A1. SOUTHERN NEW ENGLAND - MID ATLANTIC YELLOWTAIL FLOUNDER

INTRODUCTION

Yellowtail flounder, *Limanda ferruginea,* inhabit relatively shallow waters (20-100 m) of the northwest Atlantic from Labrador to Chesapeake Bay (Bigelow and Schroeder 1953, Scott and Scott 1988, Collette and Klein-MacPhee 2002). A fishery for yellowtail flounder developed off southern New England in the 1930s, coincident with the increased use of otter trawls, a decline in winter flounder abundance, and demand for food products during World War II (Scott 1954, Royce *et al.* 1959).

The available information on yellowtail flounder stock structure off the northeast U.S. indicates separate stocks on Georges Bank, off Cape Cod, and from southern New England to the Mid-Atlantic Bight. Distributional analyses indicate a relatively continuous distribution from the Mid Atlantic Bight to Nantucket Shoals, a concentration on Georges Bank, and a relatively separate concentration off Cape Cod (Royce *et al.* 1959). Geographic patterns of landings over time suggest that yellowtail resources on Georges Bank on off southern New England are separate harvest stocks (McBride and Brown 1980). Geographic variation indicates that yellowtail off Cape Cod comprise a separate phenotypic stock than resources to the south (Begg et al. 1999). Tagging data indicate less than 3% dispersion from Cape Cod, Georges Bank and southern New England fishing grounds, but substantial movement from the Mid Atlantic to southern New England (Royce et al. 1959, Lux 1963). Descriptive information on early life history stages and circulation patterns suggest that yellowtail spawn in hydrographic retention areas, but there may be some advection of eggs and larvae from Georges Bank and Cape Cod to southern New England and the Mid Atlantic Bight (Sinclair 1988). In conclusion, yellowtail flounder on Georges Bank appear to be a separate harvest stock, yellowtail off Cape Cod can be considered a separate phenotypic stock (with some question on the northern boundary of the stock area), but there is little evidence supporting separate stocks in southern New England and the Mid Atlantic Bight.

<u>Management History</u>

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

Following the implementation of the Magnuson Fisheries Conservation and Management Act (FCMA) in 1976, U.S. yellowtail resources have been managed by the New England Fisheries Management Council (Table A1.1). Groundfish regulations included minimum cod end mesh size, minimum fish size, seasonal area closures, mandatory reporting, trip limits and annual quotas. Minimum size for yellowtail was increased from 28cm in 1982 to 30cm in 1986 and 33cm in 1989. Minimum mesh size increased from 140 mm in 1991 (diamond and square mesh) to 140mm diamond-152mm square in 1994 and to 165mm in 1999. A large area south of Nantucket Shoals was closed to fishing since December 1994. Scallop dredge vessels were limited to possession of 136kg of yellowtail flounder since 1996, and in 1999 minimum twine top mesh was increased from 203mm to 254mm to reduce yellowtail bycatch.

Assessment History

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

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

Assessment methods used for southern New England yellowtail progressed to a calibrated VPA in the late 1980s. The 1988 assessment indicated high F in the 1970s and early 1980s and a strong 1980 cohort (F=0.60-1.48; NEFC 1989). Later stock assessments showed another dominant cohort spawned in 1987, but F continually increased through the 1980s, and the stock was depleted to record low biomass in the early 1990s (Conser et al. 1991, Rago et al. 1994). The VPA-based assessment of southern New England yellowtail was updated annually from 1997 to 1999, and assessments indicated a reduction in F in the late 1990s, but little rebuilding of stock biomass (NEFSC 1997, 1998; Cadrin 2000). In 2000, an updated VPA was attempted, but was rejected as a basis for management advice because sampling in 1999 was inadequate to estimate catch at age reliably (Cadrin 2001b). Therefore, recent assessments of southern New England yellowtail have been based on projections of observed catch from the 1999 VPA (Cadrin 2001b, NEFSC 2002). An updated assessment of the southern New England yellowtail flounder stock was prepared

[1] Although Lux (1967) is titled, "Landings per unit effort, age composition and total mortality of yellowtail flounder (*Limanda ferruginea*) in subarea 5Z," the southern New England analyses also include catch and effort data from statistical area 6.

concurrently with this assessment for the Groundfish Assessment Review Meeting (Cadrin 2002b).

An analytical assessment of Mid Atlantic yellowtail flounder has not been developed, and management advice has been based on descriptive summaries of landings and survey data. Assessments of the Mid Atlantic yellowtail resource indicated similar trends in catch and survey indices as in southern New England (NEFC 1987, 1988; NEFSC 1991, 1992, 1993; Rago 1995; Overholtz and Cadrin 1998). Based on survey biomass and exploitation ratios, the Mid Atlantic yellowtail resource was 2% of the B_{MSY} proxy, and the exploitation rate greatly exceeded the F_{MSY} proxy (Cadrin 2001a). An updated assessment of the Mid Atlantic yellowtail flounder stock was prepared concurrently with this assessment for the Groundfish Assessment Review Meeting (Cadrin 2002a).

FISHERY DATA

Commercial Landings

Commercial statistics for southern New England yellowtail flounder are from statistical areas 526, 537, 538, and 539, and mid Atlantic yellowtail are from statistical areas 611-623 (Figure A1.1). U.S. commercial landings of yellowtail flounder were derived from dealer weighout reports and canvas data according to historical assessment reports (Royce et al. 1959, Brown and Hennemuth 1971, Sissenwine et al. 1978, McBride et al. 1980, McBride and Clark 1983, NEFC 1986, McBride 1989, Rago et al. 1994). Total Mid Atlantic landings from canvas data were allocated to market category according to annual proportions in the weighout database. Previous to 1994, landings were allocated to statistical area, month, and gear type according to interview data collected by port agents (Burns et al. 1983). For 1994, landings reported by dealers were allocated to stock area using fishing vessel logbook data, by fishing gear, port, and season (Wigley, et al. 1998). For 1995-1997, dealers' reported landings were prorated to stock area using a modified proration that included dealer codes (NEFSC 1998).

Landings generally increased in southern New England during the 1930s and early 1940s and the fishery expanded to the Mid Atlantic in the early 1940s, with landings of 28,000mt in 1942 (Table A1.2, Figure A1.2). Annual landings were around 10,000mt from 1943 to 1948 with approximately 10% from the Mid Atlantic. A domestic industrial fishery developed in the late 1940s. Landings decreased to less than 2,000mt in the mid 1950s. Landings increased in southern New England in the late 1950s and again expanded to the Mid Atlantic in the 1960s. A distant water fishery developed in the 1960s and total annual landings were greater than 20,000mt from 1963 to 1970. The industrial and foreign fisheries were discontinued in the early 1970s. Landings generally decreased since the 1970s, with temporary increases in the early 1980s and early 1990s. Landings in 1995 were a record low 200 mt, and the proportion of landings from the Mid Atlantic generally increased from approximately 10% in the early 1990s to greater than 20% (e.g., in 1997, 70% of landings in the stock area came from the Mid Atlantic). Landings slightly increased to greater than 1,000mt per year since 1999.

A summary of port samples (each consisting of approximately 100 lengths and 1 age sample per cm) are listed in Table A1.3. Landings at age were derived by geographic region, half-year and market category, when possible. Landings at age of southern New England yellowtail flounder are described in previous assessment documents (Conser et al. 1991; Rago et al. 1994; NEFSC 1997, 1998; Cadrin 2000; Cadrin 2002b). Mid Atlantic landings were not sampled in several half-year periods, and age distributions of southern New England landings were assumed for Mid Atlantic landings in those periods by quarter and market category (2nd half of 1975, 2nd half of 1981, 2nd half of 1986, 2nd half of 1987, 2nd half of 1988, 1st half of 1989, 2nd half of 1990), or by half and market category for 2000 and 2001. Landings at age and landed mean weights at age are reported in Table A1.4. In the early 1970s a substantial portion of landings were from older fish (e.g., 17% of 1973 landings were age-6 or older), but the age distribution of landings rapidly truncated, and the portion of age 6+ fish has generally been less than 3% since 1977.

Discarded Catch

Estimates of discards for the southern New England – Mid Atlantic yellowtail fishery for 1963-1969 were derived from interviews with vessel captains; historical discards were approximated by Brown and Hennemuth (1971a) from the 1963-1969 average discard rate (Table A1.5). Discards for 1970-1977 were also based on interview data, however yellowtail interview data were suspect from 1978 to 1982 when trip limits were imposed (McBride et al. 1980, Clark et al. 1981). Discards during 1978-1982 were estimated from observer data when available (Sissenwine et al. 1978), derived directly from field selectivity studies (McBride et al. 1980), or from application of selectivity estimates to survey size frequencies (McBride and Clark 1983). Discards for 1983 were from interview data (Clark et al. 1984). Discards at age from southern New England, 1984-1993 were from a combination of sea sampling, interviews and survey data (Conser et al. 1991, Rago et al. 1994). Discards for 1994-2001 were derived from vessel logbooks (NEFSC 1997, 1998; Cadrin 2000). Updated discard estimates for southern New England are listed in Table A1.5a. Discards of Mid Atlantic yellowtail were from interview data for 1984-1993. Mid Atlantic discards for 1994-2001 were derived from logbook data by gear for all trips that reported discards of any species (NEFSC 1998, Table A1.5b).

Discarded catch accounted for an average of 30% of total catch annually, but appears to have decreased to approximately 10% since 1995. In 1969, discards peaked at 24,000mt, 40% of the total catch that year. A substantial portion of recent discards are from the scallop dredge fishery.

Discards at age were estimated from observer lengths (Table A1.3) and survey ages 1994-2001. Discards at age of southern New England yellowtail flounder are described in previous assessment documents (Conser et al. 1991; Rago et al. 1994; NEFSC 1997, 1998; Cadrin 2000; Cadrin 2002b). Age distribution of discards in southern New England were assumed for Mid Atlantic discards for 1973 to 1993 (Table A1.6). Discards were primarily ages 1 and 2 during from the 1970s through the early 1990s, but shifted to age 2 and 3 in the early 1990s, coincident with regulated mesh size increases.

Estimates of total catch at age reflect the landings at age in that they indicate a relatively wide age distribution in the catch in the early 1970s (e.g., approximately 10% of the catch was age-6 or older from 1973 to 1975; Figure A1.3, Appendix A). Subsequent catch at age was dominated by the 1980 and 1987 cohorts, but few fish older than age-6 contributed to the catch. Mean weights at age of older fish (age 4+) generally increased in the mid 1970s, were relatively light during the mid 1980s, and generally increased in recent years (Figure A1.4). Mean weight of age-1 yellowtail generally decreased in the 1990s, presumably from discards of small yellowtail in the scallop fishery.

ABUNDANCE AND BIOMASS INDICES

Stock Abundance and Biomass Indices

The NEFSC spring and autumn bottom trawl surveys have sampled offshore strata since 1963 and 1968, respectively (Despres et al. 1988). However, the southern–most offshore strata (61-76) were not sampled until 1967. Therefore southern strata were included in the spring survey index, 1968-2002 and the winter survey index 1992-2002 (strata 1, 2, 5, 6, 9, 10, 69, 73, 74; Figure A1.5), but excluded from the fall survey index, 1963-2001 (strata 1, 2, 5, 6, 9, 10). Nearly all yellowtail caught by the survey in the southern New England – Mid Atlantic stock area (99%) are in the spring and winter strata sets. The strata set for the NEFSC scallop survey was determined as all strata that were consistently sampled in the stock area (14, 15, 18, 19, 22-28, 30, 31, 33, 35, and 46).

Indices of abundance and biomass indicate relatively high stock size in the 1960s and early 1970s, followed by a rapid decrease in the mid 1970s (Table A1.6, Figure A1.6). Stock biomass increased temporarily in the early and late 1980s with the recruitment of the strong 1980 and 1987 cohorts. Recent distributions of yellowtail catches in surveys are illustrated in Figure A1.7. The average portion of yellowtail biomass in the Mid Atlantic region has been 45% of the total southern New England – Mid Atlantic yellowtail biomass (Figure A1.8). Age distribution of yellowtail in surveys indicates abundant cohorts in the 1960s and early 1970s, strong year classes in 1980 and 1987, and relatively truncated age structure since the early 1970s (Table A1.7, Figure A1.9).

Correspondence among survey indices was assessed using correlations among normalized observations for the VPA time series 1973-2001 [Ln(x/mean); Table A1.8]. Normalized indices of catch per tow at age are illustrated in Figure A1.10. Correlations among survey series were generally low for the winter survey, particularly for older ages, presumably because it is a short series with little contrast. Correlations between spring and fall survey series were strongest at ages 2-4 (r=0.71-0.82).

MORTALITY AND STOCK SIZE

Virtual Population Analysis

Abundance estimates from virtual population analysis of catch at age of age-1 to age-7+, 1973-2001, were calibrated using an ADAPT algorithm (Gavaris 1988) that estimated age 2-5 survivors in 2002 and survey catchability coefficients (*q*) using nonlinear least squares of survey observation errors. Abundance at age was calibrated with survey indices of abundance: spring survey indices (age-1 to age-7+) and winter indices (age-1 to age-5) were calibrated to January abundance, and fall survey indices (age-1 to age-7+) were calibrated to mean abundance. The instantaneous rate of natural mortality (M) was assumed to be 0.2 based on tag returns (Lux 1969), relationships of Z to effort (Brown and Hennemuth 1971a), and the oldest individual sampled in the stock area (age-14). Although catches of yellowtail older than age-8 are rare in commercial or research catches, the stock has been heavily exploited for seven decades. Maturity at age for southern New England yellowtail flounder was reported by O'Brien et al. (1993) from 1985-1990 NEFSC spring survey samples. Model Residuals are plotted in Figure A1.11.

Results show that the stock was abundant in the early 1970s with a relatively wide age structure (11% of the population in 1973 was age 6 or older), but was quickly truncated by the late 1970s (<2% age 6+ from 1978 to 2001; Table A1.9, Figure A1.12c). Fishing mortality generally increase in the 1970s and 1980s to a peak of 2.3 in 1991 and 1992, averaged 1.6 during the 1990s, and appears to have decreased to 0.68 in 2000 and increased to 0.91 in 2001 (Figure A1.12a). Recruitment was generally strong in the 1970s and moderate during the 1980s, with two exceptional year classes in 1980 and 1987. Recruitment has been low during the 1990s. Spawning biomass was high in the early 1970s, decreased in the late 1970s, and increased briefly in the early and late 1980s with recruitment of the 1980 and 1987 cohorts. Spawning biomass decreased to a record low 622mt in 1994, gradually increased to 2,100mt in 2000, and decreased to 1,900mt in 2001. Retrospective analysis indicates a strong pattern of underestimating F, and overestimating SSB in recent years (Figure A1.13).

Biomass Dynamics

Given the problems in estimating recent catch at age in the southern New England area (Cadrin 2000) an age-aggregated production model (ASPIC, Prager 1994) was fit to total catch and survey biomass indices. Initial trials did not fit the winter survey biomass series, presumably because it is relatively short and does not have much contrast, nor did the model fit the catch rate data from Lux (1969). Alternative analyses that assumed that stock biomass was at the carrying capacity in 1935 had very similar results.

Results of the biomass dynamics model indicate that biomass decreased during the 1960s and early 1970s to about 10% of the biomass estimated for the early 1960s (Figure A1.14). Similar to the age-based analysis, the biomass dynamics model indicates brief periods of rebuilding in the early and late 1980s and a further decrease to extremely low biomass in the mid 1990s. However, the biomass dynamics model indicates a slightly faster rate of rebuilding in recent years than indicated by the age-based analysis.

Biological Reference Points

Yield and biomass per recruit were calculated assuming the observed partial recruitment and mean weight at age for 1994-2001 (Thompson and Bell 1934). Results are reported in Table A1.10 and illustrated in Figure A1.15. Applying the approach used to estimate MSY proxies for southern New England yellowtail (NEFSC 2002), F_{MSY} is approximated as $F_{40\%}$ (0.26). The SSB_{MSY} proxy is 69,500mt, calculated as the product of 40%MSP (1.129 kg spawning biomass) and average long-term recruitment (61.57 million). The average long-term recruitment was derived as the fall survey age-1 index divided by the catchability coefficient estimated by ADAPT (8.08E-5). The MSY proxy is 14,200mt, derived as the product of yield per recruit at $F_{40\%}$ (0.230 kg) and average recruitment.

Alternatively, SSB_{MSY} and MSY were estimated using stochastic long-term projections assuming recent average weights at age and partial recruitment (1994-2001), and the distribution of long term recruitment. Results suggest that at an F of 0.26, the long-term average catch is 13,100mt, and long-term average SSB is 64,500mt (Figure A1.16) .

For comparison, the estimate of B_{MSY} from biomass dynamics analysis is 104,700mt of total biomass, F_{MSY} is 0.19 on total biomass, and MSY is 20,300mt. The Working Group accepted the deterministic estimates of MSY reference points based on consistency with estimates for other groundfish stocks (NEFSC 2002): F_{MSY}=0.26, SSB_{MSY}= 69,500mt and MSY=14,200mt.

Projections

Stochastic age-based projections that assume a 15% reduction in F from 2001 to 2002 and recruitment similar to that experienced in the last decade suggest that the stock cannot rebuild to B_{MSY} by 2009 even if F in 2003-2010 is zero. If the same hindcast recruitment values used to derive the reference points are assumed for projections, there stock is expected to have approximately a 50% chance of rebuilding to SSB_{MSY} by 2009 with an F of 0.08 (Figure A1.17, Appendix A). However, long-term recruitment levels are not likely in the short-term, because SSB is extremely low, and retrospective patterns indicate that projections may be overly optimistic. For comparison, stochastic projections from the biomass dynamics model at status quo F in 2002 and F=0 for 2003-2009 indicate a 25% probability of rebuilding to the ASPIC estimate of B_{MSY} by 2009 (Appendix B).

WORKSHOP DISCUSSION

Working Group Discussion

Stock Structure - The WG reviewed seven working papers/presentations on yellowtail stock structure. With respect to spatiotemporal patterns of abundance, the WG noted that recruitment trends of Cape Cod and southern New England yellowtail indicated possible autocorrelation, as evidenced by a common series of several years of poor recruitment that might be indicative of a common stock. The WG noted that historical tagging data indicate weak movement between the Cape Cod, Georges Bank, and other areas, but strong mixing between Mid Atlantic and southern New England areas, that might be indicative of a common Mid Atlantic-southern New England stock. The WG also noted that the fish from the Mid Atlantic and southern New England have concurrent spawning seasons, comparable lengths of 50% Maturity, and similar growth rates, and that detailed distribution plots indicated that most of the Mid Atlantic fish are found in areas closest to the boundary with the Southern New England stock (i.e., area 613). The WG noted that the Mid Atlantic and Southern New England areas were grouped together prior to the early 1970s, when they were separated to conform with ICNAF reporting conventions. The WG noted limited evidence in the literature to separate Gulf of Maine fish from the Cape Cod stock. The WG supported the major conclusion of working paper A1 that information available from the literature indicates separate yellowtail flounder stocks on Georges Bank, off Cape Cod, and in the Southern New England-Mid Atlantic Bight area.

The WG noted that NEFSC survey stratum 13 (southwestern Georges Bank) appears to be an Aoverlap@ or Atransition@ zone, with peaks in abundance over time that are characteristic of both the Georges Bank and southern New England stocks, and may be inhabited by fish from both stocks during times of abundance. The WG noted that a similar situation may exist in NEFSC stratum 10, adjacent to the Great South Channel. The WG supported the conclusions of working paper A2 that 1) there are two major groups of NEFSC survey strata based on patterns of abundance over time, with a boundary on southwestern Georges Bank, and 2) the current analyses confirm earlier conclusions of separate Aharvest stocks@ on Georges Bank and off southern New England. A correlation analysis of survey and catch data by management area generally confirmed the multivariate analysis by stratum. Survey indices and landings were strongly correlated between southern New England and the mid-Atlantic, not correlated between southern New England and Cape Cod or southern New England and Georges Bank, and moderately correlated between Georges Bank and Cape Cod.

The WG noted that previous investigators (e.g., Lux 1963) found no significant differences in meristics (e.g., fin and ray counts) among U.S. stocks, supporting the current morphometric work. The WG also noted that the results of the morphometric work coincides with the differences in growth noted between U.S. and Newfoundland stocks. The WG supported the working paper A4 conclusion that morphometric variation among U.S. yellowtail flounder groups is not sufficient for accurate classification to stock area.

The WG noted that the number of migrants per generation between the yellowtail stock areas, although probably low, is likely sufficient to prevent detection of significant genetic differences using RAPD-PCR. The WG noted that the expression of phenotypic differences may not be evident in the genome, or Mid Atlantic be very difficult to detect (many different primers may have to be tested to find one that isolates the gene responsible for a given phenotypic expression). The WG supported the conclusion of presentation A6 that, at this time, yellowtail flounder stock differentiation must be based on factors other than genetics.

The WG noted that historical stock area determinations included the mid Atlantic area as a part of the southern New England stock (e.g., Royce et al. 1959, Lux 1969) . Mid

Atlantic landings were excluded from assessments of AICNAF Area 5" yellowtail beginning in the early 1970s (e.g., Brown and Hennemuth 1971), apparently to conform to ICNAF jurisdictions and to respond to the concerns of Mid Atlantic fishermen of being subject to the ICNAF regulatory regime. The Mid Atlantic resource was assessed as a separate stock beginning in the mid 1970s/early 1980s (e.g., Parrack 1974, McBride and Brown 1980).

The current work reviewed by the WG indicates a single homogeneous genetic stock of yellowtail flounder on U.S. fishing grounds. Patterns over time in landings and survey indices suggest two harvest stocks with a boundary between Georges Bank and Southern New England. Differences in life history characteristics suggest two phenotypic stocks with a boundary off Cape Cod. The WG noted that the most important potential Amisalignments@ with respect to current or proposed stock definitions are in areas 521, 525, and 526 (and associated NEFSC survey strata 10, 13 and 25), where fish from adjacent stocks may overlap during times of abundance. However, the WG found no strong evidence in patterns of fishery landings, survey abundance indices, or life history parameters to suggest that revision of the current assignment to stock areas of these particular statistical areas or survey strata is appropriate. The WG concluded that current evidence indicates that three stock areas are appropriate for yellowtail flounder: 1) a Georges Bank stock including fish landed from NEFSC statistical areas 522, 525, 551-552, and 561-562, and associated NEFSC survey strata (i.e., the current stock definition used in U.S. and Canadian assessments), 2) a southern New England – Mid Atlantic stock including fish landed from areas 526, 533-539, 541, and 611-639, and associated NEFSC survey strata, and 3) a Cape Cod – Gulf of Maine stock including fish landed from areas 511-521, and associated NEFSC survey strata. Finally, the WG recommends that assessment scientists explore the potential to classify yellowtail in fishery and survey samples to stock in the Aoverlap/transition@ areas based on age structure characteristics.

Stock Assessment

The Working Group discussed the quality of historical canvas data and questioned if historical catch may be underreported in the Mid Atlantic region or misallocated from the Mid Atlantic to the southern New England region.

The Group examined three criteria for choosing indices of abundance for the VPA calibration: correlation with other indices, partial variance in an initial calibration that included all indices, and residual patterns. During the time series of the winter survey, 1992-2002, few age 6 and 7+ yellowtail were caught and those two indices accounted for a disproportionately large portion of the total model variance. The Working Group excluded those two indices from the calibration, because they were adding noise to the calibration. However, it was noted that the survey is designed to catch flatfish, and the indices may become useful as age structure rebuilds.

The Working Group discussed the recruitment assumptions for projections. Previous studies found significant effects of temperature on survival ratios, but the reference point working group (NEFSC 2002) found no trend in temperatures for the last decade which would suggest a reason why recruitment has been extremely low since 1987. The Group noted that the ASPIC model was more optimistic than the VPA in terms of current status, but was not optimistic in terms of projections. ASPIC projections indicate that biomass does not rebuild to Bmsy in 2009 at F=0. By comparison, age-based projections do not rebuild to target in 2009 at F= 0 unless the whole time series of recruitment values, including the hind-cast estimates are used.

The Working Group adopted the approach of the Reference Point Working Group (NEFSC 2002) for estimating MSY reference point proxies. The Group also noted that mean weights at age seem to show density dependence. Therefore, weights may decrease as the stock rebuilds. The Group also decided to account for sampling problems in recent years by averaging mean weights and partial recruitment from as many years as possible (1994-2001) to represent the current fishery in reference point calculations and projections.

SARC DISCUSSION

The poor sampling of commercial landings in 1999 for the entire area was considered. While there is a systematic problem in collecting a biological sample without knowledge of the statistical area from which it came (e.g. the area fished is acquired from the VTR and not from an interview with the captain at the time of landing), in this situation the lack of samples is due to the 'hit-or-miss' nature of sampling low-volume landings (in 1999 the MA landings were just 240 mt). Throughout the entire time period (1973-2001) 15% of the MA cells did not have samples and SNE samples were used to characterize the catch at age. As SNE samples were applied to MA landings in some years, the SARC suggested evaluating the impact of pooling areas using years where adequate samples exist for both areas.

The SARC noted that the discard ratio used to estimate yellowtail flounder discards in the scallop fishery may not be suitable. As the scallop fishery has had trip limit regulations, the discard/kept ratio may not be as appropriate as an effort-based ratio. However, an effort-based ratio, if applied resource-wide, would overestimate discards in areas where scallop effort and yellowtail distribution do not overlap. It was suggested that an effort-based ratio be applied in the MA area, where scallop effort and yellowtail flounder distributions overlap, and a discard/kept ratio in the SNE area, where these distributions do not overlap as much.

The SARC commented on the declining mean weights at age in the commercial catch in recent years. Mean weights at age from the NEFSC survey would be informative in confirming the commercial trends observed.

The spatial coverage of the NEFSC autumn survey was not consistent over the entire time series; from 1963 to 1967 the southernmost strata used to assess the stock were not sampled. Although the restricted spatial coverage will not impact the VPA because the VPA begins in 1973, other analyses, such as hindcast estimates of recruitment and ASPIC, may be impacted. The SARC evaluated the NEFSC autumn survey indices (with and without strata 69, 73 and 74) and concluded that the trend and magnitude were similar between the two series. The SARC accepted the analyses conducted with the spatially restricted series to gain the benefits of the longer time series.

The SARC discussed the VPA retrospective analysis, which revealed a consistent pattern of underestimating F and overestimating SSB since 1995. It was agreed that the retrospective pattern was a key element to the stock assessment results and that this information should be included in the management advice because the direction of the retrospective pattern changes perspective of stock biomass and fishing mortality from year to year. However, the overfished and overfishing status is not affected by the retrospective bias.

The SARC felt that the YPR-SPR approach was appropriate for estimating biological reference points for this stock. The discussion focused on establishing the most appropriate time series of recruitment. The SARC reviewed SSB_{MSY} and MSY estimates derived from four possible recruitment time series: 1) long-term (1963-2001) average; 2) VPA time-series (1973-2001) average; 3) last ten years (1992-2001) VPA average; and 4) pre-VPA hindcast (1963-1972) average. The average recruitment from the four time series ranged between 6.4 million (last ten years) and 193 million (pre-VPA hindcast) and caused a wide range in the point estimates of SSB_{MSY} and MSY (Figure A1.18). Given the lack of evidence of an ecological regime shift, the SARC concluded that the most credible recruitment time series was the long-term (1963-2001) series. It was also concluded that a range of biological reference points would be useful in providing boundaries about the most credible estimate.

The SARC reviewed a stock-recruitment trajectory plot where estimates from the VPA and the hindcast analysis were represented. It was noted that what appeared to be two outliers in the VPA series would not be considered outliers when the hindcast recruitment estimates were included.

Sources of Uncertainty

- Although sampling improved in 2000 and 2001, estimates of previous catch at age (particularly 1999) may be imprecise due to poor sampling intensity. Therefore, VPA- and age-based projections may also be imprecise. Retrospective patterns may indicate inadequate sampling and misallocation of catch at age.
- Retrospective patterns indicate that VPA estimates of biomass and F are likely to be optimistic. Future VPAs may indicate a lower level of SSB and a higher F for 2001 than reported here.
- Estimates of landings and discard ratios since 1994 are based on preliminary logbook data applied on a pro rata basis, and are subject to change.

Research Recommendations

- Explore the use of effort-based and discard/kept ratios for the scallop fisheries
- Analyze the impacts of applying SNE samples to MA landings for years where adequate samples exists for both areas.
- Consider using a forward projection model that allows for error in catch at age, because of

the extremely poor sampling in 1999 and more flexible assumptions about selectivity.

- o Investigate changes in maturity at age over time.
- o Examine mean weights at age from surveys to confirm trends observed in the commercial mean weights.
- o Incorporate data from the entire stock area for the fall survey calibration index.
- o Improve sea sampling coverage for otter trawl and scallop vessels to allow for better estimation of discards.
- o Increase the sampling frequency of SNE-MA yellowtail flounder during the bottom trawl surveys.
- o Collect adequate numbers of quarterly commercial samples for length and age composition.

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Table A1.1. Management history of southern New England – Mid Atlantic yellowtail flounder.

Year	Comments
1977	FCMA implemented March 1 Groundfish plan adopts quotas for cod, haddock, yellowtail flounder
1982	Interim Groundfish Plan adopted: 11 inch minimum size for yellowtail
	Scallop FMP implemented
1986	Northeast Multispecies FMP adopted: Minimum size for yellowtail flounder: 12 inches Seasonal yellowtail closure, March - May, between 69-30 and 72-30W Closed area I and II continued as spawning closures on GB
1989	Amendment 2: Yellowtail minimum size increased to 13 inches Seasonal large mesh area off Nantucket Shoals to protect cod
1991	Amendment 4: Tightened restrictions on carrying small mesh while in Regulated Mesh Areas Minimum mesh size of 5 1/2 inches in Southern New England yellowtail area
1994	Amendment 5 and emergency regulations: December: NLCA closed year round, including to scallop dredges DAS limits for most vessels West of 72-30W. Mesh determined by mesh requirements of summer flounder fishery (5 1/2 inch diamond or 6 inch square) Established Southern New England RMA, mesh of 5 1/2 inch diamond square, to increase to 5 1/2 inch diamond or 6 inch square in year 2. Area from approximately 69-40W to 72-30 W.
	Scallop Amendment 4: adopted permit moratorium, effort control/DAS program, 5.5 inch twine top minimum, and crew limits
1996	Amendment 7 Extended DAS limits to most vessels Limited possession of groundfish by scallop vessels to 300 pounds of regulated multispecies Established criteria for exempted fisheries Mid-Atlantic regulated mesh area fisheries exempt from bycatch certification
1999	Framework 27: (May 1) Increased square mesh minimum size to 6 1/2 inches in GOM/GB/SNE Regulated mesh areas Framework 29: (June)
	Amendment 9: (November): Revised overfishing definitions Scallop Framework 11: 10 inch minimum twine top mesh
2000	Scallop Framework 13: Scallop vessel closed area access programs with yellowtail bycatch limits
	Adopted management measures for small-mesh multispecies, establishing minimum mesh sizes and trip/possession limits to reduce mortality on silver, red, and offshore hake

Table A1.2. Southern New England–mid Atlantic yellowtail flounder catch (kt).

	Mid-Atlantic			Southern New England				
	U.S.	U.S.	foreign	U.S.	U.S.	industrial	foreign	
year	landings	discards	catch	landings	discards	landings	landings	total
1960	0.0	0.0	0.0	8.3	3.2	0.5	0.0	12.0
1961	0.0	0.0	0.0	12.3	4.7	0.7	0.0	17.7
1962	0.0	0.0	0.0	13.3	5.3	0.2	0.0	18.8
1963	0.0	0.0	0.0	22.3	5.4	0.3	0.2	28.2
1964	1.8	0.0	0.0	19.5	9.5	0.5	0.0	31.3
1965	2.1	0.0	0.0	19.4	7.0	1.0	1.4	30.9
1966	2.2	0.0	0.0	17.6	5.3	2.7	0.7	28.5
1967	5.3	0.0	0.0	15.3	7.7	4.5	2.8	35.6
1968	3.3	0.0	0.0	18.2	6.3	3.9	3.5	35.2
1969	3.9	0.0	0.7	15.6	2.4	4.2	17.6	44.4
1970	4.1	0.0	0.1	15.2	4.5	2.1	2.5	28.5
1971	6.9	0.0	1.0	8.6	2.2	0.4	0.3	19.3
1972	8.8	0.0	0.1	8.5	1.8	0.3	3.0	22.5
1973	4.9	0.2	0.2	7.2	1.5	0.3	0.2	14.5
1974	1.9	0.0	0.0	6.4	8.7	0.0	0.1	17.1
1975	0.6	0.0	0.0	3.2	1.9	0.0	0.0	5.7
1976	0.3	0.0	0.0	1.6	1.6	0.0	0.0	3.4
1977	0.5	0.0	0.0	2.8	1.9	0.0	0.0	5.2
1978	0.8	0.0	0.0	2.3	5.0	0.0	0.0	8.1
1979	0.2	0.0	0.0	5.3	4.4	0.0	0.0	9.9
1980	0.3	0.0	0.0	6.0	1.7	0.0	0.0	8.0
1981	0.7	0.0	0.0	4.7	1.2	0.0	0.0	6.6
1982	0.4	0.0	0.0	10.3	5.0	0.0	0.0	15.8
1983	1.5	0.2	0.0	17.0	3.5	0.0	0.0	22.2
1984	2.2	0.0	0.0	7.9	1.1	0.0	0.0	11.2
1985	0.9	0.0	0.0	2.7	1.2	0.0	0.0	4.8
1986	0.2	0.0	0.0	3.3	1.1	0.0	0.0	4.6
1987	0.2	0.0	0.0	1.6	0.9	0.0	0.0	2.7
1988	0.1	0.0	0.0	0.9	1.8	0.0	0.0	2.8
1989	0.4	0.0	0.0	2.5	5.5	0.0	0.0	8.3
1990	0.2	0.0	0.0	8.0	9.7	0.0	0.0	17.9
1991	0.2	0.0	0.0	3.9	2.3	0.0	0.0	6.4
1992	0.2	0.0	0.0	1.4	1.1	0.0	0.0	2.7
1993	0.2	0.0	0.0	0.5	0.1	0.0	0.0	0.8
1994	0.2	0.1	0.0	0.2	0.1	0.0	0.0	0.6
1995	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.3
1996	0.2	0.0	0.0	0.3	0.1	0.0	0.0	0.5
1997	0.5	0.0	0.0	0.2	0.0	0.0	0.0	0.8
1998	0.2	0.0	0.0	0.4	0.1	0.0	0.0	0.7
1999	0.5	0.0	0.0	0.7	0.1	0.0	0.0	1.3
2000	0.2	0.0	0.0	0.7	0.0	0.0	0.0	1.0
2001	0.2	0.0	0.0	0.8	0.0	0.0	0.0	1.1

Table A1.3. Commercial samples of southern New England – Mid Atlantic yellowtail flounder by geographic region, half-year and market category (values in italics are Mid Atlantic observer lengths).

		Southern New England				Mid Atlantic				
year	half	uncl. lengths	large lengths	small lengths	ages	uncl. lengths	large lengths	small lengths	ages	discard lengths
1969	1	5059	0	0	991	950	0	0	143	0
1969	2	5730	0	0	951	1120	0	0	159	0
1970	1	6313	0	0	2515	1238	0	0	377	0
1970	2	9554	0	0	3149	707	0	0	197	0
1971	1	5421	0	0	2165	1212	0	0	387	0
1971	2	3414	0	0	577	1305	0	0	250	0
1972	1	2817	479	741	1483	1132	252	420	442	0
1972	2	1761	364	515	968	395	0	0	99	0
1973	1	1441	675	777	1085	923	0	0	249	0
1973	2	2757	248	362	1035	1293	0	0	299	0
1974	1	2568	112	319	1296	327	251	741	383	0
1974	2	3767	0	299	1396	498	0	0	149	0
1975	1	767	633	1257	1039	220	345	898	456	0
1975	2	321	100	149	189	0	0	0	0	0
1976	1	412	717	843	824	235	157	0	173	0
1976	2	149	190	192	192	426	0	0	161	0
1977	1	0	707	803	572	520	379	340	497	0
1977	2	162	370	275	339	283	0	0	103	0
1978	1	0	747	1222	680	223	85	0	146	0
1978	2	431	433	472	427	322	0	0	104	0
1979	1	249	444	348	379	451	0	0	164	0
1979	2	2050	377	735	1073	164	0	0	54	0
1980	1	1664	1313	1559	1984	214	90	281	228	0
1980	2	916	365	961	803	129	0	0	52	0
1981	1	888	270	151	530	1155	0	0	465	0
1981	2	377	109	1111	554	0	0	0	0	0
1982	1	1071	608	1374	1108	821	0	0	319	0
1982	2	266	401	3361	1210	139	0	188	101	0
1983	1	205	750	2281	1060	578	90	0	197	0
1983	2	252	601	2411	915	0	0	174	50	0
1984	1	416	558	1469	520	1544	0	1244	532	0
1984	2	0	932	2976	832	469	0	161	120	0
1985	1	138	822	2524	833	842	0	260	235	0
1985	2	443	620	2725	759	172	0	154	60	0
1986	1	422	326	1753	537	380	107	410	269	0
1986	2	299	498	1517	472	0	0	0	0	0
1987	1	0	662	964	391	765	0	0	201	0
1987	2	0	586	1042	347	0	0	0	0	0
1988	1	0	800	1272	536	240	0	0	54	0
1988	2	0	381	692	294	0	0	0	0	0
1989	1	0	759	1274	559	0	0	0	0	432
1989	2	0	504	971	351	316	0	0	75	183
1990	1	0	776	1155	504	*565*	0	0	0	1311
1990	2	0	693	956	389	*0*	0	0	0	0
1991	1	0	619	932	384	*151*	0	0	25	273
1991	2	0	671	1034	434	*456*	0	0	0	209
1992	1	0	524	895	400	*376*	0	0	50	1
1992	2	0	520	660	326	*35*	0	0	0	0
1993	1	0	348	625	265	*45*	0	0	0	7
1993	2	0	72	234	0	*7*	0	0	0	0
1994	1	0	102	133	58	*3*	0	0	0	10
1994	2	0	252	254	128	*0*	94	134	0	7
1995	1	78	234	240	143	*17*	0	0	0	70
1995	2	0	94	146	50	*3*	0	0	0	57
1996	1	0	0	0	0	*21*	0	0	0	255
1996	2	0	469	691	305	*28*	0	0	60	479
1997	1	215	813	803	468	*473*	0	0	78	433
1997	2	78	328	679	238	*67*	91	0	17	253
1998	1	0	283	596	275	*27*	0	0	0	41
1998	2	0	0	127	37	*101*	100	0	0	8
1999	1	262	408	333	154	*281*	77	111	83	61
1999	2	0	0	0	0	0	0	0	0	0
2000	1	114	589	94	170	0	85	0	14	537
2000	2	300	715	598	80	0	0	0	0	26
2001	1	0	263	710	249	0	0	117	48	14
2001	2	222	626	1028	526	0	0	0	114	33

Table A1.4a. Landings at age (thousands) of yellowtail flounder in southern New England.

					Age				
Year	1	2	3	4	5	6	7	8+	Total
1973	28	2570	7169	4630	1716	1517	257	55	17,942
1974	130	1766	3922	5053	2500	950	1021	196	15,538
1975	170	2352	1496	973	1257	549	308	163	7,268
1976	0	1396	898	245	337	391	167	188	3,622
1977	66	2039	3931	392	205	253	123	160	7,169
1978	21	3209	1488	1025	165	34	44	28	6,014
1978	19	4972	8252	1033	428	96	24	0	14,824
1980	119	4557	6324	3619	472	117	19	12	15,239
1981	0	2732	6418	2449	884	128	14	0	12,625
1982	56	17414	12788	1741	404	78	7	0	32,488
1983	57	13823	33242	3347	376	129	35	7	51,016
1984	45	2624	13902	6587	740	244	7	14	24,163
1985	166	3984	1496	1312	774	135	27	4	7,898
1986	39	5926	2882	561	324	119	21	1	9,873
1987	72	1370	2014	803	139	47	8	1	4,454
1988	0	1154	504	407	101	17	6	0	2,189
1989	0	5213	1269	280	41	3	0	0	6,806
1990	0	415	18476	1352	68	5	0	0	20,316
1991	0	253	2230	6606	81	1	17	0	9,188
1992	0	301	896	1687	246	10	3	0	3,143
1993	0	211	361	417	124	4	0	0	1,117
1994	0	15	187	136	120	48	1	0	507
1995	0	154	125	182	18	1	3	0	483
1996	0	224	439	122	15	10	5	1	816
1997	0	33	319	146	14	2	2	1	517
1998	0	300	364	139	25	2	0	0	830
1999	0	9	1231	158	45	11	5	0	1,458
2000	0	420	805	323	12	2	1	1	1,563
2001	0	201	1086	297	83	18	9	0	1,694

Table A1.4b. Landed weight (kg) at age of yellowtail in southern New England.

				Age				
Year	1	2	3	4	5	6	78+	
1973	0.210	0.298	0.381	0.420	0.430	0.506	0.611	-
1974	0.203	0.308	0.359	0.429	0.477	0.476	0.518	-
1975	0.218	0.290	0.385	0.439	0.436	0.469	0.515	-
1976	-	0.303	0.427	0.528	0.533	0.568	0.603	-
1977	0.215	0.284	0.385	0.521	0.529	0.484	0.612	-
1978	0.234	0.296	0.402	0.543	0.710	0.791	0.677	-
1979	0.189	0.301	0.366	0.476	0.590	0.684	0.679	-
1980	0.206	0.281	0.384	0.499	0.690	0.891	1.182	-
1981	0.140	0.262	0.343	0.484	0.619	0.664	0.476	-
1982	0.226	0.263	0.354	0.502	0.661	0.821	0.956	-
1983	0.175	0.262	0.341	0.499	0.671	0.829	0.838	-
1984	0.182	0.239	0.298	0.388	0.497	0.652	0.724	-
1985	0.183	0.264	0.370	0.428	0.541	0.620	0.867	-
1986	0.186	0.285	0.335	0.470	0.598	0.617	0.804	-
1987	0.247	0.268	0.361	0.412	0.542	0.595	0.905	-
1988	-	0.293	0.398	0.501	0.664	0.936	0.937	-
1989	-	0.337	0.389	0.546	0.736	0.959	1.278	-
1990	-	0.327	0.378	0.461	0.800	0.884	0.781	-
1991	-	0.336	0.379	0.426	0.715	1.530	0.599	-
1992	-	0.347	0.386	0.460	0.631	0.802	1.432	-
1993	-	0.358	0.430	0.471	0.645	1.040	1.040	-
1994	-	0.319	0.349	0.416	0.556	0.717	0.876	-
1995	-	0.317	0.410	0.460	0.668	0.883	0.863	-
1996	-	0.363	0.399	0.476	0.602	0.680	0.780	-
1997	-	0.347	0.435	0.494	0.677	0.847	0.926	-
1998	-	0.284	0.399	0.528	0.694	0.790	0.707	-
1999	-	0.334	0.440	0.574	0.763	1.106	1.104	-
2000	-	0.371	0.477	0.604	0.690	0.979	1.040	-
2001	-	0.393	0.441	0.617	0.743	0.919	0.948	-

Table A1.4c. Landings at age (thousands) of yellowtail in the Mid Atlantic.

					Age				
Year	1	2	3	4	5	6	7	8+	Total
1973	0	80	3426	3297	3510	3788	660	8	14,769
1974	0	87	838	2272	1187	648	453	80	5,565
1975	6	340	387	147	340	243	108	81	1,652
1976	0	78	269	82	112	86	63	1	690
1977	2	221	917	115	73	51	44	18	1,441
1978	0	880	669	445	82	27	26	20	2,149
1979	0	142	296	29	10	5	5	1	488
1980	18	217	253	210	40	12	3	4	757
1981	0	284	841	477	227	33	3	5	1,869
1982	0	566	665	114	11	1	0	0	1,357
1983	0	593	3914	237	9	17	2	2	4,773
1984	2	434	5136	1467	138	1	9	0	7,188
1985	0	1046	659	656	335	69	11	0	2,775
1986	1	289	405	74	32	8	0	0	808
1987	4	33	335	123	28	8	1	0	532
1988	0	59	28	99	33	9	0	0	229
1989	0	705	244	51	1	0	0	0	1,001
1990	0	8	446	184	11	0	0	0	649
1991	0	0	113	208	75	33	0	0	429
1992	0	0	115	393	18	4	1	0	532
1993	0	34	71	285	21	0	0	0	411
1994	0	7	79	103	164	77	3	0	432
1995	0	45	14	7	1	2	1	2	73
1996	0	117	105	92	32	5	0	0	353
1997	0	35	751	378	46	3	1	2	1,217
1998	0	96	133	117	46	7	3	0	401
1999	0	18	835	100	44	0	0	0	998
2000	0	74	252	110	3	1	0	0	440
2001		32	200	111	43	14	10	0	409

Table A1.4d. Landed weight (kg) at age of yellowtail in the Mid Atlantic.

	Age							
Year	1	2	3	4	5	6	78+	
1973	-	0.184	0.267	0.310	0.358	0.382	0.421	0.830
1974	-	0.210	0.311	0.323	0.358	0.364	0.386	0.450
1975	0.218	0.283	0.342	0.385	0.432	0.430	0.478	0.524
1976	-	0.265	0.342	0.409	0.397	0.429	0.404	0.621
1977	0.201	0.268	0.364	0.447	0.469	0.466	0.511	0.553
1978	-	0.241	0.339	0.520	0.566	0.553	0.568	0.605
1979	-	0.249	0.317	0.424	0.586	0.461	0.344	0.830
1980	0.202	0.269	0.373	0.509	0.581	0.712	0.760	0.696
1981	0.140	0.261	0.337	0.421	0.504	0.687	0.473	0.649
1982	-	0.263	0.325	0.458	0.636	0.863	-	-
1983	0.175	0.238	0.315	0.455	0.523	0.707	0.765	0.765
1984	0.144	0.215	0.287	0.387	0.436	0.704	0.614	-
1985	-	0.235	0.355	0.367	0.419	0.494	0.450	-
1986	0.185	0.258	0.305	0.408	0.476	0.563	0.720	-
1987	0.260	0.282	0.303	0.350	0.409	0.536	0.619	-
1988	-	0.303	0.369	0.459	0.449	0.539	-	-
1989	-	0.359	0.458	0.606	0.700	0.882	-	-
1990	-	0.330	0.351	0.386	0.509	-	-	-
1991	-	0.234	0.392	0.426	0.680	0.881	-	-
1992	-	-	0.382	0.459	0.636	0.808	1.048	-
1993	-	0.302	0.431	0.422	0.614	-	-	-
1994	-	0.323	0.362	0.494	0.602	0.715	0.913	-
1995	-	0.222	0.315	0.350	0.494	0.480	0.594	0.769
1996	-	0.378	0.412	0.471	0.580	0.687	-	-
1997	-	0.296	0.416	0.474	0.552	0.952	1.128	1.941
1998	-	0.344	0.457	0.626	0.827	1.007	1.048	-
1999	-	0.360	0.458	0.548	0.563	-	-	-
2000	-	0.371	0.472	0.616	0.931	1.173	1.040	1.040
2001	-	0.366	0.464	0.643	0.817	0.968	1.030	

Table A1.5a. Discard estimates for southern New England yellowtail flounder for 2000 and 2001 from logbook (VTR) data (observer data, OB, also listed for comparison).

2000 logbook data

half year	gear	kept (mt)	disc (mt)	d/k	landings (mt)	discards (mt)
1	trawl	69.0	2.1	0.031	343.9	10.5
	dredge	0.1	3.3	23.102	0.6	13.6
2	trawl	97.7	2.5	0.026	402.6	10.5
	dredge	0.1	3.5	38.696	0.1	2.2
	total					36.8

2000 observer data

half year	gear	kept (mt)	disc (mt)	d/k	trips	discard lengths
1	trawl	0.20	0.21	1.069	2	90
	dredge					0
2	trawl	1.57	0.37	0.237	2	82
	dredge	0.04	0.63	17.859	1	22
	total					194

2001 logbook data

half year	gear	kept (mt)	disc (mt)	d/k	landings (mt)	discards (mt)
1	trawl	162.0	3.9	0.024	602.9	14.5
	dredge	0.1	2.2	40.907	0.0	0.4
2	trawl	42.7	1.3	0.029	225.0	6.6
	dredge	0.0	2.5	280.478	0.1	20.1
	total					41.7

2001 observer data

half year	gear	kept (mt)	disc (mt)	d/k	trips	discard lengths
1	trawl	11.15	0.75	0.067	1	72
	dredge	0.00	0.28		1	0
2	trawl	1.46	0.21	0.142	3	82
	dredge				0	0
	total					154

Table A1.5b. Discard estimates for Mid Atlantic yellowtail flounder, 1994-2001 from logbook (VTR) data (observer data, OB, also listed for comparison).

Trawl Discards		OB	OB	OB	VTR	VTR	VTR		
year	half	kept	discard	d/k	kept	discard	d/k	landings	discards
1994	1	0.054	0.004	0.07	0.292	0.062	0.2127	63.1	13.4
1994	2	0.001	0.024	47.20	0.675	0.043	0.0639	93.3	6.0
1995	1	0.000	0.001		1.436	0.692	0.4817	5.2	2.5
1995	2				2.994	0.170	0.0568	11.1	0.6
1996	1	0.001	0.000	0.00	24.362	1.442	0.0592	83.3	4.9
1996	2	0.000	0.345		22.607	0.815	0.0361	66.0	2.4
1997	1	1.925	0.133	0.07	84.408	3.500	0.0415	451.7	18.7
1997	2	0.000	0.381		9.887	0.714	0.0723	71.3	5.1
1998	1	0.001	0.000	0.00	29.147	2.302	0.0790	117.5	9.3
1998	2	0.018	0.002	0.13	12.033	0.765	0.0636	86.0	5.5
1999	1	0.000	0.009		103.788	4.402	0.0424	409.9	17.4
1999	2				9.022	0.484	0.0536	57.7	3.1
2000	1	0.001	0.030	21.36	46.856	0.968	0.0206	152.8	3.2
2000	2	6.269	0.424	0.07	14.233	0.467	0.0328	65.3	2.1
2001	1	0.079	0.000	0.00	38.375	0.956	0.0249	206.5	5.1
2001	2	0.000	0.003		4.040	0.175	0.0433	27.7	1.2
Dredge Discards									
1994	1	0.045	0.037	0.82	0.320	0.445	1.392	69.1	96.2
1994	2	0.001	0.006	4.57	0.091	0.068	0.747	12.6	9.4
1995	1	0.030	0.245	8.24	0.889	0.494	0.556	3.2	1.8
1995	2	0.014	0.361	25.62	0.439	0.426	0.971	1.6	1.6
1996	1	0.081	0.856	10.54	0.859	0.370	0.430	2.9	1.3
1996	2	0.054	0.674	12.57	0.529	1.150	2.174	1.5	3.4
1997	1	0.211	0.863	4.10	1.179	0.628	0.533	6.3	3.4
1997	2	0.095	0.200	2.11	0.894	0.284	0.317	6.4	2.0
1998	1	0.023	0.103	4.48	1.410	1.281	0.909	5.7	5.2
1998	2	0.000	0.058	144.50	0.839	0.578	0.689	6.0	4.1
1999	1	0.015	0.126	8.37	1.126	0.166	0.147	35.1	5.2
1999	2				0.052	0.009	0.175	0.0	0.0
2000	1	0.000	0.211		0.122	0.227	1.859	2.0	3.8
2000	2	0.000	0.033		0.077	0.261	3.387	0.1	0.4
2001	all	0.079	0.000	0.00	0.062	1.699	27.398	0.9	24.6

Table A1.6a. Discards at age (thousands) of yellowtail flounder in southern New England.

	Age						
Year	1	2	3	4	5	6	7
1973	160	2486	1130	43	0	0	0
1974	728	26568	793	45	0	0	0
1975	8670	1427	1	10	0	0	0
1976	214	5203	14	0	0	0	0
1977	5376	2732	42	0	0	0	0
1978	8677	10102	7	0	0	0	0
1979	185	14253	119	0	0	0	0
1980	869	5441	18	0	0	0	0
1981	38	4013	319	0	0	0	0
1982	113	17716	905	3	0	0	0
1983	2469	4607	5373	17	0	0	0
1984	465	3107	941	74	0	0	0
1985	2064	3031	20	0	0	0	0
1986	423	3754	39	0	0	0	0
1987	1518	2034	19	0	0	0	0
1988	5899	896	4	0	0	0	0
1989	24	14002	1834	131	6	0	0
1990	192	1633	23709	673	11	0	0
1991	445	1354	2820	2883	12	0	0
1992	477	1152	1086	659	33	0	0
1993	13	212	15	9	0	0	0
1994	9	134	35	29	12	2	0
1995	7	94	38	27	12	3	0
1996	21	81	56	29	13	2	0
1997	1	23	32	4	1	0	0
1998	0	88	114	40	9	3	1
1999	3	64	215	22	11	2	0
2000	31	35	29	13	0	0	0
2001	1	35	75	3	2	0	0

Table A1.6b. Discarded weight at age of southern New England yellowtail flounder.

	Age						
Year	1	2	3	4	5	6	7
1973	0.210	0.298	0.381	0.420			
1974	0.203	0.308	0.359	0.429			
1975	0.218	0.290	0.385	0.439			
1976	0.228	0.303	0.427				
1977	0.215	0.284	0.385				
1978	0.234	0.296	0.402				
1979	0.189	0.301	0.366				
1980	0.206	0.281	0.384				
1981	0.140	0.262	0.343				
1982	0.226	0.263	0.354	0.502			
1983	0.175	0.262	0.341	0.499			
1984	0.182	0.239	0.298	0.388			
1985	0.183	0.264	0.370				
1986	0.186	0.285	0.335				
1987	0.247	0.268	0.361				
1988	0.270	0.293	0.398				
1989	0.311	0.337	0.389	0.546	0.736		
1990	0.301	0.327	0.378	0.461	0.800		
1991	0.206	0.248	0.302	0.387	0.413		
1992	0.167	0.308	0.351	0.354	0.344		
1993	0.122	0.358	0.430	0.471			
1994	0.108	0.323	0.349	0.416	0.556	0.358	
1995	0.123	0.317	0.410	0.477	0.668	0.883	
1996	0.147	0.404	0.495	0.424	0.610	0.922	
1997	0.143	0.220	0.325	0.532	0.722		
1998	0.020	0.284	0.399	0.528	0.694	0.790	0.707
1999	0.208	0.272	0.389	0.565	0.767	0.586	1.183
2000	0.020	0.314	0.473	0.572			
2001	0.153	0.327	0.363	0.568	0.528		

Table A1.6c. Discards at age (thousands) of Mid Atlantic yellowtail flounder.

	Age					
Year	1	2	3	4	5	6
1973	32	496	225	9	0	0
1974	3	98	3	0	0	0
1975	64	11	0	0	0	0
1976	0	0	0	0	0	0
1977	69	35	1	0	0	0
1978	0	0	0	0	0	0
1979	1	52	0	0	0	0
1980	0	0	0	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	142	265	309	1	0	0
1984	5	34	10	1	0	0
1985	9	13	0	0	0	0
1986	0	1	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	1	12	0	0	0
1991	1	3	6	6	0	0
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	145	592	11	13	13	0
1995	0	15	3	3	0	1
1996	1	5	26	5	0	0
1997	1	11	64	10	0	0
1998	3	27	24	10	1	2
1999	3	15	39	8	3	0
2000	4	38	5	2	0	0
2001	0	7	51	13	2	0

Table A1.6d. Discarded weight at age of Mid Atlantic yellowtail flounder.

	Age					
Year	1	2	3	4	5	6
1973	0.210	0.298	0.381	0.420		
1974	0.203	0.308	0.359	0.429		
1975	0.218	0.290	0.385	0.439		
1976	0.228	0.303	0.427			
1977	0.215	0.284	0.385			
1978	0.234	0.296	0.402			
1979	0.189	0.301	0.366			
1980	0.206	0.281	0.384			
1981	0.140	0.262	0.343			
1982	0.226	0.263	0.354	0.502		
1983	0.175	0.262	0.341	0.499		
1984	0.182	0.239	0.298	0.388		
1985	0.183	0.264	0.370			
1986	0.186	0.285	0.335			
1987	0.247	0.268	0.361			
1988	0.270	0.293	0.398			
1989	0.311	0.337	0.389	0.546	0.736	
1990	0.301	0.327	0.378	0.461	0.800	
1991	0.206	0.248	0.302	0.387	0.413	
1992	0.167	0.308	0.351	0.354	0.344	
1993	0.122	0.358	0.430	0.471		
1994	0.065	0.171	0.348	0.407	0.377	
1995	0.146	0.233	0.318	0.385	0.506	0.507
1996	0.163	0.220	0.347	0.358	0.652	0.810
1997	0.133	0.230	0.347	0.399	0.567	0.876
1998	0.162	0.267	0.389	0.507	0.627	0.499
1999	0.234	0.251	0.399	0.501	0.608	0.899
2000	0.149	0.137	0.447	0.570	0.765	
2001	0.153	0.278	0.385	0.590	0.621	0.765

Table A1.7. NEFSC Survey indices of abundance and biomass of southern New England – Mid Atlantic yellowtail flounder.

Fall Survey

year	age-0	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	sum	kg/tow
1963	0.030	14.778	12.274	9.972	4.944	0.683	0.059	0.082	0.000	0.000	42.822	14.023
1964	0.000	13.900	19.067	3.381	5.356	2.643	0.543	0.036	0.000	0.000	44.925	13.972
1965	0.166	22.272	12.835	4.327	1.489	1.184	0.146	0.000	0.000	0.000	42.418	10.228
1966	0.569	34.899	10.656	2.342	0.902	0.175	0.000	0.000	0.000	0.000	49.542	9.033
1967	0.177	23.579	29.045	12.719	1.212	0.260	0.047	0.124	0.000	0.000	67.164	14.018
1968	0.000	13.882	21.622	24.639	1.571	0.263	0.325	0.069	0.000	0.000	62.370	13.038
1969	0.056	10.440	11.316	33.936	4.454	0.049	0.019	0.019	0.000	0.000	60.288	14.472
1970	0.067	4.414	8.047	29.866	18.927	3.305	0.359	0.047	0.000	0.000	65.032	16.211
1971	0.000	14.540	12.485	6.886	12.452	1.909	0.162	0.123	0.000	0.000	48.556	8.975
1972	0.000	3.245	32.938	33.089	33.080	18.618	2.305	0.101	0.000	0.000	123.376	31.543
1973	0.000	1.779	1.747	4.086	2.318	1.564	0.768	0.162	0.000	0.000	12.422	3.125
1974	0.132	0.695	1.185	0.433	1.640	0.687	0.297	0.146	0.014	0.042	5.271	1.545
1975	0.000	1.533	0.416	0.136	0.217	0.213	0.048	0.070	0.000	0.000	2.634	0.602
1976	0.000	1.964	4.204	0.350	0.046	0.073	0.190	0.220	0.099	0.000	7.147	1.954
1977	0.028	2.289	1.439	0.519	0.044	0.040	0.035	0.065	0.000	0.000	4.459	1.125
1978	0.000	2.080	4.771	0.296	0.236	0.024	0.006	0.048	0.000	0.021	7.481	2.004
1979	0.000	1.493	3.283	1.579	0.241	0.026	0.026	0.000	0.000	0.000	6.646	1.818
1980	0.000	1.153	2.908	0.757	0.313	0.000	0.000	0.000	0.000	0.000	5.130	1.354
1981	0.000	9.511	9.498	1.251	0.198	0.103	0.037	0.000	0.000	0.000	20.597	4.046
1982	0.000	2.040	17.794	4.392	0.535	0.215	0.000	0.000	0.000	0.000	24.976	5.706
1983	0.000	1.920	11.278	5.593	0.458	0.038	0.000	0.026	0.000	0.000	19.314	4.490
1984	0.000	1.444	1.275	1.529	0.334	0.000	0.000	0.000	0.000	0.000	4.582	1.033
1985	0.000	0.869	0.375	0.134	0.080	0.000	0.000	0.000	0.000	0.000	1.458	0.298
1986	0.000	0.606	1.826	0.523	0.123	0.025	0.000	0.000	0.000	0.000	3.104	0.754
1987	0.073	1.067	0.451	0.359	0.030	0.024	0.000	0.024	0.000	0.000	2.028	0.401
1988	0.000	4.370	0.310	0.141	0.156	0.021	0.034	0.000	0.000	0.000	5.032	0.510
1989	0.000	0.198	10.492	1.370	0.072	0.000	0.000	0.000	0.000	0.000	12.132	2.359
1990	0.000	0.539	1.847	3.117	0.194	0.000	0.000	0.000	0.000	0.000	5.696	1.305
1991	0.000	0.588	0.243	1.516	0.367	0.000	0.000	0.000	0.000	0.000	2.713	0.755
1992	0.000	0.168	0.024	0.072	0.285	0.000	0.000	0.000	0.000	0.000	0.548	0.147
1993	0.000	0.332	0.028	0.130	0.104	0.000	0.000	0.000	0.000	0.000	0.594	0.116
1994	0.000	0.732	0.448	0.107	0.129	0.066	0.025	0.000	0.000	0.000	1.507	0.308
1995	0.000	0.139	0.645	0.257	0.115	0.000	0.000	0.025	0.028	0.000	1.209	0.304
1996	0.000	0.448	0.161	0.320	0.000	0.000	0.000	0.000	0.000	0.000	0.929	0.208
1997	0.000	0.822	0.519	1.459	0.271	0.024	0.000	0.000	0.000	0.000	3.095	0.851
1998	0.023	0.890	1.620	0.124	0.049	0.000	0.023	0.000	0.000	0.000	2.728	0.655
1999	0.000	1.238	0.392	0.279	0.028	0.028	0.000	0.000	0.000	0.000	1.964	0.468
2000	0.000	0.049	1.669	0.303	0.171	0.000	0.000	0.023	0.000	0.000	2.215	0.718
2001	0.000	0.390	0.611	0.158	0.071	0.000	0.000	0.000	0.000	0.000	1.231	0.419

Table A1.7 cont.

Spring Survey

year	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	age-9	age-10	age-11	sum	kg/tow
1968	1.014	29.910	38.854	13.103	1.076	0.040	0.184	0.000	0.000	0.000	0.000	84.181	18.645
1969	2.941	18.796	29.464	14.069	1.599	0.147	0.048	0.000	0.000	0.000	0.000	67.064	14.311
1970	1.045	7.311	18.942	16.237	3.518	0.656	0.123	0.005	0.022	0.000	0.000	47.860	12.066
1971	0.447	7.616	8.124	20.765	3.713	0.371	0.004	0.000	0.000	0.004	0.000	41.043	9.552
1972	0.196	12.355	11.201	5.986	9.887	2.394	0.303	0.000	0.000	0.000	0.000	42.321	10.815
1973	0.838	5.467	14.753	8.335	6.432	7.987	0.852	0.230	0.083	0.000	0.000	44.977	12.115
1974	0.511	2.188	2.607	5.016	2.891	1.154	1.291	0.145	0.027	0.000	0.000	15.830	4.918
1975	0.358	1.171	0.406	0.665	0.709	0.531	0.156	0.197	0.000	0.000	0.000	4.193	1.307
1976	0.016	4.182	0.536	0.256	0.245	0.338	0.096	0.031	0.000	0.000	0.000	5.699	1.666
1977	1.618	1.557	2.758	0.242	0.154	0.189	0.093	0.080	0.006	0.046	0.000	6.743	1.963
1978	2.681	10.302	1.791	0.778	0.253	0.126	0.123	0.158	0.010	0.000	0.000	16.221	3.513
1979	1.002	2.967	1.601	0.255	0.124	0.018	0.018	0.014	0.000	0.000	0.012	6.009	1.318
1980	0.683	6.353	4.298	2.684	0.261	0.070	0.005	0.009	0.015	0.001	0.005	14.384	4.830
1981	0.810	18.598	4.817	2.502	0.580	0.113	0.000	0.000	0.000	0.000	0.000	27.420	6.930
1982	0.149	17.329	5.610	1.406	0.467	0.135	0.017	0.000	0.000	0.000	0.000	25.114	5.865
1983	0.016	5.329	8.803	0.598	0.191	0.000	0.000	0.000	0.000	0.000	0.000	14.938	4.097
1984	0.038	0.453	0.902	2.110	0.354	0.262	0.000	0.000	0.000	0.000	0.000	4.119	1.302
1985	0.267	1.613	0.406	0.480	0.714	0.135	0.019	0.000	0.000	0.000	0.000	3.634	0.948
1986	0.016	2.893	0.916	0.237	0.124	0.016	0.000	0.000	0.000	0.000	0.000	4.201	1.052
1987	0.000	0.086	0.701	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.954	0.319
1988	0.285	0.357	0.125	0.174	0.294	0.029	0.000	0.000	0.000	0.000	0.000	1.263	0.378
1989	0.162	11.211	0.537	0.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.022	2.090
1990	0.090	0.485	15.349	2.194	0.079	0.000	0.000	0.000	0.000	0.000	0.000	18.197	5.064
1991	0.228	0.611	2.509	4.156	0.539	0.060	0.000	0.000	0.000	0.000	0.000	8.103	2.508
1992	0.036	0.051	0.571	1.597	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.255	0.794
1993	0.016	0.253	0.112	0.441	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.894	0.341
1994	0.016	0.269	0.016	0.000	0.068	0.019	0.000	0.000	0.000	0.000	0.000	0.389	0.136
1995	0.016	1.169	0.068	0.092	0.019	0.037	0.000	0.016	0.016	0.000	0.000	1.433	0.329
1996	0.000	0.398	1.303	0.566	0.072	0.000	0.000	0.000	0.000	0.000	0.000	2.339	0.747
1997	0.053	0.885	1.144	0.327	0.067	0.000	0.000	0.000	0.000	0.000	0.000	2.475	0.789
1998	0.068	3.016	0.386	0.161	0.036	0.021	0.000	0.000	0.000	0.000	0.000	3.688	0.848
1999	0.036	0.651	1.930	0.349	0.074	0.000	0.023	0.000	0.000	0.000	0.000	3.062	1.138
2000	0.019	1.245	1.006	0.559	0.043	0.000	0.000	0.000	0.000	0.000	0.000	2.873	0.990
2001	0.000	0.069	1.158	0.240	0.082	0.023	0.000	0.000	0.000	0.000	0.000	1.572	0.657
2002	0.049	1.191	0.235	0.200	0.067	0.000	0.000	0.000	0.000	0.000	0.000	1.742	0.510

Table A1.7 continued.

Winter Survey

year	age-1	age-2	age-3	age-4	age-5	age-6	age-7	age-8	sum	kg/tow
1992	0.011	1.619	3.477	8.063	0.959	0.000	0.000	0.000	14.129	5.264
1993	0.596	1.924	1.057	2.487	0.292	0.000	0.000	0.000	6.357	2.118
1994	0.366	8.654	0.742	1.654	0.966	0.353	0.118	0.000	12.854	3.924
1995	0.090	10.681	2.698	0.597	0.253	0.185	0.016	0.000	14.519	3.464
1996	0.041	1.285	8.235	0.851	0.140	0.065	0.015	0.015	10.648	3.346
1997	0.156	2.380	9.785	2.958	0.529	0.000	0.038	0.000	15.846	5.720
1998	0.118	7.841	1.596	1.158	0.112	0.000	0.018	0.000	10.843	2.780
1999	0.243	2.909	10.176	0.777	0.311	0.056	0.023	0.000	14.494	5.226
2000	0.109	4.917	3.006	1.160	0.073	0.100	0.000	0.000	9.364	3.025
2001	0.028	0.895	8.542	1.615	0.254	0.096	0.046	0.000	11.475	4.786
2002	0.012	2.735	2.578	2.047	0.100	0.020	0.000	0.000	7.492	2.589

Scallop Survey

year	all	age-1
1982	3.123	0.362
1983	0.858	0.255
1984	0.309	0.180
1985	0.577	0.465
1986	0.199	0.015
1987	0.150	0.054
1988	7.482	7.359
1989	3.774	0.579
1990	0.370	0.158
1991	0.230	0.151
1992	0.169	0.108
1993	0.192	0.170
1994	0.732	0.573
1995	0.507	0.072
1996	38.479	0.120
1997	0.886	0.736
1998	0.567	0.253
1999	0.456	0.357
2000	0.432	0.082
2001	0.106	0.063
2002	0.152	0.020

Table A1.8. Correlation among abundance indices by age.

Age 1	Fall	Spring	Winter	Scallop
Fall	1.00			
Spring	0.45	1.00		
Winter	0.25	0.00	1.00	
Scallop	0.49	0.40	0.47	1.00

Age 2	Fall	Spring	Winter
Fall	1.00		
Spring	0.82	1.00	
Winter	0.45	0.65	1.00

Age 3	Fall	Spring	Winter
Fall	1.00		
Spring	0.71	1.00	
Winter	0.45	0.86	1.00

Age 4	Fall	Spring	Winter
Fall	1.00		
Spring	0.74	1.00	
Winter	0.46	0.57	1.00

Age 5	Fall	Spring	Winter
Fall	1.00		
Spring	0.36	1.00	
Winter	-0.46	0.54	1.00

Age 6	Fall	Spring	Winter
Fall	1.00		
Spring	0.57	1.00	
Winter	-0.49	-0.55	1.00

Age 7+	Fall	Spring	Winter
Fall	1.00		
Spring	-0.18	1.00	
Winter	-0.07	-0.31	1.00

Table A1.9c. Results of virtual population analysis of southern New England – Mid Atlantic yellowtail flounder.

Abundance (thousands)								
	age-1	age-2	age-3	age-4	age-5	age-6	age-7+	sum
1973	43532	17681	27907	16078	8927	11005	2006	127136
1974	10627	35442	9380	12035	5945	2580	2769	78778
1975	31562	7921	3212	2653	3185	1531	1256	51320
1976	14634	17779	2749	925	1149	1162	1009	39407
1977	50316	11788	8514	1182	462	535	596	73393
1978	54165	36207	5103	2545	509	126	243	98898
1979	32034	36476	16803	2220	754	193	57	88537
1980	44493	26042	12293	5915	856	221	64	89884
1981	138470	35518	12078	4097	1378	238	32	191811
1982	64223	113335	22719	3032	707	123	11	204150
1983	16726	52429	60492	5609	801	203	62	136322
1984	19164	11280	25473	10766	1334	308	36	68361
1985	20993	15223	3625	2767	1459	298	60	44425
1986	7315	15161	5158	1000	485	191	32	29342
1987	15044	5570	3392	1213	244	75	13	25551
1988	124008	10875	1450	634	155	49	11	137182
1989	17769	96192	6995	702	61	6	0	121725
1990	8083	14526	60731	2699	157	7	0	86203
1991	3934	6444	10032	11136	211	47	23	31827
1992	2267	2817	3819	3537	338	21	6	12805
1993	2041	1425	992	1229	417	8	0	6112
1994	2953	1660	753	407	363	210	7	6353
1995	3392	2278	682	334	79	18	20	6803
1996	1988	2771	1586	395	75	37	13	6865
1997	5951	1608	1882	732	98	8	9	10288
1998	3377	4871	1223	486	113	25	7	10102
1999	5753	2762	3525	427	121	19	7	12614
2000	1889	4705	2166	786	89	6	4	9645
2001	3060	1515	3339	786	239	59	35	9033
2002	---	2504	991	1455	260	79	31	---
average	25854	19827	10635	3259	1032	646	281	62582

Table A1.9b.

Fishing Mortality

	age-1	age-2	age-3	age-4	age-5	age-6	age-7+	ages 4-6
1973	0.01	0.43	0.64	0.79	1.04	0.76	0.76	0.86
1974	0.09	2.20	1.06	1.13	1.16	1.15	1.15	1.15
1975	0.37	0.86	1.04	0.64	0.81	0.85	0.85	0.77
1976	0.02	0.54	0.64	0.50	0.57	0.60	0.60	0.56
1977	0.13	0.64	1.01	0.64	1.10	0.99	0.99	0.91
1978	0.20	0.57	0.63	1.02	0.77	0.76	0.76	0.85
1979	0.01	0.89	0.84	0.75	1.03	0.86	0.86	0.88
1980	0.03	0.57	0.90	1.26	1.08	1.04	1.04	1.13
1981	0.00	0.25	1.18	1.56	2.22	1.38	1.38	1.72
1982	0.00	0.43	1.20	1.13	1.05	1.24	1.24	1.14
1983	0.19	0.52	1.53	1.24	0.76	1.58	1.58	1.19
1984	0.03	0.94	2.02	1.80	1.30	2.12	2.12	1.74
1985	0.13	0.88	1.09	1.54	1.83	1.41	1.41	1.59
1986	0.07	1.30	1.25	1.21	1.67	1.33	1.33	1.40
1987	0.12	1.15	1.48	1.86	1.41	1.66	1.66	1.64
1988	0.05	0.24	0.53	2.13	3.06	0.89	0.89	2.03
1989	0.00	0.26	0.75	1.30	1.99	0.82	0.82	1.37
1990	0.03	0.17	1.50	2.35	1.00	1.62	1.62	1.66
1991	0.13	0.32	0.84	3.29	2.13	1.60	1.60	2.34
1992	0.26	0.84	0.93	1.94	3.55	1.40	1.40	2.30
1993	0.01	0.44	0.69	1.02	0.48	0.81	0.81	0.77
1994	0.06	0.69	0.61	1.44	2.82	1.10	1.10	1.79
1995	0.00	0.16	0.34	1.29	0.57	0.58	0.58	0.81
1996	0.01	0.19	0.57	1.19	2.11	0.71	0.71	1.34
1997	0.00	0.07	1.15	1.67	1.19	1.33	1.33	1.40
1998	0.00	0.12	0.85	1.19	1.58	1.00	1.00	1.26
1999	0.00	0.04	1.30	1.37	2.84	1.40	1.40	1.87
2000	0.02	0.14	0.81	0.99	0.21	0.85	0.85	0.68
2001	0.00	0.22	0.63	0.91	0.91	0.91	0.91	0.91
average	0.07	0.55	0.97	1.35	1.46	1.13	1.13	1.31

Table A1.9c.

Spawning Biomass (mt)

	age-1	age-2	age-3	age-4	age-5	age-6	age-7+	sum
1973	1091	2974	6704	3983	2033	3082	652	20519
1974	248	2970	1912	2739	1483	633	758	10743
1975	704	1090	705	809	910	452	414	5084
1976	396	2933	773	345	417	451	414	5729
1977	1226	1742	1922	420	138	157	216	5821
1978	1397	5701	1354	822	225	58	104	9661
1979	722	5164	3879	709	267	84	23	10848
1980	1085	3932	2927	1612	342	115	42	10055
1981	2318	5716	2276	934	300	82	8	11634
1982	1734	16980	4388	869	278	56	6	24311
1983	323	7496	9789	1529	359	79	25	19600
1984	412	1233	2920	1816	348	76	5	6810
1985	436	1866	758	547	315	88	21	4031
1986	158	1707	915	257	131	62	13	3243
1987	422	630	583	208	65	20	5	1933
1988	3916	1962	416	118	24	25	7	6468
1989	661	19864	1816	208	18	4	0	22571
1990	288	3013	11096	424	73	3	0	14897
1991	92	1005	2146	1075	54	20	6	4398
1992	41	426	859	630	43	8	4	2011
1993	30	286	288	333	201	5	0	1143
1994	23	172	185	91	59	87	3	620
1995	50	433	214	82	38	9	10	836
1996	35	651	460	103	17	18	7	1291
1997	100	306	435	161	32	4	6	1044
1998	65	926	318	154	41	13	4	1521
1999	152	536	815	125	23	10	4	1665
2000	8	1062	661	290	57	4	3	2085
2001	56	355	1014	308	115	35	22	1905
average	627	3211	2156	748	290	198	96	7327

Table A1.10. Yield and spawning biomass per recruit of southern New England – Mid Atlantic yellowtail flounder.

```
  The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
   PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992
            ----------------------------------------
            Run Date: 17- 9-2002;  Time: 09:41:39.27
SNE-MA YELLOWTAIL FLOUNDER - 1994-2001 INPUT

Proportion of F before spawning:  .4167
Proportion of M before spawning:  .4167
Natural Mortality is Constant at:  .200
Initial age is:  1; Last age is:  8
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> snemayt.dat
------------------------------------------------------------
Age-specific Input data for Yield per Recruit Analysis
------------------------------------------------------------
 Age | Fish Mort  Nat Mort | Proportion | Average Weights
     |  Pattern    Pattern |   Mature   |  Catch   Stock
------------------------------------------------------------
  1  |   .0100     1.0000  |    .1300   |   .131    .131
  2  |   .1700     1.0000  |    .7400   |   .310    .310
  3  |   .6400     1.0000  |    .9800   |   .418    .418
  4  |  1.0000     1.0000  |   1.0000   |   .525    .525
  5  |  1.0000     1.0000  |   1.0000   |   .671    .671
  6  |  1.0000     1.0000  |   1.0000   |   .869    .869
  7  |  1.0000     1.0000  |   1.0000   |   .940    .940
  8+ |  1.0000     1.0000  |   1.0000   |  1.026   1.026

------------------------------------------------------------
Summary of Yield per Recruit Analysis for:
SNE-MA YELLOWTAIL FLOUNDER - 1994-2001 INPUT

 Slope of the Yield/Recruit Curve at F=0.00: -->    2.5485
   F level at slope=1/10 of the above slope (F0.1): ----->    .246
     Yield/Recruit corresponding to F0.1: ----->     .2265
   F level to produce Maximum Yield/Recruit (Fmax): ----->    .739
     Yield/Recruit corresponding to Fmax: ----->     .2581
   F level at 40 % of Max Spawning Potential (F40): ----->    .261
     SSB/Recruit corresponding to F40: -------->    1.1288
```

Table A1.10 continued.

Listing of Yield per Recruit Results for:
SNE-MA YELLOWTAIL FLOUNDER - 1994-2001 INPUT

	FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
	.000	.00000	.00000	5.5167	3.2532	4.0669	2.8223	100.00
	.100	.21897	.15373	4.4270	2.2137	2.9720	1.8000	63.78
	.200	.33004	.21222	3.8766	1.7151	2.4167	1.3144	46.57
F0.1	.246	.36506	.22653	3.7037	1.5648	2.2416	1.1691	41.42
F40%	.261	.37497	.23015	3.6548	1.5231	2.1921	1.1288	40.00
	.300	.39788	.23774	3.5420	1.4281	2.0776	1.0374	36.76
	.400	.44405	.24951	3.3154	1.2441	1.8470	.8612	30.51
	.500	.47780	.25494	3.1508	1.1173	1.6786	.7405	26.24
	.600	.50373	.25727	3.0249	1.0251	1.5492	.6531	23.14
	.700	.52444	.25804	2.9249	.9552	1.4461	.5872	20.80
Fmax	.739	.53153	.25809	2.8908	.9321	1.4108	.5654	20.03
	.800	.54146	.25801	2.8432	.9005	1.3615	.5357	18.98
	.900	.55578	.25759	2.7747	.8565	1.2904	.4943	17.51
	1.000	.56805	.25698	2.7164	.8203	1.2297	.4603	16.31
	1.100	.57874	.25630	2.6658	.7899	1.1769	.4318	15.30
	1.200	.58817	.25559	2.6214	.7640	1.1304	.4075	14.44
	1.300	.59657	.25490	2.5819	.7416	1.0891	.3865	13.69
	1.400	.60414	.25424	2.5465	.7219	1.0521	.3682	13.04
	1.500	.61100	.25361	2.5145	.7046	1.0185	.3519	12.47
	1.600	.61728	.25301	2.4854	.6891	.9880	.3374	11.96
	1.700	.62305	.25245	2.4586	.6752	.9600	.3244	11.49
	1.800	.62838	.25191	2.4340	.6625	.9342	.3126	11.08
	1.900	.63334	.25140	2.4112	.6510	.9103	.3018	10.69
	2.000	.63796	.25091	2.3899	.6404	.8880	.2920	10.34

Figure A1.1. Statistical areas for southern New England – Mid Atlantic yellowtail flounder.

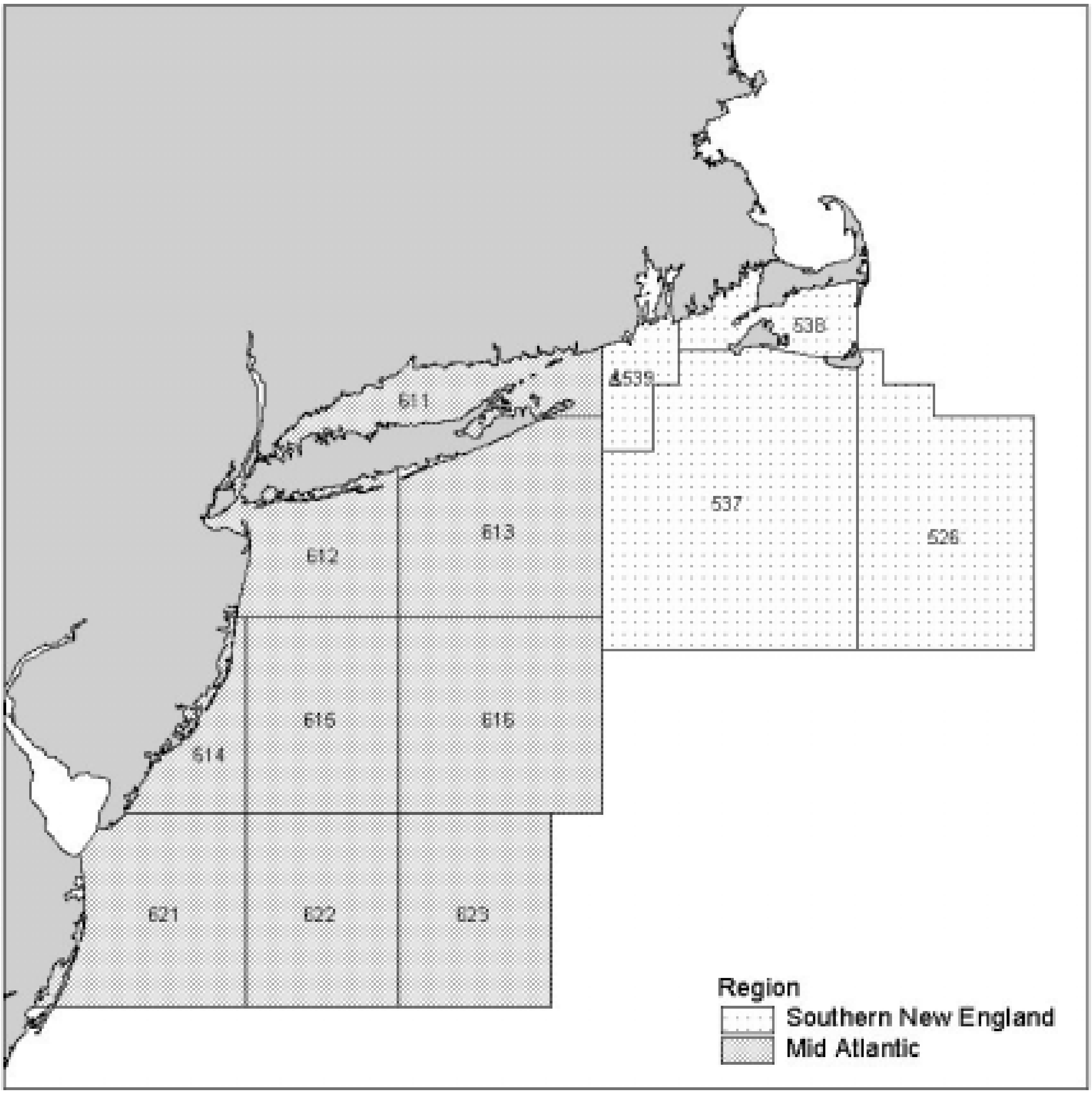


Figure A1.2. Catch of southern New England- Mid Atlantic yellowtail flounder.

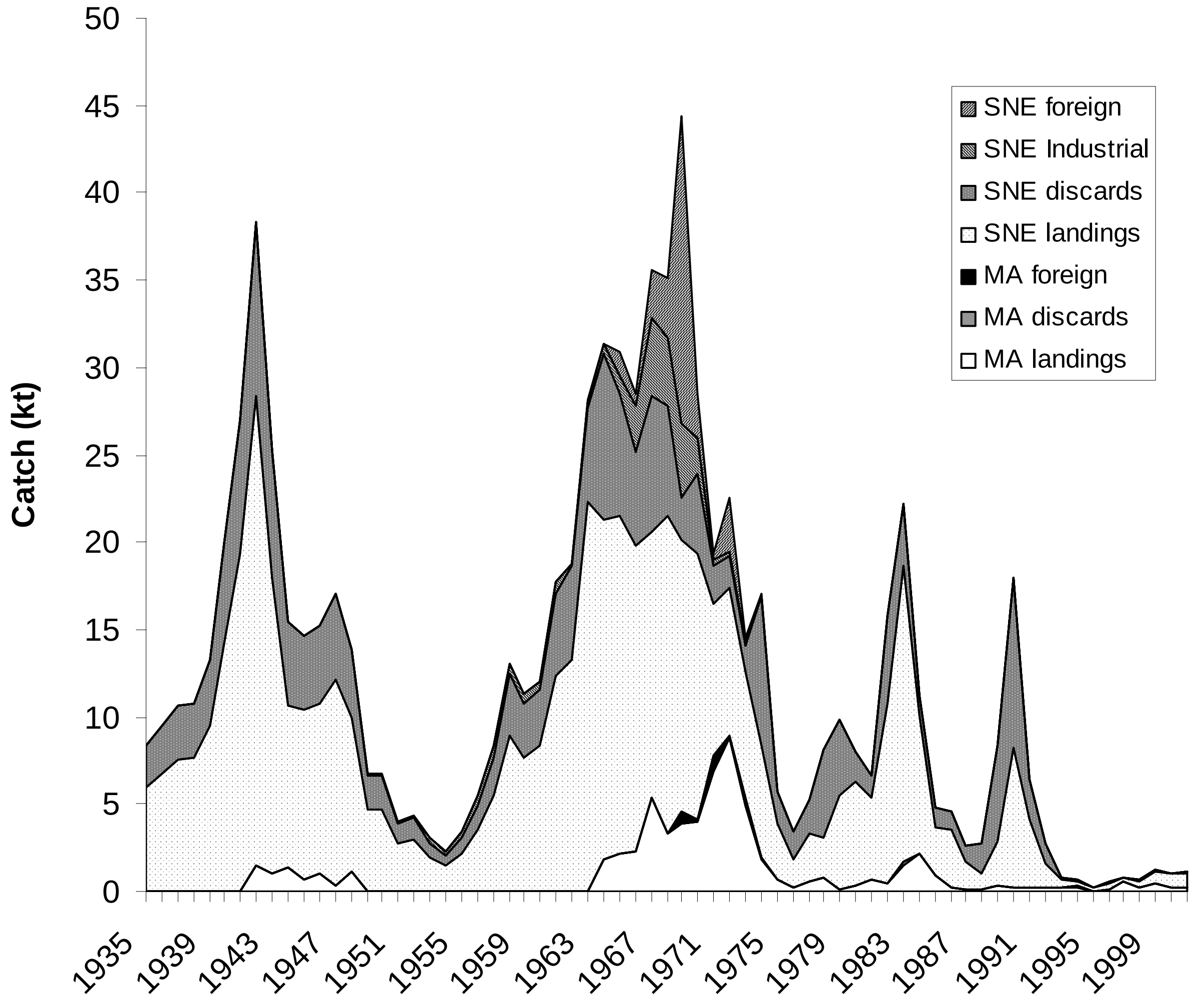


Figure A1.3. Total catch at age of southern New England – Mid Atlantic yellowtail flounder (size of circle indicates relative magnitude).

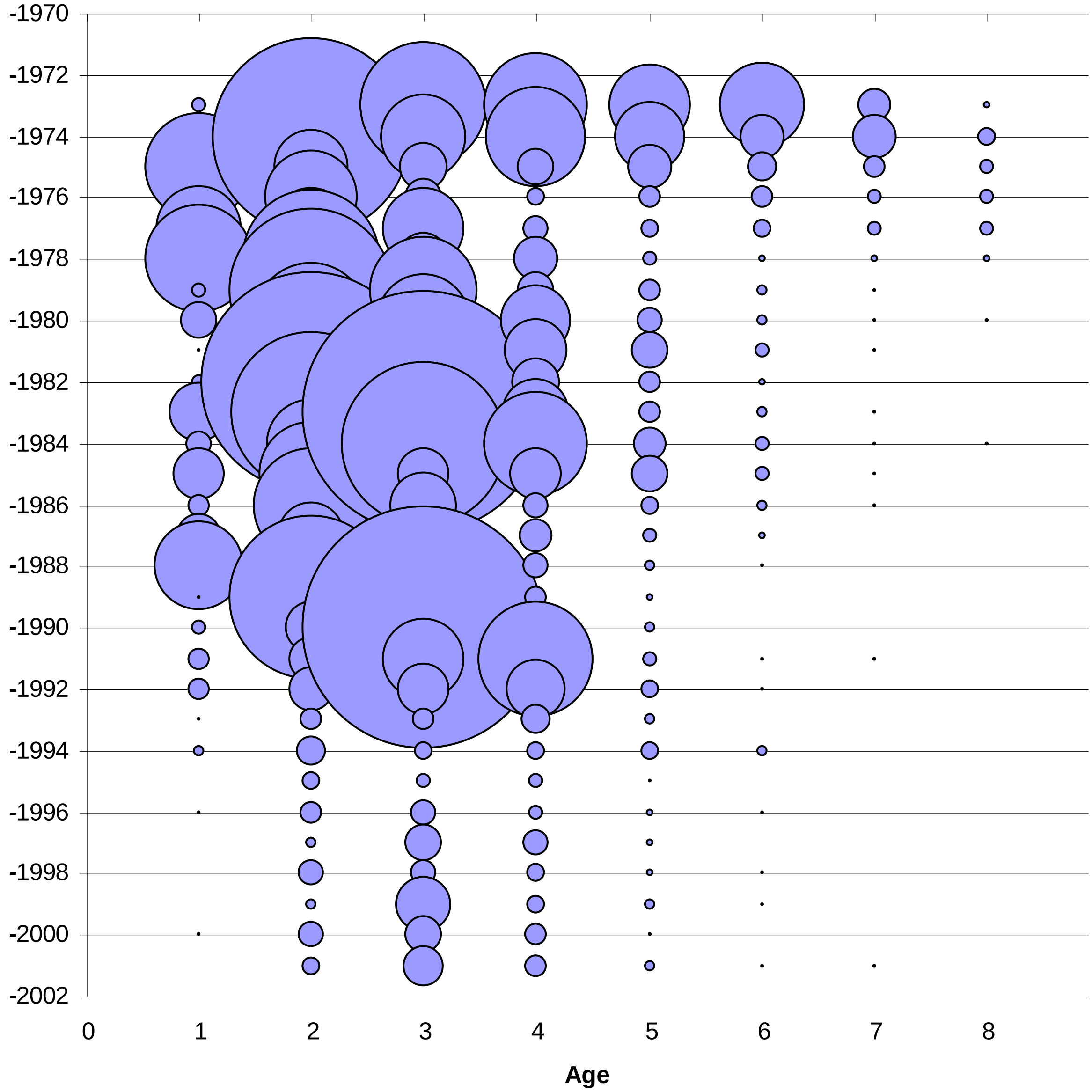


Figure A1.4. Mean weight at age of yellowtail flounder in the catch.

Figure A1.5. Survey strata for southern New England – Mid Atlantic yellowtail flounder.

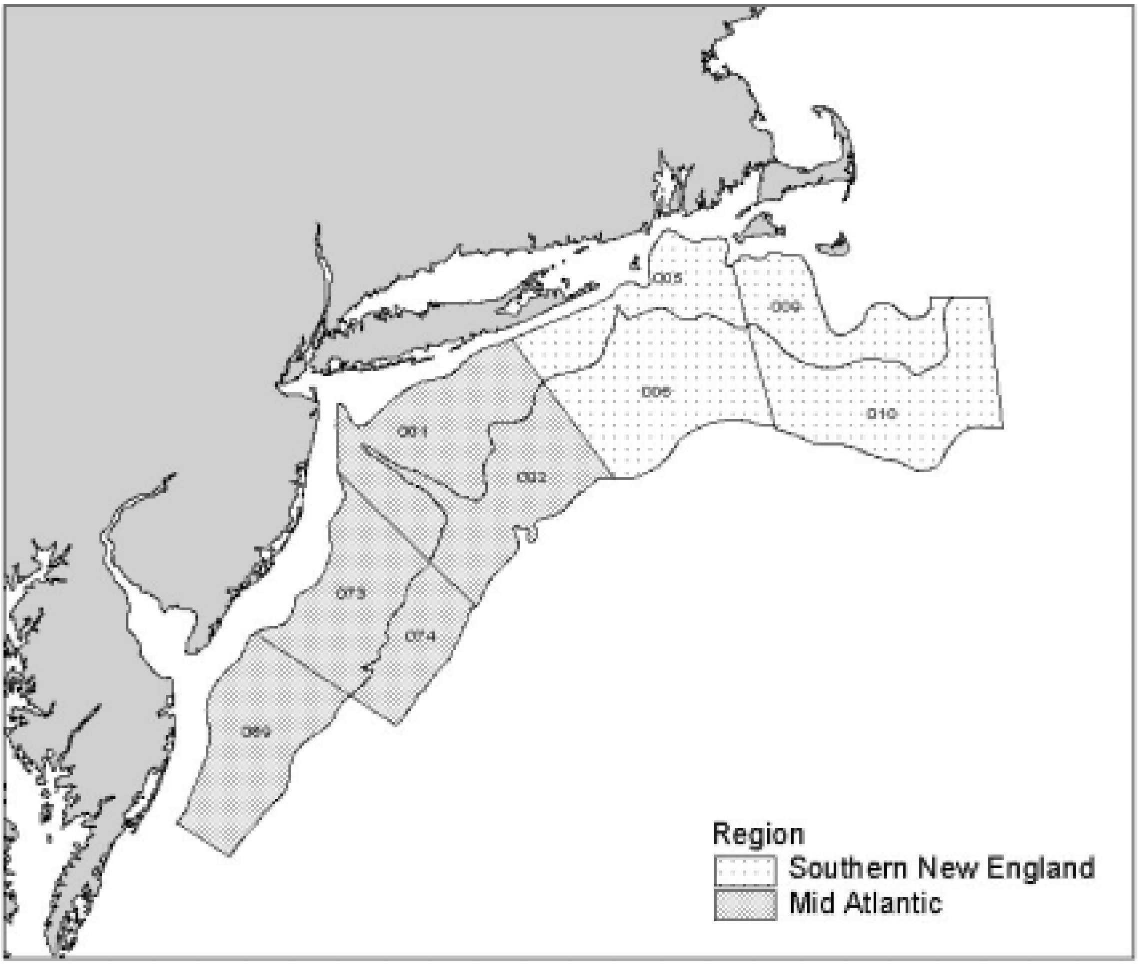
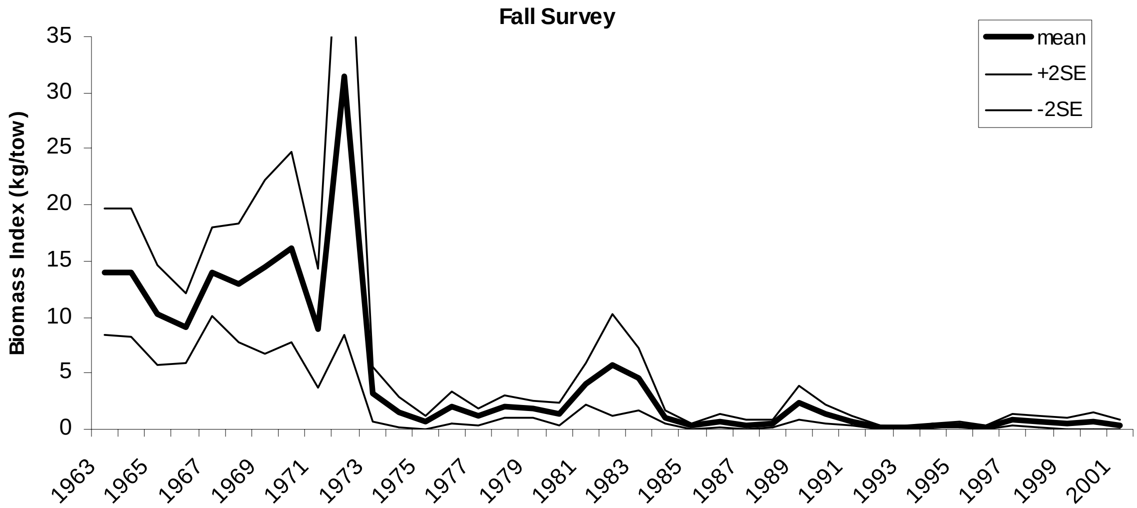
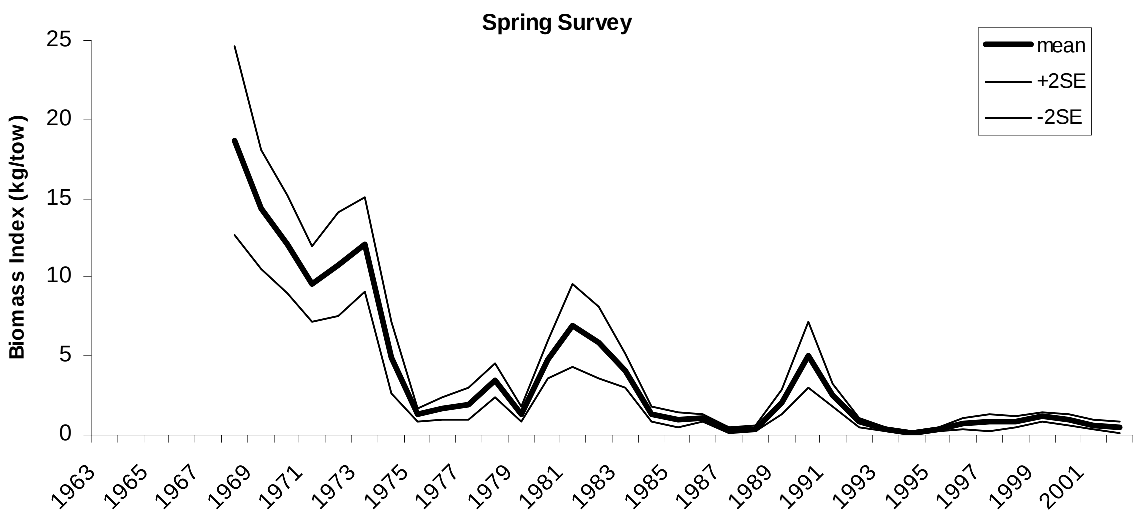


Figure A1.6. Survey indices of southern New England – Mid Atlantic yellowtail flounder biomass.





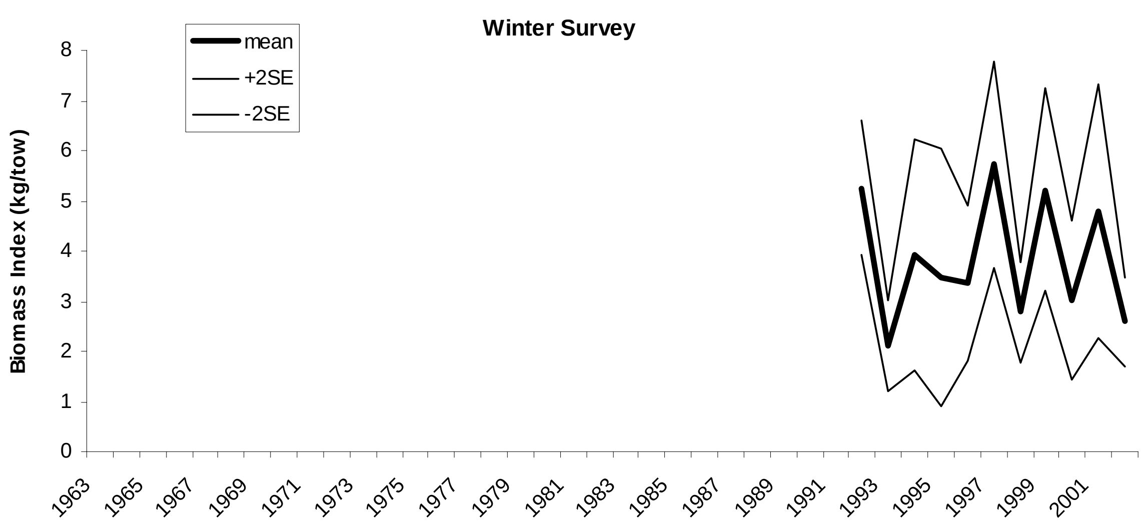


Figure A1.7a. Distribution of yellowtail flounder in recent NEFSC surveys.

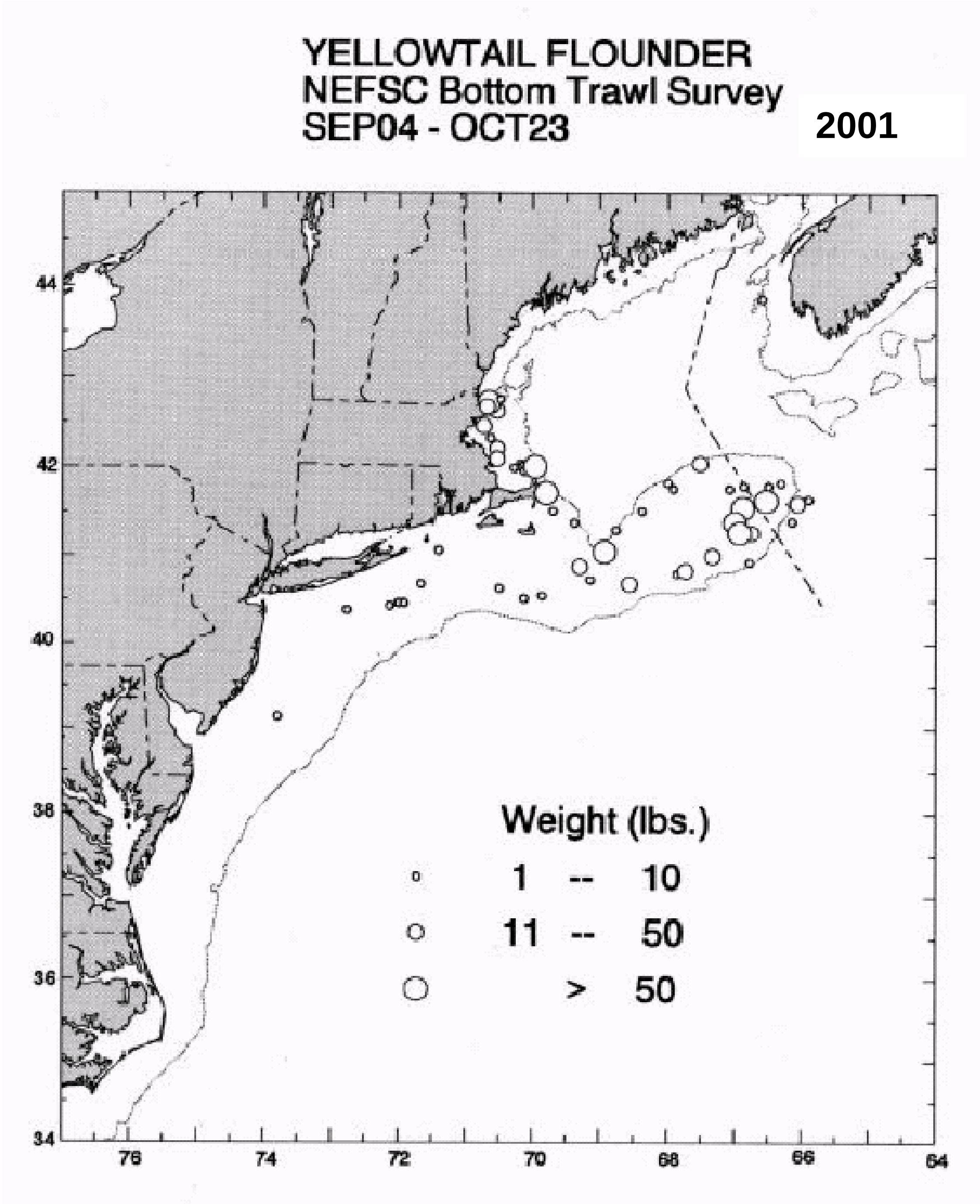


Figure A1.7b.

YELLOWTAIL FLOUNDER
NEFSC Bottom Trawl Survey
Feb 5 - Mar 2, 2002

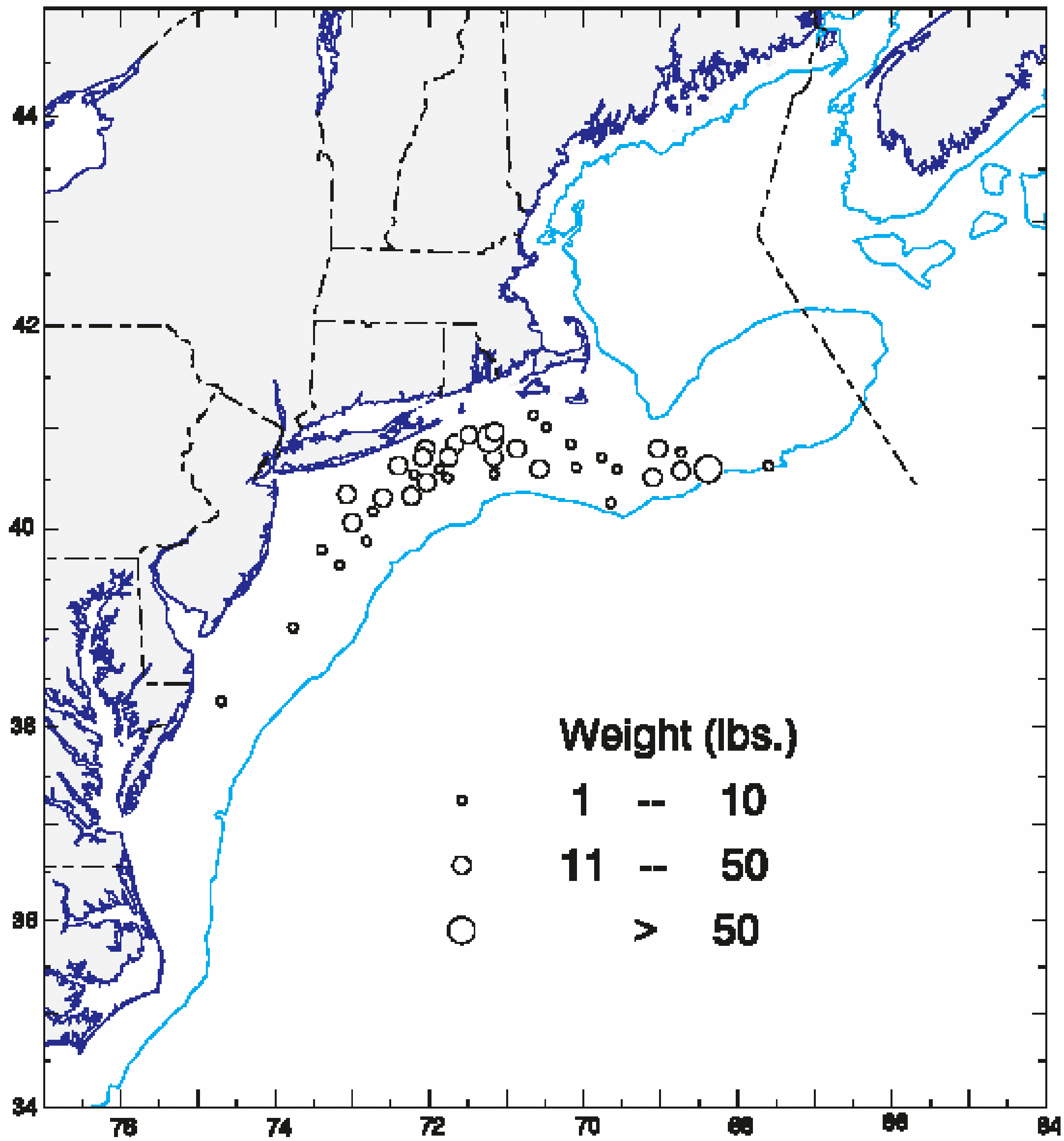


Figure A1.7c.

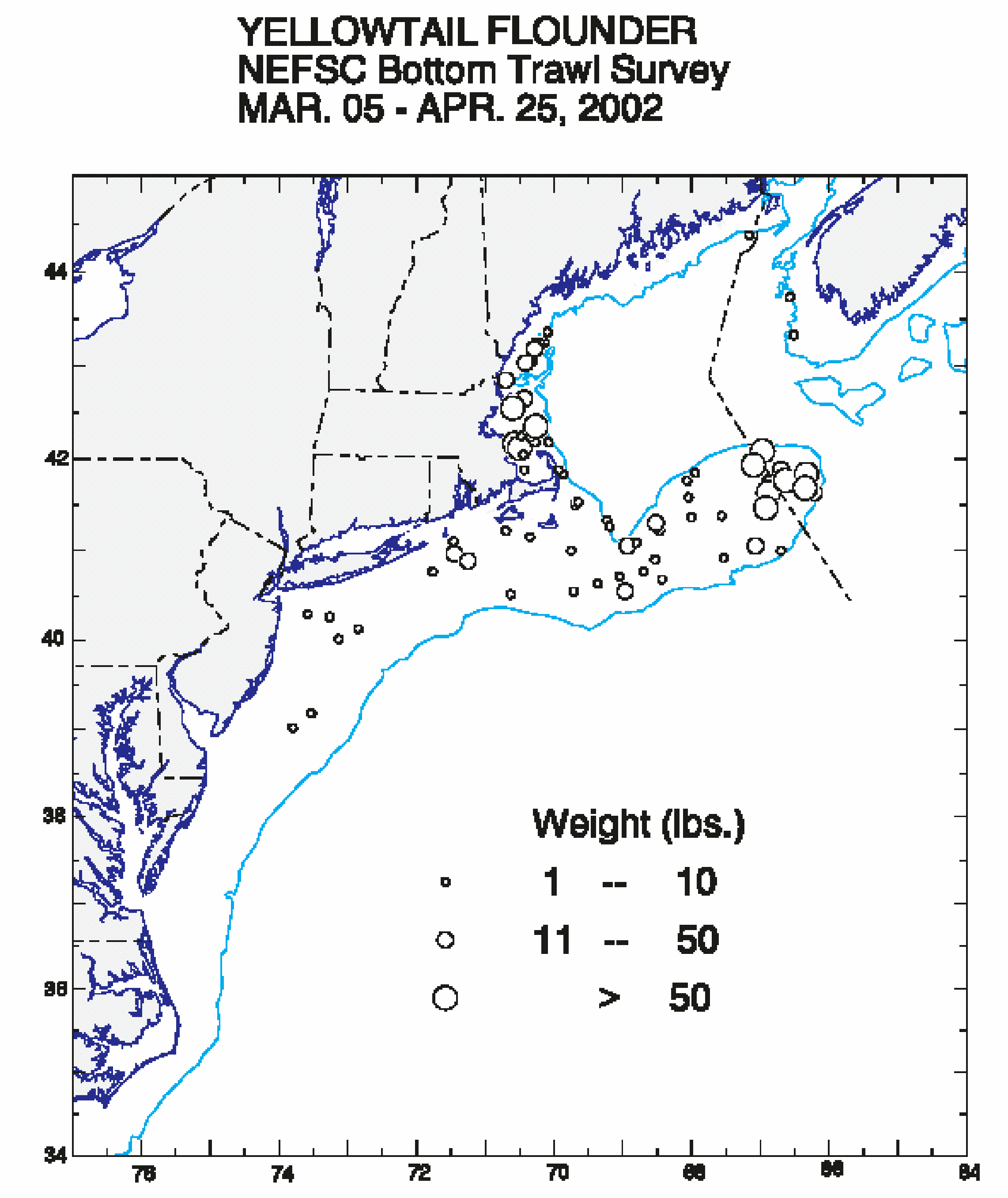

YELLOWTAIL FLOUNDER
NEFSC Bottom Trawl Survey
MAR. 05 - APR. 25, 2002
Weight (lbs.)
1 -- 10
11 -- 50
> 50
44
42
40
38
36
34
76
74
72
70

Figure A1.8. Area-swept biomass of southern New England – Mid Atlantic yellowtail flounder, by geographic region.

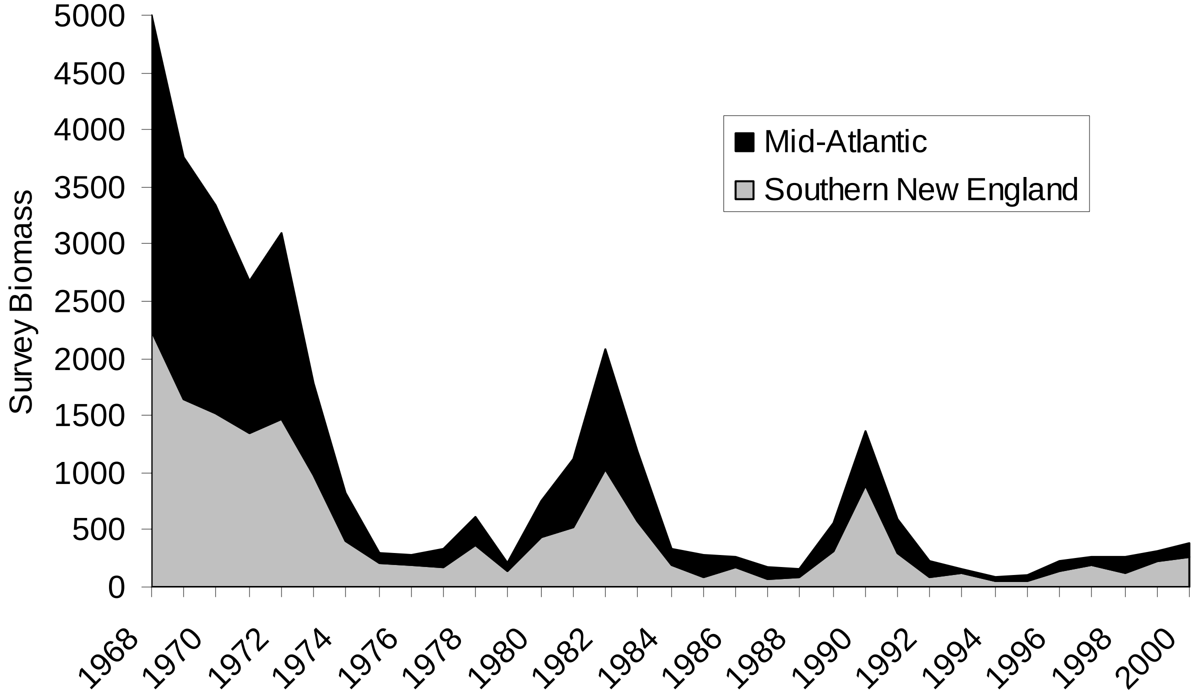


Figure A1.9a. Age distribution of southern New England – Mid Atlantic yellowtail flounder from NEFSC surveys (circle size indicates relative abundance).

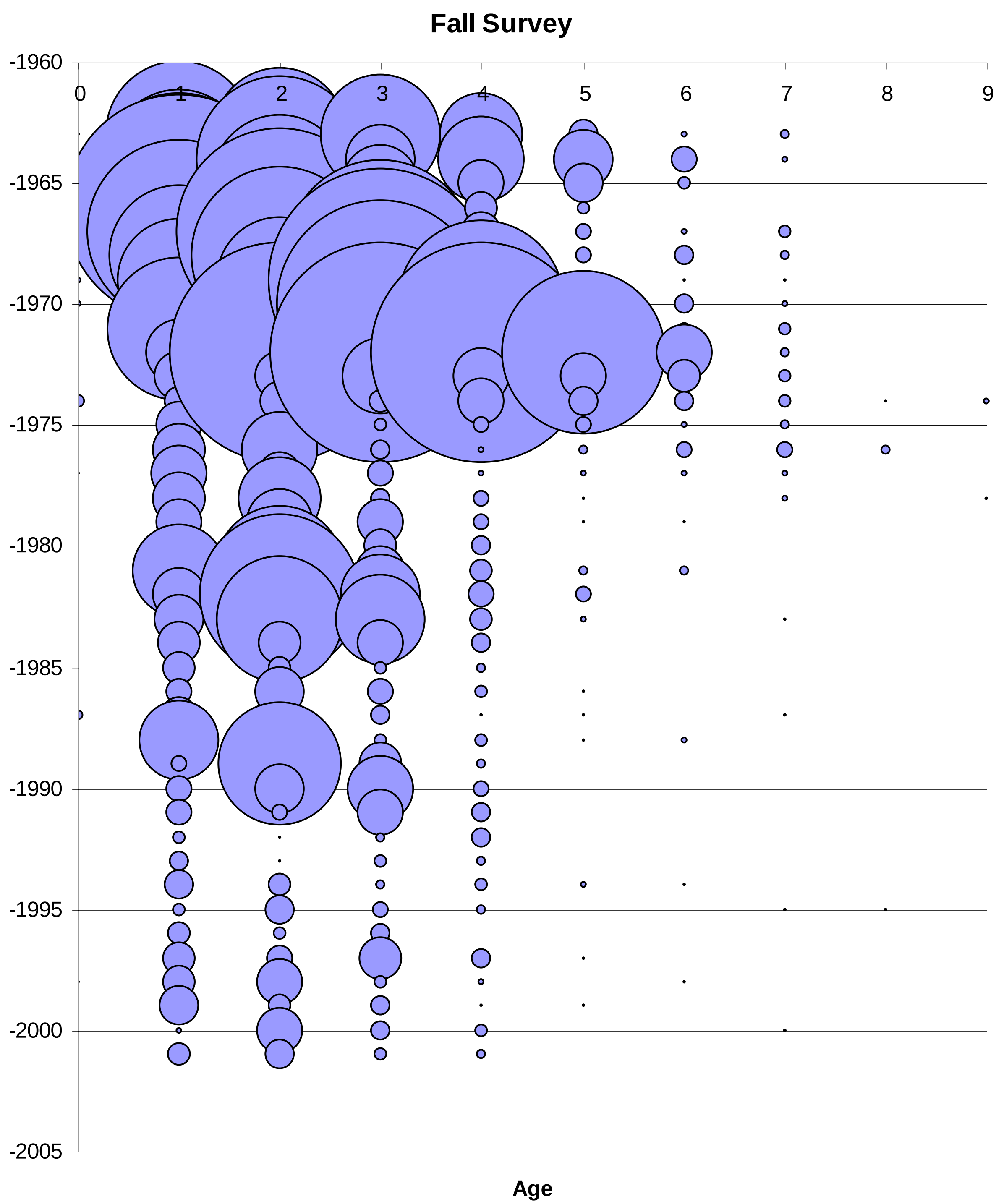
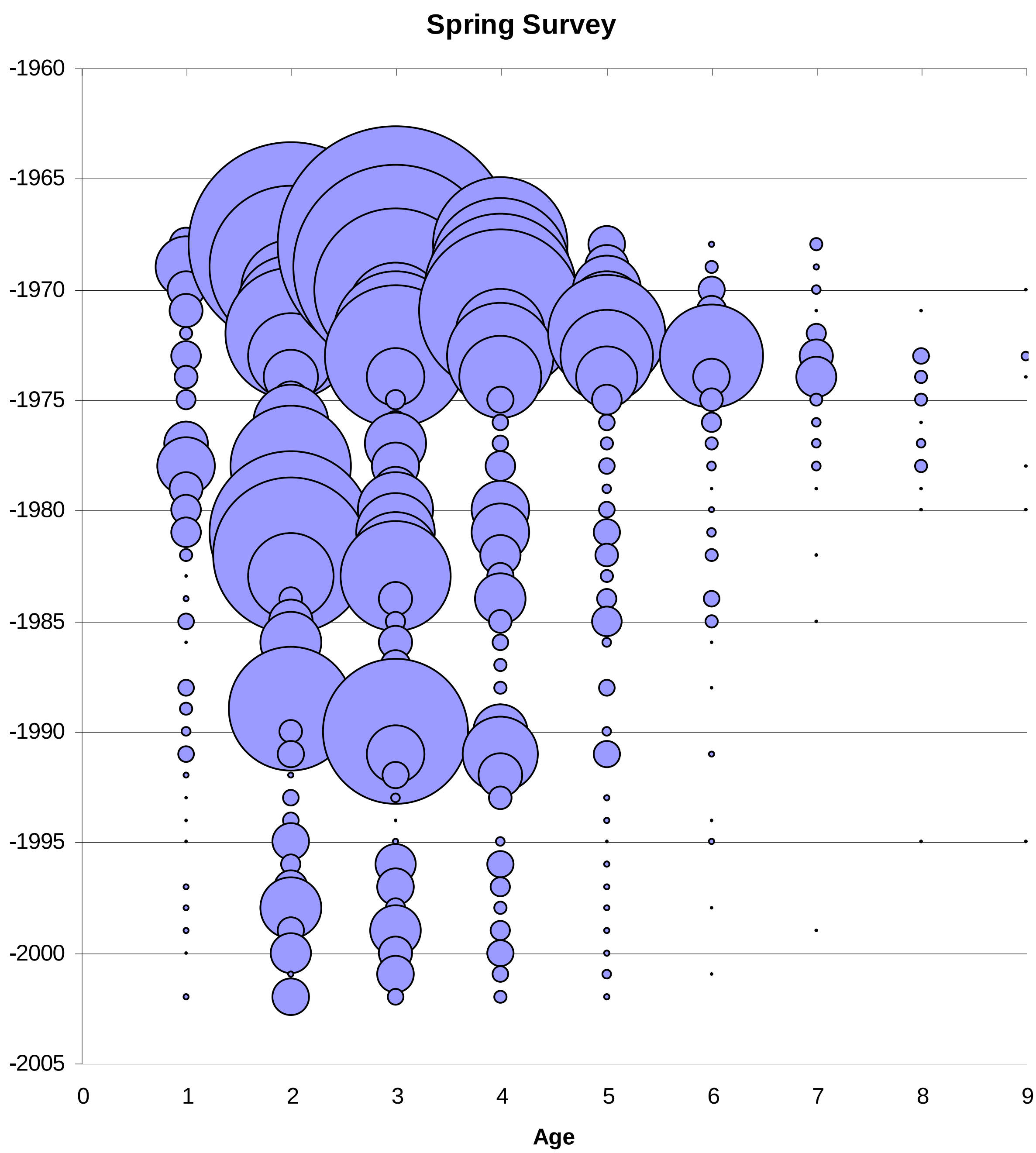


Figure A1.9b.



Spring Survey
-1960
-1965
-1970
-1975
-1980
-1985
-1990
-1995
-2000
-2005
0
1
2
3
4
5
6
7
8
9
Age

Figure A1.9c.

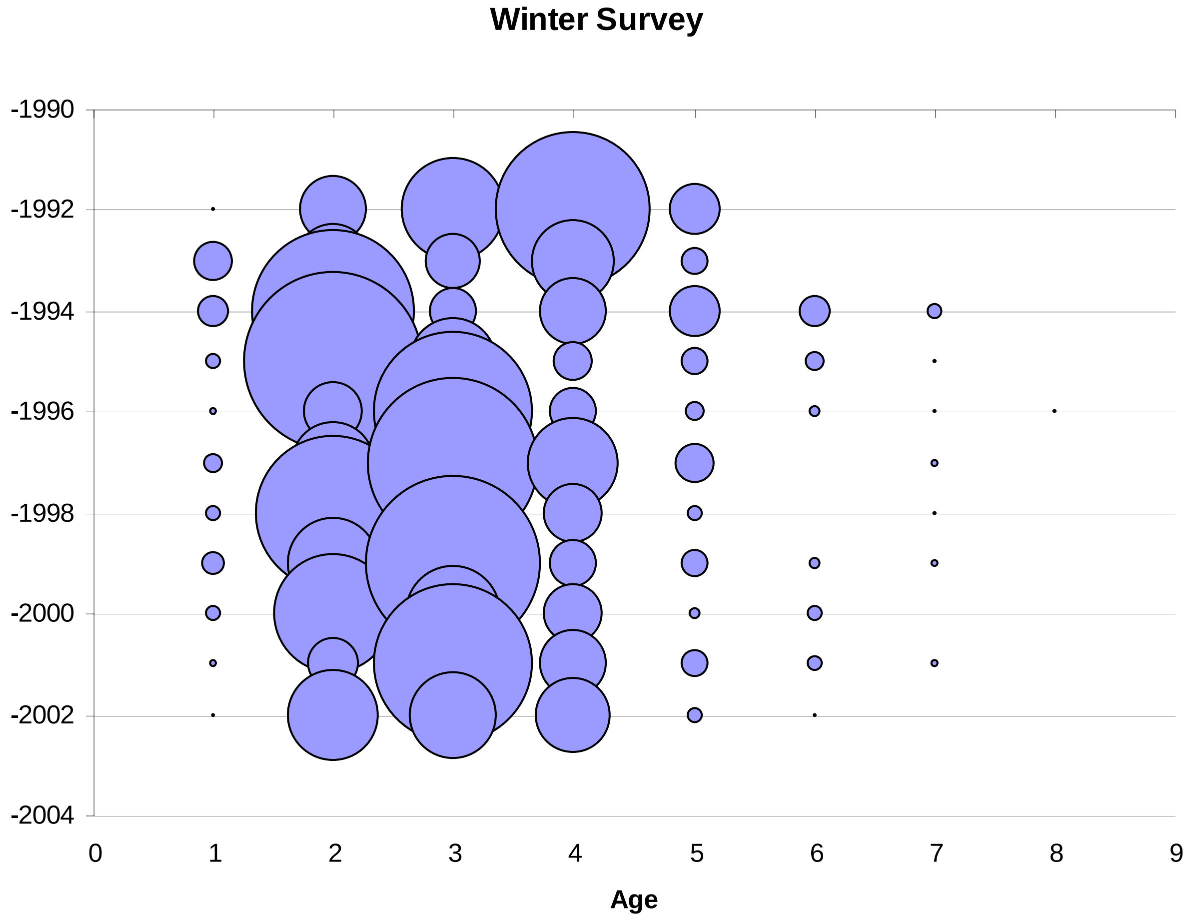

Winter Survey
-1990
-1992
-1994
-1996
-1998
-2000
-2002
-2004
0
1
2
3
4
5
6
7
8
9
Age

Figure A1.10a. Normalized indices of abundance of southern New England – Mid Atlantic yellowtail flounder, by age.

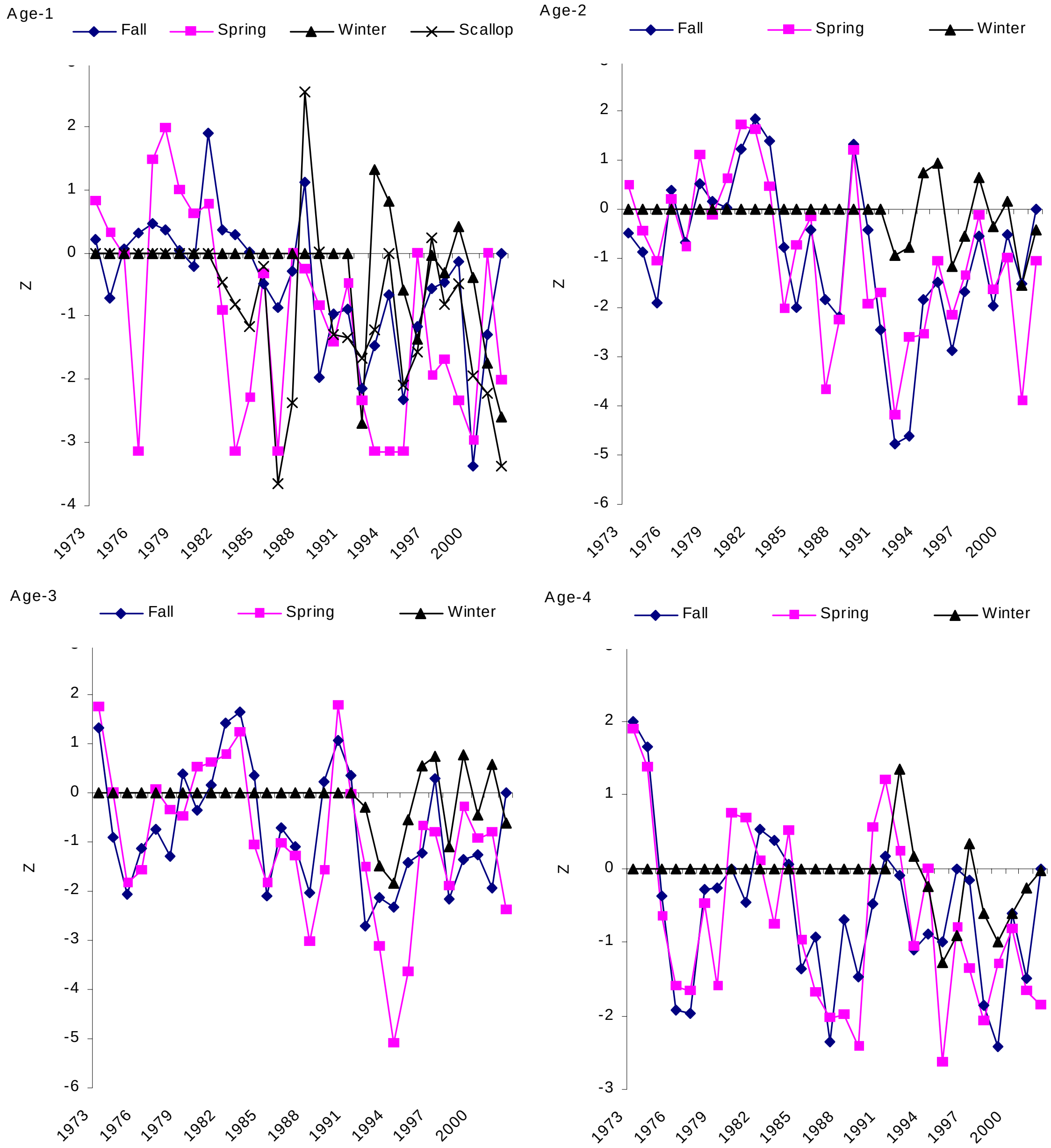


Figure A1.10b.

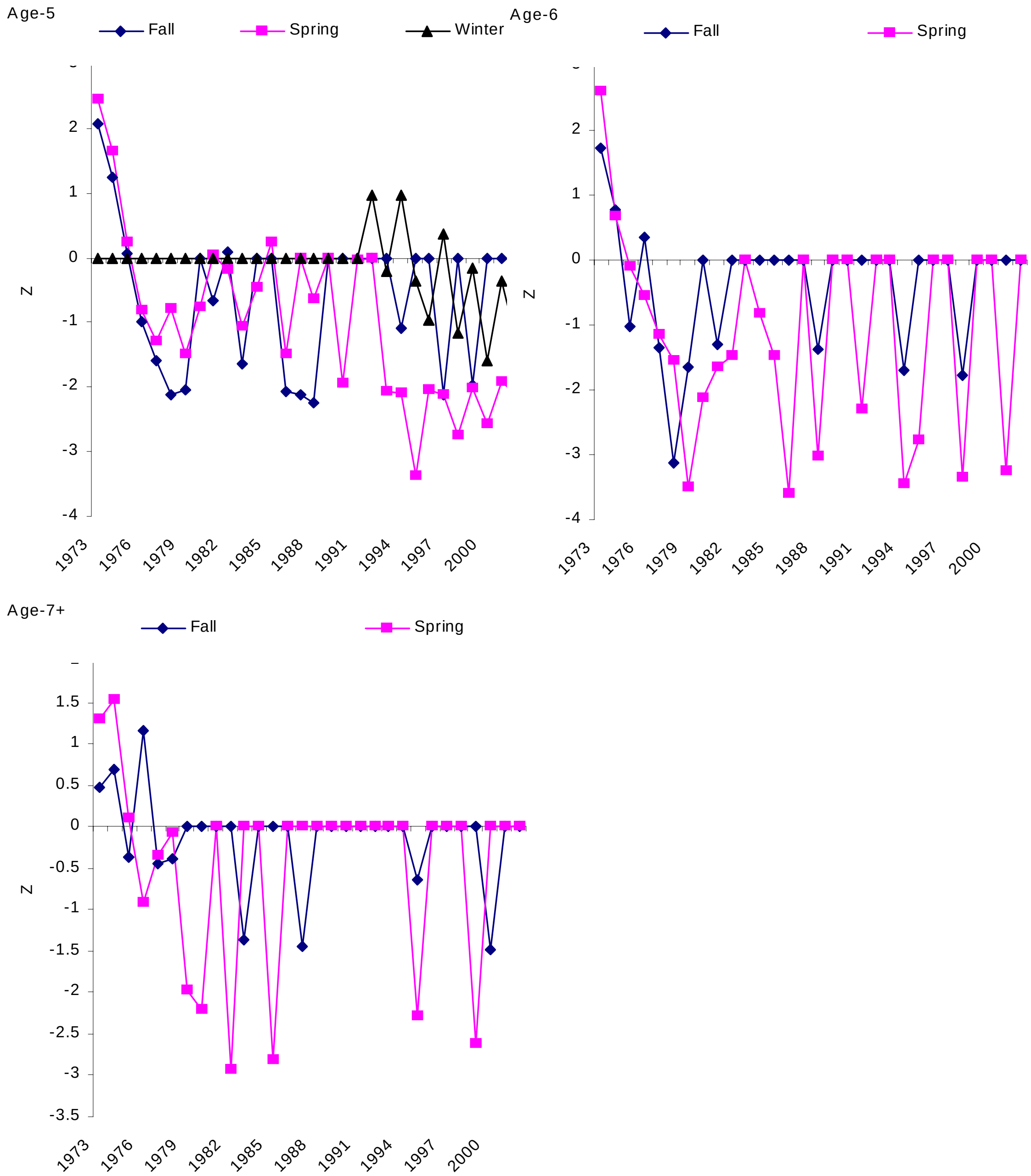


Figure A1.11a. Calibration residuals from southern New England – Mid Atlantic yellowtail flounder ADAPT analysis.

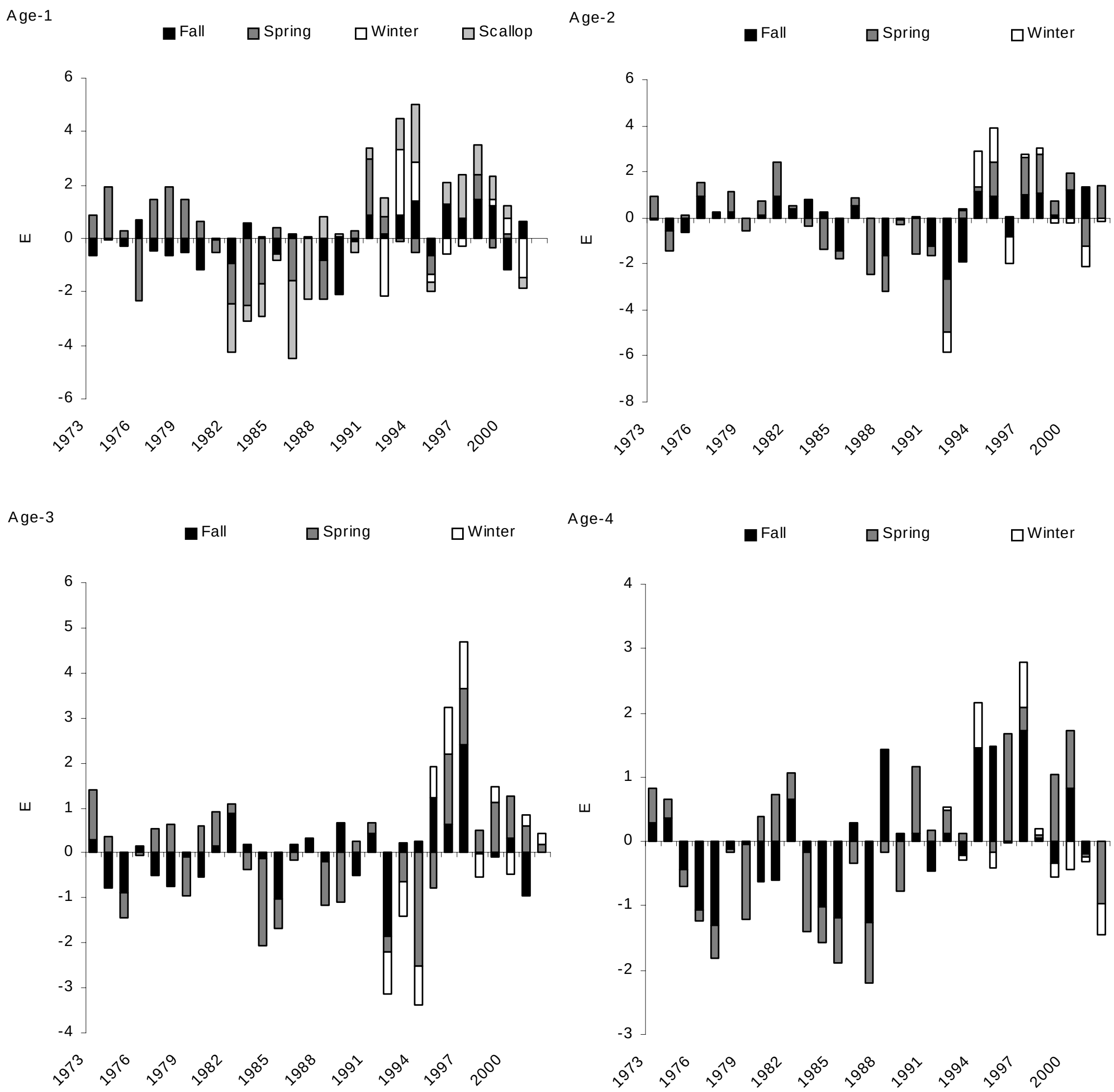
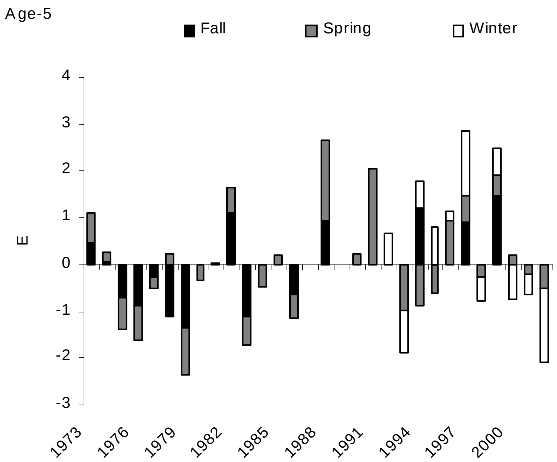
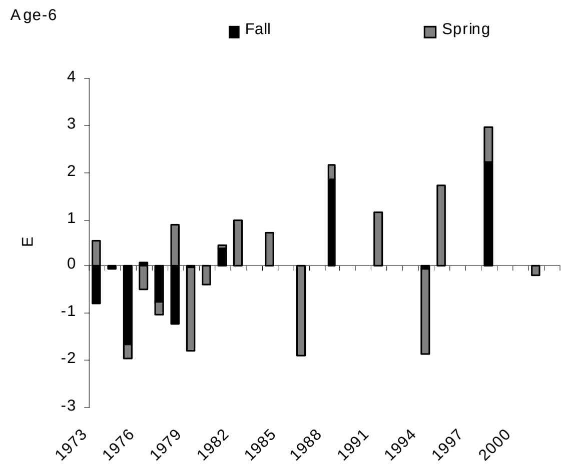


Figure A1.11b.





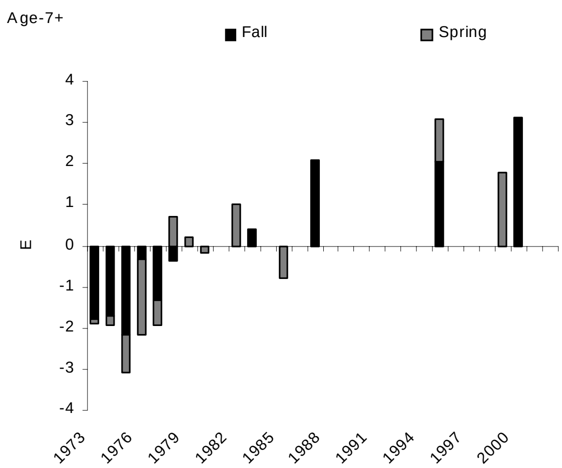
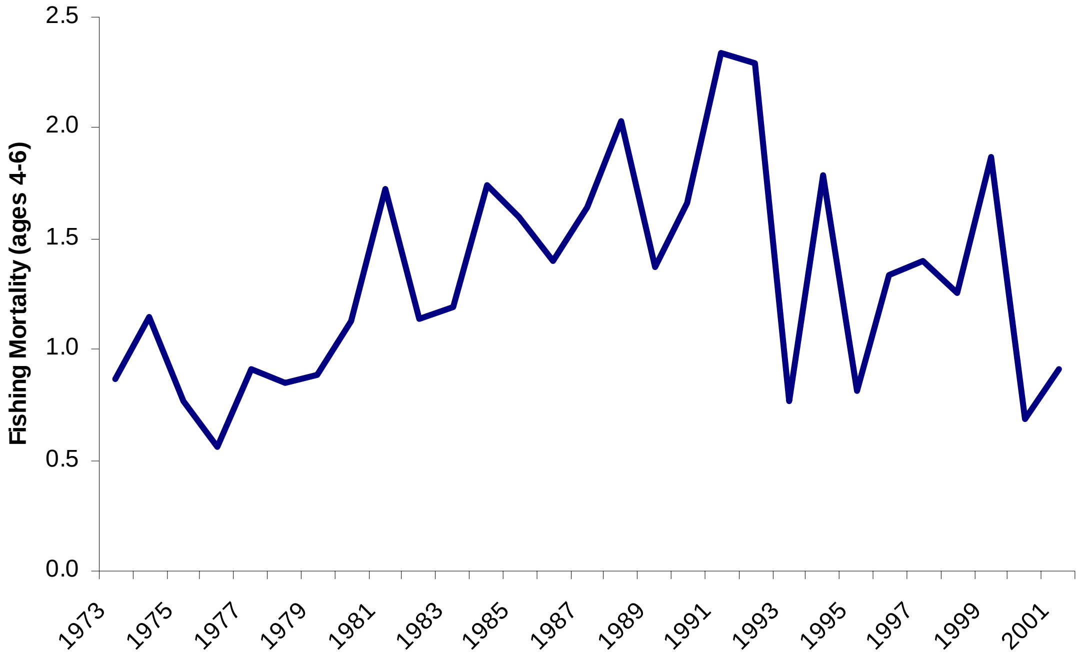


Figure A1.12a. VPA results for southern New England – Mid Atlantic yellowtail flounder.



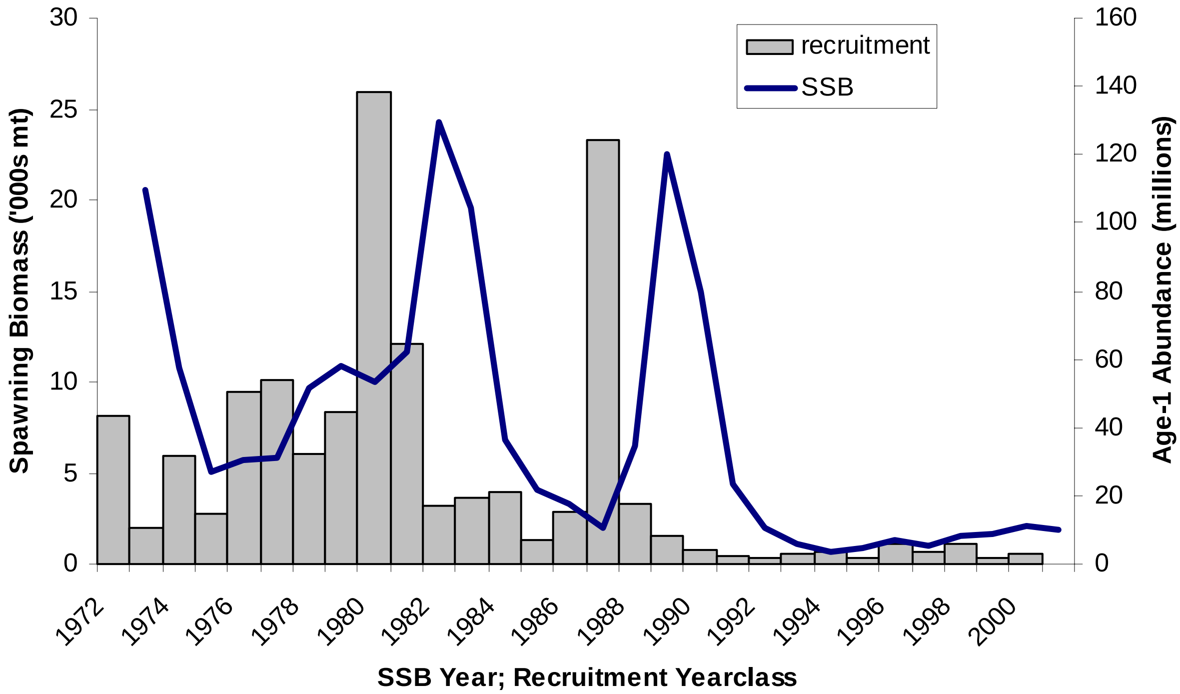


Figure A1.12b. Spawning stock and recruitment of southern New England – Mid Atlantic yellowtail flounder (points labeled by yearclass).

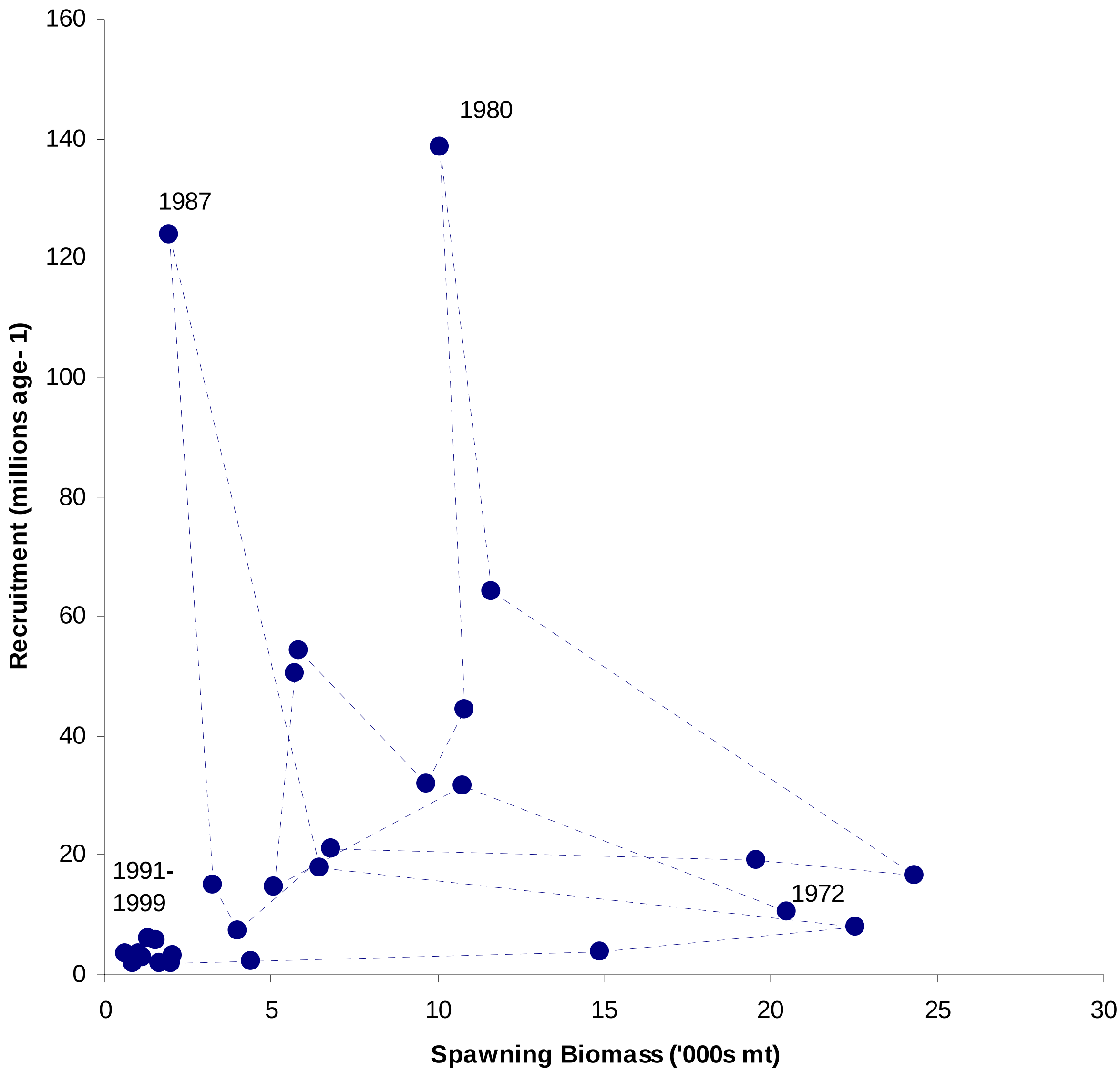


Figure A1.12c. Abundance at age of southern New England – Mid Atlantic yellowtail flounder.

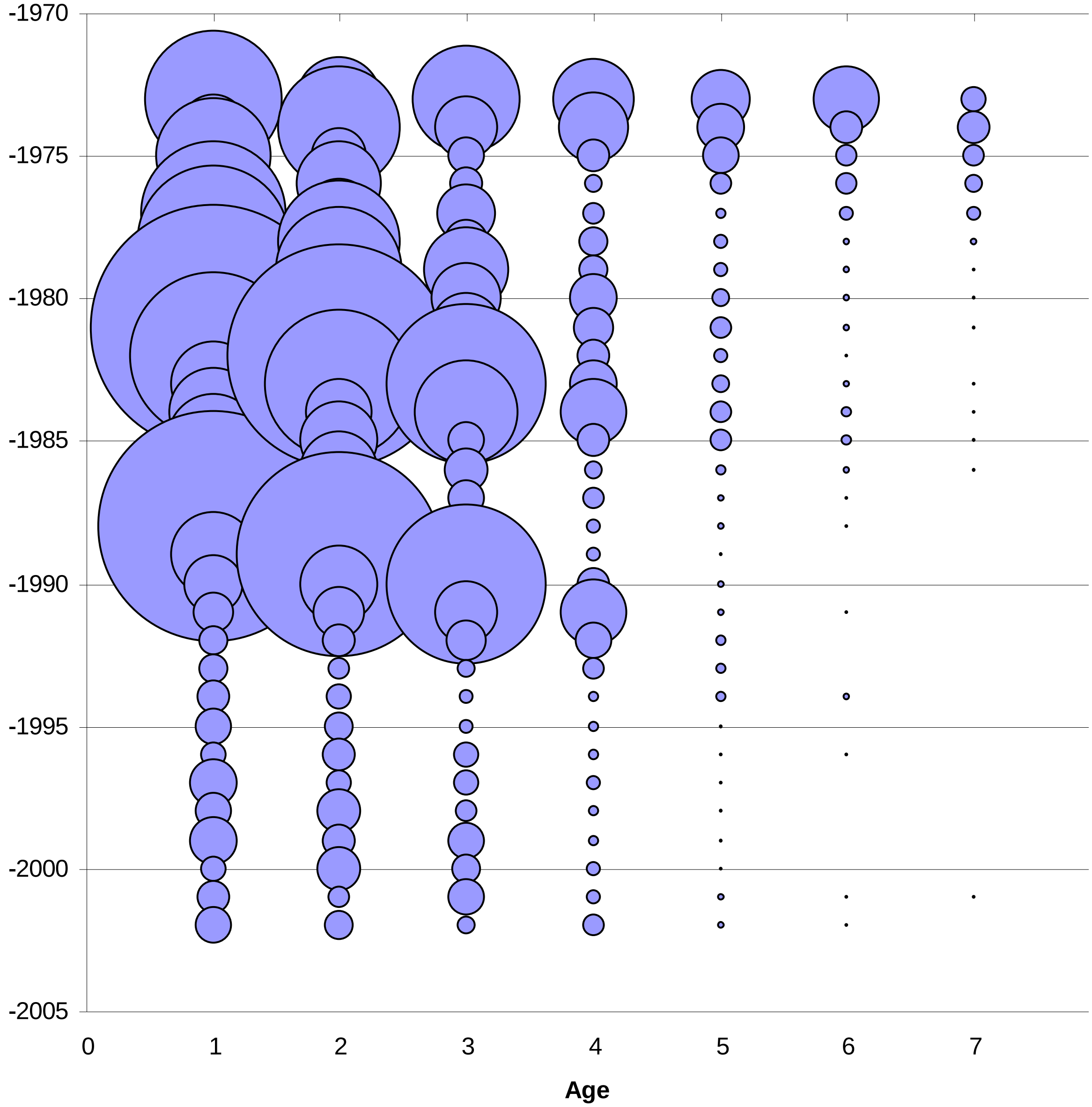


Figure A1.13. Retrospective analysis of the southern New England – Mid Atlantic yellowtail flounder VPA.

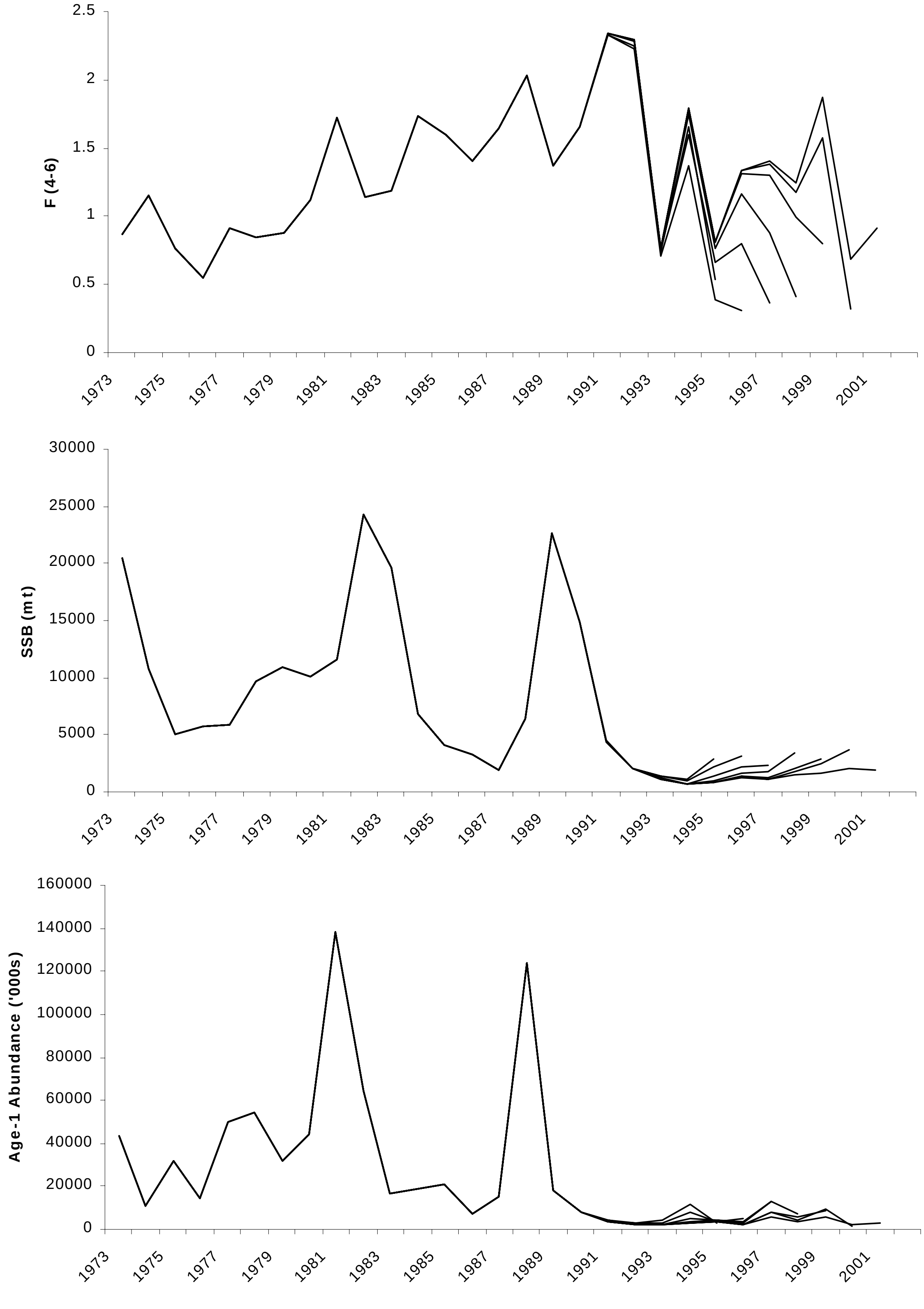
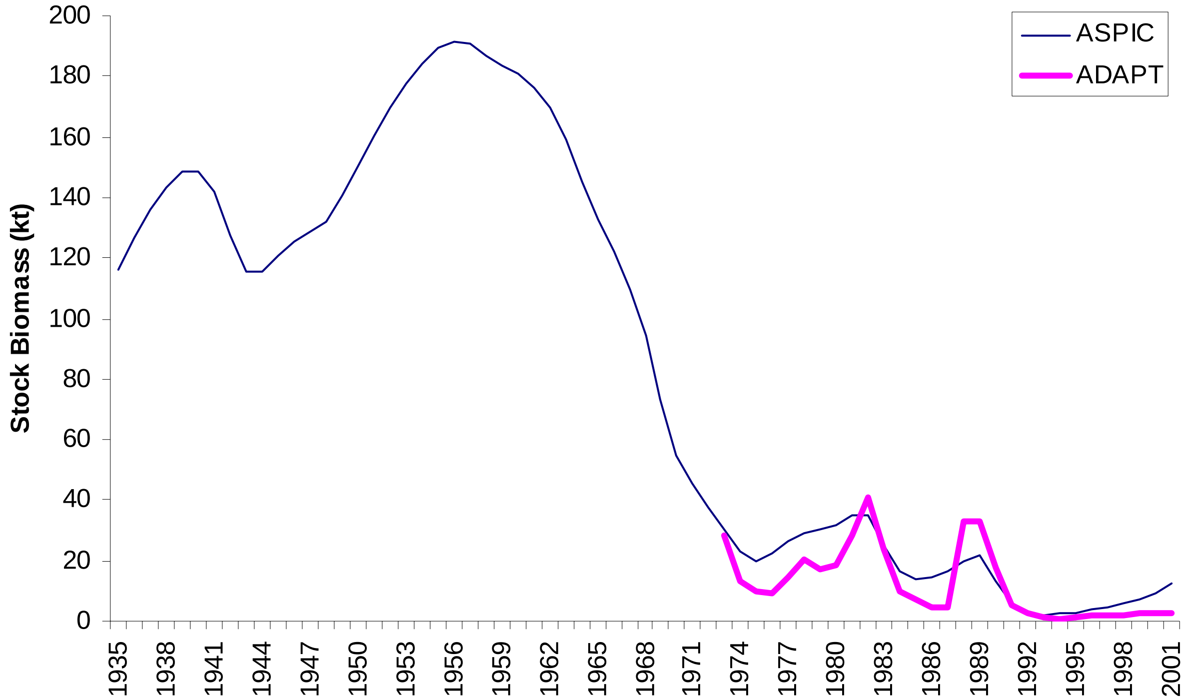


Figure A1.14. Results from biomass dynamics model (ASPIC) of southern New England – Mid Atlantic yellowtail flounder, with age-based estimates (ADAPT) for comparison.



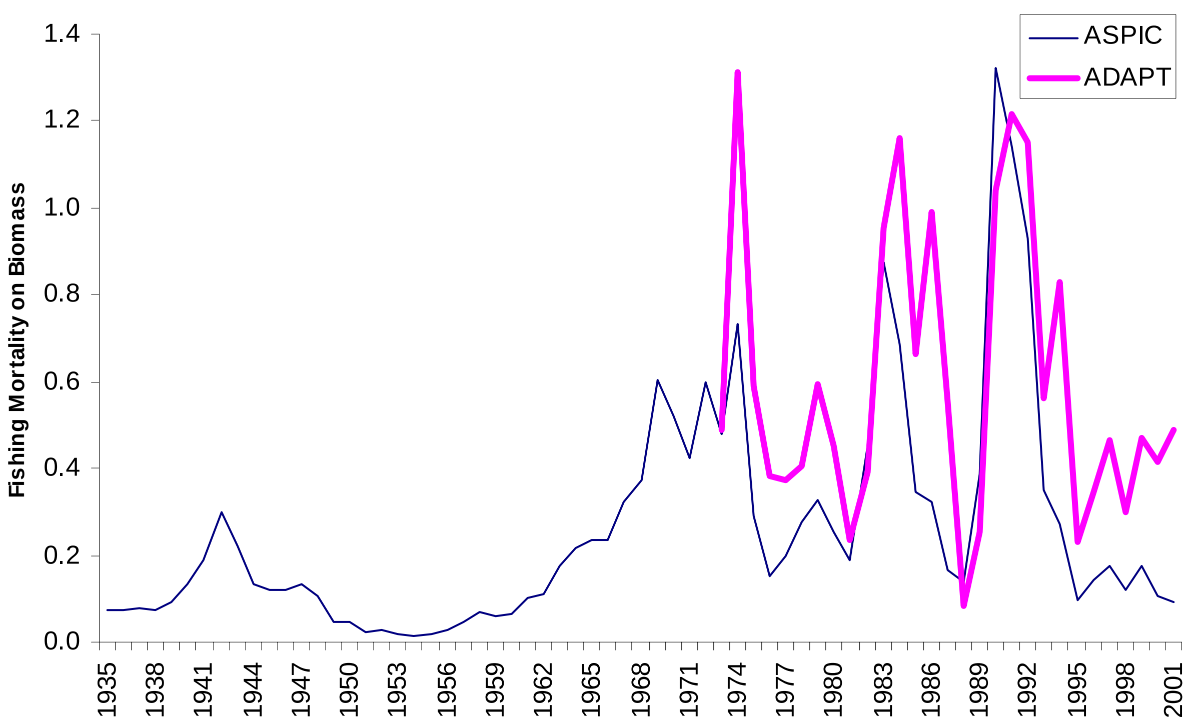


Figure A1.15. Yield and biomass per recruit of southern New England – Mid Atlantic yellowtail flounder.

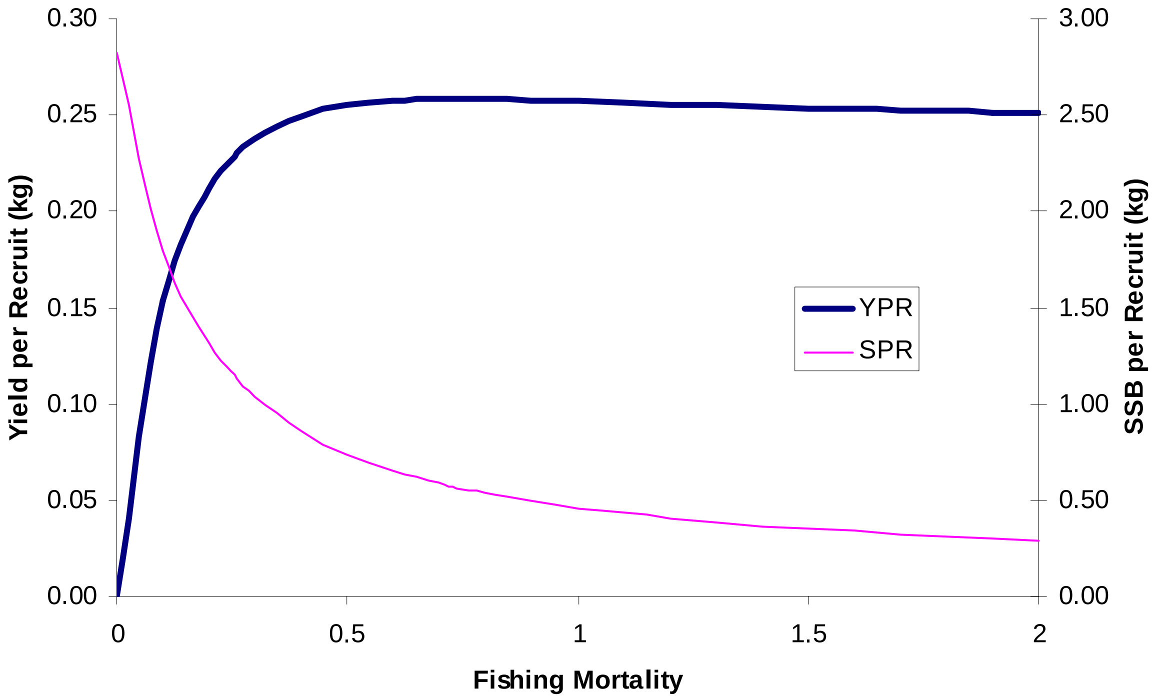


Figure A1.16. Stochastic projection of southern New England – Mid Atlantic yellowtail flounder spawning biomass (top panel) and landings (bottom panel) at F=0.26, assuming long-term recruitment (dotted lines indicate 90% confidence limits, and the dashed horizontal line indicates SSB_{MSY}).

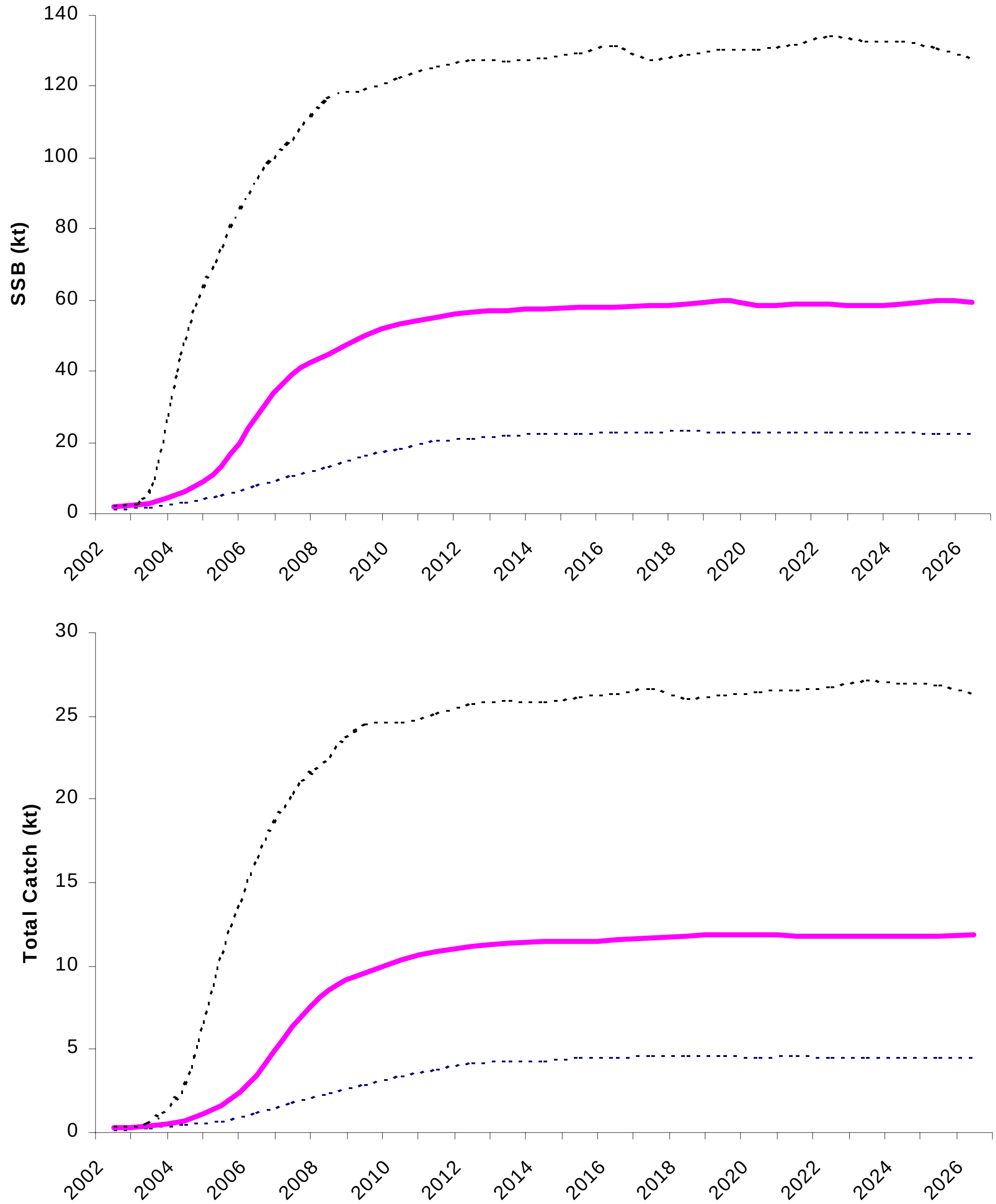


Figure A1.17. Stochastic projection of southern New England – Mid Atlantic yellowtail flounder spawning biomass (top panel) and landings (bottom panel) at a 2002 F of 0.77 and 2003-2009 F of 0.08, assuming long-term recruitment (dotted lines indicate 90% confidence limits, and the dashed horizontal line indicates SSB_{MSY}).

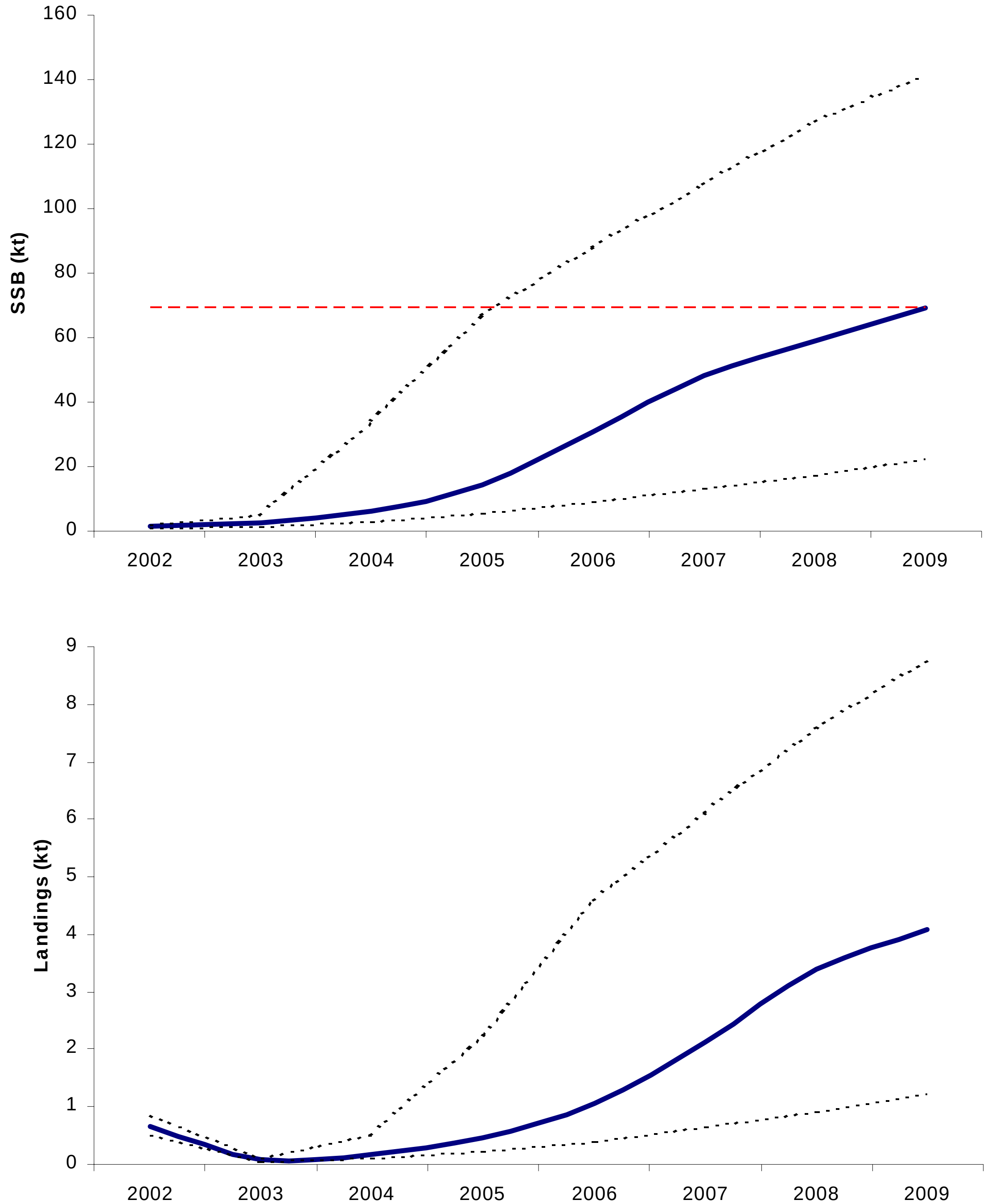


Figure A.1.18. Sensitivity analysis of MSY reference proxies for southern New England-Mid Atlantic yellowtail flounder, assuming different periods of recruitment (with 80% confidence intervals).