B. SOUTHERN NEW ENGLAND MID-ATLANTIC YELLOWTAIL FLOUNDER (*Limanda ferruginea*) STOCK ASSESSMENT FOR 2012, UPDATED THROUGH 2011

SAW 54 Terms of Reference

B. Southern New England Mid-Atlantic Yellowtail Flounder (*Limanda ferruginea*)

1. Estimate landings and discards by gear type and where possible by fleet, from all sources. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

3. Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

5. Investigate causes of annual recruitment variability, particularly the effect of temperature. If possible, integrate the results into the stock assessment (TOR-4).

6. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

7. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).
    a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-6).

8. Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).
    a. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, and recruitment as a function of stock size).
    b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
    c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

9. Review, evaluate and report on the status of research recommendations listed in most recent peer reviewed assessment and review panel reports. Identify new research recommendations.

Southern Demersal Working Group (SDWG) Meetings

The Southern New England Mid-Atlantic assessment was prepared by the Southern Demersal Working Group (SWDG). The working group held three different meetings over a three month period with each meeting dates and location provided below. Working group participation varied by meeting but did not influence the quality of input and attention to the assessment. A complete summary of the meeting notes including list of participants is presented in Appendices 1-3.

- SDWG Southern New England Mid-Atlantic Yellowtail Flounder Industry Meeting (SDIM)
    - February 27, 2012
    - University of Massachusetts School of Marine Science and Technology (SMAST), Fairhaven, MA

- SDWG Southern New England Mid-Atlantic Yellowtail Flounder Data Working Group Meeting (SDDWG)
    - April 2-4, 2012
    - Northeast Fisheries Science Center (NEFSC), Woods Hole, MA

- SDWG Southern New England Mid-Atlantic Yellowtail Flounder Models and Biological Reference Points Working Group Meeting (SDMBRPWG)
    - April 30 – May 4, 2012
    - Northeast Fisheries Science Center, Woods Hole, MA

Executive Summary

The Southern New England-Mid Atlantic yellowtail flounder stock was last assessed at the Groundfish Assessment Meeting III (GARM III) in 2008 (NEFSC, 2008). That assessment was based on a virtual population analyses (VPA) with a 6+ age group formulation. The GARM III assessment indicated that fishing mortality declined continuously from 2005, and in 2007 it was the lowest in the time series. Spawning Stock Biomass (SSB) from the GARM III assessment showed modest increases relative to the previous years and was expected to show continued growth with the support of a potential incoming 2005 strong year class. Biological Reference points were estimated from spawning stock biomass per recruit (SSB/R) and yield per recruit (YPR) analyses, by sampling the recruitment time series from a two stanza cumulative distribution function (CDF) with recruitment values associated with SSB above and below 5,000 mt (NEFSC, 2008). The value for $F_{40\%}$ *(i.e. proxy for* F_{MSY}*) was 0.25, and corresponding* SSB_{MSY} *and MSY estimates were 27,400 mt and 6,100 mt respectively. The GARM III VPA estimate of* SSB_{2007} *(3508 mt) was 13% of* SSB_{MSY} *and the estimate of* F_{2007} *(0.41) was more than one and a half times* F_{MSY}*, indicating that the stock was overfished and overfishing was occurring.*

The current benchmark assessment uses a new Statistical Catch at Age model, Age Structured Assessment Program (ASAP; Legault and Restrepo 1999), revises the 1994-2011 fishery catch estimates to reflect changes in the LW relationship, and revises the spatial stratification used for estimating discards. The discard mortality assumption was also revised in this assessment based on Reflex Action Mortality Predictor (RAMP) study of yellowtail flounder (Barkely and Cadrin 2012). The ASAP model maintained the age-6+ formulation by incorporating the entire time series of catch data, and it is tuned to the Northeast Fisheries Science Center (NEFSC) winter, spring and fall survey swept area biomass indices.

Natural mortality in previous assessments was based on the traditional longevity approach as described in Hoenig (1983) and was assumed to equal 0.2 for all ages and years. For this assessment, natural mortality was based on the Lorenzen method, with alternative life history approaches (i.e. gonadosomatic index approach, average maximum size in the population approach and Hoenig's method) providing the scale of natural mortality and the Lorenzen method defining how natural mortality declined with age (Lorenzen 1986, Gunderson and Dygert 1988, Gunderson 1997, McElroy et al. 2012). Recognizing the potential uncertainties associated with the Lorenzen approach (i.e. non-species specific parameters and the anomalous shift in age-1 weights at age during the mid-1990's), a time series average of age-specific yellow tail flounder natural mortality values, 0.3, was used in this assessment.

Biological reference points for this assessment were re-evaluated based on $F_{40\%}$ *as a proxy for* F_{MSY} *, and a corresponding* SSB_{MSY} *was derived from sampling age-1 recruitment from an empirical CDF. In this assessment, the overfishing determination is relatively certain. In contrast, the overfished determination is uncertain due to unresolved questions about the causes of temporal changes in stock productivity. Some analyses attempted to address this by examining oceanographic processes, specifically a cold pool index (see below). There was no* *clear evidence to explain the sudden drop in recruitment since the 1990's, although there is some evidence of broader ecosystem changes, which may be related to reduced Southern New England Mid-Atlantic yellowtail flounder productivity since the 1990's (i.e., in recent years). Due to uncertainty about the appropriate overfished biological reference point (i.e. reference point associated with biomass), two recruitment scenarios were explored, with sampling from the empirical CDF, to account for the temporal decline in recruitment. The two scenarios lead to very different conclusions about the biomass stock status.*

The first scenario uses age-1 recruitment from a "recent" time period, 1990-2010, recognizing a potential reduction in stock productivity since about the 1990's. The second scenario uses the entire age-1 recruitment time series, from 1973-2010, with "two stanzas" of recruitment determined by whether SSB is either above and below 4,319 mt. For both scenarios the overfishing threshold was $F_{40\%}$ = 0.316, and overfishing was not occurring based on comparisons of the threshold with the terminal year fishing mortality estimate from ASAP (2011 F_{4-5} =0.12). Biomass reference points and conclusions about whether the stock is overfished would depend on which recruitment scenario was adopted. Under the "recent" low recruitment scenario, SSB_{MSY} = 2,995 mt (2,219-3,820 mt; a 90% confidence interval) and MSY = 773 mt (573-984 mt), which would lead to the conclusion that the stock is not overfished relative to the ASAP model terminal year estimate of SSB (2011 SSB = 3,873mt). Because this stock is under a rebuilding plan with a rebuilding date set for 2014, the stock would also be considered rebuilt under the scenario of "recent" low recruitment. Under the "two stanza" recruitment scenario, SSB_{MSY} = 22,615 mt (13,164 - 36,897 mt) and MSY = 5,834 mt (3,415-9,463 mt), which would lead to the conclusion that the stock is still overfished. Neither recruitment scenario could be ruled out with a high degree of certainty.

Determining the cause of recent low recruitment was the largest source of uncertainty in this assessment. As a possible mechanism for reduced recent recruitment, the cold pool (i.e. remnant winter sea water under the summer thermocline) was investigated and modeled in ASAP. However, it could not fully explain the recent low productivity. The cold pool analyses did show that SSB_{MSY} and MSY tend to decrease in recent years as cold pools have gotten smaller and warmer. Environmental changes may be responsible for some of the changes in the stock which no longer exhibits the abundance throughout its range that existed in the 1970's and 1980's when recruitment was higher. If weak recruitment continues, the stock will not be able return to historically observed levels.

Introduction

Yellowtail flounder, *Limanda ferruginea*, is a demersal flatfish whose range in United States (US) waters extends from Labrador to Chesapeake Bay, generally at depths between 40 and 70 m (20 and 40 fathoms). Off the US coast, three stocks are considered for management purposes (Figure B1; Cadrin 2003): Cape Cod–Gulf of Maine, Georges Bank, and Southern New England–Mid-Atlantic . Yellowtail flounder have been described as relatively sedentary, although recent evidence from mark–recapture studies counters this classification with off-bottom movements (Cadrin and Westwood 2004; Walsh and Morgan 2004; Cadrin and Moser 2006), limited seasonal movements (Royce et al. 1959; Lux 1963; Stone and Nelson 2003), and transboundary movements (Stone and Nelson 2003; Cadrin 2005).

Spawning occurs during spring and summer, peaking in May (Cadrin 2003). Eggs are deposited on or near the bottom and float to the surface after fertilization. Larvae drift for approximately 2 months, then change form and settle to the bottom.

Off the northeast coast of the US, yellowtail flounder grow up to 55 cm (22 in) total length and can attain weights of 1.0 kg (2.2 lb). Growth is sexually dimorphic, with females growing at a faster rate than males (Lux and Nichy 1969; Moseley 1986; Cadrin 2003). Yellowtail flounder mature earlier than most flatfish, with approximately half of the females mature at age 2 and almost all females mature by age 3 (NEFSC, 2008).

Assessment History

The first quantitative stock assessment of yellowtail flounder was on the southern New England - Mid Atlantic resource and fishery. Royce et al. (1959) evaluated landings, length and age composition, effort, and tagging data to conclude that fishing mortality was approximately 0.30 in the 1940s. However, retrospective estimates of F during the 1940s were substantially greater (approximately 0.6, Lux 1969). Lux (1964) concluded that the stock was not overfished during the 1950s, but age-based mortality estimates for the 1960s were high (Lux 1967[1], 1969).

Subsequent assessments of yellowtail flounder in the southern New England area excluded Mid-Atlantic catch and survey data, but indicated increasing F and declining stock size in the late 1960s (Brown and Hennemuth 1971a, 1971b; Pentilla and Brown 1973). Starting in 1974, Mid Atlantic and southern New England yellowtail resources were treated as separate assessment and management units, but analyses for each area indicated high mortality and low stock size in the 1970s (Parrack 1974, Sissenwine et al. 1978, McBride and Sissenwine 1979, McBride et al. 1980, Clark et al. 1981). In the early 1980s, there was indication of strong recruitment of yellowtail from surveys and commercial catches in both southern New England and Mid Atlantic areas, but discard rates were high and F exceeded F_{max} in southern New England (McBride and Clark 1983, Clark et al. 1984, NEFC 1986).

Assessment methods used for southern New England yellowtail progressed to a calibrated VPA in the late 1980s. The 1988 assessment indicated high F in the 1970s and early 1980s and a strong 1980 cohort (F=0.60-1.48; NEFC 1989). Later stock assessments showed another dominant cohort spawned in 1987, but F continually increased through the 1980s, and the stock was depleted to record low biomass in the early 1990s (Conser et al. 1991, Rago et al. 1994). The

VPA-based assessment of southern New England yellowtail was updated annually from 1997 to 1999, and assessments indicated a reduction in F in the late 1990s, but little rebuilding of stock biomass (NEFSC 1997, 1998; Cadrin 2000). In 2000, an updated VPA was attempted, but was rejected as a basis for management advice because sampling in 1999 was inadequate to estimate catch at age reliably (Cadrin 2001b). Subsequent assessments of southern New England yellowtail were based on projections of observed catch from the 1999 VPA (Cadrin 2001b, NEFSC 2002).

In the last decade, Southern New England Mid-Atlantic yellowtail flounder has undergone three peer review assessments SAW 36 (NEFSC 2003), GARM II (NEFSC 2005) and GARM III (NEFSC 2008). Summaries and resulting stock status are presented in Table B1 and B2. All of these assessments were conducted using the ADAPT-VPA model with starting year in 1973. Prior to 2002, an analytical assessment of Mid Atlantic yellowtail flounder has not been developed, and management advice were based on descriptive summaries of landings and survey data.

SAW36 in 2002 conducted an extensive review of the yellowtail stock structure based on new evidence on morphometrics and life history information. Overall, it was concluded that there was very little evidence to support discrete stocks for the Southern New England and Mid-Atlantic. Consequently, SAW36 assessment underwent data revisions to reflect the new stock definition. Input data included fishery catch data and NEFSC survey indices through 2001with the NEFSC spring survey index through 2002. Biological reference points were based on the non-parametric yield per recruit analyses with $F_{40\%}$ used as a proxy for F_{MSY} due to the lack of a defined stock-recruit relationship. The spawning stock threshold, SSB_{MSY} was estimated at approximately 69,500 mt and $F_{40\%}$ was 0.26. Despite revisions to the stock definition in the SAW36 assessment, , SNEMA yellowtail flounder was considered overfished and overfishing was occurring.

GARM II represents updates to SARC 36 model inputs with catch data and survey indices through 2004 and the spring through 2005. The VPA results indicated that fishing mortalty remained high during 2002 -2004, averaging 0.84 and spawning stock biomass decreased to 695mt, second lowest in the time series. Reference points were updated adopting similar approach from the SAW36 assessment. Biological reference points remained unchanged from SAW 36 values and therefore the resource was considered severely overfished with overfishing occurring.

The 2008 GARM III assessment represents a benchmark update. Major changes from the previous assessment include a thorough consideration of commercial discard and revisions to the biological reference points. Biological reference points were re-estimated similarly to the previous assessments but adopted a two stanza approach for sampling the cumulative distribution for recruitment to account for apparent change in productivity. The reference points were estimated as follows: F_{MSY} = 0.254 and SSB_{MSY} = 27,400mt. Despite the decrease in terminal estimates of F (0.411) and increase in terminal SSB (3,508mt), the stock was still considered overfished and overfishing was occurring. The large increase in SSB was contingent on the relative strength of the 2005 and to a greater degree, the 2004 year class. The 2004 year class was estimated at 10.9 million, the highest observed in the last decade and half.

Fisheries Management

From 1950 to 1977, the International Commission for the Northwest Atlantic Fisheries managed yellowtail flounder resources in southern New England, Georges Bank and the Gulf of Maine (i.e., in ICNAF subarea 5). Gear restrictions and total allowable catch were the primary management strategies of ICNAF, but minimum fish size, fishing effort and closed area and season regulations were also regulated. Minimum trawl mesh size was 114 mm in the 1950s and 1960s. National catch quotas were implemented for southern New England yellowtail flounder from 1971 to 1976, but these were exceeded in most years.

Following the implementation of the Magnuson Fisheries Conservation and Management Act (FCMA) in 1976, U.S. yellowtail resources have been managed by the New England Fisheries Management Council (Table B3). Groundfish regulations included minimum cod end mesh size, minimum fish size, seasonal area closures, mandatory reporting, trip limits and annual quotas. Minimum size for yellowtail was increased from 28cm in 1982 to 30cm in 1986 and 33cm in 1989. Minimum mesh size increased from 140 mm in 1991 (diamond and square mesh) to 140mm diamond-152mm square in 1994 and to 165mm in 1999. A large area south of Nantucket Shoals was closed to fishing since December 1994. Scallop dredge vessels were limited to possession of 136kg of yellowtail flounder since 1996, and in 1999 minimum twine top mesh was increased from 203mm to 254mm to reduce yellowtail by catch.

The effort controls first adopted in 1994 were frequently changed making it difficult to isolate the effects of individual regulations. At the end of 1994, the NEFMC reacted to collapsed stocks of Atlantic cod, haddock, and yellowtail flounder on Georges Bank by recommending a number of emergency actions to tighten existing regulations to reduce fishing mortality. Prime fishing areas on Georges Bank (Areas I & II) and in the Nantucket Lightship Area were closed. The NEFMC also addressed an expected re-direction of fishing effort into Gulf of Maine and Southern New England waters while also developing Amendment 7 to the FMP. Under FMP Amendment 7, DAS controls were extended, and any fishing by an EEZ-permitted vessel required use of not less than 6 inch (152 mm) diamond or square mesh in Southern New England east of 72° 30'. Framework 27 in 1999 increased the square mesh minimum size to 6.5 inches (165 mm) in the Gulf of Maine, Georges Bank, and Southern New England mesh areas.

In 2010 the groundfish fishery experienced a major management change with the passage of Amendment 16 with the introduction of annual catch limits (ACLs) which represented a return to the hard TAC days of ICNAF. Additionally, 17 new groundfish sectors were approved and those vessels not members of a groundfish sector were subject to additional cut back in DAS and restrictive trip limits. Vessels fishing under the sector management were exempt from DAS restrictions and instead, each sector was given a share of the total commercial groundfish sub-ACL. How the catch was divided up amongst sector vessels or catch was allocated throughout the year was solely up to the sector. One of the requirements of Amendment 16 was an increase in the overall level of observer coverage. This was accomplished using observers trained through the existing Northeast Fisheries Observer Program (NEFOP) as well as a new class of observers termed At-Sea Monitors (ASMs). The data collection protocols for ASMs were restricted to catch estimation and the collection of limited biological information (e.g., lengths). The recent shift to a catch share system in 2010 on the yellowtail resource is still unknown and too soon to understand what other changes may have occurred.

Length-Weight Relationship

The length-weight relationship in previous assessments of Southern New England Mid-Atlantic yellowtail flounder for converting catch weights to numbers at age have been based estimates derived from Lux 1969 (equations 1 and 2). The study design used quarterly port samples from fish lengths and round weights of fish caught in 1955-1962 by commercial otter trawls in Southern New England and on Georges Bank. Given the apparent change in productivity in the Southern New England Mid-Atlantic yellowtail flounder stock coupled with poor recruitment in the last two decades, it is quite plausible that fish condition may have been changed over time. Additionally, fishery conditions in the 1960's are different from current conditions, warranting an evaluation of the existing LW relationship with respect to re-estimated length-weight equations.

(1) $W = 0.000011298L^{2.937}\ (Spring: April - June)$
(2) $W = 0.0000019143L^{3.451}\ (Fall: July - September)$

A comparison of the Lux 1969 LW relationship to the updated NEFSC survey-based estimates of Wigley et al. (2003) indicate differences between the approaches. Differences between both approaches could be possibly be explained by differences in the data used to estimate the LW relationships. For instance, a fishery-dependent (i.e. landings-based) LW equation is likely derived based on catches of (heavier) fish at length and therefore a fishery-independent (i.e. survey-based) length weight equation may be biased low, particularly at greater lengths. Alternatively, a fishery-independent LW relationship may be appropriate when large portions of the catch consist of discards or when catch-weights-at-age are also used to estimate stock-weights due to sparse sampling of older ages in the surveys. In the case of Southern New England Mid-Atlantic yellowtail flounder, a LW relationship based on fishery independent approach is valid. Currently in the Northeast Region, fishery surveys are the only source of individual length-weight sampling.

Since 1992 the NEFSC bottom trawl Surveys have used digital scales to record individual fish lengths. Updated survey-based length weight equations were compared to the existing length weight equations by either aggregating data across all three stocks or using the Southern New England Mid-Atlantic strata sets alone. Both seasonal (spring/fall) and annual updates were evaluated. First, to address concerns that Southern New England Mid-Atlantic yellowtail flounder condition have changed over time, the time series was divided into roughly five year blocks (fall:1992-2010; spring 1992-2011) and the relationships from each of the blocks were examined (Figure B2). Temporal trends in LW relationship for either all three stocks combined or for the SNEMA region only were nearly identical for the fall and spring season. This suggests that there is temporal stability in the LW relationship and that yellowtail condition has not changed at least within the time frame of the analyses (1992-2011). Given the stability in the LW relationship, data from 1992-2011 were aggregated to estimate updated spring and fall relationships (Equations 3-6). The updated values were then compared to the existing LW relationship (Figure B3). The updated relationships show that there was no statistical difference in the fall and in the spring when all three stocks are combined, evidenced by the 95% confidence intervals. Although, when all three stocks were combined in the spring, the LW relationship differed from the existing estimates, particularly at larger sizes (40cm +; Table B4). This could possibly be related to changes in fecundity or growth patterns during the spring in the northern extent of the stocks relative the SNEMA region. Although the relative difference at the smaller size groups appears substantial, the absolute magnitudes of the difference in the predicted weights are negligible.

(3) $W = 0.0000040023L^{3.23}$ $(Spring\text{: }SNEMA)$
(4) $W = 0.0000039591L^{3.22}$ $(Spring\text{: }All\ Stocks\ Combined)$
(5) $W = 0.0000097147L^{2.96}$ $(Fall\text{: }SNEMA)$
(6) $W = 0.000010136L^{2.95}$ $(Fall\text{: }All\ Stocks\ Combined)$

Based on these results, the SARC panel agreed to use the revised LW relationship in the 2012 benchmark assessment. Application of these length weight equations were based only on the SNEMA region estimates and was restricted the period of the LW analyses (1994-2011) while the application for pre-1994 were based on the previous assessment estimates Lux (1969).

Growth and Maturity

Yellowtail flounder off the coast of United states are known to exhibit geographical variation in growth patterns. Generally, yellowtail flounder attend to grow slower in the northern, colder waters (i.e. from Cape Cod Gulf of Maine) compared to the southern waters (i.e. Georges Bank south; Lux and Nichy, 1969; Mosely, 1986; Cadrin 2010; Figure B4). For the 2012 benchmark assessment, von Bertalanffy growth parameters were re-estimated using the NEFSC bottom trawl survey data from 1963-2011 (Equations 7 and 8). The number of ages derived from scale samples in the analyses are presented in Table B5. Due to sparse availability or low sampling of older ages, the precision of L_{inf} may be poorly estimated. Overall, the difference in growth parameters between CCGOM, GB and SNEMA lends support for each stock to be treated differently.

(7) $L_t = 35.6\left(1 - e^{-0.97(t-0.63)}\right)$ $(Spring)$
(8) $L_t = 35.2\left(1 - e^{-0.85(t+0.14)}\right)$ $(Fall)$

Examination of monthly trends in mean length of Southern New England Mid-Atlantic yellowtail flounder in the commercial fishery suggests that the majority of somatic growth tend to occur between April and December with little growth occurring between January and March (Figure B5). Mean catch weight at age suggests that fish size at age declined around the mid-1990's, particularly for the ages 1-4 and less apparent in the older ages and have increased subsequently without trend (Figure B6). This pattern is less evident in the survey data, with many of the ages with variable patterns among the various age classes (Figure B7). Non-standardized fishery catch weights at age indicated that catch weights have been fairly stable in the last five to six years, fluctuating about the time series average in the last five to six years (Figure B8). A comparison between the non-standardized spring survey mean weights at age to the fishery catch show that they are similar for ages 2-5 (Figure B9). The lack of coherence observed for the ages 1 and 6+ group is likely related to selectivity differences between the survey and commercial gears and the lack of availability of older age fish in the population.

Estimates of maturity ogives in previous assessments have been based on the time series average of the observe proportions at age. This assessment explored the logistic regression method described by O'brien et al. 1993 to fit maturity at age from the NEFSC spring survey data. In attempt to smooth the noise in the data and increase sample sizes for those years with low sampling (Table B6), a 3-year and a 5-year centered moving average was explored (Figures B10a and B10b). The application of the three year moving average was based in part on the precedence of the GARM III assessments for other species and also due to the fact that the 3-year average was tended to improve the sample size so that ogives could be estimated for years with few observations. The assessment examined the 3-year and 5-year average and concerns were raised as to whether there were enough samples to use a 5-year moving average. Examination of sample size indicated that there were some years with very limited samples (2003-2008 at age 2, Table B6). As a result, the decision for this assessment was to default to the previous approach of utilizing the time series average of observed proportion at age for the range of years in the assessment (Figure B11).

Natural Mortality

Previous assessments of Southern New England Mid-Atlantic yellowtail flounder have assumed a constant natural mortality (M) = 0.2 (NEFSC 2008, Cadrin and Legault 2005, NEFSC 2002). This assessment evaluated the sufficiency of this assumption through life history analyses of natural mortality. Hoenig (1983) demonstrated that natural mortality can be estimated as a function of maximum age (t_{max}) in a population. Depending on whether the maximum age observed from the surveys (t_{max} = 11) or the maximum age in the fishery (t_{max} = 13) is used (Figures B12a and B12b), this approach yields estimates of M = 0.27 or 0.23. This approach was further refined by Hewitt and Hoenig (2005). This approach yielded of M of 0.38 and 0.32 for the fishery and survey maximum ages respectively.

Contrary to the observed maximum age approach described above, the assessment explored the application of the maximum age models using a size-dependent approach of estimating natural mortality based on the predicted average maximum age of the population using the NEFSC survey data. The relationship between length and predicted mean age is presented in Figure B13. Length distributions used in the analyses are also presented in Figure B14. A maximum length of 54cm with corresponding predicted mean age of 8.9 for the population resulted in estimated M = 0.34 (Hoenig 1983) or M = 0.47 (Hewitt and Hoenig 2005). The decision to use a survey maximum size of 54cm was considered reasonable for this analysis because the maximum observed size (60cm) in the fishery was fairly consistent with the survey.

An alternative approach that relies on the gonadosomatic index (GSI) uses the ratio of gonad weight to the somatic weight (Gunderson 1997). The general premise is that M is positively correlated with reproductive effort, more specifically female reproductive effort. Estimates of GSI were derived from Southern New England yellowtail flounder collected primarily from commercial vessels participating in the Northeast Fisheries Science Center, Northeast Cooperative Research Program (NEFSC-NCRP) study fleet from 2009-2011. Supplemental samples of yellowtail were also obtained in months leading up to and during spawning. Details of the sample processing are provided in McElroy et al. (2012). Using a mean GSI estimate of 0.178 (Figure B15) yielded an M estimate of approximately 0.32.

Recognizing that natural mortality is likely vary with age ad time, this assessment explored the application of the Lorenzen method to estimating natural mortality. The Lorenzen approach is premised on the empirical relationship between fish body size and natural mortality with M being a power function of fish weight (Lorenzen 1996). Using average catch weights from 1973-2011 , Rivard calculations were used to convert average catch weights to January 1 weights. The Lorenzen Model was then applied to the January 1 weights to generate age and year specific M's. Parameters for the Model were based on the ocean ecosystem as presented in Lorenzen (1996). However, due to the very high M estimates that were generated using the raw weights at age, probably due to inter-species variation that is not accounted for in the Lorenzen's ecosystem model parameters, the M values were rescaled for consistency with yellowtail flounder life history. Given that natural mortality estimates from previous analyses ranged from 0.2-0.5 and the stock has experienced high fishing mortality over the time series, M was rescaled to 0.3. Further examination of the weights-at-age used to derive the Lorenzen M indicated an abrupt shift in 1994 for age-1 leading to a shift in M as well which could not be explained. As a result, a time series average Lorenzen M scaled to 0.3 was used in this assessment (Table B7 and Figure B16).

Attempts to explore predatory consumption of yellowtail flounder using the NEFSC Food Habits Database (FHDB) as another avenue to estimating M was considered. However, there is very little data with the occurrences of yellowtail flounder showing up as prey in the FHDBS. Chances are that many of the yellowtail flounder seen in stomachs automatically get aggregated into higher taxa and are not identified to species level (per Comm. Brian Smith).

Provided the number of analyses explored to evaluate M, the WG had an extensive discussion as to whether to retain the currently assumed natural mortality of 0.2 over the alternative estimates. The Lorenzen method suggests that for older ages, this assumption may be adequate, but neither the survey nor the fishey catch a lot of older fish. The traditional longevity models resulted in higher M of 0.27 or 0.32 (given observed maximum age of 11 and 13 years respectively), while other methods estimated M ranging from 0.3-0.5. Based on the available evidences of M being higher and notion of fewer older ages in the survey and commercial catch, the it was concluded to use the time series average Lorenzen age-specific M scaled to 0.3(Table B7 and Figure B16).

TOR 1. Estimate landings and discards by gear type and where possible by fleet, from all sources. Describe the spatial distribution of fishing effort. Characterize uncertainty in these sources of data.

Overview

In the recent period (1973-present), total catch has ranged from approximately 22,000mt to 290mt (Tables B8a-B8b. and Figure B17). Prior 2005, landings constituted roughly 70-80% of the total catch, but recently landings have only contributed approximately 40-50% (Figure B19) of the total catch. The magnitude of landings has been very low averaging about 400mt in the last 5 years partly due to significant restrictions on commercial landings leading to increase in commercial discards and to a greater degree the very low productivity of the resource over the last two decades.

Starting in 2005, commercial discards became a significant component, accounting for over 50% of the overall catch (Figure B19). Notable increases in discards were partly the result of restrictive trip limits that were in effect from 2003 through 2008 (Table B3). The scallop fleet has also been a primary contributor of yellowtail discarding (Table B24) for market reasons and despite efforts to gradually relax the trip limits, discards of yellowtail still constitutes up to 60%

of the total catch in the recent years (Table B8a-8b).

Commercial Landings

Since 1964 when modern statistics began, commercial landings of Southern New England Mid-Atlantic yellowtail flounder have ranged from 113mt to over 25,000mt (Tables B8a-8b). Total species landings were derived from the weighout reports of commercial seafood dealers and generally considered a census. A secondary source was required to apportion out the species landings to statistical area (stock) and assign basic information on fishing effort (e.g. gear and mesh). Prior to 1994, the partitioning of stocks from total yellowtail landings was accomplished, in part through a port interview process conducted by port agents working for the National Marine Fisheries Service (NMFS).

In 1994, with the requirement of vessel reported VTR's, the port interview process stopped and the area and effort information had to be inferred from the VTR's. Currently, a standardized procedure is used to assign area and effort from VTRs to dealer-reported landings from 1994 onward (Wigley et al. 2008). The product from this process is stored in the NEFSC allocation (AA) tables. Landings are matched to VTRs in a hierarchical manner, with landings matched at the top tier (level A, direct matching) having a higher confidence than those matched at lower tiers. The matching rates have improved overtime with approximately 60% of the Southern New England Mid-Atlantic yellowtail flounder landings being matched at the highest level since 2008 and near 90% of the landings being matched in 2011 (Figure B19). The overall precision associated with this process, in terms of CV is estimated at less than 0.1 (Table B9)

An additional source of uncertainty with stock landings stems from mis-reporting and/or under reporting of statistical areas on VTRs. Federal regulations require that a separate VTR logbook sheet be filled out for each statistical area or gear/mesh fished. Vessels fishing multiple statistical areas frequently under-report the number of statistical areas fished (Palmer and Wigley 2007, 2009 and 2011). The impacts of this misreporting are generally known to be low for most stocks but could have disproportional effects on low abundant stocks such as Southern New England Mid-Atlantic yellowtail flounder, with the impacts decreasing overtime (< 5% in 2007 and 2008; Palmer and Wigley 2011).

The commercial fishery is primarily conducted by vessels fishing with trawl gear constituting between 88%-99% of the landings (Tables B10-B11 and Figure B20). Patterns of landings by statistical area show that highest concentration of the landings came from the in the Southern New England region in statistical areas 526, 537 and 539 contributing approximately 80-90% of the total landings (Figure B21). Commercial landings of Southern New England Mid-Atlantic yellowtail flounder are classified by four primary categories: Unclassified, Large, Small and Medium. Generally the large and small market categories have dominated the landed markets, constituting over 70% of the total landings (Tables B12-13; Figure B22)

Temporal landings patterns of Southern New England Mid-Atlantic yellowtail flounder have changed slightly over the last six years. Although yellowtail flounder is a year round fishery, from 2007 through 2011, the fishery was most active between January and April and then slows down for the rest of the year (Figure B23). Presumably the slowdown in the fishery between April and December were a result of limited days at sea and restricted allocations under the sector management system, particularly in 2011.

Landings at age and mean weights at age were determined by port sampling of small, medium, large and unclassified market categories (Tables B14-B15) and pooled age-length keys by half year, when possible (Table 16). A summary of port samples are listed in Tables B14-B15. Sampling intensity has increased in recent years resulting in lower variability in landings at age estimates (Table B19). However, there is considerable uncertainty in the estimates of landings-at-age among some of the older ages, particularly in the plus 6 group where average CV exceeds 30%. Overall younger ages have become less prevalent in the commercial landings with increases in the minimum retention size (Figure B24). Estimates of weights-at-age from landings in commercial fishery are presented in Table B18 and Figure B24.

Changed in the method used to estimate landings-at-age relative to GARM III assessment included: LW equation and possibly differences in the imputation process in filling missing gaps in the ALK. Given these changes, the revised estimates were compared to the GARM III estimates. Overall the differences averaged approximately 11% for landed numbers at age (Table B20) and less than 1kg for landed mean weights at age (Table B22).

Commercial Discards

Estimates of discards for the southern New England – Mid Atlantic yellowtail fishery for 1963-1969 were derived from interviews with vessel captains; historical discards were approximated by Brown and Hennemuth (1971a) from the 1963-1969 average discard rates (Tables 8a-8b). Discards for 1970-1977 were also based on interview data, however yellowtail flounder interview data were suspect from 1978 to 1982 when trip limits were imposed (McBride et al. 1980, Clark et al. 1981). Discards during 1978-1982 were estimated from observer data when available (Sissenwine et al. 1978), derived directly from field selectivity studies (McBride et al. 1980), or from application of selectivity estimates to survey size frequencies (McBride and Clark 1983). Discards for 1983 were from interview data (Clark et al. 1984). Discards at age from southern New England, 1984-1993 were from a combination of sea sampling, interviews and survey data (Conser et al.1991, Rago et al. 1994). Direct sampling of commercial fishery discard has been conducted by fisheries observers since 1989. Of the Southern New England Mid-Atlantic yellowtail flounder observed by discarded by fishery observers, the following gear types account for greater than 99% of the total observed discards: Small mesh (<5.5”) otter trawl, Large mesh (≥5”) otter trawl, Scallop dredge limited category permit, Scallop dredge general category permits and scallop trawls (Table B24). It should be noted that GARM III discard estimates did not include scallop trawls which only constitute a very small fraction of total discards.

The total number of observed trips among these gear types ranged from a low of 23 trips in 1994 to a current high of 787 trips (Table B25). The large increase in the number of trips in 2010 and 2011 were due to additional contribution of ASMs that were required by the groundfish fishery by Amendment 16. In 2010 ASM coverage averaged approximately 25% of the total groundfish trips whereas regular observer trips (NEFOP) averaged about 7%. A comparison of the estimated discard rates between ASM and NEFOP observers was undertaken in SARC 52 (Wigley 2011) and showed no statistical difference for the majority of the gears and quarters examined. Generally, the Southern New England Mid-Atlantic yellowtail flounder ASM discard rates show no statistical difference from the NEFOP discard rates as evidenced by the 95% confidence intervals (Figure B25).

Discarded catch for years 1994-2011 was estimated using the Standardized Bycatch Reporting Methodology (SBRM) recommended in the GARM III Data meeting (GARM 2007; Wigley et al. 2007b). Observed ratios of discarded yellowtail flounder to kept of all species for all the gears mentioned above were applied to the total yellowtail flounder landings by gear and half year, with uncertainty estimated by the SBRM.

At the southern demersal industry meeting (SDIM), concerns were raised about the spatial stratification that has been used in previous assessments to derive discard rates due to differences in observer coverage between the Southern New England and the Mid-Atlantic regions. Typically, discard rates in previous assessments have been estimated by pooling the SNE and MA regions owing to low observer coverage earlier in the time series and recognizing the impacts of further stratification on the precision of estimates of discards estimates. However, due to increased sampling in the recent years, apparent differences in the spatial density of yellowtail flounder and disproportional observer coverage between SNE and the MA regions, there is potential for these discard rates to be different. Alternatively, it should be recognized that the choice to pool across multiple strata to account for low sampling/coverage may be statistically justified to avoid problems related to over-stratification, but does not address the underlying spatial differences that may exist in sampling.

Based on the observed differences in observer coverage between Southern New England region (SNE, statistical areas 526, 530, 531, 533, 534, 536, 537, 538, 539, 611, 612, and 613) and the Mid-Atlantic region (MA, statistical areas greater than 613), regional specific (SNE and MA) discard rates were estimated for years 1999-2011 in this assessment. For years 1994- 1999, the GARM III, non-stratified approach was used to mitigate the effect of low observer coverage earlier in the time series. For years 2000, 2004-2008 when there was activity in the access areas (i.e. Nantucket Lightship Area), discard estimates for the limited access scallop fleet were developed by further stratifying the SNE region to account for differences in discard rates between the open and the Nantucket Lightship access area (NLS). Although standard protocol for estimating discard is based on the ratio of kept yellowtail flounder to kept all species, discard rates for the scallop open and access areas were calculated as the ratio of observed discarded yellowtail to observed kept scallops. Personal communication with Susan Wigley of the NEFSC indicates that using K_scallops (scallop landings) as the expansion factor is sufficient for estimating discard rates, and nearly identical to using kept (landings) of all species given that the scallop dredge fleet rarely retains finfish other than scallops (e.g., occasionally monkfish and fluke are retained in minimal amounts). Note that the discard rates for years in the NLS access area were estimated on an annual scale due to the lack of consistent observer coverage by half year. Uncertainty by fleet in the manner of CV's were re-estimated for years with "blended" discard estimates (i.e. combined ratio for the groundfish trawl trips and cumulative ratio for the scallop dredge by open and access areas) to explicitly account for different sources of variances contributing to the total discard estimates. 95% confidence intervals were estimated for examine the impacts of the various spatial stratifications.

Estimates of discards using the blended stratification approach (open vs. access areas) suggested that when you account for open and closed area discard rates, total discard were generally higher compared to estimates derived using the region specific approach. The differences were significant for years 2000, 2007 and 2008 evidenced by the non-overlapping 95% confidence intervals. However, for years 2004, 2005, and 2010, there were no significant differences between the blended and non-blended approach (Figure B29). There was some evidence of improvement in the estimated CV's with the blended approach, particularly for years 2000 and 2010, but the CV's for years 2004-2008 were slightly higher.

While further stratification in the SNE area for the limited access scallop fleets could potentially provide a representative estimate of discarding rates between the open and access areas, there are several sources of uncertainty with the blended approach. The potential for tradeoff in the precision of discard estimates could occur if the level of observer coverage is not adequate to support finer level area-specific discard estimation. Secondly, the impact of spatial stratification on trip allocation remains unclear. Scenarios when trip allocations results from multiple sub trips occurring in multiple areas, as imposed by the stratification in the discard estimation (i.e. the difficulty of trip identification in open and closed area in the landings database) could result in different estimates. Lastly, area-specific stratification may not be supported by the resolution of biological sampling to adequately develop the appropriate discards-at-age, which could result in subjective decisions. While future work will need to thoroughly investigate these potential sources of uncertainty, the SARC Panel did not consider the blended approach as a major source of uncertainty in the assessment.

Discards at age (Table B26, Table 28, and Figure 30) and associated mean weights at age were estimated from sea sampled lengths and pooled age-length keys derived from commercial landings, observer and survey data.

Changes in the method used to estimate discards-at-age relative to GARM III included: differences in spatial stratification for deriving discard rates, Revised LW equation, and differences in the imputation process in filling missing gaps in the ALK. Given these changes, the revised estimates were compared to the GARM III estimates. Overall the differences between this assessment discarded at age in numbers and mean weights are presented in Tables B27 and B29.

Discard Mortality

A new study by Barkely and Cadrin 2012 summarized findings from a Reflex Action Mortality Predictor (RAMP) experiment on yellowtail flounder to estimate discard mortality. Fish were kept up to 60 days in situ, but the analyses used 20 days since most of the mortality occurred within this time frame. The tow times of 1-2 hours were approximately commercial tow times and gave the fish a range of stress conditions. The relationship between RAMP and mortality was derived from a logistic regression analyses based on a range of RAMP scores in the laboratory before sampling commercial activities. The study showed no direct evidence of additional mortality from predators or starvation, but there was likely some additional source of unknown mortality. The fish with the lowest RAMP score would be the ones more likely to evade predators. Commercial trips occurred in the Gulf of Maine (otter trawl) and on Georges Bank (scallop dredge). Monthly sampling was conducted to capture seasonal trends in mortality imposed by temperature. Information on species composition and catch size were examined. There was no evidence that tow time was a significant factor on mortality but air exposure was significant. Effects of size dependent mortality were tested for and was concluded not significant in the study. The Effects of various discarding practices (i.e. use of shovels, picks, conveyor belt etc) were explored. However, there seems to be consistency in discard mortality estimates (80-85% mortality) regardless of method. Prior discard mortality studies by the Massachusetts Department of Marine Fisheries (MA DMF) suggest 33-50% mortality. Given that 85% seems to be a lower bound on the RAMP-based discard mortality study and some mortality likely occurs post-release, the SDDWG agreed to use a value of 90% for commercial fishery discard mortality for the purpose of this assessment.

Total Catch at Age and Mean Weights at Age

Estimates of total catch at age were determined by summing the numbers at age across all the catch components: commercial landings and discards (Table B32 and Figure B33). The age structure of the fishery catch was truncated during the mid to late 1970's. The truncation has persisted through the late 1990's and it appears to be subtle expansion in the age structure in the recent years. Mean catch weights at age were estimated by using a number weighted average of the individual catch component's mean weight at age (Table B34 and Figure B8). Relative difference between the GARMIII mean catch mean weights at age compared to this assessment are presented in Table in B35).

TOR 2. Present the survey data being used in the assessment (e.g., regional indices of abundance, recruitment, state surveys, age-length data, etc.). Investigate the utility of commercial or recreational LPUE as a measure of relative abundance, and characterize the uncertainty and any bias in these sources of data.

A total of five surveys were available as tuning indices in this assessment. The NEFSC spring and fall bottom trawl survey which began in 1968 and 1963 respectively, provide a long time series of fishery independent indices. The winter survey which began in 1992 and ended in 2007 was designed specifically to efficiently catch flounders. The MARMAP (1977-1987) and the EcoMon Icthyoplankton surveys (1999-present) both provided an index of larval abundance. During the SDDWG meeting, it was discussed whether to include the southern strata in the winter survey (Strata 69-74). Traditionally, previous Southern New England Mid-Atlantic yellowtail flounder assessments have included the southern strata in the winter survey. However, given the disappearance of yellowtail by the late 1980's and 1990's in those strata that resulted in poor sampling, it was concluded that it was reasonable to exclude them from the winter survey (Figures B38 and B44). The impacts of excluding the southern strata from the winter survey resulted in an overall trend that was not markedly different with the inclusion of the southern strata.

A frequent criticism of the NEFSC bottom trawl surveys is that they do not cover the same areas where the commercial fisheries catch yellowtail flounder, and thus 'missing' much of the yellowtail flounder that exists in Southern New England. A comparison of the NEFSC spring and fall survey catches to commercial landings (binned by ten minute squares) show close agreement between survey and industry catches (Figure B39).

The NEFSC bottom trawl survey has utilized three different vessels and three different door configurations throughout the time series of the survey (Table B36). In effort to maintain consistency in the survey time series, the survey indices were converted to "Albatross IV/Polyvalent door' equivalents using several conversion factors (Table B37). The largest change in the survey occurred in 2009 when the FSV Albatross IV was decommissioned and replaced by the FSV Henry B. Bigelow. This resulted in changes not only to the vessel and doors, but also to the overall trawl gear as well as the survey protocols (summarized in Table B41). Calibration experiments to estimate survey differences were carried out in the fall and spring of 2008 (Brown 2009). The results of those experiments were peer reviewed by a panel of external experts and then summarized in Miller et al. (2010). These results provided annual calibration coefficients both in terms if abundance and biomass. Further work by Brooks et al. (2010) developed length-specific abundance calibration coefficients for yellowtail flounder. This method uses a segmented regressions model where a constant is applied to fish ≤ 20cm and ≥ 28cm, and a constant decreasing linear regression is fit to fish between 20cm and 28cm (Figure B40). Estimates of converted fall and spring survey indices are presented in Figure B41.

During a pre-SARC54 meeting with the fishing industry, there were concerned expressed by the industry with regards to the 24-hr operation of the survey. There was a sense that there were differences in the relative catchability of yellowtail flounder between day and nighttime hours. These observations are supported by archival tagging studies of yellowtail flounder showing off-bottom movements typically between 1800 and 2200 hrs lasting an average of four hours (Cadrin and Westwood 2004). An analysis was pursued as to whether there were appreciable differences in survey catchability between daytime and nighttime tows. The results showed that generally catchability was slightly higher in the evening time tows. However, the trends between day and night tows were very similar and in most years the day/night surveys fell within the 80% CI of the aggregated index (Figure B42). Because the trends were similar it was decided by the WG to use the aggregated index to calculate indices for the assessment.

Aggregated survey indices are presented in Table B40 along with corresponding CV's. Generally, survey indices were higher in the earlier time periods, reaching lows starting in the early 1990's and has remained constant over the past decade. The winter survey however varied over time without any persistent trend. Indices at age expressed as minimum swept are estimates are presented in Tables B41-B42 and B44 and Figures B45-B47. Similar to the trends observed in the commercial fisheries, there are fewer older fish present in the survey catch at age since the 1980's. However in the recent five years, there appears to be some subtle expansion in the age structure.

Examination of spatial trends in the NEFSC survey catches over time to see if these could inform the understanding small scale distribution of yellowtail show that there has been a general decline in the overall abundance of yellowtail flounder since the 1970's through the present time (Figure B48-B50).

Attempts were made by the WG to examine CPUE index for yellowtail flounder. However, there are currently no estimates of CPUE or effort for this species. Given the major changes in management, mainly the reduction in allowable days at sea (DAS) and the 2 for 1 counting of DAS, and changes in the reporting methodology, CPUE is not likely to be a good indicator of stock status. The fishery has also changed from one dominated by a directed fleet that took substantial amounts of fish to a by-catch fishery.

TOR 3. Evaluate the validity of the current stock definition, and determine whether it should be changed. Take into account what is known about migration among stock areas.

Geographic Distribution

Fishing Patterns: Fishing for yellowtail off the east coast of the U.S have been localized to three principal fishing grounds including Southern New England, Georges Bank and off Cape Cod with smaller portion of the landings from the northern Gulf of Maine and the Mid-Atlantic Bight. Spatial analyses on the patterns of yellowtail landings in the U.S suggest that yellowtail is harvested primarily from the three discrete fishing grounds (Lux, 1963; Chang 1990). McBride and Brown (1980) describe yellowtail flounder on Georges Bank and Southern New England as self sustaining units, based on the different patterns of landings between Southern New England and Georges Bank. Their rationale was premised on the notion that limited exchanges occur between Georges Bank and Southern New England, explaining the different trends in landings among the fishing grounds. Yellowtail flounder commercial catches updated through 2010 in Figure B51 show differences in the pattern of harvest between three management units. In southern New England, yellowtail flounder commercial catches have been low and stable for almost the last two decades while catches on Georges Bank increased briefly in the mid 2000's and has remained relatively stable.

Resource distribution: Several sources of fishery independent surveys also suggest two harvest stocks of yellowtail flounder with a boundary on the southwest of Georges Bank (Cadrin 2003). Efron (1971) indicated that there are two relatively distinct concentrations of yellowtail delineated east and west of Nantucket Shoals. Research surveys in the 1950's through the late 1960's illustrated that yellowtail are distributed along the continental shelf edge from the Mid-Atlantic Bight to the northeast peak of Georges Bank. An update of the spatial distribution of yellowtail flounder distribution from the Northeast fisheries Science Center bottom Trawl survey from 1963 to 2011 indicate a continuous distribution of yellowtail from the Mid-Atlantic to the northeast peak of Georges Bank and what appears to be a separate resource on Cape Cod-Gulf of Maine (Figure B53). Exploratory analyses of the trawl survey abundance by Cadrin (2003) demonstrated differences between the northern and southern strata, with the south peaking in the early to late 1980's and the north subsequently increased during the 1990's (Figure B53). Cadrin (2003) further illustrated that there is a boundary of mixing zone between the northern and southern clusters located on the southwestern Georges Bank; further confirming the subsidy hypothesis that movement between adjacent stocks may not be adequate to replenish the depleted southern stock in a desirable time frame for management purposes.

Spawning and Icthyoplankton Distribution: Yellowtail flounder exhibit four distinct geographic spawning distributions (Table B8; Neilson et al 1989; Sherman et al. 1987; Berrien and Sibunka, 1999) with geographical gradient in peak spawning time occurring earlier in the south than the north. The geographic spawning aggregations for yellowtail flounder include: Cox Ledge off Southern New England southward, a large band from Nantucket Shoals along the northern edge of Georges Bank to the southwest part of Georges Bank, north and east of Cape Cod and on Brown's Bank (Lux and Livingston, 1982; Neilson, 1986; Cadrin, 2010). Spatial and temporal distribution of icthyoplankton surveys suggest that that yellowtail flounder eggs and larvae are distributed over the continental shelf, but seasonal difference in spawning seasons south and north of Cape Cod may partially result in reproductive isolation among the areas (Cadrin, 2010).

Juvenile and Adult Distribution: Based on bottom trawl surveys, yellowtail flounder occur from Nova Scotia south to the Chesapeake Bay. Yellowtail yearlings have been reported to exhibit more seasonal movements relative to adults in response to following a narrower temperature range (Maurawski and Finn, 1998). Juveniles and adults migrate away from coastal areas off southern New England, especially around Long Island and the New York Bight, during autumn. In the spring, dense concentrations of adults appear on Georges Bank, frequently along the southern flank and northeast peak. In the winter, adults are present on Georges Bank, Southern New England and the Mid-Atlantic Bight. In the summer, adults appear along the coastal Gulf of Maine including coastal waters east of Cape Cod and from Cape Cod Bay to Ipswich Bay. In the case of yellowtail flounder juvenile geographic distribution, three distinct concentrations have been defined based on research survey catches: 1) Massachusetts Bay and Cape Cod Bay and along outer Cape Cod in the spring and fall 2) on the southern edge of Georges Bank in the spring shifting north and east in the fall and 3) southern New England in relatively shallow water in the spring and slightly deeper in the fall (Wigley and Gabriel, 1991). Overall, yellowtail distribution occurs on the continental shelf ranging from the Mid-Atlantic to the Grand Banks, delineated by deep channels and shallow shoals that define the fishing grounds (Cadrin, 2010).

Geographic Variation

Genetics: Cadrin (2010) reported on allozyme analyses conducted by Doggett et al. (unpublished) which concluding that yellowtail flounder stocks from Brown Bank, Georges Bank and the Mid-Atlantic Bight were distinguishable and were relatively discrete stocks. However, samples from Nantucket Shoals and the Cape Cod grounds were not distinguishable from Georges Bank and the Long Island area appears to consist of samples from the southern area. In contrast, Kuzirian and Chikarmane (2004) indicated that 90-95% genetic homogeneity exists among all management areas based on random amplified polymorphic DNA (RAPD).

Life History Patterns: Previous studies have shown that yellowtail flounder exhibit spatial differences in growth rates with slower growth in the northern colder regions (Cape Cod and northwards) relative to the southern regions (Georges Bank and southwards). The difference in growth rates between the Cape Cod region and the southern areas have persisted for several decades. Results from a von Bertalanffy growth analysis using data derived from the Northeast Fisheries Science Center bottom trawl survey from 1963-2011 also further supports the notion of regional growth difference among the three yellowtail flounder stocks (Figure B4, Table B47).

Geographic variation in yellowtail flounder maturity has also been reported in several studies and a summary of age and size at 50% maturity are provided in Table B10. Cadrin (2010) summary suggested that yellowtail flounder from the southern New England were significantly more fecund at length compared to those from the Grand Banks and may be related to smaller size at maturity in the southern extent of the population. Begg et al. (1999a) indicated that yellowtail maturity in the U.S. water vary by management region. Cape Cod yellowtail was found to mature later at age and length than those from Georges Bank southern New England and the Mid-Atlantic Bight. Estimated maturity at age and at length using data derived from the Northeast Fisheries Science Center bottom trawl survey from 1963-2011 also further supports the notion of regional differences in maturity among the three yellowtail flounder stocks (Table B48).

*Morphology***:** Morphometrics analyses of yellowtail flounder on U.S. fishing grounds in the 1950's and 1960's evaluated the number of dorsal and anal fin rays and found no differences among the three fishing grounds (Lux, 1963). Subsequent work by Cadrin and Silva (2005) also show that yellowtail flounder off Newfoundland have shorter-deeper bodies than those off the coast of U.S. and also found no variation among the U.S. management areas.

Movements and Migration

Icththyoplankton Dispersion: Yveseyenko and Nevinskiy (1981) evaluated geographic distribution of yellowtail flounder eggs based on patterns in the gyre system to infer drift of eggs and larvae distribution. Results of their analyses indicated that the circular flow dynamics of various closed water masses sufficiently provide pockets of larvae retention in favorable habitats including the Grand Bank, Brown Bank, Georges Bank and the Mid-Atlantic shelf. However, it was further suggested that some leakage may occur from the Brown Bank to the Gulf of Maine and from Georges Bank to southern New England. Later work by Nielson et al. (1986) also supported the previous conclusions on larvae retention with little opportunity for larvae transport. Sinclair and Iles (1986) reviewed information distribution of spawning of yellowtail flounder, icthyoplankton distribution, larvae behavior and oceanographic patterns and concluded that discrete stocks off southern New England-Mid Atlantic, Georges Bank, off Browns Bank were formed by larvae retention.

Tagging observations: Royce et al (1959) tagged and released yellowtail flounder on U.S. fishing grounds in the early to late 1940's and concluded that groups of yellowtail flounder are relatively localized with short seasonal migrations and minimal mixing among fishing grounds. However, frequent movement was observed between the Mid-Atlantic Bight to southern New England. Lux (unpublished) also tagged yellowtail off Cape Anne (northern extent of Massachusetts) in 1963 and found nearly all recaptures were caught near release sites. Stone and Nelson (2003) also tagged and released yellowtail from 1992-2002 on eastern Georges Bank and found that all but one fish were recaptured on the eastern portion of the Bank. From 2003-2006, an extensive cooperative tagging study with New England fishermen tagged and released over 46,000 conventional and data storage tags from the Gulf of Maine to the Mid-Atlantic to estimate movement and mortality rates among fishing grounds (Cadrin and Westwood, 2004; Cadrin and Moser, 2006, Cadrin 2009). Results from recaptures of the conventional tags showed that frequent movement occurred within Cape Cod and Georges Bank but very little movement among stock areas. Off-bottom movement analyses from sixty tags recaptured from the same study suggested that frequency of yellowtail off-bottom movements varied geographically among the three management areas with an average of once every ten days off Cape Cod and once every three days on Georges Bank.

Patterns of Parasite infestation: Lux (1963) reported observation from incidences of parasite infestation in yellowtail flounder and concluded that yellowtail flounder sampled from Cape Cod area were geographically isolated from those of the southern New England and Georges Bank region. Large percentage of yellowtail flounder sampled from the Cape Cod area were infested with intertidal host dependent trematodes likely due to yellowtail flounder habiting the near-shore environment for portion of their lives. However, none of the samples from Georges Bank or southern New England were infested. Subsequent work by Testerverde (1987) also concluded that geographical differences exist in the number of parasites and the degree of infestation among the three management areas.

The scientific evidence available with respect to variation in geographic abundance, life history, morphometrics and movement, suggests that there are three stocks despite homogeneity in genetic variation. Fishing patterns for yellowtail indicate that there are three harvest stocks but patterns of abundance and biomass overtime suggest two harvest stocks with a boundary on southwest of Georges Bank. Geographic patterns of maturity indicate two phenotypic stocks with a boundary on northern Georges Bank. However, growth patterns suggest that there maybe three phenotypic stocks. While yellowtail flounder appears to be a single genetic stock, variation in life history characteristics and patterns in abundance provides scientific support to assess each stock separately.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-5), and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

Update of the GARM III VPA Model

There were major changes in the treatment of the underlying data for SAW54 assessment update relative the data used in the GARM III assessment. The major changes include LW relationships, updated maturity ogive, revised assumption about natural mortality and discard mortality, re-estimation of fishery data from 1994 to present which included re-estimated landings and discards-at-age, and estimates of weights-at-age to reflect landings and discards. Additionally, the NEFSC winter survey was revised to better reflect the geographic availability of the resource, a larval index was considered for the first time as part of the tuning indices and finally four additional years of catch and survey data from 2008-2011 was included in the model time series. To fully understand how these data changes may impact the 2011 update, a bridge was built from the GARM III assessment to fully a fully updated assessment.

The GARM III assessment was conducted using the Adaptive Framework Virtual Population Analysis (ADAP-VPA) model (NOAA Fisheries Toolbox ADAPT-VPA version 2.8, 2007). This version relied on the pope's approximation to solve catch equation and allowed only for the 'backward' calculation of the plus group. The most recent version of the ADAPT-VPA software (version 3.2, 2012) provides additional options for forward and combined calculation of the plus group. However, these alternative options for plus group handling were not fully explored by the working group.

The model formulation used in GARM III utilized a truncated age range of age 6+ relative to previous assessments which had used a 7+(GARM I and GARM II) and a 8 plus group (SAW 36). Commercial landings and discards from 1973 to 2007 were accounted for in the model. Tuning indices included the NEFSC spring, fall and winter surveys all with ages 1-6+. Maturity-at age was calculated based on the time series average of the proportion at age mature. Spawning stock biomass (SSB) was calculated assuming May 1st spawning (0.4167 into the calendar year). The GARM III assessment results indicated that there was evidence of increasing stock numbers since 2004 potentially driven by what appeared to be moderately strong year classes in 2004 and 2005. Spawning Stock Biomass (SSB) from the GARM III assessment showed modest increases relative to the previous years and was expected to show continued growth with the support of a potential incoming 2005 strong year class

The general approach used to build the bridge from the GARM III VPA to an updated VPA was as follows (Note: The run numbers correspond to the run summaries presented in Table B49.

- **Run 1** - Recreated GARM III results using v.2.7 with GARM III data set to confirm model data were correctly applied.
- **Run 2** - Migrate to v.3.2 using the GARM III data set to quantify the impact of using an 'exact' solution to the catch equation. Continue to handle the plus-group using the GARM III formulation with backward calculation.
- **Run 3** – Only updated Maturity at age ogive only
- **Run 7** – Only replaced const M = 0.2 with lifetime Lorenzen M at age rescaled to 0.3
- **Run 9** – Updated commercial landings and discards-at-age and average catch weights-at-age (1994-2007)
- **Run10** – (Combo data update) Updated commercial landings and discards-at-age, average catch weights-at-age, updated maturity-at-age, revised natural mortality to utilize Lorenzen estimates of M at age
- **Run 11**- Using data updates from the run 10 model formulation, applied 90% discard mortality to the commercial discards-at age matrix, weights
- **Run 15b** – Updated biological, commercial and survey data time series through 2011
- **Run 20** – Utilizing the full time series as described in Run15b, replaced the lifetime Lorenzen M at age to use a time series average Lorenzen M at age, revised the winter survey data to exclude southern Strata sets. **This Model represents an updated VPA model by the SDMBRPWG.**

Selected runs from the bridge building exercise are presented in Table B50. There were no major diagnostic with the GARM III model following the VPA software updates (run 2, Table B50). Survey residuals were largely un-patterned. The NEFSC survey and fleet selectivities suggested constant increasing selectivity up to the maximum age, with no declines in subsequent ages (i.e. flat-topped). The impacts of discard mortality rates were examined at various rates (80-100%). Discard mortality resulted in very minimal impacts on F, SSB and recruitment estimates with decreases in retrospective patterns. However, with updates in the model time series through 2011(run 15b, Table B50), the retrospective patterns increased for F (13% to 55%) while it decreased for both SSB and recruitment. As a result, the SDMBRPWG explored the previous assumption for natural mortality, M = 0.2 (both constant and at age) to resolve the F retrospective patterns. The retrospective for F did decrease as a result of lowering M, however, this lead to slight increases in the retrospective for SSB but was still considerably lower compared to the GARM III results.

The SDMBRPWG discussed the possible model alternative runs utilizing M at age (Lifetime Lorenzen rescaled to 0.3 and 0.2). Provided that the SDMBRPWG felt there were strong evidences supporting natural mortality estimates higher than 0.2, the decision was to move forward with a Lorenzen type M formulation at age, rescaled to 0.3 as the basis for developing a suitable model. The weights-at-age used to derive the Lorenzen M had an abrupt shift for age-1 in 1994, resulting in a shift in M at age during the same period. Given the unexplained abrupt shift in The working group decided to use a time series average Lorenzen M scaled to 0.3 (Run 20, Table B50).

Updated VPA Model (through 2011)

The working group picked a base VPA (Run 20; Table B50) with time series average Lorenzen M scaled to M of 0.3. There was no patterning in the residuals (Figures B54- B56) and no indication of doming in the survey catchabilities and the fleet selectivities (Figures B57 - B58). The winter survey catchabilities (qs) were high but with the ground gear on the winter survey net, herding is expected between the doors and the net. The CVs on age-2 estimates in the terminal year were high but given that there was no spring survey estimate for 2012, they are not unexpected (Run20, Table B50).

The IBS in 2004/2005 and IBS in 2011 are less than mean biomass estimates so there were no apparent catchability issues. The retrospective pattern is underestimating fishing mortality in the terminal year (Figure B60). SSB at the start of the model was approximately 22,000 mt, declined to lower levels and had two excursions to higher SSBs due to two large year classes (Figure B62). Recruitment has been poor since the 1987 year class (Figure B64) although SSB is now starting to increase due to low F.

Development of an ASAP Statistical Catch-at-Age Model

Use of statistical catch at age model for the Southern New England Mid-Atlantic yellowtail flounder assessment was explored. More specifically, the statistical catch at age model, ASAP (Age Structured Assessment Program v.2.0.20, Legault and Restrepo 1998), which can be obtained from NOAA Fisheries Toolbox (http://nft.nefsc.noaa.gov/) was explored. ASAP was considered as an alternative modeling frame work in this assessment for a variety of reasons of which include, the ability to explore alternative model formulations to counter/lend support to the VPA results, ability to explore starting condition assumptions (e.g. ability to extend the time series beyond 1973, however, not explored in this assessment), ability to estimate stock-recruit relationship internal to the model, and the ability to explicitly model data uncertainty. Given some of the changes that have occurred in the fishery (gear, selectivity, targeting, and management), and the change to a new survey vessel (for which a calibration cannot be estimated), and the importance of age structure (maturity and growth), ASAP provides a very flexible platform to account for the various dynamics in the fishery and the survey.

As described at the NFT software website, ASAP is an age-structured model that uses forward computations assuming separability of fishing mortality into year and age components to estimate population sizes given observed catches, catch at age, and indices of abundance. Discards can be treated explicitly. The separability assumption is partially relaxed by allowing fleet-specific computations and y allowing the selectivity at age to change in blocks of years. Weights are input for different components of the objective functions which allows for configurations ranging from relatively simple age-structured production models to fully parameterized statistical catch at age models. The objective function is the sum of the negative log-likelihood of the fit to various model components. Catch at age and survey age composition are modeled assuming a multinomial distribution, while most other model components are assumed to have lognormal error. Specifically, lognormal error is assumed for: total catch in weight by fleet, survey indices, stock recruit relationship, and annual deviations in fishing mortality. Recruitment deviations are also assumed to follow a lognormal distribution, with annual deviations estimated as a bounded vector to force them to sum to zero (this centers the predictions on the expected stock recruit relationship). For more technical details, the reader is referred to the technical manual (Legault 2008).

ASAP Base Model Configuration

In developing the base ASAP model configuration, almost 30 model configurations were explored. These model configurations took advantage of ASAP flexibility of handling selectivity time blocks and indices without age information (i.e. the larval index). Summary of selected ASAP model configurations runs are presented in Table B51. A decision was made to use an age 6 plus group in the ASAP base model configuration. This decision was based on the difficulties of the VPA to estimate older ages with any precision due to the appearance of a continued truncation in the age structure over the most recent years, the high CV's in the landings-at-age observed during the early 1990's (Table B19) which could possibly be even higher prior to the 1990's and the difficulties in precisely estimating fishery selectivities of older ages as observed in GARM III (NEFSC, 2008).

Selectivity at age was initially freely estimated while the three NEFSC surveys were fixed at 1.0 for ages 4 and older (i.e. flat top selectivity). In subsequent explorations, the fishery selectivity was also fixed at 1.0 for ages 4 and older. The choice for the flat top selectivity pattern for the NEFSC survey indices was informed by the VPA results, which suggested increasing catchability with age, and the likelihood calculated in ASAP for dome versus flat-topped scenarios. Additionally, there is no biological mechanism to suggest decreasing selectivity with age.

Staring with a single selectivity for the fishery, the diagnostics (Run 1, Table B52) were examined for trends in age composition residuals. With one selectivity block (i.e. the same selectivity assumed for years 1973-20211), there were notable trends in the age composition residuals with runs of positives and negatives. Several intermediate models were explored for various selectivity blocks to capture major changes in the fisheries regulations (Table B3). Specifically, periods of changes in minimum retention size and changes in mesh regulations from

1978 to 2006. Additionally, the period of 1989 -1994 encompasses major changes in data availability, reporting sources and fisheries management. The model with six fishery selectivity blocks (1973-1977; 1978-1985; 1986-1988; 1989-1993; 1994-2001; 2002-2011) and a single time invariant selectivity block for each of the NEFSC surveys exhibited the lowest objective function and offered considerable fit to the age composition in the way of residual patterning (Run16; Table B52).

Additional model sensitivity runs were explored by including a larval index both as a single time series (1977-2011) and a split series (77-87 and 88-11), recognizing the change in survey mesh size in 1988. Relative to the single series option, the split series exhibited better model diagnostics as indicated by lower objective function, better fit to the total index and both survey and fleet age composition. Additionally, the root mean square residual estimates from the split series larval index were generally lower compared to the single series formulation (Run 20 and 22; Table B52b). However, the model diagnostics from the larval split series formulation was not an improvement over the base ASAP run. The WG considered additional attempts to improve the model formulation with the split series larval index by down weighting the CV on the larval index (per Comm. David Richardson) as well as each of the NEFSC surveys. The decision was to double the CV on the larval index owning to the uncertainty associated with the changes in the survey selectivity. Subsequent examination of the model fits for to the survey indices suggested a need for additional down weighting of the survey CV's. A constant of 0.1 was added to each of the NEFSC survey CV's including the larval index, which resulted in model improvement over the base model (Run 26; Table B52).

An alternative model examination that investigates the influence of the cold pool index on recruitment (Run28) was considered by the WG using ASAP base model Run26. The cold pool index was modeled as a covariate in a Beverton-Holt stock-recruit relationship internally estimated within ASAP to determine the effects of the cold pool on the predicted recruitment. This model formulation show that as cold pool index goes down, predicted recruitment increases. Although the cold pool model formulation is not directly comparable to the Base Model Run 26, which assumes no stock-recruit relationship, the trends in F and SSB were similar to the ASAP base Model Run 26, with tendency for the cold pool model to estimate SSB slightly lower. However, the recruitment estimates from the cold pool model formulation were drastically different in scale and magnitude. The 1980 and 1987 year classes were not reflected in the cold pool model formulation as observed in the base ASAP model 26 and other previous model formulations.

The SDMBRPWG further re-examined models with varying selectivity blocks on Run 26. The six selectivity blocks seem to produce selectivity estimates that do not necessarily agree with the expectations from the regulations. However, the SDMBRPWG deemed the improvement to the model fit with the six selectivity blocks acceptable to warrant keeping all the six blocks. Additionally, the retrospective patters were reduced and the RMSE with the six blocks. As a result, the SDMBRPWG chose ASAP model Run26 (Table B52) as the base model for this assessment.

The effective sample size (ESS) estimated for both the fishery and survey catch at age (which are treated as multinomial) was compared to the input effective sample size in an iterative fashion until the effective sample size specified more or less matched the model estimated value, or until no further improvement in trying to match the estimated value could be made. Additionally, following Francis (2011), minor adjustment in the effective sample sizes were informed by the overall fit between the predicted and observed mean age of the catch. The final ESS for the fishery was set to 50 and 10 for each of the NEFSC surveys.

ASAP Base Model 26 Diagnostics

ASAP base model 26 fits to the fishery catches were good, with no patterning of residuals over time and generally in good agreement between the model and observed catches (Figure B65). Fishery ESS of 50 appeared reasonable (Figure B66), and achieved reasonable fits between the observed catch at age (Figures B67- B71) with no large runs or obvious year class effects apparent in the residual patterning (Figure B72). Model fits to the observed mean catch at age are good, with a RMSE 1.48. Fishery selectivities were generally flat topped (Figure B73). As indicated earlier, the patterns in the selectivity blocks are somewhat noisy and not well explained by biological or management mechanisms.

Fit to the NEFSC winter survey index exhibited no strong residual patterning (Figure B72). The input ESS was generally supported by the modeled estimates (Figure B 75) with no strong patterning to the index age composition (Figure B76) Fits to the mean age were reasonable (RMSE = 0.89) lending additional support to the input ESS

Model fits to the spring survey also did not show no strong residual patterning with reasonable coherence between observed and predicted model estimate (Figure B 77). ESS value of 10 was generally supported by the model estimates, though there is some indication of increased ESS earlier and in the recent periods (Figure B78). There is very little patterning to the survey age composition (Figure B79) and the overall fit to the mean age is reasonable and comparable to the winter survey (RMSE = 0.95), further supporting the input for the ESS.

Similar to the winter and spring survey, the fall survey are reasonably good with the model tracking the observed index values fairly well with no strong residual patterns (Figure B80). The model ESS is somewhat noisy earlier and midway through the time series, but overall, the input ESS seems reasonable (Figure B81). The age composition residuals were reasonably well estimated with no long runs of residuals (either positive or negative) was observed (Figure B82). Estimated mean ages were close to the observed mean ages, with RMSE of 0.88.

Relative to the survey indices, the larval index exhibits somewhat a reduced fit between the observed and predicted model estimates (Figures B83 and B 84) but more apparent in the post 1987 period. Some patternings were observed in the early and late 2000's. However, the magnitudes of the residuals are comparable to those observed in the surveys.

The NEFSC survey fall survey exhibits higher selectivity for ages 1 and 2 fish but at age 3, the winter survey shows higher selectivity relative to the spring and fall survey (Figure B85). Similarly to the VPA, the winter survey catchabilities (q's) for the NEFSC winter survey tend to be high (> 1.00) compared to other surveys due to potential herding between the doors and the net. The spring and fall survey (q's) are approximately 0.6 and 0.4 respectively, suggesting that the survey is 40-60% efficient. However, this is possibly related to decline in the resource and lack of availability to the survey gear. Considering calibration coefficients applied to the Bigleow survey years, this would suggest greater than 100% efficiency over the last three years. Caution needs to be taken when interpreting the area swept converted q's given the assumption inherent in the calculations, such as constant tow length, no herding by the gear, 100% of survey area is habitable and the survey area is identical to the stock area which the catches come from.

ASAP Base Model 26 Results

The ASAP base model run 26 reflects the consensus opinion of the SDMBRPWG as the best model with which to evaluate stock status and provide catch advice and was accepted by the SARC 54 Panel. The assessment indicates that the total SSB ranged from 621 mt to 21,760 mt during the assessment time period, with current SSB in 2011 estimated at 3,873 mt (Table B53 and Figure B93). The model estimates SSB in 2007 at 1,920 mt, 55% of the 3,508 mt estimated at the GARM III. Currently total biomass is estimated at 5,305 mt. Current F's are near historic lows (Figure B93), with F_{avg4-5} = 0.12 (Table B54). Fishing Mortalities at age are presented in Table B55. Age-1 recruitment over the past two decades has been poor despite modest increases in SSB (Figures B92 and B93). Age-1 recruitment has not exceeded 10million since 1999 and has only exceeded it only once in the past 20 years (Table B56). Over the entire time series there, is no well defined stock-recruit relationship. The two highest recruitment events in the time series were spawned in 1980 and 1987 when SSB were at moderate and low stock sizes (~8900 mt and 2000 mt respectively). The current population structure is comprised primarily of ages 1-3, consisting of approximately 76% of the population. In 2011, there has been some expansion in the 6+ group (8% of the population), rising to the fourth highest in the time series (Table B56 and Figures B96-B97).

MCMC simulations were performed to obtain posterior distributions of SSB, and F_{avg4-5} time series. Two MCMC chains of length of initial length of 10,000 were simulated with every 200^{th} value saved. The trace of each chain's saved suggested good mixing (Figure B98). As the MCMC simulations appear to converge, 90% probability intervals as well as plots of the posterior for SSB2011 and $F_{avg4-5(2011)}$ are shown in Figures B100 and B101.

Retrospective analysis for the 2004-2011 terminal years indicates some retrospective error in F and SBB with tendency for the model to overestimate F although 2004 is a high flier) and underestimate SSB (Figures B87 –B88). F retrospective error ranged from 0.46 in 2006 to 0.26 in 2004. SSB retrospective error ranged from -0.29 in 2004 to 0.56 in 2006. Retrospective error for age-1 recruitment varied from -0.49 in 2010 to 0.63 in 2004 (Table B57). It is worth noting that the ASAP model does not exhibit nearly as severe retrospective pattern relative to the updated VPA run 20.

Historical Assessment Retrospective

Comparison between the results of the accepted ASAP (Model Run 26) for this assessment and the four previous assessments (GARM I, SAW 36, GARM II, GARM III, SARC 54) are provided in Figures B103 – B104. This historical "retrospective" examination of past model performance illustrates that the updated ASAP model appears to be consistent in trends with previous assessments. There is tendency for SSB to be slightly lower and recruitment to be estimated higher relative to previous assessments. F appeared to be within the same magnitude as previous assessments. These patterns are in addition to the intra-model retrospective errors that are present in the existing ASAP base model run 26. Given the major changes in the data that have occurred in the most recent update, the accepted assessment (Model Run26) is not entirely comparable with previous assessments. Much of the scale differences between current assessment and previous assessment are driven by changes to the underlying data and not necessarily results of the assessment.

TOR 5. Investigate causes of annual recruitment variability, particularly the effect of temperature. If possible, integrate the results into the stock assessment (TOR-4).

Recruitment of several cold-temperate fishery species has been linked to the dynamics of the cold pool, a summertime feature of the Southern New England and Mid-Atlantic Bight shelf. The cold pool is cold, remnant winter water separated from warm surface water by a strong seasonal thermocline. Taylor et al. (1957) proposed that yellowtail flounder (*Limanda ferruginea*) declined off Southern New England during the 1940's as a result of increasing temperatures. Sissenwine (1974) built upon this report and developed predictive equations for yellowtail flounder recruitment based on air temperature and the strong regional link between air temperature and coastal water temperature (Taylor et al. 1957). Sullivan et al (2005) hypothesized that yellowtail flounder recruitment was related to cold pool dynamics based on observations that yellowtail flounder settle almost exclusively to the cold-pool during the summer (Steves et al. 2000; Sullivan et al. 2000). Their analysis found that yellowtail flounder recruitment was higher when the cold pool was colder and de-stratification occurred later.

Hare et al (2012) explores the NEFSC hydrographic database to develop indices for SNEMA yellowtail flounder cold pool. A number of indices were developed bases on data collection in September

- Mean, maximum, and minimum temperature of area occupied by juvenile yellowtail flounder
- Width of temperatures <12^{o}C along four cross-shelf transects: south of Martha's Vineyard, south of Long Island, east of New Jersey, and east of Delaware Bay.
- Bottom temperature anomaly along the mid-line of the cold-pool.
- Area of bottom water on the Mid-Atlantic Bight shelf <10 ^{o}C, <11 ^{o}C, <12 ^{o}C, <13 ^{o}C, <14 ^{o}C, <15 ^{o}C, and <16 ^{o}C.

15 resulting indicators were summarized using Principal Component Analysis (PCA) and the first axis explained 68% of the variance. PCA was used to summarize the cold pool indices since all of the above indices are particular measures of the cold pool. Rather than picking just one index, using the first PCA captures to dominant signal of variability across all indices. Using this approach, a positive PCA 1 is associated with a small/warm cold pool and a negative PCA 1 is associated with a large/cold cold pool (Figure B105). The PCA 1 is termed Cold Pool Index.

Relationships between cold-pool dynamics and recruitment were explored using environmentally-explicit stock recruitment models. The first axis from the PCA was used as the environmental term and estimates from GARM III, 2012 VPA, 2012 ASAP models were used for recruitment and spawning stock biomass. In all cases, the residuals of the standard Beverton Holt models were correlated with the Cold Pool Index (Figure B106). The environmental explicit stock recruitment modeling indicated the models with the cold pool index provided a better fit than those based on spawning stock biomass alone (Table B58). Recruitment was lower in years when the cold pool was warmer and smaller. Because of a trend in the Cold Pool Index over the time series (cold pool shrinking and warming), maximum recruitment is estimated to be different comparing the first half of the time series to the second half of the time series. This suggests that stock productivity is decreasing because of changing environmental conditions.

The values from the first PCA of cold pool indices are presented in Table B59. The initial values were calculated using data through 2007. These data were updated through 2010 and some of the individual variable calculations were modified so the updated values are identical to the previous values. The correlation between the two indices for years of overlap (1967-2007) are highly correlated (r=0.99).

The environmental explicit Beverton-Holt stock recruitment models tend to fit better than the standard model for all three assessment models evaluated (Table B58): GARM III, 2012 VPA, and 2012 ASAP. Results of the cold pool index were examined in ASAP (Run 28; See TOR 4) to explore the influence the cold pool index on predicted recruitment assuming a Beverton-Holt stock-recruit relationship.

TOR 6. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for BMSY, BTHRESHOLD, FMSY and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

The existing reference points for Southern New England Mid-Atlantic yellowtail flounder are based on a spawning potential ratio (SPR) of 40%. The overfishing definition is $F_{MSY} = F_{40\%} =$ 0.254. A stock is considered overfished if spawning biomass is less than SSBMSY. The existing overfished definition is SSB_{MSY} = SSB40% = 27,400mt. A history of reference points values since 2002 are available in Table B2.

The existing reference points were derived from a VPA with a plus group at age 6. There are a numbers of reasons why a new reference points are needed for the new ASAP base model for the current assessment. There has been a revision to the commercial fishery data, particularly discards. With discard constituting more than 50% of the yellowtail catch in the recent five years, this has implications on changing the weights and selectivities at all ages. Changes in the L-W relationship parameters were re-estimated (this also affects weights at all ages). Assumption on natural mortality has been completely revised to allow for age-specific natural mortality, consequently accounting for differential in survival at different age groups.

Reference points based on parametric stock-recruit relationship was explored by the SDMBRPWG. Initial attempts to fit a Beverton-Holt function occurred without success due to the anomalous high 1980 and 1987 year class recruitment estimates at very low to moderate stock sizes. There was consensus among the SDMBRPWG that an approach to developing a proxy for reference point will be reasonable to estimate updated reference points. Yield per recruit (YPR) analysis was performed with a 5-year average for the most recent years (2007-2011) for weights at age, and selectivity at age. The rest of the inputs, maturity at age and selectivity for natural mortality were time invariant. Inputs for the YPR analyses can be found in Table B60.

The current reference points were derived at GARM III, and are based on $F_{40\%}$. The decision to use F40% as a proxy was endorsed by the independent reviewers at GARM III meeting, stating that "If recruitment and spawning stock biomass derived from the assessment are not informative about a relationship, the panel recommended use of $F_{40\%}$MSP as a proxy for F_{MSY} (NEFSC 2002) and SSB_{MSY} proxy computed using a stochastic projection approach, also referred to as the "non-parametric approach" (NEFSC 2008, p979). Additional analyses by the SDMBRPWG evaluated various proxies for F_{MSY} by comparing estimated SSB and recruitment ratios (SSB/R) with expected spawning biomass per recruit (SPR) at alternative fishing mortalities (F=0, $F_{30\%}$ and $F_{40\%}$) to investigate potential for replacement under equilibrium assumptions (i.e. constant F over the lifespan). The stock was considered to able to replace itself at $F_{40\%}$ in both early and late years, but at $F_{30\%}$, the stock would not have replaced itself in the later years.

As a result, the SDMBRPWG concluded that $F_{40\%}$ was a good proxy for F_{MSY} which was endorsed by the SARC 54 Panel.

To arrive at $SSB_{40\%}$ and corresponding MSY long term projections were run, sampling from the empirical distribution of recruitments estimates from the preferred ASAP model 26 under two recruitment scenarios. It should be noted that in this assessment, the overfishing determination is relatively certain, however, the overfished determination is uncertain due to the lack of evidence explaining the underlying mechanism related to the change in productivity of the resource. Biomass reference points and conclusions about whether the stock is overfished depended on which recruitment scenario is used. The first scenario used age-1 recruitment from a "recent" time period, 1990-2010, recognizing a potential reduction in stock productivity since about the 1990's. Following the precedent from GARM III, the second scenario used the entire assessment time series of age-1 recruitment from 1973-2010, with "two stanzas" of recruitment determined by recruitment values associated with SSB either above or below 4,319 mt. The 4,319 mt SSB threshold was derived based on a minimum residual variance analyses by relating SSB to Age-1 recruitment to allow recruitment to be sampled from the appropriate stanza depending on the given value of SSB. While there was no clear evidence to explain the sudden drop in recruitment since the 1990's, evidence of broader ecosystem changes, which may be related to Southern New England Mid-Atlantic yellowtail flounder productivity since 1990's (recent years) is more likely than not.

To approximate the distribution of SSB and MSY distributions, the long term projections were made from 1,000 estimates in 2011, which were estimated by performing MCMC simulation of the ASAP base model (described in TOR4). The resulting reference points and their 90% confidence interval corresponding with $F_{40\%}$ indicated that under the recent recruitment scenario, SSB_{MSY} = 2,995 mt (2,219-3,820 mt) and MSY = 773 mt (573-984 mt). However, when the entire age-1 recruitment time series with the two stanza approach is used, SSB_{MSY} = 22,615 mt (13,164 - 36,897 mt) and MSY = 5,834 mt (3,415-9,463 mt).

TOR 7. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model, should one be developed for this peer review. In both cases, evaluate whether the stock is rebuilt (if in a rebuilding plan).

TOR 7a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

The existing peer reviewed assessment model is a VPA. A bridge was built from existing VPA model structure to the updated VPA model structure. The updated VPA model which includes changes to the catch (revision to discards), weights at age, etc., estimates SSB_{2011} = 4,044 mt.

This is less than the existing overfished threshold of 27,400 mt; therefore the stock would be considered overfished. The updated VPA estimates average fishing mortality on ages 4-5, $F_{(4-5)2011}$ is 0.16. This is less than the existing overfishing threshold of 0.254 and therefore overfishing is not occurring. This is a change in the overfishing status from the GARM III model results which indicated that overfishing was occurring.

TOR 7b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-6).

The revised reference points are F_{MSY} proxy = F40% = 0.316 and SSB_{MSY} = 2,995 mt under the recent recruitment scenario and = 22,615 mt under the two stanza recruitment assumption. The new ASAP base model 26 estimate of SSB_{2011} is 3,873 mt. This is less than the overfished threshold of 22,615 mt under the two stanza recruitment conditions and therefore would be considered overfished. However, under recent recruitment conditions, SSB in 2011 exceeds the overfished target and therefore the stock would be considered rebuilt.

Overall, the updated model with respect to the existing reference points (GARM III) and the new new ASAP base model with respect to the two stanza recruitment reference points indicate that the stock is overfished and overfishing is not occurring. In contrast, the new ASAP model with respect to the recent recruitment scenario reference points would suggest that the stock is rebuilt and overfishing is not occurring (Table B61, Figure B107).

TOR 8. Develop approaches and apply them to conduct stock projections and to compute the pdf (probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

TOR 8a. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment, and recruitment as a function of stock size).

Short term projections of future stock status were conducted based on the new ASAP model assessment results under the two recruitment scenarios as defined previously. Numbers at age in 2011 were derived from 1000 different vectors of numbers at age produced from the MCMC chain. Short term projections assumed catch in 2012 to be equal to the catch in 2011 based on the approach from previous GARM III assessment. It should also noted that Annual Catch Limits (ACL's) in these two years were similar (2011 = 404 mt and 2012 = 552 – 585 mt) which lends additional support for the 2012 catch assumption.

Recruitment was sampled from a cumulative density function (CDF) of estimated age-1 recruitment assuming the two recruitment conditions as described on TOR 6. Projections were run under different F assumptions: F_0 = 0.00, $F_{MSY(40\%)}$ = 0.316, and $F_{75\%FMSY}$ = 0.237.

Projection results are summarized in terms of median spawning stock biomass and fishery yield under all the three F scenarios in Tables B62-B63. Under the two stanza recruitment assumption, the stock cannot rebuild to SSB_{MSY} by 2014 even at F equal zero. However, under the recent recruitment assumption, SSB in 2014 will exceed SSB_{MSY} under all three F assumptions by 27% at F_{MSY} and up to 75% at F_0. Results of the projections under F_0 and F_{MSY} in terms of rebuilding scenario or levels of SBB and yield are presented in Figures B109-B108.

TOR 8b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

Sources of uncertainties in the projections include the moderate retrospective patterns that have been observed in the last seven years. Given these patterns, there are additional sources of uncertainty in the catch advice based on these projections. Moreover, the projections are sensitive to realized to recruitment assumptions. Recruitment has been weak with no strong recruitment in over 20 years. Continued weak recruitment will impede the ability of the stock to rebuild. However, it is possible that the stock is in a new productivity regime and hence assuming recent recruitment trends could possibly be the new reality for the stock as evidenced by the levels of recruitment in the recent years.

TOR 8c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

Uncertainties that were not accounted for by assessment and reference point models were evaluated using model diagnostics. Standard model diagnostics (e.g. residual analyses, retrospective analyses etc) were used as model validation. Vulnerabilities that were not accounted for by the assessment and reference point models were evaluated using exploratory modeling and testing the influence of environmental factors on recruitment dynamics. Additional considerations of vulnerability and productivity are the implications of change in distribution, recruitment and possibly increased natural mortality. Consumption of yellowtail flounder by other fish and mammals may be increasing as predators increase; however, the empirical evidence is lacking to directly support this hypothesis.

The cause of the recent low recruitment was considered the largest uncertainty in this assessment. As a possible mechanism for reduced recent recruitment, the cold pool (i.e. remnant winter water under the summer thermocline) was investigated and modeled explicitly in ASAP. However, it could not fully explain the recent low productivity. The cold pool analyses did show that SSB_{MSY} and MSY tend to decrease in recent years as cold pools have gotten smaller and warmer. Environmental changes may be responsible for some of the changes in the stock which no longer exhibits the abundance throughout its range that was associated with the large recruitments of the 1970's and 1980's. If weak recruitment continues, the stock will not be able return to historically observed levels.

TOR 9. Review, evaluate and report on the status of research recommendations listed in most recent peer reviewed assessment and review panel reports. Identify new research recommendations.

GARM I

- *None was developed*

SAW36

- Explore the use of effort-based and discard/kept ratios for the scallop fisheries
  - *No longer applicable. The adopted approach uses a trip-based allocation approach*

- Analyze the impacts of applying SNE samples to MA landings for years where adequate samples exist for both areas.
  - *No longer applicable. Since SAW 36, the SNE and MA region has been assessed as a single stock and sampling effort has improved in recent years*

- Consider using a forward projection model that allows for error in catch at age, because of the extremely poor sampling in 1999 and more flexible assumptions about selectivity.
  - *Addressed in this assessment. A forward projecting statistical catch at age model is being proposed as the base model for SAW 54.*

- Investigate changes in maturity at age over time.

- Examine mean weights at age from surveys to confirm trends observed in the commercial mean weights.

    - *Addressed in this assessment (See section under 'Growth and Maturity")*

- Incorporate data from the entire stock area for the fall survey calibration index.
    - *Addressed in SAW 36 as well as in this assessment. It was concluded that the trend and magnitude were similar between the two series. SARC36 accepted the analyses conducted with the spatially restricted series to gain benefits of the longer time series. Similar decision was made for this assessment.*
    -
- Improve sea sampling coverage for otter trawl and scallop vessels to allow for better estimation of discards.
    - *No longer applicable. Recent sampling has improved over the previous years. However, sampling on a quarterly time step needs to be explored to determine if sampling is adequate for such temporal resolution.*

- Increase the sampling frequency of SNE-MA yellowtail flounder during the bottom trawl surveys.
    - *No longer applicable. Recent sampling has improved over the previous years. However, sampling on a quarterly time step needs to be explored to determine if sampling is adequate for such temporal resolution.*

- Collect adequate numbers of quarterly commercial samples for length and age composition
    - *Carried forward in this assessment*

GARM II

- Given the large decline in the stock abundance, the Panel noted that changes in maturity would be expected and recommended that this be explored in future assessments.
    - *Updated maturity ogive for in this assessment using the most up to data survey time series*

- Results appear to be sensitive to the 'oldest age' assumption, and alternative methods should be considered for the next benchmark assessment.
    - *No longer applicable. Plus group application was addressed in GARM III and determined a pus group at age 6 was most suitable provided the continued truncation in the age structure*

-

- The NEFSC winter survey is now showing a trend in recent years, and should be included in future ASPIC runs
  - *No longer applicable. Current assessment models are based on age-structured models*

GARM III

- The use of 'windows' of biomass rather than the breakpoint should be explored to create the stanzas in the stock – recruitment relationship. This may better address inconsistencies in rebuilding plans that might arise as the biomass grows from the lower to the higher stanza.

New from SAW 54

- Consider using fine-level stratification to develop discard estimates for scallop rotational areas, especially the Nantucket Lightship Area (NLS), for 2000 and later years.
  - *Completed in this assessment (See TOR 2)*
  - *Previous assessment does not apply any spatial stratification to derive discards rates in the fishery. This assessments adopted discard rates derived from spatially stratifying SNE from the MA region as well as for the open and closed areas in SNE to account for differential in discard rate between open and access areas for the limited access scallop trips.*

- Develop approaches (e.g., hindcast ratios) to develop discard estimates for fishery strata with little to no observer overage
  - *Completed in this assessment (See TOR 2)*
  - *Adopted a blended approach for deriving discard rates (i.e. unstratify for years with low observer coverage and stratify for years with adequate coverage)*

- Update the length-weight parameters used to convert commercial landings (in weight) into numbers of fish. This could be accomplished by expanding existing data collection programs (e.g., Cooperative Research, Industry Based Surveys, NEFSC port sampling) to collect individual fish weights while collecting length and age data. This research recommendation is applicable to numerous species/stocks in the northeast, not just SNE/MA yellowtail flounder.
  - *Partly completed in this assessment based on data available*
  - *This assessment revised the existing LW relationship from over 40 years ago and adopted spring LW relationship as basis for fishery weights to numbers*

- The work on the influence of the cold pool and associated environmental parameters on yellowtail population dynamics has not been fully developed, and merits further research.

- *Explored the application of the cold pool index in this assessment by explicitly incorporating the cold pool index in the ASAP model. Further work will continue to explore the application of environmental data in the assessment.*

- If the volume of commercial landings increases in the future, ensure that adequate samples of the landings are obtained for all market categories on at least a quarterly basis.
  - *Quarterly resolution was not explored in this assessment for deriving fishery catch data.*

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Tables

Table B1. Summary of model inputs and formulations used to assess the Southern New England Mid-Atlantic Southern New England Mid-Atlantic yellowtail flounder over the last ten years.

Year	Meeting	Stock	Model	Starting Year	Catch Data Series		Survey Series				Plus group
					Commercial landings	Commercial discards	NEFSC_Fall	NEFSC_Spring	NEFSC_Winter	Scallop	
2002	GARM I	SNE	VPA	1973	1973-2001	1973-2001	1973-2001	1973-2002	1992-2003	1982-2002	7+
2002	SAW 36	SNE/MA	VPA	1973	1973-2001	1973-2001	1973-2001	1973-2002	1992-2002	1982-2002	8+
2005	GARM II	SNE/MA	VPA	1973	1973-2004	1973-2004	1973-2004	1973-2004	1973-2004	NA	7+
2008	GARM III	SNE/MA	VPA	1973	1973-2007	1973-2007	1973-2007	1973-2007	1973-2007	NA	6+

Table B2. Summary of the results of the Southern New England Mid-Atlantic yellowtail flounder assessments over the last ten years and resulting stock status determinations based on existing biological reference points at the time of the assessment.

Year	Stock	Meeting	SSB (mt) terminal	F-terminal	F avg	Reference Points	SSBMSY (mt)	FMSY	MSY	Stock Status
2002	SNE	GARM I	1900	0.46	F_{avg4-5}	YPR	45,200	0.27	9,000	Overfished and Overfishing is occurring
2002	SNE/MA	SAW 36	1905	0.91	F_{avg4-5}	YPR	69,500	0.26	14,200	Overfished and Overfishing is occurring
2005	SNE/MA	GARM II	694	0.99	F_{avg4-5}	YPR	69,500	0.26	14,200	Overfished and Overfishing is occurring
2008	SNE/MA	GARM III	3508	0.41	F_{avg4-5}	YPR	27,400	0.25	6,100	Overfished and Overfishing is occurring

Table B3. Summary of major regulatory actions that have affected the Southern New England Mid-Atlantic yellowtail flounder fishery since 1978.

<table>
<tr><th></th><th>Management Program</th><th>Closed Areas</th><th>Minimum Codend Mesh Size -SNE/MA Area</th><th>Minimum Fish Size</th><th>Trip Limits</th><th>DAS/Effort Restrictions</th><th>Other</th></tr>
<tr><td>1978</td><td rowspan="3">Open Access/YTF quotas</td><td rowspan="7"></td><td rowspan="16">5.125 in. but numerous small mesh exemptions</td><td rowspan="8">11 in./28 cm.</td><td rowspan="25"></td><td rowspan="16"></td><td rowspan="32">Note that in SNE the fluke fishery allowed smaller mesh than the groundfish fishery in all years.</td></tr>
<tr><td>1979</td></tr>
<tr><td>1980</td></tr>
<tr><td>1981</td><td rowspan="13">Open Access/Gear Restrictions</td></tr>
<tr><td>1982</td></tr>
<tr><td>1983</td></tr>
<tr><td>1984</td></tr>
<tr><td>1985</td><td rowspan="9">Seasonal closed area</td></tr>
<tr><td>1986</td><td rowspan="3">12 in./30.5 cm.</td></tr>
<tr><td>1987</td></tr>
<tr><td>1988</td></tr>
<tr><td>1989</td><td rowspan="24">13 in./33 cm.</td></tr>
<tr><td>1990</td></tr>
<tr><td>1991</td></tr>
<tr><td>1992</td></tr>
<tr><td>1993</td></tr>
<tr><td>1994</td><td rowspan="16">Limited Entry/Amendmen t 5 Effort Control/DAS System</td><td rowspan="19">Nantucket Lightship Closed Area (seasonal 1994; year-round 1995 and later)</td><td rowspan="5">6 inch sq. or dia.</td><td rowspan="2">DAS/Trip Boats</td></tr>
<tr><td>1995</td></tr>
<tr><td>1996</td><td rowspan="6">DAS extended to most vessels</td></tr>
<tr><td>1997</td></tr>
<tr><td>1998</td></tr>
<tr><td>1999</td><td rowspan="3">6.5 in. sq., 6 in. dia.</td></tr>
<tr><td>2000</td></tr>
<tr><td>2001</td></tr>
<tr><td>2002</td><td rowspan="2">6.5 in. sq. or 7 in. dia.</td><td rowspan="2">DAS Reduction</td></tr>
<tr><td>2003</td><td rowspan="3">Mar-June: 250 lbs./DAS; Jul-Feb: 750 lbs/DAS, 3000</td></tr>
<tr><td>2004</td><td rowspan="3">7 in. dia., 6.5 in. sq.</td><td rowspan="2">DAS Reduction</td></tr>
<tr><td>2005</td></tr>
<tr><td>2006</td><td>May, June, Oct, Nov: 250 lb/trip;All other 500 lb/DAS, 2,000 lbs/trip;</td><td rowspan="3">DAS Reduction; differential DAS areas</td></tr>
<tr><td>2007</td><td rowspan="6">6.5 in. sq. or dia.</td><td rowspan="2">250 lbs/DAS, 1,000 lbs./trip</td></tr>
<tr><td>2008</td></tr>
<tr><td>2009</td><td></td><td>DAS Reduction</td></tr>
<tr><td>2010</td><td rowspan="3">Sectors/ACLs</td><td rowspan="2">250 lbs/DAS, 1,500 lbs./trip (non-</td><td rowspan="3">Change in DAS counting</td><td rowspan="3">SNEMA WFL possession prohibited</td></tr>
<tr><td>2011</td></tr>
<tr><td>2012</td><td></td></tr>
</table>

Table B4. Summary of relative percent change in predicted weight for Southern New England Mid-Atlantic yellowtail flounder derived from length-weight relationships. Percent change was calculated as the difference between the Lux (1969) predicted weights and updated survey predicted weights divided by the Lux (1969) predicted weights.

Spring						
Age	1	2	3	4	5	6+
Typical Length_cm	Avg. 5-14	28	32	39	44	46
Lux_SPR_Kg	0.0063	0.1889	0.2994	0.5926	0.8986	1.0476
SNEMA_SPR_Kg	0.0076	0.1861	0.2863	0.5419	0.7997	0.9230
% Change	-20%	1%	4%	9%	11%	12%

Fall						
Age	1	2	3	4	5	6+
Typical Length_cm	24	29	37	40	44	45
Lux_FALL_Kg	0.1278	0.2229	0.4558	0.5731	0.7583	0.8100
SNEMA_FALL_Kg	0.1188	0.2080	0.4279	0.5391	0.7149	0.7641
% Change	7%	7%	6%	6%	6%	6%

Table B5. Summary depicting the number of yellowtail flounder scales sampled from the Northeast Fisheries Science Center (NEFSC) surveys from 1963 to 2011 by survey, stock and age. Scale samples that were not aged have been excluded from this summary.

	Cape Cod Gulf of Maine		Georges Bank		Southern New England Mid-Atlantic	
Age	Fall	Spring	Fall	Spring	Fall	Spring
0	21		153		18	1
1	1120	212	2183	325	2034	399
2	1967	1245	3212	2953	3843	3560
3	1275	1887	3072	3503	2710	4157
4	340	943	1161	1995	1694	3204
5	111	234	398	726	667	1155
6	24	58	113	199	114	541
7	12	25	47	81	38	136
8	4	11	9	21	6	35
9	4	8	6	3	2	9
10	2	2		2	1	3
11		1	1	1		2
12	1	1				
13						
14			1			

Table B6. Summary of the number of the number of female yellowtail flounder maturity samples taken from the Northeast Fisheries Science Center (NEFSC) spring survey from 1973 to 2011 by age.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11	Total
1971	8	27	44	20	10	12	2	1				124
1972	16	76	84	86	51	26	25	5				369
1973	16	96	89	91	55	29	27	5				408
1974	16	172	103	100	58	41	30	6				526
1975	40	214	148	103	63	47	32	8		1		656
1976	73	267	124	107	60	35	32	9	1	1		709
1977	106	289	144	53	23	22	10	5	1	1		654
1978	149	437	310	183	38	31	9	6	2	1	1	1,167
1979	160	463	357	207	49	22	6	5	2	1	1	1,273
1980	136	466	377	225	59	23	5	3	2		1	1,297
1981	97	414	507	215	58	23	3	1	1		1	1,320
1982	56	351	463	231	58	24	2	1	1		1	1,188
1983	15	204	297	97	45	12	2					672
1984	4	156	259	68	33	10	2					532
1985	4	115	210	49	18	3	1					400
1986	14	94	60	39	15	5	1					228
1987	19	143	52	14	11	3	1					243
1988	21	125	174	39	7	3						369
1989	32	75	196	102	26	4						435
1990	34	71	187	116	26	4						438
1991	23	74	191	115	24	2						429
1992	19	26	184	112	28	3						372
1993	16	42	57	89	26	4		1	1			236
1994	5	41	24	31	7	2		1	1			112
1995	5	64	32	24	10	2		1	1			139
1996	8	85	32	26	11	2		1	1			166
1997	9	82	65	34	10	1		1	1			203
1998	8	66	68	33	10							185
1999	8	66	70	31	12							187
2000	9	56	56	28	12							161
2001	7	28	54	24	12							125
2002	6	26	22	17	11		1					83
2003	13	28	20	16	16		2					95
2004	15	44	7	11	12		3	1				93
2005	12	40	23	6	9		3	1				94
2006	10	37	27	17	9		3	1				104
2007	25	60	40	44	31	2	3	1				206
2008	36	108	76	54	52	5	2	1				334
2009	46	111	95	80	63	22	3	1				421
2010	46	102	78	79	63	22	3	1				394
2011	46	102	72	67	61	22	3	1				374
Total	1,388	5,543	5,478	3,083	1,252	468	216	68	15	5	5	17,521

Table B7. Estimates of natural mortality at age from 1973-2011 derived from average catch weights at age using the Lorenzen approach (Lorenzen, 1996)

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1973	0.356	0.311	0.294	0.288	0.281	0.270
1974	0.360	0.318	0.296	0.284	0.276	0.266
1975	0.355	0.327	0.294	0.282	0.277	0.265
1976	0.353	0.329	0.301	0.281	0.275	0.260
1977	0.364	0.330	0.302	0.276	0.267	0.262
1978	0.358	0.337	0.310	0.282	0.261	0.251
1979	0.383	0.325	0.305	0.281	0.259	0.246
1980	0.371	0.346	0.307	0.287	0.263	0.226
1981	0.418	0.325	0.298	0.270	0.251	0.238
1982	0.351	0.360	0.313	0.285	0.260	0.230
1983	0.386	0.333	0.313	0.282	0.256	0.230
1984	0.371	0.339	0.309	0.285	0.259	0.237
1985	0.373	0.331	0.302	0.287	0.266	0.242
1986	0.374	0.333	0.308	0.278	0.264	0.243
1987	0.340	0.342	0.307	0.294	0.269	0.249
1988	0.326	0.338	0.319	0.296	0.280	0.241
1989	0.559	0.296	0.281	0.246	0.224	0.194
1990	0.337	0.390	0.316	0.294	0.249	0.215
1991	0.483	0.312	0.287	0.271	0.240	0.207
1992	0.452	0.341	0.290	0.269	0.245	0.202
1993	0.439	0.347	0.285	0.273	0.251	0.205
1994	0.486	0.326	0.272	0.252	0.243	0.221
1995	0.505	0.342	0.270	0.251	0.231	0.200
1996	0.450	0.343	0.288	0.262	0.243	0.215
1997	0.418	0.359	0.280	0.269	0.251	0.222
1998	0.403	0.342	0.301	0.268	0.256	0.231
1999	0.455	0.338	0.298	0.272	0.255	0.182
2000	0.400	0.350	0.292	0.271	0.251	0.235
2001	0.439	0.325	0.292	0.266	0.249	0.228
2002	0.415	0.345	0.287	0.270	0.246	0.237
2003	0.501	0.323	0.279	0.254	0.235	0.209
2004	0.429	0.359	0.282	0.261	0.246	0.223
2005	0.469	0.334	0.281	0.257	0.240	0.219
2006	0.451	0.352	0.282	0.258	0.240	0.217
2007	0.449	0.344	0.290	0.262	0.242	0.212
2008	0.410	0.358	0.296	0.275	0.256	0.205
2009	0.465	0.326	0.287	0.258	0.245	0.219
2010	0.468	0.339	0.275	0.259	0.239	0.220
2011	0.413	0.357	0.287	0.263	0.252	0.228
Average	0.414	0.338	0.294	0.272	0.254	0.228

Table B8a. Estimates of total catch (mt) of yellowtail flounder from the Southern New England-Mid Atlantic stock. Estimates of both United States (US) and foreign fleet are shown.

Year	U.S. Commercial landings (mt)	U.S. Commercial discards (mt)	Foreign catch (mt)	Total catch (mt)	Percent discards
1935	6,000	2,400	-	8,400	29%
1936	6,800	2,700	-	9,500	28%
1937	7,600	3,000	-	10,600	28%
1938	7,700	3,100	-	10,800	29%
1939	9,500	3,800	-	13,300	29%
1940	14,200	5,700	-	19,900	29%
1941	19,300	7,700	-	27,000	29%
1942	28,400	9,900	-	38,300	26%
1943	18,000	7,300	-	25,300	29%
1944	10,600	4,800	-	15,400	31%
1945	10,400	4,200	-	14,600	29%
1946	10,800	4,400	-	15,200	29%
1947	12,100	4,900	-	17,000	29%
1948	9,900	4,000	-	13,900	29%
1949	4,900	1,900	-	6,800	28%
1950	4,900	1,900	-	6,800	28%
1951	2,900	1,100	-	4,000	28%
1952	3,200	1,200	-	4,400	27%
1953	2,300	800	-	3,100	26%
1954	1,700	600	-	2,300	26%
1955	2,500	900	-	3,400	26%
1956	4,100	1,400	-	5,500	25%
1957	6,200	2,200	-	8,400	26%
1958	9,500	3,600	-	13,100	27%
1959	8,200	3,100	-	11,300	27%
1960	8,800	3,200	-	12,000	27%
1961	13,000	4,700	-	17,700	27%
1962	13,500	5,300	-	18,800	28%
1963	22,600	5,400	200	28,200	19%
1964	21,809	9,500	-	31,309	30%
1965	22,517	7,000	1,400	30,917	23%
1966	22,540	5,300	700	28,540	19%
1967	25,140	7,700	2,800	35,640	22%
1968	25,372	6,300	3,500	35,172	18%
1969	23,686	2,400	18,283	44,369	5%

Table B8b. (Cont'd). Estimates of total catch (mt) of yellowtail flounder from the Southern New England-Mid Atlantic stock. Estimates of both United States (US) and foreign fleet are shown.

Year	U.S. Commercial landings (mt)	U.S. Commercial discards (mt)	Foreign catch (mt)	Total catch (mt)	Percent discards
1970	21,350	4,500	2,618	28,468	16%
1971	15,867	2,200	1,261	19,328	11%
1972	17,574	1,800	3,117	22,491	8%
1973	12,441	1,711	397	14,549	12%
1974	8,284	8,688	116	17,088	51%
1975	3,833	1,896	3	5,732	33%
1976	1,853	1,583	-	3,436	46%
1977	3,335	1,888	-	5,223	36%
1978	3,059	5,026	-	8,085	62%
1979	5,452	4,431	-	9,883	45%
1980	6,300	1,721	-	8,021	21%
1981	5,400	1,207	-	6,607	18%
1982	10,726	5,038	-	15,764	32%
1983	18,500	3,711	-	22,211	17%
1984	10,100	1,125	-	11,225	10%
1985	3,600	1,217	-	4,817	25%
1986	3,548	1,072	-	4,620	23%
1987	1,771	881	-	2,652	33%
1988	994	1,788	-	2,782	64%
1989	2,897	5,452	-	8,349	65%
1990	8,236	9,680	-	17,916	54%
1991	4,113	2,317	-	6,430	36%
1992	1,640	1,055	-	2,695	39%
1993	674	97	-	771	13%
1994	367	367	-	735	50%
1995	200	142	-	343	42%
1996	477	282	-	759	37%
1997	849	373	-	1,222	31%
1998	690	396	-	1,087	36%
1999	1,307	96	-	1,403	7%
2000	1,122	275	-	1,397	20%
2001	1,295	154	-	1,449	11%
2002	792	153	-	945	16%
2003	496	169	-	666	25%
2004	489	130	-	619	21%
2005	242	104	-	346	30%
2006	209	187	-	396	47%
2007	205	296	-	502	59%
2008	192	391	-	583	67%
2009	185	268	-	453	59%
2010	113	177	-	291	61%
2011	245	145	-	390	37%

Table B9. Estimates of Total Landings of Southern New England Mid-Atlantic yellowtail flounder from 1994 to 2011 and the coefficient of variation (CV) associated with the landings allocated procedure (AA tables, Wigley et al. 2008)

Year	Lanndings (mt)	CV
1994	367	0.019
1995	200	0.016
1996	477	0.009
1997	849	0.006
1998	690	0.015
1999	1307	0.009
2000	1122	0.012
2001	1295	0.011
2002	792	0.016
2003	496	0.022
2004	489	0.046
2005	242	0.043
2006	209	0.028
2007	205	0.022
2008	192	0.016
2009	185	0.011
2010	113	0.021
2011	245	0.006

Table B10. Southern New England Mid-Atlantic yellowtail flounder estimated commercial landings (mt) by gear and year from 1994 to 2011

Year	Trawl	Scallop Dredge	Gillnet	Other/ Unknown	Total
1994	324.04	41.60	1.35	0.50	367.49
1995	174.01	14.58	2.18	9.63	200.40
1996	459.29	15.69	0.91	1.31	477.20
1997	824.74	22.24	1.66	0.44	849.07
1998	669.20	16.55	2.50	1.92	690.17
1999	1286.12	14.26	4.19	2.50	1307.08
2000	1109.31	7.20	0.20	5.34	1122.06
2001	1259.48	28.09	4.27	3.57	1295.41
2002	766.23	20.49	2.72	2.49	791.92
2003	492.97	0.60	2.56	0.09	496.22
2004	348.63	0.02	6.56	133.96	489.18
2005	195.88	5.02	1.80	39.45	242.16
2006	175.22	7.51	1.16	25.16	209.05
2007	201.96	0.73	1.51	1.12	205.32
2008	185.85	0.71	1.43	4.29	192.27
2009	171.23	3.49	1.93	8.84	185.50
2010	108.17	2.59	0.68	1.84	113.27
2011	244.20	0.43	0.12	0.45	245.20

Table B11. Southern New England Mid-Atlantic yellowtail flounder percent commercial landings by gear and year from 1994 to 2011.

Year	Trawl	Scallop Dredge	Gillnet	Other/ Unknown	Total
1994	88.2%	11.3%	0.4%	0.1%	100%
1995	86.8%	7.3%	1.1%	4.8%	100%
1996	96.2%	3.3%	0.2%	0.3%	100%
1997	97.1%	2.6%	0.2%	0.1%	100%
1998	97.0%	2.4%	0.4%	0.3%	100%
1999	98.4%	1.1%	0.3%	0.2%	100%
2000	98.9%	0.6%	0.0%	0.5%	100%
2001	97.2%	2.2%	0.3%	0.3%	100%
2002	96.8%	2.6%	0.3%	0.3%	100%
2003	99.3%	0.1%	0.5%	0.0%	100%
2004	71.3%	0.0%	1.3%	27.4%	100%
2005	80.9%	2.1%	0.7%	16.3%	100%
2006	83.8%	3.6%	0.6%	12.0%	100%
2007	98.4%	0.4%	0.7%	0.5%	100%
2008	96.7%	0.4%	0.7%	2.2%	100%
2009	92.3%	1.9%	1.0%	4.8%	100%
2010	95.5%	2.3%	0.6%	1.6%	100%
2011	99.6%	0.2%	0.0%	0.2%	100%

Table B12. Southern New England Mid-Atlantic yellowtail flounder commercial landings (mt) by market category from 1994 to 2011

Year	Unclassified	Large	Small	Medium	Total
1994	21.52	183.91	162.04	0.02	367.49
1995	42.95	65.01	92.33	0.10	200.40
1996	177.50	98.24	201.06	0.39	477.20
1997	532.27	134.25	182.37	0.18	849.07
1998	234.64	168.19	287.15	0.19	690.17
1999	395.86	386.00	525.14	0.08	1307.08
2000	264.31	436.18	421.06	0.51	1122.06
2001	253.95	563.18	478.01	0.27	1295.41
2002	124.17	423.45	242.19	2.11	791.92
2003	85.01	258.48	152.72	0.02	496.22
2004	36.51	348.87	94.11	9.69	489.18
2005	22.58	117.71	85.90	15.98	242.16
2006	14.40	94.14	71.67	28.85	209.05
2007	23.79	63.28	81.67	36.58	205.32
2008	13.11	98.93	55.57	24.66	192.27
2009	19.97	114.03	35.95	15.55	185.50
2010	10.47	58.47	29.37	14.95	113.27
2011	11.60	150.56	57.90	25.14	245.20

Table B13. Southern New England Mid-Atlantic yellowtail flounder percent commercial landings by market category from 1994 to 2011

Year	Unclassified	Large	Small	Medium	Total
1994	5.9%	50.0%	44.1%	0.0%	100%
1995	21.4%	32.4%	46.1%	0.1%	100%
1996	37.2%	20.6%	42.1%	0.1%	100%
1997	62.7%	15.8%	21.5%	0.0%	100%
1998	34.0%	24.4%	41.6%	0.0%	100%
1999	30.3%	29.5%	40.2%	0.0%	100%
2000	23.6%	38.9%	37.5%	0.0%	100%
2001	19.6%	43.5%	36.9%	0.0%	100%
2002	15.7%	53.5%	30.6%	0.3%	100%
2003	17.1%	52.1%	30.8%	0.0%	100%
2004	7.5%	71.3%	19.2%	2.0%	100%
2005	9.3%	48.6%	35.5%	6.6%	100%
2006	6.9%	45.0%	34.3%	13.8%	100%
2007	11.6%	30.8%	39.8%	17.8%	100%
2008	6.8%	51.5%	28.9%	12.8%	100%
2009	10.8%	61.5%	19.4%	8.4%	100%
2010	9.2%	51.6%	25.9%	13.2%	100%
2011	4.7%	61.4%	23.6%	10.3%	100%

Table B14. Total number of length samples derived from commercially landed yellowtail flounder from 1994 to 2011 by market category and calendar half year. Sampling intensity is expressed as lengths per 100 metric tons

	Unclassified		Large		Small				
Year	Half 1	Half2	Half 1	Half2	Half 1	Half2	Total	Landings (mt)	Lengths/100mt
1994			102	170	228	254	754	367.49	205
1995	78						78	200.40	39
1996		129		752		939	1820	477.20	381
1997	277	319	736	328	915	548	3123	849.07	368
1998	92	230	283		596	127	1328	690.17	192
1999	535		1016	84	560	239	2434	1307.08	186
2000	85	51	251	186	555	411	1539	1122.06	137
2001		212	336	413	1227	514	2702	1295.41	209
2002	373	214	643	347	533	329	2439	791.92	308
2003			341	209	515	84	1149	496.22	232
2004	40		277	99			416	489.18	85
2005	47		205	191	61	192	696	242.16	287
2006	73	83	536	452	726	629	2499	209.05	1195
2007	379	720	563	1191	1077	1697	5627	205.32	2741
2008	444	70	1661	1028	2081	1093	6377	192.27	3317
2009	101		1789	307	982	96	3275	185.50	1766
2010			1775	303	1094	67	3239	113.27	2860
2011	207		2044	1439	1097	1000	5787	245.20	2360

Table B15. Total number of Southern New England Mid-Atlantic yellowtail flounder ages sampled from commercial landings from 1994 to 2010 by market category and calendar half year.

	Unclassified		Large		Small		Medium		
Year	Half 1	Half2	Half 1	Half2	Half 1	Half2	Half 1	Half2	Total
1994			28	48	53	75			204
1995	36								36
1996		32		183		241			456
1997	122	33	148	54	193	154	25		729
1998	25		75		200	37			337
1999	24		147	16	120	30			337
2000		23	45	60	129	91			348
2001		48	92	132	321	143			736
2002	75	48	157	18	160	95			553
2003			86	32	143	28			289
2004			57	15					72
2005			43	26	30	29			128
2006	50	25	154	123	251	248			851
2007	114	203	147	280	315	438			1497
2008	135		346	202	531	342			1556
2009	50		386	65	254	30			785
2010			456	47	391	29			923
2011	29		421	262	413	287			1412

Table B16. Observer length sampling aggregated to estimate length composition of commercially landed yellowtail flounder by market category and calendar half from 1994 to 2011.

	Unclassified Market		Large Market		Small Market		Medium Market	
Year	**Half 1**	**Half 2**	**Half 1**	**Half 2**	**Half 1**	**Half 2**	**Half 1**	**Half 2**
1994								
1995								
1996								
1997								
1998								
1999								
2000								
2001								
2002								
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011								

Table B17. Summary of the 2011 Southern New England Mid-Atlantic yellowtail flounder Industry based survey (IBS) biological sampling

Month	Total Length Samples	Total Age Samples	IBS Catch (mt)
Sptember	357	0	0.57
October	1601	127	2.44
November	516	69	0.41
Total	2474	196	3.42

Table B18. Southern New England Mid-Atlantic yellowtail flounder commercial landings at age in thousands of fish.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Total
1973	28	2,650	10,595	7,927	5,226	5,305	917	63	0	0	32,711
1974	130	1,853	4,760	7,325	3,687	1,598	1,474	276	0	0	21,103
1975	176	2,692	1,883	1,120	1,597	792	416	244	0	0	8,920
1976	0	1,474	1,167	327	449	477	230	189	0	0	4,312
1977	68	2,260	4,848	507	278	304	167	178	0	0	8,610
1978	21	4,089	2,157	1,470	247	61	70	48	0	0	8,163
1979	19	5,114	8,548	1,062	438	101	29	1	0	0	15,312
1980	137	4,774	6,577	3,829	512	129	22	16	0	0	15,996
1981	0	3,016	7,259	2,926	1,111	161	17	5	0	0	14,494
1982	56	17,980	13,453	1,855	415	79	7		0	0	33,845
1983	57	14,416	37,156	3,584	385	146	37	9	0	0	55,789
1984	47	3,058	19,038	8,054	878	245	16	14	0	0	31,351
1985	166	5,030	2,155	1,968	1,109	204	38	4	0	0	10,673
1986	40	6,215	3,287	635	356	127	21	1	0	0	10,681
1987	76	1,403	2,349	926	167	55	9	1	0	0	4,986
1988	0	1,213	532	506	134	26	6	0	0	0	2,418
1989	0	5,918	1,513	331	42	3	0	0	0	0	7,807
1990	0	423	18,922	1,536	79	5	0	0	0	0	20,965
1991	0	253	2,343	6,814	156	34	17	0	0	0	9,617
1992	0	301	1,011	2,080	264	14	4	0	0	0	3,675
1993	0	245	432	702	145	4		0	0	0	1,528
1994	0	15	287	239	227	78	5	0	0	0	851
1995	0	0	164	236	51	11	15	0	0	0	476
1996	0	295	624	174	20	14	5	3	0	0	1,135
1997	0	35	1,027	700	92	17	19	5	3	0	1,897
1998	0	656	815	297	44	5	1	0	0	0	1,818
1999	65	344	2,038	459	88	39	0	0	0	0	3,033
2000	2	688	1,244	503	55	9	0	0	0	0	2,501
2001	0	407	1,727	505	136	27	14	2	0	0	2,818
2002	0	240	1,021	411	25	0	0	0	0	0	1,697
2003	0	122	538	352	23	3	2	1	0	0	1,040
2004	0	17	313	278	197	84	6	10	0	0	905
2005	0	101	135	128	87	24	13	0	0	0	488
2006	0	94	165	105	42	27	17	3	2	0	456
2007	0	37	304	97	26	11	4	2	1	0	482
2008	0	4	122	261	20	3	1	1	0	0	411
2009	0	23	38	183	120	5	0	0		0	369
2010	0	3	76	42	70	27	1	0	0	0	218
2011	0	27	129	128	108	68	9	0	0	0	469

Table B19. Southern New England Mid-Atlantic yellowtail flounder sampling coefficient of variation (CV) of landings at age from 1994 to 2011.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1994		77%	13%	14%	17%	27%
1995			17%	11%	23%	22%
1996		27%	10%	27%	29%	31%
1997		33%	10%	13%	33%	39%
1998		11%	10%	13%	39%	76%
1999	91%	28%	9%	20%	38%	48%
2000	131%	15%	9%	12%	45%	77%
2001		20%	6%	10%	24%	37%
2002		17%	8%	16%	44%	
2003		16%	8%	15%	50%	74%
2004		32%	8%	11%	15%	17%
2005		12%	13%	13%	10%	25%
2006		12%	8%	8%	13%	13%
2007		12%	3%	7%	15%	14%
2008		32%	7%	3%	15%	26%
2009		16%	16%	5%	7%	38%
2010		57%	7%	10%	6%	10%
2011		13%	6%	6%	7%	8%

Table B20. Relative difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder commercially landed numbers at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Relative differences were expressed as the ratio of the current assessment numbers at age to the 2008 assessment numbers at age (*ratios less than one indicate fewer fish at age*).

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1994		1.04	1.05	1.08	1.07	1.07
1995			1.97	0.94	1.09	0.88
1996		1.01	1.00	1.00	0.99	0.99
1997		0.90	1.08	1.08	1.08	1.08
1998		1.33	1.06	0.88	0.91	1.10
1999		1.32	0.99	1.20	0.80	5.46
2000	1.07	1.00	1.14	1.08	1.05	1.16
2001		1.04	1.06	1.08	1.09	1.09
2002		1.07	1.08	1.09	1.09	
2003		1.29	1.16	1.16	0.29	0.29
2004		0.09	1.68	1.11	0.75	1.00
2005		1.23	0.91	1.16	1.01	0.98
2006		1.07	1.07	1.08	1.09	1.10
2007		0.97	1.00	1.11	1.19	1.20

Table B21. Mean weights at age (kg) of commercially landed Southern New England Mid-Atlantic yellowtail flounder from 1994 to 2011

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10
1973	0.210	0.295	0.344	0.374	0.382	0.418	0.474	0.640	0.000	0.000
1974	0.203	0.303	0.351	0.396	0.439	0.431	0.477	0.498	0.000	0.000
1975	0.218	0.289	0.376	0.432	0.435	0.457	0.505	0.518	0.000	0.000
1976	0.000	0.301	0.407	0.498	0.499	0.543	0.548	0.603	0.000	0.000
1977	0.215	0.282	0.381	0.504	0.513	0.481	0.586	0.606	0.000	0.000
1978	0.234	0.284	0.383	0.536	0.662	0.686	0.636	0.647	0.000	0.000
1979	0.189	0.300	0.364	0.475	0.590	0.673	0.620	0.830	0.000	0.000
1980	0.205	0.280	0.384	0.500	0.682	0.874	1.132	1.054	0.000	0.000
1981	0.140	0.262	0.342	0.474	0.596	0.669	0.475	0.649	0.000	0.000
1982	0.226	0.263	0.353	0.499	0.660	0.822	0.956	0.000	0.000	0.000
1983	0.175	0.261	0.338	0.496	0.668	0.815	0.834	0.821	0.000	0.000
1984	0.181	0.236	0.295	0.388	0.487	0.652	0.662	0.724	0.000	0.000
1985	0.183	0.258	0.365	0.408	0.504	0.577	0.745	0.867	0.000	0.000
1986	0.186	0.284	0.331	0.463	0.587	0.614	0.804	0.804	0.000	0.000
1987	0.248	0.268	0.353	0.404	0.520	0.587	0.863	0.905	0.000	0.000
1988	0.000	0.293	0.396	0.493	0.611	0.795	0.937	0.000	0.000	0.000
1989	0.000	0.340	0.400	0.555	0.735	0.957	0.000	0.000	0.000	0.000
1990	0.000	0.327	0.377	0.452	0.758	0.884	0.000	0.000	0.000	0.000
1991	0.000	0.336	0.380	0.426	0.698	0.900	0.599	0.000	0.000	0.000
1992	0.000	0.347	0.386	0.460	0.631	0.804	1.375	0.000	0.000	0.000
1993	0.000	0.350	0.430	0.451	0.641	1.040	0.000	0.000	0.000	0.000
1994	0.000	0.306	0.335	0.409	0.511	0.628	0.861	0.000	0.000	0.000
1995	0.000	0.000	0.341	0.404	0.585	0.790	0.750	0.000	0.000	0.000
1996	0.000	0.372	0.412	0.467	0.622	0.703	0.799	0.876	0.000	0.000
1997	0.000	0.313	0.410	0.471	0.591	0.721	0.774	0.806	0.808	0.000
1998	0.000	0.312	0.375	0.506	0.547	0.867	0.859	0.000	0.000	0.000
1999	0.128	0.310	0.400	0.558	0.626	1.705	0.000	0.000	0.000	0.000
2000	0.230	0.343	0.448	0.567	0.668	0.733	0.000	0.000	0.000	0.000
2001	0.000	0.364	0.423	0.571	0.688	0.788	0.839	1.130	0.000	0.000
2002	0.000	0.359	0.441	0.574	0.763	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.356	0.429	0.571	0.712	0.866	0.980	1.130	0.000	0.000
2004	0.000	0.335	0.438	0.548	0.582	0.785	0.924	0.834	0.000	0.000
2005	0.000	0.324	0.436	0.522	0.635	0.699	0.918	0.000	0.000	0.000
2006	0.000	0.310	0.398	0.483	0.608	0.718	0.804	0.817	0.944	1.130
2007	0.000	0.332	0.379	0.488	0.630	0.754	0.815	0.837	0.932	1.331
2008	0.000	0.350	0.406	0.474	0.605	0.765	0.884	2.414	0.763	0.000
2009	0.000	0.353	0.412	0.480	0.584	0.729	0.922	0.859	0.000	0.000
2010	0.000	0.383	0.421	0.484	0.579	0.709	0.857	1.088	1.162	0.000
2011	0.000	0.350	0.431	0.502	0.577	0.681	0.812	0.000	0.000	0.000

Table B22. Absolute difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder commercially landed mean weights at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Absolute difference were expressed as current assessment mean weights at age minus the GARM III estimates of mean weights at age (*negative weights imply lighter fish at age*)

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11
1994	0.00	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	0.00	0.00	0.00	0.00
1995	0.00	0.00	-0.07	-0.05	-0.01	-0.11	-0.09	0.00	0.00	0.00	0.00
1996	0.00	-0.01	0.00	0.00	0.02	0.03	0.04	0.05	0.00	0.00	0.00
1997	0.00	-0.01	-0.03	-0.04	-0.06	-0.08	-0.09	-0.10	-0.08	0.00	0.00
1998	0.00	-0.02	-0.03	-0.03	-0.04	-0.11	-0.11	0.00	0.00	0.00	0.00
1999	0.13	-0.07	-0.03	-0.05	-0.14	0.55	0.00	0.00	0.00	0.00	0.00
2000	-0.02	-0.03	-0.04	-0.06	-0.08	-0.10	0.00	0.00	0.00	0.00	0.00
2001	0.00	-0.02	-0.02	-0.04	-0.07	-0.08	-0.10	-0.17	0.00	0.00	0.00
2002	0.00	-0.02	-0.03	-0.06	-0.09	0.00	0.00	0.00	0.00	0.00	0.00
2003	0.00	-0.03	-0.02	-0.05	0.09	0.13	0.11	-0.18	0.00	0.00	-0.86
2004	0.00	0.00	0.04	0.06	0.01	0.00	0.29	-0.23	-0.92	0.00	0.00
2005	0.00	-0.02	-0.01	-0.02	-0.03	-0.11	0.04	-1.13	0.00	-1.13	0.00
2006	0.00	-0.02	-0.03	-0.04	-0.06	-0.08	-0.09	-0.09	-0.13	-0.17	0.00
2007	0.00	-0.02	-0.02	-0.03	-0.05	-0.08	-0.06	-0.08	-0.11	-0.22	0.00

Table B23. Southern New England Mid-Atlantic yellowtail flounder estimated discards (mt) by gear and estimated coefficient of variation (CV) from 1994 to 2011.

Year	Discards (mt)	CV
1994	367	31%
1995	142	28%
1996	282	25%
1997	373	43%
1998	396	75%
1999	96	39%
2000	275	19%
2001	154	31%
2002	153	24%
2003	169	45%
2004	130	51%
2005	104	31%
2006	187	25%
2007	296	20%
2008	391	14%
2009	268	21%
2010	177	18%
2011	145	14%

Table B24. Southern New England Mid-Atlantic yellowtail flounder discards by gear in mt (Top) and by proportion (Bottom) from 1994 to 2011

Year	Trawl Small Mesh	Trawl Large Mesh	Scallop Dredge and Scallop Trawls	Total
1994	305	3	59	367
1995	2	5	135	142
1996	20	27	236	282
1997	4	172	196	373
1998	9	270	118	396
1999	0	4	92	96
2000	3	0	115	117
2001	20	0	133	154
2002	0	3	149	153
2003	45	17	107	169
2004	4	104	12	121
2005	7	31	51	88
2006	35	50	57	142
2007	18	58	104	180
2008	10	47	135	192
2009	7	165	96	268
2010	18	15	118	151
2011	4	31	110	145

Year	Trawl Small Mesh	Trawl Large Mesh	Scallop Dredge and Scallop Trawls	Total
1994	83%	1%	16%	100%
1995	2%	4%	95%	100%
1996	7%	9%	84%	100%
1997	1%	46%	53%	100%
1998	2%	68%	30%	100%
1999	0%	4%	96%	100%
2000	2%	0%	98%	100%
2001	13%	0%	87%	100%
2002	0%	2%	98%	100%
2003	27%	10%	63%	100%
2004	3%	86%	10%	100%
2005	8%	35%	57%	100%
2006	25%	35%	40%	100%
2007	10%	32%	58%	100%
2008	5%	25%	70%	100%
2009	3%	62%	36%	100%
2010	12%	10%	78%	100%
2011	3%	22%	76%	100%

Table B25. Total number of Southern New England Mid-Atlantic yellowtail flounder trips observed by gear from 1994 to 2011. In 2010-2011, the number of observed trips includes trips observed both at-sea monitors and observers.

Year	Otter Trawl Small Mesh	Otter Trawl Large Mesh	Scallop Dredge_Gen Category Permit	Scallop Dredge_Limited Category Permit	Scallop Trawl
1994	10	6	0	7	0
1995	48	36	0	12	0
1996	42	25	0	22	0
1997	32	10	1	10	0
1998	16	6	4	7	0
1999	27	4	2	8	0
2000	24	14	11	59	0
2001	42	22	0	4	0
2002	39	12	3	8	0
2003	56	44	6	15	0
2004	169	162	14	39	8
2005	179	345	25	36	9
2006	111	158	35	66	1
2007	164	235	69	78	18
2008	102	221	113	113	28
2009	262	231	16	61	1
2010	318	278	39	84	16
2011	265	406	23	90	3

Table B26. Southern New England Mid-Atlantic yellowtail flounder commercial discards at age in thousands of fish.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Total
1973	192	2,982	1,355	52	0	0	0	0	0	0	4,581
1974	731	26,666	796	45	0	0	0	0	0	0	28,238
1975	8,734	1,438	1	10	0	0	0	0	0	0	10,182
1976	214	5,203	14	0	0	0	0	0	0	0	5,431
1977	5,445	2,767	43	0	0	0	0	0	0	0	8,255
1978	8,677	10,102	7	0	0	0	0	0	0	0	18,786
1979	186	14,305	119	0	0	0	0	0	0	0	14,610
1980	869	5,441	18	0	0	0	0	0	0	0	6,328
1981	38	4,013	319	0	0	0	0	0	0	0	4,370
1982	113	17,716	905	3	0	0	0	0	0	0	18,737
1983	2,611	4,872	5,682	18	0	0	0	0	0	0	13,182
1984	470	3,141	951	75	0	0	0	0	0	0	4,638
1985	2,073	3,044	20	0	0	0	0	0	0	0	5,138
1986	423	3,755	39	0	0	0	0	0	0	0	4,217
1987	1,518	2,034	19	0	0	0	0	0	0	0	3,571
1988	5,899	896	4	0	0	0	0	0	0	0	6,799
1989	24	14,002	1,834	131	6	0	0	0	0	0	15,997
1990	192	1,634	23,721	673	11	0	0	0	0	0	26,231
1991	446	1,357	2,826	2,889	12	0	0	0	0	0	7,530
1992	477	1,152	1,086	659	33	0	0	0	0	0	3,407
1993	13	212	15	9	0	0	0	0	0	0	249
1994	196	642	279	187	89	15	0	0	0	0	1,409
1995	1	376	122	41	7	2	2	1	2	0	555
1996	4	218	564	71	12	6	1	1	0	0	877
1997	19	163	549	245	26	2	3	1	0	0	1,008
1998	5	640	390	140	38	12	0	0	0	0	1,225
1999	5	99	104	26	7	1	2	0	0	0	245
2000	19	533	202	60	2	1	1	0	0	0	818
2001	0	97	243	47	4	0	0	0	0	0	390
2002	8	161	148	62	10	1	0	0	0	0	390
2003	3	124	214	67	13	5	3	0	0	0	430
2004	323	175	38	30	8	2	0	0	0	0	576
2005	35	93	61	45	33	7	6	0	0	0	281
2006	57	289	155	59	20	11	10	4	1	0	607
2007	10	268	443	88	21	10	7	3	1	0	851
2008	33	71	373	446	35	2	1	0	0	0	962
2009	16	161	129	150	146	9	1	0	0	0	612
2010	4	71	119	70	98	28	2	0	0	0	392
2011	18	43	83	77	53	36	9	1	0	0	320

Table B27. Relative difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder discarded numbers at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Relative differences were expressed as the ratio of the current assessment numbers at age to the 2008 assessment numbers at age (*ratios less than one indicate fewer fish at age*).

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1994	0.54	0.77	2.21	1.02	1.05	1.77
1995	1.11	1.01	1.07	1.13	1.78	0.87
1996	1.20	0.96	1.13	1.22	1.02	1.14
1997	0.86	0.37	0.97	1.72	1.05	3.51
1998	0.26	0.66	1.07	2.34	11.64	0.45
1999	0.53	0.47	0.64	1.09	0.46	3.52
2000	8.40	2.46	2.01	1.23	1.06	0.30
2001		7.19	4.24	5.12	4.25	
2002	7.89	6.30	7.26	5.62	4.99	2.06
2003	1.55	2.07	1.63	1.66	1.27	1.61
2004	81.27	2.17	0.67	0.50	0.16	0.07
2005	0.53	0.65	0.90	1.14	1.05	0.90
2006	2.95	1.29	0.82	1.43	3.65	2.13
2007	1.59	1.30	1.70	1.86	0.95	

Table B28. Mean weights at age (kg) of commercially discarded Southern New England Mid-Atlantic yellowtail flounder from 1994 to 2011

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10
1973	0.210	0.298	0.381	0.420	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.203	0.308	0.359	0.429	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.218	0.290	0.385	0.439	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.228	0.303	0.427	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.215	0.284	0.385	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.234	0.296	0.402	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.189	0.301	0.366	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.206	0.281	0.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1981	0.140	0.262	0.343	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.226	0.263	0.354	0.502	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.175	0.262	0.341	0.499	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.182	0.239	0.298	0.388	0.000	0.000	0.000	0.000	0.000	0.000
1985	0.183	0.264	0.370	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1986	0.186	0.285	0.335	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1987	0.247	0.268	0.361	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1988	0.270	0.293	0.398	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1989	0.311	0.337	0.389	0.546	0.736	0.000	0.000	0.000	0.000	0.000
1990	0.301	0.327	0.378	0.461	0.800	0.000	0.000	0.000	0.000	0.000
1991	0.206	0.248	0.302	0.387	0.413	0.000	0.000	0.000	0.000	0.000
1992	0.167	0.308	0.351	0.354	0.344	0.000	0.000	0.000	0.000	0.000
1993	0.122	0.358	0.430	0.471	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.078	0.246	0.304	0.357	0.393	0.495	0.000	0.000	0.000	0.000
1995	0.076	0.216	0.300	0.384	0.537	0.568	0.799	0.587	0.799	0.000
1996	0.102	0.280	0.315	0.428	0.570	0.686	0.743	0.745	0.000	0.000
1997	0.139	0.236	0.366	0.451	0.558	0.801	0.814	0.952	0.742	0.000
1998	0.160	0.258	0.348	0.464	0.592	0.649	0.000	0.000	0.000	0.000
1999	0.172	0.303	0.395	0.543	0.668	0.845	1.891	0.000	0.000	0.000
2000	0.181	0.289	0.416	0.504	0.641	0.909	0.763	0.000	0.000	0.000
2001	0.000	0.343	0.388	0.523	0.539	0.000	0.000	0.000	0.000	0.000
2002	0.164	0.283	0.415	0.577	0.767	0.679	0.922	0.000	0.000	0.000
2003	0.095	0.267	0.369	0.581	0.742	0.881	1.042	0.000	0.000	0.000
2004	0.136	0.291	0.418	0.463	0.544	0.806	1.106	0.000	0.000	0.000
2005	0.102	0.260	0.365	0.475	0.630	0.746	0.974	0.000	0.000	0.000
2006	0.110	0.230	0.343	0.460	0.606	0.729	0.842	1.025	0.946	1.130
2007	0.111	0.258	0.351	0.452	0.625	0.743	0.905	1.130	1.217	0.000
2008	0.151	0.261	0.382	0.453	0.554	0.767	1.005	1.104	0.763	0.000
2009	0.105	0.269	0.353	0.531	0.617	0.730	1.088	0.859	0.000	0.000
2010	0.099	0.276	0.409	0.460	0.568	0.670	0.917	1.299	0.988	0.000
2011	0.130	0.231	0.378	0.470	0.562	0.690	0.969	1.259	0.000	0.000

Table B29. Absolute difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder discarded mean weights at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Absolute difference were expressed as current assessment mean weights at age minus the GARM III estimates of mean weights at age (*negative values imply lighter fish at age*)

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11
1994	-0.05	0.05	-0.04	-0.04	0.00	0.06	-0.64	0.00	0.00	0.00	0.00
1995	0.00	-0.01	-0.02	-0.02	-0.04	-0.07	-0.10	-0.06	-0.10	0.00	0.00
1996	0.00	-0.02	-0.02	-0.05	-0.06	-0.10	-0.08	-0.08	0.00	0.00	0.00
1997	-0.05	-0.01	0.03	-0.06	-0.16	-0.10	0.08	0.95	0.74	0.00	0.00
1998	-0.01	0.01	0.00	0.05	-0.02	0.02	0.00	0.00	0.00	0.00	0.00
1999	-0.03	-0.04	-0.04	-0.05	-0.13	0.06	1.89	0.00	0.00	0.00	0.00
2000	0.11	0.02	-0.01	-0.08	-0.09	-0.06	-0.05	0.00	0.00	0.00	0.00
2001	0.00	0.05	0.02	-0.06	-0.06	0.00	0.00	0.00	0.00	0.00	0.00
2002	0.00	-0.01	0.00	0.01	0.07	-0.12	0.92	0.00	0.00	0.00	0.00
2003	-0.01	-0.01	-0.02	-0.04	-0.03	-0.05	-0.01	0.00	0.00	0.00	0.00
2004	-0.02	0.00	0.00	-0.03	-0.03	0.14	0.36	-1.02	-0.98	0.00	0.00
2005	0.01	-0.01	-0.01	-0.03	-0.05	-0.09	0.01	-1.12	0.00	-1.63	0.00
2006	-0.01	0.01	-0.02	-0.10	-0.15	-0.08	-0.08	-0.21	0.95	1.13	0.00
2007	-0.01	0.00	-0.01	-0.01	-0.16	0.74	0.91	1.13	1.22	0.00	0.00

Table B30. Total number of length and age samples derived from commercially discarded yellowtail flounder from 1994 to 2011 by gear and calendar half year. Sampling intensity is expressed as lengths per 100 metric tons

	Otter Trawl		Scallop Trawl		Scallop Dredge					
Year	Half 1	Half2	Half 1	Half2	Half 1	Half2	Total Lengths	Total Ages	Discards (mt)	Lengths/100mt
1994		25			6	36	67	507	367.34	18
1995	5	10			30	12	57	334	142.41	40
1996	4	44			62	140	250	747	282.00	89
1997	48	34			98	32	212	1194	372.62	57
1998	8	20			20	49	97	705	396.40	24
1999					39	38	77	822	95.86	80
2000	24	17			65	147	253	606	274.66	92
2001	8				25	1	34	764	154.01	22
2002		16				86	102	767	152.63	67
2003	74	18			91	38	221	511	169.34	131
2004	32	77			3	296	408	199	130.23	313
2005	142	225		7	115	140	629	273	103.60	607
2006	253	120		16	102	362	853	1290	186.83	457
2007	93	133	6	20	323	535	1110	1332	296.45	374
2008	129	64	10	17	587	638	1445	1160	390.93	370
2009	150	145	4		322	201	822	924	267.82	307
2010	77	73	51	12	352	364	929	1307	177.43	524
2011	371	115	12		448	161	1107	1405	144.89	764

Table B31. Observer length sampling aggregated to estimate length composition by commercially discarded yellowtail flounder by gear and calendar half year from 1994 to 2011.

	Large Mesh Otter Trawl			Small Mesh Otter Trawl			Scallop Dredge and Scallop Trawl	
Year	**Half 1**	**Half 2**	**Year**	**Half 1**	**Half 2**	**Year**	**Half 1**	**Half 2**
1994			1994			1994		
1995			1995			1995		
1996			1996			1996		
1997			1997			1997		
1998			1998			1998		
1999			1999			1999		
2000			2000			2000		
2001			2001			2001		
2002			2002			2002		
2003			2003			2003		
2004			2004			2004		
2005			2005			2005		
2006			2006			2006		
2007			2007			2007		
2008			2008			2008		
2009			2009			2009		
2010			2010			2010		
2011			2011			2011		

Table B32. Southern New England Mid-Atlantic yellowtail flounder total catch at age (landings + discards) in thousands of fish.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+	Total
1973	201	5,333	11,815	7,973	5,226	6,286	36,834
1974	788	25,853	5,477	7,366	3,687	3,347	46,517
1975	8,037	3,986	1,884	1,129	1,597	1,452	18,084
1976	193	6,156	1,179	327	449	896	9,200
1977	4,968	4,750	4,886	507	278	649	16,039
1978	7,830	13,181	2,163	1,470	247	179	25,070
1979	186	17,988	8,655	1,062	438	131	28,461
1980	919	9,671	6,593	3,829	512	167	21,691
1981	34	6,627	7,546	2,926	1,111	183	18,427
1982	158	33,925	14,267	1,858	415	86	50,709
1983	2,407	18,801	42,269	3,600	385	192	67,654
1984	470	5,885	19,895	8,121	878	276	35,525
1985	2,032	7,769	2,173	1,968	1,109	246	15,297
1986	421	9,594	3,322	635	356	149	14,476
1987	1,442	3,234	2,366	926	167	65	8,200
1988	5,309	2,020	536	506	134	32	8,537
1989	22	18,520	3,164	449	48	3	22,205
1990	173	1,893	40,271	2,142	89	5	44,573
1991	401	1,475	4,886	9,414	166	51	16,394
1992	429	1,338	1,989	2,674	294	18	6,741
1993	12	436	445	711	145	4	1,752
1994	177	593	539	407	307	96	2,119
1995	1	339	274	273	57	31	976
1996	4	491	1,131	238	31	30	1,924
1997	17	182	1,521	920	115	49	2,804
1998	5	1,232	1,166	423	78	16	2,920
1999	69	433	2,132	482	94	42	3,253
2000	18	1,167	1,426	558	57	10	3,237
2001	0	494	1,946	547	139	43	3,169
2002	7	385	1,154	467	34	1	2,049
2003	3	234	731	413	34	13	1,428
2004	291	174	347	305	204	101	1,423
2005	32	185	190	168	117	49	740
2006	51	354	304	159	61	72	1,002
2007	9	279	703	176	45	36	1,248
2008	30	67	458	662	51	9	1,277
2009	14	168	154	318	252	14	920
2010	3	67	183	105	158	55	571
2011	16	65	204	198	157	118	758

Table B33. Relative difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder commercially catch numbers at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Relative differences were expressed as the ratio of the current assessment numbers at age to the 2008 assessment numbers at age (*ratios less than one indicate fewer fish at age*).

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1994	0.61	0.87	1.44	1.11	1.10	1.14
1995	1.25	1.14	1.57	0.97	1.15	0.89
1996	1.35	1.04	1.11	1.08	1.04	1.05
1997	0.97	0.46	1.09	1.21	1.10	1.19
1998	0.30	0.97	1.10	1.10	1.54	0.63
1999	9.00	1.00	0.98	1.20	0.77	5.32
2000	5.61	1.35	1.22	1.10	1.05	0.84
2001		1.23	1.16	1.15	1.11	1.09
2002	8.88	1.57	1.20	1.21	1.38	2.32
2003	1.74	1.64	1.29	1.23	0.39	0.58
2004	91.42	0.66	1.50	1.02	0.68	0.85
2005	0.59	0.94	0.93	1.18	1.05	0.99
2006	3.32	1.33	1.00	1.22	1.40	1.33
2007	1.79	1.37	1.37	1.41	1.13	2.42

Table B34. Mean weights at age (kg) of commercially caught Southern New England Mid-Atlantic yellowtail flounder from 1994 to 2011

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1973	0.210	0.296	0.348	0.374	0.382	0.428
1974	0.203	0.308	0.352	0.396	0.439	0.457
1975	0.218	0.289	0.376	0.432	0.435	0.481
1976	0.228	0.303	0.408	0.498	0.499	0.557
1977	0.215	0.283	0.381	0.504	0.513	0.542
1978	0.234	0.292	0.383	0.536	0.662	0.656
1979	0.189	0.301	0.364	0.475	0.590	0.662
1980	0.206	0.281	0.384	0.500	0.682	0.925
1981	0.140	0.262	0.342	0.474	0.596	0.650
1982	0.226	0.263	0.353	0.499	0.660	0.833
1983	0.175	0.261	0.339	0.496	0.668	0.819
1984	0.182	0.237	0.295	0.388	0.487	0.656
1985	0.183	0.260	0.365	0.408	0.504	0.608
1986	0.186	0.284	0.331	0.463	0.587	0.642
1987	0.247	0.268	0.353	0.404	0.520	0.631
1988	0.270	0.293	0.396	0.493	0.611	0.821
1989	0.311	0.338	0.394	0.553	0.735	0.957
1990	0.301	0.327	0.378	0.455	0.763	0.884
1991	0.206	0.263	0.339	0.415	0.680	0.800
1992	0.167	0.317	0.369	0.436	0.602	0.918
1993	0.122	0.354	0.430	0.451	0.641	1.040
1994	0.078	0.247	0.321	0.387	0.480	0.622
1995	0.076	0.216	0.325	0.401	0.579	0.758
1996	0.102	0.335	0.368	0.457	0.604	0.740
1997	0.139	0.251	0.396	0.466	0.584	0.768
1998	0.160	0.287	0.367	0.494	0.567	0.726
1999	0.131	0.309	0.400	0.557	0.629	0.760
2000	0.185	0.321	0.444	0.561	0.667	0.752
2001	0.145	0.360	0.419	0.567	0.684	0.824
2002	0.164	0.330	0.438	0.574	0.764	0.751
2003	0.095	0.313	0.413	0.572	0.722	0.945
2004	0.136	0.295	0.436	0.540	0.581	0.799
2005	0.102	0.295	0.415	0.511	0.634	0.795
2006	0.110	0.251	0.373	0.475	0.607	0.783
2007	0.111	0.268	0.363	0.472	0.628	0.834
2008	0.151	0.266	0.388	0.461	0.574	1.077
2009	0.105	0.281	0.367	0.502	0.601	0.753
2010	0.099	0.281	0.414	0.470	0.573	0.702
2011	0.130	0.280	0.412	0.491	0.572	0.717

Table B35. Absolute difference in the estimates of Southern New England Mid-Atlantic yellowtail flounder mean weights at age from the 2008 Groundfish Assessment Review Meeting (GARM III) compared to the current assessment through 2007. Relative differences were expressed as the ratio of the current assessment numbers at age to the 2008 assessment numbers at age (*negative values imply lighter fish at age*).

Bc	-0.05	0.05	-0.03	-0.03	-0.03	-0.05
1995	0.00	-0.01	-0.04	-0.05	-0.02	-0.09
1996	0.00	-0.01	-0.02	-0.01	-0.01	0.01
1997	-0.05	0.00	-0.01	-0.05	-0.08	-0.07
1998	-0.01	0.00	-0.02	-0.03	-0.02	0.02
1999	-0.07	-0.05	-0.03	-0.05	-0.14	-0.36
2000	0.03	-0.03	-0.04	-0.07	-0.08	-0.13
2001	-0.01	-0.02	-0.03	-0.05	-0.07	-0.09
2002	0.00	-0.05	-0.04	-0.05	-0.08	-0.05
2003	-0.01	-0.04	-0.02	-0.05	0.09	0.11
2004	-0.02	-0.03	0.03	0.05	0.00	0.05
2005	0.01	-0.01	-0.01	-0.02	-0.04	-0.04
2006	-0.01	-0.01	-0.02	-0.06	-0.07	-0.07
2007	-0.01	-0.01	-0.02	-0.03	-0.10	-0.04

Table B36. Summary vessels and trawl doors used in the Northeast Fisheries Science Center (NEFSC) surveys from 1963 to 2011

Year	Spring	Autumn	Winter	Door	Gear
1963		Albatross IV		BMV	Yankee 36
1964		Albatross IV		BMV	Yankee 36
1965		Albatross IV		BMV	Yankee 36
1966		Albatross IV		BMV	Yankee 36
1967		Albatross IV		BMV	Yankee 36
1968	Albatross IV	Albatross IV		BMV	Yankee 36
1969	Albatross IV	Albatross IV		BMV	Yankee 36
1970	Albatross IV	Albatross IV		BMV	Yankee 36
1971	Albatross IV	Albatross IV		BMV	Yankee 36
1972	Albatross IV	Albatross IV		BMV	Yankee 36
1973	Albatross IV	Albatross IV		BMV	Yankee 41
1974	Albatross IV	Albatross IV		BMV	Yankee 41
1975	Albatross IV	Albatross IV		BMV	Yankee 41
1976	Albatross IV	Albatross IV		BMV	Yankee 41
1977	Albatross IV	Delaware II		BMV	Yankee 41
1978	Albatross IV	Delaware II		BMV	Yankee 41
1979	Albatross IV/Delaware II	Albatross IV/Delaware II		BMV	Yankee 41
1980	Albatross IV/Delaware II	Delaware II		BMV	Yankee 41
1981	Delaware II	Albatross IV/Delaware II		BMV	Yankee 41
1982	Delaware II	Albatross IV		BMV	Yankee 36
1983	Albatross IV	Albatross IV		BMV	Yankee 36
1984	Albatross IV	Albatross IV		BMV	Yankee 36
1985	Albatross IV	Albatross IV		Polyvalent	Yankee 36
1986	Albatross IV	Albatross IV		Polyvalent	Yankee 36
1987	Albatross IV/Delaware II	Albatross IV		Polyvalent	Yankee 36
1988	Albatross IV	Albatross IV/Delaware II		Polyvalent	Yankee 36
1989	Delaware II	Delaware II		Polyvalent	Yankee 36
1990	Delaware II	Delaware II		Polyvalent	Yankee 36
1991	Delaware II	Delaware II		Polyvalent	Yankee 36
1992	Albatross IV	Albatross IV	Albatross IV/Delaware II	Polyvalent	Yankee 36
1993	Albatross IV	Delaware II	Albatross IV	Polyvalent	Yankee 36
1994	Delaware II	Albatross IV	Delaware II	Polyvalent	Yankee 36
1995	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
1996	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
1997	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
1998	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
1999	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2000	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2001	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2002	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2003	Delaware II	Albatross IV	Delaware II	Polyvalent	Yankee 36
2004	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2005	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2006	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2007	Albatross IV	Albatross IV	Albatross IV	Polyvalent	Yankee 36
2008	Albatross IV	Albatross IV		Polyvalent	Yankee 36
2009	Henry B. Bigelow	Henry B. Bigelow		PolyIce Oval	4 Seam, 3 Bridle
2010	Henry B. Bigelow	Henry B. Bigelow		PolyIce Oval	4 Seam, 3 Bridle
2011	Henry B. Bigelow	Henry B. Bigelow		PolyIce Oval	4 Seam, 3 Bridle

Table B37. Summary of survey calibration coefficients for converting survey index values to Albatross IV, Polyvalent door equivalent units.

Calibration type	Index	Length (cm)	Calibration coefficient	Source
Delaware II to Albatross IV	Biomass (weight)	NA	0.850000	Forrester et al. 1997
	Abundance (numbers)	NA	0.850000	
Yankee 41 to Yankee 36	Biomass (weight)	NA	1.730000	
	Abundance (numbers)	NA	1.760000	
BMV door to Polyvalent door	Biomass (weight)	NA	1.280000	
	Abundance (numbers)	NA	1.220000	
Bigelow to Albatross IV	Biomass_Spring (Weight)	NA	2.244000	Miller et al. 2010
	Biomass _Fall (weight)	NA	2.402000	
	Abundance (numbers)	≤ 20	3.857302	Brooks et al 2010
		21	3.621597	
		22	3.385892	
		23	3.150187	
		24	2.914482	
		25	2.678777	
		26	2.443072	
		27	2.207367	
		≥ 28	1.971662	

Table B38. Summary differences in survey protocol from FSV Albatross IV (2008 and earlier) and FSV Henry B. Bigelow (2009-present). Adapted from Brooks et al (2010)

Measure	FSV Henry Bigelow	FSV Albatross IV
Tow Speed	3.0 kot SOG	3.8 Knots SOG
Tow duration	20 mins	30 mins
Headrope height	3.5 - 4.0 meters	1.0 - 2.0 meters
Ground Gear	Rockhopper Sweep	Roller Sweep
(Cookies, rock hoppers etc)	Total Length - 25.5 meters	Total Length 24.5 meters
	Center - 8.9 meter length, 16" rockhoppers	Center - 5.0 meters length, 16" rollers
	Wings - 8.2 meter each	Wings - 9.75 meters each, 4" cookies
	14" rockhoppers	
Mesh	Poly webbings	Nylon webbing
	Forward portions of trawls (jibs, upper and	Body of trawl = 12.7cm
	lower wing end, 1st & 2nd side panels, 1st	
	1st botom belly) 12cm, 4mm	
	Square aft to codend: 6cm, 2.5mm	Codend - 11.5cm
	Codend: 12cm, 4mm dbl.	Liner (codend and aft portion of top belly) - 1.27cm knotless
	Codend liner: 2.54cm, knotless	
Net design	4 Seam, 3 Bridle	Yankee 36 (recent years)
Door Type	550 kg polyvalent	450 kg polyvalent
Other Coments	Wing end to door distance Distance = 36.5m	Wing end to door distance Distance = 9.00

Table B39. Summary of the Northeast Fisheries Science Center (NEFSC) Southern New England Mid-Atlantic offshore survey strata and number of tow by survey (Spring/Fall/Winter) *The spring survey did not begin until 1968. The winter survey began in 1992 and ended in 2007.

Year	Strata Sampled				Tows Sampled				Proportion Positive Tows		
	Spring	Fall	Winter		Spring	Fall	Winter		Spring	Fall	Winter
1963		6				30				0.77	
1964		6				28				0.79	
1965		6				26				0.81	
1966		6				28				0.82	
1967		6				42				0.88	
1968	9	6			48	44			0.83	0.80	
1969	9	6			56	40			0.89	0.83	
1970	9	6			63	45			0.84	0.87	
1971	9	6			63	53			0.75	0.70	
1972	9	6			59	46			0.83	0.70	
1973	9	6			90	41			0.78	0.37	
1974	9	6			51	40			0.67	0.28	
1975	9	6			55	44			0.53	0.32	
1976	9	6			65	43			0.49	0.40	
1977	9	6			65	40			0.57	0.48	
1978	9	6			63	67			0.57	0.54	
1979	9	6			71	71			0.65	0.56	
1980	9	6			112	39			0.72	0.56	
1981	9	6			54	40			0.69	0.70	
1982	9	6			55	40			0.76	0.55	
1983	9	6			54	40			0.74	0.60	
1984	9	6			54	38			0.63	0.53	
1985	9	6			54	37			0.59	0.30	
1986	9	6			55	39			0.60	0.28	
1987	9	6			56	40			0.34	0.25	
1988	9	6			56	39			0.34	0.49	
1989	9	6			55	40			0.69	0.50	
1990	9	6			55	40			0.64	0.53	
1991	9	6			55	40			0.62	0.45	
1992	9	6	6		54	40	43		0.44	0.15	0.65
1993	9	6	6		54	40	39		0.28	0.25	0.54
1994	9	6	6		55	41	31		0.24	0.27	0.61
1995	9	6	6		55	38	42		0.44	0.29	0.60
1996	9	6	6		57	40	45		0.44	0.20	0.56
1997	9	6	6		55	40	42		0.42	0.43	0.71
1998	9	6	6		55	40	41		0.53	0.50	0.61
1999	9	6	6		55	40	42		0.51	0.28	0.57
2000	9	6	6		55	40	41		0.44	0.28	0.54
2001	9	6	6		55	40	54		0.36	0.28	0.61
2002	9	6	6		55	39	51		0.27	0.41	0.65
2003	9	6	6		50	40	26		0.20	0.23	0.58
2004	9	6	6		55	40	43		0.22	0.20	0.53
2005	9	6	6		55	40	31		0.31	0.48	0.55
2006	9	6	6		55	50	46		0.38	0.30	0.76
2007	9	6	6		55	40	41		0.36	0.18	0.71
2008	9	6			55	40			0.29	0.35	
2009	9	6			72	47			0.53	0.32	
2010	9	6			66	44			0.61	0.36	
2011	9	6			60	42			0.63	0.33	

Table B40. Northeast Fisheries Science Center (NEFSC) spring and fall survey indices and coefficients of variation (CV) from 1963 to 2011 for Southern New England Mid-Atlantic yellowtail flounder. *The spring survey did not begin until 1968. The winter survey began in 1992 and ended in 2007.

Year	Spring				Fall				Winter			
	Mean number/tow	CV	Mean weight/tow (kg)	CV	Mean number/tow	CV	Mean weight/tow (kg)	CV	Mean number/tow	CV	Mean weight/tow (kg)	CV
1963					54.1	0.19	19.1	0.19				
1964					54.8	0.19	18.1	0.20				
1965					51.8	0.35	13.1	0.22				
1966					60.4	0.22	11.6	0.17				
1967					81.9	0.16	18.0	0.14				
1968	102.7	0.16	23.9	0.16	76.0	0.23	16.7	0.20				
1969	81.8	0.13	18.3	0.13	72.5	0.27	17.8	0.28				
1970	62.0	0.15	15.4	0.13	79.3	0.27	20.8	0.26				
1971	50.0	0.13	12.2	0.12	59.2	0.31	11.5	0.29				
1972	51.6	0.17	13.8	0.15	150.5	0.37	40.4	0.37				
1973	27.5	0.12	7.9	0.12	15.1	0.43	4.0	0.38				
1974	11.0	0.22	3.6	0.23	6.3	0.42	2.0	0.42				
1975	2.9	0.19	1.0	0.16	2.9	0.5	0.7	0.50				
1976	3.6	0.21	1.1	0.2	8.7	0.35	2.5	0.35				
1977	4.2	0.29	1.3	0.26	4.6	0.33	1.2	0.36				
1978	11.2	0.18	2.6	0.15	7.8	0.26	2.2	0.26				
1979	3.5	0.22	0.8	0.18	6.9	0.2	2.0	0.20				
1980	8.8	0.13	3.2	0.12	5.3	0.37	1.5	0.37				
1981	16.2	0.19	4.4	0.19	21.4	0.25	4.4	0.23				
1982	26.0	0.19	6.4	0.19	30.5	0.41	7.3	0.40				
1983	18.2	0.15	5.2	0.13	23.6	0.32	5.7	0.31				
1984	5.0	0.18	1.7	0.18	5.6	0.29	1.3	0.29				
1985	3.6	0.26	0.9	0.24	1.2	0.35	0.3	0.37				
1986	4.2	0.13	1.1	0.12	2.7	0.33	0.7	0.34				
1987	1.0	0.24	0.3	0.27	2.0	0.42	0.4	0.46				
1988	1.2	0.26	0.4	0.25	5.0	0.25	0.5	0.28				
1989	10.2	0.18	1.8	0.18	10.3	0.32	2.0	0.32				
1990	15.5	0.21	4.3	0.2	4.8	0.35	1.1	0.31				
1991	6.9	0.14	2.1	0.14	2.3	0.3	0.6	0.27				
1992	2.2	0.20	0.8	0.21	0.5	0.48	0.1	0.48	13.0	0.14	4.8	0.15
1993	0.9	0.23	0.3	0.23	0.5	0.37	0.1	0.31	6.3	0.28	2.1	0.24
1994	0.3	0.29	0.1	0.35	1.5	0.41	0.3	0.40	10.9	0.33	3.3	0.3
1995	1.4	0.20	0.3	0.18	1.2	0.69	0.3	0.69	14.5	0.51	3.5	0.52
1996	2.3	0.25	0.7	0.23	0.9	0.48	0.2	0.43	10.6	0.25	3.3	0.26
1997	2.5	0.35	0.8	0.32	3.1	0.32	0.9	0.33	15.8	0.18	5.7	0.19
1998	3.7	0.23	0.8	0.21	2.7	0.41	0.7	0.42	10.8	0.22	2.8	0.19
1999	3.1	0.13	1.1	0.14	2.0	0.61	0.5	0.59	14.3	0.2	5.2	0.2
2000	2.9	0.18	1.0	0.18	2.2	0.53	0.7	0.52	9.3	0.31	3.0	0.27
2001	1.6	0.24	0.7	0.26	1.2	0.47	0.4	0.51	11.5	0.26	4.8	0.27
2002	1.7	0.37	0.5	0.34	3.0	0.46	1.1	0.48	7.5	0.18	2.6	0.17
2003	0.4	0.36	0.2	0.43	2.3	0.55	0.4	0.55	4.2	0.29	1.5	0.31
2004	0.6	0.36	0.2	0.34	0.3	0.35	0.1	0.46	2.1	0.2	0.8	0.25
2005	0.7	0.25	0.2	0.33	2.6	0.26	0.5	0.32	3.0	0.22	0.9	0.27
2006	2.0	0.38	0.4	0.37	3.5	0.32	0.7	0.33	24.6	0.29	3.8	0.27
2007	1.5	0.20	0.4	0.21	1.7	0.42	0.5	0.42	15.8	0.23	3.9	0.23
2008	1.3	0.58	0.4	0.59	3.3	0.39	0.9	0.41				
2009	2.0	0.29	0.7	0.32	1.7	0.34	0.4	0.33				
2010	2.8	0.12	0.8	0.13	12.3	0.52	3.7	0.53				
2011	2.3	0.17	0.7	0.17	1.7	0.68	0.6	0.73				

Table B41. Northeast Fisheries Science Center (NEFSC) spring survey minimum swept area numbers (000's) at age. These values were computed from offshore Strata 1, 2, 5, 6, 9, 10, 69, 73 and 74 which combined have an area of 18718 square nautical miles. To convert these values to catch/tow in numbers or biomass divide by 1671.25 (=1000*18718/0.0112, where 1000 is the units in the VPA, 18718 is the survey area, and 0.0112 is the area swept by a single tow).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	Total
1973	913	5,523	15,093	8,483	6,581	9,401	45,993
1974	592	2,508	2,956	5,700	3,477	3,087	18,319
1975	414	1,513	451	585	1,050	826	4,839
1976	19	4,301	580	279	265	500	5,943
1977	1,524	1,634	2,882	263	165	458	6,925
1978	3,065	11,880	2,110	901	293	483	18,731
1979	981	2,902	1,546	278	121	61	5,890
1980	666	6,520	4,418	2,786	274	109	14,774
1981	849	18,261	4,744	2,447	587	113	27,000
1982	340	29,951	9,723	2,438	799	273	43,524
1983	66	10,832	17,949	1,220	352	37	30,456
1984	78	924	1,838	4,457	677	423	8,398
1985	446	2,696	678	803	1,193	259	6,074
1986	27	4,835	1,530	395	207	26	7,021
1987	0	144	1,171	278	0	0	1,593
1988	402	596	208	290	491	48	2,035
1989	230	15,926	762	161	0	0	17,078
1990	127	690	21,805	3,138	90	0	25,849
1991	346	844	3,565	5,904	765	85	11,510
1992	33	85	955	2,670	0	0	3,742
1993	27	423	187	738	118	0	1,493
1994	0	382	23	0	97	27	530
1995	26	1,953	114	154	31	115	2,394
1996	0	664	2,178	947	120	0	3,909
1997	88	1,479	1,912	546	112	0	4,137
1998	113	5,040	645	269	61	34	6,163
1999	59	1,087	3,226	583	124	38	5,118
2000	32	1,936	2,478	329	26	0	4,801
2001	0	116	1,935	401	137	38	2,627
2002	82	1,990	393	334	112	0	2,911
2003	52	126	339	179	54	0	750
2004	27	227	488	137	91	32	1,003
2005	246	343	162	113	255	26	1,144
2006	84	2,647	374	177	0	53	3,335
2007	0	963	1,321	146	0	0	2,430
2008	0	83	1,145	802	82	0	2,112
2009	130	776	720	1,100	501	38	3,266
2010	136	1,503	1,693	607	748	53	4,738
2011	298	876	999	1,052	284	319	3,828

Table B42. Northeast Fisheries Science Center (NEFSC) fall survey minimum swept area numbers (000's) at age. These values were computed from offshore Strata 1, 2, 5, 6, 9, 10 which combined have an area of 12867 square nautical miles. To convert these values to catch/tow in numbers or biomass divide by 1148.84 (=1000*12867/0.0112, where 1000 is the units in the VPA, 12867 is the survey area, and 0.0112 is the area swept by a single tow).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	Total
1973	2,069	2,611	5,902	3,233	2,292	1,236	17,343
1974	1,017	1,604	569	2,241	949	690	7,069
1975	1,908	525	193	291	277	144	3,338
1976	2,752	5,893	490	65	102	714	10,017
1977	2,693	1,714	673	39	33	127	5,279
1978	2,478	5,684	353	281	29	89	8,912
1979	1,778	3,911	1,881	287	31	30	7,918
1980	1,374	3,464	902	372	0	0	6,112
1981	11,209	11,315	1,612	235	137	30	24,538
1982	2,826	24,940	6,155	750	334	0	35,006
1983	2,659	15,819	7,852	650	54	37	27,071
1984	2,024	1,787	2,143	468	0	0	6,422
1985	823	416	106	53	0	0	1,398
1986	539	1,869	526	151	17	0	3,102
1987	1,162	565	492	45	38	27	2,330
1988	5,020	365	162	162	15	30	5,754
1989	23	10,224	1,420	169	11	0	11,847
1990	27	1,953	3,318	264	0	0	5,563
1991	552	238	1,501	359	0	0	2,650
1992	192	27	82	327	0	0	629
1993	324	27	127	101	0	0	580
1994	847	513	123	133	61	29	1,705
1995	160	741	296	133	0	61	1,389
1996	515	185	367	0	0	0	1,067
1997	945	596	1,676	311	27	0	3,556
1998	1,023	1,861	142	56	0	26	3,108
1999	1,422	450	321	32	32	0	2,257
2000	57	1,917	348	197	0	26	2,545
2001	448	702	182	82	0	0	1,414
2002	291	2,008	982	161	0	0	3,443
2003	1,344	10	309	263	0	29	1,954
2004	81	112	0	26	55	29	303
2005	2,169	533	213	56	55	0	3,026
2006	1,370	2,472	196	22	0	0	4,060
2007	257	1,286	409	0	30	0	1,983
2008	1,224	452	1,233	768	68	29	3,774
2009	430	720	431	321	23	0	1,925
2010	340	6,589	3,627	2,603	932	0	14,092
2011	243	323	709	366	204	25	1,870

Table B43. Northeast Fisheries Science Center (NEFSC) winter survey percent contribution by strata for Southern New England Mid-Atlantic yellowtail flounder. Northern strata includes 1, 2, 5, 6, and 10 while the Southern Strata includes 69, 73 and 74.

Year	Northern Strata (1, 2, 5, 6, 9, 10)	Southern Strata (69, 73, 74)
1992	90%	10%
1993	92%	8%
1994	94%	6%
1995	54%	**46%**
1996	88%	**12%**
1997	96%	4%
1998	94%	6%
1999	97%	3%
2000	95%	5%
2001	98%	2%
2002	99%	1%
2003	99%	1%
2004	100%	0%
2005	98%	2%
2006	97%	3%
2007	93%	7%

Table B44. Northeast Fisheries Science Center (NEFSC) winter survey minimum swept area numbers (000's) at age. These values were computed from offshore Strata 1, 2, 5, 6, 9, 10 which combined have an area of 12867 square nautical miles. To convert these values to catch/tow in numbers or biomass divide by 1148.84 (=1000*12867/0.0131, where 1000 is the units in the VPA, 12867 is the survey area, and 0.0131 is the area swept by a single tow).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6+	Total
1973	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0
1992	14	2,049	3,496	9,958	1,225	0	16,742
1993	852	2,617	1,199	3,182	385	0	8,235
1994	317	10,046	878	1,943	1,187	577	14,947
1995	125	7,052	3,386	856	334	220	11,972
1996	0	1,568	10,411	1,044	200	137	13,360
1997	190	3,333	13,068	4,187	771	0	21,548
1998	169	10,623	2,275	1,458	158	26	14,709
1999	45	4,071	14,271	957	394	80	19,819
2000	39	6,863	4,114	1,437	92	63	12,608
2001	40	1,279	12,196	2,177	286	123	16,101
2002	17	3,822	3,684	2,925	143	28	10,619
2003	474	996	3,661	759	61	37	5,988
2004	72	1,374	456	842	189	78	3,010
2005	545	1,041	914	779	759	107	4,145
2006	994	25,397	6,569	494	127	205	33,787
2007	46	9,039	10,137	1,615	135	0	20,973
2008	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0

Table B45. Larval indices for Southern New England Mid-Atlantic yellowtail flounder for years during which the 505µm (1977-1987) and the 330 µm (1995-2011) mesh sizes were used. Note that these indices are not comparable and were treated as separate indices in the model.

Year	Abundance (N)		Year	Abundance (N)
1977	33.6		1995	42.2
1978	27.3		2000	59.1
1979	38.2		2001	243.9
1980	112.5		2002	119.8
1981	68.2		2004	77.1
1982	47.3		2005	57.2
1983	166.0		2006	47.3
1984	51.5		2007	48.9
1985	16.6		2009	64.6
1986	22.2		2010	200.2
1987	70.2		2011	222.1

Table B46. Spawning seasons of yellowtail flounder adapted from Cadrin (2010). Range indicated by "-----" and peak by "X"

Stock	Feb	Mar	Apr	May	June	Jul	Aug	Source
Grand Bank					XXX			Pitt, 1970
Scotian Shelf				---------	XXX	---------		Colton et al. 1979
						---------		Scott, 1983
					XXX	---------	---------	Sherman et al. 1987
				---------	---------	---------	---------	Neilson et al. 1988
Cape Cod				---------	---------	---------	---------	Silverman, 1983
			---------	---------	XXX	---------	---------	Sherman et al. 1987
Georges Bank		---------	XXX	XXX	---------			Colton et al. 1979
		---------	---------	---------	---------	---------	---------	Berrien, 1981
			---------	---------	---------	---------	---------	Silverman, 1983
			---------	XXX	XXX	---------	---------	Sherman et al. 1987
Southern New England		---------	---------	XXX	---------	---------	---------	Smith et al. 1975
		---------	XXX	XXX	---------			Colton et al. 1979
	---------	---------	---------	---------	---------	---------	---------	Berrien, 1981
			---------	---------	---------	---------	---------	Silverman, 1983
			---------	XXX	XXX	---------	---------	Sherman et al. 1987
Mid-Atlantic Bight		---------	---------	XXX	---------	---------	---------	Smith et al. 1975
		---------	XXX	XXX	---------			Colton et al. 1979
		---------	---------	---------	---------	---------	---------	Berrien, 1981
			---------	XXX	---------	---------	---------	Silverman, 1983
			---------	XXX	XXX	---------	---------	Sherman et al. 1987

Table B47. Estimated growth parameters for yellowtail flounder by stock and survey from data derived from the NEFSC bottom trawl survey from 1963-2011

Stock/Survey	**Linf_cm**	**k**	**t0**
CCGOM_Spring	44.6	0.43	0.23
GB_Spring	41.9	0.73	0.52
SNEMA_Spring	35.6	0.97	0.63
CCGOM_Fall	46.2	0.4	-0.5
GB_Fall	42.9	0.62	-0.26
SNEMA_Fall	35.8	0.84	-0.16

Table B48. Estimates of age at 50% maturity (A50) and length at 50% maturity (L50) of yellowtail adapted from Cadrin 2010. Note Table has been modified to include maturity estimates for CCGOM, GB and SNEMA yellowtail from the NEFSC spring bottom trawl survey from 1968-2011

Stock	A50 female (yr)	A50 male (yr)	L50 female (cm)	L50 male (cm)	Source
Grand Bank	6	5	37	31	Pitt, 1970
	6.3	5	34	28	Walsh and Morgan, 1999
			29	23	Duran et al. 1999
Scotian Shlef	7	7	40	40	Scott, 1954
	3.5	3	26	22	Beachman, 1983
Cape Cod	2.6	2.5	27	27	O'Brien et al. 1993
	3.1	2.6	30	26	Begg et al. 1999a
Cape Cod-Gulf of Maine	2.7	2.2	29.1	24.2	Alade and Cadrin, 2012; SDWGDM SARC54
Georges Bank	1.8	1.3	26	21	O'Brien et al. 1993
	2.3	2	29	21	Begg et al. 1999a
	2.1	1.6	29.3	21.7	Alade and Cadrin, 2012; SDWGDM SARC54
Southern New England	2.5	2.5	32	32	Scott 1954
			27	24	Morse and Morris 1981
	1.7	1.8	26	20	O'Brien et al, 1993
	2.3	2	27	23	Begg et al., 1999a
Mid-Atlantic Bight			25	24	Morse and Morris, 1981
	2.4	2.1	27	22	Begg et al., 1999a
Southern New England/Mid-Atlantic	2	1.6	27.4	22	Alade and Cadrin, 2012; SDWGDM SARC54

Table B49. Summary of Southern New England Mid-Atlantic yellowtail flounder ADAPT-VPA model formulation used to build a ‘bridge’ from GARM III ADAPT-VPA model to the 2011 update. *Note: the model run numbers were used for internal tracking only and don’t necessarily indicate sequential model runs

Run	Model	Software Version	Population estimation	Years	Catch	Natural Mortality	Discard Mortality	Selectivity blocks	Plus Group handling	Time of Spawning	Survey Selectivity	Survey Indices	NEFSC Survey			
													Spring (1973-2011)	Fall (1973-2011)	Winter (1992-2007)	Larval index (1977-2011)
1	VPA	v2.8	Exact	1973-2007	GARM III	Const M = 0.2	100%	N/A	Backward	May	N/A	Unadjusted	6+	6+	6+	None
2	VPA	**v3.2**	Exact	1973-2007	GARM III	Const M = 0.2	100%	N/A	Backward	May	N/A	Unadjusted	6+	6+	6+	None
11	VPA	v3.2	Exact	1973-2007	**Updated commercial catch from 1994-2007 (Revised LW and discard estimation) and updated maturity.**	**Lifetime Lorenzen M rescaled to M = 0.3**	**90%**	N/A	Backward	May	N/A	Updated	6+	6+	6+	None
15b	VPA	v3.2	Exact	1973-2011	Full catch series with with revised catch series specified in Run 11 Catch Stream through 2011	Lifetime Lorenzen M rescaled to M = 0.3	90%	N/A	Backward	May	N/A	Updated	6+	6+	6+	None
20*	VPA	v3.2	Exact	1973-2011	Full catch series as described in Run 15b	**Time series average Lorenzen M rescaled to M = 0.3**	90%	N/A	Backward	May	N/A	Updated; NEFSC Winter Survey (Exclude Southern Strata set)	6+	6+	6+	None

Table B50. Summary Southern New England Mid-Atlantic yellowtail flounder results from the 'bridge building' exercise performed to update the GARM III ADAPT-VPA model to the 2011 update. *Note: the model run numbers were used for internal tracking only and don't necessarily indicate sequential model runs.

Run		1	2	11	15b	**20***
Model description		GARM III; Discard Mortality = 100%	Software update; Discard mortality = 100%	Revised commercial catch from 1994-2007 (Revised LW and discard estimation) and updated maturity; Lifetime Lorenzen M rescaled to M = 0.3; Discard Mortality = 90%	Full catch series with with revised catch series specified in Run 11 Catch Stream through 2011; Discard Mortality = 90%	Full catch series as described in Run 15b. Time series Average Lorenzen M rescaled to M = 0.3; Discard Mortality = 90%; NEFSC Winter Survey (Southern Strata Excluded)
# of Parameters		4	4	4	4	4
RSS		337	337	332	403	403
MSR		0.746	0.746	0.733	0.814	0.818
Terminal year CV's	Age-2	0.51	0.51	0.51	0.65	0.65
	Age-3	0.34	0.34	0.34	0.46	0.47
	Age-4	0.31	0.31	0.31	0.39	0.39
	Age-5	0.37	0.37	0.39	0.19	0.19
Terminal estimates	$F_{4\text{-}5,\,2007}$	0.41	0.41	0.49	NA	NA
	$F_{4\text{-}5,\,2011}$	N/A	N/A	N/A	0.16	0.16
	SSB_{2007}	3,508	3,508	3,048	NA	NA
	SSB_{2011}	N/A	N/A	N/A	3,988	4,044
Retrospective (Mohn's Rho) *7 year peels	$F_{4\text{-}5}$	47%	47%	13%	52%	52%
	SSB	11%	11%	11%	1%	3%
	Age-1 N	46%	46%	37%	28%	32%

Table B51. Summary of Southern New England Mid-Atlantic yellowtail flounder ASAP model configurations including the base model (Run26) and various sensitivity models.

Run	Model	Software Version	Years	Catch	Fishery Selectivity Blocks	Discard Mortality	Natural Mortality	Stock-recruit	Survey Indices	Survey Selectivity	Survey Selectivity Block	NEFSC Survey			
												Spring (1973-2011)	Fall (1973-2011)	Winter (1992-2007)	Larval index (1977-2011)
1	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	None	90%	Const M = 0.2	None	Survey Updated	Fixed at 100% for age 4 only; all other ages estimated	Single Block for all surveys	1-6+	1-6+	1-6+	None
3	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(2 blocks) 1973-1993; 1994-2011	90%	Lifetime Lorenzen M rescaled to M = 0.3	None	Survey Updated	Fixed at 100% for age 4 only; all other ages estimated	Single Block for all surveys	1-6+	1-6+	1-6+	None
6	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(4 blocks) 1973-1985; 1986-1988; 1989-1993; 1994-2011	90%	Lifetime Lorenzen M rescaled to M = 0.3	None	Survey Updated	Fixed at 100% for ages 4+; estimates ages 1-3 (Flat topped)	Single Block for all surveys	1-6+	1-6+	1-6+	None
8	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(4 blocks) 1973-1985; 1986-1988; 1989-1993; 1994-2011	90%	Time series average Lorenzen M rescaled to M = 0.3	None	Survey Updated	same as Run 6	Single Block for all surveys	1-6+	1-6+	1-6+	None
16	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(6 blocks) 1973-1977; 1978-1985; 1986-1988; 1989-1993; 1994-2001; 2002-2011	90%	Time series average Lorenzen M rescaled to M = 0.3	None	Survey Updated; Winter (Southern strata excluded)	same as Run 6	Single Block for all surveys	1-6+	1-6+	1-6+	None
20	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(6 blocks) 1973-1977; 1978-1985; 1986-1988; 1989-1993; 1994-2001; 2002-2011	90%	Time series average Lorenzen M rescaled to M = 0.3	None	Survey Updated; Winter (Southern strata excluded)	Run 6 Specification; Larval survey 100% at ages 2+	Single Block for all surveys	1-6+	1-6+	1-6+	Total, tuned to ages 2+
22	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(6 blocks) 1973-1977; 1978-1985; 1986-1988; 1989-1993; 1994-2001; 2002-2011	90%	Time series average Lorenzen M rescaled to M = 0.3	None	Survey Updated; Winter (Southern strata excluded)	Run 6 Specification; Larval survey 100% at ages 2+	2 Blocks Larval survey 1977-1987; 1988-2011	1-6+	1-6+	1-6+	Total, tuned to ages 2+
26*	ASAP	v2.0.21 Intermediate Release	1973-2011	Single fleet with revised series (1994-2011)	(6 blocks) 1973-1977; 1978-1985; 1986-1988; 1989-1993; 1994-2001; 2002-2011	90%	Time series average Lorenzen M rescaled to M = 0.3	None	Survey Updated; Winter (Southern strata excluded)	Run 6 Specification; Larval survey 100% at ages 2+	2 Blocks Larval survey 1977-1987; 1988-2011	1-6+	1-6+	1-6+	Total, tuned to ages 2+

Table B52a. Summary of the Southern New England Mid-Atlantic yellowtail flounder model fit from the ASAP runs and various sensitivity analyses

Run		1	3	6	8	16
Model description		Start year in 1973; 6+ age group; NO fishery selectivity block; fishery selectivity fixed ages 4+; survey selectivity fixed age 4 ONLY (possible dome); recruitment (geometric mean); Lifetime M rescaled to 0.3	Start year in 1973; 6+ age group; fishery selectivity blocks = 2; fishery selectivity fixed ages 4+; survey selectivity fixed age 4 ONLY (possible dome); recruitment (geometric mean); Lifetime M rescaled to 0.3	Start year in 1973; 6+ age group; fishery selectivity blocks = 4; fishery selectivity fixed ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Lifetime M rescaled to 0.3	Start year in 1973; 6+ age group; fishery selectivity blocks = 4; fishery selectivity fixed ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Time series average M rescaled to 0.3	Start year in 1973; 6+ age group; fishery selectivity blocks = 6; fishery selectivity = ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Time series average M rescaled to 0.3; Winter Survey (No southern strata)
# of Parameters		105	108	108	108	114
Objective function		4804	4729	4704	4703	4675
Components of Objective function	Survey age comp.	1195	1180	1175	1175	1174
	Catch age comp.	3674	3619	3594	3592	3568
	index fit total	13	9	11	12	10
	catch total	-77	-78	-77	-77	-76
	Recr_Devs	NA	NA	NA	NA	NA
RMSE	catch total	0.80	0.78	0.82	0.82	0.83
	Index 1 = Winter	1.55	1.56	1.55	1.56	1.50
	Index2 = Spring	1.78	1.76	1.78	1.78	1.78
	Index 3 = Fall	1.67	1.63	1.65	1.65	1.64
	Index 4 = larval 77-11	NA	NA	NA	NA	NA
	Index 4 = larval 77-87	NA	NA	NA	NA	NA
	Index 5 = larval (88-11)	NA	NA	NA	NA	NA
	Index Total	1.70	1.67	1.69	1.69	1.68
	Recr_devs	NA	NA	NA	NA	NA
SSB (mt), 2011		3,844	4,020	4,355	4,303	4,223
F Avg4-5, 2011		0.11	0.12	0.12	0.12	0.11

Table B52b (Cont'd). Summary of the Southern New England Mid-Atlantic yellowtail flounder model fit from the ASAP runs and various sensitivity analyses

Run		20	22	**26***	28
Model description		Start year in 1973; 6+ age group; fishery selectivity blocks = 6; fishery selectivity = ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Time series average M rescaled to 0.3; Winter Survey (No southern strata); Include larval index	Start year in 1973; 6+ age group; fishery selectivity blocks = 6; fishery selectivity = ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Time series average M rescaled to 0.3; Winter Survey (No southern strata); split larval index (87/88)	Start year in 1973; 6+ age group; fishery selectivity blocks = 6; fishery selectivity = ages 4+; survey selectivity fixed ages 4+ (flat topped); recruitment (geometric mean); Time series average M rescaled to 0.3; Winter Survey (No southern strata); split larval index (87/88); Inrease CV on all surveys (0.1)	Start year in 1973; 6+ age group; fishery selectivity blocks = 6; fishery selectivity = ages 4+; survey selectivity fixed ages 4+ (flat topped); Time series average M rescaled to 0.3; Winter Survey (No southern strata); split larval index (87/88); recruitment (B-H) with Cold-pool index as a covariate; Inrease CV on all surveys (0.1)
# of Parameters		115	116	116	118
Objective function		5644	4683	4640	4654
Components of Objective function	Survey age comp.	1228	1173	1172	1172
	Catch age comp.	3694	3565	3560	3559
	index fit total	724	21	-8	-7
	catch total	-3	-77	-84	-84
	Recr_Devs	NA	NA	NA	13
RMSE	catch total	2.11	0.82	0.54	0.55
	Index 1 = Winter	2.32	1.53	1.13	1.14
	Index2 = Spring	3.13	1.81	1.38	1.4
	Index 3 = Fall	1.91	1.65	1.34	1.34
	Index 4 = larval 77-11	7.30	NA	NA	NA
	Index 4 = larval 77-87	NA	1.68	1.36	1.33
	Index 5 = larval (88-11)	NA	1.37	1.14	1.15
	Index Total	3.92	1.67	1.31	1.32
	Recr_devs	NA	NA	NA	1.02
SSB (mt), 2011		11,075	3,662	3,873	4,127
F Avg4-5, 2011		0.04	0.13	0.12	0.12

Table B53. Southern New England Mid-Atlantic yellowtail flounder January 1 biomass (mt) and spawning stock biomass (mt) from 1973 to 2011 as estimated from ASAP base model Run 26

Year	January 1 biomass (mt)	SSB (mt)
1973	40,940	21,760
1974	25,041	9,738
1975	14,784	3,422
1976	12,423	4,147
1977	20,528	4,460
1978	28,457	5,809
1979	26,678	7,978
1980	28,793	8,983
1981	36,959	10,464
1982	52,075	17,896
1983	38,551	17,077
1984	18,211	5,904
1985	11,100	2,668
1986	8,238	2,826
1987	7,989	2,042
1988	62,098	2,818
1989	33,838	11,553
1990	22,968	11,103
1991	9,307	4,065
1992	3,276	1,685
1993	1,887	1,024
1994	1,645	621
1995	1,522	821
1996	2,360	1,504
1997	3,476	1,349
1998	3,428	1,427
1999	3,778	1,668
2000	3,749	1,670
2001	3,381	1,561
2002	2,338	1,272
2003	1,649	1,030
2004	1,399	711
2005	1,665	686
2006	2,340	1,127
2007	2,878	1,920
2008	3,703	2,336
2009	3,919	2,648
2010	4,262	3,319
2011	5,305	3,873

Table B54. Southern New England Mid-Atlantic yellowtail flounder average (ages 4-5) fishing mortality from 1973 to 2011 as estimated from ASAP base model Run 26

	Average F 4-5		
Year	Unweighted	N-Weighted	B-Weighted
1973	0.617	0.617	0.617
1974	1.471	1.471	1.471
1975	1.116	1.116	1.116
1976	0.488	0.488	0.488
1977	0.768	0.768	0.768
1978	1.354	1.354	1.354
1979	1.237	1.237	1.237
1980	0.894	0.894	0.894
1981	0.646	0.646	0.646
1982	0.896	0.896	0.896
1983	1.353	1.353	1.353
1984	1.901	1.901	1.901
1985	1.734	1.734	1.734
1986	1.160	1.160	1.160
1987	1.040	1.040	1.040
1988	0.377	0.377	0.377
1989	1.679	1.679	1.679
1990	3.115	3.115	3.115
1991	2.340	2.340	2.340
1992	2.041	2.041	2.041
1993	1.041	1.041	1.041
1994	1.711	1.711	1.711
1995	0.767	0.767	0.767
1996	0.854	0.854	0.854
1997	1.457	1.457	1.457
1998	1.458	1.458	1.458
1999	1.570	1.570	1.570
2000	1.515	1.515	1.515
2001	1.755	1.755	1.755
2002	1.177	1.177	1.177
2003	0.885	0.885	0.885
2004	1.028	1.028	1.028
2005	0.709	0.709	0.709
2006	0.634	0.634	0.634
2007	0.431	0.431	0.431
2008	0.332	0.332	0.332
2009	0.213	0.213	0.213
2010	0.112	0.112	0.112
2011	0.121	0.121	0.121

Table B55. Southern New England Mid-Atlantic yellowtail flounder fishing mortality at age from 1973 to 2011 as estimated from the ASAP base model Run 26

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1973	0.08	0.58	0.60	0.62	0.62	0.62
1974	0.20	1.39	1.43	1.47	1.47	1.47
1975	0.15	1.05	1.09	1.12	1.12	1.12
1976	0.07	0.46	0.47	0.49	0.49	0.49
1977	0.10	0.73	0.75	0.77	0.77	0.77
1978	0.04	0.58	1.23	1.35	1.35	1.35
1979	0.04	0.53	1.12	1.24	1.24	1.24
1980	0.03	0.38	0.81	0.89	0.89	0.89
1981	0.02	0.28	0.59	0.65	0.65	0.65
1982	0.03	0.38	0.81	0.90	0.90	0.90
1983	0.04	0.58	1.23	1.35	1.35	1.35
1984	0.06	0.81	1.73	1.90	1.90	1.90
1985	0.06	0.74	1.57	1.73	1.73	1.73
1986	0.11	0.93	0.97	1.16	1.16	1.16
1987	0.10	0.84	0.87	1.04	1.04	1.04
1988	0.04	0.30	0.32	0.38	0.38	0.38
1989	0.03	0.30	0.70	1.68	1.68	1.68
1990	0.06	0.56	1.29	3.11	3.11	3.11
1991	0.04	0.42	0.97	2.34	2.34	2.34
1992	0.04	0.37	0.85	2.04	2.04	2.04
1993	0.02	0.19	0.43	1.04	1.04	1.04
1994	0.01	0.22	1.08	1.71	1.71	1.71
1995	0.00	0.10	0.48	0.77	0.77	0.77
1996	0.00	0.11	0.54	0.85	0.85	0.85
1997	0.01	0.19	0.92	1.46	1.46	1.46
1998	0.01	0.19	0.92	1.46	1.46	1.46
1999	0.01	0.20	0.99	1.57	1.57	1.57
2000	0.01	0.19	0.96	1.52	1.52	1.52
2001	0.01	0.23	1.11	1.75	1.75	1.75
2002	0.02	0.19	0.70	1.18	1.18	1.18
2003	0.02	0.14	0.53	0.88	0.88	0.88
2004	0.02	0.16	0.61	1.03	1.03	1.03
2005	0.01	0.11	0.42	0.71	0.71	0.71
2006	0.01	0.10	0.38	0.63	0.63	0.63
2007	0.01	0.07	0.26	0.43	0.43	0.43
2008	0.01	0.05	0.20	0.33	0.33	0.33
2009	0.00	0.03	0.13	0.21	0.21	0.21
2010	0.00	0.02	0.07	0.11	0.11	0.11
2011	0.00	0.02	0.07	0.12	0.12	0.12

Table B56. Southern New England Mid-Atlantic yellowtail flounder January 1 numbers at age (000's) from 1973 to 2011 as estimated from the ASAP base model Run 26.

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6+
1973	41,676	22,142	36,195	18,955	10,919	12,298
1974	15,134	25,596	8,832	14,767	7,767	9,825
1975	43,352	8,292	4,558	1,570	2,577	3,173
1976	18,597	24,908	2,065	1,145	391	1,479
1977	67,922	11,621	11,225	955	534	906
1978	70,610	40,884	4,020	3,955	337	525
1979	54,614	45,054	16,404	875	776	175
1980	66,932	34,981	19,000	3,970	193	215
1981	178,114	43,354	17,075	6,278	1,234	131
1982	84,812	116,314	23,527	7,069	2,501	555
1983	19,611	54,932	56,721	7,757	2,191	970
1984	25,499	12,514	22,048	12,356	1,523	638
1985	31,703	15,981	3,976	2,920	1,403	252
1986	9,652	19,978	5,453	613	392	227
1987	18,486	5,756	5,620	1,531	146	152
1988	190,454	11,152	1,783	1,745	411	82
1989	43,348	122,489	5,886	966	909	263
1990	12,046	28,003	64,615	2,180	137	170
1991	3,963	7,572	11,394	13,181	74	11
1992	3,318	2,528	3,544	3,207	964	6
1993	3,670	2,129	1,249	1,129	316	98
1994	7,961	2,400	1,260	603	303	114
1995	6,907	5,276	1,376	318	83	59
1996	5,019	4,594	3,416	630	112	51
1997	11,458	3,337	2,941	1,481	204	54
1998	6,549	7,601	1,977	871	262	47
1999	10,026	4,344	4,503	585	154	56
2000	5,846	6,648	2,537	1,242	92	34
2001	4,537	3,877	3,910	724	207	22
2002	2,069	3,006	2,211	959	95	31
2003	1,909	1,349	1,782	816	225	30
2004	3,248	1,252	838	782	256	82
2005	9,478	2,125	760	338	212	94
2006	7,954	6,238	1,357	370	126	118
2007	4,207	5,242	4,030	692	149	101
2008	7,496	2,783	3,498	2,319	341	127
2009	7,860	4,968	1,887	2,135	1,264	262
2010	5,156	5,222	3,432	1,236	1,311	959
2011	8,173	3,432	3,666	2,388	840	1,588

Table B57. Retrospective Rho statistics for Southern New England Mid-Atlantic yellowtail flounder $F_{ages4-5}$, SSB and Age 1 recruitment using 7-year peels.

Year	2004	2005	2006	2007	2008	2009	2010	Min	Max	Mohn's Rho (7 year Peel)
F4-5	0.26	-0.27	-0.46	-0.31	-0.25	0.00	-0.09	-0.46	0.26	-0.16
SSB	-0.29	0.26	0.56	0.21	0.20	-0.04	0.11	-0.29	0.56	0.14
N Age 1	0.63	-0.16	0.44	-0.41	0.30	-0.29	-0.49	-0.49	0.63	0.00
N Age 2	-0.10	0.42	0.41	0.18	-0.37	0.03	0.14	-0.37	0.42	0.10
N Age 3	-0.27	0.09	0.52	0.11	0.17	-0.30	0.16	-0.30	0.52	0.07
N Age 4	-0.29	0.04	0.43	0.30	0.25	-0.03	-0.09	-0.29	0.43	0.09
N Age 5	-0.08	0.19	0.55	0.44	0.38	0.09	0.12	-0.08	0.55	0.24
N Age 6	0.35	0.40	0.77	0.71	0.53	0.15	0.13	0.13	0.77	0.44

Table B58. Summary statistics for fit of standard Beverton Holt Stock Recruitment Models and Environmentally Explicit Beverton Holt Stock Recruitment Models. Recruitment was log-transformed prior to use in the stock recruitment model.

Assessment Model	Stock Recruiment Model	AICc	AIC weight
GARM III	Standard BH Model	16.86	0.1
	Environmental BH Model	12.58	0.9
2012 VPA	Standard BH Model	5.87	0.15
	Environmental BH Model	2.43	0.85
2012 ASAP	Standard BH Model	5.91	0.04
	Environmental BH Model	-0.39	0.96

Table B59. Cold Pool Index Derived from 15 Measures of Cold Pool Magnitude and Area

Year	Cold Pool Index (PCA1 through 2007)	Cold Pool Index (PCA1 through 2010)
1973	2.9319	2.9953
1974	3.0977	2.9576
1975	1.0994	0.9272
1976	-0.3608	-0.5362
1977	1.3321	1.0362
1978	-2.6783	-2.8946
1979	-1.8562	-2.1015
1980	-0.5846	-0.8412
1981	-2.5168	-2.5674
1982	1.515	0.9275
1983	-0.9842	-1.1852
1984	-1.8064	-1.9438
1985	4.3491	4.1785
1986	2.2052	2.4237
1987	-1.8991	-2.0332
1988	-3.3023	-3.6673
1989	-0.1167	-0.0407
1990	1.2867	1.2379
1991	-0.7287	-0.9686
1992	0.0869	-0.1202
1993	-2.6737	-2.7746
1994	2.1854	1.8481
1995	5.4394	5.284
1996	0.3991	-0.1767
1997	1.2235	0.8876
1998	-3.7895	-3.6034
1999	6.6025	6.4353
2000	4.4595	4.2452
2001	1.8013	1.6367
2002	0.5781	0.3118
2003	1.1521	1.0147
2004	0.502	0.0686
2005	-2.603	-2.8502
2006	5.929	5.6464
2007	-1.2874	-1.4038
2008	NaN	-1.478
2009	NaN	6.6792
2010	NaN	2.2914

Table B60. Inputs to the Southern New England Mid-Atlantic yellowtail flounder yield per recruit (YPR) analysis.

Age	Selectivity on Fishing Mortality	Selectivity on Natural Mortality	Natural Mortality	Stock Weights	Catch Weights	Spawning Stock Weights	Fraction Mature
1	0.02	1.00	0.41	0.08	0.12	0.11	0.01
2	0.16	0.83	0.34	0.18	0.27	0.24	0.47
3	0.60	0.73	0.30	0.32	0.39	0.37	0.98
4	1.00	0.68	0.28	0.43	0.48	0.46	1.00
5	1.00	0.63	0.26	0.53	0.59	0.57	1.00
6+	1.00	0.57	0.23	0.82	0.82	0.82	1.00

Table B61. Biological reference points from the GARM III assessment and this updated assessment for Southern New England Mid-Atlantic yellowtail flounder yellowtail flounder.

Recent Recruitment (Recruitment Series 1990-2010)		
	GARM III	SARC 54
FMSY	0.25	0.32
SSBMSY (mt)	27,400	2,995
MSY (mt)	6,100	773

Two Stanza Recruitment (All Recruitment series 1973-2010)		
	GARM III	SARC 54
FMSY	0.25	0.32
SSBMSY (mt)	27,400	22,615
MSY (mt)	6,100	5,834

Table B62. Summary of median short-term yield and spawning stock biomass projections for Southern New England Mid-Atlantic yellowtail flounder under three assumptions of fishing mortalities (F_0, $F_{75\%\ MSY}$ and F_{MSY}) and assuming the two stanza recruitment condition (i.e. all recruitment time series from 1973-2010)

SSB (mt) - Two Stanza Recruitment									
	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	3,140	4,013	4,988	3,140	4,013	4,988	3,140	4,013	4,988
2013	3,468	4,476	5,791	3,201	4,122	5,365	3,118	4,011	5,230
2014	4,130	5,681	11,632	3,212	4,542	10,224	2,963	4,229	9,814
2015	4,705	8,654	22,492	3,205	5,595	18,904	2,848	4,927	17,943
2016	5,501	13,796	32,564	3,211	8,393	25,285	2,794	6,887	23,405
2017	7,903	20,249	40,179	3,292	12,084	29,292	2,806	9,852	26,617
2018	11,567	26,404	48,441	3,340	15,640	32,945	2,817	12,763	29,448
2019	15,969	32,340	55,039	3,475	18,286	35,208	2,903	15,069	30,949
2020	19,891	37,459	60,761	3,631	20,398	37,223	2,971	16,755	32,648
2021	23,593	41,606	65,345	3,876	21,885	38,803	3,111	17,963	33,748
2022	26,882	44,848	68,769	4,171	23,057	39,327	3,226	18,998	34,248

Yield (mt) - Two Stanza Recruitment									
	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	390	390	390	390	390	390	390	390	390
2013	0	0	0	659	840	1,078	850	1,085	1,393
2014	0	0	0	652	876	1,496	794	1,071	1,873
2015	0	0	0	645	1,032	2,881	752	1,199	3,601
2016	0	0	0	642	1,411	4,472	729	1,560	5,456
2017	0	0	0	657	2,087	5,498	734	2,214	6,484
2018	0	0	0	670	2,843	6,358	735	3,010	7,352
2019	0	0	0	686	3,464	6,886	745	3,679	7,845
2020	0	0	0	720	3,931	7,258	771	4,204	8,200
2021	0	0	0	760	4,268	7,621	799	4,559	8,603
2022	0	0	0	809	4,507	7,795	830	4,825	8,749

Table B63. Summary of median short-term yield and spawning stock biomass projections for Southern New England Mid-Atlantic yellowtail flounder under three assumptions of fishing mortalities (F_0, $F_{75\%\,MSY}$ and F_{MSY}) and assuming recent recruitment conditions (recruitment time series from 1990-2010). *Note that the stock is considered rebuilt under this scenario.*

SSB (mt) - Recent Recruitment									
	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	3,140	4,013	4,988	3,140	4,013	4,988	3,140	4,013	4,988
2013	3,466	4,468	5,758	3,192	4,117	5,344	3,109	4,008	5,205
2014	4,030	5,248	7,130	3,131	4,122	5,733	2,885	3,815	5,353
2015	4,493	5,809	7,658	3,030	4,007	5,354	2,679	3,579	4,803
2016	4,781	6,169	7,961	2,910	3,853	4,981	2,512	3,358	4,354
2017	5,078	6,534	8,447	2,853	3,781	4,874	2,417	3,246	4,190
2018	5,274	6,765	8,544	2,774	3,694	4,682	2,322	3,146	4,010
2019	5,430	6,923	8,574	2,735	3,632	4,550	2,282	3,084	3,909
2020	5,572	7,055	8,604	2,709	3,593	4,515	2,251	3,045	3,873
2021	5,681	7,144	8,704	2,693	3,564	4,492	2,238	3,019	3,857
2022	5,768	7,219	8,745	2,673	3,541	4,459	2,226	3,004	3,827

Yield (mt) - Recent Recruitment									
	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	390	390	390	390	390	390	390	390	390
2013	0	0	0	655	837	1,061	845	1,080	1,369
2014	0	0	0	637	824	1,107	775	1,004	1,357
2015	0	0	0	615	810	1,113	715	946	1,306
2016	0	0	0	585	776	1,020	661	883	1,162
2017	0	0	0	573	759	983	633	848	1,099
2018	0	0	0	558	740	941	608	819	1,044
2019	0	0	0	546	727	914	592	800	1,013
2020	0	0	0	541	718	901	586	790	999
2021	0	0	0	537	710	894	580	780	992
2022	0	0	0	534	706	890	575	776	990

Figures

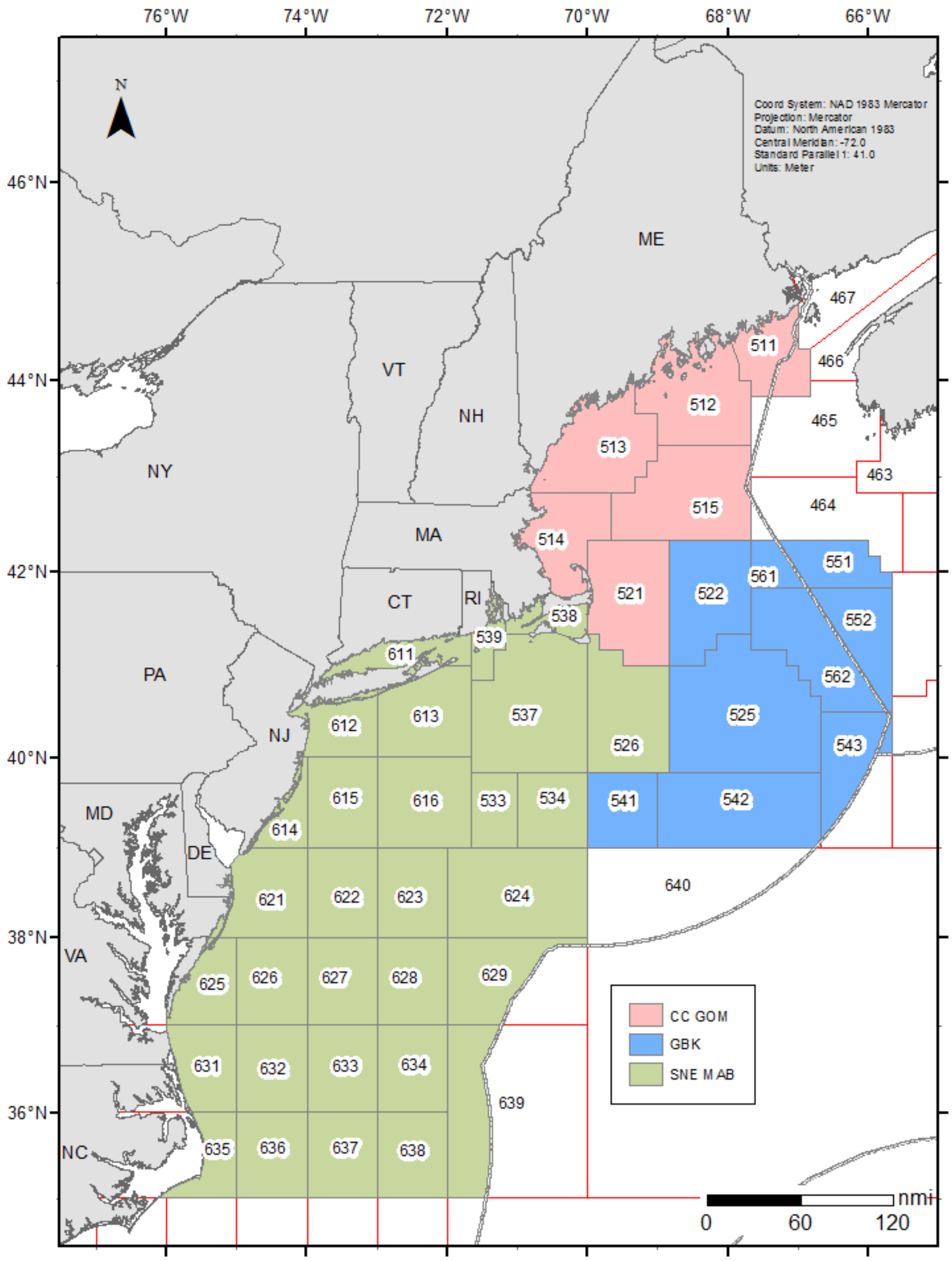


Figure B1. Map of Southern New England Mid-Atlantic yellowtail flounder management and assessment area.

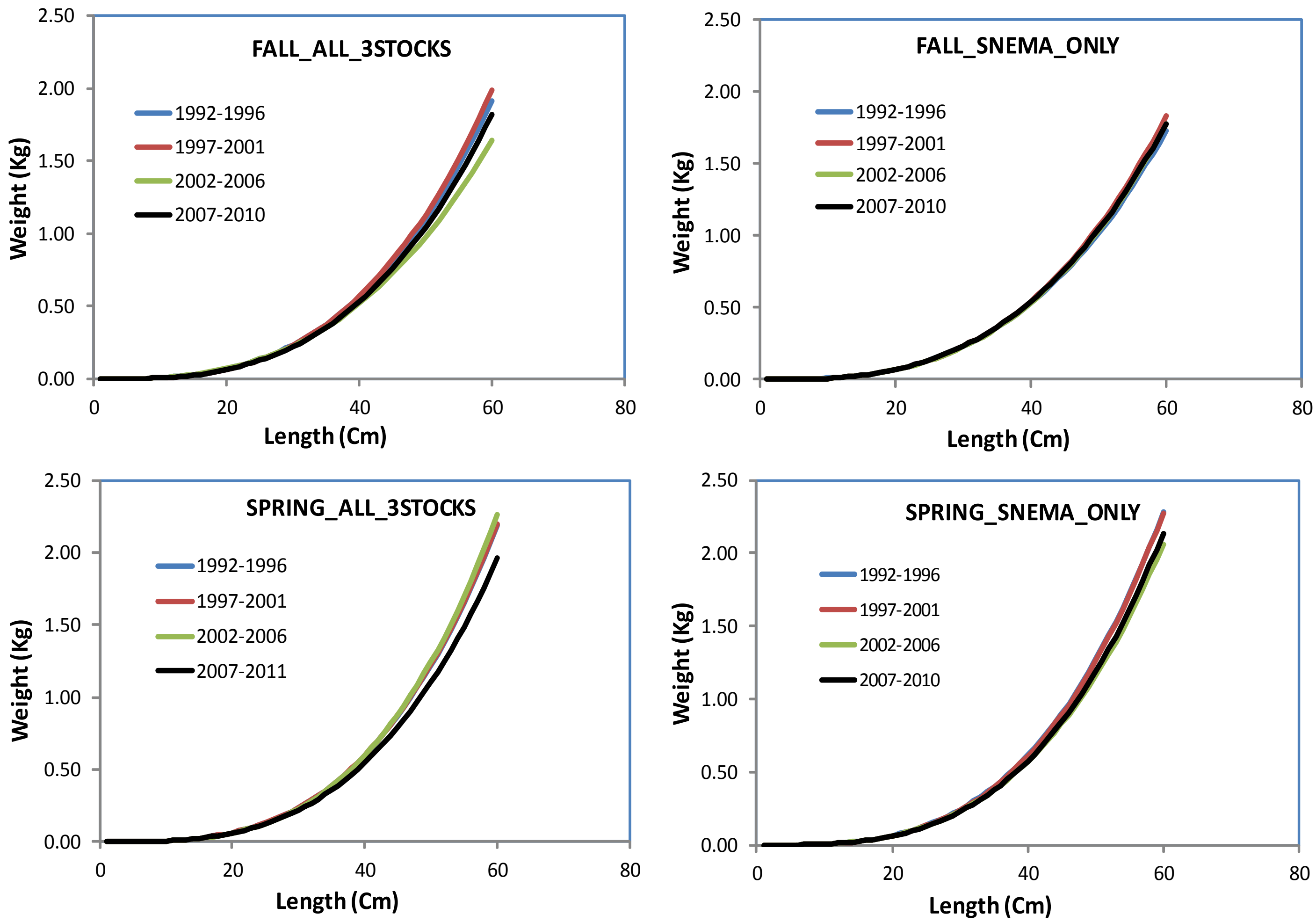
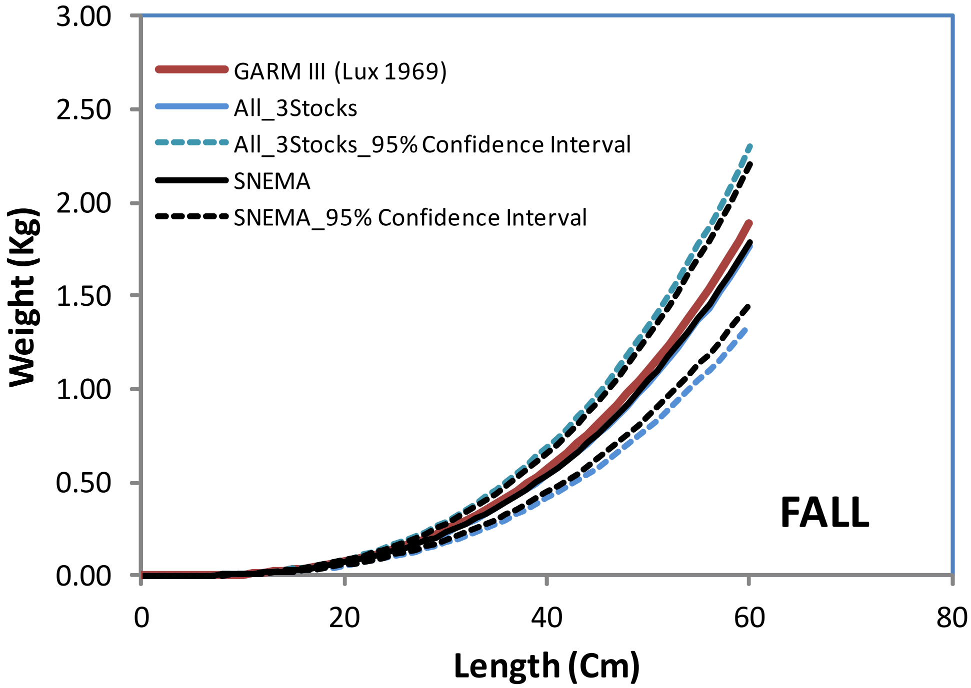


Figure B2.Temporal comparison of seasonal length-weight relationships for all three stocks combined and for ONLY the Southern New England Mid-Atlantic (SNEMA) region by time blocks estimated from the Northeast Fisheries Science Center (NEFSC) survey data



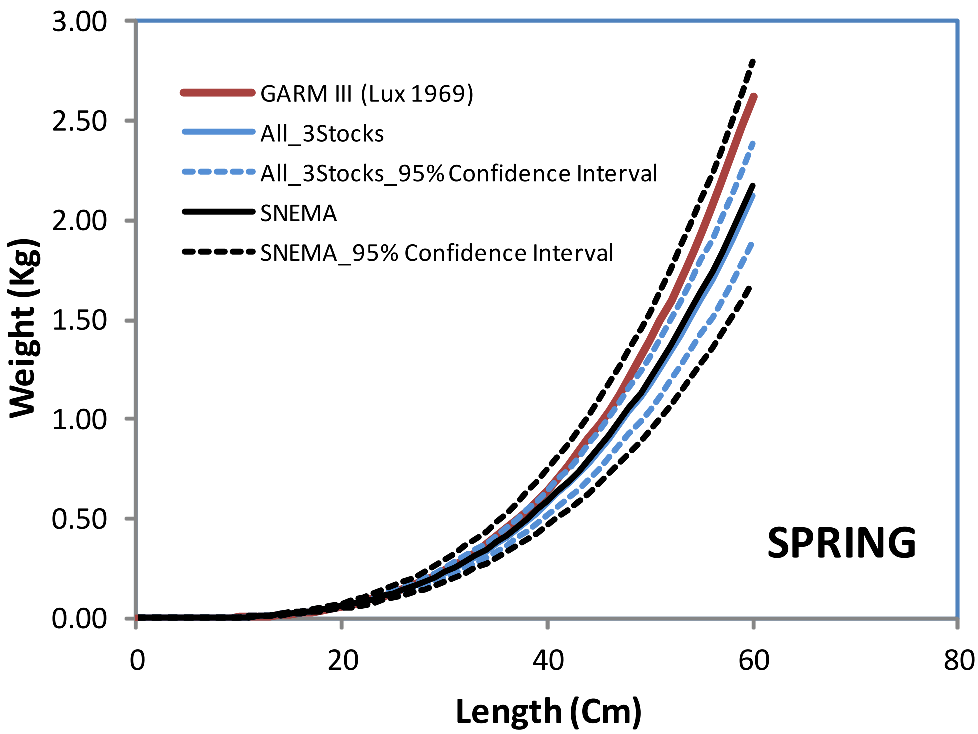


Figure B3. Comparison of seasonal length-weight relationships for all three stocks combined and for the Southern New England Mid-Atlantic strata sets estimated from the NEFSC survey data relative to length-weight relationship used in previous Southern New England Mid-Atlantic yellowtail flounder

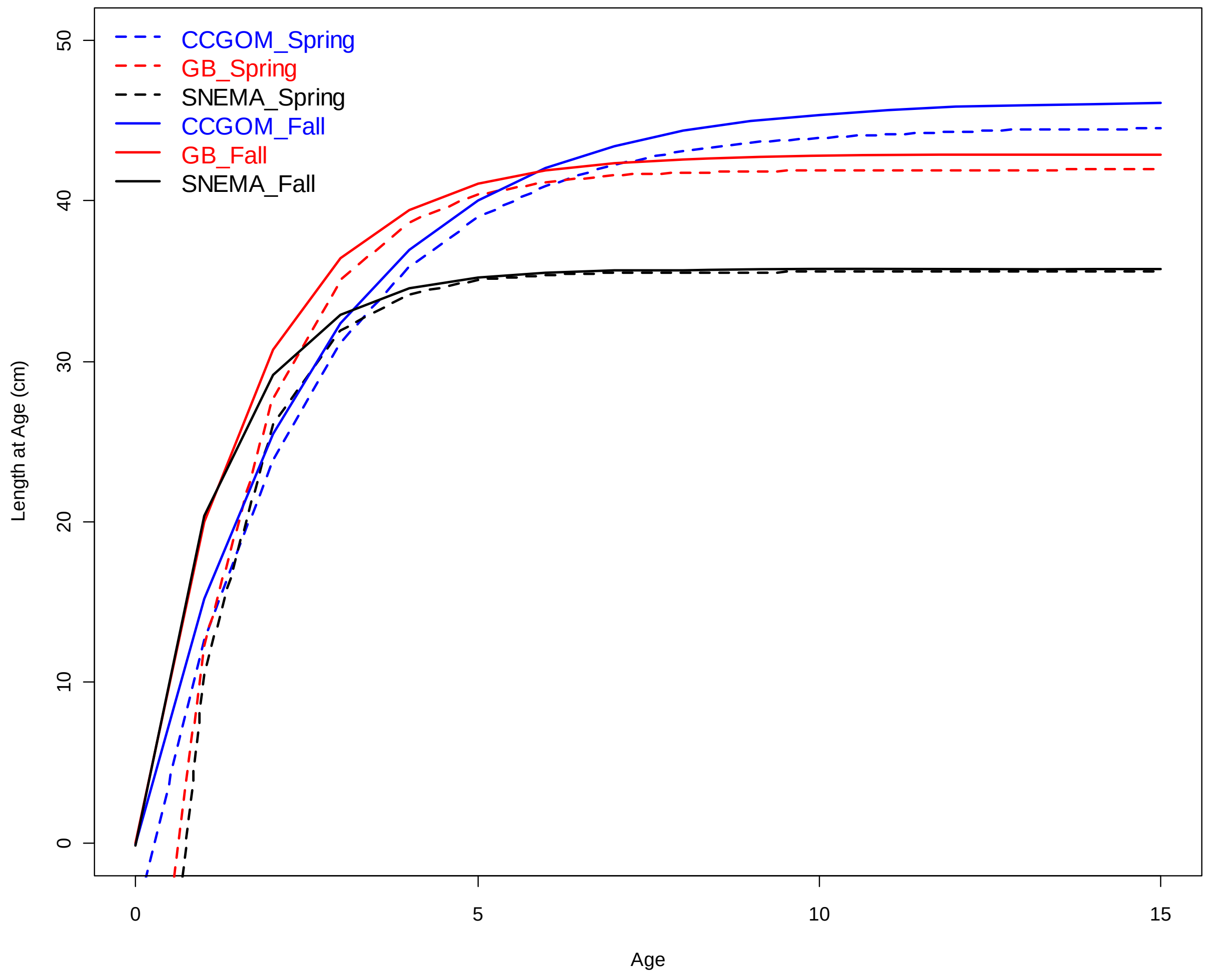


Figure B4. Von Bertalanffy growth curves for Cape Cod Gulf of Mine (CCGOM), Georges Bank (GB), and Southern New England Mid-Atlantic (SNEMA) yellowtail flounder estimated from data collected the Northeast Fisheries Science Center bottom trawl surveys between 1963 and 2011. Estimated growth parameters for the Southern New England Mid-Atlantic stock were L_{inf} = 35.6cm, K=0.97, t_0 = 0.63 in the Spring and L_{inf}= 35.2cm, K= 0.85, t_0 = -0.14 in the Fall.

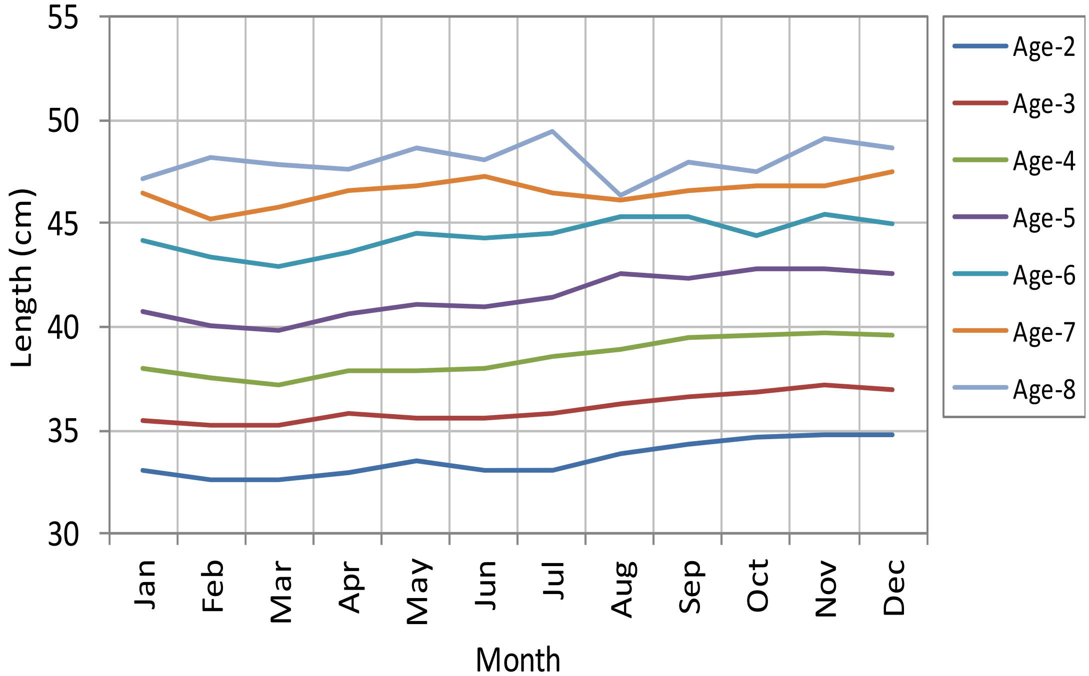


Figure B5. Mean length-at-age of Southern New England Mid-Atlantic yellowtail flounder landed by commercial fishery by month. Estimated from port samples taken between 1994-2011

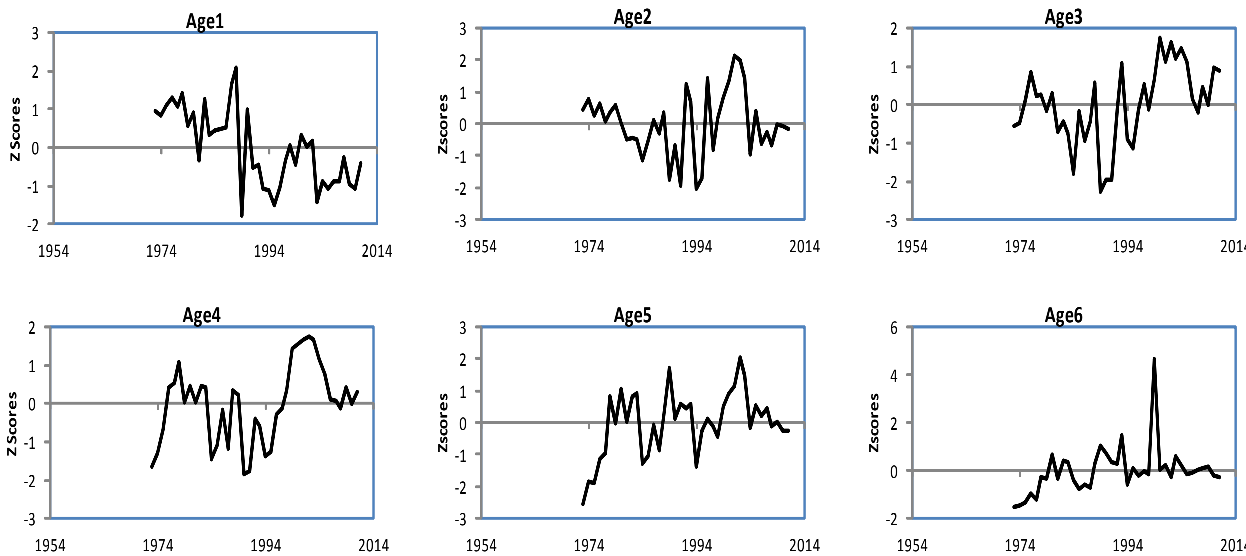


Figure B6. Average Catch weights at age for age-1through age-6+ for Southern New England Mid-Atlantic yellowtail flounder from 1973-2011. Weights at Age were estimated using a number weighted average commercial landings and discards weight at age. Average weight are presented as z-scores ([x-μ]/σ)

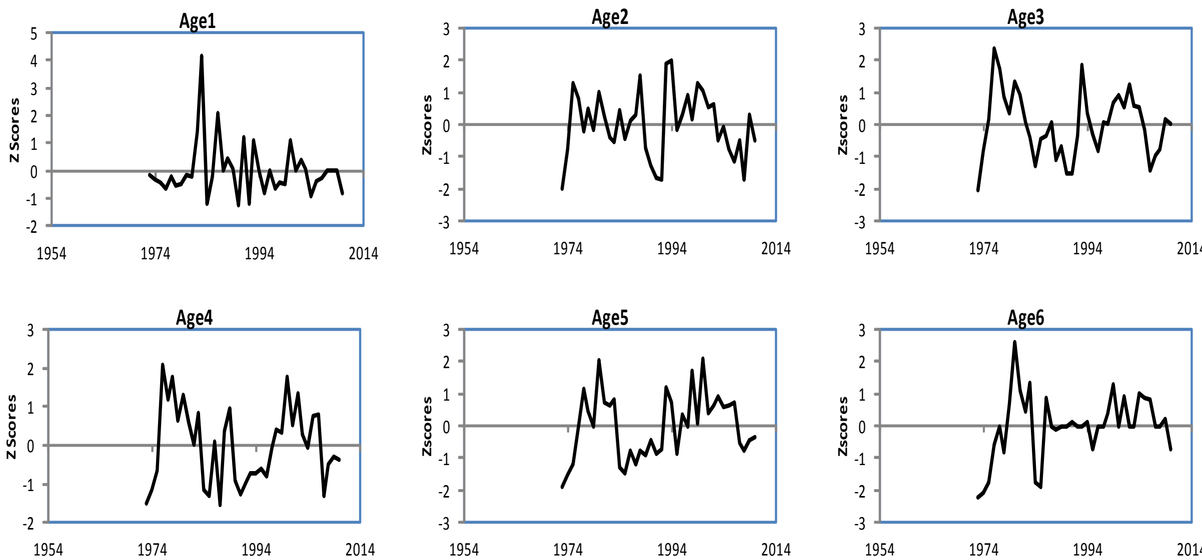


Figure B7. Average survey weights at age for ages1 through ages 6+ for Southern New England Mid-Atlantic yellowtail flounder from 1973-2011. Survey weights are based on the average weight-at-age of yellowtail sampled from the Northeast Fisheries Science Center Spring bottom trawl survey.

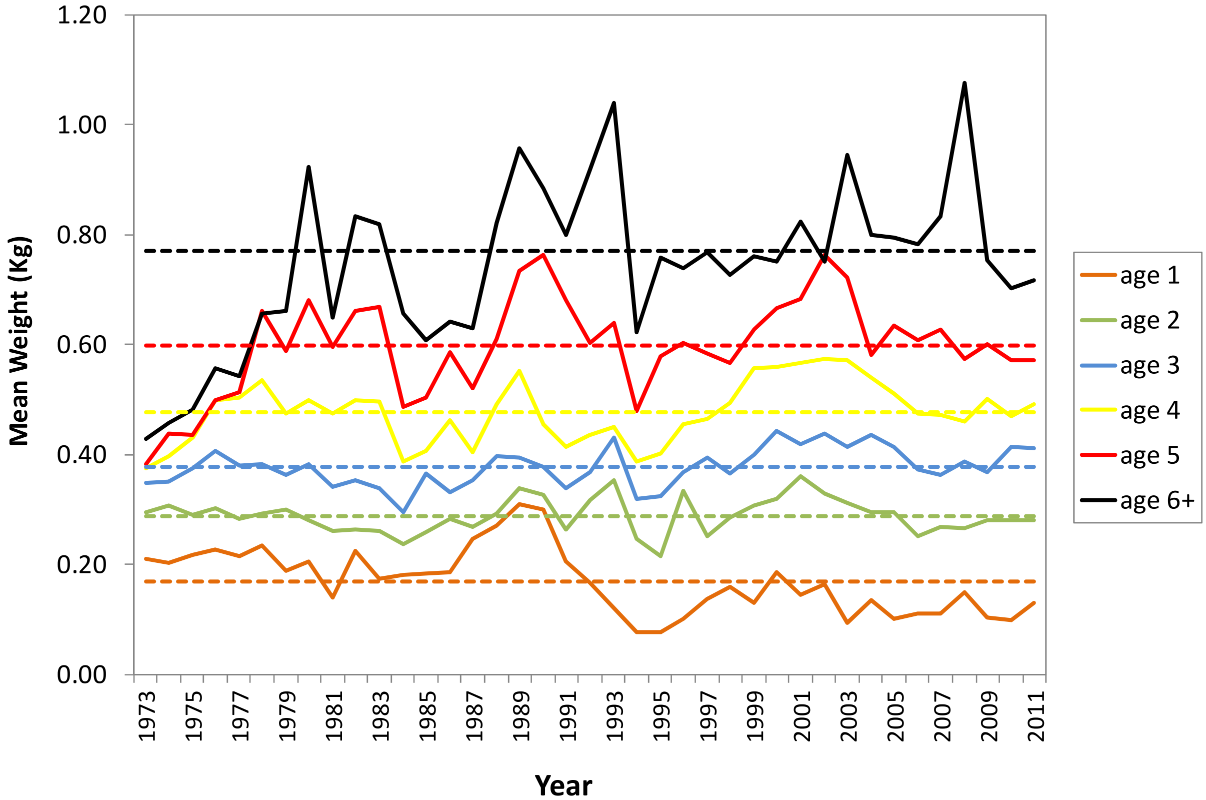


Figure B8: Non-standardized average catch weights at age for Ages 1 through 6+ for Southern New England Mid-Atlantic yellowtail flounder from 1973 to 2011. Dash lines denote the time series average.

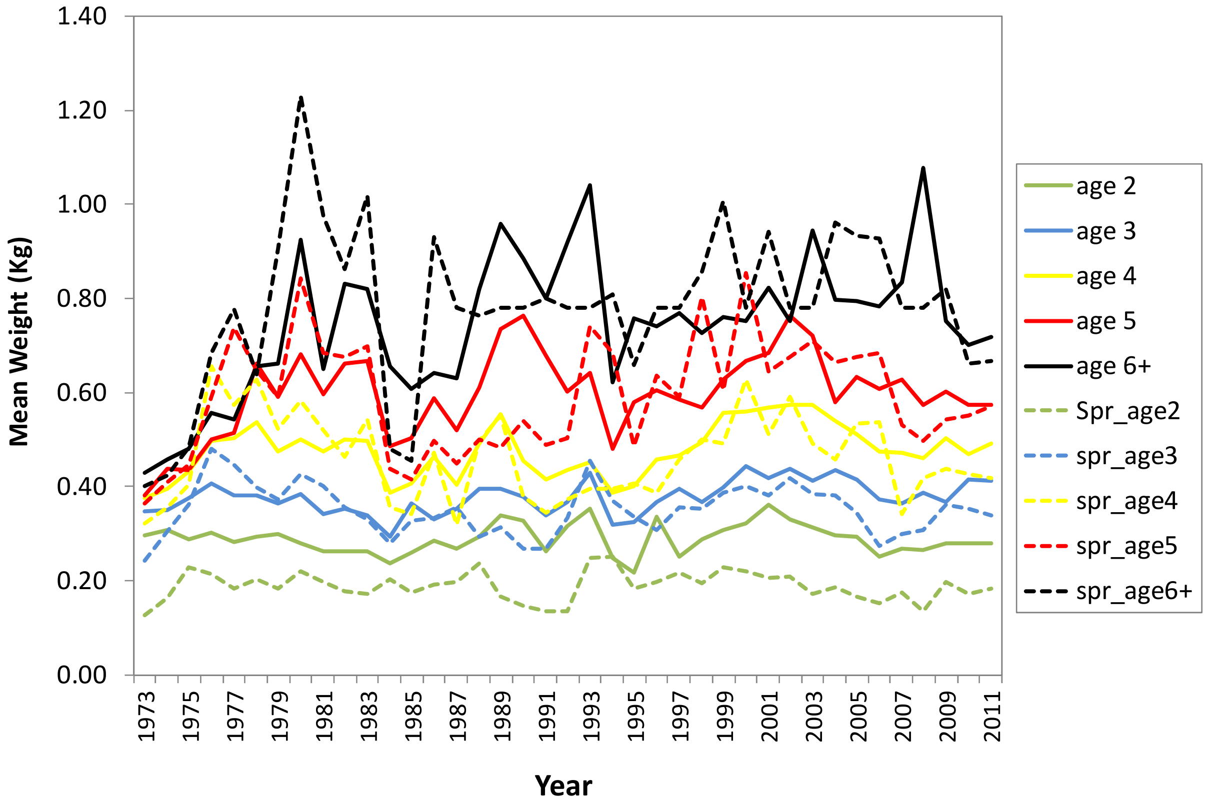


Figure B9. Comparison between catch weights-at-age and spring weights-at-age for ages-1 through 6+ for Southern New England Mid-Atlantic yellowtail flounder from 1973-2011

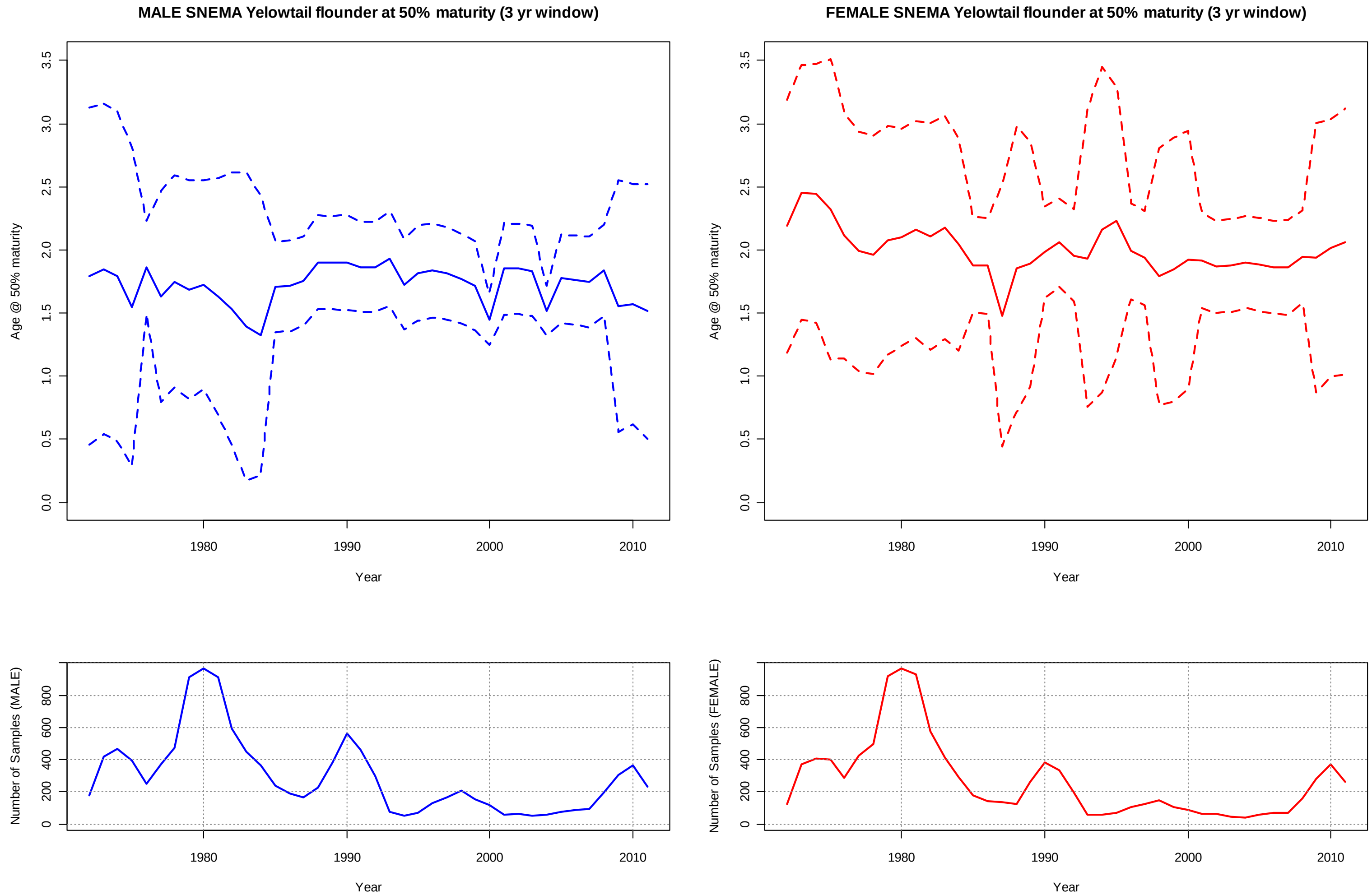


Figure B10a. Top panel-Three year moving averages of age at 50% maturity (A50) for males (left panel) and females (right panel) Southern New England Mid-Atlantic yellowtail flounder from 1973-2011 estimated from data collected from the Northeast Fisheries Science Center (NEFSC) spring trawl Survey. Samples sizes are provided in the bottom panels

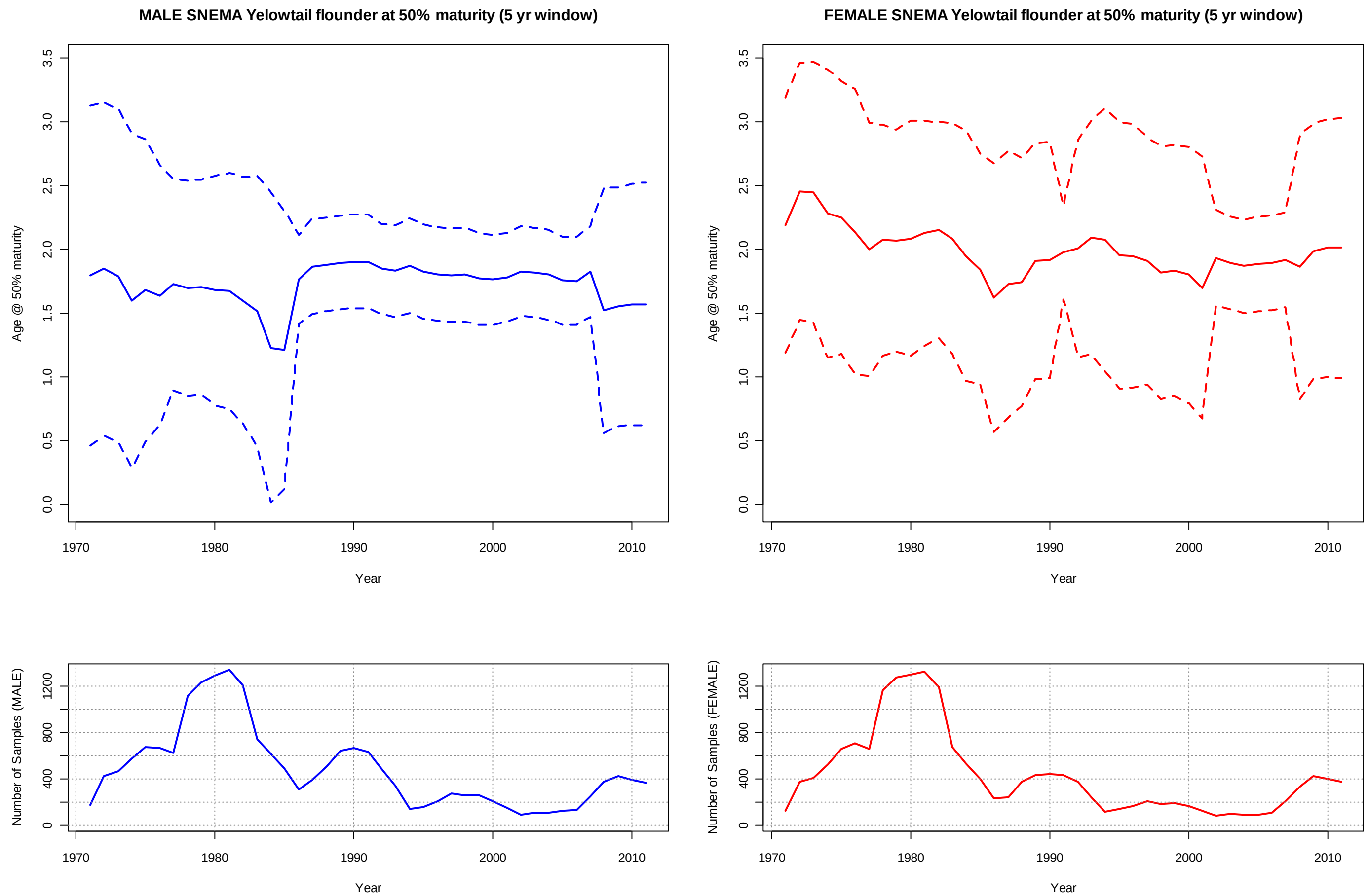


Figure B10b. Cont'd). Top panel-Five year moving averages of age at 50% maturity (A50) for males (left panel) and females (right panel) Southern New England Mid-Atlantic yellowtail flounder from 1973-2011 estimated from data collected from the Northeast Fisheries Science Center (NEFSC) spring trawl Survey. Samples sizes are provided in the bottom panels

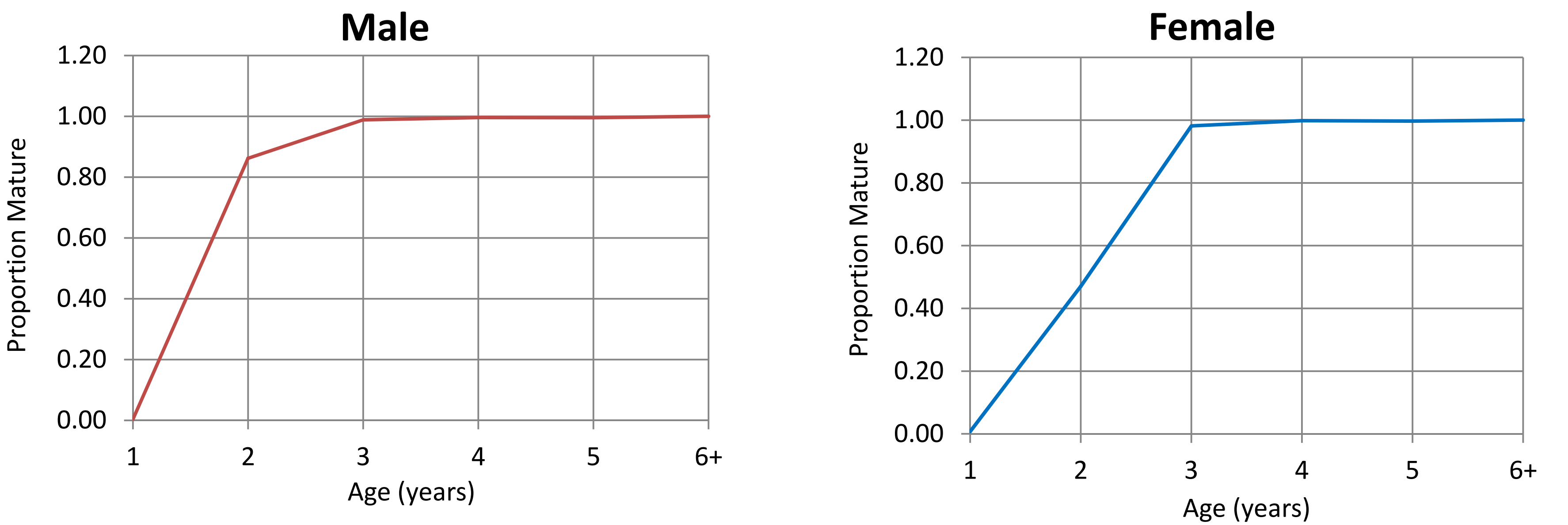


Figure B11. Observed maturity ogives for male (left) and female (right) Southern New England Mid-Atlantic yellowtail flounder from 1973-2011 from data collected from the Northeast Fisheries Science Center (NEFSC) Spring trawl Survey.

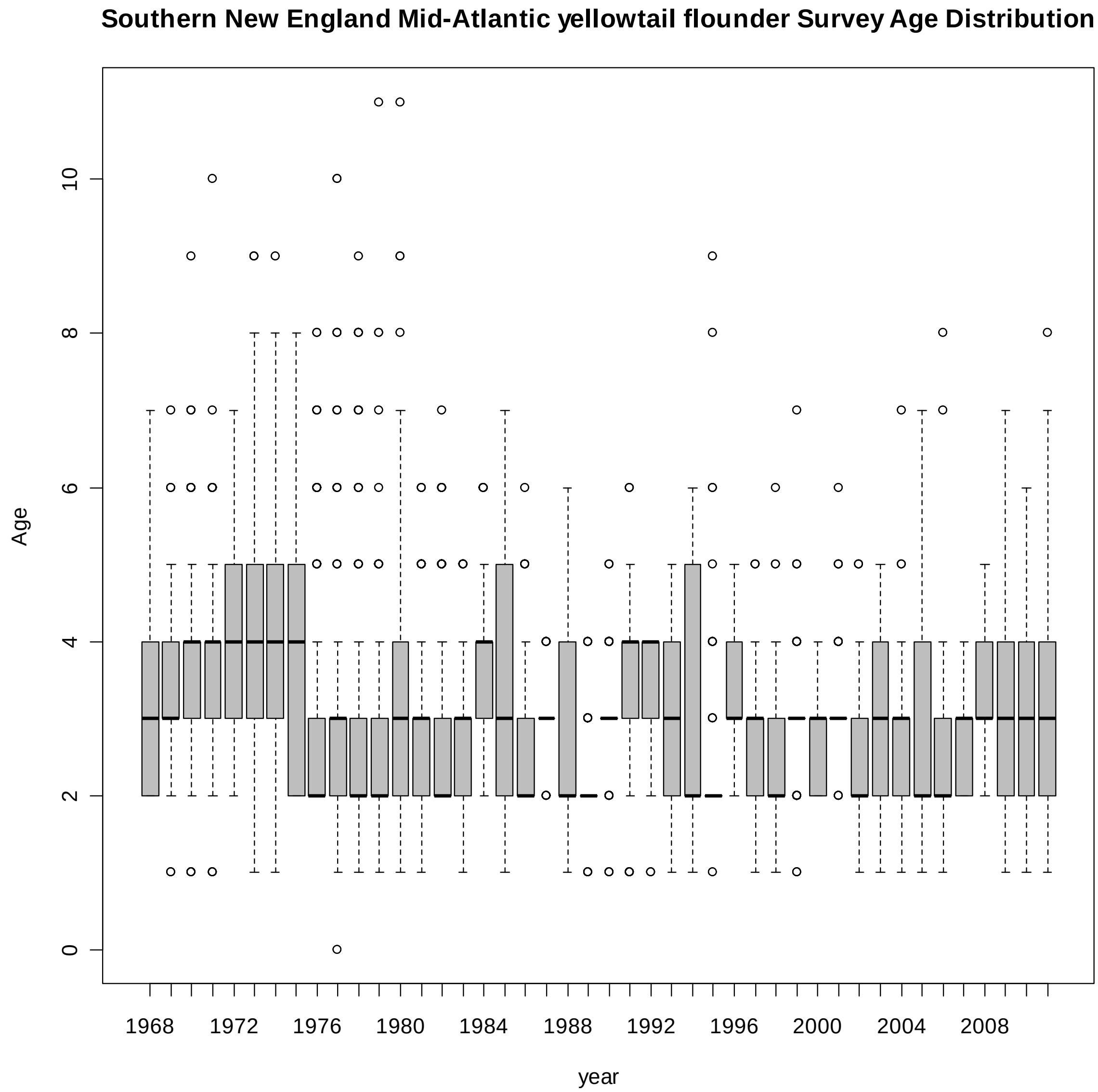


Figure B12. Age distribution of Southern New England Mid-Atlantic yellowtail flounder from the Northeast Fisheries Science Center Spring and Fall survey combined from 1973-2011. Observed maximum age of 11 resulted in natural mortality estimates ranging from 0.27 – 0.38 depending on the method.

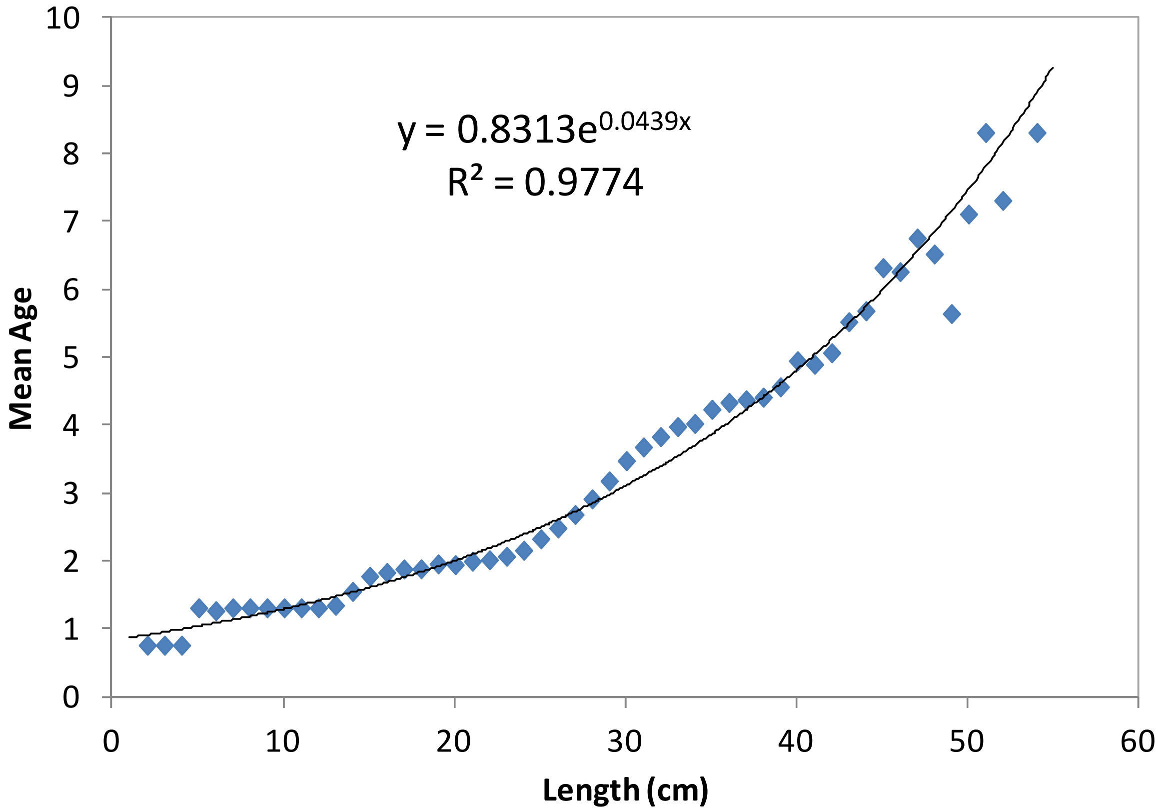


Figure B13. Observed and predicted mean age at length of Southern New England Mid-Atlantic yellowtail flounder modeled as power function from age and length data derived from the Northeast Fisheries Science Center fall and Spring Survey combined from 1973-2011.

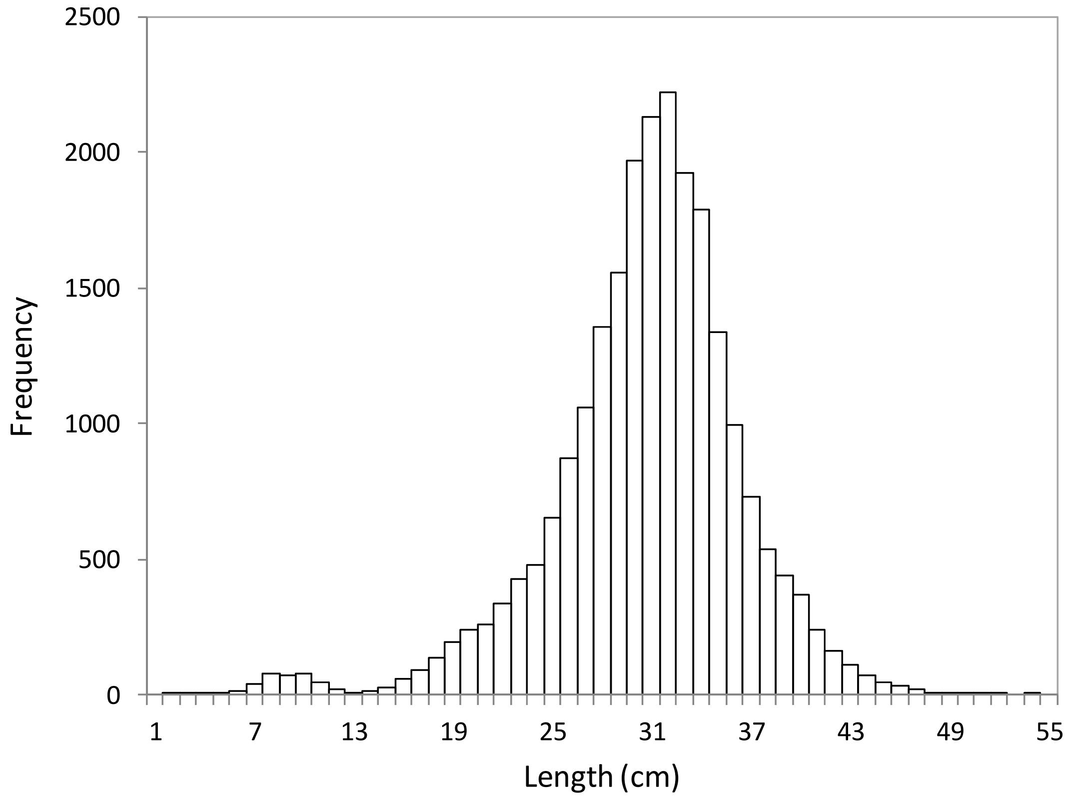


Figure B14. Southern New England Mid-Atlantic yellowtail flounder length distributions from the Northeast Fisheries Science center spring and fall survey from 1973-2011. The observed maximum length of 54cm resulted in estimated mean age of 8.9 with natural mortality estimates ranging from 0.34 – 0.47

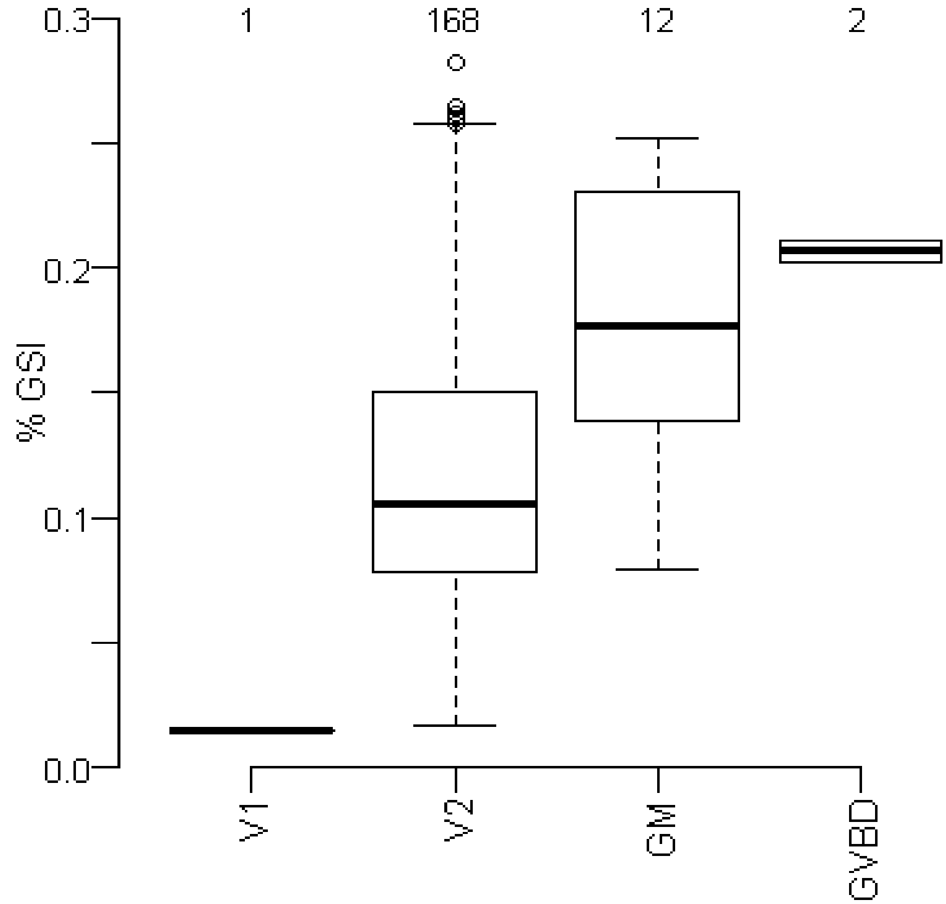


Figure B15. Gonadosomatic index (GSI) for mature (pre-spawning) female Southern New England Mid-Atlantic yellowtail flounder reported by most advanced oocytes stage from data collected from the Northeast Fisheries Science Center Northeast Cooperative Research program (NEFSC-NCRP) study fleet from December 2009 through April 2011. Fish were confirmed as pre-spawning by the lack of post-ovulatory follicles in the gonad histology sample. Numbers at the top indicate sample sizes.

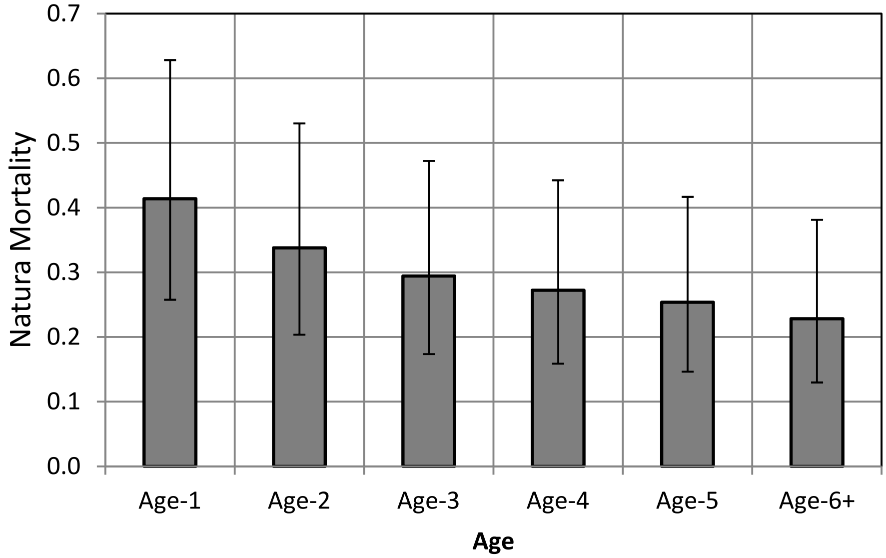


Figure B16. Southern New England Mid-Atlantic yellowtail flounder time series average estimates of natural mortality (rescaled to M = 0.3) and 95% confidence interval based on Lorenzen's method. Parameters for the power function were derived from Lorenzen (1996)

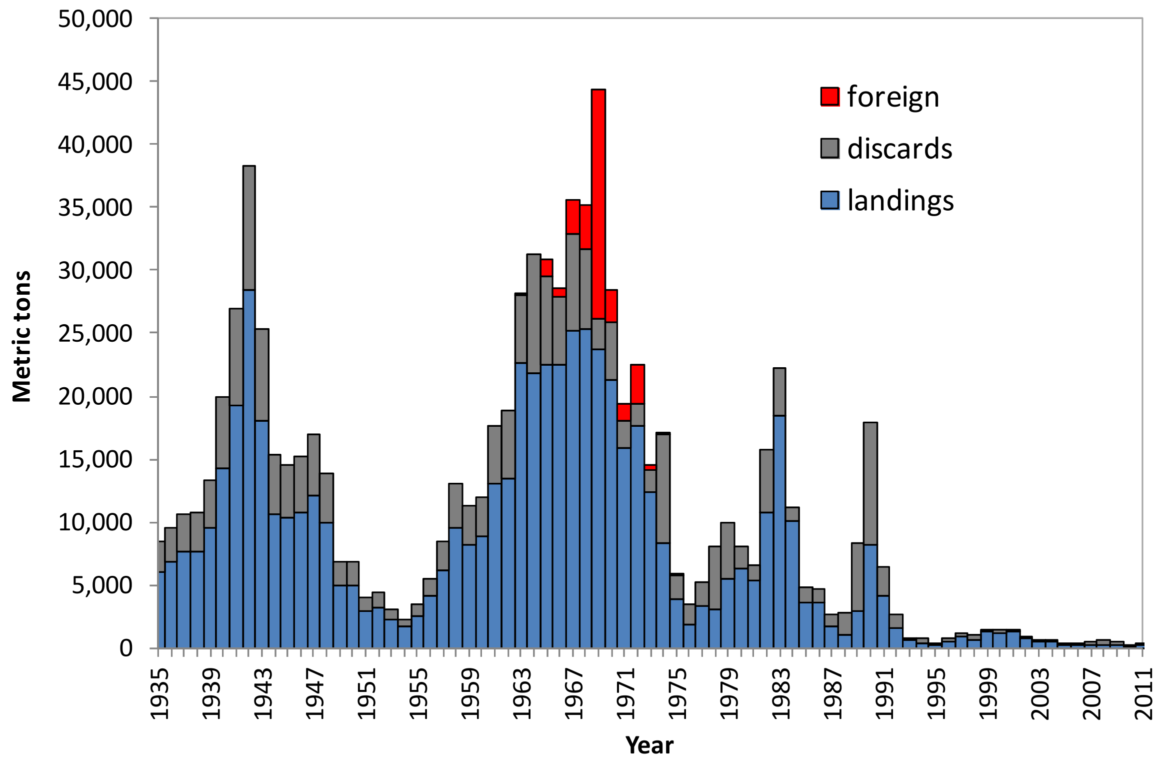


Figure B17. Total catch of Southern New England Mid-Atlantic yellowtail flounder in metric tons from 1935 – 2011 by disposition (landed and discarded)

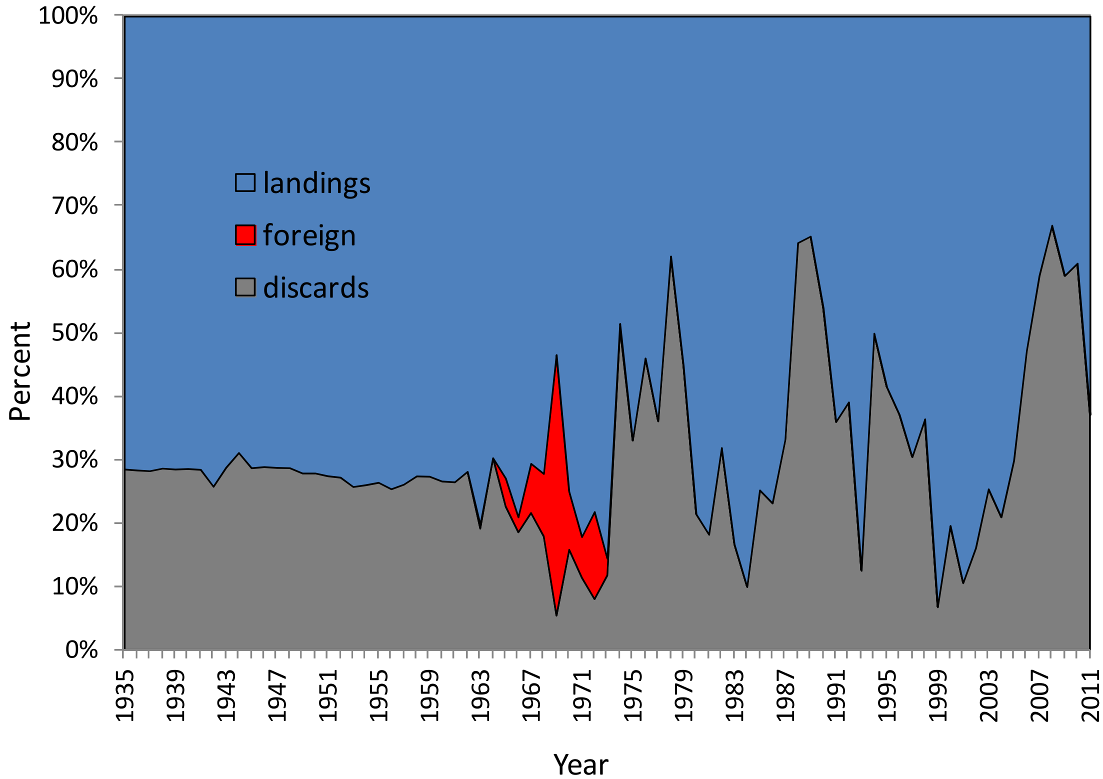
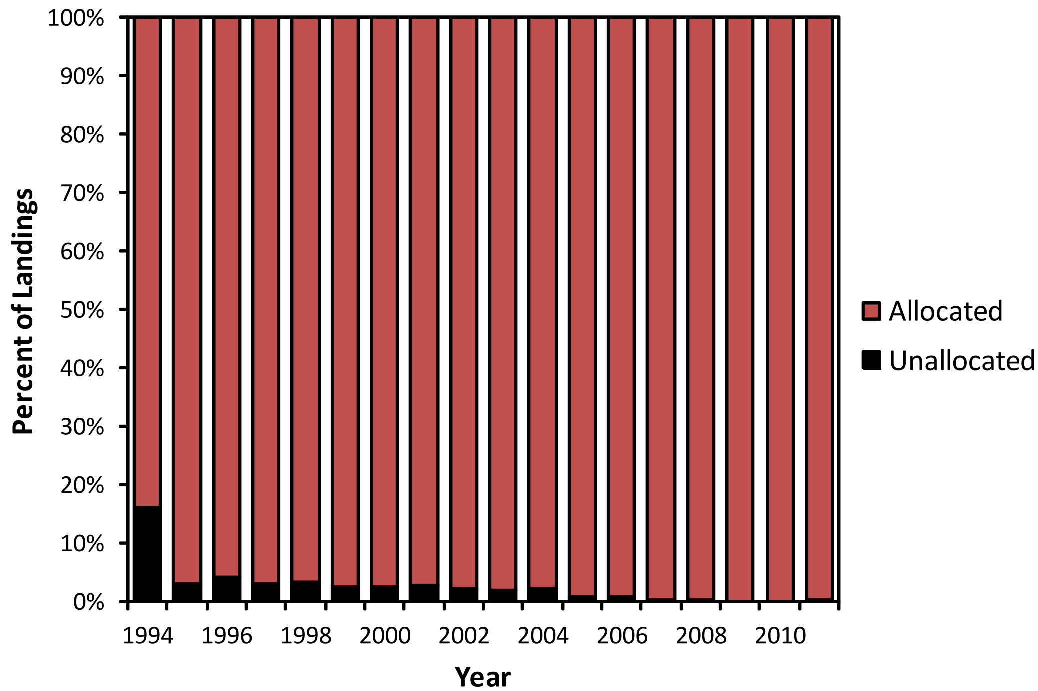


Figure B18. Total catch of Southern New England Mid-Atlantic yellowtail flounder in metric tons from 1935 – 2011 by disposition (landed and discarded) expressed as proportions



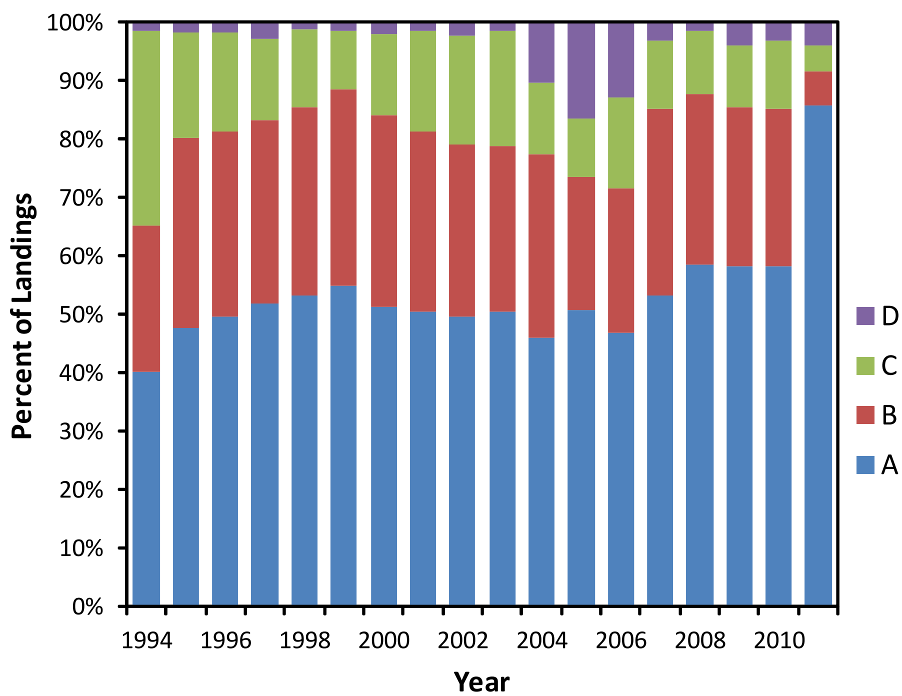
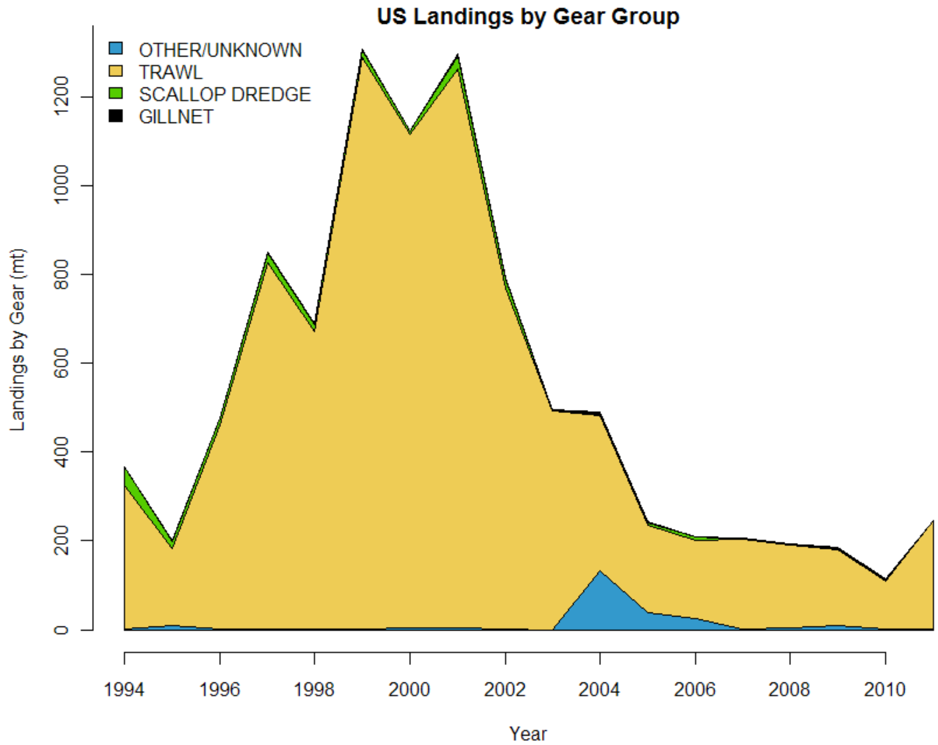


Figure B19. Fraction of commercial landings Area Allocation level (AA, See Wigley et al. 2008) for Southern New England Mid-Atlantic yellowtail flounders from 1994-2011. Certainty of landings increases from level D to A. Unallocated landings do not enter the allocation procedure.



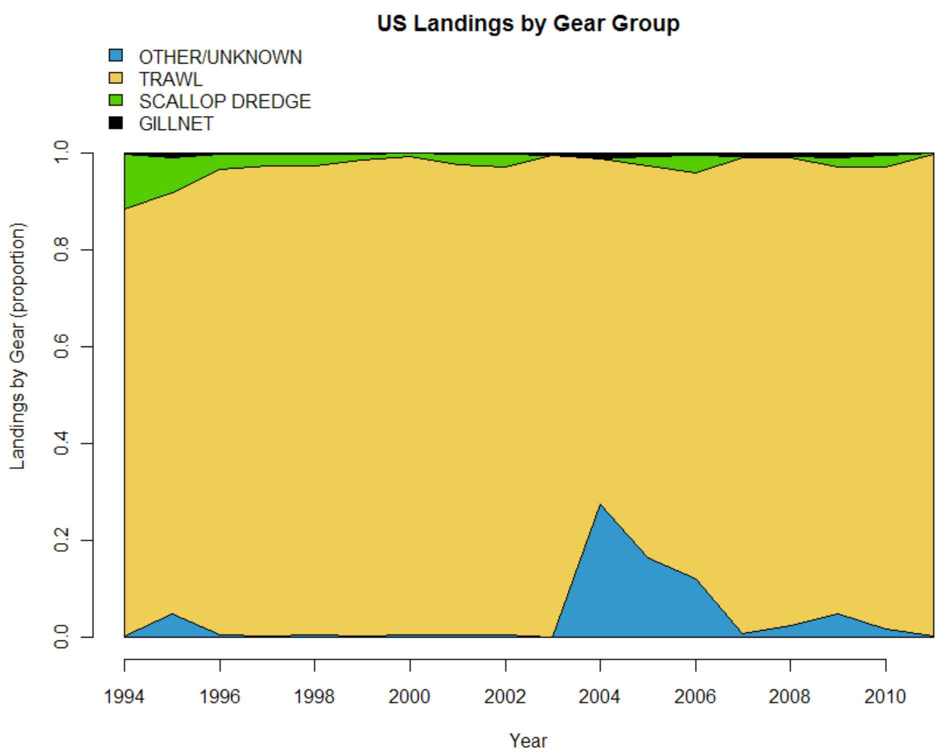


Figure B20. Total (top) and fractional (as fraction of the total, bottom) commercial landings of Southern New England Mid-Atlantic yellowtail flounder by gear from 1994-2011.

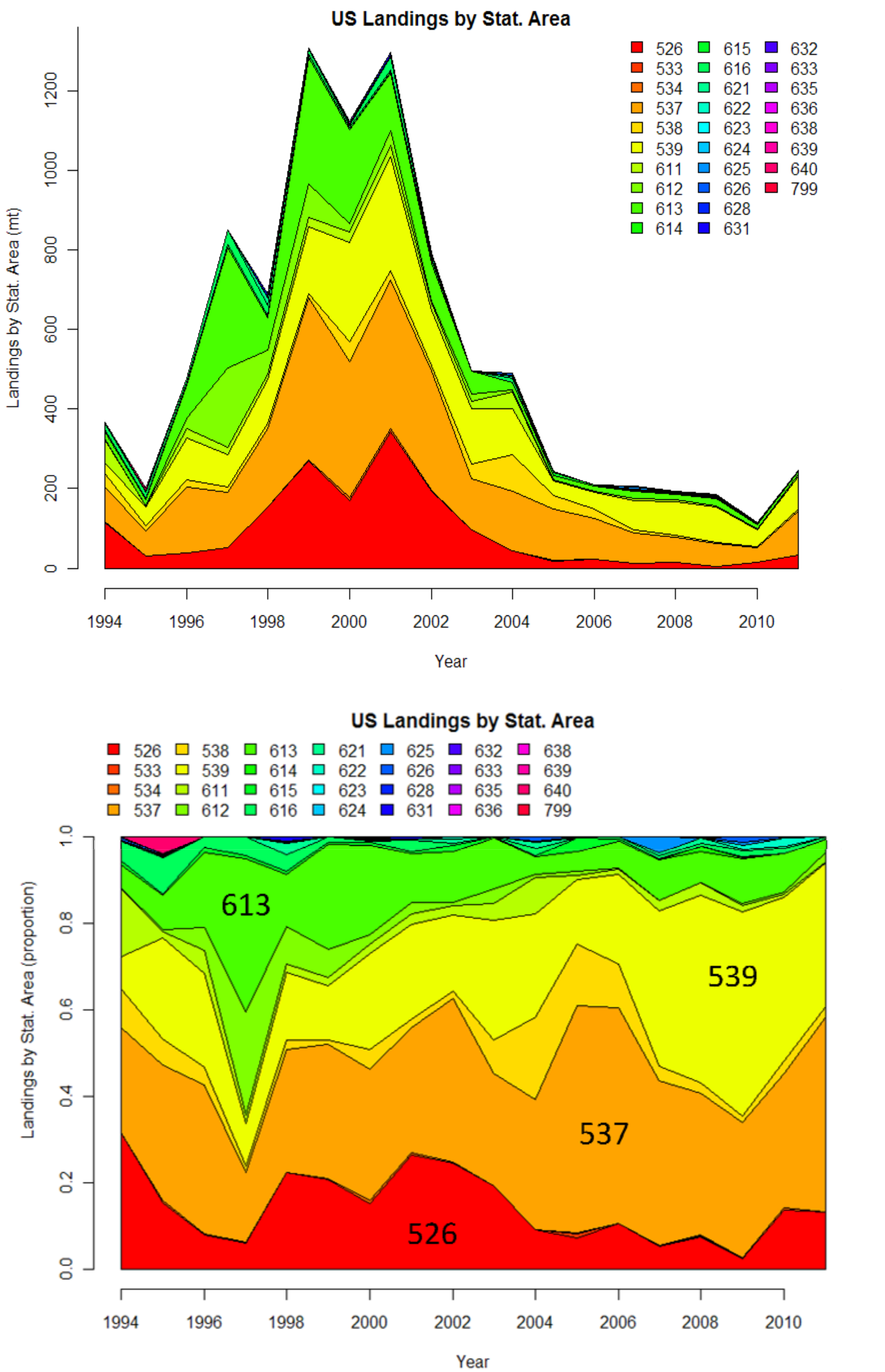


Figure B21. Total (top) and fractional (as fraction of the total, bottom) commercial landings of Southern New England Mid-Atlantic yellowtail flounder by statistical area from 1994-2011.

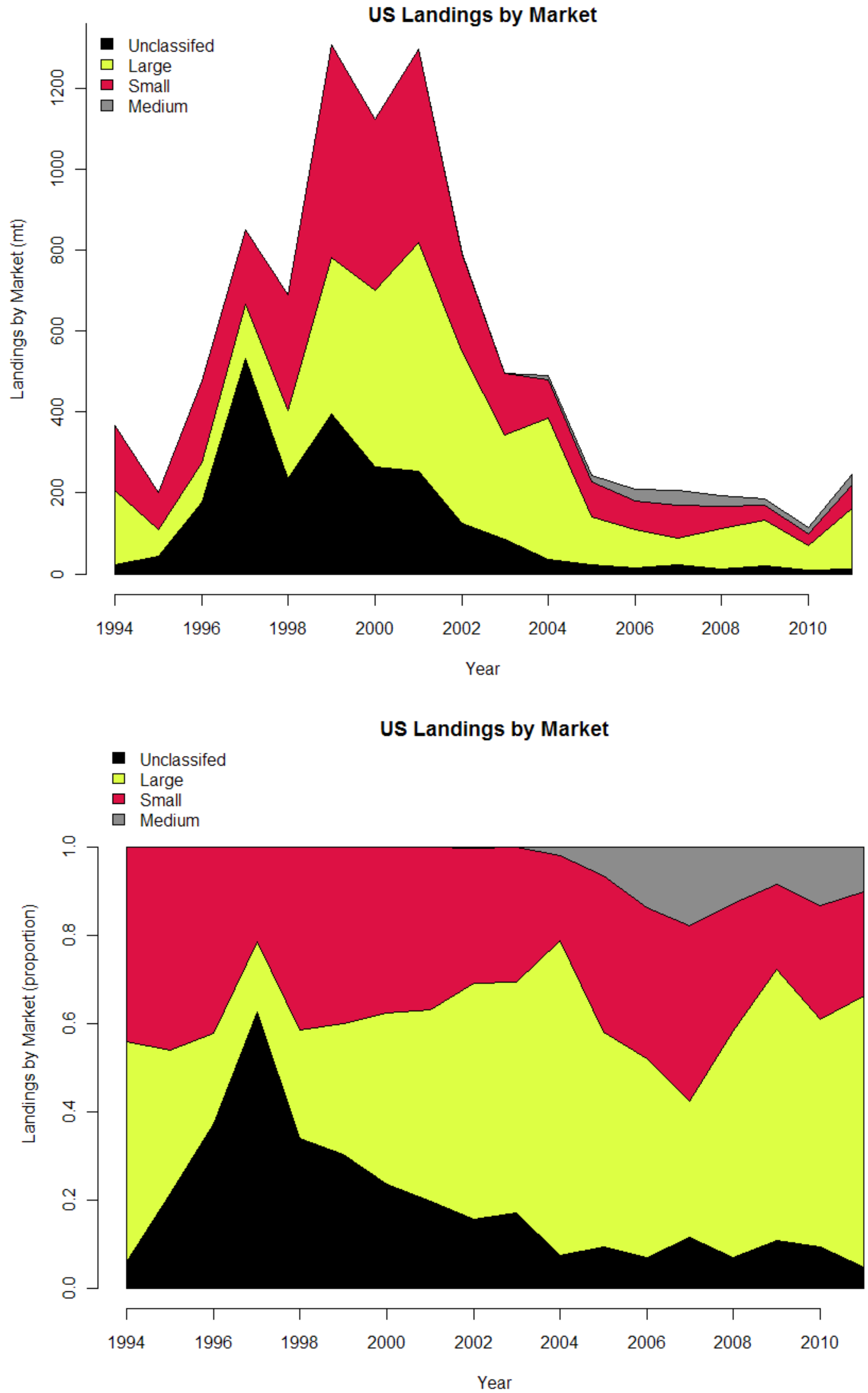


Figure B22. Total (top) and fractional (as fraction of the total, bottom) commercial landings of Southern New England Mid-Atlantic yellowtail flounder by market category from 1994-2011.

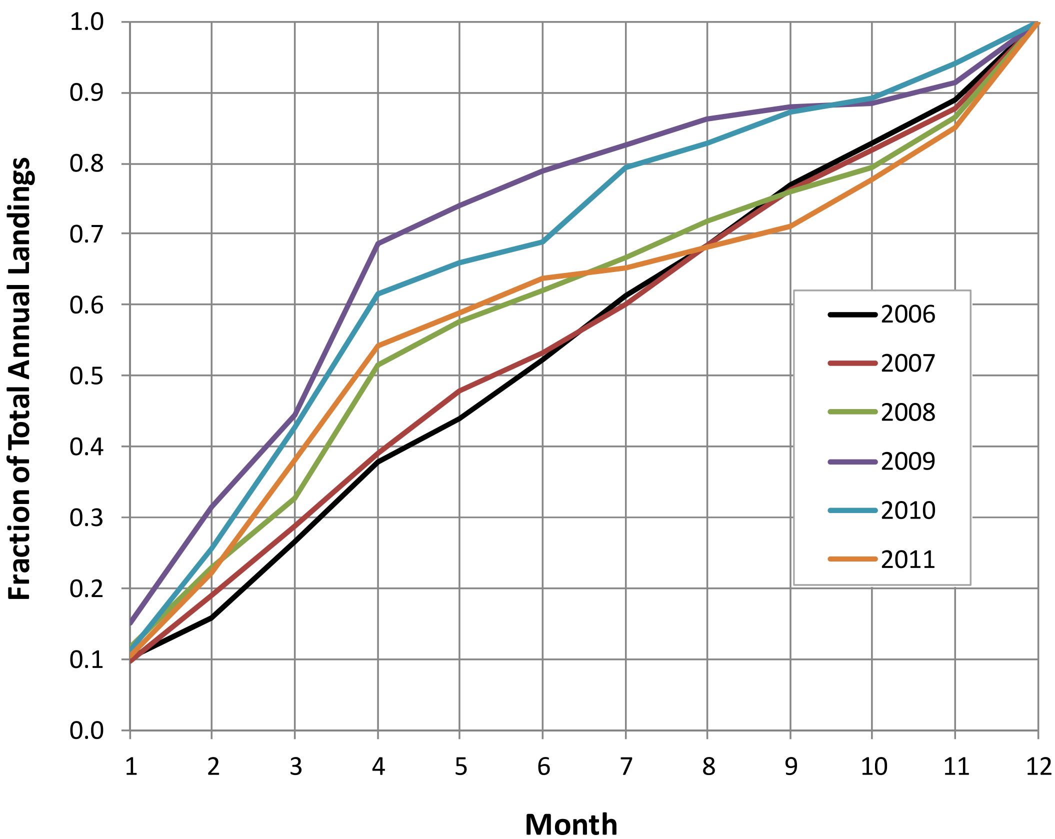


Figure B23. Cumulative monthly commercial landings of Southern New England Mid-Atlantic yellowtail flounder by year from 2006-2011

Figure B24. Commercial: landings-at-age for Southern New England Mid-Atlantic yellowtail flounder from 1973 to 2011

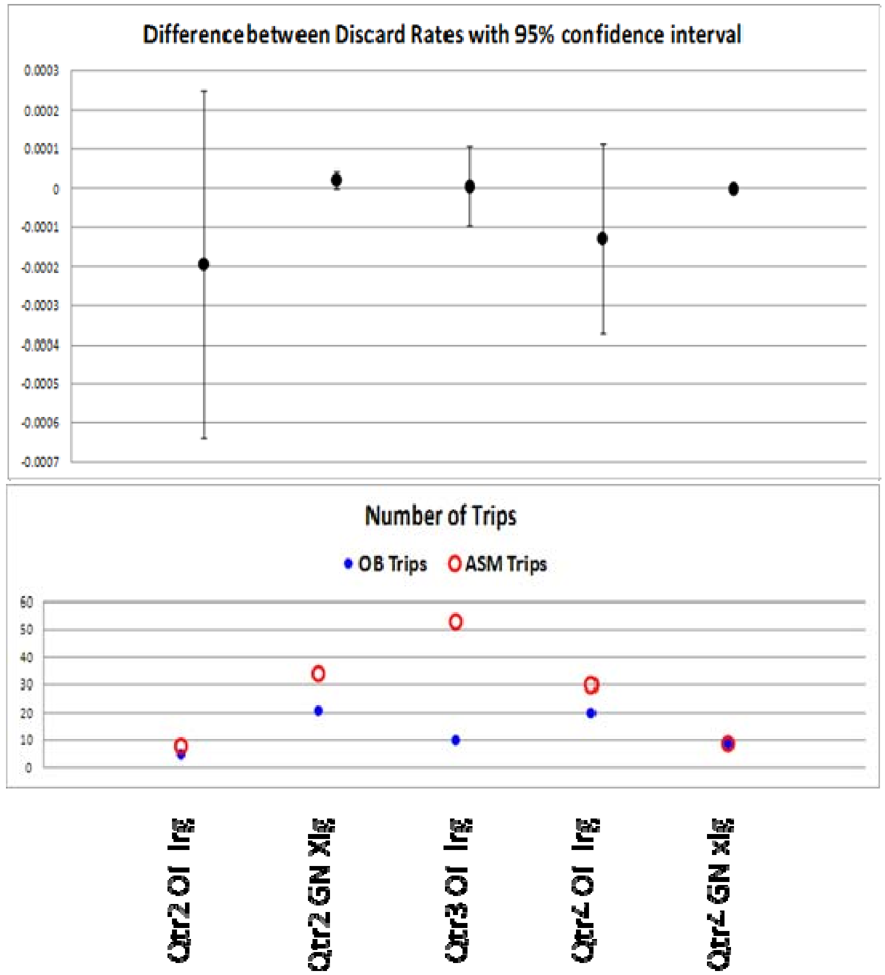


Figure B25.
Differences between the Southern New England Mid-Atlantic yellowtail flounder discard rates estimated from data collected by groundfish At-Sea Monitors (ASMs) and certified Observers showing 95% confidence intervals (top panel) and the number of trips included in each analyses (bottom panel) disaggregated by gear-mesh combination and quarter (from Wigley et al. 2011). Gera categories include Large mesh otter trawl (OT lrg), and extra large mesh Gillnet (GN Xlg).

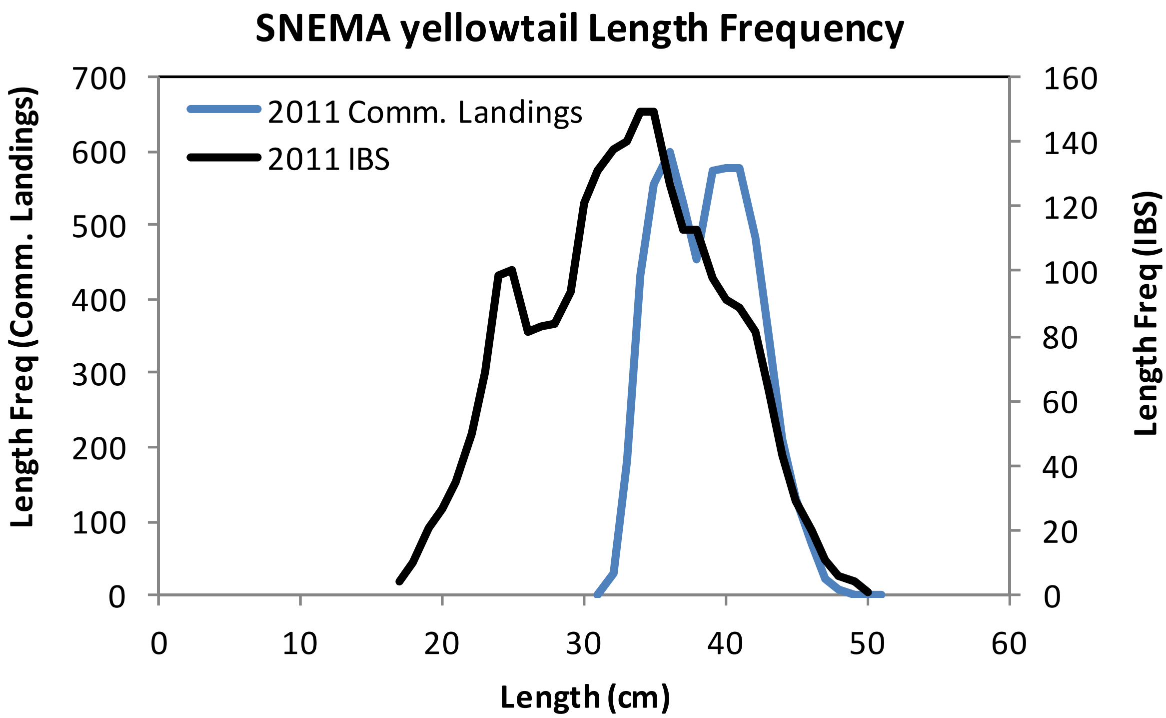


Figure B26. A comparison between Southern New England Mid-Atlantic yellowtail Industry based Survey (IBS) and 2011 commercial landings length distribution.

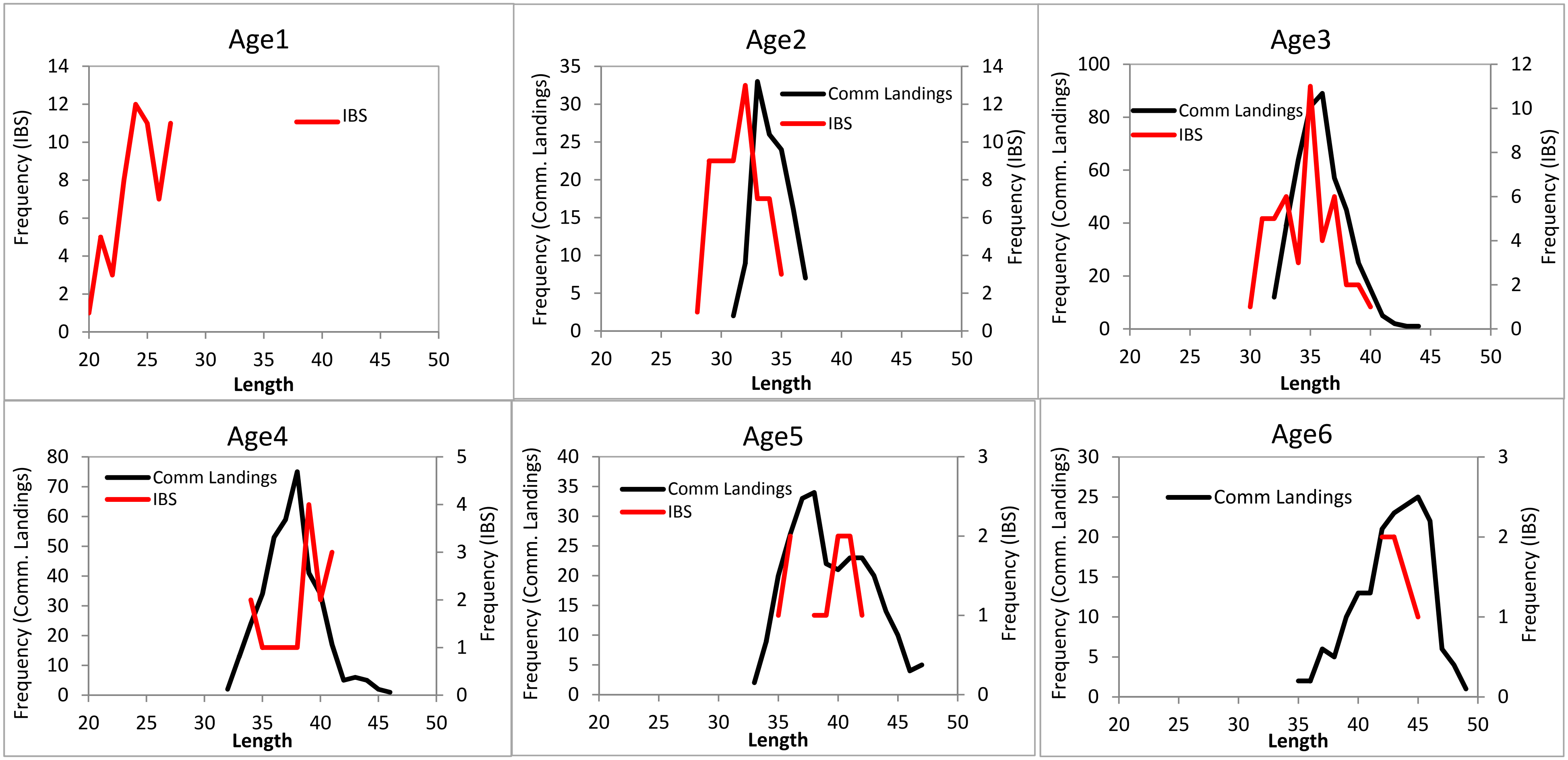


Figure B27. A comparison between Southern New England Mid-Atlantic yellowtail Industry based Survey (IBS) and 2011 commercial landings age distribution.

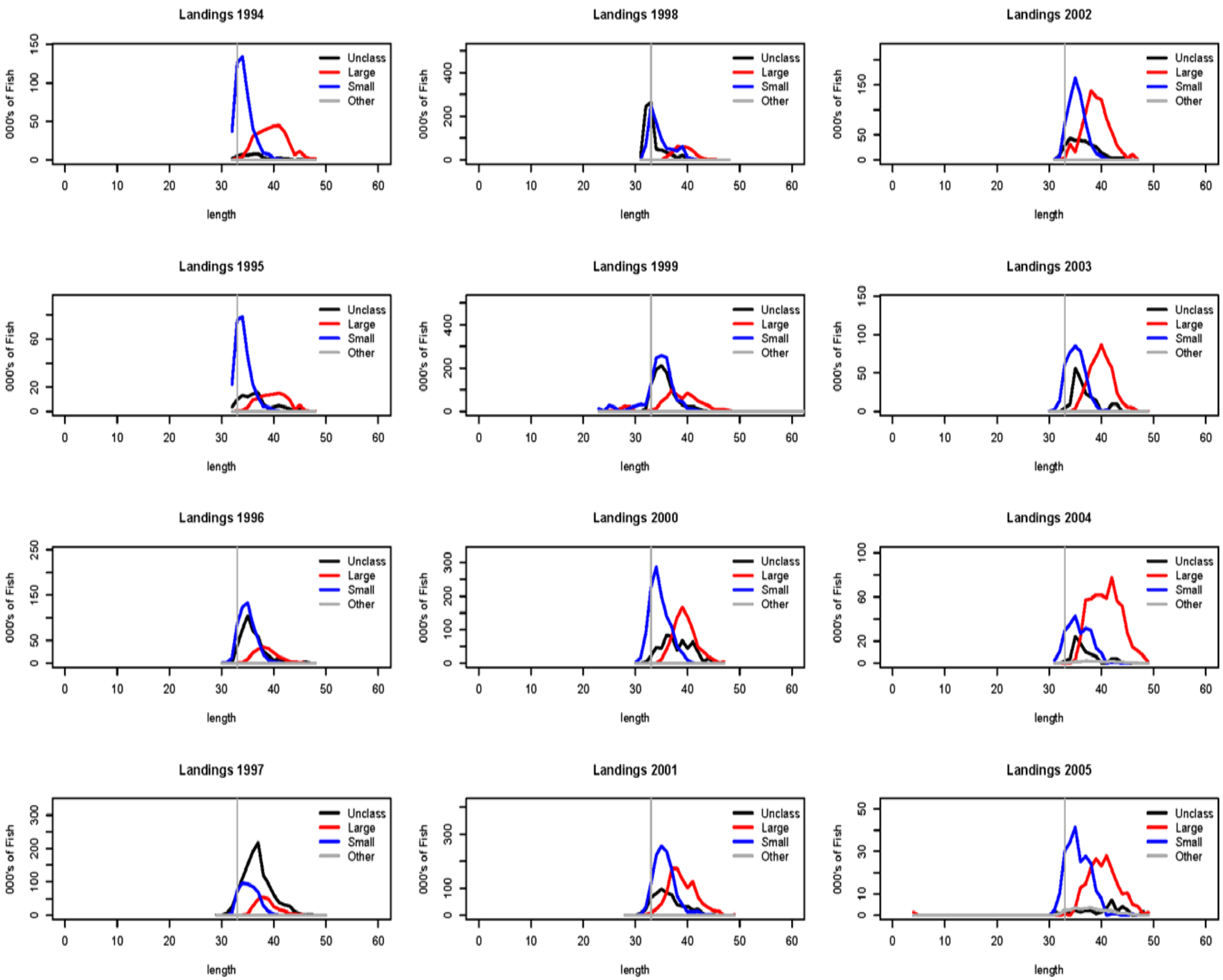


Figure B28a. Length frequency distribution of landed Southern New England Mid-Atlantic yellowtail flounder by market category in 000’s of fish from 1994 and 2005. Market groups include: Unclassified, Large, Small and Other. The 1989 –current commercial minimum retention size of 13 inches (33cm) is indicated by a dash grey line.

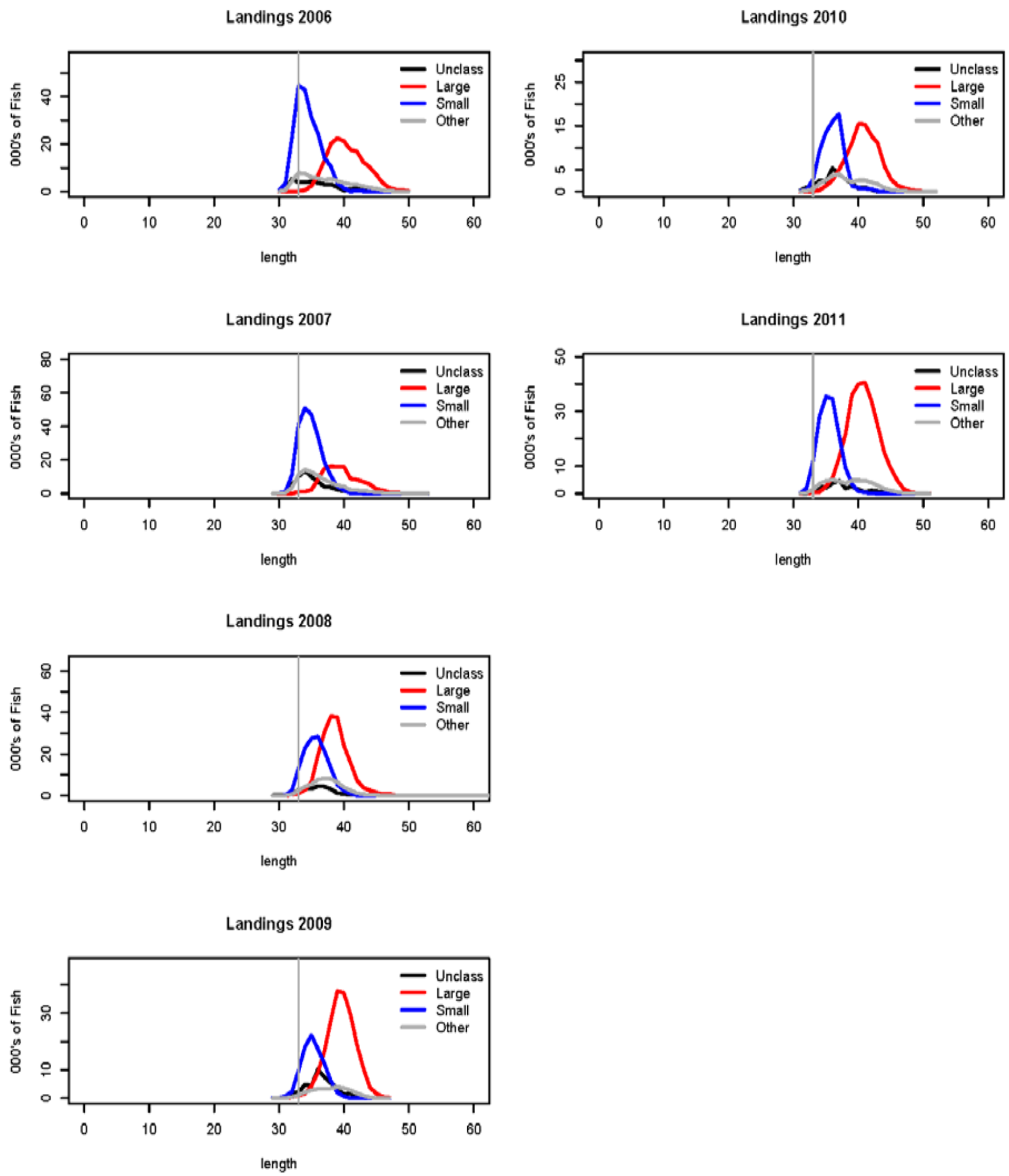


Figure B28b. (cont’d). Length frequency distribution of landed Southern New England Mid-Atlantic yellowtail flounder by market category in 000’s of fish from 2006 to 2011. Market groups include: Unclassified, Large, Small and Other. The 1989 –current commercial minimum retention size of 13 inches (33cm) is indicated by a dash grey line.

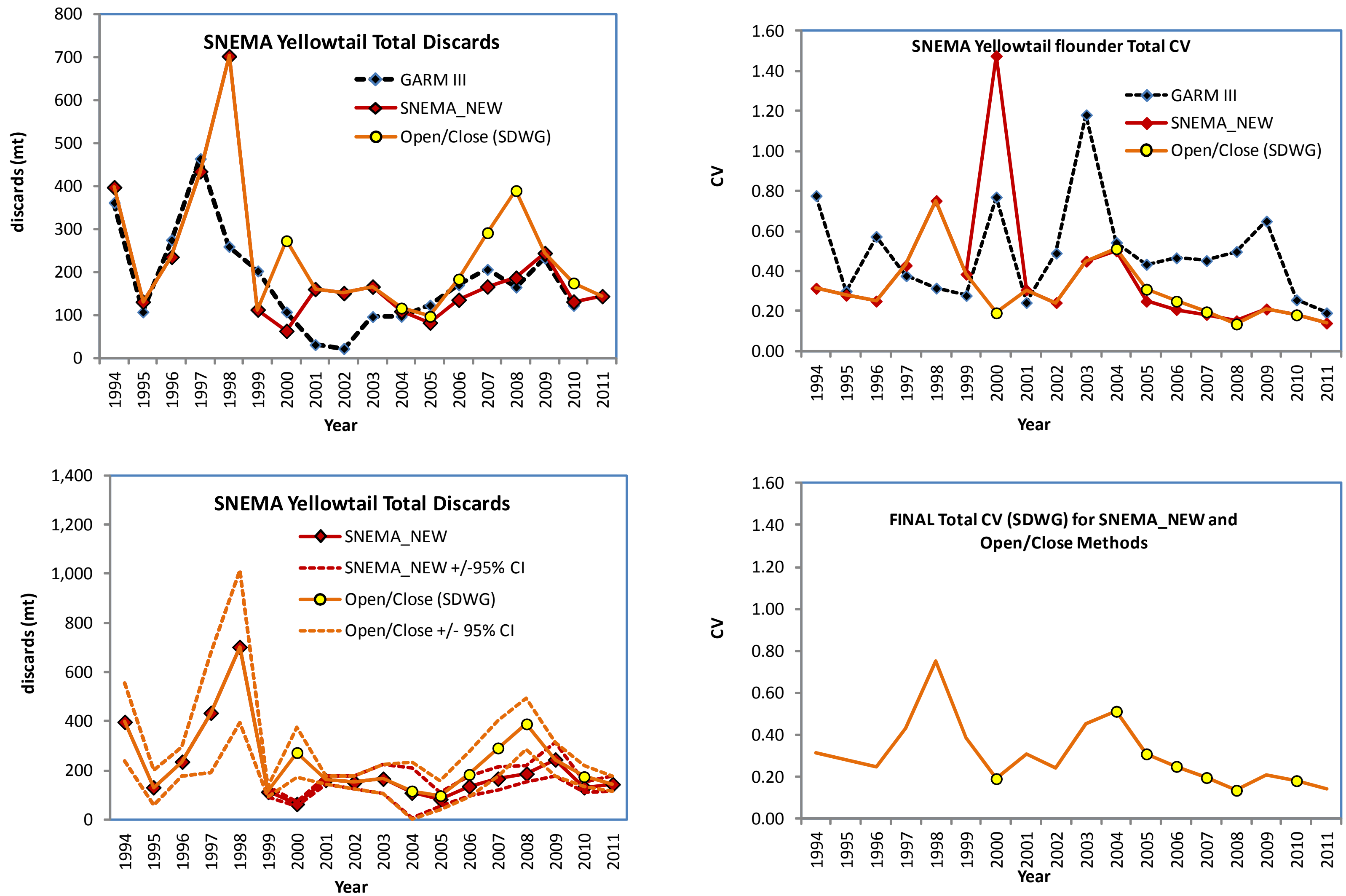


Figure B29. Comparison of the annual discard estimates for Southern New England Mid-Atlantic (SNEMA) yellowtail flounder (Left) and corresponding coefficient of Variations (CV, right) using three different spatial stratification schemes: No stratification (GARM III), SNE-MA stratification, SNE-MA with open-access area stratification in SNE for the limited access scallop fishery fleet. Note. SNE closed area is defined by the Nantucket Light-Ship (NLS). 95% CI are presented in the bottom left plot and the final accepted CV by the Southern Demersal Working Group (SDWG).

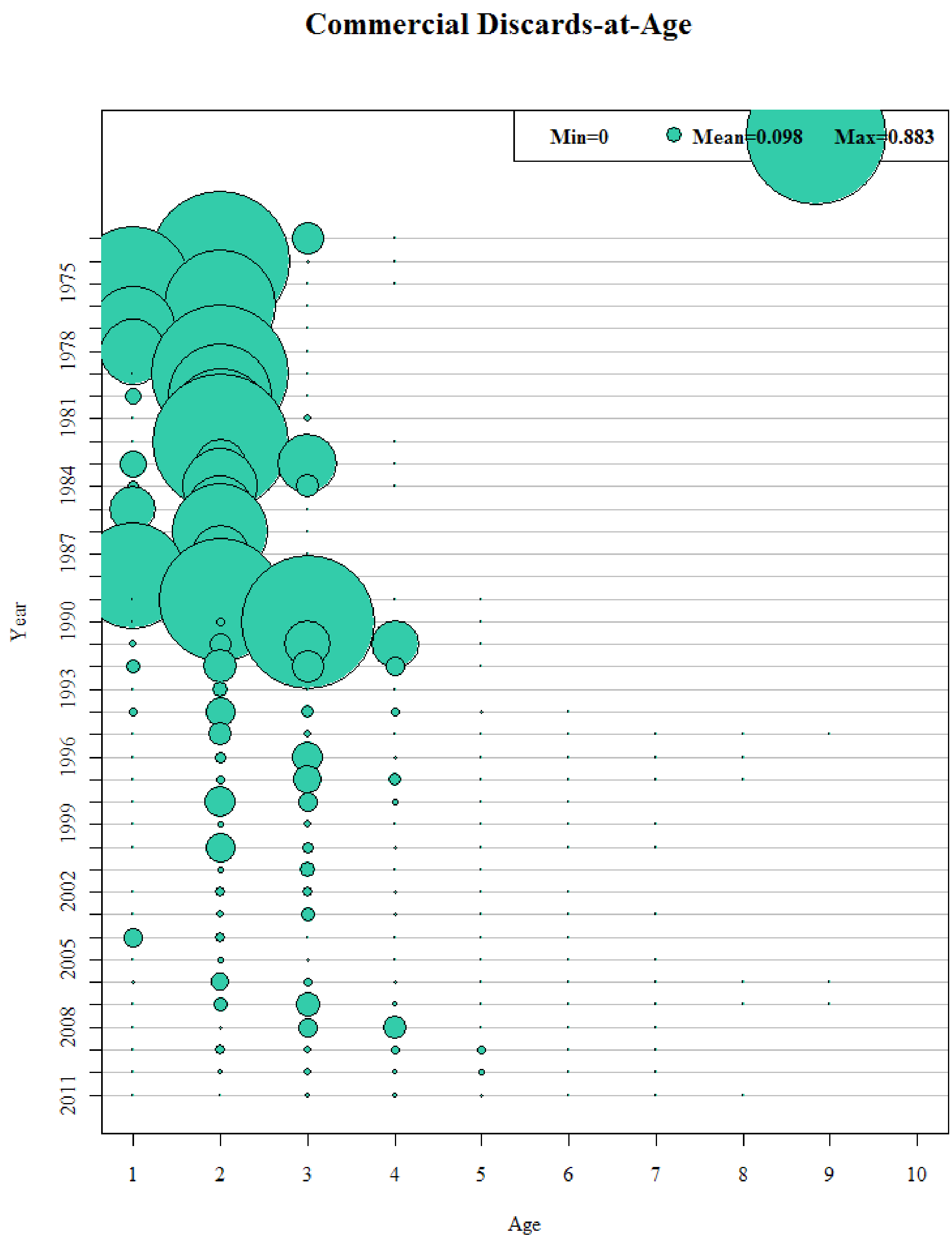


Figure B30. Commercial discards-at-age of Southern New England Mid-Atlantic yellowtail flounder from 1973 to 2011

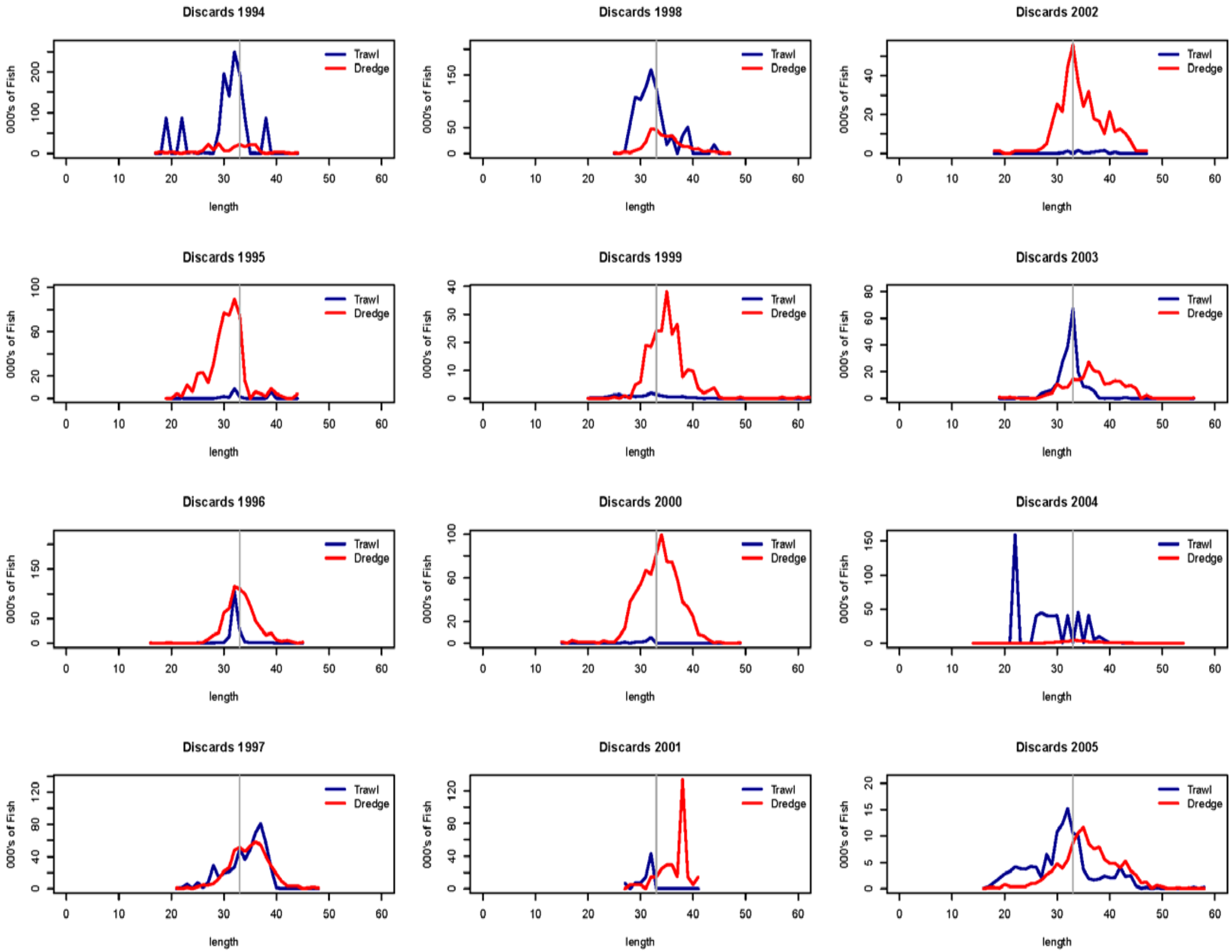


Figure B31a. Length frequency distribution of discarded Southern New England Mid-Atlantic yellowtail flounder by gear groupings (Trawl and Dredge) in 000's of fish from 194 and 2005. Commercial. The 1989 –current commercial minimum retention size of 13 inches (33cm) is indicated by a dash grey line.

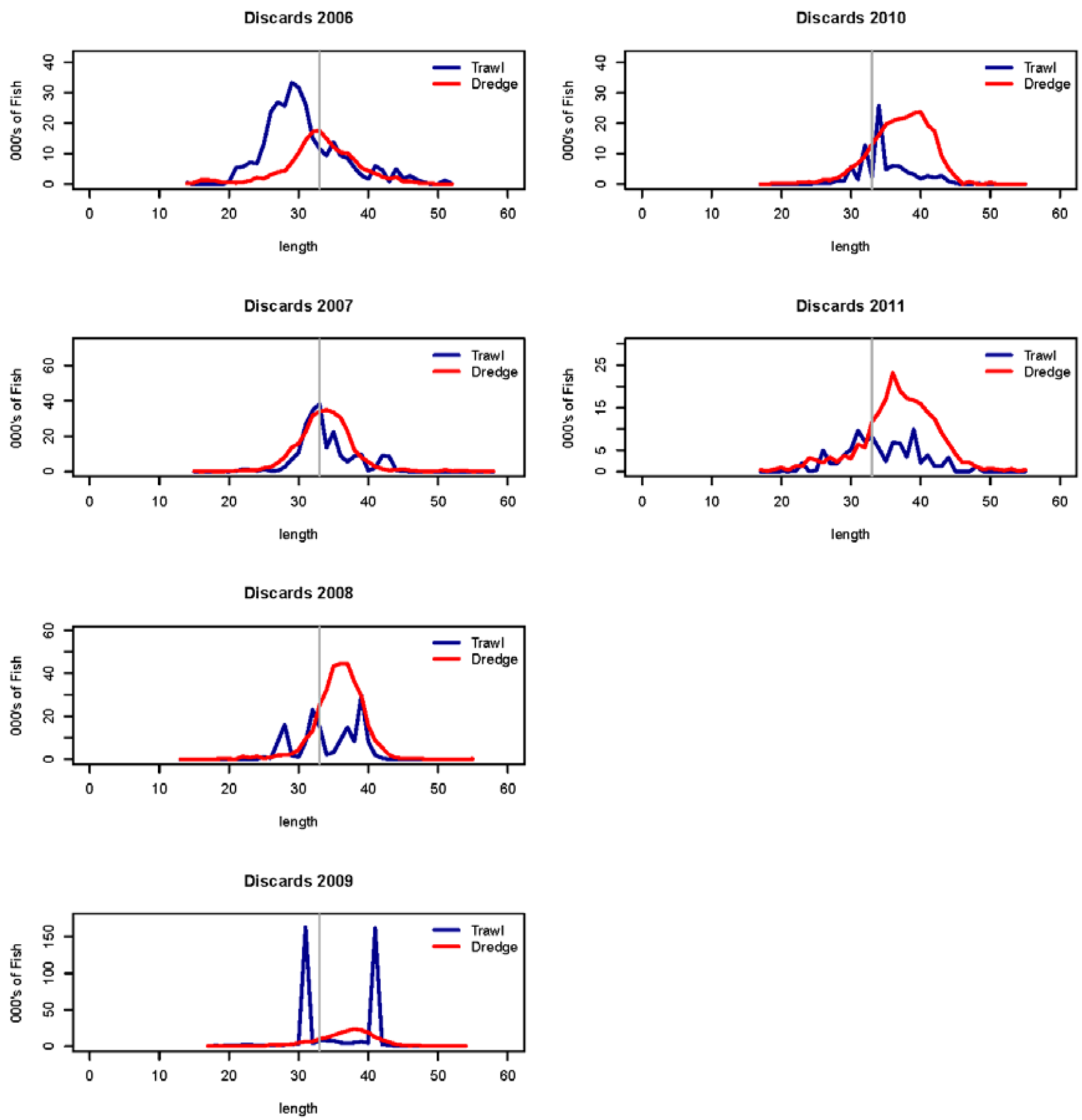


Figure B31b. (cont'd). Length frequency distribution of discarded Southern New England Mid-Atlantic yellowtail flounder by gear groupings (Trawl and Dredge) in 000's of fish from 2006 and 2011. The 1989 –current commercial minimum retention size of 13 inches (33cm) is indicated by a dash grey line.

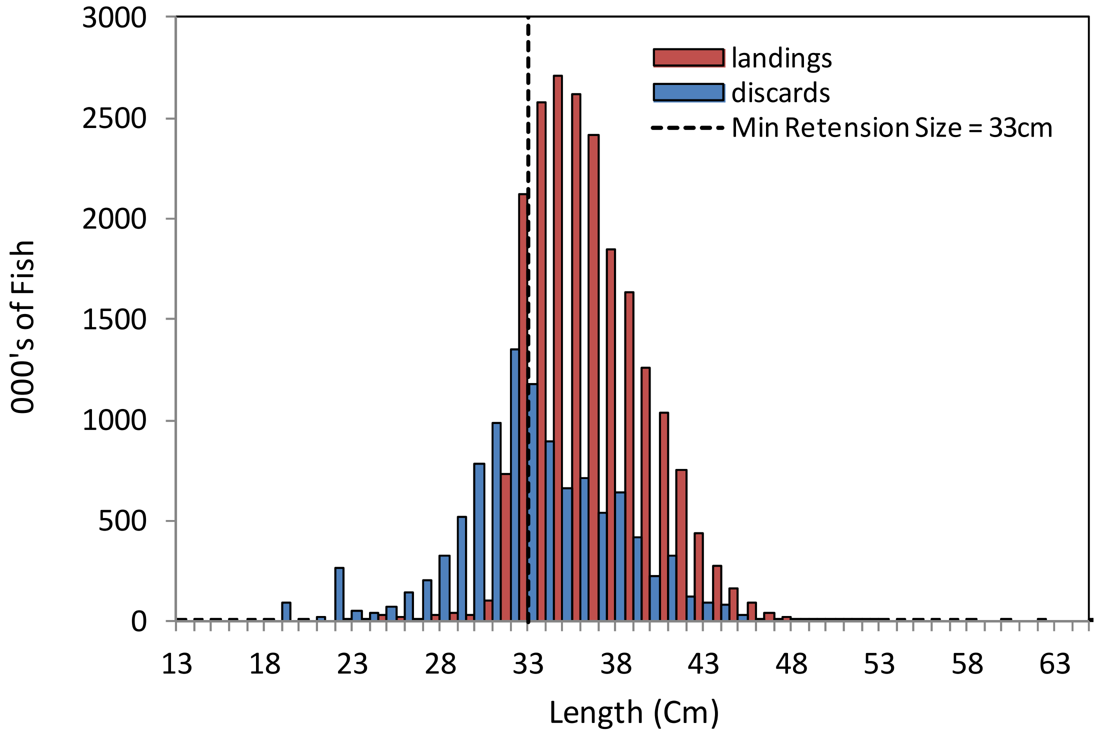


Figure B32. Length frequency distributions of Southern New England Mid-Atlantic yellowtail flounder in 000’s of fish caught in the commercial fishery from 1994 to 2011. The 1989 –current commercial minimum retention size of 13 inches (33cm) is indicated by a dash grey line.

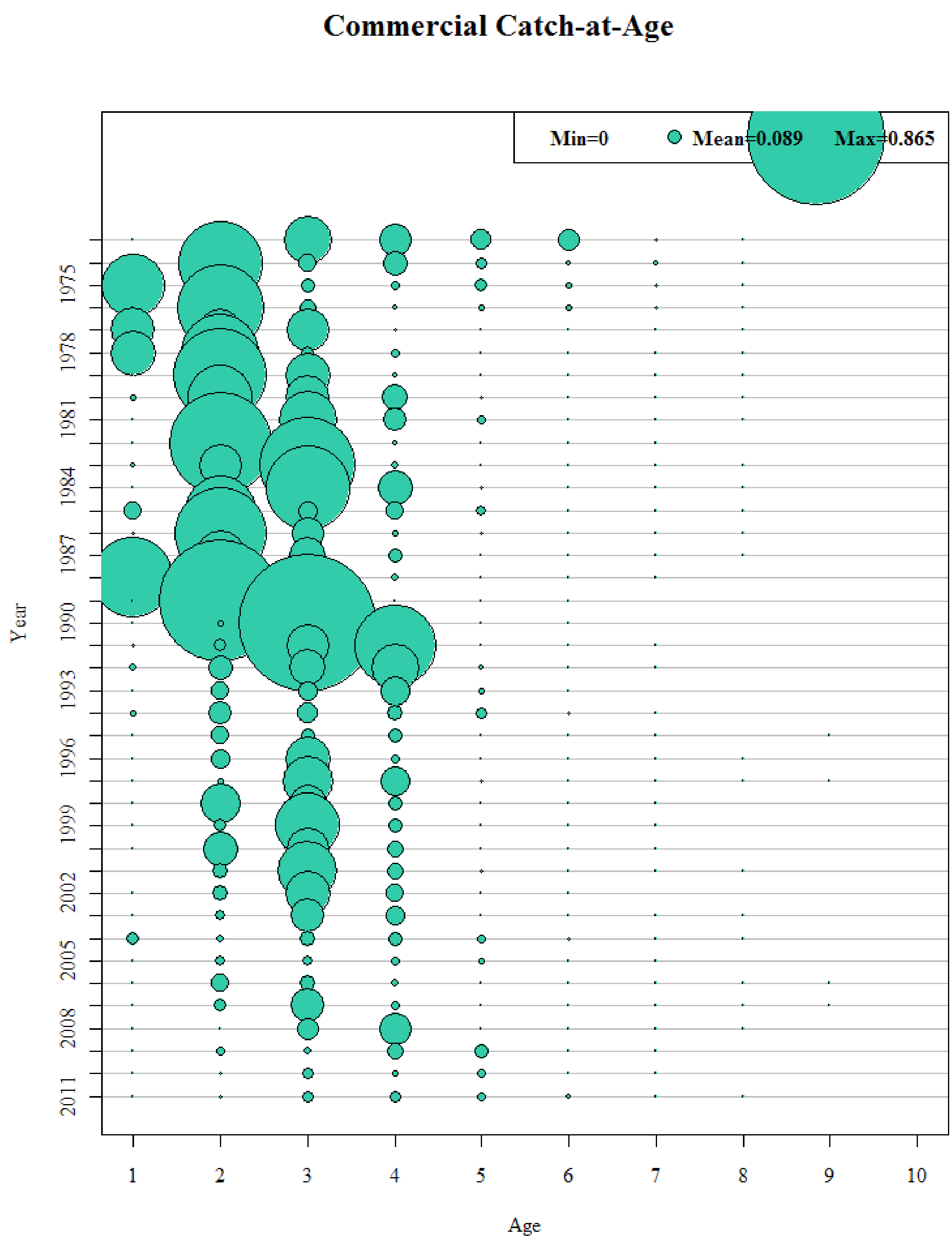


Figure B33. Commercial catch-at-age of Southern New England Mid-Atlantic yellowtail flounder from 1973 to 2011

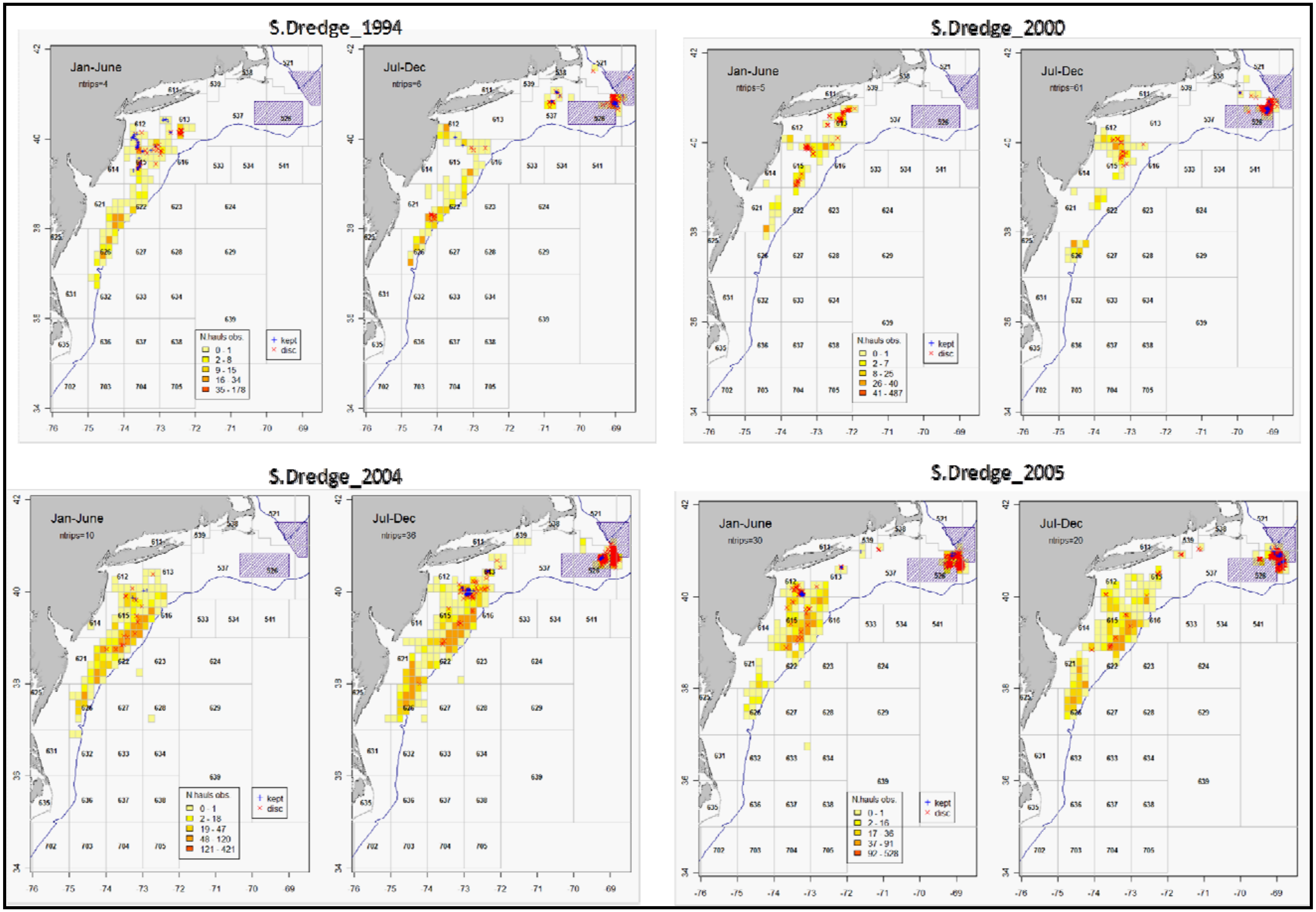


Figure B34. Spatial distributions of observed scallop dredge effort determined by the number of hauls by half year for selected years (1994, 2000 and 2004-2005) in the SNEMA region. Note: Observed kept and discarded yellowtail reflect general patterns of activity by the dredge fleet in the Southern New England Mid-Atlantic region and does not characterize the relative magnitude of the observed catches.

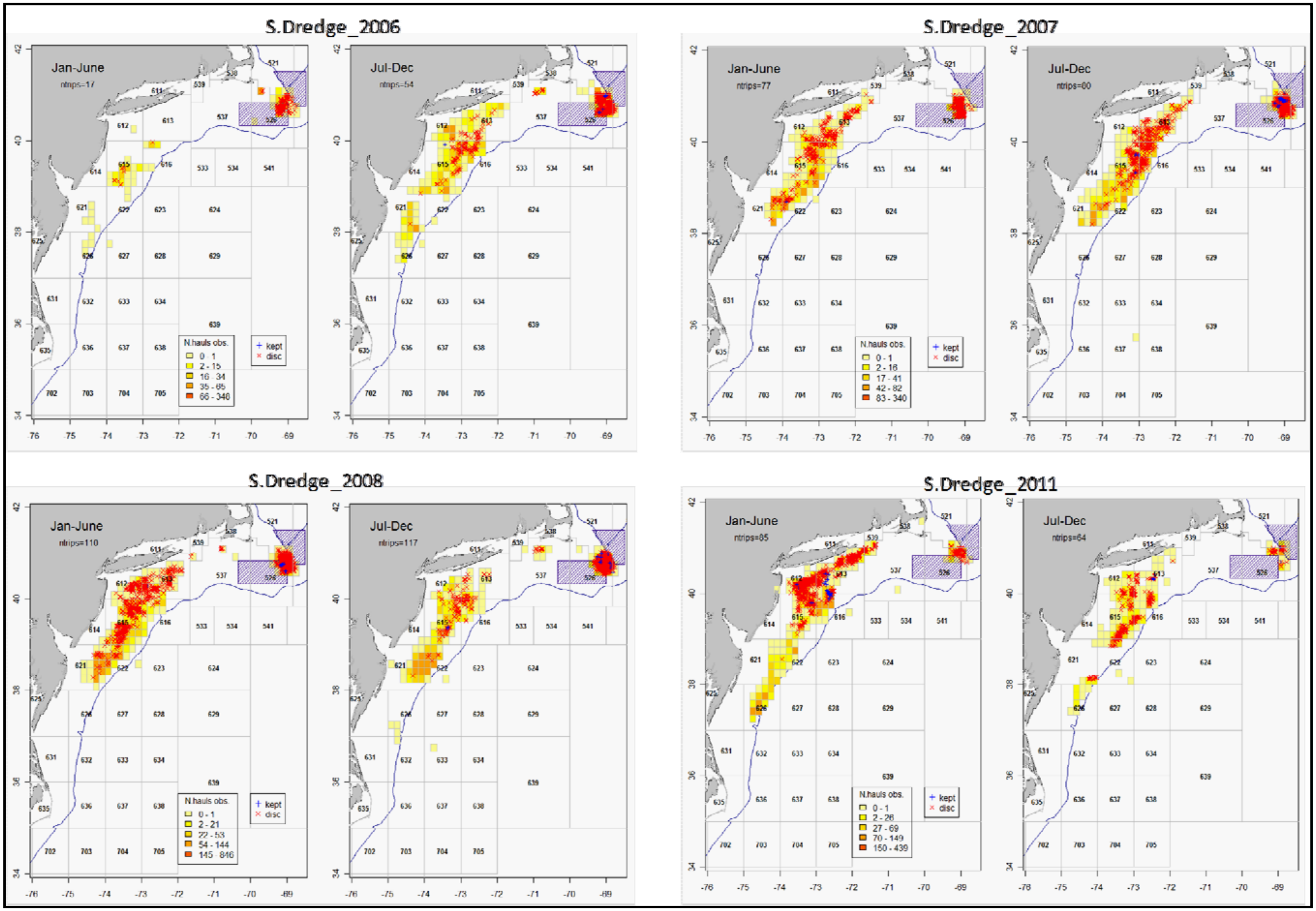


Figure B35. Spatial distributions of observed scallop dredge effort determined by the number of hauls by half year for selected years (2006-2008 and 2011) in the SNEMA stock region. Note: Observed kept and discarded yellowtail reflect general patterns of activity by the dredge fleet in the Southern New England Mid-Atlantic region and does not characterize the relative magnitude of the observed catches.

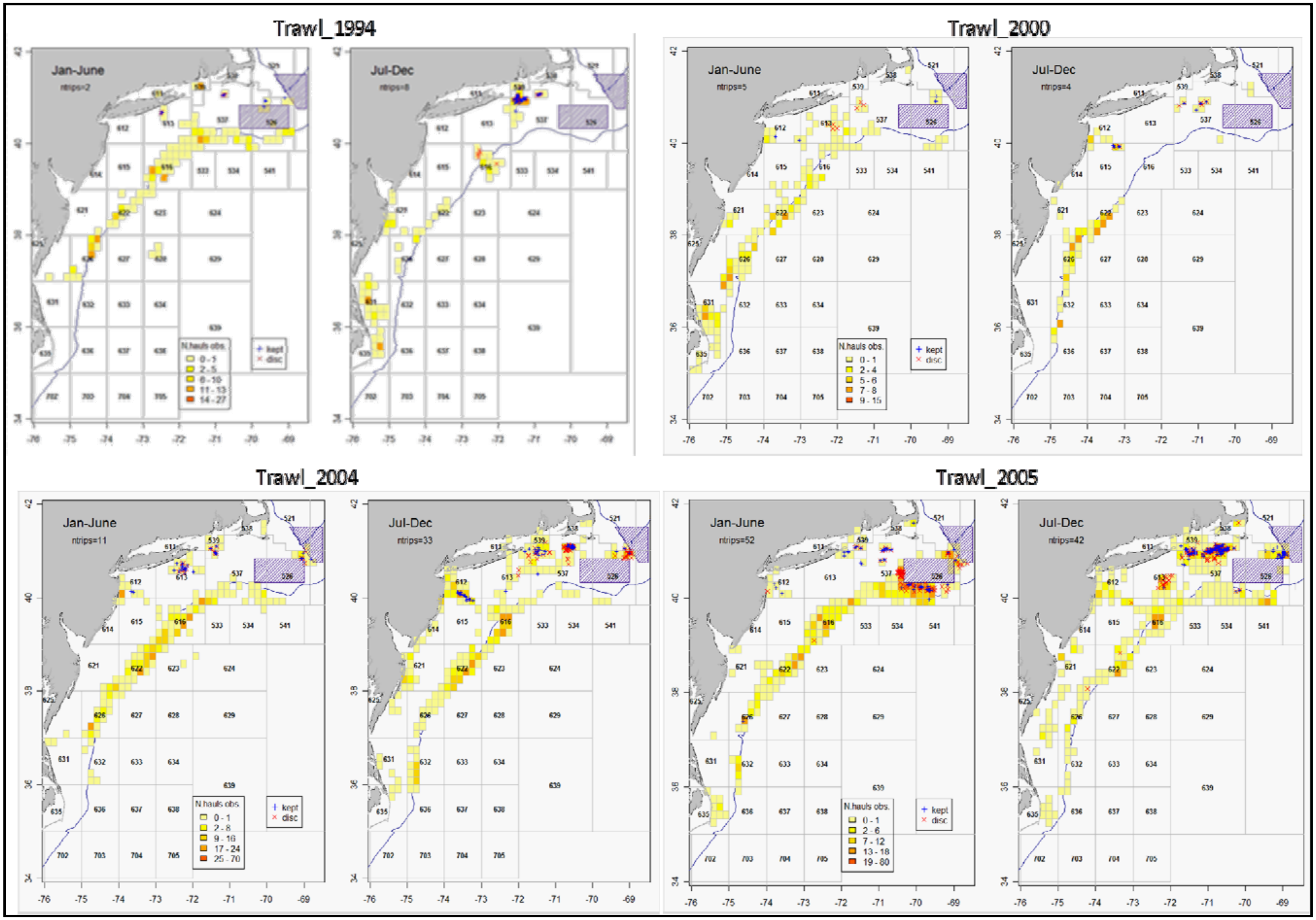


Figure B36. Spatial distributions of observed bottom trawl effort determined by the number of hauls by half year for selected years (1994, 2000 and 2004-2005)) in the SNEMA stock region. Note: Observed kept and discarded yellowtail reflect general patterns of activity by the dredge fleet in the Southern New England Mid-Atlantic region and does not characterize the relative magnitude of the observed catches.

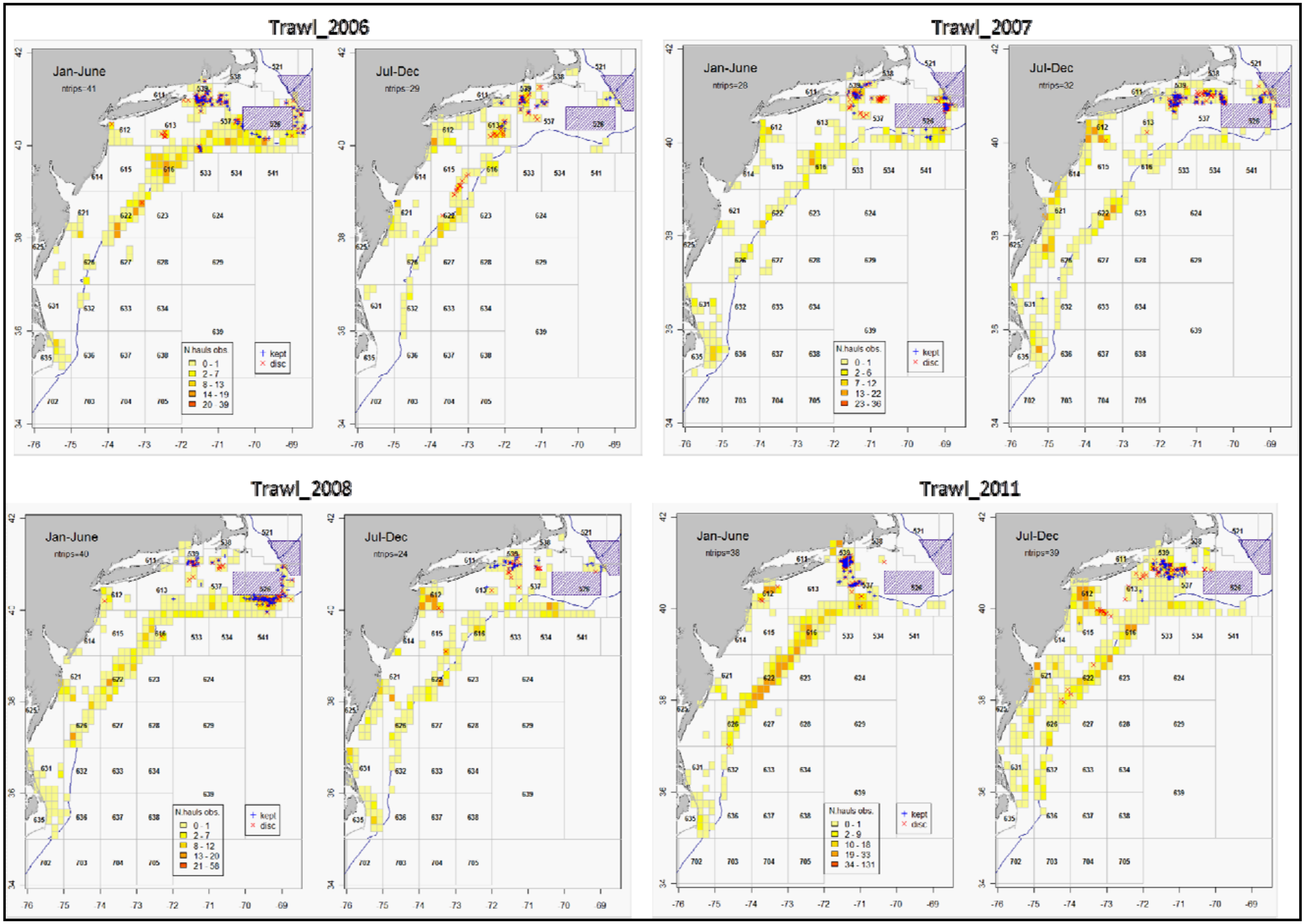


Figure B37. Spatial distributions of observed bottom trawl effort determined by the number of hauls by half year for selected years (2006-2008 and, 2011) in the SNEMA stock region. Note: Observed kept and discarded yellowtail reflect general patterns of activity by the dredge fleet in the Southern New England Mid-Atlantic region and does not characterize the relative magnitude of the observed catches.

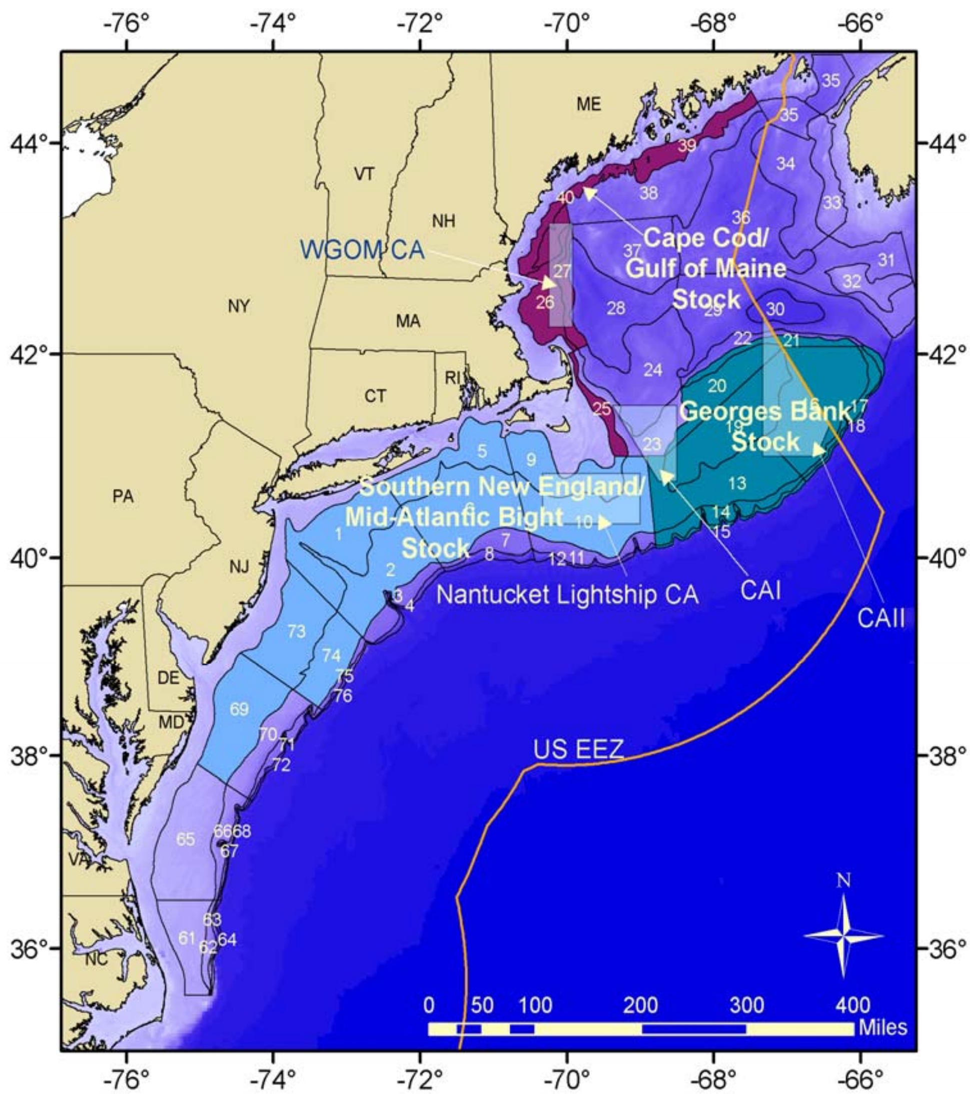


Figure B38. Map of the Northeast Fisheries Science Center (NEFSC) bottom trawl offshore survey strata included in the Southern New England Mid-Atlantic stock assessment. Strata include: (1, 2, 5, 6, 9, 10, 69, 73, and 74)

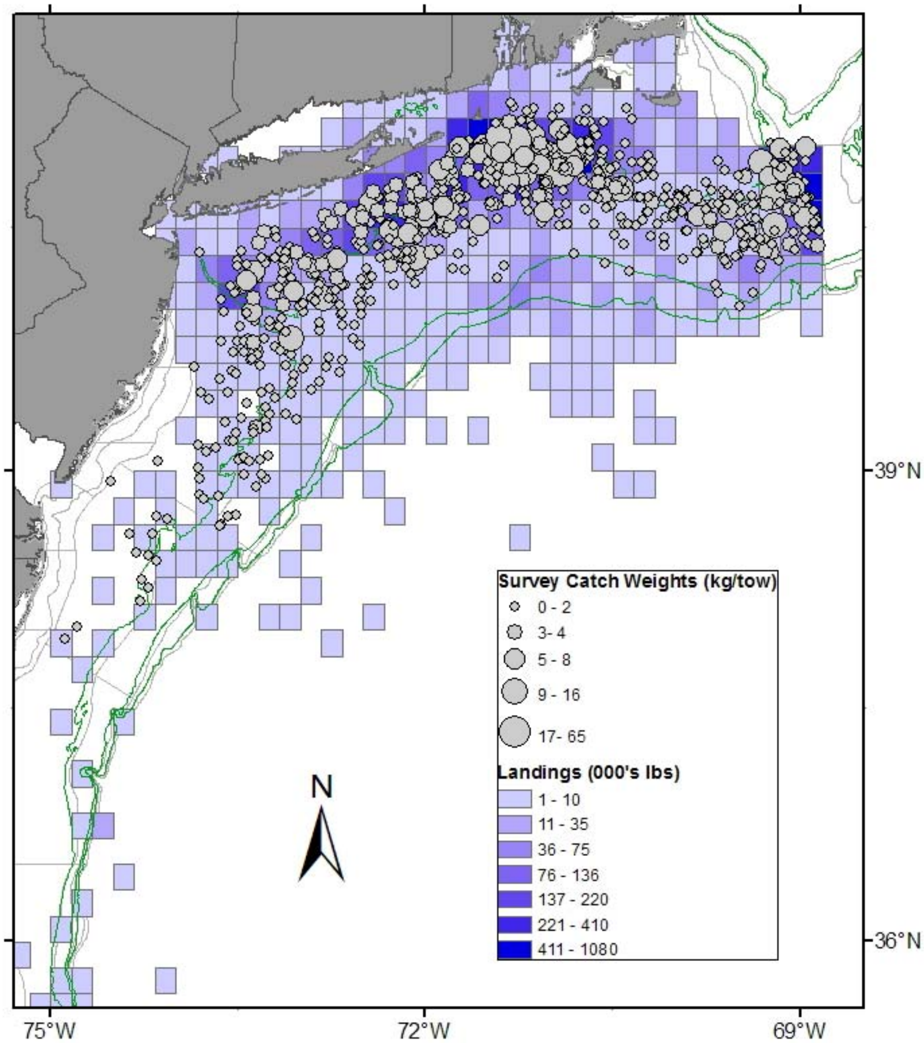


Figure 39. Spatial overlay of survey catches (kg/tow) from 1994-2011 of Southern New England Mid-Atlantic yellowtail flounder from the Northeast Fisheries Science Center (NEFSC) Bottom Trawl Survey (spring and fall combined) on commercial landings binned by ten minute squares for the same time period.

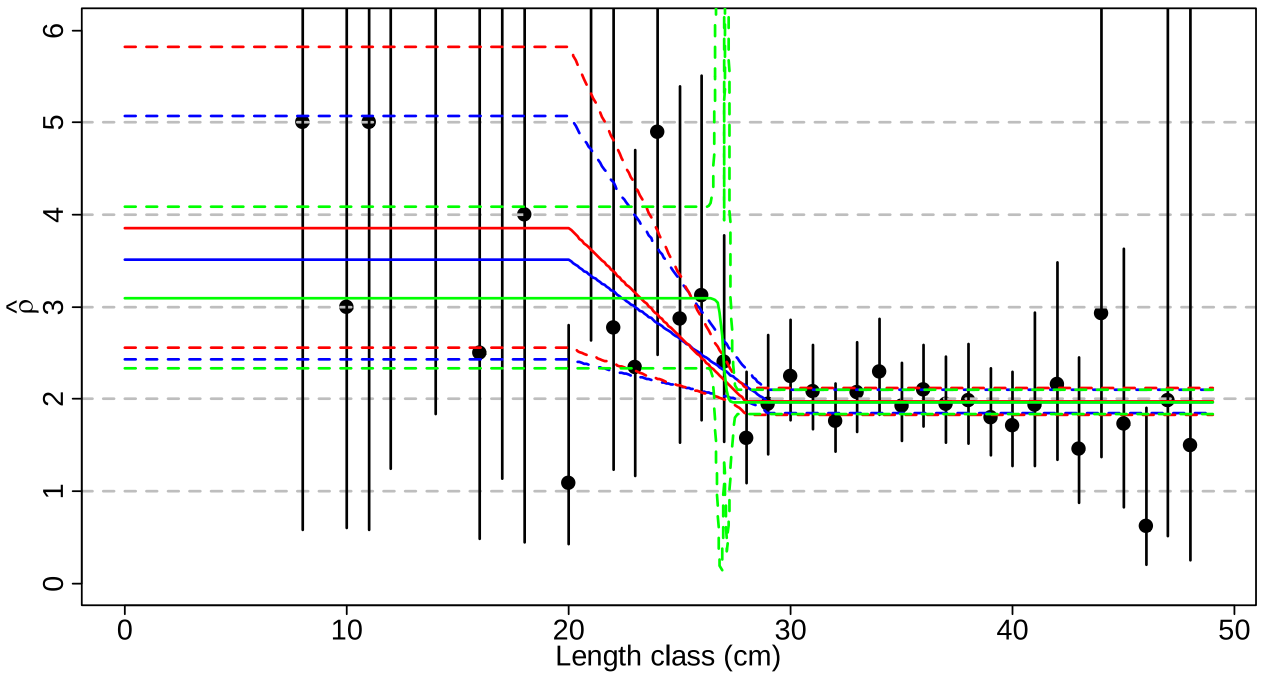


Figure B40. Beta-binomial based estimates of calibration factors and corresponding 95% confidence intervals by length class (1 cm bins) for yellowtail flounder. The black points and vertical bars represent results where different calibration factors are estimated for each length class. The blue lines represent results from a segmented regression model where the two points connecting the segments are known (20 and 29 cm), the red lines represent results from a segmented regression model where the first point (20 cm) is known but the second is estimated, and the green lines represent results from the logistic model. Segmented-regression and logistic model fits are based on data from fish ≥20 cm.

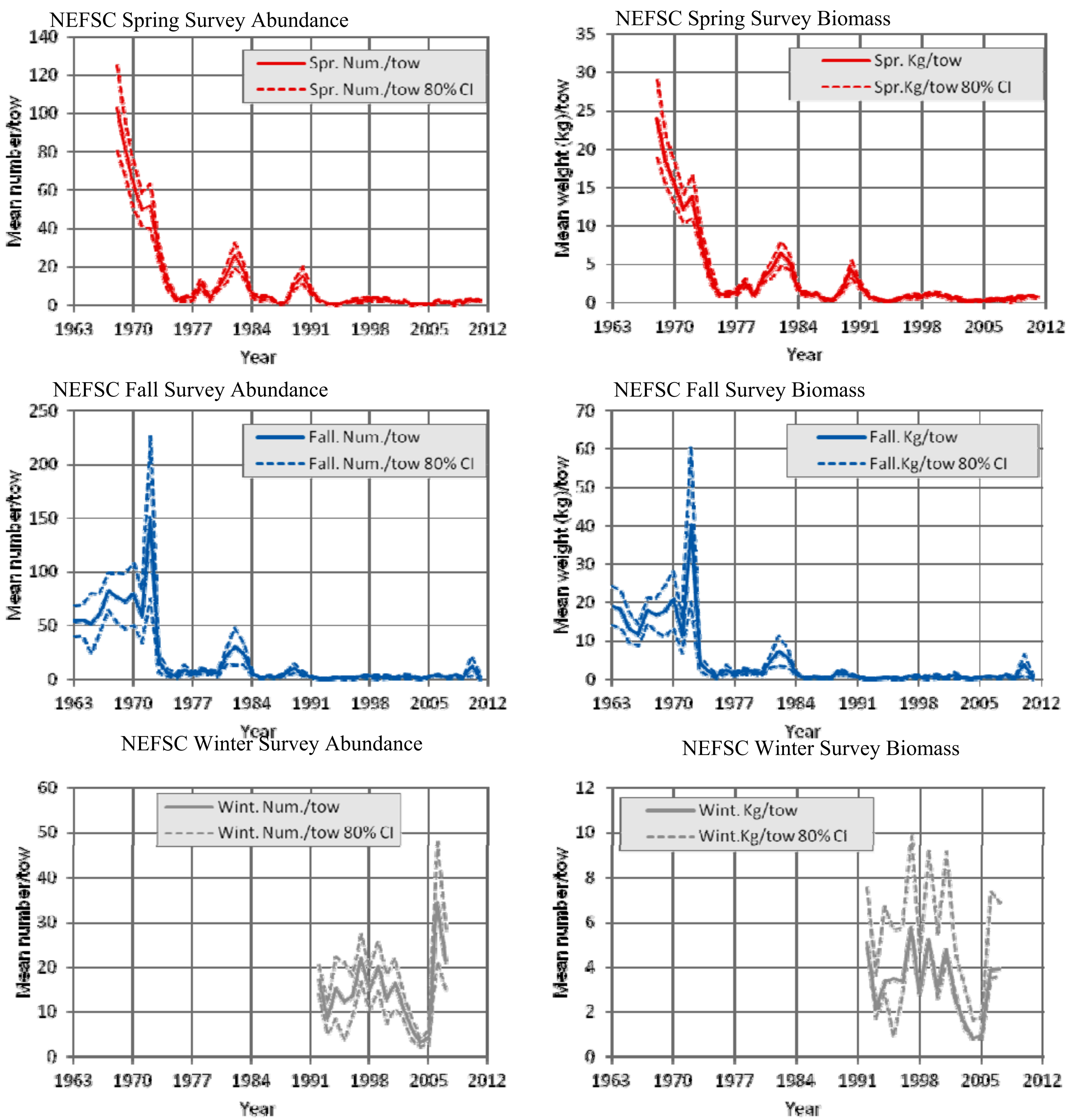


Figure B41. Northeast Fisheries Science Center Spring (Top Panels), Fall (Middle Panels) and Winter (Bottom panels) survey indices of abundance (left panels) and biomass (right panels) showing both Bigelow unconverted indices for the fall and spring (08-11) and converted indices in Albatross units for Southern New England Mid-Atlantic yellowtail flounder.

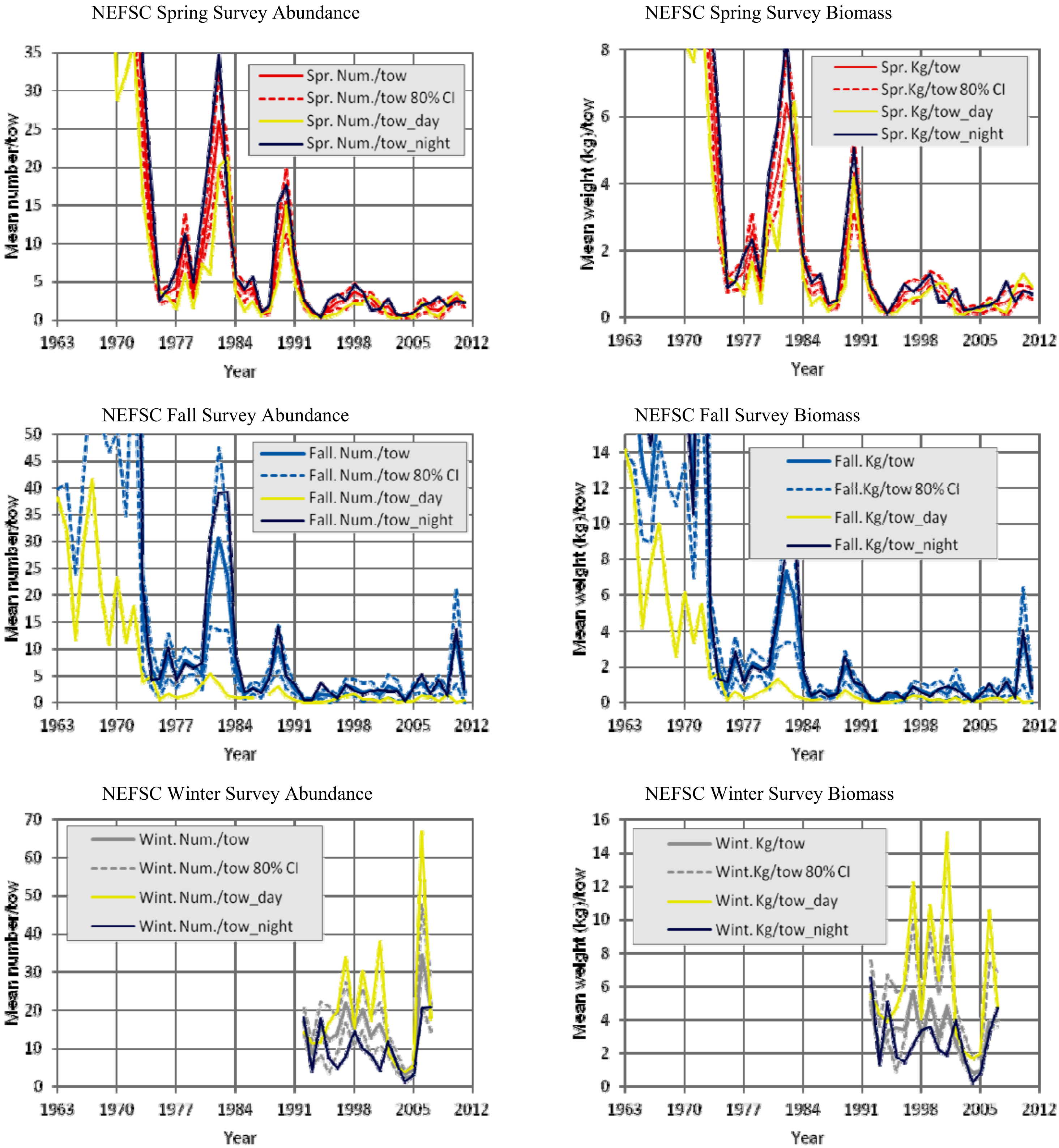
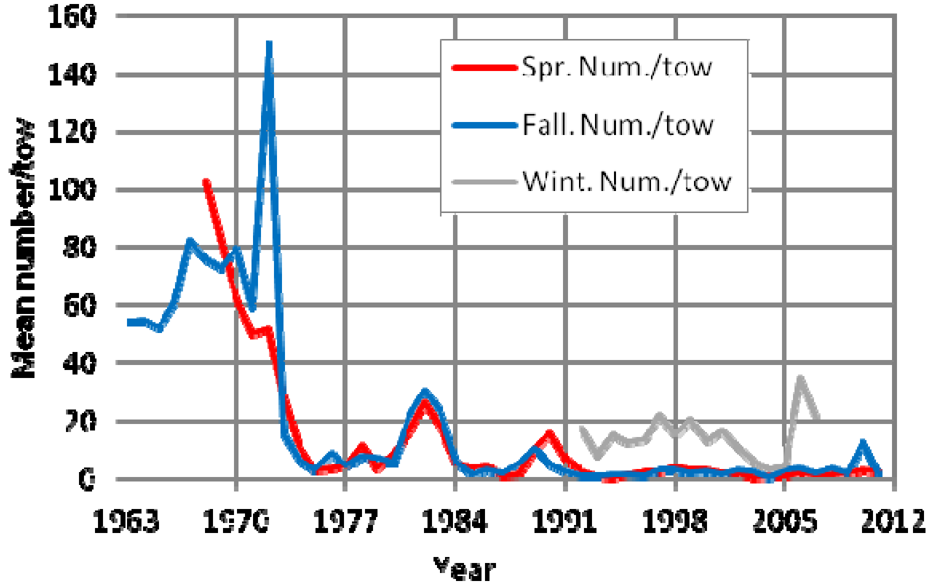


Figure B42. Northeast Fisheries Science Center Spring (top panels), Fall (Middle panels) and Winter (bottom panels) survey indices of abundance (left panels) and biomass (right panels) disaggregated by day and night only tows compared to the aggregate index (day and night combined) and its associated 80% confidence interval.

NEFSC Survey Abundance



NEFSC Survey Biomass

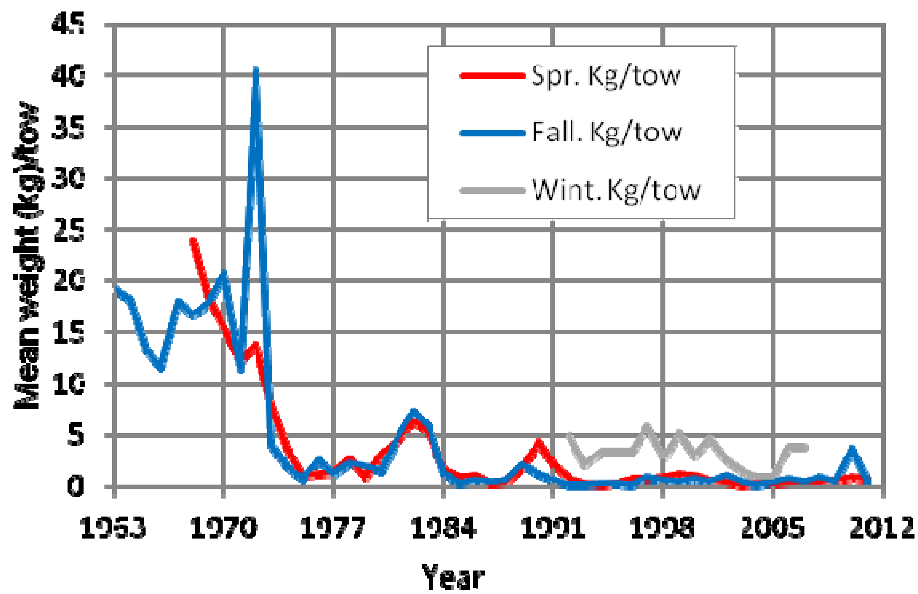
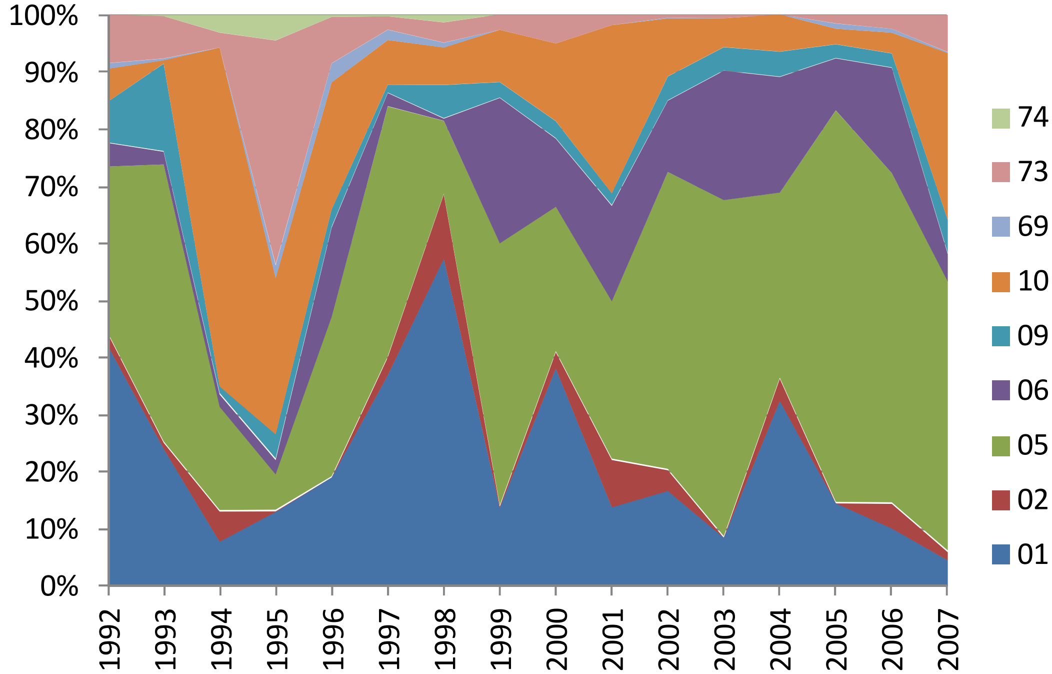


Figure B43. Northeast Fisheries Science Center spring, winter and fall bottom trawl survey of abundance (top) and biomass (bottom) from 1963 to 2011 for Southern New England Mid-Atlantic yellowtail flounder. Note: Spring survey did not begin until 1968 and the winter survey started in 1992 and ended in 2007

NEFSC Winter survey abundance contribution by Strata



NEFSC Winter Survey biomass contribution by Strata

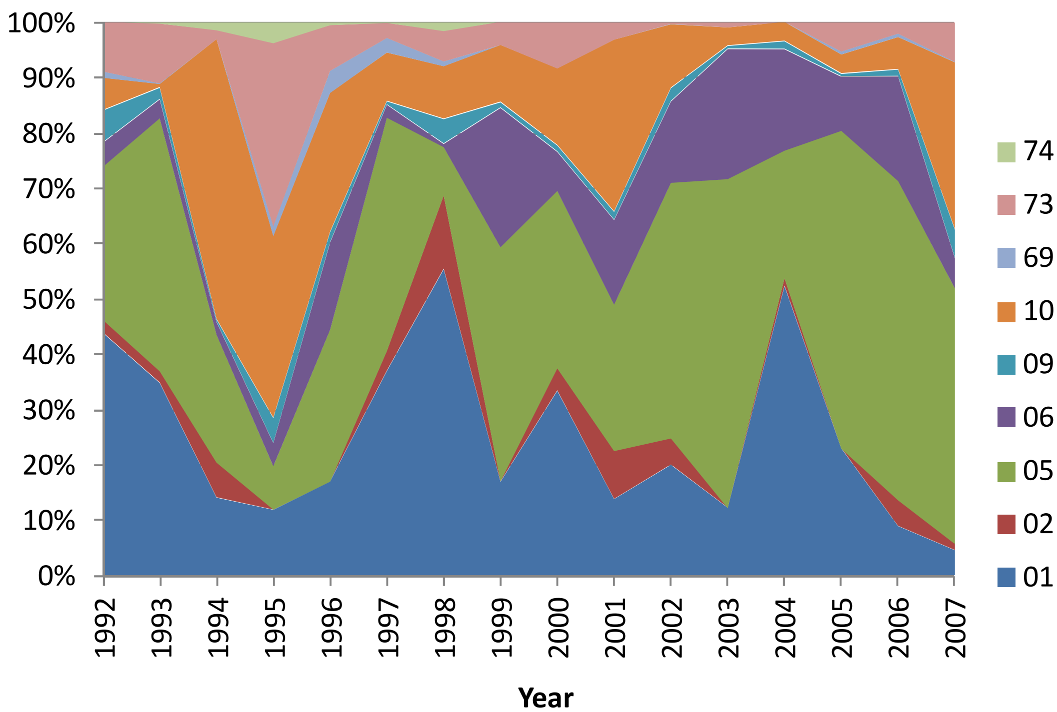


Figure B44. Northeast Fisheries Science Center winter trawl survey indices, expressed as proportions of abundance (Top) and biomass (Bottom) by strata from 1992 to 2007.

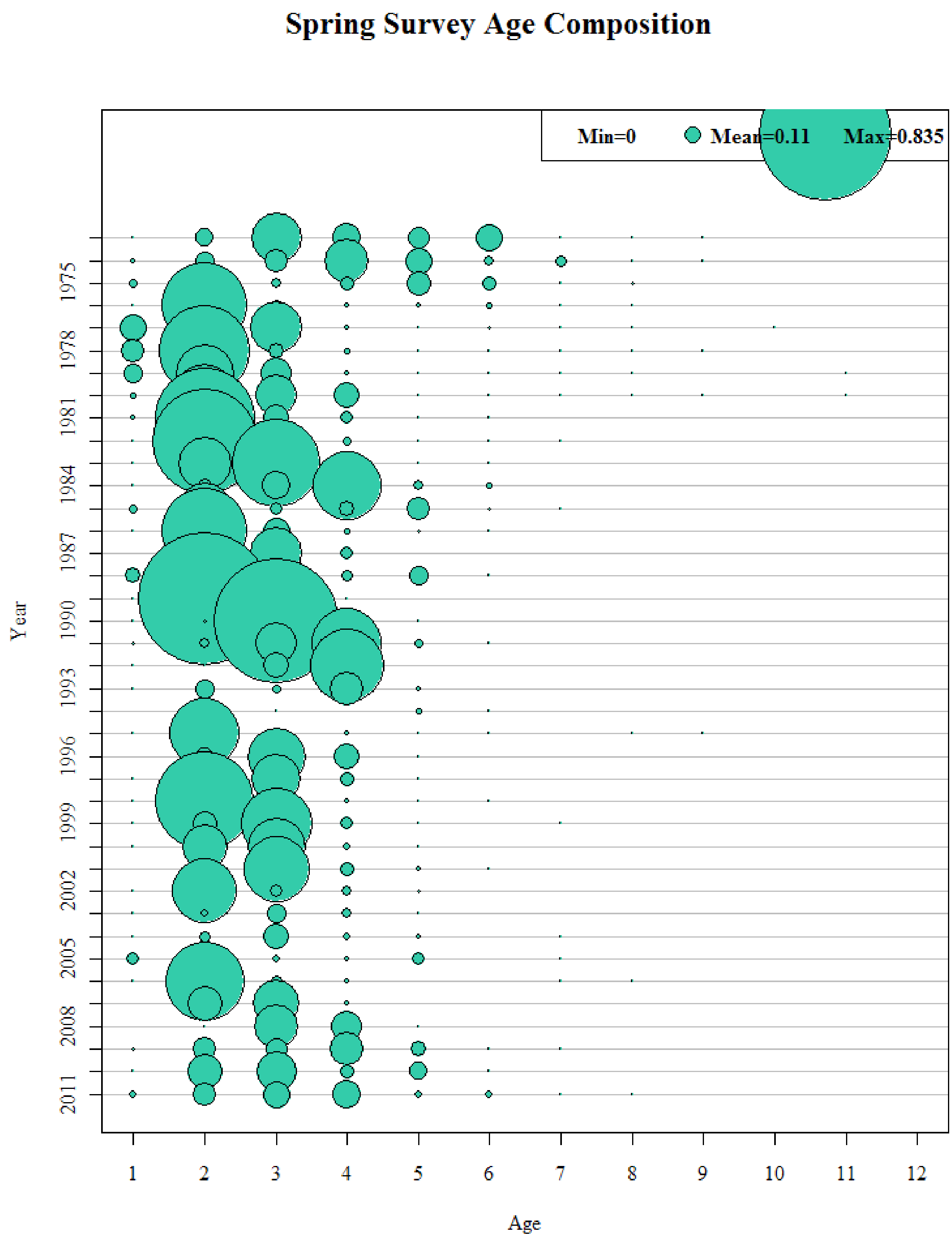


Figure B45. Numbers at age from the Northeast Fisheries Science Center (NEFSC) Spring bottom trawl survey, 1963-2011 for Southern New England Mid-Atlantic yellowtail flounder

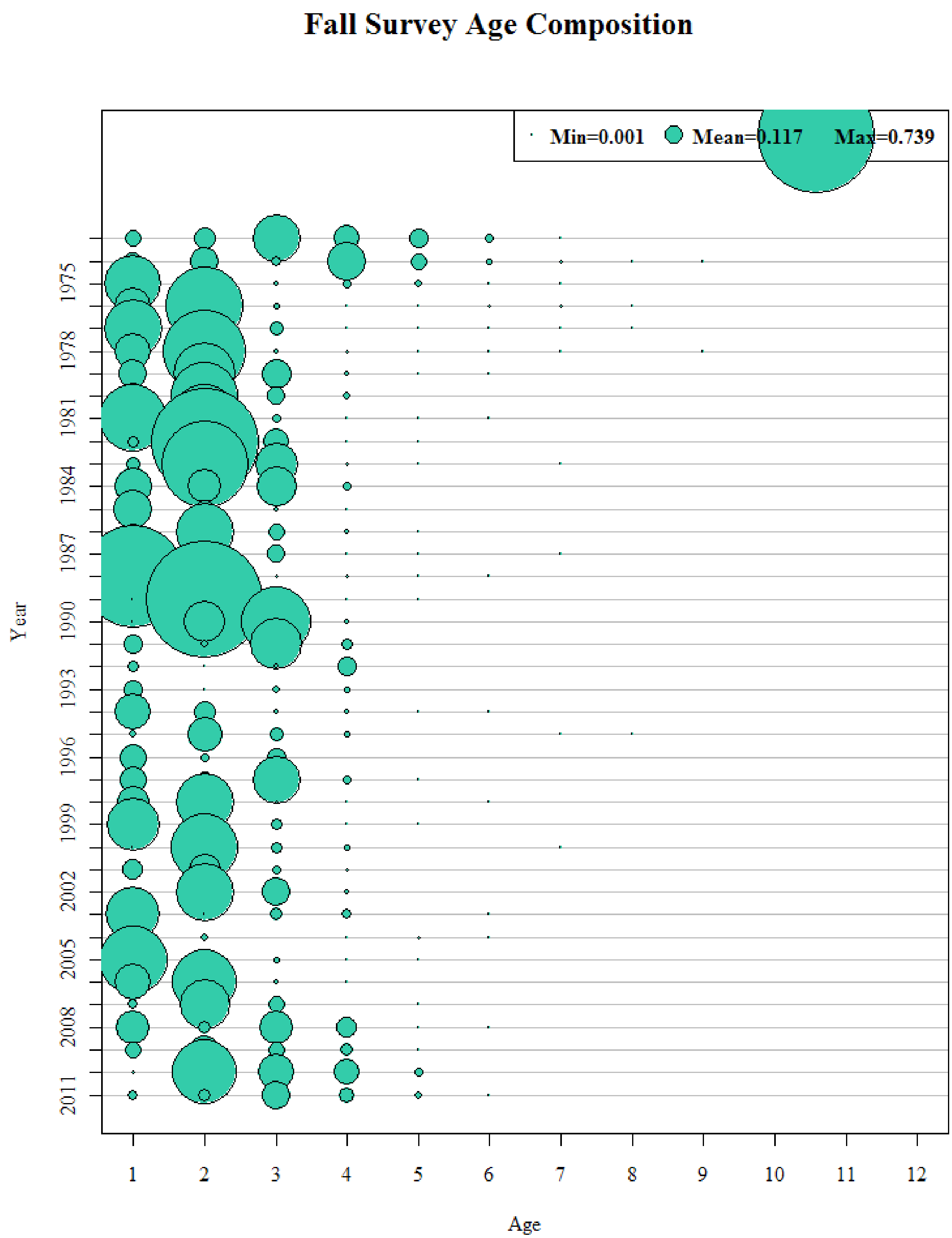


Figure B46. Numbers at age from the Northeast Fisheries Science Center (NEFSC) Fall bottom trawl survey, 1992-2007 for Southern New England Mid-Atlantic yellowtail flounder

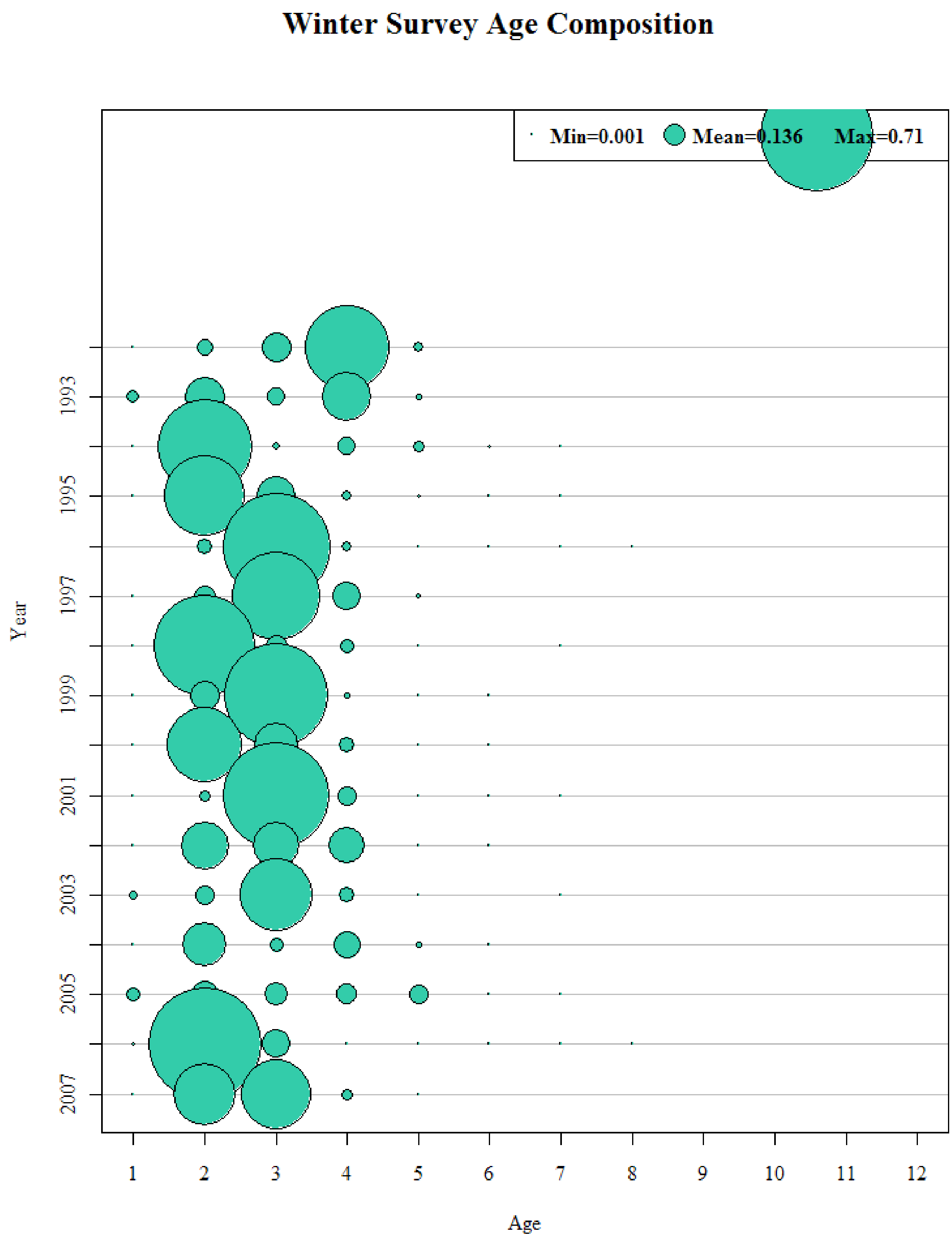


Figure B47. Numbers at age from the Northeast Fisheries Science Center (NEFSC) winter bottom trawl survey, 1968-2011 for Southern New England Mid-Atlantic yellowtail flounder

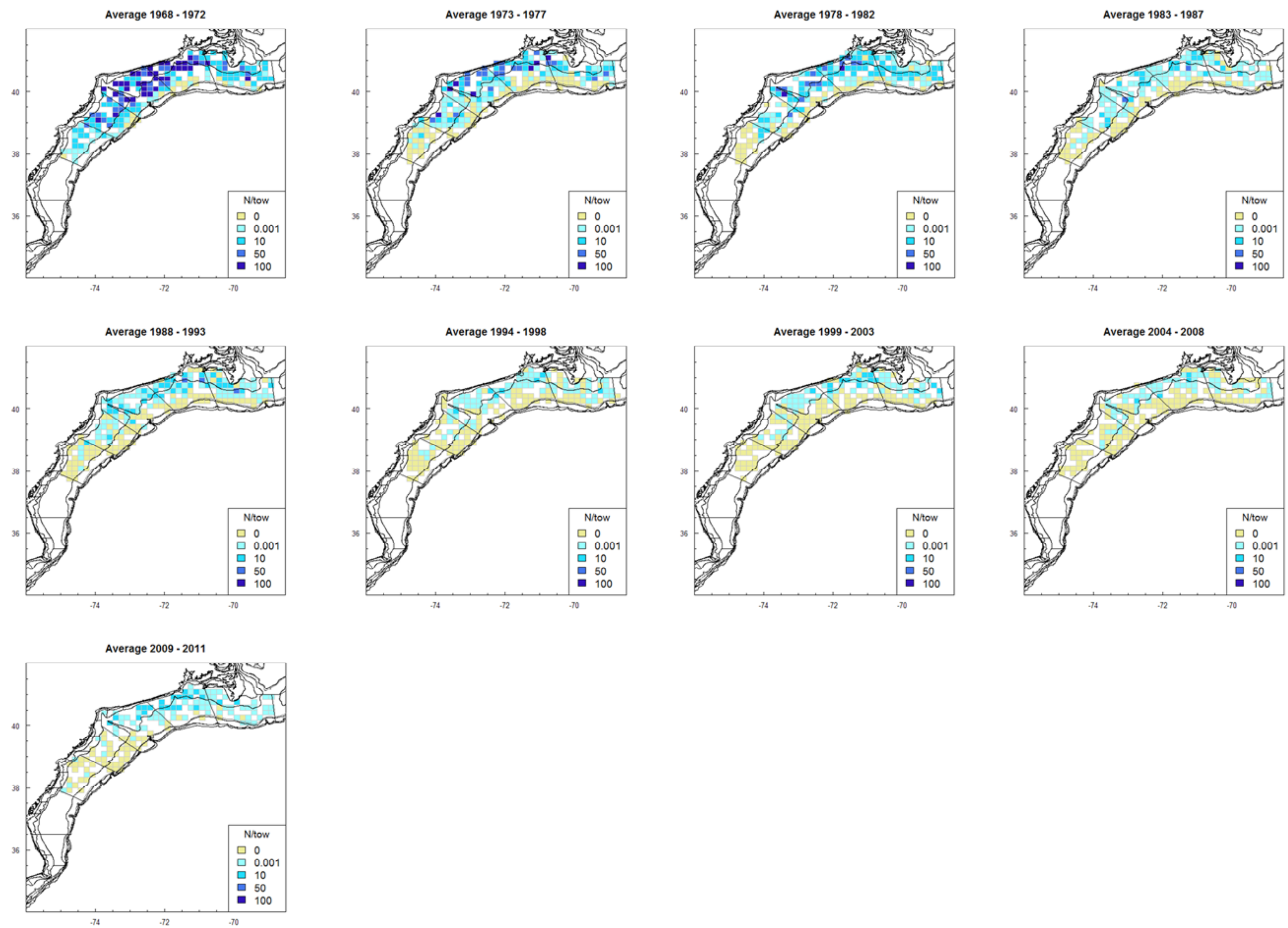


Figure B48. Southern New England Mid-Atlantic yellowtail flounder Spring survey distribution of (numbers per tow) from the Northeast Fisheries Science Center (NEFSC) bottom trawl survey from 1968-2011

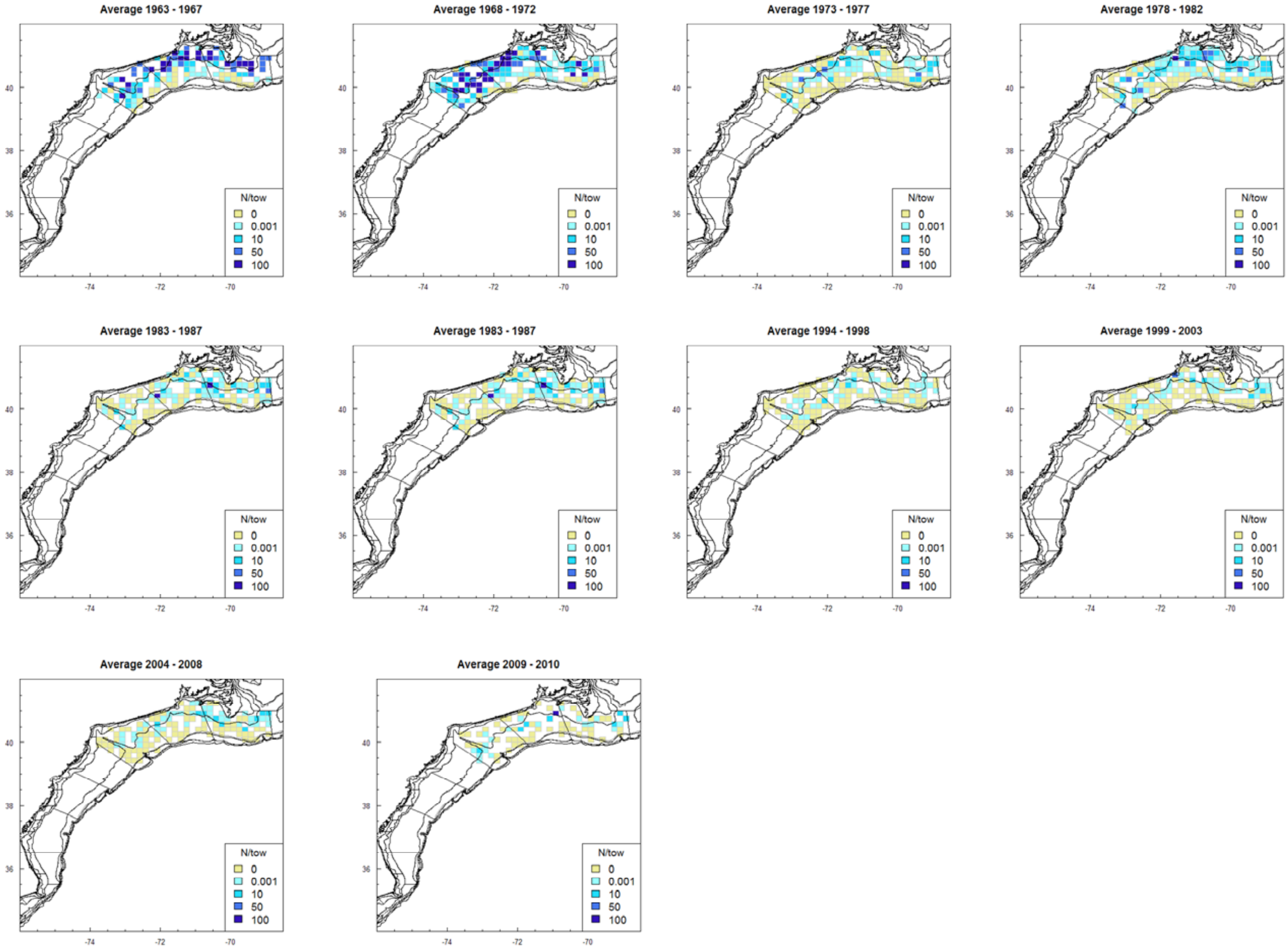


Figure B49. Southern New England Mid-Atlantic yellowtail flounder Fall distribution (numbers per tow) from the Northeast Fisheries Science Center (NEFSC) bottom trawl survey from 1963-2010. Note: *Fall 2011 data was not available when maps were created.*

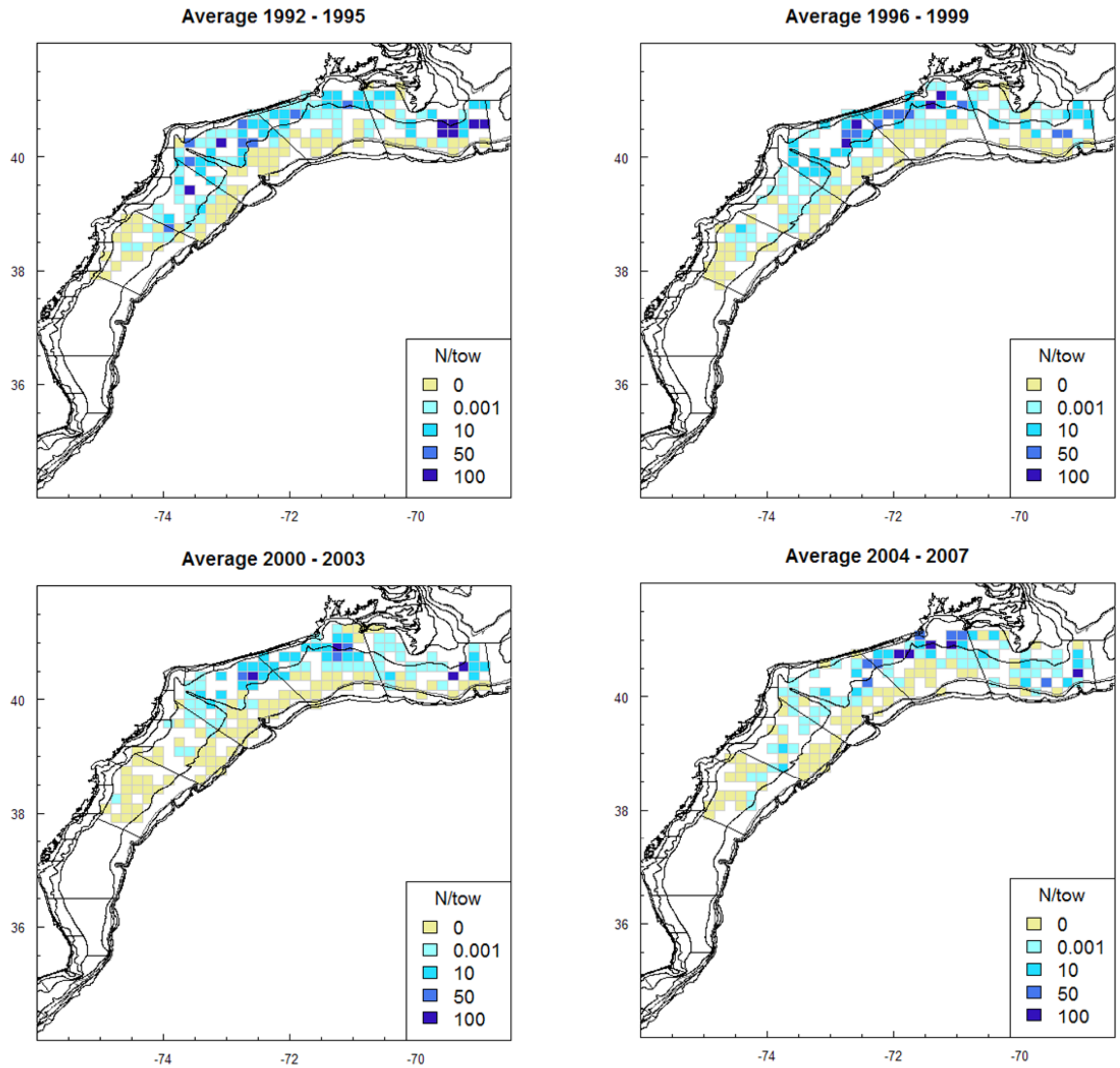


Figure B50. Southern New England Mid-Atlantic yellowtail flounder winter distribution (numbers per tow) from the Northeast Fisheries Science Center (NEFSC) bottom trawl survey 1992-2007

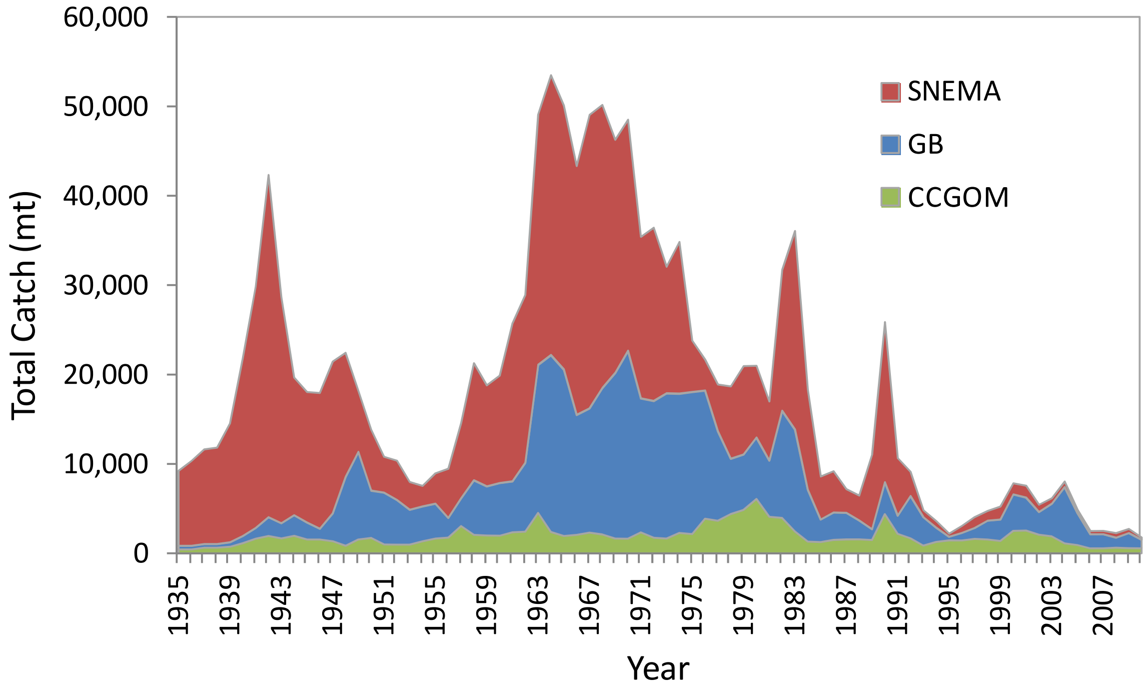


Figure B51. Total commercial catch of yellowtail flounder from 1935 to 2010 off the northeast U.S.

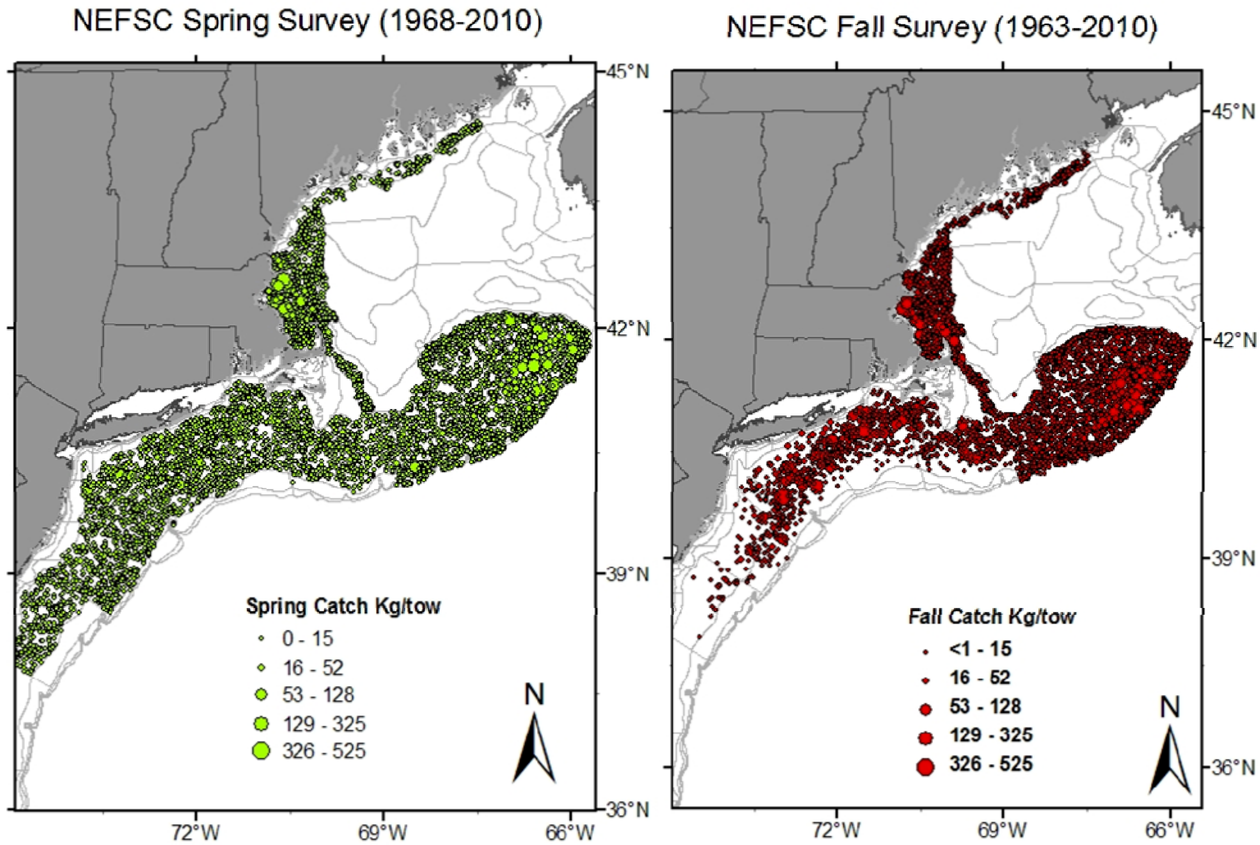


Figure B52. Geographic distribution of yellowtail flounder caught from the NEFSC fall and spring bottom trawl surveys combined from 1963-2011

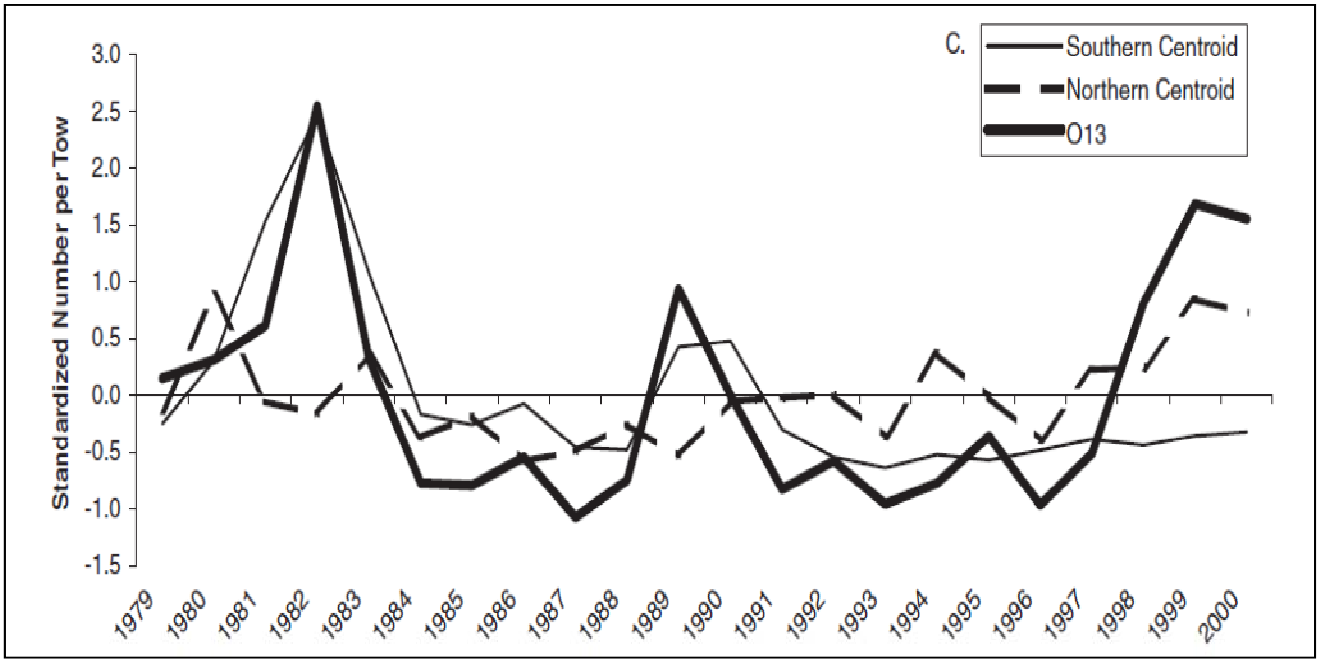


Figure B53. Standardized number per tow of yellowtail flounder in the northern strata and southern strata and "transitional stratum "O13" adapted from Cadrin 2010.

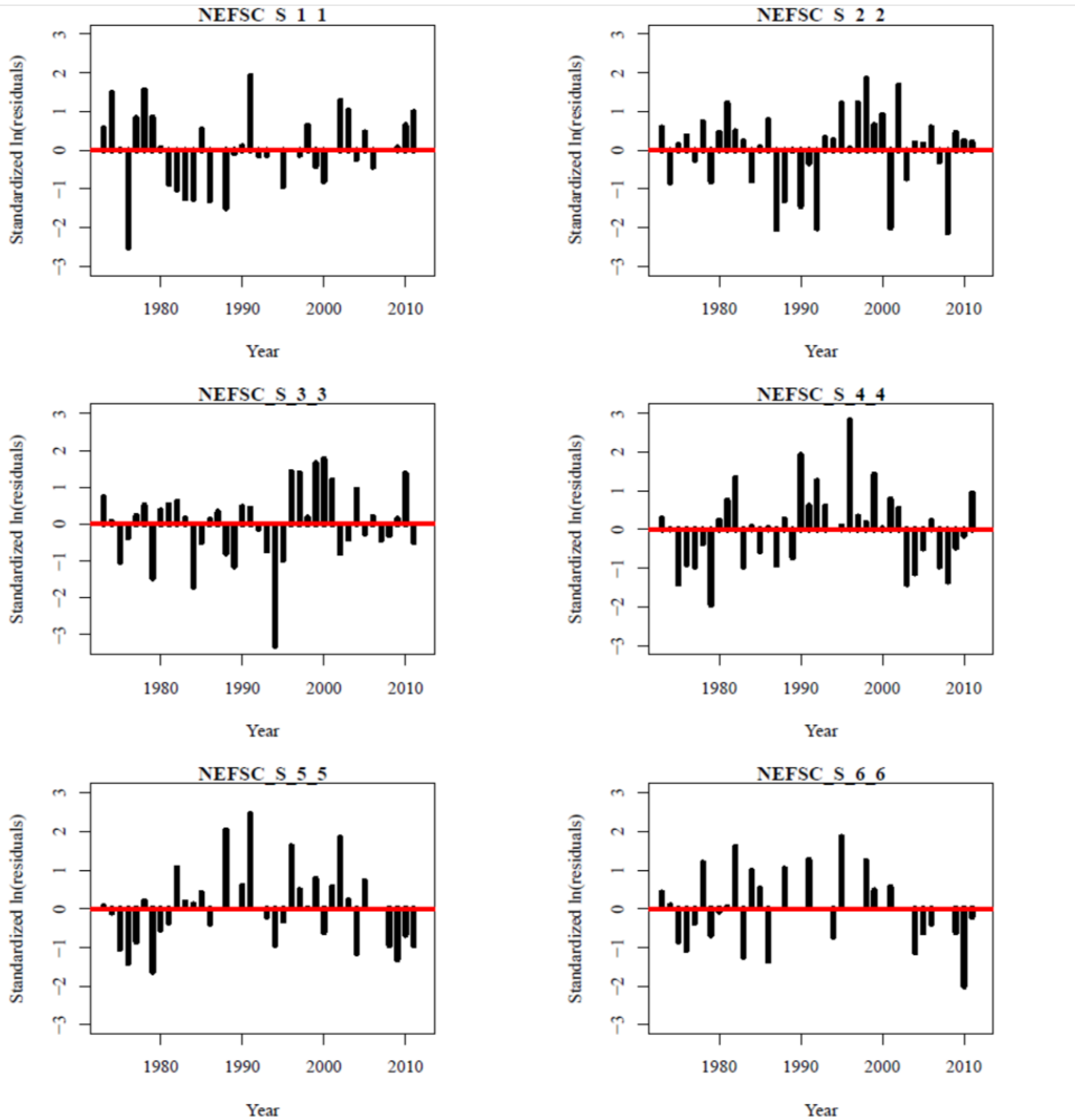


Figure B54. ADAPT-VPA Model 20 residual to the survey fits of the Northeast Fisheries Science Center Spring Southern New England Mid-Atlantic yellowtail flounder survey ages 1 through 6+

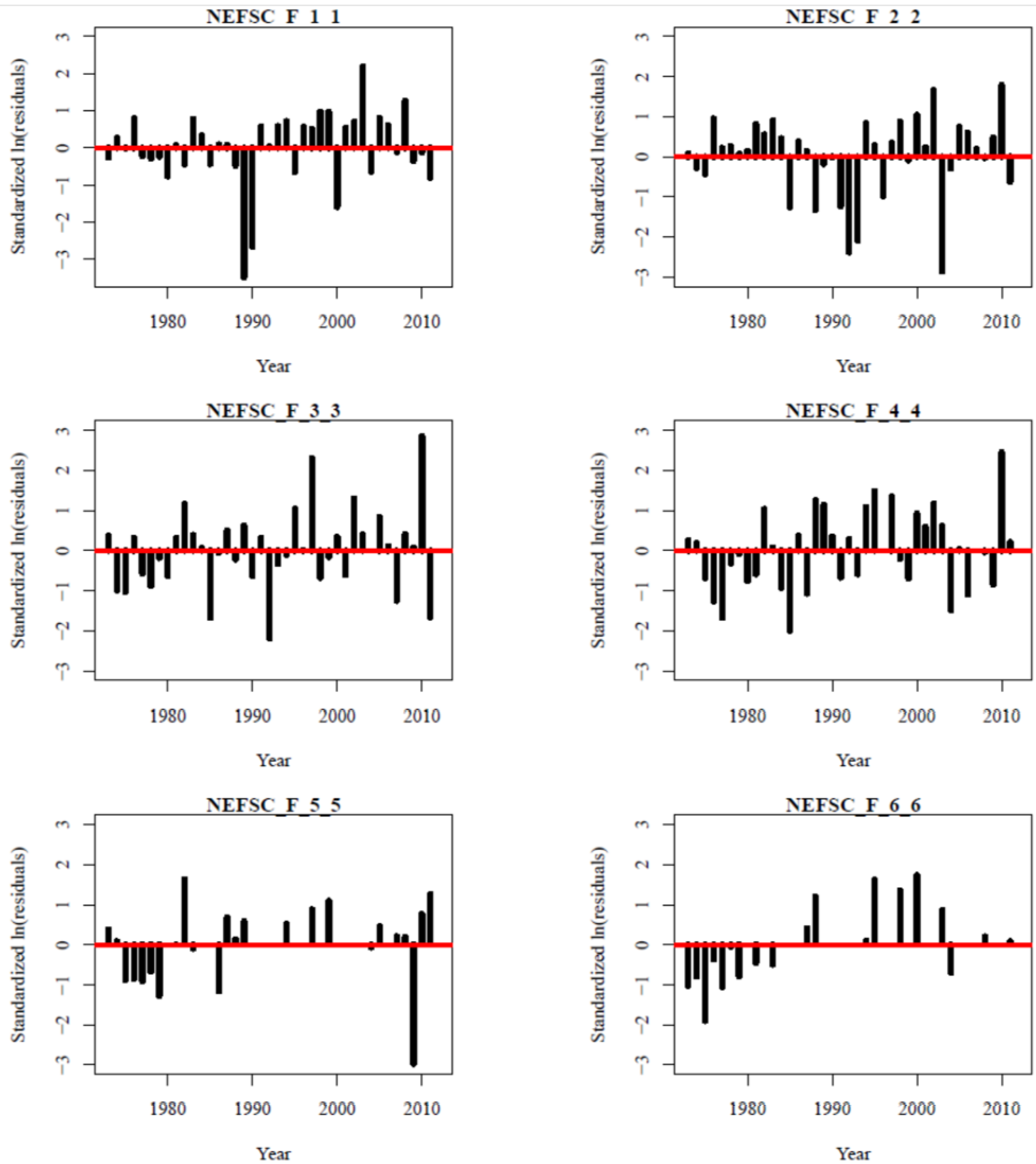


Figure B55. ADAPT-VPA Model 20 residual to the survey fits of the Northeast Fisheries Science Center Fall Southern New England Mid-Atlantic yellowtail flounder survey ages 1 through 6+

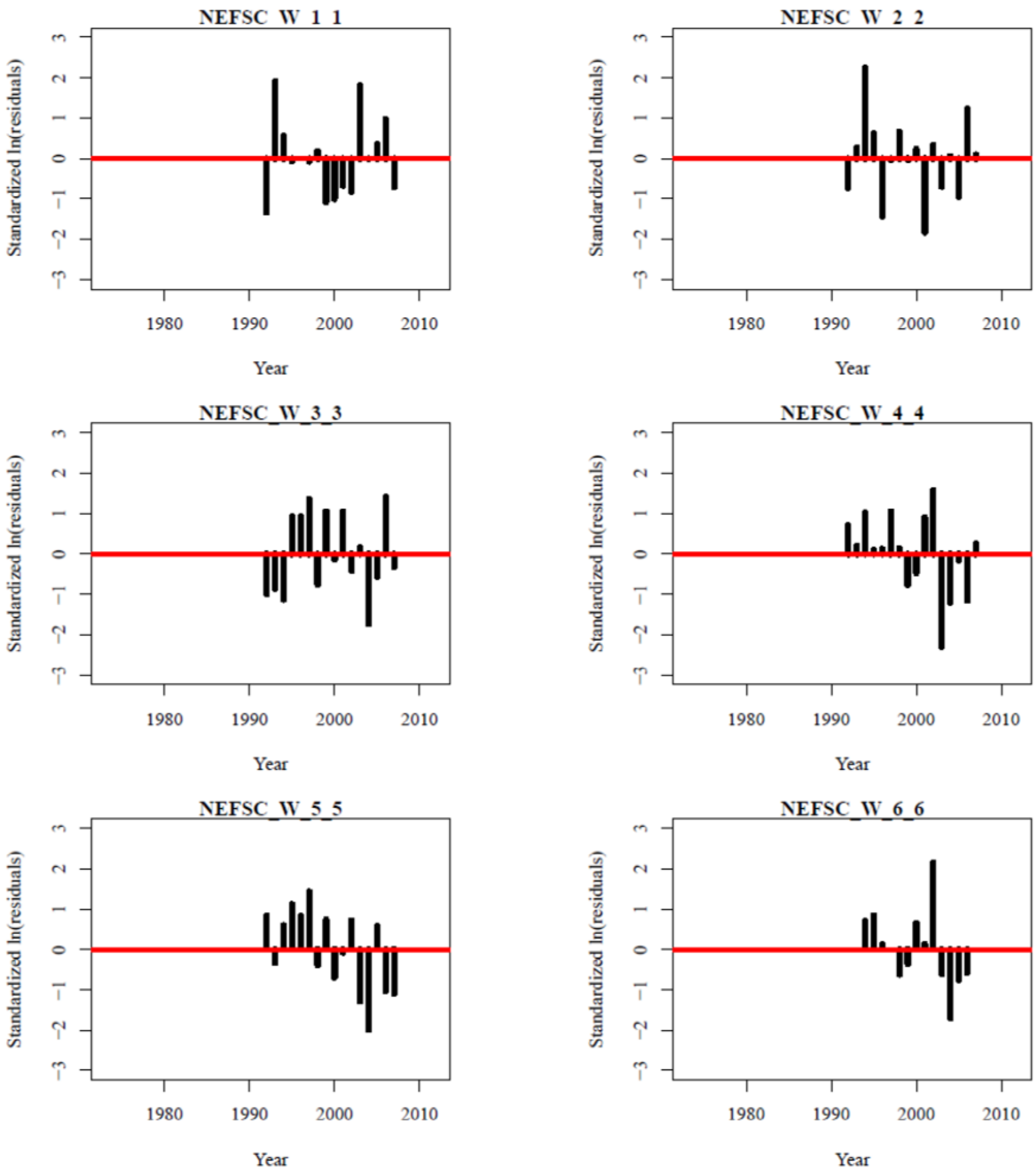


Figure B56. ADAPT-VPA Model 20 residual to the survey fits of the Northeast Fisheries Science Center Winter Southern New England Mid-Atlantic yellowtail flounder survey ages 1 through 6+

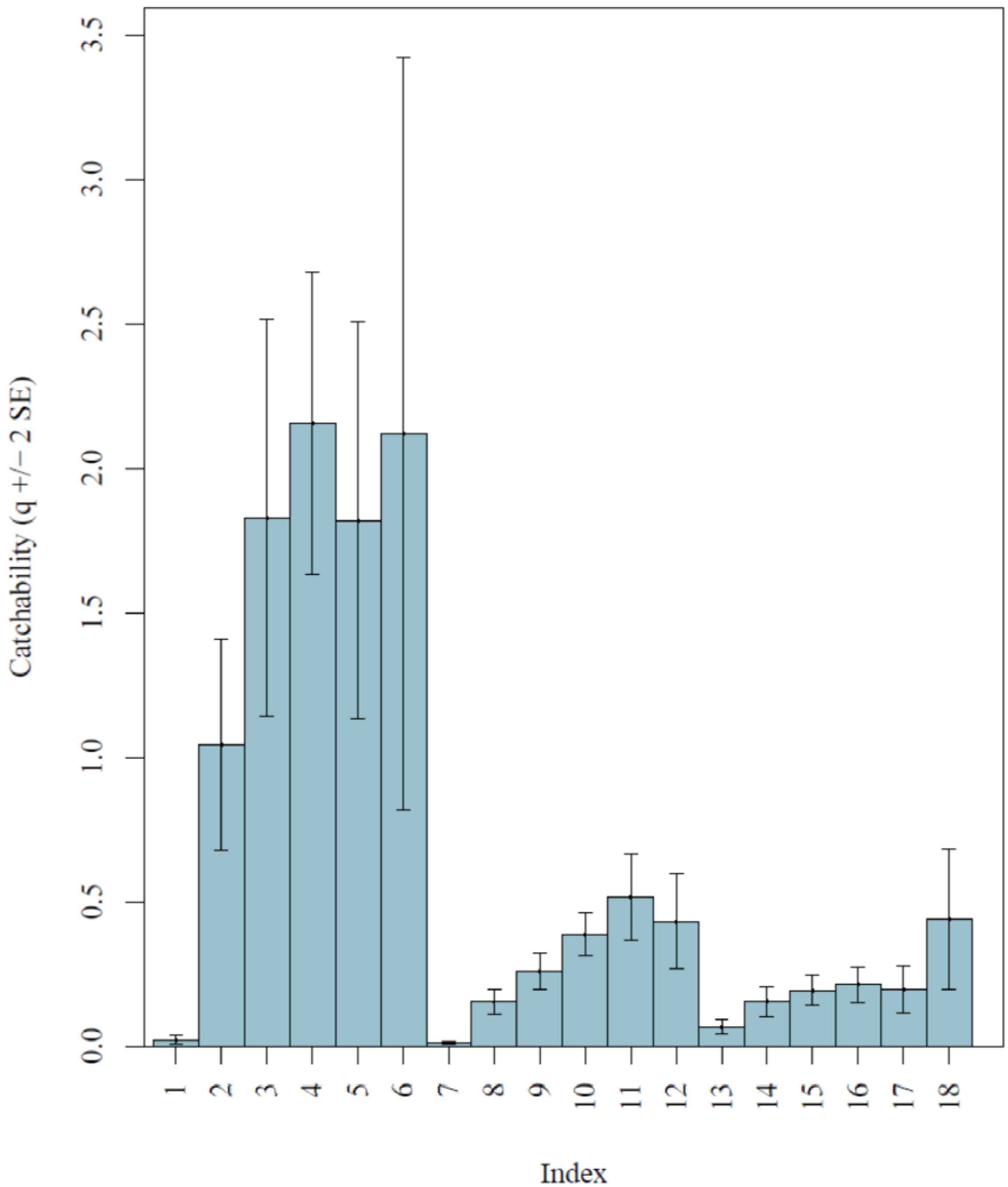


Figure B57. ADAPT-VPA model 20 patterns in survey catchability (q). Indices 1-6 = NEFSC Winter (ages 1-6+), indices 7-12 = NEFSC Spring (ages 1-6+), indices 13-18 = NEFSC Fall (ages 1-6+).

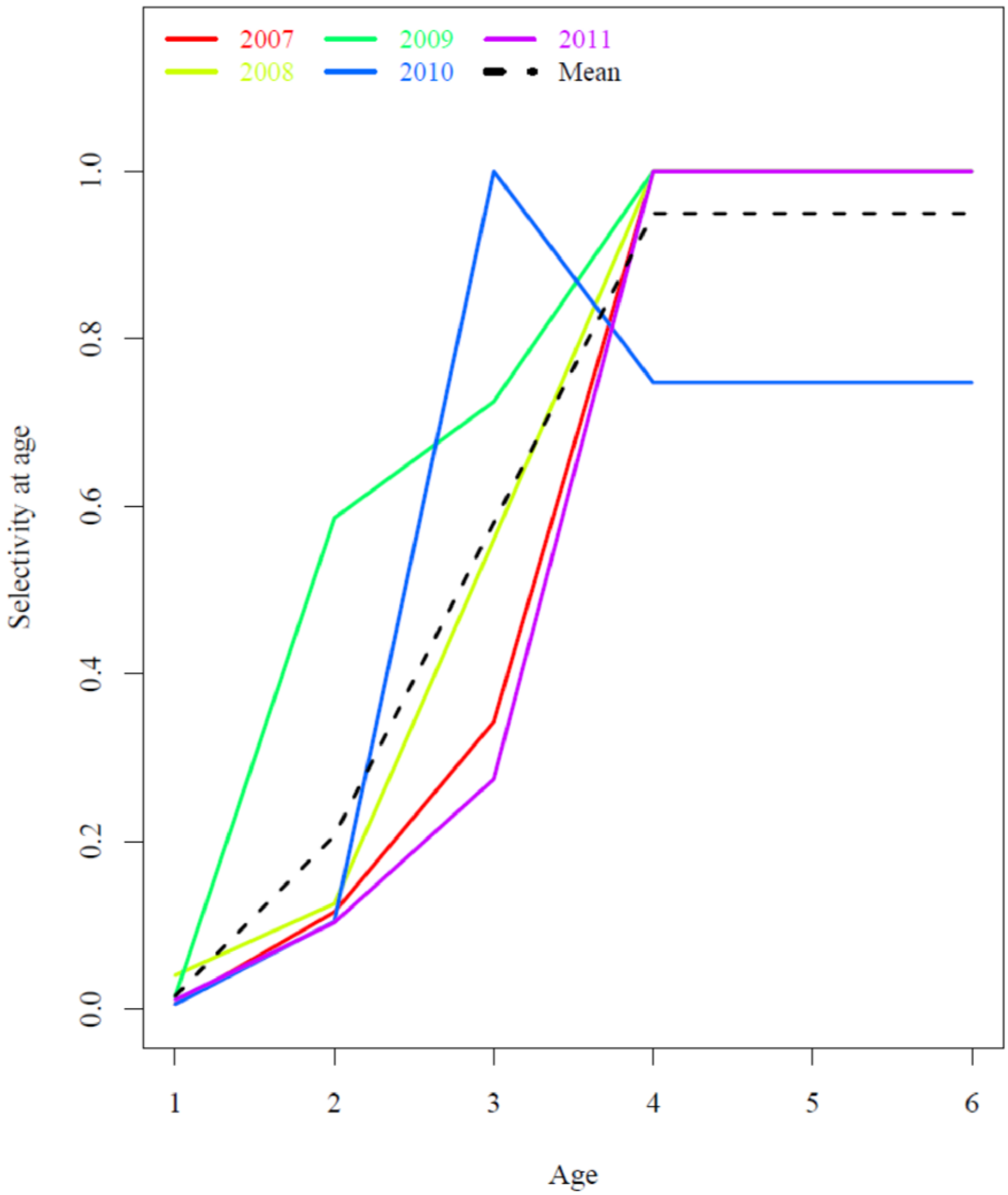
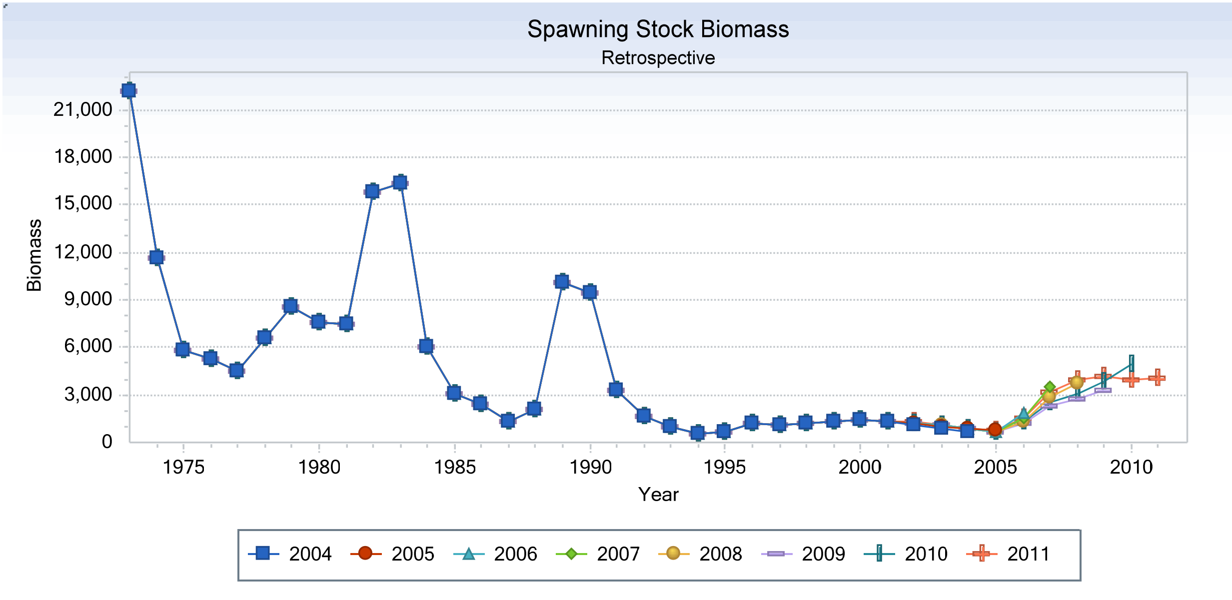


Figure B58. ADAPT-VPA model 20 catch selectivity for Southern New England Mid-Atlantic yellowtail flounder over the last five years of the model 2006 through 2011



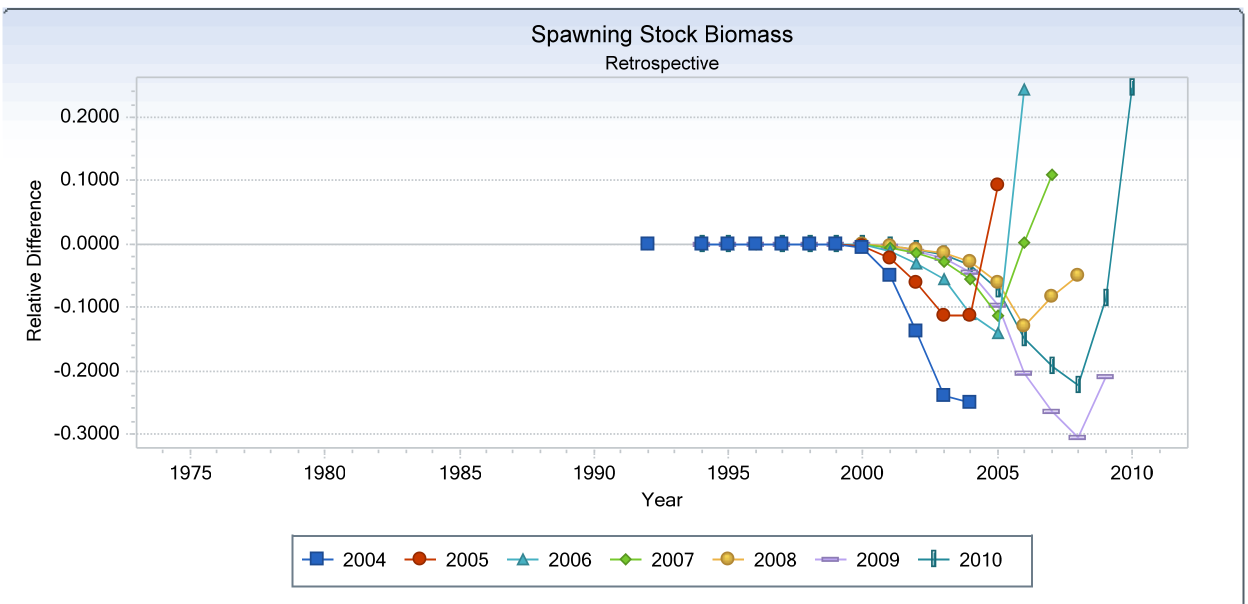
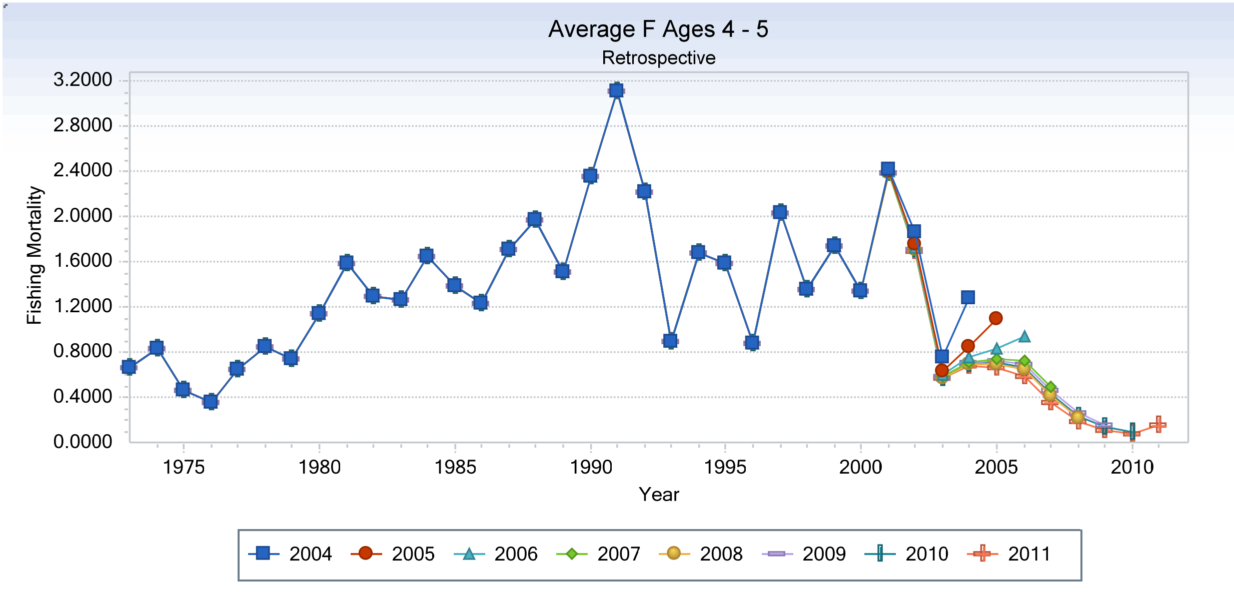


Figure B59. ADAT-VPA Model 20 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder spawning stock Biomass (mt) in absolute (top) and relative (bottom) terms.



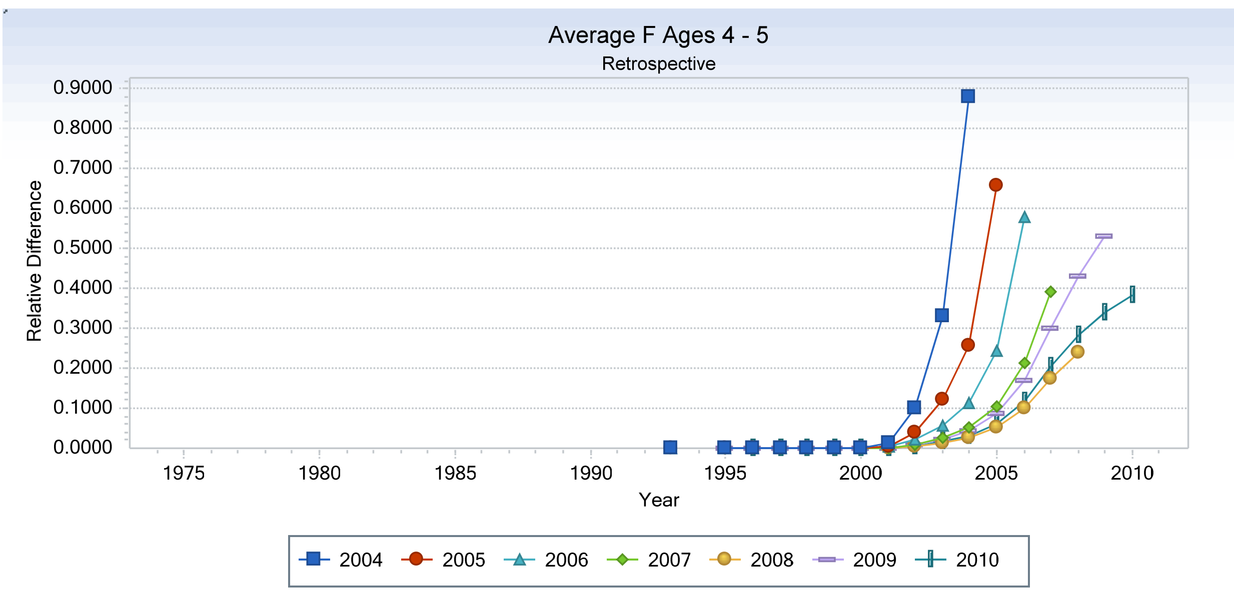


Figure B60. ADAT-VPA Model 20 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder fishing mortality (ages 4-5) in absolute (top) and relative (bottom) terms.

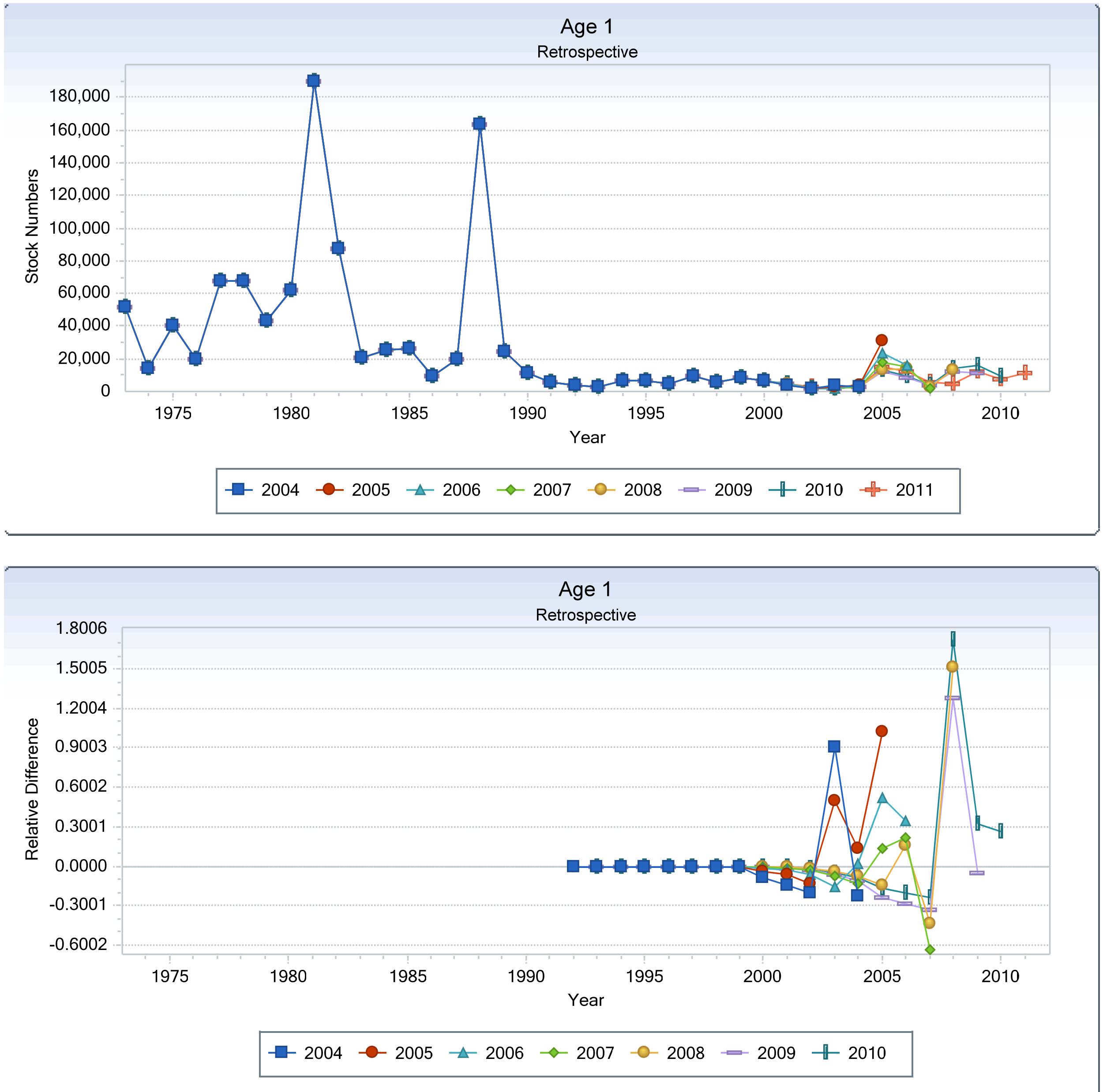


Figure B61. ADAT-VPA Model 20 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder age 1 recruitment (000's) in absolute (top) and relative (bottom) terms.

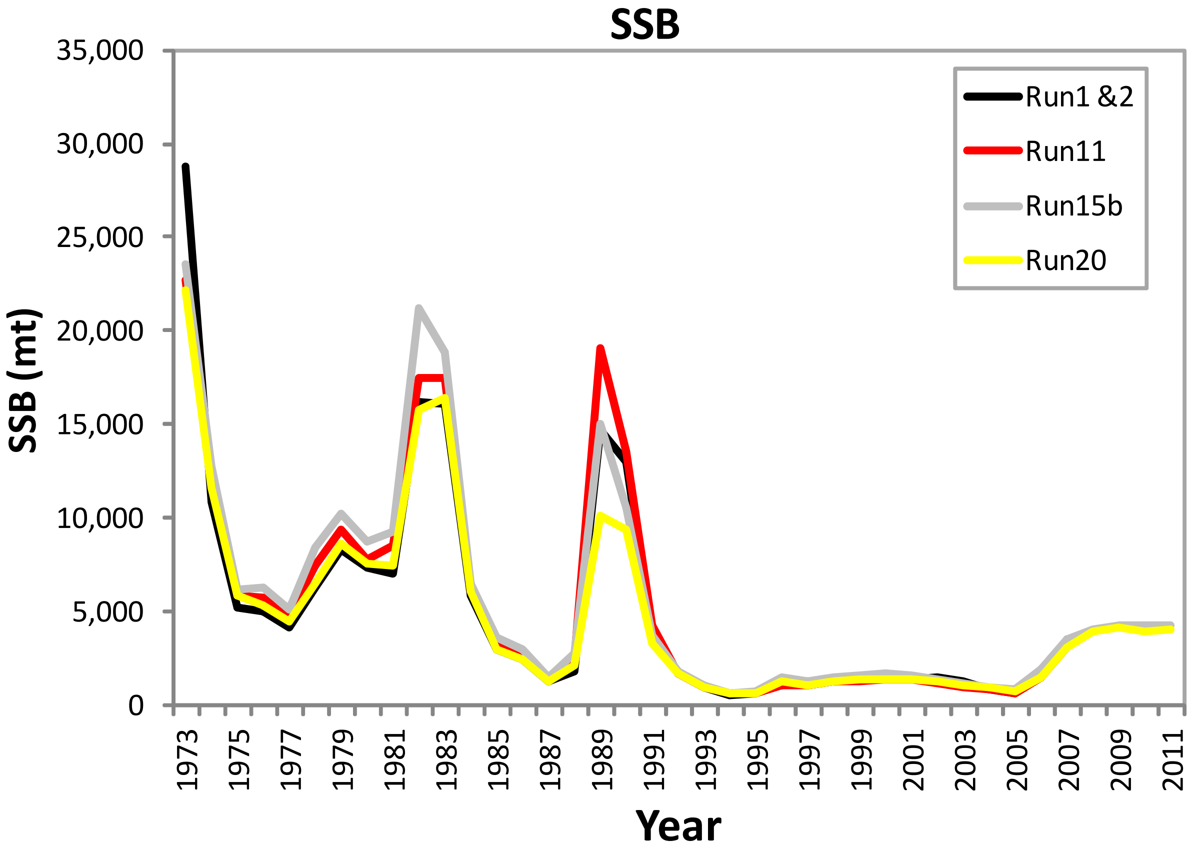


Figure B62. Comparison of estimates of Southern New England Mid-Atlantic yellowtail spawning stock biomass (mt) from ADAPT-VPA Model runs 2, 11, 15b and 20

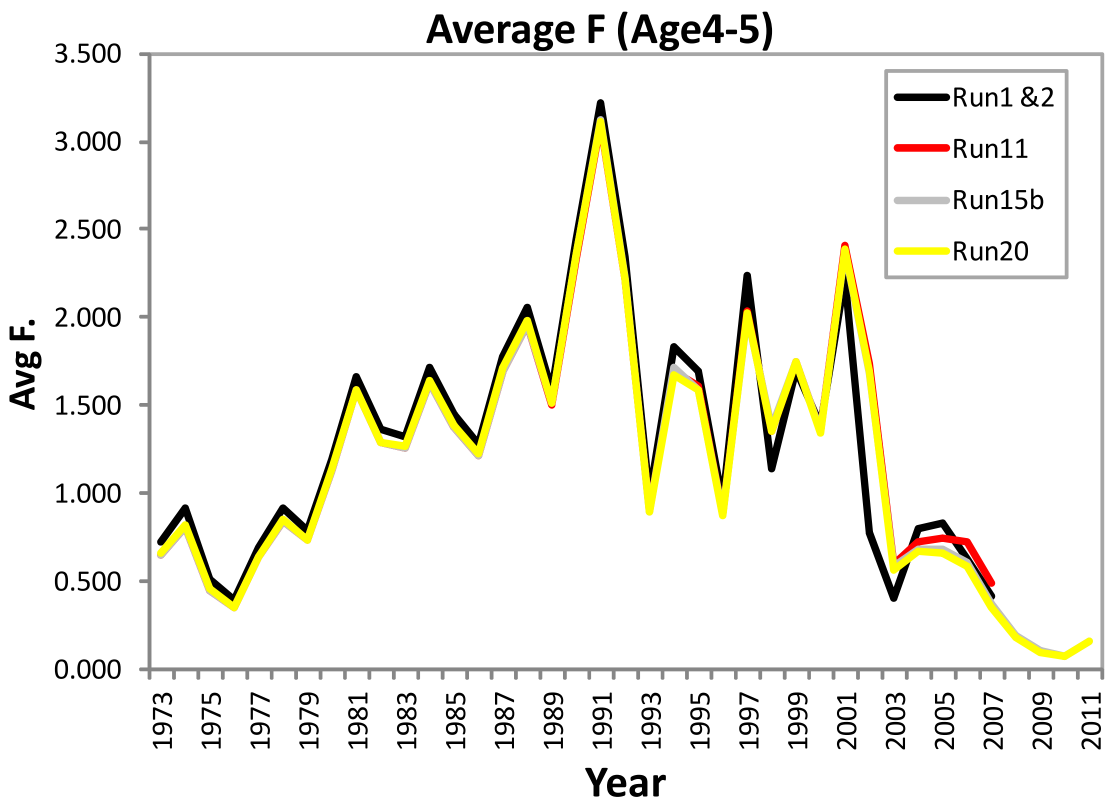


Figure B63. Comparison of estimates of Southern New England Mid-Atlantic yellowtail fishing mortality (ages 4-5) from ADAPT-VPA Model runs 2, 11, 15b and 20

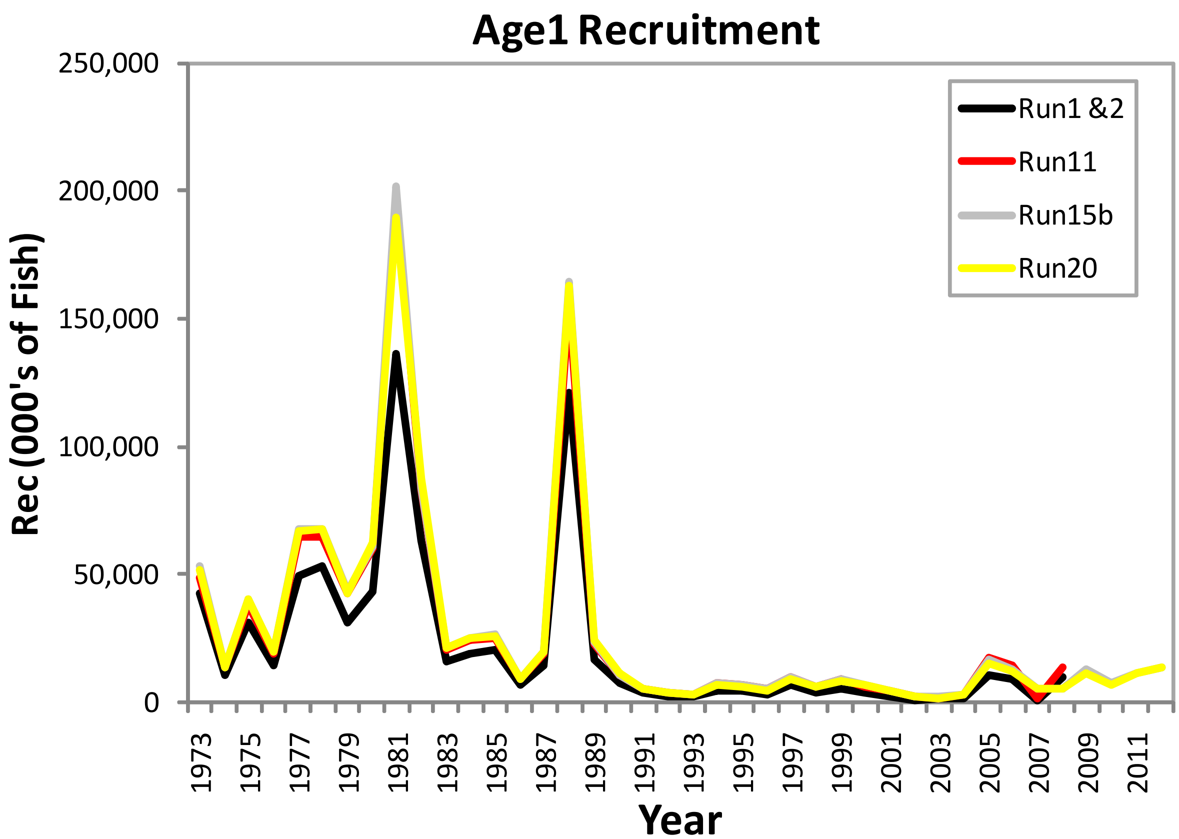


Figure B64. Comparison of estimates of Southern New England Mid-Atlantic yellowtail age 1 recruitment (000's) from ADAPT-VPA Model runs 2, 11, 15b and 20

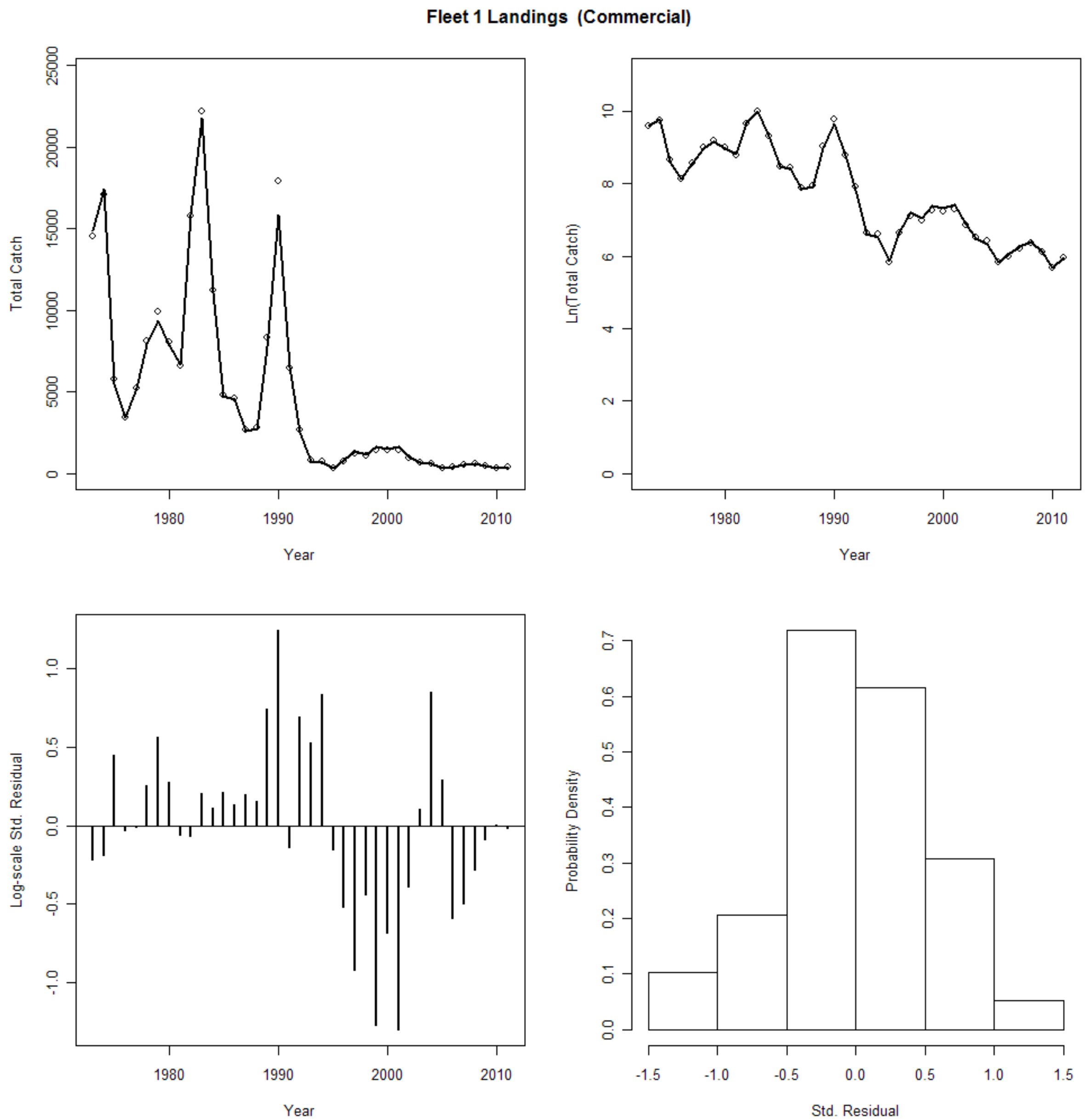


Figure B65. ASAP BASE Model 26 fit to the total Southern New England Mid-Atlantic yellowtail flounder fishery catch.

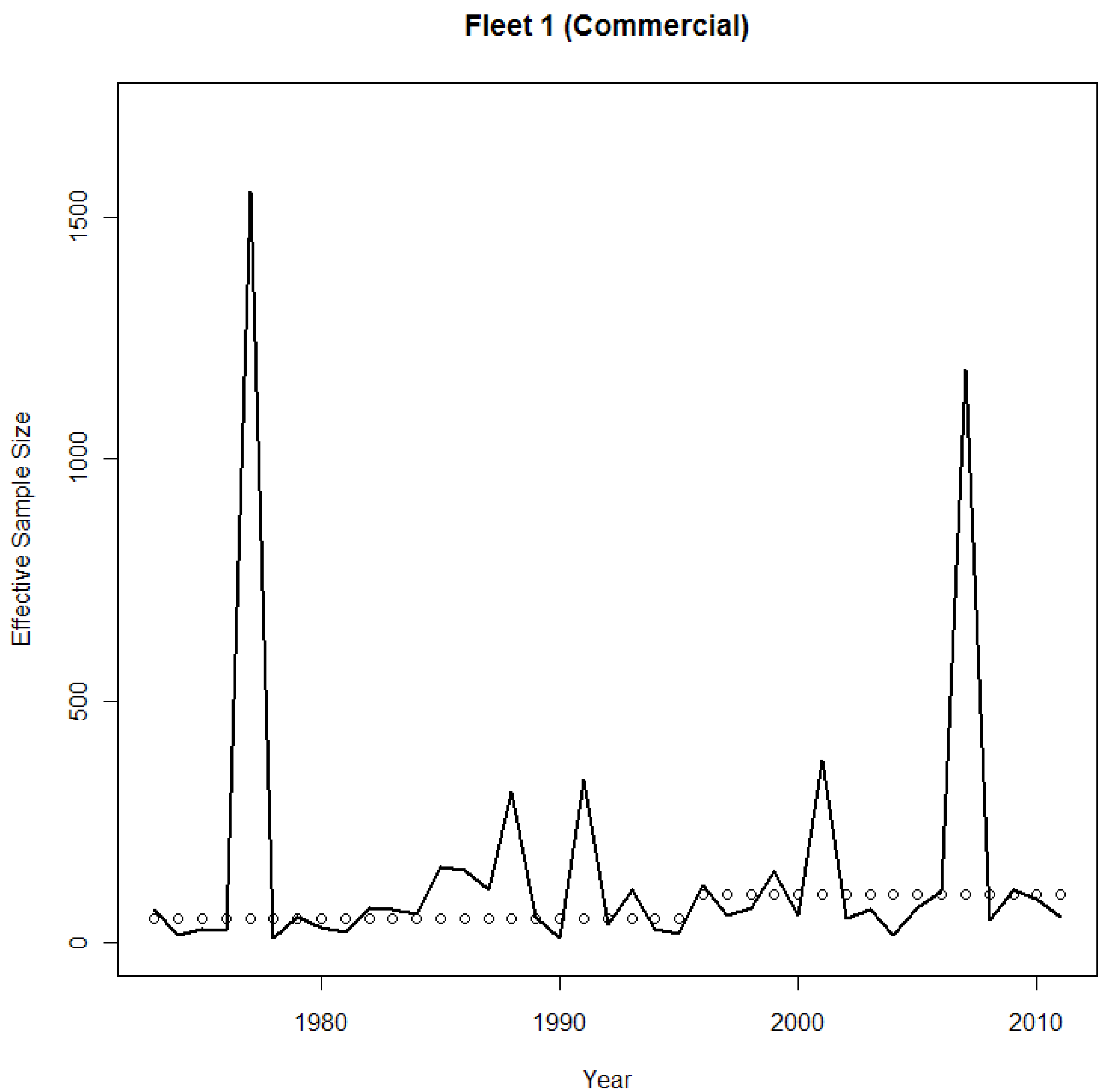


Figure B66. ASAP base Model 26 comparison of input effective sample size versus the model estimated effective sample size for Southern New England Mid-Atlantic yellowtail flounder fishery catch

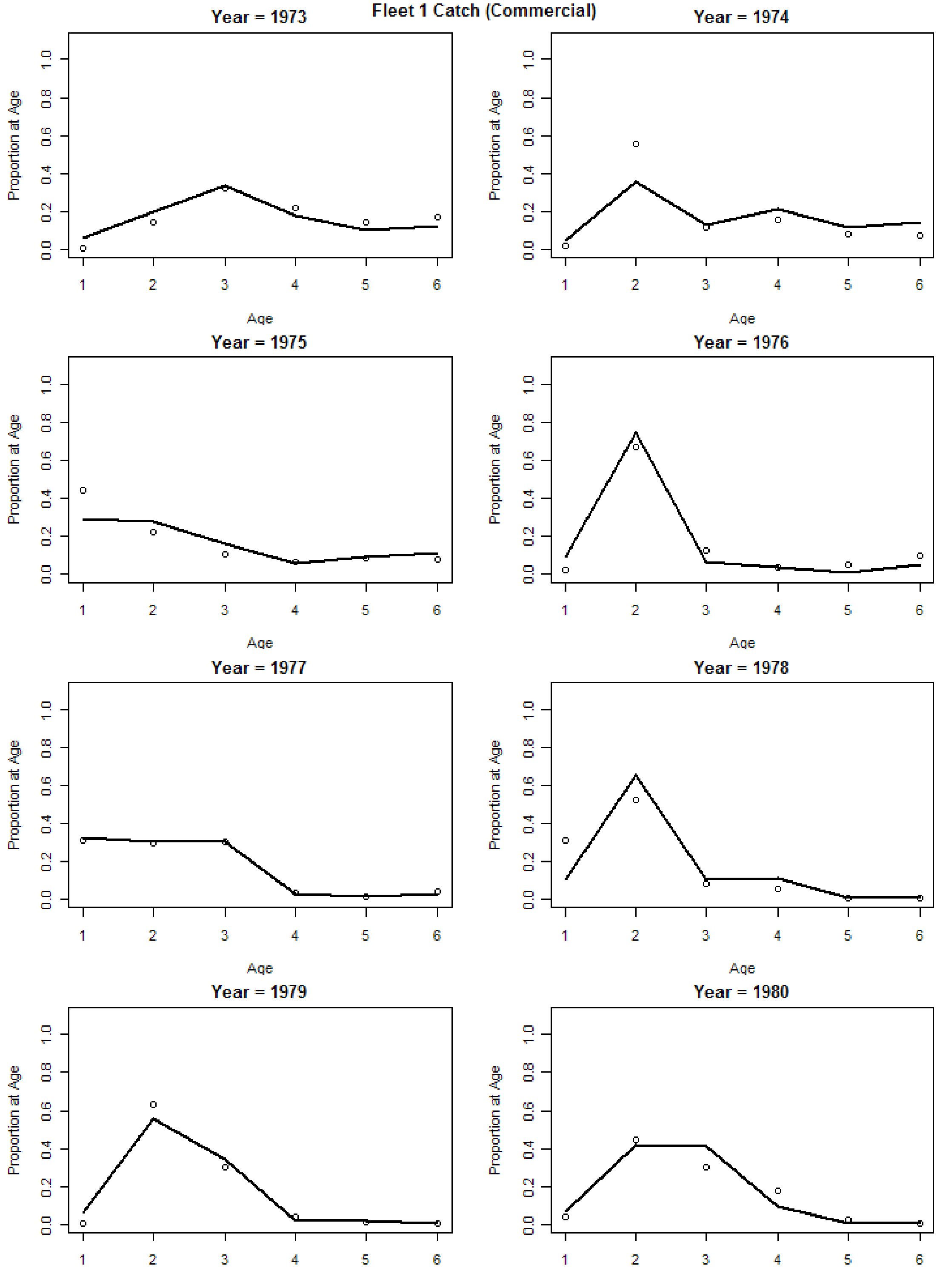


Figure B67. Comparison of the ASAP bade Model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder proportion at age in the fishery to the data estimates (1973-1980).

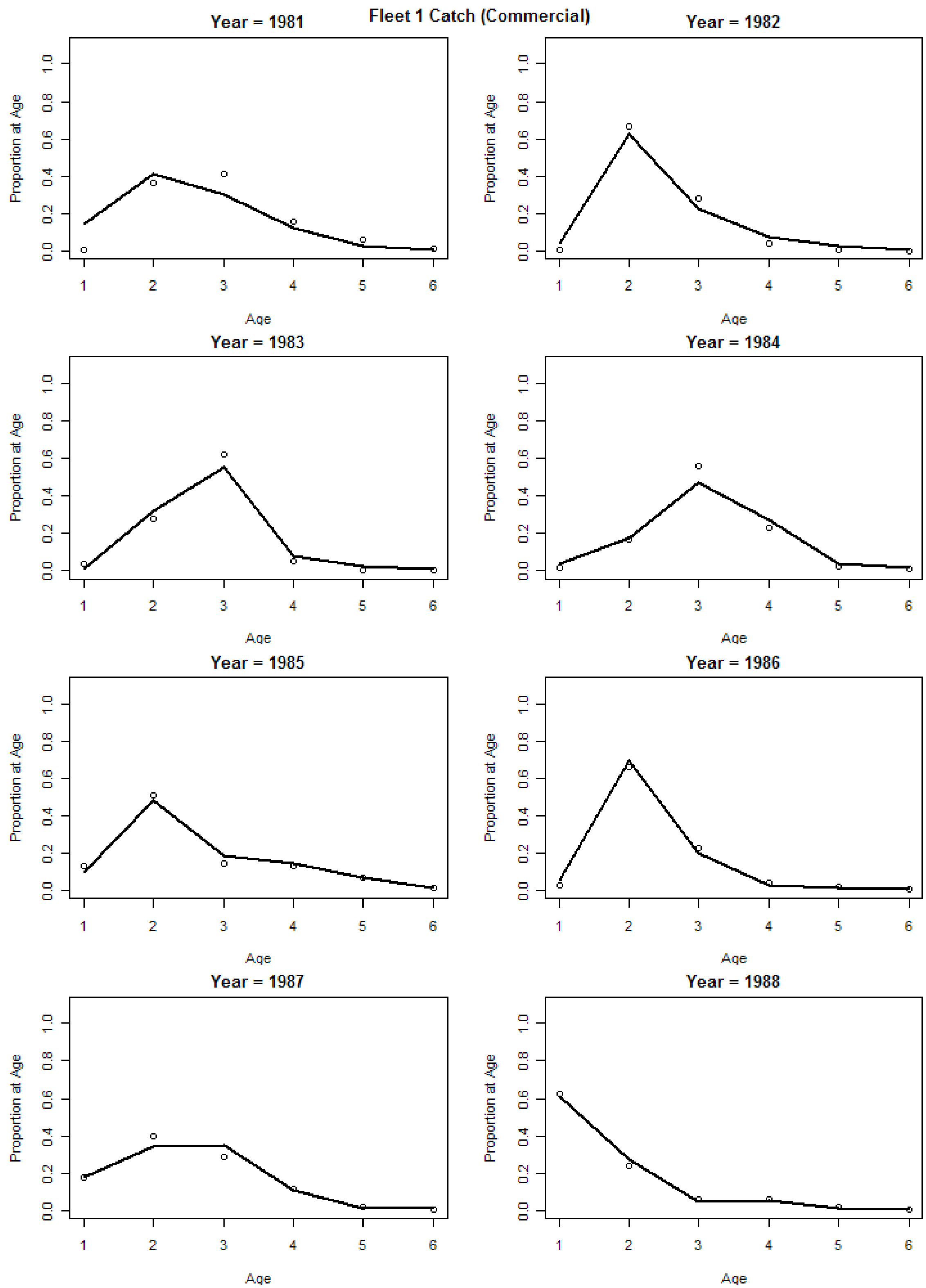


Figure B68. Comparison of the ASAP bade Model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder proportion at age in the fishery to the data estimates (1981-1988).

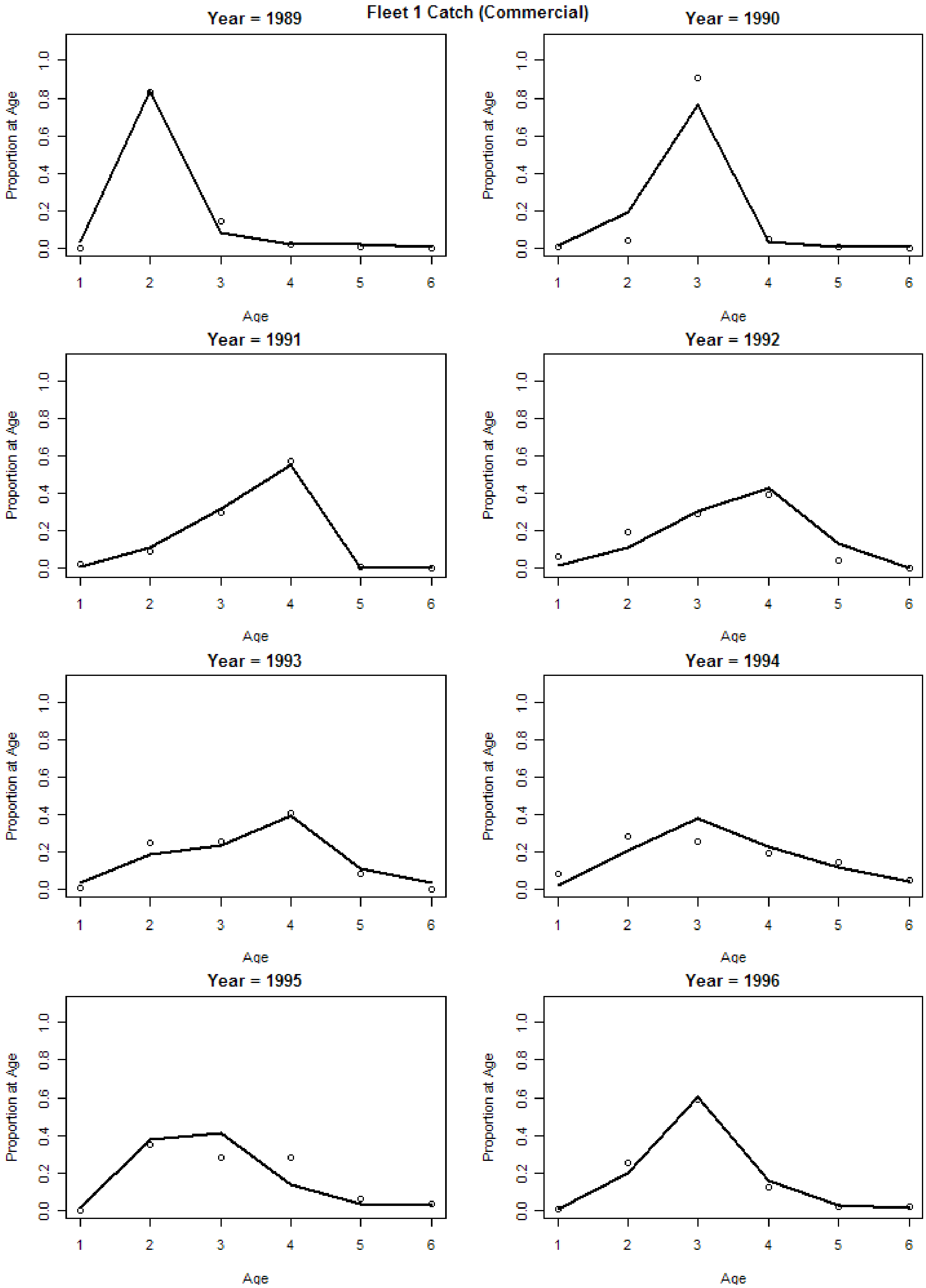


Figure B69. Comparison of the ASAP bade Model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder proportion at age in the fishery to the data estimates (1989-1996).

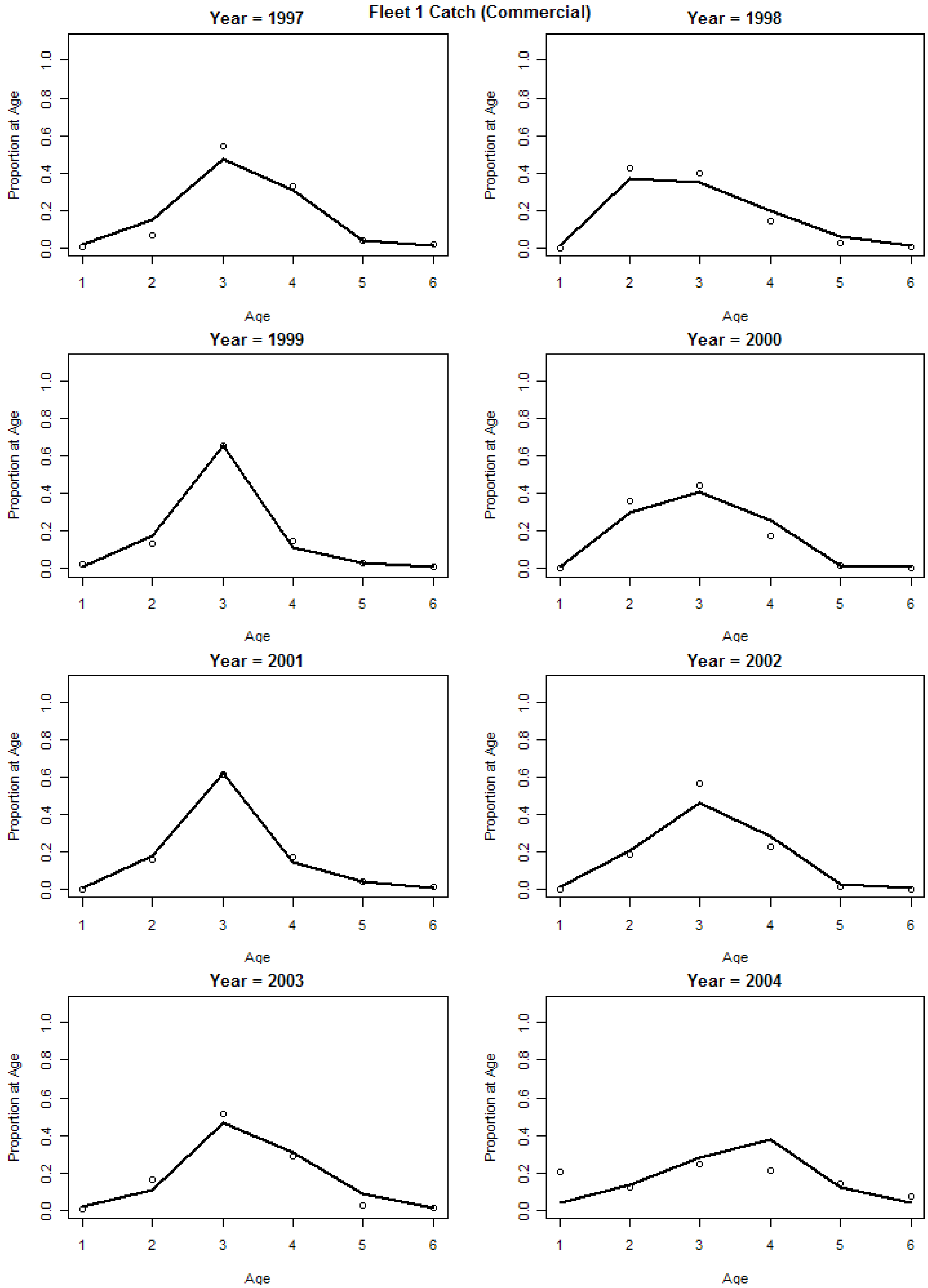


Figure B70. Comparison of the ASAP bade Model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder proportion at age in the fishery to the data estimates (1997-2004).

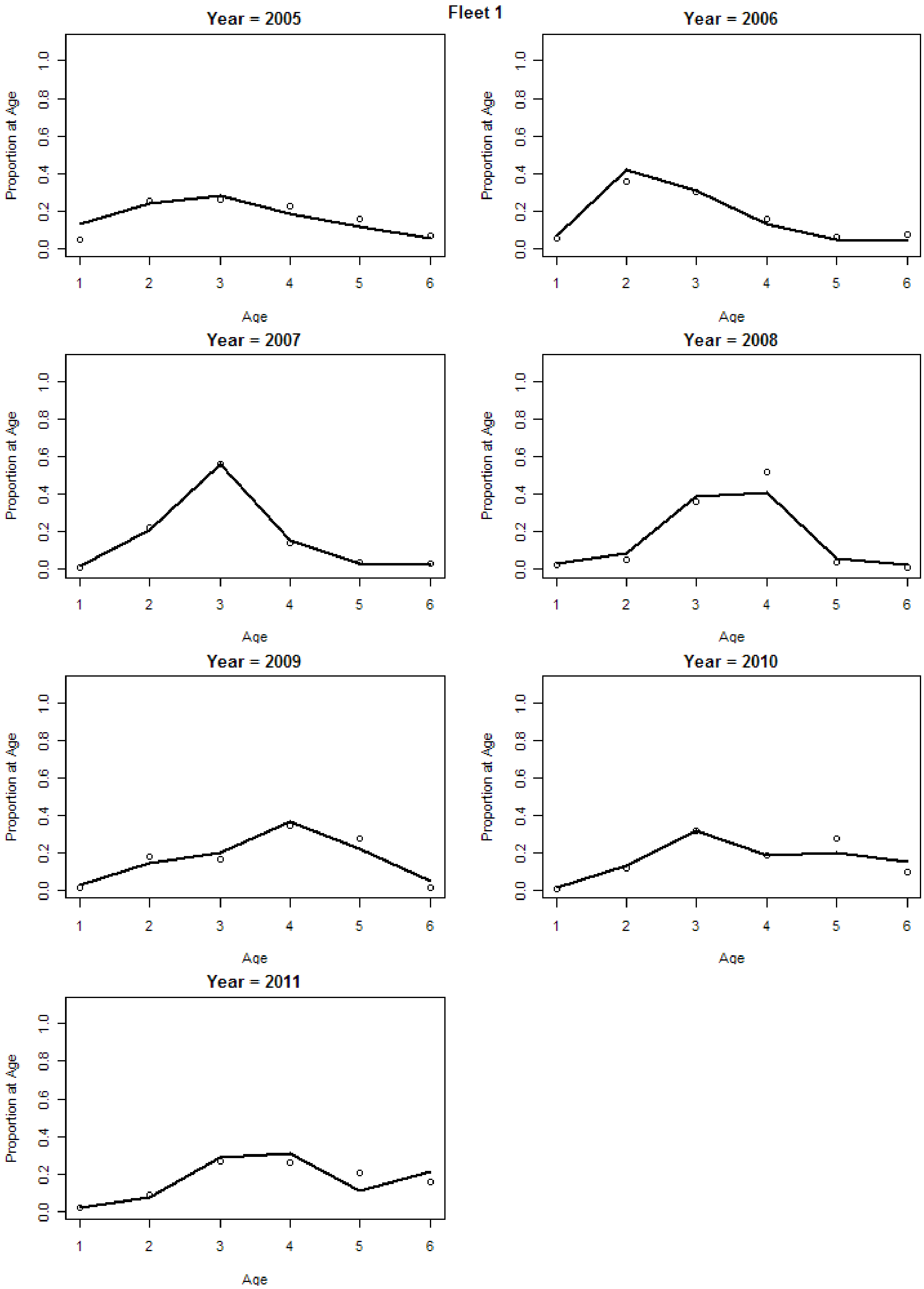


Figure B71. Comparison of the ASAP bade model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder proportion at age in the fishery to the data estimates (2005-2011).

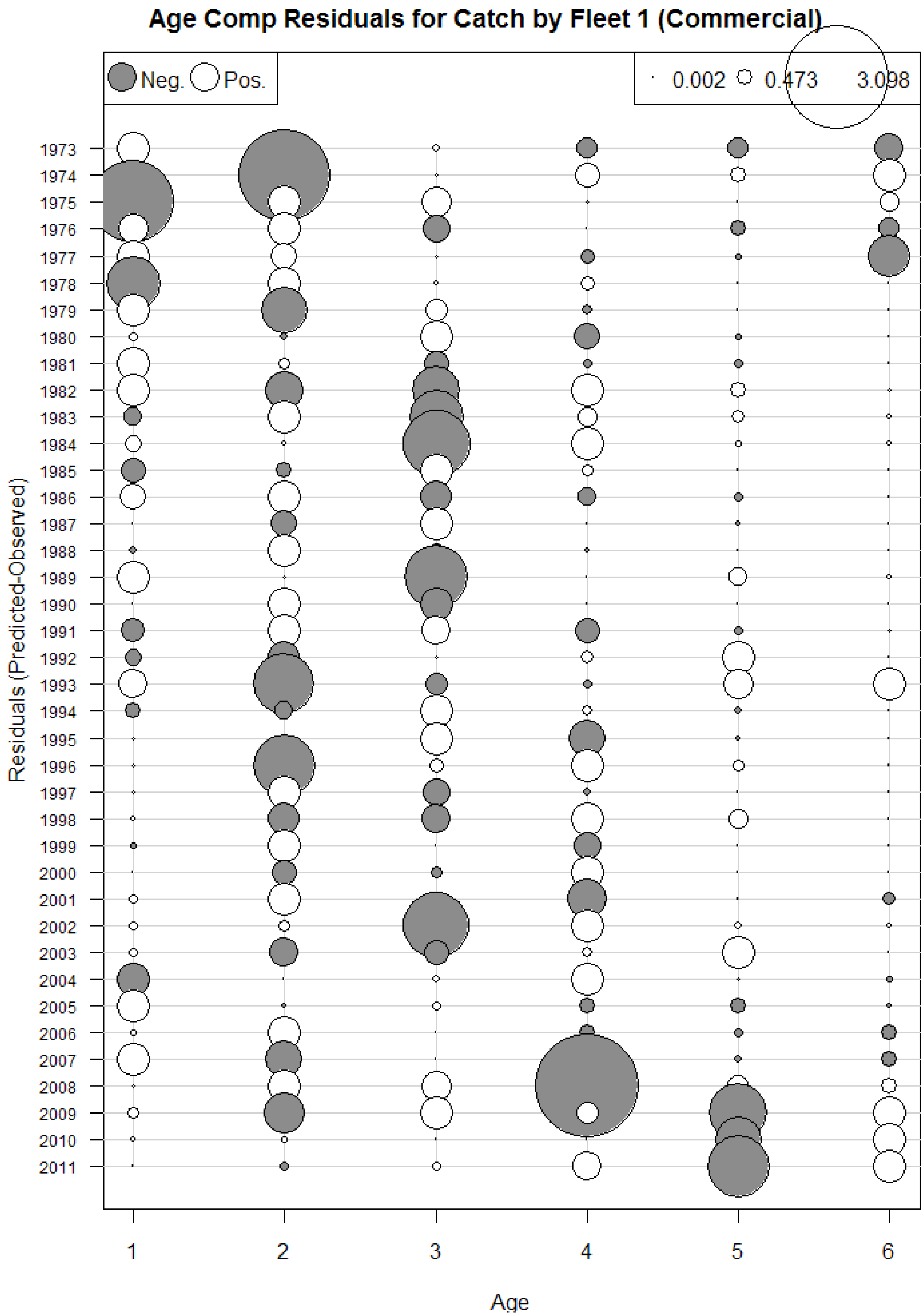


Figure B72. ASAP base Model 26) residual fit for the fishery (Fleet1) catch-at-age of the Southern New England yellowtail flounder

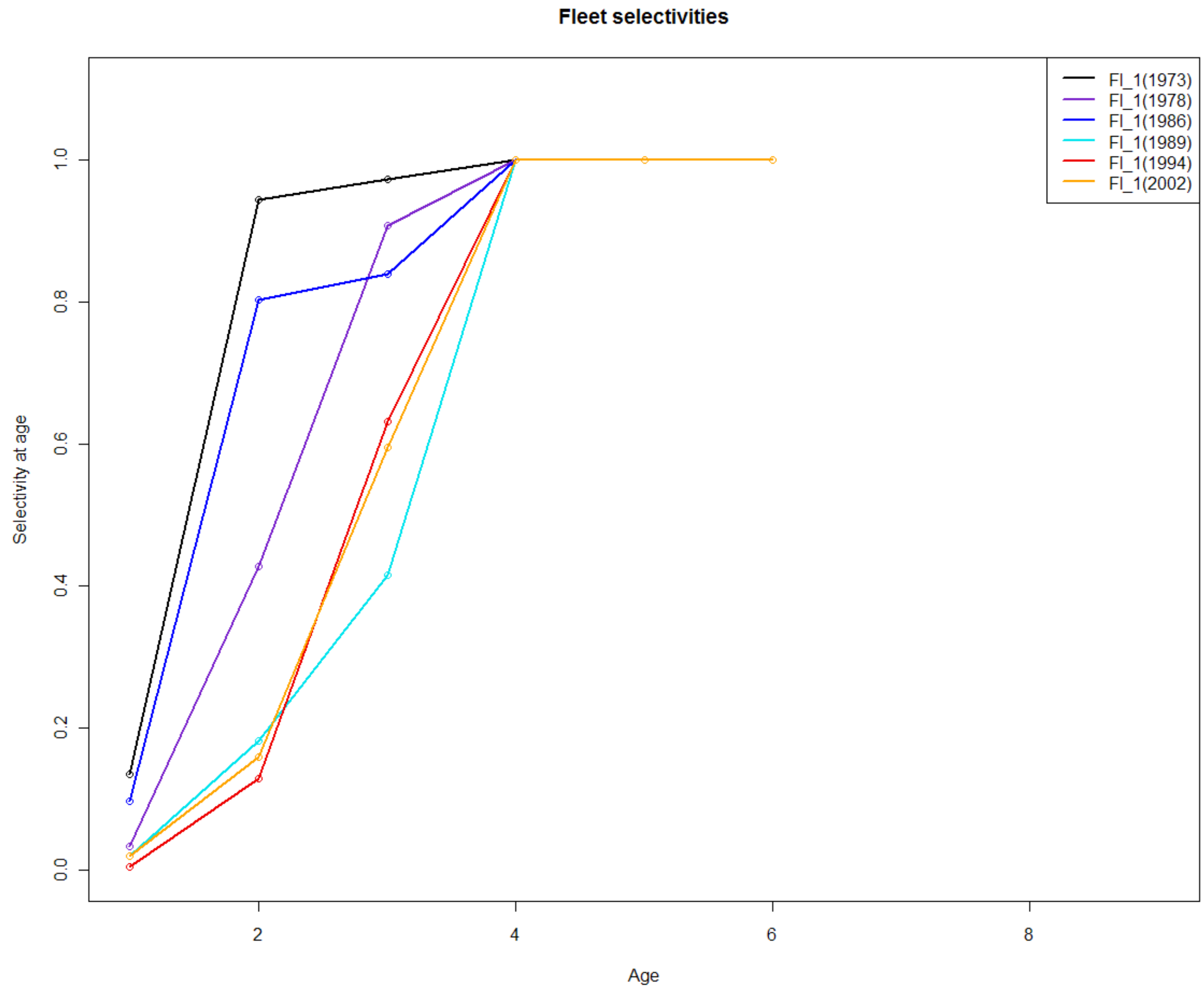


Figure B73. ASAP base Model 26 estimated selectivity blocks for Southern New England Mid-Atlantic yellowtail flounder. Block 1 (1973-1977); Block2 (1978-1985); Block 3 (1986-1988); Block 4 (1989-1993); Block 5 (1994-2001); Block 6 (2002-2011). Note selectivity was estimated for ages 1-3 and fixed for ages 4 and older.

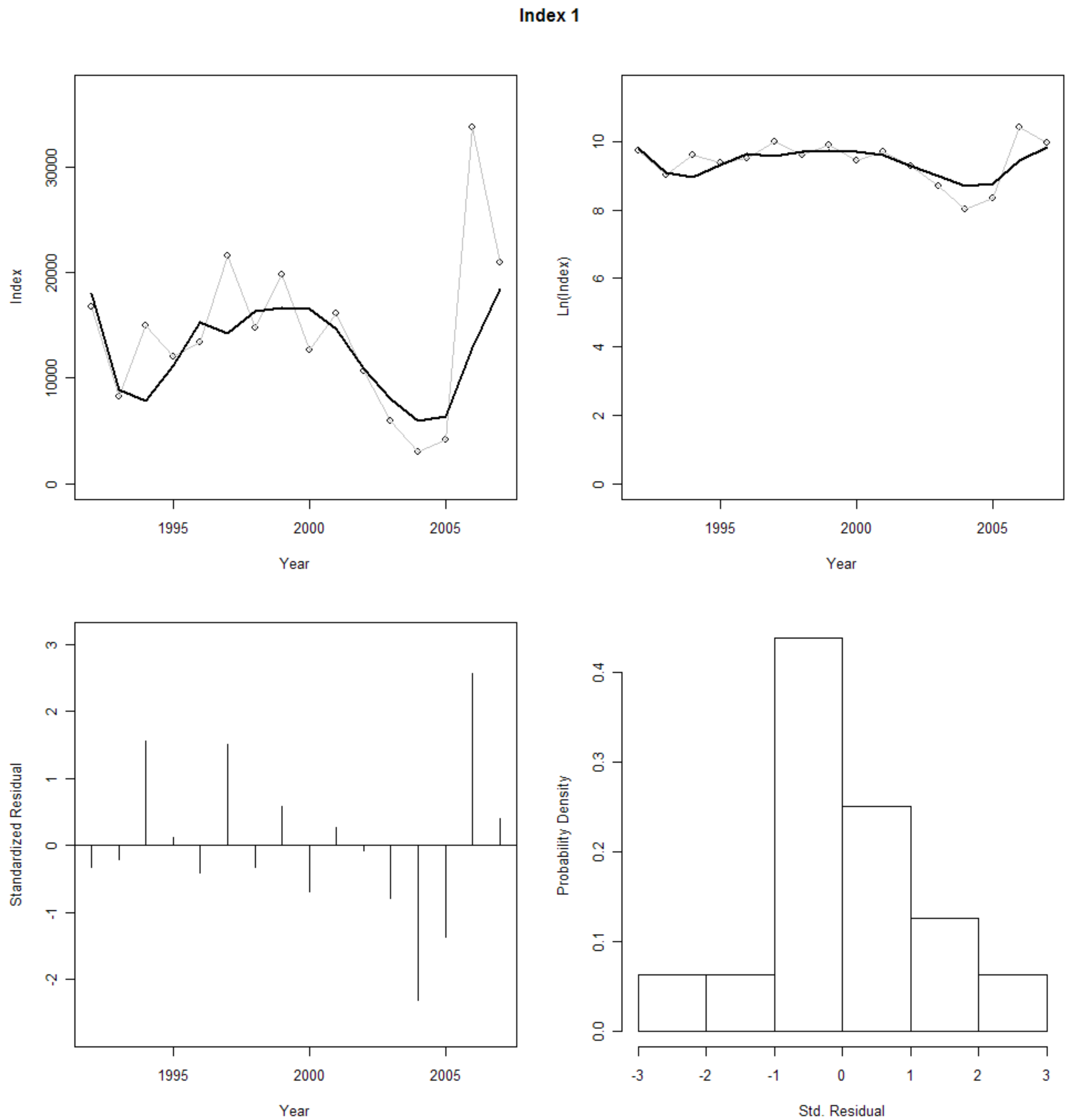


Figure B74. ASAP base Model 26 fit to the NEFSC Southern New England Mid-Atlantic yellowtail flounder winter survey (index1)

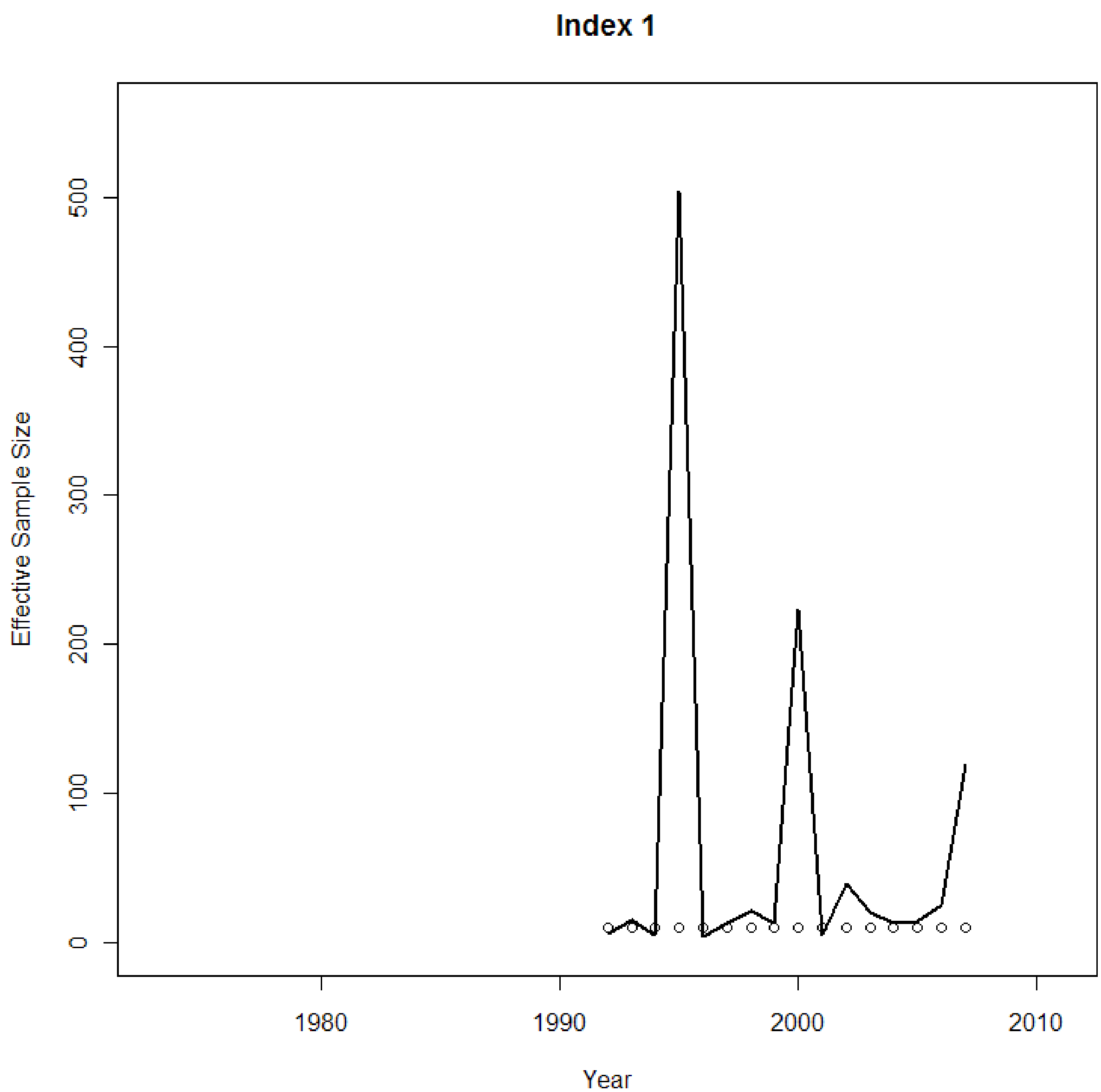


Figure B75. ASAP base Model 26 comparison of input effective sample size versus the model estimated effective sample size for the NEFSC winter survey (index 1) for the Southern New England Mid-Atlantic yellowtail flounder

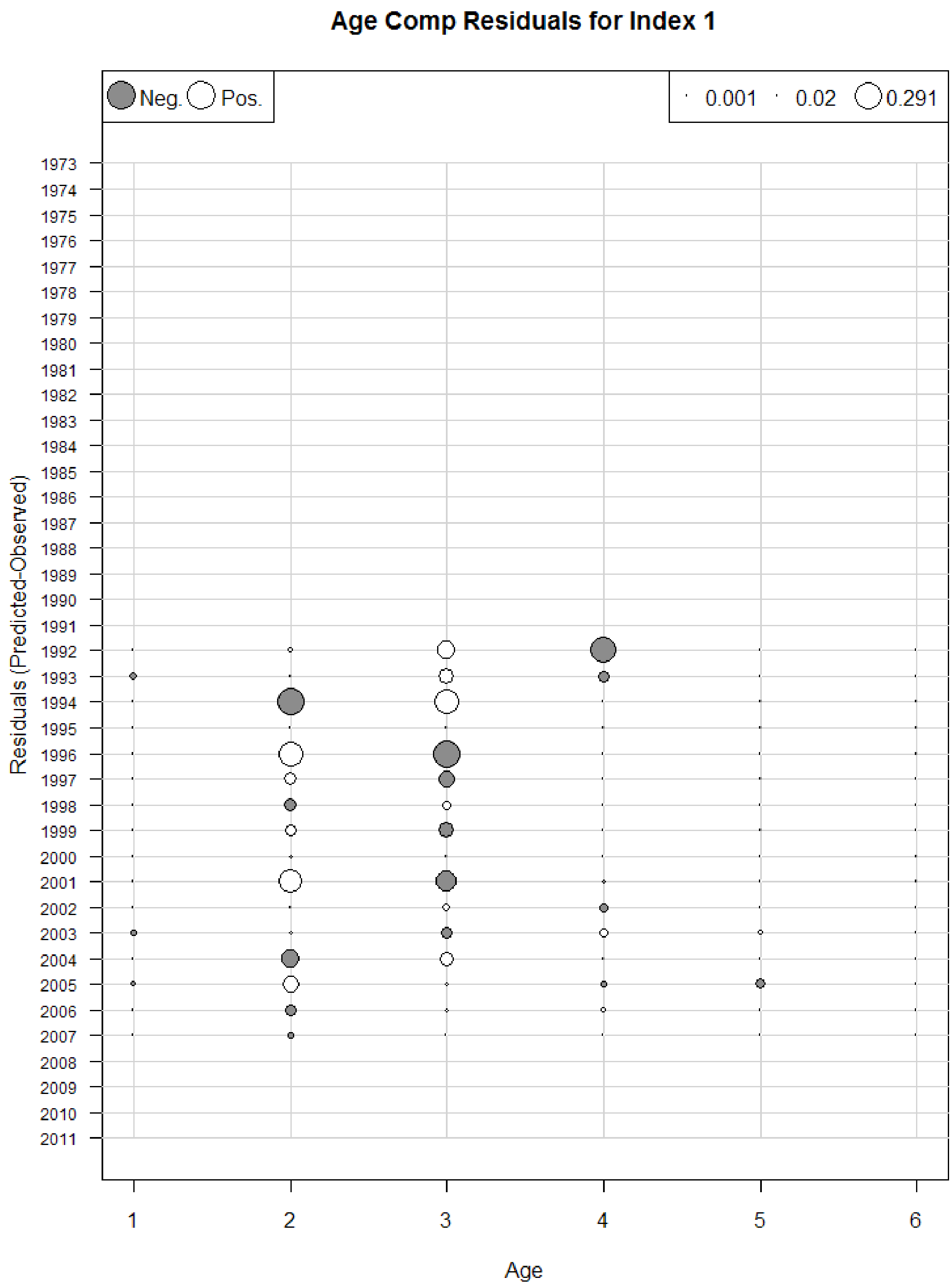


Figure B76. ASAP base Model 26 fit residuals for the NEFSC winter survey (index 1) for Southern New England Mid-Atlantic yellowtail flounder age composition

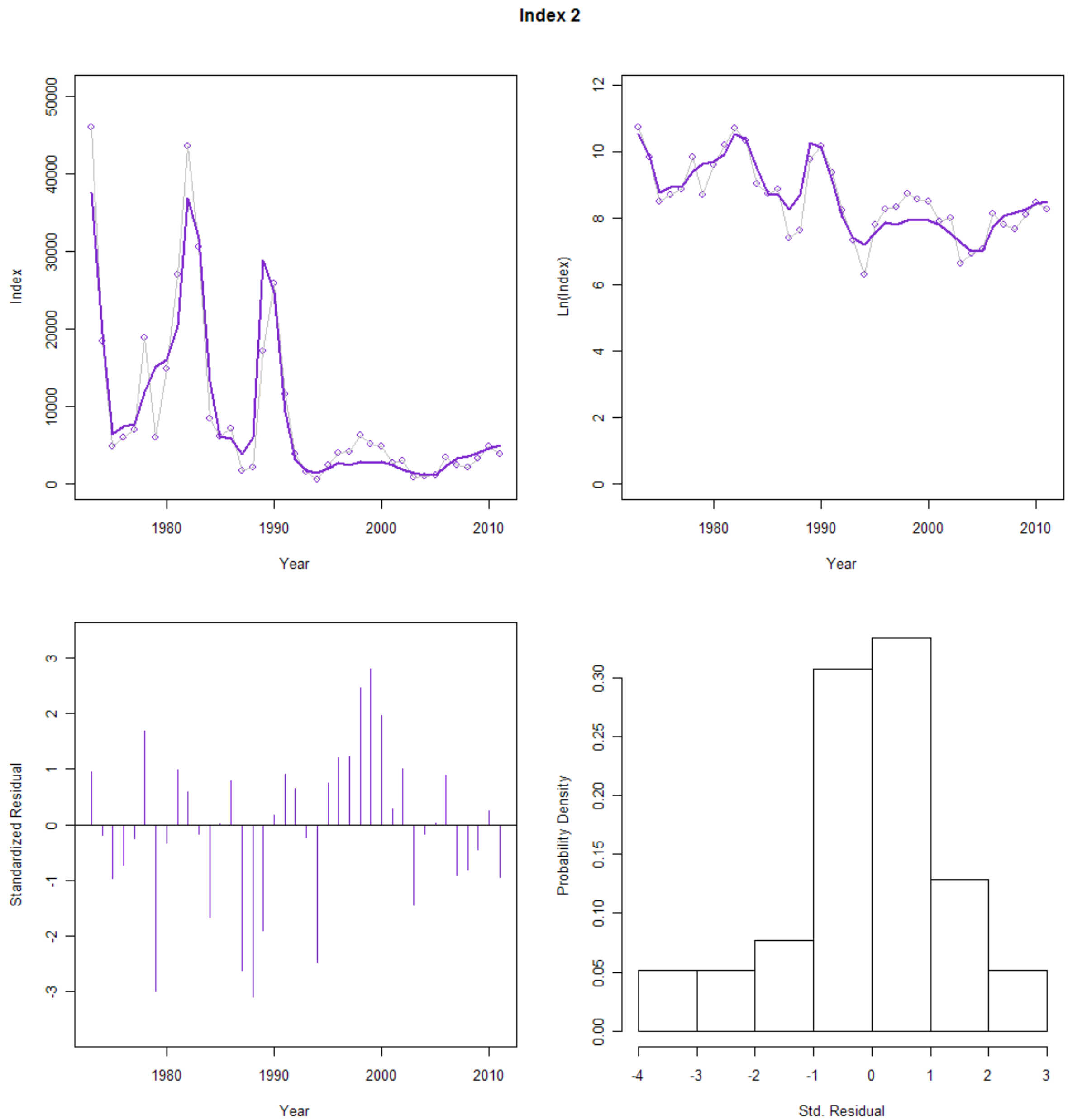


Figure B77. ASAP base Model 26 fit to the NEFSC Southern New England Mid-Atlantic yellowtail flounder spring survey (index2)

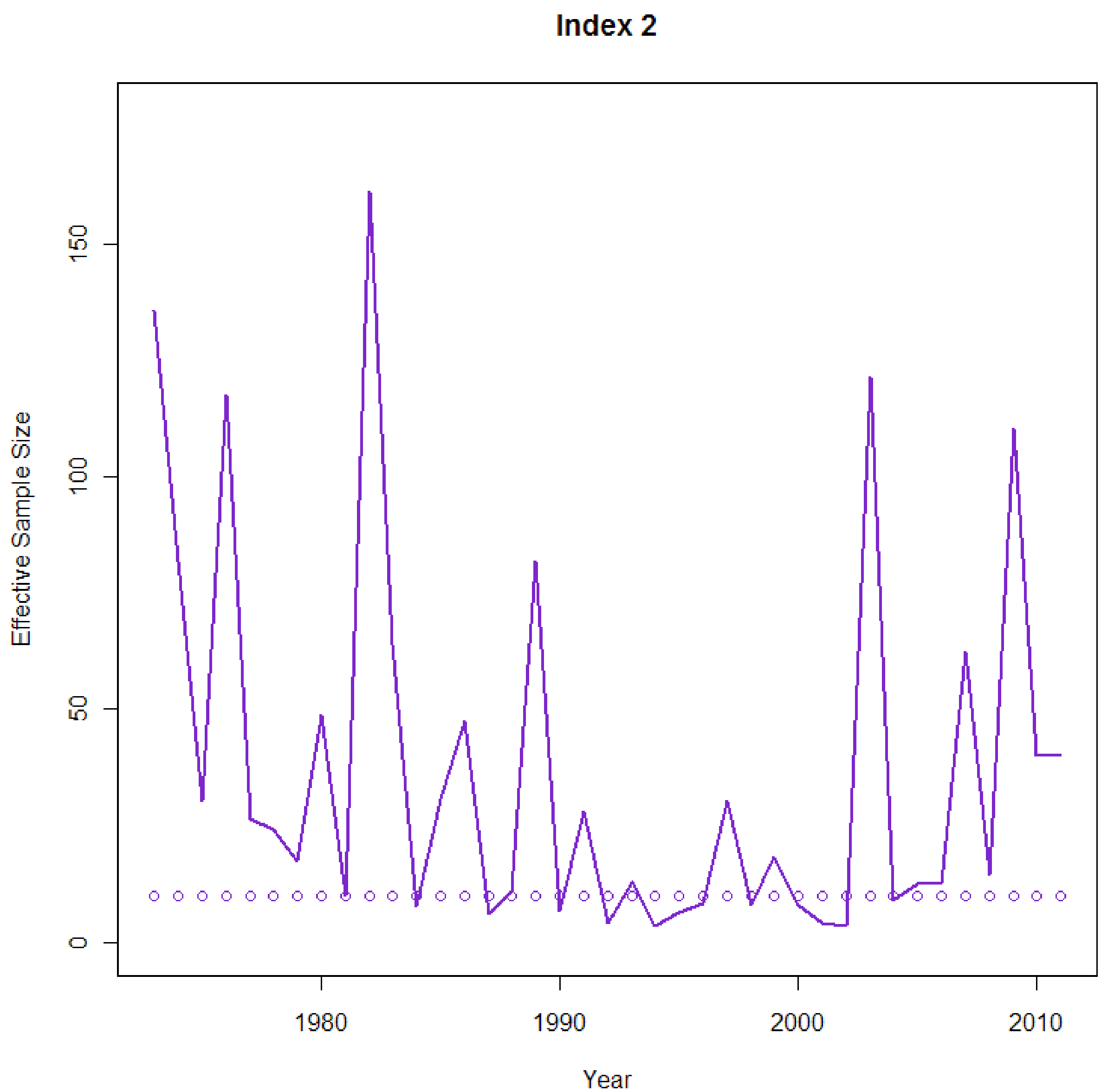


Figure B78. ASAP base Model 26 comparison of input effective sample size versus the model estimated effective sample size for the NEFSC spring survey (index 2) for the Southern New England Mid-Atlantic yellowtail flounder

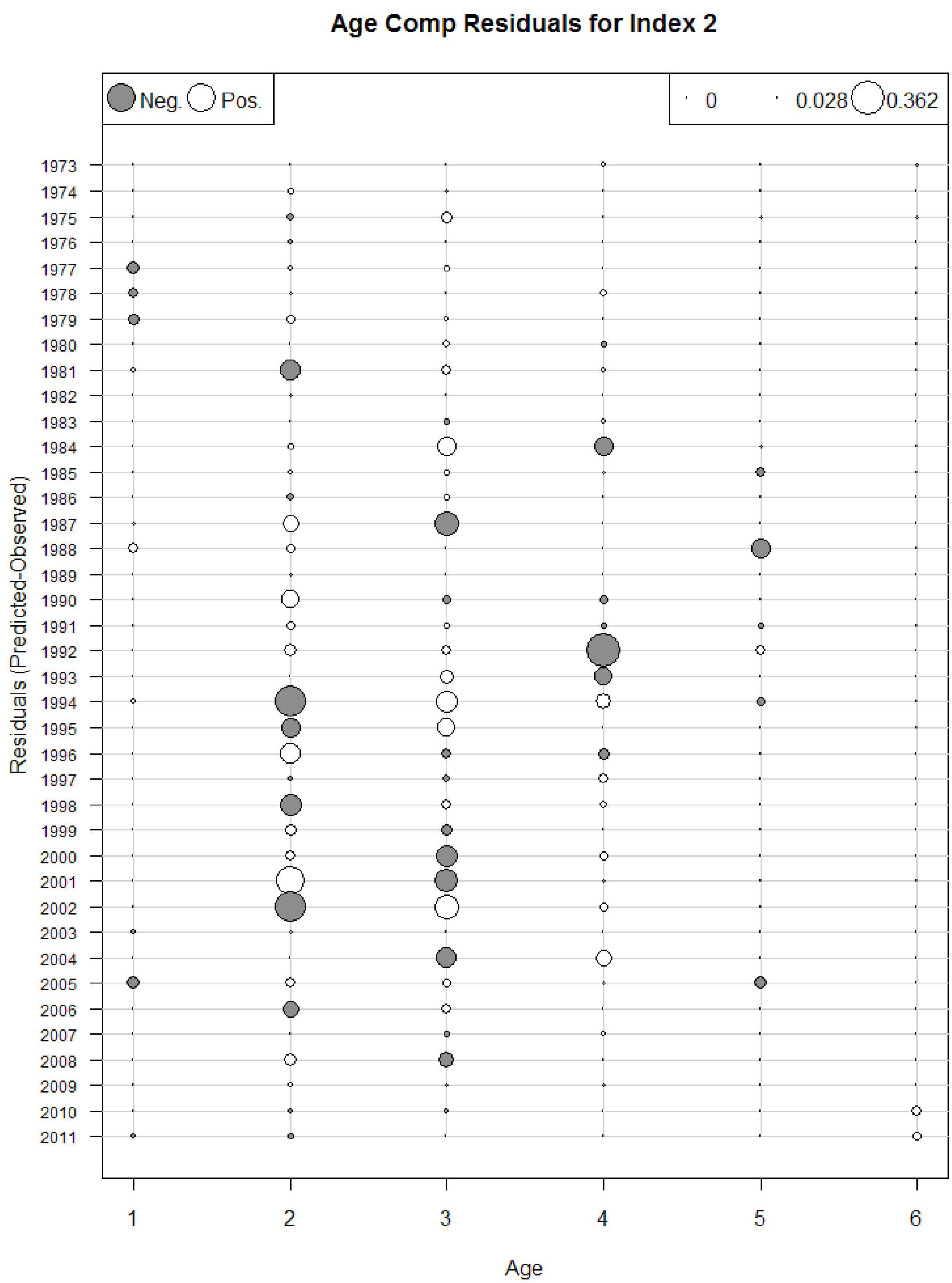


Figure B79. ASAP base Model 26 fit residuals for the NEFSC spring survey (index 2) for Southern New England Mid-Atlantic yellowtail flounder age composition

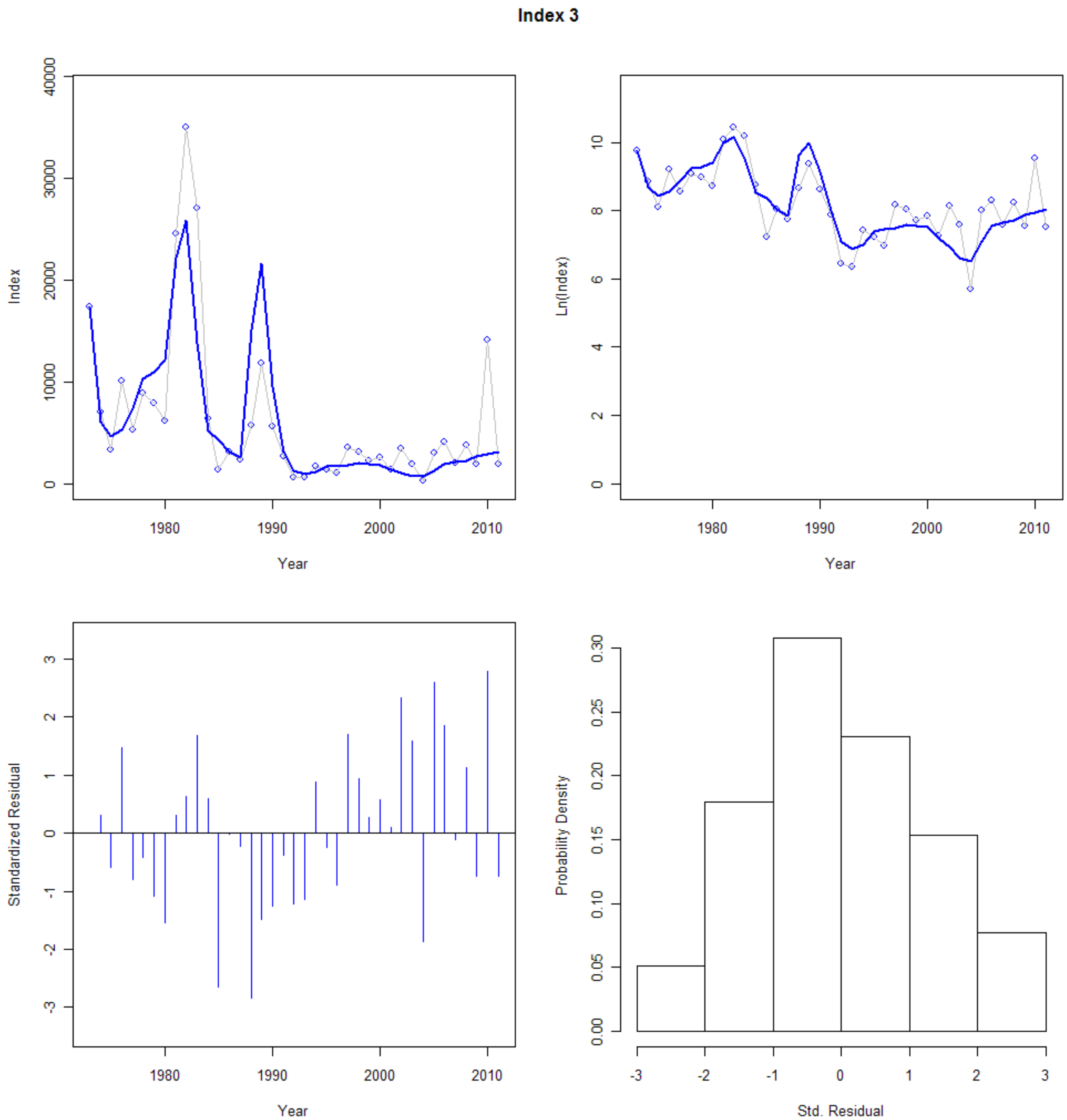


Figure B80. ASAP base model 26 fit to the NEFSC Southern New England Mid-Atlantic yellowtail flounder fall survey (index3)

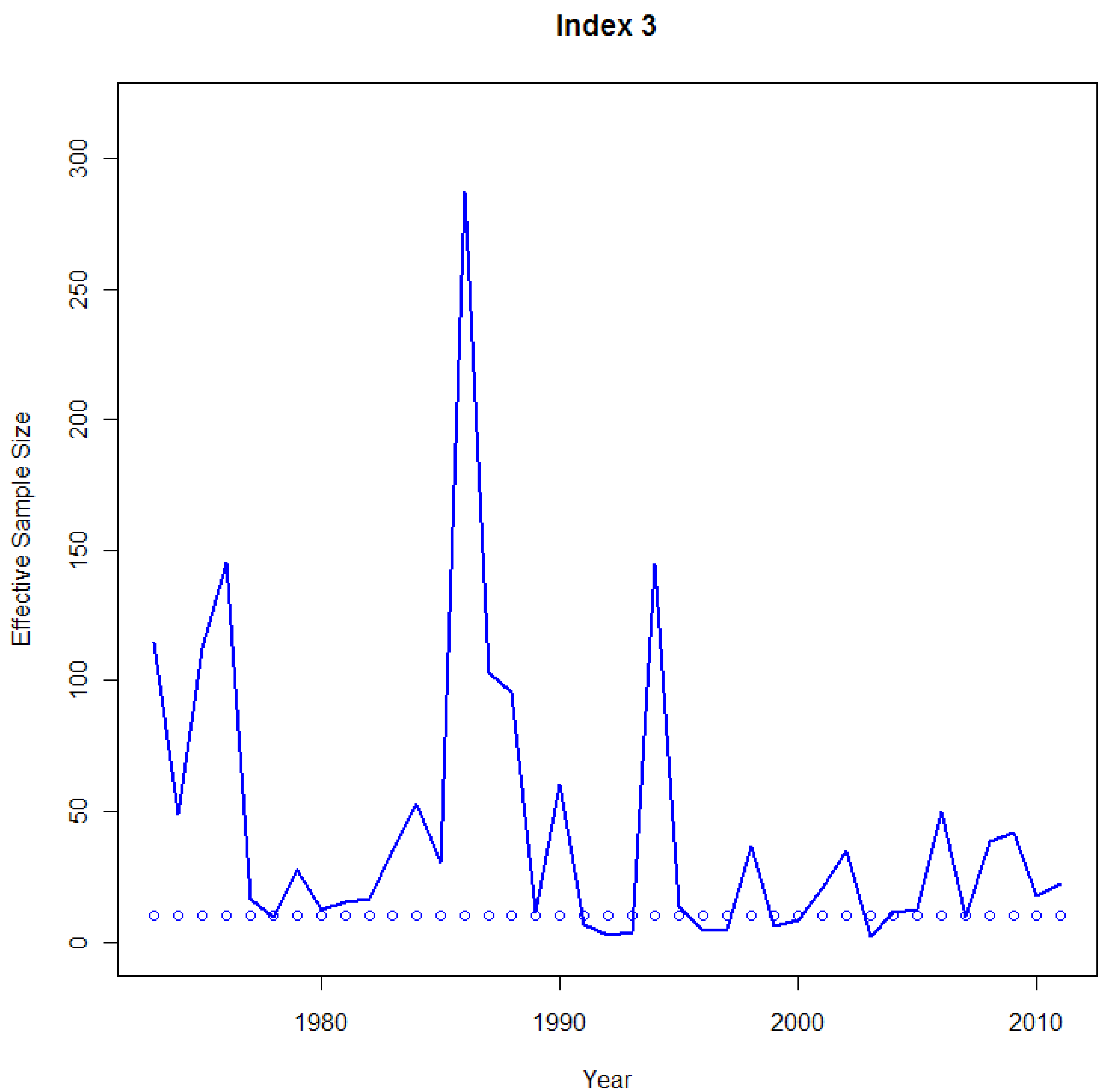


Figure B81. ASAP base Model 26 comparison of input effective sample size versus the model estimated effective sample size for the NEFSC fall survey (index 3) for the Southern New England Mid-Atlantic yellowtail flounder

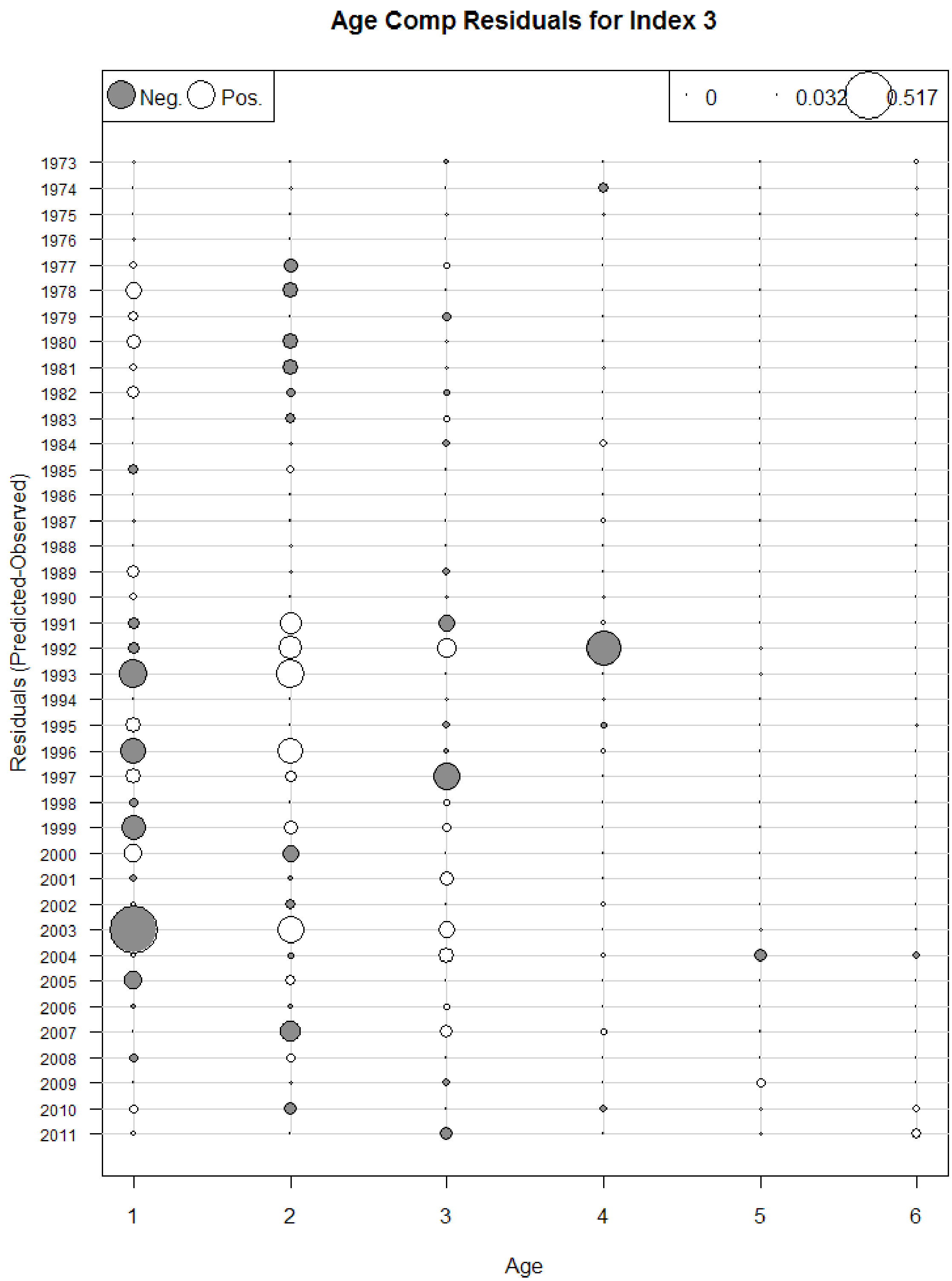


Figure B82. ASAP base Model 26 fit residuals for the NEFSC fall survey (index 3) for Southern New England Mid-Atlantic yellowtail flounder age composition

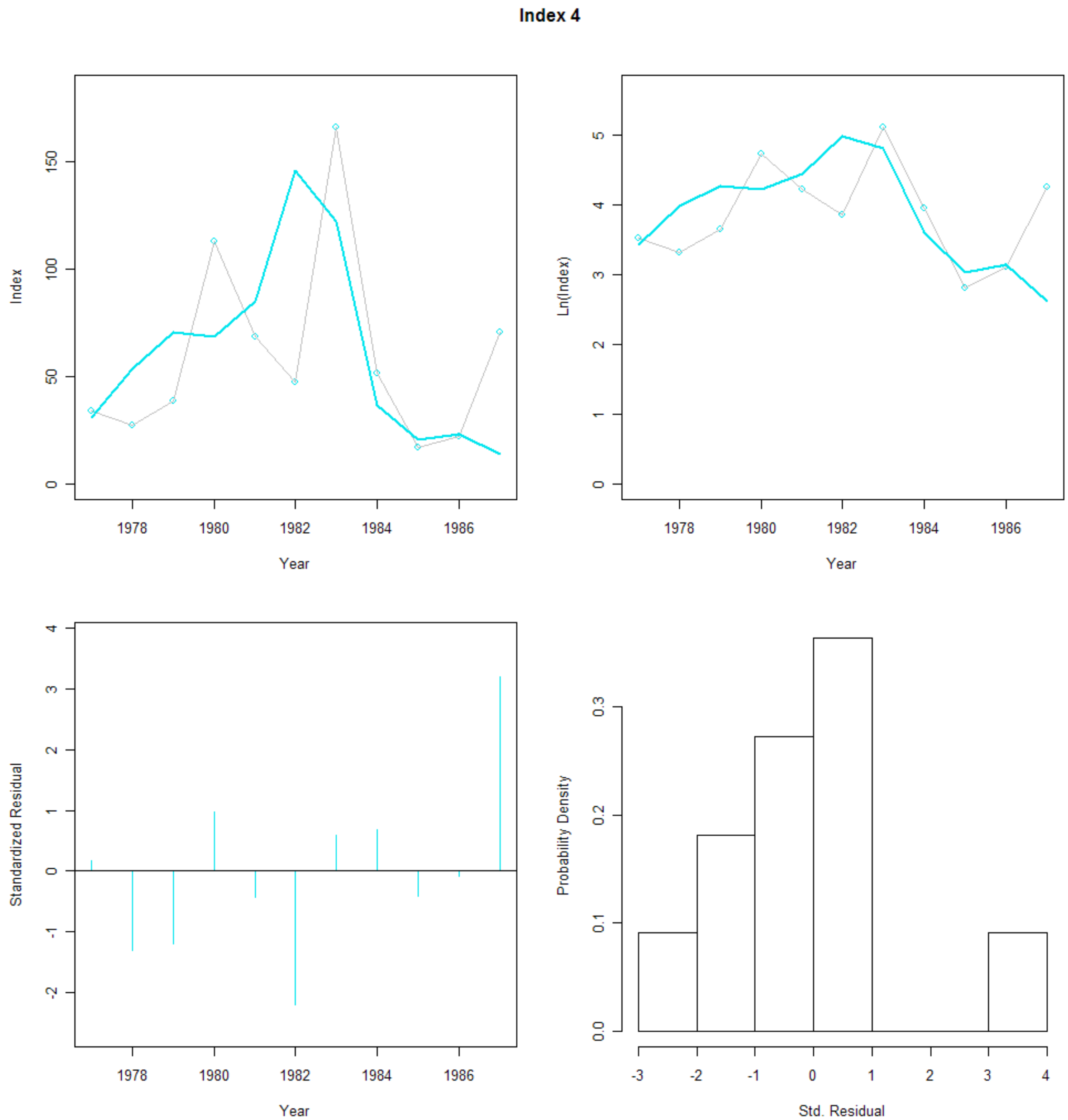


Figure B83. ASAP Model 26 fit to the NEFSC Southern New England Mid-Atlantic yellowtail flounder larval survey from 1977-1987 (index4)

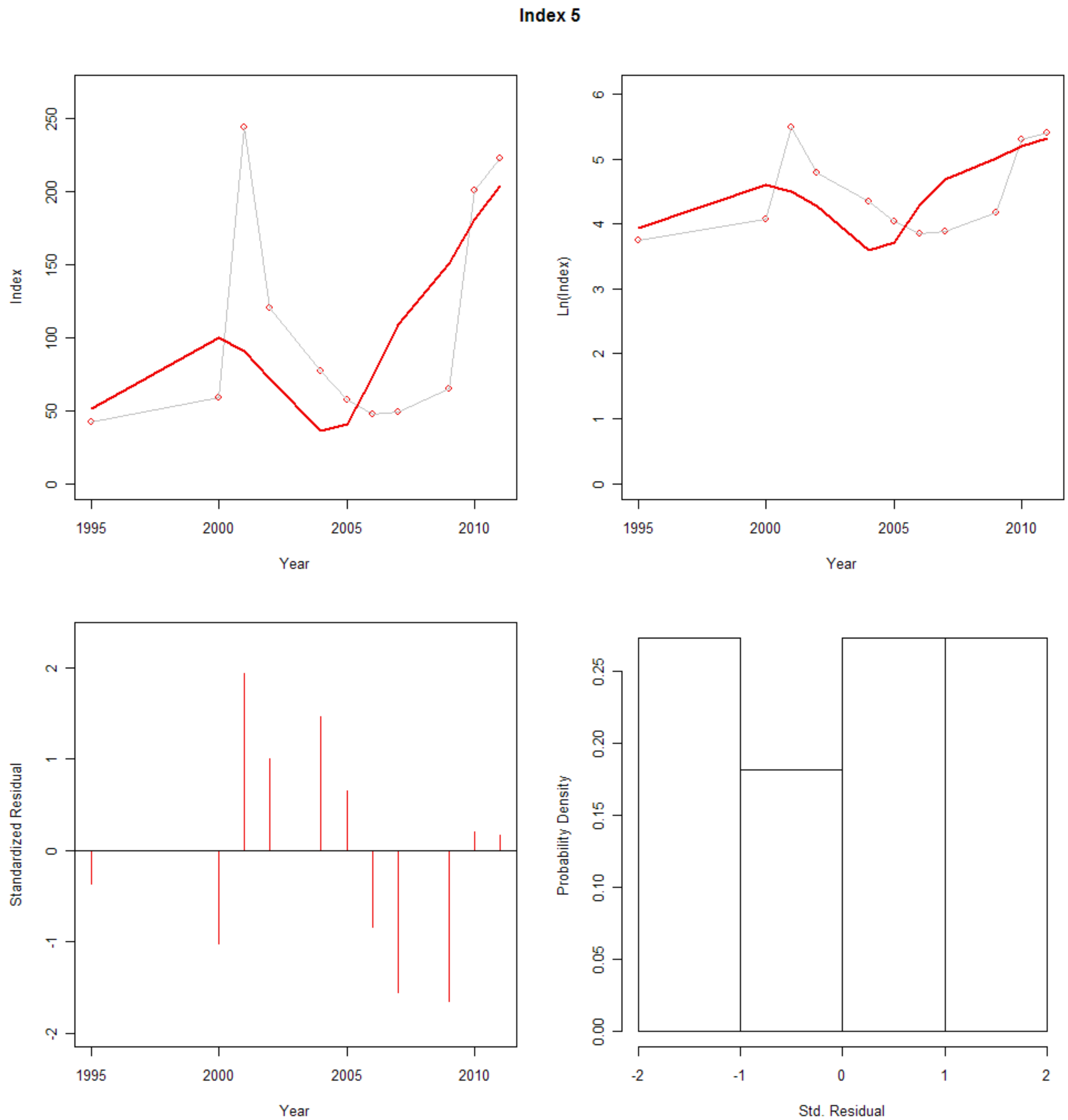


Figure B84. ASAP base Model 26 fit to the NEFSC Southern New England Mid-Atlantic yellowtail flounder larval survey from 1988-2011 (index5)

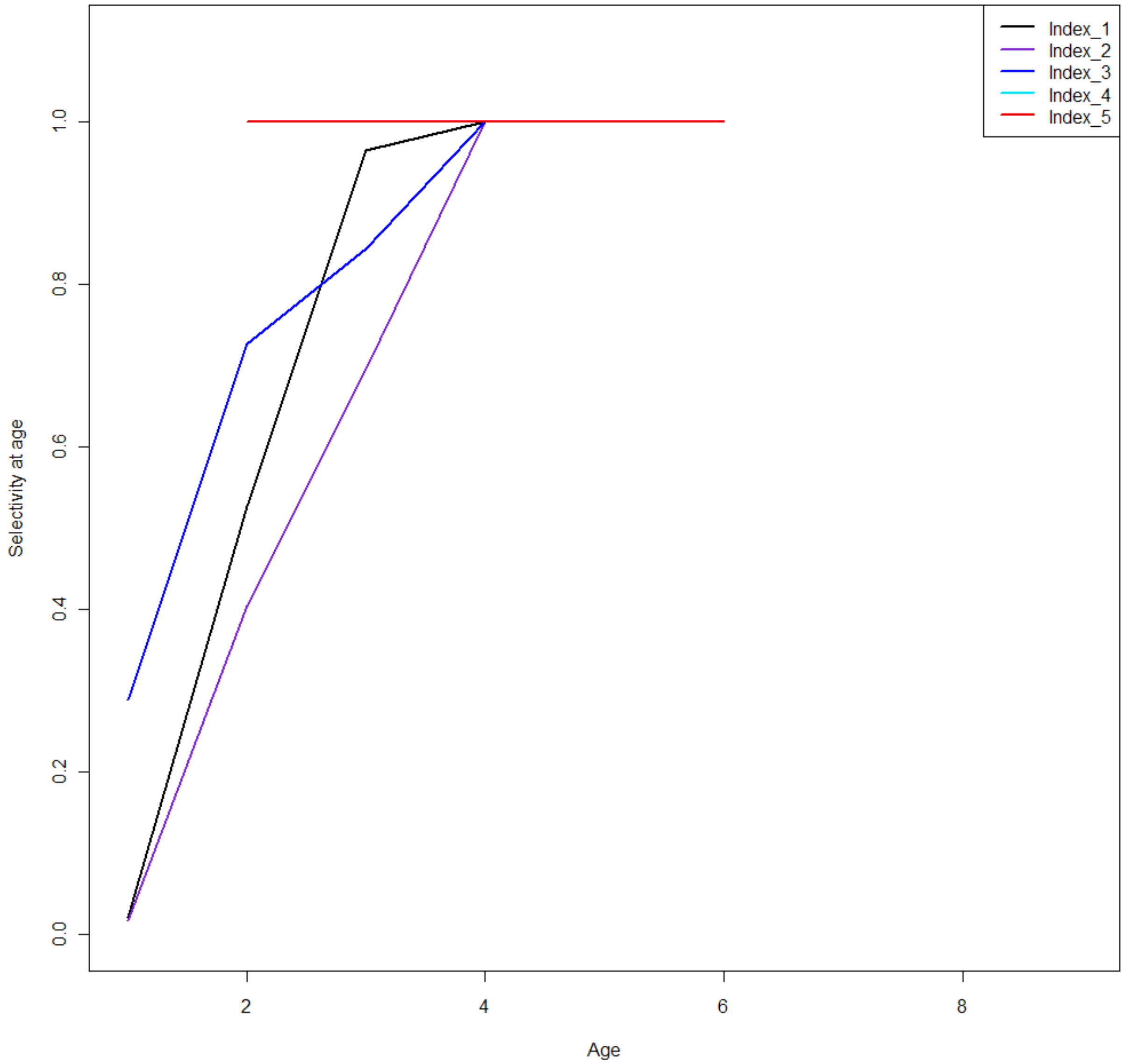


Figure B85. ASAP base Model 26 estimated selectivity at age for the NEFSC winter (index1), spring (index 2), fall (index3), larval survey 1977-1987 (index 4) and larval survey 1988-2011 (index5) of Southern New England Mid-Atlantic yellowtail flounder.

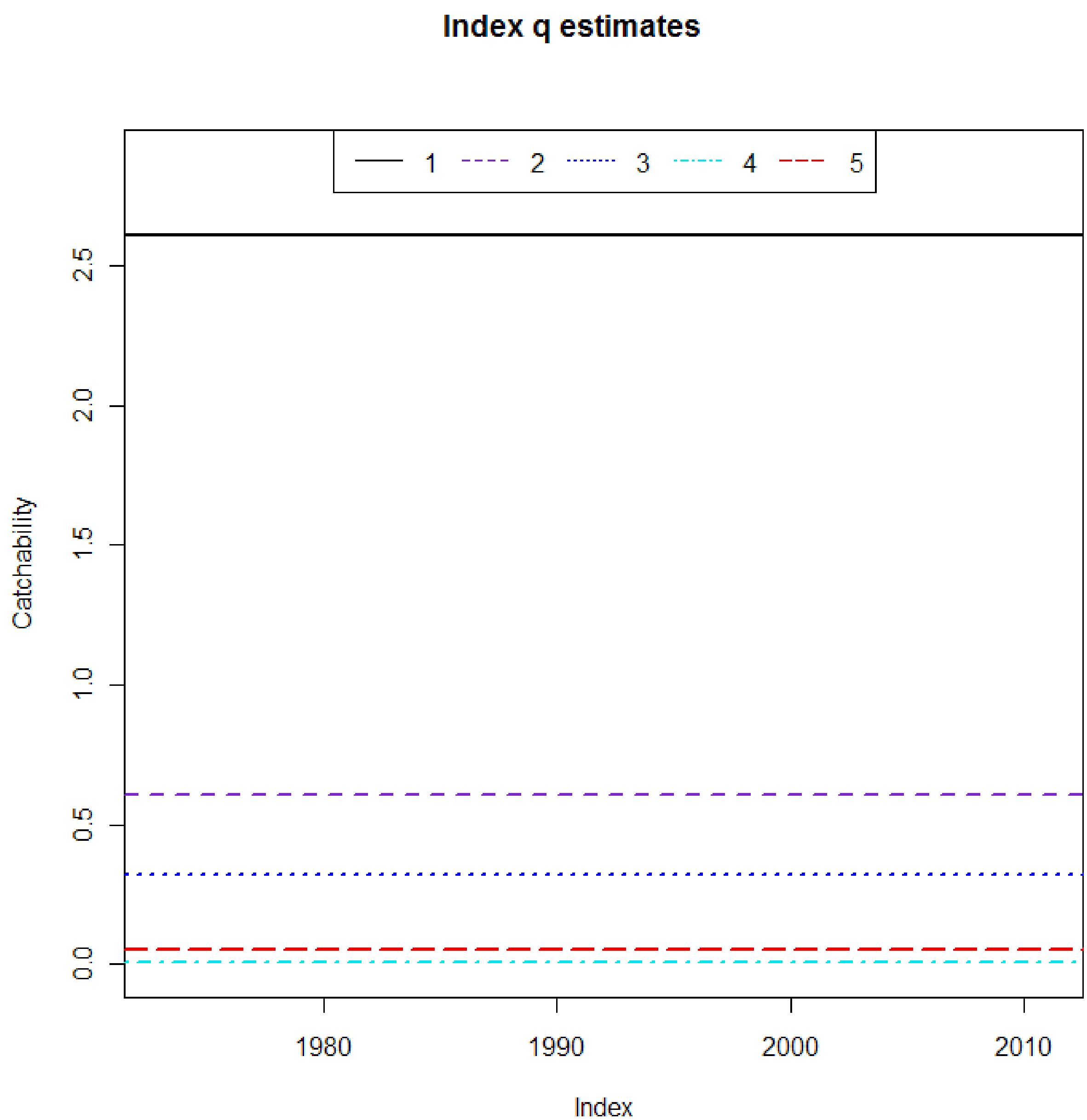
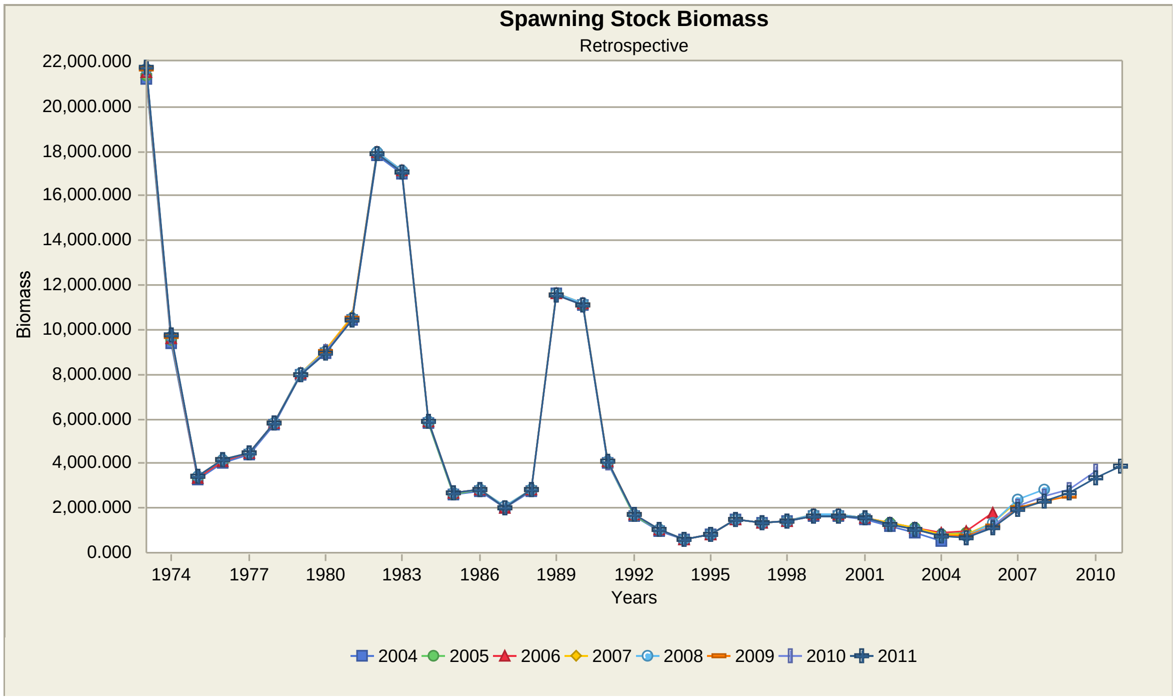


Figure B86. ASAP base Model 26 estimated survey catchability (q) for the NEFSC winter (index1), spring (index 2), fall (index3), larval survey 1977-1987 (index 4) and larval survey 1988-2011 (index5) of Southern New England Mid-Atlantic yellowtail flounder.



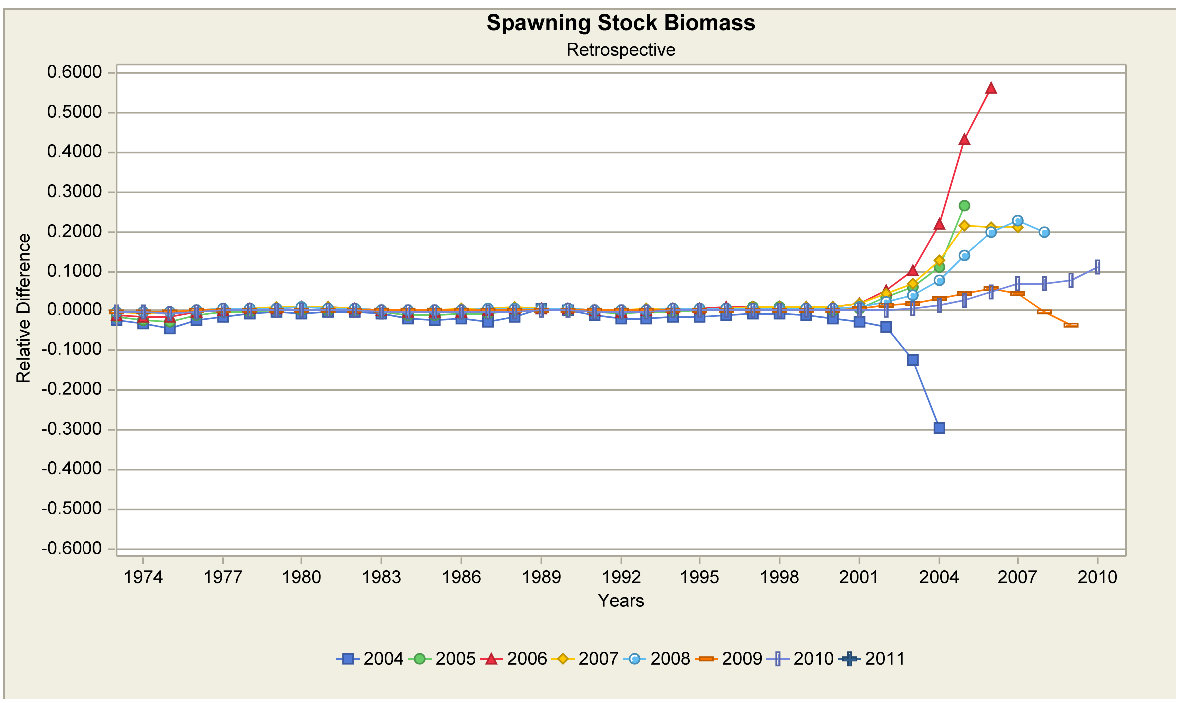
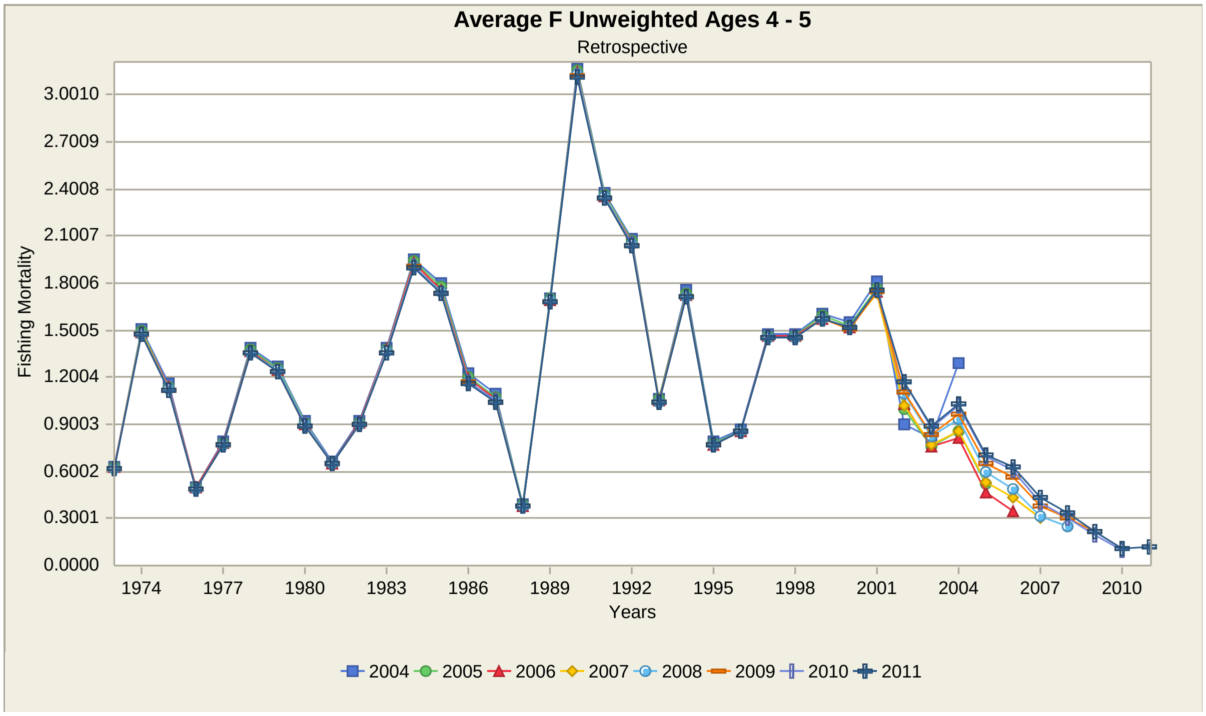


Figure B87. ASAP base Model 26 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder spawning stock Biomass (mt) in absolute (top) and relative (bottom) terms.



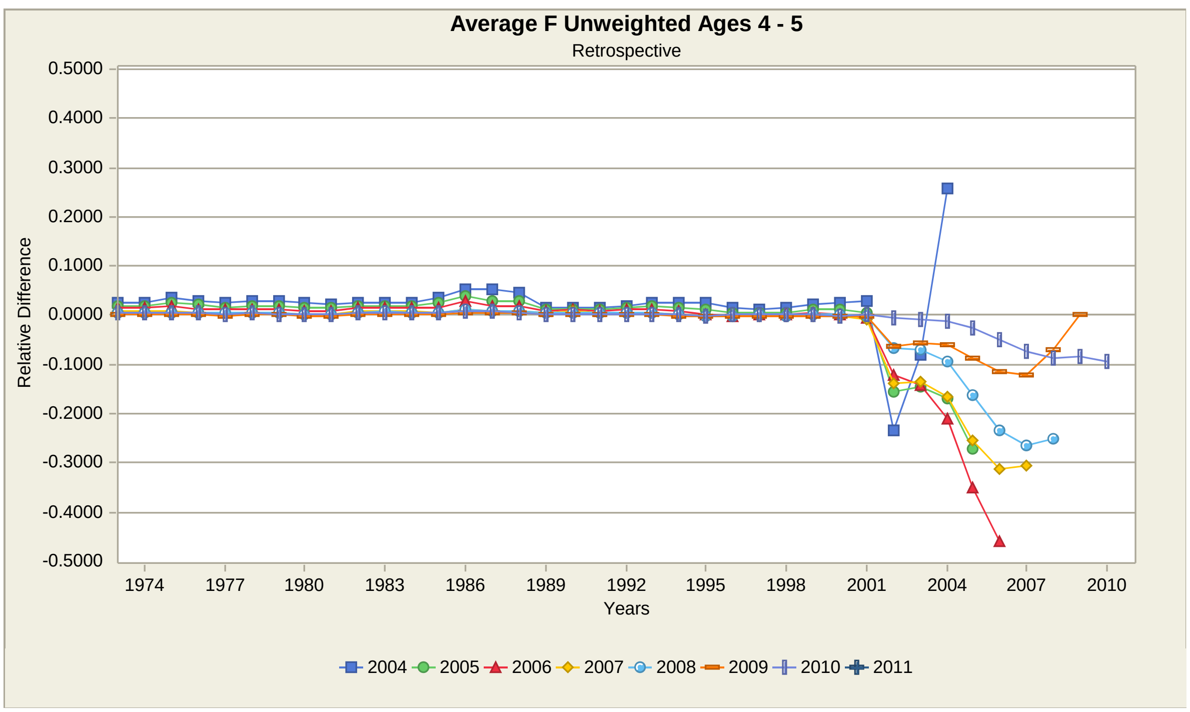
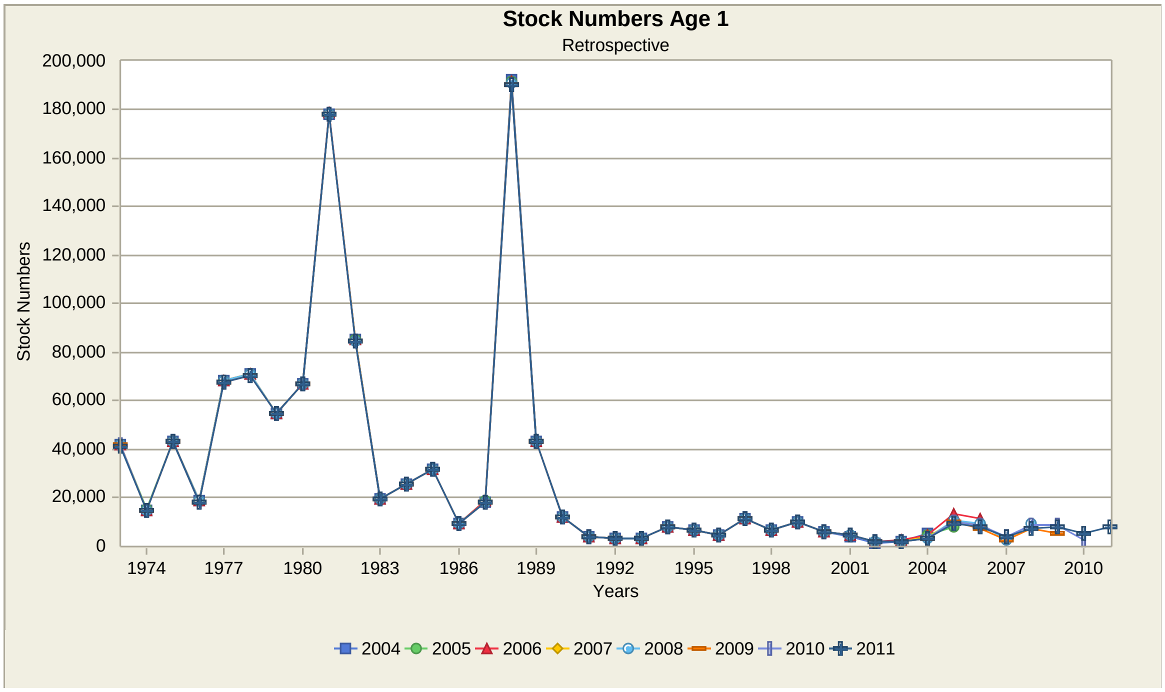


Figure B88. ASAP base Model 26 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder fishing mortality (ages 4-5) in absolute (top) and relative (bottom) terms.



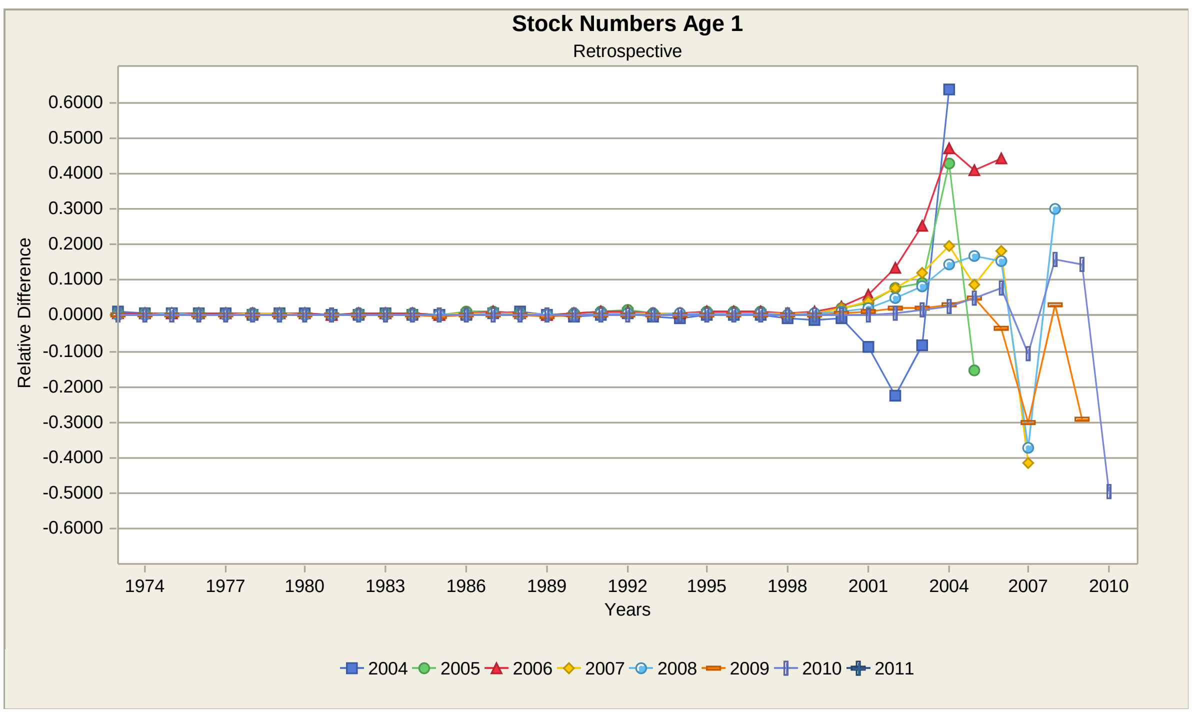


Figure B89. ASAP base Model 26 retrospective patterns in Southern New England Mid-Atlantic yellowtail flounder age 1 recruitment (000's) in absolute (top) and relative (bottom) terms.

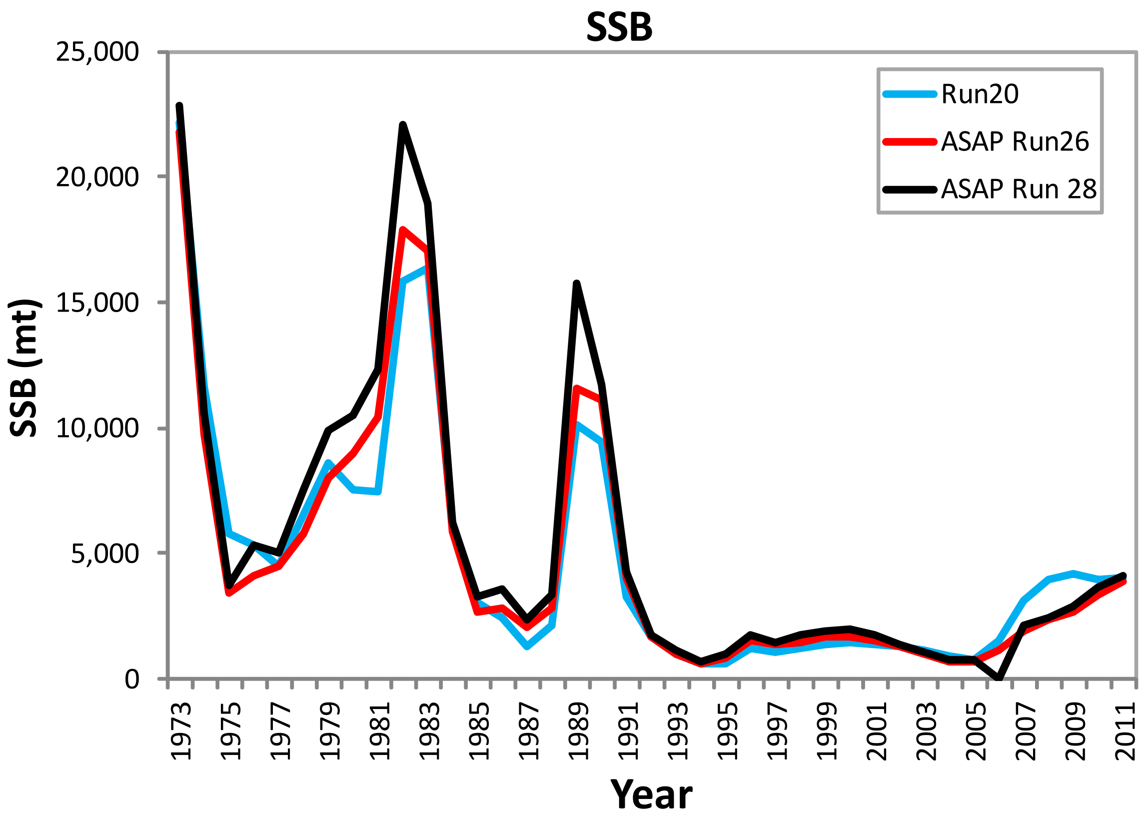


Figure B90. Comparison of estimates of Southern New England Mid-Atlantic yellowtail spawning stock biomass (mt) from ADAPT-VPA Model 20, ASAP base Model 26 ASAP and Model 28 with Cold Pool Indices

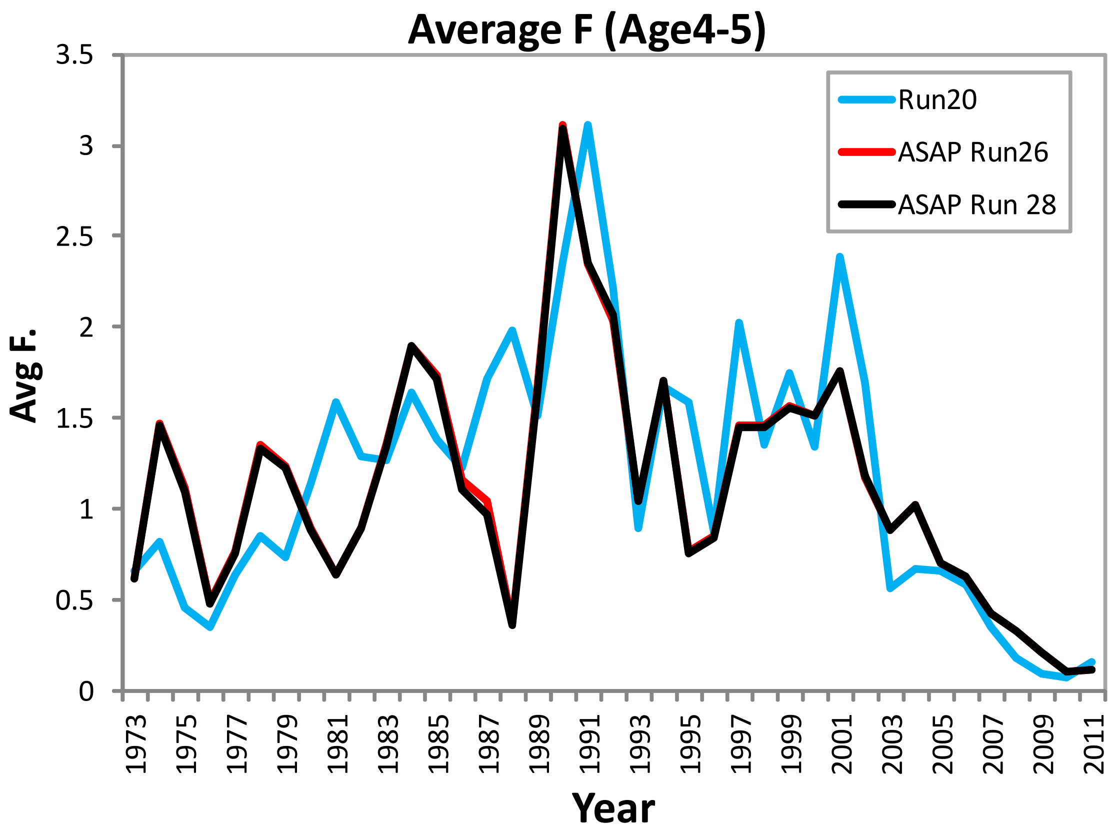


Figure B91. Comparison of estimates of Southern New England Mid-Atlantic yellowtail fishing mortality (ages 4-5) from ADAPT-VPA Model 20, ASAP base Model 26 and ASAP Model 28 with Cold Pool Indices

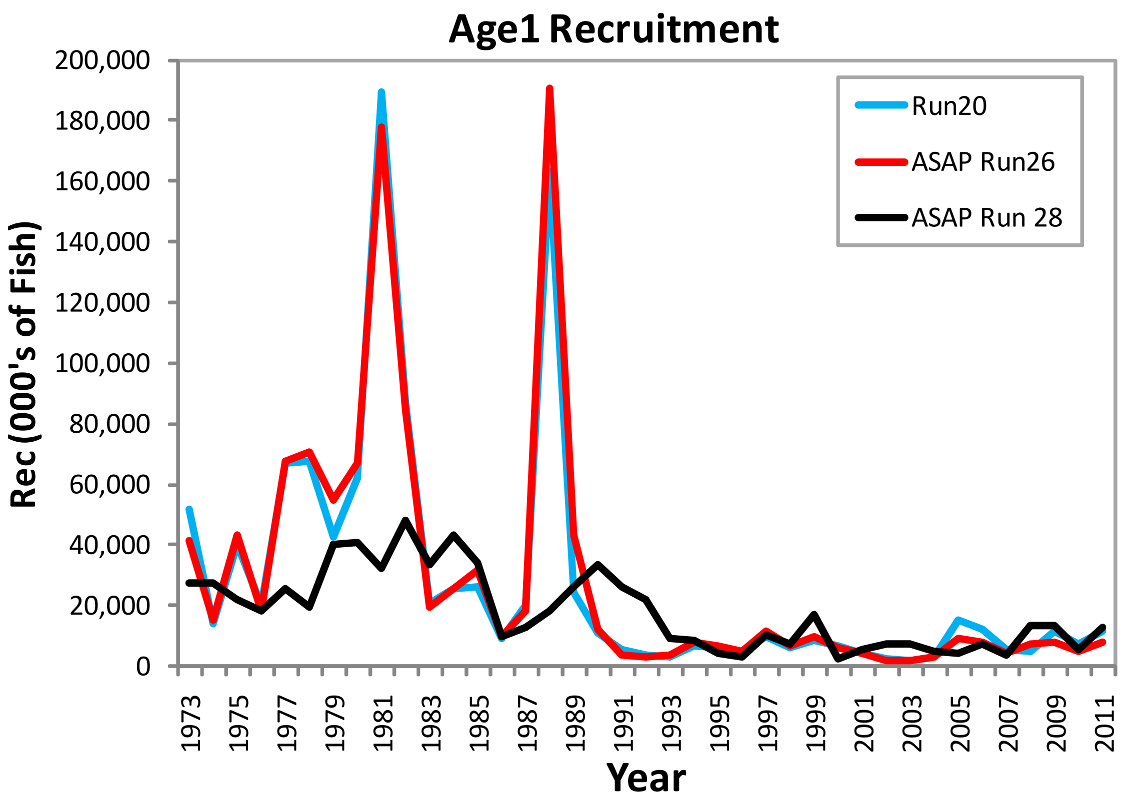
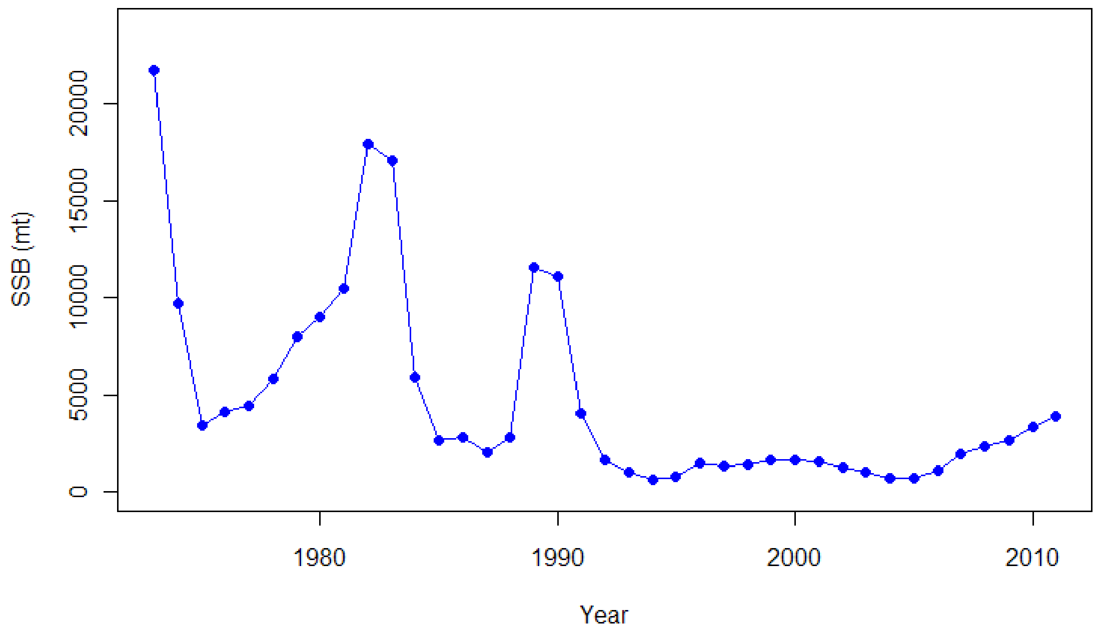


Figure B92. Comparison of estimates of Southern New England Mid-Atlantic yellowtail age 1 recruitment (000's) from ADAPT-VPA Model 20, ASAP base Model 26 and ASAP Model 28 with Cold Pool Indices



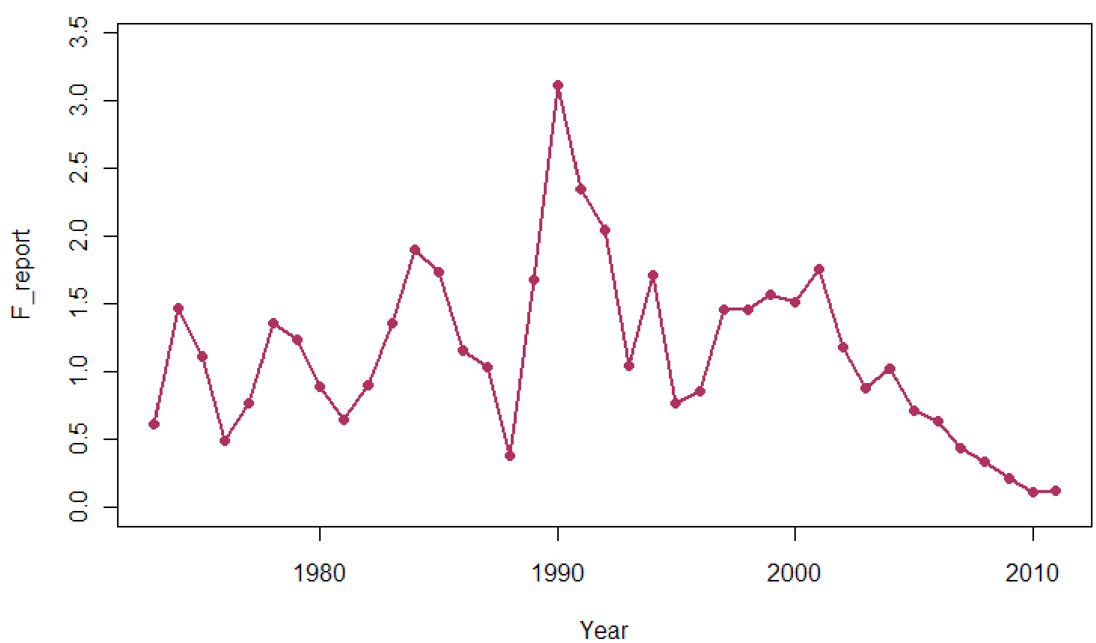


Figure B93. ASAP base Model 26 estimates of Southern New England Mid-Atlantic yellowtail flounder spawning stock biomass in mt (top) and average fishing mortality (bottom; $F_{4\text{-}5}$ = F report)

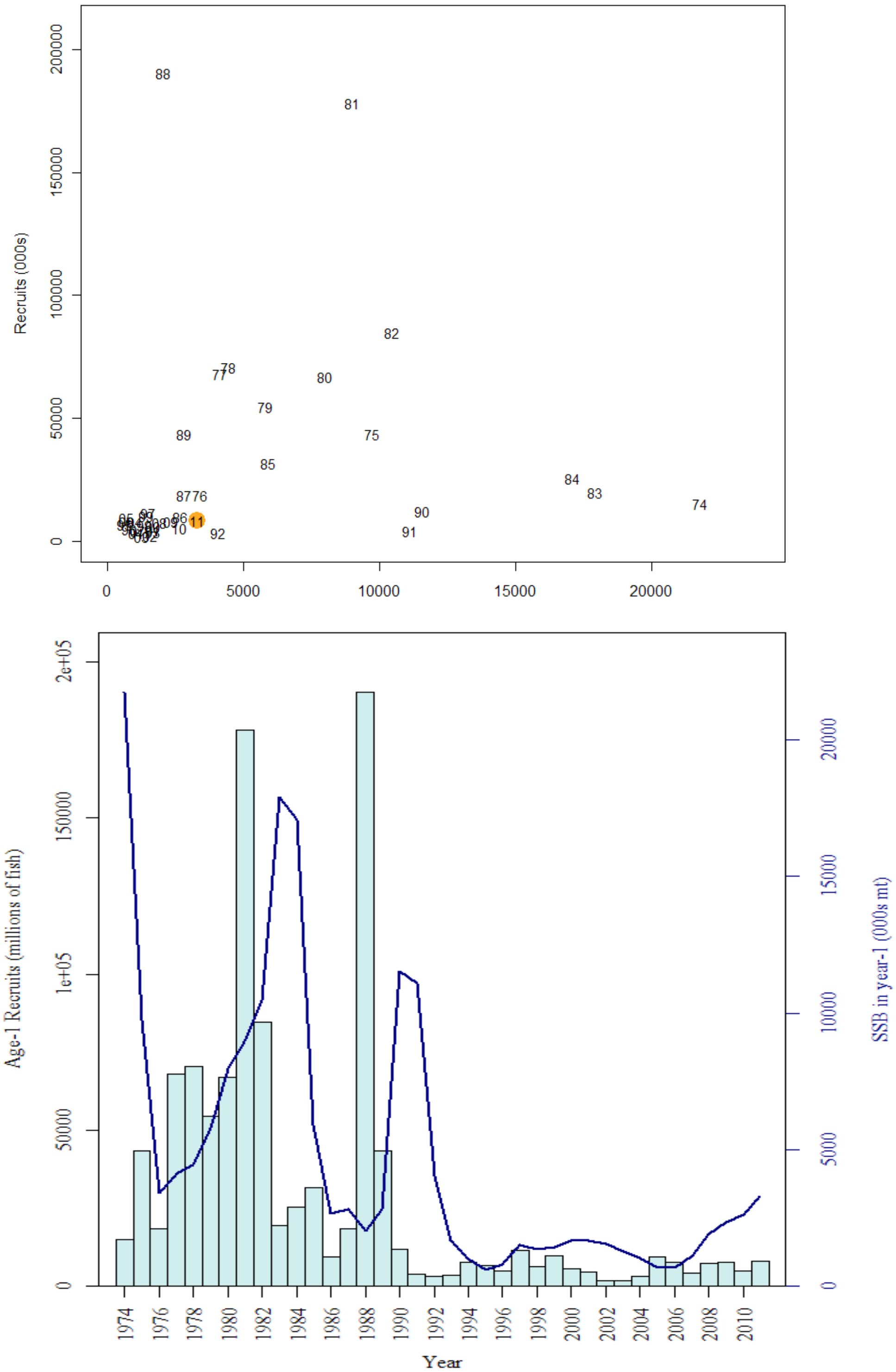


Figure B94. Top: scatter plot of ASAP model 26 estimates of Southern New England-Mid Atlantic yellowtail flounder spawning stock biomass in mt versus recruitment at age 1 (000's) . The symbol for each observation is the last two digits of the year (e.g. 88 indicated age 1 estimates of the 1987 year class). The most recent recruitment estimate is highlighted in an orange circle. Bottom: ASAP base Model 26 time series of SSB (blue line) and age1 recruitment (bars).

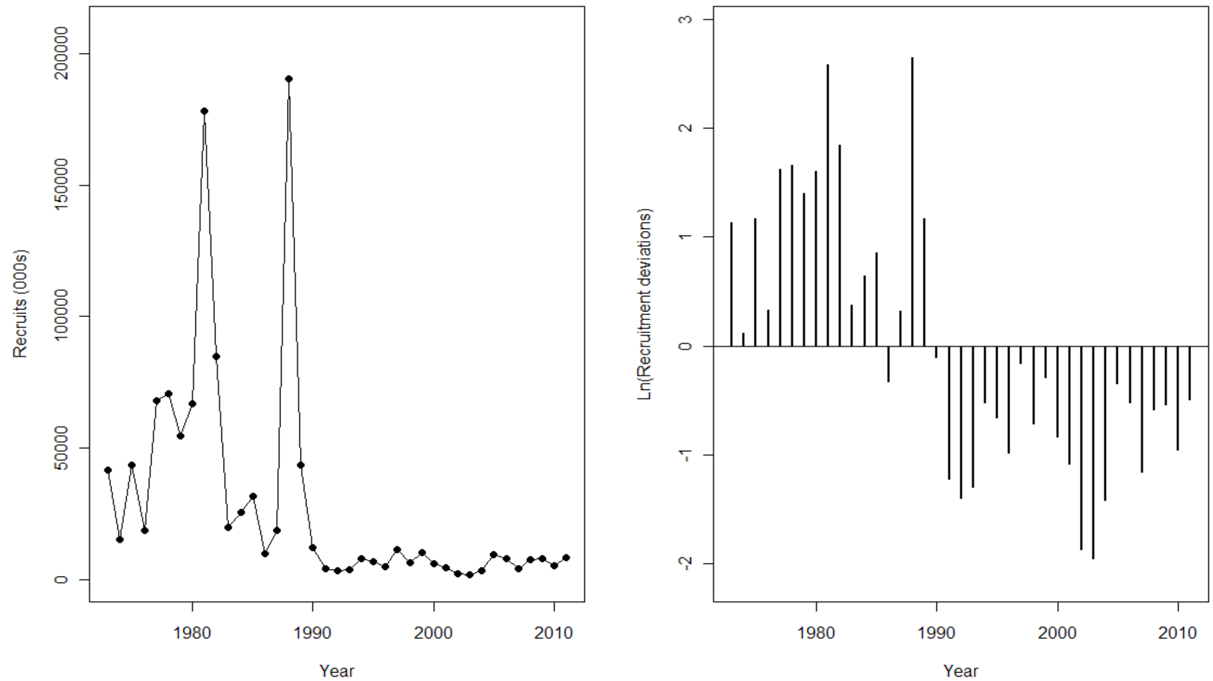


Figure B95. ASAP base Model 26 estimated Southern New England Mid-Atlantic yellowtail flounder recruitment residuals from the geometric mean.

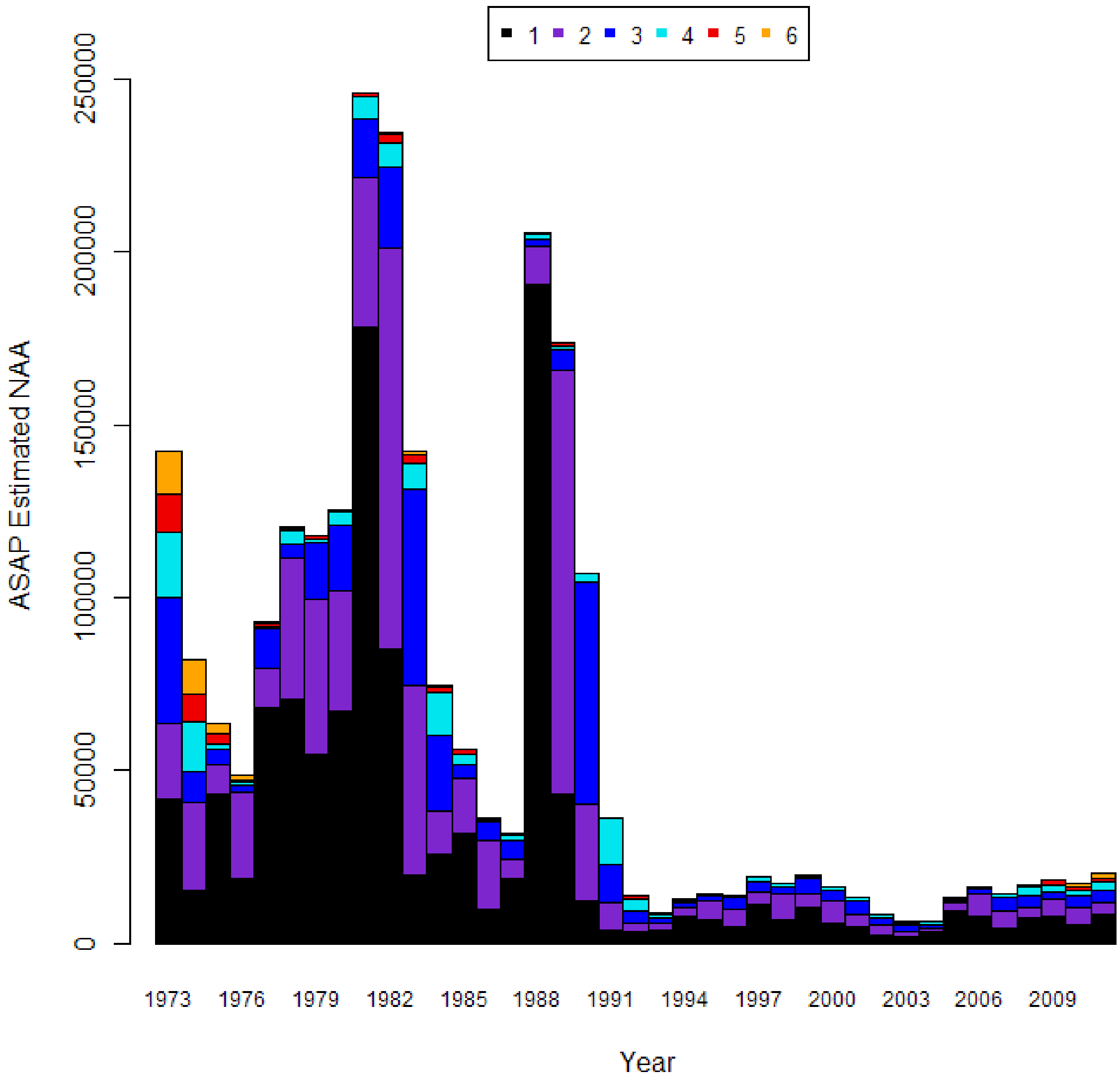


Figure B96. ASAP base Model 26 model estimates of Southern New England Mid-Atlantic yellowtail flounder numbers at age in 000's of fish

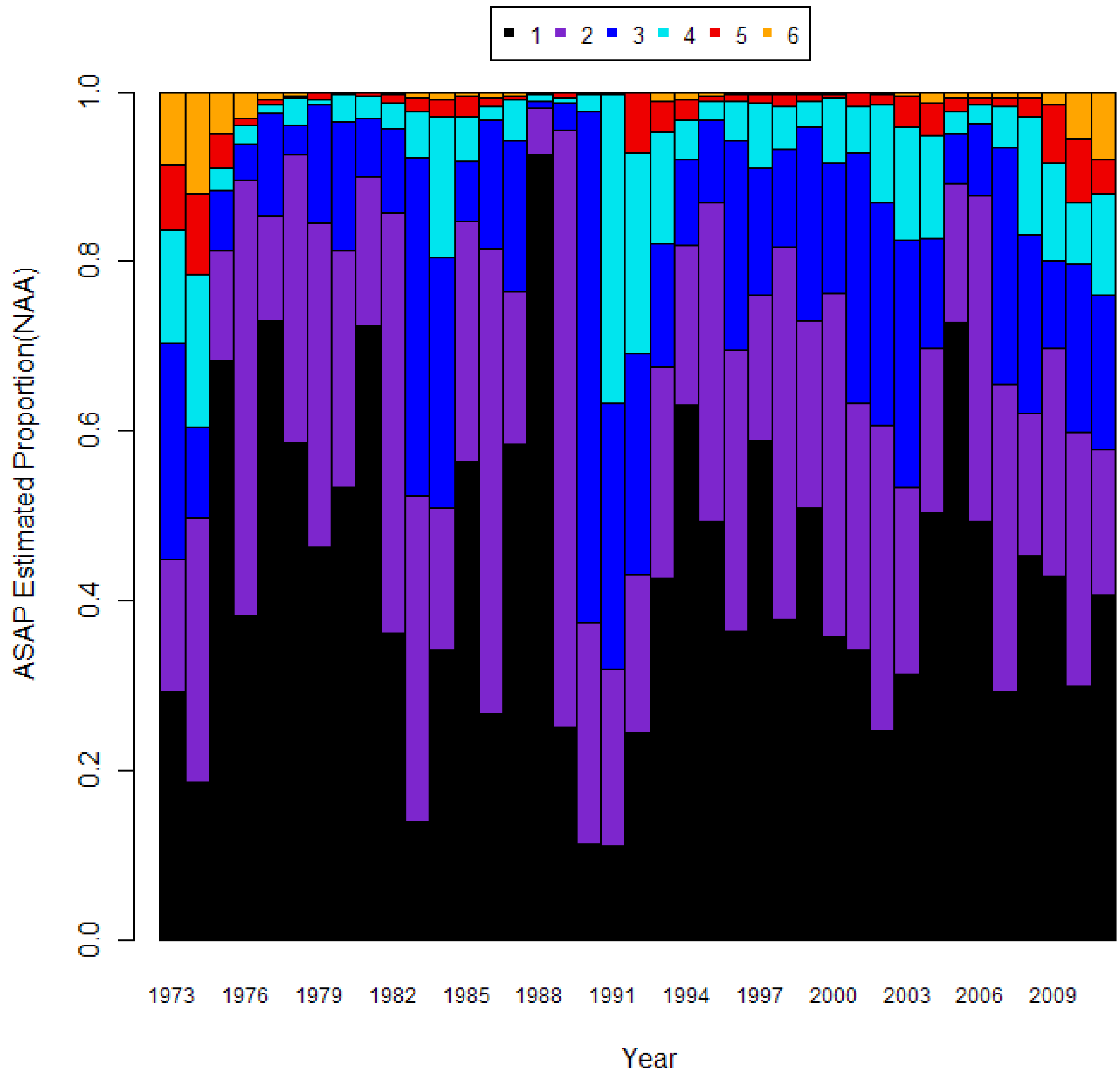


Figure B97. ASAP base Model 26 model estimates of Southern New England Mid-Atlantic yellowtail flounder numbers at age expressed as proportions

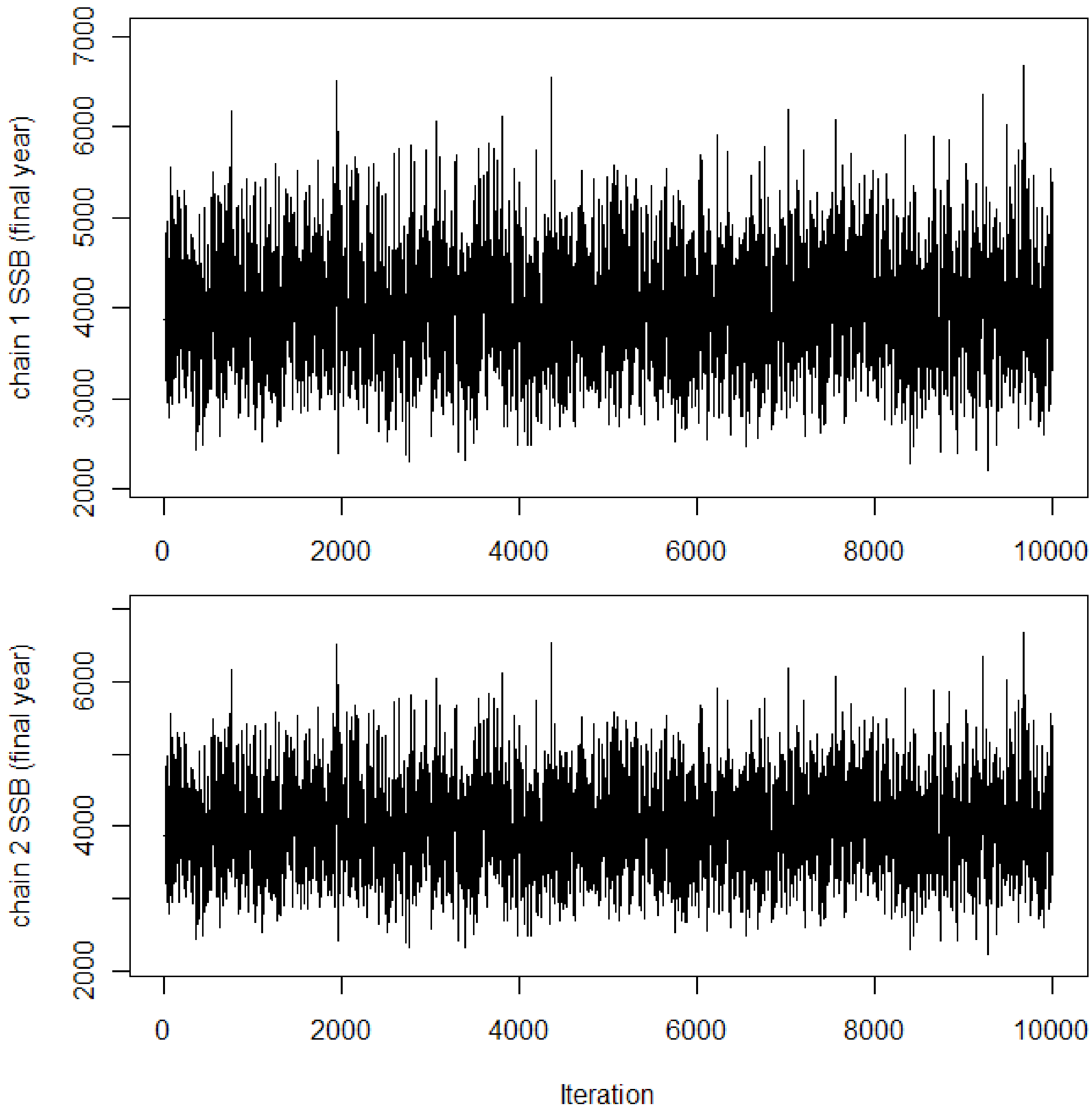


Figure B98. Trace MCMC chains for Southern New England mid-Atlantic yellowtail SSB2011, showing good mixing (ASAP base Model 26). Each chain had initial length of 10,000 and was thinned at a rate if one out of every 200th with remaining chain = 500 (above)

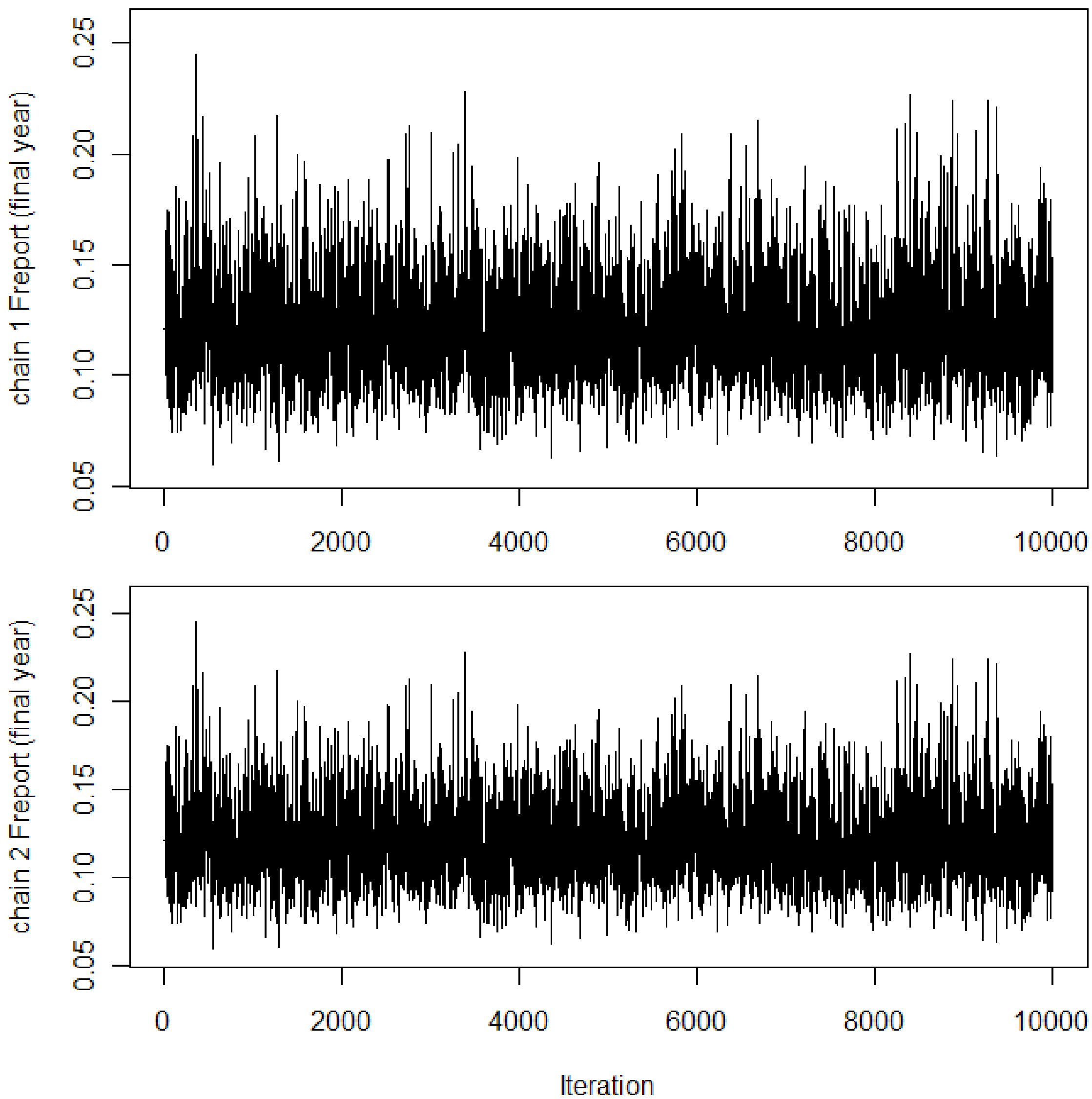


Figure B99. Trace MCMC chains for Southern New England mid-Atlantic yellowtail F 2011, showing good mixing (ASAP base Model 26). Each chain had initial length of 10,000 and was thinned at a rate if one out of every 200th with remaining chain = 500 (above)

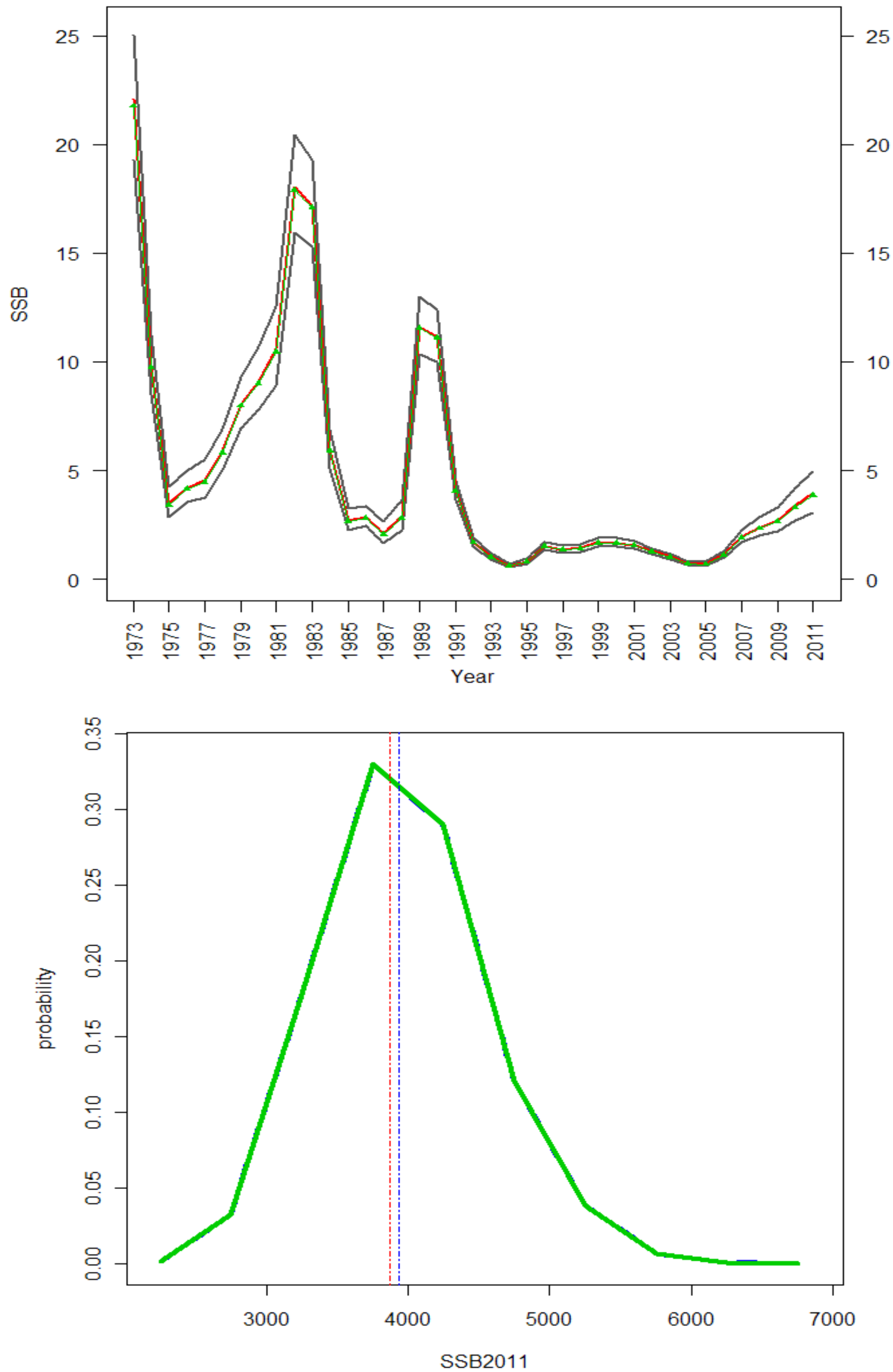
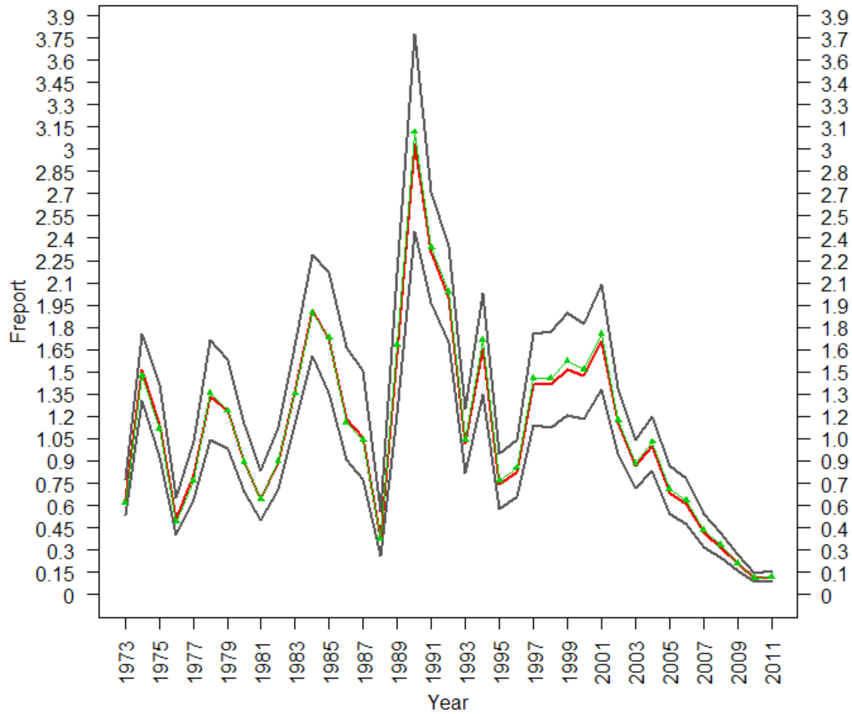


Figure B100. Top: 90% probability interval for Southern New England Mid-Atlantic yellowtail flounder spawning stock biomass from ASAP base Model 26. The median is value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model is shown in the thin green line with filled triangles. Bottom: MCMC distribution of spawning stock biomass in 2011, ASAP point estimate (red line) and median estimate (blue line) from the MCMC distribution indicated by the horizontal lines.



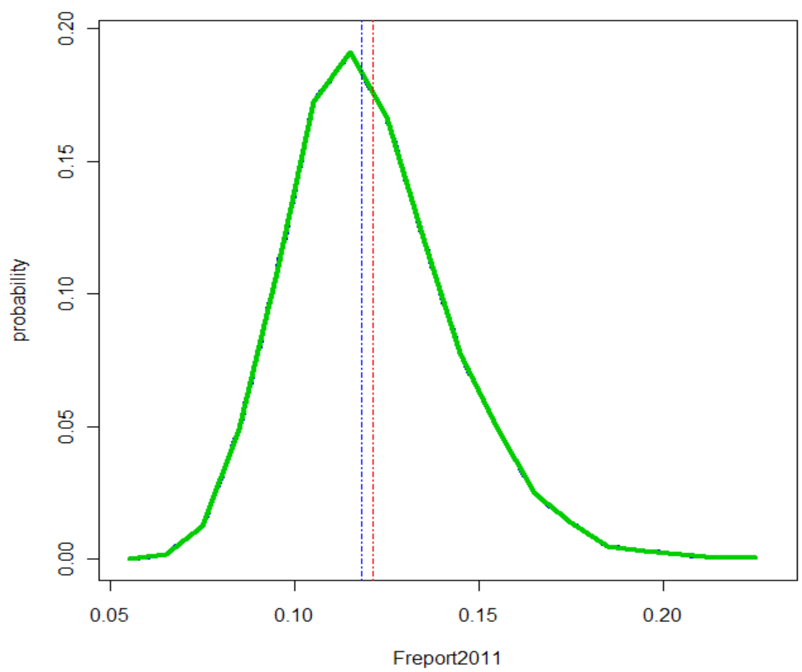


Figure B101. Top: 90% probability interval for Southern New England Mid-Atlantic yellowtail flounder average fishing mortality from ages 4 to 5 (avg. $F_{4\text{-}5}$) from ASAP base Model 26. The median is value is in red, while the 5th and 95th percentiles are in dark grey. The point estimate from the base model is shown in the thin green line with filled triangles. Bottom: MCMC distribution of average fishing mortality from ($F_{4\text{-}5}$) in 2011, ASAP point estimate (red line) and median estimate (blue line) indicated by the horizontal line.

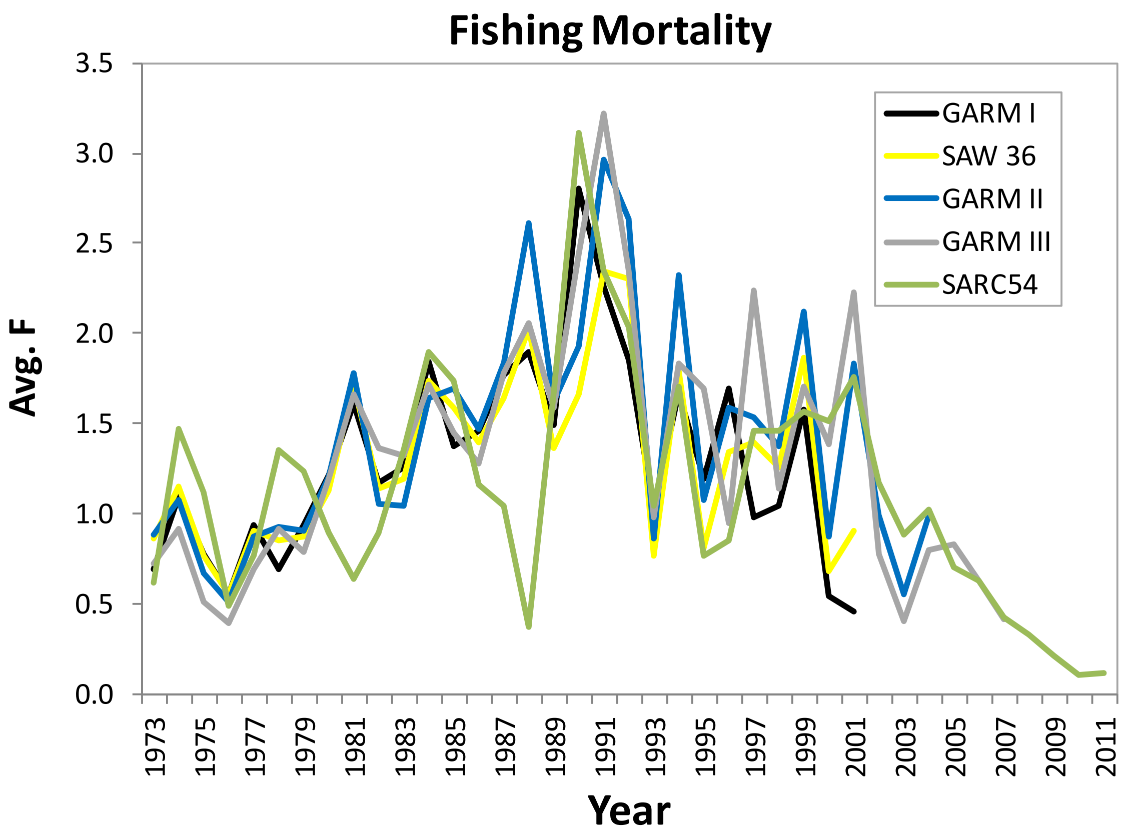


Figure B102. Comparison of average fishing mortality from previous Southern New England mid-Atlantic yellowtail stock assessments including estimates from the 2012 ASAP base Model 26 model assessment updates.

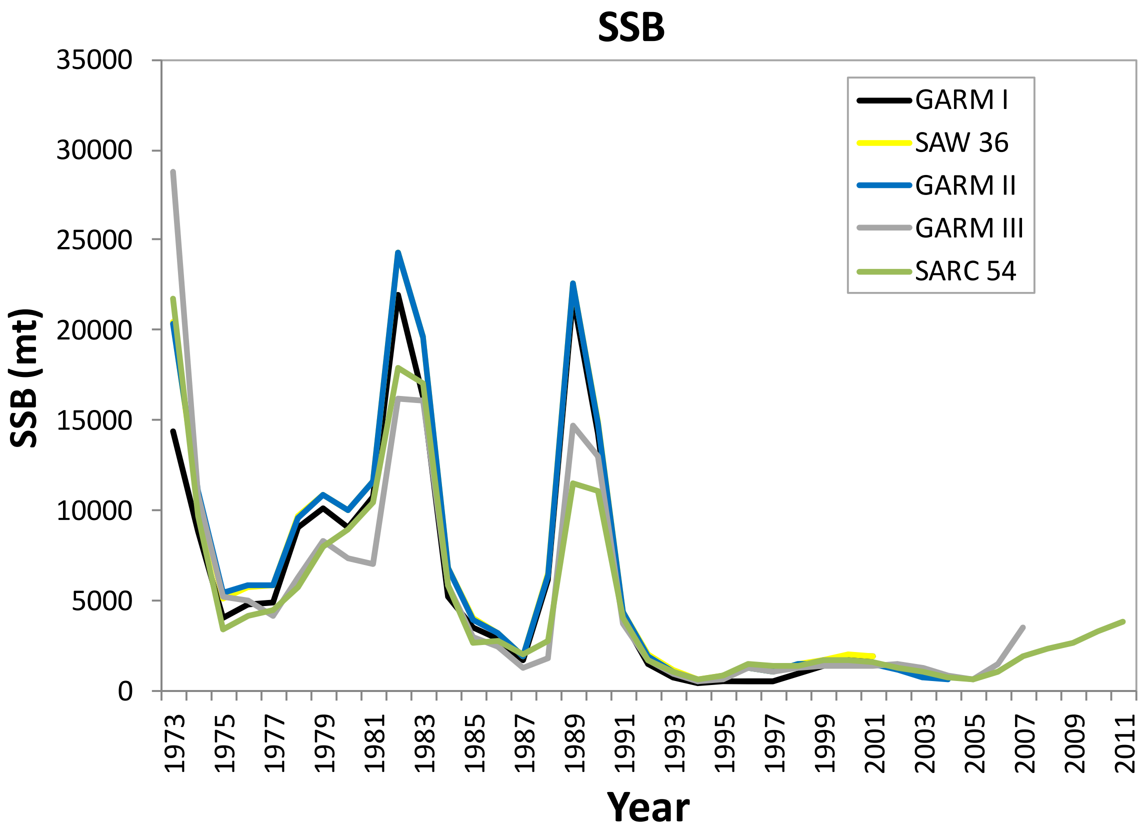


Figure B103. Comparison of spawning stock biomass (mt) from previous Southern New England mid-Atlantic yellowtail stock assessments including estimates from the 2012 ASAP base Model 26 model assessment updates.

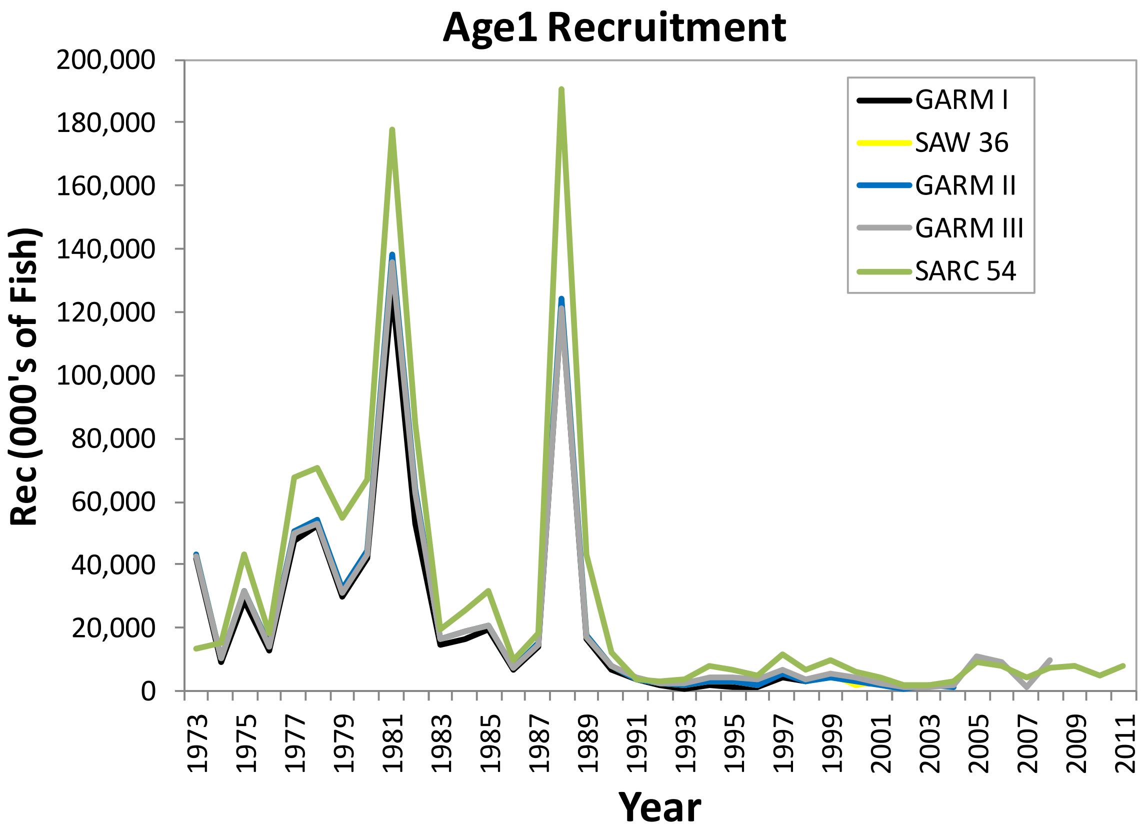


Figure B104. Comparison of age 1 recruitment from previous Southern New England mid-Atlantic yellowtail stock assessments including estimates from the 2012 ASAP base Model 26 model assessment updates.

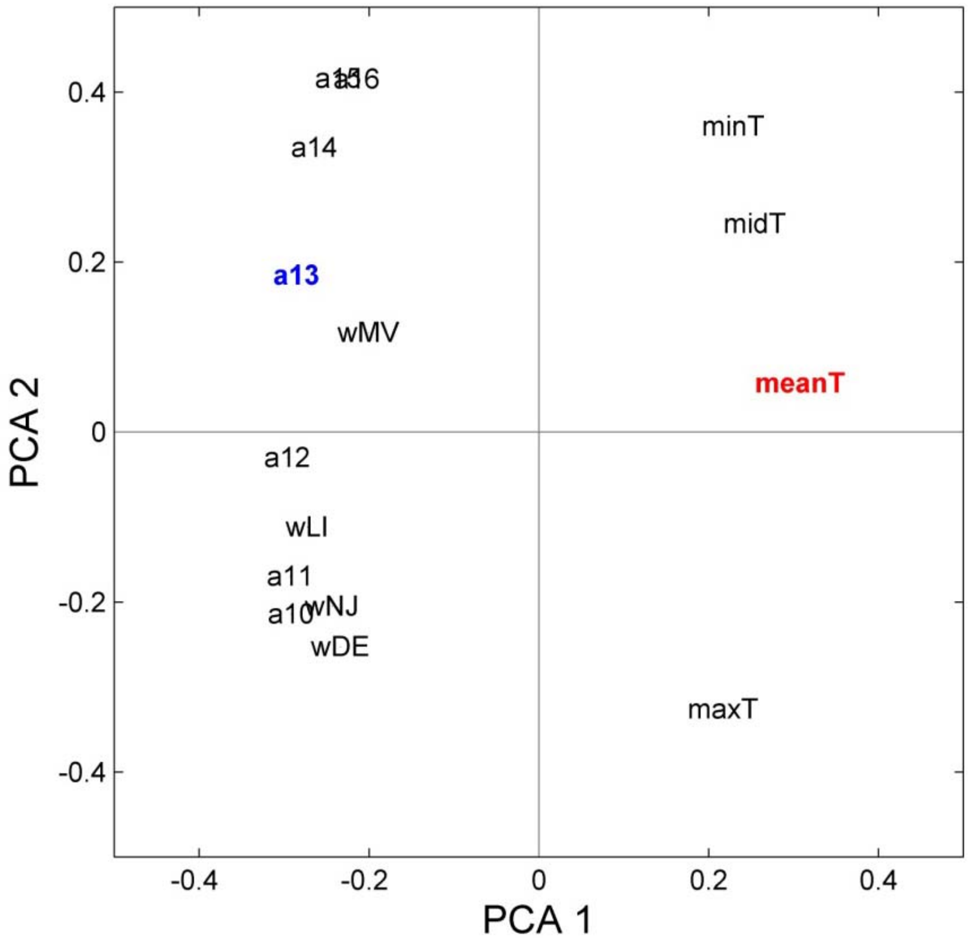


Figure B105. Ordination of 15 cold-pool variables resulting from Principal Components Analysis (PCA). Variables included are: mean (meanT), maximum (maxT), and minimum (minT) temperature of area occupied by juvenile yellowtail flounder; width of temperatures <12^{o}C along four cross-shelf transects: south of Martha's Vineyard (wMV), south of Long Island (wLI), east of New Jersey (wNJ), and east of Delaware Bay (wDB); bottom temperature anomaly along the mid-line of the cold-pool (midT); area of bottom water on the Mid-Atlantic Bight shelf <10 ^{o}C (a10), <11 ^{o}C (a11), <12 ^{o}C (a12), <13 ^{o}C (a13), <14 ^{o}C (a14), <15 ^{o}C (a15), and <16 ^{o}C (a16).

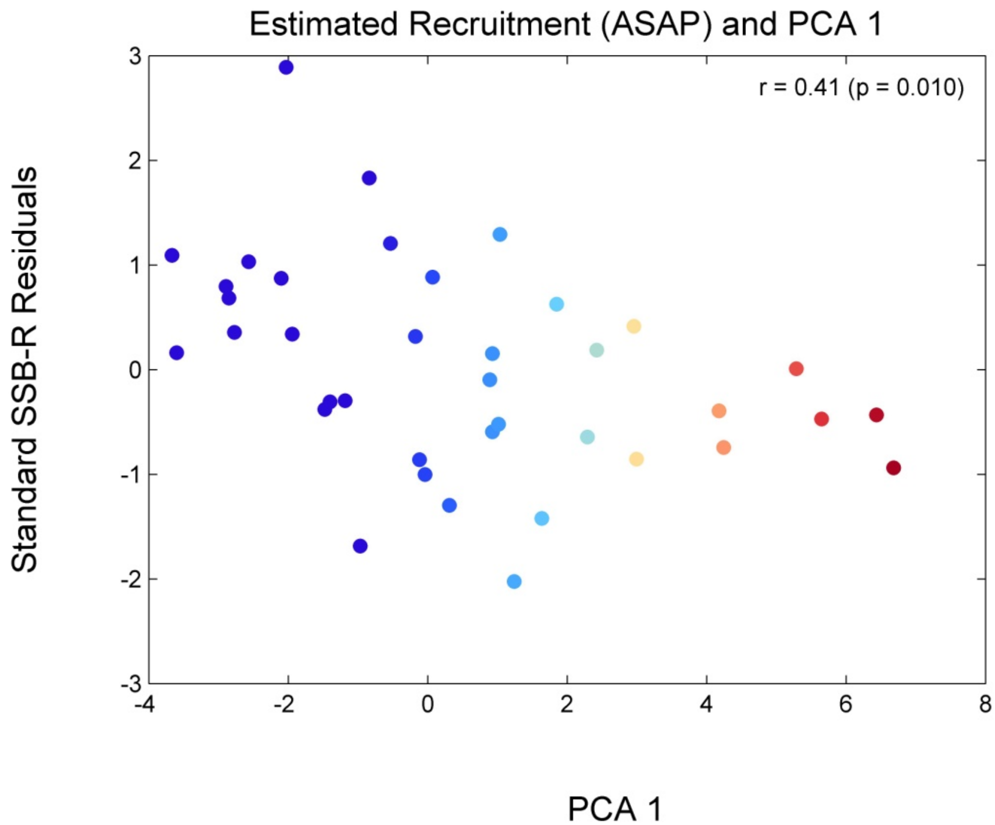


Figure B106. Relationship between residuals from the standard Beverton Holt model and the Cold Pool Index (PCA 1). Recruitment is above predicted when the cold pool is large and cold (negative PCA 1). Recruitment is below predicted when the cold pool is small and warm (positive PCA 1).

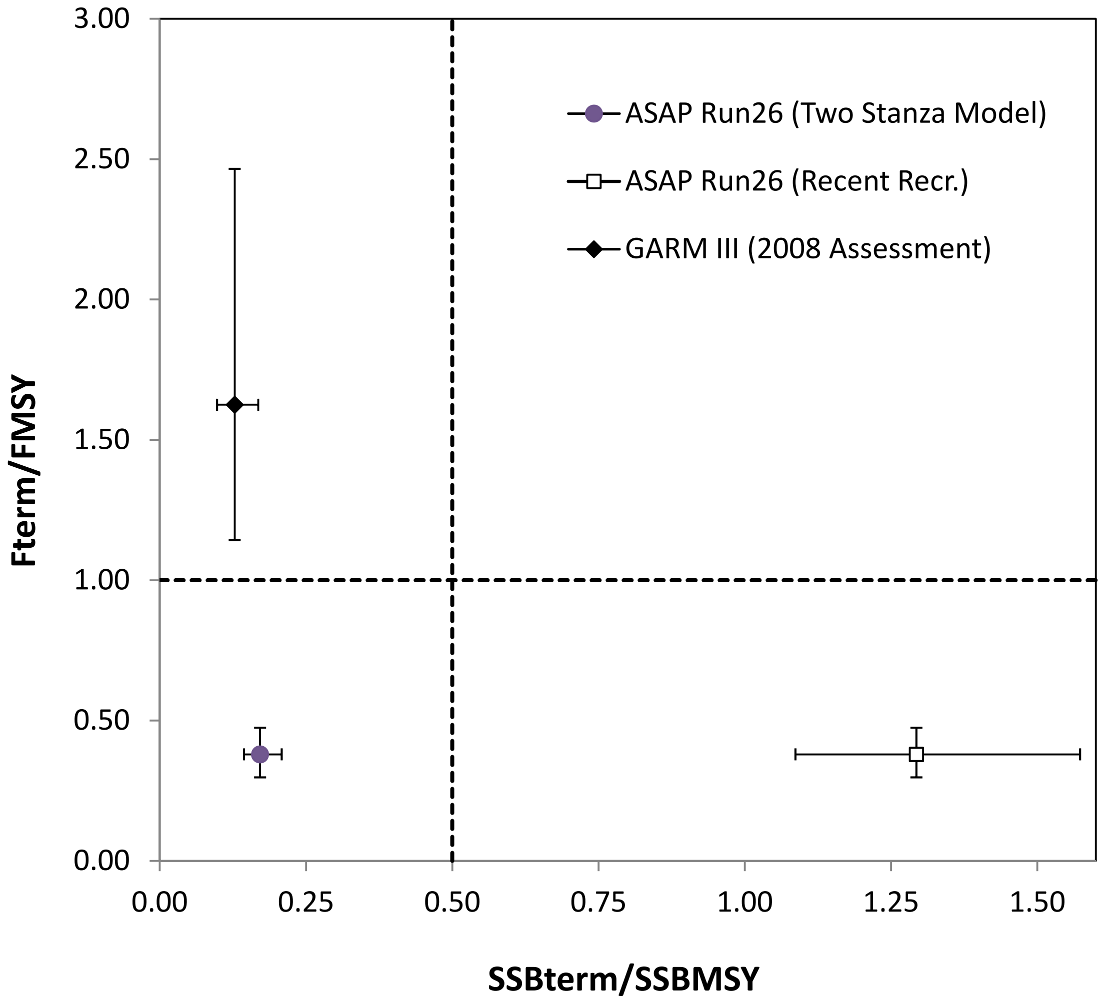


Figure B107. Status of 2011 fishing mortality and spawning stock biomass (SSB) of Southern New England Mid-Atlantic yellowtail flounder relative to F_{MSY} proxy ($F_{40\%}$) and SSB_{MSY}.

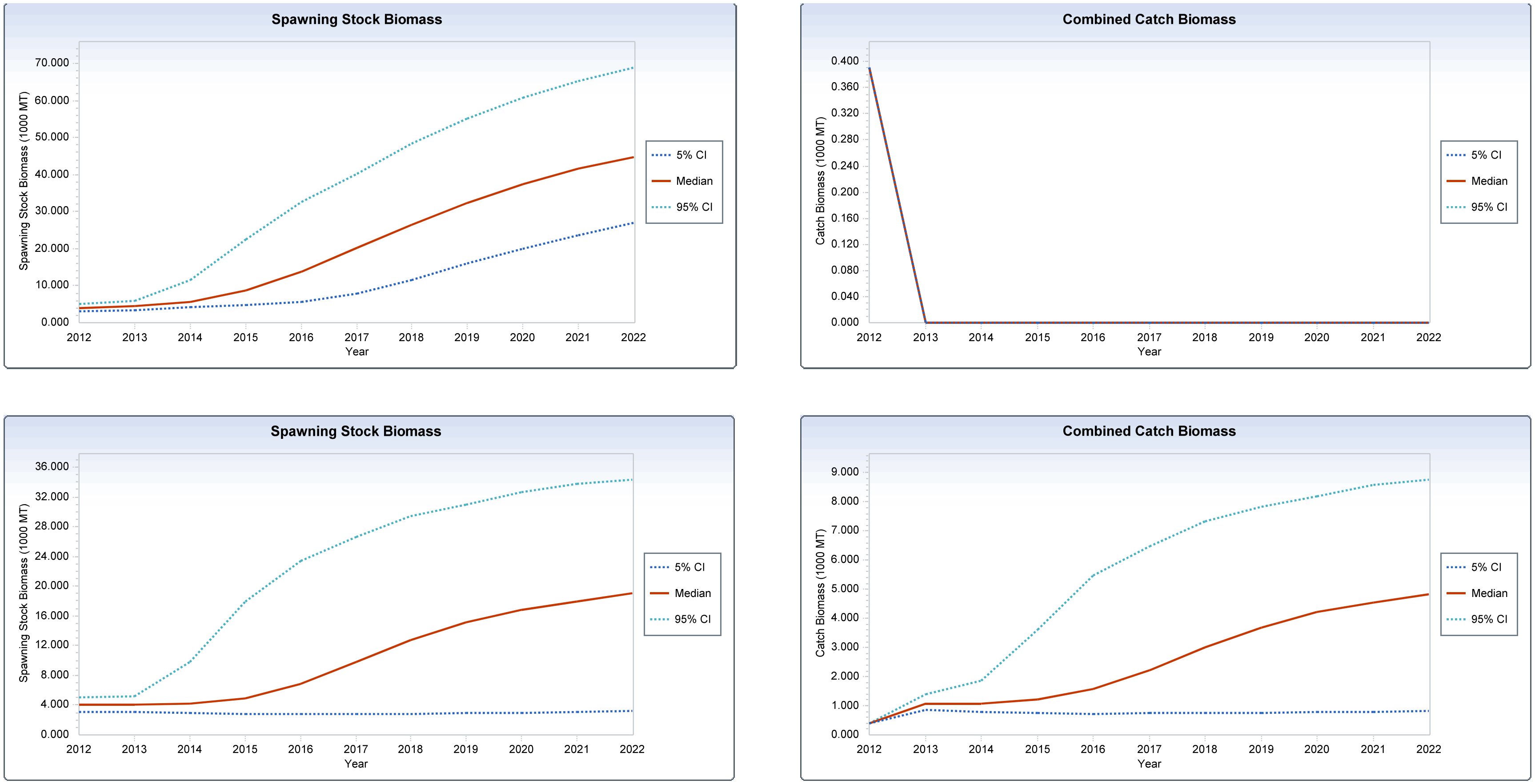


Figure B108. Short-term projections for Southern New England-Mid Atlantic yellowtail flounder in terms of fishery yields (catch, Right) and spawning stock biomass (SSB, Left) assuming the two stanza recruitment model (i.e. all recruitment series from 1973-2010) under F_0 (Top) and F_{MSY} (Bottom). Median estimates are shown (red) along with the 90% confidence interval.

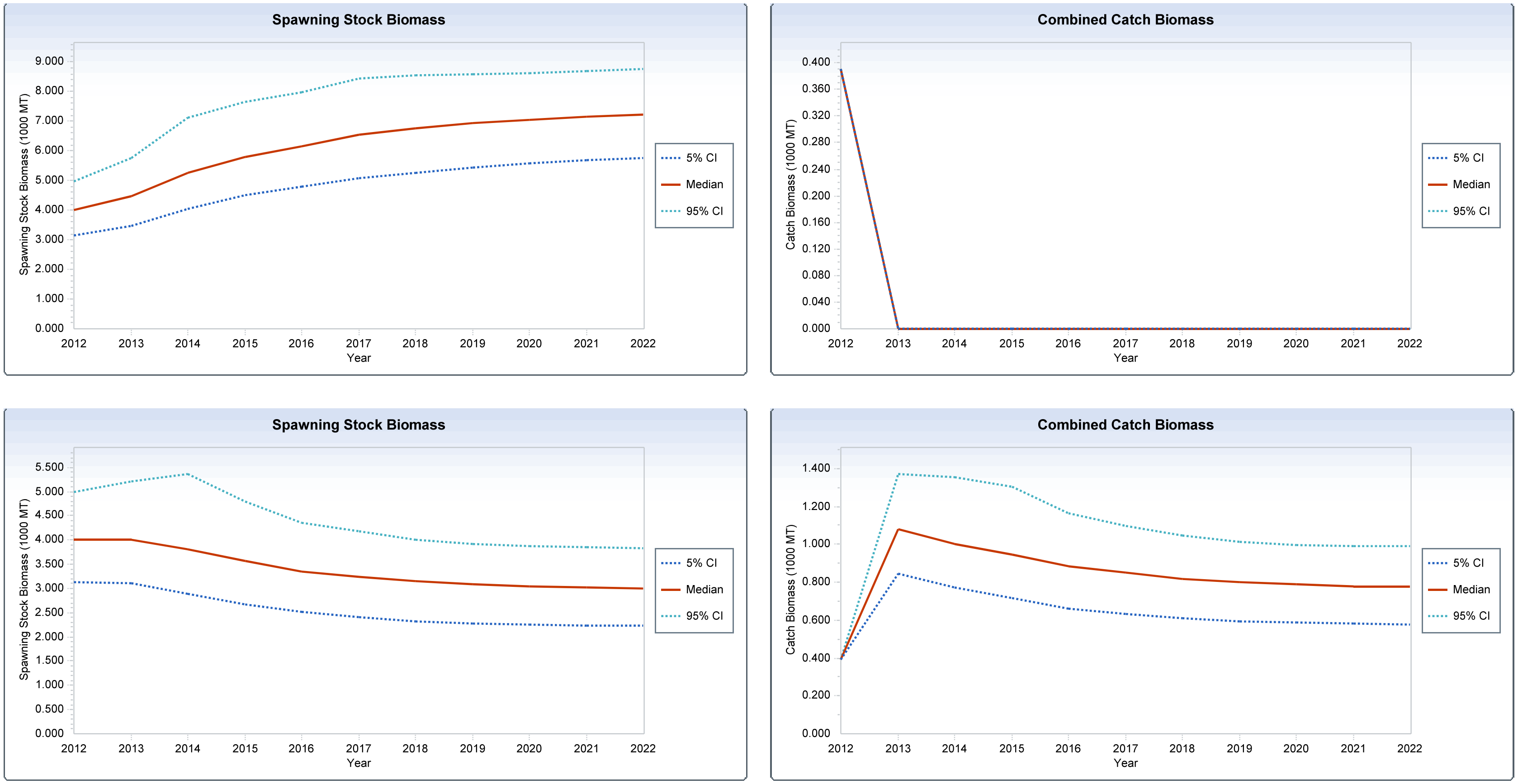


Figure B109**.** Short-term projections for Southern New England-Mid Atlantic yellowtail flounder in terms of fishery yields (catch, Right) and spawning stock biomass (SSB, Left) assuming recent recruitment conditions (i.e. recruitment series from 1990-2010) under F_0 (Top) and F_{MSY} (Bottom). Median estimates are shown (Red) along with the 90% confidence interval.