B. SOUTHERN NEW ENGLAND MID-ATLANTIC YELLOWTAIL FLOUNDER ASSESSMENT SUMMARY FOR 2012

State of Stock: A statistical catch-at-age model, ASAP (Legault and Restrepo 1999), is the best scientific information available for determining stock status for Southern New England Mid-Atlantic yellowtail flounder. For 2011, model-based estimates of spawning stock biomass (SSB) = 3,873 mt and average fishing mortality for ages 4-5 (F_{4-5}) = 0.12 (Figures B1 and B2).

Biological Reference Points (BRP's) were computed using $F_{40\%}$, a proxy for F_{MSY}, and a corresponding SSB_{MSY} proxy derived by sampling age-1 recruitment from an empirical cumulative distribution function (CDF) with two alternative recruitment scenarios. One scenario is based only on age-1 recruitment from a "recent" time period, 1990-2010, recognizing a potential reduction in stock productivity since about 1990. The other scenario uses the entire age-1 recruitment time series from 1973-2010, with "two stanzas" of recruitment determined by whether SSB is either above or below 4,319 mt. The SSB threshold of 4,319 mt was derived from a minimum residual variance analysis relating SSB to age-1 recruitment, which allowed recruitment to be sampled from the appropriate stanza depending on the value of SSB.

For both scenarios the overfishing threshold $F_{40\%}$ = 0.316, which implies that overfishing is not occurring in this stock (Figures B3 and B6). Stochastic projections at $F_{40\%}$ were used to determine biomass reference point proxies (i.e., for SSB_{MSY} and MSY). Conclusions about whether the stock is overfished depend on which recruitment scenario is used. Under the "recent" recruitment scenario, SSB_{MSY} = 2,995 mt (2,219-3,820 mt; a 90% confidence interval) and MSY = 773 mt (573-984 mt), which leads to the conclusion that the stock is not overfished (Figures B3 and B7). Because this stock is under a rebuilding plan with a rebuilding date set for 2014, the stock would be considered rebuilt under the scenario of "recent" low recruitment. Under the "two stanza" recruitment scenario, SSB_{MSY} = 22,615 mt (13,164 - 36,897 mt) and MSY = 5,834 mt (3,415-9,463 mt), which leads to the conclusion that the stock is still overfished (Figures B3 and B7). Neither scenario could be ruled out, but the SARC concluded that the evidence was 60:40 in favor of the "recent" recruitment scenario (i.e., productivity change). There is considerable uncertainty as to whether or not the stock is overfished.

Projections: Short-term projections of future stock status were conducted based on the results of the ASAP model. The projections did not account for retrospective error because the retrospective errors were considered minimal. Retrospective Mohn's Rho statistics based on 7-year peel resulted in retrospective error of -0.16 and 0.14 for average fishing mortality and spawning stock biomass respectively. The projections assumed that catch in 2012 equaled the Annual Catch Limit for 2012. Age-1 recruitment was sampled from a CDF for both the "recent" and "two stanza" recruitment scenarios. Under the more likely scenario of "recent" low recruitment, the stock is projected to be above the SSB_{MSY} associated with that scenario, with median annual catches averaging approximately 1,000 mt in 2013 - 2015 when fishing at F_{MSY} (Table B1). However, under the "two stanza" recruitment, the stock is not expected to rebuild even if the fishing mortality rate (F) were held at zero during 2013 – 2015 (Table B1).

Catch and Status Table: Southern New England Mid-Atlantic yellowtail flounder (Weights in 000's mt, recruitment in millions, arithmetic means)

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Max[1]	Min[1]	Mean[1]
Commercial Landings	0.8	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.1	0.2	18.5	0.1	3.2
Foreign Catch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Commercial discards	0.2	0.2	0.1	0.1	0.2	0.3	0.4	0.3	0.2	0.1	9.7	0.1	1.7
Catch used in the assessment	0.9	0.7	0.6	0.3	0.4	0.5	0.6	0.5	0.3	0.4	22.2	0.3	4.9
Spawning Stock Biomass	1.3	1.0	0.7	0.7	1.1	1.9	2.3	2.6	3.3	3.9	21.8	0.6	4.8
Recruitment (Age-1)	2.1	1.9	3.2	9.5	8.0	4.2	7.5	7.9	5.2	8.2	190.5	1.9	28.7
F4-5	1.2	0.9	1.0	0.7	0.6	0.4	0.3	0.2	0.1	0.1	3.1	0.1	1.1

[1]Over the period 1973-2011, the period of the assessment.

Stock Distribution and Identification: Yellowtail flounder inhabit relatively shallow waters (20-100 m) of the continental shelf of the Northwest Atlantic from Labrador to Chesapeake Bay. An evaluation of yellowtail flounder stock structure indicates that, in Southern New England and Mid-Atlantic waters, yellowtail flounder constitute a single stock. The stock area is defined as the continental shelf from Nantucket Shoals to the southern extent of the species range (U.S. statistical reporting areas 526, 537, 538, 539, and division 6). There has been a reduction in the stock over time in the Southern New England – Mid-Atlantic region (Figure B4).

Catches: In the assessment period (1973-2011), total catch has ranged from approximately 22,000 mt to 290 mt. Prior to 2005, landings constituted roughly 70-80% of the total catch, but recently landings have only contributed approximately 40-50% of the total catch. The magnitude of landings has been very low, averaging about 400 mt in the last 5 years, due to a combination of low biomass and regulatory restrictions on commercial landings that lead to an increase in commercial discards in the fishery.

Starting in 2005, commercial discards became a significant component, accounting for over 50% of the overall catch. Increases in discards were partly the result of restrictive trip limits that were in effect from 2003 through 2008. The scallop fleet has been a primary contributor of yellowtail discarding for market reasons and despite efforts to gradually relax the trip limits, discards of yellowtail remain approximately 60% of the total catch (Figure B5).

Discard mortality of yellowtail flounder in the previous assessment was assumed to be 100%. However, based on a recent study (Barkley and Cadrin 2012), this new assessment assumed a 90% discard mortality rate in the commercial catch.

Data and Assessment: The previous assessment of Southern New England Mid-Atlantic yellowtail flounder was conducted with a Virtual Population Analyses (VPA) model that used total commercial landings, discards and survey data from 1973-2007 (NEFSC, 2008). The new assessment model (ASAP) includes revised biological data (length-weight relationship, maturity at age, and natural mortality), survey input data (i.e. winter survey) and fishery input data (i.e., fishery catch weights and numbers from 1994-2011).

Catch at age from 1973-2011 was aggregated into a single fleet. The commercial fleet catch includes US catch by otter trawl and the scallop dredge with minor contributions from the scallop trawl in the recent years.

NEFSC spring and fall surveys (1973-2011) and the NEFSC winter survey (1992-2007), expressed as minimum swept area values, were used in the ASAP model along with estimated CVs and annual age composition. Conversion factors for the fall and spring NEFSC surveys were applied to account for any changes in the door, gear and vessel operations.

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

Biological Reference Points: This assessment updated F40%, the overfishing threshold proxy for F_{MSY}. A deterministic value of F40% was estimated from a yield per recruit analyses using the most recent five year average from 2007-2011of SSB weights, catch weights and fishery selectivity at age. Maturity at age and natural mortality at age were both time invariant. Expressed as fully recruited fishing mortality ($F_{ages4-5}$), F40% was estimated to equal 0.316.

Stochastic projections at $F_{40\%}$ were used to determine biomass reference point proxies (i.e., for SSB_{MSY} and MSY) under two recruitment scenarios. Under the more likely scenario of recent low recruitment, SSB_{MSY} proxy = 2,995 mt, with 5th and 95th percentiles ranging from 2,219 – 3,820 mt. Under the scenario of two stanza recruitment, SSB_{MSY} proxy = 22,615 mt, with 5th and 95th percentiles spanning 13,164 - 36,897 mt.

Under the recent low recruitment scenario, MSY proxy = 773 mt with 5th and 95th percentiles of 573 – 984 mt . Under the two-stanza recruitment scenario, MSY proxy = 5,834 mt, with 5th and 95th percentiles of 3,415 – 9,463 mt.

Under the recent low recruitment scenario, median age-1recruitment = 5.8 million fish with 5th and 95th percentiles of 2.1million to 10.1 million. Under the two stanza recruitment scenario, age-1 recruitment = 37.7 million age 1 fish, with 5th and 95th percentiles ranging from 8.5 to 127.8 million fish.

The biological reference points that had been used previously were F_{MSY} proxy = $F_{40\%}$ = 0.254, SSB_{MSY} proxy = 27,400 mt, and MSY proxy = 6,100 mt.

Fishing Mortality: The fishing mortality rate (F) has been greater than the overfishing reference points for most years since 1973. F has ranged from 0.12 to 3.1. Fishing mortality generally increased in the 1980s and early 1990s to peak at 3.1 in 1990, averaged 1.6 during the 1990s, but decreased in the 2000's to 0.12 in 2011 with a 90% confidence interval of 0.08-0.16 (Figure B6).

Biomass: Spawning stock biomass was high in the early 1970s, decreased in the late 1970s, and increased in the 1980s, with the recruitment of the 1980 and 1987 cohorts. SSB decreased to a record low 621 mt in 1994, increased briefly to 1,670 mt in 2000, but then decreased to 686 mt in 2005, the second lowest value in the time series. Since 2006, SSB has increased steadily due to moderate 2004 and 2005 year classes. In 2011, SSB = 3,873 mt, with a 90% confidence interval of 3,077-4,960 mt (Figure B7).

Total January 1 biomass in 2011 was 5,305 mt. Over the entire time series, total biomass ranged from 399 mt in 2004 to 62,098 mt in 1988 (Figure B7). Generally, the trends in total biomass are similar to trends in SSB.

Recruitment: Age-1 **r**ecruitment was generally strong in the 1970s, and moderate during the 1980s, with two relatively strong year classes in 1980 and 1987 (Figure B8). For the last two decades, recruitment has been consistently low.

Special Comments:

- Causal mechanisms for the recent low recruitment were not identified. However, a suite of environmental processes may be involved. To address this uncertainty, two scenarios were identified: "recent" low recruitment and "two stanza" recruitment. In consideration of the likelihood of the two scenarios the term "more likely" is used in this report. This is meant to be interpreted as 60% in favor of the "recent" low recruitment scenario and 40% in favor of the "two stanza" recruitment scenario.

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

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Northeast Fisheries Science Center. (in prep.) Stock Assessment of Southern New England Mid-Atlantic yellowtail flounder. 54th Northeast Stock Assessment Workshop. NEFSC Ref. Doc.

B. Southern New England Mid-Atlantic Yellowtail Flounder- Tables

Table B1. Summary of median short-term spawning stock biomass (SSB) and yield projections for Southern New England Mid-Atlantic yellowtail flounder assuming three different F's, and under the two different recruitment scenarios: "two stanza" (top tables; Age-1 recruitment based on 1973-2010) and low "recent" (bottom tables; Age-1 recruitment based on 1990-2010).

SSB (mt) - Two Stanza Recruitment

	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	3,140	4,013	4,988	3,140	4,013	4,988	3,140	4,013	4,988
2013	3,468	4,476	5,791	3,201	4,122	5,365	3,118	4,011	5,230
2014	4,130	5,681	11,632	3,212	4,542	10,224	2,963	4,229	9,814
2015	4,705	8,654	22,492	3,205	5,595	18,904	2,848	4,927	17,943

SSB (mt) - Recent Recruitment

	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	3,140	4,013	4,988	3,140	4,013	4,988	3,140	4,013	4,988
2013	3,466	4,468	5,758	3,192	4,117	5,344	3,109	4,008	5,205
2014	4,030	5,248	7,130	3,131	4,122	5,733	2,885	3,815	5,353
2015	4,493	5,809	7,658	3,030	4,007	5,354	2,679	3,579	4,803

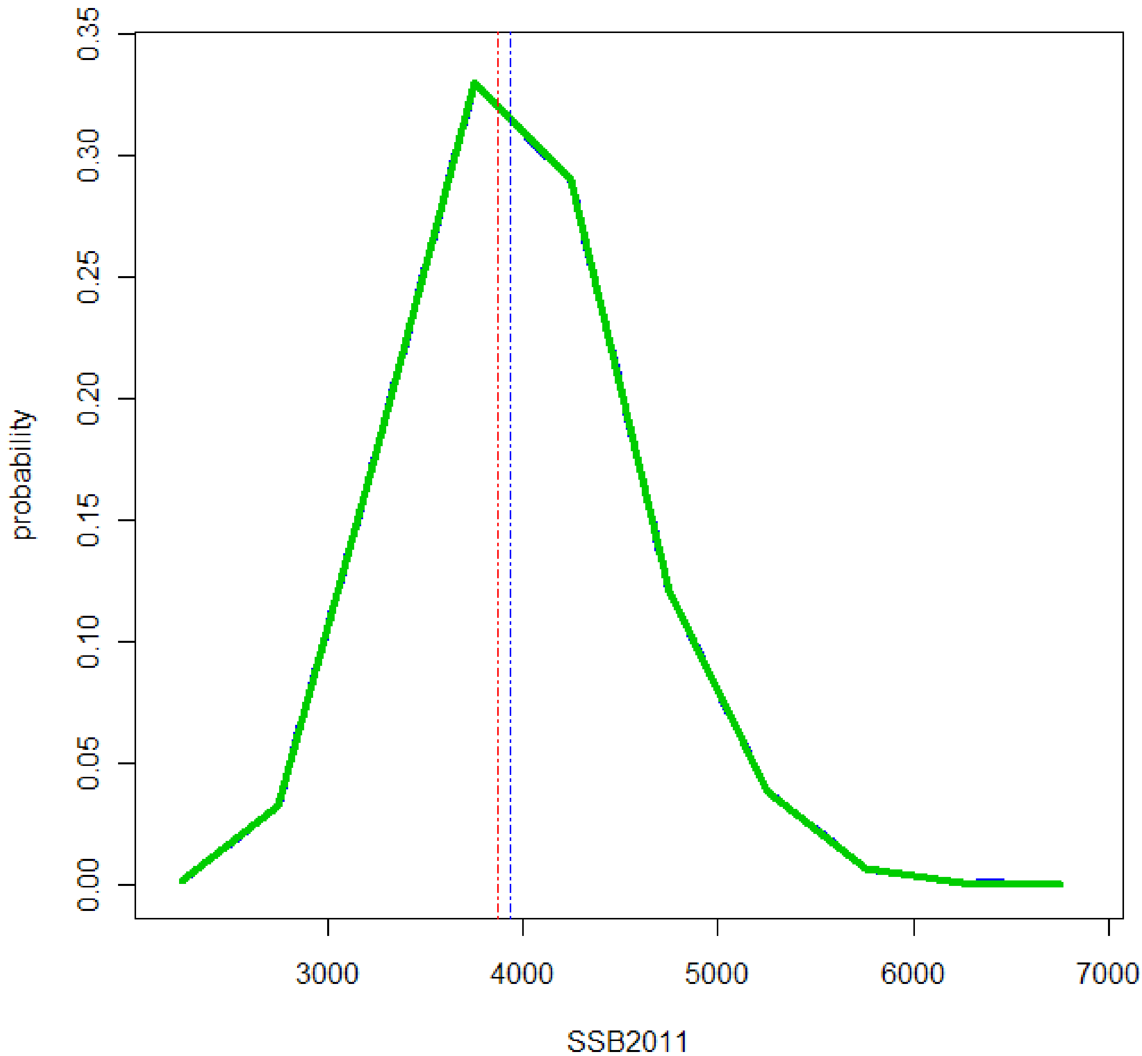
Yield (mt) - Two Stanza Recruitment

	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	390	390	390	390	390	390	390	390	390
2013	0	0	0	659	840	1,078	850	1,085	1,393
2014	0	0	0	652	876	1,496	794	1,071	1,873
2015	0	0	0	645	1,032	2,881	752	1,199	3,601

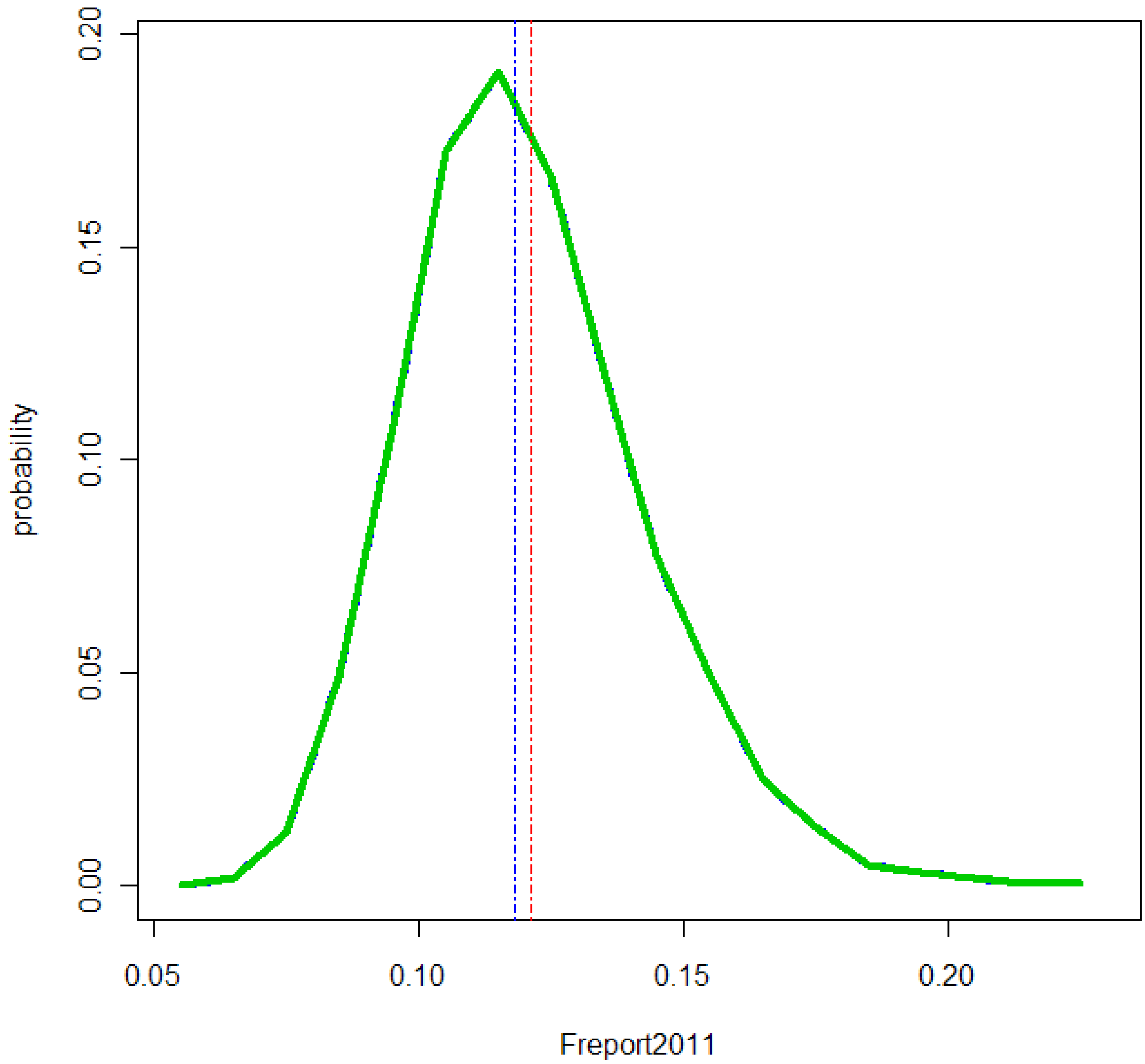
Yield (mt) - Recent Recruitment

	F_0			$F_{75\%MSY}$			F_{MSY}		
Year	5% CI	Median	95% CI	5% CI	Median	95% CI	5% CI	Median	95% CI
2012	390	390	390	390	390	390	390	390	390
2013	0	0	0	655	837	1,061	845	1,080	1,369
2014	0	0	0	637	824	1,107	775	1,004	1,357
2015	0	0	0	615	810	1,113	715	946	1,306

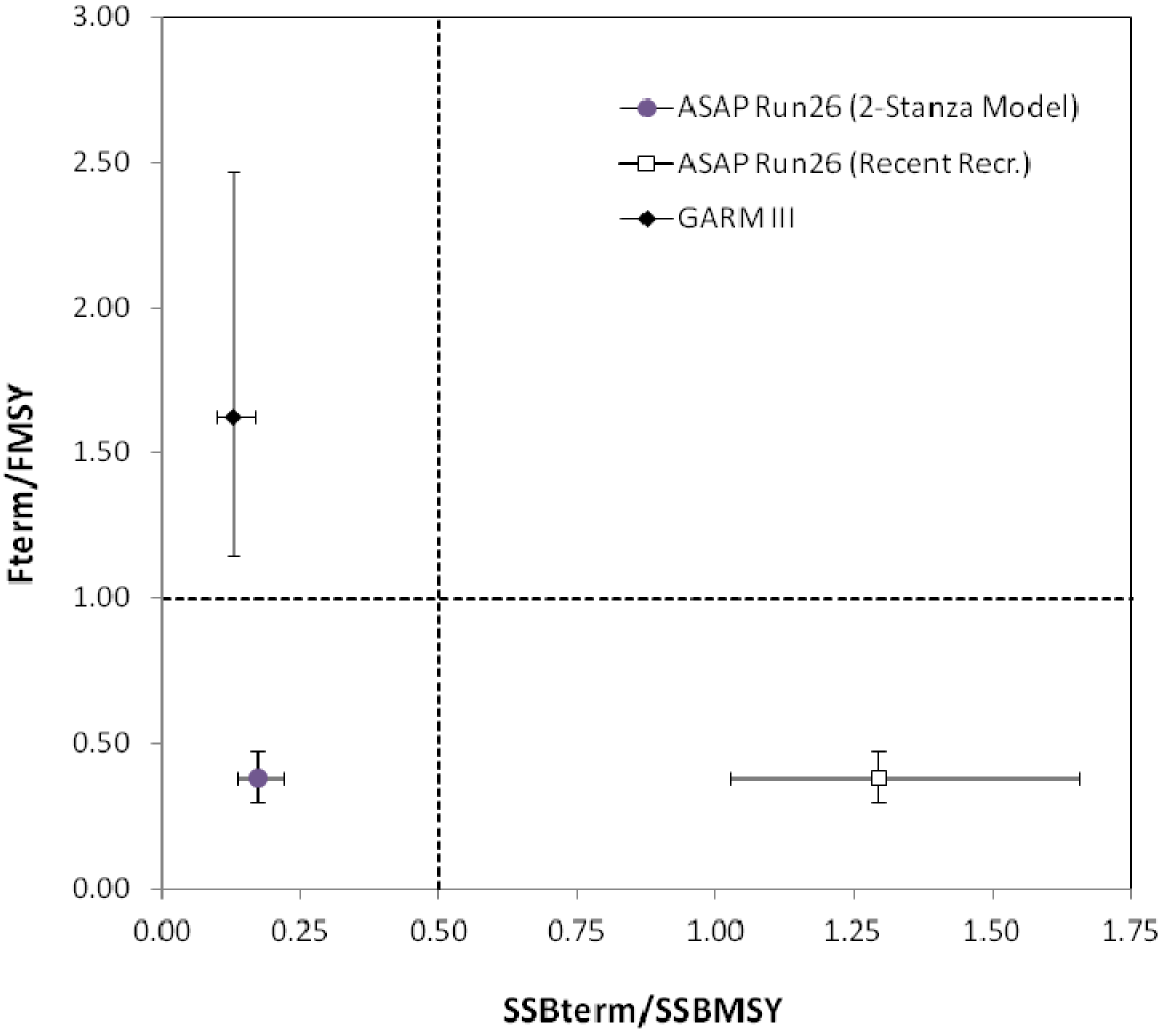
B. Southern New England Mid-Atlantic Yellowtail Flounder - Figures



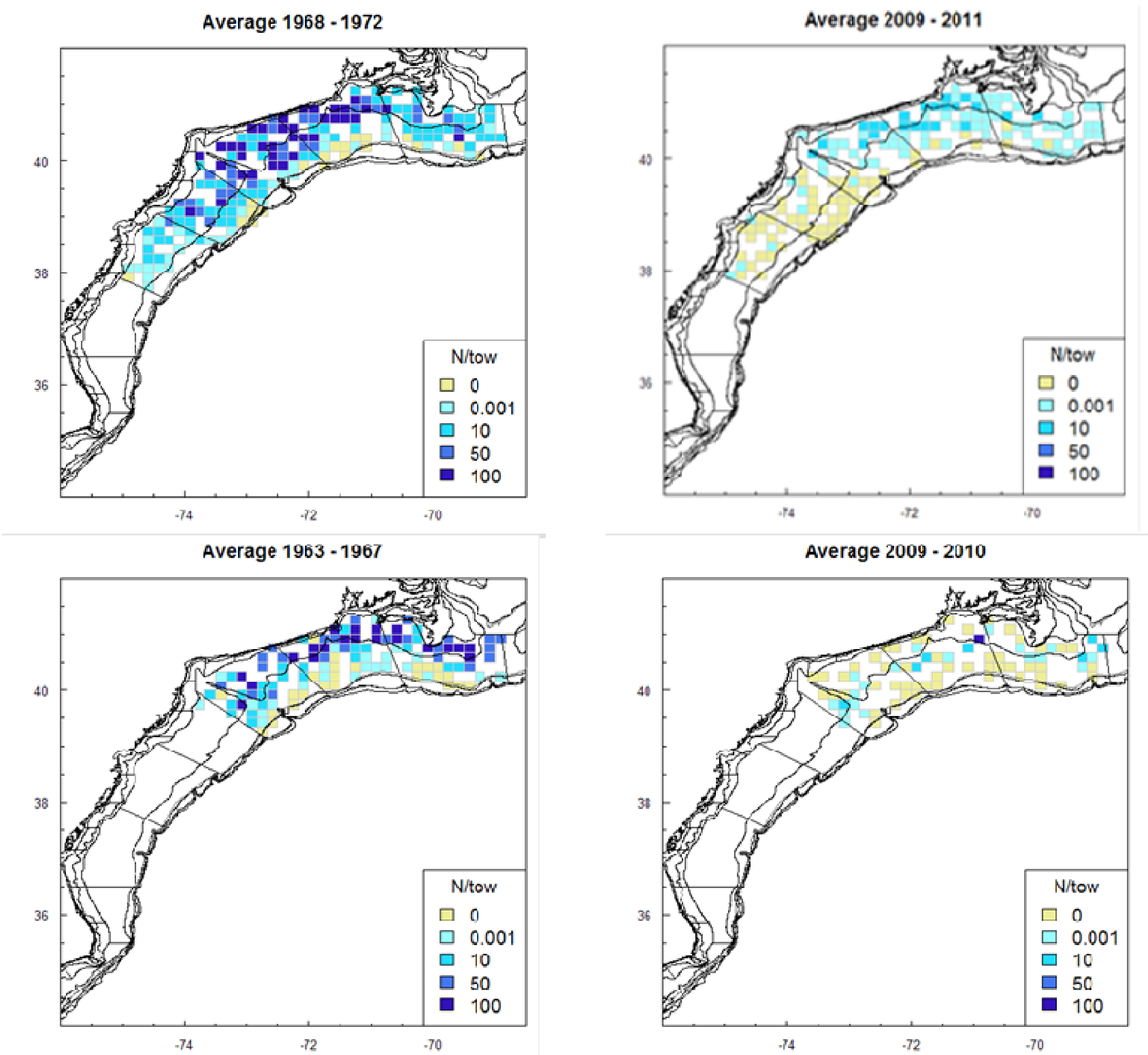
B1. MCMC distribution of the estimate of the 2011 Spawning Stock Biomass (SSB) for Southern New England Mid-Atlantic yellowtail flounder. The vertical red line represents the ASAP 2011 SSB point estimate (3,873 mt) while the blue vertical line to the right represents median 2011 SSB (3,938 mt) from the MCMC distribution.



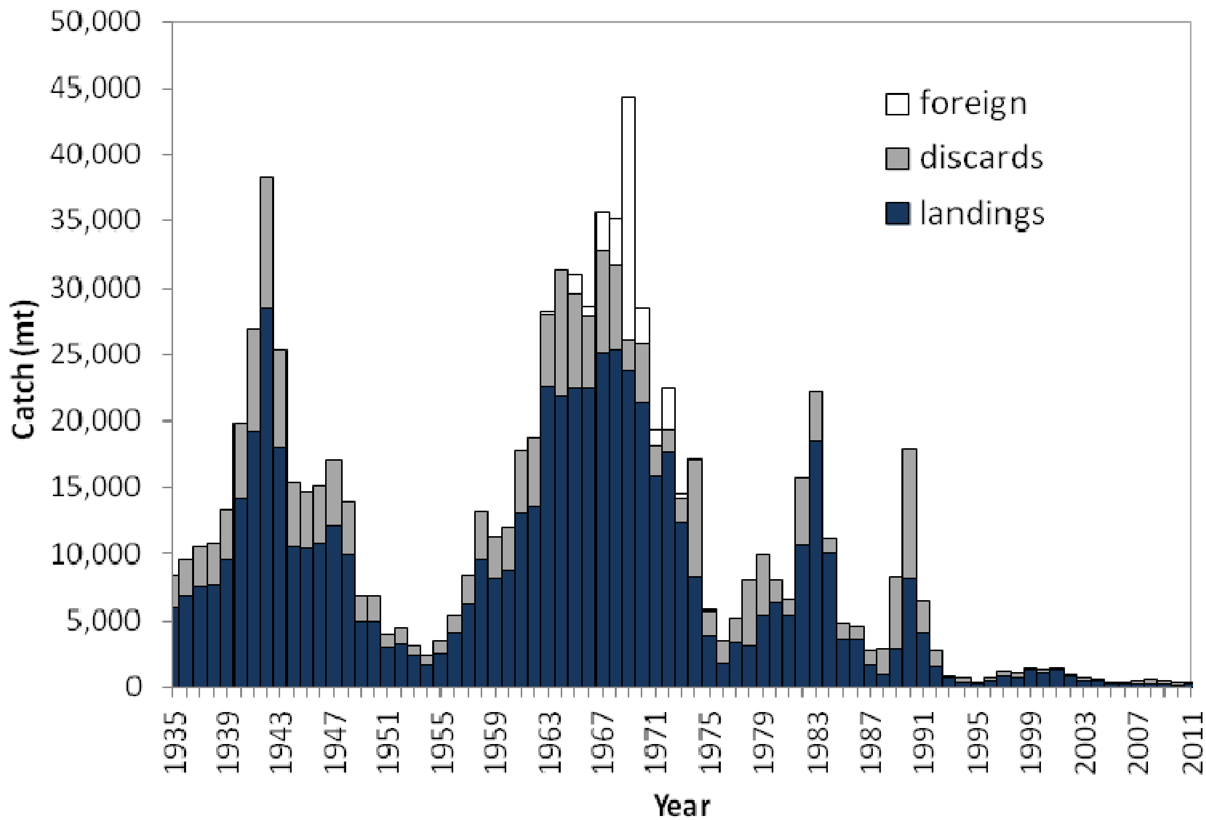
B2. MCMC distribution of the estimate of 2011 fishing mortality rate for Southern New England Mid-Atlantic yellowtail flounder. The vertical red line represents the ASAP 2011 average fishing mortality estimate (0.121) while the blue vertical line to the left represents median 2011 fishing mortality (0.118) from the MCMC distribution.



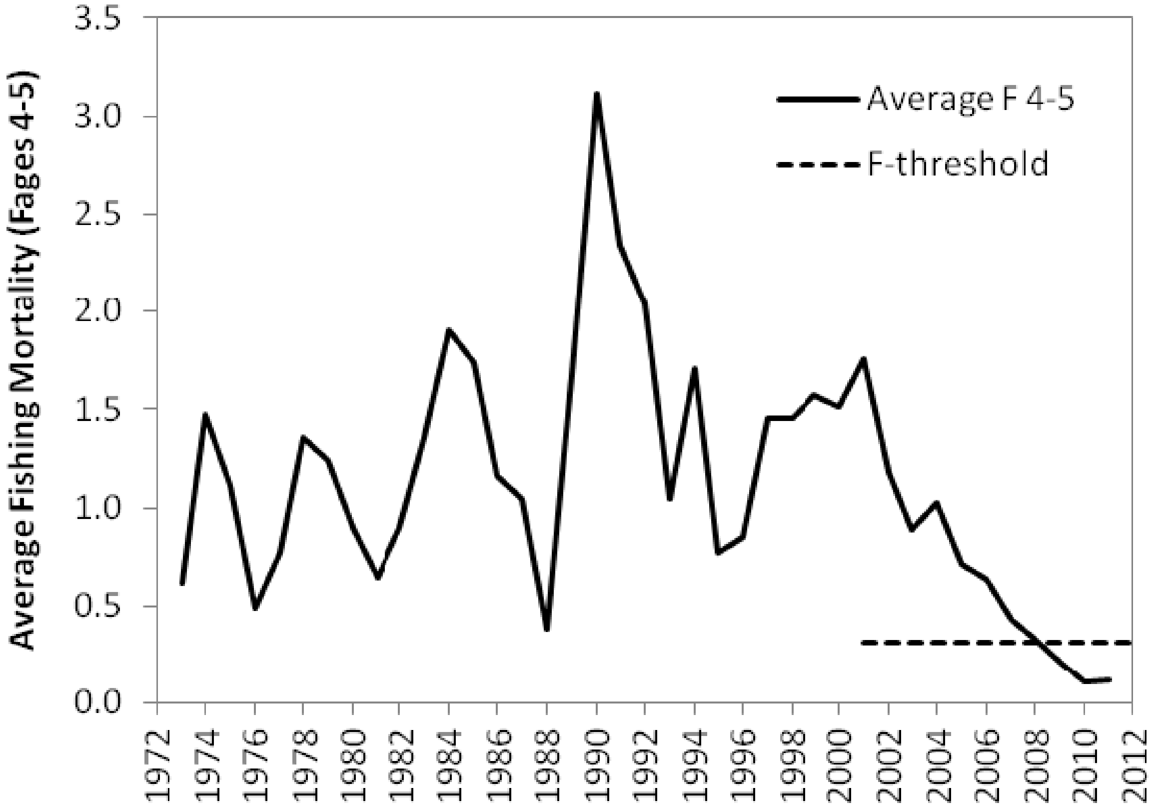
B3. Stock Status based on 2011 estimates for Southern New England Mid-Atlantic yellowtail flounder with respect to biological reference points under both the “two stanza” recruitment scenario (circle) and “recent” recruitment scenario (square). Error bars represent 90% confidence intervals. GARM III (NEFSC 2008) results are also shown (diamond). Note status change from overfishing (NEFSC 2008) to NOT overfishing based on this new SARC54 assessment.



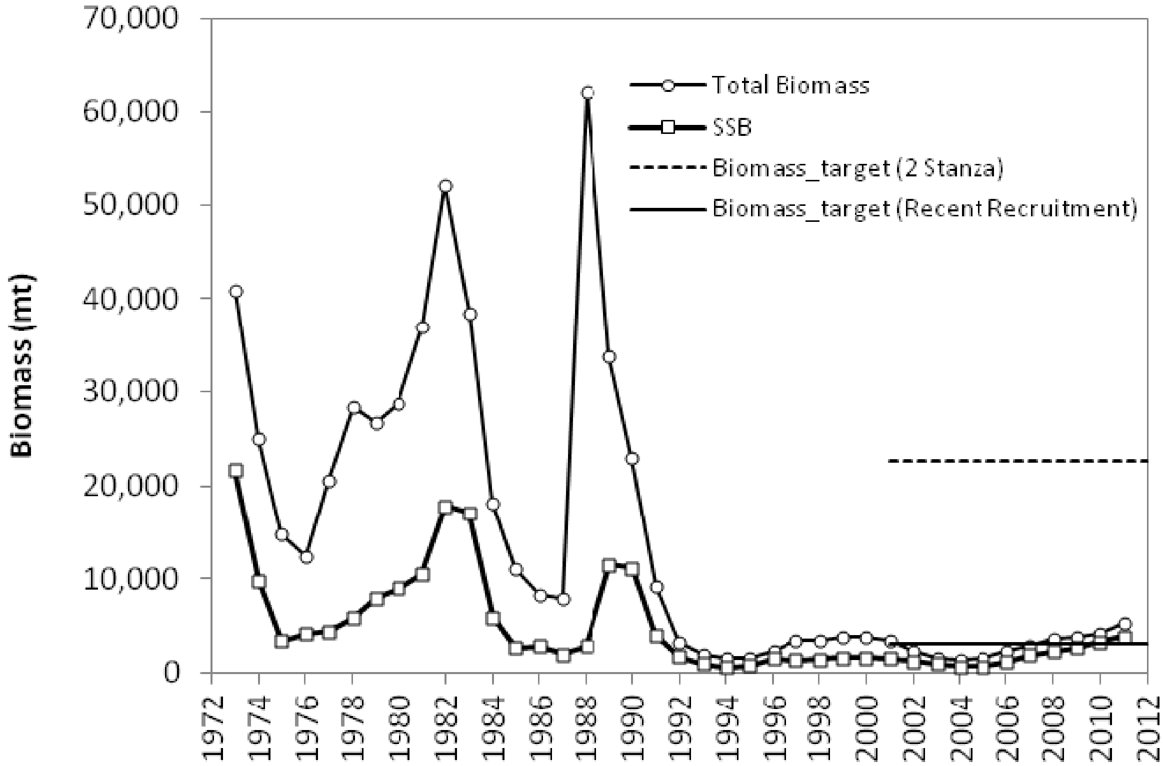
B4. Geographic distribution and abundance of yellowtail flounder in the 1960's (left) and in the recent time period (right) based on Northeast Fisheries Science Center Spring (top) and Fall (bottom) bottom trawl surveys.



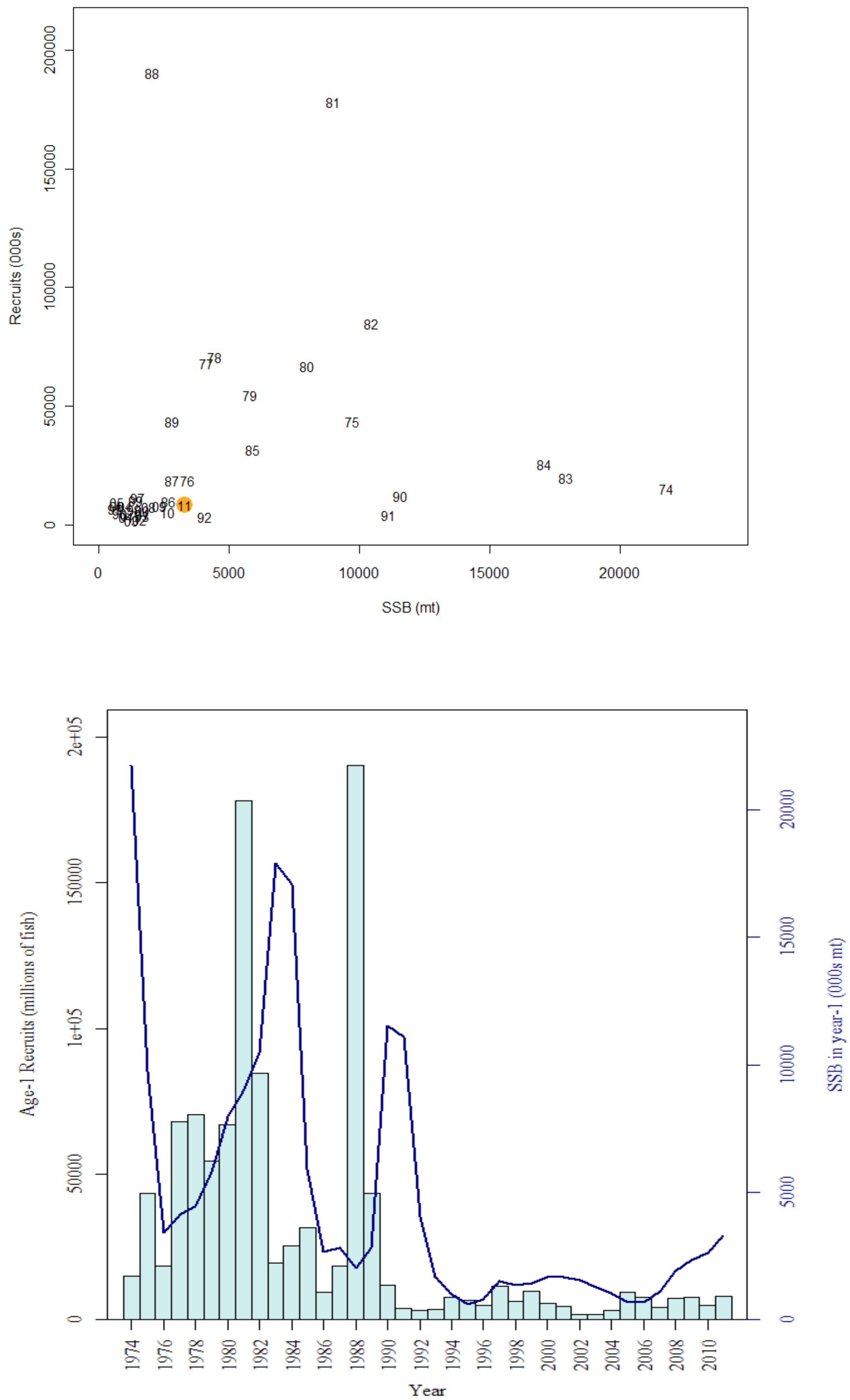
B5. Southern New England Mid-Atlantic yellowtail flounder catch, separated into landings, discards, and foreign components.



B6. Trends in fishing mortality rate for ages 4-5 (solid line) estimated from ASAP model for Southern New England Mid-Atlantic yellowtail flounder. F-threshold (dashed line) is only shown for 2002-2011 to reflect the selectivity time block for which the reference point was derived.



B7. Trends in total biomass (solid line with circles) and spawning stock biomass (solid line with squares) of Southern New England Mid-Atlantic yellowtail flounder and associated overfished threshold under the "two stanza" and "recent" low recruitment scenarios. SSB targets for the "two stanza" (horizontal dash line) and the "recent" recruitment (horizontal solid line) apply to 2002-2011, as explained in Figure B6.



B8: (Top) ASAP model estimates of Southern New England-Mid Atlantic yellowtail flounder SSB versus age-1 recruitment. The symbol for each observation is the last two digits of the year (e.g. “88” indicates age-1 estimates of the 1987 year class). The most recent recruitment estimate is highlighted (orange circle). (Bottom) ASAP base Model 26 time series of SSB (blue line) and age1 recruitment (vertical bars).