

Northeast Fisheries Science Center Reference Document 94-17

A Report of the 18th Northeast Regional Stock Assessment Workshop

**Assessment of the
Gulf of Maine - Georges Bank
Witch Flounder Stock for 1994**

by

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts**

July 1996

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The correct citation for this document is: Wigley, S.E.; Mayo, R.K. 1996. Assessment of the Gulf of Maine - Georges Bank witch flounder stock for 1994. *Northeast Fish. Sci. Cent. Ref. Doc.* 94-17; 86 p. The complete activities of SAW 18 are scheduled to be documented in the following reports:

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| CRD 94-16 | Assessment of summer flounder (<i>Paralichthys dentatus</i>), 1994 report of the SAW Summer Flounder Working Group |
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ABSTRACT

The status of witch flounder in the Gulf of Maine-Georges Bank region is presented. The 1994 analytical assessment, covering the period 1982-1993, estimates 1993 fishing mortality, 1994 stock size and spawning stock biomass, as well as estimates discards from the shrimp fishery and large-mesh otter trawl fishery, based upon analyses of sea sample, commercial and research vessel survey data through 1993. The assessment was based on several data sources including USA commercial landings at age estimates, USA spring and autumn research vessel surveys, and standardized USA commercial fishing effort data.

USA commercial landings in 1993 totaled 2,599 mt, a 17% increase over 1992 and 46% higher than in 1990. Research survey indices of abundance and biomass remained fairly stable from 1963 until the late 1970s; autumn indices declined steadily during the early and mid 1980s, reaching record low levels in 1987. Abundance sharply increased in 1993, due to a strong 1993 year class.

Average fishing mortality (ages 7-9, unweighted) increased from 0.19 in 1982 to 0.55 in 1985, declined to 0.24 during 1990 and 1991, and then increased to 0.45 in 1993. Spawning stock biomass declined from 26,000 tons in 1982 to about 7,000 tons in 1989 and has remained at this low level through 1993. Since 1982, recruitment at age 2 has ranged from approximately 4 million fish (1983 and 1984 year classes) to 26 million fish (1990 year class) with most estimates between 7 and 15 million fish. Over the 1982-1993 period, geometric mean recruitment for the 1980-1991 year classes equalled 9.8 million fish at age 2. Over the same period, the geometric mean recruitment of age 3 fish (the 1979-1991 year classes) equalled 9.05 million fish. Both series indicate 1988 and 1989 year classes were slightly above average, the 1990 year class was well above average and the 1992 year class was below average. Continued fishing at the 1993 level ($F = 0.45$) will lead to catches in 1994 remaining near the 1993 level. Due to continued growth and maturation of the strong 1990 year class, SSB is expected to increase to above 10,000-11,000 mt in 1995, but will begin to decline in 1996 unless F is reduced in 1995 to $F_{20\%}$ (0.39) or lower.

The Gulf of Maine-Georges Bank witch flounder stock is at a low biomass level and is over exploited. There is a high probability that fishing mortality in 1993 was at or above the $F_{20\%}$ level. It is also clear that, despite the variability in the survey indices, the age range of the stock has been greatly reduced ($< \text{age } 7$) since 1985-1986 and that ages 2-4 in the catch are comprised almost entirely of fish discarded in the shrimp and large-mesh otter trawl fisheries.

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INTRODUCTION

The witch flounder (*Glyptocephalus cynoglossus*, L.) or grey sole is a deep water boreal flatfish occurring on both sides of the North Atlantic. In the Northwest Atlantic, witch flounder are distributed from Labrador to Georges Bank and in continental slope waters southward to Cape Hatteras, North Carolina. In U.S. waters, the species is commercially abundant in the Gulf of Maine-Georges Bank region [defined as Northwest Atlantic Fisheries Organization Divisions 5Y and 5Ze, and NEFSC Statistical Reporting Areas (SA) 511-515, 521-522, 525-526, and 561-562; Figures 1a and 1b] (Figures 2 and 3), and, in the absence of any stock structure information, is assumed to comprise a single stock unit. Prized as a table fish, witch flounder receives a high ex-vessel price relative to other flounders and represents an important by-catch component in the New England mixed species groundfish fishery. Annual landings during the period 1910-82 averaged 3,000 metric tons (mt), and have ranged between 1,000 and 6,000 mt (Burnett and Clark 1983).

Exploitation of witch flounder has increased since the mid-1980s resulting in severe declines in abundance and biomass (NEFSC 1991a). Significant numbers of juvenile witch flounder are also discarded in the Gulf of Maine northern shrimp fishery (Wigley 1994). This report provides an update on the status of witch flounder in the Gulf of Maine-Georges Bank region, presents an analytical assessment for the stock for the 1982-1993 period, and provides estimates of discards from the shrimp fishery and large-mesh otter trawl fishery based upon analyses of sea sampling, commercial and research vessel survey data through 1993.

THE FISHERY

Commercial Landings

USA commercial landings in 1993 totaled 2,599 mt, a 17% increase over 1992 (Table 1); and 46% higher than in 1990. Canadian landings from the stock have been negligible (10 mt in 1993, preliminary; Table 2). Landings from the Grand Banks (NAFO Divisions 3LNO), from the western Scotian Shelf (NAFO Division 4X), from southern New England (NAFO Division 5Zw, SA 537-539), and from the Mid-Atlantic region (NAFO Divisions 6ABC) are not considered in this assessment (Tables 1 and 2).

The western Gulf of Maine (SA 513 and 514) and the central basin (SA 515) provide nearly half of the USA witch flounder landings (Table 1); landings from Georges Bank are confined to the deeper waters along the Northern Edge and the southern slope (SA 522, 561 and 525, 526, and 521 respectively; Table 1). Otter trawl catches account for about 94% of witch flounder landings, with shrimp trawls, sink gillnets, Scottish and Danish seines, and scallop dredges comprising the remainder (Table 3). Catches are generally highest during March-July (Table 4) when witch flounder form dense pre-spawning aggregations (Burnett et al. 1992). The majority of witch flounder are landed in Maine ports, primarily Portland, with lesser amounts landed in Gloucester, Boston, and New Bedford, MA (Table 5).

Although culling and grading practices vary by port, witch flounder have historically been landed as either 'small' or 'large'; however, three market categories ('peewee', 'medium', and 'jumbo') were added in some ports beginning in 1982 (Table 6). In 1992 and 1993, witch flounder less than 45 cm ('peewee' and 'small' market categories) constituted more than 50% of total landings (Table 7). The current regulated minimum landing size for witch flounder is 36 cm (14 inches).

Recreational Catches

There is no recreational fishery for witch flounder due to its deep-water offshore distribution and its small mouth size, which precludes the taking of a baited hook.

Discards

Discard estimates for witch flounder in the Gulf of Maine northern shrimp fishery were derived using data from the NEFSC Domestic Sea Sampling Program (DSSP). The ratio of witch flounder discarded (kg) to days fished was calculated for individual years, 1989-1993. Since depth is an important factor influencing discard, discard ratios were calculated for each of three fishing zones (i.e. depth zones) in each year. The zonal discard ratios were then applied to the number of days fished by the shrimp fleet in each zone to estimate total discards (in weight) for that year (Table 8). To estimate witch flounder discard rates prior to the DSSP program, (i.e., 1982-1988), a simple linear regression was employed using 1989-1992 annual weighted mean discard rates (the zone-specific discard rates were weighted by the days fished in each zone to calculate an annual weighted mean discard rate) and annual indices of witch flounder abundance. The NEFSC autumn bottom trawl survey index of age 3 fish was found to be the best predictor of annual discard rates ($r^2 = 0.97$, $p = 0.0127$). To obtain total witch flounder weight discarded yearly, annual discard rates (kg per day fished) were multiplied by the total number of days fished by the commercial fleet in each year (Table 8). Estimated discard weight was then translated into discarded numbers at age by applying sea-sampled discard length-frequencies expanded up to the total discard weight and then applying NEFSC spring bottom trawl survey age-length keys. Detailed information on this method is given in Wigley (1994).

The DSSP, which began in 1989, has not generated sufficient data for directly estimating the age composition of discards in the large-mesh otter trawl fishery due to low sample sizes (Table 9). The estimation of discards in the large-mesh otter trawl fishery is based upon a method developed by Mayo et al. (1992) which utilizes survey and commercial catch at length data, commercial gear retention ogives, and information on culling practices. Research vessel length frequency data were filtered through commercial gear retention ogives corresponding to the predominant meshes employed in the large mesh fishery (130 and 140 mm) and then through a culling practice ogive. Due to the high value and low abundance of this species, the culling practice of commercial fishermen was assumed to be knife edge at the minimum landing size. Estimated numbers at length for both landed and discarded witch

flounder in the large mesh otter trawl fishery are presented by season in Table 10 and as annual estimates in Table 11. Although the r-squared values associated with the estimation procedure are low (Table 11), the general pattern of discarding appears to be consistent with that expected from the strong year classes of 1979-1981, 1985 and 1989.

Sampling Intensity

Length frequency and age sampling data for witch flounder landings from the Gulf of Maine-Georges Bank region are summarized by market category in Table 12 (because some ports do not cull into 'peewee' or 'jumbo' categories, NEFSC sampling protocols incorporate these categories into the 'small' and 'large' categories, respectively). Until 1982, sampling was minimal and sporadic. During 1982-1988, an average of 48 length frequency samples was obtained annually over all market categories, representing 1 sample per 102 mt landed. In 1990, sampling requirements were adjusted to 1 sample per 50 mt to obtain more samples from the 'large' market category. However, samples for the 'large' market category have been difficult to obtain due to the sharp decrease in the landings of larger fish in recent years (Table 12). Sampling intensity during 1990-1993 averaged 35 samples annually, representing 1 sample per 56 mt landed; nonetheless, even with this increased sampling intensity, inadequate numbers of samples were obtained for some market categories and quarter combinations. Pooling of length frequency samples across quarters was thus required when only one or no samples existed.

Commercial Catch at Age

Commercial age data for the years 1982 to 1993 were available for this assessment. Quarterly age-length keys (ALKs) were applied to corresponding commercial landings length frequency data. Resulting estimates of annual age compositions are presented in Table 13 and estimates of age compositions of discarded witch flounder in the shrimp fishery and the large-mesh otter trawl fishery are presented in Tables 14 and 15, respectively. Total catch at age compositions (including commercial landings, discards from the northern shrimp fishery and the large-mesh otter trawl fishery) are presented in Table 16.

The age composition data reveal strong 1979-1981 year classes (Table 13). The 1985 year class also appears to have been strong; however, this cohort was heavily discarded in both the shrimp and large-mesh otter trawl fisheries (Tables 14 and 15). High levels of discarding were also evident for the 1988 and 1989 year classes (Table 16).

Mean Weights at Age

Mean weights and lengths at age (ages 1 to 11+) of witch flounder are presented in Tables 13-16. No discernible changes in growth are evident during the 1982-1993 period. Mean weights at age of fish discarded in the shrimp fishery were lower than those discarded

or landed in the large-mesh otter trawl fishery, reflecting seasonal differences between these fisheries. Mean weights and lengths at age of discarded fish in the large-mesh fishery were lower than those of landed fish.

Since witch flounder landings are highest during March-July, the average weights-at-age approximate mid-year weights. Mean weights at age for January 1 (necessary for computing stock biomass in the VPA) were calculated using procedures developed by Rivard (1980) and are given in Table 17.

STOCK ABUNDANCE AND BIOMASS INDICES

Commercial LPUE

Commercial catch rates (landings per unit effort, LPUE, expressed as landings in mt per day fished) were derived for vessel tonnage classes 2-4 [Class 2 consists of vessels 5 to 50 gross registered tons (GRT); Class 3, 51 to 150 GRT; and Class 4, 151 to 500 GRT]. These vessel classes account for greater than 95% of annual witch flounder otter trawl landings. LPUE indices were computed for: 1) all trips landing witch flounder, and 2) trips in which 40% or more of the total landings comprised witch flounder (Table 18). These '40% trips' may represent effort that is 'directed' towards witch flounder, a species normally taken as by-catch.

For all trips landing witch flounder, increases in LPUE occurred in 1977-1978 for tonnage classes 2 and 3 and in 1982 for tonnage class 4, and remained high during the early 1980s; however, LPUE indices declined steadily for all tonnage classes beginning in 1986. Although 1993 values increased over 1992 values, they were still among the lowest values observed in the time series (Table 18, Figure 4a). Indices for 40% trips exhibited similar trends (although too few data exist for tonnage class 4 to be meaningful), with sharp declines in LPUE apparent since the mid-1980s (Table 18, Figure 4a). Effort (days fished) associated with all trips and 40% trips increased during the late 1970s and early 1980s, peaked during 1985-1988, decreased to 1990, and have since slightly increased (Figure 4b). While there is some evidence of increased directed effort in the early and mid 1980s [a period in which both witch flounder and American plaice were abundant and a small directed fishery emerged (Burnett and Clark 1983)], it is likely that, LPUE indices derived for all trips landing witch flounder provide the best measure of relative abundance.

Research Vessel Survey Indices

The NEFSC has conducted annual research vessel stratified random bottom trawl surveys during autumn since 1963 and during spring since 1968. Details on survey sampling design and the use of survey data in stock assessments are given in Azarovitz (1981) and Clark (1981), respectively. The Commonwealth of Massachusetts Division of Marine Fisheries (DMF) began an inshore trawl survey in 1978 which complements the NEFSC survey in coastal Massachusetts waters in that depths less than 27 meters (the lower depth

limit sampled by the NEFSC offshore survey) are sampled (for details of this survey, see Howe et al. 1981). Additionally, the Northern Shrimp Technical Committee of the Atlantic States Marine Fisheries Commission (ASMFC) has conducted an annual northern shrimp survey during August in the Gulf of Maine since 1983, with catch data for witch flounder available from 1987 on (for details of the shrimp survey, see Northern Shrimp Technical Committee MS 1984). All three surveys provide useful information relative to trends in abundance, distribution, and recruitment of witch flounder in the Gulf of Maine-Georges Bank region. Strata utilized in the derivation of indices of relative abundance and biomass for witch flounder are as follows: NEFSC, offshore strata 22-30, 36-40 (Figure 5); Massachusetts DMF, regions 4 and 5 (Figure 6); and northern shrimp, strata 1-4, 6, and 8 (Figure 7).

Research vessel survey indices of abundance and biomass for NEFSC surveys, Mass. DMF surveys, and ASMFC shrimp surveys are presented in Tables 19-21 and Figures 8-10, respectively. Length frequency data from these surveys are presented in Figures 11-14, respectively.

While NEFSC spring survey indices tend to be more variable due to the prespawning aggregations of witch flounder, spring and autumn indices generally display similar trends (Figures 8a and 8b). Abundance and biomass remained fairly stable from 1963 until the late 1970s (Table 19); autumn indices declined steadily during the early and mid 1980s, reaching record low levels in 1987. Abundance sharply increased in 1993, due to a strong 1993 year class (Table 19, Figure 8b).

Length frequency data from the ASMFC shrimp survey suggest that incoming year classes can be identified prior to their appearance in the NEFSC surveys. Thus, the ASMFC survey appears to be more useful in providing a pre-recruit index than in characterizing the population as a whole (Table 21, Figure 10). The ASMFC survey data indicate improved recruitment in recent years (see length frequency modes at 12 cm, corresponding to age 1 fish, during 1990-1993, Figure 14). Significant numbers of small fish were also observed in the NEFSC autumn survey during the same year (Figure 12). The Massachusetts DMF survey indices do not reflect this recent improved recruitment (Table 20, Figures 9a and 9b). However, the DMF surveys do not consistently catch significant numbers of witch flounder less than 20 cm (Figure 13).

Age-specific relative abundance indices from NEFSC spring and autumn surveys 1980-1993 are presented in Table 22. Mean lengths at age from these surveys are presented in Table 23 and for ages 4 to 8 in Figures 15a and 15b. Too few age samples are collected during DMF surveys to reliably characterize the age composition of witch flounder in the inshore areas.

Reduced abundance levels in recent years have resulted in fewer age samples and highly variable estimates of numbers at age. Additionally, age compositions have become more truncated resulting in a diminished ability to track of individual cohorts.

MORTALITY

Natural Mortality

Burnett (MS 1987) estimated instantaneous natural mortality (M) to be 0.16 from a regression of survey-derived instantaneous total mortality estimates on commercial fishing effort. Halliday (1973) used a value of $M = 0.15$ for females and $M = 0.2$ for males in an assessment of Scotian Shelf witch flounder. In the present study, virtual population analyses, yield per recruit and spawning stock biomass per recruit analyses were performed assuming $M = 0.15$.

Total Mortality

Estimates of instantaneous total mortality (Z) were computed from NEFSC spring and autumn research vessel bottom trawl survey catch per tow at age data by combining cohorts over the following time periods: 1981-1984, 1985-1988, and 1989-1992. Given the variability in age at full recruitment to the sampling gear observed during the survey time series (Table 24), estimates were derived for each time period and each season by taking the natural logarithm of the ratio of pooled age 7+ to pooled 8+. For example, the estimate of Z for 1981-1984 was computed as:

Spring: $\ln(\text{sum age } 7+ \text{ for } 1981-1984 / \text{sum age } 8+ \text{ } 1982-1985)$

Autumn: $\ln(\text{sum age } 6+ \text{ for } 1980-1983 / \text{sum age } 7+ \text{ } 1981-1984)$.

To evaluate Z over identical year classes within each the survey series, different age groups were used in the spring and autumn.

Total mortality estimates from the two survey series exhibited similar trends, although autumn estimates were generally lower than those in the spring (Table 24). With no objective basis to select one survey series over another, total mortality was calculated by taking the geometric mean of the spring and autumn estimates during each time period. Total mortality increased from 0.34 during 1981-1984 to 0.71 during 1985-1988, and subsequently declined to 0.53 during 1989-1993 (Table 24).

ESTIMATION OF FISHING MORTALITY RATES AND STOCK SIZE

Virtual Population Analysis and Tuning

The ADAPT calibration method (Parrack 1986, Gavaris 1988, Conser and Powers 1990) was applied to derive age-specific estimates of fishing mortality in 1993. Calibration formulations included both age-aggregated and age-disaggregated indices. Several exploratory formulations were conducted using the catch-at-age estimates (landings plus discards from the shrimp and large-mesh otter trawl fishery; Table 16). Estimates of stock sizes, their associated statistics, and F in the terminal year are summarized in Table 25.

The baseline formulation was performed to estimate stock sizes for ages 3 to 9 (Table 25; RUN A) using NEFSC spring and autumn abundance indices for ages 3 to 10 and an aggregate index of age 7+, DMF inshore spring and autumn abundance indices (age-aggregated), and an age-aggregated commercial LPUE index as tuning indices. All indices were given equal weighting. Autumn survey indices were lagged forward one year and age to equate autumn indices with beginning year population sizes of the subsequent year. A flat-top partial recruitment pattern was used, with full fishing mortality on ages 8 and older as indicated by a separable VPA (Pope and Shepherd 1982). Spawning stock biomass (SSB) was calculated at spawning time by applying the witch flounder maturity ogive from O'Brien et al. (1993).

The baseline results indicated the coefficient of variation (CV) for age 3 was 96%; consequently this age was excluded from subsequent formulations. CV's for survey catchability coefficients (q) were consistent, ranging from 25% to 32%, with higher CV's associated with younger ages in the survey.

Exploratory formulations (Table 25) included varying the ages to be estimated, including LPUE age-specific indices, excluding age-aggregated indices, excluding survey indices on older ages, and lowering the age of full recruitment to age 7. Results from the exploratory formulations showed a consistent increase in F in the terminal year, an unrealistic increase in F between the fully-recruited age (7 or 8) and the previous age in the terminal year, and extremely low values of F on ages 4 and 5 (due to high estimates of age 5 and 6 stock sizes in 1994). These stock size estimates eventually translated into record-high age 2 recruitment estimates for the 1988 and 1989 year classes in 1990 and 1991. Residuals showed a pattern of high positive values (forming a ridge) apparently to be caused by the strong 1985 year class (only weakly detected in the NEFSC surveys) and improved recruitment since 1990.

Because of these problems, a final formulation was developed whereby: (a) the F on ages 4 and 5 in 1993 was estimated directly from the input partial recruitment pattern; (b) the plus group was extended from 11+ to 10+; and (c) the age at full recruitment was shortened from 8 to 7 (approximately 85-90% fully recruited). Results from this formulation yielded a relatively smooth F pattern in the terminal year and a smoother annual trend in fully recruited F s. Although the input PR for this calibration was obtained from a separable analysis (Table 26), the final calibration employed a PR derived from the 1988-1992 F pattern taken from the penultimate calibration run.

Results from the final VPA calibration including estimates of F , stock size and spawning stock biomass at age, are given in Table 27. The final calibration exhibited very low correlations (< 0.10) among estimates of slopes (q), but moderate correlations (0.20-0.30) were evident between stock sizes and q 's. The CVs on age 4 and 7-9 abundance estimates ranged from 0.4 to 0.6. A full listing of the ADAPT VPA calibration output and diagnostics is presented in Appendix 1.

Estimates of Fishing Mortality, Spawning Stock Biomass and Recruitment

Average fishing mortality (ages 7-9, unweighted) increased from 0.19 in 1982 to 0.55 in 1985, declined to 0.24 during 1990 and 1991, and then increased to 0.45 in 1993 (Table 27, Figure 16). Spawning stock biomass declined from 26,000 tons in 1982 to about 7,000 tons in 1989 and has remained at this low level through 1993 (Table 27, Figure 17).

Since 1982 recruitment at age 2 has ranged from approximately 4 million (1983 and 1984 year classes) to 26 million (1990 year class) with most estimates between 7 and 15 million fish (Table 27, Figure 17). Over the 1982-1993 period, geometric mean recruitment equalled 9.8 million fish at age 2. Over the same period, geometric mean recruitment of age 3 fish (the 1979-1991 year classes) equalled 9.05 million fish. Both series indicate the 1988 and 1989 year classes were slightly above average, the 1990 year class was the highest in the VPA time series and the 1991 year class was below average (Table 27). Presently, the 1992 year class has been assumed to be average.

Precision of F and SSB

The uncertainty associated with the estimates of stock size and fishing mortality from the final VPA was evaluated using a bootstrap procedure (Efron 1982). Two hundred bootstrap iterations were performed to derive standard errors, coefficients of variation (CVs) and bias estimates for the stock size estimates at the start of 1994, the catchability estimates (q) of the abundance indices used in calibrating the VPA, and the 1993 fully recruited fishing mortality rate (age 7+). Frequency distributions of the 1993 mean fishing mortality and spawning stock biomass bootstrap estimates were generated, and cumulative probability curves produced (Figures 18 and 19).

The bootstrap results (Appendix 2) indicate that age-specific stock sizes in 1994 were moderately well estimated with CVs ranging from 0.43 to 0.73 (Appendix 2: Table 1). CVs on the catchability estimates associated with the tuning indices of abundance generally ranged from 0.25 to 0.30 (Appendix 2: Table 2).

Except for ages 3 and 6, age-specific Fs in 1993 were reasonably well estimated with CVs ranging from 0.22 to 0.34, as was the mean fully recruited F (CV = 0.22). The age 3 and 6 Fs derived from the VPA were 15-16% higher than the bootstrap estimate. The corrected values are 0.0088 (vs. 0.0104) for age 3 and 0.41 (vs. 0.48) for age 6. The corrected estimates produce a slightly smoother exploitation pattern in the terminal year (Appendix 2: Tables 3 and 4).

The mean bootstrap estimate of the fully recruited F in 1993 (0.46) was nearly identical to the VPA point estimate (0.45; Appendix 2: Table 4). Based on the cumulative probability curve (Figure 18), there is an 80% probability that the 1993 F lies between 0.33 and 0.59. These results also imply that there is a 77% probability that the 1993 F was greater than 0.39 (the overfishing definition of $F_{20\%}$).

The bootstrap mean of spawning stock biomass in 1993 (7,400 tons) was rather precise (CV = 0.21) and slightly higher than the VPA point estimate (7,100 tons). Based on the

cumulative probability curve (Figure 19), there is an 80% probability that the 1993 SSB was between 5,800 tons and 9,100 tons.

YIELD AND SPAWNING STOCK BIOMASS PER RECRUIT

Yield-per-recruit (Y/R), total stock biomass per recruit, and spawning stock biomass per recruit (SSB/R) analyses were performed using the Thompson and Bell (1934) method. The exploitation pattern used in the yield and SSB per recruit analyses and short-term projections was computed from the 1988-1992 VPA results (Table 27). Geometric mean F at age was computed for the 1988-1992 period and divided by the geometric mean of the fully recruited annual Fs to derive the partial recruitment vector. The final exploitation pattern was smoothed, applying full exploitation on ages 7 and older, viz.

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Ages 7+
0.0001	0.0390	0.1060	0.3030	0.5120	0.6730	1.0000.

Mean weights at age used in the Y/R analyses were computed as a 4-year arithmetic average of landings mean weights at age (Table 13) over the 1990-1993 period. Mean weights at age for use in the SSB/R analyses were computed as the 4-year arithmetic average of catch mean weights at age (Table 16) over the period 1990-1993 corresponding to a March 1 mean spawning time. The maturation ogive was taken from O'Brien et al. (1993). The input data for the Y/R and SSB/R analyses are given in Table 28, and the results presented in Table 28 and in Figure 20. The results indicate that $F_{0.1} = 0.15$, $F_{\max} = 0.27$, and $F_{20\%} = 0.39$.

PROJECTIONS FOR 1994 AND 1995

Input data for the projections, including the partial recruitment vector, maturity ogive, and mean weights at age are listed in Table 29. In the projections, mean catch weights were used for mean stock weights. Because of the uncertainty regarding quantitative predictions of recruitment from trawl survey indices, a long-term geometric mean recruitment was assumed in 1994 and 1995. Due to the regulatory changes in the Gulf of Maine northern shrimp fishery, it was expected that the catch of age 1 and 2 fish would be substantially reduced, therefore, projections were performed with recruitment at age 3. The geometric mean recruitment of age 3 fish (the 1979-1991 year classes) equalled 9.05 million fish. The 1994 F scenarios used in the forecasts included: $F_{0.1}$, F_{\max} , $F_{20\%}$, $0.9F_{93}$, and F_{93} given F in 1993 equalled 0.45. The smoothed partial recruitment pattern obtained from the final VPA was applied to the fully recruited 1993 F (0.45).

Catch and Stock Size Projections

Continued fishing at the 1993 level ($F = 0.45$) will lead to catches in 1994 remaining near the 1993 level (Table 29). Due to continued growth and maturation of the strong 1990 year class, SSB is expected to increase to above 10,000 t in 1995, but will begin to decline in 1996 unless F is reduced in 1995 to $F_{20\%}$ (0.39) or lower (Figure 21).

CONCLUSIONS

The Gulf of Maine-Georges Bank witch flounder stock is at a low biomass level and is over exploited. There is a high probability that fishing mortality in 1993 was at or above the $F_{20\%}$ level. Except for the very strong 1990 year class, recent year classes have been about average. SSB may be expected to increase in the short term as the 1990 year class matures and recruits to the fishery, but will begin to decline in 1996 unless fishing mortality is reduced from the present level. It is also clear that, despite the variability in the survey indices, the age range of the stock has been greatly reduced ($< \text{age } 7$) since 1985-1986 and that ages 2-4 in the catch are comprised almost entirely of fish discarded in the shrimp and large-mesh otter trawl fisheries.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Mike Sisson, Marjorie Lambert, Brenda Figuerido, Loretta O'Brien, Lisa Henderickson, Betty Holmes, and Jay Burnett for their assistance in this assessment. We thank the members of the Stock Assessment Workshop's Northern Demersal Subcommittee for their review and helpful comments.

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Table 1. Summary of USA commercial witch flounder landings (mt) by Statistical Area, 1973 - 1993.

Year	Statistical Areas																			Total	
	300	400	465	466	511	512	513	514	515	521	522	523*	524*	525	526	537	538	539	600		5Y & 5Ze
1973		27	21	.	102	236	470	349	39	266	412	20	74	192	271	26	0	4	14	2431	2523
1974		49	2	4	19	76	319	213	23	334	294	17	104	145	192	41	2	2	3	1736	1839
1975		15	18	1	18	150	360	289	92	371	238	10	159	281	105	13	0	3	4	2073	2127
1976		22	6	2	25	140	470	365	37	278	209	24	81	144	50	12	2	1	3	1823	1871
1977		5	5	2	15	192	756	682	101	257	250	19	62	71	30	13	2	5	2	2435	2469
1978		11	5	.	8	330	1370	642	164	366	306	85	86	38	45	20	8	4	10	3440	3498
1979		5	1	.	67	270	1025	416	120	367	393	97	35	15	28	21	1	3	14	2833	2878
1980		4	7	.	44	278	1320	386	258	317	231	67	26	38	111	19	1	6	15	3076	3128
1981		7	34	.	66	317	1410	419	322	390	183	68	62	48	40	39	0	9	28	3325	3442
1982		22	34	.	155	759	1432	427	760	558	289	120	52	69	96	51	6	12	64	4717	4906
1983		31	145	.	252	1233	1460	479	1045	555	322	121	46	63	104	88	2	14	40	5680	6000
1984		15	147	.	158	750	1564	788	1322	800	430	155	67	118	181	99	1	8	57	6333	6660
1985	255	5	68	.	234	752	1474	658	1263	735	468	128	62	99	106	34	1	2	41	5979	6385
1986	539	12	66	.	204	765	1213	468	787	481	298	100	20	33	77	31	2	2	50	4446	5148
1987	346	5	15	.	103	441	1039	364	720	344	214	55	20	25	47	16	0	1	43	3372	3798
1988	359	.	11	.	94	288	958	352	617	450	207	53	35	96	47	13	1	1	39	3197	3621
1989	297	.	2	.	32	175	517	223	381	304	135	39	28	52	129	17	2	1	31	2015	2365
1990	2	5	2	.	24	135	429	182	188	164	82	35	36	55	77	28	0	2	23	1407	1469
1991	.	2	1	.	19	168	470	197	281	146	138	43	54	36	87	65	1	2	67	1639	1777
1992	.	1	.	.	13	235	520	226	332	152	188	46	39	63	219	124	0	4	62	2033	2224
1993	.	12	.	.	14	175	580	419	422	180	270	82	65	94	134	94	0	2	56	2435	2599

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Gulf of Maine-Georges Bank region (5Y&5Ze) comprises SA 511-515 (5Y) and, 521-526 (5Ze). Landings data from UKN, state and canvass not included.

Table 2. Nominal landings¹ of witch flounder (metric tons, live) from all areas and landings from the Gulf of Maine-Georges Bank region (NAFO Subareas 5Y and 5Ze), and Subarea 6, by country, 1960-1993.

Year	Subarea/Division													TOTAL	
	5Y ²			5Z				6 ³			Totals				
	Canada	USA	Other ⁴	Canada	Ze ⁵	Zw	Other ⁴	Canada	USA	Other ⁴	Canada	USA	Other		
1960	-	601	-	-	654	-	-	-	-	-	-	-	1255	-	1255
1961	-	524	-	2	498	-	-	-	-	-	-	2	1022	-	1024
1962	-	463	-	1	513	-	-	-	-	-	-	1	976	-	977
1963	-	641	-	27	585	-	121	-	-	-	-	27	1226	121	1374
1964	6	703	-	31	678	-	-	-	-	-	-	37	1381	-	1418
1965	-	730	-	22	1410	-	502	-	-	-	-	22	2140	502	2664
1966	31	744	-	37	2149	-	311	-	42	-	-	68	2935	311	3314
1967	16	895	-	47	2433	-	249	-	42	-	-	63	3370	249	3682
1968	4	1040	-	52	1541	208	191	-	18	-	-	56	2807	191	3054
1969	0	1138	-	0	1263	112	1291	-	29	19	-	-	2542	1310	3852
1970	10	978	14	9	1598	383	114	-	153	2	-	19	3112	130	3261
1971	19	1072	-	16	1955	131	2736	-	62	124	-	35	3220	2860	6115
1972	1	1121	3	12	1758	29	2530	-	26	35	-	13	2934	2568	5515
1973	1	1176	-	9	1223	24	621	-	11	8	-	10	2434	629	3073
1974	3	640	-	6	1079	37	264	-	11	28	-	9	1767	292	2068
1975	5	909	-	8	1167	17	125	-	13	92	-	13	2106	217	2336
1976	1	1041	-	4	787	14	6	-	11	-	-	5	1853	6	1864
1977	-	1756	-	11	688	20	-	-	14	13	-	11	2478	13	2502
1978	3	2552	-	15	926	30	4	-	12	2	-	18	3520	6	3544
1979	2	2031	-	15	936	24	-	-	23	-	-	17	3014	-	3031
1980	-	2532	-	18	796	28	-	-	18	1	-	18	3374	1	3393
1981	-	2534	-	7	806	48	-	-	34	-	-	7	3422	-	3429
1982	4	3826	-	5	1196	70	-	-	71	-	-	9	5163	-	5172
1983	11	4470	-	34	1214	110	-	-	43	-	-	45	5837	-	5882
1984	10	4584	-	5	1755	108	-	-	85	-	-	15	6532	-	6547
1985	4	4380	-	42	1598	37	-	-	50	-	-	46	6065	-	6111
1986	12	3036	-	55	972	44	-	-	62	-	-	67	4114	-	4181
1987	-	2668	-	23	705	18	-	-	44	-	-	23	3435	-	3458
1988	-	2349	-	45	903	22	-	-	61	-	-	45	3335	-	3380
1989	-	1329	-	13	686	24	-	-	31	-	-	13	2070	-	2083
1990	-	958	-	12	448	30	-	-	31	-	-	12	1467	-	1479
1991	-	1134	-	7	505	68	-	-	86	-	-	7	1793	-	1800
1992	1	1326	-	6	707	128	-	-	62	-	-	7	2223	-	2230
1993	2	1610	-	8	825	96	-	-	56	-	-	10	2587	-	2597

¹As reported to ICNAF/NAFO for 1960-1982 (Burnett and Clark, 1983).

²NK landings for SA5 assigned to Div. 5Y.

³Statistics not available prior to 1963.

⁴Includes West Germany, East Germany, Poland, Spain, Japan, and the USSR.

⁵Div 5Z was divided into 5Ze and 5Zw in 1968.

Note: This table includes landings from UNK, state and canvass which are not included in Table 1.

Table 3. Percentage of USA commercial witch flounder landings from the Gulf of Maine-Georges Bank region (SA 511-515,521-526*) by gear type, 1973-1993.

Year	Otter Trawl	Shrimp Trawl	Other	Total
1973	98.7		1.3	100.0
1974	99.7		0.3	100.0
1975	97.3	2.5	0.2	100.0
1976	98.8	0.9	0.3	100.0
1977	97.4	1.5	1.1	100.0
1978	98.1		1.9	100.0
1979	97.9	0.2	1.9	100.0
1980	96.6	0.6	2.8	100.0
1981	97.3	0.8	1.9	100.0
1982	96.8	0.9	2.3	100.0
1984	96.4	0.4	3.2	100.0
1985	95.1	1.0	3.9	100.0
1986	95.9	1.1	3.0	100.0
1987	95.5	1.1	3.4	100.0
1988	96.0	0.8	3.2	100.0
1989	95.3	0.4	4.3	100.0
1990	92.8	0.6	6.6	100.0
1991	95.1	0.5	4.4	100.0
1992	96.2	0.1	3.7	100.0
1993	94.2		5.8	100.0

Note: Other gear type include sink gillnet, seines, and scallop dredges.

	OTHER			TOTAL
	Gillnet	Dredge	Seine	
1988	0.6	0.5	2.1	3.2
1989	1.4	0.7	2.2	4.3
1990	2.6	2.0	2.0	6.6
1991	1.0	1.8	1.6	4.4
1992	0.9	1.7	1.1	3.7
1993	2.9	2.5	0.4	5.8

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Table 4. Percentage of USA commercial witch flounder landings from the Gulf of Maine-Georges Bank region (SA 511-515,521-526*) by month for all gear types, 1973-1993.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1973	5.0	3.2	8.8	10.9	14.2	14.4	10.8	10.7	5.3	7.6	5.6	3.6	100.0
1974	4.6	3.6	5.6	11.3	16.8	12.1	14.0	10.3	7.3	6.1	4.8	3.4	100.0
1975	3.7	4.3	6.1	10.7	14.3	13.2	13.8	9.1	7.8	6.2	6.9	3.9	100.0
1976	3.2	4.8	7.5	12.2	12.4	16.1	14.0	8.7	7.9	5.2	4.2	3.7	100.0
1977	4.3	6.1	10.2	9.2	9.2	10.9	12.0	10.9	7.8	6.7	7.1	5.4	100.0
1978	5.9	10.6	5.9	10.4	12.9	12.9	10.1	7.8	6.3	7.7	5.0	4.4	100.0
1979	7.2	5.2	8.1	7.2	9.0	15.5	12.1	9.3	7.6	6.9	6.7	5.2	100.0
1980	5.1	8.9	7.2	9.9	10.5	13.6	11.2	9.8	7.9	6.5	4.6	4.9	100.0
1981	7.5	5.8	10.5	8.0	9.0	13.0	9.2	7.8	8.5	6.9	6.6	7.2	100.0
1982	5.9	6.4	10.7	8.8	9.7	9.3	9.2	8.4	7.4	8.2	7.8	8.0	100.0
1983	9.2	8.6	11.4	12.4	10.0	9.6	7.2	7.6	6.3	5.7	5.3	6.8	100.0
1984	9.7	9.1	10.6	11.0	10.8	8.8	6.8	6.9	6.3	7.9	6.2	6.1	100.0
1985	8.0	7.3	8.8	12.6	12.5	8.1	8.3	7.7	7.9	7.4	5.3	6.1	100.0
1986	7.1	7.2	8.1	12.4	13.9	11.9	11.5	6.7	6.2	5.3	4.1	5.7	100.0
1987	6.4	6.8	8.8	9.7	15.1	11.4	8.7	7.7	6.5	5.9	5.7	7.3	100.0
1988	9.4	7.8	11.5	11.4	15.6	12.3	7.7	6.1	6.3	4.3	4.0	3.6	100.0
1989	6.9	7.6	10.4	13.9	17.0	12.7	7.1	6.8	4.7	4.8	4.1	4.0	100.0
1990	9.3	7.5	8.4	8.6	13.5	11.5	8.8	8.7	6.5	5.7	5.9	5.7	100.0
1991	4.8	4.3	3.3	8.4	13.2	10.7	10.4	9.5	10.0	10.2	7.0	8.2	100.0
1992	6.1	6.8	6.7	14.5	14.0	10.6	7.3	7.3	6.4	6.7	8.2	5.3	100.0
1993	7.8	5.9	10.5	8.1	14.7	10.6	7.1	7.7	6.4	7.7	7.1	6.4	100.0

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Table 5. Percentage of USA commercial witch flounder landings from the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*) by port, 1982-1993.

Port	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Rockland	22.9	24.4	19.8	18.4	19.6	36.2	35.7	34.8	31.3	32.1	29.3	1.0
Portland	16.3	21.5	12.6	13.6	10.1	11.2	10.5	11.1	1.6	2.4	2.6	35.7
Other Maine	14.1	13.0	11.3	8.8	10.1	11.9	10.6	6.1	8.2	9.0	10.7	10.9
New Hampshire	5.2	2.7	4.4	2.3	2.0	3.2	4.2	3.5	2.2	1.6	1.2	1.0
Boston	1.8	2.2	3.0	6.8	10.5	8.3	11.1	10.8	9.3	8.7	8.5	7.1
Gloucester	20.0	17.5	25.0	26.2	26.3	13.7	12.0	13.1	23.5	17.9	14.5	16.5
Chatham	1.3	1.0	1.5	1.4	0.8	1.9	2.1	2.0	1.0	0.8	0.7	1.0
New Bedford	3.3	4.8	8.5	10.4	11.5	6.4	5.5	7.7	8.0	9.1	15.1	13.0
Plymouth	0.7	1.3	1.1	1.1	0.8	0.9	0.8	0.7	0.4	0.8	0.8	0.7
Provincetown	5.8	5.0	4.4	3.3	2.9	1.7	1.4	3.1	4.2	6.0	3.2	4.4
Other Mass.	2.3	2.2	2.6	1.3	1.0	1.2	1.0	0.9	1.4	0.7	0.4	0.7
Newport	3.0	2.2	2.8	3.5	2.0	1.5	2.7	3.5	4.1	4.5	4.7	3.6
Point Judith	1.7	1.4	2.6	2.6	1.6	1.0	1.4	1.7	3.7	4.0	5.8	2.5
Other RI	0.5	0.2	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
New York	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.2	0.8	1.1	0.7
New Jersey	0.8	0.4	0.4	0.4	0.5	0.4	0.5	0.6	0.8	1.3	1.3	1.0
Maryland	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Virginia	0.3	0.1	0.1	0.0	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Table 6. USA commercial witch flounder landings (mt) from the Gulf of Maine-Georges Bank region (SA 511-515,521-526*) by market category, 1973 - 1993.

Year	Peewee	Small	Medium	Large	Jumbo	Uncl.	Total
1973	0	327	0	1115	0	989	2431
1974	0	456	0	1282	0	0	1738
1975	0	545	0	1530	0	0	2075
1976	0	391	0	1429	0	2	1822
1977	0	558	0	1878	0	0	2436
1978	0	1041	0	2401	0	0	3442
1979	0	871	0	1961	0	0	2832
1980	0	720	0	2338	0	17	3075
1981	0	1001	0	2271	0	52	3324
1982	12	1243	255	3020	0	190	4720
1983	82	1419	835	3318	0	24	5678
1984	213	1594	1212	3275	0	37	6331
1985	460	1661	1389	2418	6	42	5976
1986	226	1499	1127	1541	2	53	4448
1987	121	1254	876	1046	18	58	3373
1988	89	1095	927	981	18	86	3196
1989	67	601	629	635	23	61	2016
1990	77	367	429	458	10	62	1403
1991	108	542	418	508	22	39	1637
1992	269	794	412	508	2	49	2034
1993	431	957	450	526	0	71	2435

Table 7. Percentage of USA commercial witch flounder landings from the Gulf of Maine-Georges Bank region (SA 511-515,521-526) by market category, 1973 - 1993.

Year	Peewee	Small	Medium	Large	Jumbo	Uncl.	Total
1973	0.0	13.5	0.0	45.9	0.0	40.7	100.0
1974	0.0	26.2	0.0	73.8	0.0	0.0	100.0
1975	0.0	26.3	0.0	73.7	0.0	0.0	100.0
1976	0.0	21.5	0.0	78.4	0.0	0.1	100.0
1977	0.0	22.9	0.0	77.1	0.0	0.0	100.0
1978	0.0	30.2	0.0	69.8	0.0	0.0	100.0
1979	0.0	30.8	0.0	69.2	0.0	0.0	100.0
1980	0.0	23.4	0.0	76.0	0.0	0.6	100.0
1981	0.0	30.1	0.0	68.3	0.0	1.6	100.0
1982	0.3	26.3	5.4	64.0	0.0	4.0	100.0
1983	1.4	25.0	14.7	58.4	0.0	0.4	100.0
1984	3.4	25.2	19.1	51.7	0.0	0.6	100.0
1985	7.7	27.8	23.2	40.5	0.1	0.7	100.0
1986	5.1	33.7	25.3	34.6	0.0	1.2	100.0
1987	3.6	37.2	26.0	31.0	0.5	1.7	100.0
1988	2.8	34.3	29.0	30.7	0.6	2.7	100.0
1989	3.3	29.8	31.2	31.5	1.1	3.0	100.0
1990	5.5	26.2	30.6	32.6	0.7	4.4	100.0
1991	6.6	33.1	25.5	31.0	1.3	2.4	100.0
1992	13.2	39.0	20.3	25.0	0.1	2.4	100.0
1993	17.7	39.3	18.5	21.6	0.0	2.9	100.0

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Table 8. Estimated discard rate (kg per day fished), days fished, weight discarded (mt), and numbers of witch flounder discarded (thousands of fish) in the Gulf of Maine northern shrimp fishery, 1982-1993.

Year	Estimated discard rate (kg/df)	Commercial days fished	Estimated discard weight (mt)	Estimated Numbers discarded (1000's fish)
1982	5.805	999.7	5.8	60.83
1983	10.561	1159.9	12.2	128.39
1984	6.027	1757.5	10.6	111.02
1985	5.916	2094.3	12.4	93.36
1986	5.252	2400.7	12.6	95.01
1987	5.252	3718.4	19.5	147.16
1988	12.994	2826.4	36.7	817.07
1989	6.208	2845.8	17.7	178.44
1990	8.799	3239.1	28.5	477.46
1991	12.835	2607.6	33.5	494.07
1992	8.320	2320.7	19.3	406.69
1993	4.466	1905.5	8.5	221.16

Note: 1982-1988 discards rates derived via linear regression (see text),
1989-1993 discard rates derived directly from DSSP data.

Table 9. Summary of sea sampled witch flounder length frequency samples (number of samples and number of fish measured) from the large-mesh otter trawl fishery in the Gulf of Maine-Georges Bank region, by quarter and kept (K) and discarded (D) fish, 1989-1993.

Year		Quarter 1		Quarter 2		Quarter 3		Quarter 4		Total	
		K	D	K	D	K	D	K	D	K	D
1989	samples	9	1	9	6	8	18	4	6	30	31
	fish	323	6	264	62	282	494	139	92	1008	654
1990	samples	5	3	1	0	2	2	0	0	8	5
	fish	184	20	12	0	39	39	0	0	235	59
1991	samples	1	1	0	0	3	4	8	3	12	8
	fish	21	15	0	0	56	147	116	51	193	213
1992	samples	6	4	1	0	0	0	0	0	7	4
	fish	62	64	42	0	0	0	0	0	104	64
1993	samples	6	4	10	29	3	8	13	2	32	43
	fish	96	167	220	262	104	161	450	68	870	658

Table 10. Semi-annual estimates of witch flounder landings and discards (in hundreds of fish by 2-cm length group) in the Gulf of Maine - Georges Bank large-mesh otter trawl fishery, 1982-1993.

Len	1982 WINTER/SPRING			1982 SUMMER/AUTUMN			1983 WINTER/SPRING			1983 SUMMER/AUTUMN			1984 WINTER/SPRING			1984 SUMMER/AUTUMN		
	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	3	3	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0
17	0	11	11	0	0	0	0	2	2	0	0	0	0	5	5	0	0	0
19	0	69	69	0	40	40	0	8	8	0	1	1	0	4	4	0	0	0
21	0	101	101	0	27	27	0	53	53	0	14	14	0	0	0	0	0	0
23	0	193	193	0	51	51	0	94	94	0	33	33	0	0	0	0	15	15
25	0	432	432	0	132	132	0	253	253	45	171	216	0	78	78	0	43	43
27	70	506	576	145	0	145	60	879	939	149	389	538	0	126	126	7	125	132
29	209	1152	1361	291	302	593	348	1237	1585	455	943	1398	40	1400	1440	66	815	881
31	574	697	1271	585	0	585	1071	2752	3823	938	1828	2766	342	1306	1648	594	1530	2124
33	1944	12	1956	989	0	989	1996	27	2023	1591	21	1612	1685	44	1729	2181	44	2225
35	3049	0	3049	2405	0	2405	3817	0	3817	2665	0	2665	3738	0	3738	5311	0	5311
37	5006	0	5006	4530	0	4530	6177	0	6177	3265	0	3265	6502	0	6502	6549	0	6549
39	5039	0	5039	4743	0	4743	8071	0	8071	4142	0	4142	8121	0	8121	5131	0	5131
41	3096	0	3096	2973	0	2973	5832	0	5832	4120	0	4120	7054	0	7054	4166	0	4166
43	1704	0	1704	2442	0	2442	4455	0	4455	3032	0	3032	6498	0	6498	2918	0	2918
45	1271	0	1271	2370	0	2370	3590	0	3590	1927	0	1927	5527	0	5527	2732	0	2732
47	1688	0	1688	1401	0	1401	3312	0	3312	1472	0	1472	3801	0	3801	2867	0	2867
49	2289	0	2289	1626	0	1626	2570	0	2570	1803	0	1803	3301	0	3301	2197	0	2197
51	1543	0	1543	1677	0	1677	2867	0	2867	2033	0	2033	2851	0	2851	1276	0	1276
53	2467	0	2467	1590	0	1590	2752	0	2752	1721	0	1721	2250	0	2250	1552	0	1552
55	1796	0	1796	1729	0	1729	2205	0	2205	1395	0	1395	2069	0	2069	1611	0	1611
57	1733	0	1733	1542	0	1542	1876	0	1876	1198	0	1198	1574	0	1574	1630	0	1630
59	697	0	697	1022	0	1022	848	0	848	805	0	805	1138	0	1138	746	0	746
61	468	0	468	491	0	491	386	0	386	427	0	427	414	0	414	468	0	468
63	112	0	112	345	0	345	139	0	139	220	0	220	107	0	107	64	0	64
65	31	0	31	93	0	93	76	0	76	80	0	80	16	0	16	0	0	0
67	20	0	20	28	0	28	0	0	0	20	0	20	0	0	0	0	0	0
69	0	0	0	33	0	33	11	0	11	4	0	4	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	34806	3178	37984	33050	552	33602	52459	5306	57765	33507	3400	36907	57028	2964	59992	42066	2572	44638

Table 10. (continued).

Len	1985 WINTER/SPRING			1985 SUMMER/AUTUMN			1986 WINTER/SPRING			1986 SUMMER/AUTUMN			1987 WINTER/SPRING			1987 SUMMER/AUTUMN		
	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
21	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	5	5	0	48	48	0	35	35	61	0	61	0	38	38	0	0	0
27	17	186	203	8	42	50	0	0	0	7	12	19	0	0	0	0	43	43
29	145	507	652	180	120	300	103	62	165	121	40	152	0	156	156	0	0	0
31	1694	1194	2888	947	554	1501	505	247	752	426	200	626	0	0	0	17	0	17
33	3131	40	3171	2376	17	2393	2015	8	2023	1484	8	1492	93	968	1061	334	0	334
35	4370	0	4370	6743	0	6743	6007	0	6007	1951	0	1951	249	10	259	1163	7	1170
37	4865	0	4865	6113	0	6113	10022	0	10022	2742	0	2742	1268	0	1268	1892	0	1892
39	5689	0	5689	5600	0	5600	10062	0	10062	3912	0	3912	3494	0	3494	4543	0	4543
41	5954	0	5954	4409	0	4409	7310	0	7310	4146	0	4146	5469	0	5469	3379	0	3379
43	5587	0	5587	4684	0	4684	4373	0	4373	2909	0	2909	5133	0	5133	2835	0	2835
45	4631	0	4631	3392	0	3392	3542	0	3542	2286	0	2286	4323	0	4323	2726	0	2726
47	3702	0	3702	2932	0	2932	2114	0	2114	1976	0	1976	3118	0	3118	2419	0	2419
49	3476	0	3476	2143	0	2143	1348	0	1348	1680	0	1680	1717	0	1717	1635	0	1635
51	2892	0	2892	1492	0	1492	1142	0	1142	1406	0	1406	1103	0	1103	907	0	907
53	2527	0	2527	1021	0	1021	1272	0	1272	1281	0	1281	1054	0	1054	642	0	642
55	1936	0	1936	1038	0	1038	996	0	996	805	0	805	707	0	707	470	0	470
57	1406	0	1406	975	0	975	725	0	725	629	0	629	522	0	522	392	0	392
59	884	0	884	554	0	554	370	0	370	227	0	227	328	0	328	119	0	119
61	551	0	551	211	0	211	183	0	183	55	0	55	147	0	147	52	0	52
63	25	0	25	36	0	36	48	0	48	52	0	52	14	0	14	8	0	8
65	12	0	12	5	0	5	11	0	11	7	0	7	0	0	0	0	0	0
67	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	53494	1936	55430	44859	782	45641	52158	352	52510	28054	360	28414	28739	1172	29911	23533	50	23583

Table 10. (continued).

Len	1988 WINTER/SPRING			1988 SUMMER/AUTUMN			1989 WINTER/SPRING			1989 SUMMER/AUTUMN			1990 WINTER/SPRING			1990 SUMMER/AUTUMN		
	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2
17	0	2	2	0	0	0	0	0	0	0	1	1	0	0	0	0	5	5
19	0	1	1	0	0	0	0	2	2	0	1	1	0	4	4	0	3	3
21	0	7	7	0	1	1	0	6	6	0	0	0	0	0	0	0	2	2
23	0	0	0	0	70	70	0	5	5	0	27	27	0	0	0	0	31	31
25	0	0	0	0	301	301	0	177	177	0	33	33	0	0	0	0	53	53
27	0	0	0	0	241	241	0	570	570	0	21	21	0	111	111	0	529	529
29	0	0	0	0	38	38	0	1424	1424	0	283	283	20	299	319	0	535	535
31	9	179	188	0	236	236	0	1360	1360	0	1268	1268	156	363	519	0	930	930
33	38	359	397	38	52	90	0	727	727	44	507	551	707	803	1510	58	374	432
35	362	9	371	173	3	176	111	1	112	52	2	54	1990	8	1998	694	11	705
37	1297	0	1297	657	0	657	1050	0	1050	129	0	129	1288	0	1288	1497	0	1497
39	4186	0	4186	1300	0	1300	1587	0	1587	419	0	419	1179	0	1179	1032	0	1032
41	5527	0	5527	1933	0	1933	2440	0	2440	1159	0	1159	1284	0	1284	564	0	564
43	6073	0	6073	2309	0	2309	3267	0	3267	1685	0	1685	1435	0	1435	776	0	776
45	4347	0	4347	2133	0	2133	3003	0	3003	1910	0	1910	1710	0	1710	1263	0	1263
47	3183	0	3183	1654	0	1654	2191	0	2191	1156	0	1156	1260	0	1260	958	0	958
49	2059	0	2059	1066	0	1066	1613	0	1613	916	0	916	1223	0	1223	666	0	666
51	1616	0	1616	666	0	666	799	0	799	674	0	674	459	0	459	295	0	295
53	1146	0	1146	546	0	546	820	0	820	452	0	452	304	0	304	248	0	248
55	1048	0	1048	493	0	493	622	0	622	244	0	244	230	0	230	298	0	298
57	644	0	644	350	0	350	443	0	443	214	0	214	239	0	239	189	0	189
59	501	0	501	226	0	226	198	0	198	122	0	122	108	0	108	137	0	137
61	166	0	166	61	0	61	221	0	221	47	0	47	39	0	39	120	0	120
63	41	0	41	11	0	11	0	0	0	17	0	17	3	0	3	88	0	88
65	8	0	8	26	0	26	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	9
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	32251	558	32809	13642	942	14584	18365	4272	22637	9240	2144	11384	13634	1588	15222	8892	2475	11367

Table 10. (continued).

Len	1991 WINTER/SPRING			1991 SUMMER/AUTUMN			1992 WINTER/SPRING			1992 SUMMER/AUTUMN			1993 WINTER/SPRING			1993 SUMMER/AUTUMN		
	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total	Land	Discard	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
15	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	5	5
17	0	4	4	0	2	2	0	0	0	1	1	0	9	9	0	0	5	5
19	0	24	24	0	5	5	0	7	7	0	0	0	11	11	0	0	1	1
21	0	37	37	0	10	10	0	38	38	0	17	17	0	15	15	0	7	7
23	0	47	47	0	109	109	0	38	38	0	76	76	0	47	47	0	42	42
25	0	20	20	0	140	140	0	92	92	0	113	113	0	136	136	0	83	83
27	0	0	0	0	520	520	0	268	268	0	471	471	0	722	722	0	225	225
29	41	0	41	0	674	674	0	1076	1076	0	504	504	0	645	645	0	1369	1369
31	47	190	237	0	622	622	19	635	654	0	1447	1447	0	2673	2673	0	1340	1340
33	82	380	462	114	617	731	149	206	355	89	718	807	231	1893	2124	213	1356	1569
35	271	3	274	671	14	685	1753	209	1962	886	112	998	2519	487	3006	1764	166	1930
37	970	0	970	2263	0	2263	3074	8	3082	2399	0	2399	4889	30	4919	2912	25	2937
39	1832	0	1832	2536	0	2536	4434	0	4434	2560	0	2560	3983	0	3983	2452	0	2452
41	2003	0	2003	1588	0	1588	3651	0	3651	1911	0	1911	3143	0	3143	2072	0	2072
43	901	0	901	1021	0	1021	1844	0	1844	1624	0	1624	1699	0	1699	2638	0	2638
45	741	0	741	1044	0	1044	1650	0	1650	1251	0	1251	1658	0	1658	910	0	910
47	968	0	968	1124	0	1124	1584	0	1584	961	0	961	1293	0	1293	936	0	936
49	1097	0	1097	1208	0	1208	1286	0	1286	846	0	846	1268	0	1268	997	0	997
51	790	0	790	606	0	606	740	0	740	634	0	634	1225	0	1225	999	0	999
53	763	0	763	475	0	475	339	0	339	325	0	325	812	0	812	716	0	716
55	364	0	364	536	0	536	263	0	263	219	0	219	486	0	486	458	0	458
57	323	0	323	361	0	361	124	0	124	268	0	268	354	0	354	328	0	328
59	299	0	299	251	0	251	60	0	60	218	0	218	198	0	198	182	0	182
61	93	0	93	117	0	117	13	0	13	104	0	104	72	0	72	76	0	76
63	62	0	62	38	0	38	14	0	14	51	0	51	27	0	27	24	0	24
65	13	0	13	0	0	0	0	0	0	44	0	44	4	0	4	4	0	4
67	1	0	1	3	0	3	0	0	0	17	0	17	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	11661	705	12366	13956	2713	16669	20997	2577	23574	14407	3460	17867	23861	6669	30530	17681	4630	22311

Table 11. Summarized estimates of witch flounder discards and landings (in thousands of fish) in the large-mesh otter trawl fishery in the Gulf of Maine-Georges Bank region, 1982-1993.

Year	Spring			Autumn			Total			Comments
	Landings	Discards	r ²	Landings	Discards	r ²	Landings	Discards	TOTAL	
1982	3480.6	317.8	0.55	3305.0	55.2	0.06	6785.6	373.0	7158.6	
1983	5245.9	530.6	0.53	3350.7	340.0	0.29	8596.6	870.6	9467.2	79-80 strong yc
1984	5702.8	296.4	0.58	4206.6	257.2	0.58	9909.4	553.6	10463.0	81 strong yc
1985	5349.4	193.6	0.44	4485.9	78.2	0.64	9835.3	271.8	10107.1	
1986	5215.8	35.2	0.30	2805.4	36.0	0.49	8021.2	71.2	8092.4	
1987	2873.9	117.2	0.44	2353.3	5.1	0.44	5227.2	122.3	5349.5	81 yc is legal, 85 too small for gear
1988	3225.1	55.8	0.85	1364.2	94.2	0.16	4589.3	150.0	4739.3	
1989	1836.5	427.2	0.61	924.0	214.4	0.19	2760.5	641.6	3402.1	85 yc sublegal size
1990	1363.4	158.8	0.92	889.2	247.5	0.36	2252.6	406.3	2658.9	
1991	1166.1	70.5	0.50	1395.6	271.3	0.33	2561.7	341.8	2903.5	
1992	2099.7	257.7	0.33	1440.7	346.0	0.35	3540.4	603.7	4144.1	
1993	2386.1	666.9	0.25	1768.1	463.0	0.76	4154.2	1129.9	5284.1	

Note: r² derived from the regression of survey number per tow at length to numbers landed at length.

Table 12. Summary of USA commercial witch flounder landings (mt), number of length samples (n), number of fish measured (len) and number of age samples (age) by market category and quarter from the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*) for all gear types, 1981 - 1993.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4			Total All
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	
1981	mt	260	7	517	269	32	694	242	13	607	230	0	453	3324
	n	.	.	.	.	1	1	.	1	.	1	.	1	5
	len	.	.	.	.	101	103	.	89	.	105	.	100	498
	age	.	.	.	.	.	26	.	25	.	25	.	25	101
1982	mt	348	1	726	342	73	886	287	170	739	278	201	669	4720
	n	5	2	6	1	2	2	2	2	6	3	4	2	37
	len	527	194	626	126	209	216	189	210	514	307	393	189	3700
	age	128	55	150	30	55	50	50	50	150	81	105	50	954
1983	mt	475	250	910	471	286	1037	298	154	758	257	169	613	5678
	n	5	2	3	5	1	5	8	3	8	6	3	.	49
	len	680	232	265	685	96	520	1008	123	981	677	344	.	5611
	age	135	30	55	131	16	125	152	0	159	180	75	.	1058
1984	mt	462	322	1036	513	393	1000	403	248	653	429	286	586	6331
	n	5	9	4	7	1	7	8	1	2	4	2	1	51
	len	804	1112	400	970	117	775	1045	106	191	615	243	91	6469
	age	154	250	76	186	25	180	210	28	53	105	44	25	1336
1985	mt	465	377	613	697	453	850	526	291	553	433	310	408	5976
	n	12	1	2	5	4	7	7	7	6	8	2	4	65
	len	1530	105	229	657	426	698	795	800	684	824	264	349	7361
	age	319	29	50	106	77	153	97	138	113	161	25	29	1297
1986	mt	384	309	356	654	421	595	375	238	354	312	212	238	4448
	n	6	3	5	5	4	5	4	3	4	5	3	2	49
	len	662	307	515	558	410	413	302	364	406	416	337	233	4923
	age	123	60	89	106	97	129	63	75	100	87	75	52	1056
1987	mt	349	211	228	432	317	387	296	203	247	298	203	202	3373
	n	1	1	2	4	2	3	5	5	4	2	3	2	34
	len	85	145	200	323	228	316	354	583	400	204	261	178	3277
	age	25	25	50	77	47	76	78	113	95	48	64	51	749
1988	mt	424	304	271	436	393	389	184	176	208	140	140	131	3196
	n	5	4	5	5	5	3	5	4	3	3	4	3	49
	len	335	407	465	344	544	429	396	359	295	229	402	356	4561
	age	70	89	106	71	110	77	70	100	75	61	95	69	993
1989	mt	230	174	148	255	264	251	98	145	156	85	107	103	2016
	n	1	2	2	2	2	1	2	2	1	1	2	.	18
	len	94	201	222	230	236	27	150	206	100	125	202	.	1793
	age	25	50	49	50	46	25	40	51	25	25	47	.	433
1990	mt	113	125	107	147	168	147	100	119	129	84	79	85	1403
	n	1	2	3	6	3	1	6	2	2	7	2	.	35
	len	134	199	199	335	296	100	349	247	145	381	201	.	2586
	age	15	40	45	81	70	25	69	41	50	103	48	.	587
1991	mt	71	56	58	219	151	167	192	142	184	168	108	121	1637
	n	5	2	3	7	2	1	4	2	3	5	4	3	41
	len	262	224	401	537	239	125	212	165	249	300	410	274	3398
	age	53	50	80	93	45	25	49	49	52	66	97	58	717
1992	mt	180	86	82	466	163	174	205	115	138	212	97	116	2034
	n	4	2	2	7	1	2	7	1	1	2	.	1	30
	len	259	241	185	501	125	235	477	121	117	129	.	46	2436
	age	42	46	52	78	25	25	86	25	25	27	.	23	454
1993	mt	350	112	110	442	192	161	263	122	150	331	96	106	2435
	n	7	1	.	7	1	1	9	1	5	.	.	.	32
	len	830	100	.	741	107	100	728	85	499	.	.	.	3190
	age	55	25	.	56	27	26	74	.	73	.	.	.	336

*Note: USA portions of SA 523 and 524 were renamed 561 and 562, respectively, in 1985.

Table 13. Landings at age in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder from the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*), 1982 - 1993.

Year	Age											TOTAL
	1	2	3	4	5	6	7	8	9	10	11+	
Commercial Landings in Numbers (1000's) at Age												
1982	0.00	0.00	113.40	794.80	1076.80	1398.30	639.60	630.70	384.10	230.20	1517.70	6785.60
1983	0.00	0.00	208.10	727.60	978.50	1483.70	1505.40	925.60	698.30	483.20	1586.20	8596.60
1984	0.00	0.00	86.20	962.70	1720.00	1649.20	1413.60	1424.00	662.50	356.70	1634.50	9909.40
1985	0.00	0.00	0.00	960.80	1976.80	1886.10	1487.30	1217.10	591.00	390.50	1325.70	9835.30
1986	0.00	0.00	6.10	288.00	1390.70	2674.80	1511.60	805.40	398.10	214.90	731.60	8021.20
1987	0.00	0.00	0.00	79.70	314.40	1247.40	1539.40	851.40	469.80	246.70	478.40	5227.20
1988	0.00	0.00	0.00	49.80	172.40	641.50	1354.70	1130.80	393.40	261.30	585.40	4589.30
1989	0.00	0.00	0.00	7.10	48.40	306.20	739.70	859.30	340.60	120.20	339.00	2760.50
1990	0.00	0.00	0.00	174.10	550.70	245.10	262.60	451.70	320.20	78.00	170.20	2252.60
1991	0.00	0.00	0.00	165.70	676.40	479.40	217.60	225.70	269.60	289.40	237.90	2561.70
1992	0.00	0.00	0.00	465.00	766.40	854.10	654.60	184.10	162.40	109.60	344.20	3540.40
1993	0.00	0.00	0.00	395.60	958.50	859.90	559.60	548.70	205.00	261.00	365.90	4154.20
Commercial Landings in Weight (mt) at Age												
1982	0.00	0.00	24.49	218.57	371.50	592.88	351.78	458.52	340.31	226.29	2133.31	717.64
1983	0.00	0.00	40.58	186.99	315.08	608.32	779.80	567.39	555.15	472.09	2153.22	5678.61
1984	0.00	0.00	18.27	258.00	595.12	695.96	761.93	945.54	541.26	328.88	2189.16	6334.12
1985	0.00	0.00	0.00	243.08	614.78	809.14	840.32	841.02	497.62	376.44	1757.24	5979.65
1986	0.00	0.00	0.51	65.38	425.55	1091.32	805.68	544.45	339.58	209.53	966.37	4448.37
1987	0.00	0.00	0.00	21.68	107.52	541.37	863.60	584.06	388.99	241.77	623.38	3372.38
1988	0.00	0.00	0.00	15.44	63.27	279.05	728.83	755.37	322.19	256.07	776.03	3196.27
1989	0.00	0.00	0.00	1.85	16.65	130.14	424.59	586.04	278.61	116.35	460.27	2014.50
1990	0.00	0.00	0.00	53.62	177.88	107.35	153.88	310.77	271.85	81.82	247.50	1404.68
1991	0.00	0.00	0.00	47.39	250.94	212.37	125.77	158.44	225.39	281.88	337.77	1639.95
1992	0.00	0.00	0.00	152.52	293.53	392.03	401.92	136.05	133.49	96.67	427.87	2034.09
1993	0.00	0.00	0.00	115.52	348.89	371.48	299.39	365.43	180.81	267.00	488.59	2437.11
Mean Weight (kg) at Age												
1982	0.000	0.000	0.216	0.275	0.345	0.424	0.550	0.727	0.886	0.983	1.406	0.695
1983	0.000	0.000	0.195	0.257	0.322	0.410	0.518	0.613	0.795	0.977	1.357	0.661
1984	0.000	0.000	0.212	0.268	0.346	0.422	0.539	0.664	0.817	0.922	1.339	0.639
1985	0.000	0.000	0.000	0.253	0.311	0.429	0.565	0.691	0.842	0.964	1.326	0.608
1986	0.000	0.000	0.084	0.227	0.306	0.408	0.533	0.676	0.853	0.975	1.321	0.555
1987	0.000	0.000	0.000	0.272	0.342	0.434	0.561	0.686	0.828	0.980	1.303	0.645
1988	0.000	0.000	0.000	0.310	0.367	0.435	0.538	0.668	0.819	0.980	1.326	0.696
1989	0.000	0.000	0.000	0.260	0.344	0.425	0.574	0.682	0.818	0.968	1.358	0.730
1990	0.000	0.000	0.000	0.308	0.323	0.438	0.586	0.688	0.849	1.049	1.454	0.624
1991	0.000	0.000	0.000	0.286	0.371	0.443	0.578	0.702	0.836	0.974	1.420	0.640
1992	0.000	0.000	0.000	0.328	0.383	0.459	0.614	0.739	0.822	0.882	1.243	0.575
1993	0.000	0.000	0.000	0.292	0.364	0.432	0.535	0.666	0.882	1.023	1.335	0.587
Mean Length (cm) at Age												
1982	0.0	0.0	32.3	35.0	37.5	39.8	42.9	46.5	49.3	50.9	56.3	44.3
1983	0.0	0.0	31.7	34.3	36.8	39.4	42.2	44.2	47.7	50.7	55.0	35.9
1984	0.0	0.0	32.6	34.9	37.6	39.8	42.7	45.3	48.2	49.9	55.5	43.6
1985	0.0	0.0	0.0	34.2	36.3	40.0	43.3	45.9	48.6	50.6	55.3	42.9
1986	0.0	0.0	25.0	33.2	36.2	39.4	42.5	45.6	48.8	50.7	55.3	42.0
1987	0.0	0.0	0.0	35.0	37.4	40.1	43.2	45.8	48.4	50.8	55.1	44.3
1988	0.0	0.0	0.0	36.4	38.2	40.1	42.7	45.4	48.2	50.8	55.3	45.3
1989	0.0	0.0	0.0	34.6	37.5	39.9	43.5	45.6	48.1	50.6	55.7	46.0
1990	0.0	0.0	0.0	36.2	36.8	40.2	43.7	45.8	48.7	51.8	56.8	43.5
1991	0.0	0.0	0.0	35.4	38.3	40.3	43.3	46.1	48.5	50.6	56.5	43.8
1992	0.0	0.0	0.0	37.0	38.7	40.7	44.3	46.8	48.3	49.2	54.2	42.7
1993	0.0	0.0	0.0	35.8	38.1	40.0	42.6	45.3	49.3	51.5	55.5	42.8

* Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 14. Discards at age in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder in the northern shrimp fishery in the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*), 1982-1993.

Year	Age											TOTAL
	1	2	3	4	5	6	7	8	9	10	11+	
Shrimp Fishery Discards in Numbers (1000's) at Age												
1982	0.00	0.00	24.76	21.29	11.56	3.22	0.00	0.00	0.00	0.00	0.00	60.83
1983	0.00	0.00	52.28	44.91	24.43	6.77	0.00	0.00	0.00	0.00	0.00	128.39
1984	0.00	0.00	45.18	38.86	21.09	5.88	0.00	0.00	0.00	0.00	0.00	111.02
1985	0.00	2.99	6.94	50.46	30.15	2.82	0.00	0.00	0.00	0.00	0.00	93.36
1986	0.00	3.04	7.03	51.40	30.69	2.85	0.00	0.00	0.00	0.00	0.00	95.01
1987	0.00	4.71	10.89	79.62	47.53	4.42	0.00	0.00	0.00	0.00	0.00	147.16
1988	15.62	141.80	565.53	46.65	44.14	3.33	0.00	0.00	0.00	0.00	0.00	817.07
1989	2.85	8.76	62.79	85.36	18.68	0.00	0.00	0.00	0.00	0.00	0.00	178.44
1990	4.89	53.75	266.93	114.20	37.69	0.00	0.00	0.00	0.00	0.00	0.00	477.46
1991	8.29	7.71	335.15	122.74	13.84	6.35	0.00	0.00	0.00	0.00	0.00	494.07
1992	40.14	147.28	129.11	89.54	0.62	0.00	0.00	0.00	0.00	0.00	0.00	406.69
1993	45.36	113.43	41.40	15.12	5.37	0.49	0.00	0.00	0.00	0.00	0.00	221.16
Shrimp Fishery Discards in Weight (mt) at Age												
1982	-	-	1.00	2.09	1.89	0.82	0.00	0.00	0.00	0.00	0.00	5.80
1983	-	-	2.10	4.41	4.00	1.73	0.00	0.00	0.00	0.00	0.00	12.25
1984	-	-	1.82	3.82	3.46	1.50	0.00	0.00	0.00	0.00	0.00	10.59
1985	-	0.05	0.31	5.99	5.39	0.65	0.00	0.00	0.00	0.00	0.00	12.39
1986	-	0.05	0.31	6.11	5.48	0.66	0.00	0.00	0.00	0.00	0.00	12.61
1987	-	0.08	0.48	9.46	8.49	1.02	0.00	0.00	0.00	0.00	0.00	19.53
1988	0.09	2.14	19.17	5.25	9.12	0.94	0.00	0.00	0.00	0.00	0.00	36.72
1989	0.01	0.10	2.69	10.22	4.64	0.00	0.00	0.00	0.00	0.00	0.00	17.67
1990	0.05	0.76	9.90	12.00	5.78	0.00	0.00	0.00	0.00	0.00	0.00	28.50
1991	0.04	0.09	14.55	14.36	3.07	1.39	0.00	0.00	0.00	0.00	0.00	33.45
1992	0.14	2.96	5.42	10.64	0.14	0.00	0.00	0.00	0.00	0.00	0.00	19.32
1993	0.14	2.54	2.34	2.06	1.27	0.16	0.00	0.00	0.00	0.00	0.00	8.51
Mean Weight (kg) at Age												
1982	-	-	0.040	0.098	0.164	0.256	-	-	-	-	-	0.095
1983	-	-	0.040	0.098	0.164	0.256	-	-	-	-	-	0.095
1984	-	-	0.040	0.098	0.164	0.256	-	-	-	-	-	0.095
1985	-	0.017	0.044	0.119	0.179	0.231	-	-	-	-	-	0.133
1986	-	0.017	0.044	0.119	0.179	0.231	-	-	-	-	-	0.133
1987	-	0.017	0.044	0.119	0.179	0.231	-	-	-	-	-	0.133
1988	0.006	0.015	0.034	0.113	0.207	0.282	-	-	-	-	-	0.045
1989	0.004	0.011	0.043	0.120	0.249	0.000	-	-	-	-	-	0.099
1990	0.010	0.014	0.037	0.105	0.153	0.000	-	-	-	-	-	0.060
1991	0.004	0.011	0.043	0.117	0.222	0.218	-	-	-	-	-	0.068
1992	0.004	0.020	0.042	0.119	0.220	0.000	-	-	-	-	-	0.048
1993	0.003	0.022	0.057	0.136	0.237	0.317	-	-	-	-	-	0.039
Mean Length (cm) at Age												
1982	-	-	20.3	26.3	30.6	34.9	-	-	-	-	-	25.1
1983	-	-	20.3	26.3	30.6	34.9	-	-	-	-	-	25.1
1984	-	-	20.3	26.3	30.6	34.9	-	-	-	-	-	25.1
1985	-	15.7	20.7	27.8	31.4	33.9	-	-	-	-	-	28.3
1986	-	15.7	20.7	27.8	31.4	33.9	-	-	-	-	-	28.3
1987	-	15.7	20.7	27.8	31.4	33.9	-	-	-	-	-	28.3
1988	10.6	15.3	19.2	27.4	32.8	36.0	-	-	-	-	-	19.6
1989	10.2	14.0	20.6	27.9	34.6	0.0	-	-	-	-	-	25.1
1990	13.6	15.0	19.8	26.9	30.1	0.0	-	-	-	-	-	21.7
1991	10.5	13.7	20.7	27.6	33.6	33.4	-	-	-	-	-	22.7
1992	9.7	16.5	20.4	27.9	33.5	0.0	-	-	-	-	-	19.6
1993	9.3	16.9	22.1	28.9	34.2	37.3	-	-	-	-	-	17.6

Note: 1982-1988 derived from regression estimation (see text).

1989-1993 directly estimated (ratio estimator) from DSSP data.

*Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 15. Discards at age in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder in the large-mesh otter trawl fishery in the Gulf of Maine-Georges Bank region (SAR 511-515, 521-526*), 1982-1993.

Year	Age											TOTAL
	1	2	3	4	5	6	7	8	9	10	11+	
Large-mesh Otter Trawl Fishery Discards in Numbers (1000's) at Age												
1982	0.20	0.10	36.60	238.20	82.40	15.50	0.00	0.00	0.00	0.00	0.00	373.00
1983	0.00	0.30	39.40	408.30	421.20	1.40	0.00	0.00	0.00	0.00	0.00	870.60
1984	0.00	0.10	6.10	378.00	169.10	0.30	0.00	0.00	0.00	0.00	0.00	553.60
1985	0.00	0.10	7.60	101.10	152.10	10.90	0.00	0.00	0.00	0.00	0.00	271.80
1986	0.00	0.00	1.20	23.70	46.00	0.30	0.00	0.00	0.00	0.00	0.00	71.20
1987	0.00	0.10	4.30	19.40	98.20	0.30	0.00	0.00	0.00	0.00	0.00	122.30
1988	0.00	0.00	59.80	35.10	54.30	0.80	0.00	0.00	0.00	0.00	0.00	150.00
1989	0.10	0.20	7.30	538.50	95.50	0.00	0.00	0.00	0.00	0.00	0.00	641.60
1990	0.30	0.90	53.80	191.90	159.40	0.00	0.00	0.00	0.00	0.00	0.00	406.30
1991	0.00	3.50	96.40	95.20	102.10	44.60	0.00	0.00	0.00	0.00	0.00	341.80
1992	0.20	8.40	147.00	410.50	31.60	6.00	0.00	0.00	0.00	0.00	0.00	603.70
1993	1.30	7.30	172.70	696.10	250.50	2.00	0.00	0.00	0.00	0.00	0.00	1129.90
Large-mesh Otter Trawl Fishery Discards in Weight (mt) at Age												
1982	0.00	0.00	1.98	32.59	10.86	2.78	0.00	0.00	0.00	0.00	0.00	48.21
1983	0.00	0.01	3.59	57.94	70.85	0.31	0.00	0.00	0.00	0.00	0.00	132.70
1984	0.00	0.00	0.50	58.33	29.03	0.07	0.00	0.00	0.00	0.00	0.00	87.93
1985	0.00	0.00	0.76	15.24	26.72	1.61	0.00	0.00	0.00	0.00	0.00	44.33
1986	0.00	0.00	0.13	3.18	8.25	0.07	0.00	0.00	0.00	0.00	0.00	11.62
1987	0.00	0.00	0.48	2.55	21.67	0.08	0.00	0.00	0.00	0.00	0.00	24.78
1988	0.00	0.00	5.58	6.10	11.12	0.21	0.00	0.00	0.00	0.00	0.00	23.01
1989	0.00	0.01	0.53	86.38	20.06	0.00	0.00	0.00	0.00	0.00	0.00	106.98
1990	0.01	0.03	6.19	31.05	31.88	0.00	0.00	0.00	0.00	0.00	0.00	69.16
1991	0.00	0.19	10.08	14.26	20.60	9.86	0.00	0.00	0.00	0.00	0.00	55.00
1992	0.00	0.52	20.32	69.37	7.98	1.65	0.00	0.00	0.00	0.00	0.00	99.85
1993	0.02	0.39	23.66	124.32	55.19	0.65	0.00	0.00	0.00	0.00	0.00	204.23
Mean Weight (kg) at Age												
1982	0.002	0.016	0.054	0.137	0.132	0.179	-	-	-	-	-	0.129
1983	-	0.034	0.091	0.142	0.168	0.220	-	-	-	-	-	0.152
1984	-	0.016	0.082	0.154	0.172	0.220	-	-	-	-	-	0.159
1985	-	0.034	0.100	0.151	0.176	0.148	-	-	-	-	-	0.163
1986	-	-	0.112	0.134	0.179	0.220	-	-	-	-	-	0.163
1987	-	0.016	0.112	0.131	0.221	0.268	-	-	-	-	-	0.203
1988	-	-	0.093	0.174	0.205	0.265	-	-	-	-	-	0.153
1989	0.016	0.029	0.073	0.160	0.210	-	-	-	-	-	-	0.167
1990	0.021	0.032	0.115	0.162	0.200	-	-	-	-	-	-	0.170
1991	-	0.054	0.105	0.150	0.202	0.221	-	-	-	-	-	0.161
1992	0.020	0.062	0.138	0.169	0.253	0.276	-	-	-	-	-	0.165
1993	0.016	0.053	0.137	0.179	0.220	0.324	-	-	-	-	-	0.181
Mean Length (cm) at Age												
1982	8.5	15.5	22.0	28.9	28.7	31.6	-	-	-	-	-	28.3
1983	-	19.5	25.6	29.3	30.9	33.5	-	-	-	-	-	29.9
1984	-	15.5	24.6	30.1	31.1	33.5	-	-	-	-	-	30.4
1985	-	19.5	26.5	29.9	31.4	29.8	-	-	-	-	-	30.6
1986	-	-	27.5	28.9	31.6	33.5	-	-	-	-	-	30.6
1987	-	15.5	27.5	28.7	33.5	35.5	-	-	-	-	-	32.5
1988	-	-	26.0	31.1	32.9	35.5	-	-	-	-	-	29.7
1989	15.5	18.5	24.1	30.4	33.0	-	-	-	-	-	-	30.7
1990	16.8	18.9	27.6	30.5	32.5	-	-	-	-	-	-	30.9
1991	-	22.0	26.7	29.8	32.6	33.5	-	-	-	-	-	30.2
1992	16.5	23.1	29.0	30.9	34.9	35.8	-	-	-	-	-	30.5
1993	15.4	21.9	29.0	31.4	33.5	37.5	-	-	-	-	-	31.4

*Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 16. Total catch at age in numbers, weight (thousands of fish;mt) and mean weight (kg) and mean length (cm) at age of witch flounder from the Gulf of Maine-Georges Bank region (SAR 511-515, 521-526), 1982-1993.

Year	Age											TOTAL
	1	2	3	4	5	6	7	8	9	10	11+	
Commercial Catch in Numbers (1000's) at Age												
1982	0.20	0.10	174.76	1054.29	1170.76	1417.02	639.60	630.70	384.10	230.20	1517.70	7219.43
1983	0.00	0.30	299.78	1180.81	1424.13	1491.87	1505.40	925.60	698.30	483.20	1586.20	9595.59
1984	0.00	0.10	137.48	1379.56	1910.19	1655.38	1413.60	1424.00	662.50	356.70	1634.50	10574.02
1985	0.00	3.09	14.54	1112.36	2159.05	1899.82	1487.30	1217.10	591.00	390.50	1325.70	10200.46
1986	0.00	3.04	14.33	363.10	1467.39	2677.95	1511.60	805.40	398.10	214.90	731.60	8187.41
1987	0.00	4.81	15.19	178.72	460.13	1252.12	1539.40	851.40	469.80	246.70	478.40	5496.66
1988	15.62	141.80	625.33	131.55	270.84	645.63	1354.70	1130.80	393.40	261.30	585.40	5556.37
1989	2.95	8.9f	70.09	630.96	162.58	306.20	739.70	859.30	340.60	120.20	339.00	3580.54
1990	5.19	54.65	320.73	480.20	747.79	245.10	262.60	451.70	320.20	78.00	170.20	3136.36
1991	8.29	11.21	431.55	383.64	792.34	530.35	217.60	225.70	269.60	289.40	287.90	3397.57
1992	40.34	155.68	276.11	965.04	798.62	860.10	654.60	184.10	162.40	109.60	344.20	4550.79
1993	46.66	120.73	214.10	1106.82	1214.37	862.39	559.60	548.70	205.00	261.00	365.90	5505.26
Commercial Catch in Weight (mt) at Age												
1982	0.00	0.00	27.47	253.25	384.25	596.48	351.78	458.52	340.31	226.29	2133.31	4771.66
1983	0.00	0.01	46.27	249.35	389.92	610.36	779.80	567.39	555.15	472.09	2153.22	5823.56
1984	0.00	0.00	20.59	320.15	627.61	697.53	761.93	945.54	541.26	328.88	2189.16	6432.64
1985	0.00	0.05	1.06	264.31	646.90	811.40	840.32	841.02	497.62	376.44	1757.24	6036.37
1986	0.00	0.05	0.96	74.66	439.29	1092.04	805.68	544.45	339.58	209.53	966.37	4472.60
1987	0.00	0.08	0.96	33.68	137.69	542.47	863.60	584.06	388.99	241.77	623.38	3416.69
1988	0.09	2.14	24.75	26.78	83.51	280.20	728.83	755.37	322.19	256.07	776.03	3256.00
1989	0.01	0.11	3.22	98.44	41.36	130.14	424.59	586.04	278.61	116.35	460.27	2139.14
1990	0.06	0.79	16.10	96.67	215.54	107.35	153.88	310.77	271.85	81.82	247.50	1502.34
1991	0.04	0.27	24.63	76.01	274.61	223.62	125.77	158.44	225.39	281.88	337.77	1728.40
1992	0.15	3.48	25.74	232.53	301.65	393.69	401.92	136.05	133.49	96.67	427.87	2153.26
1993	0.16	2.93	26.00	241.90	405.35	372.28	299.39	365.43	180.81	267.00	488.59	2649.85
Mean Weight (mt) at Age												
1982	0.002	0.016	0.157	0.240	0.328	0.421	0.550	0.727	0.886	0.983	1.406	0.661
1983	-	0.034	0.154	0.211	0.274	0.409	0.518	0.613	0.795	0.977	1.357	0.607
1984	-	0.016	0.150	0.232	0.329	0.421	0.539	0.664	0.817	0.922	1.339	0.608
1985	-	0.017	0.073	0.238	0.300	0.427	0.565	0.691	0.842	0.964	1.326	0.592
1986	-	0.017	0.067	0.206	0.299	0.408	0.533	0.676	0.853	0.975	1.321	0.547
1987	-	0.017	0.063	0.188	0.299	0.433	0.561	0.686	0.828	0.980	1.303	0.621
1988	0.006	0.015	0.040	0.204	0.308	0.434	0.538	0.668	0.819	0.980	1.326	0.586
1989	0.004	0.012	0.046	0.156	0.254	0.425	0.574	0.682	0.818	0.968	1.358	0.598
1990	0.011	0.014	0.050	0.201	0.288	0.438	0.586	0.688	0.849	1.049	1.454	0.479
1991	0.004	0.024	0.057	0.198	0.347	0.422	0.578	0.702	0.836	0.974	1.420	0.509
1992	0.004	0.022	0.093	0.241	0.378	0.458	0.614	0.739	0.822	0.882	1.243	0.474
1993	0.003	0.024	0.121	0.219	0.334	0.432	0.535	0.666	0.882	1.023	1.335	0.482
Mean Length(cm) at Age												
1982	8.5	15.5	28.5	33.5	36.8	39.7	42.9	46.5	49.3	50.9	56.3	43.3
1983	-	19.5	28.9	32.3	34.9	39.4	42.2	44.2	47.7	50.7	55.0	35.2
1984	-	15.5	28.2	33.3	36.9	39.7	42.7	45.3	48.2	49.9	55.5	42.7
1985	-	15.8	23.7	33.6	35.9	39.9	43.3	45.9	48.6	50.6	55.3	42.5
1986	-	15.7	23.1	32.2	36.0	39.3	42.5	45.6	48.8	50.7	55.3	41.8
1987	-	15.7	22.6	31.1	35.9	40.1	43.2	45.8	48.4	50.8	55.1	43.6
1988	10.6	15.3	19.8	31.8	36.3	40.1	42.7	45.4	48.2	50.8	55.3	41.1
1989	10.4	14.1	21.0	30.1	34.5	39.9	43.5	45.6	48.1	50.6	55.7	42.2
1990	13.8	15.1	21.1	31.7	35.5	40.2	43.7	45.8	48.7	51.8	56.8	38.5
1991	10.5	16.3	22.0	31.5	37.5	39.6	43.3	46.1	48.5	50.6	56.5	39.3
1992	9.7	16.8	25.0	33.5	38.5	40.7	44.3	46.8	48.3	49.2	54.2	39.0
1993	9.5	17.2	27.7	32.9	37.1	40.0	42.6	45.3	49.3	51.5	55.5	39.4

Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 17. Mean weights at age (kg) at the beginning of the year (January 1) for witch flounder from the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*), 1982-1993. Values derived from catch mean weight-at-age data (mid-year, Table 16) using procedures described by Rivard (1980).

YEAR	Age									
	1	2	3	4	5	6	7	8	9	10+
1982	0.000	0.005	0.136	0.225	0.294	0.379	0.521	0.695	0.803	1.350
1983	0.003	0.008	0.050	0.182	0.256	0.366	0.467	0.581	0.760	1.268
1984	0.003	0.009	0.071	0.189	0.226	0.340	0.470	0.586	0.708	1.264
1985	0.003	0.009	0.034	0.189	0.264	0.375	0.488	0.610	0.748	1.244
1986	0.003	0.009	0.034	0.123	0.267	0.350	0.491	0.625	0.763	1.244
1987	0.003	0.009	0.033	0.112	0.248	0.360	0.478	0.623	0.756	1.193
1988	0.004	0.009	0.026	0.116	0.247	0.372	0.498	0.607	0.741	1.213
1989	0.003	0.008	0.026	0.078	0.231	0.371	0.515	0.625	0.733	1.256
1990	0.007	0.008	0.024	0.096	0.212	0.334	0.499	0.628	0.761	1.327
1991	0.002	0.016	0.029	0.100	0.264	0.345	0.503	0.641	0.758	1.175
1992	0.001	0.010	0.048	0.117	0.274	0.398	0.503	0.649	0.760	1.156
1993	0.001	0.009	0.052	0.143	0.284	0.404	0.495	0.639	0.802	1.205
1991-1993 Mean	0.001	0.012	0.043	0.120	0.274	0.382	0.500	0.643	0.773	1.179

*Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 18. U.S. commercial witch flounder landings (L), days fished (DF), and landings per day fished (L/DF), by vessel tonnage class, for otter trawl trips in which any witch flounder were landed, and for otter trawl trips in which 40% or more of the total catch consisted of witch flounder, in the Gulf of Maine-Georges Bank region (SA 511-515, 521-526*), 1973-1993.

YEAR	CLASS 2				CLASS 3				CLASS 4				TOTAL			
	L	DF	L\DF	TRIPS	L	DF	L\DF	TRIPS	L	DF	L\DF	TRIPS	L	DF	L\DF	TRIPS
ALL TRIPS																
1973	802	2620	0.31	2475	1284	6236	0.21	2305	234	859	0.27	316	2320	9715	0.25	5096
1974	497	2478	0.20	2612	1029	7092	0.15	2440	157	1004	0.16	356	1683	10574	0.16	5408
1975	679	2354	0.29	2488	1126	7728	0.15	2421	153	1178	0.13	395	1957	11260	0.19	5304
1976	756	2826	0.27	2507	913	6373	0.14	2131	97	860	0.11	313	1765	10059	0.19	4951
1977	1074	3183	0.34	2774	1070	6025	0.18	2479	157	872	0.18	341	2302	10080	0.25	5594
1978	1372	4033	0.34	3329	1658	7053	0.24	2920	277	1225	0.23	541	3307	12310	0.28	6790
1979	946	4465	0.21	3450	1467	6757	0.22	3240	283	1570	0.18	686	2696	12792	0.21	7376
1980	1062	4932	0.22	3149	1428	7120	0.20	3501	376	1997	0.19	755	2866	14049	0.20	7405
1981	1069	3748	0.29	4325	1637	7015	0.23	3405	423	2595	0.16	810	3129	13358	0.24	8540
1982	1162	4430	0.26	4672	2346	8626	0.27	3868	905	3559	0.25	979	4413	16615	0.27	9519
1983	1203	3930	0.31	4577	2796	9581	0.29	4155	1308	4544	0.29	1127	5307	18056	0.29	9859
1984	1281	4069	0.31	4912	3245	12157	0.27	4942	1423	4769	0.30	1110	5949	20994	0.28	10964
1985	1195	3794	0.31	4503	2765	12664	0.22	4845	1600	5530	0.29	1305	5560	21988	0.26	10653
1986	806	3289	0.25	3366	2031	10525	0.19	4091	1177	5287	0.22	1264	4015	19101	0.21	8721
1987	647	2833	0.23	2506	1623	9593	0.17	3370	845	5035	0.17	1167	3114	17461	0.18	7043
1988	560	2986	0.19	2476	1463	8948	0.16	3447	951	4871	0.20	1121	2973	16805	0.18	7044
1989	283	2269	0.12	1933	959	8538	0.11	2862	618	4292	0.14	985	1860	15099	0.12	5780
1990	265	2649	0.10	1761	661	7736	0.09	2375	347	4172	0.08	1003	1274	14557	0.09	5139
1991	316	3135	0.10	2153	830	9076	0.09	2531	383	4681	0.08	988	1529	16892	0.09	5672
1992	352	3589	0.10	2478	148	10720	0.11	2745	414	5005	0.08	897	1914	19314	0.10	6120
1993	380	3321	0.11	2312	1347	10872	0.12	2950	530	4711	0.11	841	2257	18904	0.12	6103
40% TRIPS																
1973	306	208	1.47	150	392	271	1.45	109	96	58	1.66	18	793	536	1.48	277
1974	134	99	1.34	121	169	112	1.50	69	21	16	1.25	7	323	228	1.42	197
1975	292	171	1.71	307	208	168	1.24	92	4	4	1.09	2	504	343	1.51	401
1976	211	144	1.47	258	137	90	1.54	67	3	1	3.38	1	352	234	1.51	326
1977	151	93	1.62	166	129	84	1.53	58	1	4	0.26	1	281	182	1.57	225
1978	214	162	1.33	137	197	82	2.39	76	7	2	3.58	2	418	246	1.87	215
1979	93	79	1.17	87	103	69	1.49	47	7	2	3.45	1	203	151	1.41	135
1980	93	82	1.14	76	107	40	2.66	28	54	25	2.17	13	254	147	2.00	117
1981	101	54	1.87	94	239	108	2.21	82	22	13	1.69	8	362	175	2.08	184
1982	172	112	1.53	147	289	136	2.13	106	55	31	1.75	11	516	279	1.89	264
1983	183	140	1.30	162	519	279	1.86	159	48	30	1.59	12	750	450	1.70	333
1984	234	210	1.12	367	705	595	1.18	404	176	98	1.80	28	1115	903	1.27	799
1985	266	277	0.96	382	465	580	0.80	307	177	143	1.24	44	909	1000	0.93	733
1986	185	236	0.78	279	499	785	0.64	372	127	169	0.75	42	811	1190	0.69	693
1987	155	195	0.79	215	377	569	0.66	239	86	109	0.78	25	617	873	0.71	479
1988	137	176	0.78	181	517	905	0.57	344	202	254	0.79	54	856	1335	0.66	579
1989	45	67	0.67	85	128	256	0.50	129	77	112	0.69	223	250	435	0.59	437
1990	36	57	0.63	72	49	85	0.58	39	9	16	0.54	3	94	158	0.60	114
1991	35	76	0.46	74	55	106	0.52	35	1	1	0.83	1	92	183	0.50	110
1992	42	65	0.65	59	181	382	0.48	96	25	7	3.32	5	248	454	0.79	160
1993	76	140	0.54	103	266	538	0.49	166	30	42	0.71	10	372	720	0.52	279

*Note: SA 521-526 includes SA 561 and 562, formerly USA portions of 523 and 524, respectively.

Table 19. Stratified mean catch per tow in number and weight (kg) of witch flounder in NEFSC offshore spring and autumn bottom trawl surveys in Gulf of Maine-Georges Bank region (strata 22-30, 36-40), 1963-1993.

	SPRING		AUTUMN	
	Weight	Numbers	Weight	Numbers
1963	-	-	3.46	5.52
1964	-	-	2.00	2.89
1965	-	-	2.27	3.94
1966	-	-	4.56	7.80
1967	-	-	2.02	3.01
1968	3.34	4.76	3.49	4.82
1969	2.53	3.74	4.40	5.81
1970	4.49	6.39	3.71	4.89
1971	2.06	2.74	2.95	4.32
1972	4.01	5.35	2.42	3.24
1973	6.21	8.20	2.05	3.18
1974	3.62	6.23	1.54	2.34
1975	2.75	3.72	1.03	1.66
1976	3.70	5.50	0.94	1.34
1977	1.96	4.20	3.38	5.06
1978	2.56	3.87	2.94	4.04
1979	1.77	3.01	1.62	1.94
1980	3.89	8.46	2.04	2.62
1981	4.18	8.40	2.19	3.66
1982	1.87	3.64	0.83	0.99
1983	2.74	6.41	2.12	4.72
1984	1.66	3.00	2.34	4.37
1985	2.75	5.18	1.59	2.76
1986	1.35	2.07	1.09	1.59
1987	0.65	1.01	0.37	0.48
1988	0.85	1.43	0.57	1.38
1989	0.74	1.95	0.38	0.89
1990	0.24	0.63	0.40	2.00
1991	0.57	1.68	0.54	2.08
1992	0.50	1.26	0.24	0.94
1993	0.36	1.47	0.54	5.15

Note: During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. No significant differences in catchability were found for witch flounder, therefore no adjustments have been made (Byrne and Forrester, MS 1991). No significant differences were found between research vessels, no adjustment have been made (Byrne and Forrester, MS 1991).

Spring surveys during 1973-1981 were accomplished with a 41 Yankee trawl; in all other years, a 36 Yankee trawl was used. No adjustments have been made.

Table 20. Stratified mean number and weight (kg) per tow of witch flounder in Massachusetts inshore spring and autumn surveys in the Cape Cod Bay and Mass. Bay region (Regions 4 and 5), 1978-1993.

	Year	Number Per Tow	Weight (kg) Per Tow
SPRING	1978	2.98	2.15
	1979	1.36	1.41
	1980	1.49	1.44
	1981	3.74	3.18
	1982	1.23	0.97
	1983	2.15	1.29
	1984	1.50	1.01
	1985	1.12	0.82
	1986	0.90	0.83
	1987	1.45	1.10
	1988	0.36	0.29
	1989	0.07	0.17
	1990	0.32	0.40
	1991	0.08	0.17
1992	0.24	0.34	
1993	0.03	0.01	
AUTUMN	1978	2.47	2.41
	1979	1.39	1.09
	1980	1.66	1.77
	1981	0.36	0.23
	1982	1.24	0.76
	1983	3.79	2.68
	1984	0.62	0.45
	1985	0.83	0.57
	1986	0.32	0.27
	1987	0.26	0.20
	1988	0.39	0.24
	1989	0.21	0.13
	1990	0.06	0.03
	1991	0.37	0.22
1992	0.45	0.25	
1993	0.39	0.19	

Table 21. Stratified mean number and weight (kg) per tow of witch flounder in ASMFC summer shrimp surveys in the Gulf of Maine, (Strata 1-4,6,8), 1987-1993.

Year	Number Per Tow	Weight (kg) Per Tow	Mean Length (cm)
1987	4.87	1.50	26.48
1988	2.58	0.55	24.72
1989	2.74	0.28	22.41
1990	7.26	0.93	22.47
1991	14.13	1.18	19.88
1992	19.34	1.58	20.54
1993	17.94	0.42	12.88

Note: 1983 was an exploratory cruise.
 1984 to 1986 by-catch weights only, no length frequency, not computerized yet.
 1987 onward by-catch weights and length frequency collected.

Table 22. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40). 1980-1993.

	0	1	2	3	4	5	6	AGE 7	8	9	10	11	12	13	14+	Total
SPRING																
1980	0.00	0.06	0.23	0.95	1.52	0.72	1.20	1.02	0.38	0.40	0.31	0.30	0.12	0.16	1.10	8.46
1981	0.00	0.00	0.05	0.82	0.93	2.00	1.02	0.76	0.67	0.42	0.13	0.20	0.24	0.22	0.90	8.40
1982	0.00	0.04	0.01	0.56	0.57	0.34	0.21	0.64	0.41	0.08	0.26	0.15	0.03	0.03	0.30	3.64
1983	0.00	0.00	0.03	0.58	1.25	1.33	0.55	0.64	0.67	0.48	0.20	0.09	0.08	0.11	0.41	6.41
1984	0.00	0.00	0.01	0.10	0.33	0.73	0.42	0.26	0.28	0.24	0.11	0.12	0.09	0.02	0.29	3.00
1985	0.00	0.00	0.00	0.02	0.43	1.11	1.19	0.86	0.45	0.13	0.06	0.14	0.09	0.04	0.67	5.18
1986	0.00	0.00	0.00	0.00	0.04	0.24	0.53	0.43	0.17	0.18	0.07	0.04	0.08	0.05	0.25	2.07
1987	0.00	0.00	0.00	0.00	0.06	0.12	0.12	0.26	0.17	0.03	0.06	0.03	0.00	0.00	0.15	1.01
1988	0.00	0.02	0.02	0.06	0.00	0.07	0.31	0.38	0.25	0.16	0.08	0.04	0.02	0.00	0.02	1.43
1989	0.00	0.02	0.01	0.04	0.98	0.12	0.07	0.10	0.31	0.07	0.03	0.05	0.05	0.02	0.06	1.95
1990	0.00	0.01	0.00	0.04	0.09	0.32	0.02	0.02	0.02	0.06	0.01	0.00	0.01	0.00	0.03	0.63
1991	0.00	0.04	0.00	0.78	0.11	0.11	0.19	0.02	0.09	0.10	0.14	0.02	0.02	0.00	0.07	1.68
1992	0.00	0.05	0.01	0.19	0.37	0.08	0.12	0.15	0.05	0.14	0.02	0.01	0.05	0.00	0.02	1.26
1993	0.00	0.15	0.11	0.14	0.46	0.33	0.06	0.08	0.00	0.02	0.02	0.00	0.06	0.00	0.04	1.47
AUTUMN																
1980	0.04	0.00	0.02	0.00	0.20	0.26	0.28	0.36	0.17	0.15	0.27	0.04	0.16	0.12	0.57	2.62
1981	0.03	0.07	0.03	0.24	0.44	0.61	0.46	0.27	0.26	0.18	0.21	0.17	0.04	0.13	0.48	3.66
1982	0.02	0.00	0.00	0.06	0.01	0.02	0.08	0.25	0.13	0.01	0.03	0.03	0.00	0.06	0.29	0.99
1983	0.00	0.01	0.01	0.49	1.60	0.78	0.51	0.47	0.11	0.10	0.12	0.09	0.02	0.00	0.42	0.47
1984	0.00	0.00	0.00	0.08	0.97	1.01	0.58	0.54	0.32	0.14	0.12	0.06	0.04	0.14	0.38	4.37
1985	0.00	0.00	0.01	0.07	0.06	0.60	0.62	0.58	0.24	0.13	0.09	0.01	0.03	0.10	0.22	2.76
1986	0.01	0.00	0.00	0.01	0.04	0.27	0.36	0.31	0.15	0.11	0.02	0.02	0.01	0.05	0.23	1.59
1987	0.00	0.00	0.02	0.01	0.00	0.02	0.05	0.18	0.07	0.00	0.01	0.00	0.02	0.00	0.08	0.48
1988	0.00	0.00	0.00	0.71	0.07	0.00	0.03	0.22	0.06	0.05	0.03	0.06	0.02	0.03	0.08	1.38
1989	0.17	0.02	0.02	0.08	0.30	0.01	0.02	0.04	0.05	0.09	0.01	0.00	0.03	0.00	0.04	0.89
1990	0.48	0.12	0.11	0.39	0.52	0.17	0.05	0.02	0.02	0.05	0.00	0.00	0.01	0.04	0.03	2.00
1991	0.22	0.02	0.17	0.67	0.35	0.27	0.15	0.09	0.06	0.02	0.04	0.03	0.00	0.00	0.00	2.08
1992	0.09	0.03	0.11	0.27	0.22	0.06	0.05	0.00	0.00	0.02	0.01	0.02	0.00	0.01	0.04	0.94
1993	2.54	0.67	0.11	0.55	0.76	0.23	0.06	0.03	0.08	0.00	0.02	0.04	0.00	0.01	0.01	5.15

Table 23. Witch flounder mean length (cm) at age in spring and autumn NEFSC bottom trawl surveys (Strata 22-30, 36-40), 1980-1993.

	0	1	2	3	4	5	AGE 6	7	8	9	10	11	12	13	14+
SPRING															
1980	-	9.66	16.40	20.55	26.21	30.57	34.76	38.61	40.58	45.02	48.59	49.21	49.26	52.54	55.20
1981	-	-	13.40	20.18	28.51	32.37	35.43	39.69	44.43	49.35	52.43	49.90	54.53	54.07	57.60
1982	-	8.00	15.50	20.00	27.06	32.28	35.66	40.42	44.14	48.63	50.50	51.30	57.50	53.50	57.17
1983	-	-	17.79	20.72	26.42	31.30	35.84	40.28	43.43	47.59	52.25	54.65	49.50	55.91	54.53
1984	-	-	15.50	17.70	29.55	32.72	37.50	41.82	43.29	47.16	51.35	50.90	52.97	53.50	56.99
1985	-	-	-	19.50	28.68	33.35	36.87	41.09	44.80	46.30	45.50	50.96	49.10	55.50	56.42
1986	-	-	-	-	26.81	35.03	38.26	41.81	45.79	49.05	51.36	51.94	54.08	57.10	57.06
1987	-	-	-	-	27.63	34.16	40.31	41.26	44.14	47.04	51.13	47.50	-	-	55.73
1988	-	9.50	15.50	19.24	-	33.36	39.28	42.96	45.94	50.68	54.25	49.89	59.50	-	57.50
1989	-	7.50	14.50	21.50	28.59	33.06	40.07	43.46	44.87	50.23	50.43	53.03	57.73	47.50	59.50
1990	-	9.50	-	19.50	28.03	32.56	39.50	41.50	49.50	50.17	51.50	-	53.50	-	54.75
1991	-	7.50	-	20.41	27.52	35.41	37.79	43.50	48.13	49.57	51.88	53.50	53.50	-	51.25
1992	-	8.76	11.50	22.01	29.14	35.19	38.30	42.52	44.96	49.49	45.50	51.50	56.02	-	55.50
1993	-	7.73	18.17	23.57	29.99	34.46	38.21	40.40	-	49.50	49.50	-	50.94	-	59.58
AUTUMN															
1980	5.50	-	19.50	-	27.32	32.05	34.89	39.05	43.25	47.74	48.84	50.13	51.57	53.69	56.74
1981	5.50	12.57	17.40	23.31	30.61	33.11	38.30	41.42	44.77	47.00	51.39	53.55	52.66	54.96	56.35
1982	5.50	-	-	22.73	31.50	27.50	36.73	41.85	42.98	47.50	50.67	48.84	-	52.08	56.13
1983	-	13.50	19.50	24.59	30.10	34.60	38.76	42.21	45.48	48.51	51.14	51.80	51.50	-	58.79
1984	-	-	-	24.87	30.62	34.39	38.22	42.87	45.15	47.00	50.29	51.40	55.73	53.50	58.05
1985	-	-	19.50	26.30	29.21	34.38	38.48	42.86	46.53	49.44	49.76	53.50	55.50	51.74	58.60
1986	5.50	-	-	27.50	29.50	35.26	38.17	42.93	45.35	49.14	51.50	51.38	49.50	54.54	57.41
1987	-	-	15.50	27.50	-	35.50	38.86	41.39	43.58	-	49.50	-	55.50	-	60.41
1988	-	-	-	25.35	30.86	-	43.73	44.25	47.20	47.94	49.75	54.24	55.50	53.50	56.23
1989	5.90	15.50	18.50	24.19	31.24	35.50	43.50	45.50	47.01	49.39	51.50	-	54.65	-	64.73
1990	6.16	16.68	17.41	26.67	29.99	36.22	39.50	43.50	47.50	50.37	-	-	57.50	51.49	60.33
1991	5.66	14.74	20.53	26.20	30.42	36.55	41.59	47.23	47.50	45.50	54.83	55.49	-	-	-
1992	5.94	16.06	22.80	27.94	31.96	38.13	38.00	-	-	45.50	49.50	47.50	-	49.50	56.41
1993	5.56	14.14	22.42	28.82	32.27	35.88	42.18	43.55	46.22	-	55.50	51.50	-	63.50	57.50

Table 24. Estimates of instantaneous total mortality (Z) for witch flounder in the Gulf of Maine-Georges Bank region, 1980-1993, derived from NEFSC offshore spring and autumn bottom trawl survey data.

YEAR	3+	4+	5+	6+	7+	8+	Time Period	Ln(7+/8+)		Geometric Mean
								Spring	Autumn	
Spring										
1980	8.13	7.17	5.74	4.95	3.76	2.82	1981-1984	0.48	0.24	0.34
1981	8.25	7.52	6.43	4.60	3.54	2.88				
1982	3.55	2.95	2.46	2.09	1.85	1.24				
1983	6.34	5.81	4.55	3.26	2.72	2.00				
1984	2.91	2.90	2.60	1.83	1.43	1.15	1985-1988	0.77	0.65	0.71
1985	5.19	5.17	4.71	3.65	2.45	1.54				
1986	2.06	2.06	2.02	1.78	1.25	0.84				
1987	0.99	0.99	0.93	0.82	0.69	0.43				
1988	1.39	1.33	1.33	1.26	0.96	0.58	1989-1992	0.58	0.49	0.53
1989	1.91	1.88	0.88	0.77	0.70	0.62				
1990	0.62	0.58	0.49	0.17	0.17	0.13				
1991	1.64	0.86	0.75	0.66	0.45	0.42				
1992	1.21	1.02	0.65	0.56	0.45	0.30	1987-1992	0.45	0.55	0.50
1993	1.21	1.07	0.61	0.28	0.22	0.14				
Autumn										
1980	2.55	2.55	2.34	2.07	1.75	1.43				
1981	3.50	3.29	2.83	2.24	1.71	1.46				
1982	0.99	0.93	0.91	0.88	0.80	0.56				
1983	4.68	4.18	2.58	1.82	1.27	0.83				
1984	4.35	4.26	3.32	2.33	1.73	1.20				
1985	2.73	2.69	2.61	2.00	1.32	0.84				
1986	1.58	1.58	1.53	1.26	0.91	0.60				
1987	0.45	0.44	0.44	0.42	0.37	0.18				
1988	1.36	0.63	0.58	0.57	0.54	0.33				
1989	0.68	0.60	0.30	0.29	0.27	0.25				
1990	1.29	0.91	0.40	0.18	0.16	0.14				
1991	1.66	1.00	0.67	0.38	0.24	0.17				
1992	0.79	0.52	0.31	0.26	0.20	0.20				
1993	1.79	1.24	0.48	0.25	0.19	0.16				

Table 25. Parameter estimates (with associated statistics) and estimates of terminal F from trial ADAPT calibrations for witch flounder.

RUN A BASELINE AGES 3-9, ALL INDICES						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 3	3.72012E4	3.57656E4	1.04014E0	0.96	3	0.01
N 4	2.25709E4	1.25490E4	1.79862E0	0.56	4	0.06
N 5	1.78868E4	8.03158E3	2.22706E0	0.45	5	0.09
N 6	1.13401E4	4.60169E3	2.46434E0	0.41	6	0.42
N 7	1.54324E3	7.05706E2	2.18680E0	0.46	7	0.77
N 8	4.44382E2	2.87043E2	1.54814E0	0.65	8	1.58
N 9	1.32088E2	1.03345E2	1.27812E0	0.78	9	1.58
					10	1.58
					11	1.58
RUN B AGES 4-9, ALL INDICES						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 4	2.35172E4	1.30432E4	1.80302E0	0.55	3	0.01
N 5	1.83630E4	8.22455E3	2.23270E0	0.45	4	0.05
N 6	1.15679E4	4.68032E3	2.47161E0	0.40	5	0.09
N 7	1.56761E3	7.11368E2	2.20365E0	0.45	6	0.41
N 8	4.47535E2	2.87286E2	1.55781E0	0.64	7	0.77
N 9	1.12077E2	8.52046E1	1.31538E0	0.76	8	1.71
					9	1.71
					10	1.71
					11	1.71
RUN C AGES 4-9, WITHOUT NEFC AUTUMN AGE 5 AND NEFC AUTUMN AGE 6						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 4	2.41499E4	1.22552E4	1.97058E0	0.51	3	0.01
N 5	1.76054E4	8.19530E3	2.14824E0	0.47	4	0.06
N 6	1.66369E4	7.21513E3	2.30583E0	0.43	5	0.07
N 7	1.54535E3	6.90111E2	2.23928E0	0.45	6	0.42
N 8	3.15666E2	2.11747E2	1.49077E0	0.67	7	0.97
N 9	1.17115E2	8.03816E1	1.45699E0	0.69	8	1.68
					9	1.68
					10	1.68
					11	1.68
RUN D AGES 4-9, ALL INDICES, ITERATIVE RE-WEIGHT BY INDEX (chi)						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 4	2.52698E4	1.36540E4	1.85073E0	0.54	3	0.01
N 5	2.12724E4	1.01033E4	2.10548E0	0.47	4	0.05
N 6	1.27431E4	5.32528E3	2.39295E0	0.42	5	0.08
N 7	1.26640E3	6.14919E2	2.05946E0	0.49	6	0.49
N 8	6.26531E2	2.83496E2	2.21002E0	0.45	7	0.60
N 9	1.14709E2	7.57249E1	1.51481E0	0.66	8	1.69
					9	1.69
					10	1.69
					11	1.69
RUN E AGES 4-9 USING LPUE AGE-SPECIFIC (ages 7-10), omitting all age-aggregated indices						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 4	2.38702E4	1.27472E4	1.87259E0	0.53	3	0.01
N 5	1.85870E4	8.01576E3	2.31880E0	0.43	4	0.05
N 6	1.17086E4	4.56061E3	2.56732E0	0.39	5	0.09
N 7	1.30854E3	6.97114E2	1.87708E0	0.53	6	0.48
N 8	5.78943E2	3.27880E2	1.76572E0	0.57	7	0.64
N 9	1.81839E2	1.00912E2	1.80196E0	0.55	8	1.33
					9	1.33
					10	1.33
					11	1.33
RUN F AGES 4-9, SPR 3-9, AUT 3-9, LPUE AGE-SPECIFIC 7-9						
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993	
N 4	2.39708E4	1.31487E4	1.82305E0	0.55	3	0.01
N 5	1.86547E4	8.26323E3	2.25755E0	0.44	4	0.05
N 6	1.17522E4	4.70143E3	2.49972E0	0.40	5	0.09
N 7	1.31589E3	7.19093E2	1.82993E0	0.55	6	0.47
N 8	5.82787E2	3.38553E2	1.72141E0	0.58	7	0.64
N 9	1.95265E2	1.20349E2	1.62249E0	0.62	8	1.28
					9	1.28
					10	1.28
					11	1.28

Table 25. (continued).

RUN G AGES 5-9, SPR 5-9, AUT 5-6, LPUE AGE-SPECIFIC 7-10					
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993
					3 0.02
					4 0.04
N 5	2.28591E4	1.96439E4	1.16367E0	0.86	5 0.19
N 6	5.36427E3	3.00842E3	1.78308E0	0.56	6 0.70
N 7	7.84935E2	7.86020E2	9.98619E-1	1.00	7 0.35
N 8	1.24014E3	7.45398E2	1.66373E0	0.60	8 1.17
N 9	2.29581E2	1.62985E2	1.40860E0	0.71	9 1.17
					10 1.17
					11 1.17
RUN H AGES 5-9, SPR 5-6, AUT 5-6, LPUE AGE-SPECIFIC 7-10					
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993
					3 0.01
					4 0.04
N 4	2.35158E4	2.07298E4	1.13440E0	0.88	5 0.18
N 5	5.54434E3	3.18333E3	1.74168E0	0.57	6 0.67
N 6	8.43961E2	8.35110E2	1.01060E0	0.99	7 0.27
N 7	1.67165E3	1.07211E3	1.55922E0	0.64	8 0.95
N 8	3.22786E2	2.22490E2	1.45078E0	0.69	9 0.95
					10 0.95
					11 0.95
RUN I AGES 4-8, P-R FULL AT AGE 7, SPR 3-6, AUT 3-6, LPUE AGE-SPECIFIC 7-10					
PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	F in 1993
					3 0.01
					4 0.05
N 4	2.50275E4	1.39350E4	1.79601E0	0.56	5 0.09
N 5	1.93627E4	8.70885E3	2.22333E0	0.45	6 0.44
N 6	1.22113E4	4.95918E3	2.46237E0	0.41	7 0.86
N 7	1.45033E3	9.51660E2	1.52400E0	0.66	8 0.86
N 8	3.83877E2	2.20836E2	1.73829E0	0.58	9 0.86
					10 0.86
					11 0.86

Table 26. Results from Separable Virtual Population Analysis for Gulf of Maine - Georges Bank witch flounder.

Separable analysis from 1982 to 1993 on ages 1 to 10 with Terminal F of 0.470 on age 6 and Terminal S of 1.000
 Initial sum of squared residuals was 680.246 and final sum of squared residuals is 175.600 after 150 iterations

Matrix of Residuals

Years Ages	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	WTS	
1/2	-0.226	-2.312	-2.404	-0.273	-2.590	0.049	-3.054	-2.299	-2.492	-6.442	-3.441	-17.736	0.085
2/3	-4.403	-2.507	-1.202	-1.332	-3.119	-3.115	-3.420	-2.466	-1.478	-0.217	0.360	-7.237	0.107
3/4	0.625	0.767	-0.080	-1.519	-0.425	-0.468	0.196	-1.555	0.844	0.525	0.572	0.582	0.179
4/5	0.598	0.191	0.138	0.133	0.150	-0.068	0.115	0.330	-0.103	-0.182	0.421	0.582	0.669
5/6	0.241	0.110	0.166	-0.222	0.150	-0.105	-0.089	-0.375	0.514	0.371	0.160	0.582	0.591
6/7	0.259	0.145	0.089	0.051	0.386	0.078	-0.114	0.122	0.134	0.031	0.408	0.582	1.000
7/8	-0.235	-0.046	-0.067	0.235	0.211	0.274	0.280	0.255	-0.044	0.195	-0.105	0.582	0.826
8/9	-0.264	-0.066	0.363	0.436	-0.127	0.440	0.725	0.449	0.022	0.067	-0.683	0.582	0.381
9/10	-0.477	0.195	-0.061	0.255	-0.268	0.176	0.638	0.867	-0.457	0.594	-1.061	0.582	0.270
WTS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-41.951	

Fishing Mortalities (F)

	1982	1983
F-values	0.1089	0.1515

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
F-values	0.1744	0.1830	0.1619	0.1412	0.1723	0.1889	0.1982	0.2224	0.3459	0.4700

Selection-at-age (S)

	1	2	3	4	5	6	7	8	9	10
S-values	0.0010	0.0010	0.0248	0.2994	0.6578	1.0000	1.3435	1.5490	1.3227	1.0000
ADJUSTED	0.0007	0.0007	0.0145	0.2052	0.4291	0.6671	0.8588	1.0000	1.0000	1.0000

Table 27. Estimates of beginning year stock size, instantaneous fishing mortality and spawning stock biomass for Gulf of Maine- Georges Bank witch flounder, estimated from virtual population analysis (VPA) calibrated using ADAPT procedures.

	Stock Numbers (Jan 1) in thousands												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	19358.3	10994.4	5168.2	4279.5	10975.6	8716.3	7833.7	13818.9	14964.7	30422.5	8649.2	11386.0	0.0
2	21452.4	16661.6	9462.9	4448.4	3683.4	9446.8	7502.2	6728.0	11891.3	12875.4	26177.2	7407.0	9800.0
3	15429.5	18464.2	14340.5	8144.7	3825.9	3167.5	8126.4	6325.6	5782.5	10184.3	11071.6	22386.5	6263.3
4	12345.6	13118.1	15614.1	12215.4	6996.7	3279.7	2712.2	6414.3	5379.5	4679.5	8365.3	9273.3	19069.6
5	9339.3	9647.8	10195.2	12159.3	9481.9	5685.3	2657.0	2212.4	4935.4	4184.7	3671.8	6304.8	6954.7
6	7907.2	6952.2	6982.6	7002.9	8462.4	6799.8	4466.4	2035.7	1753.4	3554.2	2866.7	2419.4	4300.0
7	4330.1	5491.2	4599.8	4474.2	4264.9	4799.2	4691.0	3245.3	1468.0	1281.8	2567.1	1669.4	1282.3
8	3542.6	3133.6	3329.7	2647.6	2471.1	2268.5	2702.6	2780.8	2107.0	1019.9	901.4	1602.2	917.7
9	2372.6	2464.0	1838.4	1544.8	1149.7	1379.7	1162.6	1277.0	1596.2	1394.4	668.5	605.0	870.0
10+	10760.8	7262.1	5486.7	4452.1	2715.0	2115.5	2485.9	1712.8	1232.4	2716.8	1859.1	1838.0	1334.7
T+	106838.4	94189.1	77018.1	61368.9	54026.6	47658.2	44340.0	46550.8	51110.5	72313.5	66797.8	64891.6	50792.3

	FISHING MORTALITY												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.02	
3	0.01	0.02	0.01	0.00	0.00	0.01	0.09	0.01	0.06	0.05	0.03	0.01	
4	0.10	0.10	0.10	0.10	0.06	0.06	0.05	0.11	0.10	0.09	0.13	0.14	
5	0.15	0.17	0.23	0.21	0.18	0.09	0.12	0.08	0.18	0.23	0.27	0.23	
6	0.21	0.26	0.30	0.35	0.42	0.22	0.17	0.18	0.16	0.18	0.39	0.48	
7	0.17	0.35	0.40	0.44	0.48	0.42	0.37	0.28	0.21	0.20	0.32	0.45	
8	0.21	0.38	0.62	0.68	0.43	0.52	0.60	0.41	0.26	0.27	0.25	0.46	
9	0.19	0.36	0.49	0.53	0.47	0.46	0.45	0.34	0.24	0.23	0.30	0.45	
10+	0.19	0.36	0.49	0.53	0.47	0.46	0.45	0.34	0.24	0.23	0.30	0.45	

	Ave F for ages												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
3+	0.15	0.24	0.31	0.33	0.29	0.25	0.26	0.20	0.18	0.18	0.24	0.32	
4+	0.17	0.27	0.36	0.39	0.34	0.30	0.29	0.23	0.19	0.20	0.28	0.37	
5+	0.19	0.31	0.41	0.44	0.40	0.34	0.34	0.26	0.21	0.22	0.31	0.42	
6+	0.20	0.34	0.45	0.50	0.45	0.41	0.40	0.30	0.22	0.22	0.32	0.46	
7+	0.19	0.37	0.50	0.55	0.46	0.47	0.48	0.34	0.24	0.24	0.29	0.45	

	SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
3	203.61	89.22	99.63	27.21	12.73	10.10	20.19	16.21	13.58	28.37	51.33	113.59	
4	960.01	824.97	1020.17	795.33	298.84	127.92	109.02	173.46	178.63	161.32	337.15	454.19	
5	2430.80	2180.17	2346.10	2806.54	2225.18	1259.90	583.73	457.95	920.49	965.41	871.53	1559.97	
6	2767.02	2330.53	2157.82	2366.95	2637.39	2255.83	1544.58	700.63	544.32	1137.76	1022.55	861.29	
7	2137.48	2358.95	1970.00	1977.40	1885.79	2085.92	2140.30	1556.47	689.46	608.16	1194.45	747.70	
8	2318.20	1664.74	1718.10	1406.02	1401.10	1263.37	1447.99	1583.33	1236.03	609.67	547.47	925.41	
9	1798.71	1719.25	1169.02	1030.98	791.18	943.15	779.31	862.90	1137.48	992.01	470.80	438.62	
10	13725.57	8453.28	6233.03	4942.06	3046.74	2280.94	2727.06	1982.80	1531.21	2995.05	1992.26	2002.62	
Total	26341.4	19621.1	16713.9	15352.5	12299.0	10227.1	9352.2	7333.8	6251.2	7497.8	6487.5	7103.4	

Note: Bold values: 9800 represent GM value from the 1980 - 1991 year classes over the 1982-1993 period; 11386 value was back-calculated.

Table 28. Yield and SSB per Recruit results for Gulf of Maine-Georges Bank witch flounder.

The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
 PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992

Run Date: 22- 6-1994; Time: 13:29:03.20

Witch flounder 1994 - revised

Proportion of F before spawning: .1667
 Proportion of M before spawning: .1667
 Natural Mortality is Constant at: .150
 Initial age is: 1; Last age is: 10
 Last age is a PLUS group;
 Original age-specific PRs, Mats, and Mean Wts from file:
 ==> WIT94R.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Prop Mat	Proportion of F			Catch	Lndgs	Average Weights	
				Lndgs	LMOT	Shmp			LMDsc	ShDsc
1	.0001	1.0000	.00	.00	.02	.98	.006	.000	.019	.005
2	.0390	1.0000	.02	.00	.04	.96	.021	.000	.050	.017
3	.1060	1.0000	.10	.16	.24	.60	.080	.000	.124	.045
4	.3030	1.0000	.36	.57	.35	.08	.215	.304	.165	.119
5	.5120	1.0000	.93	.85	.13	.02	.337	.360	.219	.208
6	.6730	1.0000	.98	.99	.01	.00	.437	.443	.274	.268
7	1.0000	1.0000	1.00	1.00	.00	.00	.578	.578	.000	.000
8	1.0000	1.0000	1.00	1.00	.00	.00	.699	.699	.000	.000
9	1.0000	1.0000	1.00	1.00	.00	.00	.847	.847	.000	.000
10+	1.0000	1.0000	1.00	1.00	.00	.00	1.269	1.269	.000	.000

Summary of Yield per Recruit Analysis for:
 Witch flounder 1994 - revised

Slope of the Yield/Recruit Curve at F=0.00: --> 3.1156
 F level at slope=1/10 of the above slope (F0.1): -----> .149
 Yield/Recruit corresponding to F0.1: -----> .1775
 F level to produce Maximum Yield/Recruit (Fmax): -----> .271
 Yield/Recruit corresponding to Fmax: -----> .1918
 F level at 20 % of Max Spawning Potential (F20): -----> .388
 SSB/Recruit corresponding to F20: -----> .6878

Listing of Yield per Recruit Results for: Witch flounder 1994 - revised

	All Components			Landings Only		LM OT Discard		Shrimp Discard	
	Fmort	Number	Weight	Number	Weight	Number	Weight	Number	Weight
	.000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	.050	.13414	.10776	.12370	.10587	.00580	.00102	.00464	.00026
	.100	.21619	.15834	.19560	.15464	.01138	.00199	.00921	.00051
F0.1	.149	.27140	.18290	.24108	.17749	.01666	.00291	.01366	.00076
	.150	.27212	.18316	.24165	.17772	.01674	.00292	.01373	.00076
	.200	.31306	.19509	.27298	.18801	.02189	.00381	.01819	.00100
	.250	.34460	.20018	.29516	.19153	.02684	.00466	.02259	.00123
Fmax	.271	.35568	.20108	.30244	.19180	.02884	.00500	.02440	.00133
	.300	.36983	.20153	.31128	.19138	.03161	.00547	.02694	.00146
	.350	.39060	.20081	.32318	.18924	.03619	.00625	.03124	.00168
F20%	.388	.40430	.19945	.33021	.18683	.03958	.00683	.03450	.00185
	.400	.40812	.19896	.33204	.18602	.04059	.00700	.03548	.00190
	.450	.42316	.19652	.33865	.18228	.04483	.00771	.03968	.00211
	.500	.43628	.19380	.34355	.17833	.04891	.00839	.04382	.00232
	.550	.44788	.19099	.34713	.17435	.05283	.00904	.04792	.00252
	.600	.45824	.18820	.34967	.17043	.05660	.00966	.05197	.00271
	.650	.46759	.18547	.35137	.16663	.06024	.01026	.05598	.00290
	.700	.47608	.18284	.35241	.16299	.06373	.01083	.05993	.00309
	.750	.48385	.18033	.35290	.15950	.06710	.01137	.06385	.00327
	.800	.49101	.17793	.35295	.15617	.07034	.01190	.06772	.00345
	.850	.49764	.17564	.35263	.15300	.07346	.01240	.07155	.00362
	.900	.50381	.17345	.35200	.14998	.07646	.01287	.07534	.00379
	.950	.50957	.17137	.35112	.14710	.07936	.01333	.07909	.00396
	1.000	.51497	.16937	.35003	.14435	.08215	.01377	.08280	.00412

Table 29. Projection results for Gulf of Maine-Georges Bank witch flounder (stock size, recruits, total stock, spawning stock, and catch numbers in thousands of fish; average catch and stock weights in kilograms; and total stock, spawning stock, and catch weights in metric tons).

The NEFC/PDB Catch and Stock Size Prediction Program - PDBPRED
 Run Date: 22- 6-1994; Time: 12:46:15.76; Projection # 1
 Witch flounder 1994 - revised

 Input for Projections:

Number of Years: 3; Initial Year: 1994; Final Year: 1996
 Number of Ages : 8; Age at Recruitment: 3; Last Age: 10
 Natural Mortality is assumed constant over time at: .150
 Proportion of F before spawning: .1667
 Proportion of M before spawning: .1667
 Last age is a PLUS group;
 Year-specific input data for Projection # 1

Year	Recruits at Age 3	Reference F	Natural Mortality	Target Catch
1994	9052.	.450	.150	N/A
1995	9052.	.450	.150	N/A
1996	9052.	.450	.150	N/A

 Age-specific Input data for Projection # 1

Age	Stock Size in 1994	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights	
					Catch	Stock
3	9052.	.1060	1.0000	.1000	.080	.080
4	19070.	.3030	1.0000	.3600	.215	.215
5	6955.	.5120	1.0000	.9300	.337	.337
6	4300.	.6730	1.0000	.9800	.437	.437
7	1282.	1.0000	1.0000	1.0000	.578	.578
8	918.	1.0000	1.0000	1.0000	.699	.699
9	870.	1.0000	1.0000	1.0000	.847	.847
10+	1335.	1.0000	1.0000	1.0000	1.269	1.269

Year	F(ref)	Recruits	Total Stock		Spawning Stock		Catch	
			Number	Weight	Number	Weight	Number	Weight
1994	.450	9052.	43782.	12861.	21385.	8681.	6524.	2715.
1995	.450	9052.	40708.	13260.	24908.	10369.	6918.	3017.
1996	.450	9052.	37699.	12796.	22485.	10053.	6706.	3084.

Year	F(ref)	Recruits	Total Stock		Spawning Stock		Catch	
			Number	Weight	Number	Weight	Number	Weight
1994	.450	9052.	43782.	12861.	21385.	8681.	6524.	2715.
1995	.410	9052.	40708.	13260.	25007.	10418.	6375.	2786.
1996	.410	9052.	38199.	13067.	23018.	10345.	6308.	2923.

Year	F(ref)	Recruits	Total Stock		Spawning Stock		Catch	
			Number	Weight	Number	Weight	Number	Weight
1994	.450	9052.	43782.	12861.	21385.	8681.	6524.	2715.
1995	.390	9052.	40708.	13260.	25057.	10442.	6099.	2669.
1996	.390	9052.	38453.	13205.	23291.	10495.	6097.	2836.

Year	F(ref)	Recruits	Total Stock		Spawning Stock		Catch	
			Number	Weight	Number	Weight	Number	Weight
1994	.450	9052.	43782.	12861.	21385.	8681.	6524.	2715.
1995	.270	9052.	40708.	13260.	25357.	10590.	4371.	1926.
1996	.270	9052.	40047.	14077.	25015.	11451.	4656.	2215.

Year	F(ref)	Recruits	Total Stock		Spawning Stock		Catch	
			Number	Weight	Number	Weight	Number	Weight
1994	.450	9052.	43782.	12861.	21385.	8681.	6524.	2715.
1995	.150	9052.	40708.	13260.	25662.	10739.	2515.	1116.
1996	.150	9052.	41761.	15027.	26901.	12510.	2862.	1392.

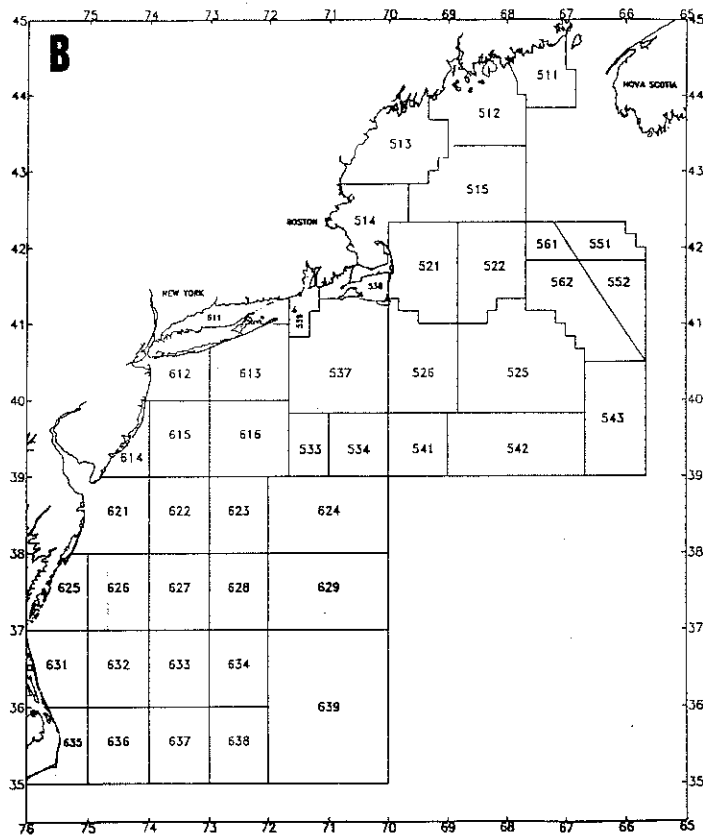
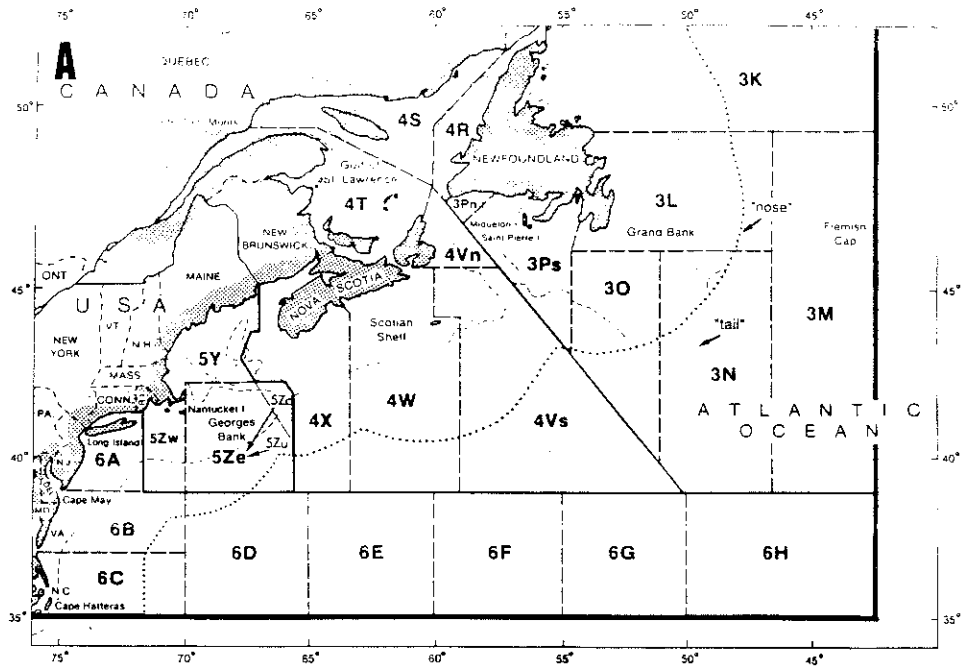


Figure 1. (A) Northwest Atlantic Fisheries Organization Subareas and (B) Statistical Areas used for reporting USA commercial fishery statistics. Prior to 1985, statistical areas 551 and 561 comprised statistical area 523, and statistical areas 552 and 562 comprised statistical area 524.

WITCH FLOUNDER - SPRING

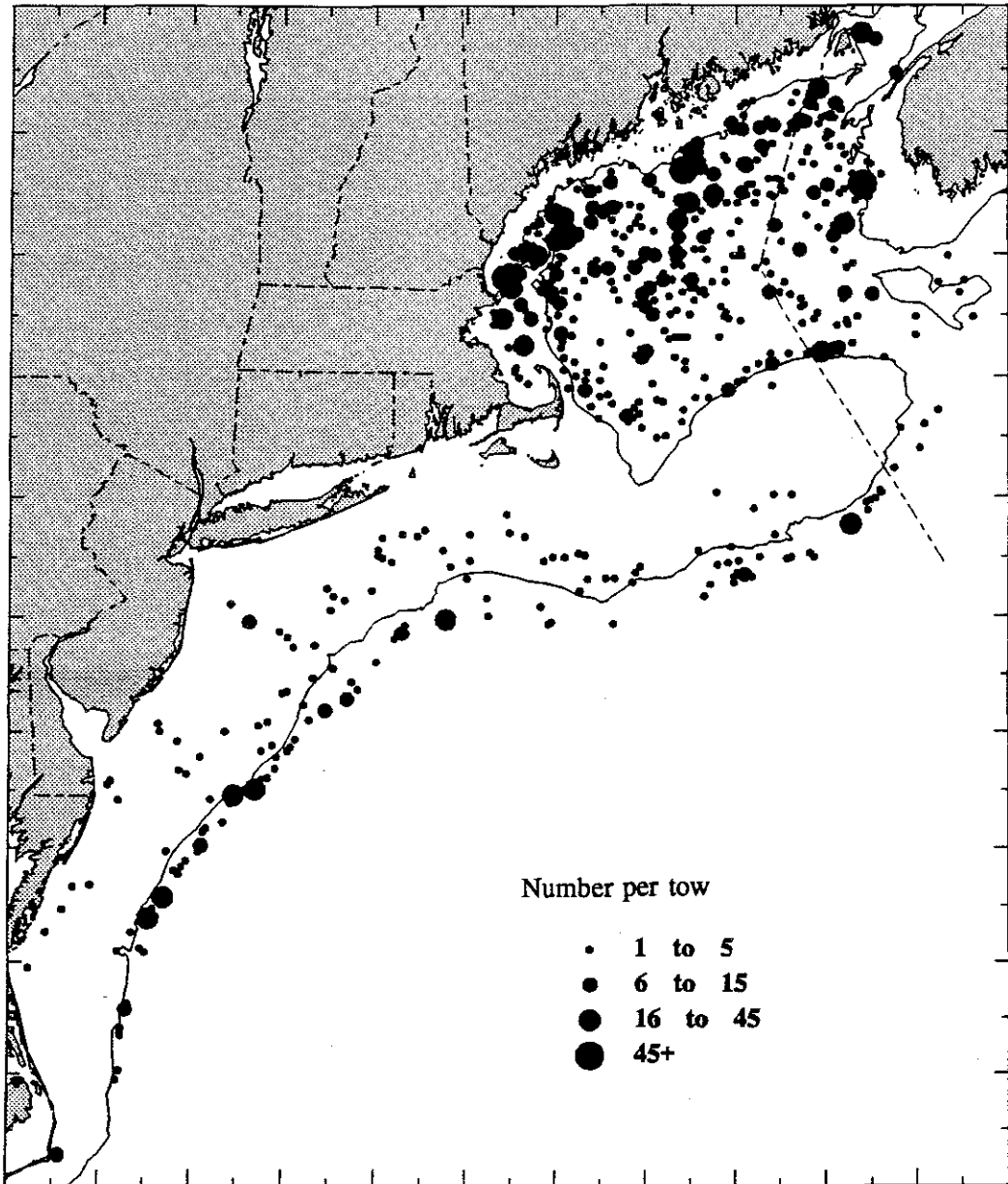


Figure 2. Distribution of witch flounder observed in NEFSC spring bottom trawl surveys, 1982-1992.

WITCH FLOUNDER - AUTUMN

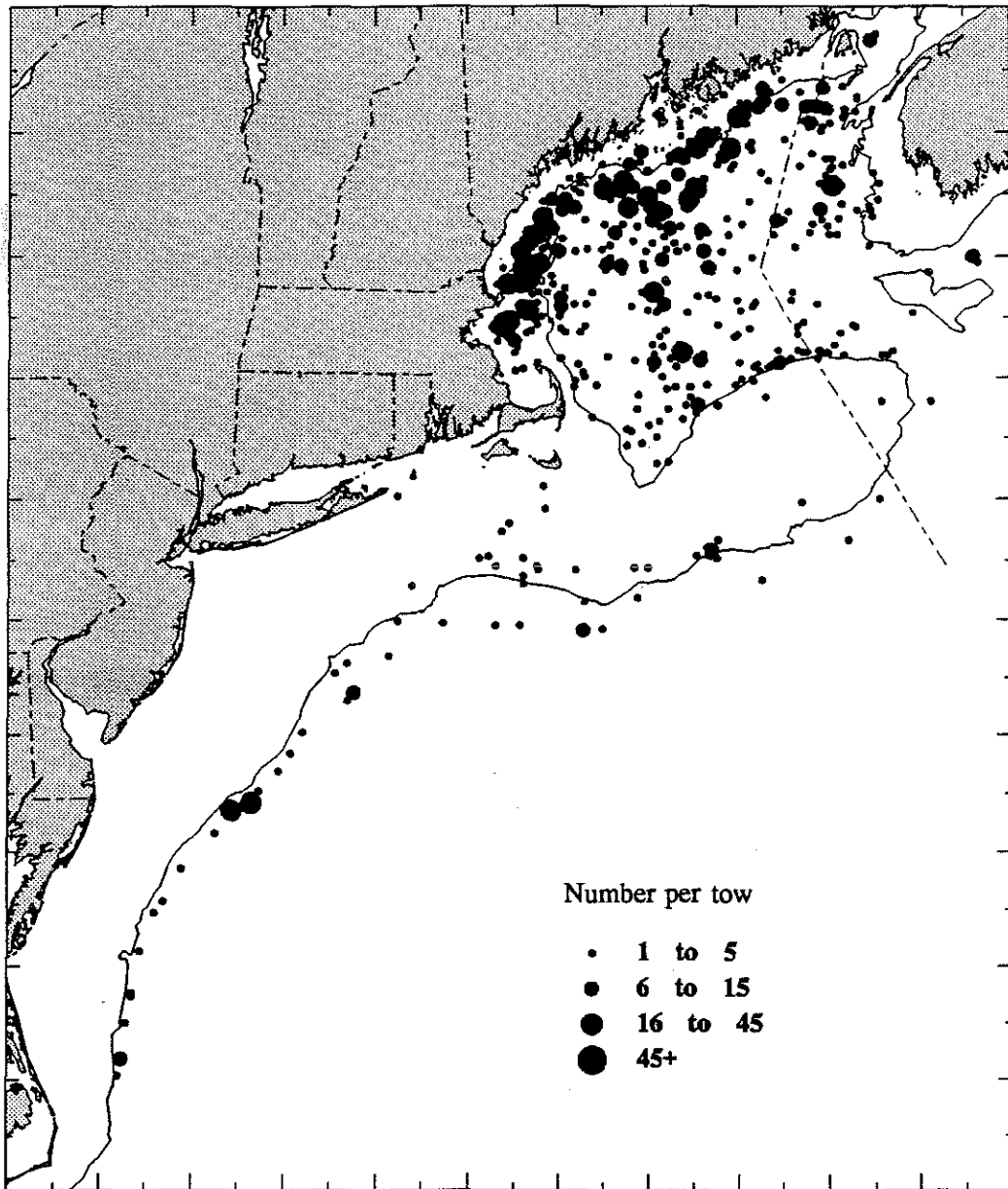


Figure 3. Distribution of witch flounder observed in NEFSC autumn bottom trawl surveys, 1982-1992.

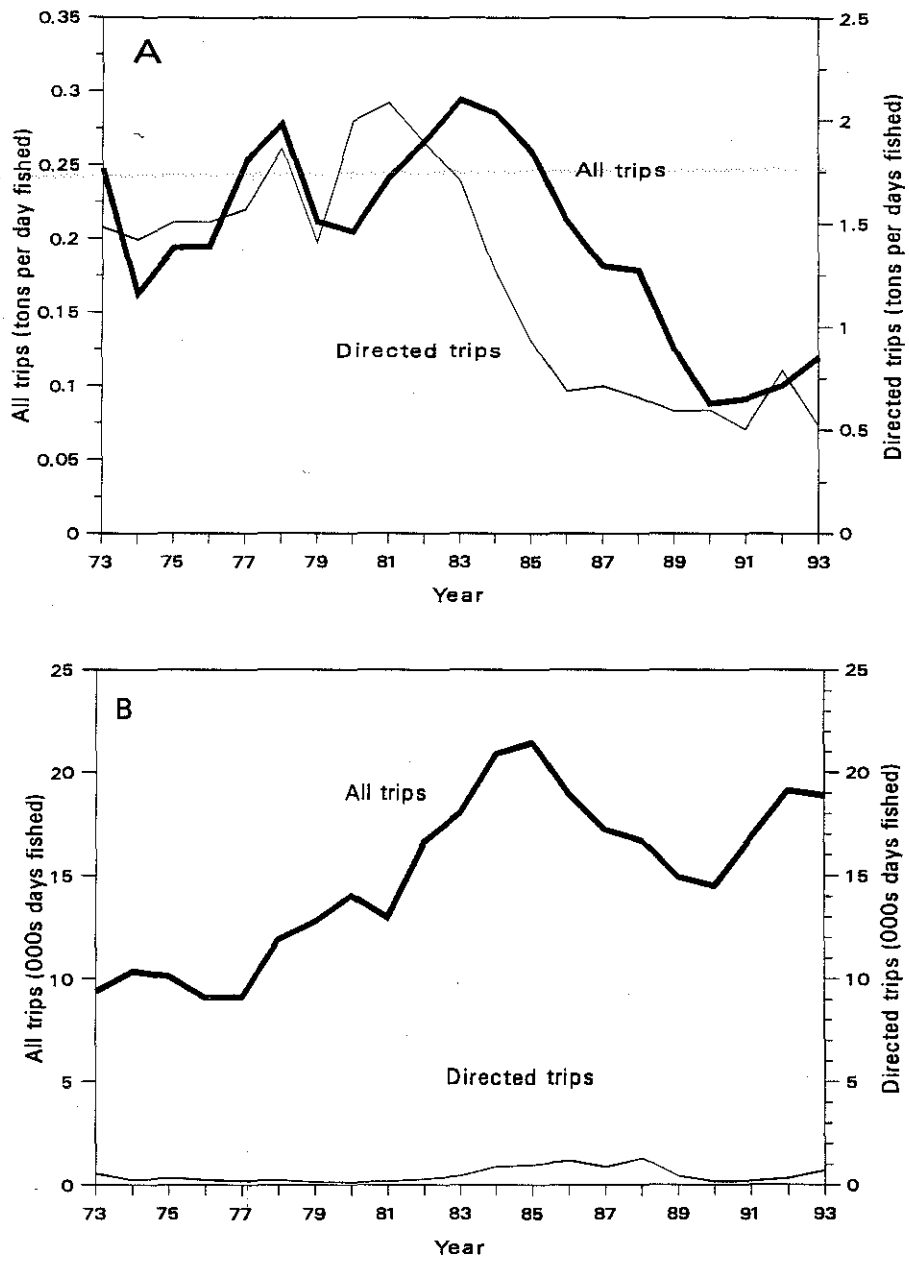


Figure 4. Trends in USA landings per day fished (A) and effort (B) of witch flounder, 1973-1993. Data are based on all otter trawl trips in which witch flounder were caught (All trips), and for otter trawl trips in which witch flounder constituted 40% or more of the trip catch, by weight (Directed trips).

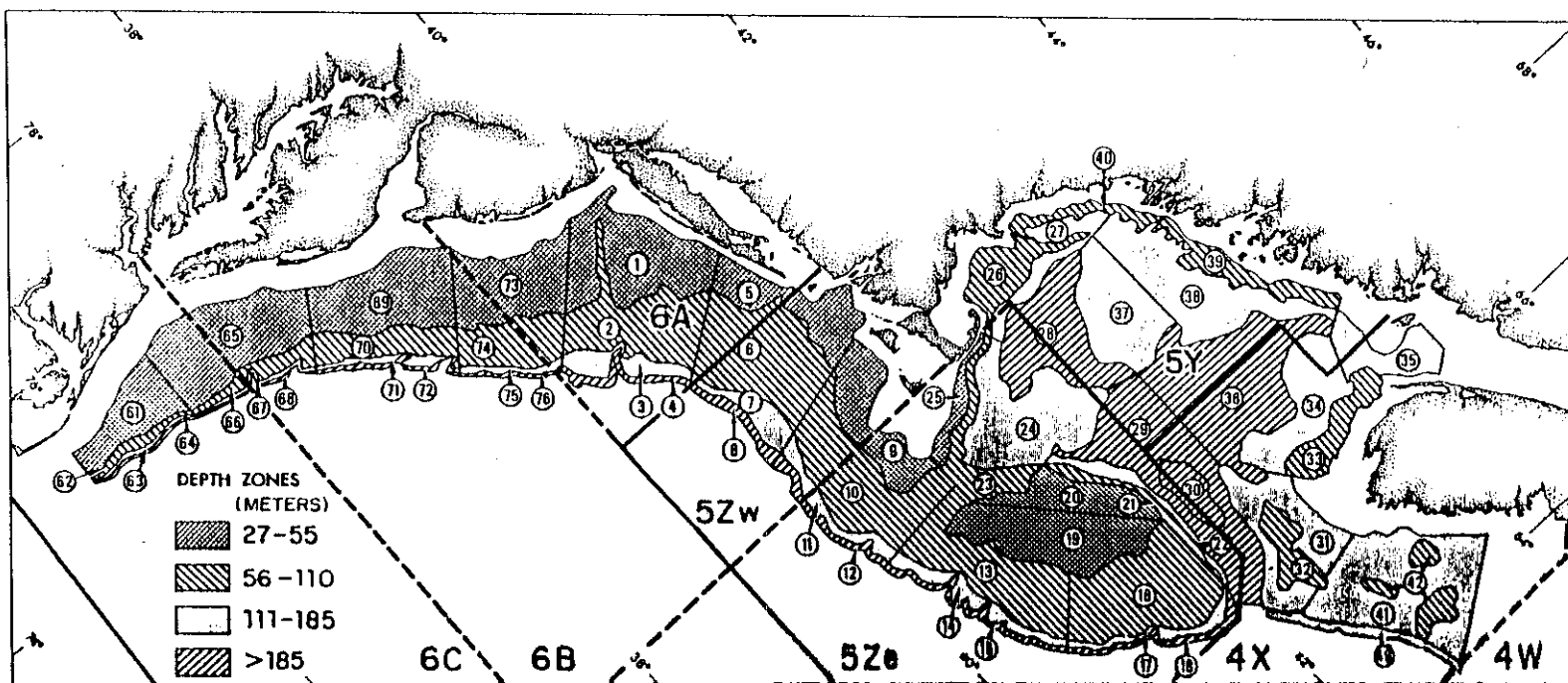


Figure 5. Sampling strata used in NEFSC spring and autumn bottom trawl surveys.

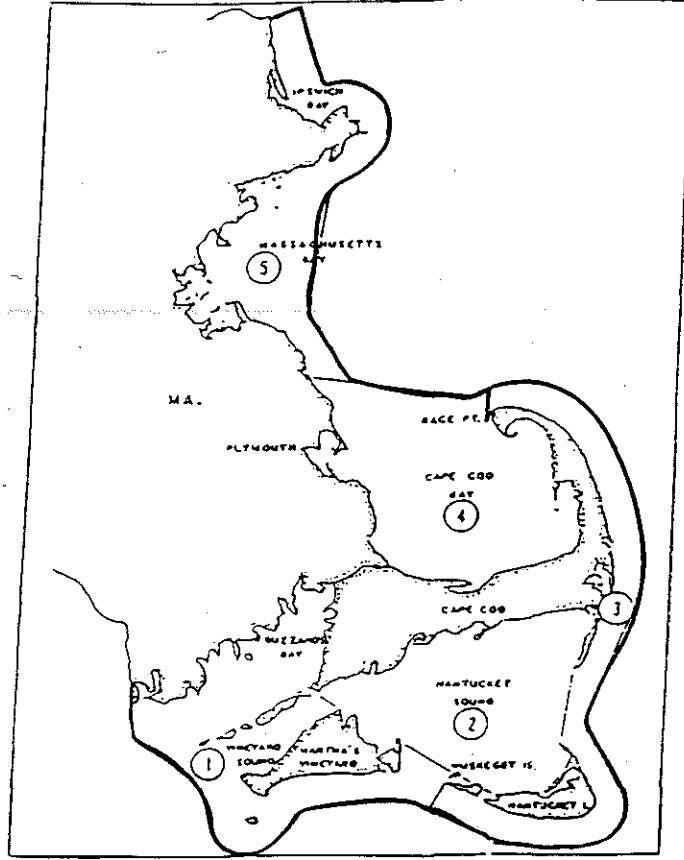


Figure 6. Massachusetts inshore bottom trawl survey area delineated by regions.

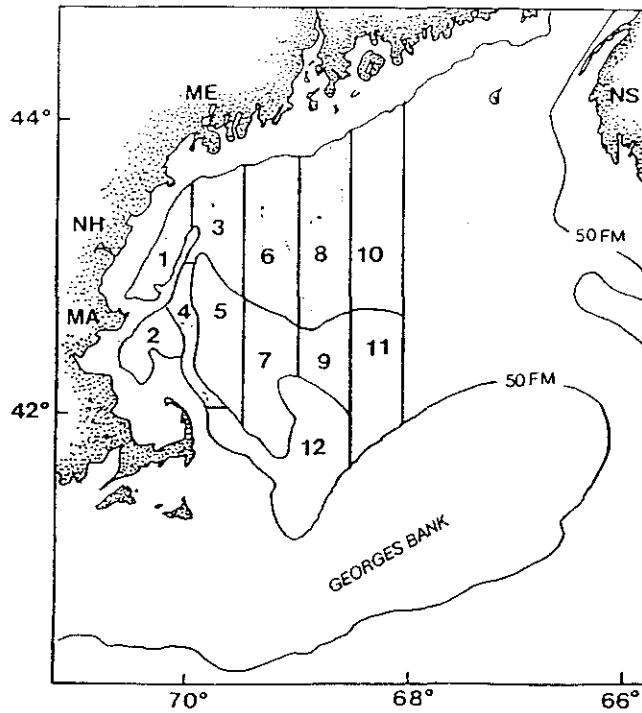


Figure 7. Sampling strata used in ASMFC northern shrimp surveys.

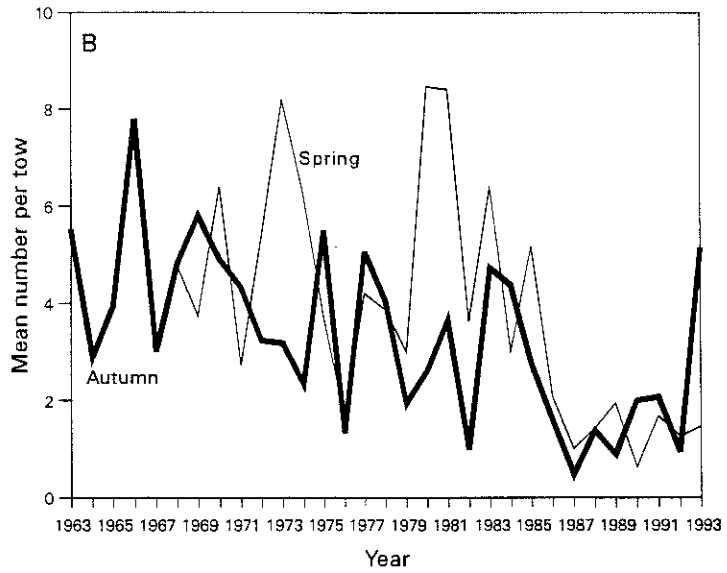
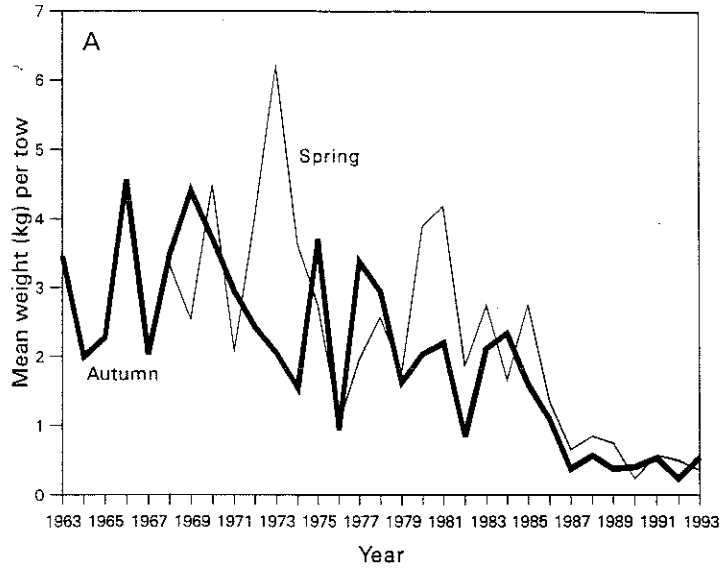


Figure 8. Stratified mean catch (kg) per tow (A) and mean number per tow (B) of witch flounder in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine-Georges Bank region, 1963-1993.

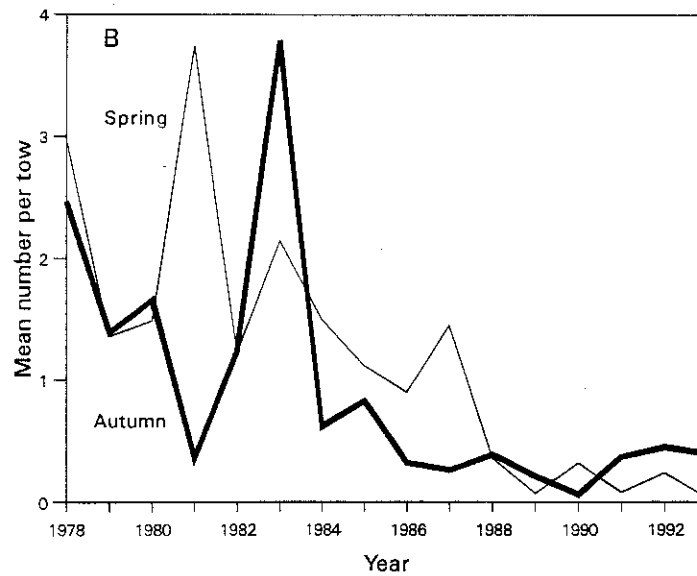
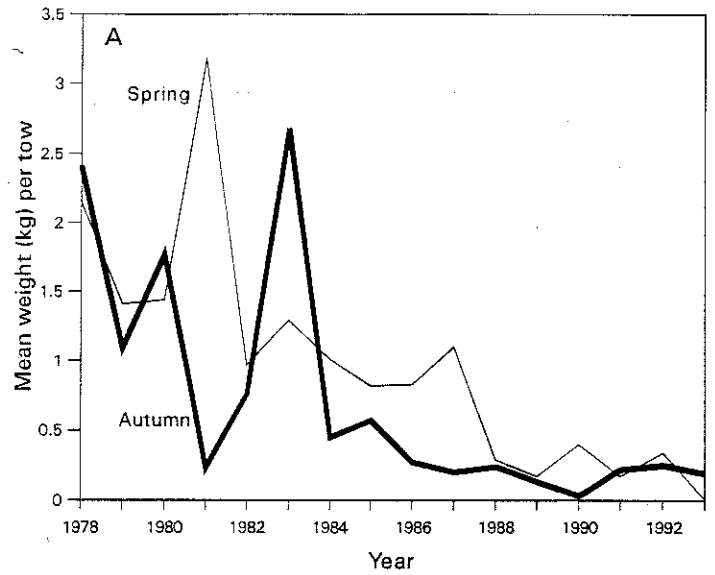


Figure 9. Stratified mean catch (kg) per tow (A) and mean number per tow (B) of witch flounder in Massachusetts Division of Marine Fisheries spring and autumn research vessel bottom trawl surveys in the Cape Cod Bay-Massachusetts Bay region, 1978-1993.

Witch Flounder Summer Shrimp Survey

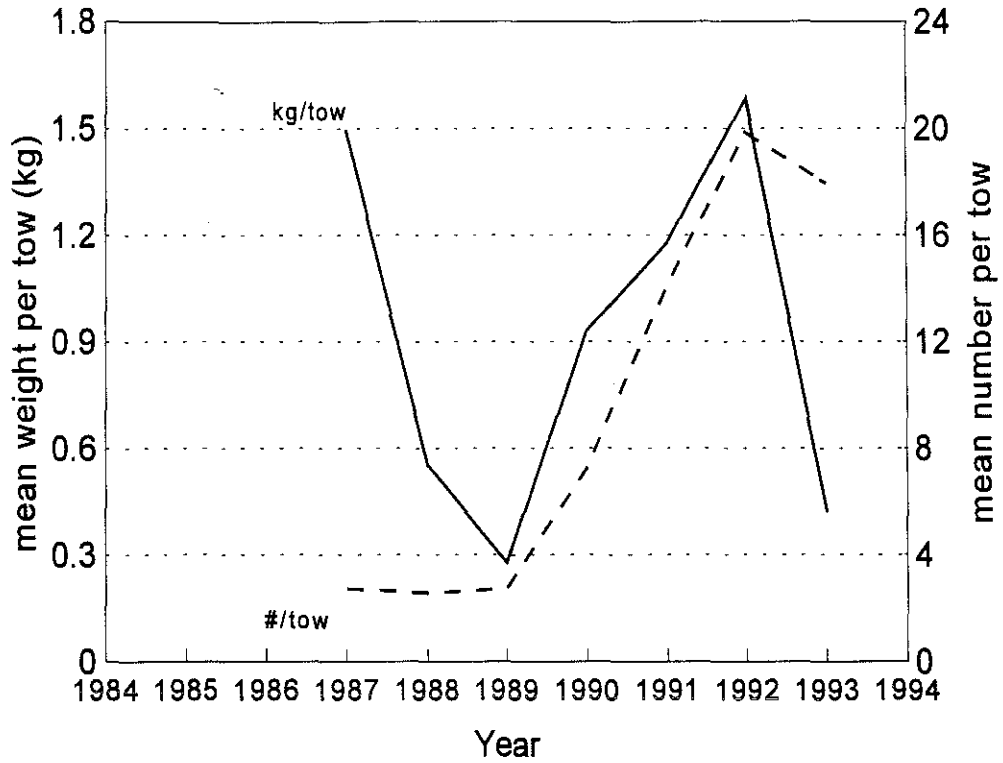


Figure 10. Stratified mean catch per tow, in number and weight (kg), of witch flounder in the ASMFC summer northern shrimp surveys, 1987-1993.

NEFSC Spring Survey Length Composition

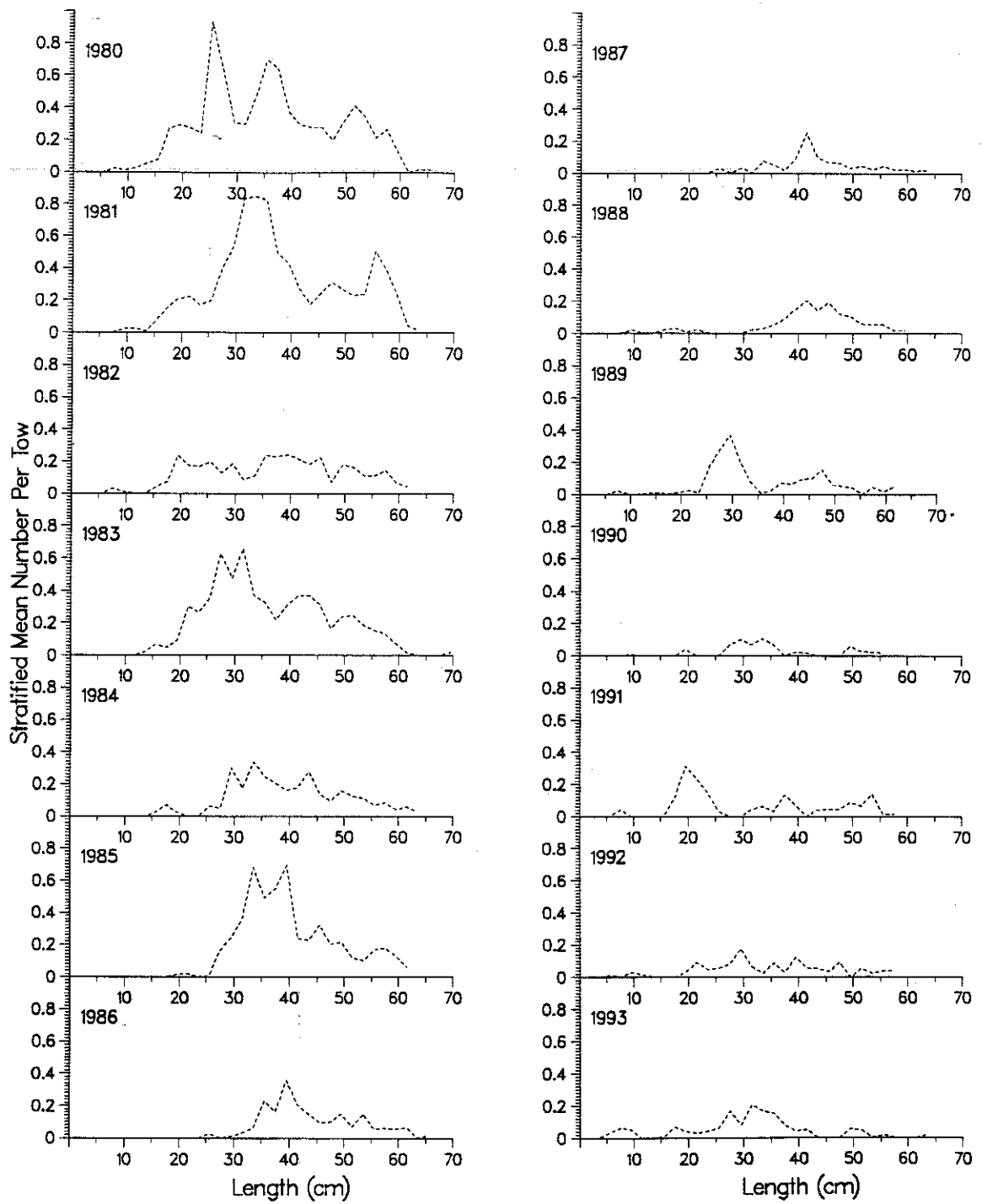


Figure 11. Stratified mean number per tow at length of witch flounder in NEFSC spring bottom trawl surveys, 1980-1993.

NEFSC Autumn Survey Length Composition

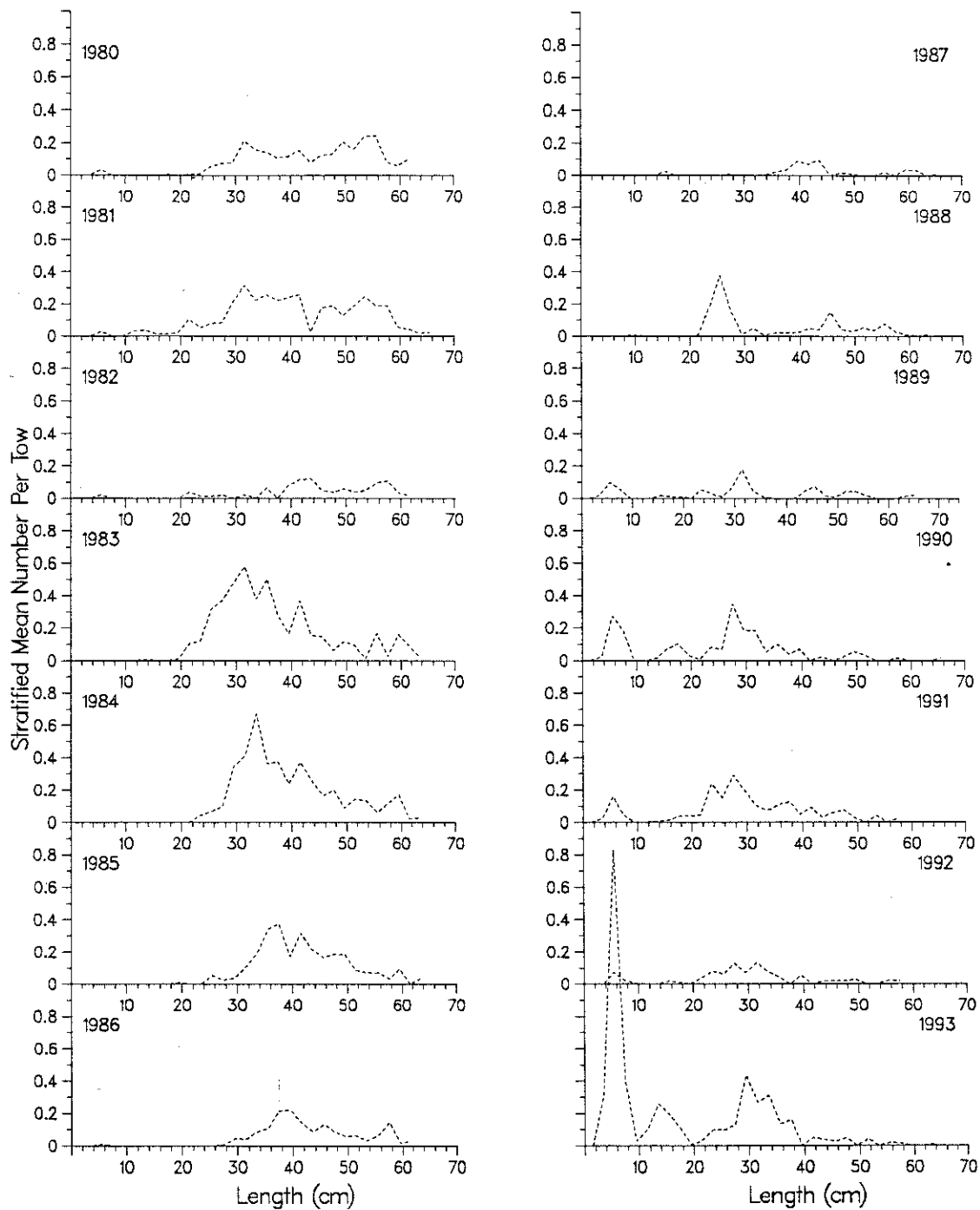


Figure 12. Stratified mean number per tow at length of witch flounder in NEFSC autumn bottom trawl surveys, 1980-1993.

MASS INSHORE SURVEY
SPRING SURVEY AUTUMN SURVEY

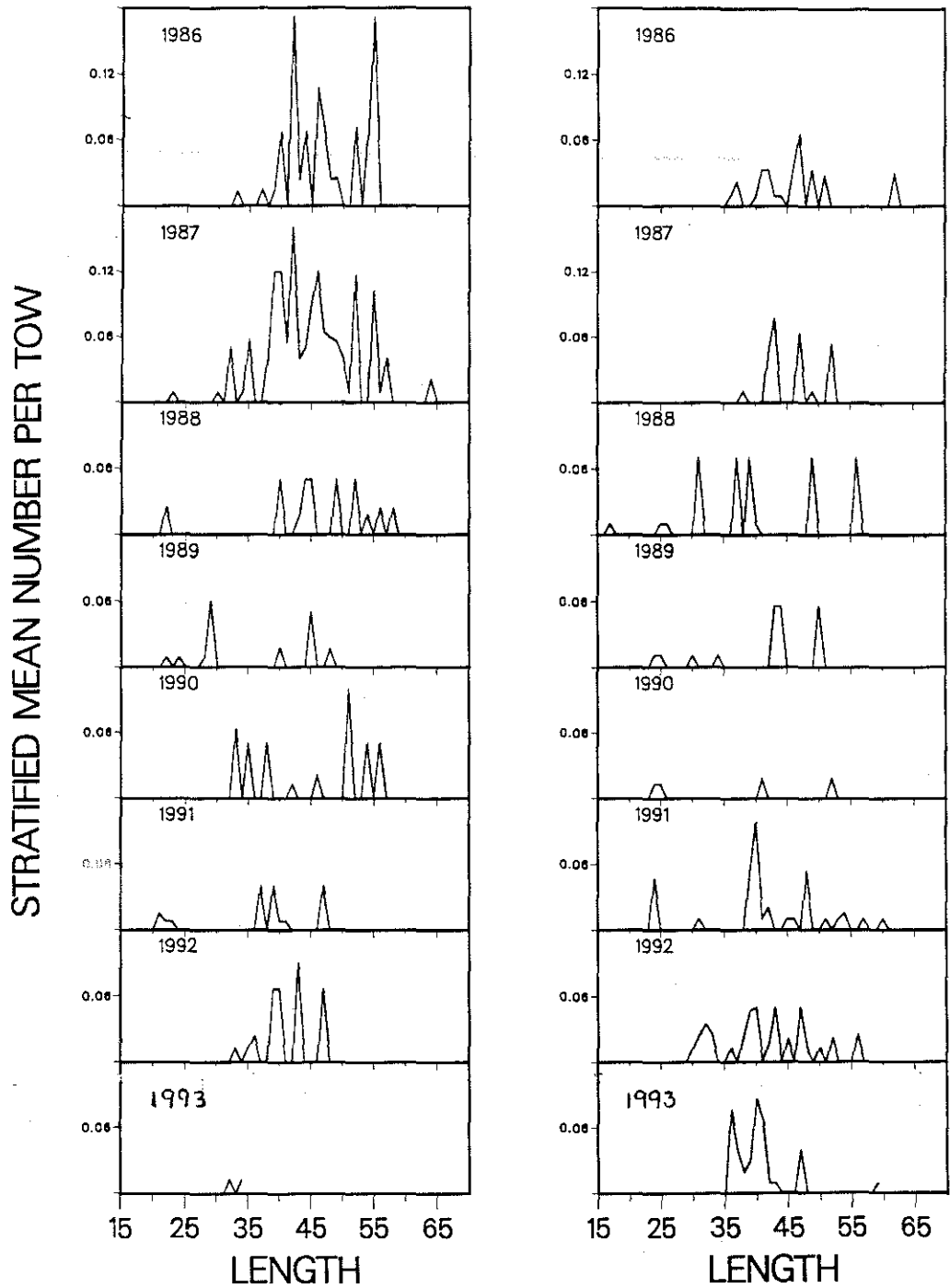


Figure 13. Stratified mean number per tow at length of witch flounder in Massachusetts spring and autumn bottom trawl surveys, 1986-1993.

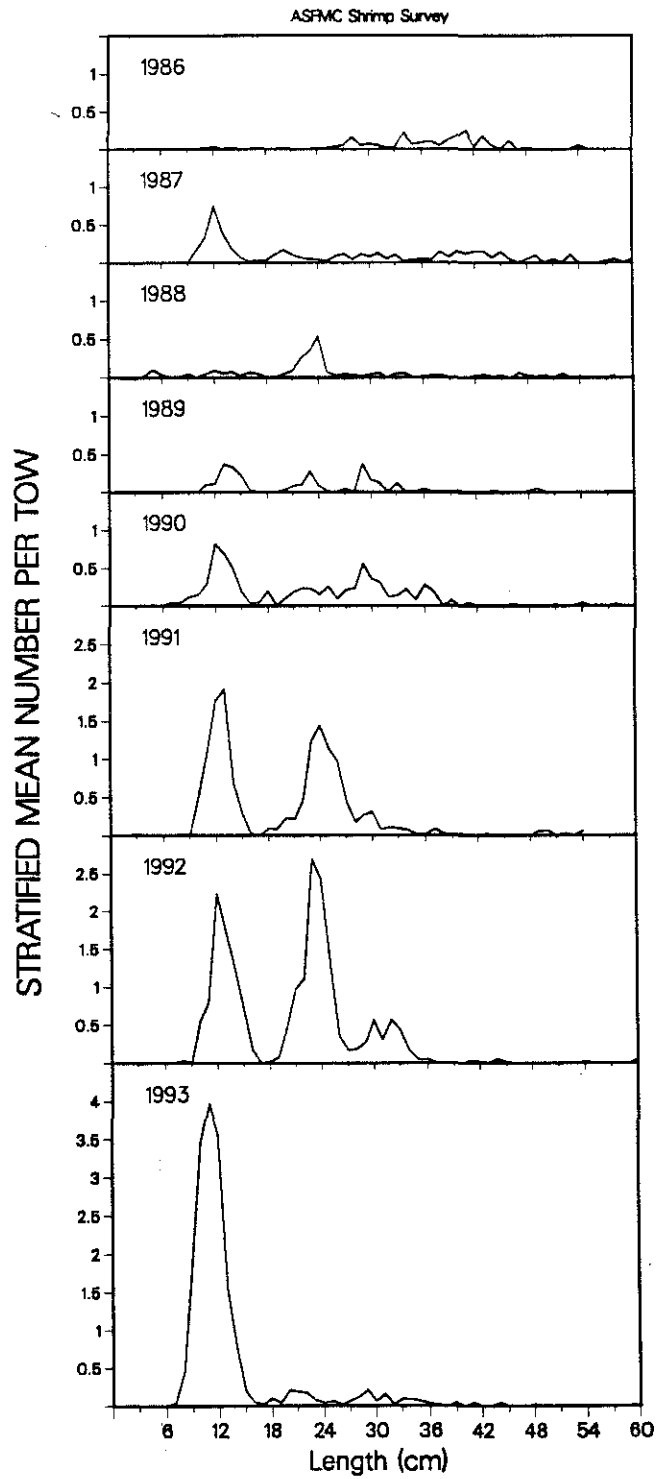


Figure 14. Stratified mean number per tow at length of witch flounder in ASMFC summer northern shrimp trawl surveys, 1986-1993.

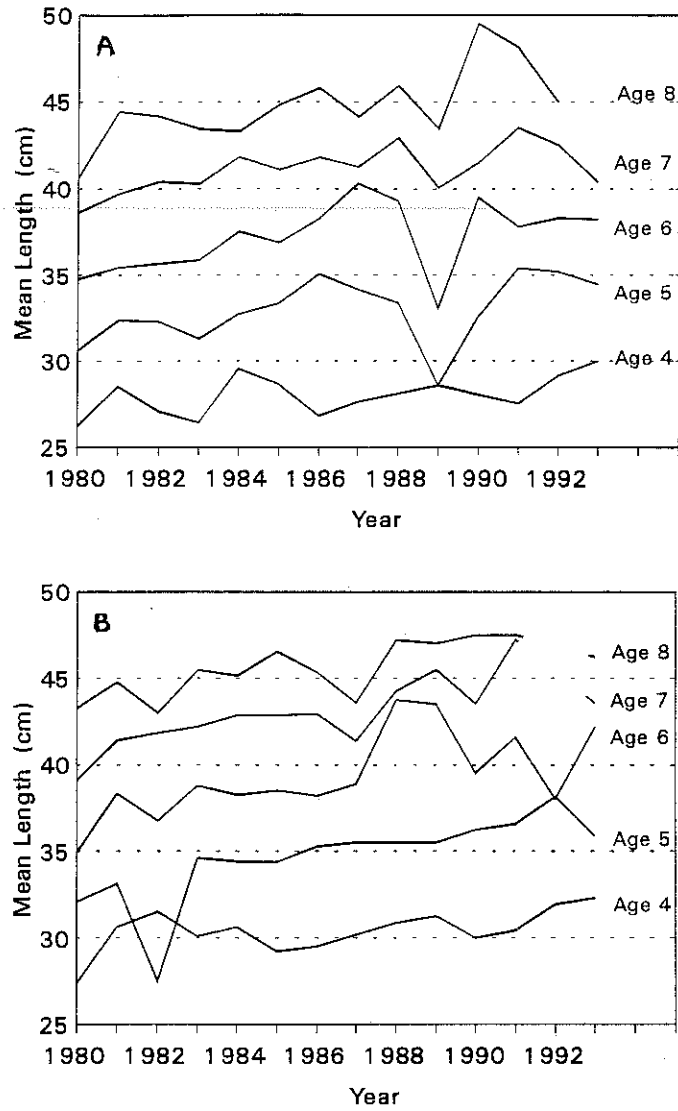


Figure 15. Mean length (cm) at age for age groups 4-8 of witch flounder in spring (A) and autumn (B) NEFSC bottom trawl surveys, 1980-1993.

**GULF OF MAINE - GEORGES BANK WITCH FLOUNDER
TRENDS IN COMMERCIAL CATCHES AND FISHING MORTALITY**

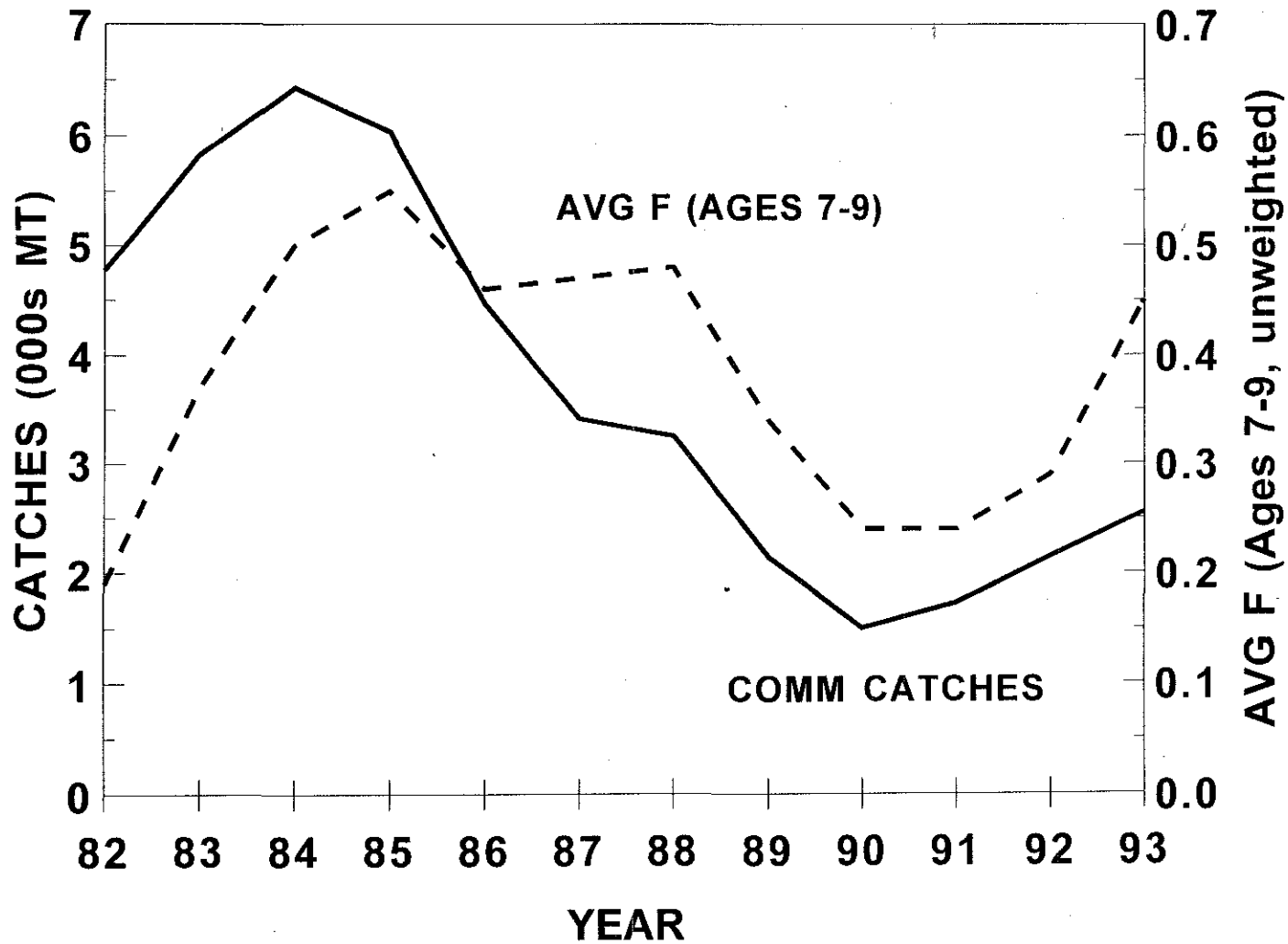


Figure 16. Trends in total commercial catches and fishing mortality for Gulf of Maine - Georges Bank witch flounder, 1982 - 1993.

**GULF OF MAINE - GEORGES BANK WITCH FLOUNDER
TRENDS IN SSB AND RECRUITMENT (R)**

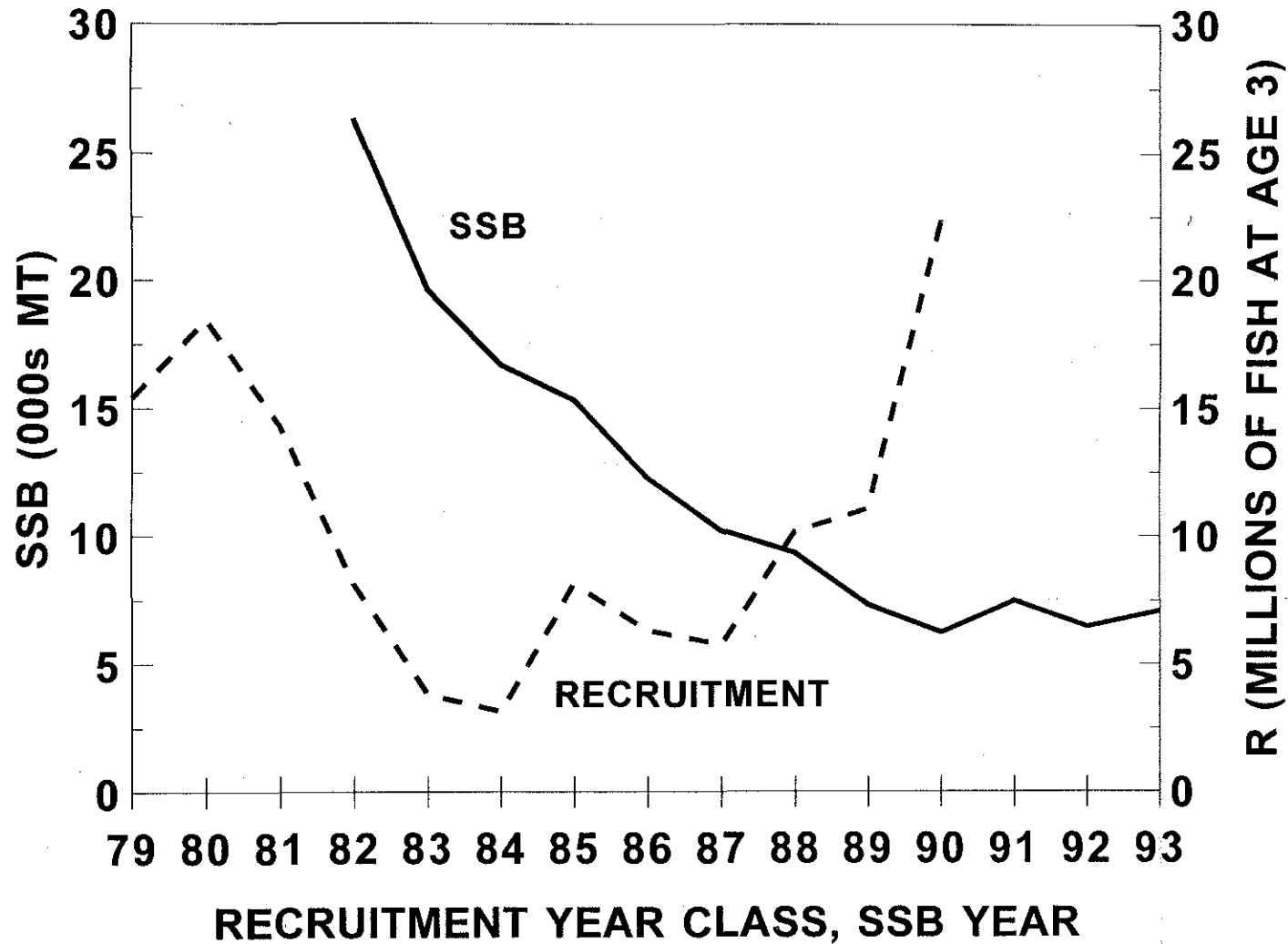


Figure 17. Trends in spawning stock biomass and recruitment for Gulf of Maine - Georges Bank witch flounder.

Witch Flounder Precision of 1993 F Estimate

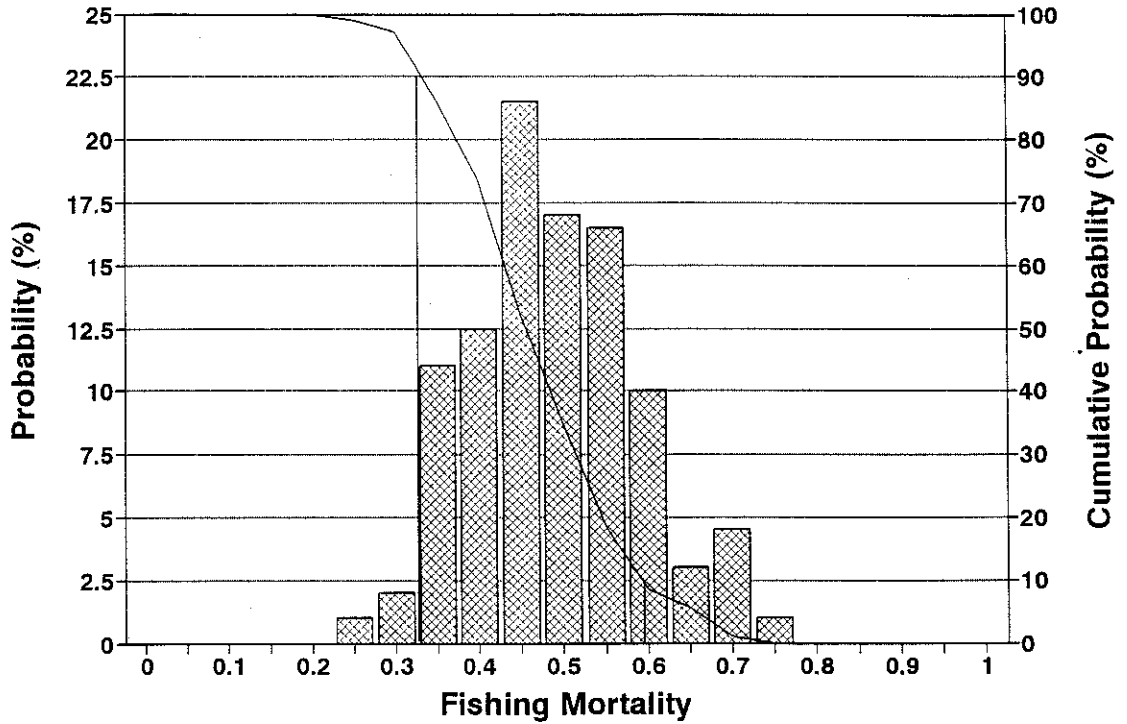


Figure 18. Precision of the estimates of the instantaneous rate of fishing mortality (F) on the fully recruited ages (7+) in 1993 for Gulf of Maine - Georges Bank witch flounder. The vertical bars show both the range of the estimator and the probability of individual values within the range. The solid line gives the probability that F is greater than any selected values on the X-axis. The precision estimates were derived from 200 bootstrap replications of the final ADAPT VPA formulation.

Witch Flounder Precision of 1993 SSB Estimate

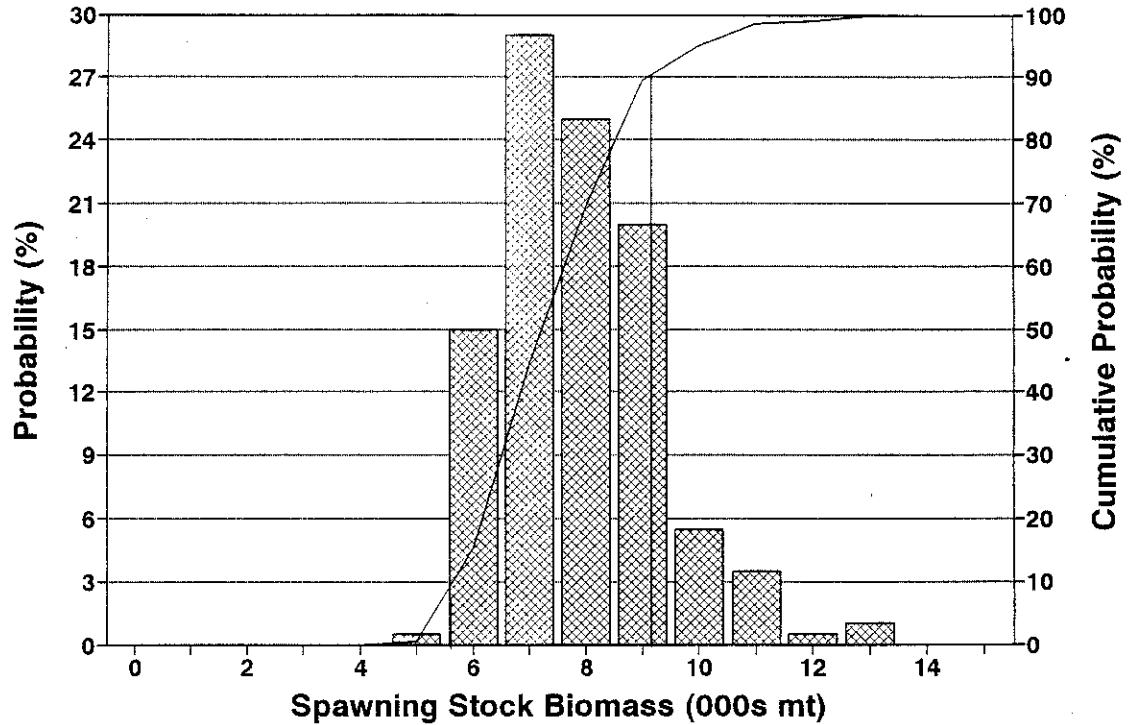


Figure 19. Precision of the estimates of the 1993 spawning stock biomass (SSB) at the beginning of the spawning season (April 1) for Gulf of Maine - Georges Bank witch flounder. The vertical bars show both the range of the estimator and the probability of the individual values within the range. The solid line gives the probability that SSB is less than any selected value on the X-axis. The precision estimates were derived from 200 bootstrap replications of the final ADAPT VPA formulation.

GULF OF MAINE-GEORGES BANK WITCH FLOUNDER YIELD AND SPAWNING STOCK BIOMASS PER RECRUIT

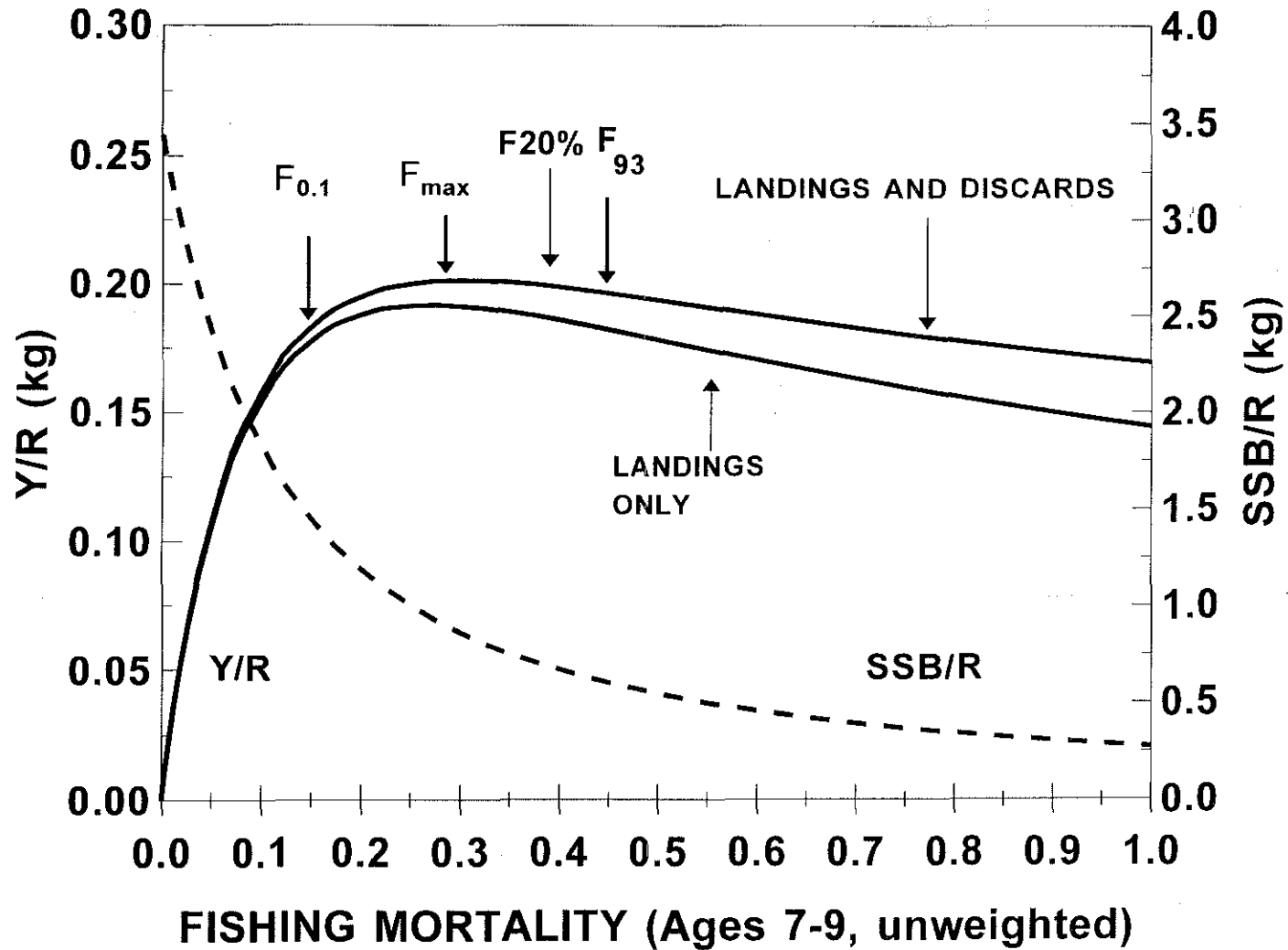


Figure 20. Yield per recruit (YPR) and spawning stock biomass per recruit (SSB/R) for Gulf of Maine - Georges Bank witch flounder.

GULF OF MAINE-GEORGES BANK WITCH FLOUNDER SHORT-TERM CATCHES AND SPAWNING STOCK BIOMASS

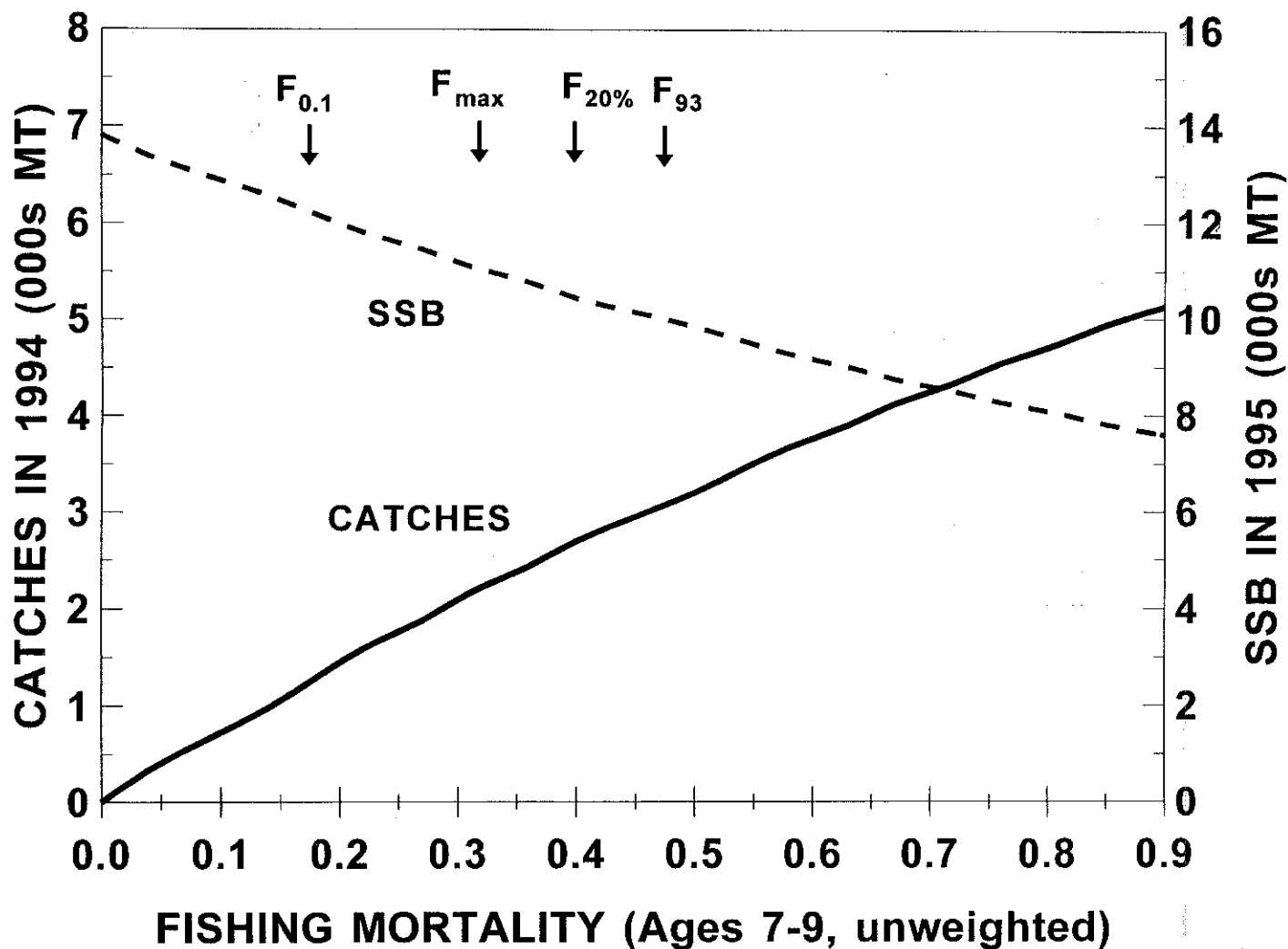


Figure 21. Predicted catches in 1994 and spawning stock biomass in 1995 of Gulf of Maine-Georges Bank witch flounder for fishing mortalities in 1994 ranging between $F=0.0$ and $F=0.9$.

APPENDIX 1

Full Listing of ADAPT VPA Calibration Output and Diagnostics for Witch Flounder

ADAPT Run Number 34 1994 6 16 13 6 53

1982-1993 WITCH FLOUNDER: GB & GM WIT94R

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

INPUT PARAMETERS AND OPTIONS SELECTED

Natural mortality is 0.15
Oldest age (not in the plus group) is 9

For all yrs prior to the terminal year (1993), backcalculated stock sizes for the following ages used to estimate total mortality (Z) for age 9: 7 8 9
This method for estimating F on the oldest age is generally used when a flat-topped partial recruitment curve is thought to be characteristic of the stock.

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

1982 1.0000
1983 1.0000
1984 1.0000
1985 1.0000
1986 1.0000
1987 1.0000
1988 1.0000
1989 1.0000
1990 1.0000
1991 1.0000
1992 1.0000
1993 1.0000

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

Partial recruitment estimate for 1993

1 0.0001
2 0.0390
3 0.1060
4 0.3030
5 0.5120
6 0.6730
7 1.0000
8 1.0000
9 1.0000

Objective function is $SUM w*(LOG(OBS) - LOG(PRED))^{**2}$

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

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

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

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

Par.	Initial Est	Lower Bnd	Upper Bnd
N 4	1.000000E4	0.000000E0	1.000000E6
N 7	1.000000E3	0.000000E0	1.000000E6
N 8	1.000000E3	0.000000E0	1.000000E6
N 9	1.000000E3	0.000000E0	1.000000E6
qRV SPR 3	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 4	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 5	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 6	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 7	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 8	1.000000E-4	0.000000E0	1.000000E0
qRV SPR 9	1.000000E-4	0.000000E0	1.000000E0
qRV FAL 3	1.000000E-4	0.000000E0	1.000000E0
qRV FAL 4	1.000000E-4	0.000000E0	1.000000E0

```

qRV FAL 5 1.000000E-4 0.000000E0 1.000000E0
qRV FAL 6 1.000000E-4 0.000000E0 1.000000E0
qRV FAL 7 1.000000E-4 0.000000E0 1.000000E0
qRV FAL 8 1.000000E-4 0.000000E0 1.000000E0
qRV FAL 9 1.000000E-4 0.000000E0 1.000000E0
qLPUEAS 7 1.000000E-4 0.000000E0 1.000000E0
qLPUEAS 8 1.000000E-4 0.000000E0 1.000000E0
qLPUEAS 9 1.000000E-4 0.000000E0 1.000000E0

```

The following indices of abundance are available:

```

1 RV SPR 3
2 RV SPR 4
3 RV SPR 5
4 RV SPR 6
5 RV SPR 7
6 RV SPR 8
7 RV SPR 9
8 RV SPR10
9 RV FAL 3
10 RV FAL 4
11 RV FAL 5
12 RV FAL 6
13 RV FAL 7
14 RV FAL 8
15 RV FAL 9
16 RV FAL10
17 LPUE AA
18 MSURV A
19 RV SPR A
20 RV AUT A
21 MSURV S
22 LPUEAS 7
23 LPUEAS 8
24 LPUEAS 9
25 LPUEAS10

```

Indices that will be used in this run are: 1 2 3 4 5 6 7 9 10 11 12 13 14 15 22 23 24

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

■	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.560	0.580	0.100	0.020	0.000	0.000	0.060	0.040	0.040	0.780	0.190	0.140
2	0.570	1.250	0.330	0.430	0.040	0.060	0.000	0.980	0.090	0.110	0.370	0.460
3	0.340	1.330	0.730	1.110	0.240	0.120	0.070	0.120	0.320	0.110	0.080	0.330
4	0.210	0.550	0.420	1.190	0.530	0.120	0.310	0.070	0.020	0.190	0.120	0.060
5	0.640	0.640	0.260	0.860	0.430	0.260	0.380	0.100	0.020	0.020	0.150	0.080
6	0.410	0.670	0.280	0.450	0.170	0.170	0.250	0.310	0.020	0.090	0.050	0.000
7	0.080	0.480	0.240	0.130	0.180	0.030	0.160	0.070	0.060	0.100	0.140	0.020
9	0.030	0.000	0.010	0.000	0.010	0.000	0.020	0.000	0.020	0.110	0.170	0.110
10	0.240	0.060	0.490	0.080	0.070	0.010	0.010	0.710	0.080	0.390	0.670	0.270
11	0.440	0.010	1.600	0.970	0.060	0.040	0.000	0.070	0.300	0.520	0.350	0.220
12	0.610	0.020	0.780	1.010	0.600	0.270	0.020	0.000	0.010	0.170	0.270	0.060
13	0.460	0.080	0.510	0.580	0.620	0.360	0.050	0.030	0.020	0.050	0.150	0.050
14	0.270	0.250	0.470	0.540	0.580	0.310	0.180	0.220	0.040	0.020	0.090	0.000
15	0.260	0.130	0.110	0.320	0.240	0.150	0.070	0.060	0.050	0.020	0.060	0.000
22	0.039	0.083	0.068	0.069	0.080	0.090	0.081	0.050	0.018	0.013	0.034	0.030
23	0.038	0.051	0.068	0.057	0.043	0.049	0.068	0.058	0.031	0.013	0.010	0.029
24	0.023	0.039	0.032	0.028	0.021	0.027	0.024	0.023	0.022	0.016	0.008	0.011

■	1994*****	
1	-999.000	0.251
2	-999.000	0.426
3	-999.000	0.408
4	-999.000	0.316
5	-999.000	0.320
6	-999.000	0.261
7	-999.000	0.141
9		0.110 0.066
10		0.550 0.279
11		0.760 0.445
12		0.230 0.338
13		0.060 0.232
14		0.030 0.250
15		0.080 0.129
22	-999.000	0.055

23 ■ -999.000 0.043
 24 ■ -999.000 0.023

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	1.00	1.00	1.00	1.00	-99.00	-99.00	1.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	-99.00	1.00	-99.00	1.00	-99.00	1.00	-99.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

	1993	1994
1	1.00	-99.00
2	1.00	-99.00
3	1.00	-99.00
4	1.00	-99.00
5	1.00	-99.00
6	-99.00	-99.00
7	1.00	-99.00
9	1.00	1.00
10	1.00	1.00
11	1.00	1.00
12	1.00	1.00
13	1.00	1.00
14	-99.00	1.00
15	-99.00	1.00
22	1.00	-99.00
23	1.00	-99.00
24	1.00	-99.00

Negative weights in the above table indicate missing values

DOWNWEIGHTS BY YEAR (delta)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

	1	2	3	4	5	6	7	9	10	11
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - WIT94R

	1982	1983	1984	1985	1986	1987	1988	1989
1	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	-99.0000	1.0000	-99.0000	1.0000	-99.0000	1.0000	-99.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	1990	1991	1992	1993	1994
1	1.0000	1.0000	1.0000	1.0000	-99.0000
2	1.0000	1.0000	1.0000	1.0000	-99.0000
3	1.0000	1.0000	1.0000	1.0000	-99.0000
4	1.0000	1.0000	1.0000	1.0000	-99.0000
5	1.0000	1.0000	1.0000	1.0000	-99.0000
6	1.0000	1.0000	1.0000	-99.0000	-99.0000
7	1.0000	1.0000	1.0000	1.0000	-99.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	-99.0000	1.0000
15	1.0000	1.0000	1.0000	-99.0000	1.0000
22	1.0000	1.0000	1.0000	1.0000	-99.0000
23	1.0000	1.0000	1.0000	1.0000	-99.0000
24	1.0000	1.0000	1.0000	1.0000	-99.0000

Negative weights in the above table indicate missing values

CATCH AT AGE (thousands) - WIT94R

	1982	1983	1984	1985	1986	1987	1988	1989
1	0.20	0.00	0.00	0.00	0.00	0.00	15.62	2.95
2	0.10	0.30	0.10	3.09	3.04	4.81	141.80	8.96
3	174.76	299.78	137.48	14.54	14.33	15.19	625.43	70.09
4	1054.39	1181.01	1379.66	1112.36	363.10	178.72	131.55	630.96
5	1170.76	1424.23	1910.19	2159.15	1467.39	460.23	270.84	162.57
6	1417.02	1491.88	1655.38	1899.82	2677.95	1252.12	645.63	306.20
7	639.60	1505.40	1413.60	1487.30	1511.60	1539.40	1354.70	739.70
8	630.70	925.60	1424.00	1217.10	805.40	851.40	1130.80	859.30
9	384.10	698.30	662.50	591.00	398.10	469.80	393.40	340.60
10	1747.90	2069.40	1991.20	1716.20	946.50	725.10	846.70	459.20
1+	7219.53	9595.89	10574.12	10200.56	8187.41	5496.77	5556.47	3580.54

	1990	1991	1992	1993
1	5.19	8.29	40.34	46.66
2	54.65	11.21	155.68	120.73
3	320.73	431.55	276.11	214.10
4	480.20	383.64	965.04	1106.82
5	747.79	792.34	798.63	1214.37
6	245.10	530.35	860.10	862.39
7	262.60	217.60	654.60	559.60
8	451.70	225.70	184.10	548.70
9	320.20	269.60	162.40	205.00
10	248.20	527.30	453.80	626.90
1+	3136.35	3397.57	4550.79	5505.26

	CAA summary for ages 3 9 4 9 5 9 6 9 7 9						
	1982	1983	1984	1985	1986	1987	1988
3	5471.331	7526.188	8582.815	8481.266	7237.872	4766.855	4552.354
4	5296.573	7226.411	8445.332	8466.724	7223.541	4751.665	3926.926
5	4242.182	6045.401	7065.677	7354.363	6860.439	4572.949	3795.375
6	3071.424	4621.175	5155.484	5195.217	5393.050	4112.715	3524.533
7	1654.400	3129.300	3500.100	3295.400	2715.100	2860.600	2878.900

	1989	1990	1991	1992	1993
3					
4					
5					
6					
7					

3	■	3109.424	2828.320	2850.775	3900.977	4710.974
4	■	3039.336	2507.592	2419.227	3624.869	4496.875
5	■	2408.375	2027.394	2035.589	2659.825	3390.058
6	■	2245.800	1279.600	1243.248	1861.200	2175.691
7	■	1939.600	1034.500	712.900	1001.100	1313.300

■	1982	1983	WT 1984	AT AGE 1985	(MID-YR) 1986	in kg. 1987	- WIT94R 1988	1989	1990	1991
1	■	0.002	0.005	0.005	0.005	0.005	0.006	0.005	0.011	0.004
2	■	0.016	0.034	0.016	0.017	0.017	0.015	0.012	0.014	0.024
3	■	0.157	0.154	0.150	0.073	0.067	0.063	0.040	0.046	0.057
4	■	0.240	0.211	0.232	0.238	0.206	0.188	0.210	0.156	0.198
5	■	0.328	0.274	0.329	0.300	0.299	0.299	0.324	0.254	0.288
6	■	0.421	0.409	0.421	0.427	0.408	0.433	0.463	0.425	0.438
7	■	0.550	0.518	0.539	0.565	0.565	0.561	0.572	0.574	0.586
8	■	0.727	0.613	0.664	0.691	0.691	0.686	0.657	0.682	0.688
9	■	0.886	0.795	0.817	0.842	0.842	0.828	0.801	0.818	0.849
10	■	1.350	1.268	1.264	1.244	1.244	1.193	1.213	1.256	1.327

■	1992	1993	
1	■	0.004	0.003
2	■	0.022	0.024
3	■	0.093	0.121
4	■	0.241	0.219
5	■	0.378	0.334
6	■	0.458	0.432
7	■	0.614	0.535
8	■	0.729	0.666
9	■	0.822	0.882
10	■	1.156	1.205

■	1982	1983	WT 1984	AT AGE 1985	(JAN 1) 1986	in kg. 1987	- WIT94R 1988	1989	1990	1991
1	■	0.000	0.003	0.003	0.003	0.003	0.004	0.003	0.007	0.002
2	■	0.005	0.008	0.009	0.009	0.009	0.009	0.008	0.008	0.016
3	■	0.136	0.050	0.071	0.034	0.034	0.033	0.026	0.026	0.029
4	■	0.225	0.182	0.189	0.189	0.123	0.112	0.116	0.078	0.100
5	■	0.294	0.256	0.263	0.264	0.267	0.248	0.247	0.231	0.212
6	■	0.379	0.366	0.340	0.375	0.350	0.360	0.372	0.371	0.334
7	■	0.521	0.467	0.470	0.488	0.491	0.478	0.498	0.515	0.499
8	■	0.695	0.581	0.586	0.610	0.625	0.623	0.607	0.625	0.628
9	■	0.803	0.760	0.708	0.748	0.763	0.756	0.741	0.733	0.761
10	■	1.350	1.268	1.264	1.244	1.244	1.193	1.213	1.256	1.327

■	1992	1993	1994	
1	■	0.001	0.001	0.002
2	■	0.010	0.009	0.009
3	■	0.048	0.052	0.062
4	■	0.117	0.143	0.283
5	■	0.274	0.284	0.335
6	■	0.398	0.404	0.393
7	■	0.503	0.495	0.461
8	■	0.649	0.639	0.578
9	■	0.760	0.802	0.694
10	■	1.156	1.205	1.205

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

■	1982	1983	PERCENT MATURE (females) - WIT94R									
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993		
1	■	0	0	0	0	0	0	0	0	0	0	
2	■	0	0	0	0	0	0	0	0	0	0	
3	■	10	10	10	10	10	10	10	10	10	10	
4	■	36	36	36	36	36	36	36	36	36	36	
5	■	93	93	93	93	93	93	93	93	93	93	
6	■	98	98	98	98	98	98	98	98	98	98	
7	■	100	100	100	100	100	100	100	100	100	100	
8	■	100	100	100	100	100	100	100	100	100	100	
9	■	100	100	100	100	100	100	100	100	100	100	
10	■	100	100	100	100	100	100	100	100	100	100	

SEX RATIO (Percent Female) - WIT94R

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	50	50	50	50	50	50	50	50	50	50	50	50
2	50	50	50	50	50	50	50	50	50	50	50	50
3	50	50	50	50	50	50	50	50	50	50	50	50
4	50	50	50	50	50	50	50	50	50	50	50	50
5	50	50	50	50	50	50	50	50	50	50	50	50
6	50	50	50	50	50	50	50	50	50	50	50	50
7	50	50	50	50	50	50	50	50	50	50	50	50
8	50	50	50	50	50	50	50	50	50	50	50	50
9	50	50	50	50	50	50	50	50	50	50	50	50
10	50	50	50	50	50	50	50	50	50	50	50	50

BEGIN MARQUARDT ALGORITHM

LAMBDA 1.00000E-2
 RSS 3.68144E2
 NPFI 3.68144E2

par
 1.00000E4 1.00000E3 1.00000E3 1.00000E3 1.00000E-4 1.
 00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1
 .00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4
 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4 1.00000E-4
 1.00000E-4

LAMBDA 1.00000E-3
 RSS 1.89579E2
 NPFI 1.89579E2

par
 1.63979E4 1.24316E3 9.02125E2 8.09756E2 2.51428E-5 7.
 42063E-5 1.07684E-4 1.30813E-4 1.60886E-4 2.13339E-4 2
 .69527E-4 5.73595E-5 5.61646E-5 7.38666E-5 9.79126E-5
 1.58718E-4 2.12091E-4 2.72535E-4 2.22599E-4 2.66487E-4
 3.20125E-4

LAMBDA 1.00000E-4
 RSS 1.51033E2
 NPFI 1.51033E2

par
 1.89555E4 1.28837E3 9.18697E2 8.87988E2 4.08450E-5 7.
 63422E-5 1.06756E-4 1.34582E-4 1.80384E-4 2.90937E-4 4
 .55138E-4 6.38318E-5 6.33501E-5 7.60727E-5 9.68194E-5
 1.76653E-4 2.87773E-4 4.64359E-4 3.14102E-4 4.44056E-4
 6.46715E-4

LAMBDA 1.00000E-5
 RSS 1.48650E2
 NPFI 1.48650E2

par
 1.90340E4 1.27906E3 9.18362E2 8.58921E2 4.66425E-5 7.
 67266E-5 1.07198E-4 1.35086E-4 1.82192E-4 3.07094E-4 5
 .31050E-4 6.46481E-5 6.41029E-5 7.64660E-5 9.72464E-5
 1.78332E-4 3.03163E-4 5.45649E-4 3.35915E-4 5.14873E-4
 8.53087E-4

LAMBDA 1.00000E-5
 RSS 1.48623E2
 NPFI 1.48623E2

par
 1.90711E4 1.28246E3 9.17680E2 8.70435E2 4.69629E-5 7.
 66001E-5 1.07045E-4 1.34918E-4 1.81950E-4 3.07078E-4 5
 .36426E-4 6.44875E-5 6.39962E-5 7.63397E-5 9.71035E-5
 1.78077E-4 3.03169E-4 5.51409E-4 3.36061E-4 5.19272E-4
 8.86212E-4

LAMBDA 1.00000E-3
 RSS 1.48623E2
 NPFI 1.48623E2

```

par
1.90696E4    1.28233E3    9.17726E2    8.69992E2    4.69659E-5    7.
66050E-5    1.07051E-4    1.34924E-4    1.81959E-4    3.07093E-4    5
.36460E-4    6.44939E-5    6.40004E-5    7.63446E-5    9.71090E-5
1.78087E-4    3.03181E-4    5.51461E-4    3.36081E-4    5.19317E-4
8.86327E-4

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RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

RESULTS

APPROX STATISTICS ASSUMING LINEARITY IN THE NEIGHBORHOOD OF SOLUTION

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SUM OF SQUARES ..... 148.623475
ORTHOGONALITY OFFSET ..... 0.001136
MEAN SQUARE RESIDUALS ..... 0.834963

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PARAMETER	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 4	1.90696E4	1.08339E4	1.76018E0	0.57
N 7	1.28233E3	7.36285E2	1.74162E0	0.57
N 8	9.17726E2	4.15050E2	2.21112E0	0.45
N 9	8.69992E2	3.88323E2	2.24039E0	0.45
qRV SPR 3	4.69659E-5	1.43807E-5	3.26590E0	0.31
qRV SPR 4	7.66050E-5	2.19351E-5	3.49236E0	0.29
qRV SPR 5	1.07051E-4	2.91680E-5	3.67016E0	0.27
qRV SPR 6	1.34924E-4	3.66063E-5	3.68581E0	0.27
qRV SPR 7	1.81959E-4	4.93019E-5	3.69071E0	0.27
qRV SPR 8	3.07093E-4	8.62060E-5	3.56232E0	0.28
qRV SPR 9	5.36460E-4	1.45777E-4	3.68000E0	0.27
qRV FAL 3	6.44939E-5	2.12561E-5	3.03413E0	0.33
qRV FAL 4	6.40004E-5	1.72105E-5	3.71867E0	0.27
qRV FAL 5	7.63446E-5	2.10750E-5	3.62252E0	0.28
qRV FAL 6	9.71090E-5	2.66523E-5	3.64355E0	0.27
qRV FAL 7	1.78087E-4	4.72474E-5	3.76924E0	0.27
qRV FAL 8	3.03181E-4	8.27011E-5	3.66598E0	0.27
qRV FAL 9	5.51461E-4	1.53044E-4	3.60327E0	0.28
qLPUEAS 7	3.36081E-4	9.18134E-5	3.66048E0	0.27
qLPUEAS 8	5.19317E-4	1.43454E-4	3.62010E0	0.28
qLPUEAS 9	8.86327E-4	2.43259E-4	3.64356E0	0.27

Variance estimates via linearization assume that at the solution, the norm of the residuals will be small relative to the norm of the J'J matrix (where J is the Jacobian)

PARAMETER	|| residuals ||	norms of the cols of J'J	Quotient
N 4	1.21911E1	1.57801E0	7.72564E0
N 7		1.42699E1	8.54323E-1
N 8		4.97428E1	2.45083E-1
N 9		6.31664E1	1.93000E-1
qRV SPR 3		4.48860E9	2.71602E-9
qRV SPR 4		1.85590E9	6.56886E-9
qRV SPR 5		1.03675E9	1.17590E-8
qRV SPR 6		6.52645E8	1.86796E-8
qRV SPR 7		3.58846E8	3.39731E-8
qRV SPR 8		1.15485E8	1.05564E-7
qRV SPR 9		4.12840E7	2.95299E-7
qRV FAL 3		2.14230E9	5.69067E-9
qRV FAL 4		3.14234E9	3.87964E-9
qRV FAL 5		2.03845E9	5.98059E-9
qRV FAL 6		1.25990E9	9.67624E-9
qRV FAL 7		4.05841E8	3.00391E-8
qRV FAL 8		1.29256E8	9.43174E-8
qRV FAL 9		3.90685E7	3.12045E-7
qLPUEAS 7		1.05189E8	1.15898E-7
qLPUEAS 8		4.40546E7	2.76728E-7
qLPUEAS 9		1.51240E7	8.06075E-7

Frobenius Norm of J'J is 6755663843
Std Natural Norm of J'J is 4488597505

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qRV SPR 3	1.17884E-5	3.60955E-6	0.31
qRV SPR 4	3.26616E-5	9.35231E-6	0.29
qRV SPR 5	4.37125E-5	1.19103E-5	0.27
qRV SPR 6	4.26135E-5	1.15615E-5	0.27
qRV SPR 7	5.82269E-5	1.57766E-5	0.27
qRV SPR 8	8.01234E-5	2.24919E-5	0.28
qRV SPR 9	7.55514E-5	2.05303E-5	0.27
qRV FAL 3	4.22793E-6	1.39346E-6	0.33
qRV FAL 4	1.78709E-5	4.80571E-6	0.27
qRV FAL 5	3.39734E-5	9.37838E-6	0.28
qRV FAL 6	3.27743E-5	8.99515E-6	0.27
qRV FAL 7	4.13709E-5	1.09759E-5	0.27
qRV FAL 8	7.57953E-5	2.06753E-5	0.27
qRV FAL 9	7.12304E-5	1.97682E-5	0.28
qLPUEAS 7	1.83209E-5	5.00505E-6	0.27
qLPUEAS 8	2.22874E-5	6.15658E-6	0.28
qLPUEAS 9	2.01928E-5	5.54206E-6	0.27

CORRELATION BETWEEN PARAMETERS ESTIMATED

1.00	0.07	0.08	0.11	-0.22	-0.04	-0.04	-0.03	-0.03	-0.02	-0.03	-0.23	-0.20	-0.04	-0.04	-0.04	-0.03	-0.04	-0.04	-0.04	-0.04
0.07	1.00	0.11	0.14	-0.13	-0.12	-0.12	-0.14	-0.04	-0.03	-0.04	-0.14	-0.13	-0.13	-0.15	-0.20	-0.04	-0.05	-0.05	-0.05	-0.05
0.08	0.11	1.00	-0.20	-0.15	-0.13	-0.11	-0.09	-0.11	-0.05	-0.06	-0.15	-0.15	-0.16	-0.14	-0.12	-0.18	0.00	-0.14	-0.03	-0.07
0.11	0.14	-0.20	1.00	-0.17	-0.18	-0.16	-0.14	-0.15	-0.15	-0.19	-0.24	-0.19	-0.18	-0.16	-0.16	-0.11	-0.29	-0.17	-0.27	-0.23
-0.22	-0.13	-0.15	-0.17	1.00	0.07	0.06	0.05	0.05	0.04	0.05	0.12	0.10	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06
-0.04	-0.12	-0.13	-0.18	0.07	1.00	0.06	0.05	0.05	0.04	0.05	0.08	0.07	0.07	0.07	0.07	0.05	0.06	0.06	0.06	0.06
-0.04	-0.12	-0.11	-0.16	0.06	0.06	1.00	0.05	0.04	0.03	0.05	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.05
-0.03	-0.14	-0.09	-0.14	0.05	0.05	0.05	1.00	0.04	0.03	0.04	0.07	0.06	0.06	0.05	0.06	0.04	0.05	0.04	0.05	0.05
-0.03	-0.04	-0.11	-0.15	0.05	0.05	0.04	0.04	1.00	0.03	0.04	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
-0.02	-0.03	-0.05	-0.15	0.04	0.04	0.03	0.03	0.03	1.00	0.04	0.05	0.04	0.04	0.04	0.04	0.03	0.05	0.04	0.05	0.04
-0.03	-0.04	-0.06	-0.19	0.05	0.05	0.05	0.04	0.04	1.00	0.07	0.06	0.06	0.06	0.05	0.05	0.04	0.06	0.05	0.06	0.06
-0.23	-0.14	-0.15	-0.24	0.12	0.08	0.07	0.07	0.06	0.05	0.07	1.00	0.12	0.09	0.08	0.08	0.07	0.08	0.07	0.08	0.08
-0.20	-0.13	-0.15	-0.19	0.10	0.07	0.06	0.06	0.06	0.04	0.06	0.12	1.00	0.08	0.07	0.07	0.06	0.07	0.06	0.07	0.07
-0.04	-0.13	-0.16	-0.18	0.07	0.07	0.06	0.06	0.06	0.04	0.06	0.09	0.08	1.00	0.07	0.07	0.06	0.06	0.06	0.06	0.07
-0.04	-0.15	-0.14	-0.16	0.07	0.07	0.06	0.05	0.05	0.04	0.05	0.08	0.07	0.07	1.00	0.07	0.05	0.06	0.06	0.06	0.06
-0.04	-0.20	-0.12	-0.16	0.07	0.07	0.06	0.06	0.05	0.04	0.05	0.08	0.07	0.07	0.07	1.00	0.05	0.06	0.05	0.06	0.06
-0.03	-0.04	-0.18	-0.11	0.06	0.05	0.05	0.04	0.05	0.03	0.04	0.07	0.06	0.06	0.05	0.05	1.00	0.04	0.05	0.05	0.05
-0.04	-0.05	0.00	-0.29	0.06	0.06	0.05	0.05	0.05	0.05	0.06	0.08	0.07	0.06	0.06	0.06	0.06	1.00	0.06	0.08	0.07
-0.04	-0.05	-0.14	-0.17	0.06	0.06	0.05	0.04	0.05	0.04	0.05	0.07	0.06	0.06	0.06	0.05	0.05	0.06	1.00	0.06	0.06
-0.04	-0.05	-0.03	-0.27	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.08	0.07	0.06	0.06	0.06	0.05	0.08	0.06	1.00	0.07
-0.04	-0.05	-0.07	-0.23	0.06	0.06	0.05	0.05	0.05	0.04	0.06	0.08	0.07	0.07	0.06	0.06	0.05	0.07	0.06	0.07	1.00

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.1831	-0.0002	1.0000	-0.1829	-0.2002	9339.282
1983	1.1809	0.0323	1.0000	1.1486	1.2570	9647.756
1984	0.5810	0.0875	1.0000	0.4935	0.5401	10195.211
1985	1.0000	0.2636	1.0000	0.7364	0.8059	12159.247
1986	-0.5314	0.0149	1.0000	-0.5464	-0.5980	9481.944
1987	-1.2246	-0.4966	1.0000	-0.7280	-0.7967	5685.285
1988	-1.7636	-1.2572	1.0000	-0.5063	-0.5541	2657.021
1989	-1.2246	-1.4404	1.0000	0.2158	0.2362	2212.378
1990	-0.2438	-0.6380	1.0000	0.3942	0.4315	4935.423
1991	-1.3116	-0.8030	1.0000	-0.5086	-0.5566	4184.668
1992	-1.6301	-0.9338	1.0000	-0.6963	-0.7620	3671.777
1993	-0.2130	-0.3931	1.0000	0.1802	0.1972	6304.772

Partial variance for this index is 0.390289

Index 4 RV SPR 6
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6

SORTED BY YEAR						
Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.4081	0.0647	1.0000	-0.4728	-0.5175	7907.204
1983	0.5547	-0.0640	1.0000	0.6187	0.6771	6952.231
1984	0.2850	-0.0596	1.0000	0.3447	0.3772	6982.584
1985	1.3265	-0.0567	1.0000	1.3832	1.5137	7002.930
1986	0.5177	0.1326	1.0000	0.3851	0.4214	8462.428
1987	-0.9677	-0.0861	1.0000	-0.8816	-0.9648	6799.825
1988	-0.0186	-0.5065	1.0000	0.4878	0.5339	4466.391
1989	-1.5067	-1.2922	1.0000	-0.2145	-0.2347	2035.647
1990	-2.7595	-1.4415	1.0000	-1.3180	-1.4424	1753.384
1991	-0.5082	-0.7349	1.0000	0.2267	0.2481	3554.197
1992	-0.9677	-0.9499	1.0000	-0.0178	-0.0195	2866.688
1993	-1.6609	-1.1195	1.0000	-0.5414	-0.5924	2419.408

Partial variance for this index is 0.550847

Index 5 RV SPR 7
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7

SORTED BY YEAR						
Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.6931	-0.2384	1.0000	0.9315	1.0194	4330.144
1983	0.6931	-0.0008	1.0000	0.6940	0.7595	5491.159
1984	-0.2076	-0.1780	1.0000	-0.0297	-0.0325	4599.764
1985	0.9886	-0.2056	1.0000	1.1943	1.3070	4474.194
1986	0.2955	-0.2535	1.0000	0.5490	0.6008	4264.935
1987	-0.2076	-0.1355	1.0000	-0.0721	-0.0789	4799.228
1988	0.1719	-0.1583	1.0000	0.3302	0.3613	4691.022
1989	-1.1632	-0.5268	1.0000	-0.6364	-0.6964	3245.277
1990	-2.7726	-1.3201	1.0000	-1.4525	-1.5896	1468.022
1991	-2.7726	-1.4557	1.0000	-1.3169	-1.4411	1281.761
1992	-0.7577	-0.7612	1.0000	0.0035	0.0038	2567.099
1993	-1.3863	-1.1915	1.0000	-0.1948	-0.2132	1669.429

Partial variance for this index is 0.694769

Index 6 RV SPR 8
Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8

SORTED BY YEAR						
Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.4520	0.0842	1.0000	0.3677	0.4024	3542.570
1983	0.9431	-0.0384	1.0000	0.9815	1.0742	3133.605
1984	0.0706	0.0223	1.0000	0.0484	0.0529	3329.659
1985	0.5451	-0.2070	1.0000	0.7520	0.8230	2647.595
1986	-0.4284	-0.2759	1.0000	-0.1525	-0.1668	2471.142
1987	-0.4284	-0.3615	1.0000	-0.0669	-0.0732	2268.487
1988	-0.0427	-0.1864	1.0000	0.1437	0.1573	2702.566
1989	0.1724	-0.1579	1.0000	0.3303	0.3614	2780.786
1990	-2.5684	-0.4353	1.0000	-2.1331	-2.3344	2106.984
1991	-1.0644	-1.1609	1.0000	0.0965	0.1056	1019.913
1992	-1.6521	-1.2845	1.0000	-0.3677	-0.4024	901.345

Partial variance for this index is 0.667561

Index 7 RV SPR 9
 Index is tuned to the sum of Jan1 full stock sizes (in number)
 for ages: 9
 SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.5656	0.2412	1.0000	-0.8068	-0.8829	2372.575
1983	1.2262	0.2790	1.0000	0.9472	1.0366	2463.990
1984	0.5331	-0.0139	1.0000	0.5469	0.5985	1838.400
1985	-0.0800	-0.1879	1.0000	0.1079	0.1180	1544.758
1986	0.2454	-0.4833	1.0000	0.7287	0.7975	1149.650
1987	-1.5464	-0.3009	1.0000	-1.2455	-1.3630	1379.727
1988	0.1276	-0.4721	1.0000	0.5997	0.6563	1162.624
1989	-0.6991	-0.3782	1.0000	-0.3209	-0.3511	1277.028
1990	-0.8532	-0.1551	1.0000	-0.6981	-0.7640	1596.235
1991	-0.3424	-0.2903	1.0000	-0.0521	-0.0571	1394.436
1992	-0.0059	-1.0255	1.0000	1.0196	1.1158	668.456
1993	-1.9518	-1.1253	1.0000	-0.8266	-0.9046	604.997

Partial variance for this index is 0.614648

Index 9 RV FAL 3
 Index is tuned to the sum of Jan1 full stock sizes (in number)
 for ages: 3
 SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.7817	-0.0049	1.0000	-0.7768	-0.8501	15429.470
1984	-1.8803	-0.0781	1.0000	-1.8022	-1.9723	14340.512
1986	-1.8803	-1.3994	1.0000	-0.4809	-0.5263	3825.860
1988	-1.1872	-0.6461	1.0000	-0.5411	-0.5922	8126.430
1990	-1.1872	-0.9863	1.0000	-0.2008	-0.2198	5782.526
1991	0.5176	-0.4203	1.0000	0.9379	1.0264	10184.258
1992	0.9529	-0.3368	1.0000	1.2897	1.4114	11071.592
1993	0.5176	0.3673	1.0000	0.1503	0.1645	22386.508
1994	0.5176	-0.9065	1.0000	1.4241	1.5585	6263.258

Partial variance for this index is 1.1603

Index 10 RV FAL 4
 Index is tuned to the sum of Jan1 full stock sizes (in number)
 for ages: 4
 SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.1514	-0.2356	1.0000	0.0842	0.0921	12345.605
1983	-1.5377	-0.1749	1.0000	-1.3628	-1.4914	13118.137
1984	0.5624	-0.0007	1.0000	0.5631	0.6162	15614.138
1985	-1.2500	-0.2462	1.0000	-1.0038	-1.0986	12215.444
1986	-1.3835	-0.8034	1.0000	-0.5801	-0.6349	6996.741
1987	-3.3295	-1.5611	1.0000	-1.7683	-1.9352	3279.653
1988	-3.3295	-1.7511	1.0000	-1.5784	-1.7273	2712.213
1989	0.9332	-0.8903	1.0000	1.8236	1.9957	6414.247
1990	-1.2500	-1.0663	1.0000	-0.1837	-0.2011	5379.488
1991	0.3341	-1.2057	1.0000	1.5398	1.6851	4679.513
1992	0.8752	-0.6248	1.0000	1.5000	1.6416	8365.306
1993	-0.0336	-0.5217	1.0000	0.4881	0.5342	9273.250
1994	0.6779	0.1992	1.0000	0.4786	0.5238	19069.617

Partial variance for this index is 1.495262

Index 11 RV FAL 5
 Index is tuned to the sum of Jan1 full stock sizes (in number)
 for ages: 5
 SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.0113	-0.3383	1.0000	0.3270	0.3578	9339.282
1983	-3.7955	-0.3058	1.0000	-3.4897	-3.8191	9647.756
1984	1.2797	-0.2506	1.0000	1.5303	1.6747	10195.211
1985	0.7792	-0.0744	1.0000	0.8536	0.9342	12159.247
1986	-2.0037	-0.3231	1.0000	-1.6806	-1.8392	9481.944
1987	-2.4092	-0.8346	1.0000	-1.5746	-1.7232	5685.285
1989	-1.8496	-1.7784	1.0000	-0.0711	-0.0779	2212.378
1990	-0.3943	-0.9761	1.0000	0.5818	0.6367	4935.423
1991	0.1558	-1.1411	1.0000	1.2968	1.4192	4184.668
1992	-0.2401	-1.2718	1.0000	1.0317	1.1290	3671.777
1993	-0.7044	-0.7312	1.0000	0.0267	0.0293	6304.772

1994 0.5352 -0.6331 1.0000 1.1683 1.2786 6954.718

Partial variance for this index is 2.333044

Index 12 RV FAL 6

Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 6

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.5919	-0.2641	1.0000	0.8560	0.9368	7907.204
1983	-2.8258	-0.3929	1.0000	-2.4330	-2.6626	6952.231
1984	0.8377	-0.3885	1.0000	1.2262	1.3420	6982.584
1985	1.0961	-0.3856	1.0000	1.4817	1.6216	7002.930
1986	0.5754	-0.1963	1.0000	0.7716	0.8445	8462.428
1987	-0.2231	-0.4150	1.0000	0.1919	0.2100	6799.825
1988	-2.8258	-0.8353	1.0000	-1.9905	-2.1783	4466.391
1990	-3.5190	-1.7704	1.0000	-1.7486	-1.9136	1753.384
1991	-0.6858	-1.0638	1.0000	0.3780	0.4137	3554.197
1992	-0.2231	-1.2788	1.0000	1.0556	1.1552	2866.688
1993	-1.7272	-1.4484	1.0000	-0.2788	-0.3051	2419.408
1994	-0.3835	-0.8733	1.0000	0.4898	0.5361	4299.947

Partial variance for this index is 1.81874

Index 13 RV FAL 7

Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 7

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.6832	-0.2599	1.0000	0.9430	1.0320	4330.144
1983	-1.0660	-0.0223	1.0000	-1.0437	-1.1422	5491.159
1984	0.7863	-0.1995	1.0000	0.9858	1.0789	4599.764
1985	0.9150	-0.2272	1.0000	1.1421	1.2499	4474.194
1986	0.9817	-0.2751	1.0000	1.2567	1.3753	4264.935
1987	0.4380	-0.1570	1.0000	0.5951	0.6512	4799.228
1988	-1.5360	-0.1798	1.0000	-1.3562	-1.4842	4691.022
1989	-2.0469	-0.5483	1.0000	-1.4986	-1.6400	3245.277
1990	-2.4523	-1.3416	1.0000	-1.1108	-1.2156	1468.022
1991	-1.5360	-1.4773	1.0000	-0.0588	-0.0643	1281.761
1992	-0.4374	-0.7827	1.0000	0.3453	0.3779	2567.099
1993	-1.5360	-1.2130	1.0000	-0.3230	-0.3535	1669.429
1994	-1.3537	-1.4768	1.0000	0.1231	0.1347	1282.327

Partial variance for this index is 0.998698

Index 14 RV FAL 8

Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 8

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.0770	0.0714	1.0000	0.0055	0.0061	3542.570
1983	-0.0000	-0.0512	1.0000	0.0512	0.0561	3133.605
1984	0.6313	0.0094	1.0000	0.6218	0.6805	3329.659
1985	0.7701	-0.2198	1.0000	0.9899	1.0833	2647.595
1986	0.8416	-0.2887	1.0000	1.1303	1.2370	2471.142
1987	0.2151	-0.3743	1.0000	0.5894	0.6451	2268.487
1988	-0.3285	-0.1992	1.0000	-0.1293	-0.1415	2702.566
1989	-0.1278	-0.1707	1.0000	0.0429	0.0469	2780.786
1990	-1.8326	-0.4482	1.0000	-1.3844	-1.5151	2106.984
1991	-2.5257	-1.1737	1.0000	-1.3520	-1.4796	1019.913
1992	-1.0217	-1.2973	1.0000	0.2756	0.3017	901.345
1994	-2.1203	-1.2793	1.0000	-0.8410	-0.9203	917.726

Partial variance for this index is 0.700489

Index 15 RV FAL 9

Index is tuned to the sum of Jan1 full stock sizes (in number)
for ages: 9

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.6996	0.2688	1.0000	0.4308	0.4714	2372.575
1983	0.0064	0.3066	1.0000	-0.3002	-0.3285	2463.990
1984	-0.1606	0.0137	1.0000	-0.1743	-0.1908	1838.400
1985	0.9072	-0.1603	1.0000	1.0675	1.1683	1544.758

1986	0.6195	-0.4557	1.0000	1.0753	1.1767	1149.650
1987	0.1495	-0.2733	1.0000	0.4228	0.4627	1379.727
1988	-0.6126	-0.4445	1.0000	-0.1681	-0.1840	1162.624
1989	-0.7668	-0.3506	1.0000	-0.4161	-0.4554	1277.028
1990	-0.9491	-0.1275	1.0000	-0.8215	-0.8991	1596.235
1991	-1.8654	-0.2627	1.0000	-1.6027	-1.7539	1394.436
1992	-0.7668	-0.9980	1.0000	0.2312	0.2530	668.456
1994	-0.4791	-0.7345	1.0000	0.2554	0.2795	869.992

Partial variance for this index is 0.589358

Index 22 LPUEAS 7

Index is tuned to the sum of mean full stock sizes (in number)
for ages: 7

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.3472	0.2178	1.0000	-0.5650	-0.6184	3699.682
1983	0.4254	0.3730	1.0000	0.0524	0.0573	4320.672
1984	0.2161	0.1721	1.0000	0.0440	0.0482	3534.276
1985	0.2418	0.1257	1.0000	0.1161	0.1270	3374.153
1986	0.3821	0.0609	1.0000	0.3212	0.3515	3162.370
1987	0.4958	0.2046	1.0000	0.2912	0.3186	3651.110
1988	0.3980	0.2052	1.0000	0.1928	0.2110	3653.039
1989	-0.0944	-0.1214	1.0000	0.0270	0.0295	2635.284
1990	-1.1011	-0.8831	1.0000	-0.2181	-0.2386	1230.398
1991	-1.4377	-1.0131	1.0000	-0.4246	-0.4647	1080.414
1992	-0.4645	-0.3741	1.0000	-0.0904	-0.0990	2046.898
1993	-0.6086	-0.8622	1.0000	0.2536	0.2775	1256.318

Partial variance for this index is 0.080226

Index 23 LPUEAS 8

Index is tuned to the sum of mean full stock sizes (in number)
for ages: 8

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.1220	0.4336	1.0000	-0.5556	-0.6080	2970.718
1983	0.1782	0.2321	1.0000	-0.0539	-0.0590	2428.713
1984	0.4626	0.1881	1.0000	0.2746	0.3005	2324.082
1985	0.2805	-0.0699	1.0000	0.3504	0.3834	1795.679
1986	-0.0083	-0.0278	1.0000	0.0195	0.0214	1872.726
1987	0.1427	-0.1518	1.0000	0.2945	0.3223	1654.409
1988	0.4565	-0.0126	1.0000	0.4691	0.5133	1901.563
1989	0.2946	0.1028	1.0000	0.1919	0.2100	2133.995
1990	-0.3196	-0.1093	1.0000	-0.2103	-0.2301	1726.269
1991	-1.1620	-0.8393	1.0000	-0.3226	-0.3531	831.847
1992	-1.4939	-0.9518	1.0000	-0.5421	-0.5932	743.352
1993	-0.3891	-0.4737	1.0000	0.0846	0.0925	1199.074

Partial variance for this index is 0.121038

Index 24 LPUEAS 9

Index is tuned to the sum of mean full stock sizes (in number)
for ages: 9

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.0153	0.5773	1.0000	-0.5620	-0.6150	2009.638
1983	0.5297	0.5349	1.0000	-0.0052	-0.0057	1926.154
1984	0.3307	0.1845	1.0000	0.1462	0.1600	1356.800
1985	0.1914	-0.0074	1.0000	0.1987	0.2175	1119.985
1986	-0.0797	-0.2740	1.0000	0.1943	0.2127	857.852
1987	0.1814	-0.0871	1.0000	0.2685	0.2939	1034.116
1988	0.0339	-0.2567	1.0000	0.2906	0.3180	872.816
1989	0.0025	-0.1107	1.0000	0.1131	0.1238	1010.049
1990	-0.0304	0.1556	1.0000	-0.1870	-0.2046	1319.538
1991	-0.3510	0.0261	1.0000	-0.3771	-0.4127	1158.086
1992	-0.9860	-0.7417	1.0000	-0.2443	-0.2674	537.384
1993	-0.7404	-0.9103	1.0000	0.1699	0.1859	454.026

Partial variance for this index is 0.078917

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

■	1982	1983	1984	1985	1986	1987	1988
1 ■	1.2307	1.0726	-0.5746	-1.7168	-99.0000	-99.0000	-0.5121
2 ■	0.3788	1.1718	-0.4764	0.0820	-1.9072	-0.6343	-99.0000
3 ■	-0.2002	1.2570	0.5401	0.8059	-0.5980	-0.7967	-0.5541
4 ■	-0.5175	0.6771	0.3772	1.5137	0.4214	-0.9648	0.5339
5 ■	1.0194	0.7595	-0.0325	1.3070	0.6008	-0.0789	0.3613
6 ■	0.4024	1.0742	0.0529	0.8230	-0.1668	-0.0732	0.1573
7 ■	-0.8829	1.0366	0.5985	0.1180	0.7975	-1.3630	0.6563
9 ■	-0.8501	-99.0000	-1.9723	-99.0000	-0.5263	-99.0000	-0.5922
10 ■	0.0921	-1.4914	0.6162	-1.0986	-0.6349	-1.9352	-1.7273
11 ■	0.3578	-3.8191	1.6747	0.9342	-1.8392	-1.7232	-99.0000
12 ■	0.9368	-2.6626	1.3420	1.6216	0.8445	0.2100	-2.1783
13 ■	1.0320	-1.1422	1.0789	1.2499	1.3753	0.6512	-1.4842
14 ■	0.0061	0.0561	0.6805	1.0833	1.2370	0.6451	-0.1415
15 ■	0.4714	-0.3285	-0.1908	1.1683	1.1767	0.4627	-0.1840
22 ■	-0.6184	0.0573	0.0482	0.1270	0.3515	0.3186	0.2110
23 ■	-0.6080	-0.0590	0.3005	0.3834	0.0214	0.3223	0.5133
24 ■	-0.6150	-0.0057	0.1600	0.2175	0.2127	0.2939	0.3180
** ■	0.0962	-0.1467	0.2484	0.5387	0.0854	-0.3110	-0.3082

■	1989	1990	1991	1992	1993	1994*****
1 ■	-0.6816	-0.5834	2.0479	0.4110	-0.6938	-99.0000
2 ■	1.6884	-0.7321	-0.3600	0.3318	0.4573	-99.0000
3 ■	0.2362	0.4315	-0.5566	-0.7620	0.1972	-99.0000
4 ■	-0.2347	-1.4424	0.2481	-0.0195	-0.5924	-99.0000
5 ■	-0.6964	-1.5896	-1.4411	0.0038	-0.2132	-99.0000
6 ■	0.3614	-2.3344	0.1056	-0.4024	-99.0000	-99.0000
7 ■	-0.3511	-0.7640	-0.0571	1.1158	-0.9046	-99.0000
9 ■	-99.0000	-0.2198	1.0264	1.4114	0.1645	1.5585
10 ■	1.9957	-0.2011	1.6851	1.6416	0.5342	0.5238
11 ■	-0.0779	0.6367	1.4192	1.1290	0.0293	1.2786
12 ■	-99.0000	-1.9136	0.4137	1.1552	-0.3051	0.5361
13 ■	-1.6400	-1.2156	-0.0643	0.3779	-0.3535	0.1347
14 ■	0.0469	-1.5151	-1.4796	0.3017	-99.0000	-0.9203
15 ■	-0.4554	-0.8991	-1.7539	0.2530	-99.0000	0.2795
22 ■	0.0295	-0.2386	-0.4647	-0.0990	0.2775	-99.0000
23 ■	0.2100	-0.2301	-0.3531	-0.5932	0.0925	-99.0000
24 ■	0.1238	-0.2046	-0.4127	-0.2674	0.1859	-99.0000
** ■	0.0370	-0.7656	0.0002	0.3523	-0.0803	0.4844

-99 in the above table indicates a missing value

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

■	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1 ■	0.85	0.65	0.19	1.66	-99.00	-99.00	0.15	0.26	0.19	2.36
2 ■	0.08	0.77	0.13	0.00	2.04	0.23	-99.00	1.60	0.30	0.07
3 ■	0.02	0.89	0.16	0.36	0.20	0.36	0.17	0.03	0.10	0.17
4 ■	0.15	0.26	0.08	1.29	0.10	0.52	0.16	0.03	1.17	0.03
5 ■	0.58	0.32	0.00	0.96	0.20	0.00	0.07	0.27	1.42	1.17
6 ■	0.09	0.65	0.00	0.38	0.02	0.00	0.01	0.07	3.06	0.01
7 ■	0.44	0.60	0.20	0.01	0.36	1.04	0.24	0.07	0.33	0.00
9 ■	0.41	-99.00	2.19	-99.00	0.16	-99.00	0.20	-99.00	0.03	0.59
10 ■	0.00	1.25	0.21	0.68	0.23	2.10	1.68	2.24	0.02	1.60
11 ■	0.07	8.19	1.58	0.49	1.90	1.67	-99.00	0.00	0.23	1.13
12 ■	0.49	3.98	1.01	1.48	0.40	0.02	2.67	-99.00	2.06	0.10
13 ■	0.60	0.73	0.65	0.88	1.06	0.24	1.24	1.51	0.83	0.00
14 ■	0.00	0.00	0.26	0.66	0.86	0.23	0.01	0.00	1.29	1.23
15 ■	0.12	0.06	0.02	0.77	0.78	0.12	0.02	0.12	0.45	1.73
22 ■	0.21	0.00	0.00	0.01	0.07	0.06	0.03	0.00	0.03	0.12
23 ■	0.21	0.00	0.05	0.08	0.00	0.06	0.15	0.02	0.03	0.07
24 ■	0.21	0.00	0.01	0.03	0.03	0.05	0.06	0.01	0.02	0.10
** ■	4.55	18.36	6.75	9.73	8.40	6.71	6.85	6.24	11.57	10.47

	1992	1993	1994*****	
1	0.09	0.27	-99.00	6.66
2	0.06	0.12	-99.00	5.41
3	0.33	0.02	-99.00	2.83
4	0.00	0.20	-99.00	3.99
5	0.00	0.03	-99.00	5.03
6	0.09	-99.00	-99.00	4.39
7	0.70	0.46	-99.00	4.45
9	1.12	0.02	1.36	6.06
10	1.51	0.16	0.15	11.84
11	0.72	0.00	0.92	16.90
12	0.75	0.05	0.16	13.17
13	0.08	0.07	0.01	7.91
14	0.05	-99.00	0.48	5.07
15	0.04	-99.00	0.04	4.27
22	0.01	0.04	-99.00	0.58
23	0.20	0.00	-99.00	0.88
24	0.04	0.02	-99.00	0.57
**	5.78	1.46	3.13	100.00

-99 in the above table indicates a missing value

Partial variance (and proportion of total) by index

	1	2	3	4	5	6
**	1.12925825	0.82307387	0.39028890	0.55084694	0.69476879	0.66756100
**	0.07926557	0.05777369	0.02739539	0.03866538	0.04876762	0.04685784
	7	9	10	11	12	13
**	0.61464804	1.16029969	1.49526192	2.33304432	1.81874049	0.99869755
**	0.04314374	0.08144445	0.10495631	0.16376243	0.12766211	0.07010117
	14	15	22	23	24*****	
**	0.70048881	0.58935791	0.08022585	0.12103798	0.07891677	14.24651708
**	0.04916913	0.04136856	0.00563126	0.00849597	0.00553937	1.00000000

STOCK NUMBERS (Jan 1) in thousands - WIT94R

	1982	1983	1984	1985	1986	1987	1988
1	19358.26	10994.36	5168.24	4279.51	10975.56	8716.28	7833.65
2	21452.41	16661.62	9462.93	4448.35	3683.40	9446.75	7502.17
3	15429.47	18464.17	14340.51	8144.73	3825.86	3167.52	8126.43
4	12345.60	13118.14	18814.14	12215.44	6996.74	3279.65	2712.21
5	9339.28	9647.76	10195.21	12159.25	9481.94	5685.28	2657.02
6	7907.20	6952.23	6982.58	7002.93	8462.43	6799.82	4466.39
7	4330.14	5491.16	4599.76	4474.19	4264.94	4799.23	4691.02
8	3542.57	3133.61	3329.66	2647.60	2471.14	2268.49	2702.57
9	2372.57	2463.99	1838.40	1544.76	1149.65	1379.73	1162.62
10	10760.83	7262.12	5486.67	4452.13	2714.97	2115.45	2485.87
1+	106838.35	94189.14	77018.11	61368.88	54026.63	47658.19	44339.95
	1989	1990	1991	1992	1993	1994	
1	13818.93	14964.72	30422.51	8649.19	1106485.82	0.00	
2	6727.99	11891.32	12875.44	26177.21	7407.00	952317.89	
3	6325.62	5782.53	10184.26	11071.59	22386.51	6263.26	
4	6414.25	5379.49	4679.51	8365.31	9273.25	19069.62	
5	2212.38	4935.42	4184.67	3671.78	6304.77	6954.72	
6	2035.65	1753.38	3554.20	2866.69	2419.41	4299.95	
7	3245.28	1468.02	1281.76	2567.10	1669.43	1282.33	
8	2780.79	2106.98	1019.91	901.35	1602.22	917.73	
9	1277.03	1596.23	1394.44	668.46	605.00	869.99	
10	1712.84	1232.40	2716.84	1859.09	1837.96	1334.71	
1+	66550.75	51110.50	72313.54	66797.76	1159991.38	993310.18	

Summaries for ages 3 9 4 9 5 9 6 9 7 9							
	1982	1983	1984	1985	1986	1987	1988
3	55266.85	59271.04	56900.27	48188.90	36652.70	27379.72	26518.27
4	39837.38	40806.88	42559.76	40044.17	32826.84	24212.20	18391.84
5	27491.78	27688.74	26945.62	27828.72	25830.10	20932.55	15679.62
6	18152.49	18040.99	16750.41	15669.48	16348.15	15247.27	13022.60
7	10245.29	11088.75	9767.82	8666.55	7885.73	8447.44	8556.21

	1989	1990	1991	1992	1993	1994
3	24290.98	23022.06	26298.75	30112.26	44260.59	39657.58
4	17965.36	17239.54	16114.49	19040.67	21874.08	33394.33
5	11551.11	11860.05	11434.98	10675.36	12600.83	14324.71
6	9338.74	6924.62	7250.31	7003.59	6296.06	7369.99
7	7303.09	5171.24	3696.11	4136.90	3876.65	3070.04

FISHING MORTALITY - WIT94R												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.02
3	0.01	0.02	0.01	0.00	0.00	0.01	0.09	0.01	0.06	0.05	0.03	0.01
4	0.10	0.10	0.10	0.10	0.06	0.06	0.05	0.11	0.10	0.09	0.13	0.14
5	0.15	0.17	0.23	0.21	0.18	0.09	0.12	0.08	0.18	0.23	0.27	0.23
6	0.21	0.26	0.30	0.35	0.42	0.22	0.17	0.18	0.16	0.18	0.39	0.48
7	0.17	0.35	0.40	0.44	0.48	0.42	0.37	0.28	0.21	0.20	0.32	0.45
8	0.21	0.38	0.62	0.68	0.43	0.52	0.60	0.41	0.26	0.27	0.25	0.46
9	0.19	0.36	0.49	0.53	0.47	0.46	0.45	0.34	0.24	0.23	0.30	0.45
10	0.19	0.36	0.49	0.53	0.47	0.46	0.45	0.34	0.24	0.23	0.30	0.45

Avg F for ages 3 9 4 9 5 9 6 9 7 9												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.15	0.24	0.31	0.33	0.29	0.25	0.26	0.20	0.18	0.18	0.24	0.32
4	0.17	0.27	0.36	0.39	0.34	0.30	0.29	0.23	0.19	0.20	0.28	0.37
5	0.19	0.31	0.41	0.44	0.40	0.34	0.34	0.26	0.21	0.22	0.31	0.42
6	0.20	0.34	0.45	0.50	0.45	0.41	0.40	0.30	0.22	0.22	0.32	0.46
7	0.19	0.37	0.50	0.55	0.46	0.47	0.48	0.34	0.24	0.24	0.29	0.45

Avg F (weighted by N) for ages 3 9 4 9 5 9 6 9 7 9												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.12	0.16	0.19	0.23	0.25	0.22	0.22	0.16	0.14	0.13	0.16	0.13
4	0.16	0.22	0.25	0.27	0.28	0.25	0.28	0.21	0.17	0.18	0.23	0.26
5	0.18	0.27	0.34	0.35	0.35	0.28	0.32	0.26	0.20	0.21	0.31	0.35
6	0.20	0.32	0.41	0.45	0.44	0.35	0.36	0.30	0.22	0.20	0.34	0.47
7	0.19	0.36	0.49	0.53	0.46	0.45	0.46	0.34	0.24	0.23	0.30	0.45

Avg F (wt by catch) for ages 3 9 4 9 5 9 6 9 7 9												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.16	0.25	0.33	0.36	0.37	0.34	0.34	0.26	0.17	0.17	0.25	0.31
4	0.17	0.26	0.34	0.36	0.37	0.34	0.38	0.27	0.19	0.20	0.27	0.32
5	0.19	0.29	0.38	0.40	0.39	0.36	0.40	0.31	0.21	0.22	0.32	0.38
6	0.20	0.33	0.44	0.47	0.44	0.39	0.42	0.32	0.23	0.21	0.34	0.47
7	0.19	0.36	0.51	0.55	0.46	0.46	0.47	0.35	0.24	0.24	0.31	0.45

BACKCALCULATED PARTIAL RECRUITMENT												
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.00	0.02	0.04
3	0.06	0.05	0.02	0.00	0.01	0.01	0.14	0.03	0.23	0.17	0.07	0.02
4	0.45	0.27	0.16	0.15	0.12	0.12	0.09	0.28	0.39	0.34	0.34	0.28
5	0.68	0.45	0.37	0.31	0.38	0.18	0.19	0.20	0.68	0.84	0.68	0.48
6	1.00	0.69	0.48	0.51	0.87	0.43	0.28	0.44	0.62	0.64	1.00	1.00
7	0.81	0.91	0.65	0.65	1.00	0.82	0.62	0.70	0.82	0.74	0.82	0.92
8	0.99	1.00	1.00	1.00	0.90	1.00	1.00	1.00	1.00	1.00	0.64	0.95
9	0.89	0.95	0.80	0.78	0.97	0.88	0.76	0.84	0.93	0.86	0.78	0.94
10	0.89	0.95	0.80	0.78	0.97	0.88	0.76	0.84	0.93	0.86	0.78	0.94

		MEAN BIOMASS (MT)						
■		1982	1983	1984	1985	1986	1987	1988
+-----+-----								
1	■	35.95	51.05	24.00	19.87	50.96	40.47	41.42
2	■	318.74	526.05	140.60	72.07	57.78	148.05	104.15
3	■	2238.45	2623.61	1984.40	554.34	236.92	185.99	286.28
4	■	2628.57	2448.79	3204.73	2564.40	1299.13	557.31	516.50
5	■	2654.36	2256.51	2792.77	3056.12	2414.82	1511.82	754.91
6	■	2789.10	2330.05	2374.71	2358.09	2633.76	2460.97	1769.52
7	■	2034.83	2238.11	1904.97	1906.40	1786.74	2048.27	2089.54
8	■	2159.71	1488.80	1543.19	1240.81	1294.05	1134.92	1249.33
9	■	1780.54	1531.29	1108.51	943.03	722.31	856.25	699.13
10	■	12307.53	7199.91	5119.59	4014.31	2519.80	1891.72	2264.04
+-----+-----								
1+	■	28947.77	22694.18	20197.46	16729.45	13016.27	10835.78	9774.81

■		1989	1990	1991	1992	1993
+-----+-----						
1	■	57.78	147.78	124.29	29.49	3454.61
2	■	73.63	159.65	292.67	541.86	165.37
3	■	268.23	261.45	528.45	944.69	2512.12
4	■	878.40	958.09	823.51	1755.73	1763.24
5	■	502.04	1212.62	1207.67	1134.01	1748.30
6	■	737.97	659.31	1251.81	1013.57	773.19
7	■	1512.65	721.01	624.48	1256.80	672.13
8	■	1455.38	1187.67	583.96	541.90	798.58
9	■	826.22	1120.29	968.16	441.73	400.45
10	■	1701.45	1351.62	2651.70	1727.43	1662.22
+-----+-----						
1+	■	8013.75	7779.50	9056.69	9387.21	13950.21

		Summaries for ages 3 9 4 9 5 9 6 9 7 9						
■		1982	1983	1984	1985	1986	1987	1988
+-----+-----								
3	■	16285.55	14917.16	14913.28	12623.19	10387.73	8755.54	7365.21
4	■	14047.10	12293.55	12928.88	12068.85	10150.81	8569.55	7078.92
5	■	11418.53	9844.76	9724.15	9504.45	8851.68	8012.23	6562.42
6	■	8764.18	7588.25	6931.38	6448.33	6436.86	6500.42	5807.51
7	■	5975.08	5258.20	4556.67	4090.24	3803.10	4039.45	4037.99

■		1989	1990	1991	1992	1993
+-----+-----						
3	■	6180.89	6120.44	5988.03	7088.43	8668.01
4	■	5912.67	5858.99	5459.59	6143.74	6155.90
5	■	5034.27	4900.90	4636.08	4388.01	4392.66
6	■	4532.23	3688.29	3428.41	3254.00	2644.36
7	■	3794.26	3028.97	2176.60	2240.43	1871.16

		CATCH BIOMASS (MT)							
■		1982	1983	1984	1985	1986	1987	1988	1989
+-----+-----									
1	■	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.01
2	■	0.00	0.01	0.00	0.05	0.05	0.08	2.14	0.11
3	■	27.50	46.32	20.61	1.07	0.96	0.96	24.79	3.22
4	■	253.85	249.97	320.75	264.93	74.78	33.74	27.73	98.45
5	■	385.32	391.07	630.02	649.28	440.69	138.03	87.87	41.43
6	■	598.64	612.94	700.76	815.67	1098.75	544.48	299.72	130.54
7	■	352.87	783.94	766.47	845.77	859.98	868.99	779.22	426.48
8	■	460.17	570.64	953.70	848.96	560.06	588.38	749.18	589.56
9	■	341.45	558.20	545.09	501.39	337.47	391.58	317.19	280.05
10	■	2360.17	2624.56	2517.47	2134.32	1177.27	865.12	1027.19	576.72
+-----+-----									
1+	■	4779.98	5837.64	6454.88	6061.44	4550.01	3431.36	3315.14	2146.57

■		1990	1991	1992	1993
+-----+-----					
1	■	0.06	0.04	0.15	0.16
2	■	0.79	0.27	3.48	2.93
3	■	16.12	24.70	25.74	26.03
4	■	96.93	76.19	233.14	242.82
5	■	216.22	275.68	302.95	406.84
6	■	107.67	219.51	395.98	374.88
7	■	154.44	126.21	403.92	301.34
8	■	312.08	159.13	134.75	367.88
9	■	272.93	226.26	134.12	182.01
10	■	329.29	619.69	524.51	755.48
+-----+-----					
1+	■	1506.53	1727.68	2158.74	2660.36

Summaries for ages 3 9 4 9 5 9 6 9 7 9

	1982	1983	1984	1985	1986	1987	1988	1989
3 ■	2419.80	3213.07	3937.40	3927.06	3372.69	2566.16	2285.71	1569.74
4 ■	2392.31	3166.75	3916.79	3925.99	3371.73	2565.19	2260.92	1566.52
5 ■	2138.45	2916.78	3596.04	3661.06	3296.95	2531.46	2233.18	1468.06
6 ■	1753.13	2525.72	2966.02	3011.78	2856.26	2393.43	2145.32	1426.64
7 ■	1154.49	1912.78	2265.26	2196.11	1757.51	1848.95	1845.60	1296.09
■	1990	1991	1992	1993				
3 ■	1176.39	1107.67	1630.60	1901.79				
4 ■	1160.28	1082.97	1604.86	1875.76				
5 ■	1063.35	1006.78	1371.72	1632.94				
6 ■	847.13	731.10	1068.77	1226.11				
7 ■	739.45	511.59	672.79	851.22				

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

	1982	1983	1984	1985	1986	1987	1988
1 ■	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 ■	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 ■	203.61	89.22	99.63	27.21	12.73	10.10	20.19
4 ■	960.01	824.97	1020.17	795.33	298.84	127.92	109.02
5 ■	2430.80	2180.17	2346.10	2806.54	2225.18	1259.90	583.73
6 ■	2767.02	2330.53	2157.82	2366.95	2637.39	2255.83	1544.58
7 ■	2137.48	2358.95	1970.00	1977.40	1885.79	2085.92	2140.30
8 ■	2318.20	1664.74	1718.10	1406.02	1401.10	1263.37	1447.99
9 ■	1798.71	1719.25	1169.02	1030.98	791.18	943.15	779.31
10 ■	13725.57	8453.28	6233.03	4942.06	3046.74	2280.94	2727.06
1+■	26341.39	19621.13	16713.87	15352.48	12298.95	10227.13	9352.19
■	1989	1990	1991	1992	1993		
1 ■	0.00	0.00	0.00	0.00	0.00		
2 ■	0.00	0.00	0.00	0.00	0.00		
3 ■	16.21	13.58	28.37	51.33	113.59		
4 ■	173.46	178.63	161.32	337.15	454.19		
5 ■	457.95	920.49	965.41	871.53	1559.97		
6 ■	700.63	544.32	1137.76	1022.55	861.29		
7 ■	1556.47	689.46	608.16	1194.45	747.70		
8 ■	1583.33	1236.03	609.67	547.47	925.41		
9 ■	862.90	1137.48	992.01	470.80	438.62		
10 ■	1982.80	1531.21	2995.05	1992.26	2002.62		
1+■	7333.75	6251.19	7497.75	6487.54	7103.37		

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

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

where $Z(a,y) = 0.1667 \times M(a,y) + 0.1667 \times F(a,y)$

$N(a,y)$ - Jan 1 stock size estimates (males & females)

$P(a,y)$ - proportion mature (generally females)

$W(a,y)$ - weight at age at the beginning of the spawning season

The $W(a,y)$ are assumed to be the same as the Jan1 weight at age estimates (see "WT AT AGE" table in input section).

Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

MEAN STOCK NUMBERS (thousands) - WIT94R

	1982	1983	1984	1985	1986	1987	1988
1	17976.24	10209.51	4799.30	3974.01	10192.05	8094.05	7266.81
2	19920.95	15472.06	8787.36	4129.29	3418.98	8770.03	6897.18
3	14242.56	16999.35	13249.59	7556.21	3545.75	2933.98	7236.61
4	10941.30	11595.34	13814.77	10791.05	6318.34	2957.42	2453.82
5	8087.13	8243.49	8499.39	10199.42	8066.71	5051.35	2332.56
6	6625.93	5695.25	5635.66	5521.25	6458.61	5680.33	3823.39
7	3699.68	4320.67	3534.28	3374.15	3162.37	3651.11	3653.04
8	2970.72	2428.71	2324.08	1795.68	1872.73	1654.41	1901.56
9	2009.64	1926.15	1356.80	1119.99	857.85	1034.12	872.82
10	9114.73	5676.95	4049.35	3227.90	2025.87	1585.54	1866.21
1+	95588.87	82567.49	66050.56	51688.93	45919.25	41412.35	38303.99
	1989	1990	1991	1992	1993		
1	12831.00	13893.91	28246.71	8012.05	1027474.89		
2	6243.33	11015.76	11950.84	24232.47	6819.15		
3	5839.79	5211.58	9244.98	10145.87	20683.76		
4	5642.57	4757.10	4155.30	7286.55	8058.47		
5	1974.00	4207.09	3484.23	3002.18	5238.58		
6	1736.40	1505.28	3033.93	2214.38	1791.11		
7	2635.28	1230.40	1080.41	2046.90	1256.32		
8	2134.00	1726.27	831.85	743.35	1199.07		
9	1010.05	1319.54	1158.09	537.38	454.03		
10	1354.75	1018.77	2256.35	1494.56	1379.32		
1+	41401.17	45885.68	65442.68	59715.69	1074354.70		

Time stamp at end of run 1994 6 16 13 8 23

APPENDIX 2

Precision Estimates of 1993 Fishing Mortality and Spawning Stock Biomass for Witch Flounder

BOOTSTRAP RESULTS FOR WIT94R Timestamp 1994 6 20 19 26 35
 1982-1993 WITCH FLOUNDER: GB & GM

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

Appendix 2: Table 1. BOOTSTRAP OUTPUT VARIABLE: N hat
 Age-specific stocksizes (on Jan 1, 1994) estimated by NLLS (ADAPT).

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
4	1.907E4	2.189E4	1.189E4	0.62	
7	1.282E3	1.394E3	7.328E2	0.57	
8	9.178E2	9.798E2	3.670E2	0.40	
9	8.696E2	9.924E2	4.155E2	0.48	

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
4	2.821E3	8.405E2	14.79	1.625E4	0.73
7	1.119E2	5.182E1	8.73	1.170E3	0.63
8	6.204E1	2.595E1	6.76	8.557E2	0.43
9	1.228E2	2.938E1	14.13	7.468E2	0.56

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

INDEX	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
1	1.179E-5	1.230E-5	3.742E-6	0.32	
2	3.266E-5	3.348E-5	9.023E-6	0.28	
3	4.371E-5	4.596E-5	1.141E-5	0.26	
4	4.262E-5	4.318E-5	1.056E-5	0.25	
5	5.823E-5	5.843E-5	1.495E-5	0.26	
6	8.013E-5	8.293E-5	2.065E-5	0.26	
7	7.556E-5	7.564E-5	1.902E-5	0.25	
9	4.228E-6	4.432E-6	1.471E-6	0.35	
10	1.787E-5	1.887E-5	4.595E-6	0.26	
11	3.398E-5	3.398E-5	8.856E-6	0.26	
12	3.278E-5	3.494E-5	9.036E-6	0.28	
13	4.137E-5	4.307E-5	1.129E-5	0.27	
14	7.580E-5	7.920E-5	2.088E-5	0.28	
15	7.124E-5	7.209E-5	1.925E-5	0.27	
22	1.832E-5	1.845E-5	4.648E-6	0.25	
23	2.229E-5	2.281E-5	5.637E-6	0.25	
24	2.020E-5	2.022E-5	5.489E-6	0.27	

INDEX	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	5.140E-7	2.646E-7	4.36	1.128E-5	0.33
2	8.176E-7	6.380E-7	2.50	3.185E-5	0.28
3	2.250E-6	8.066E-7	5.15	4.146E-5	0.28
4	5.630E-7	7.464E-7	1.32	4.205E-5	0.25
5	2.035E-7	1.057E-6	0.35	5.803E-5	0.26
6	2.850E-6	1.460E-6	3.56	7.728E-5	0.27
7	8.042E-8	1.345E-6	0.11	7.548E-5	0.25
9	2.040E-7	1.040E-7	4.83	4.024E-6	0.37
10	9.958E-7	3.249E-7	5.57	1.688E-5	0.27
11	7.327E-9	6.262E-7	0.02	3.397E-5	0.26
12	2.163E-6	6.389E-7	6.60	3.061E-5	0.30
13	1.692E-6	7.982E-7	4.09	3.968E-5	0.28
14	3.400E-6	1.476E-6	4.49	7.240E-5	0.29
15	8.575E-7	1.361E-6	1.20	7.038E-5	0.27
22	1.271E-7	3.286E-7	0.69	1.819E-5	0.26
23	5.227E-7	3.986E-7	2.35	2.177E-5	0.26
24	2.458E-8	3.881E-7	0.12	2.017E-5	0.27

Appendix 2: Table 3. BOOTSTRAP OUTPUT VARIABLE: F_t
Full vector of age-specific terminal F's (in 1993).

AGE	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
1	4.546E-5	4.642E-5	9.838E-6	0.22
2	1.773E-2	1.810E-2	3.837E-3	0.22
3	1.036E-2	1.195E-2	6.678E-3	0.64
4	1.377E-1	1.406E-1	2.981E-2	0.22
5	2.327E-1	2.377E-1	5.037E-2	0.22
6	4.849E-1	5.646E-1	3.285E-1	0.68
7	4.483E-1	4.669E-1	1.472E-1	0.33
8	4.608E-1	4.614E-1	1.500E-1	0.33
9	4.546E-1	4.642E-1	9.838E-2	0.22
10+	4.546E-1	4.642E-1	9.838E-2	0.22

AGE	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1	9.606E-7	6.956E-7	2.11	4.450E-5	0.22
2	3.746E-4	2.713E-4	2.11	1.735E-2	0.22
3	1.586E-3	4.722E-4	15.30	8.777E-3	0.76
4	2.911E-3	2.108E-3	2.11	1.348E-1	0.22
5	4.918E-3	3.562E-3	2.11	2.278E-1	0.22
6	7.972E-2	2.323E-2	16.44	4.052E-1	0.81
7	1.861E-2	1.041E-2	4.15	4.297E-1	0.34
8	6.045E-4	1.051E-2	0.13	4.602E-1	0.33
9	9.606E-3	6.956E-3	2.11	4.450E-1	0.22
10+	9.606E-3	6.956E-3	2.11	4.450E-1	0.22

Appendix 2: Table 4. BOOTSTRAP OUTPUT VARIABLE: F_{full_t}
Fully-recruited F in the terminal year (1993).

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
4.546E-1	4.642E-1	9.838E-2	0.22

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
9.606E-3	6.956E-3	2.11	4.450E-1	0.22

Appendix 2: Table 5. BOOTSTRAP OUTPUT VARIABLE: SSB spawn_t
SSB (males & females).at start of spawning season (1993).

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN
7.102E3	7.394E3	1.404E3	0.20

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
2.914E2	9.926E1	4.10	6.811E3	0.21