E+00	3.268E+00	-0.08169	-2.564E-01
14	1977	1.000E+00	1.000E+00	0.0	1.580E+00	3.650E+00	-0.83726	-2.070E+00
15	1978	1.000E+00	1.000E+00	0.0	5.055E+00	3.423E+00	0.38973	1.632E+00
16	1979	1.000E+00	1.000E+00	0.0	2.206E+00	3.327E+00	-0.41078	-1.121E+00
17	1980	1.000E+00	1.000E+00	0.0	2.801E+00	3.297E+00	-0.16316	-4.964E-01
18	1981	1.000E+00	1.000E+00	0.0	3.749E+00	2.943E+00	0.24207	8.060E-01
19	1982	1.000E+00	1.000E+00	0.0	1.523E+00	2.552E+00	-0.51618	-1.029E+00
20	1983	1.000E+00	1.000E+00	0.0	7.111E+00	2.503E+00	1.04397	4.608E+00
21	1984	1.000E+00	1.000E+00	0.0	5.604E+00	2.081E+00	0.99053	3.523E+00
22	1985	1.000E+00	1.000E+00	0.0	2.650E+00	1.530E+00	0.54946	1.120E+00
23	1986	1.000E+00	1.000E+00	0.0	1.214E+00	1.527E+00	-0.22940	-3.130E-01
24	1987	1.000E+00	1.000E+00	0.0	1.247E+00	1.684E+00	-0.30063	-4.373E-01
25	1988	1.000E+00	1.000E+00	0.0	1.648E+00	1.527E+00	0.07645	1.213E-01
26	1989	1.000E+00	1.000E+00	0.0	7.570E-01	1.216E+00	-0.47369	-4.587E-01
27	1990	1.000E+00	1.000E+00	0.0	1.573E+00	1.186E+00	0.28279	3.875E-01
28	1991	1.000E+00	1.000E+00	0.0	1.319E+00	1.111E+00	0.17143	2.078E-01
29	1992	1.000E+00	1.000E+00	0.0	8.980E-01	1.052E+00	-0.15869	-1.544E-01
30	1993	1.000E+00	1.000E+00	0.0	5.700E-01	9.503E-01	-0.51114	-3.803E-01
31	1994	1.000E+00	1.000E+00	0.0	5.780E-01	8.636E-01	-0.40155	-2.856E-01
32	1995	1.000E+00	1.000E+00	0.0	1.489E+00	1.053E+00	0.34606	4.356E-01
33	1996	1.000E+00	1.000E+00	0.0	1.504E+00	1.441E+00	0.04314	6.350E-02
34	1997	1.000E+00	1.000E+00	0.0	1.192E+00	1.754E+00	-0.38646	-5.623E-01

* Asterisk indicates missing value(s).

Georges Bank Winter Flounder -- ASPIC 3.6x -- Two Indices
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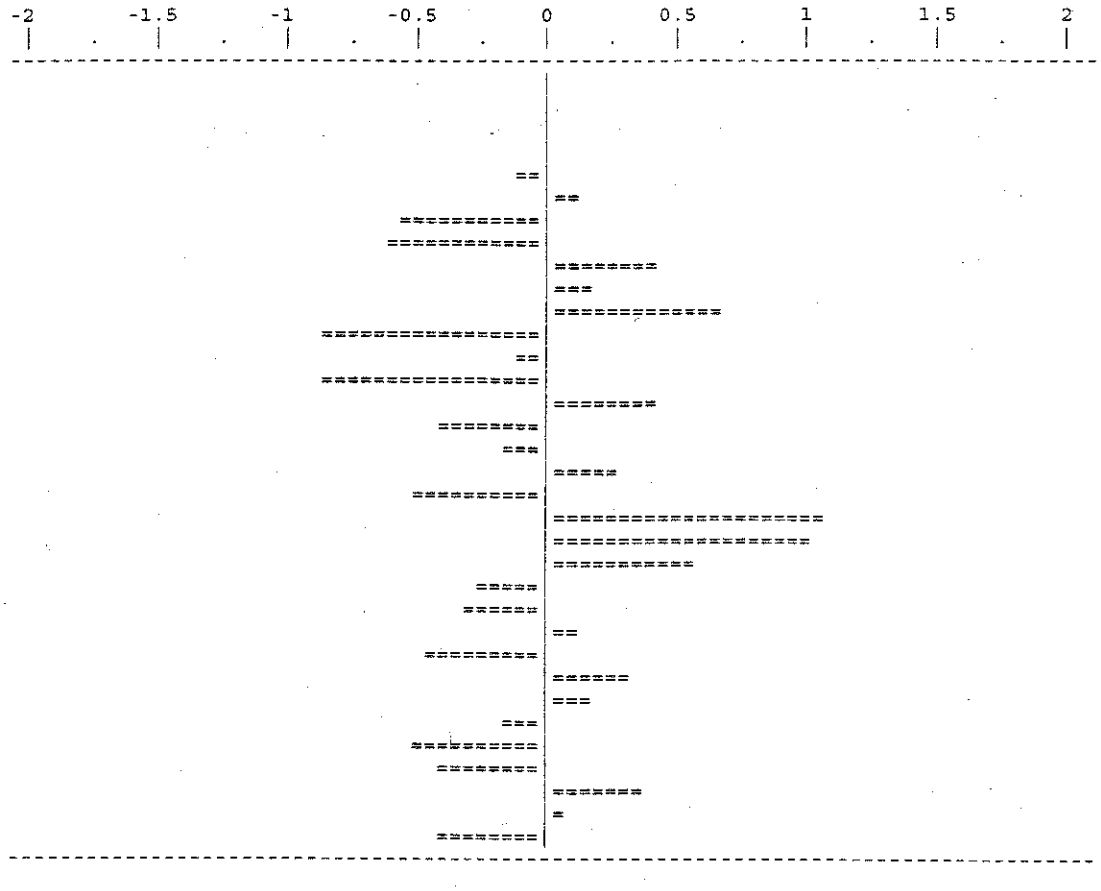
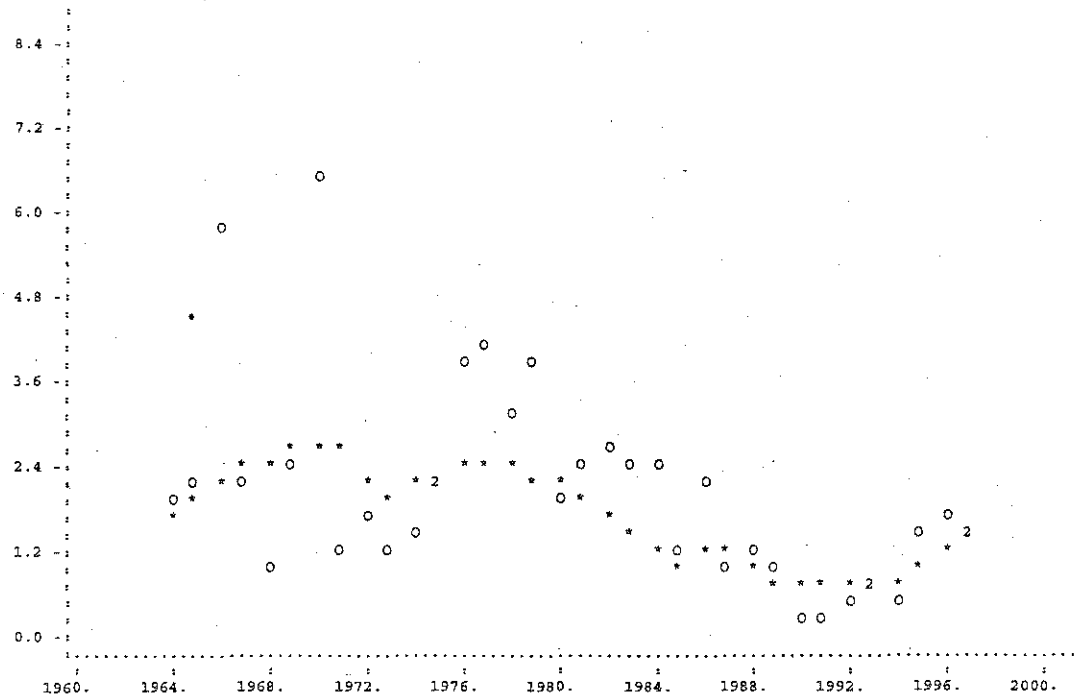
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2

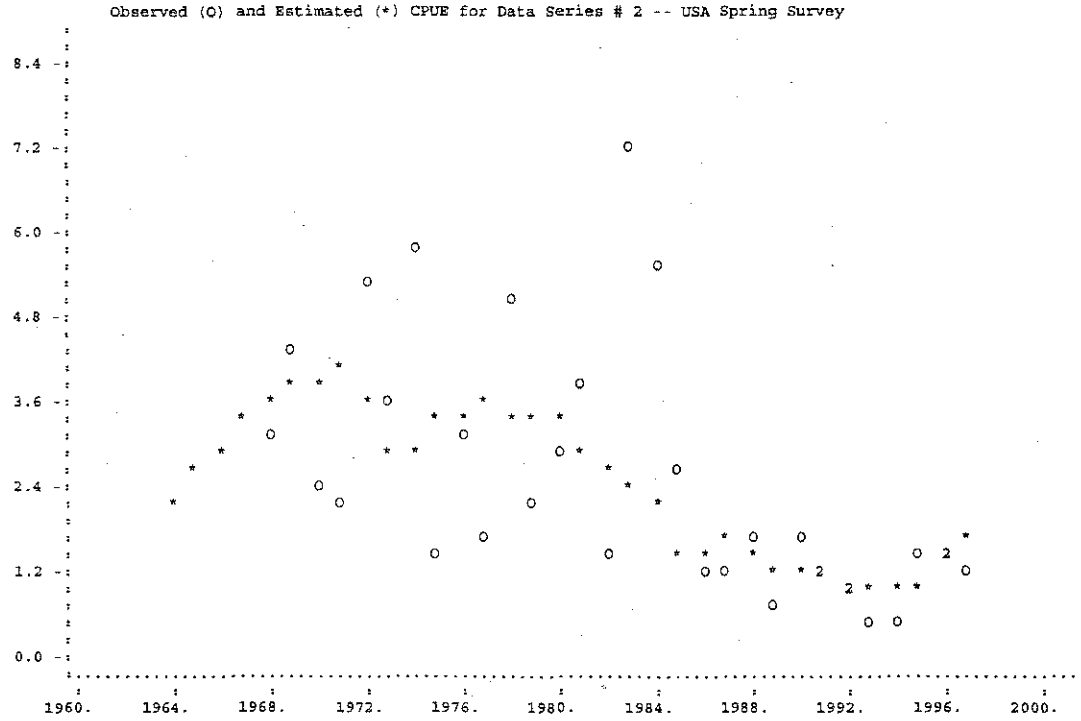
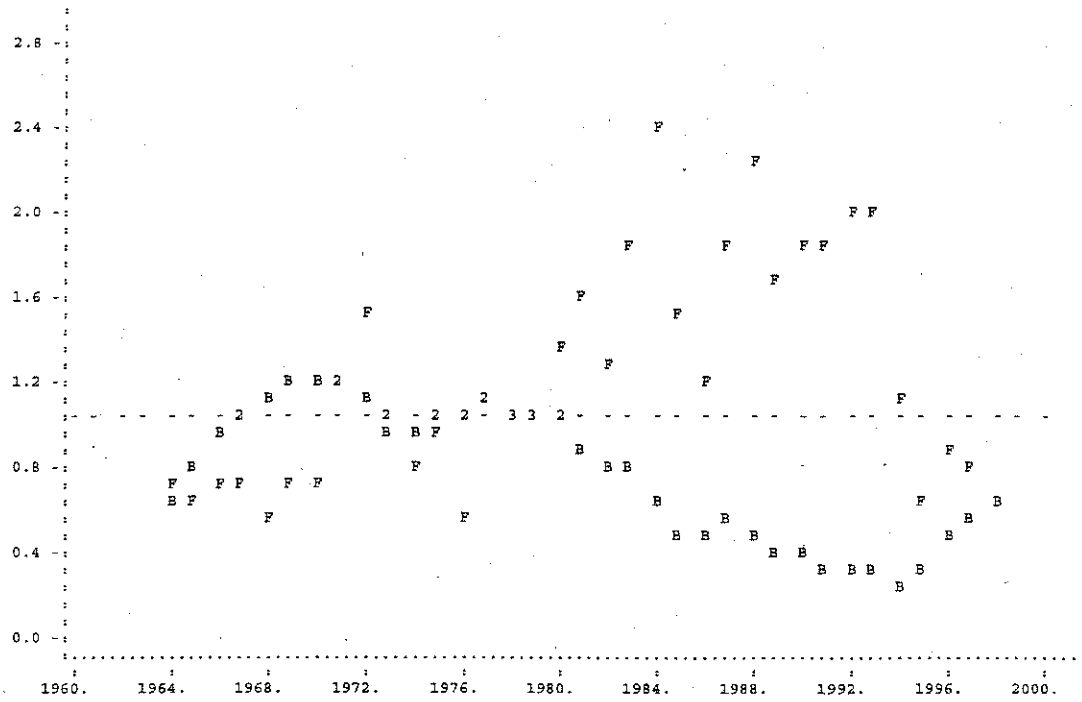
Year	Residual
1964	0.0000
1965	0.0000
1966	0.0000
1967	0.0000
1968	-0.1162
1969	0.1145
1970	-0.5425
1971	-0.6086
1972	0.4103
1973	0.1611
1974	0.6622
1975	-0.8378
1976	-0.0817
1977	-0.8373
1978	0.3897
1979	-0.4108
1980	-0.1632
1981	0.2421
1982	-0.5162
1983	1.0440
1984	0.9905
1985	0.5495
1986	-0.2294
1987	-0.3006
1988	0.0764
1989	-0.4737
1990	0.2828
1991	0.1714
1992	-0.1587
1993	-0.5111
1994	-0.4016
1995	0.3461
1996	0.0431
1997	-0.3865



Observed (O) and Estimated (*) CPUE for Data Series # 1 -- USA Fall Survey



Observed (O) and Estimated (*) CPUE for Data Series # 2 -- USA Spring Survey



Time Plot of Estimated F-Ratio and B-Ratio