A. SUMMER FLOUNDER STOCK ASSESSMENT FOR 2013

Stock Assessment Terms of Reference (TORs) for Summer Flounder

1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. Present the survey data available for use in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), and explore standardization of fishery-independent indices*. Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data. Describe the spatial distribution of the stock over time.

3. Review recent information on sex-specific growth and on sex ratios at age. If possible, determine if fish sex, size and age should be used in the assessment*.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Explore inclusion of multiple fleets in the model. Include both internal and historical retrospective analyses to allow a comparison with previous assessment results and previous projections.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} 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.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review.
   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-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).
   a. provide annual projections (3 years). For given catches, 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).

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.

8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as MAFMC SSC model recommendations from 2012. Identify new research recommendations.

(*: Completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC.)

EXECUTIVE SUMMARY

TOR 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

Total landings peaked in 1983 at 26,100 mt. During the late 1980s and into 1990, landings decreased, reaching 4,200 mt in the commercial fishery in 1990 and 1,400 mt in the recreational fishery in 1989. Total landings were only 6,500 mt in 1990. Total commercial and recreational landings in 2012 were 8,900 mt = 19.621 million lbs and total commercial and recreational discards were 1,533 mt = 3.380 million lbs, for a total catch in 2012 of 10,433 mt = 23.001 million lbs. Reported 2012 landings in the commercial fishery were 6,047 mt = 13.331 million lbs, about 5% over the commercial quota. The commercial landings are assumed to be reported with minimal error. The uncertainty of the reported landings due to assignment to statistical area equates to a Coefficient of Variation (CV) of 0.3% during 1995-2012. Estimated 2012 landings in the recreational rod-and-reel fishery (as estimated by the MRIP) were 2,853 mt = 6.290 million lbs, about 26% under the recreational harvest limit. The average annual CV of the recreational landings is 6% in numbers and 7% in weight during 1982-2012. The time series of commercial fishery discards was revised for this assessment. Commercial discard losses in the otter trawl and scallop dredge fisheries have accounted for about 14% of the total commercial catch, assuming a discard mortality rate of 80%. The average annual CV of the commercial discards is 15% during 1989-2012. Recreational discard losses have accounted for about 12% of the total recreational catch, assuming a discard mortality rate of 10%. The average annual CV of the recreational discards is 8% during 1982-2012. Commercial landings have accounted for 54% of the total catch since 1982, with recreational landings accounting for 34%, commercial discards about 8%, and recreational discards about 5%.

Catch data from both recreational and commercial fisheries vessel trip reports (VTRs) as well as observer reports were summarized to determine spatial trends in catch and effort within the fishery in recent decades. A northerly trend of offshore commercial catches (and by inference, effort) has developed during the present decade with the largest catches now south of Rhode Island. Commercial catches of summer flounder at its southern extent are reduced after 2005. The fishery observer data show a much larger presence of large summer flounder catches on Georges Bank after 2005. Recreational fishing catch (and by inference, effort) distribution from party and charter boats is relatively unchanged throughout the 1990s and 2000s.

The SARC 57 Review Panel concluded that Term of Reference 1 was met.

TOR 2. Present the survey data available for use in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), and explore standardization of fishery-independent indices*. Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data. Describe the spatial distribution of the stock over time. (*: Completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC.)

Research survey indices of abundance are available from the NEFSC, MADMF, RIDFW, CTDEP, NYDEC, NJDFW, DEDFW, MDDNR, VIMS, VIMS ChesMMAP, VIMS NEAMAP, and NCDMF surveys. All available fishery independent research surveys except for the NCDMF trawl survey in Pamlico Sound were used in model calibration.

The NEFSC trawl surveys have a survey design that was randomized and the survey extends throughout the range of the species. Rather than developing a model to standardize, the survey design serves the purpose of standardizing the dataset. For these reasons, it was felt that standardization was not needed for the NEFSC trawl surveys. The same argument can be made for the VIMS NEAMAP survey, which is a new dataset used in the stock assessment. The Rhode Island fixed station monthly trawl survey (RIDFW RIX survey) was examined as an example of state surveys for the usefulness and applicability for standardization. The conclusion of this portion of the discussion was that the state surveys would be appropriate to standardize, were this to be a procedure the SDWG or ASMFC Technical Committee wished to perform.

The earliest years (1968-1990) of NEFSC fish trawl surveys showed the largest catches of summer flounder in inshore waters from Long Island to Cape Hatteras, with intermittent catches of summer flounder in the Georges Bank-Great South Channel strata or in the Gulf of Maine. The lowest catches occurred during the early 1990s, before increasing slowly in the late 1990s. During the rebuilding period of the 2000s, larger catches of summer flounder began appearing in northern areas, particularly south of Rhode Island and Massachusetts. Nearly all summer flounder caught north of Hudson Canyon are >30 cm in size. This divide appears to stretch further south during the rebuilding period during the 2000s. Survey catches during the earliest years of the time series were focused around the Delaware-Maryland-Virginia region where the majority of the catch, particularly in inshore strata surrounding Delaware and Chesapeake Bay, were fish <30 cm. Some smaller fish begin to re-enter catches north of Hudson Canyon as Mid-Atlantic Bight and Southern New England regions have become the new areas of greatest summer flounder abundance. The annual alongshelf center of biomass of summer flounder increases (moves North) from the late 1960s to the mid-1980s, then declined (moves South) in the mid 1990s, before reaching high levels again around 2007. For both the spring and fall fish trawl surveys the average alongshelf position of summer flounder increases with increasing size. The length predicted alongshelf center of biomass declines from the late 1960s to the early 1990s, increases until around 2008 and subsequently declines slightly. The relationship of the center of summer flounder biomass to either surface or bottom temperature is minimal in the spring and moderate in the fall. Summer flounder larval distribution has changed little over the past four decades. While *many factors may be causing changes in spatial distribution of summer flounder over the last few decades, their general increased abundance northward and expansion eastward on Georges Bank is apparent. Spatial expansion is also more apparent in years of greater abundance. This kind of response may be evident in summer flounder as expansion in both the spatial distribution and size structure has developed since about 2000, after the period of heavy exploitation during the 1980s and 1990s.*

The SDWG evaluated the utility of the fishery dependent landings- and catch-per unit effort based indices as measures of abundance in the summer flounder stock assessment. The SDWG concluded that the calculation of effort in the fishery dependent data is problematic. For the commercial data, the effort information is dependent on the accurate recording by the fishermen themselves, and the collection of this data is not a focus of their operation, therefore metrics like the recording the fishing time or length of tow may not be completely accurate and could affect the calculation of the CPUE index. There is a lack of consistency in the reporting requirements for parts of the commercial VTR time series; the instructions for how effort is reported have changed. For the recreational data, the calculation of effort is even more problematic. In this analysis, all trips which caught summer flounder were used; there are different ways to define summer flounder trips. However, there is variation in the number of rods and reels (gear quantity) and the time of fishing for each trip. The catch is also inconsistently reported in the for-hire recreational VTR with it being provided in numbers or pounds on these self-reported forms. In total these elements make the calculation of effort challenging when working with fishery dependent data time series. The SDWG noted that over the long term, and especially since fishery quotas were instituted in the early 1990s, there have been a number of regulatory changes which are different in timing and magnitude for each state (primarily seasonal closures, seasonal trip/possession limits, and minimum size limits). This information is not part of the commercial and recreational catch databases and so must be developed independently and integrated within the Generalized Linear Model. This information could not be modeled adequately as covariates or classification variables within the generalized model framework (i.e., inability to develop a model which converges and produces valid parameter estimates) for the commercial fishery data. Of the commercial fishery standardized indices, only the Dealer report LPUE series indicates an increasing trend in abundance comparable to the NEFSC seasonal trawl surveys (an increase of about 80% since 1990). The recreational fishery data indices, for which inclusion of regulatory measures in the models were successful, indicated recent decreasing trends in abundance that were inconsistent with the trends indicated by most state and federal research survey index trends. The modeling difficulties call into question the utility of both the nominal and model-based fishery dependent CPUE as indices of summer flounder abundance. While the commercial trawl indices do indicate increasing trends, the SDWG felt the standardization procedure was still subject to an unknown, likely negative, bias. In addition, the SDWG felt the multiple fishery-independent surveys available to this assessment had sufficient spatial coverage, such that inclusion of the fishery-dependent indices was not necessary, as might be the case for an assessment that lacked adequate fishery independent sampling. Based on these concerns, the SDWG recommended that the fishery dependent standardized indices of abundance not be used in the summer flounder assessment model.

The SARC 57 Review Panel concluded that Term of Reference 2 was met.

TOR 3. Review recent information on sex-specific growth and on sex ratios at age. If possible, determine if fish sex, size and age should be used in the assessment*. (*: Completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC.)

The NEFSC survey data show trends in the most recent years of decreasing mean length and weight at age in all seasons and for both sexes, a trend in von Bertalanffy parameters that indicates 'slower growth' (smaller predicted length at age), and a trend of delayed maturity. There are no trends in length-weight relationship parameters or condition factor that suggest a trend of reduced 'condition' for summer flounder. There are trends in sex ratio that indicate a decreasing proportion of females (and therefore an increasing proportion of males) for ages 2 and older. Statistically significant differences in growth were found between sexes, between Northern and Southern regions (as split at the NEFSC statistical area associate with the Hudson Canyon off the continental margin of New York and New Jersey), and between early and late time periods (1900s and 2000s).

A data collection program was conducted during 2010-2011 with dual goals of 1) data collection and 2) an evaluation of the adequacy of summer flounder sex-at-age and sex-at-length keys developed from NMFS-NEFSC ocean trawl surveys in describing the sex ratio in recreational and commercial landings. The program continued until two full years of data were collected in each targeted region. Efforts were directed toward key ports in states from Massachusetts to North Carolina where summer flounder landings were high. Sex and length data were collected from over 30,000 summer flounder landed in the commercial (CF) and recreational (RF) fisheries and approximately 20,000 of those fish were aged by the NMFS-NEFSC. Minimum sampling goals were exceeded in nearly all regions. Differences in sex ratio between commercial/recreational landings and the NMFS-NEFSC ocean trawl survey were identified using a generalized linear model with a logit-link function and a binomial error distribution, commonly referred to as logistic regression. Analysis of these data showed that summer flounder sex-at-length and sex-at-age keys developed from NMFS-NEFSC ocean trawl data would not be appropriate for describing the sex ratio of recreational landings. However, that sex-at-length of summer flounder landed in the commercial fishery was well described by data collected on the NMFS-NEFSC trawl survey, and the best approach could be to 1) apply a NMFS-NEFSC sex-at-length key to commercial landings length data, and then 2) apply a commercial landings length-at-age key to arrive at an accurate measure of sex-at-age in the commercial fishery. Variation in sex ratio in both the recreational and commercial fisheries was observed to occur at fine spatial scales and perhaps over short time periods. The work further concluded that if a desire exists to accurately define sex ratio in either fishery with empirical data collection, this spatiotemporal variability might require a regular and spatially extensive sampling program in the future.

The SARC 57 Review Panel concluded that Term of Reference 3 was met.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Explore inclusion of multiple fleets in the model. Include both internal and historical retrospective analyses to allow a comparison with previous assessment results and previous projections.

Fishing mortality rates and stock sizes were estimated using the ASAP statistical catch at age model. In the summer flounder ASAP model an age-specific instantaneous natural mortality rate providing an average M = 0.25 was assumed for all years. Seasonal survey indices and all survey recruitment (age-0) indices were compared to population numbers of the same age at the appropriate season of the same year. A multinomial distribution was assumed for fishery catch at age and for survey catch at age when required. A number of additional initial model settings including specification of likelihood component emphasis factors (lambdas), size of deviation factors expressed as standard deviations, and penalty functions for extreme fishing mortality estimates. These were set at consensus values by the 2013 SDWG after multiple sensitivity runs to evaluate a range of inputs. An 'internal' retrospective analysis was conducted to examine the stability of the model estimates as data were removed from the last years of the time series. Retrospective runs were made for terminal years back to 2005. The summer flounder stock assessment has historically exhibited a retrospective pattern of underestimation of F and overestimation of SSB; the causes of this previous pattern have not been determined. In the current assessment model, however, no persistent retrospective patterns are evident. 'Historical' retrospectives indicate that general trends of fishing mortality, stock biomass, and recruitment have been consistent since the 1990s assessments.

Fishing mortality on the fully selected age 4 fish ranged between 0.790 and 1.745 during 1982-1996. The fishing mortality rate has decreased from 0.849 in 1997 to 0.285 in 2012. There is a 90% probability that the fishing mortality rate in 2012 was between 0.213 and 0.343. Spawning stock biomass (SSB) decreased from 24,300 mt in 1982 to 5,521 mt in 1989, and then increased to a peak of 53,156 mt by 2010. SSB was 51,238 mt in 2012, about 82% of the new reference point SSBMSY proxy = SSB35% = 62,394 mt. There is a 90% probability that SSB in 2012 was between 45,781 and 61,297 mt. The average recruitment from 1982 to 2012 is 43 million fish at age 0. The 1982 and 1983 year classes are the largest in the assessment time series, at 62 and 76 million fish; the 1988 year class is the smallest at only 10 million fish. The 2012 year class is currently estimated to be about 37 million fish.

The SARC 57 Review Panel concluded that Term of Reference 4 was met.

TOR 5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} 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 2008 SAW47 recommended proxies for FMSY and SSBMSY were F35% = 0.310 and the associated MSY (13,122 mt = 28.929 million lbs) and SSBMSY (60,074 mt = 132.440 million lbs) estimates from long-term stochastic projections. These 2008 SAW47 BRPs were subsequently adopted by the NMFS and MAFMC in the 2009 fishery regulation specification process, were retained in the 2009-2012 updated assessments to evaluate stock status, and are the existing (old) reference points for summer flounder.

The 2013 SDWG recommends that the updated (new) proxies for FMSY and SSBMSY are F35% = 0.309 (CV = 15%) and associated estimates from long-term stochastic projections of MSY = 12,945 mt (28.539 million lbs; CV = 13%) and SSBMSY = 62,394 mt (137.555 million lbs; CV = 13%; Table A92). The new biomass threshold of one-half SSBMSY is estimated to be 31,197 mt (68.8 million lbs; CV = 13%).

The SARC 57 Review Panel concluded that Term of Reference 5 was met.

TOR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review.

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-5).

a) A model with data through 2012, but with the same configuration and settings as the old (existing) 2012 model with data through 2011, provides estimates appropriate to compare with the old (existing) reference points, which are FMSY proxy = F35% = 0.310 and SSBMSY proxy = SSBMSY35% = 60,094 mt (TOR 6a). This model indicates that F in 2012 = 0.180 and SSB in 2012 = 60,905 mt, so the stock was not overfished and overfishing was not occurring.

b) The final model adopted by the 2013 SDWG for the evaluation of stock status indicates the summer flounder stock was not overfished and overfishing was not occurring in 2012 relative to the new biological reference points established in this 2013 SAW 57 assessment. The fishing mortality rate was estimated to be 0.285 in 2012, below the new threshold fishing mortality reference point = FMSY = F35% = 0.309. SSB was estimated to be 51,238 mt = 112.960 million lbs in 2012, 82% of the new biomass reference point = SSBMSY = SSB35% = 62,394 mt (137.555 million lbs).

The SARC 57 Review Panel concluded that Term of Reference 6 was met.

TOR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. Provide annual projections (3 years). For given catches, 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).

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.

a) Stochastic projections were made to provide forecasts of stock size and catches in 2014-2016 consistent with the new (updated) 2013 SAW 57 biological reference points. The projections assume that recent (2010-2012) patterns of fishery selectivity, discarding, maturity at age and mean weight at age will continue over the time span of the projections. Future recruitment at age 0 was generated randomly from a cumulative density function of the updated recruitment series for 1982-2012 (average recruitment = 43 million fish). If the 2013 Annual Catch Limit (ACL) of 10,133 mt = 22.339 million lbs is taken, the 2013 median (50% probability) dead discards are projected to be 1,735 mt = 3.825 million lbs, and the median landings are projected to be 8,398 mt = 18.514 million lbs. The median F in 2013 is projected to be 0.250, below the new fishing mortality threshold = FMSY proxy = F35% = 0.309. The median SSB on November 1, 2013 is projected to be 56,662 mt = 124.918 million lbs, below the new biomass target SSBMSY proxy = SSB35% = 62,394 mt = 137.555 million lbs.

If the stock is fished at the new fishing mortality threshold = FMSY proxy = F35% = 0.309 in 2014, the median landings are projected to be 9,961 mt = 21.960 million lbs, with median dead discards of 2,177 mt = 4.799 million lbs, and median total catch = 12,138 mt = 26.760 million lbs. This projected median total catch would be the Overfishing Limit (OFL) for 2014, and is less than the new MSY proxy = 12,945 mt (28.539 million lbs; 10,455 mt = 23.049 million lbs of median landings plus 2,490 mt = 5.490 million lbs of median dead discards). The median SSB on November 1, 2014 is projected to be 57,140 mt = 125.972 million lbs, 92% of the new biomass target of SSBMSY proxy = SSB35% = 62,394 mt = 137.555 million lbs. The projected catch estimates in the following table are medians of the catch distributions for fixed F in 2014-2016.

Total Catch (OFL), Landings, Dead Discards, Fishing Mortality (F) and Spawning Stock Biomass (SSB) in 2014-2016
Catches and SSB in metric tons

Year	*Total Catch*	*Landings*	*Discards*	*F*	*SSB*
2014	*12,138*	*9,961*	*2,177*	*0.309*	*57,140*
2015	*11,785*	*9,497*	*2,288*	*0.309*	*58,231*
2016	*11,914*	*9,527*	*2,387*	*0.309*	*59,268*

If the MAFMC risk policy is applied by the SSC assuming a typical level 3 stock, given the size of the SSB relative to SSBMSY, assumed OFL CV = 100%, and the potential OFL at F = 0.309 for each year, the following Acceptable Biological Catch (ABC) results:

ABC Total Catch, Landings, Dead Discards, Fishing Mortality (F) and Spawning Stock Biomass (SSB) in 2014-2016
Catches and SSB in metric tons

Year	*Total Catch*	*Landings*	*Discards*	*F*	*SSB*
2014	*8,071*	*6,649*	*1,422*	*0.197*	*60,581*
2015	*9,992*	*8,117*	*1,875*	*0.237*	*63,969*
2016	*10,729*	*8,681*	*2,048*	*0.245*	*66,469*

For the projections at fixed FMSY proxy = F35% = 0.309, there is by definition 0% probability of exceeding the fishing mortality threshold and 0% probability of falling below the biomass threshold during 2014-2016. For the ABC projections, there is a less than an annual 13% probability that fishing mortality will exceed the threshold and 0% probability that biomass will fall below the threshold.

b, c) All of the projection results presented have a realistic probability of being achieved, and the summer flounder stock has a low vulnerability to becoming overfished, given recent trends in stock productivity and the management regime in place.

The SARC 57 Review Panel concluded that Term of Reference 7 was met.

TOR 8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as MAFMC SSC model recommendations from 2012. Identify new research recommendations.

Major data and analytical needs for summer flounder assessments have been identified in the 2002 SAW 35 peer review, the 2003 assessment update, the 2005 SAW 41 assessment update, the SDWG 2006 assessment update and subsequent NOAA Fisheries Science and Technology peer review, the SDWG 2007 assessment update, the 2008 SAW 47 *benchmark assessment, the 2012 MAFMC SSC, and by the 2013 SDWG for this current benchmark assessment. Research recommendations "never die" and are retained in these documents until they are addressed (completed). Therefore, these remaining recommendations have been subset as 8.1) completed, in progress, or to be addressed, and 8.2) new (identified by the SDWG SAW Working Group for this assessment). Fifteen 'old' recommendations remain and 13 'new' recommendations have been developed.*

The SARC 57 Review Panel concluded that Term of Reference 8 was met.

SAW WORKING GROUP PROCESS

The Stock Assessment Workshop (SAW) Southern Demersal Working Group (SDWG) prepared the assessment. The SDWG met during June 3-5 and 17-19, 2013 to develop the benchmark stock assessment of summer flounder (fluke) through 2012. The following scientists and managers constituted the 2013 SDWG:

Jeff Brust	New Jersey Division of Fish and Wildlife (NJDFW)
Paul Caruso	Massachusetts Division of Marine Fisheries (MADMF)
Jessica Coakley	Mid-Atlantic Fishery Management Council (MAFMC), SDWG Chair
Kirby Rootes-Murdy	Atlantic States Marine Fisheries Commission (ASMFC)
Chris Legault	National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC) Assessment Methods Task Leader
Jason McNamee	Rhode Island Division of Fish and Wildlife (RIDFW), ASMFC Technical Committee Chair
Jason Morson	Rutgers University
Eric Powell	University of Southern Mississippi Partnership for Mid-Atlantic Fisheries Science (PMAFS)
Mark Terceiro	NMFS NEFSC Demersal Resources Task Leader Summer Flounder Assessment Lead
Tom Wadsworth	North Carolina Division of Marine Fisheries (NCDMF)

In addition to the SDWG, the following scientists and managers participated to varying degrees in the discussions:

Charles Adams	NMFS NEFSC
Jessica Blaylock	NMFS NEFSC
Eleanor Bochenek	Rutgers University
Liz Brooks	NMFS NEFSC
Kiersten Curti	NMFS NEFSC
Kiley Dancy	MAFMC
Jon Deroba	NMFS NEFSC
Charles Fildani	NMFS NEFSC
Emerson Hasbrouck	Cornell Marine Program
Katerine Kaplan	Cornell University
John Maniscalco	New York Dept. of Environ. Conservation (NYDEC)
Katey Marancik	NMFS NEFSC
Mark Maunder	Inter-American Tropical Tuna Commission (IATTC)
Richard McBride	NMFS NEFSC
David McElroy	NMFS NEFSC
Alicia Miller	NMFS NEFSC
Tim Miller	NMFS NEFSC
Paul Nitschke	NMFS NEFSC
Loretta O'Brien	NMFS NEFSC

Mike Palmer	NMFS NEFSC
David Richardson	NMFS NEFSC
Eric Robillard	NMFS NEFSC
Fred Serchuk	NMFS NEFSC
Gary Shepherd	NMFS NEFSC
Kathy Sosebee	NMFS NEFSC
Pat Sullivan	Cornell University
Vic Vecchio	NMFS Northeast Regional Office (NERO)
Allison Watts	Virginia Marine Resources Commission (VMRC)
Jim Weinberg	NMFS NEFSC
Susan Wigley	NMFS NEFSC
Mike Wilberg	University of Maryland
Greg Wojcik	Connecticut Dept. Environ. Protection (CTDEP)
Richard Wong	Delaware Department of Fish and Wildlife (DEDFW)

STOCK UNIT

The definition provided by Wilk et al. (1980) of a unit stock extending from Cape Hatteras north to New England has been accepted in this and previous assessments. A consideration of summer flounder stock structure incorporating tagging data concluded that most evidence supported the existence of stocks north and south of Cape Hatteras, with the stock north of Cape Hatteras possibly composed of two distinct spawning aggregations, off New Jersey and Virginia-North Carolina (Kraus and Musick 2001). The current assessment stock unit is consistent with the conclusions of Kraus and Musick (2001). The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) joint Fishery Management Plan (FMP) defines the management unit for summer flounder as extending from the southern border of North Carolina north to the U.S.-Canadian border. The management unit is consistent with the conclusions a summer flounder genetics study that revealed no population subdivision at Cape Hatteras (Jones and Quattro 1999).

As part of this assessment, Kajajian et al. (2013 MS; WPA12) evaluated whether otolith chemistry could be used to determine if there are chemical differences in juvenile otoliths that can subsequently be used as a natural tag to discern summer flounder nursery habitats and quantify stock structure and movement along the U.S. east coast. They used State natural resource agency and university collections of juvenile summer flounder collected (n = 138) in fall 2011 with bottom trawls from estuarine habitats along the US East Coast: Long Island Sound, Delaware Bay, Chesapeake Bay, Pamlico Sound, and the coastal inshore waters of South Carolina and Georgia. They noted that in fish that are not bilaterally symmetrical, such as summer flounder, the left and right sagittal otoliths often exhibit divergent growth patterns and mass, and may have differences in chemical composition. Prior to the analysis of area-scale differences in juvenile otolith signatures, they investigated the assumption of sagittal equivalence. Kajajian et al. (2013 MS) found there were significant mass and overall otolith chemistry differences between the left and right sagittae, originating from $\delta^{13}C$, $\delta^{18}O$, Li, Mg, and Sr.

Left sagittae were used to compare area-scale differences, and Kajajian et al. (2013 MS) found strong differences between the nurseries: Delaware Bay, Chesapeake

Bay, North Carolina, and the South-Atlantic Bight provided sufficient samples for analysis. All studied elements were significantly different between areas, thus they used the all-possible combinations approach to uncover the models that produced the highest classification success, finding that a five-variable model using $\delta^{13}C$, $\delta^{18}O$, Li, Mg, and Y produced the highest classification accuracy at 93% with the fewest variables. Kajajian et al. (2013 MS) concluded that, due to the lack of equivalence within the sagittal pair, the choice of otolith impacted subsequent analyses in the summer flounder, and that otolith chemistry can be used successfully to investigate summer flounder population structure and connectivity.

HISTORY OF MANAGEMENT AND ASSESSMENT

An overview of the history of the summer flounder FMP and assessment is provided in this section and the text box below. Management of the summer flounder fishery began through the implementation of the original Summer Flounder FMP in 1988, a time that coincided with the lowest levels of stock biomass for summer flounder since the late 1960s. The MAFMC and ASMFC cooperatively develop fishery regulations, with the National Marine Fisheries Service (NMFS) serving as the federal implementation and enforcement entity. Cooperative management was developed because significant catch is taken from both state (0-3 miles offshore) and federal waters (3-200 miles offshore).

Amendment 1 to the FMP in 1990 established the overfishing definition for summer flounder as equal to Fmax, initially estimated as 0.23 (NEFC 1990). Amendment 2 in 1992 established target fishing mortality rates for summer flounder for 1993-1995 as F = 0.53, and Fmax = 0.23 for 1996 and beyond. Regulations enacted under Amendment 2 to meet those fishing mortality rate targets included 1) an annual fishery landings quota with 60% allocated to the commercial fishery and 40% to the recreational fishery based on the historical (1980-1989) division of landings, with the commercial allocation further distributed among the states based on their share of commercial landings during 1980-1989, 2) a commercial minimum landed fish size limit at 13 in (33 cm), 3) a minimum mesh size of 5.5 in (140 mm) diamond or 6.0 in (152 mm) square for commercial vessels using otter trawls that possess 100 lbs (45 kg) or more of summer flounder, with exemptions for the flynet fishery and vessels fishing in an exempted area off southern New England during 1 November to 30 April, 4) permit requirements for the sale and purchase of summer flounder, and 5) annually adjustable regulations for the recreational fishery, including an annual harvest limit, closed seasons, a 14 in (36 cm) minimum landed fish size, and possession limits.

The results of stock assessments conducted in the mid 1990s indicated that summer flounder abundance was not increasing as rapidly as projected when Amendment 2 regulations were implemented. In anticipation of the need to drastically reduce fishery quotas in 1996 to meet the management target of Fmax, the MAFMC and ASMFC modified the fishing mortality rate reduction schedule in 1995 to allow for more stable landings between years while slowing the rate of stock rebuilding. Amendment 7 to the FMP set target fishing mortality rates of 0.41 for 1996 and 0.30 for 1997, with a target of Fmax = 0.23 for 1998 and beyond. Total landings were to be capped at 8,400 mt (18.519

million lbs) in 1996-1997 unless a higher quota in those years provided a realized F = 0.23.

Amendment 12 in 1999 defined overfishing for summer flounder as occurring when the fishing mortality rate exceeded the threshold fishing mortality rate of FMSY. Because FMSY could not be reliably estimated for summer flounder, Fmax = 0.24 was used as a proxy for FMSY. FMSY was also defined as the target fishing mortality rate. Under Amendment 12, the stock was defined to be overfished when total stock biomass fell below the biomass threshold of one-half of the biomass target, BMSY. Because BMSY could not be reliably estimated, the biomass target was defined as the product of total biomass per recruit and contemporary (1982-1996) median recruitment, at that time estimated to be 153,350 mt (338 million lbs), with the biomass threshold defined as 76,650 mt (169 million lbs). In the 1999 stock assessment (Terceiro 1999) the reference points were updated using new estimates of median recruitment (1982-1998) and mean weights at age (1997-1998), which resulted in a biomass target of 106,444 mt (235 million lbs) and minimum biomass threshold of 53,222 mt (118 million lbs). The Terceiro (1999) reference points were retained in the 2000 and 2001 stock assessments (NEFSC 2000, MAFMC 2001a) because of the stability of the input data. Concurrent with the development of the 2001 assessment, the MAFMC and ASMFC convened the Summer Flounder Overfishing Definition Review Committee to review these biological reference points. The work of this Committee was later reviewed by the MAFMC Scientific and Statistical Committee (SSC) in August 2001. The SSC recommended that using the FMSY proxy for Fmax = 0.26 was appropriate and should be retained for 2002, and endorsed the recommendation of SARC 31 (NEFSC 2000) which stated that "...the use of Fmax as a proxy for FMSY should be reconsidered as more information on the dynamics of growth in relation to biomass and the shape of the stock recruitment function become available" (MAFMC 2001b).

The 2002 SAW 35 assessment (NEFSC 2002a) indicated the summer flounder stock was overfished and overfishing was occurring relative to the biological reference points. The fishing mortality rate had declined from 1.32 in 1994 to 0.27 in 2001, marginally above the overfishing reference point (Fthreshold = Ftarget = Fmax = 0.26). Total stock biomass in 2001 was estimated at 42,900 mt (94.578 million lbs), or 19% below the biomass threshold (53,200 mt; 117.286 million lbs). The 2002 SAW35 Review Panel concluded that updating the biological reference points was not warranted at that time (NEFSC 2002a). Subsequent updates to the stock assessment were completed in 2003 (Terceiro 2003a) and 2005 (NEFSC 2005). While the 2003 assessment found the summer flounder stock was not overfished and no overfishing was occurring, the 2005 assessment found the stock again experiencing overfishing. The 2005 SAW 41 assessment provided updated values for the fishing mortality and stock biomass reference points (NEFSC 2005).

A peer review of the assessment occurred in 2006 by the NMFS Office of Science and Technology (S&T) (Terceiro 2006a, 2006b). This review made several recommendations, including modification of the definition of the overfished stock from the original definition under Amendment 2 to the FMP. Instead of using January 1 total stock biomass (TSB), the stock was considered overfished when November 1 spawning stock biomass (SSB) fell below one-half SSBMSY = 44,706 mt (98.6 million lbs). Further, the overfishing reference point was revised to be Fthreshold = Ftarget = Fmax =

0.28. The 2006 S&T assessment concluded that the stock was not overfished, but that overfishing was occurring relative to the updated reference points (Terceiro 2006b).

The 2007 assessment update (SDWG 2007) found that relative to the 2006 S&T assessment biological reference points, the stock was overfished and overfishing was occurring. The fishing mortality rate estimated for 2006 was 0.35, a significant decline from the 1.32 estimated for 1994 but still above the threshold of 0.28.

The most recent peer review of the assessment occurred at the 2008 SAW 47 (NEFSC 2008a). In the 2008 SAW 47 assessment, the age-structured assessment model changed from an ADAPT virtual population analysis (VPA) model to a forward projecting, ASAP statistical catch at age (SCAA) model, and the fishery catch was modeled as two fleets: totals landings and total discards. A new value for the instantaneous natural mortality rate (M) was adopted, changing from a constant value of M = 0.20 to age- and sex-specific values that resulted in a mean value of M = 0.25. Biological reference points were therefore also revised; the proxy for FMSY changed from Fmax to F35%, and F40% was recommended as Ftarget. The assessment concluded that the stock was not overfished and overfishing was not occurring in 2007, relative to the revised biological reference points. Fishing mortality calculated from the average of the fully recruited ages (3-7+) ranged between 1.143 and 2.042 during 1982-1996. The fishing mortality rate was estimated to be 0.288 in 2007, below the fishing mortality reference point = F35% = FMSY = 0.310. SSB was estimated to be 43,363 mt (95.599 million lbs) in 2007, about 72% of the biomass target reference point of SSB35% = SSBMSY = 60,074 mt (132.441 million lbs). The assessment exhibited a consistent retrospective pattern of underestimation of F and overestimation of SSB, but no consistent retrospective pattern in recruitment.

The last assessment update in 2012 (Terceiro 2012) indicated that the stock was not overfished and overfishing was not occurring in 2011 relative to the biological reference points established in the 2008 SAW 47 assessment. The fishing mortality rate (F) was estimated to be 0.241 in 2011, below the fishing mortality threshold reference point = FMSY = F35% = 0.310. Spawning Stock Biomass (SSB) was estimated to be 57,020 metric tons (mt) = 125.708 million lbs in 2011, 5% below the biomass target reference point = SSBMSY = SSB35% = 60,074 mt = 132.440 million lbs. The NMFS determined in November 2011 that the summer flounder stock reached the biomass target (i.e., was rebuilt) in 2010, based on the 2011 assessment update (Terceiro 2011). This 2013 SAW 57 benchmark assessment incorporates commercial and recreational fishery catch data, research survey indices of abundance, and the analyses of those data through 2012.

Summary of the history of the Summer Flounder, Scup, and Black Sea Bass FMP.			
Year	**Document**	**Plan Species**	**Management Action**
1988	Original FMP	summer flounder	- Established management plan for summer flounder
1991	Amendment 1	summer flounder	- Established an overfishing definition for summer flounder
1993	Amendment 2	summer flounder	- Established rebuilding schedule, commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements for summer flounder - Created the Summer Flounder Monitoring Committee
1993	Amendment 3	summer flounder	- Revised the exempted fishery line - Increased the large mesh net threshold - Established otter trawl retention requirements
1993	Amendment 4	summer flounder	- Revised state-specific shares for summer flounder quota allocation
1993	Amendment 5	summer flounder	- Allowed states to combine or transfer commercial summer flounder quota
1994	Amendment 6	summer flounder	- Set criteria for allowance of multiple nets on board commercial vessels for summer flounder - Established deadline for publishing catch limits, commercial mgmt. measures for summer flounder
1995	Amendment 7	summer flounder	- Revised the F reduction schedule for summer flounder
1996	Amendment 8	summer flounder and scup	- Incorporated Scup FMP into Summer Flounder FMP and established scup measures including commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements
1996	Amendment 9	summer flounder and black sea bass	- Incorporated Black Sea Bass FMP into Summer Flounder FMP and established black sea bass measures including commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements
1997	Amendment 10	summer flounder, scup, and black sea bass	- Modified commercial minimum mesh requirements, continued commercial vessel moratorium, prohibited transfer of fish at sea, and established special permit for party/charter sector for summer flounder
1998	Amendment 11	summer flounder, scup, and black sea bass	- Modified certain provisions related to vessel replacement and upgrading, permit history transfer, splitting, and permit renewal regulations
1999	Amendment 12	summer flounder, scup, and black sea bass	- Revised FMP to comply with the SFA and established framework adjustment process
2001	Framework 1	summer flounder, scup, and black sea bass	-Established quota set-aside for research for all three species

2001	Framework 2	summer flounder	- Established state-specific conservation equivalency measures for summer flounder
2003	Amendment 13	summer flounder, scup, and black sea bass	- Addressed disapproved sections of Amendment 12 and included new EIS
2003	Framework 3	scup	- Allowed the rollover of winter scup quota - Revised start date for summer quota period for scup fishery
2003	Framework 4	scup	- Established system to transfer scup at sea
2004	Framework 5	summer flounder, scup, and black sea bass	- Established multi-year specification setting of quota for all three species
2006	Framework 6	summer flounder	- Established region-specific conservation equivalency measures for summer flounder
2007	Amendment 14	scup	- Established rebuilding schedule for scup
2007	Framework 7	summer flounder, scup, and black sea bass	- Built flexibility into process to define and update status determination criteria - Scup GRAs modifiable by framework adjustment

AGEING

Historical studies of summer flounder age and growth include those of Poole (1961), Eldridge (1962), Powell (1974), Smith and Daiber (1977), Henderson (1979), and Shepherd (1980). A summer flounder aging workshop held in 1980 (Smith *et al.* 1981) noted that these early studies provided differing interpretations of the growth zones on summer flounder scales and otoliths. After comparative study by fisheries biologists from along the Atlantic coast, the workshop concluded that both structures followed the generalized temperate waters pattern of rapid growth during early summer through early winter. Scales were identified as the better structure for ageing, being preferred over otoliths due to the possibility of poor otolith calcification and/or resorption. Spawning was noted to occur to from early September in the north through the following March in the south. For uniformity, January 1 was considered the birthday, with fish not considered one year old until passing their first summer, to eliminate the possibility of fall spawn fish being classified as age 1 the following January. The 1980 workshop effectively set the first coast-wide conventions for ageing summer flounder, and importantly concluded that the minimum observed mean length of age 1 fish should be at about 17-18 cm and of age 2 fish at about 28-29 cm (Smith *et al*. 1981).

A second summer flounder ageing workshop was held in 1990 (Almeida *et al.* 1992) in response to continuing confusion among summer flounder biologists over the proper interpretation of the conventions established by the 1980 workshop (Smith *et al.* 1981). Several issues were addressed, including the differences in processing and interpreting scales and otoliths, the age classification of the first distinct annulus measured from the focus, and consideration of new studies completed since the 1980 workshop. The 1990 workshop agreed to accept the summer flounder ageing criteria provided in Dery (1988), and in particular noted that first annulus formation for a given cohort could occur after 18-21 months of growth for fish spawned in the north in the fall, and after 10-16 months of growth for fish spawned in the south early the following spring. The latter conclusion was based on a review of the work of Szedlmayer and Able (1992), which validated the first year growth assumption and interpretation of the first annulus. The 1990 workshop most importantly concluded that there was consistency in ageing techniques and interpretation and that first year growth for summer flounder was extremely rapid. The workshop noted the potential for fish born early in the calendar year and inhabiting estuarine areas of the mid-Atlantic to reach 30 cm by their first winter and be classified as age 0, in support of the Poole (1961) and Szedlmayer and Able (1992) conclusions (Almeida *et al.* 1992).

Work performed in preparation for the Stock Assessment Workshop (SAW) 22 stock assessment (NEFSC 1996b) indicated a major expansion in the size range of 1-year old summer flounder collected during the 1995 and 1996 Northeast Fisheries Science Center (NEFSC) winter bottom trawl surveys. The work also brought to light developing differences between ages determined by NEFSC and North Carolina Division of Marine Fisheries (NCDMF) fishery biology staffs. Age structure (scale) exchanges were performed prior to the SAW 22 assessment to explore these differences. The results of the first two exchanges were reported at SAW 22 (NEFSC 1996b) and indicated low levels of agreement between age readers at the NEFSC and NCDMF (31 and 46%). During 1996, research was conducted to determine inter-annular distances and to back-calculate mean length at age from scale samples collected on all NEFSC bottom trawl surveys (winter, spring and fall) for comparison with NCDMF commercial winter trawl fishery samples. While mean length at age remained relatively constant from year to year, inter-annular distances increased sharply in the samples from the 1995-1996 winter surveys, and increased to a lesser degree in samples from other 1995-1996 surveys. As a result, further exchanges were suspended pending the resolution of an apparent NEFSC ageing problem.

Age samples from the winter 1997 bottom trawl survey, aged utilizing both scales and otoliths by only by one reader, subsequently indicated a similar pattern as the previous two winter surveys (i.e., several large age 1 individuals), and some disagreement between scale and otolith ages obtained from the same fish. Because of these problems, a team of five experienced NEFSC readers was formed to re-examine the scales aged from the winter survey. After examining several hundred scales, the team determined that re-ageing all samples from 1995-1997 would be appropriate, including all winter, spring, and fall samples from the NEFSC and Massachusetts Division of Marine Fisheries (MADMF) bottom trawl surveys and all samples from the commercial fishery. The age determination criteria remained the same as those developed at the 1990 workshop (Almeida *et al.* 1992) and described in the ageing manual utilized by NEFSC staff (Dery 1988, 1997). Only those fish for which a 100% agreement of all team members was attained were included in the revised database. The data from the re-aged database were used in analyses in the SAW 25 assessment (NEFSC 1997).

A third summer flounder ageing workshop was held at the NEFSC in 1999, to continue the exchange of age structures and review of ageing protocols for summer flounder (Bolz et al. 2000). Participants at this workshop concluded that the majority of ageing disagreements in recent NEFSC-NCDMF exchanges had arisen from inconsistency among readers in the interpretation of marginal scale increments due to highly variable timing of annulus formation and in the interpretation of first year growth patterns and classification of the first annulus. The workshop recommended regular samples exchanges between NEFSC and NCDMF, and further analyses of first year growth. Subsequently, Sipe and Chittenden (2001) concluded that sectioned otoliths were the best structure for ageing summer flounder over the age range from 0 to 10 years. Since 2001, both scales and otoliths have routinely been collected in all NEFSC trawl surveys for fish larger than 60 cm.

An exchange of NEFSC and NCDMF ageing structures for summer flounder occurred again in 2006, after the SAW Southern Demersal Working Group (SDWG) listed the age sample exchange as a high research priority. This exchange examined samples from fish aged 1 to 9 (23-76 cm total length) and determined that the consistency of ageing between NCDMF and the NEFSC was at an acceptable level. During 2006-2011, overall summer flounder ageing precision, based on sample-size weighted intra- and inter-reader ageing agreement, has averaged 86% with an overall Coefficient of Variation (CV) of 3%. The degree of precision is very similar for structures sampled from surveys and the commercial fisheries. Figures A1-A2 show the intra-ager age bias and percent agreement for the 2011 NEFSC trawl survey age samples, and Figures A3-A5 the intra-ager age bias and percent agreement for the 2011 NEFSC commercial fishery age samples.

GROWTH

Trends in NEFSC survey mean length and weight at age: 1976-2012

The NEFSC winter, spring and fall trawl survey sample data were examined for trends in mean length and weight by sex and age. Age collections for the spring and fall series begin in 1976; the winter survey was conducted during 1992-2007. Data are generally presented here for ages 0 through age 7; samples for ages 8 and older are sporadic and highly variable, although they are more numerous and consistent since 2001.

The spring and winter series indicate no trend in the mean lengths of ages 1-2 for sexes combined. For ages 3-6, there is an increasing trend in mean length from 1976 to about 1990, and a decreasing trend since then, and a slight decreasing trend in the winter survey for ages 7-8 (Figures A6-A7). In the fall series, there is no obvious trend for ages 0-1, but there are relatively strong decreasing trends in mean length for combined sexes for ages 2 and older since the 1990s (Figure A8).

Individual fish weight collection on NEFSC trawl surveys began in spring 1992. In general, the patterns in mean weight reflect those in mean length, with a decreasing trend in mean weight evident for ages 3 and older (Figures A9-A11). Trends in mean weights at age in the total, combined sexes fishery catch (landings plus discards) exhibit a comparable pattern, with strongest declining trends since the 1990s for ages 3 and older (Terceiro 2012).

Trends by sex and age for all three seasonal survey series follow comparable patterns. There are no trends in the mean lengths for ages 0-1, with a weak declining trend since the 1990s for ages 2 and older. Mean lengths of ages 3 and older show decreasing trends for both sexes (Figures A12-A14).

von Bertalanffy Parameters

Early estimates of summer flounder age and growth were limited in spatial and temporal scope, and include those of Poole (1961), Eldridge (1962), Smith and Daiber (1977) and Henderson (1979). Smith and Daiber (1977) used data from 319 fish sampled from Delaware Bay during 1966-1968 to estimate the von Bertalanffy asymptotic length parameter, Linf, for males of 62 cm and for females of 88 cm, although their observed maximum ages were only age 7 for males and age 8 for females. Henderson (1979) estimated Linf for sexes combined to be 92 cm and the von Bertalanffy growth rate parameter, k, to be 0.21, based on fish sampled from the commercial fishery in 1976 with a maximum age of 10.

Fogarty (1981) used data from the NEFSC spring and fall trawl surveys for 1,889 scale samples obtained during 1976-1979 to estimate von Bertalanffy growth parameters. Fogarty concluded that female summer flounder attained a significantly larger asymptotic size than males, but that there was not a significant difference in the growth rate coefficient k. Fogarty (1981) estimated that the parameters for males were Linf = 72.7 cm, k = 0.18, with maximum age of 7; the parameters for females were Linf = 90.6 cm, k = 0.16, with maximum age of 10.

Pentilla et al. (1989) provided information on mean lengths at age for both sexes of summer flounder sampled during NEFSC trawl surveys during 1975-1988; the summer flounder ages have since been corrected to be one year younger (Almeida *et al.* 1992; JM Burnett III, NMFS NEFSC, personal communication 1997; Bolz *et al.* 2000). The data from Pentilla et al. (1989) provide parameters for males of Linf = 72.7 cm, k = 0.18, with maximum age of 11; parameters for females of Linf = 90.7 cm, k = 0.16, with maximum age of 11; and parameters for sexes combined of Linf = 81.6, k = 0.17, with maximum age of 11.

In the current work, the NEFSC trawl survey data for 1976-2012 were used to estimate growth parameters for males, females, and sexes combined for the full time series and for seven multi-year bins. The full time series data provide parameters for males (n = 18,850) of Linf = 73.5 cm, k = 0.14, with maximum length of 67 cm (age 6) and age of 12 (length 63 cm); parameters for females (n = 18,495) of Linf = 80.9 cm, k = 0.18, with maximum length of 82 cm (age 11) and age of 14 (length 76 cm); and parameters for sexes combined (n = 38,173, including small fish of undetermined sex) of Linf = 87.2, k = 0.14, with maximum age of 14 (table below, Figure A15).

Study	N fish	Max age (M, F)	Linf (M, F, B)	k (M, F, B)
Smith & Daiber (1977)	319	7,8	62,88	n/a
Henderson (1979)	n/a	10	92	0.21
Fogarty (1981)	1,889	7,10	72.7, 90.6	0.18, 0.16
Pentilla et al. (1989)	n/a	11,11	72.7, 90.7, 81.6	0.18, 0.16, 0.17
Current assessment	38,173	12,14	73.5, 80.9, 87.2	0.14, 0.18, 0.14

The seven multi-year (mostly five year) bins were for the years 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005, and 2006-2012. Von Bertalanffy parameters were estimated for males, females, and sexes combined. For the bins with more limited age ranges, the asymptote of the von Bertalanffy function is not well defined, and so the Linf estimates tend to be unrealistically high and the k estimates tend to be low (e.g., 1990-1995, with maximum ages of only 5 for males and 7 for females, sexes combined Linf = 157.3, k = 0.069), and in some cases the model did not converge to provide realistic model parameter estimates, although the predicted lengths over the observed age range were still realistic (e.g., 1976-1980 and 1991-1995 for males). The multi-year bin growth curves are tightly clustered through age 5 for females, with some divergence at older ages (in part due to the lack of older ages as noted above), with the most recent bin (2006-2012) indicating smaller predicted lengths at age than in previous years (Figure A16). The growth curves are more dispersed for males, and therefore for sexes combined, with the most recent 2006-2012 curve indicating smaller predicted lengths for older males and for all ages when sexes are combined (Figures A16-A17).

Length-Weight parameters

The length-weight parameters used to convert commercial and recreational fishery landings and discards sampled lengths (cm) to weight (kg) are taken from the work of Lux and Porter (1966; L&P), which used individual fish lengths and weights from 2,051 fish collected during 1956-1962 to compute the parameters by calendar quarters. Wigley *et al.* (2003; Wigley) updated the length-weight parameters used in audits of the NEFSC trawl survey data, using individual length and weight information from 9,373 fish for 1992-1999.

In the current work, individual length and weight information from 28,250 fish for 1992-2012 were used to estimate length-weight parameters for comparison with the earlier studies to judge whether changing from the historical Lux and Porter (1966) parameters would be justified. Parameters were estimated for the entire 1992-2012 time series, for 4 multi-year blocks (1992-1995, 1996-2000, 2001-2005, 2006-2012), and by survey seasonal time series (winter 1992-2007, spring 1992-2012, and fall 1992-2012).

A comparison among these alternative compilations indicates very little difference in the estimated length-weight relationships from Lux and Porter (1966), Wigley *et al.* (2003), and the current examination for the NEFSC trawl survey data. The relationships are virtually identical through a total length of 62 cm (the combined surveys mean length of age 7 fish; age 7 and older fish compose the assessment 'plus group'), a threshold below which over 95% of the fishery catch has occurred (see the 'SVs Age 7 xl' vertical line in Figures A18-A19). Above 62 cm, the quarterly length-weight curves of Lux and Porter (1996) bracket the Wigley *et al.* (2003) and survey multi-year bin curves in the expected way, with first quarter, pre-spawning fish larger in weight at length than fourth quarter, post-spawning fish (Figure 18). In a comparison with survey seasonal curves, the curves are again nearly identical through 62 cm (Figure A19). Above 62 cm, the quarterly length-weight curves of Lux and Porter (1996) align with the survey seasonal curves in the expected way, with the seasonal winter (post-spawning) and spring (pre-spawning) curves close to the Lux and Porter first quarter curve, with the fall survey (September; nearest to peak spawning) curve closest to the Lux and Porter third quarter curve (Figure A19). Based on the consistency of the L-W relationship over these comparisons, the Lux and Porter (1966) commercial fishery quarterly length-weight parameters were retained for this assessment.

K Condition Factor

Fulton's condition factor, K, is a measure of the relationship between fish length and weight that attempts to quantify the 'condition' of an individual or group of fish. Nash *et al.* (2006) note that it was Heincke (1908) who first used K as a measure of 'condition,' building on the 'cubic law' of growth in weight first introduced by Fulton (1904; K = x*weight / length**3, where x is a constant to scale K near 1). Nash *et al.* (2006) further point out that it was Ricker (1954) who first attributed the factor K to Fulton and coined the name 'Fulton's condition factor.'

The NEFSC winter, spring and fall trawl survey sample data were examined for trends in condition factor by season and sex. Individual fish weight collection began on NEFSC surveys in spring 1992; the winter survey was conducted during 1992-2007. There are no long-term trends in condition factor by season or sex (Figures A20-A22).

MATURITY

Morse (1981) examined the reproductive characteristics of summer flounder using a special collection sampled during the 1974-1979 NEFSC trawl surveys (2,910 total fish). Morse (1981) estimated that the length at 50% maturity (L50%) was 24.7 cm for males and 32.2 cm for females. O'Brien *et al.* (1993) used NEFSC fall trawl survey data for 1985-1989 (875 total fish) and estimated L50% to be 24.9 cm for males and 28.0 cm for females. Work for this assessment used NEFSC fall trawl survey data for 1992-2012 (9,430 fish) and estimated the time series value of L50% to be 26.8 cm for males and 31.0 cm for females.

The maturity schedule at age for summer flounder used in the 1990 SAW 11 and subsequent stock assessments through 1999 was developed by the 1990 SAW 11 SDWG using NEFSC fall survey maturity data for 1982-1989 (NEFC 1990; Terceiro 1999). The 1990 SAW 11 work indicated that the median length at maturity (50^{th} percentile, L_{50}) was 25.7 cm for male summer flounder, 27.6 cm for female summer flounder, and 25.9 cm for the sexes combined. Under the ageing convention used in the 1990 SAW 11 and subsequent assessments (Smith *et al.* 1981, Almeida *et al.* 1992, Szedlmayer and Able 1992, Bolz *et al.* 2000), the median age of maturity (50^{th} percentile, A_{50}) for summer flounder was determined to be age 0.1 years for males and 0.5 years females (i.e., fish about 13-17 months old, based on the actual spawning month and the January 1 ageing convention relative to fall sampling). Combined estimated (logistic regression) maturities indicated that at peak spawning time in the fall (November 1), 38% of age 0 fish are mature, 72% of age 1 fish are mature, 90% of age 2 fish are mature, 97% of age 3 fish are mature, 99% of age 4 fish are mature, and 100% of age 5 and older fish (age 5+) are mature. The maturities for combined sexes age 3 and older (age 3+) were rounded to 100% in the 1990 SAW 11 and subsequent assessments through 1999.

The NEFSC maturity schedules are based on simple gross morphological examination of the gonads, and it was suggested in the early 1990s that they may not have accurately reflected (i.e., overestimated) the true spawning potential of the summer flounder stock, especially for age-0 and age-1 fish. It was also noted, however, that spawning stock biomass (SSB) estimates based on age-2 and older fish showed the same long term trends in SSB as estimates which included age 0 and 1 fish in the spawning stock. A research recommendation that the true spawning contribution of young summer flounder to the SSB be investigated was included in research recommendations beginning with the SAW 16 assessment in 1993 (NEFSC 1993).

Research at the University of Rhode Island (URI) by Drs. Jennifer Specker and Rebecca Rand Merson (hereafter referred to collectively as the "URI 1999" study) attempted to address the issue of the true contribution of young summer flounder to the spawning stock. The URI 1999 study examined the histological and biochemical characteristics of female summer flounder oocytes to determine if age-0 and age-1 female summer flounder produce viable eggs and to develop an improved guide for classifying the maturity of summer flounder collected in NEFSC surveys (Specker *et al.* 1999, Merson *et al.* 2000, Merson *et al.* MS 2004). The URI 1999 study examined 333 female summer flounder (321 aged fish) sampled during the NEFSC winter 1997 survey (February 1997) and 227 female summer flounder (210 aged fish) sampled during the NEFSC fall 1997 survey (September 1997) using radio-immunoassays to quantify the biochemical cell components characteristic of mature fish. In light of the completion of URI 1999 study to address the long-standing research recommendation, the maturity data for summer flounder for 1982-1998 were examined in the 2000 SAW 31 assessment (NEFSC 2000) to determine if changes in the maturity schedule were warranted.

The NEFSC 1982-1998 and URI 1999 maturity determinations disagreed for 13% of the 531 aged fish, with most (10%) of the disagreement due to NEFSC mature fish classified as immature by the URI 1999 histological and biochemical criteria. The URI 1999 criteria indicated that 15% of the age-0 fish were mature, 82% of the age-1 fish were mature, 97% of the age-2 fish were mature, and 100% of the age 3 and older fish were mature. When the proportions of fish mature at length and age were estimated by logistic regression, median length at maturity (50^{th} percentile, L_{50}) was estimated to be 34.7 cm for females, with the following proportions mature at age: age-0: 30%, age-1: 68%, age-2: 92%, age-3: 98%, and age-4: 100%. Median age of maturity (50^{th} percentile, A_{50}) was estimated to be about 0.5 years. Based on this new information, the 2000 SAW 31 (NEFSC 2000) considered 5 options for the summer flounder maturity schedule for the 2000 stock assessment:

1) No change, use the maturity schedule for sexes combined as in the 1990 SAW 11 and subsequent assessments (rounded to 0.38, 0.72, 0.90, 1.00, 1.00, and 1.00 as in the 1997 SAW 25 and 1999 assessment analyses)

2) Consider only age-2 and older fish for sexes combined in the SSB

3) Knife edged, age-1 and older maturity for sexes combined. This would eliminate age-0 fish of both sexes from the SSB, and assume that the proportions mature at age-1 "round" to 100%

4) NEFSC 1982-1989, 1990-1998 for sexes combined, assuming a 1:1 sex ratio in deriving a combined schedule

5) NEFSC 1982-1989, 1990-1998 for males, URI 1999 for females, assuming a 1:1 sex ratio in deriving a combined schedule.

SAW 31 concluded that some contribution to spawning from ages 0 and 1 should be included, eliminating options 2 and 3. The differences among remaining options 1, 4, and 5 were considered to be relatively minor, and so the 1990 SAW 11 schedule (Option 1) was retained for subsequent assessments. SAW 31 recommended that more biochemical and histological work should be done for additional years to determine if the results of the URI 1999 study would be applicable over the full assessment time series. SAW 31 (NEFSC 2000) also noted the need for research to explore whether the viability of eggs produced by young, first time spawning summer flounder was comparable to the viability of eggs produced by older, repeat spawning summer flounder.

In the 2005 SAW 41 work (NEFSC 2005), the maturity schedule was updated and broadened to include data from 1992-2004, covering the year range for individually measured and weighed fish sampled in NEFSC research surveys. The resulting sexes combined maturity schedule (age 0: 38%; age 1: 91%; age 2: 98%; age 3+: 100%) was retained in the 2006 assessment and 2006 NMFS Science and Technology reference point peer review (Terceiro 2006a, b).

The 2008 SAW 47 SDWG examined the proportions mature at age from 1982-1991 as well as the new NEFSC sampling protocol, individual fish information on length and age at maturity from 1992-2007. Using NEFSC fall survey maturity data from 1992-2007 and logistic regression, the median length at maturity (50^{th} percentile, L_{50}) was estimated at 27.0 cm for males, 30.3 cm for females, and 27.6 cm for sexes combined. The median age of maturity (50^{th} percentile, A_{50}) was determined to be 0.1 years for males, 0.4 years for females, and 0.2 years for sexes combined. These findings were consistent with the findings of the 1990 SAW 11, the URI 1999 study, the 2000 SAW 31, and the 2005 SAW 41. An examination of the proportions of mature age-0 and age-1 fish did not indicate any trend which would warrant modification of the maturity schedule, and so the 2008 SAW 47 concluded that it was appropriate to again retain the maturity schedule from the 2005 SAW 41 assessment (NEFSC 2008a). The 2005 SAW 41 combined sex maturity schedule was also retained in the subsequent 2009-2012 updated assessments (Terceiro 2012).

Since the 2008 SAW 47 assessment, the NEFSC's general approach to the estimation of maturity schedules has advanced, mainly from work conducted for Northeast groundfish assessments in 2008 and subsequent years (NEFSC 2008b, 2012). The new approach involves the evaluation of both observed and logistic regression estimated maturity schedules to look for periodicity and/or trends. Sometimes the number of samples taken for a given year, season, or sex is not sufficient for estimation, or the observed and estimated maturity shows high inter-annual variability due to small sample sizes, and so different year-bin combinations (e.g., annual, discrete multi-year blocks, multi-year moving windows, and time series) were examined.

For this benchmark assessment of summer flounder, the standard NEFSC fall trawl survey 1982-2012 (31 years) maturity data have therefore been re-examined. The current data set consists of 6,088 males from age 0 to 11 and 4,985 females from age 0 to 12, for a total of 11,173 fish. For the entire time series, the observed percent mature of males is 43% at age 0, 95% at age 1, 99% at age 2, and 100% for age 3 and older. The observed percent mature of females is 28% at age 0, 84% at age 1, 96% at age 2, and 100% for age 3 and older. The observed percent mature of sexes combined for the time series is 37% at age 0, 91% at age 1, 98% at age 2, and 100% for age 3 and older (Figure A23). Estimated maturity ogives for the time series indicate the maturity of males to be 40% at age 0, 95% at age 1, and 100% at ages 2 and older; of females to be 28% at age 0, 95% at age 1, and 100% at ages 2 and older; and for sexes combined to be 36% at age 0, 90% at age 1, 99% at age 2, and 100% at ages 3 and older (Figure A24). The median length at maturity (50^{th} percentile, L_{50}) was estimated at 26.0 cm (95% CI from 25.7 to 26.3 cm) for males, 29.2 cm (95% CI from 28.7 to 29.6 cm) for females, and 26.8 cm (95% CI from 26.5 to 27.0 cm) for the sexes combined. The median age of maturity (50^{th} percentile, A_{50}) was estimated to be age 0.1 for males, age 0.4 for females, and age 0.2 for sexes combined (i.e., fish about 13-16 months old, based on the actual spawning month and Jan 1 ageing convention relative to fall sampling).

The NEFSC Fall survey data were pooled into three year blocks (except for the last, four year block of 2009-2012) to look for trends or abrupt changes in the observed proportions mature over time. For many of the bins, the male and female patterns are very similar, generally with age 0 observed maturity at 40-50% and age 1 at 90%. For some of the blocks (1991-1993, 1997-1999, 2006-2008) there is more divergence between the sexes at ages 0 and 1. The most recent 2009-2012 block shows the greatest divergence, with observed proportion mature for females of about 5% at age 0, 50% at age 1, and 90% at age 2 (Figures A25-A28).

Estimated maturity ogives by year (annual) and sex suggest a long term, decreasing trend in proportion mature at ages 0 and 1 for males and females, and for females at age 2. Fish of age 3 and older are generally all very close to 100% mature. The annual proportions for ages 0, 1 and 2 are variable, however, and for several years are poorly estimated with wide confidence intervals (Figures A29-A31). The next step was to estimate maturity ogives for three-year moving windows, in an attempt to stabilize the inter-annual variability and improve precision. Estimated three-year proportions mature for ages 0, 1, and 2 by sex provided a smoother inter-annual pattern and more precise estimates than the annual estimates (Figures A32-A34).

Finally, in keeping with the approach from the previous benchmark assessment (NEFSC 2008a), a sexes combined three-year moving window ogive was compiled from the NEFSC 1982-2012 fall survey data. The three-year moving window approach provides a) well-estimated proportions mature at age, b) estimated maturities at age that transition smoothly over the course of the time series, and c) reflect the recent trend of decreasing maturity at ages 0, 1, and 2. The sexes combined, three-year moving window estimates are presented in Figure A35 and in the table below. The 1982-2012 mean percent maturities at age (un-weighted, simple arithmetic average of annual values at age) are 34% at age 0, 90% at age 1, 99% at age 2, and 100% at ages 3 and older; these averages are 4% lower at age 0, 1% lower at age 1, 1% higher at age 2, and the same at ages 3 and older, compared to the 2005 SAW 41 values used in the 2005 and subsequent assessments. Changing to the proposed updated values will represent the use of the most comprehensive data set available.

MAT3	0	1	2	3	4	5	6	7+
1982	0.35	0.94	1.00	1.00	1.00	1.00	1.00	1.00
1983	0.37	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.30	0.93	1.00	1.00	1.00	1.00	1.00	1.00
1985	0.40	0.94	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.41	0.92	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.50	0.93	0.99	1.00	1.00	1.00	1.00	1.00
1988	0.58	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1989	0.51	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.46	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.44	0.98	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.46	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.48	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.45	0.92	0.99	1.00	1.00	1.00	1.00	1.00
1995	0.44	0.86	0.98	1.00	1.00	1.00	1.00	1.00
1996	0.40	0.85	0.98	1.00	1.00	1.00	1.00	1.00
1997	0.26	0.87	0.99	1.00	1.00	1.00	1.00	1.00
1998	0.19	0.84	0.99	1.00	1.00	1.00	1.00	1.00
1999	0.18	0.84	0.99	1.00	1.00	1.00	1.00	1.00
2000	0.23	0.85	0.99	1.00	1.00	1.00	1.00	1.00
2001	0.29	0.94	1.00	1.00	1.00	1.00	1.00	1.00
2002	0.26	0.97	1.00	1.00	1.00	1.00	1.00	1.00
2003	0.23	0.98	1.00	1.00	1.00	1.00	1.00	1.00
2004	0.31	0.92	1.00	1.00	1.00	1.00	1.00	1.00
2005	0.28	0.89	0.99	1.00	1.00	1.00	1.00	1.00
2006	0.28	0.83	0.98	1.00	1.00	1.00	1.00	1.00
2007	0.14	0.86	1.00	1.00	1.00	1.00	1.00	1.00
2008	0.18	0.85	0.99	1.00	1.00	1.00	1.00	1.00
2009	0.25	0.78	0.98	1.00	1.00	1.00	1.00	1.00
2010	0.33	0.79	0.97	1.00	1.00	1.00	1.00	1.00
2011	0.32	0.76	0.95	1.00	1.00	1.00	1.00	1.00
2012	0.27	0.81	0.98	1.00	1.00	1.00	1.00	1.00

Incorporating the McElroy et al. (2013; WPA9) histological results

Subsequent to completion of the above work on maturity, McElroy et al. (2013 MS) produced a working paper (WPA9) detailing their examination of the sources of variability in summer flounder female maturity rates: whether they are dependent on method, or year, or both, and if so, to what magnitude. They compared at-sea and histological maturity assignments made during recent NEFSC resource surveys, and compared female maturity schedules derived from ovarian histology to those from earlier studies (noted above). McElroy et al. (2013 MS) studied 266 female summer flounder sampled during September through November of five years, 2008–2012, as part of the NEFSC fall bottom trawl survey. They also studied female summer flounder sampled as part of the Enhanced Biological Sampling of Fish (EBSF) project supported by the NEFSC, Northeast Cooperative Research Program (NEFSC–NCRP). A total of 935 mature females were collected either in monthly sampling from December 2009 to May

2011 or targeted sampling during the primary spawning season September to November (2011 and 2012) as well as March and April when spawning has also been reported (2012 and 2013 only). Catches were sampled from commercial vessels participating in the NEFSC–NCRP's Study Fleet or other NEFSC-NCRP research studies while fishing in southern New England waters (NMFS statistical areas 537, 539, and 611). These commercial fishery sampled data were used to aid in the interpretation of gonad histology; specifically, to identify the pattern and progression of oocyte maturation (reproductive seasonality).

McElroy et al. (2013 MS) concluded that "… at-sea assignments have a high rate of agreement with microscopic classifications (89%). During this season, the majority of mature females were developing or even actively spawning; regenerating (spent) fish were rare. The largest of immature fish were difficult to classify correctly using macroscopic criteria, as some of these fish were preparing to spawn next year, for the first time; these fish were incorrectly classified at sea as resting, similar misclassifications have also been noted for winter flounder (McBride et al. 2013). An earlier study on summer flounder (NEFSC 2000) using gonad histology reported a similar misclassification rate between at-sea and histological assignments (13% vs. 11% in the current study). The non-matching maturity assignments were concentrated at the ages where the process of maturation was active (age 1 and age 2). Maturity in female summer flounder is rapid with 99% maturity achieved by age 4, using either histology or macroscopic methods. Most of the errors were for immature fish identified as resting at sea. Removing the resting fish from the dataset improved the rate of agreement (95%) between at-sea and histological classifications, and it resulted in overlapping CI's for the maturity ogives between the classification methods. This may be one way to reduce observational error in the at-sea maturity ogives. Otherwise, macroscopic classification remains an effective and cost efficient method for tracking female summer flounder maturity" and "The temporal trend using histology indicated that recently the declines in proportion mature at age for age 1 and age 2 fish were even greater than were evident in the macroscopic data (WPA1), which are the ages with the most misclassifications."

Given the McElroy et al. (2013 MS; WPA9) results, and after direct consultation with McElroy, the NEFSC Fall survey maturity data for summer flounder were re-analyzed here. McElroy et al. (2013 MS) found that most of the macroscopic classification errors were for immature females misclassified as resting (T) mature in the age 0-2 range, which were actually 'IFM' fish - first time maturing females that likely would not effectively spawn until the next year. It is not clear that the same misclassification problem occurs for resting (T) males, as the maturity stage is less ambiguous in them. The new maturity analysis removed the resting (T) females from the NEFSC Fall survey 1982-2012 data. This action removed 1,866 resting females from the initial 11,073 fish (of both sexes), or 17% of the initial sample. This change, when maturities at ages are calculated for sexes combined, resulted in about an average decrease (un-weighted average of annual maturities over the 1982-2012 series) in maturity of 4% for age 0, 2% for age 1, and no change for ages 2 and older.

Sexes combined

Age	0	1	2	3	4	5	6	7+
average	0.34	0.90	0.99	1.00	1.00	1.00	1.00	1.00
std	0.11	0.06	0.01	0.00	0.00	0.00	0.00	0.00
CV	0.33	0.07	0.01	0.00	0.00	0.00	0.00	0.00

Sexes combined - no T Females

Age	0	1	2	3	4	5	6	7+
average	0.30	0.88	0.99	1.00	1.00	1.00	1.00	1.00
std	0.10	0.07	0.01	0.00	0.00	0.00	0.00	0.00
CV	0.32	0.08	0.01	0.00	0.00	0.00	0.00	0.00

The new combined sexes, no T females, 3-year moving window maturities (MAT3-noTF) in the table below and in Figure A36 are recommended by the SDWG for use in the 2013 SARC 57 assessment.

MAT3-noTF	0	1	2	3	4	5	6	7+
1982	0.32	0.93	1.00	1.00	1.00	1.00	1.00	1.00
1983	0.34	0.94	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.26	0.91	1.00	1.00	1.00	1.00	1.00	1.00
1985	0.38	0.92	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.38	0.90	0.99	1.00	1.00	1.00	1.00	1.00
1987	0.47	0.92	0.99	1.00	1.00	1.00	1.00	1.00
1988	0.49	0.94	1.00	1.00	1.00	1.00	1.00	1.00
1989	0.42	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.39	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.39	0.97	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.42	0.96	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.42	0.94	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.36	0.89	0.99	1.00	1.00	1.00	1.00	1.00
1995	0.34	0.79	0.97	1.00	1.00	1.00	1.00	1.00
1996	0.31	0.80	0.97	1.00	1.00	1.00	1.00	1.00
1997	0.24	0.84	0.99	1.00	1.00	1.00	1.00	1.00
1998	0.17	0.81	0.99	1.00	1.00	1.00	1.00	1.00
1999	0.14	0.81	0.99	1.00	1.00	1.00	1.00	1.00
2000	0.18	0.81	0.99	1.00	1.00	1.00	1.00	1.00
2001	0.22	0.92	1.00	1.00	1.00	1.00	1.00	1.00
2002	0.23	0.95	1.00	1.00	1.00	1.00	1.00	1.00
2003	0.18	0.97	1.00	1.00	1.00	1.00	1.00	1.00
2004	0.28	0.89	0.99	1.00	1.00	1.00	1.00	1.00
2005	0.25	0.86	0.99	1.00	1.00	1.00	1.00	1.00
2006	0.25	0.80	0.98	1.00	1.00	1.00	1.00	1.00
2007	0.13	0.82	0.99	1.00	1.00	1.00	1.00	1.00
2008	0.17	0.83	0.99	1.00	1.00	1.00	1.00	1.00
2009	0.24	0.76	0.97	1.00	1.00	1.00	1.00	1.00
2010	0.32	0.77	0.96	0.99	1.00	1.00	1.00	1.00
2011	0.30	0.73	0.95	0.99	1.00	1.00	1.00	1.00
2012	0.26	0.78	0.97	1.00	1.00	1.00	1.00	1.00

Age	0	1	2	3	4	5	6	7+
average	0.30	0.88	0.99	1.00	1.00	1.00	1.00	1.00
std	0.10	0.07	0.01	0.00	0.00	0.00	0.00	0.00
CV	0.32	0.08	0.01	0.00	0.00	0.00	0.00	0.00

INSTANTANEOUS NATURAL MORTALITY RATE (M)

The instantaneous natural mortality rate (M) for summer flounder was assumed to be 0.2 in early summer flounder assessments (SAW 20; NEFSC 1996a). In the SAW 20 work, estimates of M were derived using methods described by a) Pauly (1980) using growth parameters derived from NC-DMF age-length data and a mean annual bottom temperature (17.5^{o}C) from NC coastal waters, b) Hoenig (1983) using a maximum age for summer flounder of 15 years, and c) consideration of age structure expected in unexploited populations (5% rule, 3/M rule, e.g., Anthony 1982). The SAW 20 (NEFSC

1996a) concluded that M = 0.2 was a reasonable value given the mean (0.23) and range (0.15-0.28) obtained from the various analyses, and this value for M was used in all subsequent assessments until 2008.

For the 2008 SAW 47 assessment (NEFSC 2008a) longevity- and life-history based estimators of M were reviewed. Sex and age-specific estimates of M were calculated from 1976-2007 summer flounder age and growth data from the NEFSC trawl surveys. Longevity based estimators of M are sensitive to critical underlying assumptions which include the value of p, or the small proportion of the population surviving to a given maximum age, and the maximum observed age under no or low exploitation conditions. Using a maximum age of 15 years for summer flounder, and the methods of Hoenig (1983) and Hewitt and Hoenig (2005), longevity based estimates of M for combined sexes ranged from 0.20 to 0.36 depending on whether a p=1.5% or p=5% was assumed. Other life-history based approaches were used, including those from Pauly (1980), Jensen (1996), Gunderson and Dygert (1988), and Gunderson (1997), with resulting estimates ranging from 0.20 to 0.45. Age-specific and size variable estimates of M, based on the work of Peterson and Wroblewski (1984), Chen and Watanabe (1989), Lorenzen (1996), and Lorenzen (2000), ranged from 0.19 to 0.90, with the highest values associated with age 0-1 fish (fish at smaller lengths).

While the 2008 SAW 47 work provided a wide range of methods and M estimates to be considered, each estimate involved a suite of underlying assumptions which were debated. In addition, the modeling frameworks of ADAPT virtual population analysis, ASAP statistical catch-at-age analysis, and SS2 statistical catch-at-age analysis used in the SAW 47 assessment allowed for log-likelihood profiling of M to determine which M estimate provides the best model fits. Based on an exercise using the base cases, the M that minimized the log-likelihood was 0.35, 0.20, and 0.25 under the models ADAPT, ASAP, and SS2, respectively. The estimate of M that resulted in the lowest residual or likelihood was found to be sensitive to model selection and configuration, as the data input configurations were very similar across the three models.

The SAW 47 considered the different methods of estimating M and after lengthy discussion assumed a natural mortality rate (M) of 0.20 for females and 0.30 for males, based mainly on recently observed maximum ages in the NEFSC survey data of 14 years (76 cm, in NEFSC Winter Survey 2005) for females and 12 years (63 cm, in NEFSC Spring Survey 2007) for males, and the expectation that larger and older fish are likely if fishing mortality rates were maintained at low rates in the future. A combined sex M-schedule at age was developed by assuming these initial M rates by sex, an initial proportion of females at age 0 of 40% derived from the NEFSC Fall survey indices by age and sex, and population abundance decline over time at the sex specific M rates. The final abundance weighted combined sex M-schedule at age ranged from 0.26 at age 0 to 0.24 at age 7+, with a mean of 0.25 (NEFSC 2008a). The 2008 SAW 47 M-schedule (mean M = 0.25) was retained in the subsequent 2009-2012 updated assessments (Terceiro 2012).

The 2013 SDWG discussed the results of Maunder and Wong (2011), WPA10 Maunder (2013a MS; WPA10), and Morson *et al.* (2013 MS; WPA13) with regards to the value of M to be used in the current assessment. The Maunder and Wong (2011) (which reiterated their 2008 SAW 47 work and added new simulation work) and Maunder (2013a MS; WPA10) work concluded that average M was likely higher than

0.25, with males having a mean M of about 0.30 and females a mean M of about 0.50, which would provide a combined mean M = 0.40. However, the SDWG presentation of Morson *et al.* (2013 MS; WPA13) noted that the sampling program described had identified males of ages 13 and 14, equal to the oldest females yet found in any NEFSC commercial fishery or survey sampling, lending support to the idea that M might be towards the lower end of the range of M values under consideration. Objective function profiles over a range of fixed M values in the F57_BASE model runs indicated best fits for mean M of 0.15-0.25 (see TOR 4). The 2013 SDWG concluded that the 2008 SAW47 mean M = 0.25 should be used in the 2013 SAW 57 assessment BASE model run. Sensitivity runs with mean M=0.1, 0.2, 0.3, 0.4 were provided for comparison purposes (see TOR4).

PREDATORS AND PREY

The NEFSC trawl survey foods habits 1973-2011 database was investigated to identify the most frequent predators and prey of summer flounder, relevant to Research Recommendation 10 (see TOR8). Summer flounder was identified to species as a prey item in 65 predator stomachs. Spiny dogfish was the predator in 35 cases (54%), followed by monkfish (11 cases, 17%), winter skate (7 cases, 11%). and bluefish (4 cases, 6%), with other fish species accounting for the other 9 cases and 12%, including 1 case (2%) of summer flounder cannibalism. The data are insufficient to calculate total absolute predator consumption of summer flounder.

The database contains information from 18,862 summer flounder stomachs sampled on 5,365 tows, over 70% of which were found to be empty. ‘Other fish’ (fish which could not be identified to family) were found in about 10% of the stomachs, followed by squids (6%), decapod shrimp (4%), ‘animal remains’ (3%; partially digested stomach contents), anchovies (2%), and other gadids, porgies, mysids, and other small crustaceans (Figure 50). The data were summarized into 4 multi-year blocks to look for temporal patterns. The frequency of ‘Other fish’ and decapod shrimp consumption by summer flounder decreased by about 50% over the time series, while the frequency of consumption of squid slightly increased. The frequency of consumption of anchovies peaked in the 1980s (Figures A37-A39). These results generally confirm those found by Link et al. (2002), who reported on the feeding ecology of flatfish in the northwest Atlantic. The calculation of total absolute consumption of prey by summer flounder has not been attempted here.

NEFSC TRAWL SURVEY ENVIRONMENTAL DATA

Some of the NEFSC winter, spring and fall trawl survey environmental data were summarized for the summer flounder strata sets to investigate the correspondence between the environmental factors and the distribution of summer flounder (relevant to TORs 1-2). The environmental factors were surface air temperature in degrees Celsius (also a proxy for surface water temperature), bottom water temperature in degrees Celsius, and bottom water salinity in parts per thousand (PPT). Valid bottom temperature data on a per tow basis are generally available for the entire 1968-2011/2012 time series for the summer flounder survey strata (Great South Channel to Cape Hatteras) in both spring and fall, with the exception of fall 2008, for which large numbers of observations are missing. Air temperatures are generally missing during the 1970s in both spring and fall. Bottom salinities are generally available for 1997 and later years, except for 2008.

First, the cumulative distributions of the summer flounder survey catches (expcatchnum) and the three environmental factors were compiled for the spring (offshore strata 1-12, 61-76) and fall (offshore strata 1-2, 5-6, 9-10, 61, 65, 69, 73) long time series (1968-2011/2012) strata sets. For this simple compilation, the cumulative totals are not weighted by stratum area. In the spring survey strata, over the full 1968-2012 time series, summer flounder were in general caught at stations (tow sites) that had a warmer bottom temperature (Figure A40; median [50^{th} %ile] catch at 9.0^{o}C, median tows at 7.2^{o}C), higher bottom salinity (Figure A41; median catch at 34.0 PPT, median tows at 33.6 PPT), and warmer air temperature (Figure A42; median catch at 7.0^{o}C, median tows at 6.5^{o}C) than the average environment of the strata set. In the fall survey strata, summer flounder were in general caught at stations (tow sites) that had a warmer bottom temperature (Figure A43; median catch at 15.8^{o}C, median tows at 12.3^{o}C), lower bottom salinity (Figure A44; median catch at 32.4 PPT, median tows at 32.8 PPT), but cooler air temperature (Figure A45; median [50^{th} %ile] catch at 17.8^{o}C, median tows at 18.4^{o}C) than the average environment of the strata set.

In a second compilation, the annual stratified mean values of the environmental factors for positive summer flounder catch tows (expcatchnum > 0) were compared with the annual stratified mean values of the environmental factors for all tows to investigate trends over time. Figure A46 shows that the mean bottom temperature on NEFSC spring survey tows with positive summer flounder catches (FLK_bottemp) was generally warmer than the mean bottom temperature of all tows (All_bottemp) from 1968 through the 1980s. Since 1990, these mean temperatures are more similar. The solid blue trend line shows that the mean bottom water temperature of all tows in the spring strata set has increased over time by a few tenths degree Celsius. Figure A47 shows the pattern for NEFSC fall survey tows, with the bottom temperature on tows with positive summer flounder catches generally warmer than the mean bottom temperature of all tows over the entire series. The solid red trend line shows that the mean bottom water temperature of all tows in the fall strata set has increased over time by about one-half degree Celsius.

Figure A48 shows that the mean bottom salinity on NEFSC spring survey tows with positive summer flounder catches (FLK_botsalin) was generally higher than the mean salinity of all tows (All_botsalin) since 1997. The solid blue trend line shows that the mean bottom salinity of all tows in the spring strata set has increased by about one-percent (about 0.25 PPT) since 1997. Figure A49 shows the pattern for NEFSC fall survey tows, with the bottom salinity on tows with positive summer flounder catches generally lower than the mean salinity of all tows since 1997. The solid red trend line shows that the mean salinity of all tows in the fall strata set has no trend.

Figure A50 shows the mean air temperature on NEFSC spring survey tows with positive summer flounder catches (FLK_airtemp) was generally comparable to the mean air temperature of all tows (All_airtemp) over the series. The solid blue trend line shows that the mean air temperature of all tows in the spring strata set has decreased over time by about one-half degree Celsius. Figure A51 shows the pattern for NEFSC fall survey tows, with the air temperature on tows with positive summer flounder catches generally warmer than the mean bottom temperature of all tows during the 1980s and generally cooler since the late 1990s. The solid red trend line shows that the air temperature of all tows in the fall strata set has increased over time.

GENERAL BIOLOGICAL TRENDS

The NEFSC survey data show trends in the most recent years of decreasing mean length and weight at age in all seasons and for both sexes, a trend in von Bertalanffy parameters that indicates 'slower growth' (smaller predicted length at age), and a trend of delayed maturity. A comparison of mean length at sex and age by survey season indicates there is no significant correlation between the survey mean lengths at ages 0-7 and survey bottom temperatures from the spring and fall series, except for age 1 males in the spring, for which the relationship is negative ($r = -0.41$; $df = 33$, rcritical for alpha = 5% = 0.34; Rohlf and Sokal 1981). If the expected positive relationship between summer flounder growth and temperature were to hold, this result suggests that the observed decreasing/delayed trend in mean lengths, weights, and maturities at age is not due to increasing habitat temperatures. Further, there are no trends in length-weight relationship parameters or condition factor that suggest a trend of reduced 'condition' for summer flounder. There are trends in sex ratio that indicate a decreasing proportion of females (and therefore an increasing proportion of males) for ages 2 and older.

The previous recent stock assessment update (Terceiro 2012) indicated that ages 2 and older are near to fully selected by the fisheries, and that fishing mortality has decreased substantially since the 1990s. Fully selected instantaneous fishing mortality rates (F) averaged greater than 1.0 (a percentage exploitation rate of about 60%) during 1982-1990, but have decreased to less than 0.5 (about 30%) since 2001 (Terceiro 2012). Trippel (1995), Stokes and Law (2000), and Sinclair et al. (2002a, b), among others, have all noted that varying intensities of size-selective (and therefore age-selective) fishing mortality in highly exploited fish populations can influence the observed size and age structure (and therefore sex-ratio, maturity, and fitness) of those populations, over both short and evolutionary time scales. Stokes and Law (2000) in particular noted: "…(1) there is likely to be genetic variation for traits selected by fishing; (2) selection differentials due to fishing are substantial in major exploited stocks; and (3) large phenotypic changes are taking place in fish stocks, although the causes of these changes are hard to determine unambiguously."

TOR 1. Estimate catch from all sources including landings and discards. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

COMMERCIAL FISHERY LANDINGS

Total U.S. commercial landings of summer flounder from Maine to North Carolina peaked in 1979 at nearly 18,000 mt (39.561 million lbs, Table A1, Figure A52). The reported landings in 2012 of 6,047 mt = 13.331 million lbs were about 5% over the final 2012 commercial quota of 5,750 mt = 12.677 million lbs. Since 1980, about 70% of the commercial landings of summer flounder have come from the Exclusive Economic Zone (EEZ; greater than 3 miles from shore). Large variability in summer flounder landings exist among the states, over time, and the percent of total summer flounder landings taken from the EEZ has varied widely among the states. The commercial landings are assumed to be reported with minimal error. The uncertainty of the reported landings due to assignment to statistical area equates to a Coefficient of Variation (CV) of 0.3%.

Northeast Region (NER; Maine to Virginia)

Annual commercial landings data for summer flounder in years prior to 1994 were obtained from detailed trip-level landings records contained in master data files maintained by the Northeast Fisheries Science Center (NEFSC; the "weighout system" of 1963-1993) and from summary reports of the Bureau of Commercial Fisheries and its predecessor the U.S. Fish Commission (1940-1962). Prior to 1994, summer flounder commercial landings were allocated to NEFSC 3-digit statistical area according to interview data (Burns et al. 1983). Beginning in 1994, landings estimates were derived from mandatory dealer reports under the current NMFS Northeast Region (NER) summer flounder quota monitoring system. Beginning in 1994, the dealer landings have been allocated to statistical area using fishing dealer and fishing Vessel Trip Reports (VTR data) in a multi-tiered allocation procedure at the fishing-trip level (Wigley et al., 2007). Three-digit statistical areas 537-539 (Southern New England), 611-616 (New York Bight), 621, 622, 625, and 626 (Delmarva region), and 631 and 632 (Norfolk Canyon area) have generally accounted for over 80% of the NER commercial landings since 1992 (Table A2).

A summary of length and age sampling of summer flounder landings collected by the NEFSC commercial fishery port agent system in the NER is presented in Table A3. For comparability with the manner in which length frequency sampling in the recreational fishery has been evaluated, sampling intensity is expressed in terms of metric tons (mt) of landings per 100 fish lengths measured. The sampling is proportionally stratified by market category (jumbo, large, medium, small, and unclassified), with the sampling distribution generally reflecting the distribution of commercial landings by market category. Overall sampling intensity has improved since 1995, from 165 mt per 100 lengths to less than 100 mt per 100 lengths, and temporal and geographic coverage has generally improved as well.

The age composition of the NER commercial landings for 1982-1999 was generally estimated semi-annually by market category and 1-digit statistical area (e.g., area 5 or area 6), using standard NEFSC procedures (market category length frequency samples converted to mean weights by length-weight relationships; mean weights in turn divided into landings to calculate numbers landed by market category; market category numbers at length apportioned to age by application of age-length keys). For 2000-2002, sampling was generally sufficient to make quarterly estimates of the age composition in area 6 for the large and medium market categories. Since 2003, sampling has generally been sufficient to make quarterly estimates of the age composition in areas 5 and 6 for the jumbo, large, and medium market categories. The proportion of large and jumbo market category fish (generally of ages 3 and older) in the NER landings has increased since 1996, while the proportion of small market category landings (generally of ages 0 and 1) has become very low (Table A4). The mean size of fish landed in the NER commercial fishery has been increasing since 1993, and has averaged about 1 kg (2.2 lbs) since 2007, typical of an age 4 summer flounder (Table A5).

North Carolina

The North Carolina winter trawl fishery accounts for about 99% of summer flounder commercial landings in North Carolina. A separate landings at age matrix for this component of the commercial fishery was developed from North Carolina Division of Marine Fisheries (NCDMF) length and age frequency sample data. The NCDMF program samples about 10% of the winter trawl fishery landings annually, most recently at rates of less than 10 metric tons of landings per 100 lengths measured (Table A6). All length frequency data used in construction of the North Carolina winter trawl fishery landings at age matrix were collected in the NCDMF program; age-length keys from NEFSC commercial data and NEFSC spring survey data (1982-1987) and NCDMF commercial fishery data (1988 and later) were combined by appropriate statistical area and semi-annual period to resolve lengths to age. Fishery regulations in North Carolina also changed between 1987 and 1988, with increases in both the minimum mesh size of the codend and minimum landed fish size taking effect. It is not clear whether the change in regulations or the change in keys, or some combination, is responsible for the decreases in the numbers of age-0 and age-1 fish estimated in the North Carolina commercial fishery landings since 1987. Landed numbers at age and mean weight at age from this fishery are shown in Tables A7-A8.

COMMERCIAL FISHERY DISCARDS

Background and Previous Estimation Method

In the 1993 SAW 16 assessment, an analysis of variance of Northeast Region (NER) Fishery Observer Program data (OB) was used to identify stratification variables for an expansion procedure to estimate summer flounder total landings and discards from the observer data kept (K) and discard (D) rates in the commercial fishery. Initial models included the main effects of year, quarter, fisheries statistical division (2-digit area), area (divisions north and south of Delaware Bay), and tonnage class. Quarter and division consistently emerged as significant main effects without significant interaction with the year (NEFSC 1993). This discard estimation procedure expands transformation bias-corrected geometric mean catch rates (kept and discards per day fished; K/DF and D/DF) in year, quarter, and division strata by total days fished (DF). Days fished are defined as the hours fishing on trips landing any summer flounder by any mobile gear, including fish trawls and scallop dredges. The use of fishery effort as the expansion factor (multiplier) allows estimates of landings from the fishery observer data to be compared with dealer reported landings, to help judge the potential accuracy of the procedure. For strata with no observer sampling, catch rates from adjacent or comparable strata are substituted as appropriate (except for Division 51, which generally has very low catch rates and negligible catch). Estimates of discard are stratified by 2 gear types (scallop dredges and fish trawls) for years when data were adequate (1992 and later).

Observer data were used to develop estimates of commercial fishery discards since 1989. However, adequate data (e.g., interviewed trip data, survey data) are not available to develop summer flounder discard estimates for 1982-1988. Discard numbers were assumed to be very small relative to landings during 1982-1988 (because of the lack of a minimum size limit in the EEZ), but to have increased since 1989 with the implementation of fishery regulations in the EEZ. It is recognized that not accounting directly for commercial fishery discards in 1982-1988 likely results in a small underestimation of fishing mortality and population sizes in these years.

As recommended by SAW 16 (NEFSC 1993), a commercial fishery discard mortality rate of 80% was applied to develop the final estimate of discard mortality from live discard estimates. The SAW 47 assessment (NEFSC 2008a) considered some preliminary information from a 2007 Cornell University Cooperative Extension study. This study conducted ten scientific trips on inshore multispecies commercial trawling vessels to determine discard mortality rates relative to tow duration, fish size, and the amount of time fish were on the deck of the vessel. The median mortality for all tows combined was 78.7%, very close to the estimated overall discard mortality of 80% used in the assessment. Another study (Yergey *et al.* 2012) conducted by Rutgers University using acoustic telemetry to evaluate both on-deck and latent discard mortality found total discard mortality in the trawl fishery to be 81.7%, again very close to the estimated overall discard mortality of 80% used in the assessment. This discard mortality rate is applied to the live discard estimate regardless of the discard estimation method used.

Current Observer (OB) and Vessel Trip Report (VTR) Data and Previous Estimates

The Observer (OB) sample data aggregated on an annual basis are summarized in Table A9. Discard rates of summer flounder in the scallop dredge fishery are generally much higher (recently >90%) than in the trawl fishery (generally <50%), purportedly because of closures, trip limits, and the higher economic value of kept scallops compared to kept summer flounder. The OB sample data indicated that prior to statistical transformation and stratified expansion, the overall percentage of live discards to total catch has ranged from 6% in 1995 to 59% in 2007, with an un-weighted annual average percentage (rate) of 25% over the 1989-2011 time series. The percentage in 2011 was 21% (Table A9, Figure A53 [OB Raw]; note this work was completed before the 2012 data were available).

Commercial fishery catch rate information is also reported in the NER Vessel Trip Report (VTR) data since 1994 (Table A10). As in the OB data, discard rates of summer flounder reported in the VTR data for the scallop dredge fishery are generally much higher than in the trawl fishery. A comparison of live discard to total catch percentage for the OB and VTR data sets for trawl and scallop dredge gear indicates similar discard rates from the two data sources through the 1990s. Since about 2004, overall OB and VTR discard to total catch ratios have diverged, with the OB data generally indicating higher discard rates. The VTR data indicate that prior to statistical transformation and stratified expansion, the overall percentage of live discards to total catch has ranged from 7% in 1995 to 41% in 2003, with an un-weighted average rate of 21% over the 1989-2011 time series. The percentage in 2011 was 7% (Table A10, Figure A53 [VTR Raw]).

The live discard estimates using the previous estimation method (Assess; D/DF) are summarized in Figure A54. Commercial fishery live discard in weight was highest in 1990 and 1999 (ranging from 1,315 to 1,935 mt of live discards), and lowest in 2009 (148 mt of live discards). Since 2000 the assessment estimate of total live discard has been less than 1,000 mt and less than 10% of total catch. Scallop dredge fishery discard to landed rates are much higher than trawl fishery rates. Although the scallop dredge landings of summer flounder are less than 5% of the total, the scallop dredge discards of summer flounder have generally been about 50% of the trawl fishery discards. During 1994-2011, scallop discards averaged 166 mt while trawl discards averaged 378 mt (Figure A55).

Table A11 and Figure A56 present a comparison of commercial fishery Dealer reported landings of summer flounder (i.e., the "true landings"; Dealer) with estimates of summer flounder commercial landings (using the previous Assess method, but for 'K*DF' [{K/DF}*DF]) from landings rates of NEFSC OB sampling and commercial fishing effort (days fished) reported on NER VTRs, as a means of verification of the potential accuracy of the discard estimates. Estimates of landings from combined OB / VTR data has ranged from +53% (1999) to -81% (2011) of the Dealer reported landings in the fisheries, with discards ranging from 38% (1990) to 2% (2011) of the Dealer reported landings. Since 2004, the estimate of landings from the combined OB / VTR data has averaged only about 37% of the Dealer reported landings.

For the trawl fishery, the observed discard per day fished ratio (D/DF) averaged 23 kg/DF during 1989-2003, and 19 kg/DF during 2004-2011 (a rate decrease of 17%), while the observed kept per day fished ratio (K/DF) averaged 151 kg/DF during 1989-2003, and 101 kg/DF during 2004-2011 (a rate decrease of 33%; Figure A57). The resulting observed discard to total catch percentage, however, increased slightly from about 13% during 1989-2003 to 16% during 2004-2011. While this measure of discarding increased, the expansion factor of total trawl fishery days fished (DF) with any summer flounder landings from the VTRs averaged 13,417 during 1989-2003 and 7,612 during 2004-2011, a decrease of 43%. As a result, after statistical transformation and stratified expansion, the absolute estimate of trawl fishery live discard averaged 724 mt during 1989-2003 but only 221 mt during 2004-2011, a decrease of 69% (Figure A58). For the trawl fishery estimates, the days fished expansion factor is the most influential factor on the decrease of recent absolute estimates of live discard.

For the scallop dredge fishery, the observed discard per day fished ratio (D/DF) averaged 39 kg/DF during 1989-2003, and 53 kg/DF during 2004-2011 (a rate increase of

36%), while the observed kept per day fished ratio (K/DF) averaged 7 kg/DF during 1989-2003, and 1 kg/DF during 2004-2011 (a rate decrease of 86%; Figure A59). The resulting observed discard to total catch percentage was therefore about 85% during 1989-2003, increasing to 98% during 2004-2011. While this measure of discarding increased, the expansion factor of total scallop dredge fishery days fished with any summer flounder landings from the VTRs averaged 4,147 during 1989-2003 and 1,468 during 2004-2011, a decrease of 65% (Figure A60). As a result, after statistical transformation and stratified expansion, the absolute estimate of scallop dredge fishery live discard averaged 250 mt during 1989-2003 but only 71 mt during 2004-2011, a decrease of 72%. For the scallop dredge fishery estimates, the days fished expansion factor is also the most influential factor on the decrease of recent absolute estimates of live discard.

The divergence of OB and VTR live discard to total catch percentages compared to the estimated live discard to total catch percentages, and the persistent underestimation of the OB / VTR estimated landings compared to the Dealer reported landings, has raised concern that the live discard might be consistently underestimated since 2004. The underestimation appears to be mainly driven by the days fished effort metric, but it is unclear if the effort metric is simply biased low or if the relationship between effort and catch has somehow changed over time. This concern has prompted a re-examination of the previous discard estimates and consideration of alternative estimation methods. Note that 2012 fishery catch data were not available at the time of this re-examination, and so it is based on data for 1989-2011.

The Standardized Bycatch Reporting Method (SBRM)

The Standardized Bycatch Reporting Methodology (SBRM) Omnibus Amendment to the fishery management plans of the Northeast region was implemented in February 2008 to address the requirements of the Magnuson-Stevens Fishery Conservation and Management Act to include standardized bycatch reporting methodology in all FMPs of the New England Fishery Management Council and Mid-Atlantic Fishery Management Council. The Standardized Bycatch Reporting Method (SBRM) for the estimation of discards (Wigley *et al.* 2008, 2011) has now been adopted for most NEFSC stock assessments that have been subject to a benchmark review since 2009. In this work, SBRM estimates of summer flounder landings and discards are compared with Dealer reported landings and the current estimation approach (Assess) estimates of landings and discards, as part of a re-examination of the estimation of summer flounder commercial fishery discards.

In the SBRM, the sampling unit is an individual fishing trip. Trips were partitioned into fleets using six classification variables: calendar quarter, area fished, gear type, mesh size, fishery access area, and fishing trip category. Calendar quarter was based on the landed date of the fishing trip, and was used to capture seasonal variations in both fishing activity and discard rates. Area fished was based on statistical reporting area; trips where area fished was not recorded or was otherwise unknown were excluded. Two regional areas were defined: New England (NE) comprising statistical reporting areas <'600' (which includes Southern New England, Georges Bank, and the Gulf of Maine), and Mid-Atlantic (MA) comprising statistical areas >='600'. Live discards were estimated using a combined D/K ratio estimator (Cochran 1963) where D = discard pounds of a given species, and K = the kept pounds of all species, or a subset of all species, landed in each trip as reported by VTR or Dealer records. Further computational details are provided in Wigley *et al.* (2011).

New SBRM Estimates of Commercial Fishery Discards

For summer flounder, total discards and landings (in weight) by fleet were derived by multiplying the estimated discard or kept rate in that fleet by the corresponding fleet landings from the Dealer reports. Estimates were developed by calendar quarter, gear (fish trawl and scallop dredge), and mesh strata (large => 5.5 in codend, small < 5.5 inch codend). The catch rate denominator and expansion factor landings considered were a) summer flounder (fluke) landings (flk), b) the sum of summer flounder (fluke), scup, and black sea bass landings (fsb), and c) all species landings (all).

The SBRM alternatives are compared with the current assessment estimates of landings (K*DF Assess) in Table A12 and Figure A61 Note that the "flk" alternative is not compared, since the OB kept/"flk" landings rate is always 1, providing a trivial result when raised by the Dealer reported summer flounder landings. As noted above, over the time series the K*DF cumulative estimate of landings averages about 80% of the Dealer reported landings, but has averaged only about 40% or less during 2004-2011. The weighted (by annual landings) CV of the K*DF estimated landings averaged 17% during 1989-2011, and 4% during 2004-2011.

The SBRM K*Kall approach consistently overestimates the 1992-1996 Dealer reported landings by 1.5 to 6 times (several hundred percent). The relatively large variability and occasional large estimated landings are due to comparable variability in the Kall landings expansion factor. Over the time series, the K*Kall cumulative estimate of landings averages about 1.6 times the Dealer reported landings, but has averaged only 7% above during 2004-2011. The weighted (by annual landings) CV of the K*Kall estimated landings averaged 15% during 1989-2011, and 11% during 2004-2011.

The SBRM K*Kfsb approach provided the most consistent match with the Dealer reported landings. Over the time series, the K*Kfsb cumulative estimate of landings averages about 93% of the Dealer reported landings, and has averaged 97% during 2004-2011. The weighted (by annual landings) CV of the K*Kfsb estimated landings averaged 4% during 1989-2011, and 5% during 2004-2011. The landings "verification" exercise suggests that the K*Kfsb estimator would provide the most accurate and precise discard estimate, since it best matched the Dealer reported landings and provided the most precise landings estimates. However, consideration of the estimated discards for the alternatives provides a different conclusion.

The three SBRM alternatives are compared with the current assessment estimates of discards (D*DF [Assess]) in Table A13 and Figure A62. Over the time series, the D*DF (Assess) cumulative estimate of discards has averaged 671 mt with CV of 18%; since 2004 the average is 284 mt with CV of 5%. As noted above, the landings verification exercise suggests that D*DF discard estimates since 2004 may be biased low by about 60%.

The SBRM D*Kflk estimates of discards has averaged 4,148 mt (about 6 times the current assessment estimate) with CV of 68%. Since 2004 the average is 5,484 mt (about 19 times the current assessment estimate) with CV of 35%. As noted above, the landings verification exercise for the K*Kflk estimator provides trivial results since the K*Kflk ratio is always 1.

The SBRM D*Kall estimates of discards has averaged 1,481 mt (about 2 times the current assessment estimate) with CV of 15%. Since 2004 the average is 1,852 mt (about 7 times the current assessment estimate) with CV of 9%. As noted above, the landings verification exercise suggests that D*Kall estimates since 2004 may be biased high by about 10%.

The SBRM D*Kfsb estimates of discards has averaged 8,824 mt (about 13 times the current assessment estimate) with CV of 45%. Since 2004 the average is 6,748 mt (about 24 times the current assessment estimate) with CV of 31%. As noted above, the landings verification exercise suggests that D*Kfsb estimates since 2004 may be biased low by about 6%.

Both the SBRM D*Kflk and D*Kfsb estimator time series contain instances when very large annual discard amounts are estimated, sometimes accompanied by high annual CV, but sometimes not. For the D*Kflk series, the notably large estimates occur for 1993, 2000, 2007, and 2010; for the D*Kfsb series they occur for 1993, 1996, 1997, 2000, 2007, and 2010. The time series for both estimators are characterized by highly variable annual CVs, and high overall CV. In contrast, the D*Kall time series is much less variable, with no obviously infeasible estimates.

In the D*Kflk and D*Kfsb series, for example, the 2010 total discard estimates (11,892 mt for the D*Kflk estimator; 13,297 mt for the D*Kfsb estimator) are driven by the discard ratio in the quarter 3, scallop dredge, Mid-Atlantic stratum. The scallop dredge discard ratio for both estimators is 1166:1, from data sampled on 68 observed trips. Minor expansion factor and computational differences in the estimation procedure result in quarter 3, scallop dredge, Mid-Atlantic stratum discard estimates of 7,950 mt for the D* Kflk estimator (67% of the total annual discard estimate) and 8,143 mt for the D*Kfsb estimator (61% of the total annual discard estimate). Similar, common, single stratum influences on the total annual discard estimator occur for these estimators the years 1993, 2000, and 2007.

The year 1996 provides different circumstances, however, that further illustrate the uncertainties associated with fishery discard estimation. The D*Kflk estimator provides a total discard estimate of 1,142 mt (CV = 29%) and the D*Kfsb estimator an estimate of 80,171 mt (CV = 1%). The D*Kflk 1996 discard ratio is 0.19:1 (the ratio of discards of summer flounder to kept of summer flounder), based on 8,111 kg of summer flounder discards and 41,904 kg of summer flounder landings observed on 222 trips, expanded by 3,711 mt of summer flounder landings (note the impact of stratification and computational correction factors provides a different estimate than the simple aggregate product of 0.19*3,711 = 705 mt – this applies to all aggregate estimates). The D*Kfsb 1996 discard ratio is 0.16:1 (the ratio of discards of summer flounder to kept of summer flounder plus scup plus black sea bass [fsb]), based on the same 8,111 kg of summer flounder discards and 51,031 kg of fsb landings observed on the same 222 trips, expanded by 6,518 mt of fsb landings.

The large difference in the two annual estimates of discards is due to the influence of a single fishery stratum, the 1996 quarter 4 large mesh trawl fishery in New England. The discard ratio for the D*Kfsb estimator is 674:1, based on 611 kg of summer flounder discards and <1 kg of fsb landings from 6 observed trips, expanded by 117 mt of fsb landings. These data provide a discard estimate for the stratum of about 79,000 mt, 98% of the annual discard estimate. In contrast, the discard ratio for the D*Kflk estimator was undefined, because no summer flounder were kept on the 6 observed trips; in fact only 26 of the 117 mt of the fsb landed in the 1996 quarter 4 large mesh trawl fishery in New England were summer flounder. Thus, the D*Kflk estimate of summer flounder discard for that stratum was zero.

Over the 1989-2011 time series, the D*Kflk estimator has a 0.38:1 discard ratio (the ratio of discards of summer flounder to kept of summer flounder), with a time series CV of 70%. The D*Kfsb estimator has a 0.35:1 discard ratio (the ratio of discards of summer flounder to kept of summer flounder plus scup plus black sea bass), with a time series CV of 45%. In contrast, the D*Kall estimator has a 0.007:1 discard ratio (the ratio of discards of summer flounder to kept of all species), with a time series CV of 18%.

Conclusion for Discard Estimation

The consideration of three SBRM discard estimators of summer flounder landings and discards and comparison with the current effort (days fished) based methods and estimates indicates that the estimator based on the ratio of summer flounder discard to all species kept (D*Kall) provides the best overall combination of a feasible estimate of the summer flounder landings based on the landings verification exercise (Table A13, Figure A61) and a feasible and sufficiently precise time series of discard estimates (Table A14, Figures A62-A63). The SBRM D*Kall estimates of discards in live weight average 1,481 mt (1,185 mt dead) during 1989-2011, about 2.2 times the Assess D*DF live average of 671 mt (537 mt dead; Table A13). A comparison of the Dealer reported landings and the SBRM D*Kall estimated discards shows the live discards average of 1,481 mt compared to the landings average of 5,342 mt results in a time series average of live discards to total catch percentage of about 22% (Table A14 and Figure A64). The D*Kall estimate is more in line with the aggregate OB sample data (31%) and the aggregate VTR data (20%) time series averages, compared to the current (Assess) live discards to total catch time series average percentage of 10%. The SDWG recommended that the SBRM D*Kall summer flounder discard estimate time series be used in the 2013 SAW 57 benchmark summer flounder assessment.

*SBRM D*Kall Discard Estimates at age*

Observer length frequency samples were converted to sample numbers at age and sample weight at age frequencies by application of NEFSC survey length-weight relationships and Observer, commercial fishery, and survey age-length keys. Sample weight proportions at age were next applied to the raised fishery discard estimates to derive fishery total discard weight at age. Fishery discard weights at age were then divided by fishery observer mean weights at age to derive fishery discard numbers at age. Classification to age for 1989-1993 was done by semiannual periods using Observer age-length keys, except for 1989, when first period lengths were aged using combined commercial landings (quarters 1 and 2) and NEFSC spring survey age-length keys. Since 1994, only NEFSC survey age-length keys were used, since Observer age-length keys were not yet available and commercial landings age-length keys contained an insufficient number of small summer flounder (<40 cm = 16 inches) that comprise most of the discards. For comparability with the manner in which length frequency sampling in the recreational fishery has been evaluated, sampling intensity is expressed in terms of metric tons (mt) of SBRM 'D*Kall' live discards per 100 fish lengths measured. The sampling has been stratified by gear type (fish trawl and scallop dredge) since 1994. Overall sampling intensity has improved since 1999, from 152 mt per 100 lengths to less than 20 mt per 100 lengths since 2004 (Table A15).

The final comparison between discard estimation methods was made for the SBRM D*Kall estimates apportioned to length and age (dead discards including the 80% discard mortality rate) with those using the Assess D*DF estimates of discards. The SBRM D*Kall estimates in numbers average 2.324 million fish per year during 1989-2011, about 1.8 times the Assess estimate of 1.303 million. Since 2004, the SBRM D*Kall estimate averaged about 1.3 million more fish (about 6 times) than the Assess estimate. The largest difference in absolute numbers was for 1992, with the SBRM D*Kall estimate about 6.1 million fish larger than the Assess estimate; the smallest difference in absolute numbers was for 1989, with the SBRM D*Kall estimate about 17,000 fish larger than the Assess D*DF estimate (Table A16).

The largest difference in proportions at age was in 1995 at ages 0 and 1, due to differences in the distribution of discards during the year (Figure A65). In Assess D*DF estimates, 63% of the discards were estimated in the first half of the year and 37% in the second half, with about 38% of the annual total in the trawl fishery, which tends to discard smaller/younger fish compared to the scallop dredge fishery. In the SBRM D*Kall estimates, although 82% of discards were estimated in first half of the year and 18% in the second half, about 60% of the annual total was in the trawl fishery. When these respective discard estimates in weight were apportioned to length and age in numbers, the result was SBRM D*Kall discards apportioned as 62% age 0, 19% age 1, 18% age 2, and 1% age 3 and older, compared to Assess D*DF discards apportioned as 18% age 0, 53% age 1, 27% age 2, and 2% age 3 and older. Since 2004, the largest difference in proportion at age was in 2007 at age 2, with the SBRM D*Kall estimate 14% smaller than the Assess D*DF estimate. Estimates of SBRM D*Kall discarded numbers at age and mean weight at age are summarized in Tables A17-A18.

The reasons for discarding in the fish trawl and scallop dredge fisheries have been changing over time. During 1989 to 1995, the minimum size regulation was recorded as the reason for discarding summer flounder in over 90% of the observed trawl and scallop dredge tows. In 1999, the minimum size regulation was provided as the reason for discarding in 61% of the observed trawl tows, with quota or trip limits given as the discard reason in 26% of the observed tows, and high-grading in 11% of the observed tows. In the scallop fishery in 1999, quota or trip limits was given as the discard reason in over 90% of the observed tows. During 2000-2005, minimum size regulations were identified as the discard reason in 40-45% of the observed trawl tows, quota or trip limits in 25-30% of the tows, and high grading in 3-8%. In the scallop fishery during 2000-2005, quota or trip limits was given as the discard reason for over 99% of the observed tows. During 2006-2012, minimum size regulations were identified as the discard reason in 15-20% of the observed trawl tows, quota or trip limits in 60-70% of the tows, and high grading in 5-10%. In the scallop fishery during 2006-2012, quota or trip limits was given as the discard reason for about 40% of the observed tows, with about 50% reported as “unknown.” As a result of the increasing impact of trip limits, fishery closures, and high grading as reasons for discarding, the age structure of the summer flounder discards has also changed, with a higher proportion of older fish being discarded.

RECREATIONAL FISHERY LANDINGS

Summary landings statistics for the summer flounder recreational fishery (catch type A+B1) as estimated by the NMFS Marine Recreational Fishery Statistics Survey (MRFSS 1982-2003) and Marine Recreational Information Program (MRIP 2004-2012) are presented in Tables A19-A20. Recreational fishery landings increased 20% by number and 8% by weight from 2011 to 2012 to 2,853 mt (6.290 million lbs) and were about 26% under the 2012 recreational harvest limit. The un-weighted average annual CV of the recreational landings is 6% in numbers and 7% in weight is 7% during 1982-2012.

The commercial fishery VTR system provides an alternative set of reported recreational landings by the party/charter boat sector. A comparison of VTR reports and MRFSS estimates indicates that MRFSS estimates are higher by a factor of 2-3 for the 1995-2012 period, with a generally increasing trend through 2009, but decreasing since then, and ranging from a factor of 0.95 in 2012 to 5.45 in 2007 (Table A21). It is unclear if this is due mainly to under-reporting of party/charter boat recreational landings in the VTR system, or a systematic positive bias of MRFSS/MRIP landings estimates for the party/charter boat sector.

Length frequency sampling intensity for the recreational fishery was calculated by MRFSS sub-regions (North - Maine to Connecticut; Mid - New York to Virginia; South - North Carolina) based on a metric tons of landings per hundred lengths measured basis (Burns *et al.* 1983; Table A22). To convert the recreational fishery length frequencies to age, MRFSS sample length frequency data, NEFSC commercial and survey age-length data were examined in terms of number of fish measured/aged on various temporal and geographical bases. Correspondences were made between MRFSS intercept date (quarter), commercial quarter, and survey season (spring and summer/fall), and between MRFSS sub-region, commercial statistical areas, and survey depth strata to integrate data from the different sources. Based on the number, size range, and distribution of lengths and ages, a semi-annual, sub-regional basis of aggregation was adopted for matching of commercial and survey age-length keys with recreational length frequency distributions to convert lengths to ages. Limited MRFSS length sampling for larger fish resulted in a high degree of variability in mean length for older fish, especially at ages 5 and older during the first decade of the time series. Attempts to estimate length-weight relationships from the MRFSS biological sampling data provided unsatisfactory results. As a result, the commercial fishery quarterly length (mm) to weight (g) relationships from Lux and Porter (1966) were used to calculate annual mean weights at age from the estimated age-length frequency distribution of the landings.

The recreational landings historically were dominated by relatively young fish. During 1982-1996, age 1 fish accounted for over 50% of the landings by number and fish of ages 0 to 3 accounted for over 95% of landings by number. No fish from the recreational landings were determined to be older than age 7. With increases in the minimum landed size since 1996 (to 14.5 in [37 cm] in 1997, 15 in [38 cm] in 1998-1999, generally 15.5 in [39 cm] in 2000, and various state minimum sizes from 14.0 [36 cm] to 21 in [53 cm] in 2001-2012) and a trend to lower fishing mortality rates, the age composition of the recreational landings now includes mainly fish at ages 3 and older, at mean weights of greater than 1 kg per fish (Tables A23-A24).

RECREATIONAL FISHERY DISCARDS

MRFSS/MRIP estimates of the percentage of live discard (catch type B2) to total catch (catch types A+B1+B2) in the recreational fishery for summer flounder has varied from about 18% (1985) to about 94% (2010) of the total catch (Table A25). To account for all removals from the summer flounder stock by the recreational fishery, some assumptions about the biological characteristics and discard mortality rate of the recreational live discard need to be made, because biological samples are not routinely taken of MRFSS/MRIP catch type B2 fish. In previous assessments, data available from NYDEC surveys (1988-1992) of New York party boats suggested that nearly all (>95%) of the fish released alive from boats were below the minimum regulated size (during 1988-1992, 14 in [36 cm] in New York state waters), that nearly all of these fish were age 0 and age 1 summer flounder, and that these age 0 and 1 summer flounder occurred in about the same proportions in the live discard as in the landings. It was therefore assumed that all B2 catch would be of lengths below regulated size limits, and be either age 0 or age 1 in all three sub-regions during 1982-1996. Catch type B2 was allocated on a semi-annual, sub-regional basis in the same ratio as the annual age 0 to age 1 proportion observed in the landings during 1982-1996. Mean weights at age were assumed to be the same as in the landings during 1982-1996.

The minimum landed size in federal and most state waters increased to 14.5 in (37 cm) in 1997, to 15.0 in (38 cm) in 1998-1999, and to 15.5 in (39 cm) in 2000. Applying the same logic used to allocate the 1982-1996 recreational released catch to size and age categories during 1997-2000 implied that the recreational fishery released catch included fish of ages 2 and 3. Investigation of data from the CTDEP Volunteer Angler Survey (VAS) for 1997-1999 and from the American Littoral Society (ALS) for 1999, and comparing the length frequency of released fish in these programs with the MRFSS data on the length frequency of landed fish below the minimum size, indicated this assumption was valid for 1997-1999 (MAFMC 2001a). The CTDEP VAS and ALS data, along with data from the NYDEC Party Boat Survey (PBS), was used to validate this assumption for 2000. For 1997-2000 all B2 catch was assumed to be of lengths below regulated size limits, and therefore comprised of ages 0 to 3. Catch type B2 was allocated on a sub-regional basis in the same ratio as the annual age 0 to age 3 proportions observed in the landings at lengths less than 37 cm in 1997, 38 cm in 1998-1999, and 39 cm in 2000.

In 2001, many states adopted different combinations of minimum size and possession limits to meet management requirements. Examination of data provided by MD sport fishing clubs, the CTDEP VAS, the Virginia Marine Resources Commission

(VAMRC) VAS, the ALS, and the NYDEC PBS indicated that the assumption that fish released are those smaller than the minimum size remained valid since 2001, and so catch type B2 was characterized by the same proportion at length as the landed catch less than the minimum size in the respective states. The differential minimum size by state has continued since 2001, and increased samples of the recreational fishery discards by state agency Volunteer Angler Surveys, the MRFSS/MRIP For Hire Survey (FHS), and the American Littoral Society has allowed direct characterization the length frequencies of the discards from sample data and presumably a more accurate estimate of the discard in weight (Table A26).

Studies conducted to estimate recreational fishery discard mortality for striped bass and black sea bass suggest a rate of 8% for striped bass (Diodati and Richards 1996) and 5% for black sea bass (Bugley and Shepherd, 1991). Work by the states of Washington and Oregon with Pacific halibut (a potentially much larger flatfish species, but otherwise morphologically similar to summer flounder) found "average hooking mortality...between eight and 24 percent" (IPHC, 1988). An unpublished tagging study by the NYDEC (Weber MS 1984) on the survival of released sublegal summer flounder caught by hook-and-line suggested a total, non-fishing mortality rate of 53%, which included discard plus tagging mortality as well as deaths by natural mortality. Assuming deaths by natural mortality to be about 18%, (an instantaneous natural mortality rate of 0.20), an annual discard plus tagging mortality rate of about 35% can be derived from the NYDEC results.

In the 1997 SAW25 (NEFSC 1997) and earlier assessments of summer flounder, a 25% discard mortality rate was assumed for summer flounder released alive by anglers. However, two subsequent investigations of summer flounder recreational fishery discard, or hooking, mortality suggested that a lower rate was more appropriate. Lucy and Holton (1998) used field trials and tank experiments to investigate the discard mortality rate for summer flounder in Virginia, and found rates ranging from 6% (field trials) to 11% (tank experiments). Malchoff and Lucy (1998) used field cages to hold fish angled in New York and Virginia during 1997 and 1998, and found a mean short term mortality rate of 14% across all trials. Given the results of these studies conducted specifically for summer flounder, a 10% discard mortality rate was adopted in the Terceiro (1999) stock assessment and has been retained in all subsequent assessments. Ten percent of the total B2 catch at age is therefore the basis of estimates of summer flounder recreational fishery discard mortality at age presented in Table A27. The un-weighted average annual CV of the recreational discards is 8% during 1982-2012. The mean weights at age of the recreational fishery discards are presented in Table A28.

MRIP ESTIMATES OF RECREATIONAL FISHERY CATCH

The NMFS Marine Recreational Fishery Statistics Survey (MRFSS) was replaced by the Marine Recreational Information Program (MRIP) in 2012 to provide improved recreational fishing statistics. The MRIP implemented a new statistical method for calculating recreational catch estimates, with many survey elements related to both data collection and analysis updated and refined to address issues such as data gaps, bias, consistency, accuracy, and timeliness. As part of the implementation of the MRIP, recreational fishery catch estimates for 2004-2011 have been directly replaced by those using the MRIP estimation methods. For earlier years, a constant "ratio of means" of the MRFSS and MRIP estimates has been used to adjust the recreational catch estimates. For 2012, only MRIP estimates area available. Note that MRFSS estimates, and therefore a comparison, are unavailable for 2012.

For the recreational fishery harvest number (catch types A + B1), the largest change was for the state of NJ, with a cumulative 2004-2011 decrease of about 995,000 fish, or about -11%. The largest absolute increase was for the state of NY with a cumulative 2004-2011 increase of about 444,000 fish, or about +9%. The state of NH had the largest cumulative percentage decrease at -50%; however, NH's cumulative harvest (now about 1,300 fish) is less than 0.1% of the coastal total. The commonwealth of MA had the largest cumulative percentage increase at +20%, a cumulative increase of about 210,000 fish. Over all states, the cumulative harvest in numbers decreased by about 702,000 fish (about -3%), ranging from a decrease of 285,000 fish in 2007 (-8%) to an increase of 49,000 fish in 2011 (+3%; Tables A29-A30). Therefore, for the years 1981-2003 recreational harvest in numbers was decreased by 3% for this assessment update.

For the recreational fishery harvest weight (catch types A + B1), the largest change was for the state of NJ, with a cumulative 2004-2011 decrease of about 1,229 mt, or about -11%. The largest absolute increase was for the state of NY with a cumulative 2004-2011 increase of about 967 mt, or about +12%. The state of NH had the largest cumulative percentage decrease at -50%; however, NH's cumulative harvest (now about 1 mt) is less than 0.1% of the coastal total. The commonwealth of MA had the largest cumulative percentage increase at +8%, a cumulative increase of about 115 mt. Over all states, the cumulative harvest in weight decreased by about 384 mt (about -1%), ranging from a decrease of 434 mt in 2007 (-8%) to an increase of 130 mt fish in 2005 (+3%; Tables A31-A32). Therefore, for the years 1981-2003 recreational harvest in weight was decreased by 1%.

For the recreational fishery live releases in numbers (catch type B2), the largest change was for the state of NJ, with a cumulative 2004-2011 decrease of about 4 million fish, or about -6%. The largest absolute increase was for the state of NY with a cumulative 2004-2011 increase of about 513,000 fish, or about +1%. The state of MD had the largest cumulative percentage decrease at -28%, a cumulative increase of about 2.3 million fish. The state of ME had the largest cumulative percentage increase at +59%, a cumulative increase of about 24 fish; the next largest increases were for MA (+17%, 331,000 fish) and NH (+17%, 522 fish). Over all states, the cumulative live release in numbers decreased by about 6.5 million fish (about -4%), ranging from a decrease of 2.2 million fish in 2007 (-11%) to an increase of 411,000 fish in 2011 (+2%; Tables A33-A34). Therefore, for the years 1981-2003 recreational live release and discard mortality estimates were decreased by 4%.

TOTAL CATCH COMPOSITION

NER commercial fishery landings and discards at age, North Carolina winter trawl fishery landings and discards at age, and MRFSS/MRIP recreational fishery landings and discards at age totals were summed to provide a total fishery catch at age matrix for 1982-2012 (Table A35; Figure A66). The percentage of age 3 and older fish in the total catch in numbers has increased during the last decade from only 4% in 1993 to

72% in 2008, 68% in 2009, 69% in 2010, and 80% in 2011. Overall mean weight at age in the total catch was calculated as the weighted mean (by number in the catch at age) of the respective mean value at age from each fishery component (Table A36; Figure A67).

Commercial landings have accounted for 56% of the total catch since 1982, with recreational landings accounting for 35%, commercial discards about 7%, and recreational discards about 5%. Since 2008 the comparable percentages are 58%, 29%, 12%, and 11%. Commercial discard losses in the fish trawl and scallop dredge fisheries have accounted for about 20% of the total commercial catch since 2008, assuming a discard mortality rate of 80%. Recreational discard losses have accounted for 20%-30% of the total recreational catch since 2008, assuming a discard mortality rate of 10% (Figure A68). Table A37 provides a tabulation of total catch in weight using the MRFSS and MRIP estimates of the recreational fishery catch with the changes noted above.

SPATIAL AND TEMPORAL DISTRIBUTION OF LANDINGS AND DISCARDS

Catch data from both recreational and commercial fisheries vessel trip reports (VTRs) as well as Observer reports were summarized to determine spatial trends within the fishery in recent decades. Resulting trends were used to assess the future need for research to understand any major changes in the spatial distribution of the stock. Both commercial (limited to fish trawlers and scallop dredges) and recreational gear catches were summarized in ~5 year intervals from the VTRs for 1994-2012. These data include both landed and discarded catch weights for commercial trips and catch numbers for recreational trips. Additional detail on commercial catch recorded by fisheries observers was also summarized for comparison. Although misreporting of the catch in VTR reports is considered low, the 'rough' accuracy of reported catch location is evident when comparing the spatial range being reported in observer records. Significant uncertainty in the validity of some VTRs exists, particularly for catches reported in areas well off the shelf and in inshore areas of SNE. Determining precise terms for removing VTR data due to misreporting of catch location is difficult, therefore all data is presented with reference to the aforementioned caveat regarding the validity of reported catch location.

Commercial Data

The available VTR time series begins in 1994, just when summer flounder populations began rebuilding. Heaviest commercial catches (and by inference, effort) are reported just off of Cape Hatteras, concentrated around the entrances to Hudson Bay and Narragansett Bay, and offshore along the shelf edge from the Chesapeake Bay entrance through SNE (Figure A69; yellow to brown squares). Combined fall and spring NEFSC bottom trawl surveys for this time period (also plotted, in blue circles) do not reflect these larger offshore catches, however fishing occurs year-round. These areas of higher abundance along the shelf are reflected in the winter survey catches during this time period which was occurring during the same time of year when the fishing season commenced with heavy offshore trawling. Overfishing had also been occurring for previous decades, and Figure A69 reiterates the disparity between abundance levels seen on the survey and the amount of fish being landed by fishermen at that time. Large catches of summer flounder continued along the shelf from 2001-2005 with concentrations slightly farther north off DelMarVa (Figure A70). This northerly trend of offshore commercial catches continued through the present decade with the largest shelf catches now in SNE just south of Rhode Island. While a few inshore hot spots still remain (mainly at the entrance to Delaware and Chesapeake Bays and down the coast to Cape Hatteras), VTR reported commercial catches of summer flounder at its southern extent are reduced after 2005 (Figures A71-A72).

Observer trip reports confirm similar spatial trends within the commercial fishery, though offshore outliers are mostly removed due to more accurate locations reported by observers. Recorded catch weights are reduced due to limited observer coverage, particularly in earlier years when the focus of the Observer program was directed mainly towards documentation of protected species (Figures A73-A74). Catch densities from Observer trips begin resembling a sub-sample of the commercial VTR catch data after 2000 (Figures A75-A77). Although displayed on different scales, the Observer data show a much larger presence of large summer flounder catches on Georges Bank after 2005.

Recreational Data

Recreational fishing catch (and by inference, effort) distribution from party and charter boats is relatively unchanged throughout the duration of the VTR database (Figures A78-A81). One exception is a reduced catch south of the Chesapeake Bay that becomes almost entirely absent after 2005. The highest density of recreational catch occurs in inshore waters from Delaware Bay along the coast to Narragansett Bay. Dominated by summer tourism, the high density of recreational catch follows the migratory pattern of larger fluke returning to inshore waters. Analogous with the survey trends, the majority of large adult summer flounder are seen in highest densities along the New Jersey coastline, across the south coast of Long Island, Rhode Island and extending to the south coast of Massachusetts. While catches of summer flounder do exist south of Delaware Bay, they are not appearing in higher densities and, based on survey lengths, the larger, more desirable fish for charter fishing are congregating in inshore waters farther north.

It is also important to note that this recreational catch data is from only party and charter boat trip reports and does not include recreational fishing on the private, individual angler level. While there may be a strong recreational component to summer flounder south of New Jersey, it may not be well represented at the individual level in these data. Management actions may also be an influential factor. The recreational fishery for summer flounder has been managed under a Recreational Harvest Limit (RHL) since 1993 and has been undergoing changes in an effort to provide equitable regulations among states. These efforts have been particularly focused on the liberalization of quotas and other regulations in states outside of New Jersey and New York, which dominate the recreational fishery.

The SARC 57 Review Panel concluded that Term of Reference 1 was met.

TOR 2. Present the survey data available for use in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), and explore standardization of fishery-independent indices (completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC.) Investigate the utility of commercial or recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data. Describe the spatial distribution of the stock over time.

RESEARCH SURVEY INDICES OF ABUNDANCE

NEFSC

The NEFSC stratified random bottom trawl surveys were first implemented in the fall of 1963 to sample the Gulf of Maine (GOM) waters off Maine and Nova Scotia southward to Hudson Canyon off New Jersey (NEFSC offshore strata 1-40 [depths equal to or greater than 27 meters = 15 fathoms]). Since 1968, the spring and fall trawl surveys have sampled the waters that encompass the summer flounder stock from the southern Gulf of Maine (GOM) off Massachusetts to Cape Hatteras, North Carolina, with the addition of offshore strata 61-76 (Clark 1979). Consistently sampled inshore strata 1-90 (depths generally ≤27 meters [15 fathoms], except in the GOM) were added to the trawl survey sampling in the fall of 1975. Both the spring and fall surveys were conducted using a Yankee 36 haddock net with roller sweep aboard the FSVs Albatross IV and Delaware II from 1963-2008, and then using a 4-seam, 3-bridle net using a rock-hopper sweep aboard the FSV Henry B. Bigelow since 2009. The NEFSC winter (flatfish) survey began in 1992 and ended in 2007, generally sampling offshore strata 1-18 using a flatfish net with a cookie sweep. For this assessment, the SDWG undertook a re-consideration of the strata included in indices for all three seasonal surveys. After examination of alternative strata set times series trends and precision, the SDWG decided to retain the winter, spring, and fall survey strata sets used in the assessments since 2002 (Miller and Terceiro 2013 MS; WPA8).

NEFSC spring and fall survey indices suggest that total stock biomass peaked during 1976-1977 and again during 2003-2007 (Tables A38-A39, Figure A82). The Fisheries Survey Vessel (FSV) *Albatross IV* (ALB) was replaced in spring 2009 by the FSV *Henry B. Bigelow* (HBB) as the main platform for NEFSC research surveys, including the spring and fall bottom trawl surveys. The size, towing power, and fishing gear characteristics of the HBB are significantly different from the ALB, resulting in different fishing power and therefore different survey catchability. Calibration experiments to estimate these differences were conducted during 2008 (Brown 2009), and the results of those experiments were peer reviewed by a Panel of three non-NMFS scientists during the summer of 2009 (Anonymous 2009, Miller *et al.* 2010). The Terms of Reference for the Panel were to review and evaluate the suite of statistical methods used to derive calibration factors by species before they were applied in a stock assessment context. Following the advice of the August 2009 Peer Review (Anonymous 2009), the methods proposed in Miller *et al.* (2010), and the precedents set in peer-reviews of stock assessments for haddock (Van Eeckhaute and Brooks 2010), yellowtail flounder (Legault *et al.* 2010), silver and red hake (NEFSC 2011a), and winter flounder

(NEFSC 2011b), length-based calibration factors have been used to convert 2009-2011 spring and fall HBB survey catch number and weight indices to ALB equivalents for use in the 2011-2012 updates and in the 2013 SAW 57 assessment.

The aggregate, spring calibration factors from Miller *et al.* (2010) are 3.2255 for numbers (the HBB caught ~3 times more summer flounder numbers in aggregate than the ALB in the calibration experiment), and 3.0657 for weight. The aggregate, fall calibration factors from Miller *et al.* (2010) are 2.4054 for numbers and 2.1409 for weight. The effective total catch number length-based calibration factors vary by year and season, depending on the characteristics of the HBB length frequency distributions. The effective length-based calibration factors have ranged from 1.825 to 1.994 in the spring (average = 1.887) and from 1.814 to 1.964 in the fall (average = 1.876; Tables A40-A42).

Age composition data from the NEFSC spring surveys indicate a substantial reduction in the number of ages in the stock between 1976-1990 (Table A43, Figure A83). For the period 1976-1981, fish of ages 5-8 were captured regularly in the survey, with the oldest individuals aged at 10-12 years. From 1982-1986, fish aged 5 years and older were only occasionally observed in the survey, and by 1986, the oldest fish observed in the survey were age 5. In 1990 and 1991, only three age groups were observed in the survey catch, and there was an indication that the 1988 year class was very weak. Since 1996, the NEFSC spring survey age composition has expanded significantly, with generally increasing abundance of age-3 and older fish up to age 12 for males and age 14 for females. Mean lengths at age from the NEFSC spring survey are presented in Table A44.

Summer flounder are frequently caught in the NEFSC fall survey at stations in inshore strata (< 27 meters = 15 fathoms = 90 feet) and at offshore stations in the 27-55 meter depth zone (15-30 fathoms, 90-180 feet) at about the same bathymetry as in the spring survey. NEFSC fall aggregate and at-age indices are presented in Tables A38-A40 and A42. The NEFSC fall survey catches age-0 summer flounder in abundance, providing an index of summer flounder recruitment (Table A45, Figure A84). NEFSC fall survey indices suggest improved recruitment since the late 1980s, and an increase in abundance of age-2 and older fish since 1996. Mean lengths at age from the NEFSC fall survey are presented in Table A46.

A series of NEFSC winter trawl surveys was initiated in February 1992 to provide improved abundance indices for flatfish, including summer flounder. The surveys targeted flatfish concentrated offshore during the winter. A modified trawl was used that differed from the standard trawl employed during the NEFSC spring and fall surveys in that long trawl sweeps (wires) were added before the trawl doors to better herd fish to the mouth of the net, and the large rollers used on the standard gear were replaced on the footrope with a chain "tickler" and small spacing "cookies." The design and conduct of the winter survey (timing, strata sampled, and the use of the modified trawl gear) resulted in greater catchability of summer flounder compared to the other surveys. Most fish were captured in survey strata 61-76 (27-110 meters; 15-60 fathoms) off the Delmarva and North Carolina coasts. Other concentrations of fish were found in strata 1-12, south of the New York and Rhode Island coasts, in slightly deeper waters. Significant numbers of large summer flounder were often taken along the southern flank of Georges Bank (strata 13-18).

Indices of summer flounder abundance from the winter survey indicate stable stock size during 1992-1995, with catch per tow values ranging from 10.9 in 1995 to 13.6 in 1993 (Table A47). For 1996, the winter survey index increased by 290% over 1995, from 10.9 to 31.2 fish per tow. The largest increases in 1996 occurred in the Mid-Atlantic Bight region (offshore strata 61-76), where increases up to an order of magnitude occurred in several strata, with the largest increases in strata 61, 62, and 63 off the northern coast of North Carolina. Most of the increased catch in 1996 consisted of age-1 summer flounder from the 1995 year class. In 1997, the index dropped to 10.3 fish per tow, due to the lower numbers of age-1 (1996 year class) fish caught. From 1998-2003, the winter trawl survey indices increased; with the 2003 winter survey number and weight per tow indices being the highest in the time series at 27.58 kg/tow (Figure A82). The winter survey index was lower from 2004-2007, and values ranged from 10.3 to 15.9 fish per tow. Similar to the other NEFSC surveys, there is strong evidence since the mid-1990s of increased abundance of age-3 and older fish relative to earlier years in the time series (Tables A48-A49). The NEFSC winter survey series ended in 2007.

Massachusetts DMF

Spring and fall bottom trawl surveys conducted by the Massachusetts Division of Marine Fisheries (MADMF) show a decline in abundance in numbers of summer flounder from high levels in 1986 to record lows in the early 1990s. Both the MADMF spring and fall indices then increased to record high levels in the mid-2000s, and have been relatively stable since then (Tables A50-A51, Figure A85). The MADMF also captures a small number of age-0 summer flounder in a seine survey of estuaries, and these data constitute an index of recruitment (Table A52, Figure A86).

Rhode Island DFW

Standardized spring and fall bottom trawl surveys have been conducted by the Rhode Island Department of Fish and Wildlife (RIDFW) since 1979 in Narragansett Bay and the state waters of Rhode Island Sound. Indices of abundance at age for summer flounder have been developed from the fall survey data using NEFSC fall survey age-length keys. The fall survey reached a time series high in 2009 and near high in 2011 (Table A53, Figure A87). An abundance index has also been developed from a set of fixed stations sampled monthly since 1990, which also reached a time series high in 2009 (Table A54, Figure A87). Recruitment indices are available from both the fall (Figure A86) and monthly fixed station surveys.

University of Rhode Island Graduate School of Oceanography (URIGSO)

University of Rhode Island Graduate School of Oceanography (URIGSO) has conducted a standardized, year-round, weekly two-station trawl survey at Fox Island in Narragansett Bay and at Whale Rock in Rhode Island Sound since the 1950s, with consistent sampling since 1963. Irregular length-frequency samples for summer flounder indicate that most of the survey catch is of fish from ages 0 to 3. The average aggregate numbers-based index decreased from the 1959 until 1972, increased to a peak in the mid-

1970s, decreased to a second low in 1990, and then increased to a time series peak in 2011 (Table A55, Figure A87). The URIGSO indices, developed since the last benchmark assessment in 2008, have not previously been included in the calibration of the ASAP population model.

Connecticut DEP

Spring and fall bottom trawl surveys are conducted by the Connecticut Department of Environmental Protection (CTDEP). The CTDEP surveys show a decline in abundance in numbers of summer flounder from 1986 to record lows in 1989. The CTDEP surveys indicate recovery since 1989, and evidence of increased abundance at ages 2 and older since 1995. The 2011 spring and 2002 fall indices were the highest in the respective time series. Due to vessel engine failure, no complete fall survey was conducted in 2010 (Tables A56-A57, Figure A88). An index of recruitment is available from the fall series (Figure A84).

New York DEC

The New York Department of Environmental Conservation has conducted a small-mesh otter trawl survey in the Peconic Bay estuary at the eastern end of Long Island, New York since the mid-1980s; valid data for summer flounder are available since 1987. The NYDEC survey mean number per tow indices and length frequency distributions were converted to age using the corresponding annual NEFSC fall survey age-length keys (Table A58, Figure A88). The NYDEC indices, developed since the last benchmark assessment in 2008, have not previously been included in the calibration of the ASAP population model.

New Jersey DFW

The New Jersey Division of Fish and Wildlife (NJDFW) has conducted a standardized bottom trawl survey since 1988, and indices of abundance for summer flounder are compiled from data collected from April through October (Table A59, Figure A89). The NJDFW survey mean number per tow indices and length frequency distributions were converted to age using the corresponding annual NEFSC fall survey age-length keys. The NJDFW index peaked in 2002 and has decreased since then. Over the last decade, most year classes are at or below average; however, the index of the 2005 year class was above average (Figure A90).

Delaware DFW

The Delaware Division of Fish and Wildlife (DEDFW) has conducted a standardized bottom trawl survey with a 16 foot head-rope trawl since 1980 and with a 30 foot head-rope trawl since 1991, although due to a previously undocumented un-calibrated vessel change it was determined in this assessment that only the indices from 2003 and later are directly comparable. Recruitment indices (age 0 fish; one index from the Delaware estuary proper for 1980 and later, one from the inland bays for 1986 and later) have been compiled from the 16 foot trawl survey data (Tables A60-A61, Figure A90). Indices for age-0 to age-4 and older summer flounder have been compiled from the 30 foot head-rope survey (Table A62, Figure A89). The indices use data collected from June through October (mean number per tow) with age 0 summer flounder separated from older fish by visual inspection of the length frequency.

Maryland DNR

The Maryland Department of Natural Resources (MDDNR) has conducted a standardized trawl survey in the seaside bays and estuaries around Ocean City, MD since 1972. Samples collected during May to October with a 16 foot bottom trawl have been used to develop a recruitment index for summer flounder (Table A63, Figure A91). This index suggests that weakest year class in the time series recruited to the stock in 1988 and 2005, and the strongest in 1972, 1983, 1986, 1994, and 2009.

Virginia Institute of Marine Science

The Virginia Institute of Marine Science (VIMS) has conducted a juvenile fish survey using trawl gear in Virginia rivers since 1955. An index of recruitment developed from the VIMS survey suggests weak year classes (<0.2 fish per trawl) recruited to the stock in 1955, 1959, 1961-1962, 1966, 1968, 1970, and 1975, with strong year classes (>2.0 fish per trawl) recruiting in 1956-57, 1963, 1971, 1979-1983, 1990-1991, and 1994. Recruitment indices since 1994 have been below average (Table A64, Figure A91).

The VIMS Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMap) was started in 2002, providing research survey samples from Chesapeake Bay. The ChesMMap samples are dominated by age 0-2 summer flounder. The ChesMMAP indices, developed since the last benchmark assessment in 2008, have not previously been included in the calibration of the ASAP population model (Table A65, Figures A92-A93).

The VIMS Northeast Area Monitoring and Assessment Program (NEAMAP) was started in Fall 2007, providing research survey samples along the Atlantic Coastal waters from Rhode Island to North Carolina, in depths of 20-90 feet (9-43 meters). The NEAMAP indices, developed since the last benchmark assessment in 2008, have not previously been included in the calibration of the ASAP population model (Tables A66-A67, Figures A92-A93).

North Carolina DMF

The North Carolina Division of Marine Fisheries (NCDMF) has conducted a stratified random trawl survey using two 30 foot head-rope nets with 3/4" mesh cod-end in Pamlico Sound since 1987. An index of recruitment developed from these data suggests the weakest year class recruited to the stock in 1988, with the strongest year classes in 1987, 1996, 2001, and 2002 (Table A68, Figure A91). The survey normally takes place in mid-June, but in 1999 was delayed until mid-July. The 1999 index is therefore inconsistent with the other indices in the time series, and so the 1999 value has been excluded.

Standardization of fishery-independent indices (Completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC)

The Rhode Island fixed station monthly trawl survey (RIDFW RIX survey) was examined for the usefulness and applicability for standardization. This is a spatially limited, fixed station trawl survey that takes place in RI state waters that began in 1990. Abundance data in numbers of fish was the data that was analyzed. The first procedure was to test some different models to find the appropriate functional form for the data. The final chosen model was a negative binomial generalized linear model. This model was applied to the data using depth and temperature as the covariates against which to model the data. Once the model was produced, diagnostics were performed to test the appropriateness of the model. The functional form appeared appropriate given the histogram of the catch data, there did not appear to be an issue with multi-collinearity, and the model did not have an issue with heteroskedasticity.

The model output was then taken and an annual index was created. The standardized annual index was compared to the nominal index of catch per tow. The effect of the standardization was to scale the existing trend and catch magnitude downward, but the general trend and interannual variation was very similar to the nominal index. The exercise was a first cut and additional work will be needed to complete the modeling exercise, but this analysis was an examination to satisfy the term of reference and to initiate discussion by the group. Additional work including the examination of station as another important covariate would be needed to fully standardize the dataset.

The discussion of the SDWG about this work had multiple elements to it. The first item for discussion had to do with which surveys a standardization procedure would be appropriate for. The NEFSC trawl surveys have a survey design that was randomized and the survey extends throughout the range of the species. Rather than developing a model to standardize, the survey design serves the purpose of standardizing the dataset. For these reasons, it was felt that standardization was not needed for the NEFSC trawl surveys. The same argument can be made for the VIMS NEAMAP survey, which is a new dataset used in the stock assessment.

There are also multiple state surveys that are used in the model. Many of these models also have a randomized design, some do not. Despite the randomization, one of the main features of the state surveys is that many of them are seasonal in timing and are limited to state waters, so do not extend throughout the species range. The group thought there could be some benefit to standardizing these surveys to dampen down some of the variability inherent in them but to also apply the correct functional form when analyzing the data and to make the surveys comparable from state to state by using similar data metrics to model the datasets. The conclusion of this portion of the discussion was that the state surveys would be appropriate to standardize, were this to be a procedure the SDWG or ASMFC Technical Committee wished to perform.

NEFSC Trawl Survey Catch Spatial Patterns

The summer flounder NEFSC spring trawl survey data were summarized into regional groups of strata to investigate spatial distributions of the spawning stock biomass (SSB) over time. The spring series was selected for investigation of the SSB distribution, as the fall series tends to have fewer older fish, and more of the stock is in state waters and therefore less available to NEFSC surveys. The offshore survey strata were grouped into three broad regions: SNE (Southern New England, offshore strata 5-12), MAB (Mid-Atlantic Bight, offshore strata 1-4 & 73-76), and DMV (the Delaware-Maryland-Virginia region, offshore strata 61-72; Figure A94). Survey data were compiled as indices at age in weight (kg), and then summed ages 2-12+ to create proxy SSB indices. The decreasing trend in survey SSB from the late 1970s to a low point around 1990 is common to all three regions. Likewise, the strong increasing trend since 1990 follows a similar pattern in all three regions (Figure A95).

Similar trends in abundance were seen on a finer spatial scale. Catch number per tow in ~5 year increments was summarized for the NEFSC spring (1968-2012), fall (1968-2012), and winter (1992-2007) surveys. Summer flounder demonstrate seasonal movement patterns, with adults migrating offshore to the outer continental shelf waters in October/November for the winter and returning inshore in April/May while juveniles maintain an inshore habitat year-round (Packer and Hoff 1999). Tagging studies confirmed a homing instinct of adult fish to natal estuary waters with occasional straying to the north and east (Poole 1962). There is a tendency for fish migrating offshore north of Hudson Canyon to become more permanent residents of SNE (Lux and Nichy 1981) while fish of New Jersey origin often remain south of Hudson Canyon (Poole 1962).

NEFSC trawl survey data was also summarized by stratum using the average annual minimum swept area of abundance (*N*) as a metric:

$$N = \frac{a_i}{\bar{a}_t} \times \frac{\sum c_i}{t_i}$$

where a_i is the area of stratum i, $\bar{a}_t$ is the average swept area of a standard survey tow, $\sum c_i$ represents the sum of the number of fish caught in a given stratum, and t_i is the total number of tows in stratum i. Abundance was divided into fish less than and greater than 30 cm, the approximate cutoff between age 0 and age 1 fish.

Spring

Plots of the spring (March-May) survey catches for multi-year time blocks reveal offshore aggregations of fish along the shelf edge that are caught during the early part of the spring survey (the southward March survey legs) and more inshore aggregations caught later (during the northward April survey legs) (Figures A96-A104). The earliest years showed the greatest presence of summer flounder in tows from inshore waters from Long Island to Cape Hatteras. These earlier time blocks through the 1990s, when the spring strata set for the early analytical assessments was developed, generally show only intermittent catches of summer flounder in the Georges Bank-Great South Channel strata or in the Gulf of Maine. From 1976-1980, higher catches occurred south of the Delaware Bay, both inshore and offshore through Cape Hatteras with a greater presence of summer flounder in offshore stations moving north along the shelf break through SNE. This spatial pattern continued throughout the 1980s and 1990s, with a reduction in the number of summer flounder compared to the late 1970s. The lowest catch numbers in the time series were seen during the early 1990s just before increasing slowly in the late 1990s. During the rebuilding period of the 2000s, larger catches of summer flounder began appearing in SNE waters, particularly south of Rhode Island and Massachusetts in offshore strata. More summer flounder were also present along the southern edge of Georges Bank. A few small occurrences of summer flounder appear in tows in Massachusetts and Cape Cod Bays and around outer Cape Cod throughout the time series.

Spatial abundance trends for length data summarized by stratum (Figures A105-A113) are similar to the raw survey catch data, however these maps illustrate the spatial and temporal abundance in large versus small summer flounder, are summarized by stratum, and expanded by swept area. Across the entire time series it is evident that smaller fish (< 30 cm, age 1 in the spring) are inhabiting areas in the southern range while fish in the northern range are nearly all >30 cm (mainly age 2 and older). Summer flounder less than 30 cm tend to make up the majority of the catch in spring inshore strata south of the Chesapeake Bay. This is not atypical since juvenile summer flounder tend to remain inshore for the first year before migrating offshore the following winter. Over time, these southern strata, both inshore and offshore, begin to contain a greater proportion of large summer flounder.

Fall

Plots of the fall (September-October) survey catches for multi-year time blocks reveal aggregations of fish mostly in inshore waters along the inner-half of the shelf and into the bays and estuaries. However in periods of higher abundance (1968-1975), a greater presence of summer flounder reaches farther offshore, particularly south of Delaware Bay (Figure A114). The earliest time block of 1968-1975 shows little or no catch of summer flounder in the Georges Bank-Great South Channel strata or in the Gulf of Maine. The second block of 1976-1980, however, shows more substantial catches over Georges and in mid-shelf offshore stratum 10 (Figure A115). Years of lower abundance (the 1980s and early 1990s) show summer flounder aggregating more tightly in inshore strata while catches in the Georges Bank, Great South Channel, and mid-shelf offshore strata (2, 6, 10) declined (Figures A116-A118). From RI waters to the southwest, most of the catches are confined to the inshore strata and the inner-most band of offshore strata (9, 5, 1, 61, 65, 69, 73; moving east to west/southwest). Abundance over time is similar to the spring with higher catches initially in the time series, dropping in the 1980s and 1990s, before increasing in recent years. By the late 1990s, catches of summer flounder were highest in the southern range, especially surrounding the Chesapeake Bay area (Figure A119). During the rebuilding period since 2000, larger catches began occurring more frequently in the MAB and approaching SNE. An increased presence in central Georges Bank is also noticeable in later years of greater abundance, where it was nearly absent in the 1968-1975 time period. Additionally, existence of summer flounder in survey catches in Massachusetts Bay and around Cape Cod has increased throughout the time series and was not present prior to the 1980s (Figures A120-A122).

Fall survey average annual minimum swept area abundances show an even more definitive line spatially dividing fish of sizes less than 30 cm (mainly ages 0 and 1 in the fall) and greater than 30 cm (ages 1 and older; Figures A123-A131). Nearly all summer flounder caught north of Hudson Canyon are >30 cm in size. This divide appears to stretch further south during the rebuilding period during the late 1990s and early 2000s. Survey catches during the earliest years of the time series were focused around the DMV region where the majority of the catch, particularly in inshore strata surrounding Delaware and Chesapeake Bay, were fish <30 cm. Some smaller fish begin to re-enter catches north of Hudson Canyon as MAB and SNE strata become the new areas of greatest summer flounder abundance.

Winter

While winter trawl surveys existed for 6 sporadic years from the mid 1960s until the early 1980s, the survey effort was not consistent across time and space. During the 1960s the survey did not extend to strata south of Hudson Canyon and during the 1970s and 1980s, coverage was patchy. Survey coverage during the later, consecutive years of the winter flatfish survey time series (1992-2007) was more typical of the spring and fall trawl surveys though excluded inshore strata south of Hudson Canyon, strata south of Cape Hatteras, and all of the Gulf of Maine including the Great South Channel and the majority of northern Georges Bank. Throughout the time series, survey catches of summer flounder remain tightly bound to stratum depth contours, remaining farther offshore in waters surrounding large freshwater output sources (Figures A132-A135). This pattern seems more apparent from Delaware Bay and north; summer flounder appear in shallower offshore strata (depth range 27-55 m) to the south of Delaware Bay, while are more restricted to waters 50 m and deeper to the north. Due to the large number of positive tows and the abbreviated time period, it is difficult to decipher any drastic spatial changes over time resulting from the winter survey catches. A northerly shift is apparent as larger catches occurring in the southern strata from 1992-1995 do become present in SNE in later years, while still occurring in southern strata.

Interpolative mapping of NEFSC fish trawl and ichthyoplankton surveys

Introduction

Richardson (2013a, b MS; WPA15 and WPA16) presented descriptive figures and analyses of patterns in summer flounder distribution from NEFSC fish trawl and ichthyoplankton survey catches. The objectives of this work were to present an analysis describing alongshelf shifts in distribution in the fall and spring and to evaluate the extent to which these shifts in distribution can be explained by environmental factors and by changes in the length structure of the population combined with length-specific distribution patterns and analyze of shifts in larval and mature adult distributions to examine potential shifts in spawning.

The maps of fish distribution by multi-year period were produced using an inverse-distance weighting interpolation procedure that includes a distance penalty for depth differences between the interpolated point and the sample station. This interpolation procedure is intended to produce interpolated maps that better represent the distributions of species that are associated with bathymetric features. This mapping procedure requires a parameter that converts bottom depth differences into an equivalent distance measure in kilometers. We optimized this parameter using bottom temperature data due to the difficulty in quantitatively evaluating the parameter using fish data. Specifically, we performed a leave-one-out procedure on bottom temperature to evaluate the increase in accuracy of predicted versus measured bottom temperatures for different parameter values. The depth-informed interpolation procedure performed substantially better than an interpolation procedure that does not incorporate depth. The interpolative mapping procedure was also used to create distribution maps for specific size classes of summer flounder. Changes in fishing mortality rates and natural mortality rates will affect the size-structure of a population. If the species exhibits length-specific distributions this change in size structure may also result in a change in aggregate distribution (e.g. the mean center of biomass) that is not associated with environmental factors.

The distributions of larval and mature adult summer flounder were examined over the last four decades to explore potential shifts in spawning distribution. Ichthyoplankton data was collected during the MARMAP (1977 – 1987) and ECOMON (1999 – 2009) programs, and data from the same time periods for mature adults were examined from the NEFSC spring and fall bottom trawl surveys. All datasets were aggregated spatially based on the current ECOMON strata. Both MARMAP and ECOMON were designed as multi-species surveys, and sampling effort covered the entire northeast U.S. shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia four to six times per year. MARMAP used primarily a fixed station design covering the sample area of each survey approximately evenly. ECOMON samples the same spatial extent of the shelf as MARMAP, but uses a random-stratified design based on the NEFSC bottom trawl survey design to collect samples from 47 strata. The area encompassed by each stratum determined the number of samples in each stratum. The number of stations sampled during an ECOMON survey is approximately 30 % less than that of MARMAP.
The relative proportion (percent of annual sum) of estimated absolute number of larvae and mature adults within each of 47 strata were used to examine changes in distribution. Larval abundance (larvae • 10 m^{-2}) was calculated for each station. The absolute number of larvae was estimated by multiplying the mean abundance (larvae • 10 m^{-2}) of stations within a stratum by the stratum area (m^2). The relative larval proportion of absolute number of larvae within each stratum was calculated by year and bimonthly season (January – February, March – April, May – June, July – August, September – October, November – December). The absolute number of mature adults was estimated by multiplying mean number of fish > 28 cm in length for each station within a stratum by the stratum area (m^2). The length of 28 cm was chosen based on the estimated median size at maturity (50 %) of 27.6 cm for both males and females from the 47th SAW assessment. The relative mature-adult proportion within each stratum was calculated for the spring and fall surveys. Significant differences in stratum larval and mature adult proportions between MARMAP years (n = 11) and ECOMON years (n = 11) were

examined among the strata that made up at least 99 % of the empirical cumulative distribution from south to north using a Kruskal-Wallis chi-square test. For larvae, the early (September – October), peak (November – December), and late (January – February) larval seasons were tested. The spring and fall bottom trawl surveys were tested for mature adults. Linear regression was used to analyze the along-shelf change in larval and mature adult distributions from south to north. The distance (km) north of Cape Hatteras was calculated for the center of each of the 47 strata. Kruskal-Wallis H values were set to negative if the relative proportion for a stratum was greater during MARMAP and positive if the proportion was greater during ECOMON. A linear regression was run for the along-shelf distance and Kruskal-Wallis H value for each stratum tested for the three larval seasons combined and the two bottom trawl surveys combined.

Adult fish distributions

The spring and fall distributions of summer flounder for 8 multi-year time periods are presented in Figures A136-A137. For both seasons the 1968-1972 time period was characterized by a southerly distribution of the sampled biomass. The recent time period had a more northerly distribution. The spring and fall distributions of summer flounder by length class averaged over the entire time series are shown in Figures A138-A139. A progressive northward shift in distribution is evident with increases in length.

The alongshelf grid used in the subsequent analyses is shown in Figure A140 part A and Figure A141 part A. For both the spring and fall the average alongshelf position of summer flounder increases with increasing size. On the spring survey the alongshelf position is around 200 km for fish <25 cm and is about 580 km for fish >40 cm. On the fall survey a similar pattern is evident, though the alongshelf position does not level off until fish are >50 cm. The spring survey annual alongshelf Center of Biomass of summer flounder increases (moves North) from the late 1960s to the mid-1980s, then declines (moves South) to the mid 1990s before reaching high levels again around 2007. The length predicted alongshelf center of biomass declines from the late 1960s to the early 1990s, increases until around 2008 and subsequently declines slightly. The residuals of the Observed COB from the length-predicted COB show a substantial increase in the early 1970s and a subsequent leveling off (Figure A140 part D). For the fall similar patterns emerge, although the 2005-2012 period does have fish in their most northeasterly position of the time series for both actual and residual COB (Figure A141 part D, Table A69). The residuals of the COB were minimally related ($r=0.12$) to either the annual SST or bottom temperature in the spring. In the fall a moderate relationship ($r=0.37$) to SST was evident (Figures A142-A143).

Shifts in the larval and mature adult distributions

Summer flounder larval distribution changed little over the past four decades, even as adult distributions significantly shifted northwards (Figures A144-145). Most change in relative larval proportions among stratum occurred during the early larval season (Figure A145 part A; September – October), with greater proportions in four strata ranging from off Chesapeake Bay to Georges Bank from 1999 to 2009. However, no significant change in along-shelf distance occurred (Figure A145 part D). Over the same time period, mature adults increased in relative proportions of the inner shelf strata of southern New England and northwest side of Georges Bank, primarily in the fall (Figure A145 part E, F). These shifts in relative proportion resulted in a significant northward along-shelf change in the mature adult distribution (Figure A145 part G). The time series of larval indices from the MARMAP and ECOMON programs, proposed as indices of summer flounder spawning stock biomass, are presented in Table A69.

GENERAL SPATIAL TRENDS

The heaviest commercial fishery catches (and by inference, effort) in the 1990s were reported just off of Cape Hatteras, concentrated around the entrances to Hudson Canyon and Narragansett Bay, and offshore along the shelf edge from the Chesapeake Bay entrance through SNE. Large catches of summer flounder continued along the shelf during the early 2000s with concentrations slightly farther north off the Delaware-Maryland-Virginia coast. This northerly trend of offshore commercial catches continued through the present decade with the largest catches now south of Rhode Island. Commercial catches of summer flounder at its southern extent are reduced after 2005. Fishery observer data show a much larger presence of large summer flounder catches on Georges Bank after 2005. Recreational fishing catch (and by inference, effort) distribution from party and charter boats is relatively unchanged throughout the 1990s and 2000s. One exception is reduced catch south of the Chesapeake Bay that becomes almost entirely absent after 2005. The highest density of recreational catch occurs in inshore waters from Delaware Bay along the coast to Narragansett Bay.

The earliest years (1968-1990) of NEFSC fish trawl surveys showed the largest catches of summer flounder in inshore waters from Long Island to Cape Hatteras, with intermittent catches of summer flounder in the Georges Bank-Great South Channel strata or in the Gulf of Maine. The lowest catches occurred during the early 1990s, before increasing slowly in the late 1990s. During the rebuilding period of the 2000s, larger catches of summer flounder began appearing in northern areas, particularly south of Rhode Island and Massachusetts. Nearly all summer flounder caught north of Hudson Canyon are >30 cm in size. This divide appears to stretch further south during the rebuilding period during the 2000s. Survey catches during the earliest years of the time series were focused around the Delaware-Maryland-Virginia region where the majority of the catch, particularly in inshore strata surrounding Delaware and Chesapeake Bay, were fish <30 cm. Some smaller fish begin to re-enter catches north of Hudson Canyon as Mid-Atlantic Bight and Southern New England regions have become the new areas of greatest summer flounder abundance.

The annual alongshelf center of biomass of summer flounder increases (moves North) from the late 1960s to the mid-1980s, then declined (moves South) in the mid 1990s, before reaching high levels again around 2007. For both the spring and fall fish trawl surveys the average alongshelf position of summer flounder increases with increasing size. The length predicted alongshelf center of biomass declines from the late 1960s to the early 1990s, increases until around 2008 and subsequently declines slightly. The relationship of the center of summer flounder biomass to either surface or bottom temperature is minimal in the spring and moderate in the fall. Summer flounder larval distribution has changed little over the past four decades.

While many factors may be causing changes in spatial distribution of summer flounder over the last few decades, their general increased abundance northward and expansion eastward on Georges Bank is apparent. Spatial expansion is also more apparent in years of greater abundance. This may be more than a coincidence as fishing pressure has been shown to enhance changes in spatial distribution due to the environment (Hsieh *et al.* 2006, 2008; Planque *et al.* 2010). One reason for this may be that higher levels of exploitation can lead to reduced heterogeneity in age structure, particularly a reduction in older age fish, making the stock more sensitive to shifts in the environment (Hsieh *et al.* 2006, 2008; Planque *et al.* 2010). This kind of response may be evident in summer flounder as expansion in both the spatial distribution and size structure has developed since about 2000, after the period of heavy exploitation during the 1980s and 1990s. Teasing out the mechanism(s) driving this trend and the resulting increase in SSB that followed in the 2000s may be difficult, but warrants continuing research.

FISHERY DEPENDENT INDICES OF ABUNDANCE

Fishery dependent catch rate data were modeled using generalized linear models in SAS software version 9 (SAS 2011) to developed standardized indices of abundance for summer flounder. The response variables were the continuous variable total landings or catch per day fished (for commercial trips) or per angler trip (for recreational trips), while the classification factors considered were the discrete variables year (the 'year' effect that in a main classification factors only model serves as the index of abundance), and various temporal, spatial, and vessel classification characteristics.

The SAS GENMOD procedure fits generalized linear models that allow the mean of a population to depend on a linear predictor through a nonlinear link function and allow the response probability distribution to be specified from a number of probability (error) distributions. These include the normal, lognormal, binomial, Poisson, gamma, negative binomial (negbin), and multinomial (McCullagh and Nelder 1989). SAS PROC GENMOD was used to model the fishery dependent catch rate data using lognormal (for ln-tranformed rates), gamma, Poisson, and negative binomial (for untransformed rates) probability distributions. The GENMOD procedure fits a generalized linear model to the data by maximum likelihood estimation. There is generally no closed form solution for the maximum likelihood estimates of the parameters, so the procedure estimates the parameters of the model numerically through an iterative fitting process, with the covariances, standard errors, and p-values computed for the estimated parameters based on the asymptotic normality of maximum likelihood estimators (SAS 2011).

The estimates of- and changes in several goodness of fit statistics were used to evaluate the goodness of fit of the model and the significance of the classification factors: a) the ratio of the deviance (twice the difference between the maximum attainable log likelihood and the log likelihood of the model) to the degrees of freedom (DF); this statistic is a measure of "dispersion" and of fit of the expected probability distribution to the data (closer to 1 is better) and is comparable across models, b) the value of the log-likelihood (a measure of model fit), c) the computed AIC (a measure of model fit and performance, valid for a sequence of models within each distribution, and across models with the same type of data), d) whether or not the model converged (whether the negative of the Hessian matrix was positive definite, allowing valid estimation of the parameters and their precision), and e) the significance of the classification factors as indicated by the log-likelihood ratio statistics at the 5% level (SAS 2011, Terceiro 2003b, Dick 2004, Maunder and Punt 2004).

A sequence of models, including from one factor to many factors, were fit and the differences/changes in the goodness of fit diagnostics used to determine the best model under each probability distribution assumption. A Type III analysis was used since it does not depend on the order in which the classification factors are specified. For the discrete variable Poisson and negative binomial error distributions, individual trip catch rate values were rounded to integer values.

Dealer Landings Reports LPUE

Dealer report trawl gear landings rate (LPUE) data for summer flounder were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013a MS; WPA3). Descriptive statistics indicated that the Dealer report Trawl gear landings rate distribution is overdispersed in relation to a normal distribution, as the mean is larger than the mode, the variance is several orders of magnitude larger than the mean, and skewness is larger than zero. Simple visual inspection indicates the untransformed, interval-binned distribution is likely not normal, but rather a gamma, Poisson or negative binomial. However, the distribution of the ln-transformed landings rates suggests that a lognormal assumption could be appropriate for these data.

The distributions of the observed total landings were examined for three candidate classification variables – calendar quarter (QTR; 1 = Jan-Mar, 2 = Apr-Jun, etc), 3-digit statistical area (AREA), and vessel tonnage class (TC; binned for vessels < 5 gross registered tons [TC = 1], 5-50 [TC = 2], 51-150 [TC = 3], 151-500 [TC = 4], 501-1000 [TC = 5], and 1001 and larger [TC = 6]), expressed as the cumulative sum of the total landings for each class level. The distribution by QTR indicated that about 40% of the landings were taken in the first calendar quarter. The distribution by statistical area indicated that about one-half of the total landings were taken in 5 areas: area 537 off RI and MA, area 616 off northern NJ and western Long Island, NY in the Hudson Canyon area; areas 621 and 622 off southern New Jersey and Delaware Bay, and area 626 off Delmarva. The distribution by tonnage class (TC) indicated that about 70% of the landings were taken by tonnage class 3 vessels. Total reported landings (lbs), trips, days fished, and nominal annual LPUE (landings lbs per DF), and LPUE scaled to the time series mean are presented in Table A70.

Given that the examination of the total landings lbs per day fished frequency distributions indicated that the assumption of a negbin probability (error) distribution was most appropriate for the untransformed landings rate data and that the Deviance/DF (dispersion) statistic for the negbin model was closest to 1.0, the negbin four-factor YEAR-QTR-AREA-TC model is suggested as the best model for the Dealer Report trawl gear landings rate data for summer flounder. The YEAR estimated parameters (re-transformed and bias-corrected to linear scale) serves as the “year effect” index of abundance, and are compared to the nominal index in Figure A146, with all series scaled to their respective time series means to facilitate comparison. All model configurations have a strong smoothing effect on the nominal indices from 1964 until about 2000, and then generally indicate a steeper increase in stock biomass since 2000 than does the nominal index. The lognormal model smoothed the nominal series most strongly through about 2000, but indicated the greatest increase in biomass since 2000. The gamma and negbin models provided nearly identical results, although the negbin diagnostics indicated a better fitting model. The best-fitting negbin indices and their 95% confidence intervals are therefore compared with the nominal index in Figure A147, with the series scaled to their means to facilitate comparison. The negbin annual indices, the annual Coefficents of Variation (CVs), and the 95% confidence intervals are presented in Table A71.

The data and analyses described above include only the data available from the NEFSC Dealer Report landings database. In developing these models, it was recognized that the inclusion of external information on the pattern of commercial fishery management regulations, which are known to affect both the rate of catch and behavior of fishermen, could impact the results. To that end, information on each state's open season (expressed as open or closed for each year-month) and commercial fishery trawl trip limits (expressed as the limit in lbs for each year/month) was added to the LPUE data set. For years prior to 1993, seasons were coded as open and trip limits were set at 100,000 lbs (the highest observed). This information was modeled both as covariates and as explicit classification variables. Unfortunately, attempts to develop valid model incorporating this external information failed, likely due to the lack of contrast of the cell means across classification strata. Most models failed to converge, and those that did 'converge' (i.e., stopped iterating due to the minimum residual step being attained) failed to provide valid parameter estimates for many of the classification variables.

Vessel Trip Report (VTR) CPUE

Fish Trawl Gear

Vessel Trip Report (VTR) fish trawl gear catch rate (landings plus discards; CPUE) data for summer flounder were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013b MS; WPA4). Descriptive statistics indicate that the VTR trawl gear catch rate distribution is overdispersed in relation to a normal distribution, as the mean is larger than the mode, the variance is several orders of magnitude larger than the mean, and skewness is larger than zero. Simple visual inspection indicates the untransformed, interval-binned distribution is likely not normal, but rather a gamma, Poisson or negative binomial. However, the distribution of the ln-transformed landings rates suggests that a lognormal assumption could be appropriate for these data.

The distributions of the observed total catch were examined for four candidate discrete classification variables – calendar quarter (QTR; 1 = Jan-Mar, 2 = Apr-Jun, etc.), 3-digit statistical area (AREA), vessel tonnage class (TC; binned for vessels < 5 gross registered tons [TC = 1], 5-50 [TC = 2], 51-150 [TC = 3], 151-500 [TC = 4], 501-1000 [TC = 5], and 1001 and larger [TC = 6]), and net mesh size category (MSH; LG [large] => 5 inches; SM [small] < 5 inches), expressed as the cumulative sum of the total catch for each class level. The distribution by QTR indicated that about half of the catch is taken in the first calendar quarter. The distribution by statistical area indicated that about one-third of the total catch was taken in just 3 areas: area 616 off northern NJ and western Long Island, NY in the Hudson Canyon area; area 537 off RI and MA, and area 626 off Delmarva. The distribution by tonnage class (TC) indicated that about two-thirds of the catch was taken by tonnage class 3 vessels. The distribution by mesh size indicated that large mesh trips accounted for 88% of the reported landings and 71% of the reported discards; the nominal reported discard rate (discards to total catch lbs) was 2% for large mesh trips and 6% for small mesh trips. Total catch, trips, days fished, nominal annual total catch lbs per day fished (CPUE), and CPUE scaled to the time series mean is presented in Table A72; there is an increasing trend evident in the nominal series since 1994 (Figure A148).

Given that the examination of the total catch lbs per day fished (CPUE) frequency distributions indicated that the assumption of a negbin probability (error) distribution was most appropriate for the untransformed catch rate data and that the deviance/DF (dispersion) statistic for the negbin model was closest to 1.0, the negbin five-factor YEAR-QTR-AREA-TC-MSH model is indicated as the best model for the VTR trawl gear catch rate data for summer flounder. The YEAR estimated parameters (re-transformed and bias-corrected to linear scale) serves as the "year effect" index of abundance for all three distributions, and are compared to the nominal index in Figure A148, with all series scaled to their respective means to facilitate comparison. All model configurations have a moderate smoothing effect on the nominal indices. The negbin indices and their 95% confidence intervals are compared with the nominal index in Figure A149, again with the series scaled to their means. The negbin annual indices, the annual Coefficients of Variation (CVs), and the 95% confidence intervals are presented in Table A73.

Recreational Party/Charter Boat

Vessel Trip Report (VTR) Party and Charter (P/C) boat catch rate (landings plus discards in numbers per trip; CPUE) data for summer flounder were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013c MS; WPA5). Descriptive statistics indicate that the VTR P/C boat catch distribution is overdispersed in relation to a normal distribution, as the mean is larger than the mode, the variance is 5-6 times larger than the mean, and skewness is larger than zero. Simple visual inspection indicates the untransformed distributions are likely not normal, but rather a gamma, Poisson or negative binomial. However, the distributions of the ln-transformed individual trip catch rates suggest that a lognormal assumption could be appropriate for these data.

The distributions of the observed total catch were examined for three candidate discrete classification variables – calendar month (MON), 3-digit statistical area (AREA), and VTR trip category (BOAT; Charter or Party boat) - expressed as the cumulative sum of the total catch for each class level. The distribution by QTR indicated that little of the catch is taken in the first or last calendar quarters, and that about 80% is taken during June, July, and August. The distribution by AREA indicated that about 65% of the total catch was taken in area 612 off northern NJ and western Long Island, NY; other areas with significant catch were 539 off RI and MA, 611 off eastern Long Island, NY, 614 off southern NJ, and 621 off Delmarva. The distribution by BOAT class indicated that about

77% was taken aboard Party boats, with the share between Party and Charter varying over time. Total catch, trips, anglers, nominal annual catch per trip (CPUE), and CPUE scaled to the time series mean for the boat types combined (P/C Boat) is presented in Table A74; there is a declining trend evident in the nominal series (Figure A150).

Initial reviews of the work suggested that the inclusion of external information on the pattern of recreational fishery management regulations, which are known to affect both the rate of catch and behavior of fishermen, could impact the results. To that end, information on each state's minimum retention size (SIZE) and possession (BAG) limit for each year from 1994-2012 was added to the basic VTR CPUE data set. In addition, the classification variable AREA (3-digit statistical area) was dropped in favor of the STATE variable in the negbin model, to better correspond to the pattern of the regulatory information. Most of the P/C Boat total catch is reported by boats from NY and NJ, and about 10% of the observations did not include state information and were dropped. First through third level interaction terms with YEAR (e.g., year*state, year*state*size, year*state*size*bag) were also added to the model to determine if those terms were estimable and/or significant (which has consequences for the use of the YEAR main effect as the index of abundance). The addition of the SIZE and BAG information to the YEAR-MON-STATE-BOAT model results in an improved model fit. The addition of interaction terms resulted in a converged model with improved fit, but many of the interaction term coefficients were inestimable. Therefore, the six factor YEAR-MON-STATE-BOAT-SIZE-BAG model (ST-SZ-BG) emerged as the best fitting, usable model. The six-factor ST-SZ-BG negin modeled series indicates no trend in stock abundance, in contrast to the decreasing trend of the nominal and earlier modeled series (Figure A150). The six-factor ST-SZ-BG negbin indices and their 95% confidence intervals are compared with the nominal index in Figure A151, with the series scaled to their means to facilitate comparison. The six-factor SIZE-BAG negbin annual indices, the annual Coefficents of Variation (CVs), and the 95% confidence intervals are presented in Table A75.

Fishery Observer (OB) CPUE

Fish Trawl Gear

Northeast Fishery Observer Program (NEFOP) catch rate (landings plus discards in pounds per trip; CPUE) data for summer flounder taken in observed fish trawl gear trips were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013d MS; WPA6). Descriptive statistics indicate that the observed trawl gear catch rate distribution is overdispersed in relation to a normal distribution, as the mean is (relatively) much larger than the mode, the variance is much larger than the mean, skewness is much larger than zero, and there is a high proportion of low total catch per trip observations (trips with <250 lbs per trip compose 50% of the observations).

The distributions of the observed total catch were examined for three candidate classification variables – calendar quarter (QTR), 3-digit statistical area (AREA), and vessel tonnage class (TC; binned for vessels < 5 gross registered tons [TC = 1], 5-50 [TC = 2], 51-150 [TC = 3], 151-500 [TC = 4], 501-1000 [TC = 5], and 1001 and larger [TC = 6]), expressed as the cumulative sum or proportion of the total catch for each class level.

The distribution by QTR indicated that about half of the total catch was observed in the first quarter (Jan-Mar), while only 11% was observed in quarter 2 (Apr-May). The distribution by statistical area indicated that about 65% of the total catch was observed in areas 525, 537, 612, 616, 622, and 626, with no other areas accounting for more than 4%. The distribution by vessel tonnage class indicated that about 67% was observed aboard tonnage class (TC) 3 vessels. Total observed trips, hauls, catch, days fished, nominal annual catch per day fished (CPUE), and CPUE scaled to the time series mean are presented in Table A76; there is not a strong trend in the nominal series (Figure A152).

The AICs for the gamma and negbin models (directly comparable because they are based on untransformed catch rates) were very close (gamma slightly lower/better). However, given that the examination of the total catch frequency distributions indicated that the assumption of a negbin probability (error) distribution was most appropriate for the untransformed catch rate data, and the Deviance/DF (dispersion) statistic for the negbin model was closest to 1.0, the negbin four-factor YEAR-QTR-AREA-TC model is indicated as the best model for the observed trawl gear catch rate data for summer flounder. The YEAR estimated parameters (re-transformed and bias-corrected to linear scale) serves as the “year effect” index of abundance for all three distributions, and are compared to the nominal CPUE in Figure A152, with all series scaled to their respective means to facilitate comparison.

All modeled series indicate a steeper increase in stock biomass than the nominal series. The Poisson series is the most variable over time, while the lognormal, gamma, and negbin series are less variable and match fairly closely. The negbin indices and their 95% confidence intervals are compared with the nominal index in Figure A153, with the series scaled to their means to facilitate comparison. The negbin annual indices, the annual Coefficients of Variation (CVs), and the 95% confidence intervals are presented in Table A77.

Scallop Dredge Gear

Northeast Fishery Observer Program (NEFOP) catch rate (landings plus discards in pounds per trip; CPUE) data for summer flounder taken in observed fish trawl gear trips were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013d MS; WPA6). Descriptive statistics indicate that the observed scallop dredge gear catch distribution is overdispersed in relation to a normal distribution, as the mean is (relatively) much larger than the mode, the variance is much larger than the mean, skewness is much larger than zero, and there is a relatively high proportion of low total catch per trip observations.

The distributions of the observed total catch were examined for three candidate classification variables – calendar quarter (QTR), 3-digit statistical area (AREA), and vessel tonnage class (TC; binned for vessels < 5 gross registered tons [TC = 1], 5-50 [TC = 2], 51-150 [TC = 3], 151-500 [TC = 4], 501-1000 [TC = 5], and 1001 and larger [TC = 6]), expressed as the cumulative sum of the total catch for each class level. The distribution by QTR indicated that most of the observed total catch was distributed about equally between quarters 1, 2, and 4, with only about 10% observed in the third quarter. The distribution by statistical area indicated that about half of the total catch was observed in areas 616 and 622. The distribution by vessel tonnage class indicated that about 75% of the total catch was observed aboard tonnage class (TC) 4 vessels. Total trips, hauls, catch, days fished, nominal annual CPUE, and CPUE scaled to the time series mean are presented in Table A78; the nominal series low occurred in 1998 and the high in 2007 (Figure A154).

Given that the examination of the total catch frequency distributions indicated that the assumption of a Poisson/negbin probability (error) distribution was most appropriate for the untransformed catch rate data and the Deviance/DF (dispersion) statistic for the negbin model was closest to 1.0, the negbin four-factor YEAR-QTR-AREA-TC model is suggested as the best model for the observed scallop dredge gear catch rate data for summer flounder. The YEAR estimated parameters (re-transformed and bias-corrected to linear scale) serves as the "year effect" index of abundance for all three distributions, and are compared to the nominal CPUE in Figure A154, with all series scaled to their respective means to facilitate comparison.

All modeled series provide a comparable degree of smoothing of the nominal CPUE index and indicate a steeper increase in stock biomass than the nominal series. The negbin indices and their 95% confidence intervals are compared with the nominal index in Figure A155, with the series scaled to their means to facilitate comparison. The negbin annual indices, the annual Coefficients of Variation (CVs), and the 95% confidence intervals are presented in Table A79.

MRFSS/MRIP (REC) CPUE

Recreational fishery Marine Recreational Fishery Statistics Survey (MRFSS) / Marine Recreational Information Program (MRIP) catch rate from the intercept (field creel survey) sample data were modeled to compile standardized indices of abundance for summer flounder (Terceiro 2013e MS; WPA7). Descriptive statistics indicate that the MRFSS/MRIP intercept catch distribution is over-dispersed in relation to a normal distribution, as the mean is larger than the mode, the variance is 7 times larger than the mean, and skewness is larger than zero. Simple visual inspection indicates the untransformed distributions are likely not normal, but rather a negative binomial. For these data, only negative binomial models were fit.

The distributions of the intercept total catch were examined for four candidate discrete classification variables – wave (2-month sampling intervals, e.g., January-February, Mar-April, etc. WAVE), state of landing (ST), fishing area (state or EEZ waters; AREA), and fishing mode (shore-based, private/rental boat, party/charter boat; MODE) - expressed as the cumulative sum of the intercept total catch for each class level. The first wave of the year (January-February) is not sampled from North Carolina to the north. The distribution by wave indicated that just over half of the catch was sampled in wave 4 (July-August), and that 97% is taken during May through October. The distribution by state indicated that about 30% of the total catch was sampled from NJ, 20% in NY, 17% in VA, 11% in DE, and 8% in RI, with less than 5% sampled in each of the other states. The distribution by fishing area indicated that about 93% was sampled from state water and 7% in the EEZ. The distribution by fishing mode indicated that about 76% was sampled from private rental boats, 18% from party/charter boats, and 6% from shore-based anglers. Total catch in numbers, trips, nominal annual CPUE (totcal catch per trip), and CPUE scaled to the time series mean for the intercept catch types combined (total catch) are presented in Table A80; there is an increasing trend evident in the nominal series since the late 1980s, although the 2012 CPUE was the lowest since 1995 (Figure A156).

Initial reviews of the work suggested that the inclusion of external information on the pattern of recreational fishery management regulations, which are known to affect both the rate of catch and behavior of fishermen, could impact the results. To that end, information on each state's minimum retention size (SIZE) and possession (BAG) limit for each year from 1981-2012 was added to the CPUE data set. First through third level interaction terms with YEAR (e.g., year*state, year*state*size, year*state*size*bag) were also added to the model to determine if those terms were estimable and/or significant (which has consequences for the use of the YEAR main effect as the index of abundance).

The addition of the SIZE and BAG information to the YEAR-WAVE-STATE-BOAT model results in an improved model fit. The addition of interaction terms resulted in a converged model with improved fit, but many of the interaction term coefficients were not significant and/or inestimable. Therefore, the six factor YEAR-WAVE-STATE-BOAT-SIZE-BAG model (ST-SZ-BG) emerged as the best fitting, usable model. The six-factor ST-SZ-BG negbin modeled series indicates a stronger decreasing trend over the last decade than the nominal and earlier modeled series. The six-factor ST-SZ-BG negbin indices and their 95% confidence intervals are compared with the nominal index in Figure A156, with the series scaled to their means to facilitate comparison. The six-factor SIZE-BAG negbin annual indices, the annual Coefficients of Variation (CVs), and the 95% confidence intervals are presented in Table A81.

2013 SDWG Conclusion on Utility as Indices of Abundance

The SDWG evaluated the utility of the standardized fishery dependent landings- and catch-per unit effort based indices as measures of abundance for the summer flounder stock assessment. The SDWG concluded that the calculation of effort in the fishery dependent data is problematic. For the commercial data, the effort information is dependent on the accurate recording by the fishermen themselves. The collection of this data is not a focus of their operation, however, and therefore metrics like the fishing time or length of tow may not be accurate and could therefore provide a biased CPUE index. There is a lack of consistency in the reporting requirements for parts of the commercial VTR time series; the instructions for how effort is reported have changed. For the recreational data, the calculation of effort is even more problematic. In this analysis, all trips which caught summer flounder were used; there are different ways to define summer flounder trips. However, there is variation in the number of rods and reels (gear quantity) and the time of fishing for each trip that may not be completely or accurately reported. The catch is also inconsistently reported in the for-hire recreational VTR with it being provided in numbers or pounds on these self-reported forms. In total these elements make the calculation of effort challenging when working with commercial and recreational fishery data time series.

The SDWG noted that over the long term, and especially since fishery quotas were instituted in the early 1990s, there have been a number of regulatory changes which are different in timing and magnitude for each state (primarily seasonal closures, seasonal trip/possession limits, and minimum size limits). This information is not part of the commercial and recreational catch databases and so must be developed independently and integrated within the Generalized Linear Model. This information could not be modeled adequately as covariates or classification variables within the generalized model framework (i.e., inability to develop a model which converges and produces valid parameter estimates) for the commercial fishery data.

The three commercial trawl standardized indices generally indicate increasing trends in abundance comparable to the NEFSC seasonal trawl surveys (an increase of about 80% since 1990). The recreational fishery standardized indices, for which inclusion of regulatory measures in the models were successful, indicated recent decreasing trends in abundance that were inconsistent with the trends indicated by most state and federal research survey index trends.

Figure A157 compares the time series trends of the fishery dependent indices of abundance, scaled to the terminal year (2012) to facilitate comparison; Figure A158 makes the same comparison including the three NEFSC seasonal trawl surveys. The modeling difficulties call into question the utility of both the nominal and model-based fishery dependent standardized indices as unbiased measures of summer flounder abundance. While the commercial trawl indices do indicate increasing trends, the SDWG felt the standardization procedure was still subject to an unknown, likely negative, bias. In addition, the SDWG felt the multiple fishery-independent surveys available to this assessment had sufficient spatial coverage, such that inclusion of the fishery-dependent indices was not necessary, as might be the case for an assessment that lacked adequate fishery independent sampling. Based on these concerns, the SDWG recommended that the fishery dependent standardized indices of abundance not be used in the summer flounder assessment model.

The SARC 57 Review Panel concluded that Term of Reference 2 was met.

TOR 3. Review recent information on sex-specific growth and on sex ratios at age. If possible, determine if fish sex, size and age should be used in the assessment (completion of specific sub-task is contingent on analytical support from staff outside of the NEFSC.)

NEFSC SURVEY DATA

Growth

As noted above in the introductory GROWTH section, trends in growth by sex and age for all three NEFSC seasonal survey series follow comparable patterns. There are no trends in the mean lengths for ages 0-1, with a weak declining trend since the 1990s for ages 2 and older. Mean lengths of ages 3 and older show decreasing trends for both sexes. Von Bertalanffy growth curves estimated for five-year bins from 1976-2012 are tightly clustered through age 5 for females, with some divergence at older ages, with the most recent bin (2006-2012) indicating smaller predicted lengths at age than in previous years (Figure A16). The growth curves are more dispersed for males, and therefore for sexes combined, with the most recent 2006-2012 curve indicating smaller predicted lengths for older males and for all ages when sexes are combined (Figure A17).

Sex Ratio in NEFSC Survey Raw Sample Data

The NEFSC seasonal trawl survey raw sample data (not the stratified indices by sex and age, although they generally show similar patterns) were examined for trends in sex ratio by season and age, expressed as the proportion of females at age. The spring and fall series have sufficient data for the compilation beginning in 1976. The winter survey was conducted from 1992-2007.

In the winter survey, the proportion of females showed no trend for age 1 and the mean proportion was 49%. For ages 2 and 3, the proportion decreased from about 0.7-0.8 in the early 1990s to 0.4-0.6 in the mid-2000s. For ages 4 to 6, the proportion decreased from about 0.8-1.0 in the early 1990s to about 0.7 in the mid-2000s. For ages 7 and older that compose the ‘plus group,’ the proportion ranged from 0.8 to 1.0 over the series (Figures A159-A161).

In the spring survey, the proportion of females showed no trend for age 1 and the mean proportion was 41%. For ages 2 and 3, the proportion decreased from about 0.6-1.0 in the early 1990s to about 0.5 since 2000. For ages 4 and 5, the proportion decreased from a range of 0.8 to 1.0 in the early 1990s to about 0.5 in the mid-2000s. For age 6 the proportion ranged from 0.5 to 1.0 with no trend. For ages 7 and older that compose the ‘plus group,’ the proportion has been variable, but generally near 1.0 with no trend over the series (Figures A162-A164).

In the fall survey, the proportion of females shows no trend for age 0 and the mean proportion was 33%. For ages 1 and 2, the proportion decreased from about 0.5-0.6 in the 1980s to 0.4-0.5 by 2010-2011. The proportions at ages 3 to 5 strongly decreased from about 0.8 through the late 1990s to about 0.5 by 2010-2011. For ages 6 and older the proportions have been variable with no trend (Figures A165-A167).

Sex Ratio in NEFSC stratified mean indices

NEFSC stratified mean abundance indices (numbers per tow) were calculated for the winter (1992-2007), spring and fall (1976-2012) series. The spring and fall FSV HB Bigelow 2009-2012 indices were calibrated to FSV Albatross IV equivalents using calibration factors at length described under TOR2, above. The male and female indices generally follow similar trends over time (Figures A168-A169).

As in the raw sample data, the sex ratio in the NEFSC stratified indices has changed over the last decade, with generally decreasing proportions of females at ages 2 and older. In the winter indices, the proportion of females showed no trend for age 1 and the mean proportion was 46%. For ages 2, 3, and 4, the proportion has decreased from about 0.6-0.8 in the early 1990s to about 0.4-0.5 by 2007. For ages 5 and 6, the proportion has decreased from about 0.8-1.0 in the early 1990s to about 0.6-0.7 by 2007 (Figure A168). For ages 7 and older that compose the 'plus group,' the proportion has ranged from 0.8 to 1.0 over the series.

In the spring indices, the proportion of females has an increasing trend for age 1 from about 0.3 to 0.5, and the mean proportion was 40%. For ages 2, 3, and 4, the proportion has decreased from about 0.6-0.7 in the late 1970s to about 0.4-0.5 since 2000. For ages 5 and older, the indices during the 1980s-1990s are generally very small values (often < 0.001 fish per tow, and so round to 0 and appear 'missing' in the figures) and the proportion of females over the series is variable without a strong trend. Recently the proportion of females at ages 5 and older has ranged from 0.4-0.9 (Figure A170).

In the fall survey, the proportion of females shows no trend for age 0 and the mean proportion was 33%. For ages 1 and 2, the proportion has decreased from about 0.5-0.6 in the 1980s to 0.4-0.5 by 2010-2012. The proportions at ages 3 to 7 have strongly decreased from about 0.8 through the late 1990s to about 0.4-0.7 by 2010-2012 (Figure A171).

Variation in Growth by Sex, Time, and Area

Sullivan (2013 MS; WPA11) conducted a statistical analysis of the variations in length at age by sex, area and time using data collected from NEFSC survey catch of summer flounder (*Paralichthys dentatus*) over the years 1976 through 2010. A von Bertalanffy growth model was used to systematically assess the similarity of growth patterns between sexes, areas and time periods. Statistically significant differences in growth were found between sexes, between Northern and Southern regions (as split at the NEFSC statistical area associated with the Hudson Canyon off the continental margin of New York and New Jersey), and between early and late time periods (1900s and 2000s).

Sullivan (2013 MS) found there appear to be measurable (statistically significant) differences in the length-age relationship between sexes, areas and times. The three parameter von Bertalanffy model was used to systematically compare different data stratifications. Models that include stratification by sex appear to show the greatest level of significance, followed by area and time (Figures A172-A177). Sullivan concluded that once the appropriate stratification of the data is found age-length keys should be developed based on these stratifications alone and independently of the models. Statistical significance indicated that with the sample sizes available differences in model fit between strata are measurable. Sullivan (2013 MS) concluded that whether these differences result in statistically significant or biologically relevant differences in assessment model outputs will need further examination.

COMMERCIAL AND RECREATIONAL FISHERY DATA

Morson *et al.* (2013 MS; WPA13) conducted a data collection program beginning in 2010 with dual goals of 1) data collection and 2) an evaluation of the adequacy of summer flounder sex-at-age and sex-at-length keys developed from NMFS-NEFSC ocean trawl surveys in describing the sex ratio in recreational and commercial landings. The program continued until two full years of data were collected in each targeted region. Efforts were directed toward key ports in states from Massachusetts to North Carolina where summer flounder landings were high (Figures A178-A179). Sex and length data were collected from over 30,000 summer flounder landed in the commercial (CF) and recreational (RF) fisheries and approximately 20,000 of those fish were aged by the NMFS-NEFSC. Minimum sampling goals were exceeded in nearly all regions. The exception was in the DE/MD/VA/NC area where total samples fell well short of goals in the CF. The CF season in this region is short and already heavily sampled by other research programs so obtaining fish proved difficult, however it should be noted that summer flounder landings in NC/VA come from similar statistical areas as those fish landed in NJ.

For each visit to a commercial dock or packing house, scientists collected data haphazardly from up to 100 fish in each market category available from a given fishing trip. For each fish, total length was measured to the nearest centimeter and sex was determined. Summer flounder cannot be sexed using external characteristics. To avoid a reduction in market, a minimally invasive technique was employed for determining sex that reduced damage to the fish and preserved market integrity. A one-inch incision was made on the pigmented side of the fish in an area halfway between the anterior end of the anal fin and the center of the pectoral fin. Using forceps, the gonads were pulled out through this incision. Orange eggs of female fish and the white of testes tissue could be observed even if sampling did not occur during the spawning season. Minimally five scales were removed from all fish from an area just above the lateral line, anterior to the caudal peduncle. In addition, otoliths were taken from fish greater than 60 cm. To remove the otolith without compromising market value, the operculum was pried open and held back. A cut was made into the gill arches underneath the operculum and the gill arches were scraped away to expose the otic capsule. The tip of a sharp knife was used to open the otic capsule and expose the otolith inside. After removal with a pair of forceps, the operculum was laid back into its original position, leaving little or no evidence of the sampling procedure.

Sampling of summer flounder landed in the recreational fishery was conducted at participating docks and marinas from Massachusetts to Virginia. Scientists went to each port once per week to collect racks (filleted carcasses) of all summer flounder caught that day on all participating boats that were filleted. Boat captains and crew saved fish racks in a bin and when the scientist arrived at the dock they collected the racks and recorded the date and port landed. In addition, in order to increase the number of fish available for collection, freezers were placed at each port. Bags and waterproof tags were provided to the fishermen and were available near the freezers so that samples could be accurately labeled with relevant information. On days scientists were not present, participating boats were asked to deposit all fish racks from the day's catch in these tagged bags and place the bags in the freezers. Freezers were emptied when scientists arrived to collect fresh racks. To ensure a representative sample of summer flounder sex, length, and age, all fish caught on a fishing trip were sampled without regard to size. Total length (cm) was measured on all fish and sex was determined by macroscopic investigation of exposed gonad on filleted fish carcasses. Over ninety-nine percent of all fish collected had reproductive organs intact and readily visible to the naked eye. As the fish were already filleted, scales could not be collected. Otoliths were therefore collected on all fish by cutting through the skull. Fish were held on a hard surface, pigmented side up, head facing left, and a sharp knife was aligned along the preoperculum and rotated a few degrees so that the tip of the knife pointed slightly toward the head of the fish. A deep cut was made through the bones of the head at the anterior end of the otolith capsule, limiting damage to the otoliths inside. The fish was then picked up with both hands and bent along the incision to loosen and expose the otolith for removal using forceps.

To evaluate variability in growth, observed length-at-biological age data were fitted to a von Bertalanffy growth function by non-linear least squares regression. To examine differences in growth parameters, the von Bertalanffy model was fitted by least squares to pooled data and separately to examine differences between sex, and amongst regions and years. To identify spatial differences in growth rates, data were grouped into one of three regions: North, Central, and South. The estimates from the pooled fit were used to parameterize the constrained parameters in the competing growth models. Likelihood ratio tests (Kimura 1980) were used to determine if differences existed between von Bertalanffy parameter estimates between years, regions, and sexes for mean total length-at-age data. Models were developed to assess the following hypotheses 1) separate growth curves among years, regions and sexes; 2) separate growth curves with one growth parameter (Linf, t0, or k) equal; and 3) the alternative hypotheses of no differences in growth curves.

Differences in sex ratio between commercial/recreational landings and the NMFS-NEFSC ocean trawl survey were identified using a generalized linear model with a logit-link function and a binomial error distribution, commonly referred to as logistic regression. For all models, the probability of a fish being female was modeled as the response variable. In addition, to analyze spatial dependence in sex ratio within each fishery, an autologistic model was applied where the autocovariate at a given sampling location was calculated as the inverse distance-weighted average of the fraction of fish that were female at all other sampling locations (Augustin et al. 1996).

When comparing the von Bertalanffy growth model, Morson et al (2013 MS) found differences in growth rates between sexes and areas, with summer flounder north of Cape Hatteras showing different trends in growth than those to the south. Fish grew faster in the Central and North region than in the South region, but there was no significant difference in growth rates between the North and Central regions. Growth differences between areas is consistent with Kraus and Musick (2001) which found latitudinal variation in growth rates and concluded that evidence supported the existence of stocks north and south of Cape Hatteras, with the stock north of Cape Hatteras possibly composed of two distinct spawning aggregations, off New Jersey and Virginia-North Carolina.

That the recreational fishery (RF) lands more females at a given length than the commercial fishery (CF) or the NMFS-NEFSC trawl surveys (NF) is not surprising (Figure A180). Morson *et al.* (2012) found a similarly high fraction female on a more localized scale in the recreational fishery in New Jersey and offered two explanations for why female fish are more common in recreational landings when compared to ocean trawl surveys. First, recreational fishing gear may select for female fish. Lozan (1992) found that female dab flounder (*Pleuronectes limanda*) consumed 73% more food than males of the same size. Recreational fishing depends entirely on the willingness of a fish to attack bait on a line. If female summer flounder eat more and are more aggressive predators, then the RF would land a higher fraction of female fish at a given length than the fraction potentially available in the region. Alternatively, the sex ratio at a given length observed in the RF could be an accurate representation of the sex ratio of summer flounder in the region when and where the fish were landed. In this case, some explanation needs to be advanced for why the sex ratio would be so heavily skewed toward female fish at the location and time of the RF. The RF operates inshore from late spring to early fall. If fewer male fish migrate inshore in the spring, then fewer males would be available to a fishery that takes place primarily inshore during the summer months. In this case, trawl surveys or commercial fishing methods carried out offshore or during other periods of the year might not be appropriate for describing the sex ratio of landings in the RF.

When sex-at-age data are compared among the RF, CF, and NF, Morson *et al.* (2013MS) found it was immediately clear that a population-wide sex-at-age key developed from NF data would not be appropriate to describe sex-at-age in either the CF or the RF (Figures A181-A182). This makes intuitive sense because the size limits in both fisheries will automatically select larger fish at a given age and the faster growth rates of female summer flounder dictate that the sex ratio of these larger fish will be biased toward female. This is further supported when the NF database is sampled to mimic the size restrictions of the RF and CF. While the sex-at-age in the NF begins to resemble the sex-at-age in the RF and CF using this approach, statistically significant differences between sex-at-age in the NF and the landings still remain such that a sex-at-age key developed from NF data would not appropriately describe sex-at-age in either the CF or RF. One approach that could be considered for the CF would be to apply a sex-at-length key developed from NF data followed by a length-at-age key developed from CF data to arrive at an accurate measure of sex-at-age in the CF. However, such an approach would not be advisable in the RF given the disparity in sex-at-length when compared to NF data.

Morson *et al.* (2013 MS) concluded it was difficult to make a defensible recommendation for how often sex ratio data would need to be collected in either fishery with only two years of data to compare, but temporal variation in sex ratio of landings seems likely given that a significant difference was noted in the RF in back-to-back sampling years. Morson *et al.* (2013 MS) found that for both fisheries, the spatial variation in sex ratio was best described by statistical area instead of region, latitude, or a distance-weighted spatial autocovariate. This would suggest that spatial variation in sex ratio happens at fine scales and to most appropriately account for that variation, sex ratio data would need to be collected from all statistical areas where fish are typically landed. Furthermore, in the RF, a clear trend of increasing fraction female with decreasing distance to shore and decreasing latitude was identified. Clearly, male fish are almost entirely absent from the RF south of Long Island, while off the coast of southern New England, male fish are nearly as abundant as in the CF. In bays and estuaries the fraction female is higher than in any statistical area along the coast, even at the highest latitudes. This latitudinal/closeness to shore trend in summer flounder sex ratio was evident on a smaller scale in New Jersey as well (Morson *et al.* 2012). That the fraction male is nearly as high in the RF in the northern statistical areas as in the CF would suggest that hook-and-line fishing does not preferentially target females. This provides evidence for sex-specific movements accounting for differences in sex ratio in the summer flounder RF. Perhaps males only migrate inshore at the most northern latitudes where water temperatures are cooler.

In summary, Morson *et al.* (2013 MS) concluded that summer flounder sex-at-length and sex-at-age keys developed from NMFS-NEFSC ocean trawl data would not be appropriate for describing the sex ratio of recreational landings. They found, however, that sex-at-length of summer flounder landed in the commercial fishery was well described by data collected on the NMFS-NEFSC ocean trawl survey, and that the best approach could be to 1) apply a NMFS-NEFSC sex-at-length key to commercial landings length data, and then 2) apply a commercial landings length-at-age key to arrive at an accurate measure of sex-at-age in the commercial fishery. Variation in sex ratio in both the recreational and commercial fisheries was observed to occur at fine spatial scales and perhaps over short time periods. Morson *et al.* (2013 MS) further concluded that if a desire exists to accurately define sex ratio in either fishery with empirical data collection, this spatiotemporal variability might require a regular and spatially extensive sampling program in the future.

The SARC 57 Review Panel concluded that Term of Reference 3 was met.

TOR 4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series (integrating results from TOR-3), and estimate their uncertainty. Explore inclusion of multiple fleets in the model. Include both internal and historical retrospective analyses to allow a comparison with previous assessment results and previous projections.

2013 MODEL DEVELOPMENT

Background and Existing Model Updated through 2012

Fishing mortality rates and stock sizes were estimated using the Age Structured Assessment Program (ASAP) statistical catch at age model (Legault and Restrepo 1998, NFT 2012a, 2013a). ASAP is an age-structured model that uses forward computations assuming the separability of fishing mortality into year and age components to estimate population sizes given observed catches, catch-at-age, and indices of abundance. The separability assumption is partially relaxed by allowing for fleet-specific computations and by allowing the selectivity-at-age to change in blocks of time. Weights (emphasis factors) are input for different components of the objective function 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 at age compositions are generally modeled assuming a multinomial distribution, while most other model components are assumed to have lognormal error. Specifically, lognormal error distributions were assumed for the total catch in weight, research survey catch at age calibration indices, selectivity parameters, annual fishing mortality parameters, survey catchability parameters, estimated stock numbers at age, and Beverton-Holt stock-recruitment parameters, when estimated. 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-recruitment relationship).

In the summer flounder ASAP model an age-specific instantaneous natural mortality rate providing an average M = 0.25 was assumed for all years. Seasonal survey indices and all survey recruitment (age-0) indices were compared to population numbers of the same age at the appropriate season of the same year. A multinomial distribution was assumed for fishery catch at age and for survey catch at age when required. A number of additional initial model settings including specification of the likelihood component emphasis factors (weights or lambdas, L), size of deviation factors expressed as standard deviations (i.e., ln-scale CV), and penalty functions for extreme fishing mortality estimates. These were set at consensus values by the 2013 SDWG after multiple sensitivity runs to evaluate a range of inputs.

The 2013 SAW 57 model development process started with the 2012 updated assessment model run with data through 2011 (Terceiro 2012), which differed from the previous 2008 SAW 47 benchmark assessment ASAP model (NEFSC 2008a) only in the setting of the fleet Effective Sample Size (ESS) and two stock-recruitment (S-R) function priors which were set to zero. The 2008 SAW 47 assessment process had considered models with one, two variations of two fleet, four, and six fishery fleet configurations.

Differences between the two and four fleet models were relatively minor, but convergence problems were encountered for some configurations of the six fleet model. The 2008 and 2012 models included two fleets, one for fishery landings and one for fishery discards. The 2008 and 2012 models estimated fishery landings selectivity using a single logistic two parameter function (forcing asymptotic or 'flat-topped' selection) and fishery discards using a double logistic four parameter function (allowing for domed selection; Fishery Logistic Double Logistic; model acronym FLDL). Two fishery selectivity time blocks were specified for both landings and discards: 1982-1994 and 1995 to the terminal year, with the break roughly corresponding to the full implementation of major management regulations and a major change in the commercial landings reporting system. The fishery selectivities were set with L = 1, in effect specifying a prior on the initial values.

Other 2008 SAW 47 and 2012 model details included 1) total fishery catch L set at 10, to mimic the setting of the 2008 SAW 47 Stock Synthesis model that was also under consideration at the time, 2) landings and discards CV = 0.1, 3) landings fleet age composition ESS = 153 and discards fleet age composition ESS = 100, 4) fishing mortality (F) and stock size (N) in year 1 CV = 0.9 and L = 0.1, and 5) S-R function and population scaler Ls = 0, effectively 'turning off' the influence of the S-R function in the model by setting those likelihood components to zero.

Survey indices in the 2008 and 2012 ASAP models were configured as in an ADAPT VPA, with each survey index-at-age (IAA) entered as an individual time series, with a catchability coefficient (q) is estimated for each index-at-age. As such, there are no survey 'age-compositions,' and no ESS is set or estimated. Table A82 provides a summary of the initial steps in building the 2013 model configuration and settings, while Table A83 provides summary results. Important changes between modeling steps are highlighted with bold text.

Model F57-IAA-IND47-FLDL is the first of the 2013 SAW 57 models, with the same configuration and settings as the 2012 model (which had data through 2011) and data updated through 2012. Surveys are configured as independent indices at age (IAA), the index set included in the model is the same as in the 2008 and 2012 assessments (IND47), and fishery selection is modeled as a single logistic for landings and double logistic for discards (FLDL). As a starting point, the fishery ESS were set at 100 for both fleets. Model F57-IAA-IND47-FLDL provides estimates appropriate to compare with the old (existing) reference points, which are FMSY proxy = F35% = 0.310 and SSBMSY proxy = SSBMSY35% = 60,094 mt (TOR 6a). This model indicates that F in 2012 = 0.180 and SSB in 2012 = 60,905 mt, so the stock was not overfished and overfishing was not occurring (see also TOR 6a). Summary results from the 2008 and 2012 assessments are compared with those from run F57-IAA-IND47-FLDL in Figures A183-A184.

The subsequent model building occurred in two 'phases.' In the first, new (revised) maturity and commercial discard estimates were added to the model, several structural changes were made to fishery selectivity and survey configurations, and several new survey series were added to the model. The end product of phase 1 was the BASE run for subsequent modification. In phase 2, the BASE run was changed to provide improved statistical diagnostics through several 'tuning' steps and a few input data modifications.

Model Building Phase 1

Each model configuration change (step) in phase 1 generally builds on the previous step, unless noted. Step 1 in phase 1 was to revise the maturity schedule with the 3 year moving window, no resting females estimates (model F57-IAA-IND47-FLDL-**MAT3NOT**) described earlier in the MATURITY section. These new maturity data resulted in a small decrease (4-5%) in the most recent estimates of SSB. Next, the revised commercial fishery discard estimates were added to the model (model F57-IAA-IND47-FLDL-MAT3NOT-**NEWDISC**); this change also resulted in relatively small annual changes in the SSB estimates in both directions over the time series, and about 10% increases in the most recent estimates of fishing mortality (Tables A82-A83, Figures A185-A186).

The next two steps changed the model structure in two major ways to follow current standard practice for NEFSC statistical catch at age models. First, the fishery selectivity models for both landings and discards were changed to 'estimates-at-age' (Fishery selectivity at AGE; model acronym FAGE), wherein at least one age is fixed with selection (S) = 1 and other selectivities at age are estimated relative to the reference age or ages. The references ages were age 3 (model age 4) in the first landings time block (1982-1994) and age 4 in the second time block (1995-2012), and ages 1 and 2 in the two discard time blocks. These selectivities were set with L = 1, in effect specifying a prior on the initial values. The changes in the fishery selection models resulted in a moderate dome for the oldest two landed ages in the second time block and a stronger dome for the discards, and corresponding 10-20% decreases in F and similar magnitude increases in SSB (model F57-IAA-IND47-**FAGE**-MAT3NOT-NEWDISC; Tables A82-A83, Figures A185-A186).

In the second structural change, the survey index configuration was modified from individual indices-at-age with separate qs (IAA) to aggregate indices (in numbers) with associated age compositions modeled as proportions that follow the multinomial distribution (MULTI). In this configuration, each aggregate index has a specified input CV and the associated age composition has the 'estimates-at-age' selection pattern either estimated (for surveys with several ages) or fixed = 1 (for single age, young-of-the-year [YOY] age 0 surveys). Survey selectivities were set L = 0 and so were not a component of the objective function. The changes in survey index configuration resulted in 10-20% increases in F and similar magnitude decreases in SSB (model F57-**MULTI**-IND47-FAGE-MAT3NOT-NEWDISC; Tables A82-A83, Figures A185-A186).

The last step in phase 1 was to add several new survey time series to the model: the VIMS ChesMMAP trawl, VIMS NEAMAP spring and fall trawl, the URIGSO trawl, and the NY trawl. The addition of these new surveys resulted in about a 10% decrease in F and comparable increase in SSB in the most recent years (model F57-MULTI-**ALLSV**-FAGE-MAT3NOT-NEWDISC; Tables A82-A83, Figures A185-A186).

Model Building Phase 2

As in phase 1, each change in phase 2 generally builds on the previous step, unless noted, and changes in model setting and results are summarized in Tables A84-A87. Step 1 in phase 2 was to remove the prior (L=1 to L=0) for F and N in year 1 of the model, removing these parameters from the objective function, creating the F57_BASE_1 model which estimated slightly reduced recruitment (R; ~3%) and F (~5-10%) and increased SSB (~7%) in the first selectivity time block.

In step 2, the DEDFW trawl survey index was shortened to 2003 and later years, based on information provided during the SDWG meeting the entire series was not comparable due to an un-calibrated vessel change. This change increased recent SSB (~10-15%) and R (~5-10%) and decreased recent F estimates (~10%; F57_BASE_2).

In F57_BASE_3, the total fishery catch lambda was changed from 10 to 1 (L=1), resulting in a re-scaling of the objective function and a minor decrease in recent SSB.

In F57_BASE_4, the NEFSC MARMAP and ECOMON larval survey indices of SSB, which were submitted for consideration just before the SDWG meeting, were included. These new surveys resulted in a minor decrease in recent SSB.

The first model 'tuning' step was undertaken in run F57_BASE_5. The input aggregate survey CVs, generally the means of the empirical time series averages, are intended to characterize the sampling error of those series. However, it is recognized that additional process (model) error may be present in the survey indices that are not reflected in the input CVs, as diagnosed by the distance of the Root Mean Square Error (RMSE) of each series from 1 (see the ASAP User Manual for ASAP3; NFT 2012b). Examination of the model diagnostics for the survey indices resulted in adjustments to the survey CVs, thereby allowing for larger deviations to bring their respective RMSEs within or close to the expected confidence intervals (CI) for the number of observations. Generally, input CVs of 0.3 (e.g., the NEFSC surveys) were increased to 0.4, input CVs of 0.4 (the state agency surveys) were increased to 0.6, and input CVs of 0.6 (the YOY indices) were increased to 0.9., to account for additional process error in run F57_BASE_5. This changed increased recent F by ~10-15% and decreased recent SSB by a comparable degree, relative to run F57_BASE_4.

Inspection of the F57_BASE_5 diagnostics revealed that a few of the survey RMSE were still outside their expected CIs, and so in a second 'tuning' step the CVs for those series were increased by an additional 0.1, creating run F57_BASE_6. This changed increased recent F by ~10-15% and decreased recent SSB by a comparable degree, relative to run F57_BASE_5.

Run F57_BASE_7 was configured by setting the fishery selectivity lambdas to L = 0, effectively removing the prior and omitting them from the objective function. This change allowed for a more extreme domed selection pattern for both landings and discards in both time blocks, and resulted in slightly lower F and slightly higher SSB in both periods. However, this configuration resulted in a more severe retrospective pattern (increasing the total error range for F by about 10%).

Run F57_BASE_8 retained the fishery selectivity Ls = 0 of run 7, but fixed the fishery landings selection at 1 for ages 3 and older in the first time block and ages 4 and older in the second time block. Forcing flat-topped landings selectivity in this way increased F by ~50-60% early in the time series and by ~15-30% late in the time series, with corresponding but smaller decreases in SSB.

A pattern in fishery age composition residuals for 2008 and later years had persisted through all the BASE run configurations. Run F57_BASE_9 build upon run 6, adding a third fishery selection block for 2008 and later years, with the fishery selection Ls = 1 and S = 1 for age 4 for the landings and age 2 for discards. This change resolved the fishery age composition residual pattern, and the third selection block was retained in subsequent runs.

The NCDMF member of the SDWG expressed a new concern that the NCDMF Pamlico Sound trawl survey YOY index might include a significant contribution of fish from the South Atlantic Bight stock of summer flounder, and so might not provide a valid index of recruitment. The NCDMF YOY survey was therefore removed from run 9, creating run F57_BASE_10, which provided slightly reduced estimates of recruitment (age 0) for the most recent years. With run F57_BASE_10, the modeling of the landings with a domed selectivity pattern was accepted, and it became evident that the average F for all catch also exhibited a domed pattern, such that the expression of 'fully-recruited' F was changed from ages 3-7+ to the F at S = 1 for age 4. Thus, the change in F from run 9 to 10 reflects this reporting change that is carried forward in all subsequent runs.

Inspection of the precision of all the estimated parameters of run F57_BASE_10 revealed that several of the survey selection parameters at age were poorly estimated (either constrained at the bound or with large standard error; although note the survey selectivities are not part of the objective function as L = 0). In run F57_BASE_11, constrained selection parameters at 1 were fixed at S = 1, while poorly estimated selection parameters at age (typically for the youngest or oldest ages in state agency surveys) were fixed near the value of the nearest acceptably estimated age (generally with parameter CV < 0.6). These changes resulted in a 'flatter' selection pattern in the both the landings and discards, higher recent F (as noted above now reported for age 4) and decreased recent SSB (~10%).

Maunder (2013c MS; WPA17) conducted a likelihood profile of run F57_BASE_10 over the population scaling parameter SSB0 (unexploited SSB), and suggested that the SDWG consider down-weighting the fishery and survey age composition data relative to the catch weight and aggregate survey indices. The SDWG therefore applied the Francis (2011) age composition weighting adjustments (calculated internally in ASAP; NFT 2012b) in following this recommendation, creating run F57_BASE_12. In this run, the fishery landings age composition ESS was reduced from 100 to 55, the fishery discards age composition ESS was reduced from 100 to 30, and the various survey age composition ESSs were adjusted from the 'default' 10 to values ranging 53 for the VIMS NEAMAP fall survey to 4 for the MADMF spring survey. This last model 'tuning' step reduced recent F by about 5-10%, reduced recent R by about 5-10%, and reduced recent SSB by about 2% (Tables A86-A87).

The estimation results for F57_BASE runs 1, 2, 6, 9, and 12, between which the largest 'phase 2' changes in estimates occurred, are summarized in Figures A187-A188. F57_BASE_1 is the model that includes all of the new maturity, commercial discards, and survey data, as well as the two major model structural changes to fishery selection-at-age and multinomial survey indices. F57_BASE_2 drops the early part of the DEDFW trawl surveys (uncalibrated vessel change), which exhibited large negative residuals for all ages during early model development. F57_BASE_6 incorporates the two steps of survey CV 'tuning' to better characterize suspected process (model) error. F57_BASE_9 incorporates the third fishery selectivity block for years 2008 and later.

Final run F57_BASE_12 incorporates the Francis (2011) adjustments to fishery and survey age composition ESS. As calibration indices, final run F57_BASE_12 uses a) indices of stock abundance including age compositions from the NEFSC winter, spring, and fall, Massachusetts spring and fall, Rhode Island fall and monthly fixed, Connecticut spring and fall, Delaware, New York, New Jersey, VIMS ChesMMAP, and VIMS NEAMAP spring and fall trawl surveys, b) aggregate indices of stock abundance from the URI GSO trawl survey and NEFSC MARMAP and ECOMON larval surveys, and c) stand-alone recruitment indices (age 0; Young-Of-the-Year, YOY) from surveys conducted by the states of Massachusetts, Delaware, Maryland, and Virginia.

Final 2013 SAW 57 Model: Run F57_BASE_12

Model Fit Diagnostics

Figure A189 shows the distribution of objective function components contribution to total likelihood. Figure A190 shows the RMSE for the aggregate survey indices, with all close to or inside the 95% confidence for RMSE except for the MADMF YOY index, which was still well outside the confidence interval even with the input CV increased to 1.0. The aggregate landings and discards catch and age composition fit diagnostics and residuals are presented in Figures A191-A199. The addition of the third selectivity block for 2008 and later largely eliminated a residual pattern in the fishery age composition residuals. The large discards age composition residual in 1995 could not be resolved as it is due to a large and imprecise discard estimate. The aggregate survey index and age composition fit diagnostics and residuals are presented in Figures A200-A237. Patterns in the aggregate survey index residuals and age compositions (e.g., the RIDFW fall [RIF] and monthly [RIX] indices Figures A210-A213; the URIGSO index Figure A235) were addressed by adjusting the SV CV and ESS where applicable as noted above, rather than by removing the surveys from the model.

Likelihood Profile over assumptions for Natural Mortality (M)

Run F57_BASE_12 (age-varying M from 0.26 to 0.24 with a mean of 0.25) was also run with M values from 0.1 to 0.4 (constant at all ages over times) to help judge which assumption for M fit best, given the diagnostic of total minimum log-likelihood (value of the total objective function). Figure A238 indicates equally good model fits for M values ranging from 0.20 to 0.30. Results for sensitivity runs with constant M = 0.2 and constant M = 0.3, bracketing run F57_BASE_12, are presented in Figures A239-A240.

Retrospective Analyses

An 'internal' retrospective analysis for the F57_BASE_12 was conducted to examine the stability of the model estimates as data were removed from the end of the time series. Retrospective runs were made for terminal years back to 2005. The summer flounder stock assessment has historically exhibited a retrospective pattern of underestimation of F and overestimation of SSB; the causes of this previous pattern have not been determined. In the current assessment model, however, no persistent retrospective patterns are evident. Over the last 7 years, the annual retrospective change in fishing mortality has ranged from +22% in 2006 to -5% in 2009 (Figure A241), the annual retrospective change in SSB has ranged from -2% in 2011 to -21% 2006 (Figure A242), and the annual retrospective change in recruitment has ranged from -45 in 2005 to +33% in 2009 (Figure A243).

The 2008 SAW 47 benchmark assessment, the 2009-2012 assessment updates, and final model F57_BASE_12 (2013 SAW 57) results are compared in Figures A244-A246. The ASAP model has been used in the assessment during the 2008-2013 period, but due to changes in fishery selectivity estimation, 'fully-recruited' F is reported for ages 3-7+ in the 2008-2012 assessments, but only for 'peak' age 4 (S=1) in the 2013 assessment. A long-term retrospective look over all assessments dating back to 1990 is provided in Figure A247. It should be noted that the ADAPT VPA model was used for the 1990-2007 assessments, and fully recruited F was reported for age 2-7+. Also, the assumed value for natural mortality (M) changed from 0.2 for all ages in the 1990-2007 assessments to an average value of 0.25 in the 2008-2013 assessments. Despite these changes in model assumptions, configurations, and estimation procedures, the 'historical' retrospectives indicate that general trends of fishing mortality, stock biomass, and recruitment have been consistent since the 1990s assessments.

2013 FISHING MORTALITY RATE AND STOCK SIZE ESTIMATES

In the landings, the selection of age 1 fish decreased from about 0.4 during the first time block of selectivity estimation (1982-1994) to about 0.1 or less during the second and third blocks, 1995-2007 and 2008-2012. The selection of age 2 fish decreased from 1.0 during the first block to about 0.6 during the second block to about 0.2 during the third block. The selection of age 3 fish decreased from 1.0 during the first and second blocks to about 0.6 during the third selection block, 2007-2012. The selection of age 4-6 fish increased from about 0.7 during the first block to 1.0 during the second and third blocks. The selection of age 7+ fish declined from about 0.9 in the first block to about 0.7 in the second and third blocks (Table A87). The decreases in landings selection at ages 1-3 are in line with expectations given changes in commercial and recreational fishery minimum size regulations.

In the discards, the selection of age 0 fish was about 0.1 for all three selectivity time blocks. The selection of age 1 fish decreased from 1.0 during the first block to 0.5-0.6 during the second and third blocks. The selection of age 2 fish increased from about 0.2 during the first block to 1.0 during the second and third blocks. The selection of age 3 fish increased from about 0.1 during the first block to about 0.7 in the second block and to about 0.9 in the third block. The selection of age 4 fish increased from about 0.1 during the first block to about 0.5 in the second block and to about 0.8 in the third block. The selection of age 5-7+ fish increased from about 0.1 during the first block to 0.5-0.6 during the second and third blocks (Table A87). These changes in discards selection are in line with expectations given changes in commercial and recreational fishery regulations, as fish at ages 2 and older became more frequently discarded due to increasing size limits in the recreational fishery and more frequent fishery closures and restrictive trip limits in both commercial and recreational fisheries.

The overall selection pattern has a domed shaped pattern, with the peak in selection (S=1.0) in the third fishery selectivity block occurring for age 4 (model age 5). For this reason, summer flounder are currently considered to be fully recruited to the fisheries at age 4, and fully recruited fishing mortality for comparison with reference points is expressed as the fishing mortality at age 4 (‘full’ F, ‘peak’ F, ‘apical’ F, where selectivity = 1.0).

Summary model results are provided in Table A88, and population number and fishing mortality estimates at age are provided in Tables A89-A90. Fishing mortality on the fully selected age 4 fish ranged between 0.790 and 1.745 during 1982-1996. The fishing mortality rate has decreased from 0.849 in 1997 to 0.285 in 2012 (Figure A248). There is a 90% probability that the fishing mortality rate in 2012 was between 0.213 and 0.343 (Figure A249). Spawning stock biomass (SSB) decreased from 24,300 mt in 1982 to 5,521 mt in 1989, and then increased to a peak of 53,156 mt by 2010. SSB was 51,238 mt in 2012, about 82% of the new reference point SSBMSY proxy = SSB35% = 62,394 mt (Figure A250-A251). There is a 90% probability that SSB in 2012 was between 45,781 and 61,297 mt (Figure A252). The average recruitment from 1982 to 2012 is 43 million fish at age 0. The 1982 and 1983 year classes are the largest in the assessment time series, at 62 and 76 million fish; the 1988 year class is the smallest at only 10 million fish. The 2012 year class is currently estimated to be about 37 million fish (Figures A250-A251).

The SARC 57 Review Panel concluded that Term of Reference 4 was met.

TOR 5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} 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.

BIOLOGICAL REFERENCE POINTS (BRPs)

Background

The calculation of biological reference points for summer flounder based on yield per recruit analysis using the Thompson and Bell (1934) model was first detailed in the 1990 SAW 11 assessment (NEFC 1990). The 1990 analysis estimated that Fmax = 0.230. In the 1997 SAW 25 assessment (NEFSC 1997) an updated yield per recruit analysis reflecting the fishery selection pattern and mean weights at age for 1995-1996 estimated that Fmax = 0.240. The Overfishing Definition Review Panel (Applegate et al. 1998) recommended that the MAFMC base MSY proxy reference points on yield per recruit analysis and this recommendation was adopted in formulating the FMP Amendment 12 Overfishing Definition (MAFMC 1999). These reference points were based on the 1999 assessment (Terceiro 1999) and followed what would later be described as the 'non-parametric approach' (i.e., biomass reference points calculated as the product of biomass per recruit and a reference period recruitment level; NEFSC 2002b). The analysis in the Terceiro (1999) assessment, reflecting fishery selection and mean weights at age for 1997-1998, indicated that Fthreshold = Ftarget= Fmax = 0.263, yield per recruit (Y/R) at Fmax was 0.552 kg/recruit, and January 1 Total Stock Biomass per recruit (TSB/R) at Fmax was 2.813 kg/recruit. The median number of summer flounder recruits estimated from the 1999 assessment for 1982-1998 was 37.8 million age-0 fish. Based on this median recruitment level, maximum sustainable yield (Ymax as a proxy for MSY) was estimated to be 20,897 mt (46.070 million lbs) at a Total Stock Biomass (TSBmax as a proxy for BMSY) of 106,444 mt (234.669 million lbs). The biomass threshold, one-half TSBmax as a proxy for one-half BMSY, was therefore estimated to be 53,222 mt (117.334 million lbs). The Terceiro (1999) reference points were retained in the 2000 SAW 31 assessment (NEFSC 2000) because of the stability of the input data and resulting biological reference point estimates.

The MAFMC SSC conducted a peer review of the summer flounder Overfishing Definition in concert with the 2001 assessment (MAFMC 2001a, b). The 2001 SSC reviewed six analyses estimating biological reference points for summer flounder that were conducted by members of the Summer Flounder Biological Reference Point Working Group. The 2001 SSC decided that although the new analyses conducted by the Working Group had resulted in a wide range of estimates, they did not provide a reliable alternative set of reference points for summer flounder. The 2001 SSC therefore recommended that Ftarget remain at the Terceiro (1999) estimate of Fmax = 0.263 because a better estimate had not been established by any of the new analyses. The 2001 SSC also reviewed the biomass target (BMSY) and threshold (one-half BMSY) components of the Overfishing Definition and concluded that the new analyses did not justify an alternative estimate of the BMSY proxy. The 2001 SSC endorsed the recommendations of the 2000 SAW 31 which stated that ‘The use of Fmax as a proxy for FMSY should be reconsidered as more information on the dynamics of growth in relation to biomass and the shape of the stock recruitment function become available’ (NEFSC 2000). The 2001 SSC agreed that additional years of stock and recruitment data should be collected and encouraged further model development, including model evaluation through simulation studies. They also encouraged the evaluation of alternative proxies for biological reference points that might be more appropriate for an early maturing species like summer flounder and the development and evaluation of management strategies for fisheries where BMSY is unknown. The 2001 SSC indicated that as the stock size increases, population dynamic processes that could reflect density dependent mechanisms should be more closely monitored and corresponding analyses should be expanded, i.e., rates of size and age, maturity, fecundity, and egg viability should be closely monitored as potential indicators of compensation at higher stock sizes. Finally, the 2001 SSC recommended that potential environmental influences on recruitment, including oceanographic changes and predation mortality, should be reevaluated as additional recruitment data become available. As a result of the 2001 SSC peer review (MAFMC 2001a) the Terceiro (1999) reference points were retained in the 2001 stock assessment (MAFMC 2001b). In the review of the 2002 stock assessment (NEFSC 2002a), SAW 35 concluded that revision of the reference points was not warranted at that time due to the continuing stability of the input data and resulting reference point estimates. The Terceiro (1999) reference points were subsequently retained in the 2003 (Terceiro 2003a) assessment.

The biological reference points for summer flounder were next peer-reviewed by the 2005 SAW 41, using fishery data through 2004 and research survey data through 2004/2005 (NEFSC 2005). The SAW 41 Panel noted that the Beverton-Holt (Beverton and Holt, 1957; Mace and Doonan 1988; BH) model fit the observed stock-recruitment data well, and provided reference points comparable to those derived from a non-parametric (yield and biomass per recruit) approach. The SAW 41 Panel noted, however, that the quantity of observed stock-recruitment data was limited (22 years), and the data during the early part of the time series, when the SSB was at the lowest observed levels, indicated a level of recruitment near the estimated Rmax, and exerted a high degree of leverage on the estimation of the model parameters. This leverage resulted in a high value (0.984) for the calculated steepness (h) of the BH curve, outside of the $\pm$ one standard error interval of the estimate for Pleuronectid flatfish (0.8 $\pm$ 0.1) indicated by Myers et al. (1999). The BH model results suggested that summer flounder SSB could fall to very low levels (<2,000 mt) and still produce recruitment near that produced at SSBMSY. The SAW 41 Panel concluded a) that this result might not be reasonable for the long term, given the recent stock-recruitment history of the stock (i.e., production of a very poor year class in 1988), b) the BH model estimated parameters might prove to be sensitive to subsequent additional years of S-R data, especially if they accumulated at higher levels of SSB and recruitment in the near term, and c) the BH model fit might also be sensitive to the magnitude of recently estimated spawning stock and recruitment, given the recent retrospective pattern of overestimation of stock size evident in the assessment. Given these concerns, the SAW 41 Panel advised that the BH model estimates were not suitable for use as biological reference points for summer flounder, and recommended continued use of reference points developed using the non-parametric model approach. FMP biological reference points from the 2005 assessment were Fmax = FMSY = 0.276, Ymax = MSY = 19,072 mt (42.047 million lbs), TSBmax = BMSY = 92,645 mt (204.247 million lbs), and biomass threshold of 0.5*TSBmax = 46,323 mt (102.125 million lbs; NEFSC 2005).

The biological reference points for summer flounder were peer-reviewed again in 2006 by the National Marine Fisheries Service (NMFS) Office of Science and Technology (S&T) (Methot 2006). The 2006 S&T Peer Review recommended using SSB, rather than TSB as in previous assessments, as the metric for the biomass reference point proxy. The product of the mean recruitment (37.0 million fish) and Y/R at Fmax was 21,444 mt = 47.276 million lbs (as the proxy for MSY); the product of the mean recruitment and SSB/R at Fmax was 89,411 mt = 197.118 million lbs (as the proxy for BMSY; Terceiro 2006a, b). The 2006 S&T Peer Review Panel (Methot 2006) recommended adoption of these biological reference points from the non-parametric approach for summer flounder, advising:

"The low level of recruitment observed in 2005 is essentially the same as the low 1988 recruitment, so it is within the range of recruitment fluctuation used in calculating the expected time to rebuild this stock. The Panel finds that the most representative approach to calculating BRPs and rebuilding rates would be to use the entire set of recruitments from 1982-2005. The average, not median, of these recruitments should be used for calculation of biological reference points because much of the stock's accumulated biomass comes from the larger recruitments. Random draws from this set of recruitments would provide a probability distribution of rebuilding rates that is consistent with the occasional occurrence of small recruitments (1988 and 2005) and large recruitments (1982-1987). There is no documented and obvious reason why recruitments were higher during 1982-1987. If such recruitment levels become more common as the stock rebuilds, then the stock may rebuild to an even higher level than is currently targeted. If such recruitment levels do not occur during the next few years of the rebuilding, then the rebuilding target may be not be achieved by the target time to rebuild. More precise forecasts than this are not feasible."

The two biological reference point estimation approaches previously used in the 2005 SAW 41 (NEFSC 2005) and 2006 S&T Peer Review (Terceiro 2006b) assessments were again applied in the 2008 SAW 47 benchmark assessment work (NEFSC 2008). Objective application of either approach is often compromised by lack of sufficient observation on stock and recruitment over a range of biomass to provide suitable contrast. Thus, it is often necessary to extrapolate beyond the range of observation and to infer the shape of the stock-recruit relationship from limited and variable observations (NEFSC 2002b). The 2001 MAFMC SSC review of summer flounder reference points also noted this concern (MAFMC 2001a).

The non-parametric approach was to evaluate various statistical moments (mean, variance, percentiles) of the observed series of recruitment data and apply the estimated spawning stock biomass and yield per recruit associated with common F reference points to derive the implied spawning stock biomass and equilibrium total yield (landings plus discards). The biomass and yield per recruit models were fit using the NOAA Fisheries Toolbox (NFT) YPR software (NFT 2013b). The full time series of recruitment during

1982-2007 as estimated in the 2008 SAW47 assessment was used in the yield and spawning stock biomass calculations at fishing mortality reference points, as per the 2006 S&T Peer Review Panel recommendation. The non-parametric approach assumes that compensatory mechanisms such as impaired growth, maturity, or recruit survival are negligible over the range of biomass considered (NEFSC 2002b). Once the Fmax reference point (i.e., the Fmax proxy for FMSY) was determined, a long-term (100 year) stochastic projection of stock sizes and catches was done to provide better consistency between the estimated medians of the BRP calculations and shorter-term (e.g., 1-5 year) projections (Legault 2008).

The parametric approach used fitted parametric stock-recruitment models along with yield and spawning biomass per recruit information to calculate MSY-based reference points following the procedure of Sissenwine and Shepherd (1987). Stock-recruitment models were fit using the NFT SRFIT version 6 software (NFT 2008). Since a wide range of models (Beverton-Holt [BH] and Ricker [RK] models, incorporating autoregressive error, and Bayesian priors for various parameters) had been tested in the 2005 SAW 41 work, the 2008 SAW47 parametric model exercise was limited to the simple Beverton-Holt and Ricker models (Beverton and Holt 1957, Mace and Doonan 1988, Ricker 1954).

Old (Existing) Reference Points: 2008 SAW 47 Biological Reference Points (BRPs)

For the 2008 SAW 47 assessment, the ASAP model provided the basis for the 2008 biological reference points and stock status. Average values of mean weights at age in the catch and stock, maturity schedule, and fishery selection pattern for the period 2005-2007 were used as input for ages 0-7+ for BRP calculations. In previous assessments (NEFSC 2005 and earlier) for older aged fish (ages 8-15) with very limited or missing samples, Gompertz functions based on younger ages were used to estimate mean weights for the older ages in the BRP calculations. However, the practice of extending the age structure to age 15 and use of Gompertz weights for the older ages resulted in inconsistency between the BRP biomass estimates based on long-term stochastic projections and shorter-term (e.g., 1-5 year) projections used for Total Allowable Landings (TAL) calculations (NEFSC 2002b, Legault 2008). Therefore, to increase consistency between these two types of projections, the age range of the BRP and projection calculations was set at 0-7+, with 8 additional ages (to age 15) included in the plus group calculation of yield and spawning biomass per recruit. The mean weight at age for the plus group (ages 7+) was updated for the 2008 SAW47 assessment in a new way, by using a weighted average of mean weights for ages 7-15 (observed catch weights for ages 7-10; calculated weights for ages 11-15 as estimated from observed ages 0-10) based on the relative proportions at age given a 2007 total mortality rate of 0.55 (mean M = 0.25 + 2007 F = 0.30; this value is coincidently consistent with the F35% proxy for FMSY). The combined effects of the new assumption for M and the modeling of landings and discards as distinct fleets (which resulted in a slightly domed-shaped combined fishery selectivity pattern) resulted in higher estimates of F reference points, lower estimates of MSY, lower estimates of SSB reference points, and improved stock status with respect to both the F and SSB reference points, as compared to the S&T 2006 assessment.

The reference points estimated from the parametric approach were suspect because the Beverton-Holt function steepness (h) parameters were always very near 1.0. Therefore Fmax, F40%, and F35% (and their corresponding biomass reference points) from the non-parametric approach were considered as candidate proxies for FMSY and BMSY. Fmax had been used in previous assessments as the proxy for FMSY. The estimate of Fmax using mean M = 0.25 and updated fishery selectivity and mean weights at age was relatively high (0.558) and the YPR to F relationship did not indicate a well defined peak. As a result, little gain in YPR (<5%) was realized at fishing mortality rates higher than F35% = 0.310. However, the corresponding decline in SSBR between F35% = 0.310 (~1.48 kg/r) and Fmax = 0.558 (~0.93 kg/r) was about 37%. The 2008 SAW47 concluded that F40% = 0.254 and F35% = 0.310 were candidate proxies that provided sufficient YPR (F40% YPR = 92% of Fmax YPR; F35% YPR = 97% of Fmax YPR) to allow for productive fisheries while also providing for substantial SSBR (F40% SSBR = 176% of Fmax SSBR; F35% SSBR = 155% of Fmax SSBR) to buffer against short-term declines in recruitment. Recommended proxies for FMSY and SSBMSY were F35% = 0.310 and the associated MSY (13,122 mt = 28.929 million lbs) and SSBMSY (60,074 mt = 132.440 million lbs) estimates from long-term stochastic projections. F40% = 0.254 was recommended as a fishing mortality rate target for management. These 2008 SAW47 BRPs were subsequently adopted by the NMFS and MAFMC in the 2009 fishery regulation specification process, and were retained in the 2009-2012 updated assessments to evaluate stock status (Terceiro 2009, 2010, 2011, 2012).

New (Updated) 2013 SAW 57 Reference Points

In developing recommendations for biological reference points, the SDWG reviewed recent work on the subject. Shertzer and Conn (2012) conducted analyses that tested relationships between steepness and two life-history parameters linked to longevity (M and maturity) and found that in neither case was steepness significantly related to the life-history parameter. In Maunder (2012) and Maunder (2013b MS; WPA14) steepness parameters were examined for summer flounder using a Stock Synthesis model and information from the 2008 SAW 47 assessment, and it was proposed that a conservative 0.8 value of steepness suggests a maximum SPRMSY = 30% target proxy and accordingly a lower SPRMSY/SPR0 threshold proxy than the existing F35% proxy would be appropriate. Rothschild at el. (2012) conducted a simulation study of summer flounder biological reference points and also concluded that an SPR proxy less than the existing summer flounder reference points better corresponded to MSY and was appropriate. Mangel et al. (2013) examined fixing steepness and life history parameters for both production and age-structured models and concluded that priors could be used to estimate the S-R function if needed, but that if steepness was 1, the use of other proxies was appropriate. The 2013 SDWG used the NFT programs ASAP (NFT 2013a), YPR (NFT 2013b), and AGEPRO (NFT 2013c) to estimate parametric and non-parametric reference points for summer flounder. Input values for the reference point calculations and projections (see TOR 7) are presented in Table A91. Mean selectivities, mean weights, and mean maturities at age are averages for 2010-2012.

The parametric reference points estimated internally in ASAP for the F57_BASE_12 final model run were suspect because the Beverton-Holt function steepness parameters were always very near 1.0, and the FMSY was estimated to be 3.0, constrained at the estimation boundary (Table A92). Therefore, non-parametric Spawner per Recruit (SPR) reference points such as F40%, F35%, and F30% (and their corresponding biomass reference points) were considered as candidate proxies for FMSY and SSBMSY. Fmax had been used in assessments prior to 2008 as the proxy for FMSY, with the most recent 2008 SAW 47 assessment using F35% as the proxy. The current estimate of Fmax using mean M = 0.25 and updated fishery selectivity and mean weights at age is relatively high (0.48) and the Yield per Recruit (YPR) to F relationship does not indicate a well defined peak.

The SDWG discussed the merits of F30% = 0.378 and F35% = 0.309 as the fishing mortality reference point proxy. F30% provides an increase of about 2% in YPR over F35%, but a corresponding decline in Spawning Stock Biomass per Recruit (SSBR) of 14%. The SDWG recommends that the new (updated) proxies for FMSY and SSBMSY are F35% = 0.309 (CV = 15%) and associated estimates from long-term stochastic projections of MSY = 12,945 mt (28.539 million lbs; CV = 13%) and SSBMSY = 62,394 mt (137.555 million lbs; CV = 13%; Table A92). The new biomass threshold of one-half SSBMSY is estimated to be 31,197 mt (68.8 million lbs; CV = 13%).

The SARC 57 Review Panel concluded that Term of Reference 5 was met.

TOR 6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review.

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-5).

2013 STOCK STATUS

a. Old (Existing) Model and Reference Points

Model F57-IAA-IND47-FLDL is the first of the 2013 SAW 57 models with data through 2012, but with the same configuration and settings as the old (existing) 2012 model with data through 2011. Surveys are configured as independent indices at age (IAA), the index set included in the model is the same as in the 2008 and 2012 assessments (IND47), and fishery selection is modeled as a single logistic for landings and double logistic for discards (FLDL). Model F57-IAA-IND47-FLDL provides estimates appropriate to compare with the old (existing) reference points, which are FMSY proxy = F35% = 0.310 and SSBMSY proxy = SSBMSY35% = 60,094 mt (TOR 6a). This model indicates that F in 2012 = 0.180 and SSB in 2012 = 60,905 mt, so the stock was not overfished and overfishing was not occurring.

b. New (Updated) Model and Reference Points

Model run F57_BASE_12 is the final model adopted by the 2013 SDWG for the evaluation of stock status. The summer flounder stock was not overfished and overfishing was not occurring in 2012 relative to the new biological reference points updated in this 2013 SAW 57 assessment. The fishing mortality rate was estimated to be 0.285 in 2012, below the new threshold fishing mortality reference point = FMSY = F35% = 0.309. SSB was estimated to be 51,238 mt = 112.960 million lbs in 2012, 82% of the new biomass reference point = SSBMSY = SSB35% = 62,394 mt (137.555 million lbs; Figure A253).

The SARC 57 Review Panel concluded that Term of Reference 6 was met.

TOR 7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) and candidate ABCs (Acceptable Biological Catch; see Appendix to the SAW TORs).

a. **Provide annual projections (3 years). For given catches, 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).**

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.**

a) Stochastic projections were made to provide forecasts of stock size and catches in 2014-2016 consistent with the new (updated) 2013 SAW 57 biological reference points (Tables A91-A92). The projections do not explicitly account for the recent retrospective pattern in the assessment, as per the 2006 S&T Peer Review advice (Methot 2006, Terceiro 2006a, 2006b). The projections assume that recent (2010-2012) patterns of fishery selectivity, discarding, maturity at age and mean weight at age will continue over the time span of the projections. One hundred projections were made for each of 1000 Markov Chain Monte Carlo (MCMC) realizations of 2013 stock sizes using AGEPRO version 4.2 (300,000 total iterations with a thinning factor of 300; NFT 2013c). Future recruitment at age 0 was generated randomly from the probability density function of the updated recruitment series for 1982-2012 (average recruitment = 43 million fish).

If the 2013 Annual Catch Limit (ACL) of 10,133 mt = 22.339 million lbs, the 2013 median (50% probability) dead discards are projected to be 1,735 mt = 3.825 million lbs, and the median landings are projected to be 8,398 mt = 18.514 million lbs. The median F in 2013 is projected to be 0.250, below the new fishing mortality threshold = FMSY proxy = F35% = 0.309. The median SSB on November 1, 2013 is projected to be 56,662 mt = 124.918 million lbs, below the new biomass target SSBMSY proxy = SSB35% = 62,394 mt = 137.555 million lbs.

If the stock is fished at the new fishing mortality threshold = FMSY proxy = F35% = 0.309 in 2014, median landings are projected to be 9,961 mt = 21.960 million lbs, with median dead discards of 2,177 mt = 4.799 million lbs, and median total catch = 12,138 mt = 26.760 million lbs. This projected median total catch would be the Overfishing Limit (OFL) for 2014, and is less than the new MSY proxy = 12,945 mt (28.539 million lbs; 10,455 mt = 23.049 million lbs of median landings plus 2,490 mt = 5.490 million lbs of median dead discards). The median SSB on November 1, 2014 is projected to be 57,140 mt = 125.972 million lbs, 92% of the new biomass target of SSBMSY proxy = SSB35% = 62,394 mt = 137.555 million lbs. The projected catch estimates in the following table are medians of the catch distributions for fixed F in 2014-2016.

Total Catch (OFL), Landings, Dead Discards, Fishing Mortality (F)
and Spawning Stock Biomass (SSB) in 2014-2016
Catches and SSB in metric tons

Year	Total Catch	Landings	Discards	F	SSB
2014	12,138	9,961	2,177	0.309	57,140
2015	11,785	9,497	2,288	0.309	58,231
2016	11,914	9,527	2,387	0.309	59,268

If the MAFMC risk policy is applied by the SSC and this assessment is classified as “typical level 3,” given the size of the annual SSB relative to SSBMSY and assuming OFL CV = 100% and an annual OFL corresponding to F = 0.309, then results associated with Acceptable Biological Catch (ABC) follow:

ABC Total Catch, Landings, Dead Discards, Fishing Mortality (F)
and Spawning Stock Biomass (SSB) in 2014-2016
Catches and SSB in metric tons

Year	Total Catch	Landings	Discards	F	SSB
2014	8,071	6,649	1,422	0.197	60,581
2015	9,992	8,117	1,875	0.237	63,969
2016	10,729	8,681	2,048	0.245	66,469

For the projections at fixed FMSY proxy = F35% = 0.309, there is 0% probability of exceeding the fishing mortality threshold and 0% probability of falling below the biomass threshold during 2014-2016. For the ABC projections, there is a less than a 13% probability annually that fishing mortality will exceed the threshold and 0% probability annually that biomass will fall below the threshold.

b, c) All of the projection results presented have a realistic probability of being achieved, and the summer flounder stock has a low vulnerability to becoming overfished, given recent trends in stock productivity and the management regime in place.

The SARC 57 Review Panel concluded that Term of Reference 7 was met.

TOR 8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as MAFMC SSC model recommendations from 2012. Identify new research recommendations.

Major data and analytical needs for summer flounder assessments have been identified in the 2002 SAW 35 peer review, the 2003 assessment update, the 2005 SAW 41 assessment update, the SDWG 2006 assessment update and subsequent NOAA Fisheries Science and Technology peer review, the SDWG 2007 assessment update, the 2008 SAW 47 benchmark assessment, the 2012 MAFMC SSC review, and by the 2013 SDWG for this current benchmark assessment. Research recommendations are retained in these documents until they are addressed (completed or deemed obsolete). Therefore, these remaining recommendations have been subset as 8.1) completed, in progress, or to be addressed, and 8.2) new (identified by the SDWG SAW Working Group for this assessment).

8.1 Completed, To Be Addressed, or In Progress

1) Develop a program to annually sample the length and age frequency of summer flounder discards from the recreational fishery.

SDWG Response: To date, ongoing programs are in place in the MRFSS/MRIP recreational sampling and the American Littoral Society (ALS). Most states have volunteer angler surveys (NC, VA, MD, NJ, NY, CT, RI, MA) which collects length of fish discarded (and landed) via several different methods (e.g., surveys, e-logbooks, etc.). Some progress has been made, but more synoptic data and potentially less biased data are needed including the length, age, and sex-frequency of discards.

2) A comprehensive collection of otoliths, for all components of the catch-at-age matrix, needs to be collected on a continuing basis for fish larger than 60 cm (~7 years). The collection of otoliths and the proportion at sex for all of the catch components could provide a better indicator of stock productivity.

SDWG Response: Through a PMAFS study, 2 years of data collection has occurred to determine sex ratios in the commercial and recreational landings (Working Paper A13). This is not an ongoing study. One year of data collection has occurred to determine the sex of fish in the NJ state survey, and the MA state survey has had ongoing collection of sex data in their survey (2009-present). The Northeast region fishery sampling program now collects otoliths and scales for commercial landings, and is scheduled to start collecting individual weights.

3) A reference collection of summer flounder scales and otoliths should be developed to facilitate future quality control of summer flounder production aging. In addition, a comparison study between scales and otoliths as aging structures for summer flounder should be completed.

SDWG Response: An exchange of aging structures between NEFSC and NCDMF was completed in Fall 2006 and a report was reviewed by the 2007 SDWG, in response to a 2005 SAW 41 high priority Research Recommendation. An additional exchange occurred between the NC-DMF and the NEFSC in 2009. The SDWG notes that while the exchanges indicate that the current level of aging consistency between NC and NEFSC is acceptable, there is a need to conduct and fund exchanges between all production aging entities (e.g., NC, VIMS, ODU, NEFSC) using scales and otoliths more frequently, on a schedule consistent with benchmark assessments.

4) Collect information on overall fecundity for the stock, as both egg condition and production may be a better indicator of stock productivity than weight.

SDWG Response: This recommendation has not been fully addressed and remains an ongoing data collection need. An ongoing study conducted by Dr. Chris Chambers (NOAA NMFS NEFSC Sandy Hook Laboratory) is examining summer flounder fecundity and egg condition.

5) Investigate trends in sex ratios and mean lengths and weights of summer flounder in state agency and federal surveys catches.

SDWG Response: These trends were examined in great detail for the federal surveys for this assessment (WPA1). MADMF surveys collect sex data. The VIMS NEAMAP surveys collect sex data.

6) Use NEFSC fishery observer age-length keys for 1994 and later years (as they become available) to supplement NEFSC survey data in aging the commercial fishery discard.

SDWG Response: This recommendation has not been addressed by the SDWG, as the age data are not yet available.

7) Consider use of management strategy evaluation techniques to address the implications of harvest policies that incorporate consideration of retrospective patterns (see ICES Journal of Marine Science issue of May 2007).

SDWG Response: Given the retrospective pattern has changed since this recommendation was developed (i.e., smaller and less problematic), this recommendation is no longer considered relevant by the SDWG.

8) Consider treating scallop closed areas as separate strata in calculations of summer flounder discards in the commercial fisheries.

SDWG Response: This recommendation has not been addressed; however, the SDWG does not consider this to be an issue in the current discard estimation methods applied in this assessment.

9) Examine the sensitivity of the summer flounder assessment to the various unit stock hypotheses and evaluate spatial aspects of the stock to facilitate sex and spatially-explicit modeling of summer flounder.

SDWG Response: Progress has been made on aspects of this recommendation in WPA1, WPA8, WPA11, WPA12, and WPA15.

10) Conduct further research to examine the predator-prey interactions of summer flounder and other species, including food habitat studies, to better understand the influence of these other factors on the summer flounder population.

SDWG Response: WPA1 reviewed food habits data available on summer flounder predators and prey. The SDWG concludes that the data are not sufficient to estimate predator consumption of summer flounder and has not attempted to estimate summer flounder consumption of prey.

11) Collect and evaluate information on the reporting accuracy of recreational discards estimates in the recreational fishery.

SDWG response: Some research has been conducted on reporting accuracy in the recreational for-hire fishery (Bochenek et al. 2011); however, comprehensive work across all fishing modes has not been completed.

12) Examine male female ratio at age-0 and potential factors (e.g., environmental) that may influence determination of that ratio.

SDWG: The male female ratio has been updated for the NEFSC surveys. The SDWG reviewed information in Luckenbach et al. 2009 which describes potential environmental factors that may affect sex ratios at age-0.

13) Evaluate potential changes in fishery selectivity relative to the spawning potential of the stock; analysis should consider the potential influence of the recreational and commercial fisheries.

SDWG: Some progress has been made on this topic in a report prepared for the MAFMC SSC describing a MSE for the recreational fishery.

14) Collect data to determine the sex ratio for all of the catch components.

SDWG: Through a PMAFS study, 2 years of data collection has occurred to determine sex ratios in the commercial and recreational landings (WPA13). This is not an ongoing study.

15) Determine the appropriate level for the steepness of the S-R relationship and investigate how that influences the biological reference points

SDWG: The SDWG considered WPA10 and WPA14, Rothschild et al. 2012, Mangel et al. 2013, Shertzer and Conn (2012), and Maunder (2012) in addressing this research recommendation in this assessment.

8.2 New from the July 2012 SSC report (1-5), SAW 57 SDWG (6-13)

1) Evaluate uncertainties in biomass to determine potential modifications to default OFL CV.

2) Evaluate the size distribution of landed and discarded fish, by sex, in the summer flounder fisheries

3) Evaluate past and possible future changes to size regulations on retention and selectivity in stock assessments and projections.

4) Incorporate sex -specific differences in size at age into the stock assessment.

5) Evaluate range expansion and change in distribution and their implications for stock assessment and management.

6) Continued evaluation of natural mortality and the differences between males and females. This should include efforts to estimate natural mortality, such as through mark-recapture programs, telemetry.

7) Further work examining aspects that create greater realism to the summer flounder assessment (e.g., sexually dimorphic growth, sex-specific F, differences in spatial structure [or distribution by size?] should be conducted. This could include:

a) Simulation studies to determine the critical data and model components that are necessary to provide reliable advice, and need to determine how simple a model can be while still providing reliable advice on stock status for management use, and should evaluate both simple and most complex model configurations.

b) Development of models incorporating these factors that would create greater realism.

c) These first steps (a or b) can be used to prioritize data collection, and determine if additional investment in data streams (e.g., collection of sex at age and sex at length and maturity data from the catch, additional information on spatial structure and movement, etc.) are worthwhile in terms of providing more reliable assessment results.
d) The modeling infrastructure should be simultaneously developed to support these types of modeling approaches (flexibility in model framework, MCMC/bootstrap framework, projection framework).

8) Develop comprehensive study to determine the contribution of summer flounder nursery area to the overall summer flounder population, based off approaches similar to those developed in WPA12.

9) Develop and ongoing sampling program for the recreational fishery landings and discards (i.e., collect age, length, sex) to develop appropriate age-length keys for ageing the recreational catch.

10) Apply standardization techniques to all of the state and academic-run surveys, to be evaluated for potential inclusion in the assessment.

11) Continue efforts to improve understanding of sexually dimorphic mortality and growth patterns. This should include monitoring sex ratios and associated biological information in the fisheries and all ongoing surveys to allow development of sex-structured models in the future.

12) Conduct sensitivity analyses to identify potential causes of the recent retrospective pattern. Efforts should focus on identifying factors in both survey and catch data that could contribute to the decrease in cohort abundance between initial estimates based largely on survey observations and subsequent estimates influenced by fishery dependent data as the cohort recruits to the fishery.

13) Develop methods that more fully characterize uncertainty and ensure coherence between assessments, reference point calculation and projections

We recognize that these research priorities will require additional resources and funding to complete and ensure progress in our understanding of summer flounder.

Sources of Assessment Uncertainty and Bias

The SDWG identified the following as ongoing sources of uncertainty and bias in the current assessment.

1) Sex specific differences in life history parameters and in the spatial distribution of summer flounder by size, may have an effect on the assessment model results.

2) The NEFSC research surveys and PMAFS fishery sampling confirm sexually-dimorphic, time varying, spatial differences in growth. These dynamics are not fully accounted for in the stock assessment, because not all fishery and survey catches are independently and adequately sampled.

3) The landings from the commercial fisheries used in this assessment assume no under-reporting of summer flounder landings. Therefore, reported landings and associated effort from the commercial fisheries should be considered minimal estimates.

4) The current assumption for M remains an ongoing source of uncertainty. M is highly influential on the assessment results and has a "rescaling affect" on SSB, F, R, point calculations, and the associated perception of current stock status.

The SARC 57 Review Panel concluded that Term of Reference 8 was met.

2013 SARC 57 Review Panel Special Comments

The benchmark 2008 SAW 47 assessment (NEFSC 2008) was updated annually through 2012 (Terceiro 2012). The summer flounder stock assessment has historically exhibited a consistent retrospective pattern of underestimation of F and overestimation of SSB; the causes of this previous pattern have not been determined. In the current assessment model, however, no persistent retrospective patterns are evident. Over the last 7 years, the annual retrospective change in fishing mortality has ranged from +22% in 2006 to -5% in 2009, the annual retrospective change in SSB has ranged from -2% in 2011 to -21% 2006, and the annual retrospective change in recruitment has ranged from -45 in 2005 to +33% in 2009. The historical retrospective indicates that general trends of fishing mortality, stock biomass, and recruitment have been consistent since the 1990s assessments (Figure A247).

This assessment includes several new research survey time series. The URI GSO trawl, NY trawl, VIMS ChesMMAP trawl, VIMS NEAMAP spring and fall trawl, and the NEFSC MARMAP and ECOMON larval surveys are now tabulated in the assessment and used in the population model calibration.

The NEFSC research surveys and Partnership for Mid-Atlantic Fisheries Science (PMAFS) fishery sampling confirm sexually dimorphic, temporal, and spatial differences in growth of summer flounder. The SAW 57 Southern Demersal Working Group investigated these differences in sex and how it might affect the assessment, but it was not possible to develop a full sex-disaggregated analysis. Sex-specific differences in life history parameters and in the spatial distribution of summer flounder by size may have an effect on the assessment model results and the biological reference point calculations. The assessment model presented to the SARC 57 Review Panel was deemed to provide an acceptable evaluation of stock status. Among potential approaches, simulation studies could be used to identify the critical data and model components and indicate directions for future work.

The Northward shift in the center of biomass for summer flounder may be due in part to the expansion in the age structure and increases in abundance. Environmental or other factors that may have influence on this shift have not been fully quantified.

Some progress has already been made developing a summer flounder assessment model that accounts for sexually dimorphic growth distribution and exploitation rates. Currently it has not been possible to split recreational landings or catch by sexes. The SARC 57 Review Panel would like to encourage further development in this area, with the aim of allowing sexually split assessment to better model summer flounder population. The SARC 57 Review Panel agrees that the development sex-specific sampling of surveys and landings to provide improved model input and sampling of discards and changing the model to include sex-specific parameterization are priorities and may improve the assessment.

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TABLES

Table A1. Summer flounder commercial landings by state (thousands of lb) and coastwide (thousands of pounds (>000 lbs), metric tons (mt)). * = less than 500 lb; na = not available

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	Total '000 lbs	Total mt
1940	0	0	2,847	258	149	1,814	3,554	3	444	1,247	498	10,814	4,905
1941	na	na	na	na	na	na	na	na	183	764	na	947	430
1942	0	0	193	235	126	1,286	987	2	143	475	498	3,945	1,789
1943	0	0	122	202	220	1,607	2,224	11	143	475	498	5,502	2,496
1944	0	0	719	414	437	2,151	3,159	8	197	2,629	498	10,212	4,632
1945	0	0	1,730	467	270	3,182	3,102	2	460	1,652	1,204	12,297	5,578
1946	0	0	1,579	625	478	3,494	3,310	22	704	2,889	1,204	14,305	6,489
1947	0	0	1,467	333	813	2,695	2,302	46	532	1,754	1,204	11,146	5,056
1948	0	0	2,370	406	518	2,308	3,044	15	472	1,882	1,204	12,219	5,542
1949	0	0	1,787	470	372	3,560	3,025	8	783	2,361	1,204	13,570	6,155
1950	0	0	3,614	1,036	270	3,838	2,515	25	543	1,761	1,840	15,442	7,004
1951	0	0	4,506	1,189	441	2,636	2,865	20	327	2,006	1,479	15,469	7,017
1952	0	0	4,898	1,336	627	3,680	4,721	69	467	1,671	2,156	19,625	8,902
1953	0	0	3,836	1,043	396	2,910	7,117	53	1,176	1,838	1,844	20,213	9,168
1954	0	0	3,363	2,374	213	3,683	6,577	21	1,090	2,257	1,645	21,223	9,627
1955	0	0	5,407	2,152	385	2,608	5,208	26	1,108	1,706	1,126	19,726	8,948
1956	0	0	5,469	1,604	322	4,260	6,357	60	1,049	2,168	1,002	22,291	10,111
1957	0	0	5,991	1,486	677	3,488	5,059	48	1,171	1,692	1,236	20,848	9,456
1958	0	0	4,172	950	360	2,341	8,109	209	1,452	2,039	892	20,524	9,310
1959	0	0	4,524	1,070	320	2,809	6,294	95	1,334	3,255	1,529	21,230	9,630
1960	0	0	5,583	1,278	321	2,512	6,355	44	1,028	2,730	1,236	21,087	9,565
1961	0	0	5,240	948	155	2,324	6,031	76	539	2,193	1,897	19,403	8,801
1962	0	0	3,795	676	124	1,590	4,749	24	715	1,914	1,876	15,463	7,014
1963	0	0	2,296	512	98	1,306	4,444	17	550	1,720	2,674	13,617	6,177
1964	0	0	1,384	678	136	1,854	3,670	16	557	1,492	2,450	12,237	5,551
1965	0	0	431	499	106	2,451	3,620	25	734	1,977	272	10,115	4,588
1966	0	0	264	456	90	2,466	3,830	13	630	2,343	4,017	14,109	6,400
1967	0	0	447	706	48	1,964	3,035	0	439	1,900	4,391	12,930	5,865
1968	0	0	163	384	35	1,216	2,139	0	350	2,164	2,602	9,053	4,106
1969	0	0	78	267	23	574	1,276	0	203	1,508	2,766	6,695	3,037
1970	0	0	41	259	23	900	1,958	0	371	2,146	3,163	8,861	4,019
1971	0	0	89	275	34	1,090	1,850	0	296	1,707	4,011	9,352	4,242
1972	0	0	93	275	7	1,101	1,852	0	277	1,857	3,761	9,223	4,183
1973	0	0	506	640	52	1,826	3,091	*	495	3,232	6,314	16,156	7,328
1974	*	0	1,689	2,552	26	2,487	3,499	0	709	3,111	10,028	22,581	10,243
1975	0	0	1,768	3,093	39	3,233	4,314	5	893	3,428	9,539	26,311	11,934
1976	*	0	4,019	6,790	79	3,203	5,647	3	697	3,303	9,627	33,368	15,135
1977	0	0	1,477	4,058	64	2,147	6,566	5	739	4,540	10,332	29,927	13,575
1978	0	0	1,439	2,238	111	1,948	5,414	1	676	5,940	10,820	28,586	12,966
1979	5	0	1,175	2,825	30	1,427	6,279	6	1,712	10,019	16,084	39,561	17,945

Table A1 continued.

Year	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	NC	Total '000 lbs	Total mt
1980	4	0	367	1,277	48	1,246	4,805	1	1,324	8,504	13,643	31,216	14,159
1981	3	0	598	2,861	81	1,985	4,008	7	403	3,652	7,459	21,056	9,551
1982	18	*	1,665	3,983	64	1,865	4,318	8	360	4,332	6,315	22,928	10,400
1983	84	0	2,341	4,599	129	1,435	4,826	5	937	8,134	7,057	29,548	13,403
1984	2	*	1,488	4,479	131	2,295	6,364	9	813	9,673	12,510	37,765	17,130
1985	3	*	2,249	7,533	183	2,517	5,634	4	577	5,037	8,614	32,352	14,675
1986	0	*	2,954	7,042	160	2,738	4,017	4	316	3,712	5,924	26,866	12,186
1987	8	*	3,327	4,774	609	2,641	4,451	4	319	5,791	5,128	27,052	12,271
1988	5	0	2,421	4,719	741	3,439	6,006	7	514	7,756	6,770	32,377	14,686
1989	9	0	1,878	3,083	513	1,464	2,865	3	204	3,689	4,206	17,913	8,125
1990	3	0	628	1,408	343	405	1,458	2	138	2,144	2,728	9,257	4,199
1991	0	0	1,124	1,672	399	719	2,341	4	232	3,715	3,516	13,722	6,224
1992	*	*	1,383	2,532	495	1,239	2,871	12	319	5,172	2,576	16,599	7,529
1993	6	0	903	1,942	225	849	2,466	6	254	3,052	2,894	12,599	5,715
1994	4	0	1,031	2,649	371	1,269	2,356	4	179	3,091	3,571	14,525	6,588
1995	5	0	1,128	2,325	319	1,248	2,319	4	174	3,304	4,555	15,381	6,977
1996	8	0	800	1,763	266	936	2,369	8	266	2,286	4,218	12,920	5,861
1997	3	0	745	1,566	257	823	1,321	5	215	2,370	1,501	8,806	3,994
1998	6	0	707	1,712	263	822	1,863	11	224	2,616	2,967	11,190	5,076
1999	6	0	813	1,637	245	804	1,918	8	201	2,196	2,801	10,627	4,820
2000	7	0	789	1,703	240	800	1,848	12	252	2,206	3,354	11,211	5,085
2001	22	0	694	1,800	267	751	1,745	7	223	2,660	2,789	10,958	4,970
2002	1	0	1,009	2,286	357	1,053	2,407	3	327	2,970	4,078	14,491	6,573
2003	0	0	926	2,178	272	1,073	2,384	6	329	3,492	3,559	14,219	6,450
2004	0	0	1,193	3,085	406	1,594	2,831	8	284	3,906	4,834	18,141	8,228
2005	3	0	1,274	2,926	449	1,804	2,529	5	333	3,869	4,059	17,253	7,826
2006	7	0	910	2,120	314	1,262	2,346	4	248	2,669	3,926	13,806	6,262
2007	3	0	660	1,515	207	939	1,698	3	178	2,025	2,669	9,897	4,489
2008	1	0	647	1,469	223	858	1,544	1	199	1,764	2,424	9,133	4,143
2009	0	0	732	1,794	244	1,140	1,799	0	166	1,993	2,819	10,689	4,848
2010	0	0	852	2,289	305	1,364	2,165	0	221	2,625	3,253	13,074	5,930
2011	0	0	1,131	2,825	397	1,513	2,830	1	259	4,783	2,822	16,561	7,511
2012	0	0	892	2,410	620	1,239	2,269	1	141	4,670	1,090	13,332	6,047

Table A2. Distribution of Northeast Region (ME-VA) commercial fishery landings by statistical area.

Area	1992	1993	1994	1995	1996	1997	1998	1999
511	0	0	0	0	1	0	0	0
512	0	0	0	0	1	1	0	0
513	0	3	0	0	2	0	0	2
514	9	11	10	12	3	15	17	11
515	0	0	0	0	0	0	0	0
521	8	3	14	4	16	2	9	2
522	8	8	7	6	13	6	2	3
561	2	1	0	0	1	1	3	2
562	6	4	5	10	1	1	0	3
525	22	35	26	85	140	16	27	28
526	294	242	193	128	45	22	33	17
533	0	0	0	0	6	2	3	5
537	916	557	707	770	553	449	417	354
538	228	255	341	332	273	270	229	275
539	217	157	223	258	248	284	373	418
611	117	35	181	283	170	141	204	230
612	404	393	169	221	353	297	316	403
613	237	167	280	242	188	194	128	171
614	81	97	141	129	18	41	41	13
615	61	15	49	99	20	37	41	44
616	532	476	743	730	474	245	280	122
621	1028	526	258	279	325	266	286	304
622	299	363	323	522	264	53	141	301
623	0	6	0	14	28	0	1	0
625	289	227	122	118	282	227	142	91
626	743	601	821	347	395	94	502	415
631	655	98	219	220	21	174	258	140
632	160	77	60	43	75	30	41	79
635	45	45	77	55	29	418	228	97
636	0	0	0	4	2	27	8	20
Total	6361	4402	4969	4911	3947	3313	3730	3550

Table A2 continued.

Area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
511	1	0	0	0	1	0	0	0	0	0
512	1	0	0	0	3	0	1	3	0	1
513	0	1	0	1	1	5	1	0	0	2
514	2	1	2	2	3	14	4	3	2	3
515	0	0	3	1	2	0	0	0	0	4
521	4	15	31	12	11	12	3	4	3	5
522	6	5	12	10	18	10	14	3	13	6
561	4	7	8	1	0	1	1	0	0	1
562	8	3	24	9	5	11	3	4	2	1
525	41	29	43	32	67	93	38	40	9	22
526	16	23	23	17	36	75	25	20	7	4
533	10	2	1	2	6	6	4	6	3	2
537	326	337	446	451	875	860	635	475	419	532
538	260	214	257	275	290	223	255	203	182	234
539	455	432	543	551	500	455	386	276	353	272
611	142	155	206	217	317	389	369	299	228	265
612	308	379	613	606	685	611	603	422	414	551
613	170	162	241	240	319	284	304	191	151	205
614	3	11	26	25	30	48	12	33	31	15
615	70	115	90	63	87	68	126	94	69	43
616	384	247	218	359	600	722	524	574	486	426
621	208	274	533	303	397	270	285	179	247	297
622	101	234	153	394	614	424	360	34	203	297
623	8	18	3	14	28	74	22	3	0	62
625	60	129	296	261	156	326	123	121	12	30
626	697	510	648	763	899	880	331	197	174	153
631	185	142	189	119	13	68	13	70	18	97
632	39	41	8	82	39	54	31	12	1	9
635	54	212	99	21	9	1	8	12	16	30
636	1	7	5	4	27	1	0	0	0	1
Total	3564	3705	4723	4835	6036	5985	4481	3278	3043	3570

Table A2 continued.

Area	2010	2011	2012
511	138	0	0
512	0	1	1
513	8	1	5
514	5	22	17
515	0	0	0
521	30	39	21
522	14	19	13
561	0	8	0
562	0	7	0
525	49	72	51
526	10	7	112
533	0	8	0
537	651	974	886
538	161	192	138
539	206	357	271
611	203	413	250
612	519	682	534
613	261	430	560
614	36	106	28
615	76	284	163
616	571	1205	851
621	744	309	814
622	353	443	357
623	0	66	0
625	104	269	83
626	255	387	331
631	33	45	37
632	5	6	1
635	24	17	41
636	1	0	5
Total	4455	6369	5568

Table A3. Summary of sampling of the commercial fishery for summer flounder, Northeast Region (ME-VA); landings in metric tons (mt).

Year	Lengths	Ages	ME-VA Landings (mt)	Sampling Intensity (mt/100 lengths)
1982	8,194	2,288	7,536	92
1983	6,893	1,347	10,202	148
1984	5,340	1,794	11,455	215
1985	6,473	1,611	10,767	166
1986	7,840	1,967	9,499	121
1987	6,605	1,788	9,945	151
1988	9,048	2,302	11,615	128
1989	8,411	1,325	6,217	74
1990	3,419	853	2,962	87
1991	4,627	1,089	4,626	100
1992	3,385	899	6,361	188
1993	3,638	844	4,402	121
1994	3,950	956	4,969	126
1995	2,982	682	4,911	165
1996	4,580	1,235	3,947	86
1997	8,855	2,332	3,313	37
1998	10,055	2,641	3,730	37
1999	10,460	3,244	3,550	34
2000	10,952	3,307	3,564	33
2001	10,310	2,838	3,705	36
2002	7,422	1,870	4,723	64
2003	8,687	2,210	4,835	56
2004	13,970	3,560	6,036	43
2005	17,188	4,903	5,985	35
2006	18,118	5,062	4,481	25
2007	19,581	6,247	3,278	17
2008	14,803	4,661	3,043	20
2009	18,560	4,694	3,570	19
2010	15,185	3,510	4,455	29
2011	16,587	3,121	6,232	38
2012	15,709	2,999	5,568	35

Table A4. Commercial fishery landings at age of summer flounder ('000), Northeast Region (ME-VA).

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+
1982	1441	6879	5630	232	61	97	57	22	2	0	0	14421	24
1983	1956	12119	4352	554	30	62	13	17	4	2	0	19109	23
1984	1403	10706	6734	1618	575	72	3	5	1	4	0	21121	10
1985	840	6441	10068	956	263	169	25	4	2	1	0	18769	7
1986	407	7041	6374	2215	158	93	29	7	2	0	0	16326	9
1987	332	8908	7456	935	337	23	24	27	11	0	0	18053	38
1988	305	11116	8992	1280	327	79	18	9	5	0	0	22131	14
1989	96	2491	4829	841	152	16	3	1	1	0	0	8430	2
1990	0	2670	861	459	81	18	6	1	1	0	0	4097	2
1991	0	3755	3256	142	61	11	1	1	0	0	0	7227	1
1992	114	5760	3575	338	19	22	0	1	0	0	0	9829	1
1993	151	4308	2340	174	29	43	19	2	1	0	0	7067	3
1994	119	3698	3692	272	64	12	6	0	5	0	0	7868	5
1995	46	2565	4280	239	39	8	2	1	0	0	0	7180	1
1996	0	1401	3187	798	156	15	3	0	1	0	0	5561	1
1997	0	380	2442	1214	261	69	10	4	0	0	0	4380	4
1998	0	196	1719	2022	437	72	15	1	0	0	0	4462	1
1999	0	123	1569	1522	585	160	26	8	0	0	0	3993	8
2000	0	212	1934	1083	449	119	47	15	6	1	1	3867	23
2001	0	706	1402	1000	331	155	59	16	4	1	2	3676	23
2002	0	406	2706	1375	383	133	75	9	0	1	0	5088	10
2003	0	470	2112	1353	532	255	110	39	17	2	1	4891	59
2004	0	287	2609	1765	748	301	120	58	32	6	4	5930	100
2005	0	506	1373	1629	1091	675	364	182	127	38	24	6009	371
2006	0	375	2221	1110	578	276	132	49	19	3	1	4764	72
2007	0	160	762	1449	485	225	115	43	16	6	4	3265	69
2008	0	135	452	692	951	339	147	70	32	9	4	2831	115
2009	0	164	728	1005	775	521	164	63	29	10	4	3463	106
2010	0	223	704	1203	1210	542	244	95	51	28	8	4308	182
2011	0	101	761	1870	1675	869	326	173	86	28	19	5907	306
2012	0	64	777	1899	1425	673	300	172	94	25	12	5441	303

Table A5. Mean weight (kg) at age of summer flounder landed in the commercial fishery, Northeast Region (ME-VA).

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1982	0.260	0.420	0.620	1.840	2.330	2.940	2.710	4.040	5.990	0.000	0.000	0.545
1983	0.310	0.460	0.800	1.400	2.350	1.850	2.760	3.300	4.170	4.370	0.000	0.562
1984	0.280	0.390	0.600	1.090	1.430	2.160	3.210	3.620	4.640	4.030	0.000	0.540
1985	0.330	0.440	0.590	1.080	1.730	2.220	2.590	4.710	4.780	4.800	0.000	0.587
1986	0.300	0.440	0.630	1.110	1.760	1.890	3.140	2.960	4.810	0.000	0.000	0.629
1987	0.270	0.450	0.620	1.060	2.000	2.850	3.080	3.020	4.140	0.000	0.000	0.590
1988	0.360	0.460	0.600	1.210	2.070	2.880	3.980	3.910	4.500	0.000	0.000	0.596
1989	0.357	0.554	0.738	1.062	1.833	2.466	3.568	3.592	2.251	0.000	0.000	0.736
1990	0.000	0.518	0.857	1.374	1.835	2.134	3.212	3.915	5.029	0.000	0.000	0.724
1991	0.000	0.482	0.748	1.538	2.257	3.012	3.908	3.873	0.000	0.000	0.000	0.642
1992	0.340	0.500	0.820	1.880	2.680	3.090	0.000	4.590	0.000	0.000	0.000	0.672
1993	0.354	0.488	0.751	1.625	2.099	1.786	2.810	4.136	5.199	0.000	0.000	0.623
1994	0.389	0.552	0.616	1.426	2.266	3.083	3.323	0.000	3.703	0.000	0.000	0.632
1995	0.328	0.542	0.704	1.532	2.373	2.916	3.500	4.094	0.000	0.000	0.000	0.684
1996	0.000	0.544	0.577	1.137	1.881	2.845	3.776	0.000	4.762	0.000	0.000	0.694
1997	0.000	0.544	0.637	0.842	1.310	2.101	2.559	3.429	0.000	4.853	5.004	0.756
1998	0.000	0.550	0.643	0.845	1.386	2.307	2.524	3.983	0.000	0.000	0.000	0.837
1999	0.000	0.523	0.615	0.862	1.359	1.928	2.838	3.618	0.000	0.000	0.000	0.888
2000	0.000	0.566	0.676	0.972	1.459	2.125	2.514	2.600	3.303	3.357	3.707	0.924
2001	0.000	0.588	0.762	1.031	1.721	2.376	2.847	3.566	3.898	3.806	5.499	1.009
2002	0.000	0.596	0.711	1.006	1.652	2.162	2.845	3.601	3.357	2.983	0.000	0.927
2003	0.000	0.611	0.705	0.998	1.414	1.890	2.528	3.181	3.535	3.560	4.964	0.989
2004	0.000	0.555	0.716	0.995	1.427	1.914	2.488	2.984	3.138	3.635	3.911	1.018
2005	0.000	0.556	0.627	0.793	1.056	1.385	1.692	1.989	2.274	3.098	3.375	0.996
2006	0.000	0.580	0.651	0.935	1.319	1.788	2.333	2.828	3.253	3.991	3.727	0.941
2007	0.000	0.559	0.683	0.866	1.202	1.696	2.256	2.424	2.724	3.256	4.183	1.002
2008	0.000	0.563	0.636	0.804	1.103	1.497	1.933	2.265	2.588	2.914	3.425	1.074
2009	0.000	0.536	0.635	0.803	1.051	1.509	1.927	2.523	2.899	3.288	3.670	1.029
2010	0.000	0.436	0.566	0.768	1.036	1.408	2.127	2.493	2.798	3.114	3.831	1.034
2011	0.000	0.475	0.551	0.687	1.015	1.538	1.939	2.453	2.864	3.055	3.819	1.057
2012	0.000	0.550	0.621	0.727	0.985	1.459	1.959	2.015	2.528	2.897	3.552	1.023

Table A6. Summary of North Carolina Division of Marine Fisheries (NCDMF) sampling of the commercial trawl fishery for summer flounder; landings in metric tons (mt).

Year	Lengths	Ages	Landings (mt)	Sampling Intensity (mt/100 lengths)
1982	5,403	0	2,864	53
1983	8,491	0	3,201	38
1984	14,920	0	5,674	38
1985	13,787	0	3,907	28
1986	15,754	0	2,687	17
1987	12,126	0	2,326	19
1988	13,377	189	3,071	23
1989	15,785	106	1,908	12
1990	15,787	191	1,237	8
1991	24,590	534	1,595	6
1992	14,321	364	1,168	8
1993	18,019	442	1,313	7
1994	21,858	548	1,620	7
1995	18,410	548	2,066	11
1996	17,745	477	1,913	11
1997	12,802	388	681	5
1998	21,477	476	1,346	6
1999	11,703	412	1,271	11
2000	24,177	568	1,521	6
2001	19,655	499	1,265	6
2002	21,653	609	1,841	8
2003	17,476	610	1,615	9
2004	20,436	553	2,182	11
2005	20,598	620	1,827	9
2006	20,911	682	1,781	9
2007	26,187	697	1,211	5
2008	27,703	749	1,100	4
2009	19,580	723	1,279	7
2010	23,142	783	1,476	6
2011	16,962	417	1,282	8
2012	7,439	541	495	7

Table A7. Commercial landings at age of summer flounder ('000), North Carolina commercial trawl fishery.

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+
1982	981	3463	1021	142	52	19	6	4	2	0	0	5690	6
1983	492	3778	1581	287	135	41	3	3	1	0	0	6321	4
1984	907	5658	3889	550	107	18	1	0	0	0	0	11130	0
1985	196	2974	3529	338	85	24	5	1	0	0	0	7152	1
1986	216	2478	1897	479	29	32	1	1	1	0	0	5134	2
1987	233	2420	1299	265	25	1	0	0	0	0	0	4243	0
1988	0	2917	2225	471	227	39	1	6	1	0	0	5887	7
1989	2	49	1437	716	185	37	1	2	0	0	0	2429	2
1990	2	143	730	418	117	12	1	1	0	0	0	1424	1
1991	0	382	1641	521	116	20	2	0.4	0	0	0	2682	0
1992	0	36	795	697	131	21	2	0.03	0	0	0	1682	0
1993	0	515	1101	252	44	1	0.2	0	0	0	0	1913	0
1994	6	258	1262	503	115	14	3	0	0	0	0	2161	0
1995	0	181	1391	859	331	53	2	0	0	0	0	2817	0
1996	0	580	2187	554	132	56	13	1	2	1	0	3526	4
1997	0	17	625	378	18	3	0.2	0	0	0	0	1041	0
1998	18	547	694	230	28	3	0.2	0	0	0	0	1520	0
1999	1	70	504	579	152	88	6	3	0.1	0	0	1403	3
2000	0	50	398	906	345	55	18	1	2	0	0	1775	3
2001	0	79	408	556	334	63	18	5	0.2	0	0	1463	5
2002	0	79	574	1032	460	70	30	3	0.2	0	0	2248	3
2003	0	43	336	712	362	124	50	8	0.456	0	0	1635	8
2004	0	24	608	863	449	238	57	22	2	0.6	0.02	2264	25
2005	0	17	471	832	389	143	44	14	3	0.4	0.04	1913	17
2006	0	18	436	658	447	258	95	26	5	3	0.5	1947	35
2007	0	12	120	581	345	135	54	25	11	2	1	1286	39
2008	0	13	103	272	424	133	83	31	11	1.5	0.4	1072	44
2009	0	3	122	398	443	298	99	24	18	1	1	1407	44
2010	0	19	222	513	403	178	155	43	12	7	1	1553	63
2011	0	0	165	306	529	141	94	86	25	10	4	1360	125
2012	0	2	44	159	124	88	36	18	12	6	3	492	21

Table A8. Mean weight (kg) at age of summer flounder landed in the North Carolina commercial trawl fishery.

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1982	0.340	0.456	0.756	1.284	1.658	2.054	2.116	2.231	2.577	0.000	0.000	0.531
1983	0.319	0.452	0.746	1.140	1.262	1.488	1.729	2.428	2.696	0.000	0.000	0.572
1984	0.331	0.475	0.704	1.059	1.504	2.167	3.482	0.000	0.000	0.000	0.000	0.585
1985	0.377	0.460	0.664	1.203	1.675	2.485	3.073	4.571	0.000	0.000	0.000	0.617
1986	0.360	0.512	0.674	1.092	1.623	1.955	3.398	3.233	3.626	0.000	0.000	0.637
1987	0.334	0.512	0.655	1.086	1.878	2.944	0.000	0.000	0.000	0.000	0.000	0.590
1988	0.000	0.411	0.598	0.926	1.189	1.702	2.241	2.982	3.412	0.000	0.000	0.565
1989	0.118	0.380	0.603	0.988	1.161	2.095	3.086	2.496	0.000	0.000	0.000	0.779
1990	0.079	0.483	0.664	0.867	1.306	2.095	1.897	3.972	0.000	0.000	0.000	0.773
1991	0.000	0.448	0.655	1.072	1.729	2.252	2.508	3.126	4.097	0.000	0.000	0.767
1992	0.000	0.363	0.504	0.851	1.198	1.457	2.302	0.000	0.000	0.000	0.000	0.713
1993	0.000	0.489	0.608	1.128	1.371	2.946	3.406	0.000	0.000	0.000	0.000	0.664
1994	0.272	0.451	0.618	1.270	2.039	2.443	2.888	5.780	0.000	0.000	0.000	0.839
1995	0.038	0.210	0.461	0.853	1.474	2.492	3.792	3.815	0.000	0.000	0.000	0.724
1996	0.000	0.420	0.470	0.730	1.350	1.720	2.290	3.200	2.710	4.510	0.000	0.565
1997	0.000	0.407	0.616	0.760	1.323	2.069	3.248	0.000	0.000	0.000	0.000	0.682
1998	0.405	0.714	0.890	1.237	1.491	2.802	3.381	0.000	0.000	0.000	0.000	0.889
1999	0.144	0.578	0.729	0.919	1.402	1.682	2.609	3.063	3.904	0.000	0.000	0.945
2000	0.000	0.558	0.656	0.801	1.201	1.963	2.590	3.307	3.521	0.000	0.000	0.898
2001	0.000	0.594	0.674	0.758	1.065	1.716	2.388	3.067	4.240	0.000	0.000	0.865
2002	0.000	0.520	0.650	0.760	0.990	1.650	2.200	3.030	4.420	0.000	0.000	0.821
2003	0.000	0.460	0.700	0.890	1.550	2.480	3.250	3.870	4.820	0.000	0.000	1.194
2004	0.000	0.510	0.640	0.820	1.120	1.410	2.140	2.990	3.780	4.020	0.000	0.948
2005	0.000	0.580	0.670	0.870	1.150	1.650	2.430	2.900	3.570	4.298	0.000	0.989
2006	0.000	0.600	0.669	0.815	1.070	1.427	1.842	2.573	3.097	3.803	0.000	1.004
2007	0.000	0.550	0.680	0.780	1.010	1.420	1.730	2.160	2.570	3.720	0.000	0.983
2008	0.000	0.596	0.667	0.834	1.015	1.375	1.551	1.916	2.947	4.856	0.000	1.068
2009	0.000	0.511	0.634	0.765	0.893	1.130	1.507	1.974	1.664	3.285	4.720	0.960
2010	0.000	0.558	0.636	0.791	0.995	1.243	1.483	1.906	2.950	4.881	4.852	1.008
2011	0.000	0.000	0.570	0.670	0.820	1.260	1.490	1.680	2.050	2.300	4.260	0.950
2012	0.000	0.509	0.666	0.775	0.902	1.234	1.636	2.047	1.974	2.628	4.507	1.062

Table A9. Summary NER Fishery Observer sample data for trips catching summer flounder. Total trips (trips are not split for multiple areas), observed tows, total summer flounder catch observed, total summer flounder kept observed, and total summer flounder discard observed, and percentage of summer flounder discard to summer flounder catch observed. All catches in pounds. Includes NER At-Sea Monitoring (ASM) and ASMFC-funded trips for 2010-2012.

Year	Gear	Trips	Tows	Total Catch	Total Kept	Total Discard	Discard: Total (%)
1989	All	57	413	53,714	48,406	5,308	9.9
1990	All	61	463	47,954	35,972	11,982	25.0
1991	All	82	635	61,650	50,410	11,240	18.2
1992	Trawl	66	643	136,632	118,026	18,606	13.6
	Scallop	8	178	1,477	767	710	48.1
	All	74	821	138,109	118,793	19,316	14.0
1993	Trawl	37	410	74,982	67,603	7,379	9.8
	Scallop	15	671	2,967	1,158	1,809	61.0
	All	52	1,081	77,949	68,761	9,188	11.8
1994	Trawl	51	574	174,347	163,734	10,612	6.1
	Scallop	14	651	5,811	435	5,376	92.5
	All	65	1,225	180,158	164,169	15,988	8.9
1995	Trawl	134	1,004	242,784	235,011	7,773	3.2
	Scallop	19	1,051	10,044	2,247	7,778	77.4
	All	153	2,055	252,828	237,258	15,551	6.2
1996	Trawl	111	653	101,389	90,789	10,600	10.5
	Scallop	24	1,083	9,575	1,345	8,230	86.0
	All	135	1,736	110,964	92,134	18,830	17.0
1997	Trawl	59	334	31,707	26,475	5,232	16.5
	Scallop	23	835	5,721	583	5,138	89.8
	All	82	1,169	37,428	27,058	10,370	27.7

Table A9 continued.

Year	Gear	Trips	Tows	Total Catch	Total Kept	Total Discard	Discard: Total (%)
1998	Trawl	53	329	72,396	65,507	6,889	9.5
	Scallop	22	359	1,962	652	1,310	66.8
	All	75	688	74,358	66,159	8,199	11.0
1999	Trawl	56	374	60,733	45,987	14,746	24.3
	Scallop	10	247	3,199	458	2,741	85.7
	All	66	621	63,932	46,445	17,487	27.4
2000	Trawl	115	688	162,015	144,752	17,263	10.7
	Scallop	23	608	8,457	501	7,956	94.1
	All	138	1,296	170,472	145,253	25,219	14.8
2001	Trawl	137	605	109,910	61,625	48,295	43.9
	Scallop	68	1,606	11,622	800	10,822	93.1
	All	205	2,211	121,532	62,425	59,117	48.6
2002	Trawl	175	837	141,246	124,053	17,193	12.2
	Scallop	55	2,522	25,871	887	24,984	96.6
	All	230	3,359	167,117	124,940	42,177	25.2
2003	Trawl	212	1,316	235,685	195,371	40,314	17.1
	Scallop	79	3,248	37,021	2,378	34,643	93.6
	All	291	4,564	272,706	197,749	74,957	27.5
2004	Trawl	546	2,570	561,689	477,634	84,055	15.0
	Scallop	132	4,444	59,787	4,016	55,771	93.3
	All	678	7,014	621,476	481,650	139,826	22.5
2005	Trawl	906	5,993	800,082	580,949	219,133	27.4
	Scallop	136	3,786	38,227	2,805	35,422	92.7
	All	1,042	9,779	838,309	583,754	254,555	30.4

Table A9 continued.

Year	Gear	Trips	Tows	Total Catch	Total Kept	Total Discard	Discard: Total (%)
2006	Trawl	578	4,017	566,458	309,915	256,544	45.3
	Scallop	117	1,488	15,687	1,323	14,364	91.6
	All	695	5,505	582,145	311,238	270,908	46.5
2007	Trawl	682	3,972	759,360	332,373	426,987	56.2
	Scallop	233	4,059	58,865	729	56,136	95.4
	All	915	8,031	818,225	333,102	483,123	59.0
2008	Trawl	559	2,890	482,775	288,182	194,593	40.3
	Scallop	383	8,039	91,826	3,786	88,040	95.9
	All	942	10,929	574,601	291,968	282,633	49.2
2009	Trawl	845	4,450	736,910	506,768	230,142	31.2
	Scallop	300	8,042	69,857	3,382	66,475	95.2
	All	1,145	12,492	806,767	510,150	296,617	36.8
2010	Trawl	982	4,802	1,236,762	973,384	263,378	21.3
	Scallop	221	6,817	75,859	1,788	74,072	97.6
	All	1,203	11,619	1,312,621	975,172	337,450	25.7
2011	Trawl	1,068	6,225	1,283,337	1,069,777	213,560	16.6
	Scallop	258	7,110	78,893	3,192	75,701	96.0
	All	1,326	13,335	1,362,230	1,072,969	289,261	21.2
2012	Trawl	851	4,107	837,902	726,649	111,253	13.3
	Scallop	314	9,541	76,817	5,133	71,683	93.3
	All	1,165	13,648	914,719	731,782	182,936	20.0

Table A10. Summary NER Vessel Trip Report (VTR) data for trips reporting discard of any species and catching summer flounder. Total trips, total summer flounder catch, total summer flounder kept, total summer flounder discard, and percentage of summer flounder discard to summer flounder catch. All catches in pounds.

Year	Gear	Trips	Total Catch	Total Kept	Total Discard	Discard: Total (%)
1994	Trawl	4,267	2,149,332	2,015,296	134,036	6.2
	Scallop	85	70,353	22,877	47,476	67.5
	All	4,352	2,219,685	2,038,173	181,512	8.2
1995	Trawl	3,733	2,444,231	2,332,516	111,715	4.6
	Scallop	113	78,758	25,084	53,674	68.2
	All	3,846	2,522,989	2,357,600	165,389	6.6
1996	Trawl	2,990	1,662,313	1,459,155	203,158	12.2
	Scallop	79	69,557	16,657	52,900	76.1
	All	3,069	1,731,870	1,475,812	256,058	14.8
1997	Trawl	3,044	988,599	851,090	137,509	13.9
	Scallop	51	21,553	4,665	16,888	78.4
	All	3,095	1,010,152	855,755	154,397	15.3
1998	Trawl	3,004	1,128,578	868,706	259,872	23.0
	Scallop	62	23,538	10,323	13,215	56.1
	All	3,066	1,152,116	879,029	273,087	23.7
1999	Trawl	2,884	959,275	772,924	186,351	19.4
	Scallop	41	26,334	14,324	12,010	45.6
	All	2,925	985,609	787,248	198,361	20.1
2000	Trawl	3,140	1,048,791	786,576	262,215	25.0
	Scallop	41	12,183	3,798	8,385	68.8
	All	3,181	1,060,974	790,374	270,600	25.5
2001	Trawl	3,035	1,091,056	783,900	307,156	28.2
	Scallop	71	14,662	1,349	13,313	90.8
	All	3,106	1,105,718	785,249	320,469	29.0

Table A10 continued.

Year	Gear	Trips	Total Catch	Total Kept	Total Discard	Discard: Total (%)
2002	Trawl	3,549	1,164,038	924,590	239,448	20.6
	Scallop	107	23,879	6,913	16,966	71.1
	All	3,656	1,187,917	931,503	256,414	21.6
2003	Trawl	3,008	1,484,076	877,458	606,618	40.9
	Scallop	72	21,190	6,028	15,162	71.6
	All	3,080	1,505,266	883,486	621,780	41.3
2004	Trawl	3,607	1,866,542	1,511,013	355,529	19.0
	Scallop	69	24,814	9,478	15,336	61.8
	All	3,676	1,891,356	1,520,491	370,865	19.6
2005	Trawl	2,475	1,870,302	1,542,640	327,662	17.5
	Scallop	55	11,405	5,364	6,041	53.0
	All	2,530	1,881,707	1,548,004	333,703	17.7
2006	Trawl	2,575	1,373,070	974,264	398,806	29.0
	Scallop	144	17,613	3,091	14,522	82.5
	All	2,719	1,390,683	977,355	413,328	29.7
2007	Trawl	2,633	1,253,778	822,298	431,480	34.4
	Scallop	167	32,937	12,379	20,558	62.4
	All	2,800	1,286,715	834,677	452,038	35.1
2008	Trawl	2,164	1,065,118	807,501	257,617	24.2
	Scallop	109	44,992	11,362	33,630	74.7
	All	2,273	1,110,110	818,863	291,247	26.2
2009	Trawl	2,036	1,051,784	846,685	205,099	19.5
	Scallop	85	19,836	4,166	15,670	79.0
	All	2,121	1,071,620	850,851	220,769	20.6
2010	Trawl	2,230	1,372,669	1,159,710	213,302	15.5
	Scallop	85	18,722	6,306	13,692	73.1
	All	2,315	1,391,391	1,166,016	226,994	16.3

Table A10 continued.

Year	Gear	Trips	Total Catch	Total Kept	Total Discard	Discard: Total (%)
2011	Trawl	2,323	1,866,017	1,744,319	121,778	6.5
	Scallop	67	11,078	2,269	8,904	80.4
	All	2,390	1,877,095	1,746,588	130,682	7.0
2012	Trawl	2,211	1,213,314	1,132,104	93,240	7.7
	Scallop	60	12,270	5,709	7,445	60.7
	All	2,271	1,225,584	1,137,813	100,685	8.2

Table A11. Comparison of commercial fishery dealer reported landings (metric tons; mt) of summer flounder with estimates of summer flounder commercial landings from landings rates of NER Fishery Observer sampling and commercial fishing effort (days fished) reported on commercial Vessel Trip Reports (VTR). Dealer and Landings estimates prior to 1997 do not reflect NC landings and effort.

Year	VTR Days Fished (>000)	Observed Landings Estimate (mt)	Dealer landings Estimate (mt)	Percent Difference (Obs-Dealer)
1989	19,805	7,255	5,817	25
1990	15,980	2,959	2,749	8
1991	26,096	4,123	4,355	-5
1992	18,148	5,343	6,066	-12
1993	19,947	4,032	3,995	1
1994	18,402	6,004	4,968	21
1995	14,168	5,891	4,911	20
1996	10,351	5,024	3,718	35
1997	10,975	2,663	3,994	-33
1998	15,267	3,677	5,076	-28
1999	20,670	7,396	4,820	53
2000	11,268	6,702	5,085	32
2001	11,421	1,509	4,970	-70
2002	12,268	6,609	6,573	1
2003	13,415	5,786	6,450	-10
2004	9,288	4,997	8,228	-39
2005	13,215	3,478	7,826	-56
2006	11,856	1,794	6,262	-71
2007	8,872	1,012	4,431	-77
2008	7,615	1,445	4,143	-65
2009	7,294	1,277	4,848	-74
2010	6,639	2,605	5,930	-56
2011	6,965	1,466	7,511	-81
2012	8,068	1,145	6,047	-81

Table A12. Comparison of summer flounder landings estimates from Dealer reports, the method used in previous assessments (K*DF), the SBRM using all species landings (K*Kall), and the SBRM using all fluke, scup, and black sea bass landings (K*Kfsb).

Year	Dealer Landings	K*DF (Assess)	K*DF CV (Assess)	K*Kall (SBRM)	K*Kall CV (SBRM)	K*Kfsb (SBRM)	K*Kfsb CV (SBRM)
1989	5,817	7,255	0.22	5,878	0.36	3,909	0.13
1990	2,749	2,959	0.21	3,030	0.39	2,080	0.09
1991	4,355	4,123	0.13	2,165	0.16	4,249	0.02
1992	6,066	5,343	0.14	21,483	0.12	7,761	0.05
1993	3,995	4,032	0.21	6,277	0.43	4,074	0.03
1994	4,968	6,004	0.15	17,743	0.08	6,119	0.02
1995	4,911	5,891	0.12	14,085	0.13	6,440	0.01
1996	3,718	5,024	0.33	21,543	0.20	5,690	0.02
1997	3,994	2,663	0.34	2,085	0.49	2,265	0.06
1998	5,076	3,677	0.25	7,380	0.11	3,804	0.06
1999	4,820	7,396	0.25	12,219	0.12	3,516	0.01
2000	5,085	6,702	0.19	7,300	0.05	3,306	0.04
2001	4,970	1,509	0.29	1,476	0.32	2,996	0.07
2002	6,573	6,609	0.18	8,233	0.15	3,847	0.05
2003	6,450	5,786	0.17	7,117	0.21	6,474	0.02
2004	8,228	4,997	0.10	8,757	0.08	5,970	0.04
2005	7,826	3,478	0.09	7,187	0.18	6,487	0.12
2006	6,262	1,794	0.03	6,730	0.26	6,267	0.09
2007	4,431	1,012	0.03	5,972	0.06	5,220	0.02
2008	4,143	1,445	0.03	4,096	0.11	3,053	0.04
2009	4,848	1,277	0.03	7,024	0.08	4,964	0.05
2010	6,067	2,605	0.02	6,927	0.05	7,134	0.01
2011	7,511	1,466	0.02	6,224	0.07	8,909	0.03
mean	5,342	4,046	0.17	8,301	0.15	4,980	0.04
cumulative	122,863	93,047		190,928		114,534	
2004-2011	6,165	2,259	0.04	6,615	0.11	6,001	0.05

Table A13. Comparison of summer flounder discard estimates from the method used in previous assessments (D*DF), the SBRM using fluke (summer flounder) landings (D*Kflk), the SBRM using all species landings (D*Kall), and the SBRM using all fluke, scup, and black sea bass landings (D*Kfsb).

Year	D*DF (Assess)	D*DF CV (Assess)	D*Kflk (SBRM)	D*Kflk CV (SBRM)	D*Kall (SBRM)	D*Kall CV (SBRM)	D*Kfsb (SBRM)	D*Kfsb CV (SBRM)
1989	886	0.22	2,329	1.23	570	0.37	3,607	1.35
1990	1,517	0.21	1,775	1.28	1,122	0.39	3,663	1.28
1991	1,315	0.13	418	0.19	273	0.31	396	0.10
1992	862	0.14	1,345	0.03	2,689	0.19	1,871	0.05
1993	1,057	0.21	9,273	1.49	876	0.35	10,767	1.32
1994	1,019	0.15	5,294	0.89	1,919	0.12	3,263	0.60
1995	385	0.12	931	0.24	1,027	0.15	1,036	0.22
1996	579	0.33	1,142	0.29	1,795	0.23	80,171	0.01
1997	407	0.34	3,097	1.11	1,007	0.20	18,839	1.27
1998	487	0.25	2,549	1.43	793	0.14	2,836	1.41
1999	1,935	0.25	638	0.29	2,075	0.17	921	0.29
2000	907	0.19	16,960	1.04	2,022	0.28	17,598	1.05
2001	584	0.29	1,433	0.48	507	0.16	1,062	0.41
2002	562	0.18	3,230	0.20	1,152	0.13	3,603	0.24
2003	660	0.17	3,891	0.31	1,429	0.13	4,746	0.30
2004	305	0.10	2,060	0.21	2,008	0.10	2,221	0.20
2005	287	0.09	3,209	0.14	1,855	0.06	3,717	0.14
2006	361	0.03	4,773	0.51	1,853	0.11	6,526	0.40
2007	380	0.03	9,988	0.20	2,637	0.11	13,637	0.20
2008	386	0.03	3,285	0.22	1,453	0.08	3,903	0.21
2009	148	0.03	3,184	0.21	1,808	0.06	3,933	0.18
2010	248	0.02	11,892	0.56	1,833	0.07	13,297	0.51
2011	158	0.02	2,704	0.18	1,370	0.07	1,336	0.14
mean	671	0.18	4,148	0.68	1,481	0.15	8,824	0.45
cumulative	15,435		95,398		34,070		202,949	
2004-2011	284	0.05	5,484	0.35	1,852	0.09	6,748	0.31

Table A14. Total Dealer reported landings, recommended new SBRM live discard estimates, recommended new total commercial catch, and discard as a percentage of total catch for summer flounder. Catches in metric tons.

Year	Dealer Landings	D*Kall (SBRM)	D*Kall CV (SBRM)	Total Catch	Live Discard: Catch (%)
1989	5,817	570	0.37	6,387	8.9%
1990	2,749	1,122	0.39	3,871	29.0%
1991	4,355	273	0.31	4,628	5.9%
1992	6,066	2,689	0.19	8,755	30.7%
1993	3,995	876	0.35	4,871	18.0%
1994	4,968	1,919	0.12	6,887	27.9%
1995	4,911	1,027	0.15	5,938	17.3%
1996	3,718	1,795	0.23	5,513	32.6%
1997	3,994	1,007	0.20	5,001	20.1%
1998	5,076	793	0.14	5,869	13.5%
1999	4,820	2,075	0.17	6,895	30.1%
2000	5,085	2,022	0.28	7,107	28.4%
2001	4,970	507	0.16	5,477	9.2%
2002	6,573	1,152	0.13	7,725	14.9%
2003	6,450	1,429	0.13	7,879	18.1%
2004	8,228	2,008	0.10	10,236	19.6%
2005	7,826	1,855	0.06	9,681	19.2%
2006	6,262	1,853	0.11	8,115	22.8%
2007	4,431	2,637	0.11	7,068	37.3%
2008	4,143	1,453	0.08	5,596	26.0%
2009	4,848	1,808	0.06	6,656	27.2%
2010	6,067	1,833	0.07	7,900	23.2%
2011	7,511	1,370	0.07	8,881	23.2%
mean	5,342	1,481	0.15	6,823	21.7%
2004-2011	6,165	1,851	0.08	8,016	23.1%

Table A15. Summary of Observer discard sampling of the commercial fishery for summer flounder, Northeast Region (ME-VA); landings in metric tons (mt); sampling intensity expressed as mt of live discards per 100 lengths.

Year	Gear	Lengths	Ages	Live Discards (mt)	Sampling Intensity (mt/100 lengths)
1989	All	2,337	54	570	24
1990	All	3,891	453	1,122	29
1991	All	5,326	190	273	5
1992	All	9,626	331	2,689	28
1993	All	3,410	406	876	26
1994	Trawl	2,338		1,604	69
	Scallop	660		315	48
	All	2,998	354	1,919	64
1995	Trawl	1,822		618	34
	Scallop	731		409	56
	All	2,553	n/a	1,027	40
1996	Trawl	1,873		1,326	71
	Scallop	854		469	55
	All	2,727	n/a	1,795	66
1997	Trawl	839		502	60
	Scallop	556		505	91
	All	1,395	n/a	1,007	72
1998	Trawl	721		575	80
	Scallop	150		218	145
	All	871	n/a	793	91
1999	Trawl	1,145		1,880	164
	Scallop	216		195	90
	All	1,361	n/a	2,075	152
2000	Trawl	1,470		1,218	83
	Scallop	2,611		804	31
	All	4,081	n/a	2,022	50
2001	Trawl	1,528		257	17
	Scallop	705		250	35
	All	2,233	n/a	507	23
2002	Trawl	3,438		604	18
	Scallop	2,952		548	19
	All	6,390	n/a	1,152	18
2003	Trawl	4,233		795	19
	Scallop	2,594		634	24
	All	6,827	n/a	1,429	21

Table A15 continued.

Year	Gear	Lengths	Ages	Live Discards (mt)	Sampling Intensity (mt/100 lengths)
2004	Trawl	5,760		1,249	22
	Scallop	8,811		759	9
	All	14,571	n/a	2,008	14
2005	Trawl	9,562		1,328	14
	Scallop	4,690		527	11
	All	14,252	n/a	1,855	13
2006	Trawl	8,283		1,476	18
	Scallop	1,911		377	20
	All	10,194	n/a	1,853	18
2007	Trawl	12,725		2,023	16
	Scallop	4,972		614	12
	All	17,697	n/a	2,637	15
2008	Trawl	6,815		888	13
	Scallop	8,211		565	7
	All	15,026	n/a	1,453	10
2009	Trawl	9,441		1,154	12
	Scallop	8,970		654	7
	All	18,411	n/a	1,808	10
2010	Trawl	8,460		1,023	12
	Scallop	7,826		810	10
	All	16,286	n/a	1,833	11
2011	Trawl	8,710		747	9
	Scallop	6,785		623	9
	All	15,495	n/a	1,370	9
2012	Trawl	3,725		457	12
	Scallop	5,156		440	9
	All	8,881	n/a	897	10

Table A16. Difference in absolute numbers between SBRM D*Kall method and Assess D*DF method estimates of discards at age (000s of fish; includes 80% discard mortality rate).

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1989	120	-577	448	21	4	0	0	0	0	0	0	17
1990	-398	-311	30	16	0	0	0	0	0	0	0	-663
1991	-552	-2767	14	0	0	0	0	0	0	0	0	-3305
1992	1675	3888	481	15	0	0	0	0	0	0	0	6059
1993	-353	-101	175	-1	0	0	0	0	0	0	0	-280
1994	220	1855	552	-27	2	1	0	0	0	0	0	2603
1995	1512	82	260	9	5	1	0	0	0	0	0	1868
1996	92	483	808	147	70	22	2	2	2	0	0	1627
1997	30	55	441	153	39	12	1	0	0	0	0	730
1998	56	-24	245	84	55	20	12	2	0	0	0	451
1999	8	51	147	185	67	0	0	-3	0	0	0	456
2000	-9	83	731	215	69	12	9	0	1	0	0	1112
2001	27	126	47	-49	-38	-7	-5	2	1	1	0	104
2002	87	566	377	38	3	-2	9	-4	2	0	0	1075
2003	5	343	438	140	50	27	18	9	7	1	1	1040
2004	19	167	657	315	139	72	43	18	17	4	1	1450
2005	12	169	358	242	144	117	74	40	46	27	12	1240
2006	1	61	568	181	152	81	63	26	22	4	2	1161
2007	13	102	179	616	257	140	102	48	28	8	7	1501
2008	15	137	182	151	199	74	41	9	26	10	5	849
2009	15	172	441	279	183	153	67	37	21	9	2	1379
2010	-3	291	572	400	239	100	54	28	19	9	3	1711
2011	11	108	441	384	178	93	38	23	13	6	4	1300

Table A17. Estimated summer flounder discard at age in the in the commercial fishery. Lengths converted to age using annual NEFSC trawl survey age-length keys. Includes an assumed 80% discard mortality rate. Includes NEFSC OB, ASM, and ASMFC-funded data for 2010-2012.

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+
1982	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	895	1051	542	21	4	0	0	0	0	0	0	2514	0
1990	1043	2444	97	16	0	0	0	0	0	0	0	3600	0
1991	339	657	14	0	0	0	0	0	0	0	0	1010	0
1992	2830	5432	517	18	0	0	0	0	0	0	0	8797	0
1993	688	1431	354	0	0	0	0	0	0	0	0	2473	0
1994	791	3532	1045	9	2	1	0	0	0	0	0	5380	0
1995	1653	490	466	31	5	1	0	0	0	0	0	2645	0
1996	115	1121	1047	208	70	22	2	2	2	0	0	2588	3
1997	38	304	742	225	39	12	1	0	0	0	0	1360	0
1998	83	150	464	231	55	20	12	2	0	0	0	1018	2
1999	104	1274	1398	460	166	50	4	0	0	0	0	3457	0
2000	13	247	1191	442	161	38	13	3	1	0	0	2110	4
2001	38	225	153	114	34	17	5	3	1	1	0	590	4
2002	100	690	597	123	45	21	19	5	2	0	0	1601	6
2003	7	607	694	196	75	38	28	11	7	1	1	1666	20
2004	21	206	791	368	161	81	49	25	17	4	1	1722	46
2005	16	210	454	294	166	130	84	48	46	27	12	1486	133
2006	5	110	749	233	181	97	73	34	22	4	2	1510	63
2007	22	131	259	709	293	157	114	53	28	8	7	1782	96
2008	18	190	236	193	259	106	62	38	26	10	5	1143	78
2009	17	188	487	301	196	166	73	41	23	10	3	1505	77
2010	11	354	658	455	269	116	63	32	22	11	4	1994	69
2011	14	130	515	439	197	103	43	26	15	7	5	1495	53
2012	9	283	526	364	215	93	51	26	17	9	3	1596	55

Table A18. Estimated summer flounder discard mean weight at age in the in the commercial fishery. Lengths converted to age using NEFSC trawl survey age-length keys.

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1982	0.224	0.404	0.570	1.326	1.846	1.885	2.978	0.000	0.000	0.000	0.000	0.464
1983	0.176	0.370	0.633	0.927	1.194	1.396	0.000	0.000	0.000	0.000	0.000	0.478
1984	0.205	0.364	0.620	0.968	1.771	2.197	4.166	0.000	0.000	0.000	0.000	0.461
1985	0.242	0.398	0.626	1.101	1.748	2.441	0.000	0.000	0.000	0.000	0.000	0.533
1986	0.225	0.447	0.751	1.290	1.740	2.719	3.482	5.960	0.000	0.000	0.000	0.601
1987	0.230	0.412	0.761	1.340	1.839	3.050	4.808	4.640	0.000	0.000	0.000	0.583
1988	0.293	0.488	0.707	1.114	1.921	2.316	0.000	0.000	0.000	0.000	0.000	0.590
1989	0.263	0.512	0.813	1.232	1.784	3.333	1.576	0.000	0.000	0.000	0.000	0.742
1990	0.303	0.460	0.968	1.440	1.677	2.895	6.456	0.000	0.000	0.000	0.000	0.555
1991	0.273	0.433	0.670	1.306	1.372	2.450	0.000	0.000	0.000	0.000	0.000	0.537
1992	0.225	0.504	0.717	1.617	2.279	3.340	0.000	0.000	0.000	0.000	0.000	0.604
1993	0.246	0.518	0.715	1.872	2.442	3.027	0.000	0.000	0.000	0.000	0.000	0.619
1994	0.436	0.583	0.694	1.438	1.923	2.831	3.897	0.000	0.000	0.000	0.000	0.625
1995	0.426	0.575	0.816	1.457	2.603	2.930	3.537	0.000	0.000	0.000	0.000	0.727
1996	0.343	0.532	0.622	1.338	1.341	2.361	3.537	0.000	0.000	0.000	0.000	0.629
1997	0.225	0.487	0.675	0.909	1.153	2.377	0.000	0.000	0.000	0.000	0.000	0.732
1998	0.000	0.525	0.668	0.830	1.257	2.508	2.786	0.000	0.000	0.000	0.000	0.777
1999	0.000	0.508	0.706	0.945	1.549	2.330	2.604	0.000	0.000	0.000	0.000	0.884
2000	0.000	0.760	0.984	1.307	2.388	3.481	3.481	0.000	0.000	0.000	0.000	1.234
2001	0.000	0.621	0.879	1.037	1.539	2.089	2.291	3.738	0.000	0.000	0.000	0.998
2002	0.238	0.488	0.896	1.091	1.519	2.287	2.604	3.200	4.213	0.000	0.000	1.076
2003	0.000	0.677	0.910	1.137	1.597	2.018	2.807	2.714	0.000	0.000	0.000	1.156
2004	0.599	0.635	0.850	1.048	1.412	1.905	2.316	3.002	0.000	0.000	0.000	1.099
2005	0.308	0.571	0.869	1.133	1.408	1.756	2.330	2.357	2.269	0.000	0.000	1.173
2006	0.126	0.619	0.856	1.090	1.344	1.694	2.266	3.310	3.018	3.784	2.964	1.165
2007	0.175	0.492	0.799	1.137	1.467	1.805	2.148	2.878	3.448	3.790	3.065	1.258
2008	0.238	0.445	0.751	1.159	1.397	1.678	1.995	2.103	2.605	2.718	3.054	1.530
2009	0.207	0.424	0.866	1.085	1.265	1.666	2.114	2.507	2.660	3.173	3.641	1.396
2010	0.265	0.450	0.571	0.989	1.236	1.491	1.862	2.158	2.425	2.457	2.473	1.358
2011	0.136	0.393	0.609	0.967	1.173	1.516	1.856	1.994	2.159	2.666	2.123	1.350
2012	0.326	0.433	0.904	0.982	1.188	1.522	1.701	1.799	2.496	2.781	3.650	1.254

Table A19. Estimated total landings (catch types A + B1, [000s]) of summer flounder by recreational fishermen as estimated by the Marine Recreational Fisheries Statistics Survey (MRFSS 1982-2003) and Marine Recreational Information Program (MRIP 2004-2012). SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats. Proportional Standard Error (PSE) is for the TOTAL landings estimate.

	YEAR										
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
North											
Shore	167	144	62	10	70	39	42	4	16	9	26
P/C Boat	138	201	5	3	48	7	1	1	1	8	1
P/R Boat	1,293	747	568	382	2,562	648	377	137	99	173	211
TOTAL	1,598	1,092	635	395	2,680	694	420	142	116	190	238
Mid											
Shore	682	3,296	977	272	478	251	596	84	96	505	200
P/C Boat	5,745	3,321	2,381	1,068	1,541	1,143	1,134	141	412	589	374
P/R Boat	5,731	12,345	11,764	8,454	5,924	5,499	7,153	1,141	2,658	4,573	3,983
TOTAL	12,158	18,962	15,122	9,794	7,943	6,893	8,883	1,366	3,166	5,667	4,557
South											
Shore	272	523	316	504	689	115	308	91	150	51	50
P/C Boat	53	52	110	81	20	1	1	1	1	1	1
P/R Boat	1,392	367	1,292	292	289	162	348	117	361	159	156
TOTAL	1,717	942	1,718	877	998	278	657	209	512	211	207
All											
Shore	1,121	3,963	1,355	786	1,237	405	946	179	262	565	276
P/C Boat	5,936	3,574	2,496	1,152	1,609	1,151	1,136	143	414	598	376
P/R Boat	8,416	13,459	13,624	9,128	8,775	6,309	7,878	1,395	3,118	4,905	4,350
TOTAL	15,473	20,996	17,475	11,066	11,621	7,865	9,960	1,717	3,794	6,068	5,002
PSE (%)	26	7	8	12	7	5	4	6	4	4	4

Table A19 continued.

	YEAR										
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
North											
Shore	37	47	19	22	27	44	34	61	5	18	26
P/C Boat	14	25	7	5	22	26	19	49	14	21	36
P/R Boat	298	584	388	702	669	970	769	1,448	555	401	487
TOTAL	349	656	414	729	718	1,040	822	1,558	574	440	549
Mid											
Shore	186	217	173	134	195	243	157	467	199	123	145
P/C Boat	999	809	260	650	907	333	281	600	316	238	353
P/R Boat	4,579	4,633	2,330	5,137	5,059	4,972	2,610	4,802	3,878	2,272	3,424
TOTAL	5,764	5,659	2,763	5,921	6,161	5,548	3,048	5,869	4,393	2,633	3,922
South											
Shore	118	183	49	50	33	30	22	41	22	14	32
P/C Boat	1	3	1	5	2	1	<1	1	<1	3	<1
P/R Boat	262	202	99	292	253	360	214	332	304	172	55
TOTAL	381	388	149	347	288	391	237	374	327	189	88
All Regions											
Shore	341	447	241	206	255	317	213	569	226	155	203
P/C Boat	1,014	837	268	660	931	360	301	650	331	262	390
P/R Boat	5,139	5,419	2,817	6,131	5,981	6,302	3,593	6,582	4,737	2,845	3,966
TOTAL	6,494	6,703	3,326	6,997	7,167	6,979	4,107	7,801	5,294	3,262	4,559
PSE (%)	4	4	4	3	4	4	4	3	4	4	4

Table A19 continued.

	YEAR								
	2004	2005	2006	2007	2008	2009	2010	2011	2012
North									
Shore	18	11	18	1	0	6	2	1	14
P/C Boat	22	37	39	65	41	12	17	20	16
P/R Boat	649	541	585	360	541	155	179	250	211
TOTAL	690	589	641	426	582	167	199	271	242
Mid									
Shore	129	77	105	85	62	48	35	28	77
P/C Boat	441	459	277	415	131	165	142	106	77
P/R Boat	2,899	2,801	2,814	2,043	1,531	1,351	1,049	1,364	1,741
TOTAL	3,470	3,338	3,197	2,543	1,724	1,565	1,226	1,498	1,895
South									
Shore	53	16	31	13	17	14	23	10	16
P/C Boat	1	2	1	20	<1	1	1	2	3
P/R Boat	104	83	81	107	26	61	53	50	44
TOTAL	157	101	113	140	44	76	77	61	63
All									
Shore	200	104	154	98	79	63	60	39	106
P/C Boat	464	499	317	501	172	178	160	128	96
P/R Boat	3,652	3,425	3,480	2,510	2,099	1,566	1,282	1,663	1,996
TOTAL	4,316	4,028	3,951	3,109	2,350	1,807	1,502	1,830	2,199
PSE (%)	6	6	7	6	9	7	8	8	8

Table A20. Estimated total landings (catch types A + B1, [mt]) of summer flounder by recreational fishermen as estimated by the Marine Recreational Fisheries Statistics Survey (MRFSS 1982-2003) and Marine Recreational Information Program (MRIP 2004-2012). SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats. Proportional Standard Error (PSE) is for the TOTAL landings estimate.

	YEAR										
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
North											
Shore	87	59	17	7	25	21	32	2	16	6	20
P/C Boat	85	87	4	2	45	4	<1	<1	<1	6	<1
P/R Boat	875	454	388	328	2,597	582	290	141	89	150	175
TOTAL	1,047	600	409	337	2,667	607	323	144	106	162	196
Mid											
Shore	295	1,254	399	140	293	129	330	52	56	306	126
P/C Boat	3,112	2,196	1,426	609	1,093	1,098	776	125	264	364	267
P/R Boat	3,085	8,389	5,686	4,187	3,521	3,596	4,928	985	1,665	2,673	2,536
TOTAL	6,492	11,839	7,511	4,936	4,907	4,823	6,034	1,162	1,985	3,343	2,929
South											
Shore	87	134	98	230	425	34	113	57	76	25	25
P/C Boat	12	12	23	20	7	1	<1	<1	<1	<1	<1
P/R Boat	629	102	471	142	96	54	163	71	161	80	91
TOTAL	728	248	592	392	528	89	277	129	238	106	117
All											
Shore	469	1,447	514	377	743	184	475	111	148	337	171
P/C Boat	3,209	2,295	1,453	631	1,145	1,103	778	127	266	371	269
P/R Boat	4,589	8,945	6,545	4,657	6,214	4,232	5,381	1,197	1,915	2,903	2,802
TOTAL	8,267	12,687	8,512	5,665	8,102	5,519	6,634	1,435	2,329	3,611	3,242
PSE (%)	25	7	8	11	9	9	4	6	4	4	4

Table A20 continued.

	YEAR										
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
North											
Shore	26	29	14	15	17	56	27	73	6	20	32
P/C Boat	10	14	6	8	17	22	18	43	16	30	35
P/R Boat	214	401	320	518	445	833	738	1,536	695	559	540
TOTAL	250	444	340	541	479	911	783	1,652	717	609	607
Mid											
Shore	94	122	108	78	127	160	136	363	187	135	148
P/C Boat	617	499	179	414	712	274	286	649	349	274	457
P/R Boat	2,833	2,958	1,721	3,246	3,898	4,096	2,461	4,596	3,842	2,517	4,009
TOTAL	3,544	3,579	2,008	3,738	4,737	4,530	2,883	5,608	4,378	2,926	4,614
South											
Shore	61	102	30	26	18	18	13	24	15	9	22
P/C Boat	<1	1	<1	2	1	1	<1	<1	<1	1	<1
P/R Boat	150	105	80	147	147	199	115	185	168	88	35
TOTAL	212	208	111	175	166	218	129	210	184	98	58
All											
Shore	181	253	152	119	162	234	176	460	208	164	202
P/C Boat	628	514	186	424	730	297	305	693	366	305	493
P/R Boat	3,197	3,464	2,121	3,911	4,490	5,128	3,314	6,317	4,705	3,164	4,584
TOTAL	4,006	4,231	2,459	4,454	5,382	5,659	3,795	7,470	5,279	3,632	5,279
PSE (%)	4	4	5	3	4	5	5	4	4	4	4

Table A20 continued.

	YEAR								
	2004	2005	2006	2007	2008	2009	2010	2011	2012
North									
Shore	23	12	25	1	0	1	3	1	17
P/C Boat	28	48	52	86	69	23	32	33	22
P/R Boat	841	646	755	498	843	278	296	361	279
TOTAL	892	705	832	584	912	302	330	395	318
Mid									
Shore	126	90	100	82	100	56	48	36	98
P/C Boat	563	664	362	580	209	261	222	158	105
P/R Boat	3,293	3,405	3,437	2,854	2,439	2,050	1,666	2,009	2,286
TOTAL	3,982	4,158	3,898	3,516	2,748	2,367	1,936	2,203	2,488
South									
Shore	33	11	23	8	11	8	14	8	11
P/C Boat	<1	1	1	16	<1	1	1	1	3
P/R Boat	67	54	50	75	18	39	36	38	32
TOTAL	100	66	73	100	29	48	51	47	46
All									
Shore	181	112	148	91	112	64	65	45	126
P/C Boat	591	713	414	681	278	285	255	192	129
P/R Boat	4,202	4,104	4,242	3,427	3,300	2,367	1,997	2,408	2,597
TOTAL	4,974	4,929	4,804	4,199	3,689	2,716	2,317	2,645	2,853
PSE (%)	6	6	6	7	8	11	13	12	8

Table A21. Comparison of Vessel Trip Report (VTR) reported landings of summer flounder by Party (VTRPB) and charter (VTRCB) boats, with landings estimated by the MRFSS/MRIP for the Party/Charter boat (P/C Boat) sector. Data are numeric landings in thousands of fish.

Year	VTRPB	VTRCB	VTR P/C Boat Total	MRFSS/ MRIP P/C Boat Total	Ratio MRFSS/ MRIP to VTR
1995	189	44	233	268	1.15
1996	289	58	347	660	1.90
1997	302	68	370	931	2.52
1998	281	73	354	360	1.02
1999	190	50	240	301	1.25
2000	208	75	283	650	2.30
2001	105	42	147	331	2.25
2002	104	40	144	262	1.82
2003	123	44	167	390	2.35
2004	101	32	133	464	3.49
2005	80	21	101	499	4.94
2006	42	20	62	317	5.11
2007	64	28	92	501	5.45
2008	40	13	53	172	3.25
2009	32	12	44	178	4.05
2010	32	16	48	160	3.33
2011	62	14	76	128	1.68
2012	80	21	101	96	0.95

Table A22. Recreational fishery sampling intensity of summer flounder landings by MRFSS/MRIP subregion. Includes both MRFSS/MRIP and state agency lengths.

Year	Subregion	Landings (A+B1; mt)	Number Measured	mt/100 Lengths
1982	North	1,047	231	453
	Mid	6,492	2,896	224
	South	728	576	126
	TOTAL	8,267	3,703	223
1983	North	600	311	192
	Mid	11,839	4,712	251
	South	248	170	146
	TOTAL	12,687	5,193	244
1984	North	409	168	243
	Mid	7,511	2,195	342
	South	592	283	209
	TOTAL	8,512	2,646	322
1985	North	337	78	432
	Mid	4,936	1,934	255
	South	392	274	143
	TOTAL	5,665	2,286	248
1986	North	2,667	266	1,003
	Mid	4,907	1,808	271
	South	528	288	183
	TOTAL	8,102	2,362	343
1987	North	607	217	280
	Mid	4,823	1,897	254
	South	89	445	20
	TOTAL	5,519	2,559	216
1988	North	323	310	104
	Mid	6,034	2,865	214
	South	277	743	38
	TOTAL	6,634	3,918	172
1989	North	144	107	135
	Mid	1,162	1,582	73
	South	129	358	36
	TOTAL	1,435	2,047	70

Table A22 continued.

Year	Subregion	Landings (A+B1; mt)	Number Measured	mt/100 Lengths
1990	North	106	110	96
	Mid	1,985	2,667	74
	South	238	1,293	18
	TOTAL	2,329	4,070	57
1991	North	162	189	86
	Mid	3,343	4,648	72
	South	106	820	13
	TOTAL	3,611	5,657	64
1992	North	196	425	46
	Mid	2,929	4,504	65
	South	117	566	21
	TOTAL	3,242	5,495	59
1993	North	250	338	63
	Mid	3,544	4,174	74
	South	212	995	20
	TOTAL	4,006	5,507	63
1994	North	444	621	75
	Mid	3,579	3,834	90
	South	208	1,467	14
	TOTAL	4,231	5,922	69
1995	North	340	501	68
	Mid	2,008	1,470	137
	South	111	485	23
	TOTAL	2,459	2,456	100
1996	North	541	919	59
	Mid	3,738	3,373	111
	South	175	1,188	15
	TOTAL	4,454	5,480	81
1997	North	480	786	61
	Mid	4,736	2,988	159
	South	166	1,026	16
	TOTAL	5,382	4,800	112

Table A22 continued.

Year	Subregion	Landings (A+B1; mt)	Number Measured	mt/100 Lengths
1998	North	911	857	106
	Mid	4,530	3,205	141
	South	218	1,259	17
	TOTAL	5,659	5,321	106
1999	North	783	442	177
	Mid	2,883	1,584	182
	South	129	564	23
	TOTAL	3,795	2,590	147
2000	North	1,652	707	234
	Mid	5,608	1,892	296
	South	210	722	29
	TOTAL	7,470	3,321	225
2001	North	717	351	204
	Mid	4,378	2,963	148
	South	184	933	20
	TOTAL	5,279	4,247	124
2002	North	609	366	166
	Mid	2,925	2,695	109
	South	98	596	16
	TOTAL	3,632	3,657	99
2003	North	607	514	118
	Mid	4,614	3,003	154
	South	58	139	42
	TOTAL	5,279	3,656	144
2004	North	892	1,548	58
	Mid	3,982	2,486	160
	South	100	276	36
	TOTAL	4,974	4,310	115
2005	North	705	551	127
	Mid	4,158	1,994	209
	South	66	269	25
	TOTAL	4,929	2,814	175

Table A22 continued.

Year	Subregion	Landings (A+B1; mt)	Number Measured	mt/100 Lengths
2006	North	831	987	84
	Mid	3,898	1,423	274
	South	73	281	26
	TOTAL	4,804	2,691	179
2007	North	583	1,209	48
	Mid	3,516	1,863	189
	South	100	291	34
	TOTAL	4,199	3,363	125
2008	North	912	906	101
	Mid	2,748	1,022	269
	South	29	65	45
	TOTAL	3,689	1,993	185
2009	North	302	260	116
	Mid	2,367	1,939	122
	South	48	132	36
	TOTAL	2,716	2,331	117
2010	North	330	352	94
	Mid	1,936	1,188	163
	South	51	206	25
	TOTAL	2,317	1,746	133
2011	North	395	252	157
	Mid	2,203	1,759	125
	South	47	191	25
	TOTAL	2,645	2,202	120
2012	North	318	259	123
	Mid	2,488	1,514	164
	South	46	228	20
	TOTAL	2,853	2,001	143

Table A23. Estimated recreational landings at age of summer flounder (000s; catch type A + B1).

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+ N
1982	2,750	8,445	3,498	561	215	1	3	0	0	0	0	15,473	0
1983	2,302	11,612	4,978	1,340	528	220	0	16	0	0	0	20,996	16
1984	2,282	9,198	4,831	1,012	147	4	1	0	0	0	0	17,475	0
1985	1,002	5,002	4,382	473	148	59	0	0	0	0	0	11,066	0
1986	1,170	6,405	2,785	1,089	129	15	28	0	0	0	0	11,621	0
1987	467	4,676	2,085	449	182	1	5	0	0	0	0	7,865	0
1988	429	5,742	3,311	387	88	3	0	0	0	0	0	9,960	0
1989	74	539	946	135	16	2	5	0	0	0	0	1,717	0
1990	353	2,770	529	118	23	1	0	0	0	0	0	3,794	0
1991	86	3,611	2,251	79	40	1	0	0	0	0	0	6,068	0
1992	82	3,183	1,620	90	1	26	0	0	0	0	0	5,002	0
1993	79	3,930	2,323	159	1	2	0	0	0	0	0	6,494	0
1994	790	3,998	1,698	184	28	1	4	0	0	0	0	6,703	0
1995	231	1,510	1,426	116	26	16	1	0	0	0	0	3,326	0
1996	116	2,935	3,468	354	123	1	0	0	0	0	0	6,997	0
1997	4	1,148	4,188	1,465	274	88	0	0	0	0	0	7,167	0
1998	0	768	2,915	2,714	515	63	4	0	0	0	0	6,979	0
1999	0	201	1,982	1,520	325	60	19	0	0	0	0	4,107	0
2000	0	578	4,121	2,284	643	170	5	0	0	0	0	7,801	0
2001	0	838	1975	1781	539	121	36	4	0	0	0	5,294	4
2002	1	194	1327	1204	421	92	20	1	2	0	0	3,262	3
2003	0	237	1674	1751	648	171	62	16	0	0	0	4,559	16
2004	24	213	1554	1720	681	220	120	25	0	0	0	4,557	25
2005	3	184	1197	1539	755	238	99	60	35	0	0	4,110	95
2006	4	72	1412	1319	729	317	135	40	24	0	0	4,052	64
2007	2	70	577	1580	714	286	103	33	28	0	0	3,393	61
2008	1	25	97	437	854	520	213	77	148	0	0	2,372	225
2009	1	20	108	467	661	442	130	54	21	5	1	1,910	81
2010	0	14	49	231	575	376	153	47	23	10	6	1,484	86
2011	1	8	34	254	686	520	170	71	23	8	7	1,782	109
2012	1	8	158	578	772	389	179	85	19	9	1	2,199	114

Table A24. Mean weight (kg) at age of summer flounder landings in the recreational fishery.

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1982	0.224	0.404	0.570	1.326	1.846	1.885	2.978	0.000	0.000	0.000	0.000	0.464
1983	0.176	0.370	0.633	0.927	1.194	1.396	0.000	0.000	0.000	0.000	0.000	0.478
1984	0.205	0.364	0.620	0.968	1.771	2.197	4.166	0.000	0.000	0.000	0.000	0.461
1985	0.242	0.398	0.626	1.101	1.748	2.441	0.000	0.000	0.000	0.000	0.000	0.533
1986	0.225	0.447	0.751	1.290	1.740	2.719	3.482	5.960	0.000	0.000	0.000	0.601
1987	0.230	0.412	0.761	1.340	1.839	3.050	4.808	4.640	0.000	0.000	0.000	0.583
1988	0.293	0.488	0.707	1.114	1.921	2.316	0.000	0.000	0.000	0.000	0.000	0.590
1989	0.263	0.512	0.813	1.232	1.784	3.333	1.576	0.000	0.000	0.000	0.000	0.742
1990	0.303	0.460	0.968	1.440	1.677	2.895	6.456	0.000	0.000	0.000	0.000	0.555
1991	0.273	0.433	0.670	1.306	1.372	2.450	0.000	0.000	0.000	0.000	0.000	0.537
1992	0.225	0.504	0.717	1.617	2.279	3.340	0.000	0.000	0.000	0.000	0.000	0.604
1993	0.246	0.518	0.715	1.872	2.442	3.027	0.000	0.000	0.000	0.000	0.000	0.619
1994	0.436	0.583	0.694	1.438	1.923	2.831	3.897	0.000	0.000	0.000	0.000	0.625
1995	0.426	0.575	0.816	1.457	2.603	2.930	3.537	0.000	0.000	0.000	0.000	0.727
1996	0.343	0.532	0.622	1.338	1.341	2.361	3.537	0.000	0.000	0.000	0.000	0.629
1997	0.225	0.487	0.675	0.909	1.153	2.377	0.000	0.000	0.000	0.000	0.000	0.732
1998	0.000	0.525	0.668	0.830	1.257	2.508	2.786	0.000	0.000	0.000	0.000	0.777
1999	0.000	0.508	0.706	0.945	1.549	2.330	2.604	0.000	0.000	0.000	0.000	0.884
2000	0.000	0.760	0.984	1.307	2.388	3.481	3.481	0.000	0.000	0.000	0.000	1.234
2001	0.000	0.621	0.879	1.037	1.539	2.089	2.291	3.738	0.000	0.000	0.000	0.998
2002	0.238	0.488	0.896	1.091	1.519	2.287	2.604	3.200	4.213	0.000	0.000	1.076
2003	0.000	0.677	0.910	1.137	1.597	2.018	2.807	2.714	0.000	0.000	0.000	1.156
2004	0.599	0.635	0.850	1.048	1.412	1.905	2.316	3.002	0.000	0.000	0.000	1.099
2005	0.308	0.571	0.869	1.133	1.408	1.756	2.330	2.357	2.269	0.000	0.000	1.173
2006	0.126	0.619	0.856	1.090	1.344	1.694	2.266	3.310	3.018	3.784	2.964	1.165
2007	0.175	0.492	0.799	1.137	1.467	1.805	2.148	2.878	3.448	3.790	3.065	1.258
2008	0.238	0.445	0.751	1.159	1.397	1.678	1.995	2.103	2.605	2.718	3.054	1.530
2009	0.207	0.424	0.866	1.085	1.265	1.666	2.114	2.507	2.660	3.173	3.641	1.396
2010	0.265	0.450	0.571	0.989	1.236	1.491	1.862	2.158	2.425	2.457	2.773	1.358
2011	0.136	0.393	0.609	0.967	1.173	1.516	1.856	1.994	2.159	2.666	2.123	1.350
2012	0.326	0.433	0.904	0.982	1.188	1.522	1.701	1.799	2.496	2.781	3.650	1.254

Table A25. Estimated summer flounder recreational landings (catch types A + B1), live discard (catch type B2), and total catch (catch types A + B1 + B2) in numbers (000s), Proportional Standard Error (PSE) of the total catch estimate, and live discard (catch type B2) as a proportion of total catch. Catch type B2 uses estimates for NC from NCDMF (T. Wadsworth, NCDMF, pers. comm.)

Year	A+B1	B2	A+B1+B2	PSE (%)	B2 / (A+B1+B2)
1982	15,473	8,084	23,557	59	0.34
1983	20,996	11,026	32,022	16	0.34
1984	17,475	12,307	29,782	11	0.41
1985	11,066	2,461	13,526	15	0.18
1986	11,621	13,656	25,276	8	0.54
1987	7,865	13,472	21,337	6	0.63
1988	9,960	7,201	17,161	6	0.42
1989	1,717	909	2,625	10	0.34
1990	3,794	5,283	9,077	5	0.58
1991	6,068	9,871	15,938	5	0.62
1992	5,002	7,561	12,542	5	0.60
1993	6,494	17,744	24,235	5	0.73
1994	6,703	12,333	19,035	5	0.65
1995	3,326	13,570	16,894	5	0.80
1996	6,997	13,023	19,984	4	0.65
1997	7,167	13,888	21,021	4	0.66
1998	6,979	16,961	23,939	4	0.71
1999	4,107	17,825	21,940	5	0.81
2000	7,801	18,649	26,444	4	0.71
2001	5,294	24,073	29,343	3	0.82
2002	3,262	13,360	16,648	3	0.80
2003	4,559	15,776	20,335	4	0.78
2004	4,316	15,951	20,336	4	0.79
2005	4,028	21,674	25,806	5	0.84
2006	3,951	17,396	21,404	5	0.82
2007	3,109	17,536	20,736	5	0.85
2008	2,350	20,485	22,899	5	0.90
2009	1,807	22,324	24,097	5	0.93
2010	1,502	22,174	23,736	5	0.94
2011	1,830	20,380	22,266	7	0.92
2012	2,199	14,458	16,657	5	0.87

Table A26. Recreational fishery sample size for summer flounder discard mortality assumption. Includes MRFSS landed fish sampling, American Littoral Society (ALS) reported released lengths, CT Volunteer Angler Survey (CTVAS) reported released lengths, MADMF party boat sampling (MADMF), NYDEC Party Boat Survey sampling (NYPBS), MDDNR Volunteer Angler Logs (MDVAL), and MRF For-Hire Survey (MRF FHS) reported released lengths. Number of MRFSS lengths is for landed fish measured that were less than the state or federal minimum landed size, and assumed to be indicative of the length frequency of the discarded catch. This length frequency was used to characterize the length frequency of the released catch. All other sources of released lengths were used to verify this assumption. In 2002 and 2003, samples of discarded summer flounder from CTVAS and NYPBS used to directly characterize the discard in those states. The MRF FHS began sampling in 2005. B2 mt estimates use NC from NCDMF (T. Wadsworth, NCDMF, pers. comm.)

Year	Source	Discard Mortality (B2; mt)	Number of Lengths	mt/100 Lengths
1982	MRFSS		2,048	
	ALS		1	
	Total	296	2,049	14
1983	MRFSS		2,683	
	ALS			
	Total	376	2,683	14
1984	MRFSS		1,521	
	ALS		1,134	
	Total	415	2,683	15
1985	MRFSS		1,032	
	ALS		695	
	Total	92	1,727	5
1986	MRFSS		976	
	ALS		1,445	
	Total	578	2,421	24
1987	MRFSS		1,164	
	ALS		1,496	
	Total	522	2,660	20
1988	MRFSS		1,065	
	ALS		1,640	
	Total	341	2,705	13
1989	MRFSS		448	
	ALS		171	
	Total	45	619	7

Table A26 continued.

Year	Source	Discard Mortality (B2; mt)	Number of Lengths	mt/100 Lengths
1990	MRFSS		1,588	
	ALS		1,318	
	Total	234	2,906	8
1991	MRFSS		2,230	
	ALS		2,126	
	Total	429	4,356	10
1992	MRFSS		1,401	
	ALS		1,807	
	Total	344	3,208	11
1993	MRFSS		966	
	ALS		3,923	
	Total	910	4,889	19
1994	MRFSS		1,079	
	ALS		3,061	
	Total	687	4,140	17
1995	MRFSS		267	
	ALS		2,307	
	Total	753	2,574	29
1996	MRFSS		639	
	ALS		2,383	
	Total	681	3,022	23
1997	MRFSS		221	
	ALS		2,468	
	Total	556	2,689	21
1998	MRFSS		1,083	
	ALS		3,015	
	Total	734	4,098	18
1999	MRFSS		429	
	ALS		3,688	
	Total	711	4,117	17

Table A26 continued.

Year	Source	Discard Mortality (B2; mt)	Number of Lengths	mt/100 Lengths
2000	MRFSS		421	
	ALS		5,962	
	CTVAS		2,893	
	NYPBS		681	
	Total	952	9,957	10
2001	MRFSS		637	
	ALS		3,453	
	CTVAS		999	
	NYPBS		834	
	MDVAL		2,316	
	Total	1,274	8,239	15
2002	MRFSS		721	
	CTVAS		1,526	
	ALS		2,931	
	NYPBS		1,840	
	MADMF		12	
	Total	777	7,030	11
2003	MRFSS		215	
	ALS		2,466	
	CTVAS		1,407	
	NYPBS		2,167	
	Total	882	6,255	14
2004	MRIP		321	
	ALS		2,153	
	CTVAS		661	
	NYPBS		1,222	
	Total	1,034	4,357	24
2005	MRIP		142	
	ALS		3,398	
	CTVAS		1,199	
	MRF FHS		3,210	
	Total	999	7,949	13

Table A26 continued.

Year	Source	Discard Mortality (B2; mt)	Number of Lengths	mt/100 Lengths
2006	MRIP		180	
	ALS		3,104	
	CTVAS		1,124	
	MDVAL		2,944	
	MRF FHS		2,924	
	Total	795	10,276	8
2007	MRIP		266	
	ALS		4,072	
	CTVAS		1,038	
	MRF FHS		3,364	
	Total	1,130	8,740	13
2008	MRIP		224	
	ALS		5,437	
	CTVAS		843	
	MRF FHS		3,353	
	Total	1,251	9,857	13
2009	MRIP		167	
	ALS		4,873	
	CTVAS		1,023	
	NJVAS		1,918	
	MDVAS		5,466	
	VAVAS		928	
	MRF FHS		3,366	
	Total	1,195	17,741	7
2010	MRIP		147	
	ALS		6,469	
	CTVAS		973	
	NJVAS		2,412	
	MRF FHS		3,722	
	Total	1,079	13,723	8

Table A26 continued.

Year	Source	Discard Mortality (B2; mt)	Number of Lengths	mt/100 Lengths
2011	MRIP		129	
	ALS		5,133	
	NJVAS		2,867	
	MRF FHS		3,404	
	Total	1,074	11,533	9
2012	MRIP		122	
	ALS		4,033	
	NJVAS		1,170	
	MRF FHS		1,677	
	Total	815	7,002	12

Table A27. Estimated recreational fishery discards at age of summer flounder (catch type B2). NC estimates by NCMDF. Discards during 1982-1996 allocated to age groups in same relative proportions as ages 0 and 1 in the subregional catch; during 1997-2000 allocated to age groups in same relative proportions as fish less than the annual EEZ minimum size in the subregional catch; during 2001-2012 allocated to age groups in the same relative proportion as fish less than the minimum size in the respective state catch from MRFSS sampling and as indicated by state agency or ALS sampling of the released catch. All years assume 10% release mortality.

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+ N
1982	172	636	0	0	0	0	0	0	0	0	0	808	0
1983	175	932	0	0	0	0	0	0	0	0	0	1107	0
1984	210	1,020	0	0	0	0	0	0	0	0	0	1230	0
1985	40	206	0	0	0	0	0	0	0	0	0	246	0
1986	150	1,217	0	0	0	0	0	0	0	0	0	1367	0
1987	106	1,210	0	0	0	0	0	0	0	0	0	1316	0
1988	55	665	0	0	0	0	0	0	0	0	0	720	0
1989	13	83	0	0	0	0	0	0	0	0	0	96	0
1990	60	470	0	0	0	0	0	0	0	0	0	530	0
1991	24	977	0	0	0	0	0	0	0	0	0	1001	0
1992	17	674	0	0	0	0	0	0	0	0	0	691	0
1993	34	1,740	0	0	0	0	0	0	0	0	0	1774	0
1994	216	1,017	0	0	0	0	0	0	0	0	0	1233	0
1995	189	1,168	0	0	0	0	0	0	0	0	0	1357	0
1996	50	1,249	0	0	0	0	0	0	0	0	0	1299	0
1997	24	820	522	23	0	0	0	0	0	0	0	1389	0
1998	0	685	875	136	0	0	0	0	0	0	0	1696	0
1999	84	587	987	125	0	0	0	0	0	0	0	1783	0
2000	0	587	1097	180	0	0	0	0	0	0	0	1864	0
2001	0	1261	888	239	17	0	0	0	0	0	0	2405	0
2002	75	565	569	190	8	0	0	0	0	0	0	1407	0
2003	49	785	599	194	14	0	0	0	0	0	0	1641	0
2004	85	508	794	307	7	0	0	0	0	0	0	1701	0
2005	254	1153	739	160	8	0	0	0	0	0	0	2314	0
2006	155	552	887	145	13	2	0	0	0	0	0	1754	0
2007	101	667	674	514	65	7	0	0	0	0	0	2028	0
2008	140	807	609	398	246	45	10	3	2	2	0	2262	7
2009	218	897	626	440	162	28	2	1	1	0	0	2375	2
2010	150	808	594	450	194	35	7	2	1	1	1	2243	5
2011	97	481	570	595	241	41	5	3	1	1	1	2036	6
2012	101	165	411	539	197	21	7	3	1	1	0	1446	5

Table A28. Mean weight (kg) at age of summer flounder discards in the recreational fishery.

Year	0	1	2	3	4	5	6	7	8	9	10	Total
1982	0.224	0.404	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.366
1983	0.176	0.370	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.339
1984	0.205	0.364	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.337
1985	0.242	0.398	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.373
1986	0.225	0.447	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.423
1987	0.230	0.412	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.397
1988	0.293	0.488	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.473
1989	0.263	0.512	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.478
1990	0.303	0.460	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.442
1991	0.273	0.433	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.429
1992	0.225	0.504	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.497
1993	0.246	0.518	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.513
1994	0.436	0.586	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.560
1995	0.426	0.575	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.554
1996	0.343	0.532	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.525
1997	0.225	0.394	0.417	0.423	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400
1998	0.000	0.400	0.453	0.469	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.433
1999	0.127	0.378	0.427	0.455	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.399
2000	0.000	0.478	0.523	0.540	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.510
2001	0.000	0.472	0.570	0.667	0.756	0.000	0.000	0.000	0.000	0.000	0.000	0.530
2002	0.206	0.419	0.665	0.737	0.807	1.893	0.000	0.000	0.000	0.000	0.000	0.552
2003	0.169	0.420	0.645	0.737	1.040	0.000	0.000	0.000	0.000	0.000	0.000	0.537
2004	0.255	0.454	0.678	0.769	1.078	0.000	0.000	0.000	0.000	0.000	0.000	0.608
2005	0.207	0.358	0.550	0.736	1.118	0.000	0.000	0.000	0.000	0.000	0.000	0.432
2006	0.157	0.348	0.523	0.686	0.919	1.389	0.000	0.000	0.000	0.000	0.000	0.453
2007	0.170	0.336	0.593	0.802	1.024	1.483	0.000	0.000	0.000	0.000	0.000	0.557
2008	0.184	0.349	0.558	0.742	0.897	1.162	1.634	2.321	2.506	3.354	0.000	0.553
2009	0.167	0.315	0.549	0.774	0.948	1.167	1.316	1.415	1.405	0.000	0.000	0.503
2010	0.162	0.294	0.466	0.686	0.854	1.156	1.623	2.272	3.203	3.427	2.567	0.481
2011	0.177	0.302	0.479	0.622	0.816	1.154	1.775	2.232	2.683	3.217	2.536	0.527
2012	0.206	0.335	0.486	0.623	0.782	1.283	1.657	1.918	3.260	3.187	4.007	0.564

Table A29. Estimated total landings (catch types A + B1) of summer flounder by recreational fishermen as estimated by the Marine Recreational Information Program (MRIP). SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats. Proportional Standard Error (PSE) is for the TOTAL landings estimate. MRIP Estimates are currently available only for 2004-2012.

STATE	2004	2005	2006	2007	2008	2009	2010	2011
CT	216,154	156,724	137,521	112,227	145,661	44,944	35,028	53,421
Shore	4,523	2,500	7,193	0	0	0	0	0
P/C Boat	3,155	423	0	2,020	866		436	164
P/R Boat	208,476	153,801	130,328	110,206	144,795	44,944	34,592	53,258
DE	111,362	72,696	88,149	108,264	35,227	87,232	53,512	80,897
Shore	1,271	2,418	4,822	3,565	3,028	2,535	4,748	2,111
P/C Boat	6,318	6,307	4,938	11,840	1,636	11,004	1,220	878
P/R Boat	103,773	63,971	78,388	92,859	30,562	73,693	47,544	77,908
MD	42,261	117,021	37,471	103,849	57,895	64,647	25,215	17,615
Shore	5,105	10,485	1,770	47,280	11,102	9,186	685	6,051
P/C Boat	1,134	1,974	2,537	3,057	3,866	2,072	1,111	2,401
P/R Boat	36,022	104,563	33,164	53,512	42,927	53,389	23,419	9,163
MA	224,729	267,081	238,970	138,071	232,285	50,382	45,156	76,610
Shore	0	4,344	5,819	0	0	633		0
P/C Boat	1,144	4,118	22,544	9,970	1,161	2,703	4,609	1,435
P/R Boat	223,585	258,619	210,607	128,101	231,124	47,046	40,547	75,175
NH	0	0	717	0	562	0	0	0
Shore	0	0	0	0	0	0	0	0
P/R Boat	0	0	717	0	562	0	0	0
NJ	1,616,811	1,300,223	1,556,151	1,067,404	761,843	824,887	552,401	724,828
Shore	37,807	20,662	63,429	19,586	11,171	23,586	19,901	15,294
P/C Boat	147,120	163,348	189,475	195,448	68,163	97,872	85,225	73,260
P/R Boat	1,431,885	1,116,213	1,303,247	852,370	682,509	703,429	447,274	636,275
NY	1,024,670	1,163,329	752,388	865,957	608,925	298,634	334,491	369,962
Shore	60,216	22,407	20,283	0	5,748	8,645	1,588	0
P/C Boat	203,595	283,229	71,959	198,898	53,498	50,505	41,927	24,504
P/R Boat	760,859	857,693	660,146	667,059	549,679	239,483	290,976	345,458
NC	156,967	101,289	113,340	140,296	43,537	75,538	77,431	61,323
Shore	52,899	16,062	31,139	12,842	17,179	13,653	23,347	9,925
P/C Boat	469	2,305	1,383	20,233	27	897	1,271	1,553
P/R Boat	103,599	82,922	80,817	107,221	26,331	60,988	52,813	49,844
RI	248,988	164,909	264,142	175,778	203,745	71,739	118,455	141,312
Shore	13,811	4,055	4,896	459	0	0	1,940	528
P/C Boat	17,807	32,491	16,222	53,383	39,093	9,151	12,287	18,850
P/R Boat	217,371	128,363	243,024	121,936	164,652	62,587	104,228	121,934
VA	674,552	684,272	762,597	397,041	260,221	289,075	260,050	304,289
Shore	24,735	21,364	15,061	14,687	31,111	4,452	7,603	4,775
P/C Boat	83,034	4,496	8,040	5,619	3,668	3,692	12,296	4,655
P/R Boat	566,783	658,412	739,496	376,735	225,442	280,931	240,151	294,859
TOTAL	4,316,495	4,027,544	3,951,446	3,108,887	2,349,901	1,807,077	1,501,739	1,830,258
PSE (%)	6	6	7	6	9	7	8	8

Table A30. Percentage difference in estimated total landings (catch types A + B1) of summer flounder by recreational fishermen as estimated by the MRFSS and MRIP ([MRIP-MRFSS]/MRFSS) by state and fishing mode. Positive value indicates MRIP estimate is larger. SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats.

MRIP-MRFSS (delta %)

	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
CT	0%	-26%	28%	3%	26%	-27%	-12%	-15%	-2.6%
Shore	33%	85%	81%			-100%			23.3%
P/C Boat	3%	-77%		23%	1%		-17%	56%	-11.7%
P/R Boat	-1%	-27%	26%	3%	26%	-24%	-12%	-15%	-2.9%
DE	-10%	-20%	-20%	-8%	7%	-5%	-26%	-15%	-13.2%
Shore	18%	-15%	-39%	-40%	32%	-28%	-24%	-19%	-24.3%
P/C Boat	-19%	-27%	7%	15%	-2%	-1%	-10%	3%	-4.8%
P/R Boat	-10%	-19%	-20%	-9%	5%	-5%	-26%	-15%	-13.2%
MD	-36%	37%	-36%	-34%	-35%	-28%	-36%	-39%	-24.2%
Shore	-38%	-18%	-67%	-17%	-26%	71%	104%	52%	-15.1%
P/C Boat	-73%	58%	10%	16%	65%	-37%	-29%	101%	-3.1%
P/R Boat	-33%	47%	-35%	-45%	-41%	-34%	-37%	-62%	-27.0%
MA	-20%	31%	9%	82%	55%	4%	3%	80%	19.7%
Shore	-100%	-73%	25%			-68%			-61.0%
P/C Boat		149%	4%	47%	-42%	26%	-16%	37%	16.7%
P/R Boat	-19%	40%	9%	85%	56%	7%	6%	81%	22.1%
NH			-52%		-46%				-49.7%
Shore									
P/R Boat			-52%		-46%				-49.7%
NJ	-14%	-7%	0%	-20%	-11%	-19%	-4%	-8%	-10.6%
Shore	-50%	-47%	71%	-37%	49%	-12%	14%	-26%	-17.3%
P/C Boat	-32%	-5%	-9%	29%	27%	-17%	32%	12%	-2.8%
P/R Boat	-10%	-6%	-1%	-26%	-14%	-19%	-10%	-9%	-11.4%
NY	9%	1%	-6%	22%	8%	13%	29%	28%	8.9%
Shore	87%	-4%	-2%		-38%	-12%	-22%		22.2%
P/C Boat	-11%	13%	-38%	27%	31%	17%	48%	-5%	4.3%
P/R Boat	13%	-2%	-1%	20%	7%	13%	27%	32%	9.6%
NC	-9%	-21%	-26%	-24%	-18%	30%	-16%	-7%	-15.2%
Shore	15%	8%	22%	-8%	-7%	13%	8%	-23%	6.9%
P/C Boat	-86%	23%	-36%	2%	-94%	-14%	0%	-21%	-12.0%
P/R Boat	-16%	-26%	-35%	-29%	-23%	36%	-24%	-2%	-20.5%
RI	-14%	-12%	0%	-24%	-1%	40%	40%	-1%	-4.7%
Shore	4%	-14%	53%	-76%			23%	-67%	-2.3%
P/C Boat	-20%	15%	-14%	16%	29%	-4%	-4%	13%	7.9%
P/R Boat	-14%	-17%	1%	-34%	-7%	50%	49%	-2%	-6.6%
VA	16%	17%	-12%	-17%	14%	25%	-6%	13%	3.3%
Shore	-4%	-30%	-22%	-72%	81%	-32%	-23%	-44%	-27.0%
P/C Boat	707%	-51%	18%	-24%	-22%	18%	85%	14%	140.3%
P/R Boat	3%	21%	-12%	-10%	9%	26%	-7%	15%	2.7%
TOTAL	-5.3%	-0.2%	-4.5%	-8.4%	2.4%	-5.4%	1.2%	2.7%	-3.0%

Table A31. Estimated total landings (catch types A + B1, metric tons) of summer flounder by recreational fishermen as estimated by the Marine Recreational Information Program (MRIP). SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats. Proportional Standard Error (PSE) is for the TOTAL landings estimate. MRIP Estimates are currently available only for 2004-2012.

STATE	2004	2005	2006	2007	2008	2009	2010	2011
CT	248	195	197	168	256	89	60	94
Shore	4	3	12	0	0	0	0	0
P/C Boat	4	1	0	3	1	0	1	0
P/R Boat	240	191	185	165	254	89	59	94
DE	137	95	112	148	65	118	73	97
Shore	2	4	5	5	6	3	7	3
P/C Boat	9	8	6	16	3	16	2	1
P/R Boat	126	83	101	127	56	99	64	94
MD	41	126	33	93	71	75	41	24
Shore	6	9	2	37	13	11	1	8
P/C Boat	1	2	2	3	5	2	2	3
P/R Boat	34	115	29	53	53	62	38	14
MA	280	284	278	166	283	56	51	89
Shore	0	4	7	0	0	1	0	0
P/C Boat	1	4	28	12	1	3	6	1
P/R Boat	279	276	243	155	282	52	45	87
NH	0	0	1	0	0	0	0	0
Shore	0	0	0	0	0	0	0	0
P/R Boat	0	0	1	0	0	0	0	0
NJ	1,765	1,449	1,782	1,239	952	1,117	731	928
Shore	32	20	52	22	17	22	24	19
P/C Boat	175	219	245	215	91	135	112	102
P/R Boat	1,559	1,210	1,485	1,002	844	960	595	807
NY	1,252	1,703	1,076	1,442	1,242	645	734	767
Shore	63	33	27	0	6	17	7	0
P/C Boat	259	430	100	338	104	103	86	46
P/R Boat	930	1,240	950	1,103	1,132	524	640	720
NC	100	66	74	100	29	48	51	47
Shore	33	11	23	8	11	8	14	8
P/C Boat	0	1	1	16	0	1	1	1
P/R Boat	67	54	50	75	18	39	36	38
RI	364	227	356	250	372	157	219	212
Shore	19	5	6	1	0	0	3	1
P/C Boat	23	43	23	71	66	20	25	32
P/R Boat	322	179	326	178	306	136	192	180
VA	786	785	894	594	418	413	358	387
Shore	23	24	14	18	59	3	9	7
P/C Boat	119	5	8	7	6	5	20	6
P/R Boat	645	756	872	569	354	405	328	374
TOTAL	4,974	4,929	4,804	4,199	3,689	2,716	2,317	2,645
PSE (%)	6	6	6	7	8	11	13	12

Table A32. Percentage difference in estimated total landings (catch types A + B1, metric tons) of summer flounder by recreational fishermen as estimated by the MRFSS and MRIP ([MRIP-MRFSS]/MRFSS) by state and fishing mode. Positive value indicates MRIP estimate is larger. SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats.

MRIP-MRFSS (delta%)

	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
CT	-3%	-27%	27%	3%	31%	-33%	-15%	-12%	-3.1%
Shore	33%	72%	173%			-100%			24.9%
P/C Boat	18%	-74%		26%	1%		34%	93%	2.0%
P/R Boat	-4%	-27%	23%	2%	31%	-30%	-16%	-13%	-3.4%
DE	-6%	-20%	-13%	-10%	6%	-2%	-26%	-12%	-10.9%
Shore	6%	42%	-35%	-34%	27%	-28%	-16%	-22%	-15.1%
P/C Boat	71%	-27%	8%	23%	10%	4%	-14%	6%	8.7%
P/R Boat	-10%	-21%	-12%	-12%	4%	-2%	-28%	-11%	-12.0%
MD	-37%	130%	-35%	-34%	-38%	-27%	-36%	-31%	-20.0%
Shore	-32%		-63%	-19%	-40%	77%		75%	-6.0%
P/C Boat	-59%	83%	23%	31%	59%	-29%	-34%	97%	11.7%
P/R Boat	-37%	115%	-34%	-44%	-41%	-34%	-38%	-53%	-23.6%
MA	-23%	30%	-17%	77%	48%	-2%	-7%	52%	8.4%
Shore	-100%	-29%	24%			-73%			-39.1%
P/C Boat		117%	9%	21%	-46%	20%	-13%	26%	11.4%
P/R Boat	-22%	31%	-20%	84%	50%	0%	-6%	53%	8.9%
NH			-56%		-46%				-53.4%
Shore									
P/R Boat			-56%		-46%				-53.4%
NJ	-7%	-5%	-7%	-22%	-15%	-18%	-5%	-8%	-11.0%
Shore	-58%	-48%	78%	-32%	67%	-9%	3%	-24%	-19.3%
P/C Boat	34%	14%	1%	27%	18%	-15%	32%	21%	13.5%
P/R Boat	-8%	-6%	-10%	-27%	-18%	-19%	-10%	-10%	-13.6%
NY	21%	5%	-7%	24%	9%	10%	27%	27%	12.3%
Shore	83%	36%	-4%		-46%	-19%	62%		24.4%
P/C Boat	69%	23%	-37%	44%	36%	18%	70%	-1%	26.7%
P/R Boat	9%	-1%	-3%	19%	8%	10%	23%	30%	9.5%
NC	-10%	-20%	-22%	-24%	-21%	22%	-18%	-5%	-15.2%
Shore	8%	4%	37%	-11%	-12%	2%	1%	-14%	4.9%
P/C Boat	-92%	-20%	-33%	3%	-95%	-18%	30%	-8%	-15.6%
P/R Boat	-13%	-24%	-34%	-29%	-25%	28%	-25%	-3%	-19.9%
RI	-4%	-9%	-8%	-23%	1%	40%	39%	0%	-1.5%
Shore	28%	-7%	332%	-73%			-4%	-74%	16.2%
P/C Boat	65%	13%	-9%	13%	28%	-2%	-3%	12%	13.9%
P/R Boat	-9%	-13%	-10%	-31%	-3%	49%	48%	-1%	-4.0%
VA	19%	18%	-11%	-16%	16%	23%	-6%	8%	3.6%
Shore	-13%	-32%	31%	-64%	117%	-36%	-19%	-45%	-12.1%
P/C Boat	2044%	-53%	11%	-33%	-19%	17%	114%	10%	190.6%
P/R Boat	3%	22%	-12%	-12%	9%	23%	-9%	10%	1.6%
TOTAL	1%	3%	-8%	-6%	3%	-5%	4%	4%	-1.3%

Table A33. Estimated total live releases (catch type B2) of summer flounder by recreational fishermen as estimated by the Marine Recreational Information Program (MRIP). SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats. Proportional Standard Error (PSE) is for the TOTAL landings estimate. MRIP Estimates are currently available only for 2004-2011.

	2004	2005	2006	2007	2008	2009	2010	2011
CT	269,617	778,857	1,111,460	297,486	990,604	428,159	373,075	319,973
Shore	37,742	15,055	19,236	3,887	1,748	9,817	37,667	8,270
P/C Boat	6,500	963	399	3,416	648		1,282	12
P/R Boat	225,375	762,839	1,091,825	290,182	988,208	418,342	334,127	311,692
DE	737,214	795,130	445,165	1,071,823	604,647	963,700	618,711	601,611
Shore	45,244	64,748	20,179	50,300	65,578	71,566	89,956	73,406
P/C Boat	16,886	32,919	14,060	24,010	9,379	28,762	12,355	3,583
P/R Boat	675,083	697,463	410,926	997,513	529,690	863,372	516,400	524,621
ME							65	
P/C Boat							65	
MD	806,075	360,963	252,483	1,018,330	922,577	816,487	1,225,452	486,095
Shore	178,759	157,364	50,808	335,274	330,253	273,923	573,455	237,207
P/C Boat	34,142	2,523	18,501	22,838	35,510	36,540	29,642	25,500
P/R Boat	593,173	201,077	183,174	660,218	556,814	506,024	622,354	223,388
MA	348,478	358,046	610,373	135,351	273,021	96,356	214,713	221,512
Shore	18,132	128,401	66,200	9,655	2,955	893		45,565
P/C Boat	1,279	9,721	23,359	3,252	1,952	5,171	5,915	2,495
P/R Boat	329,067	219,924	520,814	122,445	268,114	90,292	208,798	173,451
NH	265	1,809	301	218	280	762		
Shore	225			218				
P/R Boat	40	1,809	301		280	762		
NJ	6,701,873	8,939,286	6,739,513	6,192,157	8,959,312	10,414,443	10,564,678	8,247,828
Shore	408,818	779,906	422,346	674,706	460,593	638,629	1,317,649	1,431,155
P/C Boat	412,847	571,270	1,005,129	541,215	486,027	570,680	535,783	550,498
P/R Boat	5,880,207	7,588,110	5,312,038	4,976,236	8,012,692	9,205,133	8,711,246	6,266,174
NY	3,182,287	7,753,367	4,945,661	5,271,601	5,521,407	5,563,769	6,571,251	7,666,674
Shore	100,118	181,011	48,666	184,804	426,756	286,374	273,002	235,356
P/C Boat	475,156	1,108,245	553,581	629,274	502,558	477,480	358,193	586,829
P/R Boat	2,607,013	6,464,111	4,343,415	4,457,523	4,592,093	4,799,914	5,940,055	6,844,489
NC	0	1,755	55,117	4,249	4,411	10,959	15,687	5,417
Shore	0	0	16,886	0	2,364	0	149	403
P/C Boat	0	148	3,562	2,820	2,048	10,959	13,660	4,326
P/R Boat	0	1,608	34,670	1,430	0	0	1,877	689
RI	277,293	280,034	1,129,097	612,107	848,075	382,262	230,311	797,361
Shore	18,088	6,423	58,039	15,812	16,739	7,783	34,806	5,899
P/C Boat	11,841	33,821	45,119	108,834	100,541	38,053	23,161	34,108
P/R Boat	247,364	239,789	1,025,939	487,462	730,796	336,425	172,344	757,354
VA	3,696,609	2,509,013	2,164,118	3,023,421	2,424,687	3,613,064	2,419,838	2,089,498
Shore	849,401	504,097	200,203	444,811	248,877	893,987	282,305	235,368
P/C Boat	75,435	17,274	18,999	26,030	33,536	49,049	40,038	21,261
P/R Boat	2,771,774	1,987,643	1,944,916	2,552,580	2,142,273	2,670,028	2,097,495	1,832,869
TOTAL	16,019,710	21,778,262	17,453,288	17,626,743	20,549,020	22,289,961	22,233,782	20,435,970

Table A34. Percentage difference in estimated total live releases (catch type B2) of summer flounder by recreational fishermen as estimated by the MRFSS and MRIP ([MRIP-MRFSS]/MRFSS) by state and fishing mode. Positive value indicates MRIP estimate is larger. SHORE mode includes fish taken from beach/bank and man-made structures. P/C indicates catch taken from party/charter boats, while P/R indicates fish taken from private/rental boats.

MRIP-MRFSS (delta)

STATE	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
CT	-26%	-7%	23%	-8%	25%	-22%	-16%	-24%	-1%
Shore	61%	-13%	12%	-56%	52%	-18%	60%	48%	22%
P/C Boat	87%	-74%	12%	18%	32%		-40%	-32%	2%
P/R Boat	-33%	-7%	24%	-7%	25%	-23%	-20%	-25%	-2%
DE	-13%	-5%	-17%	-2%	-16%	-2%	-20%	-16%	-10%
Shore	-42%	-10%	-34%	-23%	-43%	-20%	-36%	-24%	-30%
P/C Boat	-9%	-32%	30%	36%	7%	9%	-7%	-2%	-4%
P/R Boat	-10%	-3%	-16%	-2%	-11%	0%	-17%	-14%	-8%
ME							59%		59%
P/C Boat							59%		59%
MD	-15%	-17%	-51%	-37%	-29%	-21%	-25%	-31%	-28%
Shore	-31%	-23%	-67%	-33%	-15%	12%	3%	-10%	-17%
P/C Boat	-40%	11%	32%	92%	45%	-25%	-30%	19%	-7%
P/R Boat	-7%	-12%	-46%	-41%	-38%	-31%	-40%	-46%	-34%
MA	-10%	16%	10%	37%	51%	-21%	52%	69%	17%
Shore	13%	-18%	50%	6%	-73%	-30%		20%	-1%
P/C Boat	88%	166%	2%	40%	-31%	-4%	-31%	21%	10%
P/R Boat	-11%	48%	6%	40%	60%	-22%	57%	90%	21%
NH	38%	25%	-50%	-48%	35%	220%			17%
Shore	112%			-48%					-16%
P/R Boat	-54%	25%	-50%		35%	220%			23%
NJ	-7%	-10%	-1%	-13%	-4%	-8%	-1%	-1%	-6%
Shore	-34%	11%	60%	12%	34%	-8%	8%	13%	7%
P/C Boat	-3%	8%	5%	31%	37%	4%	14%	3%	10%
P/R Boat	-5%	-13%	-5%	-19%	-7%	-8%	-3%	-4%	-8%
NY	19%	0%	-6%	0%	-10%	-4%	8%	10%	1%
Shore	15%	-62%	-38%	3%	42%	-3%	17%	-30%	-13%
P/C Boat	43%	23%	-42%	51%	0%	13%	9%	-1%	5%
P/R Boat	15%	1%	2%	-4%	-14%	-5%	8%	13%	1%
NC		-3%	-19%	-10%	41%	-16%	-17%	-12%	-16%
Shore			40%		176%		-61%	-71%	35%
P/C Boat		-14%	-14%	-15%	-10%	-16%	-7%	-3%	-11%
P/R Boat		-2%	-34%	3%			-50%	134%	-32%
RI	-7%	-18%	8%	-29%	-12%	10%	7%	-5%	-7%
Shore	10%	-75%	12%	-54%	19%	10%	101%	-8%	-6%
P/C Boat	-12%	13%	-12%	26%	49%	3%	-4%	18%	17%
P/R Boat	-7%	-16%	9%	-35%	-18%	11%	-1%	-6%	-9%
VA	4%	7%	-5%	-11%	-12%	13%	-2%	9%	0%
Shore	32%	17%	-41%	11%	-10%	20%	-6%	-7%	8%
P/C Boat	170%	-31%	39%	-28%	-23%	4%	-11%	-4%	8%
P/R Boat	-3%	5%	1%	-14%	-12%	11%	-1%	12%	-1%
TOTAL	-2%	-4%	-3%	-11%	-7%	-4%	-1%	2%	-4%

Table A35. Total catch at age of summer flounder (000s), ME-NC.

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+
1982	5344	19423	10149	935	328	117	66	26	4	0	0	36392	30
1983	4925	28441	10911	2181	693	323	16	36	5	2	0	47533	43
1984	4802	26582	15454	3180	829	94	5	5	1	4	0	50956	10
1985	2078	14623	17979	1767	496	252	30	5	2	1	0	37233	8
1986	1943	17141	11056	3783	316	140	58	8	3	0	0	34448	11
1987	1138	17214	10840	1649	544	25	29	27	11	0	0	31477	38
1988	789	20440	14528	2138	642	121	19	15	6	0	0	38698	21
1989	1080	4213	7754	1713	357	55	9	3	1	0	0	15186	4
1990	1458	8497	2217	1011	221	31	7	2	1	0	0	13445	3
1991	449	9382	7162	742	217	32	3	1	0	0	0	17989	1
1992	3043	15085	6507	1143	151	69	2	1	0	0	0	26001	1
1993	952	11924	6118	585	74	46	19	2	1	0	0	19721	3
1994	1922	12503	7697	968	209	28	13	0	5	0	0	23345	5
1995	2119	5914	7563	1245	401	78	5	1	0	0	0	17325	1
1996	281	7286	9889	1914	481	94	18	3	5	1	0	19971	8
1997	66	2669	8519	3305	592	172	11	4	0	0	0	15337	4
1998	101	2346	6667	5333	1035	158	31	3	0	0	0	15675	3
1999	189	2255	6440	4206	1228	358	55	11	0	0	0	14743	11
2000	13	1674	8741	4895	1598	382	83	19	9	1	1	17417	30
2001	38	3109	4826	3690	1255	356	118	28	5	2	2	13428	36
2002	176	1934	5773	3924	1317	316	144	18	4	1	0	13606	23
2003	56	2142	5415	4206	1631	588	250	74	25	3	2	14392	103
2004	130	1238	6356	5023	2046	840	346	130	51	11	5	16174	196
2005	273	2070	4234	4454	2409	1186	591	304	211	66	36	15833	616
2006	164	1127	5705	3465	1948	950	435	149	70	10	4	14027	234
2007	125	1040	2392	4833	1902	810	386	154	83	16	12	11754	265
2008	159	1170	1497	1992	2734	1143	515	219	219	22	9	9680	469
2009	236	1272	2071	2611	2237	1455	468	183	92	26	9	10660	310
2010	161	1401	2224	2989	2682	1232	611	213	104	55	44	11716	416
2011	112	720	2045	3464	3328	1674	638	359	150	54	35	12580	598
2012	111	522	1916	3539	2733	1264	573	304	143	50	19	11173	516

Table A36. Mean weight (kg) at age of summer flounder catch, ME-NC.

Year	0	1	2	3	4	5	6	7	8	9	10	Total	7+
1982	0.255	0.419	0.616	1.447	1.906	2.787	2.668	3.762	4.284	0.000	0.000	0.504	3.831
1983	0.244	0.419	0.716	1.075	1.257	1.495	2.567	3.221	3.875	4.370	0.000	0.522	3.351
1984	0.251	0.398	0.632	1.046	1.500	2.163	3.456	3.620	4.640	4.030	0.000	0.518	3.886
1985	0.290	0.429	0.613	1.109	1.726	2.297	2.671	4.682	4.780	4.800	0.000	0.575	4.721
1986	0.256	0.454	0.668	1.160	1.739	1.994	3.310	2.994	4.415	0.000	0.000	0.613	3.382
1987	0.263	0.446	0.651	1.140	1.941	2.862	3.378	3.020	4.140	0.000	0.000	0.580	3.344
1988	0.319	0.462	0.624	1.130	1.738	2.486	3.888	3.539	4.319	0.000	0.000	0.588	3.762
1989	0.135	0.456	0.689	1.040	1.474	2.248	2.408	2.861	2.251	0.000	0.000	0.650	2.709
1990	0.214	0.421	0.811	1.162	1.538	2.143	3.024	3.944	5.029	0.000	0.000	0.543	4.305
1991	0.166	0.441	0.701	1.186	1.812	2.519	2.975	3.660	0.000	0.000	0.000	0.589	3.660
1992	0.183	0.417	0.718	1.226	1.392	2.687	2.302	4.456	0.000	0.000	0.000	0.512	4.456
1993	0.208	0.482	0.689	1.478	1.671	1.865	2.816	4.136	5.199	0.000	0.000	0.573	4.490
1994	0.310	0.489	0.598	1.349	2.092	2.763	3.399	0.000	3.703	0.000	0.000	0.565	3.703
1995	0.228	0.532	0.675	1.058	1.643	2.645	3.624	4.094	0.000	0.000	0.000	0.631	4.094
1996	0.265	0.496	0.559	1.076	1.629	2.341	2.727	5.363	4.747	4.510	0.000	0.619	4.914
1997	0.204	0.448	0.633	0.862	1.244	2.257	2.609	3.429	0.000	0.000	0.000	0.693	3.429
1998	0.221	0.522	0.643	0.842	1.324	2.444	2.745	3.815	0.000	0.000	0.000	0.758	3.815
1999	0.156	0.340	0.583	0.876	1.423	1.944	2.736	3.467	3.904	0.000	0.000	0.738	3.471
2000	0.094	0.567	0.784	1.079	1.783	2.702	2.645	2.743	3.526	3.357	3.707	0.992	3.025
2001	0.135	0.536	0.766	0.970	1.454	2.171	2.611	3.505	3.893	4.884	5.499	0.893	3.736
2002	0.192	0.438	0.723	0.956	1.382	2.107	2.734	3.567	4.776	2.983	0.000	0.865	3.744
2003	0.171	0.473	0.739	1.026	1.526	2.072	2.794	3.183	3.733	3.598	4.993	0.979	3.357
2004	0.307	0.490	0.720	0.969	1.361	1.788	2.409	3.008	3.450	3.759	3.819	0.979	3.183
2005	0.208	0.425	0.674	0.922	1.187	1.512	1.897	2.168	2.422	3.351	3.377	0.959	2.452
2006	0.156	0.453	0.665	0.964	1.271	1.661	2.240	2.951	3.429	4.020	2.797	0.957	3.138
2007	0.167	0.387	0.681	0.941	1.279	1.734	2.220	2.526	3.172	3.440	3.563	1.025	2.831
2008	0.180	0.372	0.592	0.870	1.162	1.559	1.920	2.221	2.678	3.291	3.362	1.055	2.507
2009	0.167	0.348	0.583	0.837	1.084	1.497	1.943	2.521	2.728	3.492	3.872	0.959	2.703
2010	0.169	0.316	0.503	0.758	1.047	1.398	1.899	2.329	2.860	3.296	3.694	0.912	2.734
2011	0.182	0.327	0.495	0.676	0.998	1.501	1.864	2.197	2.666	2.940	3.482	0.962	2.457
2012	0.202	0.335	0.568	0.742	1.022	1.473	1.845	1.982	2.609	2.998	3.972	0.969	2.328

Table A37. Commercial and recreational fishery landings, revised estimated commercial and recreational dead discard, and total catch statistics (metric tons) as used in the assessment of summer flounder, Maine to North Carolina. Includes MRIP 2004-2012 estimates of recreational catch, and 1982-2003 recreational catch adjusted by the 2004-2011 MRIP to MRFSS ratio for each catch type.

	Commercial			Recreational			Total		
Year	Landings	Discard	Catch	Landings	Discard	Catch	Landings	Discard	Catch
1982	10,400	n/a	10,400	8,163	284	8,447	18,563	284	18,847
1983	13,403	n/a	13,403	12,527	361	12,889	25,930	361	26,292
1984	17,130	n/a	17,130	8,405	399	8,804	25,535	399	25,934
1985	14,675	n/a	14,675	5,594	88	5,682	20,269	88	20,357
1986	12,186	n/a	12,186	8,000	555	8,555	20,186	555	20,741
1987	12,271	n/a	12,271	5,450	502	5,951	17,721	502	18,222
1988	14,686	n/a	14,686	6,550	328	6,878	21,236	328	21,564
1989	8,125	456	8,834	1,417	43	1,460	9,542	499	10,294
1990	4,199	898	5,413	2,300	225	2,525	6,499	1,122	7,938
1991	6,224	219	7,276	3,566	412	3,978	9,790	631	11,254
1992	7,529	2,151	8,219	3,201	332	3,533	10,730	2,483	11,752
1993	5,715	701	6,561	3,956	874	4,830	9,671	1,575	11,391
1994	6,588	1,535	7,494	4,178	660	4,838	10,766	2,195	12,332
1995	6,977	821	7,285	2,428	723	3,152	9,405	1,545	10,437
1996	5,861	1,436	6,324	4,398	656	5,054	10,259	2,092	11,378
1997	3,994	806	4,320	5,314	535	5,849	9,308	1,341	10,169
1998	5,076	634	5,465	5,588	705	6,293	10,664	1,339	11,758
1999	4,820	1,660	6,368	3,747	683	4,430	8,567	2,343	10,798
2000	5,085	1,617	5,811	7,376	915	8,291	12,461	2,532	14,102
2001	4,970	405	5,438	5,213	1,225	6,438	10,183	1,630	11,876
2002	6,573	922	7,022	3,586	746	4,332	10,159	1,668	11,354
2003	6,450	1,144	6,978	5,213	847	6,060	11,663	1,991	13,038
2004	8,228	1,606	8,472	4,974	1,013	5,987	13,202	2,619	14,459
2005	7,826	1,484	8,056	4,929	950	5,879	12,755	2,434	13,935
2006	6,262	1,482	6,550	4,804	768	5,572	11,066	2,250	12,122
2007	4,489	2,110	4,793	4,199	1,002	5,201	8,688	3,112	9,994
2008	4,143	1,162	4,452	3,689	1,154	4,843	7,832	2,316	9,295
2009	4,848	1,446	4,966	2,716	1,140	3,856	7,564	2,586	8,822
2010	5,930	1,466	6,128	2,317	1,066	3,383	8,247	2,532	9,511
2011	7,511	1,096	7,637	2,645	1,093	3,738	10,156	2,189	11,375
2012	6,047	718	6,765	2,853	815	3,668	8,900	1,533	10,433

Table A38. NEFSC research trawl survey indices of abundance for summer flounder. Indices are stratified mean numbers (n) and weight (kg) per tow. Spring indices are for offshore strata 1-12 61-76; fall indices are for offshore strata 1-2, 5-6, 9-10, 61, 65, 69, and 73. Winter indices (1992-2007) are for NEFSC offshore strata 1-3, 5-7, 9-11, 13-14, 16-17, 61-63, 65-67, 69-71, and 73-75. n/a = not available due to incomplete coverage (spring) or end of survey (winter). Note that door and vessel conversion factors for 1967-2008 are not significant; 1967-2008 gear conversion factors have not been included due to limited sample size and extreme violation of underlying assumptions in experimental work.

Year	Spring (n)	Spring (kg)	Fall (n)	Fall (kg)
1967	n/a	n/a	1.35	1.25
1968	0.15	0.16	1.10	1.00
1969	0.19	0.16	0.59	0.61
1970	0.09	0.09	0.15	0.13
1971	0.22	0.28	0.42	0.27
1972	0.47	0.21	0.39	0.27
1973	0.76	0.54	0.87	0.63
1974	1.37	1.26	1.70	1.86
1975	1.97	1.61	3.00	2.48
1976	2.83	2.00	1.14	0.85
1977	2.84	1.74	2.17	1.75
1978	2.55	1.40	0.32	0.40
1979	0.40	0.35	1.17	0.94
1980	1.30	0.78	0.94	0.57
1981	1.50	0.80	0.91	0.72
1982	2.27	1.11	1.57	0.90
1983	0.95	0.53	0.90	0.47
1984	0.66	0.38	0.99	0.65
1985	2.38	1.20	1.24	0.87
1986	2.14	0.82	0.68	0.45
1987	0.93	0.38	0.26	0.28
1988	1.50	0.68	0.11	0.11
1989	0.32	0.24	0.20	0.08
1990	0.72	0.27	0.27	0.19
1991	1.08	0.35	0.51	0.17

Table A38 continued.

Year	Winter (n)	Winter (kg)	Spring (n)	Spring (kg)	Fall (n)	Fall (kg)
1992	12.30	4.90	1.20	0.46	0.85	0.49
1993	13.60	5.50	1.27	0.48	0.11	0.04
1994	12.05	6.03	0.93	0.46	0.60	0.35
1995	10.93	4.81	1.09	0.46	1.13	0.83
1996	31.25	12.35	1.76	0.67	0.71	0.45
1997	10.28	5.54	1.06	0.61	1.32	0.92
1998	7.76	5.13	1.19	0.76	2.32	1.58
1999	11.06	7.99	1.60	1.01	2.42	1.66
2000	15.76	12.59	2.14	1.70	1.90	1.82
2001	18.59	15.68	2.69	2.16	1.56	1.55
2002	22.68	18.43	2.47	2.29	1.32	1.40
2003	35.62	27.48	2.91	2.42	2.00	1.93
2004	17.77	15.25	3.03	2.43	3.00	3.06
2005	12.89	10.32	1.81	1.59	1.57	1.83
2006	21.04	15.93	1.77	1.34	2.10	1.79
2007	16.83	12.89	3.25	3.17	2.21	2.45
2008	n/a	n/a	1.40	1.38	1.38	1.62

Table A39. NEFSC research trawl spring and fall survey indices from the *FSV Henry B. Bigelow* (HBB) and **aggregate calibrated, equivalent indices for the FSV Albatross IV (ALB) time series**. Indices are stratified mean numbers (n) and weight (kg) per tow. Spring indices are for offshore strata 1-12, 61-76; fall indices are for offshore strata 1-2, 5-6, 9-10, 61, 65, 69, and 73. **The aggregate spring catch number calibration factor is 3.2255; the spring catch weight factor is 3.0657; the fall catch number factor is 2.4054; the fall catch weight factor is 2.1409.**

Year	Spring (n) HBB	Spring (kg) HBB	Spring (n) ALB	Spring (kg) ALB
2009	5.672	3.598	1.758	1.174
2010	7.131	4.808	2.211	1.568
2011	8.174	4.929	2.534	1.608
2012	6.612	5.007	1.062	1.633

Year	Fall (n) HBB	Fall (kg) HBB	Fall (n) ALB	Fall (kg) ALB
2009	7.062	5.622	2.936	2.626
2010	3.466	2.941	1.441	1.374
2011	5.663	5.751	2.354	2.686
2012	3.420	3.795	1.422	1.773

Table A40. NEFSC trawl survey spring and fall survey indices from the FSV Henry B. Bigelow (HBB) and **length calibrated, equivalent indices for the FSV Albatross IV (ALB) time series**. Indices are the sum of the stratified mean numbers (n) at length. Spring strata set includes offshore strata 1-12, 61-76. Fall strata set (aged set) includes offshore strata 1, 5, 9, 61, 65, 69, 73, and inshore strata 1-61. The HBB does not sample the shallowest inshore strata (0-18 m, 0-60 ft, 0-10 fathoms). **The length calibration factors are for the lengths observed in the 2008 calibration experiment and include a constant swept area factor of 0.579. The effective total catch number calibration factors (HBB/ALB ratios) vary by year and season, depending on the characteristics of the HBB length frequency distributions.**

Year	Spring (n) HBB	HBB CV	Spring (n) ALB	Effective Factor
2009	5.672	12.1	2.845	1.994
2010	7.131	10.9	3.772	1.891
2011	8.174	15.9	4.448	1.838
2012	6.612	13.9	3.623	1.825

Year	Fall (n) HBB	HBB CV	Fall (n) ALB	Effective Factor
2009	9.509	19.4	5.128	1.854
2010	4.876	16.9	2.688	1.814
2011	7.385	22.1	3.945	1.872
2012	5.573	23.7	2.838	1.964

Table A41. NEFSC trawl survey spring survey indices at age from the FSV Henry B. Bigelow (HBB) and **length calibrated equivalent indices at age for the FSV Albatross IV (ALB) time series.** The spring strata set includes offshore strata 1-12, 61-76. Indices at age are compiled after the application of **length calibration factors including a constant swept area factor of 0.579. The effective catch number at age calibration factors (HBB/ALB ratios) vary by year and season, depending on the characteristics of the HBB length frequency distributions**.

Spring 2009	0	1	2	3	4	5	6	7+	Total
HBB	0.00	1.76	1.54	1.15	0.61	0.41	0.11	0.11	5.67
ALB	0.00	0.72	0.89	0.63	0.32	0.20	0.05	0.04	2.85
HBB/ALB	0.00	2.44	1.73	1.83	1.91	2.05	2.20	2.75	1.99

2010	0	1	2	3	4	5	6	7+	Total
HBB	0.00	1.95	1.87	1.51	0.93	0.47	0.19	0.22	7.13
ALB	0.00	0.95	1.09	0.83	0.49	0.24	0.09	0.08	3.77
HBB/ALB	0.00	2.05	1.72	1.82	1.90	1.96	2.11	2.75	1.89

2011	0	1	2	3	4	5	6	7+	Total
HBB	0.00	1.48	2.44	2.18	1.06	0.63	0.16	0.22	8.17
ALB	0.00	0.72	1.43	1.25	0.56	0.32	0.08	0.09	4.45
HBB/ALB	0.00	2.06	1.71	1.74	1.89	1.97	2.00	2.44	1.84

2012	0	1	2	3	4	5	6	7+	Total
HBB	0.00	0.48	1.07	2.60	1.43	0.59	0.24	0.20	6.61
ALB	0.00	0.24	0.62	1.51	0.76	0.30	0.12	0.07	3.62
HBB/ALB	0.00	2.00	1.73	1.72	1.88	1.97	2.00	2.86	1.83

Table A42. NEFSC trawl survey fall survey indices at age from the FSV Henry B. Bigelow (HBB) and **length calibrated equivalent indices at age for the FSV Albatross IV (ALB) time series.** The fall strata set (aged set) includes offshore strata 1, 5, 9, 61, 65, 69, 73, and inshore strata 1-61. Indices at age are compiled after **the application of length calibration factors including a constant swept area factor of 0.579. The effective catch number at age calibration factors (HBB/ALB ratios) vary by year and season, depending on the characteristics of the HBB length frequency distributions.**

Fall 2009	0	1	2	3	4	5	6	7+	Total
HBB	0.64	3.41	2.27	1.52	0.94	0.42	0.13	0.18	9.51
ALB	0.27	1.97	1.27	0.81	0.48	0.21	0.05	0.06	5.13
HBB/ALB	2.37	1.73	1.79	1.88	1.96	2.00	2.60	3.00	1.85
2010	0	1	2	3	4	5	6	7+	Total
HBB	0.23	1.66	1.28	0.78	0.46	0.27	0.11	0.09	4.88
ALB	0.10	0.96	0.74	0.43	0.24	0.13	0.05	0.04	2.69
HBB/ALB	2.30	1.73	1.73	1.81	1.92	2.08	2.20	2.25	1.81
2011	0	1	2	3	4	5	6	7+	Total
HBB	0.33	1.74	1.99	1.30	0.65	0.48	0.31	0.59	7.39
ALB	0.15	1.01	1.14	0.71	0.33	0.23	0.15	0.23	3.95
HBB/ALB	2.20	1.72	1.75	1.83	1.97	2.09	2.07	2.57	1.87
2012	0	1	2	3	4	5	6	7+	Total
HBB	0.61	0.43	0.78	1.96	1.15	0.32	0.13	0.21	5.57
ALB	0.17	0.25	0.45	1.08	0.60	0.16	0.06	0.07	2.84
HBB/ALB	3.59	1.72	1.73	1.81	1.92	2.00	2.17	3.00	1.96

Table A43. NEFSC spring trawl survey (offshore strata 1-12, 61-76) stratified mean number of summer flounder per tow at age. Coefficient of Variation (CV) in percent.

	Age											
Year	1	2	3	4	5	6	7	8	9	10+	ALL	CV
1976	0.03	1.77	0.71	0.29	0.01	0.01	0.01				2.83	33
1977	0.61	1.31	0.71	0.10	0.09	0.01		0.01			2.84	16
1978	0.68	0.93	0.64	0.19	0.04	0.03	0.03			0.01	2.55	19
1979	0.06	0.18	0.08	0.04	0.03			0.01			0.40	23
1980	0.01	0.70	0.31	0.14	0.02	0.06	0.03	0.02		0.01	1.30	15
1981	0.60	0.54	0.17	0.08	0.05	0.03	0.02	0.01			1.50	16
1982	0.70	1.43	0.12	0.02							2.27	20
1983	0.32	0.39	0.19	0.03	0.01				0.01		0.95	15
1984	0.17	0.33	0.09	0.05		0.01	0.01				0.66	29
1985	0.55	1.56	0.21	0.04	0.02						2.38	22
1986	1.48	0.43	0.20	0.02	0.01						2.14	16
1987	0.47	0.43	0.02	0.01							0.93	15
1988	0.60	0.81	0.07	0.02							1.50	23
1989	0.06	0.23	0.02	0.01							0.32	20
1990	0.63	0.03	0.06								0.72	22
1991	0.79	0.27		0.02							1.08	17
1992	0.77	0.41	0.01		0.01						1.20	18
1993	0.73	0.50	0.04								1.27	18
1994	0.35	0.53	0.04	0.01							0.93	15
1995	0.79	0.27	0.02				0.01				1.09	21
1996	1.08	0.56	0.12								1.76	26
1997	0.29	0.67	0.09	0.01							1.06	15
1998	0.27	0.52	0.32	0.06	0.01	0.01					1.19	21
1999	0.22	0.74	0.48	0.13	0.02	0.01					1.60	22
2000	0.19	1.03	0.63	0.12	0.15	0.02					2.14	15
2001	0.48	0.89	1.02	0.20	0.05	0.04	0.01				2.69	13
2002	0.34	0.89	0.74	0.31	0.10	0.03	0.05	0.01			2.47	16
2003	0.54	1.29	0.59	0.29	0.13	0.06	0.01	0.01			2.91	11
2004	0.30	1.45	0.85	0.27	0.05	0.06	0.04				3.03	22
2005	0.26	0.65	0.58	0.15	0.10	0.05	0.02		<.0.1		1.81	20
2006	0.04	1.04	0.24	0.25	0.09	0.06	0.02	0.01		0.02	1.77	18
2007	0.24	0.52	1.46	0.57	0.18	0.13	0.07	0.04	0.01	0.03	3.25	26
2008	0.22	0.35	0.32	0.29	0.11	0.09	0.02				1.40	15
2009	0.72	0.89	0.63	0.32	0.20	0.05	0.02	0.01	0.01	<0.01	2.85	12
2010	0.95	1.09	0.83	0.49	0.24	0.09	0.05	0.02	0.01	<0.01	3.77	11
2011	0.72	1.43	1.25	0.56	0.32	0.08	0.04	0.03	0.01	0.01	4.45	16
2012	0.24	0.62	1.51	0.76	0.30	0.12	0.04	0.02	<0.01	<0.01	3.62	14

Table A44. NEFSC spring trawl survey (offshore strata 1-12, 61-76) summer flounder mean length (cm) at age.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1976	25.9	36.0	43.1	53.5	60.8	70.0	72.0					
1977	25.2	35.0	43.4	51.7	59.6	63.0		74.0				
1978	27.3	34.8	40.9	46.9	53.3	59.5	64.0				65.0	75.0
1979	25.1	37.0	43.2	51.5	54.8			77.0				
1980	29.0	28.8	38.1	44.2	51.1	53.0	67.7	77.0		81.0		
1981	25.3	32.2	39.8	48.9	55.7	62.9	67.8	74.0				
1982	28.6	36.2	47.3	46.7								
1983	25.5	37.7	43.4	53.3	61.4				77.0			
1984	27.1	33.9	41.8	56.7		63.0	56.0					
1985	26.8	36.1	42.8	57.2	54.5							
1986	28.6	36.3	46.0	56.0	63.0							
1987	27.8	37.7	47.3	58.0								
1988	27.7	36.3	47.8	45.0								
1989	30.4	39.2	51.5	60.0								
1990	28.3	47.7	48.6									
1991	27.0	38.8		42.1								
1992	27.9	37.7	57.0		72.0							
1993	27.5	37.9	51.9									
1994	33.0	36.8	48.0	53.1								
1995	29.4	40.0	46.4				72.0					
1996	29.8	36.2	47.2									
1997	29.4	38.3	49.4	54.1								
1998	27.6	39.1	42.7	50.5	50.0	60.0						
1999	28.5	35.8	42.9	49.1	57.7	64.0						
2000	29.5	37.9	44.3	49.4	55.4	60.5						
2001	29.6	39.1	44.9	53.4	60.5	63.8	55.0					
2002	29.7	39.3	45.8	52.7	58.1	63.5	62.1	66.0	54.0	68.0		
2003	32.4	39.3	46.5	51.4	57.5	65.2	51.0	65.0				
2004	29.5	37.6	46.1	50.4	56.9	61.9	63.3					
2005	29.2	39.1	45.1	50.9	55.0	58.3	71.3				73.0	
2006	28.3	36.3	42.1	47.6	51.8	54.0	57.0	63.0		62.0	66.0	
2007	28.3	38.7	43.0	48.2	55.2	53.9	60.4	65.6	61.0	69.4		63.0
2008	32.0	37.3	45.1	49.0	55.9	59.6	57.9					
2009	25.9	36.7	41.3	46.2	52.6	59.9	62.4	63.6	68.2	67.0		
2010	28.4	35.2	41.1	45.5	50.7	56.9	60.5	64.4	65.7	69.5	73.0	68.0
2011	28.3	33.9	37.9	43.6	49.4	56.5	55.7	58.3	64.5	60.4	82.0	
2012	28.8	33.9	37.0	43.3	51.3	57.5	62.3	61.6	64.7	65.2	66.9	

Table A45. NEFSC fall trawl survey (offshore strata <= 55 m [1, 5, 9, 61, 65, 69, 73, inshore strata 1-61]) mean number of summer flounder per tow at age. Coefficient of Variation (CV) in percent.

	Age									
Year	0	1	2	3	4	5	6	7+	ALL	CV
1982	0.55	1.52	0.40	0.03					2.50	25
1983	0.96	1.46	0.34	0.12	0.01	0.01			2.90	13
1984	0.18	1.39	0.43	0.07	0.01	0.01	<0.01		2.09	27
1985	0.59	0.80	0.46	0.05		0.02			1.92	17
1986	0.39	0.83	0.11	0.11		<0.01			1.44	18
1987	0.07	0.58	0.20	0.03	0.02				0.90	15
1988	0.06	0.62	0.18	0.03					0.89	10
1989	0.31	0.21	0.05						0.57	19
1990	0.44	0.38	0.03	0.04		<0.01			0.89	11
1991	0.76	0.84	0.09		0.01	<0.01	<0.01		1.70	14
1992	0.99	1.04	0.25	0.03	0.01	<0.01			2.32	17
1993	0.23	0.80	0.03	0.01			<0.01		1.07	12
1994	0.75	0.67	0.09	0.01	0.01				1.53	12
1995	0.93	1.16	0.28	0.02	0.01				2.40	14
1996	0.11	1.24	0.57	0.04					1.96	15
1997	0.17	1.29	1.14	0.29	0.02	0.01	0.01	<0.01	2.93	16
1998	0.38	2.13	1.63	0.33	0.04	0.01			4.52	20
1999	0.21	1.73	1.49	0.31	0.04	0.01			3.79	14
2000	0.22	1.20	1.22	0.40	0.15	0.06	0.03	0.04	3.32	13
2001	0.12	1.36	0.93	0.37	0.11	0.10		0.01	3.00	18
2002	0.06	1.17	0.86	0.35	0.11	0.03	0.03	0.02	2.63	21
2003	0.18	1.31	1.03	0.25	0.10	0.03	0.07	0.01	2.98	18
2004	0.36	1.49	1.37	0.66	0.19	0.07	0.06	0.04	4.24	19
2005	0.16	1.14	0.54	0.47	0.18	0.10	0.13	0.03	2.75	18
2006	0.31	0.72	1.22	0.35	0.17	0.06	0.07	0.02	2.91	14
2007	0.12	0.84	0.91	0.96	0.31	0.09	0.09	0.04	3.36	29
2008	0.39	0.52	0.59	0.33	0.46	0.16	0.10	0.09	2.64	16
2009	0.27	1.97	1.27	0.81	0.48	0.21	0.05	0.06	5.13	20
2010	0.10	0.96	0.74	0.43	0.24	0.13	0.05	0.04	2.69	17
2011	0.15	1.01	1.14	0.71	0.33	0.23	0.14	0.23	3.94	21
2012	0.17	0.25	0.45	1.08	0.60	0.16	0.06	0.08	2.84	24

Table A46. NEFSC fall trawl survey (offshore strata <= 55 m [1, 5, 9, 61, 65, 69, 73, inshore strata 1-61]) summer flounder mean length (cm) at age.

	Age							
Year	0	1	2	3	4	5	6	7+
1982	28.2	35.1	43.3	47.1				
1983	24.5	33.5	42.7	52.3	60.0	58.0		
1984	23.5	33.6	41.1	46.5	62.6	65.0	70.0	
1985	25.5	35.4	43.1	53.0		63.0		
1986	23.1	35.7	40.8	53.5		57.0		
1987	27.4	34.4	46.0	53.6	47.7			
1988	30.1	35.9	43.4	61.7				
1989	25.8	35.8	48.2	60.0				
1990	24.8	36.0	45.2	54.9	60.0	68.0		
1991	23.2	34.7	43.7	59.0	61.2	67.0	69.0	
1992	25.3	34.4	42.7	51.3	58.8	68.0		
1993	29.9	35.1	44.0	58.1	59.0		70.0	
1994	27.5	38.0	44.3	61.5	57.0			
1995	26.5	36.7	47.4	59.0	65.0			
1996	26.6	35.4	41.6	56.1				
1997	28.4	35.1	40.3	46.5	51.7	59.3	56.0	63.0
1998	24.0	34.7	42.6	50.2	58.2	68.6		
1999	24.1	34.7	40.0	48.5	55.6	56.8		
2000	25.2	35.7	42.1	48.6	53.5	59.9	68.0	66.5
2001	21.8	36.3	42.6	50.0	54.0	62.1		67.0
2002	25.4	36.8	43.8	49.5	55.3	61.4	67.9	69.9
2003	23.2	37.0	43.4	51.8	56.8	59.5	58.5	72.0
2004	23.9	36.8	43.5	48.4	56.2	59.4	60.7	71.2
2005	28.8	34.2	42.2	47.5	51.6	56.4	63.5	63.8
2006	21.5	35.9	41.1	48.1	52.9	55.2	57.6	63.5
2007	22.7	34.2	41.9	46.4	52.4	55.1	58.7	71.0
2008	21.5	35.0	40.4	44.9	48.3	50.9	57.3	63.8
2009	27.7	33.3	39.6	44.2	49.7	53.3	59.2	67.7
2010	28.1	33.0	36.8	41.4	46.9	52.9	57.9	62.8
2011	28.5	33.6	37.3	41.7	47.6	53.2	54.9	59.1
2012	26.2	34.0	36.9	40.9	45.9	54.2	57.8	62.1

Table A47. NEFSC winter trawl survey (offshore strata from 27-185 meters (15-100 fathoms) 1-3, 5-7, 9-11, 13-14, 16-17, 61-63, 65-67, 69-71, 73-75; Southern Georges Bank to Cape Hatteras): mean number and mean weight (kg) per tow. The winter survey ended in 2007.

Year	Stratified mean number per tow	Coefficient of variation (%)	Stratified mean weight (kg) per tow	Coefficient of variation (%)
1992	12.30	16	4.90	15
1993	13.60	15	5.50	12
1994	12.05	18	6.03	16
1995	10.93	12	4.81	12
1996	31.25	24	12.35	22
1997	10.28	24	5.54	17
1998	7.76	21	5.13	17
1999	11.06	13	7.99	11
2000	15.76	13	12.59	13
2001	18.59	11	15.68	13
2002	22.55	16	18.71	16
2003	35.62	19	27.48	19
2004	17.77	14	15.25	15
2005	12.89	15	10.32	20
2006	21.04	14	15.93	14
2007	16.83	13	12.89	15

Table A48. NEFSC winter trawl survey (offshore strata from 27-185 meters (15-100 fathoms) 1-3, 5-7, 9-11, 13-14, 16-17, 61-63, 65-67, 69-71, 73-75; Southern Georges Bank to Cape Hatteras): mean number at age per tow. The winter survey ended in 2007.

Year	Age											
	1	2	3	4	5	6	7	8	9	10	11	12+	Total
1992	7.15	4.74	0.33	0.04	0.01	0.03							12.29
1993	6.50	6.70	0.31	0.05	0.02	0.02							13.60
1994	3.76	7.20	0.82	0.26			0.01						12.05
1995	6.07	4.59	0.25	0.02									10.93
1996	22.17	8.33	0.60	0.12	0.03								31.25
1997	3.86	4.80	1.04	0.43	0.11	0.04							10.28
1998	1.68	3.25	2.29	0.42	0.10	0.01				0.01			7.76
1999	2.11	4.80	2.90	0.84	0.28	0.06	0.04	0.02		0.01			11.06
2000	0.70	6.52	4.96	2.51	0.78	0.17	0.08	0.04	0.01				15.76
2001	3.07	5.33	6.42	2.44	0.80	0.37	0.09	0.05	0.01		0.01	0.01	18.59
2002	2.77	10.74	5.58	2.26	0.85	0.32	0.13	0.02	0.01				22.68
2003	8.17	14.36	8.48	2.67	1.04	0.39	0.32	0.15	0.05		0.01		35.62
2004	1.45	8.68	4.56	1.64	0.62	0.41	0.19	0.16	0.02	0.03	0.01		17.77
2005	2.96	4.03	3.07	1.34	0.70	0.33	0.17	0.13	0.12	0.03		0.01	12.89
2006	2.64	9.06	4.29	2.47	1.32	0.56	0.24	0.22	0.14	0.07	0.01	0.04	21.04
2007	2.77	6.18	5.15	1.54	0.58	0.31	0.16	0.05	0.08	0.01			16.83

Table A49. NEFSC winter trawl survey (offshore strata from 27-185 meters (15-100 fathoms) 1-3, 5-7, 9-11, 13-14, 16-17, 61-63, 65-67, 69-71, 73-75; Southern Georges Bank to Cape Hatteras): summer flounder mean length (cm) at age. The winter survey ended in 2007.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12+
1992	28.0	38.4	48.8	60.0	70.0	69.0						
1993	27.9	37.3	49.4	58.7	58.5	65.0						
1994	28.0	37.5	46.1	56.4			69.0					
1995	27.4	40.2	50.8	59.6								
1996	30.9	38.2	51.4	61.2	63.6							
1997	29.2	37.8	44.5	50.0	57.3	62.5						
1998	28.4	38.0	43.3	52.2	59.7	66.3				64.0		
1999	28.4	36.9	44.5	51.6	59.2	64.1	70.2	68.8		78.0		
2000	28.2	35.9	41.4	49.0	56.3	62.2	68.2	67.1	77.0			
2001	28.3	37.3	43.6	50.2	56.3	61.0	65.3	69.4	58.6		70.0	74.0
2002	30.0	38.5	44.5	51.4	58.1	62.2	66.4	62.7	75.0			
2003	30.8	39.2	45.2	51.4	55.9	61.0	65.6	67.8	67.1		67.0	
2004	28.8	38.6	44.5	50.8	55.0	60.2	65.0	66.6	67.1	72.4	69.0	
2005	27.7	37.6	44.1	48.9	53.3	56.4	60.8	64.1	65.3	70.6		71.5
2006	30.9	36.8	41.0	46.7	51.2	54.6	60.2	61.4	62.1	68.2	65.0	73.3
2007	27.8	38.2	43.5	49.1	53.8	57.3	62.1	63.6	66.0	65.0		

Table A50. MADMF spring survey: stratified mean number per tow at age.

					Age						
Year	0	1	2	3	4	5	6	7	8+	Total	CV (%)
1978		0.102	0.547	0.288	0.232		0.045			1.214	36
1979			0.087	0.090	0.152	0.050	0.011			0.390	31
1980		0.056	0.062	0.053	0.077	0.054	0.056	0.012		0.370	20
1981		0.431	0.593	0.079	0.033	0.046	0.064		0.032	1.278	34
1982		0.350	1.584	0.142	0.042	0.022			0.010	2.150	29
1983		0.051	0.599	0.450	0.024	0.009	0.022		0.012	1.167	17
1984		0.044	0.078	0.067	0.116					0.305	27
1985		0.154	1.260	0.036	0.051	0.004				1.505	20
1986		0.995	0.522	0.185	0.009					1.711	14
1987		0.656	0.640	0.013			0.011			1.320	20
1988		0.211	1.005	0.123	0.014					1.353	18
1989			0.363	0.102			0.011			0.476	22
1990		0.257	0.021	0.081	0.013					0.372	29
1991		0.032	0.050	0.011						0.093	32
1992		0.280	0.342	0.090		0.012	0.011			0.735	21
1993		0.126	0.492	0.065	0.010				0.022	0.715	22
1994		1.860	1.217	0.048	0.023		0.011			3.159	33
1995		0.104	1.302	0.053						1.459	16
1996		0.076	0.686	0.114	0.012					0.888	18
1997		0.544	1.279	0.181	0.116		0.006			2.126	14
1998		0.144	1.212	0.659	0.049	0.050				2.114	20
1999		0.078	0.878	1.112	0.302	0.029		0.016		2.415	19
2000		0.237	1.659	1.205	0.305	0.232	0.054			3.692	17
2001		0.186	1.026	0.730	0.229	0.057				2.228	17
2002		0.151	1.511	0.397	0.102	0.066	0.026	0.014	0.019	2.286	24
2003		0.206	1.440	0.624	0.185	0.118	0.012	0.023		2.608	19
2004		0.027	0.283	0.323	0.061	0.061	0.026	0.023	0.010	0.814	19
2005		0.136	0.351	1.029	0.315	0.132	0.074	0.053	0.107	2.197	19
2006		0.049	2.440	0.975	0.229	0.070	0.086	0.020	0.021	3.890	16
2007		0.254	0.392	1.008	0.102	0.080	0.051	0.012		1.899	13
2008		0.328	0.383	0.167	0.309	0.061	0.016	0.066	0.018	1.348	12
2009		0.251	0.847	0.613	0.146	0.168	0.035	0.040	0.036	2.135	13
2010		0.983	0.670	0.651	0.415	0.043	0.062		0.011	2.835	13
2011		0.150	0.986	0.753	0.144	0.111	0.006			2.148	31
2012		0.109	0.363	1.039	0.315	0.104	0.053	0.011	0.028	2.022	13

Table A51. MADMF fall survey: stratified mean number per tow at age.

	Age										
Year	0	1	2	3	4	5	6	7	8+	Total	CV (%)
1978		0.039	0.442	0.085		0.025				0.591	21
1979			0.050	0.109		0.020				0.179	46
1980		0.123	0.351	0.022	0.022	0.009				0.527	26
1981	0.010	0.400	0.405	0.012						0.827	22
1982	0.038	0.234	1.662	0.019						1.953	15
1983		0.033	0.625	0.154	0.006					0.818	22
1984	0.033	0.485	0.267	0.127		0.011				0.923	23
1985	0.057	0.117	1.895	0.039						2.108	14
1986	0.145	2.316	0.679	0.214	0.008	0.003				3.365	16
1987		1.202	0.663	0.011	0.006					1.882	13
1988		0.474	0.429	0.006	0.007	0.006				0.922	21
1989			0.317	0.016			0.012			0.345	28
1990		0.113		0.011						0.124	33
1991	0.024	0.531	0.288	0.005						0.848	17
1992		1.181	0.186							1.367	27
1993	0.009	0.335	0.478	0.030	0.022					0.874	23
1994	0.052	2.234	0.077							2.363	16
1995	0.011	0.342	0.507							0.860	19
1996		0.761	1.282	0.114	0.006					2.163	23
1997		0.494	1.508	0.351	0.020	0.036				2.409	14
1998		0.012	0.590	0.262	0.018	0.011				0.893	21
1999	0.061	0.347	0.940	0.379	0.037					1.764	15
2000	0.074	1.383	2.303	0.494	0.100	0.092	0.014	0.028		4.488	11
2001	0.011	1.244	1.083	0.307	0.027		0.011	0.017		2.700	20
2002	0.325	2.681	1.302	0.178	0.047	0.036				4.569	13
2003	0.133	3.059	1.254	0.256	0.037	0.028	0.006		0.010	4.783	13
2004	0.026	0.589	1.455	0.136	0.011	0.010				2.227	21
2005		1.557	2.049	1.350	0.446	0.096	0.015	0.015	0.017	5.545	15
2006	0.336	0.586	3.745	0.559	0.043	0.023	0.016			5.308	14
2007	0.399	0.500	0.401	1.039	0.168	0.067	0.016			2.590	20
2008	0.257	1.341	1.238	0.142	0.241	0.045				3.264	16
2009	0.320	0.362	0.784	0.551	0.172	0.126	0.050		0.019	2.383	14
2010	0.078	2.357	0.738	0.459	0.151	0.029	0.031			3.843	20
2011		0.394	1.876	2.200	0.235	0.074	0.011		0.026	4.816	15
2012	0.103	0.216	0.596	1.196	0.249	0.049	0.000	0.000	0.013	2.422	15

Table A52. MADMF seine survey: total catch of age-0 summer flounder.

Year	Total catch
1982	3
1983	3
1984	1
1985	19
1986	5
1987	4
1988	2
1989	4
1990	11
1991	4
1992	0
1993	2
1994	1
1995	14
1996	7
1997	0
1998	13
1999	13
2000	10
2001	1
2002	70
2003	11
2004	4
2005	1
2006	43
2007	38
2008	86
2009	45
2010	4
2011	1
2012	53

Table A53. RIDFW fall trawl survey: stratified mean number per tow at age. RIDFW lengths aged with NEFSC fall trawl survey age-length keys.

	Age										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1981	0.30	0.97	1.74	0.20	0.01	0.00	0.00	0.00	0.00	0.00	3.24
1982	0.02	0.21	0.52	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.83
1983	0.03	0.14	0.42	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.71
1984	0.02	0.74	0.49	0.10	0.00	0.00	0.00	0.00	0.00	0.00	1.35
1985	0.35	0.31	0.28	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.97
1986	0.35	2.45	0.51	0.13	0.00	0.01	0.00	0.00	0.00	0.00	3.46
1987	0.04	0.94	0.37	0.02	0.04	0.00	0.00	0.00	0.00	0.00	1.42
1988	0.00	0.34	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
1989	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
1990	0.05	0.67	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84
1991	0.00	0.12	0.08	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.22
1992	0.01	0.77	0.41	0.11	0.07	0.00	0.00	0.00	0.00	0.00	1.38
1993	0.01	0.41	0.22	0.07	0.00	0.00	0.03	0.00	0.00	0.00	0.74
1994	0.04	0.12	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
1995	0.02	0.53	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.76
1996	0.10	0.95	1.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	2.09
1997	0.03	0.56	0.96	0.30	0.02	0.02	0.00	0.00	0.00	0.00	1.89
1998	0.00	0.09	0.36	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.54
1999	0.02	1.04	1.91	0.35	0.02	0.01	0.00	0.00	0.00	0.00	3.35
2000	0.40	0.50	1.24	0.45	0.14	0.03	0.00	0.00	0.00	0.00	2.76
2001	0.00	1.05	0.63	0.30	0.09	0.07	0.01	0.00	0.00	0.00	2.15
2002	0.44	2.42	1.38	0.40	0.08	0.02	0.03	0.03	0.00	0.00	4.79
2003	0.10	2.35	2.08	0.49	0.12	0.04	0.06	0.00	0.00	0.00	5.24
2004	0.03	0.48	1.30	0.78	0.19	0.06	0.01	0.00	0.00	0.00	2.85
2005	0.01	0.84	1.38	0.69	0.15	0.14	0.01	0.04	0.03	0.00	3.29
2006	0.10	0.14	1.13	0.44	0.16	0.02	0.01	0.00	0.00	0.00	2.00
2007	0.08	0.43	0.86	1.35	0.34	0.13	0.08	0.02	0.00	0.03	3.32
2008	0.12	0.55	1.10	0.62	0.85	0.41	0.16	0.10	0.02	0.00	3.93
2009	0.39	1.05	1.59	1.34	0.77	0.24	0.09	0.01	0.00	0.00	5.47
2010	0.02	0.91	1.24	0.79	0.63	0.45	0.13	0.05	0.03	0.04	4.29
2011	0.02	0.55	1.81	1.77	0.62	0.26	0.07	0.03	0.01	0.03	5.16
2012	0.08	0.14	0.35	1.22	0.85	0.26	0.14	0.03	0.00	0.01	3.09

Table A54. RIDFW monthly fixed station trawl survey: stratified mean number per tow at age. RIDFW lengths aged with NEFSC spring and fall trawl survey age-length keys.

Year	Age										
	0	1	2	3	4	5	6	7	8	9+	Total
1990	0.02	0.17	0.04	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.29
1991		0.07	0.08								0.15
1992	0.01	0.15	0.13	0.04	0.01						0.34
1993	0.01	0.11	0.09	0.04			0.01				0.26
1994	0.04	0.08	0.04		0.01						0.17
1995	0.03	0.02	0.02	0.01							0.08
1996	0.02	0.41	0.40	0.13							0.96
1997	0.04	0.17	0.38	0.13	0.01						0.73
1998		0.07	0.24	0.11	0.01						0.43
1999	0.03	0.26	0.37	0.17	0.05	0.02					0.90
2000	0.09	0.63	1.22	0.49	0.12	0.05	0.01				2.61
2001	0.01	0.42	0.28	0.15	0.06	0.04	0.02				0.98
2002	0.11	0.81	0.63	0.30	0.11	0.05		0.02			2.03
2003	0.05	1.48	1.44	0.45	0.24	0.08	0.04				3.78
2004	0.10	0.54	0.88	0.46	0.13	0.04	0.02				2.17
2005	0.04	0.55	0.98	0.53	0.17	0.16	0.02	0.03	0.01		2.49
2006	0.00	0.24	0.47	0.29	0.23	0.06	0.02	0.01			1.32
2007	0.04	0.25	0.51	0.55	0.20	0.07	0.05	0.01			1.68
2008	0.06	0.36	0.50	0.33	0.46	0.23	0.13	0.04	0.01		2.12
2009	0.12	0.89	1.50	1.28	0.74	0.36	0.12	0.04	0.02	0.01	5.08
2010	0.05	0.50	0.59	0.52	0.40	0.24	0.09	0.03	0.03	0.02	2.47
2011	0.07	0.53	1.16	1.03	0.42	0.24	0.07	0.04	0.02	0.02	3.59
2012	0.02	0.07	0.20	0.53	0.32	0.08	0.03	0.01			1.25

Table A55. University of Rhode Island Graduate School of Oceanography (URIGSO) year-round weekly fixed station trawl survey: mean number per tow.

Year	Fox Is	Whale Rk	Average
1959	2.517	3.347	2.932
1960	1.579	1.583	1.581
1961	3.358	1.492	2.425
1962	1.917	1.063	1.490
1963	0.965	0.083	0.524
1964	1.171	0.246	0.708
1965	1.079	0.679	0.879
1966	1.833	0.567	1.200
1967	0.685	0.135	0.410
1968	0.321	0.042	0.181
1969	0.347	0.033	0.190
1970	0.243	0.071	0.157
1971	0.525	0.067	0.296
1972	0.269	0.000	0.135
1973	1.071	0.322	0.697
1974	3.503	0.581	2.042
1975	2.428	1.272	1.850
1976	8.917	2.674	5.795
1977	2.451	0.350	1.401
1978	1.196	0.528	0.862
1979	1.136	0.590	0.863
1980	0.967	0.100	0.533
1981	4.917	1.284	3.101
1982	2.160	0.835	1.497
1983	1.975	0.629	1.302
1984	0.736	0.451	0.594
1985	0.554	0.432	0.493
1986	1.197	0.889	1.043
1987	1.467	1.842	1.654
1988	1.133	0.713	0.923
1989	0.667	0.096	0.381
1990	0.224	0.078	0.151
1991	1.536	0.188	0.862
1992	0.519	0.228	0.374
1993	0.621	0.083	0.352
1994	0.329	0.163	0.246
1995	0.971	1.258	1.115
1996	1.971	1.713	1.842
1997	1.708	2.071	1.890
1998	2.308	2.258	2.283
1999	4.536	4.475	4.506

Year	Fox Is	Whale Rk	Average
2000	4.783	8.161	6.472
2001	4.413	5.367	4.890
2002	6.842	8.375	7.608
2003	5.751	7.786	6.769
2004	4.146	4.921	4.533
2005	2.775	3.958	3.367
2006	2.018	2.956	2.487
2007	5.007	4.422	4.715
2008	6.808	5.725	6.267
2009	6.644	10.771	8.708
2010	6.229	9.192	7.710
2011	11.031	17.889	14.460
2012	6.745	6.142	6.443

Table A56. CTDEP spring trawl survey: summer flounder index of abundance, geometric mean number per tow at age. CTDEP lengths aged with NEFSC spring trawl survey age-length keys.

Year	Age								
	0	1	2	3	4	5	6	7+	Total
1984	0.000	0.314	0.271	0.044	0.000	0.000	0.000	0.000	0.629
1985	0.000	0.015	0.325	0.040	0.058	0.003	0.000	0.000	0.441
1986	0.000	0.753	0.100	0.082	0.008	0.006	0.000	0.000	0.949
1987	0.000	0.951	0.086	0.014	0.004	0.001	0.000	0.001	1.057
1988	0.000	0.232	0.223	0.035	0.009	0.001	0.000	0.000	0.500
1989	0.000	0.013	0.049	0.024	0.016	0.000	0.000	0.000	0.102
1990	0.000	0.304	0.022	0.013	0.006	0.001	0.000	0.001	0.347
1991	0.000	0.392	0.189	0.029	0.028	0.001	0.000	0.000	0.639
1992	0.000	0.319	0.188	0.021	0.004	0.023	0.000	0.000	0.555
1993	0.000	0.320	0.151	0.015	0.018	0.003	0.000	0.001	0.508
1994	0.000	0.496	0.314	0.025	0.018	0.005	0.000	0.002	0.860
1995	0.000	0.199	0.051	0.020	0.005	0.000	0.000	0.006	0.281
1996	0.000	0.578	0.266	0.086	0.023	0.004	0.000	0.004	0.961
1997	0.000	0.391	0.507	0.057	0.036	0.004	0.002	0.002	0.999
1998	0.000	0.064	0.594	0.503	0.116	0.006	0.025	0.002	1.310
1999	0.000	0.245	0.593	0.385	0.139	0.053	0.025	0.000	1.440
2000	0.000	0.321	0.726	0.524	0.074	0.111	0.034	0.000	1.790
2001	0.000	0.841	0.340	0.365	0.120	0.043	0.032	0.007	1.748
2002	0.000	1.057	1.264	0.465	0.233	0.087	0.044	0.035	3.185
2003	0.000	1.608	1.016	0.395	0.232	0.085	0.046	0.039	3.421
2004	0.000	0.259	0.818	0.410	0.194	0.032	0.077	0.048	1.838
2005	0.000	0.253	0.264	0.150	0.033	0.036	0.039	0.029	0.804
2006	0.000	0.038	0.360	0.068	0.065	0.034	0.026	0.022	0.613
2007	0.000	1.152	0.210	0.560	0.316	0.115	0.089	0.065	2.507
2008	0.000	0.601	0.291	0.237	0.263	0.117	0.062	0.043	1.614
2009	0.000	0.777	0.377	0.291	0.180	0.195	0.070	0.040	1.930
2010	0.000	1.867	0.281	0.211	0.144	0.094	0.042	0.049	2.688
2011	0.000	1.002	1.084	0.801	0.382	0.316	0.110	0.153	3.848
2012	0.000	0.468	0.628	0.975	0.635	0.204	0.075	0.076	3.062

Table A57. CTDEP fall trawl survey: summer flounder index of abundance, geometric mean number per tow at age. CTDEP lengths aged with NEFSC fall trawl survey age-length keys. No survey was conducted in 2010.

Year	Age								
	0	1	2	3	4	5	6	7	Total
1984	0.000	0.571	0.331	0.072	0.014	0.004	0.004	0.003	0.999
1985	0.240	0.339	0.528	0.075	0.001	0.008	0.000	0.000	1.191
1986	0.172	1.170	0.298	0.072	0.006	0.001	0.000	0.000	1.719
1987	0.075	1.067	0.223	0.033	0.003	0.000	0.000	0.000	1.401
1988	0.015	0.884	0.481	0.037	0.002	0.001	0.000	0.000	1.420
1989	0.000	0.029	0.095	0.015	0.001	0.000	0.000	0.000	0.140
1990	0.032	0.674	0.110	0.042	0.007	0.005	0.000	0.000	0.870
1991	0.036	0.826	0.340	0.036	0.013	0.005	0.004	0.000	1.260
1992	0.013	0.570	0.366	0.046	0.016	0.009	0.000	0.000	1.020
1993	0.084	0.827	0.152	0.039	0.003	0.001	0.002	0.001	1.109
1994	0.132	0.300	0.085	0.024	0.009	0.000	0.000	0.000	0.550
1995	0.023	0.384	0.117	0.012	0.002	0.001	0.000	0.002	0.541
1996	0.069	0.887	1.188	0.042	0.005	0.000	0.000	0.000	2.191
1997	0.033	0.681	1.373	0.373	0.021	0.014	0.004	0.001	2.500
1998	0.000	0.269	1.054	0.321	0.054	0.021	0.000	0.000	1.719
1999	0.044	0.679	1.484	0.346	0.114	0.011	0.002	0.000	2.680
2000	0.112	0.395	0.871	0.341	0.124	0.043	0.011	0.013	1.910
2001	0.021	2.689	1.137	0.436	0.110	0.018	0.005	0.001	4.417
2002	0.442	3.087	1.930	0.479	0.123	0.031	0.024	0.005	6.121
2003	0.000	1.459	1.319	0.407	0.087	0.091	0.016	0.009	3.388
2004	0.255	0.385	0.755	0.440	0.080	0.024	0.015	0.000	1.954
2005	0.067	1.093	0.744	0.355	0.087	0.032	0.012	0.020	2.410
2006	0.098	0.217	0.592	0.230	0.096	0.044	0.021	0.018	1.315
2007	0.130	0.567	0.387	0.468	0.201	0.078	0.041	0.016	1.888
2008	0.681	0.515	1.155	0.660	0.048	0.013	0.013	0.000	3.085
2009	0.405	0.661	0.888	0.624	0.318	0.133	0.044	0.044	3.117
2010									
2011	0.117	0.693	0.933	0.564	0.123	0.054	0.028	0.084	2.558
2012	0.163	0.459	0.828	1.424	0.585	0.184	0.063	0.030	3.736

Table A58. NYDEC Peconic Bay trawl survey: index of summer flounder abundance. NYDEC lengths aged with NEFSC trawl survey age-length keys.

	Age									
Year	0	1	2	3	4	5	6	7+	Total	CV
1987	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.24
1988	0.02	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.09	0.18
1989	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.20
1990	0.08	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.18	0.13
1991	0.12	0.32	0.04	0.00	0.00	0.00	0.00	0.00	0.48	0.10
1992	0.03	0.16	0.10	0.01	0.00	0.00	0.00	0.00	0.30	0.11
1993	0.08	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.34	0.11
1994	0.32	0.32	0.04	0.01	0.00	0.00	0.00	0.00	0.70	0.08
1995	0.21	0.18	0.03	0.00	0.01	0.00	0.00	0.00	0.43	0.09
1996	0.05	0.24	0.29	0.04	0.01	0.01	0.00	0.00	0.63	0.08
1997	0.15	0.70	0.43	0.09	0.00	0.00	0.00	0.00	1.38	0.06
1998	0.01	0.26	0.62	0.11	0.01	0.00	0.00	0.00	1.01	0.07
1999	0.04	0.12	0.26	0.12	0.03	0.00	0.00	0.00	0.57	0.09
2000	0.06	0.30	0.33	0.11	0.04	0.02	0.00	0.00	0.85	0.07
2001	0.04	0.29	0.16	0.06	0.02	0.00	0.00	0.00	0.57	0.07
2002	0.29	0.59	0.22	0.06	0.01	0.01	0.00	0.00	1.18	0.07
2003	0.03	0.35	0.23	0.07	0.02	0.00	0.01	0.00	0.72	0.08
2004	0.07	0.24	0.23	0.04	0.00	0.00	0.00	0.00	0.58	0.07
2005	0.06	0.14	0.14	0.11	0.04	0.00	0.00	0.00	0.50	0.13
2006	0.05	0.11	0.22	0.06	0.02	0.00	0.01	0.00	0.47	0.10
2007	0.10	0.11	0.14	0.14	0.04	0.01	0.01	0.00	0.55	0.08
2008	0.43	0.19	0.17	0.06	0.04	0.01	0.00	0.00	0.91	0.10
2009	0.61	0.24	0.19	0.12	0.07	0.02	0.01	0.00	1.24	0.08
2010	0.04	0.10	0.09	0.08	0.06	0.02	0.00	0.00	0.41	0.11
2011	0.05	0.16	0.20	0.14	0.05	0.03	0.02	0.00	0.65	0.09
2012	0.32	0.17	0.16	0.28	0.13	0.02	0.01	0.00	1.11	0.06

Table A59. NJDFW trawl survey, April - October: index of summer flounder abundance. NJDFW lengths aged with NEFSC fall trawl survey age-length keys.

	Age											
Year	0	1	2	3	4	5	6	7	8	9+	Total	CV
1988	0.17	3.06	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.15
1989	1.00	0.51	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.23
1990	1.28	1.44	0.11	0.03	0.00	0.00	0.00	0.00	0.00	0.00	2.86	0.17
1991	1.00	2.69	0.27	0.02	0.00	0.00	0.00	0.00	0.00	0.00	3.98	0.13
1992	1.10	3.00	0.57	0.06	0.02	0.00	0.00	0.00	0.00	0.00	4.75	0.18
1993	2.55	5.69	0.20	0.01	0.01	0.00	0.00	0.00	0.00	0.00	8.46	0.12
1994	1.66	1.07	0.08	0.00	0.02	0.00	0.00	0.00	0.00	0.00	2.83	0.22
1995	5.12	2.94	0.26	0.07	0.02	0.00	0.00	0.00	0.00	0.00	8.41	0.11
1996	1.66	5.10	2.70	0.18	0.05	0.00	0.00	0.00	0.00	0.00	9.69	0.18
1997	1.65	8.25	5.25	1.02	0.10	0.07	0.01	0.00	0.00	0.00	16.35	0.11
1998	0.67	5.80	2.67	0.29	0.03	0.01	0.00	0.00	0.00	0.00	9.47	0.14
1999	1.03	6.12	3.46	0.65	0.12	0.06	0.00	0.00	0.00	0.00	11.44	0.10
2000	0.99	3.94	1.85	0.46	0.12	0.06	0.04	0.00	0.00	0.00	7.46	0.13
2001	0.62	3.32	1.18	0.41	0.09	0.03	0.02	0.00	0.00	0.00	5.68	0.09
2002	1.51	9.11	4.13	1.28	0.47	0.24	0.05	0.04	0.00	0.00	16.84	0.15
2003	0.60	5.61	2.55	0.57	0.19	0.19	0.07	0.06	0.00	0.00	9.84	0.11
2004	0.90	6.27	2.49	0.57	0.19	0.11	0.10	0.03	0.00	0.00	10.66	0.15
2005	3.11	5.99	1.24	0.53	0.17	0.10	0.03	0.01	0.01	0.00	11.19	0.28
2006	0.81	5.74	3.22	0.48	0.20	0.11	0.08	0.02	0.00	0.00	10.65	0.12
2007	0.64	4.10	2.49	1.22	0.31	0.12	0.09	0.01	0.00	0.00	8.98	0.10
2008	1.31	2.34	1.61	0.45	0.37	0.12	0.07	0.01	0.01	0.00	6.29	0.10
2009	1.68	2.82	2.15	1.02	0.40	0.12	0.08	0.02	0.01	0.00	8.31	0.10
2010	1.28	4.53	2.75	1.48	0.67	0.23	0.09	0.01	0.01	0.02	11.07	0.11
2011	1.05	2.38	1.86	0.97	0.27	0.20	0.07	0.05	0.01	0.01	6.92	0.15
2012	1.88	1.43	1.63	2.15	0.74	0.21	0.09	0.05	0.01	0.00	8.19	0.14

Table A60. DEDFW 16 foot trawl survey: index of summer flounder recruitment at age-0 in the Delaware Bay Estuary.

Year	Geometric Mean number per tow
1980	0.12
1981	0.06
1982	0.11
1983	0.03
1984	0.08
1985	0.06
1986	0.10
1987	0.14
1988	0.01
1989	0.12
1990	0.23
1991	0.07
1992	0.31
1993	0.03
1994	0.29
1995	0.17
1996	0.03
1997	0.02
1998	0.03
1999	0.05
2000	0.18
2001	0.07
2002	0.07
2003	0.09
2004	0.10
2005	0.00
2006	0.02
2007	0.03
2008	0.05
2009	0.31
2010	0.04
2011	0.02
2012	0.02

Table A61. DEDFW 16 foot trawl survey: index of summer flounder recruitment at age-0 in Delaware Inland Bays.

Year	Geometric Mean number per tow
1986	0.317
1987	0.258
1988	0.013
1989	0.139
1990	0.361
1991	0.378
1992	0.368
1993	0.047
1994	0.571
1995	0.301
1996	0.080
1997	0.222
1998	0.390
1999	0.350
2000	0.205
2001	0.142
2002	0.125
2003	0.214
2004	0.268
2005	0.012
2006	0.170
2007	0.170
2008	0.200
2009	0.420
2010	0.130
2011	0.223
2012	0.150

Table A62. DEDFW Delaware Bay 30 foot trawl survey: index of summer flounder abundance. Due to an uncalibrated vessel change, indices for 1991-2002 (*italics*) are not used in the assessment,

Year	0	1	2	3	4	5	6	7	8	Total
1991	*1.44*	*1.13*	*0.18*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.79*
1992	*0.47*	*0.28*	*0.08*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.83*
1993	*0.04*	*1.56*	*0.73*	*0.07*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.40*
1994	*2.03*	*0.14*	*0.22*	*0.08*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*2.72*
1995	*0.95*	*1.00*	*0.28*	*0.10*	*0.07*	*0.02*	*0.00*	*0.00*	*0.00*	*2.41*
1996	*0.46*	*0.73*	*0.48*	*0.10*	*0.01*	*0.00*	*0.01*	*0.00*	*0.00*	*1.79*
1997	*0.03*	*0.12*	*0.49*	*0.47*	*0.11*	*0.00*	*0.03*	*0.01*	*0.01*	*1.27*
1998	*0.11*	*0.31*	*0.83*	*0.29*	*0.11*	*0.01*	*0.00*	*0.00*	*0.00*	*1.66*
1999	*0.20*	*0.06*	*0.77*	*0.47*	*0.16*	*0.03*	*0.00*	*0.00*	*0.00*	*1.69*
2000	*0.79*	*0.24*	*0.30*	*0.28*	*0.15*	*0.04*	*0.00*	*0.00*	*0.00*	*1.84*
2001	*0.34*	*1.55*	*0.49*	*0.26*	*0.10*	*0.02*	*0.01*	*0.00*	*0.00*	*2.77*
2002	*0.04*	*0.23*	*0.09*	*0.00*	*0.03*	*0.00*	*0.00*	*0.00*	*0.00*	*0.39*
2003	0.15	0.14	0.29	0.15	0.07	0.03	0.02	0.00	0.00	0.85
2004	0.02	0.07	0.06	0.01	0.01	0.01	0.00	0.00	0.00	0.18
2005	0.00	0.30	0.11	0.02	0.01	0.00	0.00	0.00	0.00	0.44
2006	0.41	0.10	0.23	0.07	0.01	0.01	0.00	0.00	0.00	0.83
2007	0.11	0.14	0.83	0.09	0.07	0.02	0.00	0.00	0.01	1.29
2008	0.20	0.35	0.12	0.02	0.01	0.02	0.01	0.00	0.00	0.73
2009	0.45	0.49	0.10	0.09	0.01	0.01	0.00	0.00	0.00	1.16
2010	0.04	0.46	0.35	0.13	0.03	0.01	0.00	0.00	0.00	1.03
2011	0.36	0.24	0.19	0.07	0.05	0.00	0.01	0.00	0.00	0.92
2012	0.24	0.17	0.22	0.03	0.05	0.00	0.00	0.00	0.00	0.71

Table A63. MDDNR Coastal Bays trawl survey: index of summer flounder recruitment at age-0. Geometric mean (re-transformed ln [number per hectare + 1]).

Year	Geo. mean n/tow	Coeff. of Var	Lower 95% CI	Upper 95% CI
1972	34.351	0.54	13.426	87.888
1973	10.321	0.33	5.529	19.267
1974	12.311	0.26	7.516	20.165
1975	3.606	0.18	2.547	5.104
1976	4.207	0.20	2.833	6.246
1977	4.337	0.24	2.728	6.894
1978	5.731	0.19	3.959	8.295
1979	6.715	0.26	4.077	11.060
1980	7.395	0.33	3.953	13.837
1981	8.849	0.24	5.544	14.123
1982	3.408	0.39	1.663	6.983
1983	17.699	144.41	0.031	10223.618
1984	13.310	0.33	7.161	24.738
1985	12.843	0.28	7.472	22.076
1986	59.526	0.59	21.950	161.427
1987	7.584	0.41	3.590	16.018
1988	1.763	0.13	1.371	2.267
1989	2.855	0.15	2.121	3.843
1990	4.733	0.13	3.639	6.156
1991	7.337	0.15	5.508	9.772
1992	8.487	0.15	6.285	11.461
1993	4.145	0.13	3.192	5.383
1994	22.311	0.15	16.486	30.194
1995	13.067	0.15	9.811	17.404
1996	6.493	0.14	4.954	8.509
1997	7.997	0.15	5.948	10.752
1998	14.983	0.14	11.391	19.708
1999	8.565	0.14	6.477	11.326
2000	9.874	0.16	7.272	13.407

Table A63 continued.

Year	Geo. mean n/tow	Coeff. of Var	Lower 95% CI	Upper 95% CI
2001	13.543	0.16	9.945	18.442
2002	5.406	0.14	4.136	7.066
2003	8.180	0.15	6.064	11.035
2004	6.993	0.15	5.230	9.350
2005	2.198	0.11	1.783	2.709
2006	9.658	0.14	7.263	12.843
2007	15.438	0.15	11.588	20.573
2008	12.079	0.14	9.214	15.834
2009	17.887	0.16	13.129	24.368
2010	6.713	0.13	5.170	8.717
2011	4.471	0.13	3.444	5.804
2012	7.705	0.15	5.869	10.117

Table A64. VIMS juvenile fish trawl survey: index of summer flounder recruitment at age-0. Includes all available data and incorporates gear conversion factors from studies conducted in the late 1990s. There was no survey in 1960.

Year	Geometric mean catch per trawl	Lower 95% confidence limit	Upper 95% confidence limit	Coefficient of Variation	Number of stations
1955	0	0	0	0	2
1956	4.44	2.91	6.56	0.24	29
1957	2.14	1.22	3.42	0.30	28
1958	1.48	0.23	4.00	0.85	27
1959	0.06	-0.03	0.15	0.75	27
1960	0	0	0	0	0
1961	0.19	0.12	0.61	1.11	11
1962	0	0	0	0	7
1963	2.07	0.78	4.29	0.54	12
1964	0.65	0.54	0.76	0.08	16
1965	0.74	0.27	1.39	0.44	13
1966	0	0	0	0	17
1967	0.43	-0.17	1.46	1.20	27
1968	0.14	-0.05	0.36	0.79	27
1969	0.20	0.04	0.38	0.45	27
1970	0.04	-0.02	0.10	0.75	29
1971	3.72	3.43	4.04	0.04	129
1972	0.85	0.79	0.92	0.04	84
1973	1.27	0.77	1.89	0.24	94
1974	0.82	0.31	1.51	0.42	32
1975	0.14	0.00	0.30	0.57	22
1976	0.57	0.32	0.86	0.25	68
1977	1.67	1.16	2.31	0.19	36
1978	1.24	0.47	2.40	0.47	36
1979	2.94	2.74	3.15	0.02	50
1980	10.69	6.49	17.25	0.09	70
1981	3.97	2.39	6.31	0.12	67
1982	2.27	1.54	3.21	0.11	64
1983	5.01	3.62	6.82	0.07	60
1984	1.58	0.96	2.39	0.15	41
1985	1.26	0.52	2.37	0.24	27
1986	1.26	0.77	1.89	0.15	53
1987	0.39	0.20	0.63	0.23	52
1988	0.54	0.35	0.75	0.15	143
1989	1.24	0.94	1.58	0.09	162

Table A64 continued.

Year	Geometric mean catch per trawl	Lower 95% confidence limit	Upper 95% confidence limit	Coefficient of Variation	Number of stations
1990	2.54	2.06	3.09	0.06	162
1991	2.79	2.26	3.41	0.06	153
1992	0.92	0.70	1.17	0.09	153
1993	0.52	0.38	0.68	0.12	153
1994	2.54	2.01	3.15	0.06	153
1995	0.71	0.52	0.92	0.11	149
1996	0.81	0.62	1.02	0.09	224
1997	0.89	0.69	1.12	0.09	226
1998	0.73	0.55	0.93	0.10	226
1999	0.53	0.41	0.67	0.10	219
2000	0.57	0.43	0.73	0.11	227
2001	0.47	0.34	0.61	0.12	236
2002	0.77	0.54	1.04	0.12	179
2003	0.44	0.33	0.56	0.11	225
2004	1.30	1.03	1.60	0.07	225
2005	0.35	0.25	0.46	0.13	225
2006	0.80	0.60	1.02	0.10	203
2007	1.00	0.78	1.24	0.08	225
2008	1.35	1.10	1.63	0.07	225
2009	0.75	0.58	0.92	0.09	225
2010	0.55	0.41	0.69	0.11	225
2011	0.17	0.11	0.23	0.18	225
2012	2.03	1.69	2.40	0.09	212

Table A65. VIMS ChesMMAP trawl survey indices for summer flounder. A) Aggregate indices are delta-lognormal model geometric means per tow. B) Aged indices are in numbers, are compiled independently, and are aged using a smoothed age-length key, and so do not total to the aggregate numeric indices.

A)

Year	Number (CV %)	Biomass (CV %)
2002	120.3 (27)	53.6 (24)
2003	35.4 (30)	11.8 (29)
2004	45.8 (25)	17.4 (20)
2005	150.1 (21)	56.1 (19)
2006	176.6 (26)	62.3 (22)
2007	117.0 (34)	38.8 (29)
2008	86.4 (29)	30.4 (25)
2009	35.1 (30)	15.7 (25)
2010	36.6 (29)	15.6 (24)
2011	23.2 (28)	14.1 (26)
2012	3.1 (32)	1.6 (29)

B)

Year	0	1	2	3	4+	Total
2002	62.4	22.7	6.3	4.5	5.0	100.8
2003	19.0	13.1	4.0	2.2	1.7	40.0
2004	28.1	7.4	3.1	2.1	1.7	42.3
2005	65.8	27.2	9.8	5.0	3.9	111.7
2006	100.9	25.4	7.6	4.9	4.0	142.9
2007	87.2	17.2	4.0	2.4	2.2	112.9
2008	54.7	9.3	5.0	3.6	3.3	75.8
2009	18.3	6.9	2.6	1.9	1.7	31.5
2010	20.2	8.2	2.4	1.4	1.1	33.2
2011	6.3	8.2	4.0	2.2	1.4	22.1
2012	1.8	0.6	0.6	0.4	0.3	3.6

Table A66. VIMS NEAMAP trawl survey indices for summer flounder. Indices are calculated as delta-lognormal model stratified geometric mean numbers and biomass (kg) per standard area swept tow.

Season	Number per tow	Number CV (%)	Biomass per tow	Biomass CV (%)
Fall 2007	4.31	7.1	2.65	7.9
Fall 2008	2.76	9.3	1.71	8.5
Fall 2009	4.99	8.9	2.42	7.6
Fall 2010	3.99	8.1	2.02	8.3
Fall 2011	2.55	8.2	1.48	9.1
Fall 2012	3.31	7.5	1.86	7.8
Spring 2008	3.09	8.3	1.93	8.0
Spring 2009	2.56	9.0	1.52	9.0
Spring 2010	2.36	10.0	1.34	9.0
Spring 2011	3.22	8.6	1.68	8.3
Spring 2012	1.22	10.3	0.80	10.0

Table A67. VIMS NEAMAP trawl survey indices at age for summer flounder. Aged indices are in numbers, are compiled independently, and are aged using a smoothed age-length key, and so do not total to the aggregate numeric indices in Table 60.

Spring

Year	1	2	3	4	5	6	7+	Total
2008	0.82	1.18	0.64	0.41	0.25	0.15	0.14	3.59
2009	0.96	0.84	0.46	0.30	0.19	0.11	0.10	2.96
2010	0.88	0.92	0.39	0.24	0.14	0.09	0.09	2.75
2011	1.31	1.45	0.57	0.30	0.15	0.08	0.08	3.94
2012	0.34	0.50	0.25	0.16	0.10	0.06	0.08	1.49

Fall

Year	0	1	2	3	4	5	6	7+	Total
2007	0.75	1.41	0.96	0.67	0.29	0.17	0.08	0.07	4.40
2008	0.47	0.94	0.83	0.49	0.16	0.08	0.04	0.03	3.04
2009	1.31	1.45	0.94	0.60	0.23	0.13	0.06	0.05	4.77
2010	0.99	1.36	0.85	0.47	0.17	0.09	0.04	0.04	4.01
2011	0.38	0.93	0.70	0.40	0.14	0.08	0.04	0.05	2.72
2012	0.71	0.90	0.83	0.59	0.24	0.14	0.07	0.06	3.54

Table A68. North Carolina Division of Marine Fisheries (NCDMF) Pamlico Sound trawl survey: June index of summer flounder recruitment at age-0.

Year	Mean number per tow	CV (%)
1987	19.86	14
1988	2.61	34
1989	6.63	17
1990	4.27	18
1991	5.85	24
1992	9.14	19
1993	5.13	24
1994	8.17	24
1995	6.65	25
1996	30.67	18
1997	14.14	21
1998	10.44	41
1999	n/a	n/a
2000	3.94	21
2001	22.03	15
2002	18.28	18
2003	7.23	24
2004	5.90	20
2005	9.88	22
2006	1.96	22
2007	3.62	22
2008	14.40	22
2009	4.53	22
2010	14.28	22
2011	6.64	22
2012	9.26	22

Table A69. NEFSC Marine Resources Monitoring, Assessment, and Prediction program (MARMAP 1978-1986) and Ecosystem Monitoring Program (ECOMON; 1999-2012) larval survey indices of Spawning Stock Biomass (SSB). n/a = not available.

Year	MARMAP LV	ECOMON LV
1978	43.0	
1979	36.4	
1980	65.3	
1981	n/a	
1982	55.4	
1983	67.9	
1984	87.3	
1985	55.8	
1986	11.0	
1999		213.7
2000		481.9
2001		372.2
2002		495.4
2003		415.3
2004		n/a
2005		170.5
2006		445.7
2007		266.3
2008		323.8
2009		452.0
2010		540.8
2011		713.7
2012		440.4

Table A70. Dealer report trawl gear landings (pounds), effort (days fished), and nominal landings per unit effort (LPUE).

Dealer Report Trawl Gear Landings and Effort					Nominal	Scaled
Year	Landings	Trips	Days Fished	DF/Trip	LPUE	LPUE
1964	1,971,957	3,462	2,937	0.85	671	0.56
1965	4,630,288	8,822	13,277	1.51	349	0.29
1966	536,141	2,599	1,989	0.77	270	0.23
1967	1,070,259	2,550	1,874	0.73	571	0.48
1968	455,888	2,048	1,254	0.61	364	0.31
1969	301,025	1,822	972	0.53	310	0.26
1970	250,785	1,753	996	0.57	252	0.21
1971	302,796	1,927	1,450	0.75	209	0.18
1972	302,564	825	879	1.06	344	0.29
1973	998,819	1,717	1,969	1.15	507	0.43
1974	4,019,594	4,152	4,226	1.02	951	0.80
1975	4,682,706	4,814	4,944	1.03	947	0.80
1976	10,538,429	4,861	6,394	1.32	1,648	1.39
1977	5,243,364	4,259	4,601	1.08	1,140	0.96
1978	9,712,570	6,125	5,708	0.93	1,701	1.43
1979	9,851,462	5,474	5,175	0.95	1,904	1.60
1980	6,283,606	4,803	3,870	0.81	1,624	1.37
1981	7,306,311	5,699	5,084	0.89	1,437	1.21
1982	13,999,253	8,503	8,705	1.02	1,608	1.35
1983	20,046,935	9,289	11,564	1.24	1,734	1.46
1984	21,639,813	9,723	12,287	1.26	1,761	1.48
1985	20,001,037	10,378	12,348	1.19	1,620	1.36
1986	19,205,300	9,895	14,360	1.45	1,337	1.12
1987	19,180,460	9,204	13,093	1.42	1,465	1.23
1988	20,718,050	9,052	13,266	1.47	1,562	1.31
1989	11,176,996	6,704	11,674	1.74	957	0.81
1990	5,463,173	5,571	8,796	1.58	621	0.52
1991	8,611,562	6,393	10,774	1.69	799	0.67
1992	11,924,575	6,855	13,511	1.97	883	0.74
1993	8,305,731	7,335	11,568	1.58	718	0.60
1994	8,879,124	12,566	11,982	0.95	741	0.62
1995	9,562,002	16,007	10,863	0.68	880	0.74
1996	7,650,258	13,823	7,812	0.57	979	0.82
1997	6,244,116	16,505	8,824	0.53	708	0.60
1998	8,061,887	18,242	9,151	0.50	881	0.74
1999	7,461,432	18,534	9,214	0.50	810	0.68
2000	6,780,757	16,472	7,569	0.46	896	0.75
2001	6,654,103	17,484	7,574	0.43	879	0.74
2002	8,331,080	19,595	7,770	0.40	1,072	0.90
2003	8,398,789	18,748	7,833	0.42	1,072	0.90
2004	11,288,176	15,648	6,848	0.44	1,648	1.39
2005	13,326,179	15,079	7,536	0.50	1,768	1.49
2006	11,197,703	14,203	6,716	0.47	1,667	1.40
2007	7,681,053	11,449	5,294	0.46	1,451	1.22
2008	4,928,237	11,129	4,278	0.38	1,152	0.97
2009	8,185,792	12,642	4,901	0.39	1,670	1.40
2010	7,871,289	13,715	4,804	0.35	1,638	1.38
2011	13,858,334	14,491	5,579	0.39	2,484	2.09
2012	11,003,825	13,600	5,804	0.43	1,896	1.59
Total	416,095,585	456,546	349,896	0.77	1,189	1.00

Table A71. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock biomass), index Coefficient of Variation (CV), and Lower and Upper 95% Confidence Intervals (L95CI, U95CI) from the Dealer report trawl gear landings and effort negbin YEAR-QTR-AREA-TC model.

Year	Index	CV	L95CI	U95CI
1964	0.433	0.03	0.412	0.455
1965	0.844	0.02	0.813	0.876
1966	0.374	0.03	0.354	0.395
1967	0.348	0.03	0.329	0.367
1968	0.303	0.03	0.285	0.322
1969	0.267	0.03	0.251	0.284
1970	0.272	0.03	0.255	0.290
1971	0.231	0.03	0.217	0.245
1972	0.379	0.05	0.347	0.415
1973	0.456	0.03	0.428	0.487
1974	0.702	0.02	0.671	0.734
1975	0.509	0.02	0.488	0.531
1976	0.695	0.02	0.666	0.725
1977	0.518	0.02	0.496	0.542
1978	0.635	0.02	0.611	0.660
1979	0.635	0.02	0.610	0.661
1980	0.541	0.02	0.519	0.564
1981	0.617	0.02	0.593	0.642
1982	0.683	0.02	0.659	0.707
1983	0.604	0.02	0.583	0.625
1984	0.608	0.02	0.588	0.629
1985	0.652	0.02	0.631	0.674
1986	0.536	0.02	0.519	0.554
1987	0.481	0.02	0.465	0.497
1988	0.496	0.02	0.479	0.513
1989	0.271	0.02	0.261	0.281
1990	0.185	0.02	0.178	0.193
1991	0.237	0.02	0.228	0.246
1992	0.298	0.02	0.287	0.309
1993	0.297	0.02	0.286	0.308
1994	0.392	0.02	0.380	0.404
1995	0.442	0.01	0.430	0.455
1996	0.526	0.02	0.510	0.542
1997	0.460	0.01	0.447	0.473
1998	0.559	0.01	0.543	0.575
1999	0.586	0.01	0.570	0.603
2000	0.684	0.01	0.664	0.704
2001	0.678	0.01	0.659	0.698
2002	0.855	0.01	0.832	0.879
2003	0.898	0.01	0.873	0.923
2004	1.401	0.01	1.360	1.443
2005	1.433	0.02	1.391	1.476
2006	1.173	0.02	1.138	1.209
2007	1.011	0.02	0.980	1.044
2008	0.911	0.02	0.883	0.941
2009	1.110	0.02	1.077	1.145
2010	1.306	0.02	1.267	1.346
2011	1.365	0.02	1.325	1.407
2012	1.000			

Table A72. Vessel Trip report (VTR) trawl gear catch (landings plus discards in pounds), effort (days fished), and nominal catch per unit effort (CPUE).

VTR Trawl Gear

Year	Total Catch	Trips	Days Fished	Nominal CPUE	Scaled CPUE
1994	5,939,631	9,699	7,965	746	0.59
1995	12,409,699	12,852	12,362	1,004	0.77
1996	10,641,152	12,262	9,185	1,159	0.89
1997	7,162,612	14,276	9,155	782	0.60
1998	9,094,256	16,193	10,678	852	0.65
1999	9,074,878	17,686	11,776	771	0.59
2000	9,660,300	15,854	9,701	996	0.76
2001	9,659,316	16,933	9,496	1,017	0.78
2002	12,866,048	19,778	10,452	1,231	0.94
2003	13,034,298	17,836	8,799	1,481	1.13
2004	16,076,388	18,919	9,327	1,724	1.32
2005	15,901,575	17,045	9,241	1,721	1.32
2006	12,951,765	15,321	8,399	1,542	1.18
2007	9,109,678	14,130	6,697	1,360	1.04
2008	7,711,220	11,502	5,599	1,377	1.05
2009	9,042,244	12,183	5,646	1,602	1.23
2010	11,328,834	13,473	5,821	1,946	1.49
2011	14,426,363	13,425	6,576	2,194	1.68
2012	11,216,765	12,296	6,856	1,636	1.29
Total	207,307,022	281,663	163,732	1,266	1.00

Table A73. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock biomass), index Coefficient of Variation (CV), and Lower and Upper 95% Confidence Intervals (L95CI, U95CI) from the VTR trawl gear negbin YEAR-QTR-AREA-TC-MSH model.

Year	Index	CV	L95CI	U95CI
1994	0.544	0.01	0.529	0.560
1995	0.585	0.01	0.570	0.601
1996	0.664	0.01	0.646	0.683
1997	0.614	0.01	0.598	0.630
1998	0.816	0.01	0.795	0.837
1999	0.801	0.01	0.782	0.822
2000	0.888	0.01	0.866	0.911
2001	0.950	0.01	0.926	0.974
2002	1.117	0.01	1.090	1.144
2003	1.200	0.01	1.170	1.230
2004	1.361	0.01	1.328	1.394
2005	1.378	0.01	1.344	1.413
2006	1.091	0.01	1.063	1.119
2007	1.040	0.01	1.013	1.067
2008	1.027	0.01	0.999	1.055
2009	1.216	0.01	1.183	1.249
2010	1.372	0.01	1.336	1.408
2011	1.439	0.01	1.401	1.478
2012	1.000			

Table A74. Vessel Trip report (VTR) recreational Party/Charter Boat catch (landings plus discards in numbers), effort (trips), and nominal catch per unit effort (CPUE).

VTR P/C Boat Total Catch Numbers Data

Year	Total Catch	Trips	Anglers	Nominal CPUE	Scaled CPUE
1994	774,012	6,538	174,103	118.39	1.49
1995	629,422	6,271	178,203	100.37	1.26
1996	732,093	6,739	179,539	108.64	1.36
1997	674,502	7,326	205,562	92.07	1.16
1998	709,931	8,006	223,802	88.67	1.11
1999	902,077	7,896	218,883	114.24	1.43
2000	723,734	8,443	218,239	85.72	1.08
2001	462,476	7,154	189,689	64.65	0.81
2002	423,902	6,654	177,427	63.71	0.80
2003	443,094	6,982	180,165	63.46	0.80
2004	355,939	6,026	147,862	59.07	0.74
2005	363,276	5,763	141,363	63.04	0.79
2006	282,551	5,698	123,994	49.59	0.62
2007	370,352	6,457	145,792	57.36	0.72
2008	357,833	5,675	127,799	63.05	0.79
2009	402,770	6,274	150,410	64.20	0.81
2010	700,373	7,981	210,684	87.76	1.10
2011	694,609	8,122	211,077	85.52	1.07
2012	498,073	7,875	212,440	63.25	0.79
Total	10,501,019	131,880	3,417,033	79.63	

Table A75. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock abundance), index Coefficient of Variation (CV), and Lower and Upper 95% Confidence Intervals (L95CI, U95CI), from the VTR Party/Charter Boat six-factor negbin YEAR-MON-STATE-BOAT-SIZE-BAG model.

Year	Index	CV	L95CI	U95CI
1994	1.644	0.06	1.466	1.845
1995	1.169	0.06	1.035	1.321
1996	1.399	0.06	1.238	1.581
1997	1.275	0.06	1.128	1.440
1998	1.292	0.06	1.144	1.459
1999	1.299	0.06	1.151	1.467
2000	1.165	0.06	1.033	1.314
2001	1.051	0.03	0.983	1.124
2002	1.005	0.03	0.941	1.074
2003	0.996	0.03	0.941	1.055
2004	0.969	0.03	0.911	1.030
2005	1.030	0.03	0.971	1.093
2006	1.223	0.04	1.126	1.329
2007	1.234	0.03	1.172	1.300
2008	1.202	0.03	1.127	1.281
2009	1.335	0.03	1.257	1.417
2010	1.634	0.03	1.538	1.737
2011	1.600	0.03	1.511	1.694
2012	1.000			

Table A76. Observed trawl gear catch (landings plus discards in pounds), effort (days fished), and nominal catch per unit effort (CPUE).

Observed Trawl Gear catch rate data.

Year	Trips	Hauls	Total Catch (lbs)	Days Fished	Nominal CPUE	Scaled Nominal CPUE
1989	57	415	53,290	37	1,457	0.91
1990	61	467	48,304	37	1,312	0.82
1991	95	724	65,836	67	981	0.62
1992	68	617	124,864	65	1,929	1.21
1993	45	408	74,764	43	1,744	1.09
1994	52	585	177,058	69	2,577	1.62
1995	134	1,016	244,589	114	2,137	1.34
1996	111	658	103,820	64	1,615	1.01
1997	60	349	32,628	38	850	0.53
1998	53	333	74,215	37	2,030	1.27
1999	59	383	57,164	43	1,345	0.84
2000	89	562	144,382	64	2,267	1.42
2001	138	589	106,800	54	1,971	1.24
2002	166	811	139,652	84	1,660	1.04
2003	212	1,328	239,820	151	1,592	1.00
2004	593	3,097	615,564	310	1,987	1.25
2005	1,041	7,646	940,890	924	1,018	0.64
2006	545	4,067	546,202	504	1,085	0.68
2007	634	3,792	710,275	441	1,610	1.01
2008	567	2,952	490,524	332	1,479	0.93
2009	780	4,162	618,329	440	1,406	0.88
2010	660	2,969	835,544	310	2,693	1.69
2011	595	3,540	784,990	381	2,062	1.29
2012	404	2,010	490,391	235	2,087	1.31
Total	7,219	43,480	7,719,893	4,842	1,594	1.00

Table A77. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock biomass), index Coefficient of Variation (CV), Lower and Upper 95% Confidence Intervals (L95CI, U95CI) from the Observed trawl gear Negbin YEAR-QTR-AREA-TC model.

Year	Index	CV	L95CI	U95CI
1989	0.481	0.16	0.350	0.662
1990	0.429	0.16	0.314	0.586
1991	0.578	0.13	0.447	0.748
1992	0.621	0.16	0.459	0.840
1993	0.566	0.18	0.398	0.804
1994	1.169	0.17	0.838	1.629
1995	0.562	0.12	0.448	0.705
1996	0.435	0.12	0.342	0.553
1997	0.287	0.16	0.210	0.391
1998	0.668	0.17	0.481	0.929
1999	0.801	0.17	0.581	1.106
2000	1.672	0.14	1.274	2.193
2001	1.007	0.12	0.804	1.262
2002	1.249	0.11	1.013	1.540
2003	1.238	0.10	1.022	1.498
2004	1.589	0.07	1.373	1.839
2005	1.433	0.07	1.251	1.642
2006	1.351	0.08	1.163	1.569
2007	1.690	0.07	1.460	1.957
2008	1.386	0.08	1.194	1.608
2009	1.713	0.07	1.488	1.971
2010	1.648	0.07	1.427	1.904
2011	1.359	0.07	1.174	1.573
2012	1.000			

Table A78. Observed scallop dredge gear catch (landings plus discards in pounds), effort (days fished), and nominal catch per unit effort (CPUE).

Year	Trips	Hauls	Total Catch Lbs	Days Fished	Nominal CPUE	Scaled Nominal CPUE
1992	9	178	1,477	5	279	1.15
1993	15	671	2,966	19	155	0.64
1994	14	651	5,811	28	210	0.87
1995	19	1054	10,085	45	224	0.93
1996	24	1089	9,609	49	197	0.81
1997	24	959	8,376	41	204	0.84
1998	22	362	1,978	15	129	0.53
1999	10	247	3,199	10	312	1.29
2000	77	1076	12,567	45	281	1.16
2001	69	1643	12,013	68	176	0.72
2002	76	2514	25,739	118	217	0.90
2003	79	3248	37,021	151	246	1.02
2004	168	5651	76,729	255	300	1.24
2005	156	4091	40,010	186	215	0.89
2006	124	2748	35,042	119	296	1.22
2007	195	3549	51,311	142	362	1.50
2008	298	6895	81,232	283	287	1.18
2009	291	7916	72,561	347	209	0.86
2010	187	6102	64,610	275	235	0.97
2011	205	5925	66,294	272	244	1.01
2012	251	7,951	65,937	354	186	0.77
Total	2,313	64,520	684,565	2,827	242	1.00

Table A79. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock biomass), index Coefficient of Variation (CV), Lower and Upper 95% Confidence Intervals (L95CI, U95CI) from the Observed scallop dredge negbin YEAR-QTR-AREA-TC model.

Year	Index	CV	L95CI	U95CI
1992	0.632	0.26	0.383	1.042
1993	0.791	0.20	0.540	1.160
1994	0.898	0.21	0.599	1.347
1995	0.821	0.18	0.581	1.158
1996	0.850	0.16	0.622	1.160
1997	0.723	0.16	0.526	0.995
1998	0.813	0.17	0.589	1.122
1999	1.607	0.24	1.007	2.562
2000	1.502	0.10	1.238	1.822
2001	0.831	0.10	0.679	1.018
2002	1.029	0.10	0.848	1.249
2003	1.137	0.10	0.940	1.374
2004	1.361	0.08	1.170	1.583
2005	1.372	0.08	1.179	1.597
2006	1.357	0.08	1.151	1.600
2007	1.683	0.07	1.461	1.937
2008	1.459	0.07	1.281	1.661
2009	1.214	0.07	1.067	1.382
2010	1.446	0.07	1.255	1.667
2011	1.307	0.07	1.137	1.502
2012	1.000			

Table A80. MRSS/MRIP intercept total catch in numbers, angler trips, and nominal catch per unit effort (CPUE).

MRFSS/MRIP Intercept Total Catch Number Data

Year	Total Catch	Angler Trips	Nominal CPUE	Scaled CPUE
1981	8,595	3,646	2.36	0.95
1982	8,916	3,966	2.25	0.90
1983	13,711	4,518	3.03	1.22
1984	8,418	2,918	2.88	1.16
1985	5,326	3,548	1.50	0.60
1986	14,690	5,250	2.80	1.12
1987	13,775	4,221	3.26	1.31
1988	12,969	5,596	2.32	0.93
1989	4,619	5,366	0.86	0.35
1990	14,655	8,370	1.75	0.70
1991	23,930	11,309	2.12	0.85
1992	21,098	10,125	2.08	0.84
1993	26,326	9,266	2.84	1.14
1994	21,776	10,898	2.00	0.80
1995	15,408	7,126	2.16	0.87
1996	20,989	8,778	2.39	0.96
1997	21,232	8,879	2.39	0.96
1998	25,970	10,105	2.57	1.03
1999	25,408	8,247	3.08	1.24
2000	23,634	8,241	2.87	1.15
2001	35,705	11,573	3.09	1.24
2002	24,141	9,312	2.59	1.04
2003	26,969	10,778	2.50	1.00
2004	23,020	9,767	2.36	0.95
2005	23,356	9,416	2.48	1.00
2006	16,721	4,604	3.63	1.46
2007	21,723	8,856	2.45	0.98
2008	20,132	7,904	2.55	1.02
2009	21,187	7,573	2.80	1.12
2010	22,013	7,781	2.83	1.14
2011	19,232	6,731	2.86	1.15
2012	14,296	6,230	2.29	0.92
Total	599,940	240,898	2.49	1.00

Table A81. Year effect parameter estimates (re-transformed, bias-corrected, annual indices of total stock biomass), index Coefficient of Variation (CV), Lower and Upper 95% Confidence Intervals (L95CI, U95CI) from the MRFSS/MRIP intercept six-factor negbin YEAR-WAVE-STATE-BOAT-SIZE-BAG model.

Year	Index	CV	L95CI	U95CI
1981	1.494	0.09	1.250	1.785
1982	1.474	0.09	1.234	1.761
1983	2.234	0.09	1.871	2.667
1984	2.036	0.09	1.701	2.436
1985	1.091	0.09	0.912	1.305
1986	1.774	0.09	1.488	2.115
1987	2.066	0.09	1.731	2.467
1988	1.542	0.09	1.293	1.839
1989	0.565	0.09	0.473	0.675
1990	1.159	0.09	0.973	1.380
1991	1.376	0.09	1.156	1.638
1992	1.392	0.09	1.169	1.657
1993	1.947	0.09	1.638	2.313
1994	1.366	0.09	1.150	1.623
1995	1.436	0.09	1.205	1.711
1996	1.535	0.09	1.289	1.827
1997	1.564	0.09	1.314	1.862
1998	1.907	0.10	1.559	2.333
1999	2.413	0.07	2.122	2.746
2000	2.330	0.07	2.048	2.651
2001	1.417	0.03	1.339	1.500
2002	1.147	0.03	1.089	1.207
2003	1.152	0.03	1.095	1.212
2004	1.151	0.03	1.092	1.213
2005	1.254	0.03	1.191	1.320
2006	1.710	0.03	1.615	1.811
2007	1.042	0.03	0.991	1.094
2008	1.015	0.03	0.960	1.074
2009	1.151	0.03	1.086	1.219
2010	1.202	0.03	1.133	1.275
2011	1.146	0.03	1.082	1.213
2012	1.000			

Table A82. Summary of 'phase 1' 2013 SAW 57 model building settings.

2013 SARC 57	**CODES:**	F57= 2013 SARC 57	FLDL = Fishery selex modeled as Single Logistic-Double Logisitc
ASAP for summer flounder		IAA = Indices configured independently At Age	FAGE = Fishery selex modeled At Age
Ages 0-8+ (coded ages 1-7+)		MULTI = Indices configures as Multinomials	ESS = Effective Sample Size
		IND47 = 2008 SAW 47 index set	ALLSV = all available 2013 SAW57 indices
		L = Lambda (scalar weighting factor)	CV = Coefficeint of Variation; MAT3NOT = New Maturity Schedule
		A50 = age at 50%ile (inflection age)	Y1 = First year of model; NEWDISC = New Commercial Discards

MODEL	**2008** SAW 47	**2012** Update	**F57**-IAA-IND4 -FLDL	F57-IAA-IND47-FLDL-**MAT3NOT**	F57-IAA-IND47 -FLDL-MAT3NOT-**NEWDISC**	F57-IAA-IND47-**FAGE**-MAT3NOT-NEWDISC	F57-**MULTI**-IND47 -FAGE-MAT3NOT-NEWDISC	F57-MULTI-**ALLSV** -FAGE-MAT3NOT-NEWDISC
	terminal Y = **2007**	terminal Y = **2011**	terminal Y = **2012**	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012
Years	1982-2007	1982-2011	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012
Mean M	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Fleets	2	2	2	2	2	2	2	2
FISH SELEX								
Time block start	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995
Landings Model	Single Log	Single Log	Single Log	Single Log	Single Log	F at Age	F at Age	F at Age
Ascend A50	1	1	1	1	1	n/a	n/a	n/a
Ascend Slope	1	1	1	1	1	n/a	n/a	n/a
Age Fixed S=1	n/a	n/a	n/a	n/a	n/a	3; 4	3; 4	3; 4
Selex L	1	1	1	1	1	1	1	1
Discards Model	Double Log	Double Log	Double Log	Double Log	Double Log	F at Age	F at Age	F at Age
Ascend A50	0	0	0	0	0	n/a	n/a	n/a
Ascend Slope	1	1	1	1	1	n/a	n/a	n/a
Descend A50	2	2	2	2	2	n/a	n/a	n/a
Descend Slope	1	1	1	1	1	n/a	n/a	n/a
Age Fixed S=1	n/a	n/a	n/a	n/a	n/a	1; 2	1; 2	1; 2
Selex L	1	1	1	1	1	1	1	1

EMPHASIS FACTORS								
Catch L	10	10	10	10	10	10	10	10
Landings CV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Discards CV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Landings ESS	173	**153**	100	100	100	100	100	100
Discards ESS	101	**100**	100	100	100	100	100	100
F in Y1 L	1	1	1	1	1	1	1	1
F in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
F Dev L	1	1	1	1	1	1	1	1
F Dev CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
N in Y1 L	1	1	1	1	1	1	1	1
N in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
All SVs L	1	1	1	1	1	1	1	1
SV q L	0	0	0	0	0	0	0	0
SV q CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
SV q Dev L	0	0	0	0	0	0	0	0
SV q Dev CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
S-R Model								
Rec Dev L	0	0	0	0	0	0	0	0
Rec CV	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Steepness Dev L	0.05	**0**	0	0	0	0	0	0
Steepness CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Scaler Dev L	0.05	**0**	0	0	0	0	0	0
Scaler CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table A83. Summary of 'phase 1' 2013 SAW 57 model building estimation results.

2013 SARC 57	**CODES:**	F57= 2013 SARC 57	FLDL = Fishery selex modeled as Single Logistic-Double Logisitc
ASAP for summer flounder		IAA = Indices configured independently At Age	FAGE = Fishery selex modeled At Age
Ages 0-8+ (coded ages 1-7+)		MULTI = Indices configures as Multinomials	ESS = Effective Sample Size
		IND47 = 2008 SAW 47 index set	ALLSV = all available 2013 SAW57 indices
		L = Lambda (scalar weighting factor)	CV = Coefficeint of Variation; MAT3NOT = New Maturity Schedule
		A50 = age at 50%ile (inflection age)	Y1 = First year of model; NEWDISC = New Commercial Discards

MODEL	**2008** SAW 47	**2012** Update	**F57**-IAA-IND47-FLDL	F57-IAA-IND47-FLDL-**MAT3NOT**	F57-IAA-IND47-FLDL-MAT3NOT-**NEWDISC**	F57-IAA-IND47-**FAGE**-MAT3NOT-NEWDISC	F57-**MULTI**-IND47-FAGE-MAT3NOT-NEWDISC	F57-MULTI-**ALLSV** -FAGE-MAT3NOT-NEWDISC
	terminal Y = **2007**	terminal Y = **2011**	terminal Y = **2012**	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012	terminal Y = 2012
Objective Function								
Total	4,312.99	5,245.71	5,324.25	5,324.25	5,665.49	5,149.02	7,119.52	7,624.74
Catch	3,507.28	4,037.73	4,168.50	4,168.50	4,255.23	4,251.26	4,247.30	4,247.95
Indices	53.56	270.58	277.43	277.43	290.74	263.20	**668.77**	**991.63**
Fish CAA	666.29	839.99	780.42	780.42	1,017.01	838.42	805.90	811.37
SV CAA	0.00	0.00	0.00	0.00	0.00	0.00	**1,343.95**	**1,519.26**
Fish Selex	25.03	25.13	25.04	25.04	26.22	-12.47	-21.70	-21.44
SV Selex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SV q in Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SV q Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F in Y1	1.39	1.49	1.21	1.21	1.24	1.24	1.26	1.26
F Dev	10.00	11.06	11.64	11.64	15.45	15.10	15.57	15.72
N in Y1	58.69	59.72	60.03	60.03	59.61	62.27	58.47	58.99
Rec Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-R Steepness	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-R scaler	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FISH SELEX								
Landings (by block)								
Age 0	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01
Age 1	0.42, 0.08	0.43, 0.06	0.43, 0.07	0.43, 0.07	0.42, 0.06	0.43, 0.09	0.42, 0.06	0.42, 0.07
Age 2	0.96, 0.59	0.96, 0.48	0.96, 0.49	0.96, 0.49	0.96, 0.48	1.00, 0.53	1.00, 0.42	1.00, 0.46
Age 3	1.00, 1.00	1.00, 0.93	1.00, 0.93	1.00, 0.93	1.00, 0.93	1.00, 0.92	1.00, 0.83	1.00, 0.87
Age 4	1.00, 1.00	1.00, 0.99	1.00, 0.99	1.00, 0.99	1.00, 0.99	**0.73, 1.00**	0.80, 1.00	0.79, 1.00
Age 5	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	**0.59, 1.00**	**0.79, 1.00**	0.78, 0.95
Age 6	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	**1.00, 0.84**	**0.78, 0.86**	0.77, 0.78
Age 7+	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	1.00, 1.00	**0.98, 0.52**	0.91, 0.60	**0.92, 0.48**
Discards (by block)								
Age 0	0.13, 0.05	0.13, 0.07	0.13, 0.07	0.13, 0.07	0.13, 0.08	0.13, 0.07	0.12, 0.07	0.12, 0.08
Age 1	1.00, 0.66	1.00, 0.71	1.00, 0.70	1.00, 0.70	**1.00, 0.57**	1.00, 0.54	1.00, 0.55	1.00, 0.56
Age 2	0.08, 1.00	0.08, 1.00	0.08, 1.00	0.08, 1.00	**0.18, 1.00**	0.16, 1.00	0.16, 1.00	0.16, 1.00
Age 3	0.00, 0.63	0.00, 0.76	0.00, 0.78	0.00, 0.78	**0.01, 0.93**	**0.06, 0.79**	0.06, 0.83	0.06, 0.81
Age 4	0.00, 0.30	0.00, 0.51	0.00, 0.53	0.00, 0.53	**0.00, 0.80**	**0.08, 0.55**	0.08, 0.66	0.08, 0.62
Age 5	0.00, 0.12	0.00, 0.32	0.00, 0.33	0.00, 0.33	**0.00, 0.67**	**0.09, 0.40**	**0.09, 0.54**	0.09, 0.48
Age 6	0.00, 0.04	0.00, 0.19	0.00, 0.19	0.00, 0.19	**0.00, 0.55**	**0.10, 0.34**	**0.10, 0.55**	0.10, 0.47
Age 7+	0.00, 0.02	0.00, 0.11	0.00, 0.11	0.00, 0.11	**0.00, 0.44**	**0.10, 0.28**	**0.10, 0.48**	**0.10, 0.37**
F, R, SSB								
F 1982	1.20	1.10	1.07	1.07	1.11	**0.90**	**1.06**	1.03
F 1988	2.00	1.98	2.01	2.01	1.97	**1.65**	1.66	1.67
F 2007	0.30	0.25	0.25	0.25	0.26	**0.19**	**0.23**	**0.19**
F 2011		0.24	0.22	0.22	0.24	**0.19**	**0.23**	**0.20**
F 2012			0.18	0.18	0.20	**0.16**	**0.19**	**0.17**
Age 0 1982	73,512	71,569	69,619	69,619	72,774	70,478	71,467	71,357
Age 0 1988	12,831	12,806	12,744	12,744	11,637	11,628	10,377	10,358
Age 0 2007	39,972	42,496	43,435	43,433	46,106	49,644	46,051	47,755
Age 0 2011		25,990	19,104	19,101	22,557	22,925	**17,708**	**19,402**
Age 0 2012			54,667	54,654	49,816	**53,379**	54,202	**37,668**
SSB 1982	24,674	25,006	25,320	24,686	24,456	25,567	**22,726**	23,050
SSB 1989	7,017	7,040	6,734	7,099	6,615	6,830	**6,223**	6,134
SSB 2007	43,364	49,828	48,979	46,026	49,881	**61,776**	**56,637**	**64,978**
SSB 2011		57,050	60,019	57,780	56,674	**67,730**	**58,549**	**66,482**
SSB 2012			60,905	58,971	57,434	**67,652**	**57,526**	**64,384**

Table A84. Summary of 'phase 2' 2013 SAW 57 BASE model building settings for runs 1-6.

MODEL	F57-MULTI-ALLSV-FAGE-MAT3NOT-NEWDISC	F57_BASE_1: remove starting F and N Ls	F57_BASE_2: restrict DE 30 to 2003+	F57_BASE_3: change CAT L 10 to 1	F57_BASE_4: add Larval SVs	F57_BASE_5: tune SV CVs - step 1	F57_BASE_6: tune SV CVs - step 2
Years	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012
Mean M	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Fleets	2	2	2	2	2	2	2
FISH SELEX							
Time block start	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995	1982; 1995
Landings Model	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age
Ascend A50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ascend Slope	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age Fixed S=1	3; 4	3; 4	3; 4	3; 4	3; 4	3; 4	3; 4
Selex Ls	1	1	1	1	1	1	1
Discards Model	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age
Ascend A50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ascend Slope	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Descend A50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Descend Slope	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Age Fixed S=1	1; 2	1; 2	1; 2	1; 2	1; 2	1; 2	1; 2
Selex Ls	1	1	1	1	1	1	1

EMPHASIS FACTORS							
Catch L	10	10	10	**1**	1	1	1
Landings CV	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Discards CV	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Landings ESS	100	100	100	100	100	100	100
Discards ESS	100	100	100	100	100	100	100
F in Y1 L	1	**0**	0	0	0	0	0
F in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
F Dev L	1	**0**	0	0	0	0	0
F Dev CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
N in Y1 L	1	**0**	0	0	0	0	0
N in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
All SVs L	1	1	1	1	1	1	1
SV q L	0	0	0	0	0	0	0
SV q CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
SV q Dev L	0	0	0	0	0	0	0
SV q Dev CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
S-R Model							
Rec Dev L	0	0	0	0	0	0	0
Rec CV	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Steepness Dev L	0	0	0	0	0	0	0
Steepness CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Scaler Dev L	0	0	0	0	0	0	0
Scaler CV	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table A85. Summary of 'phase 2' 2013 SAW 57 BASE model building estimation results for runs 1-6.

MODEL	F57-MULTI-ALLSV-FAGE-MAT3NOT-NEWDISC	F57_BASE_1	F57_BASE_2: restrict DE 30 to 2003+	F57_BASE_3: change CAT L 10 to 1	F57_BASE_4: add Larval SVs	F57_BASE_5: tune SV CVs - step 1	F57_BASE_6: tune SV CVs - step 2
Consequence	Lower F, higher SSB	minor increase SSB	Increase SSB	Rescale OF, decrease SSB	Minor decrease SSB	SV RMSEs closer to 1, decrease SSB	SV RMSEs yet closer to 1, less SSB
Objective Function							
Total	7,624.74	7,547.23	7,406.23	3,570.07	3,682.17	3,758.04	3,736.37
Catch	4,247.95	4,247.43	4,247.07	438.82	438.77	435.96	435.79
Indices	991.63	990.66	936.28	922.56	1,034.50	904.29	882.55
Fish CAA	811.37	814.73	811.85	801.26	802.34	798.23	798.29
SV CAA	1,519.26	1,515.34	1,431.59	1,428.19	1,427.43	1,640.65	1,640.88
Fish Selex	-21.44	-20.93	-20.56	-20.76	-20.87	-21.09	-21.14
SV Selex	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SV q in Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SV q Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F in Y1	1.26	**0.00**	0.00	0.00	0.00	0.00	0.00
F Dev	15.72	**0.00**	0.00	0.00	0.00	0.00	0.00
N in Y1	58.99	**0.00**	0.00	0.00	0.00	0.00	0.00
Rec Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-R Steepness	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S-R scaler	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FISH SELEX							
Landings (by block)							
Age 0	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01	0.02, 0.01
Age 1	0.42, 0.07	0.42, 0.07	0.42, 0.07	0.42, 0.07	0.42, 0.07	0.42, 0.07	0.42, 0.06
Age 2	1.00, 0.46	1.00, 0.46	1.00, 0.46	1.00, 0.44	1.00, 0.44	1.00, 0.44	1.00, 0.42
Age 3	1.00, 0.87	1.00, 0.87	1.00, 0.88	1.00, 0.86	1.00, 0.86	1.00, 0.84	1.00, 0.83
Age 4	0.79, 1.00	0.76, 1.00	0.76, 1.00	0.77, 1.00	0.77, 1.00	0.77, 1.00	0.78, 1.00
Age 5	0.78, 0.95	0.71, 0.94	0.71, 0.93	0.71, 0.95	0.72, 0.96	0.72, 0.98	0.72, 1.00
Age 6	0.77, 0.78	**0.71, 0.77**	0.71, 0.75	0.70, 0.78	0.70, 0.79	0.71, 0.83	0.71, 0.85
Age 7+	0.92, 0.48	**0.84, 0.47**	0.84, 0.44	0.84, 0.49	0.83, 0.50	0.85, 0.56	0.85, 0.60

Discards (by block)							
Age 0	0.12, 0.08	0.12, 0.08	0.12, 0.08	0.12, 0.07	0.12, 0.07	0.12, 0.07	0.12, 0.07
Age 1	1.00, 0.56	1.00, 0.56	1.00, 0.56	1.00, 0.55	1.00, 0.55	1.00, 0.55	1.00, 0.55
Age 2	0.16, 1.00	0.16, 1.00	0.16, 1.00	0.16, 1.00	0.16, 1.00	0.16, 1.00	0.16, 1.00
Age 3	0.06, 0.81	0.06, 0.81	0.06, 0.81	0.06, 0.82	0.06, 0.82	0.06, 0.83	0.06, 0.84
Age 4	0.08, 0.62	0.08, 0.62	0.08, 0.61	0.08, 0.63	0.08, 0.63	0.08, 0.65	0.08, 0.66
Age 5	0.09, 0.48	0.09, 0.48	0.09, 0.47	0.09, 0.49	0.09, 0.50	0.09, 0.53	0.09, 0.54
Age 6	0.10, 0.47	0.10, 0.47	0.10, 0.45	0.10, 0.48	0.10, 0.49	0.10, 0.53	0.10, 0.55
Age 7+	0.10, 0.37	0.10, 0.37	0.10, 0.34	0.10, 0.39	0.10, 0.41	0.10, 0.46	0.10, 0.50
F, R, SSB							
F 1982	1.03	**0.88**	0.88	0.93	0.92	0.90	0.91
F 1988	1.67	**1.56**	1.55	1.59	1.59	1.58	1.59
F 2007	0.19	0.19	0.17	0.18	0.18	0.21	0.22
F 2011	0.20	0.20	0.18	0.18	0.19	0.21	0.23
F 2012	0.17	0.17	0.15	0.15	0.16	0.18	0.19
Age 0 1982	71,357	**68,855**	68,957	**63,253**	63,764	66,823	67,206
Age 0 1988	10,358	10,190	10,209	9,710	9,692	**10,068**	10,043
Age 0 2007	47,755	48,038	**51,019**	49,770	49,274	45,486	43,824
Age 0 2011	19,402	19,505	**20,845**	20,849	20,714	20,327	19,897
Age 0 2012	37,668	37,907	**40,707**	40,556	40,307	40,028	42,137
SSB 1982	23,050	24,516	24,627	**22,593**	22,830	23,189	23,160
SSB 1989	6,134	6,141	6,230	5,900	5,867	6,043	6,013
SSB 2007	64,978	65,877	**72,211**	**66,425**	**64,233**	**58,140**	**56,199**
SSB 2011	66,482	67,364	**75,529**	**72,681**	**70,829**	**62,299**	**58,104**
SSB 2012	64,384	65,245	**73,694**	**71,445**	**69,738**	**61,160**	**57,098**

Table A86. Summary of 'phase 2' 2013 SAW 57 BASE model building settings for runs 7-12.

MODEL	F57_BASE_7: Fish Selex Ls = 0	F57_BASE_8: Fish Selex Ls =0, Fix Fish Selex = 1 for 3+, 4+	F57_BASE_9: Model 6, Add 3rd Fish Selex Block 2008+	F57_BASE_10: **Drop NCYOY**	F57_BASE_11: **Fix High CV SV Selex Note not in OF**	F57_BASE_12: A**pply All Francis Fish and SV ESS Adjustments**
Years	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012	1982-2012
Mean M	0.25	0.25	0.25	0.25	0.25	0.25
Fleets	2	2	2	2	2	2
FISH SELEX						
Time block start	1982; 1995	1982; 1995	**1982; 1995; 2008**	1982; 1995; 2008	1982; 1995; 2008	1982; 1995; 2008
Landings Model	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age
Ascend A50	n/a	n/a	n/a	n/a	n/a	n/a
Ascend Slope	n/a	n/a	n/a	n/a	n/a	n/a
Age Fixed S=1	3; 4	**3+; 4+**	**3; 4**	3; 4	3; 4	3; 4
Selex Ls	**0**	**0**	**1**	1	1	1
Discards Model	F at Age	F at Age	F at Age	F at Age	F at Age	F at Age
Ascend A50	n/a	n/a	n/a	n/a	n/a	n/a
Ascend Slope	n/a	n/a	n/a	n/a	n/a	n/a
Descend A50	n/a	n/a	n/a	n/a	n/a	n/a
Descend Slope	n/a	n/a	n/a	n/a	n/a	n/a
Age Fixed S=1	1; 2	1; 2	1; 2	1; 2	1; 2	1; 2
Selex Ls	1	1	1	1	1	1

EMPHASIS FACTORS						
Catch L	1	1	1	1	1	1
Landings CV	0.1	0.1	0.1	0.1	0.1	0.1
Discards CV	0.1	0.1	0.1	0.1	0.1	0.1
Landings ESS	100	100	100	100	100	**55**
Discards ESS	100	100	100	100	100	**30**
F in Y1 L	0	0	0	0	0	0
F in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9
F Dev L	0	0	0	0	0	0
F Dev CV	0.9	0.9	0.9	0.9	0.9	0.9
N in Y1 L	0	0	0	0	0	0
N in Y1 CV	0.9	0.9	0.9	0.9	0.9	0.9
All SVs L	1	1	1	1	1	1
SV q L	0	0	0	0	0	0
SV q CV	0.9	0.9	0.9	0.9	0.9	0.9
SV q Dev L	0	0	0	0	0	0
SV q Dev CV	0.9	0.9	0.9	0.9	0.9	0.9
S-R Model						
Rec Dev L	0	0	0	0	0	0
Rec CV	0.5	0.5	0.5	0.5	0.5	0.5
Steepness Dev L	0	0	0	0	0	0
Steepness CV	0.9	0.9	0.9	0.9	0.9	0.9
Scaler Dev L	0	0	0	0	0	0
Scaler CV	0.9	0.9	0.9	0.9	0.9	0.9

Table A87. Summary of 'phase 2' 2013 SAW 57 BASE model building estimation results for runs 7-12.

MODEL	F57_BASE_7: Fish Selex Ls = 0	F57_BASE_8: Fish Selex Ls =0, Fix Fish Selex = 1 for L1= 3+, L2 = 4+	F57_BASE_9: Model 6, Add 3rd Fish Selex Block 2008+	F57_BASE_10: **Drop NCYOY**	F57_BASE_11: **Fix High CV SV Selex Note not in OF**	F57_BASE_12: **Apply All Francis Fish and SV ESS Adjustments**
Consequence	More dome, worse Retro	Flat selex, substantial decrease SSB	Improved Fish CAA resids, better Retro, increase SSB	Minor R changes	Less Fish Dome, higher recent F, less recent SSB	Less Land Fish Dome, lower recent F, less recent SSB
Objective Function						
Total	3,751.11	3,758.10	3,679.02	3602.24	3,606.67	3,586.51
Catch	436.08	436.18	434.01	433.92	434.53	432.89
Indices	882.78	881.86	878.13	800.74	801.19	802.32
Fish CAA	792.66	795.65	752.97	753.62	754.01	512.33
SV CAA	1,639.59	1,644.41	1,637.15	1637.31	1640.77	1868.50
Fish Selex	**0.00**	0.00	**-23.25**	-23.34	-23.83	-29.52
SV Selex	0.00	0.00	0.00	0.00	0.00	0.00
SV q in Y1	0.00	0.00	0.00	0.00	0.00	0.00
SV q Dev	0.00	0.00	0.00	0.00	0.00	0.00
F in Y1	0.00	0.00	0.00	0.00	0.00	0.00
F Dev	0.00	0.00	0.00	0.00	0.00	0.00
N in Y1	0.00	0.00	0.00	0.00	0.00	0.00
Rec Dev	0.00	0.00	0.00	0.00	0.00	0.00
S-R Steepness	0.00	0.00	0.00	0.00	0.00	0.00
S-R scaler	0.00	0.00	0.00	0.00	0.00	0.00
FISH SELEX						
Landings (by block)						
Age 0	0.02, 0.01	0.02, 0.01	0.02, 0.01, 0.01	0.02, 0.01, 0.01	0.02, 0.01, 0.01	0.02, 0.01, 0.01
Age 1	0.42, 0.06	0.43, 0.06	0.42, 0.08, 0.03	0.42, 0.08, 0.03	0.42, 0.08, 0.03	0.41, 0.08, 0.04
Age 2	1.00, 0.40	1.00, 0.39	**1.00, 0.58, 0.17**	**1.00, 0.58, 0.17**	1.00, 0.56, 0.16	1.00, 0.55, 0.18
Age 3	1.00, 0.80	1.00, 0.79	**1.00, 1.00, 0.56**	**1.00, 1.00, 0.56**	1.00, 1.00, 0.54	1.00, 1.00, 0.55
Age 4	0.74, 1.00	**1.00, 1.00**	**0.78, 1.00, 1.00**	**0.77, 1.00, 1.00**	0.78, 1.00, 1.00	0.74, 1.00, 1.00
Age 5	**0.60, 0.94**	**1.00, 1.00**	**0.72, 0.78, 1.00**	**0.72, 0.78, 1.00**	0.73, 0.84, 1.00	0.67, 0.85, 1.00
Age 6	**0.34, 0.79**	**1.00, 1.00**	**0.71, 0.68, 0.88**	**0.71, 0.68, 0.88**	**0.72, 0.77, 0.95**	**0.70, 0.81, 1.00**
Age 7+	**0.26, 0.50**	**1.00, 1.00**	**0.84, 0.51, 0.45**	**0.84, 0.51, 0.45**	**0.87, 0.63, 0.56**	**0.87, 0.72, 0.73**

Discards (by block)						
Age 0	0.12, 0.07	0.12, 0.07	0.12, 0.07, 0.08	0.12, 0.07, 0.08	0.12, 0.07, 0.08	0.12, 0.07, 0.09
Age 1	1.00, 0.55	1.00, 0.55	1.00, 0.52, 0.58	1.00, 0.52, 0.58	1.00, 0.52, 0.58	1.00, 0.52, 0.57
Age 2	0.16, 1.00	0.16, 1.00	**0.16, 1.00, 1.00**	**0.16, 1.00, 1.00**	0.16, 1.00, 1.00	0.15, 1.00, 1.00
Age 3	0.03, 0.85	0.03, 0.85	**0.06, 0.71, 1.00**	**0.06, 0.71, 1.00**	0.06, 0.72, 1.00	0.08, 0.73, 0.93
Age 4	**0.01, 0.67**	**0.01, 0.72**	**0.08, 0.47, 0.95**	**0.08, 0.47, 0.95**	0.08, 0.50, 0.97	0.09, 0.52, 0.84
Age 5	**0.01, 0.55**	**0.01, 0.61**	**0.09, 0.46, 0.64**	**0.09, 0.46, 0.64**	0.09, 0.50, 0.67	0.10, 0.53, 0.61
Age 6	**0.00, 0.55**	**0.00, 0.68**	**0.10, 0.55, 0.51**	**0.10, 0.55, 0.51**	**0.10, 0.62, 0.56**	0.10, 0.60, 0.55
Age 7+	**0.00, 0.47**	**0.00, 0.78**	**0.10, 0.56, 0.38**	**0.10, 0.56, 0.38**	**0.10, 0.69, 0.47**	**0.10, 0.64, 0.53**
F, R, SSB						
F 1982	**0.67**	**1.09**	0.91	0.87	0.89	0.79
F 1988	**1.16**	**1.93**	1.59	1.52	1.55	1.24
F 2007	0.22	**0.29**	0.21	**0.24**	**0.26**	0.26
F 2011	0.22	**0.27**	0.28	**0.35**	**0.38**	**0.36**
F 2012	0.19	0.22	0.22	**0.28**	**0.30**	**0.28**
Age 0 1982	67,374	66,476	67,284	67,304	66,982	62,672
Age 0 1988	10,048	9,964	10,061	9,982	9,927	9,789
Age 0 2007	44,114	42,135	42,964	**43,672**	42,391	**39,987**
Age 0 2011	20,036	19,702	20,821	**20,274**	19,894	**19,562**
Age 0 2012	42,629	41,697	42,614	**42,275**	41,561	**37,185**
SSB 1982	23,604	22,951	23,202	23,224	22,983	**24,300**
SSB 1989	6,167	5,906	6,025	6,019	5,923	**5,521**
SSB 2007	55,986	**47,378**	**54,698**	**55,340**	**49,361**	**48,540**
SSB 2011	**59,246**	**51,650**	**56,402**	**57,244**	**52,080**	**51,126**
SSB 2012	**58,133**	**51,458**	**56,243**	**56,947**	**52,131**	**51,238**

Table A88. Summary results for Spawning Stock Biomass (SSB) in metric tons (mt); Recruitment (R) at age 0 (000s); Fishing Mortality (F) for fully recruited (peak) age 4.

Year	SSB	R	F
1982	24,300	62,272	0.790
1983	23,221	75,755	1.043
1984	18,627	39,574	1.175
1985	18,435	62,265	1.102
1986	18,344	62,217	1.294
1987	18,917	42,373	1.123
1988	10,110	9,789	1.542
1989	5,521	30,500	1.241
1990	9,312	36,200	0.875
1991	11,297	40,549	1.041
1992	11,483	39,499	1.040
1993	12,802	36,837	0.959
1994	13,846	45,911	0.906
1995	17,675	57,652	1.745
1996	22,638	41,085	1.360
1997	25,234	37,678	0.849
1998	26,370	40,282	0.764
1999	28,493	33,516	0.552
2000	35,347	44,873	0.569
2001	40,672	46,952	0.479
2002	46,523	50,596	0.425
2003	52,635	37,754	0.399
2004	50,659	53,490	0.446
2005	47,583	32,260	0.451
2006	49,233	38,985	0.330
2007	48,540	39,987	0.263
2008	48,942	48,675	0.312
2009	51,578	54,857	0.300
2010	53,156	34,549	0.312
2011	51,129	19,562	0.359
2012	51,238	37,185	0.285

Table A89. January 1 population number (000s) estimates at age.

	Age								
	0	1	2	3	4	5	6	7+	Total
1982	62,272	43,746	23,821	2,360	807	252	172	124	133,555
1983	75,755	46,914	21,351	6,350	636	285	96	103	151,492
1984	39,574	56,644	19,763	4,054	1,220	175	87	52	121,568
1985	62,265	29,486	22,165	3,140	652	293	47	33	118,081
1986	62,217	46,585	12,231	3,887	557	169	84	20	125,750
1987	42,373	46,157	16,902	1,656	533	119	41	23	107,804
1988	9,789	31,581	18,431	2,880	286	135	34	16	63,151
1989	30,500	7,218	10,019	1,788	283	48	26	8	49,890
1990	36,200	21,828	1,995	1,444	267	64	12	8	61,817
1991	40,549	26,555	8,345	472	351	87	22	6	76,386
1992	39,499	30,099	10,552	1,585	91	96	26	8	81,955
1993	36,837	28,233	8,827	1,991	311	25	29	10	76,263
1994	45,911	27,098	10,729	1,866	431	93	8	12	86,148
1995	57,652	33,422	9,641	2,432	436	136	32	6	103,756
1996	41,085	43,743	21,052	2,627	322	59	24	7	108,920
1997	37,678	31,204	28,328	7,037	511	64	14	8	104,844
1998	40,282	28,794	21,649	13,028	2,308	170	24	9	106,263
1999	33,516	30,779	20,053	10,380	4,647	838	69	14	100,295
2000	44,873	25,537	21,282	10,397	4,525	2,084	403	40	109,141
2001	46,952	34,239	17,807	11,094	4,474	1,994	989	214	117,761
2002	50,596	35,966	24,626	10,104	5,280	2,158	1,027	633	130,390
2003	37,754	38,790	26,089	14,481	5,086	2,689	1,164	921	126,975
2004	53,490	28,938	28,133	15,505	7,473	2,659	1,483	1,183	138,863
2005	32,260	40,952	20,774	16,143	7,614	3,727	1,407	1,455	124,332
2006	38,985	24,681	29,254	11,804	7,868	3,777	1,961	1,556	119,885
2007	39,987	29,873	17,934	17,947	6,513	4,404	2,206	2,100	120,964
2008	48,675	30,598	21,590	11,224	10,535	3,898	2,718	2,698	131,936
2009	54,857	37,273	22,545	14,922	7,144	6,003	2,253	3,275	148,272
2010	34,549	42,009	27,470	15,611	9,559	4,120	3,513	3,401	140,232
2011	19,562	26,456	30,950	18,984	9,936	5,448	2,382	4,179	117,897
2012	37,185	14,985	19,540	21,353	11,819	5,405	3,001	3,855	117,141

Table A90. Fishing mortality (F) estimates at age.

	Age							
	0	1	2	3	4	5	6	7+
1982	0.023	0.457	1.062	1.061	0.790	0.715	0.743	0.919
1983	0.031	0.605	1.402	1.400	1.043	0.943	0.980	1.212
1984	0.034	0.678	1.580	1.578	1.175	1.063	1.105	1.366
1985	0.030	0.620	1.481	1.480	1.102	0.997	1.036	1.281
1986	0.039	0.754	1.739	1.737	1.294	1.171	1.217	1.504
1987	0.034	0.658	1.510	1.507	1.123	1.016	1.056	1.305
1988	0.045	0.888	2.073	2.071	1.542	1.395	1.450	1.793
1989	0.075	1.026	1.677	1.652	1.241	1.127	1.171	1.440
1990	0.050	0.702	1.182	1.166	0.875	0.794	0.825	1.016
1991	0.038	0.663	1.401	1.395	1.041	0.943	0.980	1.210
1992	0.076	0.967	1.408	1.379	1.040	0.946	0.982	1.206
1993	0.047	0.708	1.294	1.281	0.959	0.870	0.904	1.114
1994	0.057	0.773	1.224	1.205	0.906	0.823	0.855	1.051
1995	0.016	0.202	1.040	1.771	1.745	1.500	1.442	1.297
1996	0.015	0.174	0.836	1.388	1.360	1.172	1.129	1.019
1997	0.009	0.106	0.517	0.865	0.849	0.731	0.704	0.635
1998	0.009	0.102	0.475	0.781	0.764	0.659	0.636	0.575
1999	0.012	0.109	0.397	0.580	0.552	0.482	0.472	0.435
2000	0.010	0.101	0.391	0.593	0.569	0.496	0.483	0.442
2001	0.007	0.070	0.307	0.492	0.479	0.414	0.401	0.364
2002	0.006	0.061	0.271	0.436	0.425	0.367	0.355	0.322
2003	0.006	0.061	0.260	0.411	0.399	0.345	0.335	0.305
2004	0.007	0.071	0.295	0.461	0.446	0.387	0.375	0.342
2005	0.008	0.076	0.305	0.469	0.451	0.392	0.381	0.348
2006	0.006	0.059	0.229	0.345	0.330	0.288	0.280	0.257
2007	0.008	0.065	0.209	0.283	0.263	0.233	0.230	0.214
2008	0.007	0.045	0.109	0.202	0.312	0.298	0.294	0.224
2009	0.007	0.045	0.108	0.195	0.300	0.286	0.282	0.215
2010	0.007	0.046	0.110	0.202	0.312	0.298	0.294	0.224
2011	0.007	0.043	0.111	0.224	0.359	0.346	0.343	0.259
2012	0.005	0.032	0.085	0.176	0.285	0.276	0.273	0.205

Table A91. Input values for 2013 SAW 57 YPR and SSBR reference point estimates and stock projections. Values are averages for 2010-2012.

2013 SAW 57

Mean Natural Mortality (M) = 0.25

Proportion of mortality before spawning = 0.83

Age	Fishery Selex	Fishery Selex CV	M	M CV	Jan 1 Stock Weights	Jul 1 Catch Weights	Nov 1 SSB Weights	Weights CV	Maturity	Mat CV
0	0.02	0.20	0.26	0.10	0.147	0.184	0.219	0.26	0.380	0.33
1	0.13	0.20	0.26	0.10	0.240	0.326	0.382	0.14	0.910	0.07
2	0.32	0.20	0.26	0.10	0.414	0.522	0.574	0.11	0.980	0.01
3	0.63	0.20	0.25	0.10	0.602	0.725	0.812	0.18	1.000	0.01
4	1.00	0.20	0.25	0.10	0.860	1.022	1.158	0.18	1.000	0.01
5	0.96	0.20	0.25	0.10	1.233	1.457	1.579	0.20	1.000	0.01
6	0.95	0.20	0.25	0.10	1.644	1.869	2.227	0.20	1.000	0.01
7+	0.72	0.20	0.24	0.10	3.300	3.300	3.561	0.20	1.000	0.01

Table A92. Biological reference point estimates for the 2008 SAW 47 (old = existing) and 2013 SAW 57 (new = updated) assessments. In both assessments, the non-parametric references points (**BOLD**) are used to evaluate stock status.

Assessment Model	**2008_SAW47 ASAP SCAA**	**2013_SAW57 ASAP SCAA**
NON-PARAMETRIC	(deterministic)	(stochastic)
	M=0.25	M=0.25
Median R (000s)	41,553	40,237
FMSY Proxy	F35%	F35% (5%ile, 95%ile)
FMSY	**0.310**	**0.309 (0.247,0.390)**
Y/R (kg)	**0.358**	**0.303 (0.256, 0.358)**
SSB/R (kg)	**1.443**	**1.449 (1.165, 1.856)**
MSY (mt)	**13,122**	**12,945 (10,387; 15,997)**
SSBMSY(mt)	**60,074**	**62,394 (50,044; 77,273)**
PARAMETRIC		
Internal Beverton-Holt	L = 0.05	L = 1
R0	39,140	40,993
SSB0	189,729	140,382
Steepness	0.999	0.998
FMSY	0.420	3.000 (n/a)
MSY	14,686	13,841 (11,143; 16,539)
SSBMSY	43,898	11,423 (8,452; 14,412)

FIGURES

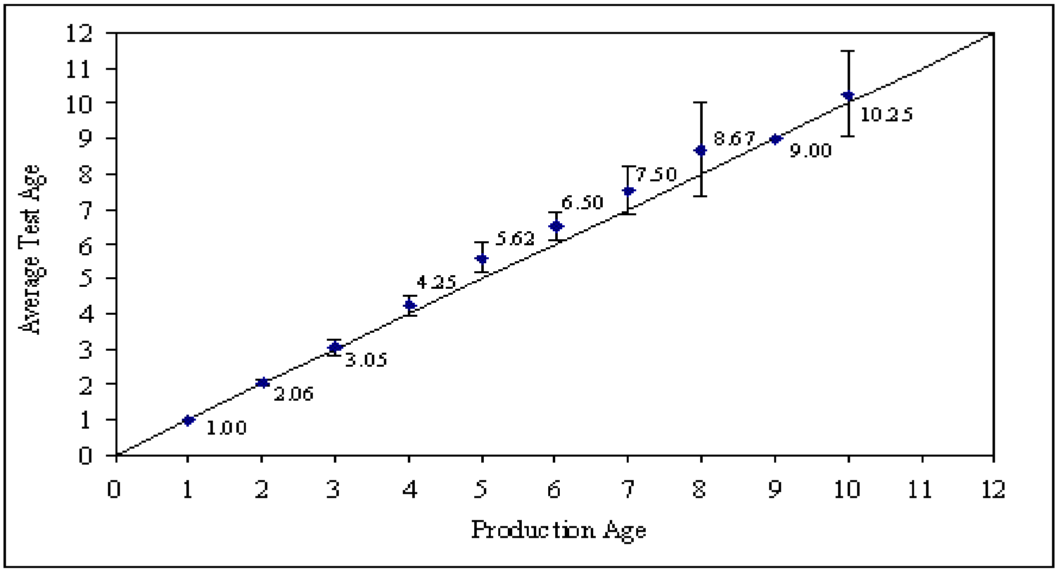


Figure A1. Age bias plot for NEFSC 2011 spring survey ages, 75% agreement.

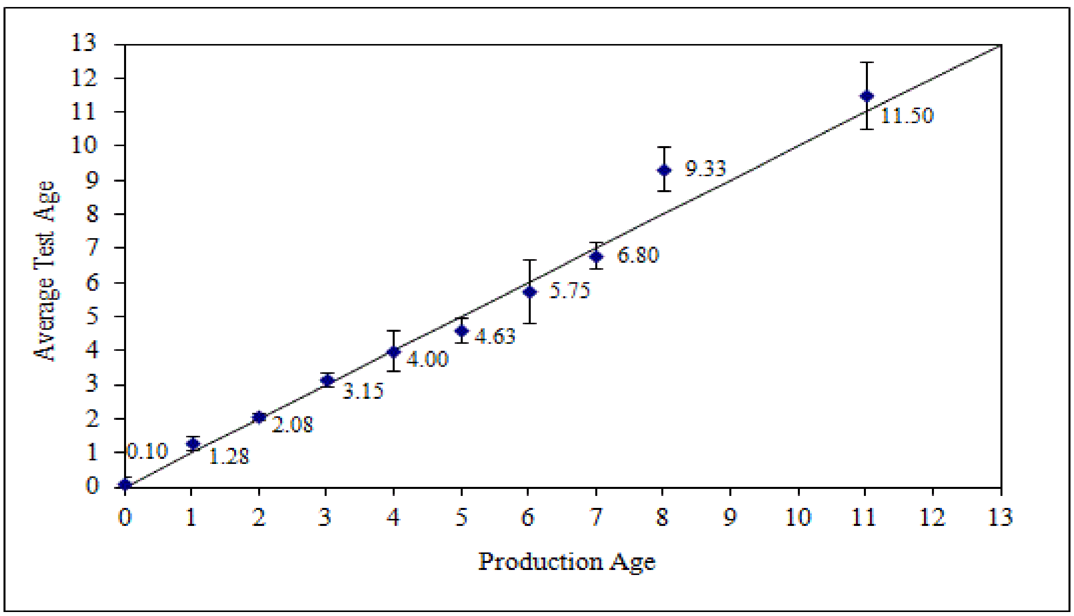


Figure A2. Age bias plot for NEFSC 2011 fall survey ages, 73% agreement.

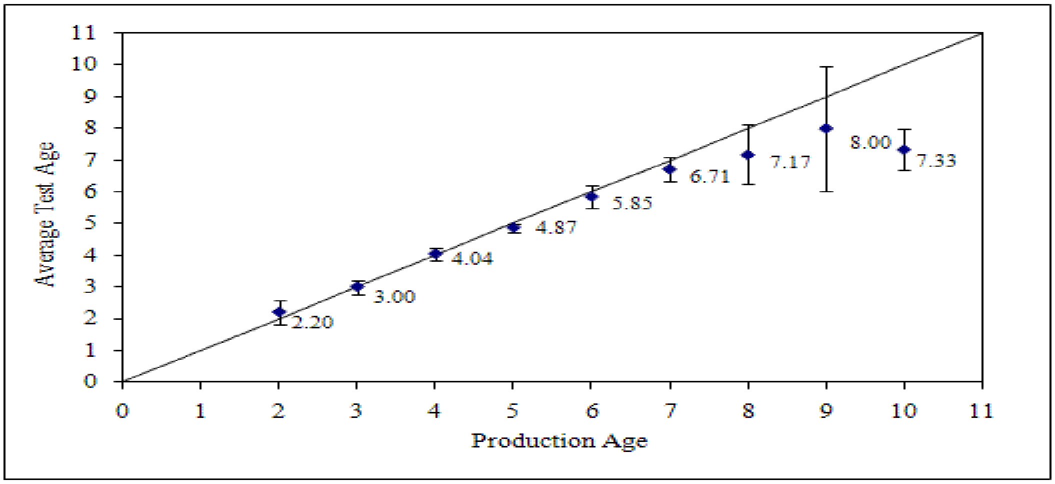


Figure A3. Age bias plot for NEFSC 2011 quarter 1 commercial ages, 69% agreement.

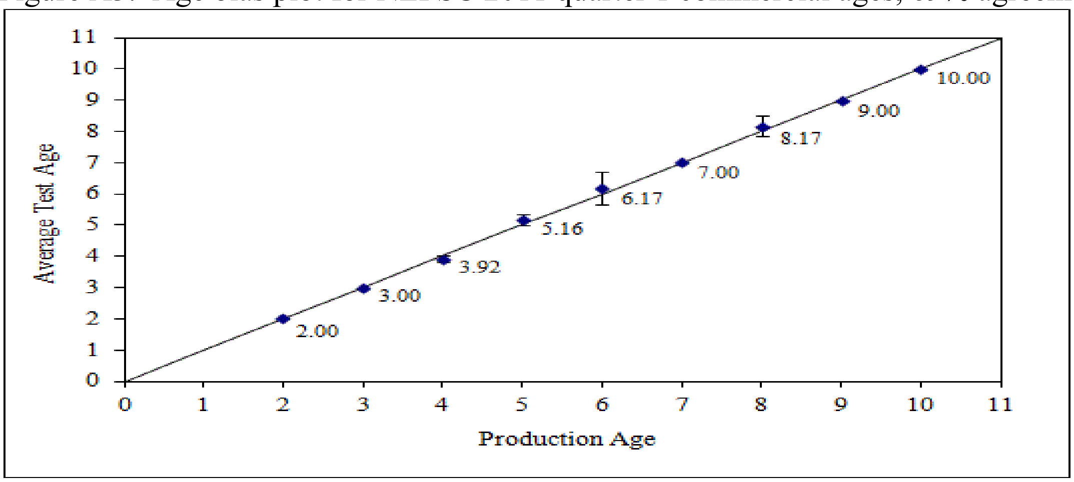


Figure A4. Age bias plot for NEFSC 2011 quarter 2 commercial ages, 92% agreement.

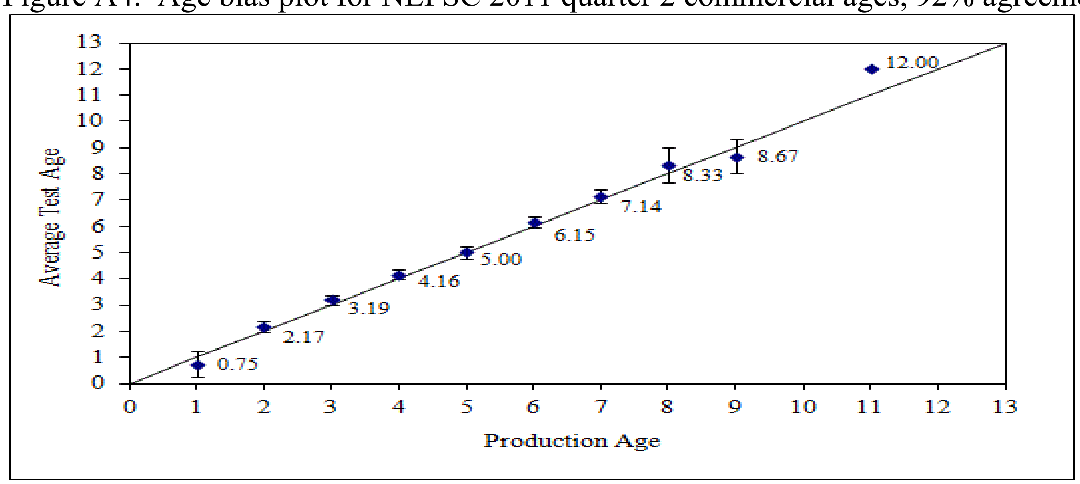


Figure A5. Age bias plot for NEFSC 2011 quarter 3-4 commercial ages, 80% agreement.

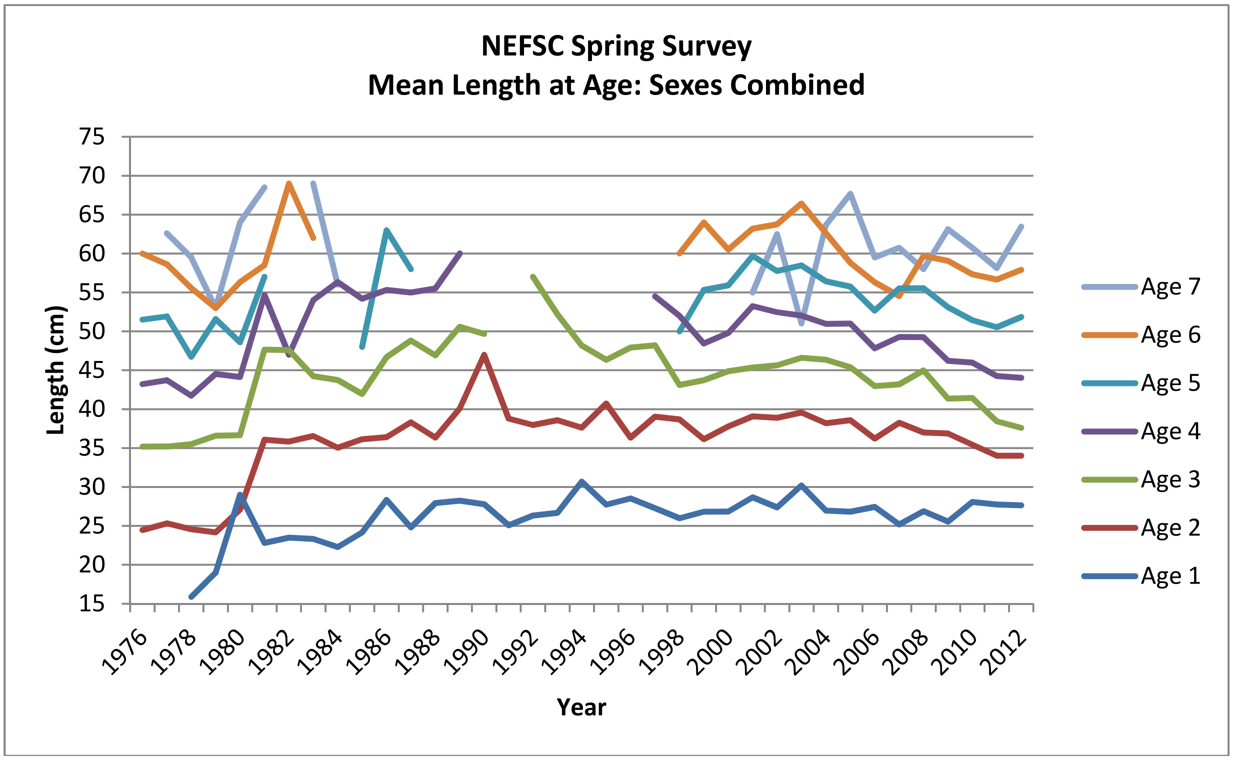


Figure A6. Trend in mean length at age for fish sampled in the NEFSC spring trawl survey: sexes combined.

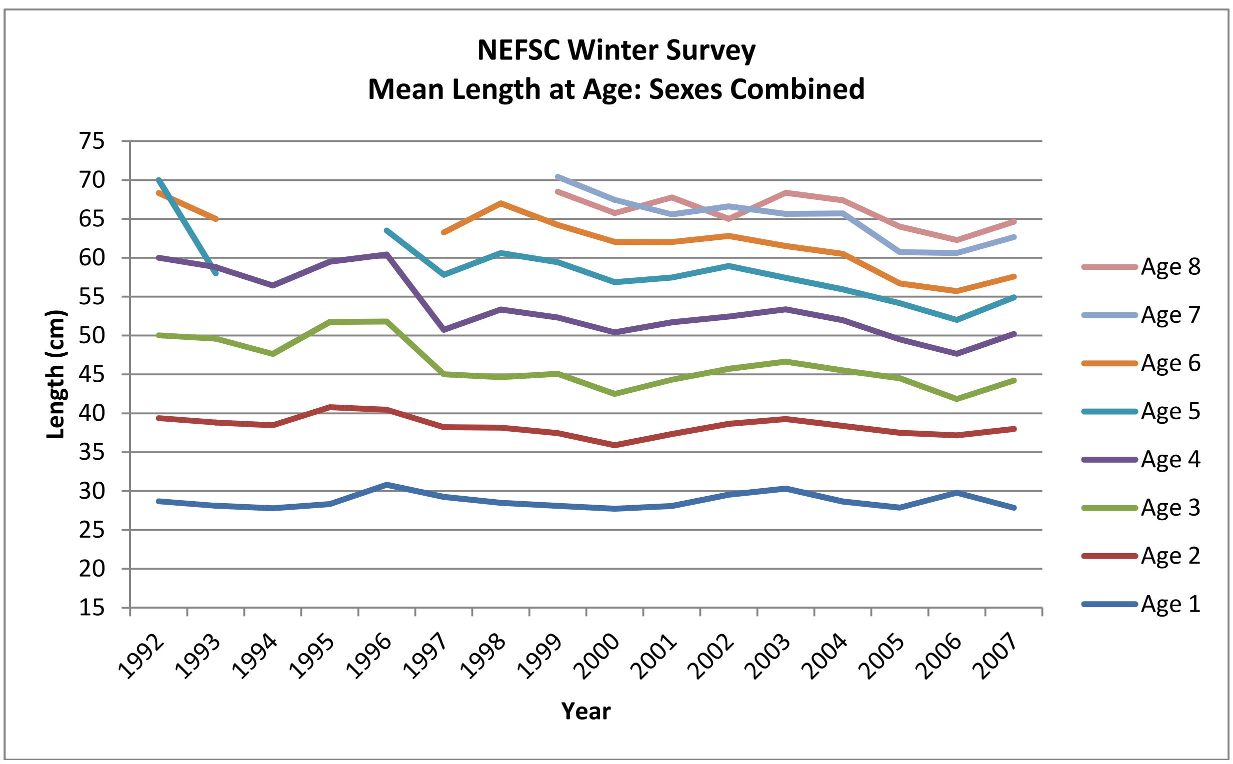


Figure A7. Trend in mean length at age for fish sampled in the NEFSC winter trawl survey: sexes combined.

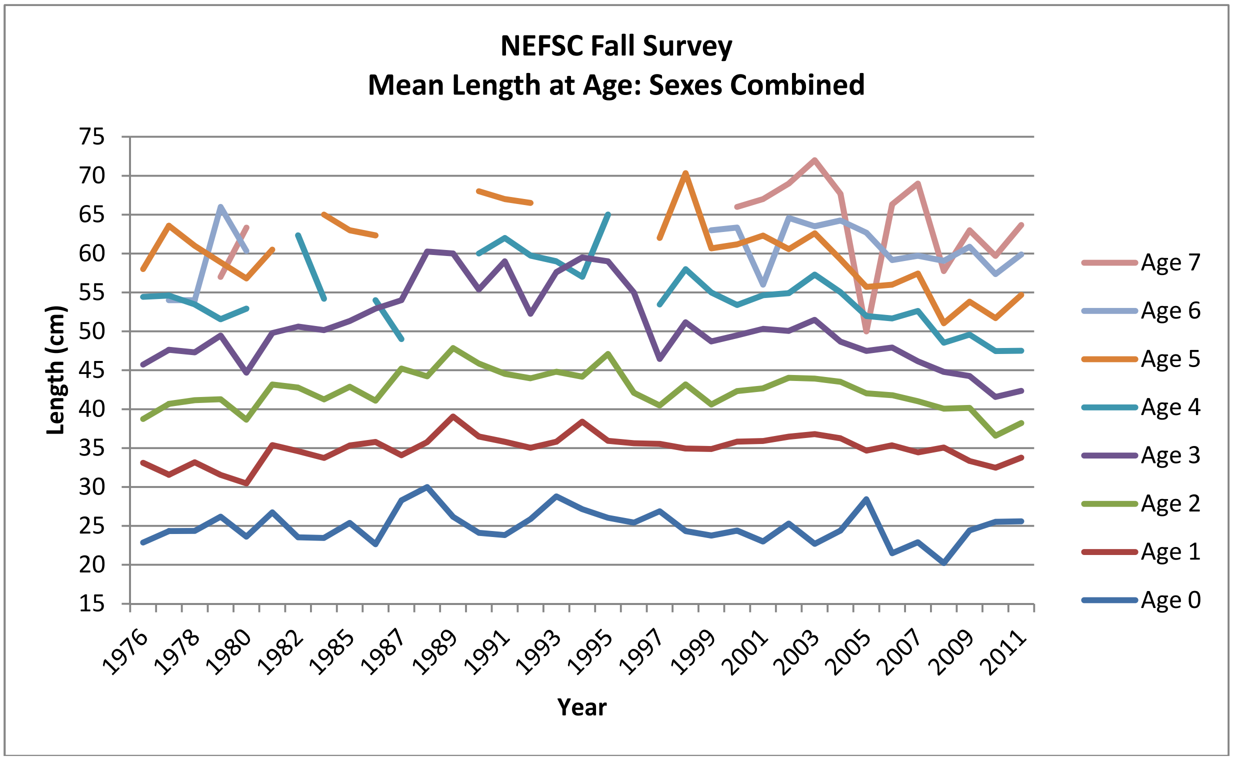


Figure A8. Trend in mean length at age for fish sampled in the NEFSC fall trawl survey: sexes combined.

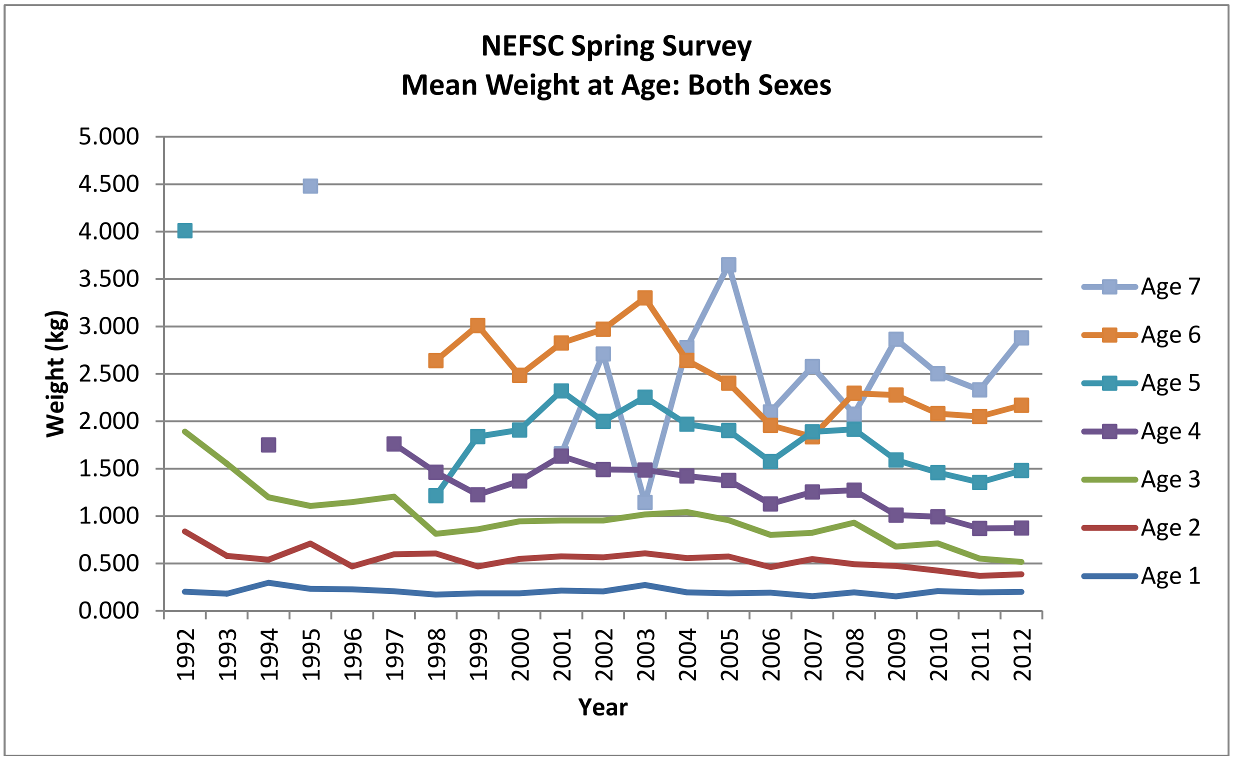


Figure A9. Trend in mean weight at age for fish sampled in the NEFSC spring trawl survey: sexes combined.

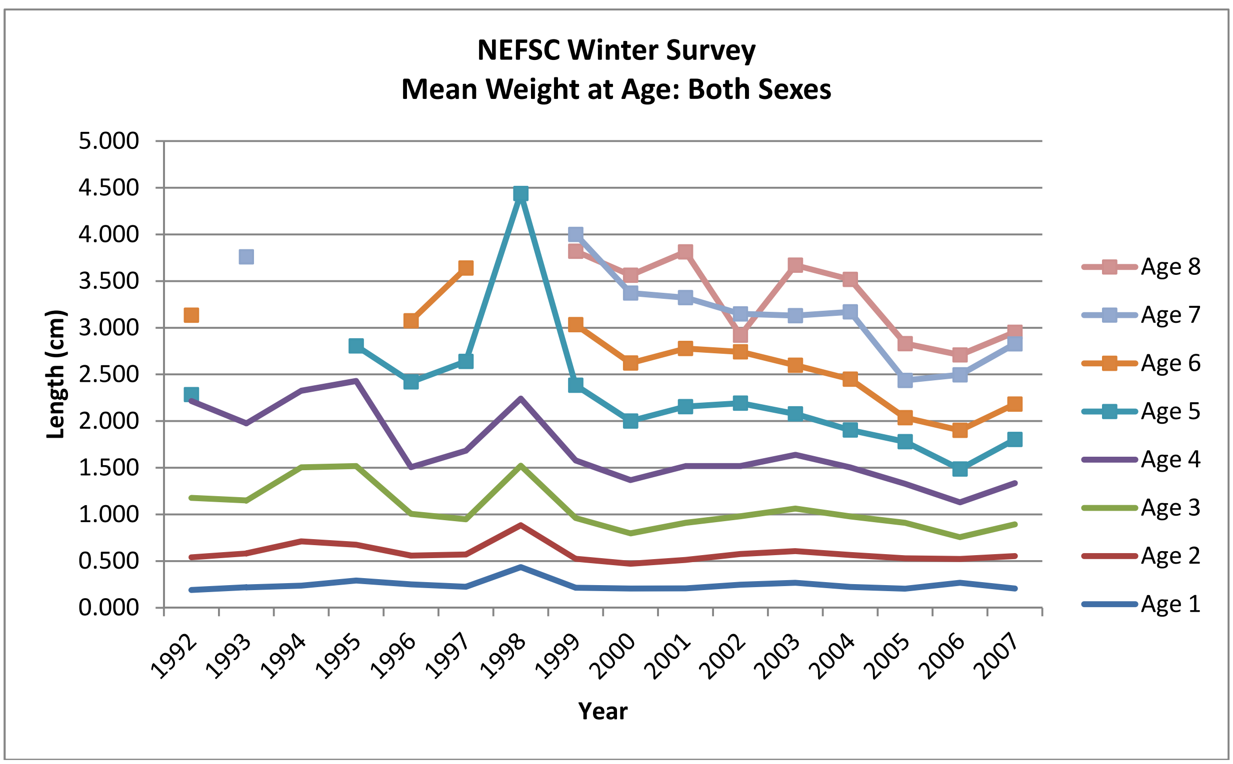


Figure A10. Trend in mean weight at age for fish sampled in the NEFSC winter trawl survey: sexes combined.

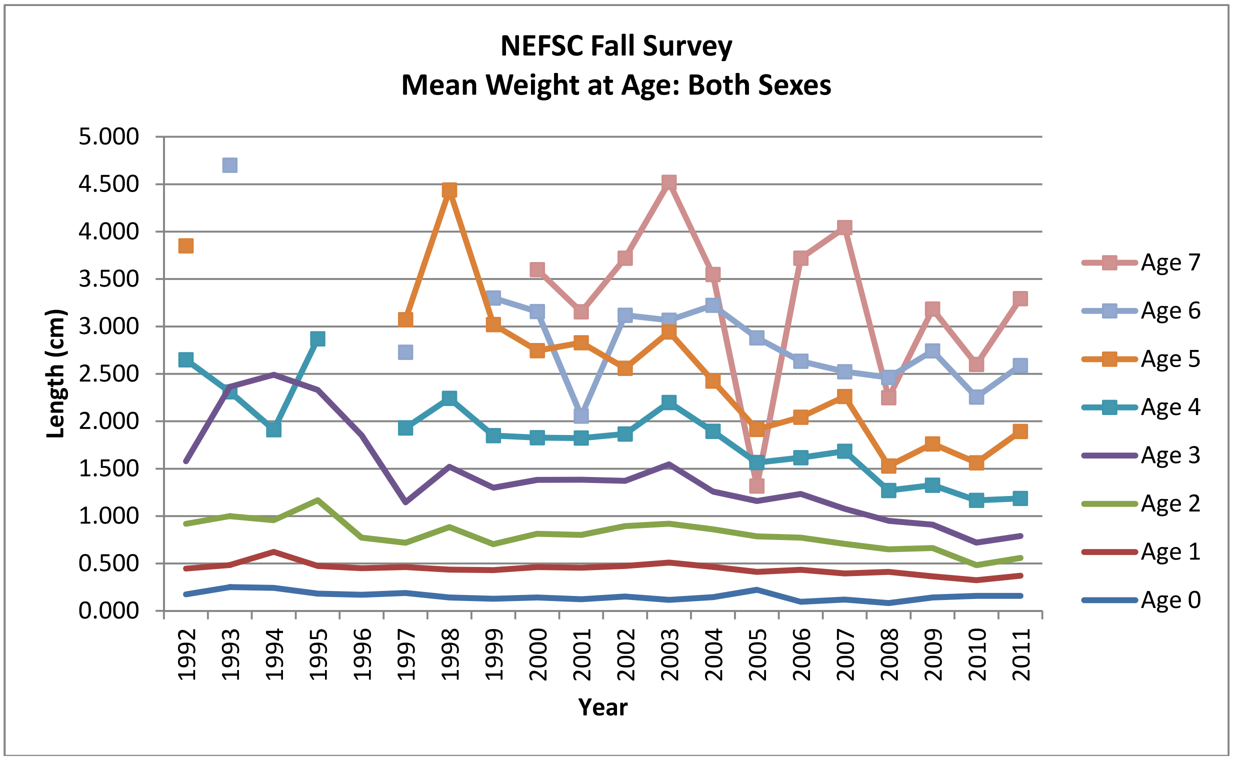


Figure A11. Trend in mean weight at age for fish sampled in the NEFSC fall trawl survey: sexes combined.

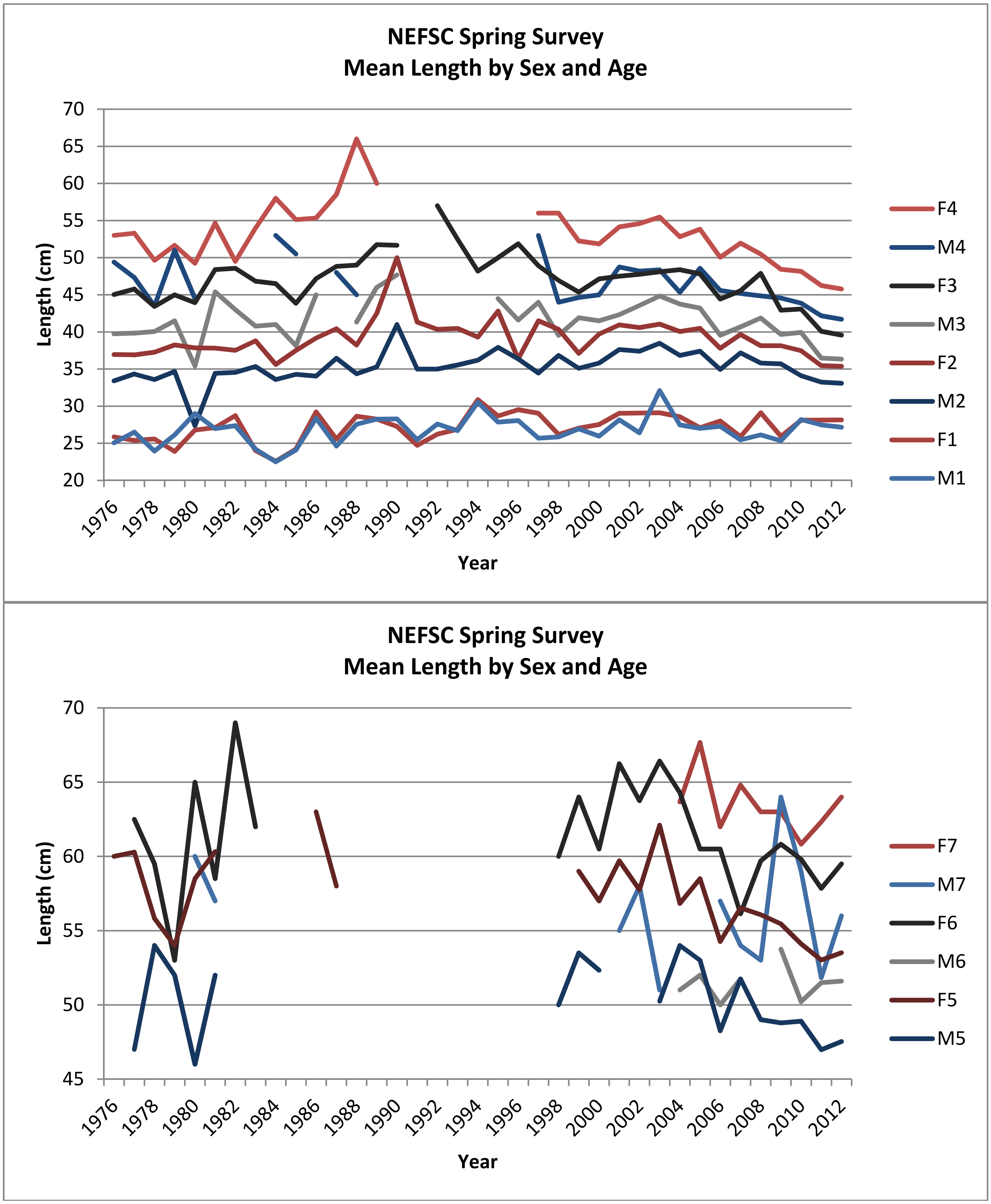
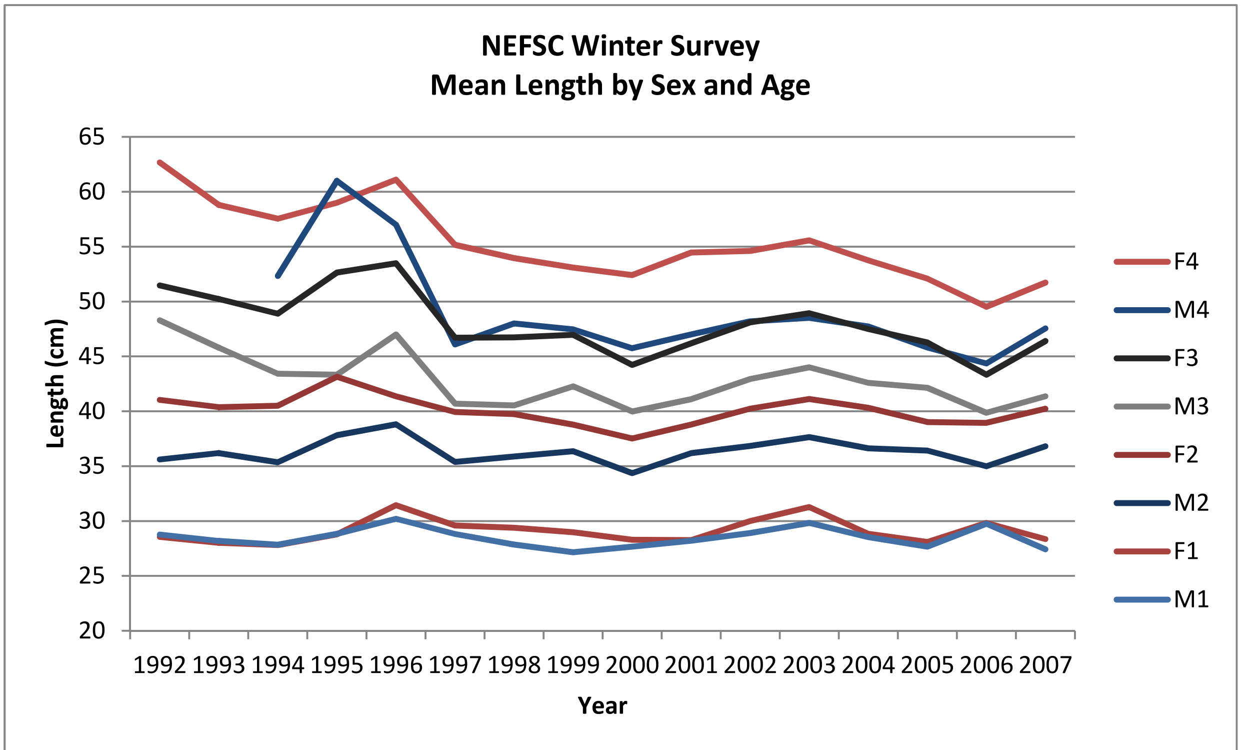


Figure A12. Trend in mean length at age for fish sampled in the NEFSC spring trawl survey: by sex and age; e.g., M1 = age 1 males, F7 = age 7 females.



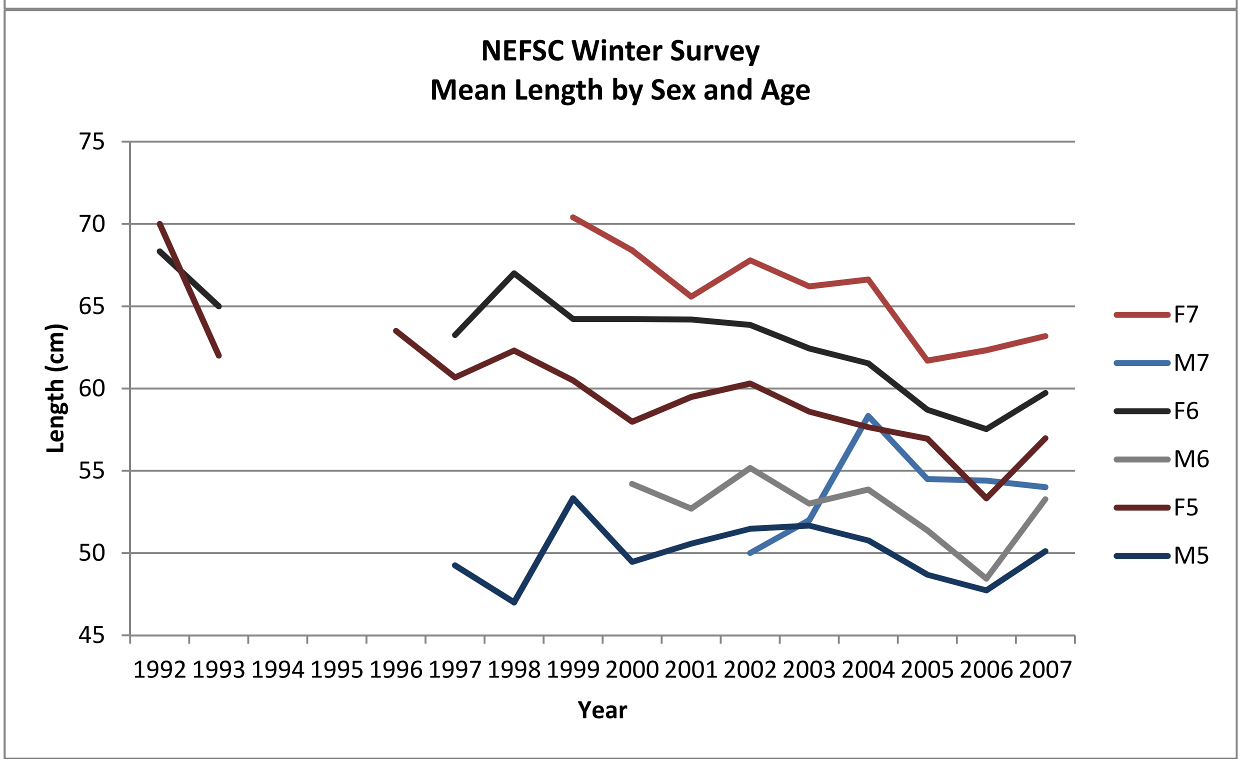
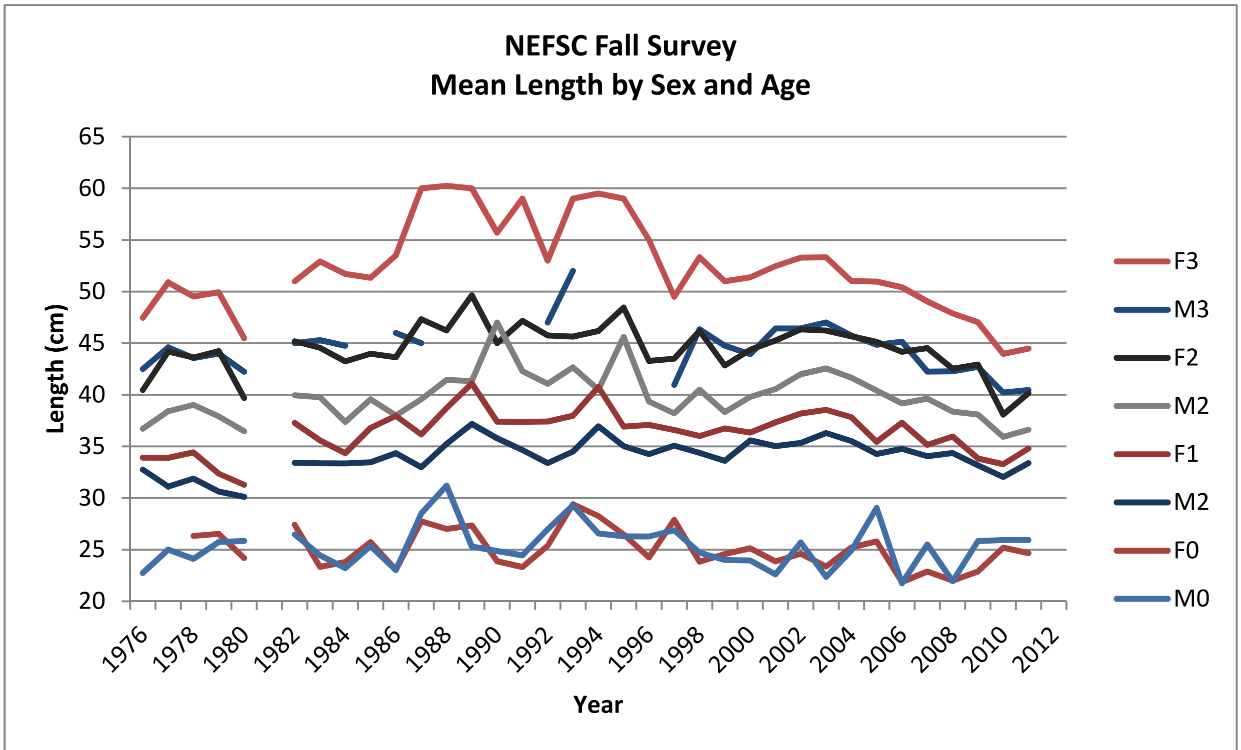


Figure A13. Trend in mean length at age for fish sampled in the NEFSC winter trawl survey: by sex and age; e.g., M1 = age 1 males, F7 = age 7 females.



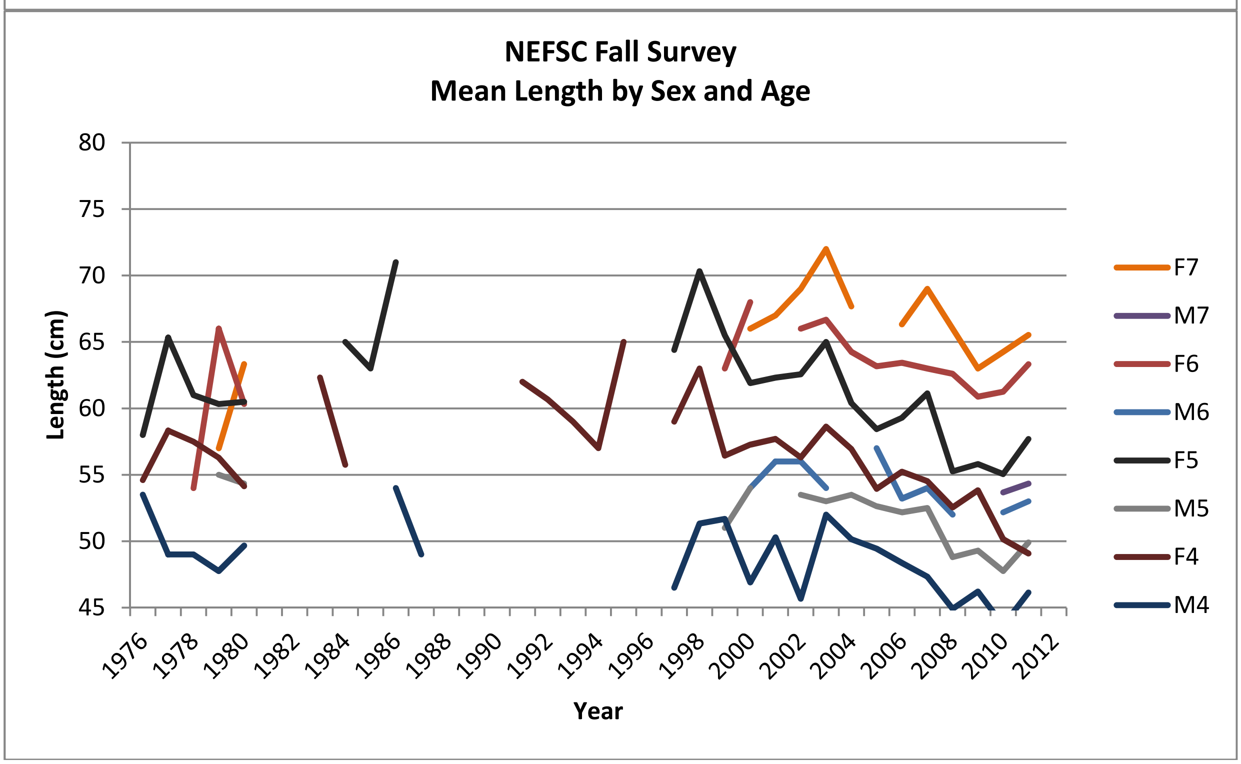


Figure A14. Trend in mean length at age for fish sampled in the NEFSC fall trawl survey: by sex and age; e.g., M0 = age 0 males, F7 = age 7 females.

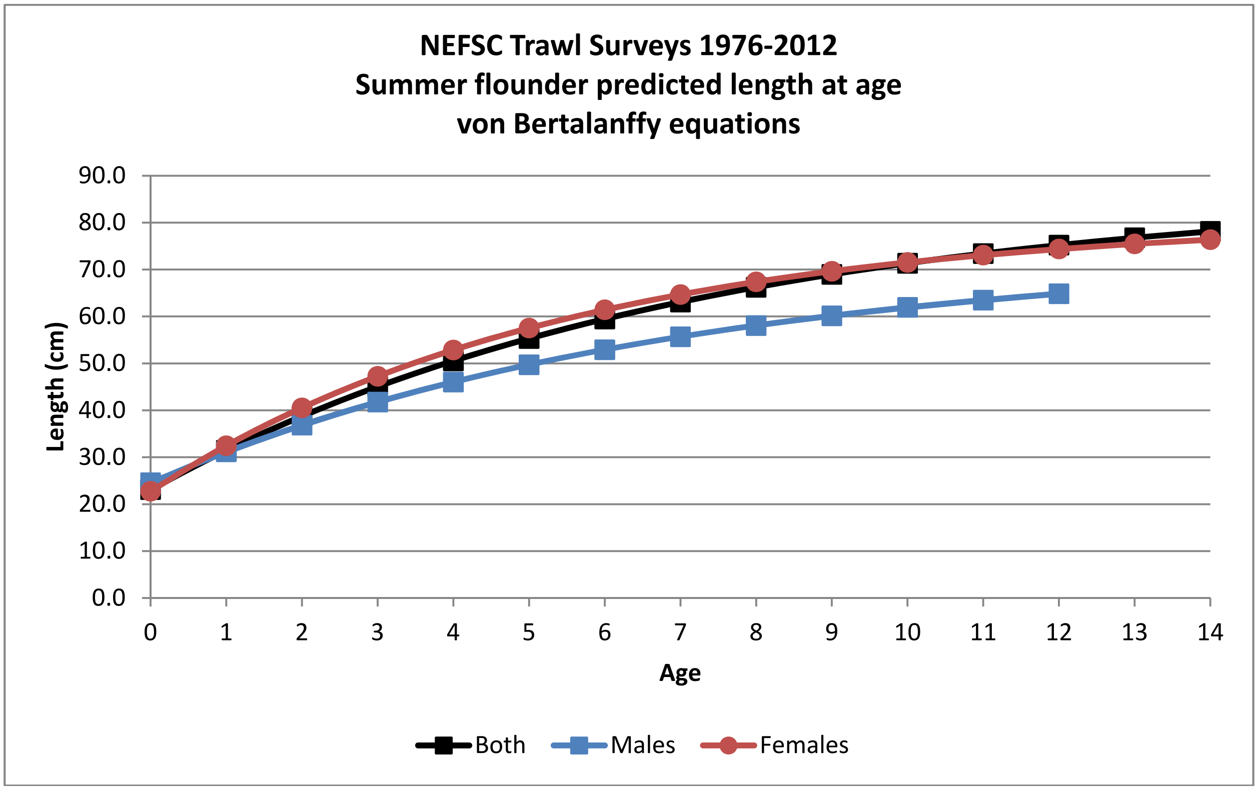
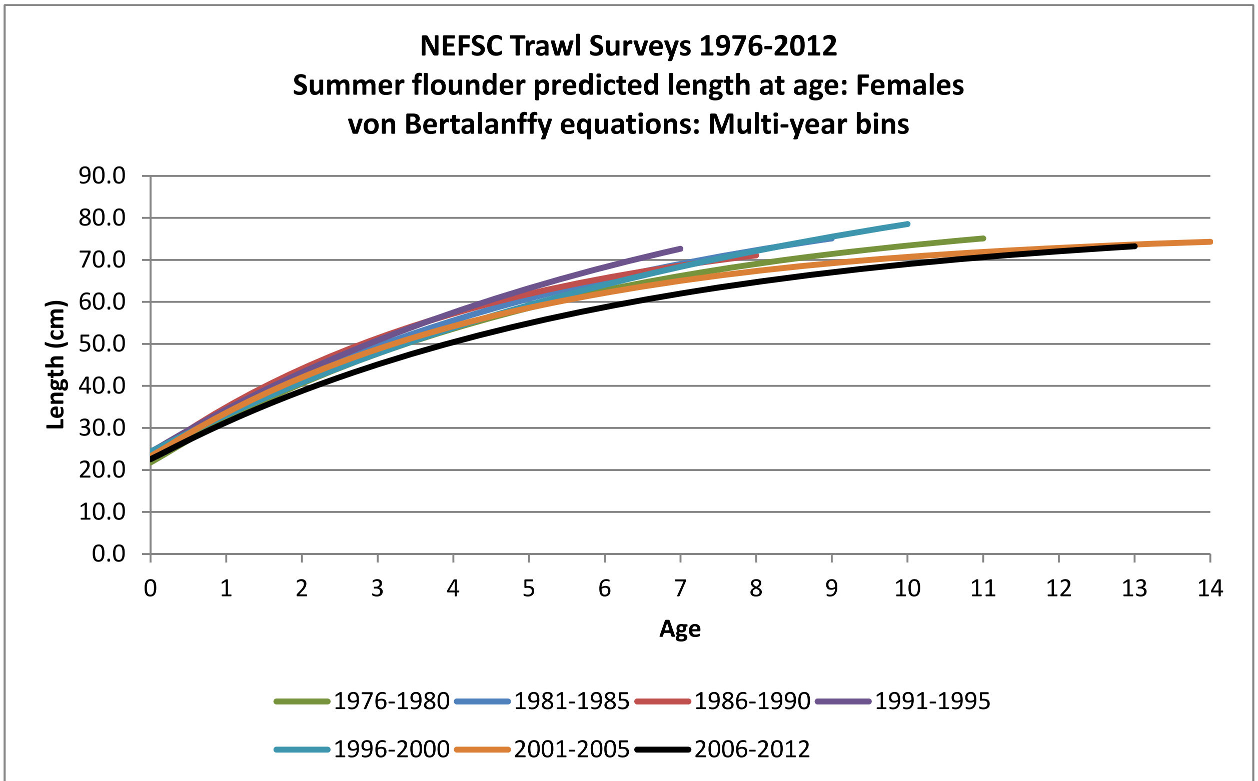


Figure A15. Predicted length at age from von Bertalanffy equations parameters estimated from NEFSC trawl survey data for 1976-2012. Maximum observed age for males is age 12; for females is age 14.



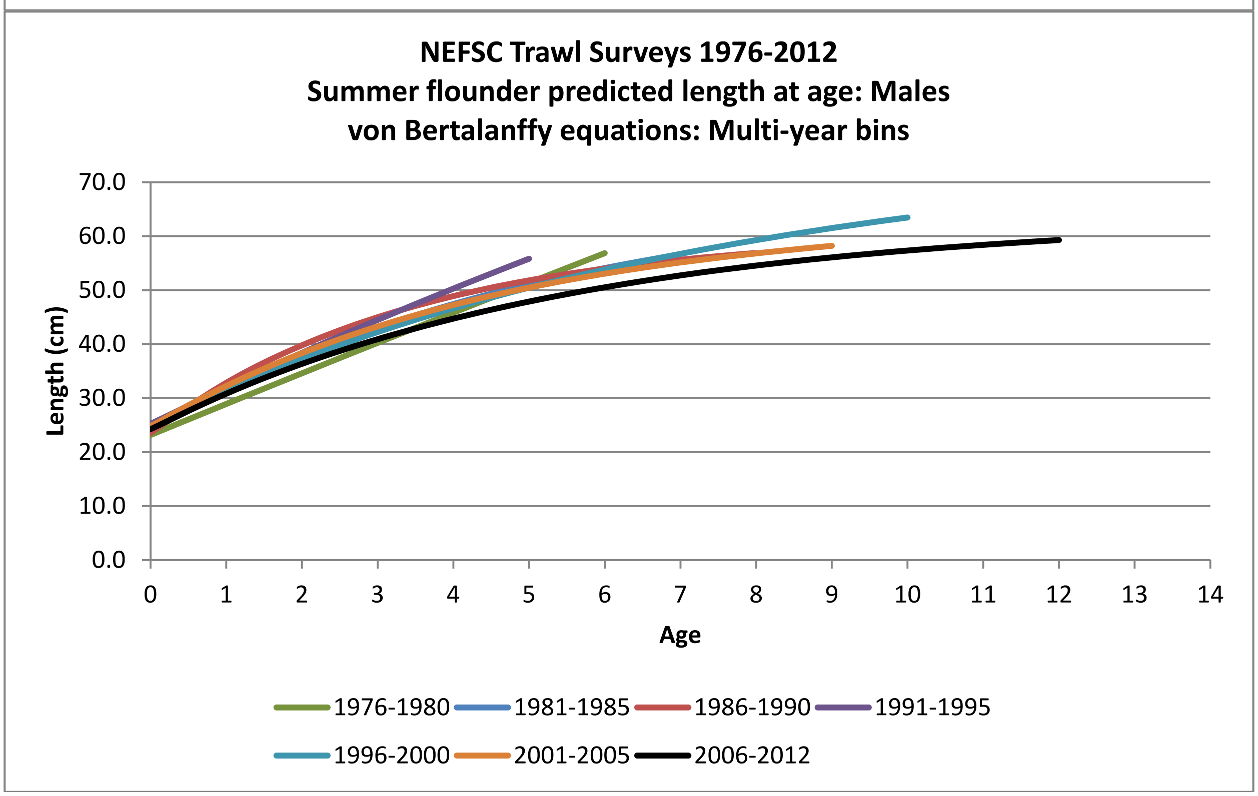


Figure A16. Predicted length at age from von Bertalanffy equations parameters estimated from NEFSC trawl survey data for multi-year bins by sex. Curves plotted through the maximum observed ages for each bin and sex.

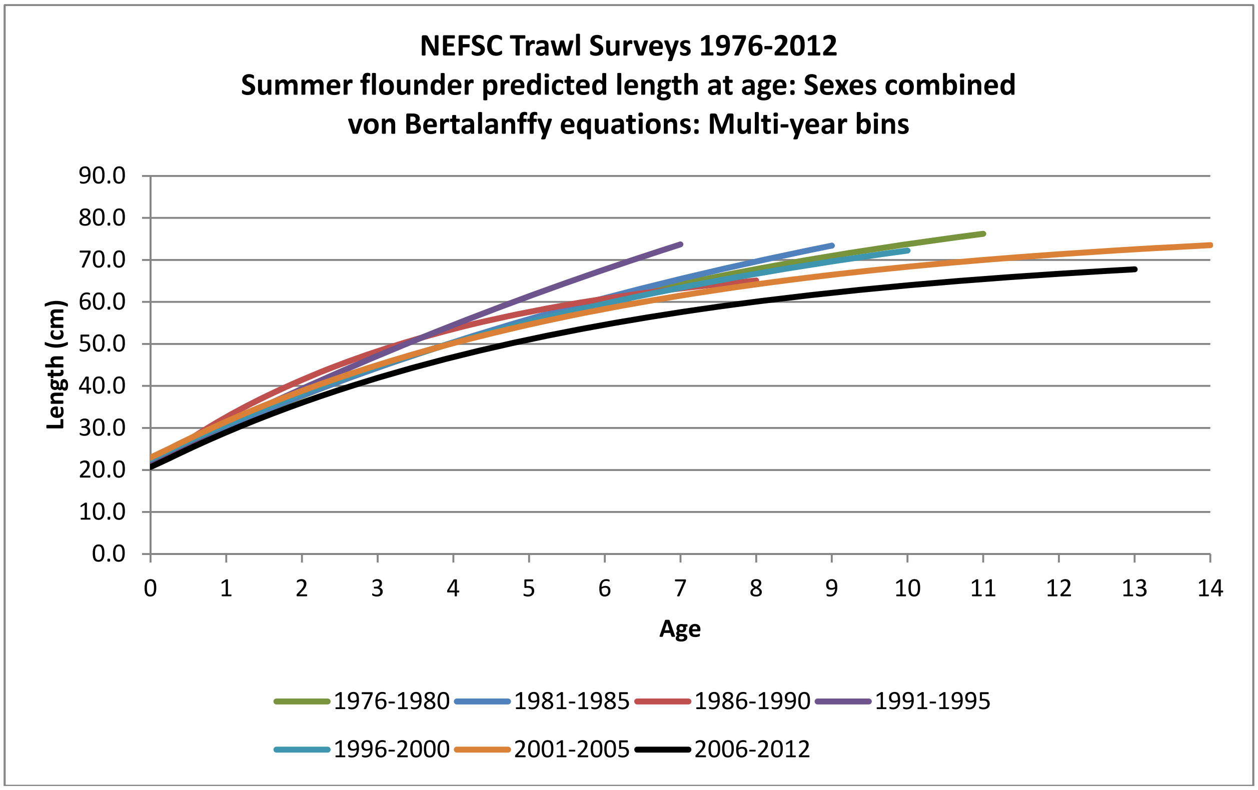


Figure A17. Predicted length at age from von Bertalanffy equations parameters estimated from NEFSC trawl survey data for multi-year bins by sexes combined. Curves plotted through the maximum observed ages for each bin.

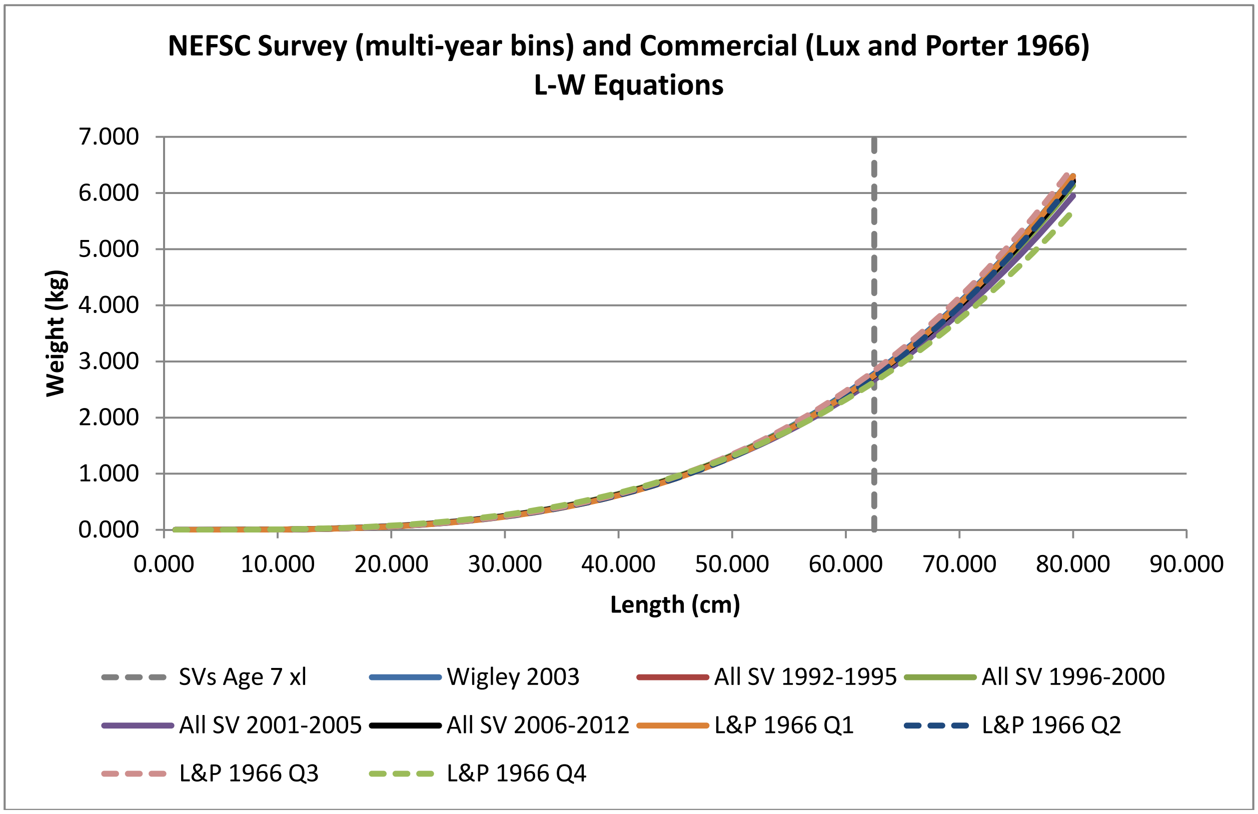


Figure A18. Length-weight relationships from the works of Lux and Porter (1966; L&P), Wigley et al. (2003; Wigley), and the current work (all surveys combined multi-year bins: 1992-1995, 1996-2000, 2001-2005, and 2006-2012). Vertical gray line is the mean length of age 7 in NEFSC surveys.

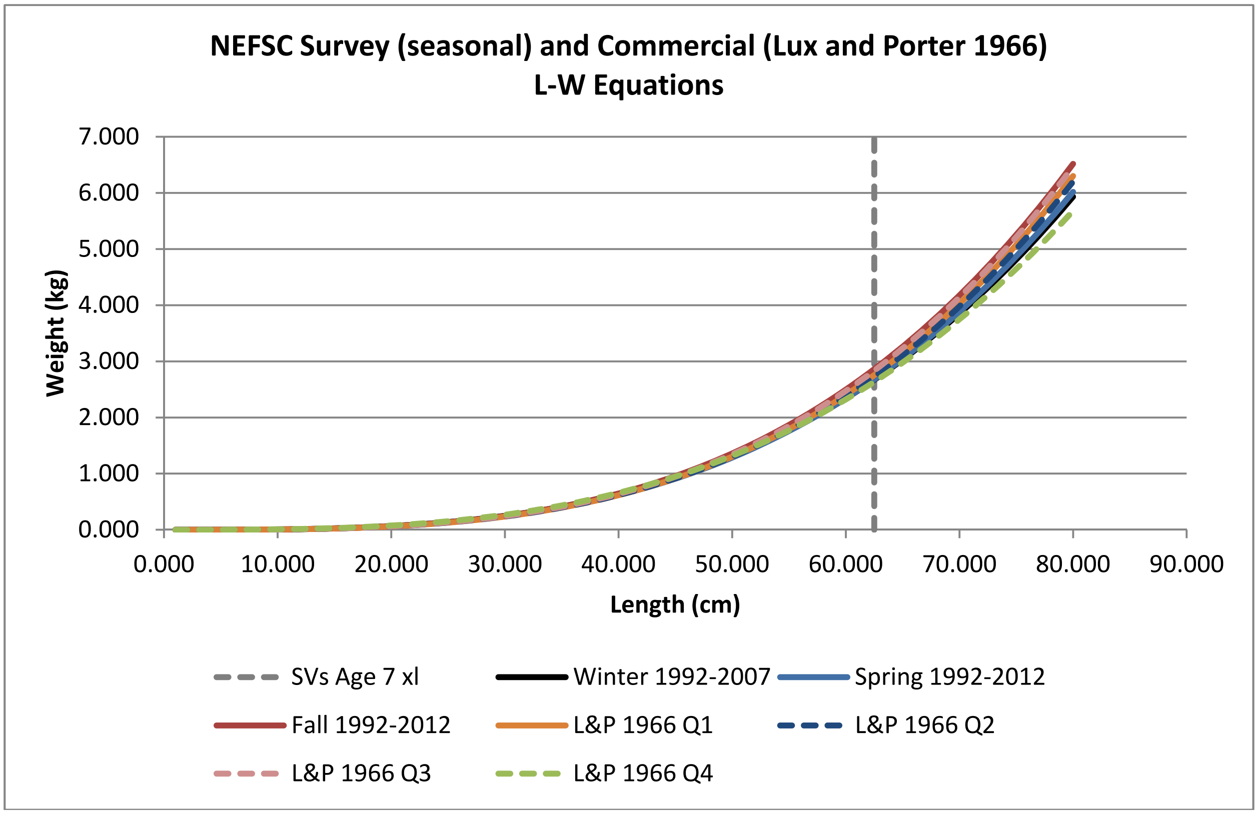


Figure A19. Length-weight relationships from the works of Lux and Porter (1966; L&P) and the current work (seasonal surveys: winter 1992-2007, spring 1992-2012, fall 1992-2012). Vertical gray line is the mean length of age 7 in NEFSC surveys.

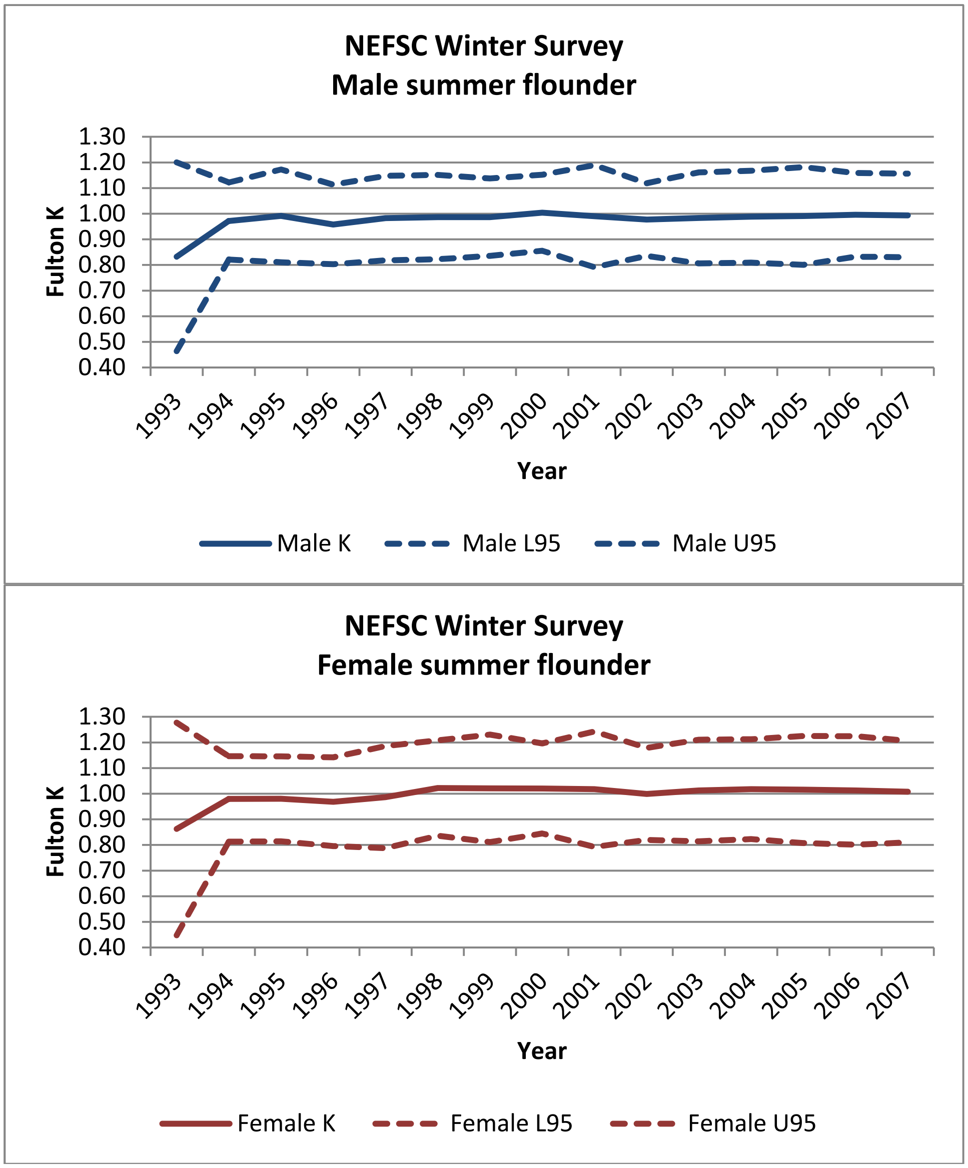


Figure A20. Seasonal condition factor of summer flounder: NEFSC winter survey by sex.

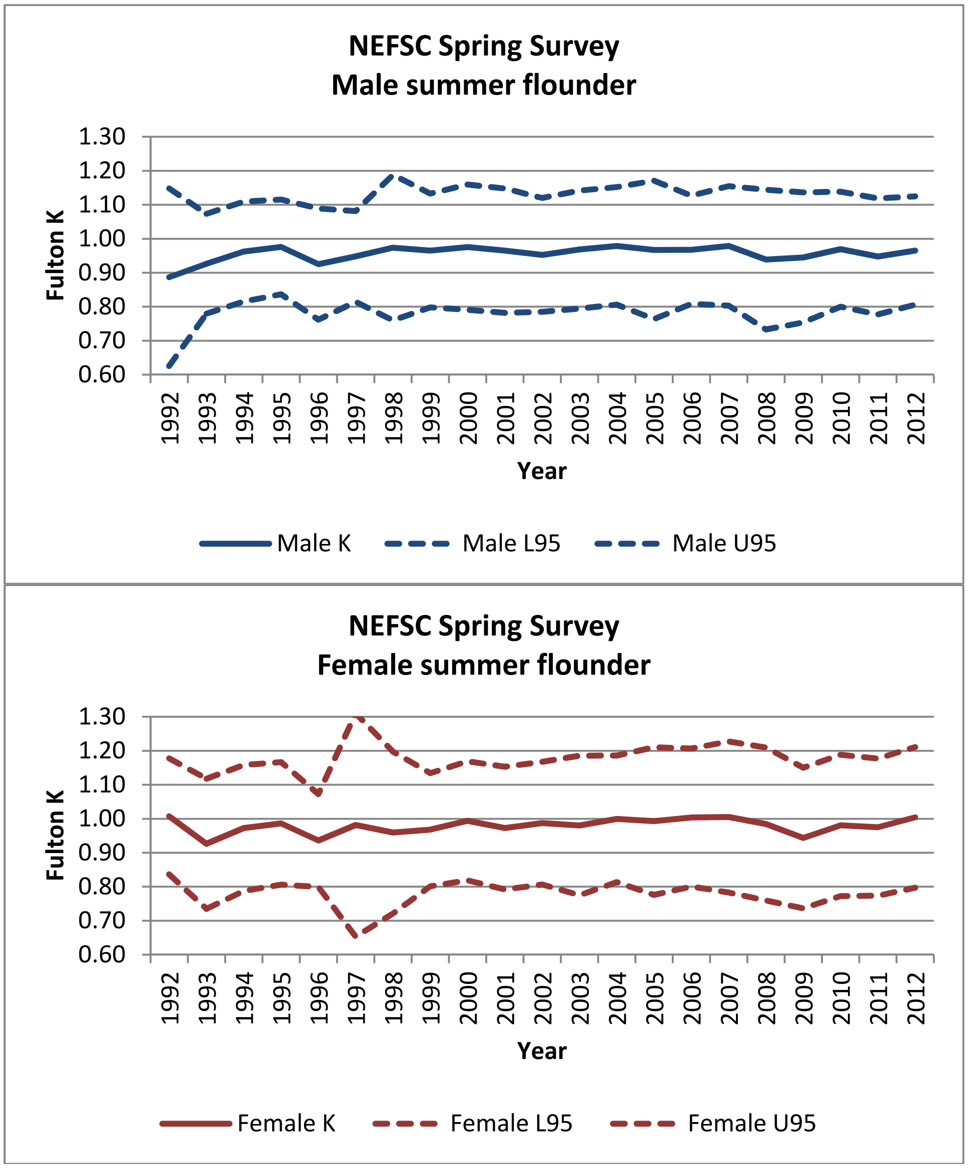


Figure A21. Seasonal condition factor of summer flounder: NEFSC spring survey by sex.

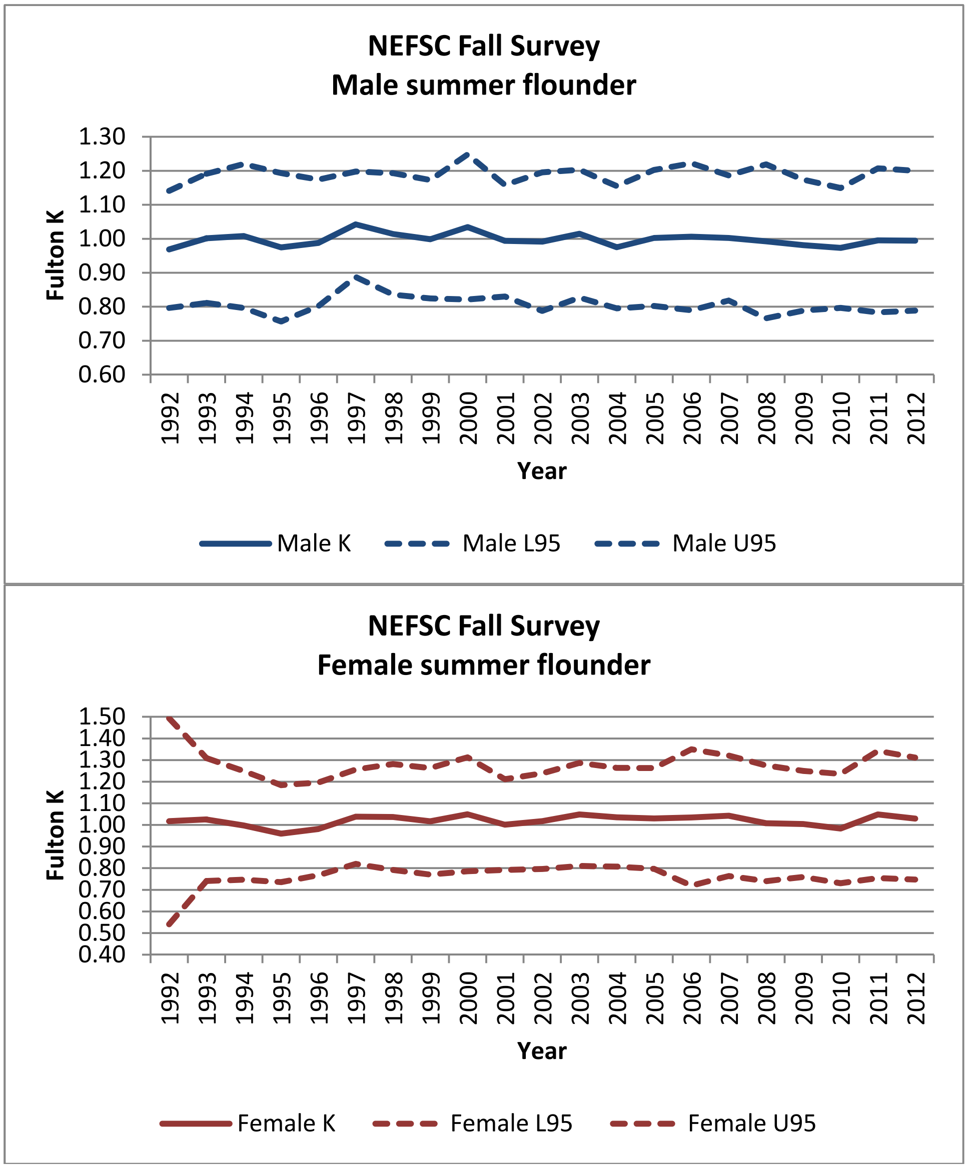


Figure A22. Seasonal condition factor of summer flounder: NEFSC fall survey by sex.

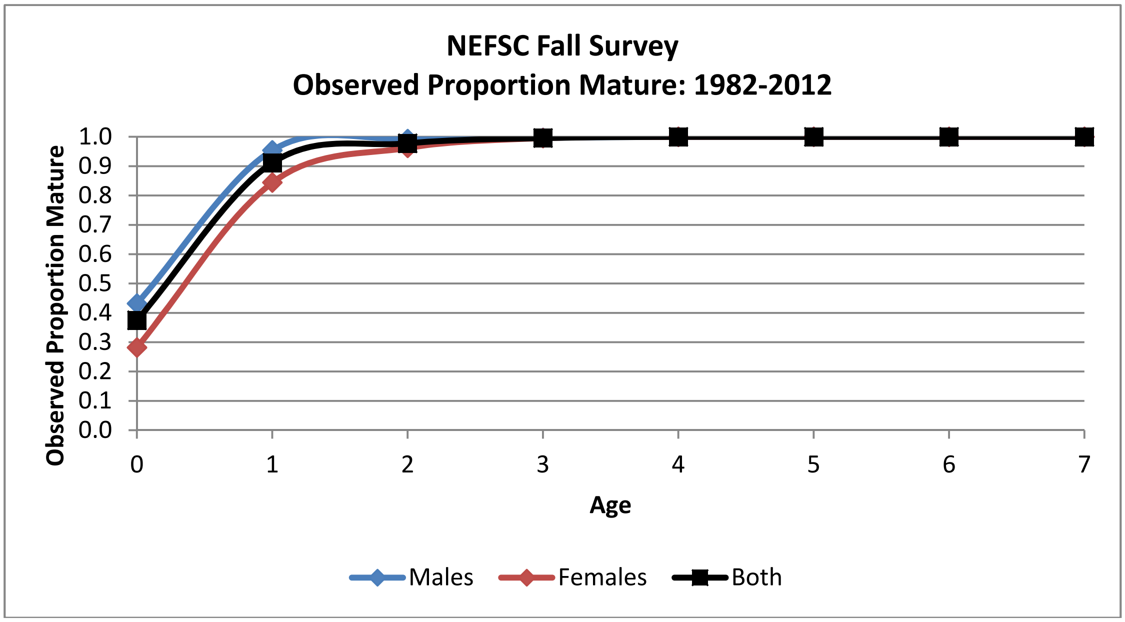


Figure A23. Observed proportion mature at age and sex from the NEFSC Fall survey time series.

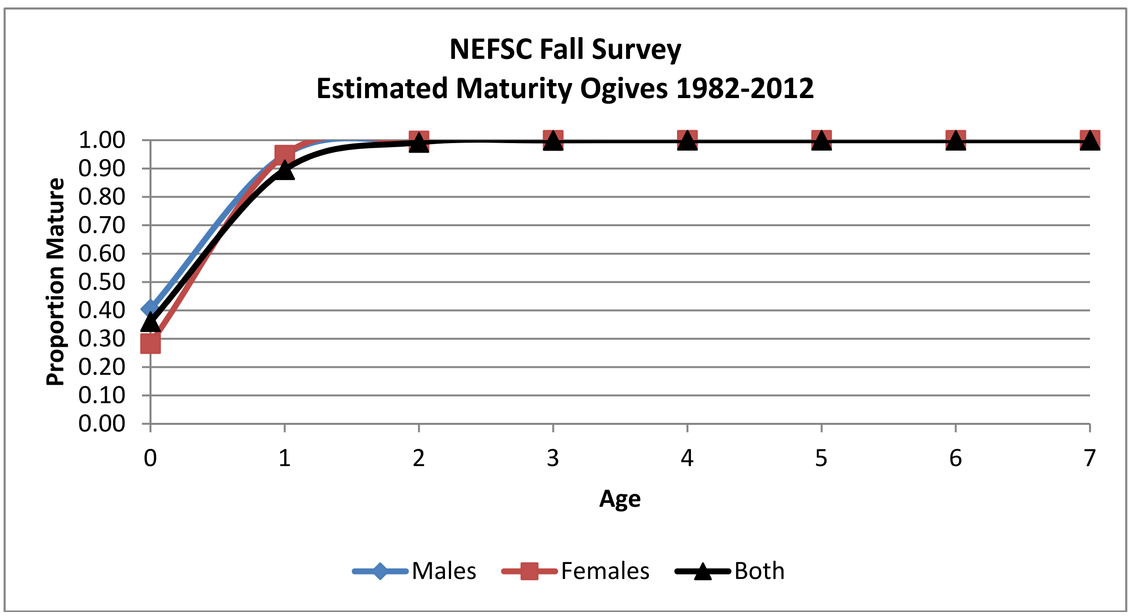


Figure A24. Estimated proportion mature at age and sex from the NEFSC Fall survey time series.

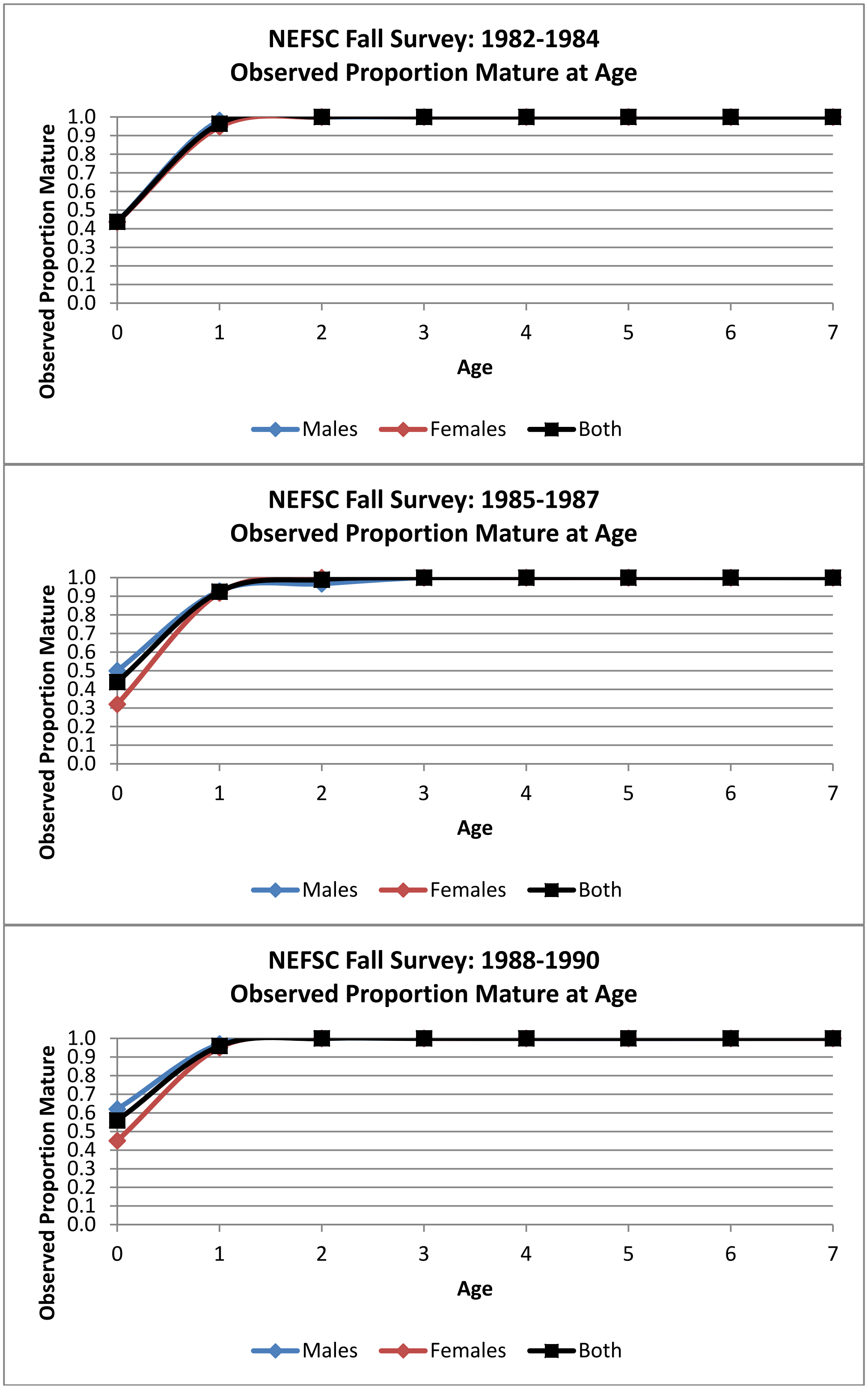


Figure A25. NFESC fall survey observed proportion mature at age: 3 year time blocks.

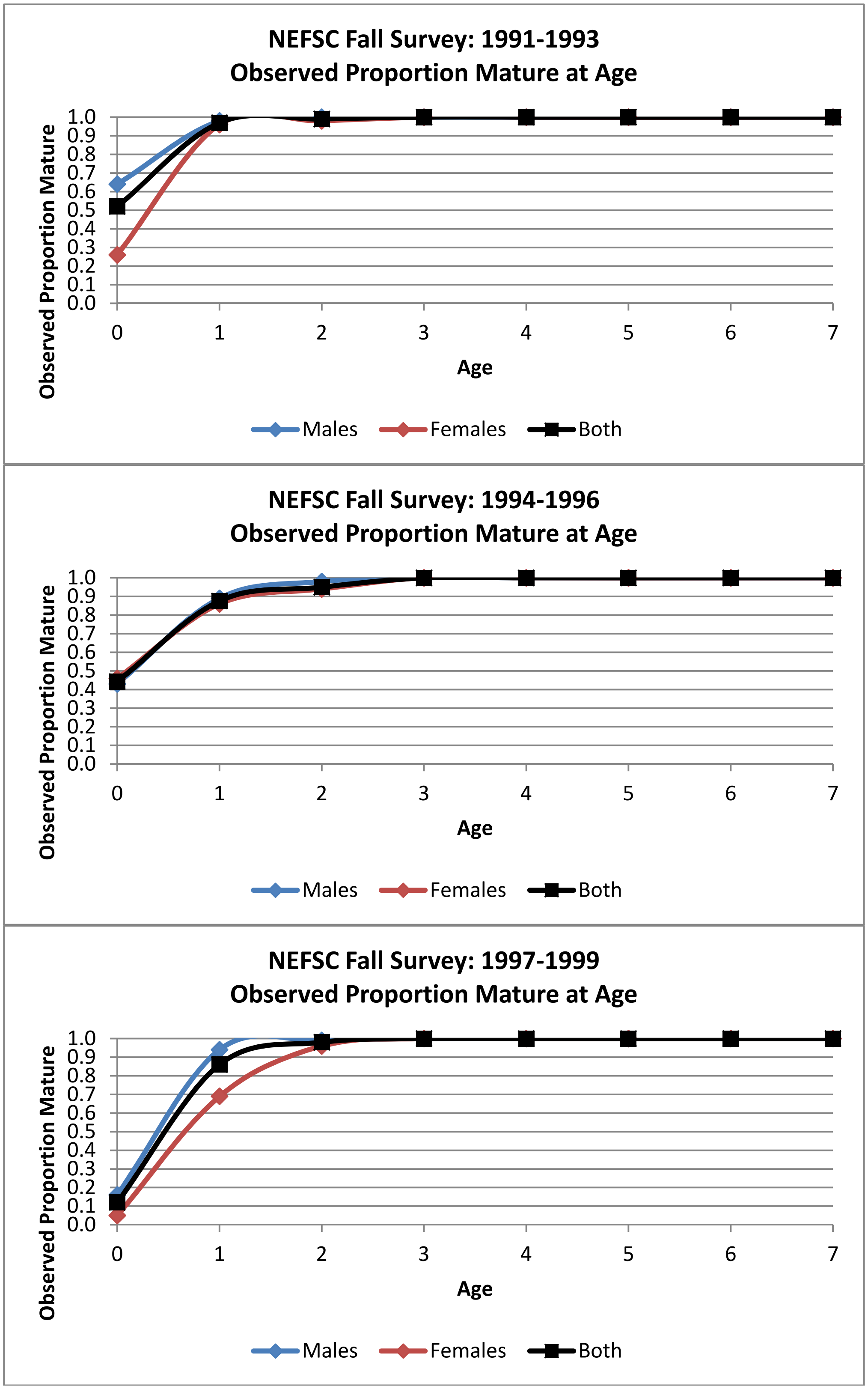


Figure A26. NFESC fall survey observed proportion mature at age: 3 year time blocks.

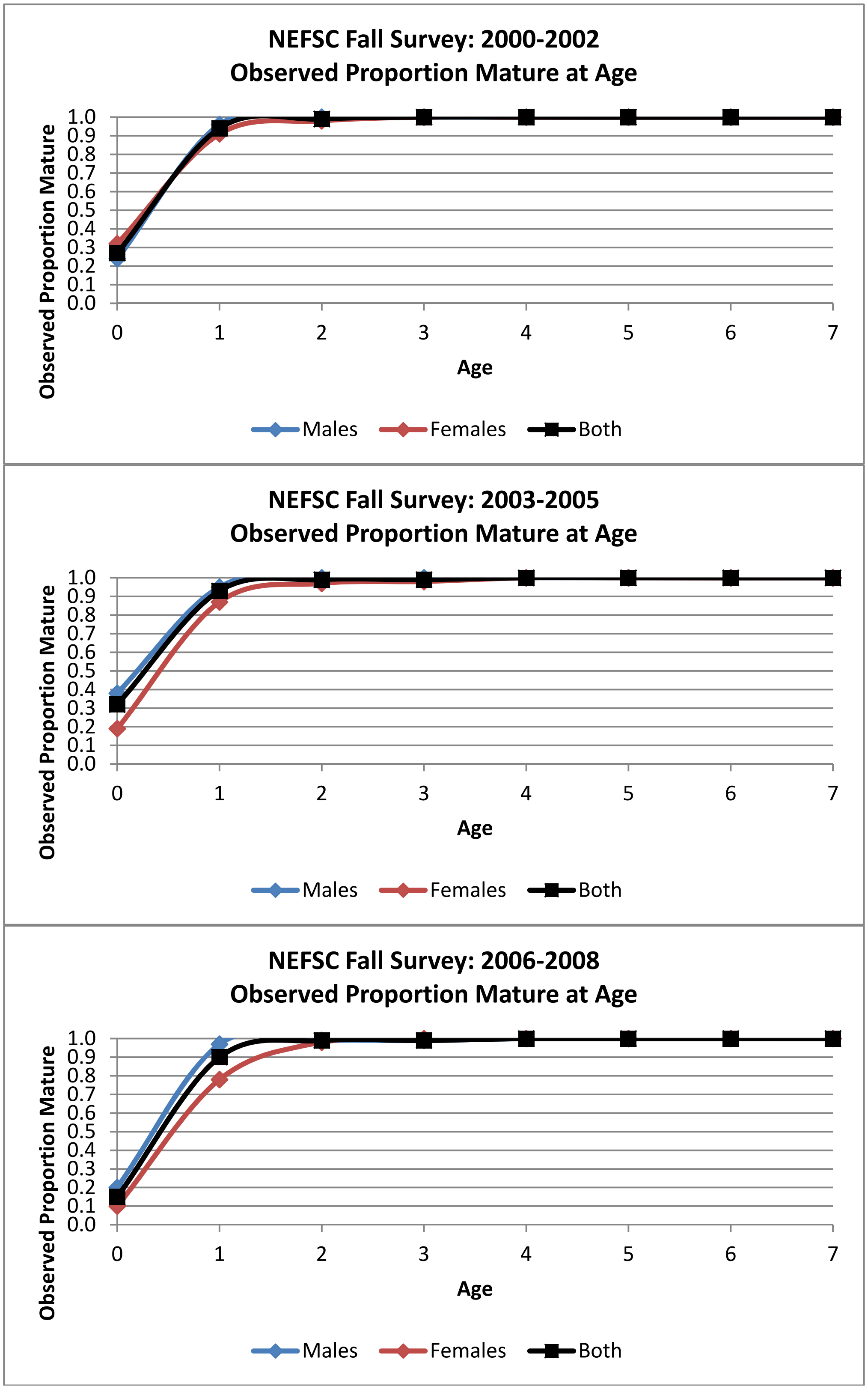


Figure A27. NFESC fall survey observed proportion mature at age: 3 year time blocks.

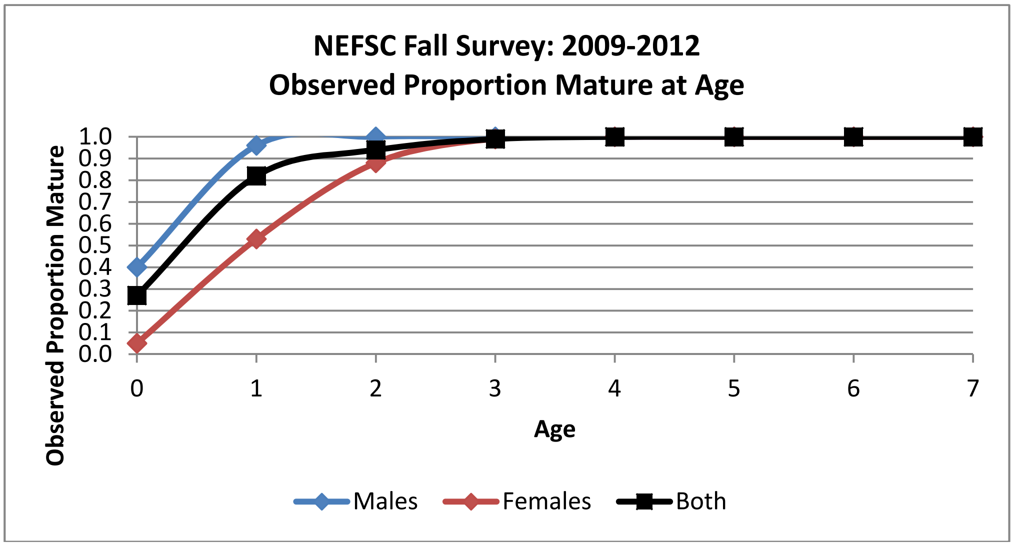


Figure A28. NFESC fall survey observed proportion mature at age: most recent year time block, 2009-2012.

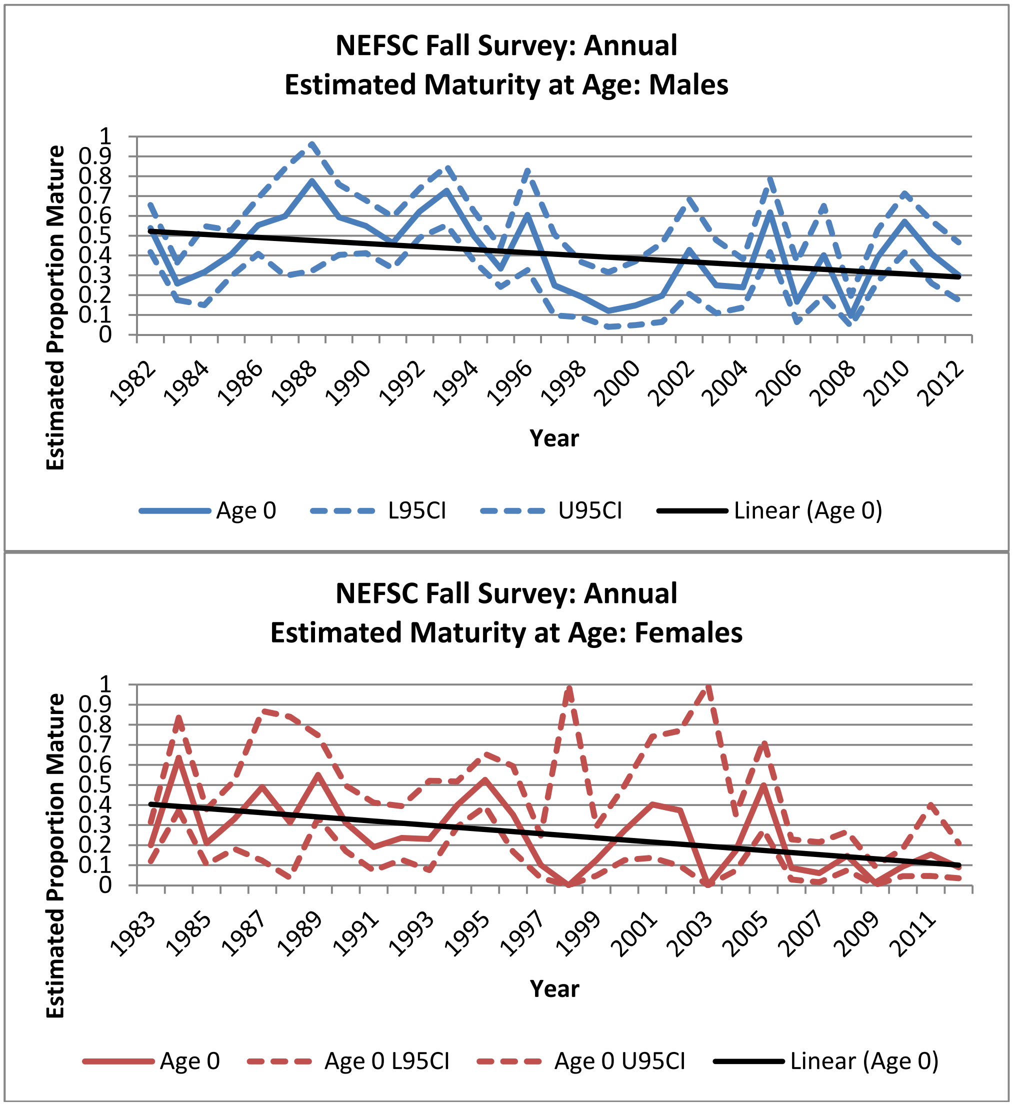


Figure A29. Estimated maturity at age 0, by year and sex. Solid line is a fit linear trend.

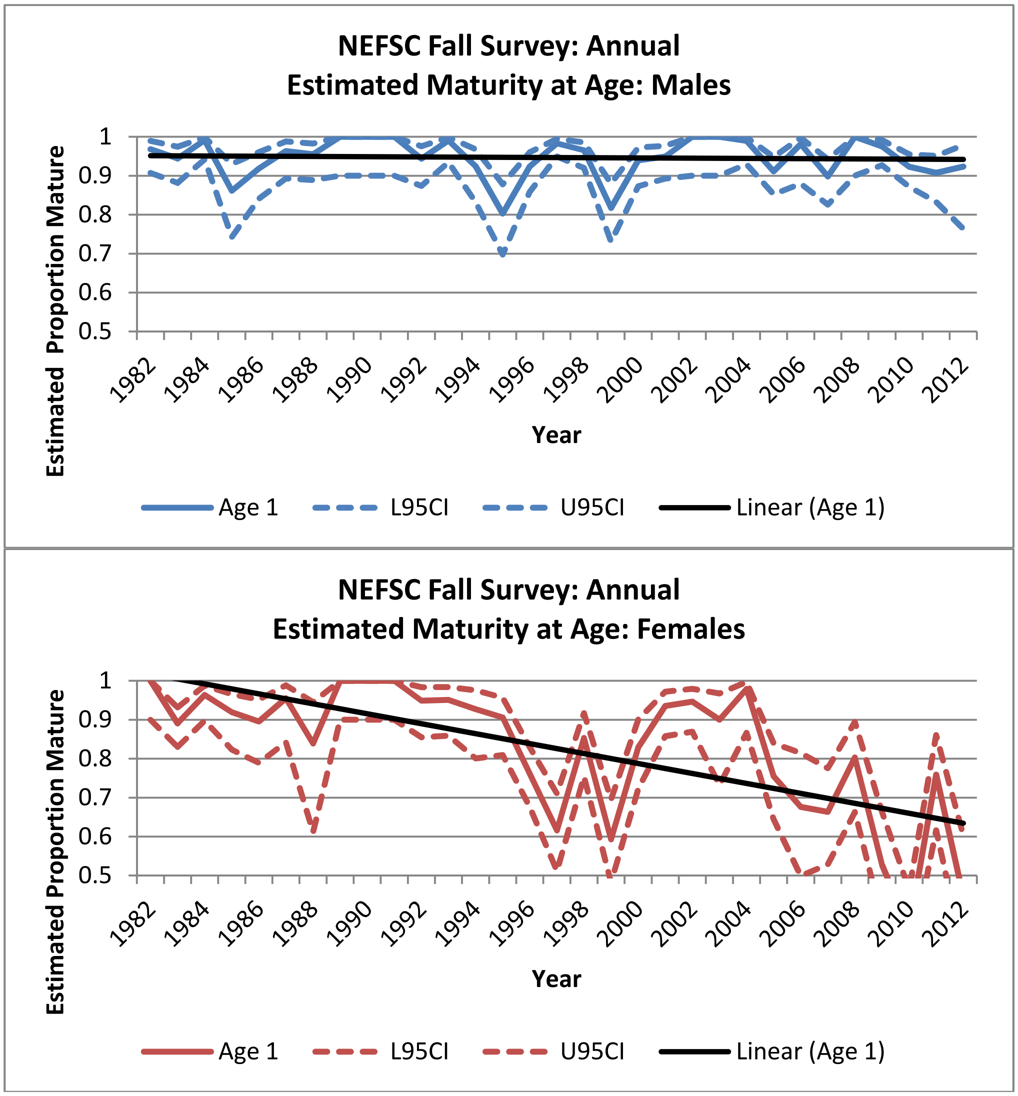


Figure A30. Estimated maturity at age 1, by year and sex. Solid line is a fit linear trend.

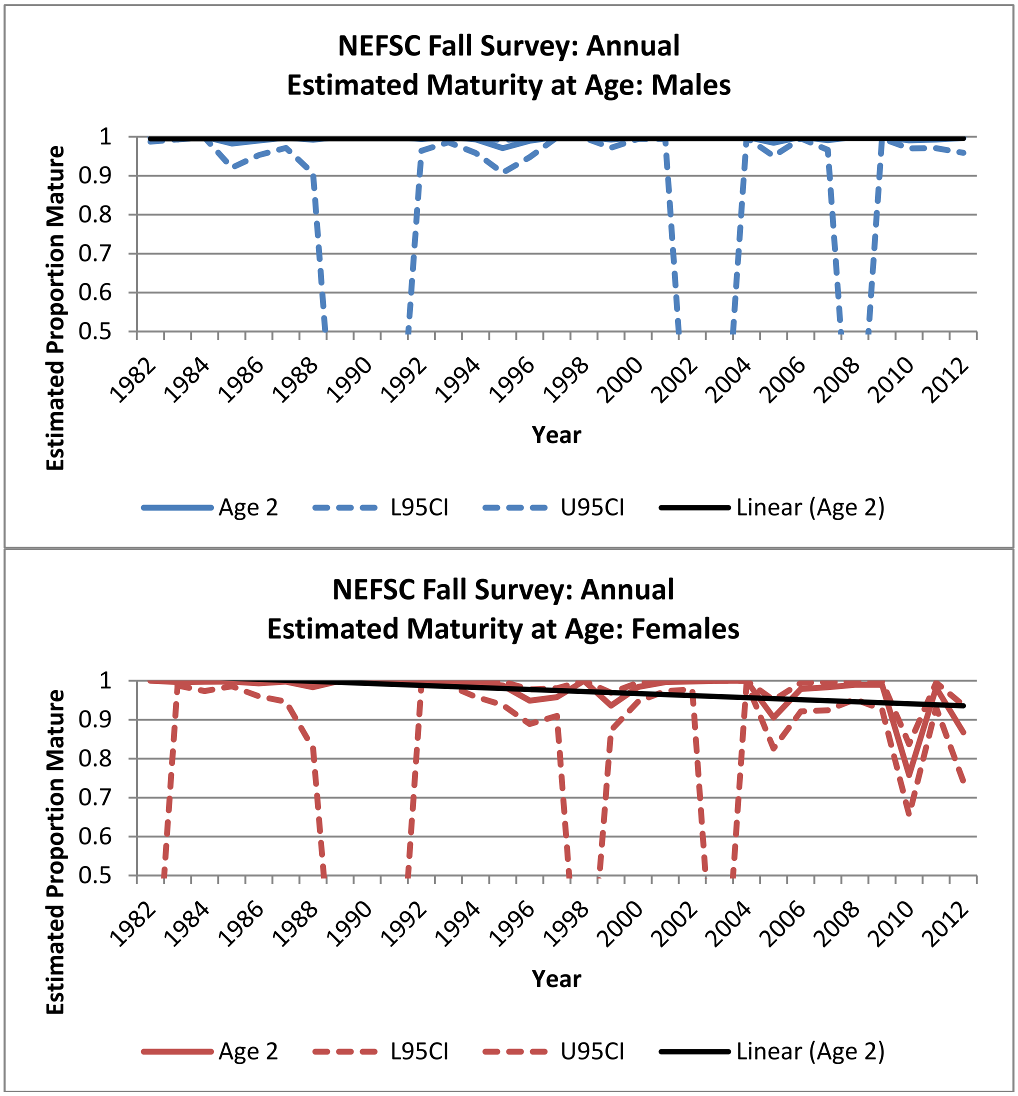


Figure A31. Estimated maturity at age 2, by year and sex. Solid line is a fit linear trend.

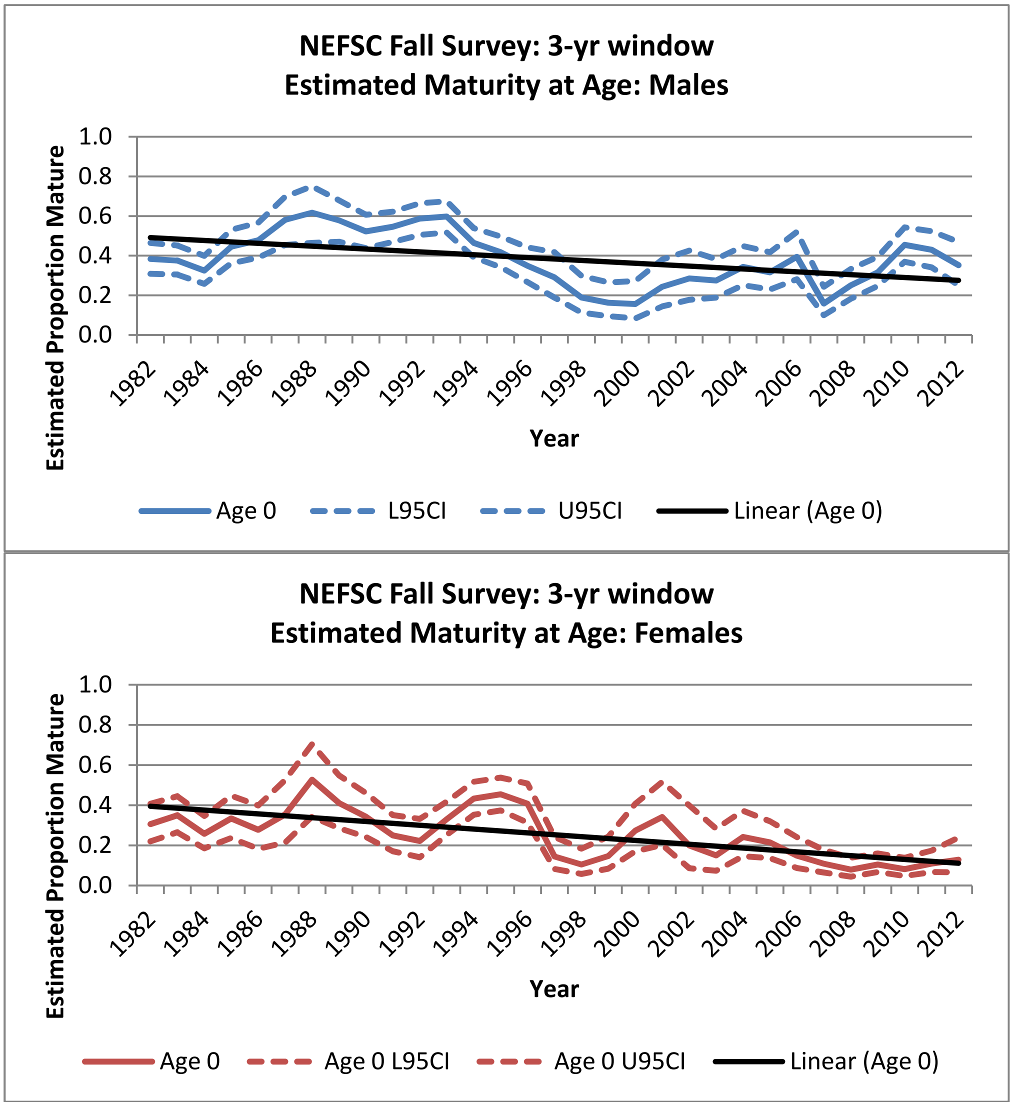


Figure A32. Estimated maturity at age 0, by 3-year moving window and sex. Solid line is a fit linear trend.

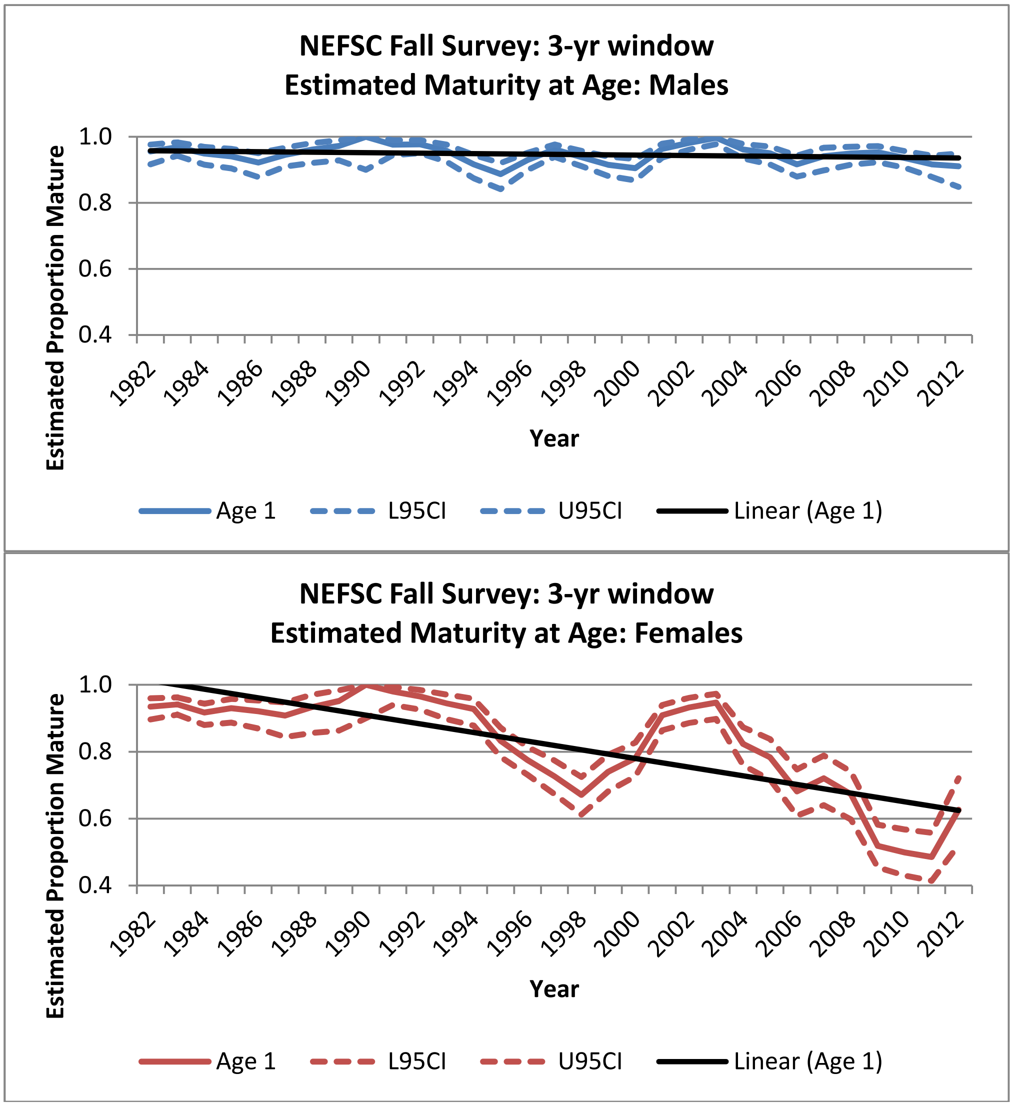


Figure A33. Estimated maturity at age 1, by 3-year moving window and sex. Solid line is a fit linear trend.

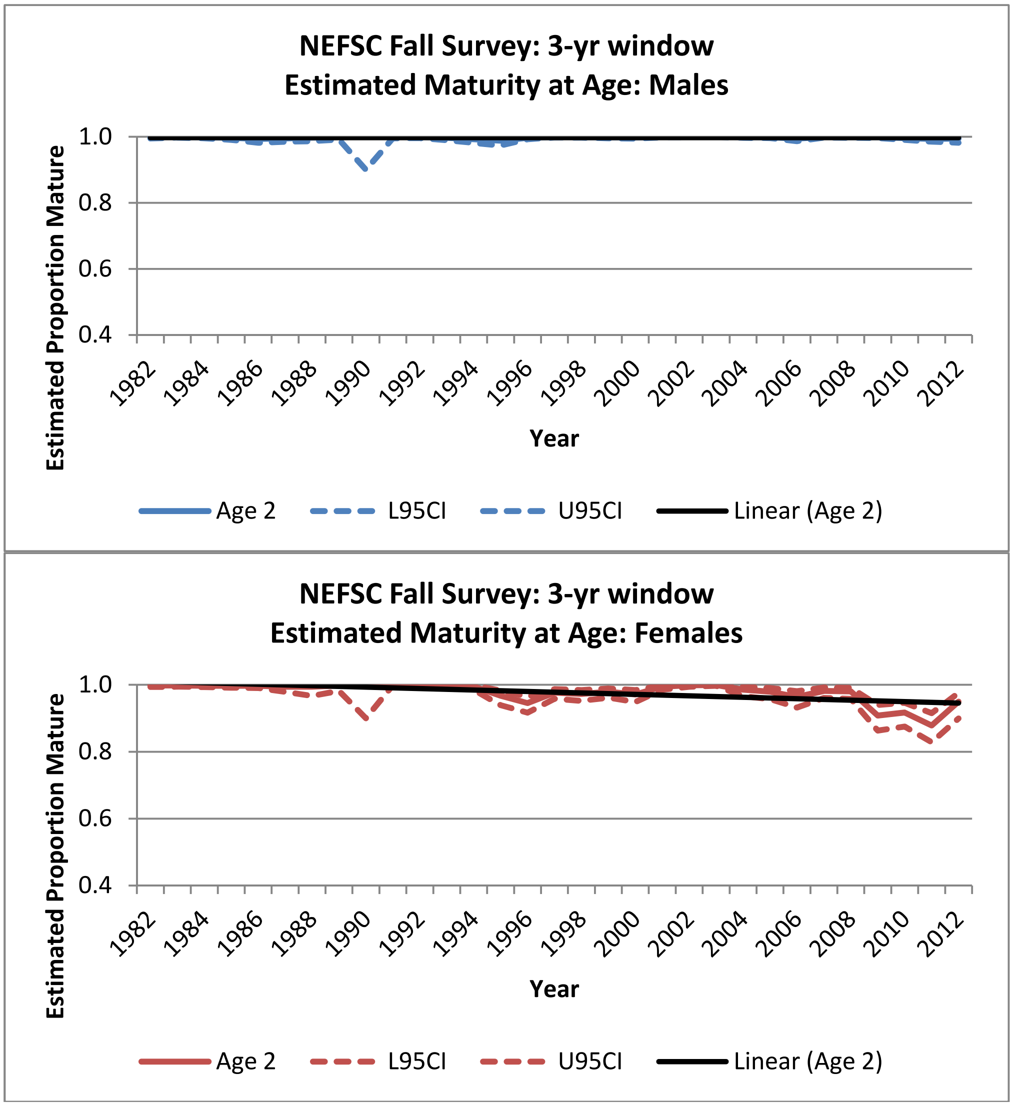


Figure A34. Estimated maturity at age 2, by 3-year moving window and sex. Solid line is a fit linear trend.

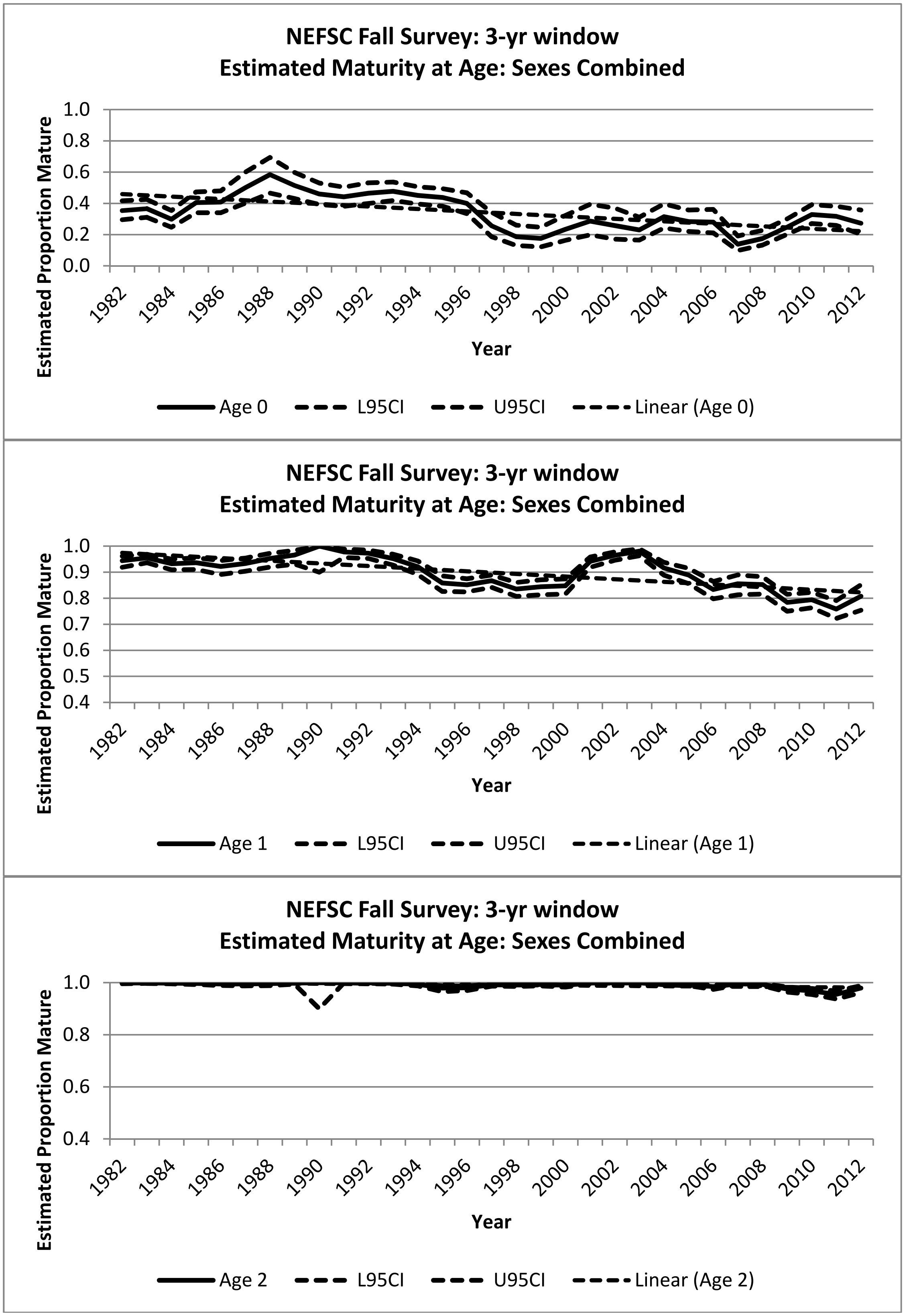


Figure A35. Estimated maturity at ages, 0, 1, and 2, for sexes combined by 3-year moving window. Straight dashed lines are fit linear trends.

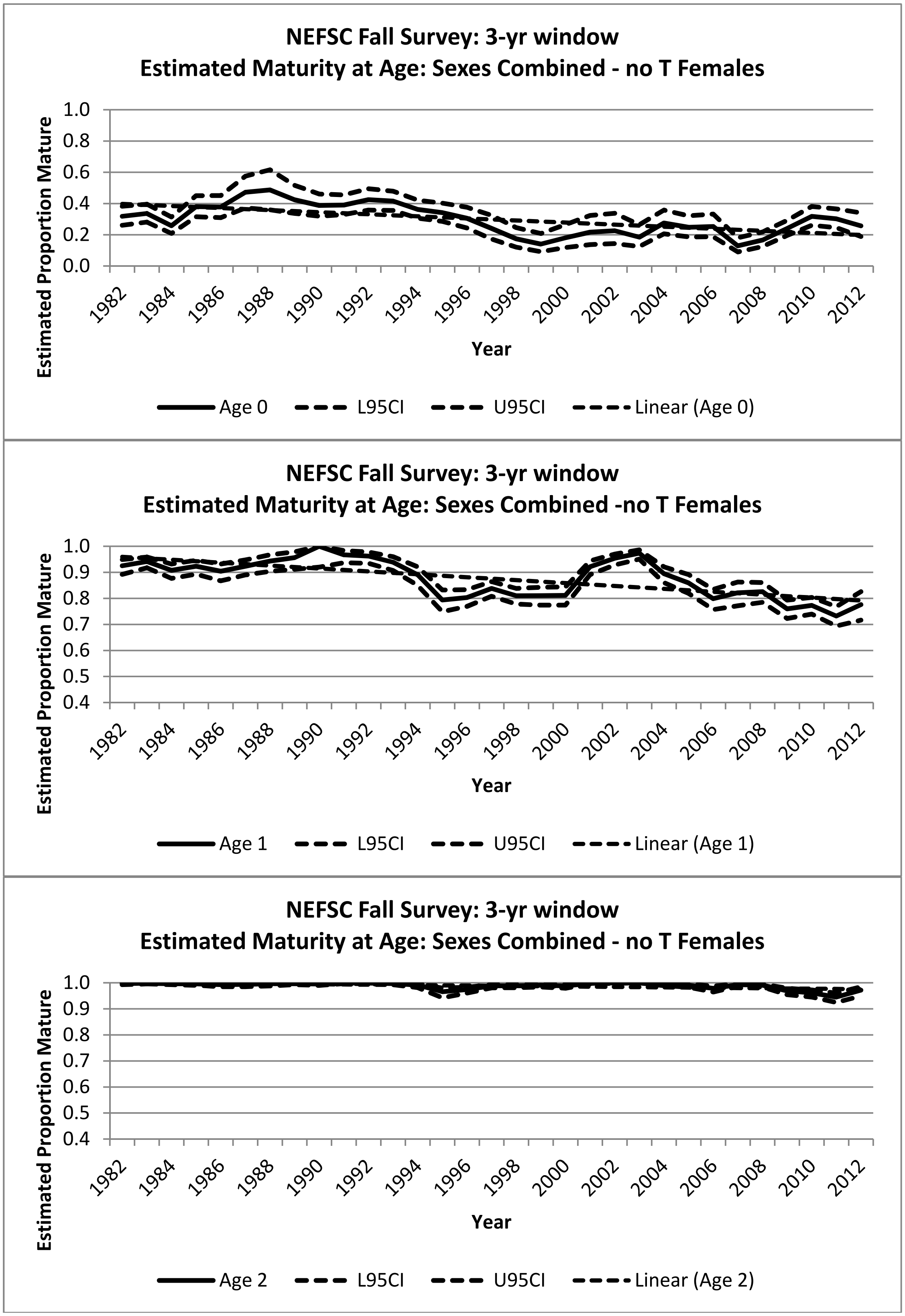


Figure A36. Estimated maturity at ages, 0, 1, and 2, for sexes combined by 3-year moving window, resting (T) females removed. Straight dashed lines are fit linear trends.

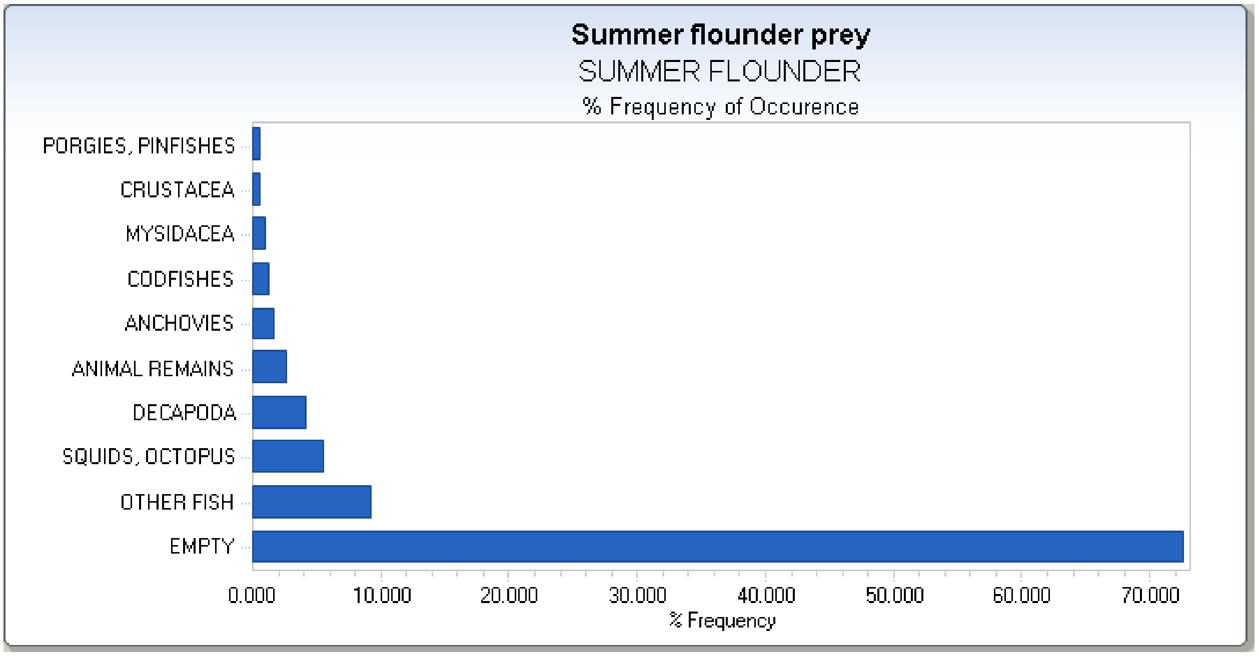
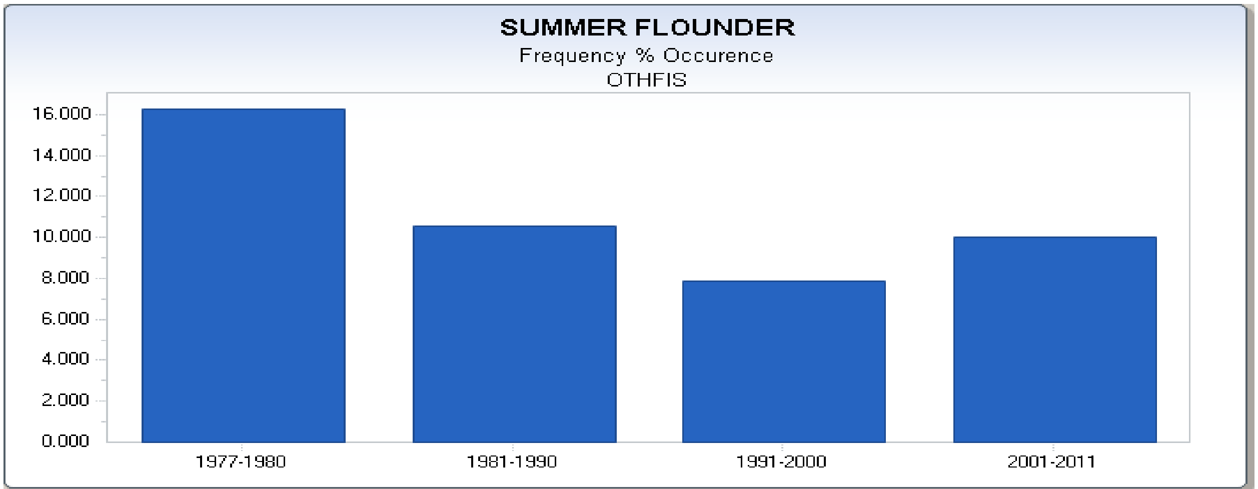


Figure A37. NEFSC trawl survey food habits data: percent frequency of occurrence of prey consumption by summer flounder.



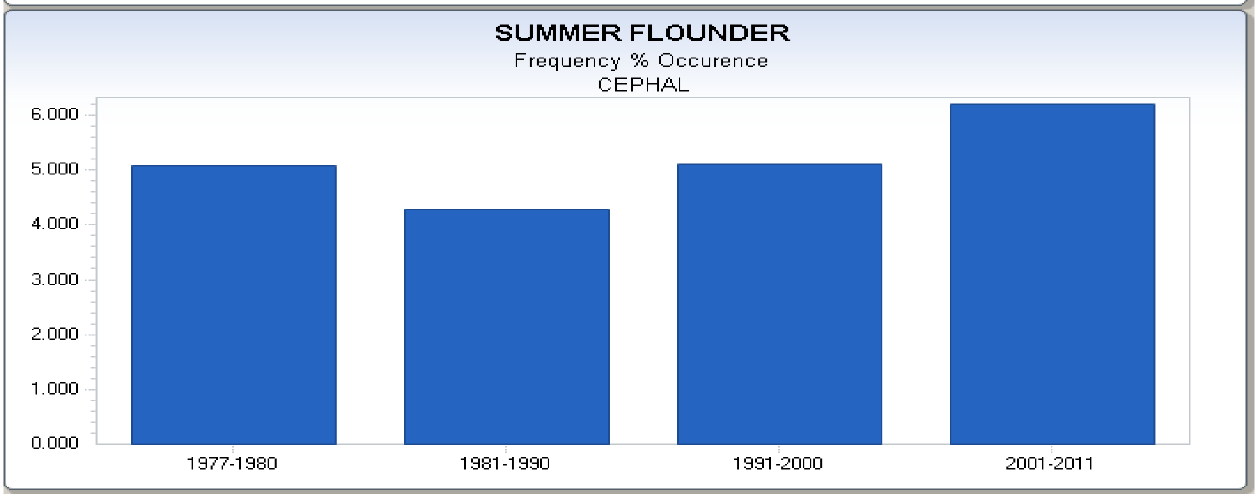
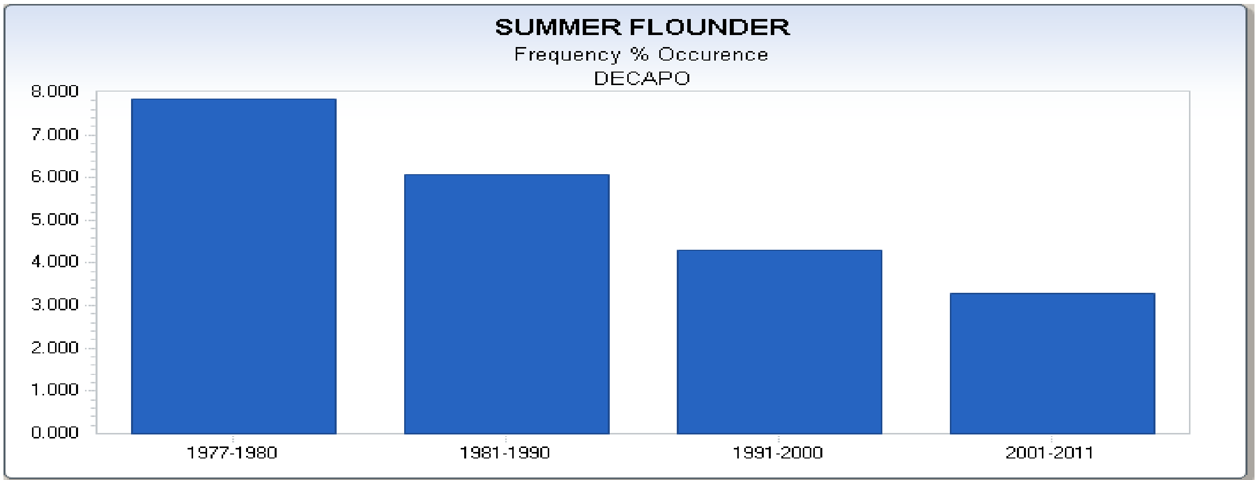


Figure A38. NEFSC trawl survey food habits data: temporal pattern in percent frequency of occurrence of prey consumption by summer flounder for ‘Other Fish’ (top) and cephalopods (squid; bottom).



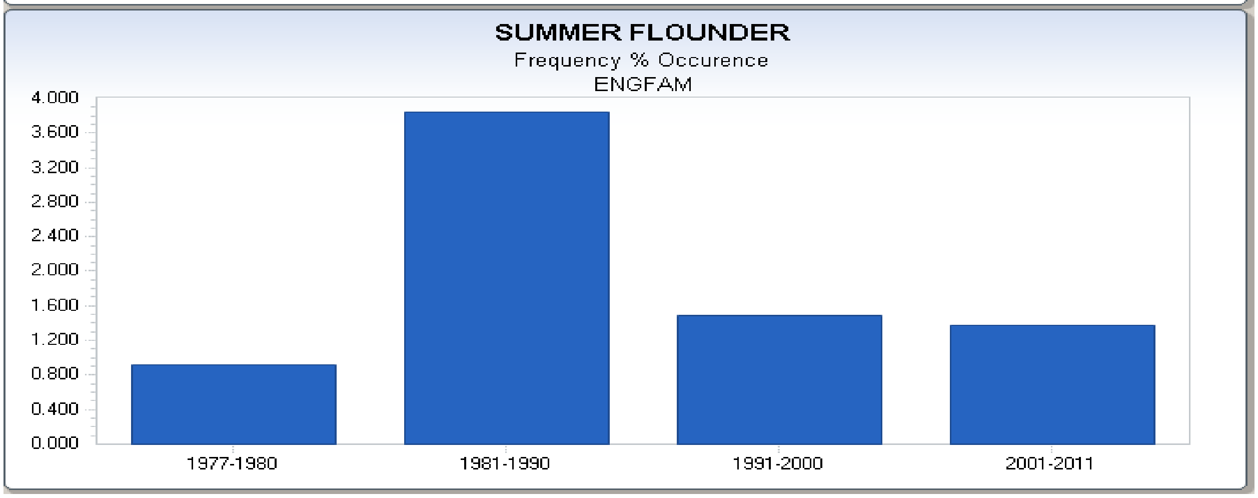


Figure A39. NEFSC trawl survey food habits data: temporal pattern in percent frequency of occurrence of prey consumption by summer flounder for decapods (shrimp; top) and engraulids (anchovies; bottom).

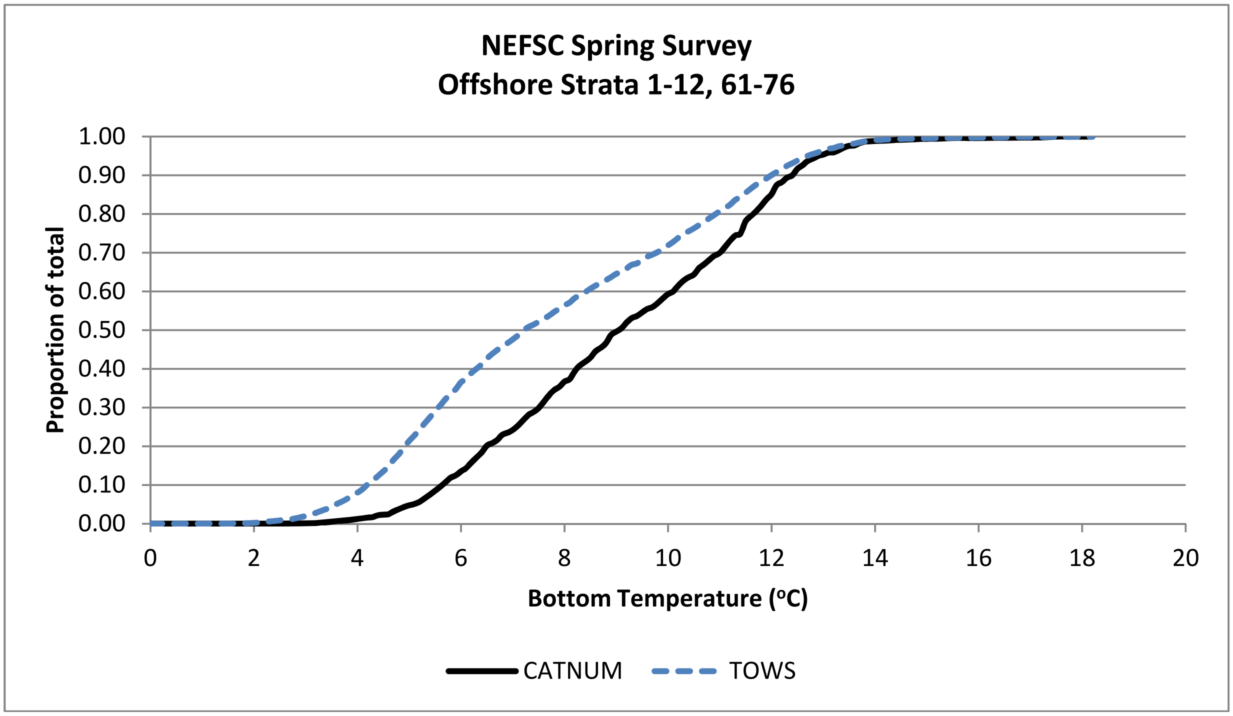


Figure A40. Cumulative proportion of total (expanded catch number per tow or number of tows) by bottom temperature for survey stations in the NEFSC spring survey strata set (1968-2012).

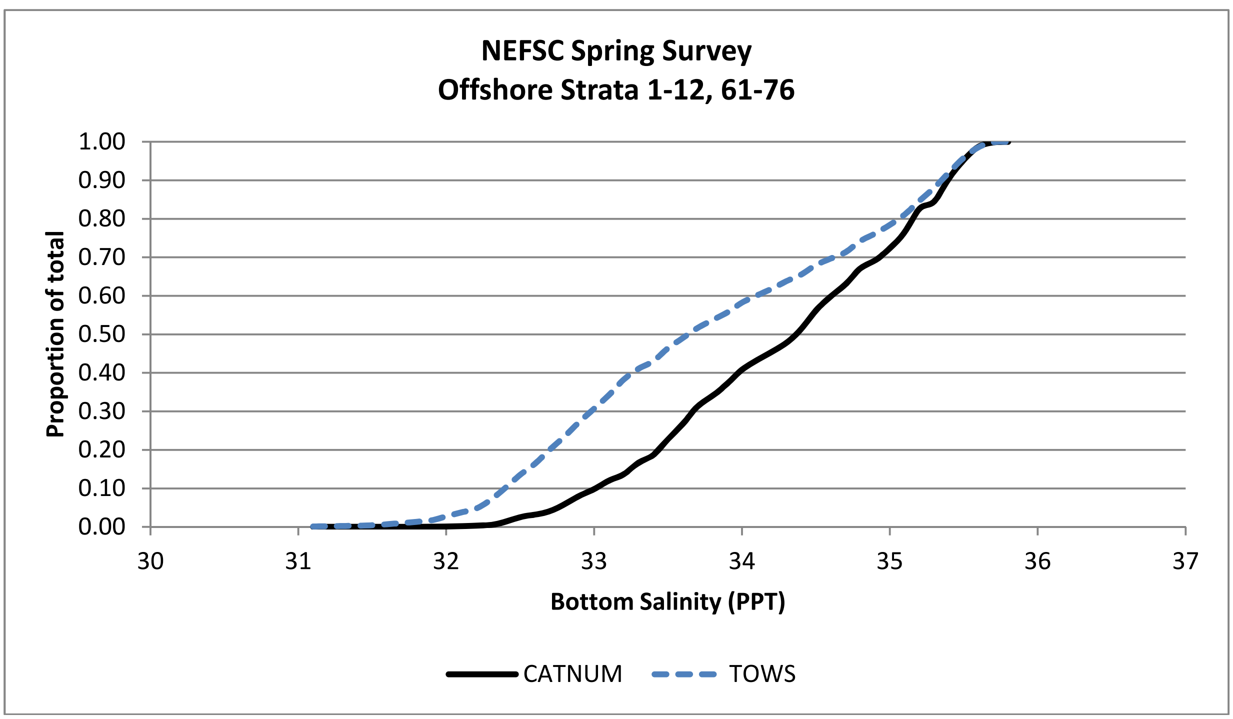


Figure A41. Cumulative proportion of total (expanded catch number per tow or number of tows) by bottom salinity for survey stations in the NEFSC spring survey strata set (1968-2012).

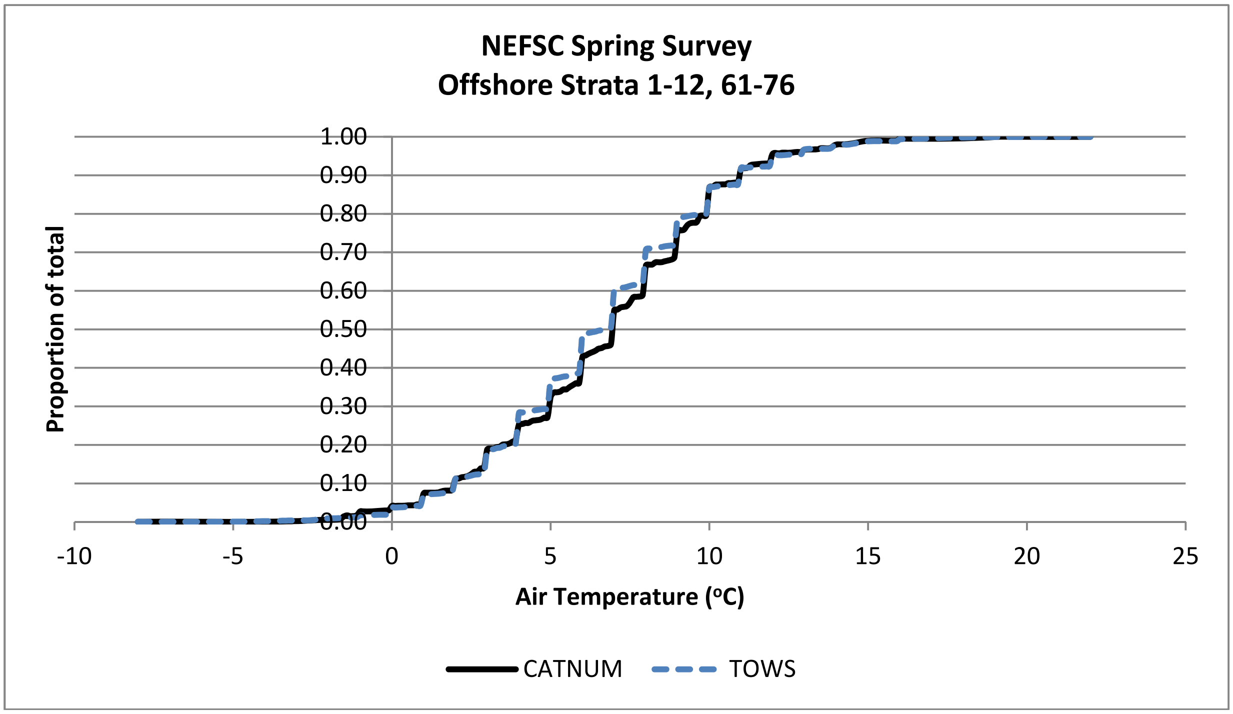


Figure A42. Cumulative proportion of total (expanded catch number per tow or number of tows) by air temperature for survey stations in the NEFSC spring survey strata set (1968-2012).

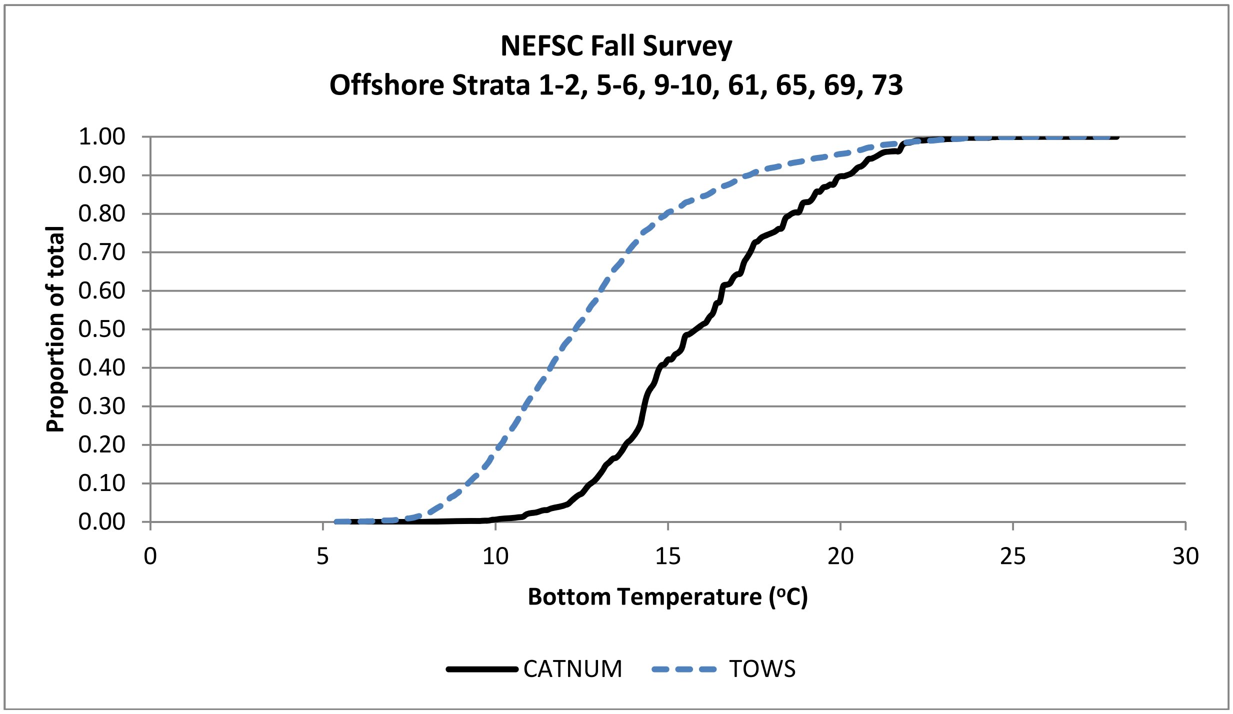


Figure A43. Cumulative proportion of total (expanded catch number per tow or number of tows) by bottom temperature for survey stations in the NEFSC fall survey strata set (1968-2012).

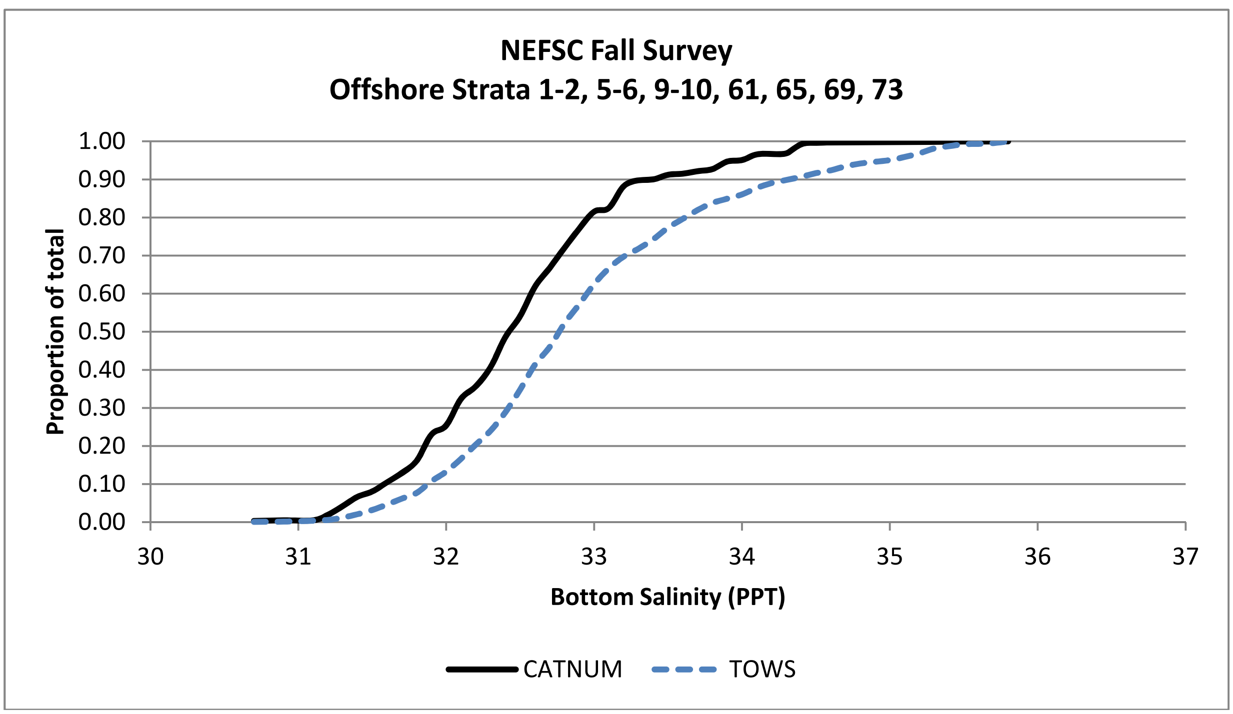


Figure A44. Cumulative proportion of total (expanded catch number per tow or number of tows) by bottom salinity for survey stations in the NEFSC fall survey strata set (1968-2012).

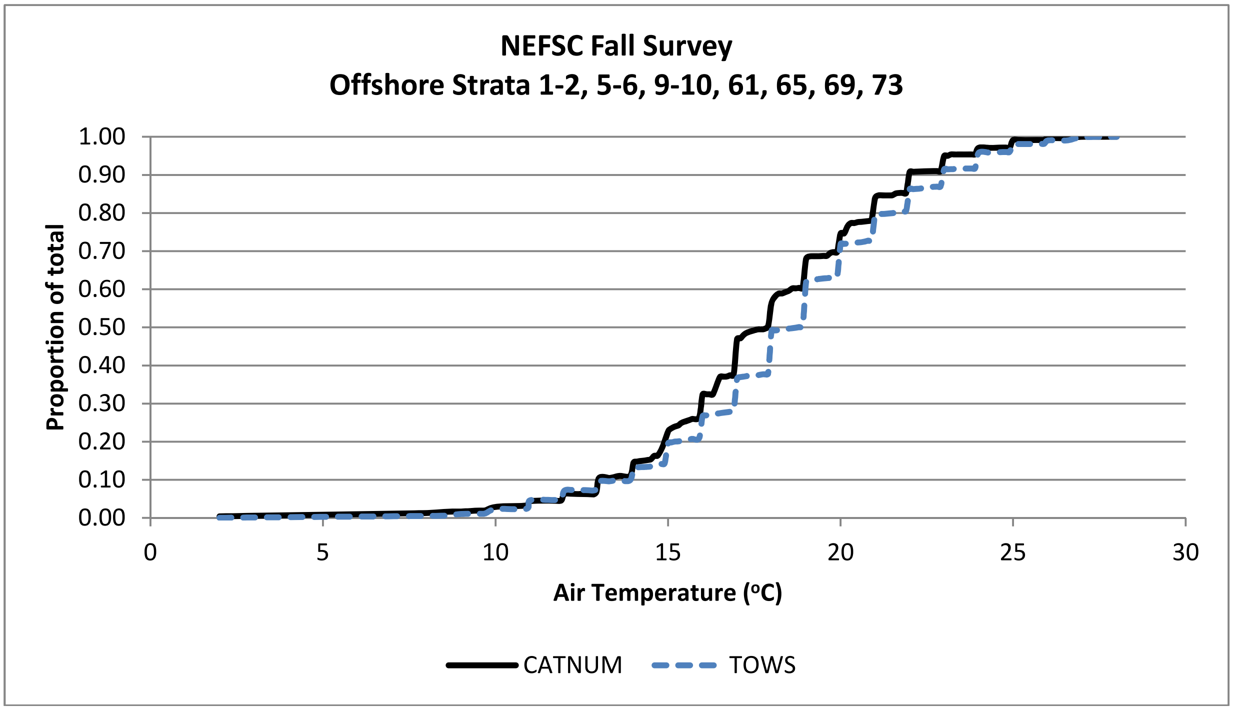


Figure A45. Cumulative proportion of total (expanded catch number per tow or number of tows) by air temperature for survey stations in the NEFSC fall survey strata set (1968-2012).

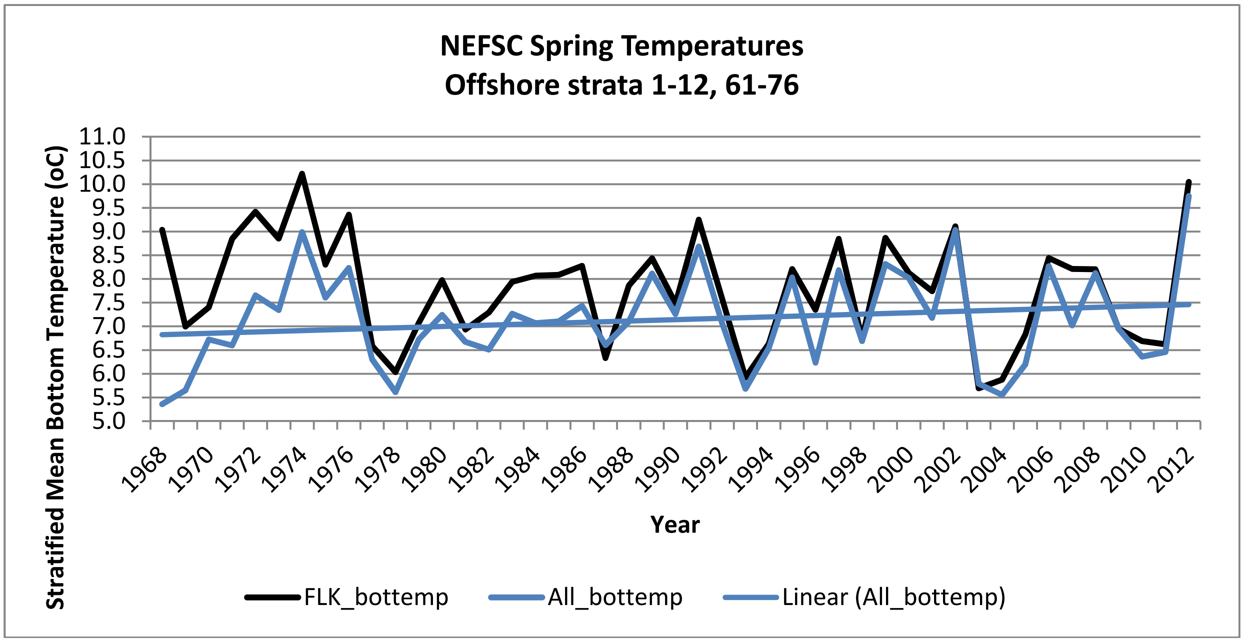


Figure A46. Annual stratified mean values of the bottom temperature for spring positive summer flounder catch tows (expcatchnum > 0; FLK_bottemp) was compared with the annual stratified mean values for all tows (All_bottemp).

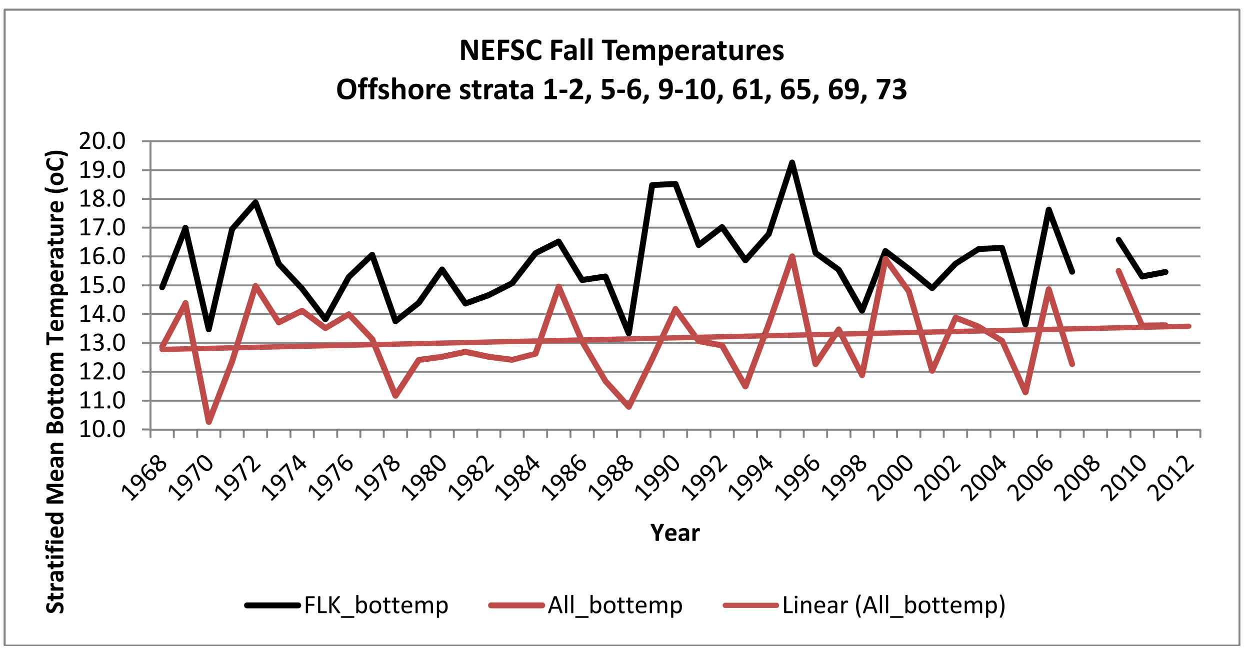


Figure A47. Annual stratified mean values of the bottom temperature for fall positive summer flounder catch tows (expcatchnum > 0; FLK_bottemp) was compared with the annual stratified mean values for all tows (All_bottemp).

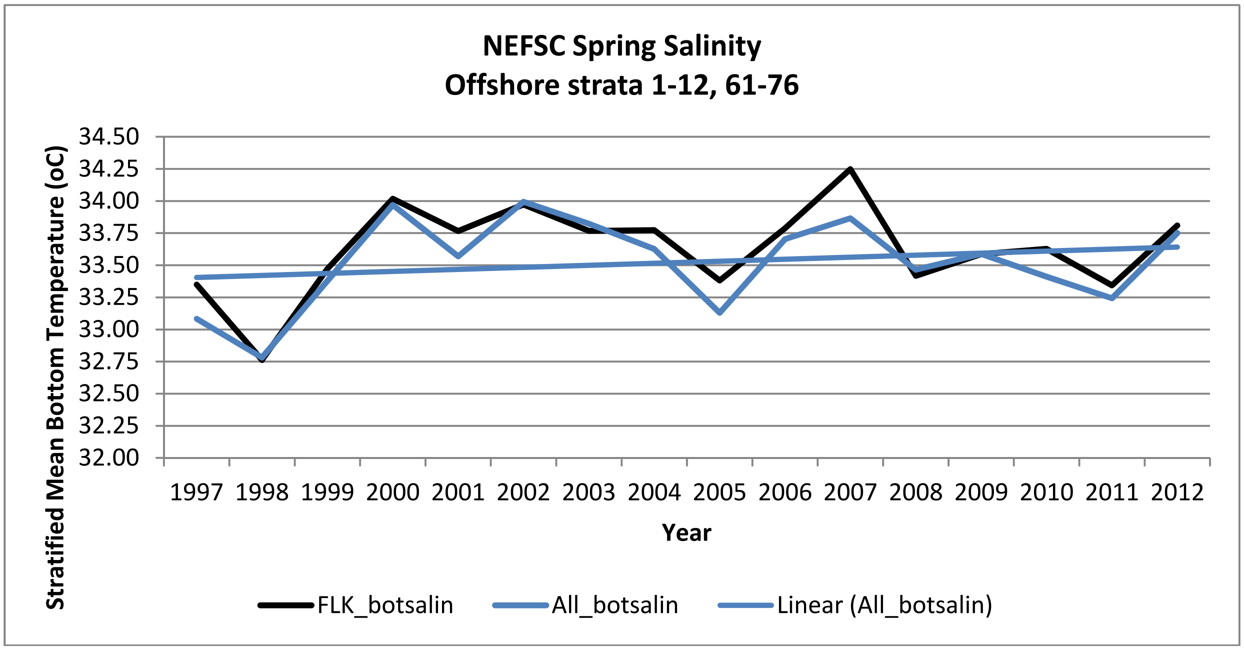


Figure A48. Annual stratified mean values of the bottom salinity for spring positive summer flounder catch tows (expcatchnum > 0; FLK_botsalin) was compared with the annual stratified mean values for all tows (All_botsalin).

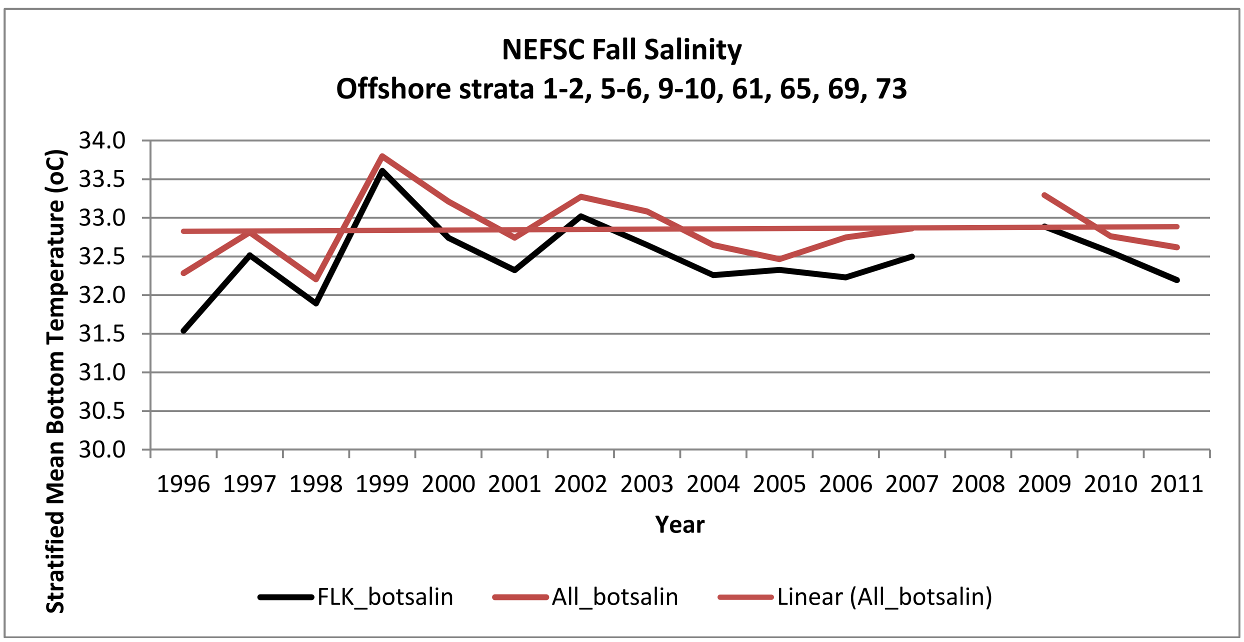


Figure A49. Annual stratified mean values of the bottom salinity for fall positive summer flounder catch tows (expcatchnum > 0; FLK_botsalin) was compared with the annual stratified mean values for all tows (All_botsalin).

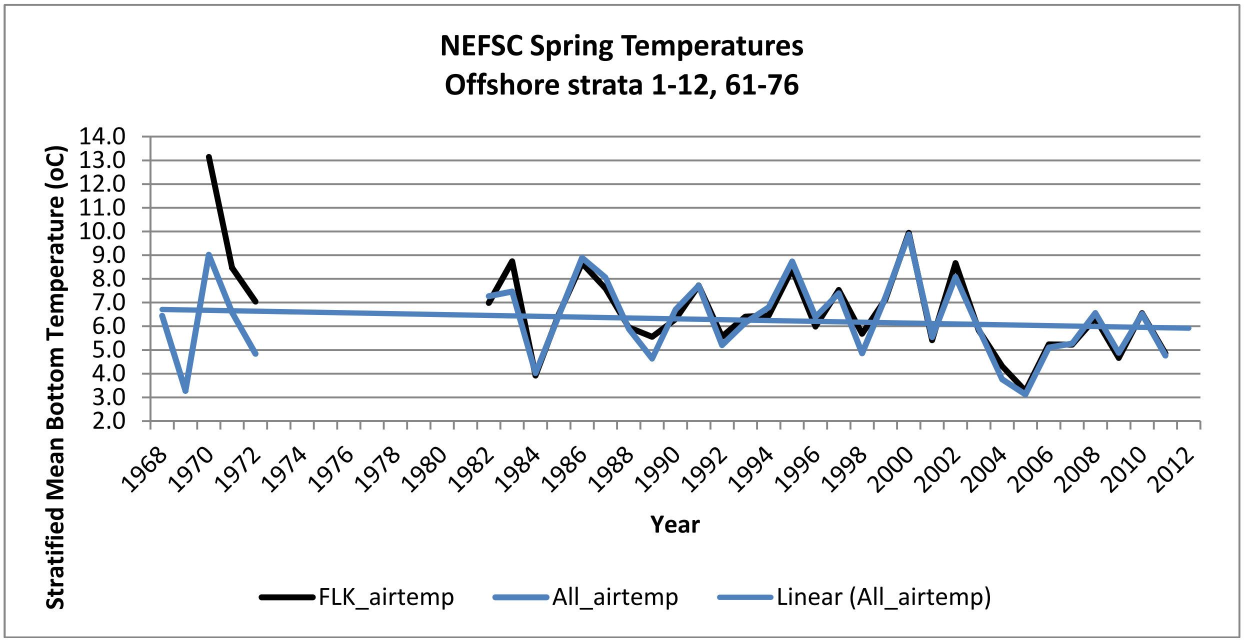


Figure A50. Annual stratified mean values of the air temperature for spring positive summer flounder catch tows (expcatchnum > 0; FLK_airtemp) was compared with the annual stratified mean values for all tows (All_airtemp).

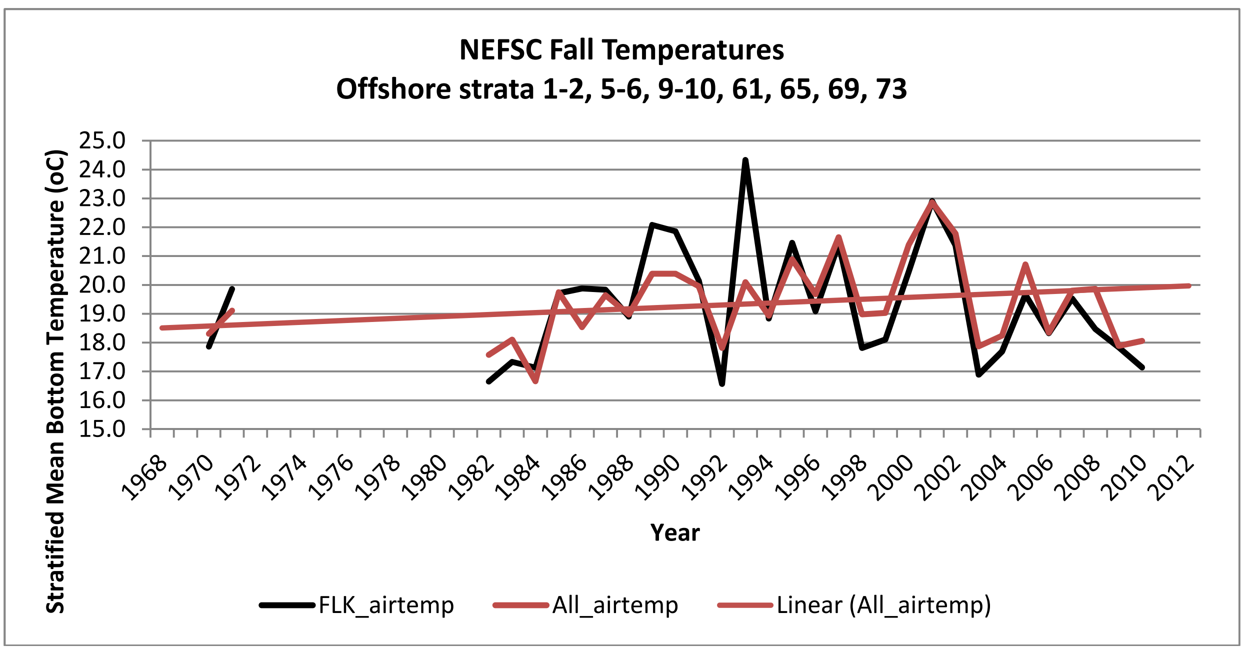


Figure A51. Annual stratified mean values of the air temperature for fall positive summer flounder catch tows (expcatchnum > 0; FLK_airtemp) was compared with the annual stratified mean values for all tows (All_airtemp).

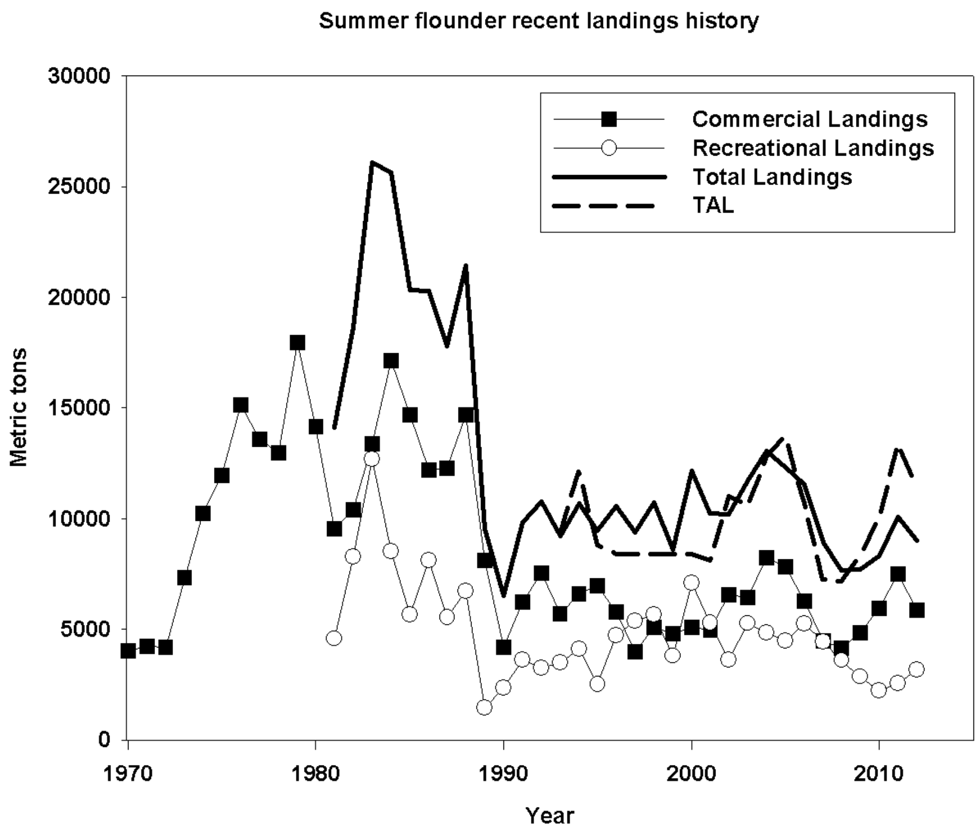


Figure A52. Summer flounder recent commercial (1970-2012), recreational (1981-2012), total fishery (1981-2012) landings, and the corresponding fishery Total Allowable Landings (TAL).

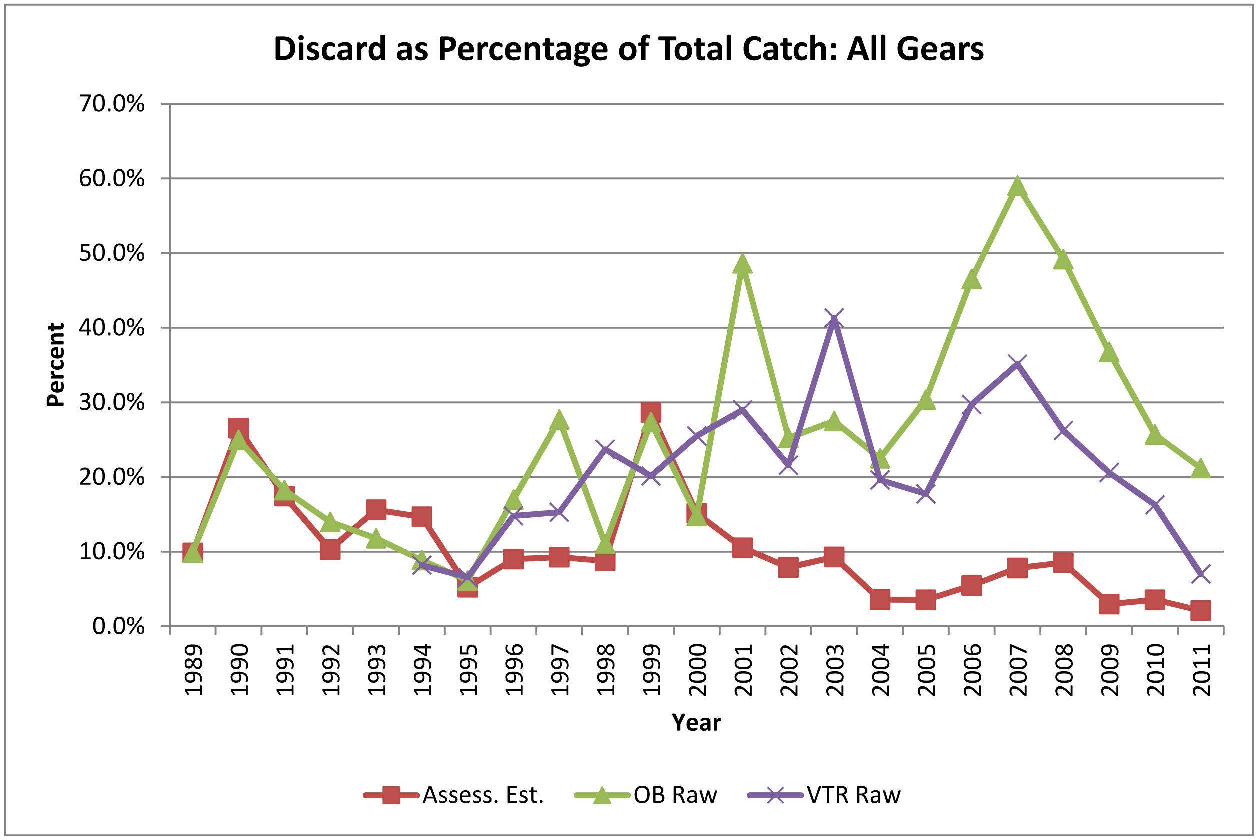


Figure A53: Discard as a percentage of total catch for all fishing gears combined: as previously estimated in the assessment (Assess Est.), as compiled from Observer data (OBRaw) and as compiled from Vessel Trip Report data (VTR Raw).

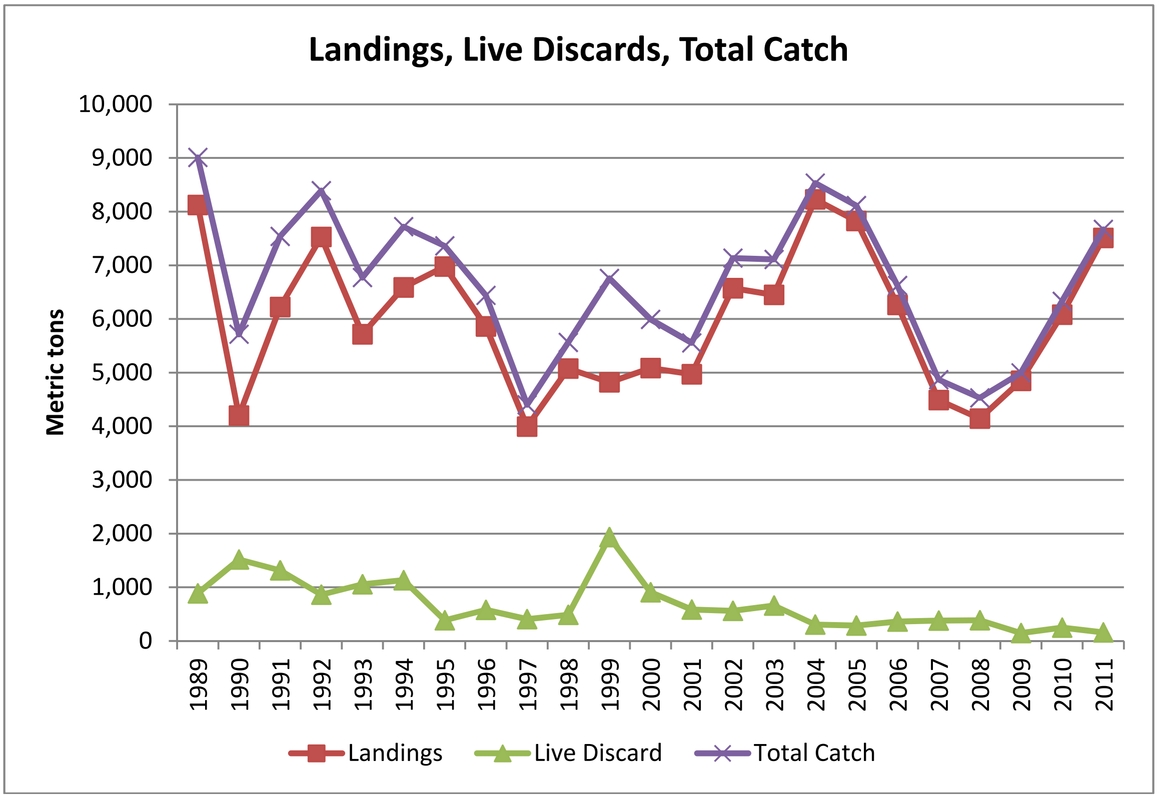


Figure A54. Dealer reported landings, live discards using the previous estimation method (Assess; D/DF), and total catch.

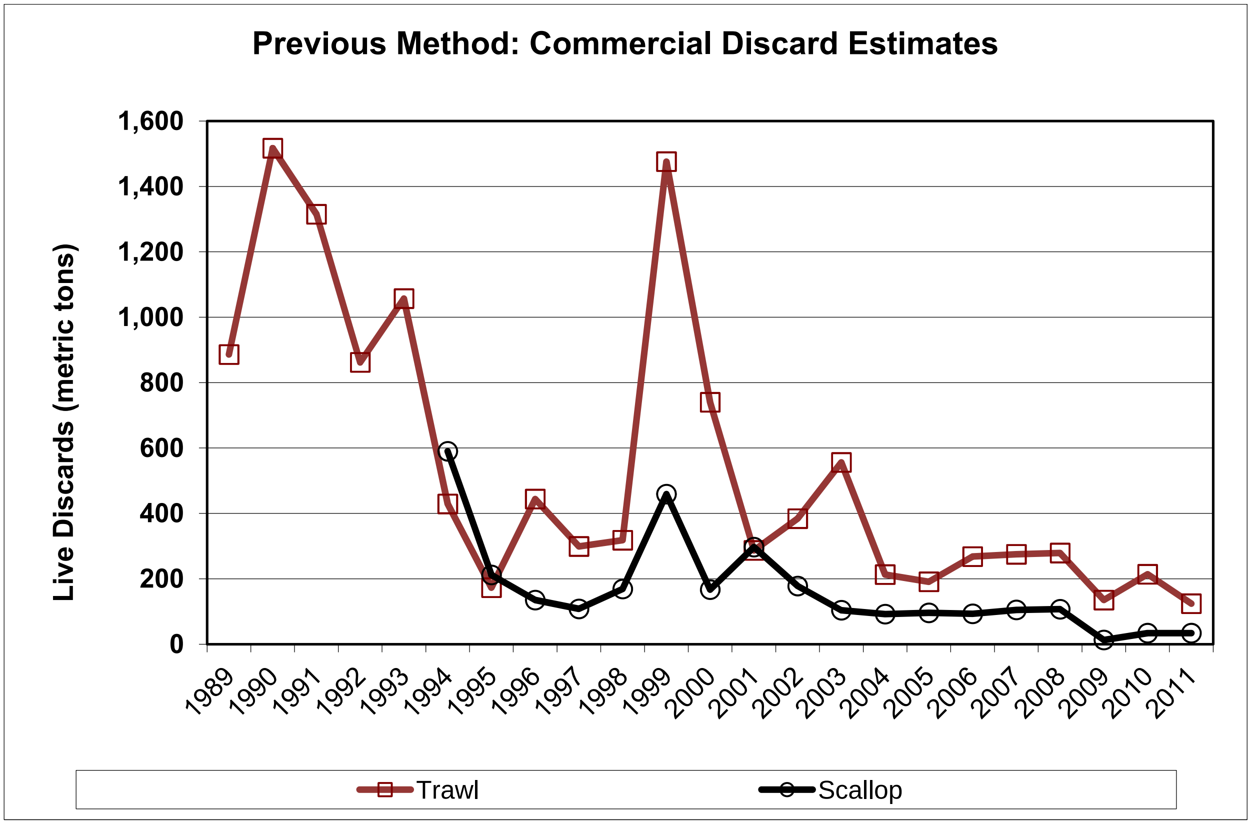


Figure A55. Live discards by gear type using the previous estimation method (Assess; D/DF).

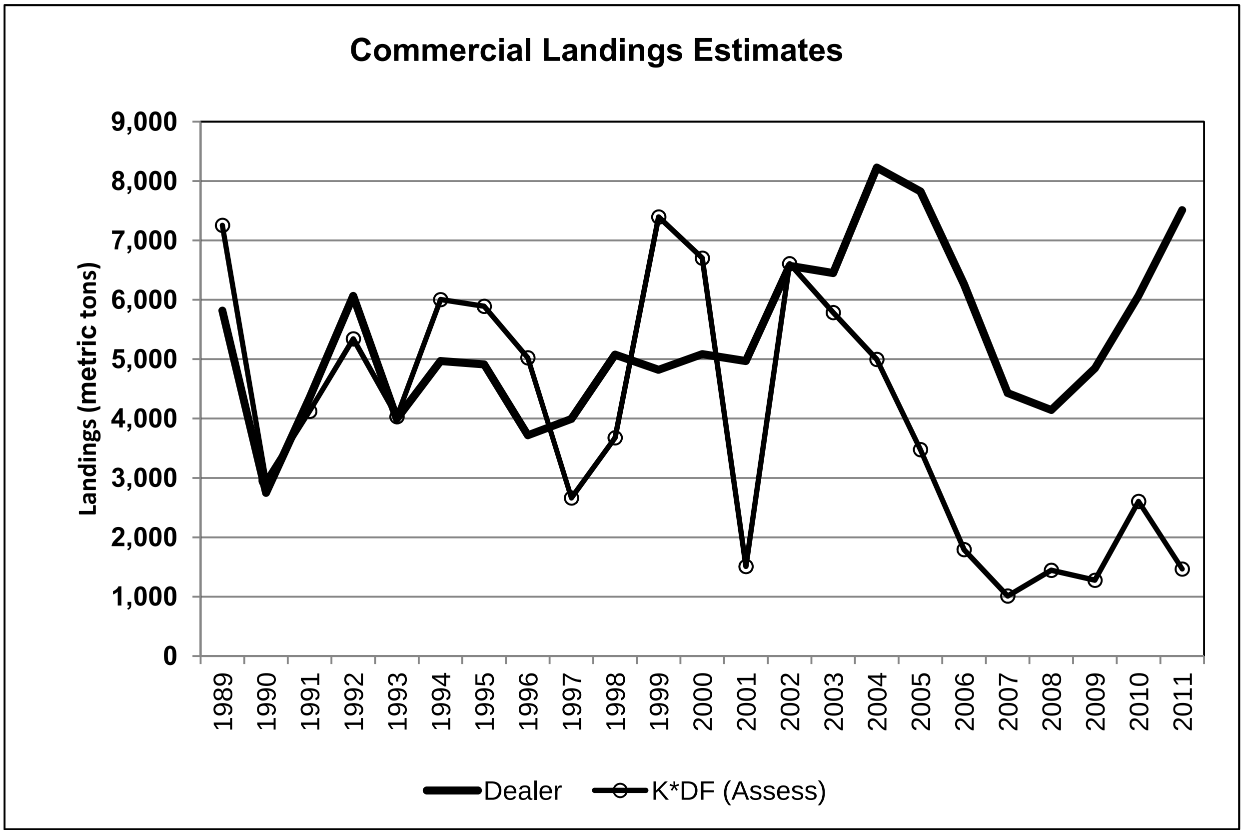


Figure A56. Comparison of commercial fishery Dealer reported landings of summer flounder (i.e., the "true landings"; Dealer) with estimates of summer flounder commercial landings using the previous Assess method, but for 'K*DF' [{K/DF}*DF].

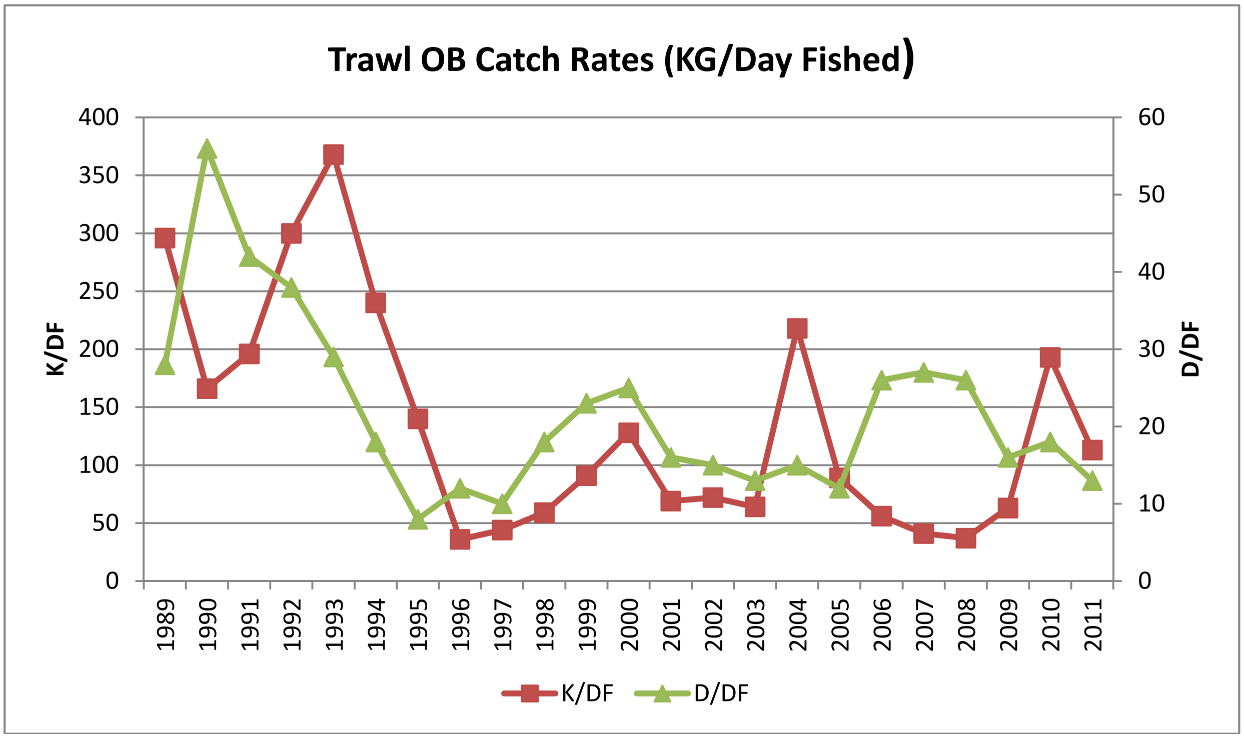


Figure A57. Observed Discard per Day Fished (D/DF) and Kept per Day Fished (K/DF) catch rates for fish trawl gear.

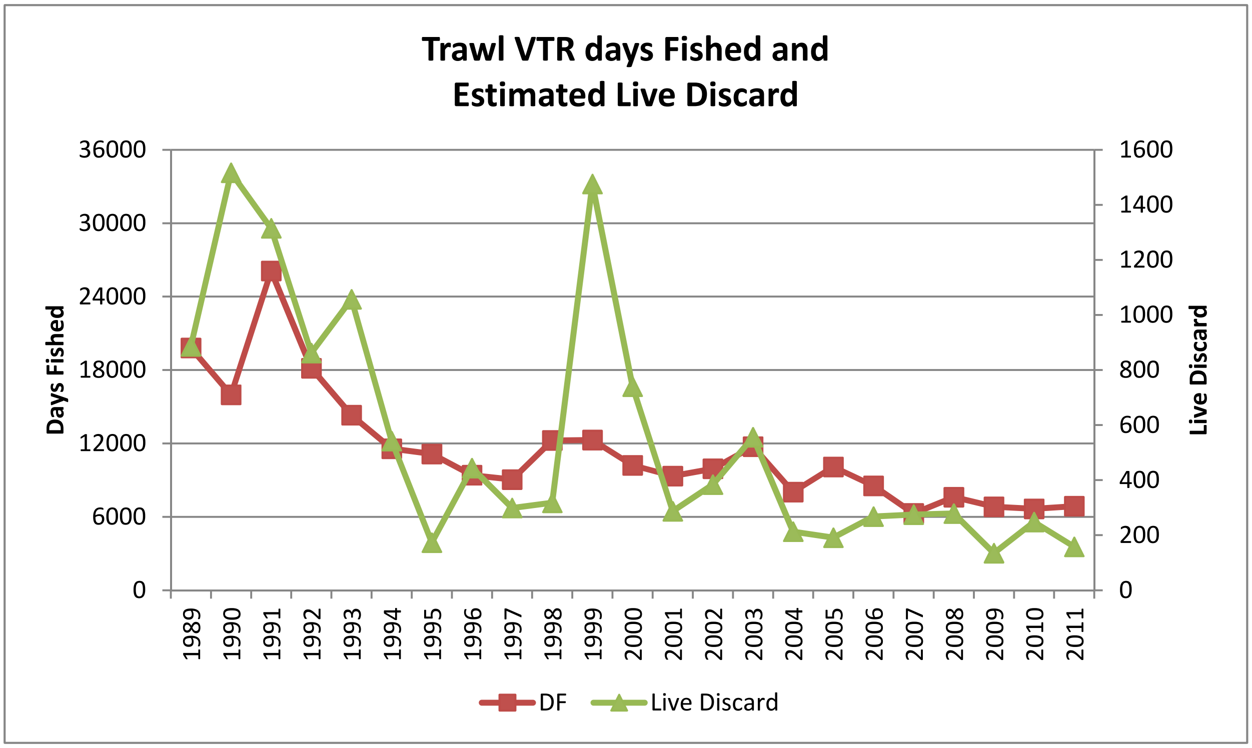


Figure A58. Fish trawl gear VTR Days Fished and previous estimation method (Assess) estimated live discard.

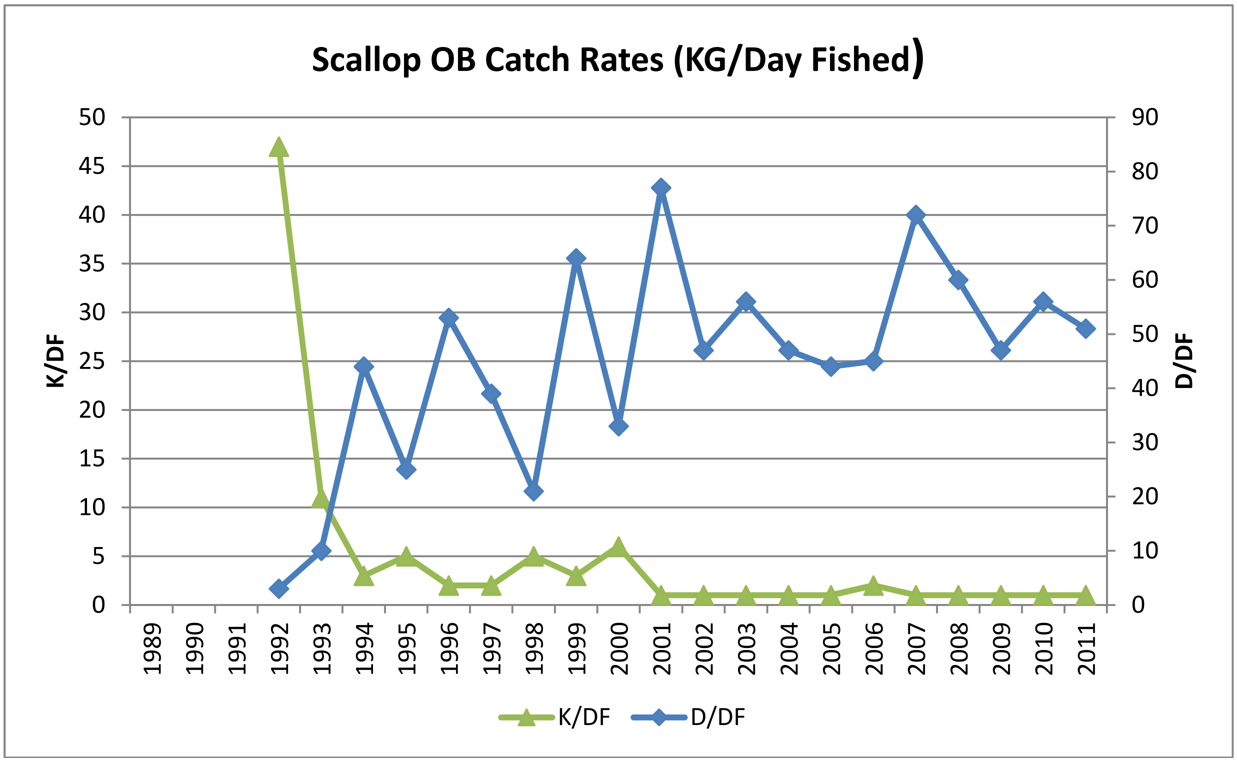


Figure A59. Observed Discard per Day Fished (D/DF) and Kept per Day Fished (K/DF) catch rates for scallop dredge gear.

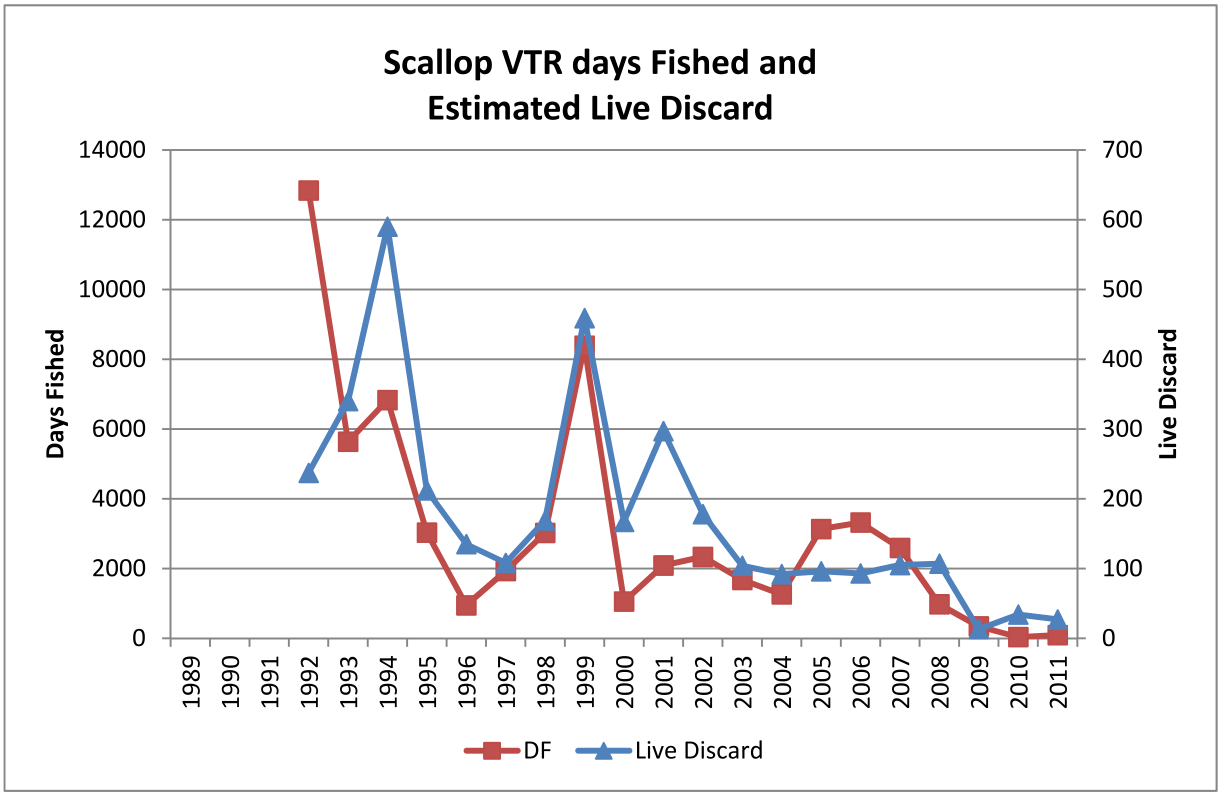


Figure A60. Scallop dredge gear VTR days fished and previous estimation method (Assess) estimated live discard.

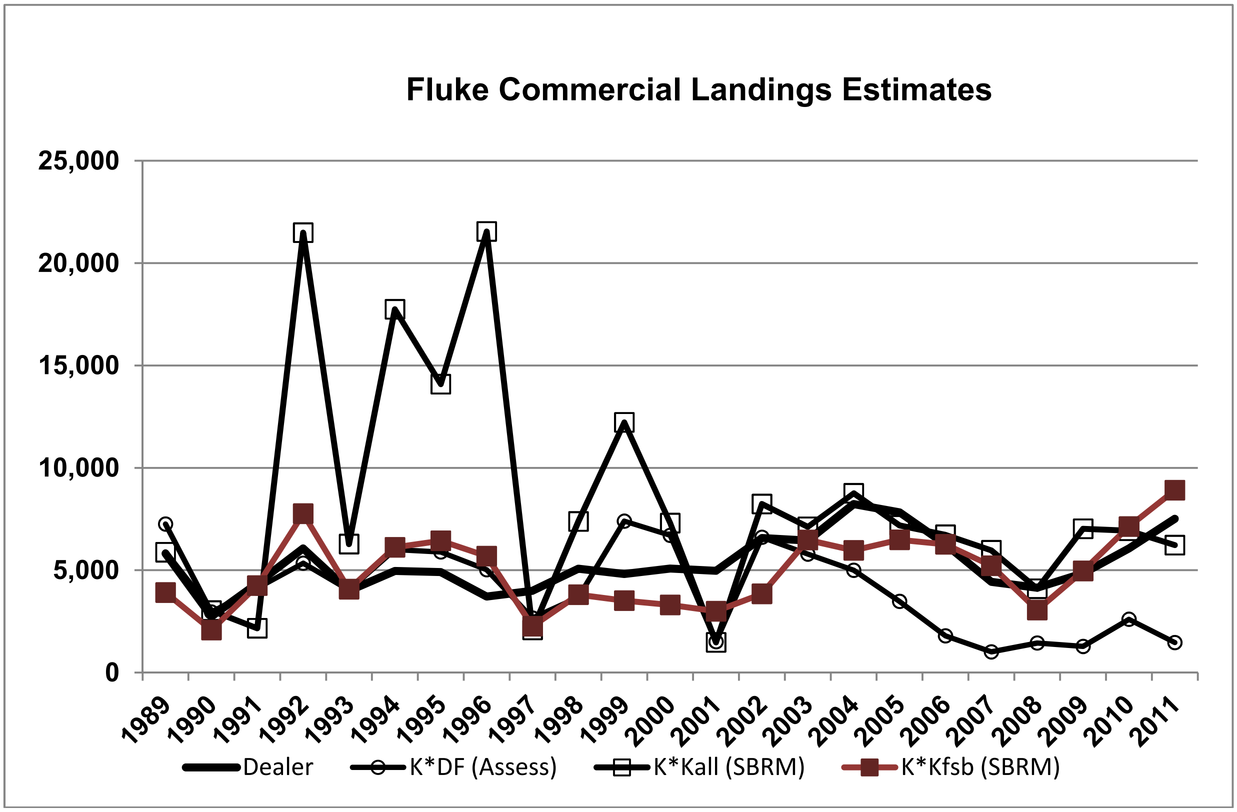


Figure A61. Comparison of summer flounder landings estimates from Dealer reports, the method used in previous assessments (K*DF), the SBRM using all species landings (K*Kall), and the SBRM using all fluke, scup, and black sea bass landings (K*Kfsb).

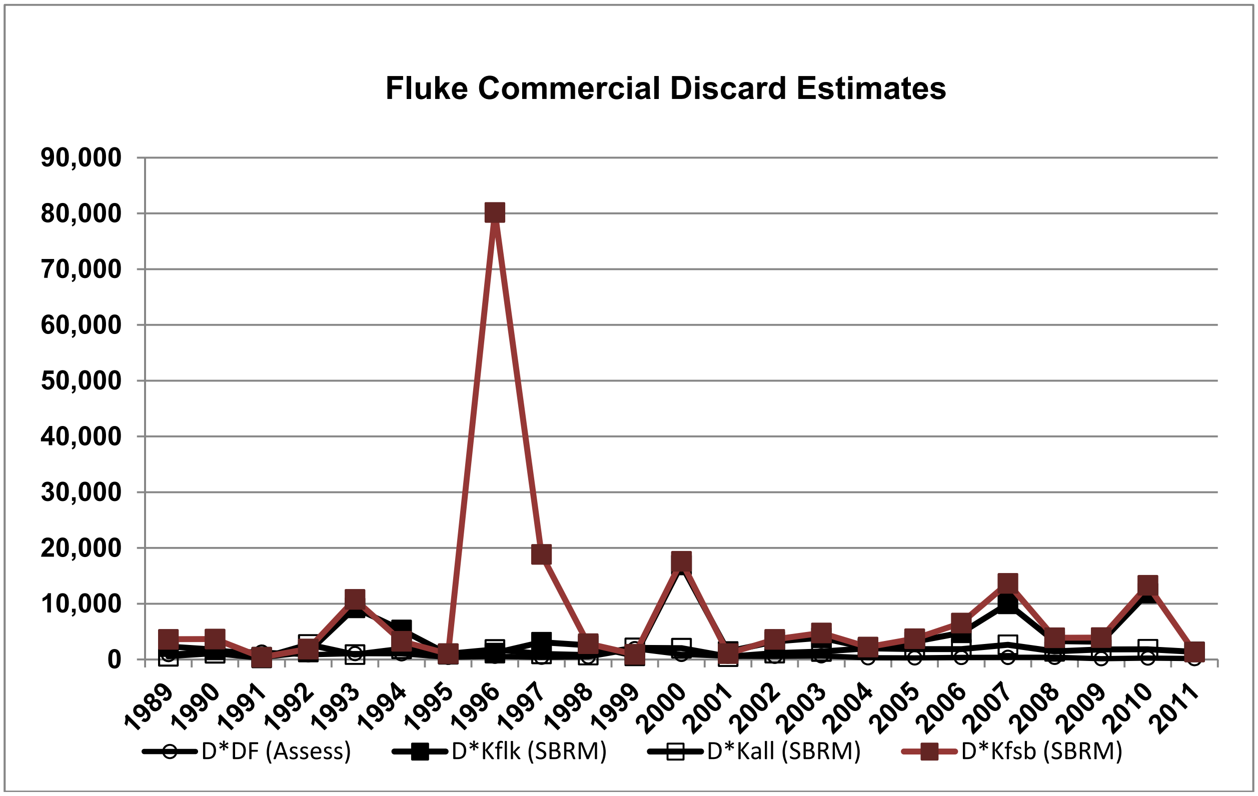


Figure A62. Comparison of summer flounder discard estimates from the method used in previous assessments (D*DF), the SBRM using fluke (summer flounder) landings (D*Kflk), the SBRM using all species landings (D*Kall), and the SBRM using all fluke, scup, and black sea bass landings (D*Kfsb).

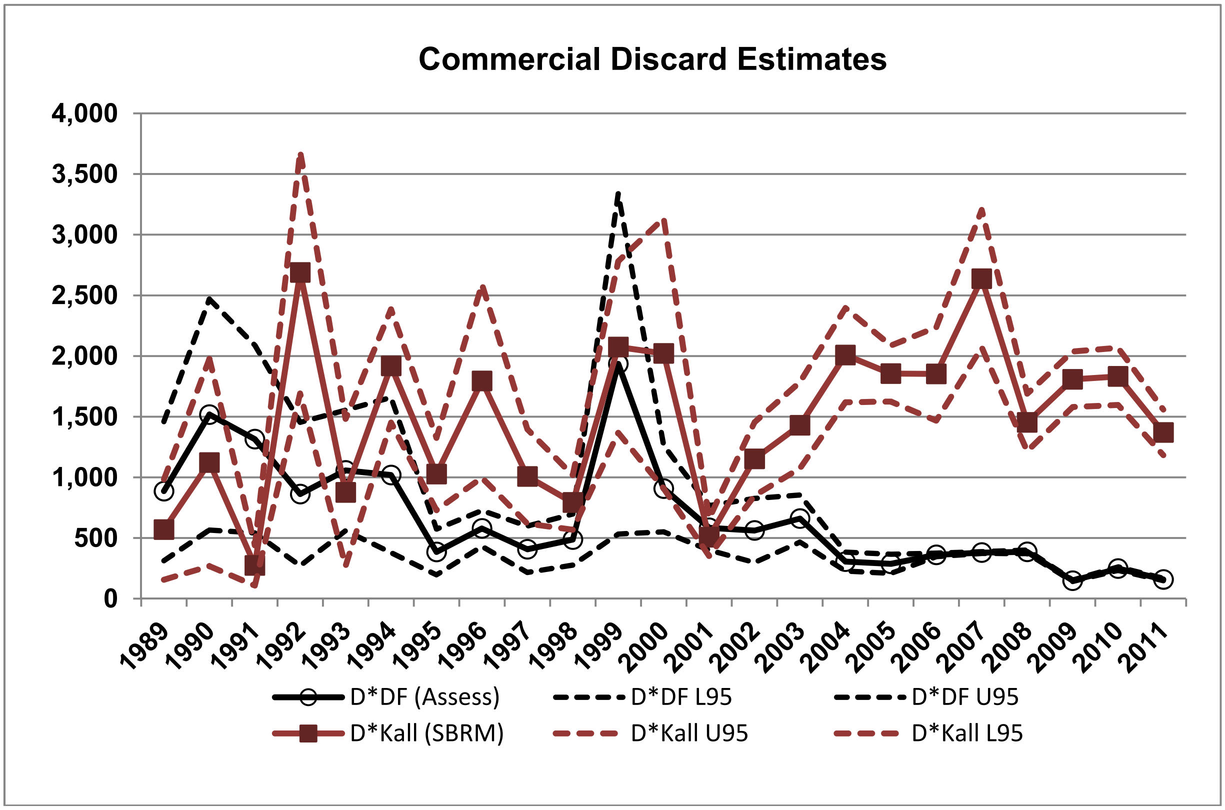


Figure A63. Comparison of summer flounder discard estimates and 95% confidence intervals from the method used in previous assessments (D*DF) and the SBRM using all species landings (D*Kall).

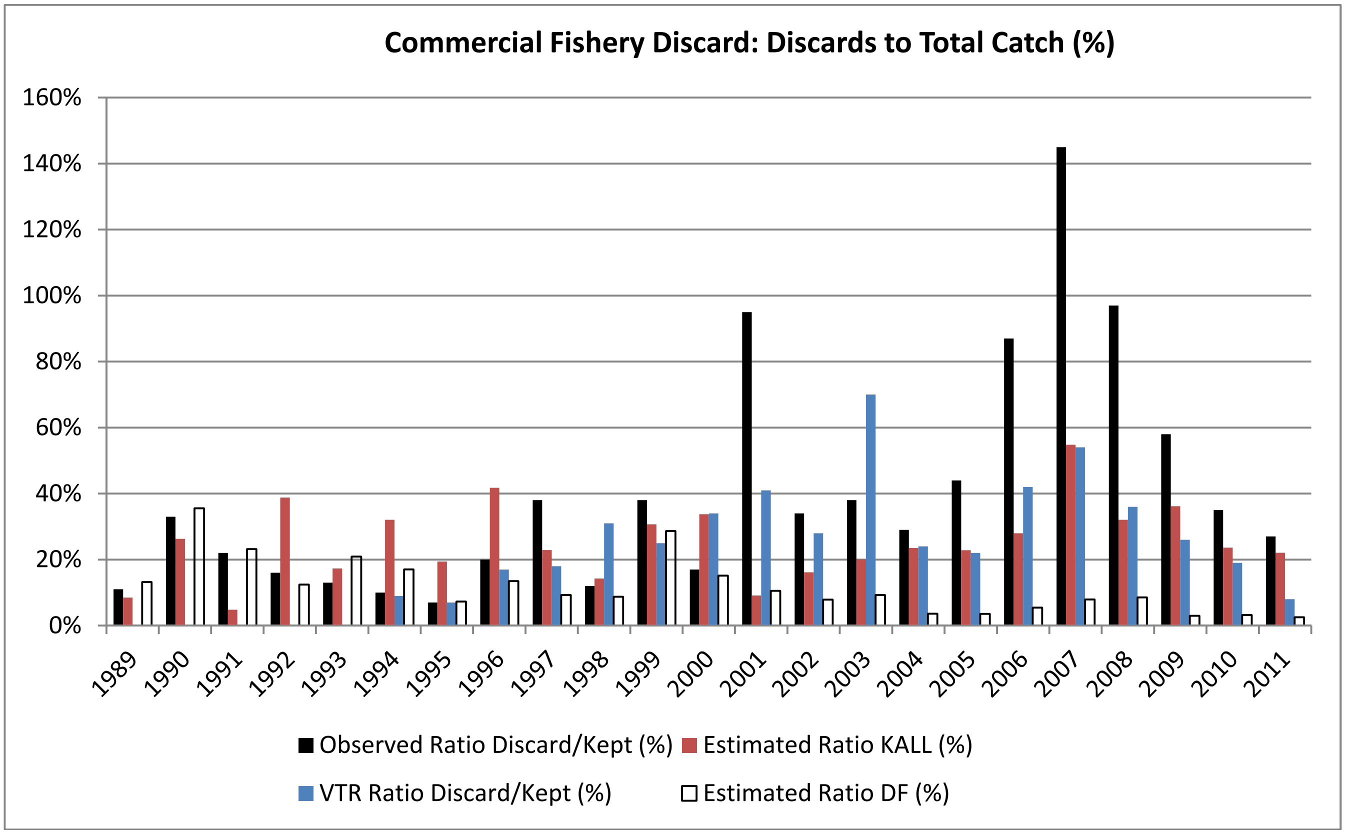


Figure A64. Comparison of summer flounder discard ratios (discard to total catch in percent) from the raw Observer data (black), the SBRM D*Kall estimates (estimated discards and Dealer reported landings; red), the raw VTR data (blue), and the method used in previous assessments (D*DF; estimated discards and Dealer reported landings).

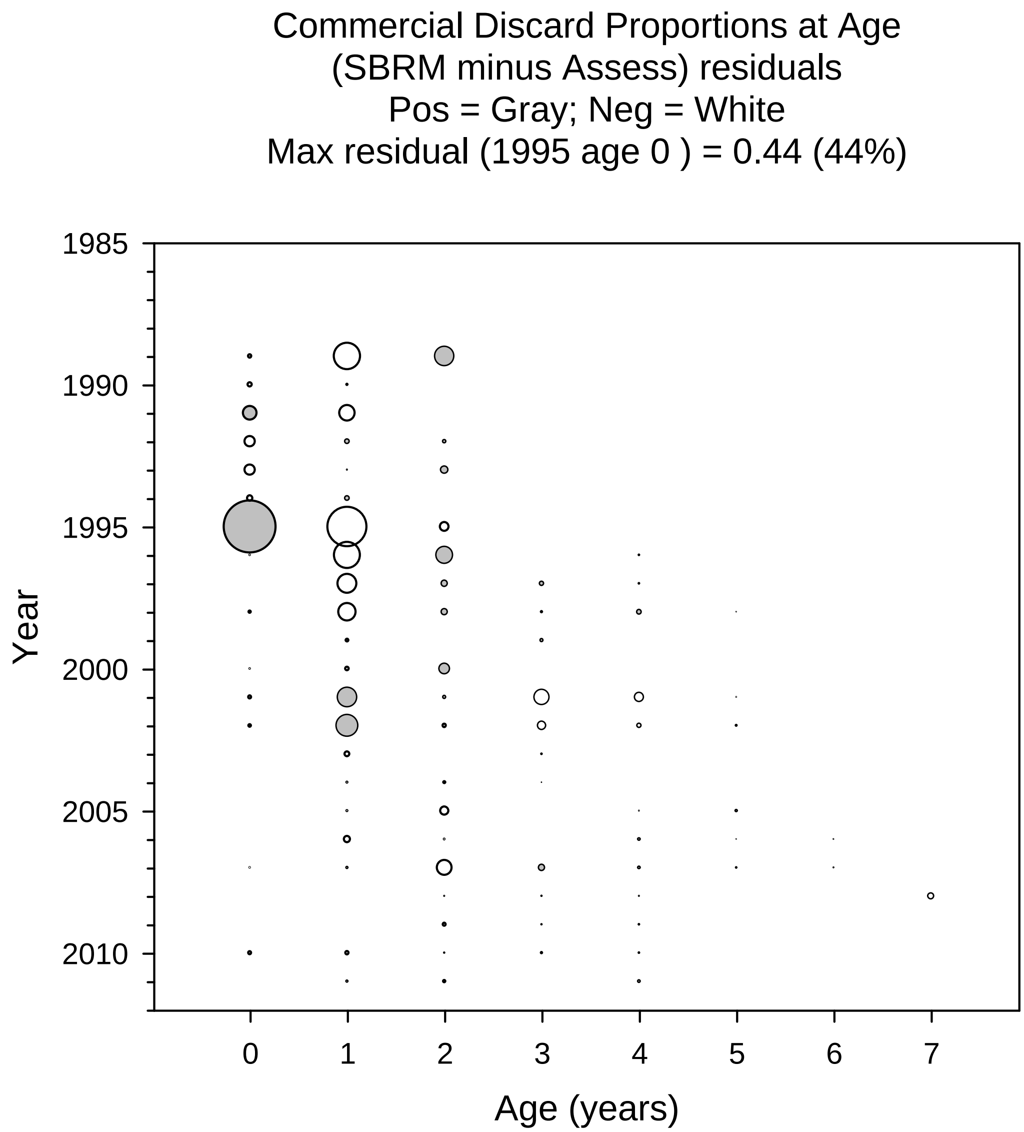


Figure A65. Comparison of SBRM D*Kall and Assess D*DF estimates of discards at age: residuals (differences) in estimated proportion at age by year.

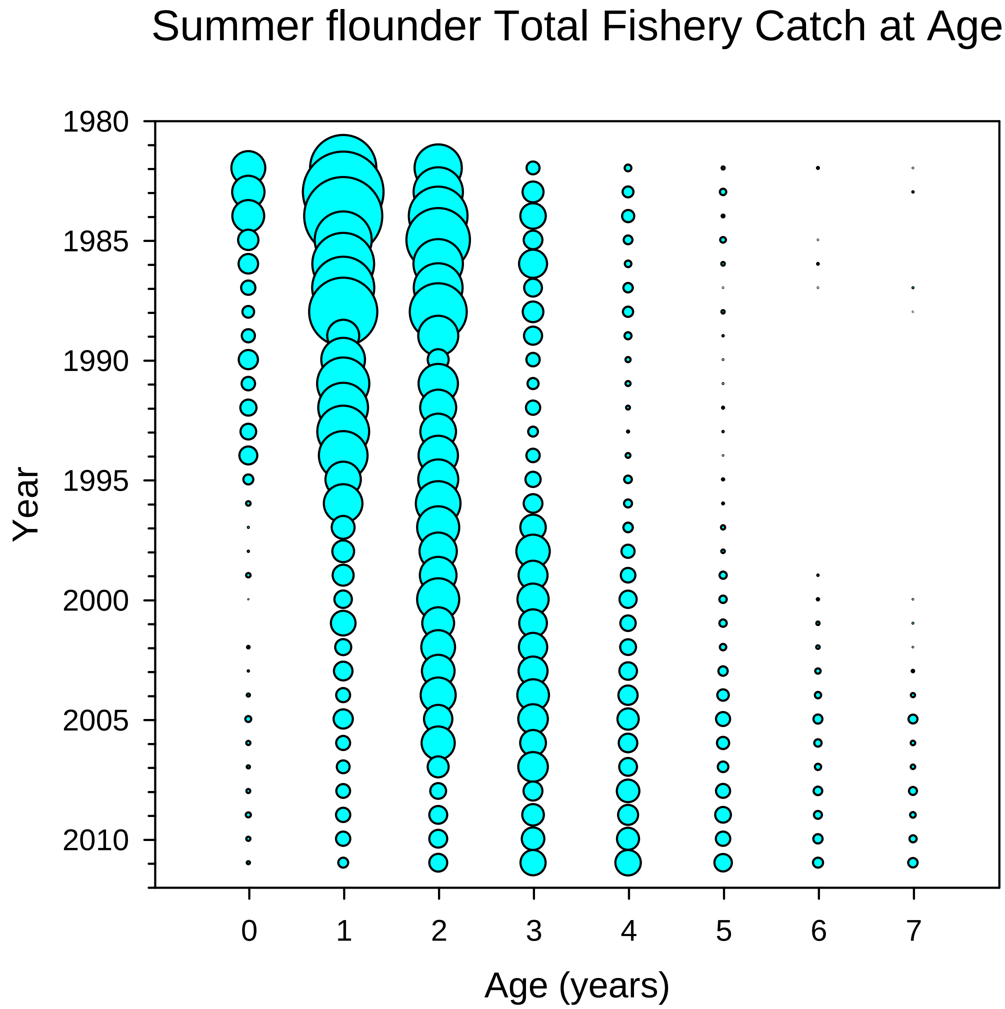


Figure A66. Total fishery catch at age for summer flounder.

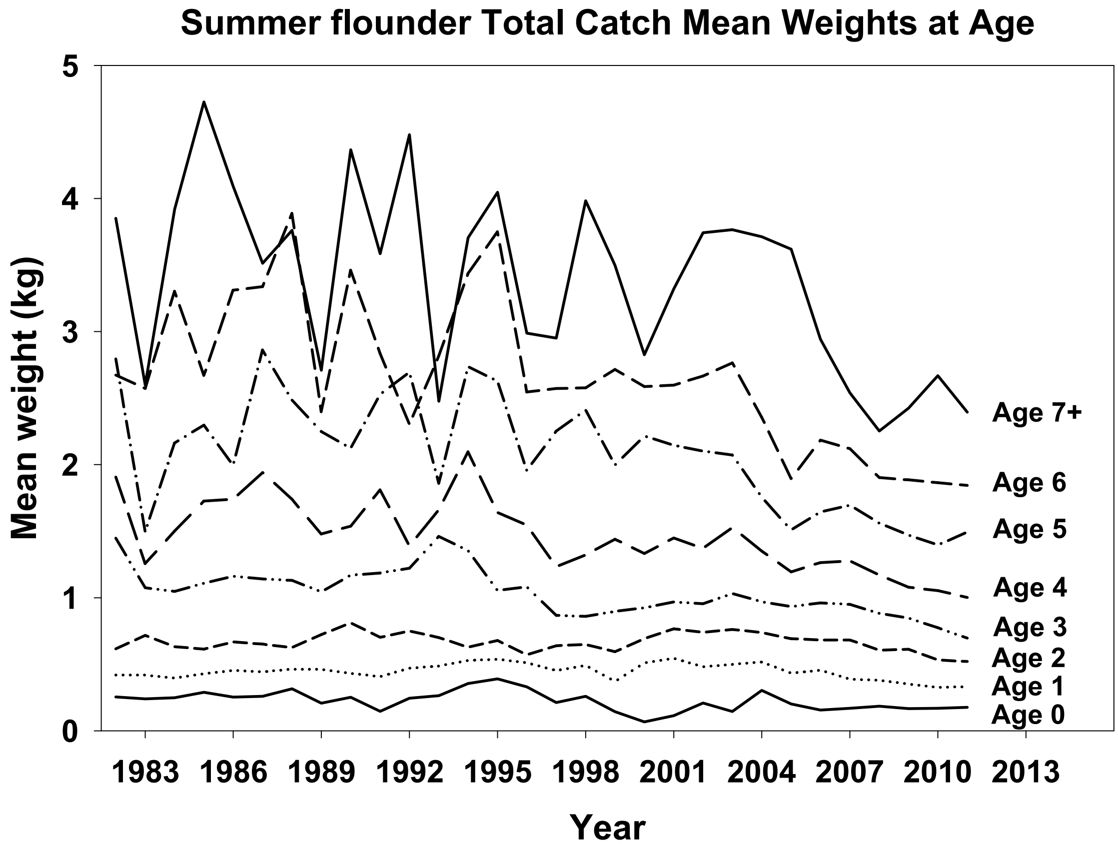


Figure A67. Mean weight at age in the total fishery catch of summer flounder.

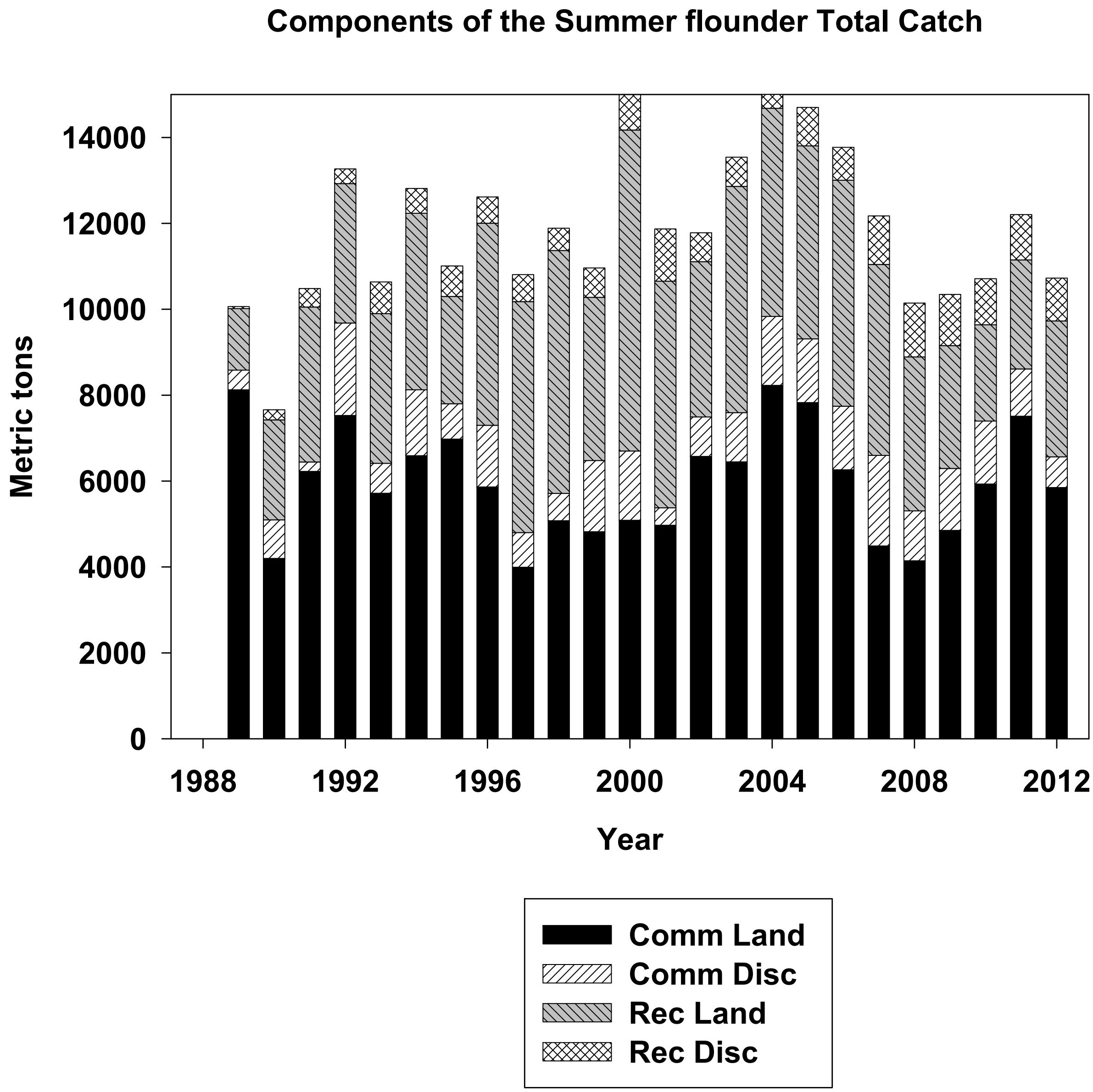


Figure A68. Components of the summer flounder fishery catch.

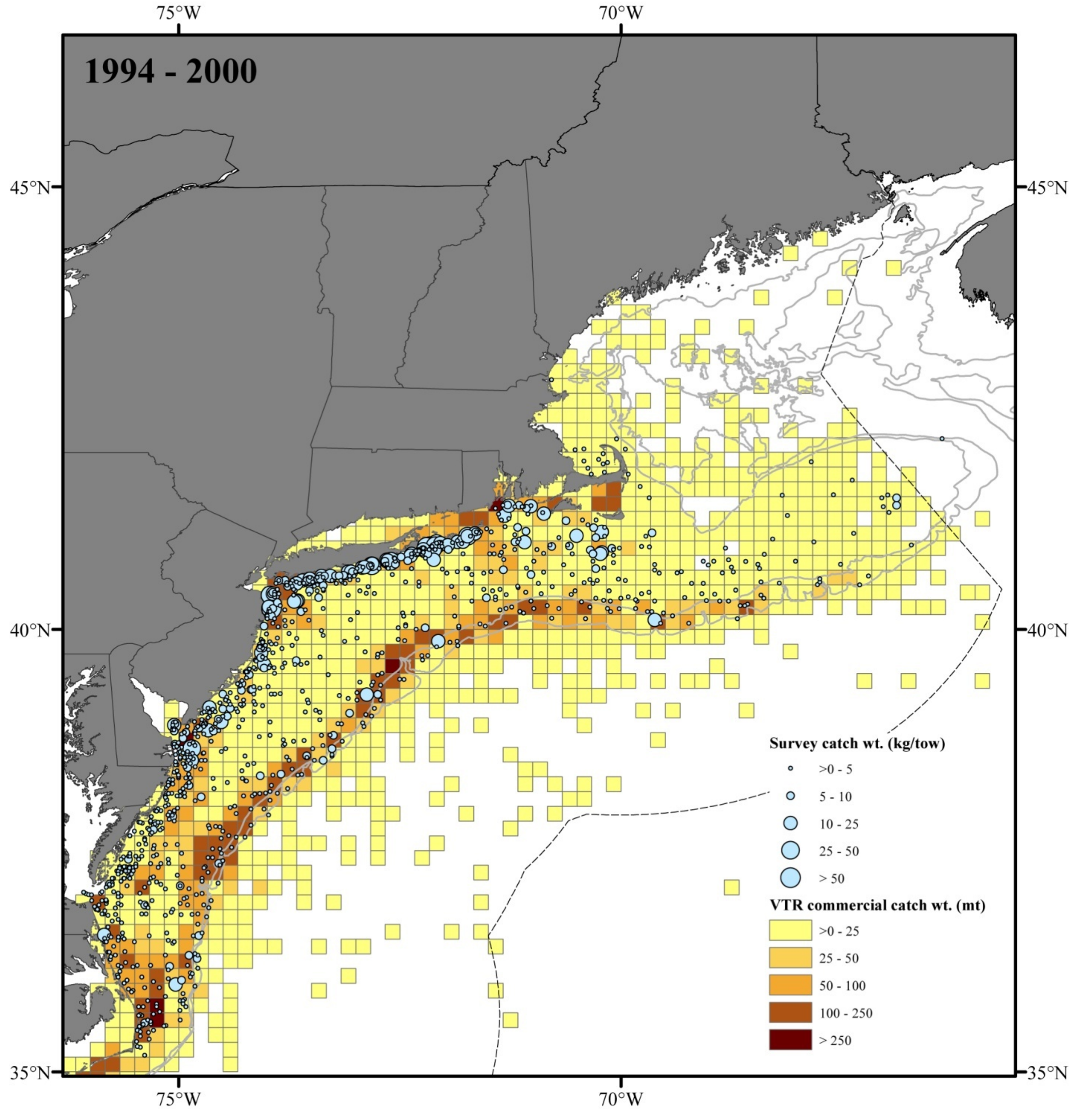


Figure A69. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and commercial VTR-reported catch weight (landings and discards) binned to ten minute squares from 1994-2000.

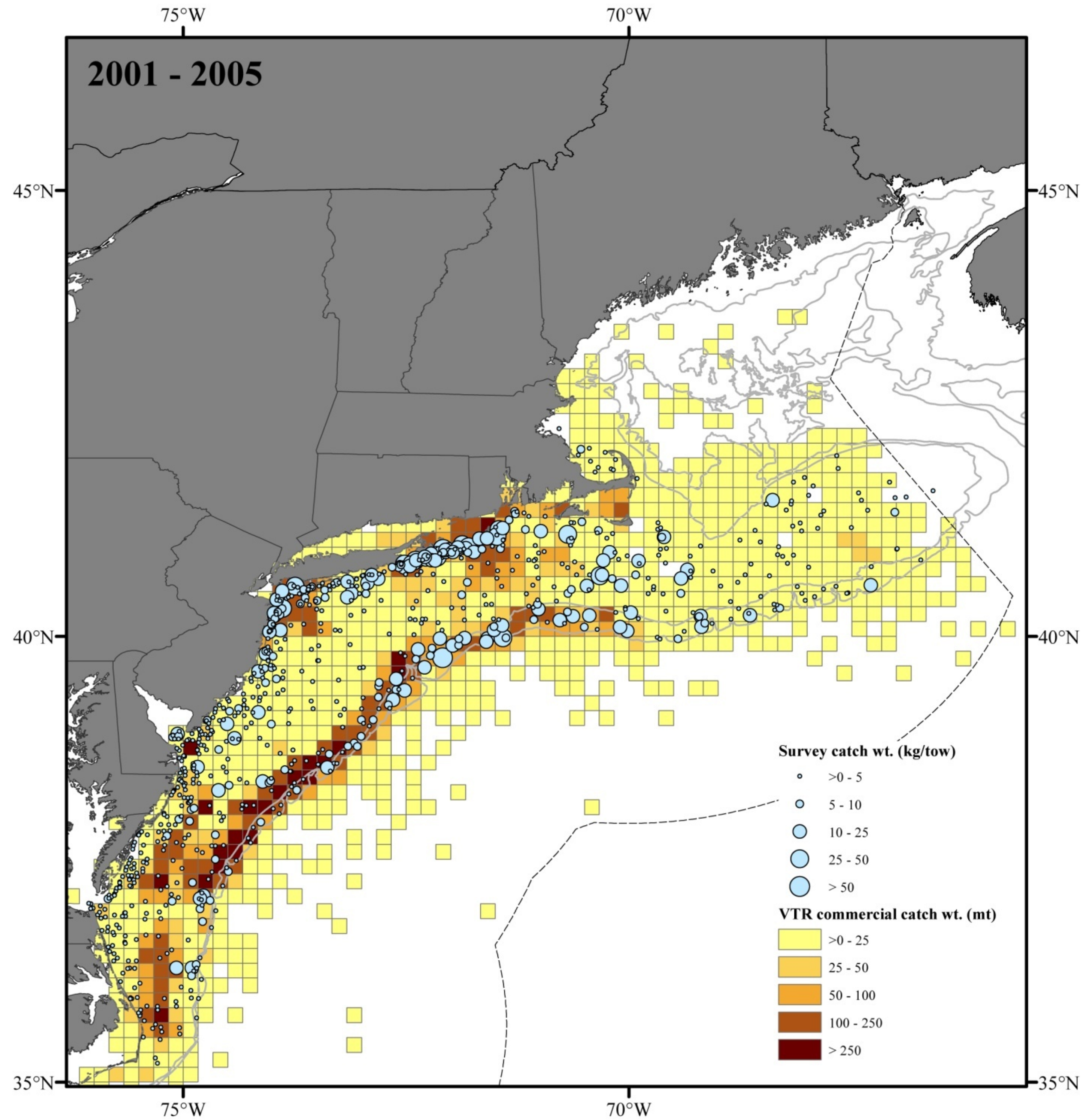


Figure A70. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and commercial VTR-reported catch weight (landings and discards) binned to ten minute squares from 2001-2005.

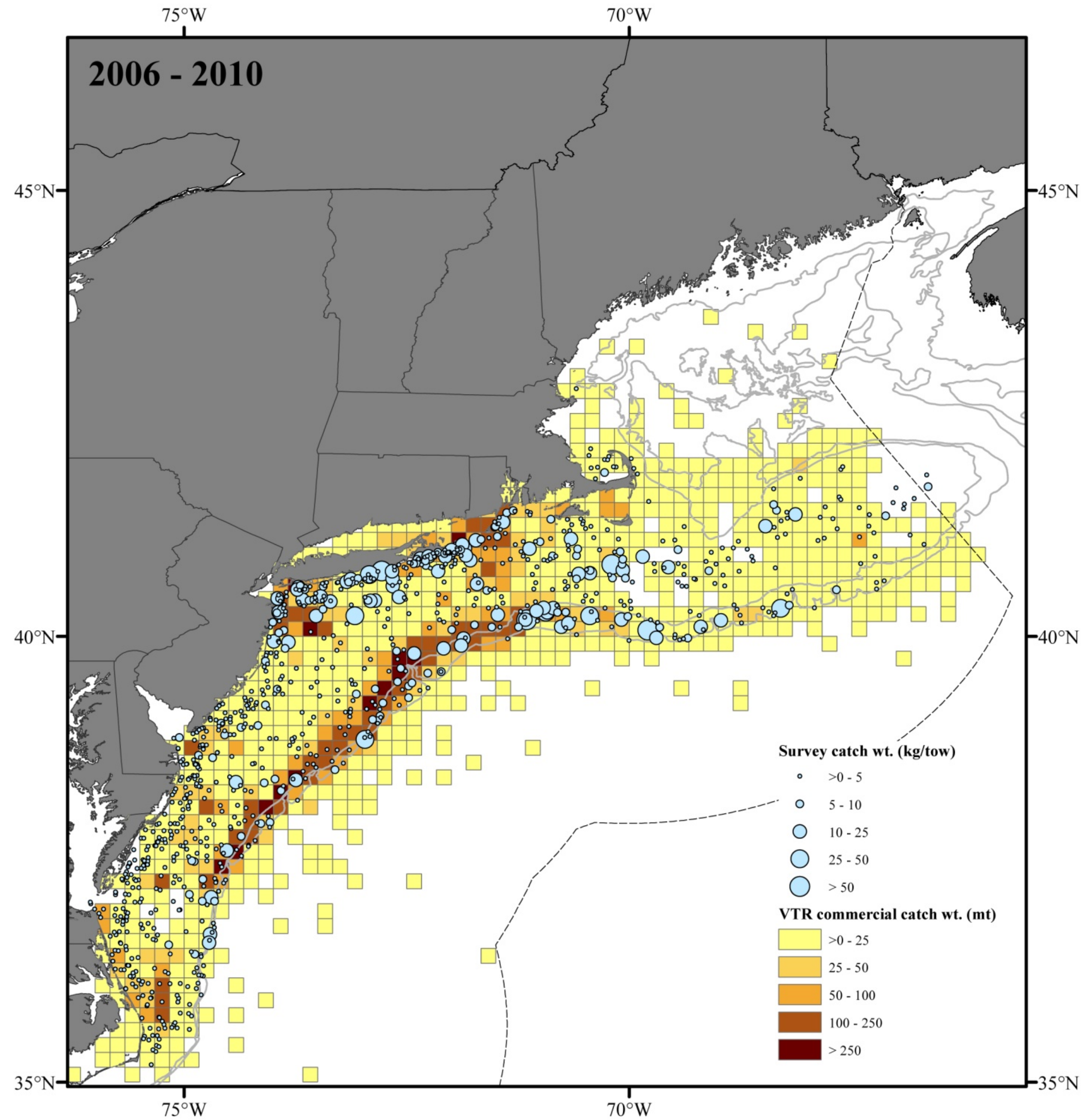


Figure A71. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and commercial VTR-reported catch weight (landings and discards) binned to ten minute squares from 2006-2010.

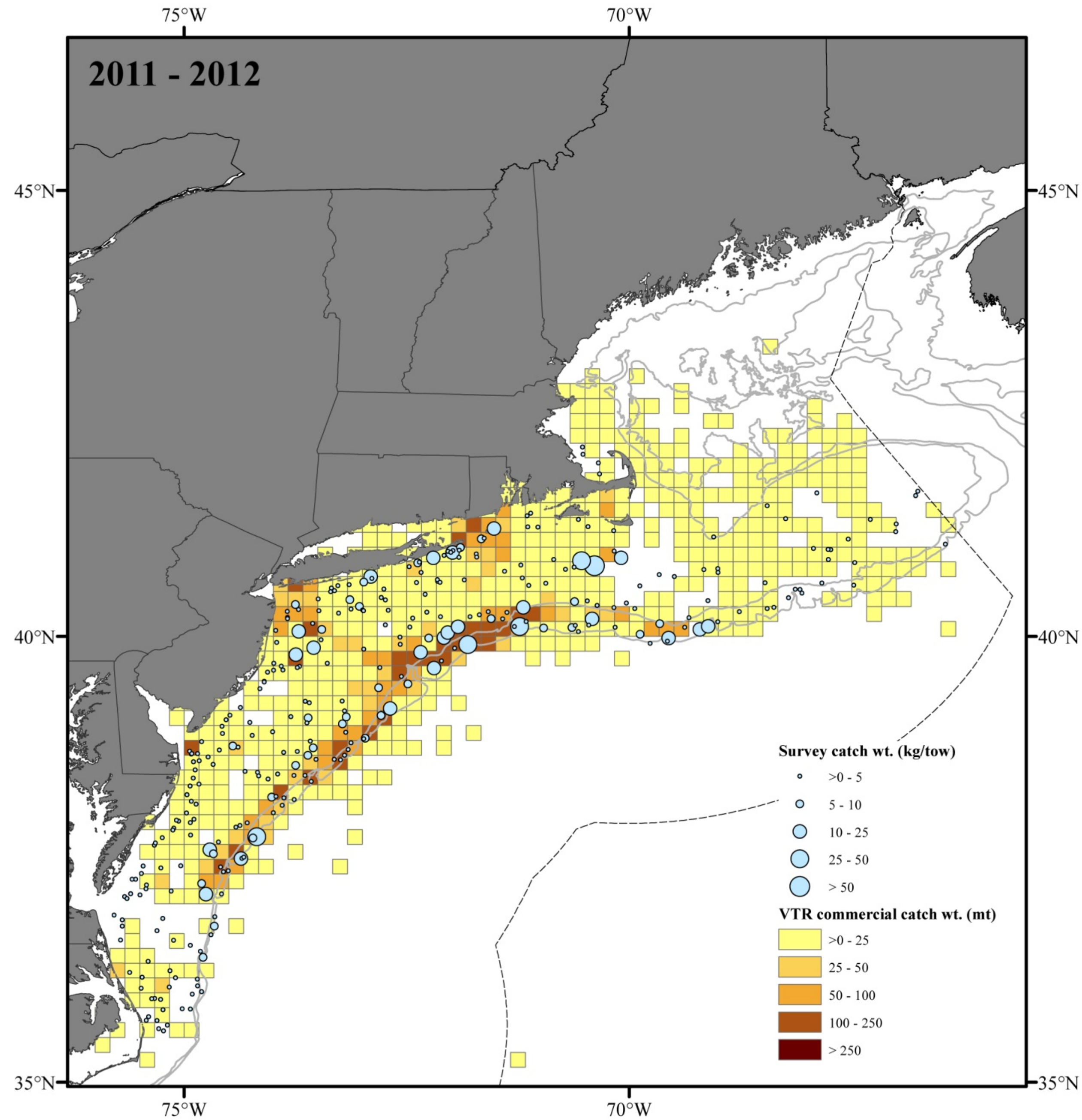


Figure A72. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and commercial VTR-reported catch weight (landings and discards) binned to ten minute squares from 2011-2012.

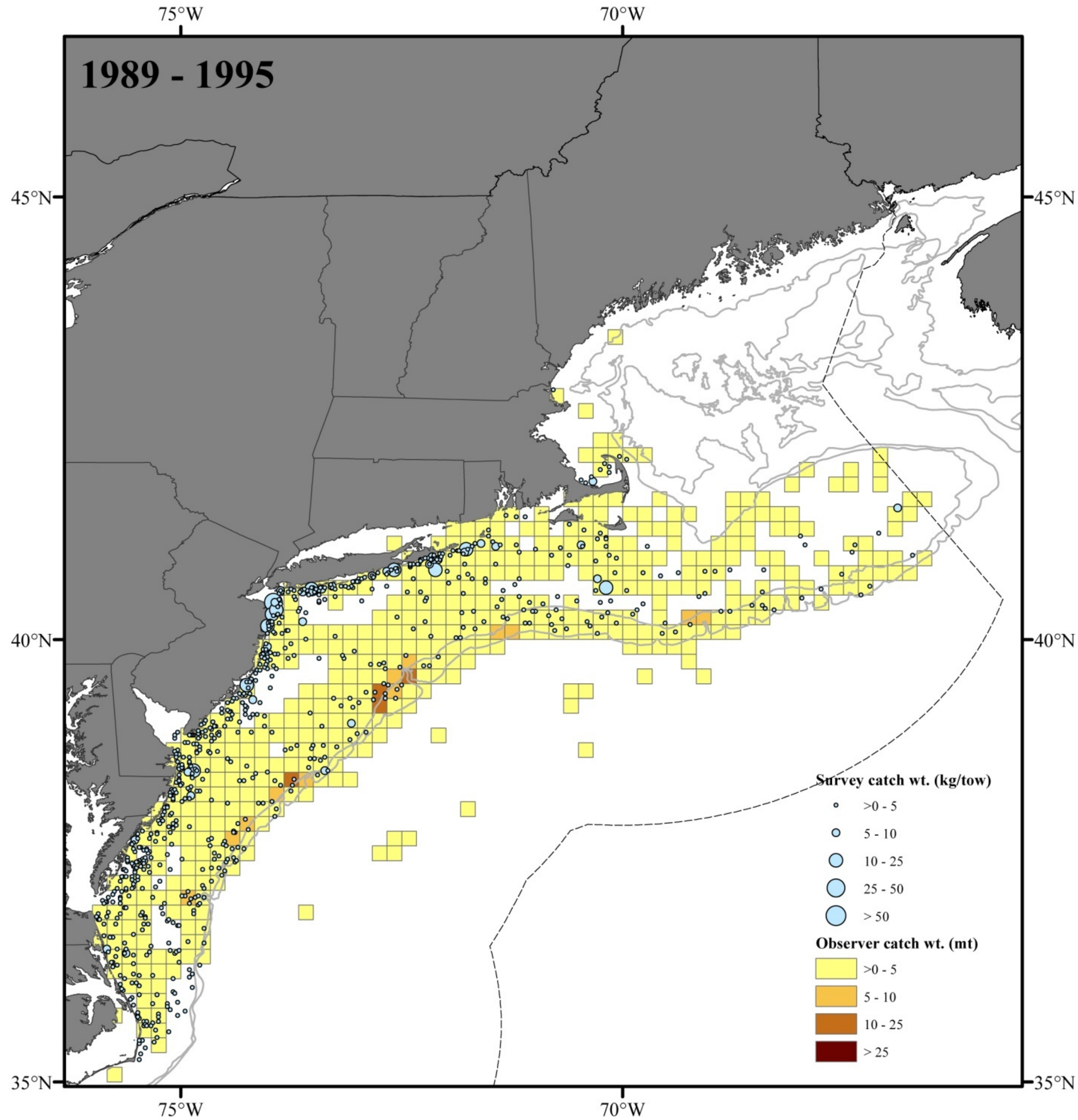


Figure A73. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and total observed catch weight (landings and discards) binned to ten minute squares from 1989-1995.

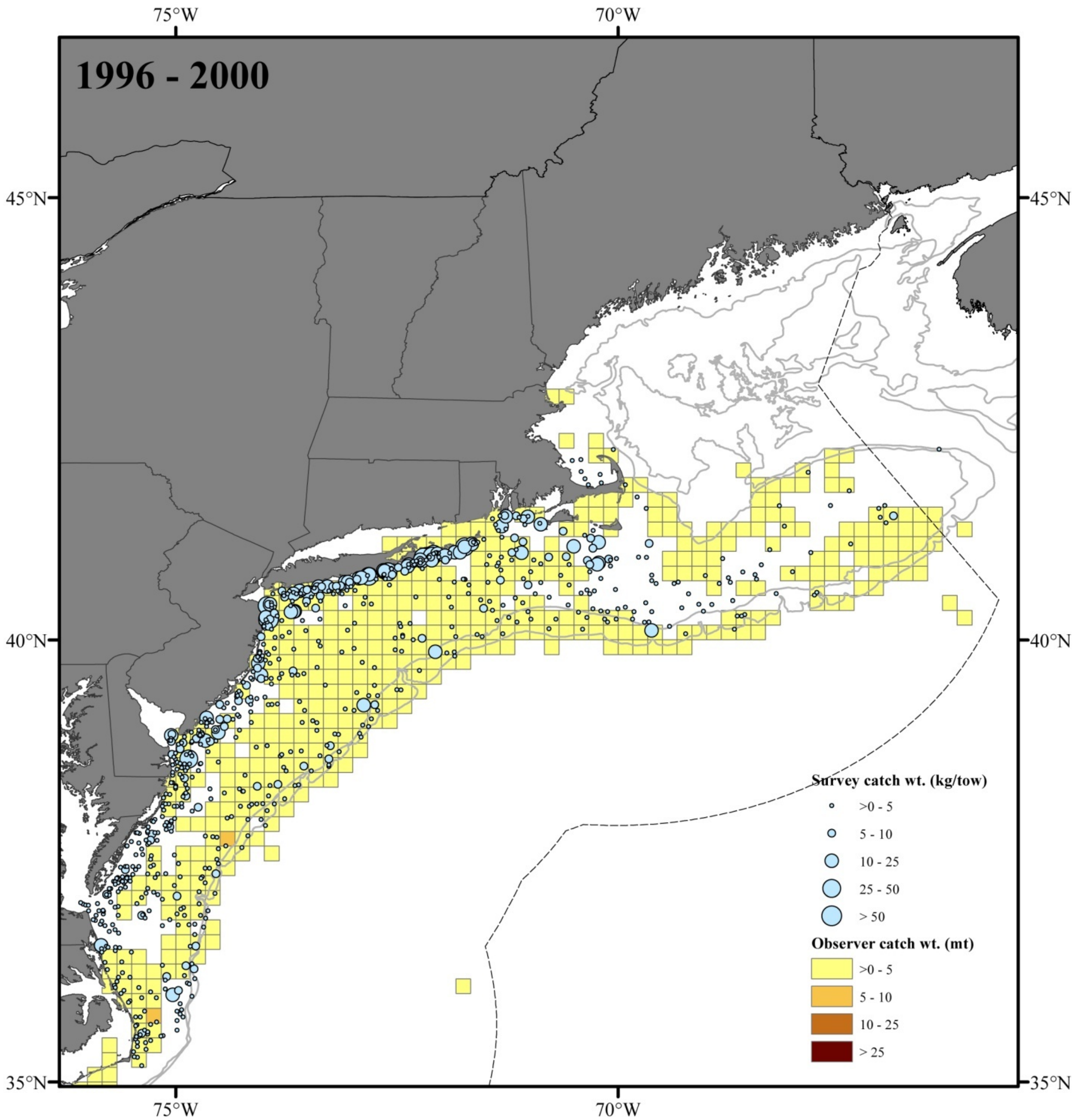


Figure A74. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and total observed catch weight (landings and discards) binned to ten minute squares from 1996-2000.

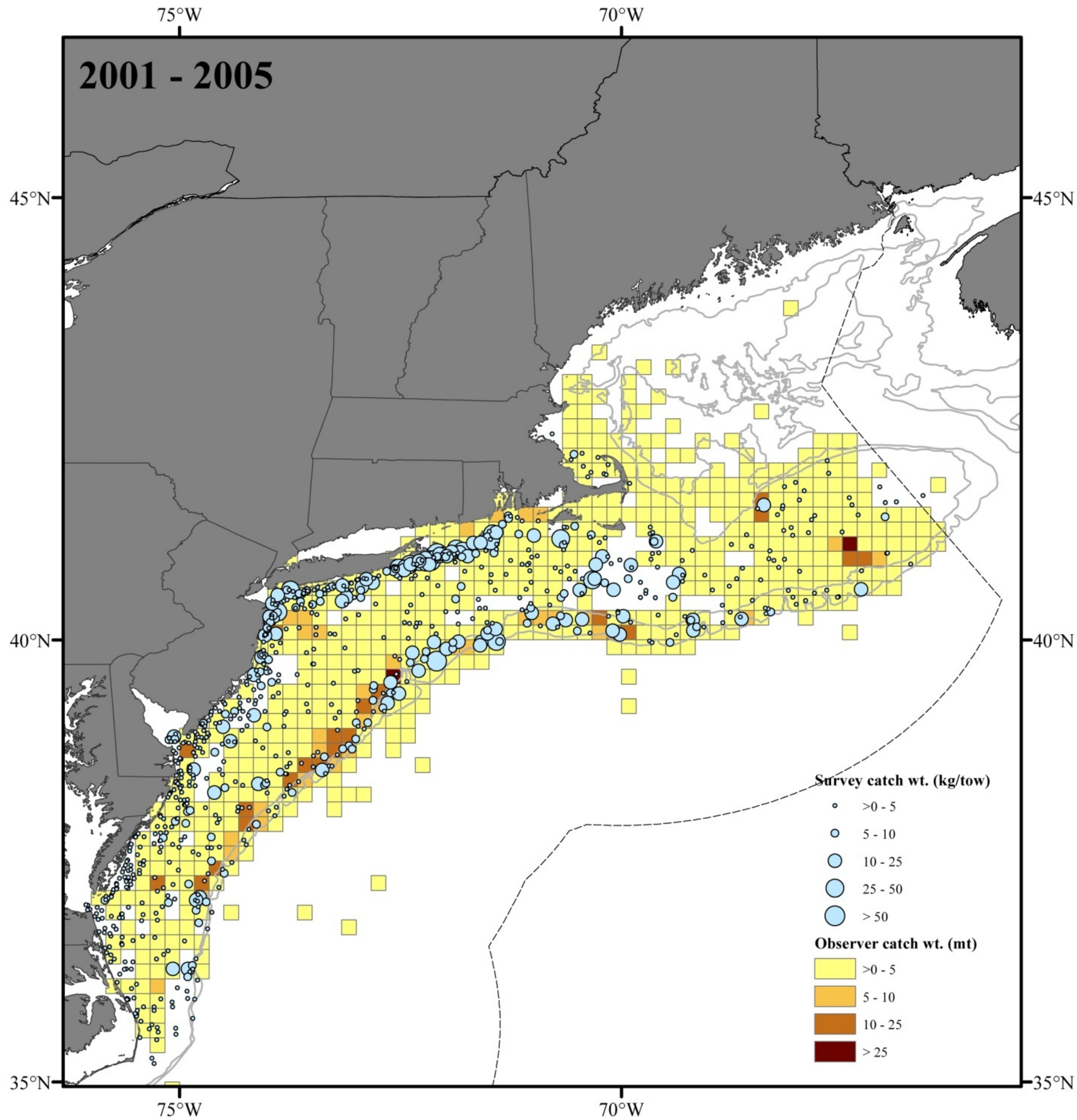


Figure A75. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and total observed catch weight (landings and discards) binned to ten minute squares from, 2001-2005.

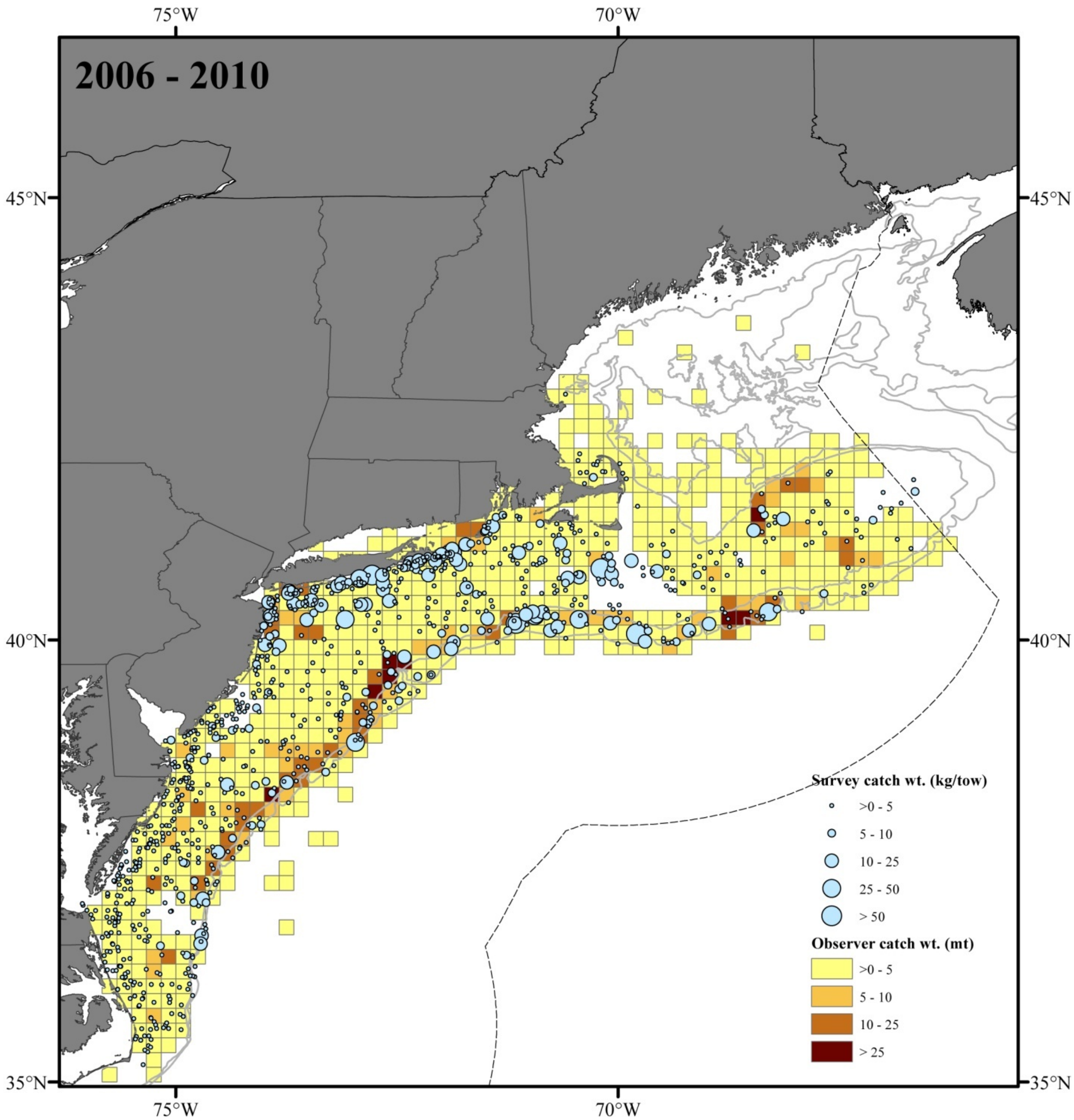


Figure A76. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and total observed catch weight (landings and discards) binned to ten minute squares from 2006-2010.

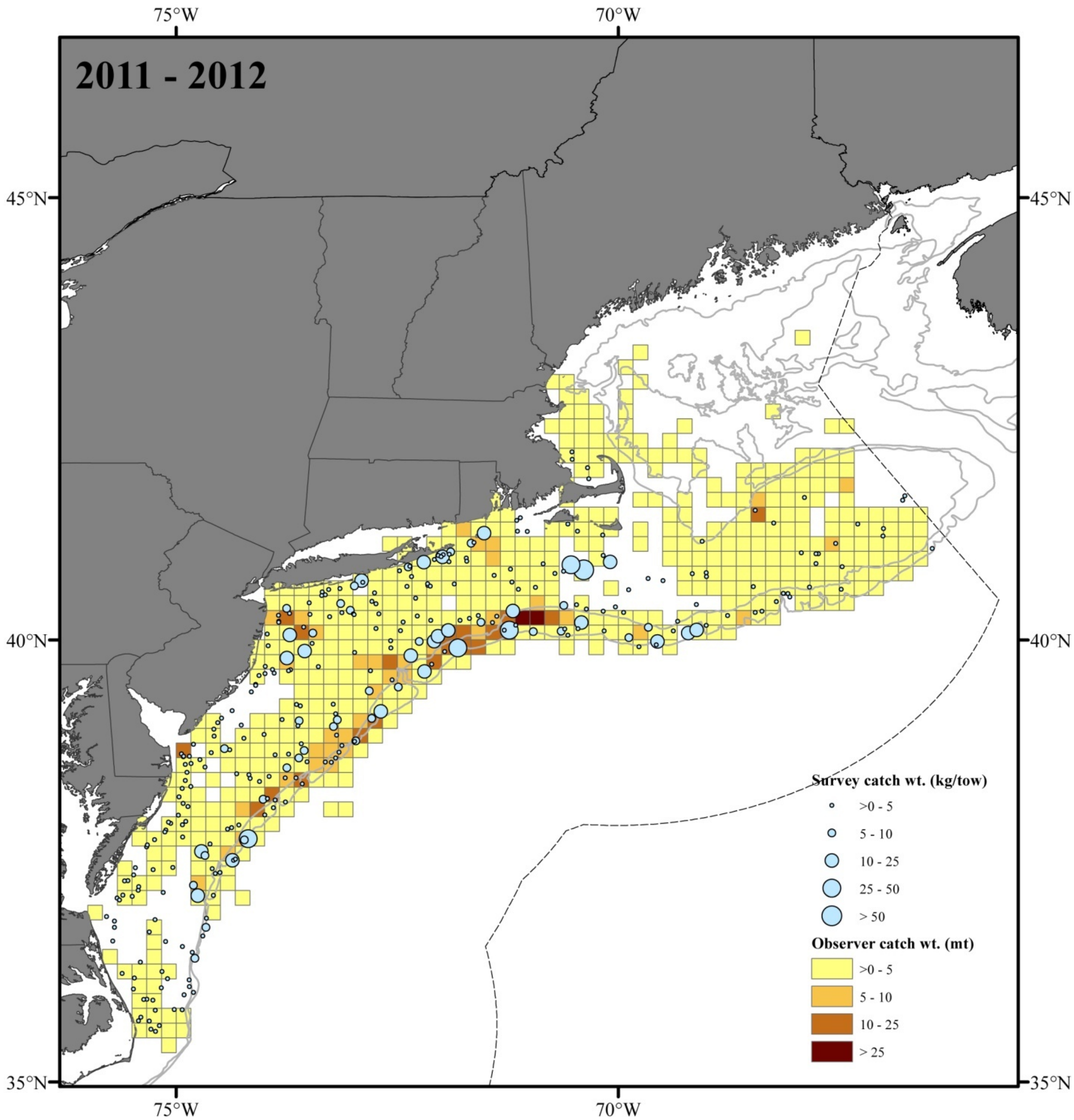


Figure A77. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and total observed catch weight (landings and discards) binned to ten minute squares from 2011-2012.

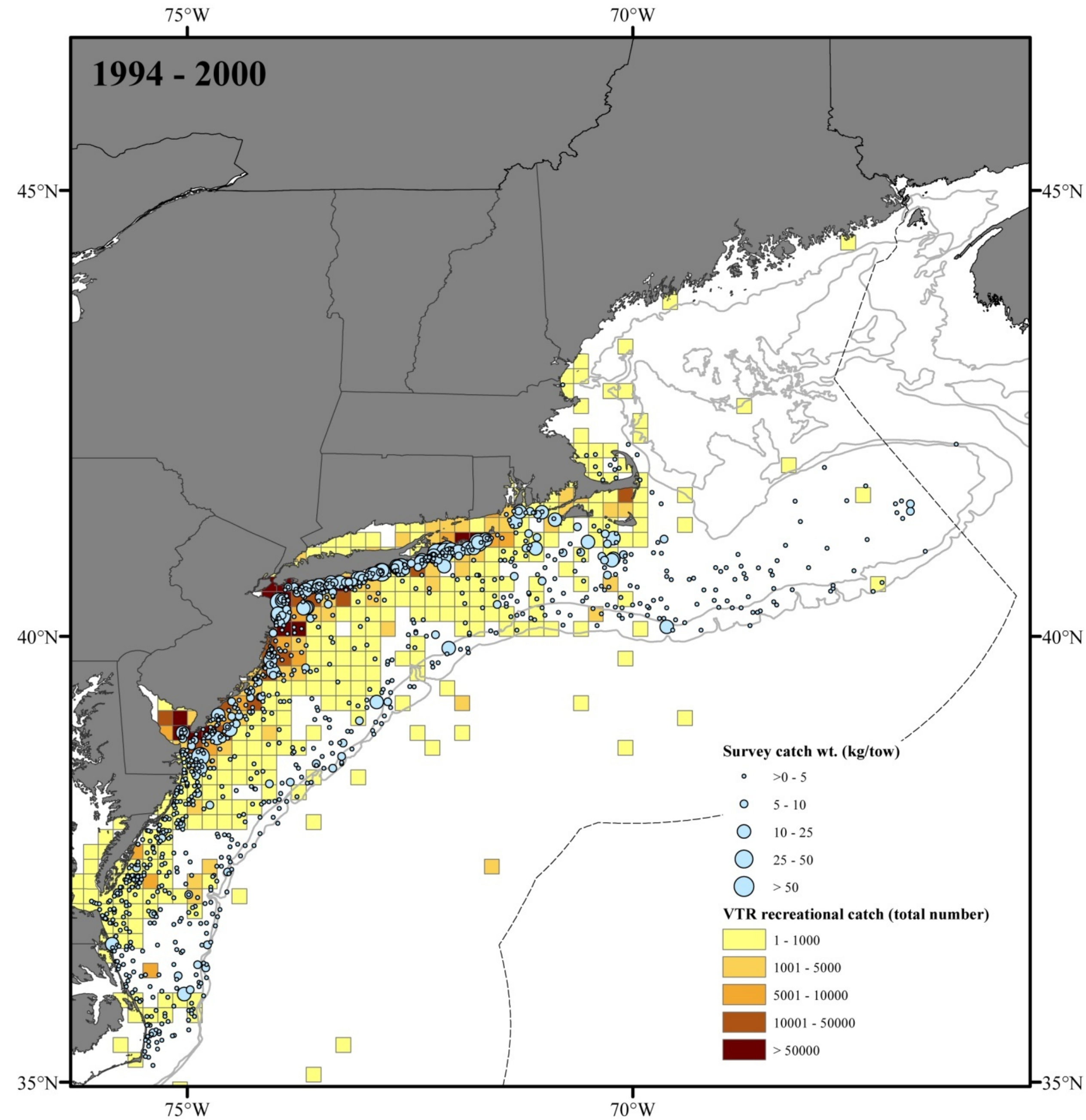


Figure A78. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and recreational (party and charter boat) VTR-reported catch (total number) binned to ten minute squares from 1994-2000.

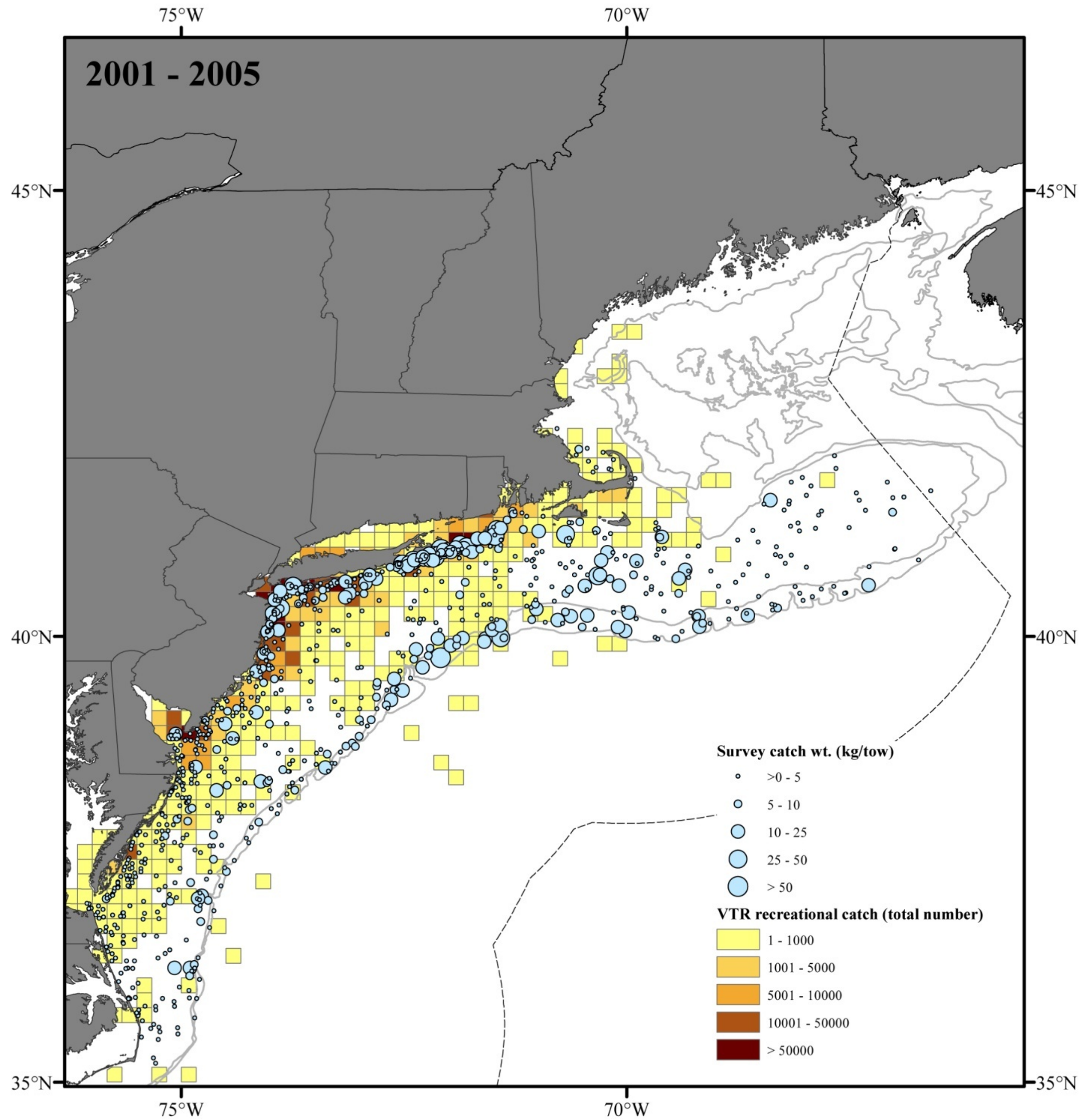


Figure A79. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and recreational (party and charter boat) VTR-reported catch (total number) binned to ten minute squares from 2001-2005.

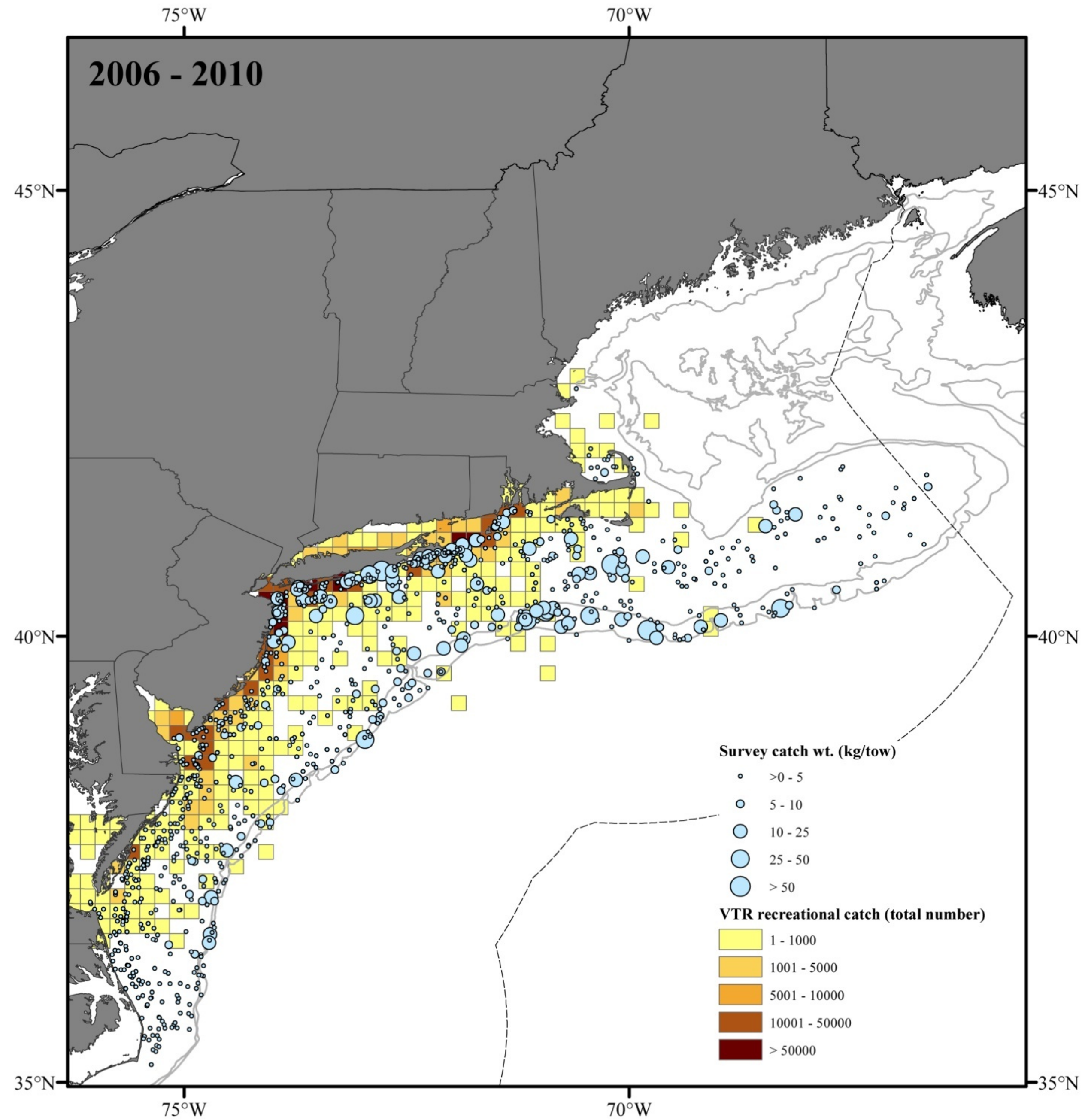


Figure A80. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and recreational (party and charter boat) VTR-reported catch (total number) binned to ten minute squares from 2006-2010.

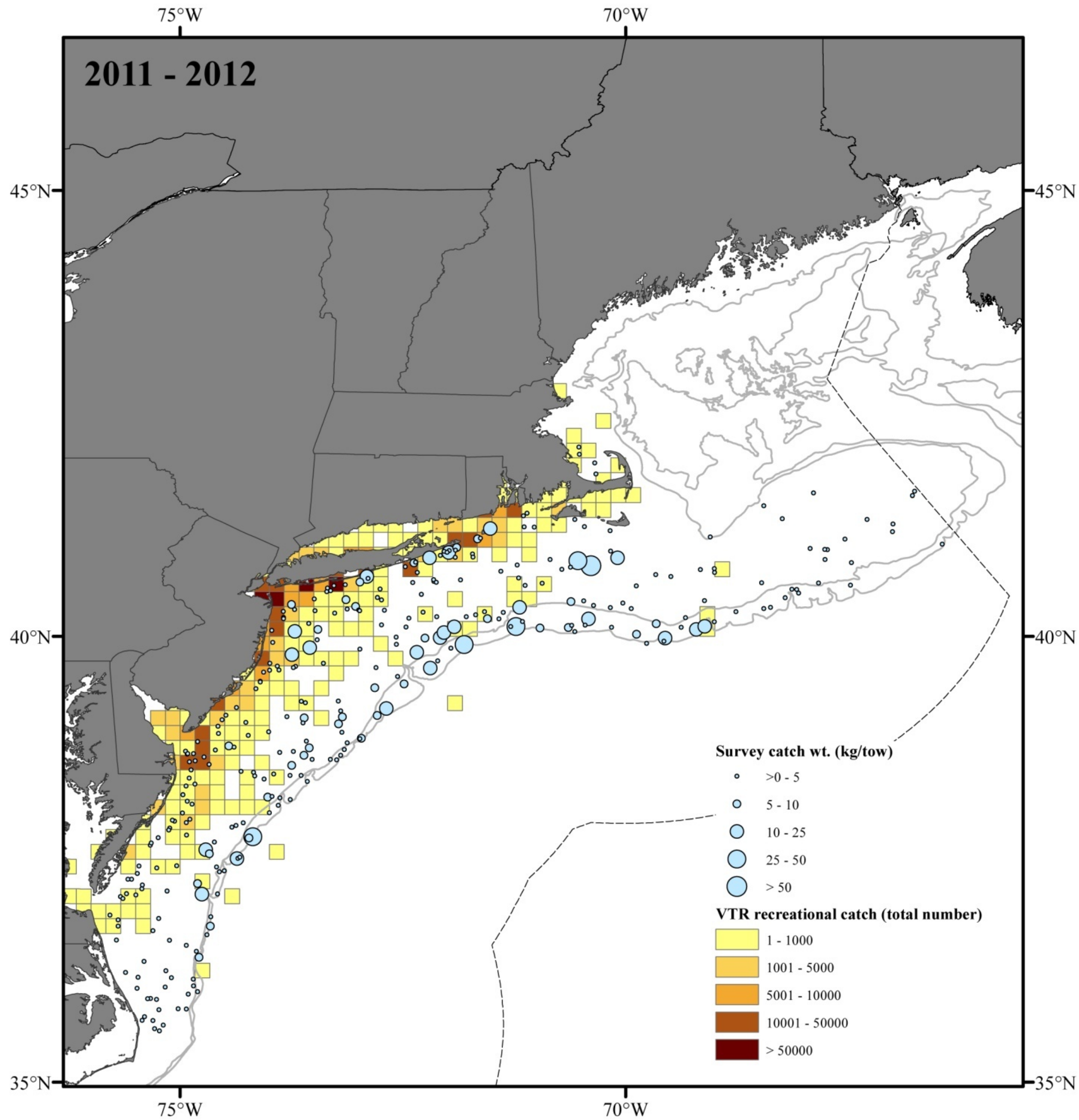


Figure A81. Spatial overlap of NEFSC trawl survey (spring and fall combined) catches (kg/tow) and recreational (party and charter boat) VTR-reported catch (total number) binned to ten minute squares from 2011-2012.

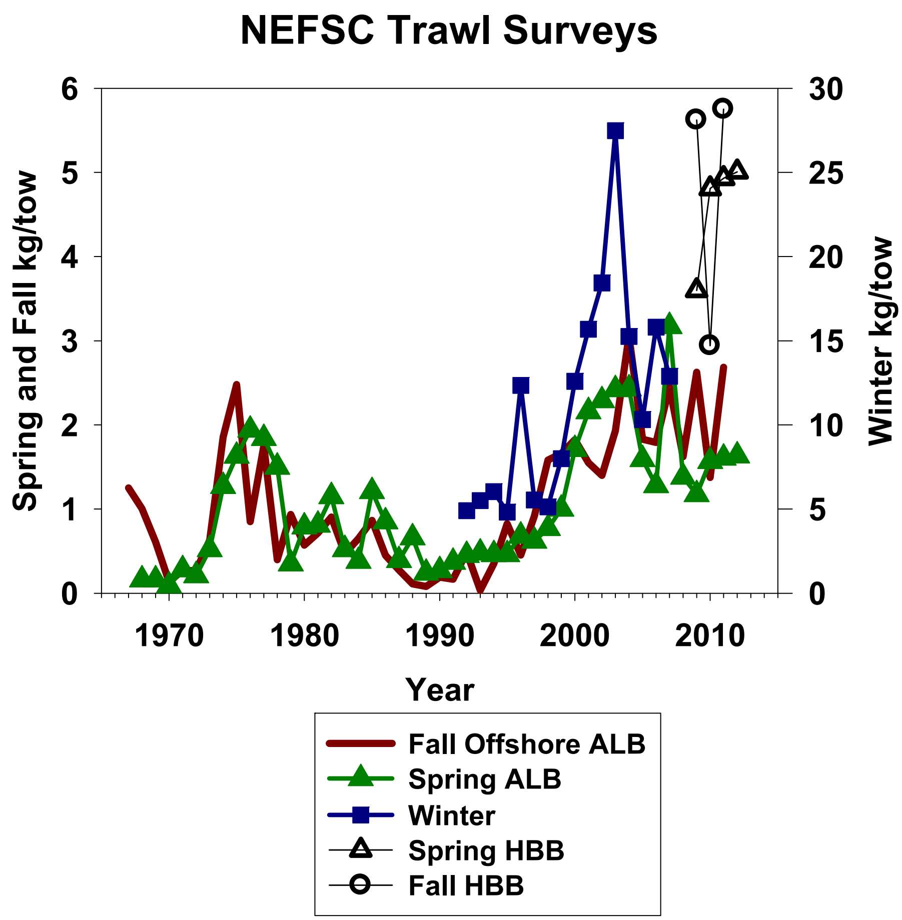


Figure A82. Trends in NEFSC trawl survey biomass indices for summer flounder.

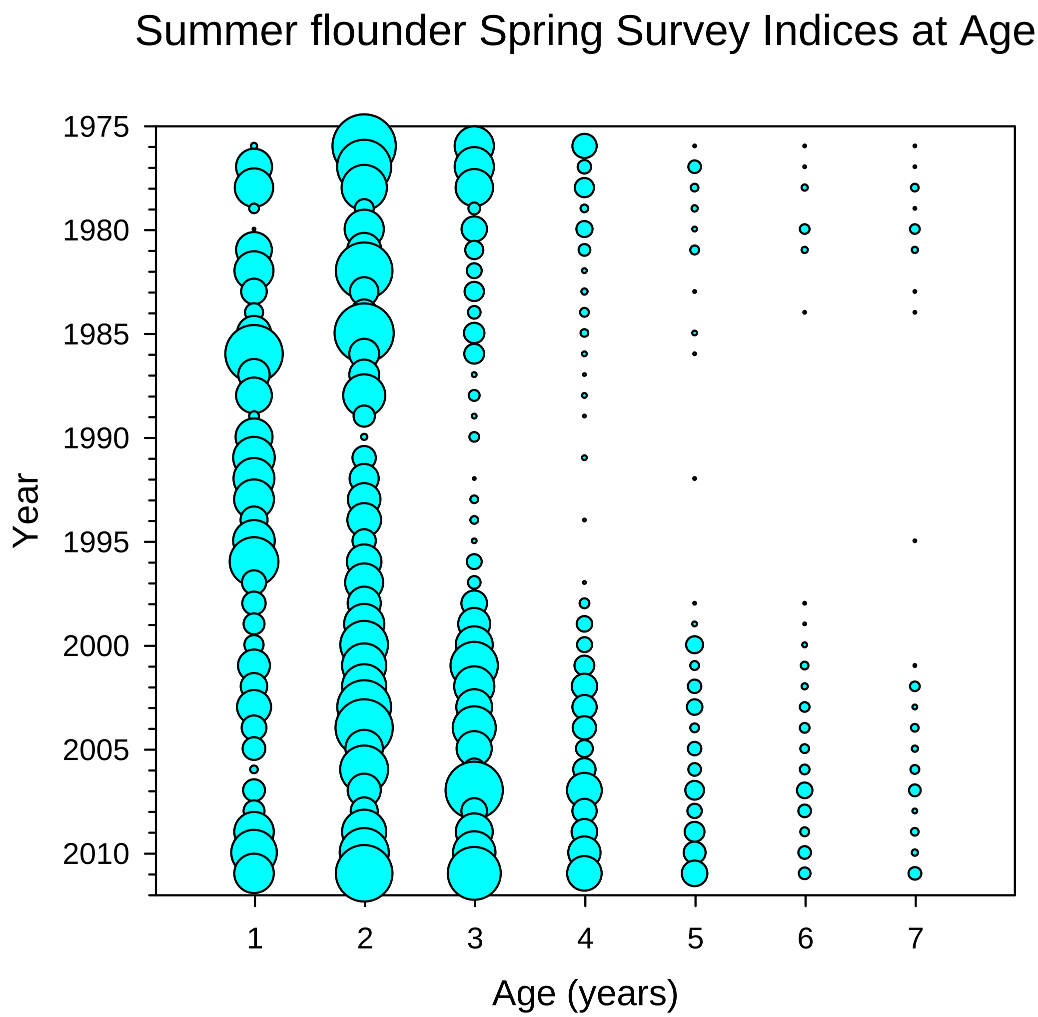


Figure A83. NEFSC spring trawl survey catch at age.

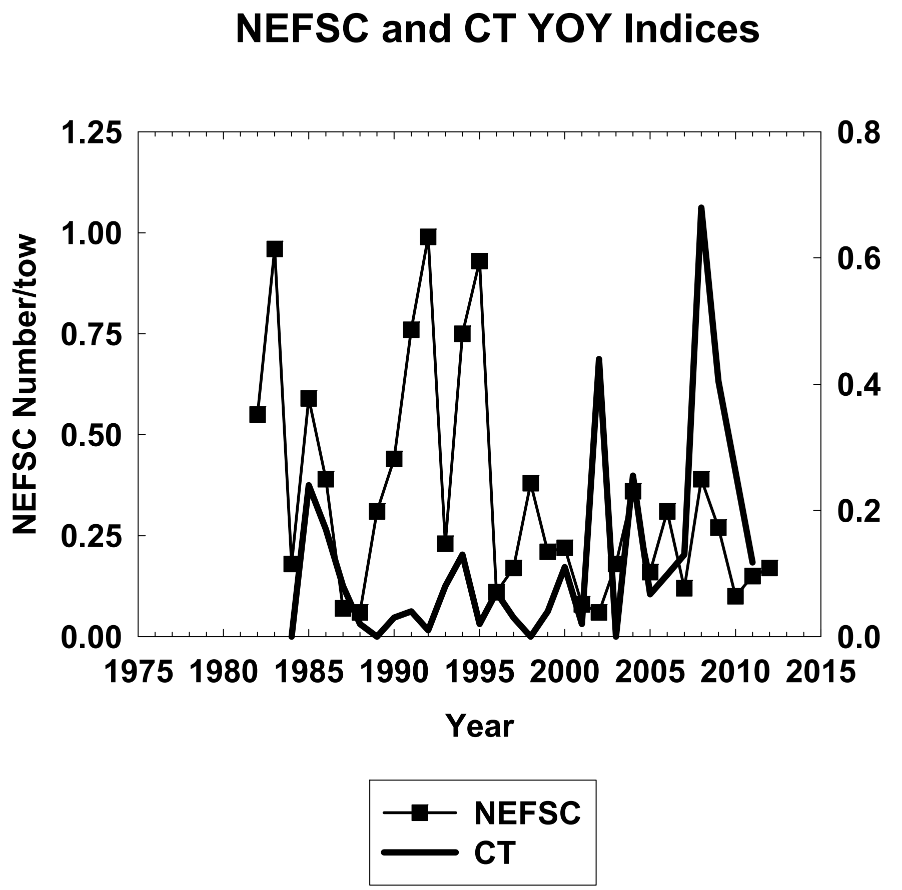


Figure A84. Trends in NEFSC and CT trawl survey recruitment indices for summer flounder.

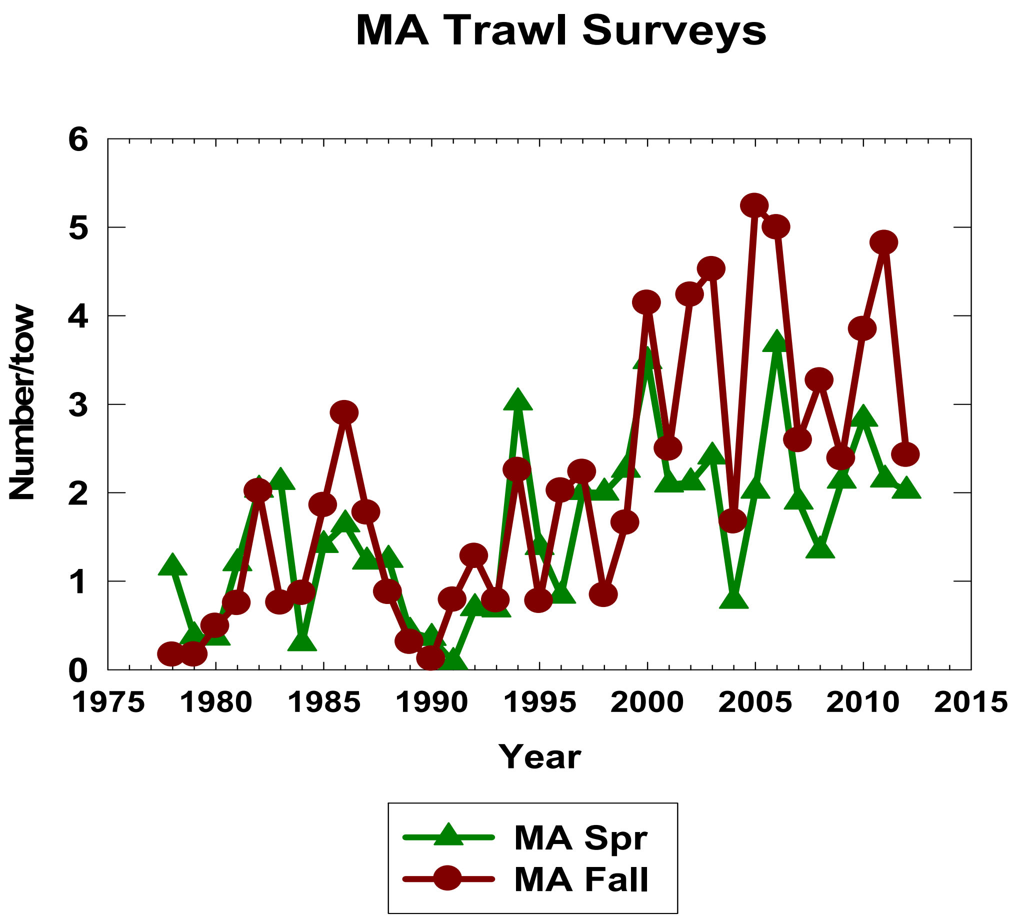


Figure A85. Trends in MA trawl survey abundance indices for summer flounder.

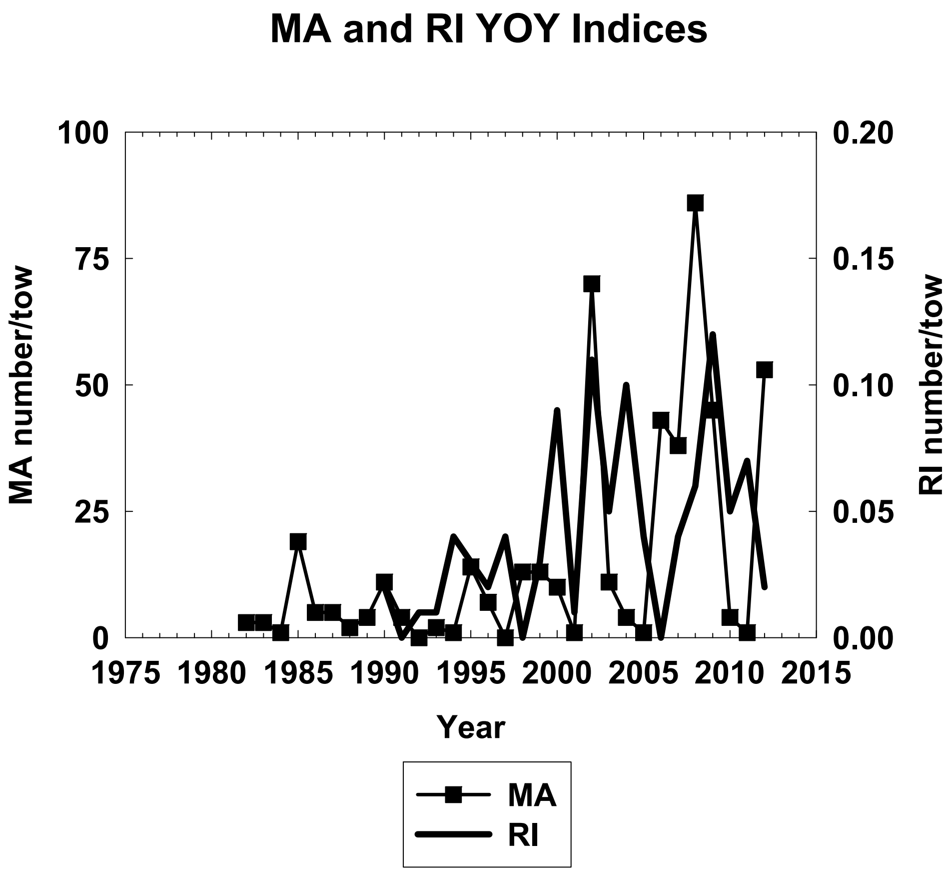


Figure A86. Trends in MA and RI trawl survey recruitment indices for summer flounder.

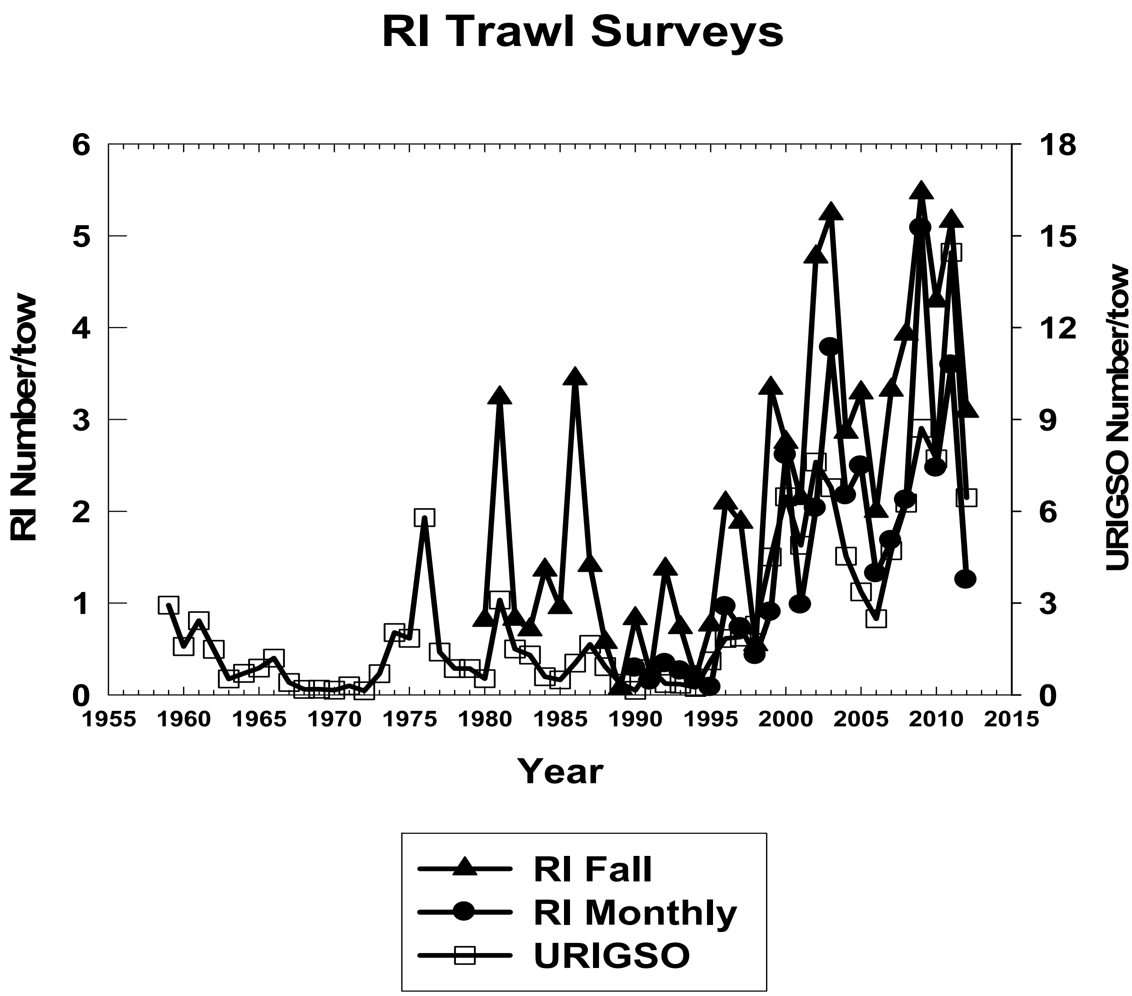


Figure A87. Trends in RI trawl survey abundance indices for summer flounder.

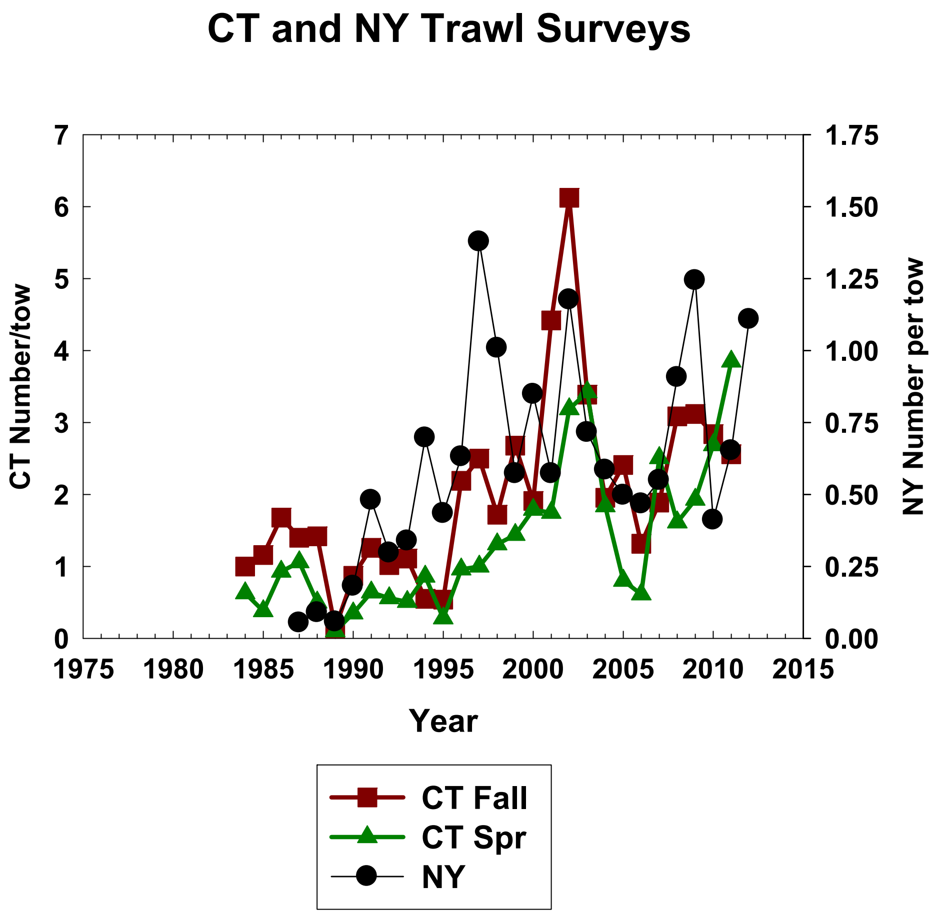


Figure A88. Trends in CT and NY trawl survey abundance indices for summer flounder.

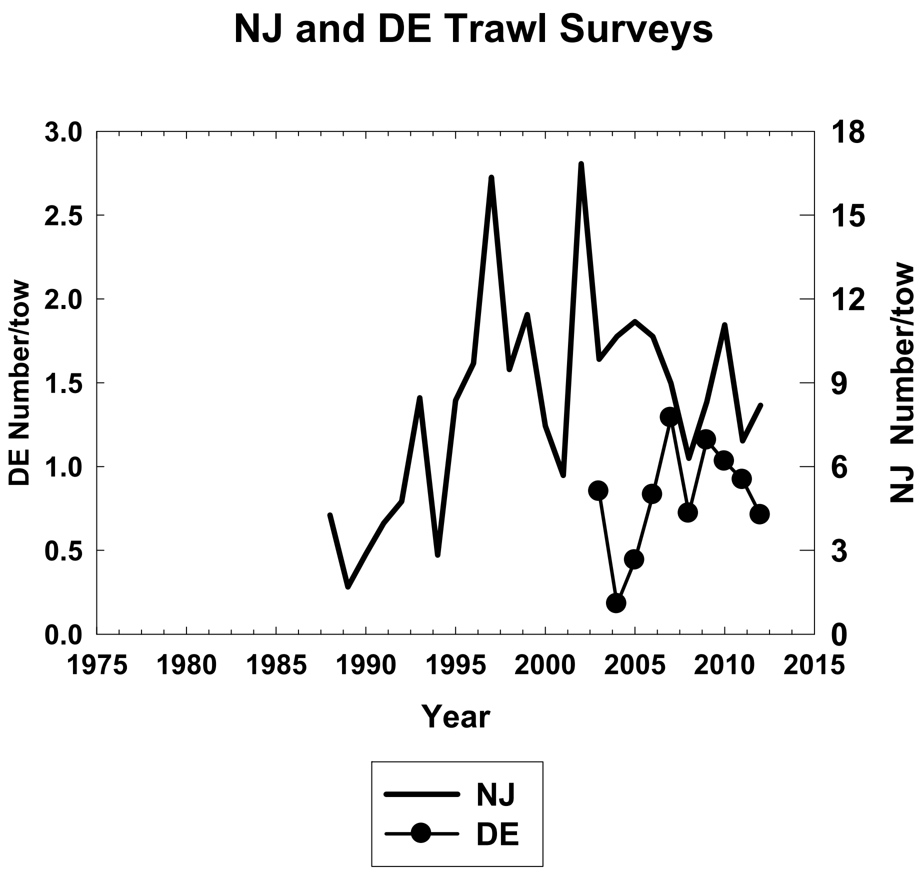


Figure A89. Trends in NJ and DE trawl survey abundance indices for summer flounder.

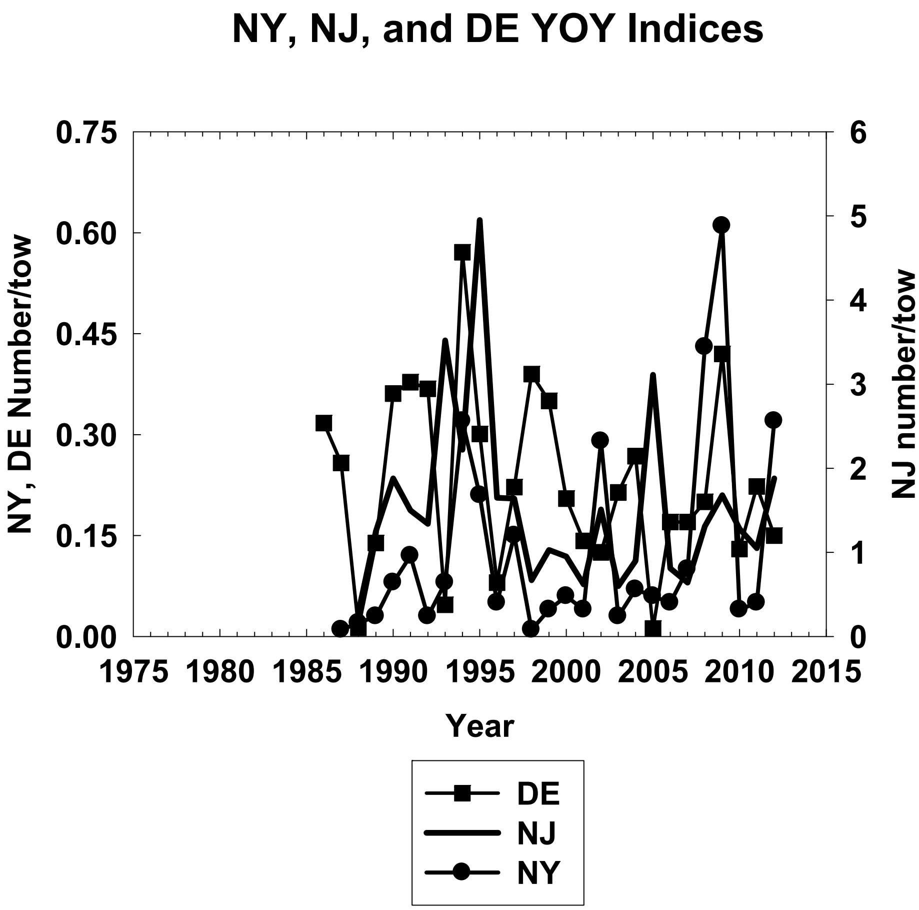


Figure A90. Trends in NY, DE, and NJ trawl survey recruitment indices for summer flounder.

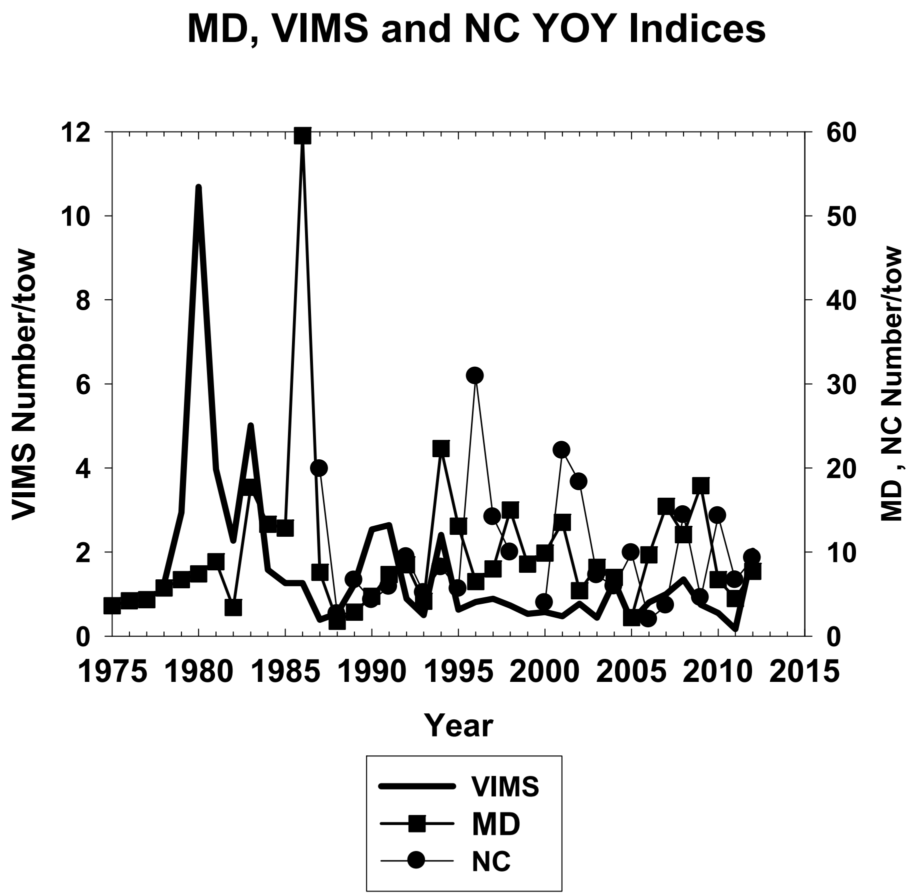


Figure A91. Trends in MD, VIMS and NC trawl survey recruitment indices for summer flounder.

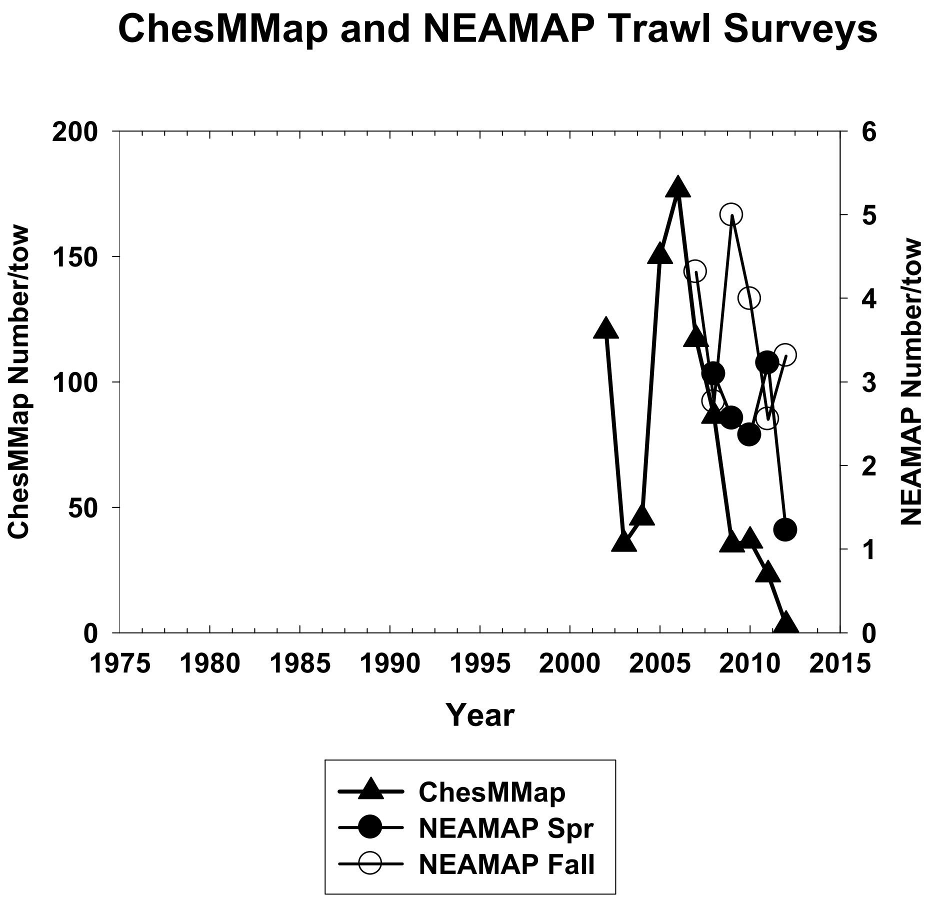


Figure A92. Trends in NEAMAP and ChesMMAP trawl survey abundance indices for summer flounder.

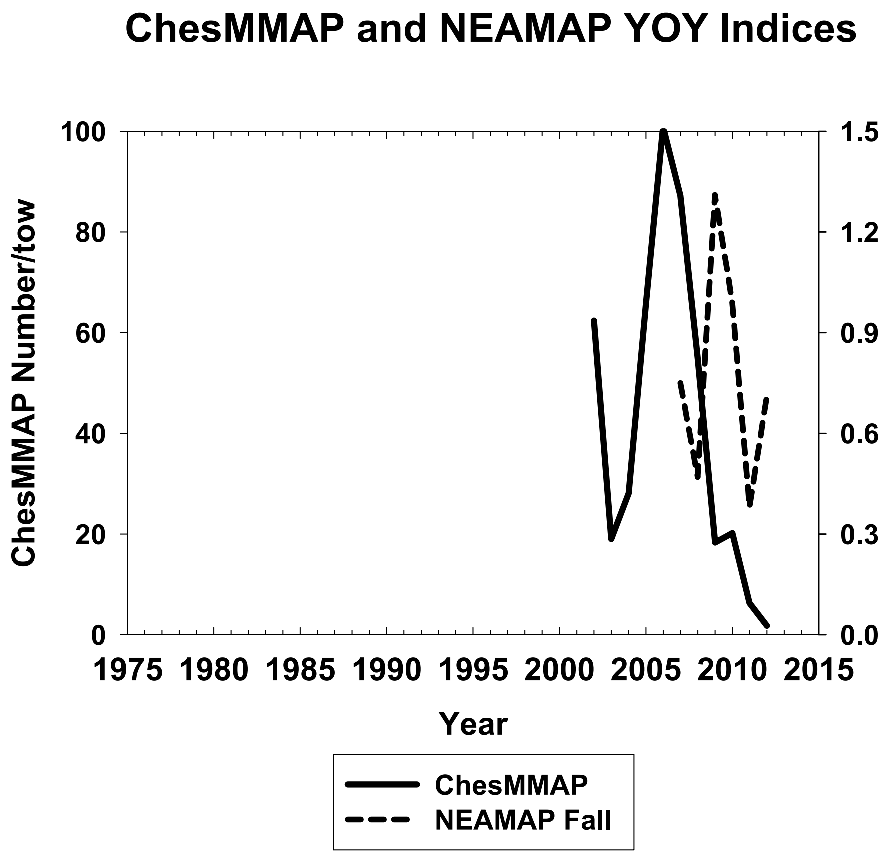


Figure A93. Trends in VIMS ChesMMAP and NEAMAP fall trawl survey recruitment indices for summer flounder.

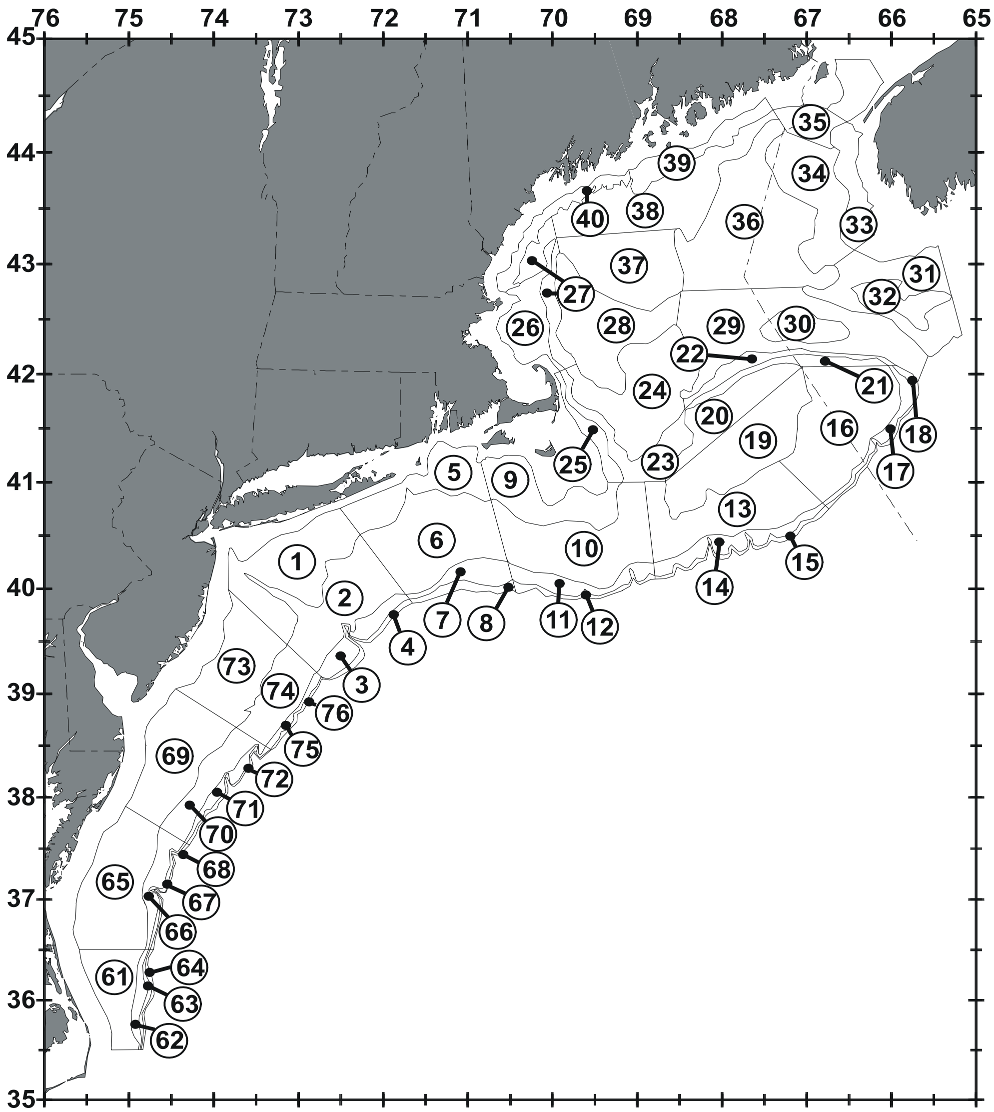


Figure A94. Offshore depth strata (27 meters [15 fathoms] to > 200 meters [109 fathoms]) sampled during Northeast Fisheries Science Center bottom trawl research surveys.

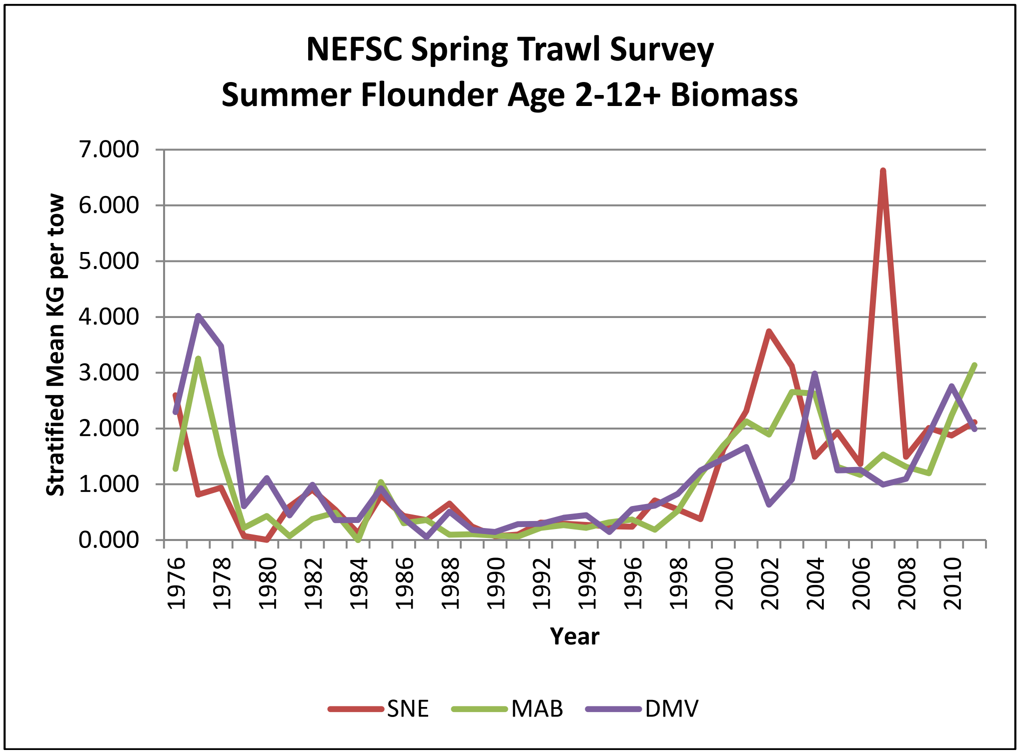


Figure A95. Annual NEFSC spring trawl survey indices of SSB of summer flounder in three distinct regions (Southern New England [SNE], Mid-Atlantic Bight [MAB], and DelMarVa [DMV]) of the northwest Atlantic.

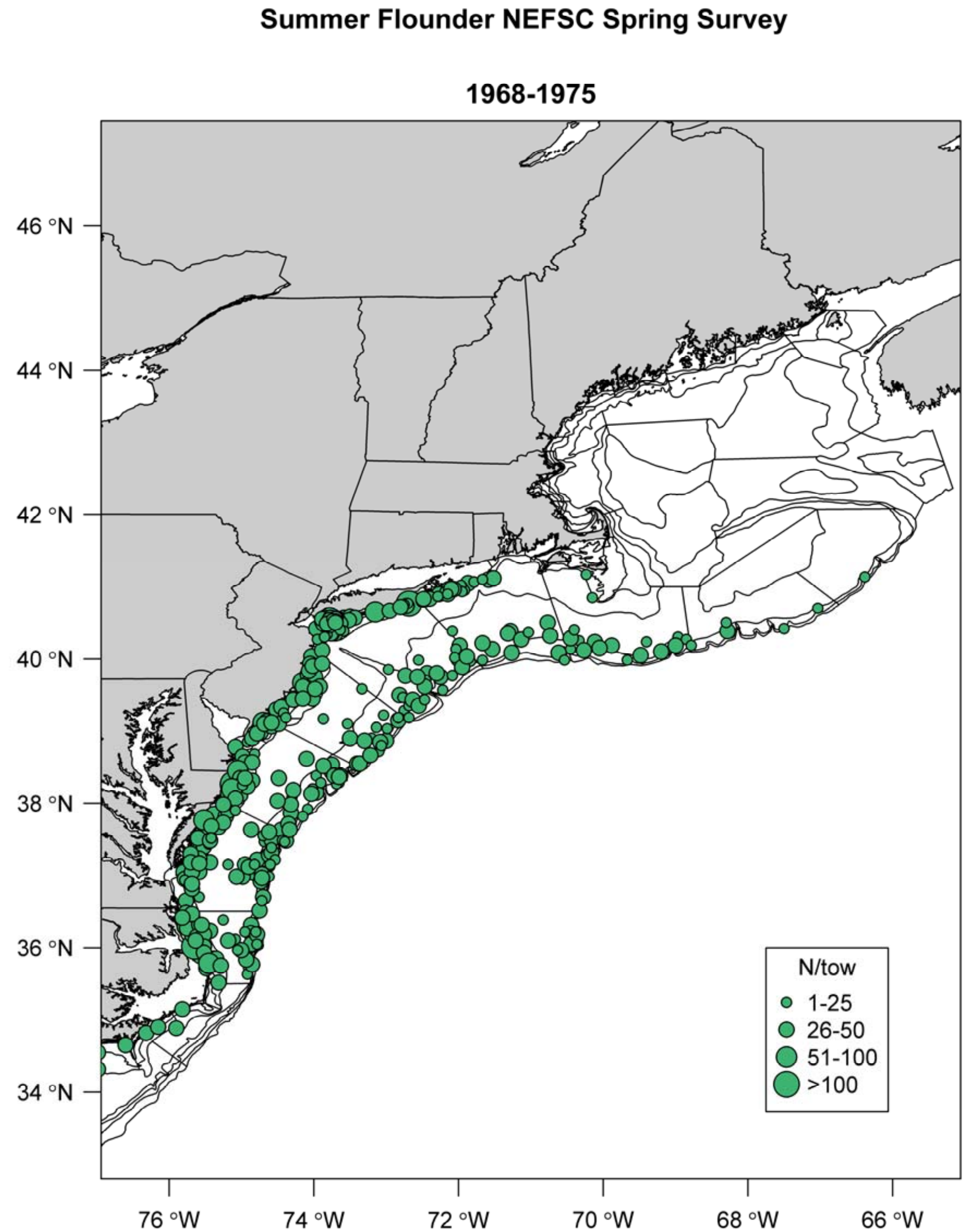


Figure A96. NEFSC spring survey catch numbers per tow, 1968-1975.

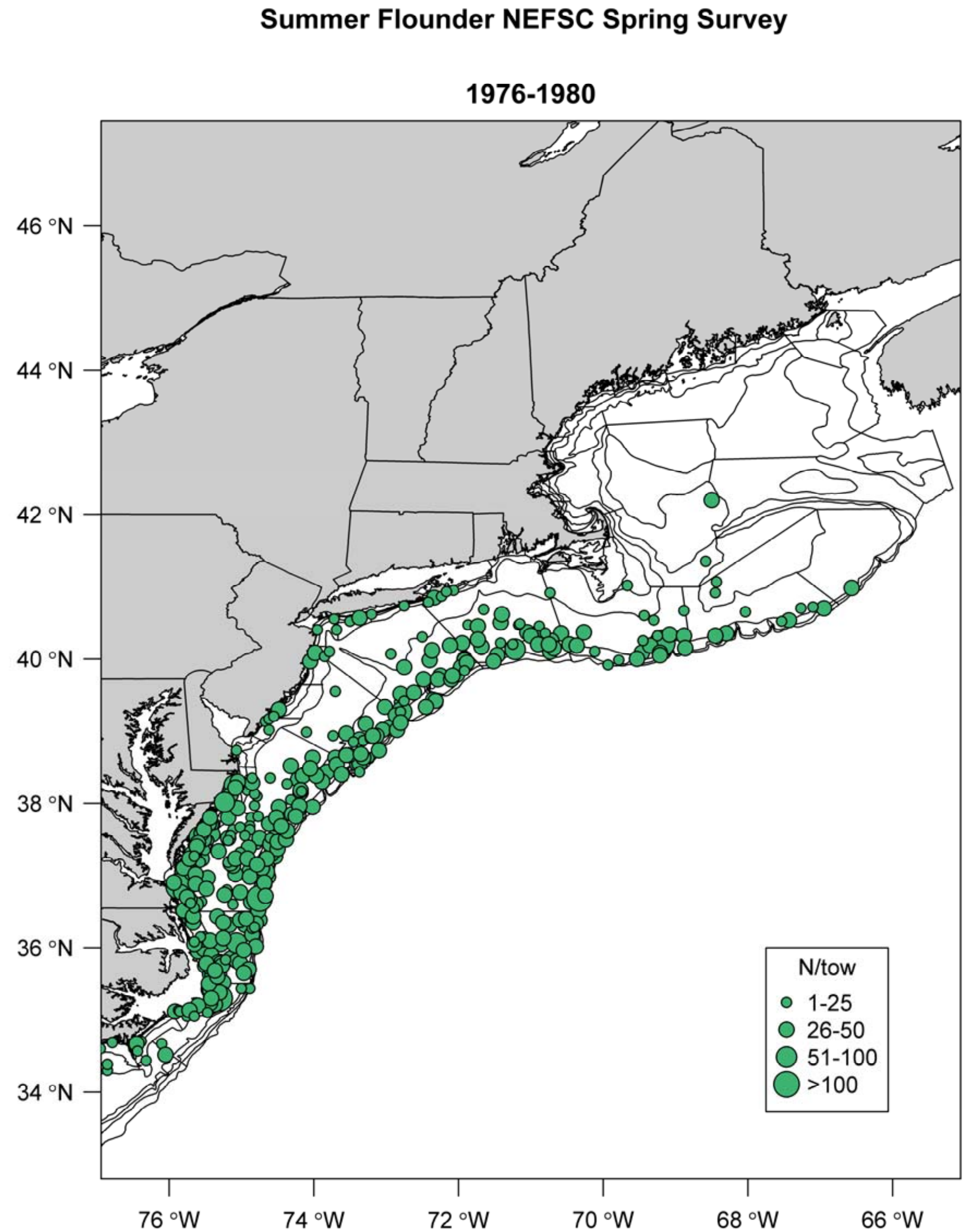


Figure A97. NEFSC spring survey catch numbers per tow, 1976-1980.

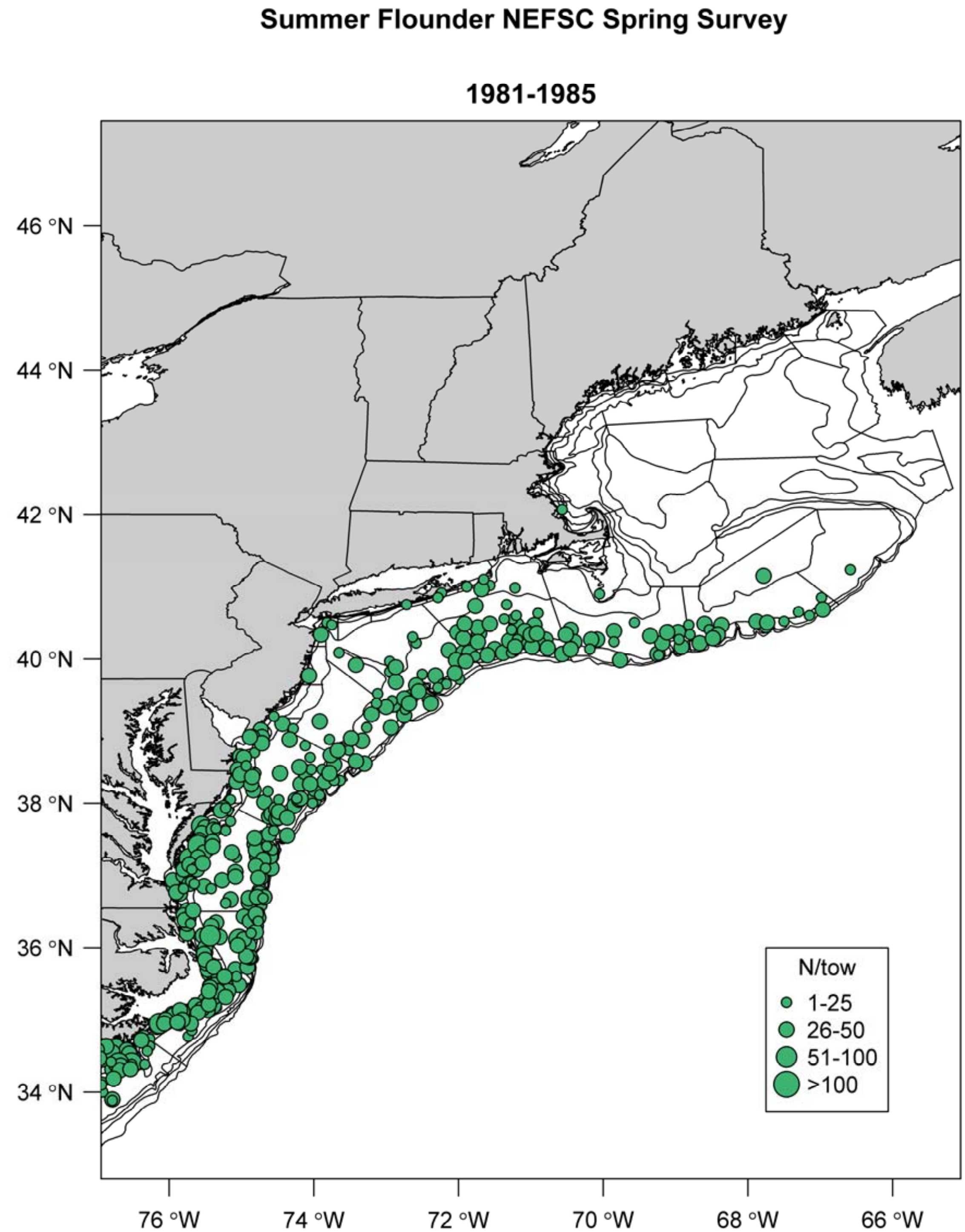


Figure A98. NEFSC spring survey catch numbers per tow, 1981-1985.

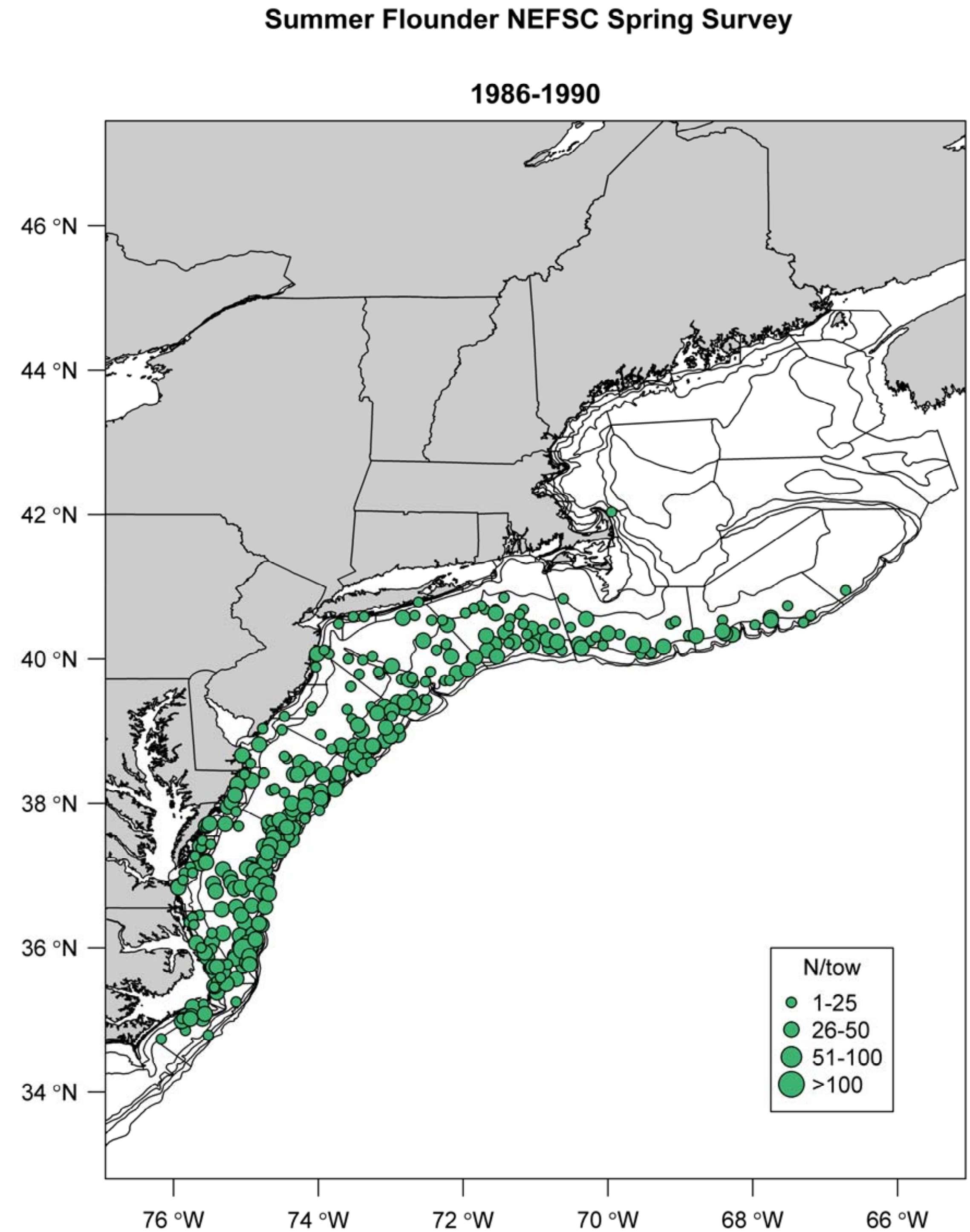


Figure A99. NEFSC spring survey catch numbers per tow, 1986-1990.

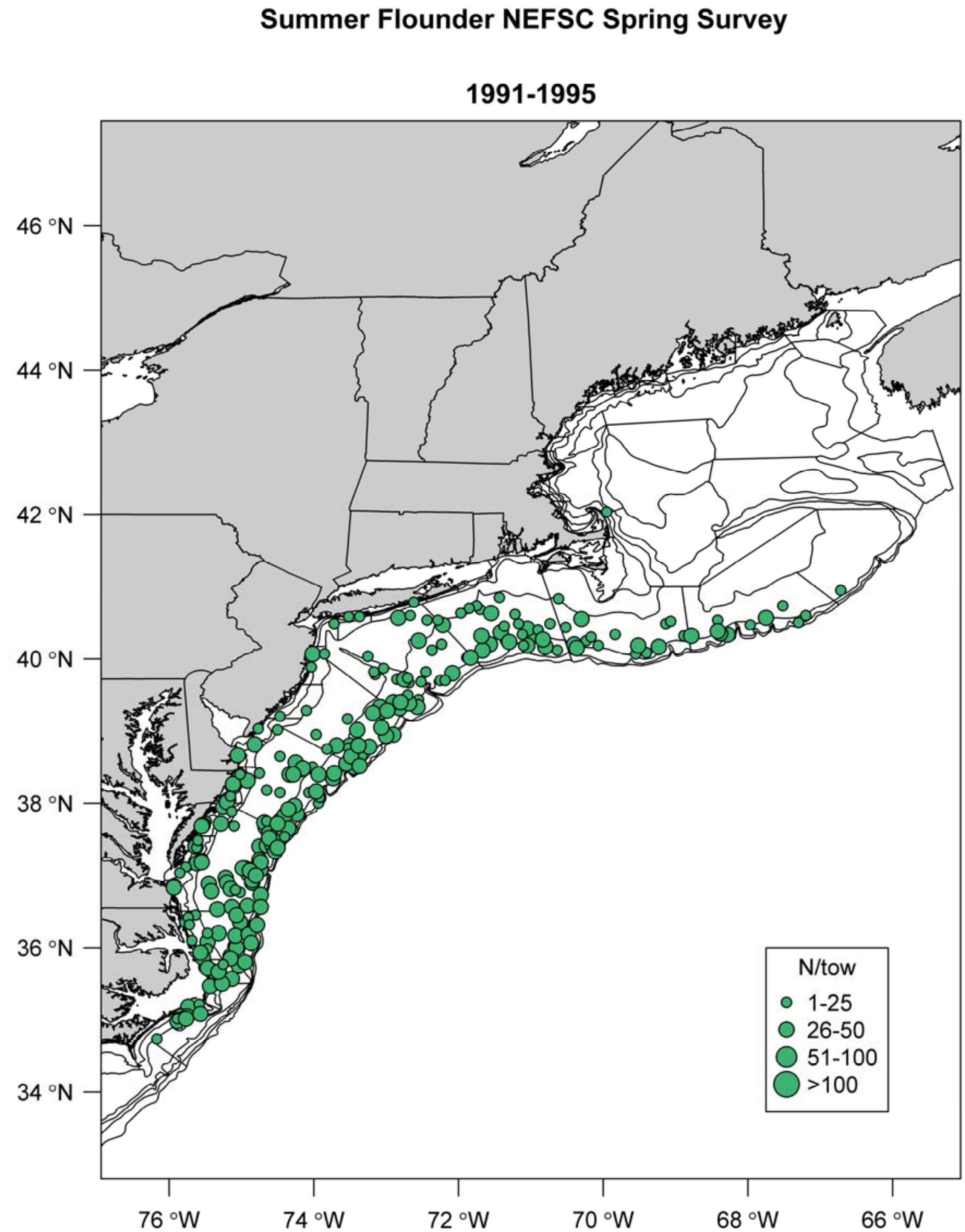


Figure A100. NEFSC spring survey catch numbers per tow, 1991-1995.

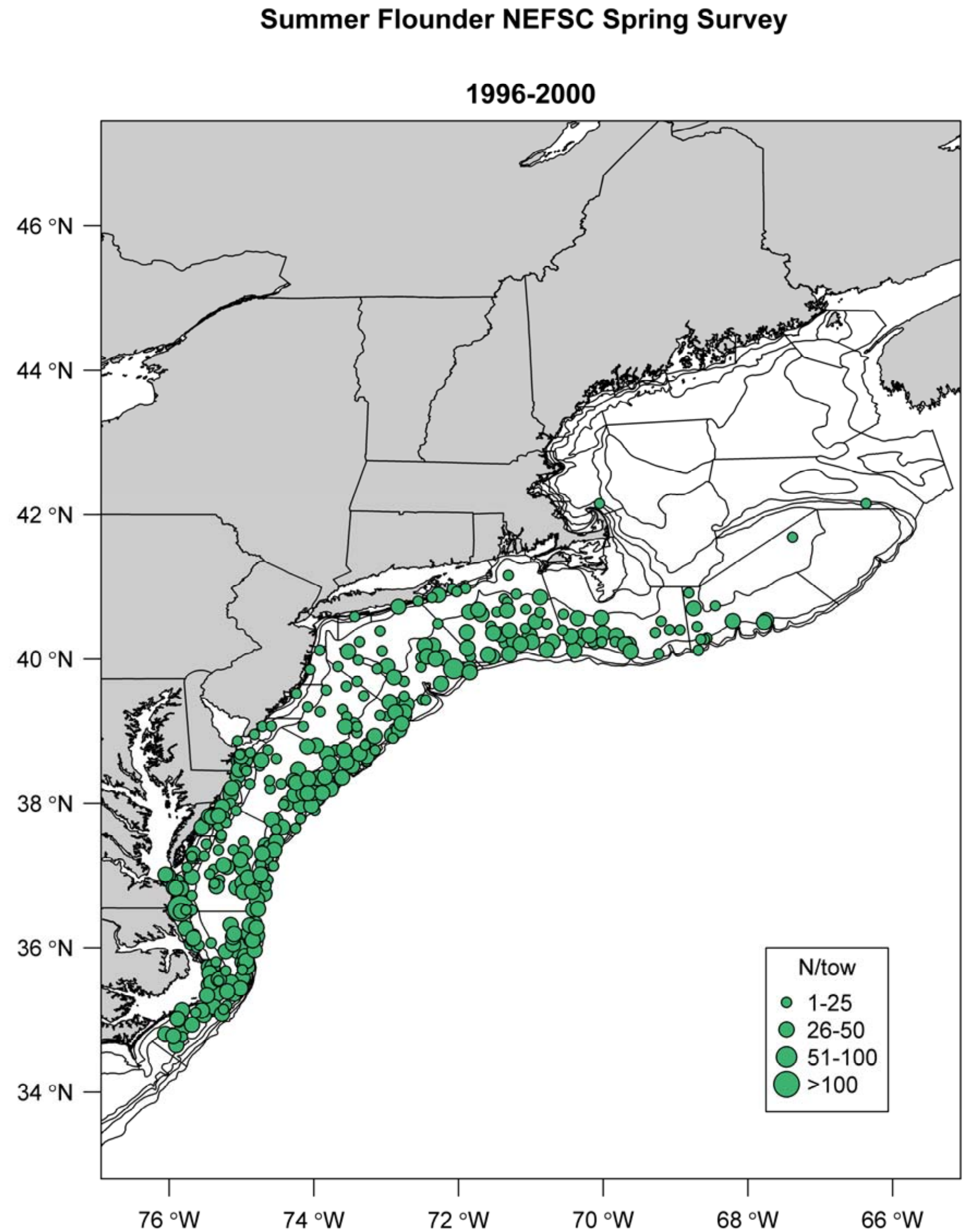


Figure A101. NEFSC spring survey catch numbers per tow, 1996-2000.

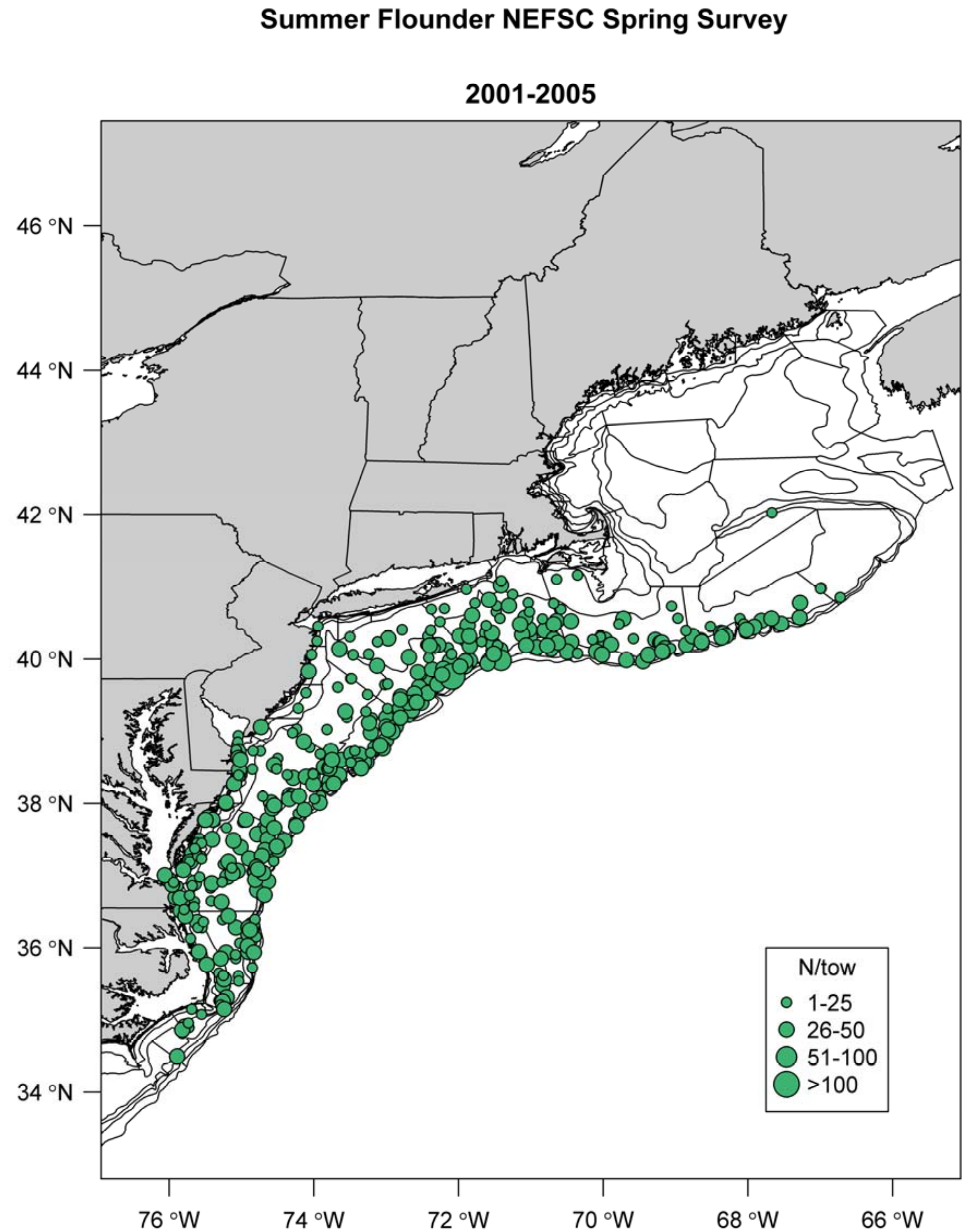


Figure A102. NEFSC spring survey catch numbers per tow, 2001-2005.

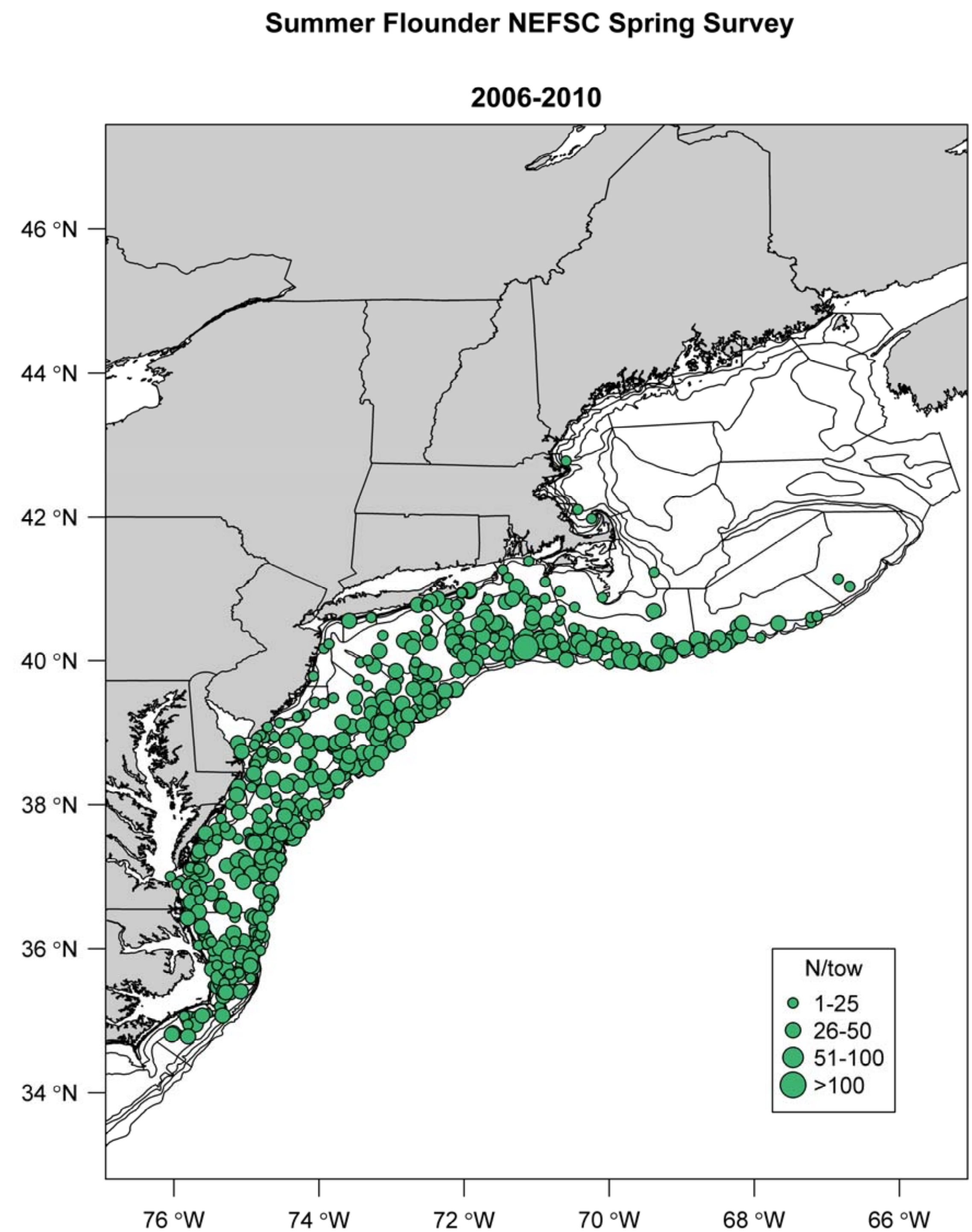


Figure A103. NEFSC spring survey catch numbers per tow, 2006-2010.

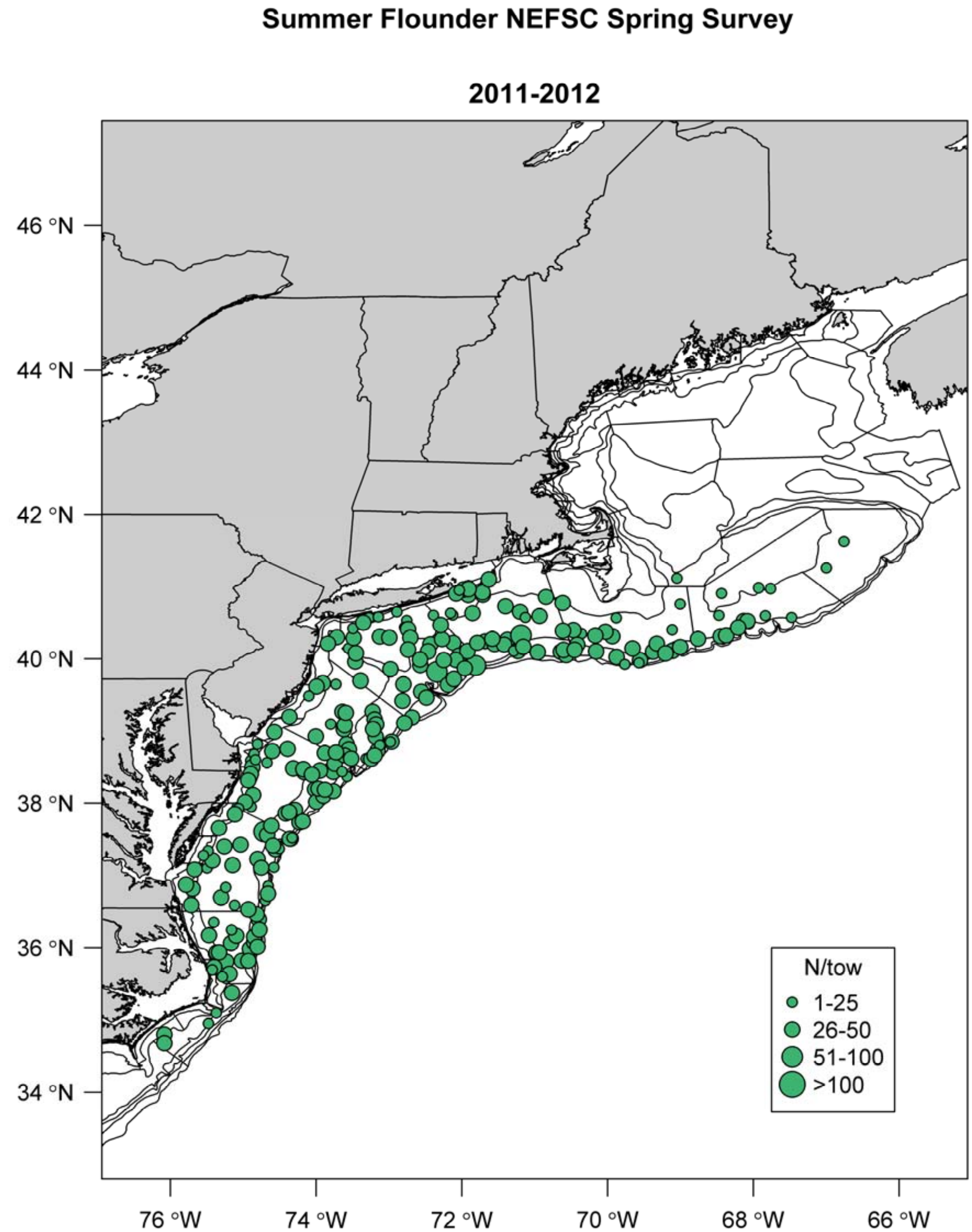


Figure A104. NEFSC spring survey catch numbers per tow, 2011-2012.

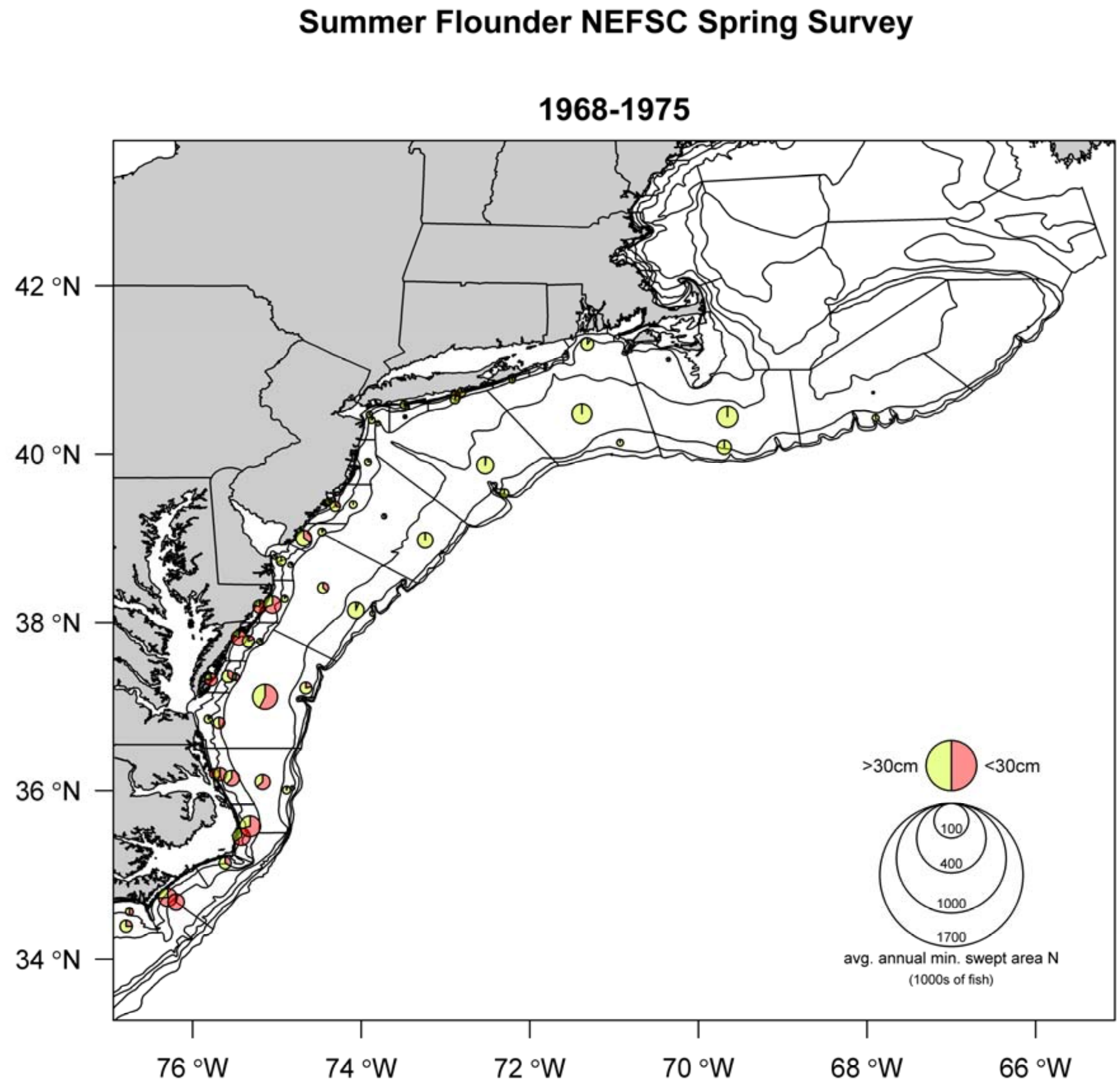


Figure A105. NEFSC spring survey average minimum swept area abundances by strata and size category, 1968-1975.

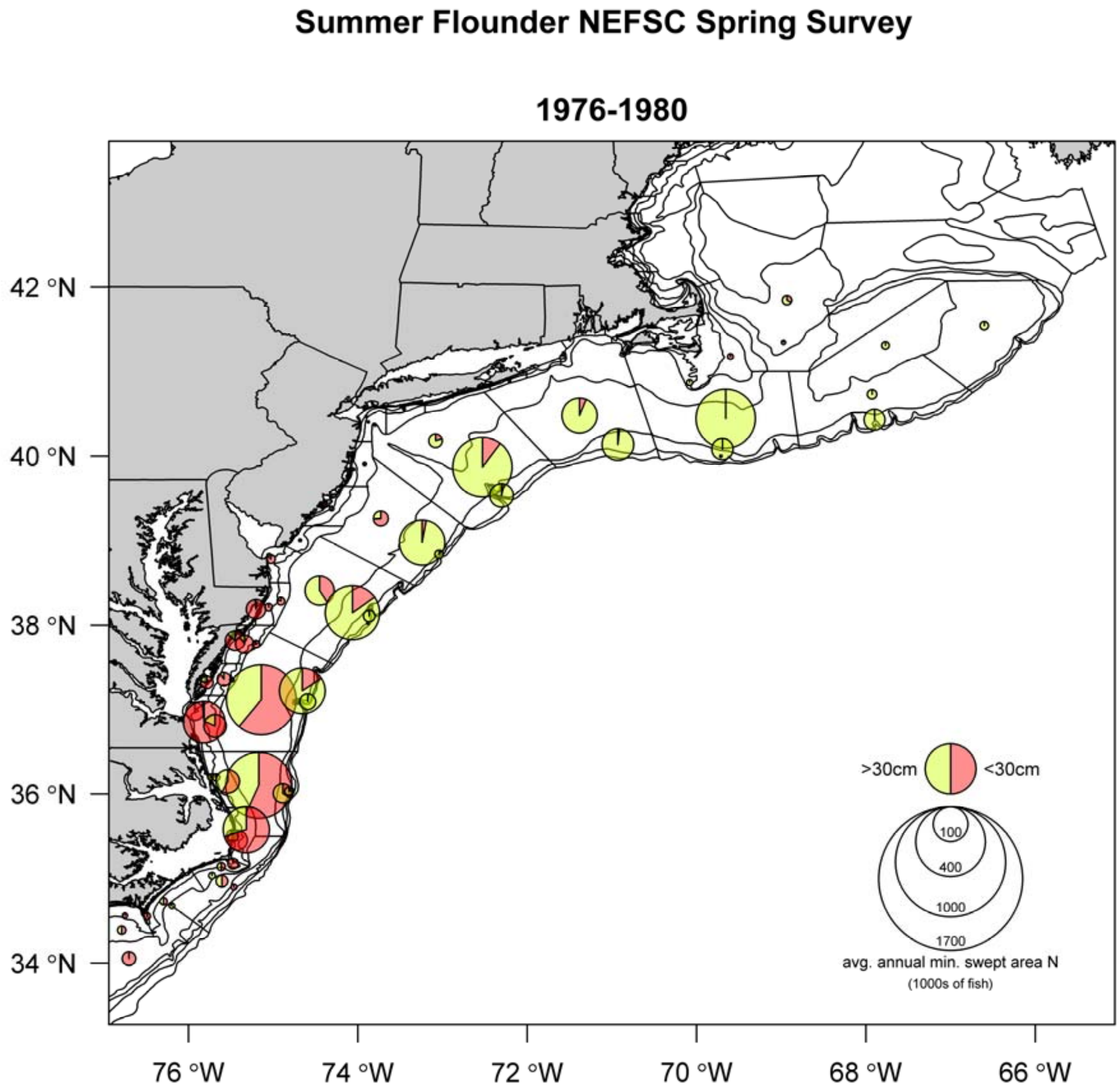


Figure A106. NEFSC spring survey average minimum swept area abundances by strata and size category, 1976-1980.

Summer Flounder NEFSC Spring Survey

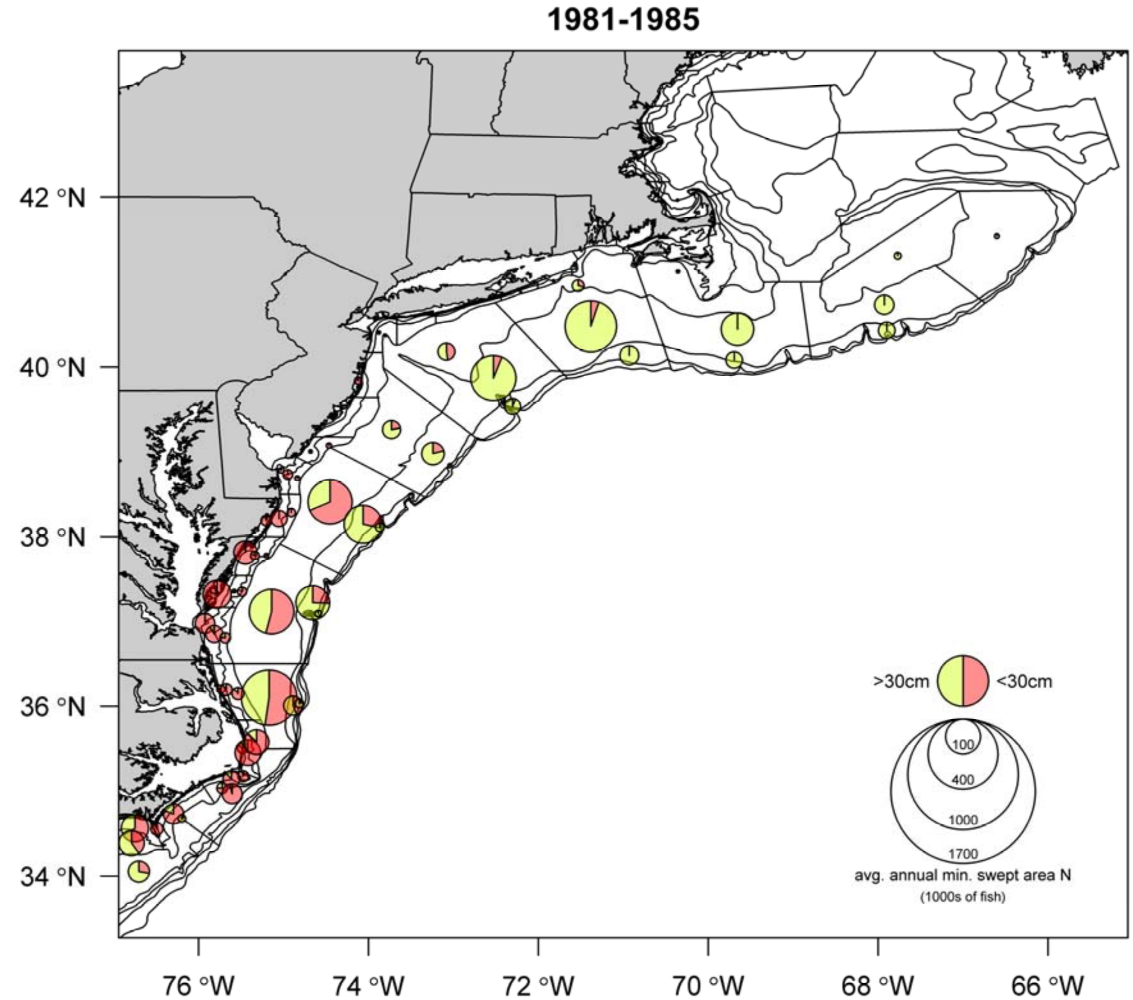


Figure A107. NEFSC spring survey average minimum swept area abundances by strata and size category, 1981-1985.

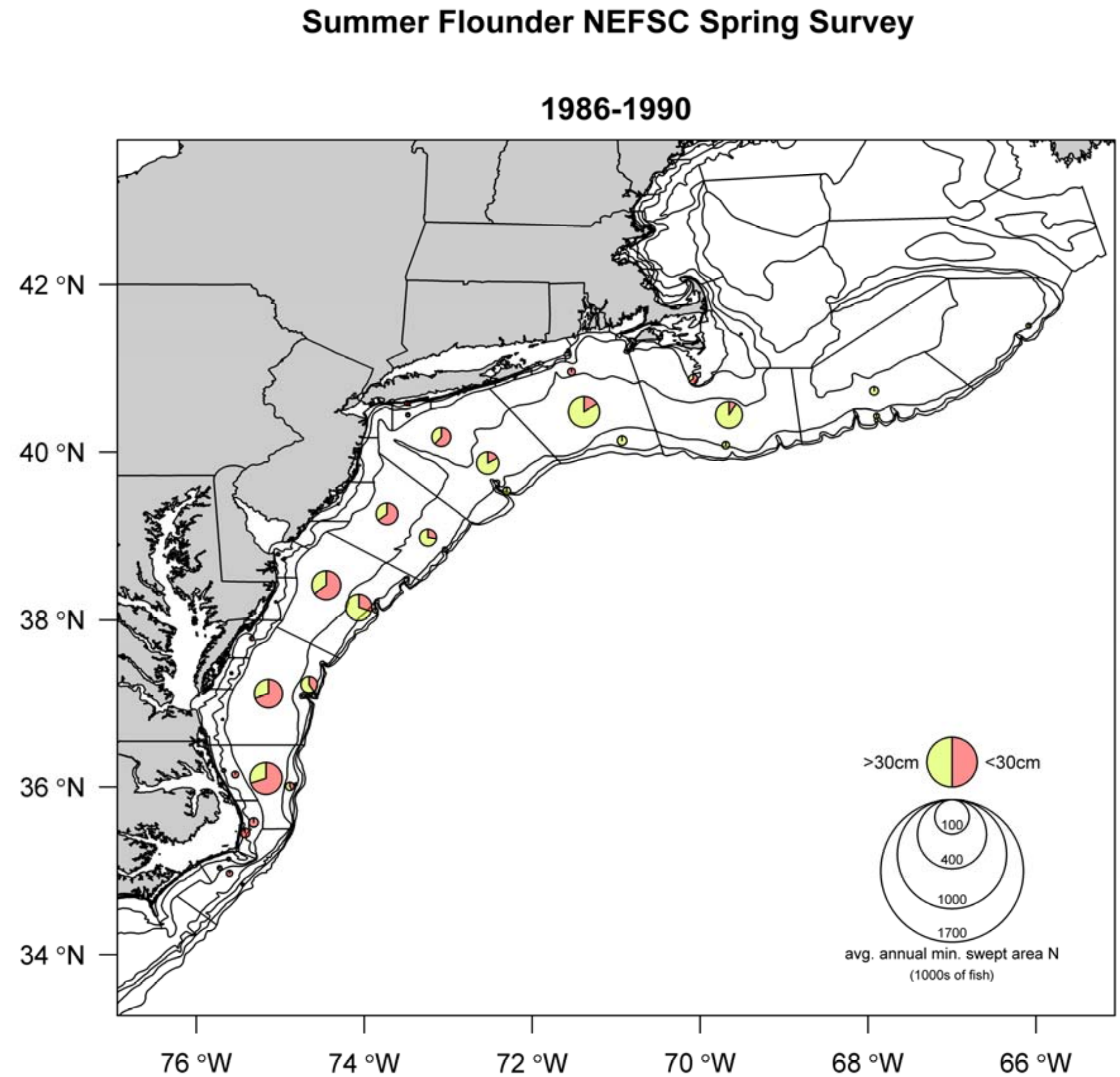


Figure A108. NEFSC spring survey average minimum swept area abundances by strata and size category, 1986-1990.

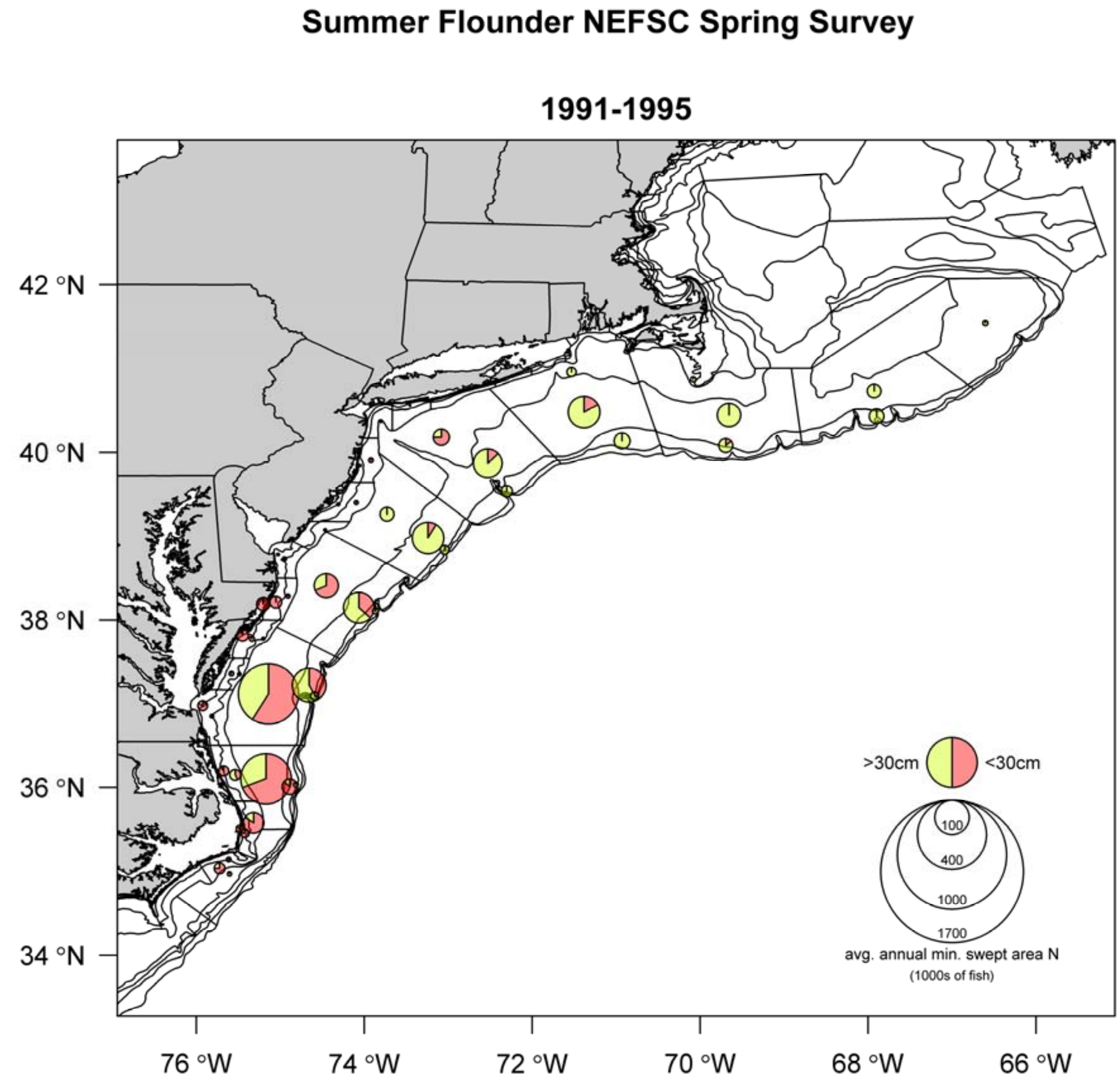


Figure A109. NEFSC spring survey average minimum swept area abundances by strata and size category, 1991-1995.

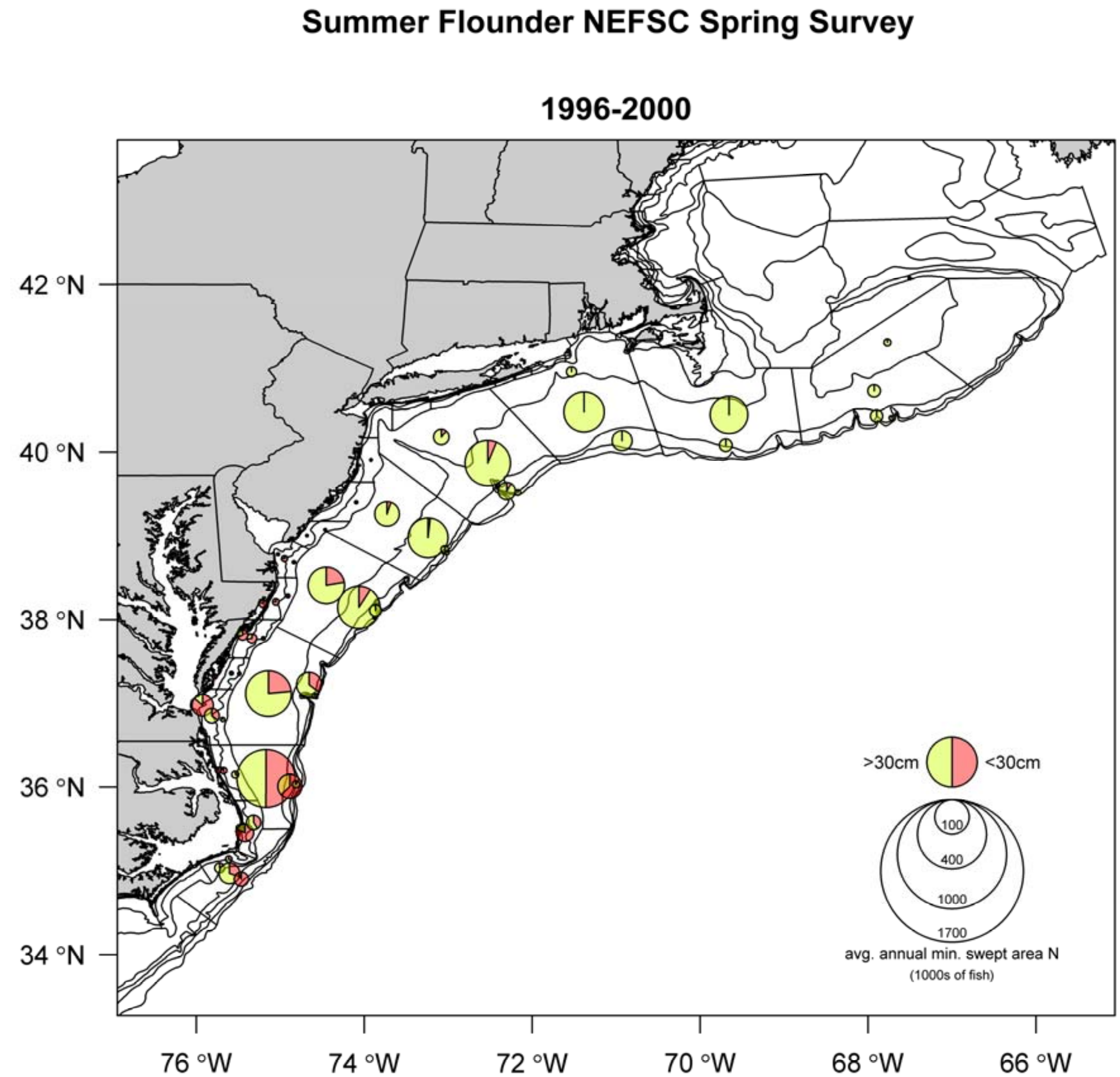


Figure A110. NEFSC spring survey average minimum swept area abundances by strata and size category, 1996-2000.

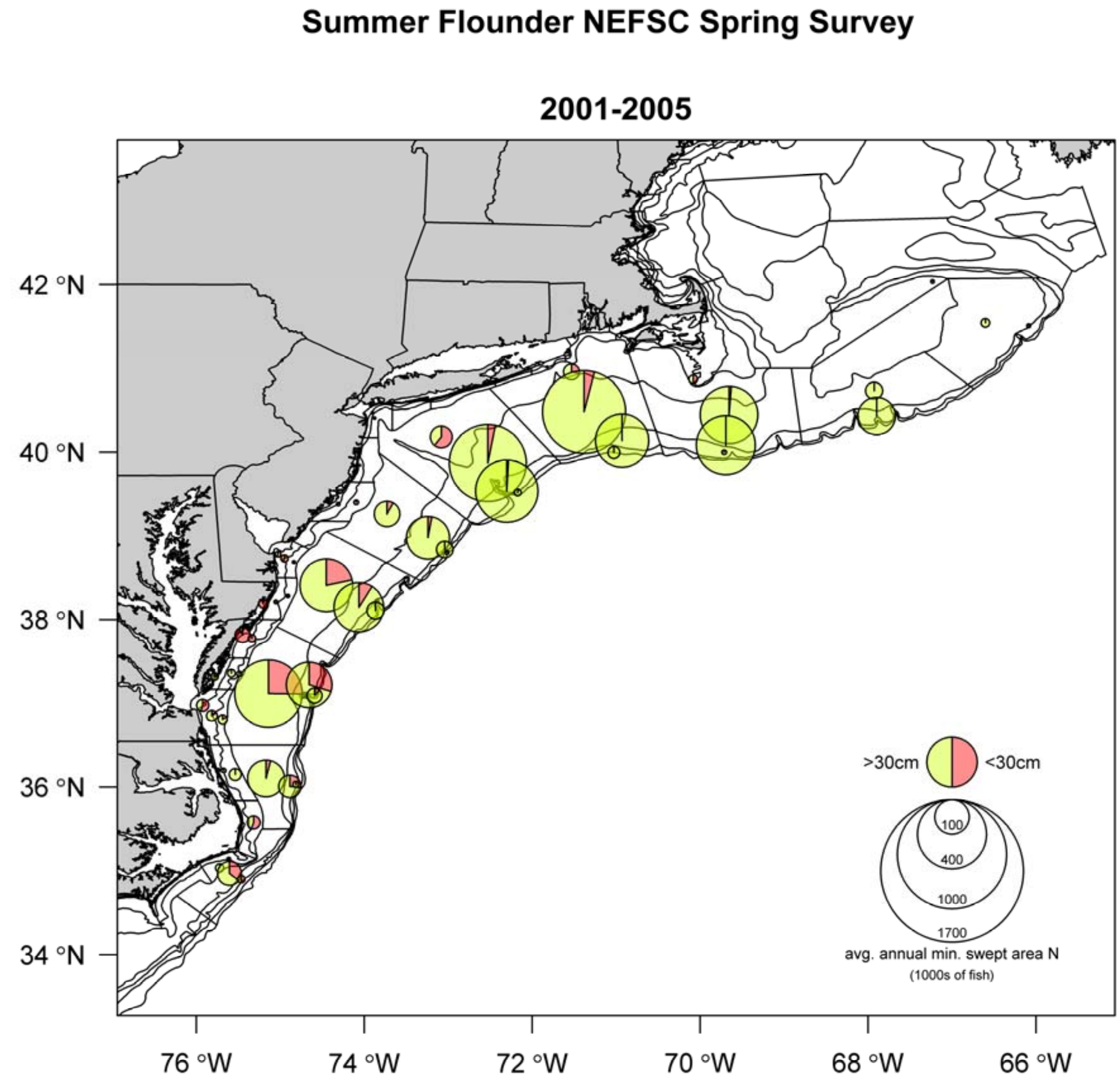


Figure A111. NEFSC spring survey average minimum swept area abundances by strata and size category, 2001-2005.

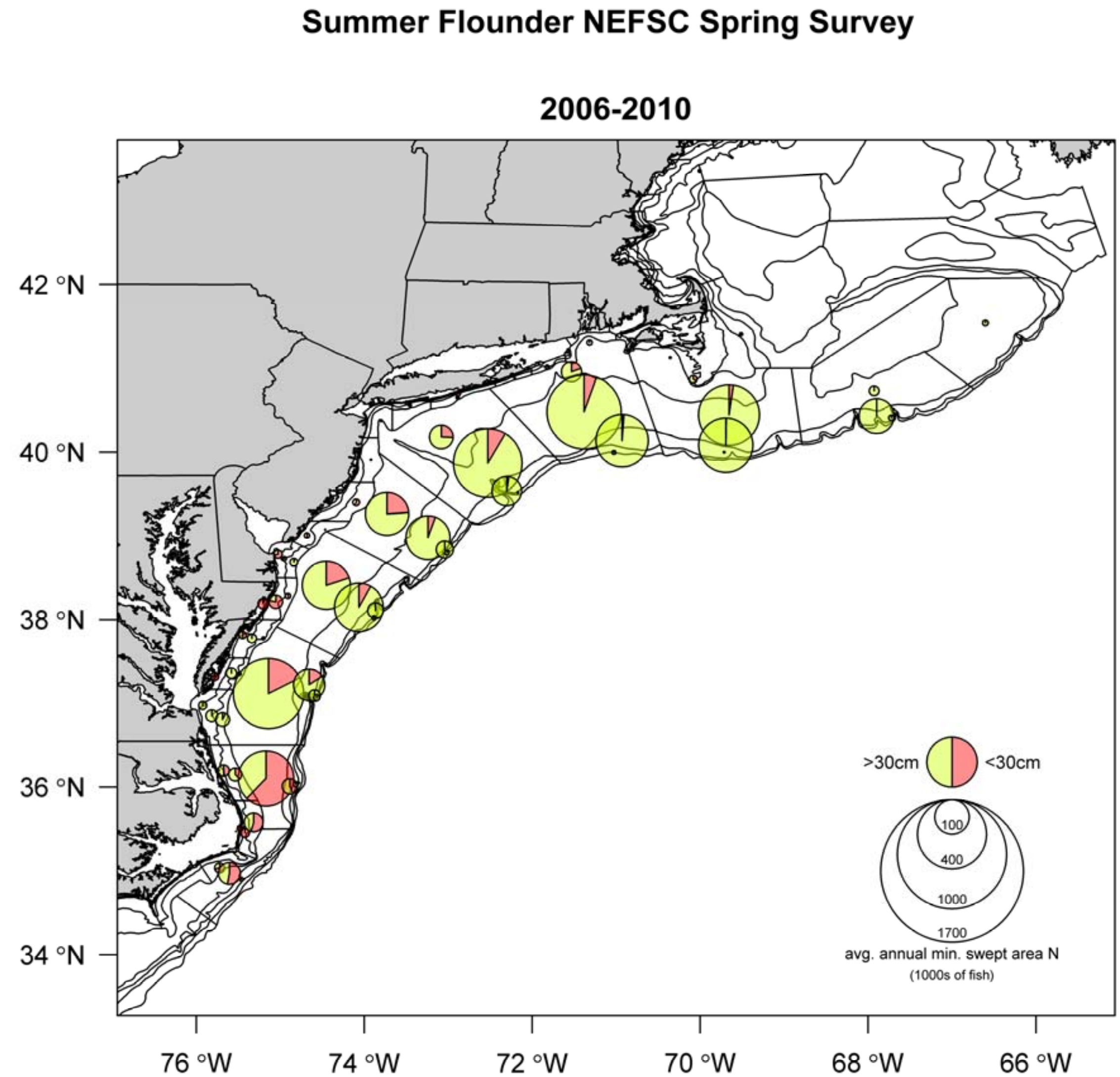


Figure A112. NEFSC spring survey average minimum swept area abundances by strata and size category, 2006-2010.

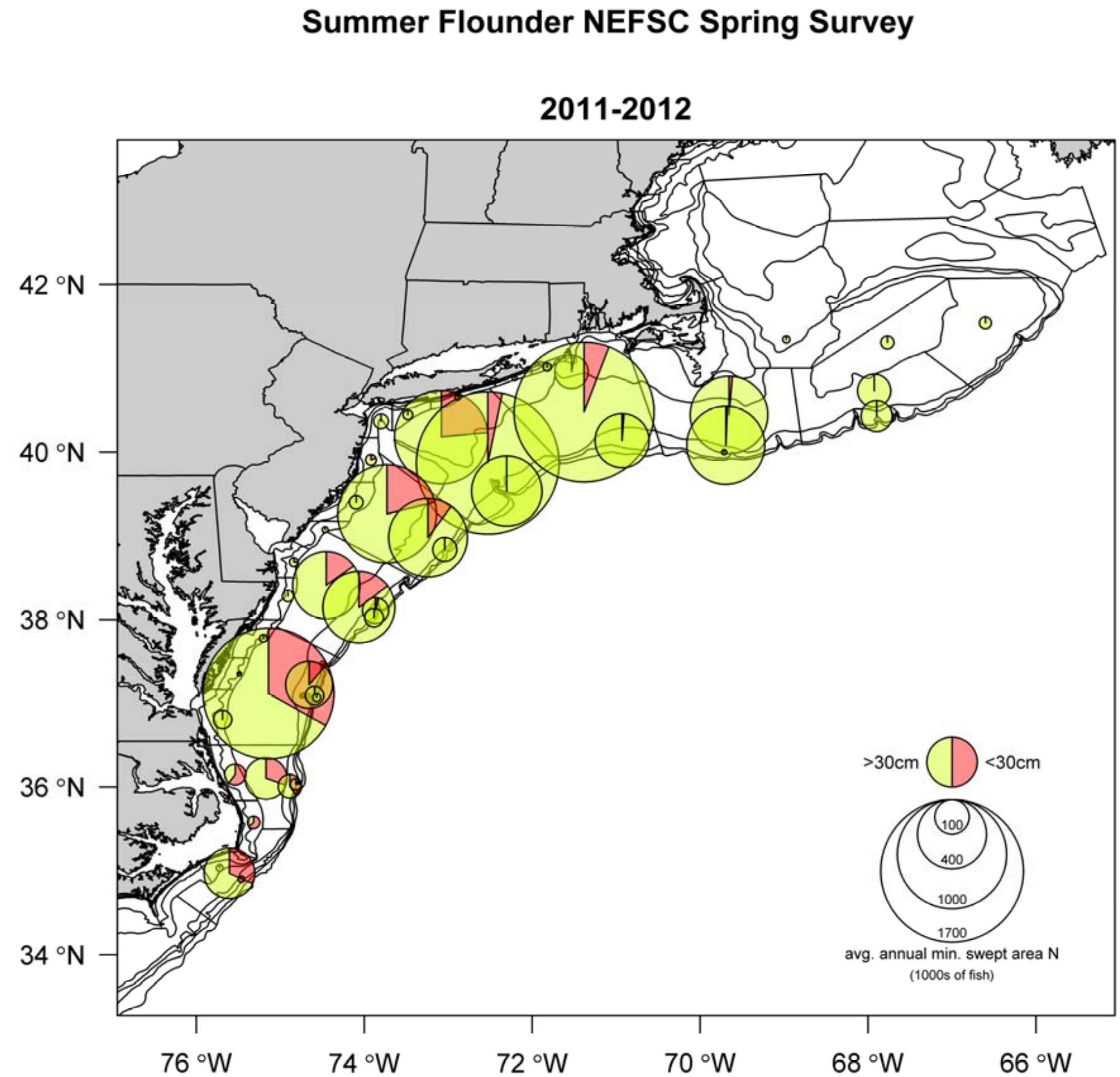


Figure A113. NEFSC spring survey average minimum swept area abundances by strata and size category, 2011-2012.

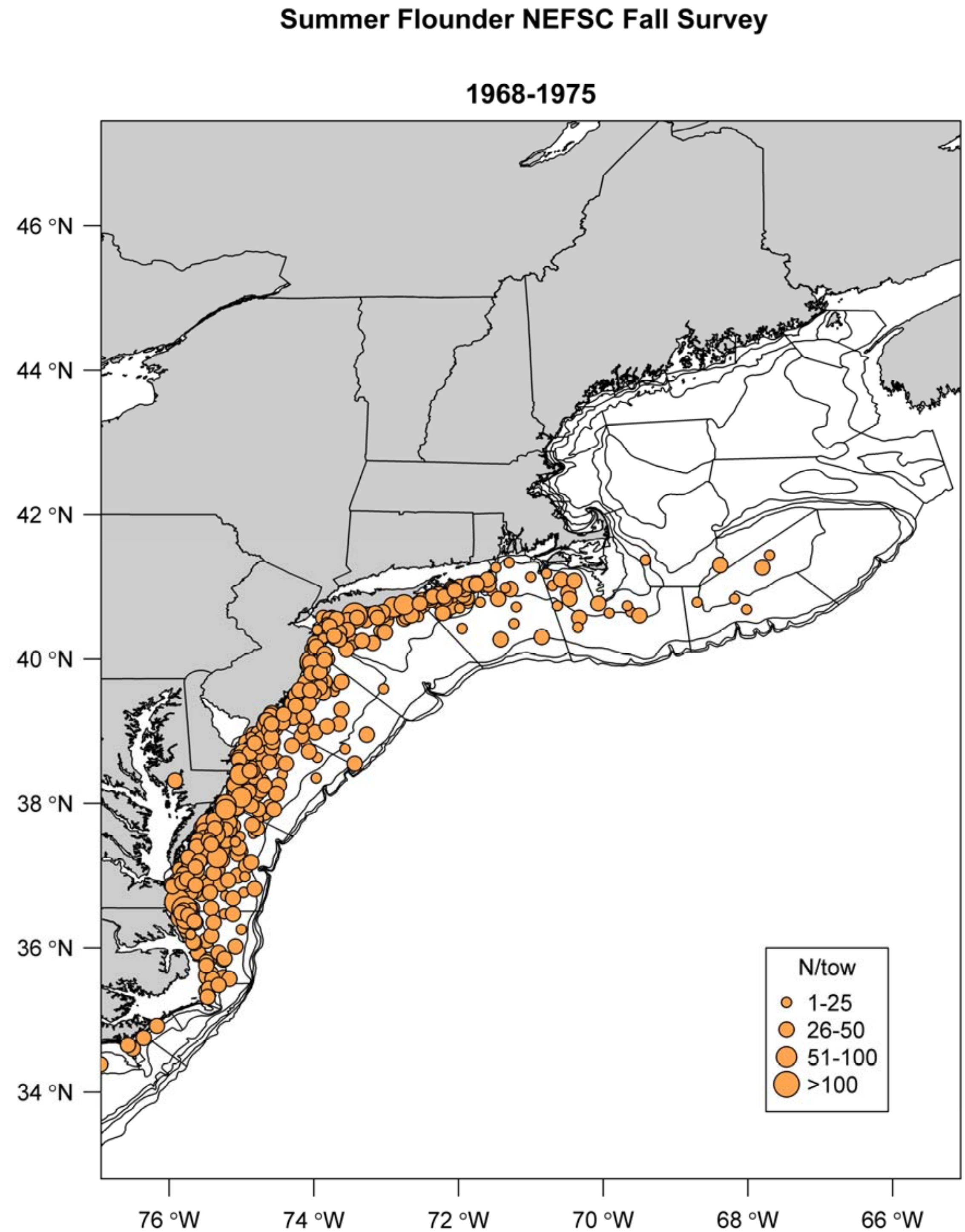


Figure A114. NEFSC fall survey catch numbers per tow, 1968-1975.

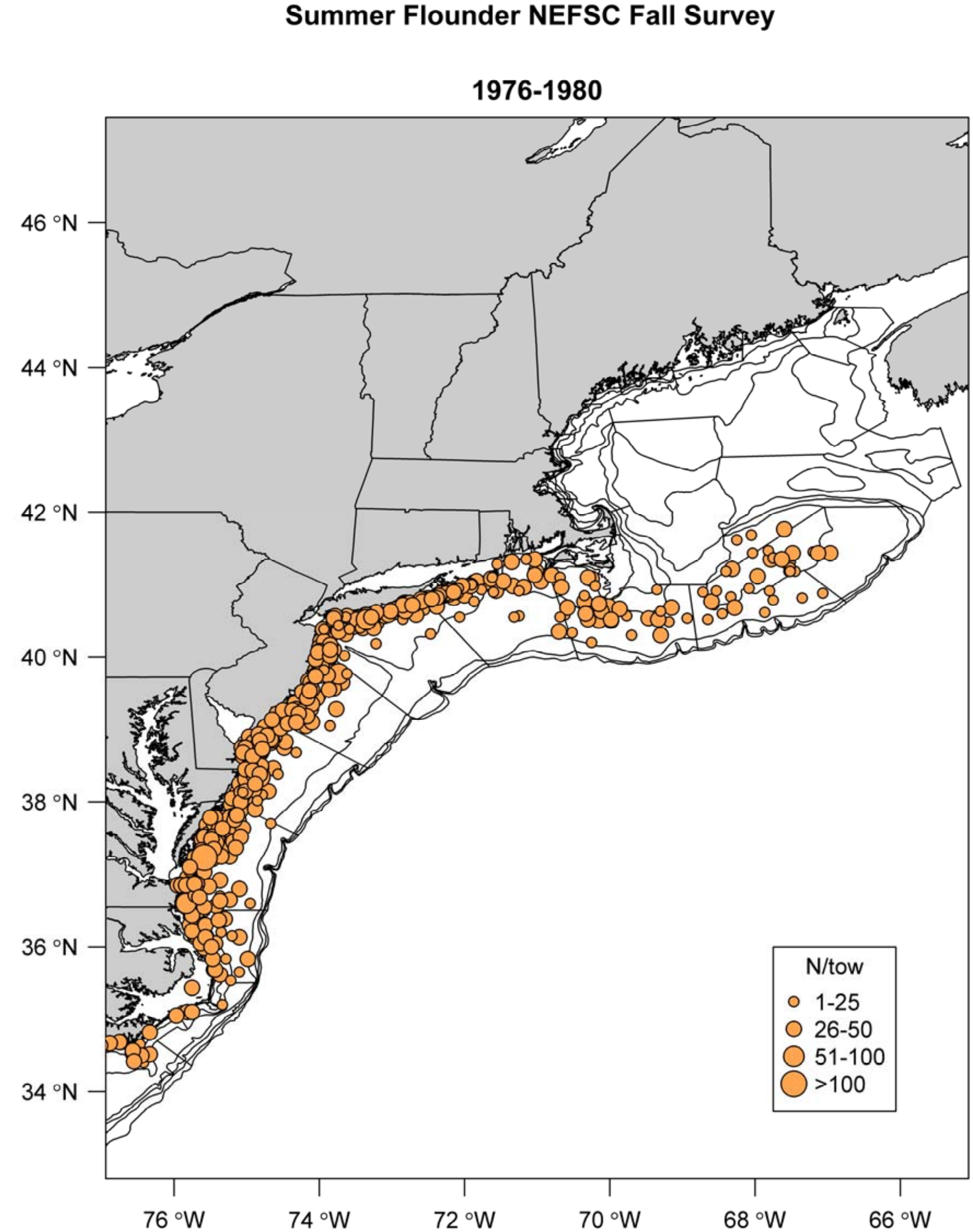


Figure A115. NEFSC fall survey catch numbers per tow, 1976-1980.

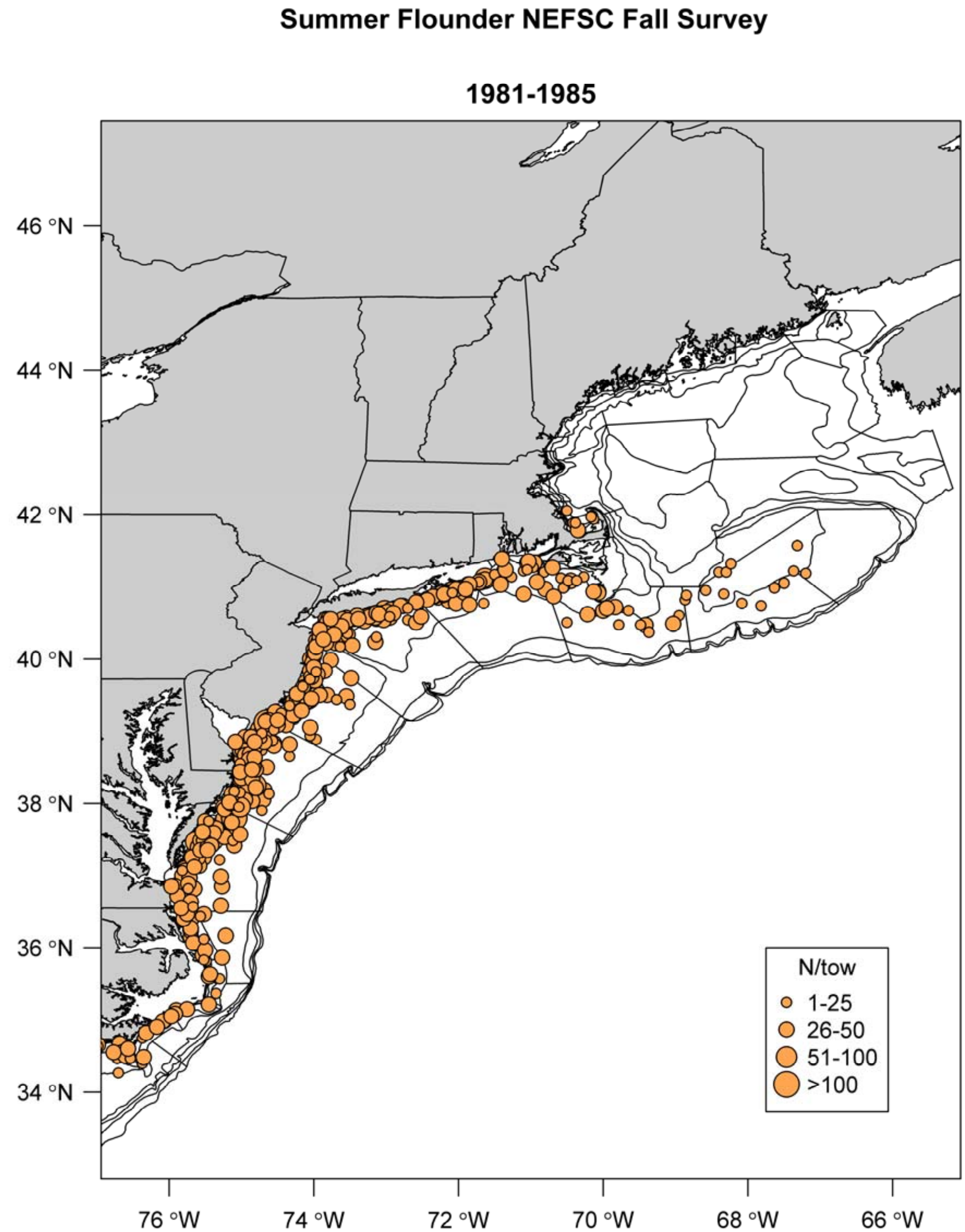


Figure A116. NEFSC fall survey catch numbers per tow, 1981-1985.

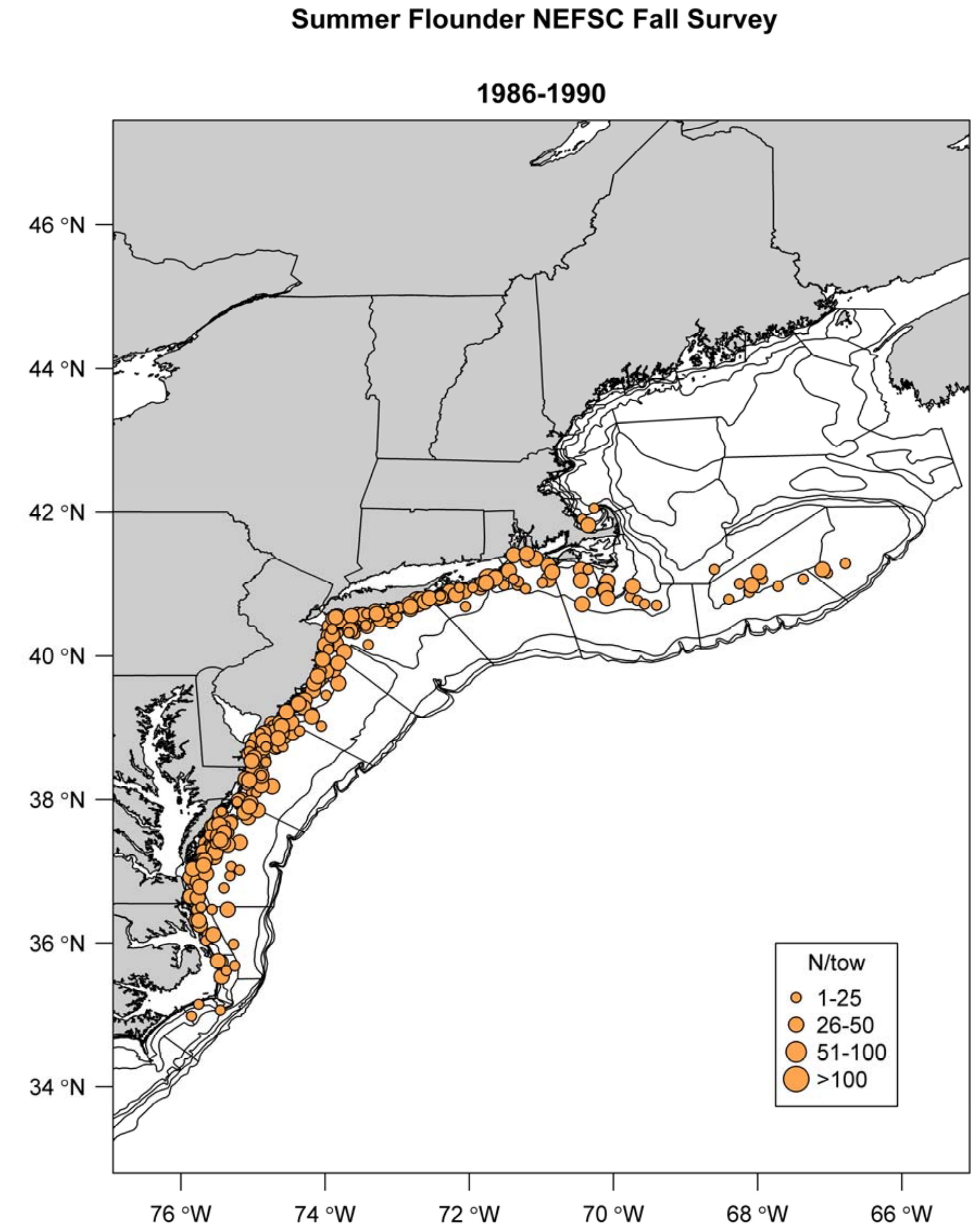


Figure A117. NEFSC fall survey catch numbers per tow, 1986-1990.

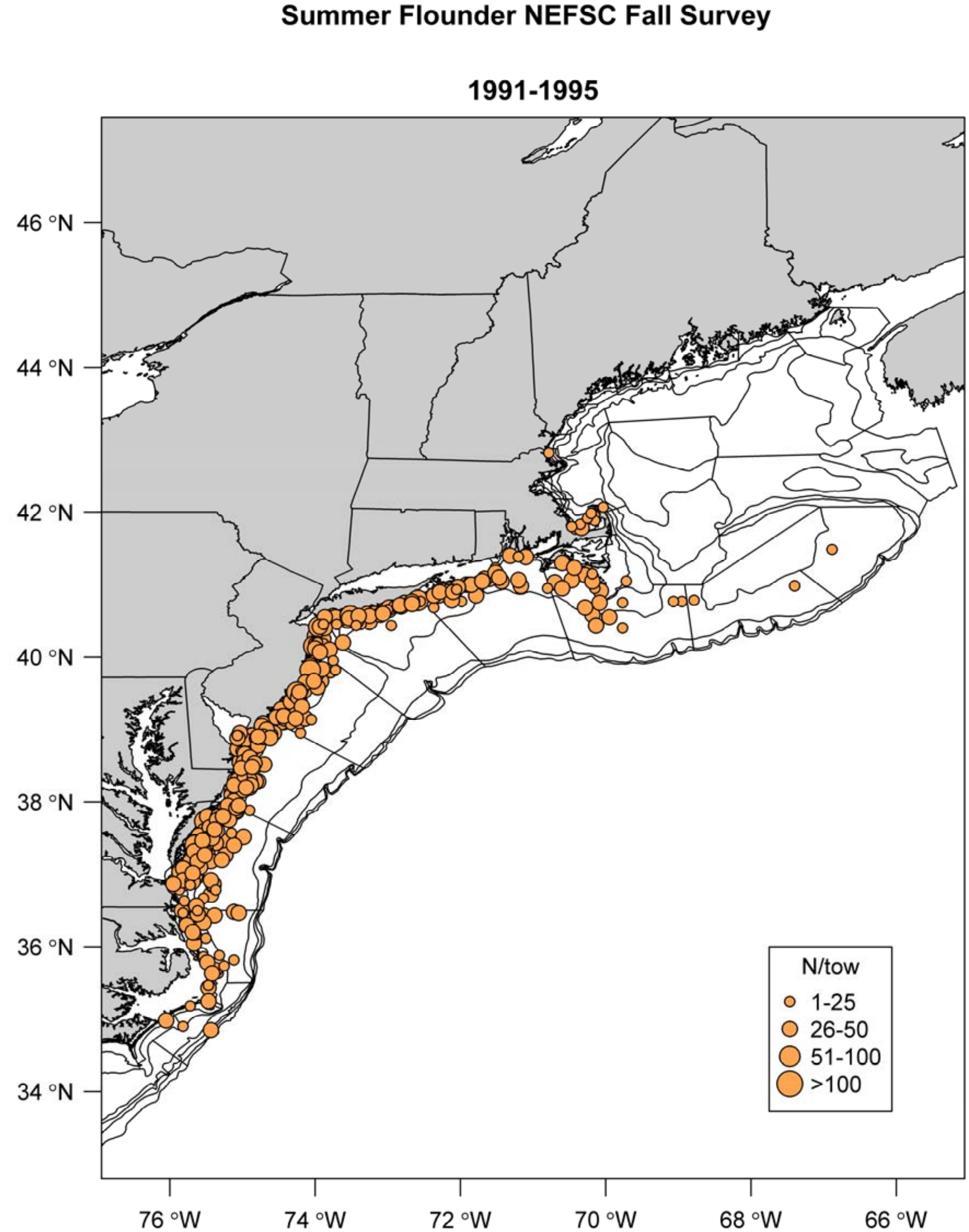


Figure A118. NEFSC fall survey catch numbers per tow, 1991-1995.

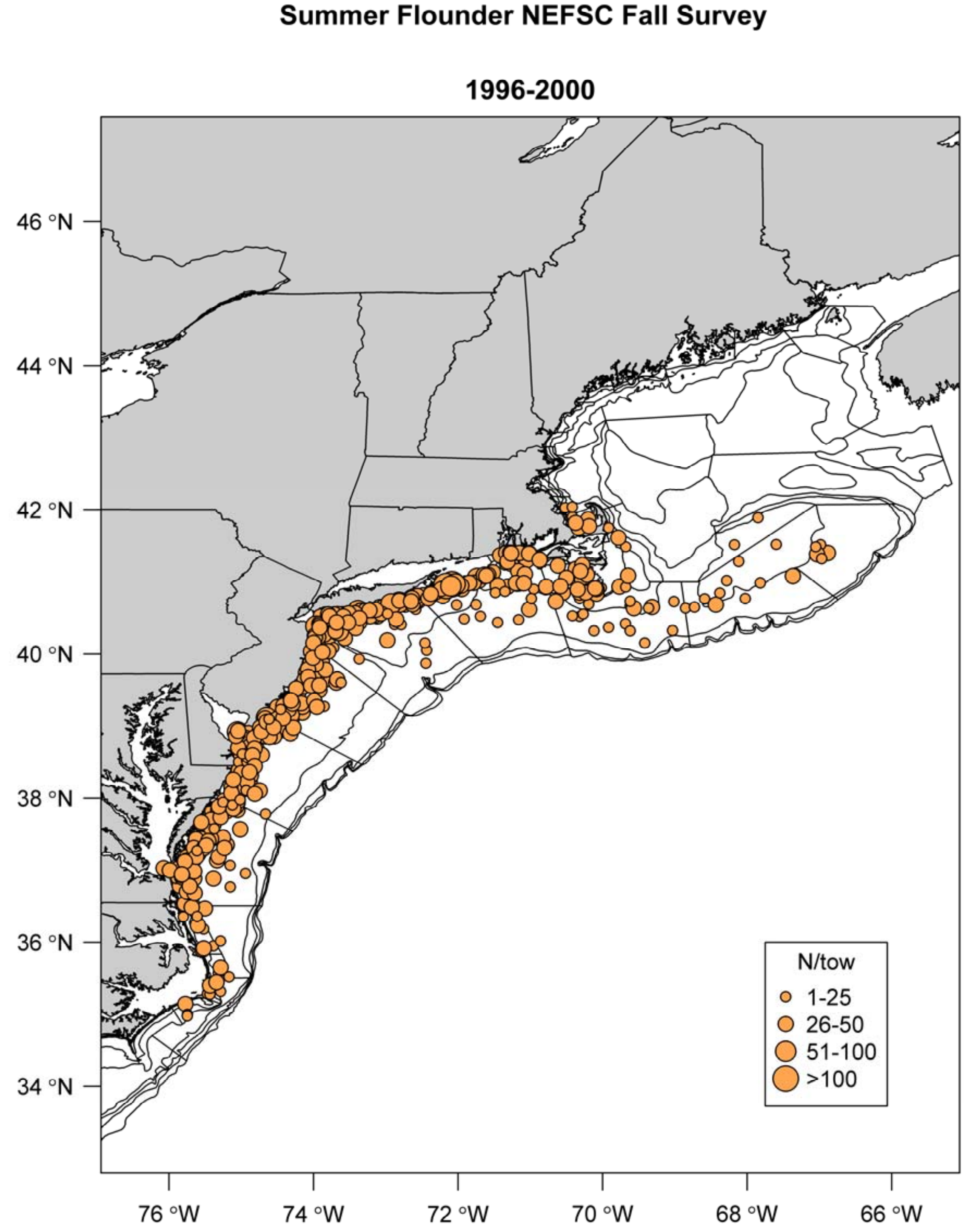


Figure A119. NEFSC fall survey catch numbers per tow, 1996-2000.

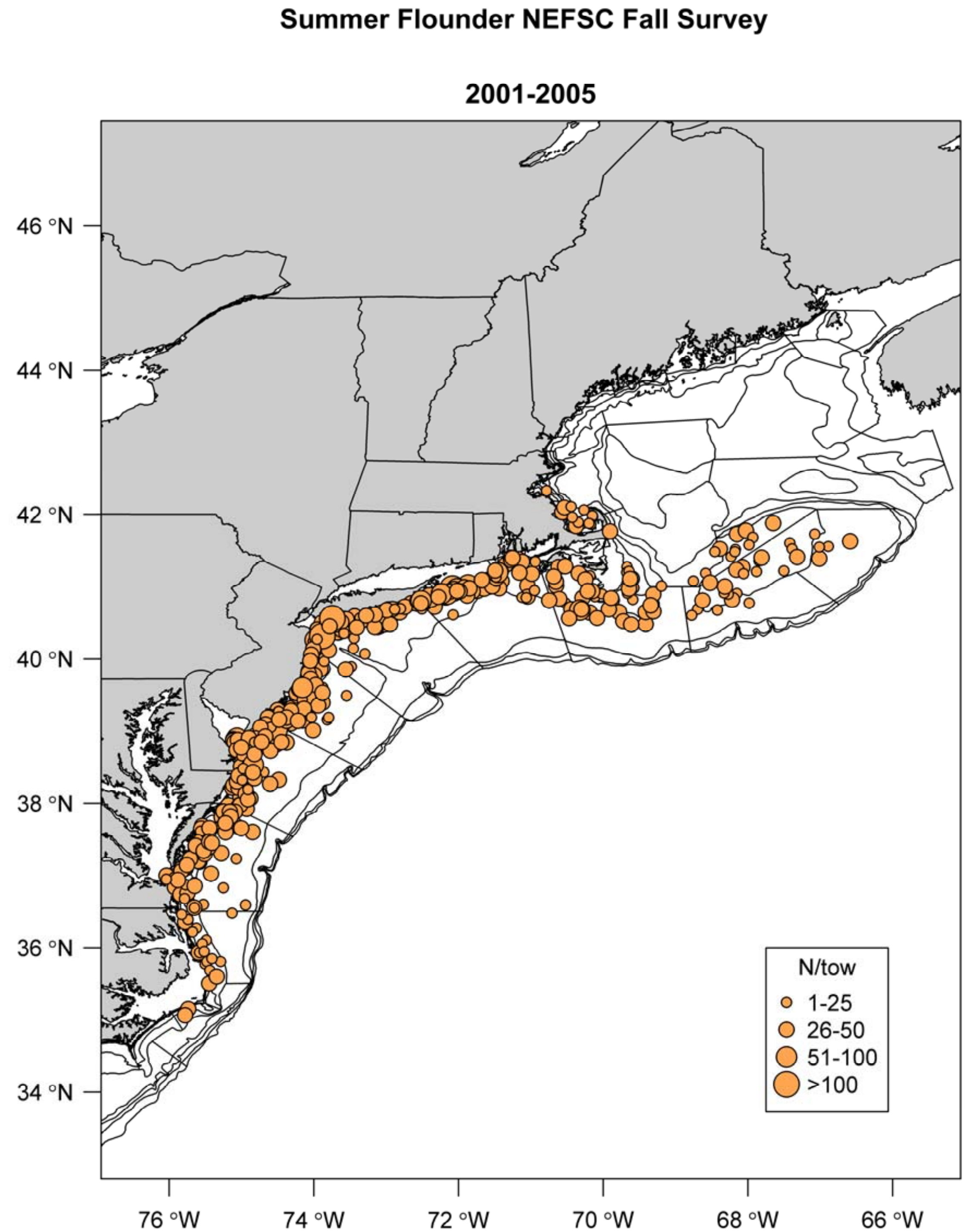


Figure A120. NEFSC fall survey catch numbers per tow, 2001-2005.

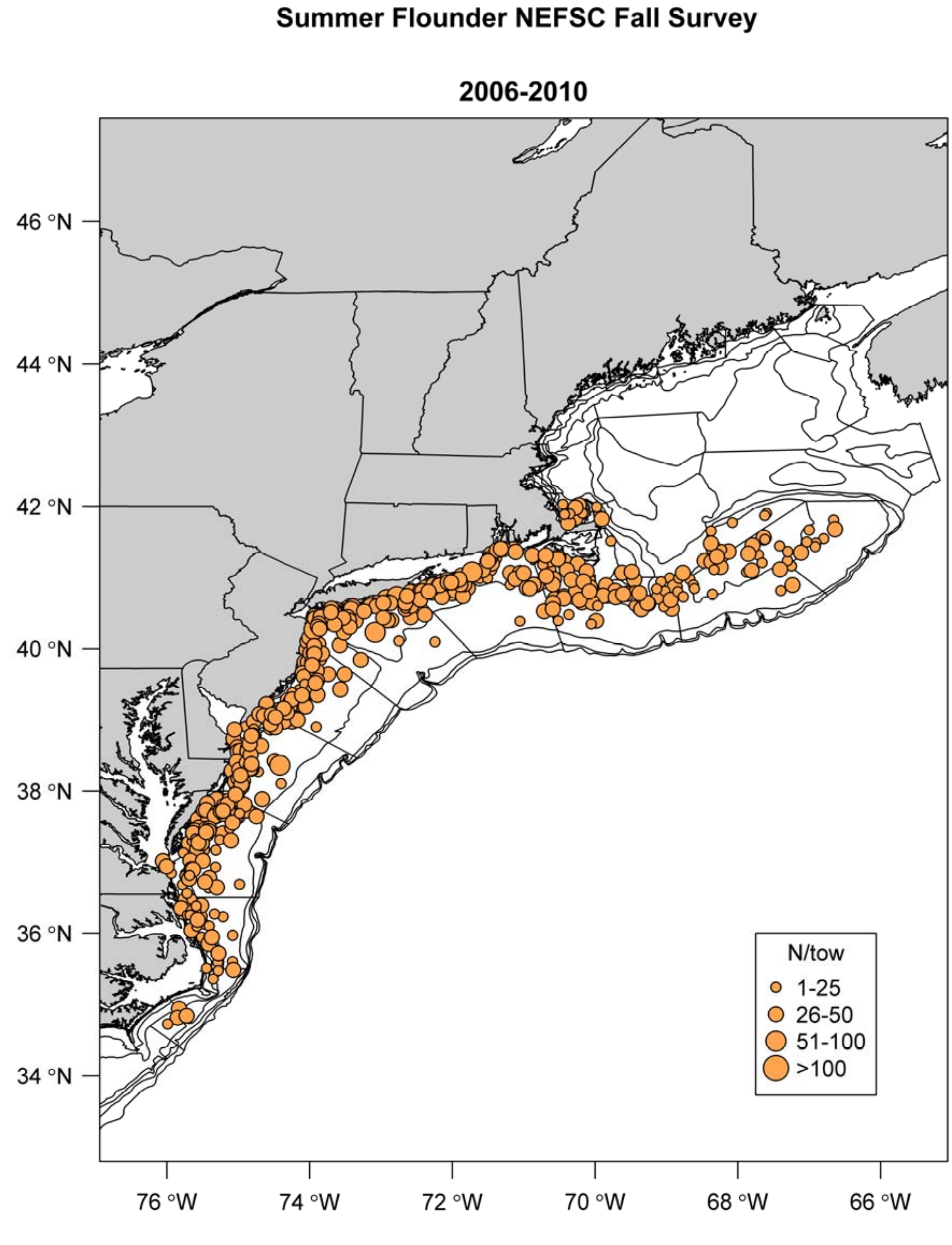


Figure A121. NEFSC fall survey catch numbers per tow, 2005-2010.

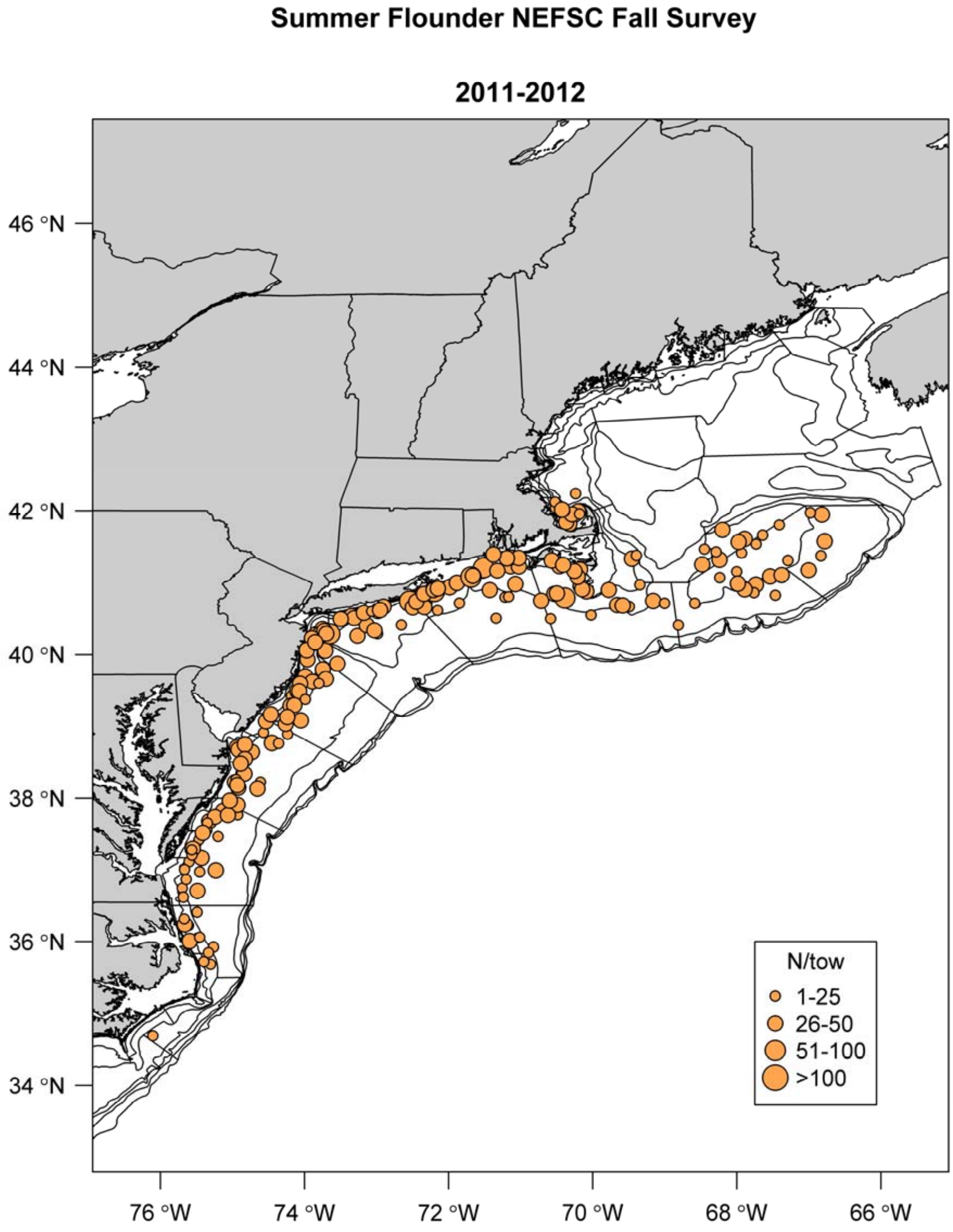


Figure A122. NEFSC fall survey catch numbers per tow, 2011-2012.

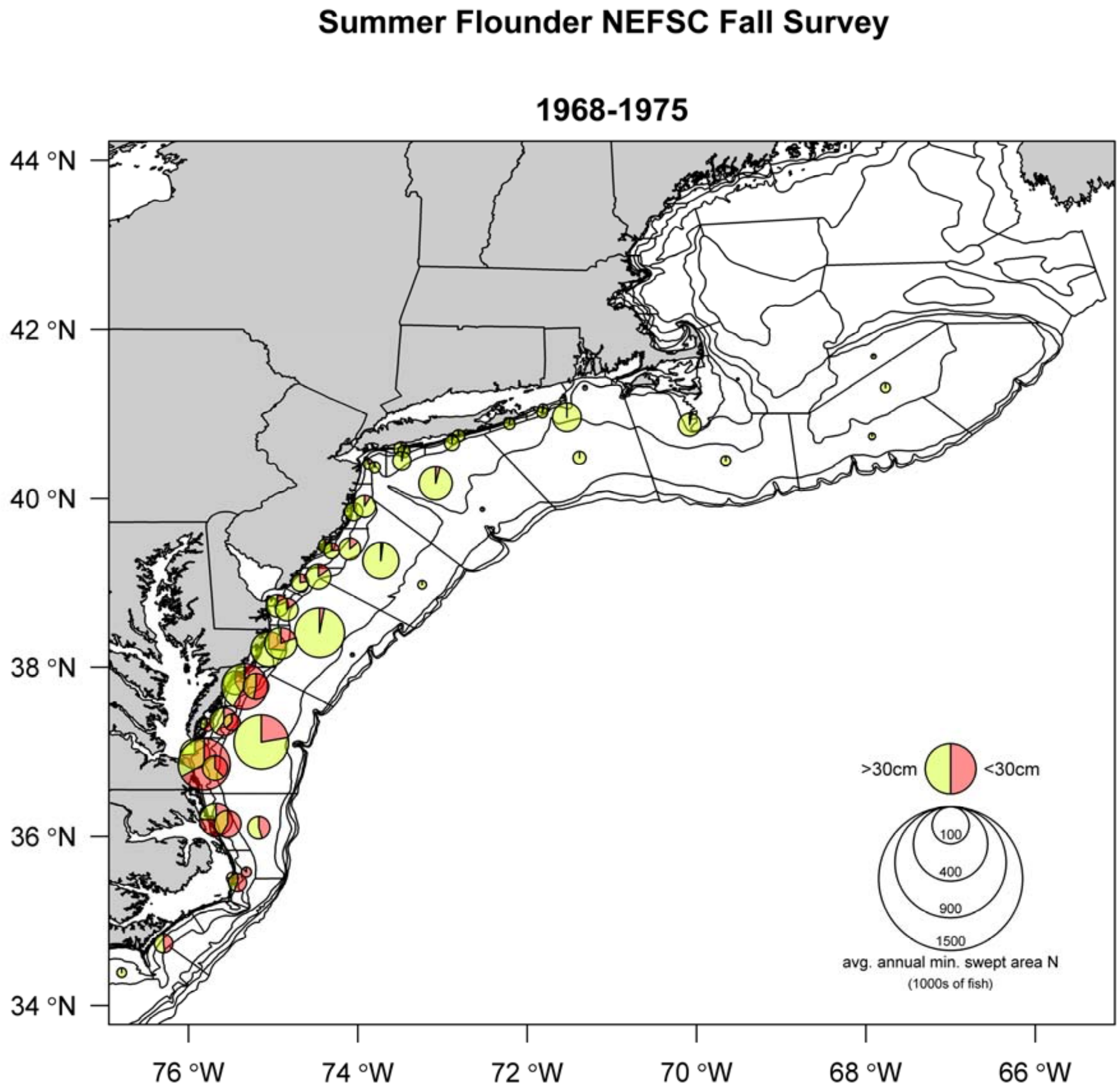


Figure A123. NEFSC fall survey average minimum swept area abundances by strata and size category, 1968-1975.

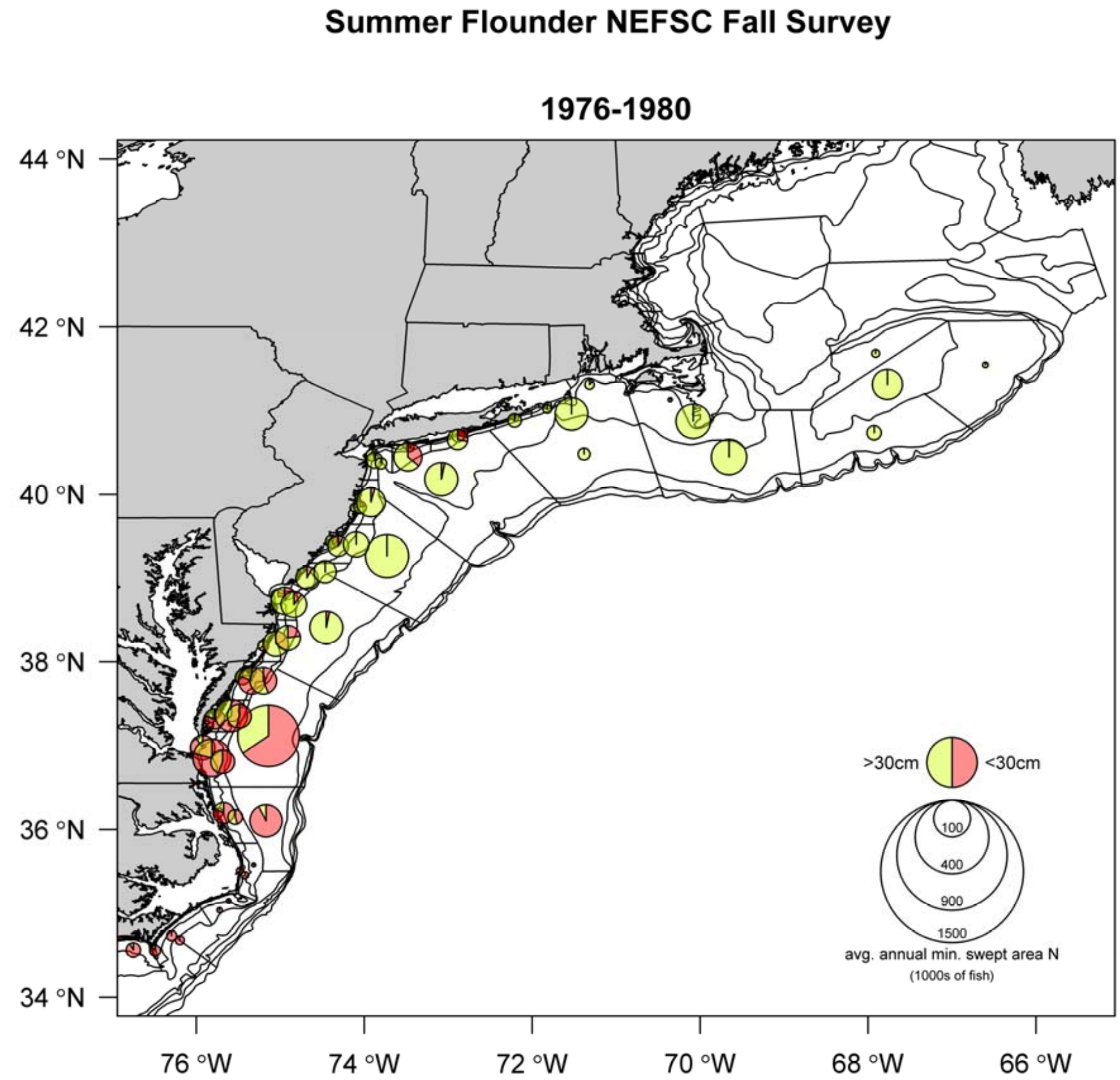


Figure A124. NEFSC fall survey average minimum swept area abundances by strata and size category, 1976-1980.

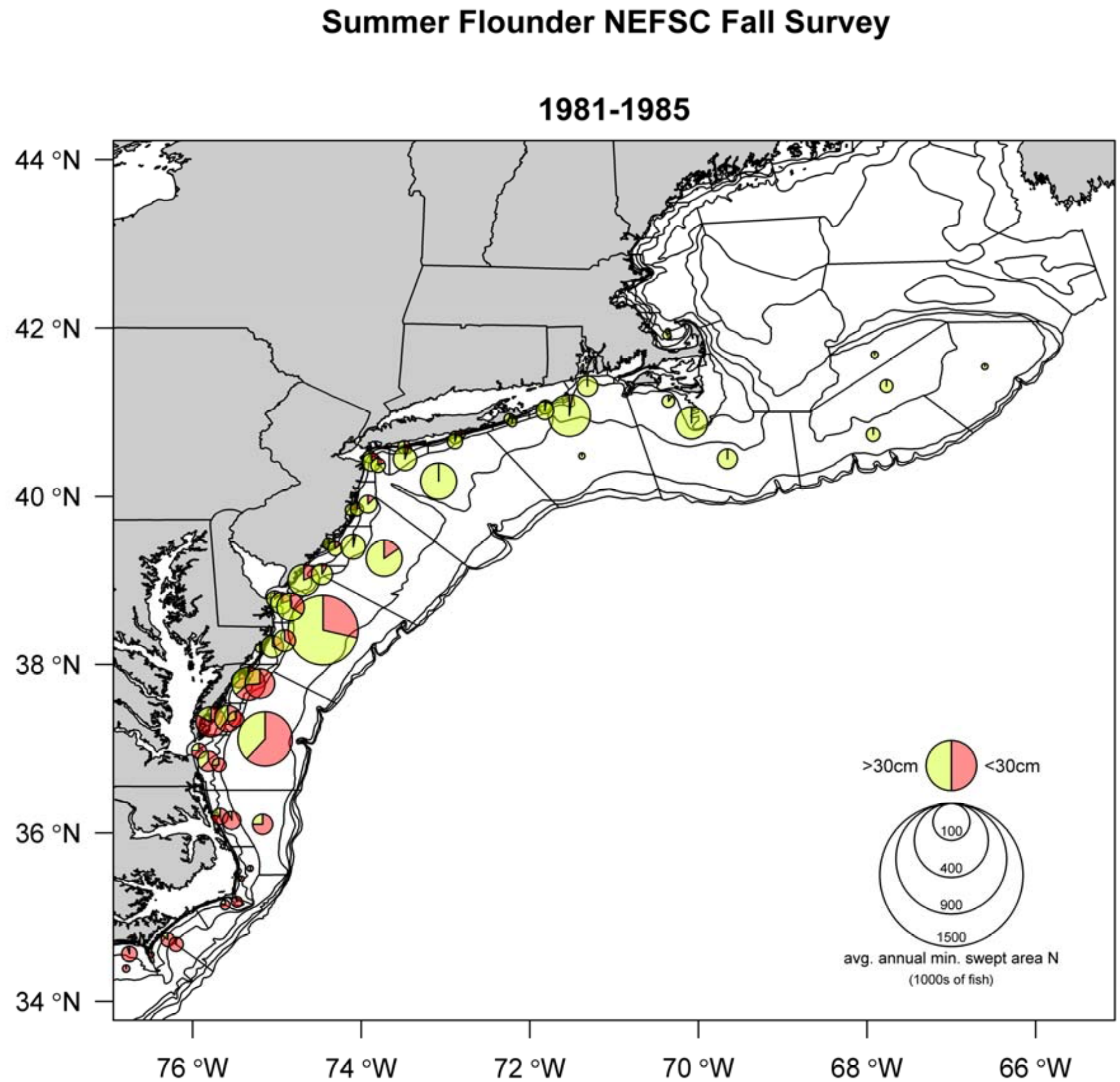


Figure A125. NEFSC fall survey average minimum swept area abundances by strata and size category, 1981-1985.

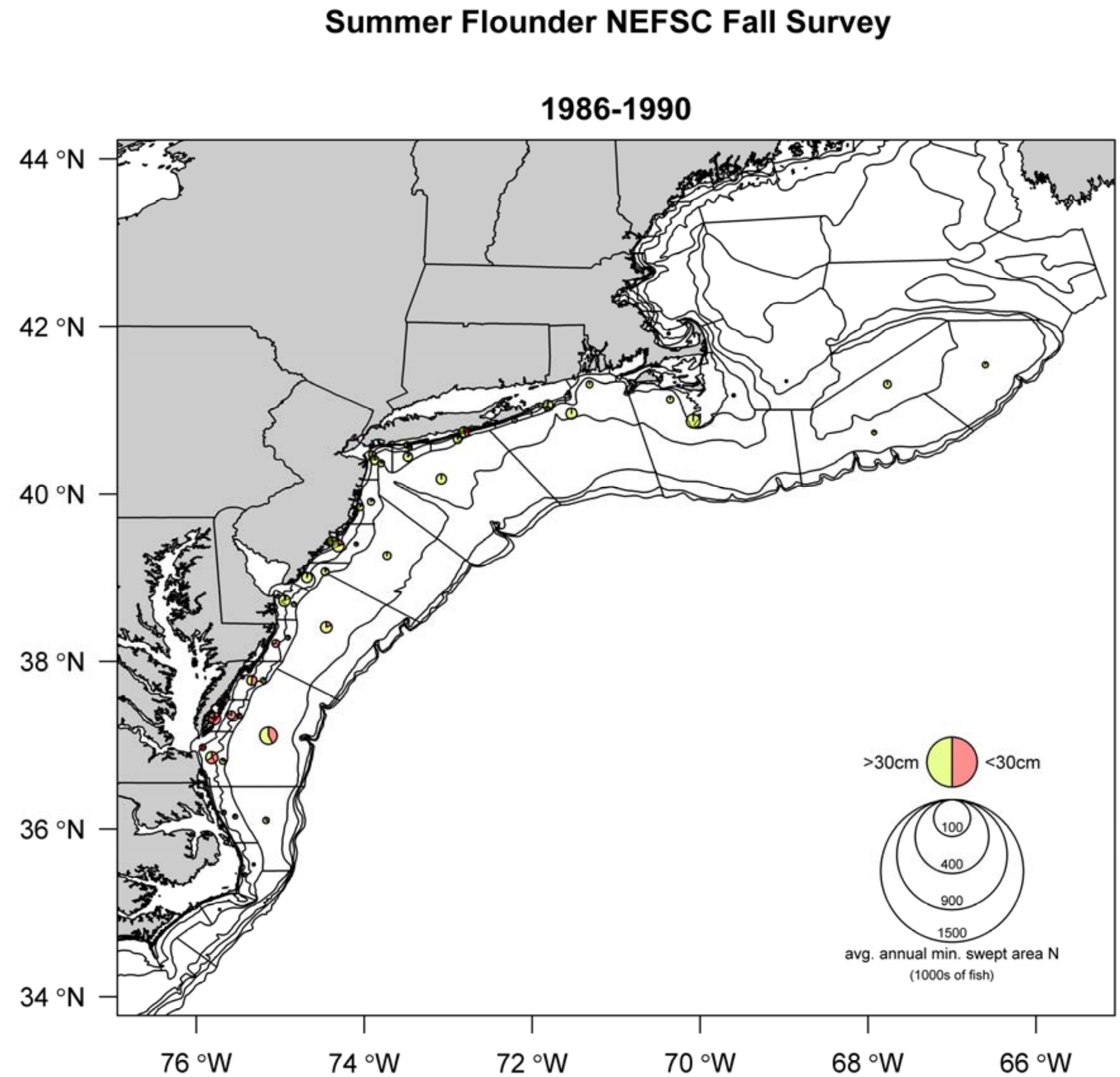


Figure A126. NEFSC fall survey average minimum swept area abundances by strata and size category, 1986-1990.

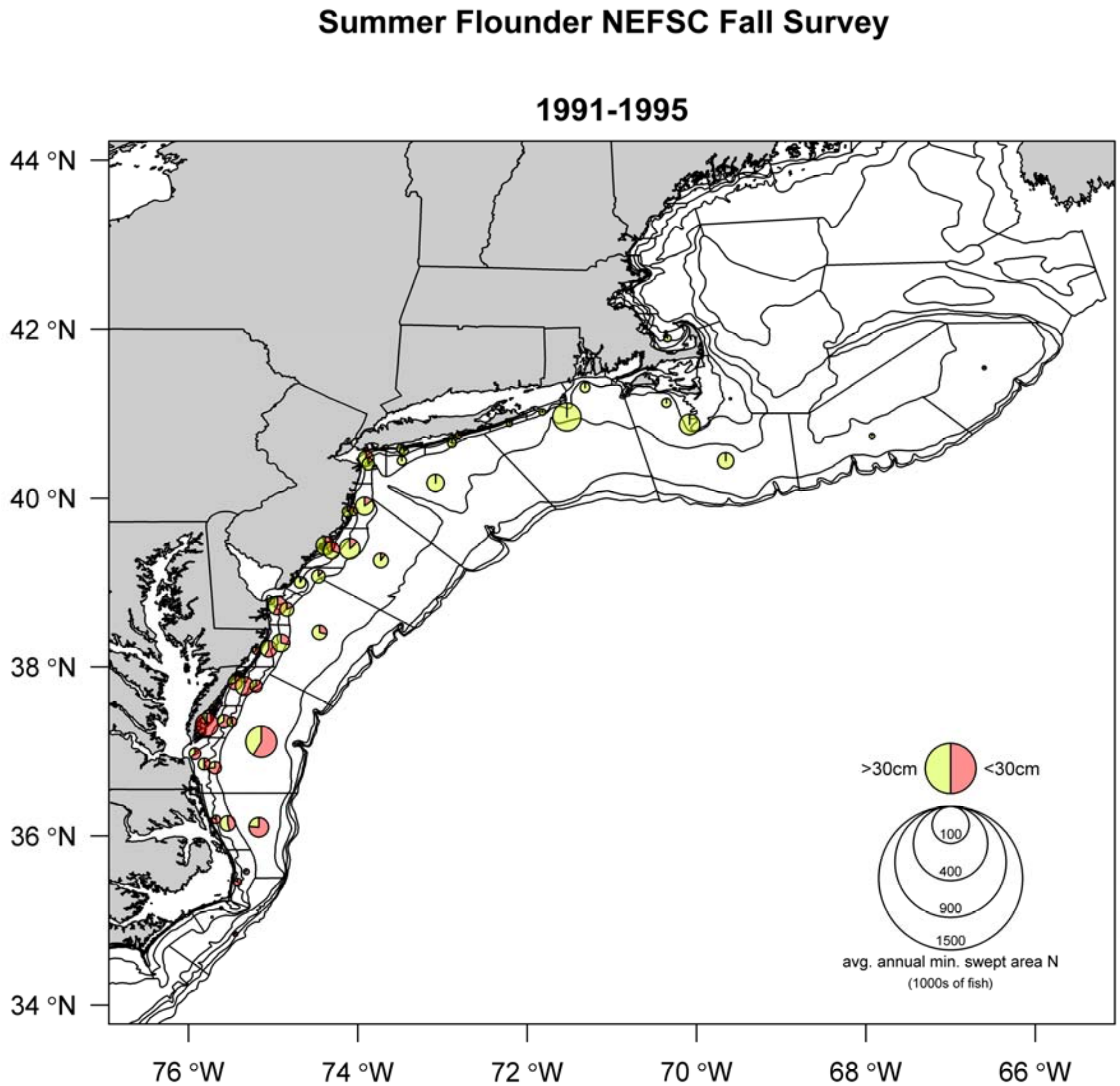


Figure A127. NEFSC fall survey average minimum swept area abundances by strata and size category, 1991-1995.

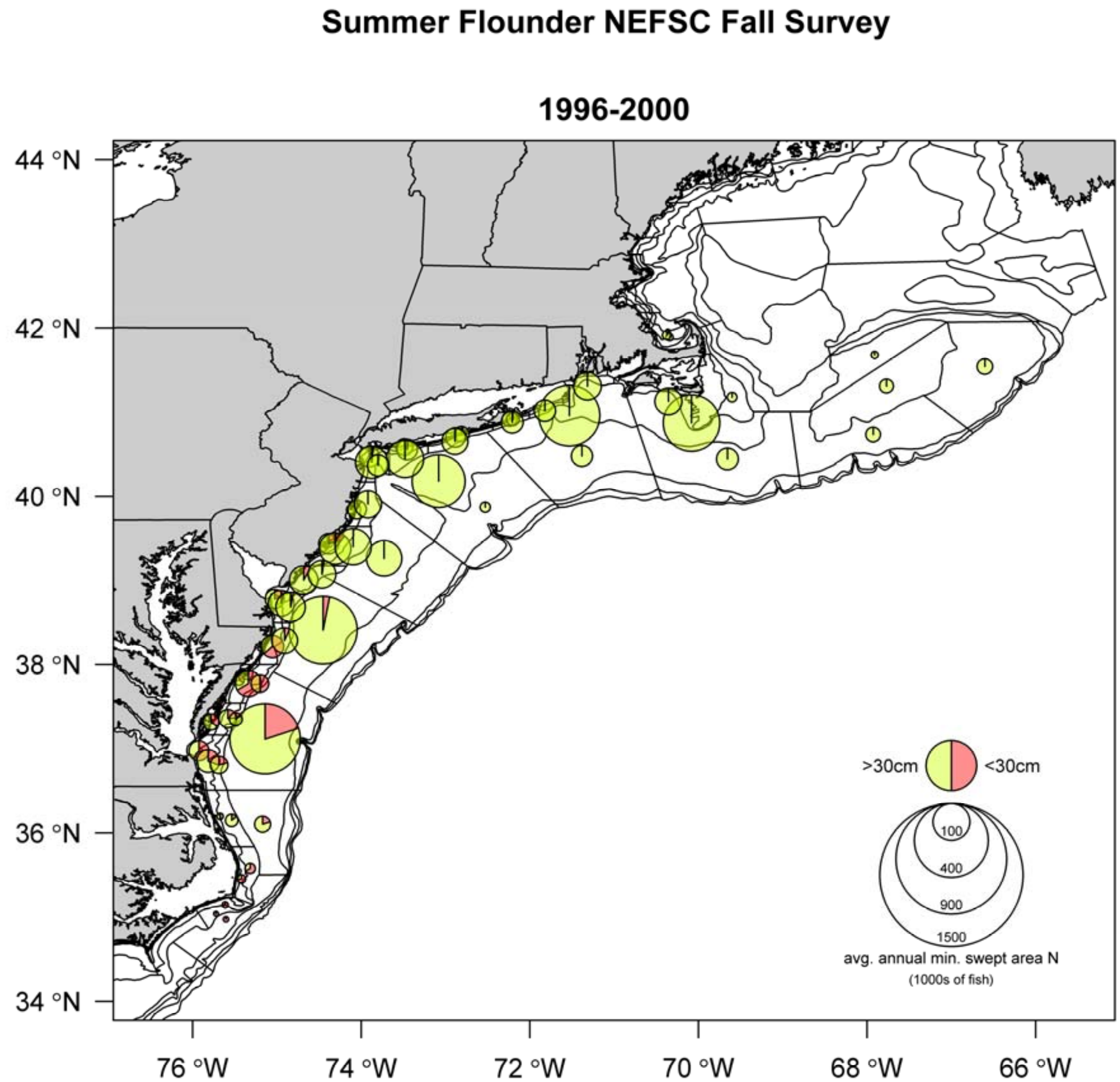


Figure A128. NEFSC fall survey average minimum swept area abundances by strata and size category, 1996-2000.

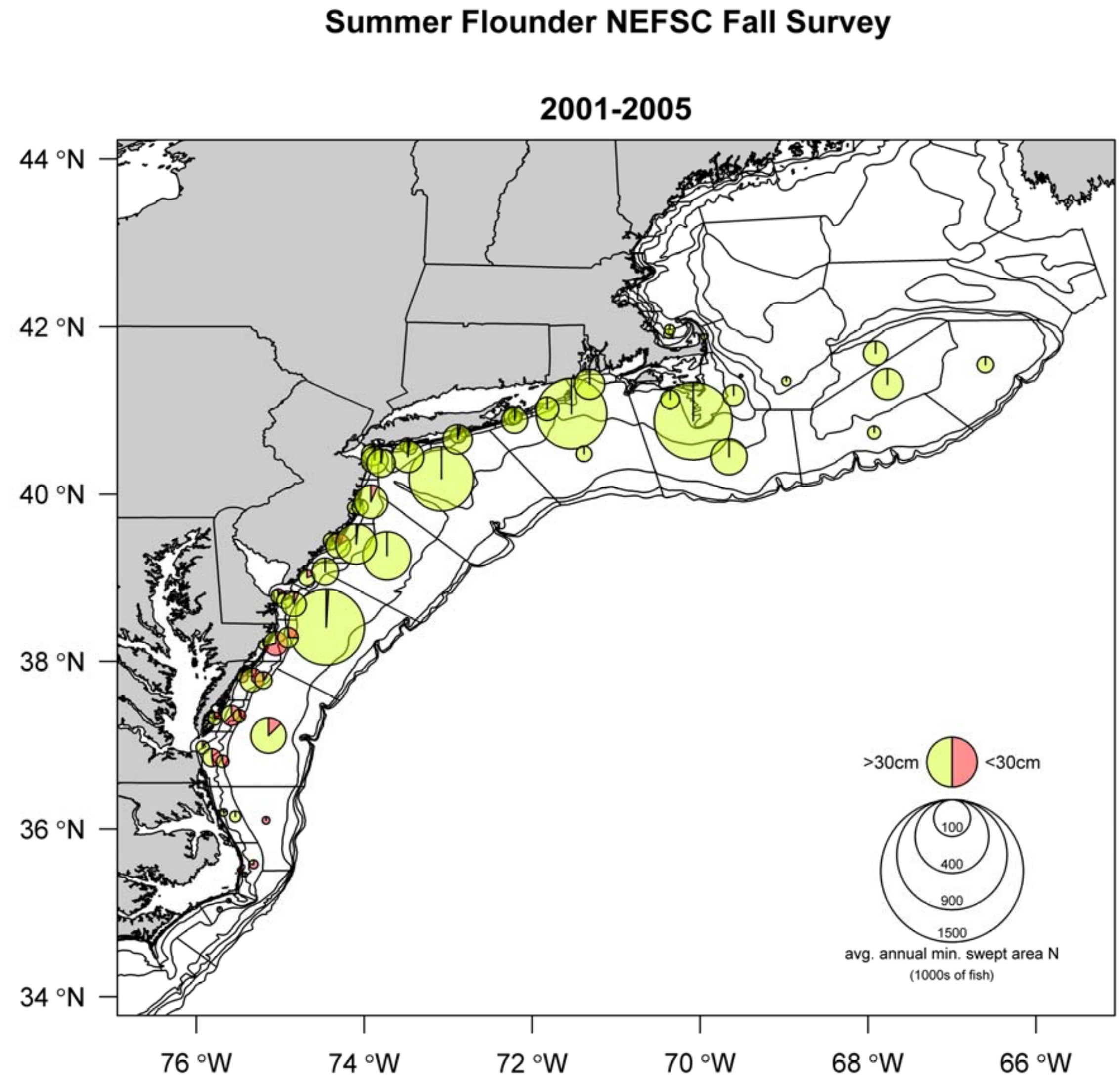


Figure A129. NEFSC fall survey average minimum swept area abundances by strata and size category, 2001-2005.

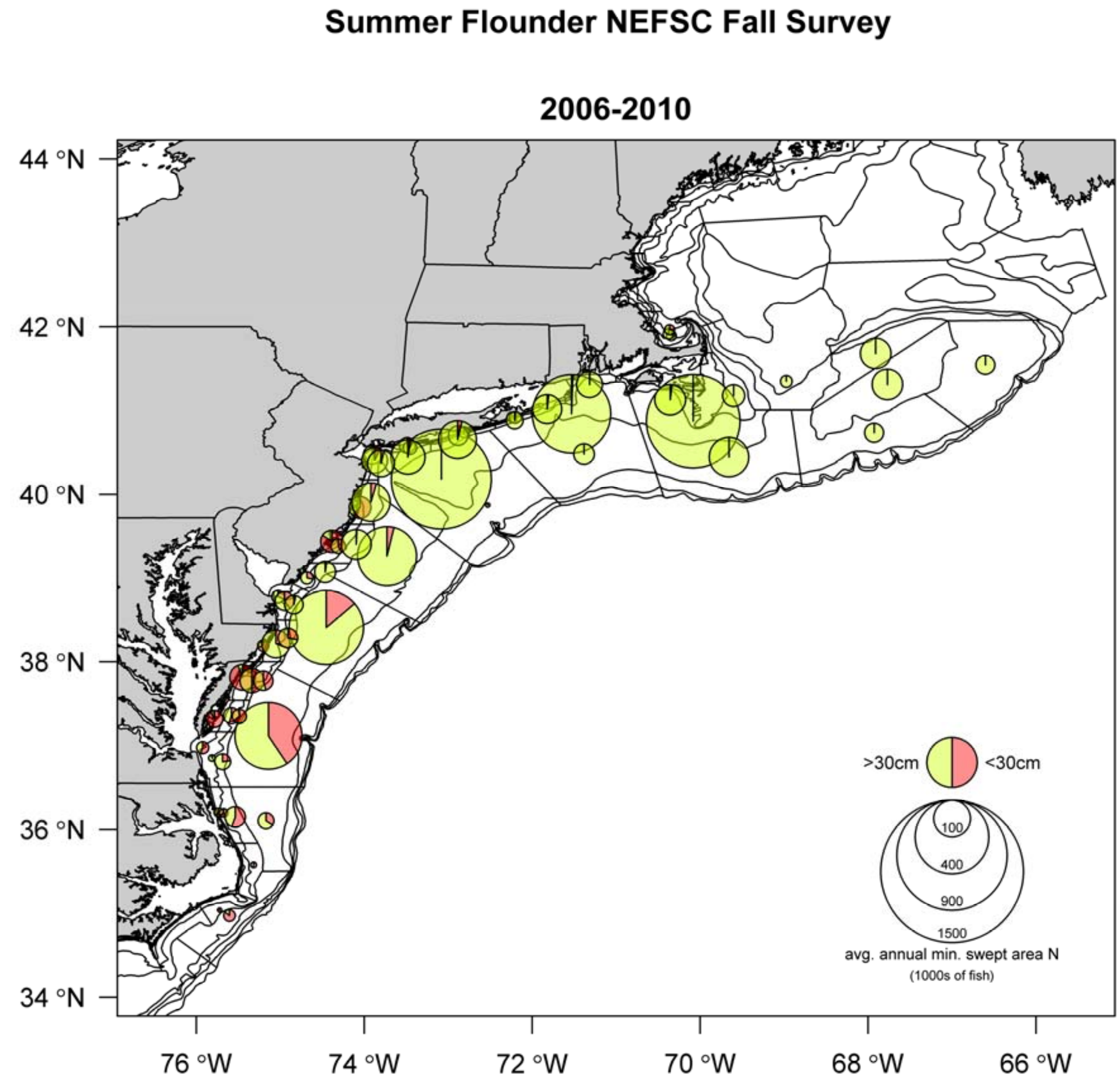


Figure A130. NEFSC fall survey average minimum swept area abundances by strata and size category, 2006-2010.

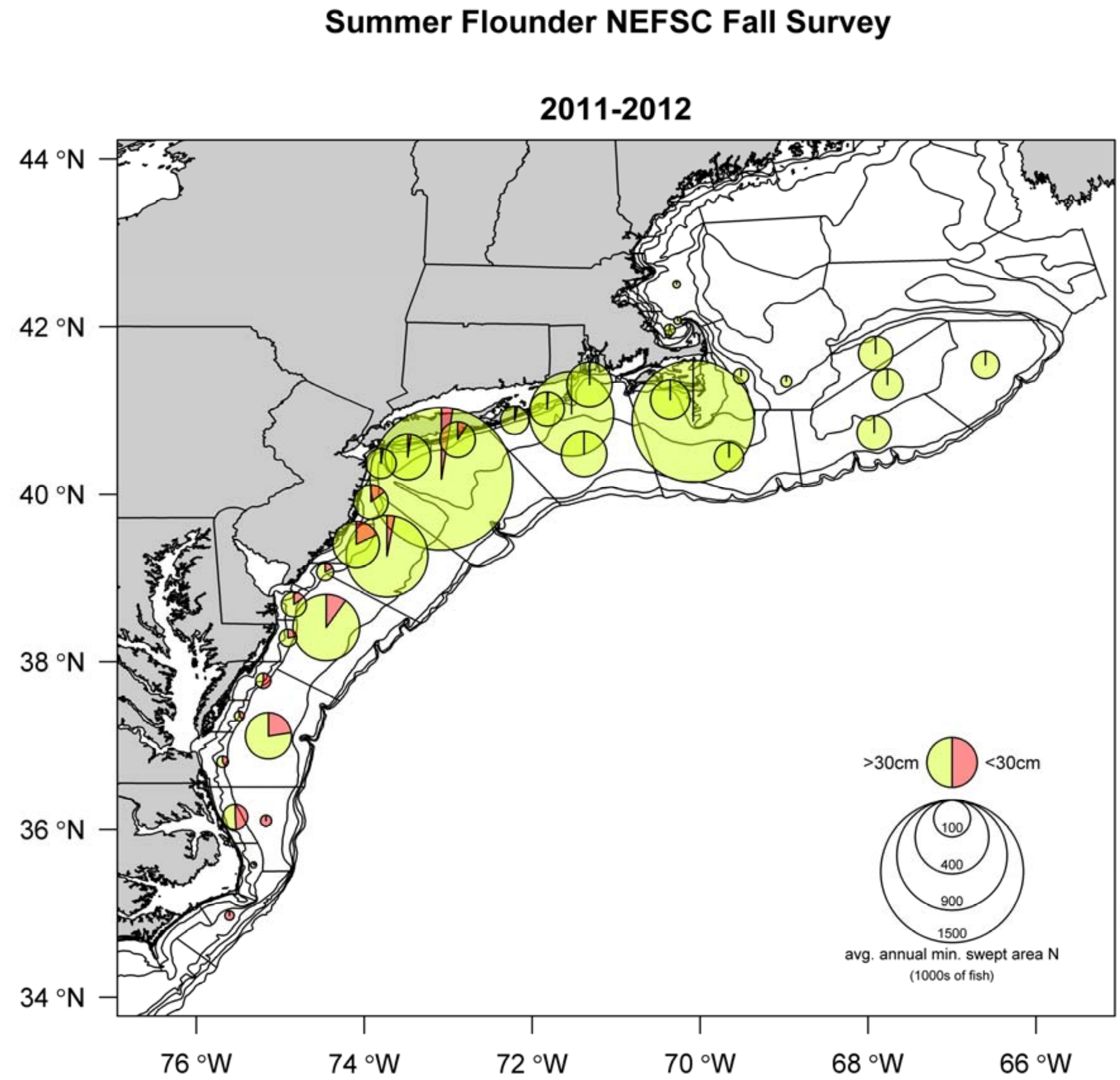


Figure A131. NEFSC fall survey average minimum swept area abundances by strata and size category, 2011-2012.

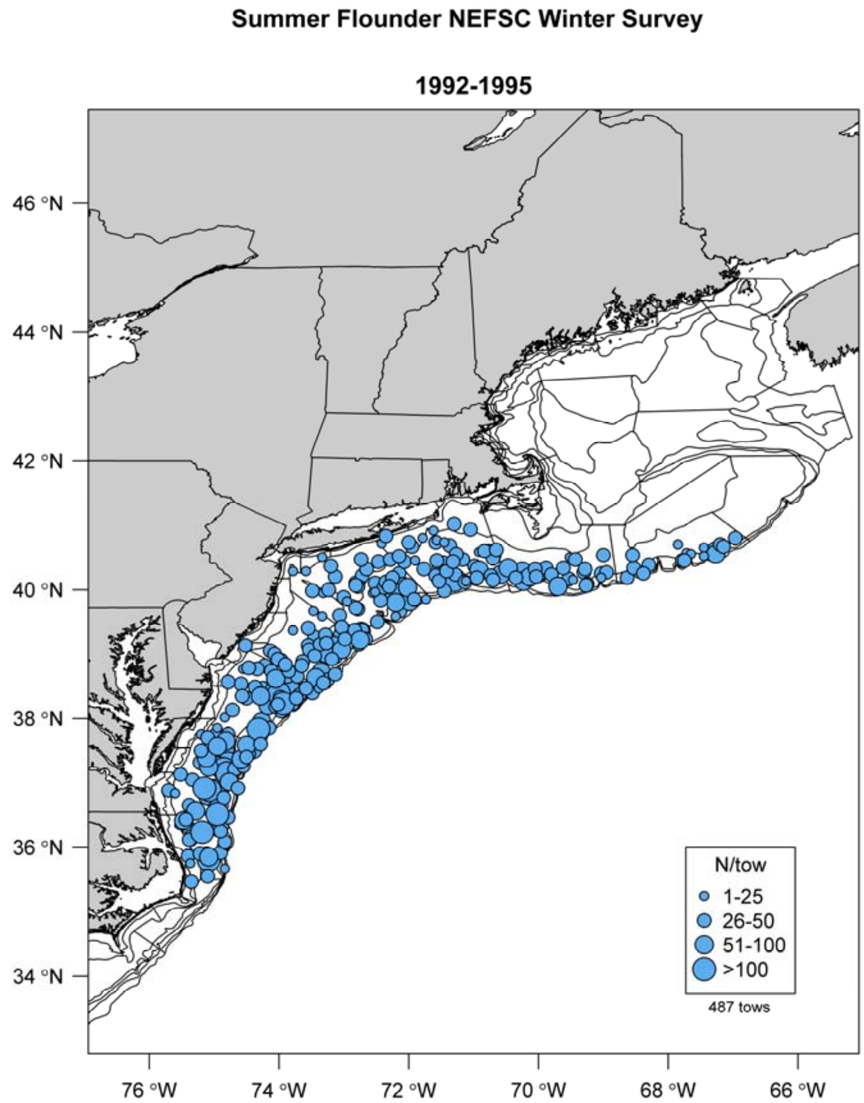


Figure A132. NEFSC winter survey catch numbers per tow, 1992-1995.

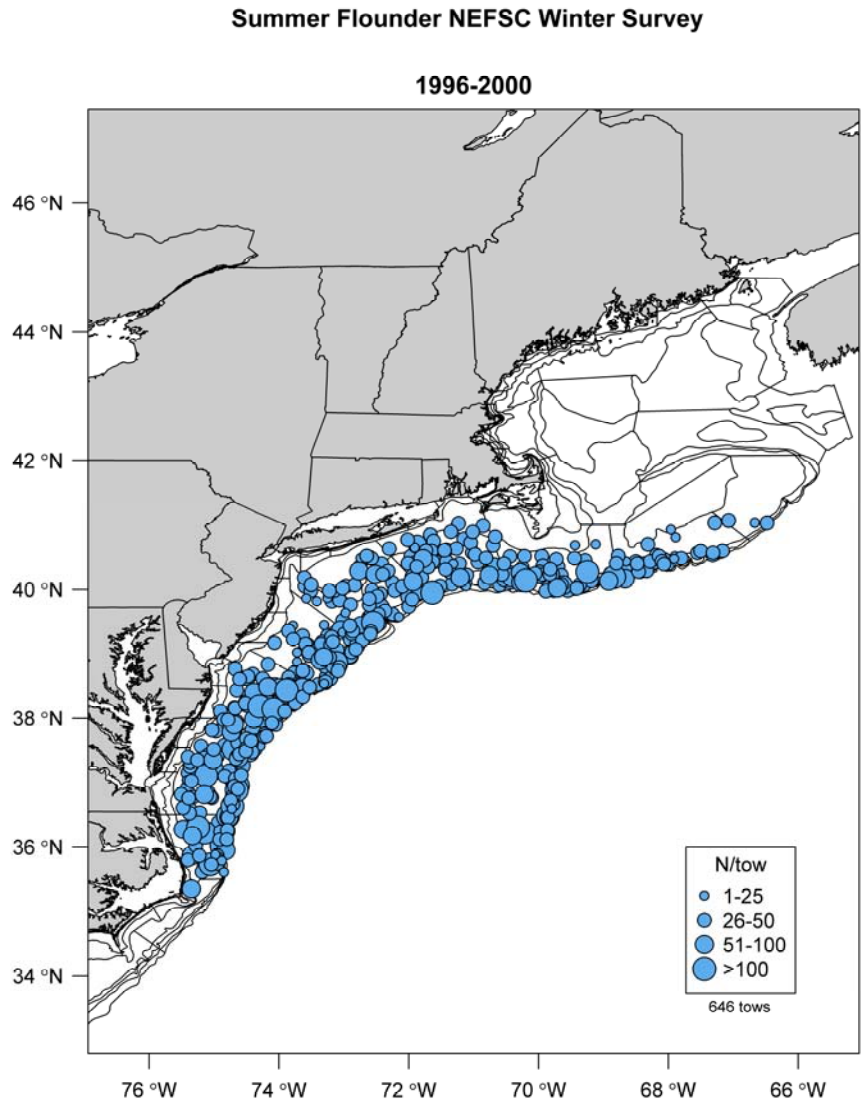


Figure A133. NEFSC winter survey catch numbers per tow, 1996-2000.

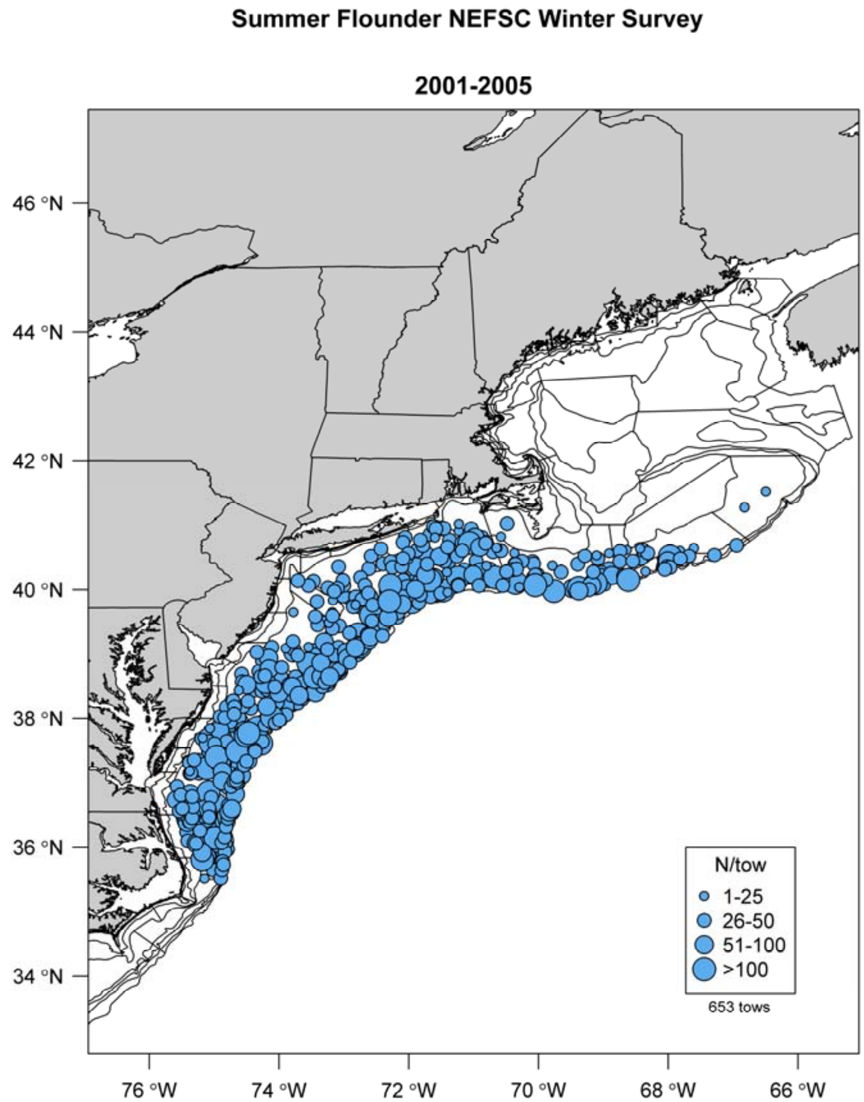


Figure A134. NEFSC winter survey catch numbers per tow, 2001-2005.

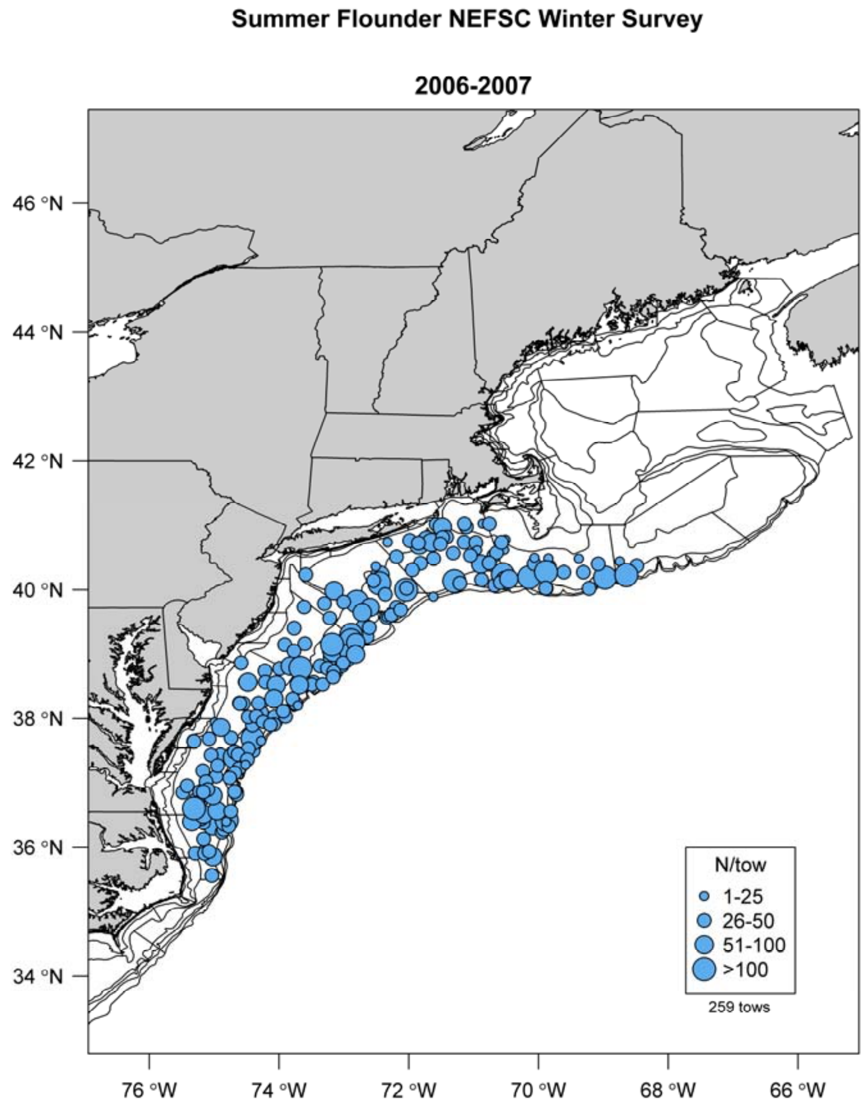


Figure A135. NEFSC winter trawl survey catches (numbers/tow) of summer flounder, 2006-2007.

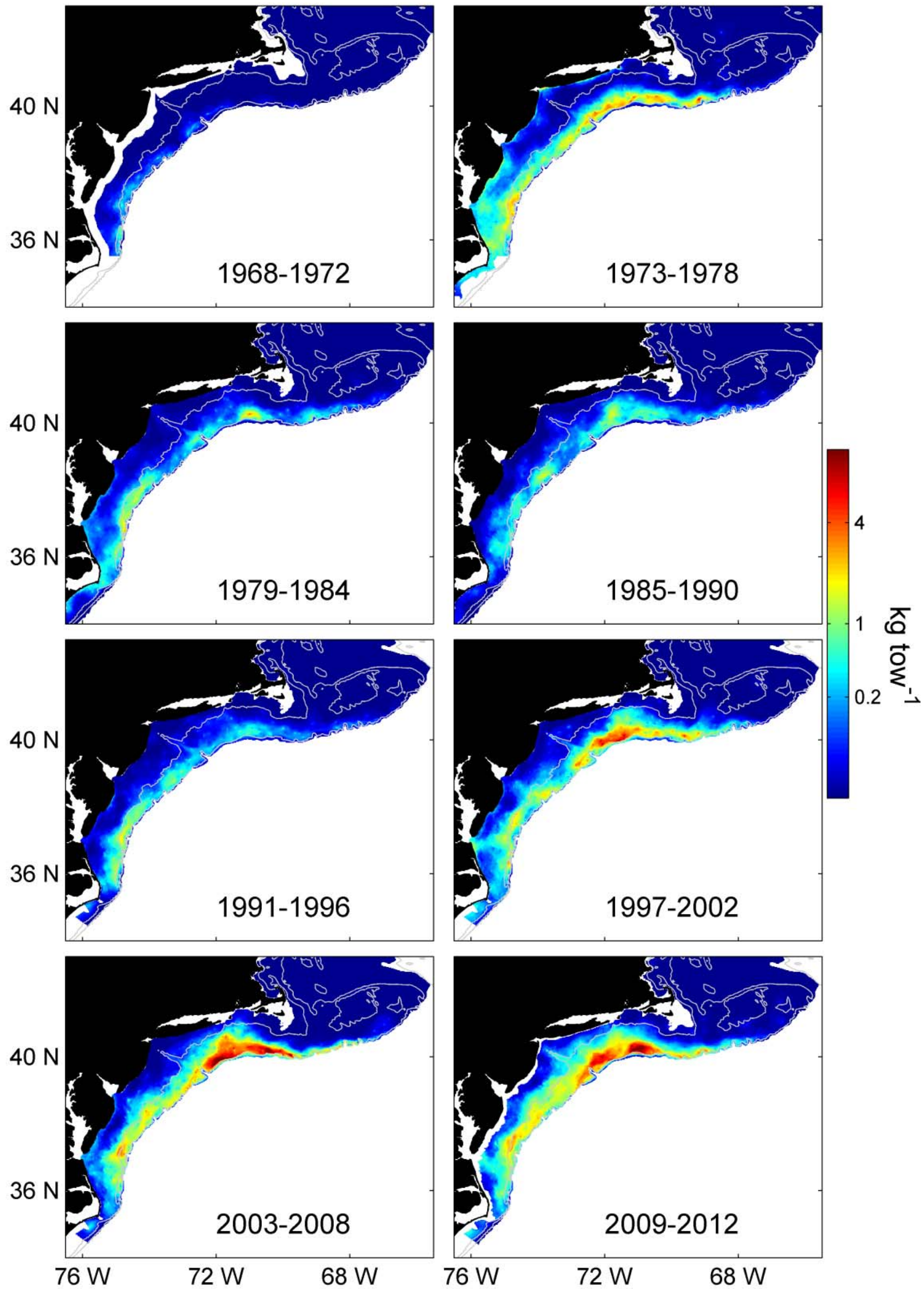


Figure A136. Distribution of summer flounder on the spring trawl survey through time. The scaling for all panels is the same. A weight calibration factor of 3.06 was used to scale the 2009-2012 Bigelow data to the Albatross time series.

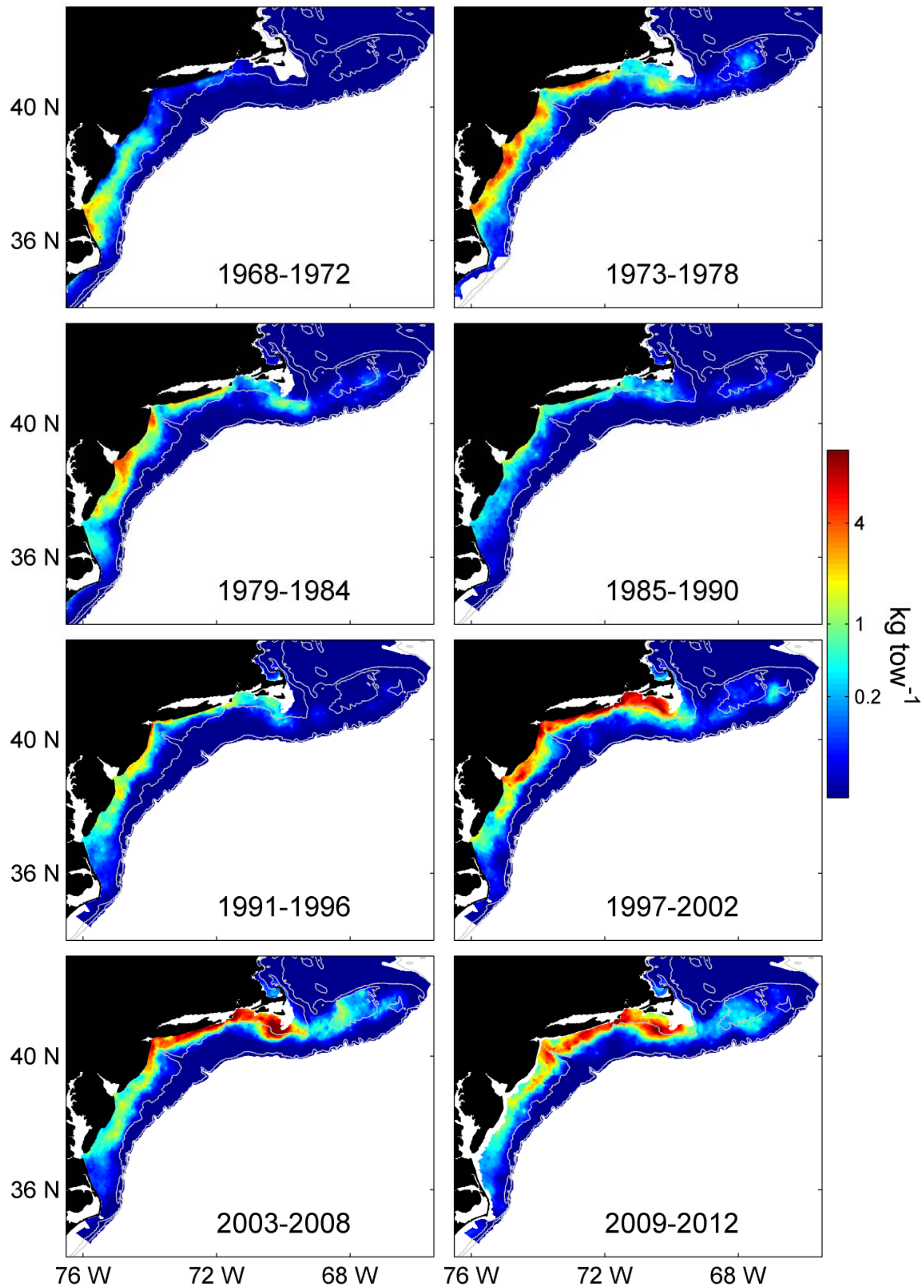


Figure A137. Distribution of summer flounder on the fall trawl survey through time. The scaling for all panels is the same. A weight calibration factor of 2.14 was used to scale the 2009-2012 Bigelow data to the Albatross time series.

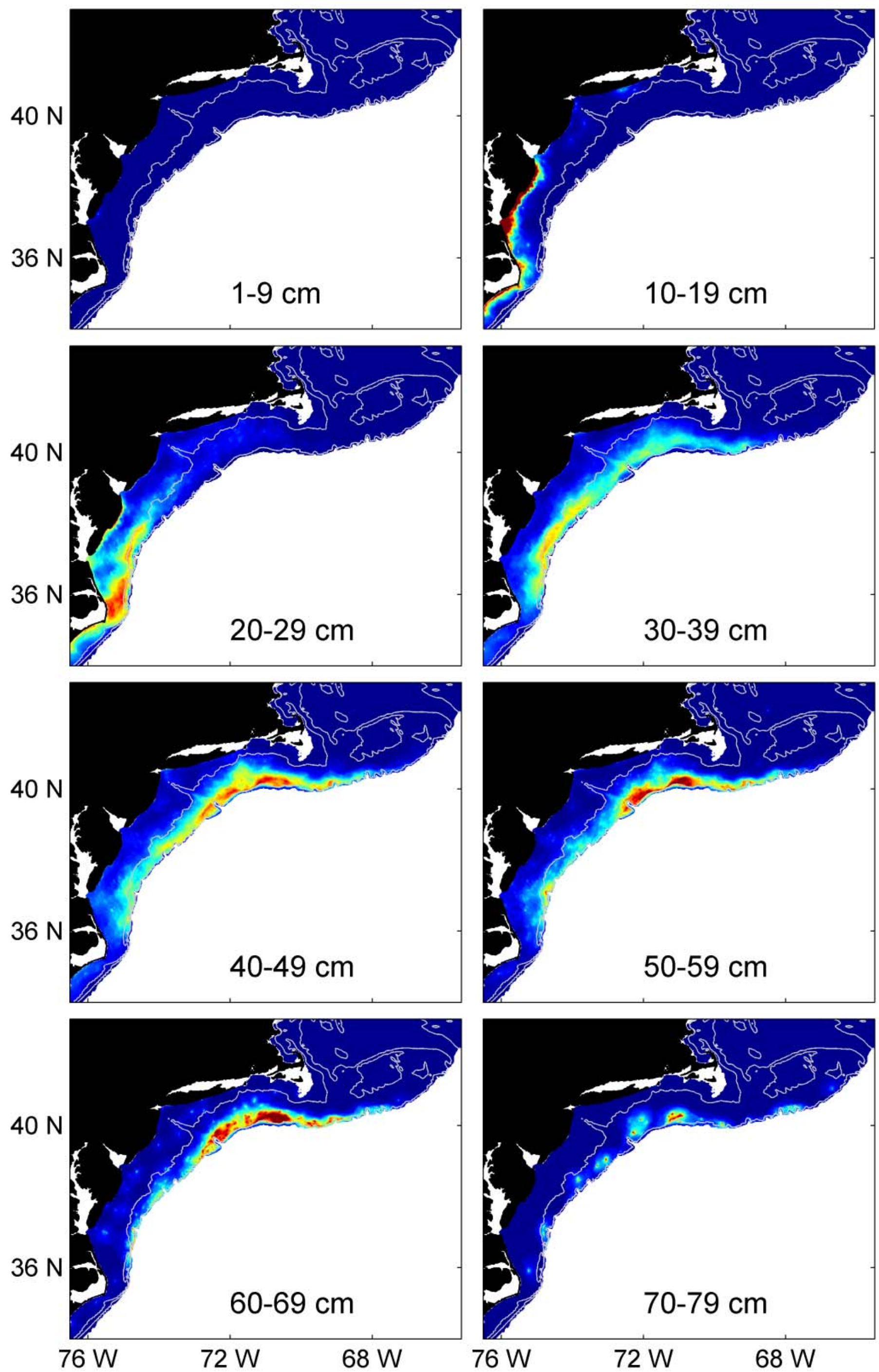


Figure A138. Average Summer Flounder distribution by length class for the 1968-2012 period on the spring trawl survey. The color scale differs by length class to aid in visualization.

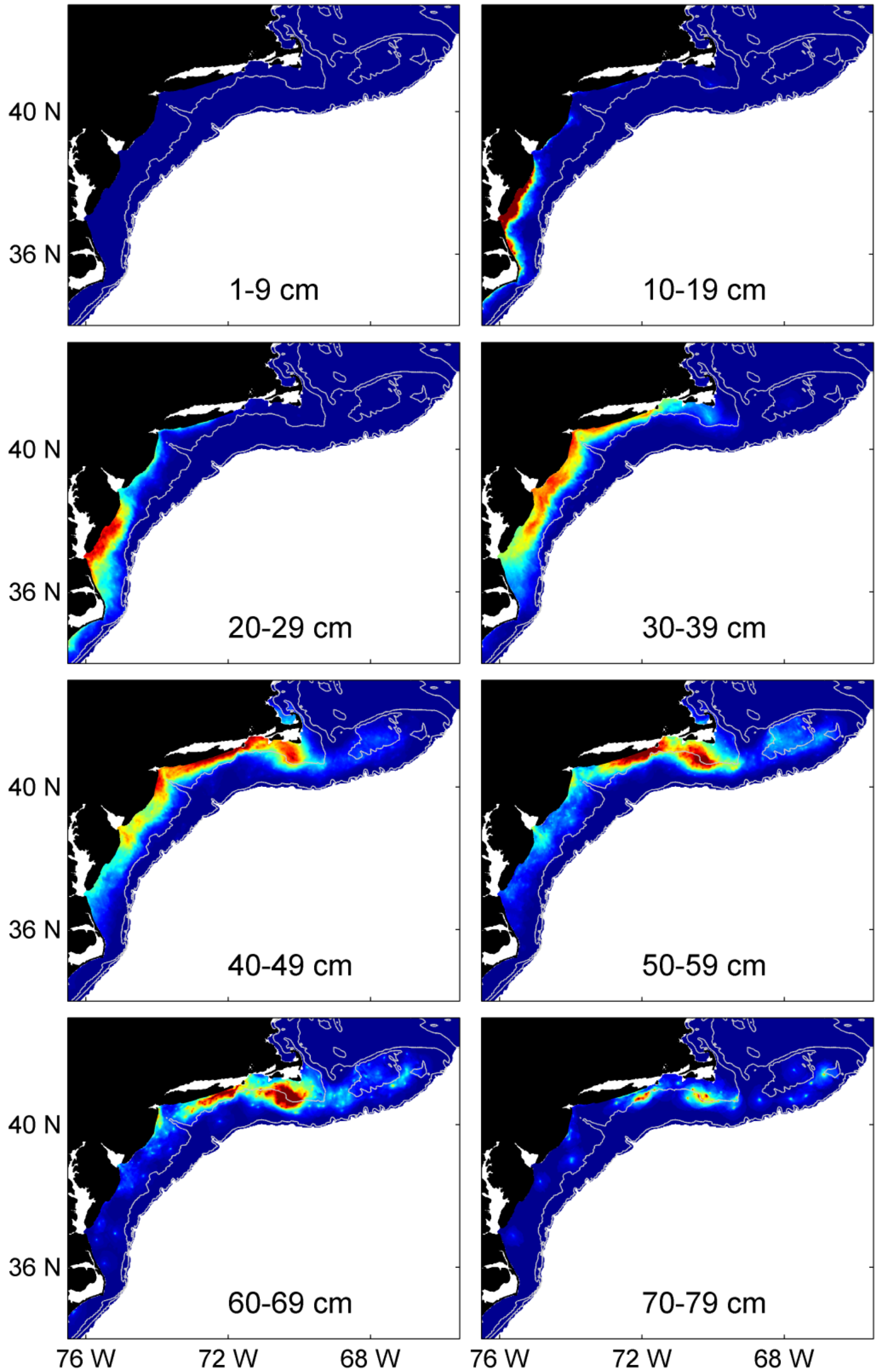


Figure A139. Average Summer Flounder distribution by length class for the 1968-2012 period on the fall trawl survey. The color scale differs by length class to aid in visualization.

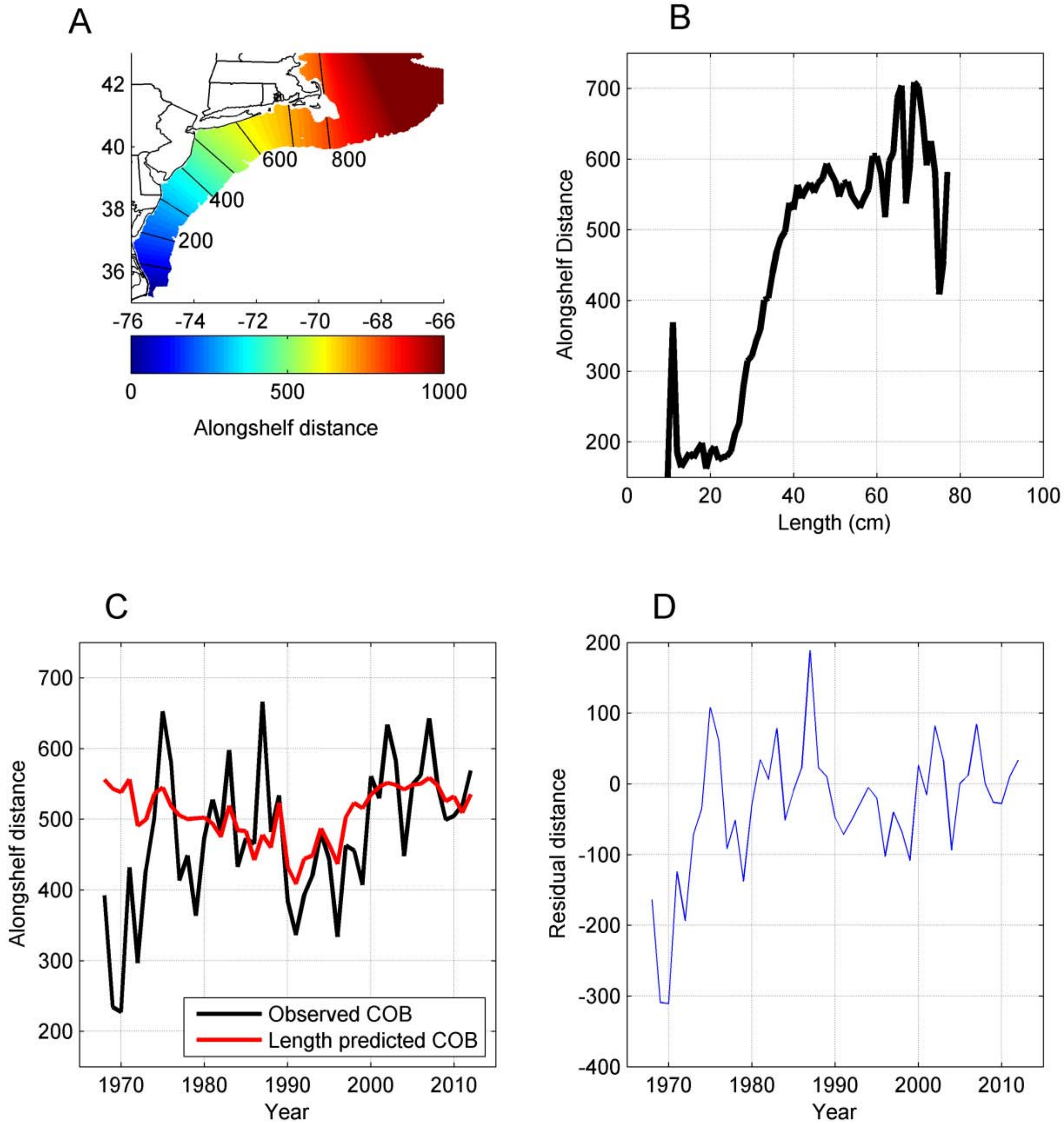


Figure A140. Alongshelf Center of Biomass of Summer Flounder on the Spring trawl survey. A) Map of alongshelf positions with distances in kilometers. B) Average alongshelf center of biomass by cm length class for the 1968-2012 spring time series. C) Annual observed center of biomass on the spring trawl survey (black) and center of biomass predicted solely based on the sampled length structure for that survey and the time-series average alongshelf position by length class. D) Residuals of the observed alongshelf distance and predicted alongshelf distance based solely on length structure. The residuals correspond to the distribution shift not explained by changes in length structure

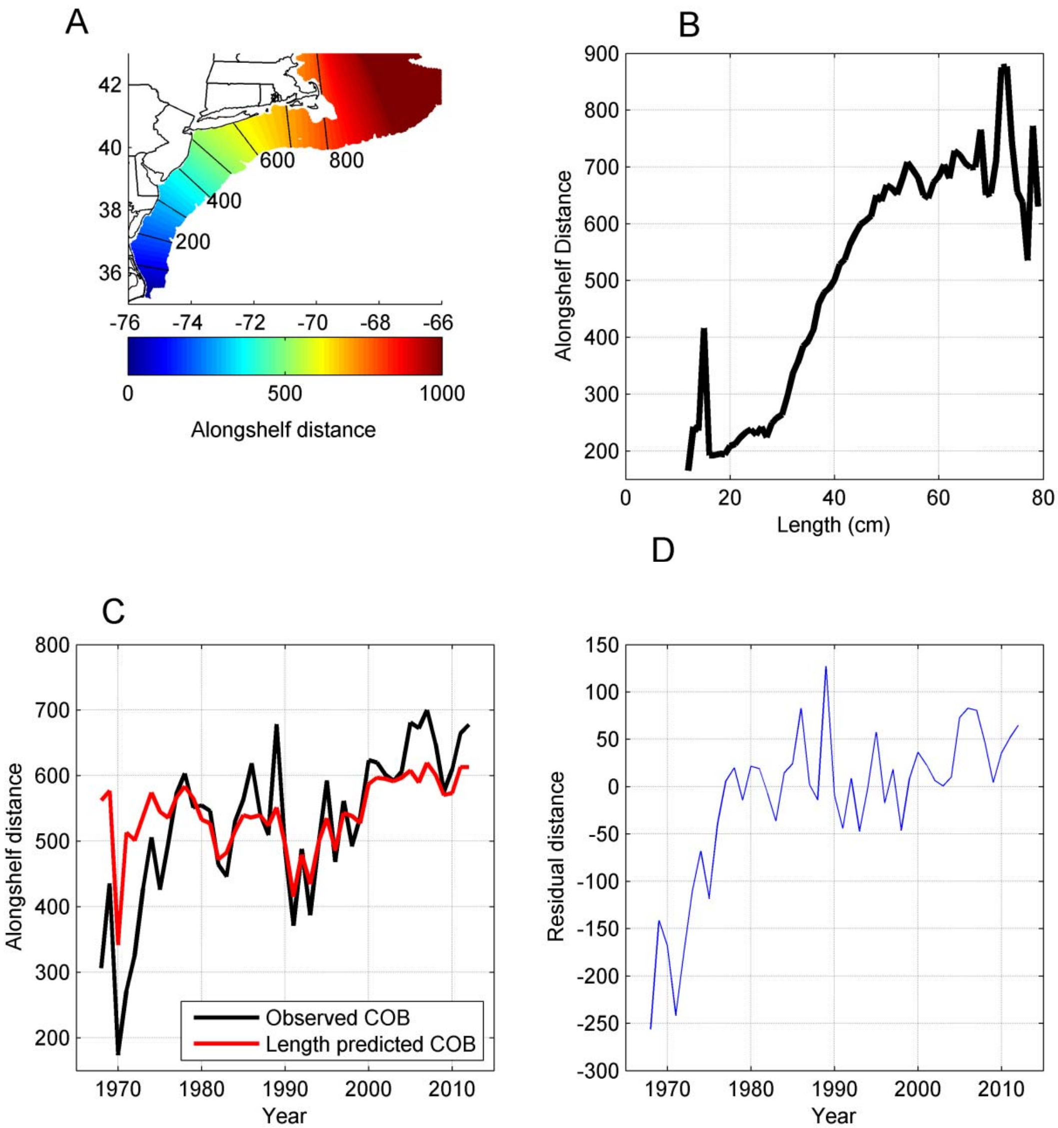


Figure A141. Alongshelf Center of Biomass of Summer Flounder on the fall trawl survey. A) Map of alongshelf positions with distances in kilometers. B) Average alongshelf center of biomass by cm length class for the 1968-2012 spring time series. C) Annual observed center of biomass on the fall trawl survey (black) and center of biomass predicted solely based on the sampled length structure for that survey and the time-series average alongshelf position by length class. D) Residuals of the observed alongshelf distance and predicted alongshelf distance by length class. The residuals correspond to the distribution shift not explained by changes in length structure.

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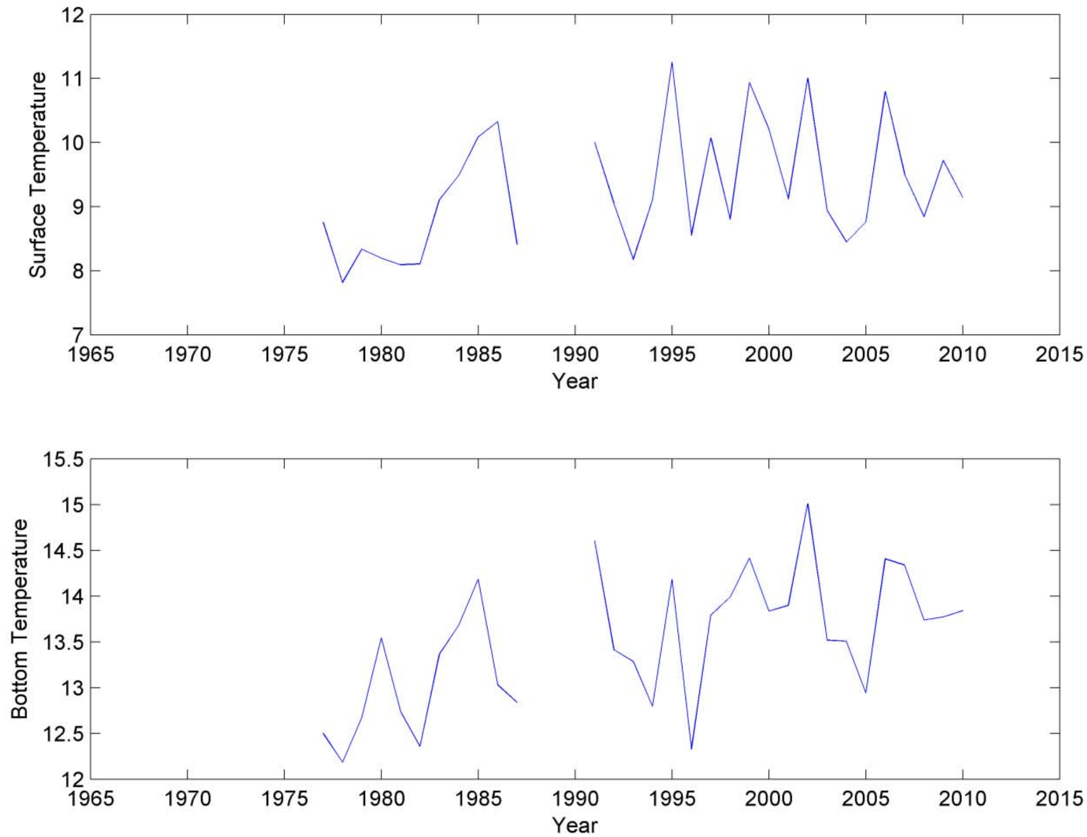


Figure A142. Annual Surface and Bottom temperatures in the Mid-Atlantic Bight

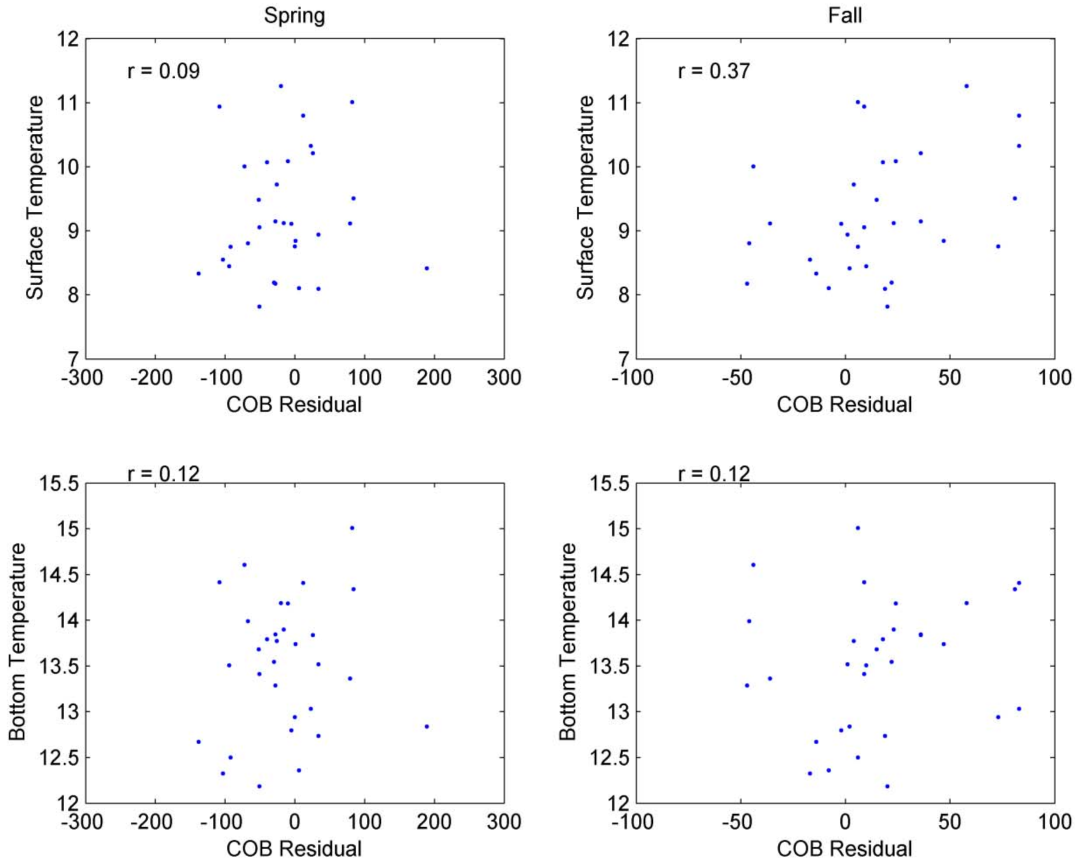


Figure A143. Regressions of the residuals of the Observed COB - Length Predicted COB versus sea surface temperature and bottom temperature for the Spring and Fall survey.

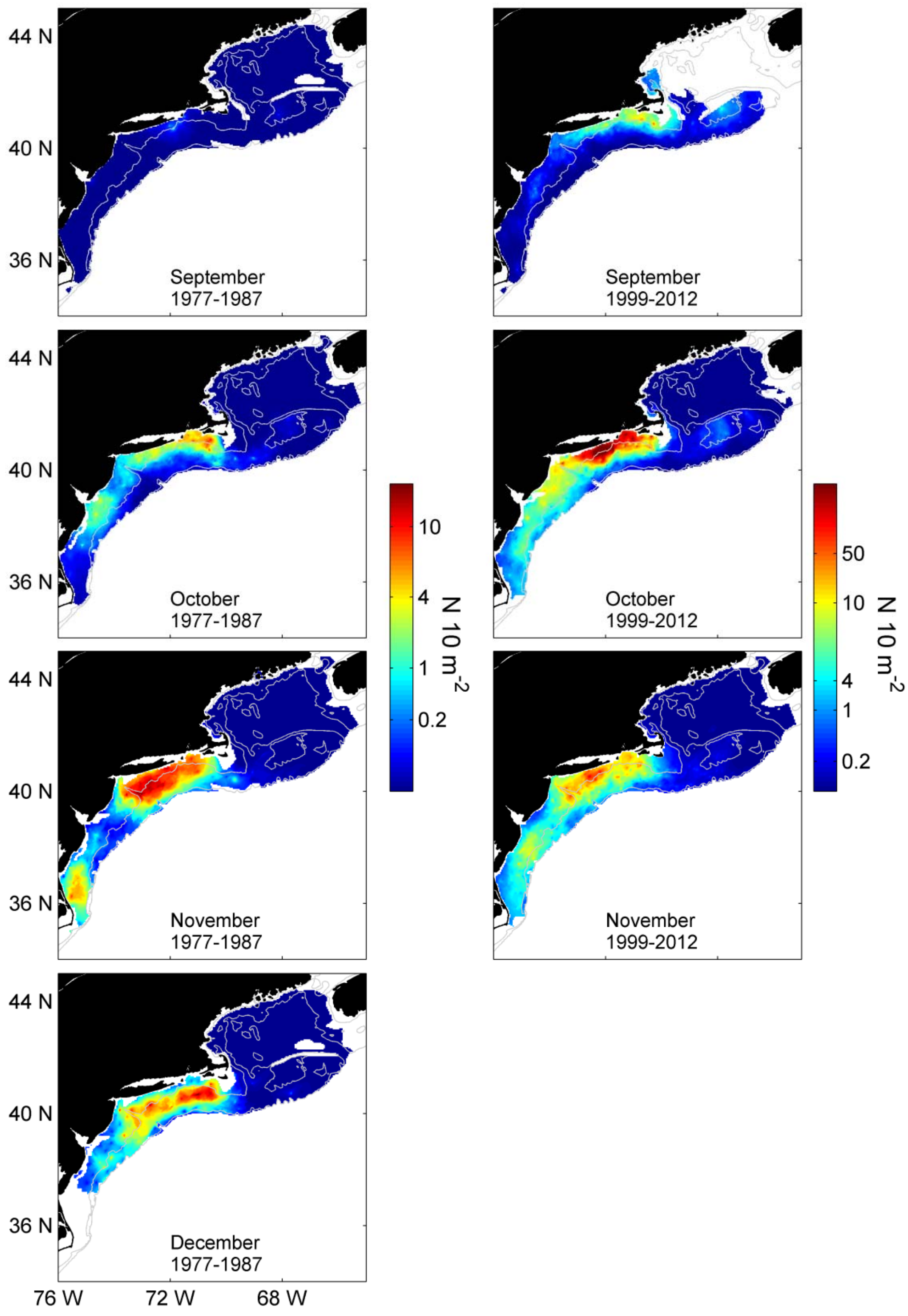


Figure A144. Seasonal summer flounder larval distributions for the MARMAP period (1977-1987) and the ECOMON period (1999-2012).

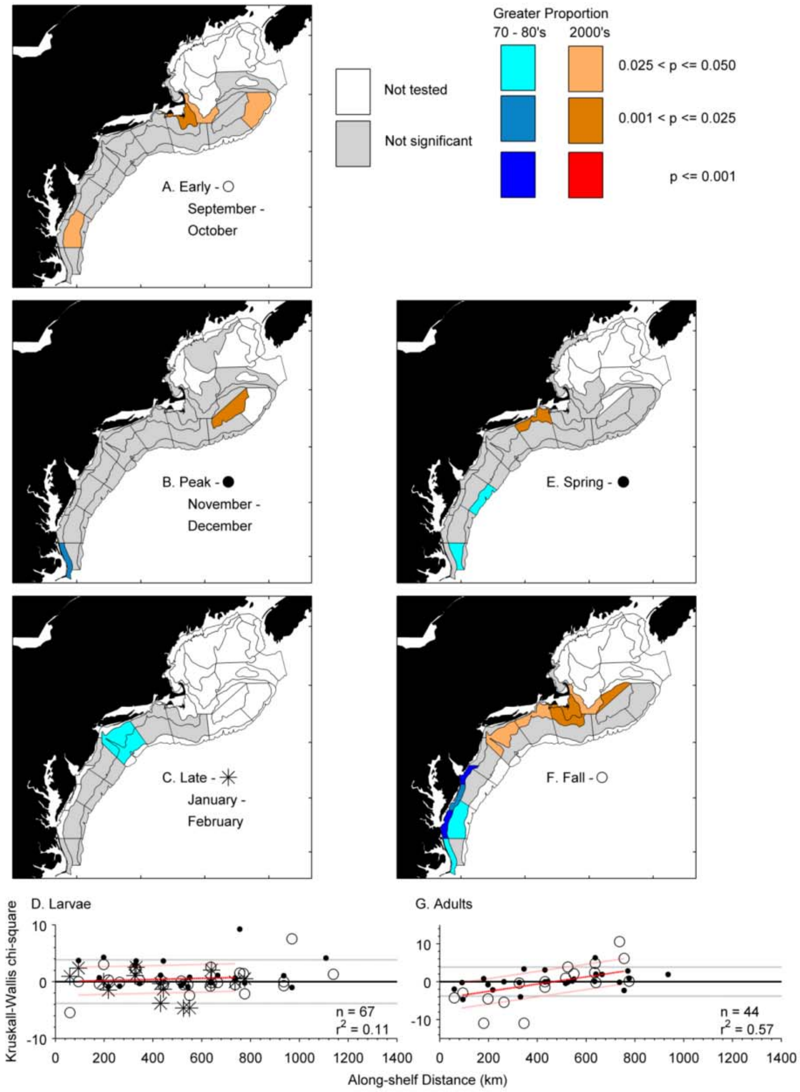


Figure A145. Change in summer flounder larval and mature adult distributions between MARMAP (1977 – 1987) and ECOMON (1999 – 2009) for early (A), peak (B), and late (C) larval seasons and the spring (E) and fall (F) bottom trawl surveys color coded to indicate significant changes in relative proportion for each stratum. Linear regressions were examined for strata (n) from all larval seasons (D) and the two trawl surveys (G) combined. The dashed red line indicates the linear regression and the dotted red lines are the 95 % confidence intervals. The black line indicates the zero line and the black dashed lines indicate significant Kruskal-Wallis H values.

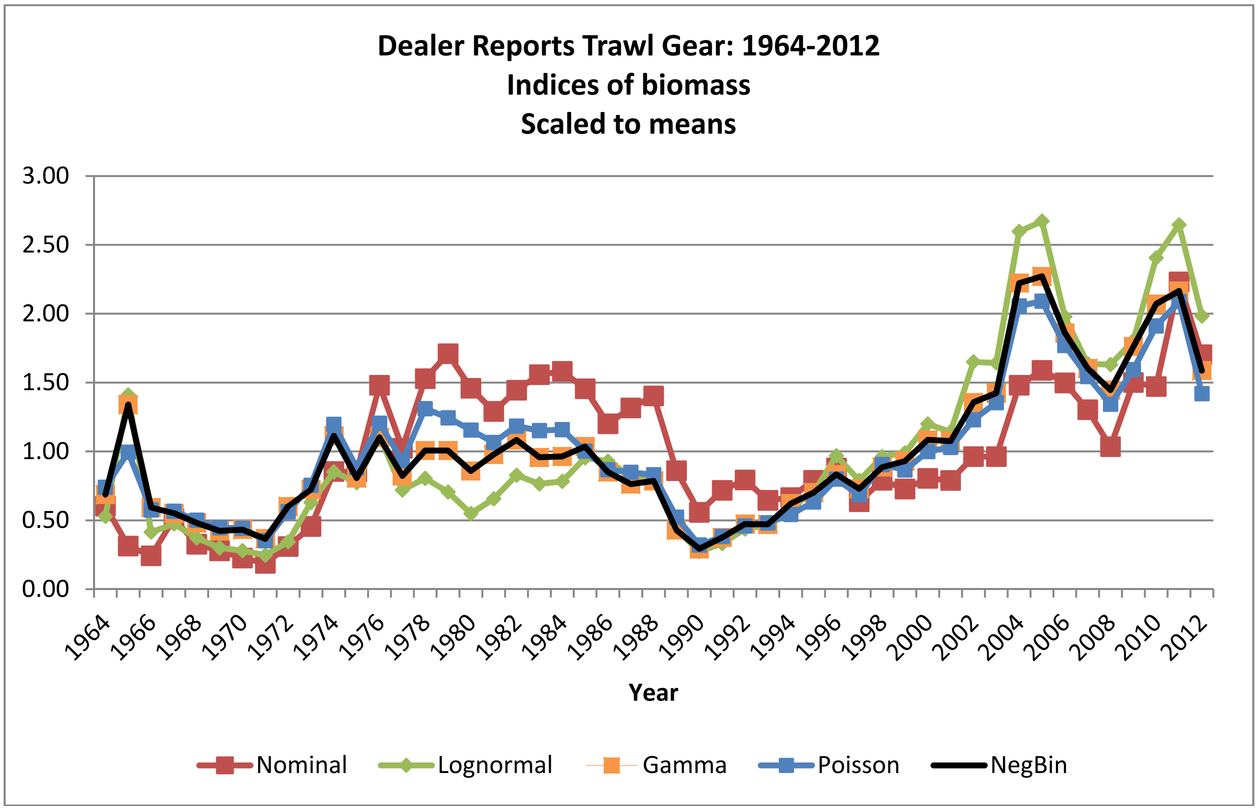


Figure A146. Comparison of the Dealer report trawl gear landings and effort nominal index and model-based standardized indices.

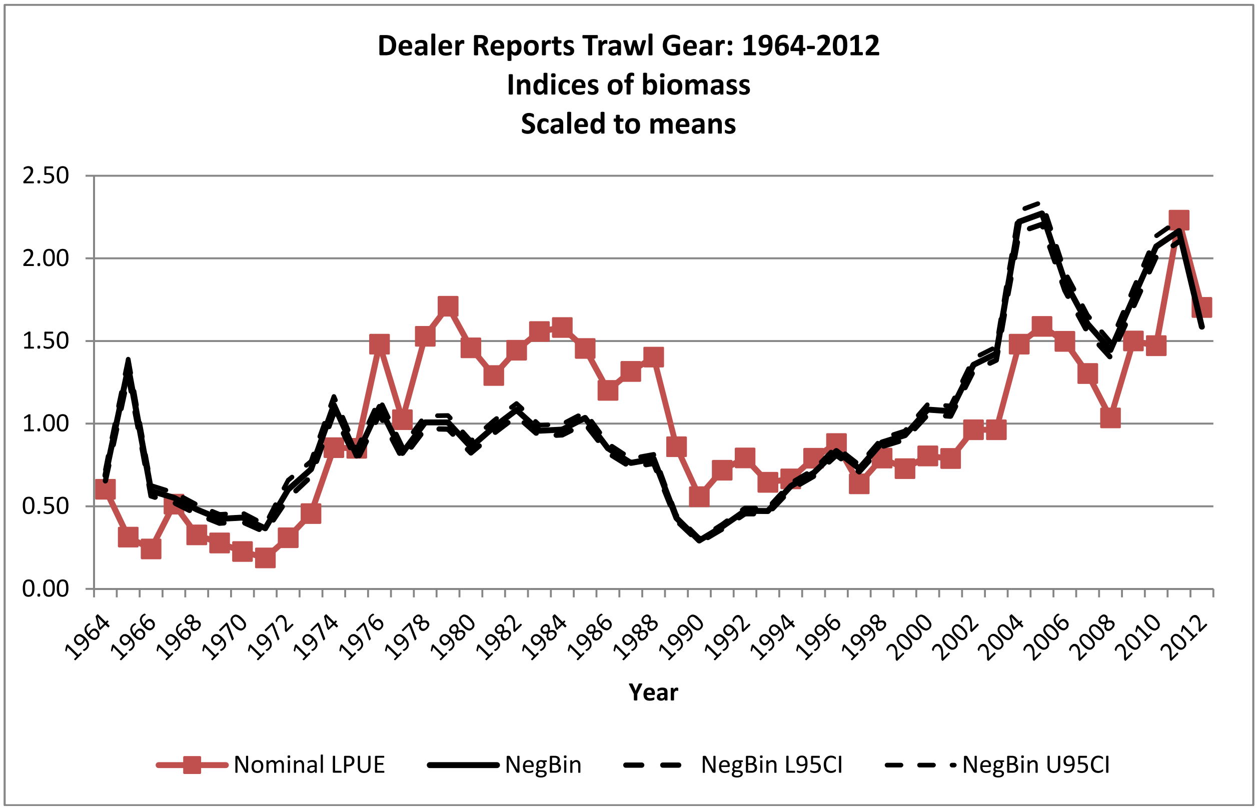


Figure A147. Comparison of the Dealer report trawl gear landings and effort nominal index and negbin model-based standardized index and 95% confidence intervals.

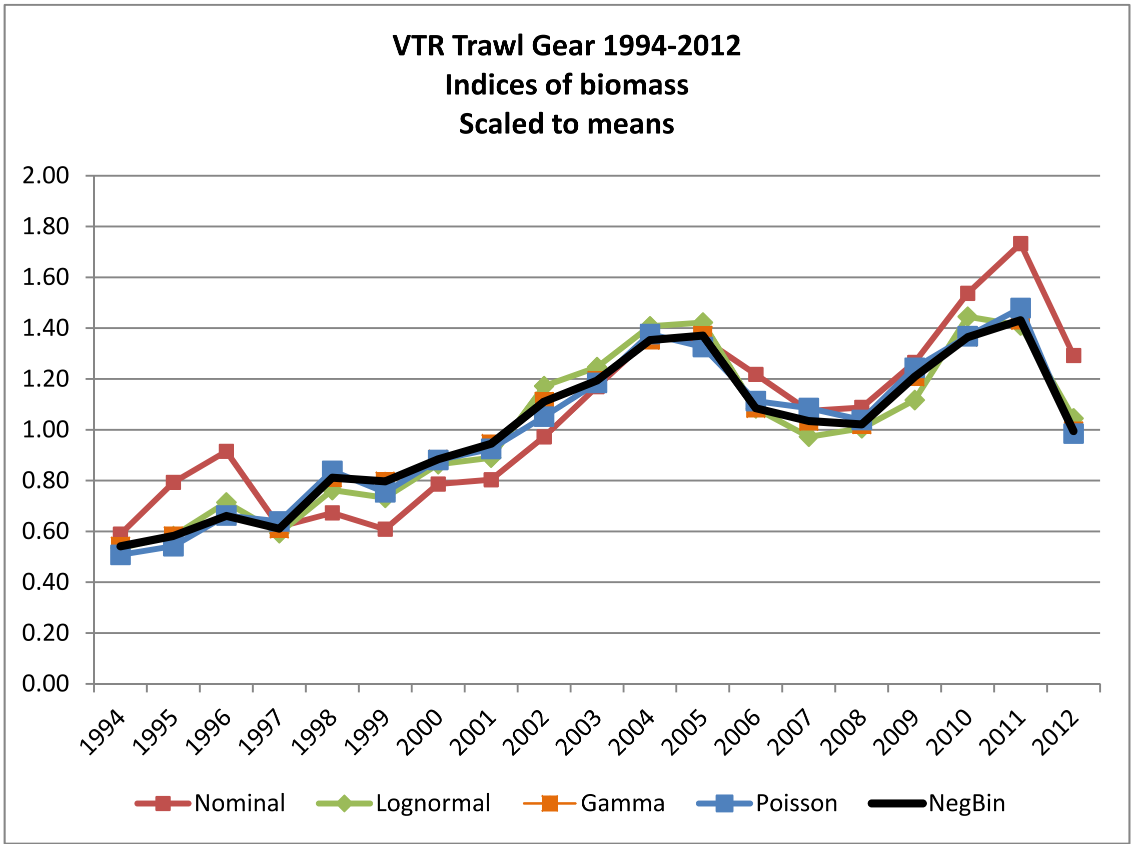


Figure A148. Comparison of the VTR trawl gear catch and effort nominal index and model-based standardized indices.

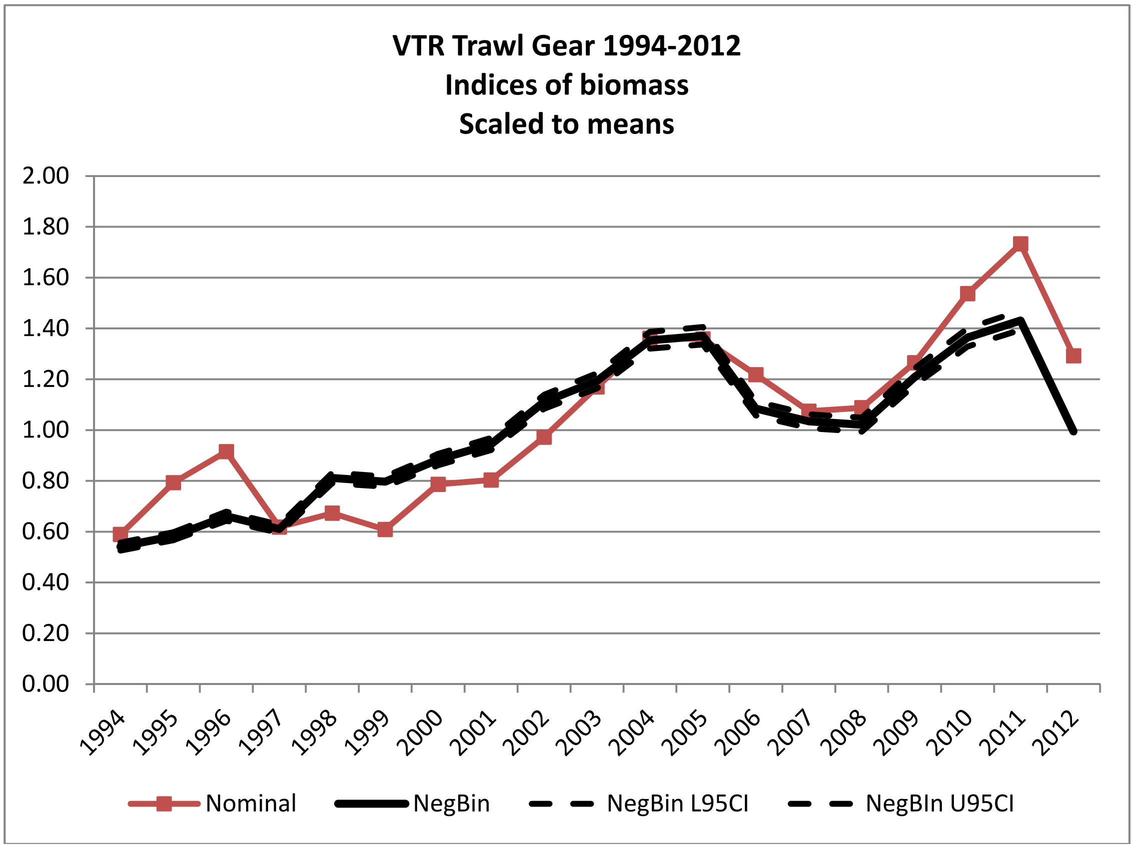


Figure A149. Comparison of the VTR trawl gear landings and effort nominal index and negbin model-based standardized index and 95% confidence intervals.

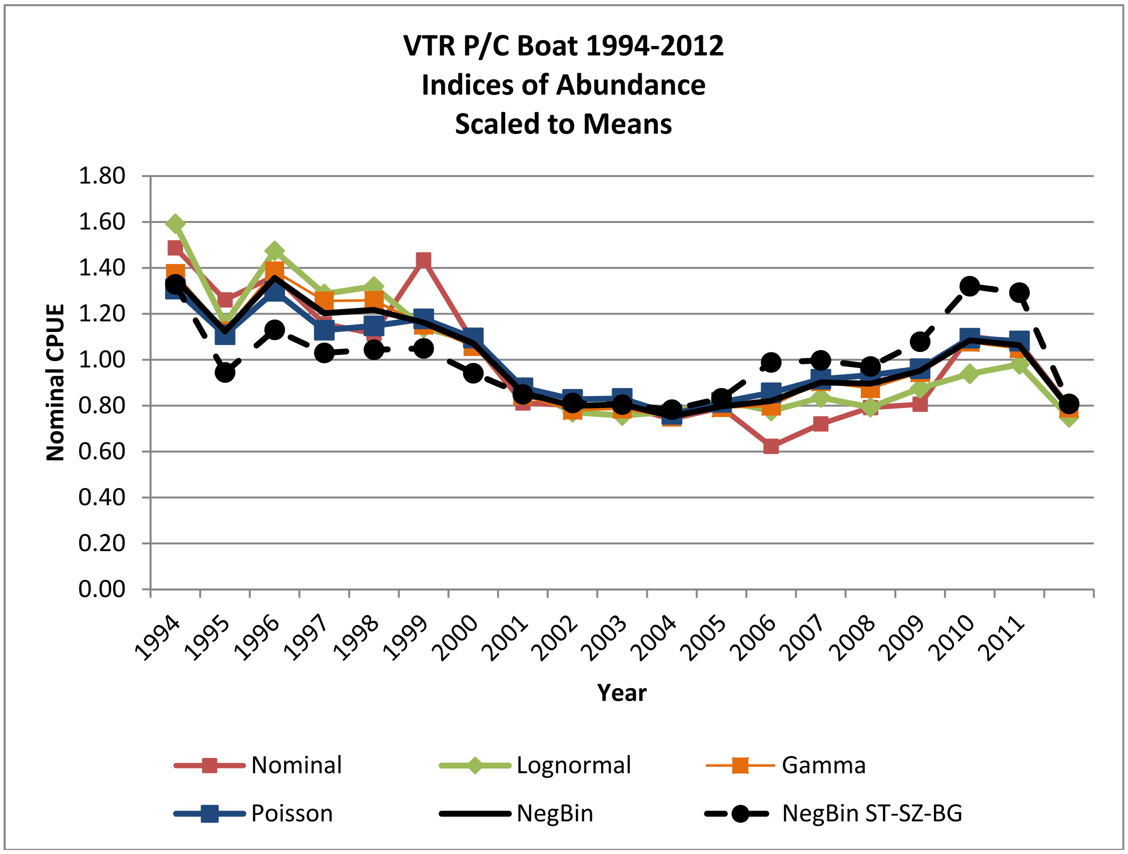


Figure A150. Comparison of the VTR Party/Charter boat nominal index and model-based standardized indices.

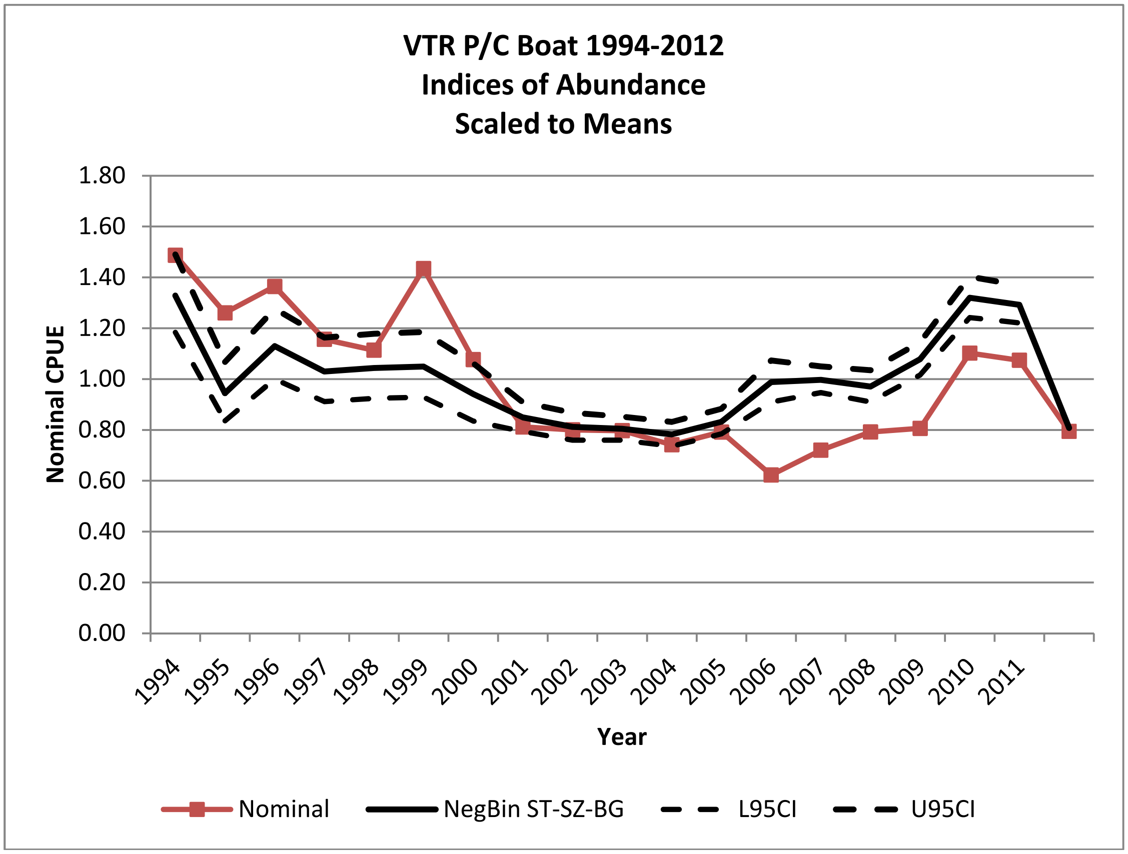


Figure A151. Comparison of the negbin six-factor ST-SZ-BG model-based indices and the nominal index.

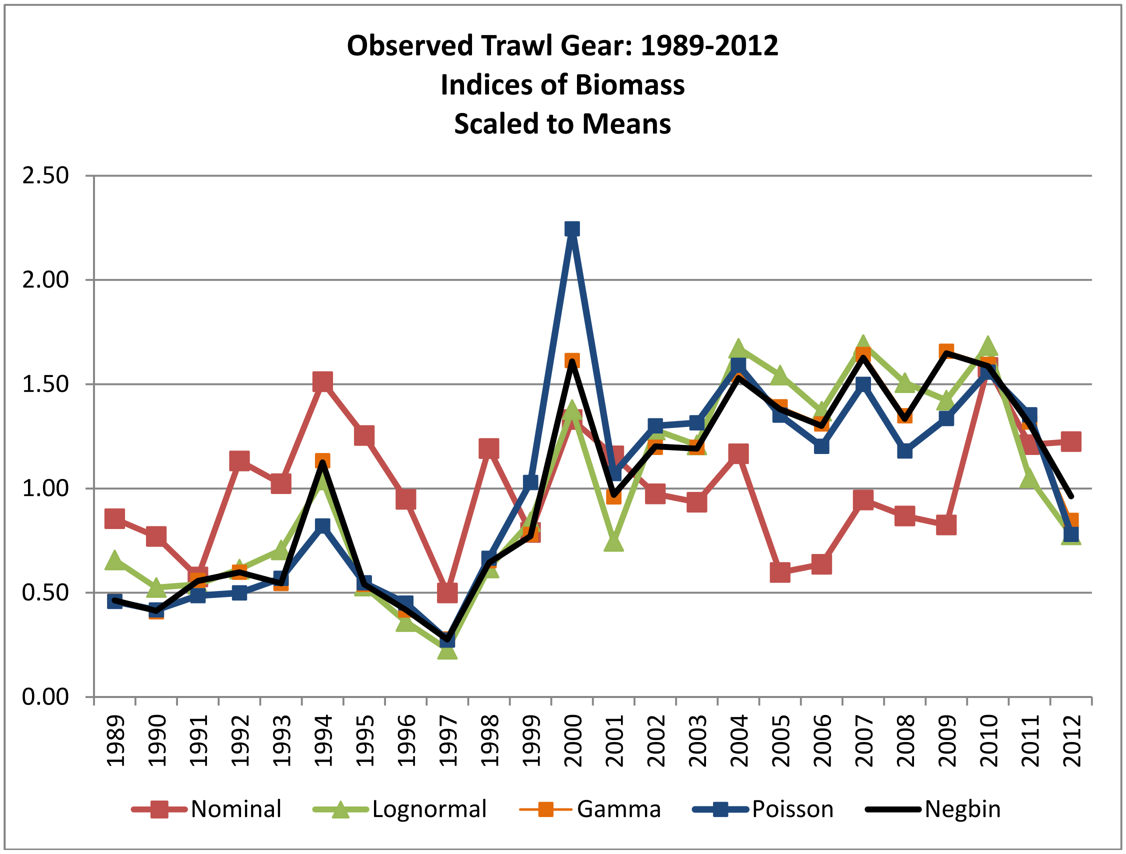


Figure A152. Comparison of the Observed trawl gear nominal index and model-based standardized indices.

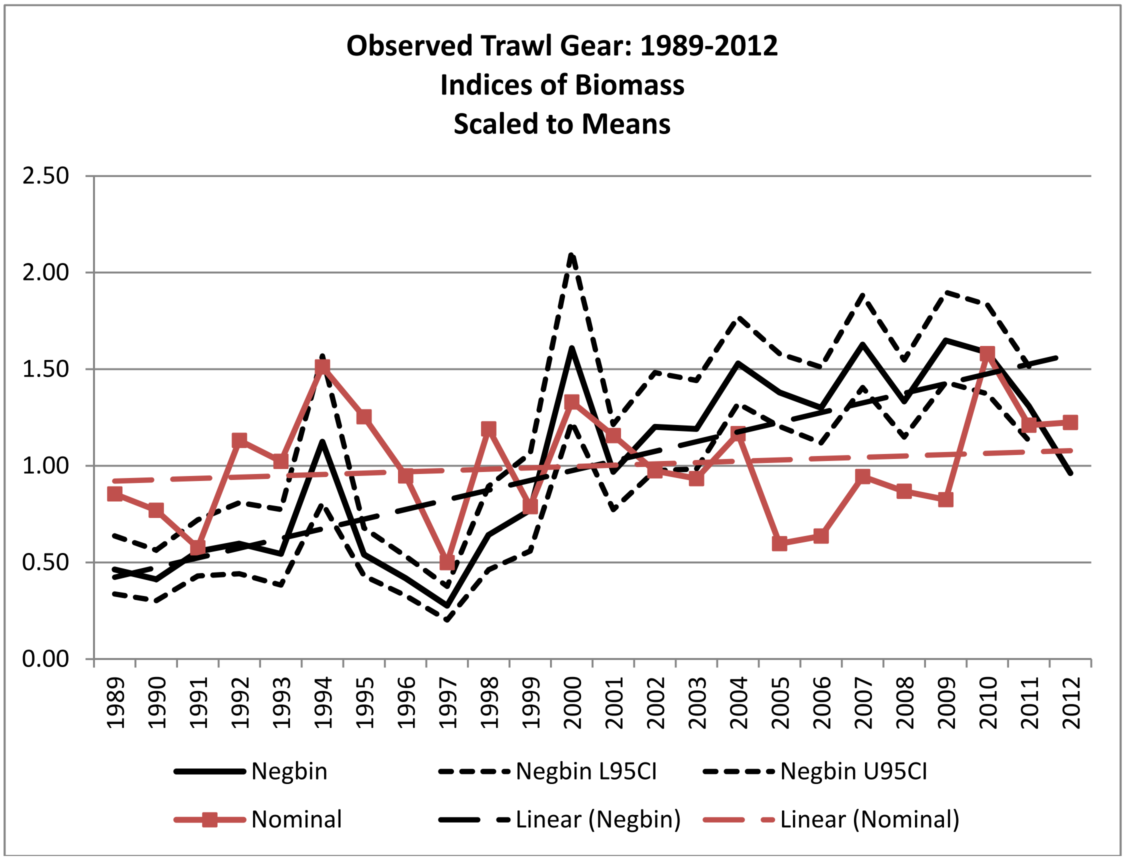


Figure A153. Comparison of the Observed trawl gear negbin model-based index and the nominal index.

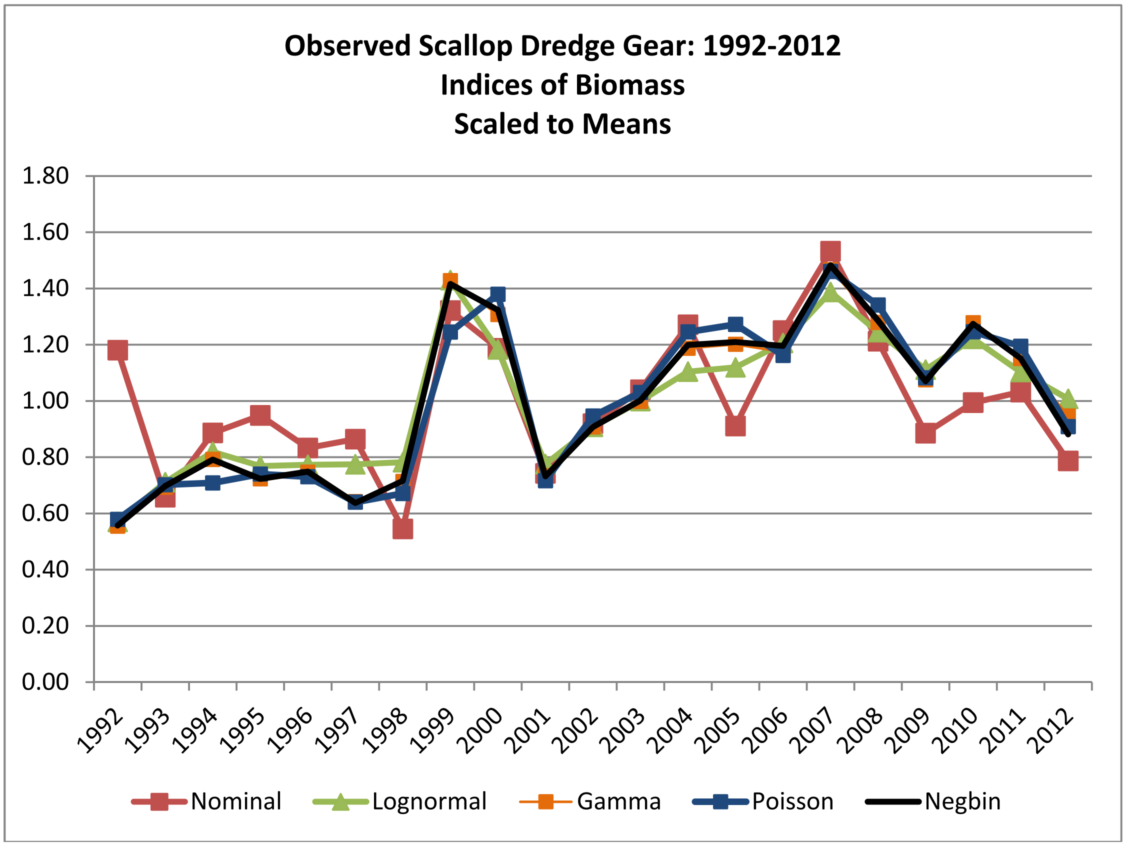


Figure A154. Comparison of the Observed scallop dredge nominal index and model-based standardized indices.

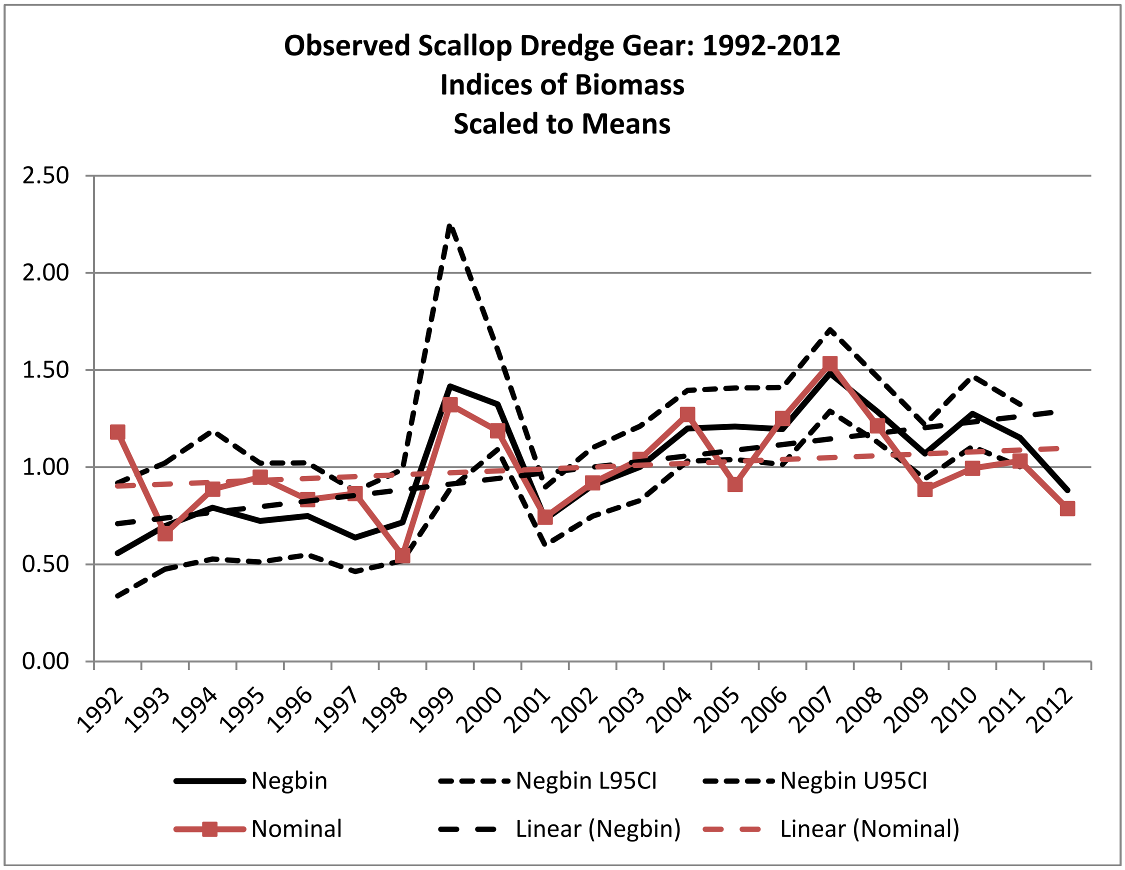


Figure A155. Comparison of the Observed scallop dredge negbin model-based index and the nominal index.

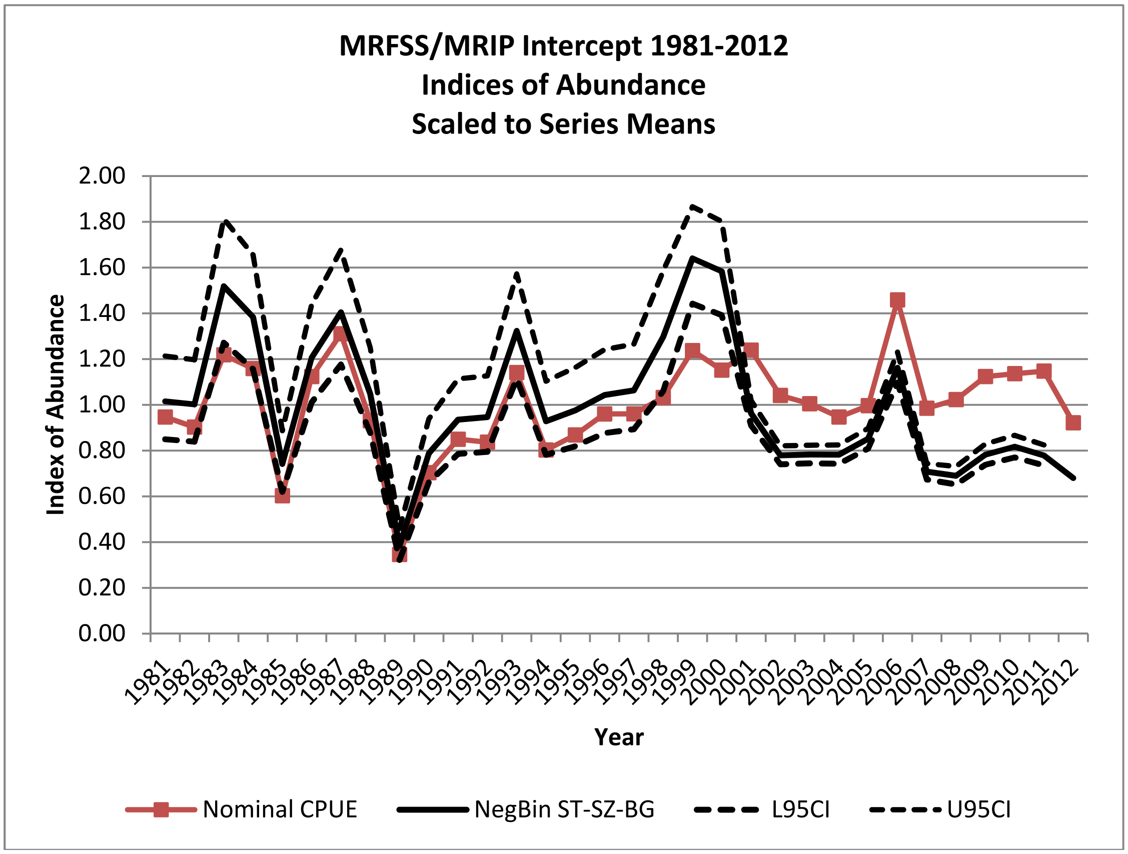


Figure A156. Comparison of the MRFSS/MRIP intercept negbin six-factor ST-SZ-BG model-based indices and the nominal index.

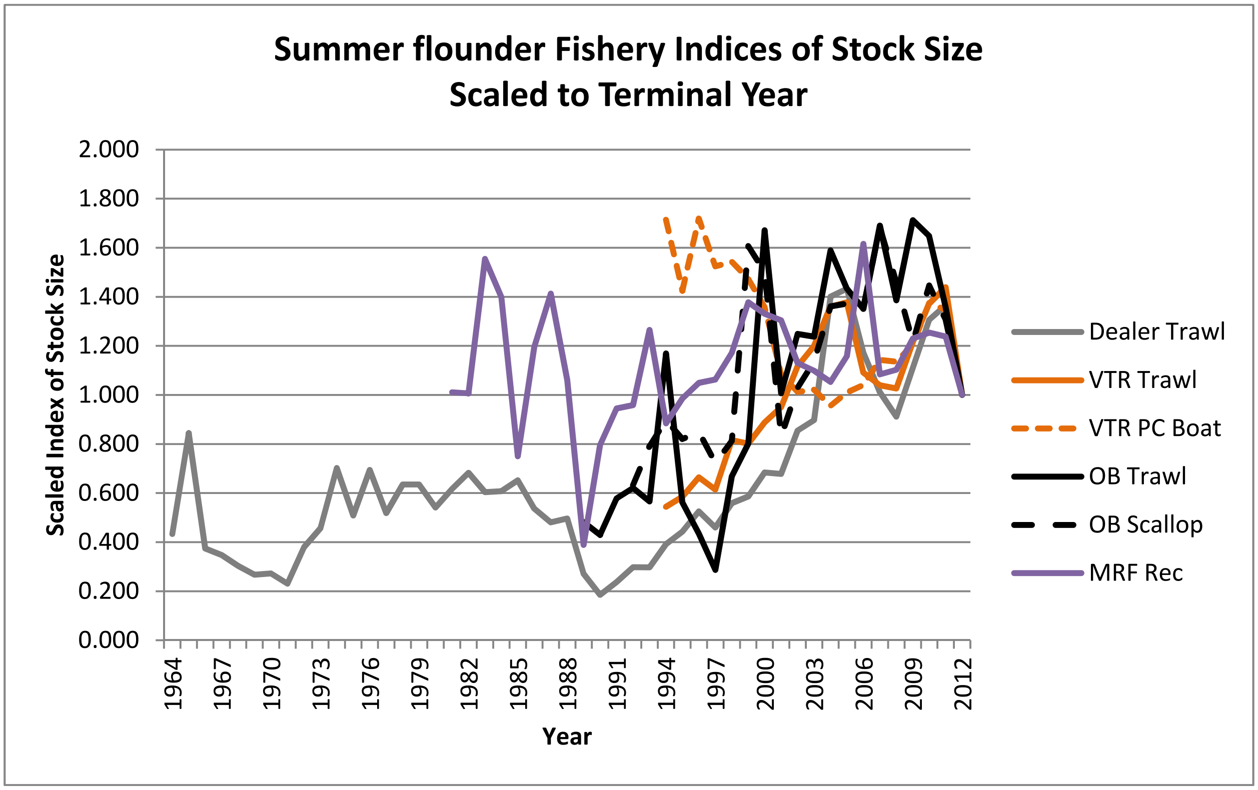


Figure A157. Trends in fishery dependent standardized indices of summer flounder stock size, scaled to the terminal year (2012) to facilitate comparison.

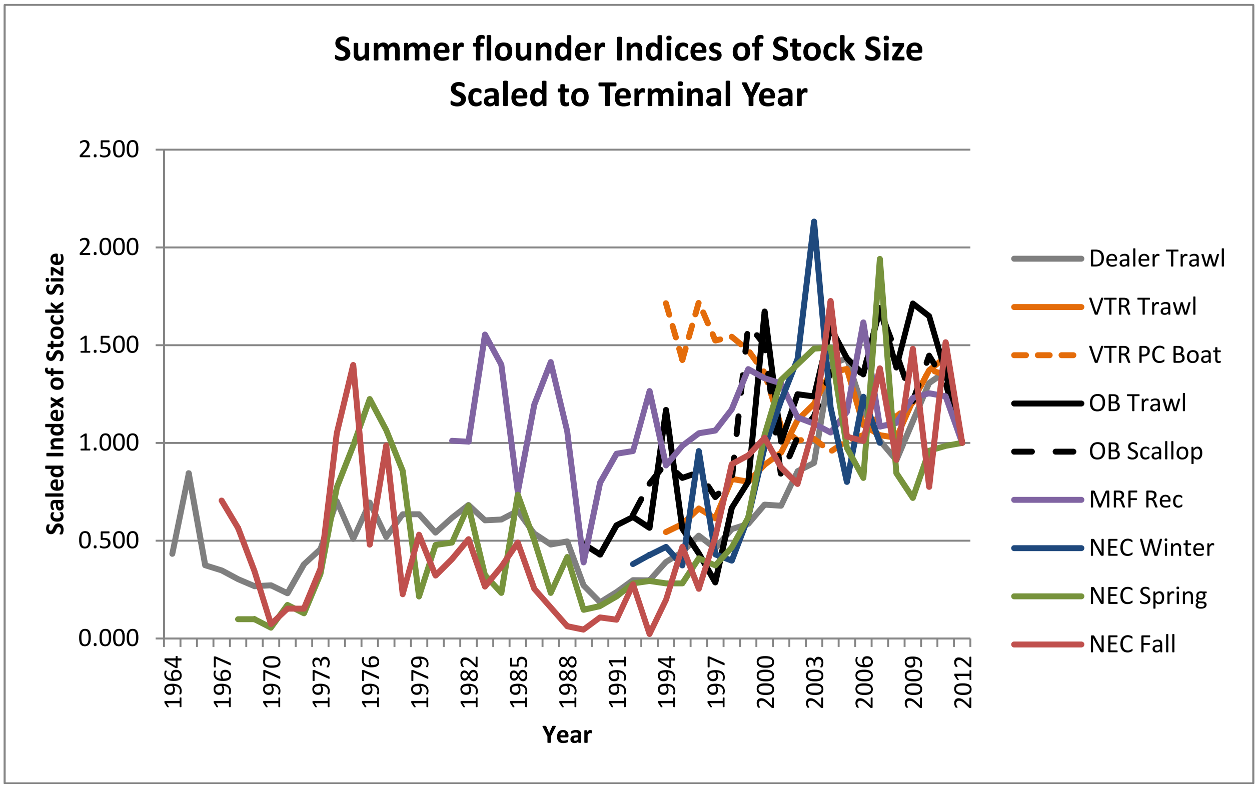


Figure A158. Trends in indices of summer flounder stock size, (including the three NEFSC seasonal trawl surveys, scaled to the terminal year (2012) to facilitate comparison.

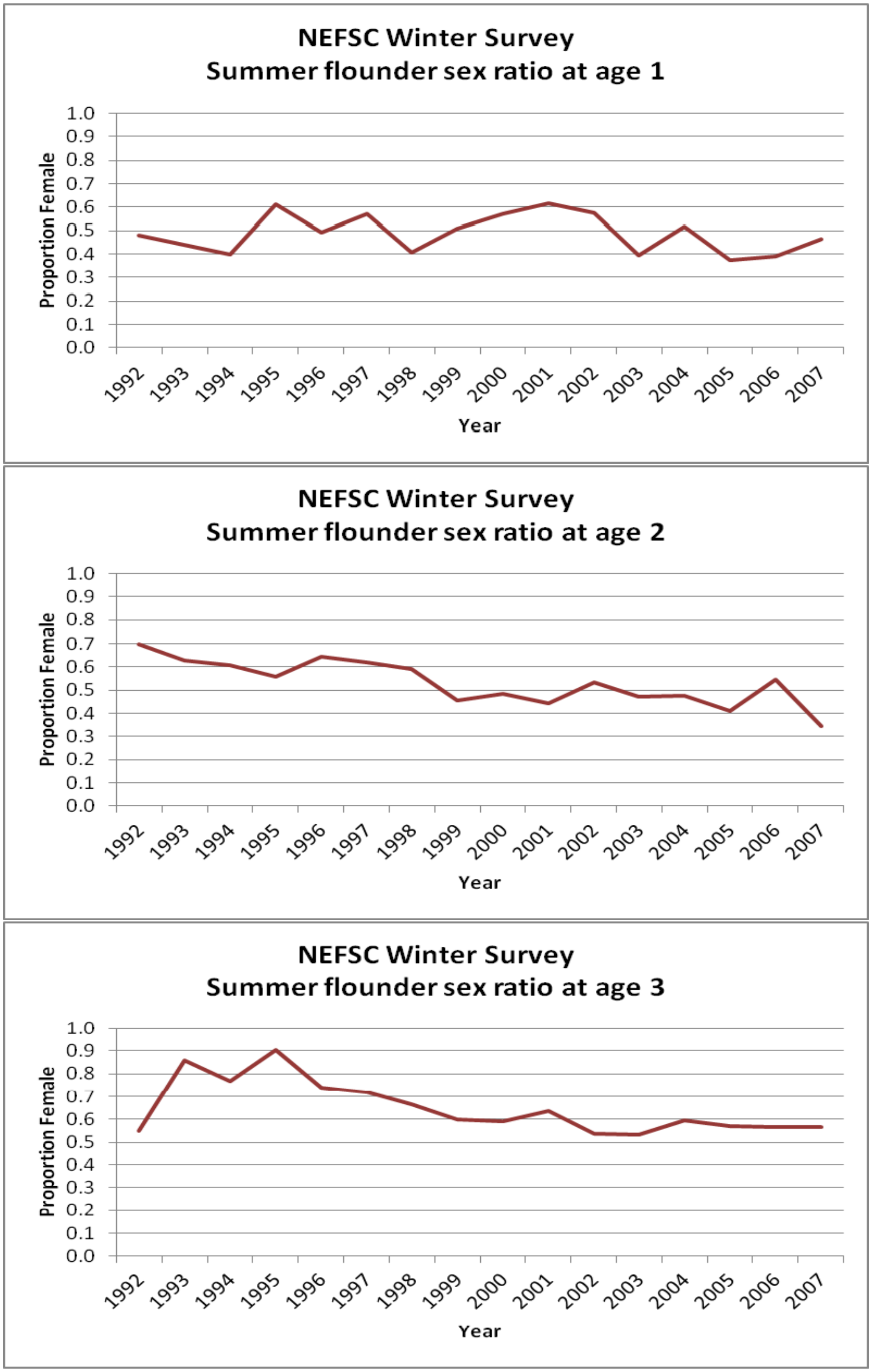
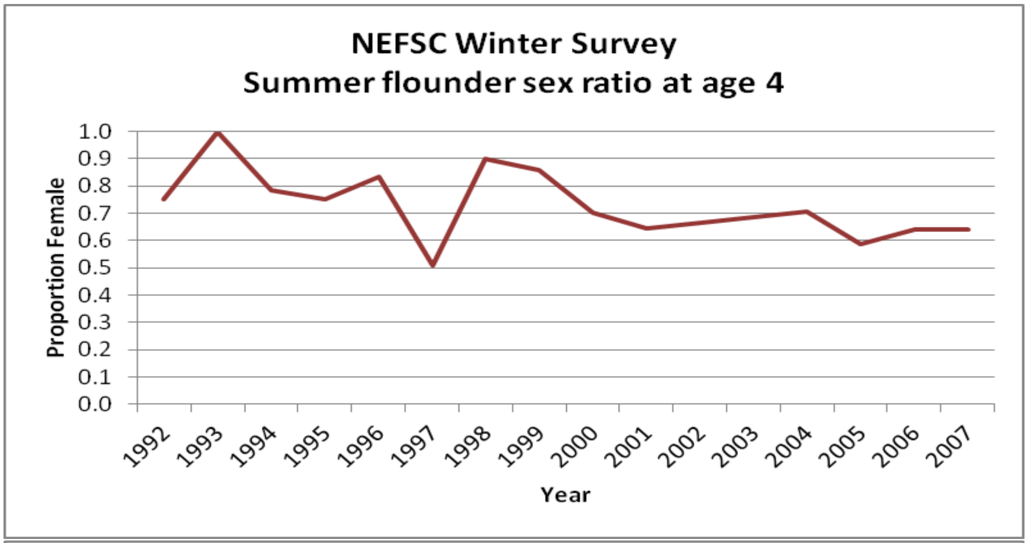
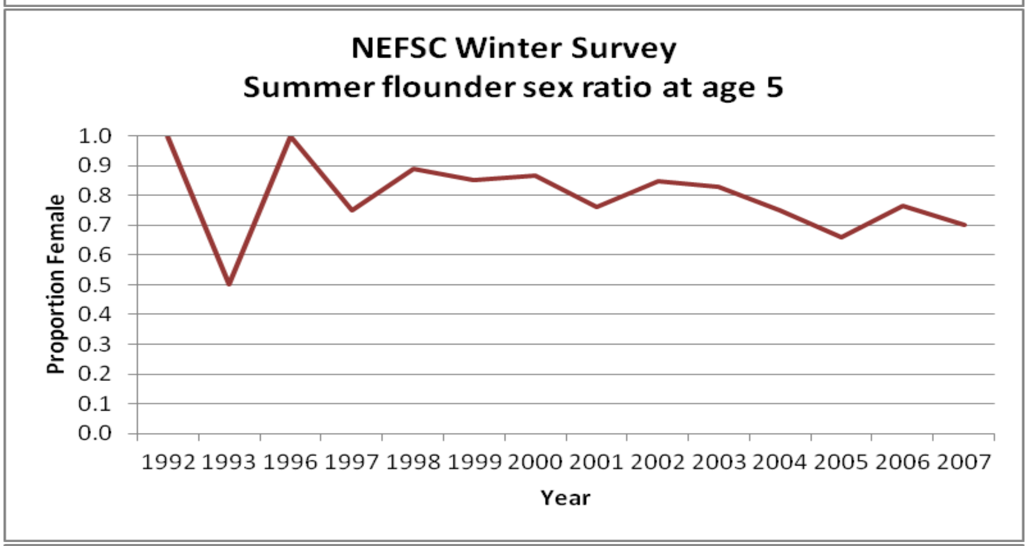


Figure A159. NEFSC winter survey: proportion female at ages 1-3.





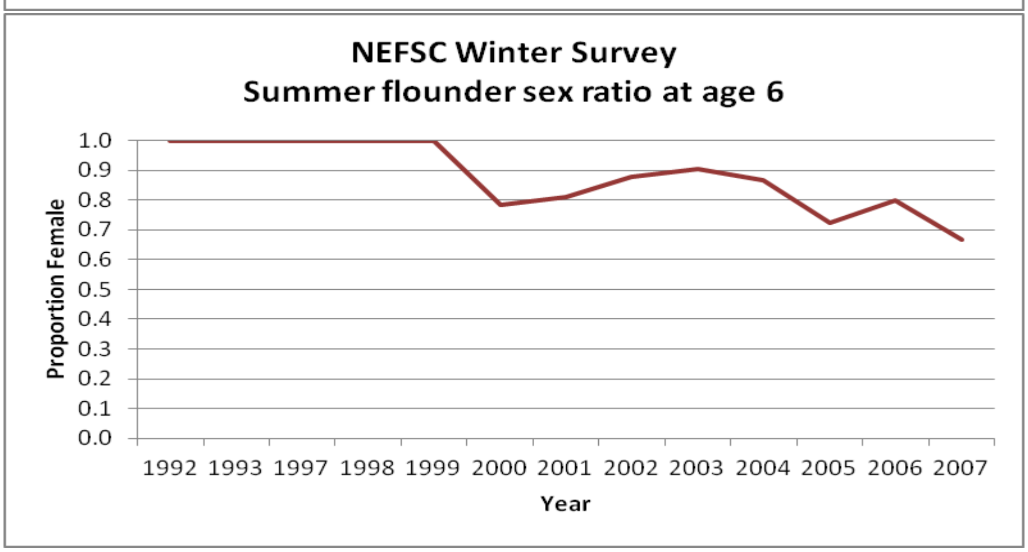


Figure A160. NEFSC winter survey: proportion female at ages 4-6.

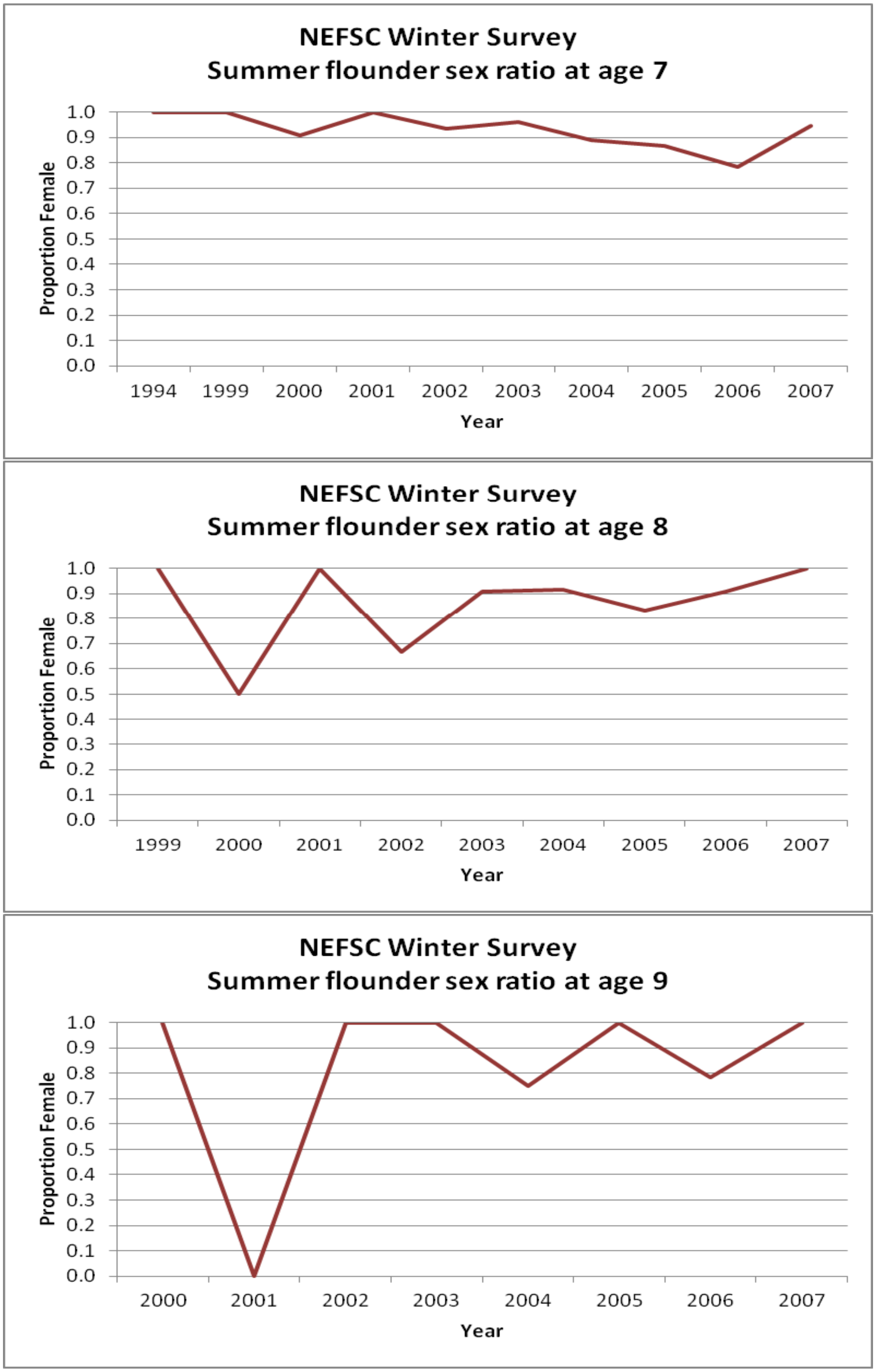


Figure A161. NEFSC winter survey: proportion female at ages 7-9.

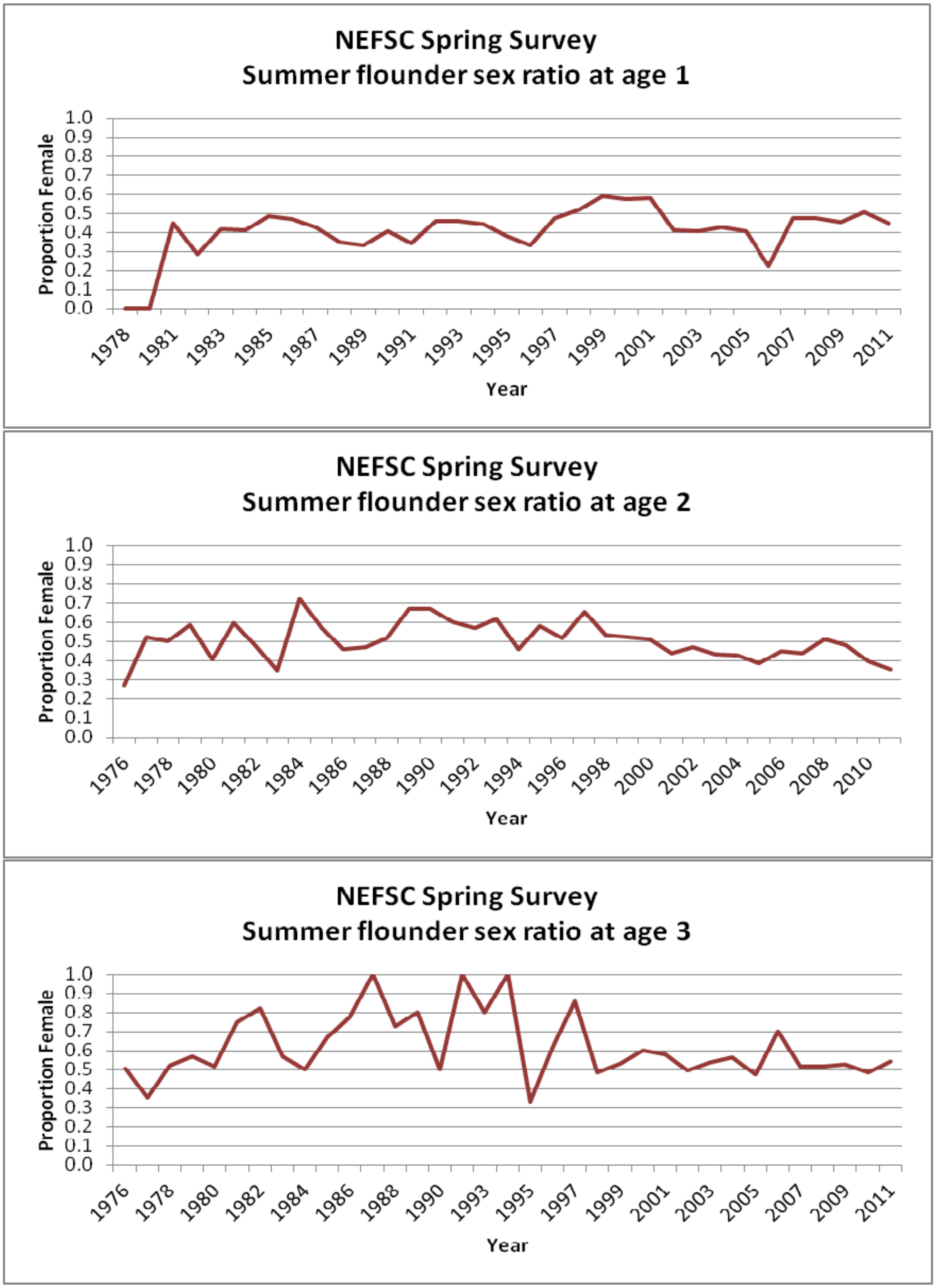


Figure A162: NEFSC spring survey: proportion female at ages 1-3.

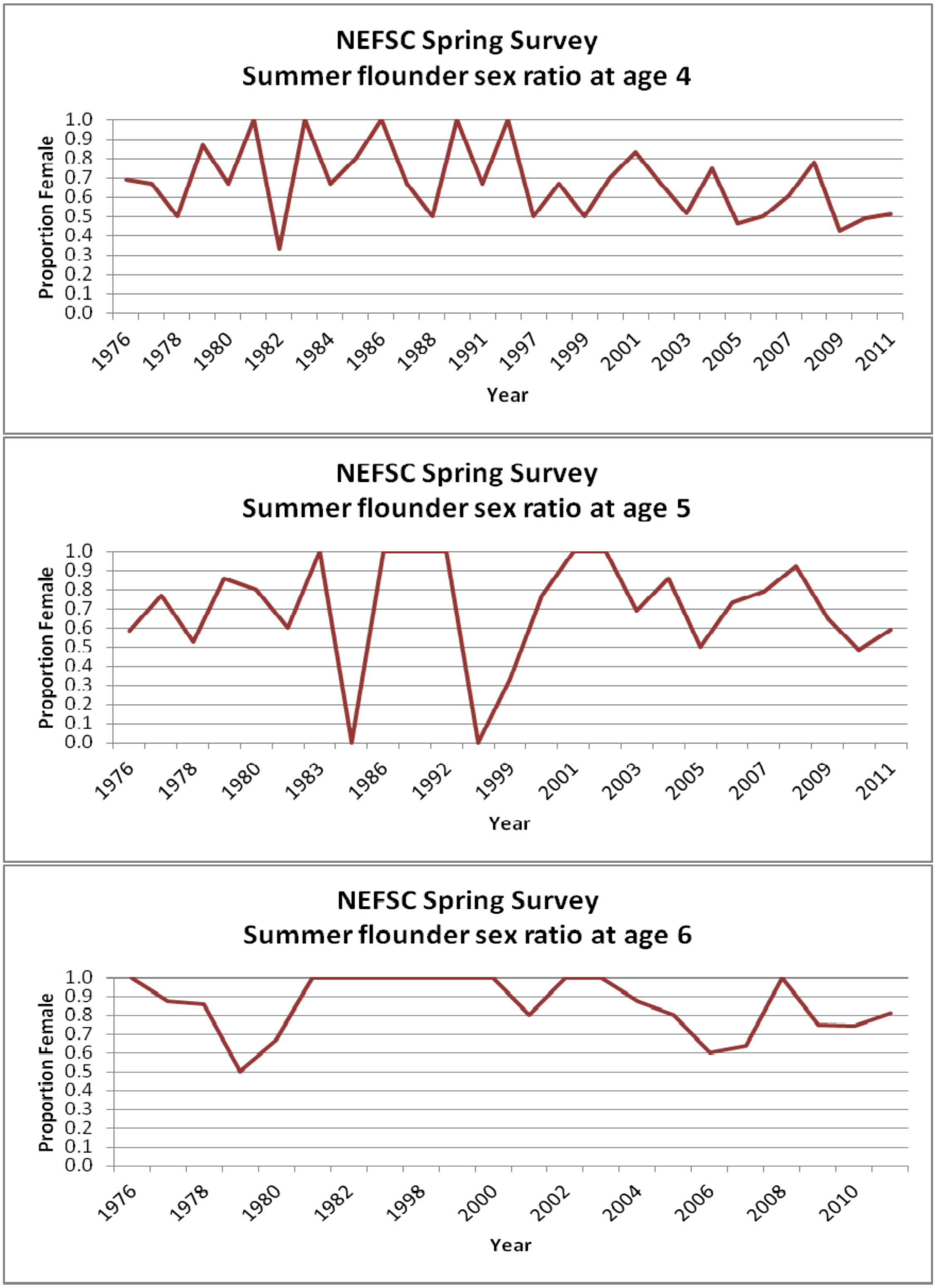


Figure A163: NEFSC spring survey: proportion female at ages 4-6.

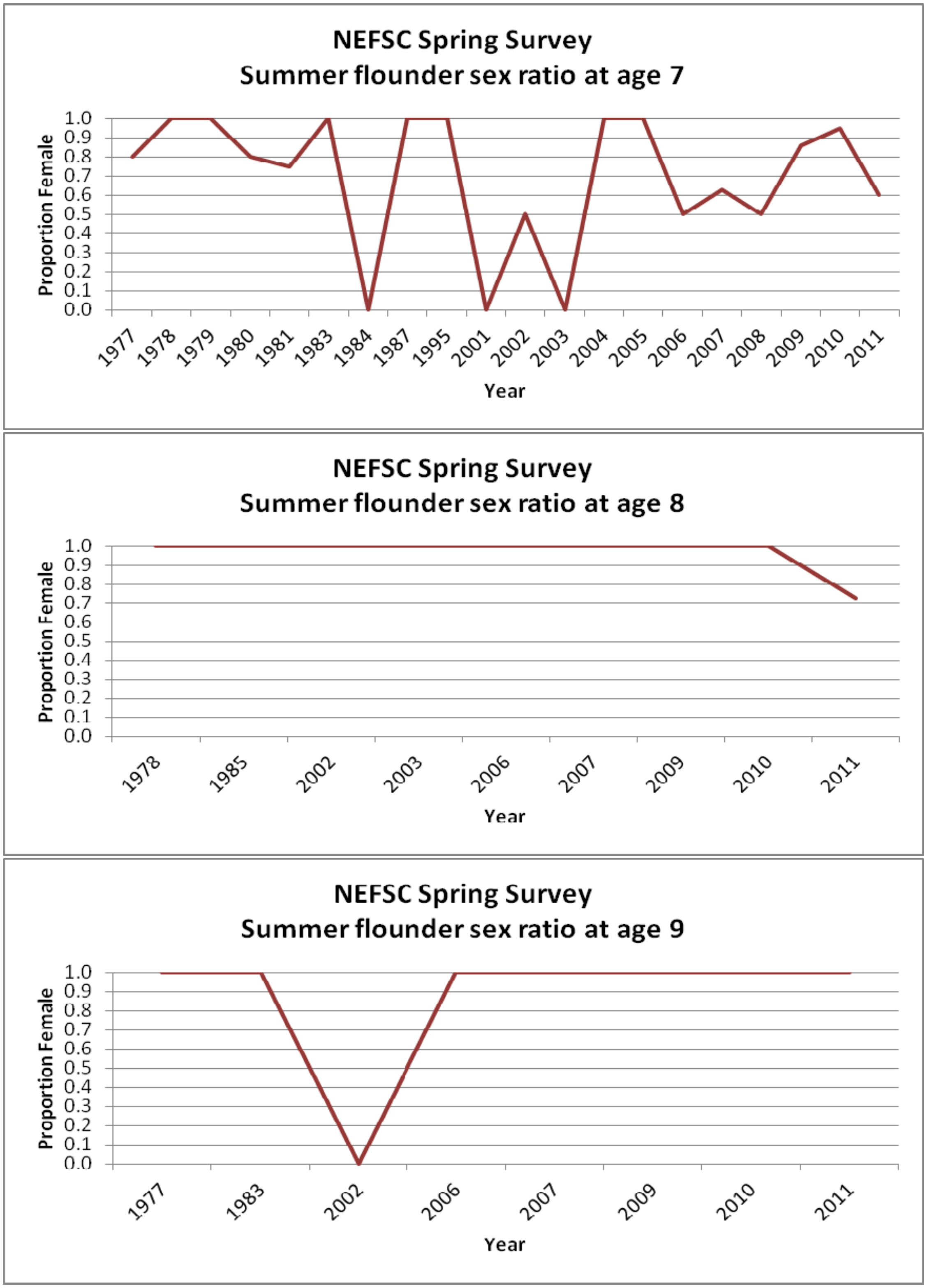


Figure A164: NEFSC spring survey: proportion female at ages 7-9.

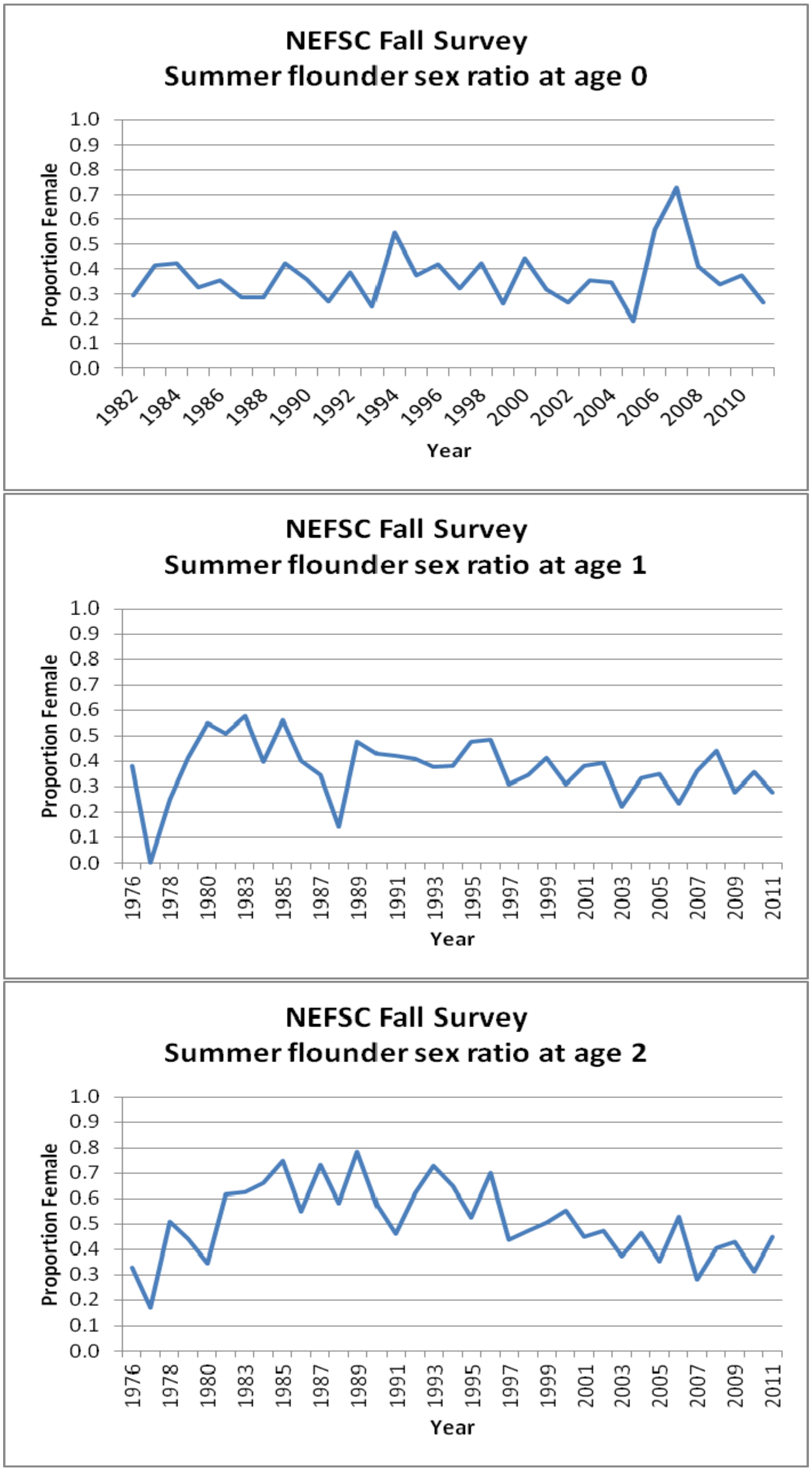


Figure A165: NEFSC fall survey: proportion female at ages 0-2.

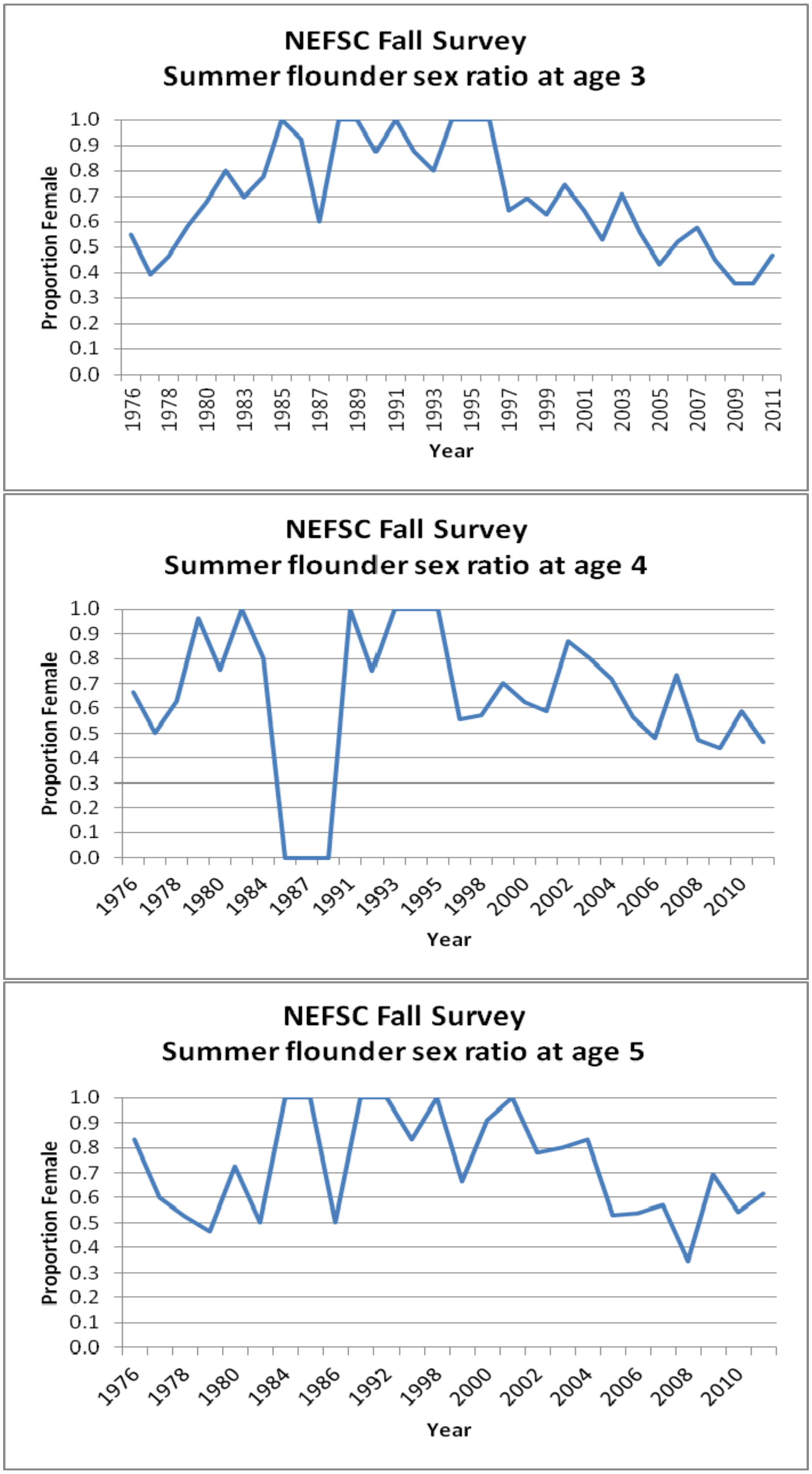


Figure A166: NEFSC fall survey: proportion female at ages 3-5.

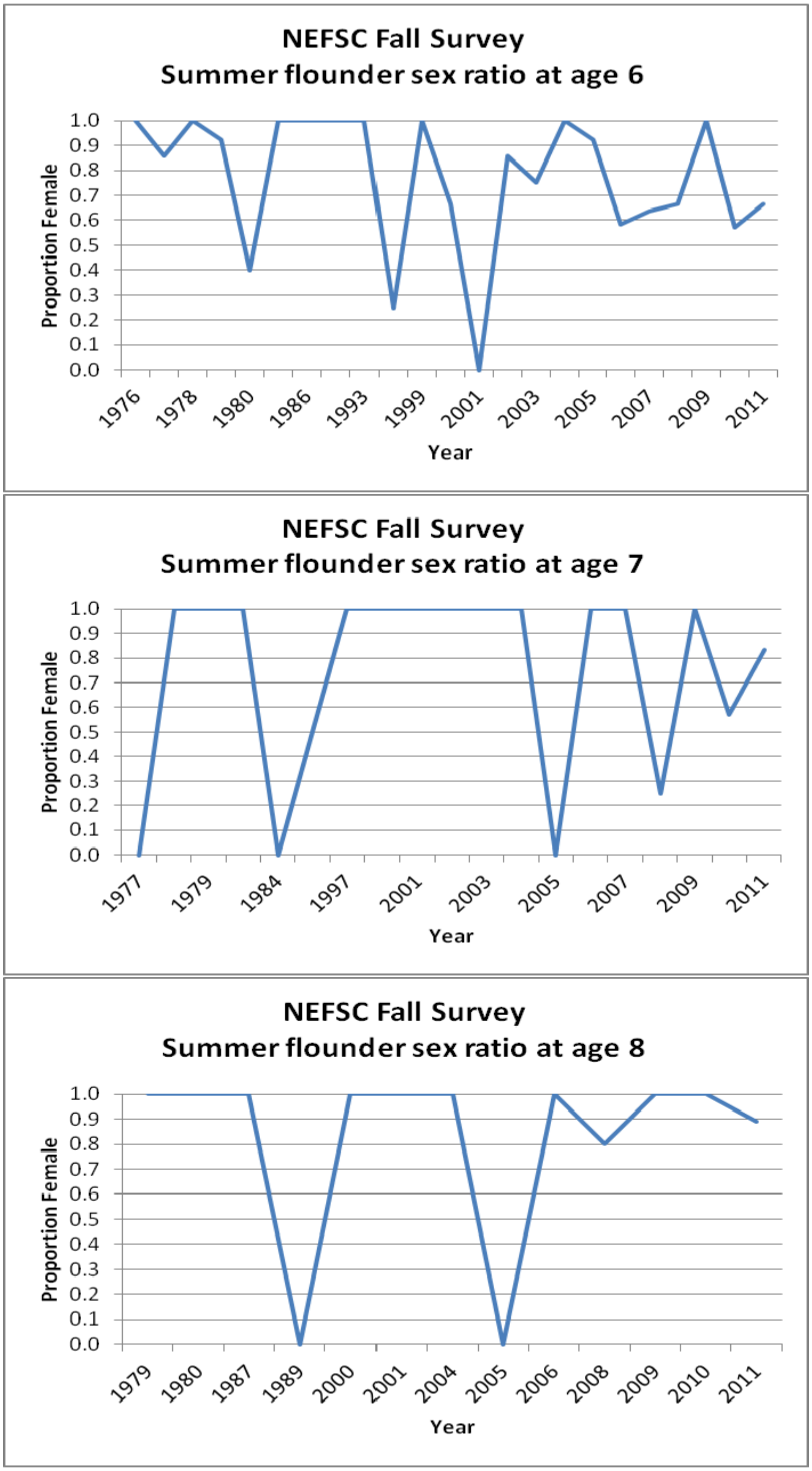
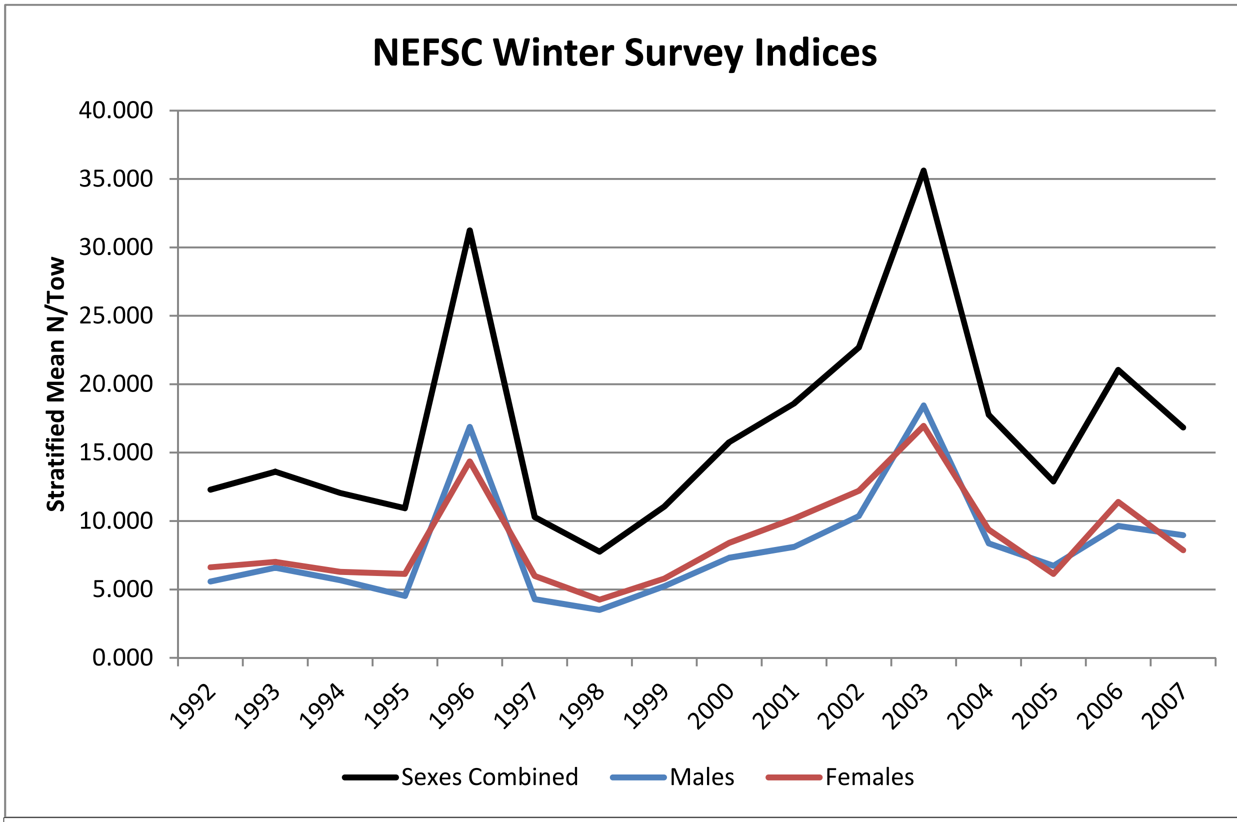


Figure A167: NEFSC fall survey: proportion female at ages 6-8.



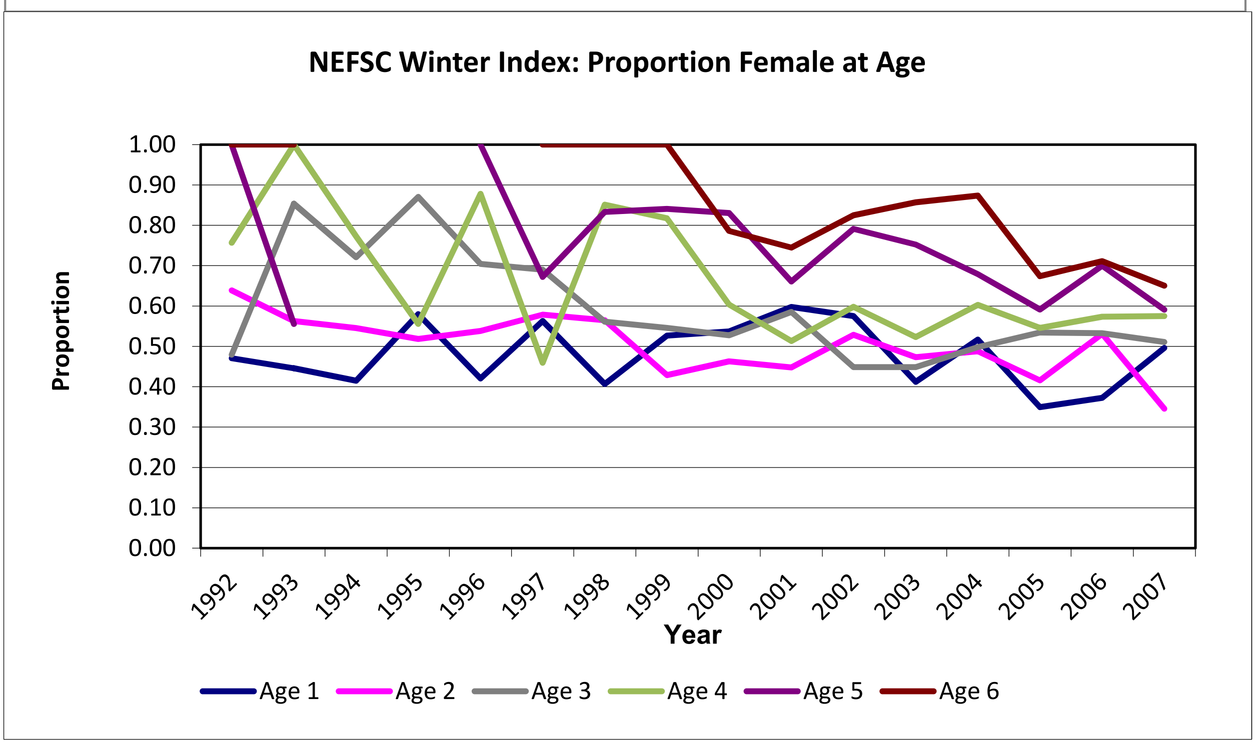


Figure A168. NEFSC winter survey indices of abundance (number per tow) for males, females, and sexes combined (top) and proportion female by age (bottom).

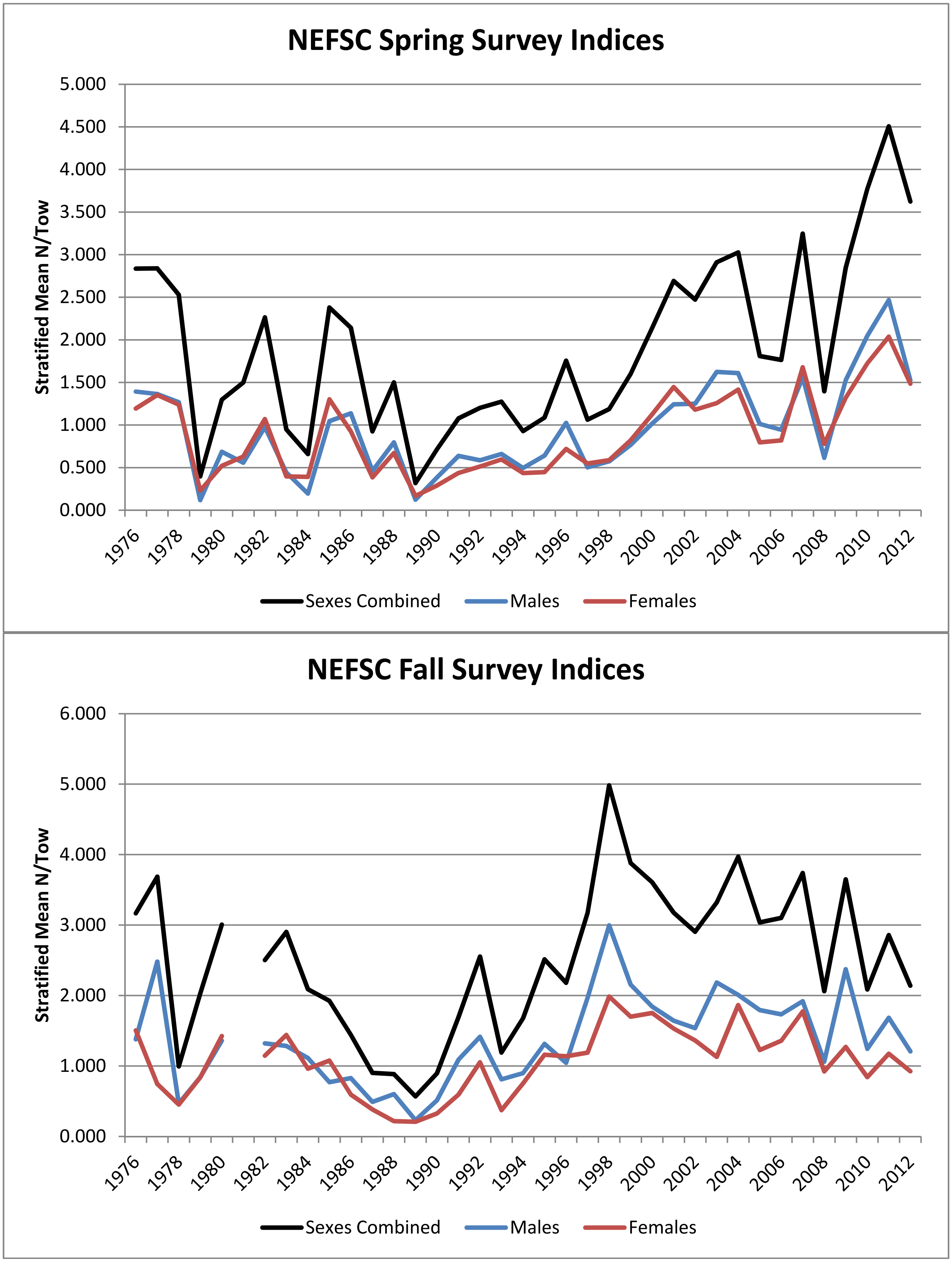


Figure A169. NEFSC spring and fall survey indices of abundance (number per tow) for males, females, and sexes combined.

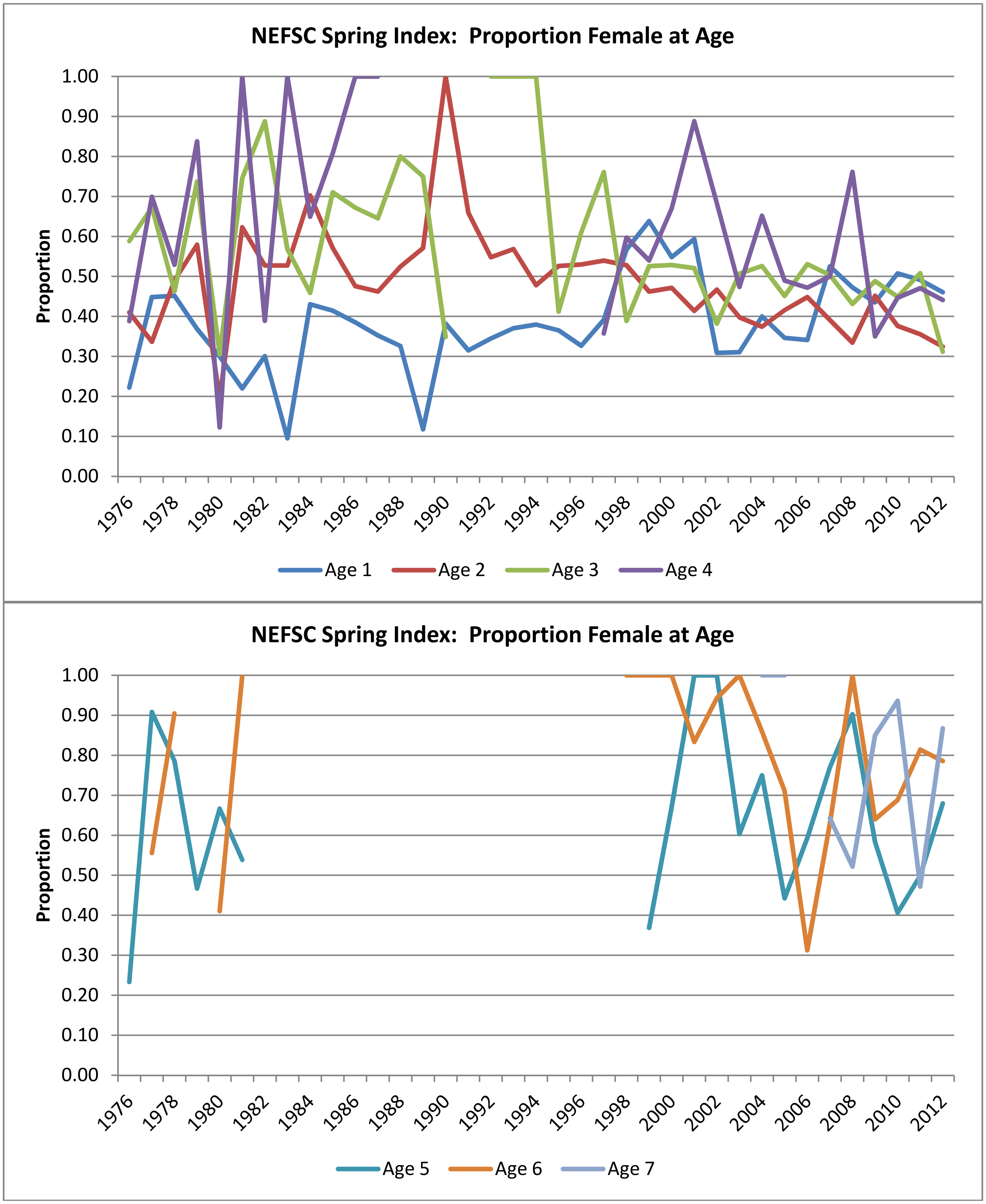
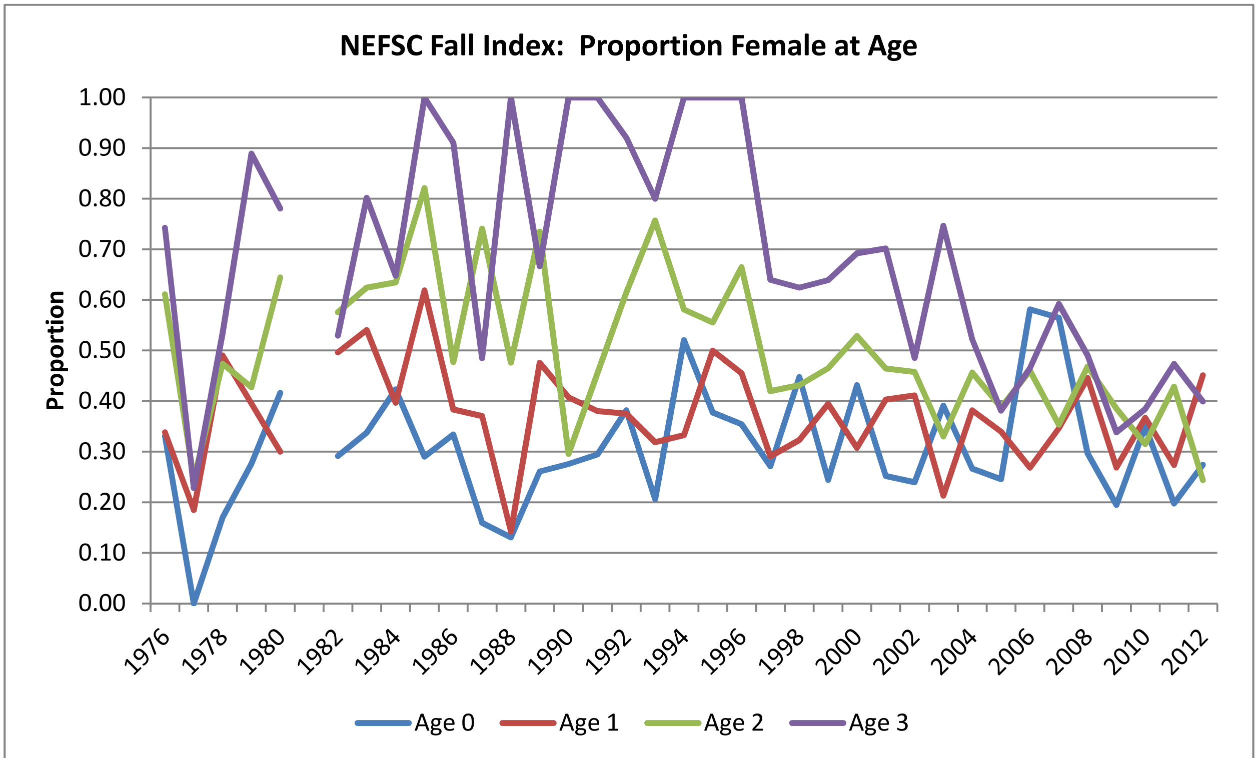


Figure A170. NEFSC spring survey index proportion female by age.



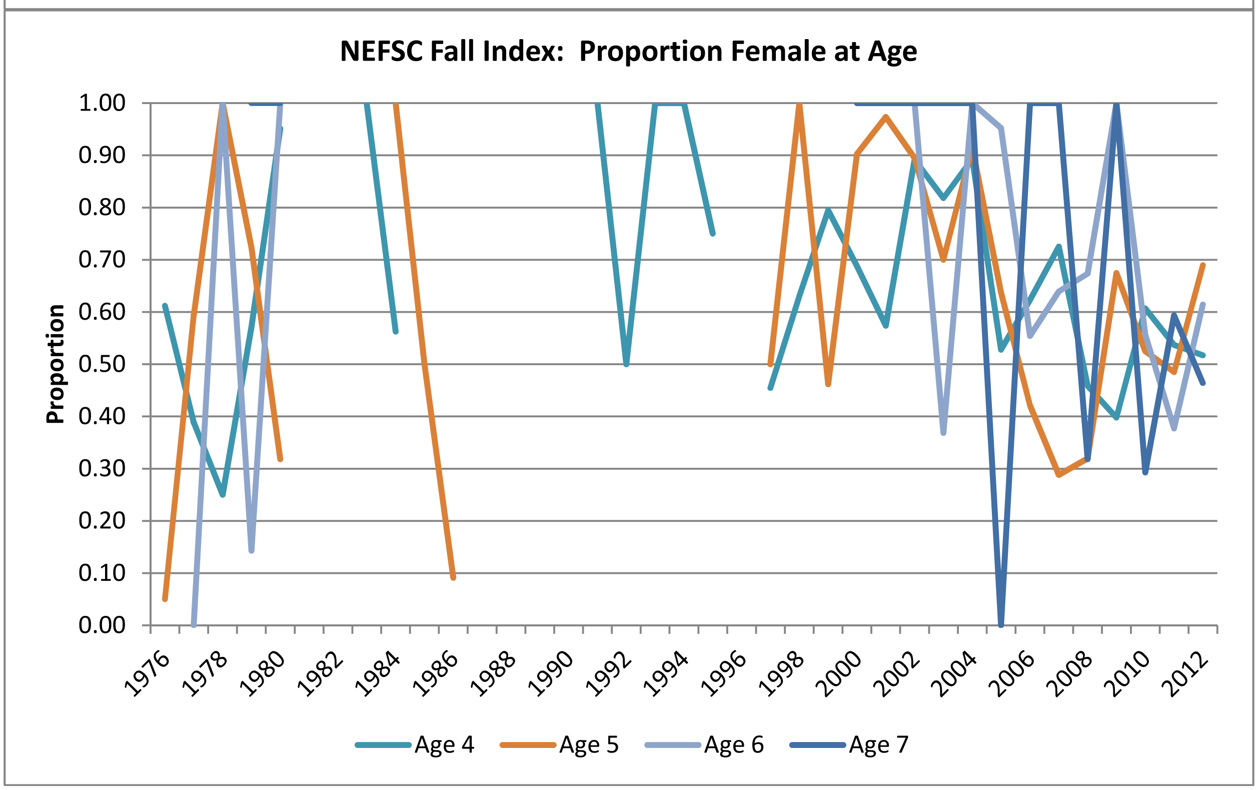


Figure A171. NEFSC fall survey index proportion female by age.

AIC for model fits when stratification by Time, Area, and Sex are applied singly.

Model	AIC
No Stratification	462475
Time Strata	462082
Area Strata	459956
Sex Strata	457161

AIC for multi-strata model fits.

Model	AIC	Delta AIC
No Stratification	462475	9666
Sex Strata	457161	4352
Sex and Time Strata	456443	3634
Sex, Time, and Area Strata	452809	0

Figure A172. Fit diagnostics for a statistical analysis of the variations in length at age by sex, area and time using data collected from NEFSC survey catch of summer flounder (*Paralichthys dentatus*) over the years 1976 through 2010.

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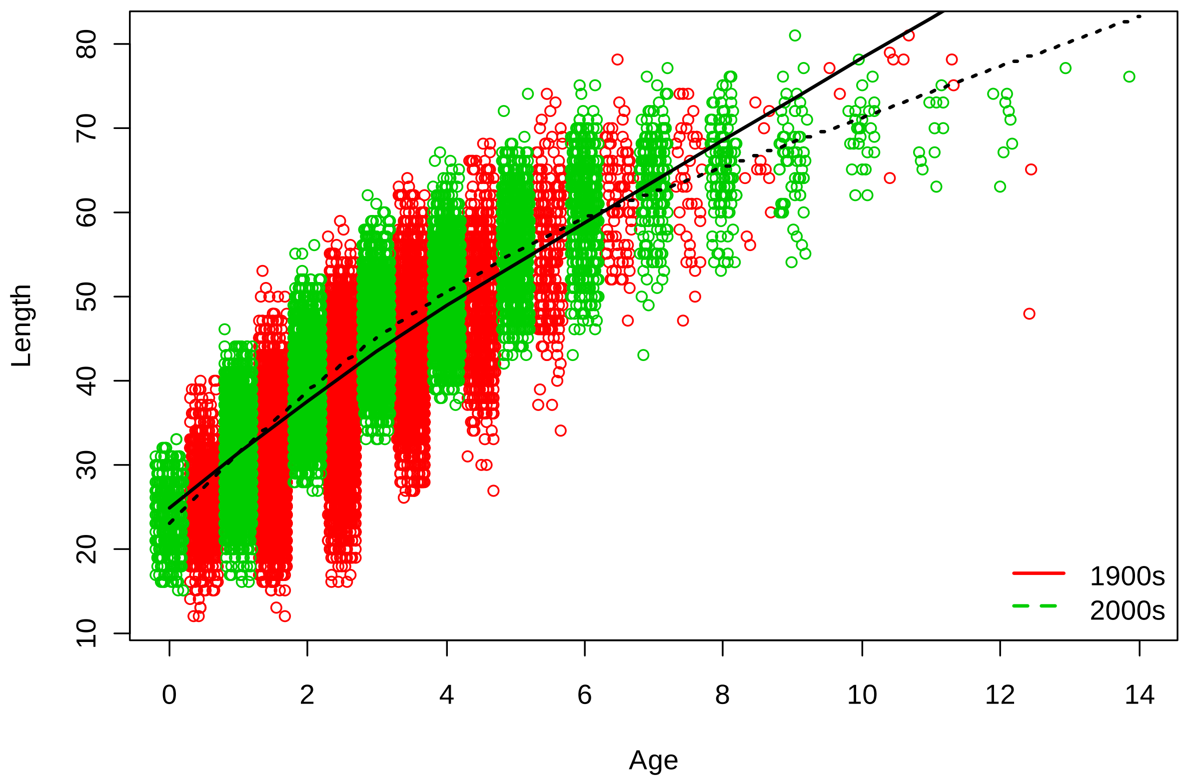


Figure A173. Model fit to time stratification, i.e. 1900s and 2000s data. Early (1900s) estimates: Linf = 142.8, k = 0.06, t0 = -3.3. Late (2000s) estimates: Linf = 85.5, k = 0.14, t0 =-2.2

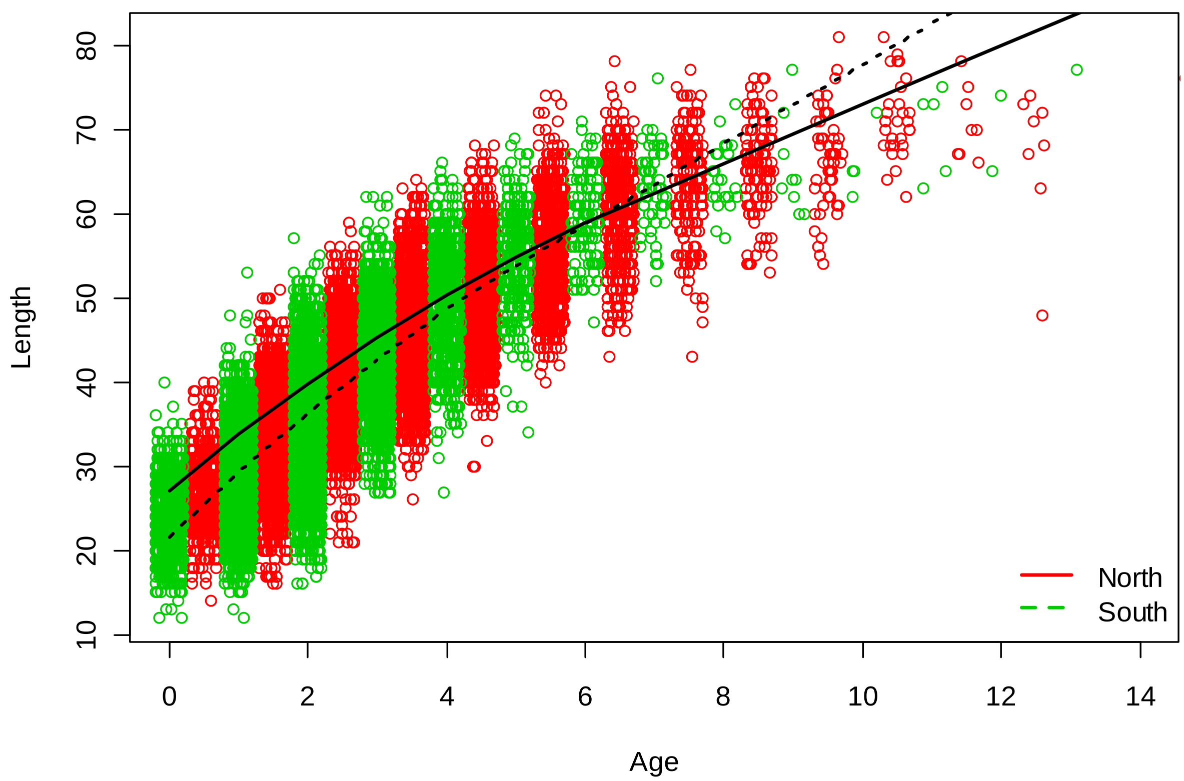


Figure A174. Model fit to area stratification, i.e. north and south data. North estimates: Linf = 101.7, k = 0.09, t0 = -3.3. South estimates: Linf = 120.7, k = 0.08, t0 = -2.5.

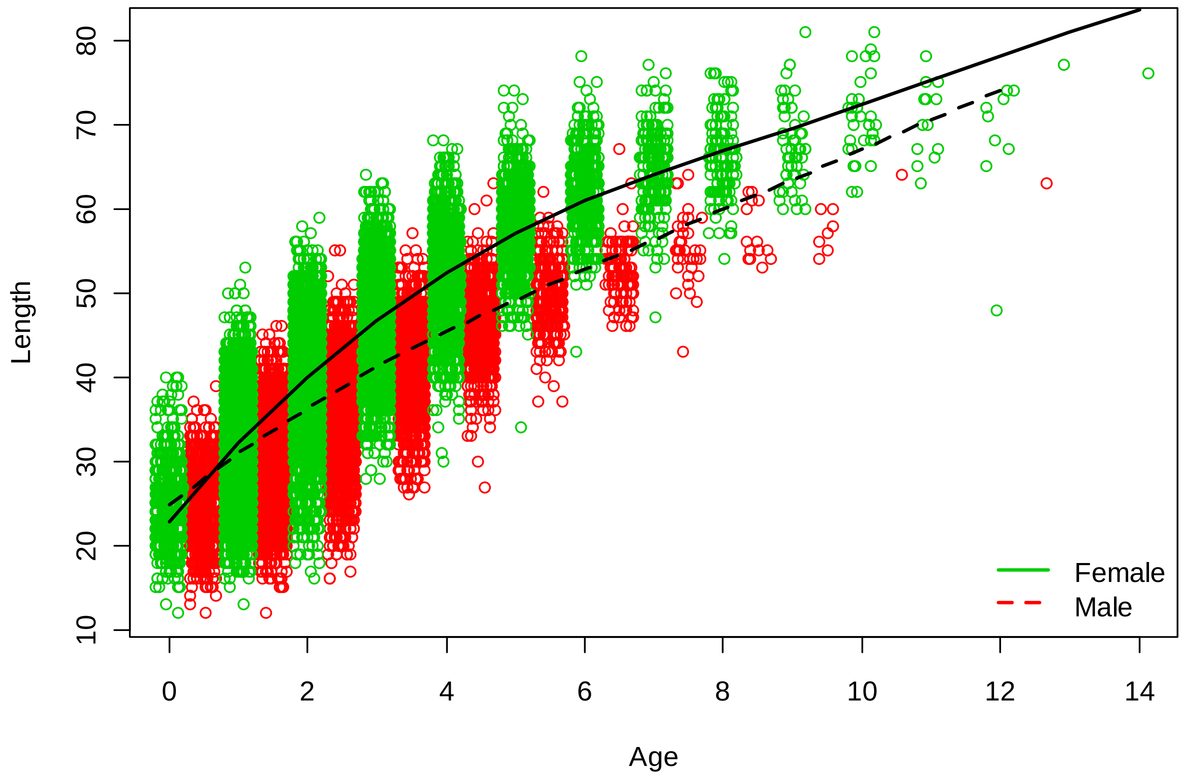
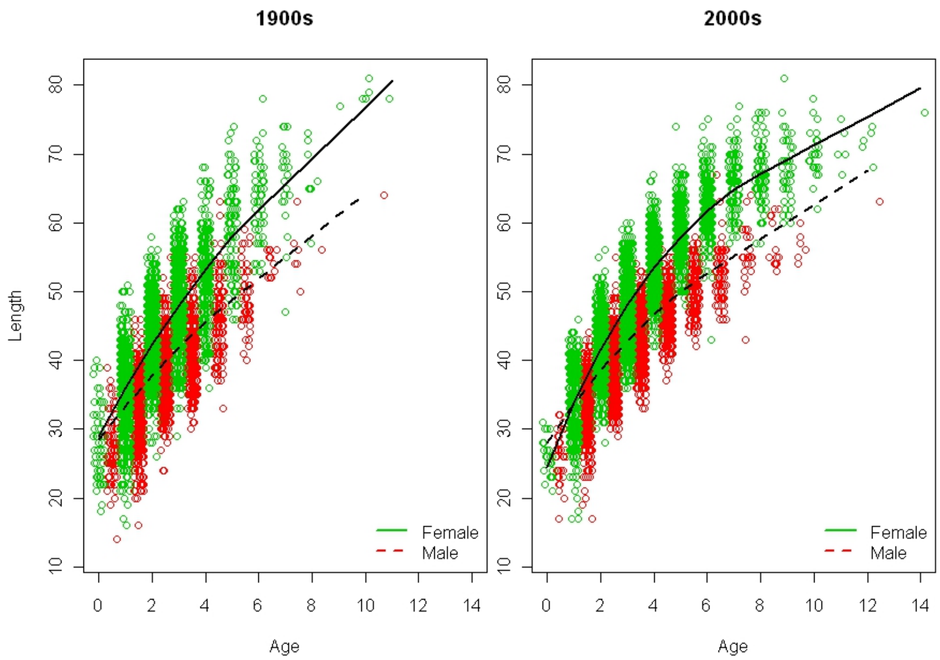
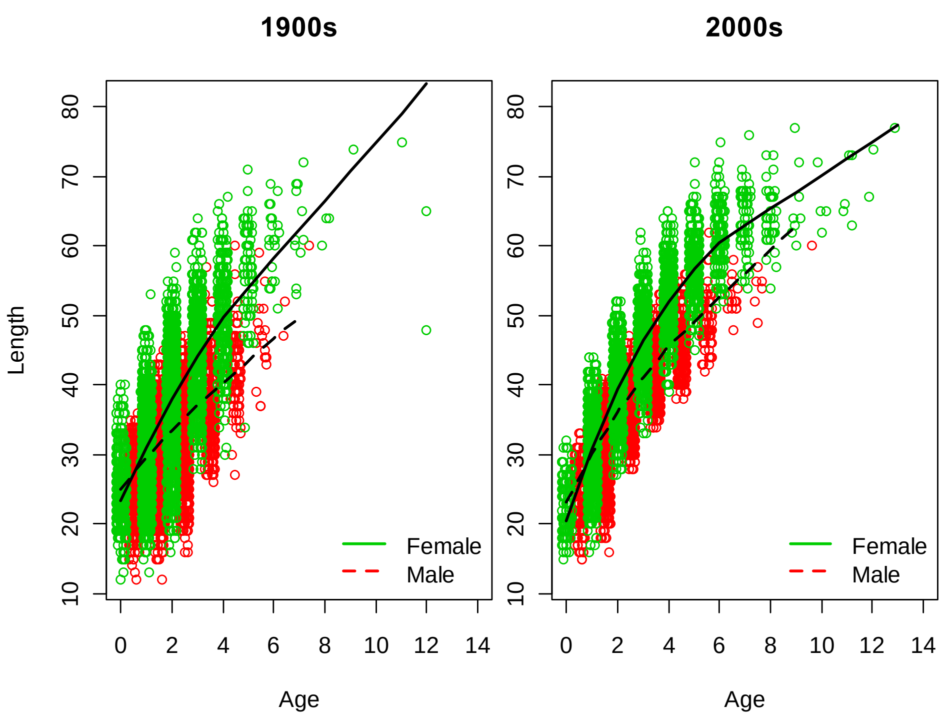


Figure A175. Model fit to sex stratification, i.e. female and male data. Female estimates: Linf = 83.6, k = 0.17, t0 = -1.9. Male estimates: Linf = 86.3, k = 0.10, t0 =-3.3



South



North

Figure A176. Model fit when all strata are included (sex, area, and time period).

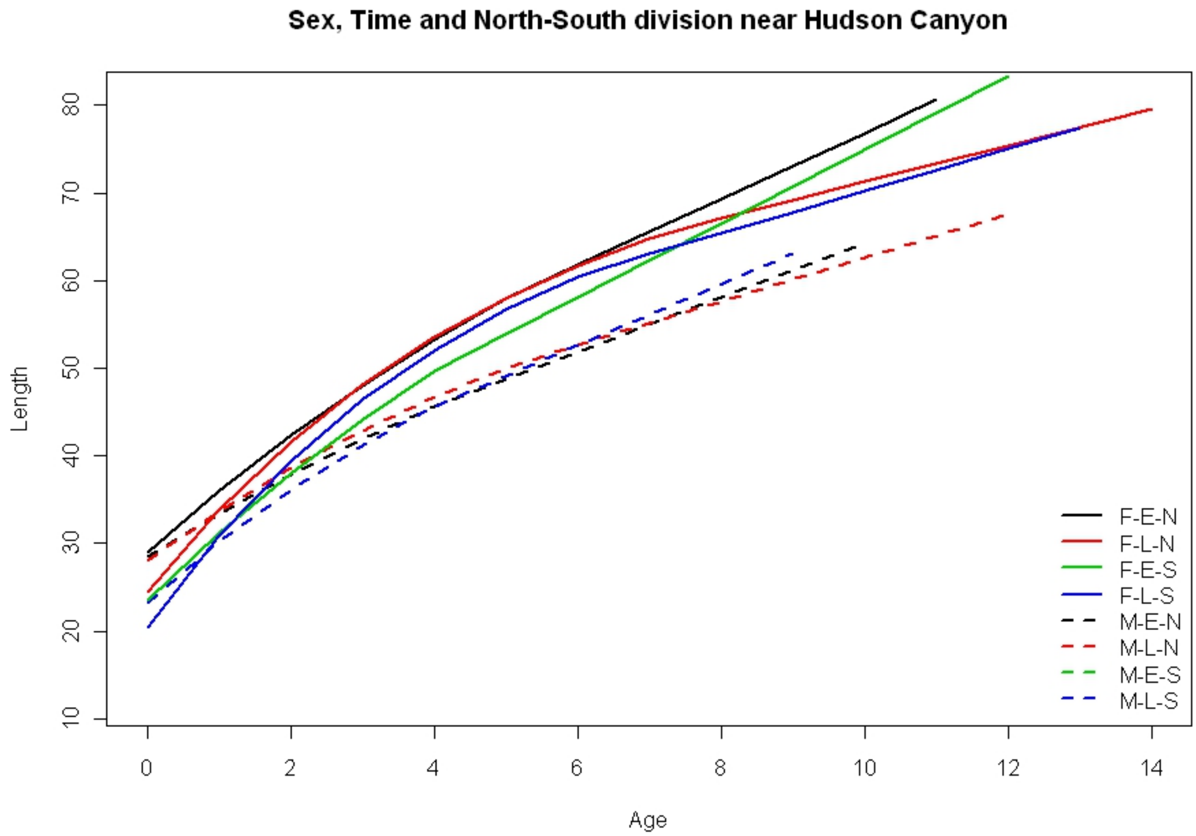


Figure A177. All model fits by strata shown together for comparison.

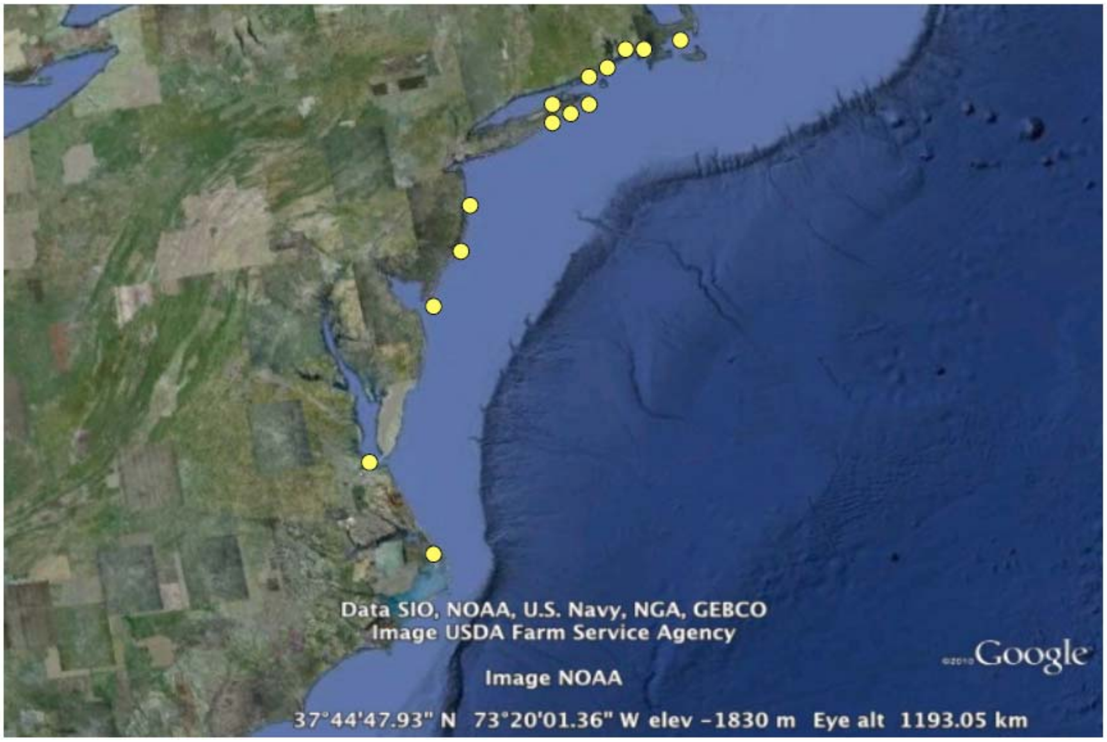


Figure A178. Location of ports (indicated by yellow circles) where summer flounder samples were collected from the commercial fishery. In order from northeast to south, these were: Hyannis, New Bedford, and Westport, MA; Point Judith, RI; Stonington, CT; Montauk, East Hampton, Mattituck, Hampton Bays, and Point Lookout, NY; Point Pleasant, Barnegat Light, and Cape May, NJ; Newport News and Hampton, VA; and Wanchese, NC.

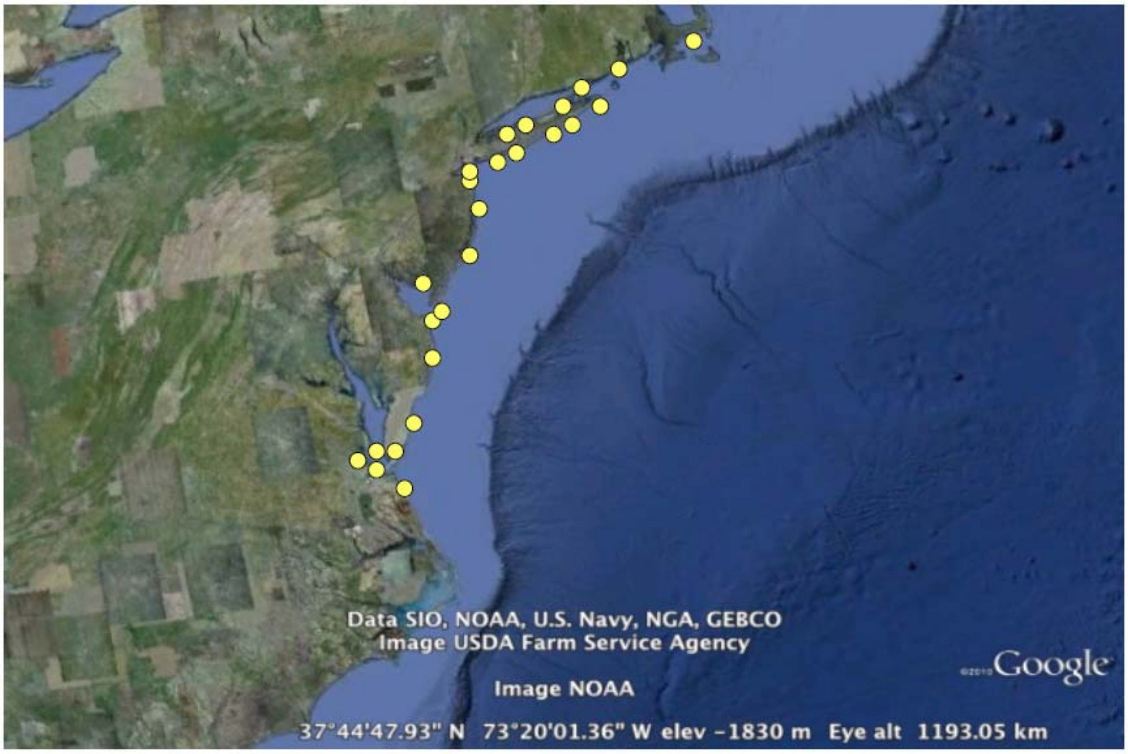


Figure A179. Location of ports (indicated by yellow circles) where summer flounder samples were collected from the recreational fishery. In order from northeast to south, these were: Hyannis and New Bedford, MA; Point Judith, RI; Niantic, CT; Montauk, East Hampton, Greenport, Mattituck, Hampton Bays, Riverhead, Moriches, Port Jefferson, Captree, Huntington, and Freeport, NY; Atlantic Highlands, Point Pleasant, Barnegat Light, Fortescue, and Cape May, NJ; Lewes, DE; Ocean City, MD; Wachapreague, Capeville, James River, Buckroe, Hampton, and Virginia Beach, VA.

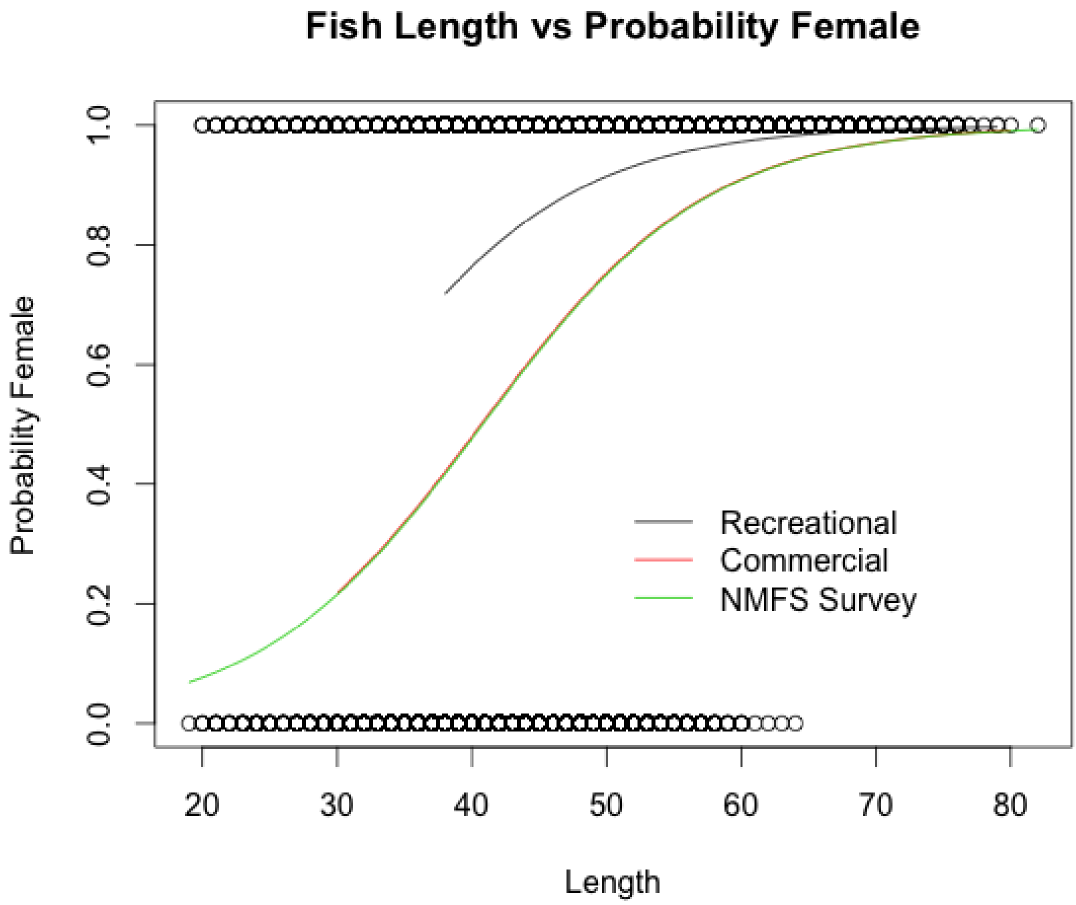


Figure A180. Probability female as a function of fish length in the commercial and recreational fisheries (2010-2011) and the NMFS-NEFSC trawl survey (2009-2011).

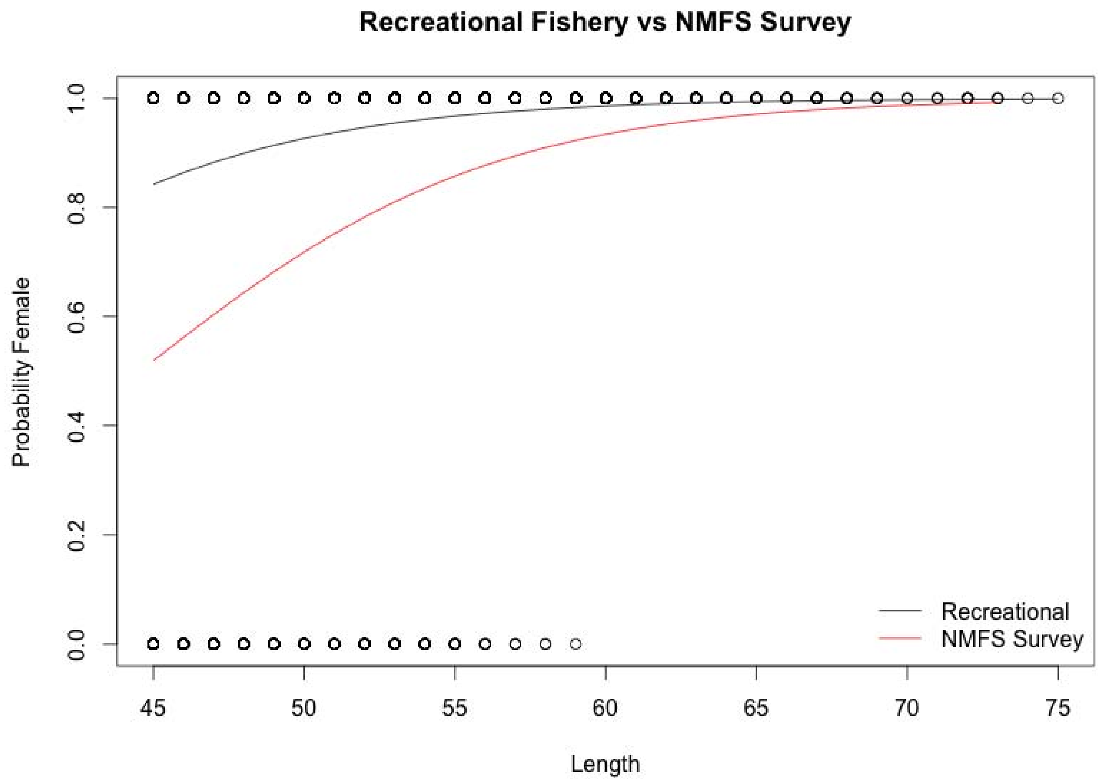


Figure A181. Probability female as a function of fish length in recreational fishery (2010-2011) and the NMFS-NEFSC trawl survey (2009-2011). Data from the NMFS-NEFSC is limited to fish greater than 45 cm total length and data from both the NMFS-NEFSC and the recreational fishery are limited to statistical areas where at least 100 individuals were collected from both the recreational fishery and the NMFS-NEFSC trawl survey.

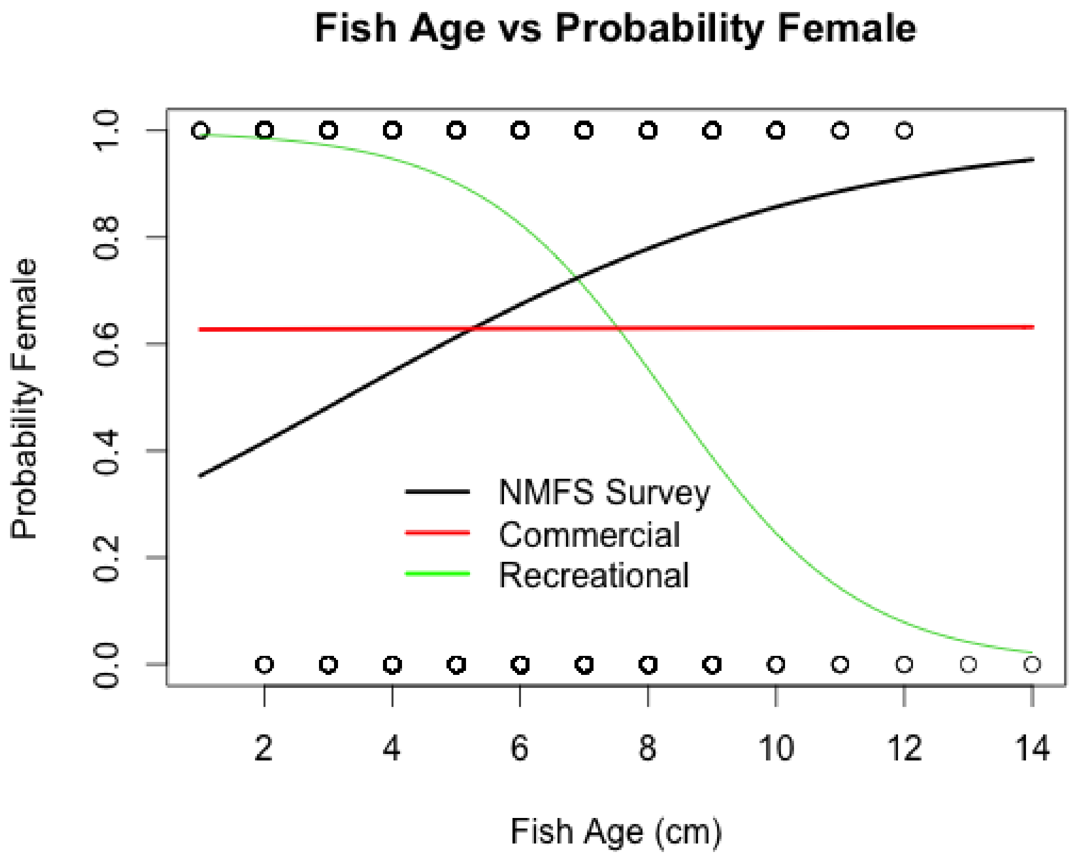


Figure A182. Probability female as a function of fish age in the commercial and recreational fisheries (2010-2011) and the NMFS-NEFSC trawl survey (2009-2011) with separate logistic regression parameters estimated for each line.

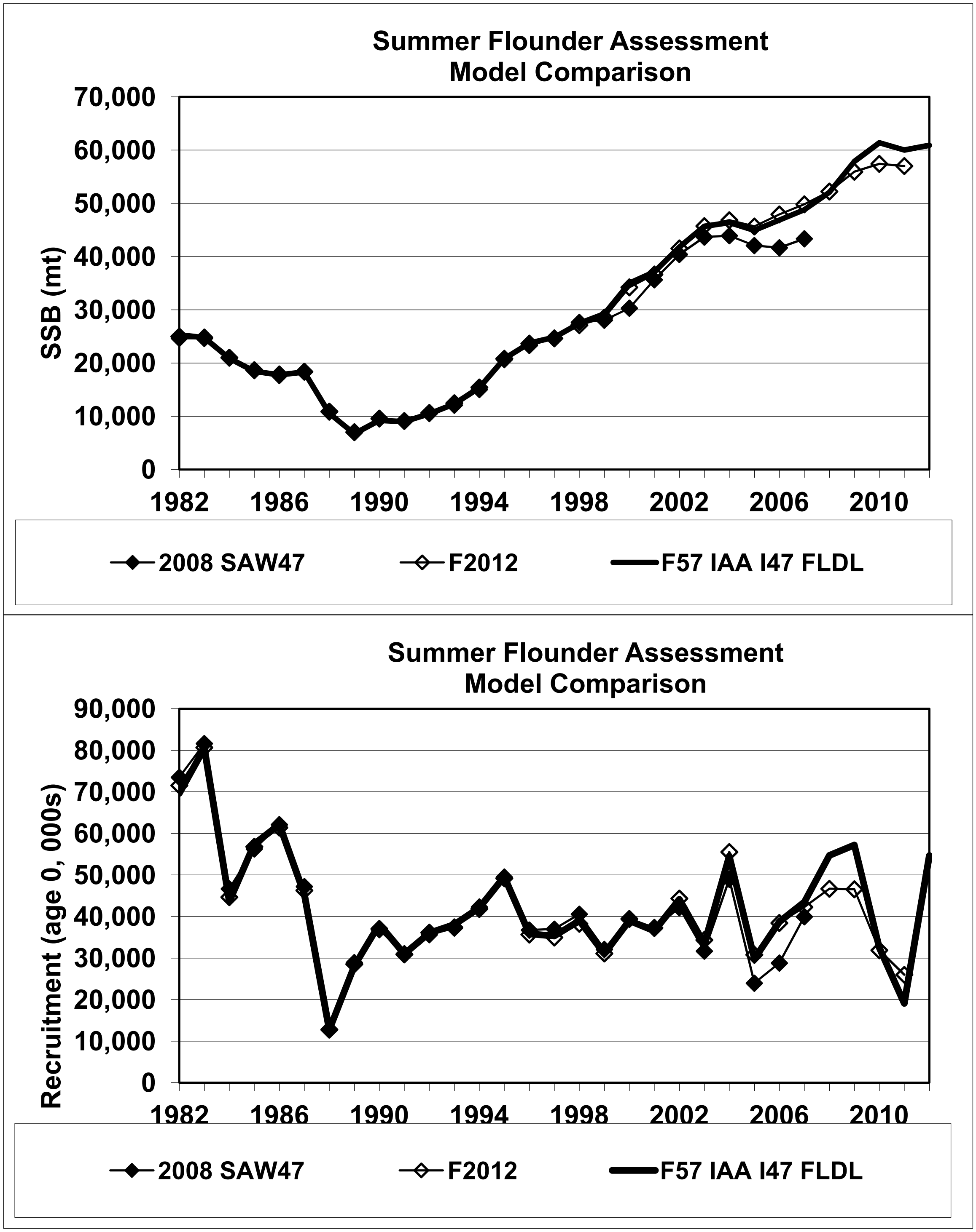


Figure A183. Comparison of SSB and R estimates from the 2008 SAW 47 benchmark and 2012 updated assessments with the comparable model and data from the 2013 SAW 57 assessment (F57-IAA-I47_FLDL; response to TOR 6a).

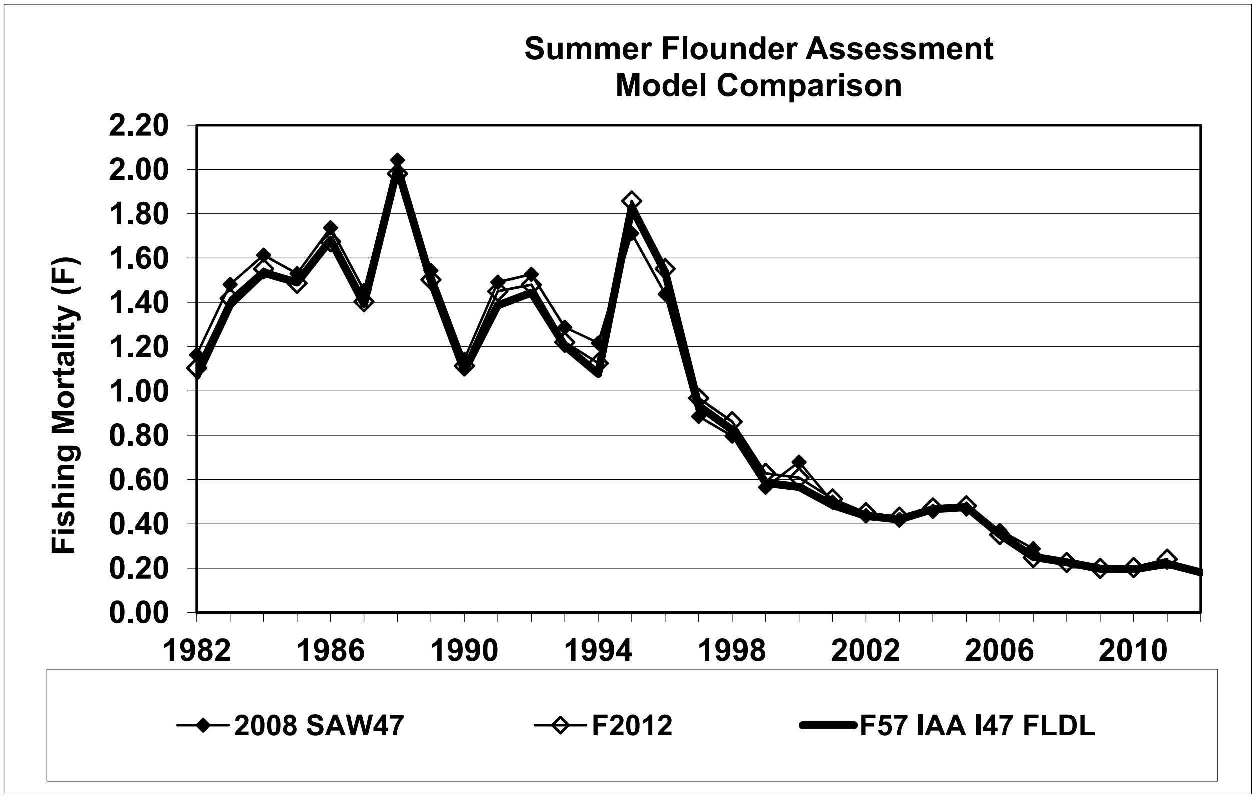


Figure A184. Comparison of fishing mortality estimates from the 2008 SAW 47 benchmark and 2012 updated assessments with the comparable model and data from the 2013 SAW 57 assessment (F57-IAA-I47_FLDL; response to TOR 6a).

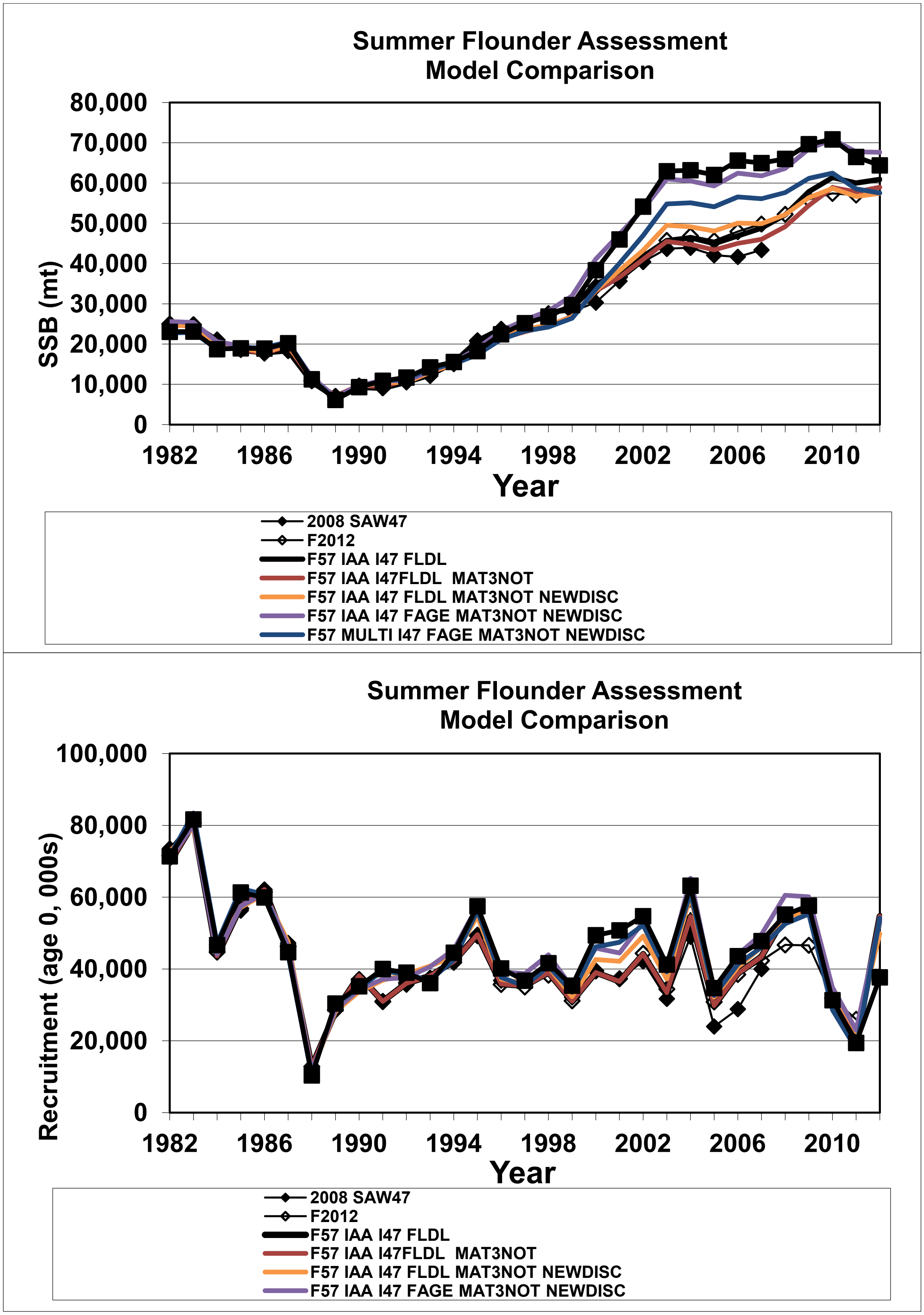


Figure A185. Comparison of SSB and R estimates from ‘phase 1’ of 2013 SAW 57 model building.

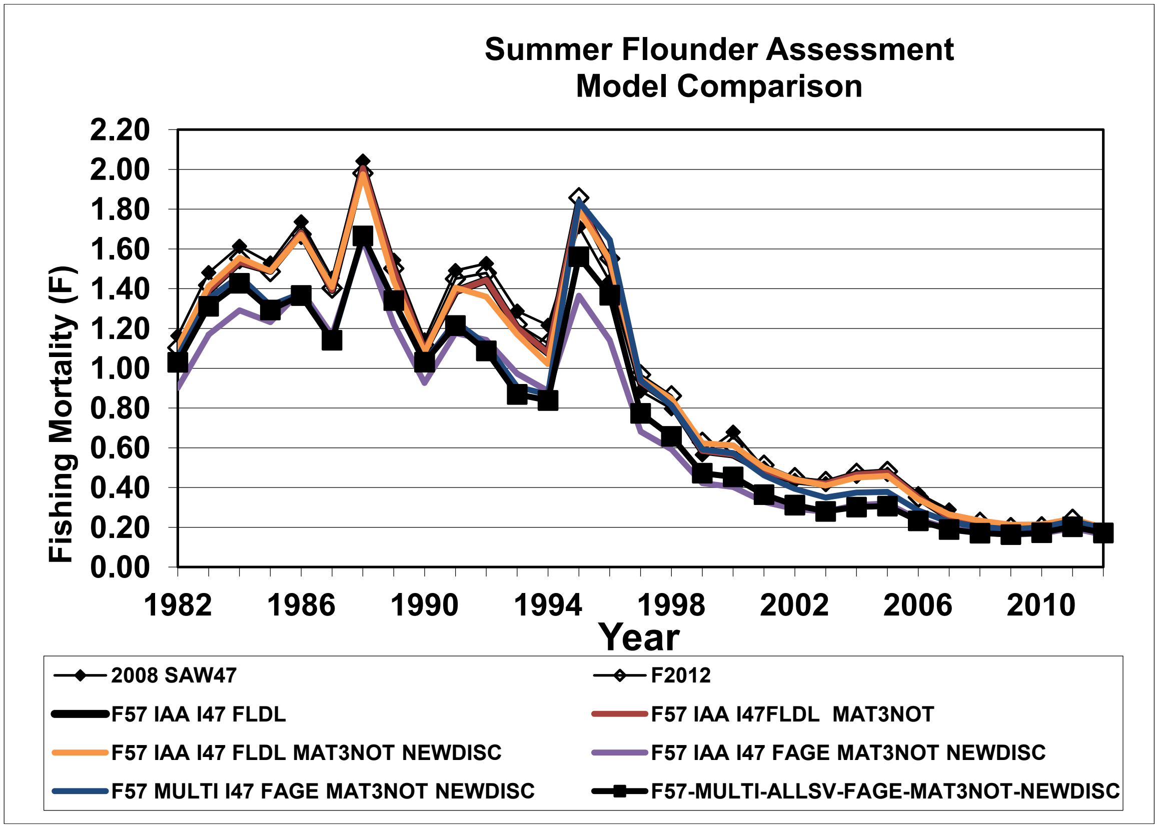
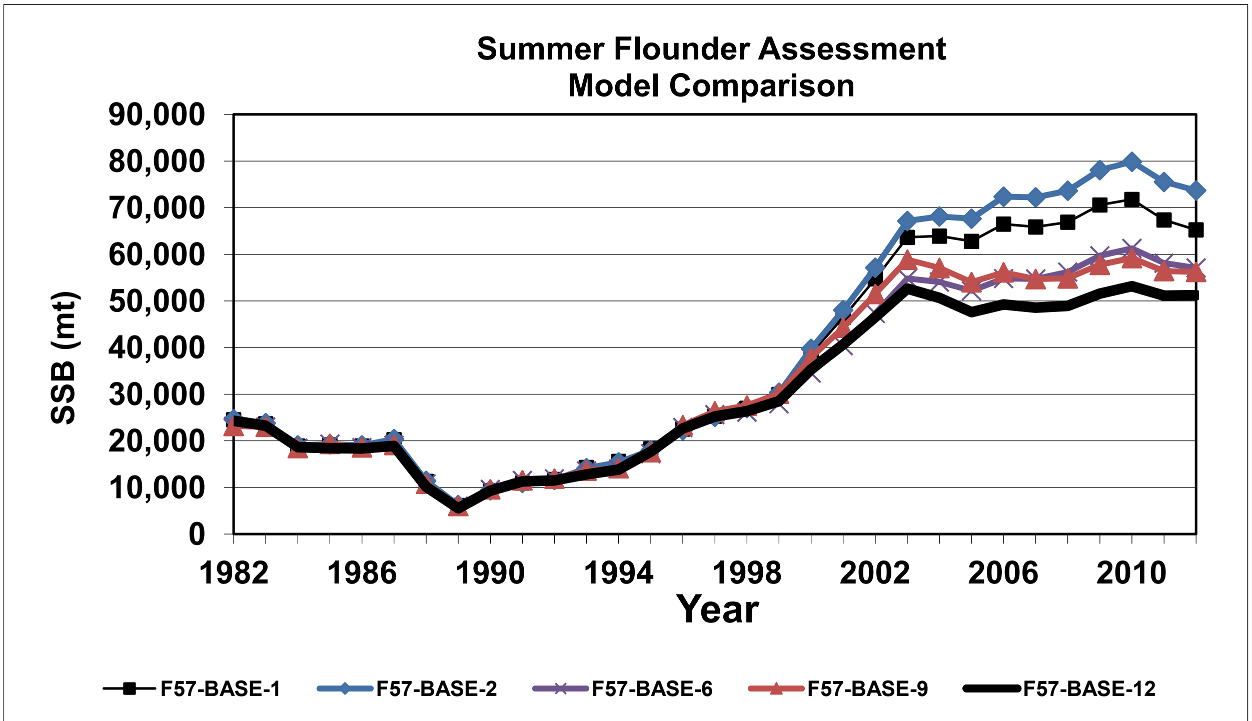


Figure A186. Comparison of of fishing mortality estimates from ‘phase 1’ of 2013 SAW 57 model building.



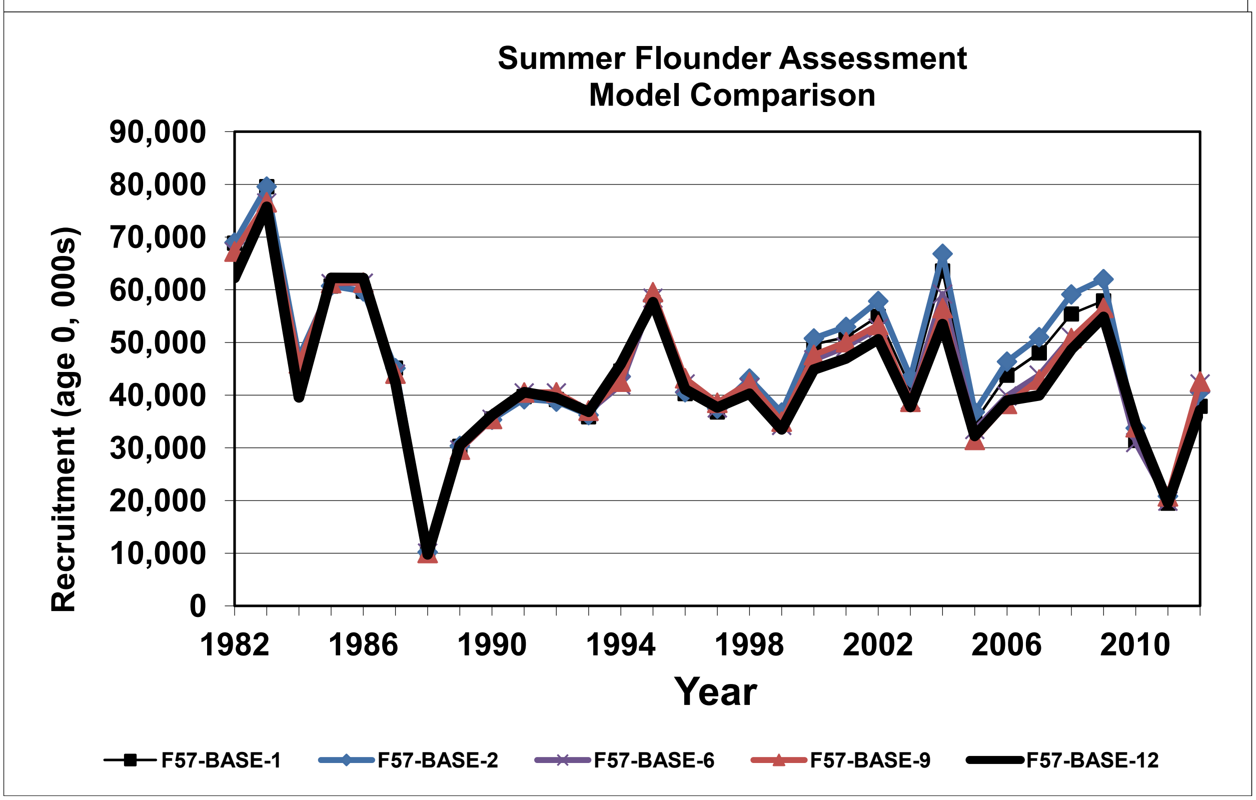


Figure A187. Comparison of SSB and R estimates from 'phase 2' of 2013 SAW 57 model building.

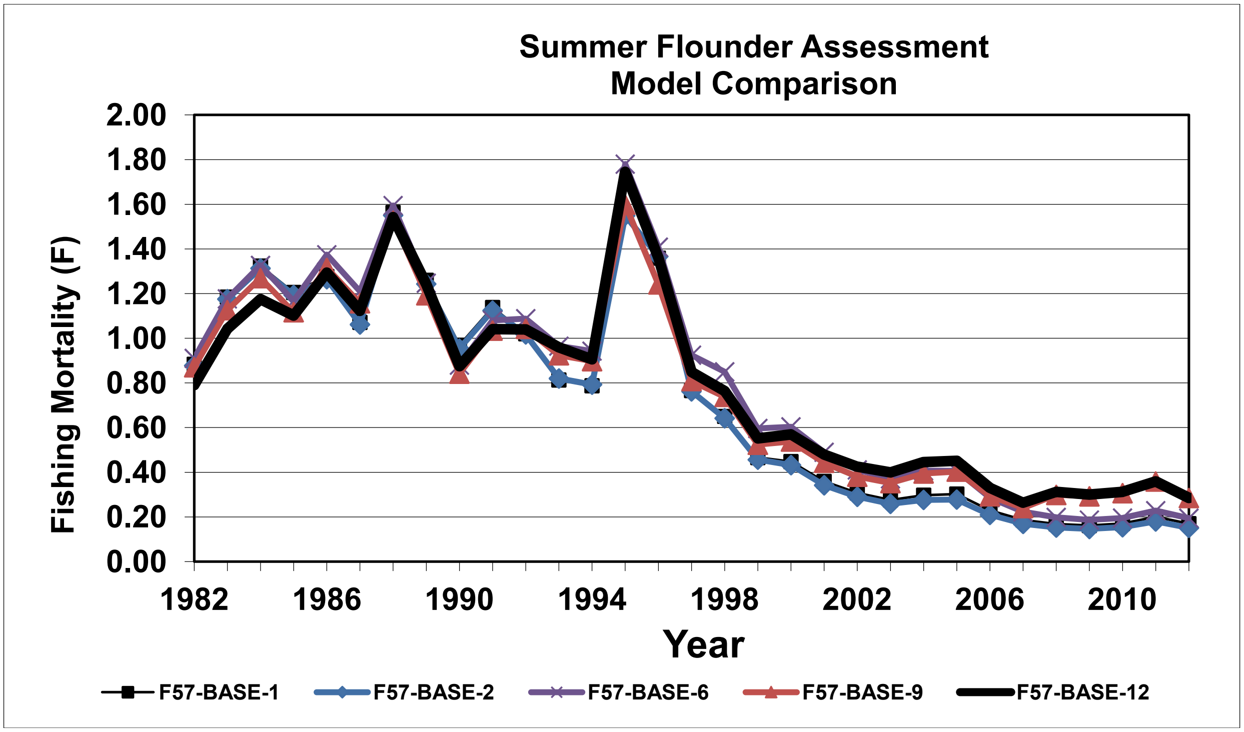


Figure A188. Comparison of of fishing mortality estimates from 'phase 2' of 2013 SAW 57 model building.

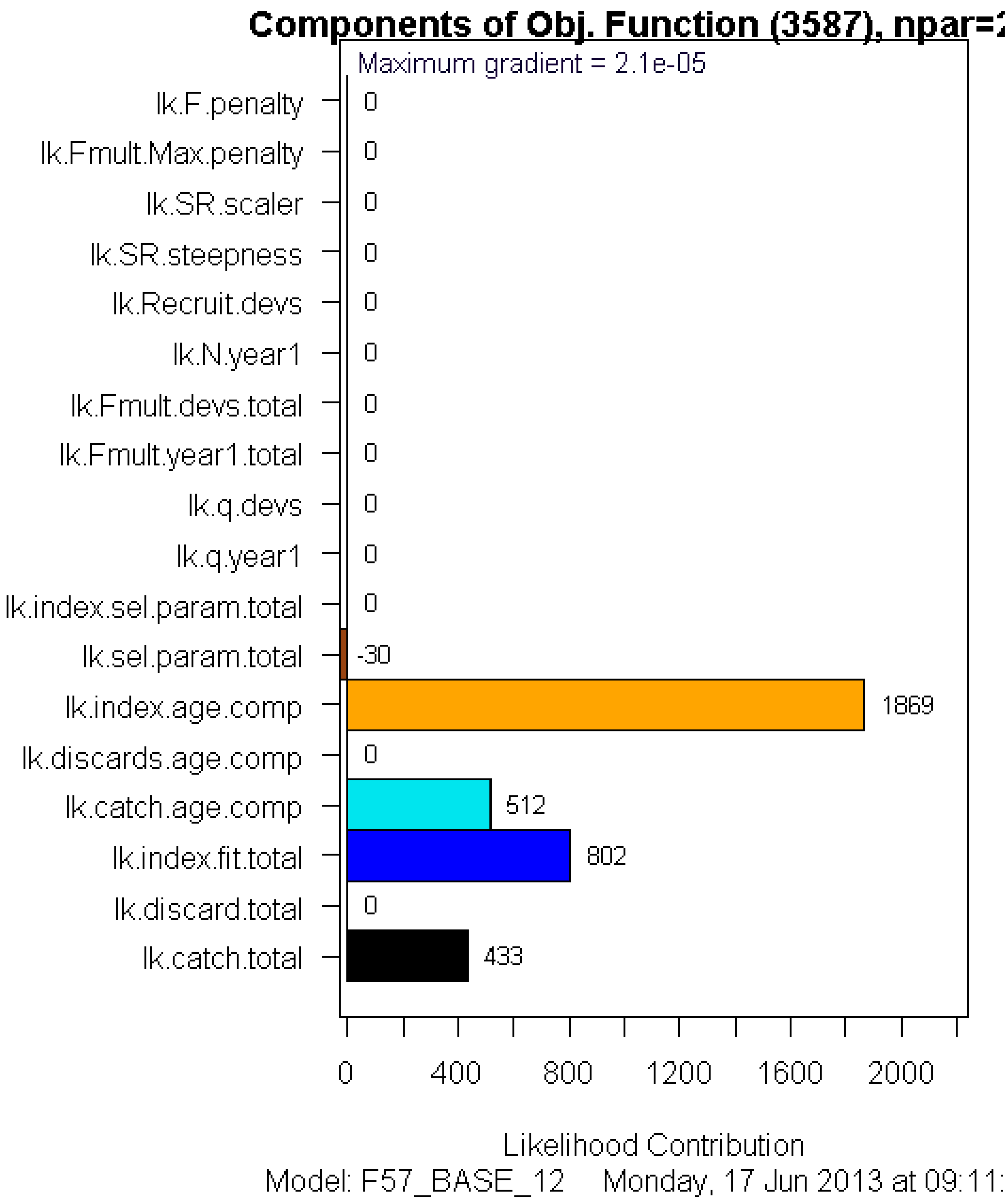


Figure A189. Distribution of objective function components contribution to total likelihood for run F57_BASE_12.

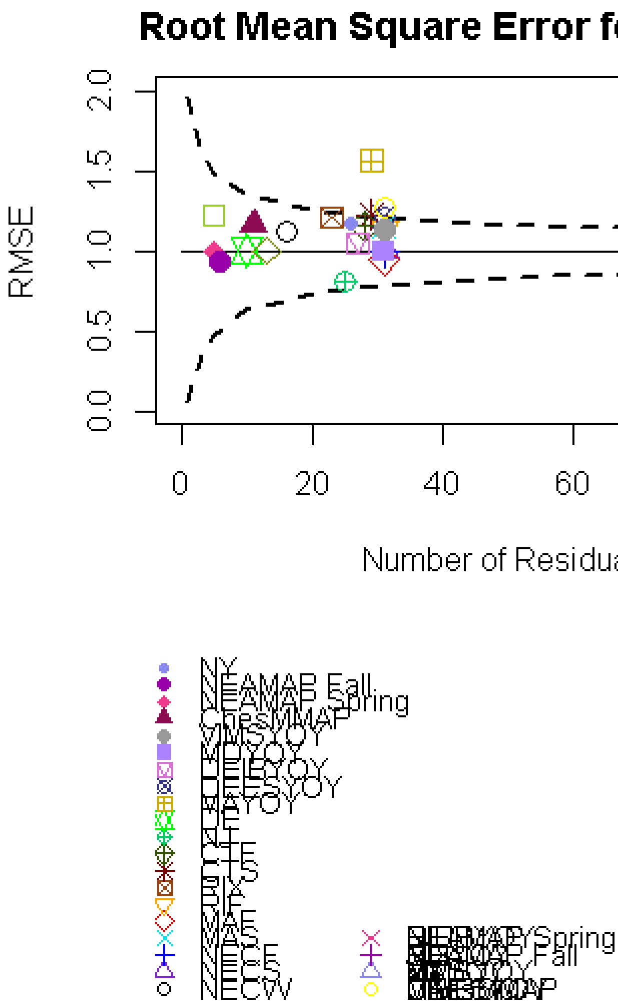


Figure A190. Final Root Mean Square Error (RMSE) values for survey indices in run F57_BASE_12.

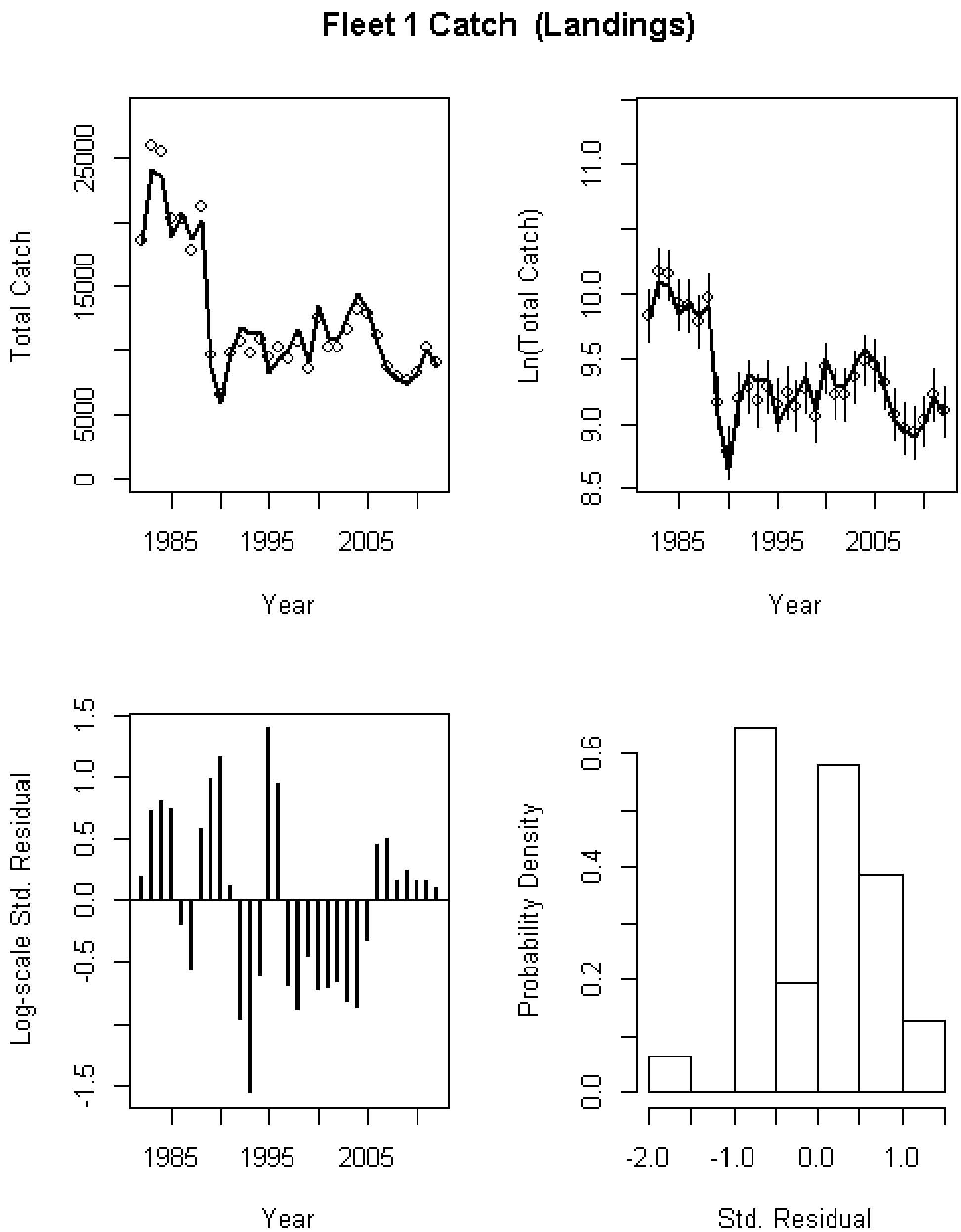


Figure A191. Fit diagnostics for the fishery landings in run F57_BASE_12.

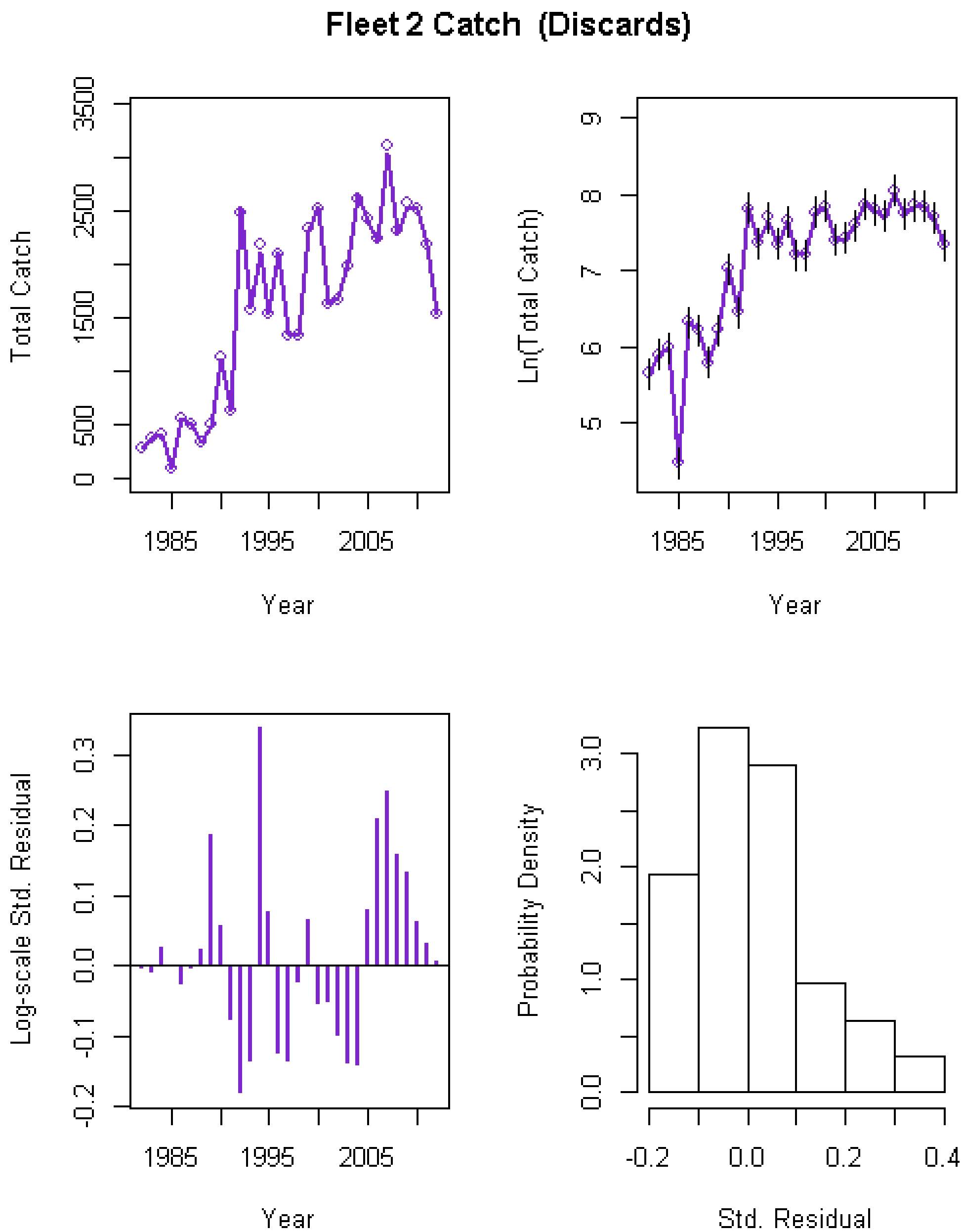


Figure A192. Fit diagnostics for the fishery discards in run F57_BASE_12.

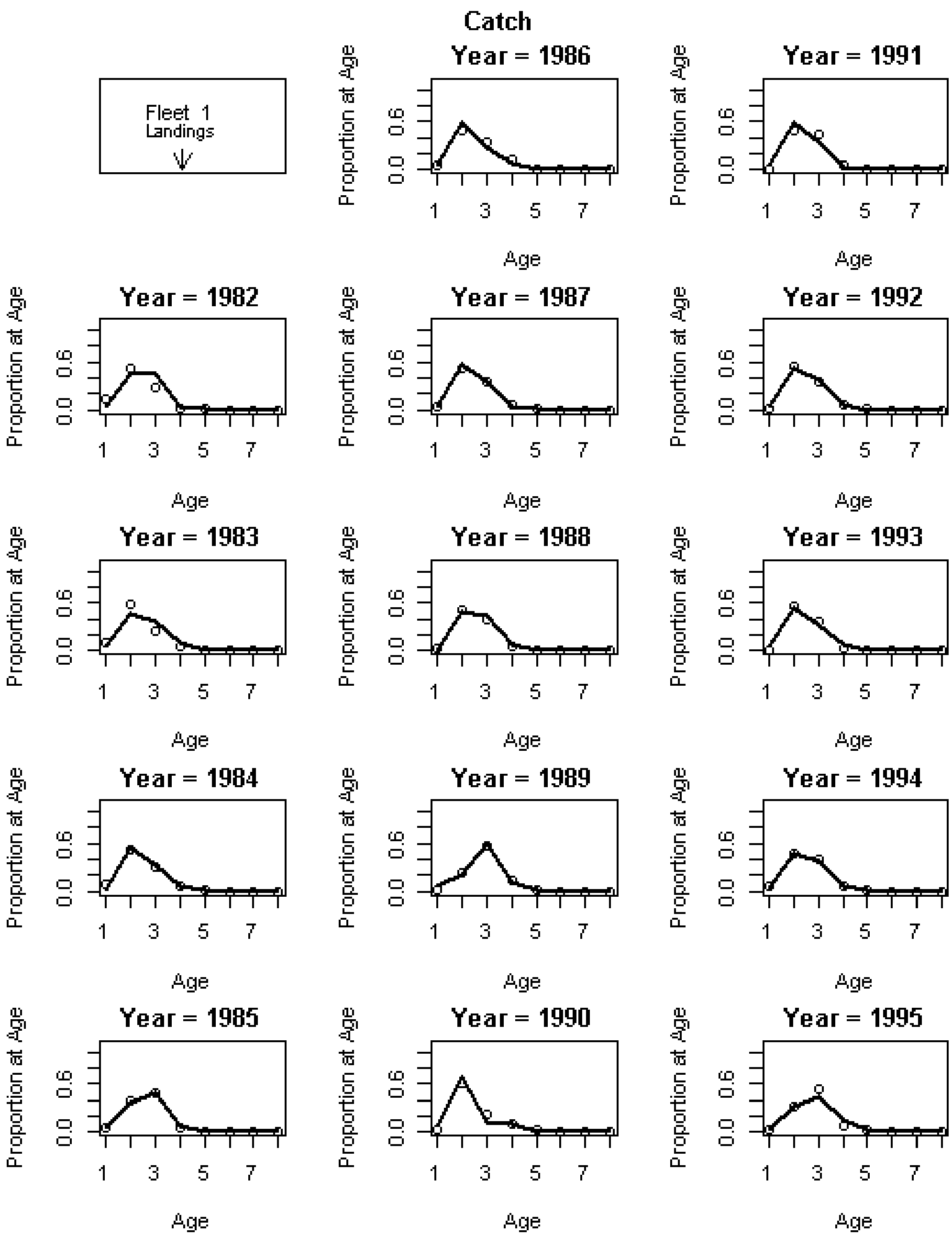


Figure A193. Fits to 1982-1995 landings proportions-at-age in run F57_BASE_12.

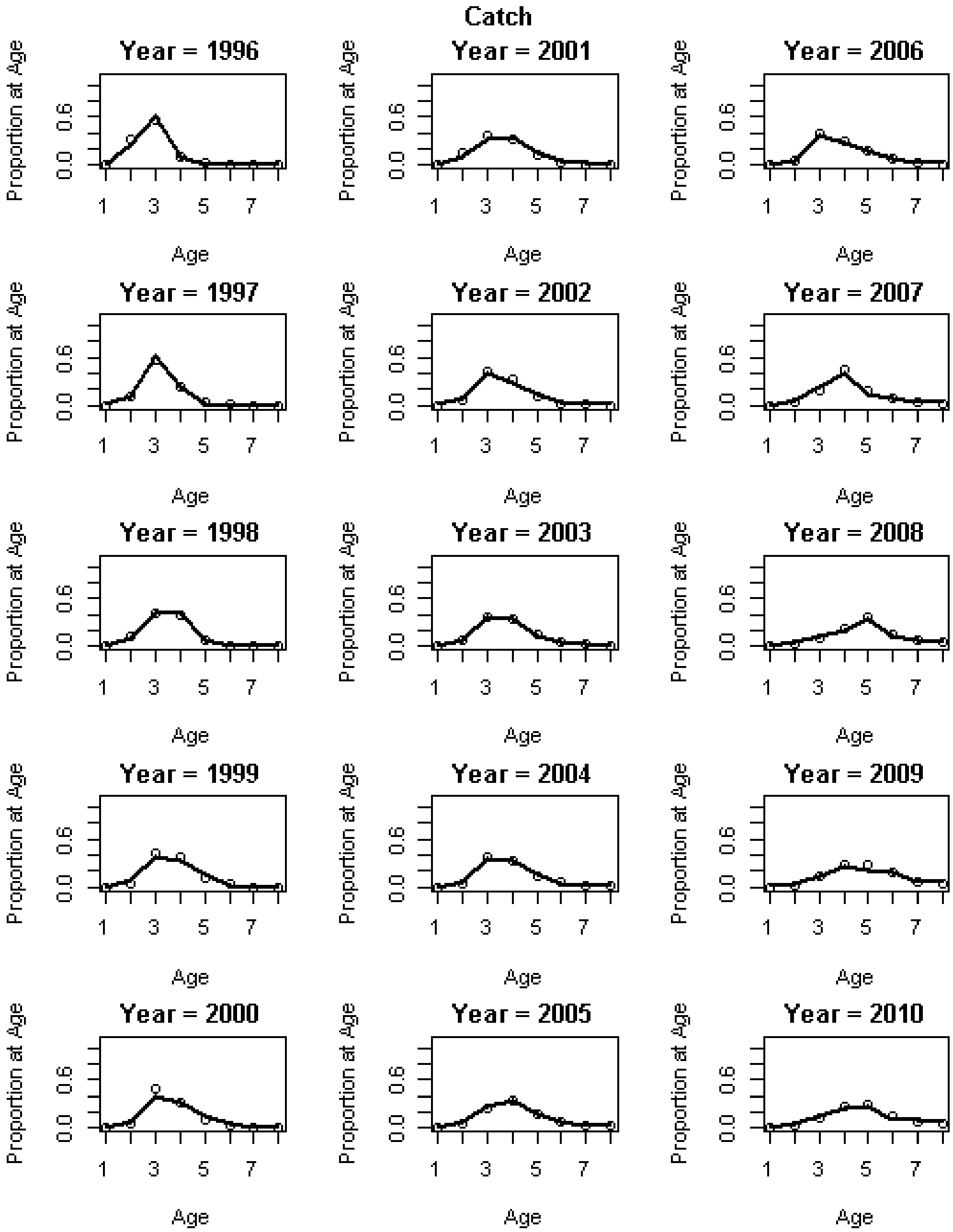


Figure A194. Fits to 1996-2010 landings proportions-at-age in run F57_BASE_12.

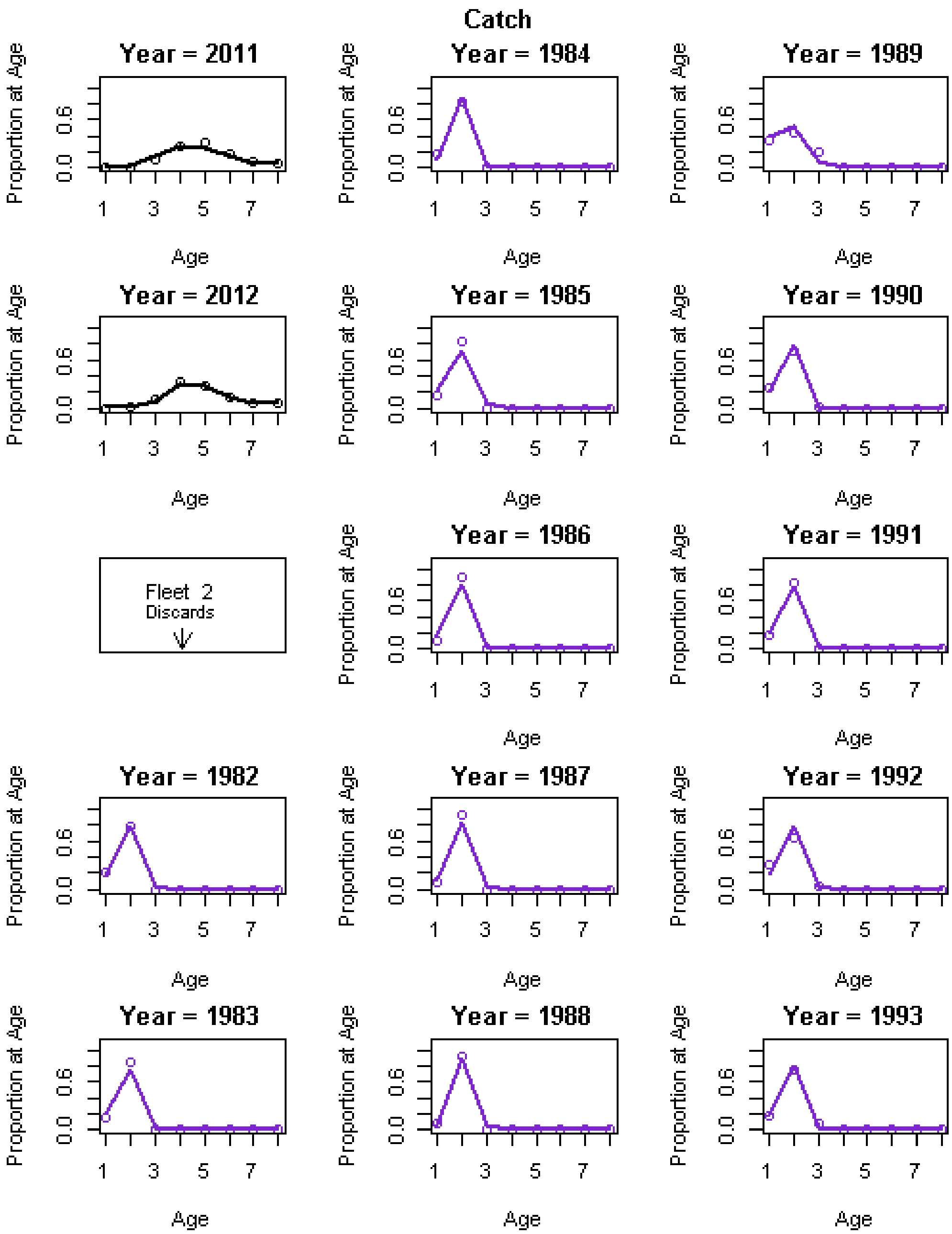


Figure A195. Fits to 2011-2010 landings and 1982-1993 discards proportions-at-age in run F57_BASE_12.

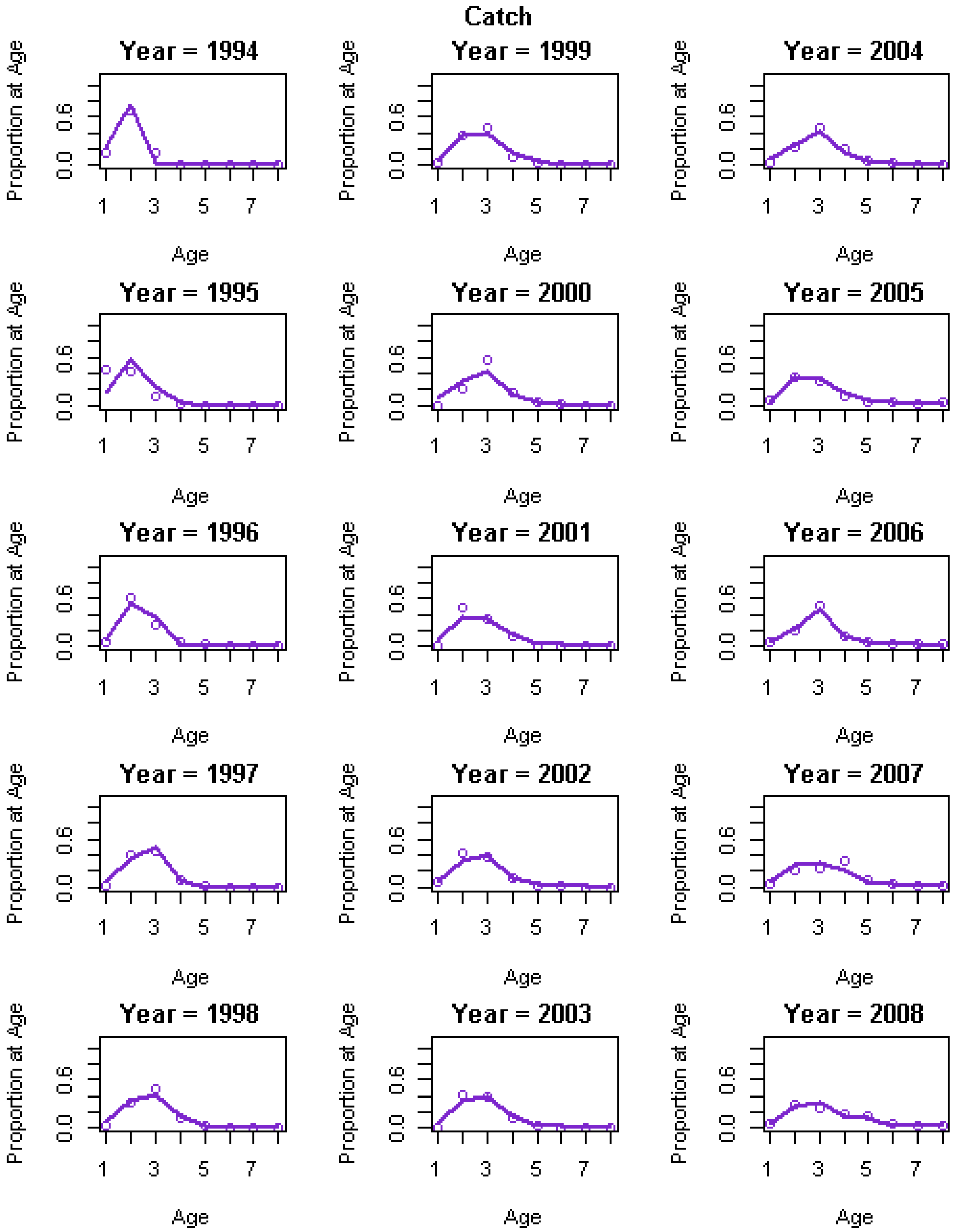


Figure A196. Fits to 1994-2008 discards proportions-at-age in run F57_BASE_12.

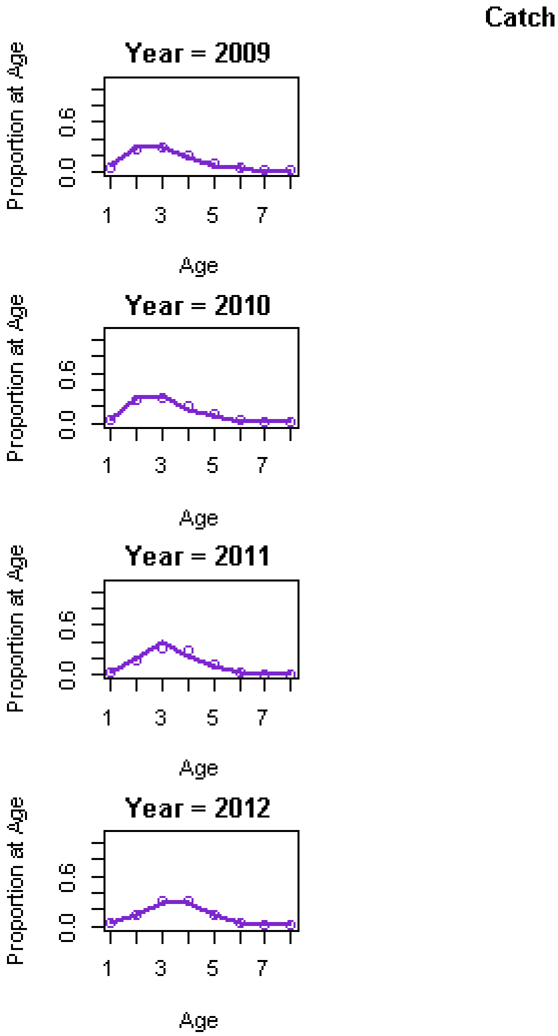


Figure A197. Fits to 2009-2012 discards proportions-at-age in run F57_BASE_12.

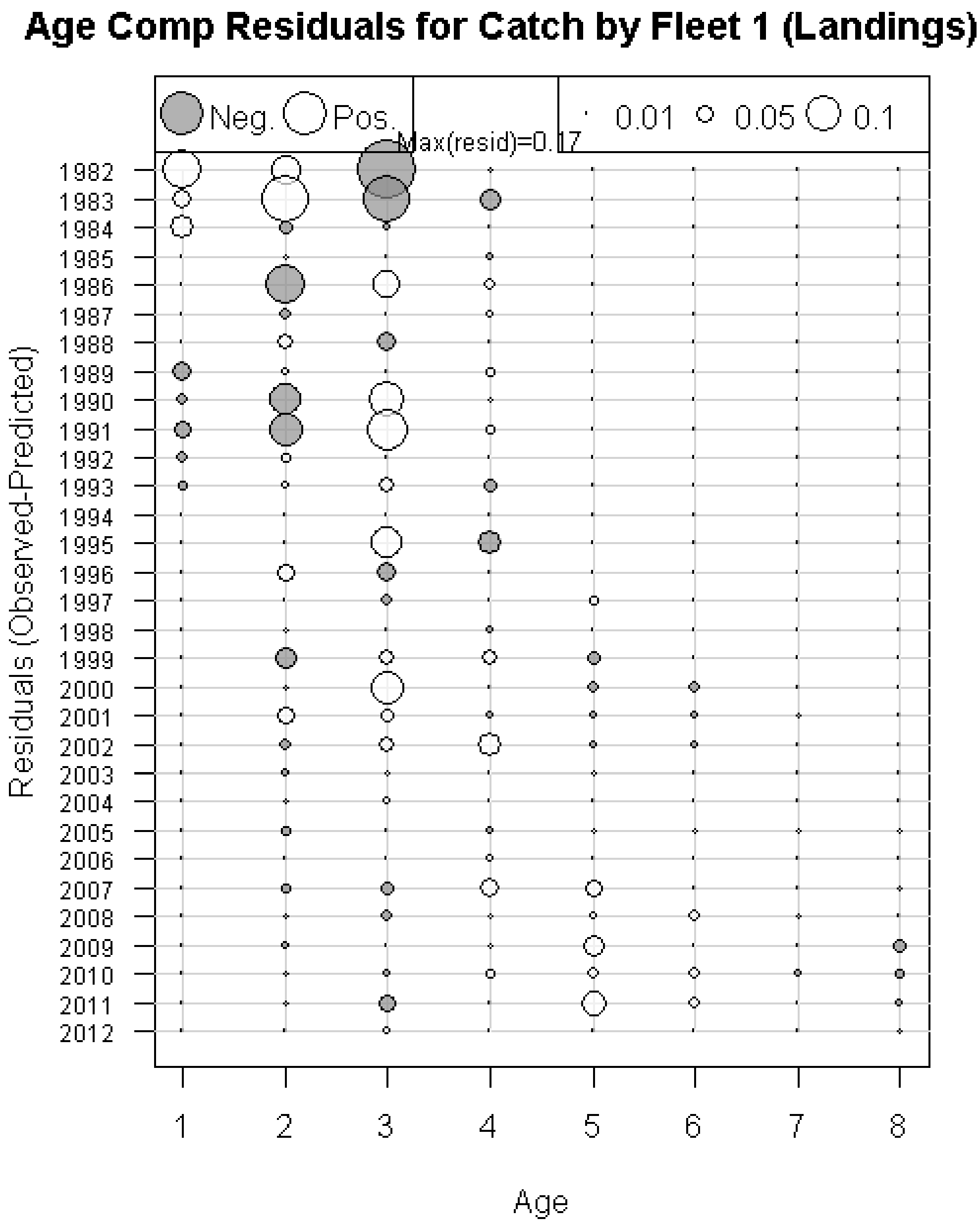


Figure A198. Fishery landings age composition residuals.

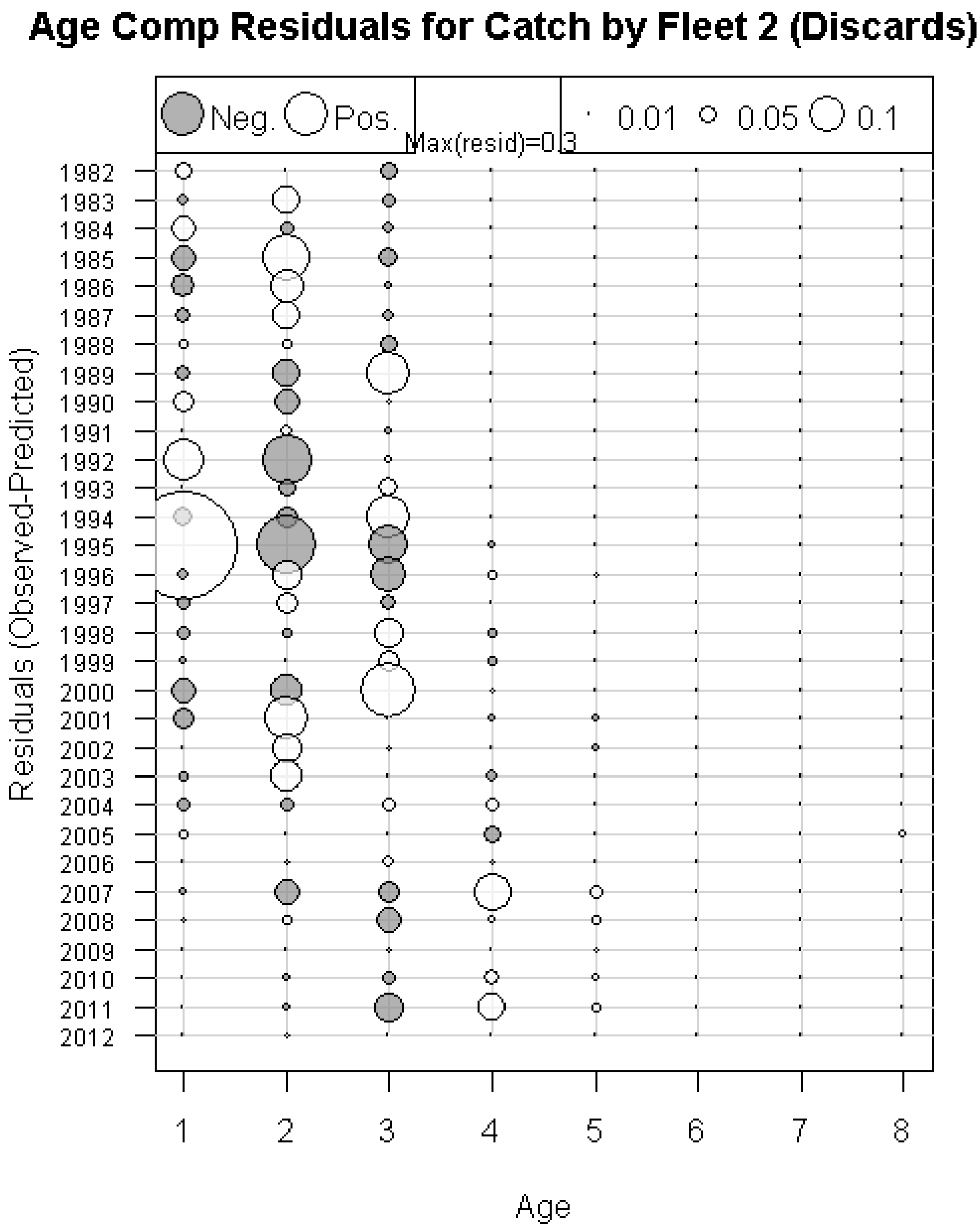


Figure A199. Fishery discards age composition residuals.

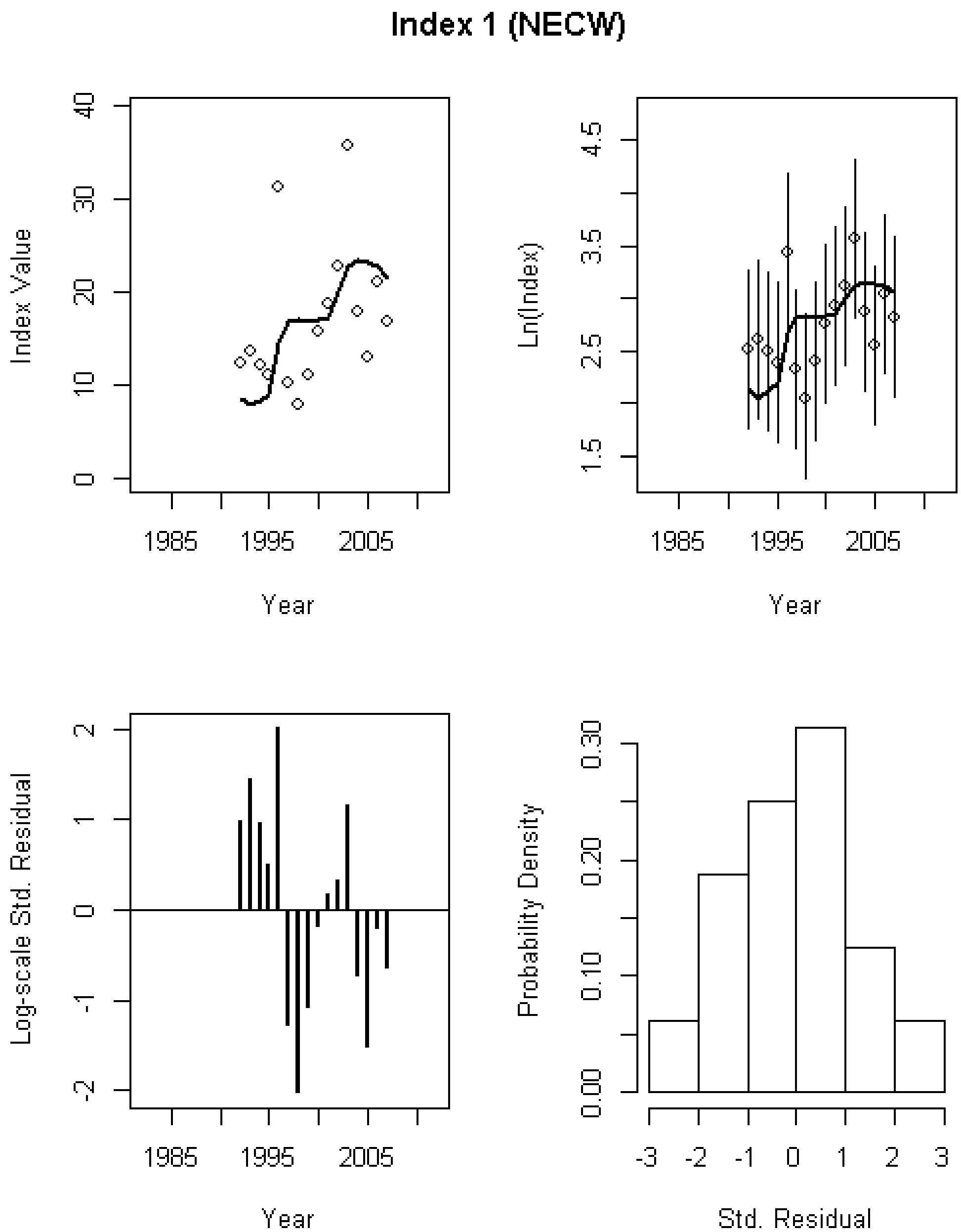


Figure A200. Fit diagnositics for the NEFSC winter trawl survey in run F57_BASE_12.

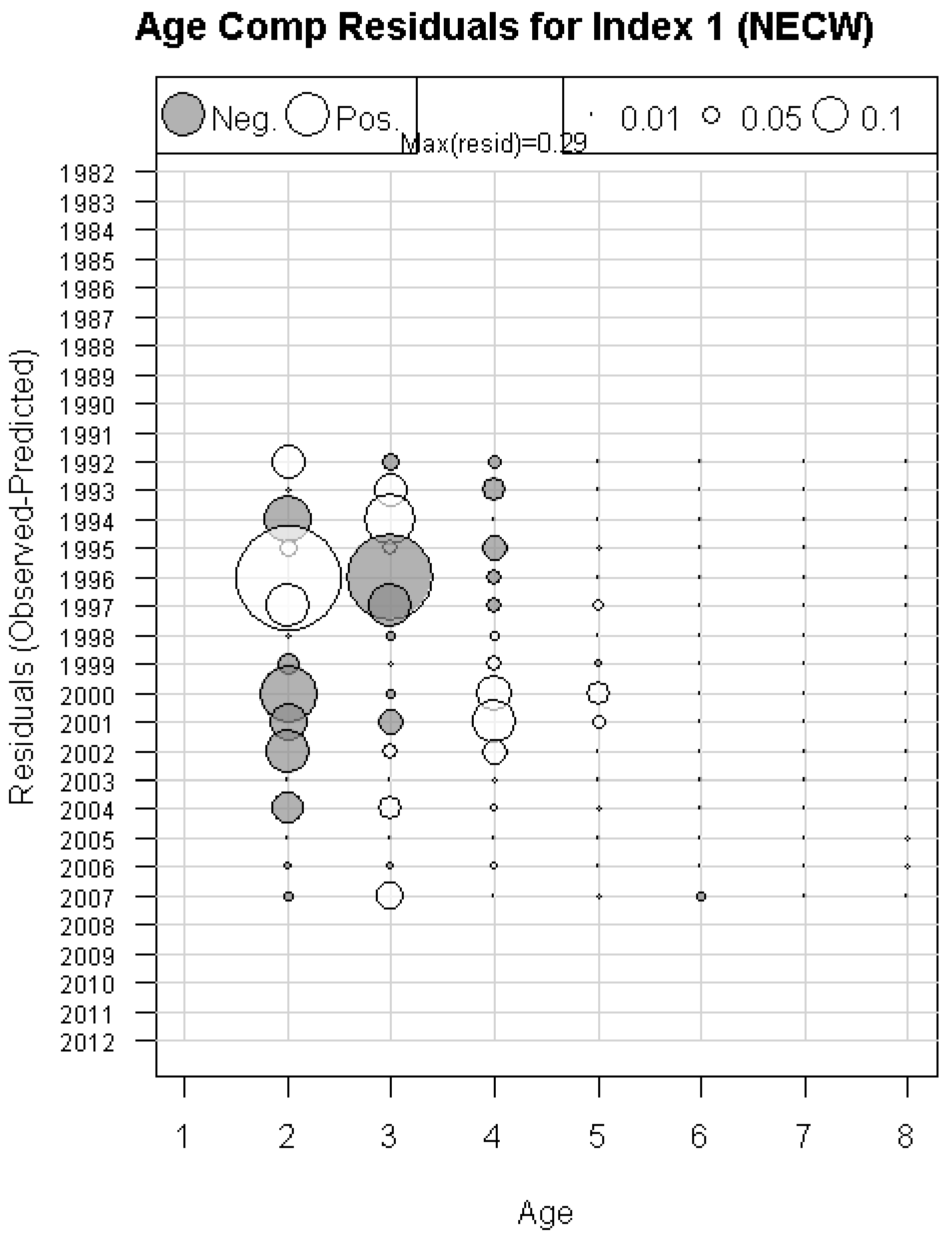


Figure A201. Age composition residuals for the NEFSC winter trawl survey in run F57_BASE_12.

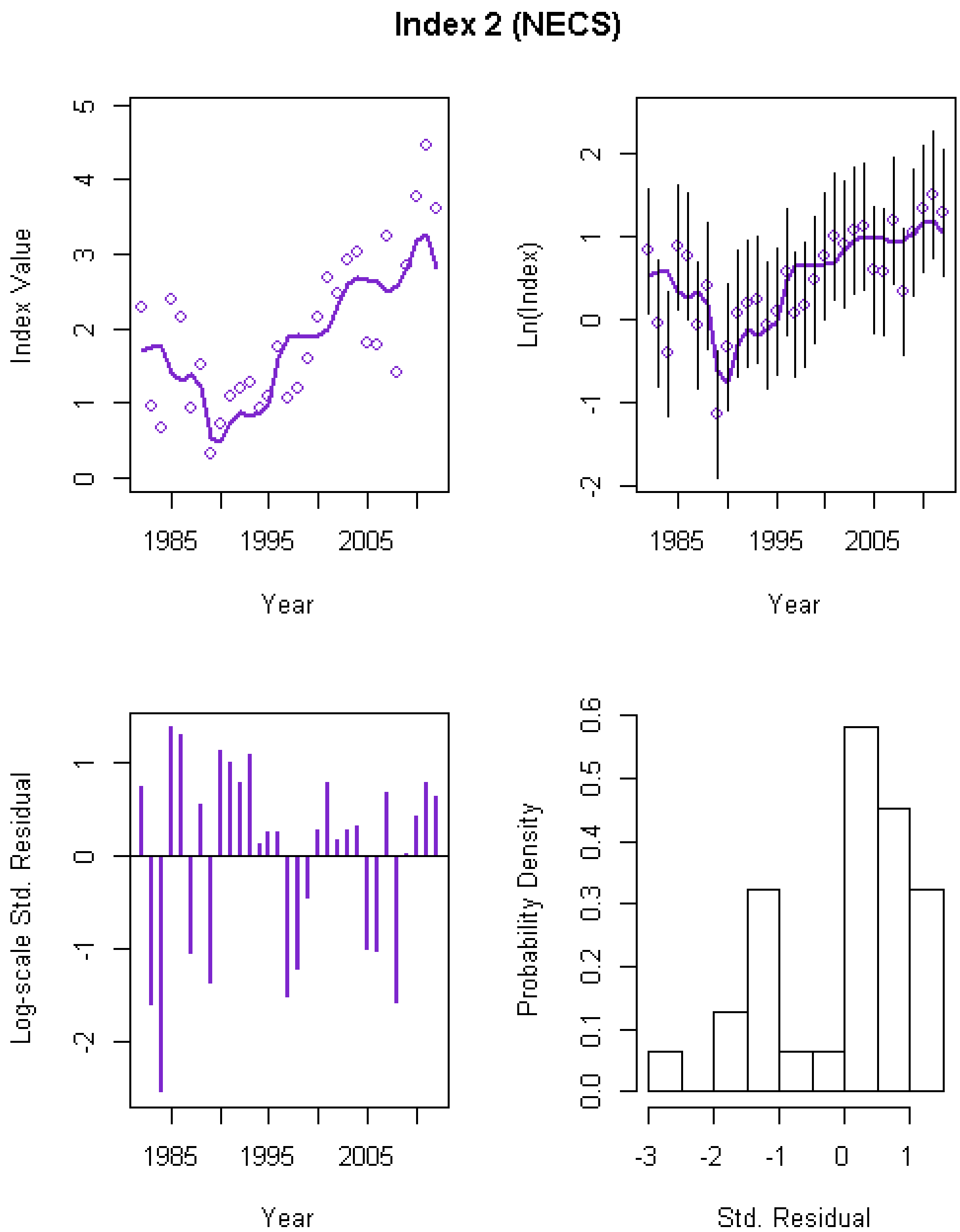


Figure A202. Fit diagnositics for the NEFSC spring trawl survey in run F57_BASE_12.

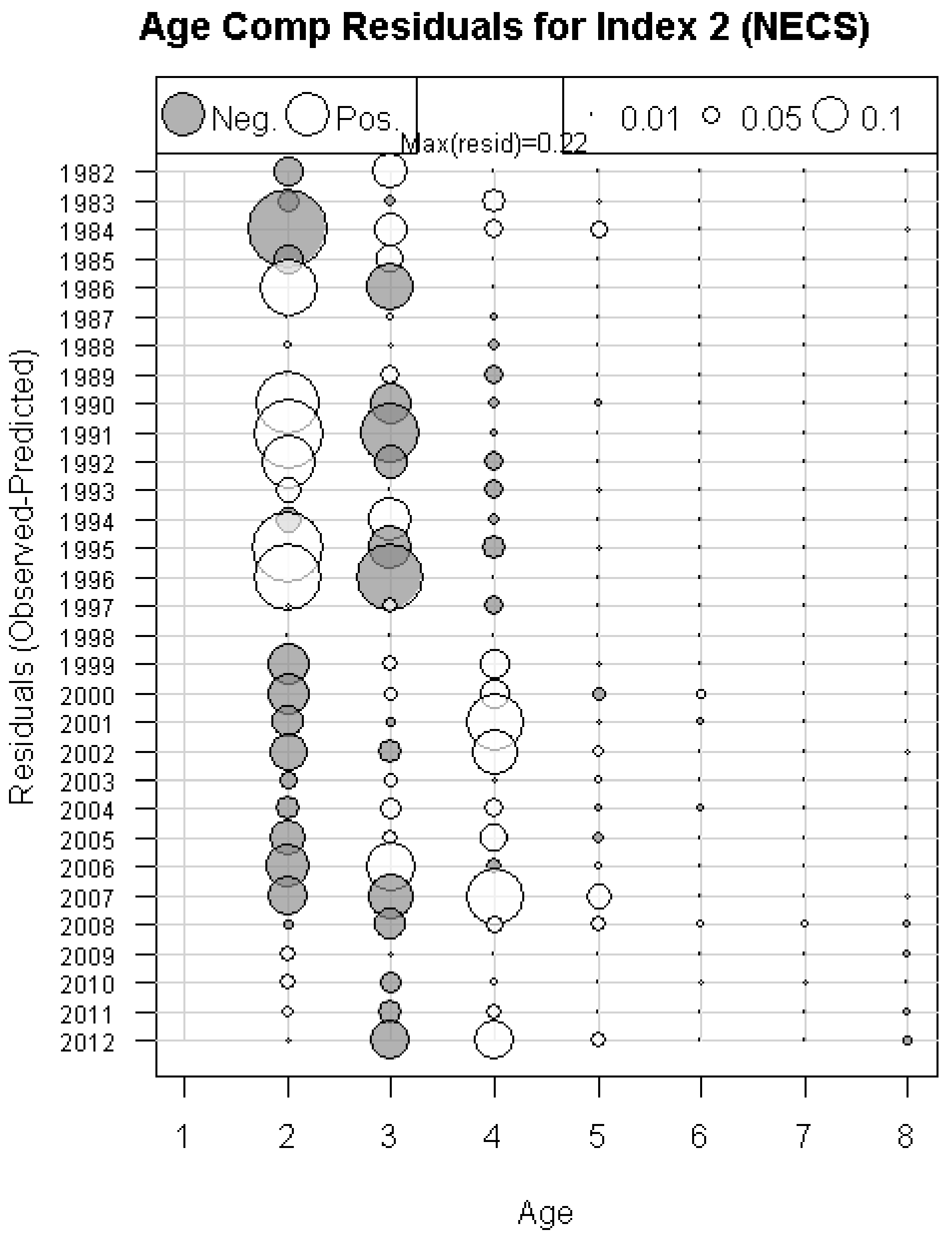


Figure A203. Age composition residuals for the NEFSC spring trawl survey in run F57_BASE_12.

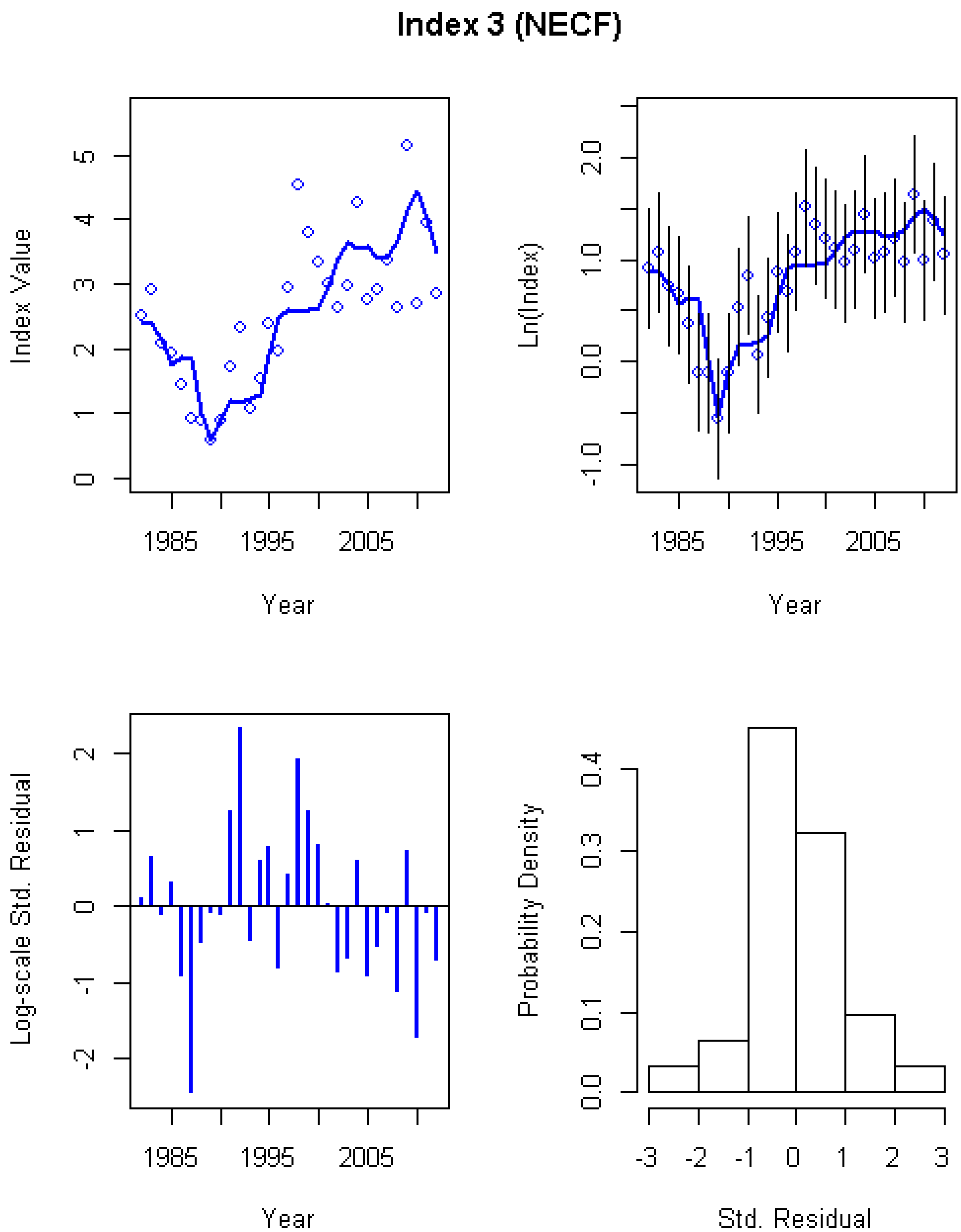


Figure A204. Fit diagnositics for the NEFSC fall trawl survey in run F57_BASE_12.

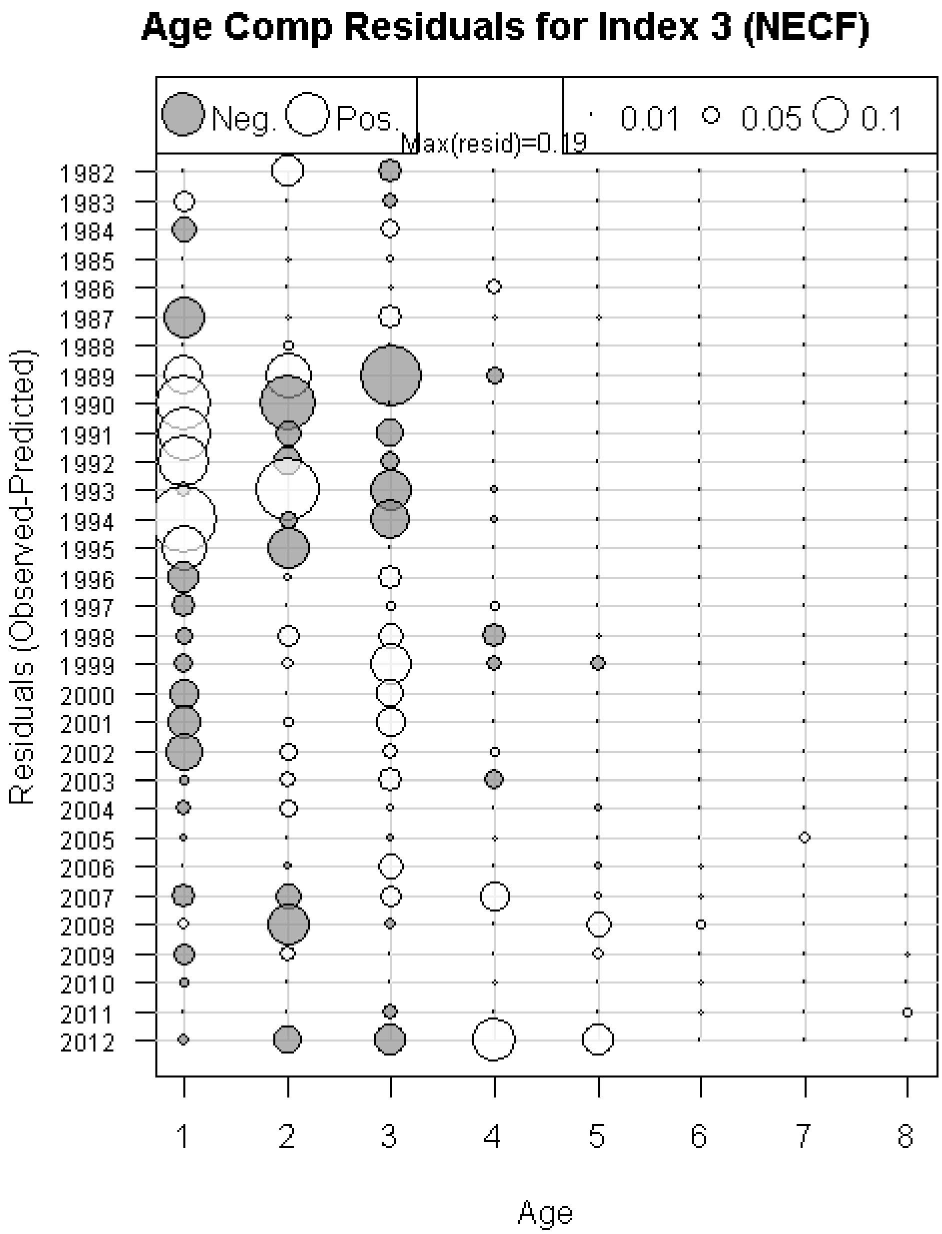


Figure A205. Age composition residuals for the NEFSC fall trawl survey in run F57_BASE_12.

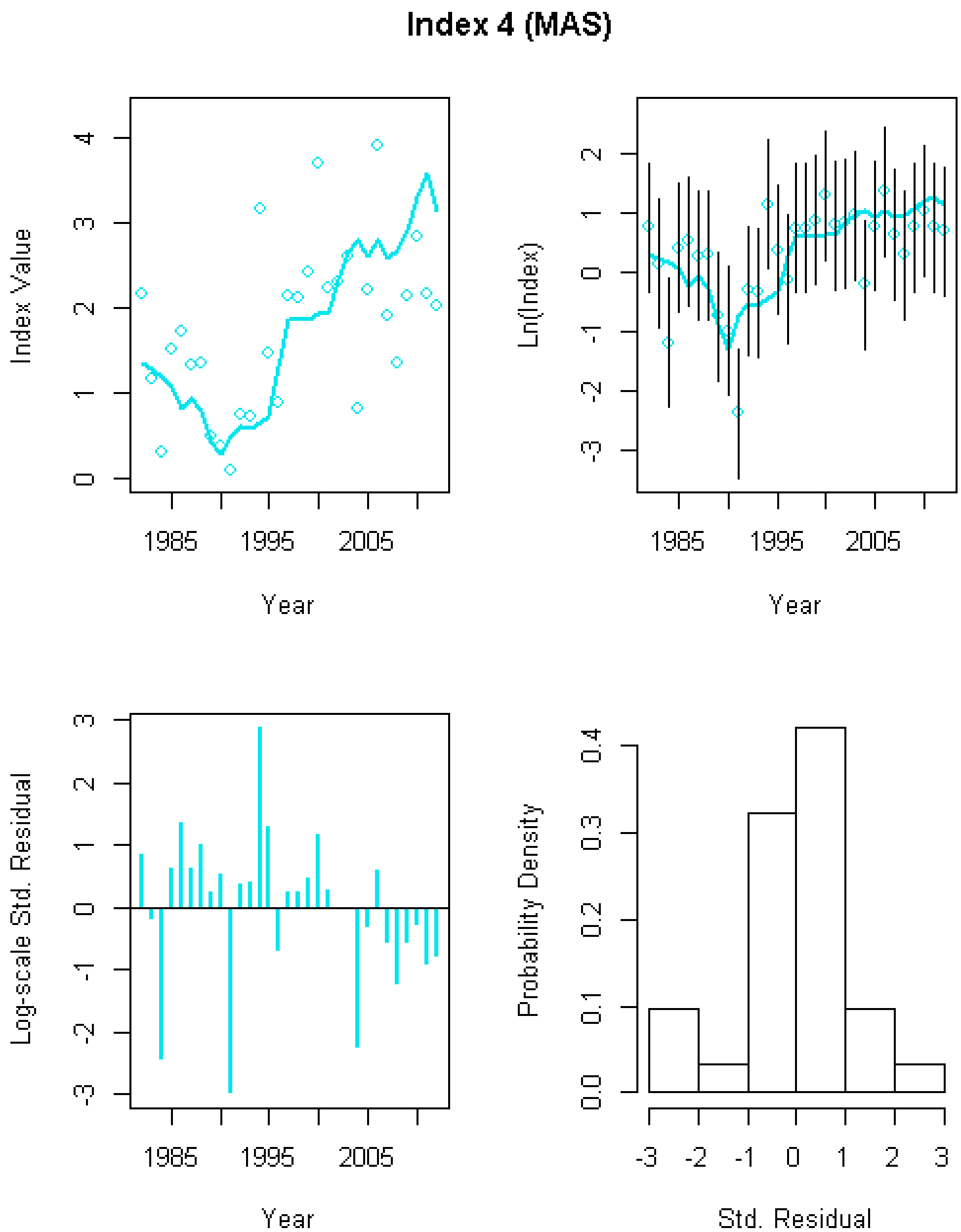


Figure A206. Fit diagnositics for the MADMF spring trawl survey in run F57_BASE_12.

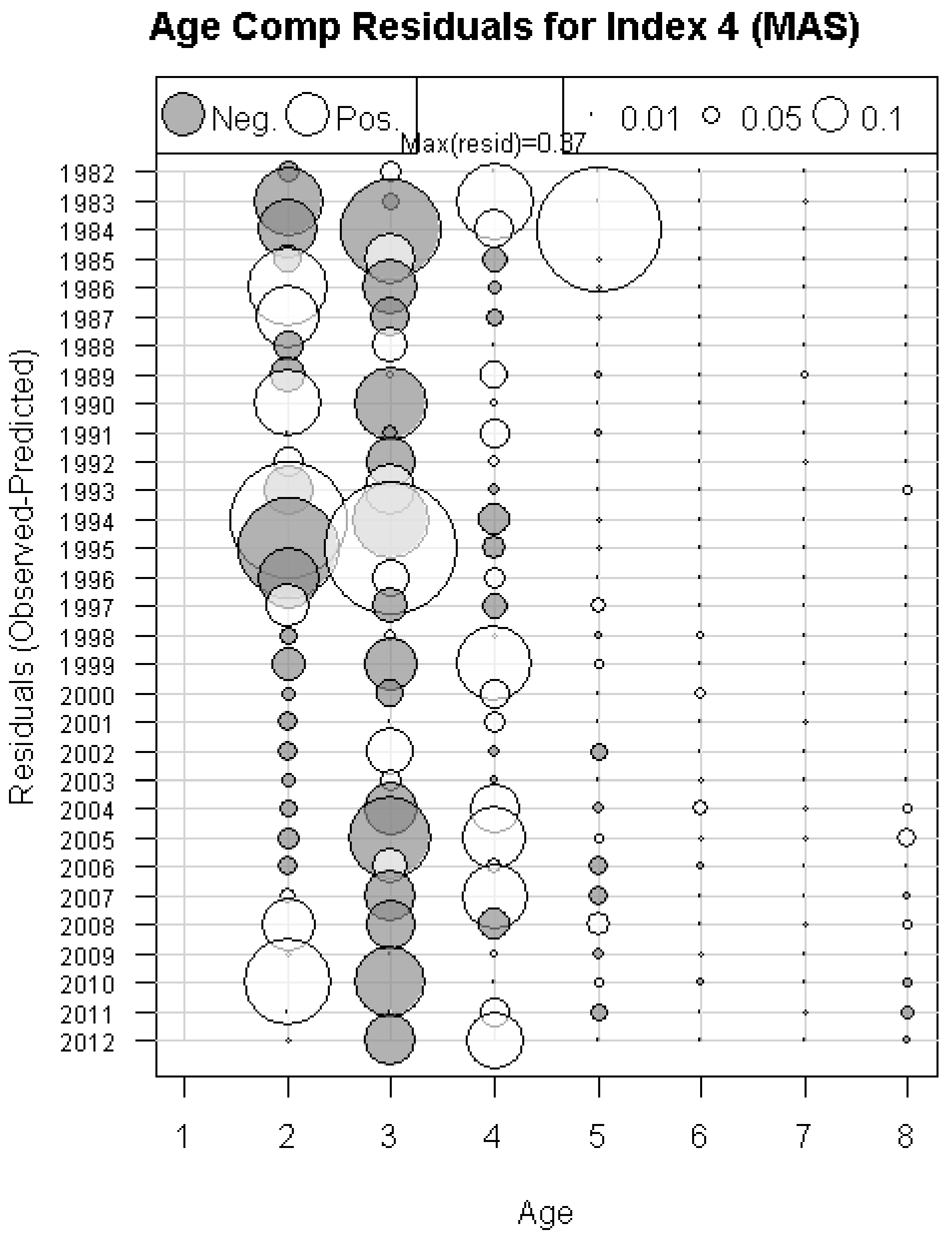


Figure A207. Age composition residuals for the MADMF spring trawl survey in run F57_BASE_12.

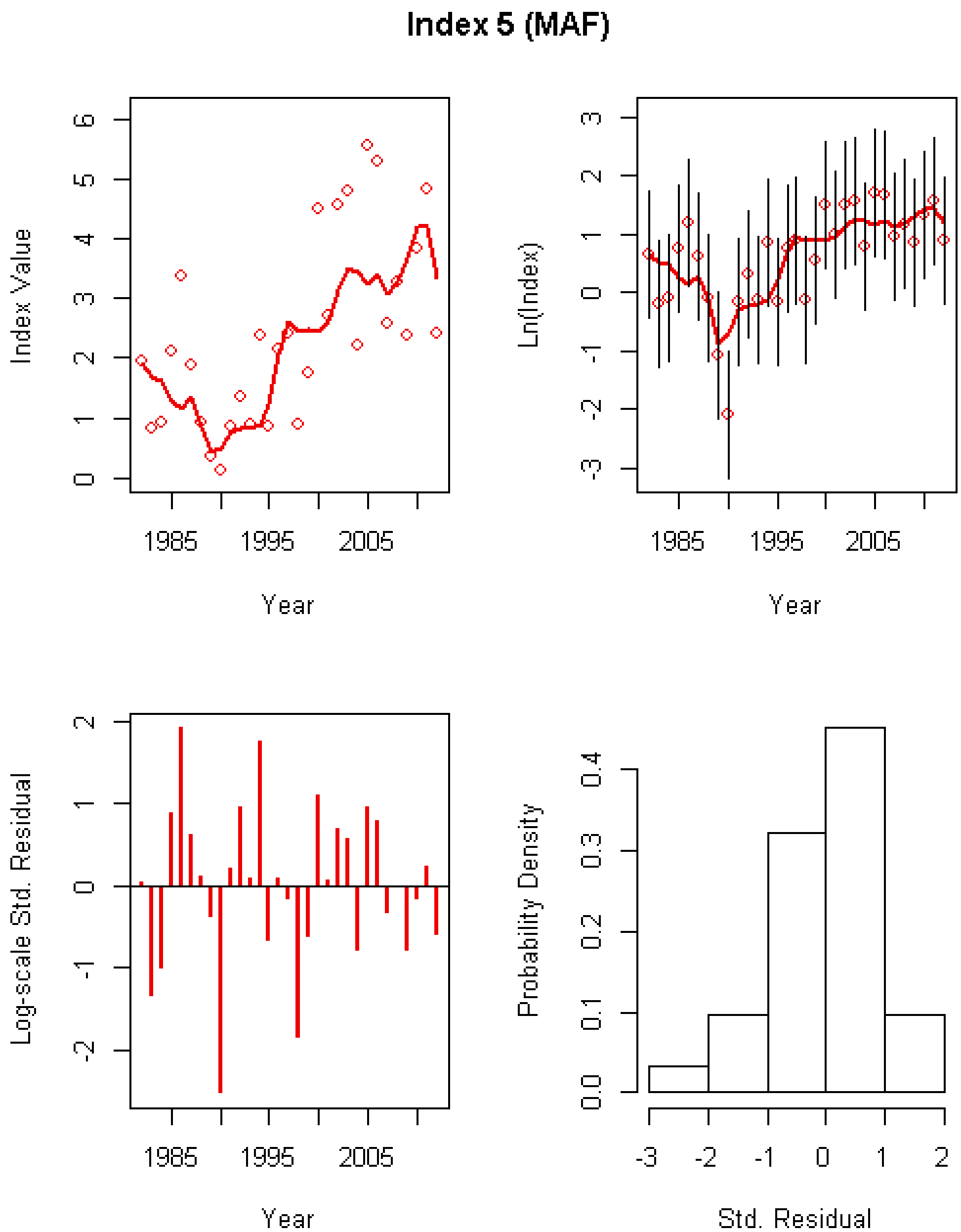


Figure A208. Fit diagnositics for the MADMF fall trawl survey in run F57_BASE_12.

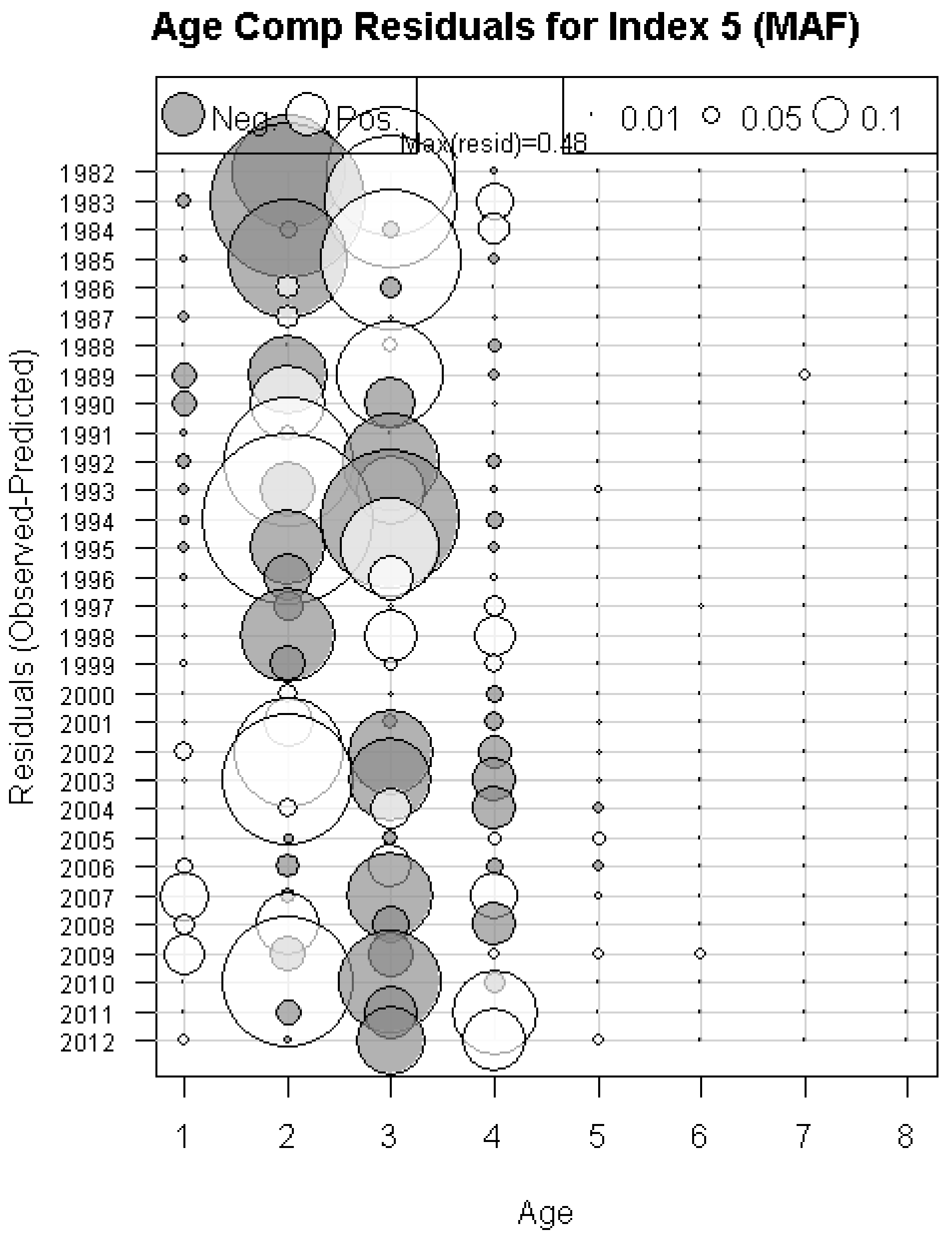


Figure A209. Age composition residuals for the MADMF fall trawl survey in run F57_BASE_12.

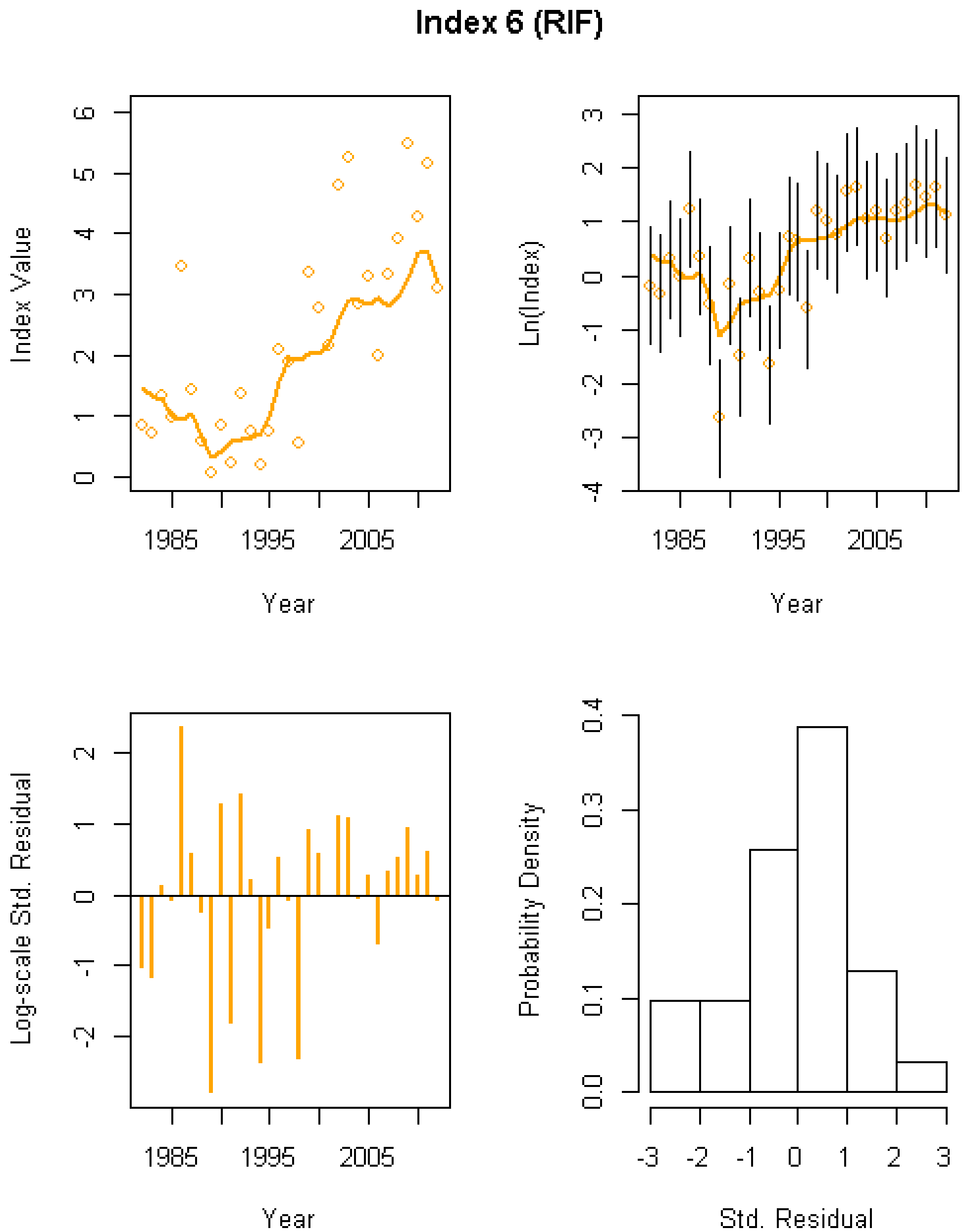


Figure A210. Fit diagnositics for the RIDFW fall trawl survey in run F57_BASE_12.

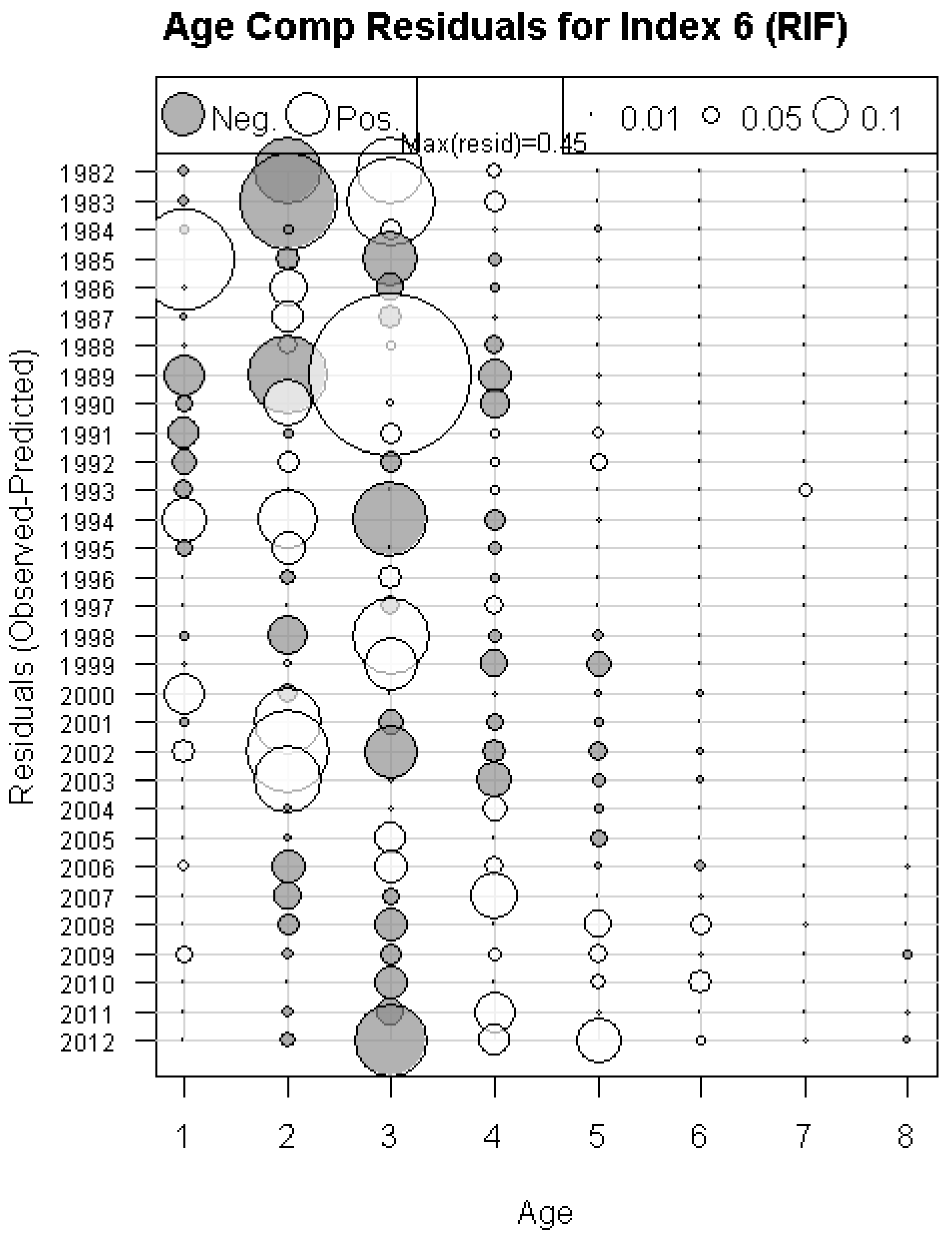


Figure A211. Age composition residuals for the RIDFW fall trawl survey in run F57_BASE_12.

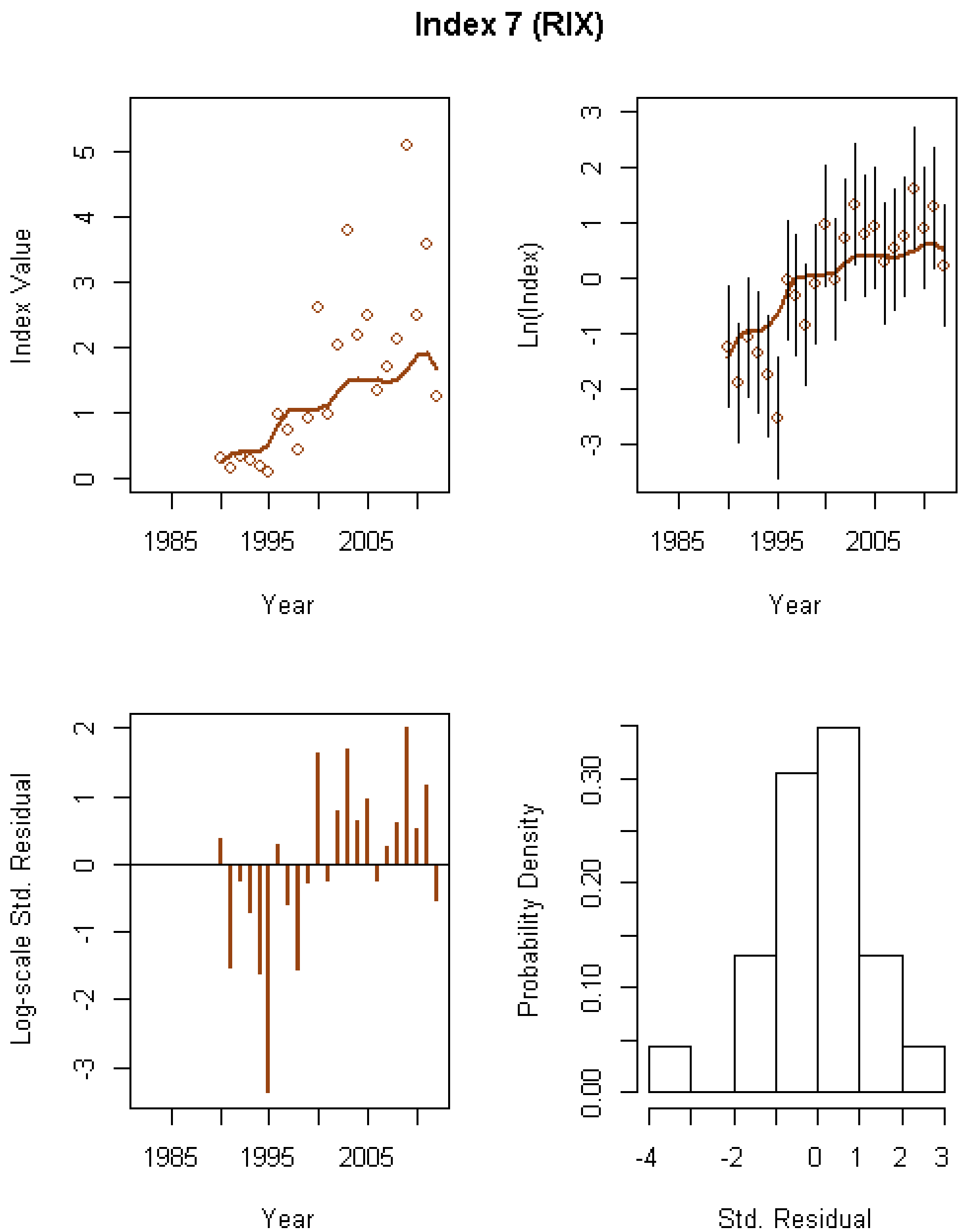


Figure A212. Fit diagnositics for the RIDFW monthly fixed station trawl survey in run F57_BASE_12.

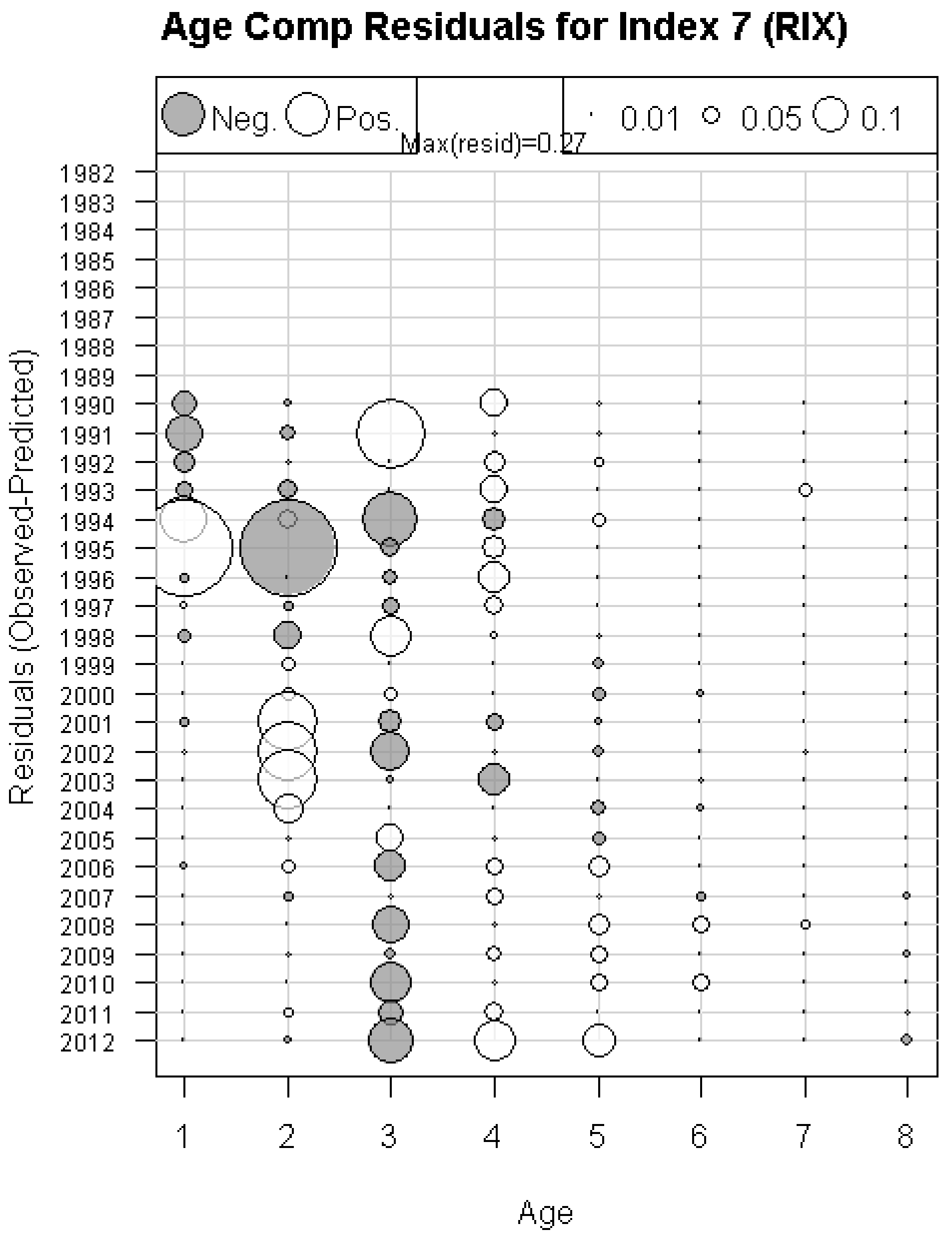


Figure A213. Age composition residuals for the RIDFW monthly fixed station trawl survey in run F57_BASE_12.

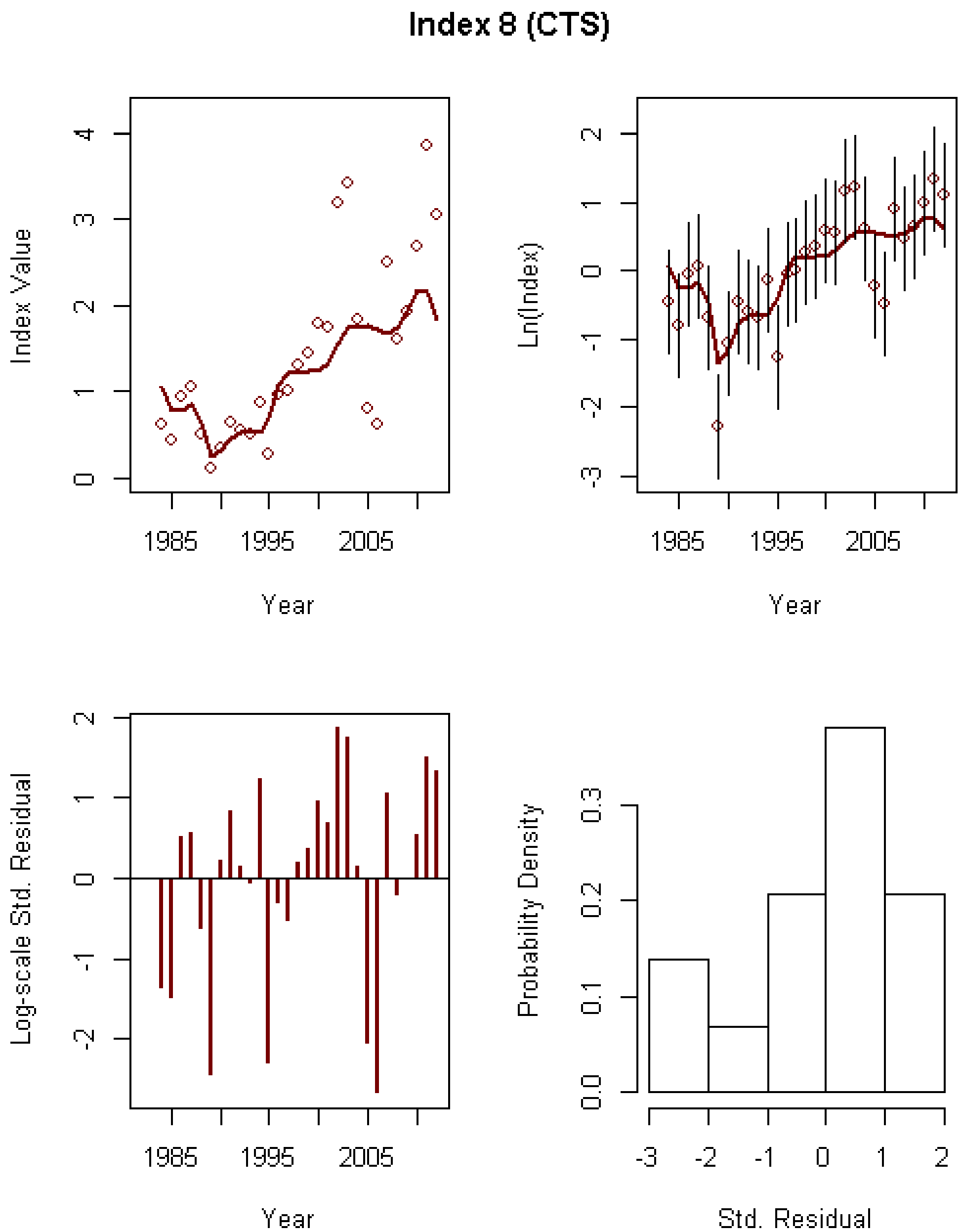


Figure A214. Fit diagnositics for the CTDEP spring trawl survey in run F57_BASE_12.

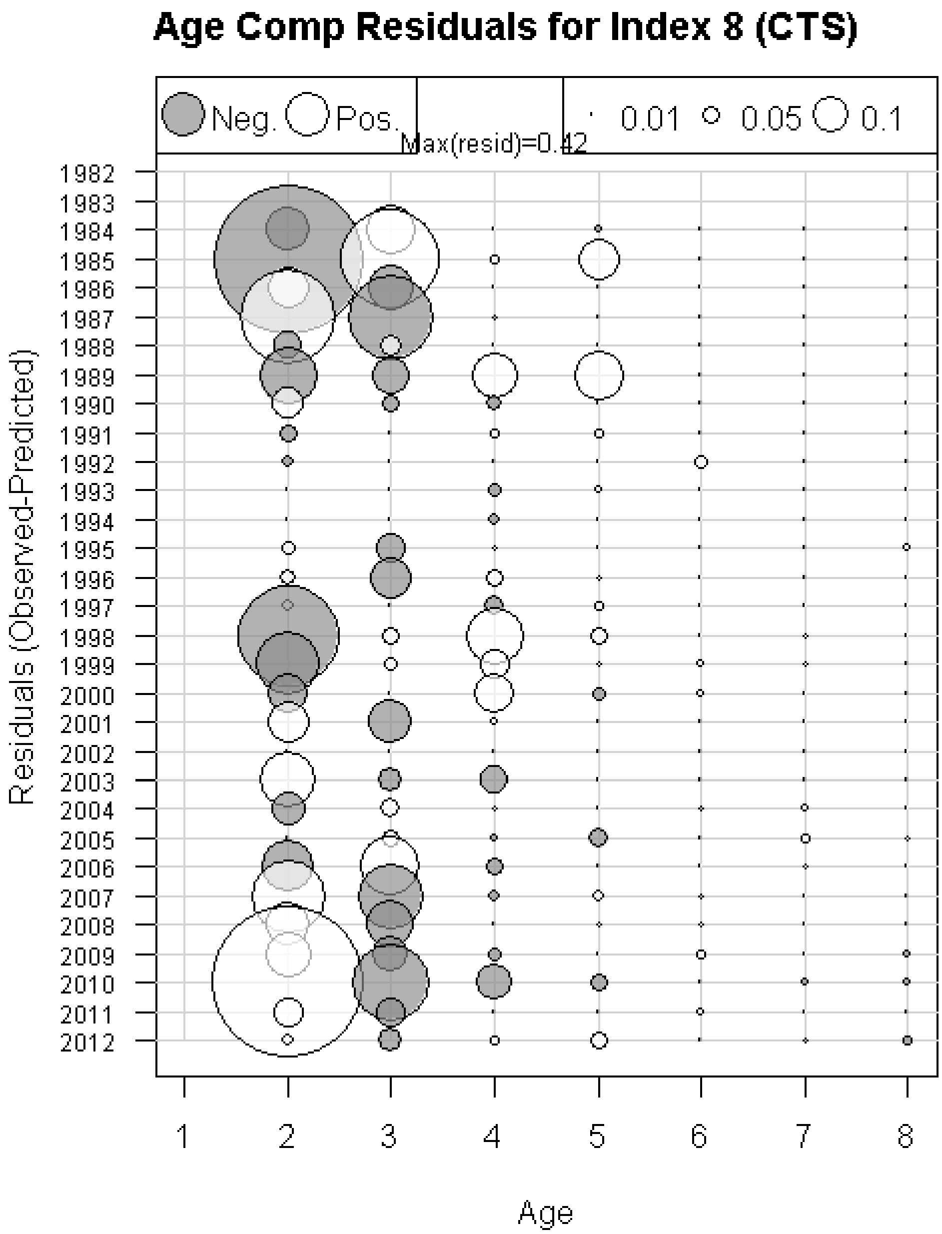


Figure A215. Age composition residuals for the CTDEP spring trawl survey in run F57_BASE_12.

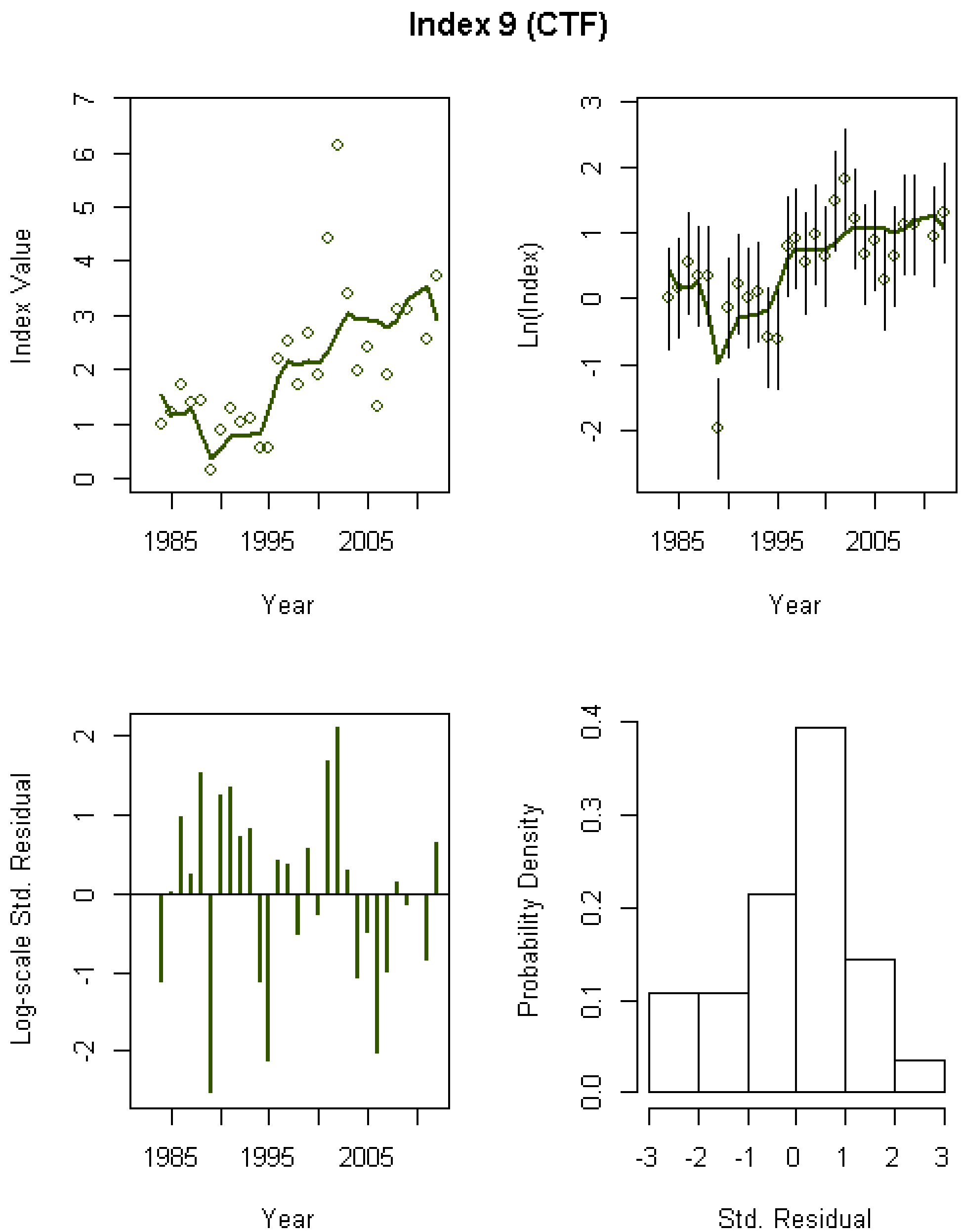


Figure A216. Fit diagnositics for the CTDEP fall trawl survey in run F57_BASE_12.

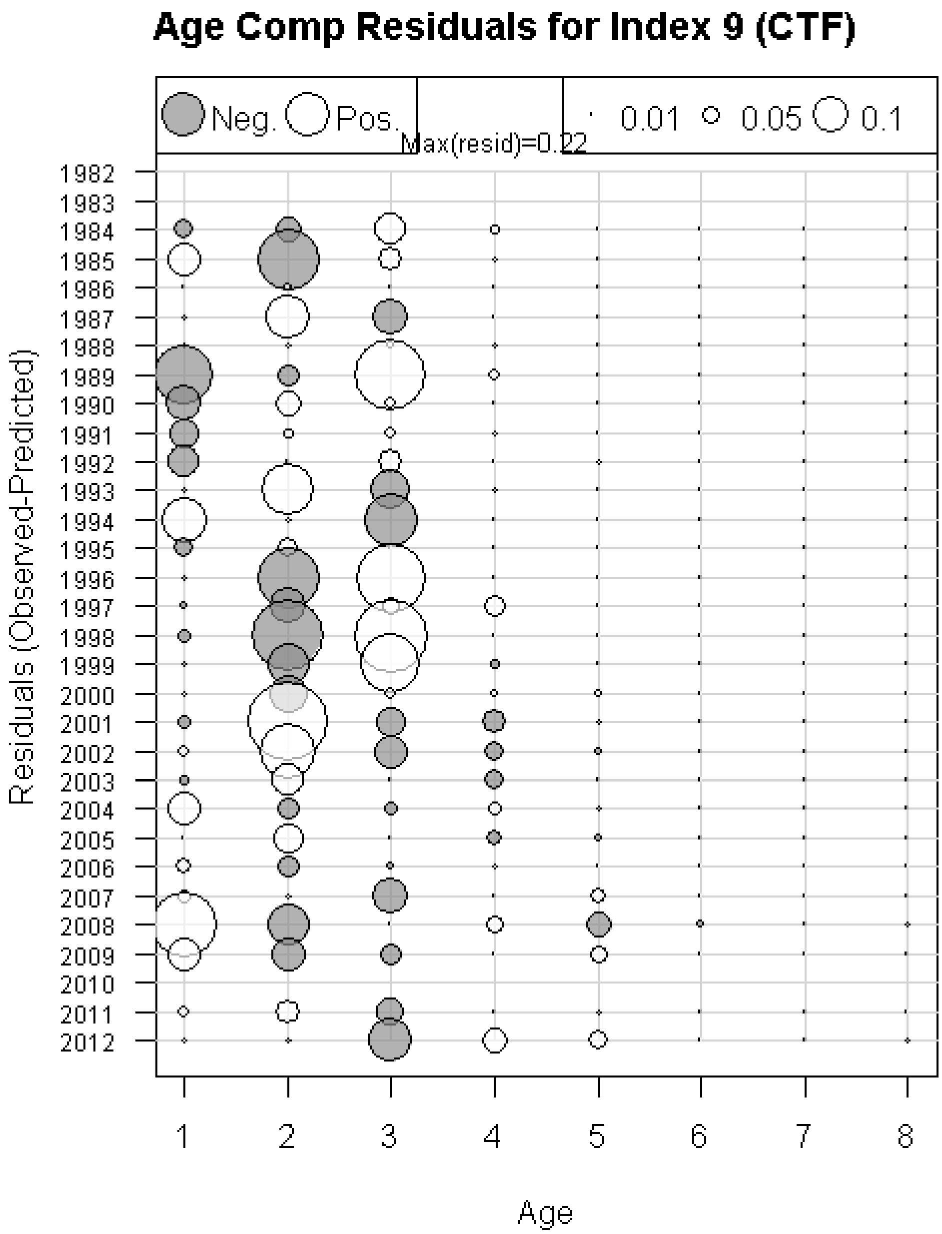


Figure A217. Age composition residuals for the CTDEP fall trawl survey in run F57_BASE_12.

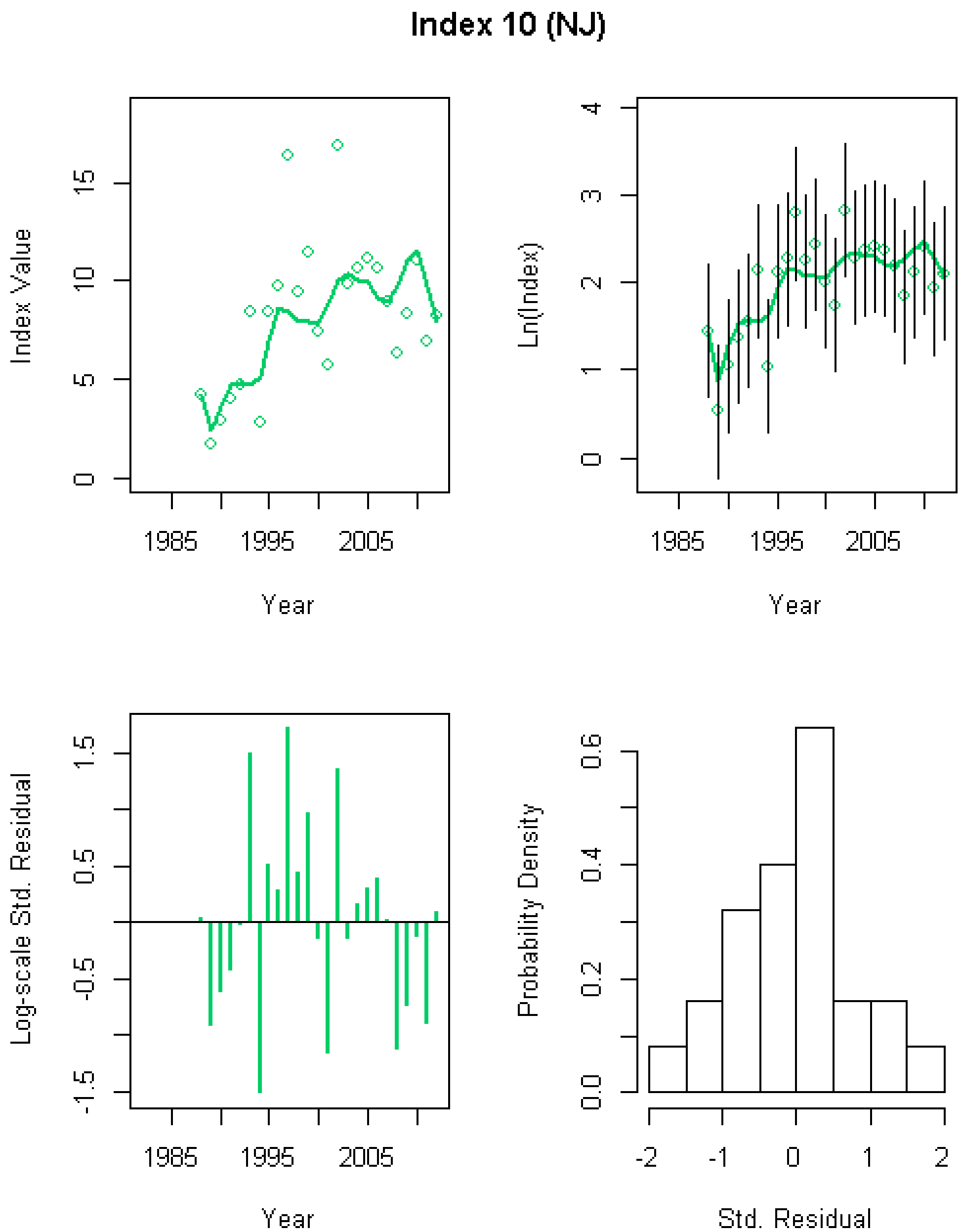


Figure A218. Fit diagnositics for the NJDFW trawl survey in run F57_BASE_12.

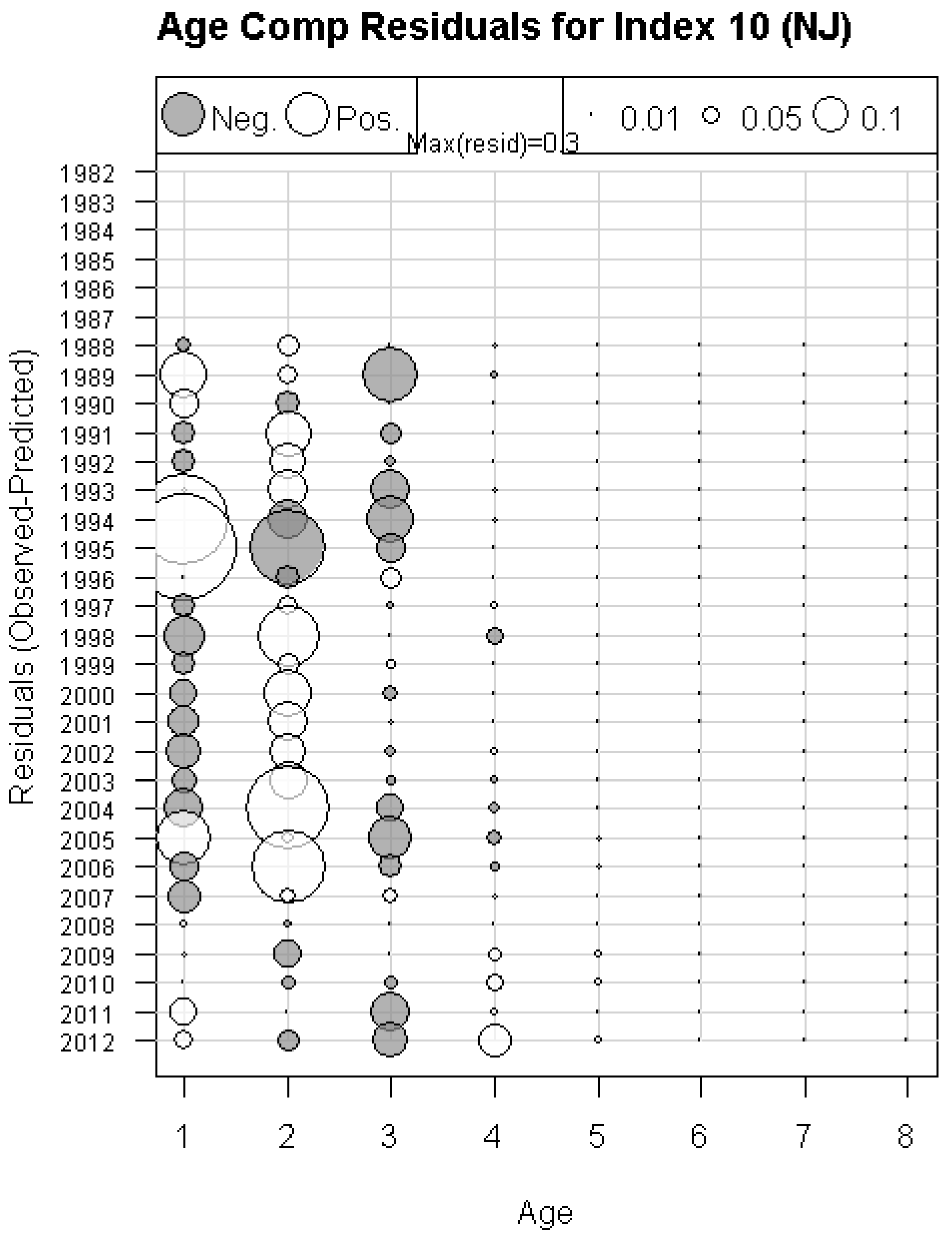


Figure A219. Age composition residuals for the NJDFW trawl survey in run F57_BASE_12.

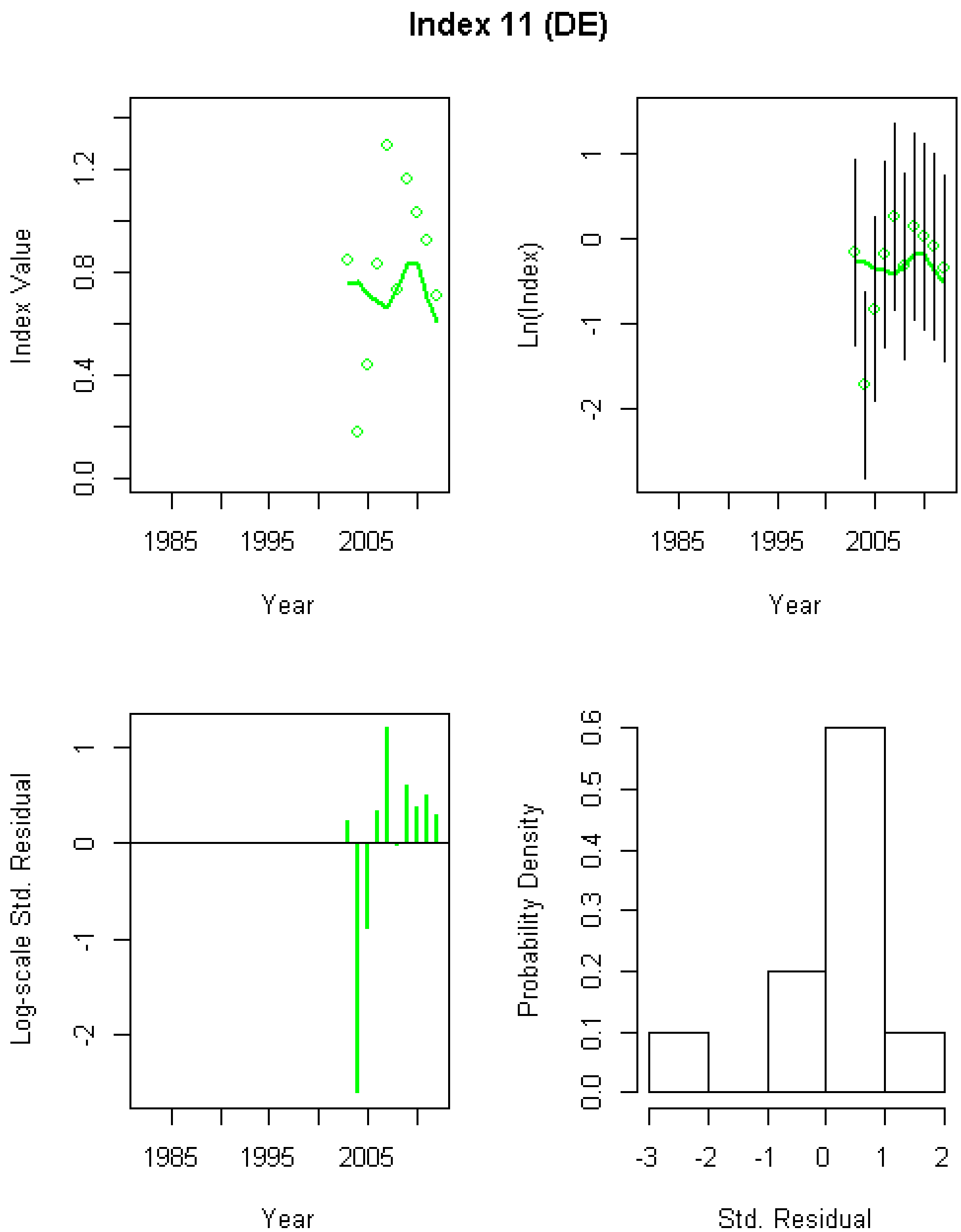


Figure A220. Fit diagnositics for the DEDFW trawl survey in run F57_BASE_12.

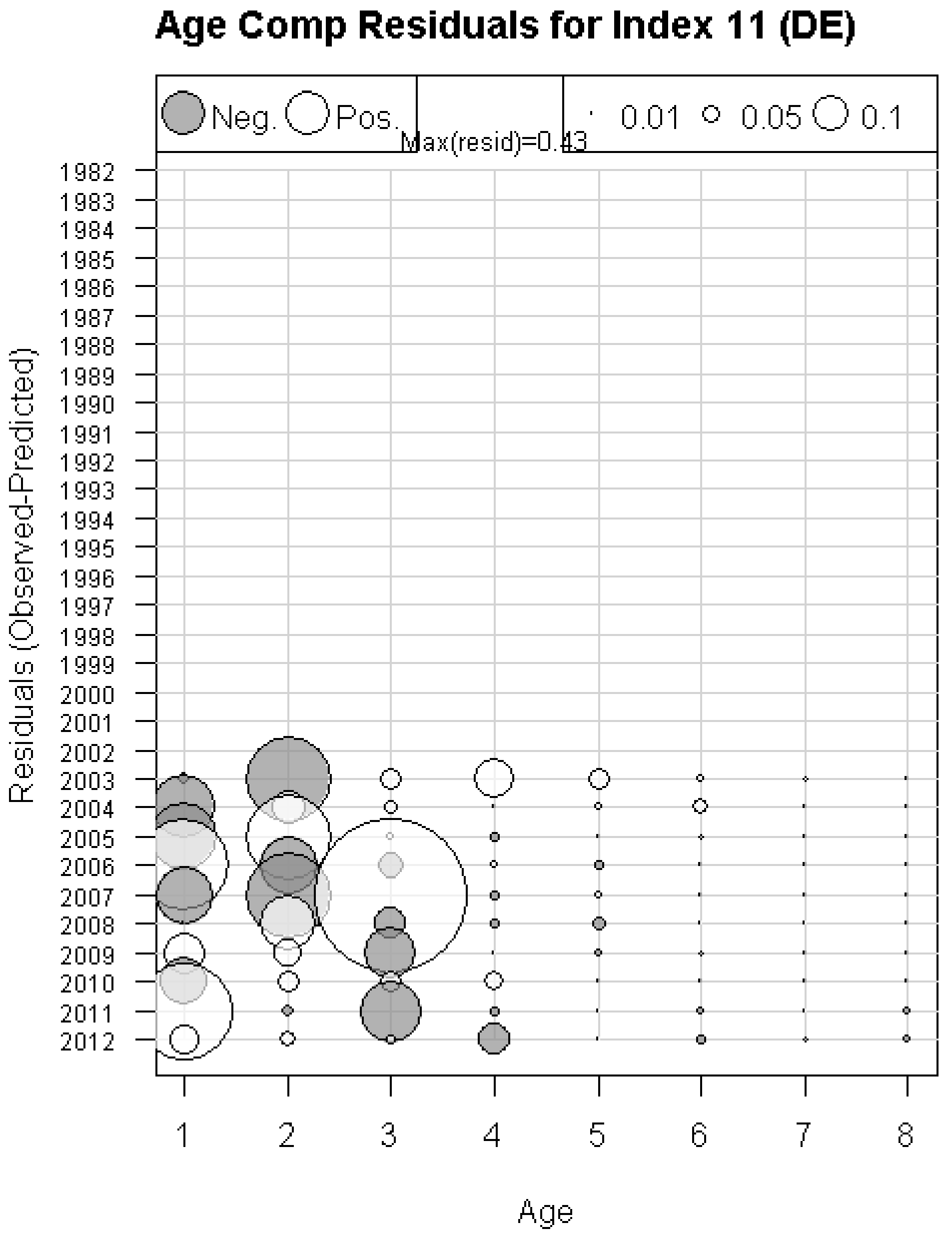


Figure A221. Age composition residuals for the DEDFW trawl survey in run F57_BASE_12.

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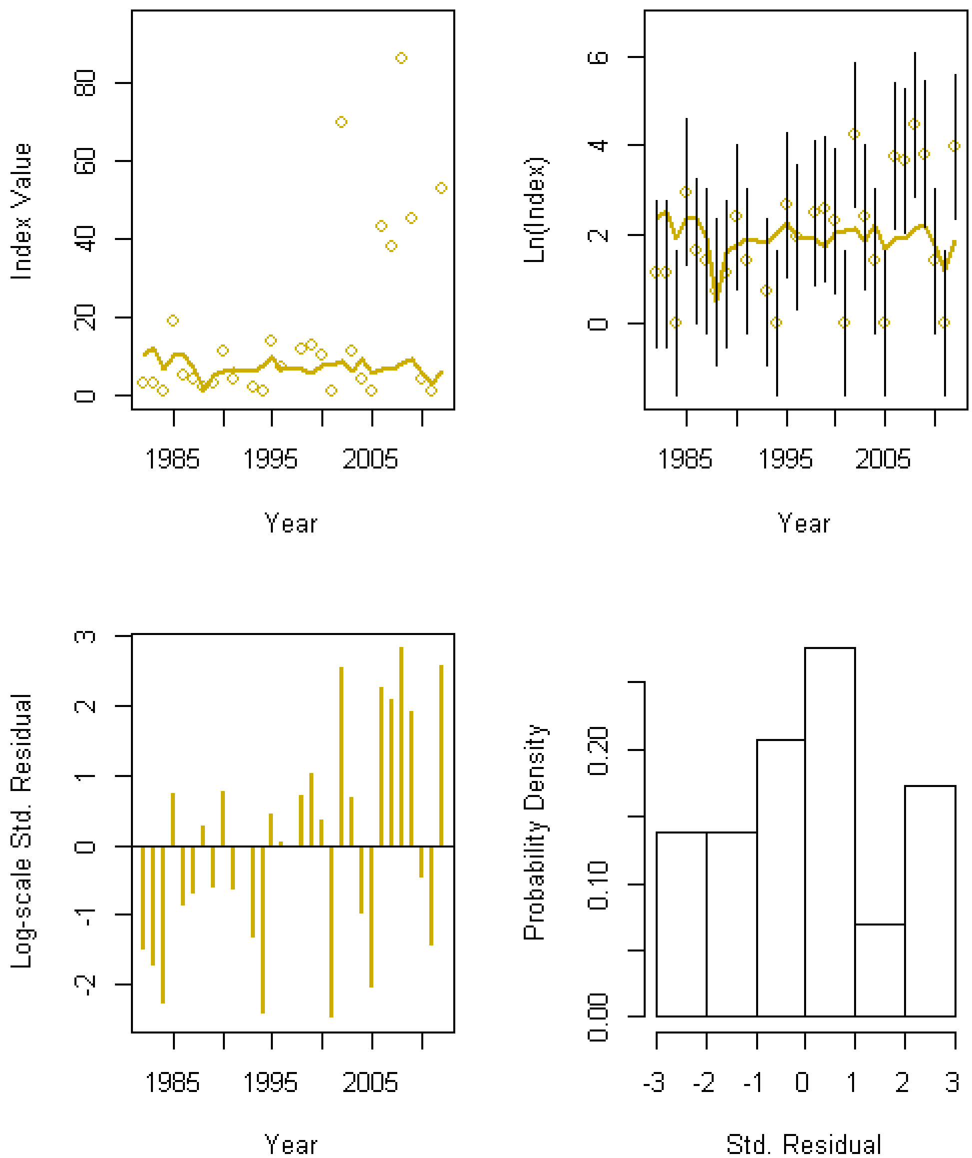

Figure A222. Fit diagnositics for the MADMF YOY seine survey in run F57_BASE_12.

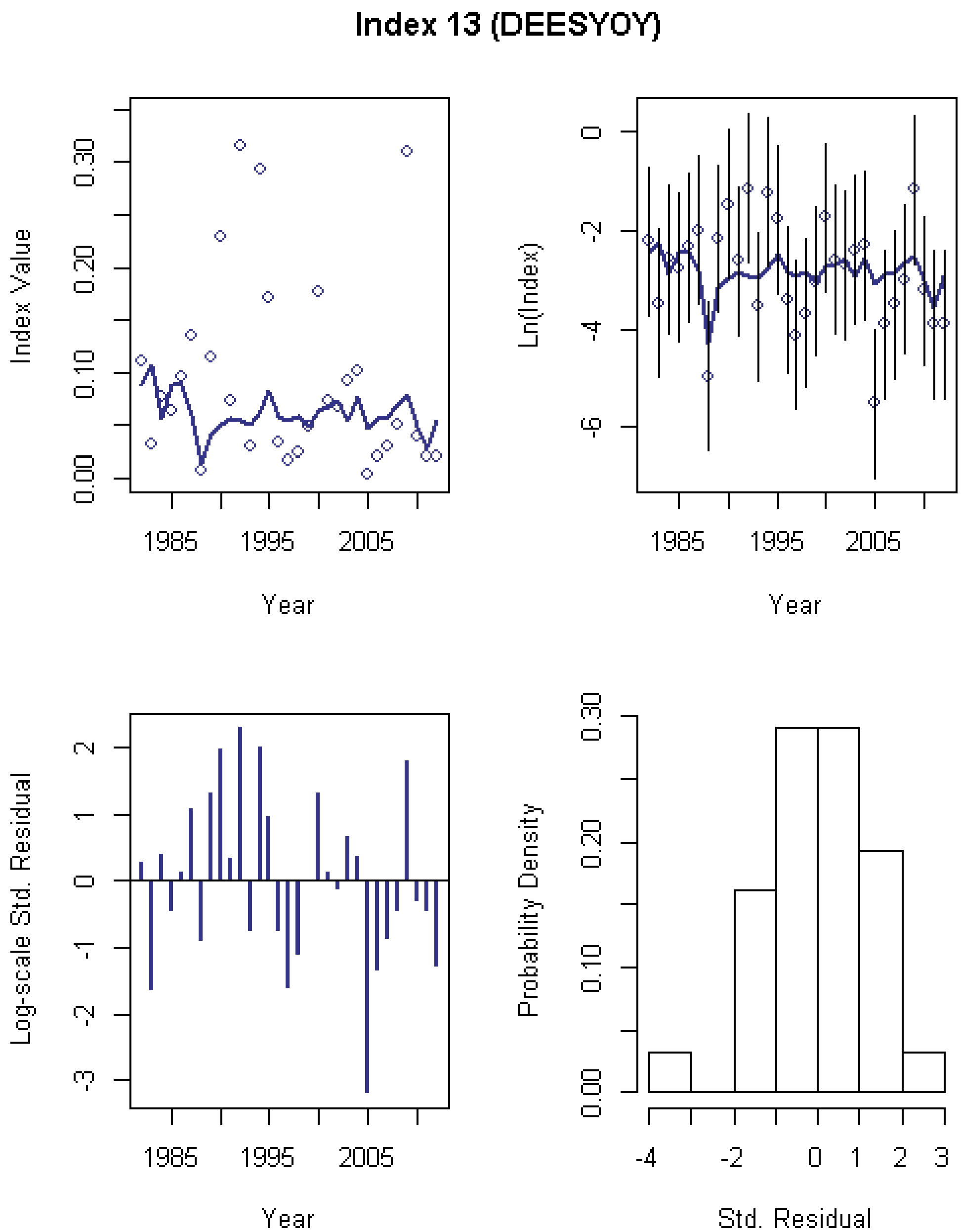

Figure A223. Fit diagnositics for the DEDFW YOY estuary trawl survey in run F57_BASE_12.

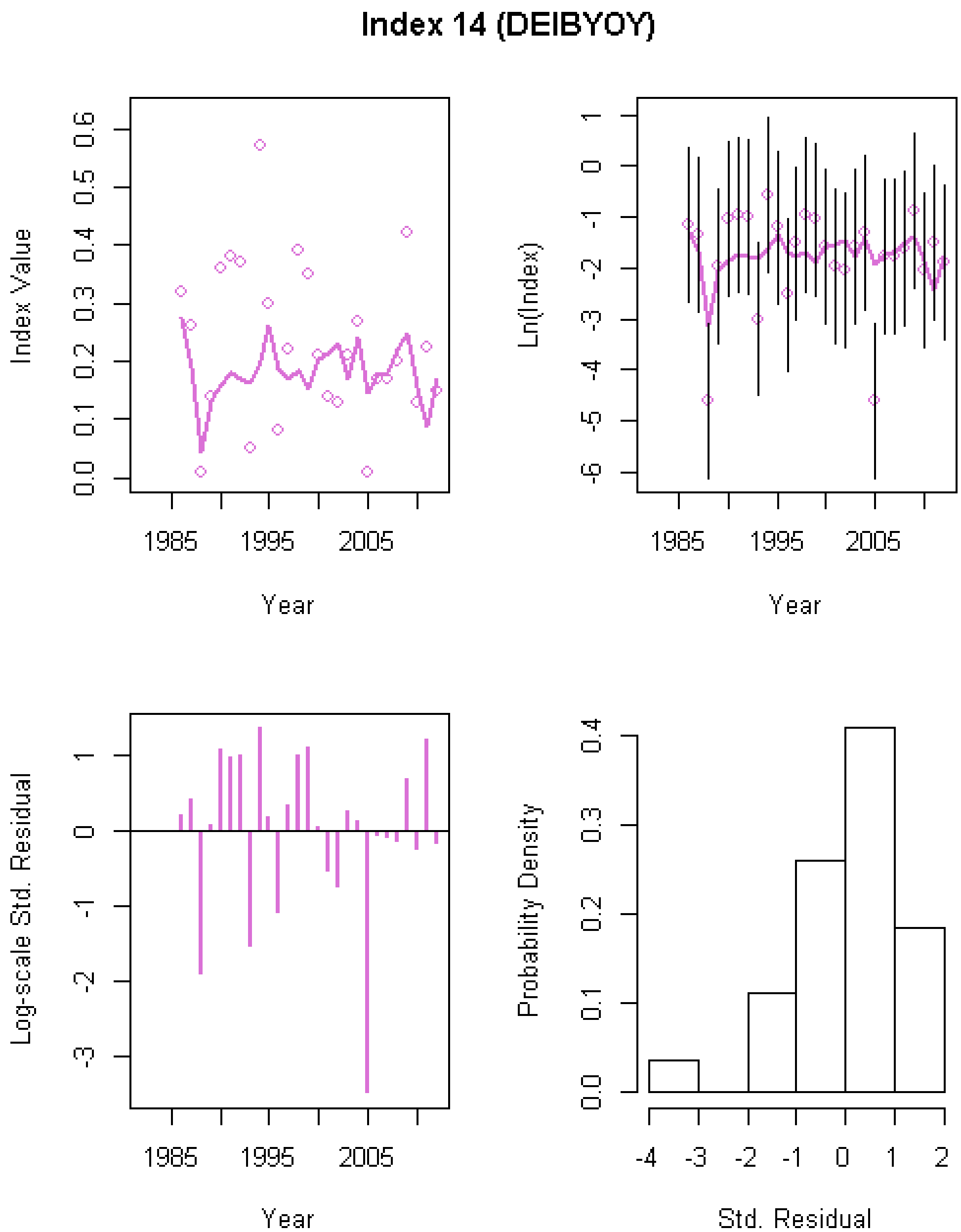

Figure A224. Fit diagnositics for the DEDFW YOY inland bays trawl survey in run F57_BASE_12.

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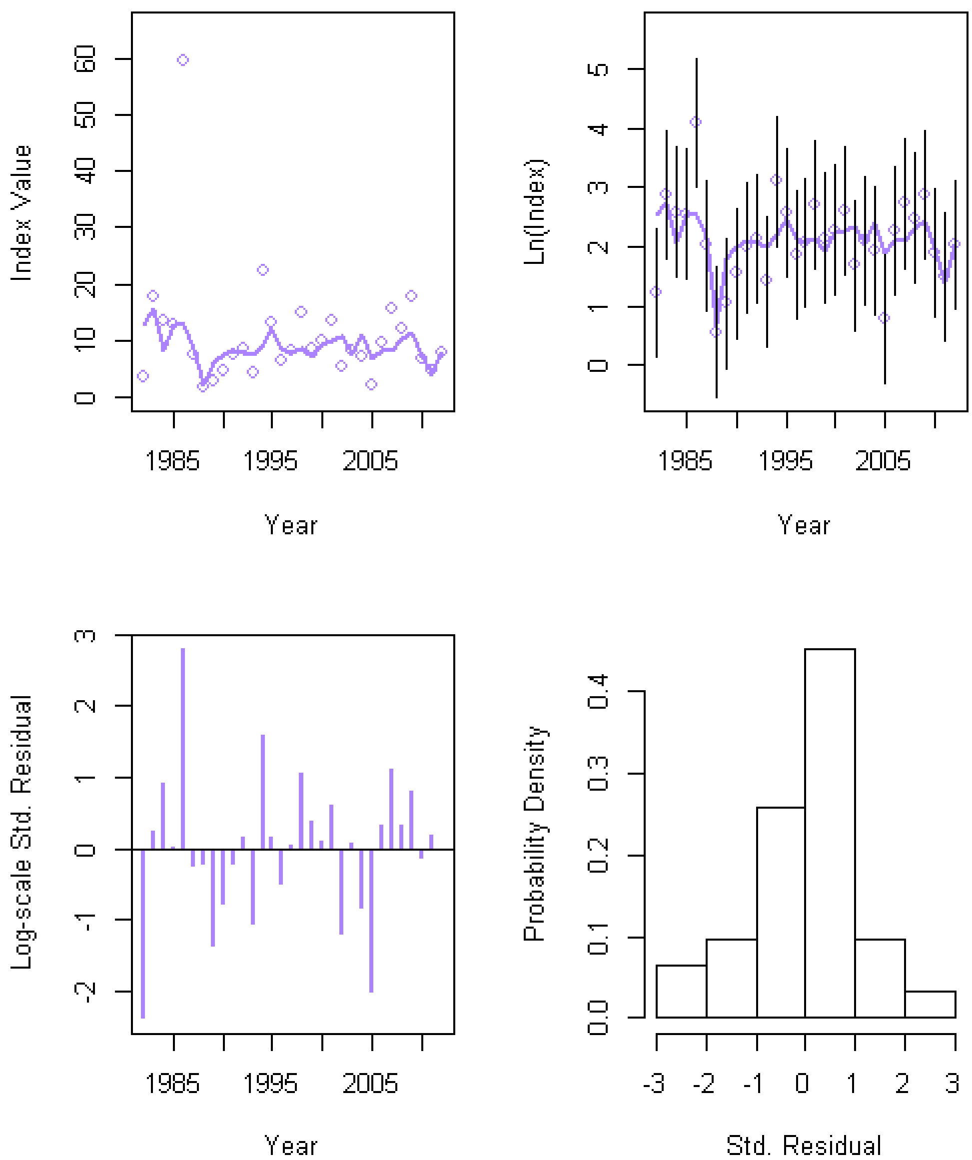


Figure A225. Fit diagnositics for the MDDNR YOY trawl survey in run F57_BASE_12.

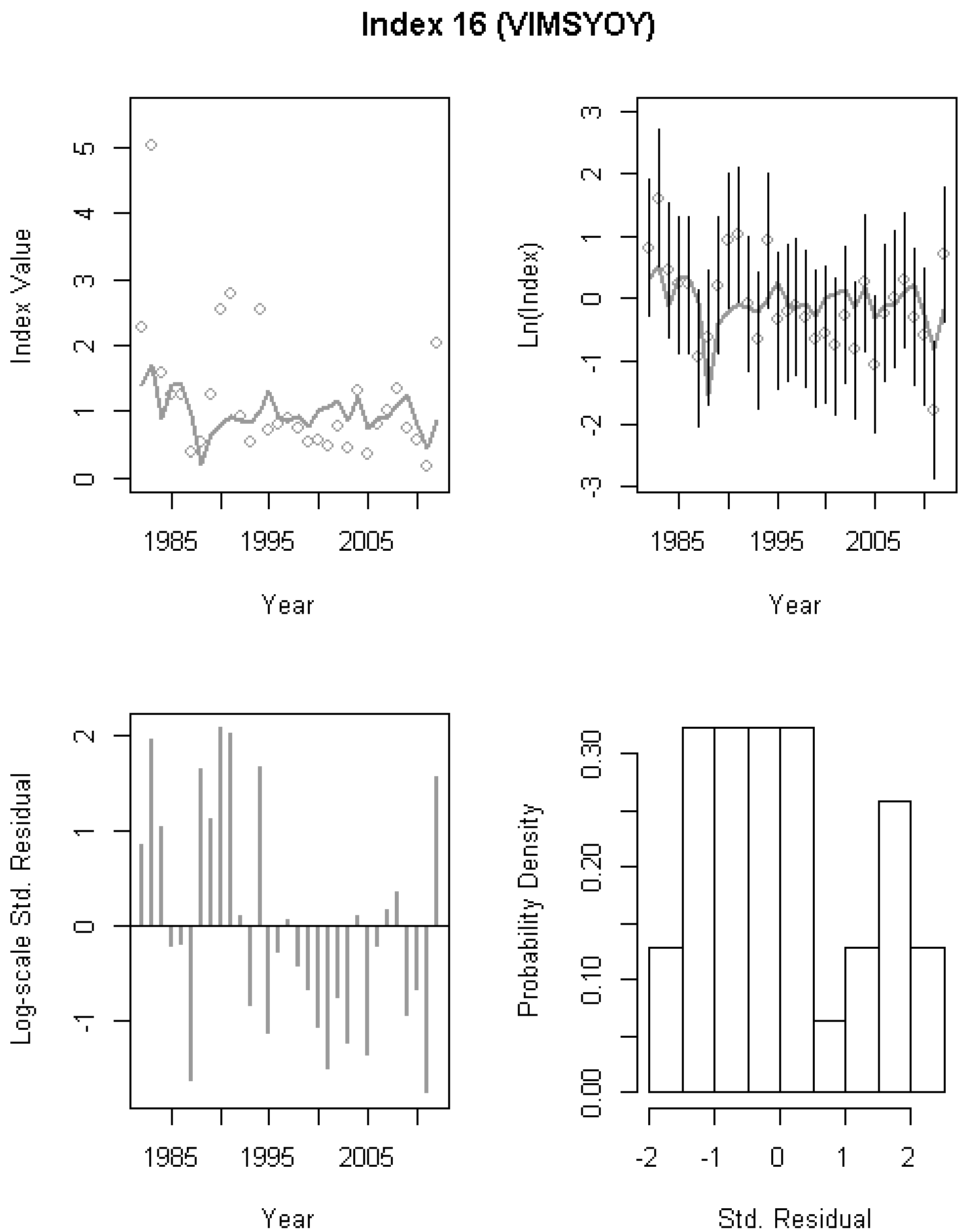


Figure A226. Fit diagnositics for the VIMS YOY trawl survey in run F57_BASE_12.

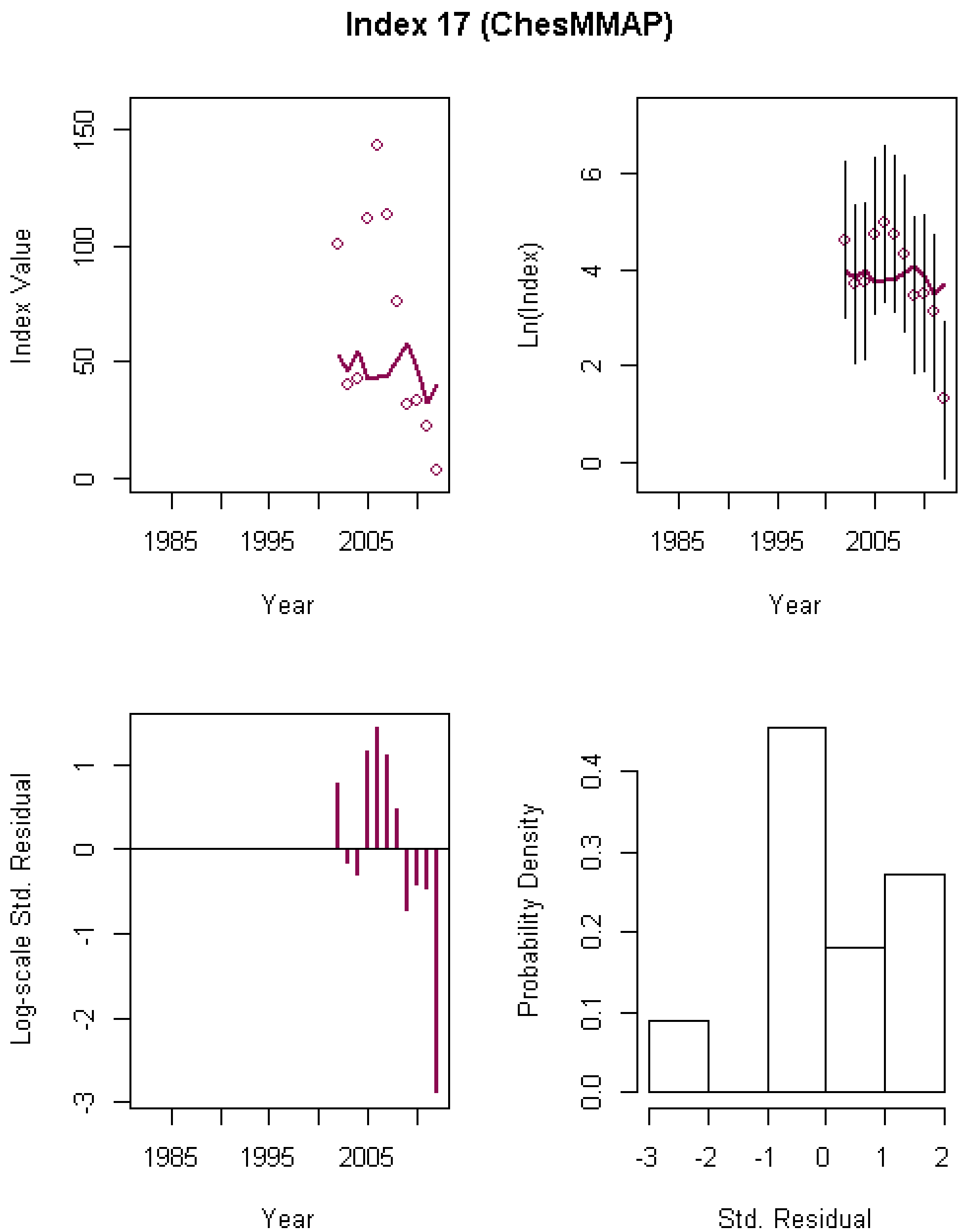


Figure A227. Fit diagnositics for the VIMS ChesMMAP trawl survey in run F57_BASE_12.

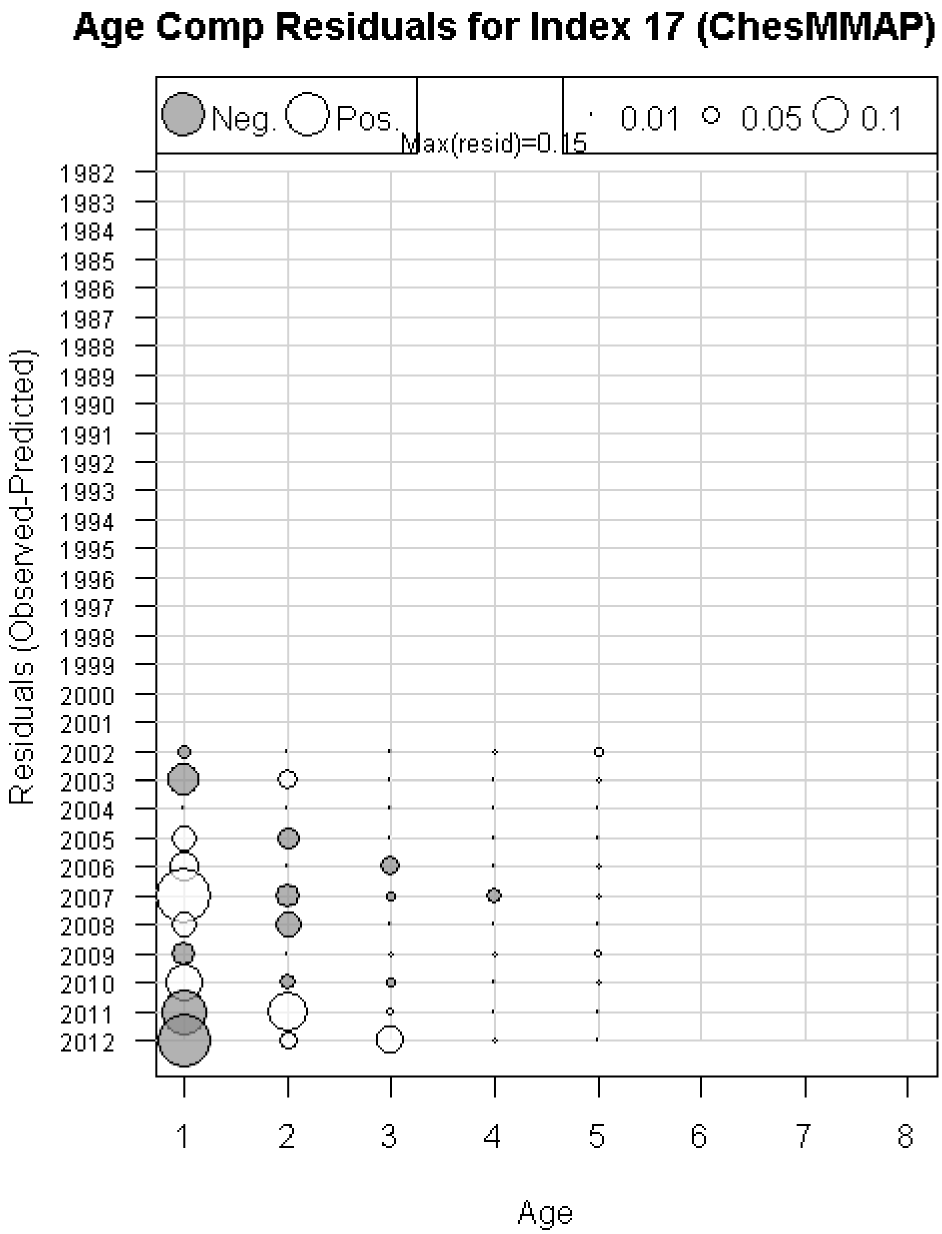


Figure A228. Age composition residuals for the VIMS ChesMMAP trawl survey in run F57_BASE_12.

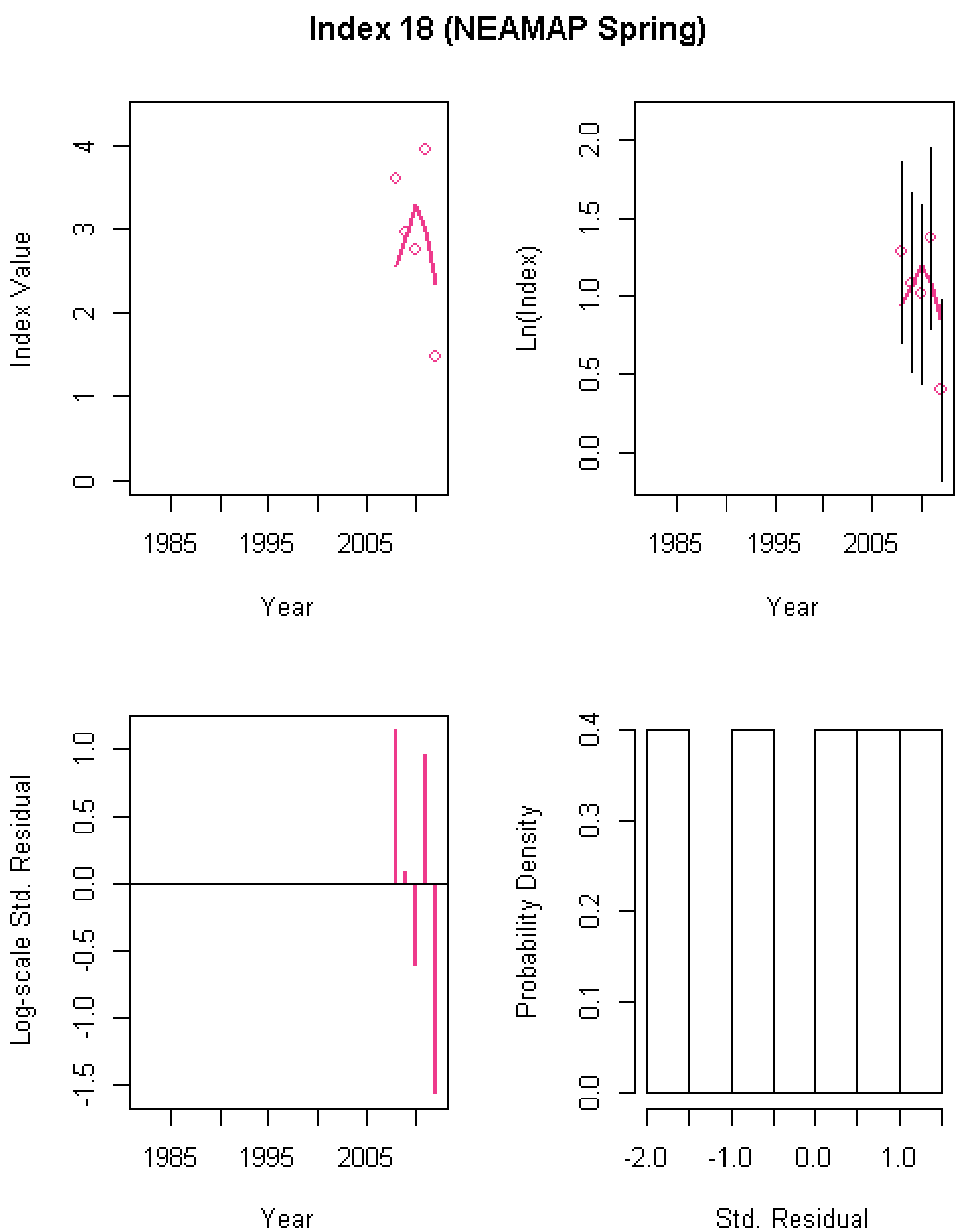


Figure A229. Fit diagnositics for the VIMS NEAMAP spring trawl survey in run F57_BASE_12.

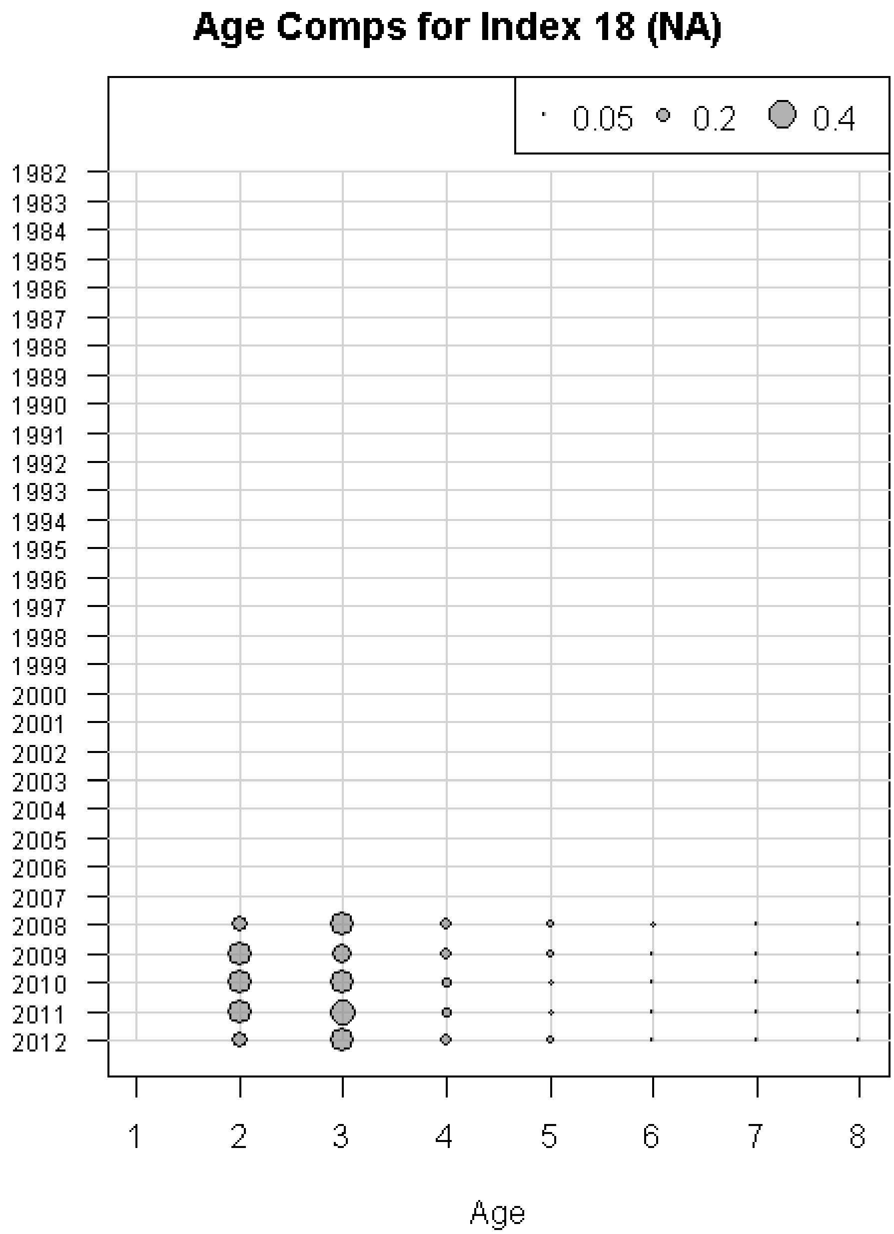


Figure A230. Age composition residuals for the VIMS NEAMAP spring trawl survey in run F57_BASE_12.

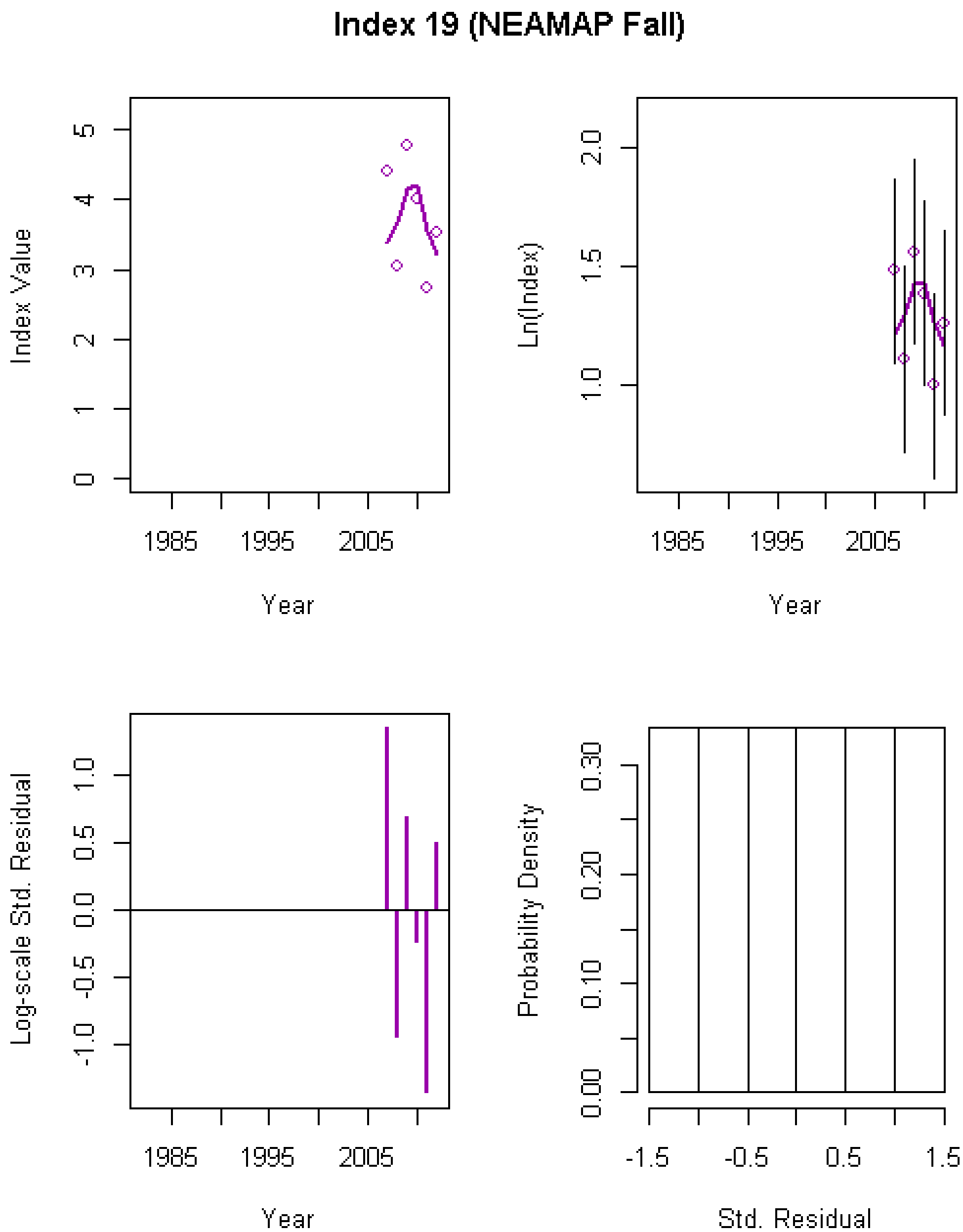


Figure A231. Fit diagnositics for the VIMS NEAMAP fall trawl survey in run F57_BASE_12.

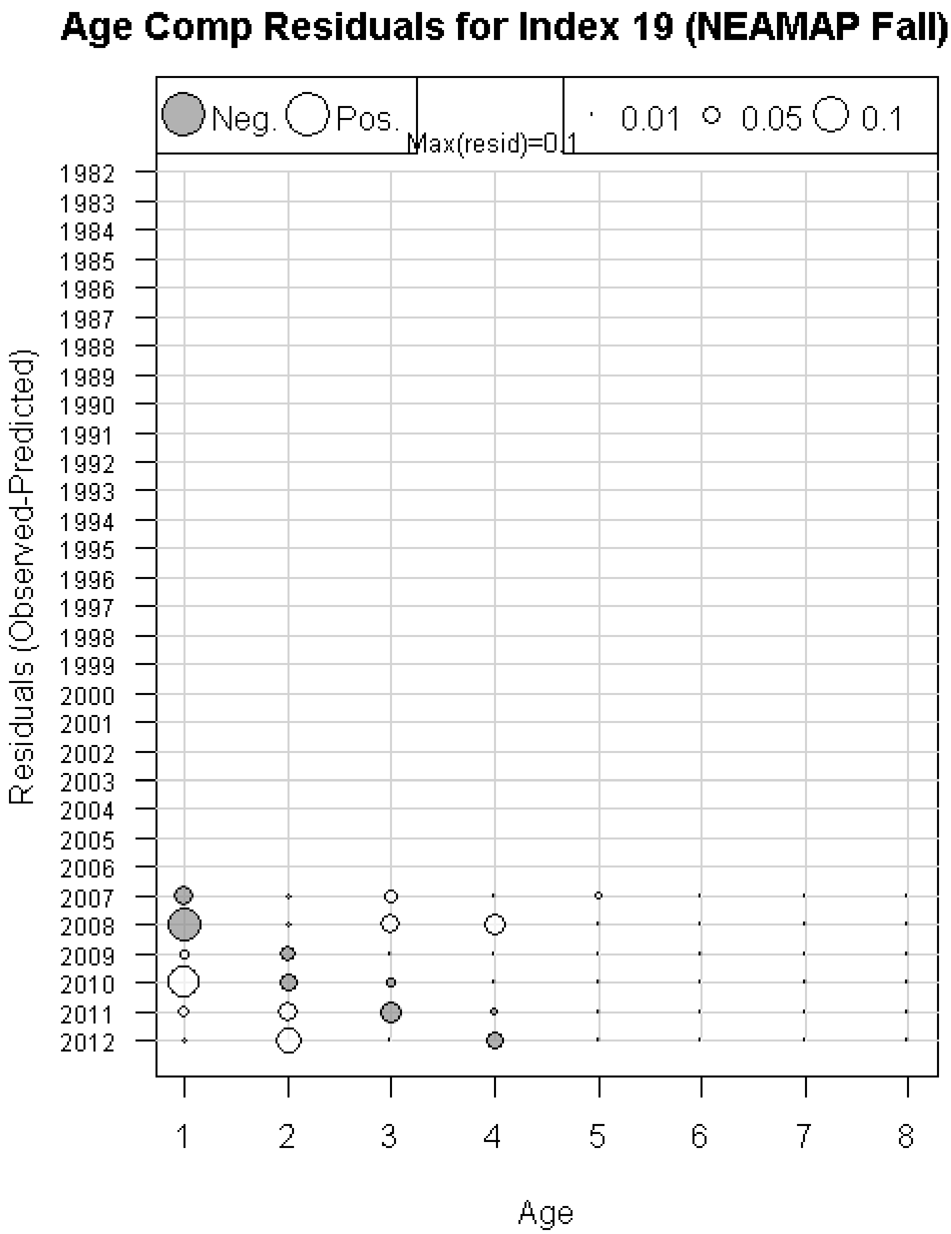


Figure A232. Age composition residuals for the VIMS NEAMAP fall trawl survey in run F57_BASE_12.

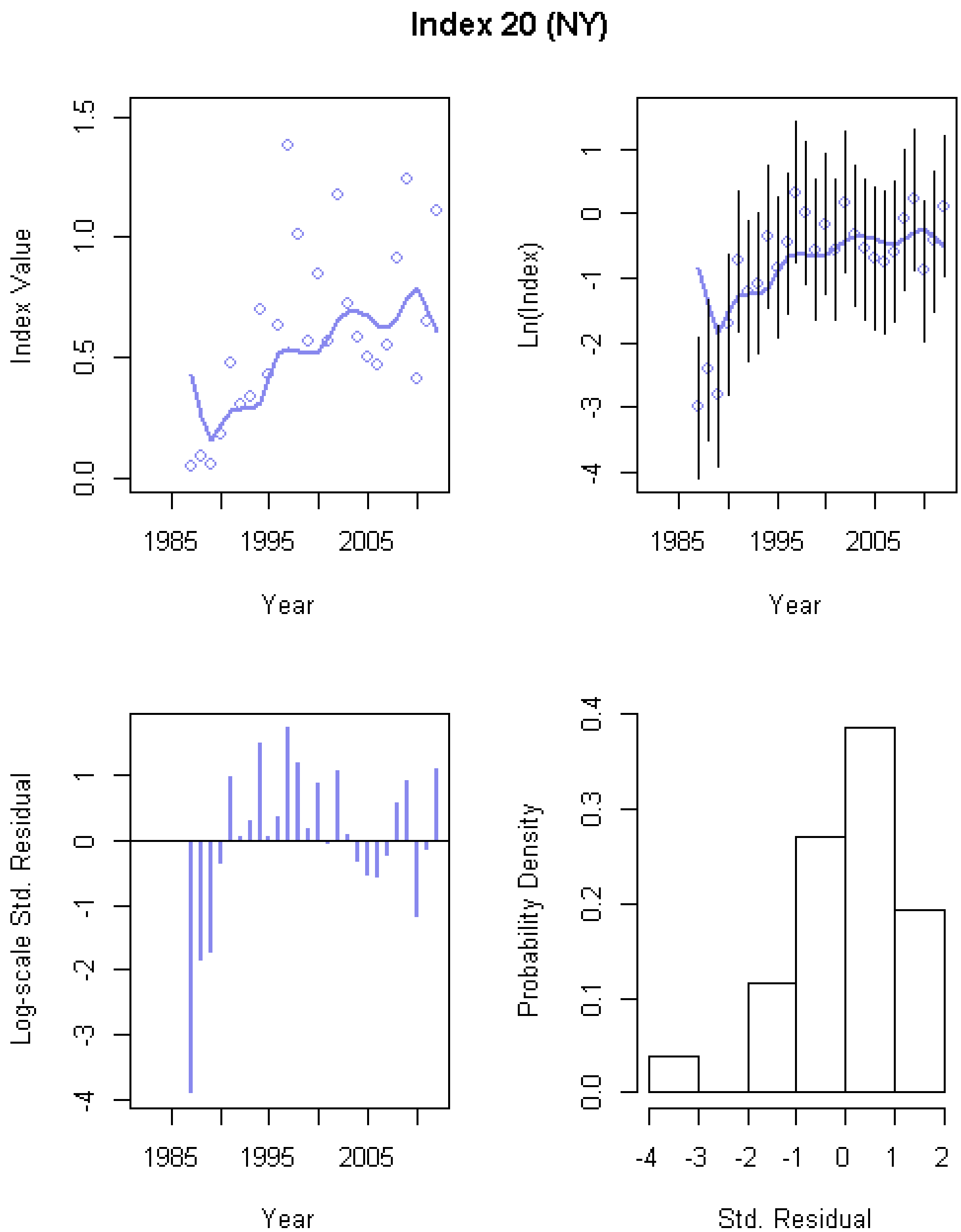


Figure A233. Fit diagnositics for the NYDEC trawl survey in run F57_BASE_12.

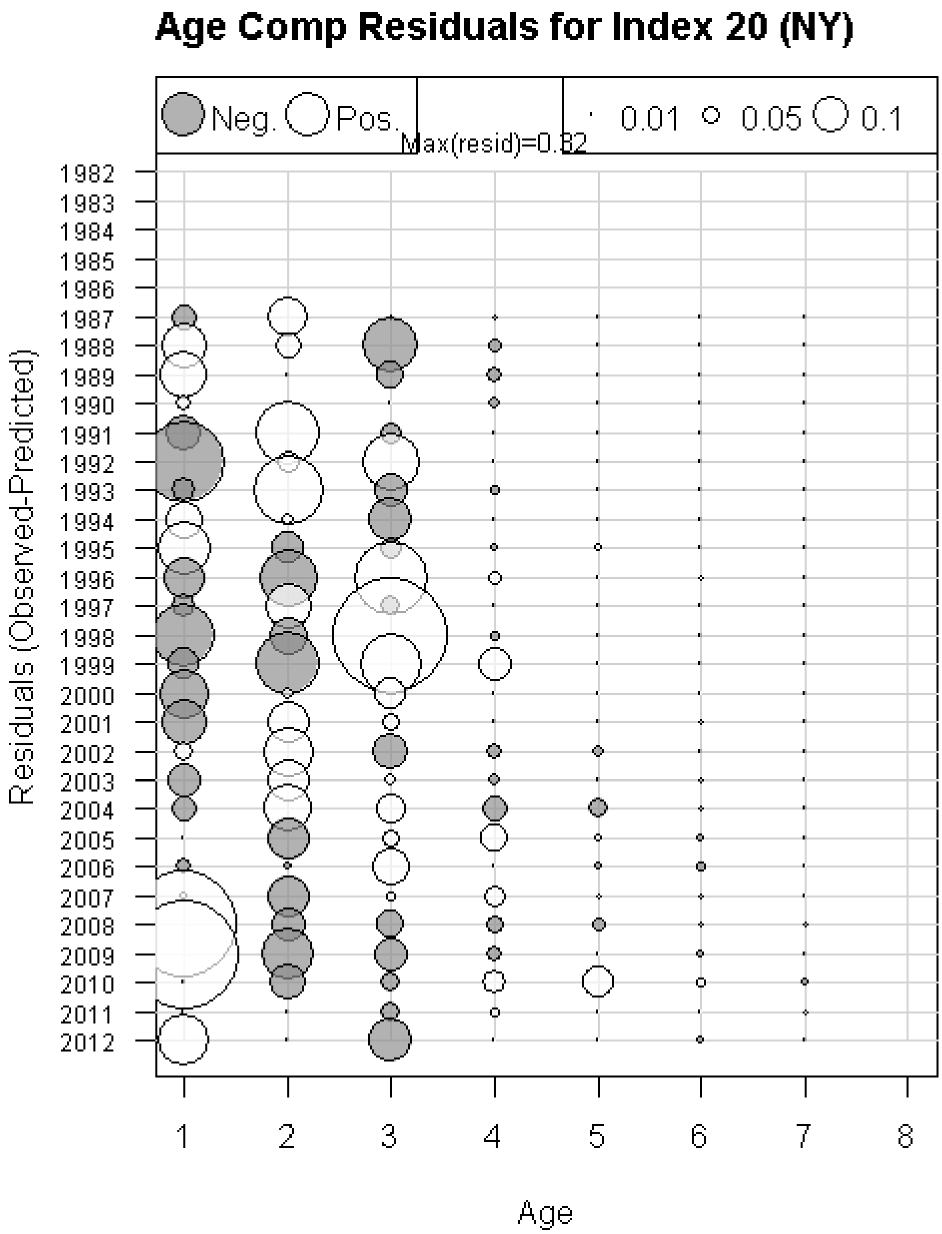


Figure A234. Age composition residuals for the NYDEC trawl survey in run F57_BASE_12.

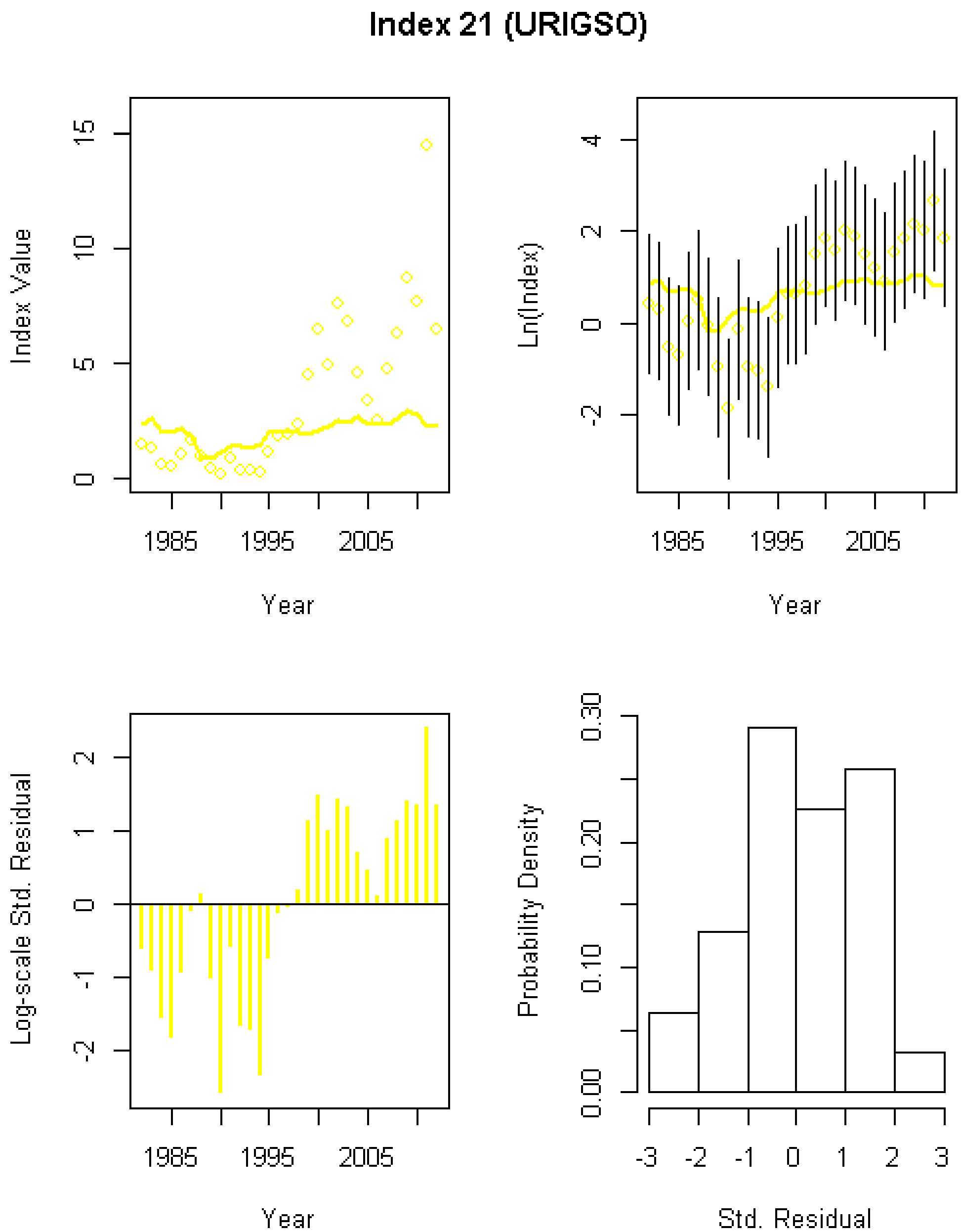


Figure A235. Fit diagnositics for the URIGSO trawl survey in run F57_BASE_12.

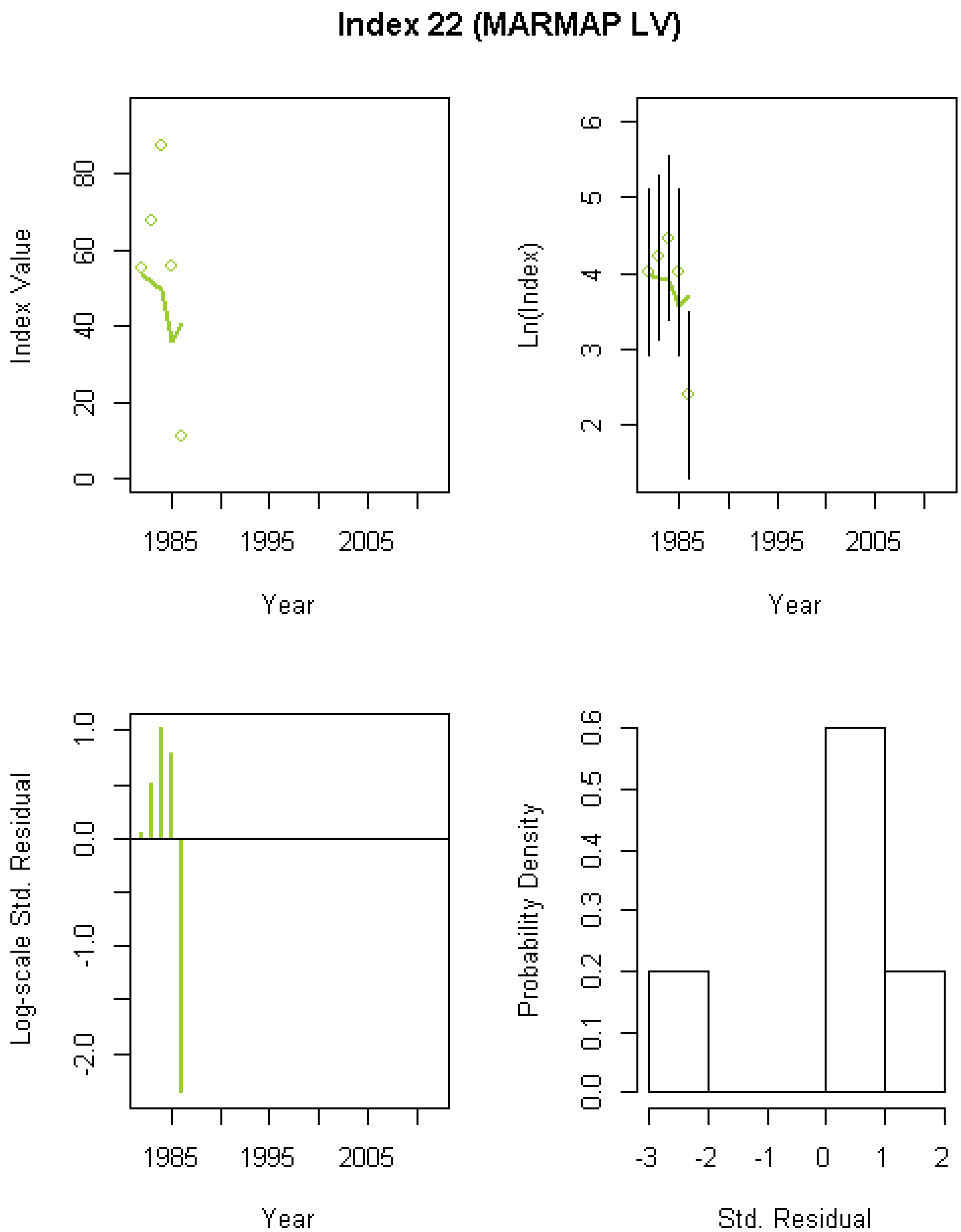


Figure A236. Fit diagnositics for the NEFSC MARMAP larval survey in run F57_BASE_12.

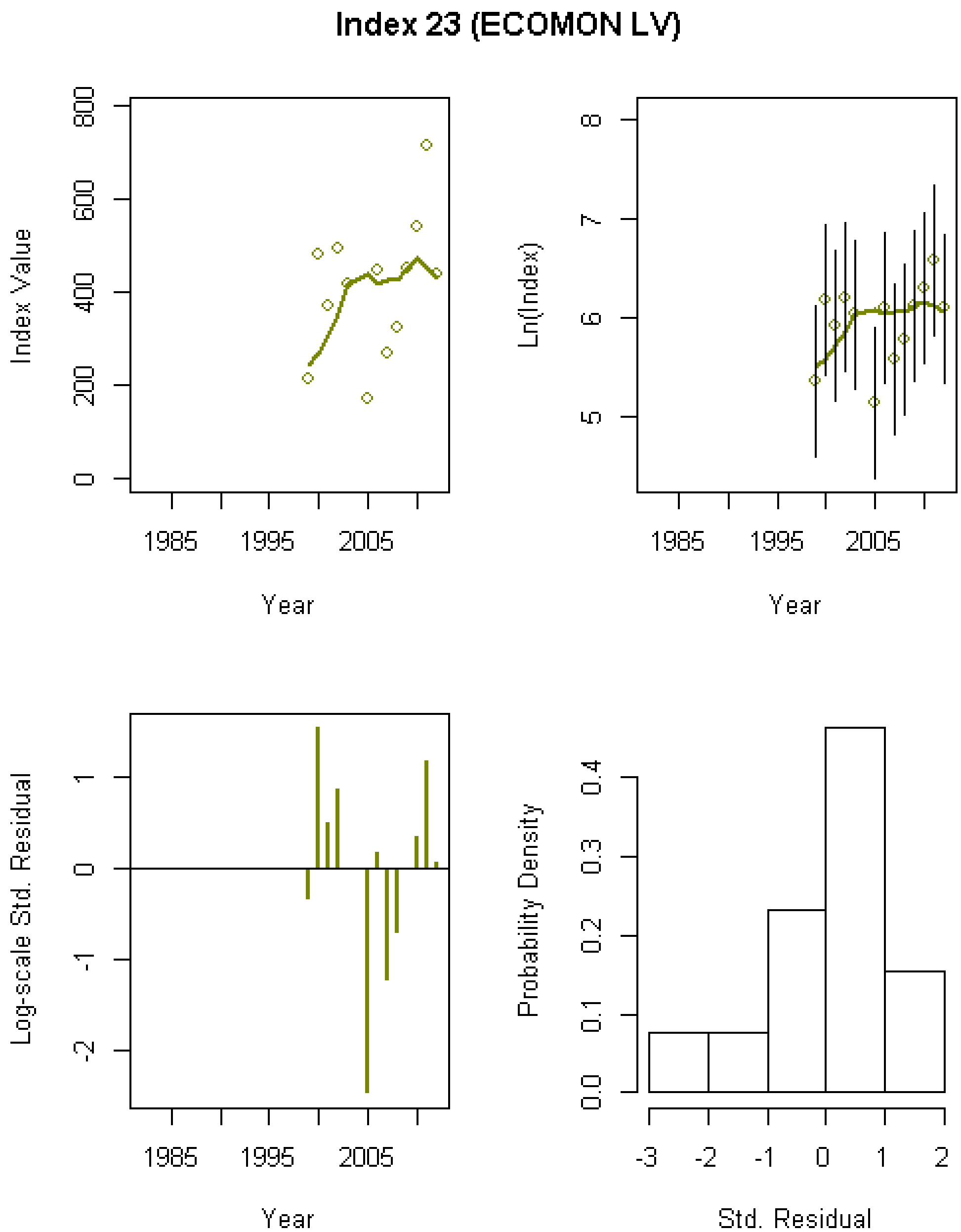


Figure A237. Fit diagnositics for the NEFSC ECOMON larval survey in run F57_BASE_12.

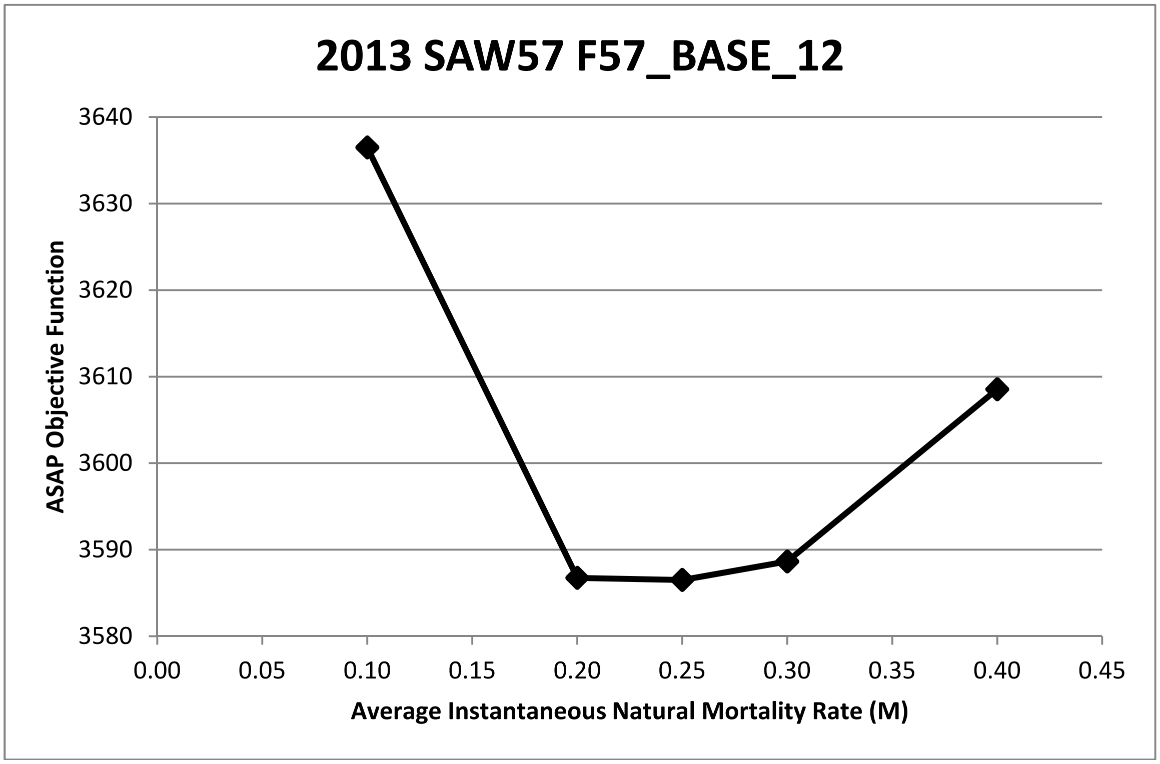


Figure A238. Likelihood profile for run F57_BASE_12 over average M values from 0.10 to 0.40.

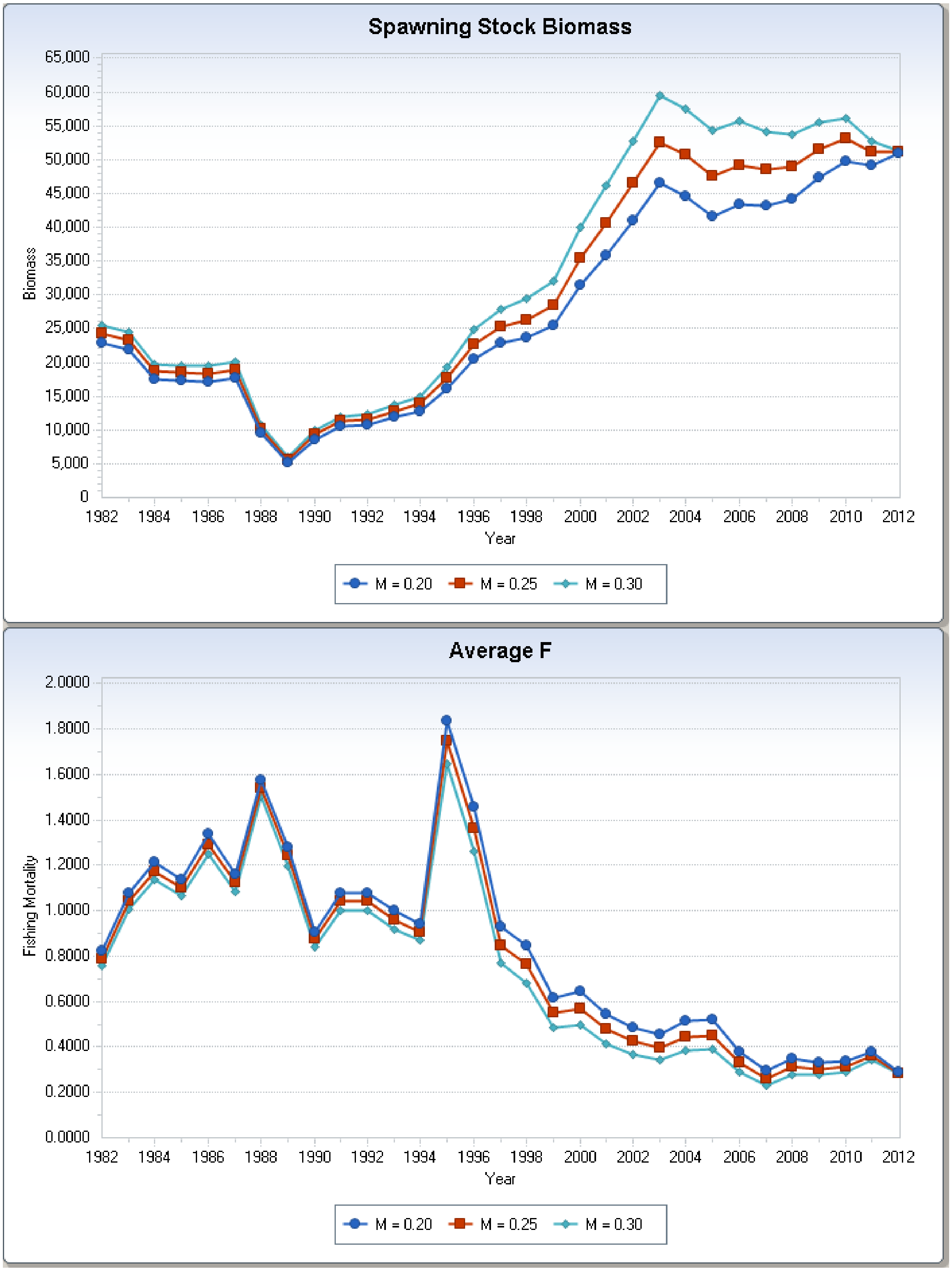


Figure A239. Results for SSB and F for sensitivity runs with average M = 0.2 and 0.3, bracketing run F57_BASE_12 with average M = 0.25.

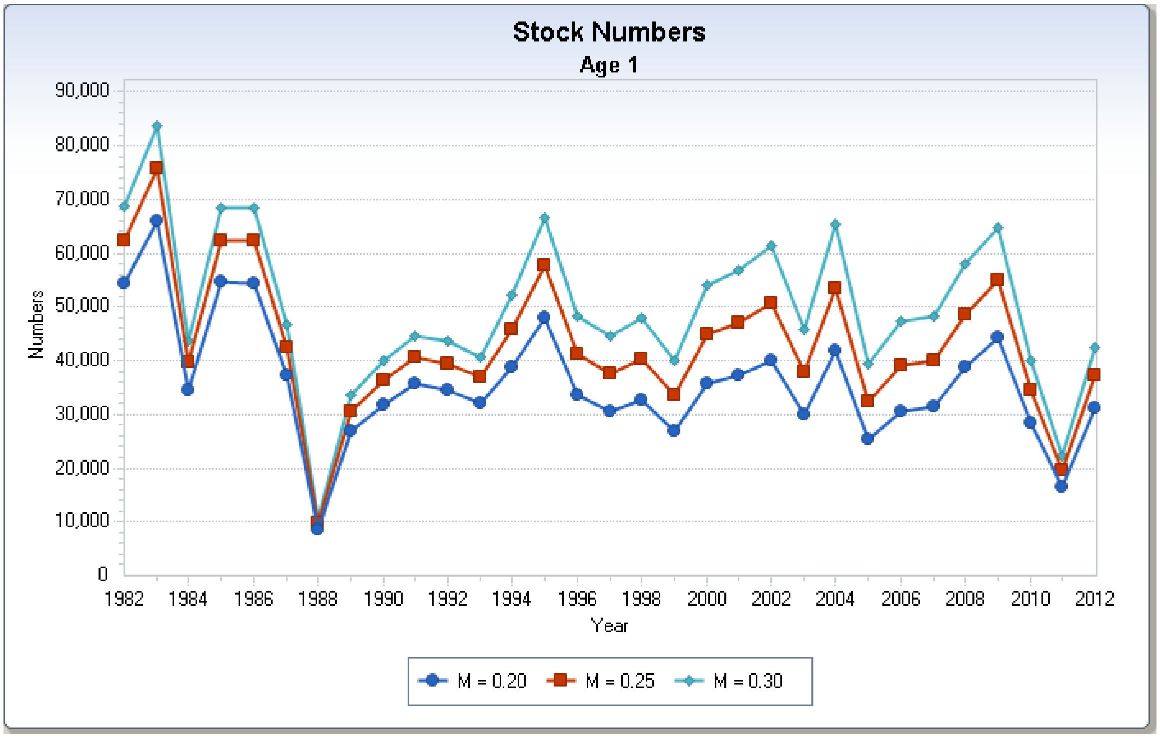


Figure A240. Results for recruitment at age 0 (model age 1) for sensitivity runs with average M = 0.2 and 0.3, bracketing run F57_BASE_12 with average M = 0.25.

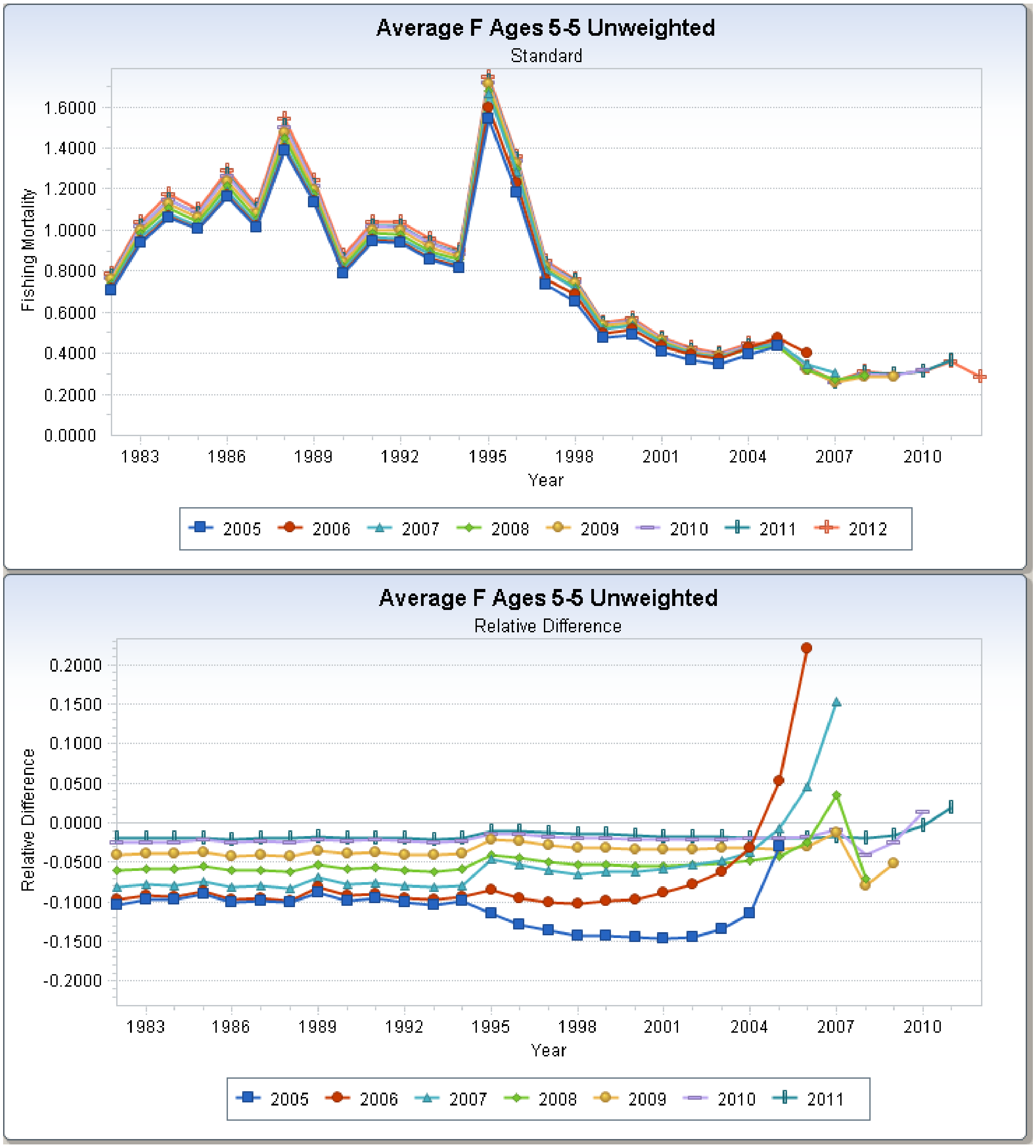
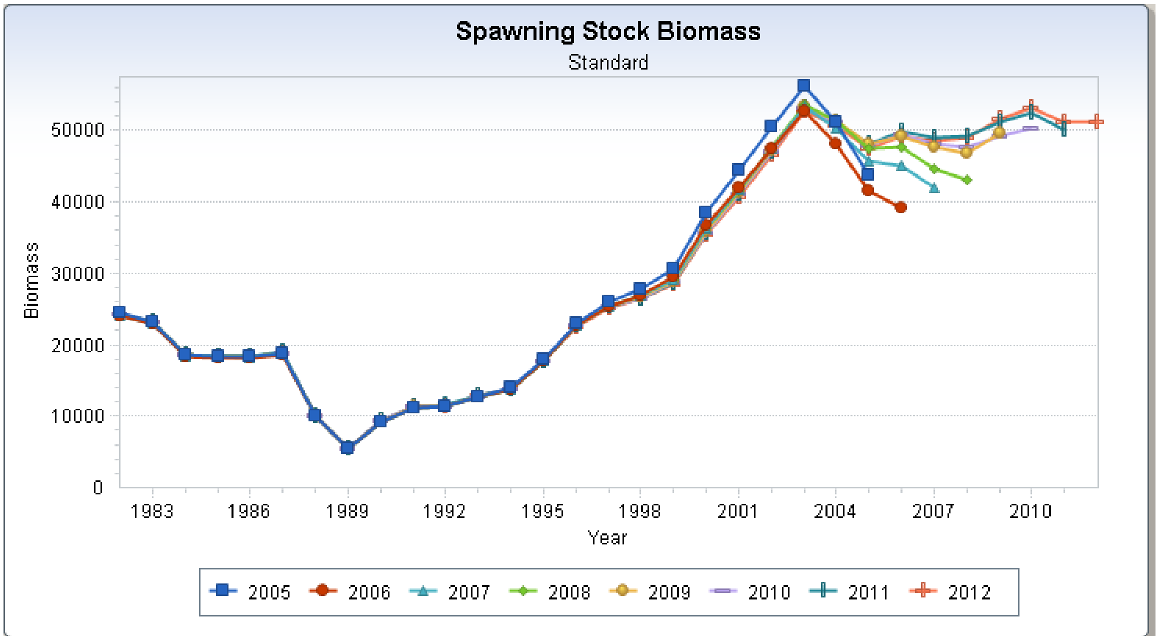


Figure A241. Retrospective analysis of fishing mortality rate (F, age 4). Note that model age 5 is true age 4.



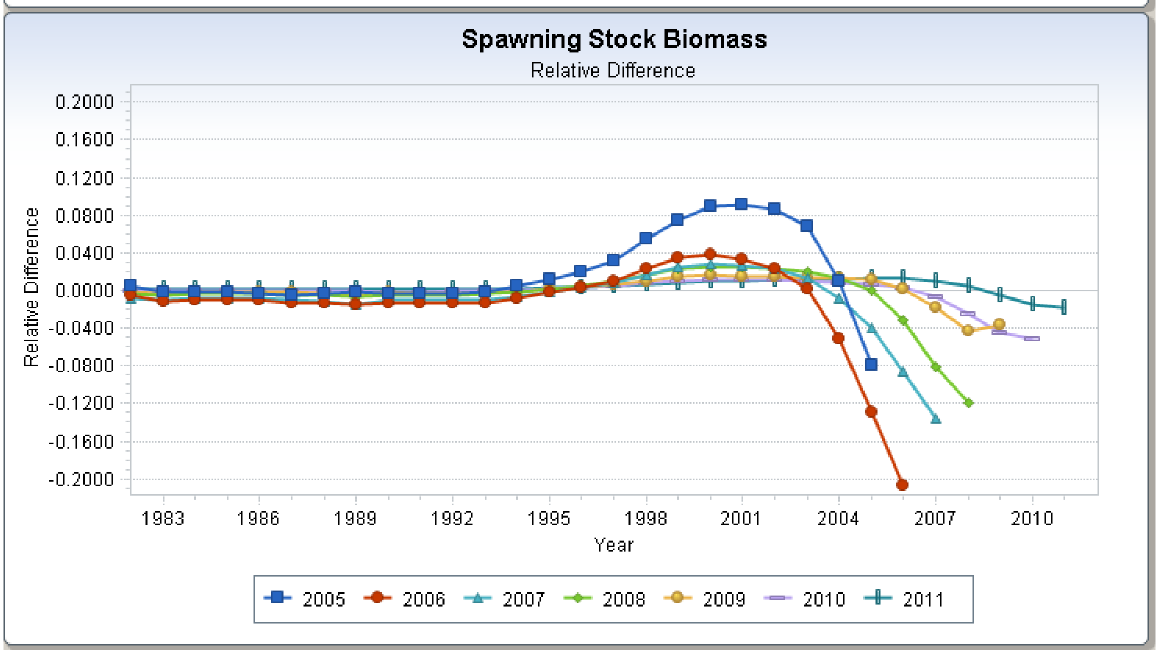
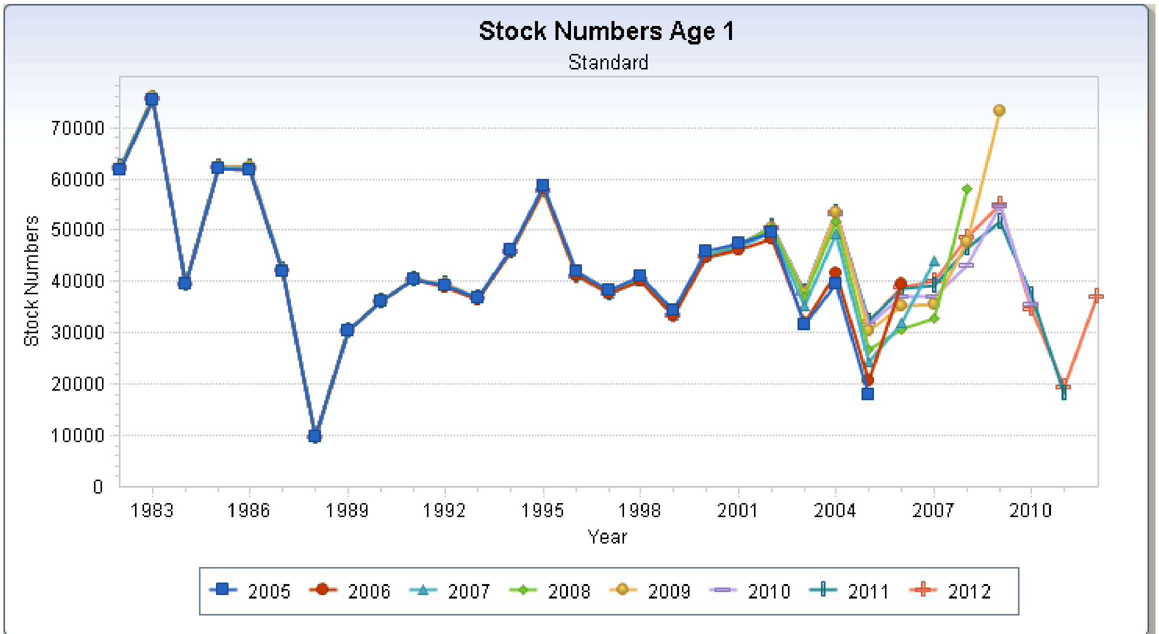


Figure A242. Retrospective analysis of Spawning Stock Biomass (SSB).



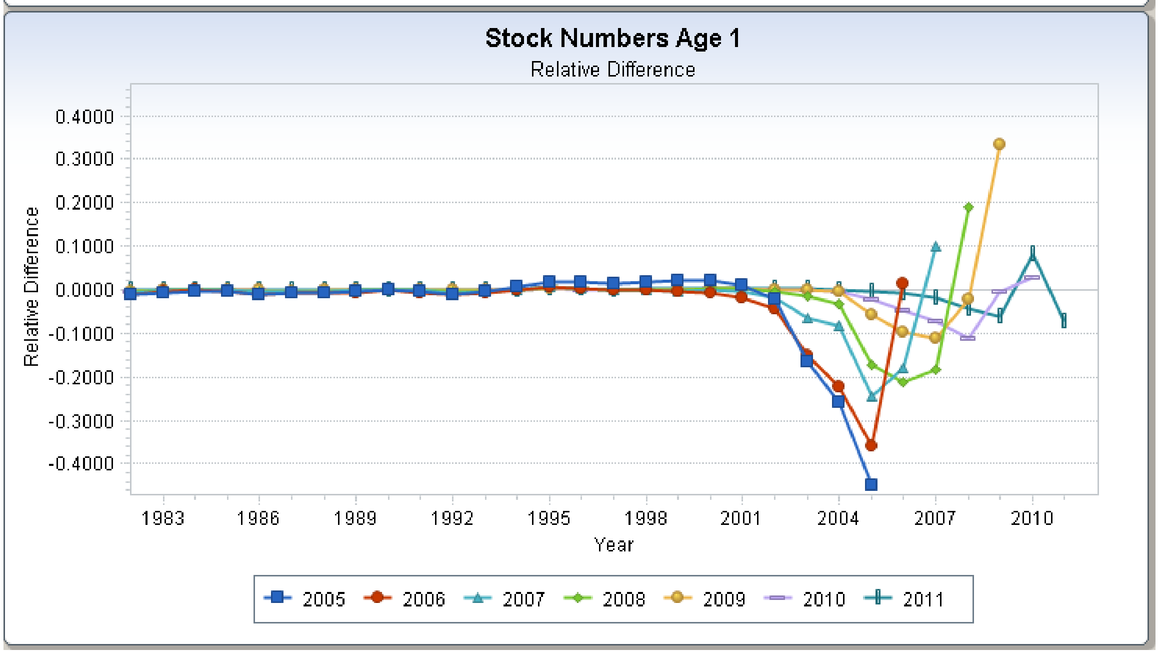


Figure A243. Retrospective analysis of recruitment at age 0. Note that model age 1 is true age 0.

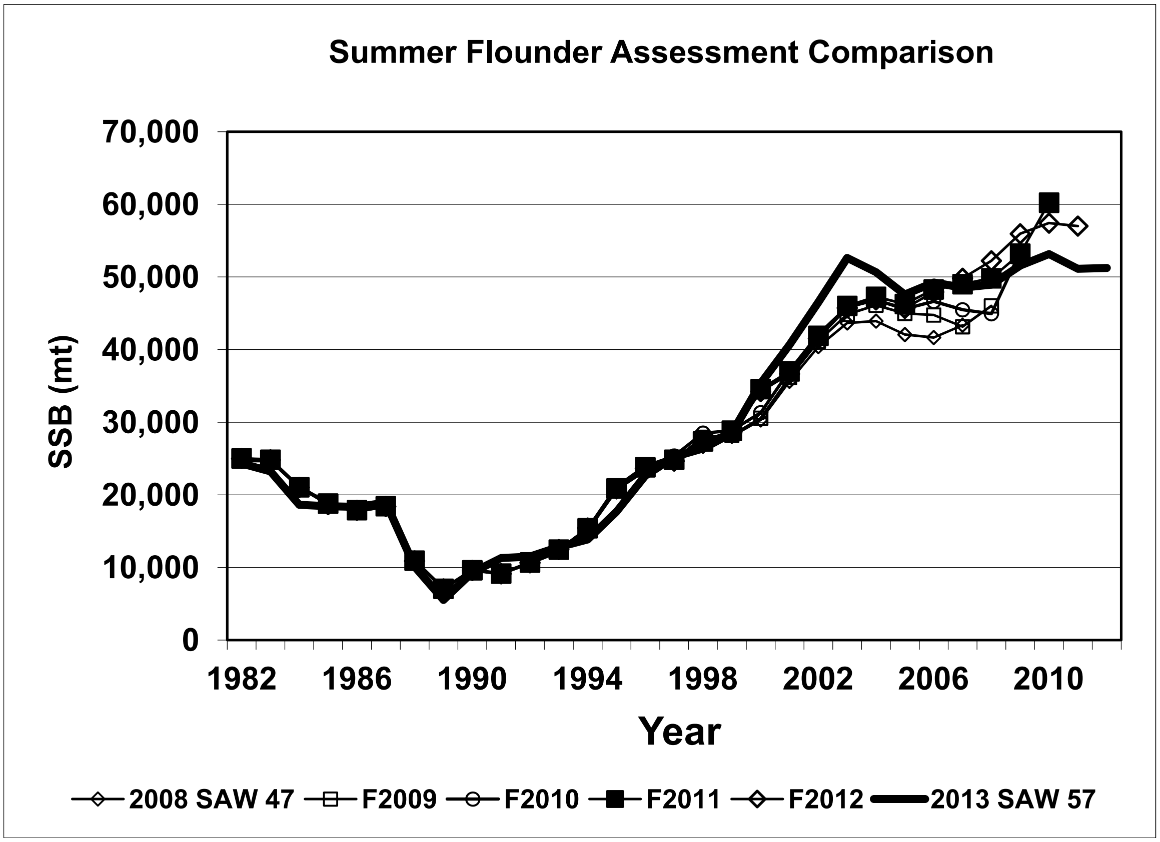


Figure A244. Estimates of Spawning Stock Biomass (SSB) for the 2008-2012 stock assessments compared with the 2013 SAW 57 results.

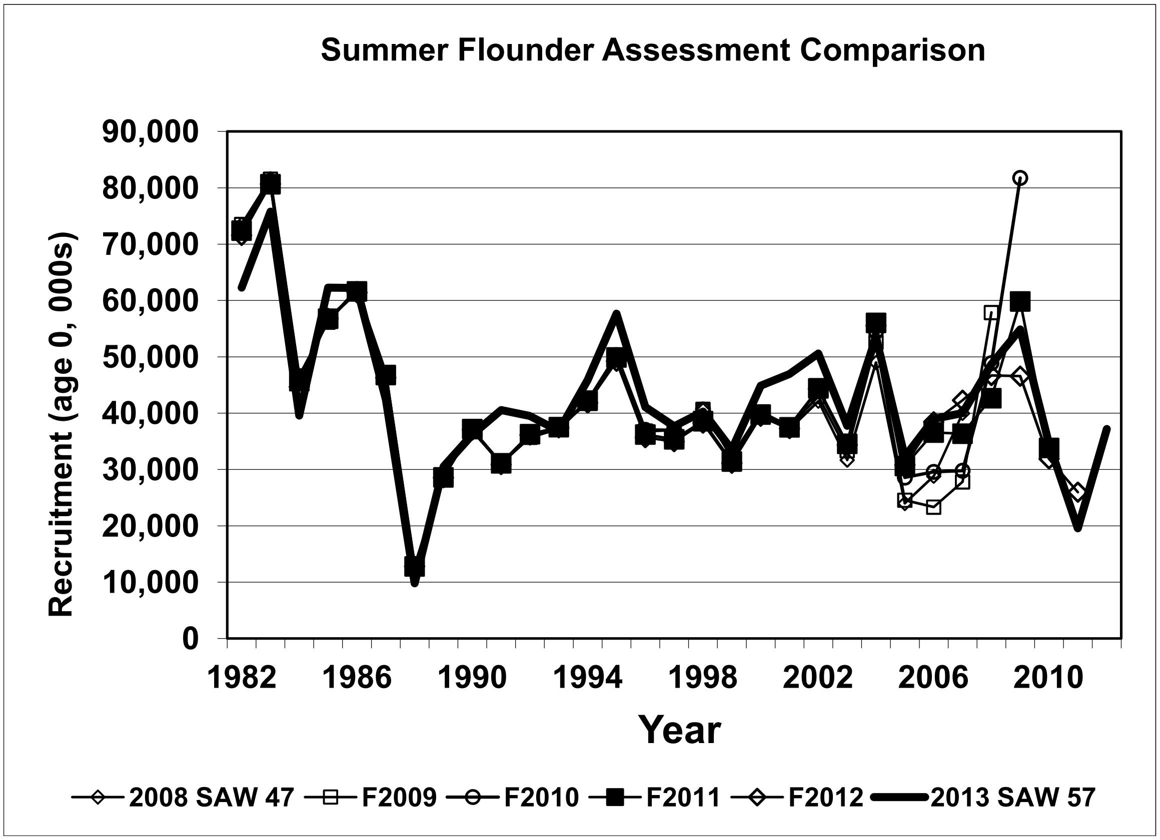


Figure A245. Estimates of recruitment at age 0 for the 2008-2012 stock assessments compared with the 2013 SAW 57 results.

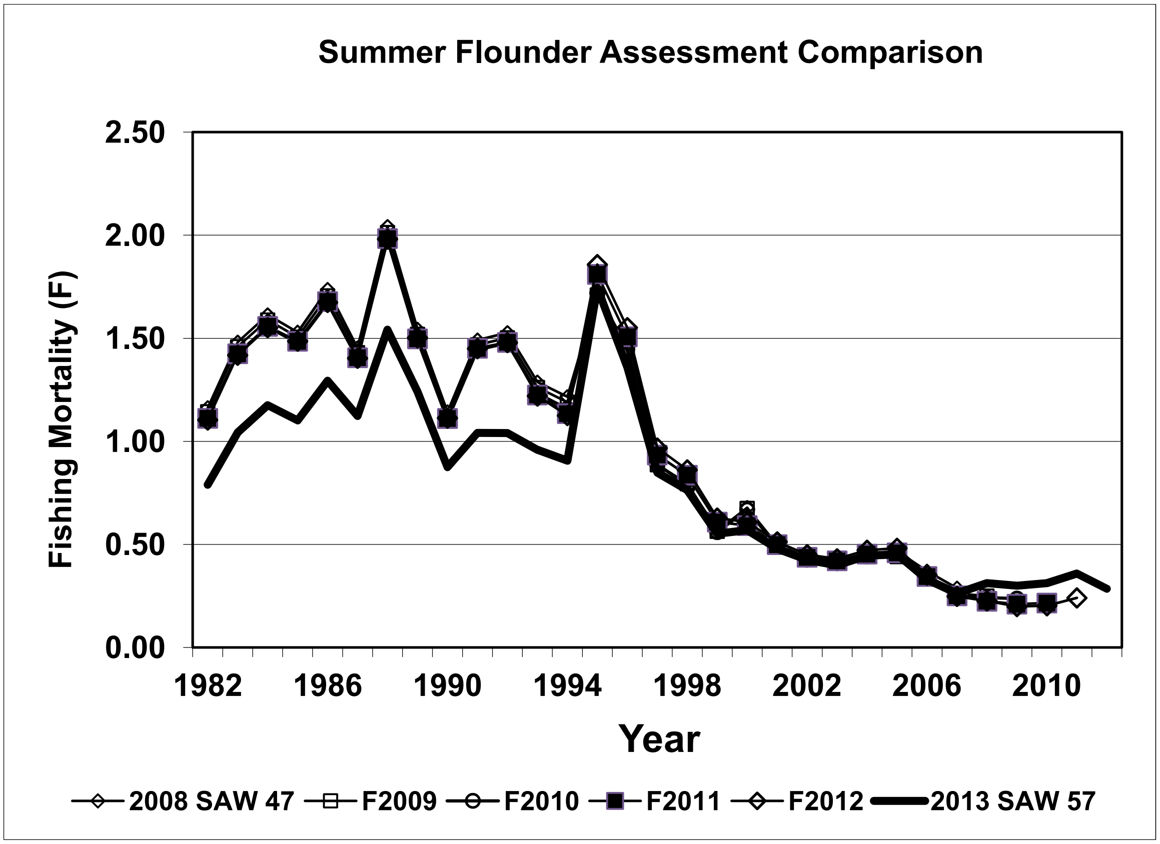


Figure A246. Estimates of fishing mortality (F) for the 2008-2012 stock assessments compared with the 2013 SAW 57 results. Note that for the 2008-2012 assessments F is reported for ages 3-7+, while in the 2013 SAW 57 assessement F is reported for age 4.

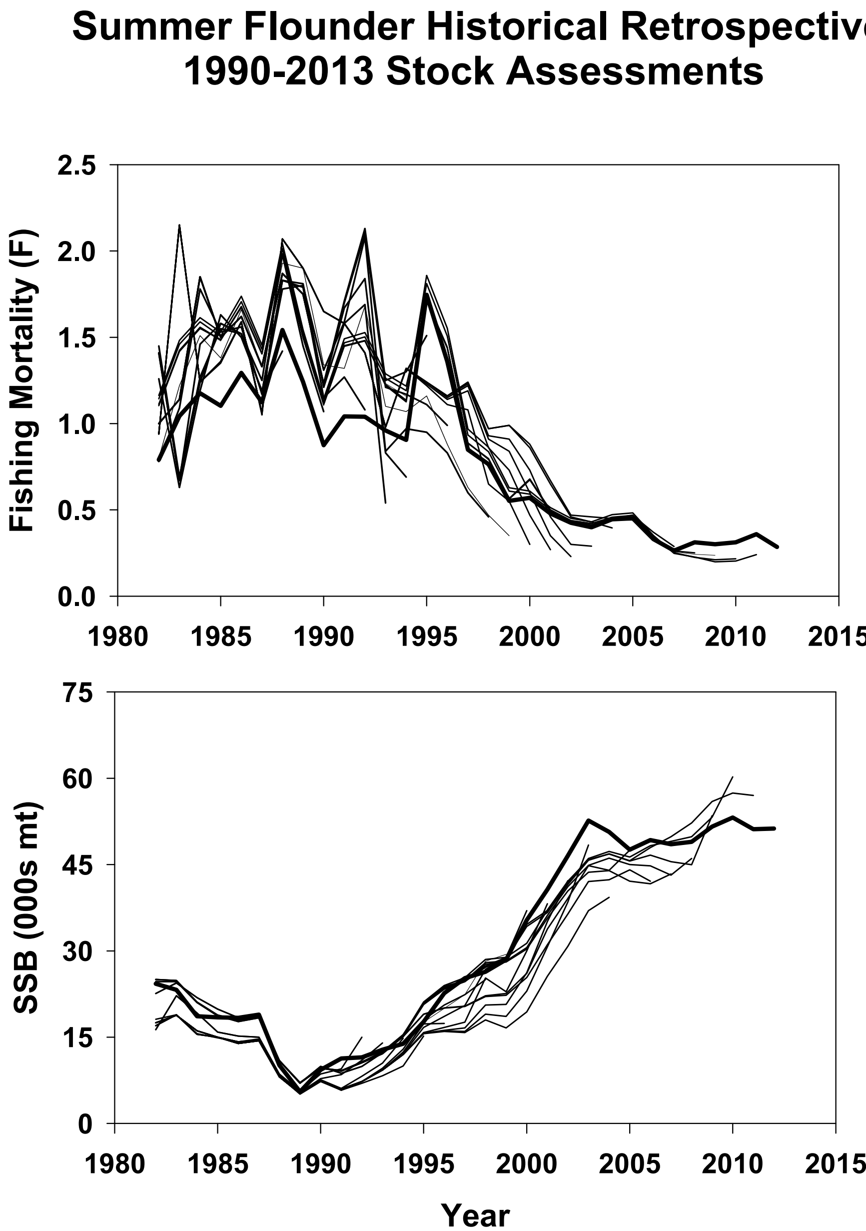


Figure A247. Historical retrospective of the 1990-2013 stock assessments of summer flounder. Note that for the 1990-2007 assessments F is reported for ages 2-7+, for the 2008-2012 assessments F is reported for ages 3-7+, while in the 2013 assessment F is reported for age 4.

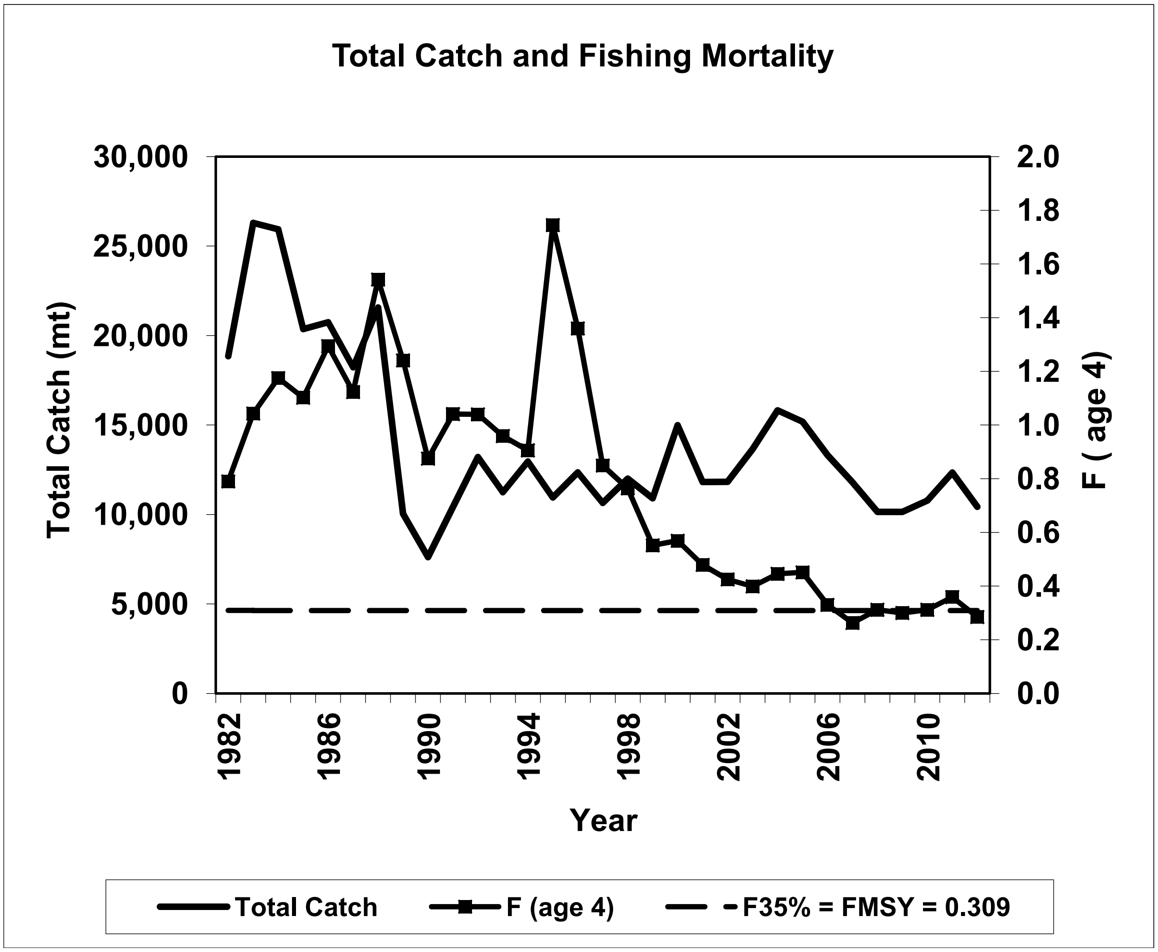


Figure A248. Total fishery catch and fully-recruited Fishing Mortality (F, peak at age 4). The horizontal dashed line is the 2013 SAW 57 fishing mortality reference point proxy.

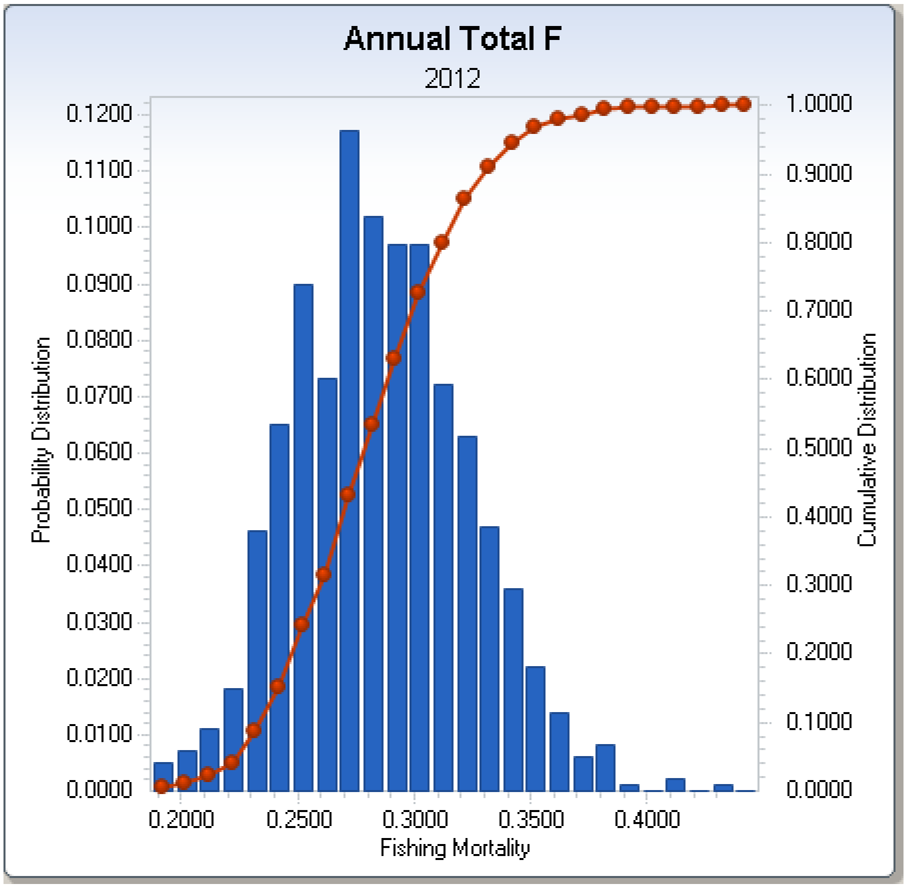


Figure A249. MCMC distribution of fishing mortality rate in 2012 (F, age 4).

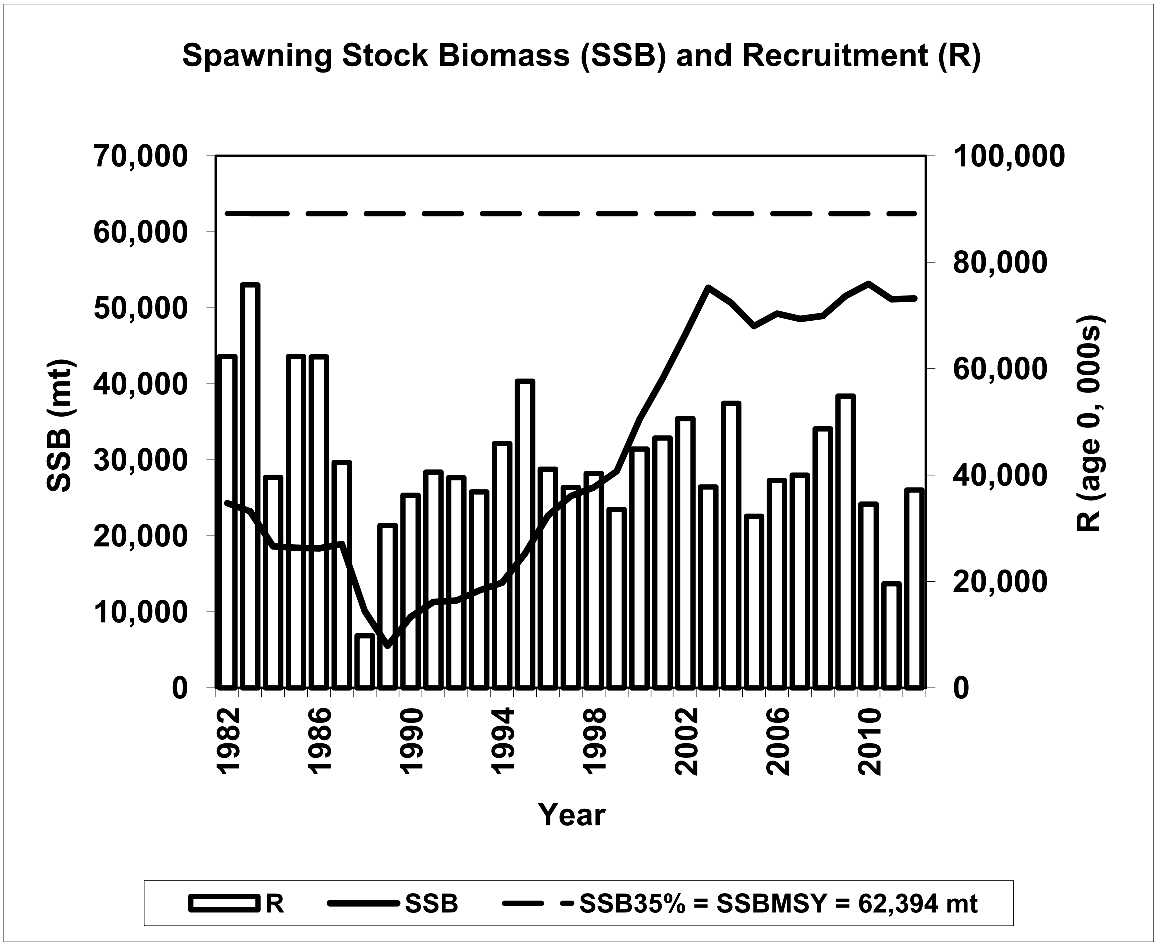


Figure A250. Spawning Stock Biomass (SSB; solid line) and Recruitment at age 0 (R; vertical bars) by calendar year. The horizontal dashed line is the 2013 SAW 57 biomass reference point proxy.

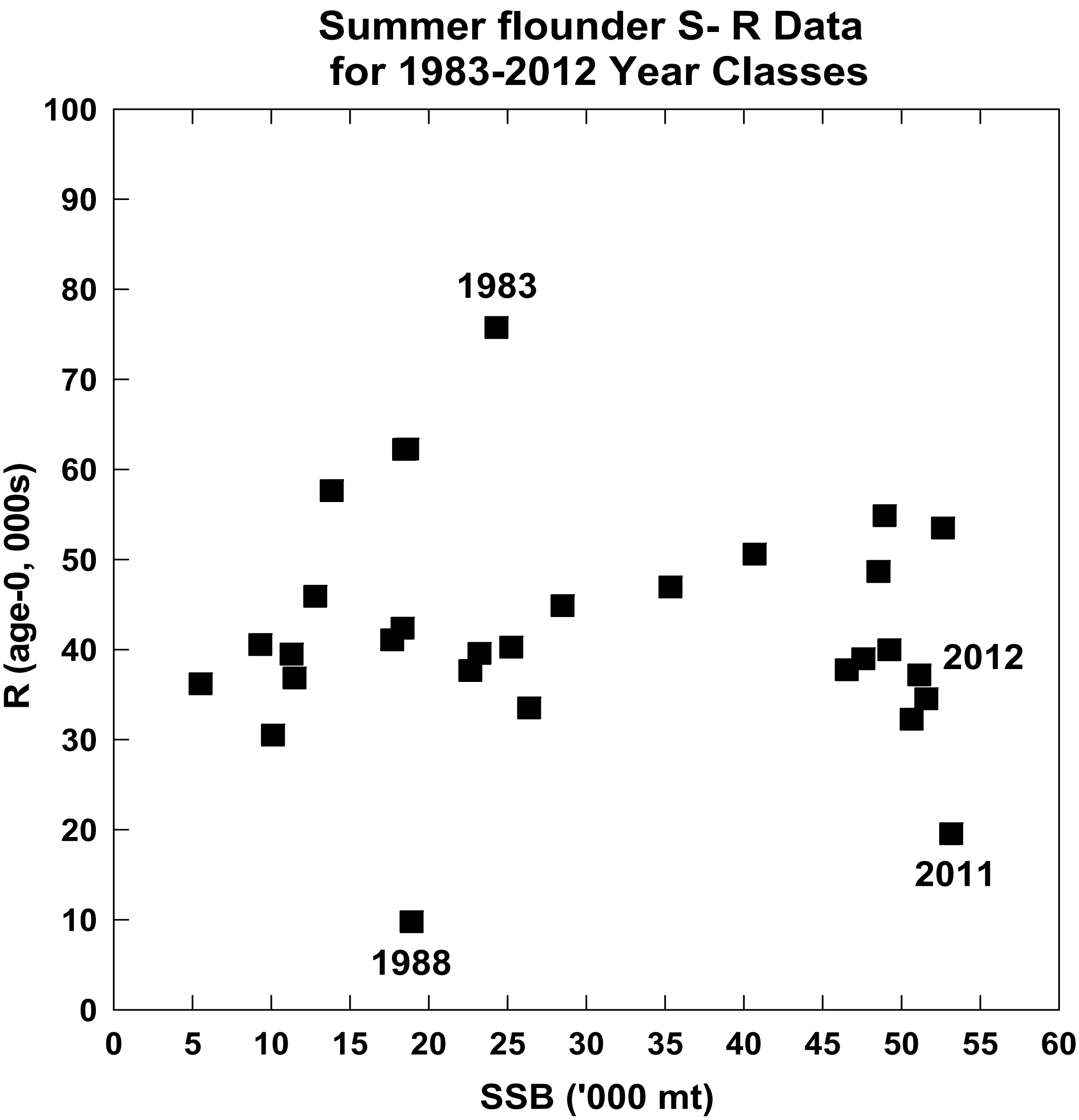


Figure A251. Stock-recruitment scatter plot for the summer flounder 1983-2012 year classes. Highest recruitment point is the 1983 year class (R = 75.5 million, SSB = 24,300 mt); highest SSB point is for the 2011 year class (R = 19.6 million, SSB = 53,156 mt). The 2012 year class is at R = 37.2 million, SSB = 51,129 mt.

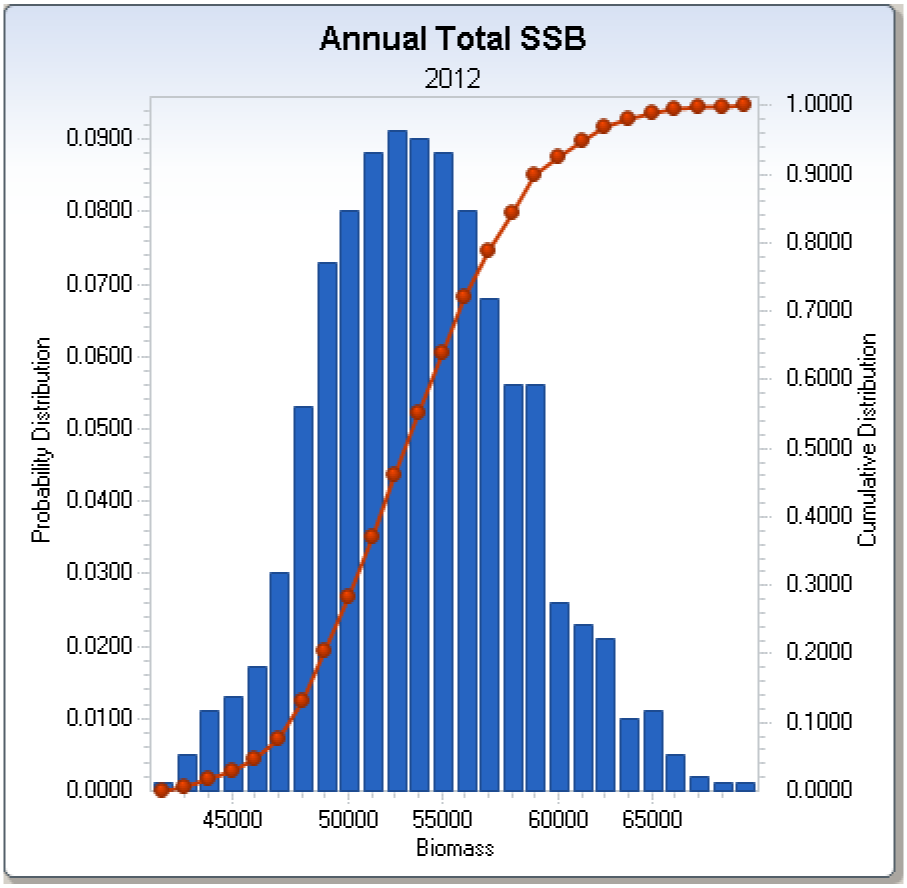


Figure A252. MCMC distribution of Spawning Stock Biomass (SSB) in 2012.

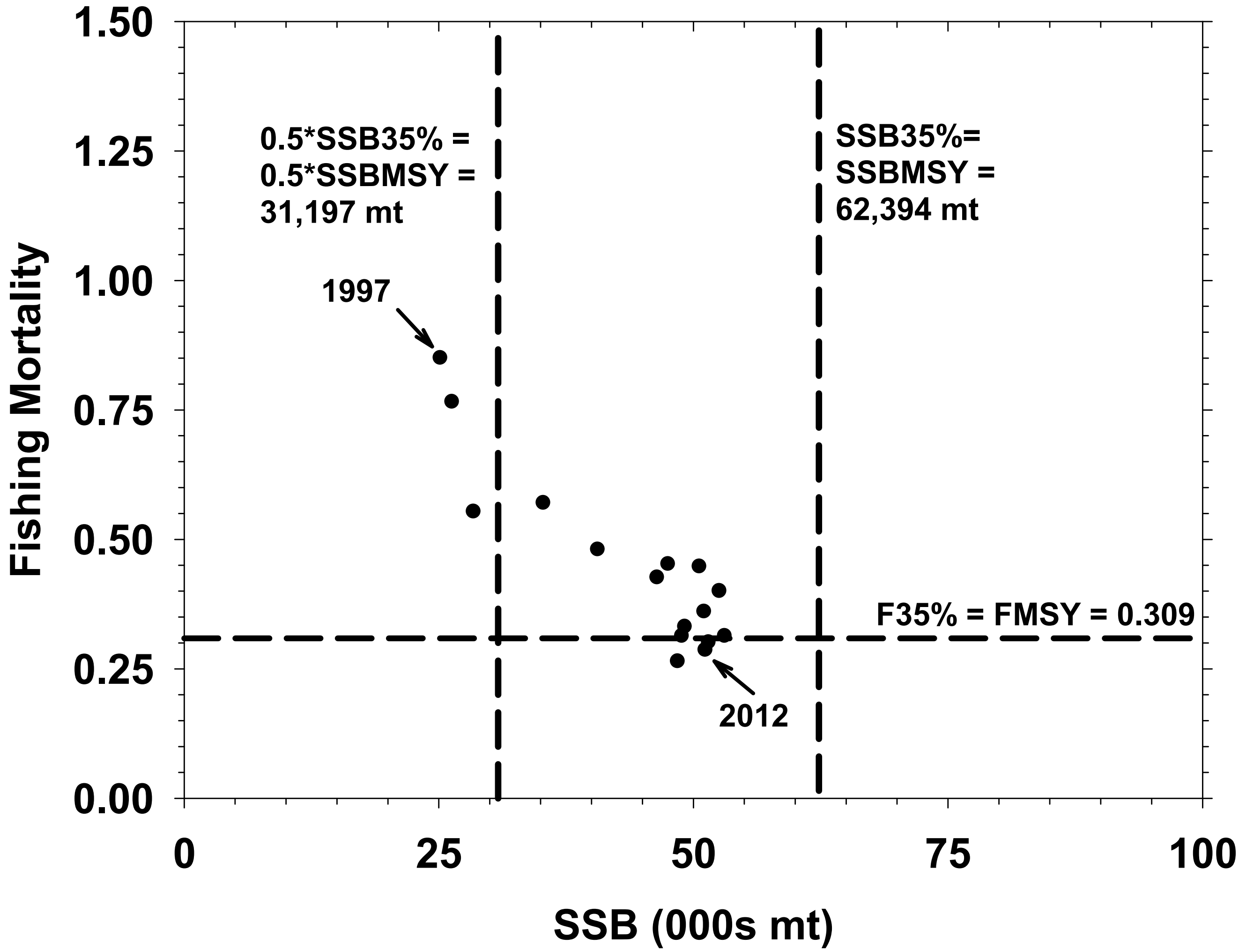


Figure A253. Estimates of summer flounder Spawning Stock Biomass (SSB) and fully-recruited Fishing Mortality (F, peak at age 4) relative to the 2013 SAW 57 biological reference points.