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A Report of the 57th Northeast Regional
Stock Assessment Workshop

57th Northeast Regional Stock Assessment Workshop (57th SAW) Assessment Summary Report

by Northeast Fisheries Science Center

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SAW-57 ASSESSMENT SUMMARY REPORT

Introduction

The 57th SAW Assessment Summary Report contains summary and detailed technical information on two stock assessments reviewed during July 23-26, 2013 at the Stock Assessment Workshop (SAW) by the 57th Stock Assessment Review Committee (SARC-57): summer flounder (*Paralichthys dentata*) and striped bass (*Morone saxatilis*). The SARC-57 consisted of 3 external, independent reviewers appointed by the Center for Independent Experts [CIE], and an external SARC chairman from the MAFMC SSC. The SARC evaluated whether each Term of Reference (listed in the Appendix) was completed successfully based on whether the work provided a scientifically credible basis for developing fishery management advice. The reviewers' reports for SAW/SARC-57 are available at website: http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC 57 Panelist Reports".

An important aspect of any assessment is the determination of current stock status. The status of the stock relates to both the rate of removal of fish from the population – the exploitation rate – and the current stock size. The exploitation rate is the proportion of the stock alive at the beginning of the year that is caught during the year. When that proportion exceeds the amount specified in an overfishing definition, overfishing is occurring. Fishery removal rates are usually expressed in terms of the instantaneous fishing mortality rate, F, and the maximum removal rate is denoted as $F_{THRESHOLD.}$

Another important factor for classifying the status of a resource is the current stock level, for example, spawning stock biomass (SSB) or total stock biomass (TSB). Overfishing definitions, therefore, characteristically include specification of a minimum biomass threshold as well as a maximum fishing threshold. If the biomass of a stock falls below the biomass threshold ($B_{THRESHOLD}$) the stock is in an overfished condition. The Sustainable Fisheries Act mandates that a stock rebuilding plan be developed should this situation arise.

As there are two dimensions to stock status – the rate of removal and the biomass level – it is possible that a stock not currently subject to overfishing in terms of exploitation rates is in an overfished condition, that is, has a biomass level less than the threshold level. This may be due to heavy exploitation in the past, or a result of other factors such as unfavorable environmental conditions. In this case, future recruitment to the stock is very important and the probability of improvement may increase greatly by increasing the stock size. Conversely, fishing down a stock that is at a high biomass level should generally increase the long-term sustainable yield. Stocks under federal jurisdiction are managed on the basis of maximum sustainable yield (MSY). The biomass that produces this yield is called B_{MSY} and the fishing mortality rate that produces MSY is called F_{MSY}.

Given this, federally managed stocks under review are classified with respect to current overfishing definitions. A stock is overfished if its current biomass is below $B_{THRESHOLD}$ and overfishing is occurring if current F is greater than $F_{THRESHOLD.}$ The table below depicts status criteria.

		BIOMASS		
		$B < B_{THRESHOLD}$	$B_{THRESHOLD} < B < B_{MSY}$	$B > B_{MSY}$
EXPLOITATION RATE	$F > F_{THRESHOLD}$	Overfished,overfishing is occurring; reduce F, adopt and follow rebuilding plan	Not overfished, overfishing is occurring; reduce F, rebuild stock	$F = F_{TARGET} <= F_{MSY}$
	$F < F_{THRESHOLD}$	Overfished, overfishing is not occurring; adopt and follow rebuilding plan	Not overfished, overfishing is not occurring; rebuild stock	$F = F_{TARGET} <= F_{MSY}$

Fisheries management may take into account scientific and management uncertainty, and overfishing guidelines often include a control rule in the overfishing definition. Generically, the control rules suggest actions at various levels of stock biomass and incorporate an assessment of risk, in that F targets are set so as to avoid exceeding F thresholds.

Outcome of Stock Assessment Review Meeting

Text in this section is based on SARC-57 Review Panel reports (available at http://www.nefsc.noaa.gov/nefsc/saw/ under the heading "SARC-57 Panelist Reports").

Regarding **summer flounder**, all eight of the stock assessment Terms of Reference (TORs) were met. The stock is neither overfished nor experiencing overfishing in 2012. Fishing mortality has decreased since 1997, and is below the new F_{MSY} proxy. SSB in 2012 was 82% of the biomass target. The population was modeled with ASAP, a forward projecting age-structured model. A variety of fishery-independent and fishery-dependent surveys were available to characterize the stock. Annual projections were provided for 3 years with no retrospective adjustment.

Regarding **striped bass**, six of the seven stock assessment TORs were met and one TOR which dealt with Biological Reference Points was partly completed. The stock is not overfished and overfishing is not occurring. A variety of fishery-independent and fishery-dependent surveys were available to characterize the stock. The present assessment uses a statistical catch-at-age (SCA) model to estimate F, recruitment, total abundance and stock biomass. There was a slight retrospective pattern. The SARC Panel encourages development of a sex-disaggregated model. Management of striped bass has a long history and ad hoc reference points, such as SSB_{1995}.

SARC-57 concluded that each of the assessments (**summer flounder** and **striped bass**) was effective in delineating stock status, determining BRPs and proxies, and in projecting probable short-term trends in stock biomass, fishing mortality, and catches.

Glossary

ADAPT. A commonly used form of computer program used to optimally fit a Virtual Population Assessment (VPA) to abundance data.

ASAP. The Age Structured Assessment Program is an age-structured model that uses forward computations assuming separability of fishing mortality into year and age components to estimate population sizes given observed catches, catch-at-age, and indices of abundance. Discards can be treated explicitly. The separability assumption is relaxed by allowing for fleet-specific computations and by allowing the selectivity at age to change smoothly over time or in blocks of years. The software can also allow the catchability associated with each abundance index to vary smoothly with time. The problem's dimensions (number of ages, years, fleets and abundance indices) are defined at input and limited by hardware only. The input is arranged assuming data is available for most years, but missing years are allowed. The model currently does not allow use of length data nor indices of survival rates. Diagnostics include index fits, residuals in catch and catch-at-age, and effective sample size calculations. Weights are input for different components of the objective function and allow for relatively simple age-structured production model type models up to fully parameterized models.

ASPM. Age-structured production models, also known as statistical catch-at-age (SCAA) models, are a technique of stock assessment that integrate fishery catch and fishery-independent sampling information. The procedures are flexible, allowing for uncertainty in the absolute magnitudes of catches as part of the estimation. Unlike virtual population analysis (VPA) that tracks the cumulative catches of various year classes as they age, ASPM is a forward projection simulation of the exploited population. ASPM is similar to the NOAA Fishery Toolbox applications ASAP (Age Structured Assessment Program) and SS2 (Stock Synthesis 2)

Availability. Refers to the distribution of fish of different ages or sizes relative to that taken in the fishery.

Biological reference points. Specific values for the variables that describe the state of a fishery system which are used to evaluate its status. Reference points are most often specified in terms of fishing mortality rate and/or spawning stock biomass. The reference points may indicate 1) a desired state of the fishery, such as a fishing mortality rate that will achieve a high level of sustainable yield, or 2) a state of the fishery that should be avoided, such as a high fishing mortality rate which risks a stock collapse and long-term loss of potential yield. The former type of reference points are referred to as "target reference points" and the latter are referred to as "limit reference points" or "thresholds". Some common examples of reference points are $F_{0.1}$, F_{MAX}, and F_{MSY}, which are defined later in this glossary.

B_0. Virgin stock biomass, i.e., the long-term average biomass value expected in the absence of fishing mortality.

B_{MSY}. Long-term average biomass that would be achieved if fishing at a constant fishing mortality rate equal to F_{MSY}.

Biomass Dynamics Model. A simple stock assessment model that tracks changes in stock using assumptions about growth and can be tuned to abundance data such as commercial catch rates, research survey trends or biomass estimates.

Catchability. Proportion of the stock removed by one unit of effective fishing effort (typically age-specific due to differences in selectivity and availability by age).

Control Rule. Describes a plan for pre-agreed management actions as a function of variables related to the status of the stock. For example, a control rule can specify how F or yield should vary with biomass. In the National Standard Guidelines (NSG), the "MSY control rule" is used to determine the limit fishing mortality, or Maximum Fishing Mortality Threshold (MFMT). Control rules are also known as "decision rules" or "harvest control laws."

Catch per Unit of Effort (CPUE). Measures the relative success of fishing operations, but also can be used as a proxy for relative abundance based on the assumption that CPUE is linearly related to stock size. The use of CPUE that has not been properly standardized for temporal-spatial changes in catchability should be avoided.

Exploitation pattern. The fishing mortality on each age (or group of adjacent ages) of a stock relative to the highest mortality on any age. The exploitation pattern is expressed as a series of values ranging from 0.0 to 1.0. The pattern is referred to as "flat-topped" when the values for all the oldest ages are about 1.0, and "dome-shaped" when the values for some intermediate ages are about 1.0 and those for the oldest ages are significantly lower. This pattern often varies by type of fishing gear, area, and seasonal distribution of fishing, and the growth and migration of the fish. The pattern can be changed by modifications to fishing gear, for example, increasing mesh or hook size, or by changing the proportion of harvest by gear type.

Mortality rates. Populations of animals decline exponentially. This means that the number of animals that die in an "instant" is at all times proportional to the number present. The decline is defined by survival curves such as: $N_{t+1} = N_t e^{-z}$

where N_t is the number of animals in the population at time t and N_{t+1} is the number present in the next time period; Z is the total instantaneous mortality rate which can be separated into deaths due to fishing (fishing mortality or F) and deaths due to all other causes (natural mortality or M) and e is the base of the natural logarithm (2.71828).To better understand the concept of an instantaneous mortality rate, consider the following example. Suppose the instantaneous total mortality rate is 2 (i.e., Z = 2) and we want to know how many animals out of an initial population of 1 million fish will be alive at the end of one year. If the year is apportioned into 365 days (that is, the 'instant' of time is one day), then 2/365 or 0.548% of the population will die each day. On the first day of the year, 5,480 fish will die (1,000,000 x 0.00548), leaving 994,520 alive. On day 2, another 5,450 fish die (994,520 x 0.00548) leaving 989,070 alive. At the end of the year, 134,593 fish [$1,000,000 \times (1 - 0.00548)^{365}$] remain alive. If, we had instead selected a smaller 'instant' of time, say an hour, 0.0228% of the population would have died by the end of the first time interval (an hour), leaving 135,304 fish alive at the end of the year [$1,000,000 \times (1 - 0.00228)^{8760}$]. As the instant of time becomes shorter and shorter, the exact answer to the number of animals surviving is given by the survival curve mentioned above, or, in this example:

$N_{t+1} = 1,000,000e^{-2} = 135,335$ fish

Exploitation rate. The proportion of a population alive at the beginning of the year that is caught during the year. That is, if 1 million fish were alive on January 1 and 200,000 were caught during the year, the exploitation rate is 0.20 (200,000 / 1,000,000) or 20%.

F_{MAX}. The rate of fishing mortality that produces the maximum level of yield per recruit. This is the point beyond which growth overfishing begins.

$F_{0.1}$. The fishing mortality rate where the increase in yield per recruit for an increase in a unit of effort is only 10% of the yield per recruit produced by the first unit of effort on the unexploited stock (i.e., the slope of the yield-per-recruit curve for the $F_{0.1}$ rate is only one-tenth the slope of the curve at its origin).

$F_{10\%}$. The fishing mortality rate which reduces the spawning stock biomass per recruit (SSB/R) to 10% of the amount present in the absence of fishing. More generally, Fx%, is the fishing mortality rate that reduces the SSB/R to x% of the level that would exist in the absence of fishing.

F_{MSY}. The fishing mortality rate that produces the maximum sustainable yield.

Fishery Management Plan (FMP). Plan containing conservation and management measures for fishery resources, and other provisions required by the MSFCMA, developed by Fishery Management Councils or the Secretary of Commerce.

Generation Time. In the context of the National Standard Guidelines, generation time is a measure of the time required for a female to produce a reproductively-active female offspring for use in setting maximum allowable rebuilding time periods.

Growth overfishing. The situation existing when the rate of fishing mortality is above F_{MAX} and when fish are harvested before they reach their growth potential.

Limit Reference Points. Benchmarks used to indicate when harvests should be constrained substantially so that the stock remains within safe biological limits. The probability of exceeding limits should be low. In the National Standard Guidelines, limits are referred to as thresholds. In much of the international literature (e.g., FAO documents), "thresholds" are used as buffer points that signal when a limit is being approached.

Landings per Unit of Effort (LPUE). Analogous to CPUE and measures the relative success of fishing operations, but is also sometimes used a proxy for relative abundance based on the assumption that CPUE is linearly related to stock size.

MSFCMA. (Magnuson-Stevens Fishery Conservation and Management Act). U.S. Public Law 94-265, as amended through October 11, 1996. Available as NOAA Technical Memorandum NMFS-F/SPO-23, 1996.

Maximum Fishing Mortality Threshold (MFMT, $F_{THRESHOLD}$). One of the Status Determination Criteria (SDC) for determining if overfishing is occurring. It will usually be equivalent to the F corresponding to the MSY Control Rule. If current fishing mortality rates are above $F_{THRESHOLD}$, overfishing is occurring.

Minimum Stock Size Threshold (MSST, $B_{THRESHOLD}$). Another of the Status Determination Criteria. The greater of (a) ½B_{MSY}, or (b) the minimum stock size at which rebuilding to B_{MSY} will occur within 10 years of fishing at the MFMT. MSST should be measured in terms of spawning biomass or other appropriate measures of productive capacity. If current stock size is below $B_{THRESHOLD}$, the stock is overfished.

Maximum Spawning Potential (MSP). This type of reference point is used in some fishery management plans to define overfishing. The MSP is the spawning stock biomass per recruit (SSB/ R) when fishing mortality is zero. The degree to which fishing reduces the SSB/R is expressed as a percentage of the MSP (i.e., %MSP). A stock is considered overfished when the fishery reduces the %MSP below the level specified in the overfishing definition. The values of %MSP used to define overfishing can be derived from stock-recruitment data or chosen by analogy using available information on the level required to sustain the stock.

Maximum Sustainable Yield (MSY). The largest average catch that can be taken from a stock under existing environmental conditions.

Overfishing. According to the National Standard Guidelines, "overfishing occurs whenever a stock or stock complex is subjected to a rate or level of fishing mortality that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis." Overfishing is occurring if the MFMT is exceeded for 1 year or more.

Optimum Yield (OY). The amount of fish that will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities and taking into account the protection of marine ecosystems. MSY constitutes a "ceiling" for OY. OY may be lower than MSY, depending on relevant economic, social, or ecological factors. In the case of an overfished fishery, OY should provide for rebuilding to B_{MSY}.

Partial Recruitment. Patterns of relative vulnerability of fish of different sizes or ages due to the combined effects of selectivity and availability.

Rebuilding Plan. A plan that must be designed to recover stocks to the B_{MSY} level within 10 years when they are overfished (i.e. when B < MSST). Normally, the 10 years would refer to an expected time to rebuilding in a probabilistic sense.

Recruitment. This is the number of young fish that survive (from birth) to a specific age or grow to a specific size. The specific age or size at which recruitment is measured may correspond to when the young fish become vulnerable to capture in a fishery or when the number of fish in a cohort can be reliably estimated by a stock assessment.

Recruitment overfishing. The situation existing when the fishing mortality rate is so high as to cause a reduction in spawning stock which causes recruitment to become impaired.

Recruitment per spawning stock biomass (R/SSB). The number of fishery recruits (usually age 1 or 2) produced from a given weight of spawners, usually expressed as numbers of recruits per kilogram of mature fish in the stock. This ratio can be computed for each year class and is often used as an index of pre-recruit survival, since a high R/SSB ratio in one year indicates above-average numbers resulting from a given spawning biomass for a particular year class, and vice versa.

Reference Points. Values of parameters (e.g. B_{MSY}, F_{MSY}, $F_{0.1}$) that are useful benchmarks for guiding management decisions. Biological reference points are typically limits that should not be exceeded with significant probability (e.g., MSST) or targets for management (e.g., OY).

Risk. The probability of an event times the cost associated with the event (loss function). Sometimes "risk" is simply used to denote the probability of an undesirable result (e.g. the risk of biomass falling below MSST).

Status Determination Criteria (SDC). Objective and measurable criteria used to determine if a stock is being overfished or is in an overfished state according to the National Standard Guidelines.

Selectivity. Measures the relative vulnerability of different age (size) classes to the fishing gears(s).

Spawning Stock Biomass (SSB). The total weight of all sexually mature fish in a stock.

Spawning stock biomass per recruit (SSB/R or SBR). The expected lifetime contribution to the spawning stock biomass for each recruit. SSB/R is calculated assuming that F is constant over the life span of a year class. The calculated value is also dependent on the exploitation pattern and rates of growth and natural mortality, all of which are also assumed to be constant.

Stock Synthesis (SS). This application provides a statistical framework for calibration of a population dynamics model using a diversity of fishery and survey data. SS is designed to accommodate both age and size structure and with multiple stock sub-areas. Selectivity can be cast as age specific only, size-specific in the observations only, or size-specific with the ability to capture the major effect of size-specific survivorship. The overall model contains subcomponents which simulate the population dynamics of the stock and fisheries, derive the expected values for the various observed data, and quantify the magnitude of difference between observed and expected data. Parameters are searched for which will maximize the goodness-of-fit. A management layer is also included in the model allowing uncertainty in estimated parameters to be propagated to the management quantities, thus facilitating a description of the risk of various possible management scenarios. The structure of SS allows for building of simple to complex models depending upon the data available.

Survival Ratios. Ratios of recruits to spawners (or spawning biomass) in a stock-recruitment analysis. The same as the recruitment per spawning stock biomass (R/SSB), see above.

TAC. Total allowable catch is the total regulated catch from a stock in a given time period, usually a year.

Target Reference Points. Benchmarks used to guide management objectives for achieving a desirable outcome (e.g., OY). Target reference points should not be exceeded on average.

Uncertainty. Uncertainty results from a lack of perfect knowledge of many factors that affect stock assessments, estimation of reference points, and management. Rosenberg and Restrepo (1994) identify 5 types: measurement error (in observed quantities), process error (or natural population variability), model error (mis-specification of assumed values or model structure), estimation error (in population parameters or reference points, due to any of the preceding types of errors), and implementation error (or the inability to achieve targets exactly for whatever reason)

Virtual population analysis (VPA) (or cohort analysis). A retrospective analysis of the catches from a given year class which provides estimates of fishing mortality and stock size at each age over its life in the fishery. This technique is used extensively in fishery assessments.

Year class (or cohort). Fish born in a given year. For example, the 1987 year class of cod includes all cod born in 1987. This year class would be age 1 in 1988, age 2 in 1989, and so on.

Yield per recruit (Y/R or YPR). The average expected yield in weight from a single recruit. Y/R is calculated assuming that F is constant over the life span of a year class. The calculated value is also dependent on the exploitation pattern, rate of growth, and natural mortality rate, all of which are assumed to be constant.

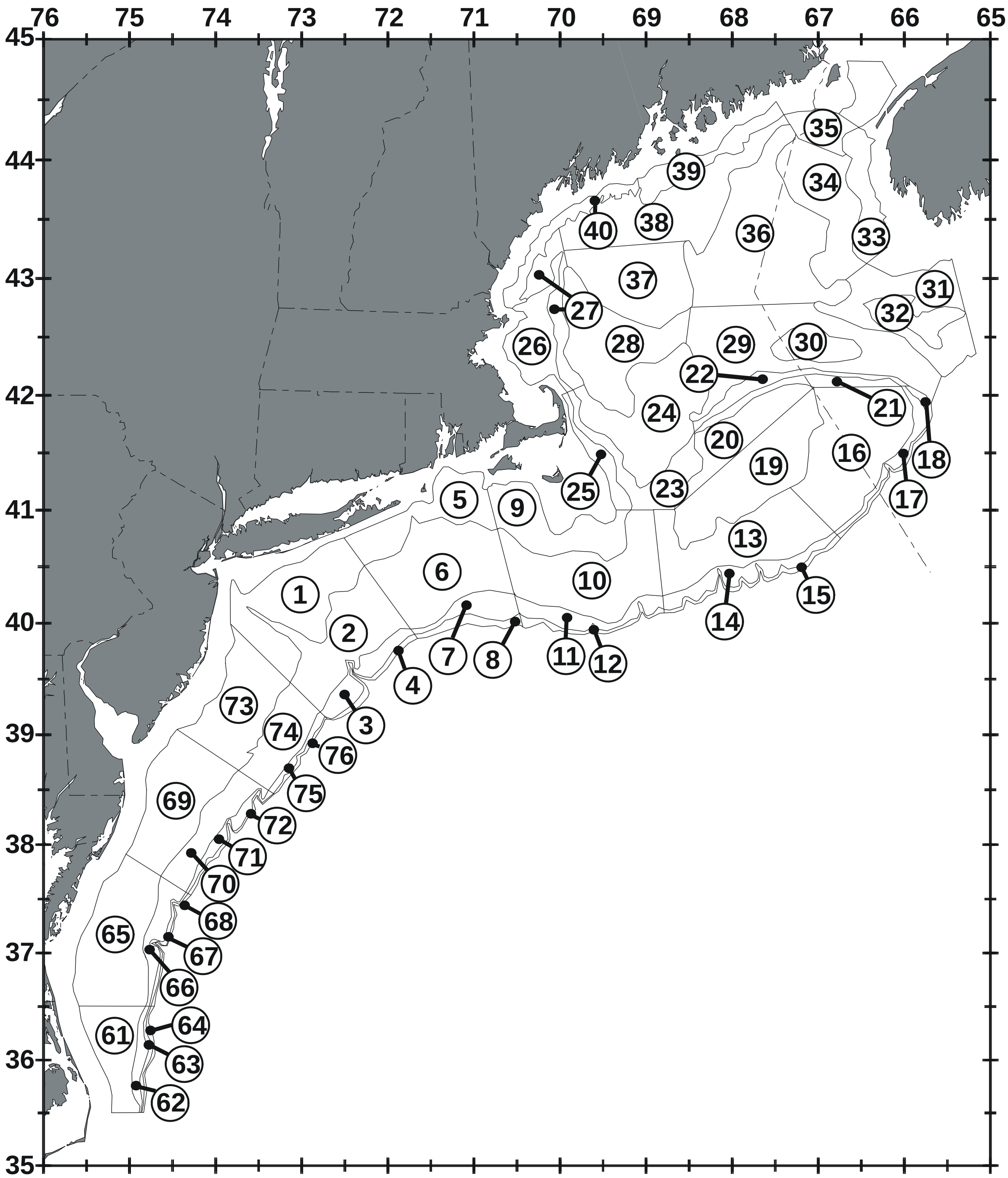


Figure 1. Offshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys. Some of these may not be sampled presently.

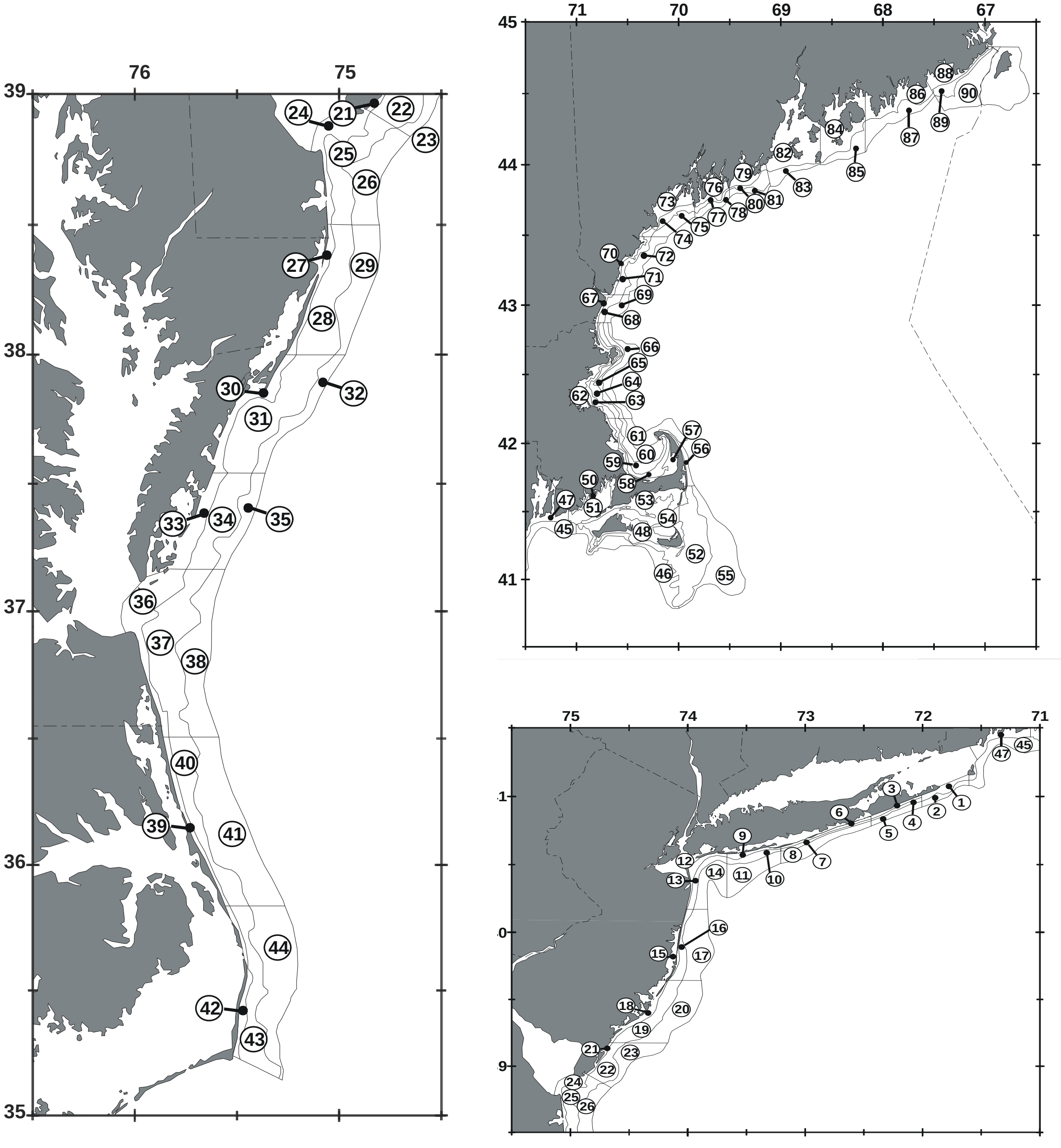
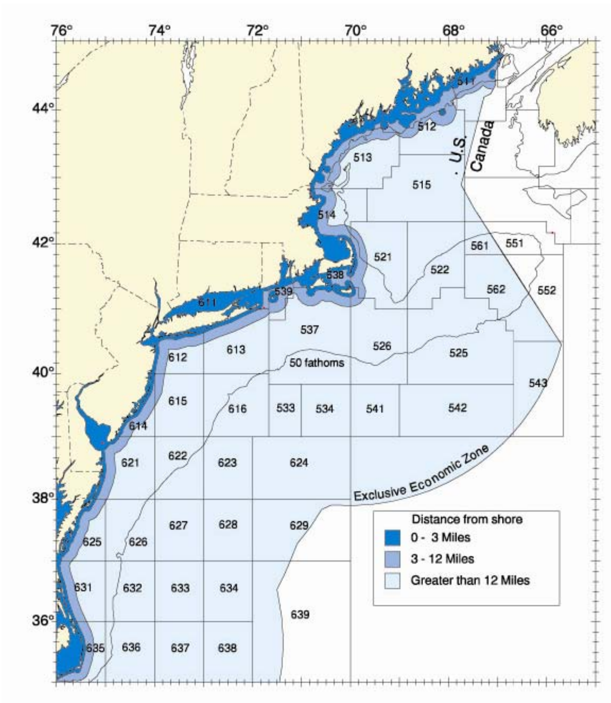


Figure 2. Inshore depth strata sampled during Northeast Fisheries Science Center bottom trawl research surveys. Some of these may not be sampled presently.



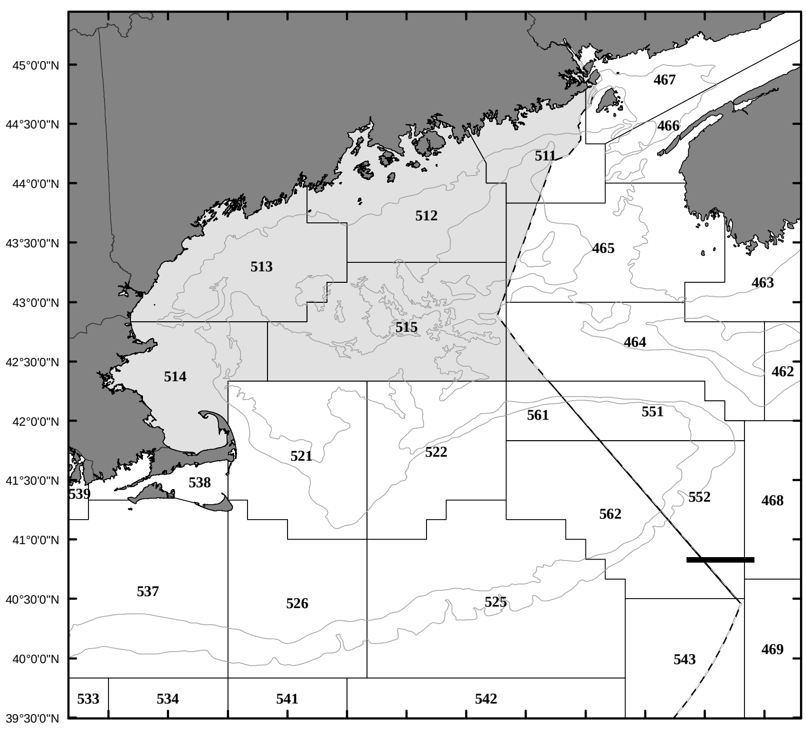


Figure 3. Statistical areas used for reporting commercial catches.

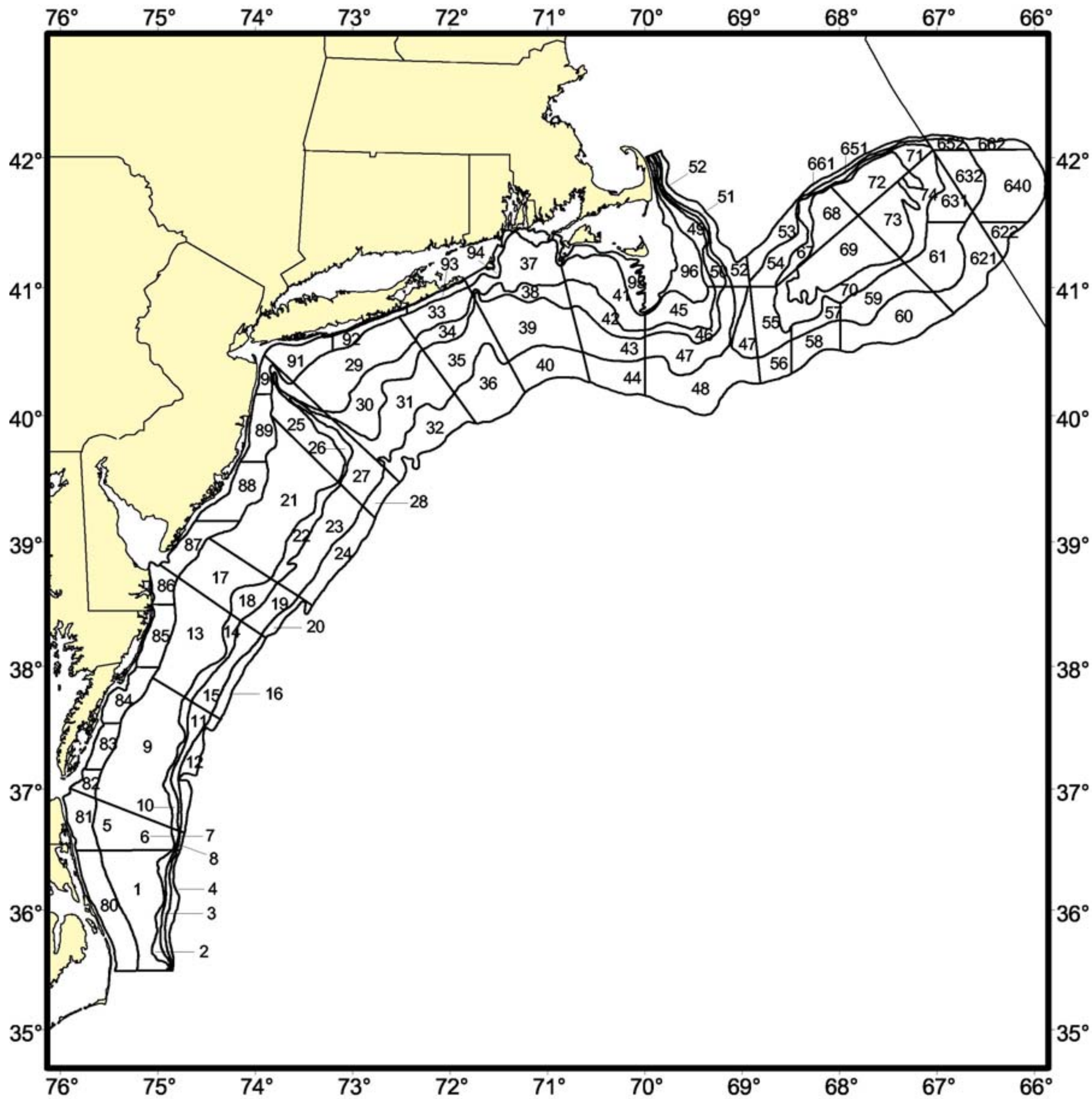


Figure 4. Northeast Fisheries Science Center clam resource survey strata, along the east coast of the US.

A. SUMMER FLOUNDER ASSESSMENT SUMMARY FOR 2013

State of Stock: The summer flounder stock was not overfished and overfishing was not occurring in 2012 relative to the new (updated) biological reference points from the 2013 SAW/SARC57 (Figure A1). Fishing mortality on the fully selected age 4 fish ranged between 0.790 and 1.745 during 1982-1996. The fishing mortality rate has decreased from 0.849 in 1997 to 0.285 in 2012, below the new reference point F_{MSY} proxy = $F_{35\%}$ = 0.309 (Figure A2). There is a 90% probability that the fishing mortality rate in 2012 was between 0.213 and 0.343. Spawning stock biomass (SSB) decreased from 24,300 mt in 1982 to 5,521 mt in 1989, and then increased to a peak of 53,156 mt by 2010. SSB was estimated to be 51,238 mt in 2012, about 82% of the new reference point SSB_{MSY} proxy = $SSB_{35\%}$ = 62,394 mt (Figure A3). There is a 90% chance that SSB in 2012 was between 45,781 and 61,297 mt. The average recruitment from 1982 to 2012 is 43 million fish at age 0. The 1982 and 1983 year classes are the largest in the assessment time series, at 62 and 76 million fish; the 1988 year class is the smallest at only 10 million fish. The 2012 year class is currently estimated to be about 37 million fish (Figure A4).

Projections: If the 2013 Annual Catch Limit (ACL) of 10,133 mt = 22.339 million lbs is taken, and the 2013 median (50% probability) projected dead discards are 1,735 mt = 3.825 million lbs, then the median landings are projected to be 8,398 mt = 18.514 million lbs. The median F in 2013 is projected to be 0.250, below the new fishing mortality threshold = F_{MSY} proxy = $F_{35\%}$ = 0.309. The median SSB on November 1, 2013 is projected to be 56,662 mt = 124.918 million lbs, below the new biomass target SSB_{MSY} proxy = $SSB_{35\%}$ = 62,394 mt = 137.555 million lbs.

If the stock is fished at the new fishing mortality threshold = F_{MSY} proxy = $F_{35\%}$ = 0.309 in 2014, the median landings are projected to be 9,961 mt = 21.960 million lbs, with median dead discards of 2,177 mt = 4.799 million lbs, and median total catch = 12,138 mt = 26.760 million lbs. This projected median total catch would be the Overfishing Limit (OFL) for 2014, and is less than the new MSY proxy = 12,945 mt (28.539 million lbs; 10,455 mt = 23.049 million lbs of median landings plus 2,490 mt = 5.490 million lbs of median dead discards). The median SSB on November 1, 2014 is projected to be 57,140 mt = 125.972 million lbs, 92% of the new biomass target of SSB_{MSY} proxy = $SSB_{35\%}$ = 62,394 mt = 137.555 million lbs. The projected catch estimates in the following table are medians of the catch distributions for fixed F in 2014-2016.

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

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

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

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

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

Catch: Total landings peaked in 1983 at 26,100 mt = 57.540 million lbs. During the late 1980s and into 1990, landings decreased, reaching 4,200 mt = 9.259 million lbs in the commercial fishery in 1990 and 1,400 mt = 3.086 million lbs in the recreational fishery in 1989. Total landings were only 6,500 mt = 14.330 million lbs in 1990. Reported 2012 landings in the commercial fishery were 6,047 mt = 13.331 million lbs, about 5% over the commercial quota. Estimated 2012 landings in the recreational fishery (as estimated by the MRIP) were 2,853 mt = 6.290 million lbs, about 26% under the recreational harvest limit. Total commercial and recreational landings in 2012 were 8,900 mt = 19.621 million lbs and total commercial and recreational dead discards were 1,533 mt = 3.380 million lbs, for a total catch in 2012 of 10,433 mt = 23.001 million lbs. Commercial landings have accounted for 54% of the total catch since 1982, with recreational landings accounting for 34%, commercial discards about 8%, and recreational discards about 5%. Commercial discard losses in the otter trawl and scallop dredge fisheries have accounted for about 14% of the total commercial catch, assuming a commercial discard mortality rate of 80%. Recreational discard losses have accounted for about 12% of the total recreational catch, assuming a recreational discard mortality rate of 10%.

Catch and Status Table: Summer flounder
(weights in 000s mt, recruitment in millions, arithmetic means)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Max[1]	Min[1]	Mean[1]
Commercial landings	6.5	8.2	7.8	6.3	4.5	4.1	4.8	5.9	7.5	6.0	17.1	4.0	7.7
Commercial discards[3]	1.1	1.6	1.5	1.5	2.1	1.2	1.4	1.5	1.1	0.7	2.2	0.2	1.2
Recreational landings	5.2	5.0	4.9	4.8	4.2	3.7	2.7	2.3	2.6	2.9	12.5	1.4	4.8
Recreational discards[3]	0.8	1.0	1.0	0.8	1.0	1.2	1.1	1.1	1.1	0.8	1.2	0.1	0.7
Total Catch	13.0	14.5	13.9	12.1	10.0	9.3	8.8	9.5	11.4	10.4	26.3	7.9	13.6
Commercial quota	6.3	7.7	8.2	6.4	4.7	4.3	5.0	6.0	8.0	5.8	8.1	8.2	7.1
Recreational harvest limit	4.2	5.1	5.5	4.3	3.1	2.9	3.3	4.0	5.3	3.9	5.5	2.9	4.7
Spawning Stock Biomass[2]	52.6	50.7	47.6	49.2	48.5	48.9	51.6	53.2	51.1	51.2	53.2	5.5	30.4
Recruitment (age 0)	37.8	53.5	32.3	39.0	40.0	48.7	54.9	34.6	19.6	37.2	75.8	9.8	43.0
F (age 4)	0.40	0.45	0.45	0.33	0.26	0.31	0.30	0.31	0.36	0.29	1.75	0.26	0.79

1: Over the period 1982-2012
2: On November 1 annually
3: Dead discards

Stock Distribution and Identification: The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for summer flounder defines the management unit as all summer flounder from the southern border of North Carolina northeast to the US-Canada border. For assessment purposes, the definition of Wilk et al. (1980) of a unit stock extending from Cape Hatteras north to New England has been accepted in this and previous assessments. The current management unit is consistent with a summer flounder genetics study, which revealed no population subdivision at Cape Hatteras (Jones and Quattro 1999). A consideration of summer flounder stock structure incorporating tagging data supported the existence of stocks north and south of Cape Hatteras, with the stock north of Cape Hatteras possibly composed of two distinct spawning aggregations, off New Jersey and Virginia-North Carolina (Kraus and Musick, 2003). The assessment is consistent with the conclusions of this study.

Data and Assessment: The population model implemented for summer flounder is the forward projecting age-structured model ASAP (Legault 1998, NFT 2013a). The model assumes age-dependent values for instantaneous natural mortality (M) that result in a mean value of M = 0.25. The catch in the model includes both commercial and recreational fishery landings and discards at age. The fishery landings and discards are treated as two fleets in the model. Indices of stock abundance including age compositions from the NEFSC winter, spring, and fall, Massachusetts spring and fall, Rhode Island fall and monthly fixed, Connecticut spring and fall, Delaware, New York, New Jersey, VIMS ChesMMAP, and VIMS NEAMAP spring and fall trawl surveys were used in the ASAP model calibration. Aggregate indices of stock abundance from the URI GSO trawl survey and NEFSC MARMAP and ECOMON larval surveys, and recruitment indices (age

0; Young-Of-the-Year, YOY) from surveys conducted by the states of Massachusetts, Delaware, Maryland, and Virginia were also used in the model calibration.

Biological Reference Points (BRPs): The SAW/SARC57 biological reference points for summer flounder are based on stochastic yield and SSB per recruit and stochastic projection models in the NOAA NFT framework (NFT 2013b, c; Thompson and Bell 1934) using values from the 2013 assessment. The new fishing mortality reference point is $F_{35\%}$ = 0.309 (CV = 15%) as a proxy for F_{MSY}. The new biomass reference point proxy is estimated as the projection of Jan 1, 2013 stock sizes at $F_{35\%}$ = 0.309 and mean recruitment of 43 million fish per year (1982-2012). The new SSB_{MSY} proxy is estimated to be 62,394 mt (137.6 million lbs; CV = 13%), and the new biomass threshold of one-half SSB_{MSY} is estimated to be 31,197 mt (68.8 million lbs; CV = 13%). The new MSY proxy is estimated to be 12,945 mt (28.539 million lbs; CV = 13%; 10,455 mt = 23.049 million lbs of landings plus 2,490 mt = 5.490 million lbs of discards).

The biological reference points estimated in the 2008 SAW47 assessment were MSY proxy = $F_{35\%}$ = 0.310, SSB_{MSY} proxy = $SSB_{35\%}$ = 60,074 mt, and MSY proxy = $MSY_{35\%}$ = 13,122 mt (NEFSC 2008). NMFS determined the summer flounder stock to be rebuilt in 2010, based on the 2011 assessment update (Terceiro 2011). The summer flounder stock is not overfished and overfishing is not occurring in 2012 relative to the SAW47 biological reference points.

Fishing Mortality: Fishing mortality calculated at the currently fully recruited (peak) age 4 ranged between 0.790 and 1.745 during 1982-1996. The fishing mortality rate has decreased from 0.849 in 1997 to 0.285 in 2012. There is a 90% probability that the fishing mortality rate in 2012 was between 0.213 and 0.343.

Spawning Stock Biomass: SSB decreased from 24,300 mt in 1982 to 5,521 mt in 1989, and then increased to a peak of 53,156 mt by 2010. SSB was estimated to be 51,238 mt in 2012, about 82% of the reference point SSB_{MSY} = $SSB_{35\%}$ = 62,394 mt. There is a 90% probability that SSB in 2012 was between 45,781 and 61,297 mt.

Recruitment: The average recruitment from 1982 to 2012 is 43 million fish at age 0. The 1982 and 1983 year classes are the largest in the assessment time series, at 62 and 76 million fish; the 1988 year class is the smallest at only 10 million fish. The 2012 year class is currently estimated to be about 37 million fish.

Special Comments: The benchmark 2008 SAW 47 assessment (NEFSC 2008) was updated annually through 2012 (Terceiro 2012). The summer flounder stock assessment has historically exhibited a consistent retrospective pattern of underestimation of F and overestimation of SSB; the causes of this previous pattern have not been determined. In the current assessment model, however, no persistent retrospective patterns are evident. Over the last 7 years, the annual retrospective change in fishing mortality has ranged from +22% in 2006 to -5% in 2009, the annual retrospective change in SSB has ranged from -2% in 2011 to -21% 2006, and the annual retrospective change in recruitment has ranged from -45 in 2005 to +33% in 2009. The historical retrospective indicates that general trends of fishing mortality, stock biomass, and recruitment have been consistent since the 1990s assessments (Figure A5).

The SAW/SARC57 assessment includes several new research survey time series. The URI GSO trawl, NY trawl, VIMS ChesMMAP trawl, VIMS NEAMAP spring and fall trawl, and the NEFSC MARMAP and ECOMON larval surveys are now tabulated in the assessment and used in the population model calibration.

The NEFSC research surveys and Partnership for Mid-Atlantic Fisheries Science (PMAFS) fishery sampling confirm sexually dimorphic, temporal, and spatial differences in growth of summer flounder. The SAW57 working group investigated these differences in sex and how it might affect the assessment, but it was not possible to develop a full sex-disaggregated analysis. Sex-specific differences in life history parameters and in the spatial distribution of summer flounder by size may have an effect on the assessment model results and the biological reference point calculations. The assessment model presented to the SARC was deemed to provide an acceptable evaluation of stock status. Among potential approaches, simulation studies could be used to identify the critical data and model components and indicate directions for future work.

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

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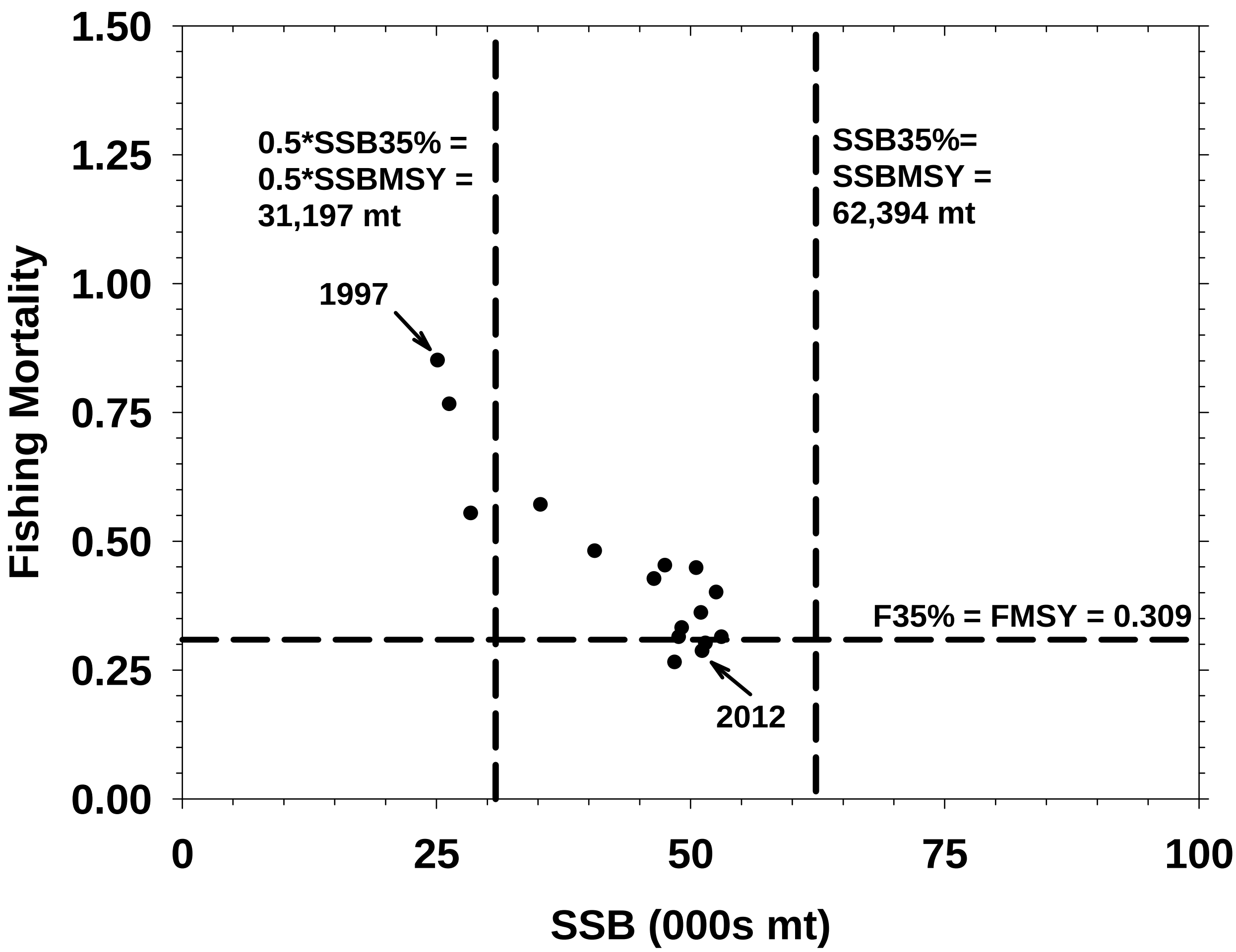

Figure A1. Estimates of summer flounder spawning stock biomass (SSB) and fully-recruited fishing mortality (F, peak at age 4) relative to the 2013 SAW/SARC57 biological reference points.

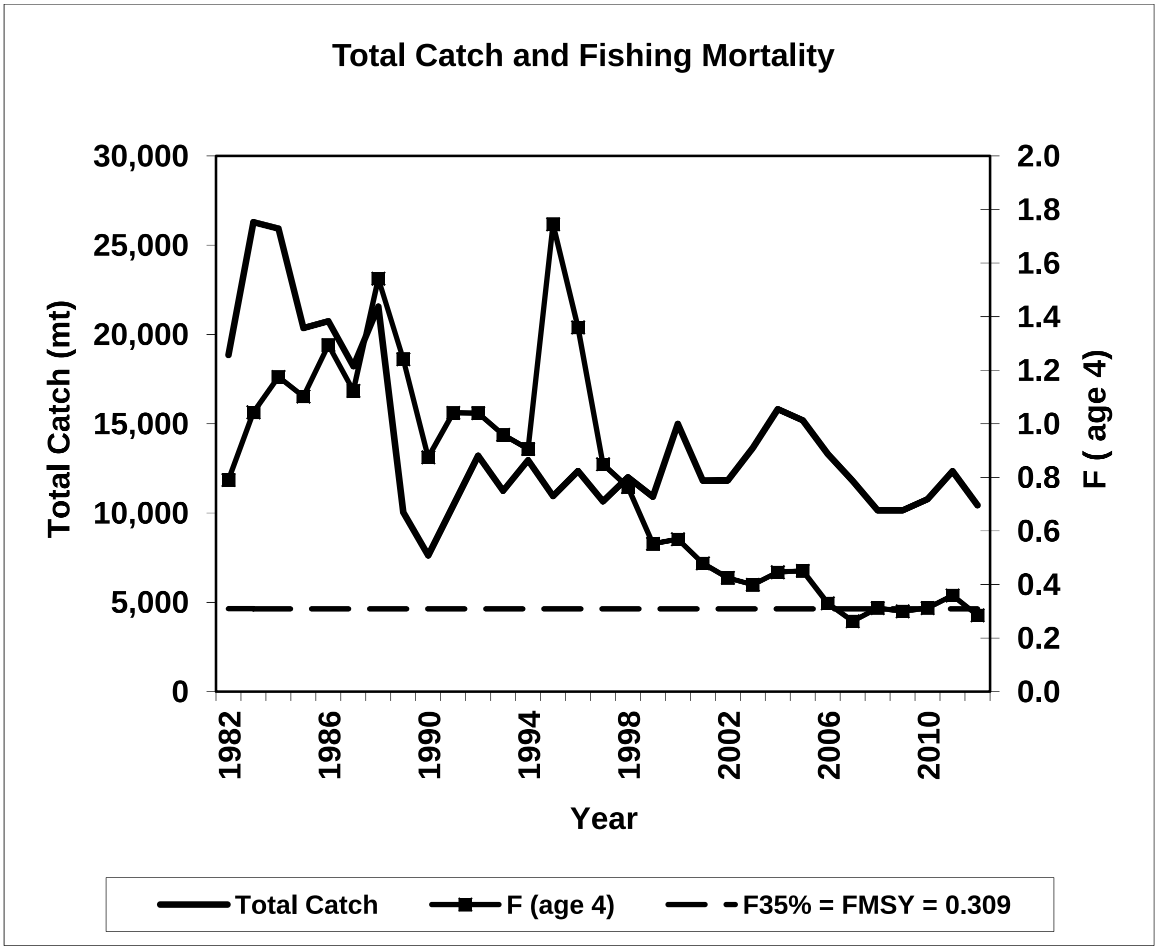

Figure A2. Total fishery catch and fully-recruited fishing mortality (F, peak at age 4) of summer flounder. The horizontal dashed line is the 2013 SAW/SARC57 fishing mortality reference point proxy.

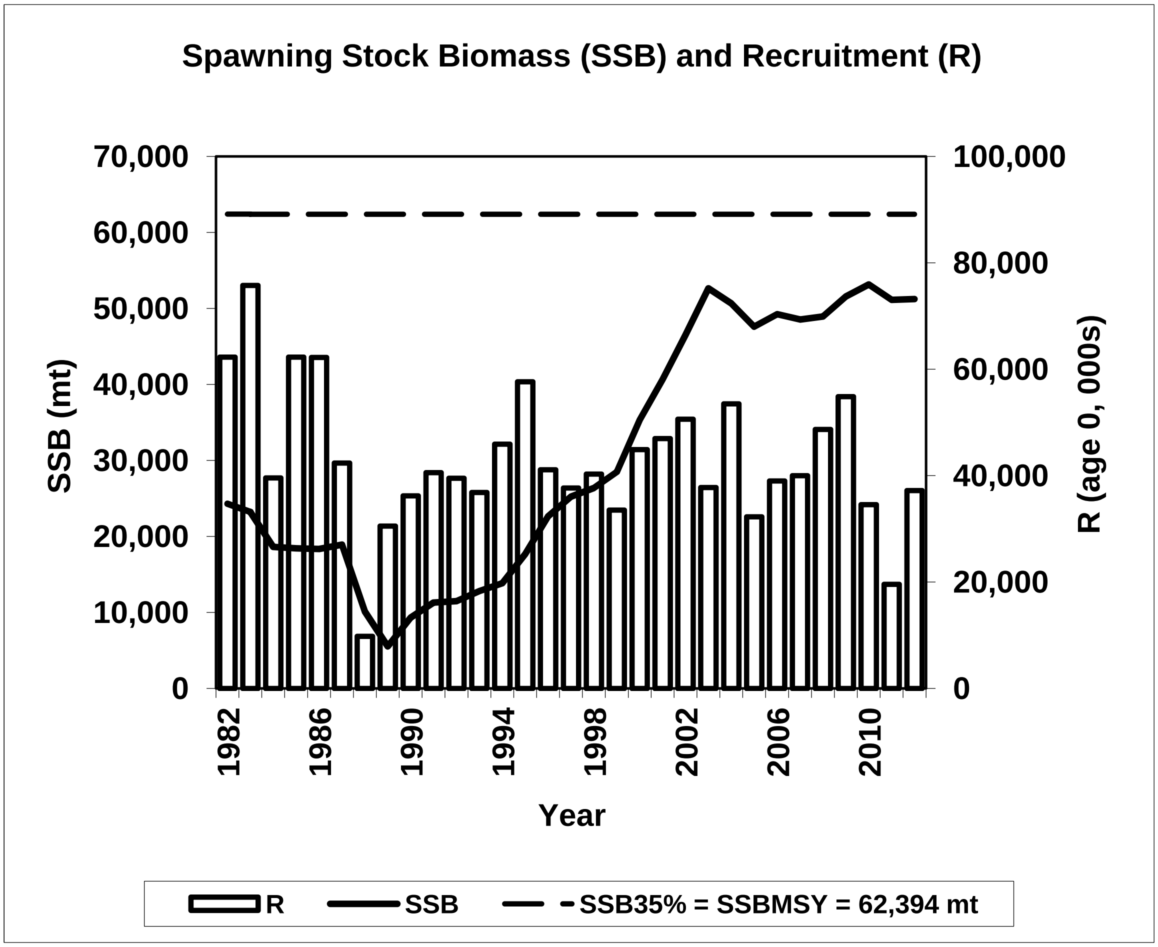

Figure A3. Summer flounder spawning stock biomass (SSB; solid line) and recruitment at age 0 (R; vertical bars) by calendar year. The horizontal dashed line is the 2013 SAW/SARC57 biomass reference point proxy.

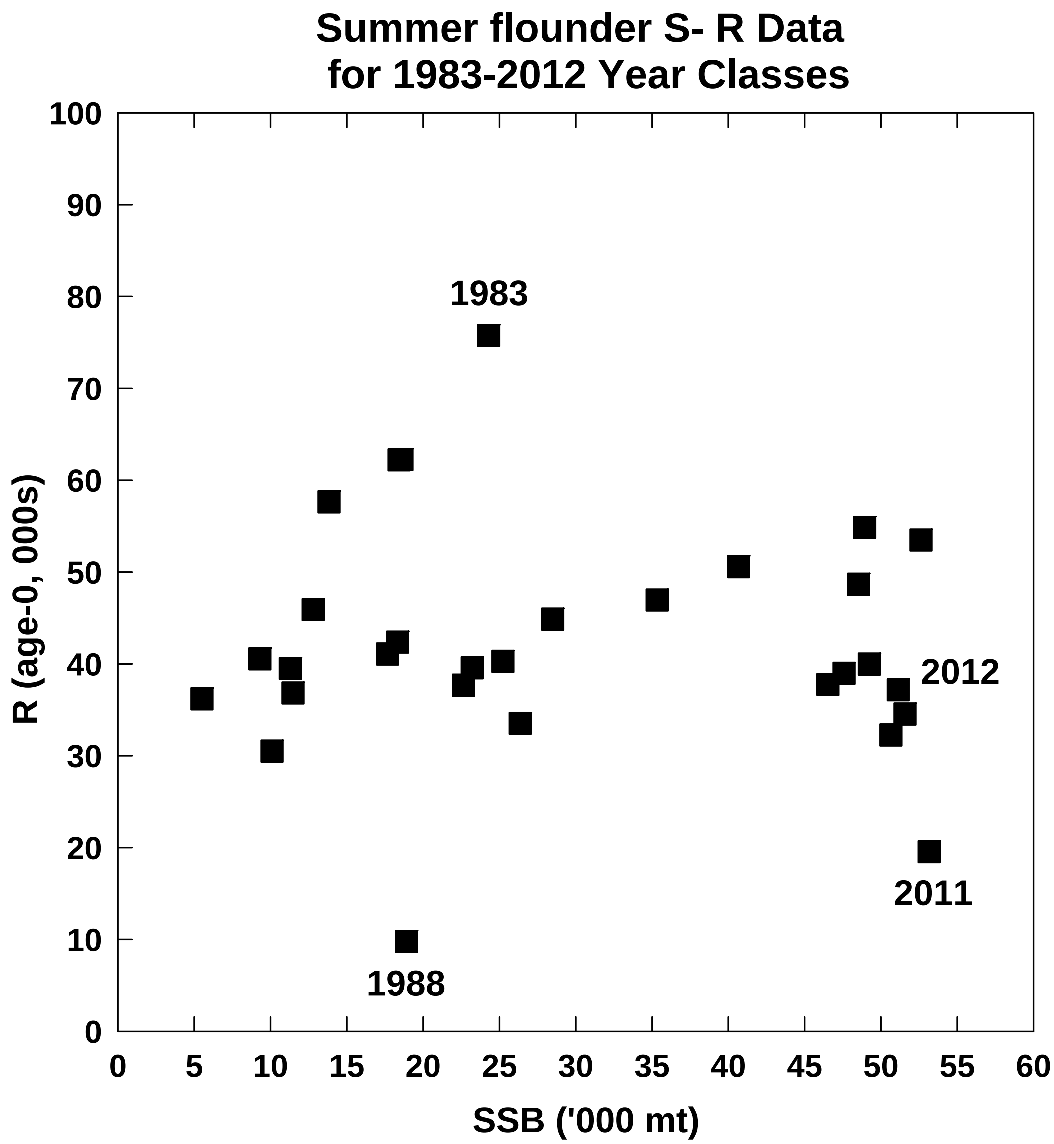

Figure A4. Stock-recruitment scatter plot for the summer flounder 1983-2012 year classes. Highest recruitment point is the 1983 year class (R = 75.5 million, SSB = 24,300 mt); highest SSB point is for the 2011 year class (R = 19.6 million, SSB = 53,156 mt). The 2012 year class is at R = 37.2 million, SSB = 51,100 mt.

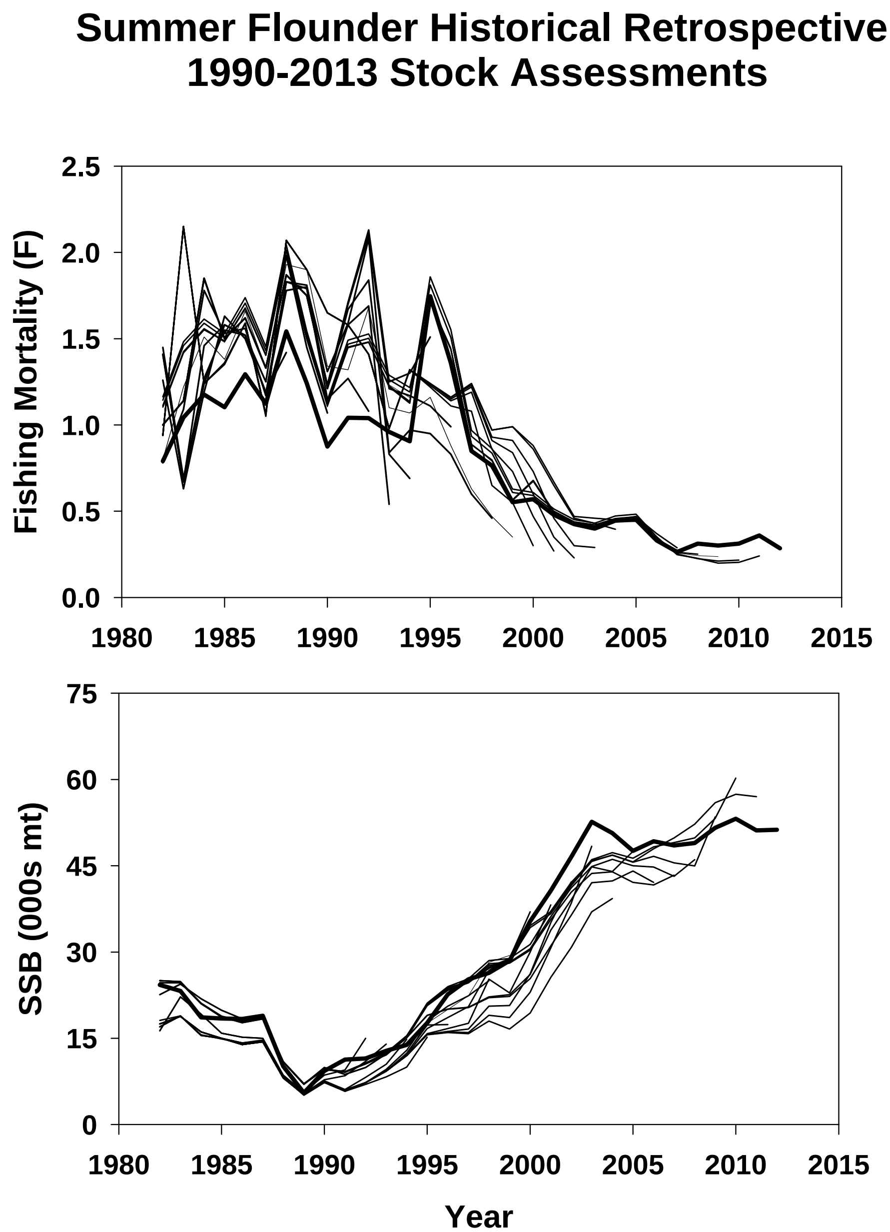

Figure A5. Historical retrospective of the 1990-2013 stock assessments of summer flounder.

B. ATLANTIC STRIPED BASS ASSESSMENT SUMMARY FOR 2013

State of the Stock:

In 2012, the Atlantic striped bass stock was not overfished or experiencing overfishing relative to the new reference points from the 2013 SAW/SARC57 (Figure B1-B3). Female spawning stock biomass (SSB) was estimated at 61.5 thousand mt (136 million lbs), above the SSB threshold of 57,904 mt, but below the SSB target of 72,380 mt. Total fishing mortality was estimated at 0.188, below the F threshold of 0.213 but above the F target of 0.175.

When compared to the biological reference points currently used in management (ASMFC 2008), the stock is neither overfished nor experiencing overfishing. Female SSB in 2012 is above both the target (46,101 mt) and the threshold (36,000 mt), and F_{2012} is below both the target (0.30) and the threshold (0.34).

Projections:

Five-year projections of female spawning SSB and fishing mortality (Figure B4) were made by using a standard forward projection methodology. If the current fully-recruited F (0.188) is maintained during 2013-2017, or if it increases to the threshold or decreases to the target, the probability of being below the SSB threshold increases until 2015-2016, but declines thereafter. If action to reduce F is delayed until 2014 or 2015, the probability of being below the SSB threshold increases (Figure B5).

If the current removals, meaning landings and dead discards of 3.59 million fish, are maintained during 2013-2017, the probability of the fully-recruited F being above the F threshold increases rapidly starting in 2013 and reaches near 1 by 2014 (Figure B6). If constant removals equal to 50% of the 2012 removals are taken during 2013-2017, the probability of fully-recruited F being above the F threshold is near zero.

Removals:

Commercial landings in the Atlantic striped bass fishery increased from roughly 115,000 fish (313 mt, 800,000 lbs) in 1990 to 913,160 fish (3,332 mt, 7.3 million lbs) in 2004. Since 2005, landings have fluctuated about an average of 988,410 fish (3,162 mt, 6.97 million lbs); however, landings have declined slightly in recent years to about 839,000 fish (2,952 mt, 6.5 million lbs) in 2012. In 2011 and 2012, the commercial coast-wide harvest was comprised primarily of ages 4-10 striped bass, while harvest in Chesapeake Bay fisheries (Maryland, Virginia, and the PRFC) was comprised mostly of ages 3-6. The estimates of dead commercial discards were 625,631 and 795,675 fish for 2011 and 2012. The highest discard losses occurred in anchor gill net, pounds net, and hook-and-line fisheries. Commercial harvest has generally exceeded dead discards since the mid 1990s.

Recreational harvest increased from 163,242 fish (1,010 mt, 2.2 million pounds) in 1990 to 2.78 million fish (14,082 mt, 31 million pounds) in 2006. Since 2006, harvest declined through 2012 to 1.5 million fish (8,740 mt, 19 million pounds). The number of striped bass that die due to discarding increased from 132 thousand fish in 1990 to 1.2 million fish in 1997. Dead discards have remained around 1.2 million fish through 2003, but increased to the series maximum of 2.1 million fish in 2006. Since 2006, dead discards have declined substantially to 459,954 fish. Total recreational striped bass removals (harvest and dead discards) in 2011 and 2012 were 2.76 million fish and 1.96 million fish, respectively (Figure B7).

Stock Distribution and Identification:

Atlantic coast migratory striped bass live along the eastern coast of North America from the St. Lawrence River in Canada to the Roanoke River and other tributaries of Albemarle Sound in North Carolina (ASMFC 1990). Stocks which occupy coastal rivers from the Tar-Pamlico River in North Carolina south to the St. Johns River in Florida are believed primarily non-migratory and riverine. Historical tagging data suggest they do not presently undertake extensive Atlantic Ocean migrations as do stocks from the Roanoke River north (ASMFC 1990).

The coastal striped bass management unit includes the coastal and estuarine areas of all states and jurisdictions from Maine through North Carolina. The stock assessment includes data from both state and federal waters. Striped bass is currently managed by the Atlantic States Marine Fisheries Commission through Amendment 6 to the Fishery Management Plan. Amendment 6 implements a separate management program for the Chesapeake Bay due to the size availability of striped bass in this area (ASMFC 2003).

The Albemarle-Roanoke stock is currently managed as a non-coastal migratory stock by the state of North Carolina under the auspices of ASFMC. The Albemarle-Roanoke management unit is defined as the striped bass inhabiting the Albemarle, Currituck, Croatan, and Roanoke Sounds and their tributaries, including the Roanoke River.

Data and Assessment:

The striped bass assessment used total catch (harvest, commercial discards, and dead recreational discards) and catch-at-age split into three “fleets”: a Chesapeake Bay fleet, a coastal harvest fleet, and a commercial discard fleet. The assessment also used several fishery-independent indices of abundance for adults (the CT trawl survey, the NEFSC bottom trawl, the NJ bottom trawl survey, the NY ocean haul seine survey, the MD spawning stock survey, and the DE spawning stock electrofishing survey), and for young-of-year and age-1 fish (NY YOY and yearling survey, NJ YOY survey, VA YOY survey, and MD YOY and yearling surveys). Two fishery-dependent indices were used: the MRFSS/MRIP CPUE and the VA poundnet index.

The accepted model for striped bass is a forward projecting statistical catch-at-age model (SCA). The 2013 SCA model is used to estimate fishing mortality, abundance, and spawning stock biomass of striped bass during 1982-2012 from total removals-at-age and fisheries-dependent and fisheries-independent survey indices.

As a complement to the SCA, Jiang *et al.*’s (2007) instantaneous rates tagging model (IRCR) was run on data from the USFWS coast-wide striped bass tagging program through the 2011 tagging year to estimate survival, fishing mortality, and natural mortality.

Biological Reference Points:

Biological reference points for striped bass based on the previous assessment and ASMFC (2008), and currently used as thresholds in management are F_{MSY} (0.34) and an SSB proxy which is equivalent to the 1995 spawning stock biomass. The SSB target was calculated as 125% of the 1995 SSB, and the F target was defined as an exploitation rate of 24% or F=0.3. The estimate for F_{MSY} was derived using the results of the 2008 SCA assessment in which four stock-recruitment models were considered; a Ricker, a log-normal Ricker model, a Shepherd and a log-normal Shepherd model. The TC used a model averaging approach among the four results, producing an estimate of F_{MSY} = 0.34 (range of 0.28-0.40).

For this 2013 SAW/SARC57 assessment, the basis of SSB_{Target} and $SSB_{Threshold}$ remain the same, but the values have been updated. The procedure for estimating fishing mortality reference points used a stochastic projection drawing recruitment from empirical estimates of age-1 abundance from 1990 onwards (Figure B8) and a distribution of starting population abundance at age. The F threshold is the fishing mortality that will produce the $SSB_{Threshold}$ (=SSB_{1995}) as a long term average. The F target is the fishing mortality that will produce SSB_{Target} (=125%SSB_{1995}) as a long term average. This resulted in an F_{Target} = 0.175 corresponding to the SSB_{Target} of 72,380 mt (160 million lbs), and an $F_{Threshold}$ = 0.213 corresponding to the $SSB_{Threshold}$ of 57,904 mt (128 million lbs) (Figure B3). This procedure provides internally consistent SSB and F reference points. Values of MSY were explored using parametric stock-recruit relationships, but these were not regarded as reliable.

Fishing Mortality:

Fully-recruited F in 2012 is 0.188 (Figure B2). Total fishing mortality has been declining since a peak in 2006. The tag-based model gave similar results in terms of total mortality. The retrospective analysis indicated that terminal year fishing mortality was slightly overestimated in previous years (Figure B10).

Recruitment:

Striped bass experienced a period of strong recruitment from 1993-2003, followed by a period of lower recruitment from 2004-2009 (although not as low as the early 1980s, when the stock was overfished) (Figure B9). The 2011 year-class was strong, but early observations from Maryland’s juvenile index indicate the 2012 year class was very weak. Retrospective analysis of recruitment revealed no consistent pattern of over- or underestimation (Figure B10).

Stock Biomass:

Female SSB grew steadily from 1982 through 2003 when it peaked at about 81 thousand mt (178 million lbs). Female SSB has declined since then and was estimated at 61.5 thousand metric tons (135 million lbs) in 2012 (Figure B1). Total biomass increased from 18,609 mt (41 million lbs) in 1982 to its peak at 221,774 mt (489 million lbs) in 1999. Total biomass declined through 2011, but increased in 2012 due to the strong 2011 year-class. The retrospective analysis indicated that terminal year SSB was slightly underestimated in previous years (Figure B10).

Special Comments:

Estimates of total biomass over the entire time period in this assessment are larger than estimates from the previous assessment because of the higher estimates of natural mortality on younger age classes derived from tag-based models. As a result the SSB reference point estimates are higher, although the basis is the same.

F reference points have been calculated to be consistent with the SSB reference points. Previously F reference points were calculated independently of SSB reference points and led to inconsistencies.

The estimate of recreational dead discards is sensitive to the assumed value of post-release mortality and this may result in a high error on these estimates.

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Total Catch of Atlantic Striped Bass (millions of fish) by Fishery

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Max[1]	Min[1]	Mean[1]
Commercial Harvest	0.87	0.91	0.97	1.05	1.02	1.01	1.04	1.03	0.93	0.84	1.23	0.01	0.65
Commercial Discards	0.26	0.46	0.79	0.19	0.60	0.30	0.61	0.25	0.63	0.80	0.80	0.04	0.34
Recreational Harvest	2.55	2.55	2.44	2.79	2.52	2.47	2.04	1.99	2.23	1.50	2.79	0.04	1.25
Recreational Dead Releases[2]	1.32	1.53	1.63	2.10	1.45	1.13	0.72	0.56	0.53	0.46	2.10	0.03	0.76

[1]: Minimum, maximum, and mean catch based on 1982-2012 data.
[2]: Assuming a 9% mortality rate on fish released alive.

Current Status of Atlantic Striped Bass

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Min[3]	Max[3]	Mean[3]
Female SSB (thousands of mt)	81.43	79.32	79.66	74.24	71.91	69.90	67.91	65.88	65.59	61.51	4.1	81.4	47.7
Total Abundance (millions of fish)	174.77	243.49	190.20	170.67	138.30	147.30	123.21	135.44	169.87	215.21	32.1	251.1	151.5
Age-1 Abundance (millions of fish)	76.71	160.13	87.40	82.80	59.05	80.41	55.94	76.56	108.57	143.55	18.3	183.4	87.1
Maximum F-at-Age	0.185	0.218	0.229	0.263	0.231	0.236	0.195	0.190	0.228	0.188	0.033	0.947	0.173

[3]: Minimum, maximum, and mean based on 1982-2012 model estimates.

	SARC46 and ASMFC 2008		Updated (SARC57, 2013)	
Reference Point	Definition	Value	Definition	Value
$\mathbf{F_{Threshold}}$	F_{MSY}	0.34	F projected to obtain $SSB_{Threshold}$	0.213
$\mathbf{F_{Target}}$	24% Exploitation rate	0.30	F projected to obtain SSB_{Target}	0.175
$\mathbf{SSB_{Threshold}}$	Estimate of 1995 SSB	36,000 mt	Estimate of 1995 SSB	57,904 mt
$\mathbf{SSB_{Target}}$	125% of $SSB_{Threshold}$	46,101 mt	125% of $SSB_{Threshold}$	72,380 mt

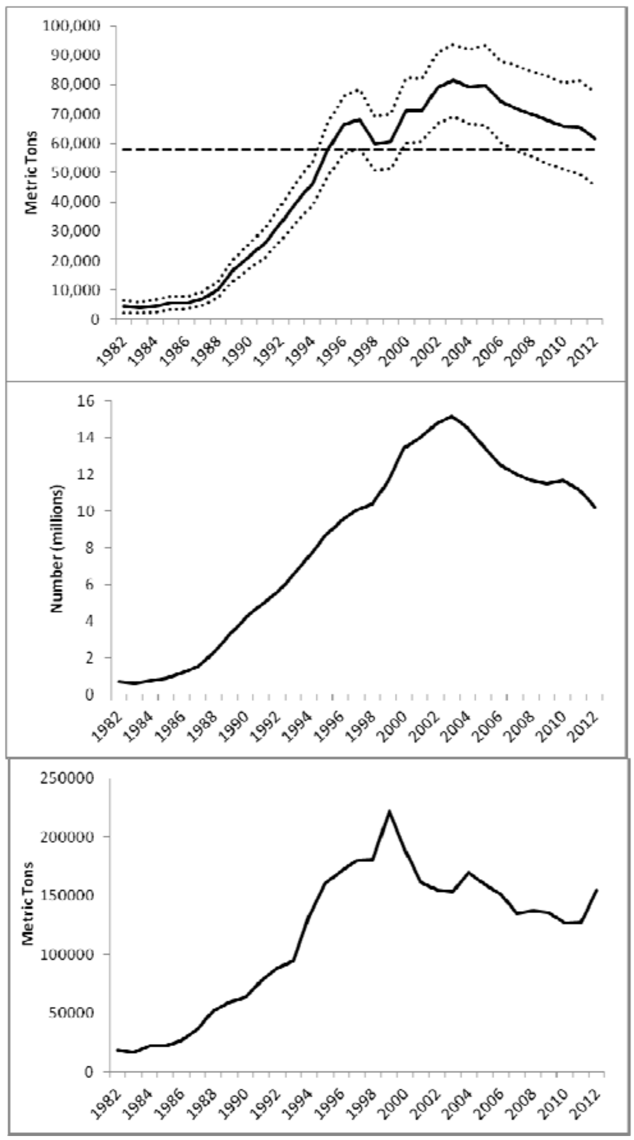

Figure B1. Striped bass. Estimates of A) female spawning stock biomass by year (solid line), B) female spawning stock numbers, and C) total January-1 biomass . Dotted lines equal 95% confidence intervals. Dashed line is the female spawning stock biomass threshold (1995 value).

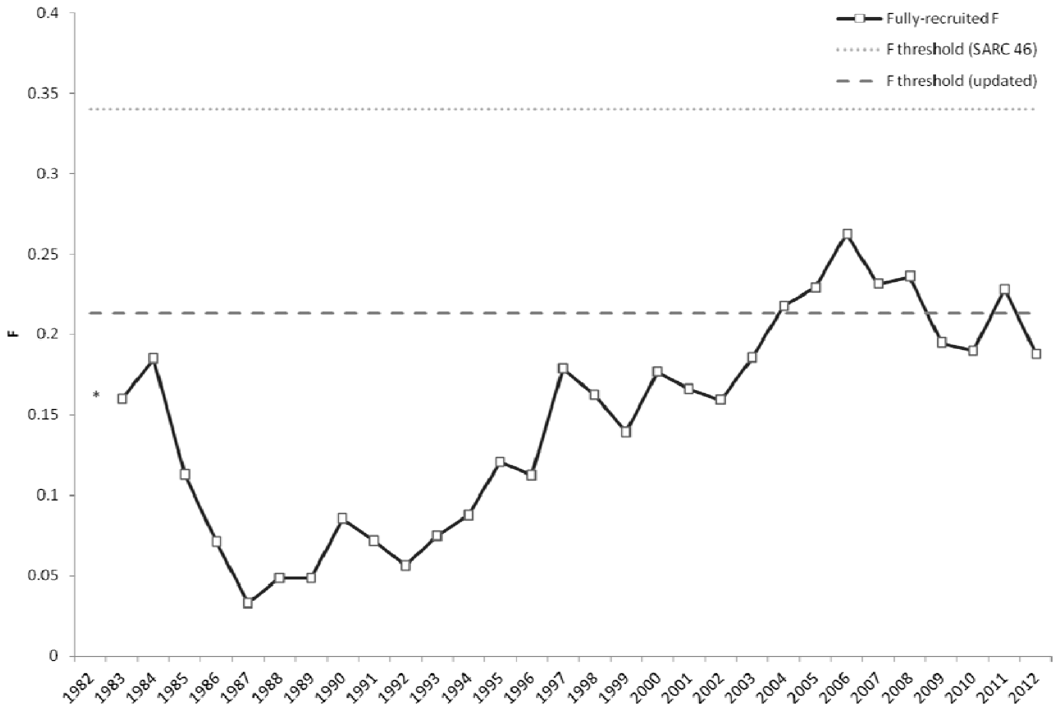

Figure B2. Striped bass. Fully recruited F relative to current (SARC 46) and updated (this SAW/SARC57 assessment) F threshold values. * indicates that the F for 1982 is not included on this graph as the model estimate was considered unrealistically high and unreliable.

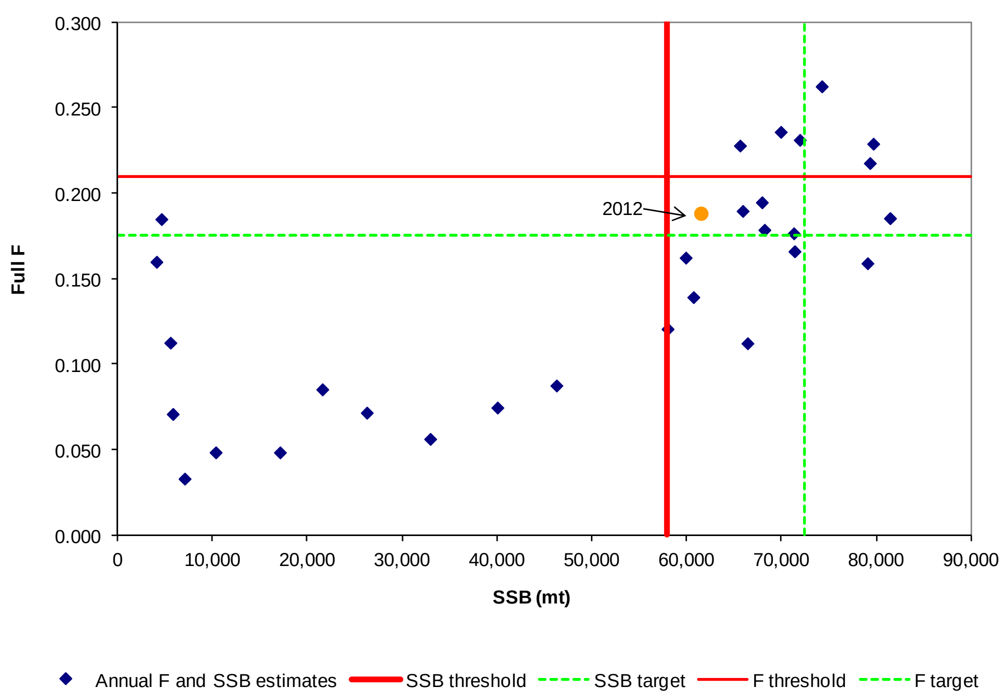

Figure B3. Striped bass. Annual estimates of F vs. SSB. Solid vertical and horizontal lines represent the SSB and F threshold reference points from SAW/SARC57, respectively, and dashed lines represent the target values. The orange circle represents the 2012 values for F and SSB.

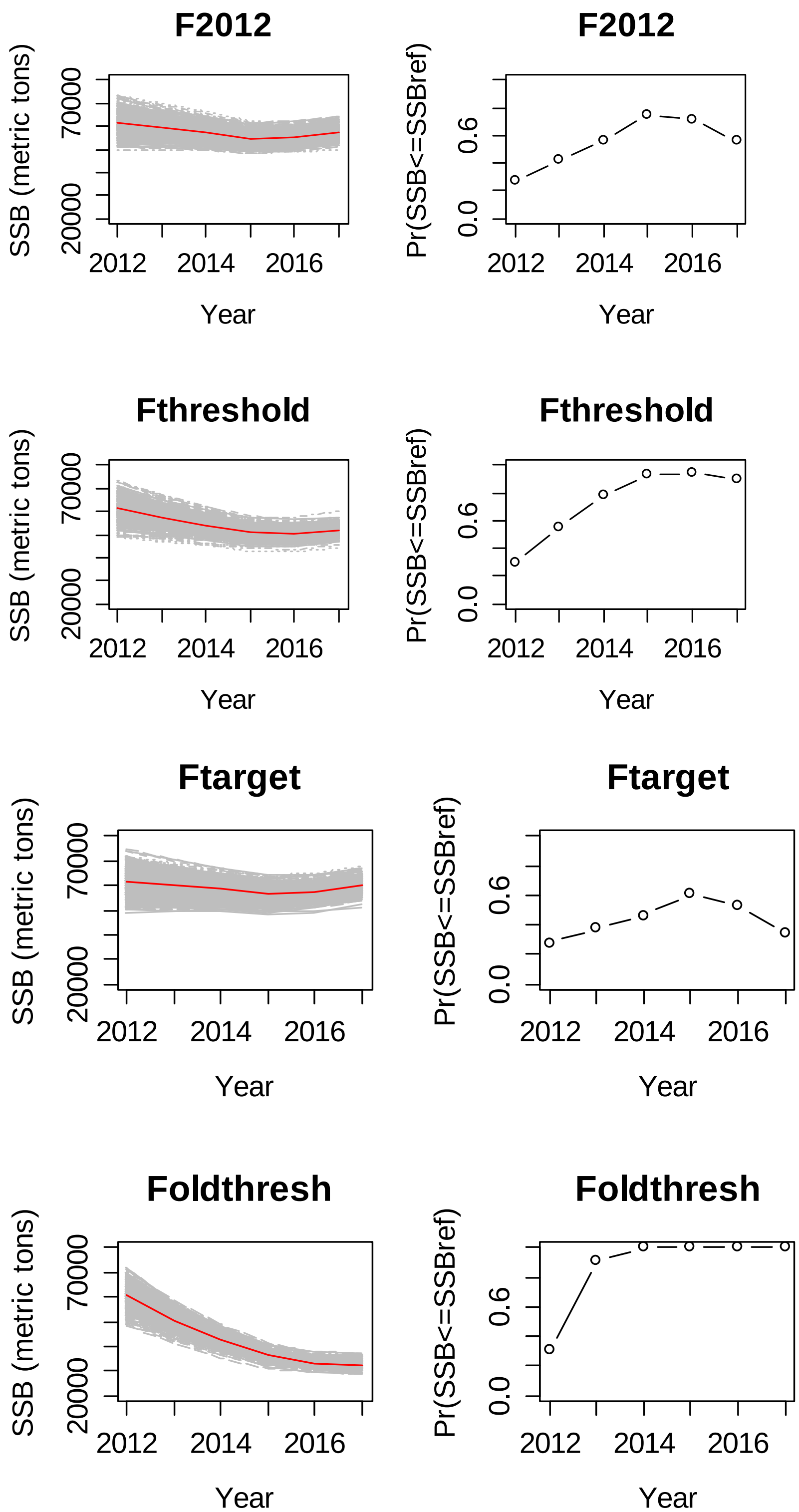

Figure B4. Striped bass. SSB trajectories and probability of being overfished under constant F scenarios.

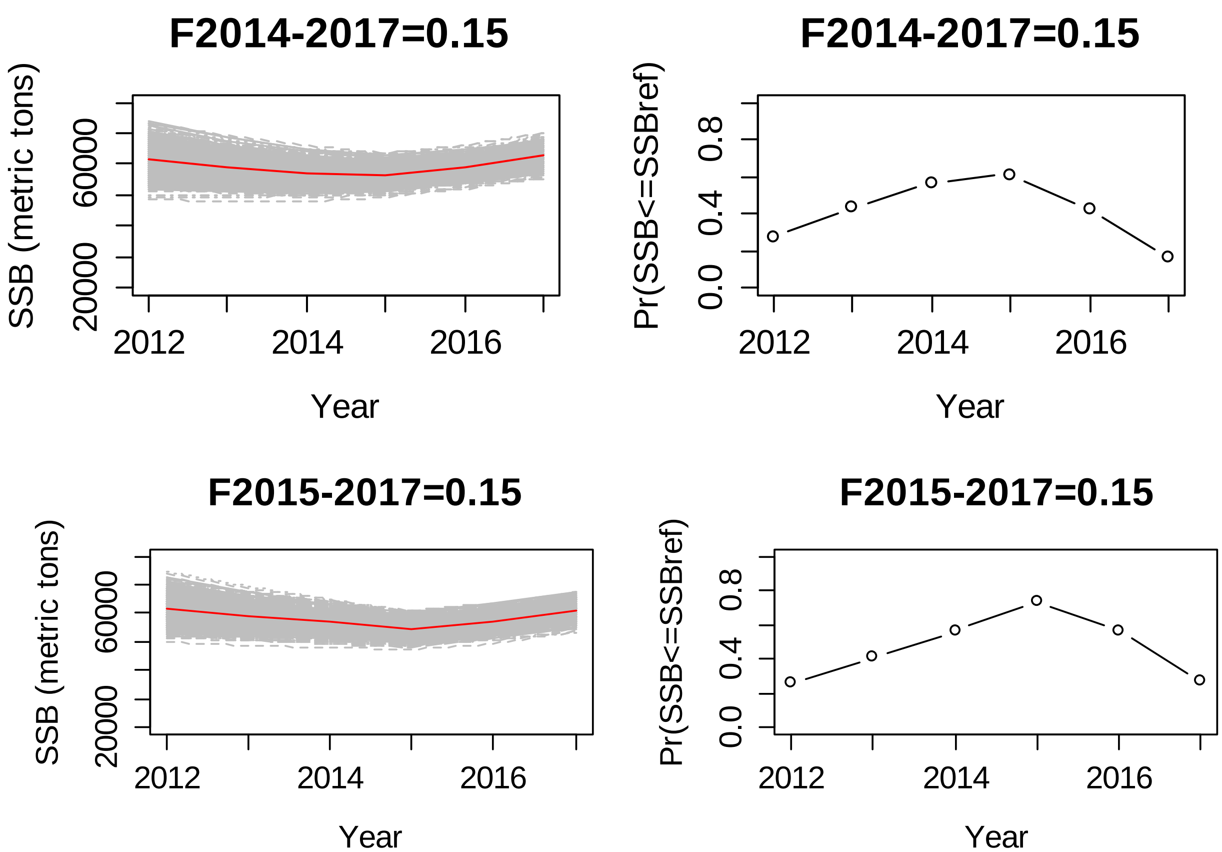

Figure B5. Striped bass. Effects of delaying reduction in F until 2014 (top) or 2015 (bottom) on SSB trajectories and probability of being below the SSB threshold.

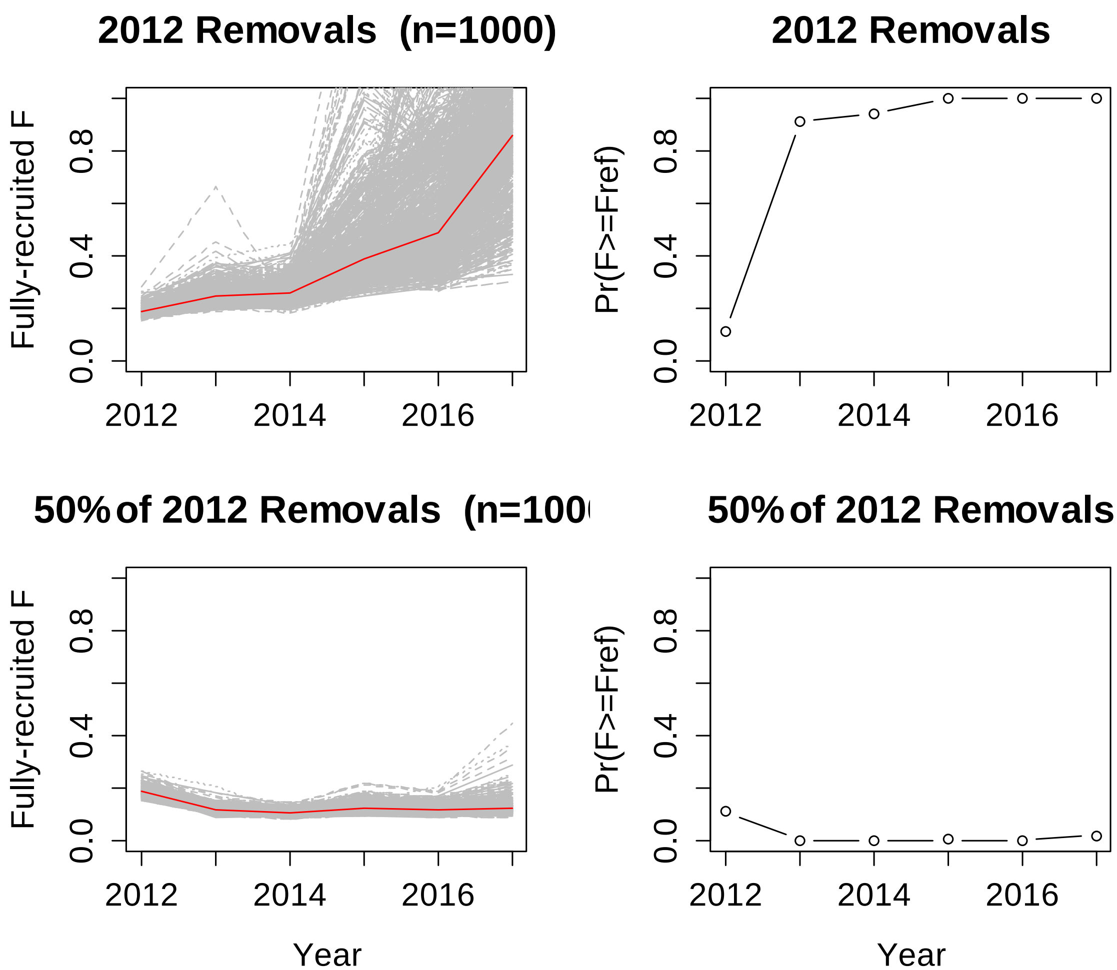

Figure B6. Striped bass. SSB trajectories and probability of overfishing under constant catch scenarios.

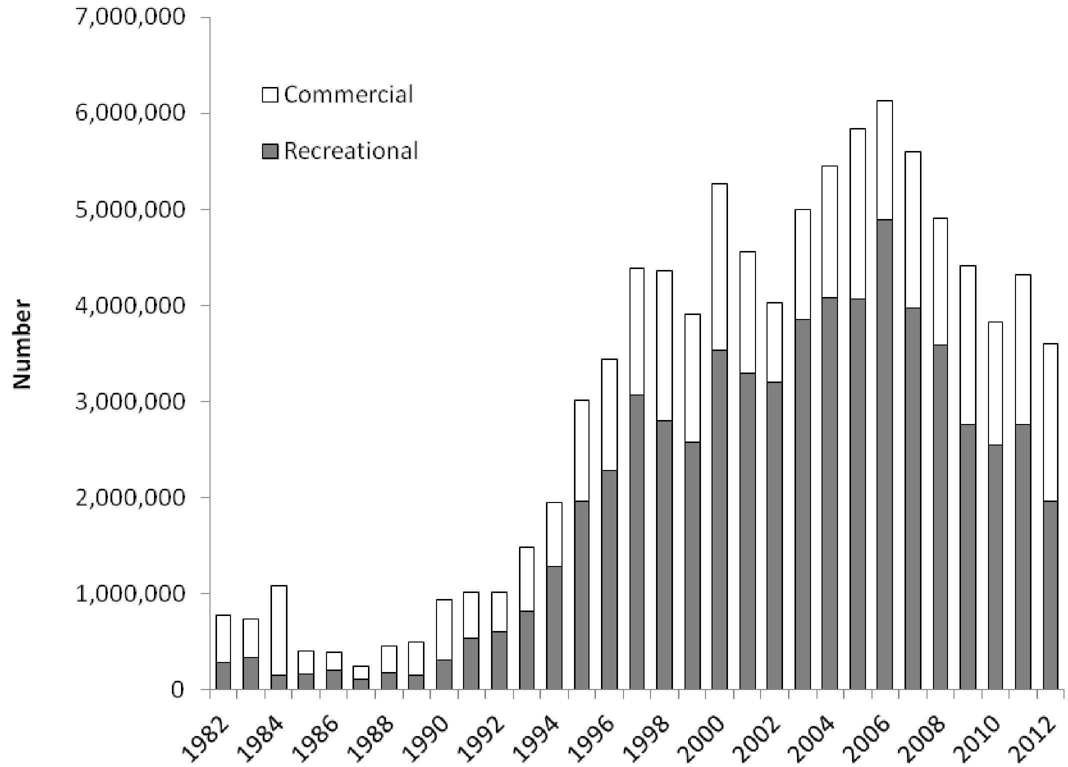

Figure B7. Total catch (numbers of fish) of Atlantic striped bass by fishery.

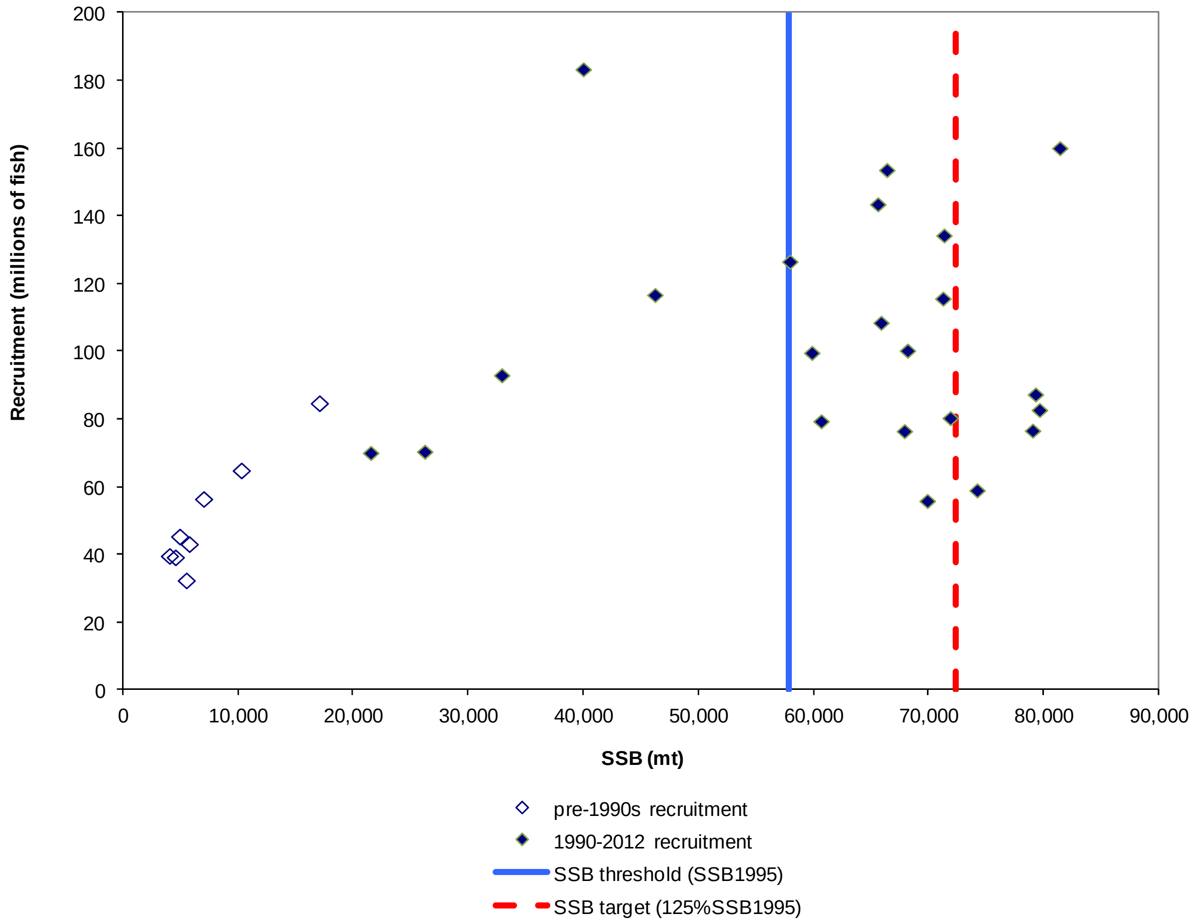

Figure B8. Striped bass. Recruitment estimates used to develop F reference points vs. spawning stock biomass. Pre-1990s estimates of recruitment were not used in F reference point projections. Vertical lines indicate SSB reference points from SAW/SARC57.

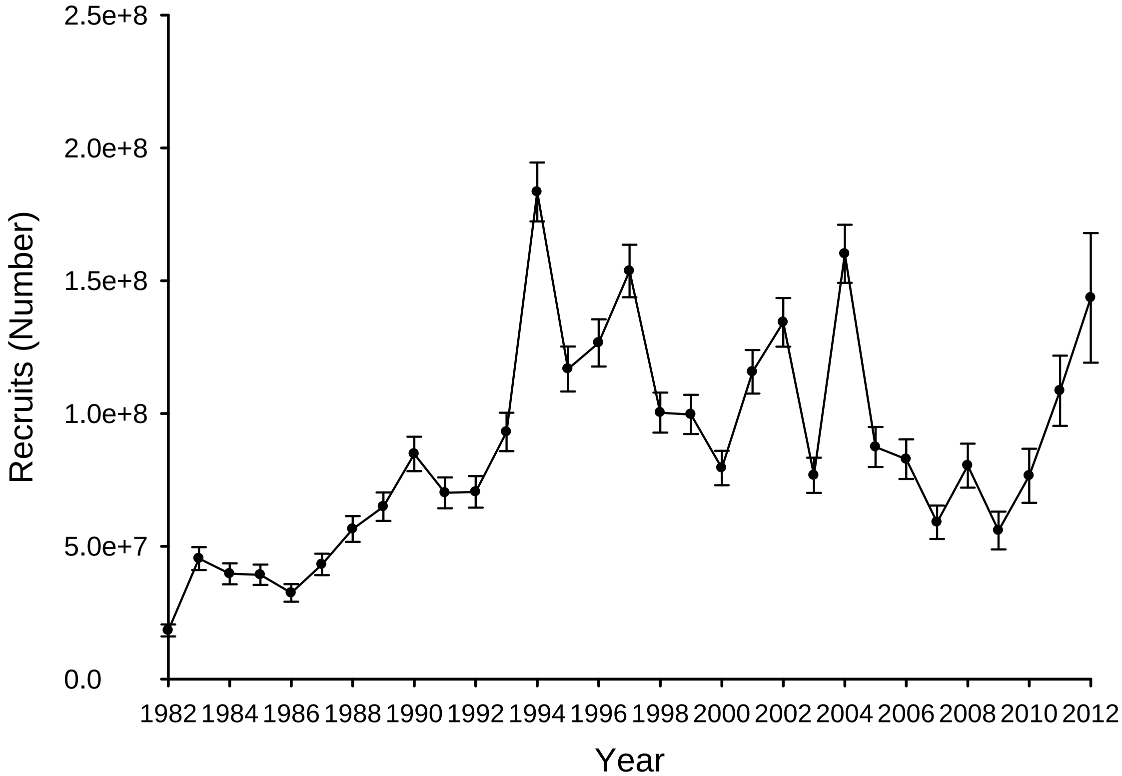

Figure B9. Model-estimated recruitment of age-1 striped bass. Error bars indicate ±1 SD.

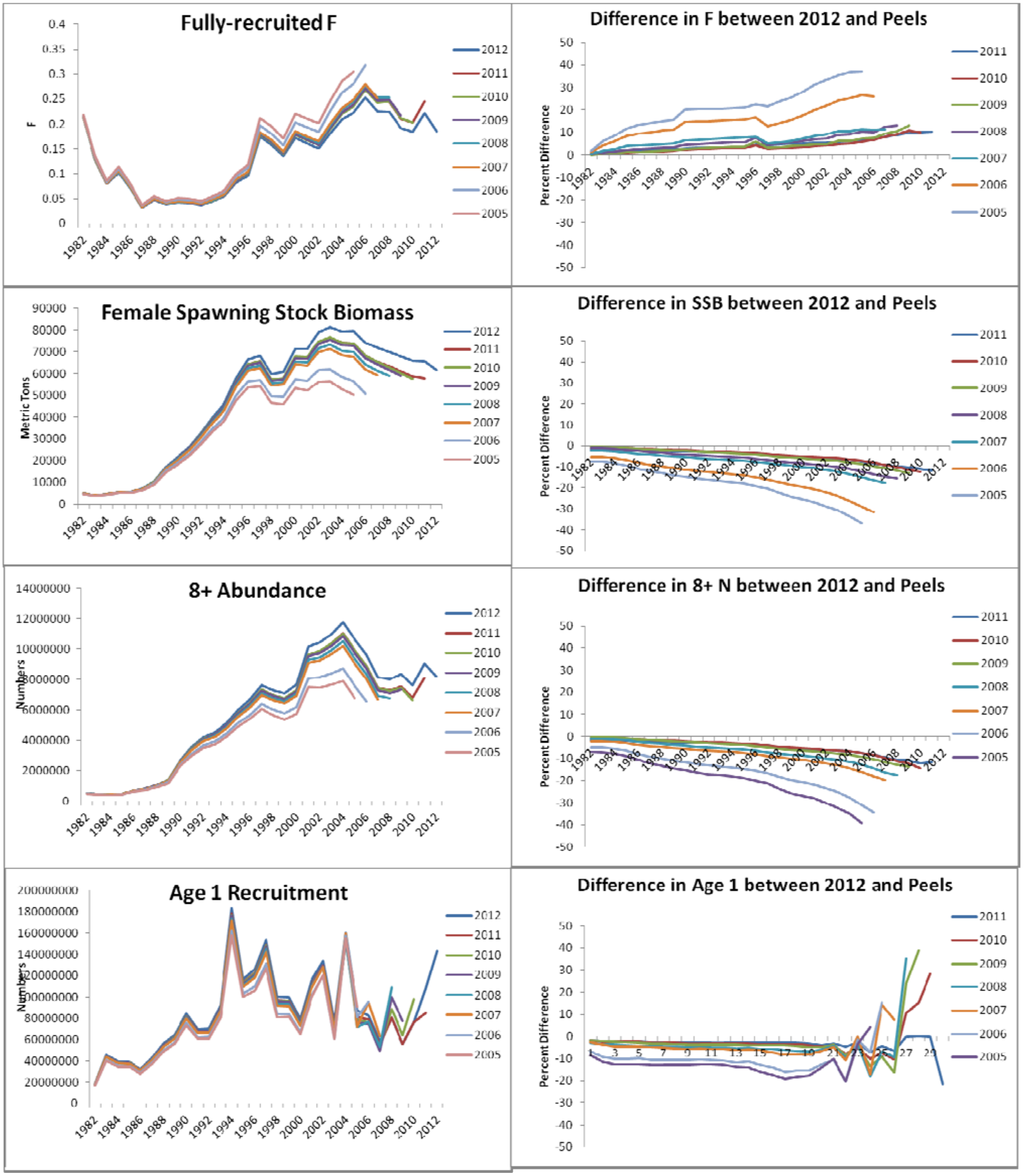

Figure B10. Retrospective analysis for preferred configuration of the striped bass SCA model.

Appendix: Stock Assessment Terms of Reference for SAW/SARC57, July 23-26, 2013
(To be carried out by SAW Working Groups) (v. 12/18/2012)

A. Summer flounder

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

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

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

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

5. State the existing stock status definitions for “overfished” and “overfishing”. Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the “new” (i.e., updated, redefined, or alternative) BRPs.

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

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

   b. Then use the newly proposed model and evaluate stock status with respect to “new” BRPs and their estimates (from TOR-5).

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

   a. Provide annual projections (3 years). For given catches, each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).
   b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
   c. Describe this stock’s vulnerability (see “Appendix to the SAW TORs”) to becoming overfished, and how this could affect the choice of ABC.
8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as MAFMC SSC model recommendations from 2012. Identify new research recommendations.

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

B. Striped bass**

1. Investigate all fisheries independent and dependent data sets, including life history, indices of abundance, and tagging data. Discuss strengths and weaknesses of the data sources. Evaluate evidence for changes in natural mortality in recent years.

2. Estimate commercial and recreational landings and discards. Characterize the uncertainty in the data and spatial distribution of the fisheries.

3. Use the statistical catch-at-age model to estimate annual fishing mortality, recruitment, total abundance and stock biomass (total and spawning stock) for the time series and estimate their uncertainty. Provide retrospective analysis of the model results and historical retrospective. Provide estimates of exploitation by stock component, where possible, and for total stock complex.

4. Use the Instantaneous Rates Tag Return Model Incorporating Catch-Release Data (IRCR) and associated model components applied to the Atlantic striped bass tagging data to estimate F and abundance from coast wide and producer area tag programs along with the uncertainty of those estimates. Provide suggestions for further development of this model.

5. Update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, SSB_{MSY}, F_{MSY}, MSY). Define stock status based on BRPs.

6. Provide annual projections of catch and biomass under alternative harvest scenarios. Projections should estimate and report annual probabilities of exceeding threshold BRPs for F and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach covering a range of assumptions about the most important sources of uncertainty, including potential changes in natural mortality.

7. Review and evaluate the status of the Technical Committee research recommendations listed in the most recent SARC report. Indentify new research recommendations. Recommend timing and frequency of future assessment updates and benchmark assessments.

(**: These TORs were developed by the ASMFC Striped Bass Stock Assessment Subcommittee and Tagging Subcommittee, with approval from the Technical Committee and Management Board.)

Appendix to the SAW Assessment TORs:

Clarification of Terms

used in the SAW/SARC Terms of Reference

On "Acceptable Biological Catch" (DOC Nat. Stand. Guidel. Fed. Reg., v. 74, no. 11, 1-16-2009):

Acceptable biological catch (ABC) is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of [overfishing limit] OFL and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*

ABC for overfished stocks. For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*

NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)

ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, [optimal yield] OY does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On "Vulnerability" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

"Vulnerability. A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Rules of Engagement among members of a SAW Assessment Working Group:

Anyone participating in SAW assessment working group meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

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