Northeast Fisheries Science Center Reference Document 99-16

A Report of the 29th Northeast Regional Stock Assessment Workshop

Assessment of the Witch Flounder Stock in Subareas 5 and 6 for 1999

by

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
Woods Hole, Massachusetts

October 1999

Northeast Fisheries Science Center Reference Documents

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This report's publication history is as follows: manuscript submitted for review -- August 5, 1999; manuscript accepted through technical review -- September 15, 1999; manuscript accepted through policy review -- September 24, 1999; and camera-ready copy submitted for publication -- October 18, 1999. This report may be cited as:

Wigley, S.E.; Brodziak, J.K.T.; Cadrin, S.X. 1999. Assessment of the witch flounder stock in Subareas 5 and 6 for 1999. *Northeast Fish. Sci. Cent. Ref. Doc.* 99-16; 153 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

TABLE OF CONTENTS

ABSTRACT

The 1999 analytical assessment for witch flounder in USA waters, covering the period 1982-1998, estimates 1998 fishing mortality (and projected 1999 fishing mortality), 1999 stock size, mean biomass 3+, spawning stock biomass, as well as estimates discards from the shrimp fishery and large-mesh otter trawl fishery, based upon analyses of sea sample, commercial and research vessel survey data through 1999.

USA commercial landings in 1998 totaled 1849 mt, a 4% increase over 1997 and 24% higher than in 1990, the lowest value since 1964. Research survey indices of abundance and biomass remained fairly stable from 1963 until the late 1970s; autumn indices declined steadily during the early and mid 1980s, reaching record low levels in 1987. Abundance sharply increased in 1993, due to a strong 1993 year class, and has remained generally high. However, survey indices of witch flounder greater than 40 cm have declined over the time series and are currently at low levels. It is clear that, despite the variability in the survey indices, the age range of the stock has been greatly reduced (< age 7) since 1985-1986 and that commercial catches at ages 2-4 is almost entirely from fish discarded in the shrimp and large-mesh otter trawl fisheries.

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 0.86 in 1996, then declined to 0.37 in 1998. Total mean biomass (3+) declined steadily from 28,000 mt in 1982 to a low of 7,700 mt in 1994 and has subsequently increased to 18,900 mt in 1998. Spawning stock biomass declined from 18,000 tons in 1982 to about 4,000 tons in 1993 and has increased sharply to 8,600 mt in 1998. However, spawning stock biomass is at a low level relative to the long-term survey biomass indices. Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 38 million fish (1996 year class) with a mean of 14 million fish. Recent recruitment has been above average, and the 1995 and 1996 year classes were estimated to be among the highest in the time series.

Based on the ADAPT estimates of age 3+ mean biomass in 1998 (18,934 mt) and F on biomass (0.13) , overfishing was occurring in 1998. Assuming 1999 catches will equal 1998 catches, the 1999 fully recruited fishing mortality rate is estimated to be 0.20, and the target fishing mortality prescribed by the control rule for the 1999 stock size is 0.096, which is approximately equivalent to 0.19 on fully recruited ages assuming the current age structure of the population. Fishing mortality should not be allowed to increase as fishing above the fishing mortality target will dissipate the potential benefits that the recent recruitment levels should produce.

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), and 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 1998 were 1,849 mt (Figure 2).

Previous witch flounder stock assessments were conducted by Burnett and Clark (1983) and Wigley and Mayo (1994). This report provides an update on the status of witch flounder in the Gulf of Maine - Georges Bank and southward (Subareas 5 and 6), presents an analytical assessment for the stock for the 1982-1998 period, and provides estimates of discards from the shrimp fishery and large-mesh otter trawl fishery based upon analyses of sea sampling, commercial and research vessel survey data through 1998.

Witch flounder is managed under the New England Fisheries Management Council's Multi-species Fisheries Management plan since 1987. A brief summary of groundfish management regulations affecting witch flounder are presented in Table 1. Significant changes in regulations include increased minimum size in 1983 and 1987; increases in mesh size in 1982, 1983, 1994; and effort reductions in 1996. Management regulations for the northern shrimp fishery also impact witch flounder (Table 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. In 1998 the Sustainable Fisheries Act revised the overfishing definition for witch flounder. A control rule was developed to define overfishing thresholds and targets (Applegate et al. 1998) for witch flounder.

THE FISHERY

Recreational Catches

There is no recreational fishery for witch flounder.

Commercial Landings

USA commercial landings in 1998 totaled 1,849 mt, a 4% increase over 1997 (Table 3); and 24% higher than in 1990, the lowest value since 1964 (Figure 2). Canadian landings from the stock have been negligible (<10 mt in 1997; Table 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.

The western Gulf of Maine (SA 513 and 514) and the central basin (SA 515) provide nearly half of the USA witch flounder landings (Table 4); landings from Georges Bank are confined to the deeper waters north of the South Channel (SA 521, 522; Table 4). Otter trawl catches account for about 97% of witch flounder landings, with sink gillnets comprising the remainder (Table 5). Catches are generally highest during March-July (Table 6) 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 (Table 7).

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 8, Figure 3). Since the early 1990s, the proportions of witch flounder landings from the peewee and small market categories have steadily increased. In 1998, witch flounder less than 45 cm ('peewee' and 'small' market categories) constituted 85% of total landings (Table 8, Figure 3). 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 9 (because some ports do not cull into 'peewee' or 'jumbo' categories, NEFSC sampling protocols incorporate these categories into the 'small' and 'large' categories, respectively). Until 1982, sampling was minimal and sporadic. During 1982-1988, an average of 48 length frequency samples was obtained

annually over all market categories, representing 1 sample per 102 mt landed. In 1990, sampling requirements were adjusted to 1 sample per 50 mt to obtain more samples from the 'large' market category. However, samples for the 'large' market category have been difficult to obtain due to the sharp decrease in the landings of larger fish in recent years (Tables 8 and 9). Sampling intensity during 1990-1998 averaged 35 samples annually, representing 1 sample per 56 mt landed; nonetheless, even with this increased sampling intensity, inadequate numbers of samples were obtained for some market categories and quarter combinations. In 1998, of the 23 samples collected, 14 were small samples (61%), 6 were medium (26%) and 3 were large (13%). Compared with the 1998 market category landings distribution by weight (small 85%; medium: 10%; large: 5%), sampling in 1998 reasonably approximated the market category distribution of landings on an annual basis. However, pooling of length frequency samples across quarters were required when only one or no samples existed. A summary of pooling procedures by year, market category and quarter is presented in Table 10.

Commercial Landings at Age

Commercial age data for the years 1982 to 1998 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 11. No discernible changes in growth are evident during the 1982-1998 period; although landings mean weights and mean lengths at ages 6 to 8 declined in 1996-1998, this may be an artifact of poor sampling in recent years.

Discards

The Domestic Sea Sampling Program (DSSP), which began in 1989, has generated various levels of coverage for different fisheries. Prior to the DSSP, 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. A summary of available sea sample data collected, by gear type, in the DSSP and the Massachusetts Division of Marine Fisheries (DMF) Sea Sampling Program are presented in Tables 12 and 13, respectively. Table 14 summarizes the available age data collected from DSSP trips. 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. An overview of the procedures used to estimate witch flounder discarded in the shrimp fishery from 1982 to 1998 is presented in Figure 4. These estimation procedures were used in the 1994 assessment (Wigley and Mayo 1994),

reviewed by the SAW 18 (NEFSC 1994), and extended through 1998 using the same methodology. The ratio of witch flounder discarded (kg) to days fished was calculated using DSSP 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 (Table 15) 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 16). To estimate witch flounder discard rates prior to the DSSP program, (i.e., 1982-1988), a simple linear regression was employed using 1989-1992 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 5; Wigley MS 1994).

With no 1998 DSSP 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 DSSP, a simple linear regression using 1993-1997 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 4 of the points were somewhat clustered (Figure 4).

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 16). Estimated discard weight was then translated into discarded numbers at age by applying witch flounder sea-sampled discard length-frequencies (Figure 6) 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 1995-1998, 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. The number of shrimp trips estimated in this analysis compares favorably with number of trips reported in the shrimp assessment which were derived via a different method (Armstrong, et al. 1998).

Without 1998 DSSP sampling, length-frequency data were unavailable to partition the 1998 estimated discard weight into numbers at length; therefore, as a surrogate, the 1997 DSSP length-frequency was used. The 1998 NEFSC spring survey age/length key was applied to apportion numbers at age for each shrimp season.

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 (Figure 7). 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.

Witch flounder discards in the northern shrimp fishery ranged from a low 6 mt in 1982 to a high of 34 mt in 1988 and 1995 (Table 17). Similarly, number of witch flounder discarded ranged from 62,000 fish discarded in 1982 to 1.8 million fish in 1994 (Table 17). Estimates of age compositions of discarded witch flounder in the shrimp fishery are presented in Table 18 and Figure 8. Discarded witch flounder from the shrimp fishery range from age 0 to 6, with ages 2 and 3 most commonly discarded (Table 18). Over the time series, an estimated 7.3 million witch flounder have been discarded in this fishery.

Large-mesh otter trawl fishery

The DSSP has not generated sufficient data for directly estimating the age composition of discards in the large-mesh otter trawl fishery due to low sample sizes over the time series (Table 12). The estimation of discards in the large-mesh otter trawl fishery is based upon a method developed by Mayo et al. (1992) which utilizes survey and commercial catch at length data, commercial gear retention ogives, and information on culling practices. An overview of the method is presented in Figure 9. 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 (Table 19). 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. A spreadsheet illustrating the method used is presented in Table 19 for 1993 using the spring survey and commercial landings from quarters 1 and 2. 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 by season in Table 20. Results indicate that in recent years, numbers discarded at sea comprised as much as 64% of the witch flounder landed. The general pattern of discarding appears to be consistent with that expected given strong recruitment during 1979-1981, 1985, and 1989-1993.

For years in which sufficient DSSP data were available, i.e., 1989, 1993, 1995, 1996, 1997, survey filtered length-frequencies were compared with DSSP length-frequencies by half-year. Length-frequencies from the kept and discarded catch were found to be generally consistent between the survey filtered data and the DSSP data.

Estimates of age compositions of discarded witch flounder in the large-mesh otter trawl fishery are presented in Table 21 and Figure 10. Witch flounder discard-at-age from the large-mesh fishery range in age from 0 to 6, with majority at ages 3 to 5. Over the time series, an estimated 17.8 million witch flounder have been discarded in this fishery.

The Vessel Trip Report data were explored for information on discarding of witch flounder. Reporting of discard information in the logbooks are 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) by quarter and gear type from 1994 to 1998. Limitations of this analysis are: 1) the dealer data used to expand discard rates to total discard weight does 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 exploratory analysis, results suggest that discarding of witch flounder in the otter trawl fishery ranges from approximately 5 to 10% of the landed weight of witch flounder. These estimates should be reviewed cautiously as not all fishermen report discarding practices. The estimate of discards to landings, by weight, derived from the survey filtering method were consistently greater ranging from 10 to 21% during the 1994 to 1998 period (Tables 1 and 21).

Discards at age from the shrimp fishery and the large-mesh otter trawl fishery were combined and given in Table 22. Mean weights at age of fish discarded in the shrimp fishery were lower than those discarded or landed in the large-mesh otter trawl fishery, reflecting seasonal differences between these fisheries. Mean weights and lengths at age of discarded fish in the large-mesh fishery were lower than those of landed fish.

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 23 and Figure 10. The age composition data reveal strong 1979-1981 year classes (Table 23). The 1985 year class also appears to have been strong; however, this cohort was heavily discarded in both the shrimp and large-mesh otter trawl fisheries (Tables 18 and 21). High levels of discarding were also evident for the 1988 and 1989, and 1991-1995 year classes (Figure 11). 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 24) 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 25). 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. Although a slight increase occurred in the early 1990s, recent LPUE indices are still below the time series average (Table 25, Figure 12a). Indices for 40% trips peaked in the early 1980's and have declined dramatically since then (Table 25, Figure 12a). Effort (days fished) associated with all trips and 40% trips increased during the late 1970s and early 1980s, peaked during 1985-1988, decreased until 1990, and have since slightly increased (Figure 12b). 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 1998 may be underestimated in this report since effort is based upon preliminary VTR data, which does 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. 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 13); Massachusetts DMF, regions 4 and 5 (Figure 14); and northern shrimp, strata 1, 3, 6, and 8 (Figure 15).

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 16a and 16b). 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 (Figure 17a and 17b). 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 18), most of the juvenile range is covered.

Research vessel survey indices of abundance, biomass, and mean length for NEFSC surveys, Mass. DMF surveys, and ASMFC shrimp surveys are presented in Tables 26-28 and Figures 19-23, respectively. Length frequency data from these surveys are presented in Figures 24-27, respectively. A summary of available age data from NEFSC surveys is given in Table 29; 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 1982-1993 are presented in Table 30, Figures 28 and 29.

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 26, Figures 19a and 19b); autumn indices declined during the early and mid 1980s, reaching record low levels in 1987. Abundance sharply increased in 1993, due to a strong 1993 year class (Table 30, Figures 19b) and has generally remained high. At the same time, mean length declined, and has not re-bounded (Figure 20). The NEFSC spring and autumn survey indices of witch flounder greater than 40 cm have declined over the time series and are currently at low levels (Figure 21).

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 28, Figure 27). The ASMFC survey data indicate improved recruitment in recent years (see length frequency modes at 12 cm, corresponding to age 1 fish, during 1990-1993, Figure 27). Significant numbers of small fish were also observed in the NEFSC autumn survey during

the same year (Figure 25). The Massachusetts DMF survey indices do not reflect this recent improved recruitment (Table 27, Figures 22a and 22b). However, the DMF surveys do not consistently catch significant numbers of witch flounder less than 20 cm (Figure 26).

Mean lengths at age from NEFSC spring and autumn surveys are presented in Table 31 and for ages 4 to 8 in Figures 30a and 30b. 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 30a and 30b); however, Von Bertalanffy growth analyses detected no significant changes in resulting growth parameters over the time period.

Reduced abundance levels in recent years have resulted in fewer age samples and highly variable estimates of numbers at age. Additionally, age compositions have become more truncated resulting in a diminished ability to track of individual cohorts (Figures 28 and 29).

NEFSC spring and autumn survey mean weights at age are given in Table 32. Survey mean weights are variable, however, similar declines in mean weights for ages 6-8 were observed during 1996-1998 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). Probit analyses (SAS 1985) of maturity at age data revealed that there have been five maturity stanzas over the assessment period (Table 33, Figures 31a and 31b). 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 and 1994-1998. 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 to 1983-84 levels, then declining in 1994-1998 to 1985-1990 levels. It appears that the strong 1985 year class may have had an effect on maturation patterns. For maturity-at-length analyses, data from 1977-1980 were applied to the 1963-1976 period.

Stratified mean weight and number per tow of mature (spawning stock) witch flounder were calculated for spring NEFSC research vessel surveys (Table 34, Figure 32). The spawning stock biomass indices closely track total biomass index 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, and 1994-1997. Given the variability in age at full recruitment to the sampling gear observed during the survey time series (Table 35), 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 35). With no objective basis to select one survey series over another, total mortality was calculated by taking the geometric mean of the spring and autumn estimates during each time period. Total mortality increased from 0.41 during 1982-1985 to 0.74 during 1986-1989, declined to 0.44 during 1990-1993, and increased to 0.54 during 1994-1997 (Table 35). Additionally, annual estimates of total mortality were calculated, and smoothed with a three year moving average (Figure 33).

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 1999 using catch-at-age estimates (i.e., landings plus

discards from the shrimp and large-mesh otter trawl fishery; Table 23). Estimates of stock sizes, their associated statistics, and F in the terminal year are summarized in Table 36.

An initial formulation (RUN 45) based upon the 1994 VPA (Wigley and Mayo 1994) was performed to estimate 1982-1999 stock sizes for ages 4,7,8,9 (Table 36) using a catch-at-age matrix with a 10+ age group, NEFSC spring and autumn abundance indices for ages 3 to 9, and age-specific commercial LPUE indices for ages 7 to 9 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. Spring indices calibrated beginning year abundance and LPUE indices calibrated mid-year stock sizes. A flat-top partial recruitment (PR) pattern was assumed, with full fishing mortality on ages 7 and older. Instantaneous rate of natural mortality (M) was assumed to be 0.15. The results of the initial run indicated that coefficients of variation (CV) for estimated ages ranged between 32% and 46% and the CVs for survey catchability coefficients (q) were consistent, ranging from 22% to 25%. Correlations of the normalized indices are given in Table 37. Normalized indices and standardized residuals are presented in Figures 34 and 35, respectively.

Alternative formulations included: 1) shortening the LPUE time series [RUN 46]; 2) excluding discards from the catch-at-age [RUN 51]; 3) excluding the LPUE indices [RUN 52]; and 4) varying the ages to be estimated and reducing the plus group from 10+ to 11+ [RUN 50]. Results from these alternative formulations showed a consistent pattern of increasing F during 1992 to 1996, and a dramatic drop in F in the terminal year. Residuals showed a persistent pattern of high negative values apparently caused by weakly detected year classes in the NEFSC surveys and improved recruitment since 1989.

Based on these alternative formulations, a final formulation was developed whereby age 3 was not estimated (due to high CV on age 3 in run 50; Table 36), and LPUE indices were excluded due to uncertainties in the later years. This formulation retained the desirability of an 11+ catch-at-age matrix which increased the numbers of fully-recruited ages for which F was estimated and should perform better for projecting rebuilding scenarios. Thus, the final ADAPT formulation (Run 54) provided stock sizes estimates for ages 4 to 10 in 1999 and corresponding F estimates for ages 1 to 10 in 1998.

Assuming full recruitment at age 7, 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. Spawning stock biomass (SSB) was calculated at time of spawning (March) by applying maturity ogives given in Table 33 and mean weight at age calculated by the Rivard method (Table 24). The final calibration assumed a PR on age 3 in 1998 derived from the 1995-1997 F pattern taken from the penultimate calibration run (due to mesh regulation changes in May 1994).

The VPA calibration indicated that 1999 age 3 stock size was 131 million fish, approximately 4-folder higher than any previously estimate of age 3 estimate. Given the extremely high estimate

of age 3 stock size in 1999, three additional VPA formulations were conducted for sensitivity of the age 3 stock size; these formulations included: 1) estimating age 3 (Run 55) ; 2) eliminating shrimp discards from the catch-at-age (Run 56); and 3) estimating age 3 and eliminating shrimp discards from the catch-at-age (Run 57; Table 36). However, the negative residual pattern associated with the stock size estimates of age 3 and 4 persisted, and given the retrospective pattern associated with age 3 recruitment (discussed below) it was determined that the best estimates of age 3 and 4 stock sizes in 1999 would come from the survey indices of recruitment. Stock sizes in 1999 for age 3 and 4 were estimated directly from the survey data using regressions of VPA stock sizes on the corresponding survey indices (Table 38; RTC3 program of ICES). The 1999 age 3 stock size was estimated to be 38.706 million fish (1996 year class) and age 4 stock size in 1999 was estimated to be 19.457 million fish (1995 year class). To estimate age 3 fish in 1998 (the 1995 year class), the 1995 year class at age 4 was back-calculated (accounting for natural mortality) to be 22.686 million fish (Table 39).

VPA Estimates of Fishing Mortality, Spawning Stock Biomass and Recruitment

A full listing of the final ADAPT VPA calibration output and diagnostics is presented in Appendix A, and results including estimates of F, stock size and spawning stock biomass at age, are given in Table 39. The mean residual for the VPA calibration was 0.811 (Appendix A). The CVs on age 4 - 10 stock size estimates ranged from 0.35 to 0.52, while the CVs on the estimates of survey catchabilities were between 0.22 and 0.25.

The VPA indicates that average fishing mortality on fully recruited ages (7+) increased from 0.21 in 1982 to 0.59 in 1985, declined to 0.24 in 1990, increased to 0.86 in 1996 then dropped to 0.37 in 1998, a 45% decrease from 1997 (Table 39, Figure 36). This trend in F is generally confirmed by the trend of pooled survey Z (Table 35, Figure 33), and is generally similar to the pattern of provisional effort estimates (Figure 12).

Mean biomass (age 3+) declined steadily from 28,000 mt in 1982 to a low of 7,700 mt in 1994 and has subsequently increased to 18,934 mt in 1998 (Table 39, Figure 37). Spawning stock biomass declined from 18,000 mt in 1982 to about 4,000 mt in 1995. Following the recruitment and maturation of the strong 1991-1993 year classes, SSB increased sharply to 8,600 mt in 1998 (Table 39, Figure 37). Both mean biomass (3+) and SSB are projected to increase in 1999.

Since 1982 recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 38 million fish (1996 year class; Table 39, Figure 37). Over the 1982-1998 period, geometric mean recruitment of age 3 fish (the 1979-1995 year classes) equaled 12 million fish; indicating that recent recruitment have been above average, with the 1995 and 1996 year classes among the highest in the VPA time series (Table 39).

The relationship between spawning stock biomass and recruitment (age 3) is presented in Figure 38. Survival ratios, estimated as the ratio of age 3 recruits over the SSB which produced those recruits, shows increasing survival in the 1990's (Figure 39). The age composition of the

spawning stock biomass revealed that more than half the SSB in 1982 was composed of age 11+ fish, but by 1998, more than half of the SSB consisted of age 5 and 6 fish (Figure 40).

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 1999, the catchability estimates (q) of the abundance indices used in calibrating the VPA, and the 1998 fully recruited fishing mortality rate (age 7+). Frequency distributions of the 1998 mean fishing mortality and spawning stock biomass bootstrap estimates were generated, and cumulative probability curves produced (Figures 41 and 42).

The bootstrap results (Appendix B) indicate that age-specific stock sizes in 1999 were moderately well estimated with CVs ranging from 0.33 to 0.56 (Appendix B: Table 1). CVs on the catchability estimates associated with the tuning indices of abundance ranged from 0.19 to 0.24 (Appendix B: Table 2). Age-specific Fs in 1998 were reasonably well estimated with CVs ranging from 0.25 to 0.61, as was the mean fully recruited F (CV = 0.25; Appendix B: Tables 4 and 5).

The mean bootstrap estimate of the fully recruited F in 1998 (0.39) was nearly identical to the VPA point estimate (0.37; Appendix B: Table 5). Based on the cumulative probability curve (Figure 41), there is an 80% probability that the 1998 F lies between 0.28 and 0.51.

The bootstrap mean of spawning stock biomass in 1998 (9,100 tons) was rather precise (CV = 0.17) and slightly higher (5%) than the VPA point estimate (8,600 tons). Based on the cumulative probability curve (Figure 42), there is an 80% probability that the 1998 SSB was between 7,400 mt and 11,000 mt.

To gain a historical perspective of spawning stock biomass, the survey time series of stratified mean weight (kg) per tow of mature fish from the NEFSC spring survey was re-scaled to the VPA SSB via a linear regression ($r^2 = 0.82$). The re-scaled survey SSB reveals that SSB has generally declined since the mid-1970's, and although SSB has increased in recent years, current levels of SSB remain at low levels (Figure 43).

Retrospective Analyses

A retrospective analysis was conducted on final formulation (Run 54) from 1998 to 1991 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 7 years prior to the current assessment. Results indicate that average fishing mortality was over

estimated during 1991-1995; however, F appears to be underestimated in 1996 and 1997 (Table 40, Figure 44a). In general, estimates of SSB were over estimated in 1994 through 1997, yet underestimated in 1991-1993 (Table 40, Figure 44b). The retrospective analysis indicated a pattern of relatively consistent estimates of the number of age 3 recruits, with the notable exception of the 1992 and 1993 year classes, which were considerably over estimated (Table 40, Figure 44c)

Stock Synthesis Model

The size-based version of the Stock Synthesis model (Methot 1989, 1990, 1998) was applied to estimate witch flounder population biomass and fishing mortality during 1982-1998. This age-structured analysis was conducted to explore whether biomass levels and trends from two different assessment models would be similar given identical input data. Several Synthesis model configurations that used different submodels and observation components were explored. In the final model, a single fishery and two research surveys (NEFSC spring and autumn bottom trawl) were included. Population numbers at age were modeled for ages 1 through 25+. Population age observations were predicted for a total of 11 age bins. The age bins were age-1, age-2, ..., age-11+. Population length observations were predicted for a total of 31 length bins consisting of 5-6 cm, ..., 65-66 cm. Selectivity-at-length curves were estimated for the fishery and both surveys. Retention of catch at length in the fishery was estimated for two time periods (1982-1987 & 1988-1998) based on a change in minimum landed fish size in 1988. Overall, the final model had a total of 10 likelihood components with equal emphasis levels. The likelihood components were: (1) fishery age composition, (2) fishery size composition, (3) distribution of fishery catch into retained and discarded categories, (4) spring survey abundance index, (5) spring survey age composition, (6) spring survey size composition, (7) autumn survey abundance index, (8) autumn survey age composition, (9) autumn survey size composition, (10) annual recruitment deviations from a mean stock-recruitment curve. Maximum likelihood estimates of a total of 38 parameters were determined when the total log-likelihood changed by less than 0.001 in successive iterations.

Results of the exploratory Synthesis analysis were generally similar to VPA results. Model fits to the spring and autumn survey weight-per-tow indices tracked observed values, although there was a notably large negative residual for the 1982 autumn survey data point. Residuals from model fits to fishery discard and landings length compositions, as well as the proportion of catch discarded by weight, exhibited some moderate residual patterns. However, residuals from model fits to survey age and length composition data appeared to be randomly distributed. Key model outputs were similar to VPA outputs (Figure 45). Estimates of population biomass, fully-recruited fishing mortality, and age-3 stock size had similar levels and trends throughout the assessment time horizon, although estimates of the 1995-1996 year classes were relatively lower with the Synthesis model. Overall, this analysis suggested that assessment results for witch flounder were relatively insensitive to the choice of an age-structured model.

BIOLOGICAL REFERENCE POINTS

Yield and spawning stock biomass per recruit

Yield-per-recruit (Y/R), total stock biomass per recruit, and spawning stock biomass per recruit (SSB/R) analyses were performed using the Thompson and Bell (1934) method. Mean weights at age used in the Y/R analyses were computed as an arithmetic average of catch mean weights at age (Table 23) over the 1982-1998 period. Mean weights at age for use in the SSB/R analyses were computed as the arithmetic average of stock mean weights at age calculated by the Rivard method (Table 24) over the period 1982-1998. The maturation ogives used are presented in Table 33. Given the changes in regulated mesh size in 1994, the exploitation pattern used in the yield and SSB per recruit analyses and short-term projections was computed from the 1995-1997 VPA results (Table 39). Geometric mean F at age was computed for the 1995-1997 period and divided by the geometric mean of the fully recruited annual Fs to derive the partial recruitment vector. The final exploitation pattern was smoothed, applying full exploitation on ages 7 and older, viz.

Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Ages 7+
0.001	0.005	0.013	0.073	0.233	0.473	1.000

The input data and results for the Y/R and SSB/R analyses are given in Table 41 and Figure 46. The biological reference points were $F_{0.1} = 0.16$, $F_{max} = 0.35$, and $F_{20\%} = 0.37$. An additional yield per recruit analysis was conducted using catch mean weights at age dis-aggregated by landings, large-mesh otter trawl discards, and shrimp fishery discards. The proportion of F for each component was also applied. Based on the landings per recruit, the biological reference points were slight lower ($F_{0.1} = 0.15$ and $F_{max} = 0.30$; Table 42).

MSY Based Reference Points

A non-equilibrium surplus production analysis (ASPIC; Prager, 1994,1995) was performed on total catch and survey indices of stock biomass from 1963 to 1998. The model was calibrated with NEFSC spring and autumn biomass indices, where spring indices were lagged back one year to calibrate biomass at the end of the previous year. Exploratory formulations included unconstrained survey catchabilities (q), and constrained q's. Spring and autumn biomass indices were well correlated (r=0.65) and fit the model reasonably well (r^2= 0.62 and 0.40, respectively. When q was unconstrained, the intrinsic rate of increase (r) was unreasonably high for this slow growing, long-lived species. In the final formulation, survey q's were fixed according to ADAPT estimates of age 3+ biomass. The dynamic range of the model was good (the B-ratio coverage was 1.7 and the B-ratio nearness = 1.0). Results of the final formulation (Table 43) estimated MSY to be 2,684 mt; B_{msy} to be 25,000 mt and that the corresponding $F_{msy} = 0.106$.

Summary of reference point estimates from alternative ASPIC analyses:

q constraint	Surveys	MSY	Bmsy	Fmsy
No	Spring and Autumn	4.303	8.87	0.49
Yes	Spring and Autumn	3.049	20.19	0.15
Yes	Spring	3.096	18.24	0.17
Yes	Autumn	3.096	19.94	0.16

The Amendment 9 control rule states that when the stock biomass exceeds B_{msy}, the overfishing threshold is F_{msy}, and target F is the lower10th percentile of F_{msy} (Applegate et al. 1998). When stock biomass is less than B_{msy}, the overfishing threshold is based on maximum F that would allow rebuilding to B_{msy} in five years as derived by projections described by Cadrin (1999). When biomass is less than the biomass threshold, F = 0. The biomass threshold is defined by the minimum stock size that is projected to rebuild to B_{msy} in 5 years at F=0, as derived by Cadrin (1999).

The Amendment 9 control rule was updated with the revised estimates of F_{msy} (0.106), B_{msy} (25,000 mt) and the tenth percentile of F_{msy} (0.090; Figure 47). Based on the ADAPT estimates of age 3+ mean biomass in 1998 (18,934 mt) and F on biomass (0.13), overfishing was occurring in 1998 (Figure 47). The target fishing mortality prescribed by the control rule for the 1999 stock size is 0.09 on biomass, which is approximately equivalent to 0.19 on fully recruited ages assuming the current age structure of the population (assuming an equilibrium age structure, the F on 3+ biomass would be 0.12).

SHORT-TERM PROJECTIONS FOR 2000 AND 2001

Short-term three year stochastic projections were performed to estimate landings, SSB and total biomass (3+) during 2000-2001 under two F scenarios using bootstrapped VPA calibrated stock sizes in 1999 (age 3 and 4 stock sizes were estimated using RCT3 where the mean and standard error were used to generate 1,000 estimates of age 3 and 4 stock sizes from a log-normal distribution, and ages 5-11+ were taken from the VPA results). Assuming status quo landings in 1999, the fully-recruited F was projected to be 0.20. The partial recruitment, maturity ogive, and mean weights at age were the same as described in the yield and SSB per recruit section (Table 44). Recruitment (age 3) in 2000-2001 was derived by re-sampling the empirical observations during 1982-1997 (1979-1994 year classes). Fishing mortality was apportioned among landings and discards based on the proportion observed landed at age during 1995-1997. The proportion of F and M which occurs before spawning equals 0.1667 (March 1); M assumed to be 0.15. Spawning stock biomass and total biomass (3+) in 1998 were estimated to be 8,652

and 18,934 mt, respectively. The F scenarios are: status quo $F_{99} = 0.20$ and $F_{control\ rule} = 0.19$.

At fishing mortality of 0.20, landings are projected to increase to 3,033 mt in 2000, and 3,769 mt in 2001. SSB is projected to increase to 18,924 mt in 2000, and increase further to 23,440 mt in 2001. Total biomass (3+) will increase to 29,695 mt in 2000, and 31,955 mt in 2001, above B_{msy} of 25,000 mt (Table 44, Figure 48). Fishing at $F_{control\ rule}$ (0.19), landings in 2000 are projected to be 2,894 mt and will increase to 3,623 mt in 2001. SSB at $F_{control\ rule}$ will increase to 18,951 mt in 2000 and 23,619 mt in 2001 and total biomass (3+) is projected to be 29,779 mt in 2000 and 32,213 mt in 2001 (Table 48).

CONCLUSIONS

Based on the ADAPT VPA estimates of age 3+ mean biomass in 1998 (18,934 mt) and the 1998 F on 3+ biomass (0.13), overfishing was occurring in 1998. However, overfishing is not expected to occur in 1999 based on catch statistics to-date where estimated 3+ biomass in 1999 is projected to be 26,048 mt and F on 3+ biomass is estimated to be 0.20. Recent year classes appear to be above average. Fishing mortality should not be allowed to increase as fishing above F=0.19 (fishing mortality target) will dissipate the potential benefits that the recent recruitment levels should produce. Spawning stock biomass is still at a low level relative to the long-term survey biomass indices. It is clear that, despite the variability in the survey indices, the age range of the stock has been greatly reduced since 1985-1986 and that the catch at ages 2-4 is due almost entirely from fish discarded in the shrimp and large-mesh otter trawl fisheries.

ACKNOWLEDGMENTS

We would like to recognize all those who diligently collected the biological samples from the commercial fisheries and from research vessel surveys. We wish to express our appreciation to Colleen Close and Betty Holmes for their technical assistance. We thank Jay Burnett for the age determinations; L. O'Brien, Mark Terceiro, and Ralph Mayo for the VPA discussions; and Kathy Sosebee for deriving the 1999 NEFSC spring survey index. We thank all members of the Stock Assessment Workshop's Northern Demersal Working Group and the SARC panel for their review and helpful comments.

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Table 1. Significant changes in management regulations governing the USA commercial fishery for witch flounder (adapted from O'Brien and Brown, 1996).

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.
1998	May	Jeffery's Ledge year-around area closure to all fishing. Rolling closures in the Gulf of Maine.
	October	Amendment 9: revised overfishing definitions as required by Sustainable Fisheries Act.

Table 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**; 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.

Table 3. Witch flounder landings, discards and catch (metric tons, live) from Subareas 5 and 6, by country, 1960-1998 [1960-1963 reported to ICNAF/NAFO (Burnett and Clark, 1983)].

Year	Landings				Discards	Total USA Catch (used in VPA)
	Canada	USA [2]	Other [1]	Total		
1960	-	1255	-	1255		
1961	2	1022	-	1024		
1962	1	976	-	977		
1963	27	1226	121	1374		
1964	37	1381	-	1418		
1965	22	2140	502	2664		
1966	68	2935	311	3314		
1967	63	3370	249	3682		
1968	56	2807	191	3054		
1969	-	2542	1310	3852		
1970	19	3112	130	3261		
1971	35	3220	2860	6115		
1972	13	2934	2568	5515		
1973	10	2523	629	3162		
1974	9	1839	292	2140		
1975	13	2127	217	2357		
1976	5	1871	6	1882		
1977	11	2469	13	2493		
1978	18	3501	6	3525		
1979	17	2878	-	2895		
1980	18	3128	1	3147		
1981	7	3422	-	3449		
1982	9	4906	-	4915	48	4953
1983	45	6000	-	6045	162	6162
1984	15	6660	-	6675	100	6760
1985	46	6130	-	6431	61	6191
1986	67	4610	-	5216	25	4635
1987	23	3450	-	3819	47	3497
1988	45	3262	-	3665	60	3322
1989	13	2074	-	2384	133	2207
1990	12	1478	-	1492	184	1662
1991	7	1798	-	1805	95	1893
1992	7	2246	-	2253	171	2417
1993	10	2605	-	2615	376	2981
1994	34	2670	-	2704	422	3092
1995	11	2212	-	2223	265	2477
1996	10	2088	-	2098	454	2542
1997	7	1775	-	1782	393	2168
1998	*	1849	-	1849	334	2184

[1] Includes West Germany, East Germany, Poland, Spain, Japan, & the former USSR.
[2] excluding landings from Grand Banks (subarea 3).
* 1998 Canadian landings not available.

Table 4. Summary of USA commercial witch flounder landings (mt) by Statistical Area, 1973 - 1998.

	Statistical Areas																								
																561	562								
YEAR	300	400	464	465	466	500	510	511	512	513	514	515	520	521	522	523*	524*	525	526	530	537	538	539	540	600	TOTAL
1973	-	27	-	21	-	-	-	102	236	470	349	39	-	266	412	20	74	192	271	-	26	0	4	-	14	2523
1974	-	49	-	2	4	-	-	19	76	319	213	23	-	334	294	17	104	145	192	-	41	2	2	-	3	1839
1975	-	15	-	18	1	-	-	18	150	360	289	92	-	371	238	10	159	281	105	-	13	0	3	-	4	2127
1976	-	22	-	6	2	-	-	25	140	470	365	37	-	278	209	24	81	144	50	-	12	2	1	-	3	1871
1977	-	5	-	5	2	-	-	15	192	756	682	101	-	257	250	19	62	71	30	-	13	2	5	-	2	2469
1978	-	11	-	5	-	-	-	8	333	1370	642	164	-	366	306	85	86	38	45	-	20	8	4	-	10	3501
1979	-	5	-	1	-	-	-	67	270	1025	416	120	-	367	393	97	35	15	28	-	21	1	3	-	14	2878
1980	-	4	-	7	-	-	-	44	278	1320	386	258	-	317	231	67	26	38	111	-	19	1	6	-	15	3128
1981	-	7	-	34	-	-	-	66	317	1410	419	322	-	390	183	68	62	48	40	-	39	0	9	-	28	3442
1982	-	22	-	34	-	-	1	154	759	1432	427	760	-	558	289	120	52	69	96	-	51	6	12	-	64	4906
1983	-	31	-	145	-	-	-	252	1233	1460	479	1045	-	555	322	121	46	63	104	-	88	2	14	-	40	6000
1984	-	15	-	147	-	-	-	158	750	1564	788	1322	-	800	430	155	67	118	181	-	99	1	8	-	57	6660
1985	255	5	-	68	-	-	-	234	752	1474	658	1263	-	735	468	128	62	99	106	-	34	1	2	-	41	6385
1986	539	12	-	66	1	-	-	204	765	1213	468	787	-	481	298	100	20	33	77	-	31	2	2	-	50	5149
1987	346	3	-	15	-	-	-	103	441	1039	364	720	-	344	214	55	20	25	47	-	16	0	1	-	43	3796
1988	358	-	-	11	-	-	-	94	288	958	352	617	-	450	207	53	35	96	47	-	13	1	1	-	39	3620
1989	297	1	-	2	-	-	-	32	175	517	224	381	-	304	135	39	28	52	129	-	21	2	1	-	31	2371
1990	2	5	-	2	-	-	-	24	135	429	183	188	-	164	82	35	36	55	77	-	38	0	2	-	23	1480
1991	-	2	-	1	-	-	-	19	168	470	198	281	-	146	138	43	54	36	87	-	85	1	2	-	67	1798
1992	-	1	-	-	-	-	-	13	235	520	227	332	-	152	188	46	39	63	219	-	143	0	4	-	64	2246
1993	-	12	-	-	-	-	-	14	175	580	419	422	-	180	270	82	65	94	134	-	98	0	2	-	58	2605
1994*	-	-	3	-	-	11	7	45	349	414	414	360	4	382	326	70	40	57	43	4	73	11	4	5	47	2670
1995*	-	-	10	10	-	14	4	25	150	311	337	455	6	382	331	42	15	33	13	4	25	4	1	2	36	2212
1996*	-	-	3	3	-	16	25	35	132	378	289	436	25	287	294	44	9	45	6	1	27	9	2	3	20	2088
1997*	-	-	-	1	-	20	12	12	165	292	224	388	11	196	286	48	8	57	13	-	21	6	1	-	14	1775
1998*	-	-	-	1	-	22	2	13	153	268	205	404	4	280	299	65	24	47	10	1	20	12	5	2	10	1849

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

* 1994-1998 spatial distribution based upon Vessel Trip Report data, considered provisional.

Table 5. Percentage of annual USA commercial witch flounder landings by gear type, 1973-1998.

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

Table 6. Percentage of annual USA commercial witch flounder landings by month for all gear types, 1973-1998.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1973	5.0	3.2	8.8	10.9	14.2	14.4	10.8	10.7	5.3	7.6	5.6	3.6	100.0
1974	4.6	3.6	5.6	11.3	16.8	12.1	14.0	10.3	7.3	6.1	4.8	3.4	100.0
1975	3.7	4.3	6.1	10.7	14.3	13.2	13.8	9.1	7.8	6.2	6.9	3.9	100.0
1976	3.2	4.8	7.5	12.2	12.4	16.1	14.0	8.7	7.9	5.2	4.2	3.7	100.0
1977	4.3	6.1	10.2	9.2	9.2	10.9	12.0	10.9	7.8	6.7	7.1	5.4	100.0
1978	5.9	10.6	5.9	10.4	12.9	12.9	10.1	7.8	6.3	7.7	5.0	4.4	100.0
1979	7.2	5.2	8.1	7.2	9.0	15.5	12.1	9.3	7.6	6.9	6.7	5.2	100.0
1980	5.1	8.9	7.2	9.9	10.5	13.6	11.2	9.8	7.9	6.5	4.6	4.9	100.0
1981	7.5	5.8	10.5	8.0	9.0	13.0	9.2	7.8	8.5	6.9	6.6	7.2	100.0
1982	5.9	6.4	10.7	8.8	9.7	9.3	9.2	8.4	7.4	8.2	7.8	8.0	100.0
1983	9.2	8.6	11.4	12.4	10.0	9.6	7.2	7.6	6.3	5.7	5.3	6.8	100.0
1984	9.7	9.1	10.6	11.0	10.8	8.8	6.8	6.9	6.3	7.9	6.2	6.1	100.0
1985	8.0	7.3	8.8	12.6	12.5	8.1	8.3	7.7	7.9	7.4	5.3	6.1	100.0
1986	7.1	7.2	8.1	12.4	13.9	11.9	11.5	6.7	6.2	5.3	4.1	5.7	100.0
1987	6.4	6.8	8.8	9.7	15.1	11.4	8.7	7.7	6.5	5.9	5.7	7.3	100.0
1988	9.4	7.8	11.5	11.4	15.6	12.3	7.7	6.1	6.3	4.3	4.0	3.6	100.0
1989	6.9	7.6	10.4	13.9	17.0	12.7	7.1	6.8	4.7	4.8	4.1	4.0	100.0
1990	9.3	7.5	8.4	8.6	13.5	11.5	8.8	8.7	6.5	5.7	5.9	5.7	100.0
1991	4.8	4.3	3.3	8.4	13.2	10.7	10.4	9.5	10.0	10.2	7.0	8.2	100.0
1992	6.1	6.8	6.7	14.5	14.0	10.6	7.3	7.3	6.4	6.7	8.2	5.3	100.0
1993	7.8	5.9	10.5	8.1	14.7	10.6	7.1	7.7	6.4	7.7	7.1	6.4	100.0
1994	8.5	7.7	7.9	11.0	9.8	10.9	8.1	7.7	7.8	8.7	6.0	5.9	100.0
1995	7.2	5.9	9.7	10.7	11.6	13.3	9.1	7.8	7.1	7.6	5.2	5.0	100.0
1996	6.1	6.3	7.0	8.4	12.9	11.8	9.9	10.0	6.8	7.7	6.0	7.1	100.0
1997	6.2	7.5	7.6	9.4	10.4	14.3	9.7	8.0	9.3	6.2	4.8	6.6	100.0
1998	4.9	7.3	11.1	11.9	12.5	13.4	8.8	8.2	6.8	5.9	4.0	5.2	100.0

Table 7. Percentage of annual USA commercial witch flounder landings by port, 1982-1998.

Port/State	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Rockland	22.9	24.4	19.8	18.4	19.6	36.2	35.7	34.8	31.3	32.1	29.3	1.0	0.5	0.7	0.6	0.9	1.2
Portland	16.3	21.5	12.6	13.6	10.1	11.2	10.5	11.1	1.6	2.4	2.6	35.7	39.3	36.5	40.3	40.8	32.9
Other Maine	14.0	13.0	11.3	8.8	10.1	11.9	10.6	6.1	8.2	9.0	10.7	10.9	11.0	8.5	8.7	8.7	11.2
NH	5.2	2.7	4.4	2.3	2.0	3.2	4.2	3.5	2.2	1.6	1.2	1.0	1.0	0.8	0.7	0.9	0.9
Boston	1.8	2.2	3.0	6.8	10.5	8.3	11.1	10.8	9.3	8.7	8.5	7.1	10.2	9.3	10.7	8.8	9.9
Gloucester	20.0	17.5	25.0	26.2	26.3	13.7	12.0	13.1	23.5	17.9	14.5	16.5	17.1	15.6	11.4	10.1	12.4
Chatham	1.3	1.0	1.5	1.4	0.8	1.9	2.1	2.0	1.0	0.8	0.7	1.0	0.6	0.8	0.6	0.7	0.8
New Bedford	3.3	4.8	8.5	10.4	11.5	6.4	5.5	7.7	8.0	9.1	15.1	13.0	9.6	20.6	19.7	20.2	21.4
Plymouth	0.7	1.3	1.1	1.1	0.8	0.9	0.8	0.7	0.4	0.8	0.8	0.7	0.2	0.1	0.1	0.0	0.3
Provincetown	5.8	5.0	4.4	3.3	2.9	1.7	1.4	3.1	4.2	6.0	3.2	4.4	2.6	2.3	1.5	1.5	2.4
Other Mass.	2.3	2.2	2.6	1.3	1.0	1.2	1.0	0.9	1.4	0.7	0.4	0.7	0.7	1.6	1.5	1.5	1.3
Newport	3.0	2.2	2.8	3.5	2.0	1.5	2.7	3.5	4.1	4.5	4.7	3.6	2.1	0.7	1.6	2.6	1.5
Point Judith	1.7	1.4	2.6	2.6	1.6	1.0	1.4	1.7	3.7	4.0	5.8	2.5	1.5	0.5	0.9	2.0	3.0
Other RI	0.5	0.2	0.0	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.5	0.3	0.3
CT	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.4	0.3	0.2	-
New York	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.2	0.8	1.1	0.7	2.1	0.7	0.5	0.4	0.2
New Jersey	0.8	0.4	0.4	0.4	0.5	0.4	0.5	0.6	0.8	1.3	1.3	1.0	0.8	0.3	0.3	0.3	0.2
Maryland	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Virginia	0.3	0.1	0.1	0.0	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.4	0.4	0.2	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 8. Percentage of annual USA commercial witch flounder landings by market category, 1973 - 1998.

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

Table 9. 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 - 1998. The sampling ratio represents the amount of landings per length sample.

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	Total All	Sampling 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	
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	

Table 9 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	Total All	Sampling Ratio
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	67
	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	
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	74
	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	52
	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	

Note: 1994-1998 landings (mt) from all areas.

Table 10. Data pooling procedures used to apply age and length frequency samples to landings by market category and quarter to estimate landings (numbers) at age of witch flounder from 1982-1998.

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=>	

Year	Mkt. Cat.	Quarter 1	Quarter 2	Quarter 3	Quarter 4
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=>	
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===>			

Table 11. **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 - 1998.

	Age																
Year	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	0.00	0.00	0.00	117.90	826.60	1119.90	1454.30	665.20	656.00	399.50	239.40	201.00	356.30	183.70	837.40	7057.20	1578.40
1983	0.00	0.00	0.00	219.80	768.60	1033.70	1567.30	1590.20	977.80	737.70	510.40	366.00	287.30	289.10	733.10	9081.00	1675.50
1984	0.00	0.00	0.00	90.60	1012.40	1808.70	1734.30	1486.50	1497.50	696.70	375.10	279.50	356.40	261.30	821.60	10420.6	1718.80
1985	0.00	0.00	0.00	0.00	985.10	2026.80	1933.80	1524.90	1247.90	606.00	400.40	261.20	221.50	170.70	705.80	10084.1	1359.20
1986	0.00	0.00	0.00	6.30	298.50	1441.60	2772.60	1566.90	834.90	412.70	222.80	188.20	157.00	137.00	276.00	8314.50	758.20
1987	0.00	0.00	0.00	0.00	81.50	321.60	1276.00	1574.70	870.90	480.60	252.40	132.40	90.80	62.10	204.10	5347.10	489.40
1988	0.00	0.00	0.00	0.00	50.80	176.00	654.70	1382.70	1154.10	401.50	266.70	124.10	94.00	71.90	307.50	4684.00	597.50
1989	0.00	0.00	0.00	0.00	7.30	49.80	315.20	761.60	884.70	350.70	123.80	73.40	61.30	56.80	157.50	2842.10	349.00
1990	0.00	0.00	0.00	0.00	183.20	579.40	257.90	276.30	475.30	336.90	82.10	43.50	38.80	19.30	77.50	2370.20	179.10
1991	0.00	0.00	0.00	0.00	181.70	741.70	525.70	238.60	247.50	295.60	317.30	52.40	44.50	22.80	141.10	2808.90	260.80
1992	0.00	0.00	0.00	0.00	513.70	846.60	943.50	723.10	203.40	179.40	121.10	219.50	46.70	26.70	87.30	3911.00	380.20
1993	0.00	0.00	0.00	0.00	422.80	1024.50	919.10	598.10	586.50	219.10	279.00	114.00	32.60	103.80	140.70	4440.20	391.10
1994	0.00	0.00	0.00	0.00	201.68	1432.10	1288.65	828.40	197.06	540.16	113.70	71.49	40.32	132.53	80.56	4926.65	324.90
1995	0.00	0.00	0.00	0.00	23.72	764.04	1599.60	849.85	267.81	97.35	269.86	55.03	43.94	8.15	49.94	4029.29	157.06
1996	0.00	0.00	0.00	0.00	45.82	468.05	1264.74	1431.51	263.42	215.63	57.09	78.87	3.57	13.02	18.23	3859.95	113.69
1997	0.00	0.00	0.00	0.00	212.65	529.11	1051.80	1016.31	592.64	83.33	49.90	17.92	36.65	2.21	13.46	3605.98	70.24
1998	0.00	0.00	0.00	0.00	18.10	488.22	1214.17	1583.87	370.71	141.42	15.54	37.18	5.55	19.90	7.71	3902.37	70.34
USA Commercial Landings in Weight (mt) at Age																	
1982	0.00	0.00	0.00	25.47	227.32	386.37	616.62	365.86	476.91	353.96	235.33	230.35	447.16	240.65	1300.48	4906.46	2218.63
1983	0.00	0.00	0.00	42.86	197.53	332.85	642.59	823.72	599.39	586.47	498.66	408.46	347.06	381.90	1137.04	5998.54	2274.45
1984	0.00	0.00	0.00	19.21	271.32	625.81	731.87	801.22	994.34	569.20	345.84	280.62	431.96	348.05	1241.44	6660.89	2302.06
1985	0.00	0.00	0.00	0.00	249.23	630.33	829.60	861.57	862.30	510.25	385.99	276.09	264.25	223.79	1037.53	6130.92	1801.65
1986	0.00	0.00	0.00	0.53	67.76	441.13	1131.22	835.16	564.39	352.03	217.23	213.04	188.24	180.43	419.80	4610.96	1001.51
1987	0.00	0.00	0.00	0.00	22.17	109.99	553.78	883.41	597.44	397.94	247.35	141.27	110.96	86.07	299.41	3449.79	637.71
1988	0.00	0.00	0.00	0.00	15.75	64.59	284.79	743.89	770.94	328.83	261.37	133.28	111.86	92.75	454.18	3262.23	792.07
1989	0.00	0.00	0.00	0.00	1.90	17.13	133.96	437.16	603.37	286.87	119.84	82.80	77.12	74.69	239.24	2074.07	473.85
1990	0.00	0.00	0.00	0.00	56.43	187.15	112.96	161.91	327.01	286.03	86.12	52.77	48.97	29.36	129.35	1478.04	260.43
1991	0.00	0.00	0.00	0.00	51.97	275.17	232.89	137.91	173.74	247.12	309.05	57.59	60.92	35.04	216.73	1798.13	370.28
1992	0.00	0.00	0.00	0.00	168.49	324.25	433.07	443.98	150.31	147.47	106.81	228.06	62.44	38.96	143.17	2247.01	472.63
1993	0.00	0.00	0.00	0.00	123.46	372.92	397.05	319.98	390.61	193.25	285.42	127.45	39.09	142.00	213.72	2604.94	522.26
1994	0.00	0.00	0.00	0.00	62.12	511.26	554.12	442.37	136.17	449.41	103.35	77.42	47.26	159.57	126.96	2670.00	411.21
1995	0.00	0.00	0.00	0.00	6.74	280.40	716.62	476.77	184.79	88.69	262.84	60.59	52.86	11.50	70.22	2212.01	195.16
1996	0.00	0.00	0.00	0.00	11.91	166.16	550.16	793.06	186.50	184.58	55.61	87.86	5.00	18.75	28.40	2087.99	140.01
1997	0.00	0.00	0.00	0.00	67.62	188.89	428.08	503.07	372.18	72.58	51.75	20.93	43.83	3.73	22.33	1775.00	90.82
1998	0.00	0.00	0.00	0.00	4.25	161.60	463.81	779.26	216.87	123.18	15.20	41.46	6.28	25.09	12.00	1849.01	84.84

Table 11 continued.

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
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	39.8	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	57.8	57.8	43.8	56.5
1992	0.0	0.0	0.0	0.0	37.0	38.6	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	53.0	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	40.8	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

Table 12. Summary of the Domestic Sea Sampling Program trips which caught witch flounder in the Gulf of Maine - Georges Bank region and the availability of length samples (number of measured fish) of kept (K) and discarded (D) witch flounder, by year, gear and quarter (Q), 1989-1998.

		Shrimp Trawl					Sink Gillnet				
Year		Q1	Q2	Q3	Q4	Total	Q1	Q2	Q3	Q4	Total
1989	Trips	6	12	.	4	22	.	.	8	7	15
	Lengths (K)	8	.	.	.	8	.	.	83	3	86
	Lengths (D)	362	491	.	.	853	.	.	.	.	.
1990	Trips	13	4	.	4	21	.	27	6	5	38
	Lengths (K)	.	.	.	.	.	.	102	95	.	197
	Lengths (D)	37	134	.	.	171	.	20	.	.	20
1991	Trips	21	9	.	5	35	.	68	134	32	234
	Lengths (K)	.	.	.	.	.	.	463	714	.	1177
	Lengths (D)	326	971	.	286	1583	.	2	.	.	2
1992	Trips	49	4	.	6	59	7	94	60	31	192
	Lengths (K)	.	.	.	.	.	.	122	56	15	193
	Lengths (D)	310	55	.	231	596	.	6	.	.	6
1993	Trips	37	1	.	3	41	5	65	28	36	134
	Lengths (K)	1	.	.	.	1	1	8	4	18	31
	Lengths (D)	998	23	.	85	1106	.	4	.	4	8
1994	Trips	50	2	.	5	57	3	5	7	3	18
	Lengths (K)	.	.	.	.	.	2	40	28	6	76
	Lengths (D)	1060	5	.	1139	2204	.	.	17	1	18
1995	Trips	45	6	.	8	59	.	7	15	3	25
	Lengths (K)	.	.	.	.	.	.	170	309	2	481
	Lengths (D)	1540	513	.	399	2452	.	.	9	.	9
1996	Trips	11	8	.	5	24	3	12	6	1	22
	Lengths (K)	.	.	.	.	.	5	149	16	.	170
	Lengths (D)	191	733	.	172	1096	1	3	1	.	5
1997	Trips	10	.	.	.	10	1	8	5	1	15
	Lengths (K)	.	.	.	.	.	.	170	3	.	173
	Lengths (D)	268	.	.	.	268	.	.	.	.	.
1998	Trips	.	.	.	.	.	.	11	4	1	16
	Lengths (K)	.	.	.	.	.	.	.	11	4	5
	Lengths (D)	.	.	.	.	.	.	.	.	.	.

Table 12. continued.

Year		Large-Mesh Otter Trawl Q1	Q2	Q3	Q4	Total	Small-Mesh Otter Trawl Q1	Q2	Q3	Q4	Total
1989	Trips	3	18	25	6	52	1	2	12	2	17
	Lengths (K)	387	218	153	139	897	.	.	.	.	.
	Lengths (D)	6	62	319	92	479	.	53	.	.	53
1990	Trips	3	8	9	8	28	.	1	2	3	6
	Lengths (K)	184	12	39	.	235	.	.	.	.	.
	Lengths (D)	20	.	10	.	30	.	.	29	.	29
1991	Trips	8	10	18	17	53	1	3	1	4	9
	Lengths (K)	21	.	56	116	193	.	.	.	.	.
	Lengths (D)	15	.	97	51	163	.	.	.	.	.
1992	Trips	23	10	4	5	42	4	1	3	3	11
	Lengths (K)	62	42	.	.	104	.	.	.	.	.
	Lengths (D)	31	.	.	.	31	33	.	.	.	33
1993	Trips	6	8	7	4	25	1	.	.	.	1
	Lengths (K)	96	220	104	447	867	.	.	.	.	.
	Lengths (D)	166	262	161	68	657	1	.	.	.	1
1994	Trips	10	6	3	2	21	.	3	.	2	5
	Lengths (K)	529	.	.	172	701	.	.	.	45	45
	Lengths (D)	39	25	102	23	189	.	.	.	4	4
1995	Trips	24	11	5	6	46	4	.	16	13	33
	Lengths (K)	2267	1229	210	573	4279	131	.	308	.	439
	Lengths (D)	1101	632	275	298	2306	694	.	342	451	1487
1996	Trips	7	11	.	1	19	2	2	26	18	48
	Lengths (K)	1211	286	.	.	1497	.	.	.	18	18
	Lengths (D)	194	90	.	75	359	.	173	946	2739	3858
1997	Trips	9	1	4	3	17	4	.	.	.	4
	Lengths (K)	666	.	44	.	710	6	.	.	.	6
	Lengths (D)	537	56	62	15	670	107	.	.	.	107
1998	Trips	4	4	2	.	10	.	.	.	.	.
	Lengths (K)	186	.	.	.	186	.	.	.	.	.
	Lengths (D)	71	129	3	.	203	.	.	.	.	.

Table 13. Number of trips, hauls and sampled fish from the Massachusetts Sea Sampling Program by year and fishery from the Gulf of Maine-Georges Bank region from trips which caught witch flounder. Parenthesis indicate number of trips and hauls which were sampled for length frequency; D= discard; K = Kept.

Year		Small-Mesh Otter Trawl	Large-Mesh Otter Trawl	Shrimp Trawl
1989	trips	1	-	-
	hauls	1	-	-
	# of fish	-	-	-
1990	trips	-	-	-
	hauls	-	-	-
	# of fish	-	-	-
1991	trips	-	-	-
	hauls	-	-	-
	# of fish	-	-	-
1992	trips	2	-	-
	hauls	5	-	-
	# of fish	-	-	-
1993	trips	2	1	6 (4)
	hauls	2	1	11 (7)
	# of fish	-	-	21 D
1994	trips	-	-	6 (3)
	hauls	-	-	13 (3)
	# of fish	-	-	148 D
1995	trips	8	-	5 (2)
	hauls	21	-	13 (3)
	# of fish	-	-	156 D
1996	trips	-	-	10 (3)
	hauls	-	-	21 (9)
	# of fish	-	-	141 D
1997	trips	-	-	6 (4)
	hauls	-	-	16 (5)
	# of fish	-	-	205 D
1998	trips	data unavailable		
	hauls			
	# of fish			

Table 14. Number of age samples (individual fish) of discarded witch flounder from Domestic Sea Sampling Program trips in the Gulf of Maine - Georges Bank region, by year and quarter, all gear types, 1989-1998.

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
1989	-	6	5	-	11
1990	-	-	-	-	-
1991	-	-	-	-	-
1992	-	-	-	-	-
1993	-	26	1	-	27
1994	29	-	-	-	29
1995	107	31	32	42	212
1996	20	128	8	48	204
1997	166	115	25	55	361
1998	60	77	3	26	166

Note: 1993-1998 not aged, values based on hand tallies.

Table 15. Results (p-values) of Kruskal-Wallis non-parametric one-way analysis of variance tests of fishing zone discard rates (kg/days fished) from sea sampled trips conducted by the NEFSC Domestic Sea Sampling Program, 1989 - 1997.

Year	Zone 1 vs Zone 2	Zone 2 vs Zone 3	Zone 1 vs Zone 3
1989	0.2923	0.0014	0.0099
1990	0.0558	0.1387	0.0170
1991	0.0623	0.0010	0.0001
1992	0.5002	0.7441	0.6044
1993	0.0075	0.0413	0.0005
1994	0.8274	0.0134	0.0020
1995	0.0061	0.0263	0.0001
1996	0.0495	0.0005	0.0003
1997	0.1002	0.4659	0.1573

Table 16. Estimated discard rates (kg/day fished) by fishing zone[1] obtained from a ratio estimator (kg of witch flounder discarded to days fished) using Domestic Sea Sampling 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 17. Days fished for January-May and December, weight discarded (mt), and numbers ('000s) of witch flounder discarded in the Gulf of Maine northern shrimp fishery for the **calendar year**, 1982-1998. Calendar year discard weight and numbers at age were derived by partitioning the shrimp discard weight and numbers at age by the proportion of days fish for December and January-May categories.

	Calendar Year			
	Days fished[1]		Estimated Discard Weight (mt)	Estimated Discard Numbers of fish('000s)
	January - May	December		
1982	970.1	35.6	5.93	62.14
1983	1121.3	141.7	12.56	131.67
1984	1612.3	237.6	10.97	110.94
1985	1843.8	272.8	12.12	91.32
1986	2122.3	428.9	13.11	98.80
1987	3279.3	380.4	21.75	235.99
1988	2434.8	426.9	33.95	723.95
1989	2412.6	491.9	18.93	219.81
1990	2712.7	377.6	28.54	468.56
1991	2210.1	172.3	29.44	443.85
1992	2141.0	113.2	18.14	384.45
1993	1789.0	161.7	8.77	356.77
1994	1820.6	530.8	16.11	1891.71
1995	2844.9	547.6	33.81	1176.37
1996	2695.3	645.2	13.75	250.46
1997	3016.0	361.4	13.31	304.52
1998	1833.9	48.7	17.12	389.10

[1] 1994-1998 days fished estimated from NMFS weighout and Vessel Trip Reports.

Table 18. **Shrimp fishery discards at age** in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 1998.

	Age																
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
1994	8.06	1368.4	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	1891.7	0.00
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	1176.3	0.00
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	0.00
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	0.00
1998	0.00	44.07	256.67	59.77	21.04	6.56	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	389.10	0.00
Shrimp Fishery Discards in Weight (mt) at Age																	
1982	0.00	0.00	0.06	1.09	2.13	1.86	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.93	0.00
1983	0.00	0.00	0.15	2.31	4.50	3.94	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56	0.00
1984	0.00	0.01	0.03	2.33	4.06	3.20	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.97	0.00
1985	0.00	0.01	0.08	0.94	5.80	4.73	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.12	0.00
1986	0.00	0.01	0.10	1.34	6.24	4.86	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.11	0.00
1987	0.01	0.29	2.63	1.11	9.37	7.45	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.75	0.00
1988	0.00	0.09	2.22	17.87	5.14	7.77	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.95	0.00
1989	0.01	0.12	1.58	4.04	9.34	3.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.93	0.00
1990	0.01	0.05	2.72	10.31	10.44	5.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.54	0.00
1991	0.01	0.25	0.47	12.97	12.04	2.56	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.44	0.00
1992	0.01	0.28	2.84	5.07	9.79	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.14	0.00
1993	0.32	0.67	2.41	2.19	1.93	1.19	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.77	0.00
1994	0.04	6.16	9.24	0.62	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.11	0.00
1995	0.01	0.37	14.52	17.74	1.02	0.06	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.81	0.00
1996	0.02	0.62	1.57	5.54	5.32	0.38	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.74	0.00
1997	0.03	1.76	3.43	4.17	2.72	1.05	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.31	0.00
1998	0.00	0.18	8.47	4.30	2.80	1.04	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.12	0.00

Table 18 continued.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
Shrimp Fishery Discards 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	-	0.004	0.033	0.072	0.133	0.158	0.220	-	-	-	-	-	-	--	-	0.044	-
														-	-		-
Shrimp Fishery Discards 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	-	-	-	-	-	-	-	-	28.2	-
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	-	10.2	19.0	23.9	28.9	30.3	33.4	-	-	-	-	-	-	-	-	19.6	

Table 19. Spreadsheet calculations for estimating semi-annual discarded witch flounder in the large-mesh otter trawl fishery. This spreadsheet illustrates 1993, quarters 1 and 2 with the NEFSC spring survey. The **bold** numbers indicate columns and the mathematical operation performed.

1993 Landings from Q1+Q2 and 1993 spring survey								
	1	**2**	**3=1*2**	**4**	**5=3*4**	**6=3-5**	**7**	**8=6*factor**
Length (cm)	Survey No/tow	140 mm Prop. Retained	Survey Retained	Prop Kept	Survey Kept	Survey Discarded	100's Numbers Landed	units Numbers Discarded
1	0.000	0.00005	0.0000	0.00	0.0000	0.0000	0	0
3	0.000	0.00008	0.0000	0.00	0.0000	0.0000	0	0
5	0.034	0.00015	0.0000	0.00	0.0000	0.0000	0	34
7	0.064	0.00028	0.0000	0.00	0.0000	0.0000	0	120
9	0.051	0.00051	0.0000	0.00	0.0000	0.0000	0	174
11	0.000	0.00092	0.0000	0.00	0.0000	0.0000	0	0
13	0.000	0.00168	0.0000	0.00	0.0000	0.0000	0	0
15	0.011	0.00305	0.0000	0.00	0.0000	0.0000	0	224
17	0.067	0.00554	0.0004	0.00	0.0000	0.0004	0	2483
19	0.042	0.01005	0.0004	0.00	0.0000	0.0004	0	2823
21	0.028	0.01816	0.0005	0.00	0.0000	0.0005	0	3401
23	0.042	0.03261	0.0014	0.00	0.0000	0.0014	0	9161
25	0.061	0.05787	0.0035	0.00	0.0000	0.0035	0	23612
27	0.165	0.10065	0.0166	0.00	0.0000	0.0166	0	111083
29	0.079	0.16938	0.0134	0.00	0.0000	0.0134	0	89503
31	0.205	0.27091	0.0555	0.01	0.0006	0.0550	0	367759
33	0.165	0.40372	0:0666	0.10	0.0067	0.0600	231	401011
35	0.152	0.55231	0.0840	0.99	0.0831	0.0008	2519	5615
37	0.076	0.69211	0.0526	1.00	0.0526	0.0000	4892	0
39	0.042	0.80377	0.0338	1.00	0.0338	0.0000	3984	0
41	0.050	0.88184	0.0441	1.00	0.0441	0.0000	3143	0
43	0.000	0.93150	0.0000	1.00	0.0000	0.0000	1699	0
45	0.000	0.96121	0.0000	1.00	0.0000	0.0000	1658	0
47	0.000	0.97833	0.0000	1.00	0.0000	0.0000	1293	0
49	0.054	0.98799	0.0534	1.00	0.0534	0.0000	1268	0
51	0.046	0.99337	0.0457	1.00	0.0457	0.0000	1225	0
53	0.000	0.99635	0.0000	1.00	0.0000	0.0000	812	0
55	0.018	0.99799	0.0180	1.00	0.0180	0.0000	486	0
57	0.000	1.0000	0.0000	1.00	0.0000	0.0000	354	0
59	0.000	1.0000	0.0000	1.00	0.0000	0.0000	198	0
61	0.000	1.0000	0.0000	1.00	0.0000	0.0000	72	0
63	0.019	1.0000	0.0190	1.00	0.0190	0.0000	27	0
65	0.000	1.0000	0.0000	1.00	0.0000	0.0000	4	0
67	0.000	1.0000	0.0000	1.00	0.0000	0.0000	0	0
69	0.000	1.0000	0.0000	1.00	0.0000	0.0000	0	0
71	0.000	1.0000	0.0000	1.00	0.0000	0.0000	0	0
TOTAL	1.471		0.5088		0.3568	0.1520	2,386,500	1,017,005
							Factor =	**6,688,621**

1: From SURVAN, stratified mean number per tow at length.
2: From LOGEST Program using 140 mm mesh in 1993 from adjusted 130-d mm from Walsh et al. (1992) for Am plaice
4: knife-edge at 36 cm
7: From Length BIOSTAT

Table 20. Estimated number (000's) of witch flounder discarded in the large-mesh otter trawl fishery in the Gulf of Maine-Georges Bank region derived from a ratio estimator of NEFSC index of 'kept' number per tow (spring and autumn) to semi-annual (quarters 1 & 2, and 3 & 4) numbers of fish landed (in thousands of fish), 1982-1998, and percentage (%) of discarded fish to landed fish.

	SPRING				AUTUMN				Total		
	Survey		Landings Q1&Q2		Survey		Landings Q3&Q4				
Year	Kept Index	Discard Index	Numbers Landed	Numbers Discarded	Kept Index	Discard Index	Numbers Landed	Numbers Discarded	Numbers Landed	Numbers Discarded	%
1982	2.137	0.178	3,481	290	0.832	0.017	3,305	69	6,786	359	5.3
1983	2.928	0.341	5,246	612	2.115	0.285	3,351	451	8,597	1,062	12.4
1984	1.852	0.103	5,703	317	2.618	0.176	4,207	282	9,909	599	6.1
1985	3.378	0.149	5,349	236	2.054	0.039	4,486	85	9,835	321	3.3
1986	1.691	0.013	4,946	37	1.248	0.018	2,806	41	7,751	79	1.0
1987	0.785	0.035	2,874	129	0.393	0.001	2,354	8	5,227	136	2.6
1988	1.144	0.019	3,225	53	0.551	0.060	1,364	150	4,589	203	4.4
1989	0.727	0.182	1,837	461	0.281	0.083	924	273	2,760	734	26.6
1990	0.204	0.081	1,364	545	0.308	0.144	889	415	2,252	960	43.0
1991	0.615	0.050	1,178	97	0.533	0.137	1,396	359	2,574	455	17.7
1992	0.541	0.071	2,100	277	0.194	0.096	1,441	711	3,541	988	27.9
1993	0.357	0.152	2,387	1,017	0.435	0.284	1,769	1,154	4,155	2,171	52.3
1994	0.591	0.401	2,571	1,744	0.582	0.111	2,152	412	4,723	2,156	45.6
1995	0.646	0.129	2,250	449	0.641	0.326	1,674	853	3,924	1,303	33.2
1996	0.357	0.179	1,884	946	1.095	0.849	1,915	1,486	3,799	2,432	64.0
1997	0.522	0.440	1,906	1,604	1.272	0.364	1,632	467	3,539	2,071	58.5
1998	1.132	0.505	2,371	1,057	0.509	0.227	1,490	665	3,861	1,723	44.6

Table 21. **Large-mesh otter trawl discards at age** in numbers (thousands of fish), weight (mt) and mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 1998.

	Age																
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
Large-mesh otter trawl 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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
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	0.00
1993	1.70	6.96	22.01	378.54	1371.0	391.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2171.25	0.00
1994	0.00	0.02	0.94	22.35	800.5	1330.4	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2155.99	0.00
1995	0.00	0.01	5.21	160.47	581.53	432.87	122.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1302.62	0.00
1996	0.00	0.00	0.23	19.93	847.12	1508.1	56.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2432.13	0.00
1997	0.00	0.01	1.18	18.38	786.45	930.79	334.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2071.03	0.00
1998	0.00	0.01	3.33	87.69	571.15	791.18	269.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1722.55	0.00
Large-mesh otter trawl discards in Weight (mt) at Age																	
1982	0.00	0.00	0.00	2.37	27.74	9.26	3.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.44	0.00
1983	0.00	0.00	0.02	5.20	70.35	73.19	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	149.04	0.00
1984	0.00	0.00	0.00	0.66	59.81	28.28	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	88.81	0.00
1985	0.00	0.00	0.00	14.88	23.47	10.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.75	0.00
1986	0.00	0.00	0.00	0.17	3.59	8.19	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	0.00
1987	0.00	0.00	0.01	0.70	3.07	21.84	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.68	0.00
1988	0.00	0.00	0.00	9.01	7.49	9.87	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.55	0.00
1989	0.00	0.00	0.12	50.63	63.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	113.86	0.00
1990	0.00	0.02	0.07	10.92	51.89	92.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	155.75	0.00
1991	0.00	0.00	0.35	14.36	17.27	22.78	10.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.41	0.00
1992	0.00	0.01	1.28	36.21	111.58	4.10	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	153.31	0.00
1993	0.00	0.10	1.10	48.83	239.92	77.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	367.77	0.00
1994	0.00	0.00	0.04	2.30	140.09	263.43	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	406.30	0.00
1995	0.00	0.00	0.36	19.26	97.70	88.31	25.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	231.23	0.00
1996	0.00	0.00	0.01	1.79	130.46	295.59	12.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	439.88	0.00
1997	0.00	0.00	0.08	2.02	129.76	177.78	70.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	379.83	0.00
1998	0.00	0.00	0.18	8.86	97.10	156.65	54.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	316.89	0.00

Table 21 continued.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
Large-mesh otter trawl 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	0.000	-	-	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	-	0.020	0.070	0.120	0.168	0.204	0.209	-	-	-	-	-	-	-	-	0.178	-
1996	-	0.014	0.050	0.090	0.154	0.196	0.212	-	-	-	-	-	-	-	-	0.181	-
1997	-	0.020	0.065	0.110	0.165	0.191	0.210	-	-	-	-	-	-	-	-	0.183	-
1998	-	0.021	0.054	0.101	0.170	0.198	0.201	-	-	-	-	-	-	-	-	0.184	-
Large-mesh otter trawl 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	-	16.7	23.8	27.9	30.8	32.8	33.0	-	-	-	-		-	-	-	31.3	-
1996	-	15.0	21.5	25.7	30.1	32.3	33.1	-	-	-	-		-	-	-	31.5	-
1997	-	16.6	23.3	27.2	30.7	32.1	33.0	-	-	-	-		-	-	-	31.7	-
1998	-	16.9	22.2	26.6	31.0	32.4	32.6						-	-	-	31.7	-

Table 22. **All discards** (shrimp fishery and large-mesh otter trawl fishery) **at age** in numbers (thousands of fish), weight (mt) and mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 1998.

	Age																
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
All Discards in Numbers (1000's) at Age																	
1982	0.03	0.06	1.72	72.59	237.87	87.77	21.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	421.15	0.00
1983	0.00	0.02	4.28	117.31	577.57	487.06	7.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1194.07	0.00
1984	0.00	0.33	0.88	56.01	453.91	194.00	5.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	710.43	0.00
1985	0.00	0.34	3.47	123.58	191.02	91.41	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	412.26	0.00
1986	0.00	0.53	3.86	16.65	78.57	75.19	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177.55	0.00
1987	2.08	18.92	79.93	22.25	99.76	145.46	4.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	372.46	0.00
1988	0.42	14.66	130.29	600.27	89.11	88.30	3.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	926.62	0.00
1989	0.85	10.69	50.32	447.05	428.96	15.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	953.33	0.00
1990	1.46	6.29	95.30	343.93	452.57	528.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1428.38	0.00
1991	3.06	17.90	23.26	441.77	226.22	130.86	56.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	899.07	0.00
1992	2.84	44.35	159.43	399.46	746.25	19.77	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1372.56	0.00
1993	113.76	85.80	129.59	417.23	1385.13	396.06	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2528.02	0.00
1994	8.06	1368.48	496.44	41.97	800.50	1330.50	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4047.70	0.00
1995	2.68	49.96	635.31	641.30	593.78	433.07	122.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2478.99	0.00
1996	5.21	32.68	51.06	119.38	906.33	1510.22	57.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2682.59	0.00
1997	8.68	74.92	104.10	104.87	810.16	938.09	334.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2375.55	0.00
1998	0.00	44.08	260.00	147.46	592.19	797.74	270.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2111.65	0.00
All Discards in Weight (mt) at Age																	
1982	0.00	0.00	0.07	3.46	29.87	11.12	3.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.34	0.00
1983	0.00	0.00	0.16	7.51	74.84	77.13	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	161.60	0.00
1984	0.00	0.01	0.04	2.99	63.87	31.48	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.72	0.00
1985	0.00	0.01	0.08	15.82	29.26	15.14	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.87	0.00
1986	0.00	0.01	0.10	1.50	9.83	13.04	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.12	0.00
1987	0.01	0.29	2.63	1.81	12.45	29.29	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.41	0.00
1988	0.00	0.09	2.22	26.88	12.63	17.63	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.45	0.00
1989	0.01	0.13	1.70	54.67	72.45	3.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	132.79	0.00
1990	0.01	0.07	2.79	21.22	62.33	97.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	184.28	0.00
1991	0.01	0.25	0.82	27.33	29.31	25.34	11.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	94.86	0.00
1992	0.01	0.30	4.13	41.28	121.37	4.24	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	171.43	0.00
1993	0.33	0.77	3.52	51.02	241.85	79.01	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	376.31	0.00
1994	0.04	6.16	9.28	2.92	140.09	263.44	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	422.33	0.00
1995	0.01	0.37	14.88	36.99	98.71	88.36	25.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	265.03	0.00
1996	0.02	0.62	1.58	7.34	135.78	295.98	12.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	453.60	0.00
1997	0.03	1.76	3.50	6.19	132.48	178.83	70.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	393.08	0.00
1998	0.00	0.18	8.65	13.16	99.89	157.69	54.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	333.90	0.00

Table 22. Continued.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
All Discards Mean Weight (kg) at Age																	
1982	0.000	0.002	0.038	0.048	0.126	0.127	0.181	-	-	-	-	-	-	-	-	0.115	-
1983	-	0.009	0.038	0.064	0.130	0.158	0.248	-	-	-	-	-	-	-	-	0.135	-
1984	-	0.017	0.040	0.053	0.141	0.162	0.253	-	-	-	-	-	-	-	-	0.140	-
1985	-	0.017	0.023	0.128	0.153	0.166	0.231	-	-	-	-	-	-	-	-	0.148	-
1986	0.000	0.017	0.026	0.090	0.125	0.173	0.229	-	-	-	-	-	-	-	-	0.141	-
1987	0.006	0.015	0.033	0.081	0.125	0.201	0.232	-	-	-	-	-	-	-	-	0.127	-
1988	0.004	0.006	0.017	0.045	0.142	0.200	0.276	-	-	-	-	-	-	-	-	0.065	-
1989	0.009	0.012	0.034	0.122	0.169	0.249	-	-	-	-	-	-	-	-	-	0.139	-
1990	0.004	0.012	0.029	0.062	0.138	0.185	-	-	-	-	-	-	-	-	-	0.129	-
1991	0.004	0.014	0.035	0.062	0.130	0.194	0.211	-	-	-	-	-	-	-	-	0.106	-
1992	0.003	0.007	0.026	0.103	0.163	0.214	0.256	-	-	-	-	-	-	-	-	0.125	-
1993	0.003	0.009	0.027	0.122	0.175	0.199	0.317	-	-	-	-	-	-	-	-	0.149	-
1994	0.005	0.004	0.019	0.070	0.175	0.198	0.256	-	-	-	-	-	-	-	-	0.104	-
1995	0.005	0.007	0.023	0.058	0.166	0.204	0.209	-	-	-	-	-	-	-	-	0.107	-
1996	0.004	0.019	0.031	0.061	0.150	0.196	0.213	-	-	-	-	-	-	-	-	0.169	-
1997	0.004	0.023	0.034	0.059	0.164	0.191	0.210	-	-	-	-	-	-	-	-	0.165	-
1998	-	0.004	0.033	0.089	0.169	0.198	0.201	-	-	-	-	-	-	-	-	0.158	-
All Discards Mean Length (cm) at Age																	
1982	5.0	7.8	19.9	21.1	28.1	28.4	31.5	-	-	-	-	-	-	-	-	27.2	-
1983	-	13.0	20.0	22.9	28.4	30.4	34.6	-	-	-	-	-	-	-	-	28.8	-
1984	-	15.7	20.0	21.6	29.3	30.6	34.8	-	-	-	-	-	-	-	-	29.0	-
1985	-	15.7	16.9	28.4	30.1	30.8	33.9	-	-	-	-	-	-	-	-	29.6	-
1986	5.0	15.7	17.3	25.1	28.2	31.2	33.8	-	-	-	-	-	-	-	-	29.0	-
1987	10.6	15.3	19.0	24.5	28.2	32.6	34.0	-	-	-	-	-	-	-	-	27.0	-
1988	10.2	10.9	15.6	20.4	29.2	32.5	35.8	-	-	-	-	-	-	-	-	21.7	-
1989	12.6	13.9	19.0	27.8	30.9	34.6	-	-	-	-	-	-	-	-	-	28.7	-
1990	9.7	14.0	18.0	22.3	29.1	31.7	-	-	-	-	-	-	-	-	-	27.6	-
1991	9.6	14.1	18.8	22.6	28.5	32.2	33.0	-	-	-	-	-	-	-	-	25.8	-
1992	9.1	10.9	17.4	26.1	30.5	33.2	35.0	-	-	-	-	-	-	-	-	27.1	-
1993	9.1	12.2	17.7	27.9	31.2	32.5	37.3	-	-	-	-	-	-	-	-	28.5	-
1994	10.7	9.8	15.9	22.8	31.2	32.4	35.0	-	-	-	-	-	-	-	-	22.4	-
1995	10.9	11.6	17.1	21.7	30.7	32.8	33.0	-	-	-	-	-	-	-	-	25.0	-
1996	10.0	15.3	18.5	22.7	29.8	32.3	33.2	-	-	-	-	-	-	-	-	30.5	-
1997	10.2	16.1	18.9	22.2	30.6	32.1	33.0	-	-	-	-	-	-	-	-	30.1	-
1998	-	10.2	19.0	25.5	30.9	32.4	32.6	-	-	-	-	-	-	-	-	29.5	-

Table 23. **Total USA commercial catch** in numbers, weight (thousands of fish; mt) and mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 1998.

	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	190.49	1064.47	1207.67	1475.40	665.20	656.00	399.50	239.40	201.00	356.30	183.70	837.40	7478.35	1578.40
1983	0.00	0.02	4.28	337.11	1346.17	1520.76	1575.12	1590.20	977.80	737.70	510.40	366.00	287.30	289.10	733.10	10275.0	1675.50
1984	0.00	0.33	0.88	146.61	1466.31	2002.70	1739.59	1486.50	1497.50	696.70	375.10	279.50	356.40	261.30	821.60	11131.0	1718.80
1985	0.00	0.34	3.47	123.58	1176.12	2118.21	1936.24	1524.90	1247.90	606.00	400.40	261.20	221.50	170.70	705.80	10496.3	1359.20
1986	0.00	0.53	3.86	22.95	377.07	1516.79	2775.35	1566.90	834.90	412.70	222.80	188.20	157.00	137.00	276.00	8492.05	758.20
1987	2.08	18.92	79.93	22.25	181.26	467.06	1280.06	1574.70	870.90	480.60	252.40	132.40	90.80	62.10	204.10	5719.56	489.40
1988	0.42	14.66	130.29	600.27	139.91	264.30	658.27	1382.70	1154.10	401.50	266.70	124.10	94.00	71.90	307.50	5610.62	597.50
1989	0.85	10.69	50.32	447.05	436.26	65.27	315.20	761.60	884.70	350.70	123.80	73.40	61.30	56.80	157.50	3795.43	349.00
1990	1.46	6.29	95.30	343.93	635.77	1108.23	257.90	276.30	475.30	336.90	82.10	43.50	38.80	19.30	77.50	3798.58	179.10
1991	3.06	17.90	23.26	441.77	407.92	872.56	581.70	238.60	247.50	295.60	317.30	52.40	44.50	22.80	141.10	3707.97	260.80
1992	2.84	44.35	159.43	399.46	1259.95	866.37	943.97	723.10	203.40	179.40	121.10	219.50	46.70	26.70	87.30	5283.56	380.20
1993	113.76	85.80	129.59	417.23	1807.93	1420.56	919.56	598.10	586.50	219.10	279.00	114.00	32.60	103.80	140.70	6968.22	391.10
1994	8.06	1368.4	496.44	41.97	1002.18	2762.60	1290.40	828.40	197.06	540.16	113.70	71.49	40.32	132.53	80.56	8974.35	324.90
1995	2.68	49.96	635.31	641.30	617.50	1197.11	1722.49	849.85	267.81	97.35	269.86	55.03	43.94	8.15	49.94	6508.28	157.06
1996	5.21	32.68	51.06	119.38	952.15	1978.27	1322.45	1431.51	263.42	215.63	57.09	78.87	3.57	13.02	18.23	6542.54	113.69
1997	8.68	74.92	104.10	104.87	1022.81	1467.20	1386.54	1016.31	592.64	83.33	49.90	17.92	36.65	2.21	13.46	5981.53	70.24
1998	0.00	44.08	260.00	147.46	610.29	1285.96	1484.36	1583.87	370.71	141.42	15.54	37.18	5.55	19.90	7.71	6014.02	70.34
USA Commercial Catch in Weight (mt) at Age																	
1982	0.00	0.00	0.07	28.93	257.18	397.49	620.44	365.86	476.91	353.96	235.33	230.35	447.16	240.65	1300.48	4953.04	2218.63
1983	0.00	0.00	0.16	50.38	272.37	409.99	644.53	823.72	599.39	586.47	498.66	408.46	347.06	381.90	1137.04	6163.84	2274.45
1984	0.00	0.01	0.04	22.19	335.19	657.29	733.21	801.22	994.34	569.20	345.84	280.62	431.96	348.05	1241.44	6758.46	2302.06
1985	0.00	0.01	0.08	15.82	278.49	645.47	830.16	861.57	862.30	510.25	385.99	276.09	264.25	223.79	1037.53	6192.03	1801.65
1986	0.00	0.01	0.10	2.03	77.59	454.17	1131.85	835.16	564.39	352.03	217.23	213.04	188.24	180.43	419.80	4639.63	1001.51
1987	0.01	0.29	2.63	1.81	34.61	139.28	554.73	883.41	597.44	397.94	247.35	141.27	110.96	86.07	299.41	3496.29	637.71
1988	0.00	0.09	2.22	26.88	28.38	82.23	285.78	743.89	770.94	328.83	261.37	133.28	111.86	92.75	454.18	3320.56	792.07
1989	0.01	0.13	1.70	54.67	74.34	20.98	133.96	437.16	603.37	286.87	119.84	82.80	77.12	74.69	239.24	2207.36	473.85
1990	0.01	0.07	2.79	21.22	118.76	285.01	112.96	161.91	327.01	286.03	86.12	52.77	48.97	29.36	129.35	1663.03	260.43
1991	0.01	0.25	0.82	27.33	81.28	300.51	244.69	137.91	173.74	247.12	309.05	57.59	60.92	35.04	216.73	1892.69	370.28
1992	0.01	0.30	4.13	41.28	289.86	328.48	433.19	443.98	150.31	147.47	106.81	228.06	62.44	38.96	143.17	2420.12	472.63
1993	0.33	0.77	3.52	51.02	365.31	451.93	397.20	319.98	390.61	193.25	285.42	127.45	39.09	142.00	213.72	2982.11	522.26
1994	0.04	6.16	9.28	2.92	202.20	774.70	554.57	442.37	136.17	449.41	103.35	77.42	47.26	159.57	126.96	3091.68	411.21
1995	0.01	0.37	14.88	36.99	105.45	368.77	742.33	476.77	184.79	88.69	262.84	60.59	52.86	11.50	70.22	2477.76	195.16
1996	0.02	0.62	1.58	7.34	147.69	462.14	562.47	793.06	186.50	184.58	55.61	87.86	5.00	18.75	28.40	2542.19	140.01
1997	0.03	1.76	3.50	6.19	200.10	367.72	498.40	503.07	372.18	72.58	51.75	20.93	43.83	3.73	22.33	2166.45	90.82
1998	0.00	0.18	8.65	13.16	104.15	319.29	518.14	779.26	216.87	123.18	15.20	41.46	6.28	25.09	12.00	2183.79	84.84

Table 23 continued.

Year	Age 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total	11+
USA Commercial Catch 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	0.000	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	0.582	1.358
1990	0.004	0.012	0.029	0.062	0.187	0.257	0.438	0.586	0.688	0.849	1.049	1.213	1.262	1.521	1.669	0.438	1.454
1991	0.004	0.014	0.035	0.062	0.199	0.344	0.421	0.578	0.702	0.836	0.974	1.099	1.369	1.537	1.536	0.510	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	0.458	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	0.345	1.266
1995	0.005	0.007	0.023	0.058	0.171	0.308	0.431	0.561	0.690	0.911	0.974	1.101	1.203	1.411	1.406	0.381	1.243
1996	0.004	0.019	0.031	0.061	0.155	0.234	0.425	0.554	0.708	0.856	0.974	1.114	1.401	1.440	1.558	0.389	1.232
1997	0.004	0.023	0.034	0.059	0.196	0.251	0.359	0.495	0.628	0.871	1.037	1.168	1.196	1.687	1.659	0.362	1.293
1998	-	0.004	0.033	0.089	0.171	0.248	0.349	0.492	0.585	0.871	0.978	1.115	1.132	1.261	1.557	0.363	1.206
USA Commercial Catch 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	5.0	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	39.8	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	57.8	57.8	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	53.0	53.4	57.8	33.0	54.1
1995	10.9	11.6	17.1	21.7	30.9	36.1	39.6	42.8	45.4	49.3	50.1	52.0	53.4	56.0	55.8	35.5	53.8
1996	10.0	15.3	18.5	22.7	30.0	33.5	39.5	42.7	45.8	48.4	50.1	52.2	55.8	56.2	57.6	37.3	53.6
1997	10.2	16.1	18.9	22.2	31.8	34.1	37.6	41.3	44.2	48.5	51.1	52.9	53.3	59.0	58.7	36.6	54.4
1998	-	10.2	19.0	25.5	31.0	34.1	37.3	41.2	43.3	48.7	50.5	52.3	52.7	54.1	57.6	36.6	53.4

Table 24. Mean weights at age (kg) at the beginning of the year (January 1) for witch flounder, 1982-1998. Values derived from catch mean weight-at-age data (mid-year, Table 23) using procedures described by Rivard (1980).

	Age														
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	11+
1982	0.000	0.019	0.132	0.229	0.295	0.380	0.521	0.695	0.844	0.923	1.116	1.223	1.282	1.553	1.406
1983	0.004	0.009	0.075	0.175	0.256	0.367	0.467	0.581	0.760	0.930	1.047	1.177	1.288	1.551	1.357
1984	0.015	0.019	0.076	0.185	0.257	0.337	0.470	0.586	0.708	0.856	0.990	1.163	1.268	1.511	1.339
1985	0.014	0.020	0.072	0.189	0.264	0.375	0.488	0.610	0.748	0.887	0.987	1.094	1.261	1.470	1.326
1986	0.012	0.021	0.045	0.162	0.266	0.353	0.478	0.618	0.768	0.906	1.045	1.126	1.253	1.521	1.321
1987	0.014	0.024	0.046	0.130	0.248	0.360	0.478	0.605	0.748	0.914	1.020	1.176	1.289	1.467	1.303
1988	0.003	0.016	0.039	0.128	0.244	0.360	0.483	0.612	0.750	0.901	1.026	1.127	1.256	1.477	1.326
1989	0.008	0.014	0.046	0.087	0.255	0.364	0.499	0.606	0.739	0.890	1.051	1.162	1.251	1.519	1.358
1990	0.007	0.019	0.046	0.151	0.209	0.375	0.499	0.628	0.761	0.926	1.084	1.193	1.383	1.669	1.454
1991	0.010	0.020	0.042	0.111	0.254	0.329	0.503	0.641	0.758	0.909	1.074	1.289	1.393	1.536	1.420
1992	0.004	0.019	0.060	0.119	0.275	0.397	0.508	0.654	0.760	0.859	1.006	1.212	1.413	1.640	1.243
1993	0.006	0.014	0.056	0.144	0.270	0.405	0.496	0.639	0.807	0.917	0.993	1.116	1.352	1.519	1.335
1994	0.002	0.013	0.043	0.157	0.238	0.370	0.480	0.608	0.744	0.895	1.053	1.145	1.201	1.576	1.266
1995	0.003	0.010	0.033	0.109	0.249	0.347	0.491	0.607	0.793	0.900	1.000	1.141	1.286	1.406	1.243
1996	0.014	0.015	0.037	0.095	0.200	0.362	0.489	0.630	0.769	0.942	1.042	1.242	1.316	1.558	1.232
1997	0.019	0.025	0.043	0.109	0.197	0.290	0.459	0.590	0.785	0.942	1.067	1.154	1.537	1.659	1.293
1998	0.001	0.028	0.055	0.100	0.220	0.296	0.420	0.538	0.740	0.923	1.075	1.150	1.228	1.557	1.206
1982-1998	0.009	0.018	0.056	0.140	0.247	0.357	0.484	0.615	0.764	0.907	1.040	1.170	1.309	1.541	1.319

Table 25. 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 - 1998.

	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	152	1178	0.13	1957	11260	0.19
1976	756	2826	0.27	913	6373	0.14	96	860	0.11	1765	10059	0.19
1977	1074	3182	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	1280	4069	0.31	3245	12156	0.27	1423	4769	0.30	5949	20994	0.28
1985	1194	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	646	2833	0.23	1623	9592	0.17	845	5035	0.17	3114	17461	0.18
1988	560	2986	0.19	1463	8948	0.16	950	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*	295	2214	0.13	761	6220	0.12	460	3448	0.13	1516	11882	0.13
1995*	291	2786	0.10	870	7415	0.12	479	4012	0.12	1640	14212	0.12
1996*	371	2651	0.14	919	7058	0.13	416	3287	0.13	1706	12996	0.13
1997*	371	2666	0.14	734	5095	0.14	281	2414	0.12	1385	10175	0.14
1998*	393	2648	0.15	699	4722	0.15	256	1877	0.14	1349	9247	0.15

Table 25 continued.

YEAR	CLASS 2			CLASS 3			CLASS 4			TOTAL		
	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF	L	DF	L\DF
40% TRIPS												
1973	306	208	1.47	392	270	1.45	96	58	1.66	793	536	1.48
1974	134	99	1.34	169	112	1.50	20	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	1.71
1984	234	210	1.12	704	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	376	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*	96	224	0.43	96	233	0.41	17	22	0.77	210	479	0.45
1995*	90	237	0.38	159	331	0.48	31	60	0.52	280	628	0.45
1996*	139	309	0.45	172	386	0.45	40	60	0.67	351	755	0.47
1997*	98	238	0.41	158	311	0.51	17	36	0.48	273	585	0.47
1998*	154	327	0.47	173	268	0.65	5	6	0.90	332	601	0.57

* based upon Vessel Trip Report data.

Table 26. Stratified mean number, weight (kg) and length (cm) 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), 1963-1998, *1999 preliminary*.

	SPRING			AUTUMN		
YEAR	Number per tow	Weight per tow	Length per tow	Number per tow	Weight per tow	Length per tow
1963	-	-	-	5.52	3.46	39.7
1964	-	-	-	2.89	2.00	44.2
1965	-	-	-	3.94	2.27	40.6
1966	-	-	-	7.80	4.56	41.2
1967	-	-	-	3.01	2.02	43.6
1968	4.76	3.34	42.5	4.82	3.49	44.8
1969	3.74	2.53	45.3	5.81	4.40	43.9
1970	6.39	4.49	44.7	4.89	3.71	45.0
1971	2.74	2.06	46.5	4.32	2.95	42.1
1972	5.35	4.01	45.8	3.24	2.42	43.9
1973	8.20	6.21	44.8	3.18	2.05	43.6
1974	6.23	3.62	39.3	2.34	1.54	40.9
1975	3.72	2.75	43.9	1.66	1.03	39.8
1976	5.50	3.70	42.3	1.34	0.94	41.9
1977	4.20	1.96	37.2	5.06	3.38	42.0
1978	3.87	2.56	41.7	4.04	2.94	42.9
1979	3.01	1.77	38.3	1.94	1.62	45.2
1980	8.46	3.89	36.0	2.62	2.04	43.6
1981	8.40	4.18	38.1	3.66	2.19	40.4
1982	3.64	1.87	37.2	0.99	0.83	44.7
1983	6.41	2.74	36.3	4.72	2.12	36.7
1984	3.00	1.66	39.9	4.37	2.34	39.7
1985	5.18	2.75	40.3	2.76	1.59	42.0
1986	2.07	1.35	44.1	1.59	1.09	43.3
1987	1.01	0.65	43.4	0.48	0.37	44.0
1988	1.43	0.85	42.3	1.38	0.57	35.2
1989	1.95	0.74	35.8	0.89	0.38	31.3
1990	0.63	0.24	35.2	2.00	0.40	24.8
1991	1.68	0.57	31.5	2.08	0.54	29.3
1992	1.26	0.50	34.8	0.94	0.24	29.5
1993	1.47	0.36	30.3	5.15	0.54	17.0
1994	3.13	0.53	27.4	2.21	0.42	24.9
1995	1.88	0.47	30.7	4.47	0.62	25.7
1996	1.36	0.28	30.5	5.38	1.02	29.7
1997	2.22	0.43	31.0	5.10	0.77	24.9
1998	4.27	0.77	29.0	3.70	0.47	24.2
1999	*3.15*	*0.48*	*28.1*			

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 27. 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), 1978-1998.

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

Table 28. 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 - 1998.

Year	Number per tow	Weight per tow	Length per tow	Individual Weight per tow
1984	3.707	1.264	33.9	0.341
1985	5.275	2.206	36.2	0.418
1986	2.046	0.741	35.9	0.362
1987	4.874	1.498	26.5	0.307
1988	2.531	0.602	25.8	0.238
1989	2.919	0.307	22.8	0.105
1990	6.657	1.023	24.5	0.154
1991	14.942	1.197	19.6	0.080
1992	24.284	1.914	20.5	0.079
1993	21.422	0.495	12.8	0.023
1994	36.358	2.200	19.1	0.061
1995	17.953	1.481	22.6	0.082
1996	15.448	1.946	25.2	0.126
1997	23.195	1.421	19.1	0.061
1998	7.347	0.520	21.9	0.071

Table 29. 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 - 1998, *1999 preliminary*.

	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	*169*	*138*	*81.7*	*10*				

Table 30. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1982-1998, *1999 preliminary*.

	AGE															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total
Spring																
1980	0.00	0.06	0.23	0.95	1.52	0.72	1.20	1.02	0.38	0.40	0.31	0.30	0.12	0.16	1.10	8.46
1981	0.00	0.00	0.05	0.82	0.93	2.00	1.02	0.76	0.67	0.42	0.13	0.20	0.24	0.22	0.90	8.40
1982	0.00	0.04	0.01	0.56	0.57	0.34	0.21	0.64	0.41	0.08	0.26	0.15	0.03	0.03	0.30	3.64
1983	0.00	0.00	0.03	0.58	1.25	1.33	0.55	0.64	0.67	0.48	0.20	0.09	0.08	0.11	0.41	6.41
1984	0.00	0.00	0.01	0.10	0.33	0.73	0.42	0.26	0.28	0.24	0.11	0.12	0.09	0.02	0.29	3.00
1985	0.00	0.00	0.00	0.02	0.43	1.11	1.19	0.86	0.45	0.13	0.06	0.14	0.09	0.04	0.67	5.18
1986	0.00	0.00	0.00	0.00	0.04	0.24	0.53	0.43	0.17	0.18	0.07	0.04	0.08	0.05	0.25	2.07
1987	0.00	0.00	0.00	0.00	0.06	0.12	0.12	0.26	0.17	0.03	0.06	0.03	0.00	0.00	0.15	1.01
1988	0.00	0.02	0.02	0.06	0.00	0.07	0.31	0.38	0.25	0.16	0.08	0.04	0.02	0.00	0.02	1.43
1989	0.00	0.02	0.01	0.04	0.98	0.12	0.07	0.10	0.31	0.07	0.03	0.05	0.05	0.02	0.06	1.95
1990	0.00	0.01	0.00	0.04	0.09	0.32	0.02	0.02	0.02	0.06	0.01	0.00	0.01	0.00	0.03	0.63
1991	0.00	0.04	0.00	0.78	0.11	0.11	0.19	0.02	0.09	0.10	0.14	0.02	0.02	0.00	0.07	1.68
1992	0.00	0.05	0.01	0.19	0.37	0.08	0.12	0.15	0.05	0.14	0.02	0.01	0.05	0.00	0.02	1.26
1993	0.00	0.15	0.11	0.14	0.46	0.33	0.06	0.08	0.00	0.02	0.02	0.00	0.06	0.00	0.04	1.47
1994	0.00	0.10	0.71	0.53	0.64	0.83	0.16	0.03	0.02	0.06	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	0.11	0.12	0.04	0.00	0.04	0.03	0.00	0.00	1.88
1996	0.00	0.02	0.04	0.24	0.41	0.33	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	0.71	0.58	0.46	0.08	0.10	0.00	0.00	0.00	0.00	0.00	0.00	2.22
1998	0.00	0.11	1.06	0.73	0.41	0.79	0.70	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*	*0.96*	*0.81*	*0.47*	*0.18*	*0.18*	*0.03*	*0.01*	*0.02*	*0.00*	*0.00*	*0.00*	*0.00*	*3.15*
Autumn																
1980	0.04	0.00	0.02	0.00	0.20	0.26	0.28	0.36	0.17	0.15	0.27	0.04	0.16	0.12	0.57	2.62
1981	0.03	0.07	0.03	0.24	0.44	0.61	0.46	0.27	0.26	0.18	0.21	0.17	0.04	0.13	0.48	3.66
1982	0.02	0.00	0.00	0.06	0.01	0.02	0.08	0.25	0.13	0.01	0.03	0.03	0.00	0.06	0.29	0.99
1983	0.00	0.01	0.01	0.49	1.60	0.78	0.51	0.47	0.11	0.10	0.12	0.09	0.02	0.00	0.42	4.72
1984	0.00	0.00	0.00	0.08	0.97	1.01	0.58	0.54	0.32	0.14	0.12	0.06	0.04	0.14	0.38	4.37
1985	0.00	0.00	0.01	0.07	0.06	0.60	0.62	0.58	0.24	0.13	0.09	0.01	0.03	0.10	0.22	2.76
1986	0.01	0.00	0.00	0.01	0.04	0.27	0.36	0.31	0.15	0.11	0.02	0.02	0.01	0.05	0.23	1.59
1987	0.00	0.00	0.02	0.01	0.00	0.02	0.05	0.18	0.07	0.00	0.01	0.00	0.02	0.00	0.08	0.48
1988	0.00	0.00	0.00	0.71	0.07	0.00	0.03	0.22	0.06	0.05	0.03	0.06	0.02	0.03	0.08	1.38
1989	0.17	0.02	0.02	0.08	0.30	0.01	0.02	0.04	0.05	0.09	0.01	0.00	0.03	0.00	0.04	0.89
1990	0.48	0.12	0.11	0.39	0.52	0.17	0.05	0.02	0.02	0.05	0.00	0.00	0.01	0.04	0.03	2.00
1991	0.22	0.02	0.17	0.67	0.35	0.27	0.15	0.09	0.06	0.02	0.04	0.03	0.00	0.00	0.00	2.08
1992	0.09	0.03	0.11	0.27	0.22	0.06	0.05	0.00	0.00	0.02	0.01	0.02	0.00	0.01	0.04	0.94
1993	2.54	0.67	0.11	0.55	0.76	0.23	0.06	0.03	0.08	0.00	0.02	0.04	0.00	0.01	0.01	5.15
1994	0.42	0.17	0.28	0.50	0.20	0.39	0.04	0.11	0.00	0.04	0.01	0.00	0.01	0.00	0.04	2.21
1995	0.51	0.21	0.80	1.57	0.86	0.49	0.22	0.00	0.00	0.01	0.05	0.00	0.00	0.00	0.01	4.74
1996	0.23	0.09	0.27	0.74	2.02	1.40	0.45	0.06	0.06	0.03	0.00	0.04	0.00	0.00	0.00	5.38
1997	0.89	0.34	1.00	0.53	0.86	0.77	0.40	0.32	0.00	0.00	0.00	0.00	0.02	0.00	0.00	5.10
1998	0.64	0.08	0.54	1.33	0.48	0.31	0.17	0.10	0.04	0.02	0.00	0.00	0.00	0.00	0.00	3.70

Table 31. Witch flounder mean length (cm) at age in spring and autumn NEFSC bottom trawl surveys (Strata 22-30, 36-40), 1982-1998, *1999 preliminary*.

	AGE														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
Spring															
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	-	8.0	15.5	20.0	27.1	32.3	35.7	40.4	44.1	48.6	50.5	51.3	57.5	53.5	57.2
1983	-	-	17.8	20.7	26.4	31.3	35.8	40.3	43.4	47.6	52.3	54.7	49.5	55.9	54.5
1984	-	-	15.5	17.7	29.6	32.7	37.5	41.8	43.3	47.2	51.4	50.9	53.0	53.5	57.0
1985	-	-	-	19.5	28.7	33.4	36.9	41.1	44.8	46.3	45.5	51.0	49.1	55.5	56.4
1986	-	-	-	-	26.8	35.0	38.3	41.8	45.8	49.1	51.4	51.9	54.1	57.1	57.1
1987	-	-	-	-	27.6	34.2	40.3	41.3	44.1	47.0	51.1	47.5	-	-	55.7
1988	-	9.5	15.5	19.2	-	33.4	39.3	43.0	45.9	50.7	54.3	49.9	59.5	-	57.5
1989	-	7.5	14.5	21.5	28.6	33.1	40.1	43.5	44.9	50.2	50.4	53.0	57.7	47.5	59.5
1990	-	9.5	-	19.5	28.0	32.6	39.5	41.5	49.5	50.2	51.5	-	53.5	-	54.8
1991	-	7.5	-	20.4	27.5	35.4	37.8	43.5	48.1	49.6	51.9	53.5	53.5	-	51.3
1992	-	8.8	11.5	22.0	29.1	35.2	38.3	42.5	45.0	49.5	45.5	51.5	56.0	-	55.5
1993	-	7.7	18.2	23.6	30.0	34.5	38.2	40.4	-	49.5	49.5	-	50.9	-	59.6
1994	-	10.4	17.9	21.4	29.3	33.8	37.9	41.9	45.5	48.0	47.5	-	-	57.5	57.5
1995	-	9.8	17.2	22.3	27.0	34.3	37.1	43.6	45.8	49.8	-	54.5	58.1	-	-
1996	-	9.5	19.5	22.3	28.3	32.4	37.0	40.6	-	-	-	55.8	-	-	-
1997	-	10.9	15.9	22.2	29.5	31.7	36.1	42.7	44.8	-	-	-	-	-	-
1998	-	11.2	20.1	24.5	30.0	33.3	35.7	38.9	42.8	45.5	-	-	-	51.1	-
1999		*10.0*	*19.5*	*24.9*	*28.5*	*34.0*	*37.1*	*40.6*	*45.5*	*44.0*	*50.0*				
Autumn															
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	5.5	-	-	22.7	31.5	29.3	36.7	41.9	43.0	47.5	50.7	48.8	-	52.1	56.1
1983	-	13.5	19.5	24.6	30.1	34.6	38.8	42.2	45.5	48.5	51.1	51.8	51.5	-	58.8
1984	-	-	-	24.9	30.6	34.4	38.2	42.9	45.2	47.0	50.3	51.4	55.7	53.5	58.1
1985	-	-	19.5	26.3	29.2	34.4	38.5	42.9	46.5	49.4	49.8	53.5	55.5	51.7	58.6
1986	5.5	-	-	27.5	29.5	35.3	38.2	42.9	45.4	49.1	51.5	51.4	49.5	54.5	57.4
1987	-	-	15.5	27.5	-	35.5	38.9	41.4	43.6	-	49.5	-	55.5	-	60.4
1988	-	-	-	25.4	30.9	-	43.7	44.3	47.2	47.9	49.8	54.2	55.5	53.5	56.2
1989	5.9	15.5	18.5	24.2	31.2	35.5	43.5	45.5	47.0	49.4	51.5	-	54.7	-	64.7
1990	6.2	16.7	17.4	26.7	30.0	36.2	39.5	43.5	47.5	50.4	-	-	57.5	51.5	60.3
1991	5.7	14.7	20.5	26.2	30.4	36.6	41.6	47.2	47.5	45.5	54.8	55.5	-	-	-
1992	5.9	16.1	22.8	27.9	32.0	37.7	38.6	-	-	45.5	49.5	47.5	-	49.5	56.4
1993	5.6	14.1	22.4	28.8	32.3	35.9	42.2	43.6	46.2	-	55.5	51.5	-	63.5	57.5
1994	6.0	16.2	20.8	23.3	32.3	36.7	43.5	44.4	-	54.2	49.5	-	51.5	-	57.2
1995	6.6	16.3	22.2	26.4	29.9	35.4	39.2	-	-	53.5	50.6	-	-	-	55.5
1996	5.3	14.0	19.0	25.1	29.5	33.8	39.8	42.3	47.0	49.3	-	53.5	-	-	-
1997	6.2	16.2	19.9	25.8	30.6	35.1	37.9	42.4	-	-	-	-	46.3	-	-
1998	5.7	15.8	21.9	25.7	30.7	34.9	39.2	42.1	44.5	45.9	-	-	-	-	-

Table 32. Mean weight (kg) at age of witch flounder from the Gulf of Maine-Georges Bank region (SA 510-515, 520-522,525-526,561-562), derived from NEFSC spring and autumn bottom trawl survey, (strata 22-30, 36-40), 1982 - 1998.

Season	Age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
Spring															
1982	0.0000	0.0018	0.0155	0.0435	0.1210	0.2248	0.3001	0.4743	0.6471	0.8945	1.0048	1.0486	1.5536	1.2022	1.5897
1983	0.0000		0.0303	0.0498	0.1067	0.1870	0.2969	0.4469	0.5764	0.7973	1.0712	1.2571	0.8985	1.3696	1.3819
1984	0.0000		0.0152	0.0283	0.1588	0.2259	0.3526	0.5156	0.5774	0.7781	1.0480	1.0267	1.1686	1.2020	1.5470
1985	0.0000			0.0368	0.1396	0.2318	0.3286	0.4761	0.6411	0.7159	0.6582	1.0047	0.8676	1.3221	1.4149
1986	0.0000				0.1115	0.2629	0.3554	0.4810	0.6438	0.8369	0.9694	1.0053	1.1611	1.3875	1.4363
1987	0.0000				0.1278	0.2560	0.4377	0.4728	0.5965	0.7548	1.0246	0.7617			1.4519
1988	0.0000	0.0025	0.0142	0.0364		0.2177	0.3888	0.5395	0.6759	0.9301	1.1715	0.9209	1.5574		1.3838
1989	0.0000	0.0010	0.0139	0.0449	0.1261	0.1971	0.3957	0.5357	0.5960	0.8765	0.8891	1.0404	1.4238		1.6465
1990	0.0000	0.0026		0.0392	0.1319	0.2157	0.4347	0.5139	0.9159	0.9573	1.0481	0.0000	1.1408		1.2886
1991	0.0000	0.0014		0.0429	0.1258	0.2777	0.3440	0.5668	0.7839	0.8905	1.0684	1.1566	1.1566		1.0003
1992	0.0000	0.0024	0.0050	0.0528	0.1450	0.2654	0.3545	0.5237	0.6403	0.8966	0.6425	0.9597	1.3531		1.2742
1993	0.0000	0.0016	0.0256	0.0661	0.1506	0.2379	0.3376	0.4098		0.8219	0.8219		0.8818		1.6168
1994	0.0000	0.0049	0.0279	0.0520	0.1472	0.2364	0.3557	0.5129	0.6685	0.8023	0.7520			1.4078	1.4078
1995	0.0000	0.0032	0.0236	0.0575	0.1093	0.2425	0.3121	0.5410	0.6389	0.8524		1.1302	1.4264		
1996	0.0000	0.0037	0.0351	0.0562	0.1292	0.2010	0.3182	0.4275				1.3229			
1997	0.0000	0.0046	0.0184	0.0539	0.1391	0.1770	0.2783	0.4841	0.5703						
1998	0.0000	0.0054	0.0402	0.0774	0.1542	0.2189	0.2763	0.3782	0.5115	0.6492				0.9561	
Mean	0.0000	0.0029	0.0221	0.0492	0.1327	0.2280	0.3451	0.4882	0.6456	0.8303	0.9361	0.9719	1.2158	1.1941	1.4184

Table 32 continued.

Season	Age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
Autumn															
1982	0.0004			0.0650	0.2006	0.1355	0.3519	0.5413	0.6042	0.8601	1.0542	0.9325		1.1450	1.5352
1983		0.0123	0.0350	0.0887	0.1739	0.2761	0.4146	0.5488	0.6837	0.8625	1.0430	1.0884	1.0481		1.7014
1984				0.0918	0.1816	0.2678	0.3844	0.5706	0.6833	0.7779	0.9723	1.0443	1.3815	1.1931	1.6480
1985			0.0391	0.0982	0.1496	0.2563	0.3698	0.5383	0.7203	0.8782	0.9041	1.1771	1.3004	1.0301	1.5836
1986	0.0007			0.1310	0.1659	0.2995	0.3868	0.5744	0.6977	0.9112	1.0621	1.0572	0.9105	1.3158	1.5631
1987			0.0195	0.1327		0.3141	0.4250	0.5204	0.6203		0.9040		1.3432		1.9129
1988	0.0036			0.0889	0.1713		0.5793	0.5299	0.7621	0.8081	0.9112	1.2072	1.2904	1.1808	1.3875
1989	0.0007	0.0155	0.0326	0.0791	0.1893	0.3111	0.6190	0.6979	0.8100	0.9369	1.0579		1.2782		2.2664
1990	0.0008	0.0231	0.0269	0.1151	0.1702	0.3120	0.4196	0.5688	0.7716	1.0079			1.5407	1.0922	1.8824
1991	0.0006	0.0155	0.0491	0.1095	0.1803	0.3383	0.5222	0.7915	0.8201	0.6711	1.2865	1.3420			
1992	0.0006	0.0181	0.0654	0.1288	0.2028	0.3662	0.3861			0.6915	0.8788	0.7444		0.8788	1.3961
1993	0.0006	0.0133	0.0600	0.1431	0.2108	0.3065	0.5220	0.5773	0.7122		1.2822	0.9898		2.0425	1.4493
1994	0.0006	0.0202	0.0467	0.0676	0.2050	0.3138	0.5493	0.5874		1.2046	0.9017		0.9650		1.4391
1995	0.0008	0.0209	0.0566	0.0999	0.1490	0.2684	0.3821			1.1259	0.9099				1.2754
1996	0.0005	0.0124	0.0326	0.0837	0.1471	0.2332	0.4038	0.5046	0.7315	0.8537		1.1060			
1997	0.0008	0.0200	0.0399	0.0949	0.1714	0.2697	0.3491	0.5110					0.7050		
1998	0.0006	0.0187	0.0565	0.0928	0.1700	0.2664	0.3951	0.4948	0.5964	0.6677					
mean	0.0009	0.0173	0.0431	0.1006	0.1774	0.2834	0.4388	0.5705	0.7087	0.8755	1.0129	1.0689	1.1763	1.2348	1.6185

Table 33. Proportion mature at age for female witch flounder derived from probit analysis of NEFSC spring bottom trawl surveys, 1980 - 1998.

	Age										
Period	1	2	3	4	5	6	7	8	9	10	11+
1980-1982	0.00	0.00	0.00	0.00	0.02	0.15	0.49	0.82	0.97	1.00	1.00
1983-1984	0.00	0.00	0.00	0.04	0.20	0.52	0.80	0.97	1.00	1.00	1.00
1985-1990	0.00	0.00	0.01	0.15	0.65	0.96	1.00	1.00	1.00	1.00	1.00
1991-1993	0.00	0.00	0.00	0.01	0.10	0.40	0.80	0.97	1.00	1.00	1.00
1994-1998	0.00	0.00	0.00	0.08	0.45	0.85	1.00	1.00	1.00	1.00	1.00

Note: No maturity at age data before 1980.

Table 34. 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), 1963-1998.

Year	Spring
1963	-
1964	-
1965	-
1966	-
1967	-
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	0.325
1995	0.377
1996	0.174
1997	0.251
1998	0.499

Note: 1977-1982, 1983-1984, 1985-1990, 1991-1993, 1994-1998 ogives were used; No maturity at length data before 1977; the 1977-1982 period was applied to the 1963-1976 period.

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 35. Estimates of instantaneous total mortality (Z) for witch flounder in the Gulf of Maine-Georges Bank region, 1980-1998, derived from NEFSC spring and autumn bottom trawl survey data.

	AGE							LN(7+/ 8+)		
	3+	4+	5+	6+	7+	8+	Time Period	Spring	Autumn	Geometric Mean
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	3.58	3.02	2.45	2.11	1.90	1.26	1982-1985	0.46	0.32	0.38
1983	6.39	5.81	4.56	3.23	2.68	2.04				
1984	2.99	2.89	2.56	1.83	1.41	1.15				
1985	5.19	5.17	4.74	3.63	2.44	1.58				
1986	2.08	2.08	2.04	1.80	1.27	0.84	1986-1989	0.79	0.72	0.75
1987	1.00	1.00	0.94	0.82	0.70	0.44				
1988	1.39	1.33	1.33	1.26	0.95	0.57				
1989	1.90	1.86	0.88	0.76	0.69	0.59				
1990	0.62	0.58	0.49	0.17	0.15	0.13	1990-1993	0.55	0.40	0.47
1991	1.65	0.87	0.76	0.65	0.46	0.44				
1992	1.20	1.01	0.64	0.56	0.44	0.29				
1993	1.21	1.07	0.61	0.28	0.22	0.14				
1994	2.32	1.79	1.15	0.32	0.16	0.13	1994-1997	0.51	0.57	0.54
1995	1.73	1.15	0.83	0.65	0.34	0.23				
1996	1.30	1.06	0.65	0.32	0.10	0.03				
1997	2.08	1.93	1.22	0.64	0.18	0.10				
1998	3.10	2.37	1.96	1.17	0.47	0.26				
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	0.88	0.80	0.55				
1983	4.71	4.22	2.62	1.84	1.33	0.86				
1984	4.38	4.30	3.33	2.32	1.74	1.20				
1985	2.75	2.68	2.62	2.02	1.40	0.82				
1986	1.58	1.57	1.53	1.26	0.90	0.59				
1987	0.44	0.43	0.43	0.41	0.36	0.18				
1988	1.36	0.65	0.58	0.58	0.55	0.33				
1989	0.67	0.59	0.29	0.28	0.26	0.22				
1990	1.30	0.91	0.39	0.22	0.17	0.15				
1991	1.68	1.01	0.66	0.39	0.24	0.15				
1992	0.70	0.43	0.21	0.15	0.10	0.10				
1993	1.79	1.24	0.48	0.25	0.19	0.16				
1994	1.34	0.84	0.64	0.25	0.21	0.10				
1995	3.21	1.64	0.78	0.29	0.07	0.07				
1996	4.80	4.06	2.04	0.64	0.19	0.13				
1997	2.90	2.37	1.51	0.73	0.34	0.02				
1998	2.45	1.12	0.64	0.33	0.16	0.06				

Table 36. Parameter estimates (with associated statistics) and estimates of terminal F from alternative ADAPT formulations.

	Run 45	Run 46	Run 51	Run 52	Run 50	Run 54	Run 55	Run 56	Run 57
CAA	10+	10+	10+	10+	11+	11+	11+	11+	11+
Est.Ages	4,7,8,9	4,7,8,9	4,7,8,9	4,7,8,9	3- 10	4 - 10	3 - 10	4 - 10	3 - 10
NMFS-s	3, 9	3 , 9	3 - 9	3 - 9	3 - 11+	3 - 11+	3 - 11+	3 - 11+	3 - 11+
NMFS-a	3, 9	3, 9	3 - 9	3 - 9	3 - 11 +	3 - 11+	3 - 11+	3 - 11+	3 - 11+
LPUE-as	7, 8, 9	7, 8, 9	7, 8, 9	-	7,8,9,10,11+	-	-	-	-
Note:	lpue 82-98 update of 1994 assessment	lpue 82-93	no discards lpue 82-93		lpue 82-93	Appendix A	SARC: Age 3	SARC: no 1998 shrimp discards	SARC: Age 3 no 1998 shrimp discards
M.S.R.	.780	.789	1.857	.894	.697	.811	.812	.899	.812
N3 (cv)					8.37e4 .62		8.37e4 .67		8.37e4 .67
N4 (cv)	6.28e4 .46	6.02e4 .46	4.02e4 .71	6.02e4 .49	5.92e4 .44	5.99e4 .47	5.92e4 .47	5.39e4 .49	5.92e4 .47
N5 (cv)					1.45e4 .37	1.46e4 .39	1.45e4 .39	1.37e4 .42	1.45e4 .39
N6 (cv)					1.45e4 .33	1.46e4 .36	1.45e4 .36	1.41e4 .38	1.45e4 .36
N7 (cv)	1.23e4 .34	1.19e4 .34	1.24e4 .49	1.19e4 .36	1.17e4 .32	1.17e4 .35	1.17e4 .35	1.15e4 .37	1.17e4 .35
N8 (cv)	2.78e3 .32	2.39e3 .36	1.59e4 .40	2.40e3 .39	2.49e3 .42	2.23e3 .45	2.50e3 .45	4.52e3 .40	2.50e3 .45
N9 (cv)	1.37e3 .34	1.00e3 .41	5.09e3 .44	1.00e3 .44	1.03e3 .41	9.68e2 .45	1.04e3 .45	1.61e3 .42	1.04e3 .45
N10 (cv)					4.20e2 .49	3.90e2 .52	4.20e2 .52	6.94e2 .50	4.20e2 .52
Age 3 in 99						131 million	83 million	2.8 million	83 million
F 1	0	0	0	0	0	0	0	0	0
F 2	.003	.003	.001	.003	.003	.002	.003	.001	0
F 3	.002	.002	.0	.002	.002	.002	.003	.002	.001
F 4	.02	.02	.005	.02	.04	.04	.04	.04	.04
F 5	.08	.01	.02	.10	.08	.08	.08	.08	.08
F 6	.11	.11	.09	.11	.11	.11	.11	.11	.11
F 7	.42	.47	.09	.48	.46	.51	.46	.28	.46
F 8	.22	.29	.07	.29	.29	.30	.29	.19	.29
F 9	.32	.39	.08	.39	.27	.29	.27	.17	.27
F10	.32	.39	.08	.39	.34	.37	.34	.21	.34
F11+					.34	.37	.34	.21	.34

Table 37. Correlations among normalized indices of witch flounder abundance at age.

	Spr vs Aut	Spr vs LPUE	Aut vs LPUE
Age 3	0.06		
Age 4	0.16		
Age 5	0.03		
Age 6	0.26		
Age 7	0.36	0.27	0.30
Age 8	0.56	0.36	0.35
Age 9	0.00	0.11	0.04
Age 10	0.00	0.10	0.01
Age 11+	0.71	0.58	0.83
total index (raw)	0.06		

Table 38. Results from RCT3 program to estimate age 3 and 4 stock sizes.

Analysis by RCT3 ver3.1 of data from file : RCTWIT3.DAT

Data for 2 surveys over 18 years : 1979 - 1996
Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as .00
Minimum of 16 points used for regression

Forecast/Hindcast variance correction used.
Yearclass = 1995

	I----------Regression----------I				I----------Prediction--------I			
Survey/ WAP Series	Slope cept	Inter- Error	Std	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights
NESP3	.64	7.62	.54	.582	16	4.30	10.39	.632 .595
NEFL3	.66	7.22	.66	.487	16	4.90	10.48	.765 .405
				VPA Mean =		9.32	.621	.000

Yearclass = 1996

	I----------Regression----------I				I----------Prediction--------I			
Survey/ WAP Series	Slope cept	Inter- Error	Std	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights
NESP3 NEFL3	.64	7.62	.54	.582	16	4.57	10.56	.642 1.000
				VPA Mean =		9.32	.621	.000

Year Class	Weighted Average Prediction	Log WAP Error	Int Std Error	Ext Std	Var Ratio	VPA	Log VPA
1995	**33693**	10.43	.49	.04	.01		
1996	**38706**	10.56	.64	.00	.00		

Analysis by RCT3 ver3.1 of data from file : rctwit4r.dat

Data for 2 surveys over 18 years : 1979 - 1996
Regression type = C
Tapered time weighting not applied
Survey weighting not applied
Final estimates not shrunk towards mean
Estimates with S.E.'S greater than that of mean included
Minimum S.E. for any survey taken as .00
Minimum of 15 points used for regression
Forecast/Hindcast variance correction used.
Yearclass = 1995

	I----------Regression----------I				I----------Prediction--------I			
Survey/ WAP Series	Slope cept	Inter- Error	Std	Rsquare Pts	No. Value	Index Value	Predicted Error	Std Weights
NESP4 NEFL4	.68	6.89	.53	.604	15	4.41	9.88	.601 1.000
				VPA Mean =		9.10	.626	.000

Year Class	Weighted Average Prediction	Log WAP Error	Int Std Error	Ext Std	Var Ratio	VPA	Log VPA
1995	**19457**	9.88	.60	.00	.00		

Table 39. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (mt) for witch flounder estimated from virtual population analysis, 1982-1998.

STOCK NUMBERS (Jan 1) in thousands

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
3	15434	17862	15866	7326	4876	2950	9502	6359	6871	8949	15279	10906	13869	27833	26142	20549	**22686**	**38706**
4	12807	13107	15061	13520	6191	4176	2519	7622	5059	5595	7293	12780	9000	11898	23361	22390	17590	**19457**
5	9766	10035	10033	11603	10546	4979	3426	2038	6155	3764	4437	5108	9322	6816	9668	19224	18322	14573
6	7903	7285	7227	6777	8022	7669	3852	2704	1693	4270	2430	3015	3079	5461	4756	6486	15185	14577
7	4566	5433	4809	4606	4037	4330	5414	2705	2035	1218	3135	1216	1742	1453	3102	2867	4296	11693
8	2990	3313	3201	2760	2550	2021	2266	3377	1621	1495	827	2028	492	731	462	1342	1525	2228
9	2341	1965	1944	1366	1218	1420	931	879	2086	955	1057	523	1201	241	381	153	605	968
10	1372	1644	1007	1027	613	665	776	429	431	1483	547	743	247	533	117	128	55	390
11+	9014	5364	4581	3459	2073	1280	1728	1203	938	1213	1711	1034	700	307	230	178	246	179
3+	66193	66008	63729	52444	40126	29490	30414	27316	26889	28942	36716	37353	39652	55273	68219	73317	80510	102771

FISHING MORTALITY

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.01	0.02	0.01	0.02	0.01	0.01	0.07	0.08	0.06	0.05	0.03	0.04	0.00	0.03	0.00	0.01	0.00
4	0.09	0.12	0.11	0.10	0.07	0.05	0.06	0.06	0.15	0.08	0.21	0.17	0.13	0.06	0.04	0.05	0.04
5	0.14	0.18	0.24	0.22	0.17	0.11	0.09	0.04	0.22	0.29	0.24	0.36	0.38	0.21	0.25	0.09	0.08
6	0.22	0.27	0.30	0.37	0.47	0.20	0.20	0.13	0.18	0.16	0.54	0.40	0.60	0.42	0.36	0.26	0.11
7	0.17	0.38	0.41	0.44	0.54	0.50	0.32	0.36	0.16	0.24	0.29	0.76	0.72	1.00	0.69	0.48	0.51
8	0.27	0.38	0.70	0.67	0.44	0.62	0.80	0.33	0.38	0.20	0.31	0.37	0.57	0.50	0.95	0.65	0.30
9	0.20	0.52	0.49	0.65	0.45	0.45	0.62	0.56	0.19	0.41	0.20	0.60	0.66	0.57	0.94	0.88	0.29
10	0.21	0.41	0.51	0.55	0.50	0.53	0.46	0.37	0.23	0.26	0.27	0.52	0.68	0.79	0.75	0.55	0.37
11+	0.21	0.41	0.51	0.55	0.50	0.53	0.46	0.37	0.23	0.26	0.27	0.52	0.68	0.79	0.75	0.55	0.37
7-9	0.21	0.43	0.53	0.59	0.48	0.53	0.58	0.42	0.24	0.28	0.27	0.58	0.65	0.69	0.86	0.67	0.37

Table 39 continued.

MEAN BIOMASS

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	40	83	104	63	204	122	52	136	230	194	123	320	137	181	1665	3796	481
2	732	651	316	121	83	340	118	253	281	577	308	406	575	656	688	2562	4682
3	2164	2447	2214	863	402	221	384	694	385	502	1441	1211	900	1481	1477	1123	5761
4	2750	2323	3036	2837	1146	724	461	1167	819	994	1411	2214	1587	1837	3290	3976	2742
5	2785	2310	2722	2959	2700	1309	949	597	1325	1049	1395	1275	2022	1763	1865	4298	4062
6	2775	2438	2450	2269	2443	2804	1408	1000	632	1547	805	1003	931	1798	1586	1908	4664
7	2148	2186	1989	1965	1553	1788	2322	1215	1026	584	1561	428	622	485	1164	1052	1550
8	1775	1574	1431	1303	1305	965	978	1827	866	887	491	1051	243	371	198	581	717
9	1747	1139	1174	792	780	883	531	515	1500	612	732	325	684	156	198	83	427
10	1134	1231	679	713	441	474	569	324	377	1183	394	555	152	337	75	95	42
11+	10652	5580	4484	3306	2016	1213	1713	1272	1134	1412	1735	1007	601	247	187	166	231
3+	27930	21228	20179	17007	12786	10381	9315	8611	8064	8770	9965	9069	7742	8475	10040	13282	18934

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

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0	0	0	5	2	1	4	3	3	0	0	0	0	0	0	0	0
4	0	88	107	368	145	79	47	96	109	6	8	17	108	100	172	189	136
5	55	486	483	1872	1729	769	522	328	787	89	114	127	913	719	814	1638	1746
6	423	1297	1175	2238	2453	2501	1255	901	577	534	344	446	854	1466	1345	1493	3658
7	1105	1859	1648	2037	1719	1858	2417	1239	964	460	1185	415	724	589	1319	1184	1617
8	1589	1708	1579	1469	1429	1074	1184	1888	932	877	486	1152	265	398	242	693	761
9	1807	1336	1237	894	846	960	614	577	1499	659	758	373	780	169	244	101	416
10	1206	1393	772	811	499	543	632	350	375	1258	438	610	192	410	95	107	46
11	11939	6633	5492	4085	2458	1491	2069	1497	1280	1609	1982	1235	771	326	244	205	272
1+	18124	14801	12493	13779	11281	9277	8743	6879	6526	5492	5315	4375	4608	4178	4475	5611	8652

Table 40. Results of retrospective analyses of ADAPT VPA for witch flounder.

Fishing Mortality
Terminal Year

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1991	0.22	0.43	0.54	0.61	0.51	0.59	0.72	0.62	0.44	0.65							
1992	0.22	0.43	0.54	0.61	0.51	0.58	0.71	0.58	0.40	0.59	0.71						
1993	0.22	0.43	0.54	0.60	0.49	0.55	0.63	0.48	0.30	0.37	0.40	1.05					
1994	0.22	0.43	0.53	0.59	0.48	0.54	0.60	0.44	0.27	0.31	0.31	0.68	0.89				
1995	0.21	0.43	0.53	0.59	0.48	0.53	0.59	0.43	0.25	0.29	0.28	0.62	0.84	0.91			
1996	0.21	0.43	0.53	0.58	0.47	0.52	0.57	0.40	0.23	0.26	0.25	0.53	0.56	0.48	0.51		
1997	0.21	0.43	0.53	0.58	0.47	0.52	0.57	0.41	0.23	0.27	0.25	0.53	0.56	0.49	0.52	0.29	
1998	0.21	0.43	0.53	0.59	0.48	0.53	0.58	0.42	0.24	0.28	0.27	0.58	0.65	0.69	0.86	0.67	0.37

Spawning Stock Biomass
Terminal Year

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1991	17920	14595	12219	13191	10436	8112	6907	4805	4409	3096							
1992	17939	14614	12245	13245	10517	8232	7077	4990	4551	3258	3709						
1993	18035	14711	12373	13522	10912	8773	7942	5943	5319	4198	3889	2979					
1994	18089	14765	12445	13677	11135	9073	8421	6497	6007	4965	4589	3815	5905				
1995	18111	14788	12477	13743	11230	9208	8634	6752	6366	5312	5124	4204	5429	6469			
1996	18145	14822	12521	13840	11368	9398	8934	7107	6832	5806	5738	4817	5364	5573	7259		
1997	18143	14820	12519	13834	11360	9386	8916	7085	6803	5776	5698	4774	5291	5406	6774	10121	
1998	18124	14801	12493	13779	11281	9277	8743	6879	6526	5492	5315	4375	4608	4178	4475	5611	8652

Population Numbers Age: 3
Terminal Year

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1991	15103	17353	13670	6195	3174	2061	11805	7850	7740	39481	6609						
1992	15149	17392	13836	6495	3117	1891	11966	7089	6411	26631	27687	41513					
1993	15295	17639	14883	6914	4075	2401	8169	6001	5462	18746	26778	26234	22855				
1994	15375	17768	15507	7099	4545	2839	8519	6227	6985	13593	25620	17807	30473	103601			
1995	15415	17834	15723	7275	4789	2838	9369	6276	6063	13310	19868	17418	26512	54199	129003		
1996	15468	17917	16086	7453	5070	3036	10025	6467	7142	10133	16197	15636	28145	48059	49645	18604	
1997	15465	17912	16065	7441	5051	3028	9978	6450	7118	10033	16105	14912	24593	42610	41960	25844	66728
1998	15434	17862	15866	7326	4876	2950	9502	6359	6871	8949	15279	10906	13869	27833	26142	20549	69778

Table 41. Yield and Spawning Stock biomass per recruit results for witch flounder.

```
  The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
   PC Ver.2.0 [Method of Thompson and Bell (1934)] 1-Jan-1999
            ---------------------------------------
            Run Date:  2- 6-1999;  Time: 20:32:18.77 Witch flounder 1998

 Proportion of F before spawning:  .1667
 Proportion of M before spawning:  .1667
 Natural Mortality is Constant at:  .150
 Initial age is:  1; Last age is: 14
 Last age is a PLUS group;
 Original age-specific PRs, Mats, and Mean Wts from file: ==> witch-t.dat
```

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch	Stock
1	.0010	1.0000	.0000	.011	.009
2	.0050	1.0000	.0000	.030	.018
3	.0130	1.0000	.0000	.094	.056
4	.0730	1.0000	.0800	.199	.140
5	.2330	1.0000	.4500	.299	.247
6	.4730	1.0000	.8500	.419	.357
7	1.0000	1.0000	1.0000	.549	.484
8	1.0000	1.0000	1.0000	.677	.615
9	1.0000	1.0000	1.0000	.846	.764
10	1.0000	1.0000	1.0000	.973	.907
11	1.0000	1.0000	1.0000	1.104	1.040
12	1.0000	1.0000	1.0000	1.236	1.170
13	1.0000	1.0000	1.0000	1.381	1.309
14+	1.0000	1.0000	1.0000	1.541	1.541

```
 Summary of Yield per Recruit Analysis for:Witch flounder 1998
    Slope of the Yield/Recruit Curve at F=0.00: -->     3.1526
    F level at slope=1/10 of the above slope (F0.1): ----->     .157
      Yield/Recruit corresponding to F0.1: ----->      .1834
    F level to produce Maximum Yield/Recruit (Fmax): ----->     .353
      Yield/Recruit corresponding to Fmax: ----->      .2030
    F level at 20 % of Max Spawning Potential (F20): ----->     .371
      SSB/Recruit corresponding to F20: -------->      .6506
```

Listing of Yield per Recruit Results for: Witch flounder 1998

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.00	.00000	.00000	7.1792	3.5838	3.5290	3.2535	100.00
	.05	.11648	.10680	6.4045	2.5600	2.7572	2.2381	68.79
	.10	.18710	.15641	5.9355	1.9824	2.2912	1.6673	51.25
	.15	.23477	.18103	5.6194	1.6203	1.9781	1.3107	40.29
F0.1	.16	.24034	.18336	5.5825	1.5798	1.9416	1.2710	39.07
	.20	.26931	.19349	5.3908	1.3764	1.7524	1.0715	32.94
	.25	.29564	.19961	5.2168	1.2034	1.5815	.9025	27.74
	.30	.31648	.20229	5.0794	1.0755	1.4471	.7780	23.91
	.35	.33347	.20304	4.9676	.9777	1.3383	.6832	21.00
Fmax	.35	.33429	.20305	4.9622	.9732	1.3330	.6788	20.86
F20%	.37	.33960	.20300	4.9272	.9440	1.2992	.6506	20.00
	.40	.34765	.20271	4.8744	.9010	1.2481	.6091	18.72
	.45	.35971	.20176	4.7952	.8393	1.1720	.5497	16.90
	.50	.37015	.20047	4.7269	.7887	1.1068	.5013	15.41
	.55	.37930	.19900	4.6671	.7465	1.0500	.4610	14.17
	.60	.38741	.19746	4.6141	.7107	1.0001	.4271	13.13
	.65	.39468	.19589	4.5668	.6800	.9558	.3981	12.24
	.70	.40124	.19433	4.5240	.6534	.9161	.3731	11.47
	.75	.40722	.19281	4.4851	.6300	.8803	.3512	10.80
	.80	.41270	.19133	4.4495	.6093	.8478	.3320	10.20
	.85	.41776	.18990	4.4167	.5908	.8181	.3148	9.68
	.90	.42245	.18851	4.3863	.5741	.7908	.2995	9.21
	.95	.42681	.18718	4.3580	.5590	.7655	.2857	8.78
	1.00	.43090	.18590	4.3316	.5453	.7422	.2732	8.40

Table 42. Yield per recruit results for witch flounder where catch mean weight at age have been dis-aggregated by landings, large-mesh otter trawl discards, and shrimp fishery discards.

```
 The NEFC Yield and Stock Size per Recruit Program - PDBYPRCM
  PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992
           Run Date:  1- 6-1999;  Time: 15:58:07.43 Witch flounder 1998
Proportion of F before spawning:  .1667
Proportion of M before spawning:  .1667
Natural Mortality is Constant at:  .150
Initial age is:  1; Last age is: 14
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:==> witch.dat
Age-specific Input data for Yield per Recruit Analysis
```

Age	Fish Mort Pattern	Nat Mort Pattern	Prop Mat	Proportion of F Lndgs	LMOT	Shmp	Average Weights Catch	Lndgs	LMDsc	ShDsc
1	.0010	1.0000	.00	.00	.00	1.00	.011	.000	.014	.012
2	.0050	1.0000	.00	.00	.01	.99	.030	.000	.041	.029
3	.0130	1.0000	.00	.00	.23	.77	.094	.208	.103	.053
4	.0730	1.0000	.08	.11	.85	.04	.199	.279	.154	.114
5	.2330	1.0000	.45	.38	.62	.00	.299	.347	.185	.199
6	.4730	1.0000	.85	.88	.12	.00	.419	.427	.220	.256
7	1.0000	1.0000	1.00	1.00	.00	.00	.549	.549	.220	.256
8	1.0000	1.0000	1.00	1.00	.00	.00	.677	.677	.220	.256
9	1.0000	1.0000	1.00	1.00	.00	.00	.846	.846	.220	.256
10	1.0000	1.0000	1.00	1.00	.00	.00	.973	.973	.220	.256
11	1.0000	1.0000	1.00	1.00	.00	.00	1.104	1.104	.220	.256
12	1.0000	1.0000	1.00	1.00	.00	.00	1.236	1.236	.220	.256
13	1.0000	1.0000	1.00	1.00	.00	.00	1.381	1.381	.220	.256
14+	1.0000	1.0000	1.00	1.00	.00	.00	1.541	1.541	.220	.256

```
Summary of Yield per Recruit Analysis for: Witch flounder 1998

  Slope of the Yield/Recruit Curve at F=0.00: -->    3.1156
    F level at slope=1/10 of the above slope (F0.1): ----->    .149
      Yield/Recruit corresponding to F0.1: ----->     .1754
    F level to produce Maximum Yield/Recruit (Fmax): ----->    .299
      Yield/Recruit corresponding to Fmax: ----->     .1920

Listing of Yield per Recruit Results for: Witch flounder 1998
```

	FMORT	ALL COMPONENTS NUMBER	ALL COMPONENTS WEIGHT	LANDINGS ONLY NUMBER	LANDINGS ONLY WEIGHT	LM OT DISCARD NUMBER	LM OT DISCARD WEIGHT	SHRIMP DISCARD NUMBER	SHRIMP DISCARD WEIGHT
	.000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
	.050	.11648	.10680	.10902	.10497	.00679	.00123	.00067	.00003
	.100	.18710	.15641	.17232	.15279	.01343	.00243	.00135	.00007
F0.1	.149	.23416	.18077	.21232	.17544	.01983	.00359	.00201	.00010
	.150	.23477	.18103	.21282	.17568	.01993	.00361	.00202	.00010
	.200	.26931	.19349	.24034	.18644	.02628	.00475	.00269	.00014
	.250	.29564	.19961	.25979	.19091	.03249	.00587	.00336	.00017
Fmax	.299	.31602	.20225	.27358	.19197	.03842	.00693	.00402	.00020
	.300	.31648	.20229	.27388	.19197	.03857	.00696	.00403	.00021
	.350	.33347	.20304	.28425	.19115	.04451	.00802	.00470	.00024
	.400	.34765	.20271	.29194	.18928	.05033	.00906	.00537	.00027
	.402	.34811	.20268	.29218	.18920	.05054	.00910	.00539	.00027
	.450	.35971	.20176	.29765	.18683	.05603	.01008	.00604	.00031
	.500	.37015	.20047	.30184	.18408	.06160	.01107	.00670	.00034
	.550	.37930	.19900	.30487	.18119	.06706	.01204	.00737	.00037
	.600	.38741	.19746	.30697	.17825	.07240	.01299	.00803	.00041
	.650	.39468	.19589	.30835	.17532	.07763	.01391	.00869	.00044
	.700	.40124	.19433	.30913	.17244	.08276	.01482	.00936	.00048
	.750	.40722	.19281	.30943	.16962	.08777	.01570	.01002	.00051
	.800	.41270	.19133	.30934	.16687	.09269	.01656	.01068	.00054
	.850	.41776	.18990	.30892	.16420	.09750	.01741	.01134	.00058
	.900	.42245	.18851	.30824	.16161	.10221	.01823	.01200	.00061
	.950	.42681	.18718	.30733	.15910	.10683	.01904	.01265	.00064
	1.000	.43090	.18590	.30623	.15666	.11136	.01983	.01331	.00067

Table 43. Surplus production model analysis (ASPIC) of witch flounder.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	36	Number of bootstrap trials:	0
Number of data series:	2	Lower bound on MSY:	8.333E-02
Objective function computed:	in EFFORT	Upper bound on MSY:	7.500E+01
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	2.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	1.000E+01
Relative conv. criterion (effort):	1.000E-04	Random number seed:	1964285
Maximum F allowed in fitting:	5.000	Monte Carlo search trials:	50000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

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

1 Fall Survey	1.000 36	
2 Spring Survey (lagged)	**0.646** 32	1.000 32
	1	2

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

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	3.075E-02	1	N/A	1.000E+00	N/A	
Loss(1) Fall Survey	7.728E+00	36	2.273E-01	1.000E+00	1.043E+00	**0.617**
Loss(2) Spring Survey (lagged)	7.473E+00	32	2.491E-01	1.000E+00	9.517E-01	**0.403**

TOTAL OBJECTIVE FUNCTION: 1.52316826E+01

NOTE: B1-ratio constraint term contributing to loss. Sensitivity analysis advised.

Number of restarts required for convergence: 3
Est. B-ratio coverage index (0 worst, 2 best): 1.7246
Est. B-ratio nearness index (0 worst, 1 best): 1.0000

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1963	2.383E+00	1.000E+00	1	1
MSY	Maximum sustainable yield	**2.684E+00**	2.500E+00	1	1
r	Intrinsic rate of increase	2.126E-01	3.000E-01	1	1
.....	Catchability coefficients by fishery:				
q(1)	**Fall Survey**	**6.544E-02**	6.544E-02	0	1
q(2)	**Spring Survey (lagged)**	**6.225E-02**	6.226E-02	0	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	
MSY	Maximum sustainable yield	2.684E+00	Kr/4	
K	Maximum stock biomass	5.049E+01		
Bmsy	Stock biomass at MSY	**2.525E+01**	K/2	
Fmsy	Fishing mortality at MSY	**1.063E-01**	r/2	
F(0.1)	Management benchmark	9.567E-02	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	2.657E+00	0.99*MSY	
B-ratio	Ratio of B(1999) to Bmsy	2.507E-01		
F-ratio	Ratio of F(1998) to Fmsy	2.621E+00		
Y-ratio	Proportion of MSY avail in 1999	4.386E-01	2*Br-Br^2	Ye(1999) = 1.177E+00
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	Fall Survey	1.624E+00	r/2q(1)	f(0.1) = 1.462E+00

Table 43 continued.

RESULTS OF BOOTSTRAPPED ANALYSIS

Param name	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
Blratio	2.760E+00	2.383E+00	-13.64%	2.090E+00	3.425E+00	2.410E+00	3.282E+00	8.726E-01	0.316
K	4.873E+01	5.049E+01	3.61%	4.465E+01	5.596E+01	4.650E+01	5.203E+01	5.526E+00	0.113
r	2.175E-01	2.126E-01	-2.23%	1.795E-01	2.527E-01	1.975E-01	2.342E-01	3.679E-02	0.169
q(1)	6.544E-02	6.544E-02	0.00%	6.544E-02	6.544E-02	6.544E-02	6.544E-02	0.000E+00	0.000
q(2)	6.225E-02	6.225E-02	0.00%	6.225E-02	6.226E-02	6.225E-02	6.225E-02	2.026E-14	0.000
MSY	2.632E+00	2.684E+00	1.96%	2.475E+00	2.794E+00	2.554E+00	2.710E+00	1.557E-01	0.059
Ye(1999)	1.231E+00	1.177E+00	-4.35%	8.363E-01	1.662E+00	1.000E+00	1.427E+00	4.264E-01	0.347
Bmsy	2.437E+01	2.525E+01	3.61%	2.232E+01	2.798E+01	2.325E+01	2.601E+01	2.763E+00	0.113
Fmsy	1.087E-01	1.063E-01	-2.23%	8.975E-02	1.263E-01	9.873E-02	1.171E-01	1.839E-02	0.169
fmsy(1)	1.662E+00	1.624E+00	-2.23%	1.371E+00	1.931E+00	1.509E+00	1.790E+00	2.811E-01	0.169
fmsy(2)	1.746E+00	1.708E+00	-2.23%	1.442E+00	2.029E+00	1.586E+00	1.881E+00	2.955E-01	0.169
F(0.1)	9.785E-02	9.567E-02	-2.01%	8.077E-02	1.137E-01	8.885E-02	1.054E-01	1.655E-02	0.169
Y(0.1)	2.606E+00	2.657E+00	1.94%	2.450E+00	2.766E+00	2.529E+00	2.683E+00	1.541E-01	0.059
B-ratio	2.651E-01	2.507E-01	-5.43%	1.842E-01	3.727E-01	2.190E-01	3.216E-01	1.026E-01	0.387
F-ratio	2.487E+00	2.621E+00	5.42%	1.802E+00	3.675E+00	2.134E+00	3.091E+00	9.572E-01	0.385
Y-ratio	4.604E-01	4.386E-01	-4.73%	3.344E-01	6.065E-01	3.900E-01	5.397E-01	1.497E-01	0.325
f0.1(1)	1.495E+00	1.462E+00	-2.01%	1.234E+00	1.738E+00	1.358E+00	1.611E+00	2.530E-01	0.169
f0.1(2)	1.572E+00	1.537E+00	-2.01%	1.297E+00	1.826E+00	1.427E+00	1.693E+00	2.659E-01	0.169
q2/q1	9.513E-01	9.513E-01	0.00%	9.513E-01	9.513E-01	9.513E-01	9.513E-01	3.096E-13	0.000

NOTES ON BOOTSTRAPPED ESTIMATES:

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

Trials replaced for lack of convergence: 0
Trials replaced for MSY out-of-bounds: 0
Trials replaced for r out-of-bounds: 0
Residual-adjustment factor: 1.0228

Table 44. Summary of short-term projection results for witch flounder. Projected median estimates of landings (mt), discards (mt), and spawning stock biomass (mt), total biomass 3+ (mt) are provided for status quo fishing mortality (F_{99} = 0.20 given 1999 catches = 1998 catches) and for the control rule fishing mortality ($F_{10th\%tile}$ = 0.19).

Projection input:

Age	Fish Mort Pattern	Proportion Mature	Discard Fraction	Average Weights Catch	Stock	Discards
3	.0130	.0000	1.00	.094	.056	0.030
4	.0730	.0800	0.89	.199	.140	0.078
5	.2330	.4500	0.62	.299	.247	0.149
6	.4730	.8500	0.12	.419	.357	0.189
7	1.0000	1.0000	0.00	.549	.484	0.235
8	1.0000	1.0000	0.00	.677	.615	0.235
9	1.0000	1.0000	0.00	.846	.764	0.235
10	1.0000	1.0000	0.00	.973	.907	0.235
11+	1.0000	1.0000	0.00	1.319	1.319	0.235

Projection results (weight reported in '000 mt)

Scenario	Year	F full	F wb3+	Median Landings	Median Discards	Median SSB	Median Biomass (3+)
F status quo	1999	0.20	0.096	2.18	0.16	14.65	25.63
	2000	**0.20**	0.096	3.03	0.17	18.92	29.69
	2001	**0.20**	0.096	3.77	0.19	23.44	31.96
F control rule	1999	0.20	0.096	2.18	0.16	14.65	25.63
	2000	0.19*	0.09	2.89	0.17	18.95	29.78
	2001	0.19*	0.09	3.62	0.18	23.62	32.21

* assumes current age structure (not equilibrium age structure).

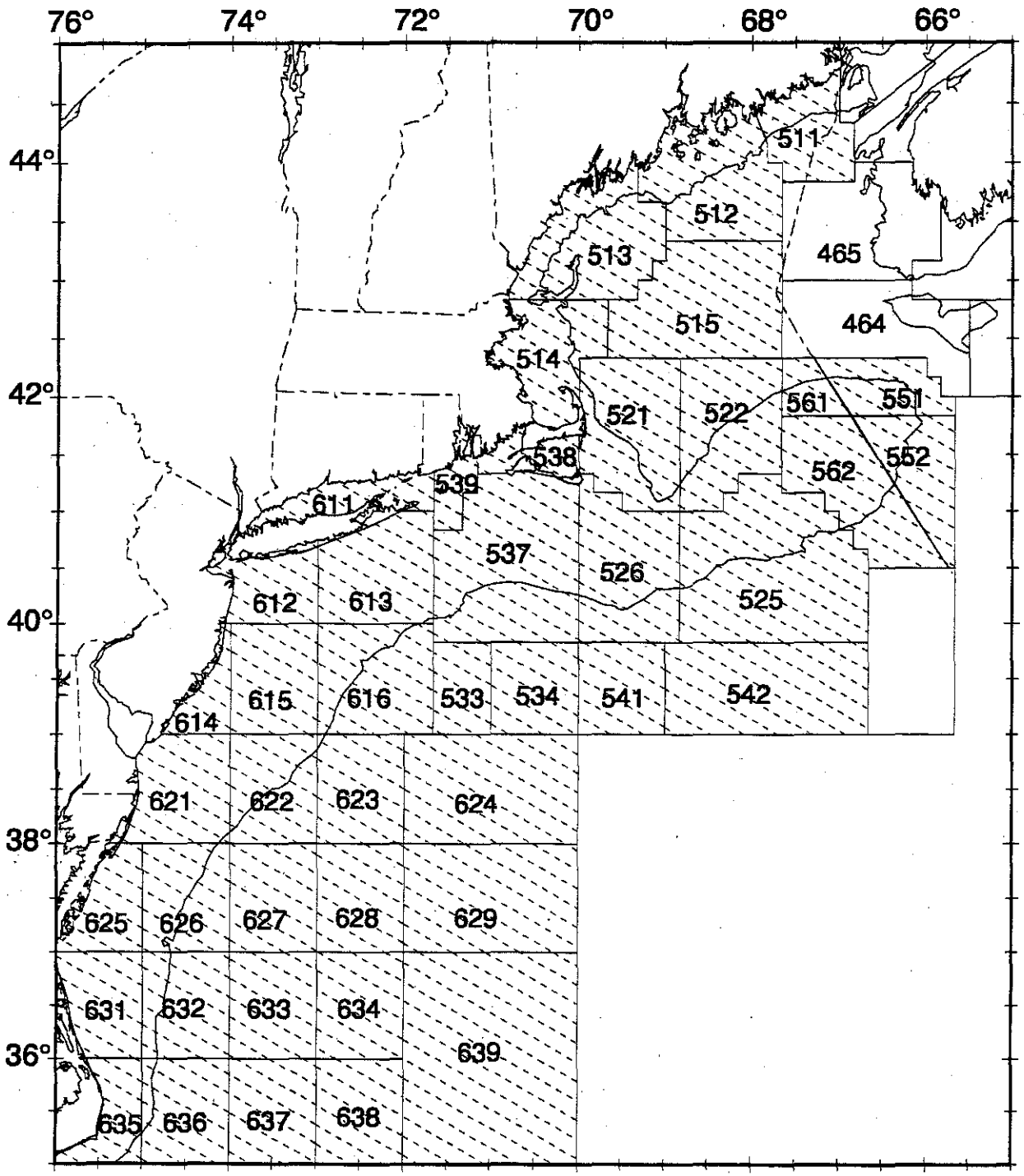


Figure 1. Statistical areas (Subareas 5 and 6) included in the witch flounder assessment. Note: in 1985, SA 523 and 524 were divided by the Hague Line, and the USA portions of SA 523 and 524 were renamed 561 and 562, respectively. The Canadian portions of SA 523 and 524 were renamed 551 and 552, respectively.

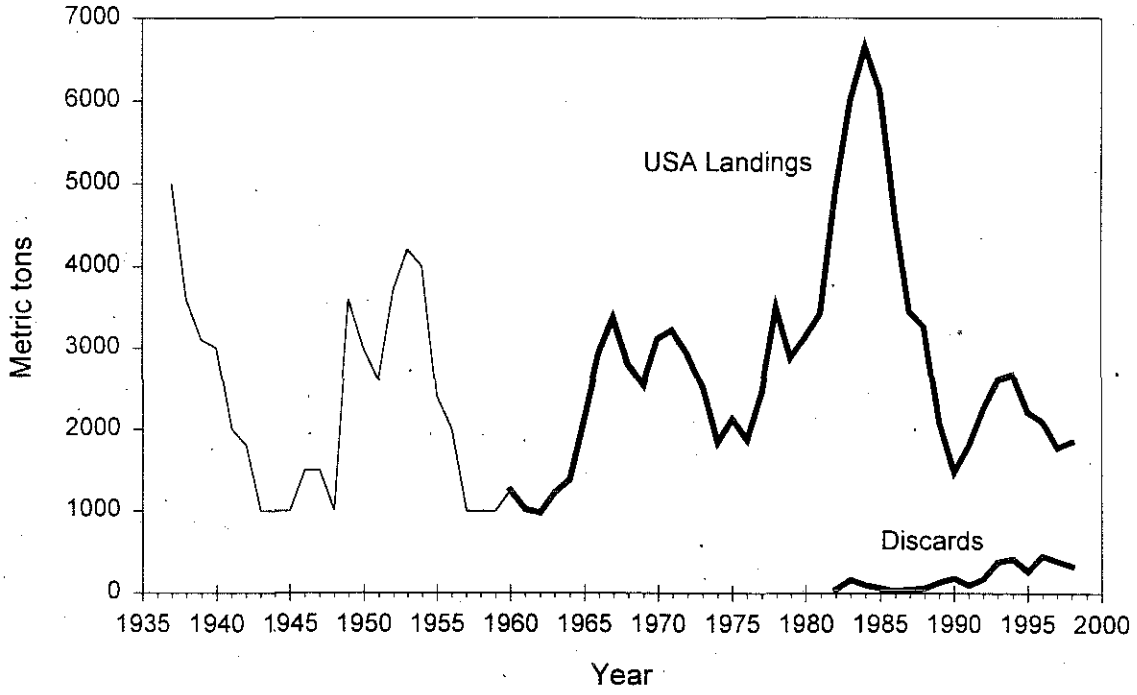


Figure 2. Historical USA witch flounder landings (mt), excluding USA landings from the Grand Banks in the mid-1980's. Thin line represents provisional landings data taken from Lange and Lux (1978). Discards from the shrimp and large-mesh otter trawl fishery.

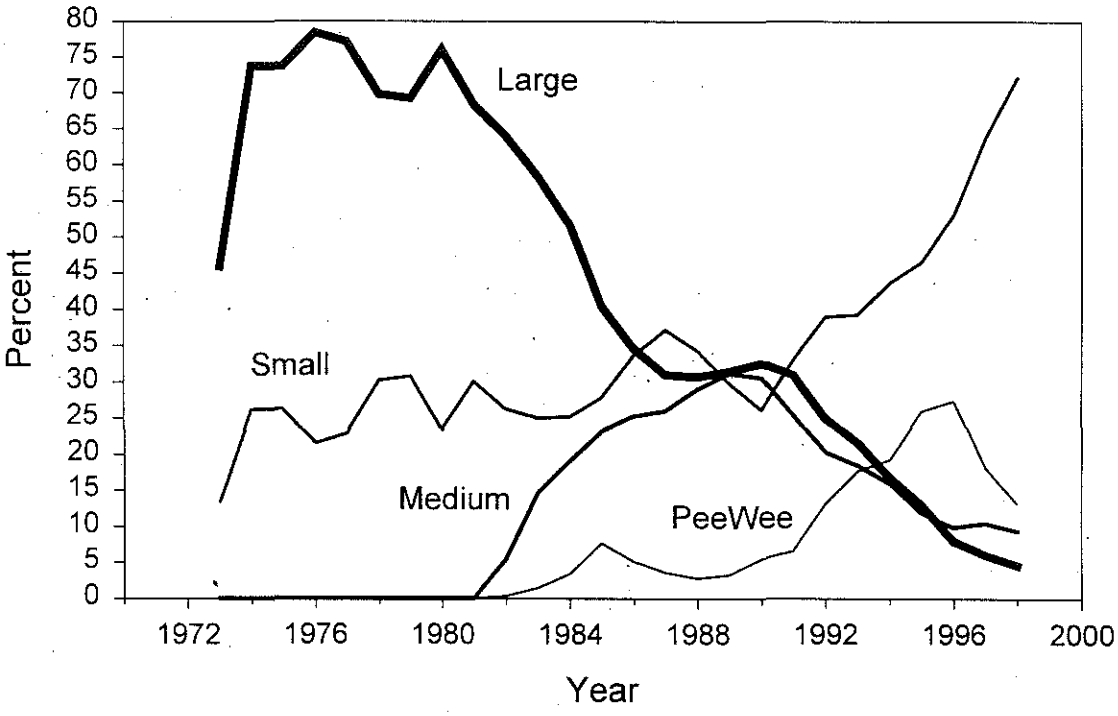


Figure 3. Commercial landings of witch flounder by maket category, 1973 - 1998.

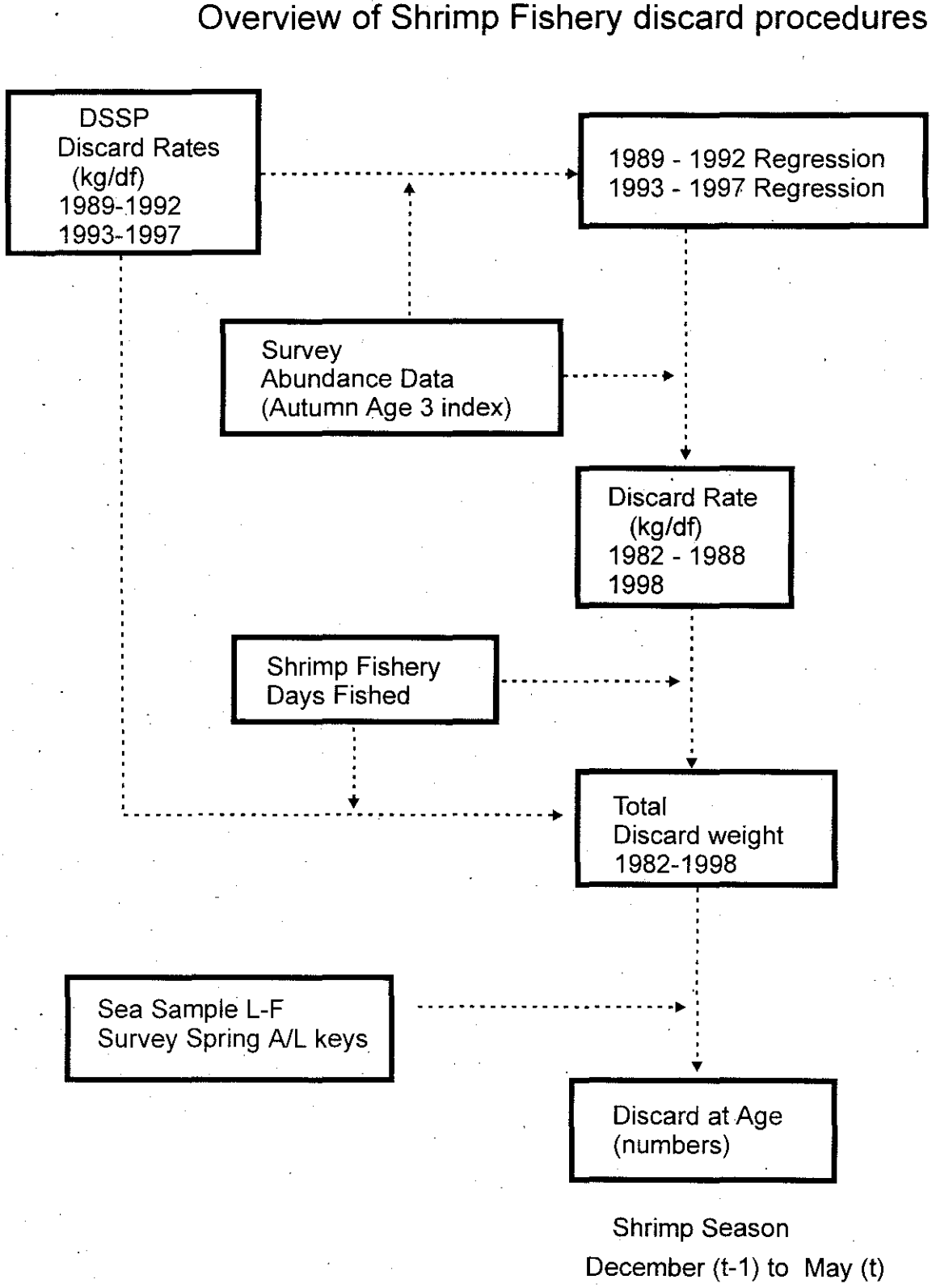


Figure 4. Overview of procedures used to estimate witch flounder discarded in the northern shrimp fishery in the Gulf of Maine - Georges Bank region , 1982 - 1998 shrimp season.

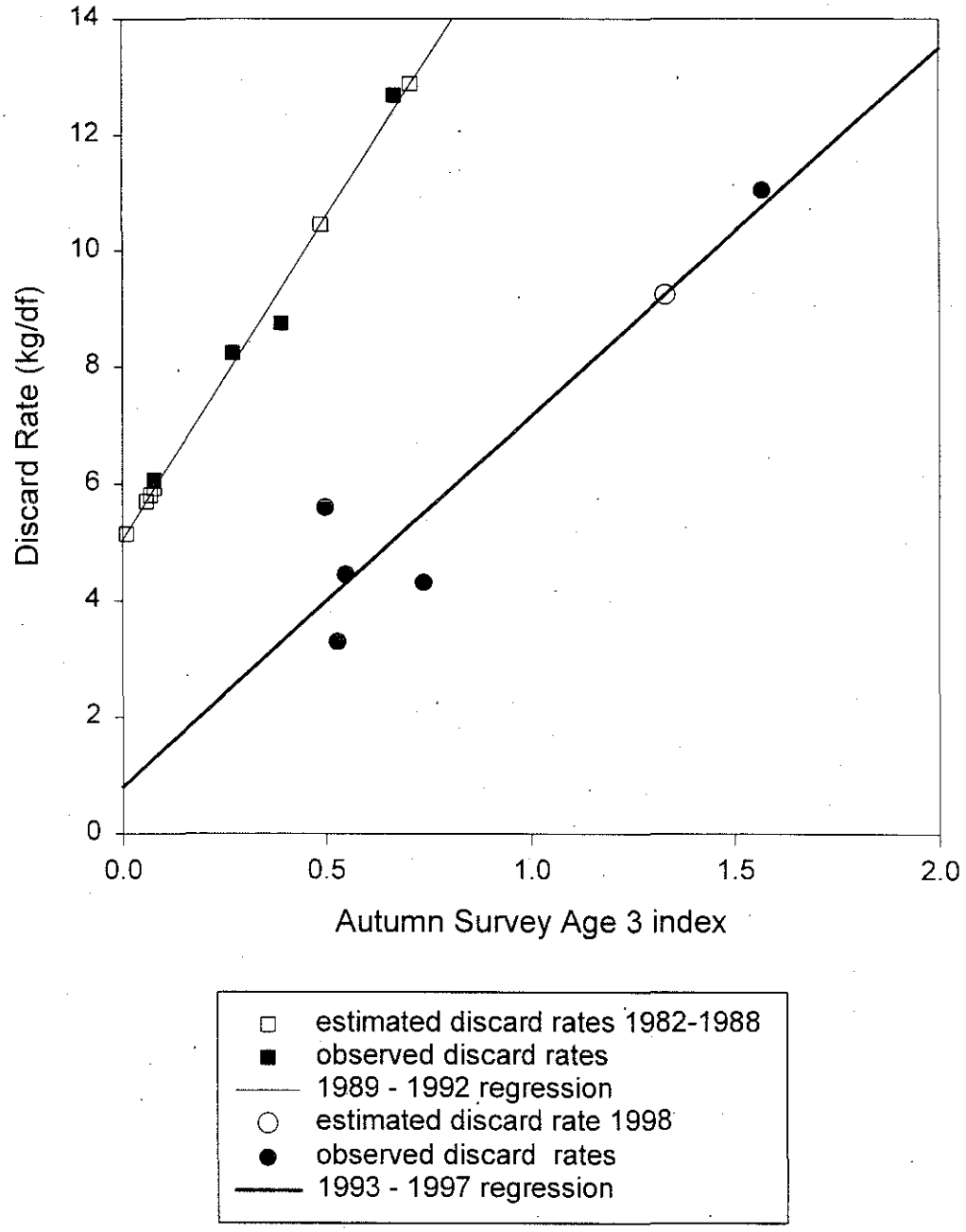


Figure 5. Observed witch flounder discard rates (kilogram per day fished, closed symbols) from the Domestic Sea Sampling Program data, and estimated discard rates (kg/df, open symbols) in the northern shrimp fishery estimated from linear regressions (solid line) of observed discard rates and NEFSC autumn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

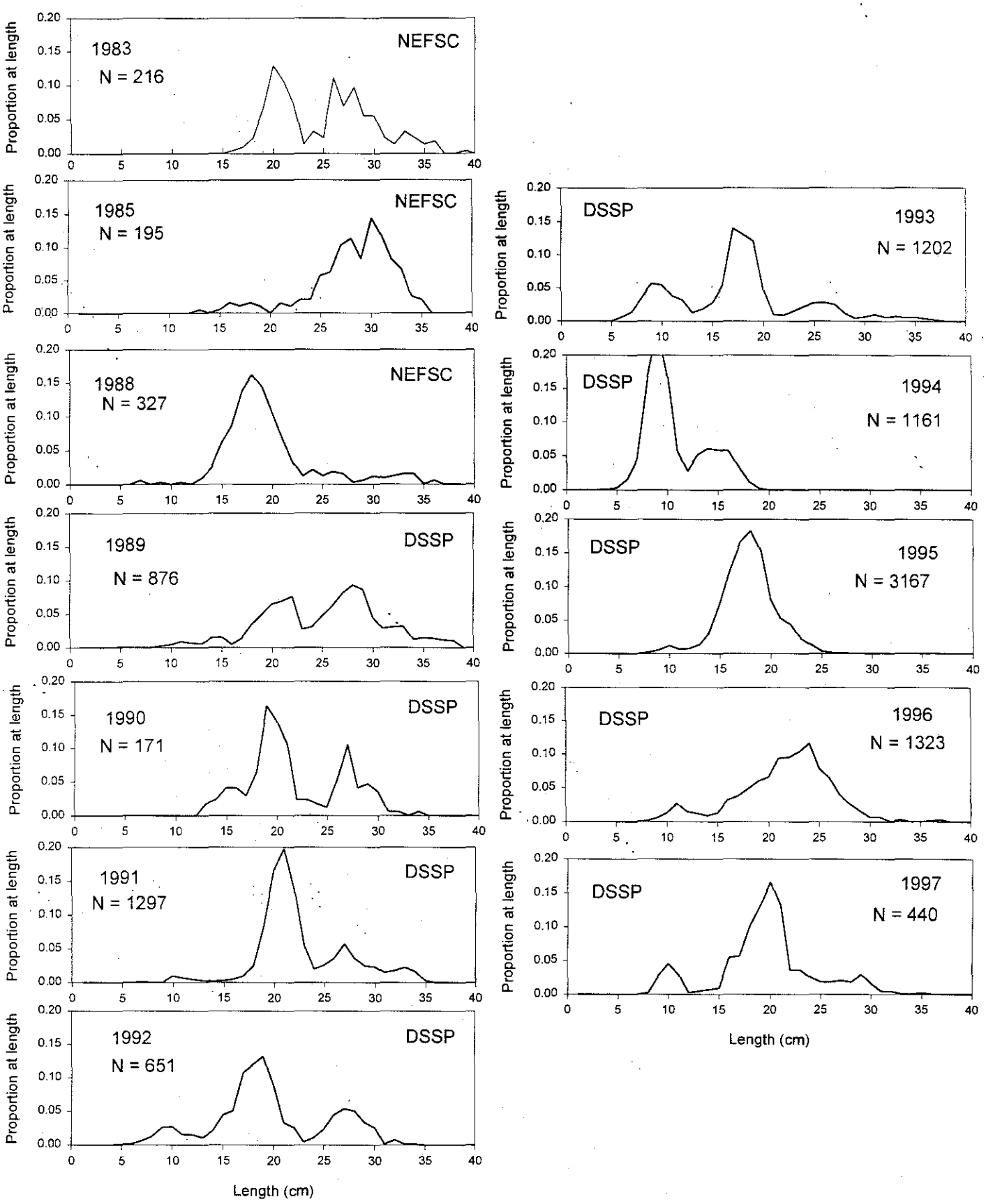


Figure 6. Proportion at length of discarded witch flounder from the Domestic Sea Sampling Program observed tows in the northern shrimp fishery, 1989- 1997. Proprotion at length for 1983, 1985, and 1988 were collected from sea sampled trips prior to the DSSP by NEFSC staff.

Overview of shrimp season to calendar year adjustments

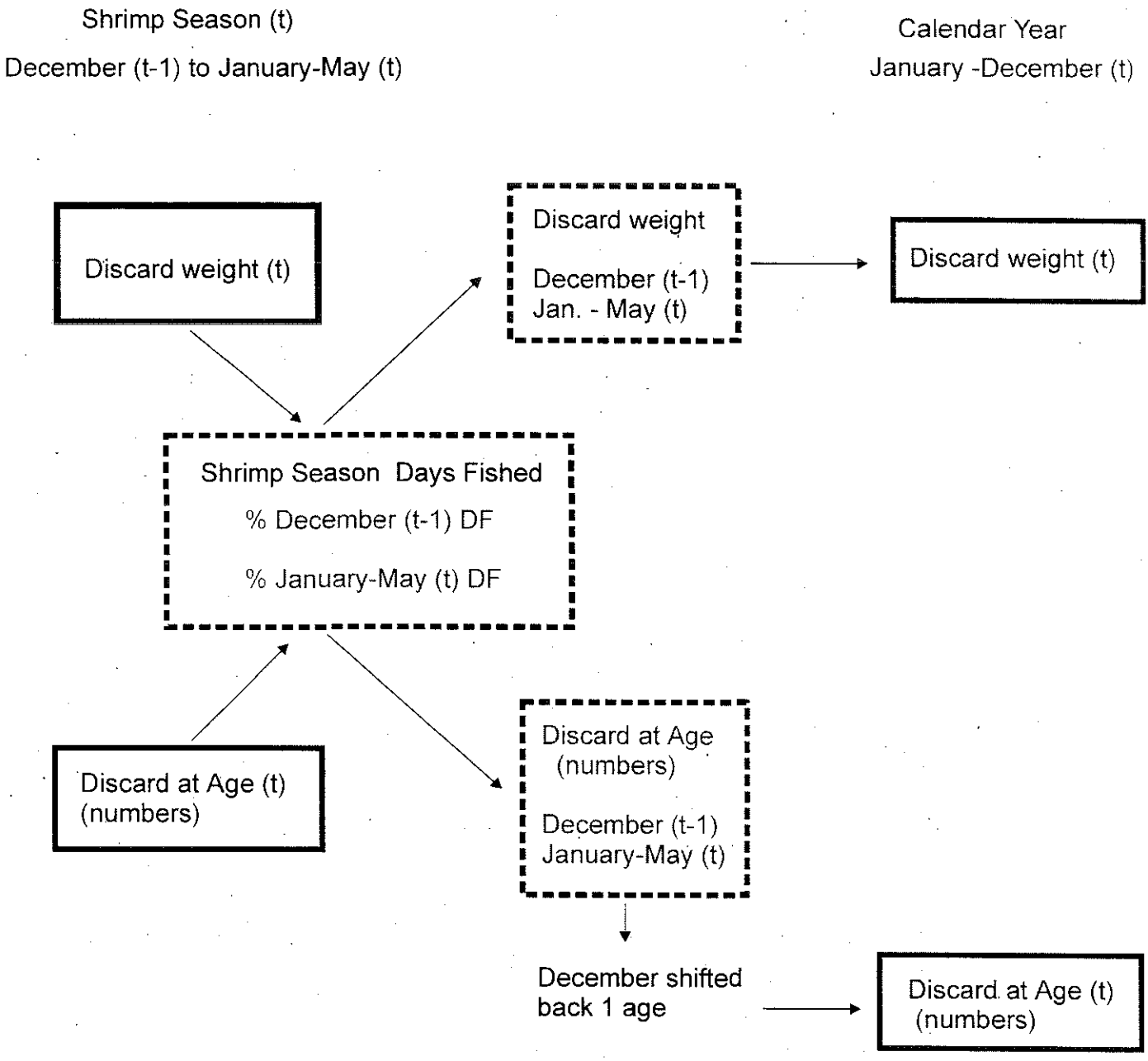


Figure 7. Overview of procedures used to adjust discard weight and numbers at age from a shrimp season to a calendar year.

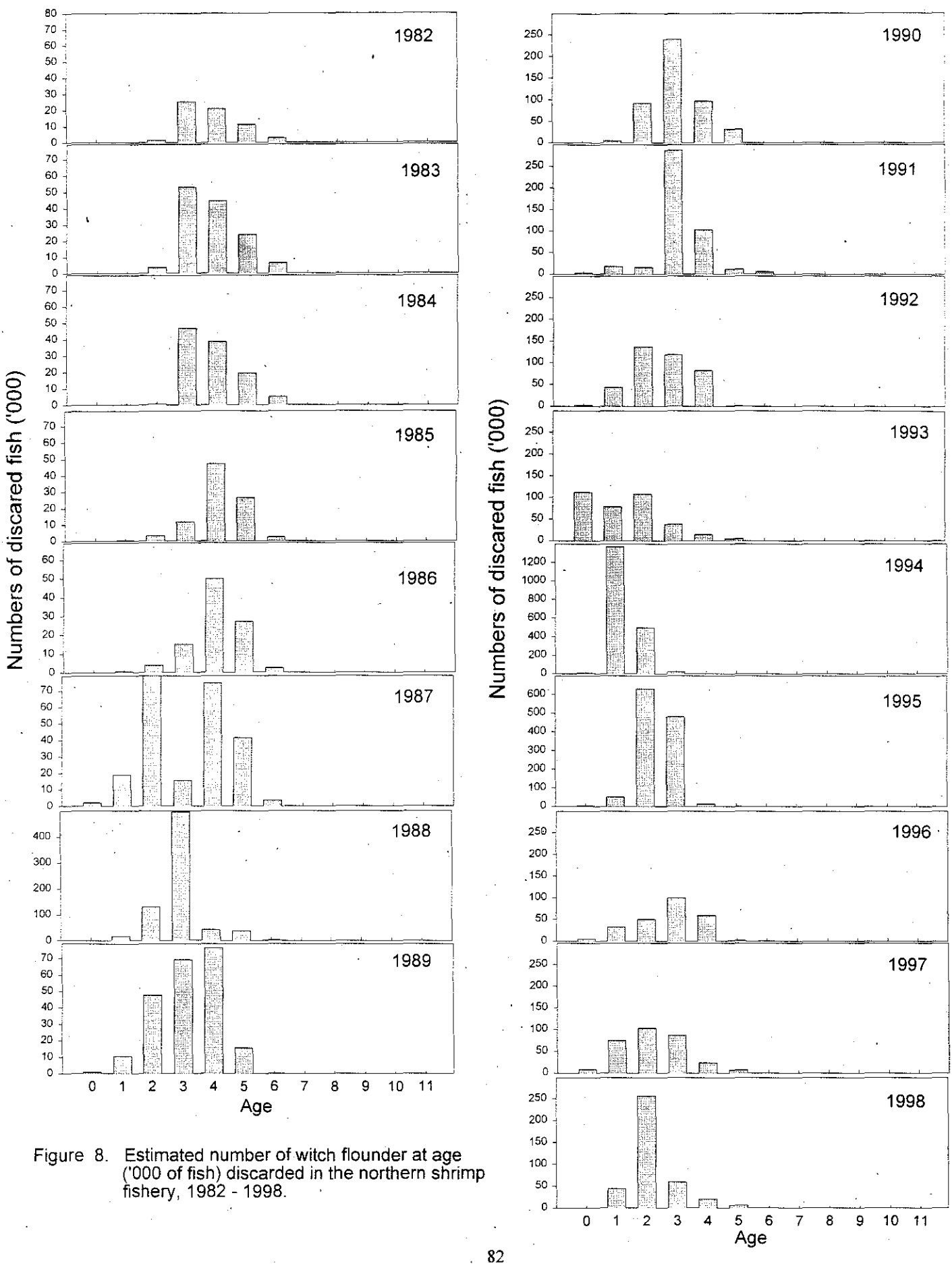


Figure 8. Estimated number of witch flounder at age ('000 of fish) discarded in the northern shrimp fishery, 1982 - 1998.

Large-Mesh Otter Trawl Fishery discard procedures

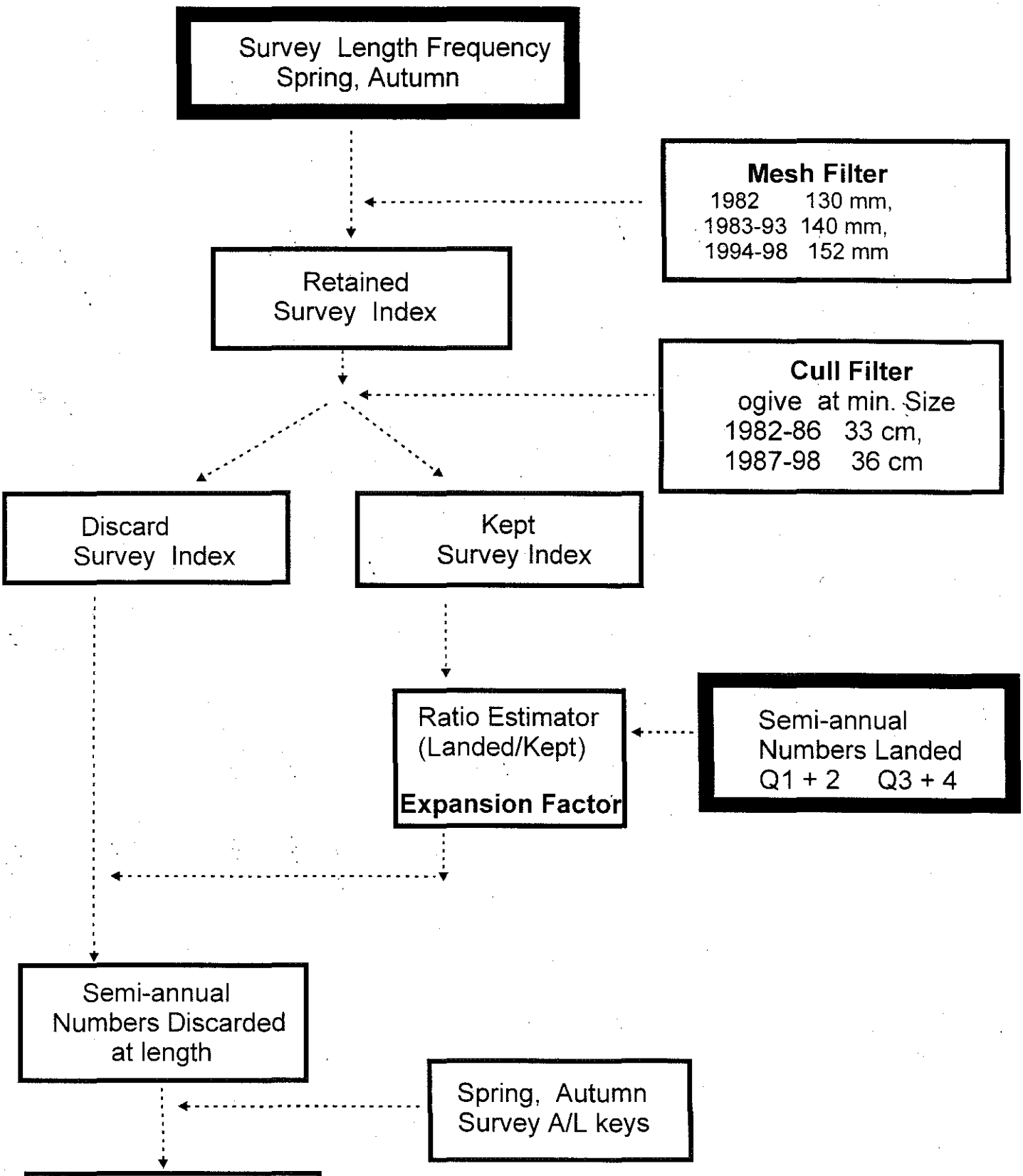


Figure 9. Overview of procedures used to estimate witch flounder discarded in the large-mesh otter trawl fishery in the Gulf of Maine - Georges Bank region, 1982 - 1998.

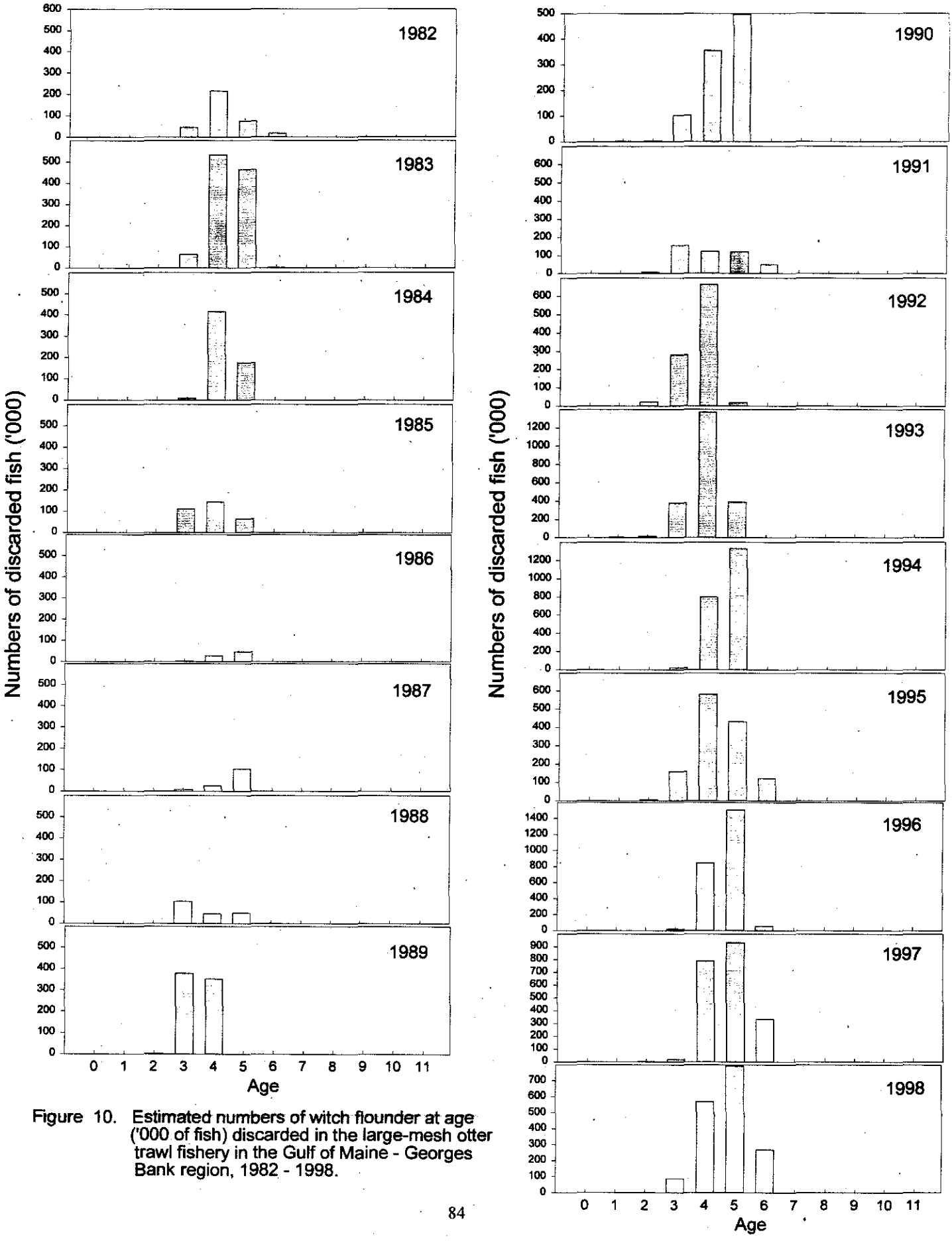


Figure 10. Estimated numbers of witch flounder at age ('000 of fish) discarded in the large-mesh otter trawl fishery in the Gulf of Maine - Georges Bank region, 1982 - 1998.

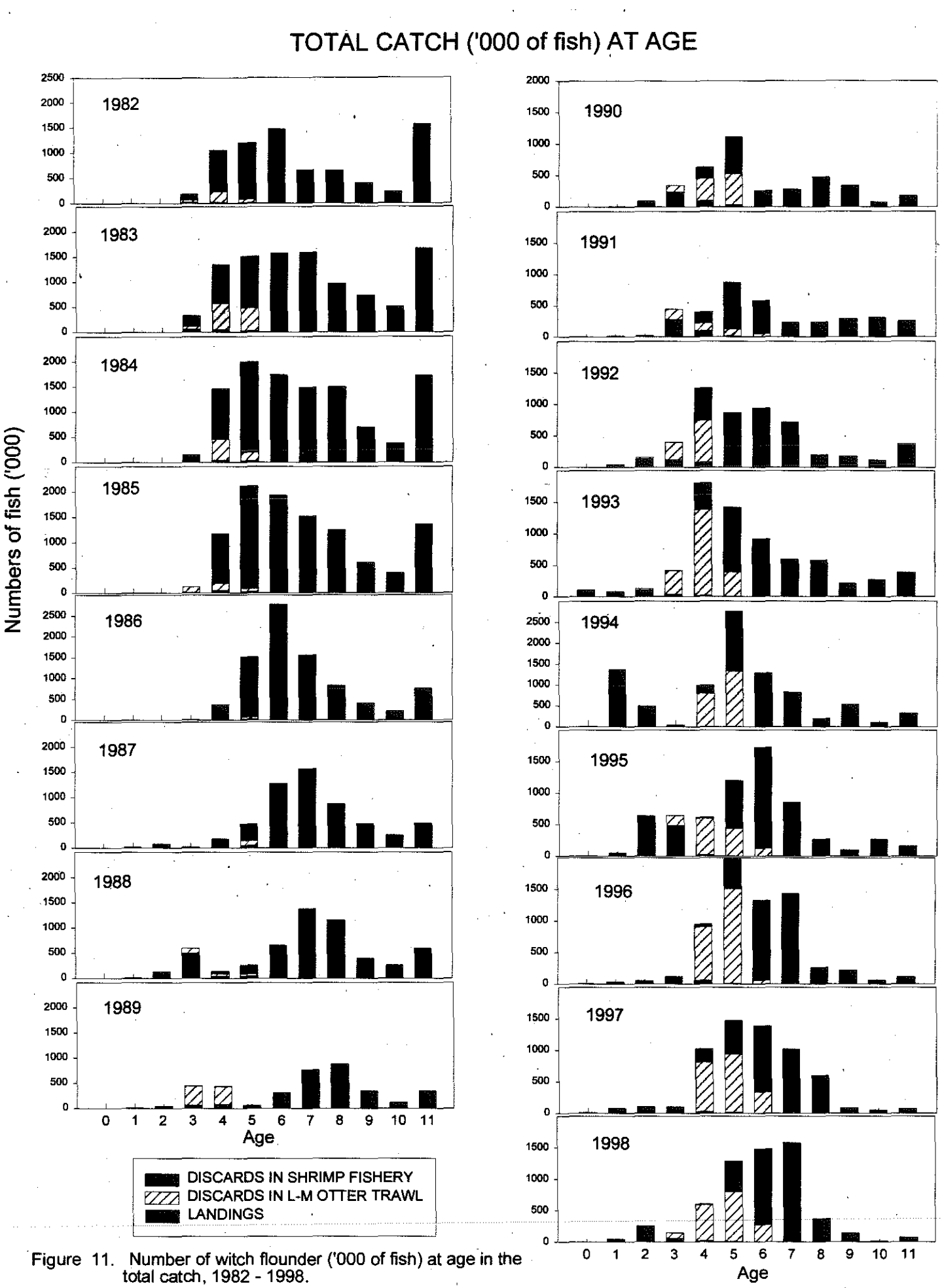


Figure 11. Number of witch flounder ('000 of fish) at age in the total catch, 1982 - 1998.

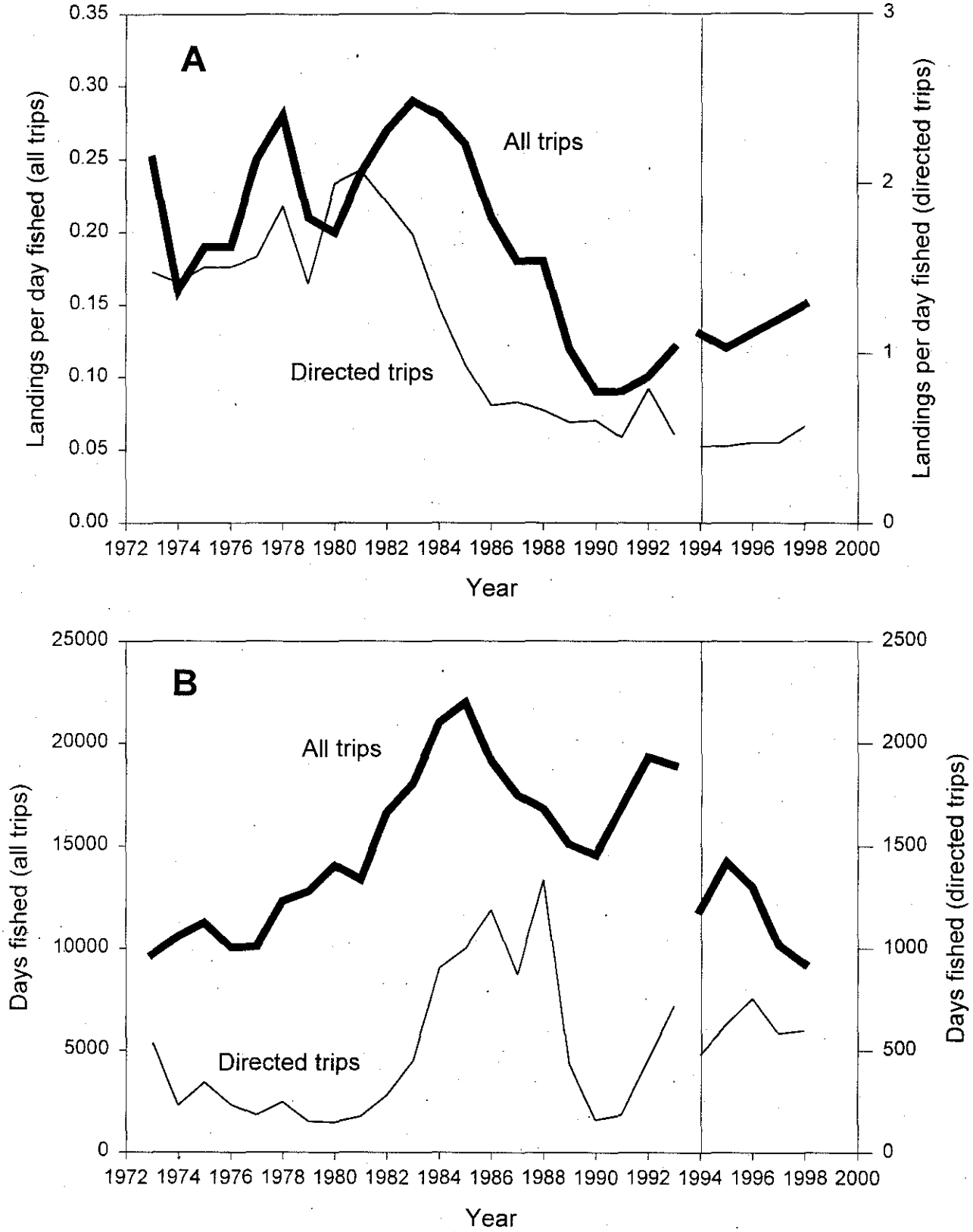


Figure 12. Trends in USA landings per day fished (A) and effort (B) of witch flounder, 1973-1998. Data are based on all otter trawl trips which witch flounder were caught (all trips) and for otter trawl trips in which witch flounder constituted 40% or more of the trip catch, by weight (directed trips). Data from 1994-1998 are base on preliminary VTR data , thus total effort (DF) may be underestimated in these years.

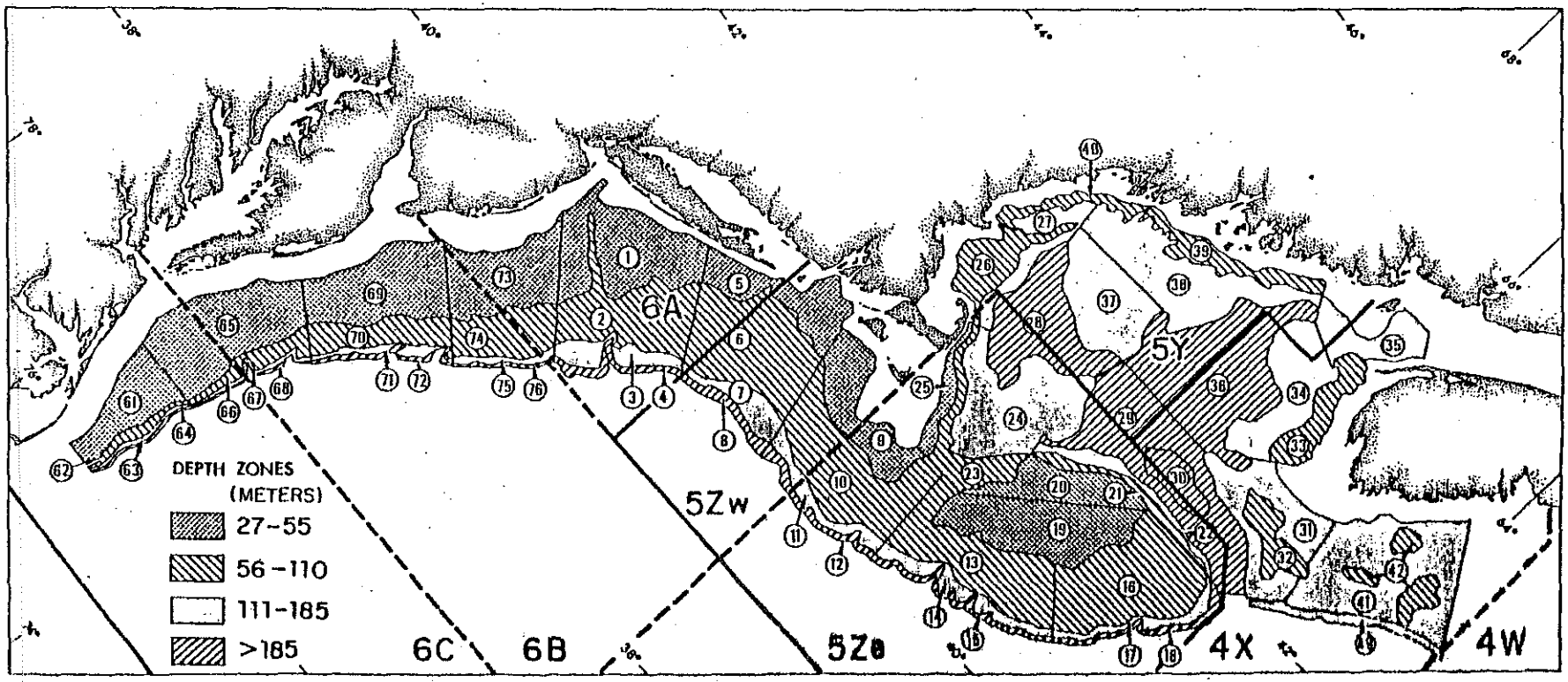


Figure 13. Sampling strata (22-30, 36-40) used during the Northeast Fisheries Science Center spring and autumn research vessel bottom trawl surveys, 1963 to present.

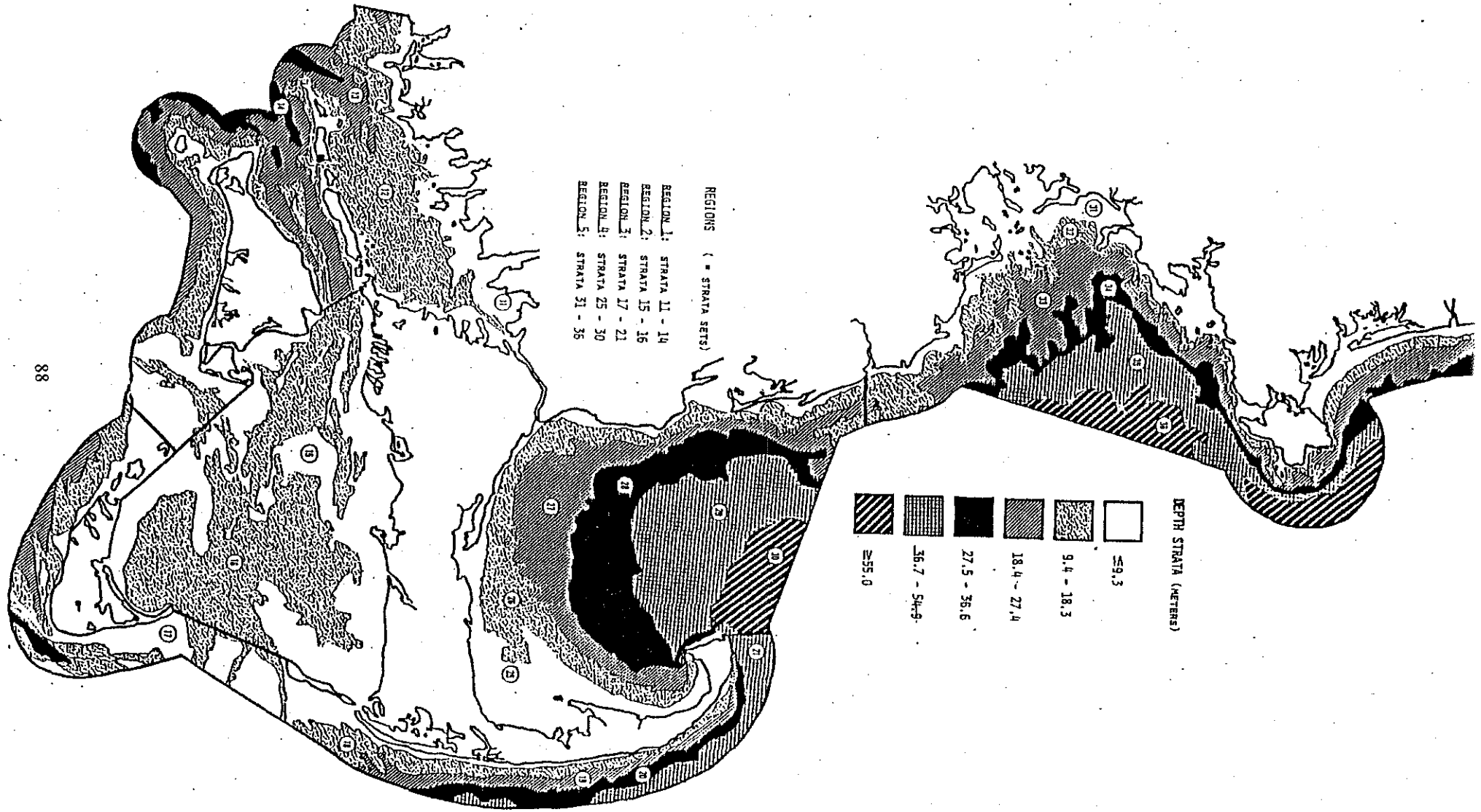


Figure 14. Sampling strata (regions 4 and 5) used during the Massachusetts Division of Marine Fisheries spring and autumn inshore research vessel bottom trawl surveys, 1978 to present.

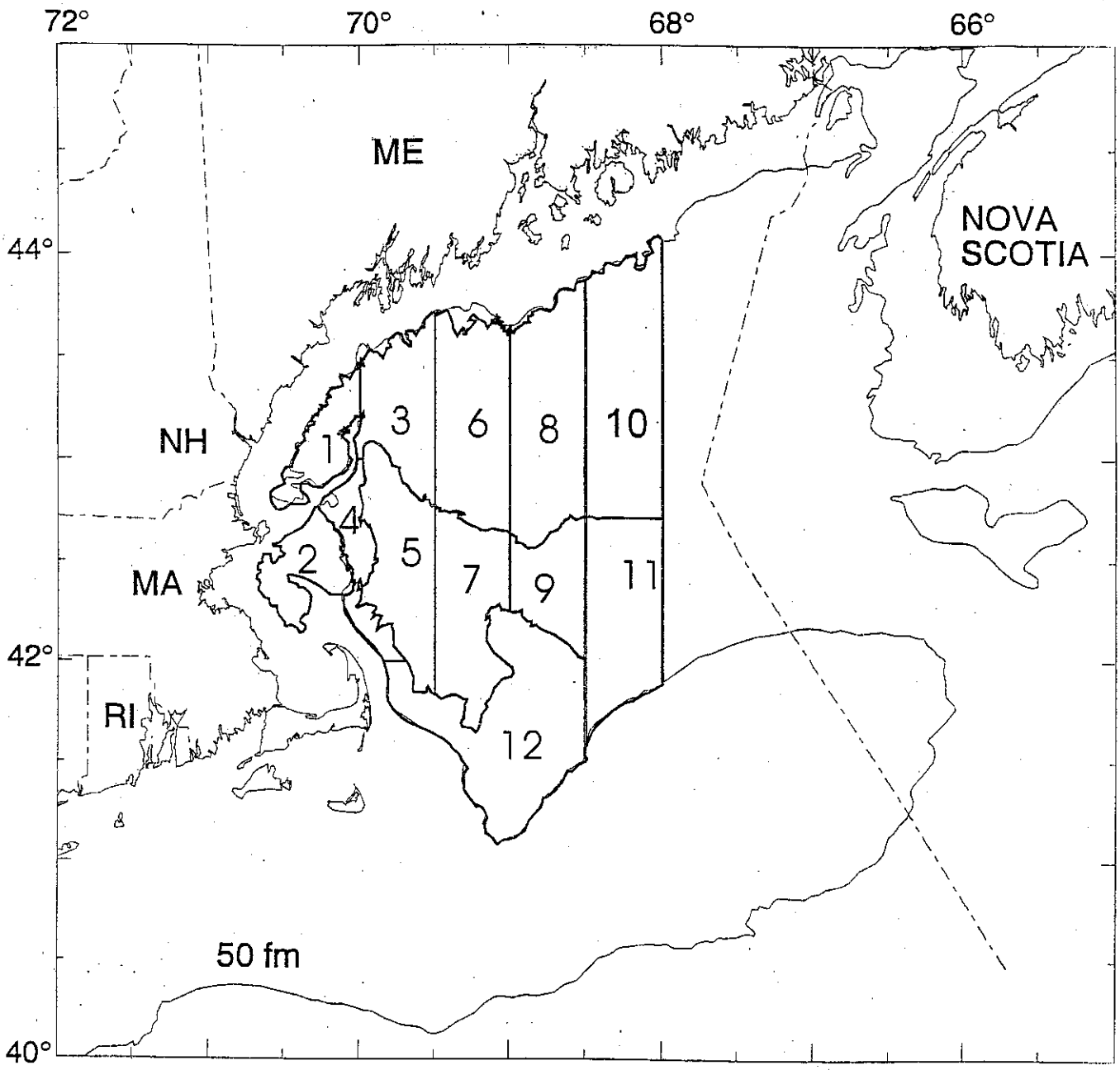


Figure 15. Sampling strata (1,3,6,8) used during the Atlantic States Marine Fisheries Commission summer northern shrimp surveys, 1984 to present.

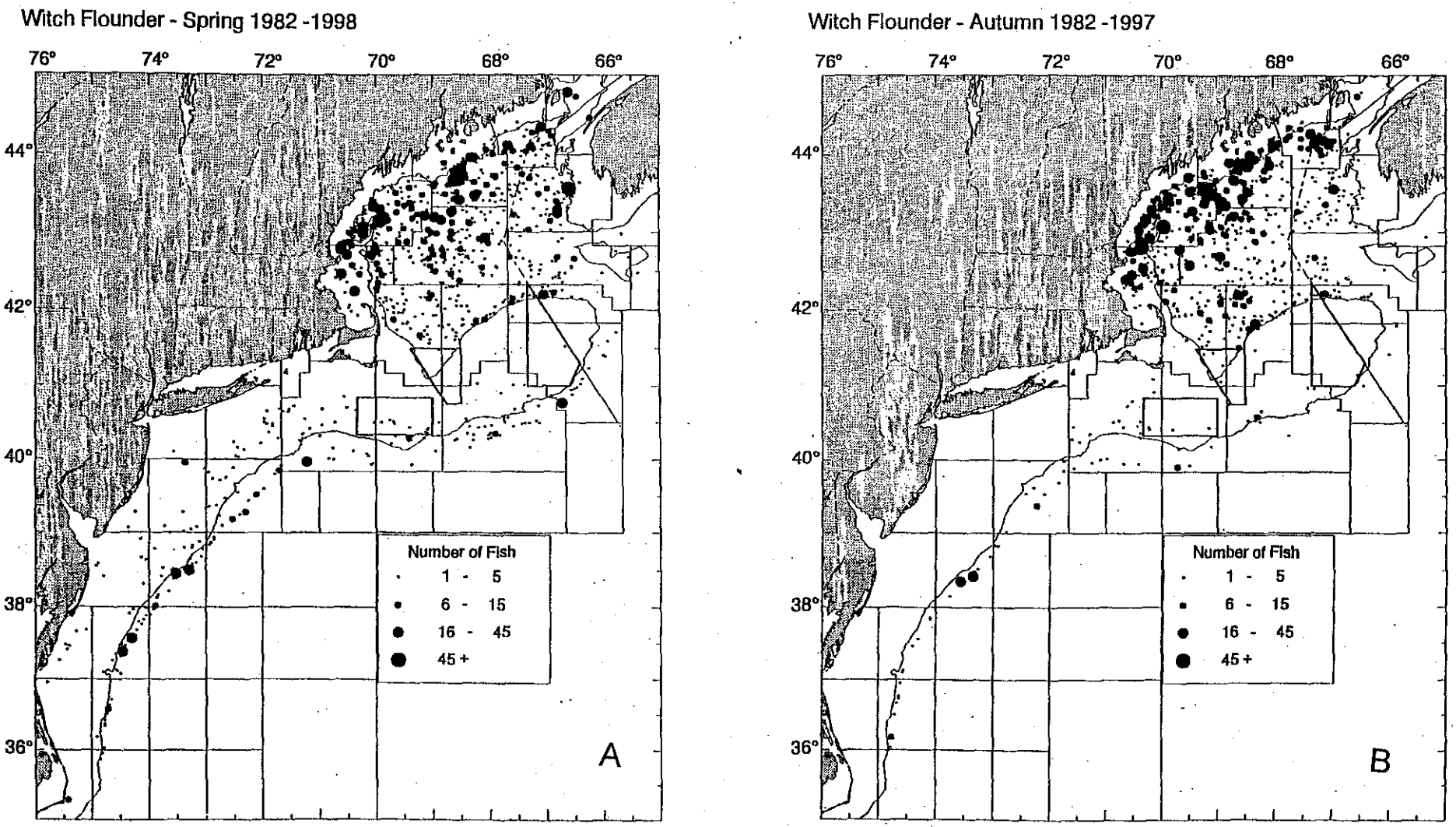
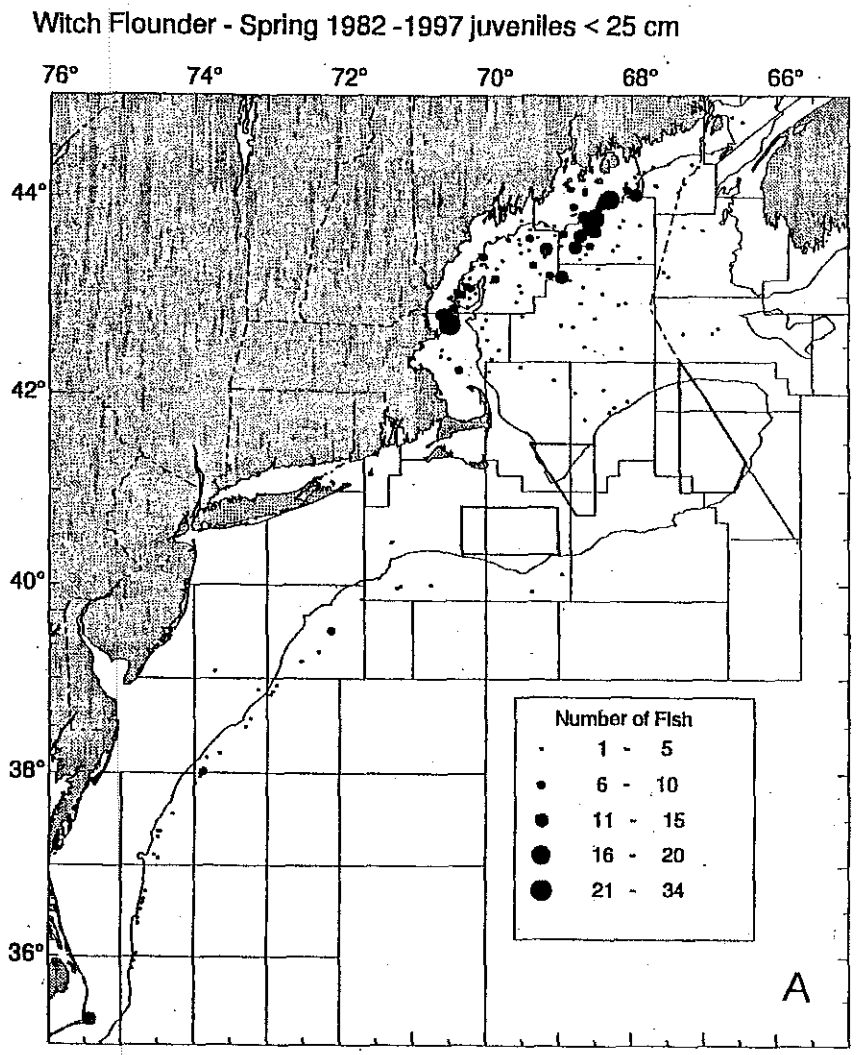


Figure 16. Distribution of witch flounder observed in the Northeast Fisheries Science Center spring (A) and autumn (B) research vessel bottom trawl surveys, 1982 to present.



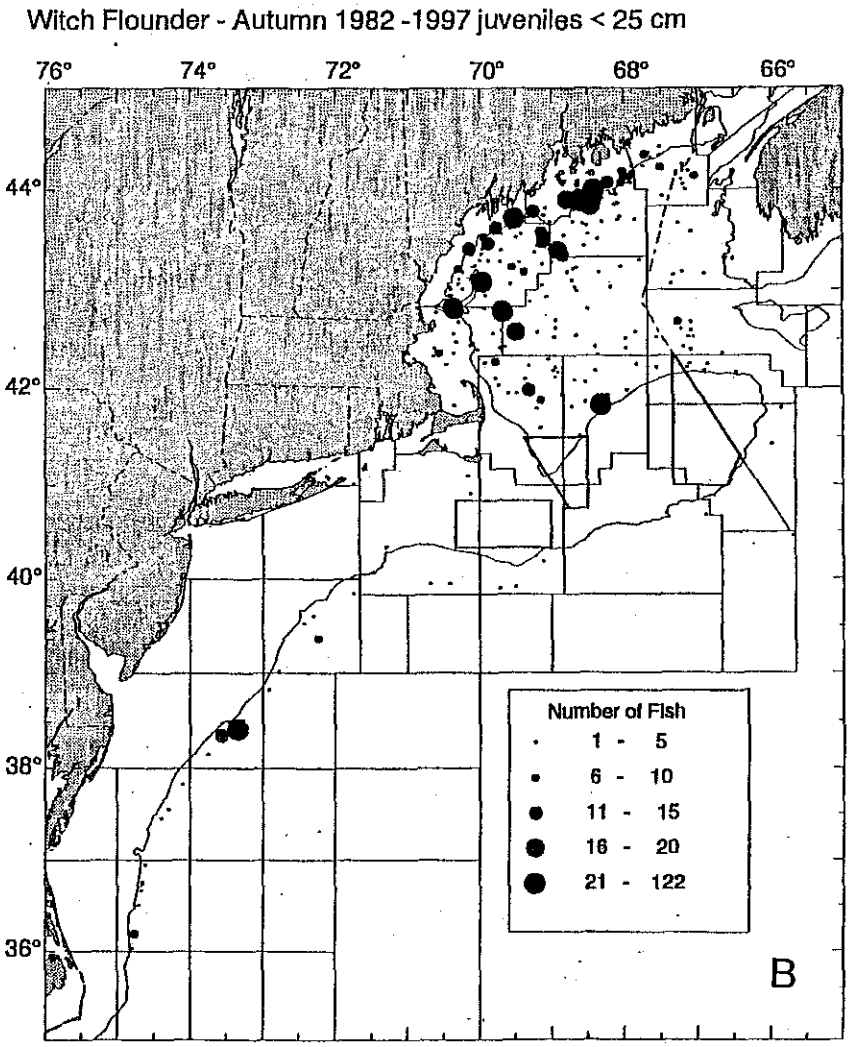


Figure 17. Distribution of juvenile (< 25 cm) witch flounder observed in the Northeast Fisheries Science Center spring (A) and autumn (B) research vessel bottom trawl surveys, 1982 to present.

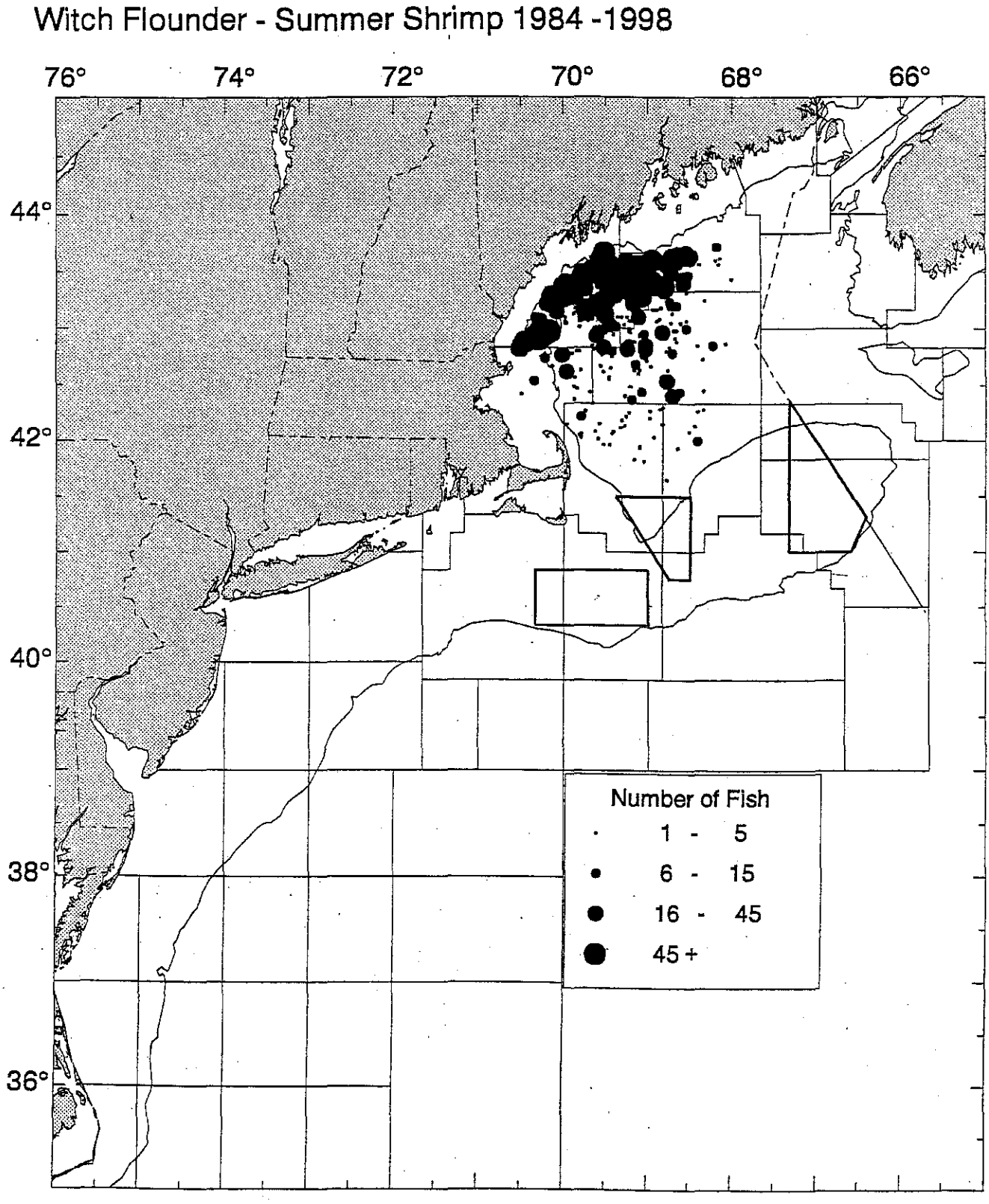


Figure 18. Distribution of witch flounder observed in the Atlantic States Marine Fisheries Commission summer northern shrimp surveys, 1984 to present.

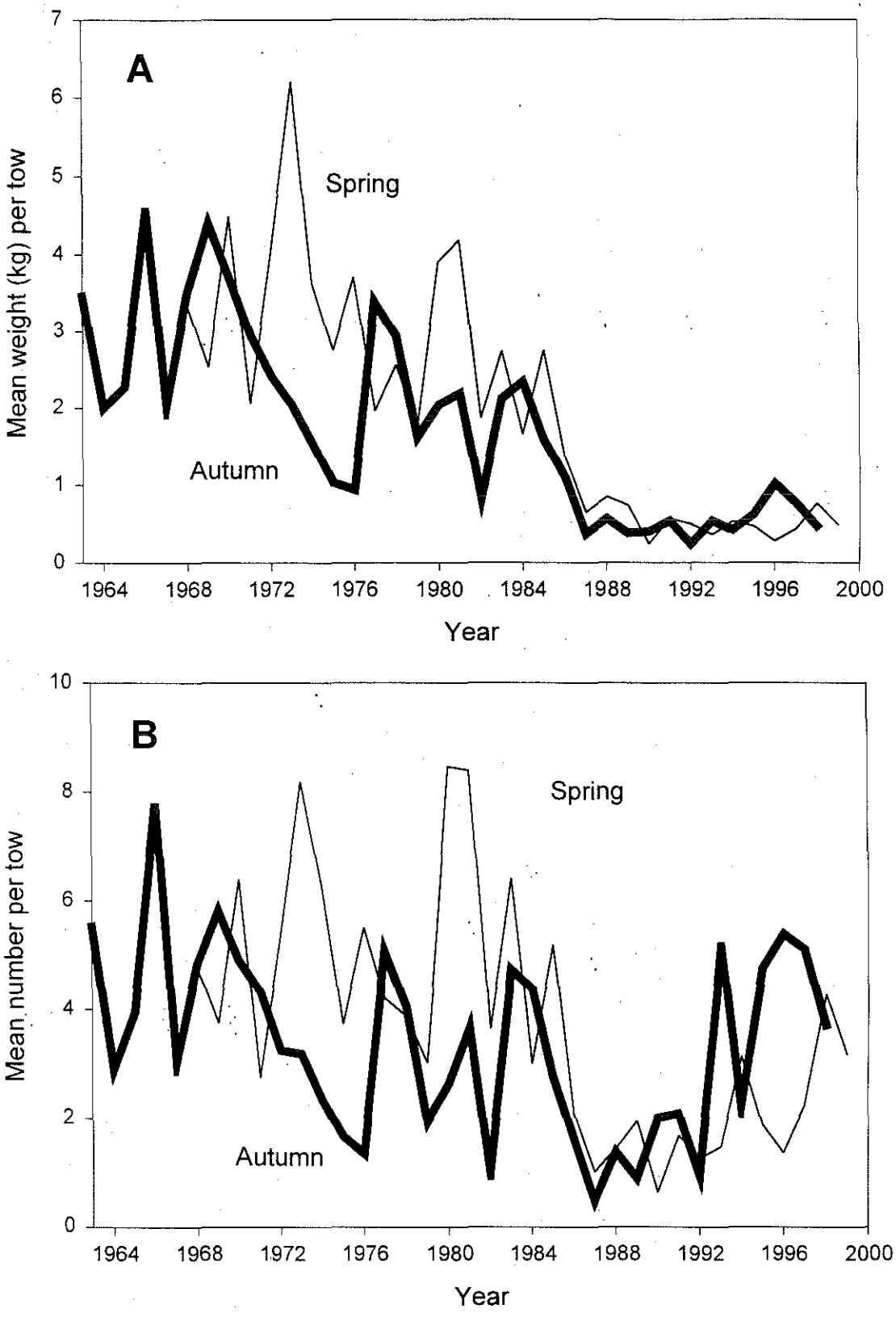


Figure 19. Stratified mean catch (kg) per tow (A) and mean number per tow (B) of witch flounder in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine-Georges Bank region, 1963 - 1998; 1999 values are preliminary.

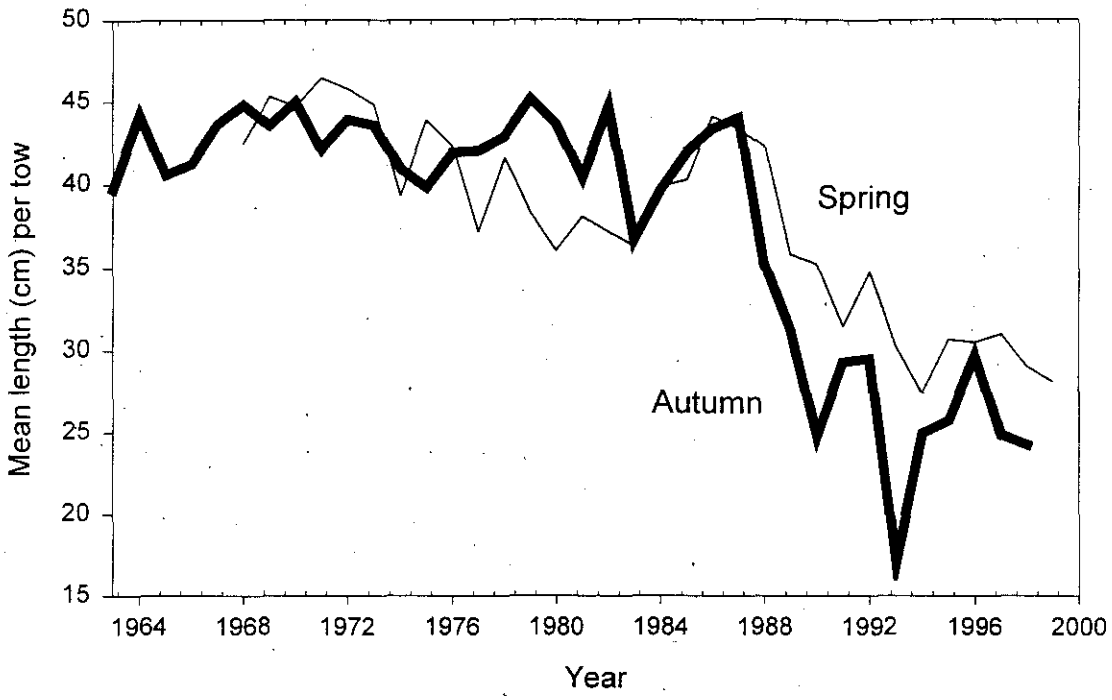


Figure 20. Stratified mean length (cm) per tow of witch flounder in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine-Georges Bank region, 1963 - 1998; 1999 value is preliminary.

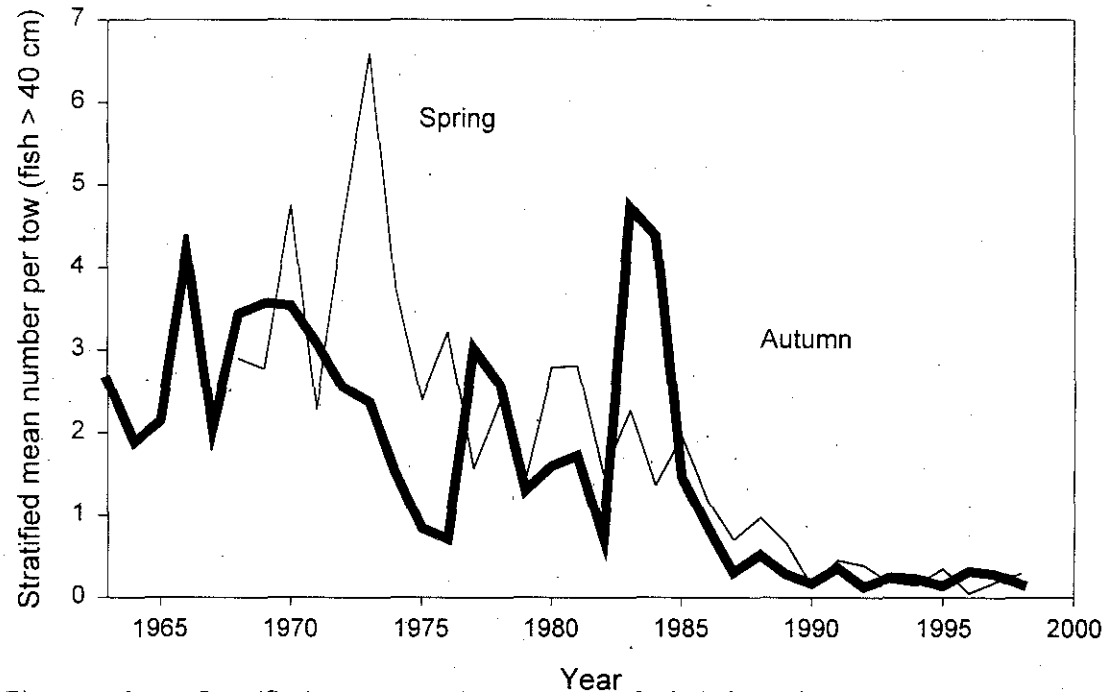


Figure 21. Stratified mean number per tow of witch flounder greater than 40 cm from the NEFSC spring and autumn bottom trawl surveys, 1963 - 1998.

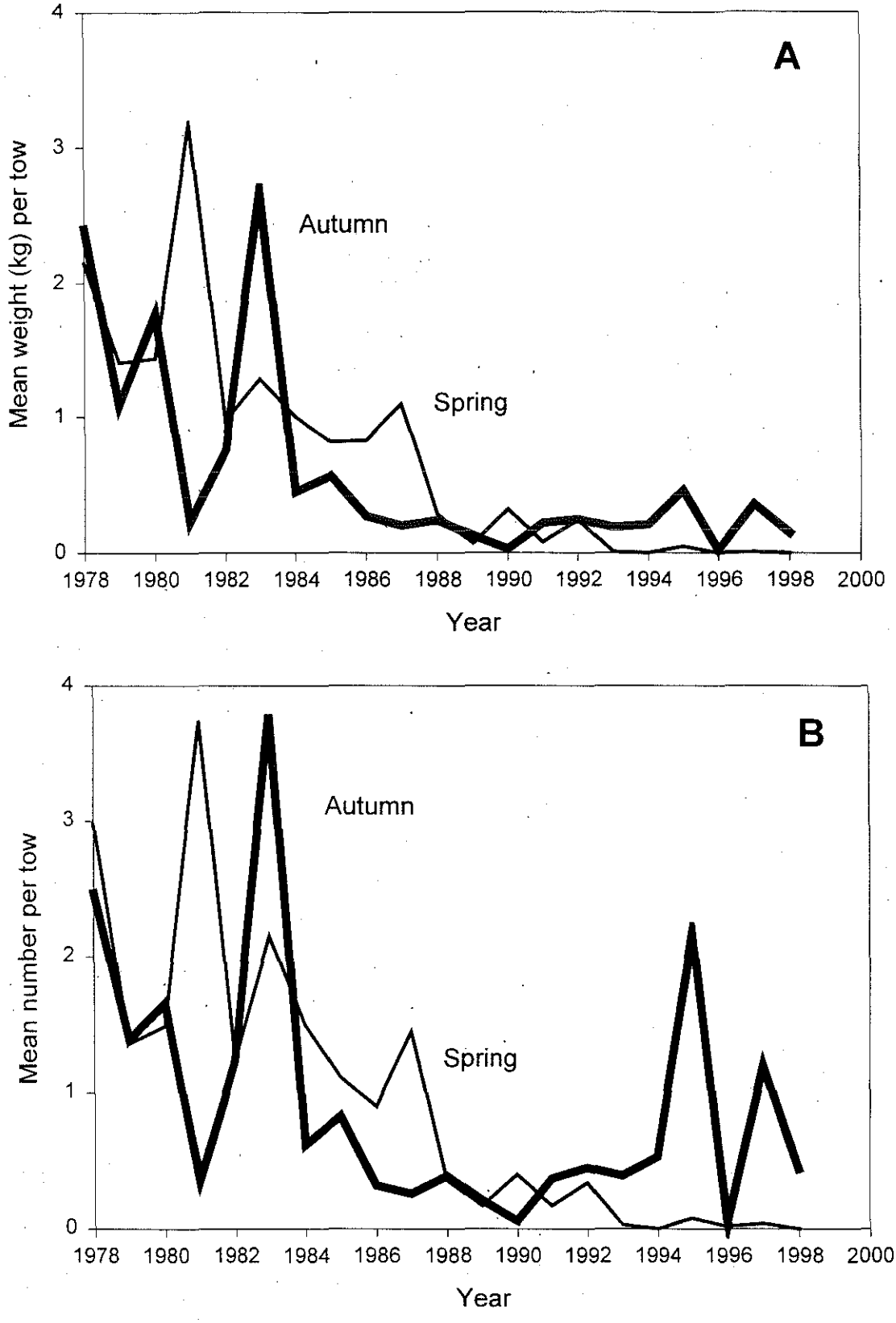


Figure 22. Stratified mean catch (kg) per tow (A) and mean number per tow (B) of witch flounder in Massachusetts Division of Marine Fisheries spring and autumn research vessel bottom trawl surveys in the Cape Cod Bay - Massachusetts Bay region, 1978 - 1998.

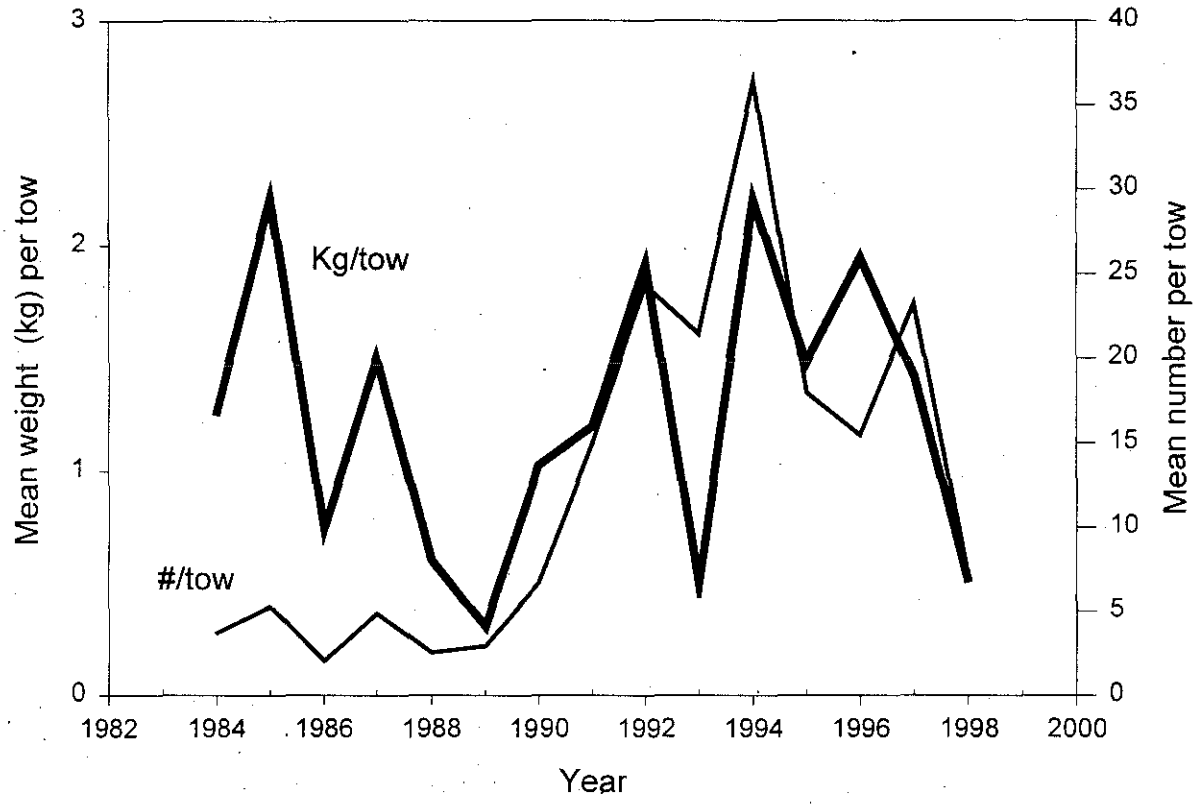


Figure 23. Stratified mean catch per tow, in weight (kg) and numbers, of witch flounder in the Atlantic States Marine Fisheries Commission summer northern shrimp trawl survey, 1984 - 1998.

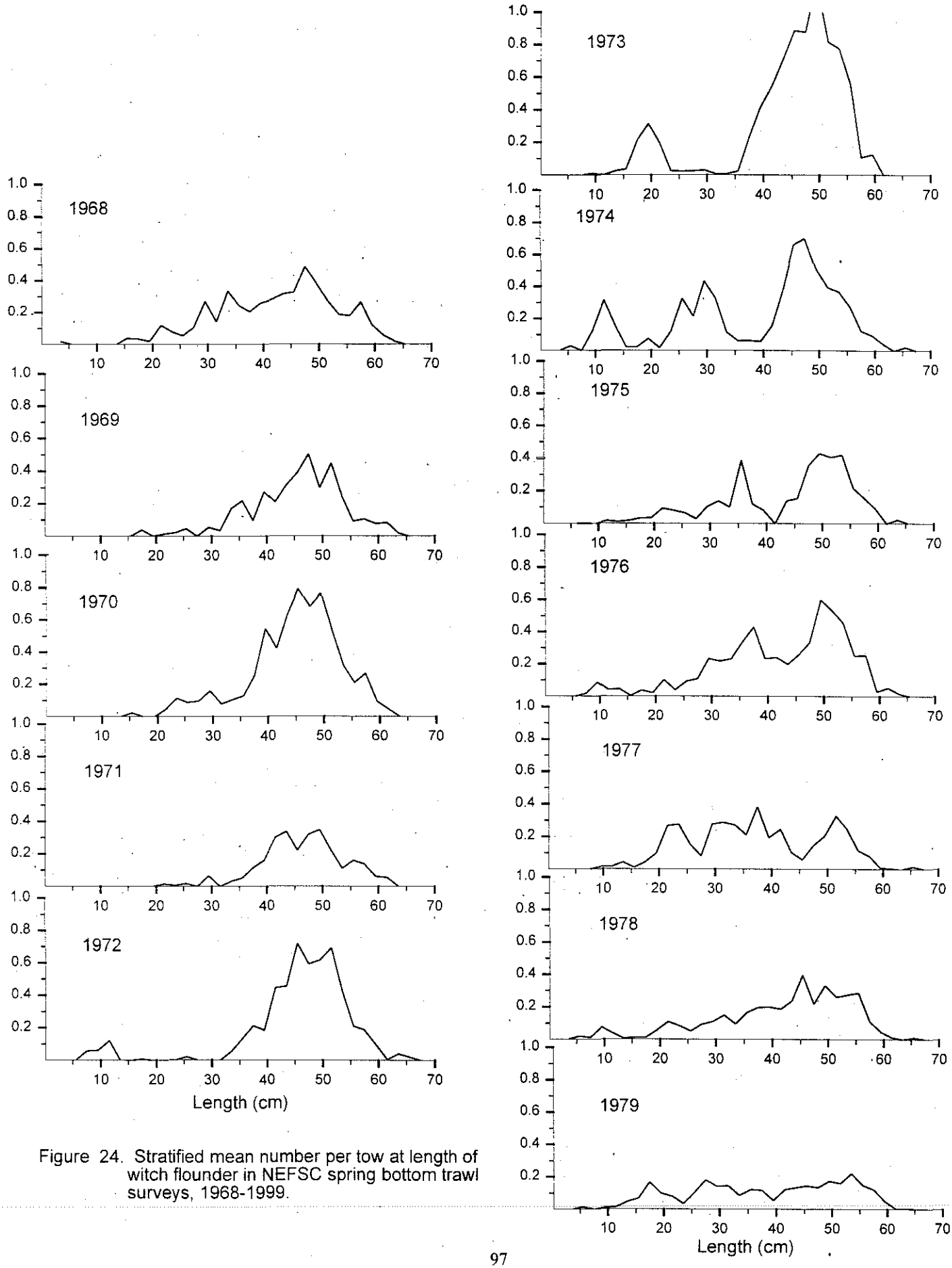


Figure 24. Stratified mean number per tow at length of witch flounder in NEFSC spring bottom trawl surveys, 1968-1999.

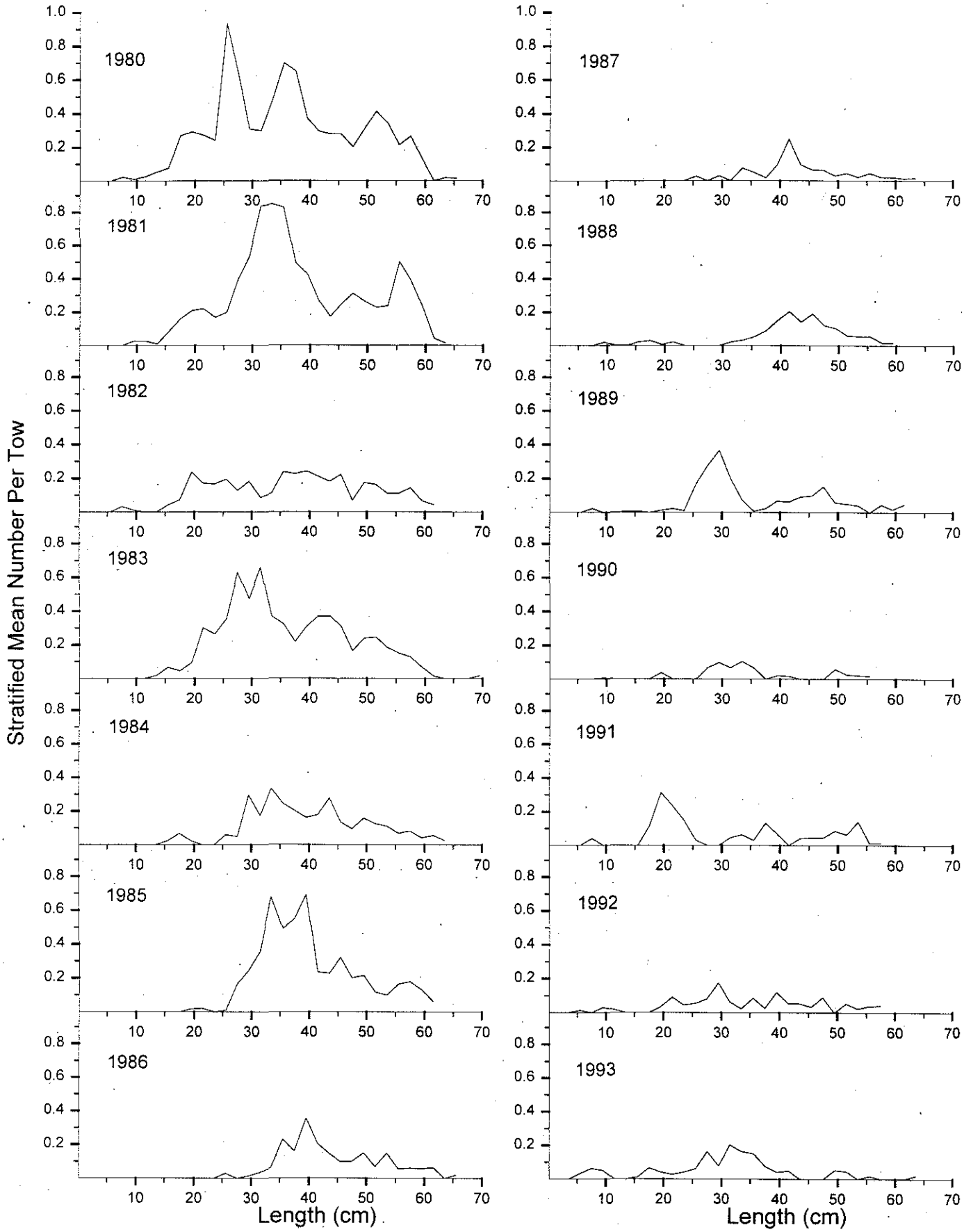


Figure 24 continued.

NEFSC SPRING SURVEY: stratified mean number per tow

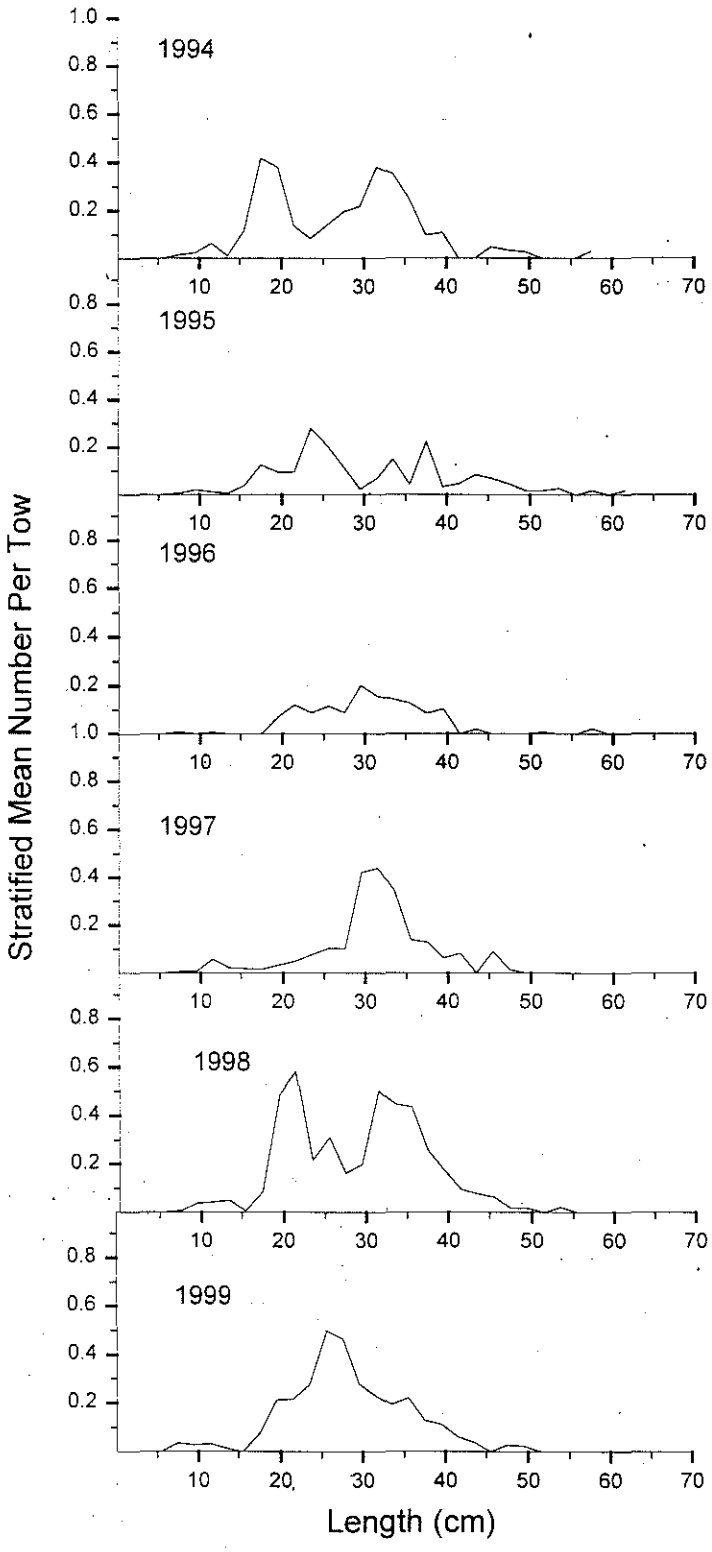


Figure 24 continued.

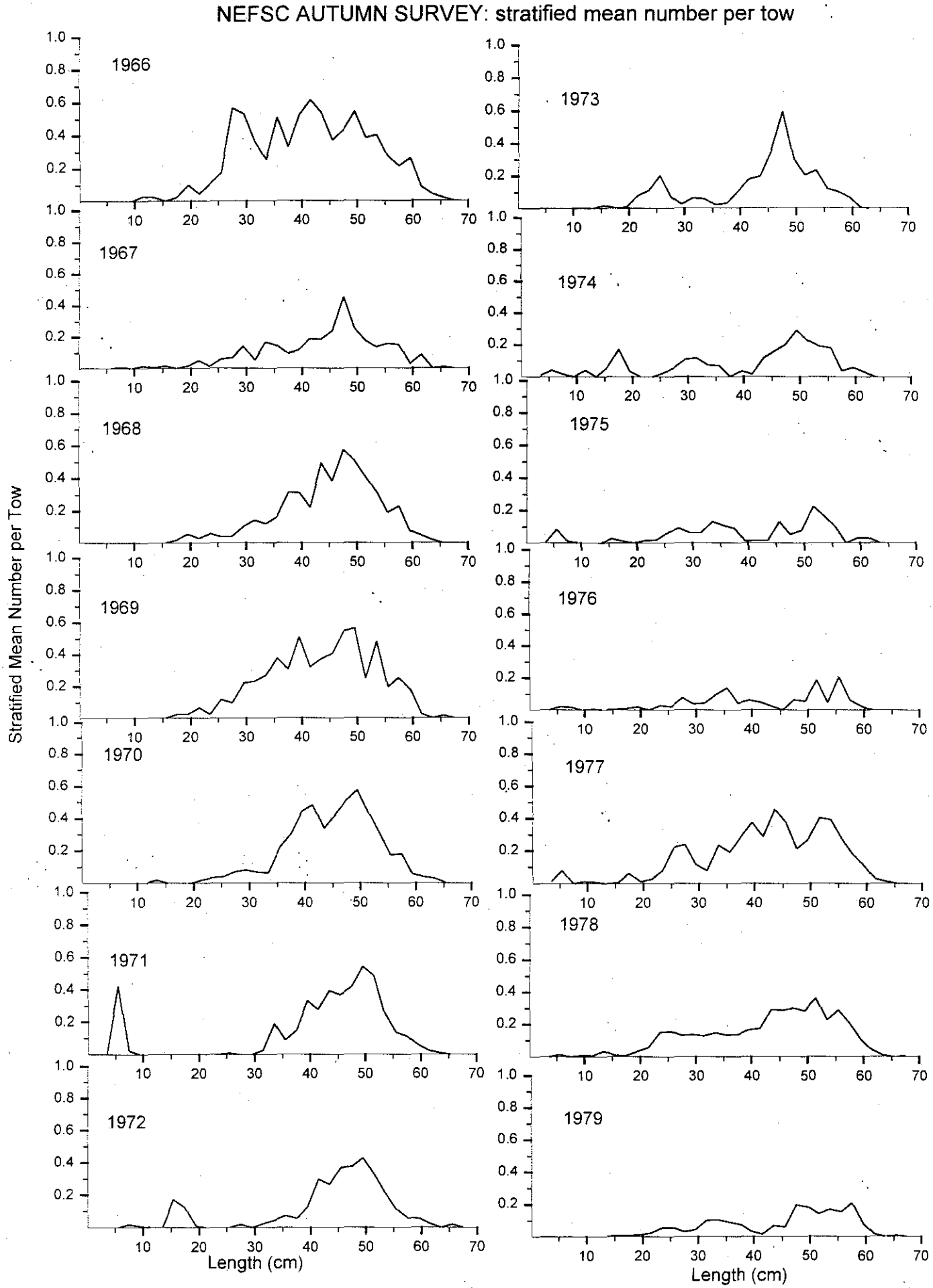


Figure 25. Stratified mean number per tow at length of witch flounder in NEFSC autumn bottom trawl surveys, 1966 - 1979.

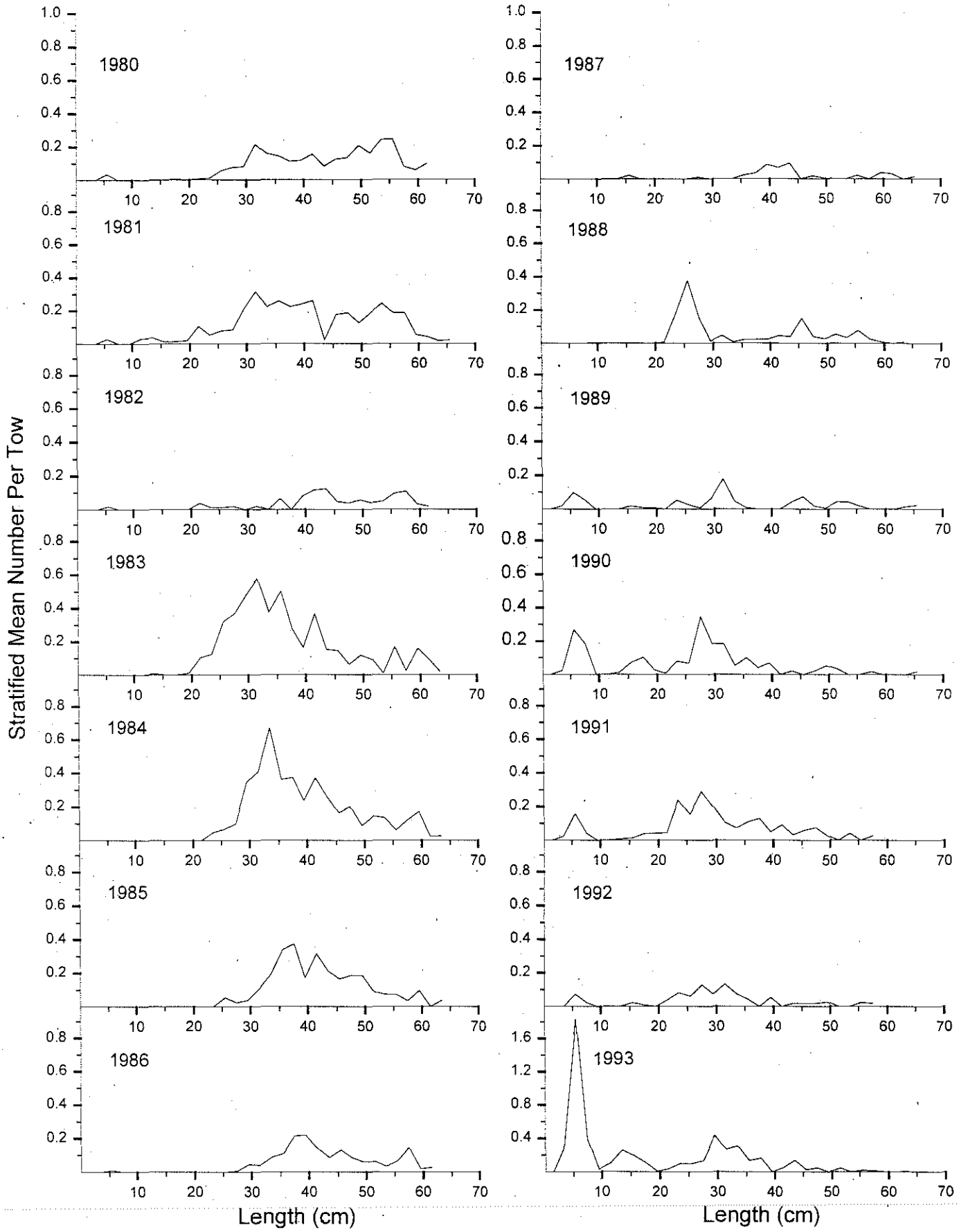


Figure 25 continued.

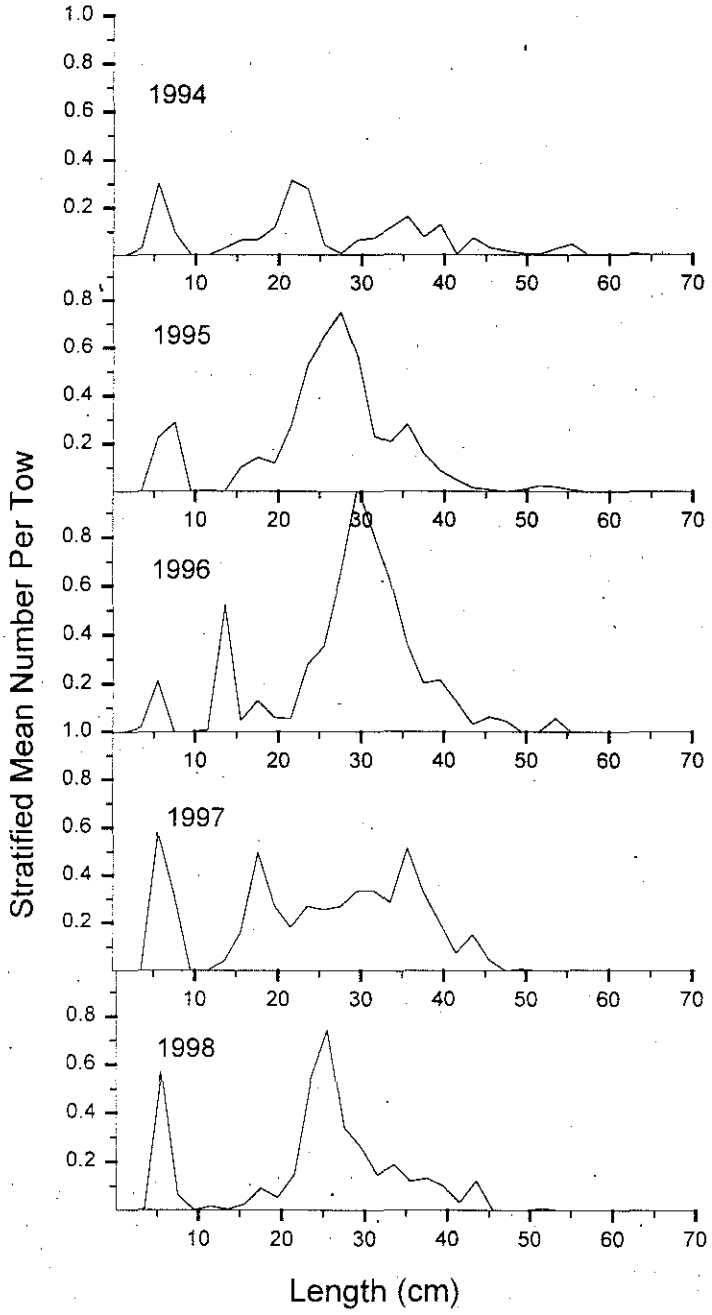


Figure 25 continued.

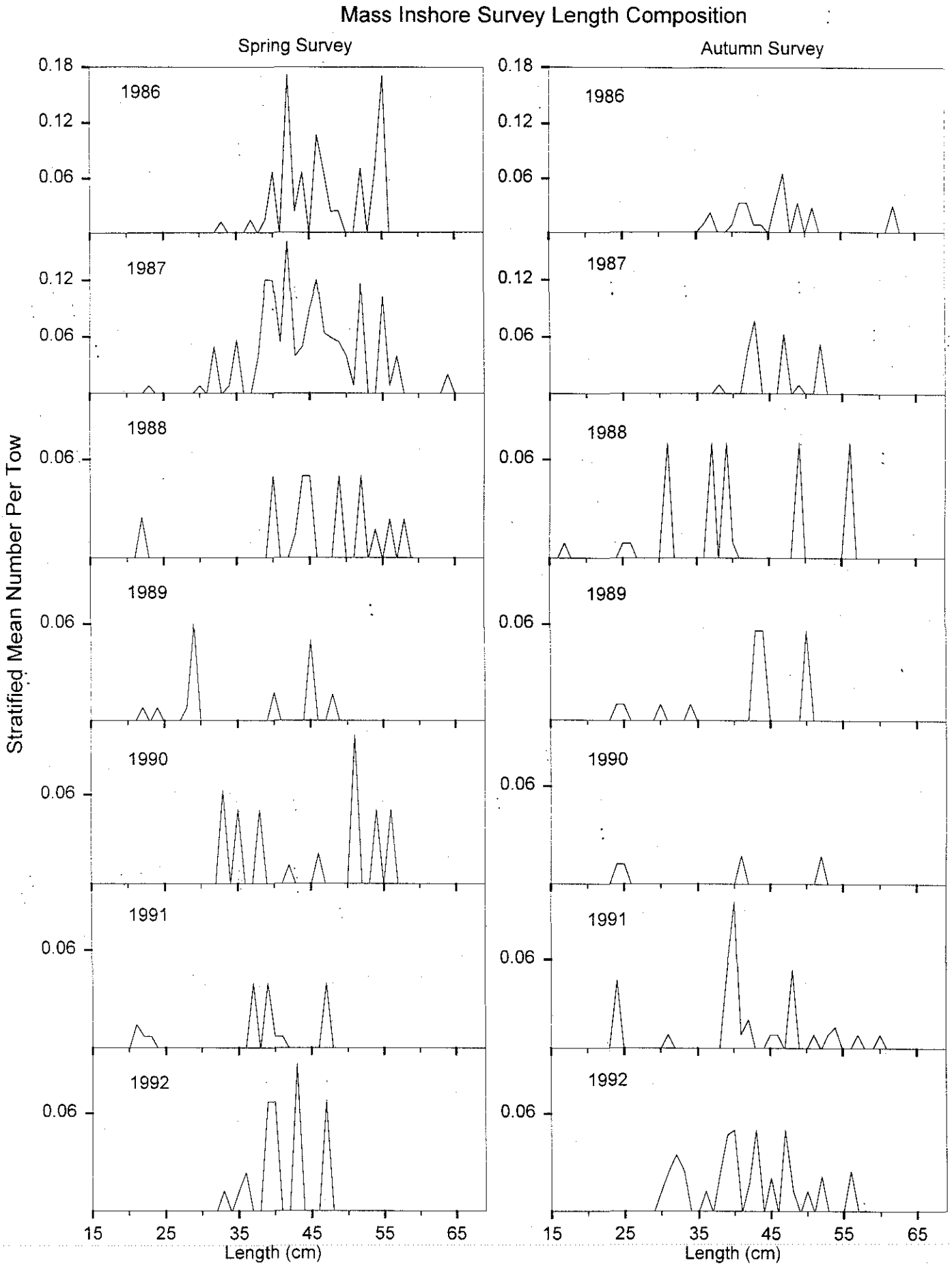


Figure 26. Stratified mean number per tow at length of witch flounder in Massachusetts Division of Marine Fisheries inshore spring and autumn bottom trawl surveys, 1986-1998.

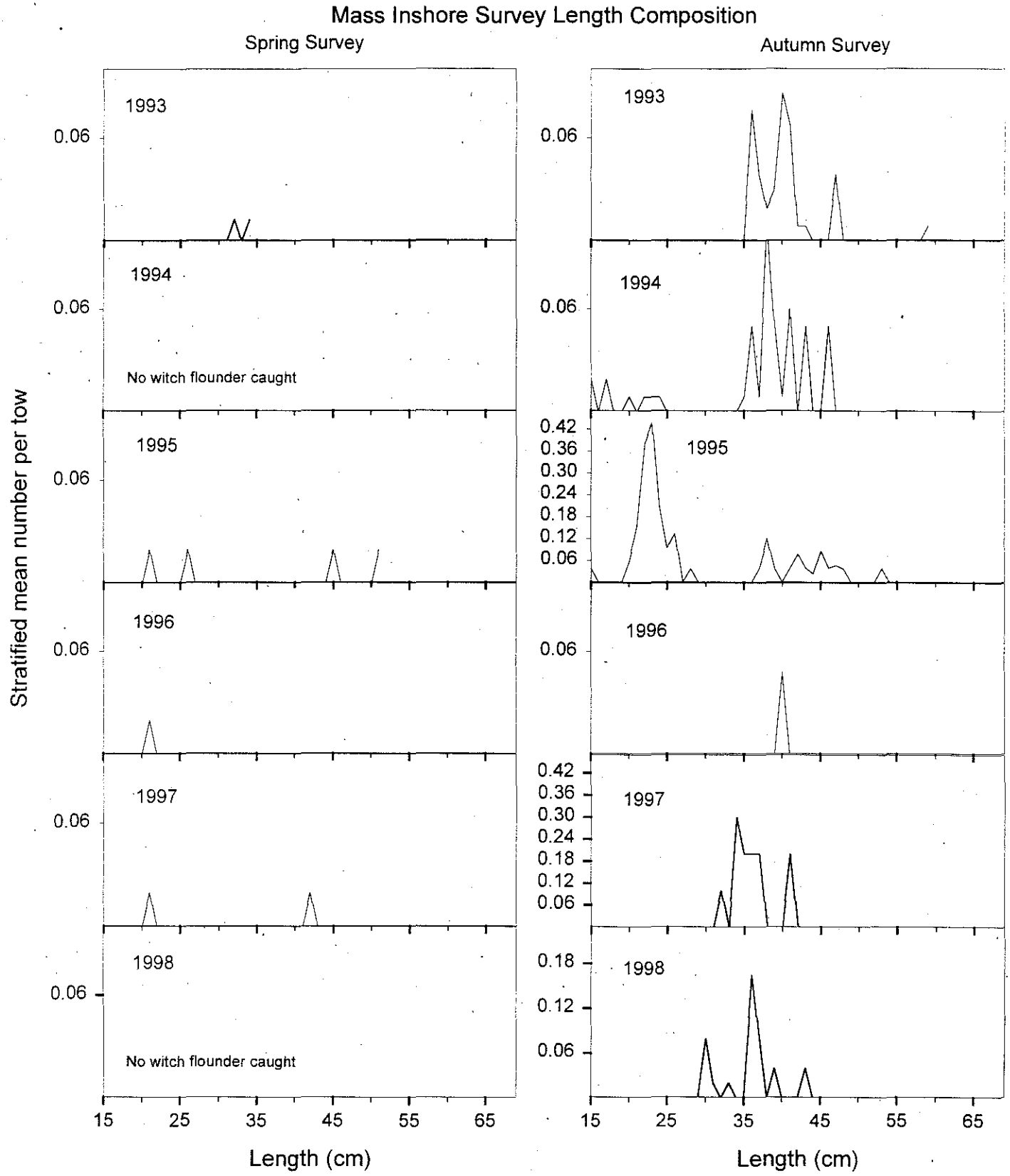


Figure 26 continued.

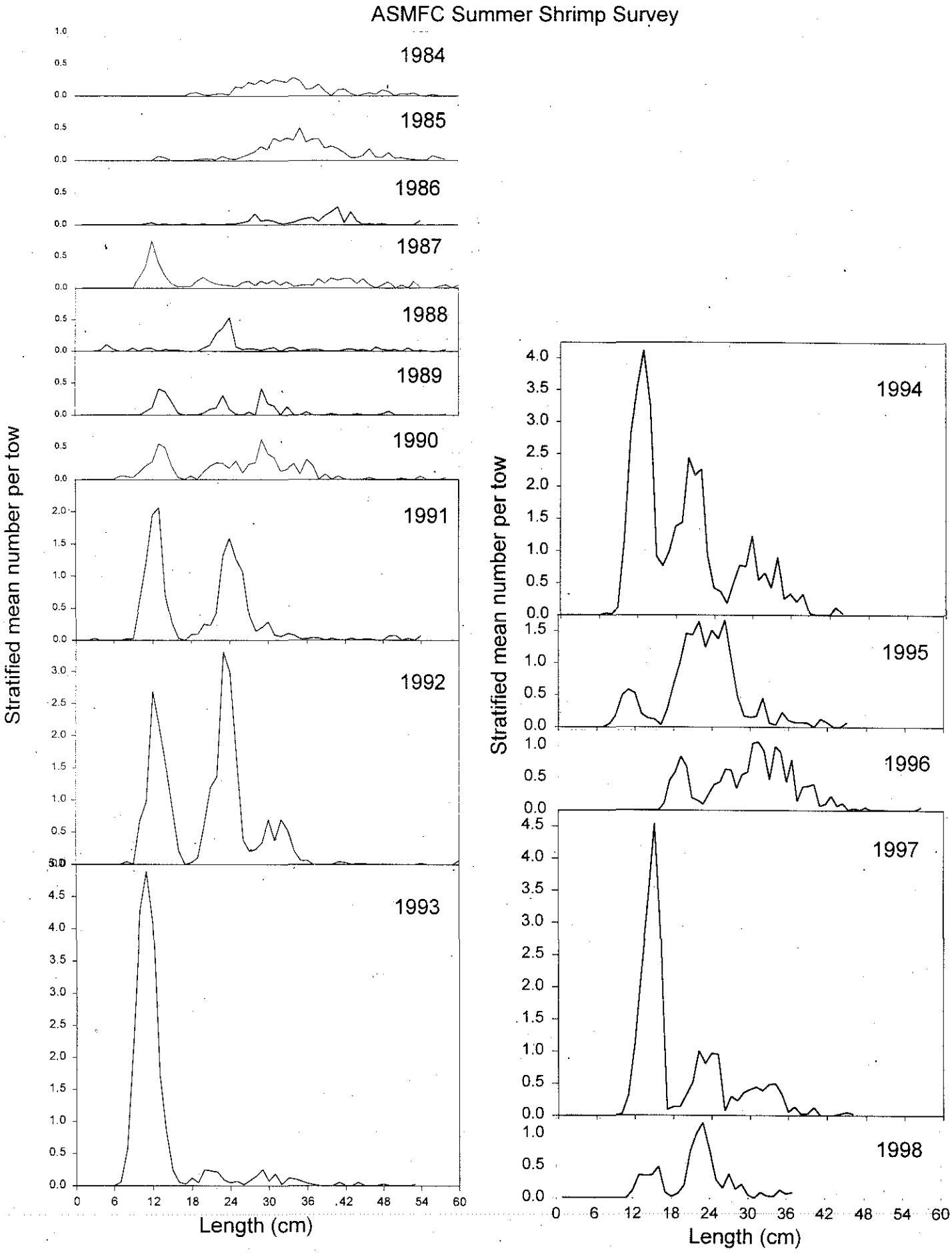


Figure 27. Stratified mean number per tow at length (cm) of witch flounder in Atlantic States Marine Fisheries Commission summer northern shrimp trawl surveys, 1984 - 1998.

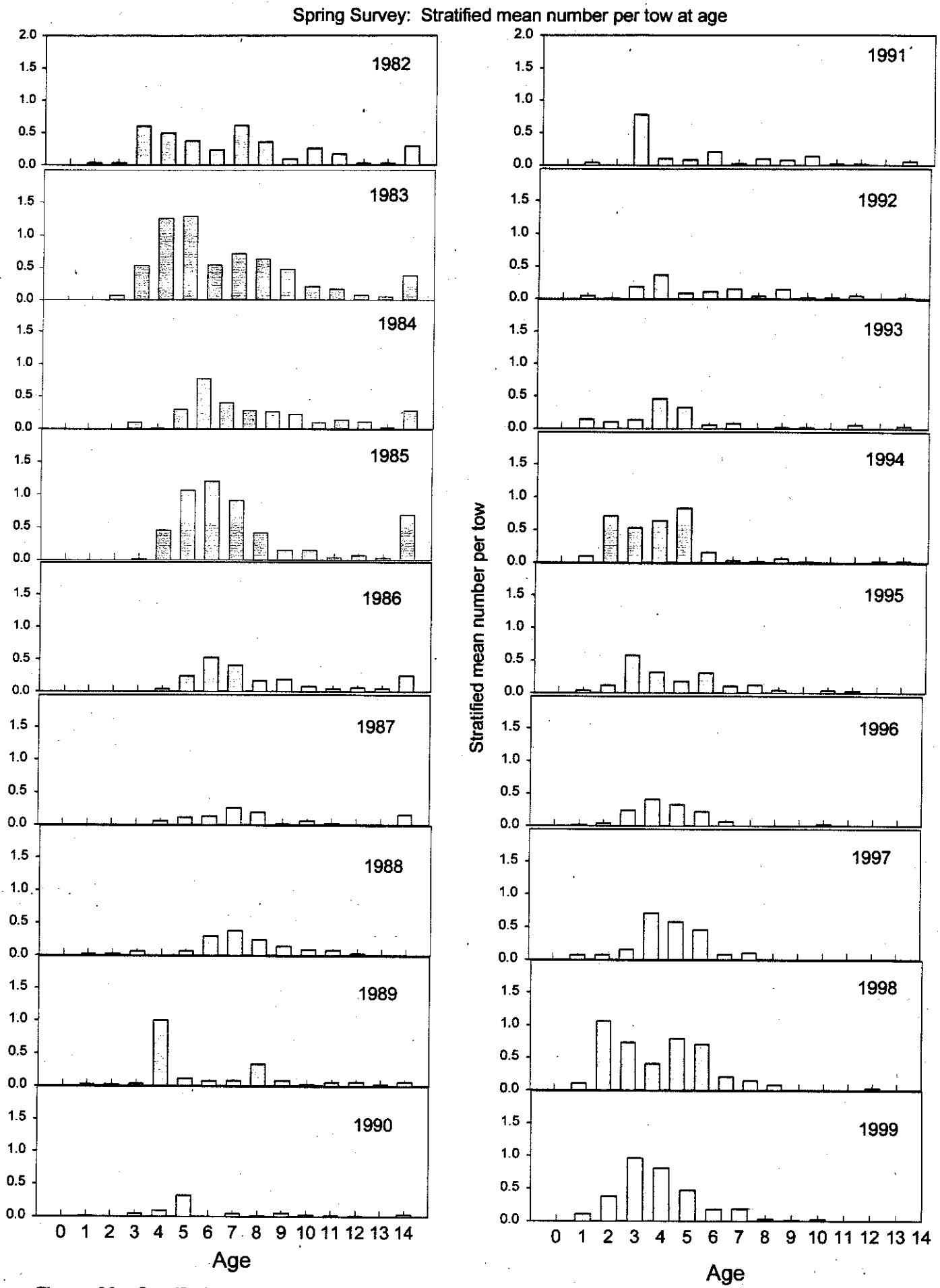


Figure 28. Stratified mean number of witch flounder per tow at age from NEFSC spring bottom trawl surveys, 1982-1998; preliminary 1999.

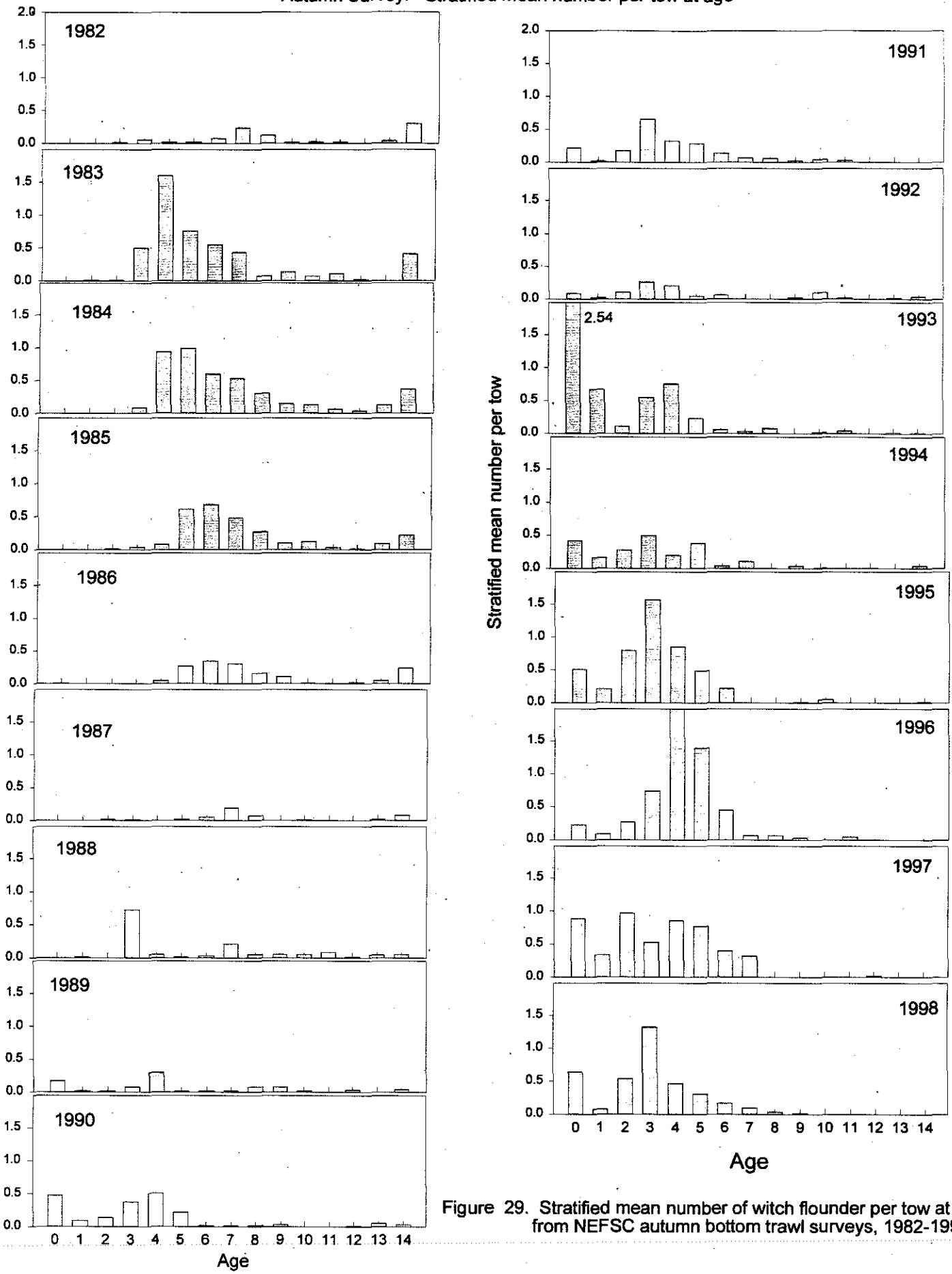


Figure 29. Stratified mean number of witch flounder per tow at age from NEFSC autumn bottom trawl surveys, 1982-1998.

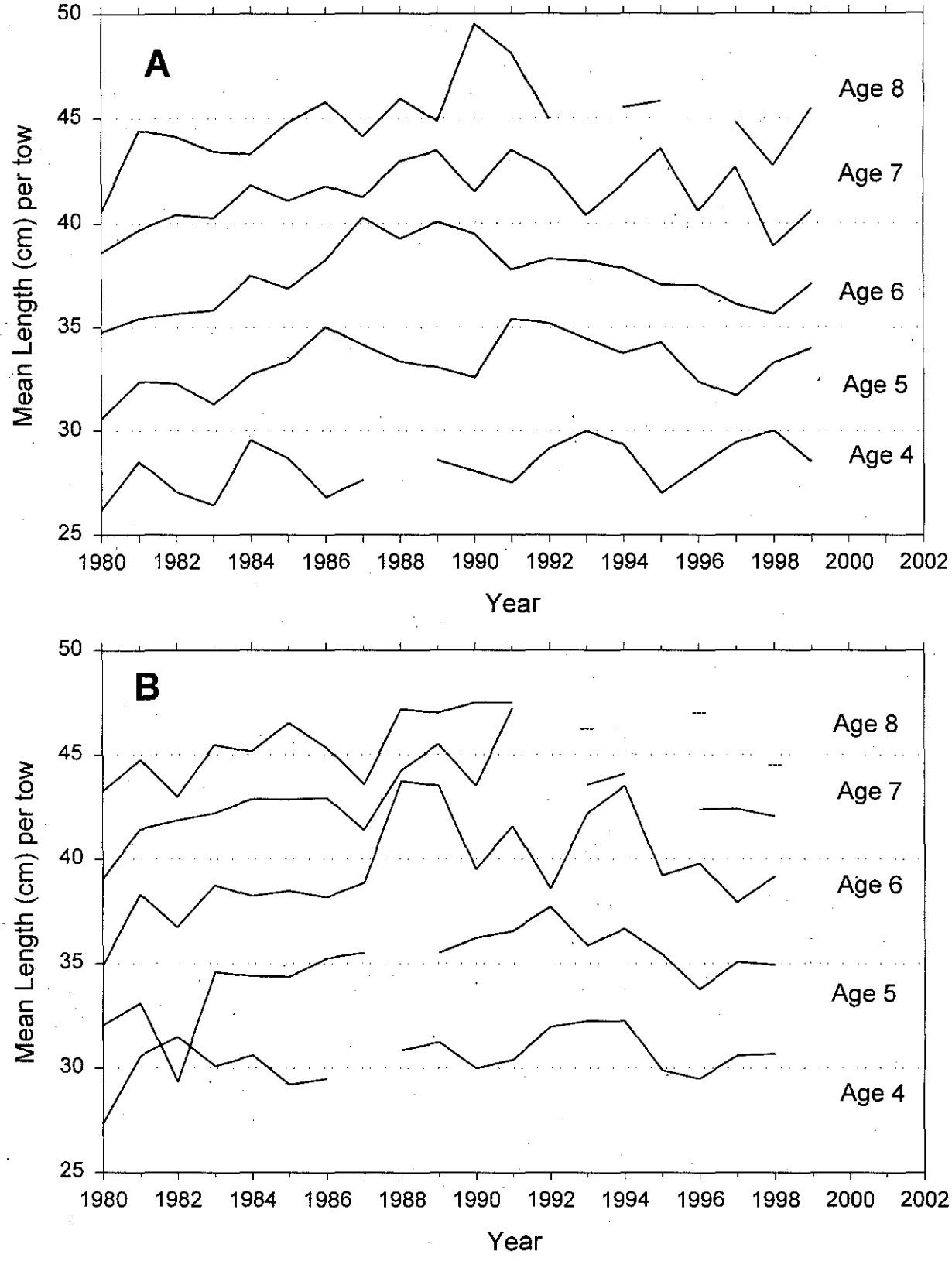


Figure 30. Mean length (cm) at age for age groups 4-8 of witch flounder in spring (A) and autumn (B) NEFSC research vessel bottom trawl surveys, 1980 - 1998, 1999 values are preliminary.

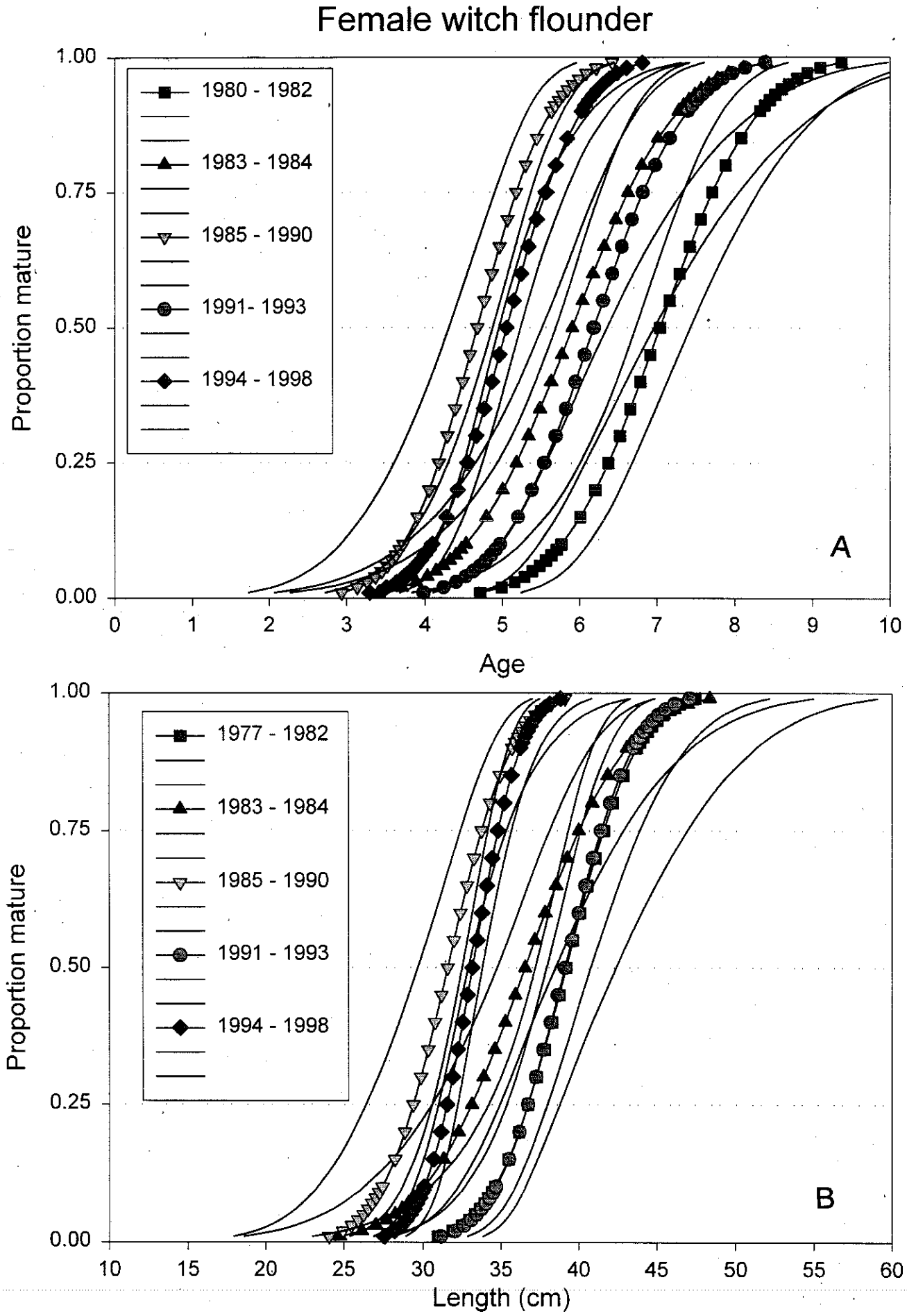


Figure 31 Proportion mature at age (A) and length (B) of female witch flounder derived from probit analysis of maturity observations collected on NEFSC spring bottom trawl surveys, 1977-1998.

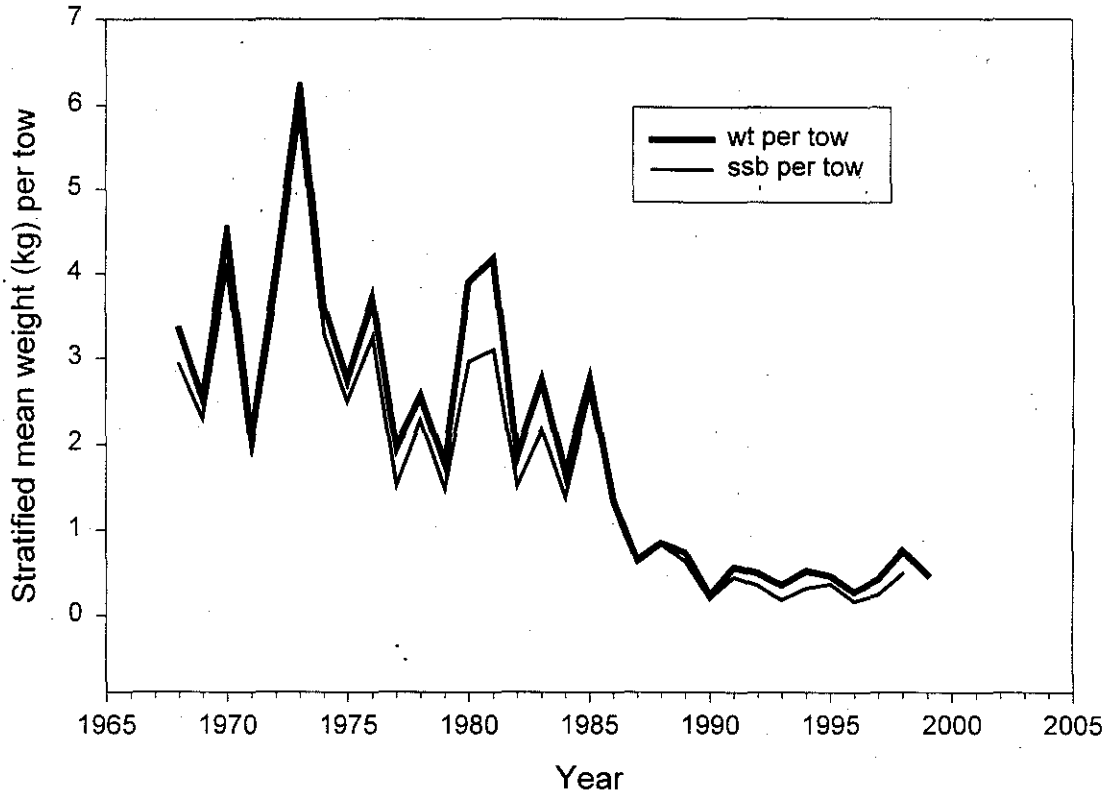


Figure 32. Stratified mean weight (kg) per tow (thick line) and spawning stock biomass (kg) per tow (thin line) of mature witch flounder from NEFSC spring bottom trawl surveys, 1968-1998.

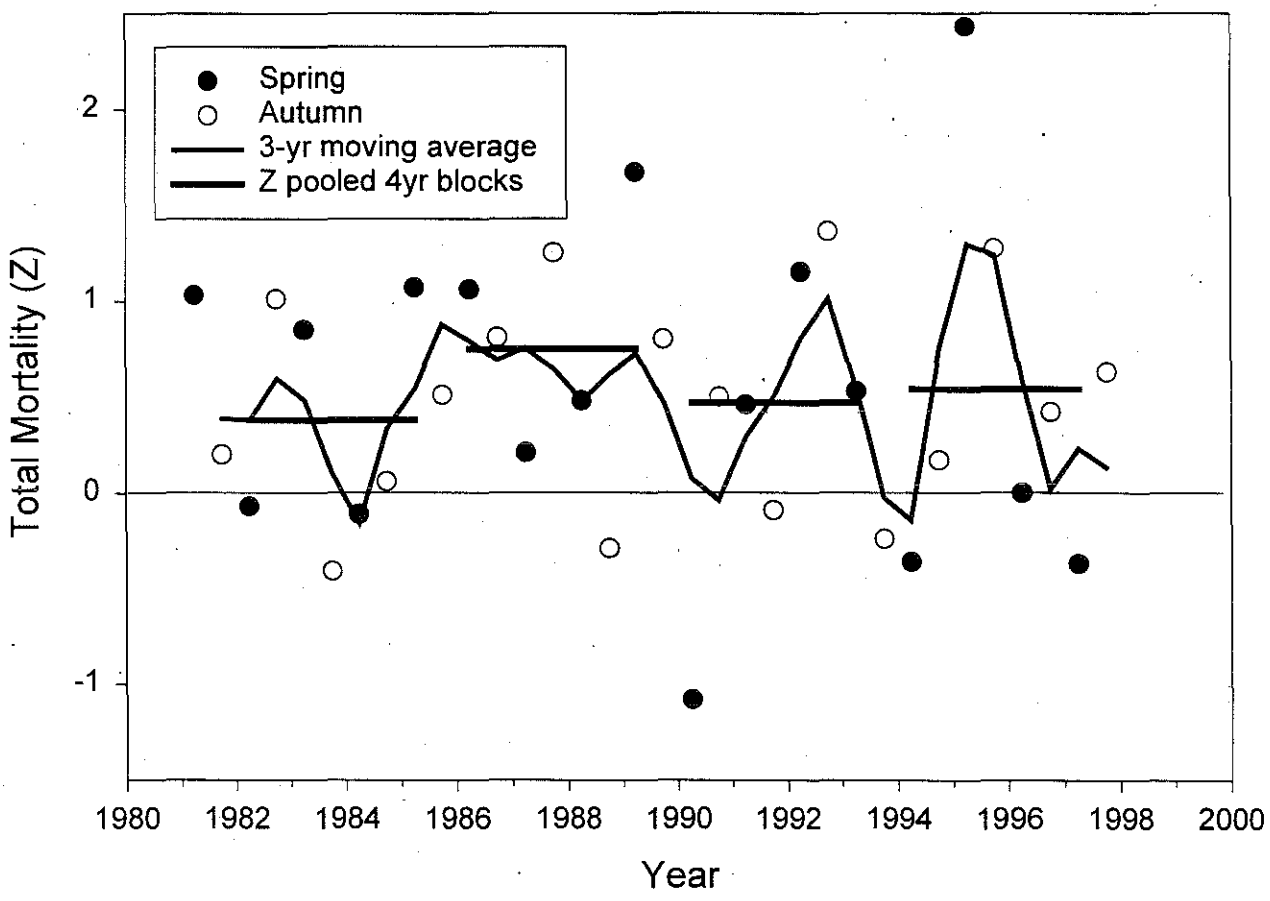


Figure 33. Estimates of instantaneous total mortality (Z) derived from NEFSC spring and autumn bottom trawl survey catch per tow at age (log ratio: 7+ / 8+), a three year moving average, and 4 year pooled estimates of Z. Natural mortality assumed to be 0.15.

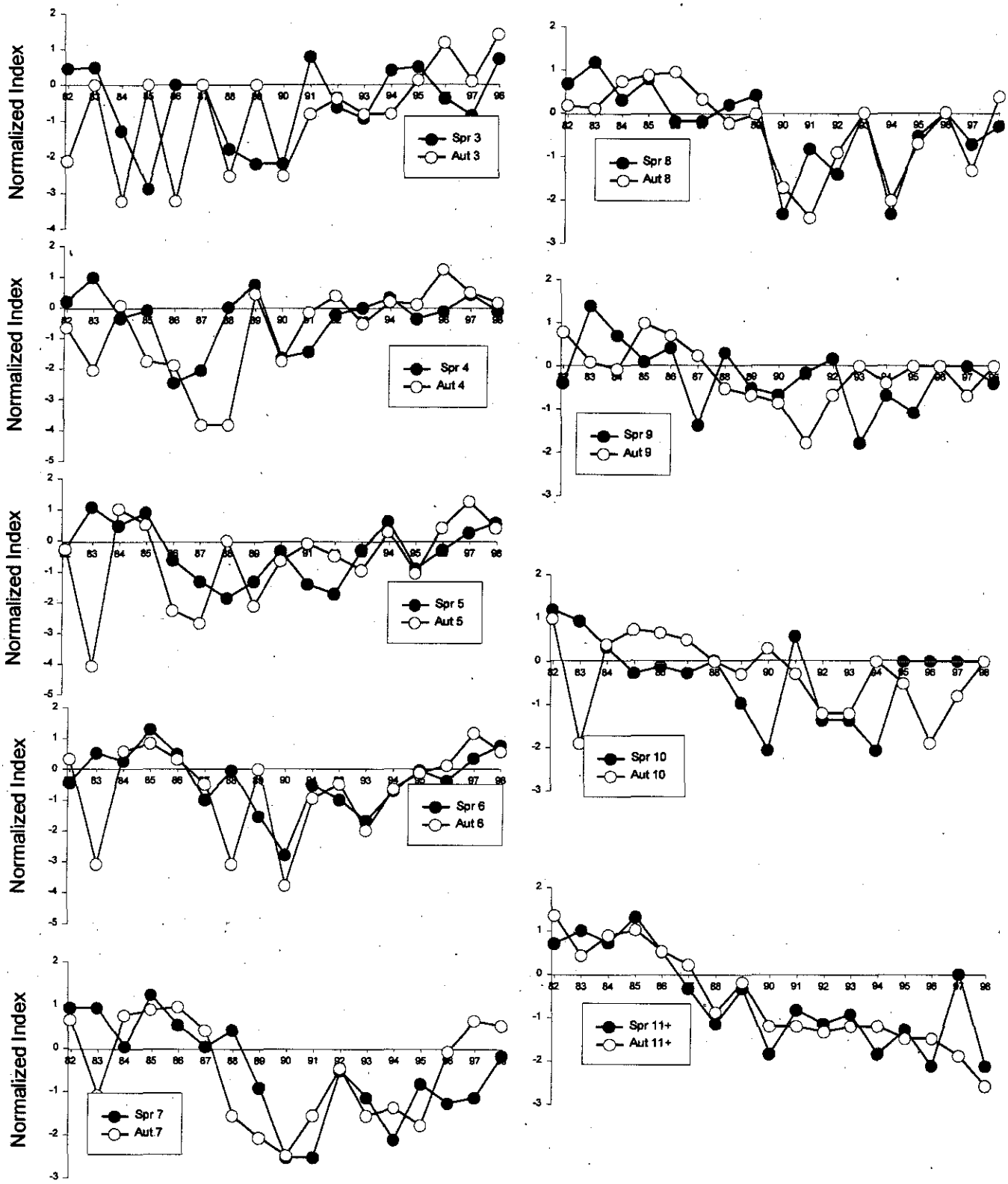


Figure 34. Normalized (ln(obs/mean)) indices of abundance (spring and autumn) at age for witch flounder.

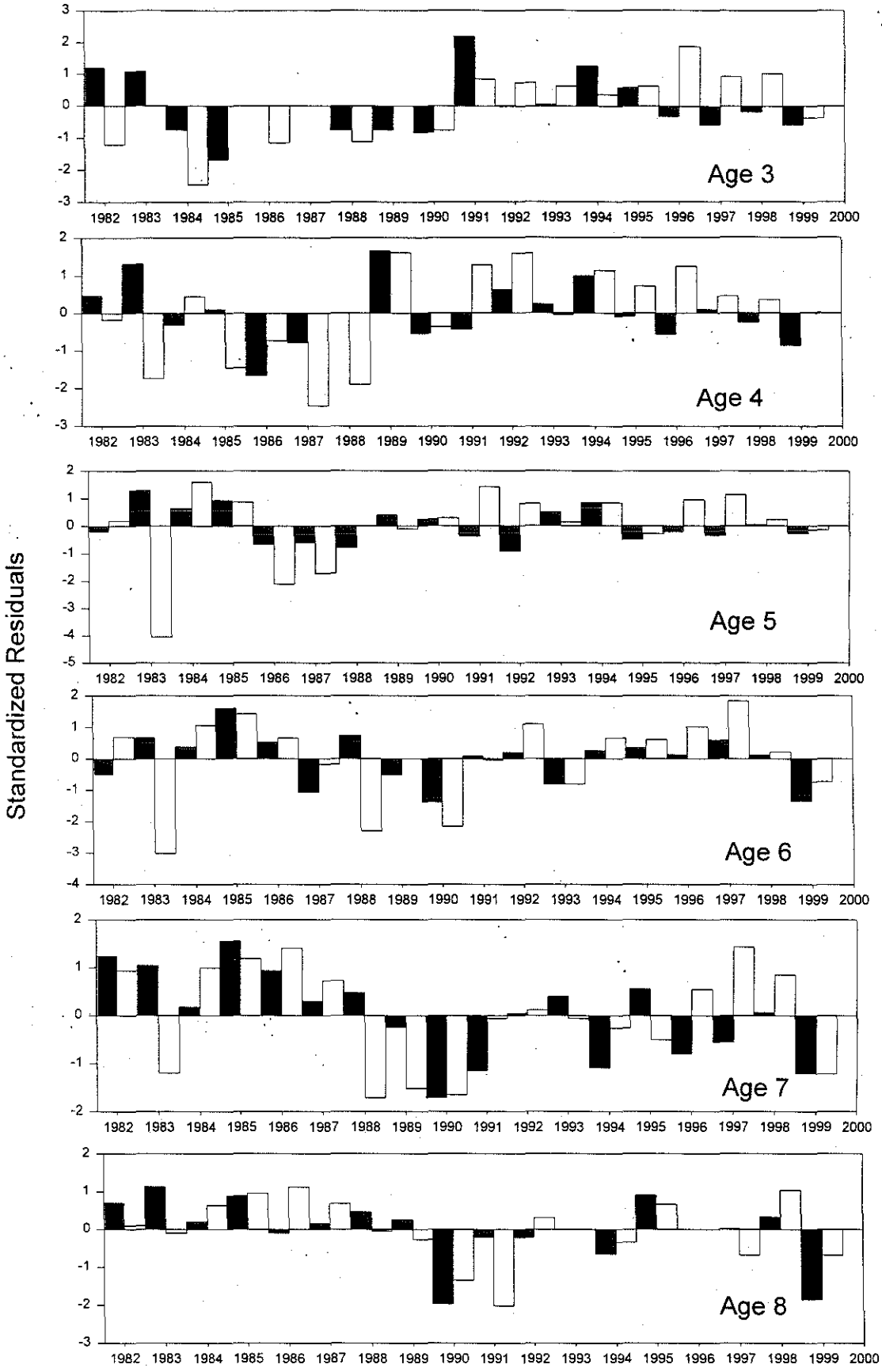


Figure 35. Standardized residuals for survey indices(spring solid bar and autumn open bar) at age includes in the ADAPT VPA calibration for the 1982-1998 witch flounder assessment.

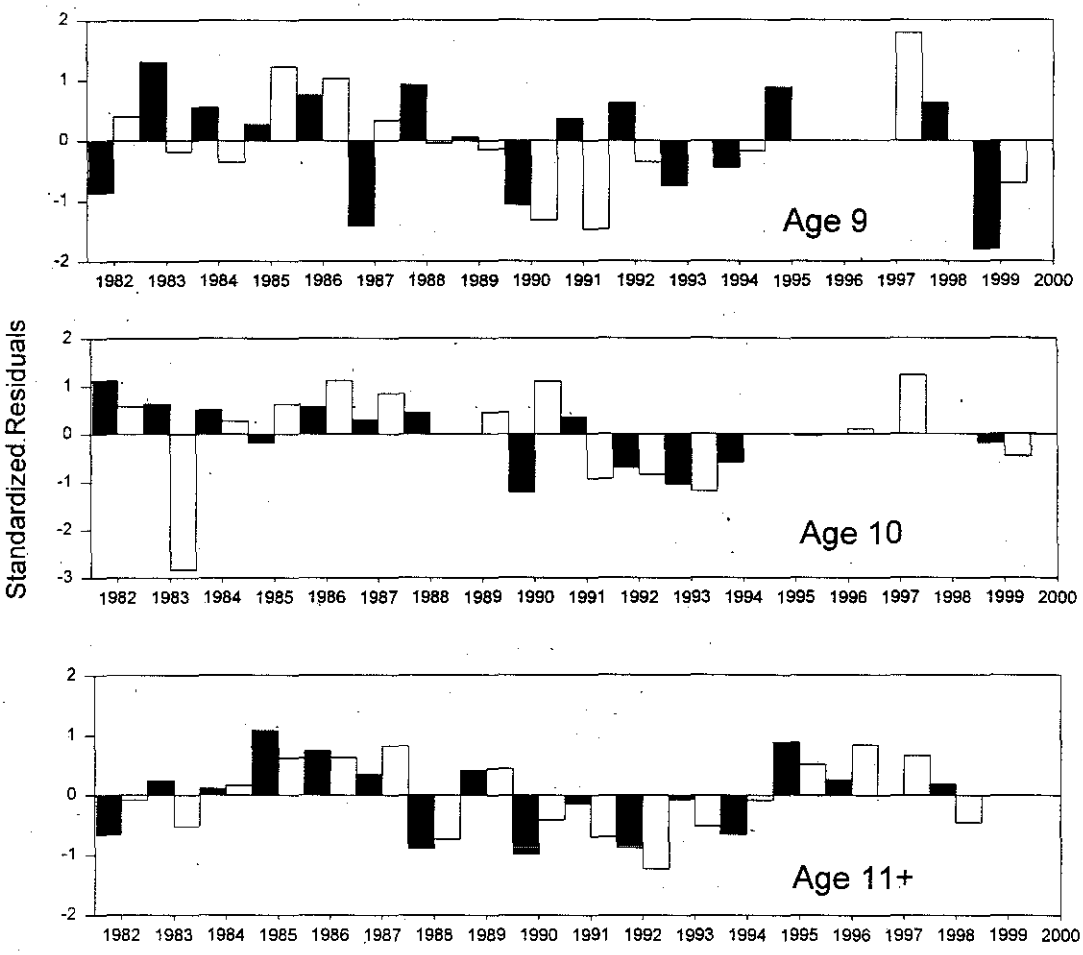


Figure 35 continued. Standardized residuals of survey indices (spring solid bar and autumn open bar) at age included in the ADAPT VPA calibration for the 1982-1998 witch flounder assessment.

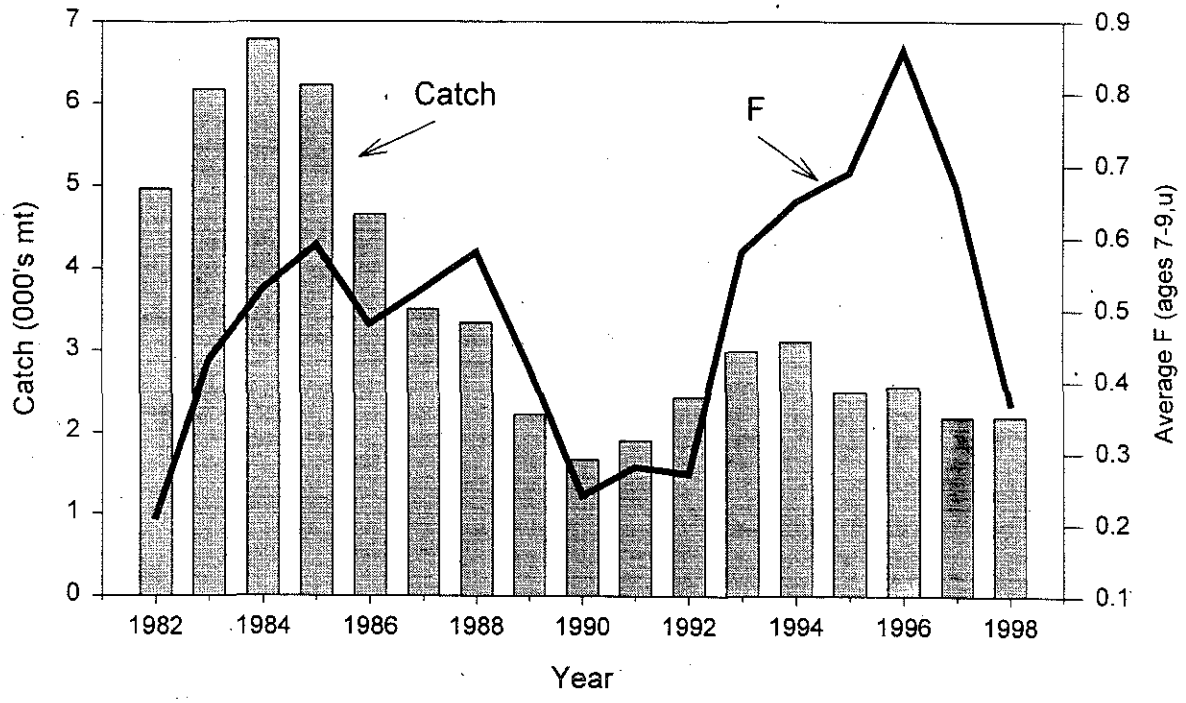


Figure 36. Trends in total catch and fishing mortality for witch flounder, 1982 - 1998.

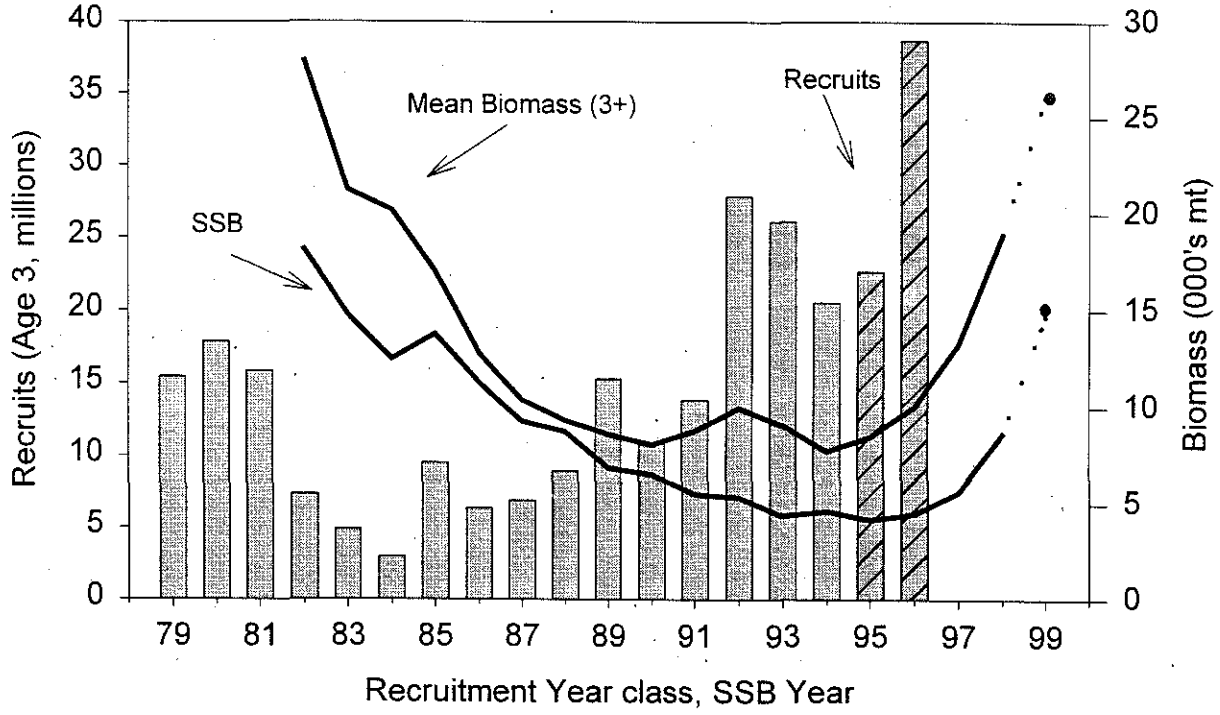


Figure 37. Trends in spawning stock biomass, mean biomass (3+) and recruitment for witch flounder, recruitment of the 1995 and 1996 year classes (hatched bars) estimated from log-log regression of survey and VPA stock size estimates. Projected 1999 estimates of mean biomass (3+) and SSB are represented by dotted lines.

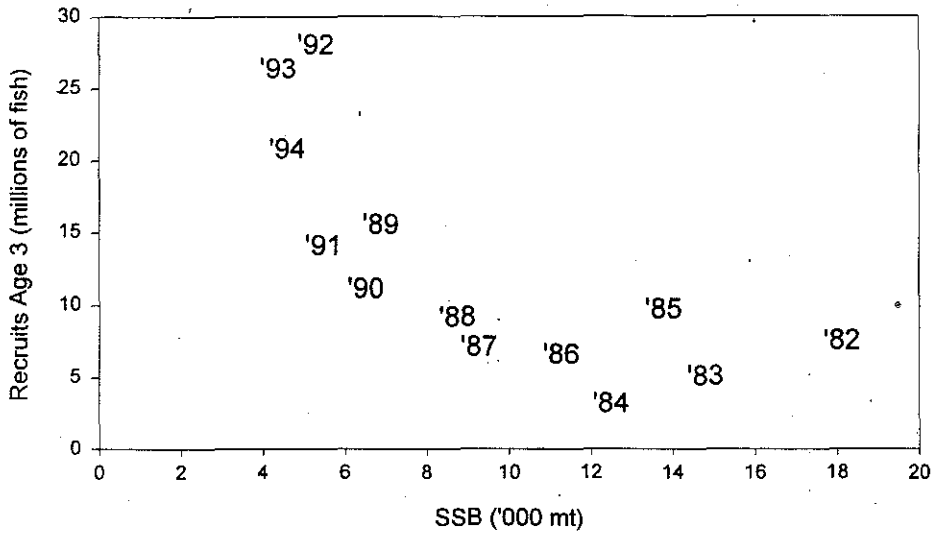


Figure 38. Spawning stock biomass and recruits (age 3) for witch flounder.

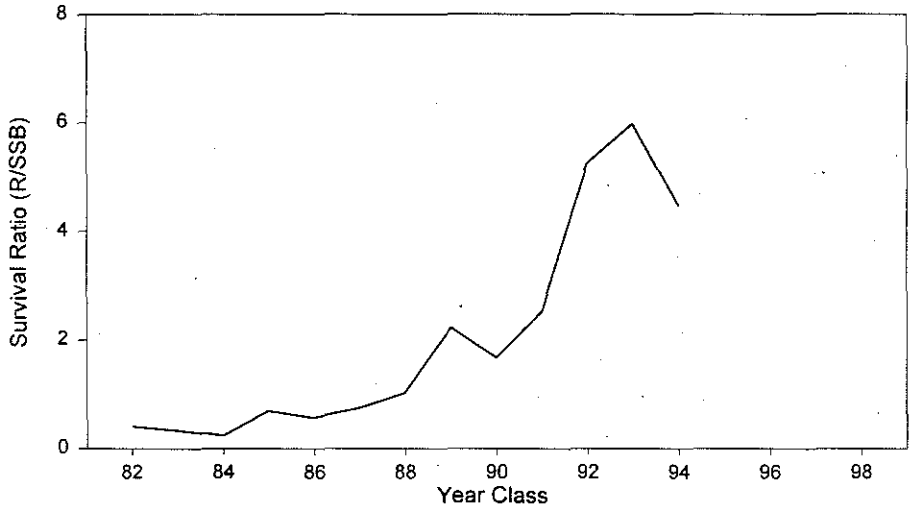


Figure 39. Survival ratios (R/SSB) estimated as the ratio of recruits at age 3 over the spawning stock biomass which produced the recruits. The survival ratios plotted for each year class,1982 - 1994.

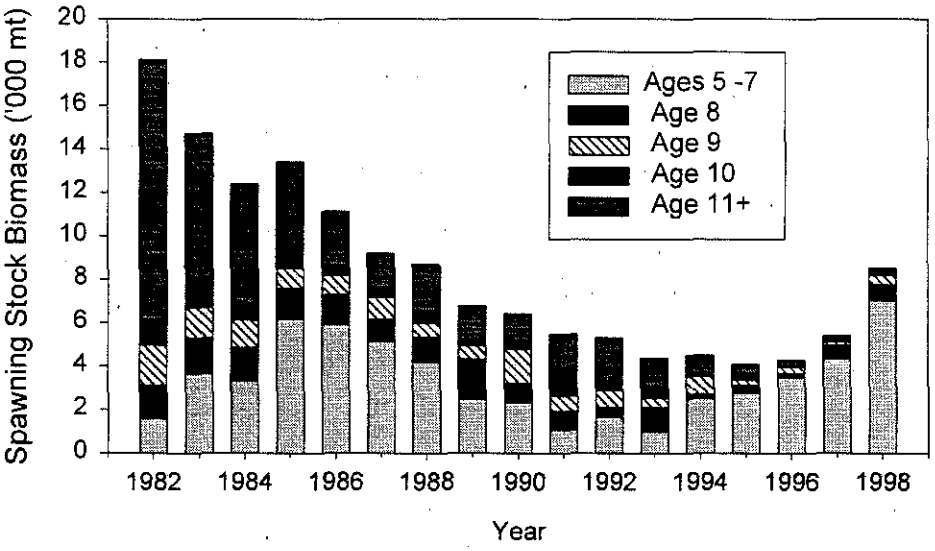


Figure 40. Age composition of spawning stock biomass for witch flounder, 1982 - 1998.

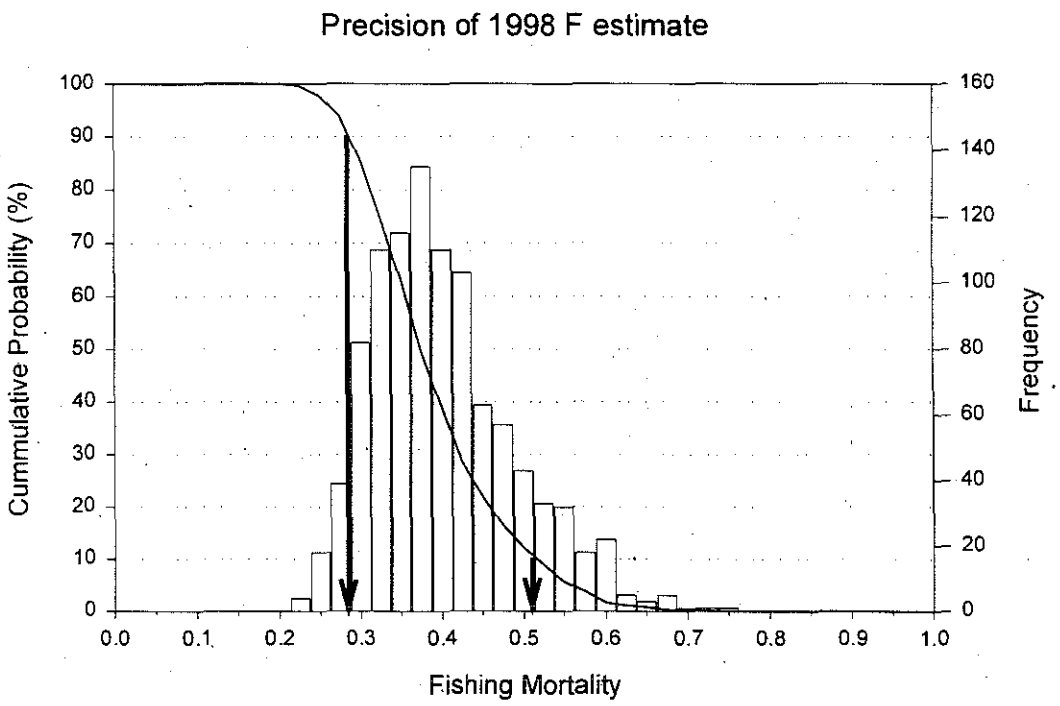


Figure 41. Precision estimates of the instantaneous rate of fishing mortality (F) on the fully recruited ages (7+) in 1998 for witch flounder. The vertical bars display both the range of the estimator and the probability of individual values within the range. The solid line gives the probability that F is greater than any selected value on the X-axis. The solid arrows indicate the approximate 90% and 10% confidence levels for F. The precision estimates were derived from 1000 bootstrap replications of the final ADAPT VPA formulation.

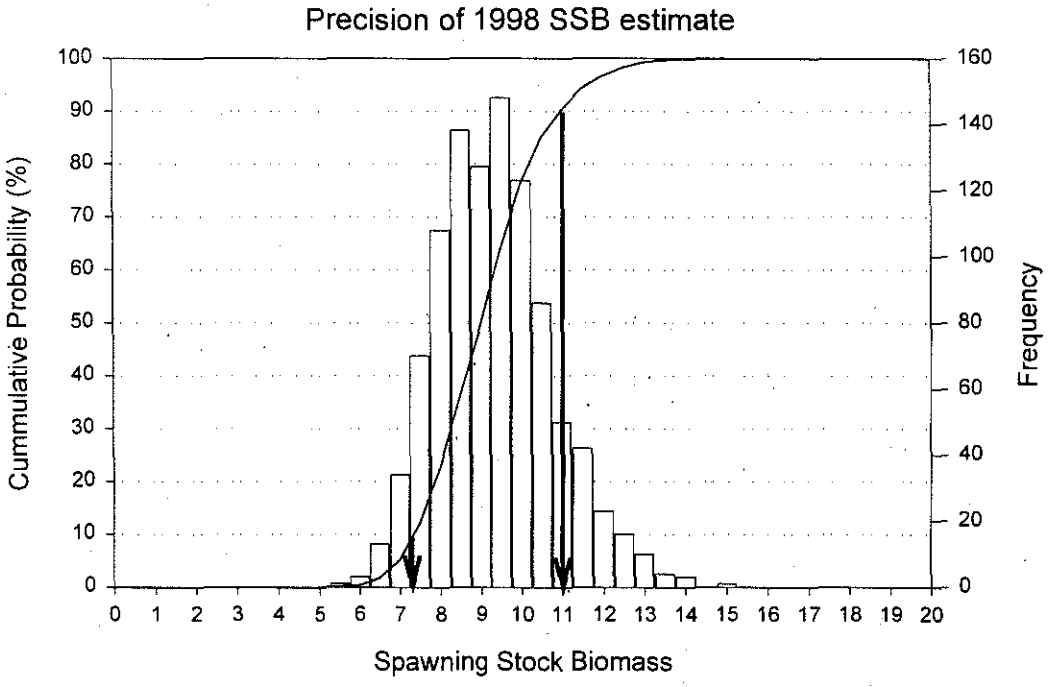


Figure 42. Precision estimates of spawning stock biomass at the beginning of spawning season (March) in 1998 for witch flounder. The vertical bars display both the range of the estimator and the probability of individual values within the range. The solid line gives the probability that SSB is less than any selected value on the X-axis. The solid arrows indicate the approximate 90% and 10% confidence levels for SSB. The precision estimates were derived from 1000 bootstrap replications of the final ADAPT VPA formulation.

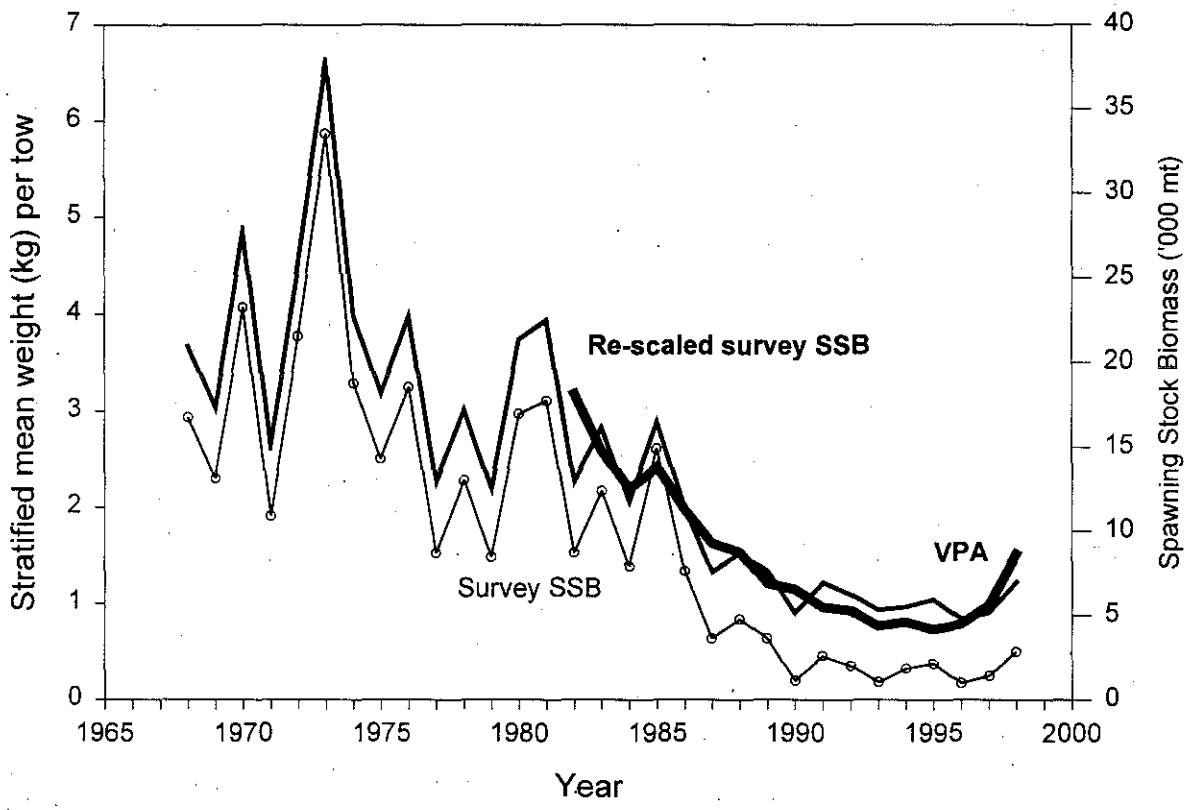


Figure 43. Stratified mean weight (kg) of mature witch flounder (spawning stock biomass) per tow from NEFSC spring bottom trawl surveys, re-scaled survey SSB, 1968 - 1998; and VPA estimated SSB, 1982 -1998.

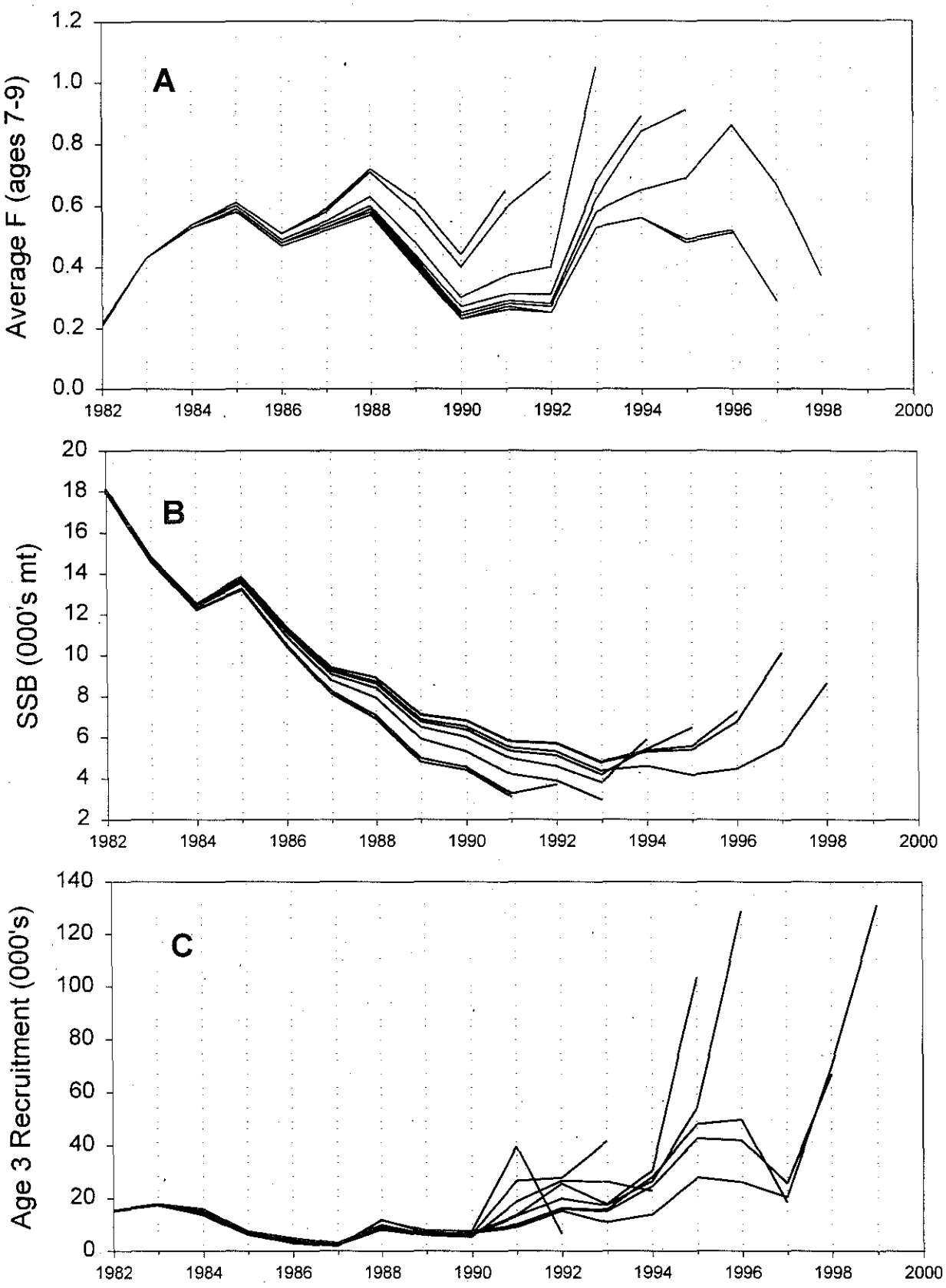
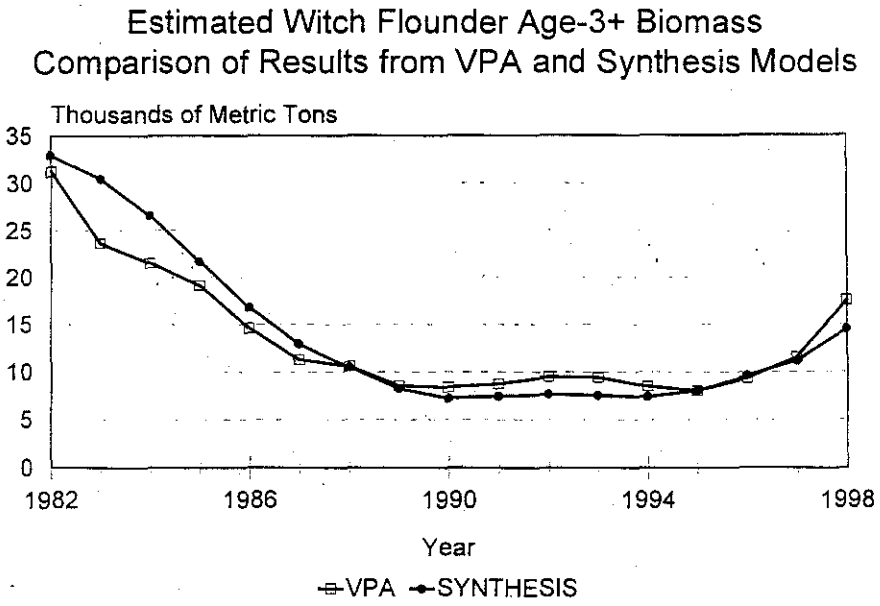


Figure 44. Retrospective analysis results of fishing mortality (A), spawning stock biomass (B) and age 3 recruitment (C) for the witch flounder assessment, 1982-1998.



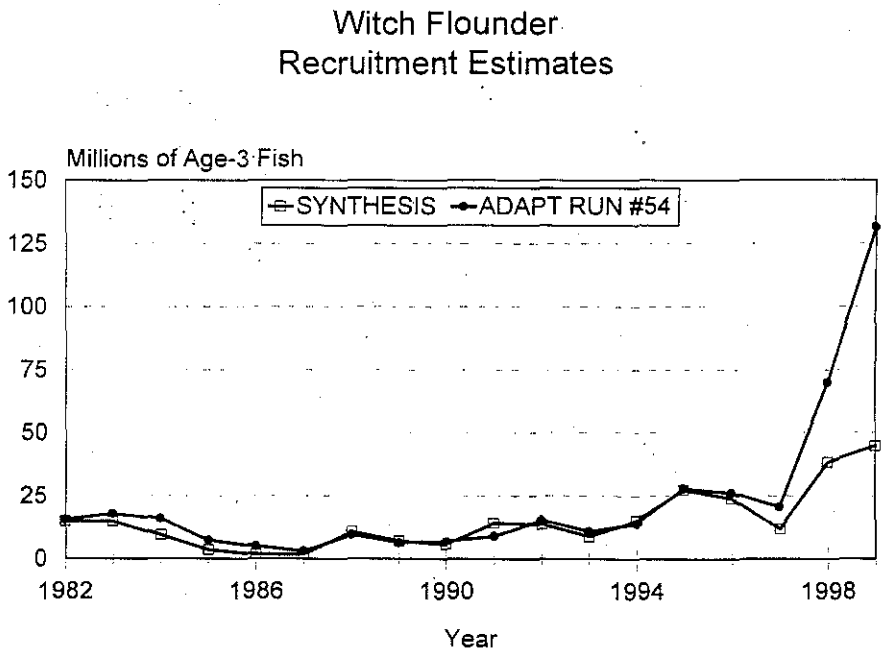


Figure 45. Comparison of ADAPT VPA and Stock Synthesis results for witch flounder.

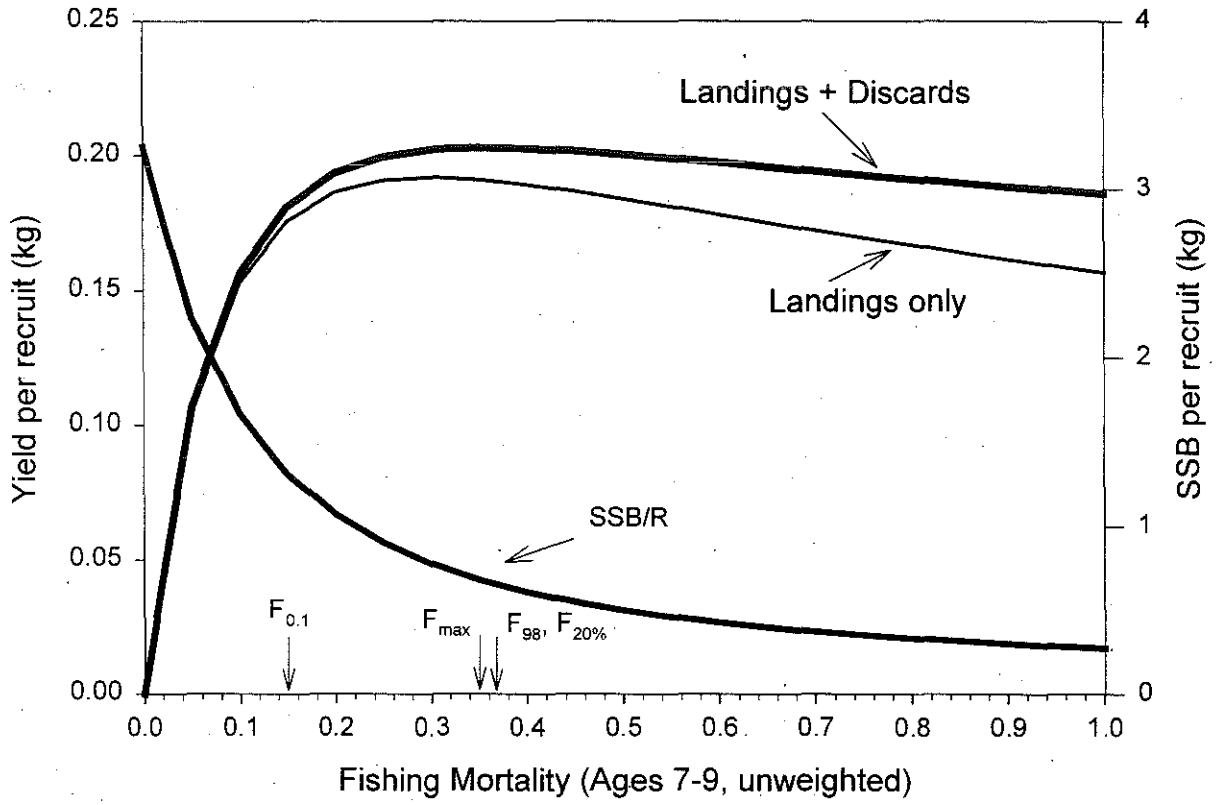


Figure 46. Yield per recruit (YPR) and spawning stock biomass per recruit (SSB/R) estimates for witch flounder. Yield (total catch= landings and discards) thick line; landings only thin line.

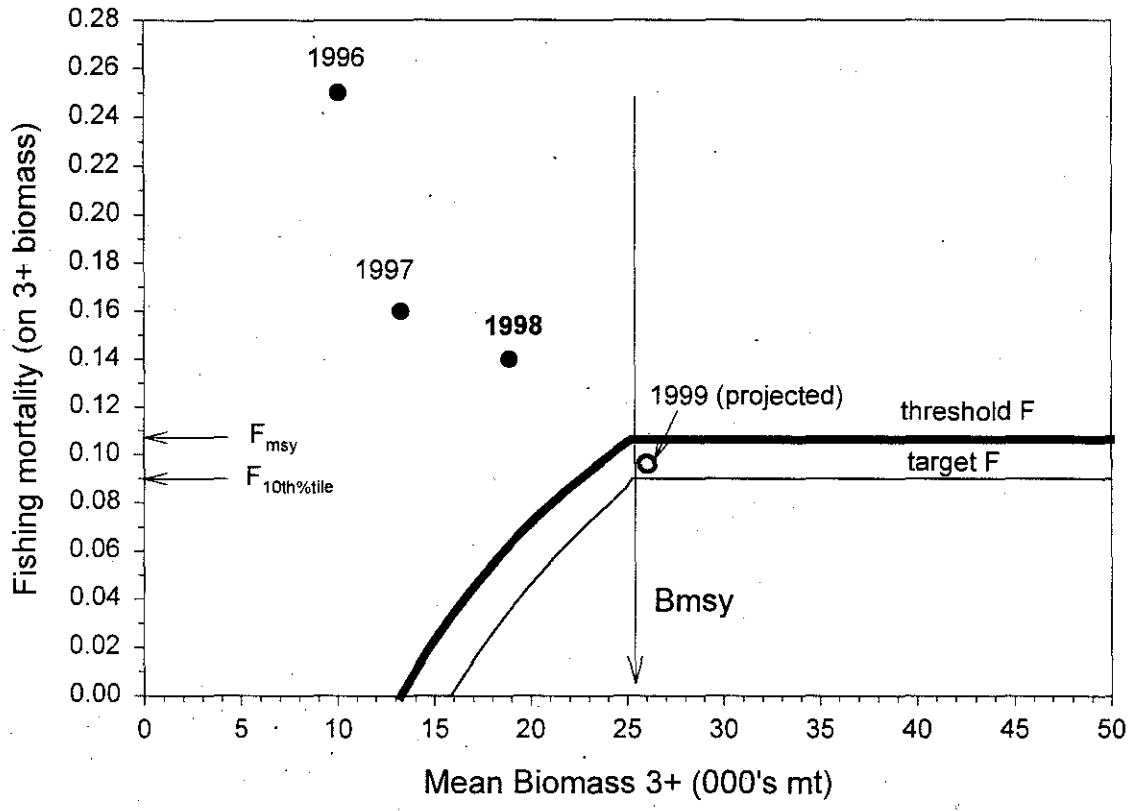


Figure 47. MSY-based refernece points and control rule for witch flounder.

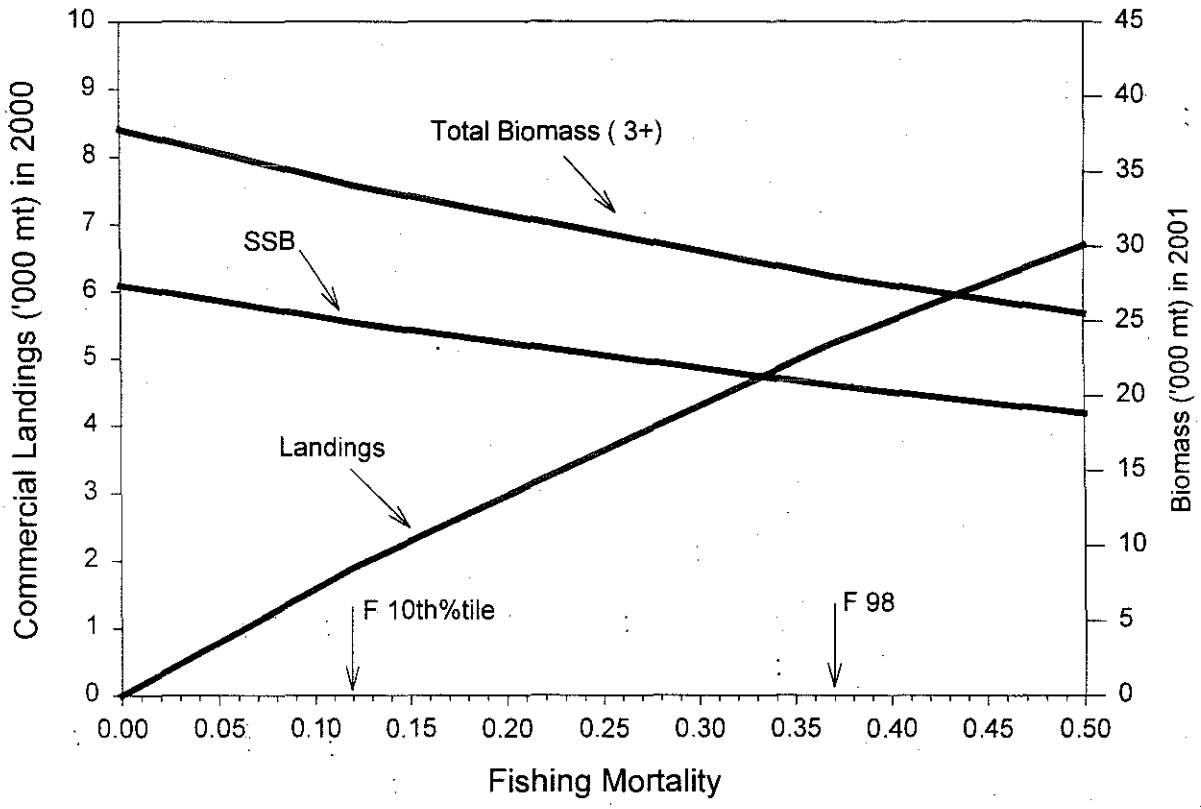


Figure 48. Results of short-term stochastic projections for witch flounder. Projected landings (mt) in 2000, spawning stock biomass (mt) and total biomass (3+; mt) in 2001 as a function of fishing mortality from F = 0.0 to F = 0.5.

APPENDIX A: Full output of VPA Run 54

Version 1.0.8
1982 1982 - 1999
Input Parameters and Options Selected

Natural mortality is 0.15
Oldest age (not in the plus group) is 10
For all years prior to the terminal year (1998), backcalculated
stock sizes for the following ages used to estimate
total mortality (Z) for age 10 : 7 8 9 10
This method for estimating F on the oldest age is generally used when a
flat-topped partial recruitment curve is thought to be characteristic of the stock.
F for age 11 + is then calculated from the following
ratios of F[age 11 +] to F[age 10]

1982	1
1983	1
1984	1
1985	1
1986	1
1987	1
1988	1
1989	1
1990	1
1991	1
1992	1
1993	1
1994	1
1995	1
1996	1
1997	1
1998	1

Stock size of the 11 + group is then calculated using
the following method: CATCH EQUATION
Partial recruitment estimate for 1999

1	0.001
2	0.005
3	0.013
4	0.073
5	0.233
6	0.473
7	1
8	1
9	1
10	1

Objective function is Sum w*(LOG(OBS)-LOG(PRED))**2
Indices normalized (by dividing by mean observed value)
before tuning to VPA stocksizes
Downweighting is None or Uniform
Biomass estimates (other than SSB) reflect mean stock sizes.
SSB calculated as in the NEFSC projection program
(see note below SSB table for description of the algorithm).
Initial estimates of parameters for the Marquardt algorithm
and lower and upper bounds on the parameter estimates:

Par.	Initial Est	Lower Bnd	Upper Bnd
N 4	1.00E+04	0.00E+00	1.00E+06
N 5	1.00E+04	0.00E+00	1.00E+06
N 6	1.00E+04	0.00E+00	1.00E+06
N 7	1.00E+04	0.00E+00	1.00E+06
N 8	1.00E+04	0.00E+00	1.00E+06
N 9	9.00E+03	0.00E+00	1.00E+06
N 10	1.00E+03	0.00E+00	1.00E+06
q Spr3	1.00E-04	0.00E+00	1.00E+00
q Spr4	1.00E-04	0.00E+00	1.00E+00
q Spr5	1.00E-04	0.00E+00	1.00E+00
q Spr6	1.00E-04	0.00E+00	1.00E+00
q Spr7	1.00E-04	0.00E+00	1.00E+00
q Spr8	1.00E-04	0.00E+00	1.00E+00
q Spr9	1.00E-04	0.00E+00	1.00E+00
q Spr10	1.00E-04	0.00E+00	1.00E+00
q Spr11+	1.00E-04	0.00E+00	1.00E+00
q Aut3	1.00E-04	0.00E+00	1.00E+00
q Aut4	1.00E-04	0.00E+00	1.00E+00
q Aut5	1.00E-04	0.00E+00	1.00E+00
q Aut6	1.00E-04	0.00E+00	1.00E+00
q Aut7	1.00E-04	0.00E+00	1.00E+00
q Aut8	1.00E-04	0.00E+00	1.00E+00
q Aut9	1.00E-04	0.00E+00	1.00E+00
q Aut10	1.00E-04	0.00E+00	1.00E+00
q Aut11+	1.00E-04	0.00E+00	1.00E+00

The following indices of abundance are available

1	Spr0
2	Spr1
3	Spr2
4	Spr3
5	Spr4
6	Spr5
7	Spr6
8	Spr7
9	Spr8
10	Spr9
11	Spr10
12	Spr11
13	Spr12
14	Spr13
15	Spr14+
16	Spr9+
17	Spr10+
18	Spr11+
19	Aut1
20	Aut2
21	Aut3
22	Aut4
23	Aut5
24	Aut6
25	Aut7
26	Aut8
27	Aut9
28	Aut10
29	Aut11
30	Aut12
31	Aut13
32	Aut14
33	Aut15+
34	Aut10+
35	Aut11+
36	Aut12+
37	LPUEAS7
38	LPUEAS8
39	LPUEAS9
40	LPUEAS10
41	LPUEAS10+
42	LPUEAS11+

The Indices that will be used in this run are:

1	Spr3
2	Spr4
3	Spr5
4	Spr6
5	Spr7
6	Spr8
7	Spr9
8	Spr10
9	Spr11+
10	Aut3
11	Aut4
12	Aut5
13	Aut6
14	Aut7
15	Aut8
16	Aut9
17	Aut10
18	Aut11+

Obs indices (before transformation) by index and year, with index means

	1982	1983	1984	1985	1986	1987	1988
Spr3	0.56	0.58	0.10	0.02	0.00	0.00	0.06
Spr4	0.57	1.25	0.33	0.43	0.04	0.06	0.00
Spr5	0.34	1.33	0.73	1.11	0.24	0.12	0.07
Spr6	0.21	0.55	0.42	1.19	0.53	0.12	0.31
Spr7	0.64	0.64	0.26	0.86	0.43	0.26	0.38
Spr8	0.41	0.67	0.28	0.45	0.17	0.17	0.25
Spr9	0.08	0.48	0.24	0.13	0.18	0.03	0.16
Spr10	0.26	0.20	0.11	0.06	0.07	0.06	0.08
Spr11+	0.51	0.69	0.52	0.94	0.42	0.18	0.08
Aut3	0.03	0.00	0.01	0.00	0.01	0.00	0.02
Aut4	0.24	0.06	0.49	0.08	0.07	0.01	0.01
Aut5	0.44	0.01	1.60	0.97	0.06	0.04	0.00
Aut6	0.61	0.02	0.78	1.01	0.60	0.27	0.02
Aut7	0.46	0.08	0.51	0.58	0.62	0.36	0.05
Aut8	0.27	0.25	0.47	0.54	0.58	0.31	0.18
Aut9	0.26	0.13	0.11	0.32	0.24	0.15	0.07
Aut10	0.18	0.01	0.10	0.14	0.13	0.11	0.00
Aut11+	1.03	0.41	0.65	0.74	0.45	0.33	0.11

	1989	1990	1991	1992	1993	1994	1995
Spr3	0.04	0.04	0.78	0.19	0.14	0.53	0.58
Spr4	0.98	0.09	0.11	0.37	0.46	0.64	0.32
Spr5	0.12	0.32	0.11	0.08	0.33	0.83	0.18
Spr6	0.07	0.02	0.19	0.12	0.06	0.16	0.31
Spr7	0.10	0.02	0.02	0.15	0.08	0.03	0.11
Spr8	0.31	0.02	0.09	0.05	0.00	0.02	0.12
Spr9	0.07	0.06	0.10	0.14	0.02	0.06	0.04
Spr10	0.03	0.01	0.14	0.02	0.02	0.01	0.00
Spr11+	0.18	0.04	0.11	0.08	0.10	0.04	0.07
Aut3	0.00	0.02	0.11	0.17	0.11	0.11	0.28
Aut4	0.71	0.08	0.39	0.67	0.27	0.55	0.50
Aut5	0.07	0.30	0.52	0.35	0.22	0.76	0.20
Aut6	0.00	0.01	0.17	0.27	0.06	0.23	0.39
Aut7	0.03	0.02	0.05	0.15	0.05	0.06	0.04
Aut8	0.22	0.04	0.02	0.09	0.00	0.03	0.11
Aut9	0.06	0.05	0.02	0.06	0.00	0.08	0.00
Aut10	0.05	0.09	0.05	0.02	0.02	0.00	0.04
Aut11+	0.22	0.08	0.08	0.07	0.08	0.08	0.06

	1996	1997	1998	1999	Average
Spr3	0.24	0.15	0.73	0.96	0.356
Spr4	0.41	0.71	0.41	0.81	0.470
Spr5	0.33	0.58	0.79	0.47	0.449
Spr6	0.22	0.46	0.70	0.18	0.323
Spr7	0.07	0.08	0.21	0.18	0.251
Spr8	0.00	0.10	0.15	0.03	0.206
Spr9	0.00	0.00	0.08	0.01	0.118
Spr10	0.00	0.00	0.00	0.02	0.078
Spr11+	0.03	0.00	0.03	0.00	0.251
Aut3	0.80	0.27	1.00	0.54	0.249
Aut4	1.57	0.74	0.53	1.33	0.461
Aut5	0.86	2.02	0.86	0.48	0.574
Aut6	0.49	1.40	0.77	0.31	0.436
Aut7	0.22	0.45	0.40	0.17	0.239
Aut8	0.00	0.06	0.32	0.10	0.224
Aut9	0.00	0.06	0.00	0.04	0.118
Aut10	0.01	0.03	0.00	0.02	0.067
Aut11+	0.06	0.04	0.02	0.00	0.265

Catch at age (thousands) C:\WITASS99\WHAT108\WIT99.54

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	01	19	15
2	02	04	01	03	04	80	130
3	190	337	147	124	23	22	600
4	1064	1346	1466	1176	377	181	140
5	1208	1521	2003	2118	1517	467	264
6	1475	1575	1740	1936	2775	1280	658
7	665	1590	1487	1525	1567	1575	1383
8	656	978	1498	1248	835	871	1154
9	400	738	697	606	413	481	402
10	239	510	375	400	223	252	267
11	1578	1676	1719	1359	758	489	598
1+	7478	10275	11131	10496	8492	5717	5610

	1989	1990	1991	1992	1993	1994	1995
1	11	06	18	44	86	1368	50
2	50	95	23	159	130	496	635
3	447	344	442	399	417	42	641
4	436	636	408	1260	1808	1002	618
5	65	1108	873	866	1421	2763	1197
6	315	258	582	944	920	1290	1722
7	762	276	239	723	598	828	850
8	885	475	248	203	587	197	268
9	351	337	296	179	219	540	97
10	124	82	317	121	279	114	270
11	349	179	261	380	391	325	157
1+	3795	3797	3705	5281	6854	8966	6506

	1996	1997	1998
1	33	75	44
2	51	104	260
3	119	105	147
4	952	1023	610
5	1978	1467	1286
6	1322	1387	1484
7	1432	1016	1584
8	263	593	371
9	216	83	141
10	57	50	16
11	114	70	70
1+	6537	5973	6014

CAA Summary for ages 6 - 11

1982	1983	1984	1985	1986	1987	1988
5014	7067	7514	7075	6571	4948	4461

1989	1990	1991	1992	1993	1994	1995
2785	1608	1942	2551	2993	3295	3364

1996	1997	1998
3404	3199	3666

Weight at age (mid year) in kg - C:\witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	0.002	0.009	0.017	0.017	0.017	0.015	0.006
2	0.038	0.038	0.040	0.023	0.026	0.033	0.017
3	0.152	0.149	0.151	0.128	0.089	0.081	0.045
4	0.242	0.202	0.229	0.237	0.206	0.191	0.203
5	0.329	0.270	0.328	0.305	0.299	0.298	0.311
6	0.421	0.409	0.421	0.429	0.408	0.433	0.434
7	0.550	0.518	0.539	0.565	0.533	0.561	0.538
8	0.727	0.613	0.664	0.691	0.676	0.686	0.668
9	0.886	0.795	0.817	0.842	0.853	0.828	0.819
10	0.983	0.977	0.922	0.964	0.975	0.980	0.980
11	1.406	1.357	1.339	1.326	1.321	1.303	1.326

	1989	1990	1991	1992	1993	1994	1995
1	0.012	0.012	0.014	0.007	0.009	0.004	0.007
2	0.034	0.029	0.035	0.026	0.027	0.019	0.023
3	0.122	0.062	0.062	0.103	0.122	0.070	0.058
4	0.170	0.187	0.199	0.230	0.202	0.202	0.171
5	0.321	0.257	0.344	0.379	0.318	0.280	0.308
6	0.425	0.438	0.421	0.459	0.432	0.430	0.431
7	0.574	0.586	0.578	0.614	0.535	0.534	0.561
8	0.682	0.688	0.702	0.739	0.666	0.691	0.690
9	0.818	0.849	0.836	0.822	0.882	0.832	0.911
10	0.968	1.049	0.974	0.882	1.023	0.909	0.974
11	1.358	1.454	1.420	1.243	1.335	1.266	1.243

	1996	1997	1998
1	0.019	0.023	0.004
2	0.031	0.034	0.033
3	0.061	0.059	0.089
4	0.155	0.196	0.171
5	0.234	0.251	0.248
6	0.425	0.359	0.349
7	0.554	0.495	0.492
8	0.708	0.628	0.585
9	0.856	0.871	0.871
10	0.974	1.037	0.978
11	1.232	1.293	1.206

January 1 Biomass Weights - C:\Witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	0.000	0.004	0.015	0.014	0.012	0.014	0.003
2	0.019	0.009	0.019	0.020	0.021	0.024	0.016
3	0.132	0.075	0.076	0.072	0.045	0.046	0.039
4	0.229	0.175	0.185	0.189	0.162	0.130	0.128
5	0.295	0.256	0.257	0.264	0.266	0.248	0.244
6	0.380	0.367	0.337	0.375	0.353	0.360	0.360
7	0.521	0.467	0.470	0.488	0.478	0.478	0.483
8	0.695	0.581	0.586	0.610	0.618	0.605	0.612
9	0.844	0.760	0.708	0.748	0.768	0.748	0.750
10	0.933	0.930	0.856	0.887	0.906	0.914	0.901
11	1.406	1.357	1.339	1.326	1.321	1.303	1.326

	1989	1990	1991	1992	1993	1994	1995
1	0.008	0.007	0.010	0.004	0.006	0.002	0.003
2	0.014	0.019	0.020	0.019	0.014	0.013	0.010
3	0.046	0.046	0.042	0.060	0.056	0.043	0.033
4	0.087	0.151	0.111	0.119	0.144	0.157	0.109
5	0.255	0.209	0.254	0.275	0.270	0.238	0.249
6	0.364	0.375	0.329	0.397	0.405	0.370	0.347
7	0.499	0.499	0.503	0.508	0.496	0.480	0.491
8	0.606	0.628	0.641	0.654	0.639	0.608	0.607
9	0.739	0.761	0.758	0.760	0.807	0.744	0.793
10	0.890	0.926	0.909	0.859	0.917	0.895	0.900
11	1.358	1.454	1.420	1.243	1.335	1.266	1.243

	1996	1997	1998
1	0.014	0.019	0.001
2	0.015	0.025	0.028
3	0.037	0.043	0.055
4	0.095	0.109	0.100
5	0.200	0.197	0.220
6	0.362	0.290	0.296
7	0.489	0.459	0.420
8	0.630	0.590	0.538
9	0.769	0.785	0.740
10	0.942	0.942	0.923
11	1.232	1.293	1.206

SSB Weights - C:\Witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	0.000	0.004	0.015	0.014	0.012	0.014	0.003
2	0.019	0.009	0.019	0.020	0.021	0.024	0.016
3	0.132	0.075	0.076	0.072	0.045	0.046	0.039
4	0.229	0.175	0.185	0.189	0.162	0.130	0.128
5	0.295	0.256	0.257	0.264	0.266	0.248	0.244
6	0.380	0.367	0.337	0.375	0.353	0.360	0.360
7	0.521	0.467	0.470	0.488	0.478	0.478	0.483
8	0.695	0.581	0.586	0.610	0.618	0.605	0.612
9	0.844	0.760	0.708	0.748	0.768	0.748	0.750
10	0.933	0.930	0.856	0.887	0.906	0.914	0.901
11	1.406	1.357	1.339	1.326	1.321	1.303	1.326

	1989	1990	1991	1992	1993	1994	1995
1	0.008	0.007	0.010	0.004	0.006	0.002	0.003
2	0.014	0.019	0.020	0.019	0.014	0.013	0.010
3	0.046	0.046	0.042	0.060	0.056	0.043	0.033
4	0.087	0.151	0.111	0.119	0.144	0.157	0.109
5	0.255	0.209	0.254	0.275	0.270	0.238	0.249
6	0.364	0.375	0.329	0.397	0.405	0.370	0.347
7	0.499	0.499	0.503	0.508	0.496	0.480	0.491
8	0.606	0.628	0.641	0.654	0.639	0.608	0.607
9	0.739	0.761	0.758	0.760	0.807	0.744	0.793
10	0.890	0.926	0.909	0.859	0.917	0.895	0.900
11	1.358	1.454	1.420	1.243	1.335	1.266	1.243

	1996	1997	1998
1	0.014	0.019	0.001
2	0.015	0.025	0.028
3	0.037	0.043	0.055
4	0.095	0.109	0.100
5	0.200	0.197	0.220
6	0.362	0.290	0.296
7	0.489	0.459	0.420
8	0.630	0.590	0.538
9	0.769	0.785	0.740
10	0.942	0.942	0.923
11	1.232	1.293	1.206

Computed (Rivard)from midyear weights: Jan 1 Weights - C:\witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	0.000	0.004	0.015	0.014	0.012	0.014	0.003
2	0.019	0.009	0.019	0.020	0.021	0.024	0.016
3	0.132	0.075	0.076	0.072	0.045	0.046	0.039
4	0.229	0.175	0.185	0.189	0.162	0.130	0.128
5	0.295	0.256	0.257	0.264	0.266	0.248	0.244
6	0.380	0.367	0.337	0.375	0.353	0.360	0.360
7	0.521	0.467	0.470	0.488	0.478	0.478	0.483
8	0.695	0.581	0.586	0.610	0.618	0.605	0.612
9	0.844	0.760	0.708	0.748	0.768	0.748	0.750
10	0.933	0.930	0.856	0.887	0.906	0.914	0.901
11	1.406	1.357	1.339	1.326	1.321	1.303	1.326

	1989	1990	1991	1992	1993	1994	1995
1	0.008	0.007	0.010	0.004	0.006	0.002	0.003
2	0.014	0.019	0.020	0.019	0.014	0.013	0.010
3	0.046	0.046	0.042	0.060	0.056	0.043	0.033
4	0.087	0.151	0.111	0.119	0.144	0.157	0.109
5	0.255	0.209	0.254	0.275	0.270	0.238	0.249
6	0.364	0.375	0.329	0.397	0.405	0.370	0.347
7	0.499	0.499	0.503	0.508	0.496	0.480	0.491
8	0.606	0.628	0.641	0.654	0.639	0.608	0.607
9	0.739	0.761	0.758	0.760	0.807	0.744	0.793
10	0.890	0.926	0.909	0.859	0.917	0.895	0.900
11	1.358	1.454	1.420	1.243	1.335	1.266	1.243

	1993	1994	1995	1996
1	0.014	0.019	0.001	0.005
2	0.015	0.025	0.028	0.028
3	0.037	0.043	0.055	0.040
4	0.095	0.109	0.100	0.144
5	0.200	0.197	0.220	0.291
6	0.362	0.290	0.296	0.279
7	0.489	0.459	0.420	0.412
8	0.630	0.590	0.538	0.576
9	0.769	0.785	0.740	0.636
10	0.942	0.942	0.923	1.026
11	1.232	1.293	1.206	1.206

Percent Mature (females)- C:\witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	00	00	00
2	00	00	00	00	00	00	00
3	00	00	00	01	01	01	01
4	00	04	04	15	15	15	15
5	02	20	20	65	65	65	65
6	15	52	52	96	96	96	96
7	49	80	80	100	100	100	100
8	82	97	97	100	100	100	100
9	97	100	100	100	100	100	100
10	100	100	100	100	100	100	100
11	100	100	100	100	100	100	100

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	00	00	00
2	00	00	00	00	00	00	00
3	01	01	00	00	00	00	00
4	15	15	01	01	01	08	08
5	65	65	10	10	10	45	45
6	96	96	40	40	40	85	85
7	100	100	80	80	80	100	100
8	100	100	97	97	97	100	100
9	100	100	100	100	100	100	100
10	100	100	100	100	100	100	100
11	100	100	100	100	100	100	100

	1996	1997	1998
1	00	00	00
2	00	00	00
3	00	00	00
4	08	08	08
5	45	45	45
6	85	85	85
7	100	100	100
8	100	100	100
9	100	100	100
10	100	100	100
11	100	100	100

Sex Ratio (Percent Female) - C:\witass99\WHAT108\wit99.54

	1982	1983	1984	1985	1986	1987	1988
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	0.5	0.5	0.5	0.5	0.5	0.5	0.5
11	0.5	0.5	0.5	0.5	0.5	0.5	0.5

	1989	1990	1991	1992	1993	1994	1995
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	0.5	0.5	0.5	0.5	0.5	0.5	0.5
11	0.5	0.5	0.5	0.5	0.5	0.5	0.5

	1996	1997	1998
1	0.5	0.5	0.5
2	0.5	0.5	0.5
3	0.5	0.5	0.5
4	0.5	0.5	0.5
5	0.5	0.5	0.5
6	0.5	0.5	0.5
7	0.5	0.5	0.5
8	0.5	0.5	0.5
9	0.5	0.5	0.5
10	0.5	0.5	0.5
11	0.5	0.5	0.5

pF is .1667
pM is .1667

Residual Sum of Squares from Marquardt Algorithm
Number 1
RSS 657.377188485207
Lambda 1.00E-02

Number 2
RSS 579.013236047291
Lambda 1.00E-03

Number 3
RSS 515.09153182248
Lambda 1.00E-01

Number 4
RSS 466.927668065019
Lambda 1.00E-02

Number 5
RSS 310.435597115004
Lambda 1.00E+00

Number 6
RSS 232.002232229904
Lambda 1.00E-01

Number 7
RSS 219.291421100636
Lambda 1.00E+01

Number 8
RSS 218.973841732394
Lambda 1.00E+00

Number 9
RSS 218.972224967912
Lambda 1.00E-01

Number 10
RSS 218.972064835959
Lambda 1.00E-02

Number 11
RSS 218.972040092422
Lambda 1.00E-03

Number 12
RSS 218.972034639586
Lambda 1.00E-04

RESULTS

Approximate Statistics Assuming Linearity Near Solution
Sum of Squares: 218.972034639586
Mean Square Residuals: 0.81101

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 4	5.99E+04	2.82E+04	2.13E+00	0.47
N 5	1.46E+04	5.74E+03	2.54E+00	0.39
N 6	1.46E+04	5.25E+03	2.77E+00	0.36
N 7	1.17E+04	4.04E+03	2.89E+00	0.35
N 8	2.23E+03	1.01E+03	2.21E+00	0.45
N 9	9.68E+02	4.35E+02	2.23E+00	0.45
N 10	3.90E+02	2.04E+02	1.91E+00	0.52
q Spr3	3.45E-05	8.05E-06	4.28E+00	0.23
q Spr4	6.19E-05	1.39E-05	4.44E+00	0.22
q Spr5	9.22E-05	2.00E-05	4.61E+00	0.22
q Spr6	1.28E-04	2.76E-05	4.63E+00	0.22
q Spr7	1.83E-04	3.95E-05	4.64E+00	0.22
q Spr8	3.56E-04	8.18E-05	4.35E+00	0.23
q Spr9	6.38E-04	1.47E-04	4.35E+00	0.23
q Spr10	8.84E-04	2.17E-04	4.08E+00	0.25
q Spr11+	4.10E-04	9.31E-05	4.40E+00	0.23
q Aut3	2.30E-05	5.77E-06	3.99E+00	0.25
q Aut4	4.75E-05	1.04E-05	4.58E+00	0.22
q Aut5	6.63E-05	1.48E-05	4.48E+00	0.22
q Aut6	9.50E-05	2.11E-05	4.50E+00	0.22
q Aut7	1.82E-04	3.91E-05	4.64E+00	0.22
q Aut8	3.69E-04	8.48E-05	4.35E+00	0.23
q Aut9	6.63E-04	1.62E-04	4.09E+00	0.24
q Aut10	1.17E-03	2.79E-04	4.19E+00	0.24
q Aut11+	4.63E-04	1.02E-04	4.53E+00	0.22

Catchability Estimates in Original Units

	Estimate	Std.Err.	C.V.
q Spr3	1.23E-05	2.87E-06	0.23
q Spr4	2.91E-05	6.54E-06	0.22
q Spr5	4.14E-05	8.97E-06	0.22
q Spr6	4.13E-05	8.92E-06	0.22
q Spr7	4.61E-05	9.93E-06	0.22
q Spr8	7.32E-05	1.68E-05	0.23
q Spr9	7.52E-05	1.73E-05	0.23
q Spr10	6.90E-05	1.69E-05	0.25
q Spr11+	1.03E-04	2.34E-05	0.23
q Aut3	5.72E-06	1.43E-06	0.25
q Aut4	2.19E-05	4.78E-06	0.22
q Aut5	3.81E-05	8.50E-06	0.22
q Aut6	4.14E-05	9.20E-06	0.22
q Aut7	4.34E-05	9.34E-06	0.22
q Aut8	8.28E-05	1.90E-05	0.23
q Aut9	7.82E-05	1.91E-05	0.24
q Aut10	7.79E-05	1.86E-05	0.24
q Aut11+	1.23E-04	2.71E-05	0.22

Summary of Residuals
Spr
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.560	0.532	0.452	-0.632	1	1.084	1.203	15434
1983	0.580	0.615	0.487	-0.486	1	0.973	1.080	17862
1984	0.100	0.547	-1.271	-0.604	1	-0.667	-0.740	15866
1985	0.020	0.252	-2.880	-1.377	1	-1.503	-1.669	7326
1986	0.000	0.000	0	0	1	0.000	0.000	00
1987	0.000	0.000	0	0	1	0.000	0.000	00
1988	0.060	0.327	-1.782	-1.117	1	-0.665	-0.738	9502
1989	0.040	0.219	-2.187	-1.518	1	-0.669	-0.743	6359
1990	0.040	0.237	-2.187	-1.441	1	-0.746	-0.829	6871
1991	0.780	0.308	0.783	-1.177	1	1.960	2.176	8949
1992	0.190	0.526	-0.629	-0.642	1	0.013	0.014	15279
1993	0.140	0.376	-0.934	-0.979	1	0.045	0.049	10906
1994	0.530	0.478	0.397	-0.739	1	1.135	1.261	13869
1995	0.580	0.959	0.487	-0.042	1	0.529	0.587	27833
1996	0.240	0.901	-0.395	-0.105	1	-0.291	-0.323	26142
1997	0.150	0.708	-0.865	-0.345	1	-0.520	-0.577	20549
1998	0.730	2.404	0.717	0.877	1	-0.160	-0.178	69778
1999	0.962	4.527	0.993	1.510	1	-0.517	-0.574	131387

Partial Variance: 0.844

Spr
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.570	0.792	0.193	-0.233	1	0.426	0.473	12807
1983	1.250	0.811	0.979	-0.210	1	1.188	1.319	13107
1984	0.330	0.932	-0.353	-0.071	1	-0.283	-0.314	15061
1985	0.430	0.836	-0.089	-0.179	1	0.090	0.100	13520
1986	0.040	0.383	-2.463	-0.960	1	-1.504	-1.670	6191
1987	0.060	0.258	-2.058	-1.354	1	-0.704	-0.782	4176
1988	0.000	0.000	0	0	1	0.000	0.000	00
1989	0.980	0.472	0.735	-0.752	1	1.487	1.651	7622
1990	0.090	0.313	-1.652	-1.162	1	-0.491	-0.545	5059
1991	0.110	0.346	-1.452	-1.061	1	-0.391	-0.434	5595
1992	0.370	0.451	-0.239	-0.796	1	0.557	0.619	7293
1993	0.460	0.791	-0.021	-0.235	1	0.214	0.237	12780
1994	0.640	0.557	0.309	-0.586	1	0.895	0.994	9000
1995	0.320	0.736	-0.384	-0.306	1	-0.078	-0.086	11898
1996	0.410	1.445	-0.136	0.368	1	-0.504	-0.560	23361
1997	0.710	1.385	0.413	0.326	1	0.087	0.097	22390
1998	0.410	1.088	-0.136	0.084	1	-0.221	-0.245	17590
1999	0.806	3.707	0.540	1.310	1	-0.770	-0.855	59922

Partial Variance: 0.584

Spr
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.340	0.900	-0.278	-0.105	1	-0.173	-0.192	9766
1983	1.330	0.925	1.086	-0.078	1	1.164	1.293	10035
1984	0.730	0.925	0.486	-0.078	1	0.564	0.627	10033
1985	1.110	1.069	0.905	0.067	1	0.838	0.931	11603
1986	0.240	0.972	-0.626	-0.028	1	-0.598	-0.664	10546
1987	0.120	0.459	-1.319	-0.779	1	-0.540	-0.600	4979
1988	0.070	0.316	-1.858	-1.153	1	-0.706	-0.784	3426
1989	0.120	0.188	-1.319	-1.672	1	0.353	0.392	2038
1990	0.320	0.567	-0.339	-0.567	1	0.228	0.253	6155
1991	0.110	0.347	-1.406	-1.059	1	-0.348	-0.386	3764
1992	0.080	0.409	-1.725	-0.894	1	-0.831	-0.922	4437
1993	0.330	0.471	-0.308	-0.753	1	0.445	0.495	5108
1994	0.830	0.859	0.615	-0.152	1	0.766	0.851	9322
1995	0.180	0.628	-0.914	-0.465	1	-0.449	-0.499	6816
1996	0.330	0.891	-0.308	-0.115	1	-0.192	-0.214	9668
1997	0.580	1.772	0.256	0.572	1	-0.316	-0.351	19224
1998	0.790	1.689	0.565	0.524	1	0.041	0.046	18322
1999	0.471	1.343	0.047	0.295	1	-0.248	-0.275	14573

Partial Variance: 0.345

Spr
Tuned to: 1-Jan
For ages: 6

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.210	1.011	-0.431	0.011	1	-0.442	-0.491	7903
1983	0.550	0.932	0.531	-0.071	1	0.602	0.669	7285
1984	0.420	0.924	0.262	-0.079	1	0.341	0.378	7227
1985	1.190	0.867	1.303	-0.143	1	1.446	1.606	6777
1986	0.530	1.026	0.494	0.026	1	0.469	0.521	8022
1987	0.120	0.981	-0.991	-0.019	1	-0.972	-1.079	7669
1988	0.310	0.493	-0.042	-0.708	1	0.666	0.740	3852
1989	0.070	0.346	-1.530	-1.062	1	-0.468	-0.520	2704
1990	0.020	0.217	-2.783	-1.530	1	-1.253	-1.391	1693
1991	0.190	0.546	-0.531	-0.605	1	0.074	0.082	4270
1992	0.120	0.311	-0.991	-1.169	1	0.178	0.197	2430
1993	0.060	0.386	-1.684	-0.953	1	-0.731	-0.812	3015
1994	0.160	0.394	-0.703	-0.932	1	0.229	0.254	3079
1995	0.310	0.698	-0.042	-0.359	1	0.317	0.352	5461
1996	0.220	0.608	-0.385	-0.497	1	0.112	0.125	4756
1997	0.460	0.829	0.353	-0.187	1	0.540	0.599	6486
1998	0.700	1.942	0.773	0.664	1	0.109	0.121	15185
1999	0.178	1.864	-0.594	0.623	1	-1.217	-1.351	14577

Partial Variance: 0.523

Spr
Tuned to: 1-Jan
For ages: 7

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.640	0.838	0.935	-0.177	1	1.112	1.235	4566
1983	0.640	0.997	0.935	-0.003	1	0.938	1.042	5433
1984	0.260	0.882	0.034	-0.125	1	0.160	0.177	4809
1985	0.860	0.845	1.231	-0.169	1	1.399	1.554	4606
1986	0.430	0.740	0.537	-0.300	1	0.838	0.930	4037
1987	0.260	0.794	0.034	-0.230	1	0.265	0.294	4330
1988	0.380	0.993	0.414	-0.007	1	0.421	0.467	5414
1989	0.100	0.496	-0.921	-0.701	1	-0.220	-0.245	2705
1990	0.020	0.373	-2.531	-0.986	1	-1.545	-1.716	2035
1991	0.020	0.223	-2.531	-1.498	1	-1.032	-1.146	1218
1992	0.150	0.575	-0.516	-0.553	1	0.037	0.041	3135
1993	0.080	0.223	-1.144	-1.500	1	0.356	0.395	1216
1994	0.030	0.320	-2.125	-1.141	1	-0.984	-1.093	1742
1995	0.110	0.266	-0.826	-1.322	1	0.497	0.551	1453
1996	0.070	0.569	-1.278	-0.564	1	-0.714	-0.793	3102
1997	0.080	0.526	-1.144	-0.643	1	-0.502	-0.557	2867
1998	0.210	0.788	-0.179	-0.238	1	0.059	0.065	4296
1999	0.182	2.145	-0.320	0.763	1	-1.083	-1.203	11693

Partial Variance: 0.712

Spr
Tuned to: 1-Jan
For ages: 8

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.410	1.064	0.690	0.062	1	0.628	0.697	2990
1983	0.670	1.179	1.181	0.165	1	1.016	1.129	3313
1984	0.280	1.139	0.309	0.130	1	0.178	0.198	3201
1985	0.450	0.982	0.783	-0.018	1	0.801	0.889	2760
1986	0.170	0.907	-0.190	-0.097	1	-0.093	-0.104	2550
1987	0.170	0.719	-0.190	-0.330	1	0.139	0.155	2021
1988	0.250	0.806	0.195	-0.215	1	0.411	0.456	2266
1989	0.310	1.202	0.410	0.184	1	0.227	0.252	3377
1990	0.020	0.577	-2.331	-0.550	1	-1.781	-1.977	1621
1991	0.090	0.532	-0.826	-0.631	1	-0.195	-0.217	1495
1992	0.050	0.294	-1.414	-1.223	1	-0.191	-0.213	827
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.020	0.175	-2.331	-1.743	1	-0.588	-0.653	492
1995	0.120	0.260	-0.539	-1.347	1	0.808	0.897	731
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.100	0.478	-0.721	-0.739	1	0.018	0.020	1342
1998	0.150	0.543	-0.316	-0.611	1	0.296	0.328	1525
1999	0.031	0.793	-1.905	-0.232	1	-1.673	-1.858	2228

Partial Variance: 0.649

Spr
Tuned to: 1-Jan
For ages: 9

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.080	1.494	-0.387	0.402	1	-0.788	-0.875	2341
1983	0.480	1.255	1.405	0.227	1	1.178	1.308	1965
1984	0.240	1.241	0.712	0.216	1	0.496	0.551	1944
1985	0.130	0.872	0.099	-0.137	1	0.236	0.262	1366
1986	0.180	0.777	0.424	-0.252	1	0.676	0.751	1218
1987	0.030	0.907	-1.368	-0.098	1	-1.269	-1.410	1420
1988	0.160	0.595	0.306	-0.520	1	0.826	0.918	931
1989	0.070	0.561	-0.520	-0.577	1	0.057	0.064	879
1990	0.060	1.331	-0.674	0.286	1	-0.961	-1.067	2086
1991	0.100	0.609	-0.164	-0.495	1	0.332	0.368	955
1992	0.140	0.675	0.173	-0.393	1	0.566	0.629	1057
1993	0.020	0.334	-1.773	-1.096	1	-0.677	-0.751	523
1994	0.060	0.767	-0.674	-0.265	1	-0.409	-0.454	1201
1995	0.040	0.154	-1.080	-1.874	1	0.794	0.881	241
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.000	0.000	0	0	1	0.000	0.000	00
1998	0.080	0.386	-0.387	-0.951	1	0.564	0.626	605
1999	0.014	0.618	-2.102	-0.481	1	-1.621	-1.800	968

Partial Variance: 0.727

Spr
Tuned to: 1-Jan
For ages: 10

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.260	1.213	1.203	0.193	1	1.010	1.122	1372
1983	0.200	1.453	0.941	0.374	1	0.567	0.630	1644
1984	0.110	0.890	0.343	-0.116	1	0.459	0.510	1007
1985	0.060	0.908	-0.263	-0.097	1	-0.166	-0.185	1027
1986	0.070	0.542	-0.109	-0.612	1	0.503	0.558	613
1987	0.060	0.588	-0.263	-0.531	1	0.268	0.297	665
1988	0.080	0.686	0.025	-0.376	1	0.401	0.445	776
1989	0.030	0.379	-0.956	-0.969	1	0.013	0.014	429
1990	0.010	0.381	-2.055	-0.964	1	-1.091	-1.211	431
1991	0.140	1.311	0.584	0.271	1	0.314	0.348	1483
1992	0.020	0.484	-1.362	-0.726	1	-0.636	-0.706	547
1993	0.020	0.657	-1.362	-0.420	1	-0.942	-1.046	743
1994	0.010	0.219	-2.055	-1.521	1	-0.534	-0.593	247
1995	0.000	0.000	0	0	1	0.000	0.000	00
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.000	0.000	0	0	1	0.000	0.000	00
1998	0.000	0.000	0	0	1	0.000	0.000	00
1999	0.023	0.345	-1.231	-1.065	1	-0.165	-0.184	390

Partial Variance: 0.393

Spr
Tuned to: 1-Jan
For ages: 11+

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.510	3.696	0.708	1.307	1	-0.599	-0.666	9014
1983	0.690	2.200	1.010	0.788	1	0.222	0.247	5364
1984	0.520	1.878	0.727	0.630	1	0.097	0.108	4581
1985	0.940	1.418	1.319	0.350	1	0.970	1.077	3459
1986	0.420	0.850	0.514	-0.163	1	0.676	0.751	2073
1987	0.180	0.525	-0.333	-0.644	1	0.311	0.345	1280
1988	0.080	0.708	-1.144	-0.345	1	-0.800	-0.888	1728
1989	0.180	0.493	-0.333	-0.707	1	0.373	0.414	1203
1990	0.040	0.384	-1.838	-0.956	1	-0.882	-0.979	938
1991	0.110	0.498	-0.826	-0.698	1	-0.128	-0.142	1213
1992	0.080	0.702	-1.144	-0.355	1	-0.790	-0.877	1711
1993	0.100	0.424	-0.921	-0.858	1	-0.064	-0.071	1034
1994	0.040	0.287	-1.838	-1.249	1	-0.589	-0.654	700
1995	0.070	0.126	-1.278	-2.073	1	0.795	0.883	307
1996	0.030	0.094	-2.125	-2.361	1	0.236	0.262	230
1997	0.000	0.000	0	0	1	0.000	0.000	00
1998	0.030	0.101	-2.125	-2.296	1	0.171	0.189	246
1999	0.000	0.000	0	0	0	0.000	0.000	00

Partial Variance: 0.354

Aut
Tuned to: 1-Jan
For ages: 3

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.030	0.355	-2.115	-1.035	1	-1.079	-1.198	15434
1983	0.000	0.000	0	0	1	0.000	0.000	00
1984	0.010	0.365	-3.213	-1.008	1	-2.206	-2.449	15866
1985	0.000	0.000	0	0	1	0.000	0.000	00
1986	0.010	0.112	-3.213	-2.187	1	-1.026	-1.139	4876
1987	0.000	0.000	0	0	1	0.000	0.000	00
1988	0.020	0.219	-2.520	-1.520	1	-1.000	-1.110	9502
1989	0.000	0.000	0	0	1	0.000	0.000	00
1990	0.020	0.158	-2.520	-1.844	1	-0.676	-0.750	6871
1991	0.110	0.206	-0.815	-1.580	1	0.765	0.849	8949
1992	0.170	0.352	-0.380	-1.045	1	0.665	0.739	15279
1993	0.110	0.251	-0.815	-1.382	1	0.567	0.630	10906
1994	0.110	0.319	-0.815	-1.142	1	0.327	0.363	13869
1995	0.280	0.640	0.119	-0.446	1	0.565	0.627	27833
1996	0.800	0.602	1.169	-0.508	1	1.677	1.862	26142
1997	0.270	0.473	0.083	-0.749	1	0.832	0.923	20549
1998	1.000	1.606	1.392	0.474	1	0.918	1.020	69778
1999	0.540	3.023	0.776	1.106	1	-0.331	-0.367	131387

Partial Variance: 1.171

Aut
Tuned to: 1-Jan
For ages: 4

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.240	0.608	-0.653	-0.497	1	-0.156	-0.173	12807
1983	0.060	0.623	-2.039	-0.474	1	-1.566	-1.738	13107
1984	0.490	0.716	0.061	-0.335	1	0.395	0.439	15061
1985	0.080	0.642	-1.752	-0.443	1	-1.309	-1.453	13520
1986	0.070	0.294	-1.885	-1.224	1	-0.661	-0.734	6191
1987	0.010	0.198	-3.831	-1.618	1	-2.214	-2.458	4176
1988	0.010	0.120	-3.831	-2.123	1	-1.708	-1.896	2519
1989	0.710	0.362	0.432	-1.016	1	1.447	1.607	7622
1990	0.080	0.240	-1.752	-1.426	1	-0.326	-0.362	5059
1991	0.390	0.266	-0.167	-1.325	1	1.157	1.285	5595
1992	0.670	0.346	0.374	-1.060	1	1.434	1.592	7293
1993	0.270	0.607	-0.535	-0.499	1	-0.036	-0.040	12780
1994	0.550	0.428	0.176	-0.850	1	1.026	1.139	9000
1995	0.500	0.565	0.081	-0.570	1	0.651	0.723	11898
1996	1.570	1.110	1.225	0.104	1	1.121	1.245	23361
1997	0.740	1.064	0.473	0.062	1	0.411	0.457	22390
1998	0.530	0.836	0.139	-0.180	1	0.319	0.354	17590
1999	1.330	2.847	1.059	1.046	1	0.013	0.015	59922

Partial Variance: 1.276

Aut
Tuned to: 1-Jan
For ages: 5

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.440	0.648	-0.266	-0.434	1	0.168	0.187	9766
1983	0.010	0.666	-4.050	-0.407	1	-3.643	-4.045	10035
1984	1.600	0.665	1.025	-0.407	1	1.432	1.591	10033
1985	0.970	0.770	0.524	-0.262	1	0.786	0.873	11603
1986	0.060	0.699	-2.258	-0.358	1	-1.901	-2.111	10546
1987	0.040	0.330	-2.664	-1.108	1	-1.556	-1.728	4979
1988	0.000	0.000	0	0	1	0.000	0.000	00
1989	0.070	0.135	-2.104	-2.001	1	-0.103	-0.114	2038
1990	0.300	0.408	-0.649	-0.896	1	0.247	0.274	6155
1991	0.520	0.250	-0.099	-1.388	1	1.289	1.431	3764
1992	0.350	0.294	-0.495	-1.223	1	0.728	0.809	4437
1993	0.220	0.339	-0.959	-1.082	1	0.123	0.137	5108
1994	0.760	0.618	0.280	-0.481	1	0.761	0.845	9322
1995	0.200	0.452	-1.055	-0.794	1	-0.261	-0.289	6816
1996	0.860	0.641	0.404	-0.444	1	0.849	0.942	9668
1997	2.020	1.275	1.258	0.243	1	1.015	1.127	19224
1998	0.860	1.215	0.404	0.195	1	0.209	0.232	18322
1999	0.480	0.967	-0.179	-0.034	1	-0.145	-0.161	14573

Partial Variance: 1.713

Aut
Tuned to: 1-Jan
For ages: 6

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.610	0.751	0.336	-0.287	1	0.623	0.691	7903
1983	0.020	0.692	-3.082	-0.368	1	-2.714	-3.013	7285
1984	0.780	0.687	0.582	-0.376	1	0.958	1.064	7227
1985	1.010	0.644	0.840	-0.440	1	1.281	1.422	6777
1986	0.600	0.762	0.320	-0.272	1	0.591	0.656	8022
1987	0.270	0.729	-0.479	-0.317	1	-0.162	-0.180	7669
1988	0.020	0.366	-3.082	-1.005	1	-2.076	-2.306	3852
1989	0.000	0.000	0	0	1	0.000	0.000	00
1990	0.010	0.161	-3.775	-1.827	1	-1.948	-2.163	1693
1991	0.170	0.406	-0.942	-0.902	1	-0.039	-0.044	4270
1992	0.270	0.231	-0.479	-1.466	1	0.987	1.096	2430
1993	0.060	0.286	-1.983	-1.250	1	-0.733	-0.814	3015
1994	0.230	0.293	-0.639	-1.229	1	0.590	0.655	3079
1995	0.390	0.519	-0.111	-0.656	1	0.545	0.605	5461
1996	0.490	0.452	0.117	-0.794	1	0.911	1.012	4756
1997	1.400	0.616	1.167	-0.484	1	1.651	1.833	6486
1998	0.770	1.443	0.569	0.367	1	0.203	0.225	15185
1999	0.310	1.385	-0.341	0.326	1	-0.666	-0.740	14577

Partial Variance: 1.601

Aut
Tuned to: 1-Jan
For ages: 7

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.460	0.829	0.655	-0.188	1	0.843	0.936	4566
1983	0.080	0.986	-1.094	-0.014	1	-1.080	-1.199	5433
1984	0.510	0.873	0.758	-0.136	1	0.894	0.993	4809
1985	0.580	0.836	0.887	-0.179	1	1.066	1.184	4606
1986	0.620	0.733	0.954	-0.311	1	1.265	1.404	4037
1987	0.360	0.786	0.410	-0.241	1	0.651	0.723	4330
1988	0.050	0.983	-1.564	-0.017	1	-1.546	-1.717	5414
1989	0.030	0.491	-2.075	-0.711	1	-1.363	-1.514	2705
1990	0.020	0.369	-2.480	-0.996	1	-1.484	-1.648	2035
1991	0.050	0.221	-1.564	-1.509	1	-0.055	-0.061	1218
1992	0.150	0.569	-0.465	-0.564	1	0.098	0.109	3135
1993	0.050	0.221	-1.564	-1.511	1	-0.053	-0.059	1216
1994	0.060	0.316	-1.382	-1.151	1	-0.230	-0.256	1742
1995	0.040	0.264	-1.787	-1.333	1	-0.454	-0.504	1453
1996	0.220	0.563	-0.082	-0.574	1	0.492	0.546	3102
1997	0.450	0.520	0.633	-0.653	1	1.286	1.428	2867
1998	0.400	0.780	0.515	-0.249	1	0.764	0.849	4296
1999	0.170	2.122	-0.340	0.753	1	-1.093	-1.213	11693

Partial Variance: 0.978

Aut
Tuned to: 1-Jan
For ages: 8

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.270	1.104	0.185	0.099	1	0.086	0.096	2990
1983	0.250	1.223	0.108	0.201	1	-0.093	-0.103	3313
1984	0.470	1.182	0.739	0.167	1	0.572	0.636	3201
1985	0.540	1.019	0.878	0.019	1	0.860	0.954	2760
1986	0.580	0.941	0.950	-0.061	1	1.010	1.122	2550
1987	0.310	0.746	0.323	-0.293	1	0.616	0.684	2021
1988	0.180	0.836	-0.220	-0.179	1	-0.042	-0.046	2266
1989	0.220	1.247	-0.020	0.220	1	-0.240	-0.267	3377
1990	0.040	0.599	-1.724	-0.513	1	-1.211	-1.345	1621
1991	0.020	0.552	-2.418	-0.595	1	-1.823	-2.024	1495
1992	0.090	0.305	-0.914	-1.186	1	0.273	0.303	827
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.030	0.182	-2.012	-1.706	1	-0.306	-0.340	492
1995	0.110	0.270	-0.713	-1.310	1	0.597	0.663	731
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.060	0.495	-1.319	-0.702	1	-0.617	-0.685	1342
1998	0.320	0.563	0.355	-0.575	1	0.930	1.032	1525
1999	0.100	0.823	-0.808	-0.195	1	-0.613	-0.680	2228

Partial Variance: 0.649

Aut
Tuned to: 1-Jan
For ages: 9

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.260	1.553	0.791	0.440	1	0.351	0.390	2341
1983	0.130	1.304	0.098	0.265	1	-0.167	-0.186	1965
1984	0.110	1.290	-0.069	0.255	1	-0.323	-0.359	1944
1985	0.320	0.906	0.999	-0.098	1	1.097	1.218	1366
1986	0.240	0.808	0.711	-0.213	1	0.924	1.026	1218
1987	0.150	0.942	0.241	-0.060	1	0.301	0.334	1420
1988	0.070	0.618	-0.521	-0.481	1	-0.040	-0.044	931
1989	0.060	0.583	-0.675	-0.539	1	-0.136	-0.151	879
1990	0.050	1.384	-0.857	0.325	1	-1.182	-1.313	2086
1991	0.020	0.633	-1.774	-0.457	1	-1.317	-1.462	955
1992	0.060	0.701	-0.675	-0.355	1	-0.320	-0.356	1057
1993	0.000	0.000	0	0	1	0.000	0.000	00
1994	0.080	0.797	-0.387	-0.227	1	-0.161	-0.178	1201
1995	0.000	0.000	0	0	1	0.000	0.000	00
1996	0.000	0.000	0	0	1	0.000	0.000	00
1997	0.060	0.102	-0.675	-2.286	1	1.611	1.789	153
1998	0.000	0.000	0	0	1	0.000	0.000	00
1999	0.040	0.642	-1.081	-0.442	1	-0.638	-0.709	968

Partial Variance: 0.689

Aut
Tuned to: 1-Jan
For ages: 10

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	0.180	1.604	0.993	0.472	1	0.521	0.579	1372
1983	0.010	1.921	-1.897	0.653	1	-2.550	-2.832	1644
1984	0.100	1.177	0.405	0.163	1	0.243	0.269	1007
1985	0.140	1.200	0.742	0.182	1	0.560	0.621	1027
1986	0.130	0.717	0.668	-0.333	1	1.001	1.111	613
1987	0.110	0.778	0.501	-0.252	1	0.752	0.836	665
1988	0.000	0.000	0	0	1	0.000	0.000	00
1989	0.050	0.502	-0.288	-0.690	1	0.402	0.447	429
1990	0.090	0.504	0.300	-0.685	1	0.985	1.094	431
1991	0.050	1.733	-0.288	0.550	1	-0.837	-0.930	1483
1992	0.020	0.640	-1.204	-0.447	1	-0.757	-0.841	547
1993	0.020	0.869	-1.204	-0.141	1	-1.063	-1.181	743
1994	0.000	0.000	0	0	1	0.000	0.000	00
1995	0.040	0.623	-0.511	-0.474	1	-0.037	-0.041	533
1996	0.010	0.136	-1.897	-1.992	1	0.095	0.106	117
1997	0.030	0.149	-0.799	-1.903	1	1.104	1.226	128
1998	0.000	0.000	0	0	1	0.000	0.000	00
1999	0.020	0.456	-1.204	-0.786	1	-0.418	-0.464	390

Partial Variance: 1.003

Aut
Tuned to: 1-Jan
For ages: 11+

Year	Obs.	Pred.	Scd. Obs.	Scd. Pred.	Wt.	Wt. Res.	Std. Res.	Pred. Stk. Sze.
1982	1.030	4.172	1.356	1.428	1	-0.072	-0.080	9014
1983	0.410	2.483	0.435	0.909	1	-0.474	-0.526	5364
1984	0.650	2.120	0.896	0.752	1	0.145	0.161	4581
1985	0.740	1.601	1.026	0.471	1	0.555	0.617	3459
1986	0.450	0.959	0.528	-0.041	1	0.570	0.633	2073
1987	0.330	0.593	0.218	-0.523	1	0.742	0.823	1280
1988	0.110	0.800	-0.880	-0.224	1	-0.657	-0.729	1728
1989	0.220	0.557	-0.187	-0.586	1	0.398	0.442	1203
1990	0.080	0.434	-1.199	-0.835	1	-0.364	-0.404	938
1991	0.080	0.562	-1.199	-0.577	1	-0.622	-0.691	1213
1992	0.070	0.792	-1.332	-0.233	1	-1.099	-1.220	1711
1993	0.080	0.479	-1.199	-0.737	1	-0.462	-0.513	1034
1994	0.080	0.324	-1.199	-1.128	1	-0.071	-0.079	700
1995	0.060	0.142	-1.486	-1.952	1	0.465	0.517	307
1996	0.060	0.106	-1.486	-2.240	1	0.753	0.837	230
1997	0.040	0.083	-1.892	-2.495	1	0.603	0.669	178
1998	0.020	0.114	-2.585	-2.175	1	-0.410	-0.456	246
1999	0.000	0.000	0	0	0	0.000	0.000	00

Partial Variance: 0.339

Partial variance (and proportion of total) by index

0.844	0.584	0.345	0.523	0.712	0.649	0.727	0.393	0.354	1.171	1.276
1.713	1.601	0.978	0.649	0.689	1.003	0.339				
0.058	0.04	0.024	0.036	0.049	0.045	0.05	0.027	0.024	0.08	0.088
0.118	0.11	0.067	0.045	0.047	0.069	0.023				

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

	1982	1983	1984	1985	1986	1987	1988
Spr3	1.203	1.080	-0.740	-1.669	0.000	0.000	-0.738
Spr4	0.473	1.319	-0.314	0.100	-1.670	-0.782	0.000
Spr5	-0.192	1.293	0.627	0.931	-0.664	-0.600	-0.784
Spr6	-0.491	0.669	0.378	1.606	0.521	-1.079	0.740
Spr7	1.235	1.042	0.177	1.554	0.930	0.294	0.467
Spr8	0.697	1.129	0.198	0.889	-0.104	0.155	0.456
Spr9	-0.875	1.308	0.551	0.262	0.751	-1.410	0.918
Spr10	1.122	0.630	0.510	-0.185	0.558	0.297	0.445
Spr11+	-0.666	0.247	0.108	1.077	0.751	0.345	-0.888
Aut3	-1.198	0.000	-2.449	0.000	-1.139	0.000	-1.110
Aut4	-0.173	-1.738	0.439	-1.453	-0.734	-2.458	-1.896
Aut5	0.187	-4.045	1.591	0.873	-2.111	-1.728	0.000
Aut6	0.691	-3.013	1.064	1.422	0.656	-0.180	-2.306
Aut7	0.936	-1.199	0.993	1.184	1.404	0.723	-1.717
Aut8	0.096	-0.103	0.636	0.954	1.122	0.684	-0.046
Aut9	0.390	-0.186	-0.359	1.218	1.026	0.334	-0.044
Aut10	0.579	-2.832	0.269	0.621	1.111	0.836	0.000
Aut11+	-0.080	-0.526	0.161	0.617	0.633	0.823	-0.729
Col Avg	0.219	-0.290	0.213	0.588	0.179	-0.234	-0.482

	1989	1990	1991	1992	1993	1994	1995
Spr3	-0.743	-0.829	2.176	0.014	0.049	1.261	0.587
Spr4	1.651	-0.545	-0.434	0.619	0.237	0.994	-0.086
Spr5	0.392	0.253	-0.386	-0.922	0.495	0.851	-0.499
Spr6	-0.520	-1.391	0.082	0.197	-0.812	0.254	0.352
Spr7	-0.245	-1.716	-1.146	0.041	0.395	-1.093	0.551
Spr8	0.252	-1.977	-0.217	-0.213	0.000	-0.653	0.897
Spr9	0.064	-1.067	0.368	0.629	-0.751	-0.454	0.881
Spr10	0.014	-1.211	0.348	-0.706	-1.046	-0.593	0.000
Spr11+	0.414	-0.979	-0.142	-0.877	-0.071	-0.654	0.883
Aut3	0.000	-0.750	0.849	0.739	0.630	0.363	0.627
Aut4	1.607	-0.362	1.285	1.592	-0.040	1.139	0.723
Aut5	-0.114	0.274	1.431	0.809	0.137	0.845	-0.289
Aut6	0.000	-2.163	-0.044	1.096	-0.814	0.655	0.605
Aut7	-1.514	-1.648	-0.061	0.109	-0.059	-0.256	-0.504
Aut8	-0.267	-1.345	-2.024	0.303	0.000	-0.340	0.663
Aut9	-0.151	-1.313	-1.462	-0.356	0.000	-0.178	0.000
Aut10	0.447	1.094	-0.930	-0.841	-1.181	0.000	-0.041
Aut11+	0.442	-0.404	-0.691	-1.220	-0.513	-0.079	0.517
Col Avg	0.108	-0.893	-0.055	0.056	-0.223	0.121	0.367

	1996	1997	1998	1999
Spr3	-0.323	-0.577	-0.178	-0.574
Spr4	-0.560	0.097	-0.245	-0.855
Spr5	-0.214	-0.351	0.046	-0.275
Spr6	0.125	0.599	0.121	-1.351
Spr7	-0.793	-0.557	0.065	-1.203
Spr8	0.000	0.020	0.328	-1.858
Spr9	0.000	0.000	0.626	-1.800
Spr10	0.000	0.000	0.000	-0.184
Spr11+	0.262	0.000	0.189	0.000
Aut3	1.862	0.923	1.020	-0.367
Aut4	1.245	0.457	0.354	0.015
Aut5	0.942	1.127	0.232	-0.161
Aut6	1.012	1.833	0.225	-0.740
Aut7	0.546	1.428	0.849	-1.213
Aut8	0.000	-0.685	1.032	-0.680
Aut9	0.000	1.789	0.000	-0.709
Aut10	0.106	1.226	0.000	-0.464
Aut11+	0.837	0.669	-0.456	0.000
Col Avg	0.388	0.533	0.281	-0.776

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

	1982	1983	1984	1985	1986	1987	1988
Spr3	0.536	0.432	0.203	1.032	0.000	0.000	0.202
Spr4	0.083	0.645	0.036	0.004	1.033	0.227	0.000
Spr5	0.014	0.619	0.146	0.321	0.163	0.133	0.227
Spr6	0.089	0.166	0.053	0.955	0.100	0.431	0.203
Spr7	0.565	0.402	0.012	0.894	0.321	0.032	0.081
Spr8	0.180	0.472	0.015	0.293	0.004	0.009	0.077
Spr9	0.284	0.634	0.112	0.025	0.209	0.736	0.312
Spr10	0.466	0.147	0.096	0.013	0.115	0.033	0.073
Spr11+	0.164	0.023	0.004	0.430	0.209	0.044	0.292
Aut3	0.532	0.000	2.221	0.000	0.481	0.000	0.456
Aut4	0.011	1.119	0.071	0.782	0.200	2.238	1.332
Aut5	0.013	6.061	0.937	0.282	1.650	1.105	0.000
Aut6	0.177	3.363	0.419	0.749	0.160	0.012	1.969
Aut7	0.325	0.533	0.365	0.519	0.730	0.194	1.092
Aut8	0.003	0.004	0.150	0.337	0.466	0.173	0.001
Aut9	0.056	0.013	0.048	0.550	0.390	0.041	0.001
Aut10	0.124	2.970	0.027	0.143	0.457	0.259	0.000
Aut11+	0.002	0.103	0.010	0.141	0.148	0.251	0.197
++	3.625	17.704	4.925	7.470	6.836	5.918	6.515

	1989	1990	1991	1992	1993	1994	1995
Spr3	0.204	0.254	1.754	0.000	0.001	0.589	0.128
Spr4	1.010	0.110	0.070	0.142	0.021	0.366	0.003
Spr5	0.057	0.024	0.055	0.315	0.091	0.268	0.092
Spr6	0.100	0.717	0.002	0.014	0.244	0.024	0.046
Spr7	0.022	1.090	0.487	0.001	0.058	0.443	0.113
Spr8	0.023	1.448	0.017	0.017	0.000	0.158	0.298
Spr9	0.001	0.421	0.050	0.146	0.209	0.076	0.288
Spr10	0.000	0.544	0.045	0.185	0.405	0.130	0.000
Spr11+	0.064	0.355	0.007	0.285	0.002	0.158	0.289
Aut3	0.000	0.208	0.267	0.202	0.147	0.049	0.146
Aut4	0.957	0.048	0.612	0.939	0.001	0.481	0.194
Aut5	0.005	0.028	0.758	0.242	0.007	0.265	0.031
Aut6	0.000	1.733	0.001	0.445	0.245	0.159	0.136
Aut7	0.849	1.006	0.001	0.004	0.001	0.024	0.094
Aut8	0.026	0.670	1.518	0.034	0.000	0.043	0.163
Aut9	0.008	0.638	0.792	0.047	0.000	0.012	0.000
Aut10	0.074	0.443	0.320	0.262	0.516	0.000	0.001
Aut11+	0.072	0.060	0.177	0.552	0.098	0.002	0.099
++	3.474	9.798	6.935	3.831	2.046	3.246	2.118

	1996	1997	1998	1999	++
Spr3	0.039	0.123	0.012	0.122	5.632
Spr4	0.116	0.003	0.022	0.271	4.160
Spr5	0.017	0.046	0.001	0.028	2.616
Spr6	0.006	0.133	0.005	0.676	3.965
Spr7	0.233	0.115	0.002	0.536	5.404
Spr8	0.000	0.000	0.040	1.279	4.329
Spr9	0.000	0.000	0.145	1.199	4.850
Spr10	0.000	0.000	0.000	0.012	2.264
Spr11+	0.025	0.000	0.013	0.000	2.364
Aut3	1.285	0.316	0.385	0.050	6.745
Aut4	0.574	0.077	0.046	0.000	9.682
Aut5	0.329	0.471	0.020	0.010	12.214
Aut6	0.379	1.245	0.019	0.203	11.414
Aut7	0.110	0.756	0.267	0.545	7.415
Aut8	0.000	0.174	0.395	0.171	4.328
Aut9	0.000	1.186	0.000	0.186	3.968
Aut10	0.004	0.557	0.000	0.080	6.237
Aut11+	0.259	0.166	0.077	0.000	2.414
++	3.376	5.367	1.449	5.368	100.000

STOCK NUMBERS (Jan 1) in thousands - C:\WTSS99\WHAT100\WTS99.54

	1982	1983	1984	1985	1986	1987	1988
1	21422	9890	6587	3987	12927	8768	9354
2	20755	18438	8512	5669	3432	11126	7529
3	15434	17862	15866	7326	4876	2950	9502
4	12807	13107	15061	13520	6191	4176	2519
5	9766	10035	10033	11603	10546	4979	3426
6	7903	7285	7227	6777	8022	7669	3852
7	4566	5433	4809	4606	4037	4330	5414
8	2990	3313	3201	2760	2550	2021	2266
9	2341	1965	1944	1366	1218	1420	931
10	1372	1644	1007	1027	613	665	776
11	9014	5364	4581	3459	2073	1280	1728
1+	108369	94337	78828	62101	56484	49384	47296

	1989	1990	1991	1992	1993	1994	1995
1	12211	20660	14940	18931	38285	37558	27856
2	8037	10500	17776	12843	16253	32872	31057
3	6359	6871	8949	15279	10906	13869	27833
4	7622	5059	5595	7293	12780	9000	11898
5	2038	6155	3764	4437	5108	9322	6816
6	2704	1693	4270	2430	3015	3079	5461
7	2705	2035	1218	3135	1216	1742	1453
8	3377	1621	1495	827	2028	492	731
9	879	2086	955	1057	523	1201	241
10	429	431	1483	547	743	247	533
11	1203	938	1213	1711	1034	700	307
1+	47564	58050	61659	68491	91892	110083	114186

	1996	1997	1998	1999
1	94356	177761	129543	00
2	23930	81183	152931	111458
3	26142	20549	69778	131387
4	23361	22390	17590	59922
5	9668	19224	18322	14573
6	4756	6486	15185	14577
7	3102	2867	4296	11693
8	462	1342	1525	2228
9	381	153	605	968
10	117	128	55	390
11	230	178	246	179
1+	186505	332260	410075	347375

	1982	1983	1984	1985	1986	1987	1988
1	0.000	0.000	0.000	0.000	0.000	0.002	0.002
2	0.000	0.000	0.000	0.001	0.001	0.008	0.019
3	0.013	0.021	0.010	0.018	0.005	0.008	0.071
4	0.094	0.117	0.111	0.098	0.068	0.048	0.062
5	0.143	0.178	0.242	0.219	0.168	0.107	0.087
6	0.225	0.265	0.300	0.368	0.467	0.198	0.204
7	0.171	0.379	0.405	0.441	0.542	0.498	0.322
8	0.270	0.383	0.702	0.668	0.435	0.625	0.796
9	0.203	0.519	0.488	0.650	0.455	0.454	0.625
10	0.208	0.407	0.513	0.545	0.497	0.526	0.462
11	0.208	0.407	0.513	0.545	0.497	0.526	0.462

	1989	1990	1991	1992	1993	1994	1995
1	0.001	0.000	0.001	0.003	0.002	0.040	0.002
2	0.007	0.010	0.001	0.013	0.009	0.016	0.022
3	0.079	0.055	0.055	0.029	0.042	0.003	0.025
4	0.064	0.146	0.082	0.206	0.165	0.128	0.058
5	0.035	0.216	0.287	0.236	0.356	0.385	0.210
6	0.134	0.179	0.159	0.542	0.399	0.601	0.415
7	0.362	0.158	0.237	0.286	0.755	0.718	0.996
8	0.332	0.380	0.197	0.308	0.374	0.565	0.502
9	0.562	0.191	0.406	0.202	0.600	0.663	0.573
10	0.372	0.230	0.262	0.272	0.518	0.685	0.790
11	0.372	0.230	0.262	0.272	0.518	0.685	0.790

	1996	1997	1998
1	0.000	0.000	0.000
2	0.002	0.001	0.002
3	0.005	0.006	0.002
4	0.045	0.050	0.038
5	0.249	0.086	0.079
6	0.356	0.262	0.111
7	0.688	0.481	0.506
8	0.954	0.646	0.304
9	0.943	0.883	0.290
10	0.749	0.547	0.367
11	0.749	0.547	0.367

Average F for 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	0.22	0.39	0.47	0.53	0.47	0.44	0.49
7,9	0.21	0.43	0.53	0.59	0.48	0.53	0.58
6,10	0.22	0.39	0.48	0.53	0.48	0.46	0.48
7,10	0.21	0.42	0.53	0.58	0.48	0.53	0.55

	1989	1990	1991	1992	1993	1994	1995
6,9	0.35	0.23	0.25	0.33	0.53	0.64	0.62
7,9	0.42	0.24	0.28	0.27	0.58	0.65	0.69
6,10	0.35	0.23	0.25	0.32	0.53	0.65	0.66
7,10	0.41	0.24	0.28	0.27	0.56	0.66	0.72

	1996	1997	1998
6,9	0.74	0.57	0.30
7,9	0.86	0.67	0.37
6,10	0.74	0.56	0.32
7,10	0.83	0.64	0.37

Average F weighted by N for 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	0.22	0.35	0.43	0.47	0.48	0.36	0.39
7,9	0.21	0.41	0.52	0.55	0.49	0.52	0.48
6,10	0.22	0.35	0.43	0.47	0.48	0.37	0.40
7,10	0.21	0.41	0.52	0.55	0.49	0.52	0.48

	1989	1990	1991	1992	1993	1994	1995
6,9	0.31	0.22	0.21	0.36	0.47	0.64	0.54
7,9	0.37	0.23	0.26	0.27	0.53	0.68	0.81
6,10	0.31	0.22	0.22	0.35	0.48	0.64	0.55
7,10	0.37	0.23	0.26	0.27	0.53	0.68	0.80

	1996	1997	1998
6,9	0.53	0.38	0.21
7,9	0.74	0.55	0.44
6,10	0.53	0.38	0.21
7,10	0.74	0.55	0.44

Average F for weighted by Catch for 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	0.22	0.36	0.46	0.49	0.48	0.43	0.49
7,9	0.22	0.41	0.54	0.56	0.50	0.53	0.55
6,10	0.22	0.37	0.47	0.50	0.48	0.43	0.48
7,10	0.22	0.41	0.54	0.56	0.50	0.53	0.54

	1989	1990	1991	1992	1993	1994	1995
6,9	0.35	0.25	0.23	0.40	0.50	0.64	0.60
7,9	0.38	0.27	0.29	0.28	0.57	0.68	0.85
6,10	0.35	0.25	0.24	0.39	0.50	0.65	0.61
7,10	0.38	0.26	0.28	0.28	0.56	0.68	0.84

	1996	1997	1998
6,9	0.59	0.43	0.31
7,9	0.75	0.56	0.46
6,10	0.59	0.43	0.31
7,10	0.75	0.56	0.46

Biomass Weighted F

1982	1983	1984	1985	1986	1987	1988
0.17	0.28	0.33	0.36	0.36	0.32	0.35

1989	1990	1991	1992	1993	1994	1995
0.25	0.19	0.20	0.23	0.31	0.37	0.27

1996	1997	1998
0.21	0.11	0.09

BACKCALCULATED PARTIAL RECRUITMENT

	1982	1983	1984	1985	1986	1987	1988
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.01	0.02
3	0.05	0.04	0.01	0.03	0.01	0.01	0.09
4	0.35	0.23	0.16	0.15	0.13	0.08	0.08
5	0.53	0.34	0.35	0.33	0.31	0.17	0.11
6	0.83	0.51	0.43	0.55	0.86	0.32	0.26
7	0.63	0.73	0.58	0.66	1.00	0.80	0.40
8	1.00	0.74	1.00	1.00	0.80	1.00	1.00
9	0.75	1.00	0.70	0.97	0.84	0.73	0.78
10	0.77	0.79	0.73	0.82	0.92	0.84	0.58
11	0.77	0.79	0.73	0.82	0.92	0.84	0.58

	1989	1990	1991	1992	1993	1994	1995
1	0.00	0.00	0.00	0.00	0.00	0.06	0.00
2	0.01	0.03	0.00	0.02	0.01	0.02	0.02
3	0.14	0.15	0.13	0.05	0.06	0.00	0.03
4	0.11	0.38	0.20	0.38	0.22	0.18	0.06
5	0.06	0.57	0.71	0.44	0.47	0.54	0.21
6	0.24	0.47	0.39	1.00	0.53	0.84	0.42
7	0.64	0.42	0.58	0.53	1.00	1.00	1.00
8	0.59	1.00	0.48	0.57	0.49	0.79	0.50
9	1.00	0.50	1.00	0.37	0.79	0.92	0.58
10	0.66	0.60	0.65	0.50	0.69	0.95	0.79
11	0.66	0.60	0.65	0.50	0.69	0.95	0.79

	1996	1997	1998
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.01	0.01	0.00
4	0.05	0.06	0.08
5	0.26	0.10	0.16
6	0.37	0.30	0.22
7	0.72	0.55	1.00
8	1.00	0.73	0.60
9	0.99	1.00	0.57
10	0.79	0.62	0.72
11	0.79	0.62	0.72

MEAN BIOMASS (using catch mean weights at age)

	1982	1983	1984	1985	1986	1987	1988
1	40	83	104	63	204	122	52
2	732	651	316	121	83	340	118
3	2164	2447	2214	863	402	221	384
4	2750	2323	3036	2837	1146	724	461
5	2785	2310	2722	2959	2700	1309	949
6	2775	2438	2450	2269	2443	2804	1408
7	2148	2186	1989	1965	1553	1788	2322
8	1775	1574	1431	1303	1305	965	978
9	1747	1139	1174	792	780	883	531
10	1134	1231	679	713	441	474	569
11	10652	5580	4484	3306	2016	1213	1713
1+	28703	21962	20598	17190	13072	10841	9484

	1989	1990	1991	1992	1993	1994	1995
1	136	230	194	123	320	137	181
2	253	281	577	308	406	575	656
3	694	385	502	1441	1211	900	1481
4	1167	819	994	1411	2214	1587	1837
5	597	1325	1049	1395	1275	2022	1763
6	1000	632	1547	805	1003	931	1798
7	1215	1026	584	1561	428	622	485
8	1827	866	887	491	1051	243	371
9	515	1500	612	732	325	684	156
10	324	377	1183	394	555	152	337
11	1272	1134	1412	1735	1007	601	247
1+	8999	8576	9541	10395	9793	8454	9312

	1996	1997	1998	
1	1665	3796	481	
2	688	2562	4682	
3	1477	1123	5761	
4	3290	3976	2742	
5	1865	4298	4062	
6	1586	1908	4664	
7	1164	1052	1550	
8	198	581	717	
9	198	83	427	
10	75	95	42	
11	187	166	231	
1+	12393	19641	25357	00

Summaries for ages 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	8445	7337	7043	6328	6080	6439	5239
7,9	5671	4899	4594	4059	3637	3635	3831
6,10	9579	8569	7722	7041	6520	6913	5808
7,10	6804	6130	5273	4772	4078	4109	4400

	1989	1990	1991	1992	1993	1994	1995
6,9	4557	4024	3629	3588	2807	2480	2809
7,9	3557	3392	2083	2783	1804	1549	1012
6,10	4881	4401	4813	3982	3361	2632	3146
7,10	3881	3769	3266	3177	2359	1701	1348

	1996	1997	1998
6,9	3146	3625	7357
7,9	1560	1716	2693
6,10	3221	3720	7398
7,10	1635	1812	2735

Catch BIOMASS (using catch mean weights)

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	00	00	00
2	00	00	00	00	00	03	02
3	29	50	22	16	02	02	27
4	258	273	337	279	78	35	29
5	398	412	660	648	455	140	82
6	624	647	736	835	1140	556	287
7	367	828	806	867	842	890	748
8	479	603	1004	870	568	603	779
9	355	591	573	515	354	401	332
10	236	502	348	389	219	249	263
11	2219	2274	2302	1802	1002	638	792
1+	4966	6179	6787	6223	4659	3515	3341

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	01	06	00
2	02	03	01	04	04	09	15
3	55	21	27	41	51	03	37
4	74	119	81	291	366	203	106
5	21	286	302	330	454	778	370
6	134	113	246	437	400	560	747
7	440	162	138	446	323	447	483
8	606	329	174	151	393	137	186
9	289	287	249	148	195	454	89
10	121	87	310	107	288	104	266
11	474	260	370	473	522	411	195
1+	2216	1668	1899	2428	2996	3112	2494

1	01	02	00
2	02	04	09
3	07	06	13
4	148	201	105
5	465	369	320
6	565	500	519
7	801	507	785
8	189	376	218
9	187	73	124
10	56	52	15
11	140	91	85
1+	2560	2180	2192

Summaries for ages 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	1825	2669	3119	3087	2904	2449	2145
7,9	1201	2022	2383	2252	1764	1893	1859
6,10	2061	3171	3467	3476	3123	2698	2408
7,10	1437	2524	2732	2641	1983	2142	2122

	1989	1990	1991	1992	1993	1994	1995
6,9	1469	892	807	1182	1311	1597	1506
7,9	1335	778	561	745	911	1038	759
6,10	1590	978	1117	1289	1598	1701	1771
7,10	1456	865	872	852	1198	1142	1024

	1996	1997	1998
6,9	1741	1455	1646
7,9	1176	956	1127
6,10	1798	1508	1661
7,10	1233	1008	1142

Jan 1 BIOMASS (using Jan 1 mean weights)

	1982	1983	1984	1985	1986	1987	1988
1	00	40	99	56	155	123	28
2	394	166	162	113	72	267	121
3	2037	1340	1206	528	219	136	371
4	2933	2294	2786	2555	1003	543	322
5	2881	2569	2578	3063	2805	1235	836
6	3003	2674	2435	2541	2832	2761	1387
7	2379	2537	2260	2248	1930	2070	2615
8	2078	1925	1876	1684	1576	1223	1387
9	1976	1494	1376	1022	935	1062	699
10	1280	1529	862	911	556	608	700
11	12674	7279	6134	4587	2738	1668	2291
1+	31635	23845	21775	19307	14821	11695	10754

	1989	1990	1991	1992	1993	1994	1995
1	98	145	149	76	230	75	84
2	113	200	356	244	228	427	311
3	293	316	376	917	611	596	919
4	663	764	621	868	1840	1413	1297
5	520	1287	956	1220	1379	2219	1697
6	984	635	1405	965	1221	1139	1895
7	1350	1015	613	1593	603	836	713
8	2046	1018	958	541	1296	299	444
9	650	1587	724	803	422	894	191
10	382	400	1348	470	682	221	480
11	1634	1363	1723	2127	1381	886	381
1+	8731	8729	9228	9823	9893	9006	8410

	1996	1997	1998
1	1321	3378	130
2	359	2030	4282
3	967	884	3838
4	2219	2441	1759
5	1934	3787	4031
6	1722	1881	4495
7	1517	1316	1804
8	291	792	820
9	293	120	448
10	110	120	50
11	283	231	296
1+	11016	16978	21953

Summaries for ages 6,9 7,9 6,10 7,10

	1982	1983	1984	1985	1986	1987	1988
6,9	9436	8629	7948	7494	7272	7115	6086
7,9	6433	5956	5512	4953	4441	4354	4700
6,10	10716	10158	8810	8405	7828	7723	6786
7,10	7713	7484	6375	5864	4996	4962	5399

	1989	1990	1991	1992	1993	1994	1995
6,9	5030	4256	3699	3902	3543	3168	3243
7,9	4046	3621	2295	2937	2321	2029	1348
6,10	5412	4655	5047	4372	4224	3389	3722
7,10	4428	4020	3642	3407	3003	2250	1827

	1996	1997	1998
6,9	3823	4109	7567
7,9	2101	2228	3073
6,10	3933	4229	7618
7,10	2211	2348	3123

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

	1982	1983	1984	1985	1986	1987	1988
1	00	00	00	00	00	00	00
2	00	00	00	00	00	00	00
3	00	00	00	05	02	01	04
4	00	88	107	368	145	79	47
5	55	486	483	1872	1729	769	522
6	423	1297	1175	2238	2453	2501	1255
7	1105	1859	1648	2037	1719	1858	2417
8	1589	1708	1579	1469	1429	1074	1184
9	1807	1336	1237	894	846	960	614
10	1206	1393	772	811	499	543	632
11	11939	6633	5492	4085	2458	1491	2069
1+	18124	14801	12493	13779	11281	9277	8743

	1989	1990	1991	1992	1993	1994	1995
1	00	00	00	00	00	00	00
2	00	00	00	00	00	00	00
3	03	03	00	00	00	00	00
4	96	109	06	08	17	108	100
5	328	787	89	114	127	913	719
6	901	577	534	344	446	854	1466
7	1239	964	460	1185	415	724	589
8	1888	932	877	486	1152	265	398
9	577	1499	659	758	373	780	169
10	350	375	1258	438	610	192	410
11	1497	1280	1609	1982	1235	771	326
1+	6879	6526	5492	5315	4375	4608	4178

	1996	1997	1998
1	00	00	00
2	00	00	00
3	00	00	00
4	172	189	136
5	814	1638	1746
6	1345	1493	3658
7	1319	1184	1617
8	242	693	761
9	244	101	416
10	95	107	46
11	244	205	272
1+	4475	5611	8652

APPENDIX B

Precision Estimates of 1998 Fishing Mortality and Spawning Stock biomass for witch flounder

Appendix B: Bootstrap results from final formulation (Run 54) of the 1998 Witch Flounder VPA.

The number of bootstraps: 1000

Appendix B: Table 1. Bootstrap Output Variable: N hat

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
N 4	59909	65144	26474	0.44
N 5	14571	15982	5731	0.39
N 6	14574	15145	4595	0.32
N 7	11690	12349	3709	0.32
N 8	2218	2450	987	0.44
N 9	968	1037	394	0.41
N 10	390	426	199	0.51

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
N 4	5235	837	8.74	54675	0.484213
N 5	1412	181	9.69	13159	0.435494
N 6	571	145	3.92	14003	0.328130
N 7	659	117	5.64	11030	0.336270
N 8	232	31	10.45	1986	0.496944
N 9	68	12	7.07	900	0.437501
N 10	36	06	9.19	354	0.560956

Appendix B: Table 2. Bootstrap Output Variable: Q_unscaled

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
q Spr3	0.0000123	0.0000123	0.0000025	0.21
q Spr4	0.0000291	0.0000295	0.0000058	0.20
q Spr5	0.0000414	0.0000423	0.0000084	0.20
q Spr6	0.0000413	0.0000423	0.0000082	0.20
q Spr7	0.0000461	0.0000470	0.0000093	0.20
q Spr8	0.0000732	0.0000755	0.0000164	0.22
q Spr9	0.0000752	0.0000767	0.0000151	0.20
q Spr10	0.0000690	0.0000710	0.0000163	0.24
q Spr11+	0.0001030	0.0001070	0.0000231	0.22
q Aut3	0.0000057	0.0000059	0.0000013	0.23
q Aut4	0.0000219	0.0000224	0.0000043	0.20
q Aut5	0.0000381	0.0000383	0.0000077	0.20
q Aut6	0.0000414	0.0000417	0.0000081	0.20
q Aut7	0.0000434	0.0000441	0.0000083	0.19
q Aut8	0.0000829	0.0000844	0.0000182	0.22
q Aut9	0.0000782	0.0000807	0.0000178	0.23
q Aut10	0.0000779	0.0000793	0.0000176	0.23
q Aut11+	0.0001228	0.0001253	0.0000249	0.20

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
q Spr3	0.00000006	0.000000080	0.504	0.000012219	0.21
q Spr4	0.00000046	0.000000182	1.573	0.000028610	0.20
q Spr5	0.00000088	0.000000266	2.122	0.000040506	0.21
q Spr6	0.00000092	0.000000258	2.226	0.000040427	0.20
q Spr7	0.00000086	0.000000295	1.869	0.000045234	0.21
q Spr8	0.00000232	0.000000518	3.175	0.000070886	0.23
q Spr9	0.00000146	0.000000476	1.944	0.000073727	0.20
q Spr10	0.00000201	0.000000514	2.910	0.000066999	0.24
q Spr11+	0.00000393	0.000000730	3.819	0.000099094	0.23
q Aut3	0.00000019	0.000000042	3.396	0.000005527	0.24
q Aut4	0.00000045	0.000000136	2.046	0.000021461	0.20
q Aut5	0.00000026	0.000000244	0.689	0.000037819	0.20
q Aut6	0.00000024	0.000000257	0.570	0.000041183	0.20
q Aut7	0.00000076	0.000000261	1.744	0.000042614	0.19
q Aut8	0.00000155	0.000000576	1.874	0.000081301	0.22
q Aut9	0.00000250	0.000000564	3.198	0.000075699	0.24
q Aut10	0.00000143	0.000000555	1.837	0.000076480	0.23
q Aut11+	0.00000254	0.000000786	2.068	0.000120255	0.21

Appendix B: Table 3. Bootstrap Output Variable: N t1

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	21239.4	21306.6	1215.9	0.0572
Age 2	111269.1	110353.1	24086.8	0.2165
Age 3	131164.7	130084.2	28414.5	0.2166
Age 4	59909.4	65144.2	26474.2	0.4419
Age 5	14570.6	15982.4	5730.6	0.3933
Age 6	14573.8	15144.6	4594.8	0.3153
Age 7	11689.7	12349.1	3709.2	0.3173
Age 8	2217.7	2449.5	986.9	0.4450
Age 9	968.1	1036.5	393.6	0.4066
Age 10	390.0	425.8	198.7	0.5094
Age 11	178.6	177.0	46.3	0.2593

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	67.23	38.45	0.317	21172.17	0.06
Age 2	-915.98	761.69	-0.823	112185.07	0.21
Age 3	-1080.55	898.55	-0.824	132245.28	0.21
Age 4	5234.76	837.19	8.738	54674.68	0.48
Age 5	1411.84	181.22	9.690	13158.76	0.44
Age 6	570.83	145.30	3.917	14002.93	0.33
Age 7	659.38	117.29	5.641	11030.36	0.34
Age 8	231.83	31.21	10.454	1985.86	0.50
Age 9	68.47	12.45	7.072	899.60	0.44
Age 10	35.83	6.28	9.188	354.13	0.56
Age 11	-1.64	1.46	-0.916	180.25	0.26

Appendix B: Table 4. Bootstrap Output Variable: F t

	NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
Age 1	0.0004	0.0004	0.0001	0.24
Age 2	0.0018	0.0019	0.0004	0.24
Age 3	0.0023	0.0025	0.0013	0.55
Age 4	0.0381	0.0396	0.0155	0.41
Age 5	0.0787	0.0828	0.0261	0.33
Age 6	0.1114	0.1150	0.0359	0.32
Age 7	0.5084	0.5248	0.1867	0.37
Age 8	0.3040	0.3220	0.1203	0.40
Age 9	0.2900	0.3199	0.1474	0.51
Age 10	0.3675	0.3889	0.0880	0.24
Age 11	0.3675	0.3889	0.0880	0.24

	BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
Age 1	0.0000215	0.0000028	5.841	0.0003460	0.25
Age 2	0.0001073	0.0000139	5.841	0.0017300	0.25
Age 3	0.0002390	0.0000396	10.477	0.0020419	0.61
Age 4	0.0014908	0.0004910	3.911	0.0366317	0.42
Age 5	0.0041224	0.0008243	5.239	0.0745615	0.35
Age 6	0.0036635	0.0011337	3.290	0.1077031	0.33
Age 7	0.0164347	0.0059038	3.233	0.4919422	0.38
Age 8	0.0180452	0.0038043	5.936	0.2859559	0.42
Age 9	0.0299096	0.0046625	10.313	0.2601053	0.57
Age 10	0.0214632	0.0027835	5.841	0.3460011	0.25
Age 11	0.0214632	0.0027835	5.841	0.3460011	0.25

Appendiz B: Table 5. Bootstrap Output Variable: F full t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
0.3675	0.3889	0.0880	0.24

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
0.02146	0.00278	5.84	0.34600	0.25

Appendix B: Table 6. Bootstrap Output Variable: B mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
25338.6121	26656.1272	4084.0426	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
1317.5151	129.1488	5.20	24021.0970	0.17

Appendix B: Table 7. Bootstrap Output Variable: SSB f mean

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
3860.2268	4733.1190	787.7977	0.20

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
872.892	24.912	22.61	2987.335	0.26

Appendix B: Table 8. Bootstrap Output Variable: SSB spawn t

NLLS ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP StdError	C.V. FOR NLLS SOLN
8645.1275	9088.0092	1419.3695	0.16

BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
442.88	44.88	5.12	8202.25	0.17