A. WITCH FLOUNDER

TERMS OF REFERENCE

1. Characterize the commercial catch (landings and discards) through 2002.

2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for 2002 and characterize the uncertainty of those estimates.

3. Evaluate and either update or re-estimate biological reference points as appropriate.

4. If stock projections are possible,
   a. provide short term projections (2003-2005) of stock status under various fishing mortality strategies and

   b. evaluate current and projected stock status against existing rebuilding or recovery schedules, as appropriate.

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 Northeast Fisheries Science Center (NEFSC) Statistical Reporting Areas (SA) 511-515, 521-522, 525-526, and 561-562; Figure 1], 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 1910-1982 averaged 3,000 metric tons (mt), ranging from 1,000 to 6,000 mt (Lange and Lux 1978, Burnett and Clark 1983). More recently, landings declined from a peak of 6,660 mt in 1984 to a low of 1,490 mt in 1990. Landings for 2002 were 3,186 mt.

Previous witch flounder stock assessments were conducted by Burnett and Clark (1983), Wigley and Mayo (1994) and Wigley et al. (1999). An assessment update was conducted for this stock in 2002 and reviewed at Groundfish Assessment Review Meeting (GARM; NEFSC 2002). The GARM assessment indicated average fishing mortality (ages 7-9, unweighted) increased from 0.21 in 1982 to 0.59 in 1985, declined to 0.24 in 1990, increased to 0.96 in 1996, then declined to 0.45 in 2001. Spawning stock biomass declined from 18,000 tons in 1982 to about 4,000 tons in 1995 and then increased to 11,368 mt in 2001. Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 84 million fish (1997 year class) with a mean of 22 million fish. In 2001, the SSB was slightly above ½ SSBmsy (9,950 mt), the minimum stock size threshold, and fishing mortality (F= 0.45) was three times higher than Fmsy, the maximum fishing mortality threshold; thus, witch flounder was not overfished but overfishing was occurring in 2001.

This assessment of witch flounder in the Gulf of Maine - Georges Bank region and southward (USA Subareas 4, 5 and 6), presents a benchmark analytical assessment for the stock for the 1982-2002 period, estimates 2002 fishing mortality and spawning stock biomass for stock status, and provides short-term projections of median landings, discards and spawning stock biomass for various fishing mortality scenarios. This assessment 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 2002.

Witch flounder is managed under the New England Fishery Management Council's Multi-species Fisheries Management plan since 1987. A brief summary of groundfish management regulations affecting witch flounder is presented in Table A.1. Significant changes in regulations include increased minimum size in 1983 and 1987; increases in mesh size in 1982, 1983, 1994, 1999; effort reductions in 1996 and 2002; and implementation of closed areas in 1994 and 1998 (Figure 2). The western Gulf of Maine area closure, Cashes Ledge area closure and the seasonal rolling closures overlap the witch flounder distribution (Figures A.1 and A.2). Management regulations for the northern shrimp fishery also impact witch flounder (Table A.2); significant changes in the shrimp fishery include a monthly 10% by-catch limit which restricted the possession of groundfish to 10% by weight of shrimp in the mid-1980's to early 1990s; and the implementation of the Nordmore grate to exclude groundfish in 1992.

THE FISHERY

Recreational Catches

There is no recreational fishery for witch flounder.

Commercial Landings

USA commercial landings in 2002 totaled 3,186 mt, a 5% increase over 2001 (Table A.3); and 117% higher than in 1990, the lowest value since 1964 (Figure A.3). Canadian landings from the stock have been negligible (32 mt in 2001; Table A.3). Landings from the Grand Banks (NAFO Divisions 3LNO) during 1985 to 1990 are not included in this assessment. Canadian landings from the western Scotian Shelf (NAFO Division 4X) are not considered due to the fact that, until recently, witch flounder were reported as 'other flounders' by Canada, and cannot be separated from other flounder species. Furthermore, samples from the western Scotian Shelf indicate slower growth of witch flounder than in the Gulf of Maine, suggesting a different phenotypic stock.

The western Gulf of Maine (SA 513 and 514) and the central basin (SA 515) provide nearly a third of the USA witch flounder landings (Table A.4); landings from Georges Bank are confined to the deeper waters north of the South Channel (SA 521, 522; Table A.4). Otter trawl catches account for about 98% of witch flounder landings, with sink gillnets comprising the remainder (Table A.5). Catches are generally highest during March-July 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 New Bedford and Gloucester, MA.

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 A.6, Figure A.4). Since the early 1990s, the proportions of witch flounder landings from the peewee and small market categories have steadily increased. In 2002, witch flounder less than 45 cm ('peewee' and 'small' market categories) constituted 87% of total landings (Table A.6, Figure A.4). The current regulated minimum landing size for witch flounder is 36 cm (14 inches).

Sampling Intensity

Length frequency and age sampling data for witch flounder landings from the Gulf of Maine-Georges Bank region are summarized by quarter and market category in Table A.7 (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 (approximately 100 fish per sample) 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 (Tables A.6 and A.7). Sampling intensity during 2001-2002 averaged 39 samples annually, representing 1 sample per 80 mt landed; nonetheless, even with this increased sampling intensity, inadequate numbers of samples were obtained for some market categories and quarter combinations. In 2002, of the 35 samples collected, 15 were small samples (43%), 10 were medium (29%) and 10 were large (29%). Compared with the 2002 market category landings distribution by weight (small 87%; medium: 10%; large: 3%), sampling in 2002 adequately approximated the market category distribution of landings on an annual basis. As in previous years, it was necessary to pool some quarters for some market categories. A summary of pooling procedures by year, market category and quarter is presented in Table A.8.

Commercial Landings at Age

Commercial age data for the years 1982 to 2002 were available for this assessment. Quarterly age-length keys (ALKs) were applied to corresponding commercial landings length frequency data by market category. Resulting estimates of annual age compositions (age 0 to 14+) are presented in Table A.9. No discernible changes in growth are evident during the 1982-2002 period; although landings mean weights and mean lengths at ages 6 to 8 declined in 1996-2002, this may be an artifact of poor sampling in recent years.

Discards

The Fisheries Observer Program (FOP), which began in 1989, has generated various levels of coverage for different fisheries. Prior to the FOP, NEFSC conducted sea sampling on an ad-hoc basis. The northern shrimp fishery, the small-mesh otter trawl fishery, and the large-mesh otter

trawl fishery are three fisheries in which discarding of witch flounder occurs. In this assessment, discard estimates have been estimated for the shrimp fishery and the large-mesh otter trawl fishery.

Northern shrimp fishery

Since the 'shrimp season' spans a calendar year, in this report, the year in which most of the fishing occurred will be used to identify the entire season. For example, 1990 will refer to the shrimp season from December 1, 1989 to May 31, 1990. These estimation procedures were used in the 1994 assessment (Wigley and Mayo 1994), reviewed by the SAW 18 (NEFSC 1994), and extended through 1997 using the same methodology. The ratio of witch flounder discarded (kg) to days fished was calculated using FOP data for individual shrimp seasons, 1989-1997, by fishing zone. Since depth is an important factor influencing discards (Wigley MS 1994), discard ratios were calculated for each of three fishing zones (zone 1 = 0-3 miles from shore, zone 2 = 3 - 12 miles, and zone 3 = greater than 12 miles) in each season. For the most part, fishing zones are analogous to depth zones. Statistical testing of zonal discard rates indicated differences between fishing zones in most years. The zone-specific discard rates were weighted by the days fished in each zone to calculate a weighted mean discard rate for each season (Table A.10). To estimate witch flounder discard rates prior to the FOP, (i.e., 1982-1988), a simple linear regression was employed using 1989-1992 (years in which the Nordmore grate was not required) weighted mean discard rates 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 ($r^2 = 0.97$, $p = 0.0127$; Figure A.5; Wigley MS 1994).

With no 1998-2002 FOP sampling in the northern shrimp fishery, an alternative method of survey filtering was explored to estimate witch flounder discard rates; however, due to insufficient length frequency data at small sizes, this method did not prove fruitful. As used for the years prior to the FOP, a simple linear regression using 1993-1997 (years in which the Nordmore grate was required) annual shrimp season discard rates and annual survey indices of autumn age 3 fish was employed ($r^2 = 0.87$, $p = 0.0206$). This five-point regression may not be as robust as the r^2 suggests, as four of the points are clustered (Figure A.5).

To obtain total weight of witch flounder discarded during a shrimp season, season discard rates (kg per day fished) were multiplied by the total number of days fished by the commercial fleet in each season (Table A.11). Estimated discard weight was then translated into discarded numbers at age by applying witch flounder sea-sampled discard length-frequencies expanded up to the total discard weight and then applying NEFSC spring bottom trawl survey ALKs. Detailed information on this method is given in Wigley (MS 1994). For 1995-2002, days fished were estimated from the Vessel Trip Reports (VTR) using a stratification level of year, ton class, port group, month, and fishing zone. To derive the number of trips by fishing zone, the proportion of VTR trips by fishing zone was applied to the number of trips in the weighout database. Days fished per trip in each fishing zone were derived from the VTR data. Days fished per trip were then multiplied by the estimated number of trips for each fishing zone to derive estimated days fished by fishing zone, and then summed over year and fishing zone.

For the 1982-1997 time period, discard estimates of numbers at age and weight were derived on a shrimp season basis due to the limited number of length frequency samples in December. To adjust the shrimp fishery discard-at-age from a shrimp season basis to calendar year, the ratio of December days fished to the entire shrimp season days fished was used to apportion of the weight and numbers discarded into December and January-May categories. The December discards-at-age were shifted back one age, and then re-combined with the January-May matrix of the corresponding calendar year. The December discard weight was combined with January-May of the same calendar year. Mean lengths and mean weights at age in the re-combined catch at age were weighted by the numbers at age from each category.

Without 1998-2002 FOP sampling, discard length-frequency data were unavailable to partition the 1998-2002 estimated discard weight into numbers at length; thus discarded numbers at age were derived by apportioning discard weight by the average age composition (calendar year) of discards in 1993-1997 and then dividing by the average 1993-1997 discard mean weights at age. The average 1993-1997 mean weights at age from the FOP were consistent with trends in mean weights from the NEFSC survey during the 1998-2002 time period.

Witch flounder discards in the northern shrimp fishery ranged from a low 0.8 mt in 2002 to a high of 34 mt in 1988 and 1995 (Table A.11). Similarly, number of witch flounder discarded ranged from 40,000 fish discarded in 2002 to 1.8 million fish in 1994 (Table A.11). Estimates of age compositions of discarded witch flounder in the shrimp fishery are presented in Table A.12. Discarded witch flounder from the shrimp fishery range from age 0 to 6, with ages 1 to 3 most commonly discarded (Table A.12).

Large-mesh otter trawl fishery

Discard estimation from the large-mesh otter trawl fishery is confounded by the lack of FOP coverage prior to 1989, sparse coverage in the beginning of the program, and the recent implementation of year-around and seasonal area closures. As a result, three estimation scenarios were examined: 1) utilizing a survey filter method; 2) utilizing the at-sea observer data (Table A.13); and 3) utilizing the Vessel Trip Report data (Table A.14). The estimated discards (in weight and numbers) are presented in Table A.15. Each method is described below.

The method used in previous witch flounder assessments to estimate large-mesh otter trawl discards was 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 mesh size employed in the large-mesh fishery (130, 140, and 152 mm) and then through a culling practice ogive. Due to the sparse gear retention studies for witch flounder, mesh selection ogives were taken from Walsh et al. (1992) for American plaice. Given the high value and low abundance of this species, the culling practice of commercial fishermen was assumed to be nearly knife edged at the minimum landing size. A semi-annual ratio estimator of survey filtered 'kept' index to semi-annual numbers landed was used to expand the estimated 'discard' survey index to obtain numbers of fish discarded at length. The method used in this analysis differs from the method described by

Mayo et al (1992) which employs an expansion factor derived from a linear regression from the ratios of kept to landed at length. Semi-annual numbers of discard fish at length were apportioned to age using the corresponding season NEFSC ALK. Estimated numbers of discarded witch flounder in the large-mesh otter trawl fishery are presented in Table A.15. Results indicate that in recent years, numbers discarded at sea comprised as much as 54% of the witch flounder landed. The general pattern of discarding appears to be consistent with that expected given strong recruitment during 1979-1981 and the mid-1990's.

Given the distribution of juvenile witch flounder in the western Gulf of Maine and the recent implementation of year-around area closures and seasonal rolling area closures in the western Gulf of Maine, there was some concern regarding the application of the survey filter method to estimate discards in recent years. Since the commercial fishery does not have year-around access to the population estimated by the NEFSC survey, it may be inappropriate to use the survey filter method to estimate discards. For the 1989-2002 period, discard weight to kept weight ratios (D/K ratio) were calculated from FOP data on a semi-annual basis (Table A.13). Total discard weight was derived by multiplying the D/K ratio by the commercial landings. The number of sea sampled trips varied from no trips in the second half of 1992 to 83 trips in the second half of 2002. The D/K ratios ranged between 0.02 and 0.50. Given the limited number of trips, tows and available discard length frequencies, discards at age were derived only for the 1995-2002 time period (Tables A.15).

The Vessel Trip Report data were explored for information on discarding of witch flounder. Reporting of discard information in the logbooks is known to be incomplete. To eliminate problems associated with incomplete reporting, a subset of the VTR data was used. The VTR subset included only logbooks which reported discards of any species (Delong et al. 1997), assuming that operators who report discards of any species would reliably report witch flounder discards. This subset was used to estimate discard ratios (discard weight/kept weight) semi-annually for large-mesh otter trawl gear from 1994 to 2002. Limitations of this analysis are: 1) the dealer data used to expand discard rates to total discard weight do not contain information on mesh size, precluding partitioning of otter trawl fisheries into small and large mesh trips; 2) there is no area information on dealer data to isolate trips from the Gulf of Maine-Georges Bank region. From this analysis, results suggest that discard rates range between 4% and 9% (Table A.14). These estimates should be reviewed cautiously as not all fishermen report discards. Discarded numbers at age were estimated by expanding the FOP length frequencies and applying the survey age/length keys (Table A.15).

For estimates of total catch at age, discards from the large-mesh otter trawl fishery were derived using the survey filter method from 1982-1994 and using the FOP method for 1995-2002 (Table A.16).

Total Catch at Age

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 A.17 and Figure A.6. The age composition data reveal strong 1979-1981 year classes (Table A.17). The 1989

and 1993 year classes also appear to have been strong; however, these cohorts were heavily discarded in both the shrimp and large-mesh otter trawl fisheries (Tables A.12 and A.16). The poor 1984 year class is also evident as well as the truncated age-structure since the early 1990's.

Since witch flounder landings are highest during March-July, the average weights-at-age in the catch approximate mid-year weights. Mean weights at age at the beginning of the year (January 1; Table A.18) were derived from mid-year weights using procedures described by Rivard (1980).

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 for the Georges Bank-Gulf of Maine region 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 A.19). These '40% trips' may represent effort that is 'directed' towards witch flounder, a species historically 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 from 1986 to 1990. Since the early 1990s, LPUE indices have steadily increased and are among the highest in the time series (Table A.19, Figure A.7a). Indices for 40% trips peaked in the early 1980's , then declined to a low in 1994, and have increased slightly in recent years (Table A.19, Figure A.7a). Effort (days fished) associated with all trips and 40% trips increased during the late 1970s and early 1980s, peaked during 1985-1988, and have generally declined since (Figure A.7b). 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. In 1994 the NEFSC commercial data collection system changed from a voluntary to a mandatory system in which fishermen self-report fishing effort. Investigation is still on-going to determine if the time series of LPUE data can be extended (considered one series) or whether the post 1993 LPUE derived under the mandatory system constitutes a separate time series. Effort (days fished) for 1994 to 2002 may be underestimated in this report since effort is based upon preliminary VTR data, which do not represent 100% of the trips.

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.

In September 2002, an offset in the trawl wraps was detected which may have effected the NEFSC bottom trawl surveys conducted from winter 2000 to the spring 2002. Extensive analyses of existing data sets and experimental studies were conducted to evaluate the offset issue (NEFSC 2002). These analyses were reviewed by a panel of experts and they concluded that no adjustments to the survey time series were justified (Groundfish Science Peer Review, 2003).

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 (ASFMC) has conducted an annual northern shrimp survey during August in the Gulf of Maine since 1983, with catch data for witch flounder available from 1984 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 3); Massachusetts DMF, regions 4 and 5; and northern shrimp, strata 1, 3, 6, and 8.

Witch flounder are generally distributed throughout the Gulf of Maine, along the Northern Edge and southern flank of Georges Bank, and southward along the continental shelf as far south as Cape Hatteras, NC (Figures A.1 and A.8). Juvenile witch flounder (< 25 cm) are distributed along the western Gulf of Maine, with a few in the canyon areas in the Mid-Atlantic region (Figures A.2a and A.2b). Concentrations of witch flounder along the western portion of the Gulf of Maine are observed in the ASMFC shrimp survey. Although this survey has limited spatial coverage (Figure A.9), most of the juvenile range is covered.

In response to a research recommendation from SARC 29, analyses were conducted to examine if the use of additional strata in the NEFSC bottom trawl survey might be appropriate. Burnett and Clark (1983) used NEFSC survey strata set 22,24,26-30, 33-40 in the first witch flounder assessment; however, Burnett (MS 1987) suggested that fish from strata 33, 34 and 35 exhibited different growth rates indicating these fish may be from a different stock inhabiting the western Scotian shelf. Based on this information, Wigley and Mayo (1994) revised the witch flounder survey strata set excluding 33, 34, and 35, and included strata 23 and 25 (Figure A.9). Following a method developed by Cadrin (2003), witch flounder catches for the entire autumn bottom trawl survey time series were examined by individual stratum. The stratified mean number per tow in each stratum was summed over the time period, and the percentage contribution of each stratum was calculated as well as the percentage of annual stratum sampling which produced no catch

(Table A.20). Results indicate that the current strata set (22-30, 36-40) accounts for approximately 93% of the survey catch and that only minor differences exist between the strata sets used in previous assessments. This analysis also indicated that stratum 6 contributed to the overall witch flounder catch. The stratified mean weight (kg) per tow was calculated for three strata sets: set 1 (22-30, 36-40); set 2 (22, 24, 26-30, 36-40); and set 3 (6, 22, 24, 26-30, 36-40). The trends of these biomass indices (and their variance) are indistinguishable (Figures A.10a and A.10b). The inclusion of stratum 6 is not justified due to its geographical discontinuity with the core strata. Since no additional strata were identified as contributing to the total catch, or improved the precision of the estimates of mean weight per tow, the strata set 22-30, 36-40 will continue to be used.

Research vessel survey indices of abundance, biomass, and mean length for NEFSC surveys, Mass. DMF surveys, and ASMFC shrimp surveys are presented in Tables A.21-A.23 and Figures A.11-A.16, respectively. A summary of available age data from NEFSC surveys is given in Table A.24; survey age samples collected during 1976 to 1979 have not been aged. Too few age samples are collected during DMF surveys to reliably characterize the age composition of witch flounder in the inshore areas, and no age samples are collected on ASMFC surveys. Age-specific relative abundance indices from NEFSC spring and autumn surveys 1980-2002, and preliminary spring 2003 are presented in Table A.25, Figures A.17 and A.18. Mean length and mean weights at age from the NEFSC spring and autumn surveys area given in Tables A.26 and A.27 and Figures A.19 - A.21.

While NEFSC spring survey indices tend to be more variable due to the pre-spawning aggregations of witch flounder, spring and autumn indices generally display similar trends. Abundance and biomass remained fairly stable from 1963 until the late 1970s (Table A.21, Figures A.11 and A.12); autumn indices declined during the early and mid 1980s, reaching record low levels in 1987. Abundance sharply increased in 1993, due to a large age 0 index (Table A.25, Figure A.12) and has continued to increased to near record high levels in 2002. During the same time, mean length declined (Figures A.15 and A.16). The age structure has been truncated since the late 1980's (Figures A.17 and A.18).

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 A.23). The ASMFC survey data indicate improved recruitment in recent years, corresponding to age 1 fish, during 1991-1994, 1997, and 1999. Significant numbers of small fish were also observed in the NEFSC autumn survey during the same years.

Mean lengths at age from NEFSC spring and autumn surveys are presented in Table A.26 and for ages 4 to 8 in Figures A.19a and A.19b. Mean lengths at age for ages 5 to 7 appear to have increased approximately 3-5 cm from 1980 to the late 1980's, and then declined (Figures A.19a and A.19b); however, Von Bertalanffy growth analyses detected no significant changes in resulting growth parameters over the time period.

NEFSC spring and autumn survey mean weights at age are given in Table A.27 and Figures A.20 and A.21. Survey mean weights are variable, however, similar declines in mean weights for ages 6-9 were observed during the mid-1990s to 2002 in both the commercial landings and spring and autumn surveys.

MATURITY

Witch flounder maturity observations have been collected on the NEFSC research bottom trawl surveys since 1977. The NEFSC spring surveys were used for maturity analyses as these surveys occur closest to and prior to spawning (Halliday 1987). In the previous witch flounder assessment, probit analyses (SAS 1985) of maturity at age data revealed that there have been six maturity stanzas over the assessment period (GARM NEFSC 2002). The proportion at which 50% of the fish are mature at age (A_{50}) was significantly different for the time periods 1980-1982, 1983-1984, 1985-1990, 1991-1993, 1994-1999, and 2000-2002. Due to small sample sizes, it was necessary to pool individual years, however, individual years were examined, and then pooled into time blocks. Trends in female A_{50} and L_{50} were similar, progressively decreasing from 1980-1982 to 1985-1990, then increasing in 1991-1993, then declining in 1994-1999 and increasing in 2000-2002 similar to 1983-1984 levels. The maturity stanzas used revealed sharp changes in proportion mature, uncharacteristic of the assumed gradual biological process. The maturity stanzas also revealed, in a few instances, biologically infeasible outcomes, i.e. over the life span of a cohort, the proportion mature at age would decrease. Given these issues, a method which has been applied to Georges Bank cod (L. O'Brien, NEFSC, pers. comm.) was employed to minimize the abrupt changes yet still capture the changing trends in maturity over time. This method used logistic regression and a five-year moving time block to estimate annual maturity ogives. For example, the proportion mature in 1982 was estimated using NEFSC spring maturity data from 1980, 1981, 1982, 1983 and 1984. Likewise, the 1983 maturity ogive used maturity data from 1981 to 1985. Annual maturity ogives were derived for 1982 to 2001 using 1980 - 2003 data. The annual 2002 maturity ogive was assumed to be equal to the 2001 ogive (Table A.28, Figure A.22). In addition to the annual maturity ogives, a single ogive using maturity data from the entire time series was also calculated (Table A.28). It was concluded that the moving time block method was appropriate for use in the VPA.

Stratified mean weight per tow of mature (spawning stock) witch flounder was calculated for spring NEFSC research vessel surveys (Table A.29, Figure A.23) using the six maturity stanzas. This analysis will be updated to incorporate the moving time-block maturity estimates in the next assessment update. The spawning stock biomass indices closely track total biomass indices except in most recent years, indicating a larger proportion of immature fish in the population.

MORTALITY

Natural Mortality

Burnett (MS 1987) estimated instantaneous natural mortality (M) to be 0.16 from a regression of survey-derived instantaneous total mortality (Z) 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: 1982-1985, 1986-1989,1990-1993, 1994-1997 and 1997-2001. Given the variability in age at full recruitment to the sampling gear observed during the survey time series (Table A.30), 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 1982-1985 was computed as:

Spring:	ln (sum age 7+ for 1982-1985 / sum age 8+ 1983-1986)
Autumn:	ln (sum age 6+ for 1981-1984 / sum age 7+ 1982-1985).

To evaluate Z over identical year classes within each of 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 A.30 and Figure A.24a). 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 ranged between 0.34 and 0.71 over the time series (Table A.30). Additionally, annual estimates of total mortality were calculated, and smoothed with a three year moving average (Figure A.24b).

ESTIMATION OF FISHING MORTALITY RATES AND STOCK SIZE

Virtual Population Analysis and Calibration

The ADAPT calibration method (Parrack 1986, Gavaris 1988, Conser and Powers 1990) was applied to estimate abundance at age in 2003 using catch-at-age estimates (i.e., landings plus discards from the shrimp and large-mesh otter trawl fishery; Table A.17). Estimates of stock sizes, their associated statistics, and F in the terminal year are summarized in the Table A.31.

New VPA software is now available in the NOAA Fisheries Toolbox. To bridge the transition between the software used in the last assessment update (FACT 1.5) and the current software, NFTv2.0.11, the accepted 2002 VPA (NEFSC 2002) formulation and input data was re-run using

the NFTv2.0.11 software. The summary statistics of the two VPAs (RUN 61-f) reveal only slight changes in stock size estimates and fishing mortality (Table A.31), and these minor changes are attributed to the use of the exact catch equation and other improvements in precision.

An initial formulation (RUN 100) based upon the 2002 VPA was performed to estimate 2003 stock sizes for ages 4 to 10 (Table A.31) using a catch-at-age matrix including ages 3-11+ and NEFSC spring and autumn abundance indices for ages 3 to 11+ as tuning indices. All indices were given equal weighting. Autumn survey indices were lagged forward one year and one age to calibrate with beginning year population sizes of the subsequent year. A flat-top partial recruitment (PR) pattern was assumed, with full fishing mortality on ages 7 and older. The F on ages 10 and 11+ in the terminal year was estimated as the average of F on ages 7 through 9. The F on ages 10 and 11+ in all years prior to the terminal year was derived from weighted estimates of Z for ages 7 through 9. Instantaneous rate of natural mortality (M) was assumed to be 0.15. Spawning stock biomass (SSB) was calculated at time of spawning (March) and mean weight at age calculated by the Rivard method (Table A.18).

The results of the initial run indicated that coefficients of variation (CV) for estimated ages ranged between 29% and 44% and the CVs for survey catchability coefficients (q) were consistent, ranging from 11% to 27%.

Two alternative formulations included: 1) using a total catch at age in which large-mesh otter trawl discards were estimated using the survey filter method for 1982-1994 and Fisheries Observer Program data for 1995 to 2002 [RUN 200]; and 2) estimating age 3 stock size using survey tuning indices [RUN 201]. Results from these alternative formulations provided estimates of stock size, F and spawning stock biomass consistent with the base run [RUN 100]. RUN 201 stock size for age 3 was poorly estimated (CV = 63%). Based on these runs, the partial recruitment pattern indicated that age 7 was not fully recruited. An alternative formulation (RUN 300) was conducted using a partial recruitment vector where the fully recruited age was increased from 7 to 8. Assuming full recruitment at age 8, the F on ages 10 and 11+ in the terminal year was estimated as the average of F on ages 8 and 9. The F on ages 10 and 11+ in all years prior to the terminal year was derived from weighted estimates of Z for ages 8 through 9. This partial recruitment pattern is consistent with recent mesh regulation changes.

The final formulation (RUN 301-f) included a 3 to 11+ catch at age with large-mesh otter trawl discards estimated using both the survey filter method and FOP data; an updated partial recruitment vector reflecting current management regulations was derived from the 1999-2002 F pattern taken from a penultimate calibration run; annual maturity ogives estimated by the five year moving time block with the 2002 maturity vector assumed to be equal to 2001. Ages 1 and 2 were deleted from the catch at age, this allowed recruitment in 2003 to be estimated using the the geometric mean; there is no difference between 1-11+ vs 3-11+ on VPA results for fishing mortality and spawning stock biomass. Based on the final formulation, two sensitivity analyses were conducted to evaluate the selection of tuning indices. The VPA was tuned with only

NEFSC spring survey indices and then tuned with only NEFSC autumn survey indices (Table A.31). Estimates of F and SSB from analyses using a single tuning series bounded the F and SSB estimated using both spring and autumn tuning indices. Using only the spring tuning series (RUN 301-f-spr), F was slightly higher (F= 0.43) and SSB is slightly lower (15,798 mt) then the final run (RUN 301-f). Conversely, using only the autumn tuning indices (RUN 301-f-aut), F is slightly lower (F = 0.39) and SSB is slightly higher (21,569 mt; Table A.31) then the final run (RUN 301-f) .

VPA Estimates of Fishing Mortality, Spawning Stock Biomass and Recruitment

The VPA results, including estimates of F, stock size and spawning stock biomass at age are given in Tables A.32. The mean residual for the VPA calibration was 0.791 and the CV on age 3-10 stock sizes ranged from 31% to 64% while the CVs on the estimates of survey catchabilities were between 13% and 26%. The normalized survey indices and standardized residuals are presented in Figures A.25 And A.26.

The VPA indicates that fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.67 in 1985, declined to 0.22 in 1992, increased to 1.13 in 1996, then declined to 0.41 in 2002 (Table A.33 and Figure A.27). Spawning stock biomass declined from 16,897 mt in 1982 to about 3,800 mt in 1996. With recent increases in recruitment and declines in fishing mortality, SSB has increased to 18,296 mt in 2002 (Table A.33 and Figure A.28). Since 1982 recruitment of age 3 has ranged from approximately 3 million fish (1984 year class) to 67.6 million fish (1997 year class; Table A.33 and Figure A.28). Over the 1982-2002 period, average recruitment of age 3 fish (the 1979 - 2000 year classes) was 19.6 million (the geometric mean equaled 14.4 million fish). The 1995-1999 year classes appear to be above average, and the 1997 year class is the largest in the VPA time series (Table A.33 and Figure A.28) .

The relationship between spawning stock biomass and recruitment (age 3) is presented in Figure A.29. The negative stock-recruitment relationship observed in previous assessments continues with the addition of the 2000 year class.

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). One thousand bootstrap iterations were performed to derive standard errors, coefficients of variation (CVs) and bias estimates for the stock size estimates at the start of 2003, the catchability estimates (q) of the abundance indices used in calibrating the VPA, and the 2002 fully recruited fishing mortality rate (age 8+). Frequency distributions of the 2002 mean fishing mortality and spawning stock biomass bootstrap estimates were generated and cumulative probability curves produced (Figures A.30 and A.31).

Bootstrap results suggest that the estimates of 2003 abundance had CVs between 32% to 84%, 24% for 2002 F_{8-9} and 15% for 2002 spawning stock biomass. There is an 80% probability that the 2002 F (0.41) lies between 0.31 and 0.56 (Figure A.30), and the 2002 SSB (18,296 mt) lies between 15,603 mt and 22,969 mt (Figure A.31).

Retrospective Analyses

A retrospective analysis was conducted on the final VPA (Run 301-f) from 2002 to 1992 by sequentially removing the terminal year of the data to evaluate internal consistency of the current ADAPT formulation with respect to terminal estimates of F, SSB, and recruits at age 3 for the seven years prior to the current assessment. Results indicate that average F was underestimated (Figure A.32a) and spawning stock biomass was consistently overestimated (Figure A.32b). The retrospective analysis indicated that the number of age 3 recruits were generally overestimated, and the 1995-1997 year classes were considerably overestimated (Figure A.32c).

Statistical Catch-at-age model

A statistical catch-at-age analysis was conducted for the witch flounder stock. An age-structured forward-projection model (a.k.a., age-structured production model) was fit to fishery and survey data during 1937-2002. This model provided an alternative long-term perspective on resource dynamics in comparison to VPA-based analyses that were limited to the period 1982-2002. Age-structured population dynamics of witch flounder were described using forward-projection methods for statistical catch-at-age analyses (Fournier and Archibald 1982, Methot 1990, Ianelli and Fournier 1998, Quinn and Deriso 1999). Models were fit to data with the AD Model builder software for nonlinear optimization (Otter Research 2001).

Six alternative statistical catch-at-age models were developed and fit. Brodziak and Wigley (2003 ms) contains a complete description of the basic model and input data. Common features of the six models were:

- Natural mortality was M=0.15 for all age classes.
- Catch scenario 2 was used (same catch as used in the VPA).
- Fishery selectivity was estimated for historic (1937-1993) and current (1994-present) time periods.
- NEFSC spring and fall survey biomass and numbers at age data were used.
- Emphasis values for likelihood components were:Recruitment λ_1=10, Fishery age composition λ_2=1, NEFSC Fall survey age composition λ_3=1, NEFSC Fall survey biomass index λ_4=100, NEFSC Spring survey age composition λ_5=1, NEFSC Spring survey biomass index λ_6=100, Catch biomass λ_7=100, Fishing mortality λ_8=1, Fishing mortality penalty λ_9=1

The primary differences among the six alternative models were:

1. Dome-shaped selectivity possible for fishery, spring, and fall surveys; time frame is 1937-2002.
2. Flat-topped selectivity for fishery, spring, and fall surveys; time frame is 1937-2002.
3. Dome-shaped selectivity possible for fishery, spring, and fall surveys; time frame is 1963-2002.
4. Flat-topped selectivity for fishery, spring, and fall surveys; time frame is 1963-2002.
5. Flat-topped selectivity for fishery and spring survey; Dome-shaped selectivity possible for fall survey; time frame is 1963-2002.

6. Flat-topped selectivity for fishery and spring survey; Dome-shaped selectivity possible for fall survey; time frame is 1937-2002.

Models 1, 2, and 6 were considered to be the primary models, while models 3, 4, and 5 provided sensitivity analyses to the choice of time frame. The Northern Demersal Working Group (WG) reviewed the model diagnostics. In general, the selectivity patterns of models that allowed dome-shaped fishery or survey selectivity appeared to be too sharply domed to be biologically plausible. In contrast, models with the assumption of flat-topped selectivity provided a poorer fit to the data, as measured by the root-mean squared errors for the NEFSC fall and spring survey biomass index and the catch biomass fits to the data. The WG chose to reduce the emphasis on the NEFSC fall and spring survey biomass index and the catch biomass likelihood components to 10 down from 100. This choice alleviated the problem of implausible selectivity patterns in the fishery and the survey. As a result, the WG concluded that Model 1 with reduced emphasis values was the best alternative of the statistical catch-at-age analyses (SCAA). Model results are reported to confirm the basic trends of VPA-based results and show the likely effect of extending the assessment time horizon back to 1937.

Model results showed that current fishery selectivity at age was estimated to be lower at ages 1-6 than historic selectivity (Figure A.33). This was consistent with increases in fishery mesh size and changes in discarding practices (e.g., shrimp fishery) that occurred around 1994. The resulting catch biomass predictions generally matched observed catch biomasses (Figure A.34) with some moderate deviations in the early 1980s.

Model results showed that NEFSC fall survey selectivity was dome-shaped with a peak at age-5 (Figure A.35). The NEFSC spring survey selectivity was flat-topped with full selection occurring at roughly age-7. The resulting predicted NEFSC fall and spring survey indices generally matched the trends in observed indices (Figures A.36 and A.37). Both surveys indicate a longterm decline in biomass from the 1970s through the early 1990s. Biomass increases in the late-1990s differed moderately between the fall and spring surveys

There was general agreement between VPA and SCAA results during 1982-2002. Spawning biomass estimates were very similar during 1989-1999 (Figure A.38, SCAA estimate of 10.5 kt in 2002). The VPA indicates a smaller decrease in spawning biomass during 1982-1988 and a greater increase during 2000-2002. Fishing mortality estimates were also similar (Figure A.39, SCAA estimate of 0.48 in 2002). Both VPA and SCAA estimates increased to roughly the mid-1990s and then declined. Recruitment estimates also exhibited similar patterns (Figure A.40, SCAA estimate of 14.1 million age-1 fish in 2002), although the VPA indicated larger increases in recruitments during the late-1990s. Despite differences in model configuration and estimation approach, the SCAA generally confirmed point estimates and trends in the VPA results.

BIOLOGICAL REFERENCE POINTS

Yield-per-recruit (Y/R) and spawning stock biomass per recruit (SSB/R) analyses were performed using the Thompson and Bell (1934) method for witch flounder ages 3 to 20. Input vectors for partial recruitment, maturation at age and mean weights at age were all updated since the last assessment. Mean weights at age used in the Y/R analyses were computed as an arithmetic average of catch mean weights at age (Table A.17) over the 1999-2002 period. Mean weights at age for use in the SSB/R analyses were derived by applying the length-weight relationship for witch flounder to predicted lengths at age from von Bertalanffy growth curve analyses of NEFSC survey data from 1980-2002. The maturation ogive from the entire time series (1980-2003) was also used (Table A.28). Given the changes in regulated mesh size in 1999, the exploitation pattern used in the yield and SSB per recruit analyses and short-term projections was computed from the 1999-2002 VPA results. Geometric mean F at age was computed for the 1999-2002 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 8 and older, viz.

Age 3	Age 4	Age 5	Age 6	Age 7	Ages 8+
0.0036	0.0229	0.0703	0.1931	0.5282	1.000

The input data and results for the Y/R and SSB/R analyses are given in Table A.34 and Figure A.41. The reference points were $F_{0.1} = 0.196$, $F_{max} = 0.545$, and $F_{40\%} = 0.230$.

The biological reference points were updated by applying the approach used to estimate MSY proxies for witch flounder (NEFSC 2002). Fmsy is approximated as F40% (0.23), the SSBmsy proxy is 25, 248 mt, the product of 40%MSP (1.2882 kg spawning biomass) and average long-term recruitment (19.6 million). The MSY proxy is 4,375 mt, the product of yield per recruit at F40% (0.2232 kg) and average recruitment.

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In 2002, spawning stock biomass was slightly greater than ½ SSBmsy (12,624 mt), the minimum stock size threshold, and fishing mortality in 2002 was nearly double Fmsy, the maximum fishing mortality threshold; therefore, witch flounder was not overfished but overfishing was occurring in 2002 (Figure A.42).

To evaluate the effects of simultaneous changes in the three input vectors described above (i.e. partial recruitment, maturation and mean weights) on F40%, Y/R, SSB/R and the SSBmsy proxy, a decomposition analysis (P.Rago, NEFSC, pers. comm.) was conducted. This analysis is analogous to decomposing a sum of squares in an analysis of variance (decomposing the total resulting difference into its components).

For F40%, Y/R and SSB/R:
Total effect = effect of vector 1 + effect of vector 2 + effect of vector 3 + interaction terms.

For SSB_{MSY}:
Total effect = SSB/R effect + Recruit effect + interaction term.

The effect is the difference between the former YPR estimate and the current YPR estimate, for F40%, Y/R, SSB/R and for SSB_{MSY}.

To accomplish this, the former YPR analysis (Run 0) was re-run using ages 3-20 to coincide with the ages used in the current YPR analysis (Run 1). Then, YPR analyses were conducted where each former vector was replaced with a current vector (Runs 2 through 7), until all vectors were replaced with current vectors (Run 8). The resultant F, Y/R and SSB/R at 40%MSP from each run (Runs 0 to 8) are reported in Table A.35. The total effect of changing all three vectors at once equals Run 1 - Run 8.

Results of the decomposition analysis (Table A.35) indicate that changes in F40% were effected most by new partial recruitment vector. Changes in Y/R resulted from the interaction of all three new input vectors while changes in the SSB/R resulted from the interaction between the mean weights and maturity vectors. Changes in SSBmsy were effected most by changes in new mean age 3 recruitment.

SHORT-TERM PROJECTIONS FOR 2004 AND 2005

Short-term stochastic projections were performed to estimate landings, discards and SSB during 2003-2005 under various F scenarios using bootstrapped VPA calibrated stock sizes in 2002 The partial recruitment, maturity ogive, and mean weights at age were the same as described in the yield and SSB per recruit section (Table A.36). Recruitment (age 3) in 2003-2005 was derived by re-sampling the cumulative density function based on the empirical observations during 1982-2002 (1979-2000 year classes). Fishing mortality was apportioned among landings and discards based on the proportion observed landed at age during 1999-2002. The proportion of F and M which occurs before spawning equals 0.1667 (March 1); M was assumed to be 0.15. Spawning stock biomass in 2002 was estimated to be 18,296 mt. The F scenarios are: status quo F_{2003} = 0.41, Fmsy = 0.230, 75% of Fmsy = 0.17 and $landings_{2003}$ = $landings_{2002}$ (F= 0.199). Fishing at the status quo F (0.41) or at the target (Fmsy = 0.23) in 2003 - 2005 is expected to allow biomass to increase above SSBmsy and initiate rebuilding of the age structure (Table A.36). Comparison of the current age structure and the age structure under MSY conditions are given in Figure A.43.

CONCLUSIONS

Based on the ADAPT VPA, the witch flounder stock was not overfished, but overfishing was occurring in 2002. Fully recruited fishing mortality in 2002 was 0.41, nearly double Fmsy (0.23), and spawning stock biomass was estimated to be 18,296 mt in 2002, 72% of SSBmsy (25,248 mt) . Recent year classes appear to be above average. Although the spawning stock

biomass has increased, the age structure still remains truncated. Fishing mortality should be reduced to Fmsy or below to allow the age structure to rebuild.

WORKING GROUP DISCUSSION

The Working Group noted the truncated age structure in the landings during the 1990s, and concluded that the 11+ group was appropriate for this species. The Working Group discussed the survey filter method and its potential to overestimate discards when closed area exists. The Working Group concurred that the survey filter method should be used only when Fisheries Observer Program data are not available or insufficient to characterize discards. The Working Group accepted the large-mesh otter trawl discards which had been estimated using both the survey filter method for the 1982-1994 period and the FOP data for the 1995-2002 period.

The maturity analyses and limitations of using multiple maturity stanzas was also discussed. The Working Group examined the annual estimates of A50 over time relative to the six stanzas and agreed that, while time trends in A50 were evident, the multi-year moving time block method used to estimate annual maturity ogives was appropriate.

The Working Group pointed out that very few witch flounder are caught during the NEFSC bottom trawl surveys. In most years, the stratified mean number per tow of witch flounder is less than five fish. During the late 1980's and early 1990's, the abundance of witch flounder may have gone below detectable levels with one or less than one fish per tow.

The Working Group pointed out that the recent, above-average year classes may be poorly determined, and based on the retrospective pattern for recruitment, these year classes may be overestimated.

SARC DISCUSSION

The effect of low sampling intensity of witch flounder in commercial landings was discussed. It was noted that in recent years, the sampling ratio has decreased especially in the small market category (87% percent of commercial landings), and it was recommended that the commercial sampling be allocated appropriately to the landings of each market category.

The SARC noted that there has been a recent increase in the proportion of smaller witch flounder in the NMFS survey, as well as the truncation of older age classes. The truncation of the age structure in the survey is consistent with high fishing mortality in the 1990s. Since full recruitment is estimated to occur at age eight, there is concern that age truncation could have a serious effect on the future reproductive potential. However, since the 1997 and 1998 above average recruitment events, the age structure is starting to expand compared to the early 1990s when fishing mortality was high and recruitment of the 1983 and 1984 year classes was very poor.

The SARC discussed the difference between survey selectivity estimates in the VPA and SCAA models. In the SCAA, there appears to be a flat-top pattern for the spring and a dome-shaped pattern for the autumn NEFSC survey. The VPA model indicates that the two surveys have similar selectivity. The SARC noted the recent decrease in mean length per tow of witch flounder, which is more apparent in the autumn compared to the spring survey. The greater inter-annual variability of mean length per tow in the autumn survey may be magnifying the discrepancy between the two models. Alternatively, the differences in selectivity and mean weights between the surveys could be a manifestation of seasonal pre-spawning aggregations of witch flounder that differentially affect the availability of older or younger witch flounder to the surveys.

The SARC discussed the decline in the mean weights at age, since declines in mean weight are counter-intuitive compared to the usual response of stocks to overfishing. There were three possible hypotheses: 1) a fishery effect; 2) a density dependent effect or 3) an environmental effect. Fishery effects on mean weights at age can occur when a fishery tends to catch larger fish of a cohort as often occurs for partially-recruited age classes. The declining mean weights at age occurred in fully-recruited year classes, however. Changes in mean weight at age are also commonly observed as a response to year class strength, a density-dependent effect. On the other hand, the year class strength was low for the older year classes where declining mean weights were observed. The other possibility, suggested by the SARC, is that environmental effects may have caused changes in large fish distribution or in growth rates which may or may not reverse as the stock size increases.

Also noted was the peculiar stock-recruitment pattern for witch flounder, where the strongest year classes were spawned when SSB was lowest, and vice versa. The SARC thought that further investigation was needed to evaluate the productivity of witch flounder and the value of biomass targets derived from assumptions about the estimated relationship between spawning biomass and recruitment. It was recommended that a longer time series of data from the SCAA results be explored as well as examining the relationship with trends in abundance of primary predators identified in the food habits data base or other factors to identify possible causes for the observed recruitment pattern. SARC analyses of NEFSC food habits data revealed that witch flounder occurred as prey items in 64 predators (13 species) during the 1978 to 2000 period.

There were several methodological issues raised by the SARC. The SARC commented that estimation uncertainty for input parameters were not included in the YPR analysis. Concerning the ability to compare and evaluate different model formulations and methods, the SARC recommended using an overall statistic (e.g. AIC statistic) for this purpose.

For the accepted VPA formulation, the SARC noted that the CVs are within acceptable ranges and residuals do not show strong patterns that would indicate the model's lack of fit to the data, although in older ages, there may be some positive bias in the earlier years of the time series. It was noted that the uncertainty of the assumptions associated with the model were not addressed since the 80% CI estimates only reflect uncertainty of the model fit and does not incorporate all

sources of uncertainty. The SARC also discussed the justification for using F40% as the basis for estimating a SSB proxy as a substitute for Bmsy. It was concluded that using F40% was an acceptable parameter to use for a slow-growing, late-maturing, flatfish species. Changes in the SSBmsy proxy value were attributed mainly to the addition of new recruitment data that included the strong 1995 - 2000 year classes occurring during 1998 to 2002.

The SARC considered an alternative statistical catch at age model (SCAA) for comparison with the VPA results. The SCAA approach can potentially account for uncertainty in the catch and incorporate information when the full catch-at-age data are not available (e.g. historical landings). The SARC agreed to accept the VPA assessment, although the SCAA model is under development and is giving comparable estimates. The SARC commented that the projections using the terminal year estimates of numbers at age may be optimistic given the retrospective patterns of the VPA. Uncertainties in the discard estimates may also be contributing to the observed retrospective pattern. The SCAA model avoids this problem because it accounts for errors in the catch.

The SARC also noted the landings were comprised of small fish, the age-structure of the population was truncated, and the changes in growth and maturity were occurring. There is concern that average recruitment from the VPA time series may overestimate average recruitment over all stock sizes in the projections. The SARC was also concerned about the reliability of projections since the SSB includes young spawning fish and that the retrospective patterns tend to be optimistic. It was noted that the VPA estimated higher stock biomass in recent years than those estimated by the SCAA model.

SOURCES OF UNCERTAINTY

- The research bottom trawl survey catches very few witch flounder; in most years, the stratified mean number per tow of witch flounder is less than 5 fish. Abundance of witch flounder in the late 1980s and early 1990's may have gone below levels that provide reliable estimates of trends in abundance and biomass.

- Low sampling intensity of commercial length samples across market category and quarter, especially seen in the recent decreased ratio of small market category sampling, results in imprecise mean weights at age and estimates of numbers at age.

- The VPA calibration may be confounded because survey-based estimates of discards use the same information as that used as tuning indices. Survey information was used to estimate discards for the large-mesh otter trawl fishery during 1982 to 1994, as a substitute for the lack of FOP data prior to 1989 and sparse FOP coverage through 1994.

- Retrospective patterns suggest that 2002 SSB may be overestimated (i.e. future assessments may provide lower estimates of 2002 SSB) and fishing mortality may be underestimated (i.e. future assessments may provide higher estimates of F).

- Various factors including selectivity ogives, mean length of discards, and sampling frequency, introduce uncertainties in the VPA that are not appropriately treated because the VPA assumes that catches are known without error.

RESEARCH RECOMMENDATIONS

- Continue to develop alternative models to the VPA, focusing on those that incorporate sampling error and uncertainties in input parameters. While the statistical catch-at-age model is a useful approach, it is still at the developmental stage; further work is needed to examine the sensitivity of the model's weighting factors.

- Investigate the sensitivity of SSB estimates to the number of years used to calculate annual proportion mature at age using a multiple year time block.

- Explore the sensitivity of the assessment models to discard at age estimates, especially with respect to retrospective patterns and other diagnostics.

- Explore the usefulness of the Maine Department of Marine Resources inshore survey for estimating trends in relative abundance and biomass, and for use as assessment tuning indices.

- Improve the biological sampling of all market categories. Sampling should be proportion to landings.

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Table A.1. Significant changes in management regulations governing the USA commercial fishery for witch flounder (adapted from O'Brien and Brown, 1996), updated by Tom Nies, NEFMC (pers. comm., 2003).

1953-1977		ICNAF era
1953		Minimum mesh in body and codend 4 ½ inches.
1970		Areas 1(A) and 2(B) closed during haddock spawning, from March - April.
1972-1974		Areas 1(A) and 2(B) closure extended to March - May.
1975		Areas 1(A) and 2(B) closures extended to February - May.
1977 - Present		Extended Jurisdiction and National Management
1977		USA Fishery Conservation and Management Act of 1976 (FCMA) in effect.
1977-1982		Fishery Management Plan (FMP) for Atlantic groundfish: Seasonal spawning closures for haddock (Areas 1 and 2), quotas for haddock, etc
1982		**Mesh size 5 1/8 inches (130 mm).**
1982-1985		The 'Interim Plan' for Atlantic groundfish: Eliminated all catch controls, retained closed area and mesh size regulations, implemented minimum landing sizes.
1983		Mesh size increased to 5 ½ inches (140 mm). **Witch flounder minimum size 33 cm.**
1984	October	Hague Line separating USA and Canadian fishing zones in the Gulf of Maine and Georges Bank region.
1985		Fishery Management Plan for the Multispecies Fishery.
1987		**Witch flounder minimum size increased to 36 cm.**
1991		Amendment 4 established overfishing definitions for witch flounder in terms of Fmed (F20%) replacement levels.
1993		Area 2 closure is extended from January 1 - June 30.
1994	January	Amendment 5 implemented: expanded Area 2, Area 1 closure not in effect.
	May	6 inch (152 mm) mesh restriction implemented (delayed from March 1). Square or diamond mesh allowed.
	December	Area 1, Area 2 and Nantucket Lightship Area closed year-around.
1996	July	Amendment 7 implemented: **Days-at-sea (DAS) restrictions**. Haddock trip limits Raised to 1000 pounds
1997	May	Additional scheduled DAS restrictions from Amendment 7 accelerated.
1998	May	Western Gulf of Maine Closure Area adopted: Jeffery's Ledge area closed to all groundfishing.
	Rolling closures in the western Gulf of Maine.	
	October	Amendment 9: revised overfishing definitions as required by Sustainable Fisheries Act.
1999	May	**Codend mesh regulations changed to 6-inch diamond mesh, 6 1/2-inch square mesh**. Additional rolling closures adopted in the western Gulf of Maine Cashes Ledge seasonal closure adopted Roller gear limited to a maximum of 12 inches in an area of the western Gulf of Maine. Gulf of Maine cod trip limit ranged from 30 to 400 lbs. in this fishing year.

Table A.1 continued. Significant changes in management regulations.

2000	May	May closure implementation on northern Georges Bank. Changes to large mesh permit category, granting additional DAS to vessels using larger than 6-inch diamond / 6-inch square mesh.
2002	June 1	Additional restrictions adopted during this fishing year (result of lawsuit over FW33): Vessels limited to 25% of allocated DAS May to July; Increase in minimum mesh size for trawl vessel to 6 ½ inch diamond/ 6 ½ inch square; Reduced number of rolling closures in the western Gulf of Maine (effective in January 2003, with result there were additional rolling closures in calendar year 2002 compared to calendar year 2001; Cashes Ledge seasonal closure expanded to year-around closure; Increase in GOM cod trip limit to 500 lbs. per day/4,000 lbs per trip; Increase in mesh size for large mesh permit category.
2002	August 1	Reduction in allocated DAS based on past history of use for each permit; Front-loading of DAS clock prohibited; Additional restrictions on number and deployment of gillnets.

Table A.2. Significant changes in management regulations governing the USA northern shrimp fishery in the Gulf of Maine.

1972	Adoption of mesh regulations, Establishment of count/pound limits, Establishment of closed areas.
1973	Adoption of interim minimum mesh regulations; mesh size not less than 1.5 inches (38 mm).
1975	**Minimum mesh regulations increased to 1.75 inches (44 mm)**. Harvest restricted to 4,200 mt (9.2 million pounds). Fishery closure from July - September.
1976	Harvest restricted to 2,300 mt (5 million pounds) by season closure and quota management. Open season: January 1 - April 15 1976.
1977	Harvest restricted to 1,600 mt (3.5 million pounds). Open season: January 1 - May 15 1977.
1978	**Closure of fishery**.
1979	Open season: February 1 - March 31, 1979
1980	Open season: February 15 - May 31, 1980
1981	Open season: February 15 - May 31, 1981
1982	Open season: January 1 - April 15, 1982
1983	Open season:
1984	Open season:
1985	Open season:
1986 - 1991	Open season: 183 days, by-catch limit of 10% by weight of groundfish allowed.
1992 April	**Nordmore grate regulation** (max 25 mm space); no bycatch of groundfish allowed, no Sunday fishing
1993	Open season: Dec 15 - May 15, no Sundays, separator gear Dec 15 - Mar 15; grate Apr-May15
1994	Open season: December 15 - April 15
1995	Open season: December 1 - May 31 with 1 day off per week.
1996	Open season: December 1 - May 31 with 1 week off.
1997	Open season: December 1 - May 27 with 4 or 5 day block off per month.
1998	Open season: December 8 - May 22 with 3 weekends of no fishing
1999	Open season: December 1 - May 30, no weekend fishing.
2000	Open season: (51 day season)
2001	Open season: Jan 9 - March17; April 16-30 and no days off (83 day season)
2002	Open season: February 15 - March 11 (25 day season)
2003	Open season: Jan 15 - Feb 27 no Friday fishing (38 day season)

Table A.3. Witch flounder landings, discards and catch (metric tons, live) by country, 1937-2002 [1937-1959 provisional landings reported in Lange and Lux, 1978; 1960-1963 reported to ICNAF/NAFO (Burnett and Clark, 1983)].

	LANDINGS							
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1937			*5000*			*5000*		
1938			*3600*			*3600*		
1939			*3100*			*3100*		
1940			*3000*			*3000*		
1941			*2000*			*2000*		
1942			*1800*			*1800*		
1943			*1000*			*1000*		
1944			*1000*			*1000*		
1945			*1000*			*1000*		
1946			*1500*			*1500*		
1947			*1500*			*1500*		
1948			*1000*			*1000*		
1949			*3600*			*3600*		
1950			*3000*			*3000*		
1951			*2600*			*2600*		
1952			*3700*			*3700*		
1953			*4200*			*4200*		
1954			*4000*			*4000*		
1955			*2400*			*2400*		
1956			*2000*			*2000*		
1957			*1000*			*1000*		
1958			*1000*			*1000*		
1959			*1000*			*1000*		
1960	1255		1255			1255		
1961	1022		1022	2		1024		
1962	976		976	1		977		
1963	1226		1226	27	121	1374		
1964	1381		1381	37		1418		
1965	2140		2140	22	502	2664		
1966	2935		2935	68	311	3314		
1967	3370		3370	63	249	3682		
1968	2807		2807	56	191	3054		
1969	2542		2542		1310	3852		
1970	3112		3112	19	130	3261		
1971	3220		3220	35	2860	6115		
1972	2934		2934	13	2568	5515		
1973	2523		2523	10	629	3162		
1974	1839		1839	9	292	2140		
1975	2127		2127	13	217	2357		
1976	1871		1871	5	6	1882		
1977	2469		2469	11	13	2493		
1978	3501		3501	18	6	3525		
1979	2878		2878	17		2895		
1980	3128		3128	18	1	3147		
1981	3442		3442	7		3449		

continued

Table A.3 continued. Witch flounder landings, discards and catch (metric tons, live).

	LANDINGS							
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1982	4906		4906	9		4915	48	4954
1983	6000		6000	45		6045	162	6162
1984	6660		6660	15		6675	100	6760
1985	6130	255	6385	46		6431	61	6191
1986	4610	539	5149	67		5216	25	4635
1987	3450	346	3796	23		3819	47	3497
1988	3262	358	3620	45		3665	60	3322
1989	2068	297	2365	13		2378	133	2201
1990	1465	2	1467	12		1479	184	1649
1991	1777		1777	7		1784	95	1872
1992	2227		2227	7		2234	171	2398
1993	2601		2601	10		2611	376	2977
1994	2665		2665	34		2699	422	3087
1995	2209		2209	11		2220	193	2402
1996	2087		2087	10		2097	254	2341
1997	1771		1771	7		1778	300	2071
1998	1848		1848	10		1858	286	2134
1999	2121		2121	19		2140	213	2334
2000	2439		2439	53		2492	115	2554
2001	3019		3019	32		3051	224	3243
2002	3186		3186			3186	279	3465

Table A.4. Percentage of USA commercial witch flounder landings (mt) by Statistical Area, 1973 - 2002.

	Statistical Areas																									
YEAR	300	400	464	465	466	500	510	511	512	513	514	515	520	521	522	523 561	524 562	525	526	530	537	538	539	540	600	TOTAL
1973	-	1.1	-	0.8	-	-	-	4.0	9.4	18.6	13.8	1.5	-	10.5	16.3	0.8	2.9	7.6	10.7	-	1.0	0.0	0.2	-	0.6	100.0
1974	-	2.7	-	0.1	0.2	-	-	1.0	4.1	17.3	11.6	1.3	-	18.2	16.0	0.9	5.7	7.9	10.4	-	2.2	0.1	0.1	-	0.2	100.0
1975	-	0.7	-	0.8	0.0	-	-	0.8	7.1	16.9	13.6	4.3	-	17.4	11.2	0.5	7.5	13.2	4.9	-	0.6	0.0	0.1	-	0.2	100.0
1976	-	1.2	-	0.3	0.1	-	-	1.3	7.5	25.1	19.5	2.0	-	14.9	11.2	1.3	4.3	7.7	2.7	-	0.6	0.1	0.1	-	0.2	100.0
1977	-	0.2	-	0.2	0.1	-	-	0.6	7.8	30.6	27.6	4.1	-	10.4	10.1	0.8	2.5	2.9	1.2	-	0.5	0.1	0.2	-	0.1	100.0
1978	-	0.3	-	0.1	-	-	-	0.2	9.5	39.1	18.3	4.7	-	10.5	8.7	2.4	2.5	1.1	1.3	-	0.6	0.2	0.1	-	0.3	100.0
1979	-	0.2	-	0.0	-	-	-	2.3	9.4	35.6	14.5	4.2	-	12.8	13.7	3.4	1.2	0.5	1.0	-	0.7	0.0	0.1	-	0.5	100.0
1980	-	0.1	-	0.2	-	-	-	1.4	8.9	42.2	12.3	8.2	-	10.1	7.4	2.1	0.8	1.2	3.5	-	0.6	0.0	0.2	-	0.5	100.0
1981	-	0.2	-	1.0	-	-	-	1.9	9.2	41.0	12.2	9.4	-	11.3	5.3	2.0	1.8	1.4	1.2	-	1.1	0.0	0.3	-	0.8	100.0
1982	-	0.4	-	0.7	-	-	0.0	3.1	15.5	29.2	8.7	15.5	-	11.4	5.9	2.4	1.1	1.4	2.0	-	1.0	0.1	0.2	-	1.3	100.0
1983	-	0.5	-	2.4	-	-	-	4.2	20.6	24.3	8.0	17.4	-	9.3	5.4	2.0	0.8	1.1	1.7	-	1.5	0.0	0.2	-	0.7	100.0
1984	-	0.2	-	2.2	-	-	-	2.4	11.3	23.5	11.8	19.8	-	12.0	6.5	2.3	1.0	1.8	2.7	-	1.5	0.0	0.1	-	0.9	100.0
1985	4.0	0.1	-	1.1	-	-	-	3.7	11.8	23.1	10.3	19.8	-	11.5	7.3	2.0	1.0	1.6	1.7	-	0.5	0.0	0.0	-	0.6	100.0
1986	10.5	0.2	-	1.3	0.0	-	-	4.0	14.9	23.6	9.1	15.3	-	9.3	5.8	1.9	0.4	0.6	1.5	-	0.6	0.0	0.0	-	1.0	100.0
1987	9.1	0.1	-	0.4	-	-	-	2.7	11.6	27.4	9.6	19.0	-	9.1	5.6	1.4	0.5	0.7	1.2	-	0.4	0.0	0.0	-	1.1	100.0
1988	9.9	-	-	0.3	-	-	-	2.6	8.0	26.5	9.7	17.0	-	12.4	5.7	1.5	1.0	2.7	1.3	-	0.4	0.0	0.0	-	1.1	100.0
1989	12.5	0.0	-	0.1	-	-	-	1.3	7.4	21.8	9.4	16.1	-	12.8	5.7	1.6	1.2	2.2	5.4	-	0.9	0.1	0.0	-	1.3	100.0
1990	0.1	0.3	-	0.1	-	-	-	1.6	9.1	29.0	12.4	12.7	-	11.1	5.5	2.4	2.4	3.7	5.2	-	2.6	0.0	0.1	-	1.6	100.0
1991	-	0.1	-	0.1	-	-	-	1.1	9.3	26.1	11.0	15.6	-	8.1	7.7	2.4	3.0	2.0	4.8	-	4.7	0.1	0.1	-	3.7	100.0
1992	-	0.0	-	-	-	-	-	0.6	10.5	23.2	10.1	14.8	-	6.8	8.4	2.0	1.7	2.8	9.8	-	6.4	0.0	0.2	-	2.8	100.0
1993	-	0.5	-	-	-	-	-	0.5	6.7	22.3	16.1	16.2	-	6.9	10.4	3.1	2.5	3.6	5.1	-	3.8	0.0	0.1	-	2.2	100.0
1994*	-	-	0.1	-	-	0.4	0.3	1.7	13.1	15.5	15.5	13.5	0.1	14.3	12.2	2.6	1.5	2.1	1.6	0.1	2.7	0.4	0.1	0.2	1.8	100.0
1995*	-	-	0.5	0.5	-	0.6	0.2	1.1	6.8	14.1	15.2	20.6	0.3	17.3	15.0	1.9	0.7	1.5	0.6	0.2	1.1	0.2	0.0	0.1	1.6	100.0
1996*	-	-	0.1	0.1	-	0.8	1.2	1.7	6.3	18.1	13.8	20.9	1.2	13.7	14.1	2.1	0.4	2.2	0.3	0.0	1.3	0.4	0.1	0.1	1.0	100.0
1997*	-	-	-	0.1	-	1.1	0.7	0.7	9.3	16.5	12.6	21.9	0.6	11.0	16.1	2.7	0.5	3.2	0.7	-	1.2	0.3	0.1	-	0.8	100.0
1998*	-	-	-	0.1	-	1.2	0.1	0.7	8.3	14.5	11.1	21.8	0.2	15.1	16.2	3.5	1.3	2.5	0.5	0.1	1.1	0.6	0.3	0.1	0.5	100.0
1999*	-	-	-	0.1	-	0.4	0.1	0.7	8.2	12.0	11.9	15.8	1.5	17.7	20.9	2.9	1.3	3.0	0.5	-	1.8	-	0.1	-	1.1	100.0
2000*	-	-	-	0.1	-	0.3	0.1	1.0	5.6	12.4	14.5	12.9	0.2	22.8	20.6	2.5	1.0	2.4	0.3	-	0.8	0.2	0.3	0.1	2.0	100.0
2001*	-	-	0.1	0.1	-	-	0.1	1.7	5.2	14.1	15.6	11.2	-	24.8	18.0	4.8	0.5	1.5	0.4	-	0.8	0.1	0.2	-	0.8	100.0
2002*	-	-	-	0.1	-	-	-	1.5	5.5	15.3	23.0	10.5	-	18.4	16.9	3.2	1.6	2.2	0.5	-	0.2	0.3	0.2	0.1	0.5	100.0

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

* 1994-2002 spatial distribution based upon Vessel Trip Report data, considered provisional.

Table A.5. Percentage of annual USA commercial witch flounder landings by gear type, 1973-2002.

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	0.0	5.8	100.0
1994	96.2	0.0	3.8	100.0
1995	96.1	0.0	3.9	100.0
1996	96.7	0.0	3.3	100.0
1997	96.9	0.0	3.1	100.0
1998	97.5	0.0	2.5	100.0
1999	97.4	0.0	2.6	100.0
2000	97.5	0.0	2.5	100.0
2001	97.5	0.0	2.5	100.0
2002	97.8	0.0	2.2	100.0

Table A.6. Percentage of annual USA commercial witch flounder landings by market category, 1973 - 2002.

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
1994	19.3	43.7	16.0	16.8	0.0	4.1	100.0
1995	26.0	46.6	11.9	13.0	0.0	2.5	100.0
1996	27.4	53.1	9.9	8.0	0.0	1.7	100.0
1997	18.2	63.7	10.5	6.1	0.0	1.4	100.0
1998	13.2	72.1	9.4	4.6	0.0	0.7	100.0
1999	10.1	74.3	10.1	4.6	0.0	0.9	100.0
2000	8.1	76.6	9.7	3.6	0.0	2.0	100.0
2001	9.0	77.9	9.1	2.9	0.0	1.1	100.0
2002	8.2	78.5	9.7	2.6	0.0	0.9	100.0

Table A.7. 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 for all gear types, 1981 - 2002. The sampling ratio represents the amount of landings per length sample.

	Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
Year	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
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	128
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	116
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	124
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	92
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	90
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	

Table A.7 continued.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
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	69
	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	65
	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	112
	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	40
	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	40
	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	68
	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	76
	len	830	100	.	741	107	100	728	85	499	.	.	.	3190	
	age	55	25	.	56	27	26	74	.	73	.	.	.	336	

Table A.7. continued.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4				Sampling
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1994	mt	403	143	98	505	183	154	390	122	117	383	91	80	2670	
	n	.	.	.	3	5	6	5	5	1	5	3	4	37	72
	len	.	.	.	560	532	749	356	648	105	342	368	407	4067	
	age	.	.	.	59	104	134	44	113	26	56	60	82	678	
1995	mt	336	91	77	586	117	100	399	61	70	304	48	40	2212	
	n	3	3	3	6	3	5	.	.	.	2	.	1	26	85
	len	208	348	347	459	367	517	.	.	.	217	.	94	2557	
	age	53	84	89	81	75	135	.	.	.	27	.	25	569	
1996	mt	313	57	36	545	86	60	458	56	44	363	42	28	2088	
	n	5	2	3	5	2	1	5	4	4	5	3	3	42	50
	len	504	218	292	331	240	127	494	464	468	343	277	348	4106	
	age	59	45	78	53	50	26	59	86	101	60	70	69	756	
1997	mt	313	40	25	478	86	41	398	55	27	265	31	16	1775	
	n	6	3	3	9	4	3	9	3	1	9	1	1	52	34
	len	557	350	351	812	418	309	783	308	107	505	128	50	4678	
	age	77	68	70	108	73	77	98	81	20	73	18	23	786	
1998	mt	372	39	19	587	79	31	380	40	20	239	26	14	1849	80
	n	5	2	1	4	1	1	5	3	1	.	.	.	23	
	len	339	206	128	238	88	135	484	186	100	.	.	.	1904	
	age	45	50	19	30	.	29	47	22	.	.	.	.	242	
1999	mt	386	48	19	616	79	31	436	67	30	353	38	18	2121	51
	n	3	.	.	4	.	.	17	2	3	11	1	.	41	
	len	282	.	.	308	.	.	1110	201	306	775	109	.	3091	
	age	15	.	.	62	.	.	143	.	32	91	16	.	359	
2000	mt	477	53	17	583	93	27	555	89	28	451	50	16	2439	21
	n	31	2	.	47	.	.	17	1	.	5	5	2	110	
	len	2253	91	.	2445	.	.	994	105	.	308	558	217	6971	
	age	390	10	.	460	.	.	224	20	.	67	92	51	1314	

Table A.7 continued.

Year		Quarter 1 Small	Quarter 1 Med.	Quarter 1 Large	Quarter 2 Small	Quarter 2 Med.	Quarter 2 Large	Quarter 3 Small	Quarter 3 Med.	Quarter 3 Large	Quarter 4 Small	Quarter 4 Med.	Quarter 4 Large	All	Sampling Ratio
2001	mt	583	71	17	824	99	30	699	98	28	507	50	13	3019	70
	n	8	4	2	3	3	2	8	2	3	5	3	.	43	
	len	744	422	134	237	352	159	594	209	213	313	232	.	3609	
	age	125	63	42	47	48	64	126	34	46	61	48	.	704	
2002	mt	740	79	18	774	103	26	849	114	29	400	45	9	3186	91
	n	4	1	2	3	5	3	5	2	3	3	2	2	35	
	len	312	121	107	212	518	209	389	150	194	262	226	115	2815	
	age	73	14	44	65	68	63	86	32	62	49	30	49	635	

Table A.8. The data pooling to apply age and length frequency samples to landings by market category and quarter to estimate numbers at age of witch flounder from 1982-2002.

Year	Mkt. Cat.	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1982	Small	<=Pooled =>		X	X
	Med.	X	X	X	X
	Large	X	X	X	X
1983	Small	X	X	X	X
	Med.	<=Pooled =>		X	X
	Large	X	X	<=Pooled =>	
1984	Small	X	X	X	X
	Med.	<=Pooled =>		<=Pooled =>	
	Large	X	X	<=Pooled =>	
1985	Small	X	X	X	X
	Med.	X	X	X	X
	Large	X	X	X	X
1986	Small	X	X	X	X
	Med.	X	X	X	X
	Large	X	X	X	X
1987	Small	<=Pooled =>		X	X
	Med.	<=Pooled =>		X	X
	Large	X	X	X	X
1988	Small	X	X	X	X
	Med.	X	X	X	X
	Large	X	X	X	X
1989	Small	<=Pooled =>		<=Pooled =>	
	Med.	X	X	X	X
	Large	<===Pooled ===>			
1990	Small	<=Pooled =>		X	X
	Med.	X	X	X	X
	Large	<=Pooled =>		<=Pooled =>	
1991	Small	X	X	X	X
	Med.	X	X	X	X
	Large	<=Pooled =>		X	X
1992	Small	X	X	X	X
	Med.	<===Pooled ===>			
	Large	X	X	<=Pooled =>	

Table A.8. Continued.

Year	Mkt. Cat.	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1993	Small	X	X	<=Pooled =>	
	Med.	<===Pooled ===>			
	Large	<===Pooled ===>			
1994	Small	<=Pooled =>		X	X
	Med.	<=Pooled =>		X	X
	Large	<=Pooled =>		<=Pooled =>	
1995	Small	X	<== Pooled ==>		
	Med.	X	<==Pooled ==>		
	Large	X	<==Pooled ==>		
1996	Small	X	X	X	X
	Med.	<=Pooled =>		X	X
	Large	<=Pooled =>		X	X
1997	Small	X	X	X	X
	Med.	X	X	<=Pooled =>	
	Large	X	X	<=Pooled =>	
1998	Small	X	X	<=Pooled =>	
	Med.	<=Pooled =>		<=Pooled =>	
	Large	<===Pooled ===>			
1999	Small	<=Pooled =>		X	X
	Med.	<===Pooled ===>			
	Large	<===Pooled ===>			
2000	Small	X	X	X	X
	Med.	<===Pooled ===>			
	Large	<===Pooled ===>			
2001	Small	X	X	X	X
	Med.	<=Pooled =>		<=Pooled =>	
	Large	<===Pooled ===>			
2002	Small	X	X	X	X
	Med.	<=Pooled =>		<=Pooled =>	
	Large	<=Pooled =>		<=Pooled =>	

Table A.9. USA commercial landings at age in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 2002.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commercial Landings in Numbers (1000's) at Age																	
1982	0.0	0.0	0.0	117.9	826.6	1119.9	1454.3	665.2	656.0	399.5	239.4	201.0	356.3	183.7	837.4	7057.2	1578.4
1983	0.0	0.0	0.0	219.8	768.6	1033.7	1567.3	1590.2	977.8	737.7	510.4	366.0	287.3	289.1	733.1	9081.0	1675.5
1984	0.0	0.0	0.0	90.6	1012.4	1808.7	1734.3	1486.5	1497.5	696.7	375.1	279.5	356.4	261.3	821.6	10420.0	1718.8
1985	0.0	0.0	0.0	0.0	985.1	2026.8	1933.8	1524.9	1247.9	606.0	400.4	261.2	221.5	170.7	705.8	10084.0	1359.2
1986	0.0	0.0	0.0	6.3	298.5	1441.6	2772.6	1566.9	834.9	412.7	222.8	188.2	157.0	137.0	276.0	8314.5	758.2
1987	0.0	0.0	0.0	0.0	81.5	321.6	1276.0	1574.7	870.9	480.6	252.4	132.4	90.8	62.1	204.1	5347.1	489.4
1988	0.0	0.0	0.0	0.0	50.8	176.0	654.7	1382.7	1154.1	401.5	266.7	124.1	94.0	71.9	307.5	4684.0	597.5
1989	0.0	0.0	0.0	0.0	7.3	49.7	314.3	759.4	882.1	349.7	123.4	73.2	61.1	56.7	157.1	2833.8	349.0
1990	0.0	0.0	0.0	0.0	181.6	574.3	255.6	273.9	471.1	333.9	81.4	43.1	38.5	19.1	76.9	2349.2	179.1
1991	0.0	0.0	0.0	0.0	179.5	732.9	519.4	235.8	244.6	292.1	313.6	51.8	44.0	22.5	139.5	2775.6	260.8
1992	0.0	0.0	0.0	0.0	509.3	839.4	935.5	717.0	201.6	177.9	120.0	217.6	46.3	26.5	86.5	3877.7	380.2
1993	0.0	0.0	0.0	0.0	422.2	1022.8	917.7	597.2	585.6	218.8	278.5	113.9	32.6	103.6	140.4	4433.2	391.1
1994	0.0	0.0	0.0	0.0	201.3	1429.4	1286.2	826.9	196.7	539.2	113.5	71.4	40.2	132.3	80.4	4917.4	324.9
1995	0.0	0.0	0.0	0.0	23.7	763.0	1597.4	848.7	267.5	97.2	269.5	55.0	43.9	8.1	49.9	4023.8	157.1
1996	0.0	0.0	0.0	0.0	45.8	467.7	1263.8	1430.4	263.2	215.5	57.1	78.8	3.6	13.0	18.2	3857.2	113.7
1997	0.0	0.0	0.0	0.0	212.2	527.9	1049.4	1014.0	591.3	83.1	49.8	17.9	36.6	2.2	13.4	3597.8	70.2
1998	0.0	0.0	0.0	0.0	18.1	488.0	1213.5	1583.0	370.5	141.4	15.5	37.2	5.6	19.9	7.7	3900.2	70.3
1999	0.0	0.0	0.0	0.0	185.2	585.7	1391.7	1178.3	763.2	251.3	31.6	40.8	0.0	0.0	13.5	4441.3	54.4
2000	0.0	0.0	0.0	0.0	75.4	266.2	1062.1	1611.1	1027.6	623.7	94.8	174.3	6.2	5.0	27.4	4973.9	212.8
2001	0.0	0.0	0.0	0.0	18.8	382.2	940.5	1669.0	1459.4	634.3	425.4	95.8	163.5	8.6	38.8	5836.3	306.7
2002	0.0	0.0	0.0	0.0	173.2	644.9	1242.7	2098.3	1274.4	632.1	96.4	102.7	11.0	65.6	25.3	6366.6	202.6

Table A.9. continue. USA commercial landings.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commercial Landings Mean Weight (kg) at Age																	
1982	0.000	0.000	0.000	0.216	0.275	0.345	0.424	0.550	0.727	0.886	0.983	1.146	1.255	1.310	1.553	0.695	1.406
1983	0.000	0.000	0.000	0.195	0.257	0.322	0.410	0.518	0.613	0.795	0.977	1.116	1.208	1.321	1.551	0.661	1.357
1984	0.000	0.000	0.000	0.212	0.268	0.346	0.422	0.539	0.664	0.817	0.922	1.004	1.212	1.332	1.511	0.639	1.339
1985	0.000	0.000	0.000	0.000	0.253	0.311	0.429	0.565	0.691	0.842	0.964	1.057	1.193	1.311	1.470	0.608	1.326
1986	0.000	0.000	0.000	0.084	0.227	0.306	0.408	0.533	0.676	0.853	0.975	1.132	1.199	1.317	1.521	0.555	1.321
1987	0.000	0.000	0.000	0.000	0.272	0.342	0.434	0.561	0.686	0.828	0.980	1.067	1.222	1.386	1.467	0.645	1.303
1988	0.000	0.000	0.000	0.000	0.310	0.367	0.435	0.538	0.668	0.819	0.980	1.074	1.190	1.290	1.477	0.696	1.326
1989	0.000	0.000	0.000	0.000	0.260	0.344	0.425	0.574	0.682	0.818	0.968	1.128	1.258	1.315	1.519	0.730	1.358
1990	0.000	0.000	0.000	0.000	0.308	0.323	0.438	0.586	0.688	0.849	1.049	1.213	1.262	1.521	1.669	0.624	1.454
1991	0.000	0.000	0.000	0.000	0.286	0.371	0.443	0.578	0.702	0.836	0.974	1.099	1.369	1.537	1.536	0.640	1.420
1992	0.000	0.000	0.000	0.000	0.328	0.383	0.459	0.614	0.739	0.822	0.882	1.039	1.337	1.459	1.640	0.575	1.243
1993	0.000	0.000	0.000	0.000	0.292	0.364	0.432	0.535	0.666	0.882	1.023	1.118	1.199	1.368	1.519	0.587	1.335
1994	0.000	0.000	0.000	0.000	0.308	0.357	0.430	0.534	0.691	0.832	0.909	1.083	1.172	1.204	1.576	0.542	1.266
1995	0.000	0.000	0.000	0.000	0.284	0.367	0.448	0.561	0.690	0.911	0.974	1.101	1.203	1.411	1.406	0.549	1.243
1996	0.000	0.000	0.000	0.000	0.260	0.355	0.435	0.554	0.708	0.856	0.974	1.114	1.401	1.440	1.558	0.541	1.232
1997	0.000	0.000	0.000	0.000	0.318	0.357	0.407	0.495	0.628	0.871	1.037	1.168	1.196	1.687	1.659	0.492	1.293
1998	0.000	0.000	0.000	0.000	0.235	0.331	0.382	0.492	0.585	0.871	0.978	1.115	1.132	1.261	1.557	0.474	1.206
1999	0.000	0.000	0.000	0.000	0.325	0.355	0.406	0.516	0.584	0.628	0.917	0.683	-	-	1.442	0.477	0.872
2000	0.000	0.000	0.000	0.000	0.319	0.327	0.376	0.450	0.533	0.633	0.677	0.834	1.167	1.298	1.379	0.490	0.925
2001	0.000	0.000	0.000	0.000	0.291	0.325	0.384	0.469	0.550	0.646	0.647	0.718	0.816	1.016	1.206	0.517	0.840
2002	0.000	0.000	0.000	0.000	0.354	0.344	0.416	0.477	0.554	0.651	0.824	0.844	0.716	0.993	1.120	0.501	0.919
mean																	
1982-02	0.000	0.000	0.000	0.034	0.287	0.345	0.421	0.535	0.654	0.807	0.934						1.237
1999-02	0.000	0.000	0.000	0.000	0.322	0.338	0.396	0.478	0.555	0.640	0.766						0.889

Table A.9 continued. USA commercial landings.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commercial Landings Mean Length (cm) at Age																	
1982	0.0	0.0	0.0	32.3	35.0	37.5	39.8	42.9	46.5	49.3	50.9	53.2	54.6	55.2	58.0	44.3	56.3
1983	0.0	0.0	0.0	31.7	34.3	36.8	39.4	42.2	44.2	47.7	50.7	52.8	54.0	56.6	55.8	35.9	55.0
1984	0.0	0.0	0.0	32.6	34.9	37.6	39.8	42.7	45.3	48.2	49.9	51.2	54.1	55.6	57.6	43.6	55.5
1985	0.0	0.0	0.0	0.0	34.2	36.3	40.0	43.3	45.9	48.6	50.6	51.9	53.8	55.3	57.1	42.9	55.3
1986	0.0	0.0	0.0	25.0	33.2	36.2	39.4	42.5	45.6	48.8	50.7	53.0	53.9	55.4	57.7	42.0	55.3
1987	0.0	0.0	0.0	0.0	35.0	37.4	40.1	43.2	45.8	48.4	50.8	52.1	54.2	56.2	57.1	44.3	55.1
1988	0.0	0.0	0.0	0.0	36.4	38.2	40.1	42.7	45.4	48.2	50.8	52.1	53.7	55.0	57.1	45.3	55.3
1989	0.0	0.0	0.0	0.0	34.6	37.5	39.9	43.5	45.6	48.1	50.6	52.9	54.6	55.3	57.6	46.0	55.7
1990	0.0	0.0	0.0	0.0	36.2	36.8	40.2	43.7	45.8	48.7	51.8	54.1	54.6	57.8	59.2	43.5	56.8
1991	0.0	0.0	0.0	0.0	35.4	38.3	40.3	43.3	46.1	48.5	50.6	52.5	56.0	57.9	57.9	43.8	56.5
1992	0.0	0.0	0.0	0.0	37.0	38.7	40.7	44.3	46.8	48.3	49.2	51.7	55.5	57.0	58.9	42.7	54.2
1993	0.0	0.0	0.0	0.0	35.8	38.1	40.0	42.6	45.3	49.3	51.5	52.8	53.9	55.9	57.7	42.8	55.5
1994	0.0	0.0	0.0	0.0	36.0	37.6	39.7	42.3	45.6	48.0	49.1	51.8	53.1	53.4	57.8	41.7	54.1
1995	0.0	0.0	0.0	0.0	35.3	37.9	40.2	42.8	45.4	49.3	50.1	52.0	53.4	56.0	55.8	42.0	53.8
1996	0.0	0.0	0.0	0.0	34.4	37.5	39.8	42.7	45.8	48.4	50.1	52.2	55.8	56.2	57.6	42.0	53.6
1997	0.0	0.0	0.0	0.0	36.4	37.6	39.1	41.3	44.2	48.5	51.1	52.9	53.3	59.0	58.7	40.9	54.4
1998	0.0	0.0	0.0	0.0	33.4	36.8	38.4	41.2	43.3	48.7	50.5	52.3	52.7	54.1	57.6	40.5	53.4
1999	0.0	0.0	0.0	0.0	36.6	37.5	39.0	41.8	43.3	44.3	49.4	45.2	-	-	56.4	40.7	48.0
2000	0.0	0.0	0.0	0.0	36.4	36.7	38.2	40.2	42.2	44.2	45.2	47.7	53.0	54.6	55.3	40.9	49.0
2001	0.0	0.0	0.0	0.0	35.5	36.6	38.4	40.7	42.5	44.6	44.5	45.9	47.7	50.8	53.3	41.6	47.9
2002	0.0	0.0	0.0	0.0	37.4	37.2	39.3	40.9	42.7	44.6	47.9	48.2	45.8	50.5	52.2	41.6	49.3

Table A.10. Discard rates (kg/day fished) by fishing zone[1] obtained from a ratio estimator (kg of witch flounder discarded to days fished) using Fisheries Observer Program data collected from the northern shrimp fishery, number of days fished by the shrimp fishery, mean discard rates (kg/df) and estimated discard weight (kg) of witch flounder in the northern shrimp fishery, during the 1989 - 1997 shrimp seasons.

		Sea Sample Data					
Shrimp Season	Fishing Zone	Trips	Discard Rate (kg/df)	Commercial days fished	Mean discard rate	Estimated discard weight (kg)	Estimated discard weight (mt)
1989	1	5	0.0000	398.2			
	2	15	2.2032	1680.2			
	3	16	17.7543	761.1			
				2839.5	6.0626	17,215	17.2
1990	1	4	0.0000	416.9			
	2	23	7.0751	1610.9			
	3	20	14.1459	1176.8			
				3204.6	8.7512	28,044	28.0
1991	1	13	0.9770	528.0			
	2	25	4.4822	1154.8			
	3	24	29.9863	904.9			
				2587.7	12.6856	32,827	32.8
1992	1	30	2.7834	187.3			
	2	60	8.9270	1764.1			
	3	20	7.6787	361.9			
				2313.3	8.2343	19,048	19.0
1993	1	38	1.3559	526.9			
	2	53	3.7619	1094.2			
	3	13	12.9178	281.1			
				1902.2	4.4485	8,462	8.5
1994*	1	37	3.3021	498.7			
	2	56	5.8385	1334			
	3	5	11.1394	149.6			
				1982.3	5.6004	11,102	11.1
1995*	1	24	2.0007	2036.2			
	2	46	27.5162	1109			
	3	18	11.7543	230.5			
				3375.7	11.0492	37,299	37.3
1996*	1	8	0.3532	2079.4			
	2	31	7.6343	958.2			
	3	11	28.919	205.3			
				3242.9	4.3130	13,987	14.0
1997*	1	6	0.4065	1996.1			
	2	19	2.9403	1191.8			
	3	3	16.3461	473.2			
				3661.1	3.2915	12,051	12.1

[1] Fishing zones: 1 = 0-3 miles; 2 = 3 - 12 miles, and 3 = greater than 12 miles from shore.
* Commercial days fished have been estimated from Vessel Trip Report data.

Table A.11. Witch flounder discard rates (kg/df), days fished (df), discarded metric tons (mt), numbers of discarded fish (in thousands) in the northern shrimp fishery during 1982-2002.

		Calendar Year				
		Days Fished				
Year	Shrimp Season Disc. Rate	Jan-Apr	Dec.	Total	mt	Numbers ('000)
1982	5.7025	970.1	35.6	1005.7	5.90	62.14
1983	10.4523	1121.3	141.7	1263	12.56	131.67
1984	5.9234	1612.3	237.6	1849.9	10.93	110.94
1985	5.8129	1843.8	272.8	2116.6	12.12	91.32
1986	5.1502	2122.3	428.9	2551.2	13.14	98.80
1987	5.1502	3279.3	380.4	3659.7	21.79	235.99
1988	12.8824	2434.8	426.9	2861.7	33.95	723.95
1989	6.0626	2412.6	491.9	2904.5	18.93	219.81
1990	8.7512	2712.7	377.6	3090.3	28.53	468.56
1991	12.6856	2210.1	172.3	2382.4	29.46	443.85
1992	8.2343	2141.0	113.2	2254.2	18.13	384.45
1993	4.4485	1789.0	161.7	1950.7	8.86	356.77
1994	5.6004	1820.6	530.8	2351.4	16.06	1891.71
1995	11.0492	2844.9	547.6	3392.5	33.80	1176.37
1996	4.3130	2695.3	645.2	3340.5	13.75	250.46
1997	3.2915	3016.0	361.4	3377.4	13.27	304.52
1998	9.2437	1842.6	96.9	1939.5	18.04	873.52
1999	10.3851	1120.5	0	1120.5	11.64	563.50
2000	9.8775	792.9	0	792.9	7.83	379.26
2001	6.6415	672.8	0	672.8	4.47	216.38
2002	3.5325	238	0	238	0.84	40.68

Note: 1982-1988 discard rates were derived from a linear regression using 1989-1993 discard rates and NEFSC autumn age 3 abundance indices.

1998-2002 discard rates were derived from a linear regression using 1989-1993 discard rates and NEFSC autumn age 3 abundance indices.

Table A.12. Witch flounder discards at age in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age in the shrimp fishery, 1982 - 2002.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Shrimp Fishery Discards in Numbers (1000's) at Age																
1982	0.00	0.00	1.59	25.24	21.12	11.27	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.14
1983	0.00	0.00	3.62	53.11	44.65	23.81	6.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	131.67
1984	0.00	0.33	0.77	46.84	38.55	19.41	5.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	110.94
1985	0.00	0.34	3.37	11.72	47.06	26.39	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.32
1986	0.00	0.53	3.86	15.07	49.83	27.04	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.80
1987	2.08	18.92	79.51	15.62	74.59	41.46	3.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	235.99
1988	0.42	14.62	130.29	495.50	42.57	37.70	2.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	723.95
1989	0.74	10.47	47.52	69.23	76.39	15.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	219.81
1990	1.19	5.18	92.78	239.97	97.13	32.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	468.56
1991	2.96	17.79	15.98	287.35	102.86	11.59	5.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	443.85
1992	2.71	43.41	136.92	118.76	82.06	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	384.45
1993	112.06	78.84	107.58	38.69	14.13	5.02	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	356.77
1994	8.06	1368.46	495.50	19.62	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1891.71
1995	2.68	49.95	630.10	480.83	12.25	0.20	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1176.37
1996	5.21	32.68	50.83	99.45	59.21	2.09	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	250.46
1997	8.68	74.91	102.92	86.49	23.71	7.30	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	304.52
1998	49.78	391.44	264.72	132.04	30.13	4.78	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	873.52
1999	32.11	252.51	170.76	85.18	19.44	3.09	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	563.50
2000	21.61	169.95	114.93	57.33	13.08	2.08	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	379.26
2001	12.33	96.96	65.57	32.71	7.46	1.19	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	216.38
2002	2.32	18.23	12.33	6.15	1.4	0.22	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.68

Note: 1998-2002 estimated using 1993-1997 Fisheries Observer Program data.

Table A.12 continued. Discards in the shrimp fishery.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Shrimp fishery Mean Weight (kg) at Age																
1982			0.040	0.043	0.101	0.165	0.256									0.095
1983			0.040	0.044	0.101	0.166	0.256									0.095
1984		0.017	0.044	0.050	0.105	0.165	0.256									0.099
1985		0.017	0.023	0.081	0.123	0.179	0.231									0.133
1986		0.017	0.026	0.089	0.125	0.180	0.231									0.133
1987	0.006	0.015	0.033	0.071	0.126	0.180	0.231									0.092
1988	0.004	0.006	0.017	0.036	0.121	0.206	0.282									0.047
1989	0.010	0.012	0.033	0.058	0.122	0.249										0.086
1990	0.004	0.010	0.029	0.043	0.107	0.155										0.061
1991	0.004	0.014	0.030	0.045	0.117	0.221	0.218									0.066
1992	0.003	0.007	0.021	0.043	0.119	0.225										0.047
1993	0.003	0.009	0.022	0.057	0.136	0.237	0.317									0.025
1994	0.005	0.004	0.019	0.032		0.282										0.009
1995	0.005	0.007	0.023	0.037	0.083	0.289	0.282									0.029
1996	0.004	0.019	0.031	0.056	0.090	0.184	0.289									0.055
1997	0.004	0.023	0.033	0.048	0.115	0.144	0.256									0.044
1998	0.003	0.006	0.023	0.042	0.100	0.184	0.286									0.021
1999	0.003	0.006	0.023	0.042	0.100	0.184	0.286									0.021
2000	0.003	0.006	0.023	0.042	0.100	0.184	0.286									0.021
2001	0.003	0.006	0.023	0.042	0.100	0.184	0.286									0.021
2002	0.003	0.006	0.023	0.042	0.100	0.184	0.286									0.021
Mean 1982-02	0.004	0.011	0.027	0.050	0.110	0.197	0.267									0.058

Noe:1998-2002 estimated using 1993-1997 Fisheries Observer Program data.

Table A.12 continued. Discards in the shrimp fishery.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Shrimp fishery Mean Length (cm) at Age																
1982			20.3	20.6	26.5	30.7	34.9									25.1
1983			20.3	20.6	26.5	30.7	34.9									25.1
1984		15.7	20.7	21.2	26.7	30.7	34.9									25.4
1985		15.7	16.9	24.2	28.1	31.4	33.9									28.3
1986		15.7	17.3	24.9	28.2	31.4	33.9									28.3
1987	10.6	15.3	19.0	23.4	28.2	31.4	33.9									24.3
1988	10.2	10.9	15.6	19.4	27.9	32.8	36.0									19.8
1989	13.6	13.9	18.9	22.2	28.1	34.6										24.0
1990	10.5	13.6	17.9	20.4	27.0	30.2										21.9
1991	9.7	14.2	17.7	20.9	27.6	33.6	33.4									22.5
1992	9.3	10.8	16.6	20.5	27.9	33.7										19.5
1993	9.2	12.0	16.9	22.1	28.9	34.2	37.3									14.7
1994	10.7	9.8	15.9	18.5	-	36.0										11.5
1995	10.9	11.6	17.0	19.6	24.9	36.2	36.0									18.0
1996	10.0	15.3	18.4	22.1	25.6	31.7	36.2									21.2
1997	10.2	16.1	18.9	21.2	27.6	29.5	35.0									19.6
1998	9.4	10.4	16.8	20.3	26.4	31.5	36.1									14.9
1999	9.4	10.4	16.8	20.3	26.4	31.5	36.1									14.9
2000	9.4	10.4	16.8	20.3	26.4	31.5	36.1									14.9
2001	9.4	10.4	16.8	20.3	26.4	31.5	36.1									14.9
2002	9.4	10.4	16.8	20.3	26.4	31.5	36.1									

Note: 1998-2002 estimated using 1993-1997 Fisheries Observer Program data.

Table A.13 . Summary of number of trips, tows, kept and discard pounds of witch flounder, discard: kept ratio observed in the large-mesh otter trawl fishery in the Georges Bank - Gulf of Maine area (observed tows only; excluding trips targeting loligo) from the Fisheries Observer Program, 1989 - 2002.

	January - June								July- December								Annual mt
			Fish in	Pounds		D/K	metric tons				fish in	Pounds		D/K	metric tons		
Year	Trips	Tows	disc l-f	kept	discard	ratio	Landing	Disc.	Trips	Tows	disc lf	kept	Disc	ratio	landings	discard	
1989	3	17	68	850	14	0.016	1298.64	20.78	4	19	411	427	142	0.333	663.58	220.97	241.75
1990	2	2	20	50	1	0.020	795.25	15.91	1	12	10	535	48	0.090	573.98	51.66	67.56
1991	4	45	15	1655	49	0.030	757.7	22.73	6	52	148	1882	159	0.084	947.63	79.60	102.33
1992	4	80	31	1896	222	0.117	1273.78	149.03	0	0	0	0	0	***0.117***	884.62	103.50	252.53
1993	3	37	428	1607	806	0.502	1411.03	708.34	2	24	229	1665	125	0.075	1041.84	78.14	786.48
1994	5	70	63	7298	332	0.045	1427.92	64.26	5	126	125	3794	157	0.041	1139.81	46.73	110.99
1995	31	640	1500	35968	2561	0.071	1244.48	88.36	11	199	571	8240	669	0.081	878.28	71.14	159.50
1996	17	267	272	14016	1387	0.099	1049.86	103.94	1	13	75	638	90	0.141	968.59	136.57	240.51
1997	9	203	593	10907	1831	0.168	945.2	158.79	7	134	77	4518	750	0.166	772.52	128.24	287.03
1998	7	93	200	3786	595	0.157	1095.59	172.01	2	14	3	277	37	0.134	705.15	94.49	266.50
1999	3	46	5	3663	454	0.124	1149.74	142.57	15	148	225	10057	644	0.064	914.79	58.55	201.11
2000	29	211	101	25343	666	0.026	1218.38	31.68	30	266	134	26149	1711	0.065	1159.65	75.38	107.06
2001	34	332	48	36279	1864	0.051	1596.02	81.40	45	383	459	35016	3581	0.102	1356.47	138.36	219.76
2002	27	298	795	36836	2439	0.066	1678.73	110.80	83	500	2361	44451	5268	0.119	1408.75	167.64	278.44
average						0.107								0.115			

Note: in 1993, one 'dirty' trip' during Jan-June; if excluded, d/k ratio = 0.132.; dis mt = 186.3 mt

1999 and 1998 annual discard length frequencies were used due to low numbers of fish in each half year.

Table A.14. Number of trips, witch flounder kept and discarded weight (mt), discard:kept ratio from the Vessel Trip Reports, and commercial landings and estimated total discard weight.

Year		Qtr 1+2	Qtr 3+4	Total
1994	VTR trips	1228	2487	
	VTR kept (mt)	209.13	631.67	
	VTR disc. (mt)	20.07	36.98	
	Ratio (d/k)	**0.09597**	**0.05854**	
	Landings (mt)	1427.29	1139.81	2567.1
	Discards (mt)	136.976	66.7282	203.7
1995	VTR trips	2674	1801	
	VTR kept (mt)	603.17	331.91	
	VTR disc. (mt)	32.25	17.41	
	Ratio (d/k)	**0.05347**	**0.05245**	
	Landings (mt)	1244.48	878.28	2122.8
	Discards (mt)	66.5393	46.0693	112.6
1996	VTR trips	2216	1662	
	VTR kept (mt)	469.79	411.2	
	VTR disc. (mt)	21.62	22.93	
	Ratio (d/k)	**0.04602**	**0.05576**	
	Landings (mt)	1049.86	968.59	2018.5
	Discards (mt)	48.3151	54.0121	102.3
1997	VTR trips	1906	1360	
	VTR kept (mt)	355.61	302.67	
	VTR disc. (mt)	16.39	17.22	
	Ratio (d/k)	**0.04609**	**0.05689**	
	Landings (mt)	945.2	772.52	1717.7
	Discards (mt)	43.5641	43.9515	87.5
1998	VTR trips	1645	1129	
	VTR kept (mt)	320.93	223.35	
	VTR disc. (mt)	17.06	11.82	
	Ratio (d/k)	**0.05316**	**0.05292**	
	Landings (mt)	1095.59	705.15	1800.7
	Discards (mt)	58.2394	37.3175	95.6
1999	VTR trips	1417	1655	
	VTR kept (mt)	389.71	334.3	
	VTR disc. (mt)	18.75	17.11	
	Ratio (d/k)	**0.04811**	**0.05118**	
	Landings (mt)	1149.74	914.79	2064.5
	Discards (mt)	55.3171	46.8204	102.1
2000	VTR trips	1421	1608	
	VTR kept (mt)	397.84	369.31	
	VTR disc. (mt)	21.84	19.76	
	Ratio (d/k)	**0.0549**	**0.05351**	
	Landings (mt)	1218.38	1159.65	2378.0
	Discards (mt)	66.8847	62.0473	128.9
2001	VTR trips	1327	1165	
	VTR kept (mt)	531.92	410.55	
	VTR disc. (mt)	24.28	19.91	
	Ratio (d/k)	**0.04565**	**0.0485**	
	Landings (mt)	1596.02	1356.47	2952.5
	Discards (mt)	72.8519	65.7833	138.6
2002	VTR trips	791	1227	
	VTR kept (mt)	494.02	388.52	
	VTR disc. (mt)	23.78	16.15	
	Ratio (d/k)	**0.04814**	**0.04157**	
	Landings (mt)	1678.73	1408.75	3087.5
	Discards (mt)	80.8068	58.5589	139.4

Table A.15. Numbers and weight (mt) of discarded witch flounder in the large-mesh otter trawl fishery derived by three scenarios: 1) Vessel trip reports (VTR), 2) Fisheries Observer Program (FOP), and 3) survey filter method.

Year	VTR	FOP	Survey filter method
Numbers (1000's)			
1982			359.01
1983			1062.39
1984			599.49
1985			320.94
1986			78.75
1987			136.47
1988			202.67
1989			733.52
1990			959.82
1991			455.22
1992			988.11
1993			2171.25
1994	832.65		2155.99
1995	639.95	906.50	1302.62
1996	543.51	1277.79	2432.13
1997	489.12	1604.49	2071.03
1998	549.41	1541.34	1722.55
1999	520.04	1024.35	1932.76
2000	668.38	555.11	3022.89
2001	695.16	1102.21	3820.86
2002	701.19	1400.56	3475.61
Weight (mt)			
1982			42.44
1983			149.04
1984			88.81
1985			48.75
1986			12.00
1987			25.68
1988			26.55
1989		241.8	113.86
1990		67.6	155.75
1991		102.3	65.41
1992		252.5	153.31
1993		786.45	367.77
1994	203.7	110.99	406.30
1995	112.6	159.50	231.23
1996	102.3	240.51	439.88
1997	87.5	287.03	379.83
1998	95.6	266.50	316.89
1999	102.1	201.11	342.33
2000	128.9	107.05	546.34
2001	138.6	219.76	700.93
2002	139.4	278.44	645.23

Table A.16. Large-mesh otter trawl discards at age in numbers (thousands of fish), mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 2002, estimated using a **survey filter method 1982-1994) and FOP data (1995-2002).**

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Large-mesh Otter Trawl Fishery Discards in Numbers (1000's) at Age																
1982	0.03	0.06	0.13	47.35	216.75	76.50	18.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	359.01
1983	0.00	0.02	0.66	64.20	532.92	463.25	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1062.39
1984	0.00	0.00	0.11	9.17	415.36	174.59	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	599.49
1985	0.00	0.00	0.10	111.86	143.96	65.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	320.94
1986	0.00	0.00	0.00	1.58	28.74	48.15	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	78.75
1987	0.00	0.00	0.42	6.63	25.17	104.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	136.47
1988	0.00	0.04	0.00	104.77	46.54	50.60	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	202.67
1989	0.11	0.22	2.80	377.82	352.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	733.52
1990	0.27	1.11	2.52	103.96	355.44	496.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	959.82
1991	0.10	0.11	7.28	154.42	123.36	119.27	50.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	455.22
1992	0.13	0.94	22.51	280.70	664.19	19.17	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	988.11
1993	1.70	6.96	22.01	378.54	1371.00	391.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2171.25
1994	0.00	0.02	0.94	22.35	800.5	1330.43	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2155.99
1995	0.00	0.00	25.41	147.96	334.33	278.03	116.71	2.65	1.09	0.31	0.00	0.00	0.00	0.00	0.00	906.50
1996	0.00	0.00	0.00	22.43	419.44	737.88	98.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1277.79
1997	0.00	0.00	0.00	48.80	822.57	480.73	243.46	5.05	2.47	1.41	0.00	0.00	0.00	0.00	0.00	1604.49
1998	0.00	1.45	29.48	199.19	508.67	571.00	201.32	28.61	0.93	0.70	0.00	0.00	0.00	0.00	0.00	1541.34
1999	0.00	0.43	23.69	75.74	321.49	506.95	69.80	22.80	2.19	1.25	0.00	0.00	0.00	0.00	0.00	1024.35
2000	0.00	0.00	4.58	46.17	197.98	187.57	95.56	18.26	4.99	0.00	0.00	0.00	0.00	0.00	0.00	555.11
2001	0.00	0.00	0.85	37.22	316.95	557.06	157.64	32.29	0.09	0.09	0.00	0.00	0.00	0.00	0.00	1102.21
2002	0.00	2.01	5.09	34.81	574.48	577.81	161.64	33.89	6.61	2.47	1.04	0.00	0.00	0.00	0.00	1400.56

Table A.16 continued. Discards in the large-mesh otter trawl fishery (**survey filter method (1982-1994) and FOP data (1995-2002)** .

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Large-mesh Otter Trawl Fishery Discards Mean Weight (kg) at Age																
1982	0.000	0.002	0.014	0.050	0.128	0.121	0.169									0.118
1983		0.009	0.029	0.081	0.132	0.158	0.209									0.140
1984			0.014	0.072	0.144	0.162	0.209									0.148
1985			0.031	0.133	0.163	0.160										0.152
1986				0.105	0.125	0.170	0.209									0.152
1987			0.014	0.105	0.122	0.210	0.256									0.188
1988		0.002		0.086	0.161	0.195	0.256									0.131
1989	0.001	0.013	0.044	0.134	0.179											0.155
1990	0.001	0.018	0.028	0.105	0.146	0.187										0.162
1991	0.001	0.010	0.048	0.093	0.140	0.191	0.210									0.144
1992	0.001	0.015	0.057	0.129	0.168	0.214	0.256									0.155
1993	0.001	0.014	0.050	0.129	0.175	0.199										0.169
1994		0.026	0.044	0.103	0.175	0.198	0.256									0.188
1995			0.059	0.095	0.152	0.221	0.252	0.473	0.595	0.702						0.176
1996				0.077	0.145	0.208	0.251									0.188
1997				0.108	0.157	0.185	0.242	0.495	0.471	0.702						0.179
1998		0.008	0.041	0.089	0.165	0.200	0.219	0.225	0.355	0.370						0.174
1999		0.021	0.037	0.097	0.162	0.218	0.281	0.406	0.447	0.505						0.196
2000			0.066	0.096	0.155	0.198	0.280	0.313	0.403							0.193
2001			0.070	0.130	0.171	0.208	0.230	0.258	0.309	0.309						0.199
2002		0.018	0.054	0.122	0.180	0.205	0.234	0.264	0.414	0.577	0.566					0.199
Mean 1982-02	0.001	0.009	0.037	0.102	0.155	0.180	0.236	0.264	0.428	0.528	0.566					

Table A.16 continued. Discard in the large-mesh otter trawl fishery (**survey filter method (1982-1994) and FOP data (1995-2002)** .

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL
Large-mesh Otter Trawl Fishery Discards Mean Length (cm) at Age																
1982	5.0	7.8	15.0	21.4	28.3	28.1	31.0	-	-	-	-					27.5
1983		13.0	18.5	24.7	28.6	30.4	33.0	-	-	-	-					29.2
1984		-	15.0	23.6	29.5	30.6	33.0	-	-	-	-					29.7
1985		-	19.0	28.8	30.7	30.5	-	-	-	-	-					30.0
1986	5.0	-	-	27.0	28.3	31.1	33.0	-	-	-	-					30.0
1987		-	15.0	27.0	28.1	33.0	35.0	-	-	-	-					31.8
1988		9.0	-	25.4	30.4	32.3	35.0	-	-	-	-					28.3
1989	5.9	14.4	20.7	28.8	31.5	-	-	-	-	-	-					30.1
1990	6.1	16.0	18.1	26.8	29.6	31.8	-	-	-	-	-					30.4
1991	5.5	12.7	21.3	25.8	29.2	32.1	33.0	-	-	-	-					29.1
1992	5.7	15.0	22.5	28.4	30.8	33.2	35.0	-	-	-	-					30.0
1993	5.5	14.5	21.5	28.5	31.2	32.5	-	-	-	-	-					30.8
1994		17.9	20.7	26.5	31.2	32.4	35.0	-	-	-	-					31.9
1995			22.7	25.9	29.9	33.5	34.8	41.8	44.7	47.0						30.8
1996				24.6	29.5	32.9	34.8									31.7
1997				27.1	30.3	31.8	34.4	42.4	41.6	47.0						31.3
1998		12.3	20.3	25.6	30.7	32.5	33.3	33.4	38.5	39.0						30.9
1999		17.0	19.7	26.1	30.5	33.3	35.9	40.0	41.1	42.7						31.9
2000			23.5	26.1	30.0	32.3	35.8	36.7	39.7							31.7
2001			23.9	28.5	31.0	32.9	33.9	35.1	37.0	37.0						32.4
2002		16.0	21.9	27.7	31.4	32.7	34.0	35.1	40.1	44.2	44.0					32.3

Table A.17. **Total USA commercial catch** [landings + shrimp trawl discards + large-mesh otter trawl discards using survey filter and FOP] in numbers, (thousands of fish), mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 2002.

	Age																
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commercial Catch in Numbers (1000's) at Age																	
1982	0.03	0.06	1.72	190.5	1064.5	1207.7	1475.4	665.2	656.0	399.5	239.4	201.0	356.3	183.7	837.4	7478.4	1578.4
1983	0.00	0.02	4.28	337.1	1346.2	1520.8	1575.1	1590.2	977.8	737.7	510.4	366.0	287.3	289.1	733.1	10275.1	1675.5
1984	0.00	0.33	0.88	146.6	1466.3	2002.7	1739.6	1486.5	1497.5	696.7	375.1	279.5	356.4	261.3	821.6	11131.0	1718.8
1985	0.00	0.34	3.47	123.6	1176.1	2118.2	1936.2	1524.9	1247.9	606.0	400.4	261.2	221.5	170.7	705.8	10496.4	1359.2
1986	0.00	0.53	3.86	23.0	377.1	1516.8	2775.4	1566.9	834.9	412.7	222.8	188.2	157.0	137.0	276.0	8492.1	758.2
1987	2.08	18.92	79.93	22.3	181.3	467.1	1280.1	1574.7	870.9	480.6	252.4	132.4	90.8	62.1	204.1	5719.6	489.4
1988	0.42	14.66	130.29	600.3	139.9	264.3	658.3	1382.7	1154.1	401.5	266.7	124.1	94.0	71.9	307.5	5610.6	597.5
1989	0.85	10.69	50.32	447.1	436.3	65.2	314.3	759.4	882.1	349.7	123.4	73.2	61.1	56.7	157.1	3787.2	348.0
1990	1.46	6.29	95.30	343.9	634.1	1103.2	255.6	273.9	471.1	333.9	81.4	43.1	38.5	19.1	76.9	3777.6	177.5
1991	3.06	17.90	23.26	441.8	405.8	863.7	575.4	235.8	244.6	292.1	313.6	51.8	44.0	22.5	139.5	3674.7	257.8
1992	2.84	44.35	159.43	399.5	1255.6	859.2	936.0	717.0	201.6	177.9	120.0	217.6	46.3	26.5	86.5	5250.3	377.0
1993	113.76	85.80	129.59	417.2	1807.3	1419.0	918.1	597.2	585.6	218.8	278.5	113.9	32.6	103.6	140.4	6961.3	390.5
1994	8.06	1368.48	496.44	42.0	1001.8	2759.9	1288.0	826.9	196.7	539.2	113.5	71.4	40.2	132.3	80.4	8965.1	324.3
1995	2.68	49.95	655.51	628.8	370.3	1041.2	1714.5	851.4	268.5	97.5	269.5	55.0	43.9	8.1	49.9	6106.7	156.8
1996	5.21	32.68	50.83	121.9	524.4	1207.7	1362.9	1430.5	263.2	215.5	57.1	78.8	3.6	13.0	18.2	5385.5	113.6
1997	8.68	74.91	102.92	135.3	1058.5	1016.0	1293.4	1019.1	593.8	84.6	49.8	17.9	36.6	2.2	13.4	5506.9	70.1
1998	49.78	392.89	294.20	331.2	556.9	1063.7	1415.5	1611.6	371.4	142.1	15.5	37.2	5.6	19.9	7.7	6315.1	70.3
1999	32.11	252.94	194.45	160.9	526.1	1095.8	1462.0	1201.1	765.3	252.5	31.6	40.8	0.0	0.0	13.5	6029.2	54.4
2000	21.61	169.95	119.51	103.5	286.5	455.9	1158.0	1629.4	1032.6	623.7	94.8	174.3	6.2	5.0	27.4	5908.3	212.8
2001	12.33	96.96	66.42	69.9	343.2	940.4	1098.3	1701.3	1459.6	634.4	425.4	95.8	163.5	8.6	38.8	7154.9	306.7
2002	2.32	20.24	17.42	41.0	749.1	1222.9	1404.4	2132.2	1281.1	634.6	97.5	102.7	11.0	65.6	25.3	7807.9	205.2

Table A.17 continued. **Total USA commercial catch** (landings + shrimp trawl discards + LM otter trawl discards) .

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commerical Mean Weight (kg) at Age																	
1982	0.000	0.002	0.038	0.152	0.242	0.329	0.421	0.550	0.727	0.886	0.983	1.146	1.255	1.310	1.553	0.662	1.406
1983		0.009	0.038	0.149	0.202	0.270	0.409	0.518	0.613	0.795	0.977	1.116	1.208	1.321	1.551	0.600	1.357
1984		0.017	0.040	0.151	0.229	0.328	0.421	0.539	0.664	0.817	0.922	1.004	1.212	1.332	1.511	0.607	1.339
1985		0.017	0.023	0.128	0.237	0.305	0.429	0.565	0.691	0.842	0.964	1.057	1.193	1.311	1.470	0.590	1.326
1986		0.017	0.026	0.089	0.206	0.299	0.408	0.533	0.676	0.853	0.975	1.132	1.199	1.317	1.521	0.546	1.321
1987	0.006	0.015	0.033	0.081	0.191	0.298	0.433	0.561	0.686	0.828	0.980	1.067	1.222	1.386	1.467	0.611	1.303
1988	0.004	0.006	0.017	0.045	0.203	0.311	0.434	0.538	0.668	0.819	0.980	1.074	1.190	1.290	1.477	0.592	1.326
1989	0.009	0.012	0.034	0.122	0.170	0.321	0.425	0.574	0.682	0.818	0.968	1.128	1.258	1.315	1.519	0.581	1.358
1990	0.004	0.012	0.029	0.062	0.186	0.257	0.438	0.586	0.688	0.849	1.049	1.213	1.262	1.521	1.669	0.437	1.454
1991	0.004	0.014	0.035	0.062	0.199	0.344	0.420	0.578	0.702	0.836	0.974	1.099	1.369	1.537	1.536	0.509	1.420
1992	0.003	0.007	0.026	0.103	0.230	0.379	0.459	0.614	0.739	0.822	0.882	1.039	1.337	1.459	1.640	0.457	1.243
1993	0.003	0.009	0.027	0.122	0.202	0.318	0.432	0.535	0.666	0.882	1.023	1.118	1.199	1.368	1.519	0.428	1.335
1994	0.005	0.004	0.019	0.070	0.202	0.280	0.430	0.534	0.691	0.832	0.909	1.083	1.172	1.204	1.576	0.344	1.266
1995	0.005	0.007	0.024	0.051	0.158	0.328	0.435	0.561	0.690	0.910	0.974	1.101	1.203	1.411	1.406	0.393	1.243
1996	0.004	0.019	0.031	0.060	0.149	0.265	0.422	0.554	0.708	0.856	0.974	1.114	1.401	1.440	1.558	0.435	1.232
1997	0.004	0.023	0.033	0.070	0.189	0.274	0.376	0.495	0.627	0.868	1.037	1.168	1.196	1.687	1.659	0.376	1.293
1998	0.003	0.006	0.024	0.070	0.163	0.260	0.359	0.487	0.584	0.869	0.978	1.115	1.132	1.261	1.557	0.338	1.206
1999	0.003	0.006	0.024	0.068	0.217	0.291	0.400	0.514	0.584	0.627	0.917	0.683			1.442	0.387	0.872
2000	0.003	0.006	0.024	0.066	0.196	0.273	0.368	0.448	0.532	0.633	0.677	0.834	1.167	1.298	1.379	0.432	0.925
2001	0.003	0.006	0.023	0.089	0.176	0.256	0.362	0.465	0.550	0.646	0.647	0.718	0.816	1.016	1.206	0.453	0.840
2002	0.003	0.007	0.032	0.110	0.220	0.278	0.395	0.474	0.553	0.651	0.821	0.844	0.716	0.993	1.120	0.444	0.918
Mean																	
1982-02	0.0040	0.0106	0.0287	0.0914	0.1984	0.2984	0.4131	0.5344	0.6534	0.8066	0.9339						1.2372
1999-02	0.0031	0.0063	0.0258	0.0830	0.2021	0.2746	0.3813	0.4752	0.5548	0.6393	0.7656						0.8887

Table A.17 continued. **Total USA commercial catch** (landings+ shrimp trawl discards + LM otter trawl discards) .

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	TOTAL	11+
USA Commerical Mean Length (cm) at Age																	
1982	5.0	7.8	19.9	28.1	33.5	36.8	39.7	42.9	46.5	49.3	50.9	53.2	54.6	55.2	58.0	43.3	56.3
1983		13.0	20.0	28.6	31.8	34.7	39.4	42.2	44.2	47.7	50.7	52.8	54.0	56.6	55.8	35.0	55.0
1984		15.7	20.0	28.4	33.1	36.9	39.7	42.7	45.3	48.2	49.9	51.2	54.1	55.6	57.6	42.7	55.5
1985		15.7	16.9	28.4	33.6	36.1	39.9	43.3	45.9	48.6	50.6	51.9	53.8	55.3	57.1	42.4	55.3
1986		15.7	17.3	25.1	32.2	36.0	39.3	42.5	45.6	48.8	50.7	53.0	53.9	55.4	57.7	41.8	55.3
1987	10.6	15.3	19.0	24.5	31.3	35.9	40.1	43.2	45.8	48.4	50.8	52.1	54.2	56.2	57.1	43.2	55.1
1988	10.2	10.9	15.6	20.4	31.8	36.3	40.1	42.7	45.4	48.2	50.8	52.1	53.7	55.0	57.1	41.4	55.3
1989	12.6	13.9	19.0	27.8	30.9	36.8	39.9	43.5	45.6	48.1	50.6	52.9	54.6	55.3	57.6	41.6	55.7
1990	9.7	14.0	18.0	22.3	31.1	34.3	40.2	43.7	45.8	48.7	51.8	54.1	54.6	57.8	59.2	37.5	56.8
1991	9.6	14.1	18.8	22.6	31.6	37.4	39.6	43.3	46.1	48.5	50.6	52.5	56.0	57.9	57.9	39.4	56.5
1992	9.1	10.9	17.4	26.1	33.1	38.5	40.7	44.3	46.8	48.3	49.2	51.7	55.5	57.0	58.9	38.6	54.2
1993	9.1	12.2	17.7	27.9	32.3	36.6	40.0	42.6	45.3	49.3	51.5	52.8	53.9	55.9	57.7	37.6	55.5
1994	10.7	9.8	15.9	22.8	32.2	35.1	39.7	42.3	45.6	48.0	49.1	51.8	53.1	53.4	57.8	33.0	54.1
1995	10.9	11.6	17.3	21.1	30.1	36.7	39.8	42.8	45.4	49.3	50.1	52.0	53.4	56.0	55.8	35.7	53.8
1996	10.0	15.3	18.4	22.5	29.5	34.7	39.4	42.7	45.8	48.4	50.1	52.2	55.8	56.2	57.6	38.6	53.6
1997	10.2	16.1	18.9	23.3	31.4	34.8	38.2	41.3	44.2	48.5	51.1	52.9	53.3	59.0	58.7	36.9	54.4
1998	9.4	10.4	17.1	23.5	30.5	34.5	37.6	41.1	43.3	48.6	50.5	52.3	52.7	54.1	57.6	34.6	53.4
1999	9.4	10.4	17.2	23.0	32.5	35.6	38.9	41.8	43.3	44.3	49.4	45.2			56.4	36.8	48.0
2000	9.4	10.4	17.1	22.9	31.5	34.8	38.0	40.1	42.1	44.2	45.2	47.7	53.0	54.6	55.3	38.4	49.0
2001	9.4	10.4	16.9	24.7	31.1	34.4	37.7	40.5	42.5	44.6	44.5	45.9	47.7	50.8	53.3	39.3	47.9
2002	9.4	11.0	18.3	26.6	32.8	35.1	38.7	40.8	42.6	44.6	47.9	48.2	45.8	50.5	52.2	39.7	49.3

Table A.18. Mean weights at age (kg) at the beginning of the year (January 1) for witch flounder, 1982-2002. Values derived from catch mean weight-at-age data using procedures described by Rivard (1980).

	Age										
Year	1	2	3	4	5	6	7	8	9	10	11+
1982	0.0005	0.0193	0.1316	0.2287	0.2951	0.3789	0.5210	0.6952	0.8437	0.9332	1.4056
1983	0.0042	0.0090	0.0755	0.1753	0.2552	0.3670	0.4667	0.5806	0.7602	0.9304	1.3575
1984	0.0143	0.0191	0.0763	0.1848	0.2577	0.3371	0.4696	0.5865	0.7077	0.8561	1.3393
1985	0.0137	0.0199	0.0719	0.1893	0.2639	0.3751	0.4880	0.6103	0.7477	0.8875	1.3255
1986	0.0121	0.0208	0.0456	0.1623	0.2663	0.3525	0.4781	0.6180	0.7677	0.9061	1.3209
1987	0.0142	0.0236	0.0456	0.1300	0.2477	0.3602	0.4783	0.6047	0.7481	0.9143	1.3031
1988	0.0027	0.0161	0.0384	0.1284	0.2438	0.3598	0.4829	0.6122	0.7496	0.9008	1.3256
1989	0.0076	0.0145	0.0457	0.0874	0.2554	0.3636	0.4992	0.6057	0.7392	0.8904	1.3577
1990	0.0066	0.0187	0.0457	0.1510	0.2092	0.3752	0.4990	0.6284	0.7609	0.9263	1.4542
1991	0.0103	0.0202	0.0426	0.1108	0.2533	0.3286	0.5032	0.6414	0.7584	0.9094	1.4198
1992	0.0033	0.0190	0.0604	0.1192	0.2745	0.3974	0.5081	0.6536	0.7596	0.8587	1.2431
1993	0.0062	0.0135	0.0563	0.1445	0.2703	0.4046	0.4955	0.6395	0.8073	0.9170	1.3353
1994	0.0019	0.0130	0.0434	0.1571	0.2380	0.3698	0.4802	0.6080	0.7444	0.8954	1.2656
1995	0.0036	0.0105	0.0308	0.1050	0.2572	0.3491	0.4909	0.6068	0.7931	0.9002	1.2426
1996	0.0142	0.0151	0.0382	0.0868	0.2048	0.3719	0.4907	0.6301	0.7683	0.9416	1.2316
1997	0.0229	0.0251	0.0465	0.1061	0.2021	0.3154	0.4569	0.5895	0.7840	0.9422	1.2930
1998	0.0030	0.0239	0.0483	0.1069	0.2215	0.3135	0.4279	0.5378	0.7381	0.9215	1.2061
1999	0.0030	0.0120	0.0406	0.1233	0.2180	0.3226	0.4293	0.5333	0.6055	0.8924	0.8721
2000	0.0031	0.0120	0.0399	0.1150	0.2436	0.3272	0.4236	0.5231	0.6078	0.6517	0.9247
2001	0.0026	0.0118	0.0463	0.1076	0.2237	0.3145	0.4137	0.4967	0.5864	0.6400	0.8403
2002	0.0038	0.0138	0.0504	0.1395	0.2213	0.3179	0.4140	0.5072	0.5982	0.7283	0.9179
mean											
1982-2002	0.0073	0.0167	0.0533	0.1361	0.2439	0.3525	0.4722	0.5956	0.7322	0.8735	1.2372
1999-2002	0.0031	0.0124	0.0443	0.1214	0.2267	0.3206	0.4202	0.5151	0.5995	0.7281	0.8888

Table A.19. USA commercial witch flounder landings (L), days fished (DF), and landings per day fished (L/DF), by vessel tonnage class, for otter trawl trips 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 51, 52, 56), 1973 - 2002. *Note: in 1994-2002, Vessel Trip Report data were used.*

	CLASS 2			CLASS 3			CLASS 4			TOTAL		
YEAR	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF
ALL TRIPS												
1973	802	2620	0.31	1284	6236	0.21	234	859	0.27	2320	9715	0.25
1974	497	2478	0.20	1029	7092	0.15	157	1004	0.16	1683	10574	0.16
1975	679	2354	0.29	1126	7728	0.15	153	1178	0.13	1957	11260	0.19
1976	756	2826	0.27	913	6373	0.14	97	860	0.11	1765	10059	0.19
1977	1074	3183	0.34	1070	6025	0.18	157	872	0.18	2302	10080	0.25
1978	1372	4033	0.34	1658	7053	0.24	277	1225	0.23	3307	12310	0.28
1979	946	4465	0.21	1467	6757	0.22	283	1570	0.18	2696	12792	0.21
1980	1062	4932	0.22	1428	7120	0.20	376	1997	0.19	2866	14049	0.20
1981	1069	3748	0.29	1637	7015	0.23	423	2595	0.16	3129	13358	0.24
1982	1162	4430	0.26	2346	8626	0.27	905	3559	0.25	4413	16615	0.27
1983	1203	3930	0.31	2796	9581	0.29	1308	4544	0.29	5307	18056	0.29
1984	1281	4069	0.31	3245	12157	0.27	1423	4769	0.30	5949	20994	0.28
1985	1195	3794	0.31	2765	12664	0.22	1600	5530	0.29	5560	21988	0.26
1986	806	3289	0.25	2031	10525	0.19	1177	5287	0.22	4015	19101	0.21
1987	647	2833	0.23	1623	9593	0.17	845	5035	0.17	3114	17461	0.18
1988	560	2986	0.19	1463	8948	0.16	951	4871	0.20	2973	16805	0.18
1989	283	2269	0.12	959	8538	0.11	618	4292	0.14	1860	15099	0.12
1990	265	2649	0.10	661	7736	0.09	347	4172	0.08	1274	14557	0.09
1991	316	3135	0.10	830	9076	0.09	383	4681	0.08	1529	16892	0.09
1992	352	3589	0.10	1148	10720	0.11	414	5005	0.08	1914	19314	0.10
1993	380	3321	0.11	1347	10872	0.12	530	4711	0.11	2257	18904	0.12
1994	*261*	*2067*	*0.13*	*581*	*5126*	*0.11*	*302*	*2384*	*0.13*	*1143*	*9578*	*0.12*
1995	*291*	*2784*	*0.10*	*852*	*7328*	*0.12*	*462*	*3911*	*0.12*	*1605*	*14023*	*0.11*
1996	*369*	*2647*	*0.14*	*908*	*6992*	*0.13*	*399*	*3200*	*0.12*	*1677*	*12839*	*0.13*
1997	*371*	*2666*	*0.14*	*731*	*5084*	*0.14*	*277*	*2395*	*0.12*	*1379*	*10145*	*0.14*
1998	*393*	*2641*	*0.15*	*694*	*4697*	*0.15*	*255*	*1867*	*0.14*	*1342*	*9205*	*0.15*
1999	*407*	*2316*	*0.18*	*682*	*4387*	*0.16*	*288*	*1675*	*0.17*	*1378*	*8377*	*0.17*
2000	*555*	*2665*	*0.21*	*993*	*5431*	*0.18*	*398*	*2564*	*0.16*	*1946*	*10660*	*0.18*
2001	*321*	*1349*	*0.24*	*771*	*3750*	*0.21*	*396*	*2115*	*0.19*	*1488*	*7213*	*0.21*
2002	*320*	*875*	*0.37*	*446*	*1781*	*0.25*	*185*	*988*	*0.19*	*951*	*3644*	*0.28*

Table A.19 continued.

	CLASS 2			CLASS 3			CLASS 4			TOTAL		
YEAR	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF
40% TRIPS												
1973	306	208	1.47	392	271	1.45	96	58	1.66	793	536	1.48
1974	134	99	1.34	169	112	1.50	21	16	1.25	323	228	1.42
1975	292	171	1.71	208	168	1.24	4	4	1.09	504	343	1.51
1976	211	144	1.47	137	90	1.54	3	1	3.38	352	234	1.51
1977	151	93	1.62	129	84	1.53	1	4	0.26	281	182	1.57
1978	214	162	1.33	197	82	2.39	7	2	3.58	418	246	1.87
1979	93	79	1.17	103	69	1.49	7	2	3.45	203	151	1.41
1980	93	82	1.14	107	40	2.66	54	25	2.17	254	147	2.00
1981	101	54	1.87	239	108	2.21	22	13	1.69	362	175	2.08
1982	172	112	1.53	289	136	2.13	55	31	1.75	516	279	1.89
1983	183	140	1.30	519	279	1.86	48	30	1.59	750	450	1.70
1984	234	210	1.12	705	595	1.18	176	98	1.80	1115	903	1.27
1985	266	277	0.96	465	580	0.80	177	143	1.24	909	1000	0.93
1986	185	236	0.78	499	785	0.64	127	169	0.75	811	1190	0.69
1987	155	195	0.79	377	569	0.66	86	109	0.78	617	873	0.71
1988	137	176	0.78	517	905	0.57	202	254	0.79	856	1335	0.66
1989	45	67	0.67	128	256	0.50	77	112	0.69	250	435	0.59
1990	36	57	0.63	49	85	0.58	9	16	0.54	94	158	0.60
1991	35	76	0.46	55	106	0.52	1	1	0.83	92	183	0.50
1992	42	65	0.65	181	382	0.48	25	7	3.32	248	454	0.79
1993	76	140	0.54	266	538	0.49	30	42	0.71	372	720	0.52
1994	*95*	*221*	*0.43*	*90*	*225*	*0.40*	*17*	*22*	*0.77*	*202*	*468*	*0.45*
1995	*90*	*237*	*0.38*	*155*	*323*	*0.48*	*28*	*53*	*0.54*	*274*	*613*	*0.45*
1996	*139*	*309*	*0.45*	*169*	*378*	*0.45*	*40*	*60*	*0.67*	*348*	*746*	*0.47*
1997	*98*	*238*	*0.41*	*158*	*311*	*0.51*	*17*	*36*	*0.48*	*273*	*585*	*0.47*
1998	*154*	*327*	*0.47*	*172*	*263*	*0.65*	*5*	*6*	*0.90*	*331*	*596*	*0.57*
1999	*164*	*370*	*0.44*	*140*	*240*	*0.59*	*17*	*14*	*1.18*	*321*	*624*	*0.54*
2000	*212*	*329*	*0.64*	*164*	*200*	*0.82*	*21*	*14*	*1.49*	*396*	*543*	*0.76*
2001	*97*	*117*	*0.83*	*138*	*143*	*0.96*	*8*	*7*	*1.28*	*244*	*267*	*0.92*
2002	*132*	*127*	*1.05*	*104*	*91*	*1.14*	*0*	*0*	*0.00*	*236*	*217*	*1.09*

Table A.20. The sum of the 1963-2001 NEFSC autumn stratified mean number per tow by stratum (Stratum sum),the percentage of annual stratum sampling which produced no catch (% Zero Catch), and the percentage of stratum contribution (all years) to the total (% Total).

Strata	Stratum sum	% Zero Catch	% Total
1	0.00	100.0	0.0
2	0.70	84.6	0.1
3	0.22	92.3	0.0
4	2.88	76.9	0.3
5	0.23	97.4	0.0
6	19.30	48.7	1.8
7	0.43	94.9	0.0
8	2.51	64.1	0.2
9	0.53	92.3	0.0
10	8.54	56.4	0.8
11	1.23	92.3	0.1
12	2.01	86.8	0.2
13	7.80	43.6	0.7
14	0.68	89.7	0.1
15	4.26	69.2	0.4
16	0.98	74.4	0.1
17	1.12	92.3	0.1
18	7.40	74.4	0.7
19	0.00	100.0	0.0
20	0.02	97.4	0.0
21	1.43	89.7	0.1
22	73.23	5.1	6.8
23	5.75	66.7	0.5
24	85.01	2.6	7.9
25	0.61	94.9	0.1
26	73.21	5.1	6.8
27	94.59	0.0	8.8
28	22.08	15.4	2.1
29	18.72	7.7	1.7
30	8.93	56.4	0.8
33	6.88	61.5	0.6
34	55.51	2.6	5.2
351	93.13	8.3	8.7
36	48.86	0.0	4.5
37	109.01	0.0	10.2
38	185.36	0.0	17.3
39	38.84	5.1	3.6
40	85.47	10.3	8.0
61	0.00	100.0	0.0
62	0.00	100.0	0.0
63	0.10	97.1	0.0
64	0.60	90.6	0.1
65	0.00	100.0	0.0
66	0.00	100.0	0.0
67	0.05	97.1	0.0
68	1.10	75.8	0.1

Strata	Stratum sum	% Zero Catch	% Total
69	0.02	97.1	0.0
70	0.00	100.0	0.0
71	0.00	100.0	0.0
72	3.35	81.8	0.3
73	0.00	100.0	0.0
74	0.00	100.0	0.0
75	0.05	97.1	0.0
76	1.20	80.0	0.1
Total	1073.89		100.0

Strata set 22-30,36-40	92.5
Strata set 6,22-30,36-40	93.9
Strata set 22,24,26-30,36-40	91.8

Table A.21. Stratified mean number, weight (kg), length (cm), and individual weight (kg) per tow of witch flounder in NEFSC offshore spring and autumn bottom trawl surveys in Gulf of Maine-Georges Bank region (strata 22-30,36-40), 1963-2003.

	SPRING				AUTUMN			
Year	Number per tow	Weight per tow	Length per tow	Ave. wt. per tow	Number per tow	Weight per tow	Length per tow	Ave. wt. per tow
1963	-	-	-	-	5.52	3.46	39.7	0.627
1964	-	-	-	-	2.89	2.00	44.2	0.691
1965	-	-	-	-	3.94	2.27	40.6	0.577
1966	-	-	-	-	7.80	4.56	41.2	0.584
1967	-	-	-	-	3.01	2.02	43.7	0.673
1968	4.83	3.35	42.3	0.695	4.82	3.49	44.8	0.724
1969	3.74	2.53	45.3	0.676	5.81	4.40	43.5	0.757
1970	6.39	4.49	44.7	0.702	4.89	3.71	45.0	0.760
1971	2.70	2.04	46.5	0.756	4.32	2.95	42.1	0.683
1972	5.35	4.01	45.8	0.749	3.24	2.42	43.9	0.747
1973	8.20	6.21	44.8	0.758	3.18	2.05	43.6	0.646
1974	6.23	3.62	39.3	0.581	2.38	1.58	41.0	0.666
1975	3.72	2.75	43.9	0.739	1.66	1.03	39.8	0.621
1976	5.50	3.70	42.3	0.673	1.34	0.94	41.9	0.699
1977	4.20	1.96	37.2	0.467	5.06	3.38	42.0	0.669
1978	3.87	2.56	41.7	0.662	4.04	2.94	42.8	0.727
1979	2.91	1.71	38.2	0.587	1.94	1.62	45.2	0.838
1980	8.46	3.89	36.0	0.460	2.62	2.04	43.7	0.777
1981	8.14	4.05	38.0	0.497	3.66	2.19	40.4	0.600
1982	3.64	1.87	37.2	0.513	0.99	0.83	44.7	0.842
1983	6.41	2.74	36.3	0.427	4.72	2.12	36.7	0.448
1984	3.00	1.66	39.9	0.554	4.37	2.34	39.7	0.534
1985	5.18	2.75	40.3	0.531	2.76	1.59	41.9	0.577
1986	2.07	1.35	44.1	0.650	1.59	1.09	43.3	0.683
1987	1.01	0.65	43.4	0.646	0.48	0.37	43.9	0.774
1988	1.43	0.85	42.3	0.590	1.38	0.57	35.2	0.414
1989	1.95	0.74	35.8	0.382	0.89	0.38	31.4	0.423
1990	0.63	0.24	35.2	0.378	2.00	0.40	24.7	0.200
1991	1.68	0.57	31.5	0.341	2.08	0.54	29.2	0.258
1992	1.26	0.48	34.8	0.383	0.94	0.24	29.5	0.254
1993	1.47	0.36	30.3	0.245	5.15	0.54	17.0	0.105
1994	3.13	0.53	27.4	0.170	2.21	0.42	24.9	0.191
1995	1.88	0.47	30.6	0.248	4.74	0.62	25.7	0.132
1996	1.36	0.28	30.5	0.204	5.38	1.02	29.7	0.189
1997	2.22	0.43	31.0	0.195	5.11	0.77	24.9	0.150
1998	4.27	0.77	29.0	0.179	3.70	0.47	24.2	0.127
1999	3.15	0.48	28.1	0.153	5.92	0.88	26.3	0.148
2000	3.45	0.52	27.3	0.151	6.63	1.11	27.1	0.167
2001	4.41	0.75	29.5	0.171	7.94	1.71	32.3	0.216
2002	8.10	1.62	31.4	0.199	4.31	1.06	33.2	0.247
2003	5.20	1.30	34.2	0.250				

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, and 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 A.22. Stratified mean number, weight (kg),length (cm) per tow of witch flounder in Massachusetts Division of Marine Fisheries inshore spring and autumn surveys in the Cape Cod Bay and Mass. Bay region (Regions 4 and 5), 1978-2002.

	SPRING			AUTUMN		
Year	Number per tow	Weight per tow	Length per tow	Number per tow	Weight per tow	Length per tow
1978	2.98	2.15	45.3	2.47	2.41	48.2
1979	1.36	1.41	47.9	1.39	1.09	44.4
1980	1.49	1.44	46.0	1.66	1.77	48.2
1981	3.74	3.18	43.7	0.36	0.23	42.3
1982	1.23	0.97	46.1	1.24	0.76	40.3
1983	2.15	1.29	38.9	3.79	2.68	45.9
1984	1.50	1.01	41.6	0.62	0.45	44.7
1985	1.12	0.82	43.9	0.83	0.57	44.2
1986	0.90	0.83	47.1	0.32	0.27	46.3
1987	1.45	1.10	44.7	0.26	0.20	45.7
1988	0.36	0.29	46.1	0.39	0.24	40.8
1989	0.17	0.07	35.9	0.21	0.13	42.2
1990	0.40	0.32	45.0	0.06	0.03	37.5
1991	0.17	0.08	37.4	0.37	0.22	41.5
1992	0.34	0.24	41.3	0.45	0.25	41.3
1993	0.03	0.01	33.0	0.39	0.19	40.2
1994	0.00	0.00	-	0.53	0.21	34.9
1995	0.08	0.05	36.6	2.17	0.46	28.7
1996	0.02	<0.01	21.0	0.05	0.02	40.0
1997	0.04	0.01	31.5	1.20	0.36	36.0
1998	0.00	0.00	-	0.44	0.15	35.7
1999	0.01	<0.01	11.0	1.38	0.38	34.9
2000	0.95	0.11	24.4	1.28	0.43	34.4
2001	0.16	0.04	33.0	0.66	0.20	34.8
2002	0.11	0.03	32.5	2.40	0.79	37.1

Table A.23. Stratified mean number, weight (kg), length (cm), and individual weight (kg) per tow of witch flounder in the ASMFC summer shrimp surveys in the Gulf of Maine (Strata set 1,3,6,8), 1984 - 2002.

Year	Number per tow	Weight per tow	Length per tow	Individual Weight per tow
1984	4.68	1.60	33.9	0.341
1985	6.19	2.52	36.2	0.408
1986	2.05	0.74	35.9	0.362
1987	4.87	1.50	26.5	0.307
1988	2.53	0.60	25.8	0.238
1989	2.92	0.31	22.8	0.105
1990	6.66	1.02	24.5	0.154
1991	14.94	1.20	19.6	0.080
1992	24.28	1.91	20.5	0.079
1993	21.42	0.50	12.8	0.023
1994	36.36	2.20	19.1	0.061
1995	17.95	1.48	22.6	0.082
1996	15.45	1.95	25.2	0.126
1997	23.20	1.42	19.1	0.061
1998	7.35	0.52	21.9	0.071
1999	110.07	5.93	18.7	0.054
2000	32.43	3.09	24.2	0.095
2001	41.52	5.57	27.2	0.134
2002	45.25	7.05	28.8	0.156

Table A.24. Number of witch flounder caught, aged, percent of fish sampled, and the maximum age observed in the NEFSC spring and autumn bottom trawl surveys (strata 22-30, 36-40), 1980 - 2002.

	Spring				Autumn			
Year	Caught	Aged	% Sampled	Max. Age	Caught	Aged	% Sampled	Max. Age
1980	593	361	60.9	24	189	146	77.2	24
1981	557	209	37.5	23	202	143	70.8	22
1982	245	69	28.2	18	64	53	82.8	24
1983	410	176	42.9	20	359	154	42.9	22
1984	171	145	84.8	26	293	204	69.6	21
1985	269	151	56.1	25	340	232	68.2	30
1986	119	118	99.2	22	258	218	84.5	22
1987	108	108	100.0	24	30	27	90.0	24
1988	74	67	90.5	12	93	82	88.2	20
1989	100	91	91.0	18	59	55	93.2	21
1990	33	27	81.8	16	131	118	90.1	18
1991	93	87	93.5	15	187	107	57.2	11
1992	86	75	87.2	17	79	67	84.8	18
1993	88	81	92.0	19	414	166	40.1	16
1994	196	127	64.8	16	174	102	58.6	21
1995	142	106	74.6	19	352	174	49.4	14
1996	84	72	85.7	13	295	169	57.3	11
1997	129	79	61.2	12	368	243	66.0	12
1998	367	281	76.6	13	359	217	60.4	13
1999	187	138	73.8	10	556	244	43.9	10
2000	231	141	61.0	10	411	224	54.5	12
2001	315	197	62.5	10	475	234	49.3	10
2002	568	289	50.9	21	339	201	59.3	12

Table A.25. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980-2002, preliminary spring 2003.

	Age															
SPRING	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +	Total
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	0.99	8.40
1982	0.00	0.04	0.04	0.61	0.48	0.38	0.24	0.61	0.36	0.09	0.26	0.17	0.03	0.03	0.29	3.64
1983	0.00	0.00	0.07	0.53	1.26	1.29	0.54	0.72	0.63	0.48	0.21	0.17	0.08	0.05	0.38	6.41
1984	0.00	0.00	0.10	0.01	0.31	0.78	0.40	0.31	0.20	0.20	0.11	0.17	0.12	0.02	0.27	3.00
1985	0.00	0.00	0.00	0.02	0.46	1.06	1.20	0.91	0.41	0.15	0.15	0.04	0.07	0.03	0.69	5.18
1986	0.00	0.00	0.00	0.00	0.04	0.24	0.53	0.41	0.17	0.19	0.08	0.04	0.06	0.05	0.25	2.07
1987	0.00	0.00	0.00	0.00	0.06	0.11	0.13	0.26	0.19	0.01	0.06	0.02	0.00	0.00	0.16	1.01
1988	0.00	0.02	0.02	0.06	0.00	0.07	0.30	0.38	0.24	0.14	0.09	0.08	0.03	0.00	0.00	1.43
1989	0.00	0.02	0.01	0.04	1.00	0.11	0.07	0.08	0.33	0.08	0.02	0.06	0.06	0.02	0.06	1.95
1990	0.00	0.01	0.00	0.04	0.09	0.32	0.00	0.04	0.01	0.05	0.02	0.01	0.01	0.00	0.03	0.63
1991	0.00	0.04	0.00	0.78	0.11	0.09	0.21	0.03	0.10	0.08	0.14	0.02	0.02	0.00	0.06	1.68
1992	0.00	0.05	0.01	0.19	0.37	0.09	0.11	0.15	0.04	0.15	0.02	0.02	0.05	0.00	0.02	1.26
1993	0.00	0.15	0.11	0.14	0.47	0.32	0.06	0.09	0.00	0.02	0.02	0.00	0.07	0.00	0.04	1.47
1994	0.00	0.11	0.70	0.54	0.64	0.81	0.16	0.03	0.03	0.07	0.01	0.00	0.00	0.02	0.02	3.13
1995	0.00	0.04	0.12	0.58	0.32	0.18	0.31	0.12	0.11	0.04	0.00	0.04	0.03	0.00	0.00	1.88
1996	0.00	0.02	0.04	0.24	0.39	0.35	0.22	0.07	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.36
1997	0.00	0.07	0.07	0.15	0.69	0.62	0.44	0.08	0.08	0.01	0.00	0.00	0.00	0.00	0.00	2.22
1998	0.00	0.11	1.08	0.71	0.39	0.80	0.71	0.21	0.15	0.08	0.00	0.00	0.00	0.03	0.00	4.27
1999	0.00	0.11	0.38	0.97	0.80	0.48	0.16	0.18	0.03	0.01	0.02	0.00	0.00	0.00	0.00	3.15
2000	0.00	0.01	0.25	1.19	0.69	0.66	0.24	0.25	0.12	0.00	0.04	0.00	0.00	0.00	0.00	3.45
2001	0.00	0.11	0.10	0.71	1.48	1.02	0.40	0.29	0.16	0.11	0.03	0.00	0.00	0.00	0.00	4.41
2002	0.00	0.02	0.06	0.90	2.63	2.26	0.82	0.68	0.35	0.19	0.10	0.01	0.00	0.03	0.04	8.10
2003	0.00	0.00	0.00	0.16	0.78	1.57	1.08	0.81	0.43	0.23	0.05	0.07	0.00	0.02	0.01	5.20

Table A.25 continued. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980-2002.

	Age															
AUTUMN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +	Total
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	0.03	0.08	0.24	0.13	0.01	0.03	0.03	0.01	0.04	0.30	0.99
1983	0.00	0.01	0.01	0.51	1.60	0.76	0.55	0.44	0.08	0.14	0.07	0.11	0.02	0.00	0.41	4.72
1984	0.00	0.00	0.00	0.09	0.94	0.99	0.60	0.53	0.31	0.15	0.13	0.07	0.04	0.13	0.38	4.37
1985	0.00	0.00	0.01	0.06	0.08	0.61	0.68	0.48	0.27	0.10	0.12	0.03	0.01	0.09	0.22	2.76
1986	0.01	0.00	0.00	0.00	0.05	0.27	0.35	0.31	0.16	0.11	0.01	0.01	0.02	0.05	0.24	1.59
1987	0.00	0.00	0.02	0.00	0.01	0.02	0.05	0.19	0.07	0.00	0.01	0.00	0.00	0.02	0.08	0.48
1988	0.00	0.01	0.00	0.72	0.05	0.01	0.04	0.21	0.05	0.05	0.05	0.08	0.01	0.04	0.05	1.38
1989	0.17	0.02	0.02	0.08	0.30	0.01	0.02	0.02	0.08	0.08	0.02	0.00	0.03	0.00	0.04	0.89
1990	0.48	0.09	0.14	0.38	0.51	0.22	0.02	0.02	0.02	0.03	0.00	0.00	0.01	0.05	0.03	2.00
1991	0.22	0.02	0.18	0.66	0.33	0.29	0.14	0.07	0.06	0.03	0.05	0.03	0.00	0.00	0.00	2.08
1992	0.10	0.03	0.11	0.26	0.22	0.05	0.06	0.00	0.00	0.02	0.01	0.02	0.00	0.02	0.04	0.94
1993	2.54	0.67	0.15	0.54	0.78	0.22	0.06	0.02	0.08	0.00	0.02	0.04	0.00	0.01	0.01	5.15
1994	0.43	0.16	0.29	0.53	0.17	0.40	0.04	0.11	0.00	0.04	0.01	0.00	0.01	0.00	0.04	2.21
1995	0.51	0.20	0.76	1.62	0.86	0.47	0.23	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.01	4.74
1996	0.23	0.09	0.26	0.79	1.99	1.39	0.44	0.07	0.06	0.04	0.00	0.03	0.00	0.00	0.00	5.38
1997	0.89	0.34	0.98	0.52	0.87	0.77	0.38	0.33	0.00	0.00	0.00	0.00	0.02	0.00	0.00	5.10
1998	0.64	0.08	0.52	1.36	0.47	0.30	0.17	0.11	0.04	0.01	0.00	0.00	0.00	0.00	0.00	3.70
1999	0.32	0.52	1.18	1.51	1.04	0.60	0.36	0.28	0.05	0.04	0.01	0.00	0.00	0.00	0.00	5.91
2000	0.94	0.10	0.72	1.41	1.75	0.67	0.59	0.23	0.15	0.05	0.00	0.00	0.03	0.00	0.00	6.63
2001	0.00	0.04	0.21	0.95	3.16	1.89	0.81	0.61	0.16	0.06	0.06	0.00	0.00	0.00	0.00	7.94
2002	0.00	0.00	0.27	0.43	1.48	1.00	0.53	0.33	0.15	0.07	0.00	0.05	0.01	0.00	0.00	4.31

Table A.26. Witch flounder mean length (cm) at age in spring and autumn NEFSC bottom trawl surveys (Strata 22-30, 36-40), 1980-2002, preliminary 2003.

	Age														
SPRING	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +
1980	-	9.7	16.4	20.6	26.2	30.6	34.8	38.6	40.6	45.0	48.6	49.2	49.3	52.5	55.2
1981	-	-	13.4	20.2	28.5	32.4	35.4	39.7	44.4	49.4	52.4	49.9	54.5	54.1	57.6
1982	-	7.9	15.0	20.7	27.2	32.8	36.1	41.0	44.1	48.2	50.7	51.3	58.0	53.0	58.1
1983	-	-	17.9	20.9	26.5	31.2	35.5	40.2	43.7	47.4	52.5	54.9	50.0	55.6	56.1
1984	-	-	17.4	19.0	29.4	32.6	37.5	42.2	43.0	46.0	51.3	50.6	54.2	54.3	57.4
1985	-	-	-	19.5	28.8	33.5	36.6	41.2	44.4	46.9	49.3	49.3	48.5	55.0	56.3
1986	-	-	-	-	27.3	35.0	38.5	41.7	45.8	49.1	51.8	52.3	54.2	56.1	57.9
1987	-	-	-	-	28.0	34.4	40.9	40.8	44.1	46.0	51.5	48.0	-	-	56.7
1988	-	9.0	15.0	19.5	-	33.1	39.2	43.0	46.0	50.2	54.2	51.2	58.3	-	-
1989	-	7.0	15.0	20.6	28.5	33.0	39.8	44.0	44.9	50.5	50.2	53.1	58.3	47.0	60.7
1990	-	9.0	-	19.8	28.3	32.4	-	40.9	49.0	49.8	51.5	52.0	53.0	-	54.9
1991	-	7.5	-	20.4	27.4	35.3	37.2	43.1	48.2	48.2	52.7	53.0	54.0	-	52.4
1992	-	8.5	11.0	21.7	29.3	35.0	38.4	42.5	45.7	49.3	46.0	51.0	57.3	-	56.0
1993	-	7.9	17.9	23.5	30.0	34.5	38.1	40.5	-	50.0	50.0	-	50.3	-	60.1
1994	-	10.8	17.9	21.5	29.4	33.7	38.1	41.2	46.0	48.2	48.0	-	-	57.0	57.0
1995	-	9.7	17.3	22.4	27.1	34.3	37.2	43.7	45.7	50.3	-	54.0	58.7	-	-
1996	-	9.4	19.6	22.3	28.1	32.5	37.1	40.6	0.0	-	-	56.3	-	-	-
1997	-	10.8	15.9	22.2	29.5	31.4	36.3	42.3	43.9	48.0	-	-	-	-	-
1998	-	11.0	20.3	24.6	29.9	33.3	35.7	39.1	42.6	45.2	-	-	-	51.7	-
1999	-	10.0	19.5	25.0	28.5	34.0	37.2	40.6	45.5	44.0	50.0	-	-	-	-
2000	-	9.0	18.1	20.9	27.3	31.2	36.5	38.5	41.1	-	50.3	-	-	-	-
2001	-	7.4	15.9	23.5	27.0	32.4	36.0	38.2	40.8	41.5	45.3	-	-	-	-
2002	-	11.0	18.0	20.2	29.0	32.2	34.7	37.8	42.1	44.3	45.1	42.0	-	45.3	54.8
2003	-	-	-	22.4	27.7	31.9	34.9	38.1	40.8	42.7	43.6	45.4	-	47.5	49.5

Table A.26 continued. Witch flounder mean length (cm) at age in spring and autumn NEFSC bottom trawl surveys (Strata 22-30, 36-40), 1980-2002.

	Age														
AUTUMN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +
1980	5.5	-	19.5	-	27.3	32.0	34.9	39.1	43.3	47.7	48.8	50.1	51.6	53.7	56.7
1981	5.5	12.6	17.4	23.3	30.6	33.1	38.3	41.4	44.8	47.0	51.4	53.6	52.7	55.0	56.4
1982	5.0	0.0	0.0	22.0	28.5	29.2	36.4	41.9	42.8	47.3	50.2	49.1	51.0	52.0	56.8
1983	0.0	14.0	19.0	24.7	30.1	34.7	39.2	42.2	45.0	48.5	52.0	50.9	51.0	0.0	58.8
1984	0.0	0.0	0.0	25.1	30.7	34.2	38.2	42.8	45.2	46.6	50.2	51.3	54.8	53.5	58.6
1985	0.0	0.0	20.0	26.0	29.7	34.6	38.8	42.7	46.8	49.1	50.8	53.3	55.0	53.1	58.7
1986	6.0	0.0	0.0	0.0	29.7	35.5	38.2	42.4	45.4	49.4	51.0	51.3	49.0	53.9	57.7
1987	0.0	0.0	16.0	0.0	28.0	36.0	39.1	41.6	43.8	0.0	49.0	0.0	0.0	55.0	60.9
1988	0.0	10.0	0.0	25.4	31.5	38.0	42.0	42.9	45.6	48.6	50.0	54.3	56.0	55.1	56.8
1989	5.7	15.0	18.5	24.1	31.1	36.0	44.0	45.0	46.7	49.9	52.0	0.0	54.8	0.0	64.2
1990	6.2	16.3	17.6	26.7	29.8	36.2	40.0	43.0	47.0	50.9	0.0	0.0	58.0	51.2	58.9
1991	5.7	14.9	20.8	26.3	30.5	36.8	41.9	46.4	47.6	46.6	53.5	55.0	0.0	0.0	0.0
1992	5.9	15.8	23.1	27.7	32.1	37.7	37.9	0.0	0.0	46.0	50.0	47.0	0.0	49.0	56.5
1993	5.6	14.2	22.2	28.8	32.2	36.4	42.3	43.6	46.2	0.0	55.0	51.0	0.0	63.0	57.0
1994	5.7	16.0	20.9	23.5	32.7	36.6	43.5	44.0	0.0	54.2	50.0	0.0	51.0	0.0	57.2
1995	6.6	16.7	22.0	26.5	29.9	35.5	39.2	0.0	0.0	54.0	50.6	0.0	0.0	0.0	56.0
1996	5.5	14.2	18.7	25.0	29.6	33.8	39.6	42.1	47.4	50.5	0.0	53.0	0.0	0.0	0.0
1997	6.3	16.3	19.8	25.8	30.6	35.1	38.0	42.0	0.0	0.0	0.0	0.0	47.1	0.0	0.0
1998	5.9	15.7	22.0	25.7	30.7	35.0	39.3	41.9	44.9	43.0	0.0	0.0	0.0	0.0	0.0
1999	5.5	15.6	20.4	26.1	30.2	34.6	38.2	41.6	41.6	45.1	45.0	0.0	0.0	0.0	0.0
2000	6.1	15.6	22.6	26.3	31.0	33.4	38.0	42.3	44.1	46.3	0.0	0.0	51.0	0.0	0.0
2001	0.0	14.6	18.9	28.0	30.6	33.1	36.7	39.9	41.9	41.0	46.4	0.0	0.0	0.0	0.0
2002	0.0	0.0	22.7	26.0	31.3	34.3	37.2	41.7	41.9	44.6	0.0	50.5	51.0	0.0	0.0

Table A.27. Mean weight (kg) at age of witch flounder from the Gulf of Maine-Georges Bank region, derived from NEFSC spring and autumn bottom trawl survey, (strata 22-30, 36-40), 1982 - 2002, and preliminary spring 2003.

	Age														
SPRING	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +
1982	0.0000	0.0018	0.0155	0.0479	0.1220	0.2350	0.3174	0.4939	0.6395	0.8643	1.0226	1.0519	1.5952	1.1711	1.6152
1983	0.0000	0.0000	0.0291	0.0494	0.1069	0.1861	0.2878	0.4433	0.5885	0.7790	1.0889	1.2747	0.9215	1.3281	1.4180
1984	0.0000	0.0000	0.0261	0.0342	0.1540	0.2234	0.3539	0.5318	0.5647	0.7143	1.0398	0.9979	1.2606	1.2534	1.5434
1985	0.0000	0.0000	0.0000	0.0368	0.1424	0.2349	0.3247	0.4841	0.6268	0.7516	0.8984	0.8858	0.8318	1.2805	1.4087
1986	0.0000	0.0000	0.0000	0.0000	0.1115	0.2604	0.3592	0.4737	0.6481	0.8299	0.9880	1.0206	1.1601	1.3053	1.4627
1987	0.0000	0.0000	0.0000	0.0000	0.1278	0.2542	0.4637	0.4615	0.6012	0.6891	1.0154	0.7974	0.0000	0.0000	1.4347
1988	0.0000	0.0025	0.0142	0.0364	0.0000	0.2177	0.3875	0.5340	0.6686	0.8996	1.1689	0.9765	1.5001	0.0000	0.0000
1989	0.0000	0.0010	0.0139	0.0408	0.1255	0.2039	0.3869	0.5537	0.5946	0.8807	0.8600	1.0413	1.4373	0.6851	1.6452
1990	0.0000	0.0026	0.0000	0.0392	0.1328	0.2150	0.0000	0.4708	0.8717	0.9235	1.0370	1.0687	1.1408	0.0000	1.2886
1991	0.0000	0.0014	0.0000	0.0429	0.1244	0.2784	0.3348	0.5487	0.8060	0.8278	1.0986	1.1110	1.1845	0.0000	1.0707
1992	0.0000	0.0024	0.0050	0.0519	0.1449	0.2641	0.3635	0.5224	0.6620	0.8765	0.6694	0.9535	1.4308	0.0000	1.3139
1993	0.0000	0.0016	0.0256	0.0661	0.1507	0.2395	0.3347	0.4116	0.0000	0.8459	0.8459	0.0000	0.8667	0.0000	1.6168
1994	0.0000	0.0051	0.0274	0.0524	0.1481	0.2352	0.3566	0.4681	0.6750	0.7940	0.7810	0.0000	0.0000	1.4078	1.4078
1995	0.0000	0.0032	0.0233	0.0572	0.1089	0.2378	0.3138	0.5452	0.6325	0.8816	0.0000	1.1302	1.5043	0.0000	0.0000
1996	0.0000	0.0037	0.0351	0.0563	0.1252	0.2024	0.3170	0.4300	0.0000	0.0000	0.0000	1.3229	0.0000	0.0000	0.0000
1997	0.0000	0.0046	0.0183	0.0532	0.1400	0.1733	0.2840	0.4763	0.5430	0.7288	0.0000	0.0000	0.0000	0.0000	0.0000
1998	0.0000	0.0053	0.0403	0.0777	0.1507	0.2179	0.2770	0.3836	0.5071	0.6355	0.0000	0.0000	0.0000	0.9754	0.0000
1999	0.0000	0.0040	0.0347	0.0816	0.1278	0.2311	0.3126	0.4251	0.6275	0.5562	0.8621	0.0000	0.0000	0.0000	0.0000
2000	0.0000	0.0025	0.0284	0.0464	0.1155	0.1806	0.3075	0.3789	0.4746	0.0000	0.9379	0.0000	0.0000	0.0000	0.0000
2001	0.0000	0.0015	0.0199	0.0654	0.1052	0.1957	0.2810	0.3412	0.4287	0.4549	0.6114	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0046	0.0255	0.0388	0.1307	0.1867	0.2401	0.3232	0.4634	0.5493	0.5910	0.4552	0.0000	0.5938	1.1331
2003	0.0000	0.0000	0.0000	0.0588	0.1141	0.1833	0.2461	0.3324	0.4183	0.4860	0.5191	0.5881	0.0000	0.6712	0.7743

Table A.27 continued. Mean weight (kg) at age of witch flounder from the Gulf of Maine-Georges Bank region , derived from NEFSC spring and autumn bottom trawl survey, (strata 22-30, 36-40), 1982 - 2002.

	AGE														
AUTUMN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 +
1982	0.0004	0.0000	0.0000	0.0604	0.1486	0.1591	0.3462	0.5470	0.5905	0.8193	1.0054	0.9316	1.0589	1.1331	1.5423
1983	0.0000	0.0123	0.0350	0.0883	0.1728	0.2794	0.4271	0.5435	0.6757	0.8757	1.1119	1.0501	1.0340	0.0000	1.7009
1984	0.0000	0.0000	0.0000	0.0905	0.1817	0.2639	0.3836	0.5656	0.6852	0.7623	0.9759	1.0446	1.3091	1.2035	1.6588
1985	0.0000	0.0000	0.0391	0.0969	0.1536	0.2592	0.3875	0.5341	0.7256	0.8551	0.9579	1.1245	1.2535	1.1205	1.5848
1986	0.0007	0.0000	0.0000	0.0000	0.1614	0.3015	0.3832	0.5534	0.6969	0.9241	1.0232	1.0493	0.8921	1.2559	1.5656
1987	0.0000	0.0000	0.0195	0.0000	0.1327	0.3141	0.4168	0.5181	0.6258	0.0000	0.9040	0.0000	0.0000	1.3432	1.9129
1988	0.0000	0.0036	0.0000	0.0900	0.1876	0.3540	0.5152	0.5472	0.6645	0.8253	0.9117	1.2061	1.3376	1.2693	1.4267
1989	0.0007	0.0155	0.0326	0.0791	0.1893	0.3111	0.6190	0.6686	0.7652	0.9710	1.0973	0.0000	1.3101	0.0000	2.2664
1990	0.0008	0.0210	0.0275	0.1135	0.1642	0.3173	0.4439	0.5688	0.7716	1.0181	0.0000	0.0000	1.5867	1.0437	1.7592
1991	0.0006	0.0155	0.0502	0.1083	0.1791	0.3388	0.5257	0.7467	0.8148	0.7657	1.2266	1.3420	0.0000	0.0000	0.0000
1992	0.0006	0.0181	0.0651	0.1236	0.2044	0.3524	0.3850	0.0000	0.0000	0.6915	0.9203	0.7444	0.0000	0.8587	1.3961
1993	0.0006	0.0133	0.0591	0.1416	0.2104	0.3147	0.5233	0.5872	0.7075	0.0000	1.2822	0.9898	0.0000	2.0425	1.4493
1994	0.0006	0.0187	0.0459	0.0707	0.2116	0.3133	0.5605	0.5893	0.0000	1.1912	0.9017	0.0000	0.9650	0.0000	1.4443
1995	0.0008	0.0207	0.0533	0.1000	0.1503	0.2703	0.3794	0.0000	0.0000	1.1259	0.9099	0.0000	0.0000	0.0000	1.2754
1996	0.0005	0.0124	0.0315	0.0828	0.1488	0.2328	0.4005	0.4964	0.7359	0.9408	0.0000	1.0769	0.0000	0.0000	0.0000
1997	0.0008	0.0195	0.0402	0.0950	0.1704	0.2700	0.3529	0.5031	0.0000	0.0000	0.0000	0.0000	0.7415	0.0000	0.0000
1998	0.0006	0.0185	0.0552	0.0928	0.1695	0.2669	0.3936	0.4937	0.6344	0.5333	0.0000	0.0000	0.0000	0.0000	0.0000
1999	0.0005	0.0176	0.0452	0.1021	0.1671	0.2672	0.3707	0.4932	0.4978	0.6581	0.6407	0.0000	0.0000	0.0000	0.0000
2000	0.0007	0.0163	0.0591	0.0993	0.1743	0.2248	0.3510	0.5116	0.5813	0.6765	0.0000	0.0000	0.9435	0.0000	0.0000
2001	0.0000	0.0131	0.0347	0.1227	0.1673	0.2179	0.3122	0.4124	0.4878	0.4468	0.6933	0.0000	0.0000	0.0000	0.0000
2002	0.0000	0.0000	0.0587	0.0959	0.1831	0.2442	0.3225	0.4775	0.4920	0.5955	0.0000	0.9261	0.9391	0.0000	0.0000

Table A.28. Proportion mature at age for female witch flounder derived from logistic regression analysis using a 5-year moving average of NEFSC spring bottom trawl surveys, 1980 - 2003.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
2	0.00	0.00	0.00	0.00	0.00	0.03	0.13	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.03
3	0.01	0.01	0.02	0.01	0.02	0.12	0.32	0.12	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.01	0.04	0.05	0.06	0.07
4	0.04	0.06	0.07	0.05	0.09	0.37	0.60	0.36	0.22	0.18	0.18	0.14	0.13	0.13	0.13	0.07	0.14	0.15	0.15	0.16
5	0.14	0.20	0.24	0.24	0.37	0.71	0.83	0.70	0.47	0.39	0.42	0.35	0.34	0.42	0.45	0.37	0.39	0.37	0.33	0.35
6	0.40	0.51	0.59	0.68	0.76	0.91	0.94	0.91	0.74	0.64	0.70	0.65	0.64	0.78	0.82	0.81	0.71	0.67	0.59	0.59
7	0.73	0.82	0.86	0.93	0.95	0.98	0.98	0.98	0.90	0.84	0.88	0.86	0.86	0.95	0.96	0.97	0.91	0.87	0.81	0.79
8	0.92	0.95	0.97	0.99	0.99	0.99	0.99	0.99	0.97	0.94	0.96	0.95	0.95	0.99	0.99	1.00	0.97	0.96	0.93	0.91
9	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.99	0.99	0.99	1.00	1.00	1.00	0.99	0.99	0.97	0.97
10	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99
11+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Number of fish																				
mature	108	153	204	203	186	177	145	111	104	89	80	85	76	81	132	123	127	148	186	191
immature	98	112	115	102	47	24	11	37	60	88	107	139	139	139	190	198	205	247	301	248
total	206	265	319	305	233	201	156	148	164	177	187	224	215	220	322	321	332	395	487	439

Long-term (non-averaged) proportion mature at age for female witch flounder from NEFSC spring bottom trawl surveys, 1980-2003.

Age	1980- 2003
1	0.00
2	0.00
3	0.01
4	0.04
5	0.14
6	0.40
7	0.73
8	0.92
9	0.98
10	0.99
11+	1.00

Table A.29. Stratified mean weight (kg) per tow of mature witch flounder (spawning stock biomass) in the NEFSC spring bottom trawl survey in Gulf of Maine-Georges Bank region (strata 22-30, 36-40), 1968-2002.

Year	Mature weight (kg) per tow
1968	2.930
1969	2.300
1970	4.073
1971	1.907
1972	3.772
1973	5.868
1974	3.289
1975	2.499
1976	3.248
1977	1.522
1978	2.278
1979	1.480
1980	2.964
1981	3.104
1982	1.519
1983	2.166
1984	1.383
1985	2.607
1986	1.329
1987	0.638
1988	0.836
1989	0.637
1990	0.200
1991	0.455
1992	0.356
1993	0.186
1994	0.323
1995	0.377
1996	0.174
1997	0.249
1998	0.498
1999	0.251
2000	0.228
2001	0.331
2002	0.782
2003	0.751

Note: 1977-1982, 1983-1984, 1985-1990, 1991-1993, 1994-1999, 2000-2002 ogives were used;
No maturity at length data before 1977; the 1977-1982 period was applied to the 1963-1976 period.

Table A.30. Estimates of instantaneous total mortality (Z) for witch flounder in the Gulf of Maine-Georges Bank region, 1980-2002, derived from NEFSC spring and autumn bottom trawl survey data.

YEAR	3+	4+	5+	6+	7+	8+
Spring						
1980	8.18	7.23	5.71	4.99	3.79	2.77
1981	8.31	7.49	6.56	4.56	3.54	2.78
1982	3.56	2.95	2.46	2.09	1.85	1.24
1983	6.34	5.80	4.54	3.25	2.71	1.99
1984	2.90	2.89	2.58	1.80	1.40	1.09
1985	5.18	5.17	4.71	3.65	2.45	1.54
1986	2.07	2.07	2.03	1.79	1.26	0.85
1987	1.01	1.01	0.95	0.83	0.70	0.44
1988	1.39	1.33	1.33	1.25	0.95	0.57
1989	1.91	1.87	0.87	0.76	0.69	0.61
1990	0.62	0.58	0.49	0.17	0.17	0.13
1991	1.64	0.86	0.75	0.67	0.46	0.42
1992	1.20	1.01	0.64	0.55	0.44	0.29
1993	1.21	1.07	0.60	0.28	0.22	0.14
1994	2.32	1.78	1.14	0.33	0.17	0.14
1995	1.72	1.14	0.83	0.65	0.33	0.22
1996	1.31	1.06	0.67	0.32	0.10	0.03
1997	2.08	1.93	1.24	0.62	0.18	0.10
1998	3.08	2.37	1.98	1.19	0.47	0.26
1999	2.67	1.69	0.90	0.41	0.25	0.07
2000	3.19	2.00	1.30	0.64	0.40	0.15
2001	4.21	3.49	2.02	1.00	0.60	0.30
2002	8.02	7.12	4.49	2.23	1.41	0.73
Autumn						
1980	2.58	2.58	2.38	2.12	1.84	1.48
1981	3.49	3.25	2.81	2.20	1.74	1.47
1982	0.97	0.91	0.90	0.87	0.80	0.56
1983	4.70	4.19	2.60	1.84	1.29	0.85
1984	4.37	4.28	3.34	2.34	1.74	1.21
1985	2.75	2.70	2.62	2.01	1.33	0.84
1986	1.58	1.58	1.53	1.26	0.91	0.60
1987	0.46	0.46	0.45	0.43	0.38	0.19
1988	1.37	0.64	0.59	0.58	0.54	0.33
1989	0.68	0.60	0.30	0.29	0.27	0.25
1990	1.30	0.92	0.41	0.19	0.17	0.15
1991	1.66	1.00	0.67	0.38	0.24	0.17
1992	0.70	0.45	0.22	0.17	0.11	0.11
1993	1.79	1.24	0.47	0.25	0.19	0.17
1994	1.33	0.80	0.64	0.24	0.21	0.10
1995	3.26	1.63	0.78	0.30	0.07	0.07
1996	4.80	4.02	2.03	0.64	0.20	0.14
1997	2.89	2.37	1.50	0.73	0.35	0.02
1998	2.46	1.10	0.63	0.33	0.17	0.05
1999	3.89	2.38	1.34	0.74	0.37	0.10
2000	4.87	3.47	1.72	1.05	0.46	0.23
2001	7.69	6.74	3.58	1.70	0.88	0.27
2002	4.04	3.61	2.13	1.13	0.60	0.27

Times period	Spring	Autumn	Geometric mean
1982-1985	0.48	0.23	0.34
1986-1989	0.77	0.65	0.71
1990-1993	0.59	0.61	0.60
1994-1997	0.53	0.36	0.44
1998-2001	0.52	0.60	0.56

Table A.31. Parameter estimates (with associated statistics) and estimates of terminal F from alternative ADAPT VPA formulations; stock sizes in '000s.

	Run 61-f	Run 61-f	Run 100	Run 200	Run 201	Run 300	Run 301-f	Run 301f-spr	Run 301f-aut
Software	FACT 1.5	NFTv2011	NFTv2011	NFTv2011	NFTv2011	NFTv2011	NFTv2011	NFTv2011	NFTv2011
CAA	1982-2001 1-11+	1982-2001 1-11+	1982-2002 1-11+	1982-2002 1-11+	1982-2002 1-11+	1982-2002 1-11+	1982-2002 3-11+	1982-2002 3-11+	1982-2002 3-11+
Est.Ages	4-10	4-10	4 - 10	4 - 10	3-10	3-10	3-10	3-10	3-10
NMFS-s	3-11+	3-11+	3 - 11+	3 - 11+	3-11+	3-11+	3-11+	3-11+	-
NMFS-a	3-11+	3-11+	3 - 11+	3 - 11+	3-11+	3-11+	3-11+	-	3-11+
Notes:	GARM VPA	Re-Run of GARM VPA	LM discards (sf method)	LM discards (sf & FOP)	LM discards (sf & FOP)	LM discards (sf & FOP)	LM discards (sf and FOP)	LM discards (sf and FOP)	LM discards (sf and FOP)
M.S.R.	.7673	.7289	.7469	.7485	.7459	.792	.791	.603	1.00
N3 (cv)					19,621 (.63)	19,703 (.64)	19,759 (.64)	11,429 (.79)	34,449 (1.03)
N4 (cv)	5.76e4 (.45)	57,321 (.44)	25,111 (.44)	24,755 (.44)	25,291 (.44)	25,373 (.45)	25,441 (.45)	36,289 (.56)	17,944 (.73)
N5 (cv)	6.08e4 (.38)	60,440 (.36)	41,902 (.37)	41,897 (.37)	42,456 (.37)	42,628 (.37)	42,739 (.37)	94,857 (.46)	40,928 (.60)
N6 (cv)	2.91e4 (.34)	28,936 (.33)	40,091 (.33)	41,003 (.32)	41,370 (.32)	41,550 (.33)	41,657 (.33)	36,267 (.41)	48,035 (.52)
N7 (cv)	1.67e4 (.32)	16,563 (.31)	19,965 (.31)	20,937 (.30)	21,063 (.30)	21,145 (.31)	21,203 (.31)	16,900 (.38)	26,672 (.48)
N8 (cv)	4.73e3 (.37)	3,844 (.35)	11,861 (.29)	12,420 (.28)	12,261 (.28)	10,122 (.32)	10,370 (.32)	8,067 (.41)	13,403 (.49)
N9 (cv)	1.56e3 (.44)	1,744 (.42)	2,547 (.38)	2,511 (.38)	2,283 (.40)	3,842 (.34)	3,903 (.33)	3,323 (.43)	4,742 (.51)
N10 (cv)	1.06e3 (.44)	1,197 (.42)	1,017 (.43)	972 (.44)	809 (.47)	754 (.47)	791 (.45)	795 (.57)	787 (.72)
Age 3 in T+1	22,643	23,362	6,268	8,026	19,620	19,707	19,760	11,429	34,449
F 1	0.00	0.0004	0.0000	0.0003	0.0004	0.0003	-	-	-
F 2	0.00	0.0026	0.0020	0.0002	0.0008	0.008	-	-	-
F 3	0.00	0.0026	0.0017	0.0015	0.0015	0.0015	0.0015	0.0010	0.0021
F 4	0.02	0.0205	0.0347	0.0164	0.0162	0.0162	0.0161	0.0154	0.0168
F 5	0.07	0.0725	0.0513	0.0273	0.0270	0.0269	0.0268	0.0308	0.0233
F 6	0.07	0.0725	0.0688	0.0603	0.0599	0.0597	0.0595	0.0741	0.0476
F 7	0.28	0.3375	0.1575	0.1474	0.1492	0.1780	0.1741	0.2186	0.1373
F 8	0.62	0.5716	0.3795	0.3857	0.4169	0.2685	0.2648	0.3045	0.2229
F 9	0.44	0.3985	0.4527	0.4706	0.5435	0.5734	0.5526	0.5508	0.5550
F10	0.45	0.4358	0.3299	0.3346	0.3699	0.3339	0.4087	0.4277	0.03890
F11+	0.45	0.4358	0.3299	0.3346	0.3699	0.3339	0.4087	0.4277	0.3890
Ave F 7-9	0.45	0.4358	0.3299	0.3346	0.3699	-	-	-	-
Ave F 8-9						0.3339	0.4087	0.4277	0.3890
SSB ('000 mt)	11,368	11,267	15,331	16,548	16,242	16,212	18,296	15,798	21,569

Table A.32. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality and spawning stock biomass (mt) for witch flounder estimated from virtual population analysis, 1982-2002.

Stock Numbers (Jan 1) in thousands

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	15404	17700	16340	7650	5414	3001	9740	6214	6670	8831	14342
4	12174	13082	14922	13928	6470	4639	2562	7827	4934	5422	7192
5	9563	9493	10014	11486	10899	5220	3825	2076	6333	3660	4291
6	7830	7114	6765	6768	7929	7978	4060	3047	1726	4431	2353
7	4289	5375	4668	4216	4039	4267	5683	2886	2332	1249	3281
8	2752	3077	3160	2647	2224	2034	2222	3615	1783	1754	857
9	2102	1763	1746	1344	1132	1146	949	853	2297	1100	1283
10	1101	1440	839	862	599	594	544	448	413	1668	677
11+	7260	4728	3844	2926	2039	1151	1218	1263	900	1371	2127
Total	62476	63772	62297	51828	40746	30029	30804	28229	27388	29487	36404

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	9670	13610	12671	15878	20226	29659	42904	67651	58704	29603	19760
4	11974	7936	11675	10324	13554	17283	25221	36778	58131	50462	25441
5	5029	8635	5904	9706	8400	10686	14360	21220	31390	49716	42739
6	2900	3019	4887	4119	7237	6290	8213	11345	17842	26146	41658
7	1164	1649	1414	2627	2289	5033	4106	5717	8693	14340	21204
8	2162	453	660	438	949	1033	2846	2426	3417	5910	10370
9	552	1320	209	321	136	274	547	1743	1138	1599	3903
10	940	274	640	91	80	39	105	239	926	398	792
11+	1318	782	373	180	112	179	181	536	667	655	603
Total	35708	37679	38434	43683	52982	70476	98483	147655	180909	178829	166470

Table A.32. continued.

Fishing Mortality

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	0.013	0.021	0.010	0.018	0.005	0.008	0.069	0.081	0.057	0.055
4	0.099	0.117	0.112	0.095	0.065	0.043	0.061	0.062	0.149	0.084
5	0.146	0.189	0.242	0.221	0.162	0.101	0.077	0.034	0.207	0.292
6	0.226	0.271	0.323	0.366	0.470	0.189	0.191	0.118	0.173	0.150
7	0.182	0.381	0.417	0.490	0.536	0.503	0.303	0.332	0.135	0.227
8	0.295	0.416	0.705	0.700	0.514	0.612	0.807	0.304	0.333	0.162
9	0.228	0.593	0.556	0.657	0.495	0.595	0.602	0.577	0.170	0.335
10	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.226
11+	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.226

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.030	0.048	0.003	0.055	0.008	0.007	0.012	0.004	0.002	0.001	0.002
4	0.208	0.177	0.146	0.035	0.056	0.088	0.035	0.023	0.008	0.006	0.016
5	0.242	0.360	0.419	0.210	0.144	0.139	0.113	0.086	0.023	0.033	0.027
6	0.554	0.414	0.609	0.471	0.438	0.213	0.276	0.212	0.116	0.069	0.060
7	0.267	0.793	0.766	1.023	0.868	0.646	0.420	0.376	0.365	0.236	0.174
8	0.291	0.343	0.623	0.571	1.021	1.093	0.486	0.340	0.607	0.610	0.265
9	0.161	0.552	0.574	0.688	1.244	1.085	0.805	0.679	0.483	0.900	0.553
10	0.211	0.382	0.586	0.598	1.109	1.092	0.545	0.388	0.553	0.675	0.409
11+	0.211	0.382	0.586	0.598	1.109	1.092	0.545	0.388	0.553	0.675	0.409

Table A.32. continued.

Spawning Stock Biomass (mt)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	20	13	24	5	5	16	115	33	24	25
4	107	132	185	127	91	216	191	238	156	104
5	376	458	580	684	1019	880	745	360	587	336
6	1115	1241	1243	1584	1916	2471	1297	964	454	886
7	1543	1883	1715	1720	1636	1794	2494	1303	999	496
8	1634	1544	1559	1388	1218	1072	1148	2010	1003	1004
9	1632	1172	1088	878	780	757	628	559	1640	754
10	949	1207	628	665	487	479	422	367	358	1411
11+	9521	5781	4505	3374	2414	1323	1392	1577	1227	1829
Total	16897	13431	11528	10425	9567	9008	8433	7410	6447	6844

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	50	21	23	11	12	9	56	85	158	186	102
4	145	229	154	155	113	97	251	453	618	975	1096
5	463	437	636	601	852	599	883	1114	1657	2384	3739
6	582	694	630	1200	1139	1740	1304	1671	2095	3192	4736
7	1369	424	585	542	1044	888	1782	1405	1800	2664	4443
8	500	1210	230	352	225	455	485	1343	1040	1361	2545
9	916	392	862	144	196	87	171	286	925	544	825
10	547	789	217	509	69	61	32	86	137	511	262
11+	2490	1610	875	409	180	118	192	145	441	489	548
Total	7063	5806	4212	3922	3828	4053	5156	6587	8871	12305	18296

Table A.33. Summary of witch flounder catch (mt), spawning stock biomass (mt), fully recruited fishing mortality, recruitment (age 3, thousands of fish) and the year class.

Year	Catch (mt)	SSB (mt)	Ave F 8-9	Recruits Age 3 ('000)	Year class
1982	4954	16897	0.262	15.404	1979
1983	6159	13431	0.505	17.700	1980
1984	6759	11527	0.631	16.340	1981
1985	6192	10425	0.679	7.650	1982
1986	4636	9566	0.504	5.414	1983
1987	3494	9008	0.604	3.001	1984
1988	3320	8432	0.704	9.740	1985
1989	2199	7411	0.440	6.214	1986
1990	1645	6448	0.252	6.670	1987
1991	1870	6845	0.249	8.831	1988
1992	2395	7062	0.226	14.342	1989
1993	2973	5806	0.447	9.670	1990
1994	3073	4212	0.598	13.610	1991
1995	2386	3923	0.629	12.671	1992
1996	2338	3830	1.132	15.878	1993
1997	2065	4054	1.089	20.226	1994
1998	2124	5156	0.645	29.659	1995
1999	2327	6588	0.510	42.904	1996
2000	2551	8871	0.545	67.651	1997
2001	3241	12306	0.755	58.704	1998
2002	3466	18296	0.409	29.603	1999
2003				19.760	2000
min	1645	3830	0.226	3.001	
max	6759	18296	1.132	67.651	
mean	3341	8576	0.563	19.613	
geomean				14.448	
median				14.342	

Table A.34. Yield and Spawning Stock biomass per recruit results for witch flounder.

```
##  Yield per Recruit and Spawning Stock Biomass per Recruit
##  YPR  Version 2.0
##  Date of Run: 19 May 2003   10:59
##  Input Data File: H:\WITCHASS\YPR\YPR2003\RUN301-F.DAT

 Model Title:  Witch Flounder (run 301)
 Start Age = 3
 End Age   = 20  (Does Not Include Plus Group)
 Fishing Mortality Upper Bound                =     1.0000
 Fishing Mortality Calculation Increment      =     0.0001
 Fishing Mortality Printing Increment         =       0.05
 Natural Mortality                            =     0.1500
 Proportion Fishing Mortality Before Spawning =     0.1667
 Proportion Natural Mortality Before Spawning =     0.1667

 Age      Selectivity F  Selectivity M    Stock Weight   Catch Weight     Maturity
   3            0.0036         1.0000         0.0787         0.0830         0.0200
   4            0.0229         1.0000         0.1459         0.2021         0.0800
   5            0.0703         1.0000         0.2319         0.2746         0.3000
   6            0.1931         1.0000         0.3328         0.3813         0.6200
   7            0.5282         1.0000         0.4442         0.4752         0.8700
   8            1.0000         1.0000         0.5615         0.5548         0.9700
   9            1.0000         1.0000         0.6816         0.6393         1.0000
  10            1.0000         1.0000         0.8006         0.7656         1.0000
  11            1.0000         1.0000         0.9175         0.9175         1.0000
  12            1.0000         1.0000         1.0399         1.0399         1.0000
  13            1.0000         1.0000         1.1348         1.1348         1.0000
  14            1.0000         1.0000         1.2335         1.2335         1.0000
  15            1.0000         1.0000         1.3259         1.3259         1.0000
  16            1.0000         1.0000         1.4097         1.4097         1.0000
  17            1.0000         1.0000         1.4875         1.4875         1.0000
  18            1.0000         1.0000         1.5575         1.5575         1.0000
  19            1.0000         1.0000         1.6215         1.6215         1.0000
  20            1.0000         1.0000         1.6787         1.6787         1.0000


 Reference Point    F        YPR       SSBR    Mean Age   Mean GT Exp Spawn
 F Zero           0.00000   0.00000   3.22009   7.88231  12.35089   3.51035
 F-01             0.19560   0.21504   1.42574   6.17333   9.86110   1.89110
 F-Max            0.54470   0.23913   0.70920   5.25697   7.88807   1.10782
 F at   40 %MSP   0.23030   0.22321   1.28817   6.01053   9.54415   1.75334


    FMORT      CTHN      CTHW      STKN      STKW    SPNSTKN   SPNSTKW      MSP     MNAGE      MNGT      EXSP
  0.00000   0.00000   0.00000   6.69668   3.73482   3.97773   3.22009 100.00000   7.88231  12.35089   3.51035
  0.05000   0.12719   0.10688   6.09150   3.01110   3.36959   2.49680  77.53824   7.27308  11.60967   2.88137
  0.10000   0.21103   0.16547   5.65531   2.51453   2.93327   2.00314  62.20754   6.79993  10.93332   2.43786
  0.15000   0.26898   0.19799   5.33144   2.16433   2.61075   1.65669  51.44853   6.43444  10.33526   2.11483
  0.20000   0.31092   0.21626   5.08406   1.91048   2.36545   1.40670  43.68521   6.15113   9.81886   1.87226
  0.25000   0.34258   0.22661   4.89003   1.72147   2.17388   1.22138  37.93009   5.92942   9.38004   1.68494
  0.30000   0.36738   0.23250   4.73412   1.57712   2.02062   1.08043  33.55283   5.75361   9.01047   1.53659
  0.35000   0.38740   0.23583   4.60609   1.46422   1.89534   0.97064  30.14315   5.61208   8.70022   1.41647
  0.40000   0.40401   0.23766   4.49893   1.37397   1.79097   0.88322  27.42858   5.49635   8.43945   1.31728
  0.45000   0.41806   0.23861   4.40769   1.30039   1.70256   0.81225  25.22442   5.40025   8.21931   1.23399
  0.50000   0.43018   0.23903   4.32886   1.23933   1.62656   0.75359  23.40289   5.31927   8.03229   1.16300
  0.55000   0.44078   0.23913   4.25986   1.18785   1.56039   0.70436  21.87379   5.25012   7.87222   1.10172
  0.60000   0.45016   0.23902   4.19878   1.14384   1.50214   0.66244  20.57223   5.19034   7.73411   1.04823
  0.65000   0.45855   0.23880   4.14416   1.10574   1.45036   0.62633  19.45062   5.13808   7.61399   1.00106
  0.70000   0.46613   0.23850   4.09490   1.07240   1.40393   0.59486  18.47345   5.09193   7.50869   0.95912
  0.75000   0.47302   0.23815   4.05013   1.04293   1.36197   0.56718  17.61382   5.05081   7.41569   0.92152
  0.80000   0.47934   0.23778   4.00915   1.01665   1.32381   0.54262  16.85101   5.01388   7.33296   0.88760
  0.85000   0.48516   0.23740   3.97141   0.99303   1.28889   0.52065  16.16884   4.98047   7.25889   0.85680
  0.90000   0.49055   0.23701   3.93647   0.97165   1.25675   0.50087  15.55453   4.95004   7.19216   0.82868
  0.95000   0.49558   0.23662   3.90396   0.95218   1.22704   0.48294  14.99784   4.92216   7.13170   0.80287
  1.00000   0.50028   0.23623   3.87358   0.93434   1.19945   0.46661  14.49050   4.89647   7.07662   0.77908
```

Table A.35. Summary of yield and spawning stock biomass per recruit results, corresponding biological reference points and differences between current and former analyses.

	Results			Age 3		
	F40%	Y/R	SSB/R	Mean Rec	Bmsy	MSY
RUN 0 BRP ages 3-11+	0.1643	0.2405	1.6023	12.42	19,901	2,987
RUN 1 BRP with ages 3-20	0.2033	0.2506	1.3692	12.42	17,006	3,113
RUN 2 with new pr	0.2666	0.2712	1.3694	19.6	26,840	5,316
RUN 3 with new wts	0.1918	0.2151	1.3321	19.6	26,108	4,217
RUN 4 with new maturity	0.1920	0.2473	1.3249	19.6	25,968	4,847
RUN 5 with new pr and wts	0.2478	0.2263	1.3322	19.6	26,111	4,435
RUN 6 with new wts and maturity	0.1807	0.2121	1.2883	19.6	25,251	4,158
RUN 7 with new pr and maturity	0.2485	0.2675	1.3246	19.6	25,963	5,244
RUN 8 with new pr, wts and maturity	0.2303	0.2232	1.2882	19.6	25,248	4,375

Differences between estimates from the current (RUN 8) and former (RUN 1) yield and spawning stock biomass per recruit analyses.

	F40%	Y/R	SSB/R	Bmsy (000's)
Total Effect = RUN 8 - RUN 1	0.07	-0.0173	-0.3142	8.242
P-R effect = RUN 2 - RUN 1	0.06	0.0206	0.0002	
Wt effect = RUN 3 - RUN 1	-0.01	-0.0355	-0.0372	
Mat effect = RUN 4 - RUN 1	-0.01	-0.0033	-0.0443	
2-way interaction				
PR and wt interaction effect	0.04	-0.0244	-0.0371	
Wt and mat interaction effect	-0.02	-0.0385	-0.0809	
PR and mat interaction effect	0.05	0.0169	-0.0446	
3-way interaction				
Total effect - all of the above effects	-0.04	0.0469	-0.0702	
SSB/R effect				-1.006
Recruit effect				9.830
interaction				-0.582

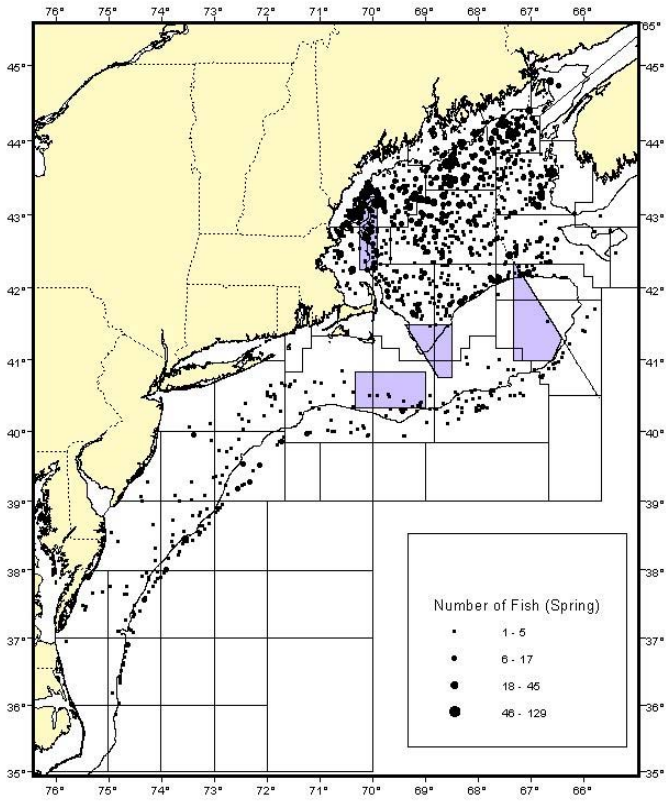
Table A.36. Summary of short-term projection results for witch flounder. Projected median estimates of landings (mt), discards (mt), and spawning stock biomass (mt) are provided: 1) status quo fishing mortality ($F_{2003} = F_{2002} = 0.41$); 2) fishing mortality at Fmsy = F40% = 0.23; 3) fishing mortality at 75% of F_{MSY}; and 4) status quo landings ($landings_{2003} = landings_{2002}$).

Projection input:

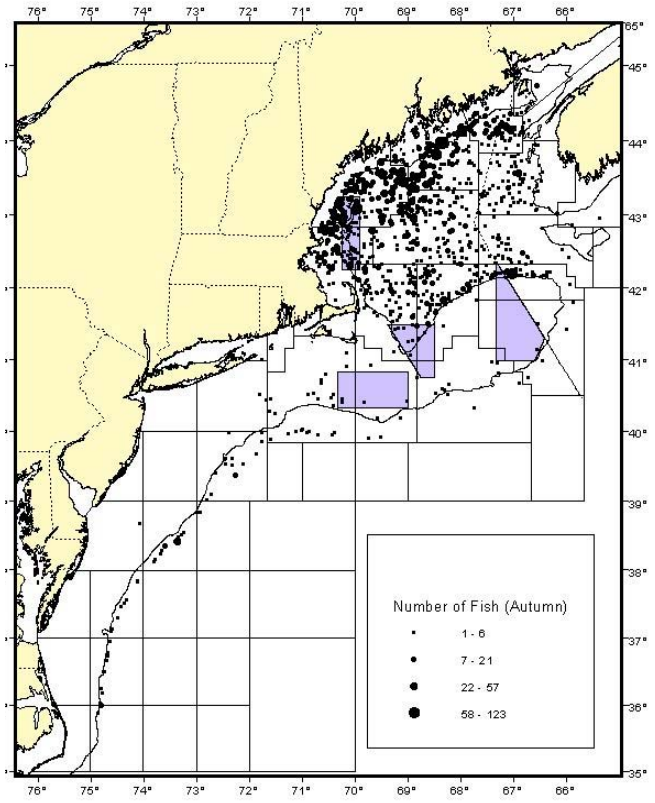
Age	Selectivity F	Selectivity M	Stock Weight	Land Weight	Maturity
3	0.0036	1.0000	0.0443	0.0000	0.0700
4	0.0229	1.0000	0.1214	0.3220	0.1600
5	0.0703	1.0000	0.2267	0.3380	0.3500
6	0.1931	1.0000	0.3206	0.3960	0.5900
7	0.5282	1.0000	0.4202	0.4780	0.7900
8	1.0000	1.0000	0.5151	0.5550	0.9100
9	1.0000	1.0000	0.5995	0.6400	0.9700
10	1.0000	1.0000	0.7281	0.7660	0.9900
11+	1.0000	1.0000	0.8888	0.8889	1.0000

Projection results (weight reported in '000 mt)

Scenario	Year	F	Median Landings	Median Discards	Median SSB
F status quo	2003	0.41	6.254	0.251	26.677
F status quo	2004	0.41	8.652	0.191	32.121
F status quo	2005	0.41	10.474	0.132	33.733
F status quo	2003	0.41	6.254	0.251	26.677
F_{MSY}	2004	0.23	5.174	0.109	32.705
F_{MSY}	2005	0.23	6.992	0.076	37.600
F status quo	2003	0.41	6.254	0.251	26.677
75% F_{MSY}	2004	0.17	3.908	0.081	32.902
75% F_{MSY}	2005	0.17	5.480	0.057	39.080
$Landings_{2003} = Landings_{2002}$	2003	0.199	3.186	0.121	27.241
F_{MSY}	2004	0.23	5.781	0.111	35.389
F_{MSY}	2005	0.23	7.519	0.077	40.160
$Landings_{2003} = Landings_{2002}$	2003	0.199	3.186	0.121	27.241
75%F_{MSY}	2004	0.17	4.366	0.083	35.613
75%F_{MSY}	2005	0.17	5.899	0.058	41.753

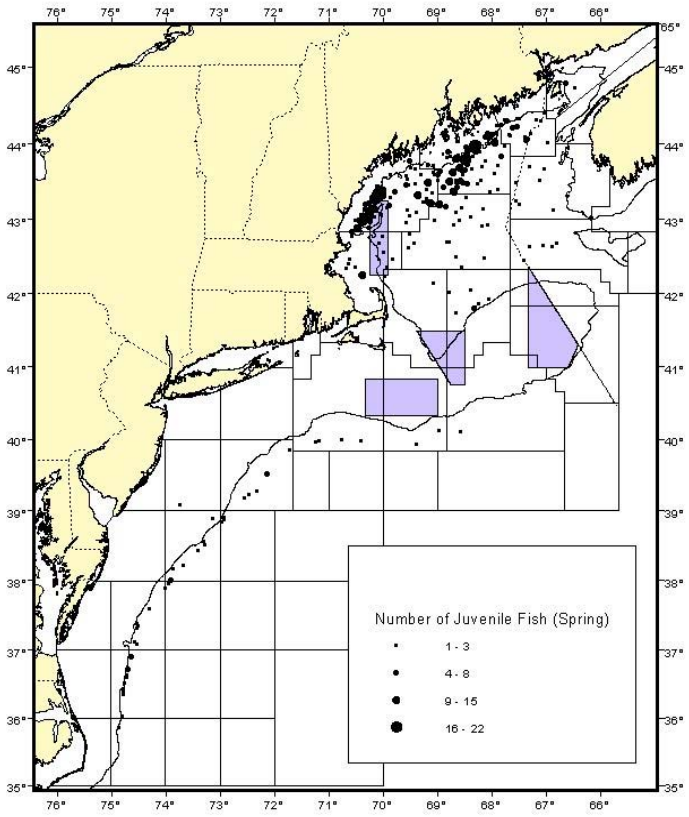


Witch Flounder - Spring 1983 - 2002

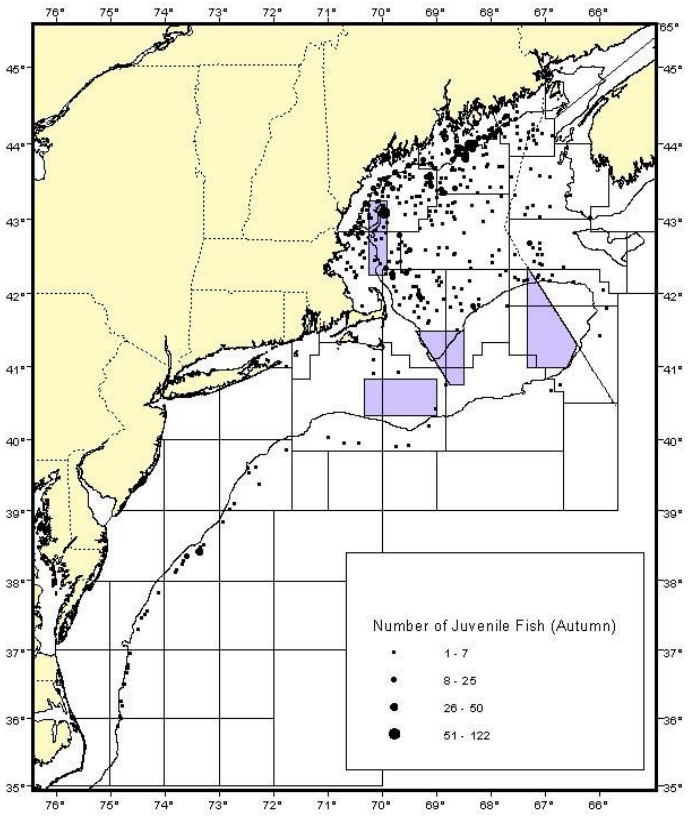


Witch Flounder - Autumn 1983 - 2002

Figure A.1 Number of witch flounder per tow in the NEFSC spring and autumn bottom trawl surveys, 1983-2002; year-around area closures are indicated by shaded polygons.



Witch Flounder - Spring 1983 - 2002 Juveniles < 25 cm



Witch Flounder - Autumn 1983 - 2002 Juveniles < 25 cm

Figure A.2. Number of juvenile (< 25 cm) witch flounder per tow in the NEFSC spring and autumn surveys, 1983-2002; year-around area closures are indicated by shaded polygons.

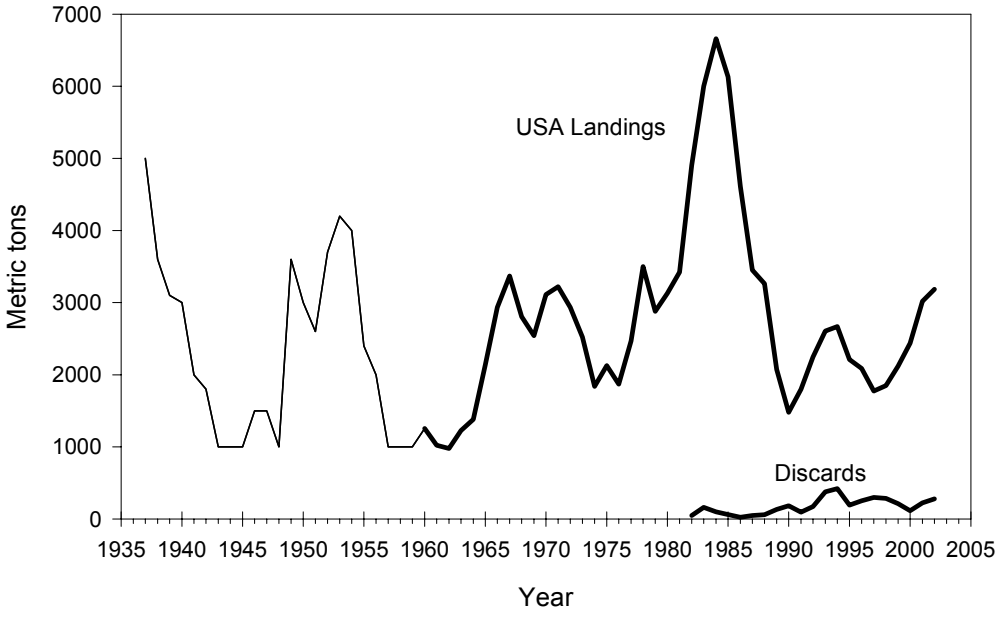


Figure A.3. Historical USA witch flounder landings (mt), excluding USA landings from the Grand Banks in the mid-1980's. Thin line represents provisional landings data taken from Lange and Lux (1978); discards are from the shrimp and large-mesh otter trawl fishery.

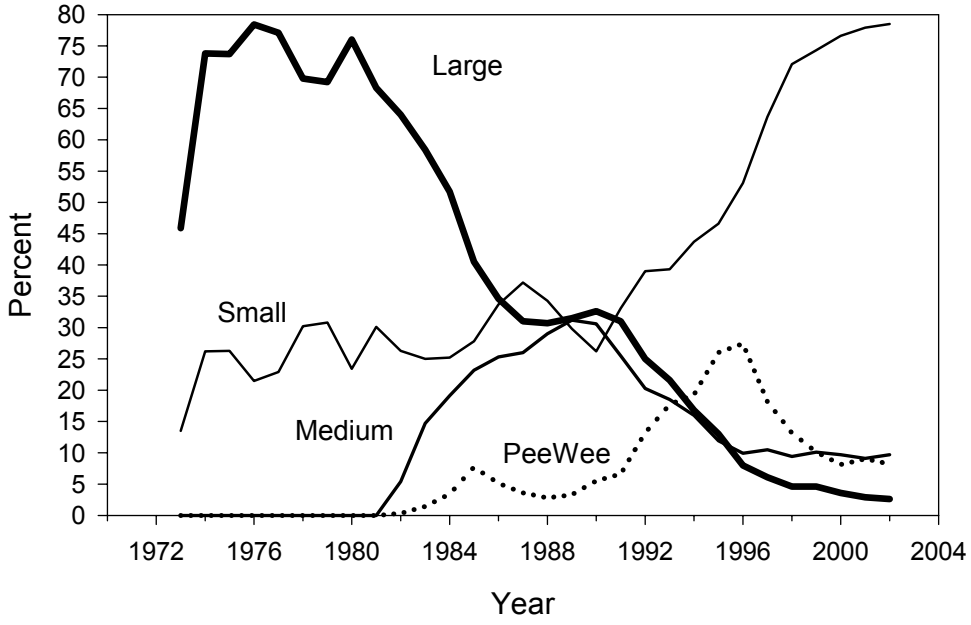


Figure A.4. Commercial landings of witch flounder by market category, 1973 – 2002.

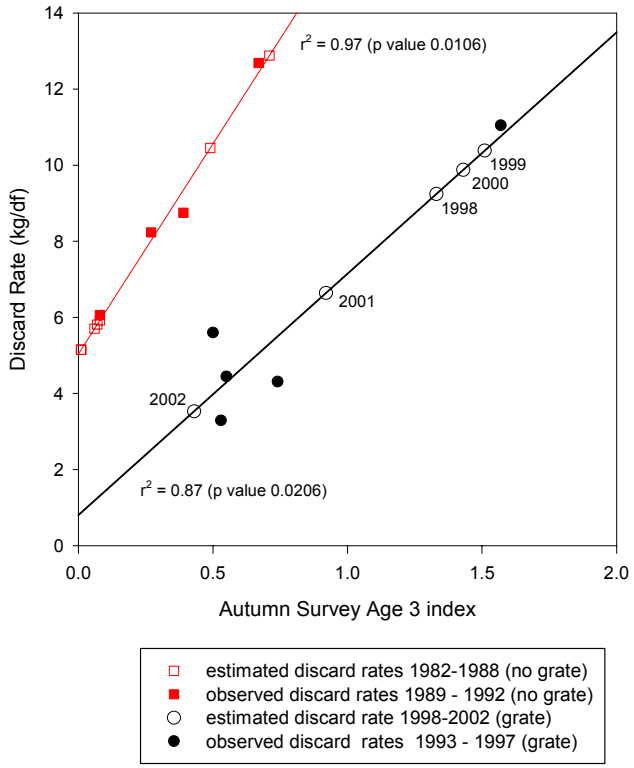


Figure A.5. Observed witch flounder discard rates (kg per day fished, closed symbols) from the Fisheries Observer Program, and estimated discard rates (kg/df, open symbols) in northern shrimp fishery estimated from linear regressions (solid line) of observed discard rates and NEFSC autumn survey age 3 index.

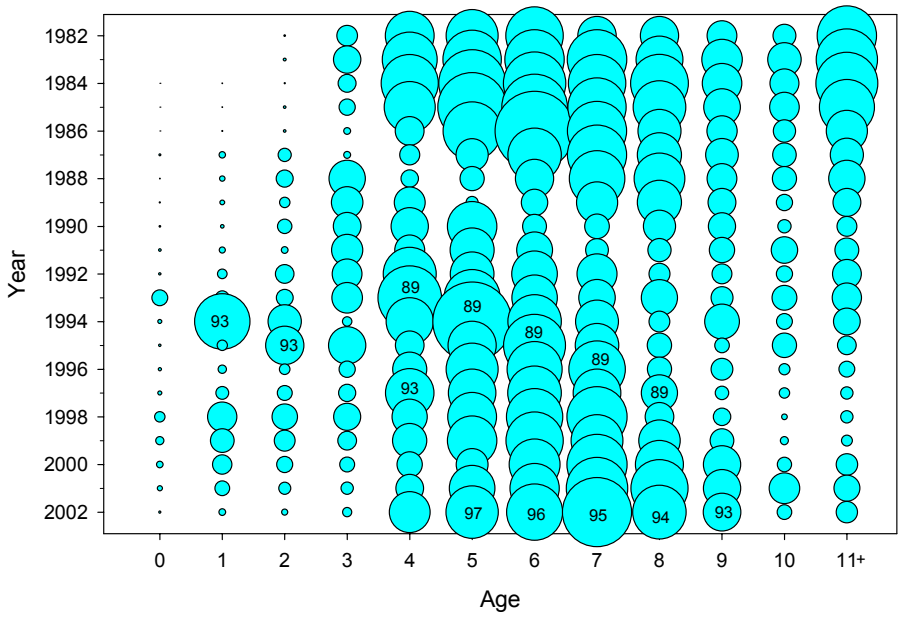


Figure A.6. Witch flounder catch at age (in numbers), 1982 – 2002; selected cohorts are labeled.

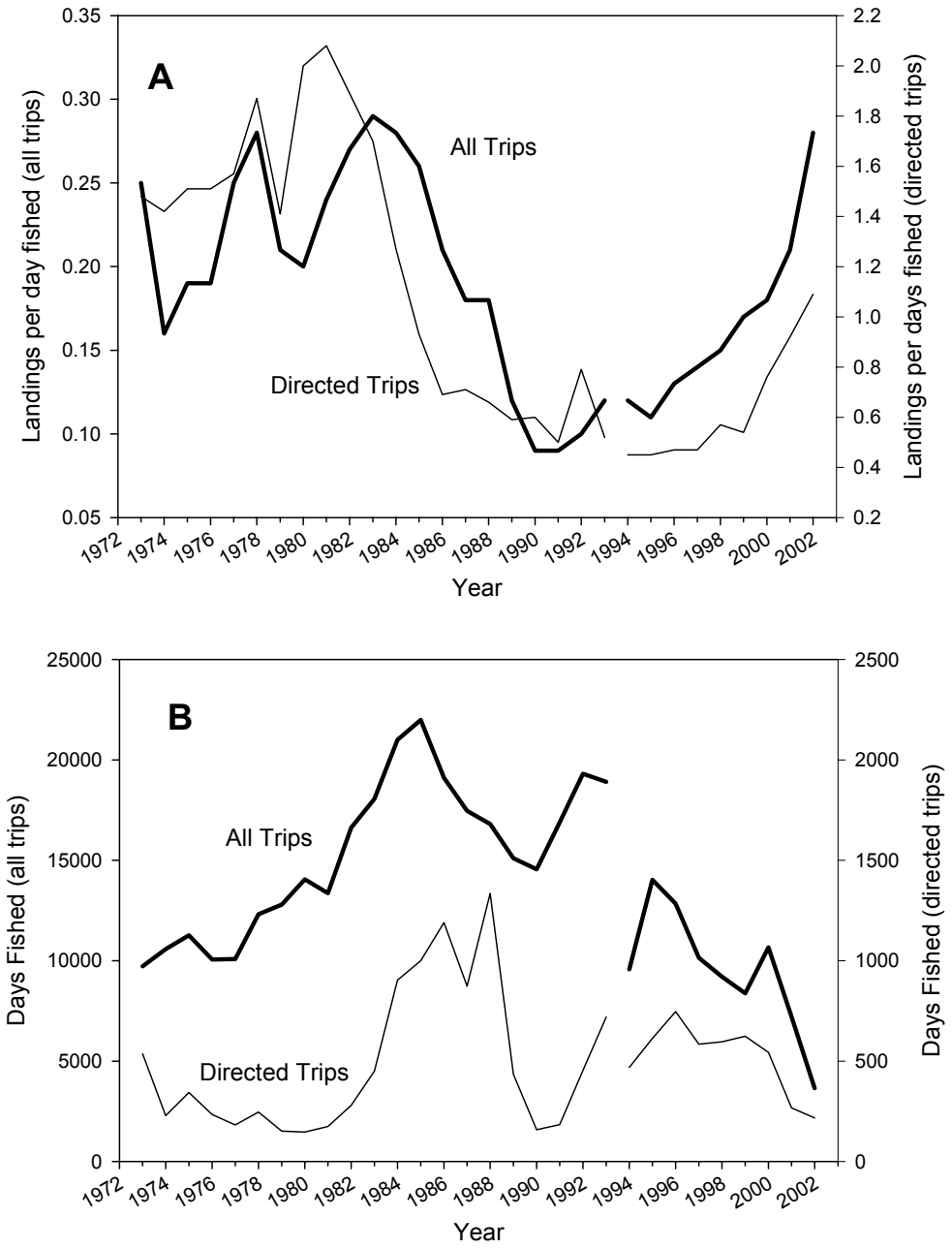


Figure A.7. Trends in USA landings per day fished (A) and effort (B) of witch flounder, 1973 -2002.

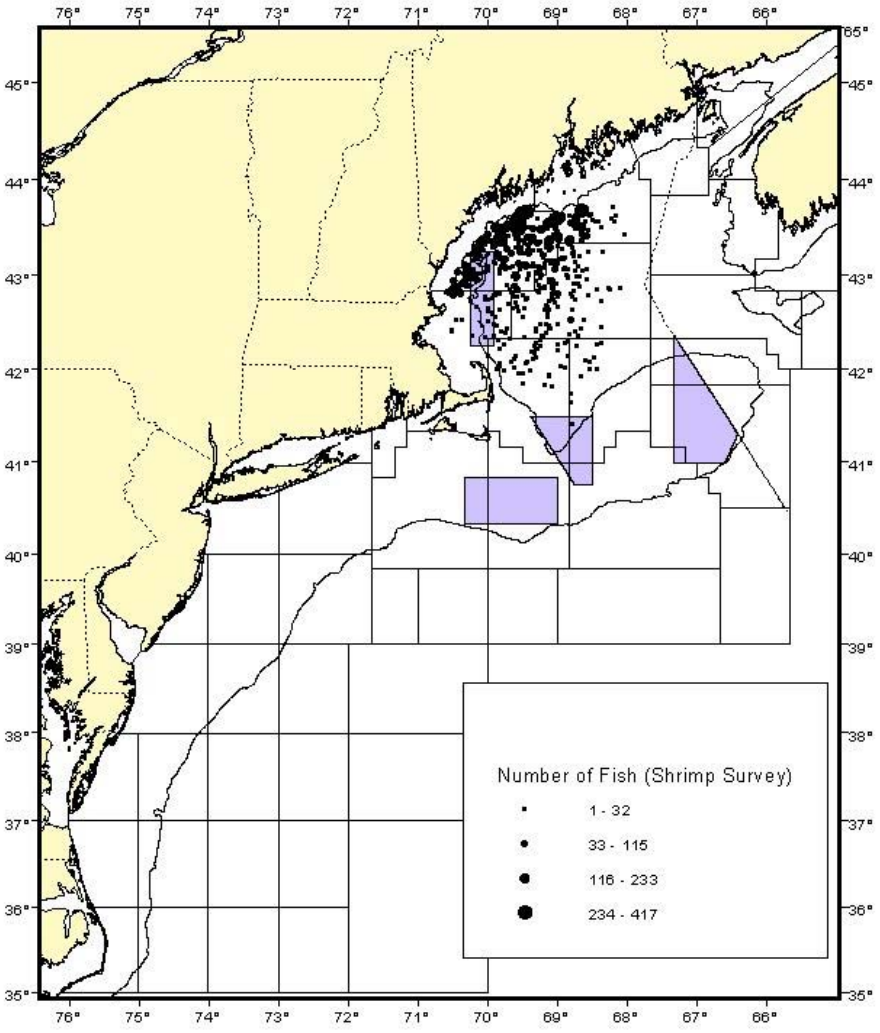


Figure A.8. Number of witch flounder per tow in the ASMFC northern shrimp survey, 1985-2002; year-around area closures are indicated by shaded polygons.

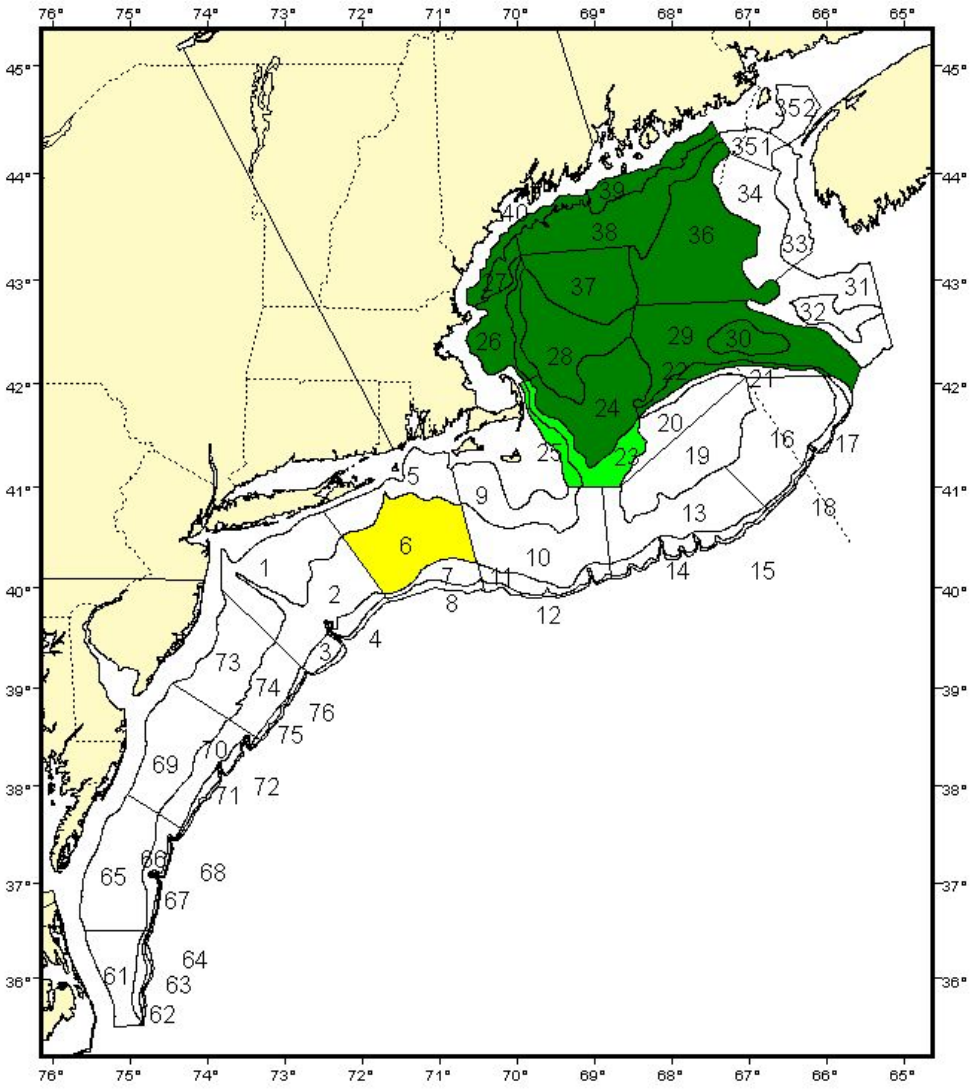


Figure A.9. NEFSC bottom trawl survey sampling strata.

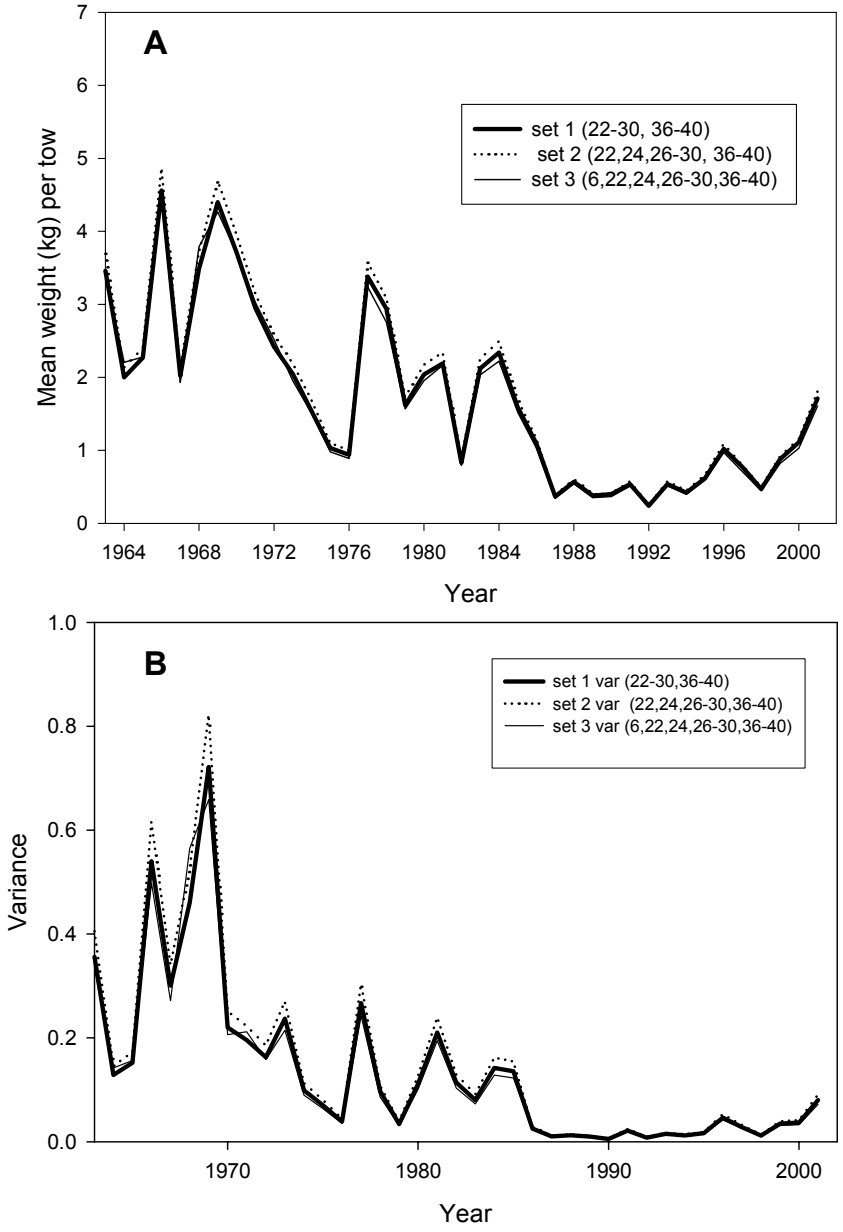


Figure A.10. Stratified mean catch (kg) per tow (A) and variance (B) of witch flounder in the NEFSC autumn bottom trawl surveys for three strata sets in the Georges Bank-Gulf of Maine region, 1963 – 2001.

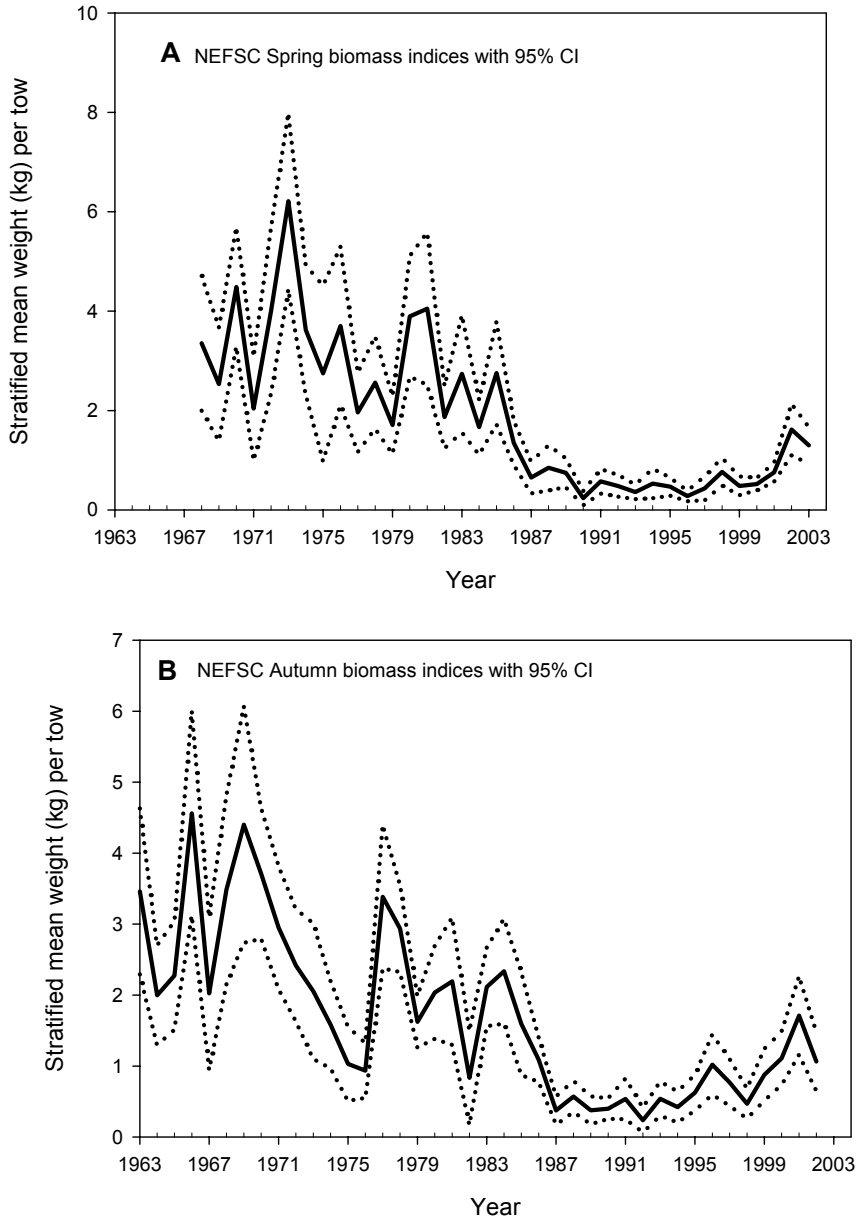


Figure A.11. Stratified mean weight (kg) per tow, with 95% confidence limits, of witch flounder in the NEFSC spring (A) and autumn (B) bottom trawl surveys, 1963 – 2003.

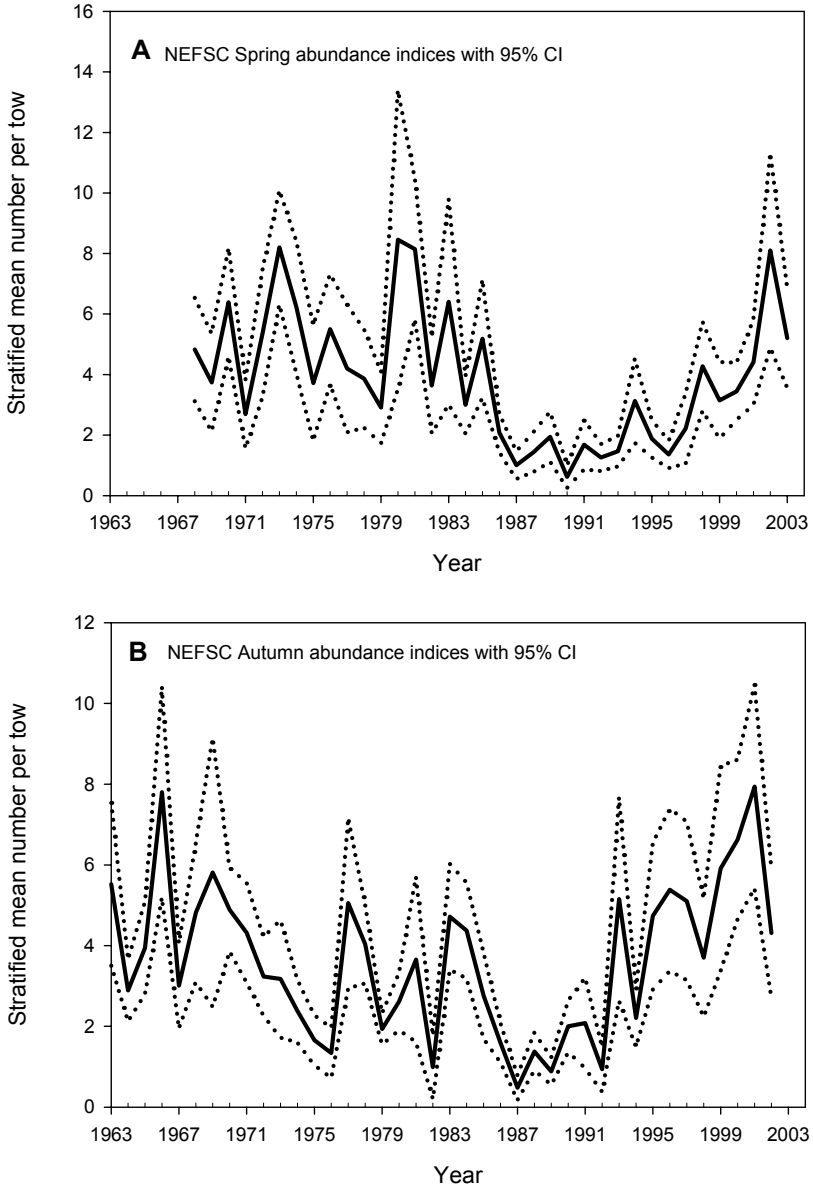


Figure A.12. Stratified mean number per tow, with 95% confidence limits, of witch flounder in the NEFSC spring (A) and autumn (B) bottom trawl surveys, 1963 – 2003.

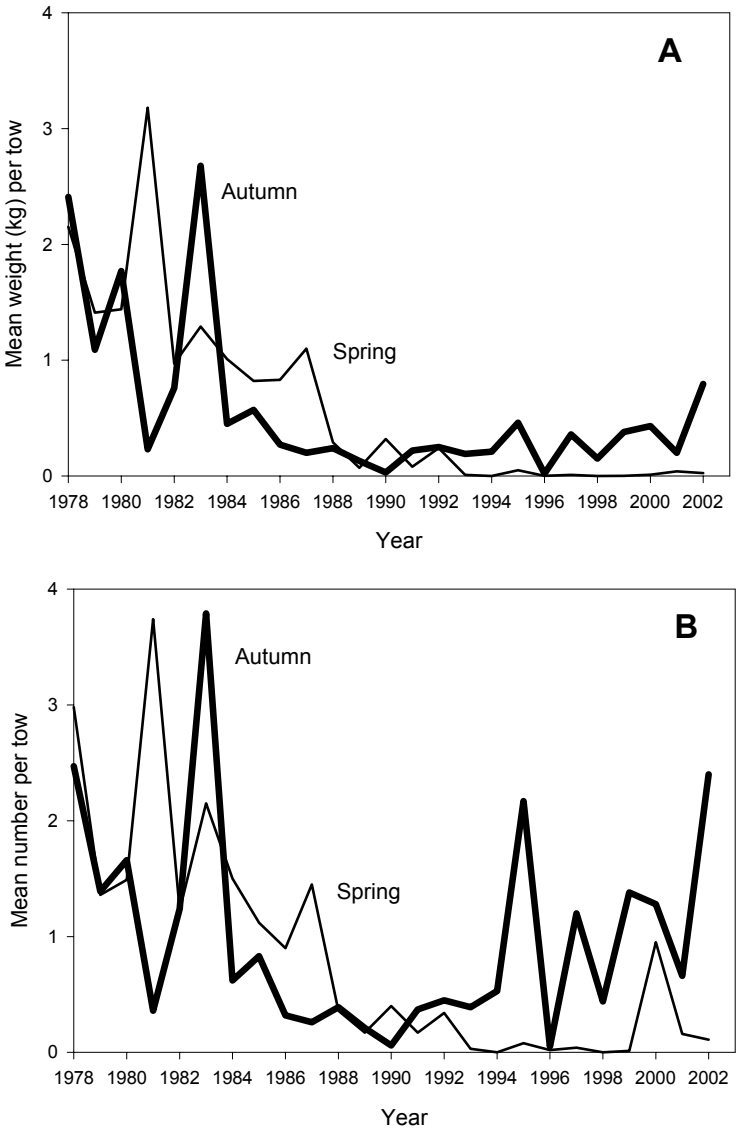


Figure A.13. Stratified mean weight (kg) per tow (A) and mean number per tow (B) of witch flounder in the Massachusetts Division of Marine Fisheries spring and autumn bottom trawl surveys in Cape Cod Bay - Mass. Bay region, 1978 – 2002.

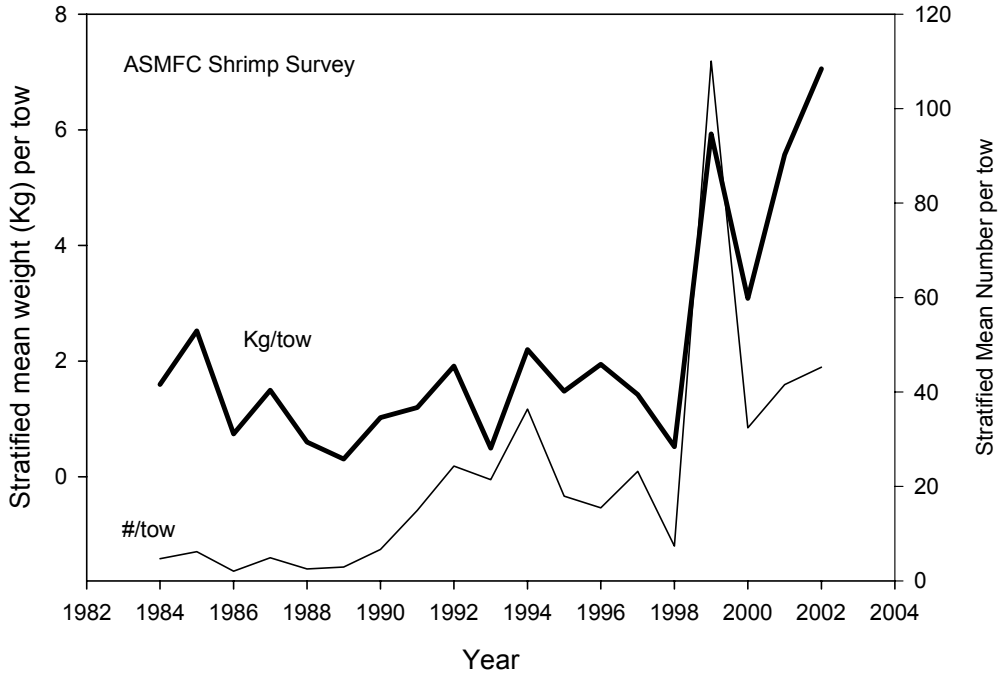


Figure A.14. Stratified mean catch per tow, in weight (kg) and numbers, of witch flounder in the Atlantic States Marine Fisheries Commission summer northern shrimp survey, 1984 – 2002.

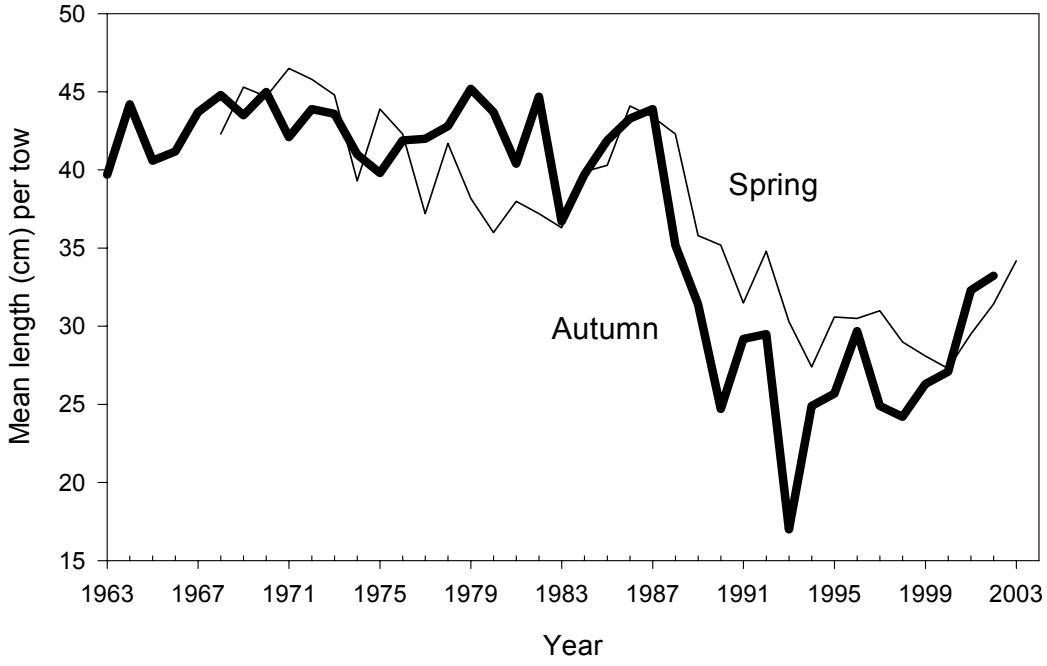


Figure A.15. Stratified mean length (cm) per tow of witch flounder in NEFSC spring and autumn bottom trawl surveys in the Georges Bank- Gulf of Maine region, 1963 – 2003.

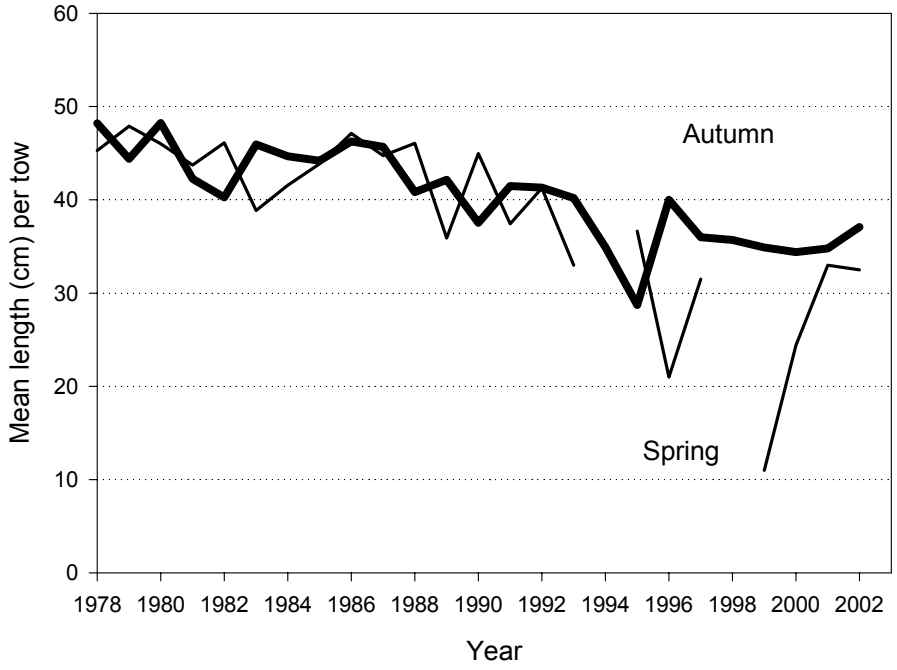


Figure A.16. Stratified mean length (cm) per tow of witch flounder in Massachusetts Division of Marine Fisheries spring and autumn bottom trawl surveys in the Cape Cod Bay – Mass. Bay region, 1978 – 2002.

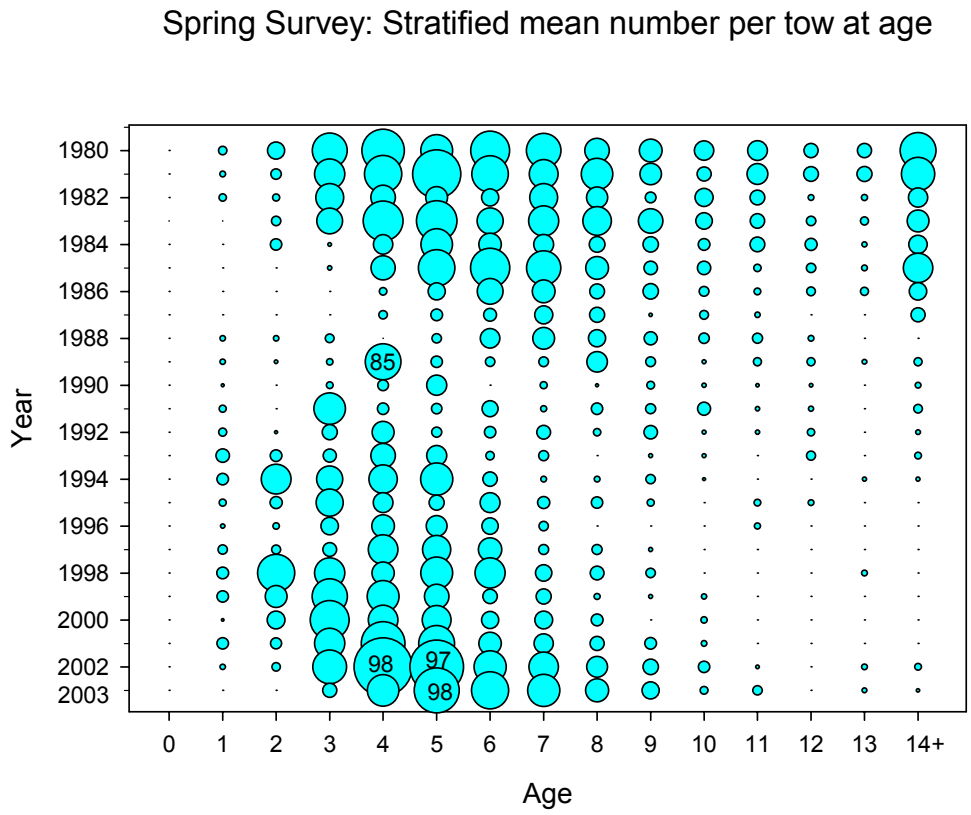


Figure A.17. Stratified mean number of witch flounder per tow at age from NEFSC spring bottom trawl surveys, 1980-2002, preliminary 2003; selected cohorts are labeled.

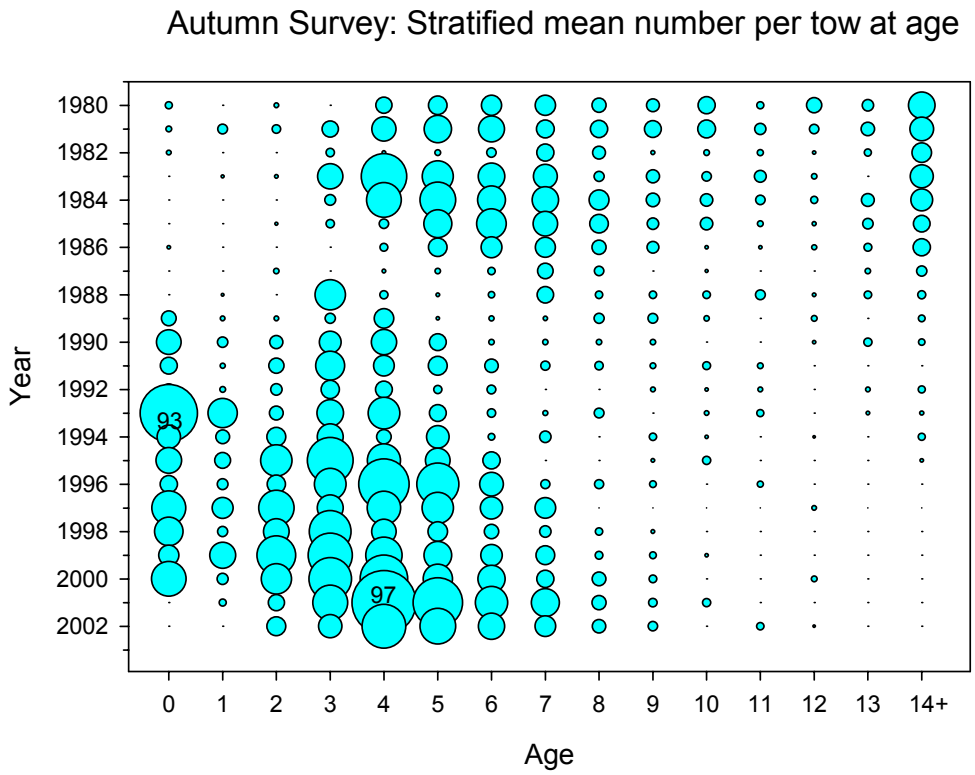


Figure A.18. Stratified mean number of witch flounder per tow at age from NEFSC autumn bottom trawl surveys, 1980-2002; selected cohorts are labeled.

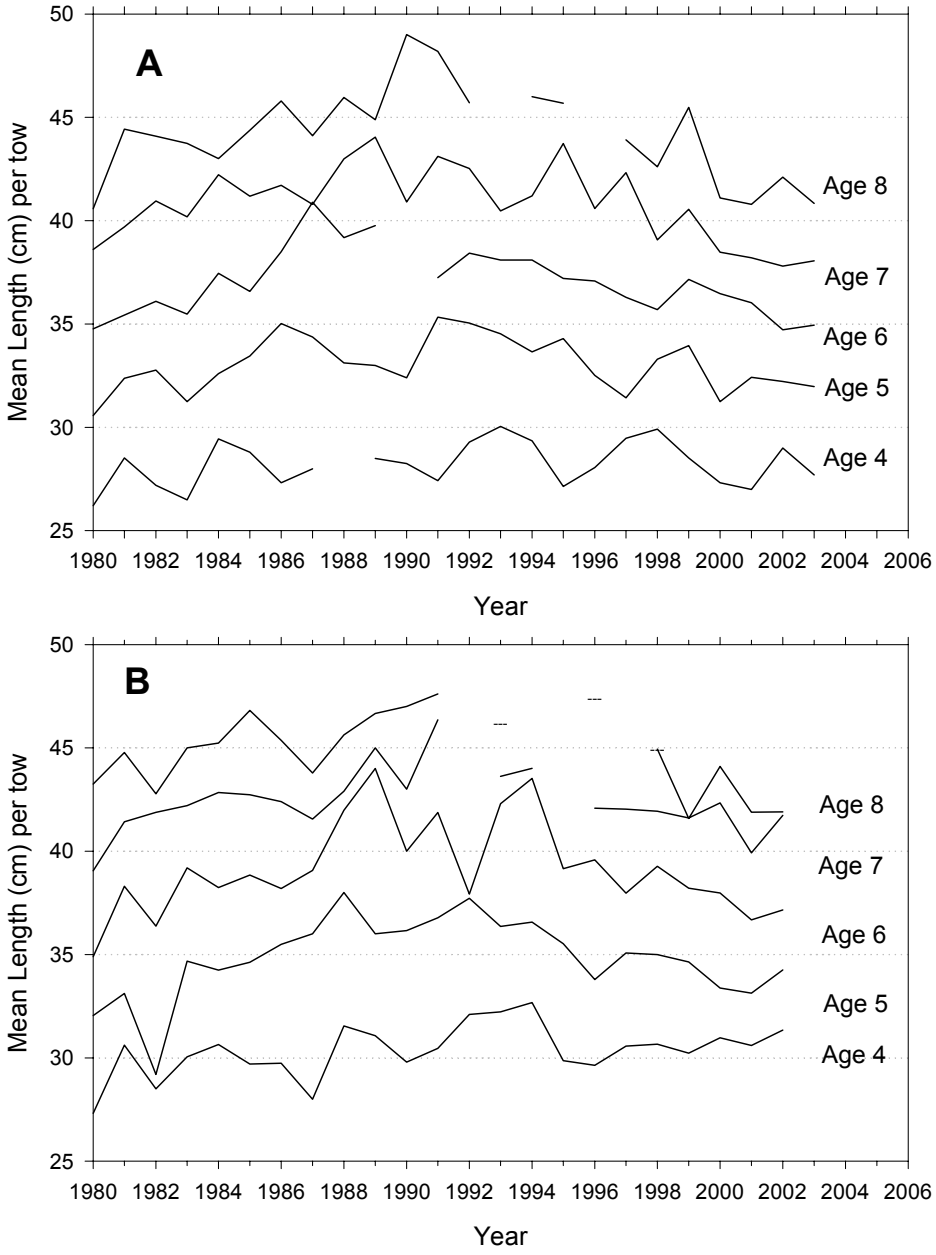


Figure A.19. Mean length (cm) at age of witch flounder for age groups 4 – 8 in spring (A) and autumn (B) NEFSC bottom trawl surveys, 1980 – 2002, preliminary 2003.

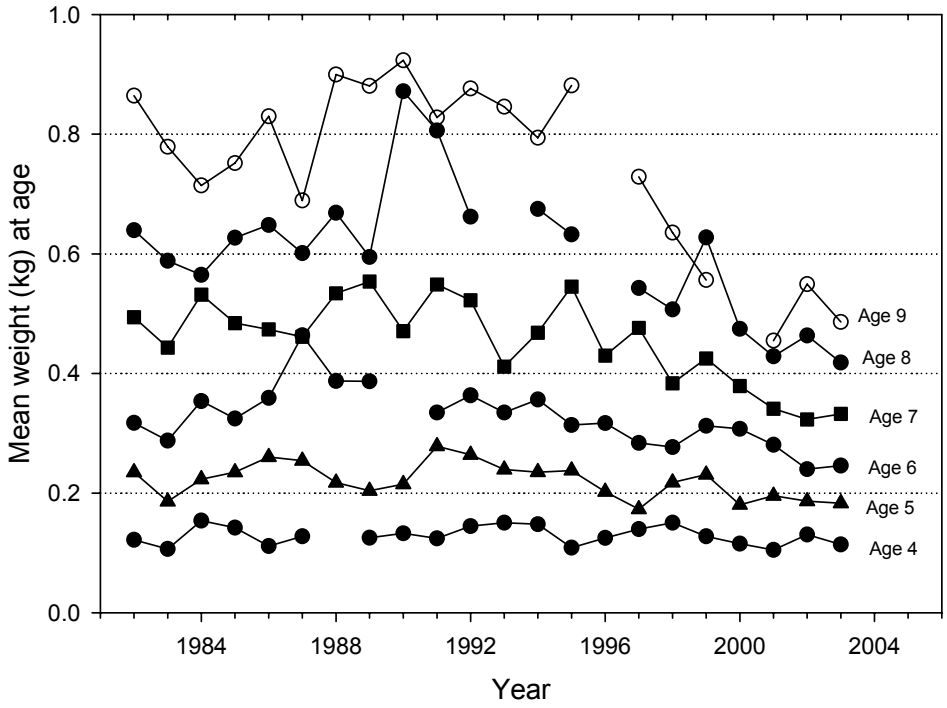


Figure A.20. Mean weight at age of witch flounder in the NEFSC spring bottom trawl survey, 1980 – 2002, preliminary 2003.

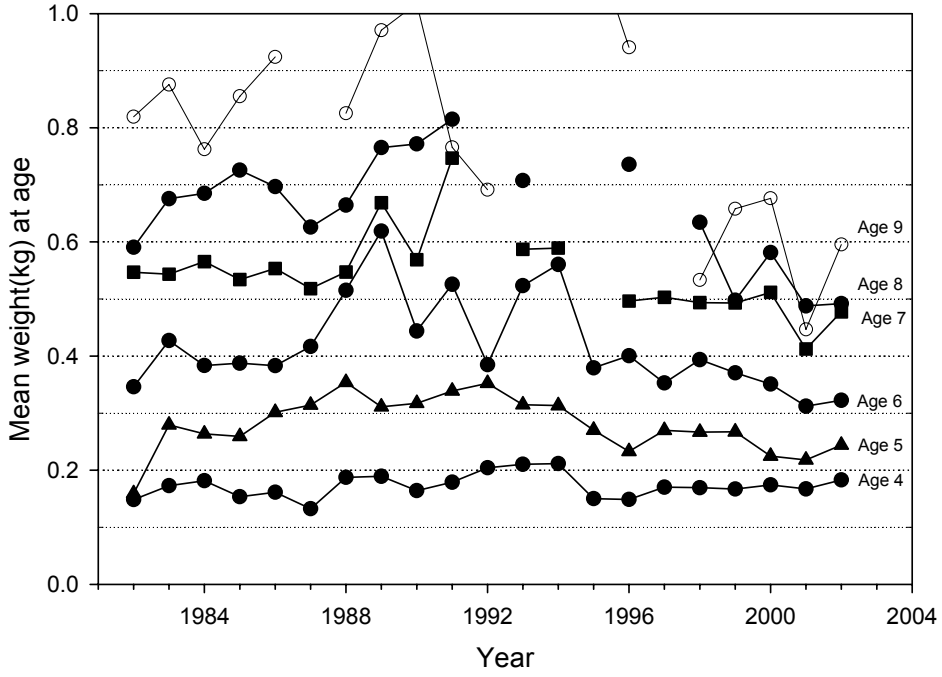


Figure A.21. Mean weight at age of witch flounder in the NEFSC autumn bottom trawl survey, 1980 – 2002.

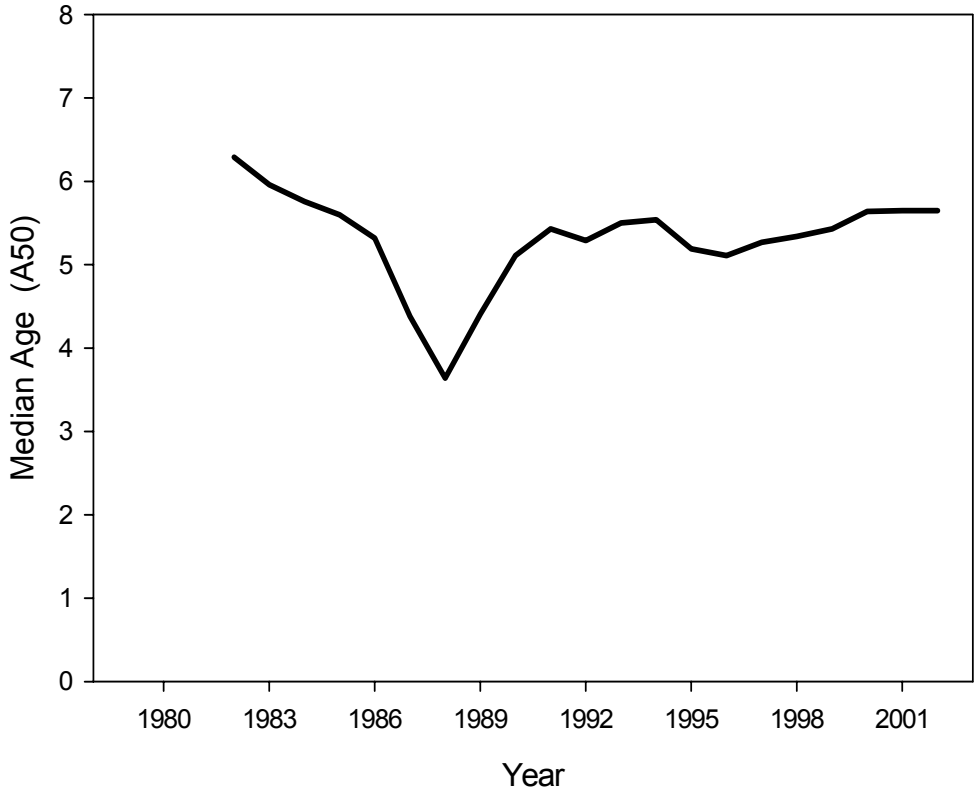


Figure A.22. Annual estimates of median age (A50) of witch flounder derived from a five-year moving time block of maturity observations collected during NEFSC spring surveys, 1980-2003.

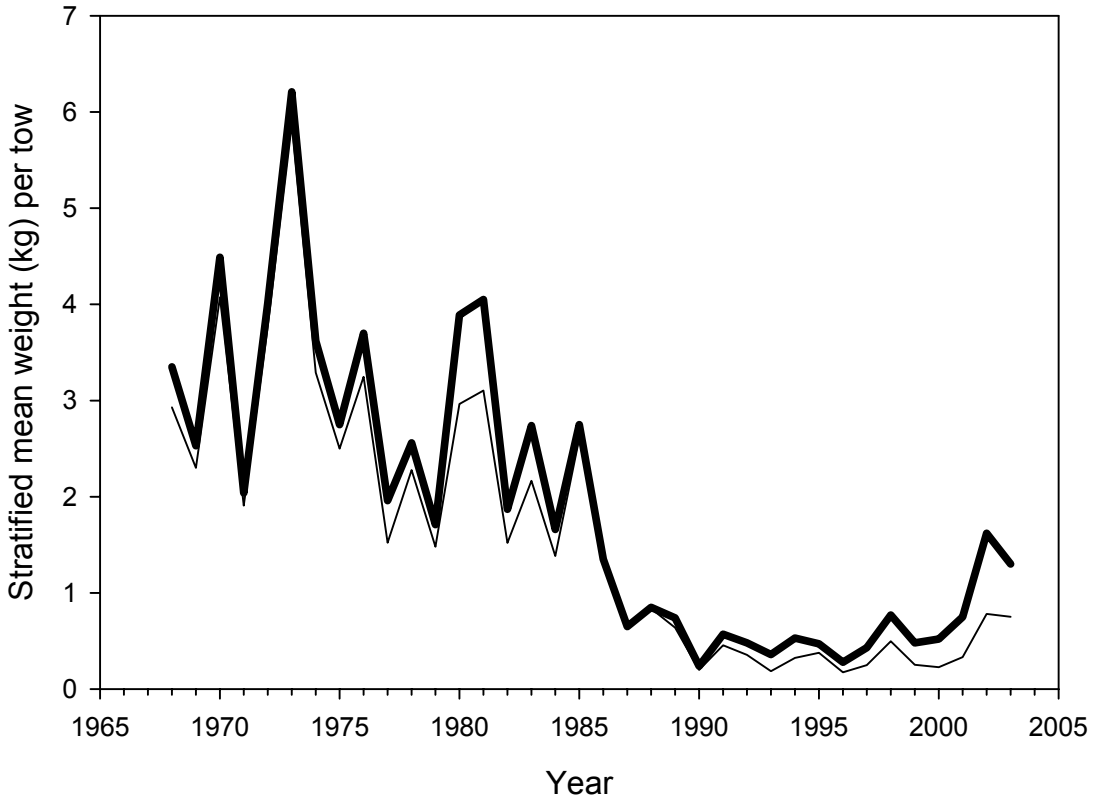


Figure A.23. Stratified mean weight (kg) per tow (thick line) and spawning biomass (kg) per tow (thin line) of witch flounder from the NEFSC spring bottom trawl surveys, 1968 2002, preliminary 2003.

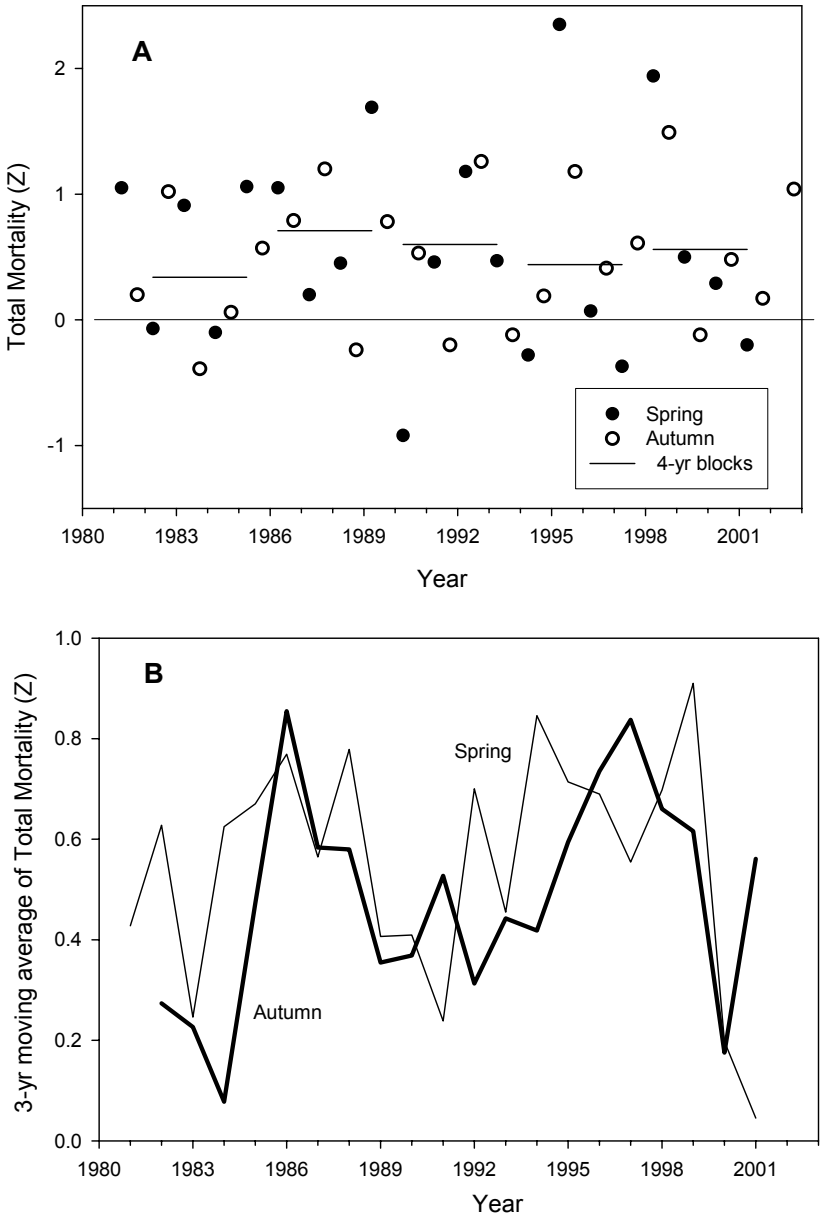


Figure A.24. Estimates of instantaneous total mortality (Z) derived from the NEFSC spring and autumn survey catch per tow at age (log ratio 7+ / 8+) (A) and 3-yr moving average (B).

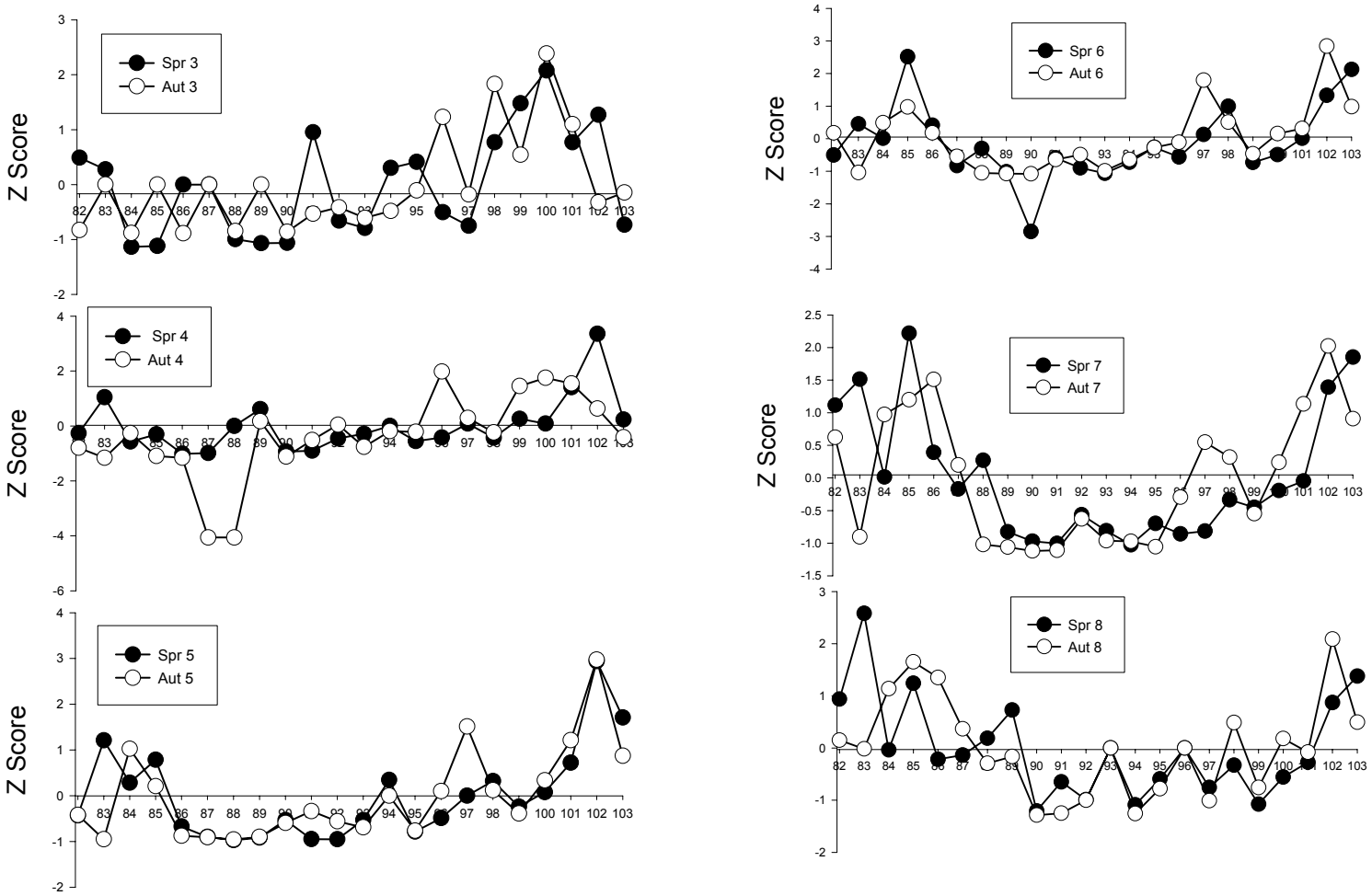


Figure A.25. Scaled (Z score) NEFSC spring and autumn survey indices for ages 3 to 11+, 1982-2003.

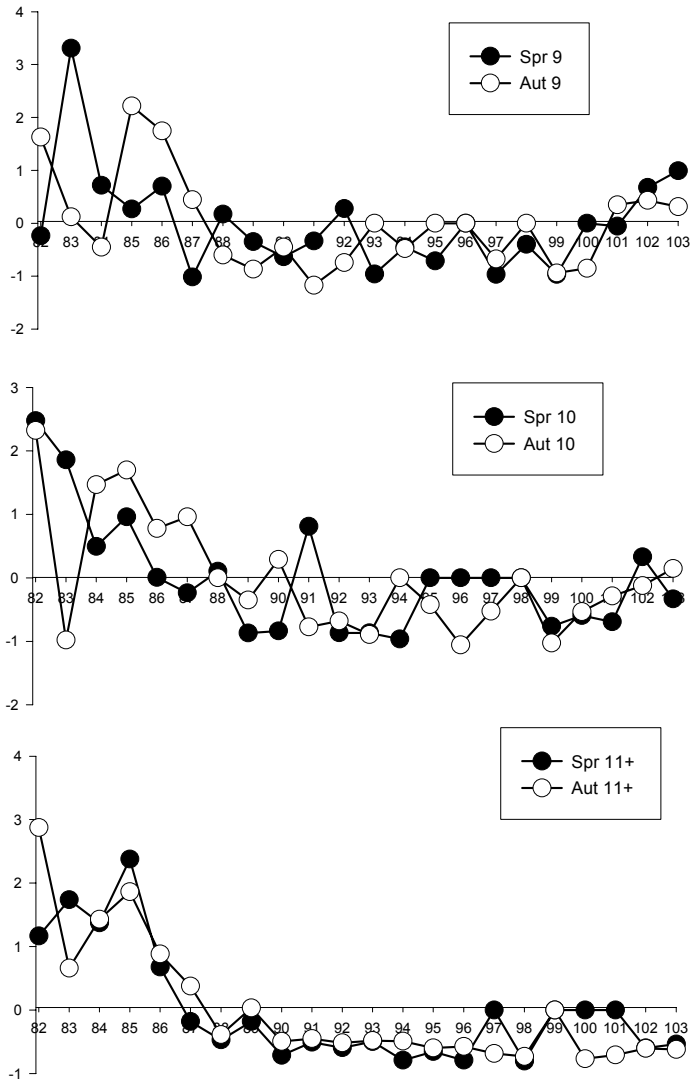


Figure A.25 continued.

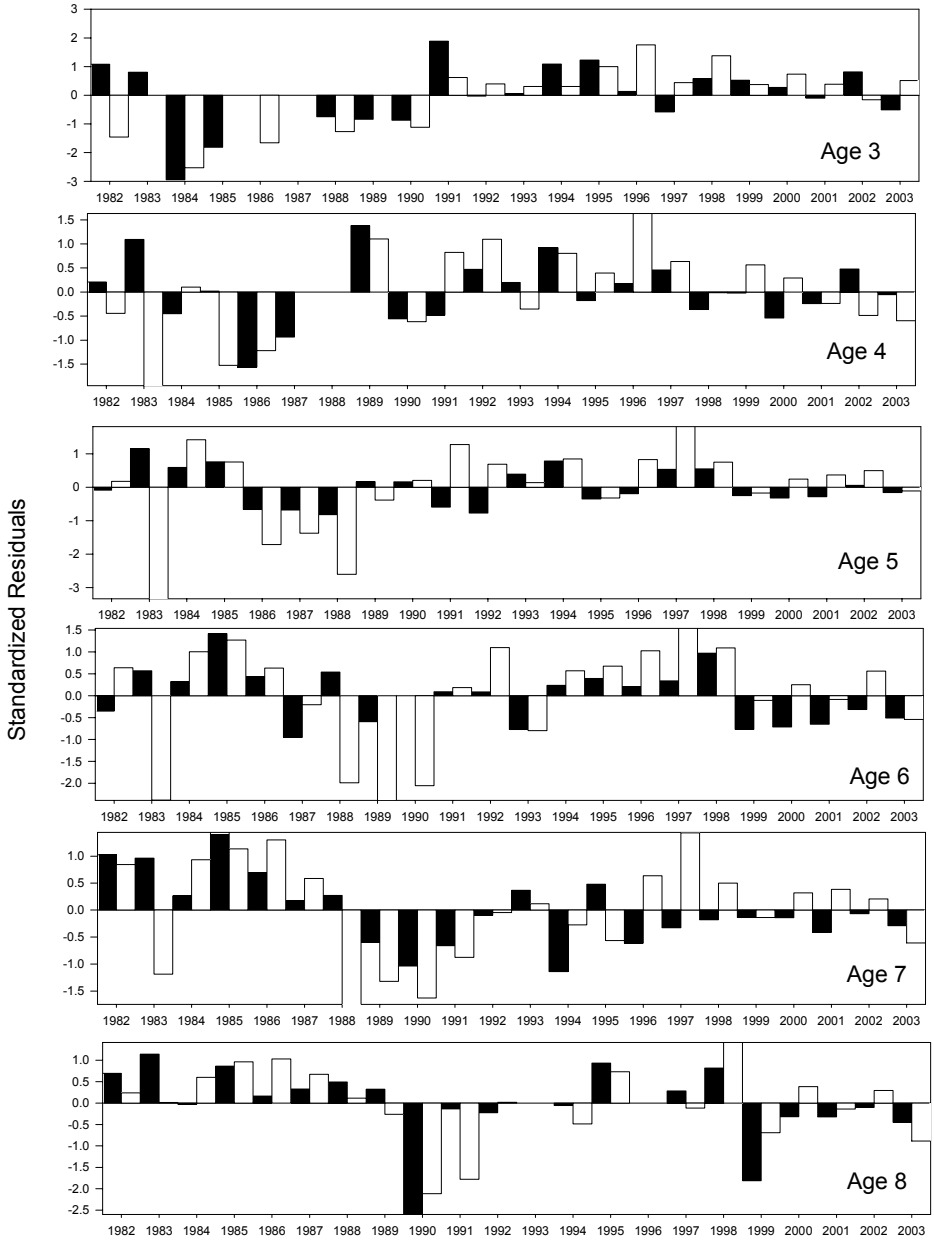


Figure A.26. Standardized residuals for survey indices (spring solid bar and autumn open bar) at age.

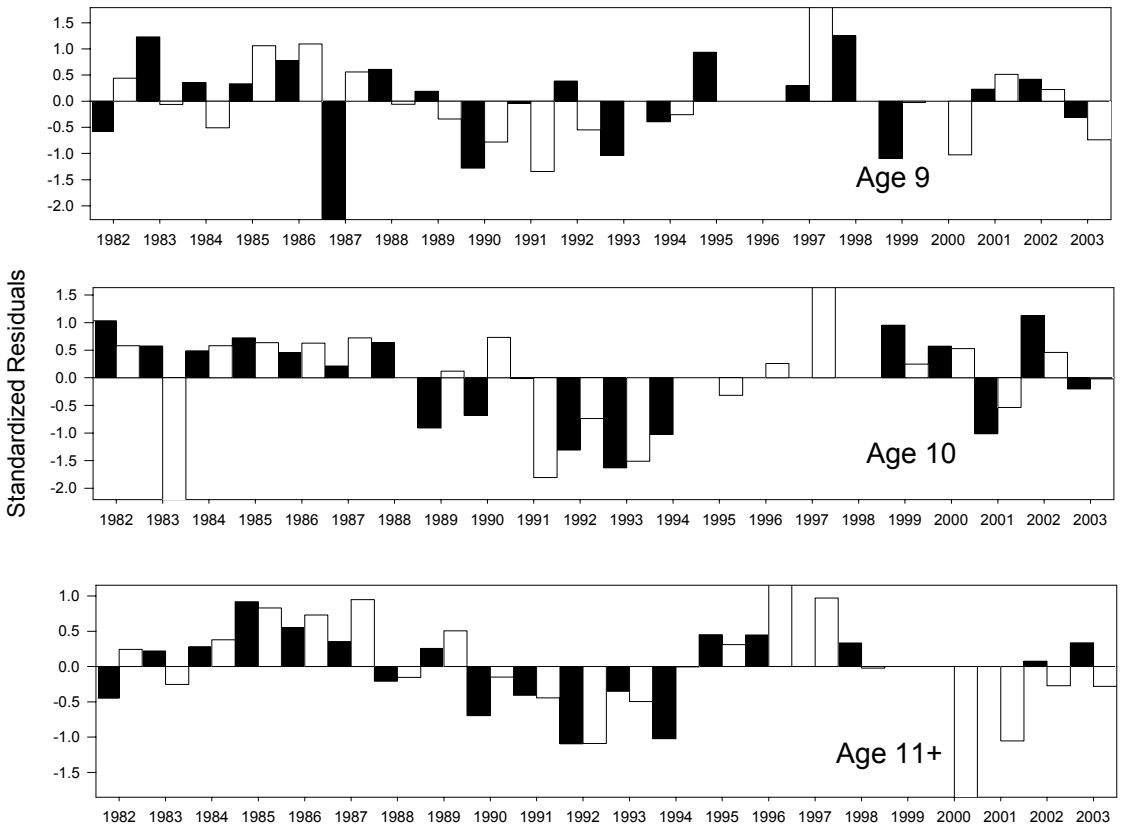


Figure A.26. continued.

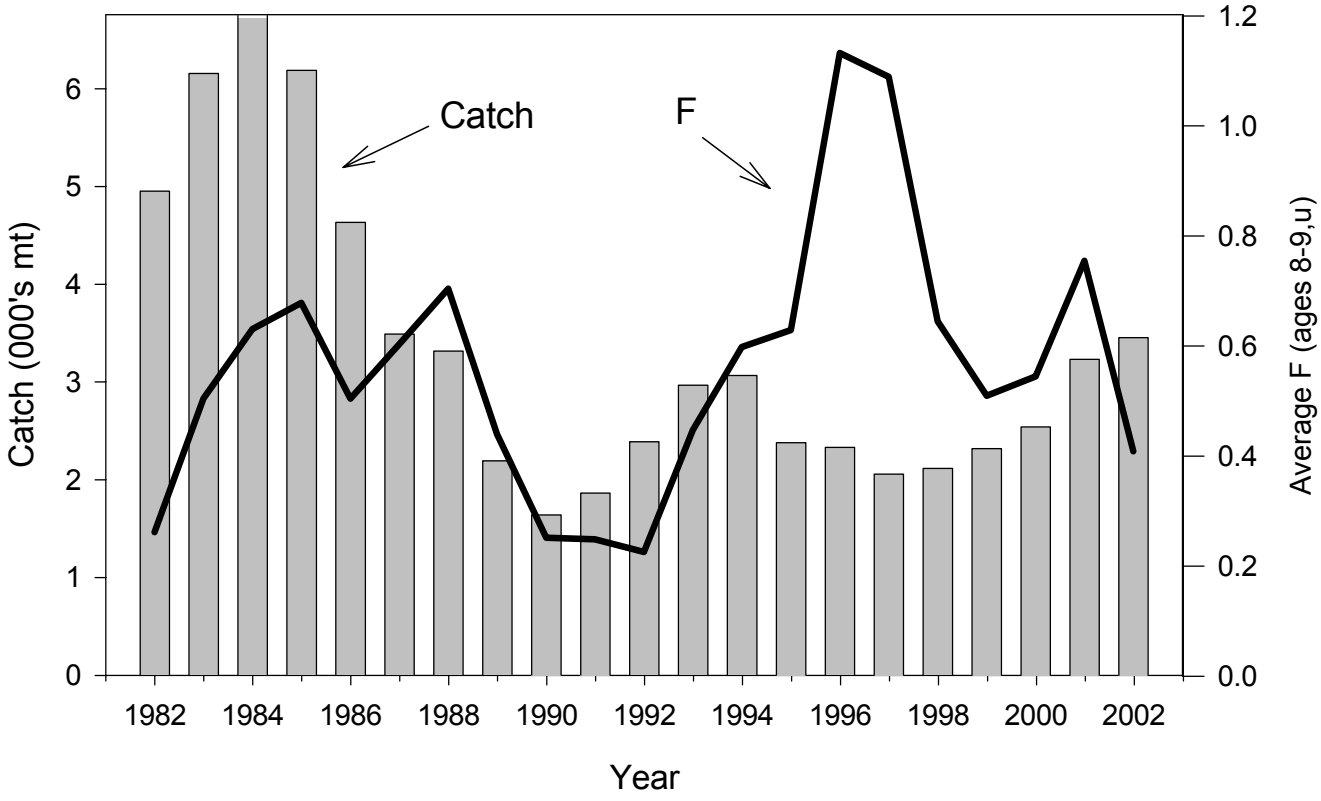


Figure A.27. Trends in total catch and fishing mortality for witch flounder, 1982-2002.

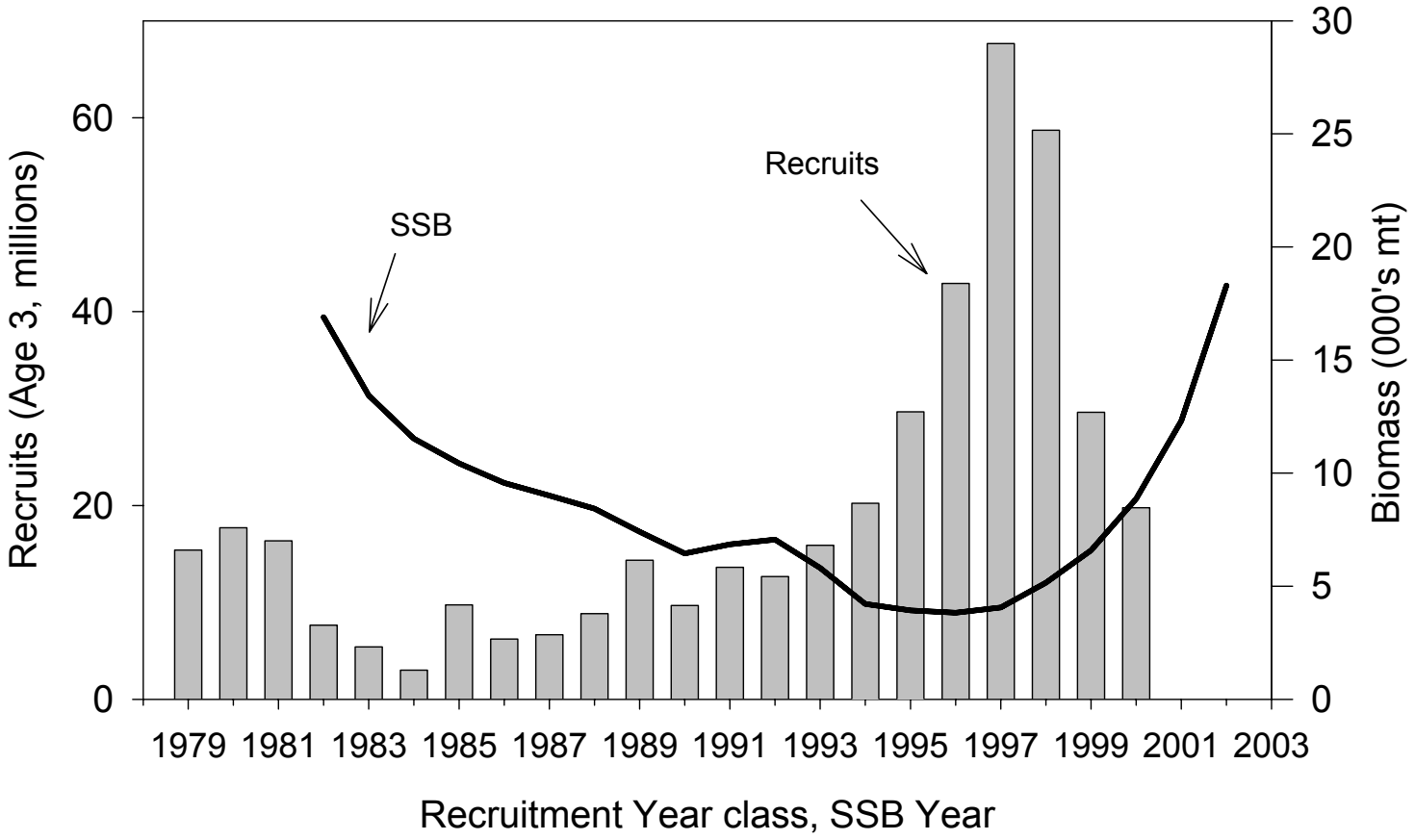


Figure A.28. Trends in spawning stock biomass and recruitment (Age 3) for witch flounder, 1982-2002.

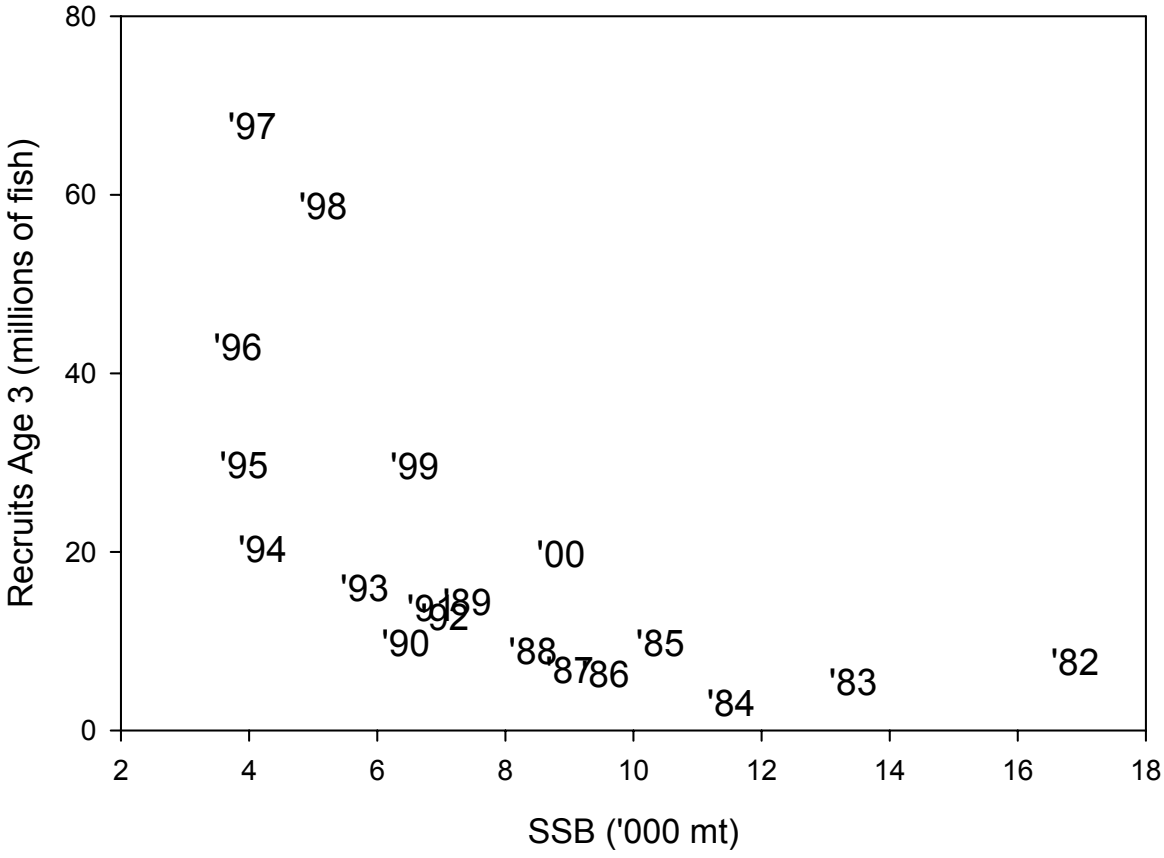


Figure A.29. Spawning stock biomass and recruits (Age 3) for witch flounder, 1982 – 2002 year classes.

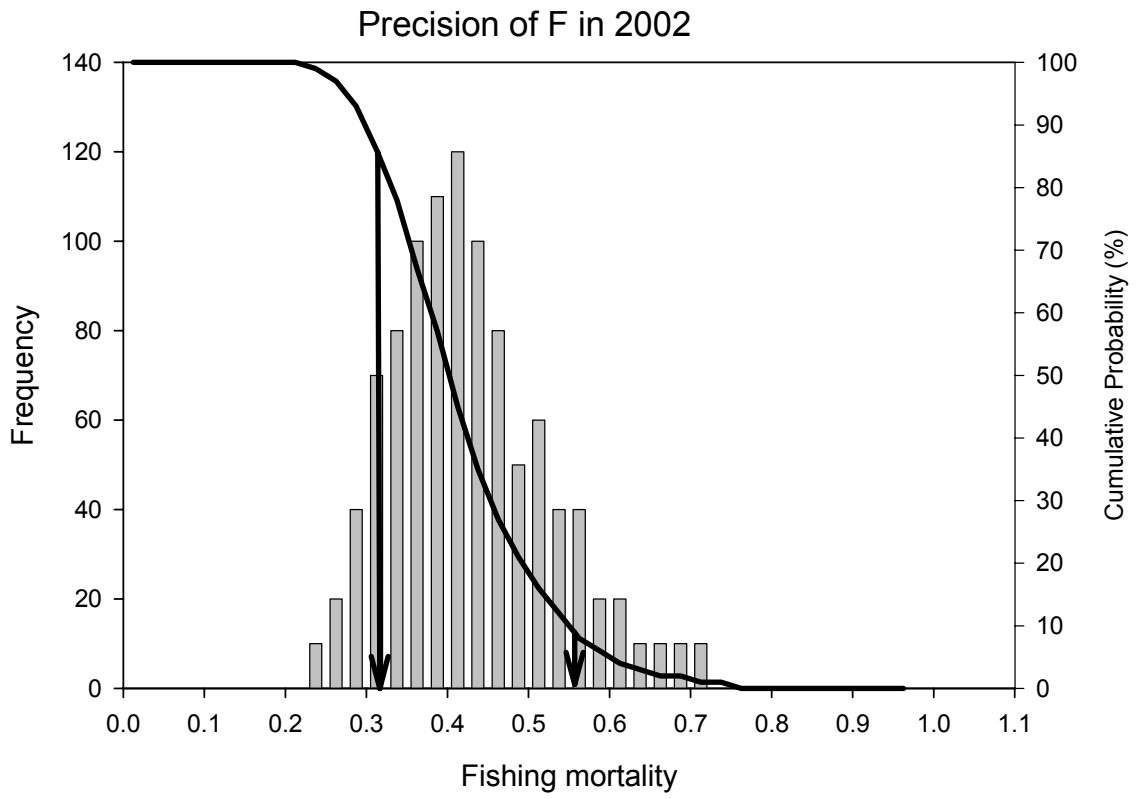


Figure A.30. Precision estimates of fishing mortality (F8-9) in 2002 for witch flounder. Vertical bars display both the range of the bootstrap estimates and the probability of individual values in the range. The arrows indicate the 80% confidence intervals.

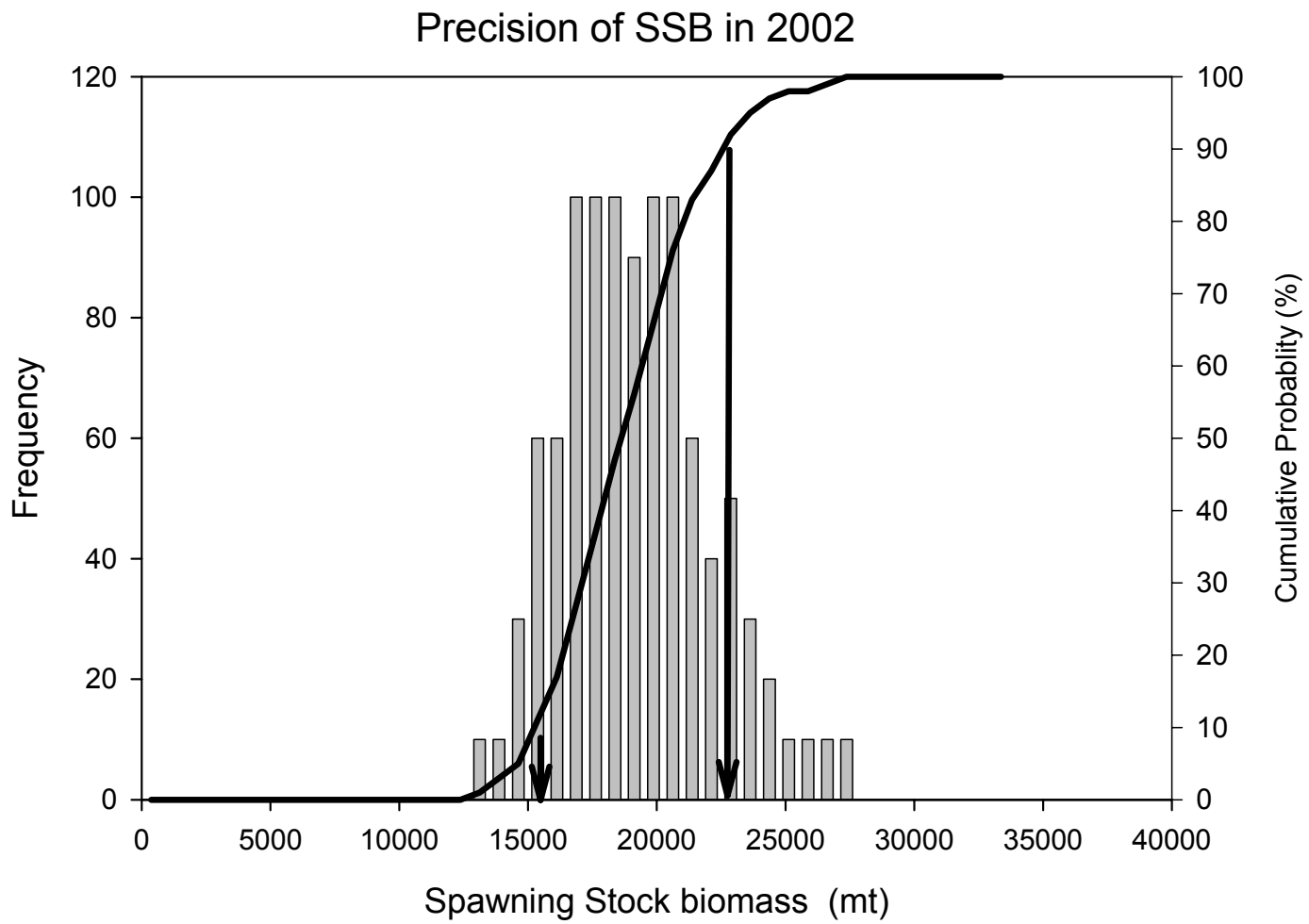


Figure A.31. Precision estimates of spawning stock biomass (mt) in 2002 for witch flounder. Vertical bars display both the range of the bootstrap estimates and the probability of individual values in the range. The arrows indicate the 80% confidence intervals.

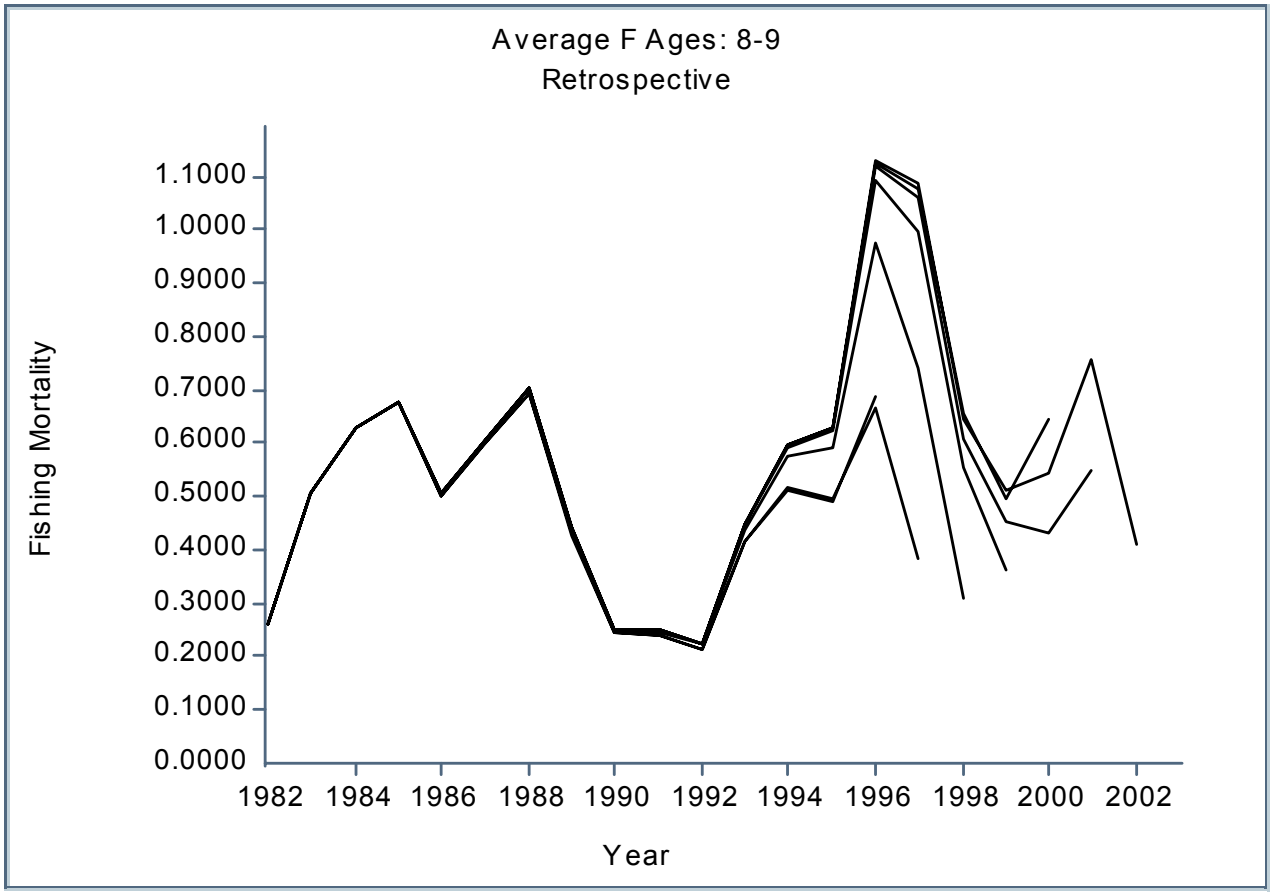


Figure A.32a. Retrospective analysis results for fishing mortality, (F8-9).

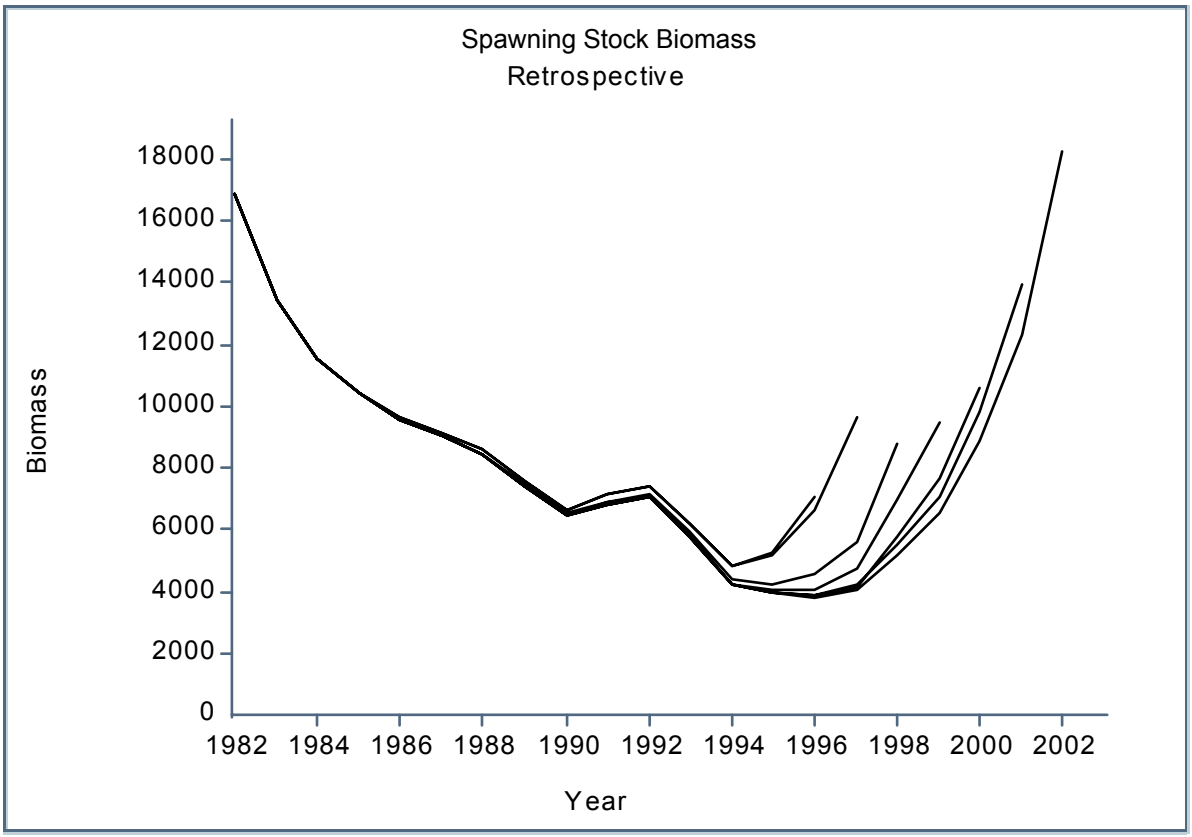


Figure A.32b. Retrospective analysis results for spawning stock biomass.

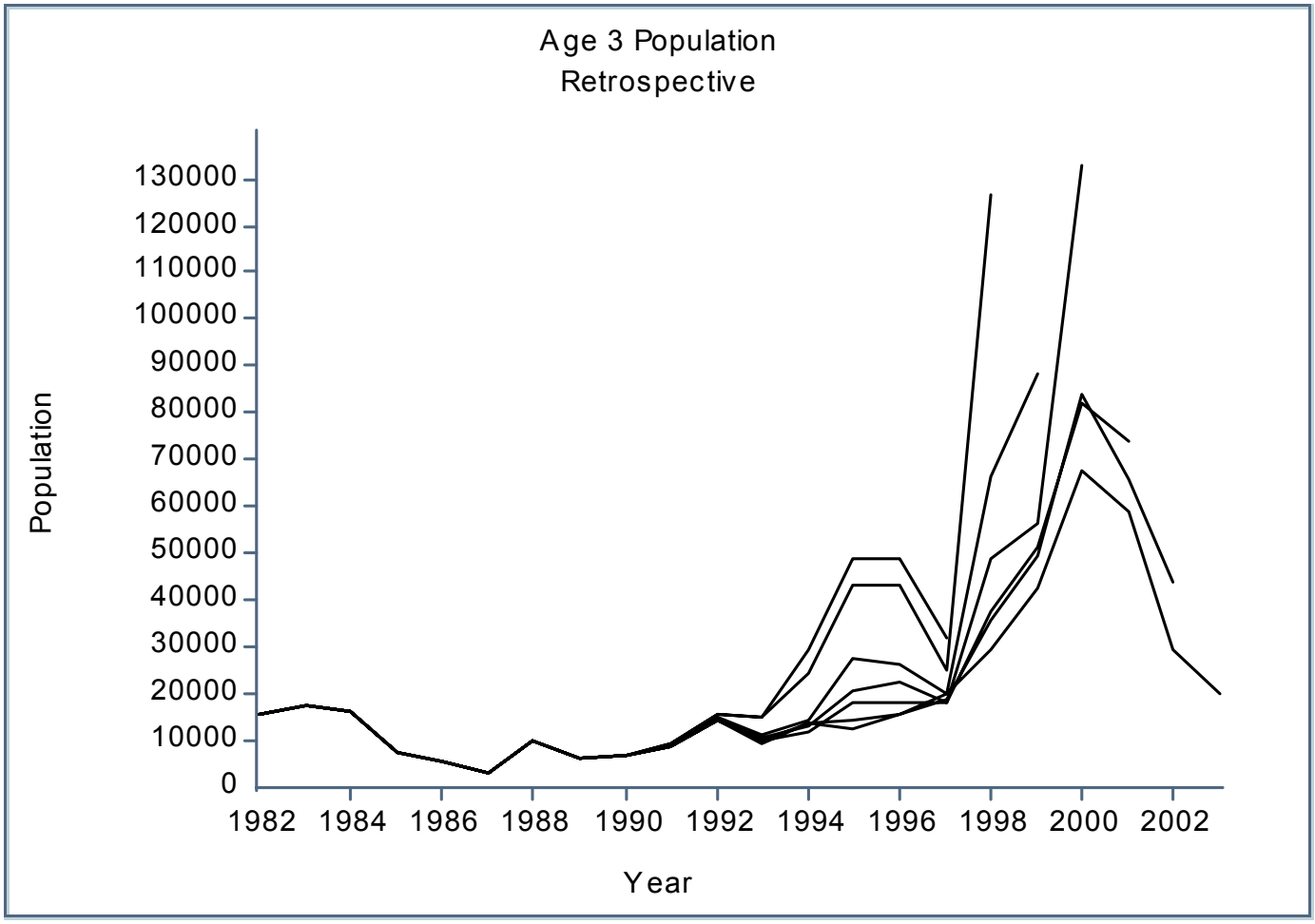


Figure A.32c. Retrospective analysis results for age 3 recruitment.

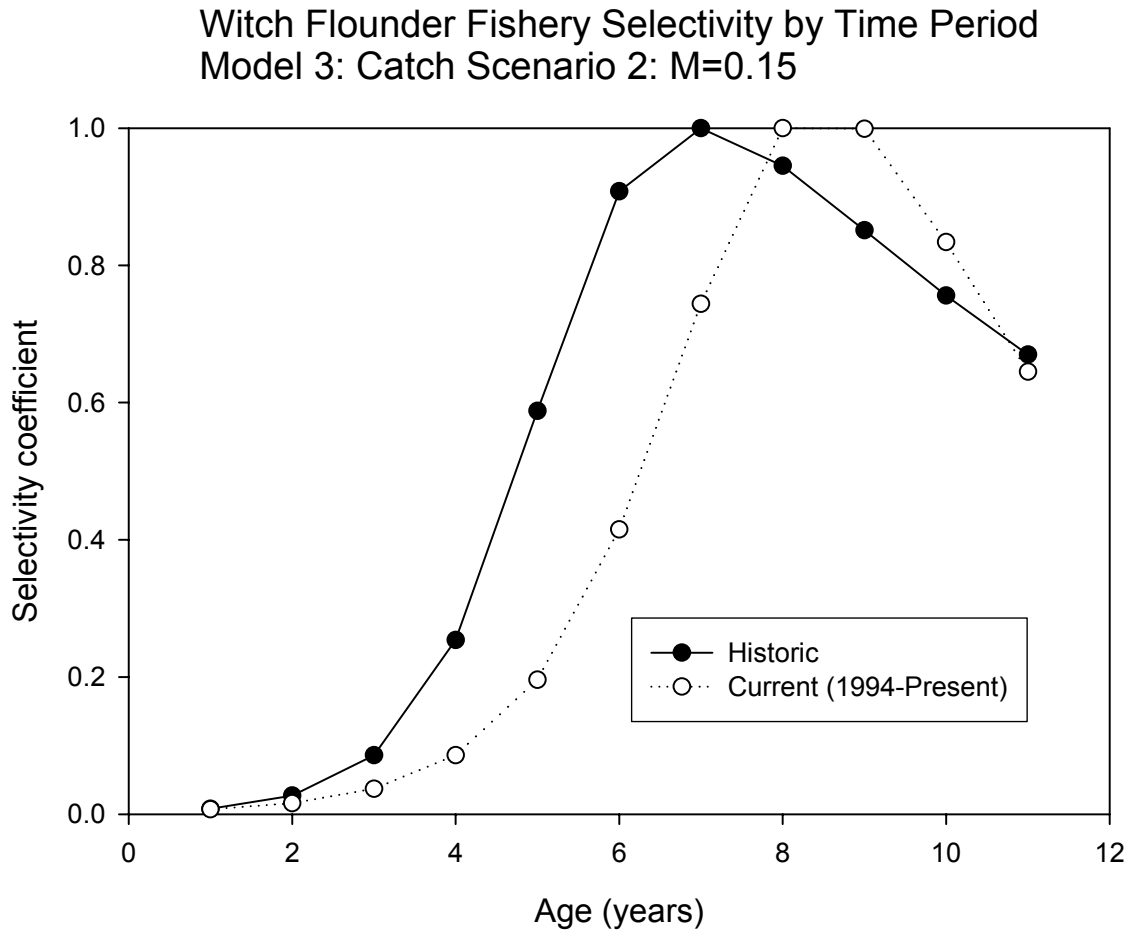


Figure A.33. Selectivity at age.

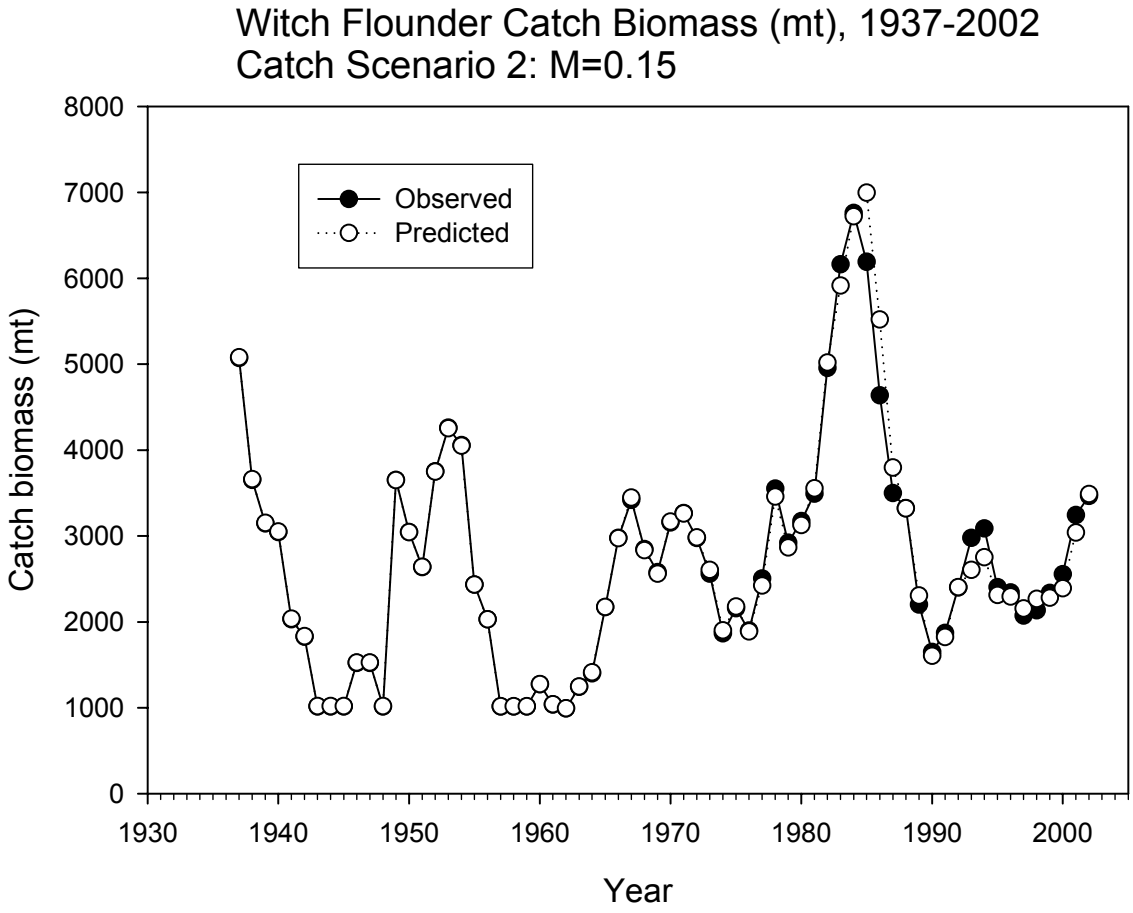


Figure A.34. Trends in catch biomass (mt), 1937 – 2002.

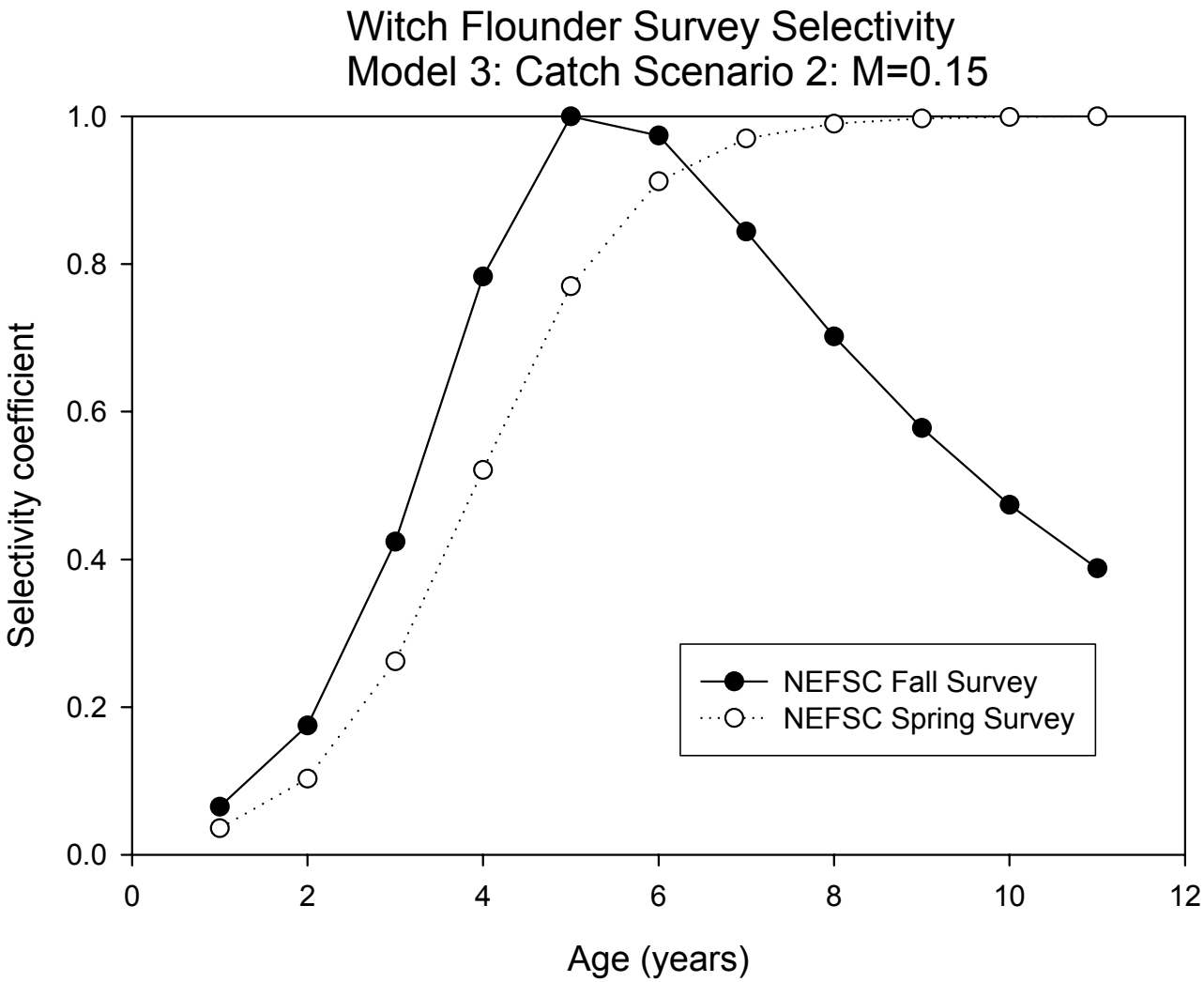


Figure A.35. Survey selectivity at age.

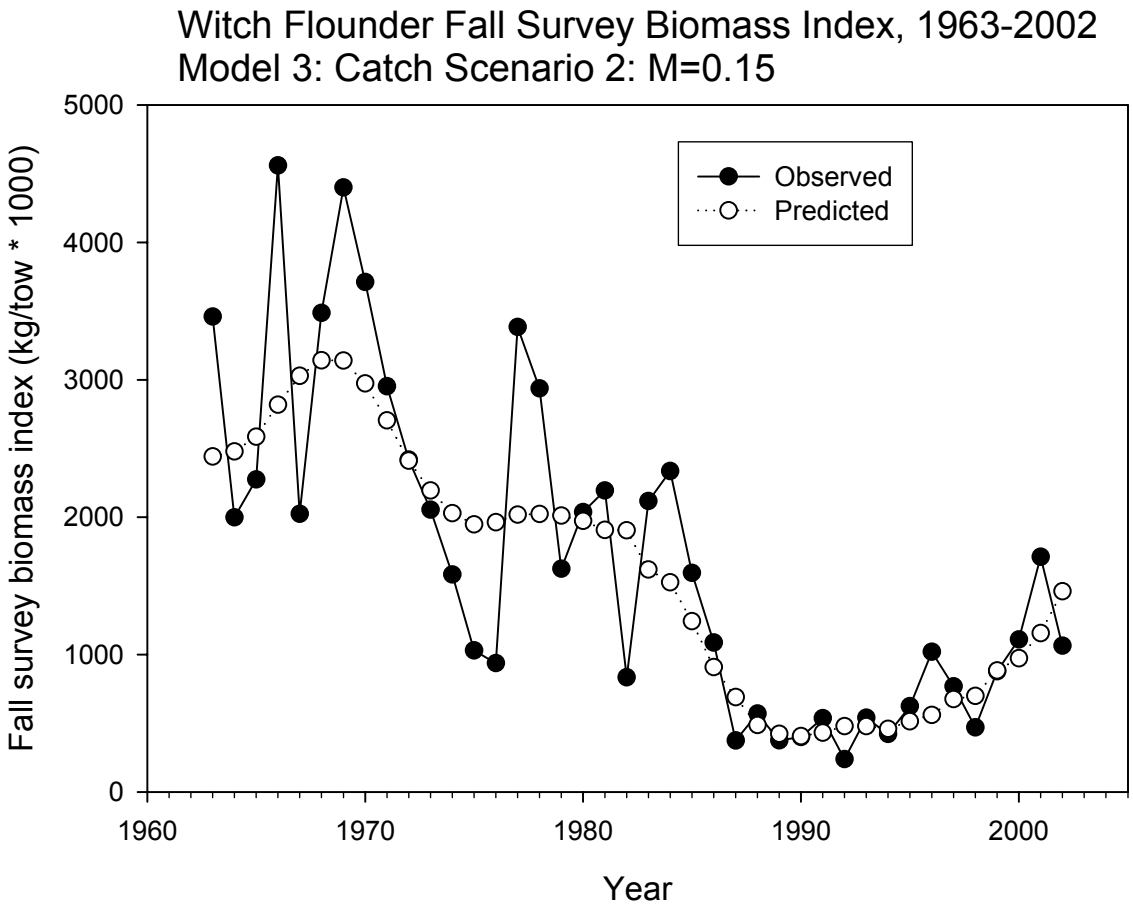


Figure A.36. Trends in NEFSC autumn survey biomass.

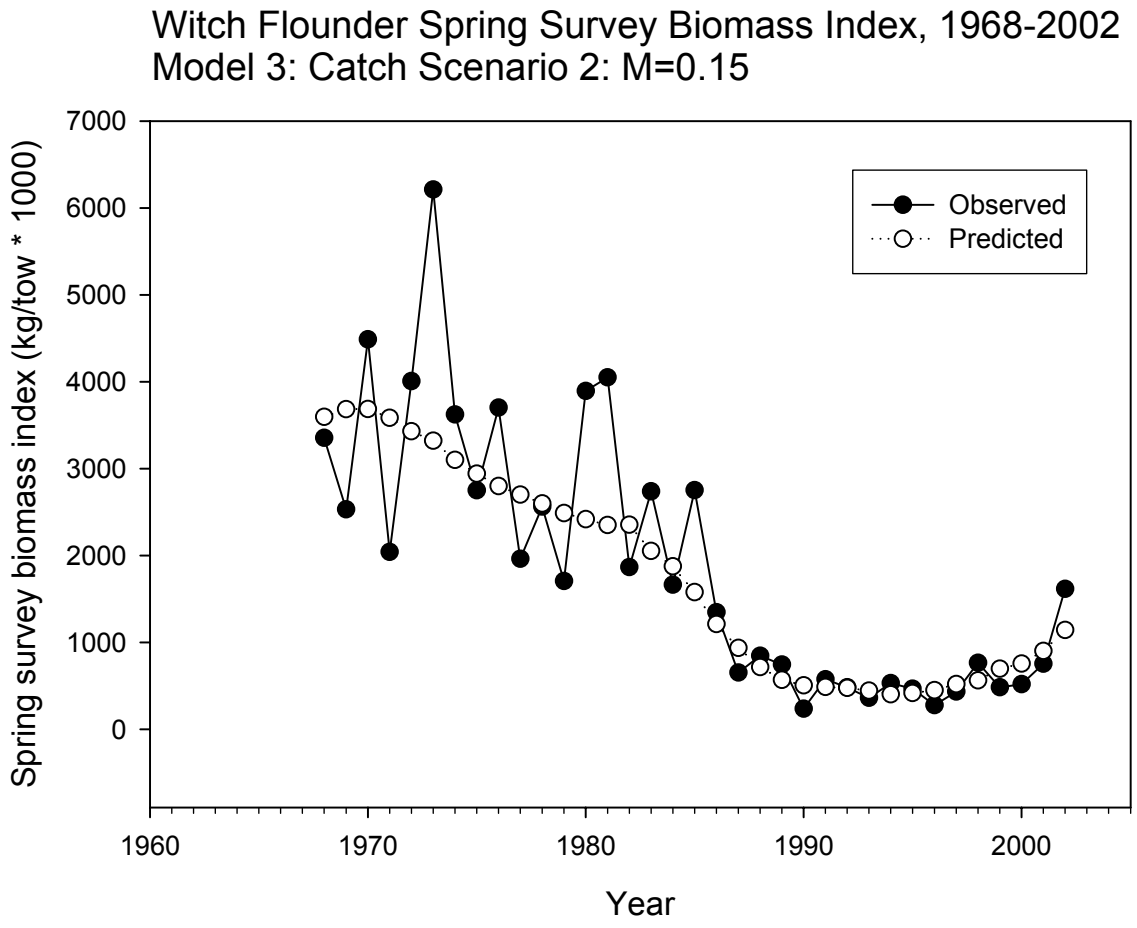


Figure A.37. Trends in NEFSC spring survey biomass.

Comparison of ADAPT virtual population analysis (VPA) and statistical catch-at-age analysis (SCAA) estimates of witch flounder spawning biomass, 1982-2002

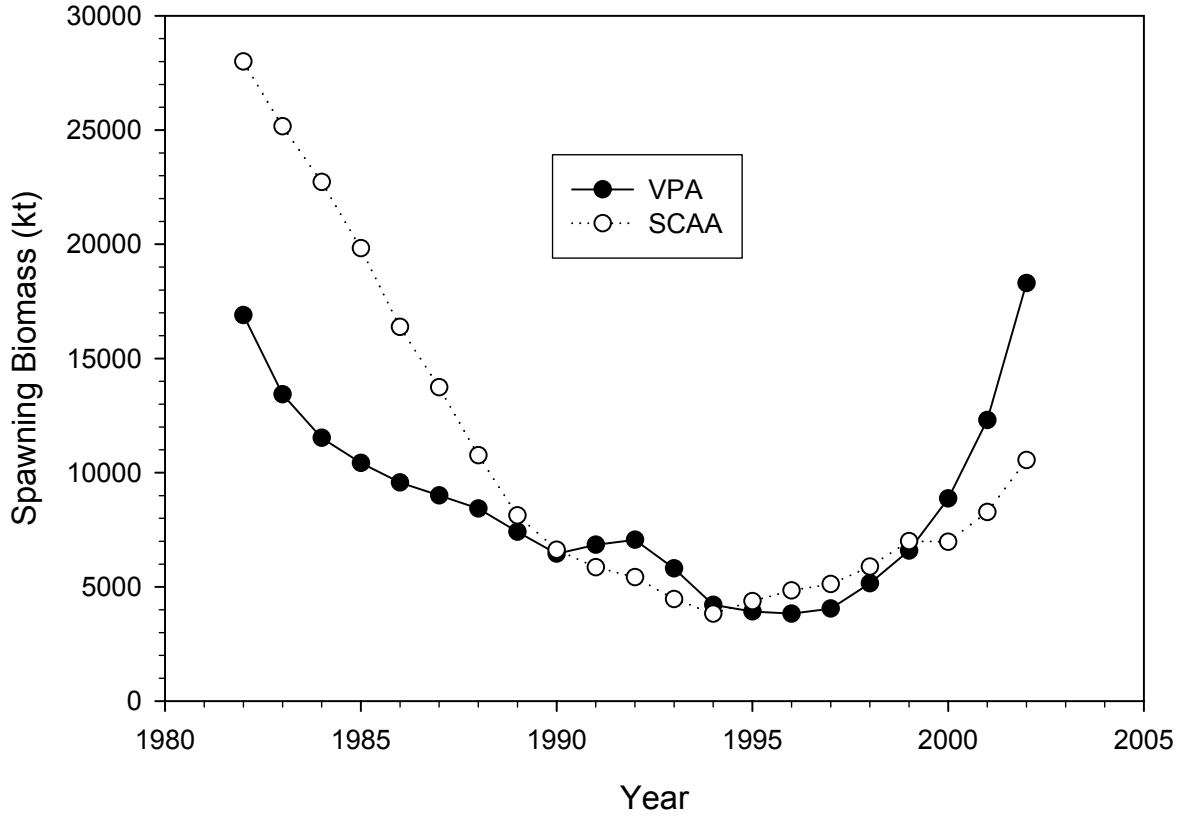


Figure A.38. Comparison of VPA and SCAA estimates of spawning stock biomass.

Comparison of ADAPT virtual population analysis (VPA) and statistical catch-at-age analysis (SCAA) estimates of witch flounder fishing mortality, 1982-2002

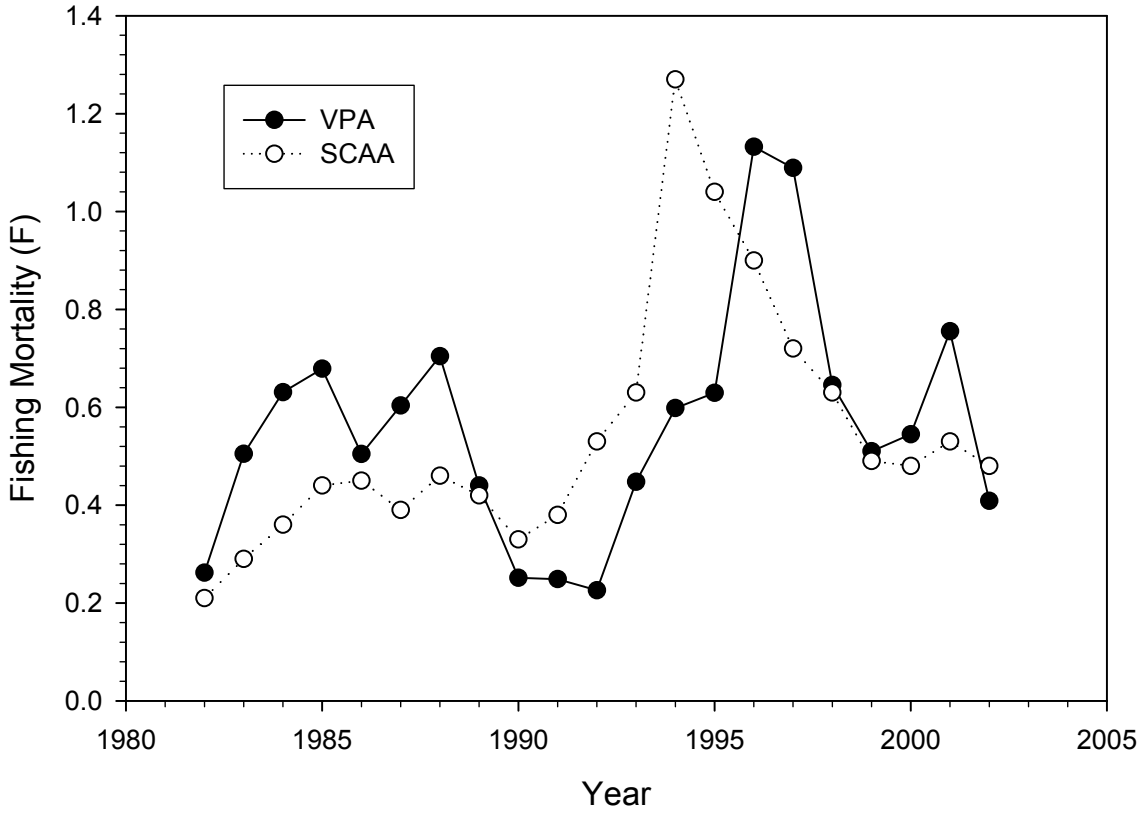


Figure A.39. Comparison of VPA and SCAA estimates of fishing mortality.

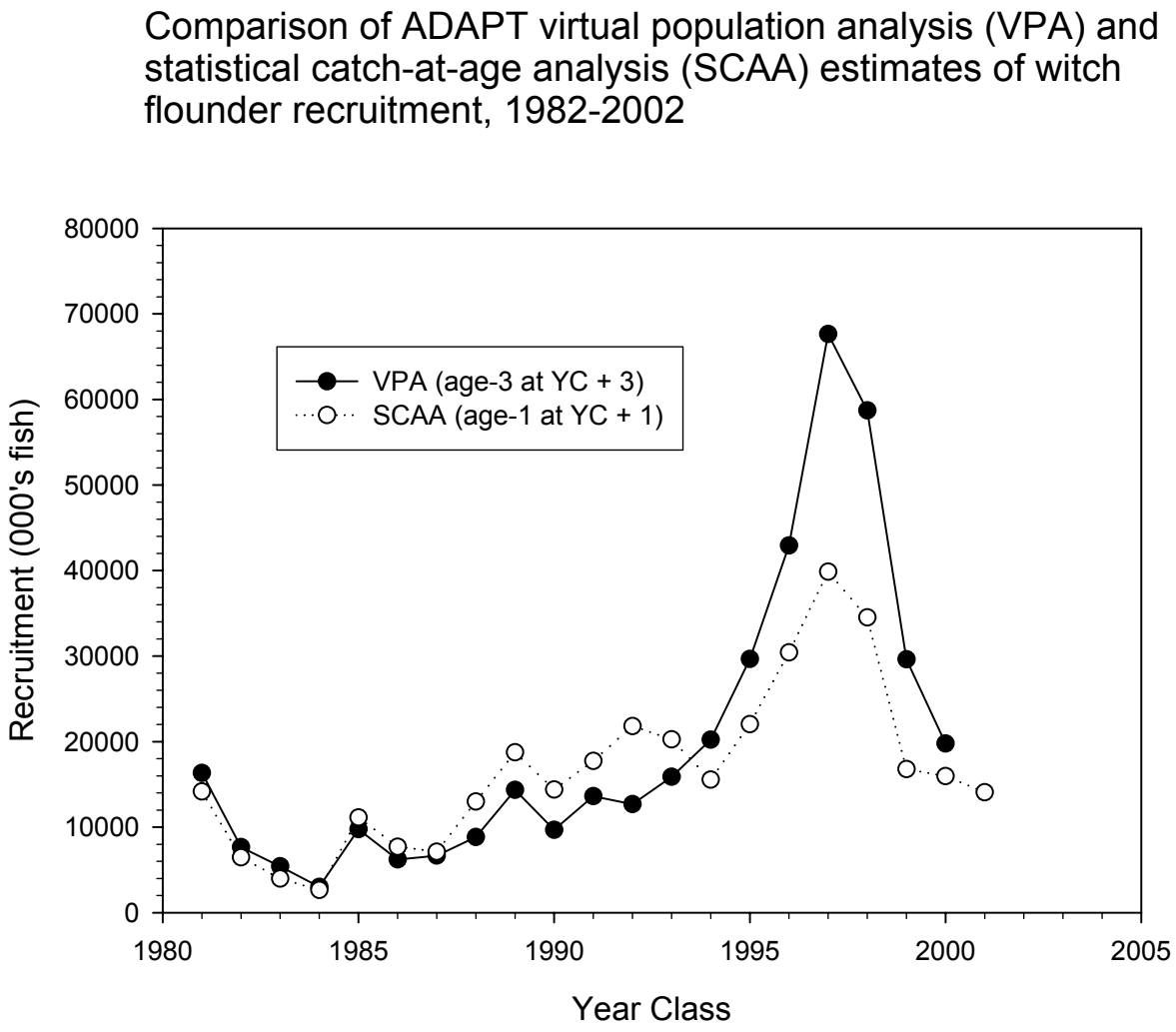


Figure A.40. Comparison of VPA and SCAA estimates of recruitment.

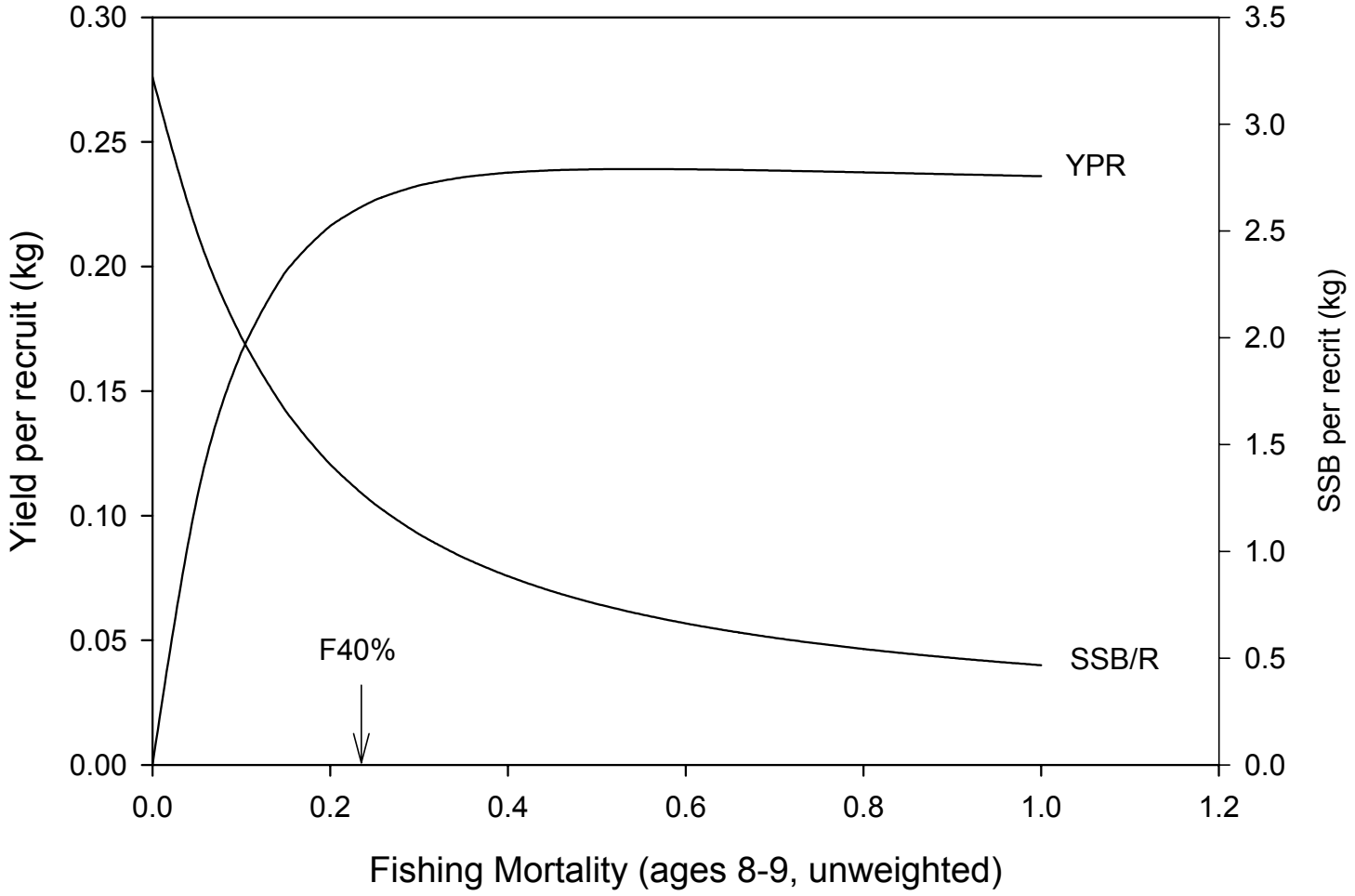


Figure A.41. Yield per recruit (YPR) and spawning stock biomass per recruit (SSB/R) estimates for witch flounder.

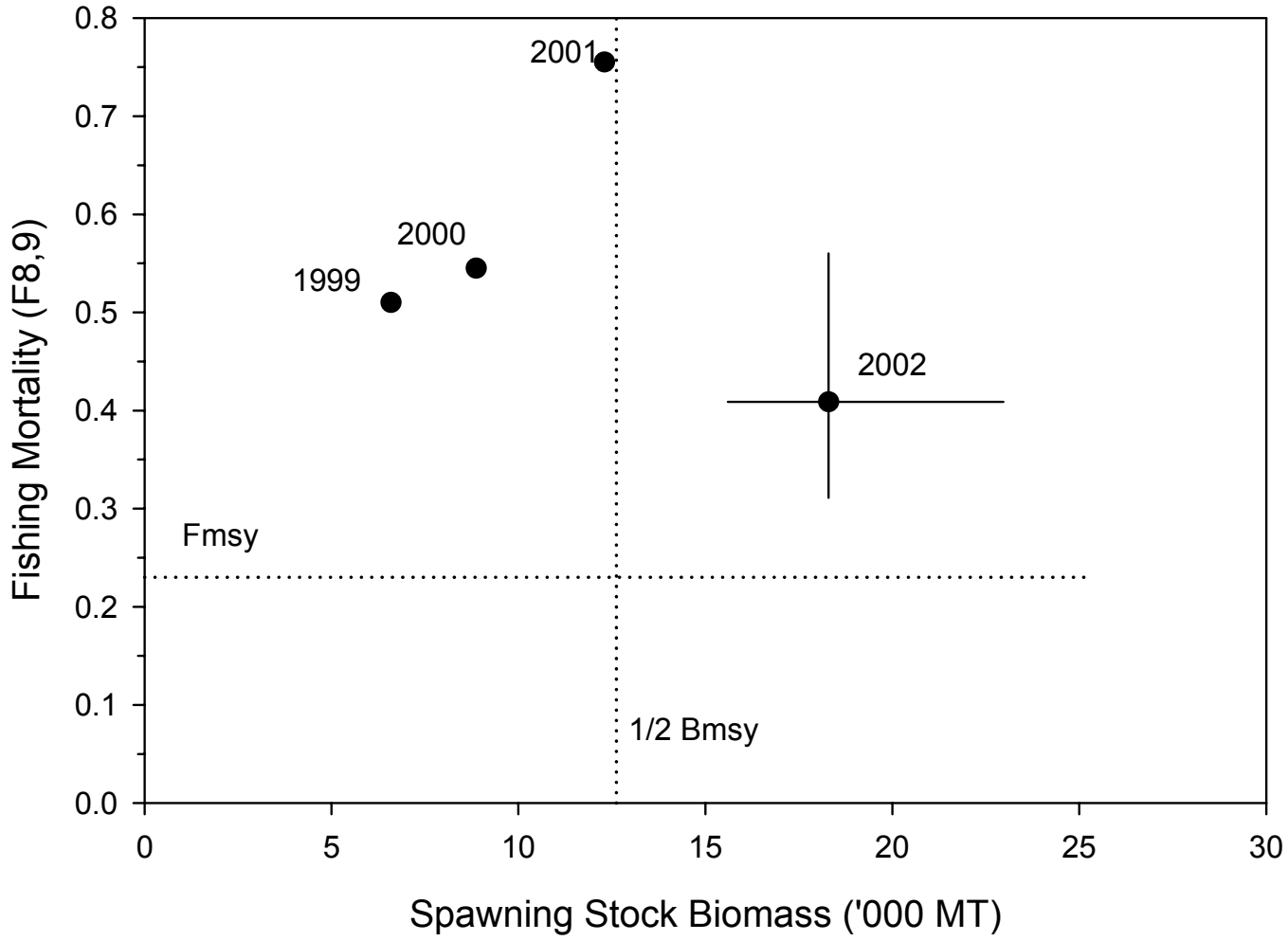


Figure A.42. Spawning stock biomass and fishing mortality (F 8-9) for witch flounder, 1999-2001, and 2002 with 80% confidence interval.

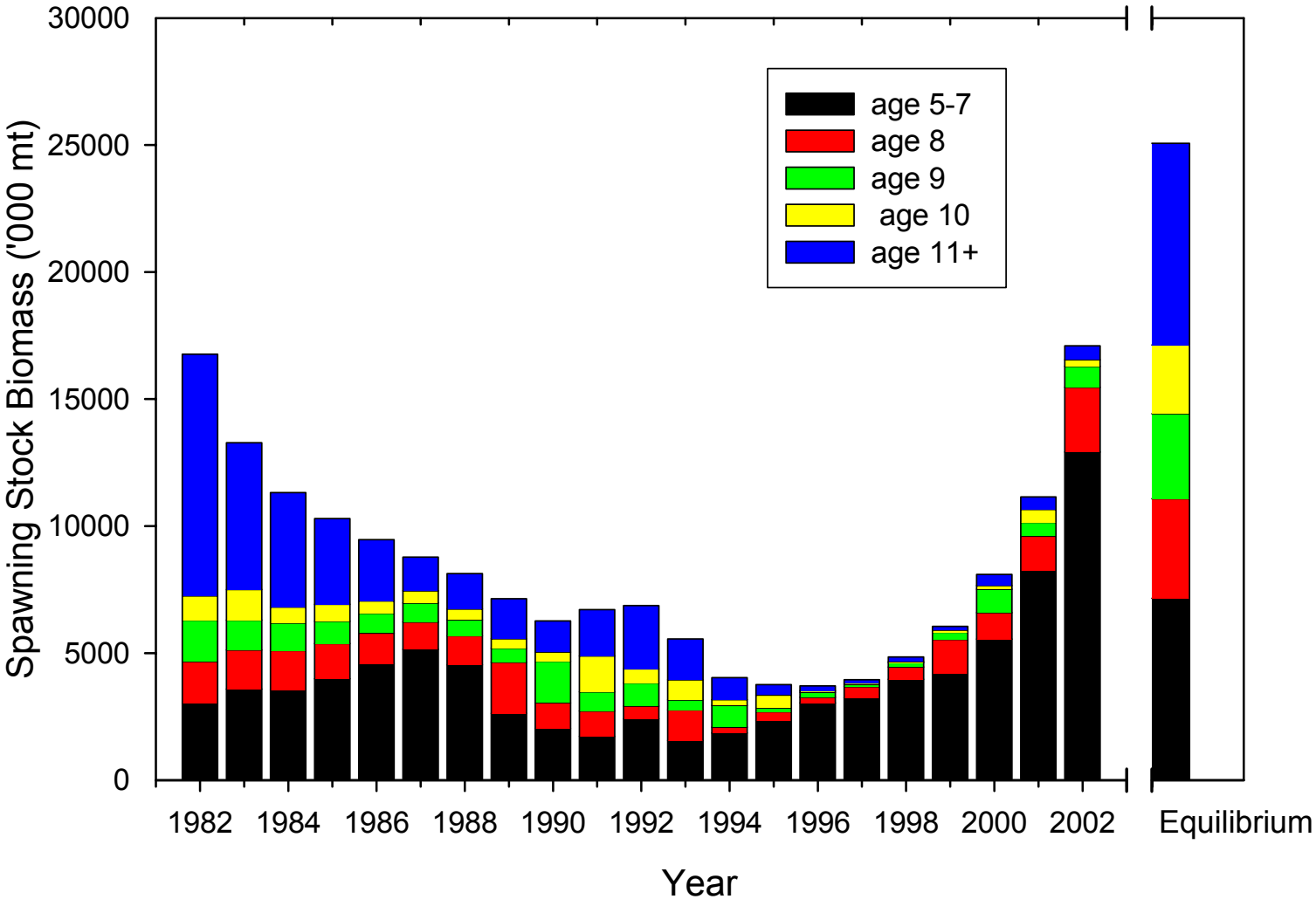


Figure A.43. Age distribution of witch flounder spawning stock biomass, 1982 – 2002 and the expected age distribution of witch flounder at equilibrium.